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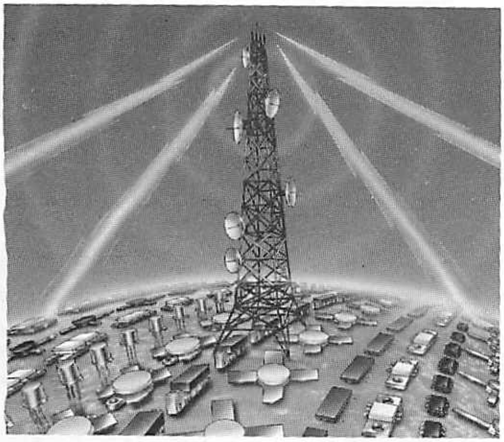
MOTOROLA

RF DEVICE DATA

VOLUME I



MOTOROLA
RF DEVICE DATA
Volume I

Prepared by
Technical Information Center

Extensive changes have been made to the sixth edition of the RF Data Manual. In March, 1988, Motorola acquired the RF Devices Division of TRW. The RF products manufactured by the acquired facilities were included for the first time in the fifth edition of the RF Data Book. During the past 2 years, a consolidation of products has taken place with the result being the deletion of a large number of products previously included in the fifth edition. However, an equally large number of new products has resulted in the data book remaining as a 2 *volume* set.

Once again, Volume 1 contains all Discrete Transistors (along with the Discrete portion of the RF Selection guide). All other devices, primarily amplifiers along with tuning diodes, are included in Volume 2. Also in Volume 2 is a greatly expanded section on Applications. The many diverse Application Notes from the TRW facilities in California and France have been integrated along with the previously available application notes from the RF facility in Arizona. This data forms one of the most comprehensive groups of RF application available in the industry today.

HOW TO USE THIS RF DATA BOOK:

Note that all devices in a given section — Discrete Transistors, Amplifiers and Tuning Diodes — are organized in conventional alphanumeric order.

If you know the part for which you desire technical data, simply turn to the appropriate page in Volume 1 or 2. If you are seeking a replacement for a competitor's part, then use the **Cross Reference** in Volume 2 to find the Motorola recommended replacement. If you have a requirement for a specified frequency band, then use the **Selector Guide** (in both Volumes 1 and 2) to find a suitable part with the desired voltage, output power, gain or other requisite characteristic.

Although information in these books has been carefully checked, no responsibility for inaccuracies can be assumed by Motorola. Please consult your nearest Motorola Semiconductor sales office for further assistance regarding any aspect of Motorola RF Products.

Sixth Edition
First Printing

Printed in U.S.A.

DATA CLASSIFICATION

Product Preview

Data sheets herein contain information on a product under development. Motorola reserves the right to change or discontinue these products without notice.

Advanced Information

Data sheets herein contain information on new products. Specifications and information are subject to change without notice.

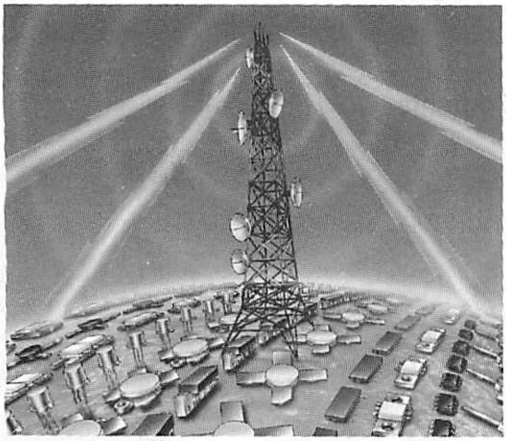
Formal

For a fully characterized device there must be devices in the warehouse and price authorization.

Designer's

The Designer's Data Sheet permits the design of most circuits entirely from the information presented. Limit curves — representing boundaries on device characteristics — are given to facilitate "worst case" design.

MASTER INDEX



Volume I

Selector Guide

1

Table of Contents

RF Power TMOS FETs

Motorola RF Power MOSFETs, (trademark TMOS), are constructed using a planar process to enhance manufacturing repeatability. *They are N-channel field effect transistors* with an oxide insulated gate which controls vertical current flow.

Compared with bipolar transistors, RF Power FETs exhibit higher gain, higher input impedance, enhanced thermal stability and lower noise. The FETs listed in this section are specified for operation in RF Power Amplifiers and are grouped by frequency range of operation and type of application. Arrangement within each group is by order of first voltage then increasing output power.

1

TO 150 MHz HF/SSB

For military and commercial HF/SSB fixed, mobile, and marine transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} Typical Gain dB @ 30 MHz	Typical IMD d_3 dB	Typical IMD d_{11} dB	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts							
MRF138	30	0.6	17	−30	−60	1.5	211-07/2
MRF140	150	4.7	15	−30	−60	0.6	211-11/2
V_{DD} = 50 Volts							
MRF148	30	0.5	18	−35	−60	1.5	211-07/2
MRF150	150	2.9	17	−32	−60	0.6	211-11/2
MRF153	300	6	17	−25	—	0.25	368-01/2
MRF154	600	12	17	−25	—	0.13	368-01/2

TO 225 MHz VHF AM/FM

For VHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Typical Efficiency %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF134	5	0.2	14/150	55	10	211-07/2
MRF136	15	0.38	16/150	60	3.2	211-07/2
MRF136Y	30	1.2	14/150	54	1.8	319B-01/1
MRF137	30	0.75	16/150	60	1.8	211-07/2
MRF141	150	10	10/175	55	0.6	211-11/2
MRF141G	300	13	10/175	55	0.35	375-01/2
MRF171	45	1.4	15/150	60	1.5	211-07/2
MRF172	80	4.7	12.3/150	60	0.8	211-11/2
MRF174	125	8.3	11.8/150	60	0.65	211-11/2
MRF175GV	200	8	14/225	65	0.44	375-01/2
MRF175LV	100	4	14/225	65	0.65	333-04/1
V_{DD} = 50 Volts						
MRF151	150	7.5	13/175	45	0.6	211-11/2
MRF151G	300	7.5	16/175	55	0.35	375-01/2
MRF176GV	200	4	17/225	55	0.44	375-01/2

TO 500 MHz UHF AM/FM

For VHF/UHF military and commercial aircraft radio transmitters.

Device	P_{out} Output Power Watts	P_{in} Input Power Typical Watts	G_{ps} (Typ)/Freq. dB/MHz	η Typical Efficiency %	θ_{JC} °C/W	Package/Style
V_{DD} = 28 Volts						
MRF158R (1)	2	0.02	20/400	55	22	79-05/7
MRF160R (1)	4	0.04	20/400	55	12	79-05/7
MRF161	5	0.4	13.5/400	45	10	244-04/3
MRF162	15	0.65	13.6/400	50	3.5	244-04/3
MRF163	25	1.6	12/400	50	2	244-04/3
MRF166C (1)	20	0.4	17/400	55	2.5	319-05/3
MRF164W (1)	20	0.4	17/400	50	1.5	412-01/1
MRF175GU	150	9.5	12/400	55	0.44	375-01/2
MRF175LU	100	10	10/400	55	0.65	333-04/1
V_{DD} = 50 Volts						
MRF176GU	150	6	14/400	50	0.44	375-01/2

(1) To be introduced

New introductions

RF Power Bipolar Transistors

Motorola's broad line of bipolar RF power transistors are characterized for operation in RF power amplifiers. Typical applications are in military and commercial landmobile, avionics and marine radio transmitters. Groupings are by frequency band and type of application. Within each group, the arrangement of devices is by major supply voltage rating, then in the order of increasing output power. Details of package dimensions begin on Page 62. All devices are NPN polarity except where otherwise noted.

1

HF Transistors

1.5–30 MHz, HF/SSB

Designed for broadband operation, these devices feature specified Intermodulation Distortion at rated power output. Applications include mobile, marine, fixed station, and amateur HF/SSB equipment, operating from 12.5, 13.6, 28 or 50 volt supplies.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB @ 30 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF476	3 PEP/CW	0.1	15	17.5	221A-04/1
MRF475	12 PEP/CW	1.2	10	10	221A-04/1
MRF433	12.5 PEP/CW	0.125	20	8.8	211-07/1
MRF479	15 PEP/CW	0.95	12	5.9	221A-04/2
MRF406	20 PEP/CW	1.25	12	2.2	211-07/1
MRF477	40 PEP/CW	1.25	15	2	221A-04/2
MRF421	100 PEP/CW	10	10	0.6	211-11/1
V_{CC} = 28 Volts					
MRF410	10 PEP/CW	0.5	13	4.4	211-07/1
MRF410A	10 PEP/CW	0.5	13	4.4	145A-09/1
MRF485	15 PEP/CW	1.5	10	3.4	221A-04/1
MRF426	25 PEP/CW	0.16	22	2.5	211-07/1
MRF401	25 PEP/CW	1.25	13	3.5	145A-09/1
MRF466	40 PEP/CW	1.25	15	1	211-07/1
MRF486	40 PEP/CW	1.25	15	2	221A-04/2
MRF464	80 PEP/CW	2.53	15	0.7	211-11/1
MRF464A	80 PEP/CW	2.53	15	0.7	145A-10/1
MRF422	150 PEP/CW	15	10	0.6	211-11/1
V_{CC} = 50 Volts					
MRF427	25 PEP/CW	0.4	18	2.2	211-11/1
PT9798	75 PEP/CW	2.4	15 (3)	1	211-07/1
MRF428	150 PEP/CW	7.5	13	0.5	211-11/1
MRF429	150 PEP/CW	7.5	13	0.8	211-11/1
PT9790	150 PEP/CW	4.8	15 (3)	0.5	211-11/1
MRF448	250 PEP/CW	15.7	12	0.6	211-11/1
MRF430	600 PEP/CW	60	10	0.2	368-01/1

14–30 MHz, CB/AMATEUR BAND

These HF transistors are designed for economical, high-volume use in CW, AM and SSB applications.

V_{CC} = 12.5 or 13.6 Volts

MRF476	3	0.1	15	17.5	221A-04/1
MRF475	4	0.4	10	10	221A-04/1
MRF450	50	4	11	1.5	211-07/1
MRF450A	50	4	11	1.5	145A-09/1
MRF455	60	3	13	1	211-07/1
MRF455A	60	3	13	1	145A-09/1
MRF454	80	5	12	0.7	211-11/1

27–50 MHz, LOW-BAND FM BAND

For use in the FM "Low-Band," for Mobile communications.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB @ 50 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 or 13.6 Volts					
MRF475	4	0.4	10	10	221A-04/1
MRF497	40	4	10	2	221A-04/2
MRF492	70	5.6	11	0.7	211-11/1

VHF Transistors

30–200 MHz BAND

Designed for Military Radio and Commercial Aircraft VHF bands, these 28-volt devices include the all-gold metallized MRF314/15/16/17 high-reliability series.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
2N3553	2.5	0.25	10/175	25	79-04/1
PT9730	4	0.2	13/175	17.5	145D-01/1
2N5641	7	1	8.4/175	11.6	144B-05/1
MRF340	8	0.4	13/136	11.6	221A-04/2
PT9732	8	0.5	12/175	8.8	145D-01/1
PT9734	15	1	11.8/175	5.8	145D-01/1
2N5642	20	3	8.2/175	5.9	145A-09/1
MRF342	24	1.9	11/136	3.2	221A-04/2
PT9731	25	2.5	10/175	3.9	145D-01/1
MRF314	30	3	10/150	2.2	211-07/1
MRF314A	30	3	10/150	2.2	145A-09/1
2N5643	40	6.9	7.6/175	2.9	145A-09/1
MRF315	45	5.7	9/150	1.6	211-07/1
MRF315A	45	5.7	9/150	1.6	145A-09/1
PT9733	50	10	7/175	2.1	145D-01/1
MRF344	60	15	6/136	2	221A-04/2
MRF316 (4)	80	8	10/150	0.8	316-01/1
MRF317 (4)	100	12.5	9/150	0.65	316-01/1
TP9386	150	15	10/175	0.7	316A-01/1

(4) Internal Impedance Matched

1

66–88 MHz BAND

Power output chains up to 25 watts output are obtainable in the international VHF FM "Mid-Band" for which these transistors are optimized.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF229	1.5	0.15	10/90	35	79-05/5
MRF232	7.5	0.95	9/90	8.8	145A-09/1
MRF233	15	1.5	10/90	3.5	145A-09/1
MRF234	25	2.8	9.5/90	2.5	145A-09/1

88–108 MHz, FM BROADCAST BAND

These parts are designed for solid state transmitter applications in the FM broadcast band. They feature diffused ballast resistors and gold metallization that enhances long term reliability.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts Bipolar					
TP9380	75	7	10.3/108	1.5	211-11/1
TP9383	150	18	9.2/108	0.75	211-11/1
V_{CC} = 50 Volts TMOS					
TP1940	300	3	20/108	0.35	375-01/2

136–174 MHz HIGH BAND

The "workhorse" VHF FM High-Band is served by Motorola with the broadest range of devices and package combinations in the industry.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB @ 175 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
2N4427	1	0.1	10	50	79-04/1
MRF604	1	0.1	10	91	26-03/1
MRF553	1.5	0.11	11.5	25	317D-02/2
MRF607	1.75	0.12	11.5	36	79-04/1
2N6080	4	0.25	12	14.6	145A-09/1
MRF220	4	0.25	12	14.6	211-07/1
MRF237	4	0.25	12	22	79-05/5
MRF260	5	0.5	10	14.6	221A-04/2
MRF212	10	1.25	9	4.7	145A-09/1
MRF261	10	3	5.2	5.9	221A-04/2
2N6081	15	3.5	6.3	5.7	145A-09/1

(continued)

New introductions

136–174 MHz, HIGH BAND (continued)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB @ 175 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts — continued					
MRF221	15	3.5	6.3	5.7	211-07/1
MRF262	15	3.5	6.3	4.7	221A-04/2
MRF2628	15	0.95	12	4	244-04/1
TP2317	20	4	7	2.2	145D-01/1
2N6082	25	6	6.2	2.7	145A-09/1
TP2325	25	6	6.2	2.2	145D-01/1
2N6083	30	8.1	5.7	2.7	145A-09/1
MRF238	30	3.7	9	2.7	145A-09/1
MRF239	30	3	10	2.7	145A-09/1
MRF264	30	9.1	5.2	2.4	221A-04/2
MRF1946	30	3	10	1.6	211-07/1
MRF1946A	30	3	10	1.8	145A-09/1
TP2330	30	3	10	2.2	145D-01/1
TP2330F	30	3.8	9	2.2	211-07/1
TP2335	35	2.8	11	2.2	145D-01/1
2N6084	40	14.3	4.5	1.8	145A-09/1
MRF224	40	14.3	4.5	2.2	211-07/1
MRF240	40	5	9	2.2	145A-09/1
MRF240A	40	5	9	2.2	211-07/1
MRF4070 (4)	70	20	5	1.8	316-01/1
MRF247 (4)	75	15	7	0.7	316-01/1

225 MHz, ULTRA HIGH BAND

Specifically designed and characterized for the 225 MHz band, these devices eliminate the guesswork required when adapting 175 MHz characterized devices to this application.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts (Max)	G_{PE} (Min) Power Gain dB @ 225 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts					
MRF207	1	0.15	8.2	50	79-04/1
MRF227	3	0.13	13.5	21.8	79-05/5
MRF208	10	1	10	4.7	145A-09/1
MRF226	13	1.6	9	3.9	145A-09/1
TP2033	30	3.9	8.9	2.2	145D-01/1
TP2037	35	4.5	8.9	2.2	145D-01/1

(4) Internal Impedance Matched

1

400–512 MHz BAND (continued)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_{PE} (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 24 Volts					
TP5002	1.5	0.075	13/470	21	244C-01/1
TP5002S	1.5	0.075	13/470	21	249A-01/1
TP5015	15	1.34	11/470	7	319-06/2
TP5025	25	3	9/470	4	319-06/2
TP5040	40	5	9/470	2	395-01/1
TP5060	50	11.2	6.5/470	0.7	827-01/1
V_{CC} = 28 Volts					
TP5050	50	11.2	6.5/470	1.5	316A-01/1
TP5060	60	13.4	6.5/470	0.7	827-01/1
MRF338	80	15	7.3/470	0.7	333-04/1

800 MHz Transistors

806–960 MHz BAND

Designed specifically for the 800 MHz mobile radio band, types MRF840 through 847 offer superior gain and ruggedness, using the unique CS-12 package, which minimizes common-element impedance, and thus maximizes gain and stability. Devices are listed for mobile and base station applications.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_P (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 12.5 Volts — Class C (Except as Noted)					
MRF559 (8)	0.5	0.08	8/870	50	317-01/2
MRF581 (8)	0.6	0.06	10/870	40	317-01/2
MRF837 (8)	0.75	0.11	8/870	40	317-01/1
MRF8372 (8)	0.75	0.11	8/870	45	751-02/1
TP3009 (8)	0.75	0.14	7.5/900	26	305B-01/1
TP3009S (8)	0.75	0.14	7.5/900	26	305C-01/1
MRF838 (8)	1	0.22	6.5/870	70	305A-01/1
MRF838A (8)	1	0.22	6.5/870	70	305-01/1
MRF557 (8)	1.5	0.23	8/870	25	317D-02/2
TP3010 (8)	1.5	0.3	7/900	14	305B-01/1
TP3010S (8)	1.5	0.3	7/900	14	305C-01/1
MRF839 (8)	3	0.46	8/870	9	305A-01/1
MRF839F (8)	3	0.46	8/870	9	319-06/2
TP3013 (8)	4	0.71	7.5/900	7	319-06/2
MRF840 (4)	10	2.5	6/870	3.1	319-06/1
TP3012 (4)(8)	10	2	7/900	4	319-06/2
TP3015 (9)	18	3.2	7.5/915	2.5	319-06/2
MRF873 (4)	15	3	7	4	319-06/1
MRF842 (4)	20	5	6/870	1.5	319-06/1
MRF844 (4)	30	9	5.2/870	1.5	319-06/1
MRF846 (4)	40	15	4.3/870	1.2	319-06/1
MRF847 (4)	45	16	4.5/870	1	319-06/1

(4) Internal Impedance Matched
(8) Common Emitter
(9) Common Emitter — Class AB

☐ New introductions

806–960 MHz BAND (continued)

Device	P_{out} Output Power Watts	Class	P_{in} Input Power Watts	Gp (Min)/Freq. Power Gain dB/MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 24 Volts						
MRF890	2	C	0.25	9/900	25	305-01/1
TP3019	2	AB or A	0.25	9/960	14	305-01/1
TP3019S	2	AB or A	0.25	9/960	14	305A-01/1
MRF891 (4)	5	C	0.63	9/900	7	319-06/2
TP3021	10	AB or A	1	10/960	5	319-06/2
MRF892 (4)	14	C	2	8.5/900	3.5	319-06/1
MRF894 (4)	30	C	6	7/900	1.5	319-06/1
MRF898 (4)	60	C	12	7/900	1	333A-04/1
V_{CC} = 26 Volts						
TP3020A	2.2	A	0.28	9/960	20	244C-01/1
TP3005	4	AB or A	0.57	8.5/960	7	319-06/2
TP3004	5	AB or A	0.63	9/900	7	319-06/2
TP3022A	15	AB	2.12	8.5/960	6	319-06/2
TP3030	23	AB	3.65	8/900	2.5	319-06/2
TP3031	25	AB	4	8/960	2.5	319-06/2
TP3024A (6)	35.5	AB	6.35	7.5/960	3	395-01/1
TP3040 (4)	40	AB	7.11	7.5/960	1.8	319-06/2
TP3061 (4)	45	AB	7.13	8/960	1.2	333A-02/2
TP3060 (4)	60	AB	10.67	7.5/900	1.2	333A-02/2
TP3062 (6)	60	AB	12	7/960	1.2	398-01/1

Microwave Transistors

L-BAND PULSE POWER

These products are designed to operate in short pulse width, 10 μs, low duty cycle, 1%, power amplifiers operating in the 960 to 1215 MHz band. All devices have internal impedance matching. The prime application is avionics equipment for distance measuring (DME), area navigation (TACAN) and interrogation (IFF). All devices offered with hermetic option.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	Gp (Min) Power Gain dB @ 1090 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 18 Volts — Class A & AB Common Emitter					
MRF1000MA	0.2	0.02	10	25	332-04/2
MRF1000MB	0.2	0.02	10	25	332A-03/2
MRF1000MC	0.2	0.02	10	25	361A-01/2

(4) Internal Impedance Matched
(6) Internal Impedance Matched Push-Pull Transistors

New introductions

1

L-BAND PULSE POWER (continued)

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	Gp (Min) Power Gain dB @ 1090 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 35 Volts — Class B & C Common Base					
MRF1002MA	2	0.2	10	25	332-04/1
MRF1002MB	2	0.2	10	25	332A-03/1
MRF1002MC	2	0.2	10	25	361A-01/1
MRF1004MA	4	0.4	10	25	332-04/1
MRF1004MB	4	0.4	10	25	332A-03/1
MRF1004MC	4	0.4	10	25	361A-01/1
MRF1008MA	8	0.8	10	15	332-04/1
MRF1008MB	8	0.8	10	15	332A-03/1
MRF1008MC	8	0.8	10	15	361A-01/1
V_{CC} = 50 Volts — Class C Common Base					
MRF1015MA	15	1.5	10	10	332-04/1
MRF1015MB	15	1.5	10	10	332A-03/1
MRF1015MC	15	1.5	10	10	361A-01/1
MRF1035MA	35	3.5	10	5	332-04/1
MRF1035MB	35	3.5	10	5	332A-03/1
MRF1035MC	35	3.5	10	5	361A-01/1
MRF1090MA	90	9	10	0.6	332-04/1
MRF1090MB	90	9	10	0.6	332A-03/1
MRF1090MC	90	9	10	0.6	361A-01/1
MRF1150M	150	25	7.8	0.3	336-03/2
MRF1150MA	150	25	7.8	0.3	332-04/1
MRF1150MB	150	25	7.8	0.3	332A-03/1
MRF1150MC	150	25	7.8	0.3	361A-01/1
MRF1250M	250	63	6	0.15	336-03/2
MRF1325M	325	81	6	0.15	336-03/2

L-BAND LONG PULSE POWER

These products are designed for pulse power amplifier applications in the 960 to 1215 MHz frequency range. They are capable of handling up to 10 μs pulses in long pulse trains resulting in up to a 50% duty cycle over a 3.5 millisecond interval. Overall duty cycle is limited to 25% maximum. The primary applications for devices of this type are military systems, specifically JTIDS and commercial systems, specifically Mode S. Package type is hermetic.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_{PB} (Min) Power Gain dB @ 1215 MHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts — Class C Common Base					
MRF10005	5	0.71	8.5	8	336E-02/1
V_{CC} = 36 Volts — Class C Common Base					
MRF10030	30	11.2	9.5	3	376A-01/1
MRF10120	120	19	8	0.6	355-01/1

☐ New introductions

2 GHz NARROWBAND CW

The MRW2000 Series of NPN Silicon microwave power transistors are designed for common base service in amplifier or oscillator applications in the 1 to 2.3 GHz frequency range.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_{PB} (Min) Power Gain dB @ 2 GHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts — Class B & C Common Base					
MRW2001 (10)	1	0.13	9	35	328F-01/2
MRW2003 (10)	3	0.48	8	15	328F-01/2
MRW2005 (10)	5	0.8	8	8.5	328F-01/2
MRW2010 (10)	10	2	7	6	328F-01/2
MRW2015 (10)	15	3.8	6	3.5	393-01/1
MRW2020 (10)	20	6	5.2	3	393-01/1

2.3 GHz NARROWBAND CW

The MRW2300 Series are common-base configured transistors in hermetic packages with guaranteed performance characteristics at 2.3 GHz. They feature diffused ballast resistors and gold metallization for extreme ruggedness and reliability. All are available with TX equivalent screening.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_{PB} (Min) Power Gain dB @ 2.3 GHz	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
MRW2301	1.5	0.24	8	35	328F-01/2
MRW2304	4	0.64	8	17	328F-01/2
MRW2307	7	1	8.5	8.5	328F-01/2

3 GHz NARROWBAND CW

The MRW3000 Series are the industry's first 100% VSWR tolerant 3 GHz devices. They are common-base configured in hermetic packages (with or without flanges) and rated for 28 volt operation.

Device	P_{out} Output Power Watts	P_{in} Input Power Watts	G_{PB} (Min) Power Gain dB @ 3 GHz	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
MRW3001	1	0.2	7	35	328F-01/2
MRW3003	3	0.75	6	17	328F-01/2
MRW3005	5	1.6	5	8.5	328F-01/2

(10) Available in flangeless package (Case 328-02/1) by placing suffix "F" after device number

1

0.6–2.7 GHz BROADBAND COMMON BASE

The MicRoAmp transistor employs MOS capacitors and other matching elements to transform the input, and in some devices, the output impedance to a more manageable level prior to the point where package parasitics can reduce the bandwidth capability (U.S. Patent 3,713,006). These devices are assembled in common-base configuration and include an all-gold metal system and diffused ballast resistors for long life. Those epoxy-sealed devices followed by Note 11 are also available in hermetic packages and TX equivalent.

Device	Instantaneous Frequency Range F_L-F_H (MHz)	Min Output Power Watts	Min Gain dB	θ_{JF} °C/W	Package/Style
V_{CC} = 22 V					
MRAL1417-2	1400–1700	2	8	15	394-01/1
MRAL1417-6	1400–1700	6	7.4	8	394-01/1
MRAL1417-11	1400–1700	11	7.4	4.5	394-01/1
MRAL1417-25	1400–1700	25	7	2.5	394-01/1
MRAL1720-2	1700–2000	2	7.5	15	394-01/1
MRAL1720-5	1700–2000	5	6.5	8	394-01/1
MRAL1720-9	1700–2000	9	6.5	4.5	394-01/1
MRAL1720-20	1700–2000	20	6	2.5	394-01/1
MRAL2023-1.5 (11)	2000–2300	1.5	8	30	394-01/1
MRAL2023-3 (11)	2000–2300	3	8	16	394-01/1
MRAL2023-6 (11)	2000–2300	6	6.8	8	394-01/1
MRAL2023-12 (11)	2000–2300	12	6.8	4.5	394-01/1
MRAL2023-18 (11)	2000–2300	18	6.5	2.5	394-01/1
MRAL2327-1.3	2300–2700	1.3	5.5	30	394-01/1
MRAL2327-3	2300–2700	3	6.6	16	394-01/1
MRAL2327-6	2300–2700	6	7	8	394-01/1
MRAL2327-12 (11)	2300–2700	12	7	4.5	394-01/1
V_{CC} = 28 Volts					
MRA0610-3 (11)	600–1000	3	7.8	15	394-01/1
MRA0610-9 (11)	600–1000	9	7.8	6	394-01/1
MRA0610-18A (11)	600–1000	18	7.8	4	394-01/1
MRA0610-40A	600–1000	40	7	2.5	394-01/1
MRA1014-2 (11)	1000–1400	2	8.2	15	394-01/1
MRA1014-6 (11)	1000–1400	6	7.4	8	394-01/1
MRA1014-12 (11)	1000–1400	12	7.8	4.5	394-01/1
MRA1014-35	1000–1400	35	7	2.5	394-01/1
MRA1214-55H	1200–1400	50	6.5	1.4	402-01/1
MRA1300-10L	500–1500	10	7	2.1	360A-01/1
MRA1417-2 (11)	1400–1700	2	8	15	394-01/1
MRA1417-6 (11)	1400–1700	6	7.4	8	394-01/1
MRA1417-11 (11)	1400–1700	11	7.4	4.5	394-01/1
MRA1417-25A	1400–1700	25	7	2.5	394-01/1
MRA1720-2	1700–2000	2	7.5	15	394-01/1
MRA1720-5	1700–2000	5	6.5	8	394-01/1
MRA1720-9	1700–2000	9	6.5	4.5	394-01/1
MRA1720-20	1700–2000	20	6	2.5	394-01/1

(11) Hermetic package (393-01/1) is available by placing suffix "H" after device number

New introductions

L-BAND CW, NARROWBAND, COMMON BASE

The MRA1600 Series microwave power transistors is primarily intended for large-signal output and driver amplifier stages for satellite up/down links. Each is designed for Class C, common base amplifier applications.

Device	Instantaneous Frequency Range F_L-F_H (MHz)	Min Output Power Watts	Min Gain dB	θ_{JF} °C/W	Package/Style
V_{CC} = 28 Volts					
MRA1600-2	1600–1660	2	8.4	15	394-01/1
MRA1600-13	1600–1660	13	7.6	4.5	394-01/1
MRA1600-30	1600–1660	30	7	2.5	394-01/1

POWER OSCILLATORS

These oscillator devices are common collector configuration with diffused ballast resistors, gold metallization and hermetic packages to provide high reliability in severe environmental conditions. Each is fully characterized for power oscillator applications.

Device	Operating Conditions V_{CE}/I_C V/mA	Output Power — Watts/@ Freq. — GHz				Package/Style
		Minimum	Typ @ Low F	Typ @ Mid F	Typ @ High F	
TP62601	20/220	1.25/2	1.85/2.5	1.35/2	0.85/3	328F-01/3
TP62602	20/440	2.5/2	2.5/2	2/2.5	1.3/3	328F-01/3
TP63601	20/120	0.6/2.3	0.75/2.3	0.5/2.8	0.28/3.3	328F-01/3
TP63602	20/230	1.2/2.3	1.5/2.3	1/2.8	0.55/3.3	328F-01/3
TP64601	20/120	0.3/4	0.55/3	0.35/4	0.15/5	328F-01/3
TP64602	20/240	0.55/4	1.2/3	0.65/4	0.15/5	328F-01/3

Linear Transistors

The following sections describe a wide variety of devices specifically characterized for linear amplification. Included are low power and high power parts covering frequencies from 100 MHz to 4 GHz.

TO 1 GHz, CLASS A

These devices offer a selection of performance and price for linear amplification to 1 GHz. The "MRA" prefix parts are input matched and feature high overdrive and extreme ruggedness capability.

Device	P_o @ 1 dB Comp. Point Watts	G_{SS} (Min)/Freq. Small Signal Gain dB/MHz	Bias Point (Vdc/A)	θ_{JC} °C/W	Package/Style
V_{CC} = 19 Volts					
MRA1000-3.5L	3.5	10/1000	19/0.6	8	145D-01/1
MRA1000-7L	7	9/1000	19/1.2	4	145D-01/1
MRA1000-14L	14	8/1000	19/2.4	2.1	145D-01/1
MRA0500-19L	19	8/500	19/3.5	1.5	145D-01/1
V_{CC} = 25 Volts					
RF1029	1.5	8/1000	—	12	244A-01/1
RF1030	3	7.5/1000	—	6	244A-01/1
RF1031	4.5	7/1000	—	3.5	244A-01/1
RF1032	6	6.5/1000	—	3.5	244A-01/1

New introductions

1

VHF ULTRA LINEAR FOR TV APPLICATIONS

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band III. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P_{ref} Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone IMD (12) dB	θ_{JC} °C/W	Package/Style
V_{CC} = 28 Volts					
TPV394A	5	15/225	−58	2.5	244C-01/1
TPV364	10	10/225	−54	2	145D-01/1
TPV385	14	14/225	−53	1.5	316A-01/1
TPV375	20	8/225	−51	1.5	211-11/1
TPV387	24	13/225	−50	1	316A-01/1
TPV376	30	7.5/225	−53	1	316A-01/1
TPV3100	28	14/225	−51	0.8	827-01/1
TPV387	90 (13)	10/225	—	1	316A-01/1
TPV3100	100 (13)	13/225	—	0.8	827-01/1
V_{CC} = 50 Volts TMOS					
TPV1325B	250 (13)	13/225	—	0.35	375-01/2

UHF ULTRA LINEAR FOR TV APPLICATIONS

The following devices have been characterized for ultra-linear applications such as low-power TV transmitters in Band IV and V. Each features diffused ballast resistors and an all-gold metal system to provide enhanced reliability and ruggedness.

Device	P_{ref} Watts	Gp (Min)/Freq. Power Gain dB/MHz	3 Tone IMD (12) dB	θ_{JC} °C/W	Package/Style
V_{CC} = 20 Volts					
TPV590	0.25	14/860	−58	30	305B-01/1
TPV591	0.5	13/860	−58	16	305B-01/1
TPV596	0.5	11.5/860	−58	20	244C-01/1
TPV597	1	10.5/860	−58	9	244C-01/1
TPV598	4	7/860	−60	5	244C-01/1
V_{CC} = 25 Volts					
TPV693	1.8	9.5/860	−60	8	244C-01/1
TPV593	2	8.5/860	−60	11	244C-01/1
TPV698	4	8.5/860	−54	6.2	244C-01/1
TPV657	6	8/860	−58	2.5	827-01/1
TPV595A	14	8.5/860	−47	2.5	395-01/1
TPV695A	14	9.5/860	−47	2.5	395-01/1
TPV7025	25	8.5/860	−45	1.5	398-01/1
TPV8100B	110	9/860	—	0.6	398-01/1
V_{CC} = 26 Volts					
TPV695B	30 (13)	8.5/860	—	2.5	395-01/1
V_{CC} = 28 Volts					
TPV5051	50 (13)	6.5/860	—	1.8	395-01/1
TPV5055B	50 (13)	7/860	—	1.5	398-01/1
TPV8200B	180 (13)	7.5/860	—	0.4	397-01/1

(12) Vision Carrier: −8 dB; Sound Carrier: −7 dB, Sideband Carrier: −16 dB
(13) Output power at 1 dB compression in Class AB

MICROWAVE LINEAR POWER

Common emitter microwave devices are offered for a wide variety of uses in small and medium signal, Class A, AB and C applications up to 4 GHz. The use of all-gold metal systems, diffused ballast resistors and hermetic packaging results in devices that display excellent reliability even in military environment. Many part types are available with off-the-shelf TX equivalent screening.

Device	G_{SS} (Min) @ Freq. Small Signal Gain dB/GHz	1 dB Comp. Watts	P_{sat} Watts	−30 dB IMD Watts	Emitter Current mA	Package/Style
V_{CE} = 20 V						
MRW52001	6/2	1.8	2.5	1.5	220	400-01/1
MRW52101	6/2	1.8	2.5	1.5	220	328E-01/2
MRW52201	5/2	1.8	2.5	1.5	220	401A-01/1
MRW52401	5/2	1.8	2.5	1.5	220	328G-01/1
MRW52501 (14)	5/2	1.8	2.5	1.5	220	401-01/1
MRW52601 (14)	6/2	1.8	2.5	1.5	220	328F-01/1
MRW52102	6/2	3.6	5	3	440	328E-01/2
MRW52202	5/2	3.6	5	3	440	401A-01/1
MRW52402	5/2	3.6	5	3	440	328G-01/1
MRW52502 (14)	5/2	3.6	5	3	440	401-01/1
MRW52602	6/2	3.6	5	3	440	328F-01/1
MRW52104	5/2	7.2	10	6	880	328E-01/2
MRW52204	5/2	7.2	10	6	880	401A-01/1
MRW52504	5/2	7.2	10	6	880	401-01/1
MRW52604 (14)	5/2	7.2	10	6	880	328F-01/1
MRW53001	6/3	0.8	1	0.8	120	400-01/1
MRW53101	6/3	0.8	1	0.8	120	328E-01/2
MRW53201	5/3	0.8	1	0.8	120	401A-01/1
MRW53401	5/3	0.8	1	0.8	120	328G-01/1
MRW53501 (14)	5/3	0.8	1	0.8	120	401-01/1
MRW53601 (14)	6/3	0.8	1	0.8	120	328F-01/1
MRW53102	6/3	1.6	2	1.5	230	328E-01/2
MRW53202	5/3	1.6	2	1.5	230	401A-01/1
MRW53402	5/3	1.6	2	1.5	230	328G-01/1
MRW53502	5/3	1.6	2	1.5	230	401-01/1
MRW53602 (14)	5/3	1.6	2	1.5	230	328F-01/1
MRW53505	5/3	4	5	4	600	401-01/1
MRW53605	6/3	4	5	4	600	328F-01/1
MRW54001	5/4	0.5	0.8	0.5	120	400-01/1
MRW54101	6/4	0.5	0.8	0.5	120	328E-01/2
MRW54201	5/4	0.5	0.8	0.5	120	401A-01/1
MRW54501 (14)	5/4	0.5	0.8	0.5	120	401-01/1
MRW54601 (14)	6/4	0.5	0.8	0.5	120	328F-01/1

BIAS DEVICES

The BT500 and BT500F bias devices are used to provide the proper bias point for Class AB linear amplifiers. They feature excellent thermal tracking and simple external circuitry. The BT500 is a hermetic, metal sealed device.

Device	I_F Typ mA	h_{FE} Min-Max	$V_{(BR)EBO}$ Min V	Package/Style
Bias Devices for Class AB 28–50 Volt Transistors				
BT500	500	20–100	4	036-03/1
BT500F	500	20–100	4	211-07/1

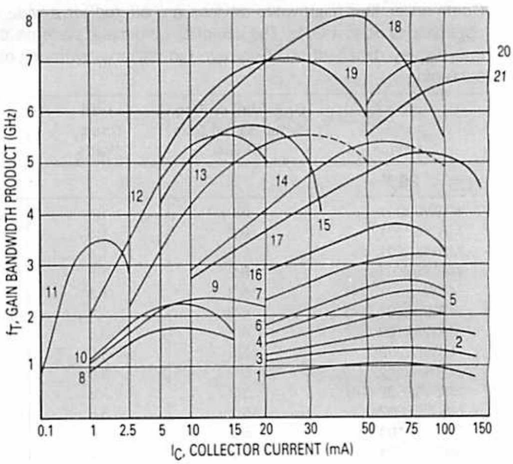
(14) Available in JTX equivalent by replacing "TRW" with "TX" prefix

1

RF Small-Signal Bipolar Transistors

RF Small-Signal Transistor Gain Characteristics

Curve numbers apply to transistors listed in the subsequent tables.



Selection by Package

In small-signal RF applications, the package style is often determined by the end application or circuit construction technique. To aid the circuit designer in device selection, the Motorola broad range of RF small-signal amplifier transistors is organized by package. Devices for other applications such as oscillators or switches are shown in the appropriate preceding tables. **These devices are NPN polarity unless otherwise designated.**

PLASTIC SOE CASE

Device	Gain-Bandwidth f_T @ GHz Typ	I_C mA	Curve No. Page 36	Noise Figure NF @ dB Typ	f MHz	Gain dB Typ @	f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 29-04/2, TO-226AA											
MPS536 (5)	5	−20	19	4.5	500	14	500	−10	−30	625	
MPS571	6	50	18	2	500	14	500	10	80	625	
MPS901	4.5	15	12	2.5	900	12	900	15	30	625	
MPS911	7	30	13	1.7	500	16.5	500	12	40	625	
MPS3866	0.8	50	1	—	—	10	400	30	400	625	
Case 317-01/2 — MACRO-X											
MRF521 (5)	4.2	−50	—	2.8	1000	11	1000	−10	−70	750	
MRF536 (5)	6	−20	19	4.5	1000	10	1000	−10	−30	300	
MRF559	3	100	16	—	—	13	512	18	150	2000	
MRF571	8	50	18	1.5	1000	12	1000	10	70	1000	
MRF581	5	75	17	2	500	15.5	500	18	200	2500	
MRF581A	5	75	17	1.8	500	15.5	500	15	200	2500	
MRF837	5	75	17	—	—	10	870	16	200	2500	
MRF901	4.5	15	12	2	1000	12	1000	15	30	375	
MRF911	5	30	13	2.5	1000	12.5	1000	12	40	400	
MRF931	3	1	11	3.8	500	16	500	5	5	50	
MRF941	8	15	—	1.7	2000	12.5	2000	10	50	400	
MRF951	7.5	30	—	1.7	2000	12.5	2000	10	100	1000	
MRF961	4.5	50	14	2	500	15	500	15	100	500	
MRF2369	6	40	18	1.5	1000	12	1000	15	70	750	

(5) PNP

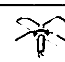
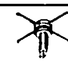
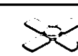
(continued)

PLASTIC SOE CASE (continued)

Device	Gain-Bandwidth f_T @ GHz Typ	I_C mA	Curve No. Page 36	Noise Figure NF @ dB Typ	f MHz	Gain @ dB Typ	f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 317A-01/2 — MACRO-T — continued											
BFR90	5	14	12	2.4	500	18	500	15	30	180	
BFR91	5	30	13	1.9	500	16	500	12	35	180	
BFR96	4.5	50	14	2	500	14.5	500	15	100	500	
BFW92A	4.5	10	15	2.7	500	16	500	15	35	180	
MRF580	5	75	17	2	500	14	500	18	200	2500	
MRF580A	5	75	17	1.8	500	14	500	15	200	2500	
Case 317D-01/2,3											
MRF542 (15)	—	—	2	—	—	5.5	250	70	400	3000	
MRF543 (5) (15)	—	—	2	—	—	5.5	250	70	400	3000	
MRF553	—	—	—	—	—	13	175	16	500	3000	
MRF555	—	—	—	—	—	12.5	470	16	400	3000	
MRF557	—	—	—	—	—	9	870	16	400	3000	
Case 318-07/6 — SOT-23											
BFR92	3.4	14	—	3	500	—	—	15	25	350	
BFR93	3.4	30	—	2.5	30	—	—	12	35	350	
BFS17	1.3	25	—	5	30	—	—	15	—	350	
MMBR536 (5)	5.5	−20	19	4.5	500	14	500	−10	−30	350	
MMBR571	8	50	18	2	500	16.5	500	10	80	350	
MMBR901	4	15	12	1.9	1000	12	1000	15	30	350	
MMBR911	6	30	13	2	500	17	500	12	40	350	
MMBR920	4.5	14	—	2.4	500	15	500	15	35	350	
MMBR930	5.5	30	—	1.9	500	11	500	12	35	350	
MMBR941	8	15	—	2.1	2000	8.5	2000	10	50	400	
MMBR951	8	30	—	2.1	2000	7.5	2000	10	100	500	
MMBR931	3	1	11	4.3	1000	10	1000	5	5	350	
MMBR2060	1.0	20	—	3.5	450	12.5	450	14	50	350	
MMBR2857	1	4	—	4.5	450	12.5	450	15	40	350	
MMBR4957 (5)	1.2	−2	10	3	450	17	450	−30	−30	350	
MMBR5031	1	5	—	2.5	450	17	450	10	20	350	
MMBR5179	1.4	5	8	4.5	200	15	200	12	50	350	
Case 318A-05/1 — SOT-143											
MRF0211L	5.5	40	18	1.8	1000	9.5	1000	15	70	580	
MRF5211L (5)	4.2	−50	—	2.8	1000	11	1000	−10	−70	580	
MRF5711L	8	50	18	1.6	1000	13.5	1000	10	70	580	
MRF9011L	3.8	15	12	2.3	1000	10.2	1000	15	30	300	
MRF9331L	5	1	—	2.5	1000	12.5	1000	8	1	50	
MRF9411L	8	15	—	2.1	2000	9.5	2000	10	50	400	
MRF9511L	8	30	—	2.1	2000	9	2000	10	100	500	

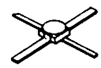
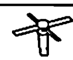
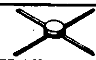
(5) PNP
(15) Common Base Configuration

PLASTIC SOE CASE (continued)

Device	Gain-Bandwidth f_T GHz Typ	@ I_C mA	Curve No. Page 36	Noise Figure NF dB Typ	@ f MHz	Gain dB Typ	@ f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 751-02/1 — SO-8											
MRF3866	0.8	50	1	—	—	10.5	400	30	400	1000	
MRF4427	1.6	50	1	—	—	18	175	20	400	1500	
MRF5160 (5)	0.8	−50	1	—	—	10	400	−40	−400	1000	
MRF5583 (5)	2.1	−35	5	—	—	15	250	−30	−500	1000	
MRF5812	5.5	75	17	2	500	15.5	500	15	200	1500	
MRF5943	1.5	35	4	3.4	200	12	250	30	400	1000	
MRF8372	5	75	17	—	—	10	870	16	200	1500	
MRFQ17	2.25	50	5	—	—	12	500	25	300	1000	
MRFQ19	5.3	50	14	3.5	500	14.6	500	15	150	1000	
CERAMIC SOE CASE											
Case 144D-06/1											
2N5947	1.5	75	3	3.8	200	11	250	30	400	5000	
MRF511	2.1	80	7	7.3	200	11	250	25	250	5000	
Case 244A-01/1,3											
LT2001	3	90	7	2.5	300	11.5	300	20	200	5000	
MRF546 (15)	—	—	—	—	—	6	250	70	600	9000	
MRF547 (15) (5)	—	—	—	—	—	5.5	250	−70	−600	9000	
MRF548 (15)	—	—	2	—	—	5.5	250	70	400	5000	
MRF549 (15) (5)	—	—	2	—	—	5.5	250	−70	−400	5000	
PT4572A	2.5	90	6	2.3	300	14	300	25	200	5000	
Case 244C-01/1											
TP3401	5	150	—	—	—	14	500	13	200	4300	
TP3402	5	300	—	—	—	10.5	500	13	400	9500	
Case 244D-01/1											
LT4217	5.5	90	17	2.5	500	15	500	12	400	5000	
TP3098	2.6	100	6	6.5	500	11.5	500	20	200	5000	
Case 249A-01/1											
TP3401S	5	150	—	—	—	14	500	13	200	4300	

(5) PNP
(15) Common Base Configuration

CERAMIC SOE CASE (continued)

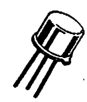
Device	Gain-Bandwidth f_T @ GHz Typ	I_C mA	Curve No. Page 38	Noise Figure NF @ dB Max	f MHz	Gain @ dB Min	f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 303-01/1											
2N6603	5.5	15	12	2	1000	13	1000	15	30	400	
2N6604	5.5	30	13	2.7	1000	12	1000	15	50	500	
2N6618	—	—	—	2.2	2000	11	2000	20	20	300	
2N6679	($f_{1\ dB}$ is 18.5 dBm Typ @ 4 GHz)					9	4000	20	70	900	
MRF522 (5)	4.2	−50	—	2.8	1000	11	1000	−10	−50	620	
MRF572	8	50	18	1.5	1000	12	1000	10	70	750	
MRF942	8	15	—	1.7	2000	12.5	2000	10	50	300	
MRF952	7.5	30	—	1.7	2000	12.5	2000	10	100	600	
MRF962	4.5	50	14	2	500	16.5	500	15	100	750	
Case 305B-01/1											
LT3005	3	90	7	2.5	300	14	300	20	200	5000	
TP3400	3	125	—	7	500	14.5	860	20	400	5000	
Case 358-01/1											
MRF573	8	50	18	2	1000	10	1000	10	70	750	
Case 401-01/1											
LT3014	3	90	7	3.1	300	14	500	20	200	5000	

METAL CAN
Case 20-03/10, TO-206AF

Device	f_T GHz Typ	I_C mA	Curve No.	NF dB Max	f MHz	Gain dB Min	f MHz	$V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
2N2857	1.6	8	8	4.5	450	12.5	450	15	40	200	
2N4957 (5)	1.6	−2	10	3	450	17	450	−30	−30	200	
2N4958 (5)	1.5	−2	10	3.3	450	16	450	−30	−30	200	
2N4959 (5)	1.5	−2	10	3.8	450	13	450	−30	−30	200	
2N5031	1.6	5	8	2.5	450	14	450	10	20	200	
2N5032	1.5	5	8	3	450	14	450	10	20	200	
2N5179	1.4	10	8	4.5	200	15	200	12	50	200	
2N6304	1.8	10	9	4.5	450	15	450	15	50	200	
2N6305	1.8	10	9	5.5	450	12	450	15	50	200	
BFR99 (5)	1.7	−10	9	6	800	—	—	−25	−50	225	
BFX89	1.6	25	9	6.5	500	19	200	15	50	200	

(5) PNP

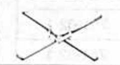
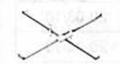
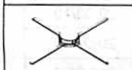
METAL CAN (continued)

Device	Gain-Bandwidth f_T @ GHz Typ	I_C mA	Curve No. Page 36	Noise Figure NF @ dB Max	f MHz	Gain @ dB Min	f MHz	Maximum Ratings $V_{(BR)CEO}$ Volts	I_C mA	P_T mW	Package
Case 20-03/10, TO-206AF											
BFY90	1.7	25	9	5	500	21 (16)	200	15	50	200	
MM4049 (5)	5	−20	19	3 (16)	500	11.5	500	−10	−30	200	
MRF501	1	5	8	4.5 (16)	200	15 (16)	200	15	50	200	
MRF502	1.2	5	8	4 (16)	200	17 (16)	200	15	50	200	
MRF524 (5)	4.2	−50	—	2.5	500	9	500	−10	−50	200	
MRF904	4	15	12	1.5 (16)	450	16 (16)	450	15	30	200	
MRF914	4.5	20	13	2 (16)	500	15 (16)	500	12	40	200	
Case 26-03/1											
LT3046	3	40	7	2.5	300	15.5	300	20	150	2500	
MRF965	4.5	50	—	2 (16)	500	12	500	15	100	750	
Case 79-04/1, TO-205AD											
2N3553	0.5	100	—	—	—	10	175	40	1000	7000	
2N3866	0.7	50	—	—	—	10	400	30	400	5000	
2N3866A	1	50	—	—	—	10	400	30	400	5000	
2N5109	1.5	50	4	3 (16)	200	11	216	20	400	2500	
2N5583 (5)	1.5	−100	5	—	—	—	—	−30	−500	5000	
2N5943	1.5	50	4	3.4 (16)	200	11.4 (16)	200	30	400	3500	
LT1001A	3	90	7	2.5	300	13.5	300	20	200	3000	
LT4239	5	90	21	2.5	500	14	500	12	400	3000	
MM8000	0.8	50	1	2.7 (16)	200	11.4 (16)	200	30	400	3500	
MM8001	1	50	4	2.7 (16)	200	11.4 (16)	200	30	400	3500	
MRF517	2.7	60	7	7.5	300	10 (16)	300	20	150	2500	
MRF525 (TO-39CE)	3	50	7	4	400	13	400	20	150	2500	
MRF544	1.4	50	2	—	—	16.5 (16)	250	70	400	3500	
MRF545 (5)	1.2	−50	2	—	—	15.5 (16)	250	−70	−400	3500	
MRF586	4.5	90	17	4	500	9	500	17	200	2500	
PT4579	2.5	90	6	2.3	300	12	300	25	200	3000	

(5) PNP
(16) Typical

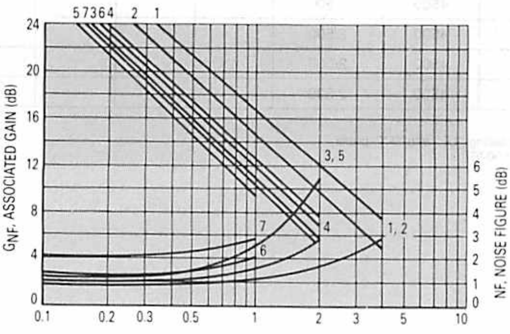
Low-Noise

The Small-Signal devices listed are designed for low noise and high gain amplifier mixer, and multiplier applications. Each transistor type is available in various packages. **Polarity is NPN unless otherwise noted.**

Package	Name	Case Number	Curve Number 1	2	3(5)	4	5	6	7
	MACRO-T	317A-01/2	—	—	—	—	MRF580	—	BFR91
	MACRO-X	317-01/2	—	MRF941 MRF951(18)	MRF521	MRF571 MRF2369(17)	MRF581	MRF901	MRF911
	.1" Ceramic	303-01/1	2N6618 2N6679(18)	MRF942 MRF952(18)	MRF522	MRF572	—	2N6603	2N6604
	.07" Ceramic	303A-01/1	2N6617	—	—	—	—	—	—
	MICRO-X (To Be Introduced)	358-01/1	—	MRF943 MRF953(18)	MRF523	MRF573	—	—	—
	TO-206AF	20-03/10	—	—	MRF524	—	—	MRF904	MRF914
	TO-226AA	29-04/2	—	—	—	MPS571	—	MPS901	MPS911
	SOT-23	318-07/6	—	MMBR941 MMBR951(18)	—	MMBR571	—	MMBR901	MMBR911
	SOT-143	318A-05/1	—	MRF9411 MRF9511(18)	MRF5211	MRF5711 MRF0211(17)	—	MRF9011	—
	SO-8	751-03/1	—	—	—	—	MRF5812	—	—

(5) PNP
(17) Higher Voltage Version
(18) Higher Current Version

Gain and Noise Figure versus Frequency



CATV, MATV and Class A Linear

For Class A linear CATV/MATV applications. Listed according to increasing gain-bandwidth (f_T).

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T MHz Typ	Noise Figure	Distortion Specifications				$V_{(BR)CEO}$ V	Package/ Style
			Typ/Freq. dB/MHz	2nd Order IMD	3rd Order IMD	12 Ch. Cross-Mod.	Output Level dBmV		
MRF501	6/5	1000	4.5/200					15	20-03/10
MRF502	6/5	1200	4/200					15	20-03/10
2N5179	6/10	1400	3.2/200					12	20-03/10
MMBR5179	6/5	1500	4/450					12	318-06/6
2N5109	15/50	1500	3/200					20	79-04/1
2N5943	15/50	1500	3.4/200	−50		−4	+50	30	79-04/1
MRF5943	15/50	1500	3.4/200					30	751-02/1
MRF5583 (5)	10/−100	1500						−30	751-02/1
BFX89	5/25	1600	2.5/500					15	20-03/10
BFY90	5/25	1700	2.5/500					15	20-03/10
2N6304	5/10	1800	3.2/450					15	20-03/10
2N6305	5/10	1800	4/450					15	20-03/10
MMBR4957 (5)	10/−2	2000	3/450					−30	318-06/6
MMBR5031	6/5	2000	1.9/450					10	318-06/6
MRF511	20/80	2100	7.3/200	−50	−65	−57	+50	25	144D-06/1
MRFQ17	12.5/50	2200						25	751-02/1
PT4572A	14/90	2500	2.3/300					25	244A-01/1
PT4579	14/90	2500	2.3/300					25	79-04/1
TP3098	15/100	2600	6.5/500				1 (28)	20	244A-01/1
MRF517	15/60	2700	6.5/300	−60	−72	−57	+45	20	79-04/1
LT1001A (19)	14/90	3000	2.5/300					20	79-04/1
LT2001	14/90	3000	2.5/300					20	244A-01/1
LT3005	14/90	3000	2.5/300					20	305B-01/1
LT3014 (19)	14/90	3000	3.1/300					20	401-01/1
LT3046	14/90	3000	2.5/300					20	26-03/1
TP3400	18/125	3000	7/500				1.2 (28)	20	305B-01/1
MMBR920	10/14	4500	2.4/500					15	318-06/6
BFW92A	10/10	4500	2.7/500					15	317A-01/2
MRF586	15/90	4500	3/500	−50	−72		+50	17	79-04/1
BFR96	10/50	4500	2/500					15	317A-01/2
MRF961	10/50	4500	2/500					15	317-01/2
MRF962	10/50	4500	2/500					15	303-01/1
MRF965	10/50	4500	2/500					15	26-03/1

(5) PNP
(19) Available in JTX equivalent by replacing "LT" with "TX" prefix
(28) Output in volts according to DIN45004B

(continued)

Device	Nominal Test Conditions V_{CE}/I_C Volts/mA	f_T MHz Typ	Noise Figure Typ/Freq. dB/MHz	Distortion Specifications 2nd Order IMD	3rd Order IMD	12 Ch. Cross-Mod.	Output Level dBmV	$V_{(BR)CEO}$ V	Package/ Style
BFR90	10/14	5000	2.4/500					15	317A-01/2
BFR91	5/30	5000	1.9/500					12	317A-01/2
LT4217	14/90	5000	4/500					12	244D-01/1
LT4239 (19)	14/90	5000	4/500					12	79-04/1
MRF581	10/75	5000	2/500		−65		+50	18	317-01/2
MRF581A	10/75	5000	1.8/500		−65		+50	15	317-01/2
MRF5812	10/75	5000	1.8/500		−65		+50	15	751-02/1
MRF587	15/90	5500	3/500	−52	−72		+50	17	144D-06/1
TP3401	12.5/150	5000					1.2 (20)	13	244C-01/1
TP3401S	12.5/150	5000					1.2 (20)	13	249A-01/1
TP3402	12.5/300	5000					1.6 (20)	13	244C-01/1
2N6679	(Has $P_{1\ dB}$ of 18.5 dBm Typ @ 4 GHz)							20	303-01/1

High-Voltage

These discrete devices are specially designed for CRT driver applications requiring high frequency response and high voltage, such as high resolution color graphics video monitors. Gold metallized dice are used to insure high reliability and improved ruggedness.

Device	$V_{(BR)CEO}$ V	$V_{(BR)CBO}$ V	$I_{C(max)}$ mA	h_{FE}	$f_T/V_{CE}, I_C$ GHz/V, mA	C_{CB}/V_{CE} pF/V	Package/ Style
NPN							
LT1814 (19)	70	120	400	20–60	1/15, 50	3.5/15	401-01/2
LT1817	70	120	400	20–60	1/15, 50	2.5/15	244D-01/2
LT1839 (19)	70	120	300	20–60	1/15, 50	2.5/15	79-04/1
MRF544	70	120	400	15–	1.4/10, 50	1.8/10	79-04/1
MRF542	70	120	400	15–	—	2/10	317D-01/3
MRF546	70	120	600	15–	—	3.6/10	244A-01/3
MRF548	70	120	400	15–	—	2/10	244A-01/3
PNP							
LT5817	−65	−80	−400	15–60	1.5/10, −60	1.5/−10	244D-01/2
LT5839 (19)	−65	−80	−300	15–60	1.5/10, −60	1.5/−10	79-04/1
MRF545	−70	−100	−400	15–	1.2/25, −50	2/−10	79-04/1
MRF543	−70	−100	−400	15–	—	2/−10	317D-02/3
MRF547	−70	−100	−600	15–	—	3.6/−10	244A-01/3
MRF549	−70	−100	−400	15–	—	2/−10	244A-01/3
NPN-PNP Pair							
CR820	70/−65	120/−80	—	40(16)	1/±15, ±50	2.5/±15	

(16) Typical
(19) Available in JTX equivalent by replacing "LT" and "TX" prefix
(20) Output in volts according to DIN45004B

High-Speed Switches

The transistors listed below are for use as high-frequency current-mode switches. They are also suitable for RF amplifier and oscillator applications. The devices are listed in ascending order of collector current. These devices are NPN polarity unless otherwise designated.

Device	Test Conditions I_C/V_{CE} mA/Volts	f_T MHz Min	$r_b' C_C$ ps Max	Package/Style
2N3959	10/10	1300	25	22-03/1
2N3960	10/10	1600	40	22-03/1
2N5835	10/6	2500	5 (16)	20-03/10
MM4049 (5)	20/5	4000	15	20-03/10
MRF914	20/10	4500 (16)	—	20-03/10
2N5583 (5)	50/10	1000	8 (16)	79-04/1
2N5836	50/6	2000	6 (16)	26-03/1
2N5943	50/15	1200	5.5 (16)	79-04/1
2N5837	100/3	1700	6 (16)	26-03/1

UHF and Microwave Oscillators

The transistors listed below are for UHF and microwave oscillator applications as initial signal sources or as output stages of limited range transmitters. Devices are listed in order of increasing output power.

Device	Test Conditions		P_{out} mW Min	f_T MHz Typ	Package/Style
	f MHz	V_{CC} Volts			
2N5179	500	10	20	1400	20-03/10
2N2857	500	10	30	1600	20-03/10
MM8009	1680	20	200	1400	79-04/1
2N5108	1680	20	300	1400	79-04/1
MRF905	1680	20	500 (16)	2200	26-03/1
2N3866	400	15	1000	800	79-04/1
MPS3866	400	15	1000	800	29-04/2
MRF3866	400	15	1000	800	751-02/1

High Reliability (MIL) Transistors

The listed devices are active per QPL-19500 (Qualified Products List). For detailed specification, see indicated page numbers.

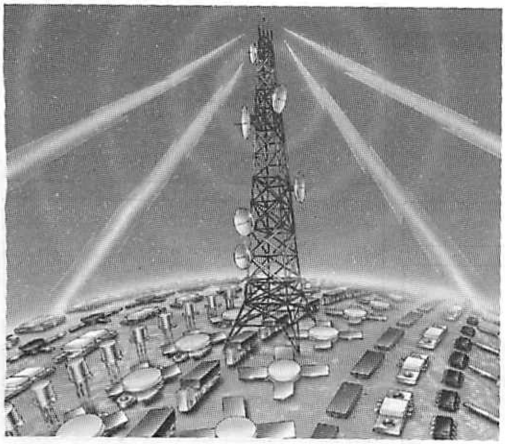
Device	Page #	JAN	JTX	JTXV	JANS
2N2857	39	X	X	X	X
2N3553	22	X	X	X	
2N3866	25	X	X	X	
2N3959	44			X	
2N3960	44	X	X	X	
2N4957	39	X	X	X	
2N5109	40	X	X	X	
2N6603	39	X	X	X	
2N6604	39	X	X	X	

(5) PNP (16) Typical

Complementary Devices

The transistor complements listed are suitable for most applications requiring NPN and PNP devices of similar RF characteristics. Special matching of complementary transistors is available upon request. See indicated pages for specifications.

NPN	Page #	PNP	Page #
2N2857	1-21	2N4958	1-21
2N3866	1-8	2N5160	1-8
2N5943	1-22	2N5583	1-22
MRF904	1-22	MM4049	1-22
MRF571	1-18	MRF521	1-18



Volume I

Discrete Transistor Data Sheets

2

2N2857

2

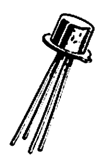
The RF Line

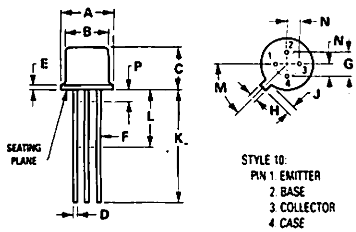
NPN SILICON
RF SMALL-SIGNAL
TRANSISTORS

NPN SILICON RF SMALL-SIGNAL TRANSISTORS

. . . designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain—Bandwidth Product —
  f_T = 1.6 GHz (Typ) @ I_C = 8.0 mAdc
- Low Collector-Base Time Constant —
  $r_b'C_c$ = 15 ps (Max) @ I_E = 2.0 mAdc
- Characterized with Scattering Parameters
- Ideal for Micro-Power Applications





STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CB}	30	Vdc
Emitter-Base Voltage	V_{EB}	2.5	Vdc
Collector Current — Continuous	I_C	40	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.72	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

2

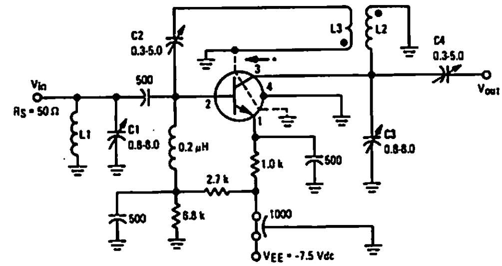
*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage** (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.01	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30	–	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product ① (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1000	–	1900	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	–	0.7	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	50	–	220	–
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 6.0 Vdc, f = 31.9 MHz)	$r_b'C_c$	4.0	–	15	ps
Noise Figure (Figure 1)	NF				dB
(I_E = 0.1 mAdc, V_{CE} = 1.0 Vdc, R_S = 50 ohms, f = 450 MHz) ②		–	5.8	–	
(I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 ohms, f = 450 MHz)		–	4.1	4.5	
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1)	G_{pe}				dB
(I_E = 0.1 mAdc, V_{CE} = 1.0 Vdc, f = 450 MHz) ②		–	11	–	
(I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)		12.5	–	19	
Power Output (Figure 2) (I_E = 12 mAdc, V_{CB} = 10 Vdc, f = 500 MHz)	P_{out}	30	–	–	mW

*Indicates JEDEC Registered Data.
**Motorola guarantees this data in addition to JEDEC Registered Data.
① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.
② Micro-Power Specifications.

2

FIGURE 1 — TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN

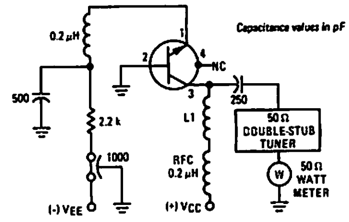


Capacitance values in pF

L1, L2 – Silver-plated brass rod, 1-1/2" long and 1/4" dia. Install at least 1/2" from nearest vertical chassis surface.
L3 – 1/2 turn #16 AWG wire, located 1/4" from and parallel to L2.
* – External interlead shield to isolate collector lead from emitter and base leads.

Neutralization Procedure:
(A) Connect 450-MHz signal generator (with $R_S = 50$ ohms) to input terminals of amplifier.
(B) Connect 50-ohm RF voltmeter across output terminals of amplifier.
(C) Apply V_{EE}, and with signal generator adjusted for 5 mV output from amplifier, tune C1, C3, and C4 for maximum output.
(D) Interchange connections to signal generator and RF voltmeter.
(E) With sufficient signal applied to output terminals of amplifier, adjust C2 for minimum indication at input.
(F) Repeat steps (A), (B), and (C) to determine if retuning is necessary.

FIGURE 2 — TEST CIRCUIT FOR OSCILLATOR POWER OUTPUT



L1 – 3 turns #16 AWG wire, 3/8" O.D. 1-1/4" long.

FIGURE 3 — NOISE FIGURE versus FREQUENCY

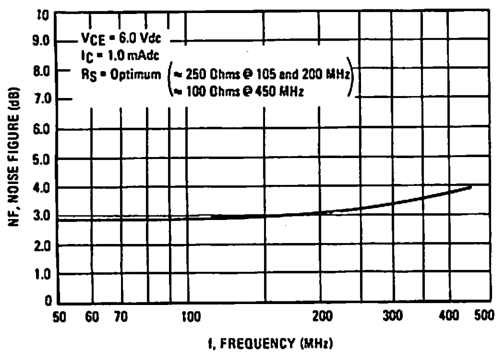


FIGURE 4 — NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

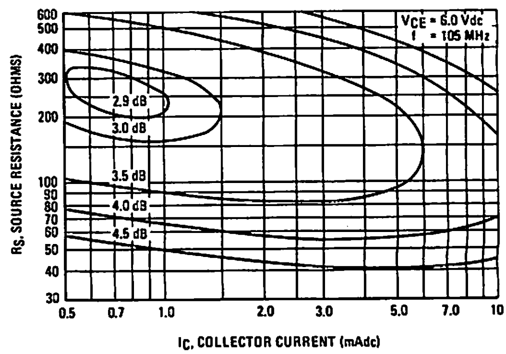


FIGURE 5 — NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

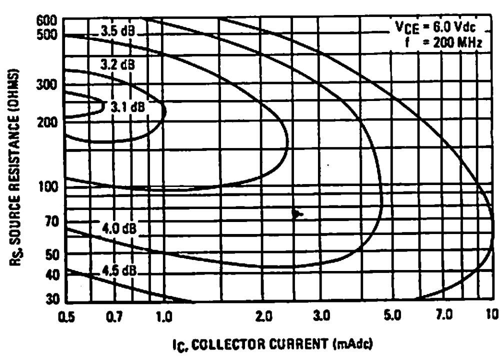


FIGURE 6 – CURRENT-GAIN–BANDWIDTH PRODUCT

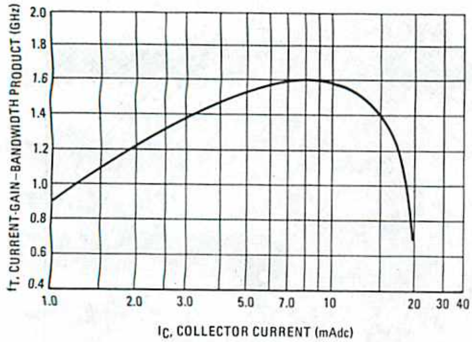


FIGURE 7 – NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

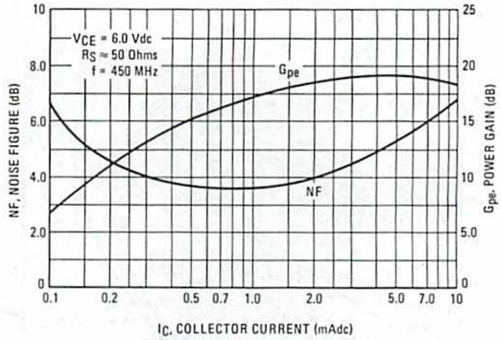


FIGURE 8 – INPUT ADMITTANCE versus FREQUENCY

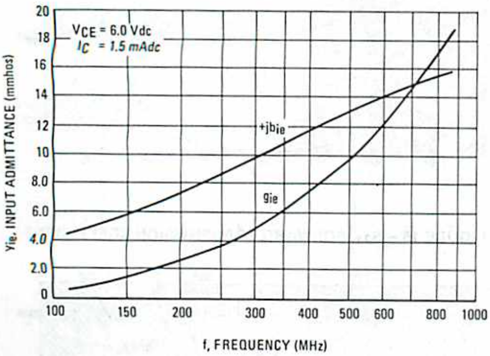


FIGURE 9 – OUTPUT ADMITTANCE versus FREQUENCY

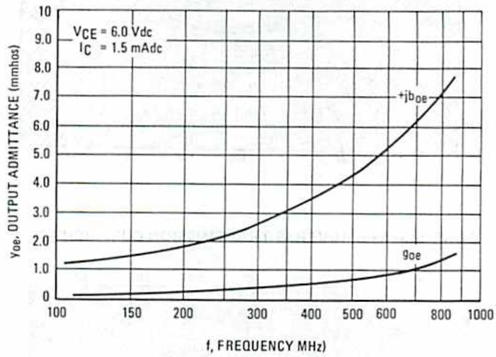


FIGURE 10 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

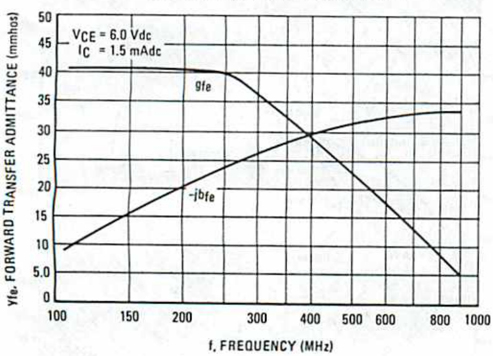


FIGURE 11 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

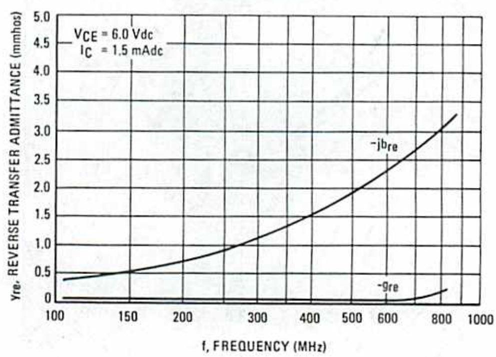


FIGURE 12 — S_{11}, INPUT REFLECTION COEFFICIENT

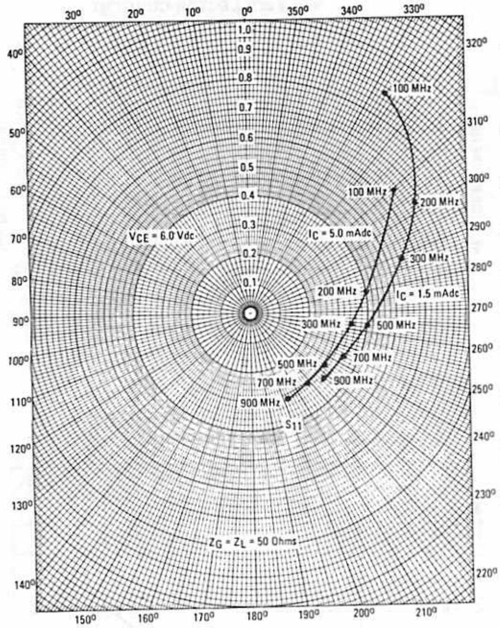


FIGURE 13 — S_{22}, OUTPUT REFLECTION COEFFICIENT

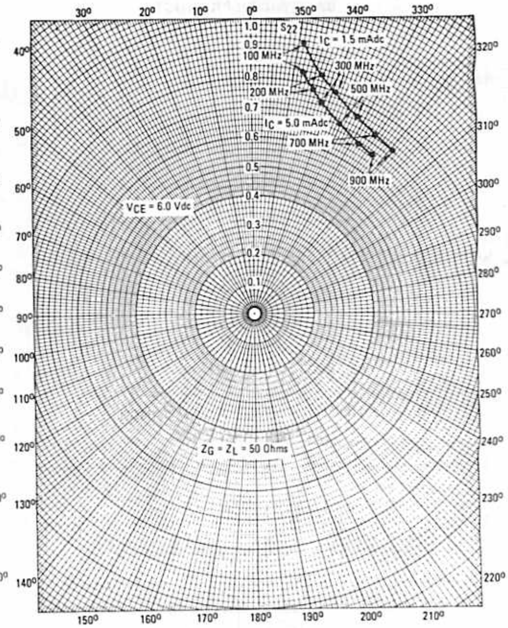


FIGURE 14 — S_{12}, REVERSE TRANSMISSION COEFFICIENT

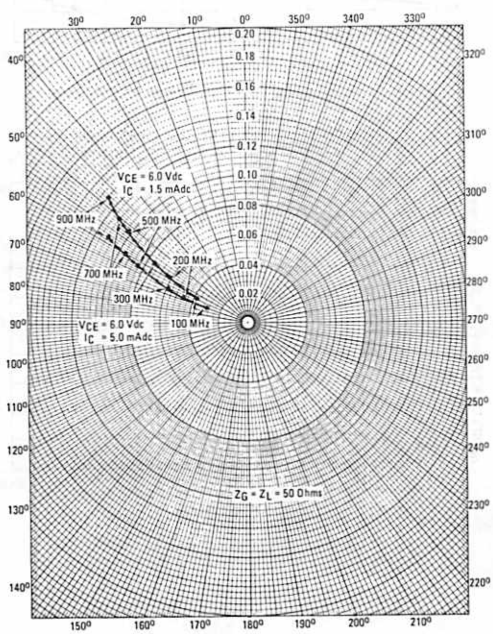


FIGURE 15 — S_{21}, FORWARD TRANSMISSION COEFFICIENT

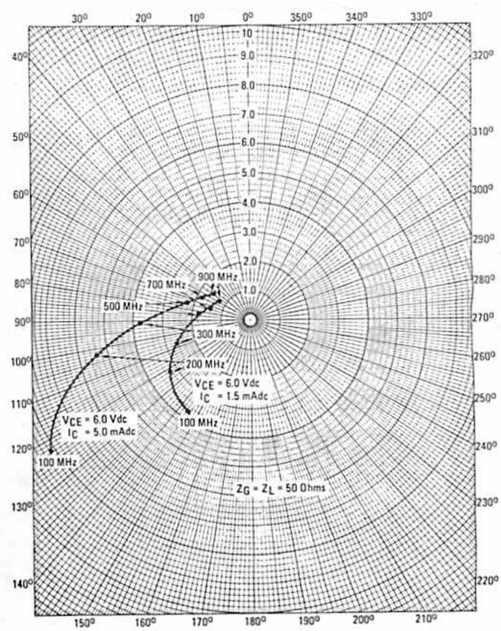
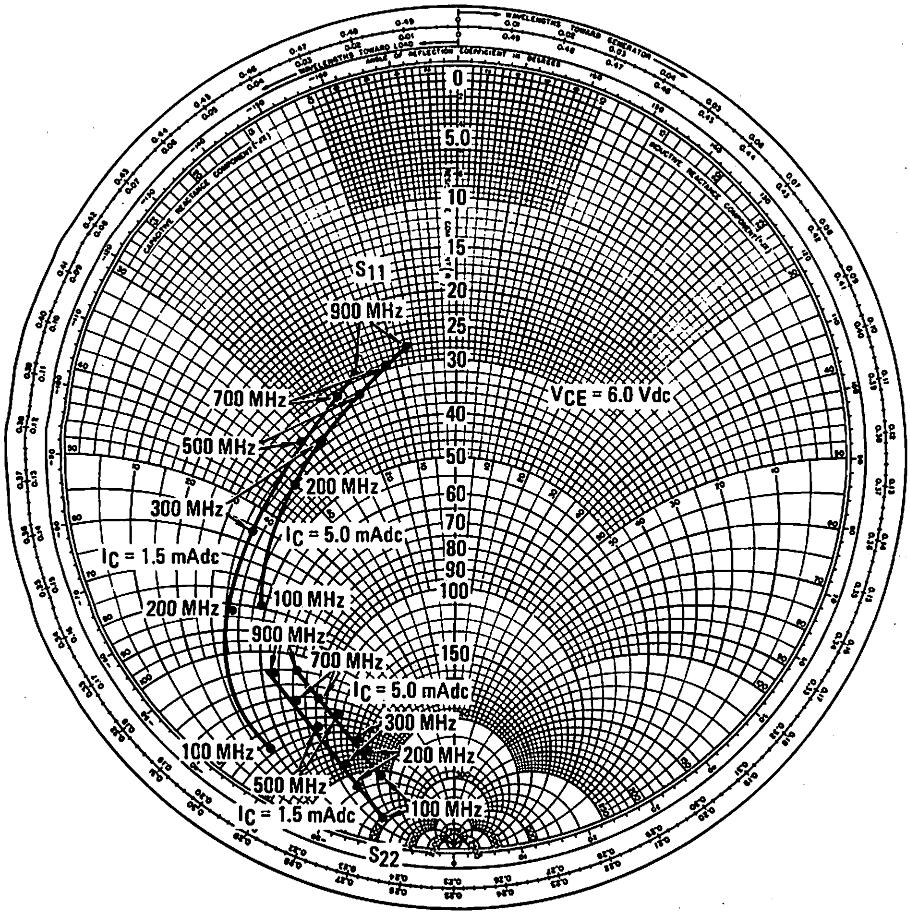


FIGURE 16 – S_{11}, INPUT REFLECTION COEFFICIENT AND S_{22}, OUTPUT REFLECTION COEFFICIENT



2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N3553

The RF Line

2

NPN SILICON HIGH-FREQUENCY TRANSISTOR

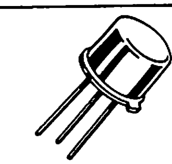
. . . designed for amplifier and oscillator applications in military and industrial equipment. Suitable for use as output, driver or pre-driver stages in VHF equipment.

- Specified 175 MHz, 28 Vdc Characteristics —
  Output Power = 2.5 Watts
  Minimum Gain = 10 dB
  Efficiency = 50%

2.5 W — 175 MHz

HIGH FREQUENCY TRANSISTOR

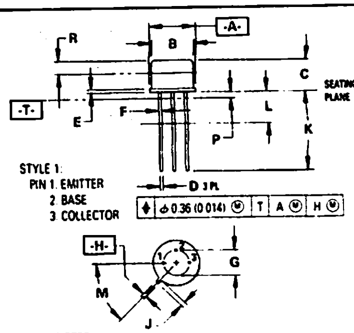
NPN SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



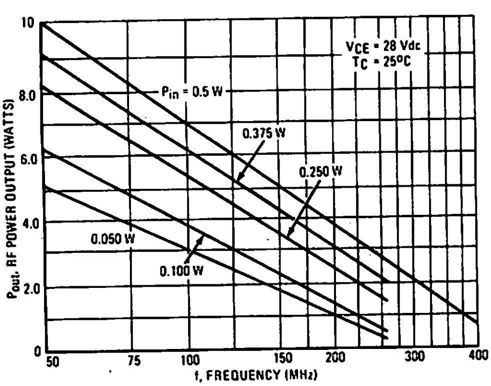
STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

FIGURE 1 — OUTPUT POWER versus FREQUENCY



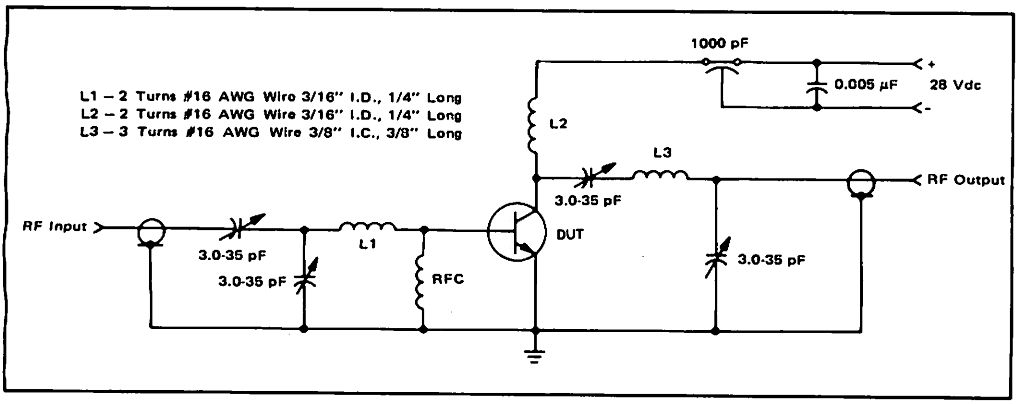
2

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (1) (I_C = 200 mAdc, I_B = 0)	$V_{CEO(sus)}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, I_B = 0)	I_{CEO}	–	–	0.1	mAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, $V_{BE(off)}$ = 1.5 Vdc, T_C = 200°C) (V_{CE} = 65 Vdc, $V_{BE(off)}$ = 1.5 Vdc)	I_{CEX}	– –	– –	5.0 1.0	mAdc
Emitter Cutoff Current (V_{BE} = 4.0 Vdc, I_C = 0)	I_{EBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–	–
Collector-Emitter Saturation Voltage (I_C = 250 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	–	–	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 100 mAdc, V_{CE} = 28 Vdc, f = 100 MHz)	f_T	–	500	–	MHz
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	–	8.0	10	pF
FUNCTIONAL TESTS					
Power Input (V_{CE} = 28 Vdc, P_{out} = 2.5 Watts, f = 175 MHz)	P_{in}	–	–	0.25	Watt
Common-Emitter Amplifier Power Gain (V_{CE} = 28 Vdc, P_{out} = 2.5 Watts, f = 175 MHz)	G_{pe}	10	–	–	dB
Collector Efficiency (V_{CE} = 28 Vdc, P_{out} = 2.5 Watts, f = 175 MHz)	η	50	–	–	%

**Indicates JEDEC Registered Data*
(1) Pulsed thru a 25 mH inductor.

FIGURE 2 — 175 MHz TEST CIRCUIT SCHEMATIC

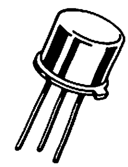


MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N3866
2N3866A

The RF Line

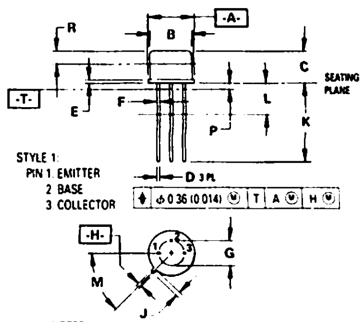
1.0 W – 400 MHz
HIGH FREQUENCY TRANSISTOR
NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for amplifier and oscillator applications in military and industrial equipment. Suitable for use as output, driver or pre-driver stages in VHF and UHF equipment.

- Specified 400 MHz, 28 Vdc Characteristics –
  Output Power = 1.0 Watt
  Minimum Gain = 10 dB
  Efficiency = 45%
- Large Signal Series Equivalent Impedances
- S-Parameter Characterization



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
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2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	5.0 28.6	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

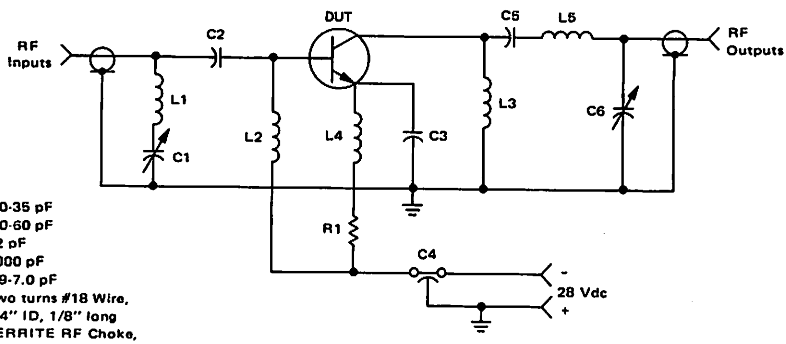
*Indicates JEDEC Registered Data

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)		$V_{CEO(sus)}$	30	—	Vdc
Collector-Base Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 Ω)		$V_{CER(sus)}$	55	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, I_B = 0)		I_{CEO}	—	0.02	mAdc
Emitter Cutoff Current (V_{BE} = 3.5 Vdc, I_C = 0)		I_{EBO}	—	0.1	mAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = −1.5 Vdc (Rev.), T_C = 200°C) (V_{CE} = 55 Vdc, V_{BE} = −1.5 Vdc (Rev.)		I_{CEX}	 — —	 5.0 0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 360 mAdc, V_{CE} = 5.0 Vdc) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	 Both 2N3866 2N3866A	h_{FE}	 5.0 10 25	 — 200 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)		$V_{CE(sat)}$	—	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	 2N3866 2N3866A	f_T	 500 800	 — —	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)		C_{ob}	—	3.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)		G_{PE}	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)		η	45	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 – 400 MHz TEST CIRCUIT SCHEMATIC



C1: 3.0-35 pF
C2,C5: 8.0-60 pF
C3: 12 pF
C4: 1000 pF
C6: 0.9-7.0 pF
L1: Two turns #18 Wire, 1/4" ID, 1/8" long
L2: FERRITE RF Choke, One Turn, z = 450 Ohms
L3,L4: RF Choke, 0.1 μH
L5: 2-3/4 Turns, #18 Wire, 1/4" ID, 3/16" long
R1: 5.6 Ohms

FIGURE 2 — POWER OUTPUT versus FREQUENCY (Class C)

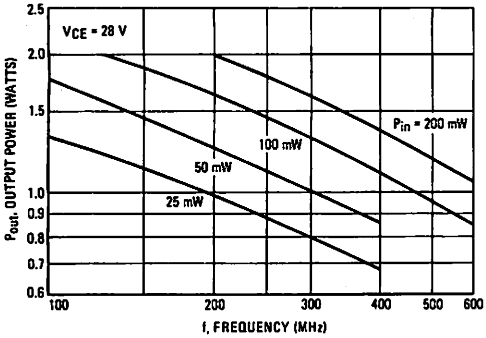


FIGURE 3 — CURRENT-GAIN — BANDWIDTH PRODUCT

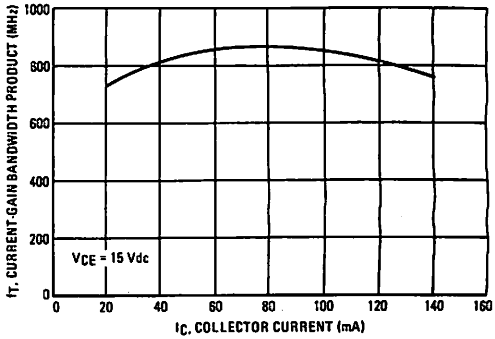


FIGURE 4 — COLLECTOR-BASE TIME CONSTANT

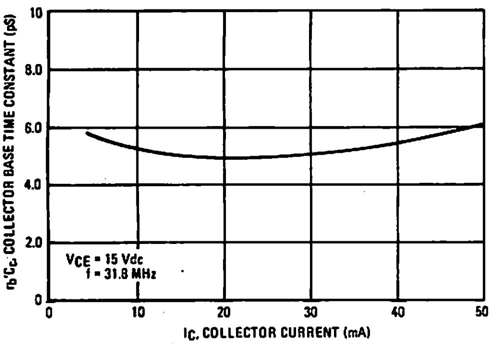


FIGURE 5 — OUTPUT CAPACITANCE

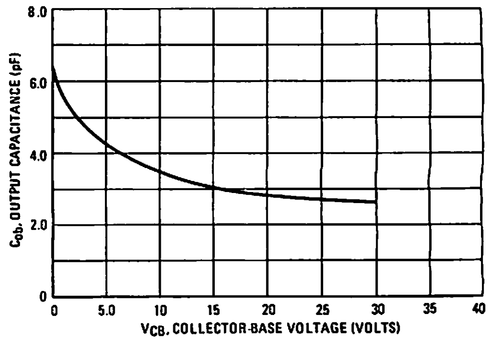


FIGURE 6 — OUTPUT POWER versus INPUT POWER (CLASS C)

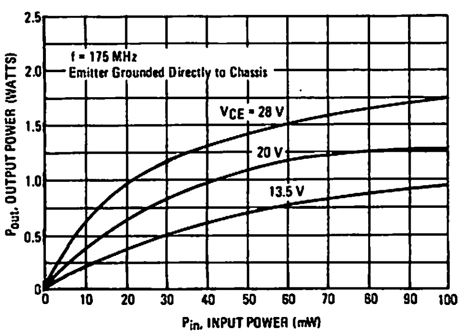


FIGURE 7 — SMALL-SIGNAL CURRENT GAIN

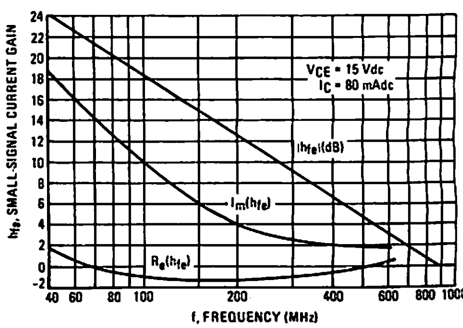


FIGURE 8 — LARGE-SIGNAL SERIES EQUIVALENT IMPEDANCES

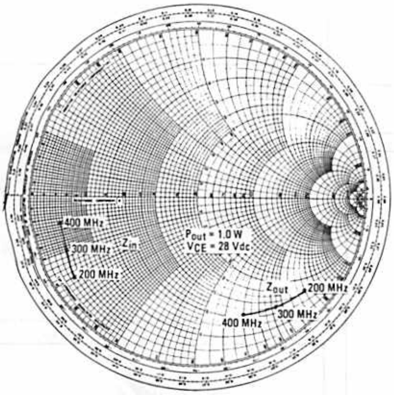


FIGURE 9 — S_{11} AND S_{22} versus FREQUENCY

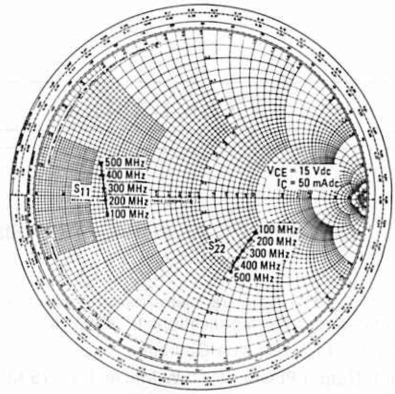


FIGURE 10 — S_{21} versus FREQUENCY

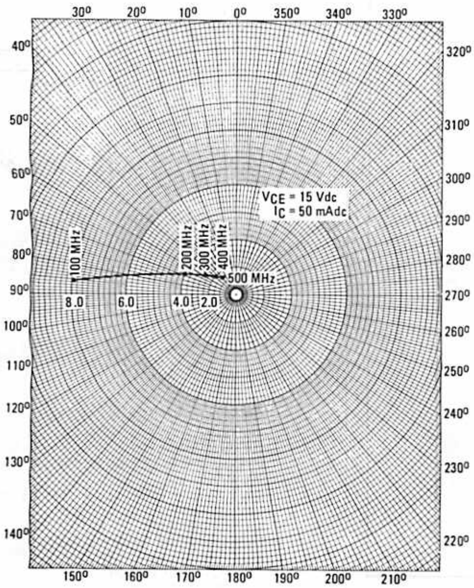
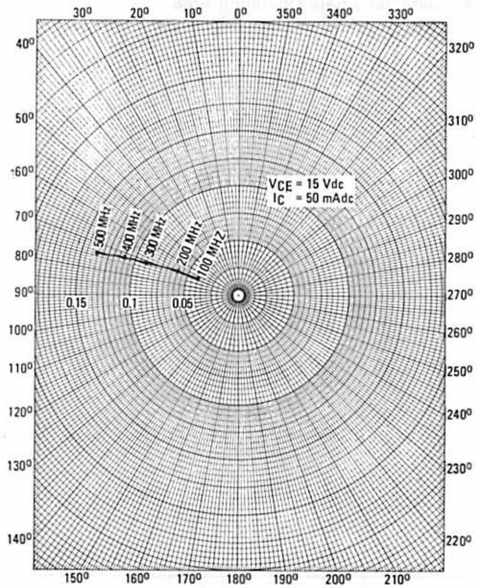


FIGURE 11 — S_{12} versus FREQUENCY



2N3924

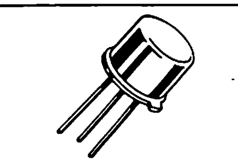
The RF Line

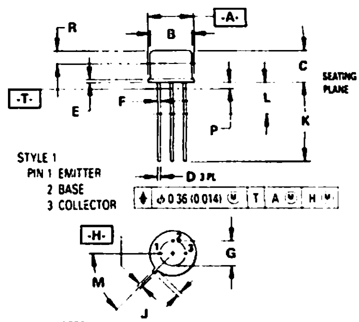
NPN SILICON RF POWER TRANSISTOR

. . . optimized Annular transistor for large-signal power-amplifier and driver applications to 300 MHz.

- Designed for 13.6 Volt Operation
- High Output Power — 4.0 W Min @ f = 175 MHz
- Multiple-Emitter Construction for Excellent High-Frequency Performance
- Guaranteed Safe Operating Area
  $V_{CEO(sus)}$ Measured at I_C = 200 mAdc

**NPN SILICON
RF POWER TRANSISTOR**





NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

**CASE 79-04
TO-205AD
(TO-39)**

***MAXIMUM RATINGS** (T_A = 25°C unless otherwise noted)

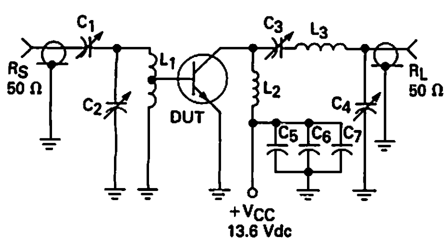
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current	I_C	0.5	Adc
Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	7.0 40	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Sustaining Voltage (Figure 2) (I_C = 200 mAdc)		$V_{CEO(sus)}$	18	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.25 mAdc, I_E = 0)		$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)		$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)		I_{CBO}	— —	— —	0.1 5.0	mAdc
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 13.6 Vdc, f = 100 MHz		f_T	—	350	—	MHz
Output Capacitance (V_{CB} = 13.6 Vdc, I_E = 0, f = 100 kHz		C_{ob}	—	12.5	20	pF
FUNCTIONAL TESTS						
Power Input	Test Circuit Figure 1	P_{in}	—	—	1.0	Watt
Common-Emitter Amplifier Power Gain	V_{CE} = 13.6 Vdc, R_S = 50 ohms, R_L = 50 ohms, f = 175 MHz	G_{pe}	6.0	7.3	—	dB
Collector Efficiency	P_{out} = 4.0 Watts	η	70	—	—	%

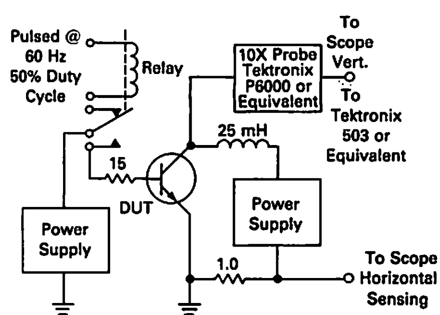
FIGURE 1 — 175 MHz TEST CIRCUIT



C_1, C_2, C_4 .... 5–50 pF (Air variable)
C_3 ....7–100 pF (Air variable)
C_5 ....470 pF (Disc ceramic)
C_6 ....0.01 μF (Disc ceramic)
C_7 ....0.001 μF (Disc ceramic)

L_1 — 1½ turns #14 AWG tinned wire; ⅜" ID Air wound; winding length 5⁄16"; base tapped 1 turn from ground
L_2 — RFC
L_3 — 2 turns #14 AWG tinned wire; ¼" ID Air wound; winding length 5⁄16"

FIGURE 2 — PULSE TEST CIRCUIT



2

CLASS C DESIGN DATA FOR V_{CE} = 13.6 Vdc, T_C = 25°C

(Emitter Grounded Directly to the Chassis — No Tuned-Emitter Techniques Used)

FIGURE 3 — POWER OUTPUT versus FREQUENCY

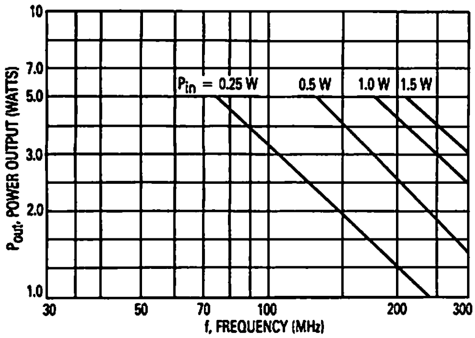


FIGURE 4 — POWER OUTPUT versus POWER INPUT

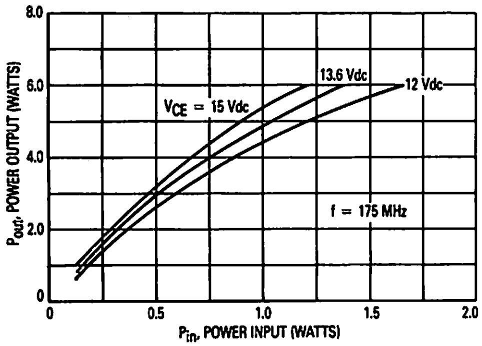


FIGURE 5 — PARALLEL EQUIVALENT INPUT RESISTANCE

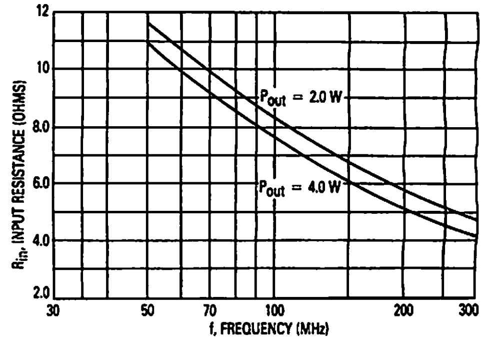


FIGURE 6 — PARALLEL EQUIVALENT INPUT CAPACITANCE

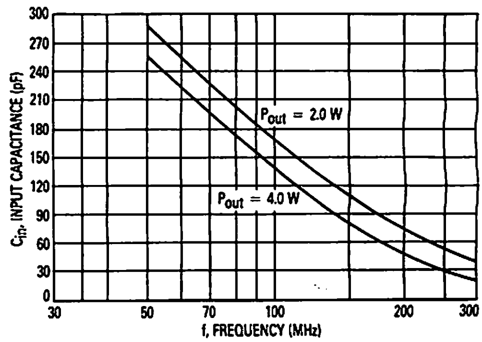
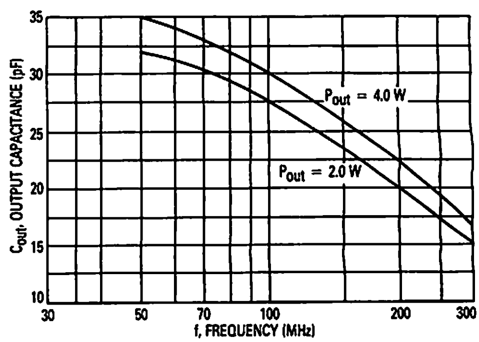


FIGURE 7 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N3948

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

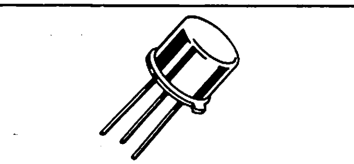
. . . designed for amplifier applications in industrial and commercial equipment. Suitable for use as output, driver or pre-driver stages in UHF equipment.

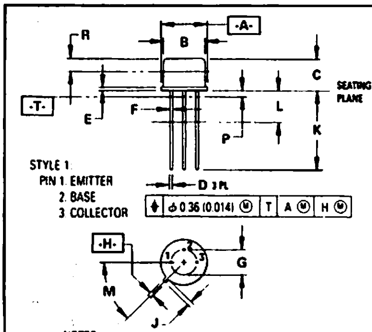
- Specified 400 MHz, 13.6 Vdc Characteristics —
  Output Power = 1.0 Watt
  Minimum Gain = 6.0 dB
  Efficiency = 45%

1.0 W — 400 MHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CB}	36	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	175	°C/W

*Indicates JEDEC Registered Data

2

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	20	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	0.1	µAdc
(V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)		–	100	
ON CHARACTERISTICS				
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	15	–	–
DYNAMIC CHARACTERISTICS				
Current-Gain – Bandwidth Product (I_E = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	700	–	MHz
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.5	pF
FUNCTIONAL TEST				
Power Gain (V_{CC} = 13.6 Vdc, f = 400 MHz, P_{in} = 0.25 W)	G_{pe}	6.0	–	dB
Output Power (V_{CC} = 13.6 Vdc, f = 400 MHz, P_{in} = 0.25 W)	P_{out}	1.0	–	Watt
Collector Efficiency (V_{CC} = 13.6 Vdc, f = 400 MHz, P_{in} = 0.25 W)	η	45	–	%

*Indicates JEDEC Registered Data

FIGURE 1 — 400 MHz RF AMPLIFIER TEST CIRCUIT

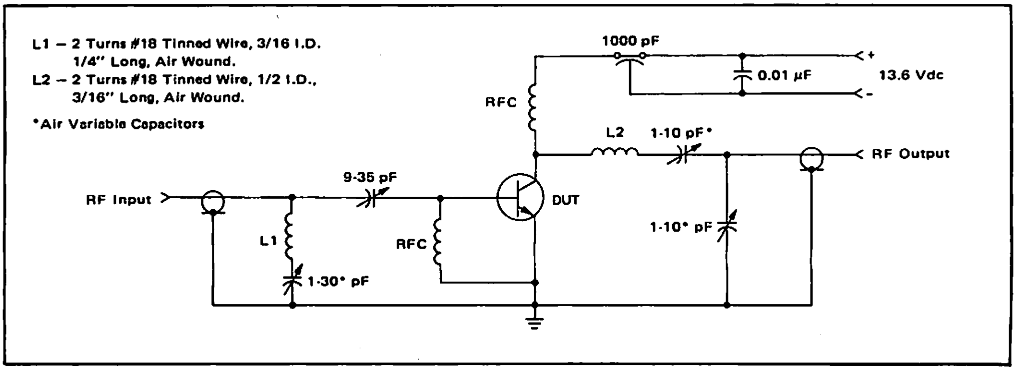


FIGURE 2 — OUTPUT POWER versus FREQUENCY

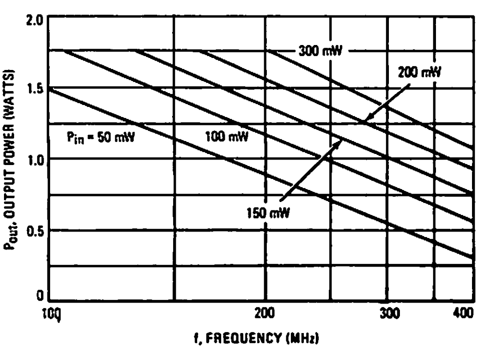
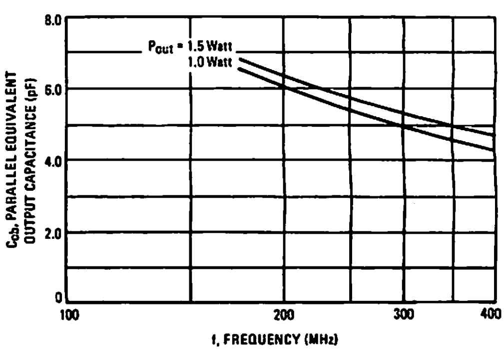


FIGURE 3 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE



2N3959
2N3960

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

. . . designed for high-speed current-mode logic switching applications.

- High Current-Gain—Bandwidth Product — f_T = 1800 MHz (Typ) @ I_C = 10 mAdc
- Low Input and Output Capacitance — C_{ib} and C_{ob} = 2.5 pF (Max)
- *Excellent* Current-Mode Performance — t_r = 1.7 ns (Typ) @ I_C = 30 mAdc
- Low Collector-Base Time Constant — $r_b'C_c$ = 25 ps (Max) @ I_C = 10 mAdc — 2N3959

Current-Mode logic operation, because of the absence of storage time, offers improved high-speed performance for digital applications. In addition, the low impedance drive circuit offers improved delay, rise, and fall times.

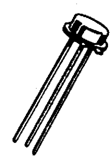
The basic characteristics of importance in current-mode logic applications are Current-Gain—Bandwidth Product (f_T), Input and Output Capacitance (C_{ib} and C_{ob}), and Base Spreading Resistance (r'_b).

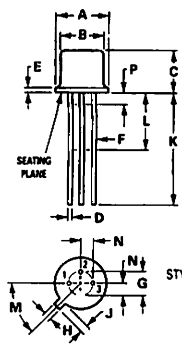
The 2N3959 and 2N3960 offer a combination of extremely high f_T values, low capacitances, and low base spreading resistance which results in exceptionally high speed in current-mode logic circuits.

1.8 GHz — 10 mAdc

HIGH FREQUENCY TRANSISTORS

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.406	0.533	0.016	0.021
E	—	0.762	—	0.030
F	0.406	0.483	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 22-03
TO-206AA
(TO-18)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base Voltage	V_{EB}	4.5	Vdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	400 2.3	mW mW/°C
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	750 4.3	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	0.436	°C/mW
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.233	°C/mW

*Indicates JEDEC Registered Data.

2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Fig. No.	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	–	$V_{(BR)CEO}$	12	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	–	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	–	$V_{(BR)EBO}$	4.5	–	–	Vdc
Collector Reverse Current	–	I_{CEX}				μAdc
(V_{CE} = 10 Vdc, V_{EB} = 2.0 Vdc)			–	–	0.005	
(V_{CE} = 10 Vdc, V_{EB} = 2.0 Vdc, T_A = 150°C)			–	–	5.0	
Base Cutoff Current (V_{CE} = 10 Vdc, V_{EB} = 2.0 Vdc)	–	I_{BL}	–	–	0.005	μAdc
Collector Forward Current (V_{CE} = 5.0 Vdc, V_{BE} = 0.4 Vdc)	–	I_{CEX}	–	–	1.0	μAdc
***ON CHARACTERISTICS**						
DC Current Gain	1	h_{FE}				–
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			25	–	–	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)			40	–	400	
(I_C = 30 mAdc, V_{CE} = 1.0 Vdc)			25	–	–	
Collector-Emitter Saturation Voltage	–	$V_{CE(sat)}$				Vdc
(I_C = 1.0 mAdc, I_B = 0.1 mAdc)			–	–	0.2	
(I_C = 30 mAdc, I_B = 3.0 mAdc)			–	–	0.3	
Base-Emitter "on" Voltage	–	$V_{BE(on)}$				Vdc
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)			–	–	0.8	
(I_C = 30 mAdc, V_{CE} = 1.0 Vdc)			–	–	1.0	
***DYNAMIC CHARACTERISTICS**						
Current-Gain—Bandwidth Product	2	f_T				MHz
(I_C = 5.0 mAdc, V_{CE} = 4.0 Vdc, f = 100 MHz) 2N3959			1000	–	–	
2N3960			1300	–	–	
(I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 100 MHz) 2N3959			1300	–	–	
2N3960			1600	–	–	
(I_C = 30 mAdc, V_{CE} = 4.0 Vdc, f = 100 MHz) 2N3959			1000	–	–	
2N3960			1200	–	–	
Output Capacitance (V_{CB} = 4.0 Vdc, I_E = 0, f = 1.0 MHz)	4	C_{ob}	–	2.0	2.5	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 MHz)	4	C_{ib}	–	1.5	2.5	pF
Collector-Base Time Constant	3	$r_b'C_c$				ps
(I_C = 5.0 mAdc, V_{CE} = 4.0 Vdc) 2N3959			–	–	30	
2N3960			–	–	50	
(I_C = 10 mAdc, V_{CE} = 10 Vdc) 2N3959			–	–	25	
2N3960			–	–	40	
(I_C = 30 mAdc, V_{CE} = 4.0 Vdc) 2N3959			–	–	30	
2N3960			–	–	50	
SWITCHING CHARACTERISTICS (Figure 7)						
Turn-On Delay Time	–	$t_{d(on)}$				ns
(I_C = 10 mAdc, V_{out} = 1.0 Vdc)			–	2.4	–	
(I_C = 30 mAdc, V_{out} = 1.0 Vdc)			–	2.0	–	
Rise Time	–	t_r				ns
(I_C = 10 mAdc, V_{out} = 1.0 Vdc) Both Devices			–	3.0	–	
(I_C = 30 mAdc, V_{out} = 1.0 Vdc) 2N3959			–	2.2	–	
2N3960			–	1.7	–	
Turn-Off Delay Time	–	$t_{d(off)}$				ns
(I_C = 10 mAdc, V_{out} = 1.0 Vdc)			–	1.6	–	
(I_C = 30 mAdc, V_{out} = 1.0 Vdc)			–	1.6	–	
Fall Time	–	t_f				ns
(I_C = 10 mAdc, V_{out} = 1.0 Vdc) Both Devices			–	3.3	–	
(I_C = 30 mAdc, V_{out} = 1.0 Vdc) 2N3959			–	2.3	–	
2N3960			–	1.9	–	

*Indicates JEDEC Registered Data.

FIGURE 1 — TYPICAL DC CURRENT GAIN

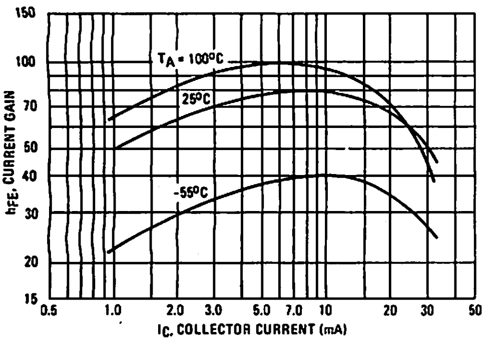


FIGURE 2 — TYPICAL CURRENT-GAIN — BANDWIDTH PRODUCT

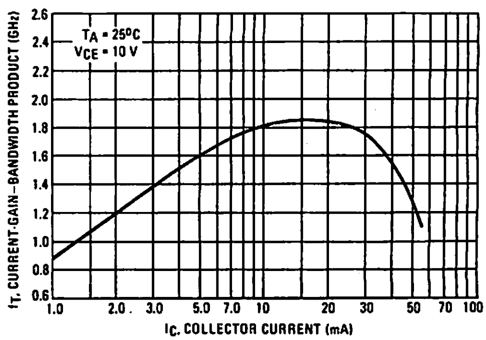


FIGURE 3 — TYPICAL COLLECTOR-BASE TIME CONSTANT

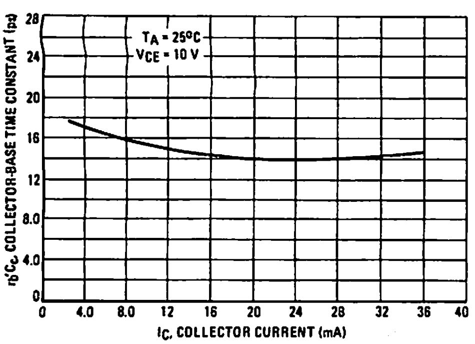
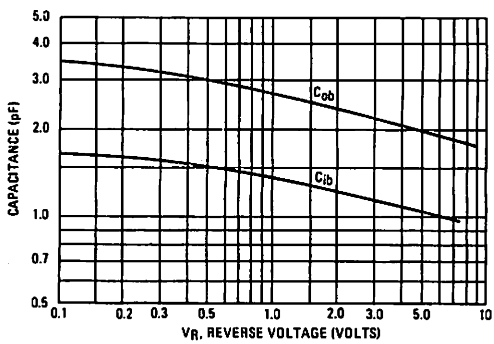


FIGURE 4 — TYPICAL JUNCTION CAPACITANCE



2

2

TURN-ON AND TURN-OFF TIMES

FIGURE 5 – V_{out} = 1.0 Vdc

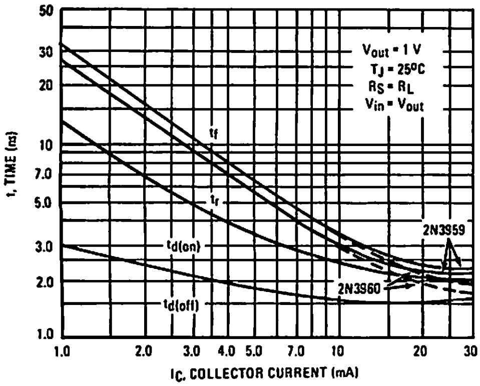


FIGURE 6 – V_{out} = 2.0 Vdc

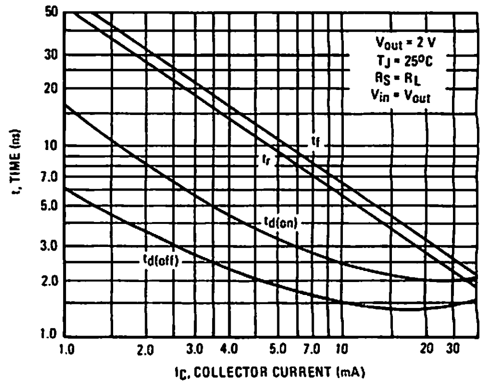
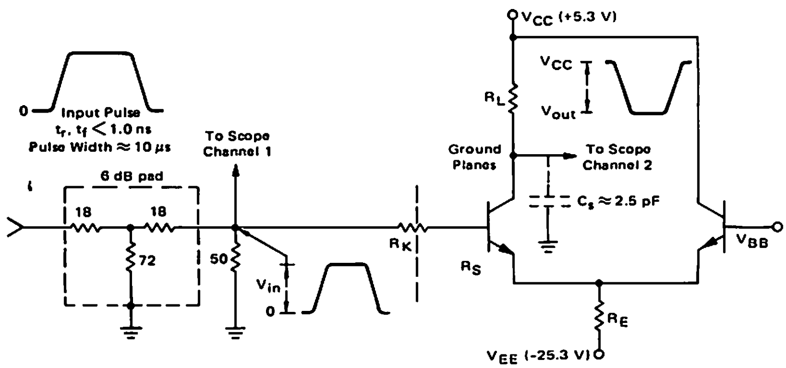


FIGURE 7 – SWITCHING TIMES TEST CIRCUIT



This test set up is designed to simulate a cascade of identical stages. ∴The source resistance (R_S) equals the load resistance (R_L). Values used in the test are shown in the table.

For V_{in} = V_{out} = 1 V, V_{BB} = +0.5 V, R_L & R_K values appropriately reduced.

V_{in} = V_{out} = 2 volts, V_{BB} = +1.0V			
I_C (mA)	R_E (kΩ)	R_L (Ω)	R_K (Ω)
1.0	24.0	2.0 k	2.0 k
3.0	8.2	680	680
10	2.4	200	180
30	0.8	68	36

2N4427

2

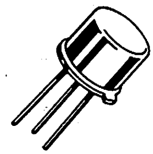
The RF Line

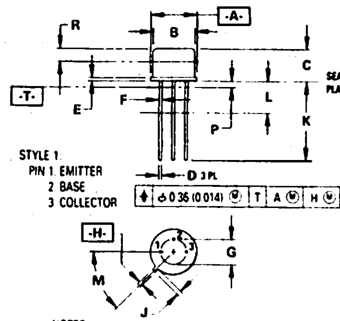
NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Specified 175 MHz, 12 Vdc Characteristics —
  Output Power = 1.0 Watt
  Minimum Gain = 10 dB
  Efficiency = 50%

1 W — 175 MHz
HIGH FREQUENCY TRANSISTOR
NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

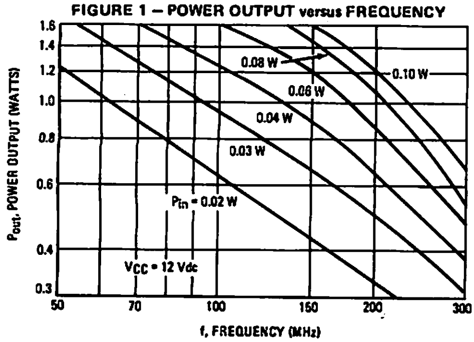
CASE 79-04
TO-205AD
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	20	Vdc
*Collector-Base Voltage	V_{CB}	40	Vdc
*Emitter-Base Voltage	V_{EB}	2.0	Vdc
*Collector Current — Continuous	I_C	400	mAdc
*Base Current — Continuous	I_B	400	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
*Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.5 20	Watts mW/°C
*Storage Temperature Range	T_{stg}	-65 to + 200	°C

*Indicates JEDEC Registered Data

FIGURE 1 — POWER OUTPUT versus FREQUENCY



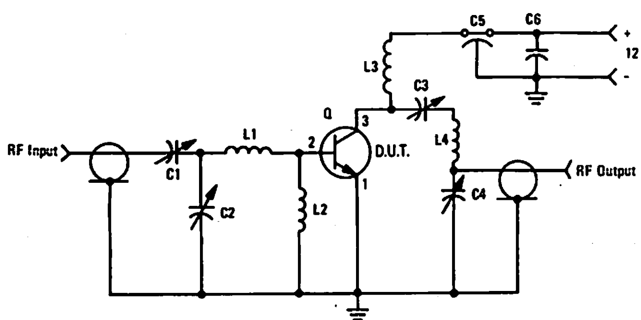
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	20	–	Vdc
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	40	–	Vdc
*Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	–	0.02	mAdc
*Collector Cutoff Current (V_{CE} = 40 Vdc, V_{BE} = –1.5 Vdc) (V_{CE} = 12 Vdc, V_{BE} = –1.5 Vdc, T_C = +150°C)	I_{CEV}	– –	0.1 5.0	mAdc
*Emitter Cutoff Current (V_{EB} = 2.0 Vdc, I_C = 0)	I_{EBO}	–	0.1	mAdc
ON CHARACTERISTICS				
*DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10 5.0	200 –	–
*Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	–	0.5	Vdc
DYNAMIC CHARACTERISTICS				
*Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	500	–	MHz
*Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	4.0	pF
FUNCTIONAL TEST				
*Power Input (Figure 2) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	P_{in}	–	100	mW
Common-Emitter Amplifier Power Gain (P_{in} = 100 mW, V_{CC} = 12 Vdc, f = 175 MHz)	G_{pe}	10	–	dB
*Collector Efficiency (Figure 2) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	η	50	–	%

*Indicates JEDEC Registered Data

FIGURE 2 — 175 MHz RF AMPLIFIER CIRCUIT FOR POWER-OUTPUT TEST



C1, C2, C3, and C4: 3-30 pF
C5: 1,000 pF
C6: 0.01 µF
L1: 2 turns No. 16 wire, 3/16" ID, 1/4" long
L2: Ferrite choke, Z = 450 ohms
L3: 2 turns No. 16 wire, 1/4" ID, 1/4" long
L4: 4 turns No. 16 wire, 3/8" ID, 3/8" long
Q: 2N4427

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N4428

The RF Line

NPN SILICON RF POWER TRANSISTOR

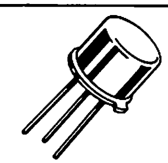
. . . designed primarily for use in large signal VHF and UHF amplifier output stages in military and industrial communications applications.

- Specified 28 Volt, 500 MHz Characteristics –
  Output Power = 750 mW
  Typical Gain = 10 dB
  Efficiency = 35%

0.75 W – 500 MHz

RF POWER TRANSISTOR

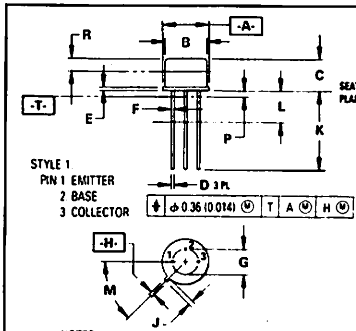
NPN SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	55	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current – Continuous	I_C	425	mAdc
Base Current – Continuous	I_B	150	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	3.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



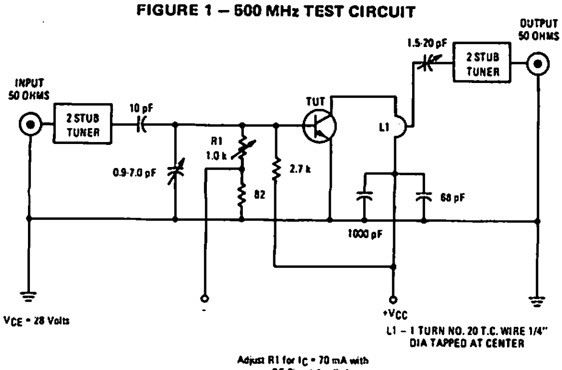
STYLE 1
PIN 1 EMITTER
2 BASE
3 COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
P	–	1.27	–	0.050
R	2.54	–	0.100	–

CASE 79-04
TO-205AD
(TO-39)

FIGURE 1 – 500 MHz TEST CIRCUIT



2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, I_B = 0)	$V_{CEO(sus)}$	35	–	–	Vdc
Collector-Emitter Sustaining Voltage (I_C = 20 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	55	–	–	Vdc
Collector Cutoff Current (V_{CE} = 55 Vdc, $V_{BE(on)}$ = -1.5 Vdc)	I_{CEX}	–	–	1.0	mAdc
Emitter Cutoff Current (V_{EB} = 3.5 Vdc, I_C = 0)	I_{EBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain	h_{FE}				–
(I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		20	–	200	
(I_C = 400 mAdc, V_{CE} = 5.0 Vdc)		5.0	–	–	
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	700	1000	–	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.2	3.5	pF
FUNCTIONAL TEST					
Power Input (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	P_{in}	–	–	75	mW
Collector Efficiency (Figure 1) (P_{out} = 750 mW, V_{CE} = 28 Vdc, R_S = 50 Ohms, f = 500 MHz)	η	35	–	–	%

*Indicates JEDEC Registered Data.

FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

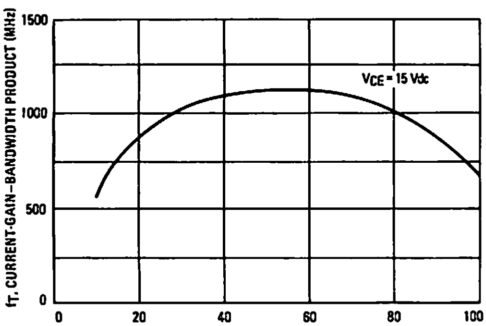
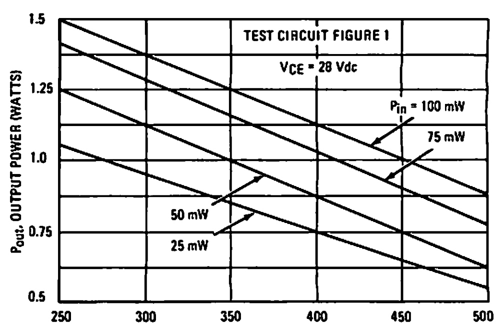


FIGURE 3 — OUTPUT POWER versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N4957
2N4958
2N4959

The RF Line

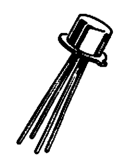
PNP SILICON HIGH FREQUENCY TRANSISTORS

. . . designed for high-gain, low-noise amplifier, oscillator and mixer applications.

- Low Noise Figure @ 450 MHz —
  NF = 3.0 dB (Max) — 2N4957
  = 3.3 dB (Max) — 2N4958
  = 3.8 dB (Max) — 2N4959
- High Power Gain @ 450 MHz —
  G_{pe} = 17 dB (Min) — 2N4957
  = 16 dB (Min) — 2N4958
  = 15 dB (Min) — 2N4959
- High Current-Gain — Bandwidth Product —
  f_T = 1.2 GHz (Min) @ I_E = −2.0 mAdc — 2N4957
  = 1.0 GHz (Min) @ I_E = −2.0 mAdc — 2N4958, 2N4959

I_C = −30 mA
HIGH FREQUENCY TRANSISTORS

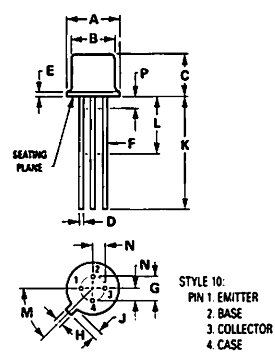
PNP SILICON



***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−30	Vdc
Collector-Base Voltage	V_{CBO}	−30	Vdc
Emitter-Base Voltage	V_{EBO}	−3.0	Vdc
Collector Current — Continuous	I_C	−30	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.



NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

2

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	−30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −100 μAdc, I_E = 0)	$V_{(BR)CBO}$	−30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −100 μAdc, I_C = 0)	$V_{(BR)EBO}$	−3.0	—	—	Vdc
Collector Cutoff Current	I_{CBO}				μAdc
(V_{CB} = −10 Vdc, I_E = 0)		—	—	−0.1	
(V_{CB} = −10 Vdc, I_E = 0, T_A = 150°C)		—	—	−100	
ON CHARACTERISTICS					
DC Current Gain (I_C = −2.0 mAdc, V_{CE} = −10 Vdc)	h_{FE}	20	40	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (1)	f_T				MHz
(I_E = −2.0 mAdc, V_{CE} = −10 Vdc, f = 100 MHz) 2N4957		1200	1600	2500	
2N4958, 2N4959		1000	1500	2500	
Collector-Base Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.4	0.8	pF
Small-Signal Current Gain (I_C = −2.0 mAdc, V_{CE} = −10 Vdc, f = 1.0 kHz)	h_{fe}	20	—	200	—
Collector-Base Time Constant (I_E = −2.0 mAdc, V_{CB} = −10 Vdc, f = 63.6 MHz)	$r_b'C_c$	1.0	—	8.0	ps
Noise Figure	NF				dB
(I_C = −2.0 mAdc, V_{CE} = −10 Vdc, f = 450 MHz) 2N4957		—	2.6	3.0	
2N4958		—	2.9	3.3	
2N4959		—	3.2	3.8	
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain	G_{pe}				dB
(V_{CE} = −10 Vdc, I_C = −2.0 mAdc, f = 450 MHz) 2N4957		17	—	25	
2N4958		16	—	25	
2N4959		15	—	25	

*Indicates JEDEC Registered Data.
(1) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

FIGURE 1 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT

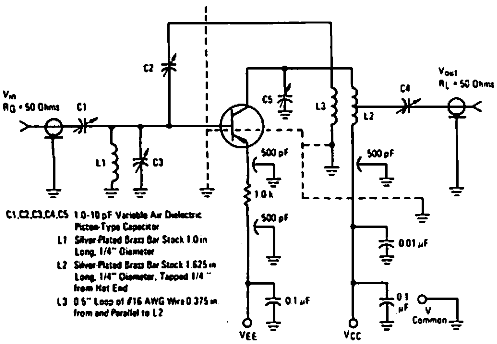


FIGURE 2 — UNILATERALIZED POWER GAIN versus FREQUENCY

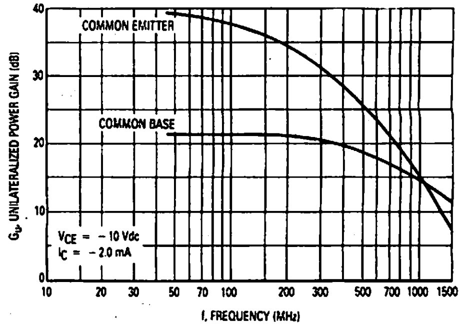


FIGURE 3 — NOISE FIGURE versus FREQUENCY

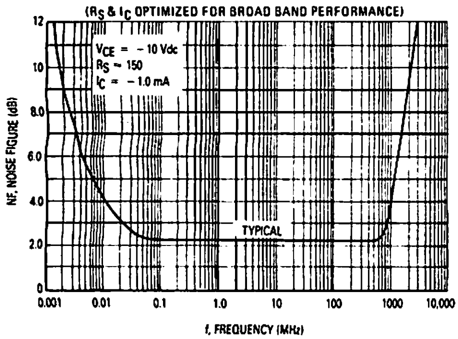


FIGURE 4 — NOISE FIGURE AND POWER GAIN versus COLLECTOR CURRENT

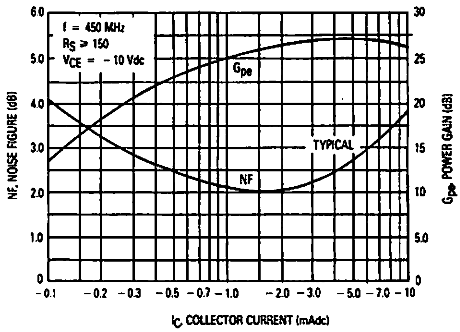


FIGURE 5 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT

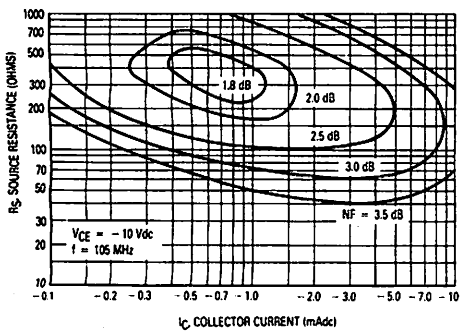
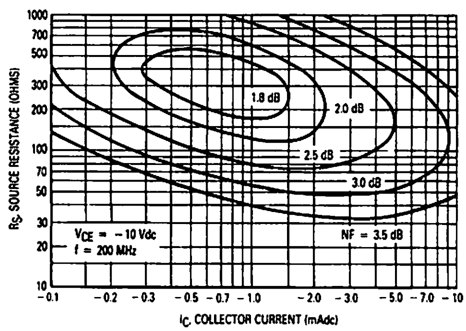


FIGURE 6 — CONTOURS OF NOISE FIGURE versus SOURCE RESISTANCE AND COLLECTOR CURRENT



2

COMMON EMITTER CIRCUIT DESIGN DATA

$V_{CE} = -10$ Vdc $I_C = -2.0$ mA

FIGURE 7 – TRANSDUCER GAIN versus FREQUENCY

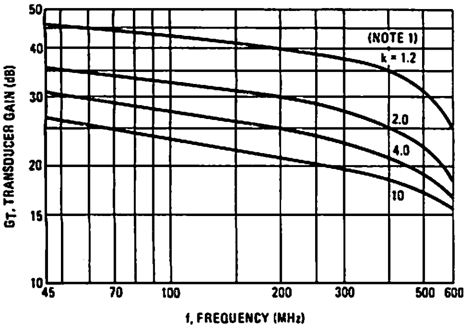


FIGURE 8 – LINVILL STABILITY FACTOR versus FREQUENCY

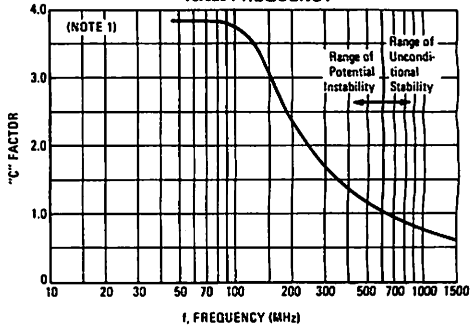


FIGURE 9 – LOAD ADMITTANCE versus FREQUENCY (REAL)

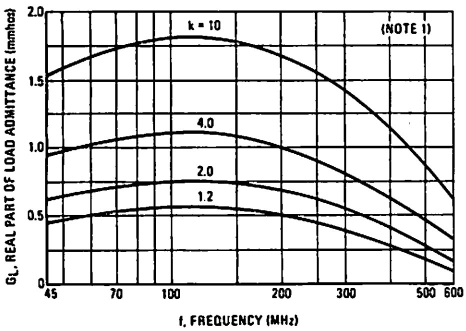


FIGURE 10 – LOAD ADMITTANCE versus FREQUENCY (IMAGINARY)

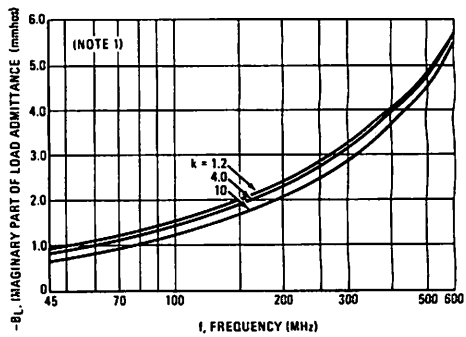


FIGURE 11 – SOURCE ADMITTANCE versus FREQUENCY (REAL)

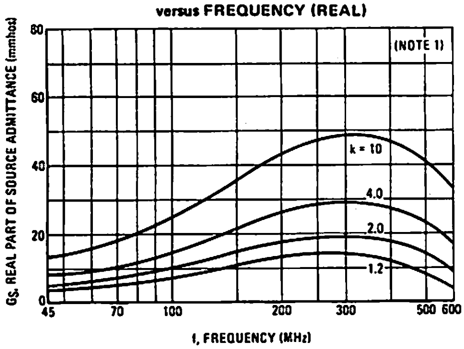
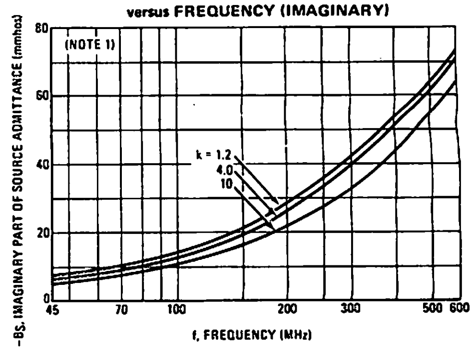


FIGURE 12 – SOURCE ADMITTANCE versus FREQUENCY (IMAGINARY)



NOTE 1

Figures 7 through 18 are included to assist the circuit designer in determining the stability of his particular circuit. Two stability criteria are given in these figures.

The Linvill "C" factor* is a measure of transistor stability when the input and output are terminated in the worst-case (open circuit) condition. When "C" is less than 1.0, the circuit is unconditionally stable. When "C" is greater than 1.0, the circuit is potentially unstable.

The Stern "K" factor† has been defined to determine the stability of a practical amplifier terminated in finite load and source admittances. If "K" is greater than 1.0, the circuit will be stable. If less than 1.0, the circuit will be unstable. For further details, see Application Note AN-215A

* "Transistors and Active Circuits," Linvill and Gibbons, McGraw Hill, 1961.

† "Stability and Power Gain of Tuned Transistor Amplifiers," Arthur P. Stern, Proc. I.R.E., March 1967.

COMMON BASE CIRCUIT DESIGN DATA

V_{CE} = −10 Vdc I_C = −2.0 mA

FIGURE 13 – TRANSDUCER GAIN versus FREQUENCY

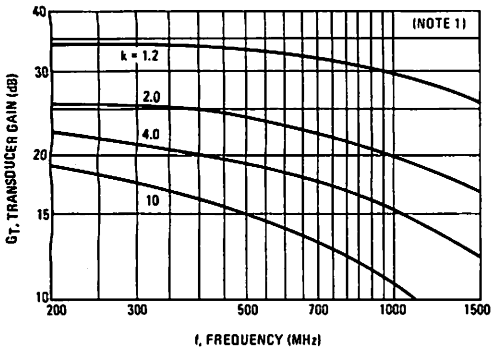


FIGURE 14 – LINVILL STABILITY FACTOR versus FREQUENCY

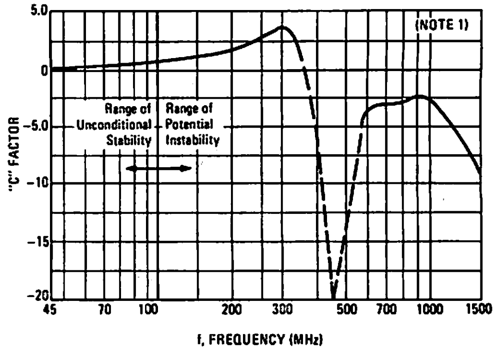


FIGURE 15 – LOAD ADMITTANCE versus FREQUENCY (REAL)

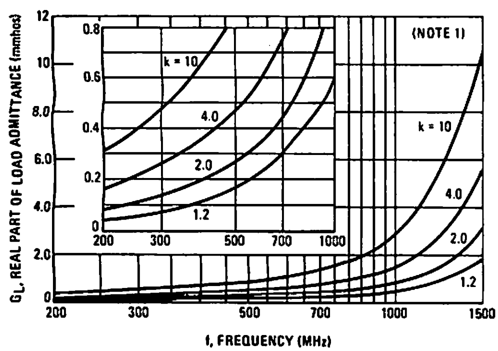


FIGURE 16 – LOAD ADMITTANCE versus FREQUENCY (IMAGINARY)

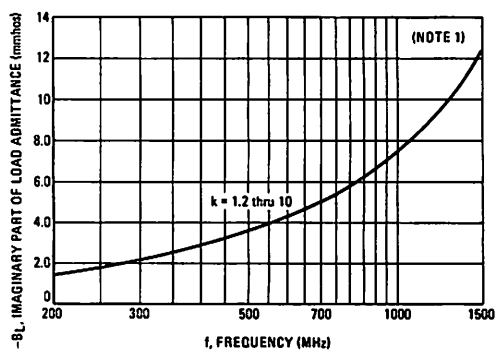


FIGURE 17 – SOURCE ADMITTANCE versus FREQUENCY (REAL)

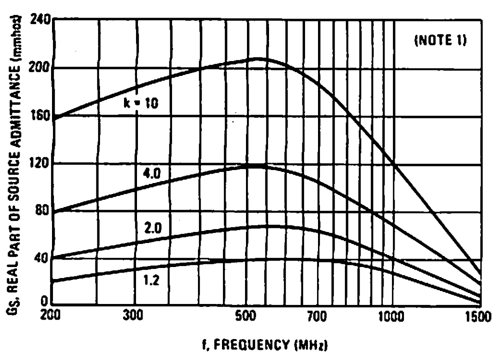


FIGURE 18 – SOURCE ADMITTANCE versus FREQUENCY (IMAGINARY)

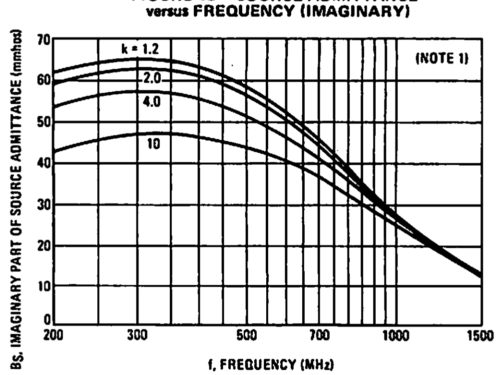


FIGURE 19 — SMALL-SIGNAL CURRENT GAIN versus FREQUENCY

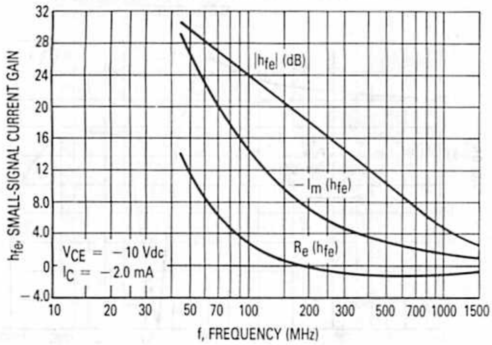


FIGURE 20 — POLAR h_{fe}

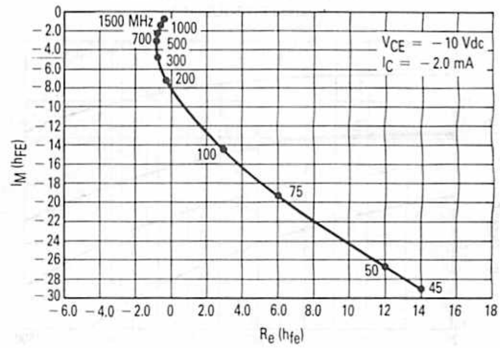


FIGURE 21 — f_T versus COLLECTOR CURRENT

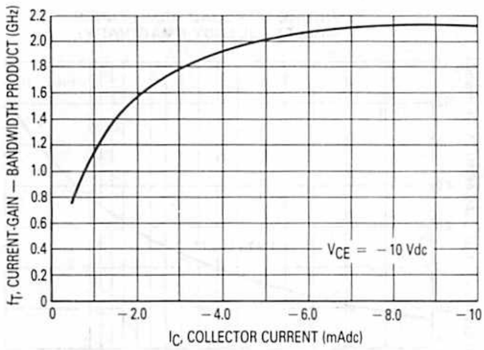


FIGURE 22 — DC CURRENT GAIN

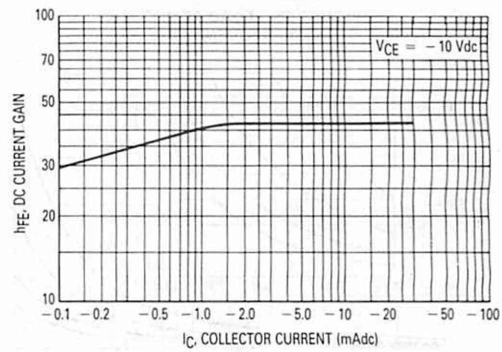


FIGURE 23 — CAPACITANCE

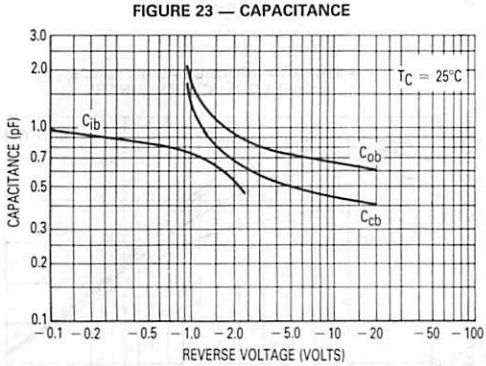
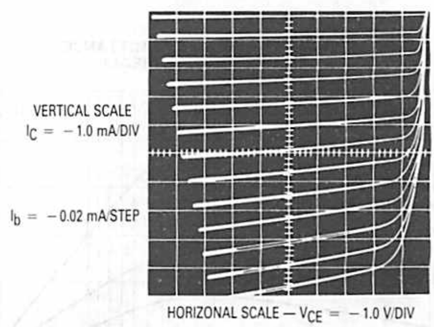
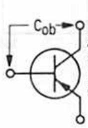
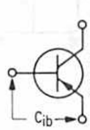


FIGURE 24 — COLLECTOR CHARACTERISTICS

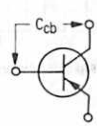




Apply reverse bias between collector and base and measure capacitance between these terminals. Emitter is open.



Apply reverse bias between emitter and base and measure capacitance between these terminals. Collector is open.



Apply reverse bias between collector and base and measure capacitance between these terminals. Emitter is guarded.

Y PARAMETERS versus CURRENT
(f = 450 MHz)

COMMON BASE

V_{CB} = −10 Vdc ——— V_{CB} = −15 Vdc – – –

COMMON EMITTER

V_{CE} = −10 Vdc ——— V_{CE} = −15 Vdc – – –

FIGURE 25 – INPUT ADMITTANCE

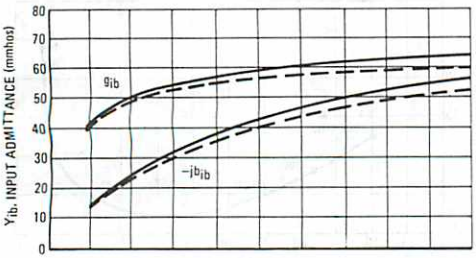


FIGURE 26 – INPUT ADMITTANCE

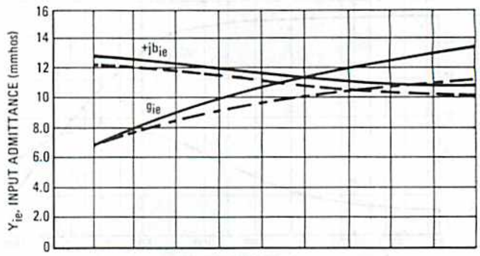


FIGURE 27 – FORWARD TRANSFER ADMITTANCE

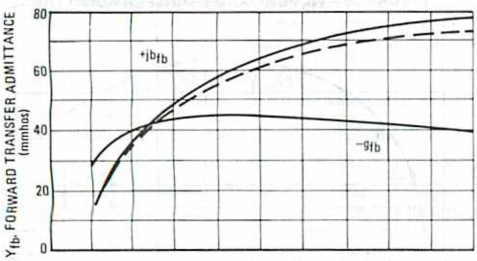


FIGURE 28 – FORWARD TRANSFER ADMITTANCE

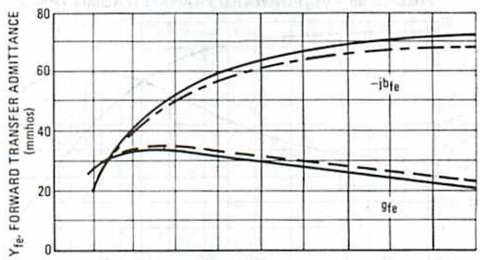


FIGURE 29 – OUTPUT ADMITTANCE

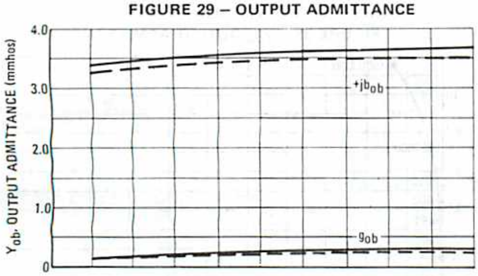


FIGURE 30 – OUTPUT ADMITTANCE

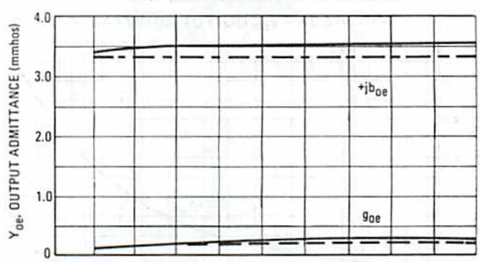


FIGURE 31 – REVERSE TRANSFER ADMITTANCE

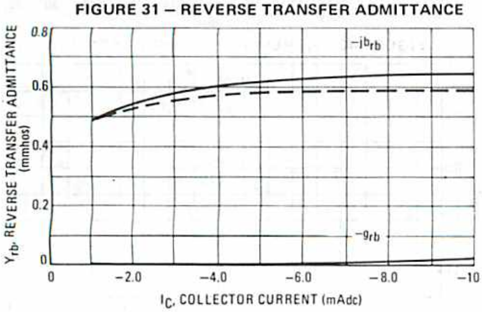
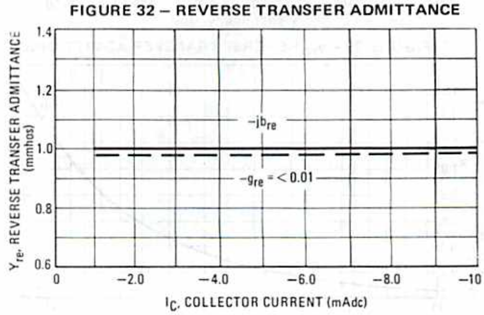


FIGURE 32 – REVERSE TRANSFER ADMITTANCE



2

COMMON BASE y PARAMETER VARIATIONS

(V_{CB} = −10 Vdc, I_C = −2.0 mAdc)

y PARAMETERS versus FREQUENCY

FIGURE 33 – y_{ib} INPUT ADMITTANCE

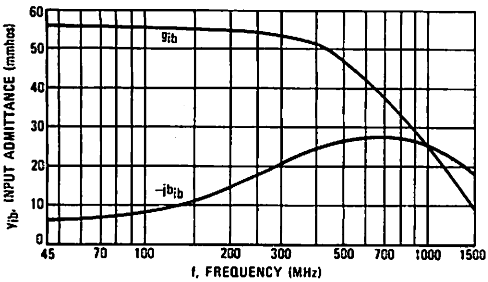


FIGURE 35 – y_{fb} FORWARD TRANSFER ADMITTANCE

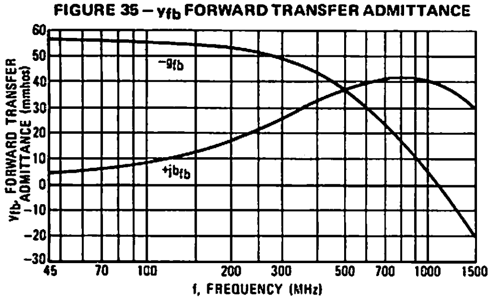


FIGURE 37 – y_{ob} OUTPUT ADMITTANCE

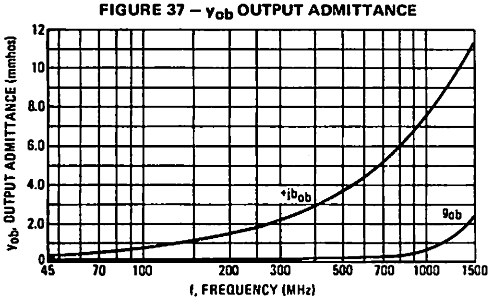
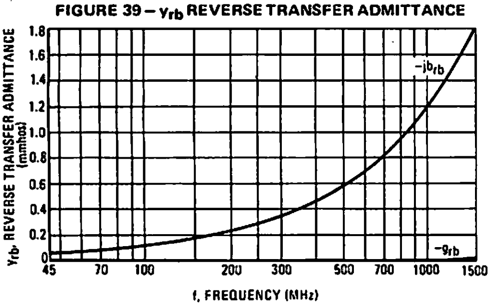


FIGURE 39 – y_{rb} REVERSE TRANSFER ADMITTANCE



POLAR y PARAMETERS versus FREQUENCY

FIGURE 34 – y_{ib} INPUT ADMITTANCE

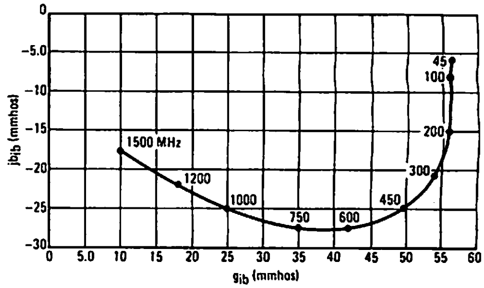


FIGURE 36 – y_{fb} FORWARD TRANSFER ADMITTANCE

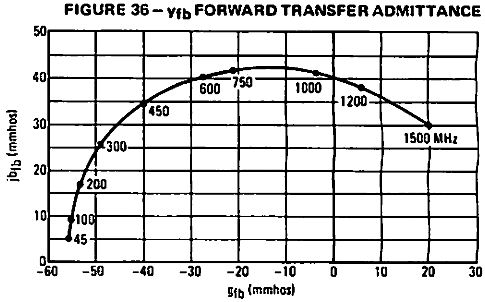


FIGURE 38 – y_{ob} OUTPUT ADMITTANCE

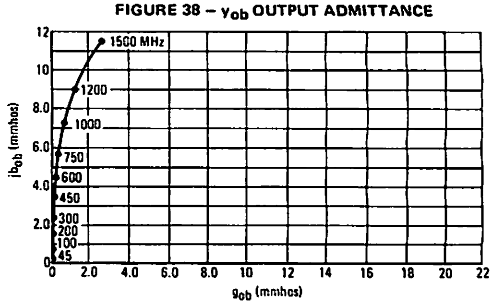
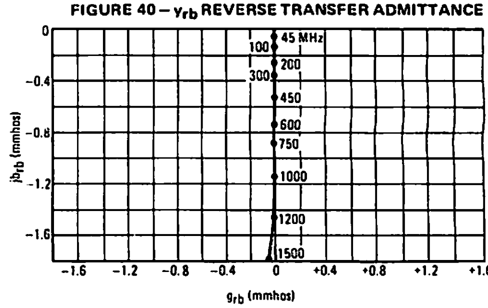


FIGURE 40 – y_{rb} REVERSE TRANSFER ADMITTANCE

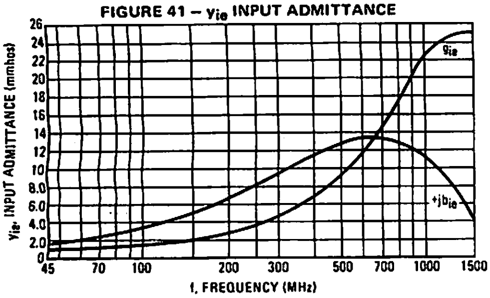


COMMON EMITTER y PARAMETER VARIATIONS

(V_{CE} = −10 Vdc, I_C = −2.0 mAdc)

y PARAMETERS versus FREQUENCY

FIGURE 41 – y_{ie} INPUT ADMITTANCE



POLAR y PARAMETERS versus FREQUENCY

FIGURE 42 – y_{ie} INPUT ADMITTANCE

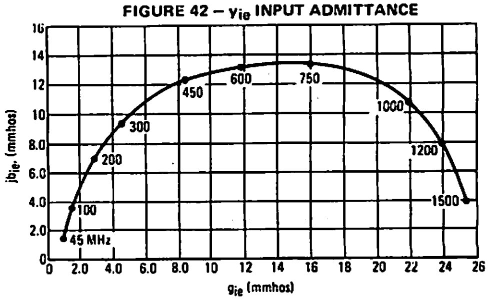


FIGURE 43 – y_{fe} FORWARD TRANSFER ADMITTANCE

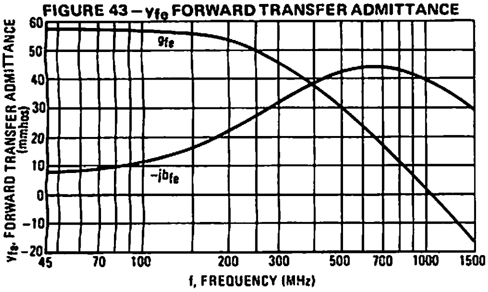


FIGURE 44 – y_{fe} FORWARD TRANSFER ADMITTANCE

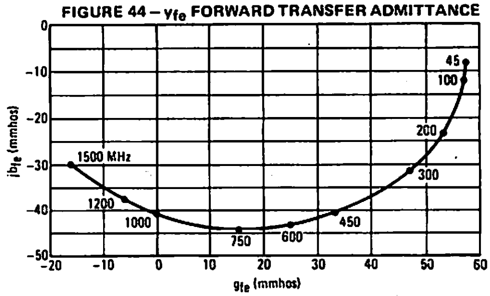


FIGURE 45 – y_{oe} OUTPUT ADMITTANCE

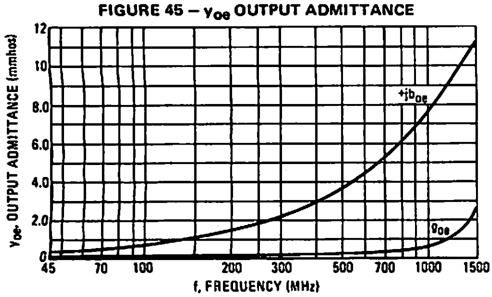


FIGURE 46 – y_{oe} OUTPUT ADMITTANCE

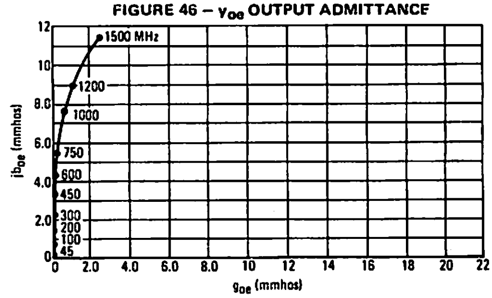


FIGURE 47 – y_{re} REVERSE TRANSFER ADMITTANCE

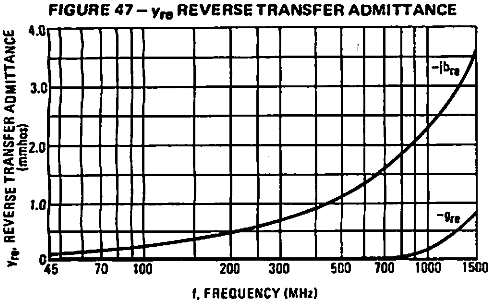
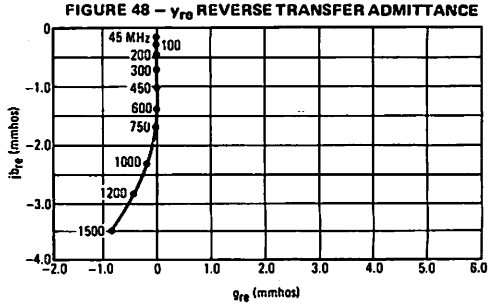


FIGURE 48 – y_{re} REVERSE TRANSFER ADMITTANCE



2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5031
2N5032

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

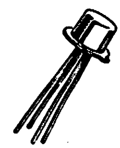
. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers.

- High Current-Gain — Bandwidth Product —
  f_T = 1000 MHz (Min) @ I_C = 5.0 mAdc
- Low Noise Figure @ f = 450 MHz —
  NF = 2.5 dB (Max) — 2N5031
  = 3.0 dB (Max) — 2N5032
- High Power Gain —
  G_{pe} = 14 dB (Min) @ f = 450 MHz

2.5 dB @ 450 MHz — 2N5031
3.0 dB @ 450 MHz — 2N5032

HIGH FREQUENCY TRANSISTORS

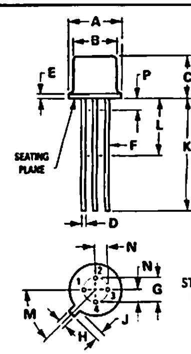
NPN SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	–	–	Vdc
*Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
*Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	–	1.0	10	nAdc
ON CHARACTERISTICS					
*DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	–	300	–
DYNAMIC CHARACTERISTICS					
*Current-Gain—Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1000	–	3500	MHz
*Output Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	–	1.3	1.5	pF
Collector-Base Time Constant (I_C = 6.0 mAdc, V_{CE} = 6.0 Vdc, f = 31.8 MHz)	$r_b'C_c$	–	5.0	–	ps
*Noise Figure (Figure 1) (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz) 2N5031	NF	–	–	2.5	dB
2N5032		–	–	3.0	
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (V_{CE} = 6.0 Vdc, I_C = 1.0 mAdc, f = 450 MHz)	G_{pe}	14	17	25	dB

*Indicates JEDEC Registered Data.
(1) Tuned for Minimum Noise.

FIGURE 1 — POWER GAIN AND NOISE FIGURE TEST CIRCUIT

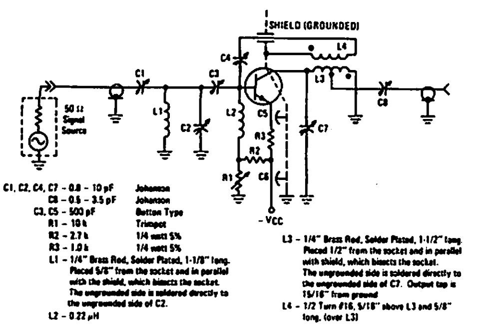
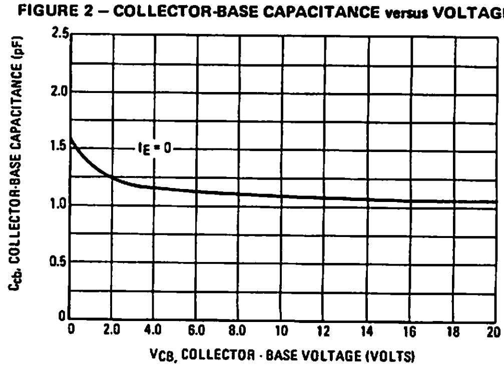


FIGURE 2 — COLLECTOR-BASE CAPACITANCE versus VOLTAGE



2

2

FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

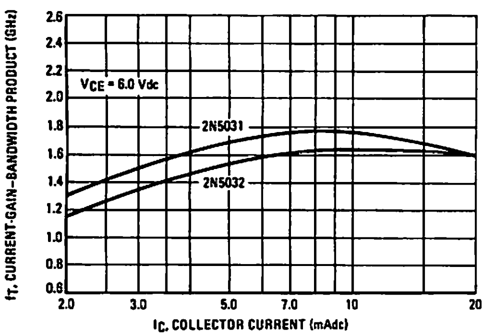


FIGURE 4 – S_{11} AND S_{22}

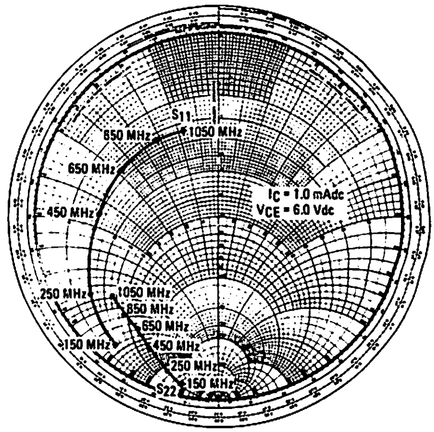


FIGURE 5 – S_{12}

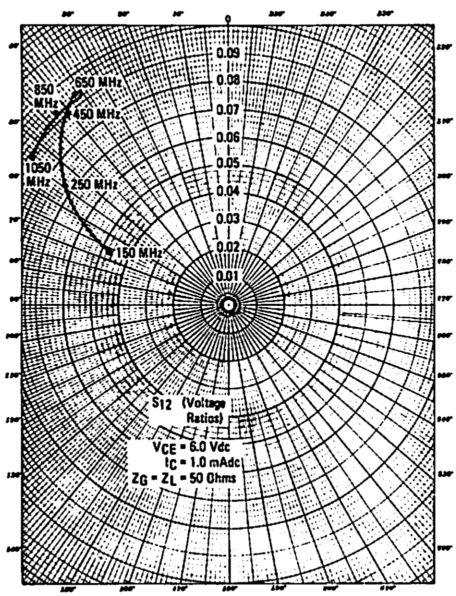


FIGURE 6 – S_{21}

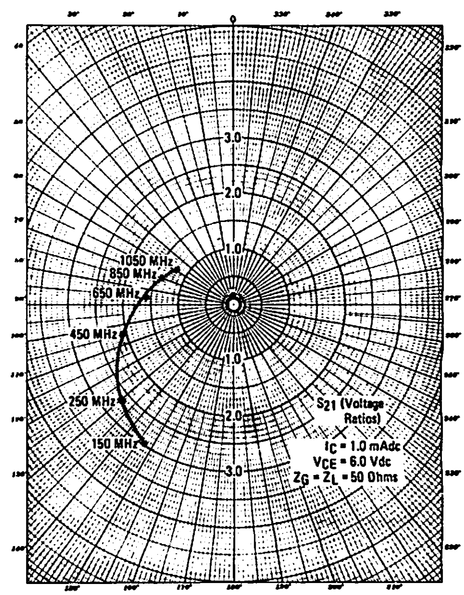


FIGURE 7 – NOISE FIGURE versus FREQUENCY

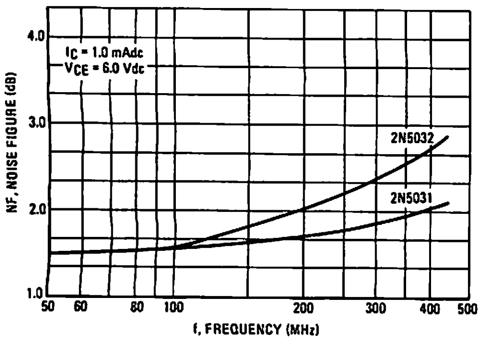


FIGURE 8 – POWER GAIN versus FREQUENCY

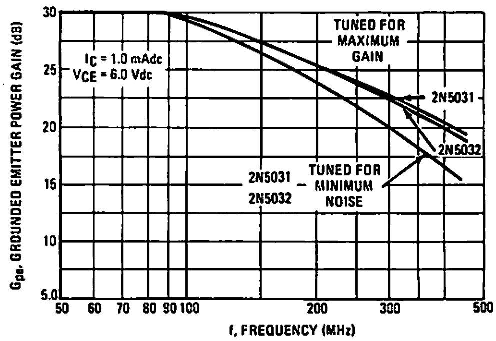


FIGURE 9 – INPUT ADMITTANCE versus FREQUENCY

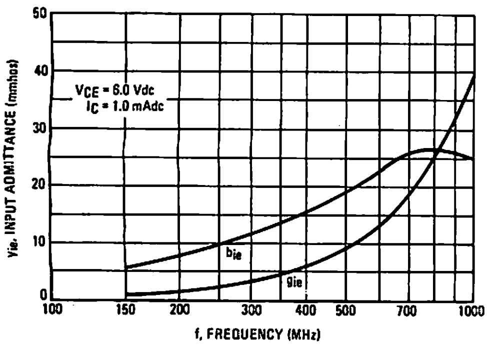


FIGURE 10 – OUTPUT ADMITTANCE versus FREQUENCY

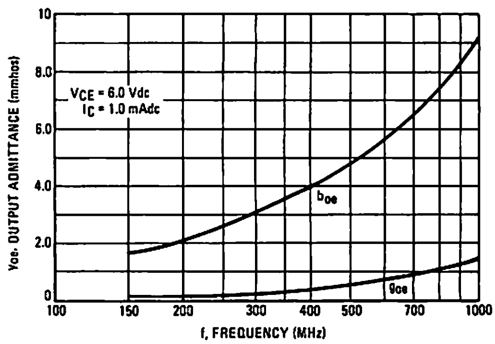


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

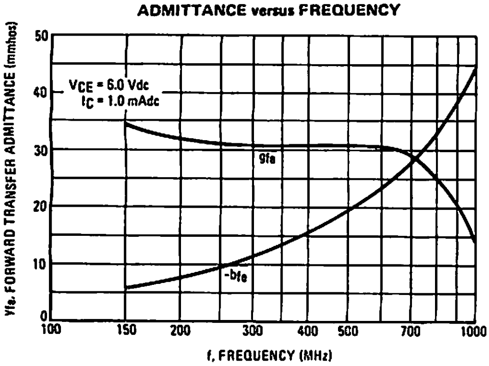
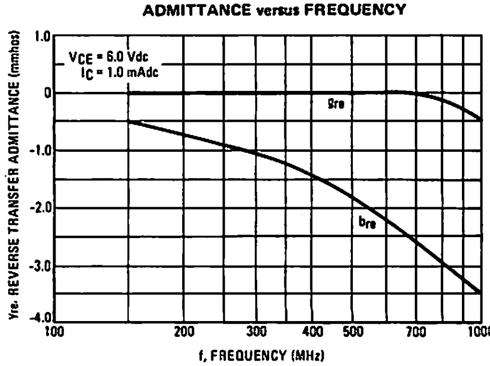


FIGURE 12 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5108

2

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

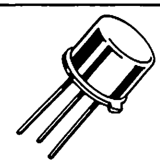
. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

- Specified 1 GHz, 28 Vdc Characteristics —
  Output Power = 1.0 Watt
  Minimum Gain = 5.0 dB
  Efficiency = 35%
- Typical 1.68 GHz, 28 Vdc Characteristics —
  Output Power = 0.3 Watt
  Efficiency = 15%

1.0 W - 1 GHz

HIGH FREQUENCY TRANSISTOR

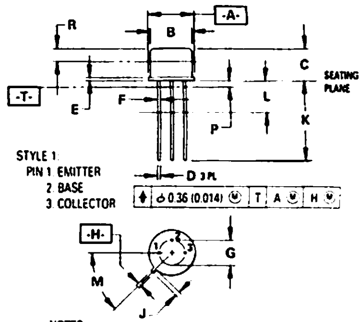
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
*Collector-Emitter Voltage (R_{BE} = 10 Ohms)	V_{CER}	55	Vdc
*Collector-Base Voltage	V_{CB}	55	Vdc
*Emitter-Base Voltage	V_{EB}	3.0	Vdc
*Collector Current — Continuous	I_C	0.4	Adc
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 0.02	Watts W/°C
*Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

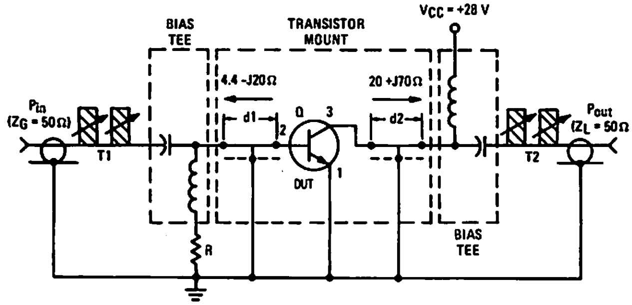
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
*Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{CER(sus)}$	55	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	–	–	Vdc
*Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
*Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	20	μAdc
*Collector Cutoff Current (V_{CE} = 50 Vdc, V_{BE} = 0) (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 150°C)	I_{CES}	 – –	 – –	 1.0 10	 μAdc mAdc
ON CHARACTERISTICS					
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
DYNAMIC CHARACTERISTICS					
*Current-Gain–Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	1200	–	–	MHz
*Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	1.3	3.0	pF
FUNCTIONAL TEST					
*Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 1.0 W, V_{CC} = 28 Vdc, I_C = 102 mAdc, f = 1.0 GHz)	G_{PE}	5.0	–	–	dB
Power Output (Figure 1) (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	P_{out}	1.0	–	–	Watt
*Collector Efficiency (P_{in} = 316 mW, V_{CE} = 28 Vdc, f = 1.0 GHz)	η	35	–	–	%
Power Output (Oscillator) (Figure 2) (V_{CE} = 20 Vdc, V_{EB} = 1.5 Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%)	P_{out}	–	0.3	–	Watt

*Indicates JEDEC Registered Data.

2

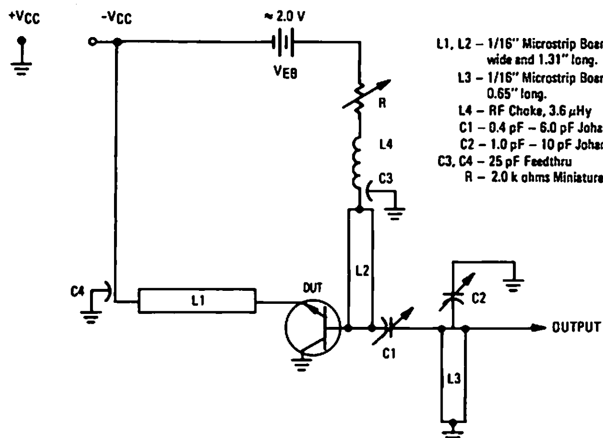
FIGURE 1 — 1 GHz RF AMPLIFIER OUTPUT POWER TEST CIRCUIT



d1: 1" Input line, center conductor width = 0.280"
d2: 1" Output line, center conductor width = 0.125"
Q: 2N5108
R: 3.9 ohms
T1, T2: Microlab Double Stub Tuner, or Equivalent
Bias Tee: Microlab 08N, or Equivalent
Transistor Mount: 1/32" Microstrip board

Note: Impedance measurements are made at transistor socket pins.

FIGURE 2 — 1.68 GHz RF OSCILLATOR OUTPUT POWER TEST CIRCUIT



L1, L2 – 1/16" Microstrip Board. Lines are 0.16" wide and 1.31" long.
L3 – 1/16" Microstrip Board. 0.16" wide and 0.65" long.
L4 – RF Choke, 3.6 μHy
C1 – 0.4 pF – 6.0 pF Johnson 4640
C2 – 1.0 pF – 10 pF Johnson 4355
C3, C4 – 25 pF Feedthru
R – 2.0 k ohms Miniature Trim pot

FIGURE 3 — OUTPUT POWER versus INPUT POWER

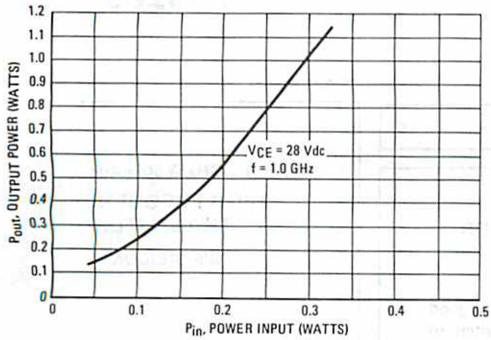


FIGURE 4 — OUTPUT POWER versus FREQUENCY

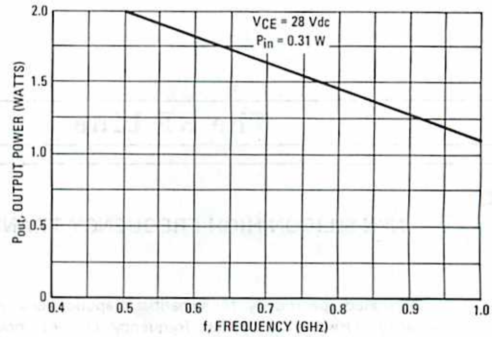


FIGURE 5 — OUTPUT POWER versus COLLECTOR-EMITTER VOLTAGE

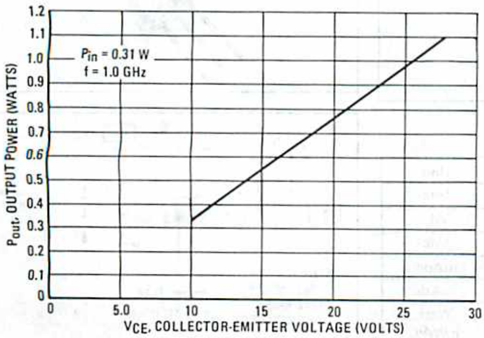


FIGURE 6 — OSCILLATOR OUTPUT POWER versus COLLECTOR CURRENT

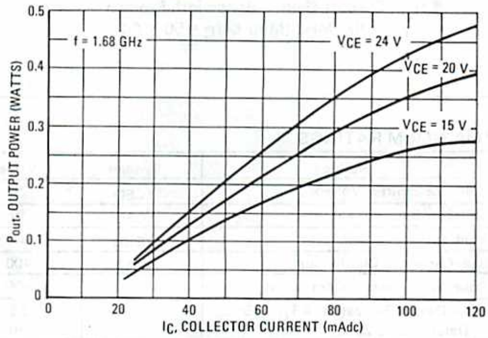


FIGURE 7 CURRENT-GAIN—BANDWIDTH PRODUCT versus CURRENT

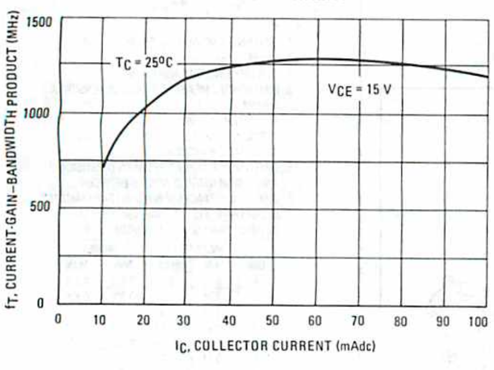
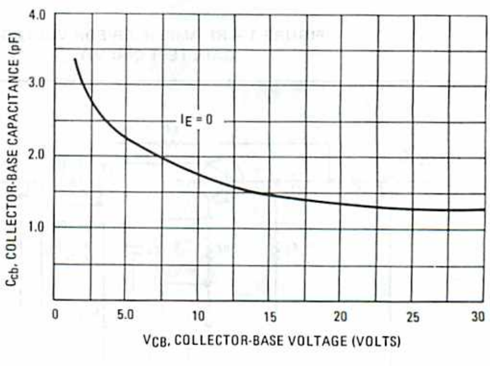


FIGURE 8 COLLECTOR BASE CAPACITANCE versus VOLTAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5109

2

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

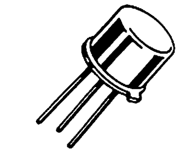
. . . designed specifically for broadband applications requiring good linearity. Useable as a high frequency current mode switch to 200 mA.

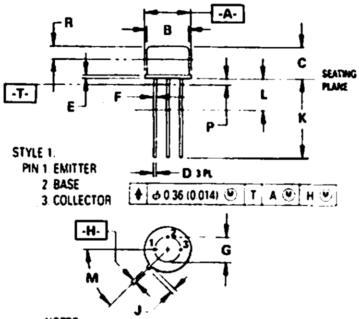
- Low Noise Figure — @ f = 200 MHz
  NF = 3.0 dB (Typ)
- High Current-Gain — Bandwidth Product —
  f_T = 1200 MHz (Min) @ I_C = 50 mAdc

1.2 GHz @ 50 mAdc

HIGH FREQUENCY TRANSISTOR

NPN SILICON





NOTES:
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5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

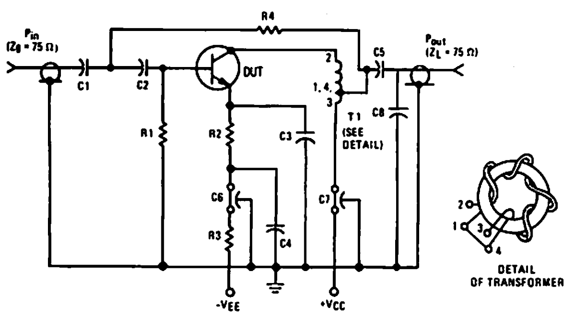
CASE 79-04
TO-205AD
(TO-39)

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Base Current — Continuous	I_B	400	mAdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_C = 75°C (1) Derate above 25°C	P_D	2.5 20	Watt mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

(1) Total Device Dissipation at T_A = 25°C is 1.0 Watt.
* Indicates JEDEC Registered Data.

FIGURE 1 — RF AMPLIFIER FOR VOLTAGE GAIN TEST CIRCUIT



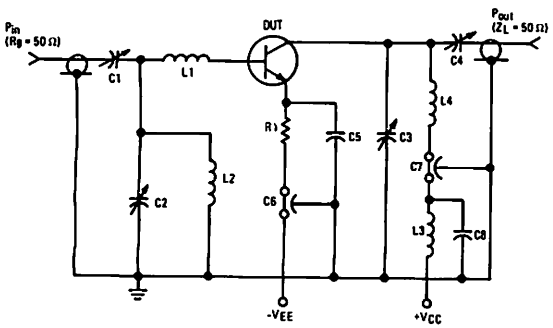
C1, C2, C3, C5 0.002 μF
C4 0.03 μF
C6, C7 1500 pF
C8 18 pF
R1 4.7 k, 1/4 W
R2 6.8 Ω, 1/2 W
R3 330 Ω, 1 W
R4 200 Ω, 1/4 W
T1 4 Turns #30 Wire
Bifilar wound on "Indiana General" Core #CF-102-Q1, or equivalent

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Sustaining Voltage ($I_C = 5.0$ mAdc, $I_B = 0$)	$V_{CEO(sus)}$	20	–	–	Vdc
Collector-Emitter Sustaining Voltage (1) ($I_C = 5.0$ mAdc, $R_{BE} = 10\ \Omega$)	$V_{CER(sus)}$	40	–	–	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $I_B = 0$)	I_{CEO}	–	–	20	μAdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = -1.5$ V, $T_C = 150^\circ C$)	I_{CEX}	–	–	5.0	mAdc
($V_{CE} = 35$ Vdc, $V_{BE} = -1.5$ V)		–	–	5.0	mAdc
Emitter Cutoff Current ($V_{BE} = 3.0$ Vdc, $I_C = 0$)	I_{EBO}	–	–	100	μAdc
***ON CHARACTERISTICS**					
DC Current Gain	h_{FE}				
($I_C = 360$ mAdc, $V_{CE} = 5.0$ Vdc)		5.0	–	–	–
($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc)		40	–	120	–
DYNAMIC CHARACTERISTICS					
*Current-Gain – Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc, f = 200 MHz)	f_T	1200	–	–	MHz
*Collector-Base Capacitance ($V_{CB} = 15$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	–	1.8	3.5	pF
Noise Figure ($I_C = 10$ mAdc, $V_{CE} = 15$ Vdc, f = 200 MHz) (Figure 2)	NF	–	3.0	–	dB
FUNCTIONAL TEST					
*Common-Emitter Amplifier Voltage Gain (Figure 1) ($I_C = 50$ mAdc, $V_{CC} = 15$ Vdc, f = 50 to 216 MHz)	G_{ve}	11	–	–	dB
*Power Input (Figure 2) ($I_C = 50$ mAdc, $V_{CC} = 15$ Vdc, $R_S = 50$ ohms, $P_{out} = 1.26$ mW, f = 200 MHz)	P_{in}	–	–	0.1	mW

*Indicates JEDEC Registered Data.
(1) Pulsed thru a 25 mH Inductor; 50% Duty Cycle

FIGURE 2 – 200 MHz TEST CIRCUIT



C1, C2, C3 1.0 – 30 pF
C4 1.0 – 20 pF
C5 10,000 pF
C6, C7 1,000 pF
C8 0.01 μF

L1 4-1/2 turns, No. 22 wire, 3/16" I.D.
L4 3-1/2 turns, No. 22 wire, 3/16" I.D.
L2, L3 0.82 μH RFC
R1 240 OHMS, 2 WATTS

2

FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT

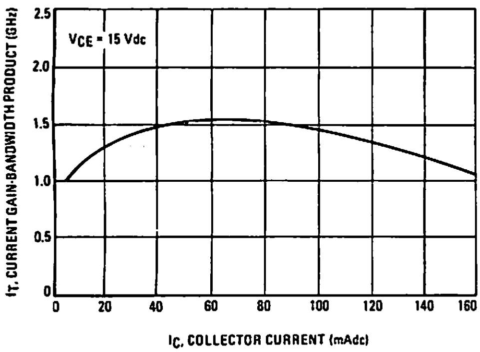


FIGURE 4 – COLLECTOR-BASE TIME CONSTANT

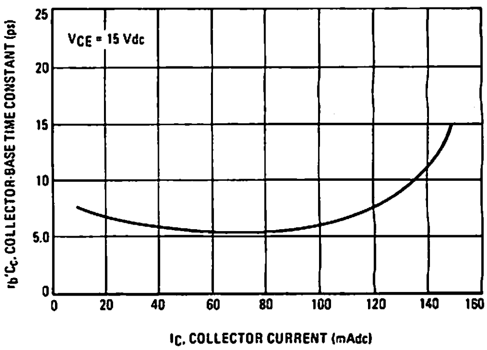


FIGURE 5 – SATURATION VOLTAGES

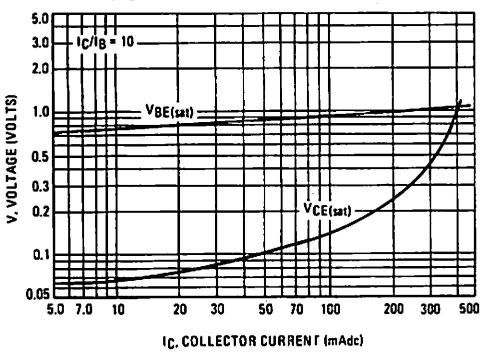


FIGURE 6 – CAPACITANCES versus REVERSE VOLTAGE

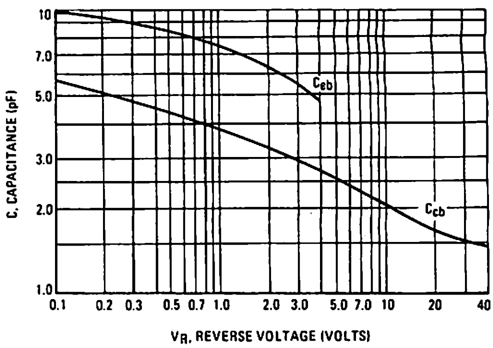


FIGURE 7 – INPUT ADMITTANCE versus FREQUENCY

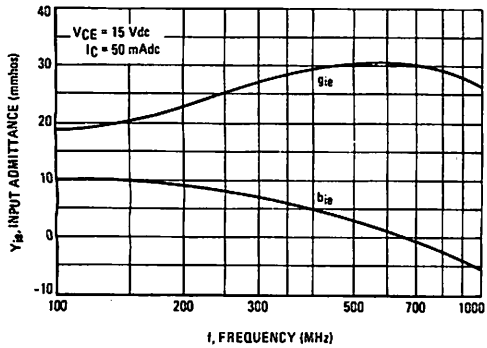


FIGURE 8 – INPUT ADMITTANCE versus COLLECTOR CURRENT

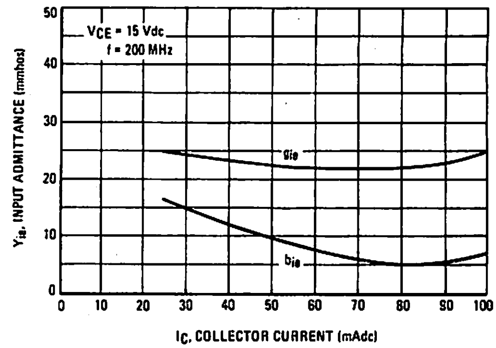


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FIGURE 9 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

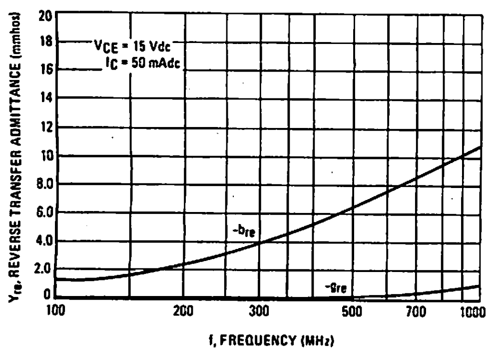


FIGURE 10 – REVERSE TRANSFER ADMITTANCE versus COLLECTOR CURRENT

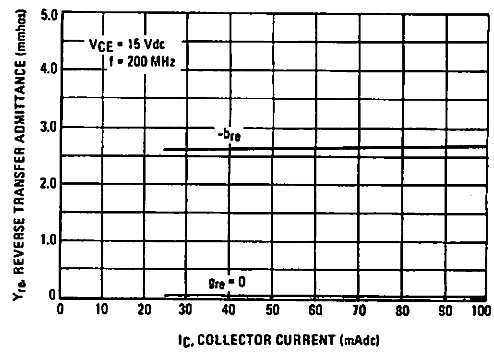


FIGURE 11 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

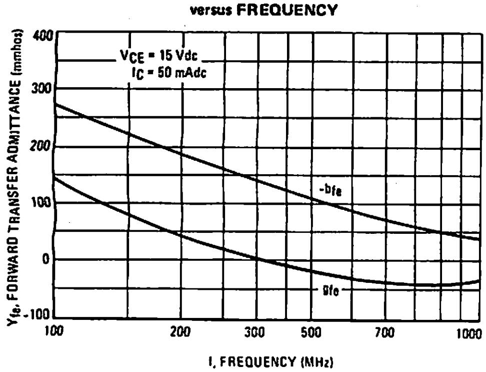
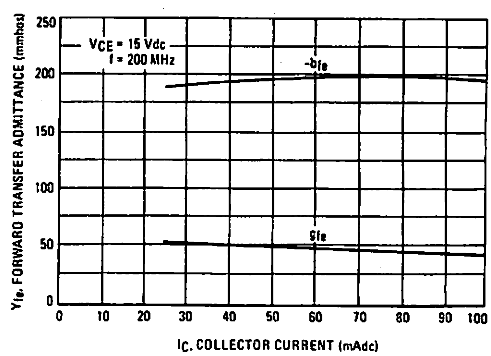


FIGURE 12 – FORWARD TRANSFER ADMITTANCE versus COLLECTOR CURRENT



2

FIGURE 13 – OUTPUT ADMITTANCE versus FREQUENCY

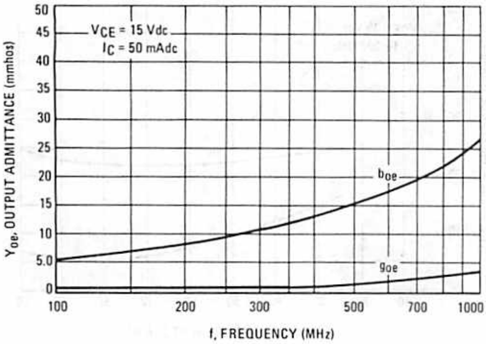


FIGURE 14 – OUTPUT ADMITTANCE versus COLLECTOR CURRENT

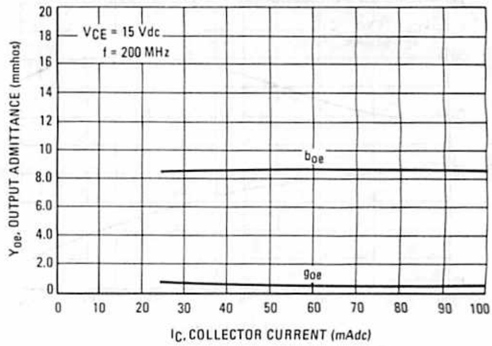


FIGURE 15 – INPUT REFLECTION COEFFICIENT versus FREQUENCY

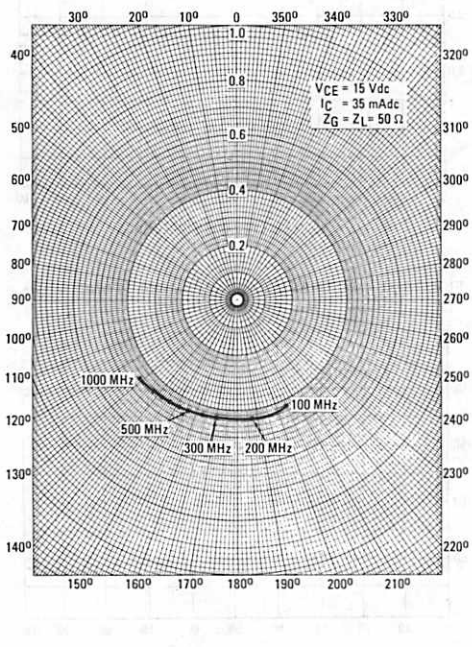


FIGURE 16 – OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

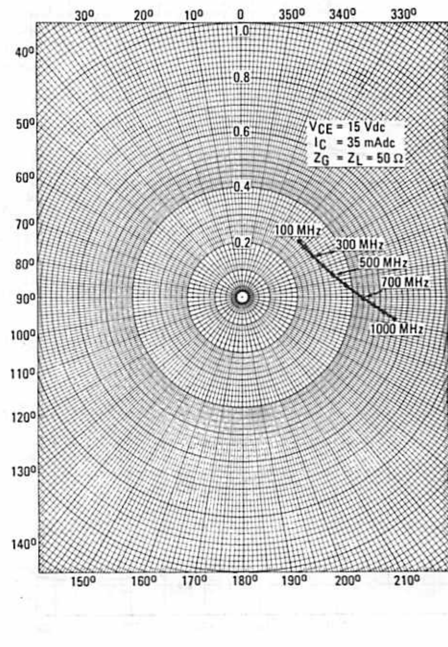


FIGURE 17 — REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

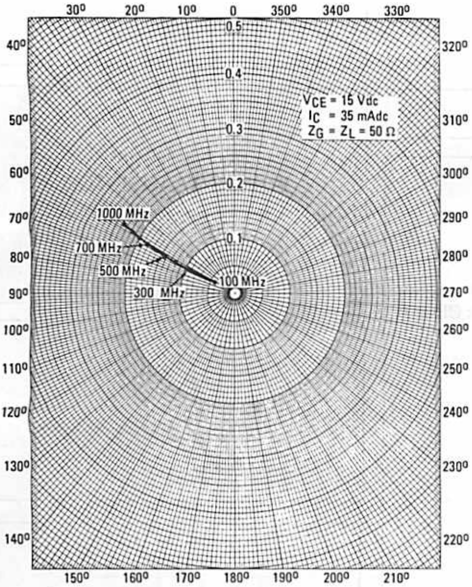


FIGURE 18 — FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY

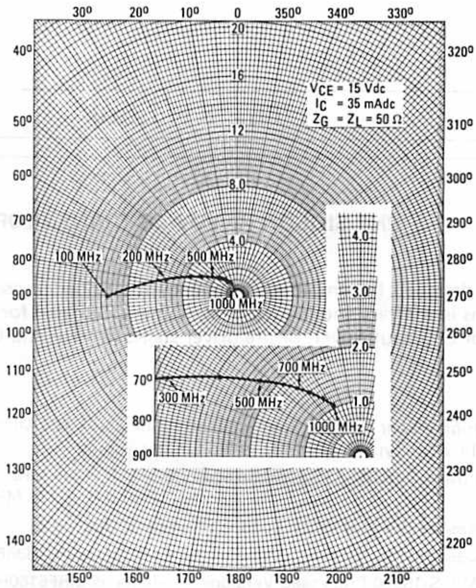
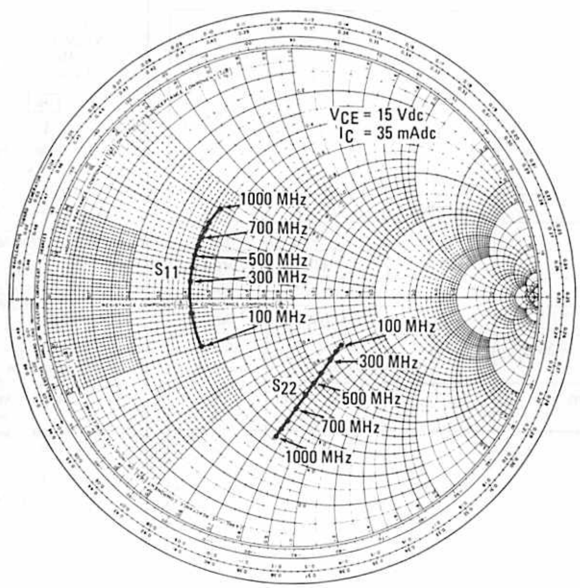


FIGURE 19 — INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION COEFFICIENT versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5160

2

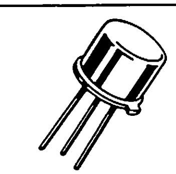
The RF Line

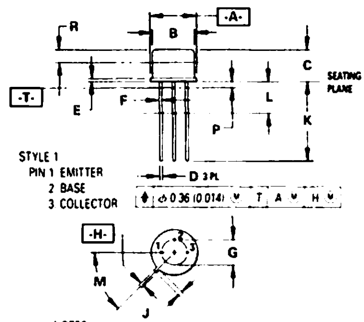
PNP SILICON RF POWER TRANSISTOR

. . . designed for amplifier, frequency multiplier or oscillator applications in military and industrial equipment. Suitable for use as Class A, B, or C output driver, or pre-driver stages in VHF and UHF.

- High Power Gain — G_{PE} = 8.0 dB (Min) @ f = 400 MHz, 14.5 db (Typ) @ 175 MHz — No Emitter Tuning
- Power Output — P_{out} = 1.0 Watt (Min @ f = 400 MHz
  = 1.5 Watt (Typ) @ f = 175 MHz
- Resists Burnout When Load is Shorted or Opened
- Designed for Use in Complementary Circuits with 2N3866
- MIL-S-19500 Processed Versions Available as MRF5160HX, MRF5160HXV

I_C = −400 mA
POWER TRANSISTOR
PNP SILICON





STYLE 1
PIN 1 EMITTER
2 BASE
3 COLLECTOR

NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14 5M, 1982
2 CONTROLLING DIMENSION INCH
3 DIMENSION J MEASURED FROM DIMENSION A MAXIMUM
4 DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING
5 DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−40	Vdc
Collector-Base Voltage	V_{CB}	−60	Vdc
Emitter-Base Voltage	V_{EB}	−4.0	Vdc
Collector Current	I_C	−0.4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.

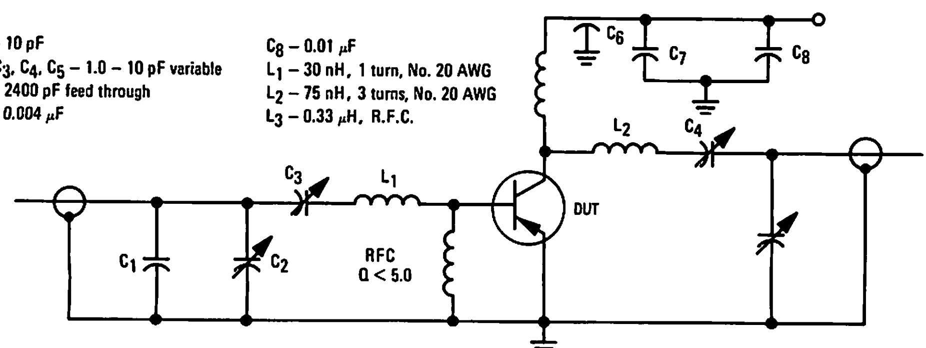
***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = −5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	−40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.1 mAdc, I_C = 0)	$V_{(BR)EBO(sus)}$	−4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = −28 Vdc, I_B = 0)	I_{CEO}	—	—	−20	μAdc
Collector Cutoff Current (V_{CE} = −60 Vdc, V_{BE} = 0)	I_{CES}	—	—	−0.1	mAdc
Collector Cutoff Current (V_{CB} = −28 Vdc, I_E = 0)	I_{CBO}	—	—	−1.0	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mAdc, V_{CE} = −5.0 Vdc)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = −50 mAdc, V_{CE} = −15 Vdc, f = 200 MHz)	f_T	500	900	—	MHz
Collector-Base Capacitance (V_{CB} = −28 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	—	2.5	4.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = −28 Vdc, P_{in} = 0.16 Watt, f = 400 MHz) (V_{CE} = −28 Vdc, P_{in} = 50 mW, f = 175 MHz)	G_{PE}	 8.0 —	 8.8 14.5	 — —	dB
Power Output (V_{CE} = −28 Vdc, P_{in} = 0.16 Watt, f = 400 MHz) (V_{CE} = −28 Vdc, P_{in} = 50 mW, f = 175 MHz)	P_{out}	 1.0 —	 1.2 1.4	 — —	Watt
Collector Efficiency (V_{CE} = −28 Vdc, P_{in} = 0.16 Watt, f = 400 MHz)	η	45	55	—	%

*Indicates JEDEC Registered Data.

FIGURE 1 — 400-MHz TEST CIRCUIT

C_1 – 10 pF
C_2, C_3, C_4, C_5 – 1.0 – 10 pF variable
C_6 – 2400 pF feed through
C_7 – 0.004 μF
C_8 – 0.01 μF
L_1 – 30 nH, 1 turn, No. 20 AWG
L_2 – 75 nH, 3 turns, No. 20 AWG
L_3 – 0.33 μH, R.F.C.



2

2

FIGURE 2 — POWER OUTPUT versus FREQUENCY

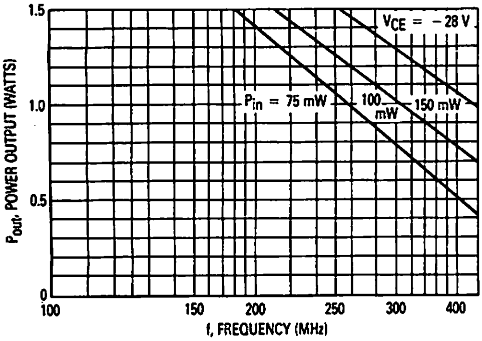


FIGURE 3 — POWER OUTPUT versus POWER INPUT

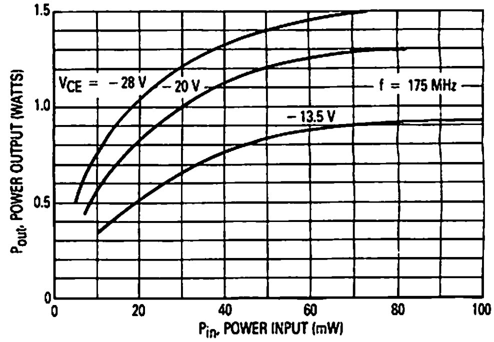


FIGURE 4 — PARALLEL INPUT IMPEDANCE versus FREQUENCY

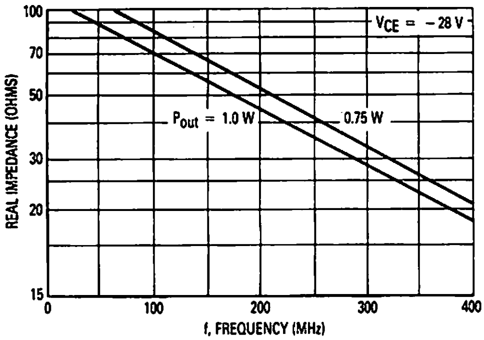


FIGURE 5 — PARALLEL INPUT IMPEDANCE versus FREQUENCY

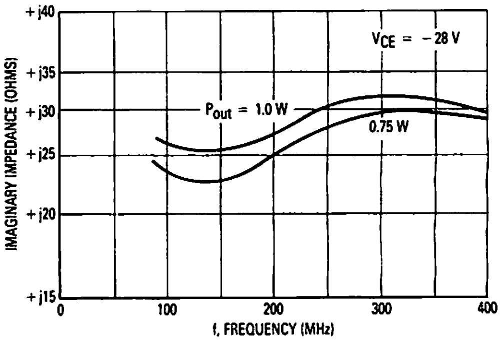


FIGURE 6 — PARALLEL OUTPUT CAPACITANCE versus FREQUENCY

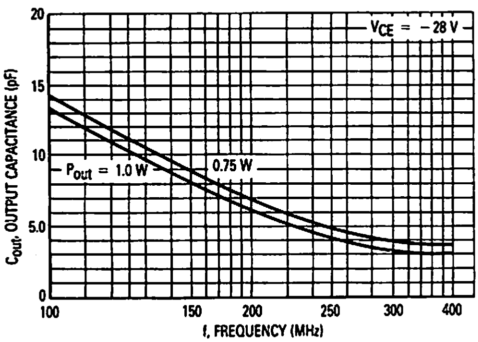


FIGURE 7 — CURRENT-GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT

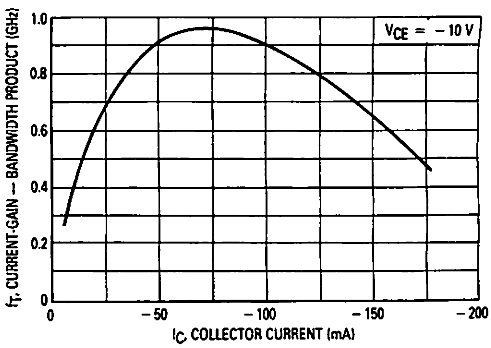


FIGURE 8 – 2N5160 300-MHz COMPLEMENTARY POWER OUTPUT CIRCUIT

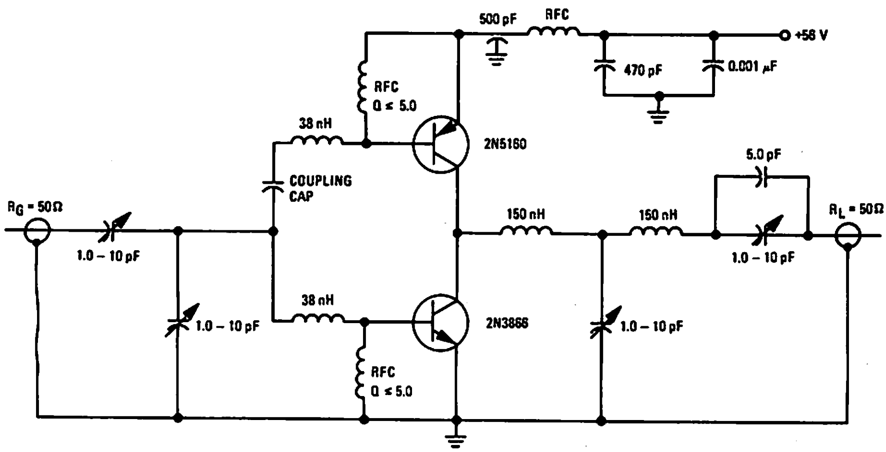
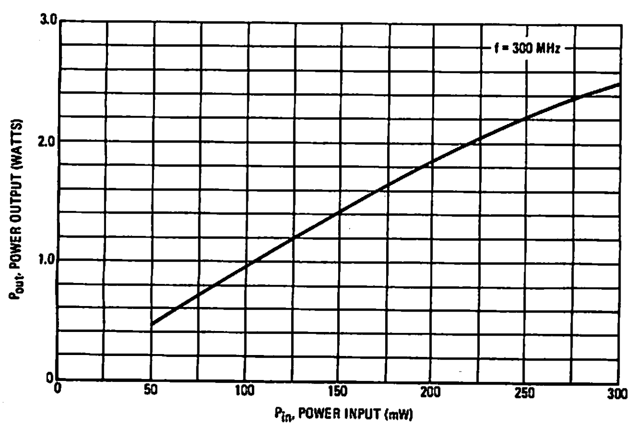


FIGURE 9 – COMPLEMENTARY CIRCUIT – POWER OUTPUT versus POWER INPUT



2N5179

The RF Line

2

4.5 dB @ 200 MHz

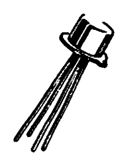
HIGH FREQUENCY TRANSISTOR

NPN SILICON

NPN SILICON RF HIGH FREQUENCY TRANSISTOR

. . . designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

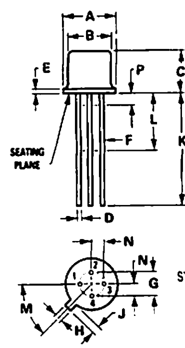
- High Current-Gain — Bandwidth Product —
  f_T = 1.4 GHz (Typ) @ I_C = 10 mAdc
- Low Collector-Base Time Constant —
  $r_b'C_c$ = 14 ps (Max) @ I_E = 2.0 mAdc
- Characterized with Scattering Parameters
- Low Noise Figure —
  NF = 4.5 dB (Max) @ f = 200 MHz



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage Applicable 1.0 to 20 mAdc	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CB}	20	Vdc
Emitter-Base-Voltage	V_{EB}	2.5	Vdc
Collector Current	I_C	50	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

2

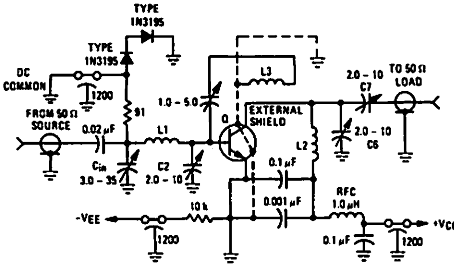
*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	12	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.001 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0) (V_{CB} = 15 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	– –	0.02 1.0	µAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	250	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	–	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	–	1.0	Vdc
DYNAMIC CHARACTERISTICS				
Current-Gain – Bandwidth Product (1) (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	900	2000	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	–	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	300	–
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 6.0 Vdc, f = 31.9 MHz)	$r_b'C_c$	3.0	14	ps
Noise Figure (See Figure 1) (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 ohms, f = 200 MHz)	NF	–	4.5	dB
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (See Figure 1) (V_{CE} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	G_{pe}	15	–	dB
Power Output (See Figure 2) (V_{CB} = 10 Vdc, I_E = 12 mAdc, f≥500 MHz)	P_{out}	20	–	mW

*Indicates JEDEC Registered Values.
(1) f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

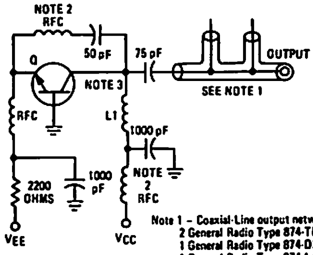
2

FIGURE 1 — 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



L1 1-3/4 Turns, #18 AWG, 0.5" L, 0.5" Diameter
L2 2 Turns, #16 AWG, 0.5" L, 0.5" Diameter
L3 2 Turns, #13 AWG, 0.25" L, 0.5" Diameter (Position 1/4" from L2)

FIGURE 2 — 500 MHz OSCILLATOR CIRCUIT



Note 1 – Coaxial-Line output network consisting of:
2 General Radio Type 874-TEE or equivalent
1 General Radio Type 874-D20 Adjustable Stub or equivalent
1 General Radio Type 874-LA Adjustable Line or equivalent
1 General Radio Type 874-WN3 Short-circuit termination or equivalent
Note 2 – RFC = 0.2 μH Ohmite #2-460 or equivalent
Note 3 – Lead Number 4 (case) floating
L1 – 2 turns #16 AWG wire, 3/8 inch OD, 1-1/4 inch long
Q = 2N5179

FIGURE 3 — NOISE FIGURE versus FREQUENCY

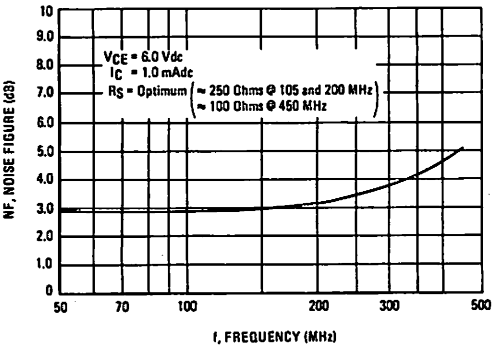


FIGURE 4 — NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT

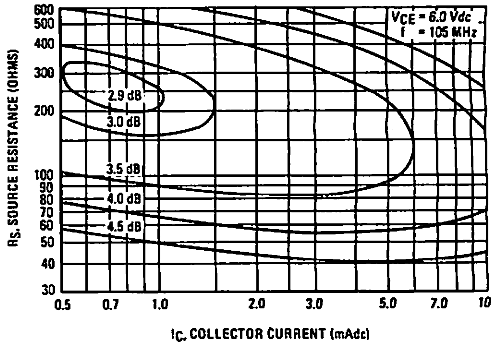


FIGURE 5 — NOISE FIGURE versus SOURCE RESISTANCE and COLLECTOR CURRENT

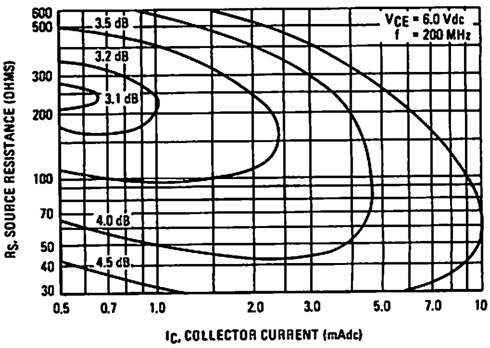


FIGURE 6 – CURRENT-GAIN-BANDWIDTH PRODUCT

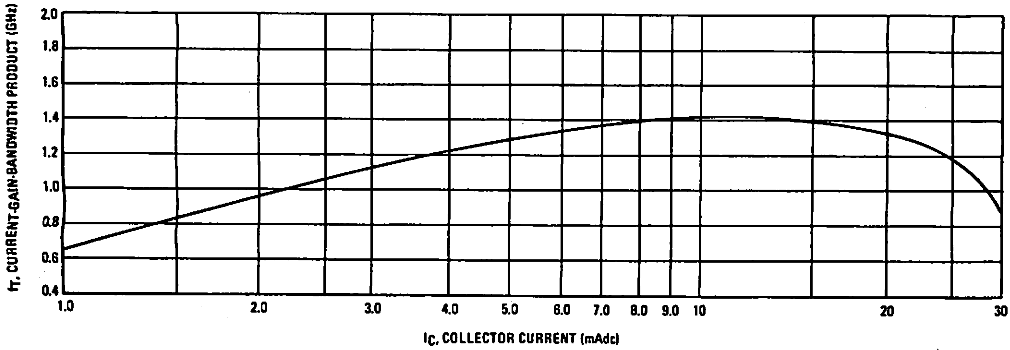


FIGURE 7 – INPUT ADMITTANCE versus FREQUENCY

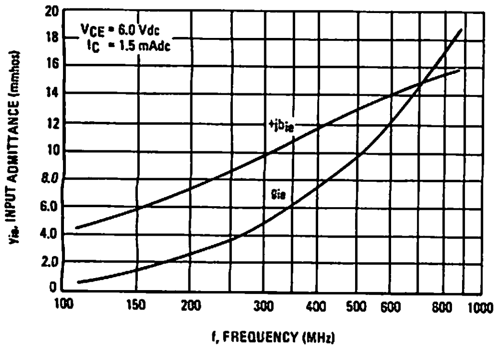


FIGURE 8 – OUTPUT ADMITTANCE versus FREQUENCY

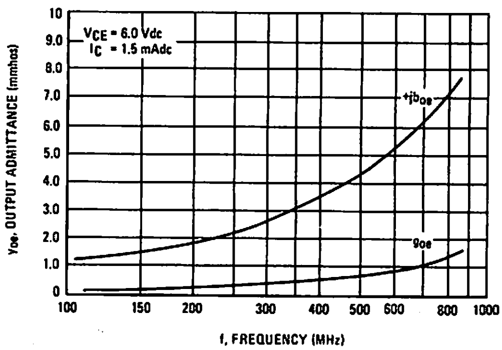


FIGURE 9 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

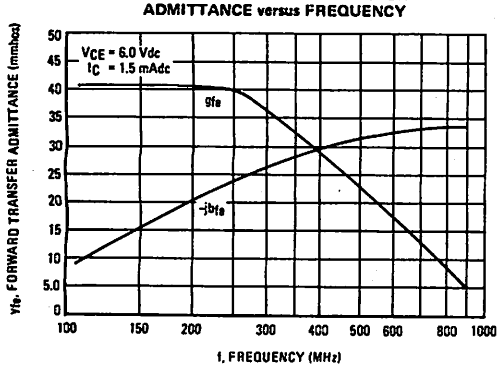


FIGURE 10 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

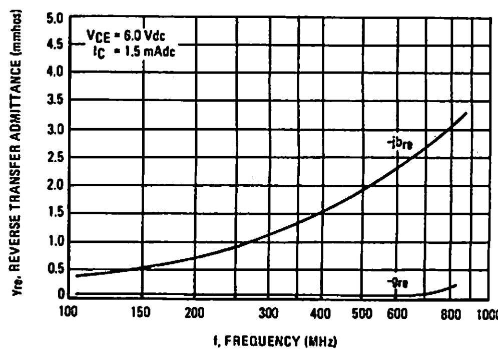


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FIGURE 11 — S_{11}, INPUT REFLECTION COEFFICIENT

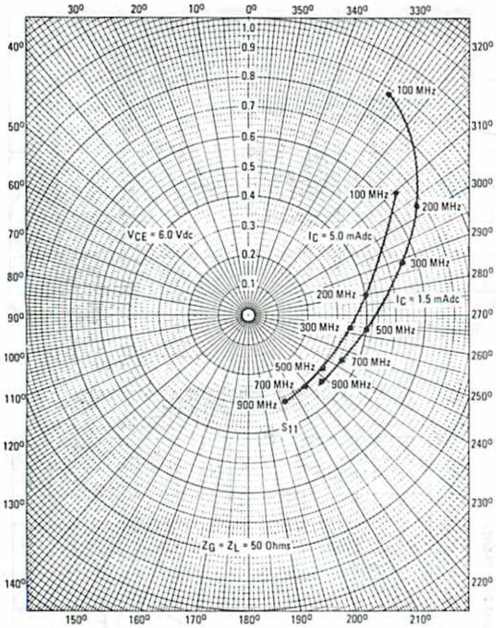


FIGURE 12 — S_{22}, OUTPUT REFLECTION COEFFICIENT

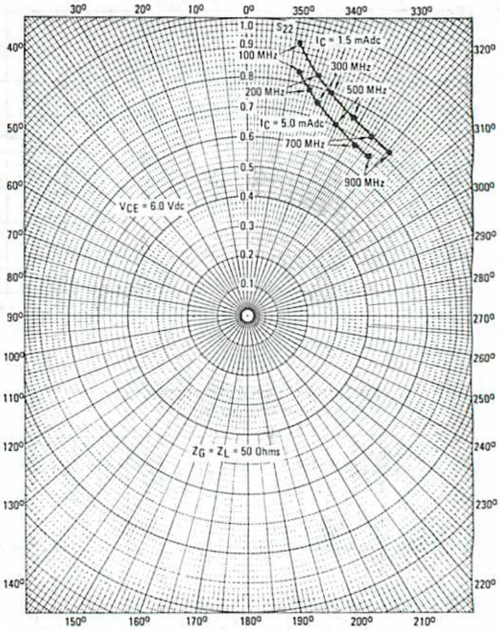


FIGURE 13 — S_{12}, REVERSE TRANSMISSION COEFFICIENT

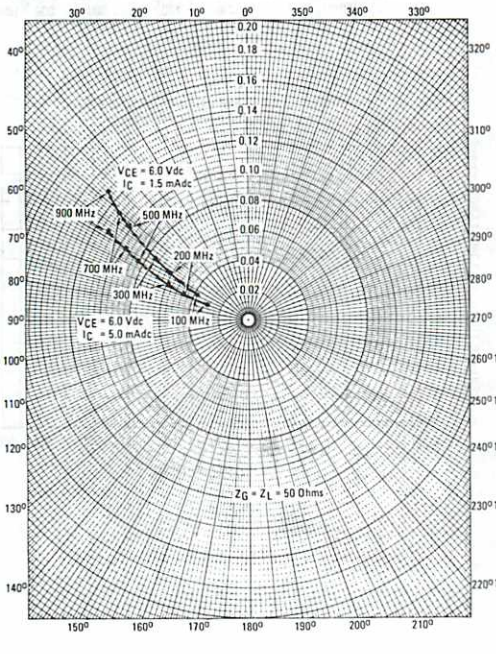


FIGURE 14 — S_{21}, FORWARD TRANSMISSION COEFFICIENT

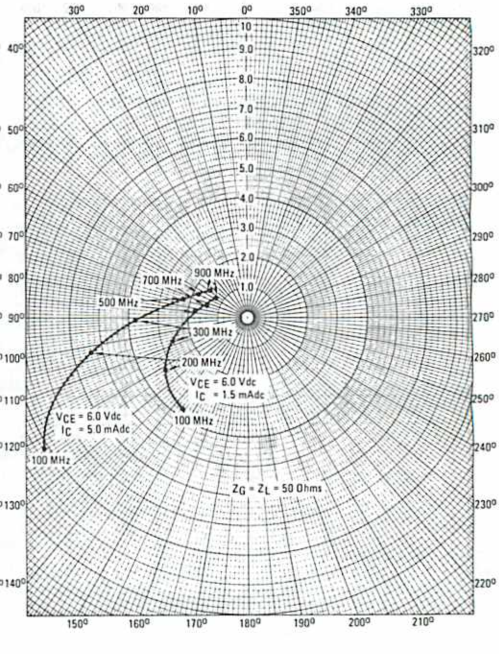
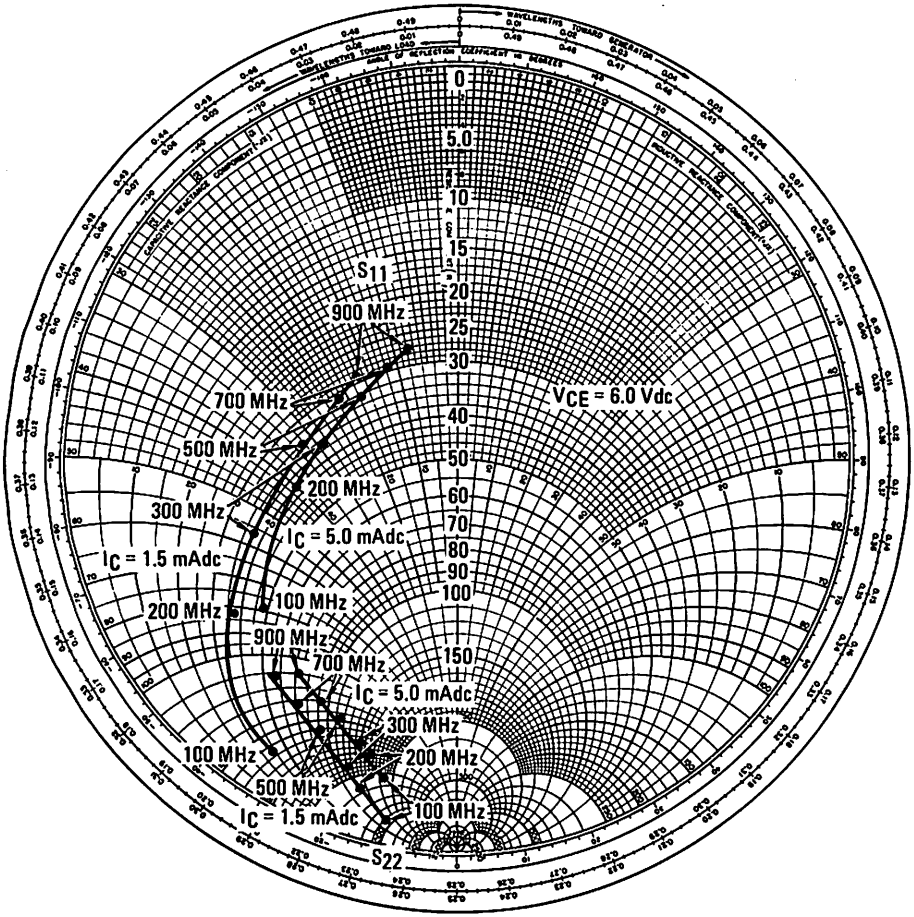


FIGURE 15—S_{11}, INPUT REFLECTION COEFFICIENT AND S_{22}, OUTPUT REFLECTION COEFFICIENT



2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5583

The RF Line

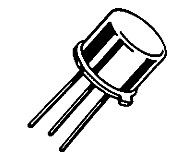
2

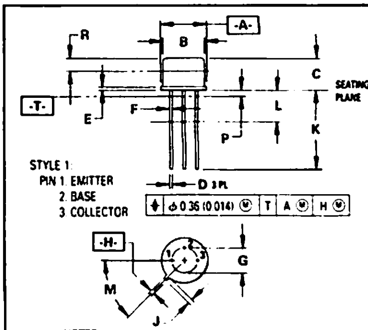
PNP SILICON HIGH FREQUENCY TRANSISTOR

...designed for applications in high frequency amplifiers and non-saturated switching circuits. High gain-bandwidth product characteristic provides excellent performance in a variety of small signal and linear amplifier applications.

- High Current-Gain — Bandwidth Product — f_T = 1300 (Min) @ I_C = −100 mAdc
- Low Collector-Base Time Constant — $r_b'C_c$ = 8.0 ps (Typ) @ I_C = −50 mAdc
- MIL-S-19500 Processed Versions Available as MRF5583HX, MRF5583HXV

I_C = −500 mA
HIGH FREQUENCY TRANSISTOR
PNP SILICON





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
*Collector-Emitter Voltage	V_{CEO}	−30	Vdc
*Collector-Base Voltage	V_{CB}	−30	Vdc
*Emitter-Base Voltage	V_{EB}	−3.0	Vdc
*Collector Current — Continuous	I_C	−500	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
*Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
*Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

*Indicates JEDEC Registered Data.

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted.)

Characteristic	Figure No.	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**						
Collector-Emitter Breakdown Voltage (1) (I_C = −10 mAdc, I_B = 0)	—	$V_{(BR)CEO}$	−30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −10 μAdc, I_E = 0)	—	$V_{(BR)CBO}$	−30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −100 μAdc, I_C = 0)	—	$V_{(BR)EBO}$	−3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = −20 Vdc, I_E = 0)	4	I_{CBO}	—	—	−50	nAdc
Emitter Cutoff Current (V_{EB} = −2.0 Vdc, I_C = 0)	—	I_{EBO}	—	—	−0.5	μAdc
***ON CHARACTERISTICS**						
DC Current Gain (Note 1)	1	h_{FE}				—
(I_C = −40 mAdc, V_{CE} = −2.0 Vdc)			20	40	—	
(I_C = −100 mAdc, V_{CE} = −2.0 Vdc)			25	40	100	
(I_C = −300 mAdc, V_{CE} = −5.0 Vdc)			15	22	—	
Collector-Emitter Saturation Voltage (Note 1) (I_C = −100 mAdc, I_B = −10 mAdc)	2, 3	$V_{CE(sat)}$	—	−0.6	−0.8	Vdc
Base-Emitter On Voltage (Note 1) (I_C = −100 mAdc, V_{CE} = −2.0 Vdc)	3	$V_{BE(on)}$	—	−0.84	−1.8	Vdc
SMALL-SIGNAL CHARACTERISTICS						
*Current-Gain — Bandwidth Product	7	f_T				MHz
(I_C = −40 mAdc, V_{CE} = −10 Vdc, f = 100 MHz)			1000	1300	—	
(I_C = −100 mAdc, V_{CE} = −10 Vdc, f = 100 MHz)			1300	1500	—	
*Collector-Base Capacitance (V_{CB} = −15 Vdc, I_E = 0, f = 1.0 MHz)	5	C_{cb}	—	2.5	5.0	pF
*Emitter-Base Capacitance (V_{EB} = −0.5 Vdc, I_C = 0, f = 100 kHz)	5	C_{eb}	—	18	35	pF
Collector-Base Time Constant (I_C = −50 mAdc, V_{CB} = −10 Vdc, f = 63.6 MHz)	8	$r_b'C_c$	—	8.0	—	ps
SWITCHING CHARACTERISTICS						
Delay Time (V_{CC} = −31.4 Vdc, I_C = −150 mAdc, R_C = 160 Ohms, R_E = 26.6 Ohms)	9, 10	t_d	—	1.0	—	ns
Rise Time	9, 10	t_r	—	2.1	—	
Fall Time	9, 10	t_f	—	1.8	—	

*Indicates JEDEC Registered Data.
Note 1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle = 2.0%.

2

2

FIGURE 1 — DC CURRENT GAIN

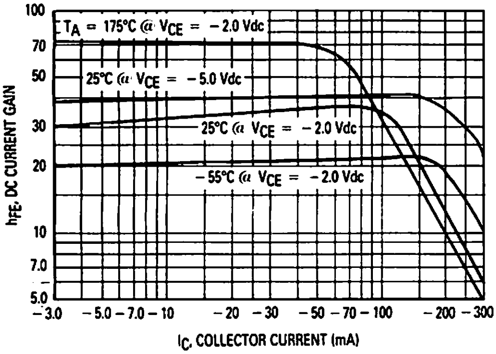


FIGURE 2 — COLLECTOR SATURATION REGION

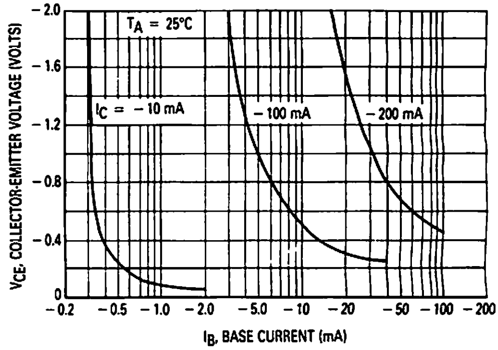


FIGURE 3 — "ON" VOLTAGES

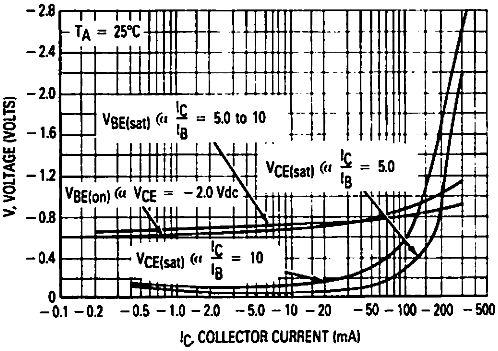


FIGURE 4 — COLLECTOR CURRENT versus BASE VOLTAGE

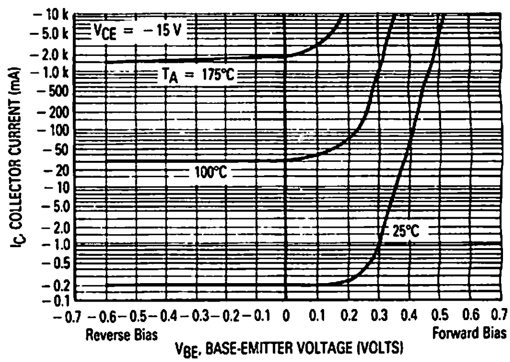


FIGURE 5 — CAPACITANCES

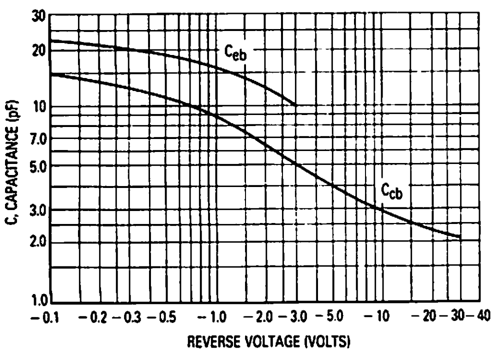


FIGURE 6 — TEMPERATURE COEFFICIENTS

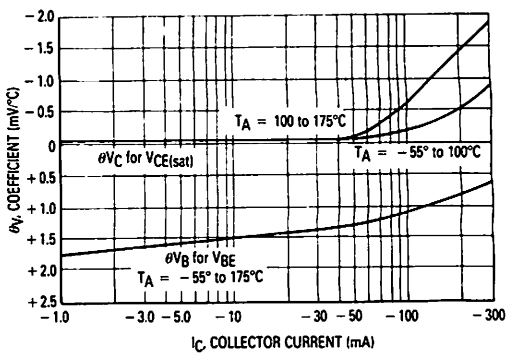


FIGURE 7 — CURRENT-GAIN — BANDWIDTH PRODUCT

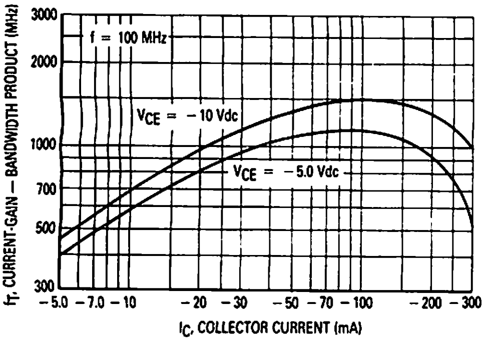


FIGURE 8 — COLLECTOR-BASE TIME CONSTANT

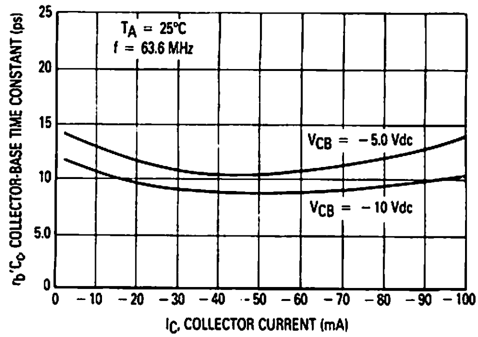


FIGURE 9 — SWITCHING TIMES

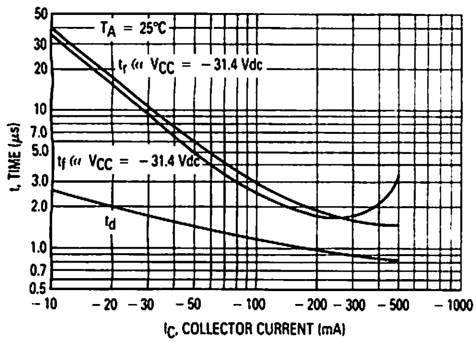
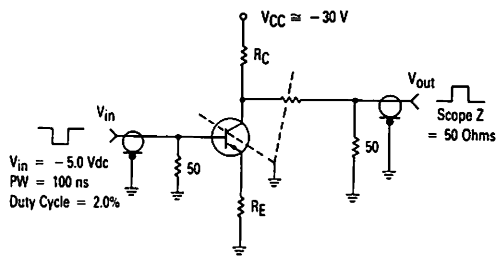


FIGURE 10 — SWITCHING TIMES TEST CIRCUIT



IC mA	RC Ohms	RE Ohms	VCC Volts
−50	526	80	−34.4
−150	160	26.6	−31.4
−300	78	13.3	−30.6
−500	46.5	8.0	−30.3

2

2N5641

The RF Line

2

NPN SILICON RF POWER TRANSISTOR

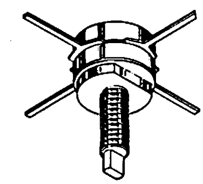
... designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

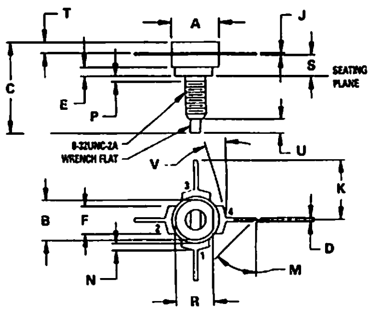
- Specified 28 Volt, 175 MHz Characteristics –
  Output Power = 7.0 Watts
  Minimum Gain = 8.4 dB
  Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

7.0 W – 175 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	0.64	0.89	0.025	0.035
E	1.78	—	0.070	—
F	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
M	45° NOM		45° NOM	
N	1.27	1.52	0.050	0.060
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132
V	10°	20°	10°	20°

CASE 144B-05

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^\circ C$ Derate above 25°C	P_D	15 86	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

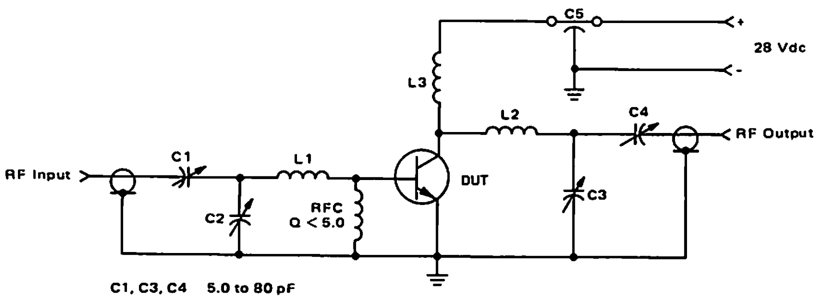
*Indicates JEDEC Registered Data.

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Charcteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	8.5	15	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 7.0 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	G_{PE}	8.4	12.5	–	dB
Collector Efficiency (Figure 1) (P_{out} = 7.0 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	η	60	–	–	%

Note 1: Pulsed through 25 mH inductor.
*Indicates JEDEC Registered Data.

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1, C3, C4	5.0 to 80 pF
C2	9.0 - 180 pF
C5	0.1 μF
L1	1-1/4 Straight #14 AWG
L2	3 Turns #16 AWG, 14" I.D.
L3	0.22 μH

FIGURE 2 – OUTPUT POWER versus FREQUENCY

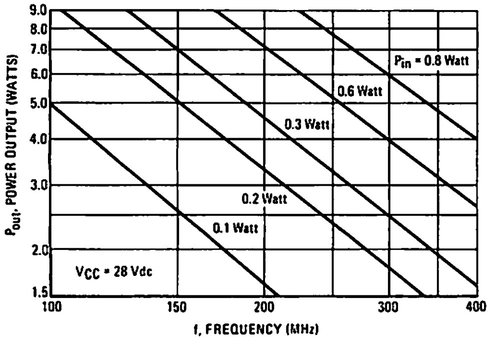


FIGURE 3 – OUTPUT POWER versus FREQUENCY

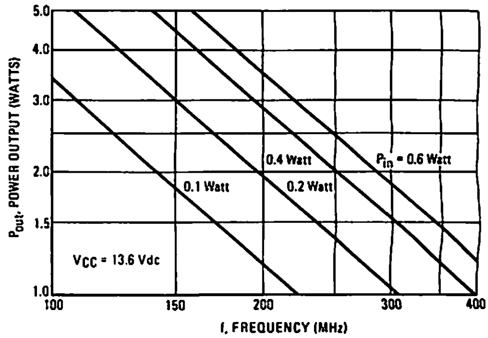
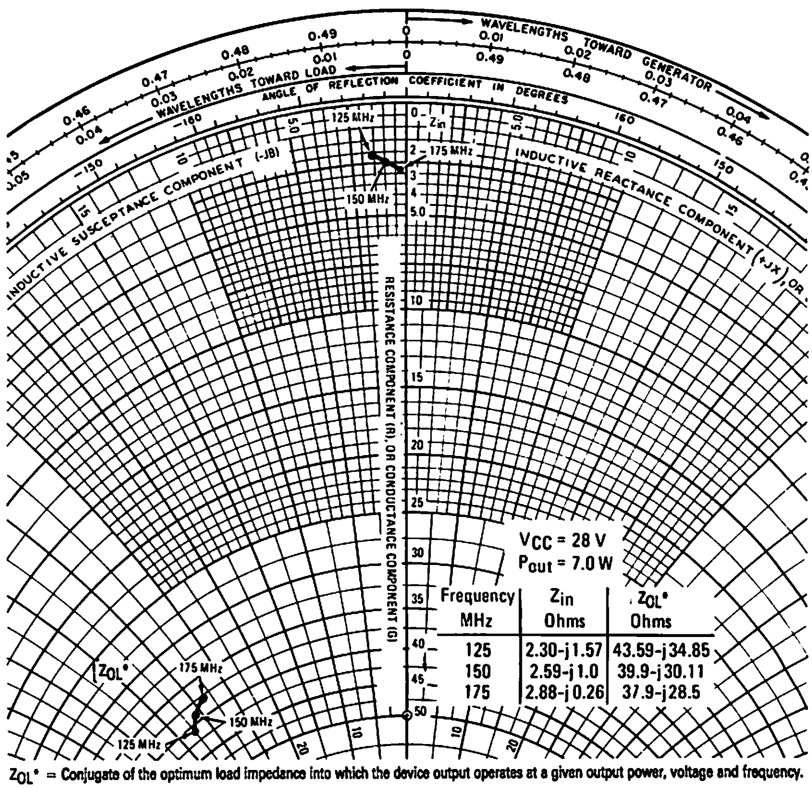


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
125	2.30-j1.57	43.59-j34.85
150	2.59-j1.0	39.9-j30.11
175	2.88-j0.26	37.9-j28.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N5642

The RF Line

NPN SILICON RF POWER TRANSISTOR

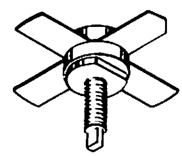
. . . designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

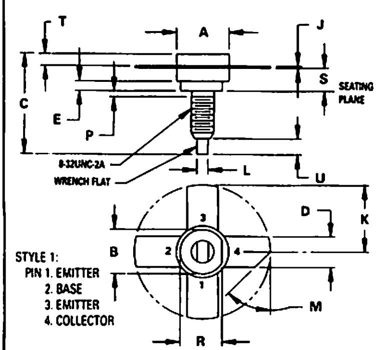
- Specified 28 Volt, 175 MHz Characteristics –
  Output Power = 20 Watts
  Minimum Gain = 8.2 dB
  Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

20 W – 175 MHz

RF POWER TRANSISTOR

NPN SILICON





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	3.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	30 171	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

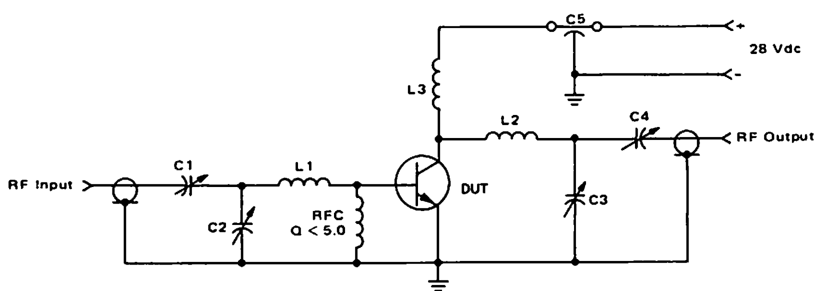
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	22	35	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	G_{PE}	8.2	10.2	–	dB
Collector Efficiency (Figure 1) (P_{out} = 20 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	η	60	–	–	%

Note 1: Pulsed through 25 mH inductor.
*Indicates JEDEC Registered Data.

FIGURE 1 – 175 MHz TEST CIRCUIT SCHEMATIC



C1	3.0-30 pF
C2, C3, C4	9.0-180 pF
C5	0.1 µF
L1	1" Straight #14 AWG
L2	1 Turn #16 AWG, 1/4" I.D.
L3	0.22 µH

FIGURE 2 – OUTPUT POWER versus FREQUENCY

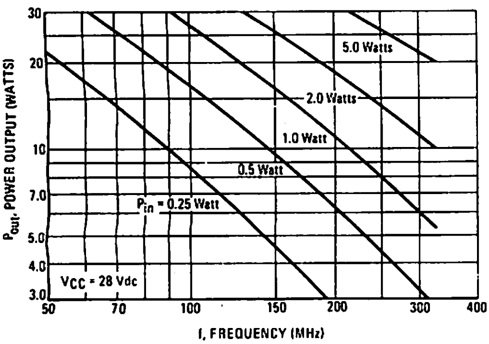


FIGURE 3 – OUTPUT POWER versus FREQUENCY

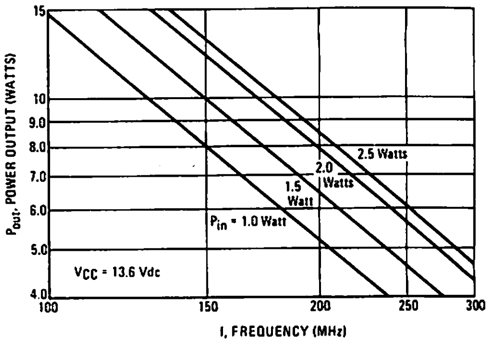
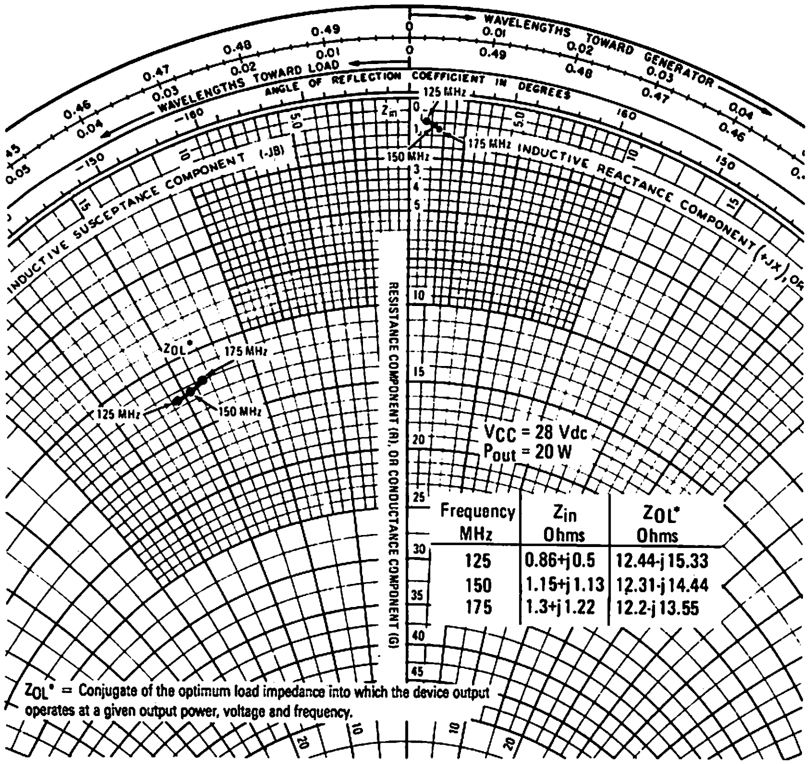


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
125	0.86+j0.5	12.44-j15.33
150	1.15+j1.13	12.31-j14.44
175	1.3+j1.22	12.2-j13.55

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5643

The RF Line

NPN SILICON RF POWER TRANSISTOR

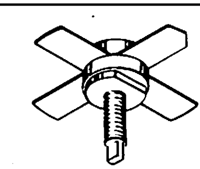
. . . designed primarily for wideband large-signal amplifier stages in the 125-175 MHz frequency range.

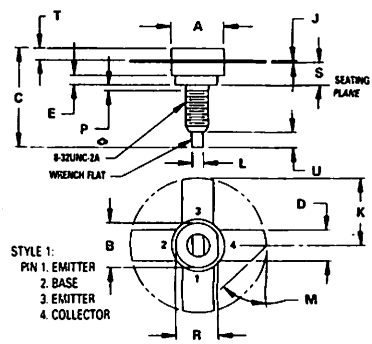
- Specified 28 Volt, 175 MHz Characteristics –
  Output Power = 40 Watts
  Minimum Gain = 7.6 dB
  Efficiency = 60%
- Characterized from 125 to 175 MHz
- Includes Series Equivalent Impedances

40 W – 175 MHz

RF POWER
TRANSISTOR

NPN SILICON





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DIM	MILLIMETERS		INCHES	
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B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	65	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	5.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	60 342	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J,T_{stg}	-65 to +200	°C

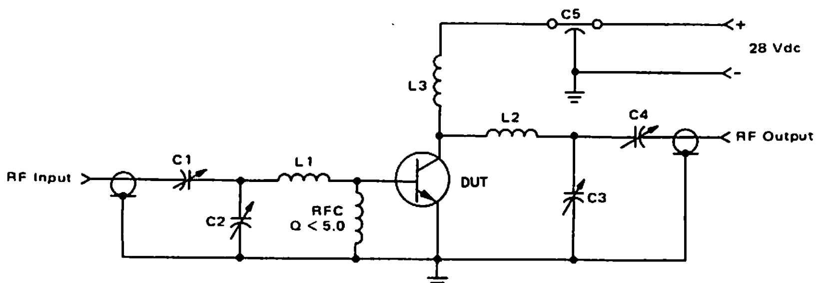
*Indicates JEDEC Registered Data.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (Note 1) (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	45	65	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 40 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	G_{PE}	7.6	8.1	–	dB
Collector Efficiency (Figure 1) (P_{out} = 40 Watts, V_{CE} = 28 Vdc, f = 175 MHz)	η	60	–	–	%

Note 1: Pulsed through 25 mH inductor.
*Indicates JEDEC Registered Data.

FIGURE 1 – 175 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C3, C4	ARCO 464 25-280 pF
C5	0.1 µF
L1	1" Straight #14 AWG
L2	1 Turn #16 AWG, 1/4" I.D.
L3	0.22 µH

FIGURE 2 — OUTPUT POWER versus FREQUENCY

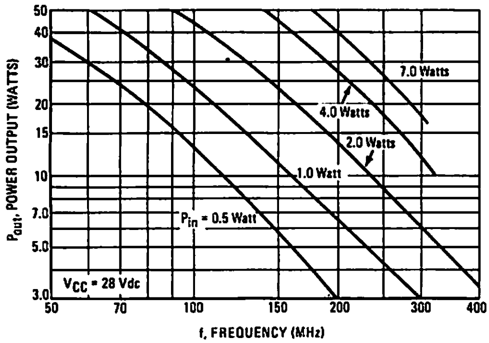


FIGURE 3 — OUTPUT POWER versus FREQUENCY

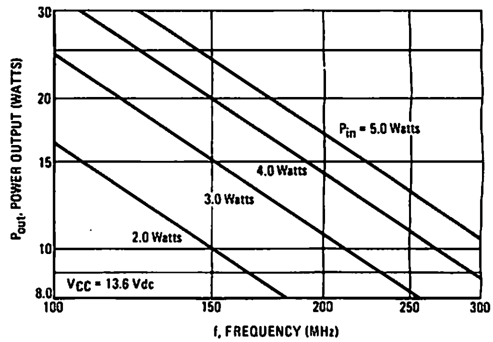
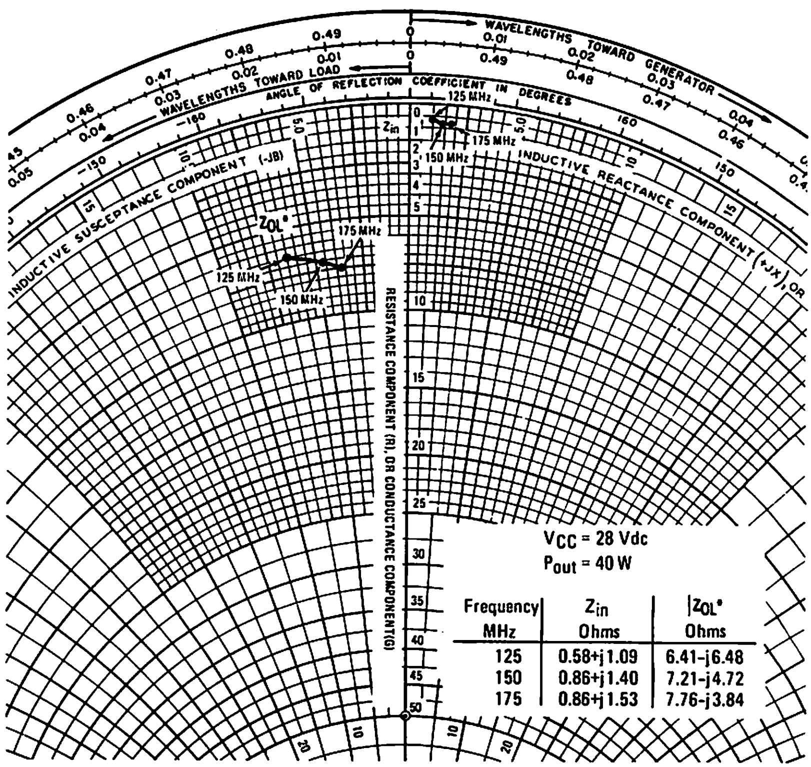


FIGURE 4 — SERIES EQUIVALENT IMPEDANCE



V_{CC} = 28 Vdc
P_{out} = 40 W

Frequency MHz	Z_{in} Ohms	$|Z_{OL}^*|$ Ohms
125	0.58+j1.09	6.41-j6.48
150	0.86+j1.40	7.21-j4.72
175	0.86+j1.53	7.76-j3.84

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5835
2N5836
2N5837

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTORS

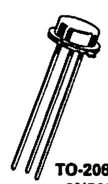
. . . designed primarily for use in fact current-mode switching circuits in military and industrial equipment. Suitable for use in general high-frequency amplifier applications to 1.5 GHz.

- 2N5835 — 10 mAdc, 6.0 Vdc Characteristics
  f_T = 2.5 GHz (Min)
  $r_B'C_c$ = 5.0 ps (Typ)
  t_r = 250 ps (Typ)
- 2N5836 — 50 mAdc, 6.0 Vdc Characteristics —
  f_T = 2.0 GHz (Min)
  $r_b'C_c$ = 6.0 ps (Typ)
  t_r = 320 ps (Typ)
- 2N5837 — 100 mAdc, 3.0 Vdc Characteristics —
  f_T = 1.7 GHz (Min)
  $r_b'C_c$ = 6.0 ps (Typ)
  t_r = 650 ps (Typ)
- MIL-S-19500 Processed Versions Available as MRF5836HX, MRF5836HXV

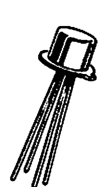
2.5 GHz @ 10 mAdc – 2N5835
2.0 GHz @ 50 mAdc – 2N5836
1.7 GHz @ 100 mAdc – 2N5837

HIGH FREQUENCY TRANSISTORS

NPN SILICON



TO-206AB
2N5836
2N5837

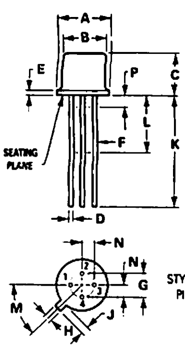


TO-206AF
2N5835

*MAXIMUM RATINGS

Rating	Symbol	2N5835	2N5836	2N5837	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	5.0	Vdc
Collector-Base Voltage	V_{CBO}	15	15	10	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	3.5	3.5	Vdc
Collector Current — Continuous	I_C	15	200	300	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	300 —	300 —	mW mW/°C
Total Device Dissipation @ T_C = 100°C **Derate above 100°C**	P_D	– –	0.75 7.5	0.75 7.5	Watts mW/°C
Storage Junction Temperature Range	T_{stg}	-65 to +200			°C

*Indicates JEDEC Registered Data

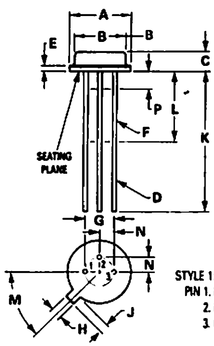


STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
TO-206AB
(TO-46)

2

*ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

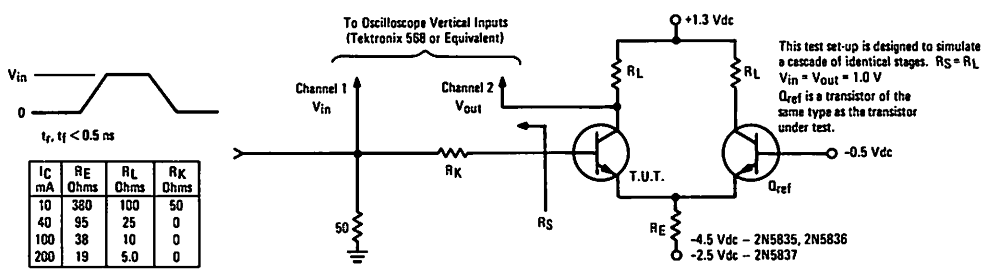
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 10 μAdc, I_E = 0)	2N5835		15	–	–	
(I_C = 100 μAdc, I_E = 0)	2N5836		15	–	–	
	2N5837		10	–	–	
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)		$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current		I_{CBO}				μAdc
(V_{CB} = 7.5 Vdc, I_E = 0)	2N5835		–	–	0.01	
(V_{CB} = 10 Vdc, I_E = 0)	2N5836		–	–	10	
(V_{CB} = 5.0 Vdc, I_E = 0)	2N5837		–	–	10	
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)		I_{EBO}	–	–	100	μAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 10 mAdc, V_{CE} = 6.0 Vdc)	2N5835		25	–	–	
(I_C = 50 mAdc, V_{CE} = 6.0 Vdc)	2N5836		25	–	–	
(I_C = 100 mAdc, V_{CE} = 3.0 Vdc)	2N5837		25	–	–	
Base-Emitter On Voltage		$V_{BE(on)}$				Vdc
(I_C = 10 mAdc, V_{CE} = 6.0 Vdc)	2N5835		–	–	0.9	
(I_C = 50 mAdc, V_{CE} = 6.0 Vdc)	2N5836		–	–	0.9	
(I_C = 100 mAdc, V_{CE} = 3.0 Vdc)	2N5837		–	–	0.9	
DYNAMIC CHARACTERISTICS						
Current-Gain—Bandwidth Product ①		f_T				GHz
(I_C = 10 mAdc, V_{CE} = 6.0 Vdc, f = 200 MHz)	2N5835		2.5	–	–	
(I_C = 50 mAdc, V_{CE} = 6.0 Vdc, f = 200 MHz)	2N5836		2.0	–	–	
(I_C = 100 mAdc, V_{CE} = 3.0 Vdc, f = 200 MHz)	2N5837		1.7	–	–	
Collector-Base Capacitance		C_{cb}				pF
(V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	2N5835		–	–	0.8	
	2N5836		–	–	3.5	
(V_{CB} = 5.0 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	2N5837		–	–	5.0	
Collector-Base Time Constant ②		$r_b'C_c$				ps
(I_C = 10 mAdc, V_{CE} = 6.0 Vdc, f = 63.6 MHz)	2N5835		–	5.0	–	
(I_C = 50 mAdc, V_{CE} = 6.0 Vdc, f = 63.6 MHz)	2N5836		–	6.0	–	
(I_C = 100 mAdc, V_{CE} = 3.0 Vdc, f = 63.6 MHz)	2N5837		–	6.0	–	
SWITCHING CHARACTERISTICS ②						
Rise Time (See Figure 1) (I_C = 10 mAdc)	2N5835	t_r	–	250	–	ps
(I_C = 40 mAdc)	2N5836		–	320	–	
(I_C = 100 mAdc)	2N5837		–	650	–	

*Indicates JEDEC Registered Data

① f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

② Typical values shown in addition to JEDEC Registered Data.

FIGURE 1 — SWITCHING TIME TEST CIRCUIT



IC mA	RE Ohms	RL Ohms	RK Ohms
10	380	100	50
40	95	25	0
100	38	10	0
200	19	5.0	0

FIGURE 2 – SWITCHING TIME

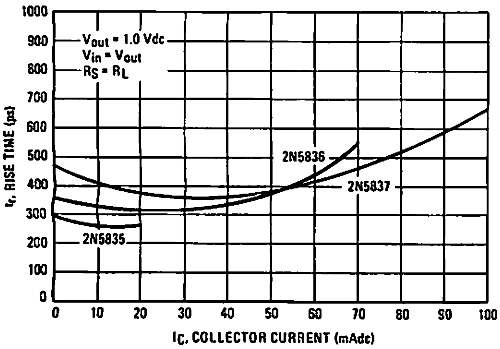


FIGURE 3 – CURRENT-GAIN–BANDWIDTH PRODUCT

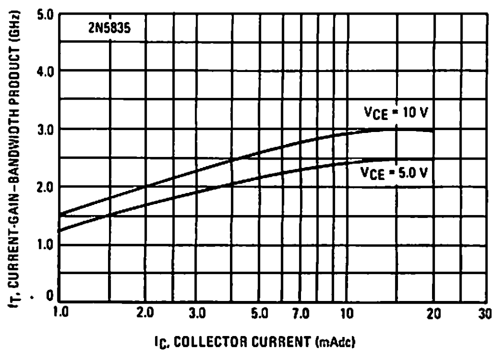


FIGURE 4 – CURRENT-GAIN–BANDWIDTH PRODUCT

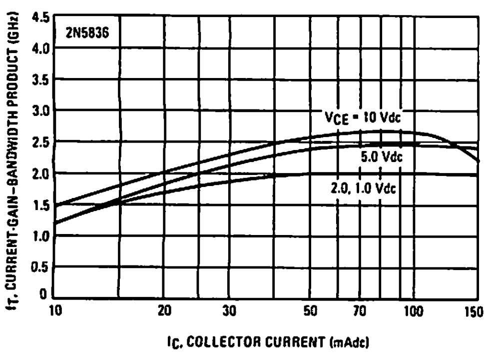


FIGURE 5 – CURRENT-GAIN–BANDWIDTH PRODUCT

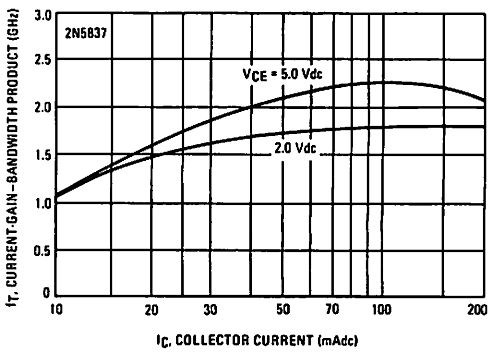


FIGURE 6 – COLLECTOR-BASE TIME CONSTANT

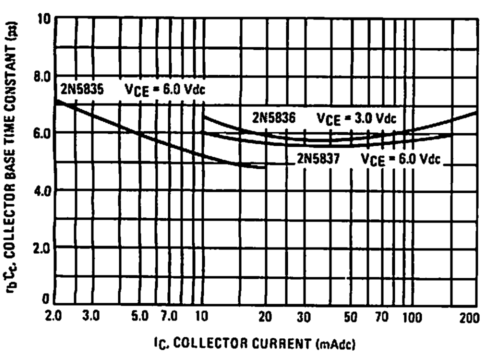
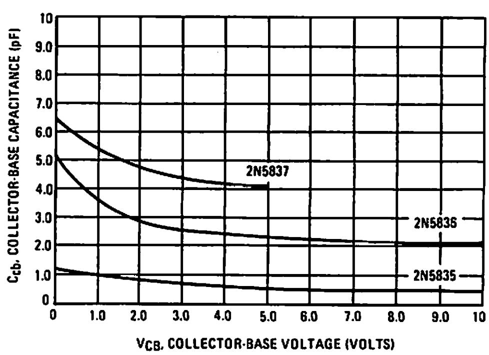


FIGURE 7 – COLLECTOR-BASE CAPACITANCE



2

2N5835 SCATTERING PARAMETERS
(I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, Z_G = Z_L = 50 Ohms)

FIGURE 8 – S_{11}, INPUT REFLECTION COEFFICIENT

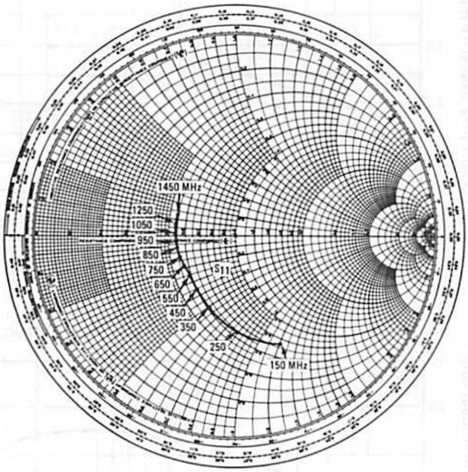


FIGURE 9 – S_{22}, OUTPUT REFLECTION COEFFICIENT

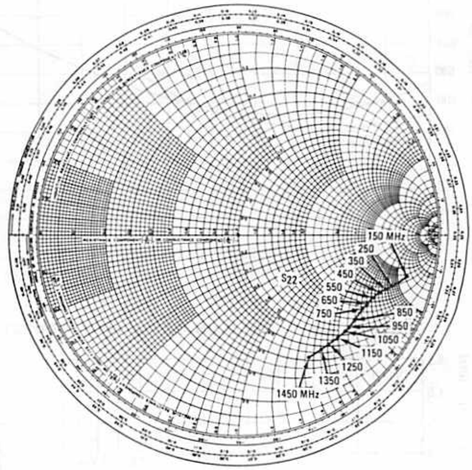


FIGURE 10 – S_{12}, REVERSE TRANSMISSION COEFFICIENT

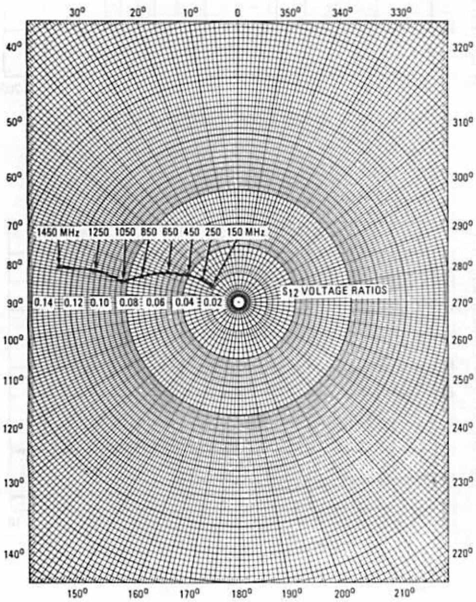
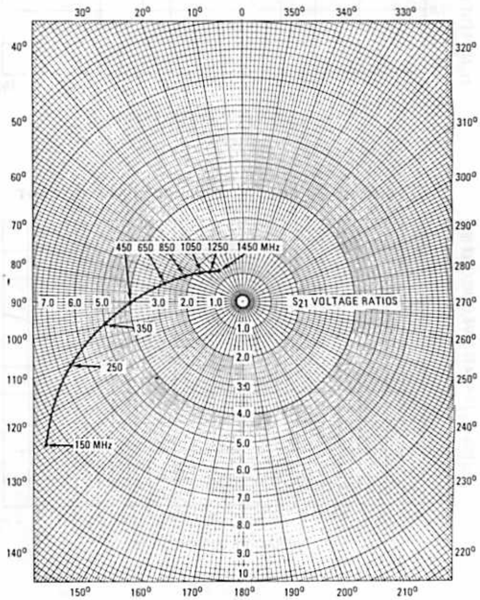


FIGURE 11 – S_{21}, FORWARD TRANSMISSION COEFFICIENT



2N5836 SCATTERING PARAMETERS
(I_C = 100 mAdc, V_{CE} = 10 Vdc, Z_G = Z_L = 50 Ohms)

FIGURE 12 – S_{11}, INPUT REFLECTION COEFFICIENT

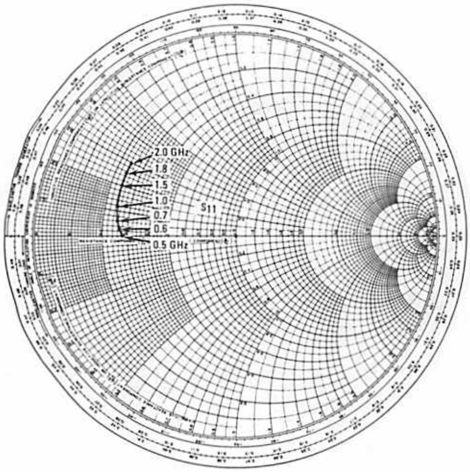


FIGURE 13 – S_{22}, OUTPUT REFLECTION COEFFICIENT

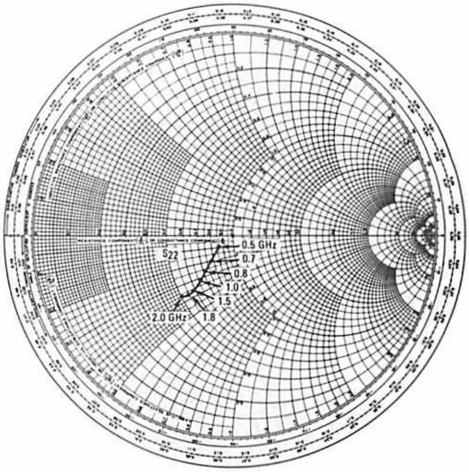


FIGURE 14 – S_{12}, REVERSE TRANSMISSION COEFFICIENT

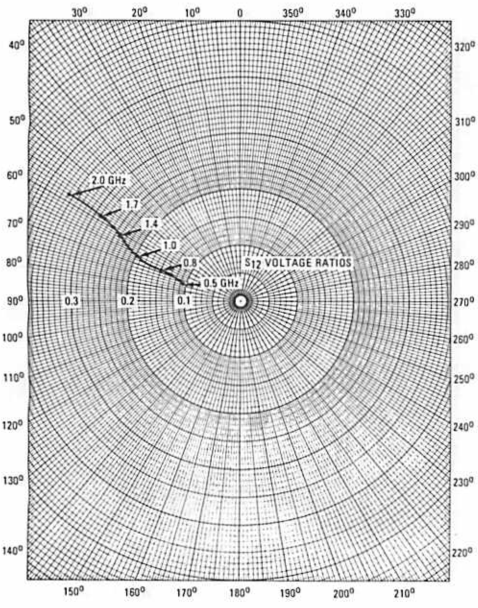
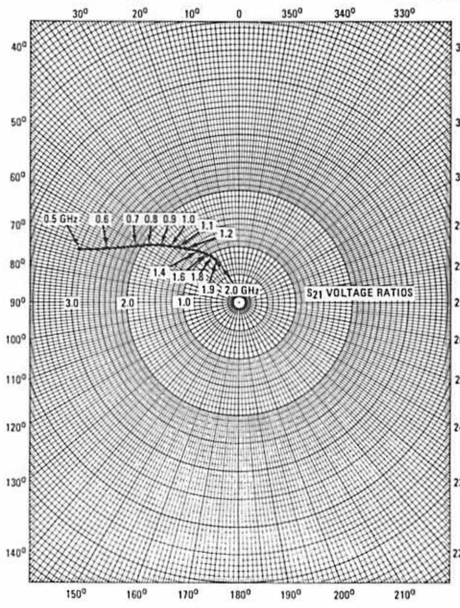


FIGURE 15 – S_{21}, FORWARD TRANSMISSION COEFFICIENT



2N5837 SCATTERING PARAMETERS

(I_C = 100 mAdc, V_{CE} = 3.0 Vdc, Z_G = Z_L = 50 Ohms)

FIGURE 16 – S_{11}, INPUT REFLECTION COEFFICIENT

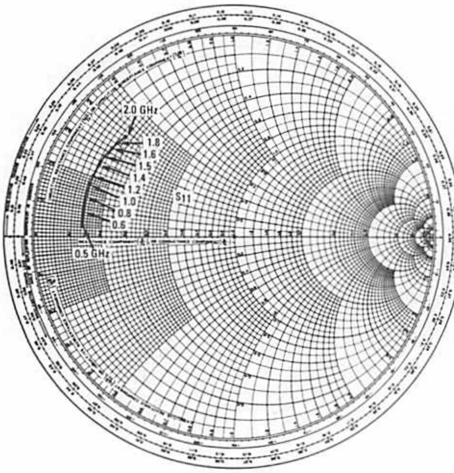


FIGURE 17 – S_{22}, OUTPUT REFLECTION COEFFICIENT

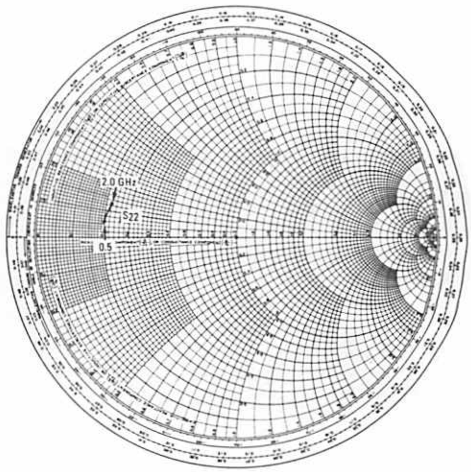


FIGURE 18 – S_{12}, REVERSE TRANSMISSION COEFFICIENT

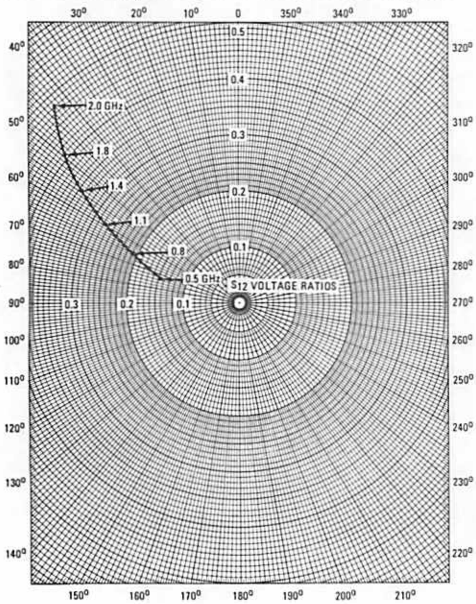
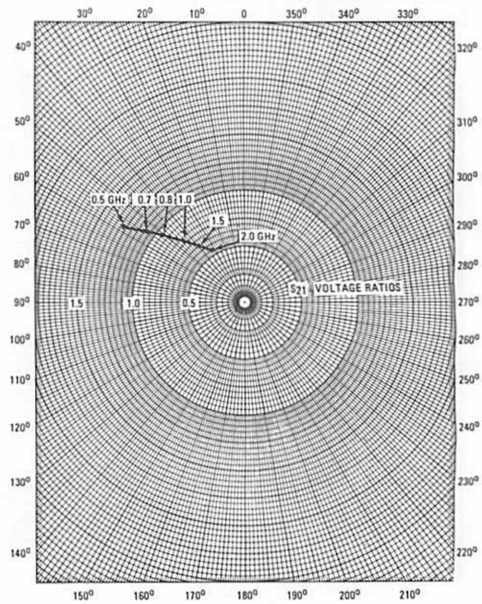


FIGURE 19 – S_{21}, FORWARD TRANSMISSION COEFFICIENT



MOTOROLA SEMICONDUCTOR TECHNICAL DATA

2N5849

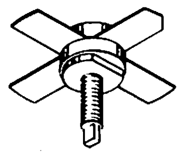
2

The RF Line

40 W–50 MHz

RF POWER TRANSISTOR

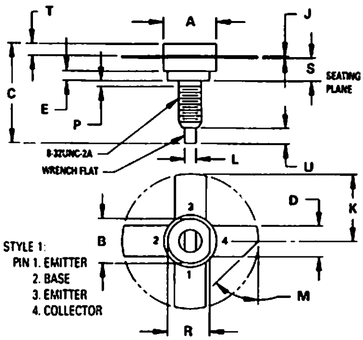
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in large-signal amplifier output stages, the 2N5849 is intended for use in industrial communications equipment operating at frequencies to 80 MHz.

- Specified 12.5 Volt, 50 MHz Characteristics –
  Output Power = 40 Watts
  Minimum Gain = 7.5 dB
  Efficiency = 50%



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CB}	48	Vdc
Emitter-Base Voltage	V_{EB}	4.0	Vdc
Collector Current – Continuous	I_C	7.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	100 571	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

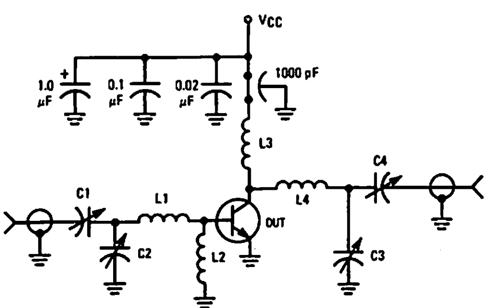
This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

*ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage(1) (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	24	–	–	Vdc
Collector-Emitter Breakdown Voltage(1) (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	48	–	--	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_A = +125°C)	I_{CES}	–	–	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.4 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	3.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{ob}	–	180	230	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 50 MHz)	G_{PE}	7.5	–	–	dB
Collector Efficiency (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 50 MHz)	η	50	–	–	%

*Indicates JEDEC Registered Data.
(1)Pulsed thru a 25 mH Inductor.

FIGURE 1 – 50 MHz POWER GAIN TEST CIRCUIT



C1 25-280 pF, Arco 464 or Equivalent
C2 80-480 pF, Arco 466 or Equivalent
C3 0-75 pF, Hammarlund MAPC 75 or Equivalent
C4 0-50 pF, Hammarlund MAPC 50 or Equivalent
L1 1 Turn #14 AWG 5/16" I.D.
L2 2-1/2 Turns #22 AWG on 3/8" Ferrite Bead
L3 18 Turns #18 AWG 3/8" I.D. 2 Layers, 9 Turns Each
L4 4 Turns #14 AWG 7/16" I.D. 7/16" Long

FIGURE 2 – POWER OUTPUT versus POWER INPUT

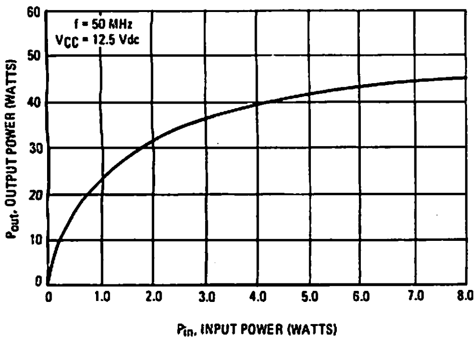


FIGURE 3 – POWER OUTPUT versus FREQUENCY

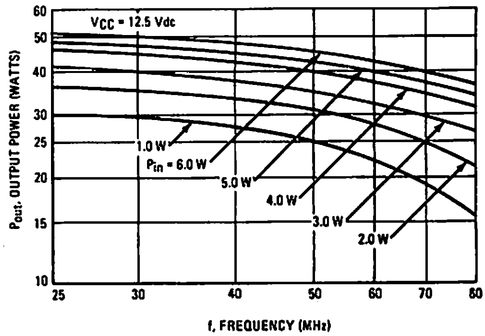


FIGURE 4 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

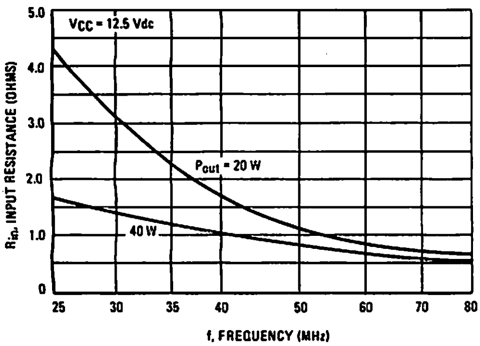


FIGURE 5 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

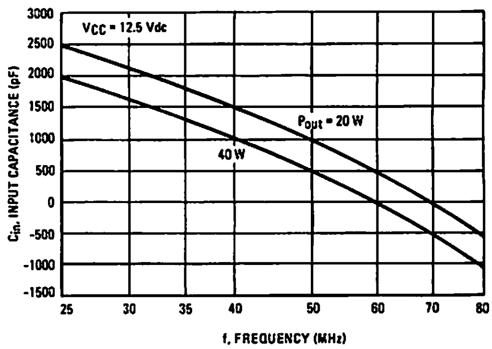


FIGURE 6 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

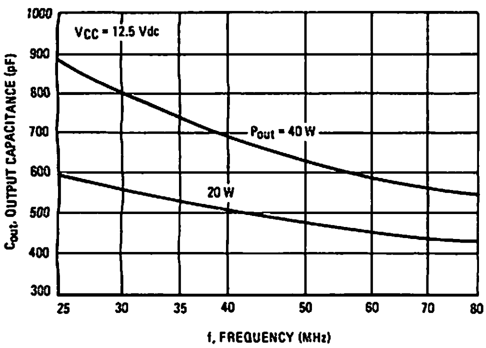
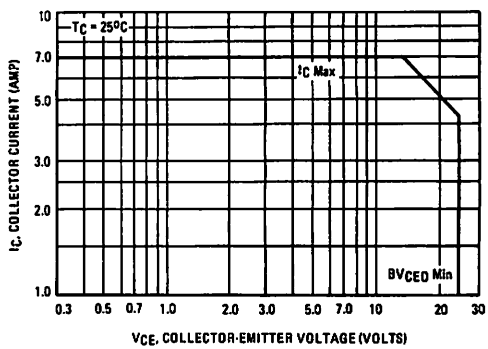


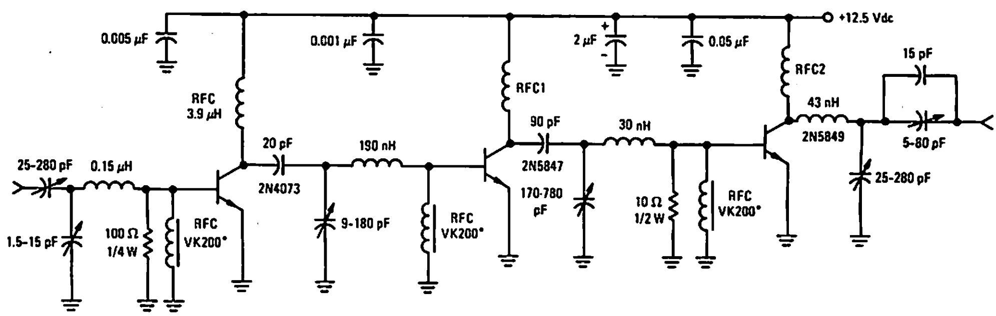
FIGURE 7 – DC SAFE OPERATING AREA



2

2

40 WATT, 50 MHz TRANSMITTER SCHEMATIC



P_o = 40 W
P_{in} = 20 mW
Overall Gain = 33 dB
Overall Efficiency = 59.2%

*Ferroxcube Part Number
RFC1 – 20 Turns #18 AWG, 3/16" I.D., 2 Layers, 10 Turns Each, Close Wound.
RFC2 – 18 Turns, #18 AWG, 3/16" I.D., 2 Layers, 9 Turns Each, Close Wound.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5943

The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

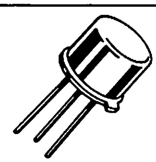
. . . designed specifically for broadband applications requiring low cross-modulation distortion and low-noise figure. Characterized for use in CATV applications.

- Low Noise Figure — @ f = 200 MHz
  NF (Narrowband) = 3.4 dB (Typ)
  NF (Broadband) = 6.8 dB (Typ)
- High Current-Gain — Bandwidth Product —
  f_T = 1200 MHz (Min) @ I_C = 50 mAdc
- Completely Characterized with s and y-Parameters

1.2 GHz — 50 mAdc

NPN SILICON HIGH-FREQUENCY TRANSISTOR

NPN SILICON

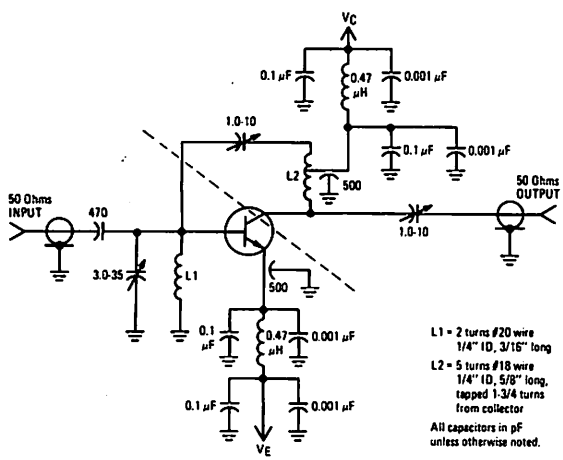


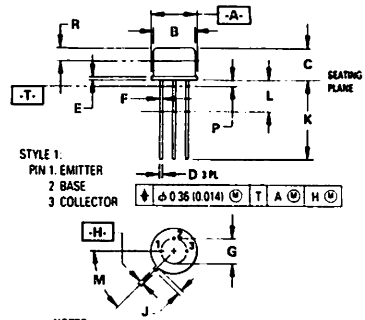
*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.7	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 0.02	Watts W/°C*
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

FIGURE 1 — NARROW-BAND TEST CIRCUIT





STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

2

***ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)**

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 µAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, I_B = 0)	I_{CEO}	–	–	50	µAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	10	µAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 15 Vdc)	h_{FE}	25	–	300	–
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.15	0.2	Vdc
Base-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{BE(sat)}$	–	0.88	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (Figure 2)	f_T				MHz
(I_C = 25 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)		1000	1350	–	
(I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)		1200	1550	2400	
(I_C = 100 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)		1000	1425	–	
Collector-Base Capacitance (Figure 5) (V_{CB} = 30 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	1.0	1.6	2.5	pF
Emitter-Base Capacitance (Figure 5) (V_{EB} = 0.5 Vdc, I_C = 0, f = 100 kHz)	C_{eb}	–	8.4	15	pF
Small-Signal Current Gain (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 1.0 kHz)	h_{fe}	25	–	350	–
Collector-Base Time Constant (I_E = 50 mAdc, V_{CB} = 15 Vdc, f = 31.8 MHz)	$r_b'C_c$	2.0	5.5	20	ps
Noise Figure	NF				dB
(I_C = 30 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) (Figure 1)		–	3.4	–	
(I_C = 35 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) (Figures 6, 11, 14) (1)		–	6.8	8.0	
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain	G_{pe}				dB
(I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) (Figure 1)		–	11.4	–	
(I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 250 MHz) (Figure 6)		7.0	7.6	–	
Intermodulation Distortion (Figure 7) (I_C = 50 mAdc, V_{CE} = 15 Vdc, V_{out} = +50 dBmV)	IM	–	–	-50	dB
Cross Modulation Distortion (Figure 8)	XM				dB
(I_C = 50 mAdc, V_{CE} = 15 Vdc, V_{out} = +40 dBmV)		–	-67	–	
(I_C = 50 mAdc, V_{CE} = 15 Vdc, V_{out} = +50 dBmV)		–	-45	-42	

*Indicates JEDEC Registered Data.
(1) Includes noise figure of post-amplifier and matching pad.

2

FIGURE 2 – CURRENT-GAIN – BANDWIDTH PRODUCT

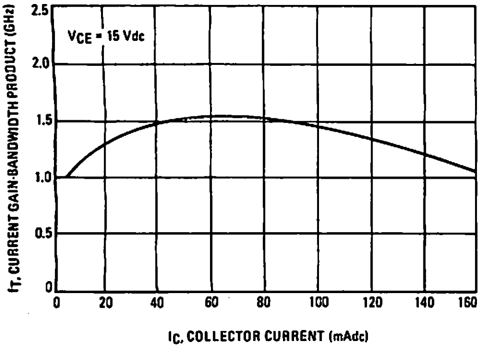


FIGURE 3 – COLLECTOR-BASE TIME CONSTANT

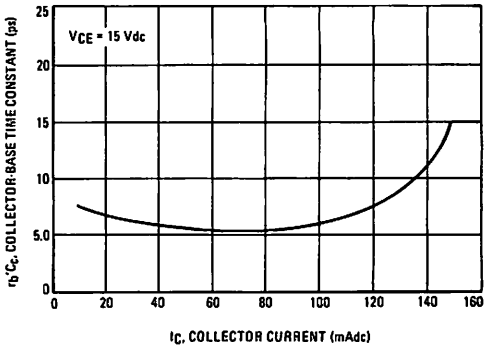


FIGURE 4 – SATURATION VOLTAGES

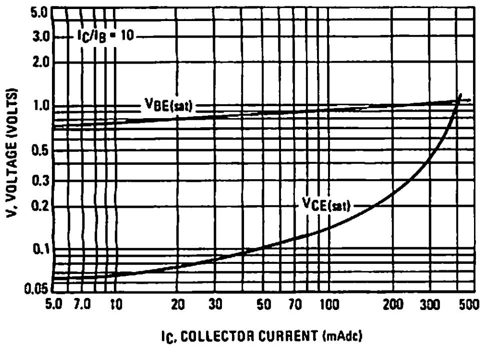


FIGURE 5 – CAPACITANCES versus REVERSE VOLTAGE

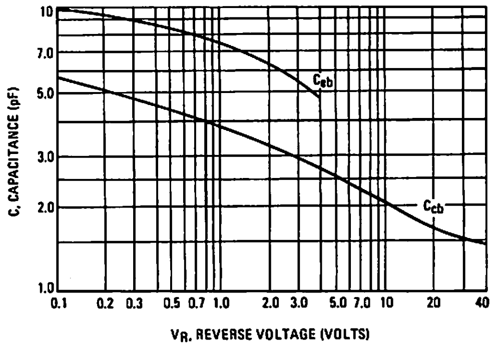
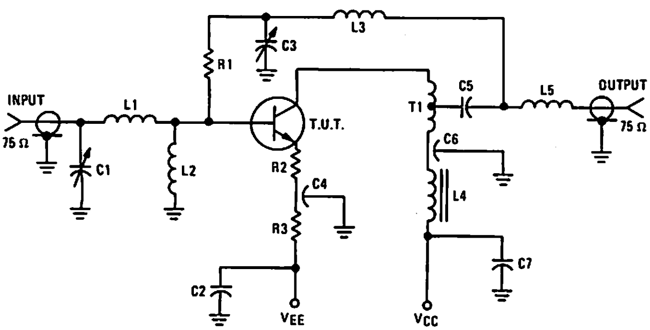


FIGURE 6 – BROADBAND TEST CIRCUIT



C1	1.0-10 pF	JOHANSON 2951 OR EQUIVALENT
C2, C7	0.01 μF	
C3	0.5-6.0 pF	JOHANSON 4642 OR EQUIVALENT
C4, C6	1500 pF	
C5	470 pF	
L1	2 TURNS AWG #26, 5/32" I.D.	
L2	1 μH MOLDED CHOKE	
L3	5 TURNS AWG #26, 3/32" I.D.	
L4	FERRITE CHOKE, 3 TURNS #30 ON STACKPOLE 57-0156 BEAD	
L5	2 TURNS AWG #26, 3/32" I.D.	
T1	AWG #30 TRIFILAR WOUND 1-9-9 ON STACKPOLE 57-0985, #11 TOROID	
R1	270 OHMS	
R2	18 OHMS	
R3	150 OHMS	

GARLOCK TEFLON SOCKET

2

FIGURE 7 — CROSS-MODULATION DISTORTION versus COLLECTOR CURRENT

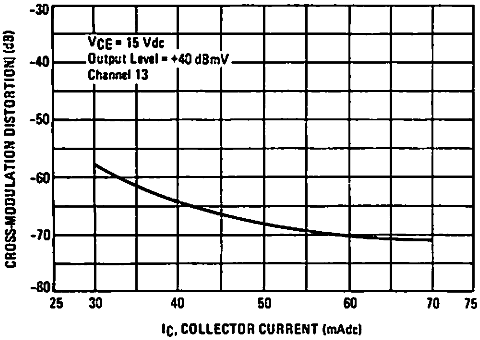


FIGURE 8 — CROSS-MODULATION DISTORTION versus OUTPUT LEVEL

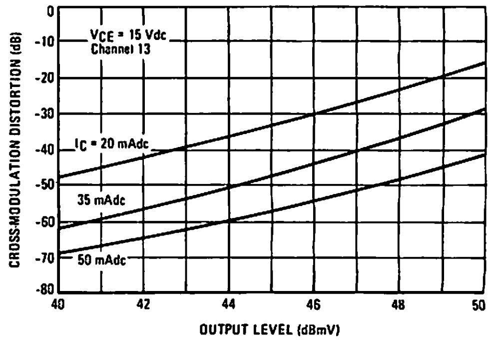


FIGURE 9 — NARROWBAND NOISE FIGURE versus COLLECTOR CURRENT

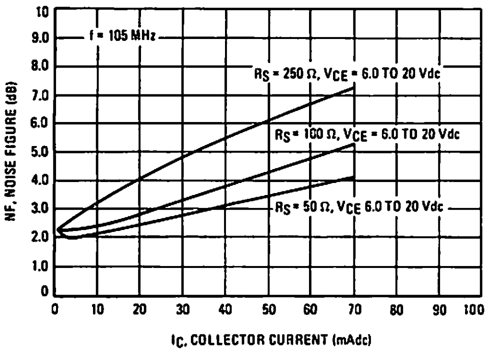


FIGURE 10 — NARROWBAND NOISE FIGURE versus COLLECTOR CURRENT

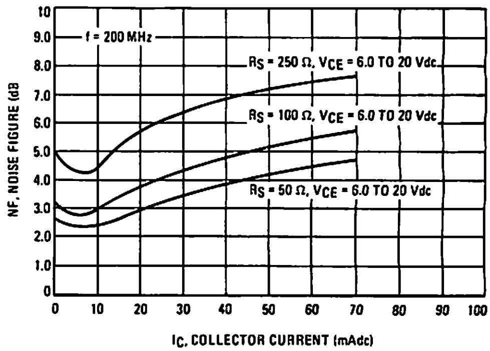


FIGURE 11 — BROADBAND NOISE FIGURE versus COLLECTOR CURRENT

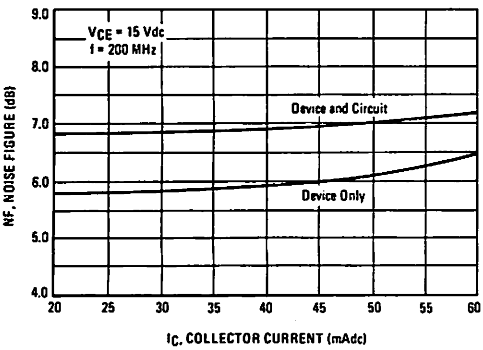


FIGURE 12 — NARROWBAND NOISE FIGURE versus FREQUENCY

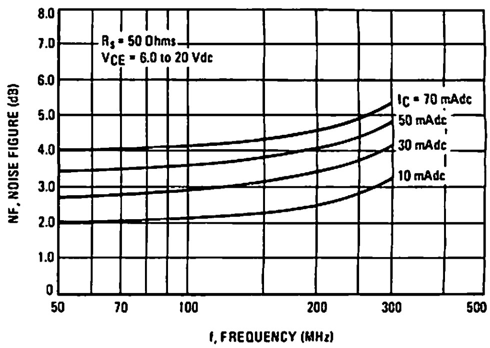


FIGURE 13 — INPUT ADMITTANCE versus FREQUENCY

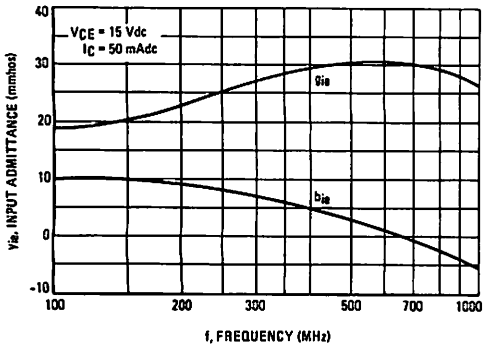


FIGURE 14 — INPUT ADMITTANCE versus COLLECTOR CURRENT

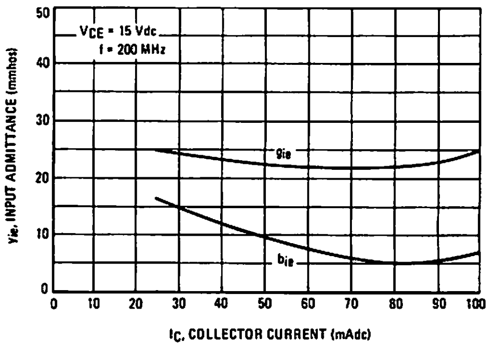


FIGURE 15 — REVERSE TRANSFER ADMITTANCE versus FREQUENCY

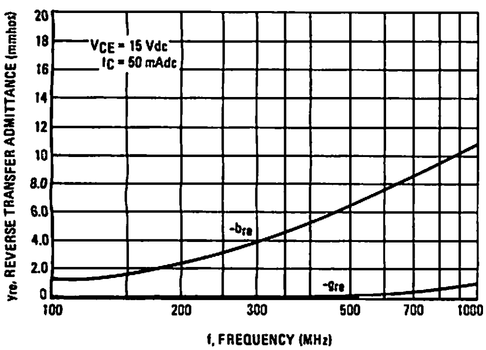


FIGURE 16 — REVERSE TRANSFER ADMITTANCE versus COLLECTOR CURRENT

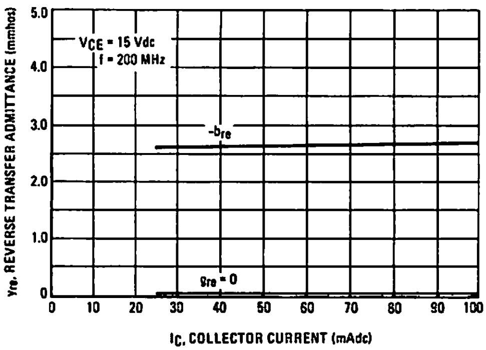


FIGURE 17 — FORWARD TRANSFER ADMITTANCE versus FREQUENCY

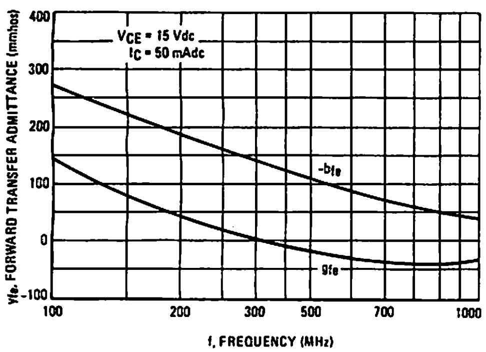


FIGURE 18 — FORWARD TRANSFER ADMITTANCE versus COLLECTOR CURRENT

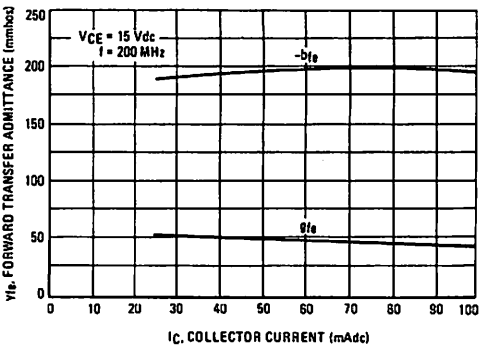


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FIGURE 19 – OUTPUT ADMITTANCE versus FREQUENCY

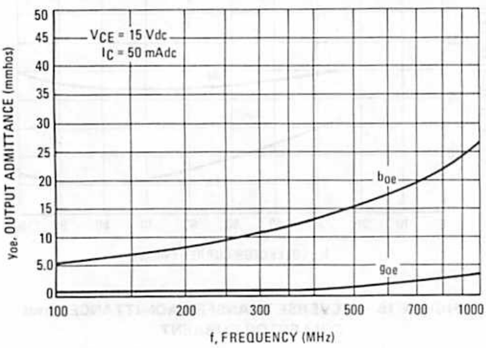


FIGURE 20 – OUTPUT ADMITTANCE versus COLLECTOR CURRENT

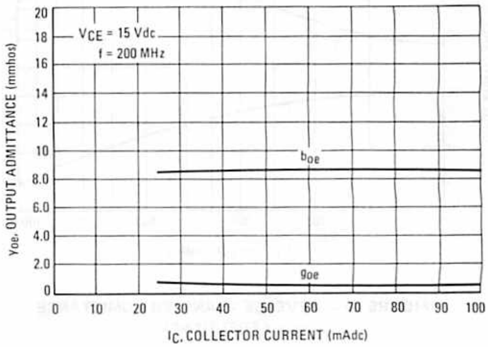


FIGURE 21 – INPUT REFLECTION COEFFICIENT versus FREQUENCY

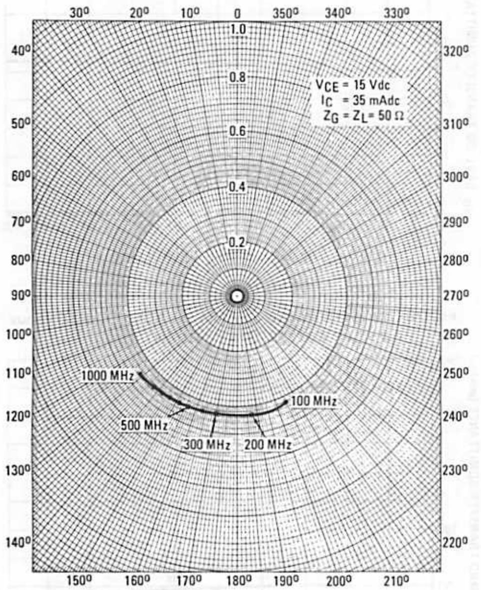
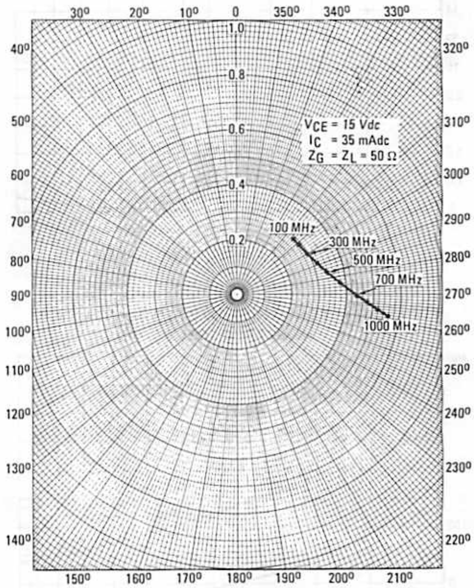


FIGURE 22 – OUTPUT REFLECTION COEFFICIENT versus FREQUENCY



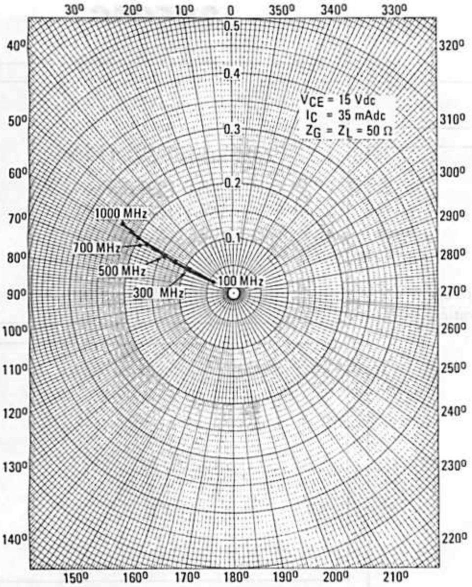


FIGURE 23 – REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY

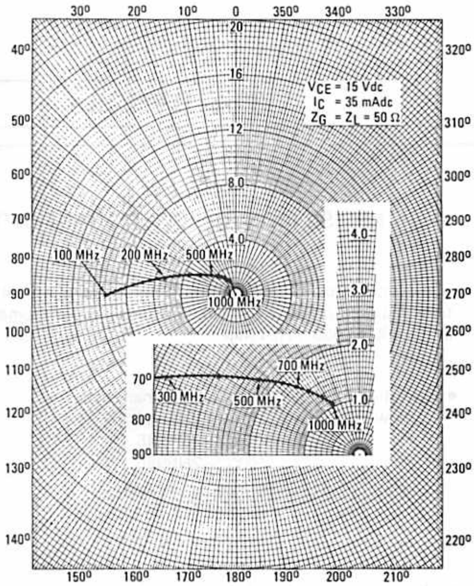
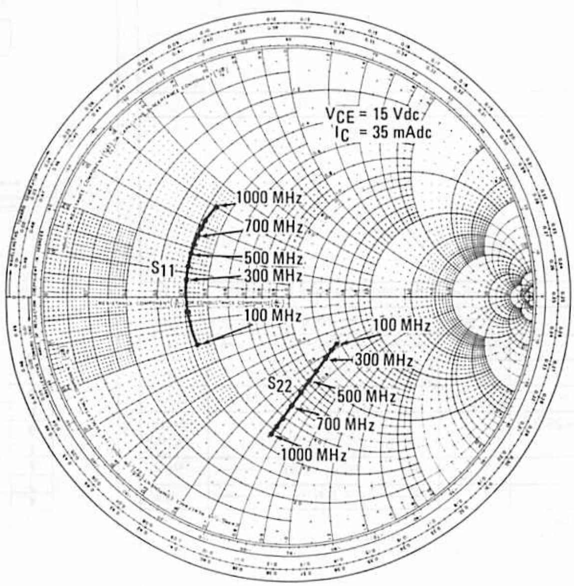


FIGURE 24 – FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY

FIGURE 25 – INPUT REFLECTION COEFFICIENT AND OUTPUT REFLECTION COEFFICIENT versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N5944
2N5945
2N5946

The RF Line

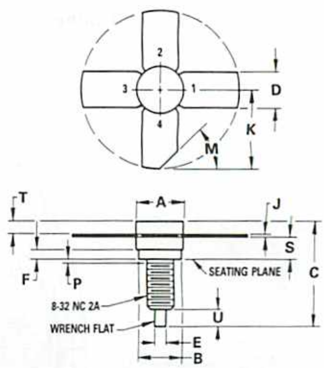
2

NPN SILICON RF POWER TRANSISTORS

. . . designed for 7.0 to 15 Volts, UHF large signal amplifier applications required in industrial and commercial FM equipment operating in the 400 to 960 MHz range.

- Specified 12.5 Volt, 470 MHz Characteristics –
  Power Output = 2.0 W – 2N5944
  4.0 W – 2N5945
  10 W – 2N5946
  Minimum Gain = 9.0 dB – 2N5944
  8.0 dB – 2N5945
  6.0 dB – 2N5946
  Efficiency = 60% Minimum
- Characterized with series equivalent large-signal impedance parameters

2.0, 4.0, 10 W – 470 MHz
RF POWER
TRANSISTORS
NPN SILICON



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	2N5944	2N5945	2N5946	Unit
*Collector-Emitter Voltage	V_{CEO}	← 16 →			Vdc
*Collector-Base Voltage	V_{CBO}	← 36 →			Vdc
*Emitter-Base Voltage	V_{EBO}	← 4.0 →			Vdc
*Collector Current – Continuous	I_C	0.4	0.8	2.0	Adc
*Total Device Dissipation @ $T_C = 25^oC$(1) Derate above 25°C	P_D	5.0 28.5	15 85.5	37.5 214	Watts mW/°C
*Storage Temperature Range	T_{stg}	← -65 to +200 →			°C
Stud Torque(2)	—	← 6.5 →			in-lbs.

*Indicates JEDEC Registered Data
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) For repeated assembly use 5 in-lbs.

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 50 mAdc, I_B = 0)	2N5944		16	–	–	
(I_C = 100 mAdc, I_B = 0)	2N5945		16	–	–	
(I_C = 200 mAdc, I_B = 0)	2N5946		16	–	–	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 50 mAdc, V_{BE} = 0)	2N5944		36	–	–	
(I_C = 100 mAdc, V_{BE} = 0)	2N5945		36	–	–	
(I_C = 200 mAdc, V_{BE} = 0)	2N5946		36	–	–	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 1.0 mAdc, I_C = 0)	2N5944		4.0	–	–	
(I_E = 2.0 mAdc, I_C = 0)	2N5945		4.0	–	–	
(I_E = 4.0 mAdc, I_C = 0)	2N5946		4.0	–	–	
Collector Cutoff Current		I_{CES}				mAdc
(V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 55°C)	2N5944		–	0.2	10	
	2N5945,2N5946		–	0.5	20	
Collector Cutoff Current		I_{CBO}				mAdc
(V_{CB} = 15 Vdc, I_E = 0)	2N5944,2N5945		–	–	1.0	
	2N5946		–	–	2.0	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				–
(I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	2N5944		20	80	–	
(I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	2N5945		20	80	–	
(I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	2N5946		20	80	–	
DYNAMIC CHARACTERISTICS						
Output Capacitance		C_{ob}				pF
(V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	2N5944		–	11	15	
	2N5945		–	18	25	
	2N5946		–	38	45	
FUNCTIONAL TEST (Figures 20 and 21).						
Common-Emitter Amplifier Power Gain		G_{PE}				dB
(V_{CC} = 12.5 Vdc, P_{out} = 2.0 W, I_C(max) = 267 mAdc, f = 470 MHz)	2N5944		9.0	10	–	
(V_{CC} = 12.5 Vdc, P_{out} = 4.0 W, I_C(max) = 533 mAdc, f = 470 MHz)	2N5945		8.0	9.0	–	
(V_{CC} = 12.5 Vdc, P_{out} = 10 W, I_C(max) = 1.33 Adc, f = 470 MHz)	2N5946		6.0	7.0	–	
Collector Efficiency		η				%
(V_{CC} = 12.5 Vdc, P_{out} = 2.0 W, I_C(max) = 240 mAdc, f = 470 MHz)	2N5944		60	–	–	
(V_{CC} = 12.5 Vdc, P_{out} = 4.0 W, I_C(max) = 500 mAdc, f = 470 MHz)	2N5945		60	–	–	
(V_{CC} = 12.5 Vdc, P_{out} = 10 W, I_C(max) = 1.3 Adc, f = 470 MHz)	2N5946		60	–	–	

*Indicates JEDEC Registered Data

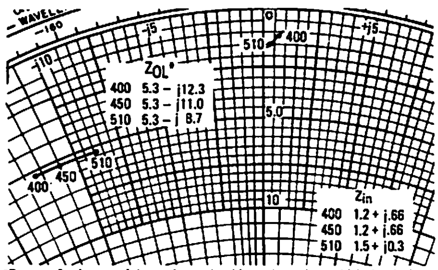
These devices are available in various packages, such as a studless stripline package, TO-205AD (TO-39) and also in chip form on beryllium oxide carriers for hybrid assemblies.

For further information, contact your nearest Motorola representative or the factory representative.

2

2N5944
TYPICAL PERFORMANCE DATA

FIGURE 1 — SERIES EQUIVALENT IMPEDANCE



*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

V_{CC} = 12.5 Vdc, P_{out} = 2.0 W

FIGURE 2 — OUTPUT POWER versus SUPPLY VOLTAGE

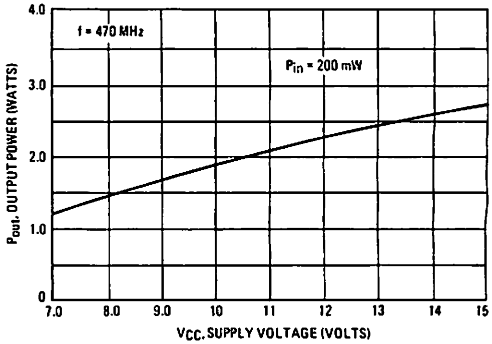


FIGURE 3 — OUTPUT POWER versus INPUT POWER

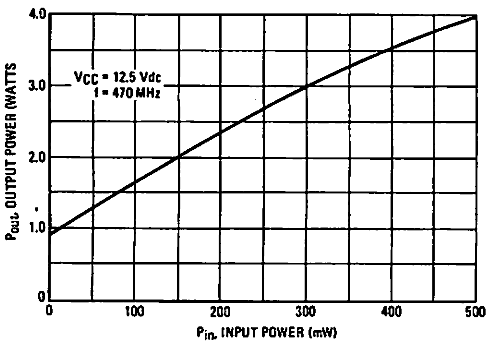


FIGURE 4 — OUTPUT POWER versus FREQUENCY

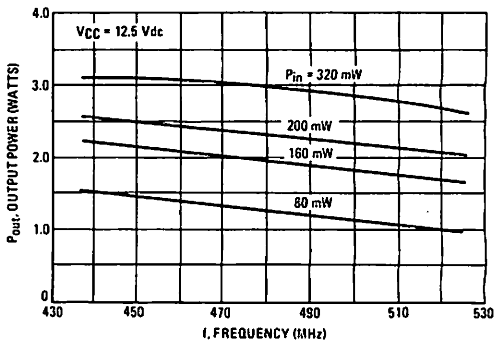


FIGURE 5 — OUTPUT POWER versus INPUT POWER

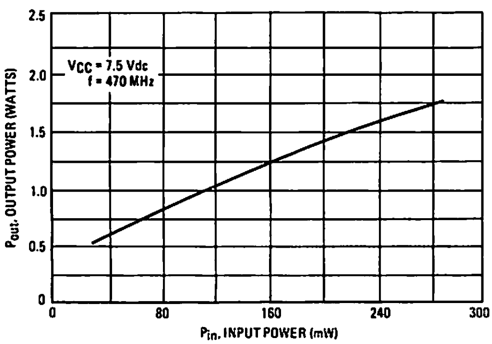
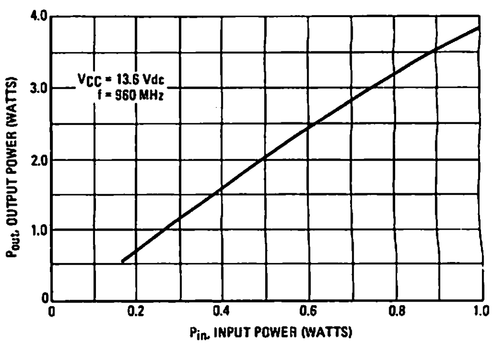
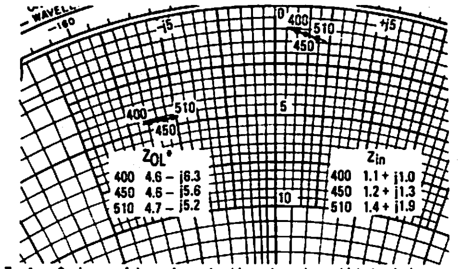


FIGURE 6 — OUTPUT POWER versus INPUT POWER



2N5945
TYPICAL PERFORMANCE DATA

FIGURE 7 – SERIES EQUIVALENT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

V_{CC} = 12.5 Vdc, P_{out} = 4.0 W

FIGURE 8 – OUTPUT POWER versus SUPPLY VOLTAGE

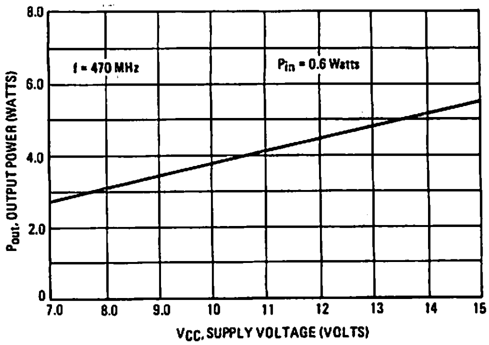


FIGURE 9 – OUTPUT POWER versus INPUT POWER

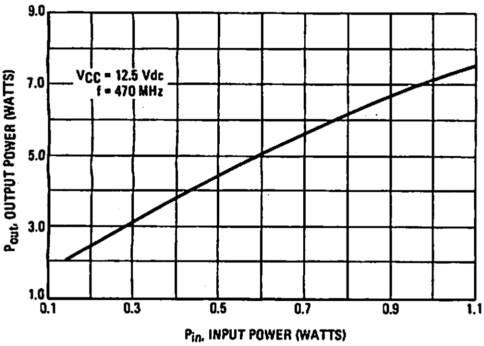


FIGURE 10 – OUTPUT POWER versus FREQUENCY

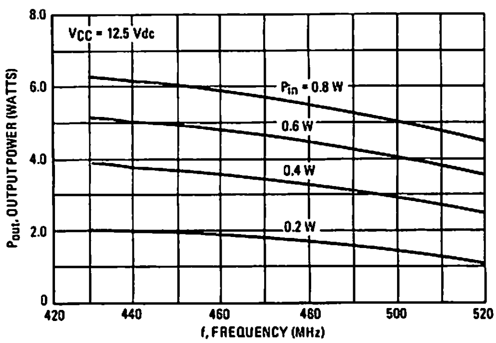


FIGURE 11 – OUTPUT POWER versus INPUT POWER

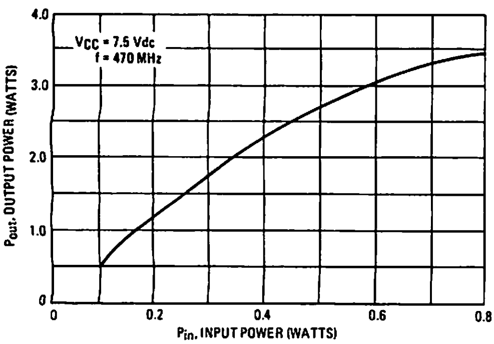
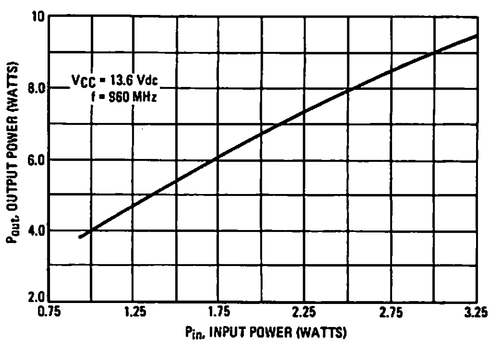


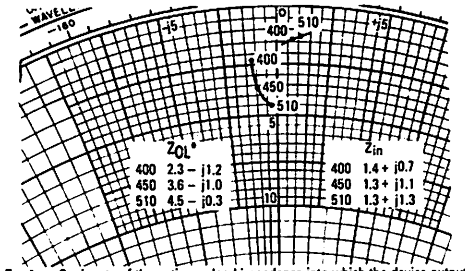
FIGURE 12 – OUTPUT POWER versus INPUT POWER



2

2N5946
TYPICAL PERFORMANCE DATA

FIGURE 13 – SERIES EQUIVALENT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

V_{CC} = 12.5 Vdc, P_{out} = 12 W

FIGURE 14 – OUTPUT POWER versus SUPPLY VOLTAGE

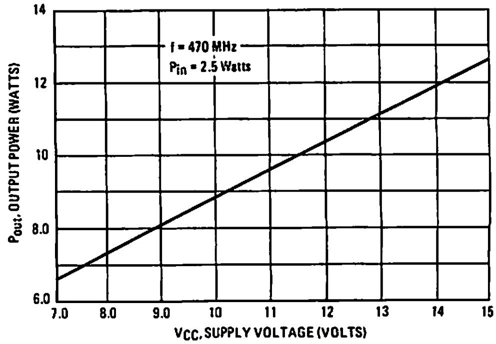


FIGURE 15 – OUTPUT POWER versus INPUT POWER

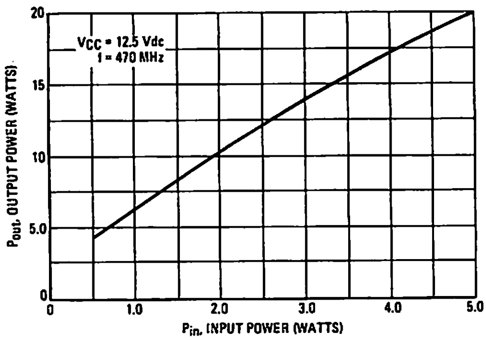


FIGURE 16 – OUTPUT POWER versus FREQUENCY

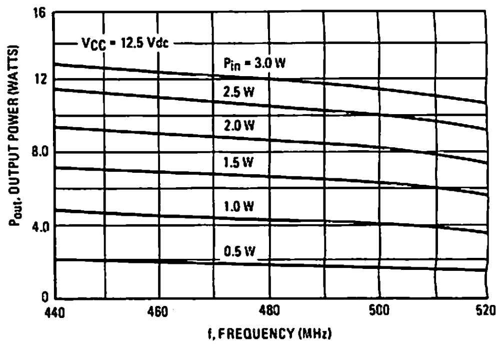


FIGURE 17 – OUTPUT POWER versus INPUT POWER

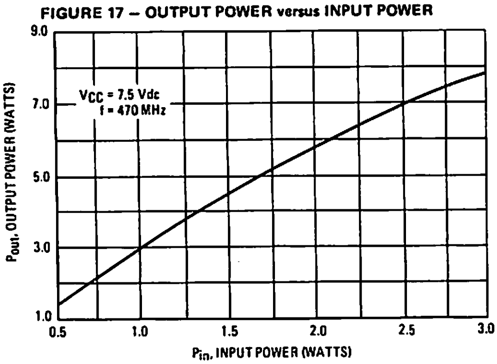
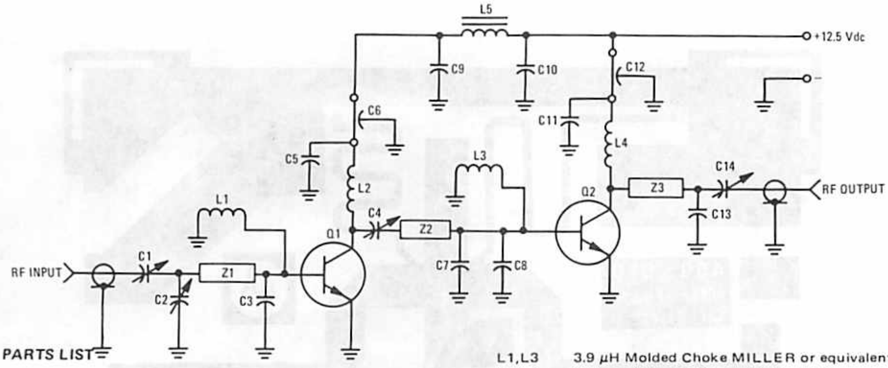


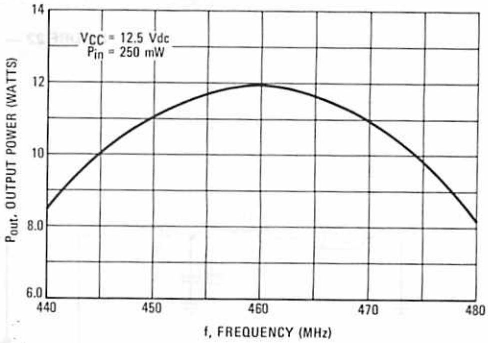
FIGURE 18 — 10-WATT BROADBAND UHF AMPLIFIER



PARTS LIST

C1,C2,C4,C13,C14	0.9-7.0 pF ARCO 400 or equivalent
C3,C7,C8	25 pF UNELCO or equivalent
C5,C11	0.1 μF Ceramic 35 V
C6,C12	680 pF ALLEN BRADLEY Feedthru
C9,C10	1.0 μF, 35 V Tantalum
L1,L3	3.9 μH Molded Choke MILLER or equivalent
L2,L4	5 Turns #18 AWG Enameled 0.2" I.D.
L5	FERROXCUBE Ferrite Choke VK200 20/4B
Z1,Z2,Z3	Microstrip Lines (See Template Below)
Q1	2N5944
Q2	2N5946

FIGURE 19 — OUTPUT POWER versus FREQUENCY



10 W AMPLIFIER PERFORMANCE

V_{CC} = 12.5 Vdc

Frequency MHz	P_{in} mW	P_{out} W	I_C Amp
440	250	8.5	1.5
450	250	11	1.6
460	250	12	1.6
470	250	10.9	1.5
480	250	8.2	1.2

P.C. Board 3×2×0.062 Inch G10 Per Template

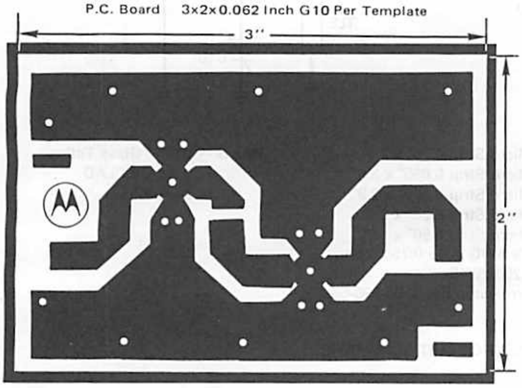


FIGURE 20 — PC BOARD PHOTOMASTER — 10 WATT BROADBAND AMPLIFIER

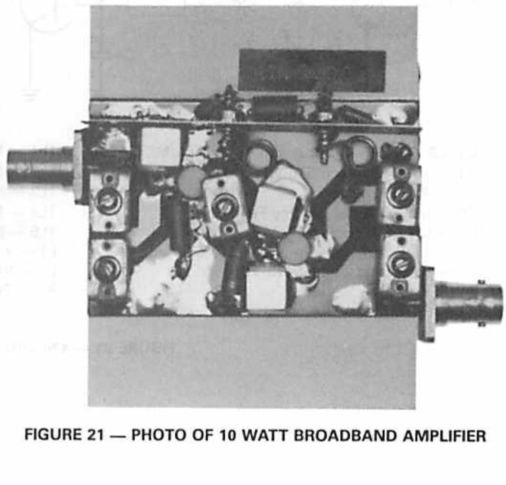
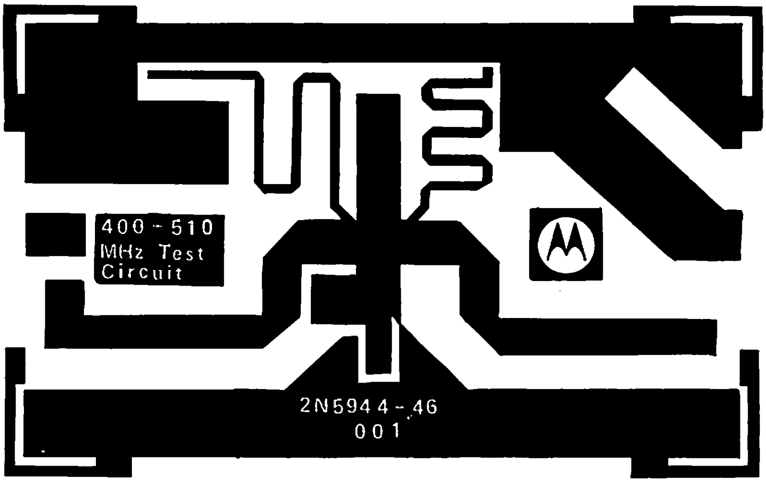
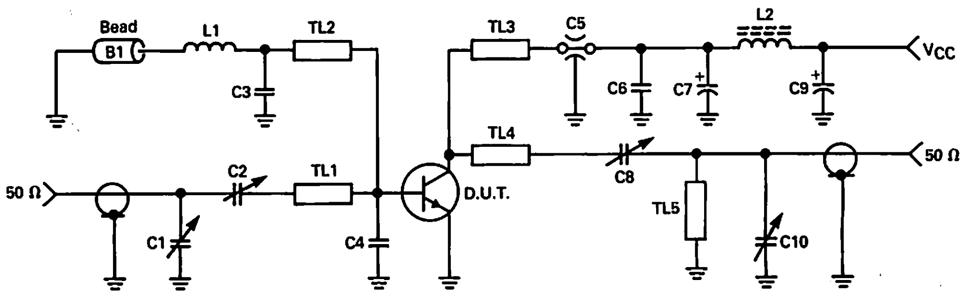


FIGURE 21 — PHOTO OF 10 WATT BROADBAND AMPLIFIER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 22 — 470 MHz TEST CIRCUIT



C1, C2, C8, C10 — Johanson Trimmer, JMC #5501
C3 — 100 pF Unelco 350 Vdc J101
C4 — 15 pF Unelco
C5 — 680 pF Allen Bradley Feed-Thru
C6 — 0.1 μF Monolithic
C7 — 1 μF Tantalum Sprague ±10% 35 Vdc
C9 — 5 μF Electrolytic 5–25 Vdc

TL1 — Micro Strip 0.26" x 2.9"
TL2 — Micro Strip 0.055" x 3.9"
TL3 — Micro Strip 0.055" x 2.9"
TL4 — Micro Strip 0.26" x 2.9"
TL5 — Micro Strip 0.50" x 1.2"
L1 — #18 AWG Wire 0.750" Long
L2 — VK200 20/4B
B1 — Ferroxcube Bead, 56-590-65-3B

Board — 0.062" Glass Teflon
2 oz. Cu CLAD
$\epsilon_r = 2.55$

FIGURE 23 — 470 MHz TEST CIRCUIT SCHEMATIC

2N6080

The RF Line

NPN SILICON RF POWER TRANSISTOR

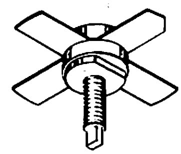
. . . designed for 12.5 Volt VHF large-signal power amplifier applications required in military and industrial equipment operating to 300 MHz.

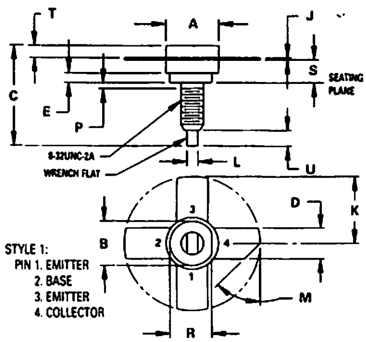
- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 4.0 W
  Minimum Gain = 12 dB
  Efficiency = 50%
- Characterized with Series Equivalent Large-Signal Impedance Parameters

4.0 W – 175 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25^oC$ (2) Derate above 25°C	P_D	12 68.5	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque (1)	—	6.5	in. lb.

*Indicates JEDEC Registered Data.
(1) For repeated assembly use 5 in lb.
(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	–	–	5.0	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.25 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	15	20	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 4.0 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	12	–	–	dB
Collector Efficiency (P_{out} = 4.0 W, V_{CC} = 12.5 Vdc, f - 175 MHz)	η	50	–	–	%

*Indicates JEDEC Registered Data.

FIGURE 1 – 175 MHz TEST CIRCUIT

C1,C6 5.0-80 pF, ARCO 462 or equivalent
C2,C5 9.0-180 pF, ARCO 463
C3 7.0 pF
L1 25 nH, 1 Turn #18 AWG, 1/4" Length, 1/4" I.D.
L2 Ferrite Choke VK-200 20/4B Ferroxcube
L3 150 nH, 8 Turns #18 AWG, 3/4" Length, 3/16" I.D.
L4 30 nH, 1-1/2 Turns, #18 AWG, 1/4" Length, 1/4" I.D.
R1 330 Ohms

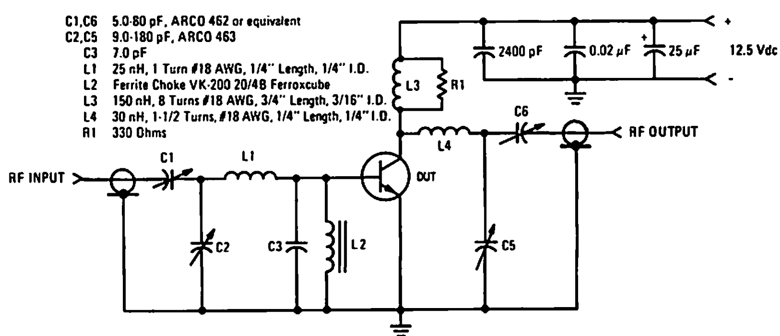


FIGURE 2 – OUTPUT POWER versus INPUT POWER

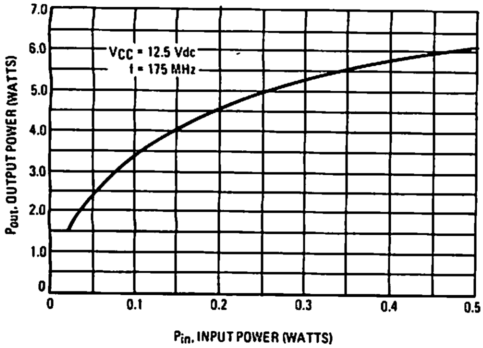


FIGURE 3 – OUTPUT POWER versus FREQUENCY

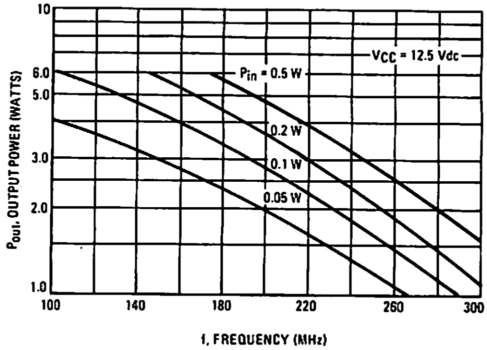


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

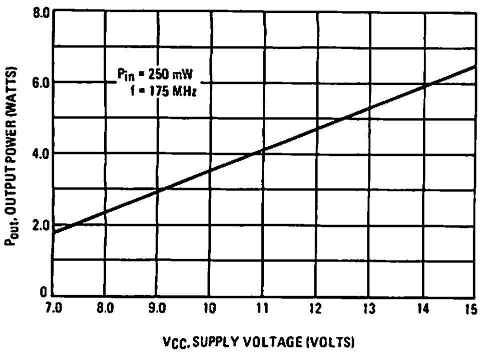
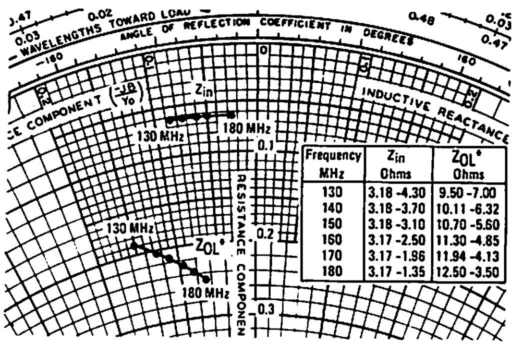


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Zin Ohms	ZOL* Ohms
130	3.18 -4.30	9.50 -7.00
140	3.18 -3.70	10.11 -6.32
150	3.18 -3.10	10.70 -5.60
160	3.17 -2.50	11.30 -4.85
170	3.17 -1.96	11.94 -4.13
180	3.17 -1.35	12.50 -3.50

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N6081
MRF221

The RF Line

NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 Volt VHF large-signal power amplifier applications required in commercial and industrial equipment operating to 300 MHz.

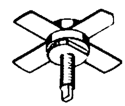
- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 15 W
  Minimum Gain = 6.3 dB
  Efficiency = 60%
- Characterized with Series Equivalent Large-Signal Impedance Parameters

15 W – 175 MHz

RF POWER TRANSISTORS

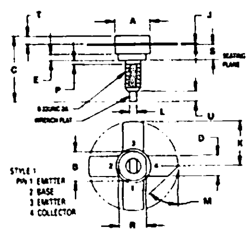
NPN SILICON

2N6081



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	–	0.070	–
J	0.08	0.18	0.003	0.007
K	12.45	–	0.490	–
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

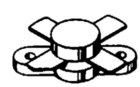
NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-09

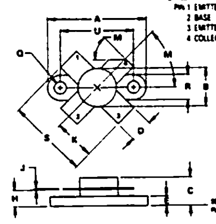
MRF221



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	11.30	0.395	0.445
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.22	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



CASE 211-07

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	31 177	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C
Stud Torque (2)	–	6.5	in. lb.

*Indicates JEDEC Registered Data for 2N6081.
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) For repeated assembly use 5 in. lb.

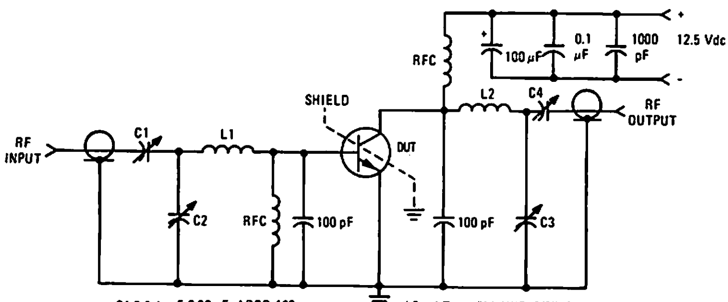
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	–	–	8.0	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	70	85	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 15 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	6.3	–	–	dB
Collector Efficiency (P_{out} = 15 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	60	–	–	%

*Indicates JEDEC Registered Data for 2N6081.

FIGURE 1 – 175 MHz TEST CIRCUIT



C1,2,3,4 5.0-80 pF ARCO 462
L1 Straight Wire, #14 AWG, 1-3/8" Long
L2 1 Turn, #14 AWG, 3/8" ID, Length Plus Leads = 1"
RFC VK200-20/4B, FERROXCUBE.

2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

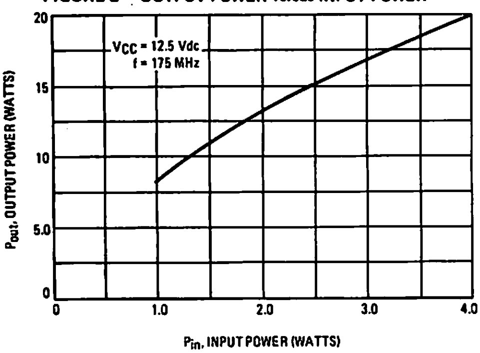


FIGURE 3 – OUTPUT POWER versus FREQUENCY

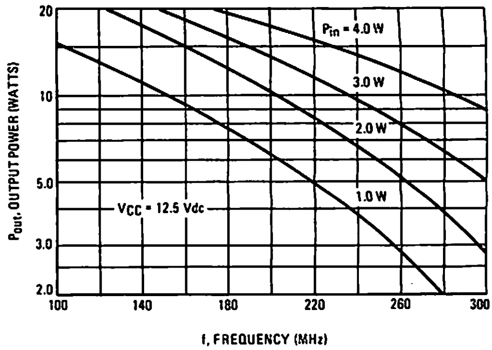


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

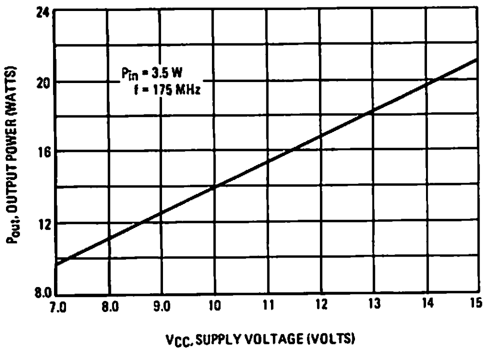
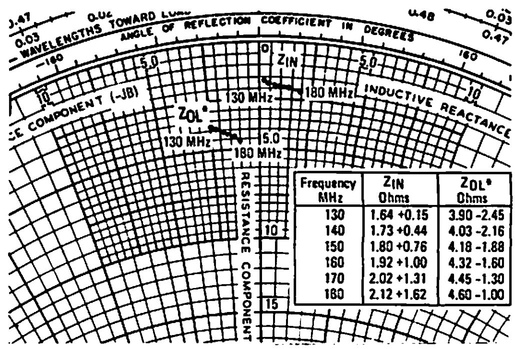


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{IN} Ohms	Z_{OL}* Ohms
130	1.64 +0.15	3.90 -2.45
140	1.73 +0.44	4.03 -2.16
150	1.80 +0.76	4.18 -1.88
160	1.92 +1.00	4.32 -1.60
170	2.02 +1.31	4.45 -1.30
180	2.12 +1.62	4.60 -1.00

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6082

2

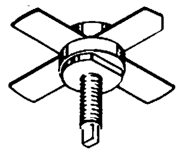
The RF Line

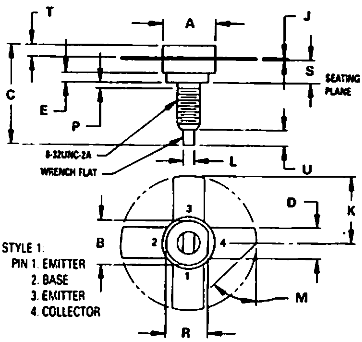
NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
  Output Power = 25 W
  Minimum Gain = 6.2 dB
  Efficiency = 65%

25 W — 175 MHz
RF POWER TRANSISTOR
NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ T_C = 25°C(2) Derate above 25°C	P_D	65 .37	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

*Indicates JEDEC Registered Data for 2N6082.
(1)For Repeated Assembly Use 5 in. lb.
(2)These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

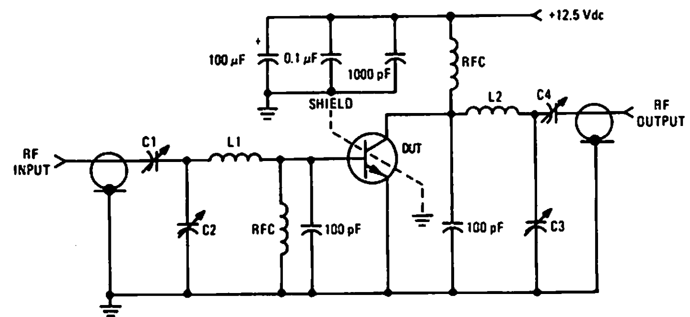
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 15 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C	I_{CES}	–	–	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	110	130	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 25 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	6.2	–	–	dB
Collector Efficiency (P_{out} = 25 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	65	–	–	%

*Indicates JEDEC Registered Data for 2N6082.

FIGURE 1 – 175 MHz TEST CIRCUIT



C1,2,3,4 5.0-80 pF ARCO 462
L1 Straight Wire, #14 AWG, 1-3/8" Long
L2 1 Turn, #14 AWG, 3/8" ID, Length Plus Leads = 1"
RFC VK200-20/4B, FERROXCUBE.

FIGURE 2 – OUTPUT POWER versus INPUT POWER

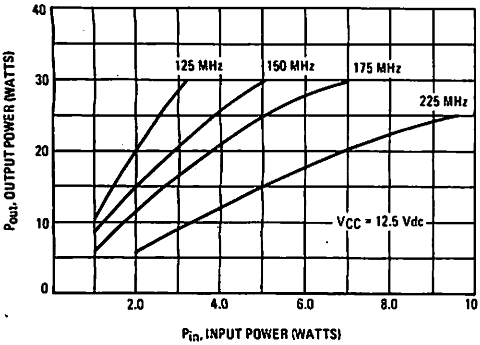
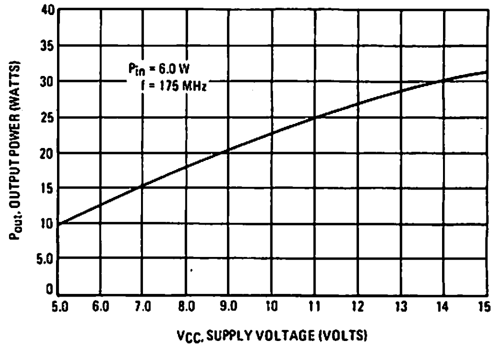
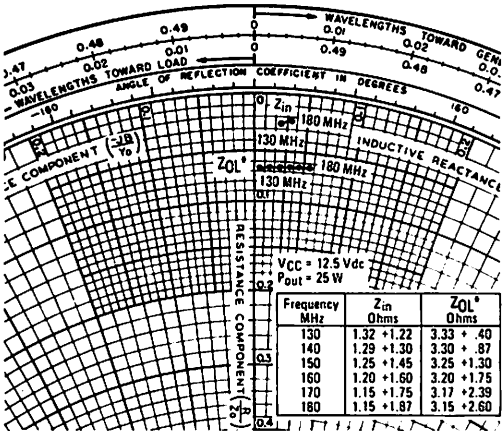


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE



2

FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



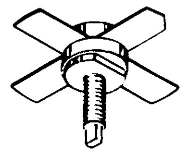
Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
130	1.32 +1.22	3.33 + .40
140	1.29 +1.30	3.30 + .87
150	1.25 +1.45	3.25 +1.30
160	1.20 +1.60	3.20 +1.75
170	1.15 +1.75	3.17 +2.39
180	1.15 +1.87	3.15 +2.60

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6083

The RF Line

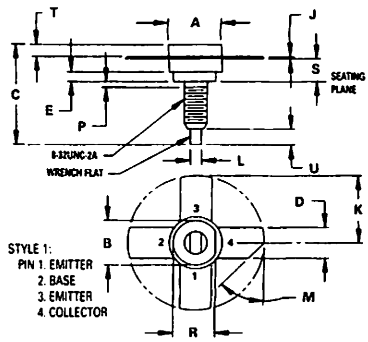
**30 W – 175 MHz
RF POWER
TRANSISTOR**
NPN SILICON



NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 30 W
  Minimum Gain = 5.7 dB
  Efficiency = 65%



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Total Device Dissipation @ T_C = 25°C(2) Derate above 25°C	P_D	65 .37	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

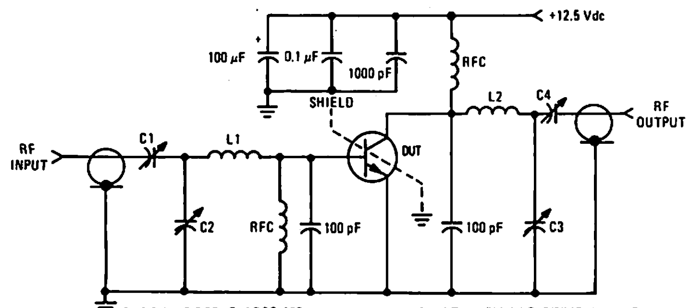
*Indicates JEDEC Registered Data for 2N6083.
(1)For Repeated Assembly Use 5 in. lb.
(2)These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 15 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	–	–	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	110	130	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 30 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	5.7	–	–	dB
Collector Efficiency (P_{out} = 30 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	65	–	–	%

*Indicates JEDEC Registered Data for 2N6083.

FIGURE 1 — 175 MHz TEST CIRCUIT



C1,2,3,4 5.0-80 pF ARCO 462
L1 Straight Wire, #14 AWG, 1-3/8" Long
L2 1 Turn, #14 AWG, 3/8" ID, Length Plus Leads = 1"
RFC VK200-20/4B, FERROXCUBE.

2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

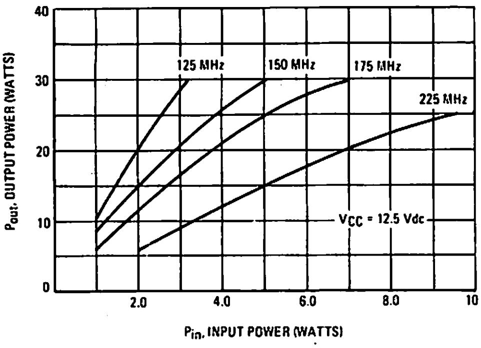


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

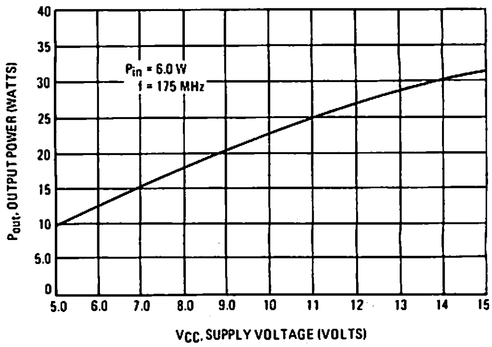
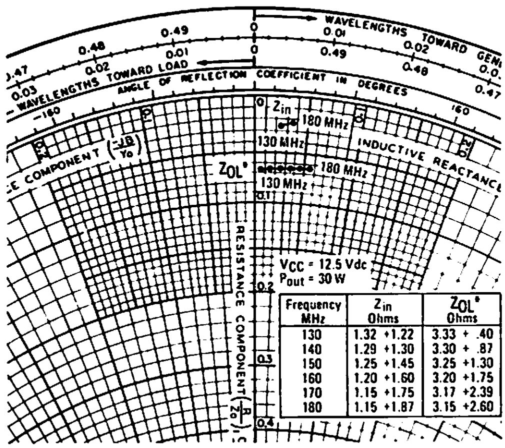


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
130	1.32 +1.22	3.33 + .40
140	1.29 +1.30	3.30 + .87
150	1.25 +1.45	3.25 +1.30
160	1.20 +1.60	3.20 +1.75
170	1.15 +1.75	3.17 +2.39
180	1.15 +1.87	3.15 +2.60

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6084
MRF224

2

The RF Line

40 W — 175 MHz
RF POWER
TRANSISTORS
NPN SILICON

NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 Volt VHF large-signal amplifier applications required in commercial and industrial equipment operating to 300 MHz.

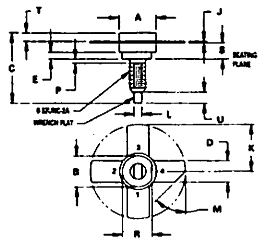
- Specified 12.5 Volt, 175 MHz Characteristics —
  - Output Power = 40 W
  - Minimum Gain = 4.5 dB
  - Efficiency = 70%

***MAXIMUM RATINGS**

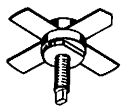
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ T_C = 25°C(2) Derate above 25°C	P_D	80 .46	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Stud Torque(1)	—	6.5	in.lb.

*Indicates JEDEC Registered Data for 2N6084.
(1)For Repeated Assembly Use 5 In. lb.
(2)These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2N6084



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

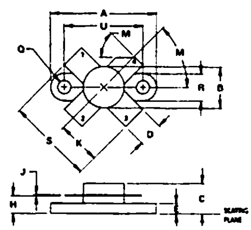


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

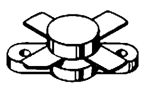
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MRF224



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

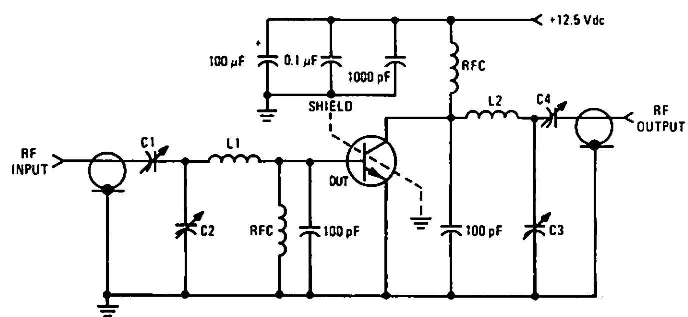
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	–	–	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	2.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	170	200	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	4.5	–	–	dB
Collector Efficiency (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	70	–	–	%

*Indicates JEDEC Registered Data for 2N6084.

FIGURE 1 — 175 MHz TEST CIRCUIT



C1,2,3,4 5.0-80 pF ARCO 462
L1 Straight Wire, #14 AWG, 1-3/8" Long
L2 1 Turn, #14 AWG, 3/8" ID, Length Plus Leads = 1"
RFC VK200-20/4B, FERROXCUBE.

FIGURE 2 – OUTPUT POWER versus INPUT POWER

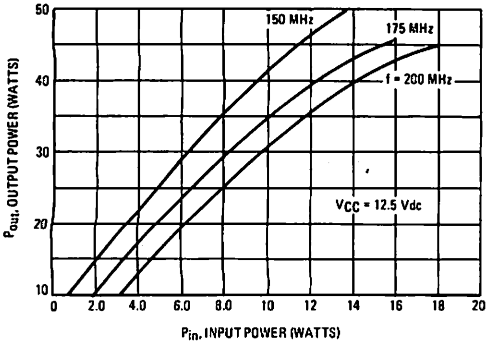


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

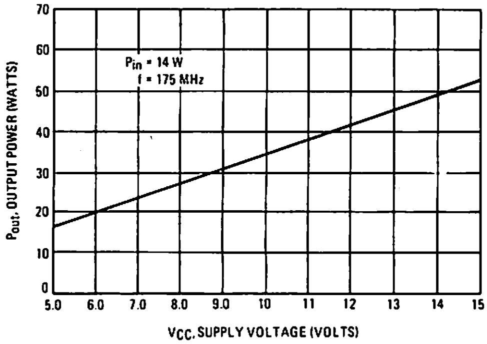
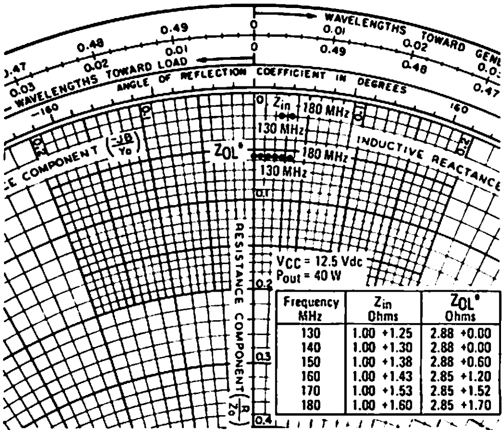


FIGURE 4 – SERIES EQUIVALENT IMPEDANCE



Frequency MHz	Z_{in} Ohms	Z_{OL}* Ohms
130	1.00 +1.25	2.88 +0.00
140	1.00 +1.30	2.88 +0.00
150	1.00 +1.38	2.88 +0.60
160	1.00 +1.43	2.85 +1.20
170	1.00 +1.53	2.85 +1.52
180	1.00 +1.60	2.85 +1.70

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2N6166

The RF Line

2

NPN SILICON RF POWER TRANSISTOR

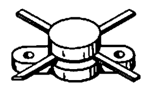
. . . designed for VHF power amplifier applications in military and industrial equipment. Particularly suited for use in Class AB, B, or C amplifier applications to 200 MHz

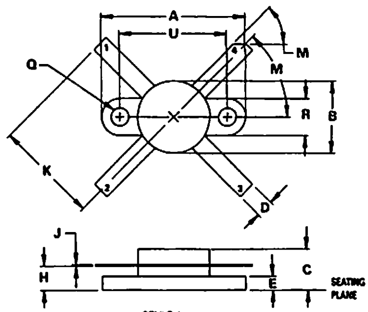
- Specified 28-Volt, 150-MHz Characteristics –
  Output Power = 100 Watts
  Minimum Gain = 6.0 dB
  Efficiency = 60%
- Specified 13.5-Volt, 150 MHz Characteristics –
  Output Power = 30 Watts
  Minimum Gain = 4.5 dB
- Parallel Impedance Characterization

100 WATTS – 150 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	2.16	3.93	0.085	0.155
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	17.78	—	0.700	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.23	6.47	0.245	0.255
U	18.29	18.54	0.720	0.730

CASE 211-10

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	9.0	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above 25°C	P_D	117 0.667	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	θ_{JC}	1.5	°C/W

*Indicates JEDEC Registered Data.

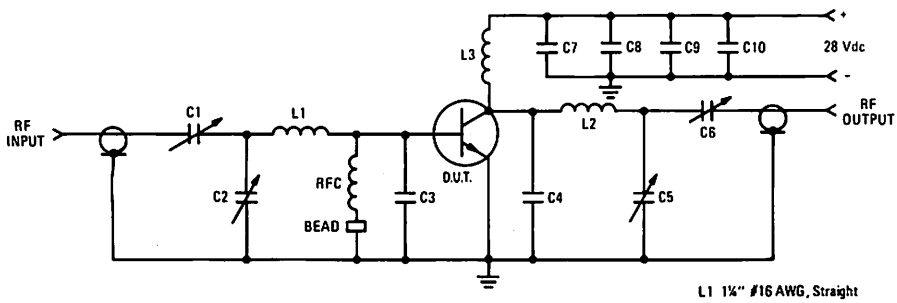
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0, T_C = 55°C)	I_{CES}	–	5.0	mAdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	3.0	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	130	pF
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (P_{out} = 100 W, V_{CC} = 28 Vdc, I_C (Max) = 5.95 Adc, f = 150 MHz)	G_{PE}	6.0	–	dB
Common-Emitter Amplifier Power Gain (P_{out} = 30 W, V_{CC} = 13.5 V, f = 150 MHz)	G_{PE}	4.5	–	dB
Collector Efficiency (P_{out} = 100 W, V_{CC} = 28 Vdc, I_C (Max) = 5.95 Adc, f = 150 MHz)	η	60	–	%

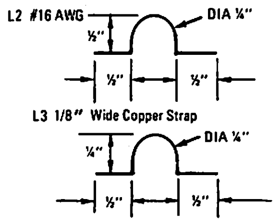
*Indicates JEDEC Registered Data.

FIGURE 1 – 150 MHz TEST CIRCUIT



C1, C6 2.7-30 pF, Arco 461 or Equivalent
C2, C5 9.0-180 pF, Arco 463 or Equivalent
C3 100 pF Underwood
C4 25 pF Underwood
C7 0.01 µF Ceramic Disc
C8 0.1 µF Ceramic Disc
C9 2400 pF Button
C10 5.0 µF/50 V
RFC 0.15 µH J. W. Miller
BEAD: FERROXCUBE 56-590-65-3B

L1 1¼" #16 AWG, Straight



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OUTPUT POWER versus FREQUENCY

FIGURE 2 – V_{CC} = 28 Vdc

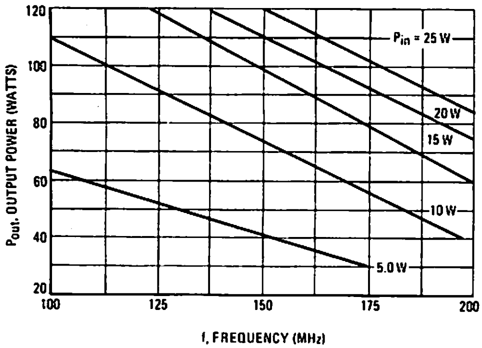


FIGURE 3 – V_{CC} = 13.5 Vdc

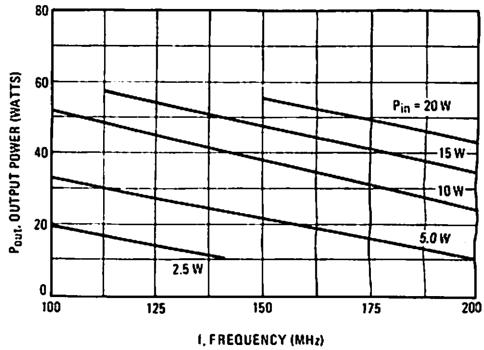


FIGURE 4 – OUTPUT POWER versus INPUT POWER

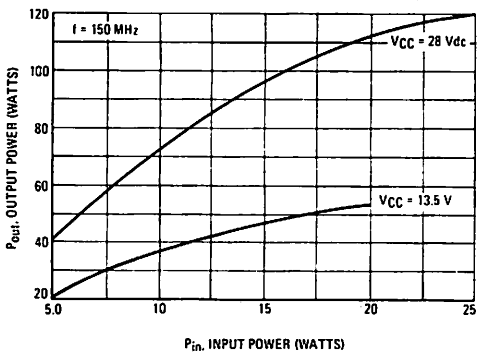


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE

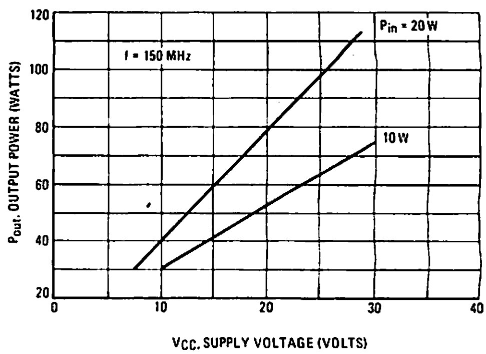


FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

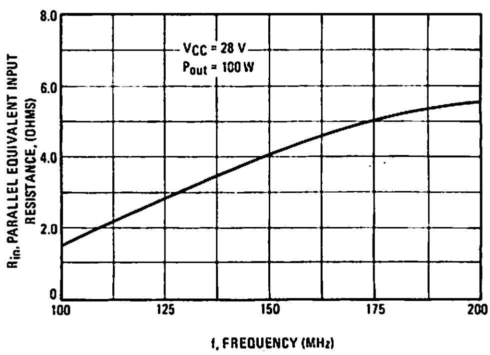


FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

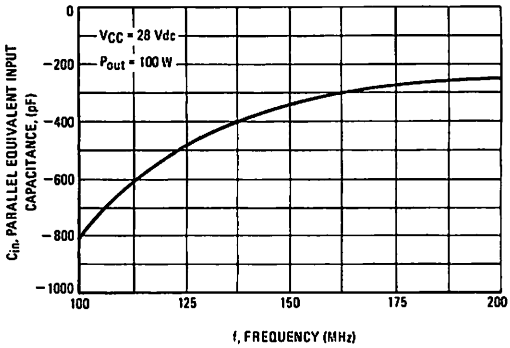
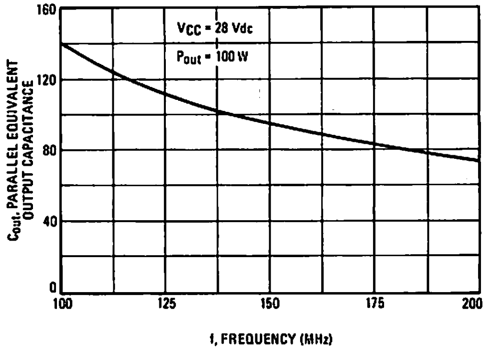


FIGURE 8 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY



2N6304
2N6305

The RF Line

2

NPN SILICON HIGH-FREQUENCY TRANSISTORS

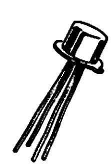
. . . designed for use as low-noise, high-gain, general-purpose amplifiers.

- High Current-Gain – Bandwidth Product –
  f_T = 1.4 GHz (Min) @ I_C = 10 mAdc – 2N6304
  = 1.2 GHz (Min) @ I_C = 10 mAdc – 2N6305
- Low Noise Figure –
  NF = 4.5 dB (Max) @ f = 450 MHz – 2N6304
  = 5.5 dB (Max) @ f = 450 MHz – 2N6305
- High Power Gain –
  G_{pe} = 15 dB (Min) @ f = 450 MHz – 2N6304
  = 12 dB (Min) @ f = 450 MHz – 2N6305

1.4 GHz @ 10 mAdc – 2N6304
1.2 GHz @ 10 mAdc – 2N6305

HIGH FREQUENCY TRANSISTORS

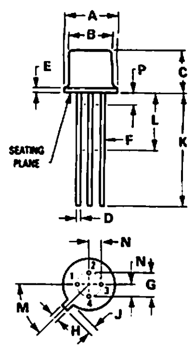
NPN SILICON



*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage 1.0 to 20 mAdc	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current Continuous	I_C	50	mAdc
Total Continuous Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.



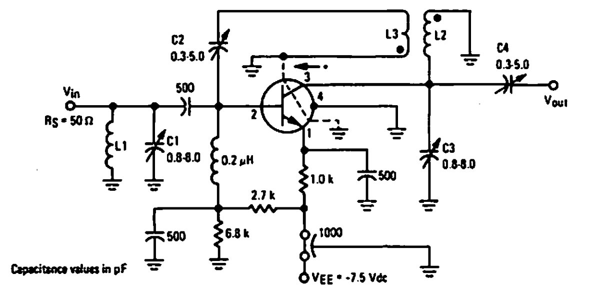
STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

**CASE 20-03
TO-206AF
(TO-72)**

FIGURE 1 – TEST CIRCUIT FOR NOISE FIGURE AND POWER GAIN



L1, L2 – Silver-plated brass rod, 1-1/2" long and 1/4" dia. Install at least 1/2" from nearest vertical chassis surface.

L3 – 1/2 turn #18 AWG wire, located 1/4" from and parallel to L2.

* – External interlead shield to isolate collector lead from emitter and base leads.

Neutralization Procedure:

(A) Connect 450-MHz signal generator (with R_S = 50 ohms) to input terminals of amplifier.

(B) Connect 50-ohm RF voltmeter across output terminals of amplifier.

(C) Apply V_{EE}, and with signal generator adjusted for 5 mV output from amplifier, tune C1, C3, and C4 for maximum output.

(D) Interchange connections to signal generator and RF voltmeter.

(E) With sufficient signal applied to output terminals of amplifier, adjust C2 for minimum indication at input.

(F) Repeat steps (A), (B), and (C) to determine if retuning is necessary.

***ELECTRICAL CHARACTERISTICS** (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	30	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)		$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)		I_{CBO}	–	–	10	nAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	25	–	250	–
DYNAMIC CHARACTERISTICS						
Current-Gain—Bandwidth Product (I_C = 10 mAdc, V_{CE} · 5.0 Vdc, f · 100 MHz)	2N6304 2N6305	f_T	1400 1200	– –	– –	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	–	0.8	1.0	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 kHz)		h_{fe}	25	–	250	–
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 5.0 Vdc, f = 31.8 MHz)	2N6304 2N6305	$r_b'C_c$	2.0 2.0	–	12 15	ps
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, R_S = 50 ohms, f = 450 MHz) (Figure 1)	2N6304 2N6305	NF	– –	– –	4.5 5.5	dB
FUNCTIONAL TEST						
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 450 MHz) (Figure 1)	2N6304 2N6305	G_{pe}	15 12	– –	– –	dB

**Indicates JEDEC Registered Data.*

FIGURE 2 – COLLECTOR-BASE CAPACITANCE versus COLLECTOR BASE VOLTAGE

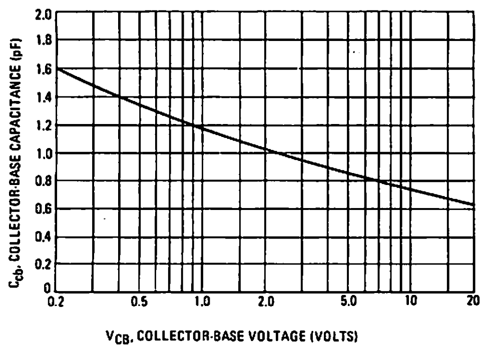


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FIGURE 3 – CURRENT-GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

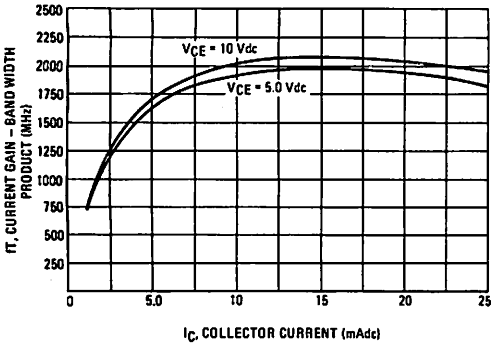

FIGURE 4 – COLLECTOR-BASE TIME CONSTANT versus EMITTER CURRENT

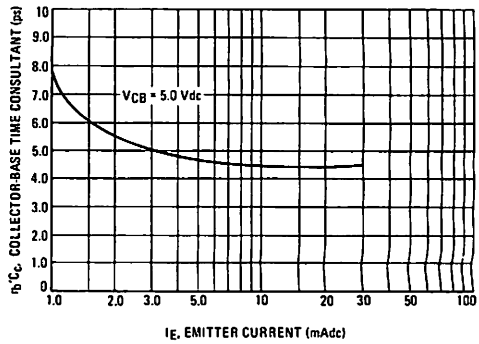

FIGURE 5 – REVERSE TRANSFER ADMITTANCE versus FREQUENCY

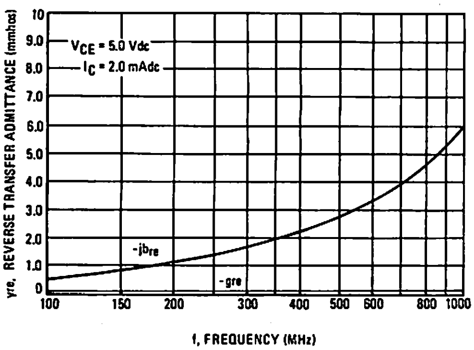

FIGURE 6 – INPUT ADMITTANCE versus FREQUENCY

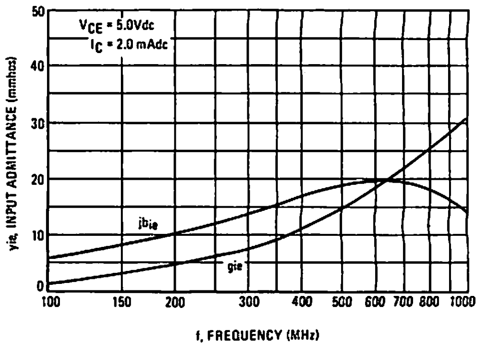

FIGURE 7 – OUTPUT ADMITTANCE versus FREQUENCY

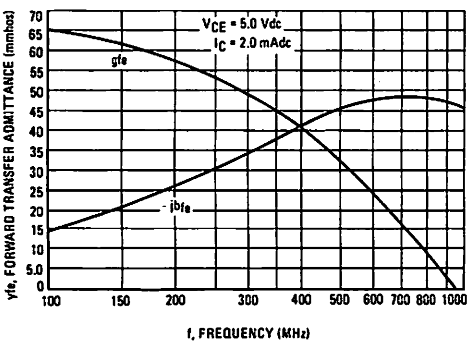

FIGURE 8 – FORWARD TRANSFER ADMITTANCE versus FREQUENCY

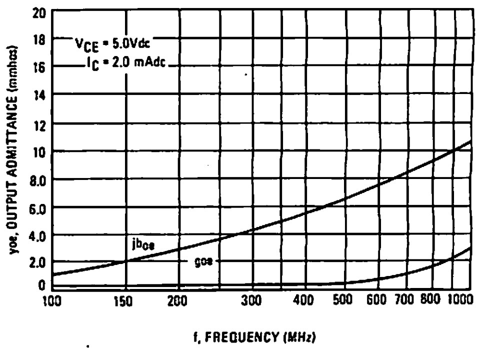

FIGURE 9 – S_{11}, INPUT REFLECTION COEFFICIENT

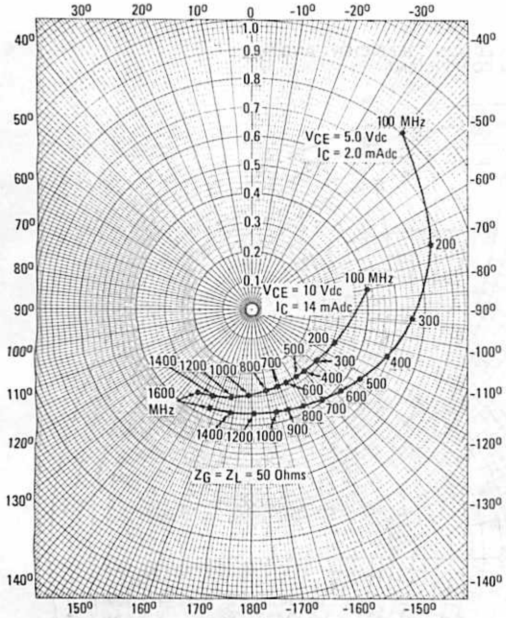

FIGURE 10 – S_{22}, OUTPUT REFLECTION COEFFICIENT

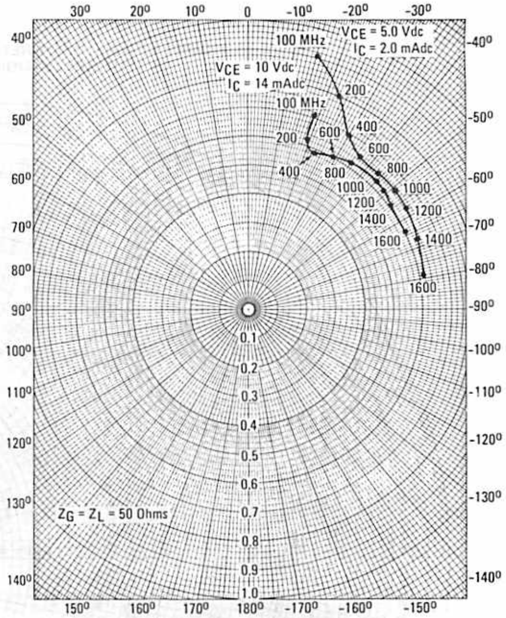

FIGURE 11 – S_{12}, REVERSE TRANSMISSION COEFFICIENT

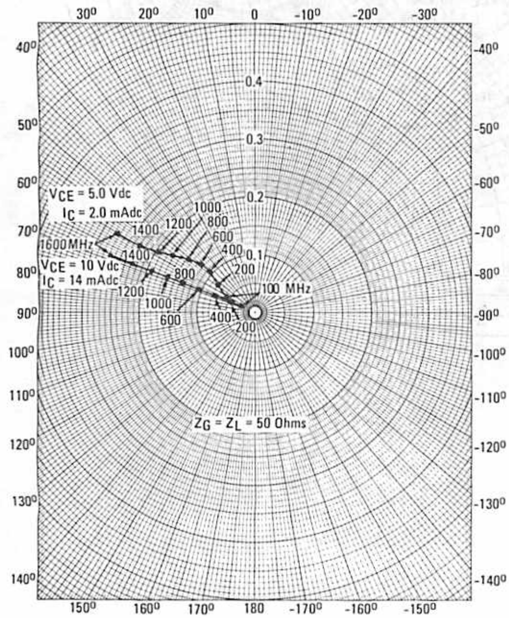

FIGURE 12 – S_{21}, FORWARD TRANSMISSION COEFFICIENT

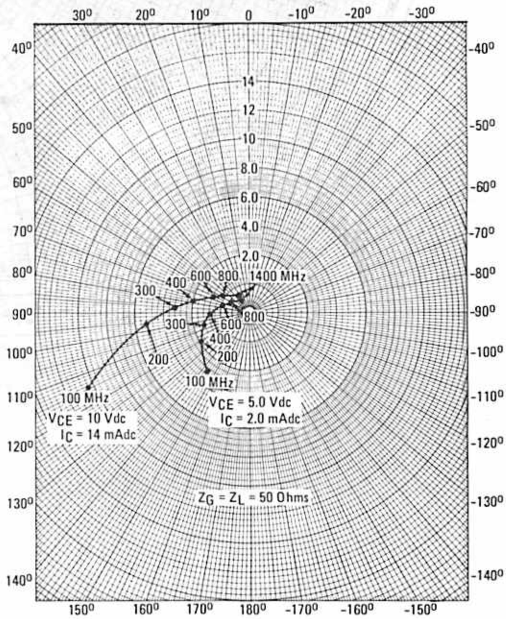

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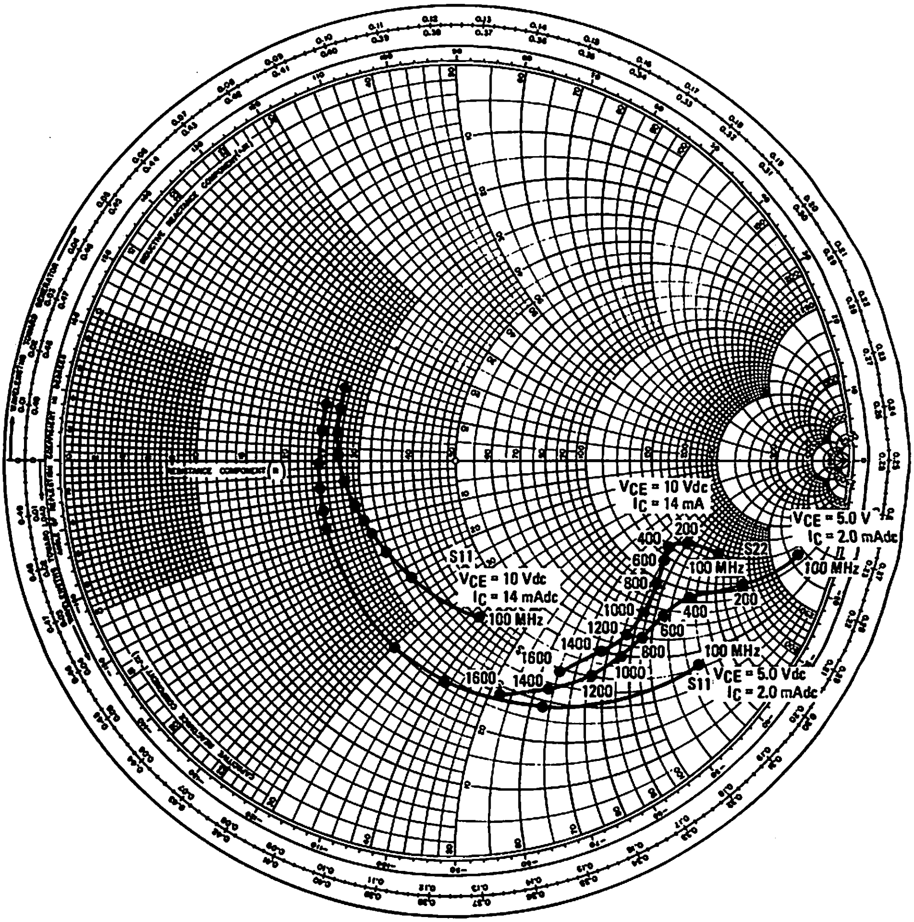
FIGURE 13 – S_{11}, INPUT REFLECTION COEFFICIENT AND S_{22}, OUTPUT REFLECTION COEFFICIENT



2N6439

The RF Line

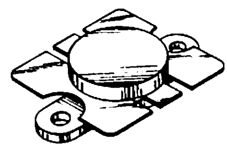
NPN SILICON RF POWER TRANSISTOR

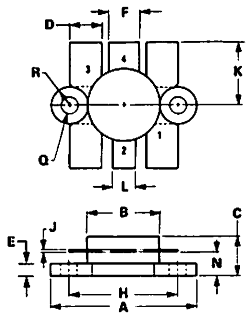
. . . designed primarily for wideband large-signal output amplifier stages in the 225-400 MHz frequency range.

- Guaranteed Performance in 225–400 MHz Broadband Amplifier @ 28 Vdc
  Output Power = 60 Watts over 225–400 MHz Band
  Minimum Gain = 7.8 dB @ 400 MHz
- Built-In Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- *Gold Metallization* System for High Reliability Applications

60 W – 225–400 MHz
CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR
NPN SILICON

2





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.055	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

*MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	146 0.83	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.2	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
* Indicates JEDEC Registered Data.

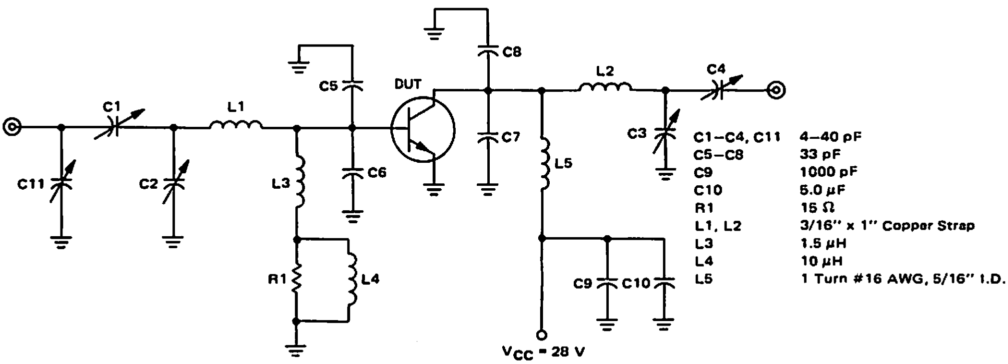
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	67	75	pF
BROADBAND FUNCTIONAL TESTS (Figure 6)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 225–400 MHz)	G_{PE}	7.8	8.5	–	dB
Electrical Ruggedness (P_{out} = 60 W, V_{CC} = 28 Vdc, f = 400 MHz, VSWR 30:1 all phase angles)	–	No Degradation in P_{out}			–
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	G_{PE}	7.8	10	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	η	55	–	–	%

* Indicates JEDEC Registered Data.

FIGURE 1 – 400 MHz TEST AMPLIFIER (NARROW BAND)



NARROW BAND DATA

FIGURE 2 — P_{out} versus FREQUENCY

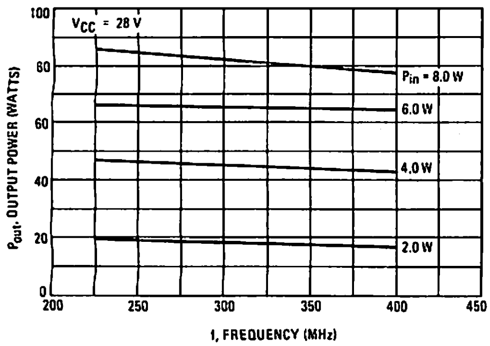


FIGURE 3 — OUTPUT POWER versus INPUT POWER

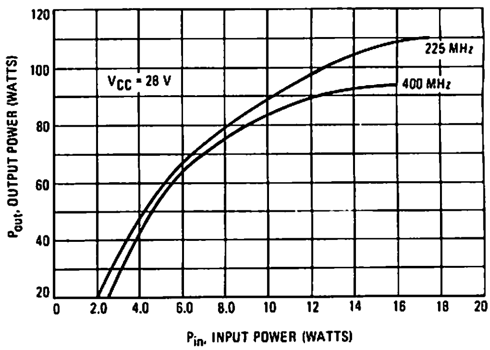


FIGURE 4 — POWER-GAIN versus FREQUENCY

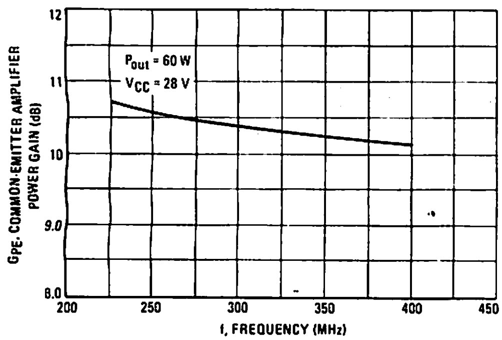


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE

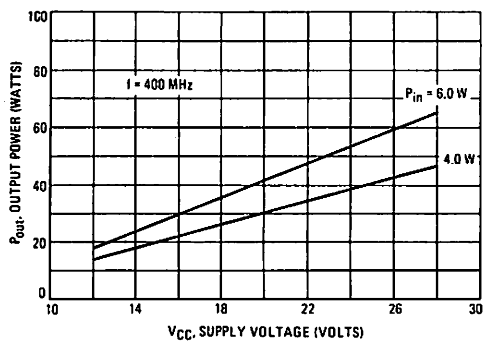
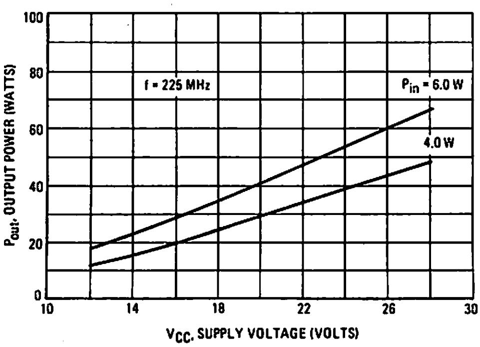
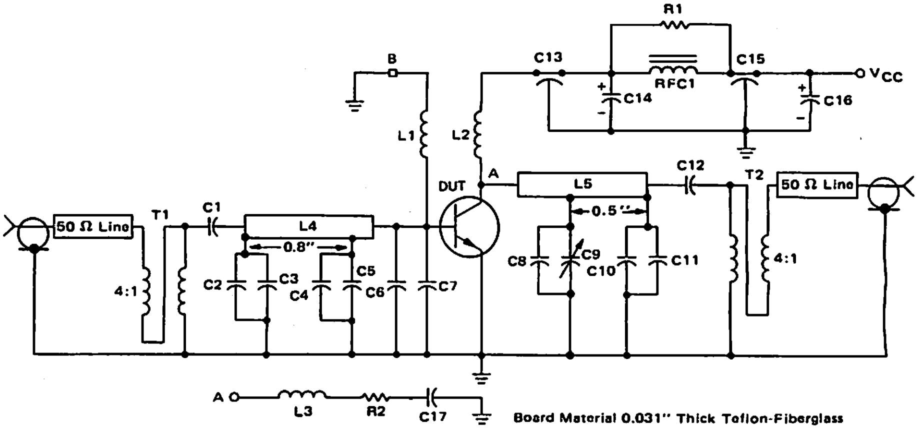


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE



2

FIGURE 7 — 225-400 MHz BROADBAND TEST CIRCUIT SCHEMATIC



			Board Material 0.031" Thick Teflon-Fiberglass
C1	68 pF	RFC1	Ferrite Bead Choke, Ferroxcube VK200 19/4B
C2, C4, C8, C10	27 pF	B	Ferroxcube 56-590-65/4B Ferrite Bead
C3, C5, C11	10 pF	T1, T2	25 Ohms (UT25) Miniature Coaxial Cable, 1 turn
C6, C7	51 pF	R1	11 Ω, 1 W
C9	1–10 pF JOHANSON	R2	20 Ω, 1/4 W
C12	100 pF	L1	10 Turns, #22 AWG, 1/8" I.D.
C13, C15	680 pF	L2	4 Turns, #16 AWG, 1/4" I.D.
C14, C16	1.0 μF, 35 V Tantalum	L3	6 Turns, #24 AWG, 1/8" I.D.
C17	0.1 μF, ERIE Red Cap	L4, L5	1" x 0.25" Microstrip Line

BROADBAND DATA (Circuit, Figure 7)

FIGURE 8 — POWER GAIN versus FREQUENCY

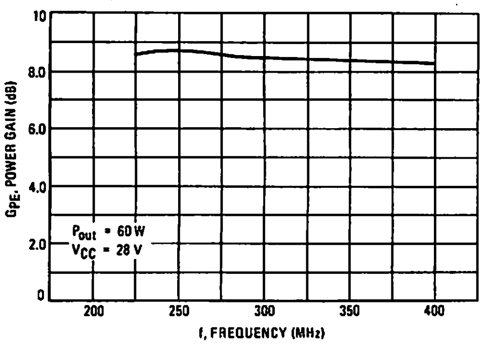


FIGURE 9 — EFFICIENCY versus FREQUENCY

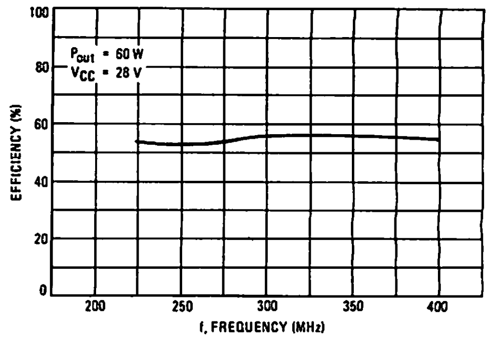


FIGURE 10 — INPUT VSWR versus FREQUENCY

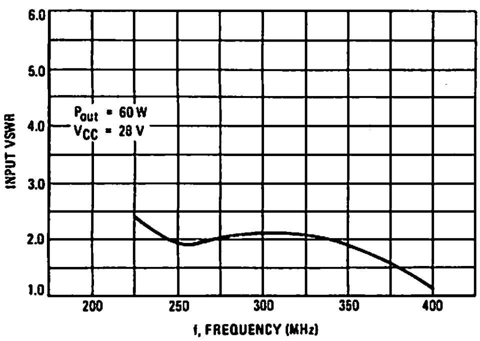
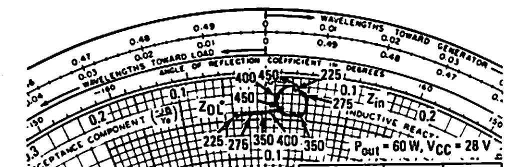


FIGURE 11 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



FREQUENCY MHz	Z_{in} OHMS	Z_{OL}^* OHMS
225	0.7 + j1.6	2.2 − j1.8
275	0.9 + j2.2	2.1 − j0.9
350	2.2 + j2.1	2.1 − j0.1
400	1.2 + j0.6	2.0 + j0.2
450	0.5 + j1.6	1.9 + j0.9

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

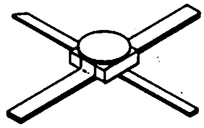
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N6603

The RF Line

NF = 2.0 dB @ 1.0 GHz
HIGH FREQUENCY TRANSISTOR
NPN SILICON

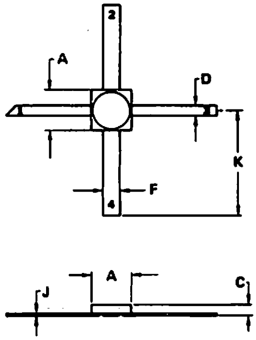
2



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for use in high-gain, low-noise, small signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure –
  NF = 2.0 dB (Typ) @ f = 1.0 GHz
  = 2.9 dB (Typ) @ f = 2.0 GHz
- High Power Gain –
  MAG = 17 dB (Typ) @ f = 1.0 GHz
  = 11 dB (Typ) @ f = 2.0 GHz
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- JAN, JTX, JTXV Available



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
1. DIMENSION "K" APPLIES TO ALL LEADS.
2. DIRECTION OF 45° CUT ON PIN 1 IS VENDOR OPTION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.29	2.67	0.090	0.105
C	0.89	1.40	0.035	0.055
D	0.41	0.61	0.016	0.024
F	0.89	1.09	0.035	0.043
J	0.08	0.15	0.003	0.006
K	4.45	5.84	0.175	0.230

CASE 303-01

***MAXIMUM RATINGS (T_A = 25°C Free Air Temperature)**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current—Continuous	I_C	30	mAdc
Total Device Dissipation @ T_C = 125°C Derate Above 100°C	P_D	400 5.33	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data

Specification and Package Options

Devices using the same die type as the 2N6603:

MRF901 – 4 Lead Plastic Macro-T Case 302-01
MRF902 – 100 mil Metal/Ceramic Case 303-01
MRF904 – TO-72
MMBR901 – MiniBloc Plastic (SOT-23) TO-236
MRFC901 – Unencapsulated Chip

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 15 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	–	200	–
***DYNAMIC CHARACTERISTICS**					
Collector-Base Capacitance (1) (V_{CB} = 10 Vdc, I_E = 0, 0.1 MHz < f < 1.0 MHz)	C_{cb}	0.25	–	0.75	pF
***FUNCTIONAL TEST**					
Common-Emitter Amplifier Power Gain (V_{CE} = 10 Vdc, I_C = 15 mA, f = 1.0 GHz—Figure 2)	G_{pe}	15	–	21	dB
Spot Noise Figure (R_S = Optimum—Figure 2) (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	NF	1.0	–	2.5	dB
Power Gain at Optimum Noise Figure (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	G_{NF}	10	–	–	dB
TYPICAL 2 GHz PERFORMANCE					
Maximum Available Gain (Figure 2) (2) (V_{CE} = 10 Vdc, I_C = 15 mA, f = 2.0 GHz)	MAG	–	11	–	dB
Noise Figure (R_S = Optimum—Figure 2) (V_{CE} = 10 Vdc, I_C = 5.0 mA, f = 2.0 GHz)	NF	–	2.9	–	dB

*Indicates JEDEC Registered Data.

(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

(2) MAG is calculated from the S-Parameters using the equation $MAG = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 — BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE

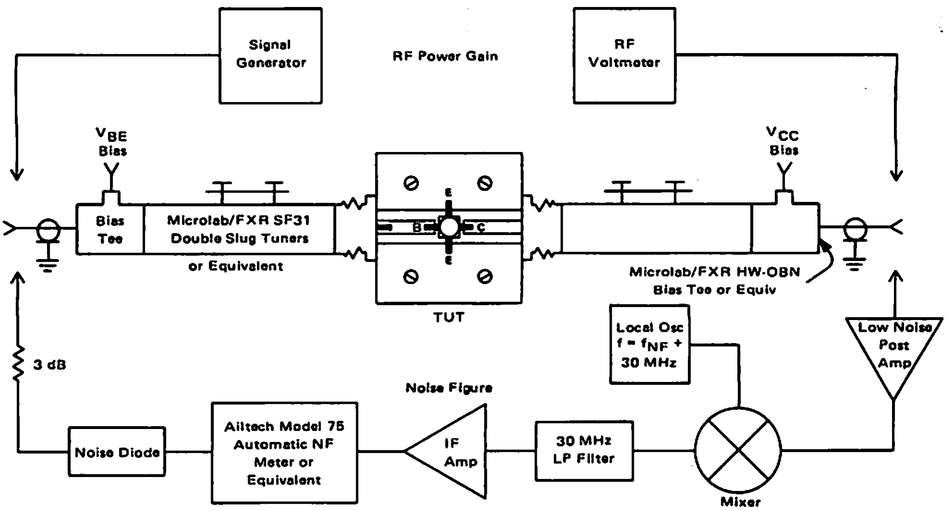


FIGURE 2 — POWER GAIN AND NOISE FIGURE versus FREQUENCY

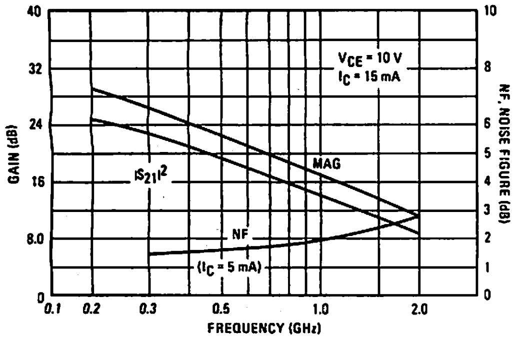


FIGURE 3 — OUTPUT CAPACITANCE versus VOLTAGE

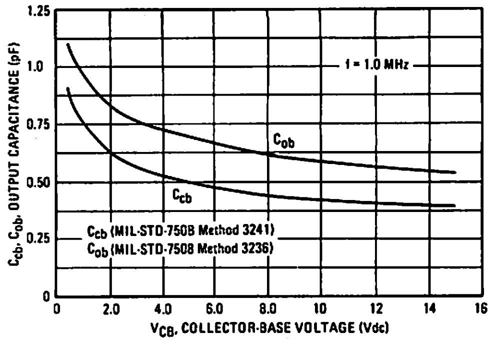


FIGURE 4 — CURRENT GAIN—BANDWIDTH PRODUCT versus COLLECTOR CURRENT

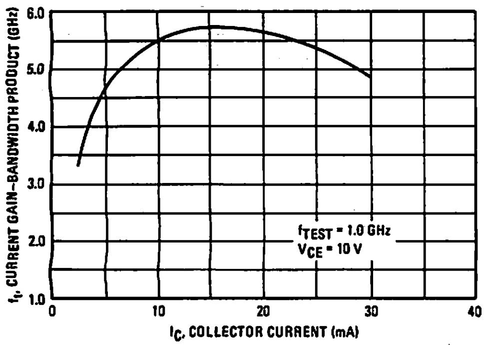


FIGURE 5 — POWER GAIN versus COLLECTOR CURRENT

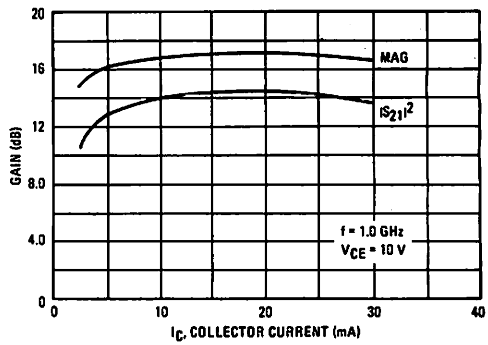
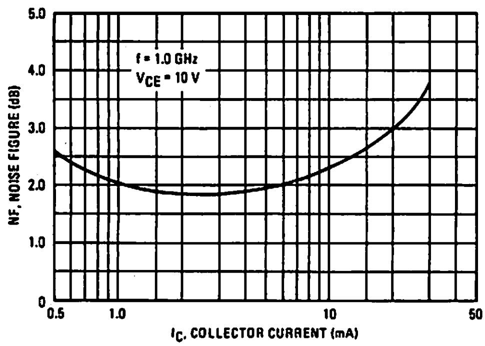


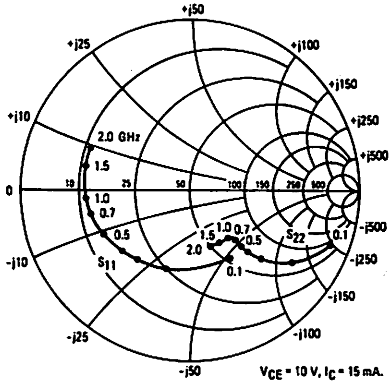
FIGURE 6 — NOISE FIGURE versus COLLECTOR CURRENT



2

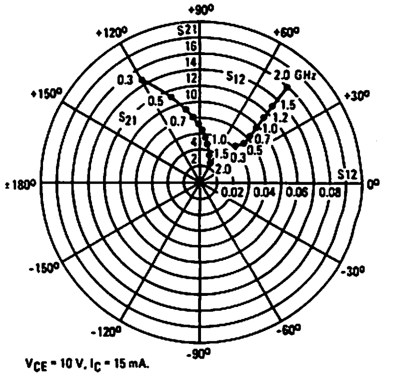
COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY



V_{CE} = 10 V, I_C = 15 mA.

FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



V_{CE} = 10 V, I_C = 15 mA.

S – PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11 |S11|	S11 ∠φ	S21 |S21|	S21 ∠φ	S12 |S12|	S12 ∠φ	S22 |S22|	S22 ∠φ
5.0	5	100	0.69	-30	12.16	160	0.026	72	0.95	-16
		200	0.65	-61	11.03	143	0.046	59	0.84	-31
		500	0.63	-122	7.05	111	0.074	36	0.56	-54
		1000	0.64	-158	4.13	88	0.087	28	0.39	-68
		2000	0.65	170	2.14	61	0.107	29	0.33	-91
	10	100	0.52	-50	18.74	154	0.022	69	0.91	-22
		200	0.54	-92	15.53	135	0.037	53	0.74	-40
		500	0.62	-146	8.49	104	0.052	38	0.43	-62
		1000	0.65	-172	4.66	84	0.065	37	0.29	-75
		2000	0.67	162	2.38	60	0.094	42	0.26	-97
	15	100	0.42	-70	22.72	150	0.019	66	0.87	-26
		200	0.51	-113	17.72	130	0.030	50	0.68	-44
		500	0.63	-157	8.96	100	0.042	41	0.38	-64
		1000	0.66	-178	4.80	82	0.056	44	0.26	-75
		2000	0.69	159	2.43	59	0.090	48	0.24	-97
	30	100	0.39	-116	24.57	142	0.014	62	0.80	-29
		200	0.56	-145	17.17	120	0.021	49	0.58	-42
		500	0.67	-171	7.96	95	0.030	49	0.34	-49
		1000	0.69	175	4.18	78	0.047	56	0.29	-56
		2000	0.71	157	2.13	55	0.084	58	0.29	-81
10	5	100	0.71	-27	12.01	161	0.021	73	0.96	-13
		200	0.67	-55	11.10	145	0.039	60	0.87	-25
		500	0.63	-115	7.44	114	0.064	39	0.62	-44
		1000	0.64	-153	4.43	90	0.077	30	0.46	-55
		2000	0.64	172	2.27	62	0.094	31	0.39	-76
	10	100	0.55	-43	18.77	155	0.018	71	0.92	-18
		200	0.55	-83	16.00	137	0.031	54	0.78	-32
		500	0.60	-140	9.06	106	0.046	39	0.49	-48
		1000	0.63	-168	5.02	85	0.058	39	0.36	-56
		2000	0.65	164	2.55	60	0.084	43	0.33	-76
	15	100	0.46	-60	23.14	152	0.016	68	0.90	-21
		200	0.51	-103	18.39	131	0.027	52	0.72	-36
		500	0.61	-152	9.67	102	0.037	42	0.43	-49
		1000	0.64	-175	5.21	83	0.049	45	0.33	-54
		2000	0.66	161	2.61	59	0.079	51	0.31	-74
	30	100	0.39	-98	27.29	144	0.013	63	0.83	-24
		200	0.53	-135	19.38	122	0.019	50	0.63	-35
		500	0.64	-167	9.11	96	0.027	48	0.41	-39
		1000	0.66	177	4.77	79	0.042	55	0.36	-45
		2000	0.69	157	2.41	56	0.074	58	0.35	-67

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

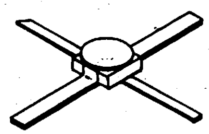
2N6604

The RF Line

NF = 2.7 dB @ 1.0 GHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for use in high-frequency, low-noise, small-signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure — NF = 2.7 dB (Typ) @ f = 1.0 GHz
- High Power Gain — G_U(max) = 16 dB (Typ) @ f = 1.0 GHz
- High Current — Specified Performance @ I_C = 30 mA
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- JAN, JTXV Available

***MAXIMUM RATINGS (T_A = 25°C Free Air Temperature)**

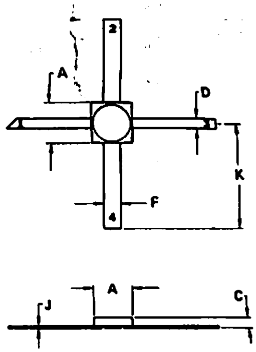
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current—Continuous	I_C	50	mAdc
Total Device Dissipation @ T_C = 125°C Derate Above 75°C	P_D	500 6.66	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

*Indicates JEDEC Registered Data.

Specifications and Package Options

Devices using the same die type as the 2N6604:

- MRF911 — 4 Lead Plastic Macro-T Case 302-01
- MRF914 — TO-72
- MMBR930 — MiniBloc Plastic (SOT-23) TO-236
- BFR91 — 3 Lead Plastic Macro-T Case 302A-01
- BFRC91 — Unencapsulated Chip



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
1. DIMENSION "K" APPLIES TO ALL LEADS.
2. DIRECTION OF 45° CUT ON PIN 1 IS VENDOR OPTION.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.29	2.67	0.090	0.105
C	0.89	1.40	0.035	0.055
D	0.41	0.61	0.016	0.024
F	0.89	1.09	0.035	0.043
J	0.08	0.15	0.003	0.006
K	4.45	5.84	0.175	0.230

CASE 303-01

2

2

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Breakdown Voltage ($I_C = 1.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 30$ mAdc, $V_{CE} = 10$ Vdc)	h_{FE}	30	–	200	–
***DYNAMIC CHARACTERISTICS**					
Collector-Base Capacitance (1) ($V_{CB} = 10$ Vdc, $I_E = 0$, $0.1\text{ MHz} < f < 1.0\text{ MHz}$)	C_{cb}	0.30	–	0.80	pF
***FUNCTIONAL TEST**					
Common-Emitter Amplifier Power Gain (Figure 2) ($V_{CE} = 10$ Vdc, $I_C = 30$ mAdc, $f = 1.0$ GHz)	G_{pe}	15	–	21	dB
Spot Noise Figure (R_S = Optimum – Figure 2) ($V_{CE} = 10$ Vdc, $I_C = 5.0$ mAdc, $f = 1.0$ GHz)	NF	1.5	–	3.0	dB
Power Gain at Optimum Noise Figure ($V_{CE} = 10$ Vdc, $I_C = 5.0$ mAdc, $f = 1.0$ GHz)	G_{NF}	9.0	–	–	dB
TYPICAL 2 GHz PERFORMANCE					
Maximum Unilateral Gain (Figure 2) (2) ($V_{CE} = 10$ Vdc, $I_C = 30$ mAdc, $f = 2.0$ GHz)	$G_U(max)$	–	10	–	dB
Noise Figure (R_S = Optimum – Figure 2) ($V_{CE} = 10$ Vdc, $I_C = 5.0$ mAdc, $f = 2.0$ GHz)	NF	–	4.3	–	dB

*Indicates JEDEC Registered Data.

(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

(2) $G_U(max)$ is calculated from the S-Parameters using the equation $G_U(max) = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 – BLOCK DIAGRAM FOR POWER GAIN AND NOISE FIGURE

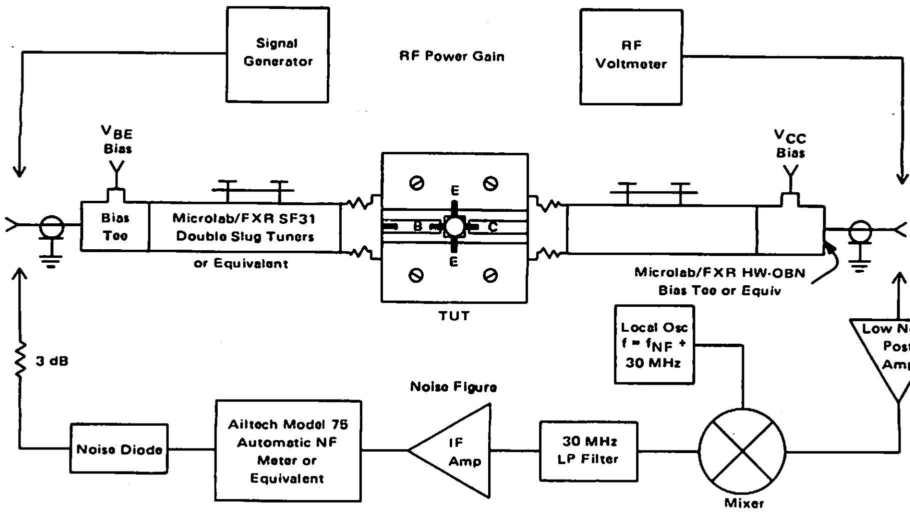


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FIGURE 2 — POWER GAIN AND NOISE FIGURE versus FREQUENCY

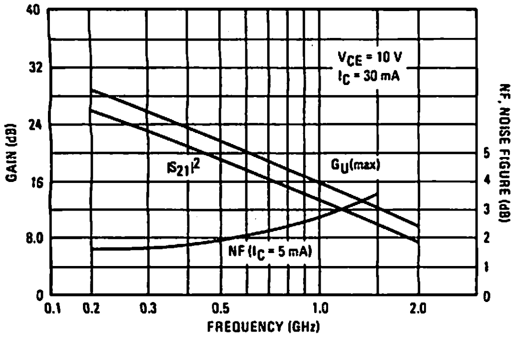


FIGURE 3 — OUTPUT CAPACITANCE versus VOLTAGE

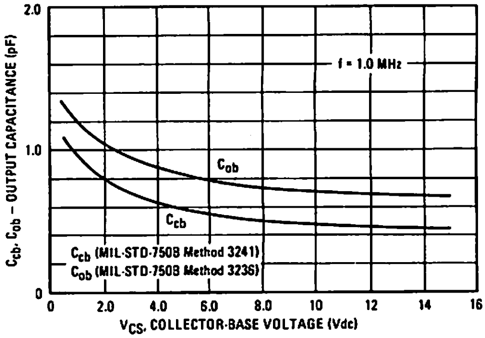


FIGURE 4 — CURRENT GAIN—BANDWIDTH PRODUCT versus COLLECTOR CURRENT

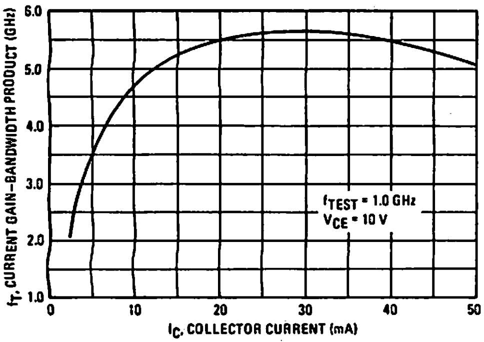


FIGURE 5 — POWER GAIN versus COLLECTOR CURRENT

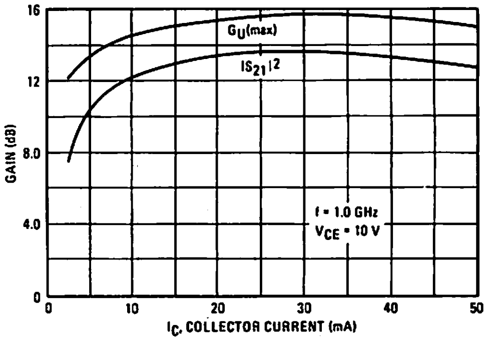
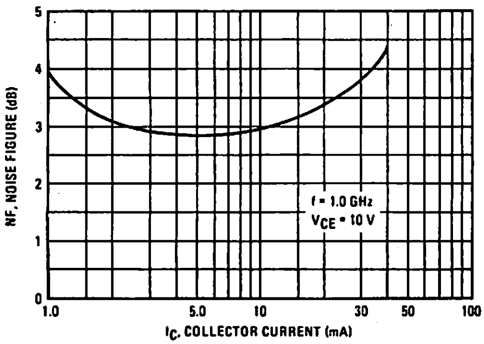
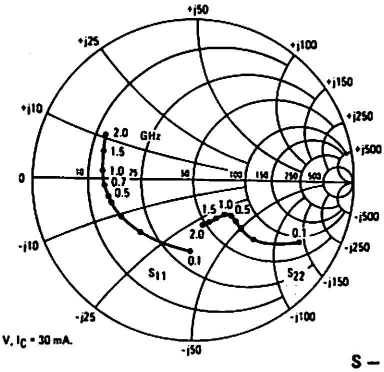


FIGURE 6 — NOISE FIGURE versus COLLECTOR CURRENT



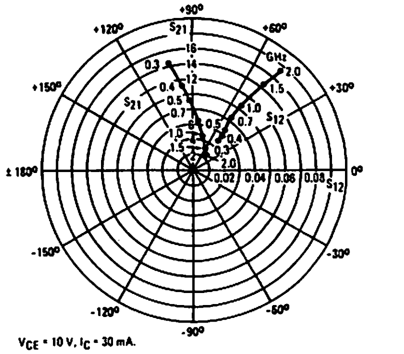
COMMON EMITTER SCATTERING PARAMETERS

FIGURE 7 – INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY



V_{CE} = 10 V, I_C = 30 mA.

FIGURE 8 – FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



V_{CE} = 10 V, I_C = 30 mA.

S – PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11 |S11|	S11 ∠φ	S21 |S21|	S21 ∠φ	S12 |S12|	S12 ∠φ	S22 |S22|	S22 ∠φ
5.0	5	100	0.72	-40	12.37	153	0.028	67	0.91	-18
		200	0.65	-78	10.38	133	0.048	51	0.76	-32
		500	0.61	-137	5.75	100	0.067	34	0.50	-45
		1000	0.61	-168	3.13	78	0.082	31	0.41	-54
		2000	0.63	161	1.58	47	0.112	30	0.41	-80
	10	100	0.57	-60	19.54	146	0.024	63	0.85	-27
		200	0.55	-105	14.70	125	0.038	47	0.64	-43
		500	0.59	-155	7.12	95	0.051	39	0.37	-55
		1000	0.61	-178	3.77	76	0.069	40	0.29	-62
		2000	0.64	156	1.91	50	0.106	39	0.30	-86
	30	100	0.43	-111	30.58	135	0.016	57	0.72	-39
		200	0.53	-145	19.35	114	0.022	49	0.46	-57
		500	0.62	-173	8.42	91	0.035	51	0.24	-69
		1000	0.63	172	4.36	75	0.058	54	0.18	-76
		2000	0.67	151	2.19	52	0.099	49	0.21	-99
	50	100	0.46	-134	32.34	129	0.013	57	0.64	-42
		200	0.57	-158	19.19	110	0.018	51	0.40	-56
		500	0.64	-178	8.13	89	0.031	57	0.22	-62
		1000	0.65	170	4.17	74	0.053	58	0.19	-70
		2000	0.70	150	2.10	52	0.092	54	0.22	-97
10	5	100	0.74	-36	12.34	154	0.023	69	0.93	-15
		200	0.67	-71	10.56	135	0.040	54	0.81	-25
		500	0.59	-131	6.09	102	0.058	37	0.57	-36
		1000	0.58	-164	3.32	79	0.073	33	0.50	-44
		2000	0.60	164	1.67	48	0.098	32	0.49	-69
	10	100	0.60	-52	19.75	148	0.020	65	0.87	-21
		200	0.56	-95	15.30	127	0.032	49	0.69	-33
		500	0.56	-149	7.69	97	0.044	41	0.45	-41
		1000	0.58	-174	4.07	77	0.061	42	0.39	-47
		2000	0.61	159	2.03	50	0.095	40	0.39	-70
	30	100	0.44	-94	32.03	136	0.014	59	0.75	-31
		200	0.50	-135	20.76	115	0.021	49	0.52	-41
		500	0.57	-168	9.13	91	0.032	52	0.33	-43
		1000	0.59	175	4.71	75	0.052	54	0.29	-48
		2000	0.64	154	2.34	52	0.089	49	0.30	-72
	50	100	0.44	-117	33.56	129	0.012	59	0.68	-31
		200	0.52	-150	19.94	109	0.017	50	0.47	-36
		500	0.59	-174	8.52	89	0.028	56	0.34	-35
		1000	0.61	173	4.38	75	0.049	57	0.32	-43
		2000	0.66	152	2.21	51	0.083	52	0.34	-70

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

The RF Line
NPN Silicon High Frequency Transistor

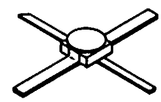
2N6618

NPN SILICON HIGH FREQUENCY TRANSISTOR NF = 2.2 dB MAX @ 2 GHz

2

. . . designed for use in high-frequency, low-noise, small-signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- Low Noise Figure — NF = 1.8 dB (Typ) @ f = 2 GHz
- High Power Gain — G_A = 12 dB (Typ) @ f = 2 GHz
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- Capable of MIL-S-19500 and MIL-STD-750/883 Environmental and Test Requirements



CASE 303-01, STYLE 1

***MAXIMUM RATINGS** (T_A = 25°C Free Air Temperature)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Collector Current — Continuous	I_C	20	mAdc
Total Device Dissipation @ T_C = 125°C Derate Above 125°C	P_D	300 4	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature (Soldering 10 seconds each lead)	—	250	°C

*Indicates JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Breakdown Voltage (I_C = 100 μA, I_B = 0)	$V_{(BR)CES}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (V_{CE} = 10 V)	I_{CEO}	—	—	500	nAdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 3 mAdc, V_{CE} = 10 Vdc)	h_{FE}	50	100	250	—
***DYNAMIC CHARACTERISTICS**					
Collector-Base Capacitance (1) (V_{CB} = 10 Vdc, I_C = 0, f = 1 MHz)	C_{cb}	—	0.14	—	pF
***FUNCTIONAL TEST**					
Common-Emitter Associated Gain (V_{CE} = 10 Vdc, I_C = 3 mAdc, f = 2 GHz)	G_A	11	12	—	dB
Minimum Noise Figure (V_{CE} = 10 Vdc, I_C = 3 mAdc, f = 2 GHz)	NF_{MIN}	—	1.8	2.2	dB

*Indicates JEDEC Registered Data.
(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.

2

TYPICAL S-PARAMETERS
V_{CE} = 10 V, I_C = 3 mA

f (MHz)	S_{11} Mag.	S_{11} Ang.	S_{21} dB	S_{21} Mag.	S_{21} Ang.	S_{12} Mag.	S_{12} Ang.	S_{22} Mag.	S_{22} Ang.
100	0.89	−17		9.30	168	0.01	72	0.99	−6
200	0.89	−34		9.05	156	0.01	72	0.97	−11
300	0.84	−50		8.78	146	0.02	64	0.93	−14
400	0.83	−63		8.12	138	0.03	61	0.92	−17
500	0.80	−76		7.39	129	0.03	54	0.88	−21
600	0.78	−87		6.83	123	0.04	41	0.83	−23
700	0.73	−97		6.31	117	0.04	39	0.82	−24
800	0.72	−106		6.01	110	0.04	37	0.80	−25
900	0.71	−112		5.43	105	0.04	34	0.80	−27
1000	0.70	−120		5.12	101	0.04	30	0.74	−28
1500	0.64	−143		3.60	85	0.05	27	0.70	−34
2000	0.64	−161		2.82	71	0.05	24	0.67	−37
2500	0.62	−174		2.30	56	0.05	23	0.69	−52
3000	0.62	175		1.90	44	0.06	28	0.70	−56
3500	0.61	165		1.66	34	0.06	35	0.73	−68
4000	0.61	157		1.46	24	0.06	40	0.78	−70
5000	0.62	142		1.18	8	0.08	39	0.76	−82
6000	0.60	127		0.98	−9	0.09	38	0.78	−95

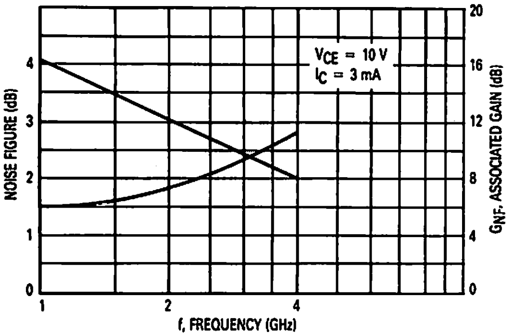


Figure 1. NF_{MIN} and Associated Gain versus Frequency

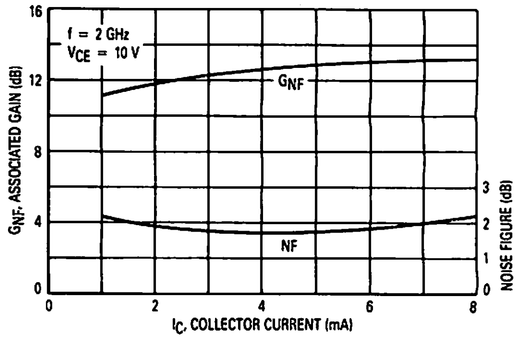


Figure 2. NF_{MIN} and Associated Gain versus Collector Current

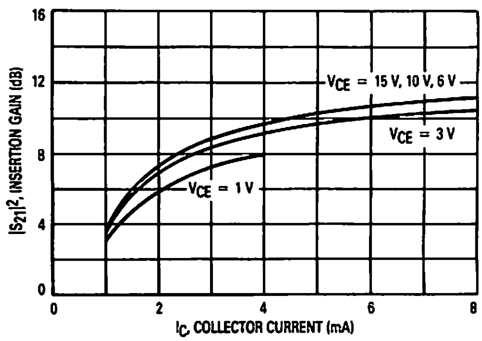


Figure 3. $|S_{21}|^2$, Insertion Gain versus Bias at 2 GHz

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

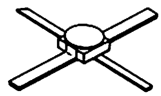
The RF Line
NPN Silicon High Frequency Transistor

2N6679

... designed for use in high-frequency, small-signal, narrow and wideband amplifiers. Ideal for use in microstrip thin and thick film applications.

- High Output Power — $P_{1\,dB}$ = 18.5 dBm Typ @ f = 4 GHz
- High Power Gain — G_T = 10.5 dB Typ @ f = 4 GHz
- High Current — Specified Performance @ I_C = 25 mA
- Ion Implantation and Gold Metallization
- Metal/Ceramic Hermetic Package
- Capable of MIL-S-19500 and MIL-STD-750/883 Environmental and Test Requirements

NPN SILICON HIGH FREQUENCY TRANSISTOR
G_T = 10.5 dB TYP @ 4 GHz



CASE 303-01, STYLE 1

***MAXIMUM RATINGS** (T_A = 25°C Free Air Temperature)

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Collector Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_C = 87°C Derate Above 87°C	P_D	900 8	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C
Lead Temperature (Soldering 10 seconds each lead)	—	250	°C

*Indicates Ratings Same As or Greater Than JEDEC Registered Data.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
***OFF CHARACTERISTICS**					
Collector-Emitter Breakdown Voltage (I_C = 100 μA, V_{BE} = 0)	$V_{(BR)CES}$	30	—	—	Vdc
Collector-Emitter Leakage Current (V_{CE} = 15 V)	I_{CEO}	—	—	500	nAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	100	nAdc
***ON CHARACTERISTICS**					
DC Current Gain (I_C = 15 mAdc, V_{CE} = 15 Vdc)	h_{FE}	50	100	220	—
***DYNAMIC CHARACTERISTICS**					
Collector-Base Capacitance (1) (V_{CB} = 10 Vdc, I_C = 0, f = 1 MHz)	C_{cb}	—	0.27	—	pF
***FUNCTIONAL TEST**					
Tuned Gain (2) (V_{CE} = 15 Vdc, I_C = 25 mAdc, f = 4 GHz)	G_T	9	10	—	dB
Power Output at 1 dB Compression (V_{CE} = 15 Vdc, I_C = 25 mA, f = 4 GHz)	$P_{1\,dB}$	—	18.5	—	dBm

*Indicates JEDEC Registered Data.
(1) C_{cb} measurement employs a three-terminal capacitance bridge incorporating a guard circuit. The emitter terminal shall be connected to the guard terminal of the bridge.
(2) $G_T = \dfrac{|S_{21}|^2(1-|\Gamma_S|^2)(1-|\Gamma_L|^2)}{|(1-S_{11}\Gamma_S)(1-S_{22}\Gamma_L)-S_{12}S_{21}\Gamma_L\Gamma_S|^2}$ Γ_S = Source reflection coefficient. Γ_L = Load reflection coefficient.

2

TYPICAL S-PARAMETERS

V_{CE} = 15 V, I_C = 25 mA

f (MHz)	S_{11} $\lvert S_{11}\rvert$	S_{11} $\angle\phi$	S_{21} $\lvert S_{21}\rvert$	S_{21} $\angle\phi$	S_{12} $\lvert S_{12}\rvert$	S_{12} $\angle\phi$	S_{22} $\lvert S_{22}\rvert$	S_{22} $\angle\phi$
100	0.60	−76	38.6	141	0.01	55	0.83	−20
500	0.67	−158	12.7	95	0.02	40	0.50	−27
1000	0.68	−178	6.6	77	0.03	53	0.46	−32
1500	0.68	170	4.4	64	0.04	54	0.47	−41
2000	0.69	162	3.4	54	0.05	54	0.47	−50
2500	0.69	154	2.7	42	0.06	55	0.49	−59
3000	0.69	146	2.3	31	0.07	55	0.53	−70
3500	0.69	138	1.93	21	0.08	54	0.55	−79
4000	0.69	131	1.7	11	0.09	51	0.57	−89
4500	0.69	123	1.5	1	0.10	49	0.59	−97
5000	0.69	114	1.35	−9	0.12	44	0.62	−106
5500	0.69	106	1.23	−19	0.14	39	0.64	−113
6000	0.69	98	1.11	−28	0.15	33	0.68	−122
6500	0.69	90	1.01	−37	0.17	31	0.69	−130

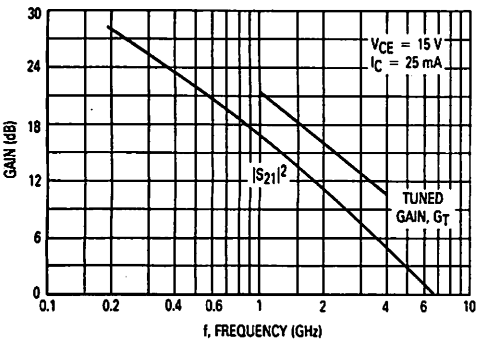


Figure 1. $|S_{21}|^2$ and Tuned Gain versus Frequency

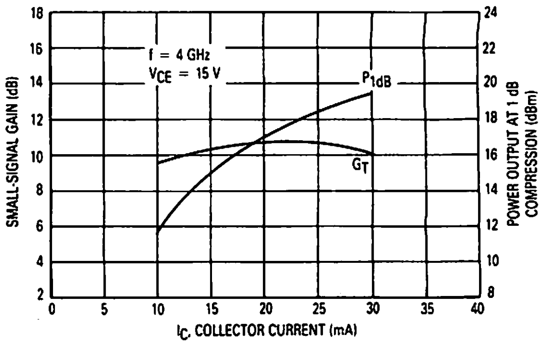


Figure 2. Power Output at 1 dB Compression and Small-Signal Gain versus Collector Current

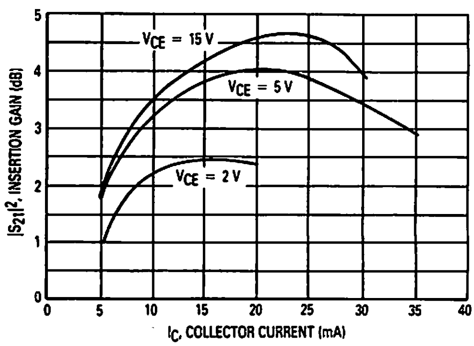
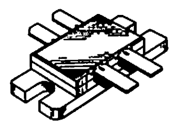


Figure 3. $|S_{21}|^2$, Insertion Gain versus Bias at 4 GHz

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2N6985

**125 WATTS, 30–400 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



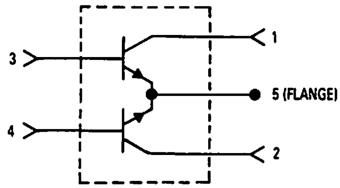
CASE 382-01, STYLE 1

The RF Line

NPN Silicon Push-Pull RF Power Transistor

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30-400 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 125 W
  Typical Gain = 10 dB (Class C), 11 dB (Class AB)
  Efficiency = 55% (Typ)
- Hermetic Package to Meet Stringent Environmental Requirements
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- *Gold Metallization System* for High Reliability
- 100% Tested for Load Mismatch
- MIL-S-19500 Processed Versions Available as MRF6985HX, MRF5985HXV



The 2N6985 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) *Derate above 25°C*	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.
* Indicates JEDEC Registered Data.

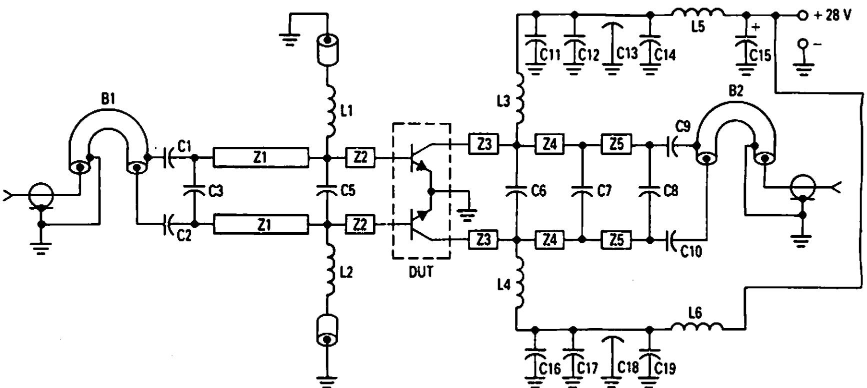
2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5	mAdc
ON CHARACTERISTICS (NOTE 1)					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (NOTE 1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TEST (NOTE 2 — See Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	G_{pe}	8	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES: 1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

* Indicates JEDEC Registered Data.



C1, C2 — 240 pF, 100 Mil Chip Cap (ATC) or Equivalent
C3 — 4.7 pF, 100 Mil Chip Cap (ATC) or Equivalent
C8 — 12 pF, 100 Mil Chip Cap (ATC) or Equivalent
C5 — 27 pF, 100 Mil Chip Cap (ATC) or Equivalent
C6 — 20 pF, 100 Mil Chip Cap (ATC) or Equivalent
C7 — 12 pF, 100 Mil Chip Cap (ATC) or Equivalent
C9, C10 — 270 pF, 100 Mil Chip Cap (ATC) or Equivalent
C11, C12, C16, C17 — 470 pF 100 Mil Chip Cap (ATC) or Equivalent
C13, C18 — 680 pF Feedthru
C14, C19 — 0.1 µF Erie Redcap or Equivalent
C15 — 20 µF, 50 V

L1, L2 — 0.15 µH Molded Choke With Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG, 0.200 ID
L5, L6 — 3-1/2 Turns #18 AWG, 0.200 ID

B1 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L
B2 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L

Z1 — Microstrip Line 650 Mil L × 125 Mil W
Z2 — Microstrip Line 220 Mil L × 125 Mil W
Z3 — Microstrip Line 280 Mil L × 125 Mil W
Z4 — Microstrip Line 300 Mil L × 125 Mil W
Z5 — Microstrip Line 450 Mil L × 125 Mil W

Board Material — 0.06" Teflon-Fiberglass, ϵ_r = 2.55, 2 oz. Cu. CLAD, Double Sided

Figure 1. 400 MHz Test Fixture

OUTPUT POWER versus INPUT POWER CLASS C

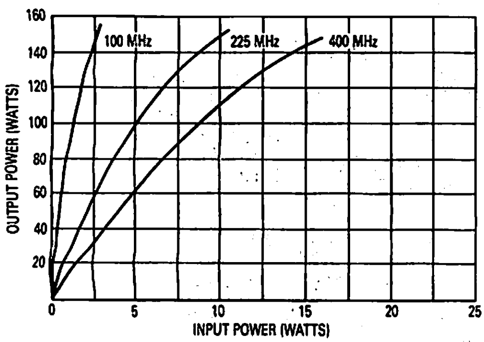


Figure 2. V_{CC} = 28 V

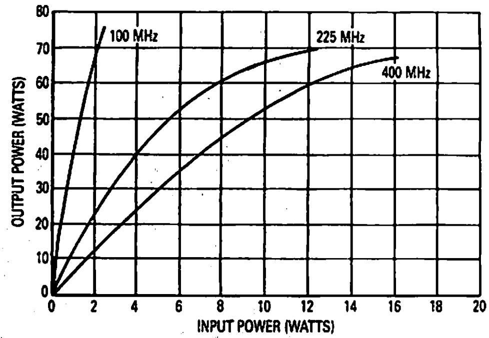


Figure 3. V_{CC} = 13.5 V

OUTPUT POWER versus SUPPLY VOLTAGE CLASS C

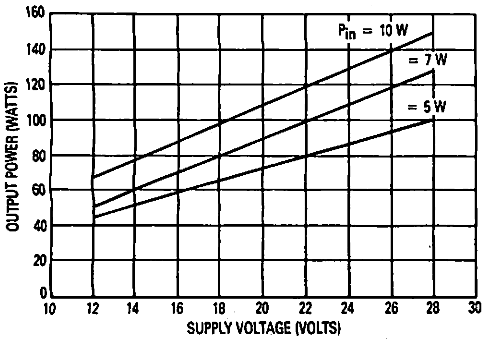


Figure 4. f = 225 MHz

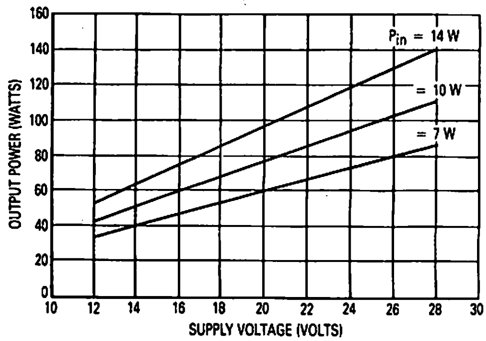


Figure 5. f = 400 MHz

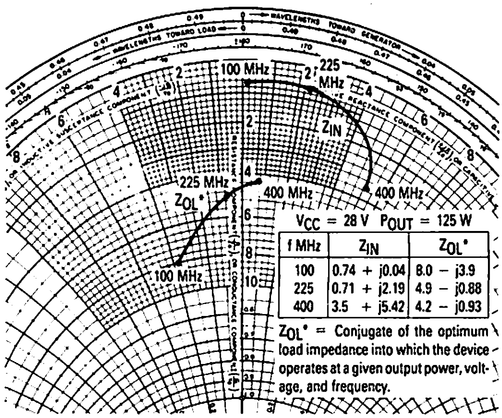


Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

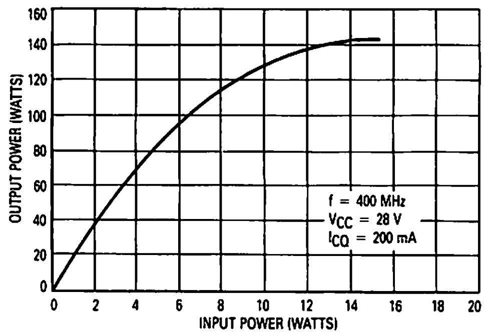
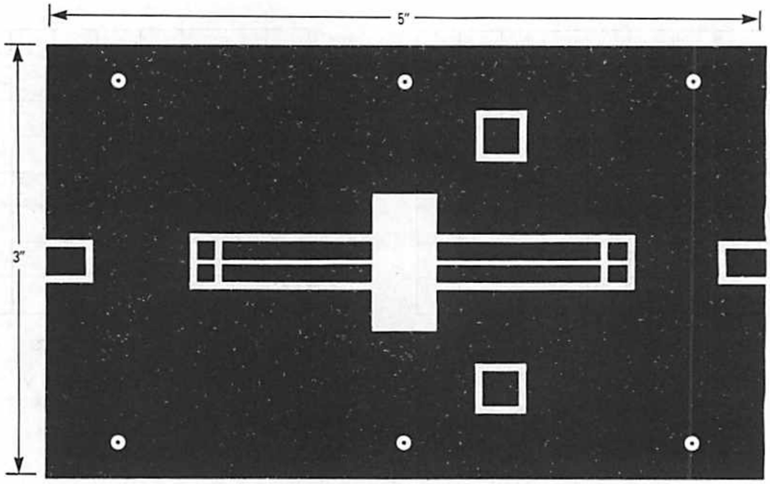


Figure 7. Class AB Output Power versus Input Power

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

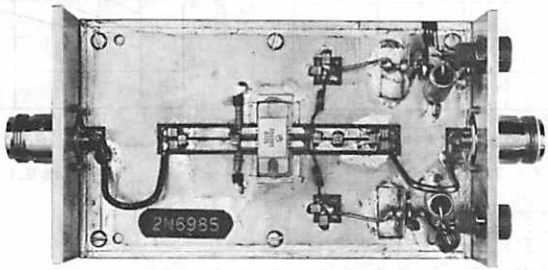


Figure 9. Test Fixture Photo

2N6986

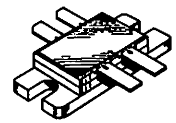
**100 WATTS, 30–500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**

The RF Line

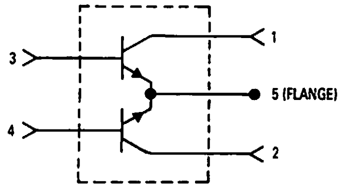
NPN Silicon Push-Pull RF Power Transistor

... designed primarily for wideband large-signal output and driver amplifier stages in the 30-500 MHz frequency range.

- Specified 28 Volt, 500 MHz Characteristics —
  Output Power = 100 W
  Typical Gain = 10.3 dB (Class AB); 9 dB (Class C)
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch
- Hermetic Package to Meet Stringent Environmental *Requirements*
- MIL-S-19500 Processed Versions Available as MRF6986HX, MRF6986HXV



CASE 382-01, STYLE 1



The 2N6986 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

***MAXIMUM RATINGS**

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

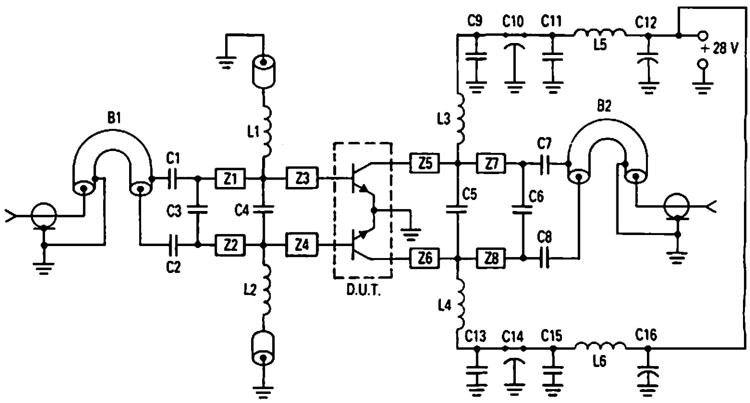
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF push-pull amplifiers.
* Indicates JEDEC Registered Data.

2

***ELECTRICAL CHARACTERISTICS** (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5	mAdc
ON CHARACTERISTICS (NOTE 1)					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (NOTE 1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TEST (NOTE 2 — See Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	G_{pe}	7.5	9	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES: 1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.
* Indicates JEDEC Registered Data.



C1, C2, C7, C8 — 240 pF 100 mil Chip Cap
C3 — 12 pF 100 mil Chip Cap
C4 — 10 pF 100 mil Chip Cap
C5 — 36 pF 100 mil Chip Cap
C6 — 12 pF 100 mil Chip Cap
C9, C13 — 1000 pF 100 mil Chip Cap
C10, C14 — 680 pF Feedthru Cap
C11, C15 — 0.1 µF Ceramic Disc Cap
C12, C16 — 50 µF 50 V

L1–L2 — 0.15 µH Molded Choke with Ferrite Bead
L3–L4 — 2-1/2 Turns #20 AWG 0.200" ID
L5–L6 — 3-1/2 Turns #18 AWG 0.200" ID

B1, B2 — Balun 50 Ω Semi Rigid Coax, 86 mil OD, 2" Long

Z1, Z2 — 450 mil Long × 125 mil W. Microstrip
Z3, Z4 — 340 mil Long × 125 mil W. Microstrip
Z5, Z6 — 280 mil Long × 125 mil W. Microstrip
Z7, Z8 — 600 mil Long × 125 mil W. Microstrip

Board Material — 0.03" Teflon-Fiberglass, ϵ_r = 2.55, 2 oz. Copper Clad both sides.

Figure 1. 500 MHz Test Fixture

OUTPUT POWER versus INPUT POWER CLASS C

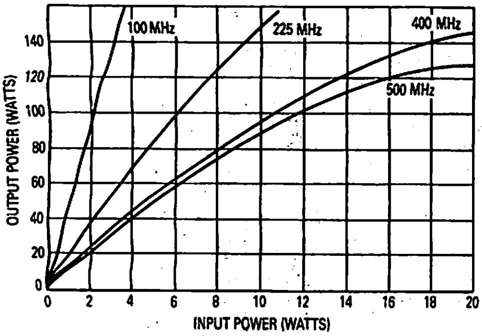


Figure 2. V_{CC} = 28 V

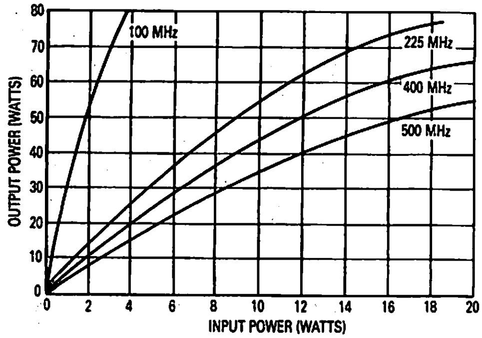


Figure 3. V_{CC} = 13.5 V

OUTPUT POWER versus SUPPLY VOLTAGE CLASS C

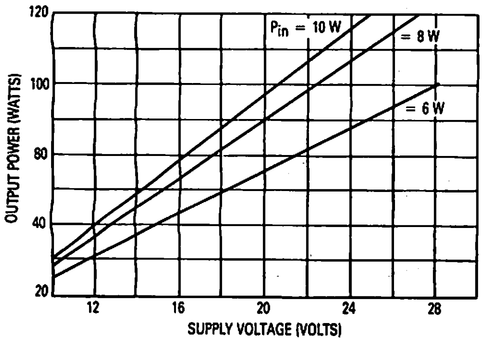


Figure 4. f = 225 MHz

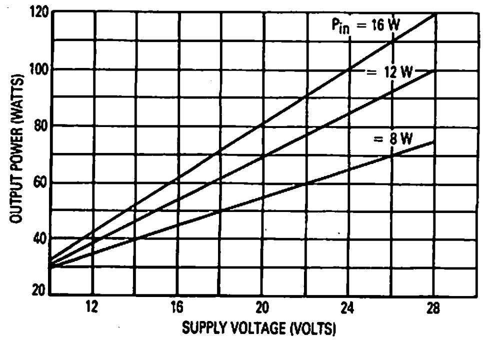
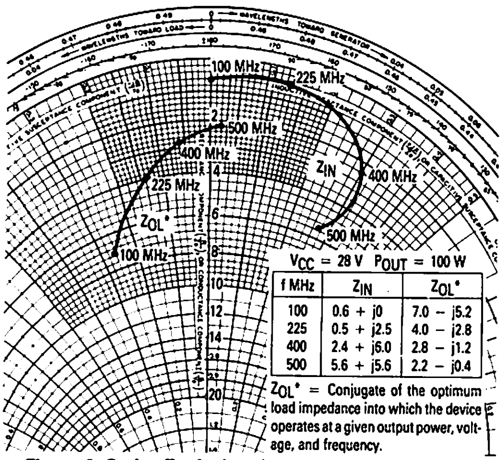


Figure 5. f = 500 MHz



V_{CC} = 28 V P_{OUT} = 100 W

f MHz	Z_{IN}	Z_{OL}*
100	0.6 + j0	7.0 − j5.2
225	0.5 + j2.5	4.0 − j2.8
400	2.4 + j6.0	2.8 − j1.2
500	5.6 + j5.6	2.2 − j0.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedance

Input and output impedances are measured from base to base and collector to collector respectively.

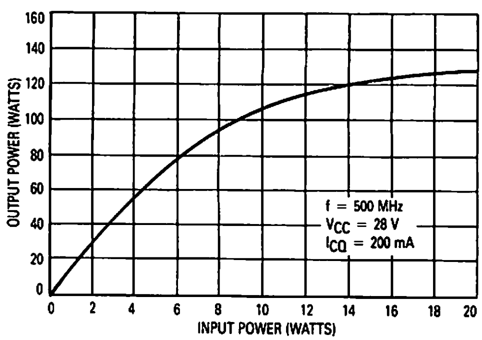
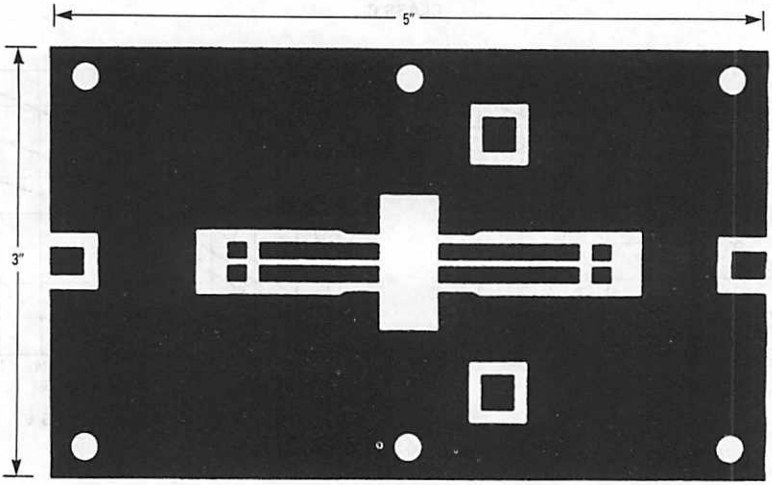


Figure 7. Class AB Output Power versus Input Power



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

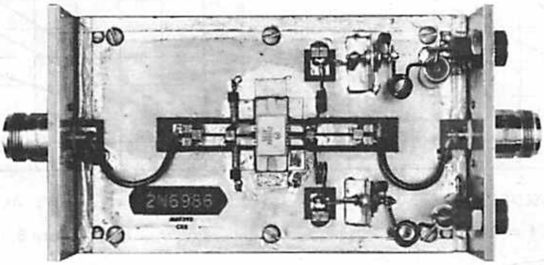


Figure 9. Test Fixture Photo

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

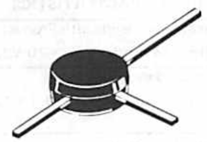
BFR90

The RF Line

f_T = 5.0 GHz @ 14 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also used in applications requiring fast switching times.

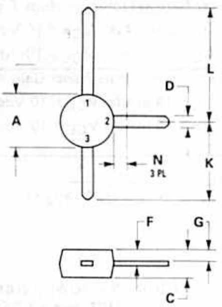
- High Current-Gain – Bandwidth Product – f_T = 5.0 GHz (Typ) @ I_C = 14 mA
- Low Noise Figure – NF = 2.4 dB (Typ) @ f = 0.5 GHz
  = 3.0 dB (Typ) @ f = 1.0 GHz
- High Power Gain – G_{max} = 18 dB (Typ) @ f = 0.5 GHz
  = 12 dB (Typ) @ f = 1.0 GHz

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	30	mAdc
Total Device Dissipation @ T_A = 60°C Derate Above 60°C	P_D	180 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	500	°C/W



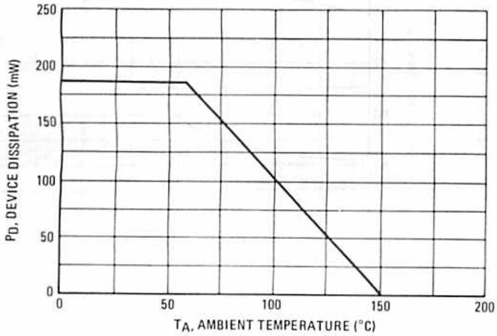
STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01

FIGURE 1 – POWER DERATING



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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	–	250	–
DYNAMIC CHARACTERTISTICS					
Current-Gain Bandwidth Product (I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	–	5.0	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.5	1.0	pF
FUNCTIONAL TESTS					
Noise Figure	NF				dB
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	2.4	–	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	3.0	–	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	15	–	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	10	–	
Maximum Available Power Gain (1)	G_{max}				dB
(I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	18	–	
(I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	12	–	

(1) $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 2 – POWER GAIN AND NOISE FIGURE versus FREQUENCY

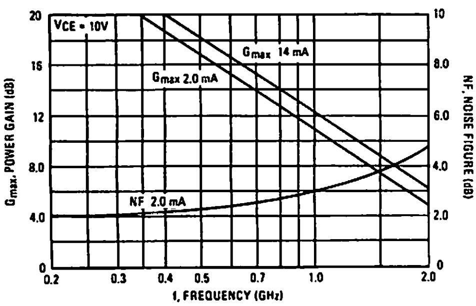

FIGURE 3 – POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

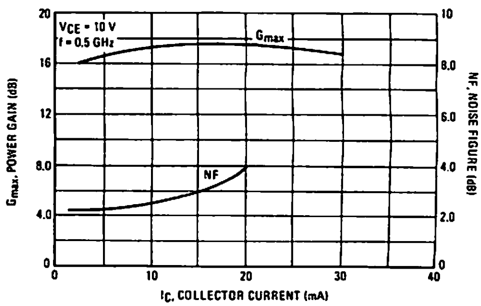

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FIGURE 4 – S_{11} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ
	2.0	0.77	-45	0.48	-90	0.33	-125	0.27	-160	0.28	170
5.0	5.0	0.52	-60	0.25	-110	0.18	-150	0.18	170	0.21	145
	10	0.33	-75	0.15	-125	0.13	-175	0.15	150	0.20	130
	20	0.20	-95	0.12	-155	0.14	165	0.17	145	0.22	130
	30	0.17	-116	0.14	-170	0.17	160	0.21	145	0.26	130
	2.0	0.79	-40	0.50	-80	0.33	-115	0.26	-150	0.25	175
	5.0	0.56	-55	0.27	-95	0.16	-135	0.13	-175	0.17	150
10	10	0.39	-65	0.16	-105	0.10	-150	0.10	165	0.15	140
	20	0.25	-75	0.10	-120	0.09	-175	0.12	150	0.18	130
	30	0.25	-75	0.10	-120	0.09	-175	0.12	150	0.18	130

FIGURE 5 – S_{22} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ
	2.0	0.89	-20	0.69	-30	0.61	-35	0.55	-35	0.52	-45
	5.0	0.75	-25	0.55	-30	0.50	-30	0.47	-30	0.43	-40
5.0	10	0.64	-25	0.49	-25	0.45	-25	0.43	-30	0.40	-35
	20	0.57	-25	0.47	-20	0.44	-25	0.43	-25	0.40	-35
	30	0.55	-20	0.47	-20	0.46	-20	0.44	-25	0.42	-35
	2.0	0.91	-15	0.74	-25	0.66	-30	0.62	-35	0.59	-40
	5.0	0.79	-20	0.61	-25	0.56	-25	0.54	-30	0.51	-35
10	10	0.70	-20	0.56	-20	0.53	-25	0.51	-25	0.48	-35
	20	0.63	-20	0.54	-25	0.53	-20	0.51	-25	0.49	-35
	30	0.63	-15	0.56	-15	0.55	-20	0.54	-25	0.52	-35

FIGURE 6 – S_{21} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ
	2.0	5.76	140	3.81	105	2.73	90	2.20	75	1.70	60
	5.0	9.92	125	5.24	95	3.50	80	2.80	70	2.10	60
5.0	10	12.33	115	5.82	90	3.79	75	2.90	65	2.20	55
	20	13.62	105	6.00	85	3.88	75	2.95	65	2.25	55
	30	13.41	105	5.80	80	3.74	75	2.85	65	2.15	55
	2.0	5.77	145	3.88	110	2.80	90	2.25	75	1.75	60
	5.0	10.05	130	5.42	95	3.60	80	2.85	70	2.10	60
10	10	12.56	115	6.00	90	3.90	80	3.05	70	2.25	55
	20	13.77	110	6.13	85	3.92	75	3.05	65	2.20	55
	30	13.23	105	5.79	85	3.70	75	2.85	65	2.15	55

FIGURE 7 – S_{12} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ
	2.0	0.06	65	0.10	55	0.12	55	0.14	55	0.17	60
	5.0	0.05	65	0.08	65	0.12	65	0.15	65	0.19	65
5.0	10	0.04	65	0.08	70	0.12	70	0.15	70	0.20	65
	20	0.04	75	0.08	75	0.12	75	0.15	70	0.20	70
	30	0.03	75	0.07	75	0.11	75	0.15	75	0.19	70
	2.0	0.05	70	0.03	55	0.11	55	0.12	55	0.15	60
	5.0	0.04	65	0.07	65	0.10	65	0.13	65	0.17	70
10	10	0.04	65	0.07	70	0.10	70	0.13	70	0.17	70
	20	0.03	70	0.07	75	0.10	75	0.13	75	0.17	70
	30	0.03	75	0.06	75	0.10	75	0.13	75	0.17	70

2

BFR91

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

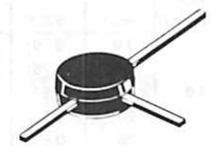
. . . designed primarily for use in high-gain, low-noise, small-signal amplifiers. Also used in applications requiring fast switching times.

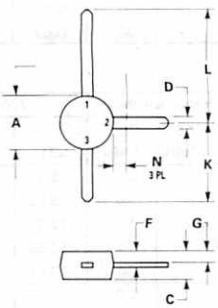
- High Current-Gain – Bandwidth Product – f_T = 5.0 GHz (Typ) @ I_C = 30 mA
- Low Noise Figure – NF = 1.9 dB (Typ) @ f = 0.5 GHz
- High Power Gain – G_{max} = 16 dB (Typ) @ f = 0.5 GHz

f_T = 5.0 GHz @ 30 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01

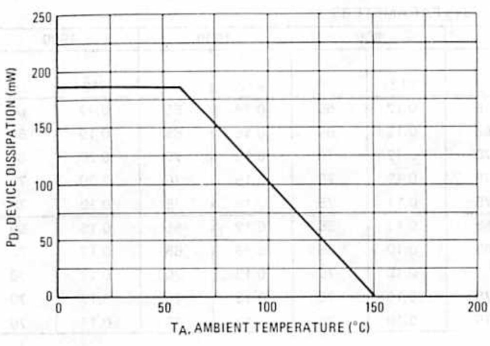
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current – Continuous	I_C	35	mAdc
Total Device Dissipation @ T_A = 60°C Derate Above 60°C	P_D	180 2.0	mW mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	500	°C/W

FIGURE 1 – POWER DERATING



ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	25	–	250	–
DYNAMIC CHARACTERTISTICS					
Current-Gain Bandwidth Product (I_C = 30 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)	f_T	–	5.0	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.7	1.0	pF
FUNCTIONAL TESTS					
Noise Figure	NF				dB
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)		–	1.9	–	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 GHz)		–	2.5	–	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)		–	11	–	
(I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 GHz)		–	8.0	–	
Maximum Available Power Gain (1)	G_{max}				dB
(I_C = 30 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)		–	16	–	
(I_C = 30 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 GHz)		–	10	–	

(1) $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 2 - POWER GAIN AND NOISE FIGURE versus FREQUENCY

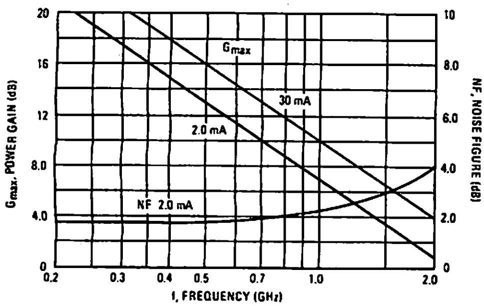


FIGURE 3 - POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

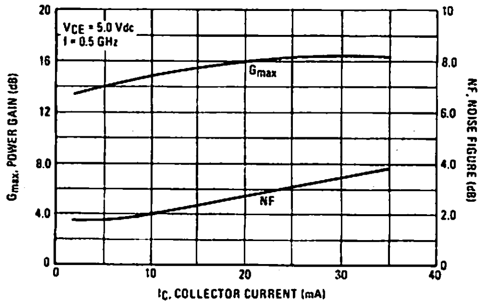


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FIGURE 4 – S_{11} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ
	2.0	0.72	-65	0.51	-125	0.46	-165	0.47	170	0.51	145
	5.0	0.49	-90	0.35	-150	0.34	175	0.36	155	0.41	135
5.0	10	0.34	-110	0.28	-165	0.29	165	0.32	145	0.36	130
	20	0.26	-130	0.24	180	0.27	155	0.30	140	0.34	125
	30	0.24	-145	0.24	175	0.27	155	0.30	140	0.34	125
	2.0	0.74	-60	0.51	-120	0.45	-160	0.45	170	0.49	150
	5.0	0.52	-80	0.33	-140	0.31	-175	0.32	160	0.37	145
10	10	0.36	-95	0.24	-155	0.24	170	0.27	155	0.31	140
	20	0.25	-115	0.19	-170	0.21	160	0.24	145	0.29	130
	30	0.22	-120	0.19	-175	0.21	160	0.25	145	0.20	130

FIGURE 5 – S_{22} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ
	2.0	0.83	-25	0.62	-35	0.55	-40	0.51	-45	0.49	-60
	5.0	0.66	-30	0.45	-35	0.40	-40	0.37	-40	0.34	-50
5.0	10	0.52	-35	0.36	-35	0.32	-35	0.30	-35	0.27	-50
	20	0.42	-35	0.30	-30	0.27	-30	0.26	-30	0.22	-45
	30	0.38	-35	0.28	-25	0.26	-30	0.25	-30	0.21	-40
	2.0	0.86	-20	0.67	-30	0.62	-35	0.58	-40	0.56	-50
	5.0	0.71	-25	0.53	-30	0.48	-30	0.45	-35	0.43	-45
10	10	0.59	-30	0.45	-25	0.41	-30	0.40	-30	0.37	-40
	20	0.50	-25	0.40	-25	0.38	-25	0.37	-30	0.34	-40
	30	0.47	-25	0.40	-20	0.38	-25	0.37	-30	0.34	-35

FIGURE 6 – S_{21} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ
	2.0	5.25	130	3.06	95	2.10	75	1.70	65	1.20	50
	5.0	8.72	120	4.34	90	2.84	75	2.30	65	1.60	50
5.0	10	10.85	110	4.92	85	3.22	70	2.60	65	1.80	50
	20	12.13	105	5.34	80	3.44	70	2.75	60	1.90	50
	30	12.50	100	5.42	80	3.47	70	2.75	60	1.90	50
	2.0	5.36	135	3.20	95	2.20	80	1.85	65	1.30	50
10	5.0	9.05	120	4.55	90	3.00	75	2.45	65	1.65	50
	10	11.37	110	5.22	85	3.40	75	2.65	65	1.85	50
	20	12.83	105	5.64	80	3.63	70	2.75	60	2.00	50
	30	13.10	100	5.62	80	3.63	70	2.75	60	2.00	50

FIGURE 7 – S_{12} PARAMETERS

Frequency (MHz)		200		500		800		1000		1500	
V_{CE} (Volts)	I_C (mA)	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ
	2.0	0.08	55	0.11	45	0.12	50	0.14	55	0.17	65
	5.0	0.06	55	0.09	60	0.13	65	0.17	65	0.22	65
5.0	10	0.05	60	0.09	65	0.14	70	0.19	65	0.24	65
	20	0.05	70	0.07	70	0.15	70	0.19	70	0.25	65
	30	0.04	75	0.10	75	0.15	70	0.19	70	0.25	65
	2.0	0.06	60	0.09	45	0.10	50	0.12	60	0.15	70
	5.0	0.05	60	0.08	60	0.11	65	0.15	65	0.19	70
10	10	0.05	65	0.08	65	0.12	70	0.16	70	0.21	70
	20	0.04	70	0.08	70	0.13	70	0.17	70	0.22	70
	30	0.04	70	0.08	75	0.13	70	0.17	70	0.22	70

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFR92
BFR92A

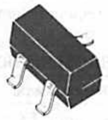
The RF Line

NPN Silicon
High Frequency Transistors

. . . designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

RF TRANSISTORS

NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	25	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

BFR92, T1, T2 = P1
BFR92A, T1, T2 = P2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mA)		$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μA)		$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 100 μA)		$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V)	BFR92 BFR92A	I_{CBO}	— —	50 60	nA
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mA, V_{CE} = 10 V)	BFR92 BFR92A	h_{FE}	25 40	— —	—
Collector-Emitter Saturation Voltage (1) (I_C = 25 mA, I_B = 5.0 mA)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) (I_C = 25 mA, I_B = 5.0 mA)		$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 14 mA, V_{CE} = 10 V, f = 500 MHz)		f_T	3.0	—	GHz
Noise Figure (V_{CE} = 1.5 V, I_C = 3.0 mA, R_S = 50 Ω, f = 500 MHz)		NF	—	3.0 (Typ)	dB
Capacitance-Collector to Base (V_{CB} = 10 Vdc, f = 1.0 MHz)		C_{cb}	—	0.7 (Typ)	pF

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFR93
BFR93A

The RF Line

NPN Silicon High Frequency Transistors

2

. . . designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

RF TRANSISTORS

NPN SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	35	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

BFR93 = R1
BFR93A = R2

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (1) (I_C = 10 mA)		$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 μA)		$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 100 μA)		$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CE} = 10 V)		I_{CEO}	—	50	nA
Collector Cutoff Current (V_{CB} = 10 V)		I_{CBO}	—	50	nA
ON CHARACTERISTICS					
DC Current Gain (1) (I_C = 30 mA, V_{CE} = 5.0 V) (I_C = 30 mA, V_{CE} = 5.0 V)	 BFR93A BFR93	h_{FE}	 40 25	 — —	—
Collector-Emitter Saturation Voltage (1) (I_C = 35 mA, I_B = 7.0 mA)		$V_{CE(sat)}$	—	0.5	Vdc
Base-Emitter Saturation Voltage (1) (I_C = 35 mA, I_B = 7.0 mA)		$V_{BE(sat)}$	—	1.2	Vdc
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 30 mA, V_{CE} = 5.0 V, f = 500 MHz)		f_T	3.0	—	GHz
Noise Figure (V_{CE} = 5.0 V, I_C = 2.0 mA, R_S = 50 Ω, f = 30 MHz)		NF	—	3.0	dB

(1) Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFR96 BFRC96 MRF961 MRF962 MRF965

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

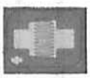
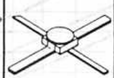
The BFR96 series transistors use the same state-of-the-art microwave transistor chip which features fine-line geometry, ion-implanted arsenic emitters and gold top metalization. These transistors are intended for low-to-medium power amplifiers requiring high gain, low noise figure, and low intermodulation distortion. The BFR96 and MRF961 are particularly suitable for broadband MATV/CATV amplifiers. The MRF962 uses a hermetic stripline, ceramic package and is intended for high reliability applications up to 2 GHz. The MRF965 makes an excellent VHF/UHF Class C driver amplifier for several hundred milliwatts power output.

f_T = 4.5 GHz @ 50 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON

2

MAXIMUM RATINGS		BFRC96	BFR96	MRF961	MRF962	MRF965	
		 Chip	 Case 317A-01 Style 2	 Case 317-01 Style 2	 Case 303-01 Style 1	 Case 26-03 Style 1	
Ratings	**Symbol**			**Values**			**Unit**
Collector-Emitter Voltage	V_{CEO}	15	15	15	15	15	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	3.0	3.0	3.0	3.0	Vdc
Collector Current — Continuous	I_C	100	100	100	100	100	mAdc
Total Device Dissipation @ $T_C = 100^oC$ (1) Derate above $T_C = 100^oC$	P_D	0.75 $T_J = 200^oC$ max	0.5 10	0.5 10	0.75 7.5	0.75 7.5	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +200	−65 to +150	−65 to +150	−65 to +200	−65 to +200	°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	–	–	100	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	–	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	–	4.5	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, Emitter Guarded) BFR96, MRF961, MRF962	C_{cb}	–	1.2	1.5	pF
MRF965		–	1.6	2.0	
FUNCTIONAL TESTS					
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF	–	2.0	–	dB
Maximum Unilateral Gain/Insertion Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) BFR96, MRF965	$G_U(max)$/ $\|S_{21}\|^2$	–/12	14.5/13	–	dB
MRF961		–/13.5	17/15	–	
MRF962		–/15	20.5/16.5	–	

NOTE 1. $$G_U(max) = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 1 – MAXIMUM UNILATERAL GAIN versus FREQUENCY

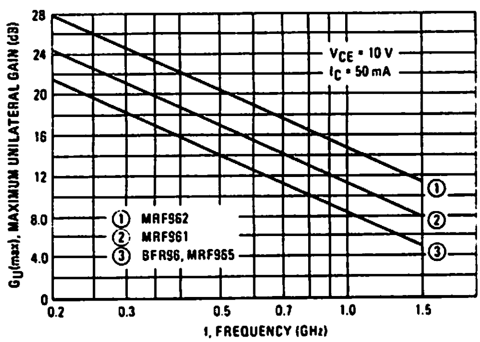


FIGURE 2 – $|S_{21}|^2$ versus FREQUENCY

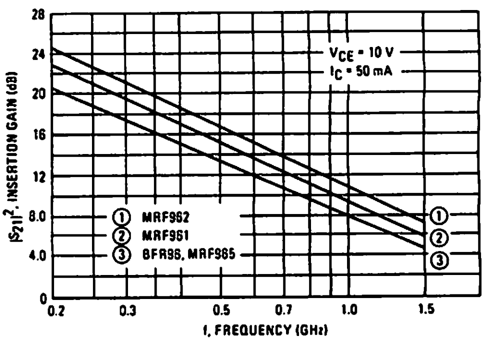


FIGURE 3 – MAXIMUM UNILATERAL GAIN versus COLLECTOR CURRENT

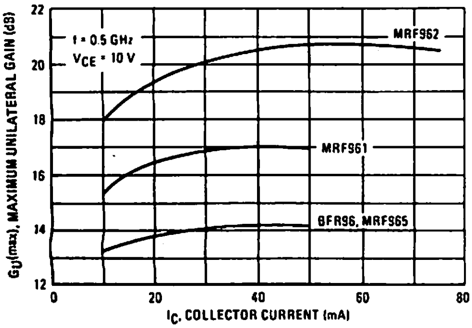


FIGURE 4 – GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

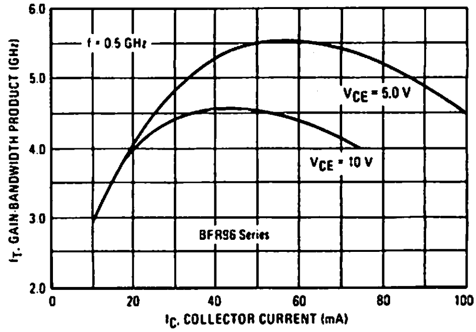


FIGURE 5 – NOISE FIGURE versus FREQUENCY

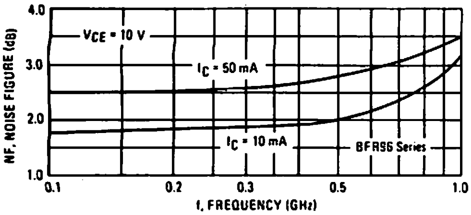


FIGURE 6 – NOISE FIGURE versus COLLECTOR CURRENT

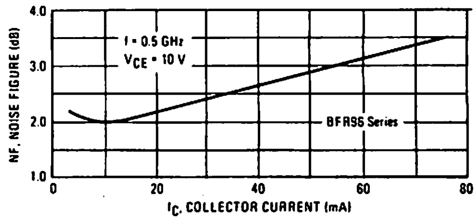


FIGURE 7 – COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

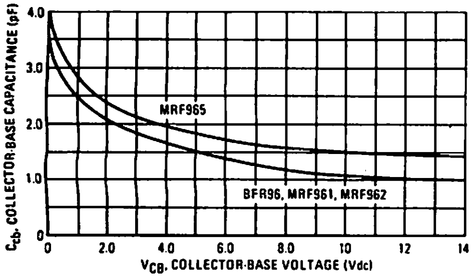


FIGURE 8 – OUTPUT POWER AND EFFICIENCY versus INPUT POWER (MRF965)

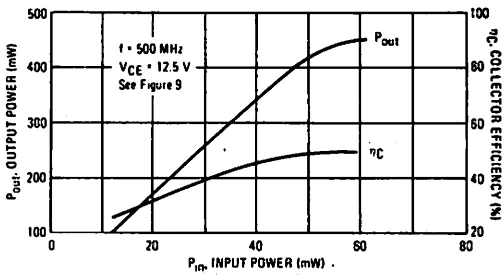
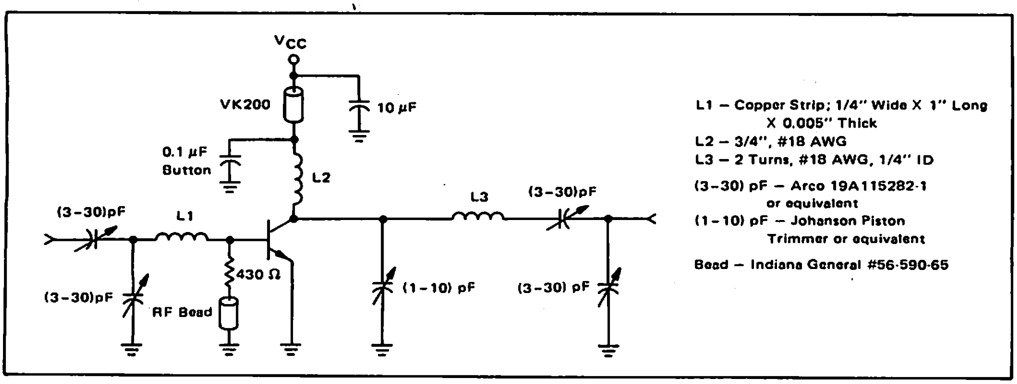


FIGURE 9 – MRF965 CLASS C AMPLIFIER @ 500 MHz, 400 mW



L1 – Copper Strip; 1/4" Wide X 1" Long X 0.005" Thick
L2 – 3/4", #18 AWG
L3 – 2 Turns, #18 AWG, 1/4" ID
(3–30) pF – Arco 19A115282-1 or equivalent
(1–10) pF – Johanson Piston Trimmer or equivalent
Bead – Indiana General #56-590-65

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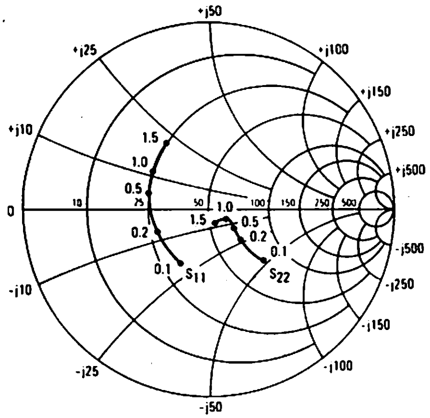
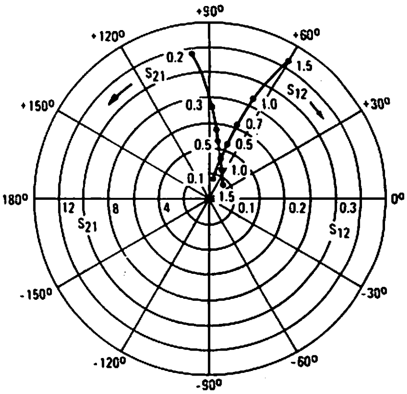
BFR96 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
(V_{CE} = 10 V, I_C = 50 mA)



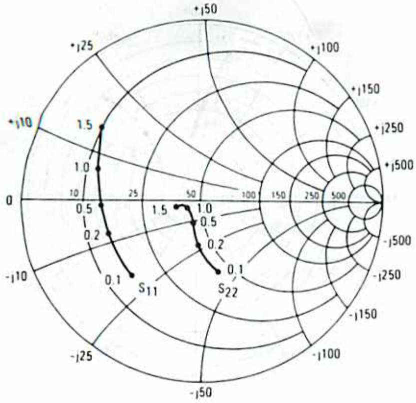
FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
(V_{CE} = 10 V, I_C = 50 mA)



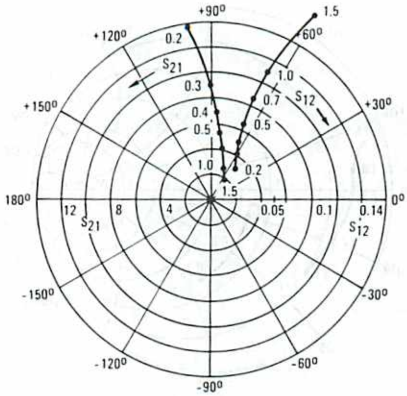
V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	10	100	0.51	-95	15.04	121	0.047	54	0.58	-48
		300	0.43	-163	5.87	92	0.082	58	0.26	-63
		500	0.46	174	3.61	79	0.120	63	0.19	-63
		700	0.48	162	2.65	68	0.161	63	0.15	-64
		1000	0.48	146	1.92	57	0.220	63	0.12	-79
		1500	0.54	121	1.40	43	0.320	58	0.13	-118
	25	100	0.39	-122	19.41	112	0.037	60	0.42	-68
		300	0.39	-176	6.81	89	0.079	68	0.16	-94
		500	0.42	166	4.11	78	0.129	70	0.10	-103
		700	0.44	156	3.05	69	0.176	68	0.06	-119
		1000	0.44	142	2.20	59	0.244	64	0.06	-159
		1500	0.49	118	1.62	45	0.348	57	0.10	177
	50	100	0.35	-140	21.10	106	0.032	64	0.33	-81
		300	0.38	176	7.11	88	0.081	72	0.13	-116
		500	0.42	162	4.28	78	0.133	72	0.09	-136
		700	0.43	153	3.16	70	0.183	69	0.07	-163
		1000	0.42	140	2.28	60	0.252	65	0.08	165
		1500	0.47	116	1.66	47	0.357	57	0.12	155
10	10	100	0.53	-83	15.96	124	0.039	58	0.65	-36
		300	0.38	-154	6.44	94	0.070	59	0.35	-41
		500	0.41	-179	3.98	81	0.102	64	0.30	-39
		700	0.42	166	2.94	70	0.138	65	0.27	-39
		1000	0.42	151	2.12	60	0.191	66	0.24	-47
		1500	0.49	125	1.50	44	0.278	63	0.22	-72
	25	100	0.38	-104	20.85	115	0.032	60	0.48	-48
		300	0.32	-169	7.54	91	0.070	68	0.23	-48
		500	0.35	170	4.61	80	0.109	71	0.19	-43
		700	0.37	160	3.37	70	0.152	69	0.16	-39
		1000	0.37	146	2.43	61	0.210	67	0.13	-44
		1500	0.43	121	1.73	47	0.304	61	0.10	-74
	50	100	0.33	-119	22.59	109	0.029	63	0.39	-51
		300	0.30	-176	7.74	88	0.069	72	0.19	-47
		500	0.34	166	4.70	79	0.113	73	0.16	-40
		700	0.36	158	3.45	70	0.156	70	0.14	-35
		1000	0.36	144	2.46	61	0.217	66	0.11	-39
		1500	0.42	119	1.75	47	0.310	60	0.08	-72

MRF961 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S11 $\|S_{11}\|$	S11 ∠φ	S21 $\|S_{21}\|$	S21 ∠φ	S12 $\|S_{12}\|$	S12 ∠φ	S22 $\|S_{22}\|$	S22 ∠φ
5.0	10	100	0.65	-101	16.61	125	0.047	46	0.61	-56
		300	0.64	-160	6.61	96	0.064	39	0.27	-87
		500	0.66	-178	4.01	83	0.078	45	0.19	-98
		700	0.68	171	2.93	73	0.093	49	0.16	-108
		1000	0.68	160	2.07	63	0.119	53	0.16	-124
		1500	0.72	143	1.43	50	0.158	54	0.21	-141
	25	100	0.60	-129	22.41	115	0.034	44	0.49	-84
		300	0.63	-172	7.94	93	0.049	50	0.26	-132
		500	0.66	174	4.78	83	0.071	58	0.21	-150
		700	0.67	166	3.45	75	0.092	60	0.20	-164
		1000	0.67	156	2.46	66	0.124	61	0.21	-177
		1500	0.71	140	1.73	54	0.173	60	0.24	175
	50	100	0.59	-147	25.12	109	0.025	46	0.42	-104
		300	0.64	-178	8.47	91	0.046	60	0.28	-151
		500	0.67	171	5.05	83	0.070	65	0.26	-167
		700	0.68	164	3.67	75	0.093	65	0.25	-178
		1000	0.67	154	2.60	67	0.128	65	0.26	170
		1500	0.72	138	1.83	56	0.178	62	0.29	163
10	10	100	0.65	-90	17.47	128	0.040	50	0.67	-41
		300	0.61	-154	7.31	97	0.057	41	0.33	-57
		500	0.62	-174	4.46	84	0.069	46	0.25	-58
		700	0.64	175	3.27	74	0.084	50	0.22	-60
		1000	0.64	163	2.33	64	0.106	54	0.20	-72
		1500	0.69	145	1.56	50	0.140	57	0.22	-96
	25	100	0.57	-116	24.36	119	0.030	48	0.51	-62
		300	0.58	-167	8.10	94	0.045	52	0.20	-89
		500	0.61	178	5.43	83	0.070	58	0.14	-97
		700	0.63	169	3.93	75	0.084	60	0.10	-106
		1000	0.62	159	2.78	66	0.112	61	0.09	-124
		1500	0.67	142	1.91	53	0.156	60	0.12	-140
	50	100	0.55	-132	26.97	112	0.024	47	0.40	-73
		300	0.57	-173	9.32	91	0.042	59	0.16	-104
		500	0.60	174	5.58	82	0.064	64	0.11	-115
		700	0.62	167	4.04	74	0.086	64	0.08	-128
		1000	0.61	158	2.85	66	0.115	64	0.08	-149
		1500	0.67	141	1.96	55	0.158	61	0.12	-158

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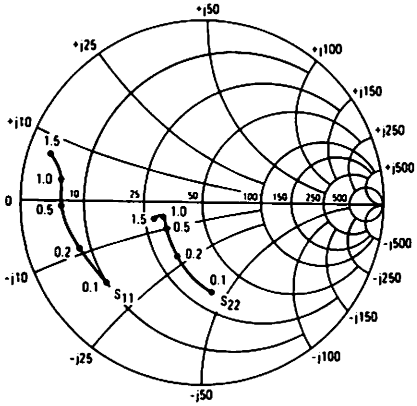
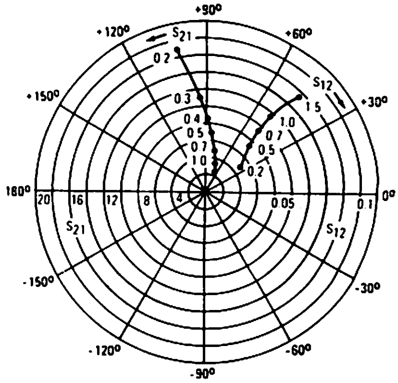
MRF962 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	10	100	0.70	-102	17.42	128	0.044	43	0.65	-57
		300	0.75	-156	7.11	98	0.058	24	0.32	-97
		500	0.78	-170	4.36	86	0.064	25	0.26	-110
		700	0.78	-176	3.16	77	0.071	26	0.23	-117
		1000	0.78	176	2.26	67	0.078	27	0.24	-126
		1500	0.79	167	1.51	54	0.092	29	0.31	-133
	25	100	0.69	-131	24.24	118	0.029	38	0.56	-87
		300	0.77	-167	8.76	95	0.039	32	0.35	-137
		500	0.79	-176	5.26	85	0.046	36	0.32	-150
		700	0.80	178	3.82	78	0.055	40	0.31	-158
		1000	0.79	173	2.72	70	0.067	42	0.32	-164
		1500	0.81	164	1.82	59	0.086	42	0.34	-167
	50	100	0.71	-147	27.72	113	0.021	37	0.53	-107
		300	0.78	-173	9.59	94	0.030	40	0.41	-152
		500	0.81	179	5.72	85	0.038	46	0.39	-163
		700	0.81	176	4.09	78	0.048	50	0.38	-169
		1000	0.81	171	2.89	71	0.061	51	0.38	-175
		1500	0.82	163	1.96	62	0.082	49	0.40	-177
10	10	100	0.71	-92	18.77	131	0.037	47	0.70	-44
		300	0.74	-150	8.09	100	0.051	28	0.34	-69
		500	0.75	-166	5.01	87	0.056	28	0.27	-75
		700	0.76	-174	3.62	78	0.064	28	0.24	-79
		1000	0.76	179	2.58	69	0.071	30	0.24	-88
		1500	0.77	168	1.72	55	0.085	31	0.31	-104
	25	100	0.67	-120	27.10	122	0.027	42	0.57	-68
		300	0.73	-163	10.27	97	0.035	36	0.27	-110
		500	0.76	-174	6.21	86	0.043	39	0.22	-124
		700	0.77	-179	4.48	78	0.051	41	0.20	-132
		1000	0.77	175	3.19	71	0.062	43	0.20	-139
		1500	0.78	166	2.13	59	0.080	42	0.25	-142
	50	100	0.68	-137	31.53	116	0.020	37	0.49	-85
		300	0.74	-169	11.17	95	0.028	40	0.27	-131
		500	0.77	-177	6.69	85	0.037	46	0.24	-144
		700	0.77	178	4.82	78	0.047	48	0.23	-152
		1000	0.77	173	3.42	71	0.059	50	0.23	-158
		1500	0.79	165	2.30	61	0.078	47	0.27	-159

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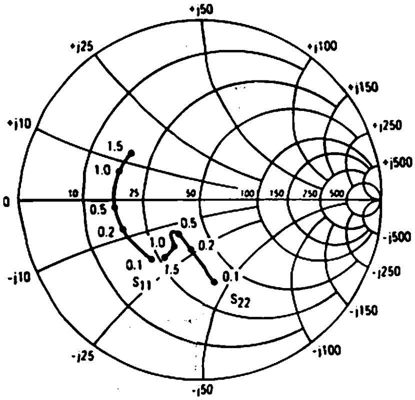
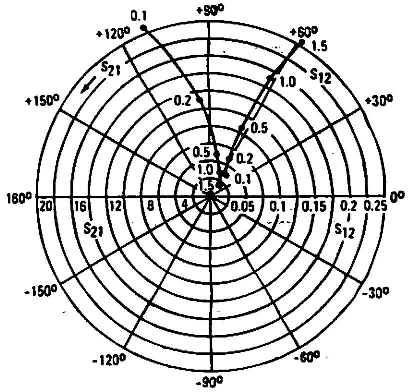
MRF965 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)

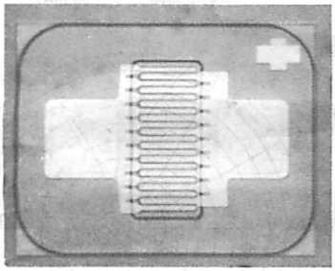


FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 50 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} $\angle\phi$	S_{21} $\|S_{21}\|$	S_{21} $\angle\phi$	S_{12} $\|S_{12}\|$	S_{12} $\angle\phi$	S_{22} $\|S_{22}\|$	S_{22} $\angle\phi$
5.0	10	100	0.56	-102	13.87	121	0.054	48	0.58	-62
		300	0.57	-158	5.47	90	0.084	46	0.32	-94
		500	0.56	-169	3.40	77	0.110	52	0.27	-106
		700	0.52	178	2.53	69	0.136	54	0.39	-115
		1000	0.55	167	1.79	57	0.181	56	0.35	-112
		1500	0.54	150	1.27	42	0.242	57	0.43	-122
	25	100	0.48	-129	17.61	112	0.041	51	0.47	-85
		300	0.55	-169	6.38	89	0.076	57	0.30	-125
		500	0.54	-176	3.97	77	0.111	62	0.27	-138
		700	0.50	172	2.94	71	0.114	61	0.30	-143
		1000	0.53	162	2.08	61	0.198	60	0.32	-135
		1500	0.50	146	1.50	47	0.267	57	0.37	-140
	50	100	0.47	-144	19.34	107	0.035	56	0.42	-100
		300	0.55	-173	6.72	87	0.073	63	0.31	-138
		500	0.53	-179	4.17	77	0.112	66	0.29	-150
		700	0.50	168	3.10	71	0.147	64	0.33	-153
		1000	0.53	159	2.19	62	0.206	61	0.32	-146
		1500	0.50	143	1.59	49	0.277	58	0.36	-149
10	10	100	0.56	-92	14.67	123	0.047	50	0.63	-50
		300	0.53	-152	6.00	92	0.077	47	0.34	-73
		500	0.53	-165	3.74	78	0.100	53	0.29	-82
		700	0.49	-177	2.76	70	0.124	56	0.31	-93
		1000	0.52	170	1.96	57	0.166	58	0.38	-94
		1500	0.51	153	1.36	42	0.221	59	0.46	-108
	25	100	0.46	-117	19.10	115	0.036	53	0.49	-68
		300	0.50	-164	7.09	90	0.071	57	0.26	-99
		500	0.49	-172	4.39	78	0.102	62	0.23	-110
		700	0.45	175	3.25	71	0.133	61	0.25	-119
		1000	0.49	164	2.28	60	0.181	61	0.30	-112
		1500	0.47	148	1.61	46	0.246	59	0.37	-120
	50	100	0.42	-131	20.99	110	0.033	56	0.41	-79
		300	0.49	-169	7.46	88	0.069	62	0.24	-111
		500	0.48	-175	4.63	78	0.103	65	0.21	-123
		700	0.45	172	3.40	71	0.136	64	0.25	-129
		1000	0.48	162	2.39	61	0.188	62	0.29	-119
		1500	0.45	146	1.70	48	0.251	59	0.35	-126

BFRC96 CHIP TOPOGRAPHY



Nominal Chip Size: 0.014″ X 0.016″ X 0.005″
Front Metalization: Gold
Back Metalization: Gold
Emitter/Base Bond Pad: 2.8 mil Dia.
#Emitter Fingers: 10
#Base Fingers: 11
Emitter Diffusion: Ion-Implanted Arsenic

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFW92A

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

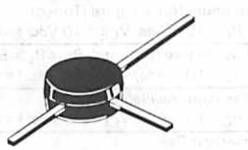
. . . designed primarily for use in MATV/CATV amplifiers and other broadband linear applications demanding high power gain with low noise over a wide current range.

- High Power Gain —
  MAG = 16 dB (Typ) @ f = 0.5 GHz
- Low Noise Figure —
  NF = 2.7 dB (Typ) @ f = 0.5 GHz
- Ion-Implanted Arsenic Emitters
- Gold Top Metal
- Silicon Nitride Passivation
- *Industry Standard Plastic Macro-T Package*
- Compatible with Other BFW92 Types

f_T = 4.5 GHz @ 10 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON



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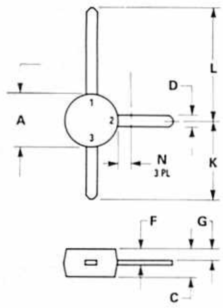
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	35	mAdc
Total Device Dissipation @ T_C = 105°C Derate Above 105°C	P_D	180 4.0	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to 150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance Junction to Case (2)	$R_{\theta JC}$	250	°C/W

Note: Case temperature measured on collector lead immediately adjacent to body of package



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01

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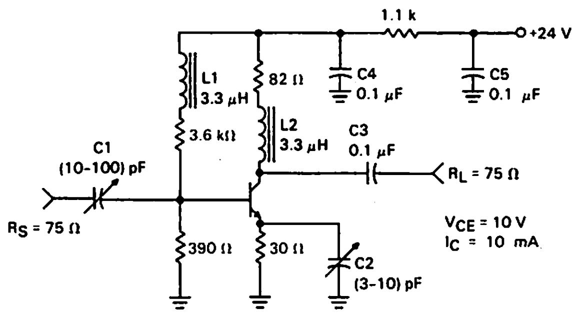
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, f = 1.0 MHz, Emitter Guarded)	C_{cb}	—	0.5	1.0	pF
FUNCTIONAL PERFORMANCE					
Optimum Noise Figure (Tuned) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF_{opt}	—	2.7	—	dB
Noise Figure (Untuned, R_S = R_L = 50 Ω) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	NF	—	3.0	—	dB
Maximum Available Gain (1) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MAG	—	16	—	dB
Insertion Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	$\|S_{21}\|^2$	—	14	—	dB

(1) $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 — 30-900 MHz BROADBAND AMPLIFIER



C3, C4, C5 — 0.1 μF Chip Capacitor
L1, L2 — 3.3 μH Molded Inductor

All Resistors 1/4 W, 20%

FIGURE 2 — BROADBAND GAIN (Circuit Figure 1)

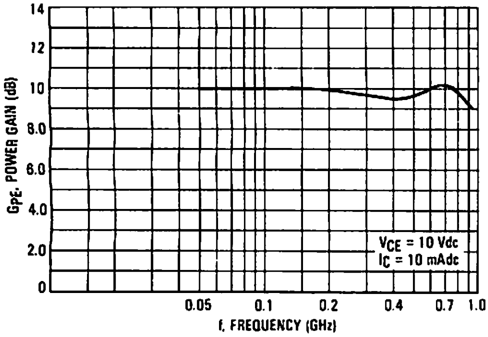


FIGURE 3 — 2nd AND 3rd ORDER INTERCEPT POINTS

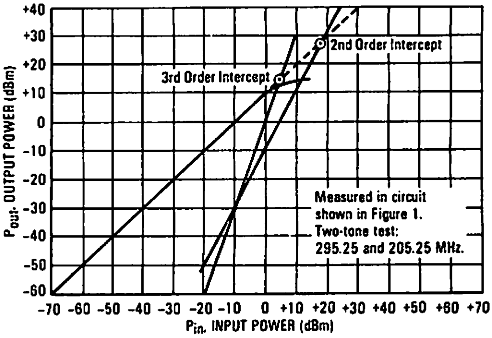


FIGURE 4 — MAXIMUM AVAILABLE GAIN versus FREQUENCY

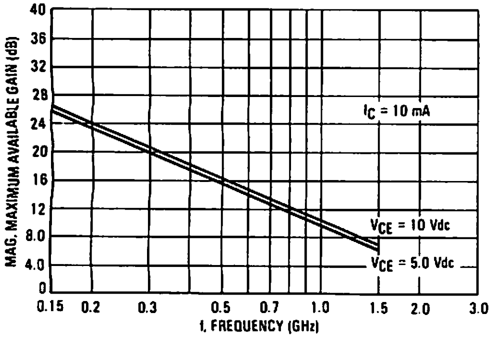


FIGURE 5 — $|S_{21}|^2$ versus FREQUENCY

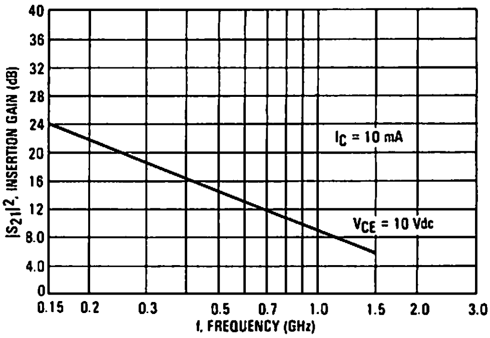


FIGURE 6 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

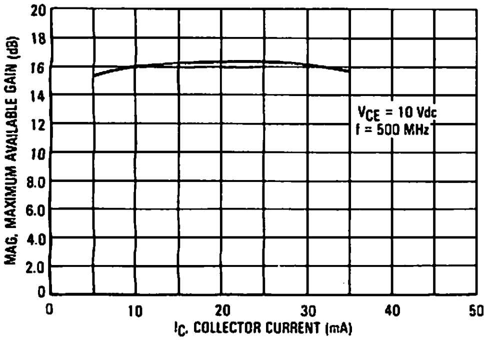


FIGURE 7 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

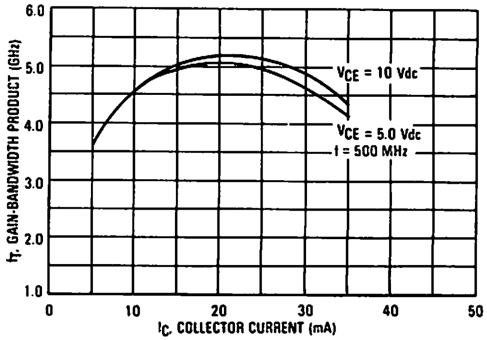


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FIGURE 8 — NOISE FIGURE versus COLLECTOR CURRENT

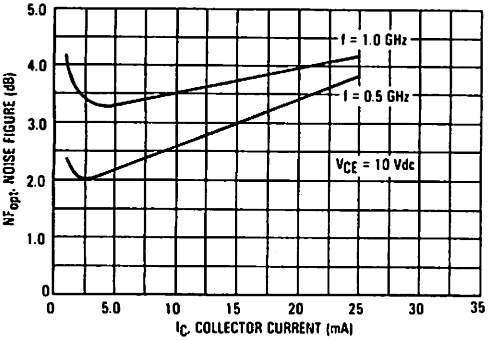


FIGURE 9 — NOISE FIGURE versus COLLECTOR CURRENT Untuned, $R_S = R_L = 50\ \Omega$

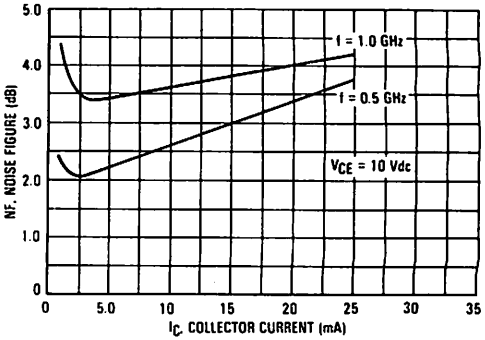


FIGURE 10 — NOISE FIGURE versus FREQUENCY

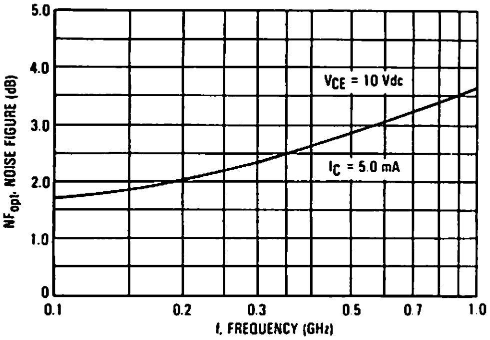


FIGURE 11 — NOISE FIGURE versus FREQUENCY Untuned $R_S = R_L = 50\ \Omega$

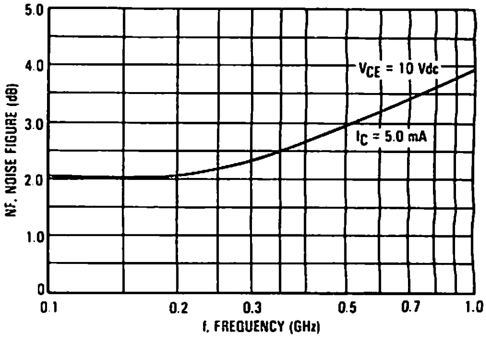


FIGURE 12 — C_{ib} INPUT CAPACITANCE versus EMITTER BASE VOLTAGE

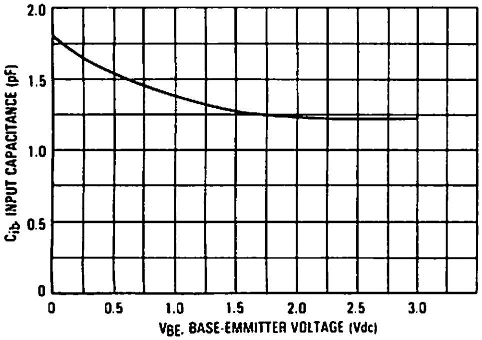
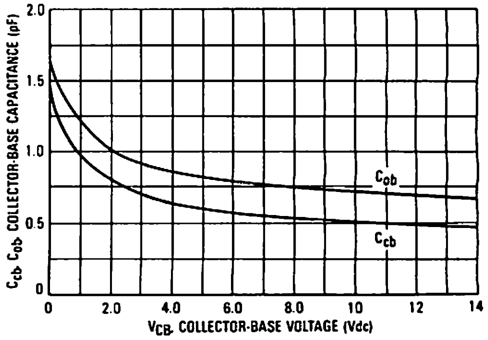
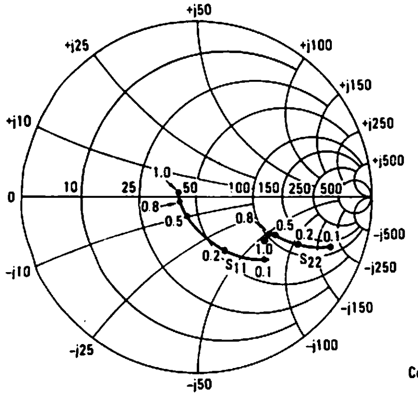


FIGURE 13 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

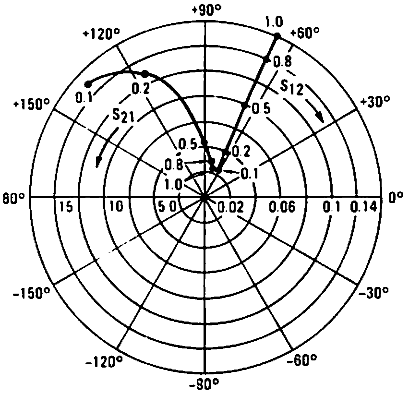


BFW92A COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 10 mA)



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 10 mA)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\lvert S_{11}\rvert$	S_{11} $\angle\phi$	S_{21} $\lvert S_{21}\rvert$	S_{21} $\angle\phi$	S_{12} $\lvert S_{12}\rvert$	S_{12} $\angle\phi$	S_{22} $\lvert S_{22}\rvert$	S_{22} $\angle\phi$
5.0	5.0	100	0.71	-33	11.2	145	0.031	69	0.87	-18
		200	0.49	-60	8.6	122	0.052	62	0.70	-26
		500	0.21	-119	4.5	92	0.094	61	0.48	-30
		800	0.17	-161	3.0	78	0.137	60	0.44	-36
		1000	0.16	176	2.5	71	0.164	60	0.44	-40
	10	100	0.52	-46	16.6	135	0.027	67	0.78	-23
		200	0.31	-75	11.2	113	0.044	65	0.58	-29
		500	0.14	-150	5.2	88	0.089	67	0.40	-29
		800	0.15	173	3.3	76	0.135	65	0.37	-34
		1000	0.16	154	2.8	70	0.164	64	0.37	-38
	15	100	0.40	-55	19.7	129	0.025	69	0.72	-26
		200	0.22	-88	12.1	109	0.041	68	0.52	-29
		500	0.14	-170	5.4	86	0.087	70	0.36	-27
		800	0.16	161	3.5	76	0.134	68	0.34	-33
		1000	0.17	145	2.9	69	0.164	66	0.35	-37
	20	100	0.33	-62	21.1	125	0.023	69	0.68	-27
		200	0.18	-99	12.5	106	0.039	69	0.49	-28
		500	0.14	178	5.5	85	0.086	72	0.35	-26
		800	0.17	155	3.5	75	0.133	69	0.33	-32
		1000	0.18	142	2.9	69	0.164	67	0.34	-37
	25	100	0.27	-69	21.9	122	0.022	70	0.65	-27
		200	0.15	-111	12.7	104	0.038	71	0.47	-27
		500	0.16	172	5.5	85	0.085	73	0.35	-25
		800	0.19	153	3.5	75	0.132	70	0.33	-31
		1000	0.20	140	2.9	69	0.163	68	0.33	-36
10	5.0	100	0.73	-30	11.1	146	0.026	71	0.90	-14
		200	0.53	-52	8.8	124	0.044	63	0.75	-21
		500	0.21	-98	4.7	94	0.082	62	0.57	-25
		800	0.14	-136	3.1	80	0.120	62	0.53	-30
		1000	0.11	-161	2.6	73	0.143	62	0.53	-34
	10	100	0.57	-39	16.7	137	0.023	70	0.82	-18
		200	0.35	-62	11.5	115	0.038	66	0.65	-23
		500	0.12	-117	5.4	89	0.078	69	0.50	-23
		800	0.09	-163	3.5	78	0.118	67	0.47	-28
		1000	0.09	168	2.9	71	0.144	66	0.48	-32
	15	100	0.46	-46	19.9	130	0.021	70	0.77	-20
		200	0.26	-68	12.6	110	0.035	68	0.60	-22
		500	0.09	-137	5.6	87	0.076	71	0.47	-21
		800	0.09	177	3.7	77	0.117	69	0.45	-27
		1000	0.10	153	3.0	71	0.143	68	0.46	-31
	20	100	0.39	-50	21.5	126	0.020	70	0.74	-21
		200	0.21	-73	13.0	107	0.034	71	0.58	-21
		500	0.08	-154	5.7	86	0.075	72	0.46	-20
		800	0.10	168	3.7	76	0.117	70	0.45	-27
		1000	0.11	148	3.0	71	0.142	69	0.45	-31
	25	100	0.34	-54	22.3	123	0.019	70	0.71	-20
		200	0.17	-79	13.0	105	0.033	71	0.57	-20
		500	0.08	-166	5.7	86	0.075	73	0.47	-19
		800	0.11	162	3.7	76	0.116	70	0.45	-26
		1000	0.13	144	3.0	70	0.141	69	0.46	-30

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BFX89
BFY90

The RF Line

2

NPN SILICON HIGH-FREQUENCY TRANSISTORS

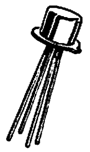
. . . designed for VHF and UHF applications where high-gain, low-noise and good intermodulation characteristics are required. Particularly suited for wideband MATV amplifiers.

- High Current-Gain — Bandwidth Product — f_T
  1.2 GHz (Min) @ I_C = 25 mAdc — BFX89
  1.3 GHz (Min) @ I_C = 25 mAdc — BFY90
- Low Noise Figure — NF
  6.5 dB (Max) @ f = 500 MHz — BFX89
  5.0 dB (Max) @ f = 500 MHz — BFY90
- High Power Gain — G_{pe}
  19 dB (Min) @ f = 200 MHz — BFX89
  21 dB (Typ) @ f = 200 MHz — BFY90
- JEDEC Equivalents — 2N6304, 2N6305

f_T = 2.0 GHz @ 10 mA

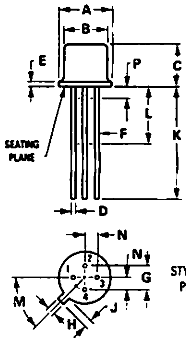
HIGH FREQUENCY TRANSISTORS

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	50	mAdc
Total Continuous Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C



STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	10	nAdc
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 2.0 mAdc, V_{CE} = 1.0 Vdc)			25	—	150	
(I_C = 25 mAdc, V_{CE} = 1.0 Vdc)			20	—	125	
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (1)	BFX89	C_{cbo}	—	0.85	1.7	pF
(V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	BFY90		—	0.85	1.5	
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	BFY90	C_{ibo}	—	—	2.0	pF
Current-Gain-Bandwidth Product (2)		f_T				GHz
(I_C = 2.0 mA, V_{CE} = 5.0 Vdc, f = 500 MHz)	BFX89		—	1.0	—	
	BFY90		1.0	—	—	
(I_C = 25 mA, V_{CE} = 5.0 Vdc, f = 500 MHz)	BFX89		1.2	1.7	—	
	BFY90		1.3	—	—	
FUNCTIONAL TEST						
Common-Emitter Amplifier Power Gain (2)	BFX89	G_{pe}	19	—	—	dB
(V_{CE} = 10 Vdc, I_C = 8.0 mA, f = 200 MHz)	BFY90		—	21	—	
Spot Noise Figure (R_S = Optimum) (2)	BFX89	NF	—	2.5	6.5	dB
(V_{CE} = 5.0 Vdc, I_C = 2.0 mA, f = 500 MHz)	BFY90		—	2.5	5.0	

Notes 1. Pin 4 is not grounded.
2. Pin 4 is grounded.
3. $G_u(max)$ is calculated from the S-Parameters using the equation $G_u(max) = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 1 — POWER GAIN versus FREQUENCY

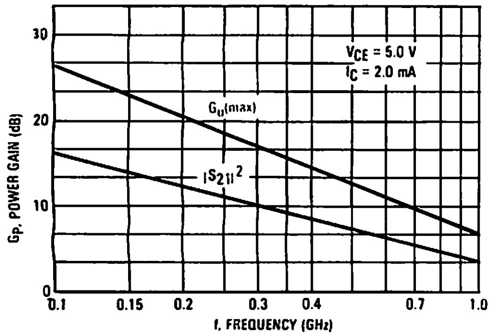


FIGURE 2 — POWER GAIN versus COLLECTOR CURRENT

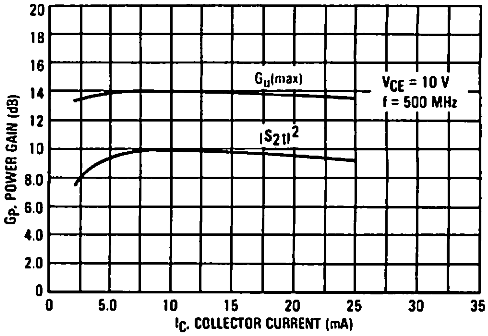


FIGURE 3 — NOISE FIGURE versus FREQUENCY

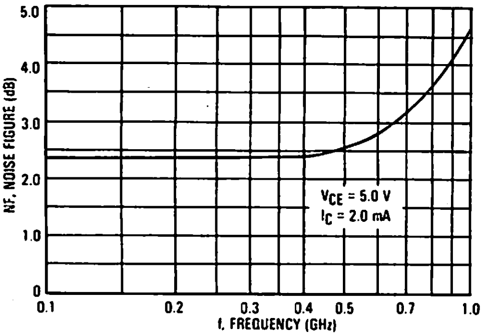


FIGURE 4 — NOISE FIGURE versus COLLECTOR CURRENT

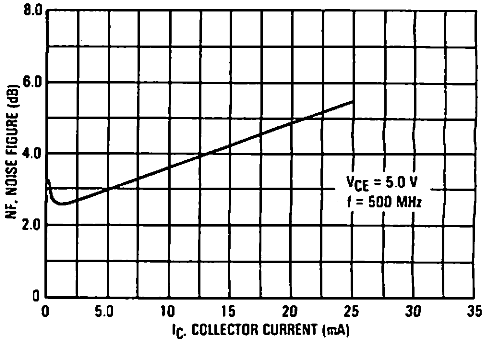


FIGURE 5 — CURRENT GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

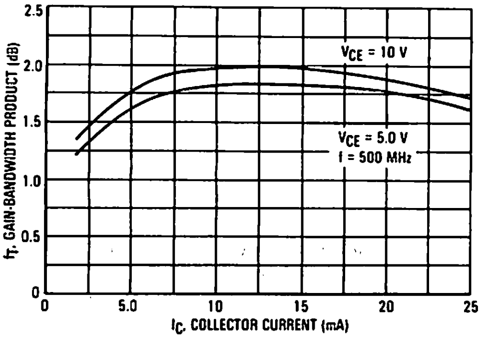
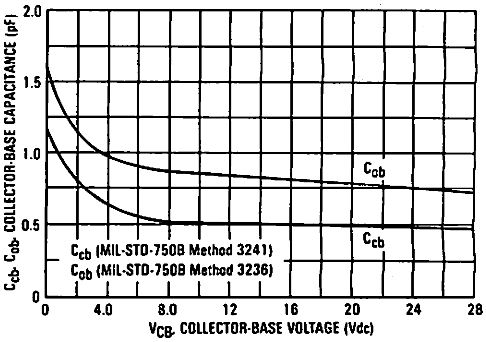
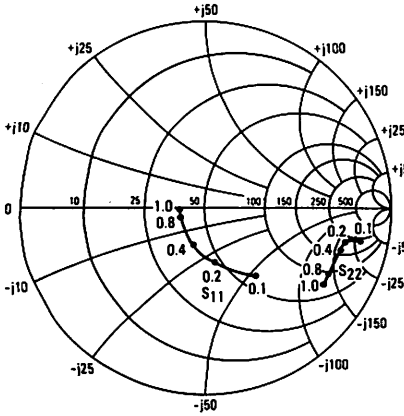


FIGURE 6 — OUTPUT CAPACITANCE versus VOLTAGE



COMMON EMITTER SCATTERING PARAMETERS

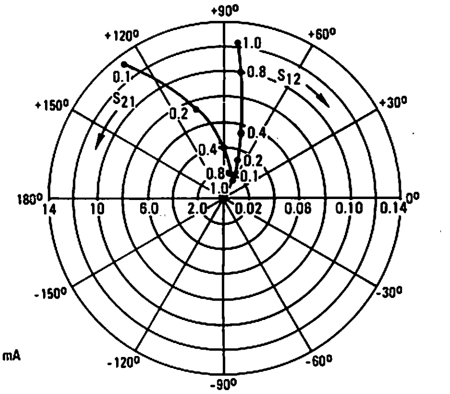
FIGURE 7 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY



Coordinates in Ohms

V_{CE} = 10 V, I_C = 10 mA

FIGURE 8 — FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



S — PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
5.0	2.0	100	0.81	-37	5.76	148	0.031	72	0.95	-11
		200	0.64	-66	4.56	127	0.050	63	0.87	-17
		400	0.41	-105	2.91	102	0.071	62	0.79	-23
		800	0.26	-157	1.63	77	0.105	74	0.75	-34
		1000	0.23	179	1.38	68	0.129	80	0.74	-41
	5.0	100	0.60	-54	9.73	133	0.026	68	0.87	-13
		200	0.41	-84	6.33	112	0.040	66	0.78	-17
		400	0.26	-121	3.54	92	0.064	72	0.73	-21
		800	0.19	-169	1.89	72	0.112	80	0.72	-31
		1000	0.17	168	1.59	64	0.140	82	0.71	-39
	10	100	0.71	-66	12.13	122	0.022	70	0.81	-14
		200	0.28	-96	7.11	104	0.036	71	0.73	-15
		400	0.19	-133	3.85	88	0.064	77	0.70	-19
		800	0.18	-178	2.00	69	0.115	83	0.71	-30
		1000	0.17	160	1.66	61	0.143	84	0.70	-37
	25	100	0.26	-88	12.79	112	0.019	73	0.76	-13
		200	0.20	-122	7.04	97	0.034	76	0.71	-13
		400	0.20	-156	3.68	83	0.062	81	0.70	-18
		800	0.23	165	1.88	65	0.114	86	0.71	-30
		1000	0.24	146	1.56	58	0.145	88	0.70	-38
10	2.0	100	0.83	-34	5.82	150	0.025	73	0.96	-9
		200	0.66	-61	4.60	129	0.042	65	0.89	-15
		400	0.42	-97	2.98	104	0.059	64	0.83	-20
		800	0.25	-147	1.69	79	0.088	77	0.80	-31
		1000	0.20	-172	1.42	70	0.108	82	0.79	-38
	5.0	100	0.63	-48	9.94	135	0.021	70	0.90	-11
		200	0.43	-76	6.54	114	0.034	68	0.82	-15
		400	0.26	-108	3.72	94	0.054	73	0.77	-19
		800	0.16	-155	1.98	74	0.095	83	0.77	-24
		1000	0.14	180	1.65	66	0.119	85	0.76	-36
	10	100	0.47	-57	12.42	125	0.019	70	0.85	-12
		200	0.30	-83	7.43	106	0.031	72	0.78	-14
		400	0.19	-113	4.04	90	0.054	78	0.75	-18
		800	0.14	-160	2.09	71	0.098	84	0.75	-28
		1000	0.13	173	1.73	64	0.121	86	0.75	-35
	25	100	0.32	-71	13.05	114	0.017	72	0.81	-11
		200	0.21	-99	7.27	99	0.029	76	0.77	-12
		400	0.16	-135	3.81	85	0.052	81	0.76	-16
		800	0.17	177	1.96	68	0.096	87	0.76	-28
		1000	0.18	154	1.62	61	0.120	89	0.76	-35

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

BT500

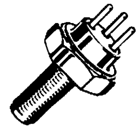
The RF Line
RF Bias Source

. . . designed for use in Class AB amplifiers to provide a thermally tracked bias source.

- Gold Metallized Die for Improved Reliability
- Hermetic Package

2

BIAS SOURCE
FOR
CLASS AB
RF DEVICES



CASE 036-03, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Forward Voltage (I_E = 500 mA)	V_f	1	—	1.3	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	100	—

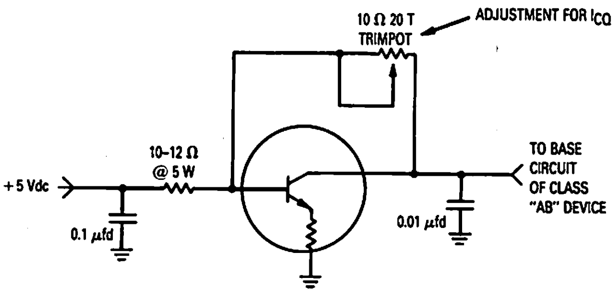


Figure 1. Suggested Circuit for BT500

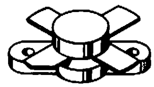
BT500F

The RF Line
RF Bias Source

. . . designed for use in Class AB amplifiers to provide a thermally tracked bias source.

- Gold Metallized Die for Improved Reliability
- Isolated SOE Style Package

BIAS SOURCE FOR CLASS AB RF DEVICES



.380 SOE F
CASE 211-07, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Forward Voltage (I_E = 500 mA)	V_f	1	—	1.3	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	100	—

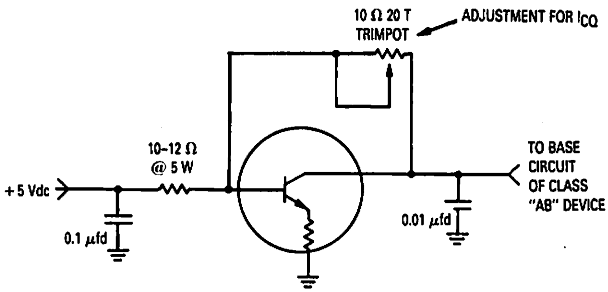


Figure 1. Suggested Circuit for BT500F

CD6150 (See LT4217)

2

JO2015A

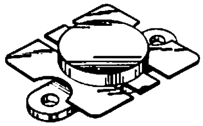
The RF Line

UHF Power Transistor

The JO2015A is an internally matched NPN silicon UHF power transistor. Its multicell design allows optimum heat dissipation and operating efficiency. A slotted-grid finger structure assures uniform current injection. Ruggedability and long-term reliability are guaranteed by unique, diffused silicon ballasting resistors coupled with a refractory-gold passivated metallization system.

- 50 W — P_{out} (65 W — P_{sat})
- 28 V — V_{CC}
- 225–400 MHz
- Internally Matched
- Gold Metallization

50 W — 400 MHz UHF POWER TRANSISTOR



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 10 V)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	80	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 400 MHz, I_Q = 100 mA)	G_{PE}	10	—	—	dB
Collector Efficiency (V_{CE} = 28 V, I_Q = 100 mA, P_{out} = 50 W, f = 400 MHz)	η_c	55	—	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 50 W, f = 400 MHz, Load VSWR = 10:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power (V_{CE} = 28 V, f = 400 MHz, I_Q = 100 mA)	P_{sat}	65	—	—	W

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

JO3037

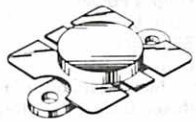
The RF Line

NPN Silicon UHF Power Transistor

37 W — 512 MHz RF POWER TRANSISTOR NPN SILICON

. . . designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics:
  - *Output Power* — 37 Watts
  - Gain — 4.9 dB, Min
  - Efficiency — 60%, Typ
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors



.500 J ZERO
CASE 316A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	83 0.48	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	10	—	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	200	—
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{in} = 12 W, f = 470 MHz)	G_{PE}	4.9	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 37 W, f = 470 MHz)	η_c	—	60	—	%
Load Mismatch (V_{CE} = 15.5 V, P_{in} = 12 W, f = 470 MHz, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

JO3501
JO3502
PTE801

2

The RF Line
NPN Silicon
UHF Power Transistors

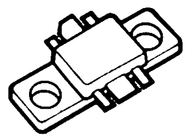
. . . designed for 24 Volt UHF large-signal applications in industrial and commercial FM equipment operating at frequencies to 960 MHz.

- Specified 24 Volt, 960 MHz Characteristics:

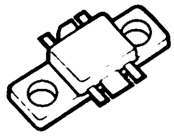
	PTE801	JO3501	JO3502
Output Power	2 W	15 W	35 W
Gain, Min	9 dB	9.2 dB	7.7 dB
Efficiency	45%	55%	55%
Configuration	C.E.	C.B.	C.B.

- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

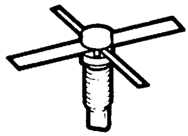
2 W, 15 W, 35 W
960 MHz
UHF POWER
TRANSISTORS
NPN SILICON



EA
CASE 828-01, STYLE 1
JO3501



EB
CASE 319C-01, STYLE 1
JO3502



.200 SOE
CASE 305B-01, STYLE 1
PTE801

MAXIMUM RATINGS

Rating	Symbol	PTE801	JO3501	JO3502	Unit
Collector-Emitter Voltage	V_{CEO}	30	20	20	Vdc
Collector-Base Voltage	V_{CES}	55	50	50	Vdc
Emitter-Base Voltage	V_{EBO}		4		Vdc
Collector Current — Continuous	I_C	0.75	2	4	Adc
Operating Junction Temperature	T_J		200		°C
Storage Temperature Range	T_{stg}		−65 to +150		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	22	4.6	2.3	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
Collector-Emitter Breakdown Voltage		$V_{(BR)CEO}$				Vdc
(I_C = 5 mA, I_B = 0)	PTE801		30	—	—	
(I_C = 5 mA, I_B = 0)	JO3501		20	—	—	
(I_C = 25 mA, I_B = 0)	JO3502		20	—	—	
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 5 mA, V_{BE} = 0)	PTE801		55	—	—	
(I_C = 25 mA, V_{BE} = 0)	JO3501		50	—	—	
(I_C = 25 mA, V_{BE} = 0)	JO3502		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 1 mA, I_C = 0)	PTE801		4	—	—	
(I_E = 5 mA, I_C = 0)	JO3501		4	—	—	
(I_E = 5 mA, I_C = 0)	JO3502		4	—	—	
Collector Cutoff Current	PTE801	I_{CES}	—	—	2	mAdc
(V_{CE} = 25 V, V_{BE} = 0)	JO3501		—	—	5	
	JO3502		—	—	10	

ON CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	PTE801		10	—	150	
(I_C = 1 A, V_{CE} = 5 V)	JO3501		10	—	100	
(I_C = 1 A, V_{CE} = 5 V)	JO3502		10	—	100	

FUNCTIONAL TESTS

Characteristic		Symbol	Min	Typ	Max	Unit
Common-Emitter Amplifier Power Gain	PTE801	G_{PE}	9	—	—	dB
(V_{CE} = 24 V, P_{out} = 2 W, f = 960 MHz)						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 24 V, P_{out} = 15 W, f = 960 MHz)	JO3501		9.2	—	—	
(V_{CE} = 24 V, P_{out} = 35 W, f = 960 MHz)	JO3502		7.7	—	—	
Collector Efficiency		η				%
(V_{CE} = 24 V, P_{out} = 2 W, f = 960 MHz)	PTE801		45	—	—	
(V_{CE} = 24 V, P_{out} = 15 W, f = 960 MHz)	JO3501		55	—	—	
(V_{CE} = 24 V, P_{out} = 35 W, f = 960 MHz)	JO3502		55	—	—	

J04036

36 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON

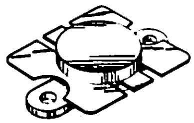
The RF Line

NPN Silicon VHF Power Transistor

2

. . . designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics:
  Output Power — 36 Watts
  Gain — 7.8 dB, Min
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors



CASE 316A-01, STYLE 1
(.500 J ZERO)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	6.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 0.57	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{in} = 6 W, f = 175 MHz)	G_{PE}	7.8	—	—	dB
Load Mismatch (V_{CE} = 15.5 V, P_{in} = 6 W, f = 175 MHz, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Return Loss (V_{CE} = 12.5 V, P_{in} = 6 W, f = 175 MHz, Circuit in Figure 7)	IRL	10	—	—	dB

TYPICAL CHARACTERISTICS

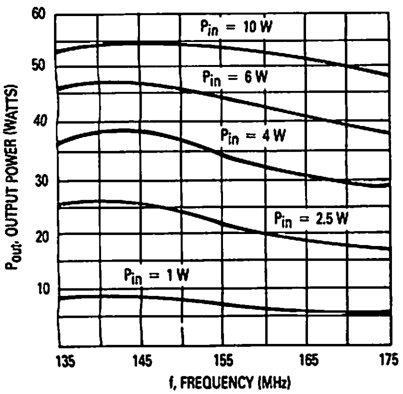


Figure 1. Output Power versus Frequency

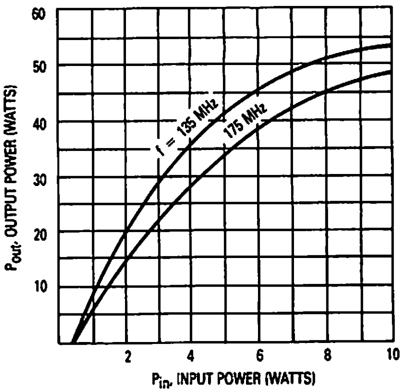


Figure 2. Output Power versus Input Power

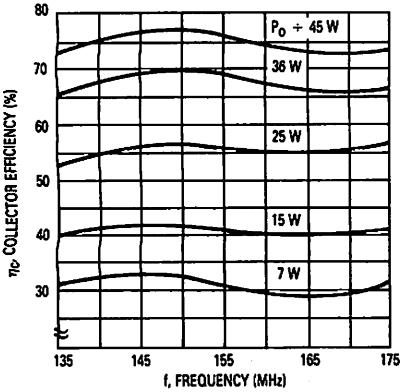


Figure 3. Collector Efficiency versus Frequency

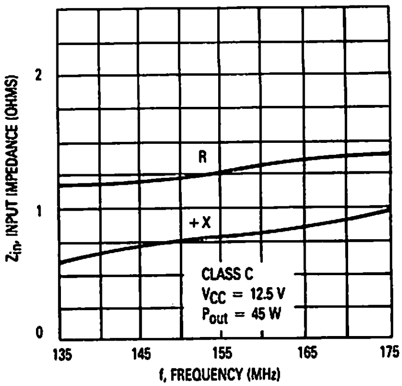


Figure 4. Series Input Impedance versus Frequency

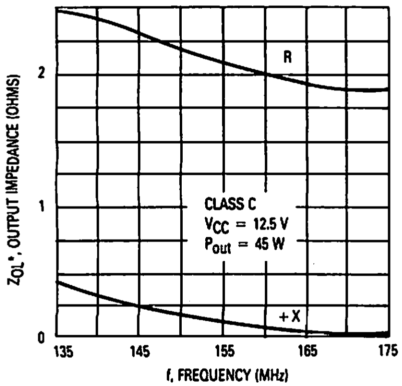


Figure 5. Series Output Impedance versus Frequency

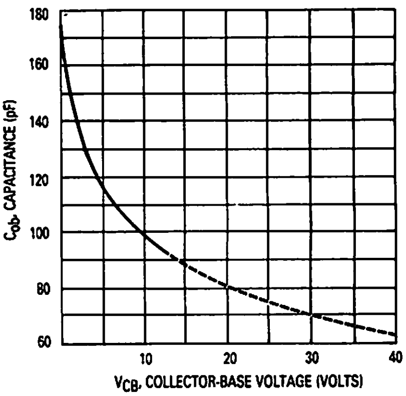
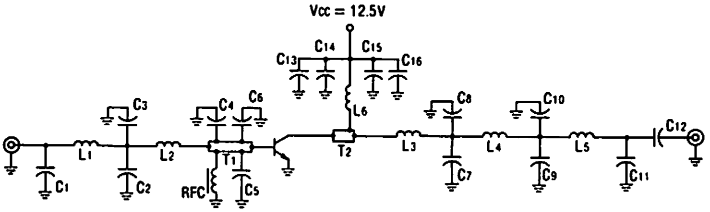


Figure 6. Output Capacitance versus Voltage

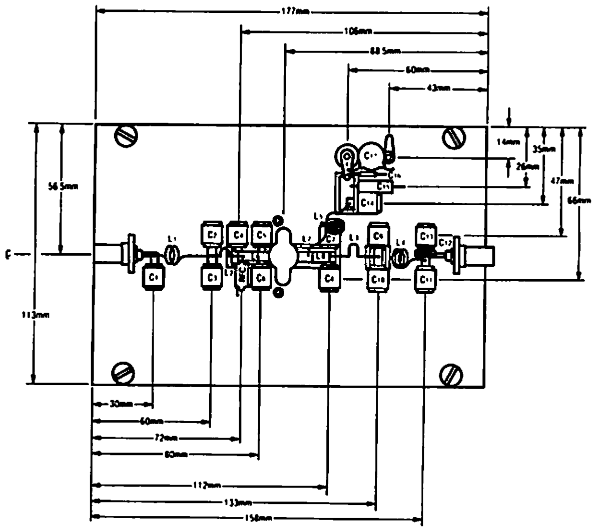


2

C1, C2 — 25 pF
C3, C4 — 80 pF
C5 — 250 pF
C6 — 200 pF
C7 — 150 pF
C8 — 100 pF
C9, C10 — 40 pF
C11 — 25 pF
C12, C13 — 1000 pF
C14 — 0.001 μF
C15 — 0.01 μF
C16 — 25 μF
L1 — 2T 18 AWG .2" dia.
L2 — .2" hairpin .125" wide x .025 thick copper strip
L3 — .1" x .2" wide x .005" thick copper loop
L4 — .3" hairpin 18 AWG
L5 — 3T 18 AWG, .2" dia.
L6 — 4T 18 AWG, .2" dia.
RFC — 2-1/2T on VK-211-07/38 ferroxcube
T1 — .2" width .5" length from package as ref.
T2 — .2" width .4" length from package as ref.

NOTES:
1. All capacitors in signal path are Underwood Electric Corp. Case Type J101.
2. Position C5 and C6 as close to pkg. as possible.

Figure 7. Broadband Test Fixture

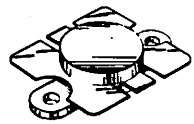


C1 — 25 pF
C2, C4 — 80 pF
C3 — 30 pF
C5 — 250 pF
C6 — 200 pF
C7 — 150 pF
C8 — 100 pF
C9, C10 — 40 pF
C11 — 10 pF
C12, C14 — 1000 pF
C13 — 15 pF
C15 — 5 μF 25 V
C16 — 0.001K Disc
C17 — 0.01 μ 1KV Disc
L1 — 2T .2" dia. 18 AWG .250" long
L2 — .2" hairpin .125" wide x .025 thick
RFC1 — 2-1/2T on VK-211-07/3B ferroxcube
L3 — .3" hairpin #18 AWG
L4 — 3T .2" dia. #10 AWG .500" long
L5 — 4T .2" dia. #18 AWG .400" long
L6 — .5" x .2"
L7 — .4" x .2"
L8 — .1" x .2" wide x .005" thick
Material: .062" Epoxy Board, Copper Clad — 2 Sides

Figure 8. Test Fixture Component Layout

J04045

**45 W — 175 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 316A-01, STYLE 1
(.500 J ZERO)

The RF Line

NPN Silicon VHF Power Transistor

. . . designed primarily for 12.5 Volt wideband, large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics:
  Output Power — 45 Watts
  Gain — 6.5 dB, Min
- Internally Matched for Broadband Operation
- Tested for Load Mismatch Stress
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Collector Current — Continuous	I_C	6.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 0.57	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACATERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	200	—
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{in} = 10 W, f = 175 MHz)	G_{PE}	6.5	—	—	dB
Load Mismatch (V_{CE} = 15.5 V, P_{in} = 10 W, f = 175 MHz, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Return Loss (V_{CE} = 12.5 V, P_{in} = 10 W, f = 175 MHz, Circuit in Figure 7)	IRL	10	—	—	dB

TYPICAL CHARACTERISTICS

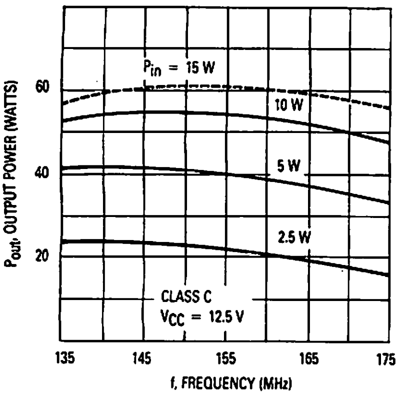


Figure 1. Output Power versus Frequency

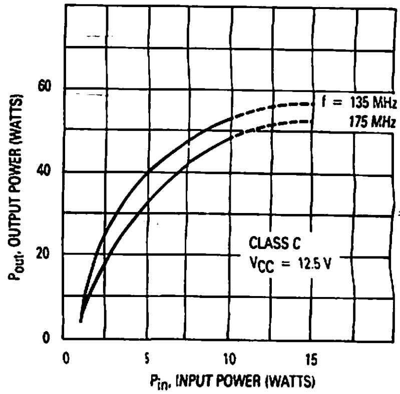


Figure 2. Output Power versus Input Power

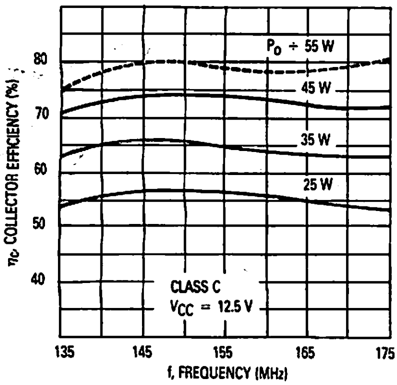


Figure 3. Broadband Collector Efficiency

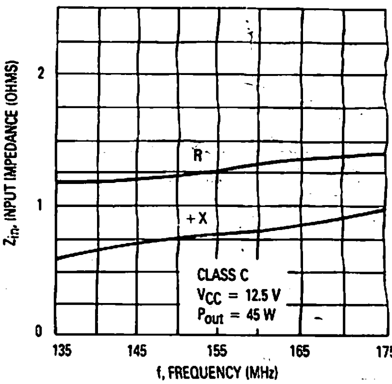


Figure 4. Series Input Impedance

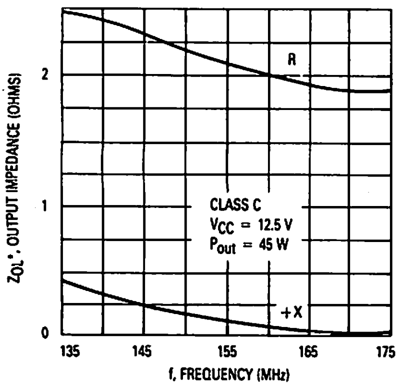


Figure 5. Series Output Impedance

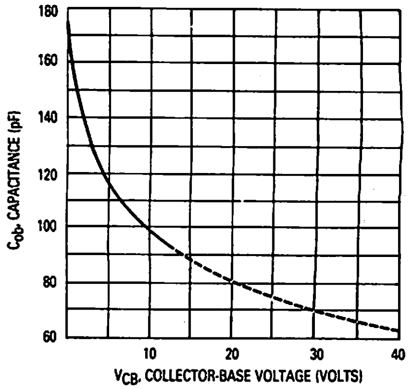
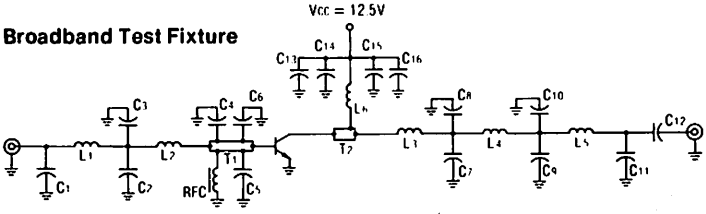


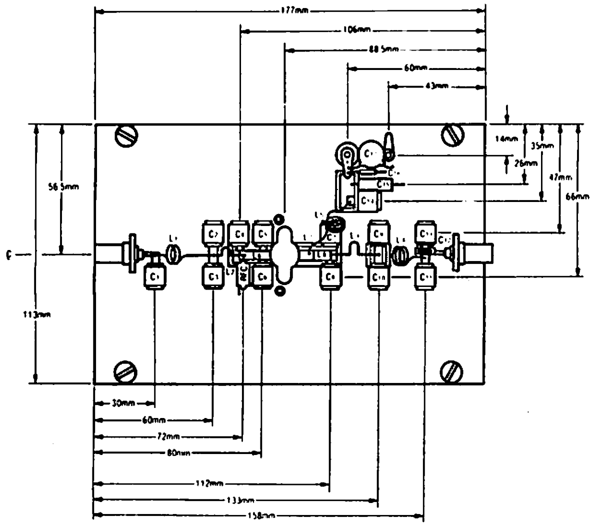
Figure 6. Output Capacitance



C1, C2 — 25 pF
C3, C4 — 80 pF
C5 — 250 pF
C6 — 200 pF
C7 — 150 pF
C8 — 100 pF
C9, C10 — 40 pF
C11 — 25 pF
C12, C13 — 1000 pF
C14 — 0.001 μF
C15 — 0.01 μF
C16 — 25 μF
L1 — 2T 18 AWG .2" dia.
L2 — .2" hairpin .125" wide x .025 thick copper strip
L3 — .1" x .2" wide x .005" thick copper loop
L4 — .3" hairpin 18 AWG
L5 — 3T 18 AWG, .2" dia.
L6 — 4T 18 AWG, .2" dia.
RFC — 2-1/2T on VK-211-07/38 ferroxcube
T1 — .2" width .5" length from package as ref.
T2 — .2" width .4" length from package as ref.

NOTES:
1. All capacitors in signal path are Underwood Electric Corp. Case Type J101.
2. Position C5 and C6 as close to pkg. as possible.

Figure 7. Broadband Test Fixture



C1 — 25 pF
C2, C4 — 80 pF
C3 — 30 pF
C5 — 250 pF
C6 — 200 pF
C7 — 150 pF
C8 — 100 pF
C9, C10 — 40 pF
C11 — 10 pF
C12, C14 — 1000 pF
C13 — 15 pF
C15 — 5 μF 25 V
C16 — 0.001K Disc
C17 — 0.01 μ 1KV Disc
L1 — 2T .2" dia. 18 AWG .250" long
L2 — .2" hairpin .125" wide x .025 thick
RFC1 — 2-1/2T on VK-211-07/3B ferroxcube
L3 — .3" hairpin #18 AWG
L4 — 3T .2" dia. #10 AWG .500" long
L5 — 4T .2" dia. #18 AWG .400" long
L6 — .5" x .2"
L7 — .4" x .2"
L8 — .1" x .2" wide x .005" thick
Material: .062" Epoxy Board, Copper Clad — 2 Sides

Figure 8. Test Fixture Component Layout

2

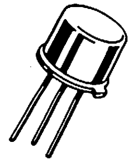
LT1001A

The RF Line
NPN Silicon
High Frequency Transistor

I_C = 200 mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON

. . . designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.5 dB Typ @ f = 300 MHz
- High Gain — $|S_{21}|^2$ Typ = 13.5 dB @ f = 300 MHz
- Low Distortion — ITO = 45 dBm Typ @ f = 300 MHz
- Gold Metallization
- Diffused Ballast Resistors



CASE 79-04, STYLE 1
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	50	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	$V_{CE(sat)}$	—	500	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	1.6	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	3	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	GU_{MAX}	—	15	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$\|S_{21}\|^2$	—	13.5	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$P_{o1\,dB}$	—	26	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	ITO	—	45	—	dBm

TYPICAL CHARACTERISTICS

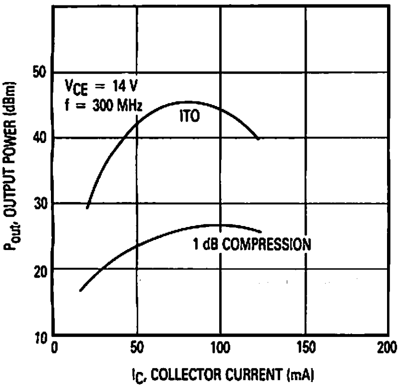


Figure 1. Third Order Intercept and 1 dB Compression versus Current

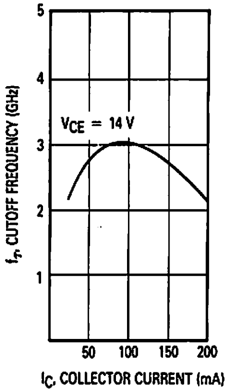


Figure 2. Gain-Bandwidth Product versus Collector Current

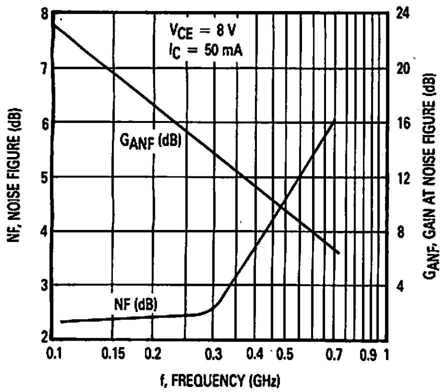


Figure 3. Noise Figure and Associated Gain versus Frequency

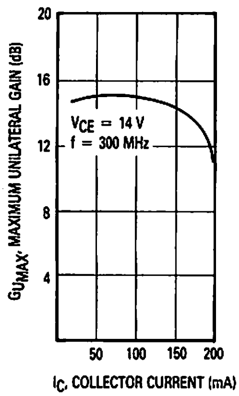


Figure 4. GU_{MAX} versus Collector Current

2

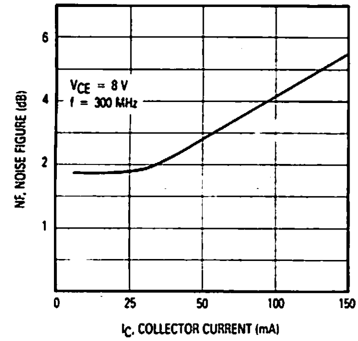


Figure 5. Noise Figure versus Collector Current

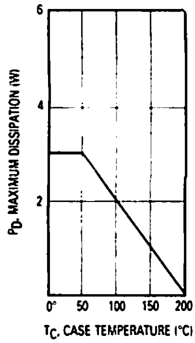


Figure 6. Dissipation versus Temperature

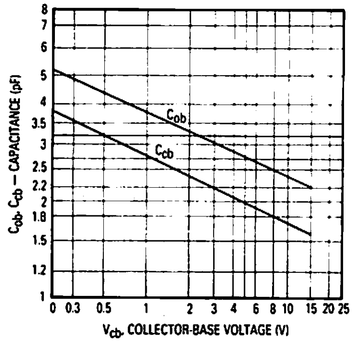


Figure 7. Junction Capacitance versus Voltage

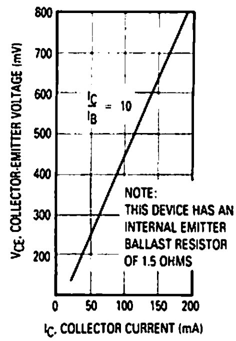


Figure 8. Collector Saturation Characteristics

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
8	50	0.1	0.44	−132	12.52	101	0.05	59	0.44	−78
		0.2	0.35	−168	6.32	85	0.08	66	0.26	−86
		0.3	0.35	175	4.31	76	0.12	69	0.23	−94
		0.4	0.36	161	3.28	68	0.15	70	0.23	−103
		0.5	.036	146	2.67	61	0.19	70	0.24	−110
		0.6	0.37	136	2.28	55	0.23	69	0.26	−120
		0.7	0.37	124	2.02	50	0.27	68	0.29	−127
		0.8	0.36	114	1.81	44	0.3	66	0.32	−136
		0.9	0.36	105	1.64	39	0.34	65	0.34	−144
		1	0.35	94	1.52	35	0.38	63	0.65	−152
14	90	0.1	0.41	−127	13.58	103	0.04	58	0.46	−48
		0.2	0.38	−158	7.14	86	0.06	63	0.38	−57
		0.3	0.39	−173	4.85	76	0.08	66	0.39	−66
		0.4	0.38	−178	3.65	67	0.1	67	0.42	−75
		0.5	0.39	174	3.02	61	0.13	70	0.43	−79
		0.6	0.39	168	2.54	56	0.15	71	0.46	−85
		0.7	0.39	161	2.2	49	0.17	70	0.49	−92
		0.8	0.39	156	1.91	44	0.19	71	0.53	−96
		0.9	0.39	150	1.69	38	0.22	70	0.57	−102
		1	0.4	144	1.53	34	0.24	70	0.59	−105

Figure 9. Common Emitter S-Parameters

LT1814

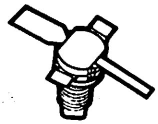
The RF Line

NPN Silicon High Frequency Transistor

... specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CEO}$ = 120 V Min
- High Cutoff Frequency — f_T = 1000 MHz Min
- Low Output Capacitance — C_{cb} = 2.5 pF Max @ V_{CB} = 15 V
- Gold Metallization
- *Hermetic SOE Package*

**f_T = 1000 MHz MIN
HIGH FREQUENCY TRANSISTOR
NPN SILICON**



**CASE 401-01, STYLE 2
(GP-14)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	400	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CE} = 80 V, V_{BE} = 0)	I_{CES}	—	—	100	μAdc
Collector Cutoff Current (V_{CB} = 80 V, I_E = 0)	I_{CBO}	—	—	20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	$V_{CE(sat)}$	—	—	800	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{cb}	—	—	4	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = 15 V, I_C = 50 mA, f = 250 MHz)	f_T	1	—	—	GHz
Insertion Gain (V_{CE} = 10 V, I_C = 50 mA, f = 200 MHz)	$\|S_{21}\|^2$	15	—	—	dB
Maximum Oscillation Frequency (V_{CE} = 10 V, I_C = 80 mA, f = 200 MHz)	f_{MAX}	2	—	—	GHz

TYPICAL CHARACTERISTICS

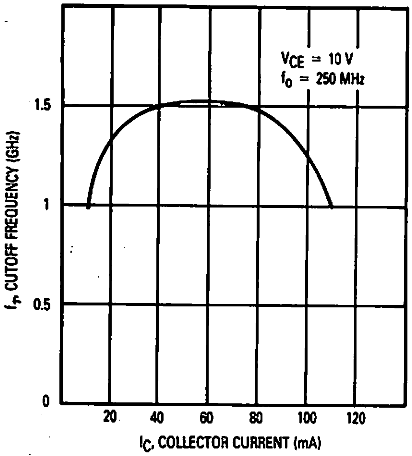


Figure 1. Gain Bandwidth Product versus Collector Current

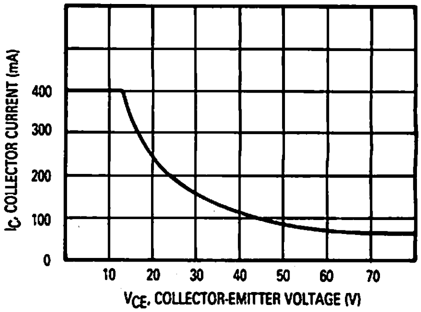


Figure 2. Safe Operating Area

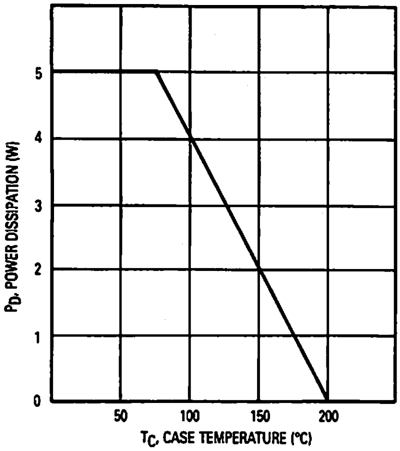


Figure 3. Power Dissipation versus Temperature

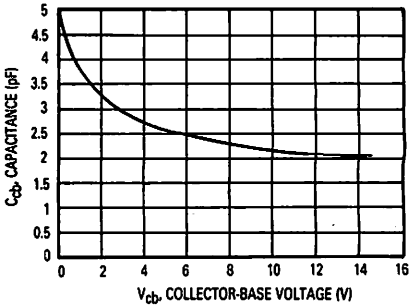


Figure 4. Junction Capacitance versus Voltage

LT1817

2

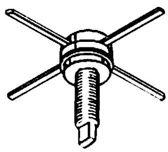
The RF Line

NPN Silicon High Frequency Transistor

. . . specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CBO}$ = 120 V Min
- *High Cutoff Frequency — f_T = 1000 MHz Min*
- Low Output Capacitance — C_{cb} = 2.5 pF Max @ V_{CB} = 15 V
- Gold Metallization
- *Common Base Configuration*

**f_T = 1000 MHz MIN
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 244D-01, STYLE 2
(TO-117A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	400	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 80 V, I_E = 0)	I_{CBO}	—	—	20	μAdc
Collector Cutoff Current (V_{CE} = 80 V, V_{BE} = 0)	I_{CES}	—	—	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	$V_{CE(sat)}$	—	—	800	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{cb}	—	—	2.5	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = 15 V, I_C = 50 mA, f = 200 MHz)	f_T	1	—	—	GHz
Insertion Gain (V_{CE} = 10 V, I_C = 50 mA, f = 200 MHz)	$\|S_{21}\|^2$	15	—	—	dB

2

TYPICAL CHARACTERISTICS

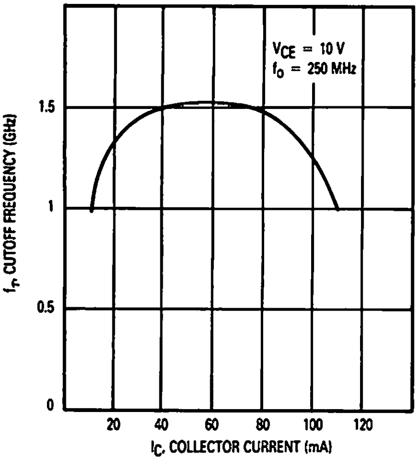


Figure 1. Gain Bandwidth Product versus Collector Current

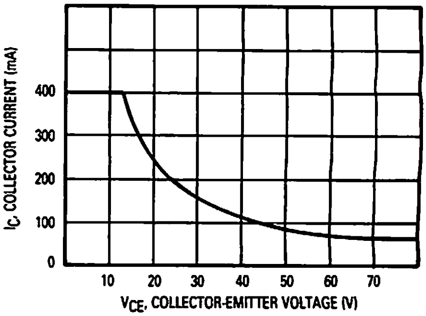


Figure 2. Safe Operating Area

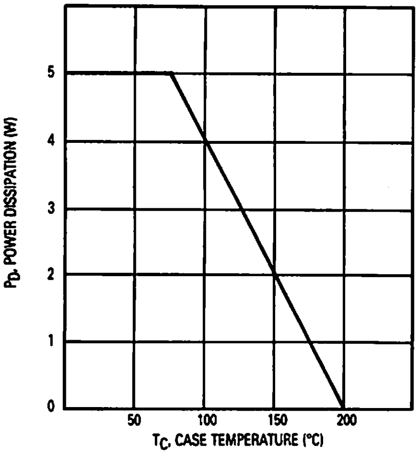


Figure 3. Power Dissipation versus Temperature

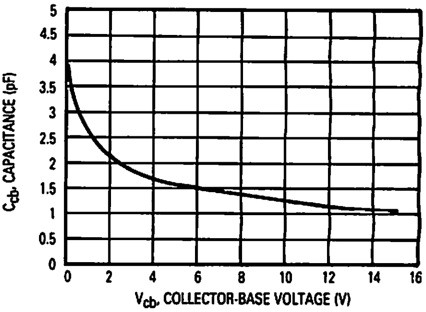


Figure 4. Junction Capacitance versus Voltage

LT1839

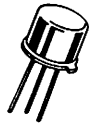
The RF Line

NPN Silicon High Frequency Transistor

. . . specifically designed for CRT driver applications requiring high frequency and high voltage, such as high resolution color graphics video monitors.

- High Voltage — $V_{(BR)CBO}$ = 120 V Min
- High Cutoff Frequency — f_T = 1000 MHz Min
- Low Output Capacitance — C_{cb} = 2.5 pF Max @ V_{CB} = 15 V
- Gold Metallization

**f_T = 1000 MHz MIN
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 79-04, STYLE 1
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	300	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 80 V, I_E = 0)	I_{CBO}	—	—	20	µAdc
Collector Cutoff Current (V_{CE} = 80 V, V_{BE} = 0)	I_{CES}	—	—	100	µAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_B = 5 mA)	$V_{CE(sat)}$	—	—	800	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{cb}	—	—	2.5	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = 10 V, I_C = 80 mA, f = 250 MHz)	f_T	1	—	—	GHz
Insertion Gain (V_{CE} = 10 V, I_C = 50 mA, f = 200 MHz)	$\|S_{21}\|^2$	13	—	—	dB

2

TYPICAL CHARACTERISTICS

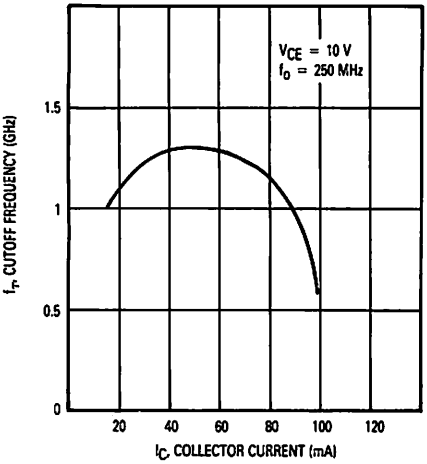


Figure 1. Gain Bandwidth Product versus Collector Current

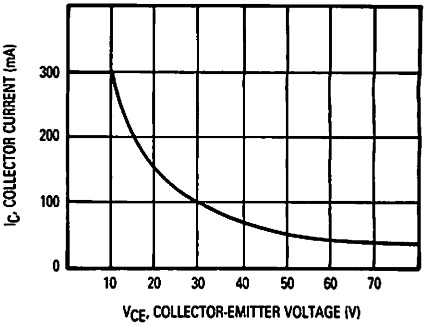


Figure 2. Safe Operating Area

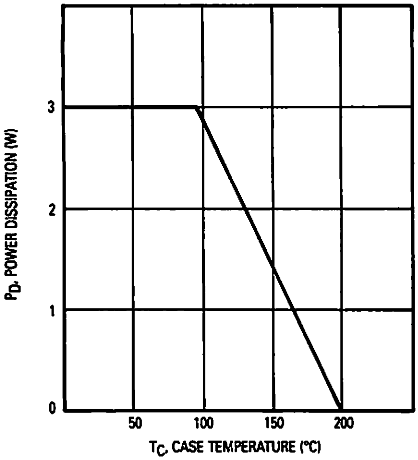


Figure 3. Power Dissipation versus Temperature

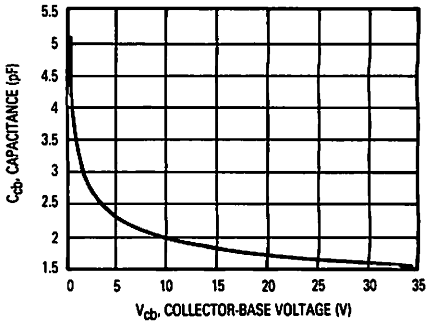


Figure 4. Junction Capacitance versus Voltage

LT2001

2

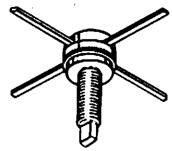
The RF Line

NPN Silicon High Frequency Transistor

I_C = 200 mA
HIGH FREQUENCY TRANSISTOR
NPN SILICON

. . . designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range.

- Low Noise — 2.5 dB Typ @ f = 300 MHz
- High Output — $P_{o1\,dB}$ = 26 dBm Typ @ f = 500 MHz
- Low Distortion — ITO_{typ} = 46 dBm @ f = 500 MHz
- Diffused Ballast Resistors



CASE 244A-01, STYLE 1
(TO-117A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	200	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	50	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_C/I_B = 10)	$V_{CE(sat)}$	—	500	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	1.2	—	pF
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	3	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	G_{UMAX}	—	14	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$\|S_{21}\|^2$	—	11.5	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$P_{o1\,dB}$	—	26	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	ITO	—	46	—	dBm

2

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
8	50	0.1	0.49	−119	15.08	114	0.03	53	0.47	−57
		0.2	0.43	−159	9.12	96	0.05	59	0.33	−58
		0.3	0.42	177	6.39	83	0.06	62	0.31	−71
		0.4	0.42	165	4.88	73	0.08	65	0.31	−76
		0.5	0.42	152	3.91	65	0.1	65	0.33	−87
		0.6	0.45	141	3.29	57	0.12	65	0.32	−98
		0.7	0.44	135	2.83	51	0.14	65	0.35	−106
		0.8	0.46	126	2.5	43	0.16	63	0.38	−126
		0.9	0.48	118	2.21	36	0.18	62	0.39	−136
		1	0.48	114	1.98	31	0.2	60	0.4	−145
14	90	0.1	0.51	−132	17.28	111	0.02	55	0.51	37
		0.2	0.49	−163	9.25	96	0.04	65	0.4	39
		0.3	0.51	−177	6.34	88	0.05	73	0.37	43
		0.4	0.52	174	4.76	83	0.06	79	0.36	50
		0.5	0.49	171	3.89	60	0.08	67	0.39	61
		0.6	0.51	166	3.27	51	0.1	65	0.41	69
		0.7	0.52	161	2.78	44	0.11	64	0.42	79
		0.8	0.53	158	2.44	36	0.13	62	0.43	87
		0.9	0.54	155	2.19	30	0.15	60	0.47	94
		1	0.54	151	1.93	22	0.16	58	0.47	104

Figure 9. Common Emitter S-Parameters

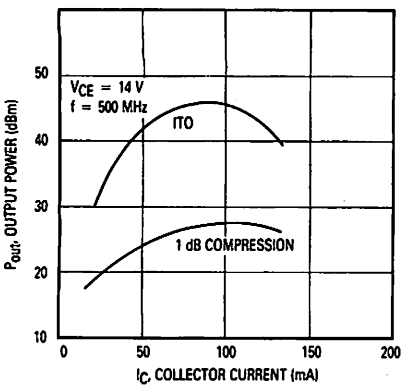


Figure 1. Third Order Intercept and 1 dB Compression versus Current

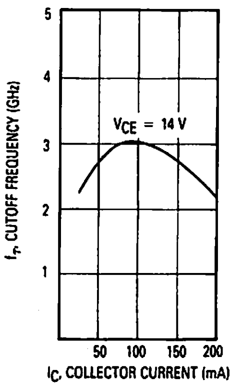


Figure 2. Gain-Bandwidth Product versus Collector Current

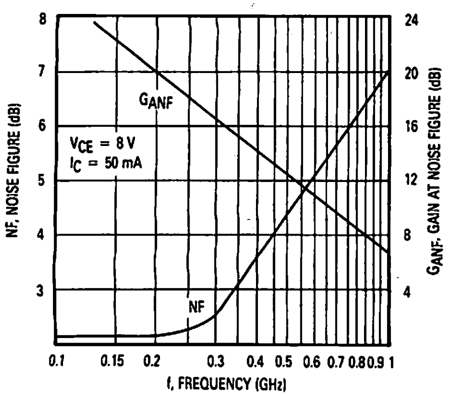


Figure 3. Noise Figure and Associated Gain versus Frequency

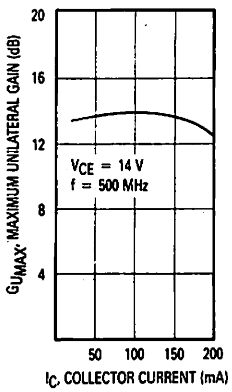


Figure 4. $G_{U_{MAX}}$ versus Collector Current

2

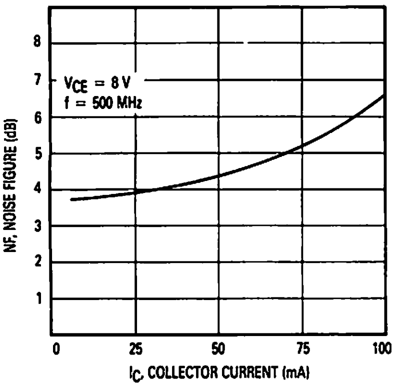


Figure 5. Noise Figure versus Collector Current

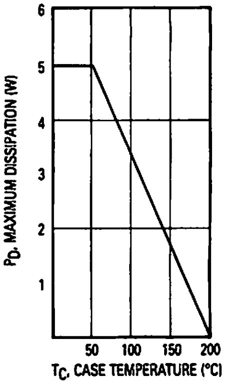


Figure 6. Dissipation versus Temperature

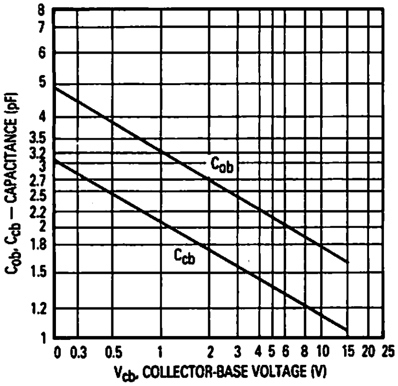


Figure 7. Junction Capacitance versus Voltage

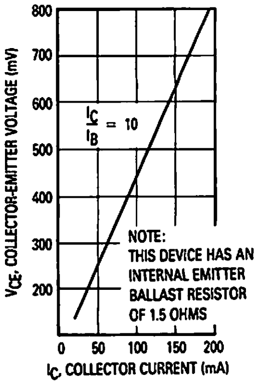


Figure 8. Collector Saturation Voltage versus Current

LT3005

2

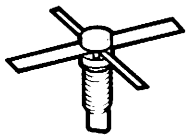
The RF Line

NPN Silicon High Frequency Transistor

I_C = 200 mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON

. . . designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.5 dB Typ @ f = 300 MHz
- High Gain — $|S_{21}|^2$ = 14 dB Typ @ f = 500 MHz
- High Output — $P_{01\ dB}$ = 26 dBm Typ @ f = 500 MHz
- Gold Metallization
- Diffused Ballast Resistors



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	50	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_C/I_B = 10)	$V_{CE(sat)}$	—	500	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	1.1	—	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	3	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	GU_{MAX}	—	18	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$\|S_{21}\|^2$	—	14	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$P_{o1\ dB}$	—	26	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	ITO	—	46	—	dBm
Maximum Oscillation Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_{MAX}	—	4	—	GHz

TYPICAL CHARACTERISTICS

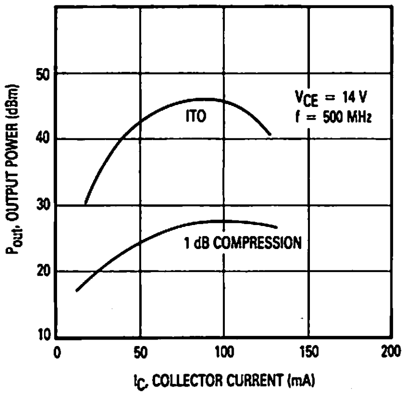


Figure 1. Third Order Intercept and 1 dB Compression versus Current

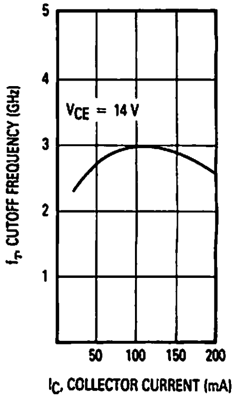


Figure 2. Gain-Bandwidth Product versus Collector Current

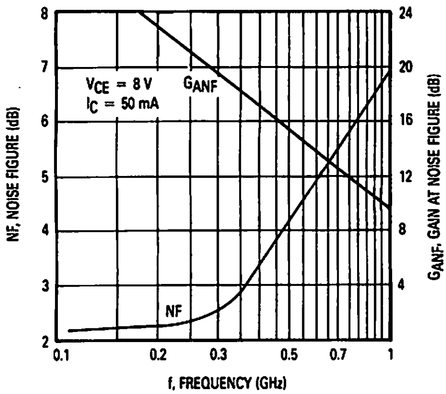


Figure 3. Noise Figure and Associated Gain versus Frequency

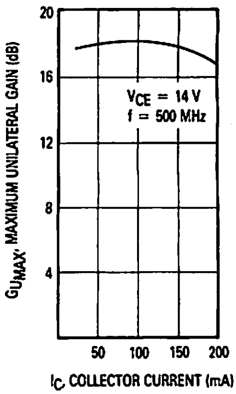


Figure 4. GU_{MAX} versus Collector Current

TYPICAL CHARACTERISTICS

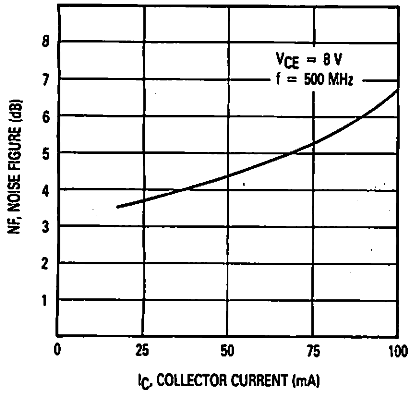


Figure 5. Noise Figure versus Collector Current

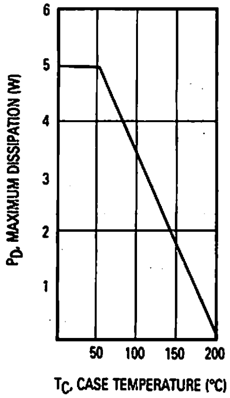


Figure 6. Dissipation versus Temperature

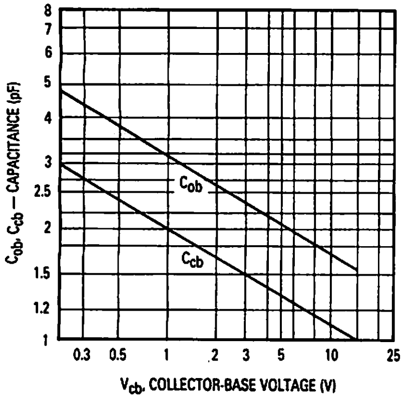


Figure 7. Junction Capacitance versus Voltage

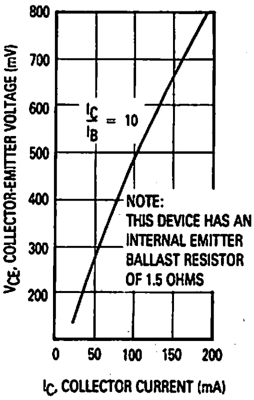


Figure 8. Collector Saturation Characteristics

LT3014

2

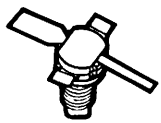
The RF Line

NPN Silicon High Frequency Transistor

I_C = 200 mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON

... designed for ultra-linear communications or instrumentation applications. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization and diffused emitter ballasting are combined to achieve the high reliability demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications. In addition, the LT3014 is hermetic, making it suitable for high reliability applications.

- High Gain — $|S_{21}|^2$ = 14 dB Typ @ f = 500 MHz
- Low Distortion — ITO = 45 dBm Typ
- High Output — $P_{o1\ dB}$ = 26 dBm Typ @ f = 500 MHz
- Hermetic Package
- Gold Metallization
- Diffused Ballast Resistors



CASE 401-01, STYLE 1
(GP-14 S)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	50	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_C/I_B = 10)	$V_{CE(sat)}$	—	500	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	1.1	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	3.1	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	3	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	GU_{MAX}	—	19	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$\lvert S_{21}\rvert^2$	—	14	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$P_{o1\ dB}$	—	26	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	ITO	—	46	—	dBm
Maximum Oscillation Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_{MAX}	—	4.5	—	GHz

TYPICAL CHARACTERISTICS

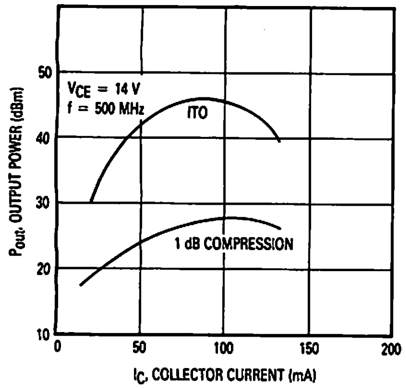


Figure 1. Third Order Intercept and 1 dB Compression versus Current

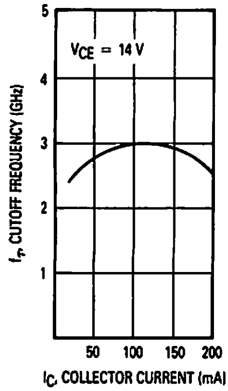


Figure 2. Gain-Bandwidth Product versus Collector Current

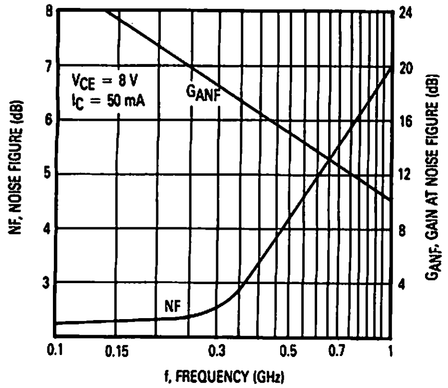


Figure 3. Noise Figure and Associated Gain versus Frequency

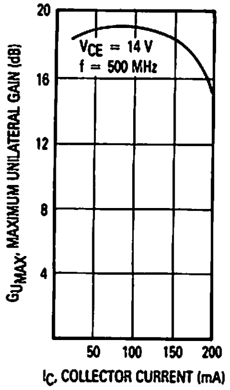


Figure 4. GU_{MAX} versus Collector Current

2

TYPICAL CHARACTERISTICS

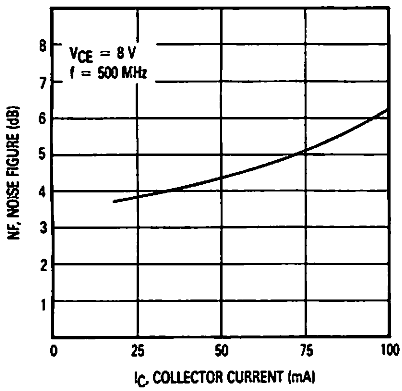


Figure 5. Noise Figure versus Collector Current

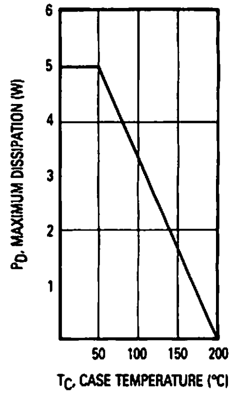


Figure 6. Dissipation versus Temperature

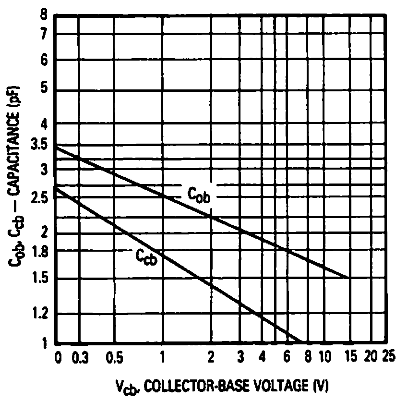


Figure 7. Junction Capacitance versus Voltage

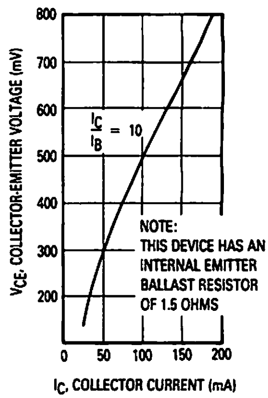


Figure 8. Collector Saturation Characteristics

2

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
8	50	0.1	0.78	−124	20.68	116	0.03	34	0.66	−71
		0.2	0.76	−158	11.31	96	0.03	25	0.37	−82
		0.3	0.77	−176	7.83	84	0.04	23	0.35	−95
		0.4	0.79	172	5.92	75	0.04	24	0.35	−101
		0.5	0.79	163	4.67	67	0.04	26	0.37	−111
		0.6	0.8	154	3.92	59	0.04	28	0.38	−121
		0.7	0.81	147	3.35	54	0.04	30	0.42	−124
		0.8	0.8	140	2.84	45	0.04	32	0.45	−142
		0.9	0.8	134	2.49	39	0.05	34	0.47	−150
		1	0.78	129	2.19	33	0.05	37	0.5	−154
14	90	0.1	0.76	−121	21.95	116	0.02	36	0.58	−46
		0.2	0.77	−151	12.27	96	0.03	26	0.42	−56
		0.3	0.78	−164	8.38	85	0.03	26	0.38	−62
		0.4	0.79	−171	6.3	77	0.03	28	0.38	−70
		0.5	0.78	−173	5.01	68	0.03	21	0.44	−75
		0.6	0.79	−178	4.14	60	0.03	21	0.47	−81
		0.7	0.79	179	3.47	53	0.03	23	0.49	−87
		0.8	0.79	176	3.02	47	0.03	25	0.51	−92
		0.9	0.8	171	2.65	37	0.04	26	0.54	−99
		1	0.8	168	2.33	31	0.04	26	0.56	−104

Figure 9. Common Emitter S-Parameters

LT3046

2

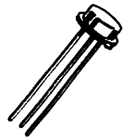
The RF Line

NPN Silicon High Frequency Transistor

I_C = 150 mA
HIGH FREQUENCY TRANSISTOR
NPN SILICON

... designed for ultra-linear communications or instrumentation applications.

- Low Noise — 2.5 dB Typ @ f = 200 MHz
- High Gain — $|S_{21}|^2$ = 15 dB Typ @ f = 300 MHz
- Low Distortion — ITO = 45 dBm Typ @ f = 300 MHz



CASE 26-03, STYLE 1
(TO-46)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.15	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	50	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	100	300	—
Collector-Emitter Saturation Voltage (I_C = 50 mA, I_C/I_B = 10)	$V_{CE(sat)}$	—	300	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	1.5	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 25 mA, f = 300 MHz)	NF_{MIN}	—	2.5	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 40 mA)	f_τ	—	3	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 40 mA, f = 300 MHz)	GU_{MAX}	—	17.5	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 40 mA, f = 300 MHz)	$\|S_{21}\|^2$	—	15.5	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 40 mA, f = 300 MHz)	$P_{o1\ dB}$	—	22	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 40 mA, f = 300 MHz)	ITO	—	40	—	dBm

2

TYPICAL CHARACTERISTICS

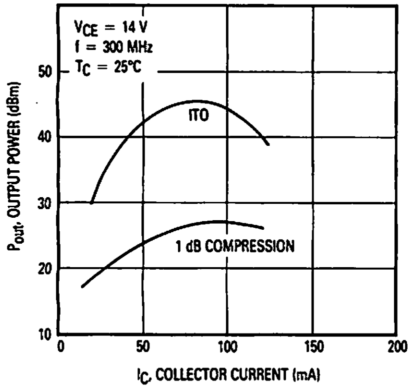


Figure 1. Third Order Intercept and 1 dB Compression versus Current

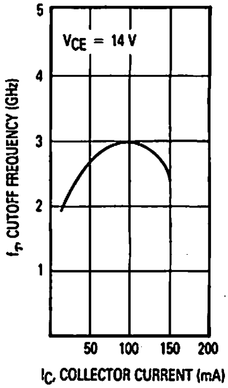


Figure 2. Gain-Bandwidth Product versus Collector Current

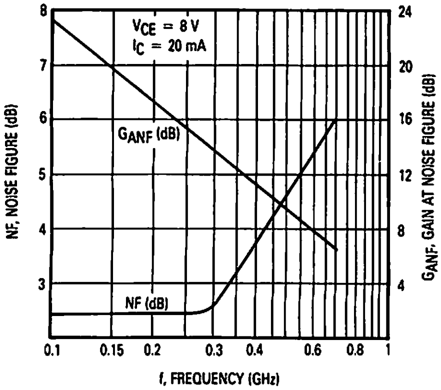


Figure 3. Noise Figure and Associated Gain versus Frequency

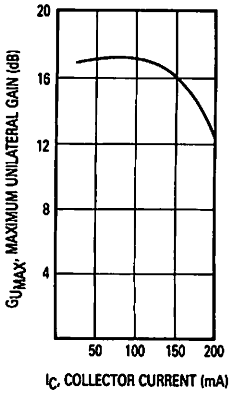


Figure 4. GU_{MAX} versus Collector Current

TYPICAL CHARACTERISTICS

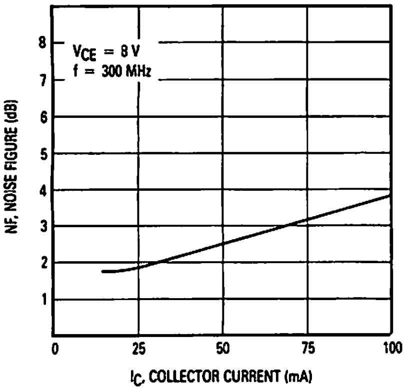


Figure 5. Noise Figure versus Collector Current

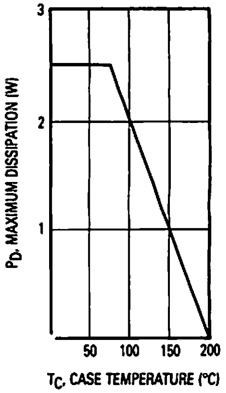


Figure 6. Dissipation versus Temperature

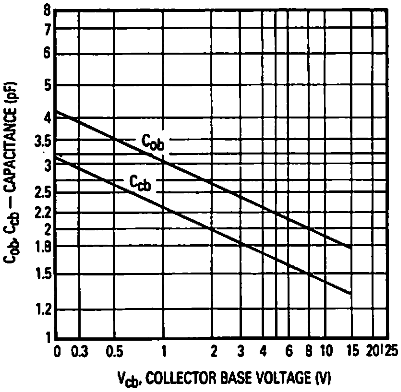


Figure 7. Junction Capacitance versus Voltage

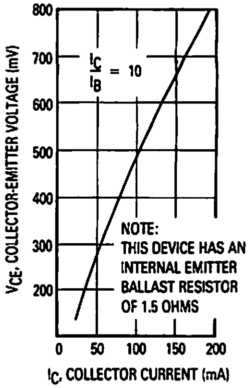


Figure 8. Collector Saturation Characteristics

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
8	20	0.1	0.47	−118	12.11	109	0.05	57	0.61	−61
		0.2	0.37	−155	6.3	90	0.07	64	0.36	−61
		0.3	0.38	−176	4.34	80	0.1	70	0.31	−71
		0.4	0.38	171	3.32	72	0.13	74	0.3	−76
		0.5	0.39	155	2.68	65	0.16	76	0.29	−89
		0.6	0.41	147	2.3	60	0.19	77	0.28	−96
		0.7	0.4	136	2.02	55	0.23	78	0.32	−106
		0.8	0.42	128	1.83	49	0.27	76	0.31	−126
		0.9	0.44	120	1.65	44	0.32	75	0.32	−136
		1	0.42	110	0.66	40	0.36	74	0.4	−147
14	40	0.1	0.61	−114	15.24	115	0.04	57	0.54	−61
		0.2	0.58	−146	8.48	97	0.05	64	0.38	−61
		0.3	0.59	−160	5.88	59	0.06	70	0.34	−71
		0.4	0.58	−168	4.45	81	0.07	74	0.33	−76
		0.5	0.59	−174	3.56	75	0.08	76	0.33	−89
		0.6	0.65	−179	2.98	70	0.09	77	0.34	−96
		0.7	0.59	177	2.61	65	0.1	78	0.37	−106
		0.8	0.59	173	2.28	61	0.11	76	0.39	−126
		0.9	0.6	169	2.04	57	0.13	75	0.41	−136
		1	0.61	164	1.83	54	0.14	74	0.43	−147

Figure 9. Common Emitter S-Parameters

2

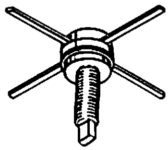
LT5817

The RF Line
PNP Silicon High Frequency Transistor

I_C = −400 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTOR
PNP SILICON

. . . specifically designed for CRT driver applications requiring high voltage and high frequency, such as high resolution color graphics video monitors.

- PNP Complement to LT1817
- High Voltage — $V_{(BR)CBO}$ = −80 V Min
- High Cutoff Frequency — f_T = 1500 MHz Min
- Low Output Capacitance — C_{cb} = 2.5 pF Max @ V_{CB} = −15 V
- Gold Metallization
- *Common Base Configuration*



CASE 244D-01, STYLE 2
(TO-177A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−65	Vdc
Collector-Base Voltage	V_{CBO}	−80	Vdc
Emitter-Base Voltage	V_{EBO}	−3	Vdc
Collector Current — Continuous	I_C	−400	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −1 mA, I_B = 0)	$V_{(BR)CEO}$	−65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.1 mA, I_E = 0)	$V_{(BR)CBO}$	−80	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.1 mA, I_C = 0)	$V_{(BR)EBO}$	−3	—	—	Vdc
Collector Cutoff Current (V_{CB} = −50 V, I_E = 0)	I_{CBO}	—	—	−20	μAdc
Collector Cutoff Current (V_{CE} = −50 V, V_{BE} = 0)	I_{CES}	—	—	−100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mA, V_{CE} = −5 V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage (I_C = −50 mA, I_B = −5 mA)	$V_{CE(sat)}$	—	—	800	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = −15 V, I_E = 0, f = 1 MHz)	C_{cb}	—	—	2.5	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = −15 V, I_C = −50 mA, f = 200 MHz)	f_T	1.5	—	—	GHz
Insertion Gain (V_{CE} = −15 V, I_C = −50 mA, f = 200 MHz)	$\lvert S_{21}\rvert^2$	15	—	—	dB

TYPICAL CHARACTERISTICS

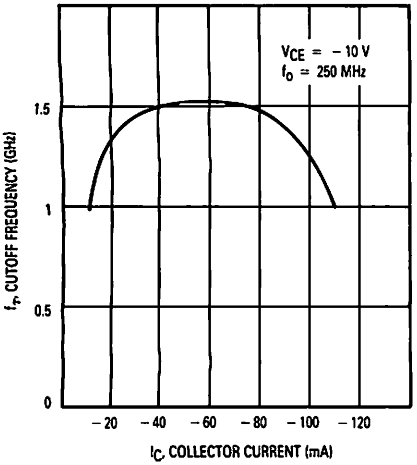


Figure 1. Gain Bandwidth Product versus Collector Current

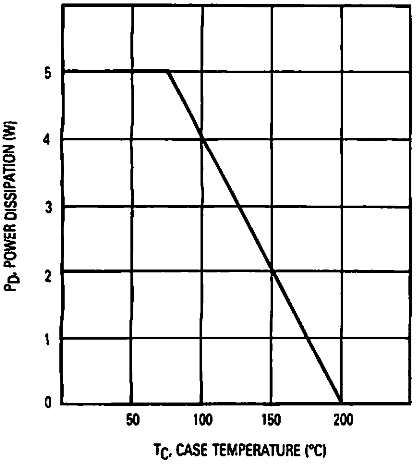


Figure 2. Power Dissipation versus Temperature

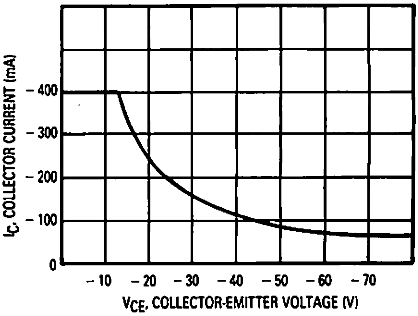


Figure 3. Safe Operating Area

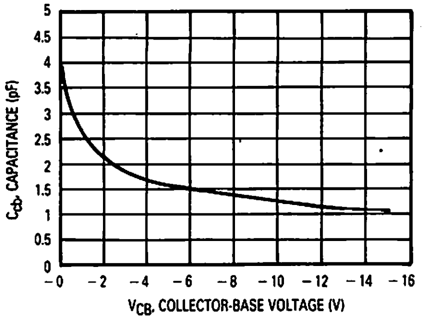


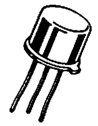
Figure 4. Junction Capacitance versus Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

LT5839

I_C = −300 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTOR
PNP SILICON



CASE 79-04, STYLE 1
(TO-39)

The RF Line

PNP Silicon High Frequency Transistor

. . . specifically designed for CRT driver applications requiring high frequency and high voltage, such as high resolution color graphics video monitors.

- PNP Complement to LT1839
- High Voltage — $V_{(BR)CBO}$ = −80 V Min
- High Cutoff Frequency — f_T = 1500 MHz Min
- Low Output Capacitance — C_{cb} = 2.5 pF Max @ V_{CB} = −15 V
- Gold Metallization

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−65	Vdc
Collector-Base Voltage	V_{CBO}	−80	Vdc
Emitter-Base Voltage	V_{EBO}	−3	Vdc
Collector Current — Continuous	I_C	−300	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −1 mA, I_B = 0)	$V_{(BR)CEO}$	−65	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.1 mA, I_E = 0)	$V_{(BR)CBO}$	−80	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.1 mA, I_C = 0)	$V_{(BR)EBO}$	−3	—	—	Vdc
Collector Cutoff Current (V_{CB} = −50 V, I_E = 0)	I_{CBO}	—	—	−20	μAdc
Collector Cutoff Current (V_{CE} = −50 V, V_{BE} = 0)	I_{CES}	—	—	−100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mA, V_{CE} = −5 V)	h_{FE}	20	—	60	—
Collector-Emitter Saturation Voltage (I_C = −50 mA, I_B = −5 mA)	$V_{CE(sat)}$	—	—	800	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = −15 V, I_E = 0, f = 1 MHz)	C_{cb}	—	—	2.5	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = −10 V, I_C = −50 mA, f = 250 MHz)	f_T	1.5	—	—	GHz
Insertion Gain (V_{CE} = −10 V, I_C = −50 mA, f = 200 MHz)	$\|S_{21}\|^2$	13	—	—	dB

TYPICAL CHARACTERISTICS

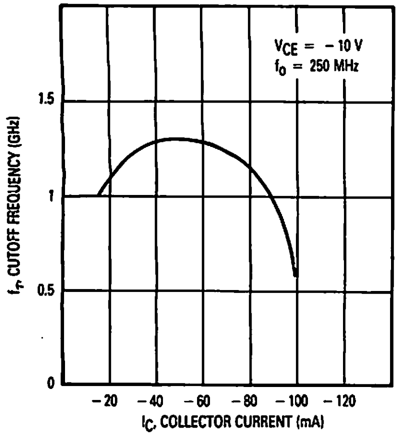


Figure 1. Gain Bandwidth Product versus Collector Current

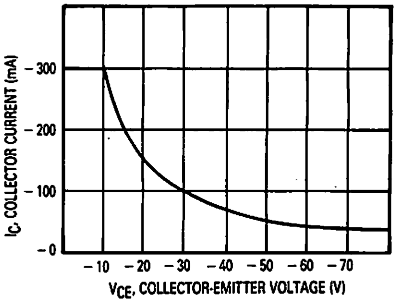


Figure 2. Safe Operating Area

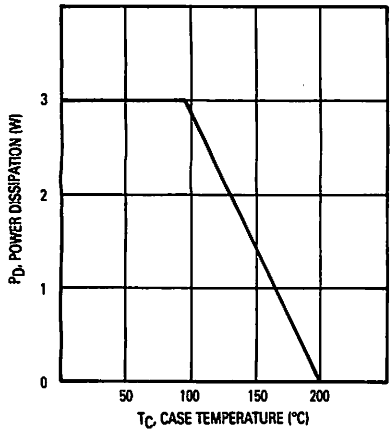


Figure 3. Power Dissipation versus Temperature

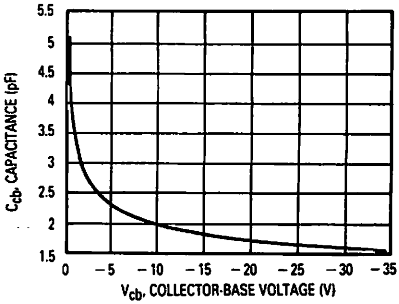


Figure 4. Junction Capacitance versus Voltage

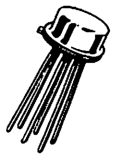
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MD4957

The RF Line

MULTIPLE DEVICES

DUAL PNP SILICON AMPLIFIER



DUAL PNP SILICON ANNULAR 450 MHz AMPLIFIER

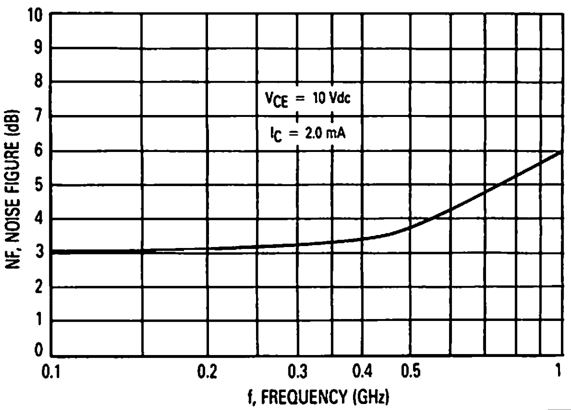
. . . designed for high-gain, low-noise amplifier, oscillator, and mixer applications.

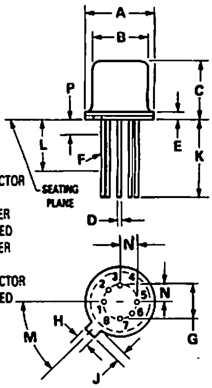
- Low Noise Figure — NF = 3.0 dB (Typ) @ 450 MHz
  6.0 dB (Typ) @ 1.0 GHz
- High Power Gain — G_{pe} = 18 dB (Typ) @ 450 MHz
  13 dB (Typ) @ 1.0 GHz
- High Gain-Bandwidth Product — f_T = 1500 MHz (Typ)
- Low Collector-Base Capacitance — C_{cb} = 0.8 pF (Typ)

MAXIMUM RATINGS (each side)

Rating	Symbol	Value		Unit
Collector-Emitter Voltage	V_{CEO}	30		Vdc
Collector-Base Voltage	V_{CB}	30		Vdc
Emitter-Base Voltage	V_{EB}	3.0		Vdc
Collector Current	I_C	30		mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		°C
		One Side	Both Sides	
Total Device Dissipation @ T_A = 25°C	P_D	200	400	mW
Derate above 25°C		1.15	2.3	mW/°C

FIGURE 1 — NOISE FIGURE (TYPICAL) versus FREQUENCY





STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. OMITTED
5. EMITTER
6. BASE
7. COLLECTOR
8. OMITTED

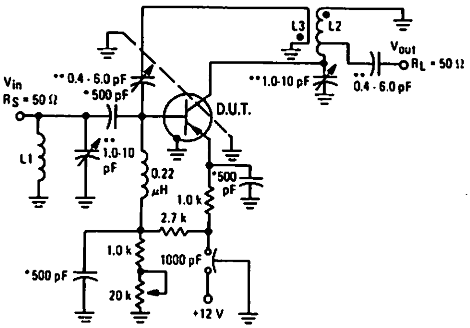
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.40	0.335	0.370
B	7.75	8.51	0.305	0.335
C	4.19	4.70	0.165	0.185
D	0.41	0.53	0.016	0.021
E	—	1.02	—	0.040
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.71	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	
P	—	1.27	—	0.050

CASE 654-02

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 100 MHz)	f_T	1000	1500	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 100 kHz)	C_{cb}	—	0.8	1.5	pF
Small-Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	20	—	200	—
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 10 Vdc, f = 63.6 MHz)	$r_b'C_c$	—	10	20	ps
Noise Figure	NF				dB
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 450 MHz) Figure 2		—	3.0	—	
(I_C = 2.0 mAdc, V_{CE} = 10 Vdc, R_S = 50 Ohms, f = 1.0 GHz)		—	6.0	—	
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain	G_{pe}				dB
(V_{CE} = 10 Vdc, I_C = 2.0 mAdc, f = 450 MHz)		—	18	—	
(V_{CE} = 10 Vdc, I_C = 2.0 mAdc, R_S = 50 Ohms, f = 1.0 GHz)		—	13	—	

FIGURE 2 — NOISE FIGURE AND POWER GAIN TEST CIRCUIT



*Button type capacitors
**Variable air piston type capacitors
1. L1 — silver plated brass bar, 1.0 in. lg by 0.25 in od.
2. L2 — silver plated brass bar, 1.5 in. lg by 0.25 in od. Tap is 0.25 in. from collector
3. L3 — ½ turn of AWG No. 16 wire 0.25 in. from and parallel to L2.
4. The noise source is a hot-cold body (All type 70 or equivalent) with a test receiver (All type 136 or equivalent).
5. Each half of dual transistor tested separately.

COMMON EMITTER Y PARAMETER VARIATIONS

Y PARAMETERS VS FREQUENCY
$V_{CE} = 10$ Vdc
$I_C = 2.0$ mA

FIGURE 3 — INPUT ADMITTANCE

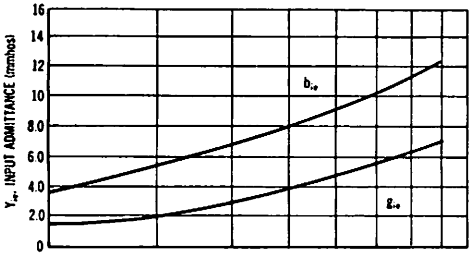


FIGURE 4 — FORWARD TRANSFER ADMITTANCE

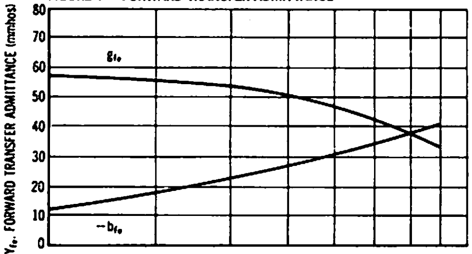


FIGURE 5 — OUTPUT ADMITTANCE

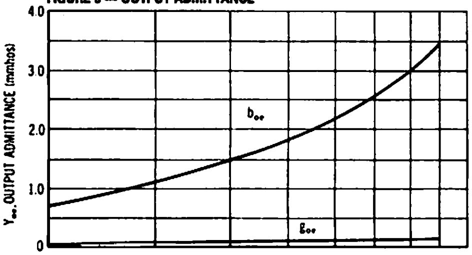
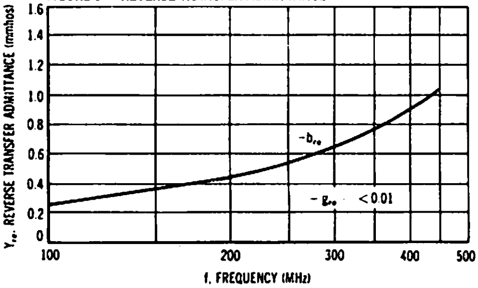


FIGURE 6 — REVERSE TRANSFER ADMITTANCE



Y PARAMETERS VS CURRENT
$V_{CE} = 10$ Vdc ——— $V_{CE} = 15$ Vdc — — —
f = 450 MHz

FIGURE 7 — INPUT ADMITTANCE

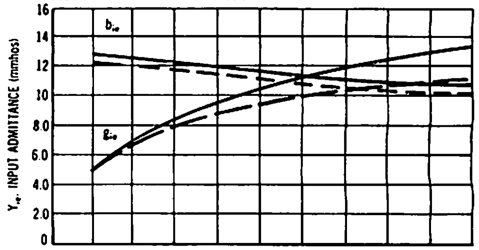


FIGURE 8 — FORWARD TRANSFER ADMITTANCE

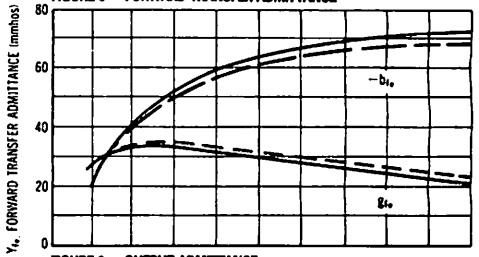


FIGURE 9 — OUTPUT ADMITTANCE

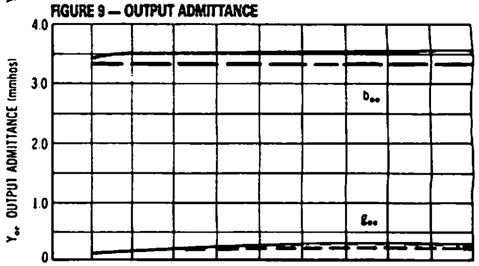
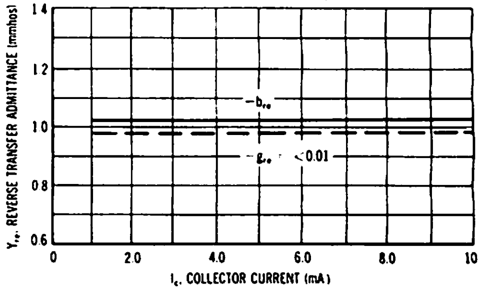


FIGURE 10 — REVERSE TRANSFER ADMITTANCE



COMMON BASE Y PARAMETER VARIATIONS

Y PARAMETERS versus FREQUENCY

$V_{CB} = 10$ Vdc

$I_C = 2.0$ mA

FIGURE 11 — INPUT ADMITTANCE

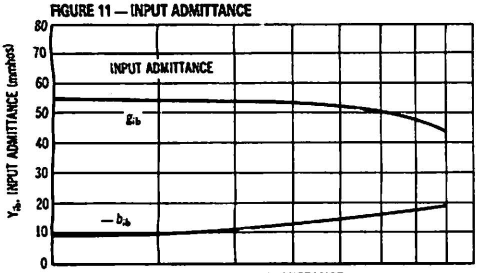


FIGURE 12 — FORWARD TRANSFER ADMITTANCE

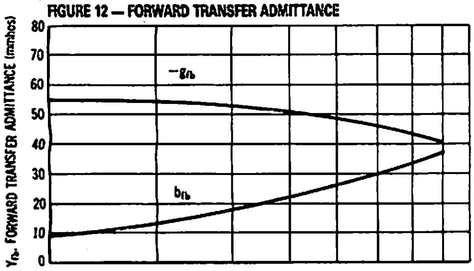


FIGURE 13 — OUTPUT ADMITTANCE

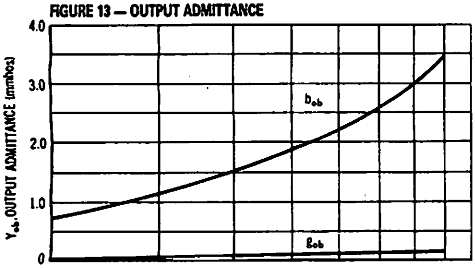
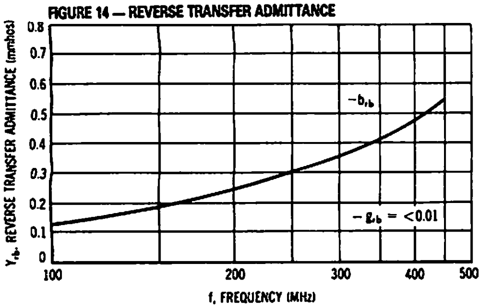


FIGURE 14 — REVERSE TRANSFER ADMITTANCE



Y PARAMETERS versus CURRENT

$V_{CB} = 10$ Vdc ——— $V_{CB} = 15$ Vdc – – –

f = 450 MHz

FIGURE 15 — INPUT ADMITTANCE

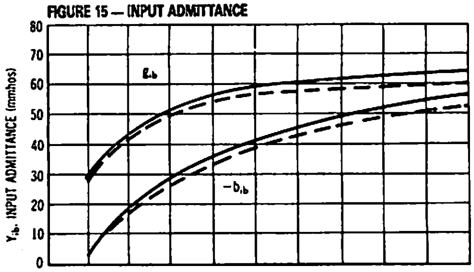


FIGURE 16 — FORWARD TRANSFER ADMITTANCE

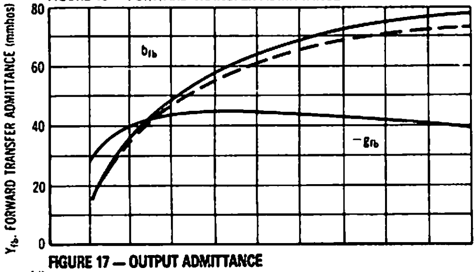


FIGURE 17 — OUTPUT ADMITTANCE

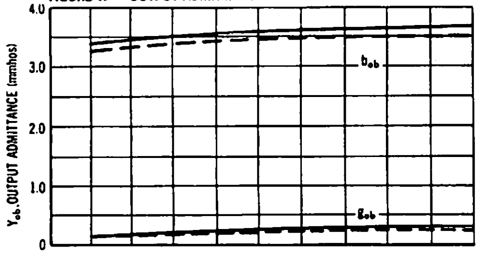
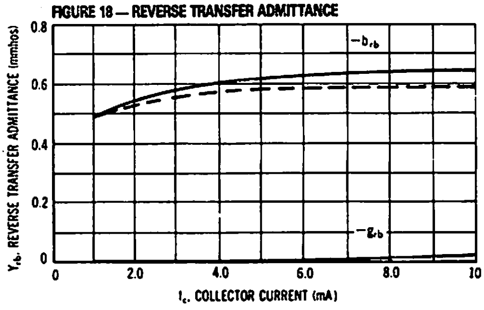


FIGURE 18 — REVERSE TRANSFER ADMITTANCE

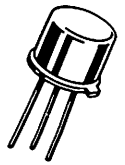


MM4018

The RF Line

I_C = −400 mA
RF POWER TRANSISTOR

PNP SILICON



PNP SILICON RF POWER TRANSISTOR

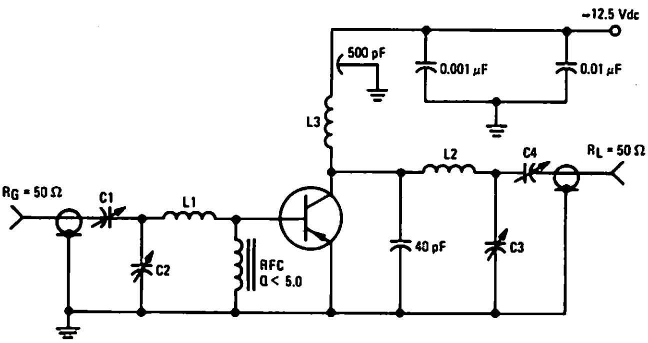
. . . designed for amplifier, frequency multiplier or oscillator applications in military and industrial equipment. Suitable for use as Class A, B, or C driver, or pre-driver stages in VHF applications.

- Power Output — P_{out} = 0.5 W (Min) @ f = 175 MHz
- High Current-Gain — Bandwidth Product — f_T = 900 MHz (Typ) @ I_C = −50 mAdc

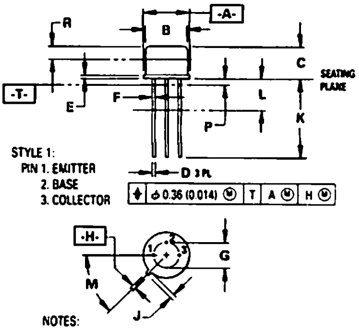
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−20	Vdc
Collector-Base Voltage	V_{CB}	−40	Vdc
Emitter-Base Voltage	V_{EB}	−4.0	Vdc
Collector Current — Continuous	I_C	−0.4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

FIGURE 1 — 175 MHz OUTPUT POWER TEST CIRCUIT



C1, C2 3.0 – 30 pF, ARCO 461 OR EQUIVALENT
C3, C4 8.0 – 80 pF, ARCO 462 OR EQUIVALENT
L1 100 nH, 4 TURNS NO. 18 AWG, 1/4" I.D., 5/8" LENGTH
L2 40 nH, 2 TURNS NO. 18 AWG, 1/4" I.D., 1/2" LENGTH
L3 200 nH, 8 TURNS NO. 18 AWG, 1/4" I.D., 7/8" LENGTH



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	−20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	−40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	−4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = −15 Vdc, I_B = 0)	I_{CEO}	—	—	−20	μAdc
Collector Cutoff Current (V_{CE} = −40 Vdc, V_{BE} = 0)	I_{CES}	—	—	−0.1	mAdc
Collector Cutoff Current (V_{CB} = −15 Vdc, I_E = 0)	I_{CBO}	—	—	−10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mAdc, V_{CE} = −5.0 Vdc)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = −50 mAdc, V_{CE} = −15 Vdc, f = 200 MHz)	f_T	—	900	—	MHz
Output Capacitance (V_{CB} = −12.5 Vdc, I_E = 0, f = 100 kHz)	C_{ob}	—	3.5	—	pF
FUNCTIONAL TESTS					
Power Output (Figure 1) (P_{in} = 50 mW, V_{CC} = −12.5 Vdc, f = 175 MHz)	P_{out}	0.5	—	—	Watt
Collector Efficiency (Figure 1) (P_{in} = 50 mW, V_{CC} = −12.5 Vdc, f = 175 MHz)	η	45	55	—	%

FIGURE 2 — POWER OUTPUT versus POWER INPUT

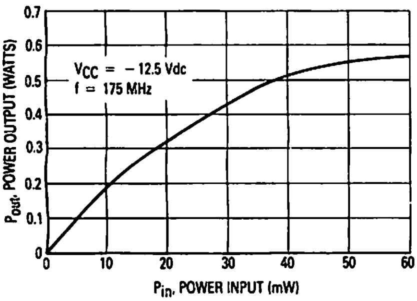


FIGURE 3 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

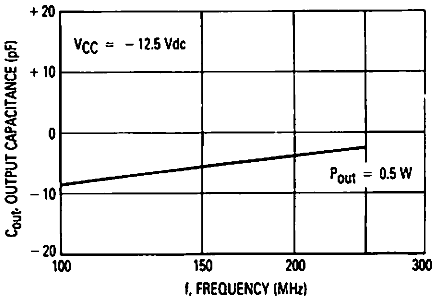


FIGURE 4 — PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

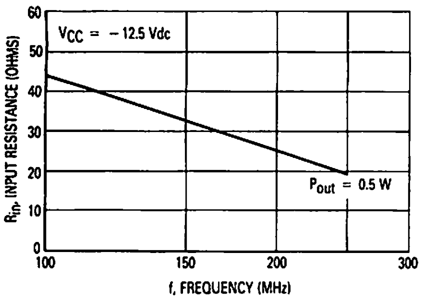
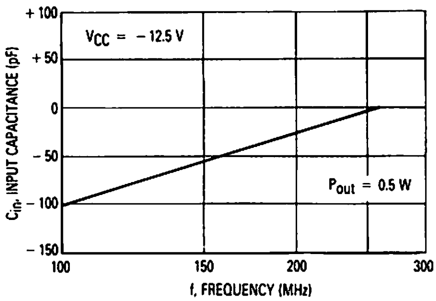


FIGURE 5 — PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY



2

MM4049
MMC4049
MRF534
MRF536

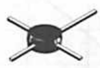
The RF Line

PNP SILICON HIGH-FREQUENCY TRANSISTORS

. . . designed for use as a high-frequency current mode switch. Because of the extremely high Current-Gain — Bandwidth this transistor also makes an excellent RF amplifier and oscillator.

- High Current-Gain — Bandwidth Product —
  f_T = 4.0 GHz (Min) @ I_C = −20 mAdc — MM4049, MRF534
  f_T = 5.0 GHz (Min) @ I_C = −20 mAdc — MRF536
- Low Collector-Base Capacitance —
  C_{cb} = 1.25 pF (Max) @ V_{CB} = −5.0 Vdc

I_C = −30 mA
HIGH FREQUENCY TRANSISTORS
PNP SILICON

		MMC4049	MM4049	MRF534	MRF536	
						
MAXIMUM RATINGS		Chip	Case 20-03 TO-206AF Style 10	Case 22-03 TO-206AA Style 1	Case 317-01 Macro-X Style 2	
Ratings	Symbol			Values		Unit
Collector-Emitter Voltage	V_{CEO}	−10	−10	−10	−10	Vdc
Collector-Base Voltage	V_{CBO}	−15	−15	−15	−15	Vdc
Emitter-Base Voltage	V_{EBO}	−4.5	−4.5	−4.5	−4.5	Vdc
Collector Current — Continuous	I_C	−30	−30	−30	−30	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	300 $T_{J\,max}$=200°C	200 1.14	300 1.71	300 2.40	mW mW/°C
Operating and Storage Junction Temperature Junction	T_J, T_{stg}	-65 to +200	-65 to +200	-65 to +200	-65 to +150	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −2.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	−10	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −100 μAdc, I_E = 0)	$V_{(BR)CBO}$	−15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −100 μAdc, I_C = 0)	$V_{(BR)EBO}$	−4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = −10 Vdc, I_E = 0)	I_{CBO}	—	—	−10	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −25 mAdc, V_{CE} = −2.0 Vdc)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = −20 mAdc, V_{CE} = −5.0 Vdc, f = 500 MHz) MRF534, MM4049	f_T	4.0	—	—	GHz
MRF536		5.0	—	—	
Collector-Base Capacitance (V_{CB} = −5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.3	pF
FUNCTIONAL TESTS					
Maximum Available Gain	MAG				dB
(I_C = −15 mAdc, V_{CE} = −5.0 Vdc, f = 500 MHz) MRF534		10	12	—	
(I_C = −15 mAdc, V_{CE} = −5.0 Vdc, f = 500 MHz) MM4049		11.5	13	—	
(I_C = −15 mAdc, V_{CE} = −5.0 Vdc, f = 1.0 GHz) MRF536		8.5	10	—	

FIGURE 1 — CURRENT-GAIN — BANDWIDTH PRODUCT versus CURRENT

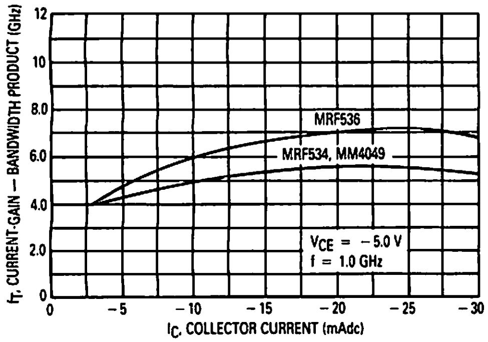


FIGURE 2 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

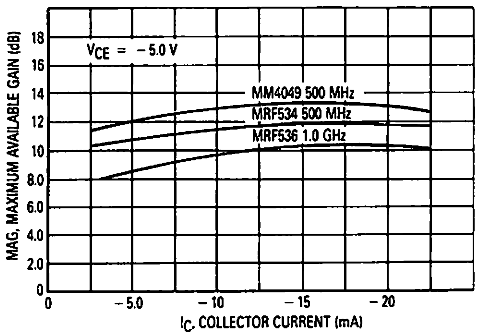
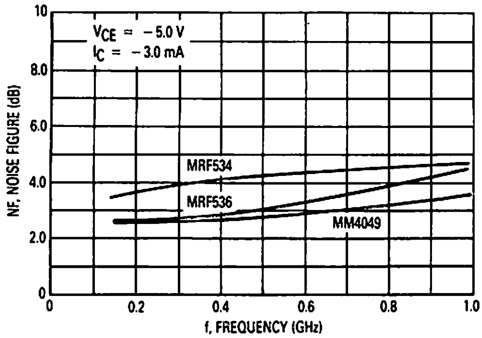


FIGURE 3 — NOISE FIGURE versus FREQUENCY



MRF534 COMMON-EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\lvert S_{11}\rvert$	S_{11} $\angle\phi$	S_{21} $\lvert S_{21}\rvert$	S_{21} $\angle\phi$	S_{12} $\lvert S_{12}\rvert$	S_{12} $\angle\phi$	S_{22} $\lvert S_{22}\rvert$	S_{22} $\angle\phi$
−5.0	−5.0	200	0.734	−22	3.70	126	0.066	66	0.507	−39
		400	0.580	−28	2.56	108	0.116	65	0.409	−48
		600	0.444	−37	2.09	95	0.158	62	0.403	−52
		800	0.400	−47	1.80	86	0.195	56	0.364	−56
		1000	0.366	−47	1.55	79	0.234	51	0.348	−69
	−10	200	0.645	−27	5.36	124	0.058	69	0.394	−43
		400	0.503	−33	3.44	106	0.109	71	0.316	−52
		600	0.376	−43	2.68	93	0.153	69	0.323	−52
		800	0.333	−54	2.24	84	0.192	65	0.290	−55
		1000	0.295	−54	1.91	77	0.233	61	0.276	−71
	−20	200	0.586	−28	5.90	122	0.053	70	0.338	−52
		400	0.454	−34	3.73	105	0.099	73	0.259	−60
		600	0.329	−46	2.87	93	0.143	72	0.267	−58
		800	0.289	−59	2.38	85	0.181	68	0.240	−59
		1000	0.248	−58	2.04	77	0.221	65	0.235	−75
−10	−5.0	200	0.752	−21	4.28	125	0.066	70	0.550	−28
		400	0.624	−26	2.77	107	0.123	68	0.495	−38
		600	0.512	−34	2.19	94	0.168	65	0.503	−44
		800	0.476	−44	1.86	86	0.207	60	0.464	−51
		1000	0.447	−45	1.60	79	0.246	55	0.443	−64
	−10	200	0.685	−24	5.47	123	0.060	71	0.442	−33
		400	0.553	−28	3.46	105	0.113	71	0.385	−42
		600	0.433	−37	2.68	93	0.156	68	0.397	−46
		800	0.391	−49	2.25	85	0.194	63	0.362	−51
		1000	0.359	−47	1.92	78	0.233	59	0.342	−65
	−20	200	0.621	−26	6.38	121	0.055	71	0.372	−40
		400	0.488	−31	3.97	104	0.103	72	0.316	−48
		600	0.365	−41	3.04	93	0.145	70	0.332	−50
		800	0.323	−52	2.51	85	0.182	66	0.301	−54
		1000	0.290	−50	2.13	79	0.219	63	0.288	−68

MM4049 COMMON-EMITTER S-PARAMETERS

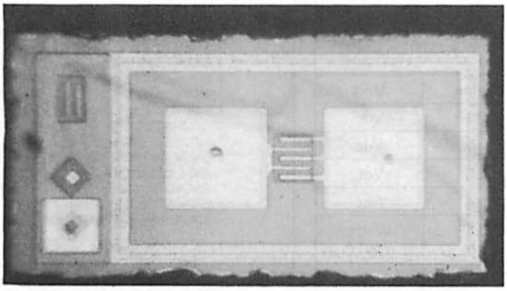
V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\lvert S_{11}\rvert$	S_{11} $\angle\phi$	S_{21} $\lvert S_{21}\rvert$	S_{21} $\angle\phi$	S_{12} $\lvert S_{12}\rvert$	S_{12} $\angle\phi$	S_{22} $\lvert S_{22}\rvert$	S_{22} $\angle\phi$
−5.0	−5.0	200	0.634	−31	6.37	120	0.060	69	0.711	−23
		400	0.469	−34	3.95	93	0.107	65	0.602	−30
		600	0.379	−40	2.90	77	0.147	62	0.587	−33
		800	0.368	−51	2.32	65	0.183	56	0.550	−36
		1000	0.381	−54	1.93	55	0.223	50	0.528	−44
	−10	200	0.523	−29	7.79	112	0.056	72	0.632	−23
		400	0.418	−28	3.74	89	0.104	68	0.543	−29
		600	0.344	−34	3.20	74	0.146	65	0.542	−32
		800	0.345	−46	2.54	64	0.184	58	0.513	−34
		1000	0.366	−50	2.09	54	0.225	52	0.493	−42
	−20	200	0.454	−25	8.43	106	0.065	73	0.584	−21
		400	0.390	−23	4.67	85	0.105	70	0.513	−27
		600	0.325	−30	3.31	72	0.148	66	0.620	−30
		800	0.327	−44	2.61	62	0.188	59	0.497	−32
		1000	0.351	−48	2.15	52	0.231	52	0.476	−41
−10	−5.0	200	0.731	−25	5.83	121	0.053	70	0.736	−18
		400	0.589	−30	3.65	95	0.096	67	0.654	−26
		600	0.502	−38	2.71	79	0.132	64	0.645	−29
		800	0.496	−49	2.21	68	0.164	57	0.612	−33
		1000	0.499	−54	1.83	58	0.198	51	0.592	−42
	−10	200	0.643	−25	7.37	114	0.051	71	0.668	−18
		400	0.542	−27	4.28	90	0.094	69	0.600	−25
		600	0.466	−34	3.10	76	0.132	65	0.603	−28
		800	0.465	−46	2.49	66	0.166	59	0.577	−31
		1000	0.476	−51	2.05	57	0.202	53	0.557	−40
	−20	200	0.570	−23	8.44	109	0.049	73	0.621	−18
		400	0.496	−24	4.73	88	0.093	71	0.562	−24
		600	0.427	−31	3.38	75	0.131	67	0.572	−27
		800	0.427	−43	2.69	66	0.165	60	0.551	−30
		1000	0.445	−47	2.21	57	0.203	54	0.532	−38

2

MRF536 COMMON-EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} $\angle\phi$	S_{21} $\|S_{21}\|$	S_{21} $\angle\phi$	S_{12} $\|S_{12}\|$	S_{12} $\angle\phi$	S_{22} $\|S_{22}\|$	S_{22} $\angle\phi$
−5.0	−5.0	400	0.401	−74	5.38	108	0.090	54	0.490	−48
		800	0.181	−102	3.03	86	0.138	51	0.350	−64
		1200	0.136	−157	2.13	70	0.181	48	0.320	−70
		1600	0.151	175	1.68	59	0.210	45	0.270	−80
		2000	0.160	148	1.44	52	0.240	41	0.269	−100
	−10	400	0.289	−94	6.58	103	0.076	56	0.379	−56
		800	0.140	−137	3.55	84	0.122	55	0.266	−73
		1200	0.174	169	2.46	70	0.165	53	0.238	−77
		1600	0.196	154	1.93	60	0.196	50	0.198	−87
		2000	0.227	130	1.65	51	0.230	46	0.202	−110
	−20	400	0.233	−118	7.28	99	0.066	60	0.296	−65
		800	0.163	−169	3.88	82	0.110	59	0.204	−84
		1200	0.233	156	2.65	69	0.153	57	0.179	−84
		1600	0.253	144	2.06	59	0.185	55	0.143	−96
		2000	0.290	123	1.75	50	0.220	51	0.160	−121
−10	−5.0	400	0.478	−54	5.14	109	0.086	58	0.535	−39
		800	0.279	−66	2.90	88	0.141	53	0.420	−55
		1200	0.166	−97	2.08	73	0.184	48	0.388	−62
		1600	0.151	−123	1.67	64	0.209	44	0.330	−72
		2000	0.110	−158	1.44	55	0.243	39	0.313	−90
	−10	400	0.356	−67	6.59	105	0.075	59	0.418	−47
		800	0.182	−84	3.59	86	0.125	56	0.311	−62
		1200	0.119	−141	2.53	73	0.166	52	0.284	−67
		1600	0.131	−166	2.00	62	0.193	49	0.230	−76
		2000	0.135	154	1.72	55	0.226	45	0.222	−98
	−20	400	0.260	−85	7.66	101	0.066	61	0.328	−53
		800	0.124	122	4.09	84	0.111	59	0.236	−69
		1200	0.148	172	2.83	72	0.152	56	0.216	−71
		1600	0.172	158	2.22	62	0.182	54	0.172	−80
		2000	0.201	130	1.88	54	0.214	50	0.171	−104

MMC4049 CHIP TOPOGRAPHY



Nominal Chip Size: 12 × 22 mils
Front Metalization: Aluminum
Back Metalization: Aluminum
Emitter/Base Bond Pad: 4.0 × 4.0 mils
#Emitter Fingers: 2
#Base Fingers: 3

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MM8000
MM8001

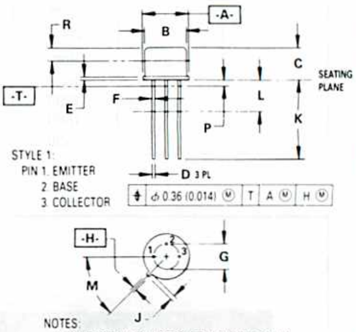
The RF Line

NPN SILICON
AMPLIFIER
TRANSISTORS

NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed for high-frequency C.A.T.V. amplifier applications. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- High Current-Gain—Bandwidth Product — f_T = 900 MHz (Min) @ I_C = 50 mAdc (MM8001)
- Low Output Capacitance — C_{ob} = 3.5 pF (Max) @ V_{CB} = 30 Vdc
- Low Noise Figure — NF = 2.7 dB (Typ) @ I_C = 10 mAdc



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

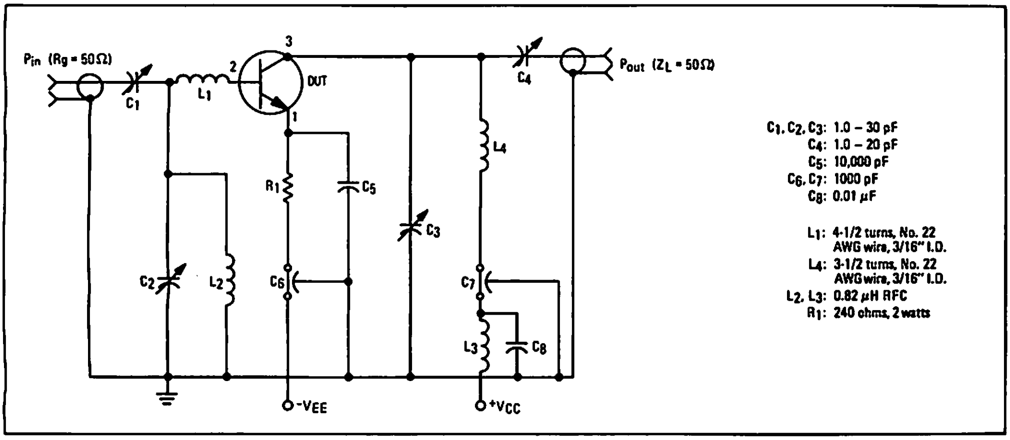
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CB}	40	Vdc
Emitter-Base Voltage	V_{EB}	3.5	Vdc
Collector Current	I_C	0.4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, I_B = 0)	I_{CEO}	—	—	20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 15 Vdc)	h_{FE}	30	—	—	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product	f_T				MHz
(I_C = 25 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) MM8000		550	—	—	
MM8001		700	—	—	
(I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) MM8000		700	—	—	
MM8001		900	—	—	
(I_C = 100 mAdc, V_{CE} = 15 Vdc, f = 200 MHz) MM8000		700	—	—	
MM8001		900	—	—	
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	3.5	pF
Noise Figure Figure 1 (I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	NF	—	2.7	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain Figure 1 (I_C = 10 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	G_{pe}	—	11.4	—	dB

FIGURE 1 — 200 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MM8009

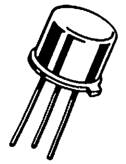
The RF Line

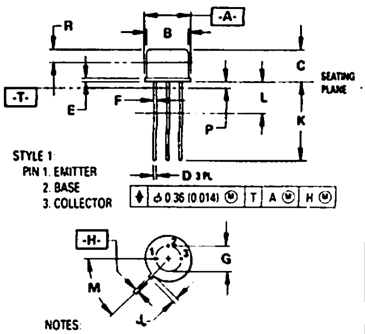
0.9 W – 1.0 GHz
RF POWER TRANSISTOR
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military and industrial equipment. Suitable for use as output, driver, or pre-driver stages in UHF equipment and as a fundamental frequency oscillator at 1.68 GHz.

- High Output Power – P_{out} = 0.9 Watt (Min) @ f = 1.0 GHz
- High Current-Gain–Bandwidth Product – f_T = 1000 MHz (Min) @ I_C = 50 mAdc
- Ideal for Radiosonde Applications – P_{out} (Oscillator) = 300 mW (Typ) @ f = 1.68 GHz





STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CB}	45	Vdc
Emitter-Base Voltage	V_{EB}	3.0	Vdc
Collector Current – Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.0 5.71	Watt mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	3.5 20	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage ($I_C = 100\ \mu Adc$, $I_E = 0$)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 100\ \mu Adc$, $I_C = 0$)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $I_B = 0$)	I_{CEO}	–	–	100	µAdc
Collector Cutoff Current ($V_{CE} = 35$ Vdc, $V_{BE} = 0$)	I_{CES}	–	–	10	µAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 100$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	20	–	–	–
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product ($I_C = 50$ mAdc, $V_{CE} = 15$ Vdc, f = 100 MHz)	f_T	1000	–	–	MHz
Output Capacitance ($V_{CB} = 30$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	2.3	3.0	pF
FUNCTIONAL TEST					
Power Output (Figure 1) ($P_{in} = 316$ mW, $V_{CE} = 28$ Vdc, f = 1.0 GHz)	P_{out}	0.9	–	–	Watt
Power Output (Oscillator) (Figure 2) ($V_{CE} = 20$ Vdc, $V_{EB} = 1.5$ Vdc, f = 1.68 GHz) (Minimum Efficiency = 15%)	P_{out}	–	0.3	–	Watt
Collector Efficiency ($P_{in} = 316$ mW, $V_{CE} = 28$ Vdc, f = 1.0 GHz)	η	35	–	–	%

FIGURE 1 – 1.0 GHz POWER AMPLIFIER TEST CIRCUIT

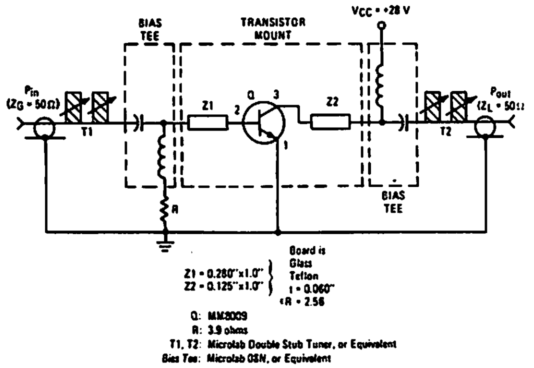
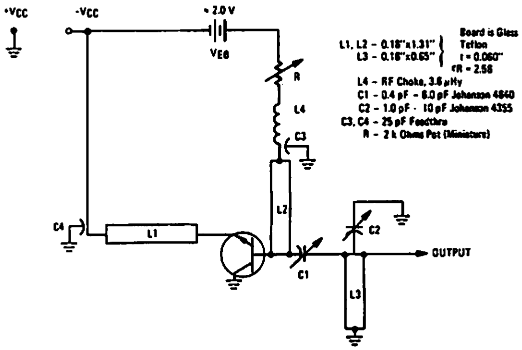


FIGURE 2 – 1.68 GHz POWER OSCILLATOR TEST CIRCUIT



2

FIGURE 3 – POWER OUTPUT versus POWER INPUT

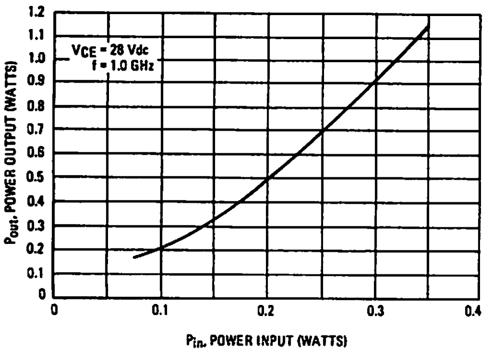


FIGURE 4 – POWER OUTPUT versus FREQUENCY

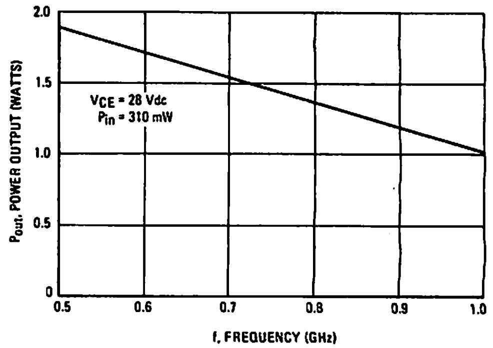


FIGURE 5 – POWER OUTPUT versus VOLTAGE

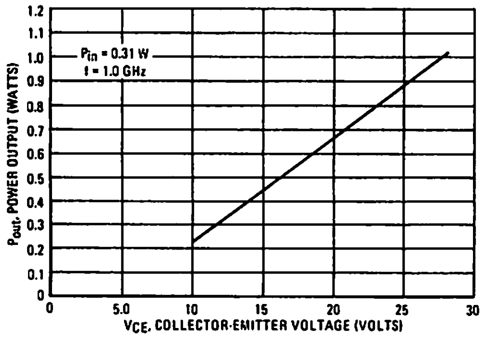


FIGURE 6 – OSCILLATOR POWER OUTPUT versus CURRENT

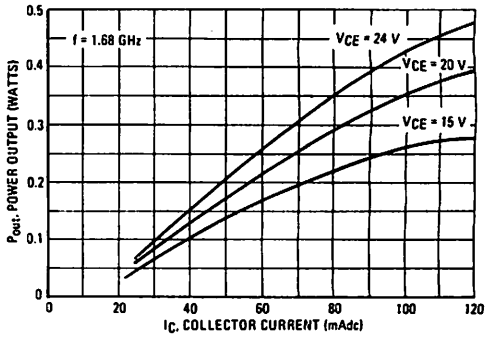


FIGURE 7 – CURRENT-GAIN–BANDWIDTH PRODUCT

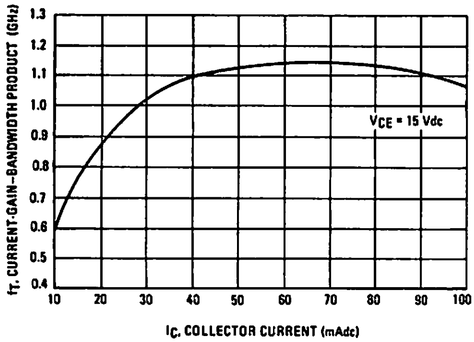
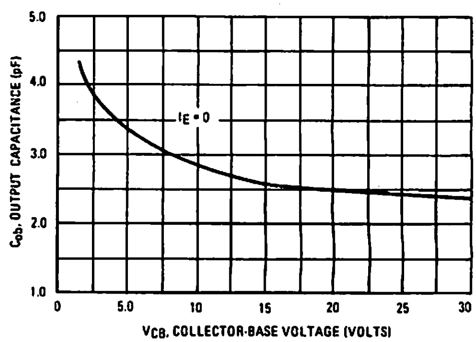


FIGURE 8 – OUTPUT CAPACITANCE versus VOLTAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR536L (See MPS536)
MMBR571L (See MPS571)

MMBR901L

Die Source Same as MRF901

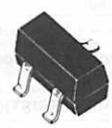
The RF Line
NPN Silicon High Frequency Transistors

. . . designed primarily for use in high-gain, low-noise, small-signal UHF and microwave amplifiers constructed with thick and thin-film circuits using surface mount components.

- High Power Gain — G_{pe} = 12 dB Typ @ f = 1 GHz
- Low Noise Figure — NF = 1.9 dB Typ @ f = 1 GHz

RF AMPLIFIER TRANSISTOR

NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR901L = 7A

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	200	—
SMALL-SIGNAL CHARACTERISTICS				
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	1.0	pF
Common-Emitter Amplifier Power Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mAdc, f = 1.0 GHz)	G_{pe}	12 (Typ)	—	dB
Noise Figure (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	NF	—	1.9 (Typ)	dB

MMBR911L (See MPS911)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR920L

The RF Line
NPN Silicon High Frequency Transistor

2

. . . designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — G_{pe} = 15 dB Typ @ f = 500 MHz
- Low Noise — NF = 2.4 dB Typ @ f = 500 MHz

RF AMPLIFIER TRANSISTOR

NPN SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR920L = 7B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 14 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	—	250	—
SMALL SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 14 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	NF	 — —	 2.4 3.0	 — —	dB
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	G_{pe}	 — —	 15 10	 — —	dB

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR930L

The RF Line
NPN Silicon
High Frequency Transistor

. . . designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — G_{pe} = 11 dB Typ @ f = 500 MHz
- Low Noise — NF = 1.9 dB Typ @ f = 500 MHz

AMPLIFIER TRANSISTOR
NPN SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	35	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR930L = 7C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	25	—	250	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 1.0 GHz)	NF	 — —	 1.9 2.5	 — —	dB
Common-Emitter Amplifier Power Gain (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz) (I_C = 2.0 mAdc, V_{CE} = 5.0 Vdc, f = 0.5 GHz)	G_{pe}	 — —	 11 8.0	 — —	dB

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

MMBR931L

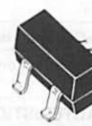
Die Source Same as MRF931

The RF Line
NPN Silicon
High Frequency Transistor

. . . designed primarily for use in low-power amplifiers to 1 GHz. Ideal for pagers and other battery operated systems where power consumption is critical.

RF AMPLIFIER TRANSISTOR

NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	5.0	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25°C$ Derate above 25°C	P_D	50 0.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	2500	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR931L = 7D

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 0.1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	5.0	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 0.01$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	10	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 0.1$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 5.0$ Vdc, $I_E = 0$)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	30	—	150	—
SMALL-SIGNAL CHARACTERISTICS					
Collector-Base Capacitance ($V_{CB} = 1.0$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{cb}	—	—	0.5	pF
Noise Figure ($I_E = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc, f = 1.0 GHz)	NF	—	4.3	—	dB
Power Gain at Optimum Noise Figure ($I_E = 0.25$ mAdc, $V_{CE} = 1.0$ Vdc, f = 1.0 GHz)	G_{NF}	—	10	—	—

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

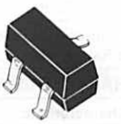
MMBR941L (See MRF941)
MMBR951L (See MRF951)

MMBR2060L

The RF Line
NPN Silicon High Frequency Transistor

. . . designed primarily for use in high-gain, low-noise amplifier, oscillator and mixer applications. Packaged for thick or thin-film circuits using surface mount components.

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	14	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	50	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR2060L = 7E

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	14	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)	I_{CBO}	—	50	nAdc
Emitter Cutoff Current (V_{EB} = 4.0, I_C = 0)	I_{EBO}	—	100	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—
Collector-Emitter Saturation Voltage (I_C = 80 mAdc, I_B = 8.0 mAdc)	$V_{CE(sat)}$	—	0.38	Vdc
Base-Emitter Saturation Voltage (I_C = 40 mAdc, I_B = 20 mAdc)	$V_{BE(sat)}$	—	0.98	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 20 mAdc, V_{CE} = 1.0 Vdc, f = 100 MHz)	f_T	1.0 (Typ)	—	GHz
Small-Signal Current Gain (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 500 MHz)	h_{FE}	2.0	—	—
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0)	C_{cb}	—	1.0	pF
Emitter-Base Capacitance (V_{EB} = 0.5 Vdc, I_C = 0)	C_{eb}	—	3.0	pF
Noise Figure (V_{CE} = 10 Vdc, I_E = 1.5 mAdc, f = 450 MHz)	NF	—	3.5 (Typ)	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 10 Vdc, I_E = 1.5 mAdc, f = 450 MHz)	G_{pe}	12.5 (Typ)	—	dB

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR2857L

Die Source Same as 2N2857

The RF Line
NPN Silicon High Frequency Transistor

... designed primarily for use in high-gain, low-noise amplifier, oscillator and mixer applications. Packaged for thick or thin-film circuits using surface mount components.

RF AMPLIFIER TRANSISTOR
NPN SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	40	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, $T_A = 25°C$ Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR2857L = 7K

ELECTRICAL CHARACTERISTICS ($T_A = 25°C$ unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage ($I_C = 3.0$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	15	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 1.0$ μAdc, $I_E = 0$)	$V_{(BR)CBO}$	30	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 3.0$ mAdc, $I_E = 0$)	$V_{(BR)CES}$	30	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	—	0.05	μAdc
ON CHARACTERISTICS				
DC Current Gain ($I_C = 3.0$ mAdc, $V_{CE} = 1.0$ Vdc)	h_{FE}	30	—	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain-Bandwidth Product ($I_C = 4.0$ mAdc, $V_{CE} = 10$ Vdc, f = 100 MHz)	f_T	1000 (Typ)	—	MHz
Collector-Base Capacitance ($V_{CB} = 10$ Vdc, $I_E = 0$, f = 0.1 MHz)	C_{cb}	—	1.0	pF
Small-Signal Current Gain ($I_C = 2.0$ mAdc, $V_{CE} = 6.0$ Vdc, f = 1.0 kHz)	h_{fe}	50	—	—
Noise Figure ($I_C = 1.5$ mAdc, $V_{CE} = 6.0$ Vdc, $R_S = 50\ \Omega$, f = 450 MHz)	NF	—	4.5 (Typ)	dB
Common-Emitter Amplifier Power Gain ($I_C = 1.5$ mAdc, $V_{CE} = 6.0$ Vdc, f = 450 MHz)	G_{PE}	12.5 (Typ)	—	dB

MMBR4957L

Die Source Same as 2N4957

The RF Line

PNP Silicon High Frequency Transistor

. . . designed for high-gain, low-noise amplifier oscillator and mixer applications. Specifically packaged for thick and thin-film circuits using surface mount components.

- High Gain — G_{pe} = 17 dB Typ @ f = 450 MHz
- Low Noise — NF = 3 dB Typ @ f = 450 MHz

I_C = −30 mA
HIGH FREQUENCY TRANSISTOR
PNP SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−30	Vdc
Collector-Base Voltage	V_{CBO}	−30	Vdc
Emitter-Base Voltage	V_{EBO}	−3.0	Vdc
Collector Current — Continuous	I_C	−30	mAdc
Operating and Storage Junction *Temperature Range*	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR4957L = 7F

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = −1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	−30	—	Vdc
Collector-Base Breakdown Voltage (I_C = −100 μAdc, I_E = 0)	$V_{(BR)CBO}$	−30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −100 μAdc, I_C = 0)	$V_{(BR)EBO}$	−3.0	—	Vdc
Collector Cutoff Current (V_{CB} = −10 Vdc, I_C = 0)	I_{CBO}	—	−0.1	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = −2.0 mAdc, V_{CE} = −10 Vdc)	h_{FE}	20	150	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_E = −2.0 mAdc, V_{CE} = −10 Vdc, f = 100 MHz)	f_T	1200 (Typ)	—	MHz
Collector-Base Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.8	pF
Common-Emitter Amplifier Power Gain (V_{CE} = −10 Vdc, I_C = −2.0 mAdc, f = 450 MHz)	G_{pe}	17 (Typ)	—	dB
Noise Figure (I_C = −2.0 mAdc, V_{CE} = −10 Vdc, f = 450 MHz)	NF	—	3.0 (Typ)	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f MHz	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
-5.0	-5.0	0.1	0.61	-37	9.28	148	0.03	72	0.90	-16
		0.3	0.39	-83	5.56	112	0.07	62	0.69	-27
		0.5	0.30	-107	3.73	95	0.09	62	0.62	-30
		0.7	0.26	-125	2.79	84	0.12	62	0.59	-34
		0.9	0.24	-140	2.26	76	0.14	61	0.58	-38
		1.2	0.24	-158	1.78	65	0.17	60	0.58	-45
		1.5	0.23	-172	1.49	55	0.20	60	0.58	-51
		2.0	0.23	156	1.17	43	024	60	0.56	-61
		2.5	0.25	133	0.98	33	0.29	59	0.54	-72
		3.0	0.29	105	0.85	26	0.34	58	0.50	-83
	-10	0.1	0.42	-55	11.54	138	0.03	71	0.84	-18
		0.3	0.28	-108	5.81	104	0.06	66	0.64	-25
		0.5	0.25	-132	3.72	90	0.08	67	0.59	-28
		0.7	0.25	-148	2.77	81	0.11	66	0.58	-32
		0.9	0.25	-162	2.23	73	0.13	66	0.57	-37
		1.2	0.26	-177	1.74	62	0.16	65	0.57	-43
		1.5	0.26	170	1.46	54	0.19	65	0.57	-50
		2.0	0.27	142	1.14	41	0.24	65	0.56	-60
		2.5	0.30	122	0.95	32	0.29	64	0.53	-72
		3.0	0.34	97	0.82	26	0.35	61	0.50	-83
	-15	0.1	0.24	-90	6.83	129	0.02	69	0.80	-12
		0.3	0.24	-136	3.17	107	0.05	70	0.72	-19
		0.5	0.27	-153	2.23	96	0.08	69	0.69	-26
		0.7	0.29	-167	1.75	86	0.10	70	0.66	-32
		0.9	0.31	-178	1.47	77	0.12	70	0.65	-38
		1.2	0.32	168	1.20	65	0.15	70	0.64	-46
		1.5	0.32	155	1.03	56	0.18	72	0.63	-53
		2.0	0.34	130	0.83	44	0.24	71	0.60	-65
		2.5	0.36	111	0.71	36	0.31	68	0.57	-78
		3.0	0.41	89	0.64	31	0.37	64	0.51	-90
-10	-5.0	0.1	0.65	-33	9.36	149	0.03	74	0.92	-14
		0.3	0.42	-73	5.77	114	0.06	64	0.72	-25
		0.5	0.31	-95	3.91	98	0.09	63	0.65	-29
		0.7	0.26	-111	2.94	87	0.11	63	0.62	-32
		0.9	0.24	-126	2.39	78	0.14	62	0.61	-37
		1.2	0.23	-144	1.87	67	0.17	60	0.60	-43
		1.5	0.21	-159	1.58	58	0.19	60	0.60	-49
		2.0	0.20	166	1.24	46	0.23	60	0.58	-58
		2.5	0.21	141	1.04	35	0.27	59	0.56	-69
		3.0	0.25	109	0.90	28	0.32	59	0.52	-79
	-10	0.1	0.49	-46	12.33	141	0.03	71	0.87	-17
		0.3	0.30	-91	6.45	107	0.06	67	0.66	-24
		0.5	0.25	-114	4.19	93	0.08	67	0.61	-27
		0.7	0.23	-132	3.10	83	0.11	66	0.59	-31
		0.9	0.22	-147	2.50	75	0.13	65	0.58	-35
		1.2	0.23	-164	1.96	65	0.16	64	0.58	-41
		1.5	0.23	-178	1.63	57	0.18	65	0.58	-47
		2.0	0.23	150	1.27	44	0.23	65	0.57	-57
		2.5	0.25	128	1.06	35	0.28	64	0.55	-67
		3.0	0.30	101	0.92	27	0.33	62	0.51	-78
	-15	0.1	0.38	-57	12.51	135	0.02	71	0.84	-17
		0.3	0.25	-107	5.97	103	0.05	69	0.66	-21
		0.5	0.23	-130	3.84	90	0.08	69	0.63	-25
		0.7	0.23	-147	2.84	81	0.10	68	0.61	-29
		0.9	0.24	-161	2.29	74	0.12	67	0.61	-34
		1.2	0.26	-177	1.80	64	0.15	68	0.60	-41
		1.5	0.26	170	1.50	55	0.18	68	0.61	-47
		2.0	0.27	141	1.17	43	0.23	69	0.59	-57
		2.5	0.29	120	0.97	34	0.28	67	0.57	-68
		3.0	0.34	96	0.84	27	0.34	64	0.53	-79

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MMBR5031L

Die Source Same as 2N5031

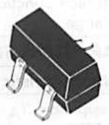
The RF Line

NPN Silicon High Frequency Transistor

. . . designed for thick and thin-film circuits using surface mount components and requiring low-noise, high-gain signal amplification at frequencies to 1 GHz.

- High Gain — G_{pe} = 17 dB Typ @ f = 450 MHz
- Low Noise — NF = 2.5 dB Typ @ f = 450 MHz

RF AMPLIFIER TRANSISTOR
NPN SILICON



CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	300 2.4	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	417	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR5031L = 7G

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	Vdc
Collector Cutoff Current (V_{CB} = 6.0 Vdc, I_E = 0)	I_{CBO}	—	10	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	h_{FE}	25	300	—
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1,000 (Typ)	—	MHz
Collector-Base Capacitance (V_{CE} = 6.0 Vdc, I_E = 0, f = 0.1 MHz)	C_{cb}	—	1.5	pF
Noise Figure (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	NF	—	2.5 (Typ)	dB
Common-Emitter Amplifier Power Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz)	G_{pe}	17 (Typ)	25	dB

MMBR5179L

Die Source Same as 2N5179

The RF Line

NPN Silicon High Frequency Transistor

... designed for small-signal amplification at frequencies to 500 MHz. Specifically packaged for use in thick and thin-film circuits using surface mount components.

- High Gain — G_{pe} = 15 dB Typ @ f = 200 MHz
- Low Noise — NF = 4.5 dB Typ @ f = 200 MHz

2

RF AMPLIFIER TRANSISTOR

NPN SILICON

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
(TO-236AA/AB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	50	mAdc
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
*Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	350 2.8	mW mW/°C
Storage Temperature	T_{stg}	150	°C
*Thermal Resistance Junction to Ambient	$R_{\theta JA}$	357	°C/W

*Package mounted on 99.5% alumina 10 x 8 x 0.6 mm.

DEVICE MARKING

MMBR5179L = 7H

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.01 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	0.02	μAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 3.0 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	25	—	—
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	—	0.4	Vdc
Base-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{BE(sat)}$	—	1.0	Vdc
SMALL SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	f_T	1,400 (Typ)	—	MHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)	C_{cb}	—	1.0	pF
Small Signal Current Gain (I_C = 2.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 kHz)	h_{fe}	25	—	—
Noise Figure (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 Ω, f = 200 Mhz)	NF	—	4.5 (Typ)	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	G_{pe}	15 (Typ)	—	dB

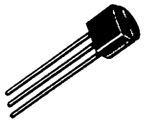
MPS536
MMBR536L

PNP Silicon High Frequency Transistors

... this high current gain-bandwidth transistor makes an excellent RF amplifier and oscillator. It is available in the surface mount SOT-23 as well as the popular TO-92 low cost plastic packages.

- High Current Gain-Bandwidth Product
  f_T = 5.5 GHz (Typ) @ I_C = −20 mA — MMBR536
  f_T = 4.5 GHz (Typ) @ I_C = −20 mA — MPS536
- High Gain
  G_{NF} = 14 dB (Typ)
- Low Collector-Base Capacitance
  C_{cb} = 0.8 pF (Typ) @ V_{CB} = −5 Vdc
- Tape and Reel Packaging Options

I_C = −30 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTORS



CASE 29-04, STYLE 2
TO-92
MPS536

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR536L

2

MAXIMUM RATINGS

Rating	Symbol	MPS536	MMBR536L	Unit
Collector-Emitter Voltage	V_{CEO}	−10	−10	Vdc
Collector-Base Voltage	V_{CBO}	−15	−15	Vdc
Emitter-Base Voltage	V_{EBO}	−4.5	−4.5	Vdc
Collector Current — Continuous	I_C	−30	−30	mA
Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5	200* 1.6	mW mW/°C
Storage Temperature	T_{stg}	−65 to +150	−65 to +150	°C

*Free air

DEVICE MARKING

MMBR536L = 7R

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C *For both package types unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −2 mA, I_B = 0)	$V_{(BR)CEO}$	−10	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −100 μA, I_E = 0)	$V_{(BR)CBO}$	−15	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −10 μA, I_C = 0)	$V_{(BR)EBO}$	−4.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = −10 Vdc, I_E = 0)	I_{CBO}	—	—	−10	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −20 mA, V_{CE} = −5 V)	h_{FE}	20	—	200	—
DYNAMIC CHARACTERISTICS					
Current Gain-Bandwidth Product (I_C = −20 mAdc, V_{CE} = −5 Vdc, f = 1 GHz) MPS536	f_T	—	4.5	—	GHz
MMBR536L		—	5.5	—	
Collector-Base Capacitance (V_{CB} = −5 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	0.8	1.2	pF
FUNCTIONAL TESTS					
Gain @ Noise Figure (I_C = −10 mAdc, V_{CE} = −5 Vdc) f = 500 MHz	G_{NF}	—	14	—	dB
f = 1 GHz		—	8	—	
Noise Figure (I_C = −10 mAdc, V_{CE} = −5 Vdc) f = 500 MHz	NF	—	4.5	—	dB
f = 1 GHz		—	6	—	

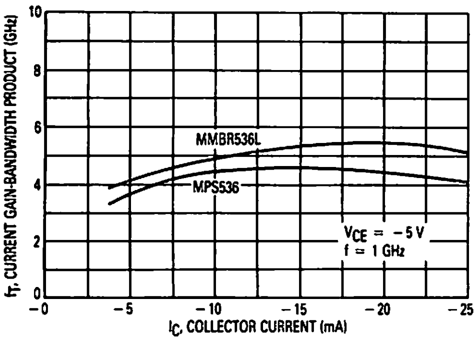


Figure 1. Current Gain-Bandwidth Product versus Collector Current

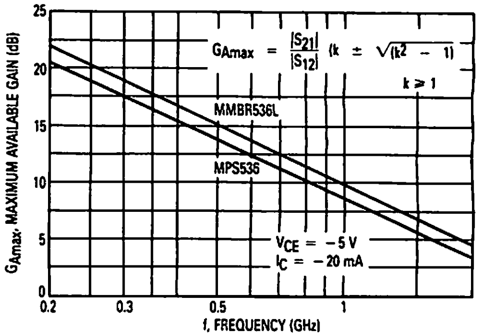


Figure 2. Maximum Available Gain (G_{Amax}) versus Frequency

MPS536

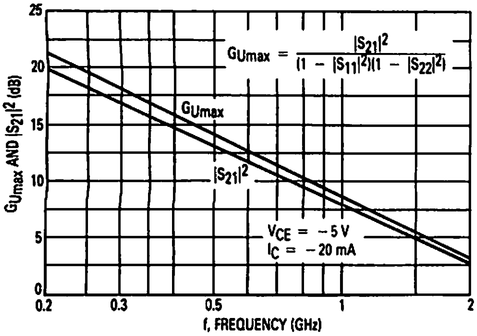


Figure 3. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

MMBR536L

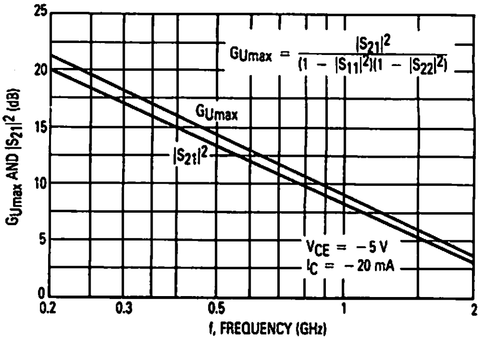


Figure 4. Maximum Unilateral Gain (G_{Umax}) and Insertion Gain ($|S_{21}|^2$) versus Frequency

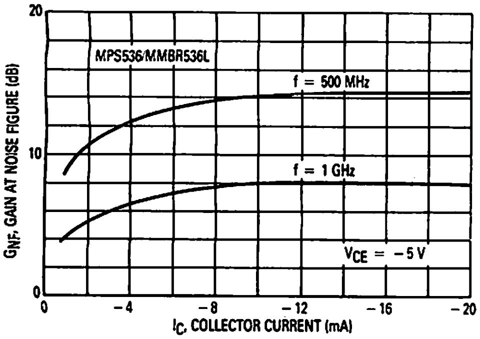


Figure 5. Gain at Noise Figure versus Collector Current

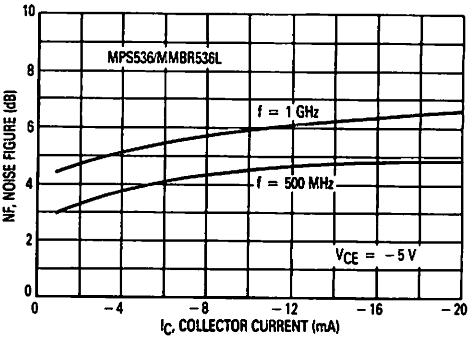


Figure 6. Noise Figure versus Collector Current

2

MPS536

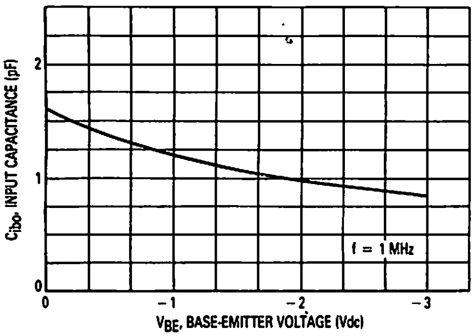


Figure 7. Input Capacitance versus Emitter-Base Voltage

MPS536

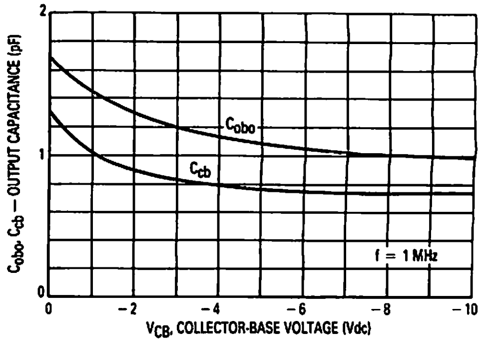


Figure 8. Output Capacitance versus Collector-Base Voltage

MMBR536L

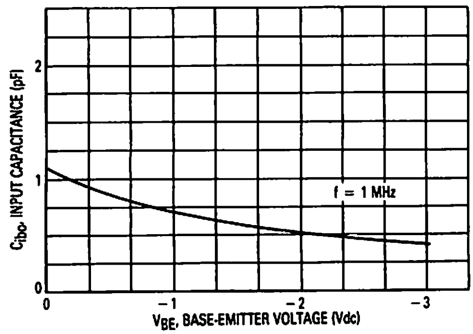


Figure 9. Input Capacitance versus Emitter-Base Voltage

MMBR536L

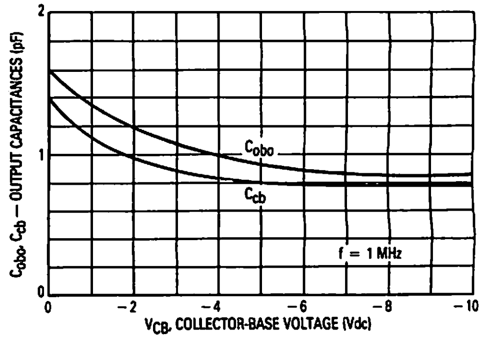
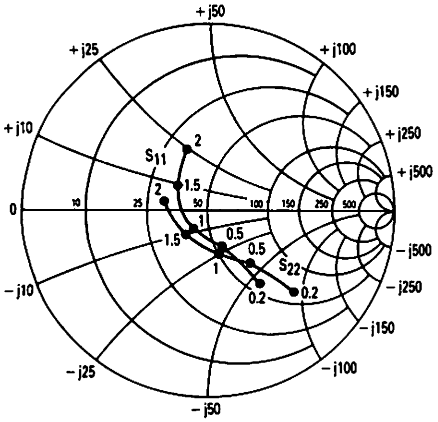


Figure 10. Output Capacitance versus Collector-Base Voltage

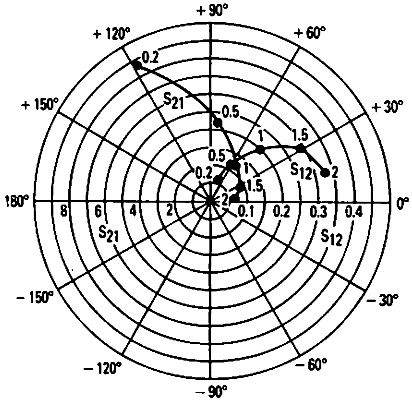
MPS536

INPUT/OUTPUT REFLECTION COEFFICIENT
versus
FREQUENCY
$V_{CE} = -10$ V, $I_C = -10$ mA



MPS536

FORWARD/REVERSE TRANSMISSION COEFFICIENTS
versus
FREQUENCY
$V_{CE} = -10$ V, $I_C = -10$ mA



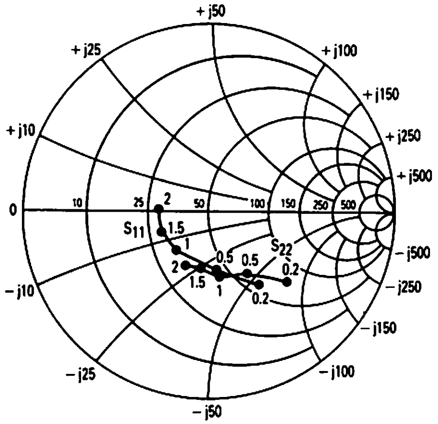
MPS536
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−10	−5	200	0.60	−43	6.60	125	0.07	68	0.71	−35
		500	0.30	−60	3.64	87	0.14	57	0.47	−43
		1000	0.17	−103	2.11	56	0.22	43	0.32	−69
		1500	0.15	156	1.70	28	0.30	28	0.22	−112
		2000	0.28	110	1.29	2	0.33	13	0.25	−174
	−10	200	0.48	−52	8.78	118	0.06	69	0.62	−42
		500	0.21	−66	4.31	84	0.12	60	0.37	−46
		1000	0.12	−122	2.40	54	0.20	47	0.24	−73
		1500	0.18	138	1.90	29	0.29	31	0.16	−126
		2000	0.32	104	1.41	4	0.33	16	0.23	170
	−20	200	0.38	−59	10.21	112	0.06	70	0.54	−46
		500	0.14	−76	4.72	81	0.12	63	0.30	−47
		1000	0.11	−144	2.58	53	0.20	49	0.19	−74
		1500	0.22	132	1.99	28	0.29	34	0.12	−139
		2000	0.35	103	1.46	4	0.33	19	0.22	161

2

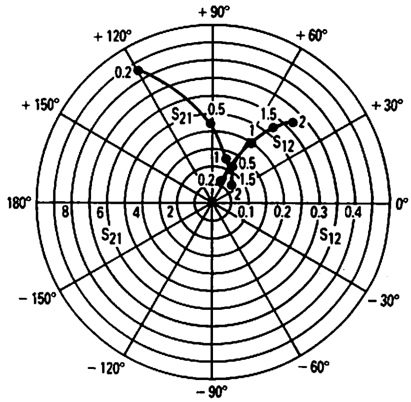
MMBR536L

INPUT/OUTPUT REFLECTION COEFFICIENTS
versus
FREQUENCY
V_{CE} = −10 V, I_C = −10 mA



MMBR536L

FORWARD AND REVERSE TRANSMISSION COEFFICIENTS
versus
FREQUENCY
V_{CE} = −10 V, I_C = −10 mA



MMBR536L
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{22}\|$	∠φ
−10	−5	200	0.60	−44	6.47	126	0.07	66	0.68	−35
		500	0.37	−70	3.57	97	0.14	60	0.48	−50
		1000	0.27	−105	2.16	74	0.22	53	0.40	−69
		1500	0.24	−138	1.62	58	0.29	46	0.37	−87
		2000	0.22	−166	1.38	44	0.33	42	0.34	−103
	−10	200	0.48	−54	8.65	120	0.06	66	0.58	−40
		500	0.30	−82	4.32	94	0.12	62	0.38	−58
		1000	0.24	−122	2.52	74	0.20	57	0.32	−78
		1500	0.24	−155	1.84	59	0.27	51	0.30	−96
		2000	0.24	178	1.54	46	0.32	47	0.28	−112
	−20	200	0.39	−63	10.10	115	0.06	67	0.49	−50
		500	0.25	−94	4.77	91	0.11	65	0.32	−65
		1000	0.24	−136	2.72	73	0.19	60	0.27	−84
		1500	0.24	−167	1.96	58	0.26	54	0.26	−102
		2000	0.26	168	1.63	46	0.32	50	0.25	−119

MPS571
MMBR571L

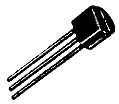
The RF Line

NPN Silicon High Frequency Transistors

I_C = 80 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTORS

. . . designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers *superior quality and* performance at low cost.

- High Gain-Bandwidth Product
  f_T = 8 GHz (Typ) @ 50 mA
- Low Noise Figure
  NF = 2 dB (Typ) @ 500 MHz
- High Gain
  G_{NF} = 17 dB (Typ) @ 30 mA/500 MHz
- State-of-the-Art Technology
  Fine Line Geometry
  Ion-Implanted Arsenic Emitters
  Gold Top Metallization and Wires
  Silicon Nitride Passivation
- Tape and Reel Packaging Options



CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS571

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR571L

MAXIMUM RATINGS

Ratings	Symbol	MPS571	MMBR571L	Unit
Collector-Emitter Voltage	V_{CEO}	10		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	3		Vdc
Collector Current — Continuous	I_C	80		mA
Power Dissipation @ T_A = 25°C	P_D	625	200 (Free Air)	mW
Storage Temperature	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBR571L = 7X

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5 Vdc)	h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	0.7	1	pF
Current Gain-Bandwidth Product (V_{CE} = 5 Vdc, I_C = 50 mAdc, f = 1 GHz) MPS571	f_T	—	6	—	GHz
MMBR571L		—	8	—	
FUNCTIONAL TESTS					
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 5 Vdc) MPS571 f = 0.5 GHz	G_{NF}	—	14	—	dB
f = 1 GHz		—	9	—	
MMBR571L f = 0.5 GHz		—	16.5	—	
f = 1 GHz		—	10.5	—	
Noise Figure (I_C = 10 mAdc, V_{CE} = 5 Vdc) MPS571 f = 0.5 GHz	NF	—	2	—	dB
f = 1 GHz		—	2.6	—	
MMBR571L f = 0.5 GHz		—	2	—	
f = 1 GHz		—	2.6	—	

Figure 1. Maximum Available Gain versus Frequency

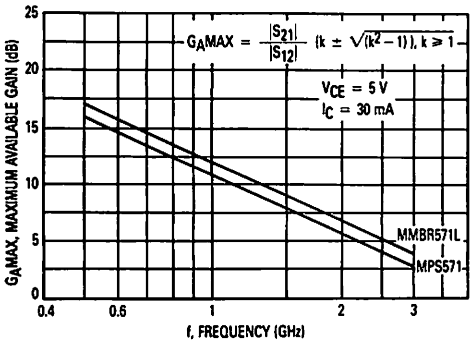


Figure 2. Current Gain-Bandwidth versus Collector Current @ 1 GHz

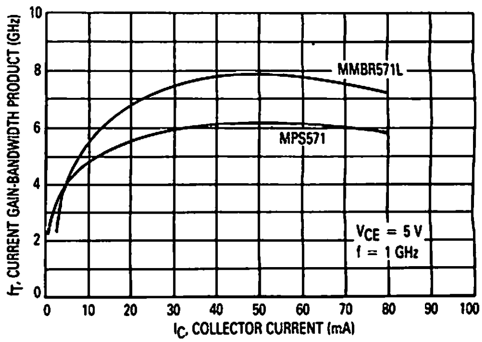


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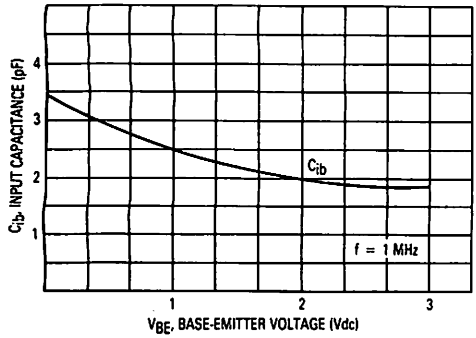
Figure 3. Input Capacitance versus Emitter Base Voltage

(a) TO-92 MPS571



(b) SOT-23 MMBR571L

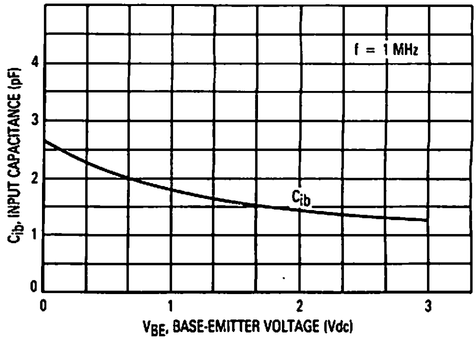
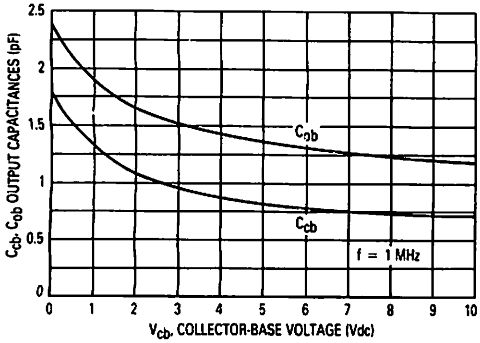


Figure 4. Output Capacitances versus Collector-Base Voltage

(a) TO-92 MPS571



(b) SOT-23 MMBR571L

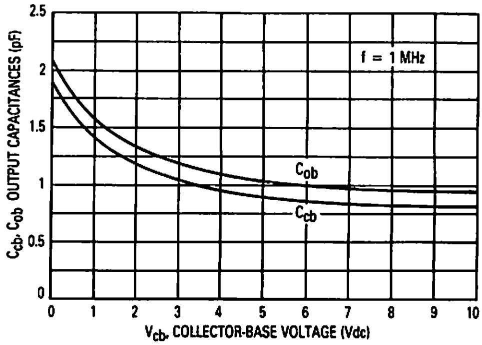
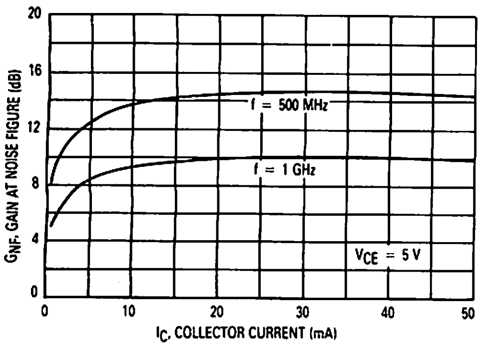


Figure 5. Gain at Noise Figure versus Collector Current

(a) TO-92 MPS571



(b) SOT-23 MMBR571L

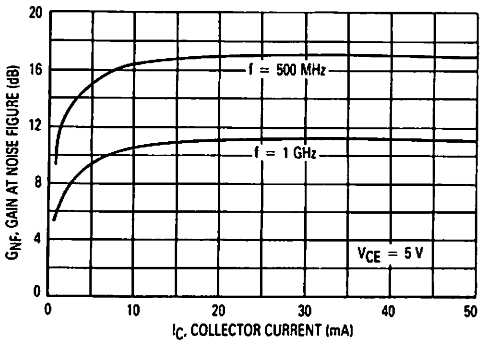


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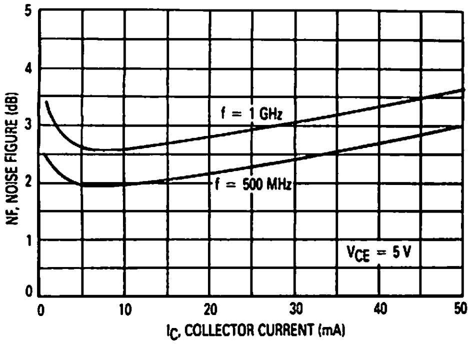
Figure 6. Noise Figure versus Collector Current

(a) TO-92 MPS571



(b) SOT-23 MMBR571L

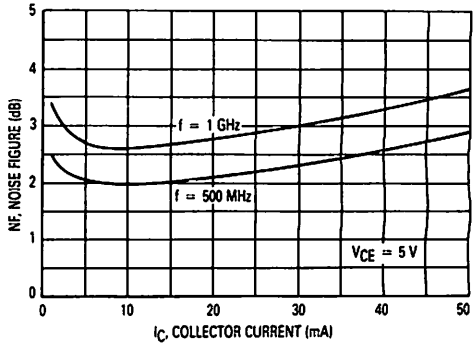
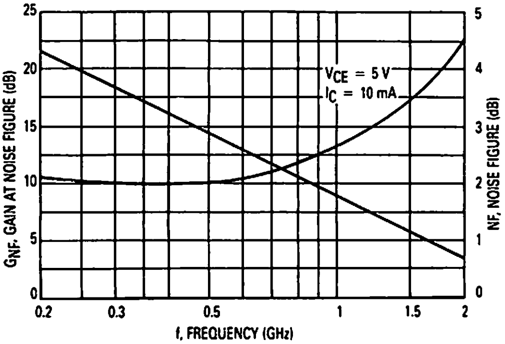


Figure 7. Gain at Noise Figure and Noise Figure versus Frequency

(a) TO-92 MPS571



(b) SOT-23 MMBR571L

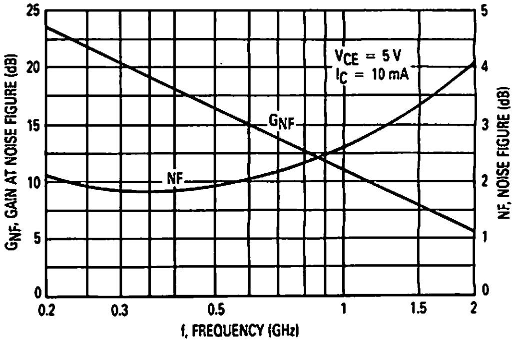
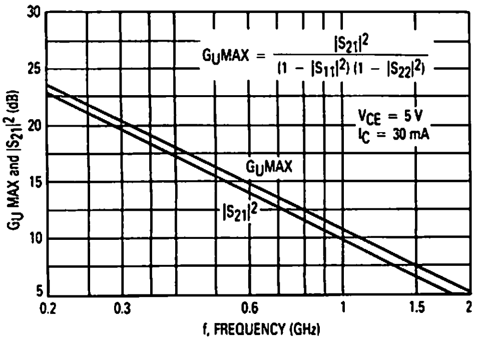
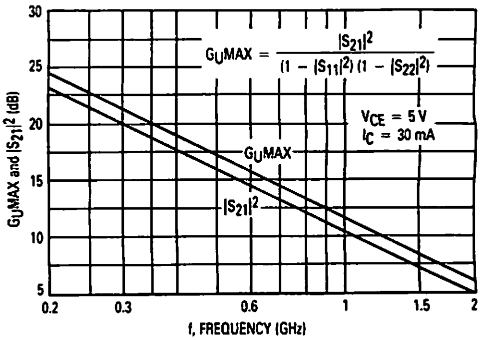


Figure 8. Maximum Unilateral Gain and Insertion Gain versus Frequency

(a) TO-92 MPS571



(b) SOT-23 MMBR571L



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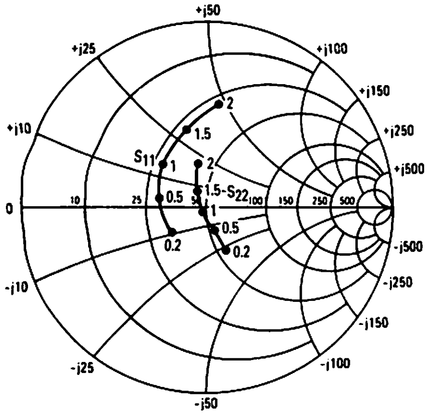
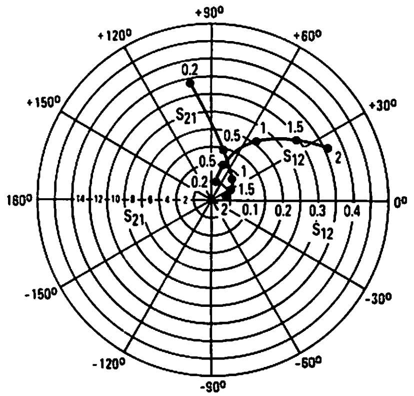
TO-92 MPS571

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
V_{CE} = 5 V, I_C = 30 mA



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
V_{CE} = 5 V, I_C = 30 mA



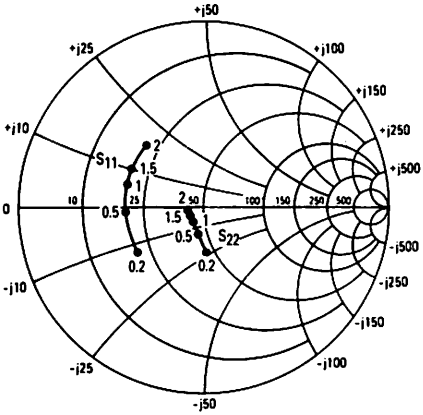
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
5	5	200	0.62	-80	8.22	122	0.07	56	0.63	-44
		500	0.40	-148	4.52	87	0.11	50	0.36	-58
		1000	0.39	155	2.51	54	0.16	48	0.23	-78
		1500	0.46	122	1.86	32	0.23	42	0.15	-114
		2000	0.59	100	1.50	14	0.31	33	0.14	173
	15	200	0.33	-121	12.88	105	0.05	67	0.37	-59
		500	0.28	-175	5.62	79	0.10	65	0.18	-67
		1000	0.32	143	2.99	53	0.19	55	0.08	-94
		1500	0.40	117	2.14	32	0.27	42	0.07	171
		2000	0.55	95	1.74	17	0.35	30	0.198	117
	30	200	0.23	-143	13.65	99	0.05	75	0.26	-62
		500	0.23	169	5.75	76	0.11	70	0.13	-68
		1000	0.30	130	3.05	50	0.21	55	0.04	-136
		1500	0.41	106	2.11	28	0.29	38	0.12	130
		2000	0.56	85	1.70	11	0.36	23	0.26	102
	50	200	0.21	-158	13.96	96	0.05	79	0.21	-61
		500	0.23	162	5.82	75	0.11	72	0.11	-66
		1000	0.30	128	3.09	49	0.21	56	0.03	-149
		1500	0.41	105	2.11	28	0.29	39	0.12	127
		2000	0.56	84	1.70	11	0.36	23	0.27	100

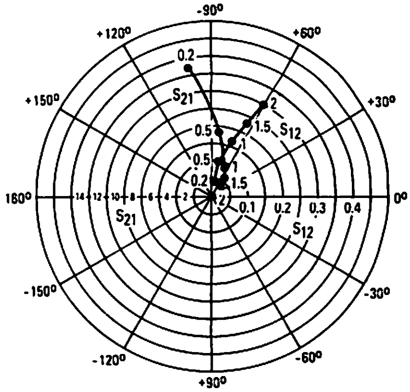
2

SOT-23 MMBR571L

INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
V_{CE} = 5 V, I_C = 30 mA



FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
V_{CE} = 5 V, I_C = 30 mA



COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5	5	200	0.68	−82	8.41	126	0.07	53	0.61	−45
		500	0.52	−142	4.62	93	0.10	46	0.35	−60
		1000	0.50	179	2.57	72	0.14	53	0.26	−71
		1500	0.51	161	1.82	57	0.19	58	0.24	−77
		2000	0.52	143	1.48	45	0.24	59	0.22	−86
	15	200	0.46	−125	13.65	108	0.05	60	0.35	−73
		500	0.43	−169	6.03	86	0.09	66	0.17	−94
		1000	0.44	168	3.20	72	0.16	67	0.14	−111
		1500	0.45	152	2.21	58	0.22	64	0.11	−118
		2000	0.46	137	1.80	48	0.29	59	0.10	−131
	30	200	0.42	−148	14.79	102	0.04	68	0.26	−87
		500	0.41	−177	6.31	84	0.09	72	0.14	−115
		1000	0.42	165	3.35	71	0.16	70	0.12	−135
		1500	0.44	151	2.29	59	0.23	65	0.11	−144
		2000	0.44	135	1.84	48	0.30	60	0.10	−157
	50	200	0.41	−159	15.14	98	0.04	73	0.21	−96
		500	0.42	179	6.38	83	0.09	75	0.13	−124
		1000	0.43	163	3.35	70	0.16	71	0.12	−143
		1500	0.44	148	2.32	58	0.23	66	0.10	−151
		2000	0.45	134	1.84	48	0.30	60	0.09	−163

MPS901
MPS1983

The RF Line

I_C = 30 mA

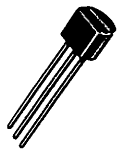
HIGH FREQUENCY TRANSISTORS

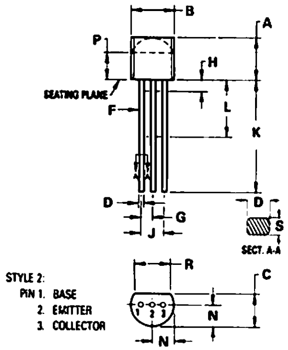
NPN SILICION

NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed primarily for use in high-gain, low-noise small-signal amplifiers.

- High Current-Gain-Bandwidth Product — f_T = 4.5 GHz (Typ) @ I_C = 15 mAdc
- High Power Gain — G_{pe} = 12 dB (Typ) @ f = 900 MHz
- Low Noise Figure — NF = 2.4 dB (Typ) @ f = 900 MHz
- Low Feedback Capacitance — C_{cb} = 0.5 pF (Typ) @ V_{cb} = 10 V
- Die Source Same as MRF901





NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED.
2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE. LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12.70mm (0.5") FROM SEATING PLANE.
3. CONTROLLING DIM: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

CASE 29-04
TO-226AA
(TO-92)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current – Continuous	I_C	30	mA
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 3.0	mW mW/°C
Operating Junction Temperature	T_J	150	°C
Storage Temperature Range	T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 10 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	80	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwidth Product I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	4.5	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.5	1.0	pF
Noise Figure (Figure 1) (I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 900 MHz)	NF	—	2.4	—	dB
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Figure 1) (I_C = 10 mA, V_{CE} = 10 Vdc, f = 900 MHz)	G_{pe}	—	12	—	dB

FIGURE 1 — 900 MHz TEST CIRCUIT SCHEMATIC

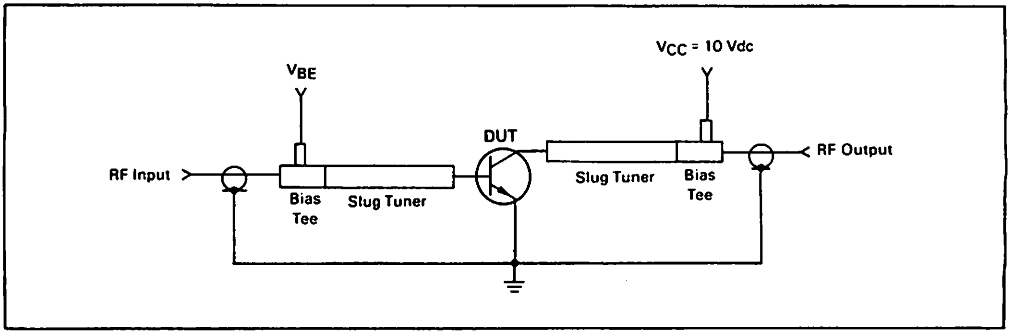
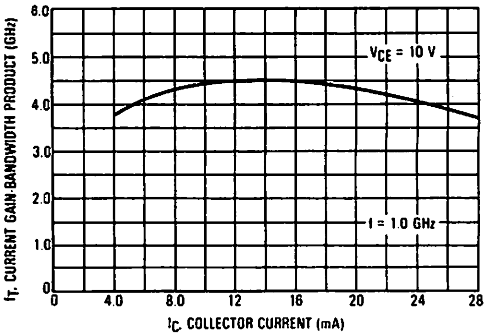


FIGURE 2 — CURRENT GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT



2

FIGURE 3 — MAXIMUM AVAILABLE GAIN versus COLLECTOR CURRENT

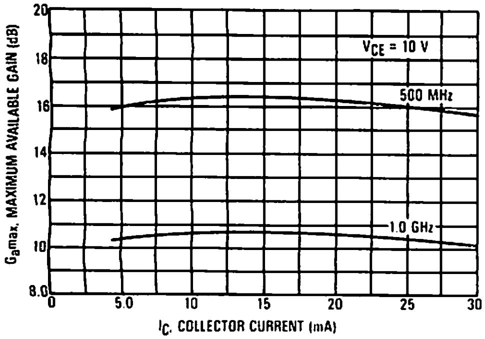


FIGURE 4 — $|S_{21}|^2$ versus FREQUENCY

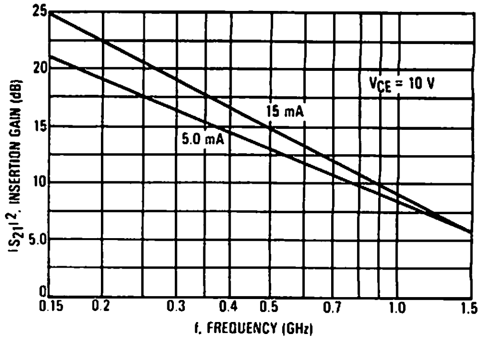


FIGURE 5 — NOISE FIGURE versus COLLECTOR CURRENT

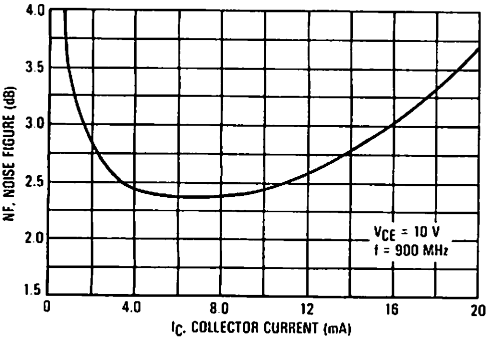


FIGURE 6 — NOISE FIGURE versus FREQUENCY

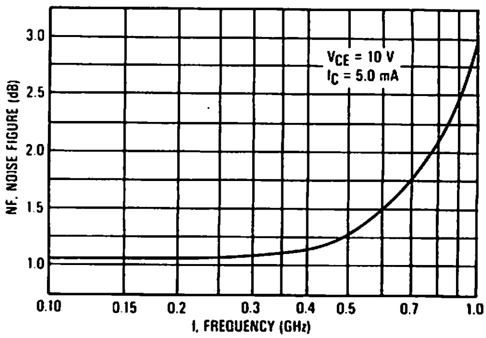


FIGURE 7 — INPUT CAPACITANCE versus EMITTER-BASE VOLTAGE

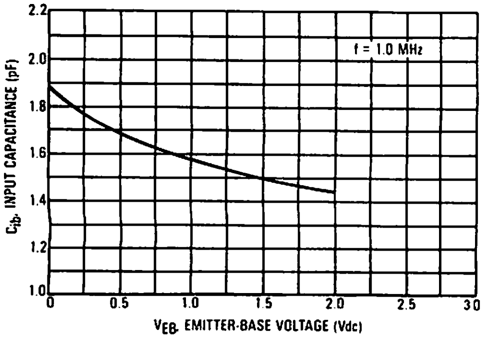


FIGURE 8 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

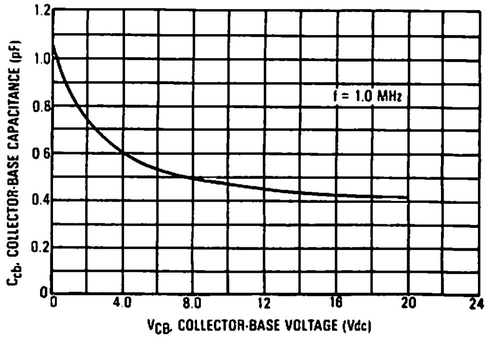


TABLE I

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	100	0.76	-35	9.42	142	0.03	67	0.85	-18
		200	0.60	-63	7.98	122	0.05	58	0.70	-26
		500	0.28	-127	4.79	84	0.09	55	0.53	-35
		1000	0.27	148	2.71	50	0.15	51	0.42	-51
		1500	0.43	113	2.02	23	0.21	42	0.28	-79
	10	100	0.57	-51	14.80	131	0.03	65	0.75	-22
		200	0.36	87	10.80	108	0.04	62	0.60	-26
		500	0.18	151	5.23	77	0.08	62	0.48	-31
		1000	0.25	136	2.86	47	0.15	55	0.39	-48
		1500	0.42	109	2.12	22	0.22	42	0.25	-75
	15	100	0.42	67	17.80	123	0.02	66	0.69	-22
		200	0.26	105	11.50	101	0.04	66	0.56	-23
		500	0.17	169	5.27	74	0.08	66	0.47	-28
		1000	0.26	131	2.86	46	0.15	57	0.39	-47
		1500	0.43	108	2.12	21	0.22	44	0.25	-73
	20	100	0.33	82	18.66	117	0.02	67	0.66	-21
		200	0.22	120	11.54	98	0.03	68	0.55	-21
		500	0.17	171	5.16	72	0.08	67	0.48	-27
		1000	0.28	129	2.80	45	0.15	58	0.40	-45
		1500	0.45	107	2.07	19	0.22	45	0.27	-71
	25	100	0.28	103	18.11	113	0.02	68	0.64	-20
		200	0.22	138	11.03	95	0.03	70	0.55	-19
		500	0.20	169	4.94	71	0.08	68	0.50	-25
		1000	0.32	128	2.68	43	0.15	60	0.42	-44
		1500	0.49	106	1.98	17	0.22	47	0.30	-71
	30	100	0.31	127	16.10	109	0.02	67	0.64	-16
		200	0.28	156	9.69	93	0.03	70	0.57	-16
		500	0.28	160	4.32	69	0.07	70	0.53	-25
		1000	0.39	125	2.37	41	0.14	63	0.46	-44
		1500	0.55	104	1.73	15	0.21	51	0.34	-72

TABLE II

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
10	5.0	100	0.79	33	9.36	144	0.03	68	0.88	-15
		200	0.63	58	7.97	124	0.04	58	0.74	-22
		500	0.28	117	4.87	86	0.07	57	0.60	-31
		1000	0.23	153	2.80	53	0.13	56	0.50	-46
		1500	0.38	116	2.09	26	0.19	48	0.38	-69
	10	100	0.60	-48	14.87	132	0.02	66	0.79	-18
		200	0.39	-79	11.06	110	0.03	63	0.65	-21
		500	0.16	-135	5.38	79	0.07	64	0.56	-28
		1000	0.20	138	2.97	50	0.13	59	0.47	-44
		1500	0.37	111	2.21	25	0.20	49	0.36	-66
	15	100	0.46	-61	18.20	124	0.02	66	0.74	-18
		200	0.28	-94	11.94	102	0.03	66	0.62	-19
		500	0.14	-154	5.45	76	0.07	67	0.55	-26
		1000	0.22	131	2.97	48	0.13	61	0.48	-42
		1500	0.38	109	2.21	24	0.20	50	0.36	-64
	20	100	0.37	-72	19.38	119	0.02	67	0.71	-17
		200	0.23	-105	11.97	99	0.03	68	0.61	-18
		500	0.14	-172	5.36	74	0.07	69	0.56	-24
		1000	0.23	128	2.91	47	0.13	62	0.48	-41
		1500	0.40	108	2.16	22	0.20	51	0.37	-64
	25	100	0.32	-86	19.40	115	0.02	68	0.70	-16
		200	0.22	-119	11.67	97	0.03	69	0.61	-16
		500	0.19	-176	5.28	74	0.06	70	0.57	-23
		1000	0.26	127	2.82	46	0.13	63	0.50	-41
		1500	0.43	107	2.09	21	0.19	53	0.40	-63
	30	100	0.29	-103	18.29	112	0.02	68	0.70	-14
		200	0.22	-135	10.86	95	0.03	70	0.62	-15
		500	0.20	165	4.82	72	0.06	72	0.59	-22
		1000	0.31	125	2.63	44	0.12	66	0.53	-41
		1500	0.47	106	1.95	19	0.19	55	0.43	-64

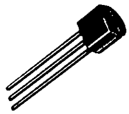
The RF Line
NPN Silicon
High Frequency Transistors

MPS911
MMBR911L

I_C = 60 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTORS
NPN SILICON

... designed for low noise, wide dynamic range front-end amplifiers and low-noise VCO's. Available in a surface-mountable plastic package, as well as the popular TO-226AA (TO-92) package. This Motorola series of small-signal plastic transistors offers *superior quality* and performance at low cost.

- High Gain-Bandwidth Product
  f_T = 7 GHz (Typ) @ 30 mA
- Low Noise Figure
  NF = 1.7 dB (Typ) @ 500 MHz
- High Gain
  G_{NF} = 17 dB (Typ) @ 10 mA/500 MHz
- State-of-the-Art Technology
  Fine Line Geometry
  Ion-Implanted Arsenic Emitters
  Gold Top Metallization and Wires
  Silicon Nitride Passivation
- Tape and Reel Packaging Options



CASE 29-04, STYLE 2
TO-226AA
(TO-92)
MPS911

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR911L

MAXIMUM RATINGS

Ratings	Symbol	MPS911	MMBR911L	Unit
Collector-Emitter Voltage	V_{CEO}	12		Vdc
Collector-Base Voltage	V_{CBO}	20		Vdc
Emitter-Base Voltage	V_{EBO}	3		Vdc
Collector Current — Continuous	I_C	60		mA
Power Dissipation @ T_A = 25°C	P_D	625	200 (Free Air)	mW
Storage Temperature	T_{stg}	−55 to +150		°C

DEVICE MARKING

MMBR911L = 7P

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mA, I_B = 0)	$V_{(BR)CEO}$	12	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	—	1	pF
Current Gain-Bandwidth Product (V_{CE} = 10 Vdc, I_C = 30 mAdc, f = 1 GHz)	f_T				GHz
MPS911		—	7	—	
MMBR911L		—	6	—	
FUNCTIONAL TESTS					
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc)	G_{NF}				dB
MPS911 f = 0.5 GHz		—	16.5	—	
f = 1 GHz		—	11	—	
MMBR911L f = 0.5 GHz		—	17	—	
f = 1 GHz		—	11	—	
Noise Figure (I_C = 10 mAdc, V_{CE} = 10 Vdc)	NF				dB
MPS911 f = 0.5 GHz		—	1.7	—	
f = 1 GHz		—	2.7	—	
MMBR911L f = 0.5 GHz		—	2	—	
f = 1 GHz		—	2.9	—	

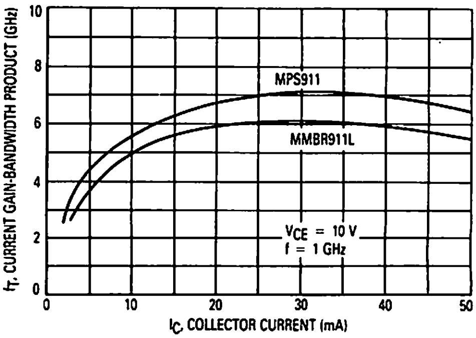
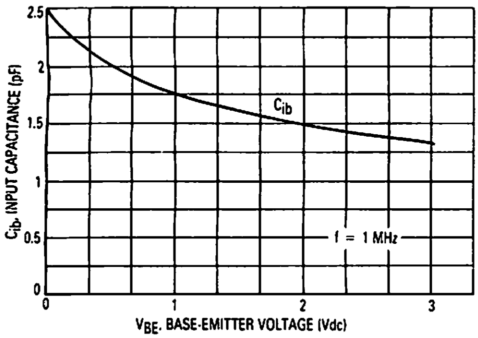


Figure 1. Current Gain-Bandwidth versus Collector Current @ 1 GHz

Figure 2. Input Capacitance versus Base-Emitter Voltage

(a) TO-92 MPS911



(b) SOT-23 MMBR911L

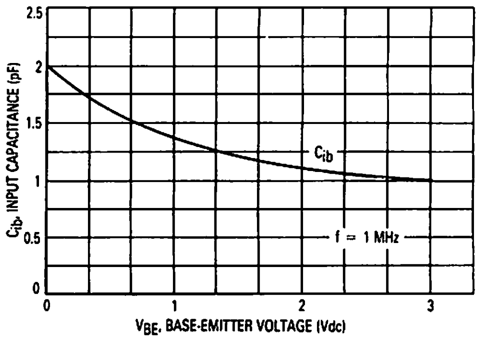
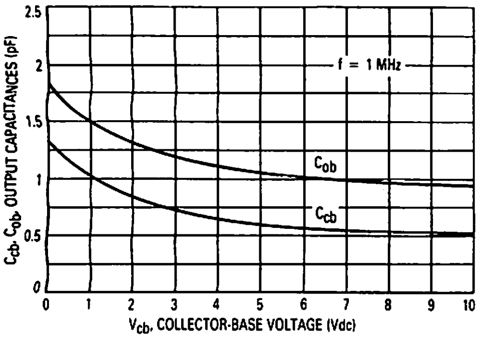


Figure 3. Output Capacitances versus Collector-Base Voltage

(a) TO-92 MPS911



(b) SOT-23 MMBR911L

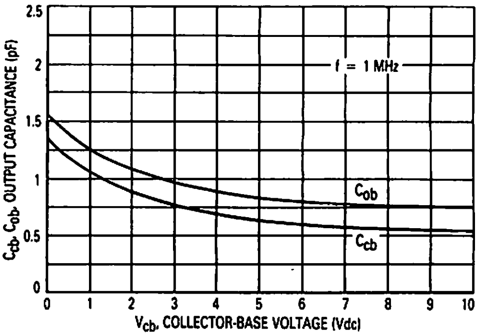
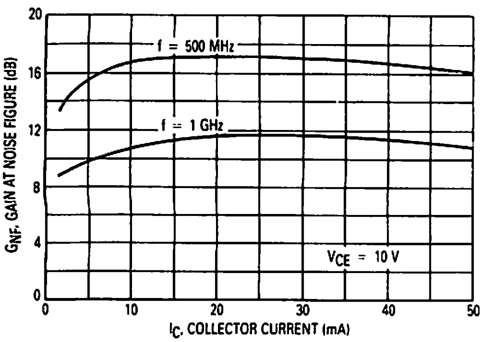
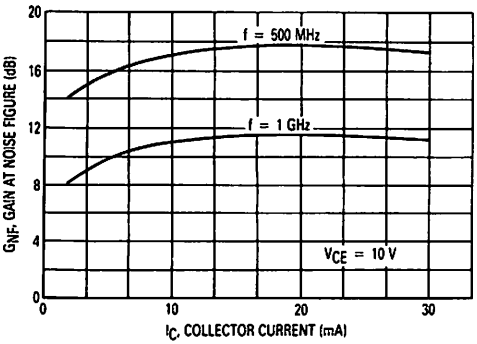


Figure 4. Gain at Noise Figure versus Collector Current

(a) TO-92 MPS911



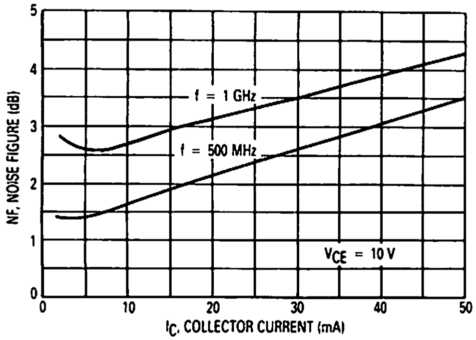
(b) SOT-23 MMBR911L



2

Figure 5. Noise Figure versus Collector Current

(a) TO-92 MPS911



(b) SOT-23 MMBR911L

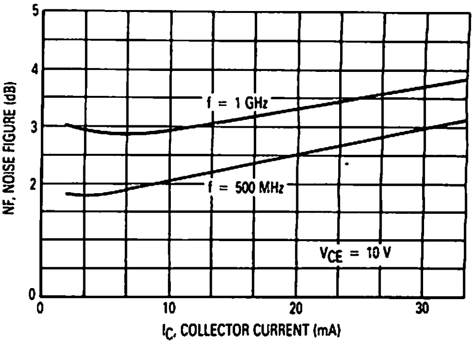
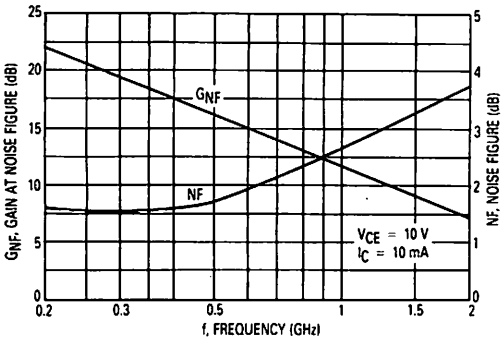


Figure 6. Gain at Noise Figure and Noise Figure versus Frequency

(a) TO-92 MPS911



(b) SOT-23 MMBR911L

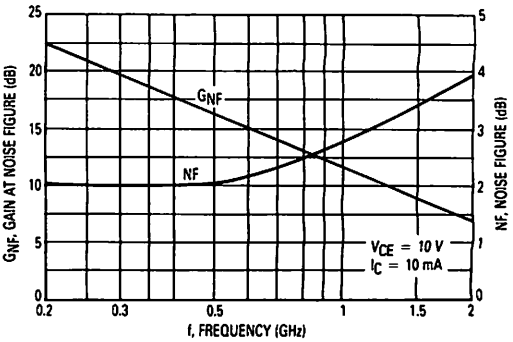
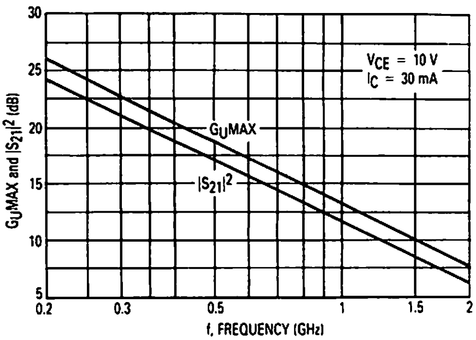
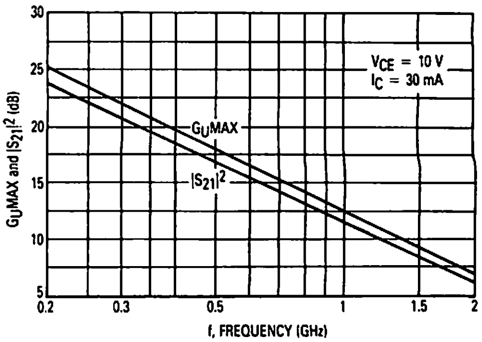


Figure 7. Maximum Unilateral Gain and Insertion Gain versus Frequency

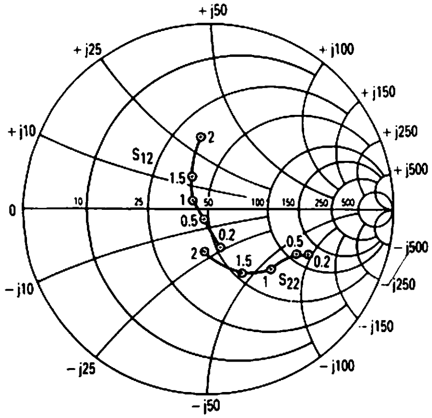
(a) TO-92 MPS911



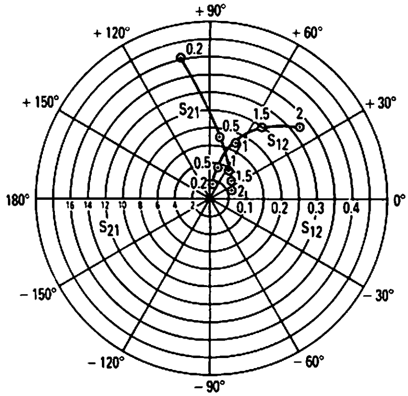
(b) SOT-23 MMBR911L



TO-92 MPS911



INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
V_{CE} = 10 V, I_C = 30 mA



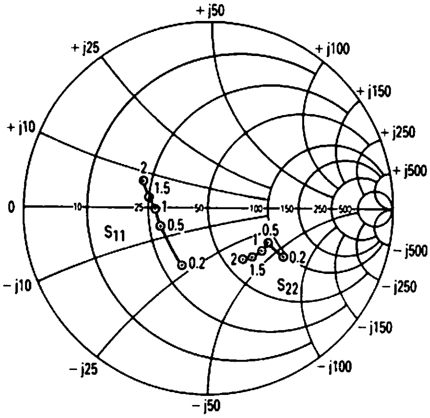
FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
V_{CE} = 10 V, I_C = 30 mA

COMMON EMITTER S-PARAMETERS

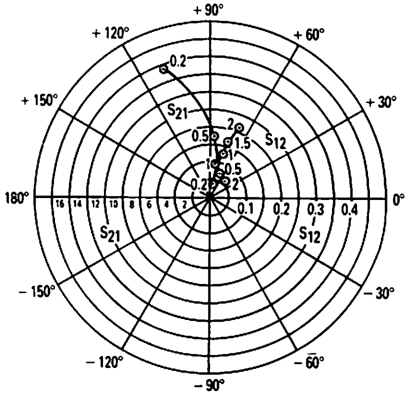
V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
10	2	200	0.78	−46	4.42	134	0.06	69	0.95	−18
		500	0.46	−107	3.35	98	0.10	56	0.78	−30
		1000	0.30	172	2.23	61	0.14	54	0.66	−48
		1500	0.41	118	1.66	34	0.20	51	0.57	−70
		2000	0.60	89	1.43	11	0.29	45	0.46	−107
	5	200	0.72	−55	8.75	126	0.05	68	0.87	−23
		500	0.31	−107	5.23	92	0.09	63	0.68	−31
		1000	0.18	178	3.05	61	0.15	60	0.57	−46
		1500	0.27	122	2.22	38	0.22	52	0.50	−66
		2000	0.45	94	1.90	17	0.30	43	0.38	−97
	10	200	0.48	−64	12.79	114	0.04	73	0.74	−24
		500	0.16	−100	6.19	85	0.09	71	0.60	−29
		1000	0.09	165	3.45	59	0.17	63	0.50	−44
		1500	0.22	112	2.50	36	0.25	50	0.41	−65
		2000	0.41	90	2.14	16	0.32	38	0.26	−98
	20	200	0.29	−67	15.30	106	0.04	78	0.65	−23
		500	0.08	−92	6.76	82	0.09	75	0.55	−27
		1000	0.06	144	3.71	58	0.17	64	0.46	−43
		1500	0.20	108	2.65	30	0.25	51	0.37	−63
		2000	0.38	89	2.25	18	0.32	38	0.23	−94
	30	200	0.20	−70	16.04	103	0.04	80	0.61	−22
		500	0.05	−97	6.90	81	0.09	77	0.53	−25
		1000	0.07	138	3.76	58	0.17	66	0.46	−41
		1500	0.20	109	2.68	38	0.25	52	0.37	−61
		2000	0.38	90	2.28	20	0.32	40	0.24	−91
	50	200	0.13	−78	15.26	99	0.04	82	0.62	−18
		500	0.03	−145	6.48	79	0.09	78	0.56	−23
		1000	0.11	126	3.55	56	0.17	67	0.49	−40
		1500	0.24	105	2.56	36	0.25	53	0.39	−62
		2000	0.43	87	2.17	17	0.32	40	0.25	−95

2

SOT-23 MMBR911L



INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY
V_{CE} = 10 V, I_C = 30 mA



FORWARD AND REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY
V_{CE} = 10 V, I_C = 30 mA

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
10	2	200	0.82	-45	4.14	145	0.06	66	0.88	-16
		500	0.60	-96	3.23	112	0.09	49	0.71	-27
		1000	0.47	-149	2.16	85	0.11	49	0.62	-34
		1500	0.46	-179	1.59	71	0.13	55	0.58	-43
		2000	0.47	162	1.35	57	0.16	62	0.56	-51
	5	200	0.66	-63	8.63	134	0.05	64	0.75	-25
		500	0.43	-117	5.29	100	0.07	58	0.55	-31
		1000	0.37	-163	3.05	82	0.11	63	0.48	-36
		1500	0.38	176	2.17	70	0.15	65	0.45	-44
		2000	0.40	160	1.81	57	0.19	65	0.43	-51
	10	200	0.49	-83	12.70	124	0.04	65	0.62	-30
		500	0.33	-134	6.42	94	0.07	66	0.44	-32
		1000	0.32	-171	3.53	80	0.12	70	0.41	-36
		1500	0.35	173	2.46	69	0.16	69	0.38	-45
		2000	0.37	159	2.04	58	0.20	66	0.35	-52
	20	200	0.36	-103	15.25	114	0.03	69	0.52	-32
		500	0.28	-149	6.95	90	0.06	72	0.39	-30
		1000	0.29	-176	3.73	78	0.12	73	0.37	-35
		1500	0.33	172	2.60	68	0.17	71	0.34	-43
		2000	0.36	158	2.14	58	0.21	67	0.32	-52
	30	200	0.32	-114	15.64	109	0.03	71	0.48	-29
		500	0.27	-156	6.92	88	0.06	73	0.38	-27
		1000	0.29	-178	3.71	78	0.12	74	0.37	-33
		1500	0.34	170	2.58	68	0.16	72	0.34	-44
		2000	0.37	156	2.13	57	0.21	68	0.32	-51

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MPS1983 (See MPS901)

MPS3866

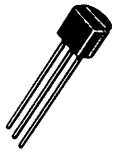
Die Source Same as 2N3866

The RF Line

I_C = 400 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON



CASE 29-04, STYLE 2
TO-226AA
(TO-92)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 10 Ω)	$V_{(BR)CER}$	55	—	Vdc
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{CEO(sus)}$	30	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, I_B = 0)	I_{CEO}	—	0.02	mAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = −1.5 Vdc (Rev.), T_C = 150°C) (V_{CE} = 55 Vdc, V_{BE} = −1.5 Vdc (Rev.)	I_{CEX}	 — —	 5.0 0.1	mAdc
Emitter Cutoff Current (V_{BE} = 3.5 Vdc, I_C = 0)	I_{EBO}	—	0.1	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)(1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	 5.0 10	 — 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	—	1.0	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	500	—	MHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	—	3.0	pF
FUNCTIONAL TEST				
Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	G_{pe}	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	η	45	—	%

(1) Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRA0500-19L

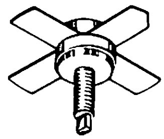
The RF Line
UHF Power Transistor

2

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 500 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 500 MHz Characteristics:
  Output Power — 19 Watts, 1 dB Compression
  Power Gain — 8 dB Min, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**8 dB
TO 500 MHz
19 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	117 0.667	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mA, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 19 V, I_E = 0)	I_{CBO}	—	—	30	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	75	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 19 V, P_{in} = 1 mW, f = 500 MHz)	G_{SS}	8	—	—	dB
Load Mismatch (V_{CE} = 19 V, I_C = 3.5 A, P_{out} = 19 W, f = 500 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (V_{CE} = 19 V, I_C = 3.5 A, f = 500 MHz) (No degradation)	$P_{in_{over}}$	—	—	10	W
Output Power, 1 dB Compression Point (V_{CE} = 19 V, f = 500 MHz, I_C = 3.5 A)	$P_{o1\ dB}$	19	—	—	W

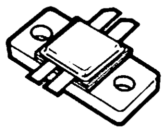
MRA0510-50H

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 500 to 1000 MHz frequency range.

- Designed for Class AB Linear Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
  Output Power — 50 Watts
  Power Gain — 7 dB Min, Class AB
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

**7 dB
500–1000 MHz
50 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



CASE 391-01, STYLE 1
(HLP-42)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	125 0.715	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mA, R_{BE} = 1 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	24	pF

Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 1 GHz, I_{CQ} = 2 x 120 mA)	G_{PE1}	7	—	—	dB
Load Mismatch (V_{CE} = 28 V, I_{CQ} = 2 x 120 mA, P_{out} = 50 W, f = 1 GHz, Load VSWR = 5:1, All Phase Angles)	ψ	No Degradation in Output Power			
Broadband Power Gain (V_{CE} = 28 V, P_{out} = 45 W, f = 500 MHz & 1 GHz, I_{CQ} = 2 × 120 mA)	G_{PE2}	6.5	—	—	dB

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

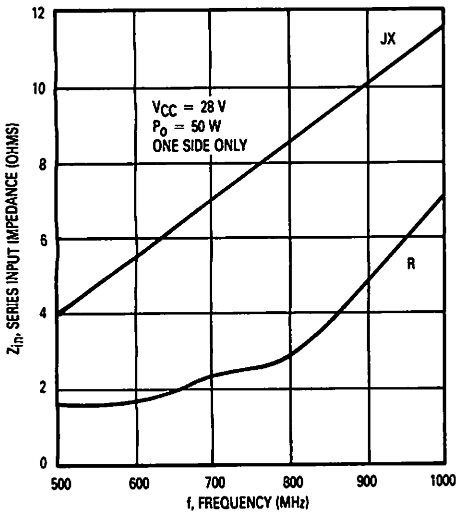


Figure 1. Input Impedance versus Frequency

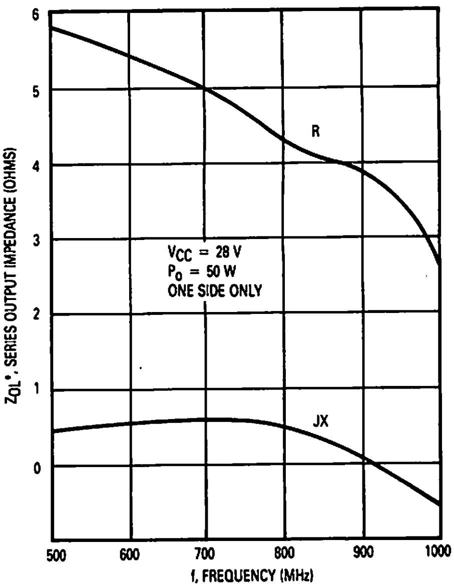


Figure 2. Output Impedance versus Frequency

MRA0610 Series

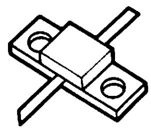
2

The RF Line
UHF Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 600 to 1000 MHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
  Output Power — 3 to 40 Watts
  Power Gain — 7 to 7.8 dB Min, Common Base
  Collector Efficiency — 50 to 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**7 to 7.8 dB
600–1000 MHz
3 TO 40 WATTS
BROADBAND
UHF POWER
TRANSISTORS**



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-3	-9	-18A	-40A	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1.5	2.5	5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	6	4	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA0610-3		50	—	—	
(I_C = 60 mA, V_{BE} = 0)	-9		50	—	—	
(I_C = 100 mA, V_{BE} = 0)	-18A		50	—	—	
(I_C = 200 mA, V_{BE} = 0)	-40A		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA0610-3		3.5	—	—	
(I_E = 0.75 mA, I_C = 0)	-9		3.5	—	—	
(I_E = 1.25 mA, I_C = 0)	-18A		3.5	—	—	
(I_E = 2.5 mA, I_C = 0)	-40A		3.5	—	—	
Collector Cutoff Current	MRA0610-3	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	-9		—	—	1.5	
	-18A		—	—	2.5	
	-40A		—	—	5	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRA0610-3		10	—	100	
(I_C = 0.3 A, V_{CE} = 5 V)	-9		10	—	100	
(I_C = 0.5 A, V_{CE} = 5 V)	-18A		10	—	100	
(I_C = 1 A, V_{CE} = 5 V)	-40A		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRA0610-3	C_{ob}	—	—	4.5	pF
(V_{CB} = 28 V, I_E = 0, f = 1 MHz)	- 9		—	—	10	
	-18A		—	—	14	
	-40A		—	—	28	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 3 W, f = 0.6 & 1 GHz)	MRAL0610-3		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 0.6 & 1 GHz)	-9		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 18 W, f = 0.6 & 1 GHz)	-18A		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 40 W, f = 0.6 & 1 GHz)	-40A		7	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 3 W, f = 0.6 & 1 GHz)	MRA0610-3		50	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 0.6 & 1 GHz)	-9		55	—	—	
(V_{CE} = 28 V, P_{out} = 18 W, f = 0.6 & 1 GHz)	-18A		50	—	—	
(V_{CE} = 28 V, P_{out} = 40 W, f = 0.6 & 1 GHz)	-40A		50	—	—	

TYPICAL CHARACTERISTICS
MRA0610-3 — 3 WATTS BROADBAND

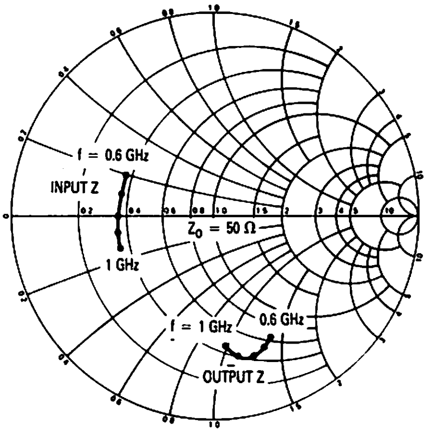


Figure 2. Series Equivalent Input/Output Impedance V_{CC} = 28 V

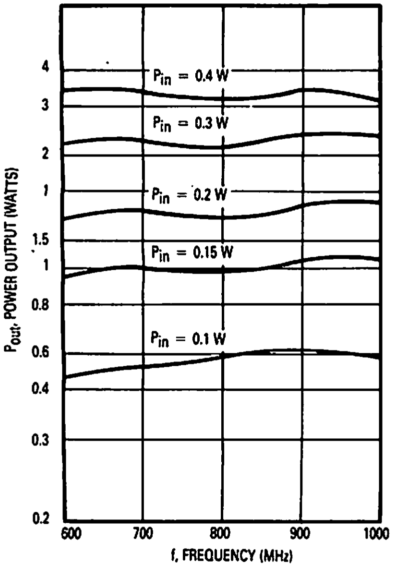


Figure 1. Power Output versus Frequency

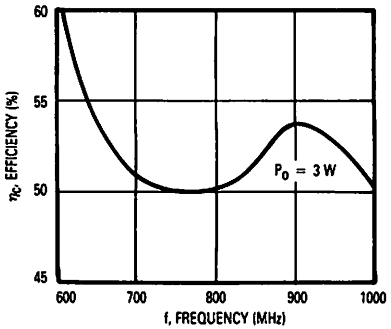


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA0610-9 — 9 WATTS BROADBAND

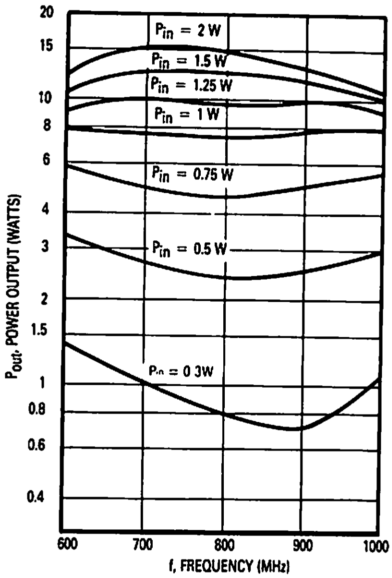


Figure 4. Power Output versus Frequency

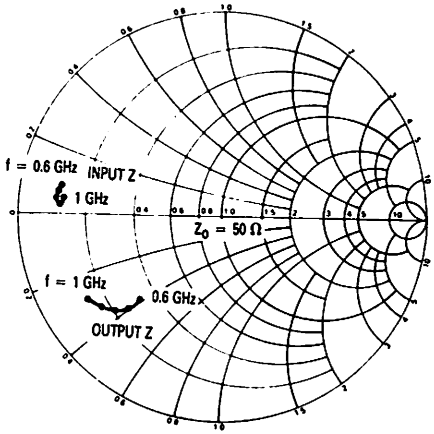


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

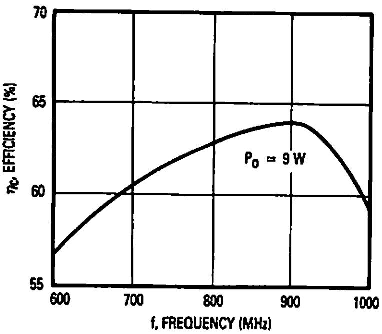


Figure 6. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA0610-18A — 18 WATTS BROADBAND

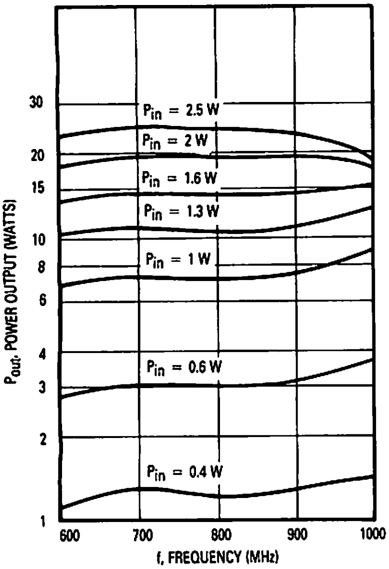


Figure 7. Power Output versus Frequency

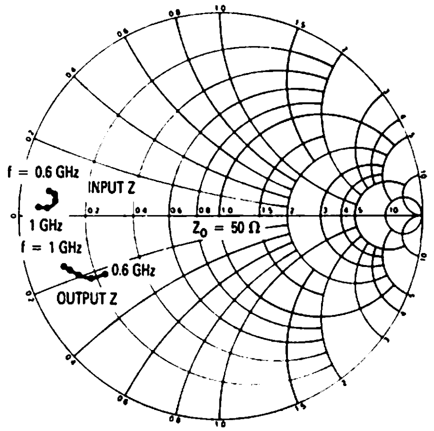


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

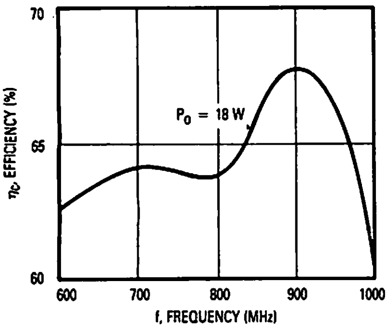


Figure 9. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS

MRA0610-40A — 40 WATTS BROADBAND

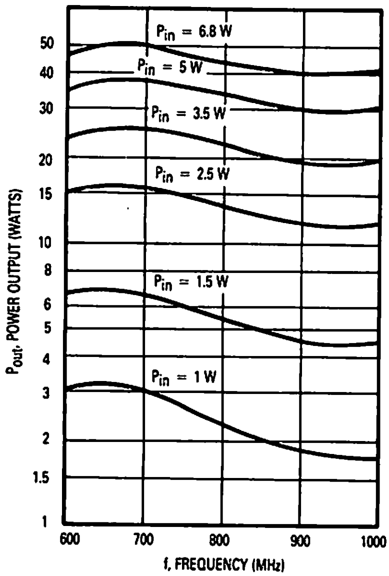


Figure 10. Power Output versus Frequency

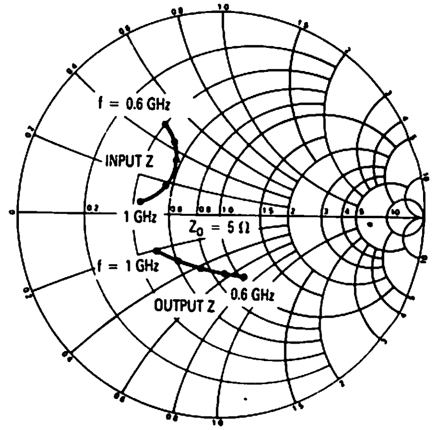


Figure 11. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

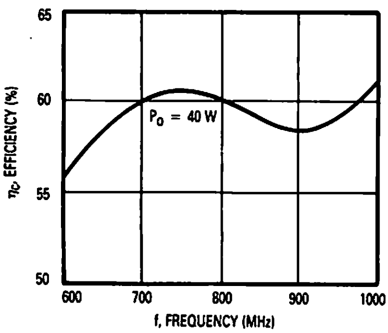


Figure 12. Efficiency versus Frequency

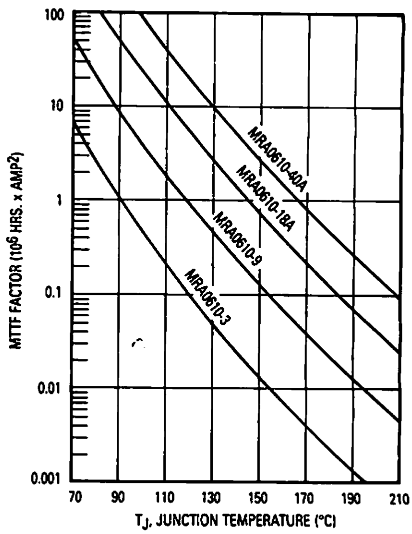
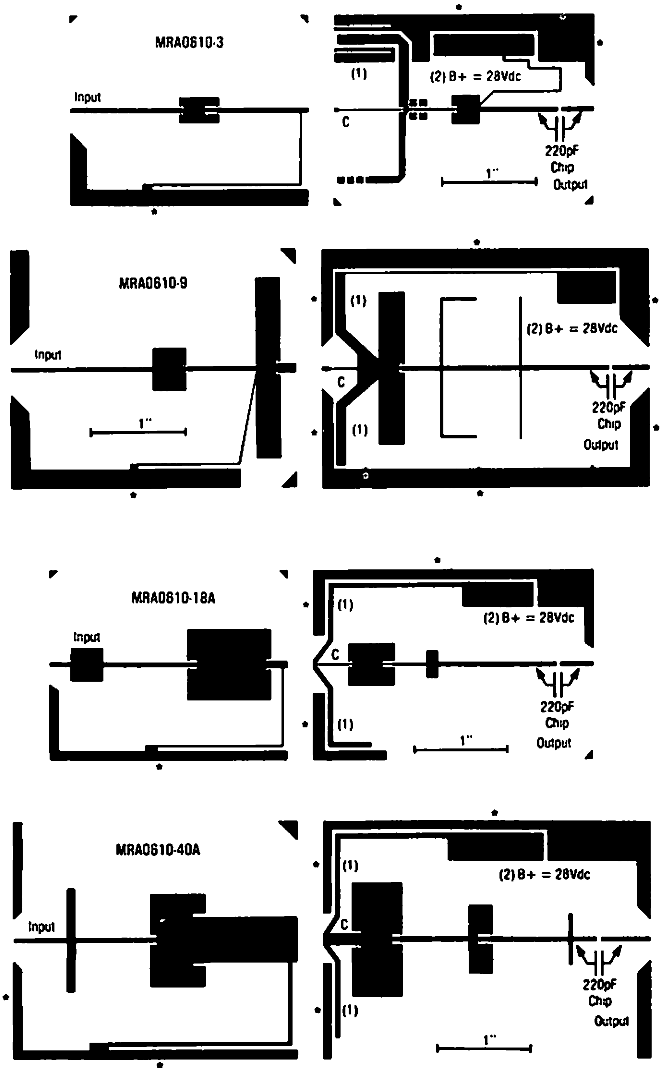


Figure 13. MTTF Factor versus Junction Temperature

Note: Divide by $I_C{}^2$ to obtain metal lifetime in hours



*Foil wrap or plate around to ground plane. Board material 0.020 inch glass teflon ϵ_r = 2.55.
(1) Bypass capacitor to ground for shunt inductor (220pF chip).
(2) Use B+ bypass of 0.01 and 1 μF capacitors at this point.

Figure 14. Test Circuit Boards for MRA0610 Series
(Not to Scale)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

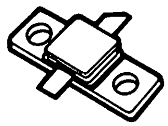
MRA0610H Series

The RF Line
UHF Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 600 to 1000 MHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1000 MHz Characteristics:
  Output Power — 3 to 18 Watts
  Power Gain — 7.8 dB Min, Common Base
  Collector Efficiency — 50 to 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

7.8 dB
600–1000 MHz
3 TO 18 WATTS
BROADBAND
UHF POWER
TRANSISTORS



CASE 393-01, STYLE 1
(HLP-11)

MAXIMUM RATINGS

Rating	Symbol	-3H	-9H	-18H	Unit
Collector-Base Voltage	V_{CES}		50		Vdc
Emitter-Base Voltage	V_{EBO}		3.5		Vdc
Collector Current — Continuous	I_C	0.5	1.5	2.5	Adc
Operating Junction Temperature	T_J		200		°C
Storage Temperature Range	T_{stg}		−65 to +200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	6	4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA0610- 3H		50	—	—	
(I_C = 60 mA, V_{BE} = 0)	- 9H		50	—	—	
(I_C = 100 mA, V_{BE} = 0)	-18H		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA0610- 3H		3.5	—	—	
(I_E = 0.75 mA, I_C = 0)	- 9H		3.5	—	—	
(I_E = 1.25 mA, I_C = 0)	-18H		3.5	—	—	
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	MRA0610- 3H	I_{CBO}	—	—	0.5	mAdc
	- 9H		—	—	1.5	
	-18H		—	—	2.5	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRA0610- 3H		10	—	100	
(I_C = 300 mA, V_{CE} = 5 V)	- 9H		10	—	100	
(I_C = 500 mA, V_{CE} = 5 V)	-18H		10	—	100	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz) MRA0610-3H	C_{ob}	—	—	4.5	pF
-9H		—	—	10	
-18H		—	—	14	
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain	G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 3 W, f = 600 MHz and 1 GHz) MRA0610-3H		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 600 MHz and 1 GHz) -9H		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 18 W, f = 600 MHz and 1 GHz) -18H		7.8	—	—	
Collector Efficiency	η_c				%
(V_{CE} = 28 V, P_{out} = 3 W, f = 600 MHz and 1 GHz) MRA0610-3H		50	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 600 MHz and 1 GHz) -9H		55	—	—	
(V_{CE} = 28 V, P_{out} = 18 W, f = 600 MHz and 1 GHz) -18H		55	—	—	

2

TYPICAL CHARACTERISTICS

Note: Divide by I_C^2 to obtain metal lifetime in hours.

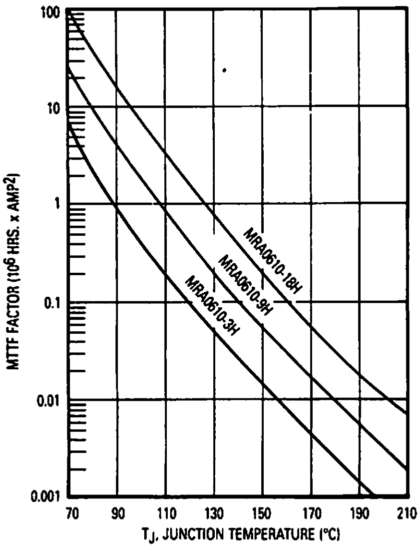


Figure 1. MTTF Factor versus Junction Temperature

2

MRA1000-3.5L

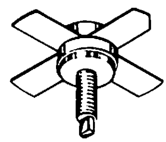
The RF Line

UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
  Output Power — 3.5 Watts
  Power Gain — 10 dB, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**10 dB
TO 1000 MHz
3.5 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	22 0.125	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{\theta JC}$	8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $I_B = 0$)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 10$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 10$ mA, $I_E = 0$)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 30$ V, $I_E = 0$)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 250$ mA, $V_{CE} = 5$ V)	h_{FE}	20	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 24$ V, $I_E = 0$, f = 1 MHz)	C_{ob}	—	—	15	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 19 V, P_{in} = 1 mW, f = 1 GHz, I_C = 600 mA)	G_{SS}	10	—	—	dB
Load Mismatch (V_{CE} = 19 V, I_C = 600 mA, P_{out} = 3.5 W, f = 1 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (V_{CE} = 19 V, I_C = 600 mA, f = 1 GHz) (No degradation)	$P_{in_{over}}$	—	—	1.75	W

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	$\angle\phi$	Mag	$\angle\phi$	Mag	$\angle\phi$	Mag	$\angle\phi$
19	600	0.5	0.91	174	1.78	53	0.03	23	0.55	−164
		0.6	0.9	173	1.64	47	0.03	21	0.58	−170
		0.7	0.87	171	1.53	36	0.03	19	0.63	−159
		0.8	0.85	168	1.51	24	0.03	15	0.68	−157
		0.9	0.82	168	1.49	10	0.03	5	0.74	−158
		1	0.78	168	1.5	−7	0.03	−4	0.83	−160

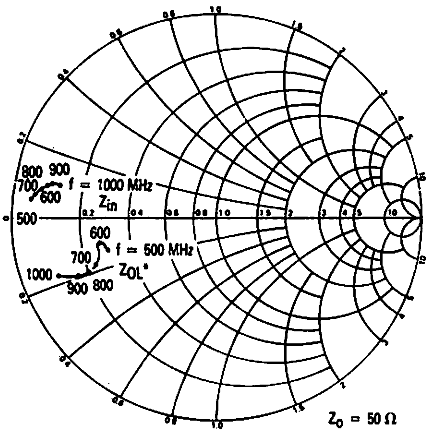
Figure 1. Common Emitter S-Parameters

Freq. (MHz)	Z^*_{OL} Re	Z^*_{OL} Im	Z_{IN} (Ohms) Re	Z_{IN} (Ohms) Im
500	14.6	-6.31	2.38	2.53
600	13.2	-4.07	2.74	3.18
700	11.7	-8.95	3.36	4.14
800	9.95	-9.65	4.12	5.13
900	7.72	-9.72	4.99	5.33
1000	4.67	-8.74	6.38	5.04

V_{CC} = 19 V, P_c = 3.5 W

Z^*_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given frequency, output power and voltage.

Figure 2. Z_{IN} and Z^*_{OL} versus Frequency



V_{CC} = 19 V, P_o = 3.5 W, Z_o = 50 Ω

Figure 3. Series Equivalent Input/Output Impedance

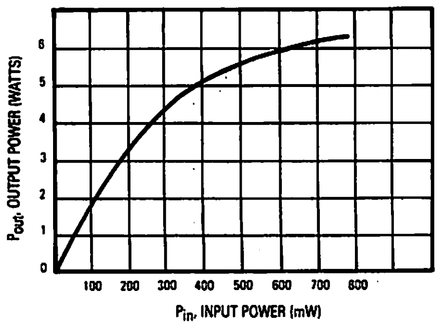
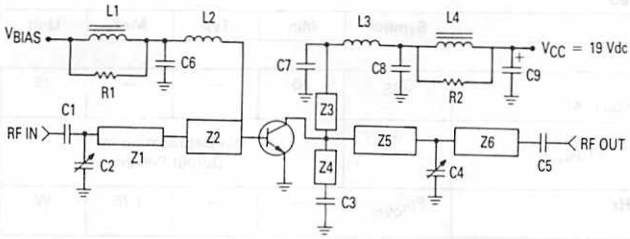


Figure 4. Power Input versus Power Output



L1 — 7T, 20 Gauge on 200 Mil Ferrite Toroid
L2 — 8T, 20 Gauge, 100 Mil Dia.
L3 — 11T, 20 Gauge, 100 Mil Dia.
L4 — 8T, 20 Gauge, on 275 Mil Ferrite Toroid
C1, C3, C5, C6, C7 — 500 pF ATC
C2, C4 — 0.8–10 pF JFD
C9 — 0.1 μF, 50 V, Ceramic
R1, R2 — 15 Ω, 1/4 Watt

Z1 — 50 Ω, microstripline, ℓ = 0.110λ
Z2 — 10 Ω, microstripline, ℓ = 0.162λ
Z3, Z4 — 50 Ω, microstripline, ℓ = 0.052λ
Z5 — 24 Ω, microstripline, ℓ = 0.080λ
Z6 — 50 Ω, microstripline, ℓ = 0.125λ

Figure 5. 1 GHz Test Circuit

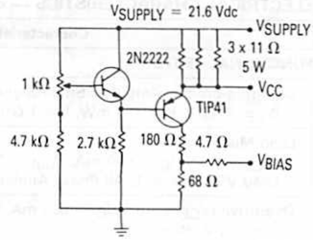
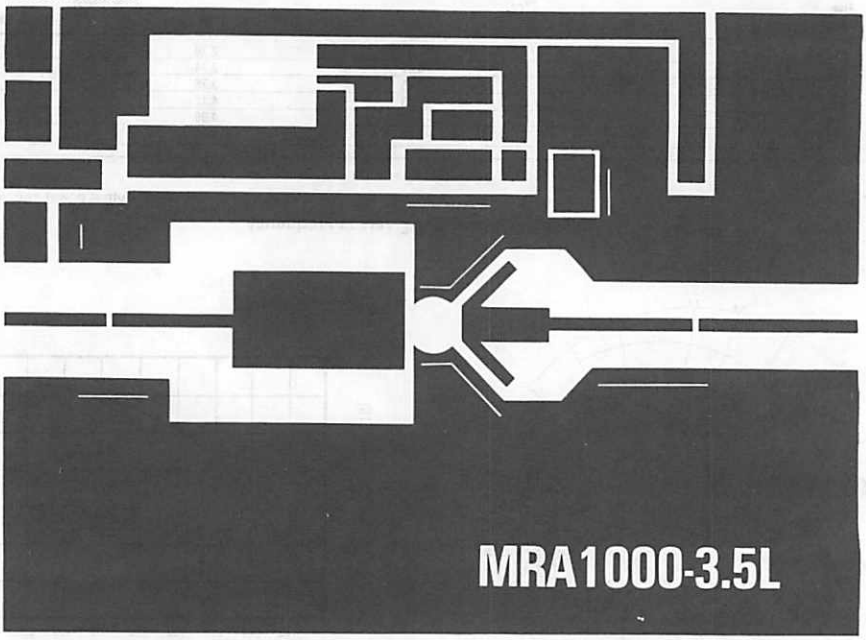


Figure 6. Bias Circuit

Test Circuit Mask



(Not to Scale)
Board Material = 1/32 Teflon-Fiberglass

Figure 7. Test Circuit Mask

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRA1000-7L

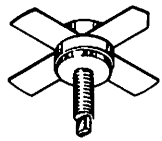
2

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
  - Output Power — 7 Watts
  - Power Gain — 9 dB Min, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

9 dB
TO 1000 MHz
7 WATTS
BROADBAND
UHF POWER
TRANSISTOR



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	42 0.25	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 19 V, I_E = 0)	I_{CBO}	—	—	15	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	22	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 19 V, f = 1 GHz, I_C = 1.2 A)	G_{SS}	9	10	—	dB
Load Mismatch (V_{CE} = 19 V, I_C = 1.2 A, P_{out} = 7 W, f = 1 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (V_{CE} = 19 V, I_C = 1.2 A, f = 1 GHz) (No degradation)	$P_{in_{over}}$	—	—	3.5	W
Output Power, 1 dB Compression Point (V_{CE} = 19 V, f = 1 GHz, I_C = 1.2 A)	$P_{o1\ dB}$	7	—	—	W

TYPICAL CHARACTERISTICS

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	$\angle\phi$	Mag	$\angle\phi$	Mag	$\angle\phi$	Mag	$\angle\phi$
19	1200	0.5	0.95	174	1.08	56	0.02	48	0.7	−179
		0.6	0.94	173	1.01	48	0.03	47	0.7	−177
		0.7	0.92	171	0.97	38	0.03	45	0.71	−176
		0.8	0.9	169	0.97	26	0.03	40	0.72	−175
		0.9	0.87	168	0.99	11	0.03	32	0.76	−174
		1	0.83	168	0.99	−9	0.03	30	0.82	−174

Figure 1. Common Emitter S-Parameters

Freq. (MHz)	Z_{OL}* (Ohms) Re	Z_{OL}* (Ohms) Im	Z_{IN} (Ohms) Re	Z_{IN} (Ohms) Im
500	8.69	-0.51	1.30	2.53
600	8.69	-1.14	1.59	3.01
700	8.39	-1.74	2.05	3.88
800	8.01	-2.21	2.67	4.63
900	7.00	-2.74	3.40	5.19
1000	4.95	-2.64	4.61	5.17

V_{CC} = 19 V, P_o = 7 W

Figure 2. Z_{IN} and Z_{OL}* versus Frequency

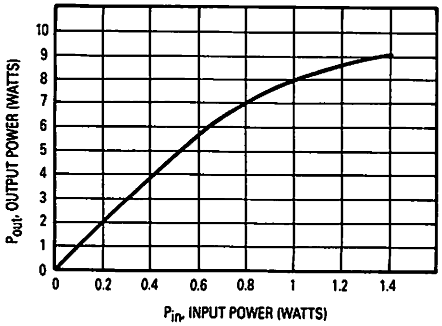
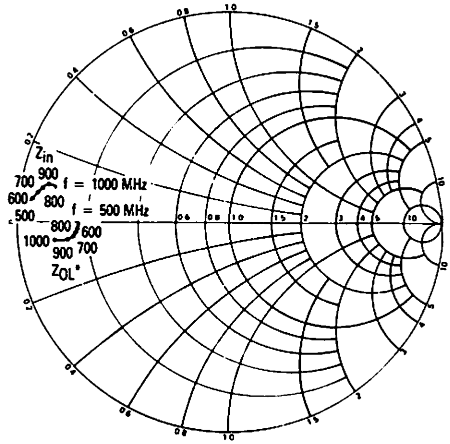
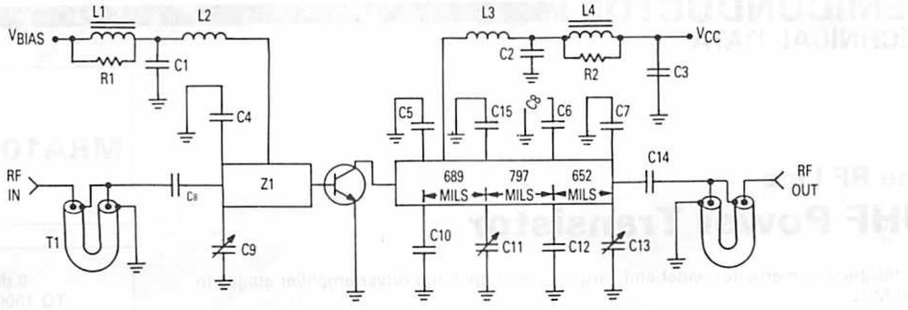


Figure 3. Power Output versus Power Input



V_{CC} = 19 V, P_o = 7 W, Z_O = 50 Ohms

Figure 4. Series Equivalent Input/Output Impedance



L1 — 7T, 20 Gauge on 200 Mil Ferrite Torroid
L2 — 7T, 20 Gauge, 100 Mil Dia.
L3 — 5T, 20 Gauge, 100 Mil Dia.
L4 — 8T, 20 Gauge, on 200 Mil Ferrite Torroid
R1, R2 — 15 Ohm, 1/4 Watt
C1, C2 — 500 pF ATC
C3 — 25 μF, Electrolytic
C4 — 3.3 pF ATC
C5 — 5.6 pF ATC
C6 — 1.6 pF ATC
C7 — 1.2 pF ATC

C8 — 33 pF ATC
C9, C13 — 0.3–1.3 pF Johanson
C10 — 6.2 pF ATC
C11 — 1–16 pF Johanson
C12 — 3 pF ATC
C14 — 33 pF ATC
C15 — 18 pF ATC
T1, T2 — 50 Ohm, ℓ = 2000 Mils
Z1 — 12.5 Ohm, ℓ = 914 Mils, 32 Mil, Teflon (ϵ_r = 2.55)
Z2 — 12.5 Ohm, ℓ = 2392 Mils, 32 Mil, Teflon (ϵ_r = 2.55)

Figure 5. 1 GHz Test Circuit

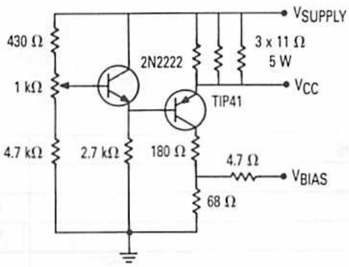
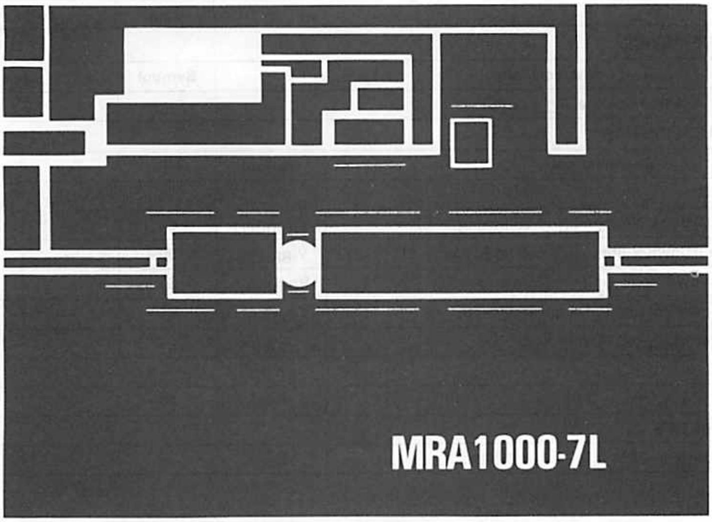


Figure 6. Bias Circuit



(Not to Scale)

Board Material = 1/32", Glass Teflon, K = 2.55

Figure 7. Test Circuit Mask

2

MRA1000-14L

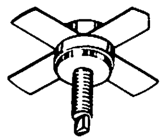
2

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1000 MHz.

- Designed for Class A Linear Power Amplifiers
- Specified 19 Volt, 1000 MHz Characteristics:
  - Output Power — 14 Watts
  - Power Gain — 8 dB, Small-Signal
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**8 dB
TO 1000 MHz
14 WATTS
BROADBAND
UHF POWER
TRANSISTOR**



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	83 0.48	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2.1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mA, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 19 V, I_E = 0)	I_{CBO}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	90	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	40	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 19 V, P_{in} = 1 mW, f = 1 GHz, I_C = 2.4 A)	G_{SS}	8	—	—	dB
Load Mismatch (V_{CE} = 19 V, I_C = 2.4 A, P_{out} = 14 W, f = 1 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (V_{CE} = 19 V, I_C = 2.4 A, f = 1 GHz) (No degradation)	$P_{in_{over}}$	—	—	7	W
Output Power, 1 dB Compression Point (V_{CE} = 19 V, f = 1 GHz, I_C = 2.4 A)	$P_{o1\ dB}$	14	—	—	W

TYPICAL CHARACTERISTICS

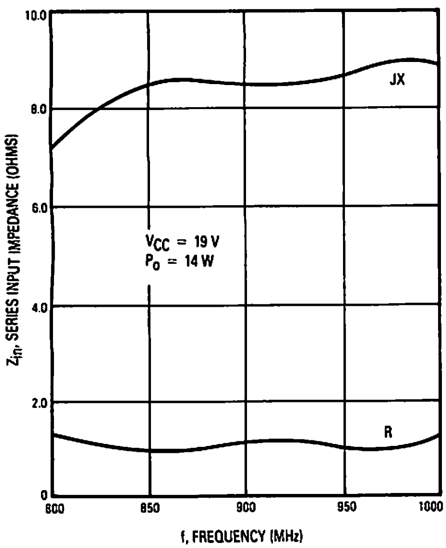


Figure 1. Input Impedance versus Frequency

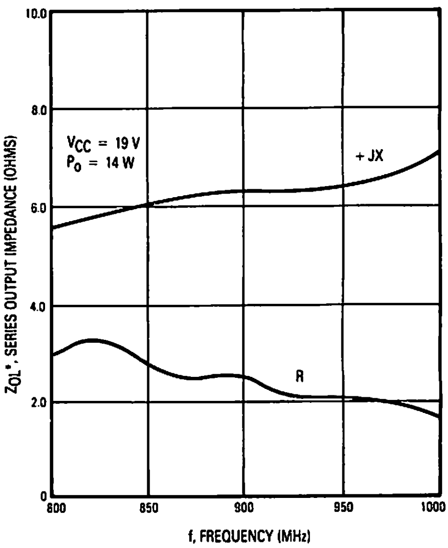


Figure 2. Output Impedance versus Frequency

S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
19	2400	0.5	0.98	175	0.56	57	0.02	69	0.84	177
		0.6	0.97	174	0.53	50	0.02	69	0.83	177
		0.7	0.96	173	0.5	41	0.03	66	0.83	176
		0.8	0.96	172	0.52	39	0.03	64	0.83	176
		0.9	0.94	168	0.5	18	0.03	58	0.83	176
		1	0.91	165	0.52	1	0.03	60	0.85	175

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRA1014 Series

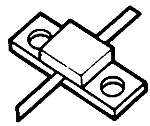
The RF Line
Microwave Power Transistors

2

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 1.4 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.4 GHz Characteristics:
  - Output Power — 2 to 35 Watts
  - Power Gain — 7 to 8.2 dB
  - Collector Efficiency — 45 to 50%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7 to 8 dB
1–1.4 GHz
2 TO 35 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-12	-35	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	2	5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1014-2		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	-6		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-12		50	—	—	
(I_C = 200 mA, V_{BE} = 0)	-35		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA1014-2		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	-6		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-12		3.5	—	—	
(I_E = 2.5 mA, I_C = 0)	-35		3.5	—	—	
Collector Cutoff Current	MRA1014-2	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	-6		—	—	1	
	-12		—	—	2	
	-35		—	—	5	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRA1014-2		10	—	100	
(I_C = 0.2 A, V_{CE} = 5 V)	-6		10	—	100	
(I_C = 0.4 A, V_{CE} = 5 V)	-12		10	—	100	
(I_C = 1 A, V_{CE} = 5 V)	-35		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRA1014-2	C_{ob}	—	—	4.5	pF
(V_{CB} = 28 V, I_E = 0, f = 1 MHz)	-6		—	—	8	
	-12		—	—	12	
	-35		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.0 & 1.4 GHz)	MRA1014-2		8.2	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.0 & 1.4 GHz)	-6		7.4	—	—	
(V_{CE} = 28 V, P_{out} = 12 W, f = 1.0 & 1.4 GHz)	-12		7.8	—	—	
(V_{CE} = 28 V, P_{out} = 35 W, f = 1.0 & 1.4 GHz)	-35		7	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.0 & 1.4 GHz)	MRA1014-2		45	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.0 & 1.4 GHz)	-6		50	—	—	
(V_{CE} = 28 V, P_{out} = 12 W, f = 1.0 & 1.4 GHz)	-12		50	—	—	
(V_{CE} = 28 V, P_{out} = 35 W, f = 1.0 & 1.4 GHz)	-35		50	—	—	

(1) Not measureable because of output matching network.

TYPICAL CHARACTERISTICS

MRA1014-2 — 2 WATTS BROADBAND

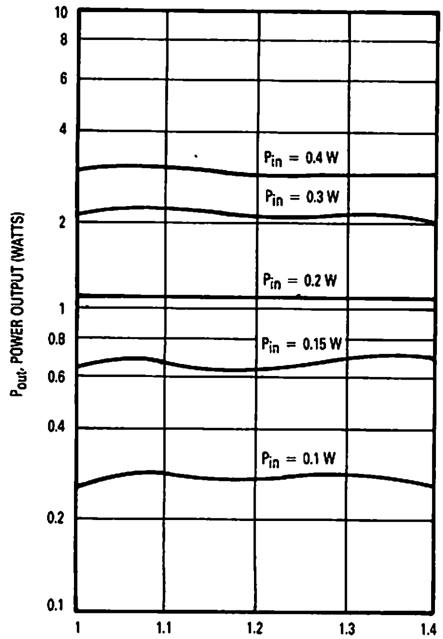


Figure 1. Power Output versus Frequency

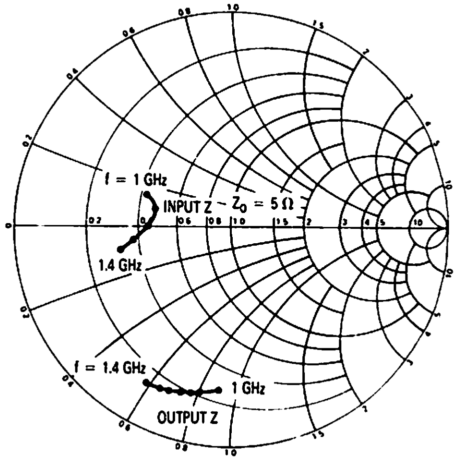


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

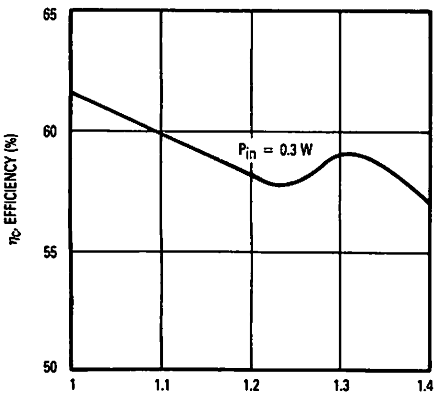


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1014-6 — 6 WATTS BROADBAND

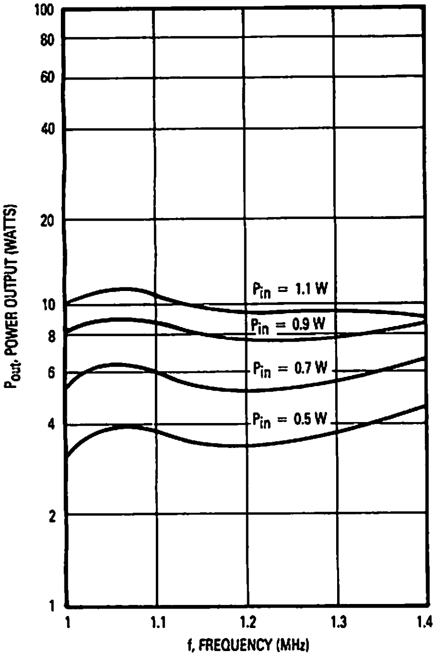


Figure 4. Power Output versus Frequency

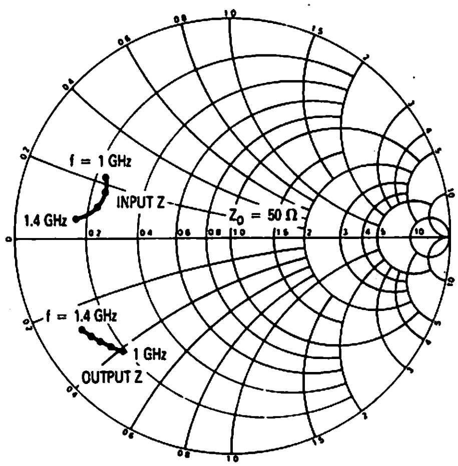


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

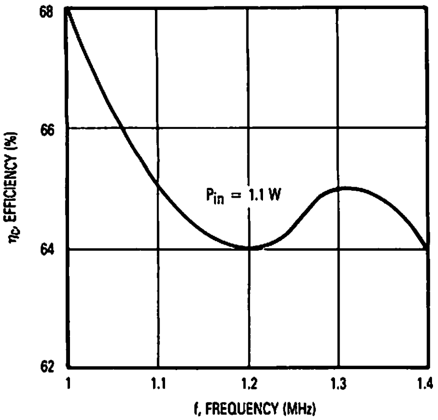


Figure 6. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS

MRA1014-12 — 12 WATTS BROADBAND

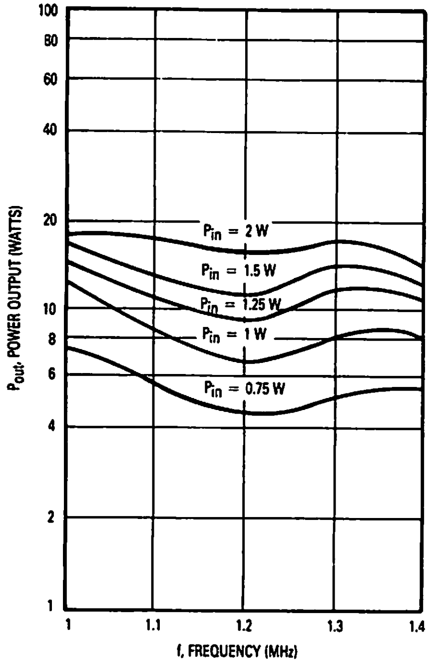


Figure 7. Power Output versus Frequency

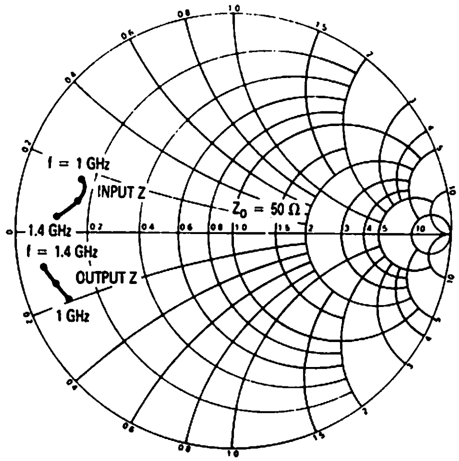


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

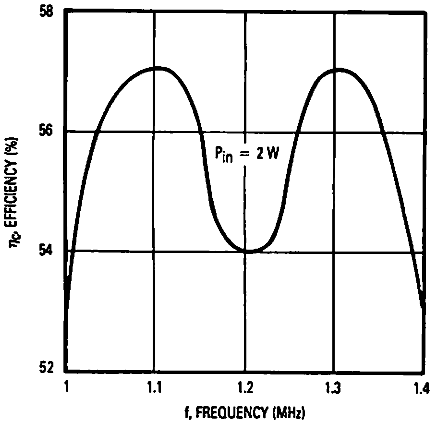


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1014-35 — 35 WATTS BROADBAND

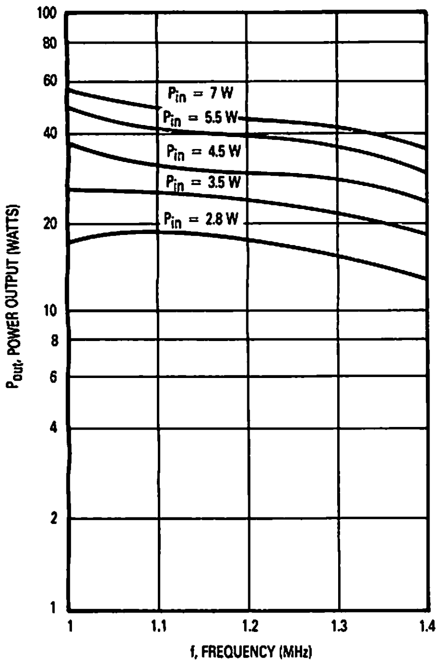


Figure 10. Power Output versus Frequency

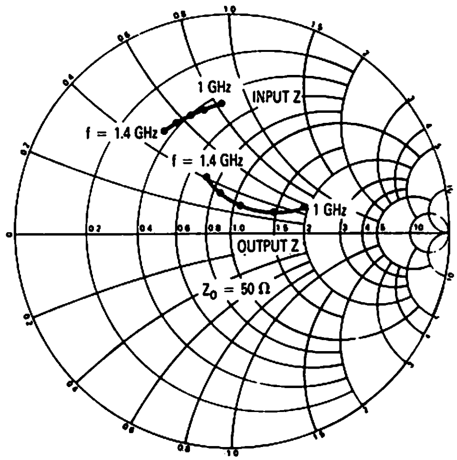


Figure 11. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

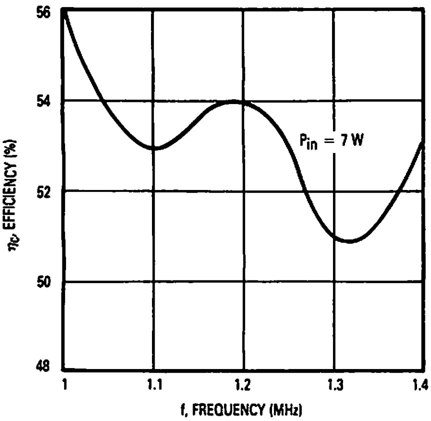
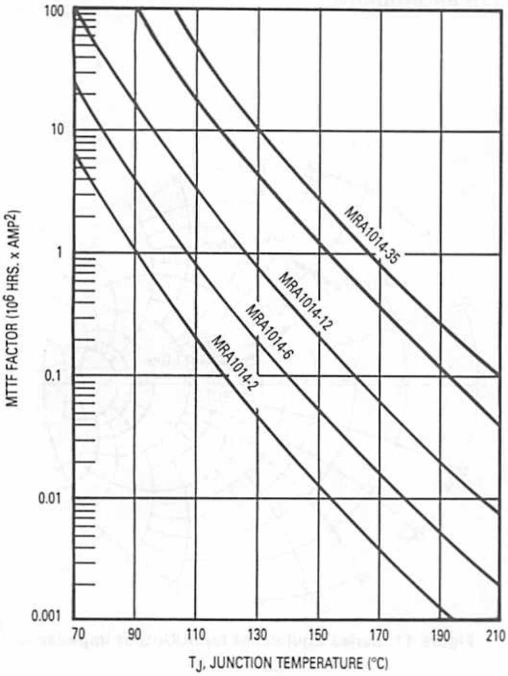


Figure 12. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



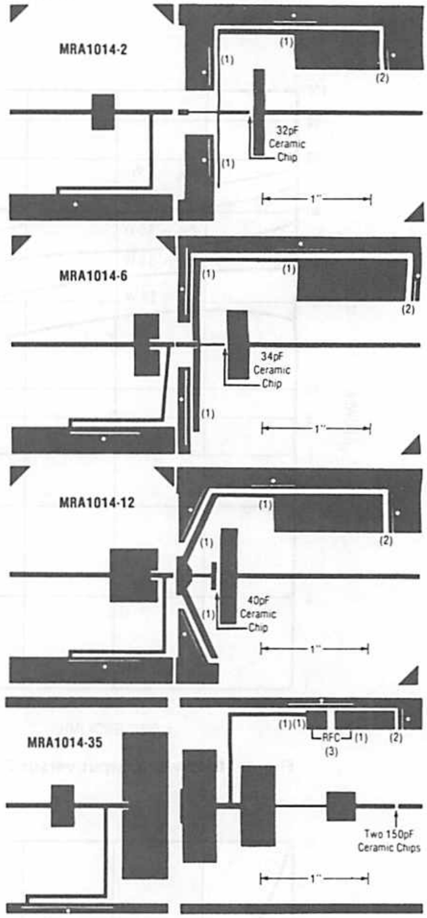
Example of MTTF for MRA1014-12 Conditions

$$P_o = 12\ W$$
$$P_{in} = 2\ W$$
$$V_{CC} = 28\ V$$
$$\eta = 50$$
$$T_{FLANGE} = 70°C$$
$$I_C \simeq I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.857\ A$$
$$P_{DISS} = P_{in} + V_{CC} \cdot I_C - P_o = 13.99\ W$$
$$T_{JUNC} = T_{FLANGE} + \theta_{JF} \times P_{DISS} = 132.9°C$$
$$MTTF = \frac{0.7 \times 10^6\ \text{Hrs. Amp}^2}{I_C^2} = 953{,}095\ \text{Hrs}$$
$$MTTF = 108.8\ \text{Yrs}$$

Figure 13. MTTF Factor (Normalized to 1 Ampere^2 Continuous Duty)

TEST CIRCUIT BOARDS FOR MRA1014 SERIES

NOTE: Scale is not 1:1.



*Foil wrap or plate around to ground plane. Board material 0.020 inch glass teflon ε_r = 2.55
(1) Bypass capacitor to ground (150pF chip)
(2) Use B+ bypass of 0.01 and 1μF capacitors at this point
(3) 10 turns #20 enamel close wound on 0.040 mandril

Figure 14. Test Circuit Boards (Not to Scale)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRA1014H Series

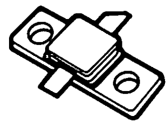
The RF Line

Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 1.4 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
  Output Power — 2 to 12 Watts
  Power Gain — 7.4 to 8 dB
  Collector Efficiency — 35 to 50%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- *Hermetic Package for Military/Space Applications*

7.4 to 8 dB
1–1.4 GHz
2 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 393-01, STYLE 1
(HLP-11)

2

MAXIMUM RATINGS

Rating	Symbol	-2H	-6H	-12H	Unit
Collector-Base Voltage	V_{CES}	50			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Collector Current — Continuous	I_C	0.5	1	2	Adc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1014- 2H		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	- 6H		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-12H		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.5 mA, I_C = 0)	MRA1014- 2H		3.5	—	—	
(I_E = 1 mA, I_C = 0)	- 6H		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-12H		3.5	—	—	
Collector Cutoff Current	MRA1014- 2H	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	- 6H		—	—	1	
	-12H		—	—	2	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRA1014- 2H		10	—	100	
(I_C = 200 mA, V_{CE} = 5 V)	- 6H		10	—	100	
(I_C = 400 mA, V_{CE} = 5 V)	-12H		10	—	100	

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	MRA1014- 2H	C_{ob}	—	—	4.5	pF
	- 6H		—	—	8	
	-12H		—	—	12	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.0 & 1.4 GHz)	MRA1014- 2H		8	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.0 & 1.4 GHz)	- 6H		7.4	—	—	
(V_{CE} = 28 V, P_{out} = 12 W, f = 1.0 & 1.4 GHz)	-12H		7.8	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.0 & 1.4 GHz)	MRA1014- 2H		35	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.0 & 1.4 GHz)	- 6H		50	—	—	
(V_{CE} = 28 V, P_{out} = 12 W, f = 1.0 & 1.4 GHz)	-12H		50	—	—	

MRA1214-55H

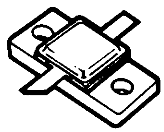
2

The RF Line
Microwave Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.2 to 1.4 GHz frequency range.

- Designed for Class C, Common-Base Pulse Power Amplifiers
- Specified 28 Volt, 1.4 GHz Characteristics:
  Output Power — 50 W CW, Min
  100 W Pulse, Typ
  Power Gain — 6.5 dB Min, CW
  Collector Efficiency — 45% Min, CW
- Built-In Matching Networks — Input and Output — for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

**6.5 dB
1.2–1.4 GHz
50 WATTS
MICROWAVE
POWER
TRANSISTOR**



CASE 402-01, STYLE 1
(HLP-15M)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	58	Vdc
Collector Current — Continuous	I_C	7.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	1.4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 120 mA, V_{BE} = 0)	$V_{(BR)CES}$	58	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 15 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	7.2	mAdc
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W CW, f = 1.4 GHz)	G_{PB}	6.5	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 50 W CW, f = 1.4 GHz)	η	45	—	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 50 W, f = 1.4 GHz, Load VSWR = 3:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

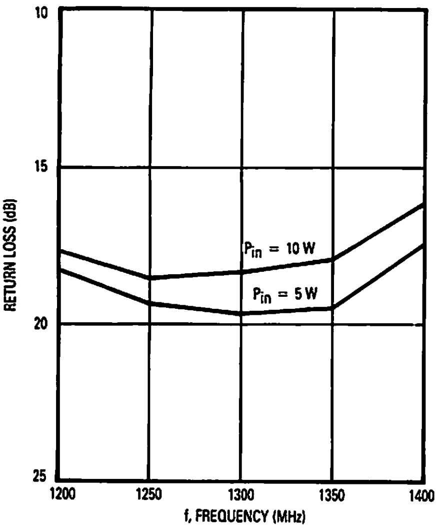


Figure 1. Input Return Loss versus Frequency

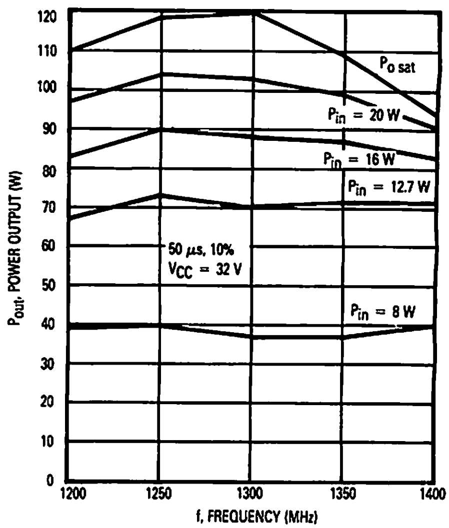


Figure 2. Power versus Frequency — Short Pulse

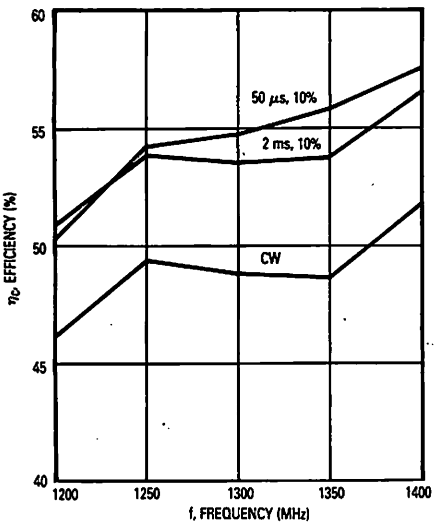


Figure 3. Efficiency versus Frequency

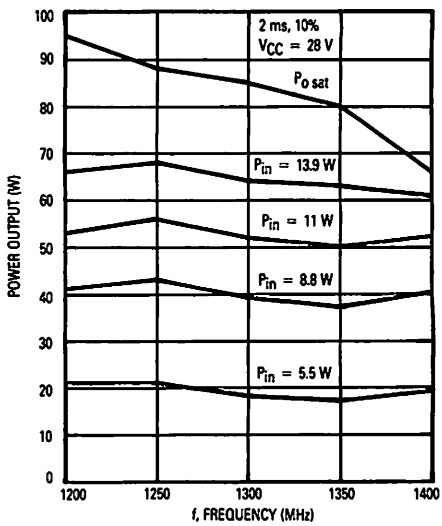
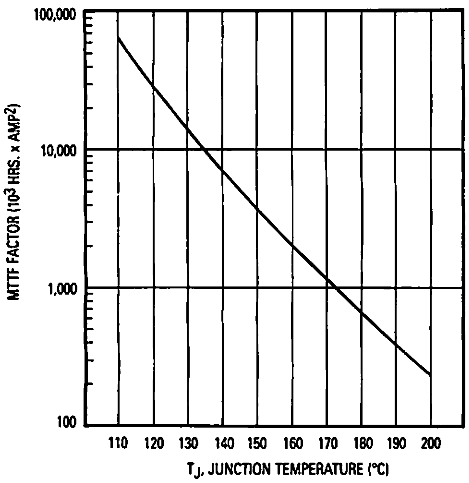


Figure 4. Power versus Frequency — Long Pulse



Note: Divide MTTF factor by I_C^2 to obtain metal lifetime in hours.

Example Calculation

For P_o = 50 W, η_c = 45%
T_F = 50°C

$$I_C = \frac{P_o(100)}{V_{CC}\,\eta_c} = \frac{50(100)}{(28)(45)} = 3.97 \text{ Amp}$$

$P_D = V_{CC}\,I_C - P_o + P_{in}$
$= (28)(3.97) - 50 \text{ W} + 11.2 = 72.3 \text{ W}$

$T_J = \theta_{JC}\,P_D + T_F = 151°C$

MTTF ~ 254,000 Hours

Figure 5. MTTF versus Junction Temperature

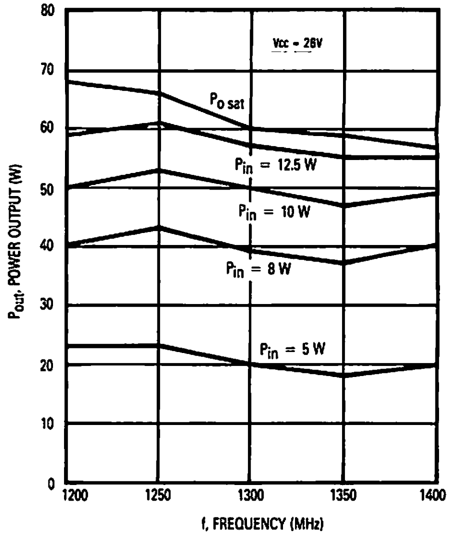


Figure 6. Power versus Frequency — CW

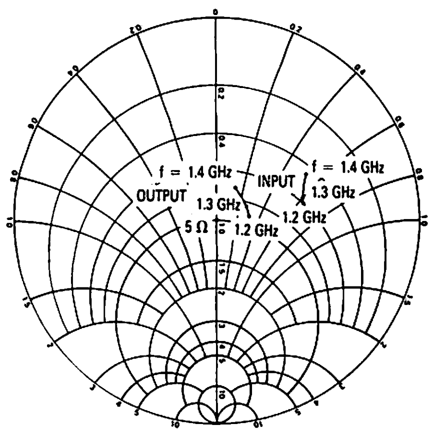


Figure 7. Series Equivalent Input/Output Impedance

Note: Consult factory for artwork transparency

PART DETAILS

NO.	PURPOSE	VALUE	DESCRIPTION
*	Foil wrapped around or through to ground.	1–2 mil.	Brass
(1)	DC blocking capacitor	100 pF	Ceramic Chip (ATC)
(2)	V_{CC} bypass capacitor to ground.	0.1 μF	Ceramic Chip
(3)	Position to obtain maximum output power.	120 pF	Ceramic Chip
(4)	DC filter capacitor to ground.	50 μF (50 V)	Tantalum, Electrolytic
(5)	Wire inductor with Ferrite Beads.	#28 AWG	Wire
(6)	RF input connector.	50 ohms	"N" Type
(7)	RF output connector.	50 ohms	"N" Type

BOARD MATERIAL: Double-sided, 20 mil. Glass/Teflon (ϵ_r = 2.55) 2 oz. Copper

SUBSTRATE MOUNTING: Solder to brass or copper heat sink (2" x 4.1" x 0.5").

Figure 8. Printed Circuit Board Layout (Not to Scale)

MRA1300-10L

Advance Information

The RF Line

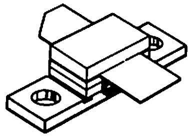
2

Microwave Linear Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 500–1500 MHz frequency range.

- Designed for Class A Common-Emitter Linear Power Amplifiers
- Specified 25 Volt, 1300 MHz Characteristics:
  Output Power — 10 Watts
  Power Gain — 8.0 dB, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**8.0 dB
500–1500 MHz
10 WATTS
MICROWAVE
LINEAR POWER
TRANSISTOR**



CASE 360A-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Power Dissipation	P_D	83	W
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mA, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 A, V_{CE} = 5.0 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	40	pF

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, I_C = 1.8 A, P_{out} = 10 W, f = 1300 MHz)	G_{PE}	7.0	8.0	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, I_C = 1.8 A, P_{out} = 10 W, f = 1400 MHz)	G_{PE}	—	6.5	—	dB
Load Mismatch (V_{CE} = 25 V, I_E = 1.8 A, P_{out} = 10 W, f = 1300 MHz Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Overdrive (V_{CE} = 25 Vdc, I_C = 1.8 A, f = 1300 MHz)	P_{in}	—	—	6.0	W

V_{CE} (Volts)	I_C (Amperes)	f MHz	S_{11} $\lvert S_{11}\rvert$	S_{11} $\angle\phi$ (deg.)	S_{21} $\lvert S_{21}\rvert$	S_{21} $\angle\phi$ (deg.)	S_{12} $\lvert S_{12}\rvert$	S_{12} $\angle\phi$ (deg.)	S_{22} $\lvert S_{22}\rvert$	S_{22} $\angle\phi$ (deg.)
25	1.8	500	0.97	178	0.55	57	0.01	8	0.83	-177
		600	0.97	177	0.39	49	0.01	7	0.83	-177
		700	0.96	177	0.46	40	0.01	6	0.84	-177
		800	0.94	176	0.44	30	0.01	2	0.84	-177
		900	0.93	175	0.44	18	0.01	-3	0.84	-176
		1000	0.90	175	0.45	3	0.01	-19	0.86	-175
		1100	0.87	176	0.46	-18	0.01	-36	0.89	-175
		1200	0.86	178	0.44	-41	0.01	-64	0.92	-176
		1300	0.88	-180	0.37	-67	0.01	-91	0.95	-178
		1400	0.92	-179	0.28	-90	0.01	-128	0.95	-180
		1500	0.94	-179	0.20	-108	0.01	-169	0.94	178

Figure 1. Common-Emitter S-Parameters

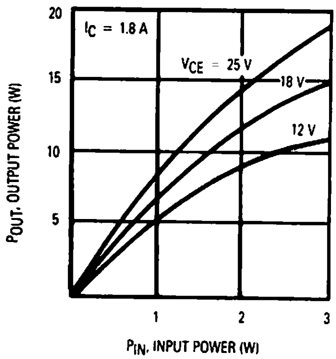


Figure 2. Output Power versus Input Power

MRA1417 Series

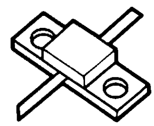
The RF Line
Microwave Power Transistors

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.7 GHz Characteristics:
  - Output Power — 2 to 25 Watts
  - Power Gain — 7 to 8 dB Min
  - Collector Efficiency — 40 to 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

7 to 8 dB
1.4–1.7 GHz
2 TO 25 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-11	-25A	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1417-2		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	-6		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-11		50	—	—	
(I_C = 160 mA, V_{BE} = 0)	-25A		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA1417-2		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	-6		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-11		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-25A		3.5	—	—	
Collector Cutoff Current	MRA1417-2	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	-6		—	—	1	
	-11		—	—	2	
	-25A		—	—	4	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRA1417-2		10	—	100	
(I_C = 0.2 A, V_{CE} = 5 V)	-6		10	—	100	
(I_C = 0.4 A, V_{CE} = 5 V)	-11		10	—	100	
(I_C = 0.8 A, V_{CE} = 5 V)	-25A		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRA1417-2	C_{ob}	—	—	4.5	pF
(V_{CB} = 28 V, I_E = 0, f = 1 MHz)	-6		—	—	8	
	-11		—	—	12	
	-25A		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRA1417-2		8	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	-6		7.4	—	—	
(V_{CE} = 28 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11		7.4	—	—	
(V_{CE} = 28 V, P_{out} = 25 W, f = 1.4 & 1.7 GHz)	-25A		7	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRA1417-2		45	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	-6		40	—	—	
(V_{CE} = 28 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11		45	—	—	
(V_{CE} = 28 V, P_{out} = 25 W, f = 1.4 & 1.7 GHz)	-25A		45	—	—	

(1) Not measurable because of output matching network.

2

TYPICAL CHARACTERISTICS
MRA1417-2 — 2 WATTS BROADBAND

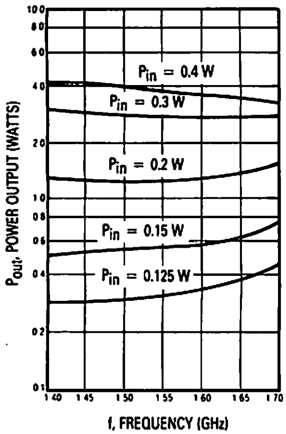


Figure 1. Power Output versus Frequency

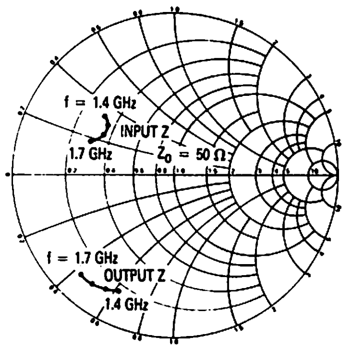


Figure 3. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

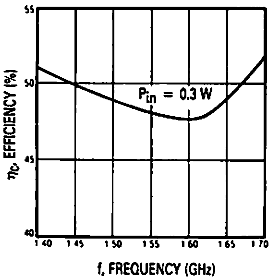


Figure 2. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS
MRA1417-6 — 6 WATTS BROADBAND

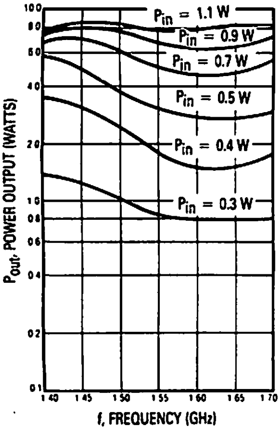


Figure 4. Power Output versus Frequency

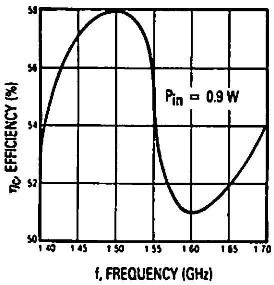


Figure 5. Efficiency versus Frequency

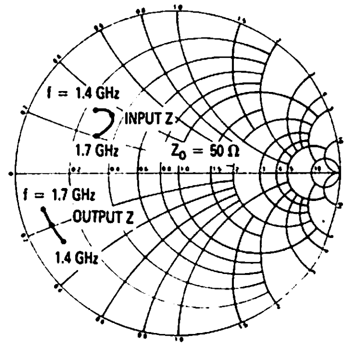


Figure 6. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

TYPICAL CHARACTERISTICS
MRA1417-11 — 11 WATTS BROADBAND

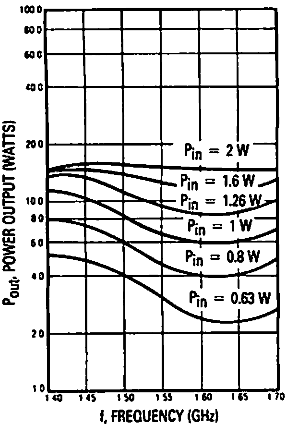


Figure 7. Power Output versus Frequency

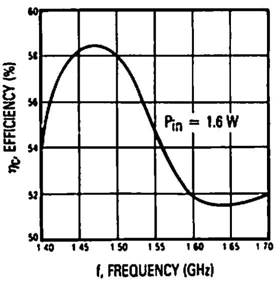


Figure 8. Efficiency versus Frequency

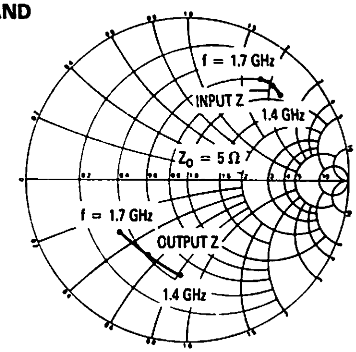


Figure 9. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

TYPICAL CHARACTERISTICS
MRA1417-25A — 25 WATTS BROADBAND

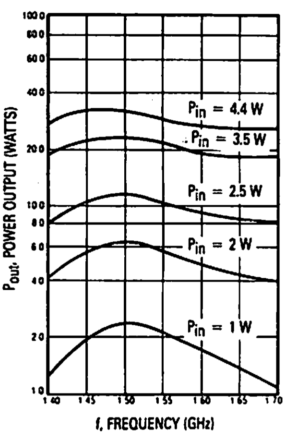


Figure 10. Power Output versus Frequency

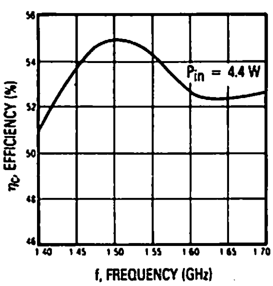


Figure 11. Efficiency versus Frequency

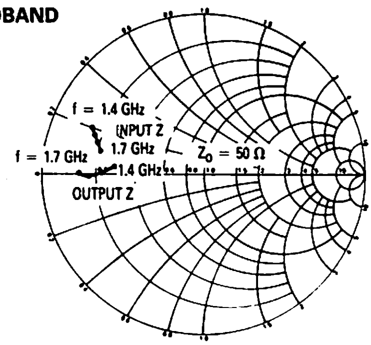
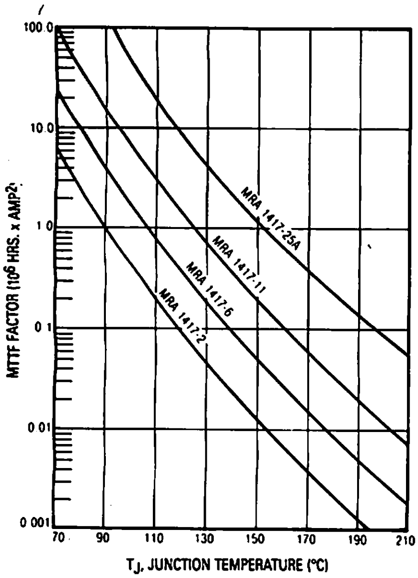


Figure 12. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

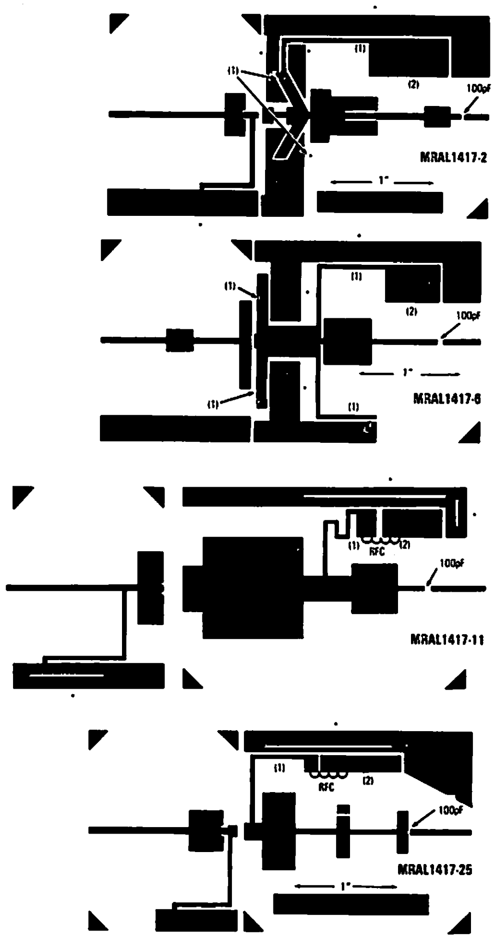
The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than $\pm 10\%$ to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1417-11 Conditions

$$P_O = 11\ W$$
$$P_{in} = 2\ W$$
$$V_{CC} = 28\ V$$
$$\eta = 45\%$$
$$T_{FLANGE} = 70°C$$
$$I_C = I_E = \frac{100 \times P_O}{\eta_C \times V_{CC}} = 0.873\ A$$
$$P_{DISS} = P_{in} + V_{CC} \cdot I_C - P_O = 15.44\ W$$
$$T_{JUNC} = T_{FLANGE} + \theta_{JF} \times P_{DISS} = 139.4°C$$
$$MTTF = \frac{0.36 \times 10^6\ Hrs.\ Amp^2}{I_C^2} = 472{,}360\ Hrs$$
$$MTTF = 53.9\ Yrs$$

Figure 13. MTTF Factor (Normalized to 1 Ampere^2 Continuous Duty)



Board material: 18 mil dielectric thickness teflon fiberglass.
*Ground through to backside ground plane.
(1)Bypass 100pF chip capacitor.
(2)V_{CC} bypassed by 0.1µF chip and 5µF electrolytic.

Figure 14. Test Circuit Boards (Not to Scale)

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRA1417H Series

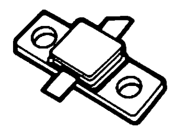
The RF Line
Microwave Power Transistors

7.4 to 8 dB
1.4–1.7 GHz
2 TO 11 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1.7 GHz Characteristics:
  Output Power — 2 to 11 Watts
  Power Gain — 7.4 to 8 dB, Min
  Collector Efficiency — 40 to 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications



CASE 393-01, STYLE 1
(HLP-11)

MAXIMUM RATINGS

Rating	Symbol	-2H	-6H	-11H	Unit
Collector-Base Voltage	V_{CES}	50			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Collector Current — Continuous	I_C	0.5	1	2	Adc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1417- 2H		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	- 6H		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-11H		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA1417- 2H		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	- 6H		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-11H		3.5	—	—	
Collector Cutoff Current	MRA1417- 2H	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	- 6H		—	—	1	
	-11H		—	—	2	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRA1417- 2H		10	—	100	
(I_C = 200 mA, V_{CE} = 5 V)	- 6H		10	—	100	
(I_C = 400 mA, V_{CE} = 5 V)	-11H		10	—	100	

(continued)

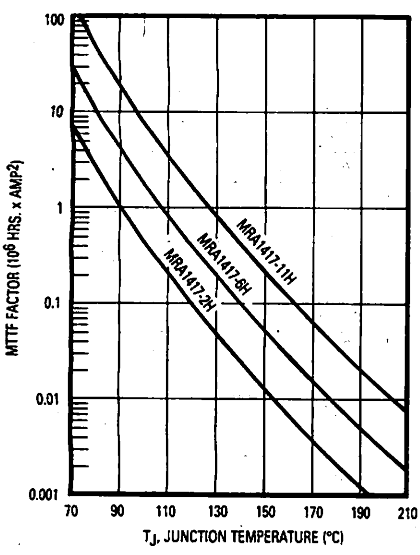
ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	MRA1417- 2H	C_{ob}	—	—	4.5	pF
	- 6H		—	—	8	
	-11H		—	—	12	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRA1417- 2H		8	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	- 6H		7.4	—	—	
(V_{CE} = 28 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11H		7.4	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRA1417- 2H		40	—	—	
(V_{CE} = 28 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	- 6H		45	—	—	
(V_{CE} = 28 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11H		45	—	—	

2

TYPICAL CHARACTERISTICS

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1417-11H Conditions

P_o = 11 W
P_{in} = 2 W
V_{CC} = 28 V
η = 45%
T_{FLANGE} = 70°C

$$I_C = I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.873\ A$$

P_{DISS} $P_{in} + V_{CC} \cdot I_C - P_o$ = 15.44 W
T_{JUNC} $T_{FLANGE} + \theta_{JF} \times P_{DISS}$ = 139.4°C

$$MTTF = \frac{0.36 \times 10^6\ Hrs.\ Amp^2}{I_C^2} = 472{,}360\ Hrs.$$

MTTF = 53.9 Yrs

Figure 1. MTTF Factor (Normalized to 1 Ampere^2 Continuous Duty)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

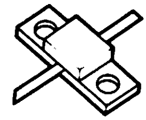
The RF Line
Microwave Power Transistors

MRA1600 Series

... designed primarily for large-signal output and driver amplifier stages for mobile satellite up links.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 1640 MHz Characteristics:
  Output Power — 2.0 to 30 Watts
  Power Gain — 7.0 to 8.4 dB Min
  Collector Efficiency — 39% to 45% Min
- Internally Compensated
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**7.0 to 8.4 dB
1600–1660 MHz
2.0 to 30 WATTS
NARROWBAND
MICROWAVE POWER
TRANSISTORS**



CASE 394-01
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-13	-30	Unit
Collector-Base Voltage	V_{CES}	50			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Collector Current — Continuous	I_C	0.5	4.0	8.0	Adc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	−65 to +150			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case (Rated P_{out})	$R_{\theta JC}$	15	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1600-2		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-13		50	—	—	
(I_C = 160 mA, V_{BE} = 0)	-30		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA1600-2		3.5	—	—	
(I_E = 1.0 mA, I_C = 0)	-13		3.5	—	—	
(I_E = 2.0 mA, I_C = 0)	-30		3.5	—	—	
Collector Cutoff Current	MRA1600-2	I_{CBO}	0.5	—	—	mAdc
(V_{CB} = 28 V, I_E = 0)	-13		2.0	—	—	
	-30		4.0	—	—	

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5.0 V)	MRA1600-2		10	—	100	
(I_C = 0.4 A, V_{CE} = 5.0 V)	-13		10	—	100	
(I_C = 0.8 A, V_{CE} = 5.0 V)	-30		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRA1600-2	C_{ob}	—	—	4.5	pF
(V_{CB} = 28 V, I_E = 0, f = 1.0 MHz)	-13		—	—	12	
	-30		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2.2 W, f = 1.60 and 1.64 GHz)	MRA1600-2		8.4	—	—	
(V_{CE} = 28 V, P_{out} = 12.7 W, f = 1.60 and 1.64 GHz)	-13		7.6	—	—	
(V_{CE} = 28 V, P_{out} = 30 W, f = 1.60 and 1.64 GHz)	-30		7.0	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 2.2 W, f = 1.60 and 1.64 GHz)	MRA1600-2		39	—	—	
(V_{CE} = 28 V, P_{out} = 12.7 W, f = 1.60 and 1.64 GHz)	-13		45	—	—	
(V_{CE} = 28 V, P_{out} = 30 W, f = 1.60 and 1.64 GHz)	-30		45	—	—	

(1) Not measurable because of shunt inductor bypass.

TYPICAL CHARACTERISTICS
MRA1600-2

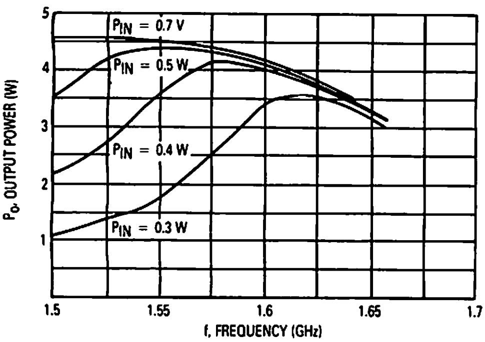


Figure 1. Output Power versus Frequency

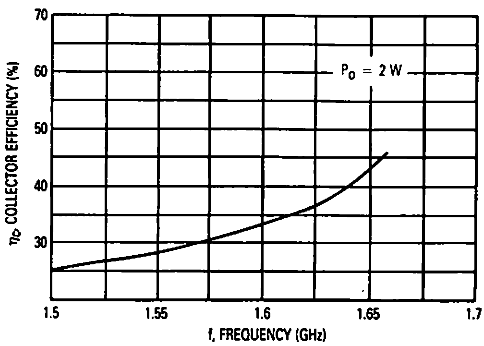


Figure 2. Efficiency versus Frequency

f GHz	R_{IN}	JX_{IN}	R_O(2)	JX_O(2)
1.500	17.662	10.579	8.813	- 17.216
1.525	17.146	10.661	8.001	- 17.786
1.550	16.608	10.328	7.240	- 18.350
1.575	16.087	9.986	6.728	- 19.386
1.600	15.596	9.635	6.408	- 20.420
1.625	15.149	9.273	6.164	- 20.950
1.650	14.643	8.913	5.793	- 21.495
1.675	14.214	8.541	5.416	- 22.565
1.700	13.823	8.581	5.027	- 23.122

Figure 3. Input/Output Impedances (P_o = 2.2 W, V_{CE} = 28 V)

(2) Z_{OL}^* = R_O + JX_O is the conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

TYPICAL CHARACTERISTICS
MRA1600-13

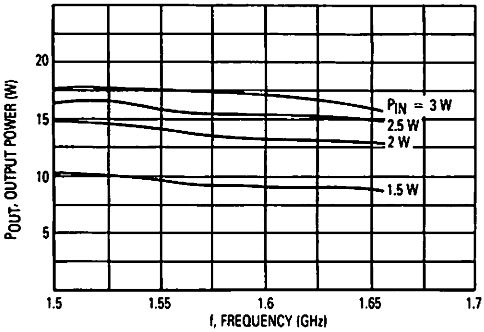


Figure 4. Output Power versus Frequency

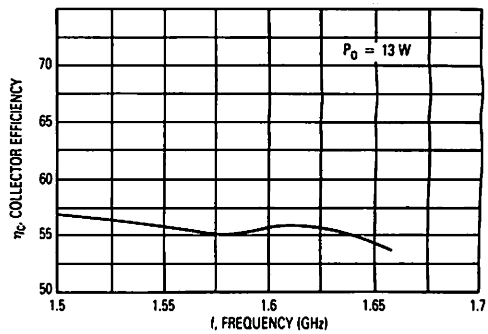


Figure 5. Efficiency versus Frequency

f GHz	R_{IN}	JX_{IN}	R_O(1)	JX_O(1)
1.500	6.840	10.887	4.293	−4.342
1.525	6.581	10.452	4.175	−3.908
1.550	6.333	10.465	3.877	−3.475
1.575	6.119	10.026	3.497	−3.479
1.600	5.904	9.588	3.087	−3.047
1.625	5.699	9.150	2.707	−3.049
1.650	5.482	8.714	2.320	−3.489
1.675	5.259	8.277	2.004	−3.491
1.700	5.121	7.838	1.732	−3.492

Figure 6. Input/Output Impedances (P_o = 12.7 W, V_{CE} = 28 V)

(1) Z_{OL}* = R_O + JX_O is the conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRA1600-30

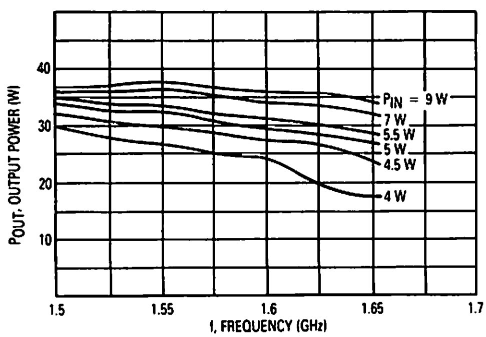


Figure 7. Output Power versus Frequency

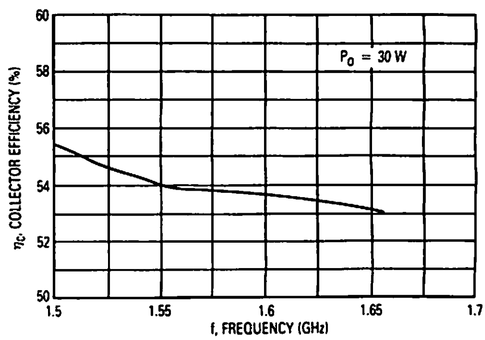


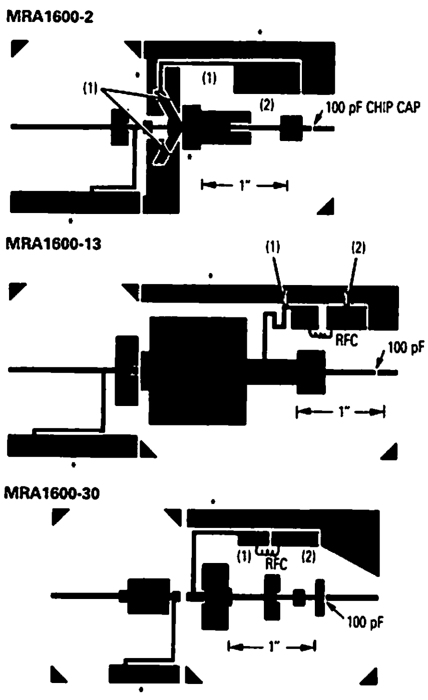
Figure 8. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRA1600-30

f GHz	R_{IN}	JX_{IN}	R_O (1)	JX_O (1)
1.500	6.169	4.308	6.310	2.579
1.525	6.012	4.312	5.782	2.514
1.550	5.815	3.882	5.228	1.727
1.575	5.659	3.452	4.835	1.297
1.600	5.447	3.022	4.425	0.866
1.625	5.353	3.023	4.107	0.433
1.650	5.194	2.592	3.746	−0.434
1.675	5.029	2.161	3.475	−0.869
1.700	4.912	1.729	3.247	−1.304

Figure 9. Input/Output Impedances (P_o = 30 W, V_{CE} = 28 V)

(1) $Z_{OL}{}^* = R_O + JX_O$ is the conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



(1) Bypass 100 pF Chip Cap
(2) V_{CC} Bypassed by 0.1 μF Chip Cap and 5 μF Electrolytic
•Ground thru to back side GND Plane
Board Material: 18 Mil Dielectric thickness
Teflon Fiberglass

Figure 10. Test Circuit Boards for MRA1600 Series (not to scale)

MRA1720 Series

The RF Line

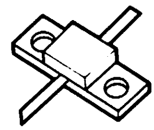
Microwave Power Transistors

2

... designed primarily for wideband, large-signal output and driver amplifier stages in the 1.7 to 2 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 28 Volt, 2 GHz Characteristics:
  Output Power — 2 to 20 Watts
  Power Gain — 6 to 7.5 dB Min
  Collector Efficiency — 35 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**6 to 7.5 dB
1.7–2 GHz
2 TO 20 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS**



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-5	-9	-20	Unit
Collector-Base Voltage	V_{CES}	50				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRA1720-2		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	-5		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	-9		50	—	—	
(I_C = 160 mA, V_{BE} = 0)	-20		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRA1720-2		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	-5		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-9		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-20		3.5	—	—	
Collector Cutoff Current	MRA1720-2	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	-5		—	—	1	
	-9		—	—	2	
	-20		—	—	4	

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRA1720-2		10	—	100	
(I_C = 0.2 A, V_{CE} = 5 V)	-5		10	—	100	
(I_C = 0.4 A, V_{CE} = 5 V)	-9		10	—	100	
(I_C = 0.8 A, V_{CE} = 5 V)	-20		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRA1720-2	C_{ob}	—	—	4.5	pF
(V_{CB} = 28 V, I_E = 0, f = 1 MHz)	-5		—	—	8	
	-9		—	—	12	
	-20		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.7 & 2.0 GHz)	MRA1720-2		7.5	—	—	
(V_{CE} = 28 V, P_{out} = 5 W, f = 1.7 & 2.0 GHz)	-5		6.5	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 1.7 & 2.0 GHz)	-9		6.5	—	—	
(V_{CE} = 28 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	-20		6	—	—	
Collector Efficiency		η_C				%
(V_{CE} = 28 V, P_{out} = 2 W, f = 1.7 & 2.0 GHz)	MRA1720-2		35	—	—	
(V_{CE} = 28 V, P_{out} = 5 W, f = 1.7 & 2.0 GHz)	-5		40	—	—	
(V_{CE} = 28 V, P_{out} = 9 W, f = 1.7 & 2.0 GHz)	-9		40	—	—	
(V_{CE} = 28 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	-20		40	—	—	

(1) Not measureable because of shunt inductor bypass.

2

TYPICAL CHARACTERISTICS

MRA1720-2 — 2 WATTS BROADBAND

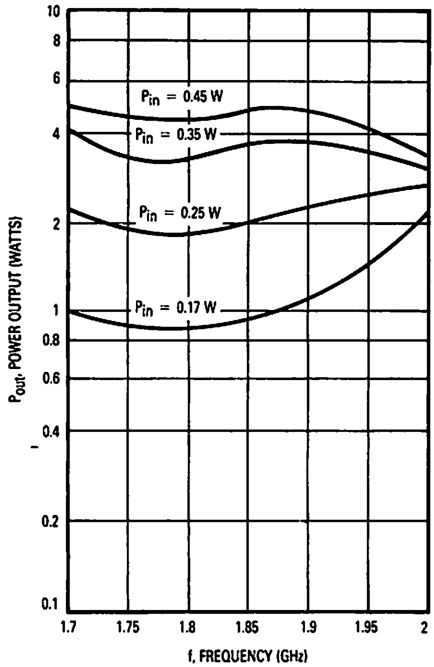


Figure 1. Power Output versus Frequency

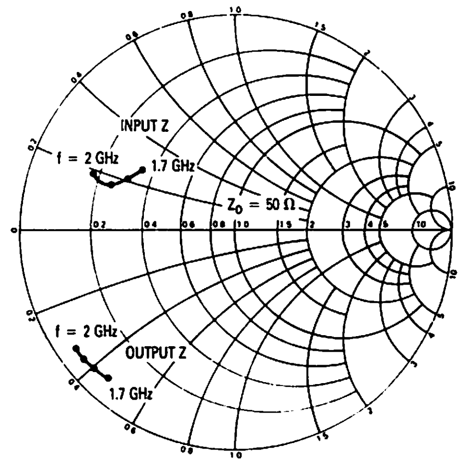


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

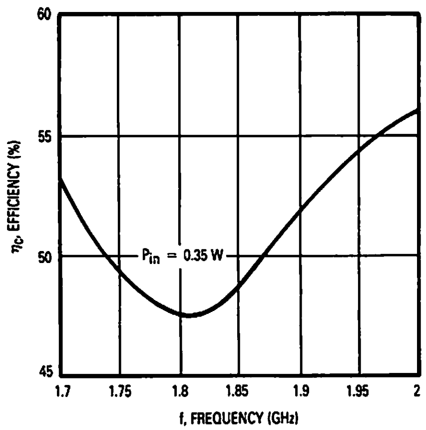


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1720-5 — 5 WATTS BROADBAND

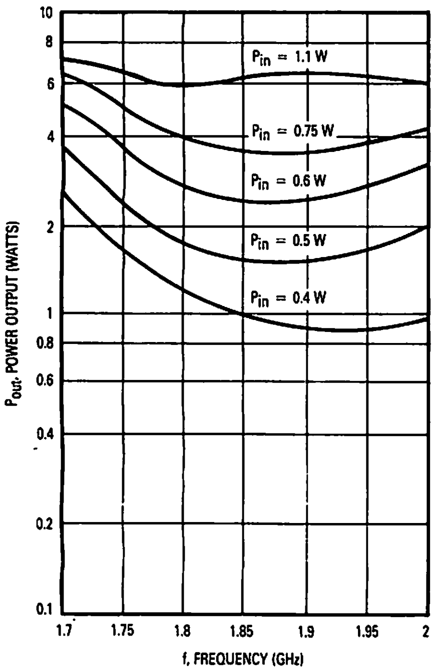


Figure 4. Power Output versus Frequency

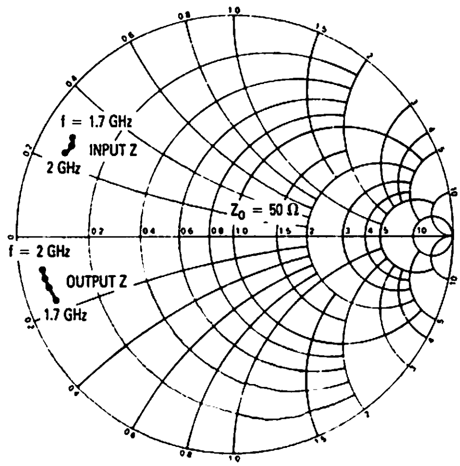


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

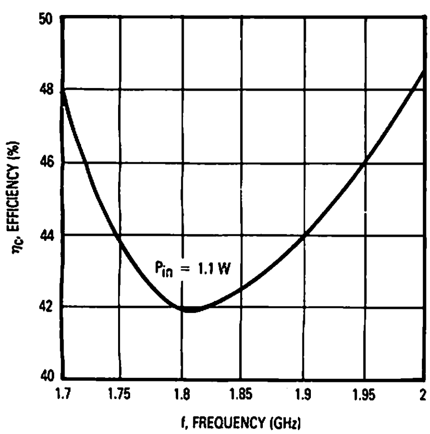


Figure 6. Efficiency versus Frequency

2

2

TYPICAL CHARACTERISTICS

MRA1720-9 — 9 WATTS BROADBAND

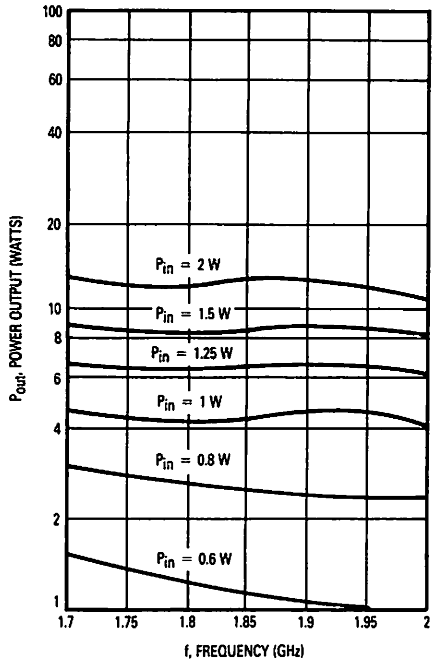


Figure 7. Power Output versus Frequency

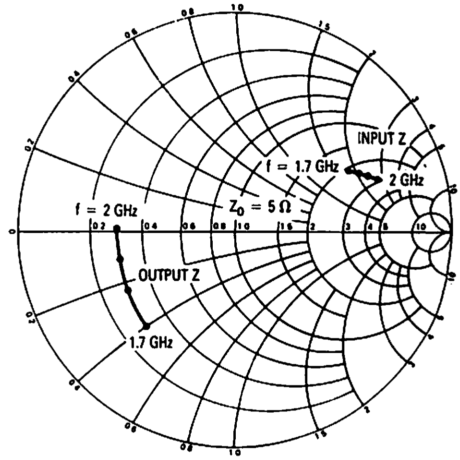


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

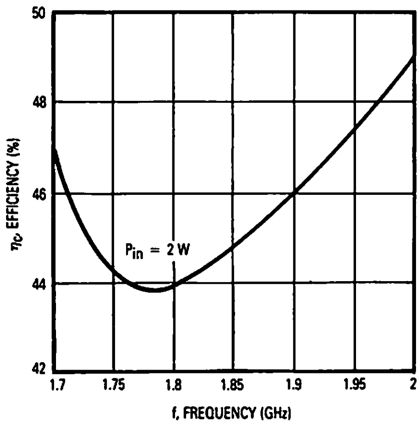


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRA1720-20 — 20 WATTS BROADBAND

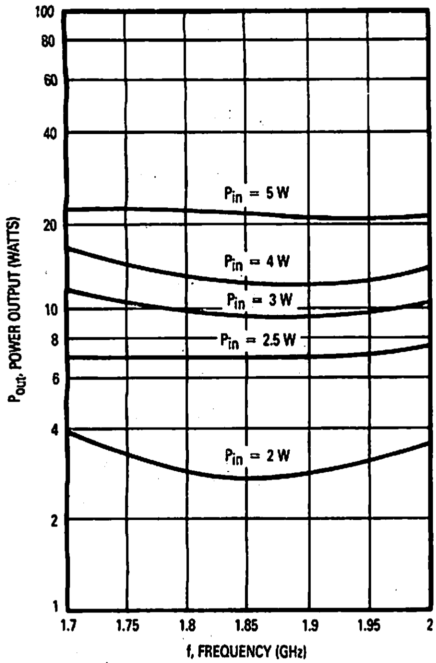


Figure 10. Power Output versus Frequency

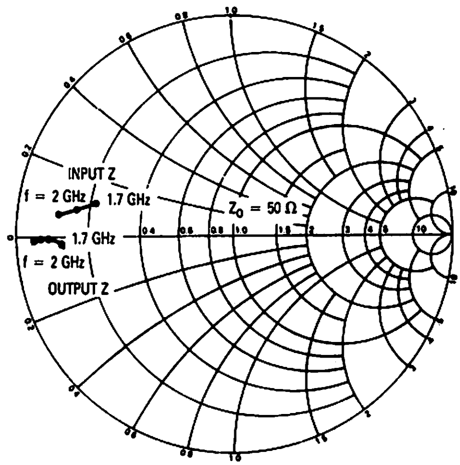


Figure 11. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

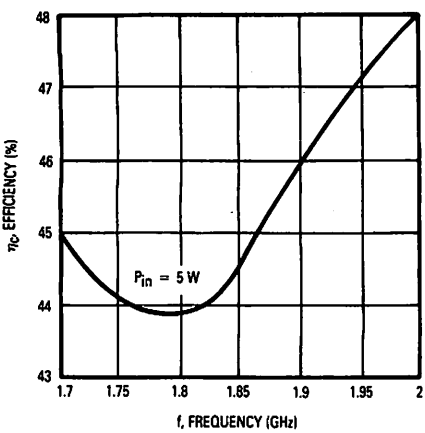
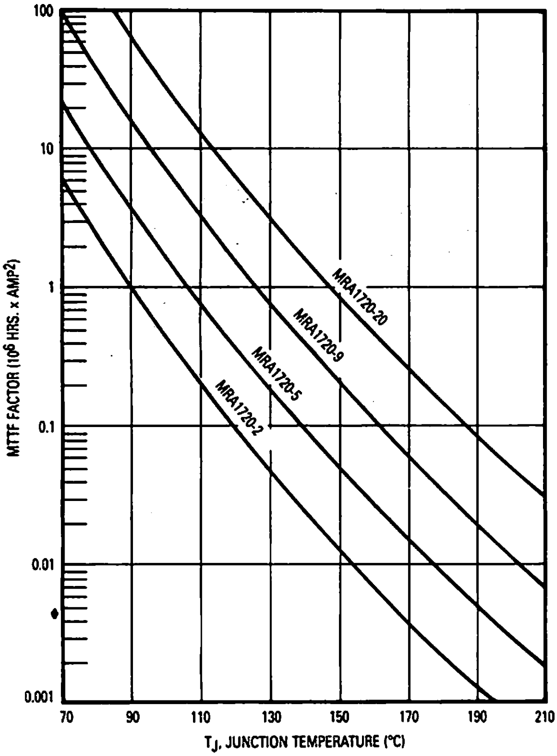


Figure 12. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ± 10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA1720-9 Conditions

$P_o = 9\ W$

$P_{in} = 2\ W$

$V_{CC} = 28\ V$

$\eta = 40\%$

$T_{FLANGE} = 70°C$

$I_C = I_C = \dfrac{100 \times P_o}{\eta_c \times V_{CC}} = 0.803\ A$

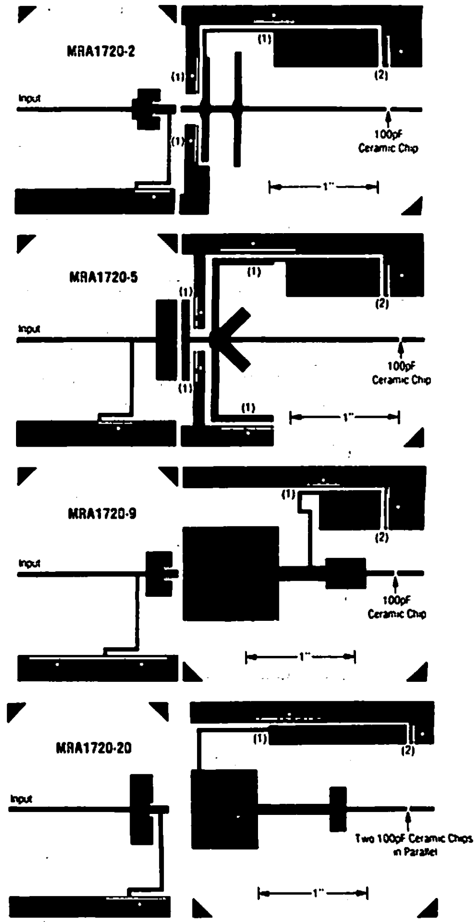
$P_{DISS} = P_{in} + V_{CC} \cdot I_C - P_o = 15.48\ W$

$T_{JUNC} = T_{FLANGE} + \theta_{JF} \times 15.48 = 139.6°C$

$MTTF = \dfrac{0.4 \times 10^6\ Hrs.\ Amp^2}{I_C{}^2} = 620{,}338\ Hrs$

$MTTF = 70.8\ Yrs$

Figure 13. MTTF Factor versus Junction Temperature



*Foil wrap or plate around to ground plane
(1) Bypass capacitor to ground (100pF ceramic chip)
(2) Use Vcc bypass of 100pF chip, 0.1µF chip and 5µF.
Board material 0.020 inch glass-teflon $\epsilon_r = 2.55$

Figure 14. Test Circuit Boards (Not to Scale)

MRAL1417 Series

2

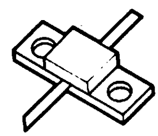
The RF Line

Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.4 to 1.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 1.7 GHz Characteristics:
  Output Power — 2 to 25 Watts
  Power Gain — 7 to 8 dB Min
  Collector Efficiency — 40 to 45%
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**7 to 8 dB
1.4–1.7 GHz
2 TO 25 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS**



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-6	-11	-25	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRAL1417-2		42	—	—	
(I_C = 40 mA, V_{BE} = 0)	-6		42	—	—	
(I_C = 80 mA, V_{BE} = 0)	-11		42	—	—	
(I_C = 160 mA, V_{BE} = 0)	-25		42	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRAL1417-2		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	-6		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-11		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-25		3.5	—	—	
Collector Cutoff Current	MRAL1417-2	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 22 V, I_E = 0)	-6		—	—	1	
	-11		—	—	2	
	-25		—	—	4	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRAL1417-2		10	—	100	
(I_C = 0.2 A, V_{CE} = 5 V)	-6		10	—	100	
(I_C = 0.4 A, V_{CE} = 5 V)	-11		10	—	100	
(I_C = 0.8 A, V_{CE} = 5 V)	-25		10	—	100	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRAL1417-2		8	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	-6		7.4	—	—	
(V_{CE} = 22 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11		7.4	—	—	
(V_{CE} = 22 V, P_{out} = 25 W, f = 1.4 & 1.7 GHz)	-25		7	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 22 V, P_{out} = 2 W, f = 1.4 & 1.7 GHz)	MRAL1417-2		45	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 1.4 & 1.7 GHz)	-6		40	—	—	
(V_{CE} = 22 V, P_{out} = 11 W, f = 1.4 & 1.7 GHz)	-11		45	—	—	
(V_{CE} = 22 V, P_{out} = 25 W, f = 1.4 & 1.7 GHz)	-25		45	—	—	

TYPICAL CHARACTERISTICS

MRAL1417-2 Device Impedance

	Z_{OUT} (Ω)		Z_{IN} (Ω)	
Freq.	R	jx	R	jx
1.4GHz	6.17	-18.8	19.2	12.7
1.45GHz	6.67	-19.0	18.3	12.4
1.5GHz	7.08	-19.1	17.4	12.1
1.55GHz	7.25	-18.9	16.6	11.9
1.6GHz	7.14	-18.8	15.9	11.6
1.65GHz	6.71	-18.7	15.2	11.3
1.7GHz	6.00	-18.8	14.5	11.1

MRAL1417-11 Device Impedance

	Z_{OUT} (Ω)		Z_{IN} (Ω)	
Freq.	R	jx	R	jx
1.4GHz	3.40	-4.15	5.46	11.9
1.45GHz	4.28	-3.90	5.09	1.1
1.5GHz	5.17	-3.32	4.76	10.4
1.55GHz	5.42	-2.09	4.45	9.78
1.6GHz	4.73	-1.00	4.22	9.17
1.65GHz	3.71	-0.56	3.98	8.63
1.7GHz	2.77	-0.66	3.80	8.08

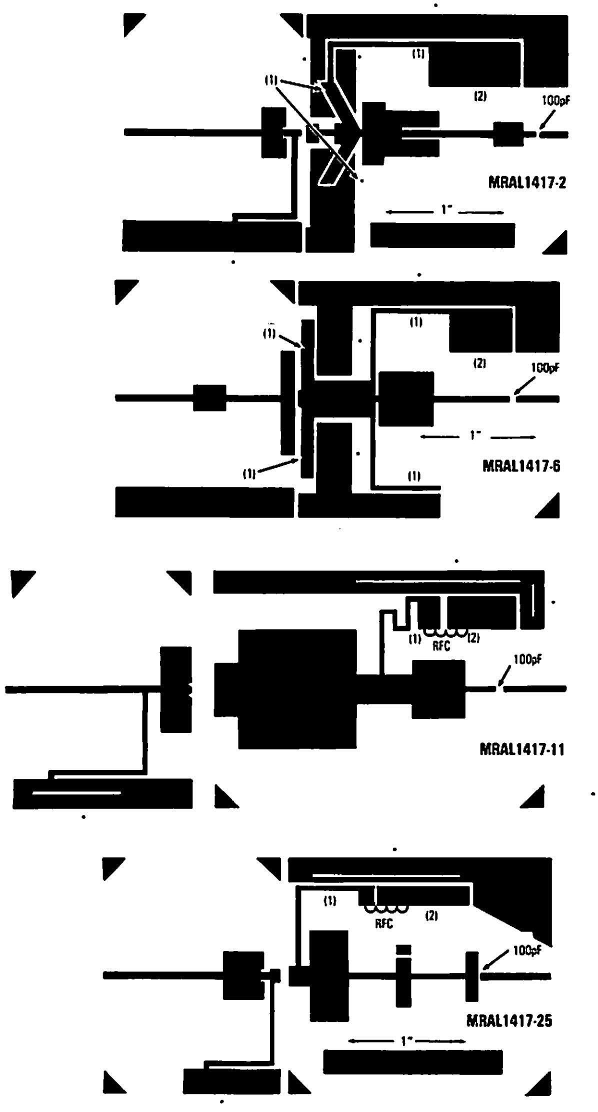
MRAL1417-6 Device Impedance

	Z_{OUT} (Ω)		Z_{IN} (Ω)	
Freq.	R	jx	R	jx
1.4GHz	8.18	-9.16	13.8	11.2
1.45GHz	8.27	-8.05	13.9	10.4
1.5GHz	7.86	-7.23	14.2	9.77
1.55GHz	7.25	-6.72	14.6	9.23
1.6GHz	6.55	-6.54	15.2	8.75
1.65GHz	5.89	-6.53	15.9	8.49
1.7GHz	5.23	-6.78	16.8	8.42

MRAL1417-25 Device Impedance

	Z_{OUT} (Ω)		Z_{IN} (Ω)	
Freq.	R	jx	R	jx
1.4GHz	6.74	3.80	7.76	6.47
1.45GHz	6.45	3.61	7.33	5.80
1.5GHz	6.14	3.41	6.70	5.16
1.55GHz	5.71	3.16	6.62	4.56
1.6GHz	5.41	2.90	6.34	3.96
1.65GHz	5.09	2.61	6.09	3.44
1.7GHz	4.77	2.34	5.88	2.95

Figure 1. Z_{IN} and Z_{OUT} versus Frequency



Board material : 18 mil dielectric thickness teflon fiberglass.
*Ground through to backside ground plane.
(1)Bypass 100pF chip capacitor.
(2)V_{CC} bypassed by 0.1μF chip and 5μF electrolytic.

Figure 2. Test Circuit Boards (Not to Scale)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRAL1720 Series

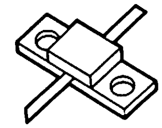
The RF Line

Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1.7 to 2 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2 GHz Characteristics:
  - Output Power — 2 to 20 Watts
  - Power Gain — 6 to 7.5 dB, Min
  - Collector Efficiency — 35 to 40%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

6 to 7.5 dB
1.7–2 GHz
2 TO 20 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-2	-5	-9	-20	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.5	1	4	8	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	15	8	4.5	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 20 mA, V_{BE} = 0)	MRAL1720-2		42	—	—	
(I_C = 40 mA, V_{BE} = 0)	-5		42	—	—	
(I_C = 80 mA, V_{BE} = 0)	-9		42	—	—	
(I_C = 160 mA, V_{BE} = 0)	-20		42	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.25 mA, I_C = 0)	MRAL1720-2		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	-5		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-9		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-20		3.5	—	—	
Collector Cutoff Current	MRAL1720-2	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 22 V, I_E = 0)	-5		—	—	1	
	-9		—	—	2	
	-20		—	—	4	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRAL1720-2		10	—	100	
(I_C = 0.2 A, V_{CE} = 5 V)	-5		10	—	100	
(I_C = 0.4 A, V_{CE} = 5 V)	-9		10	—	100	
(I_C = 0.8 A, V_{CE} = 5 V)	-20		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	MRAL1720-2	C_{ob}	—	—	4.5	pF
	-5		—	—	8	
	-9		—	—	12	
	-20		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 2 W, f = 1.7 & 2.0 GHz)	MRAL1720-2		7.5	—	—	
(V_{CE} = 22 V, P_{out} = 5 W, f = 1.7 & 2.0 GHz)	-5		6.5	—	—	
(V_{CE} = 22 V, P_{out} = 9 W, f = 1.7 & 2.0 GHz)	-9		6.5	—	—	
(V_{CE} = 22 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	-20		6	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 22 V, P_{out} = 2 W, f = 1.7 & 2.0 GHz)	MRAL1720-2		45	—	—	
(V_{CE} = 22 V, P_{out} = 5 W, f = 1.7 & 2.0 GHz)	-5		40	—	—	
(V_{CE} = 22 V, P_{out} = 9 W, f = 1.7 & 2.0 GHz)	-9		40	—	—	
(V_{CE} = 22 V, P_{out} = 20 W, f = 1.7 & 2.0 GHz)	-20		40	—	—	

(1) Not measurable because of output matching network.

TYPICAL CHARACTERISTICS
MRAL1720-2

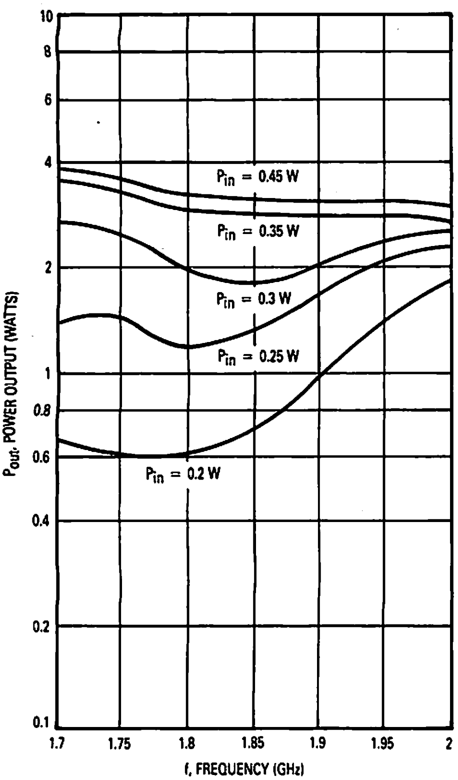


Figure 1. Power Output versus Frequency

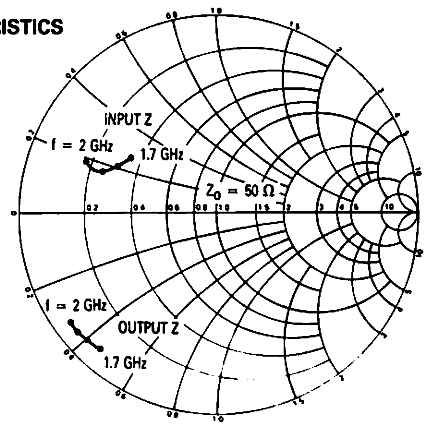


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

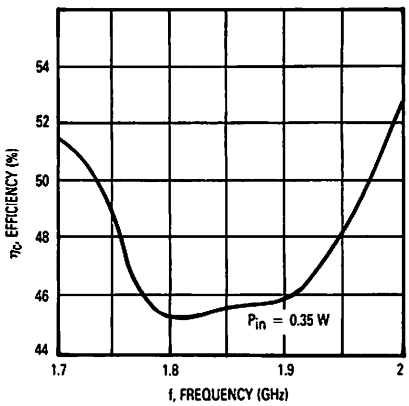


Figure 3. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL1720-5

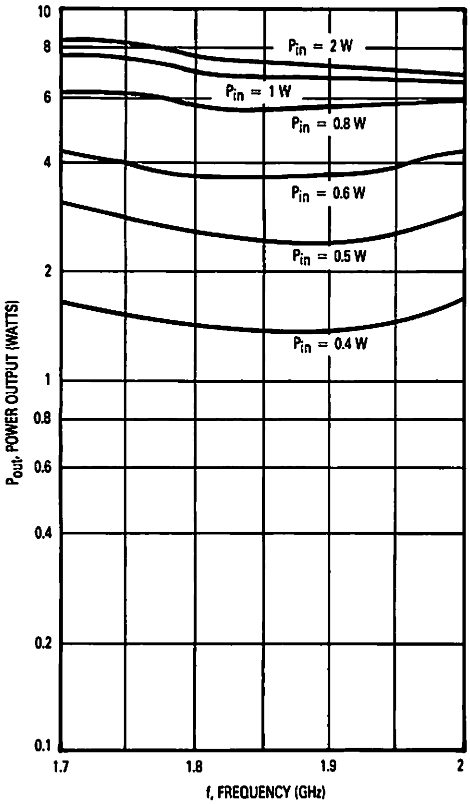


Figure 4. Power Output versus Frequency

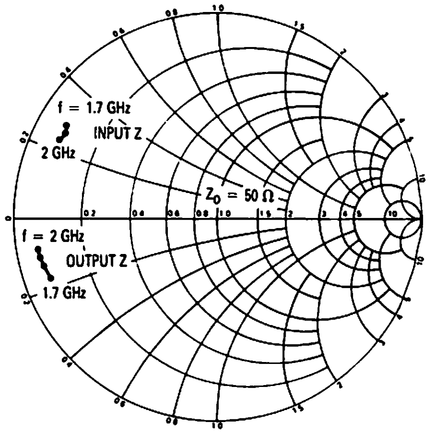


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

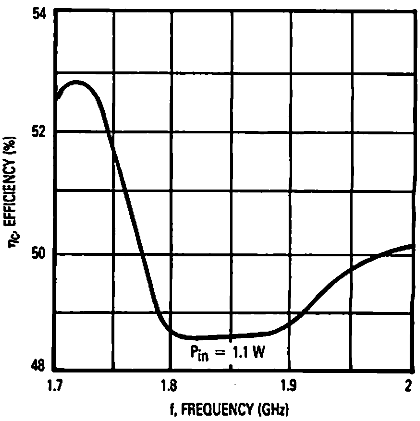


Figure 6. Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRAL1720-9

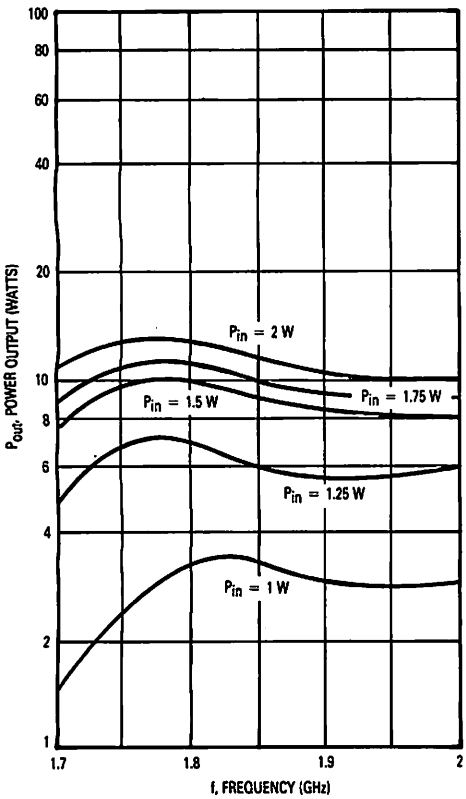


Figure 7. Power Output versus Frequency

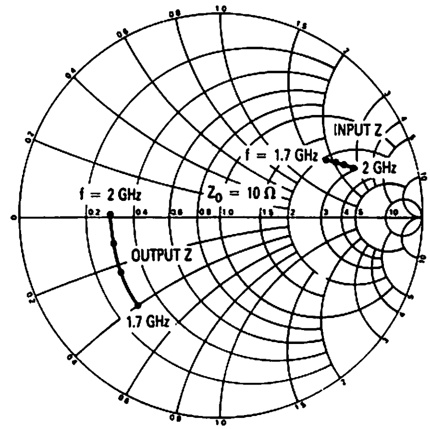


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 22 V
V_{CC} = 22 V

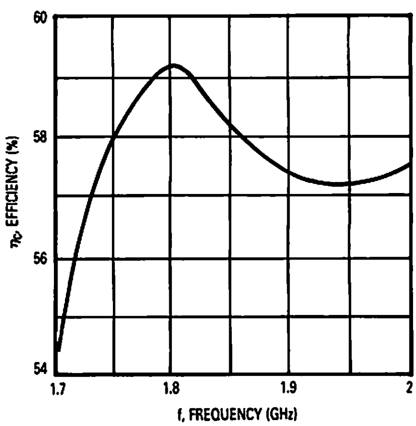


Figure 9. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS

MRAL1720-20

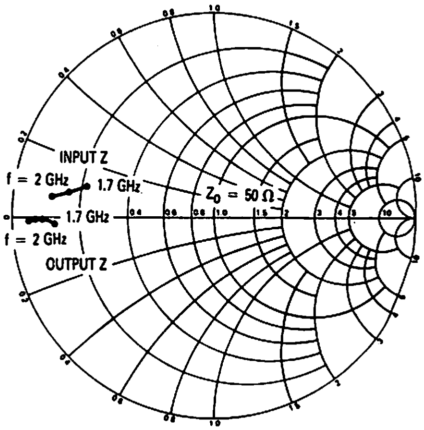


Figure 11. Series Equivalent Input/Output *Impedance*
V_{CC} = 22 V

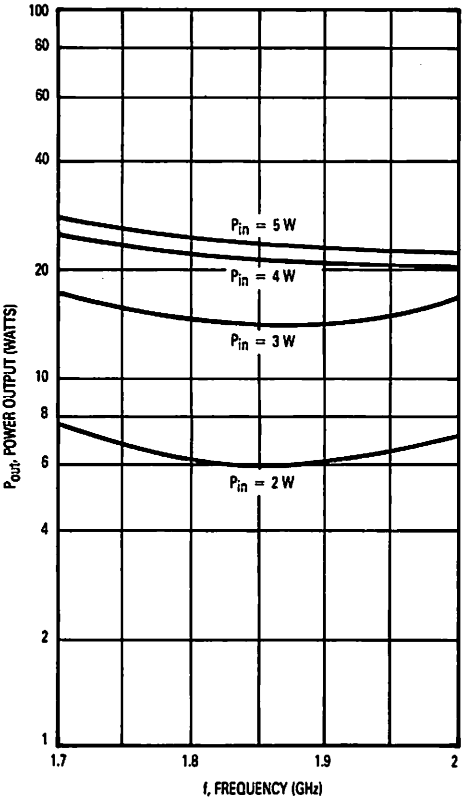


Figure 10. Power Output versus Frequency

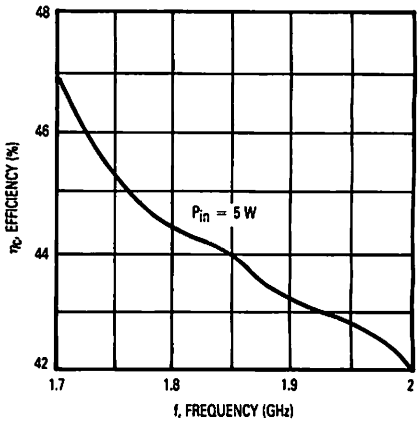


Figure 12. Efficiency versus Frequency

The graph shown displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.

Example of MTTF for MRA1720-9 Conditions

$P_o = 9\ W$
$P_{in} = 2\ W$
$V_{CC} = 28\ V$
$\eta = 40\%$
$T_{FLANGE} = 70°C$

$$I_C \simeq I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.803\ A$$

$$P_{DISS} = P_{in} + V_{CC} \cdot I_C - 8 = 15.48\ W$$

$$T_{JUNC} = T_{FLANGE} + \theta_{JF} \times 15.48 = 139.6°C$$

$$MTTF = \frac{0.4 \times 10^6\ \text{Hrs. Amp}^2}{I_C^2} = 620{,}338\ \text{Hrs}$$

$$MTTF = 70.8\ \text{Yrs}$$

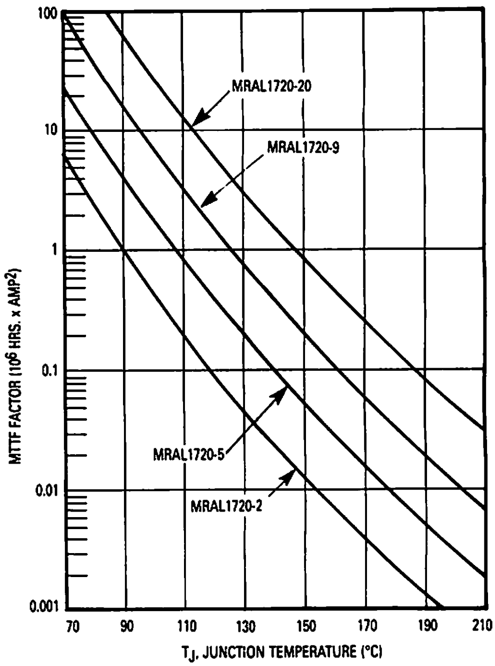
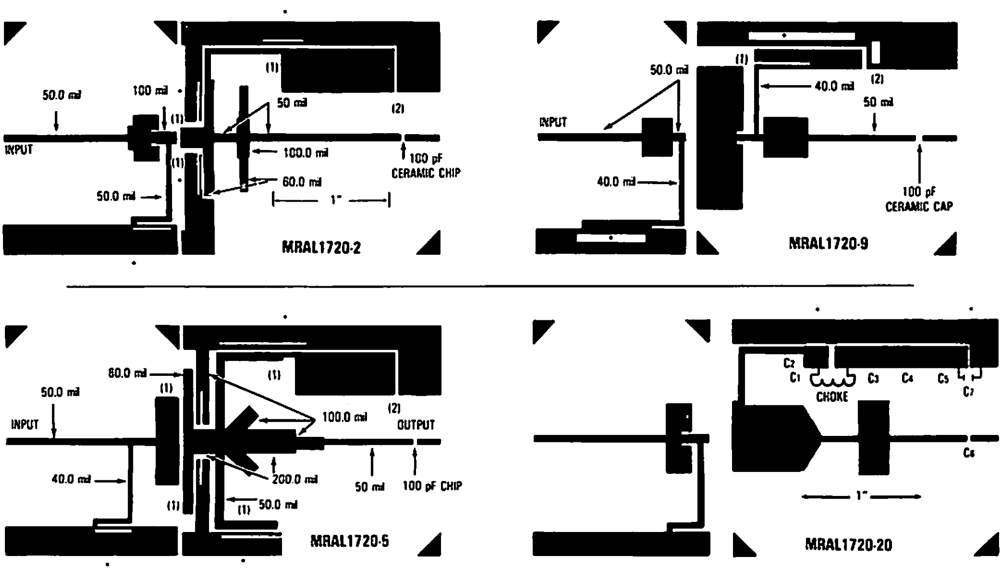


Figure 13. MTTF Factor versus Junction Temperature



*Foil wrap or plate around to ground plane.
(1) Bypass capacitor to ground (100 pF ceramic chip).
(2) Use V_{CC} bypass of 100 pF chip, 0.1 μF chip and 5 μF.
Board material 0.020 inch glass-teflon ϵ_r = 2.55.

1) C1, C5 = 0.1 μF chip capacitor
2) C2, C3, C4 = 120 pF
3) C6 = 100 pF (ATC)
4) C7 = 50 μF 50 WV Electrolytic
5) * = 1 mil Shim thru ground plane
6) Material = Glass/Teflon
ϵ_r = 2.55
Thickness = .020 in.
1.0 oz copper

Figure 14. Test Circuit Boards (Not to Scale)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRAL2023 Series

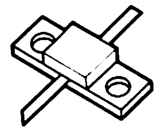
The RF Line
Microwave Power Transistors

2

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
  Output Power — 1.5 to 12 Watts
  Power Gain — 6.8 to 8 dB Min
  Collector Efficiency — 35 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

6.8 to 8 dB
2–2.3 GHz
1.5 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-1.5	-3	-6	-12	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.25	0.5	1.25	2.5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	30	16	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRAL2023-1.5		42	—	—	
(I_C = 20 mA, V_{BE} = 0)	-3		42	—	—	
(I_C = 50 mA, V_{BE} = 0)	-6		42	—	—	
(I_C = 100 mA, V_{BE} = 0)	-12		42	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.2 mA, I_C = 0)	MRAL2023-1.5		3.5	—	—	
(I_E = 0.4 mA, I_C = 0)	-3		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-6		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-12		3.5	—	—	
Collector Cutoff Current	MRAL2023-1.5	I_{CBO}	—	—	0.25	mAdc
(V_{CB} = 22 V, I_E = 0)	-3		—	—	0.5	
	-6		—	—	1.25	
	-12		—	—	2.5	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRAL2023-1.5		10	—	90	
(I_C = 0.2 A, V_{CE} = 5 V)	-3		10	—	90	
(I_C = 0.5 A, V_{CE} = 5 V)	-6		10	—	90	
(I_C = 1 A, V_{CE} = 5 V)	-12		10	—	90	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRAL2023-1.5	C_{ob}	—	—	3.5	pF
(V_{CB} = 22 B, I_E = 0, f = 1 MHz)	-3		—	—	5	
	-6		—	—	10	
	-12		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 1.5 W, f = 2.0 & 2.3 GHz)	MRAL2023-1.5		8	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.0 & 2.3 GHz)	-3		8	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.0 & 2.3 GHz)	-6		6.8	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.0 & 2.3 GHz)	-12		6.8	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 22 V, P_{out} = 1.5 W, f = 2.0 & 2.3 GHz)	MRAL2023-1.5		35	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.0 & 2.3 GHz)	-3		40	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.0 & 2.3 GHz)	-6		40	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.0 & 2.3 GHz)	-12		40	—	—	

(1) Not measurable because of output matching network.

2

TYPICAL CHARACTERISTICS
MRAL2023-1.5

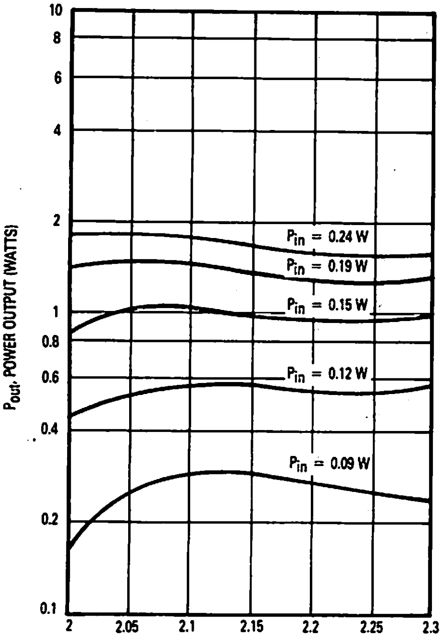


Figure 1. Power Output versus Frequency

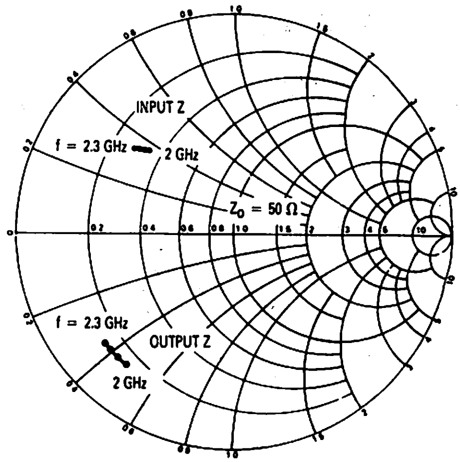


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

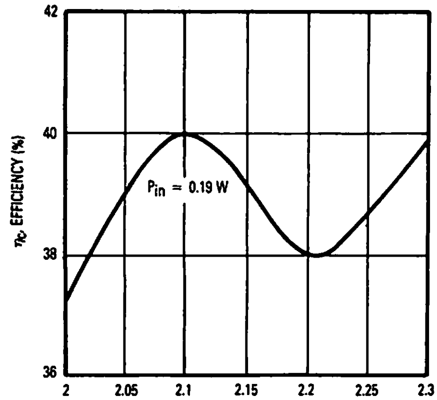


Figure 3. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS
MRAL2023-3

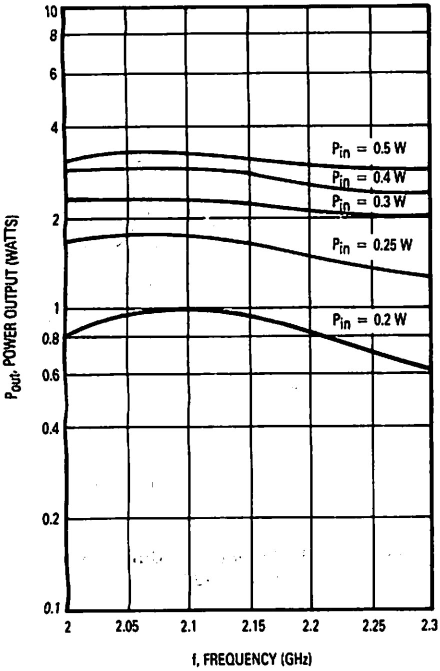


Figure 4. Power Output versus Frequency

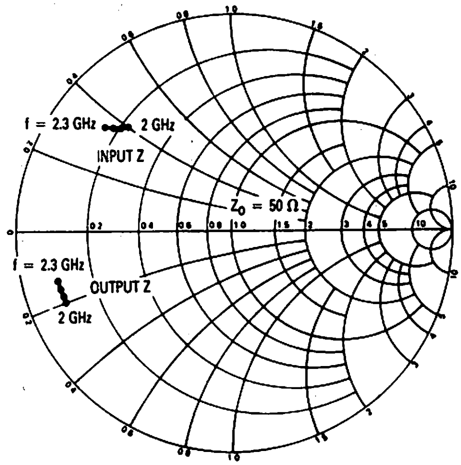


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

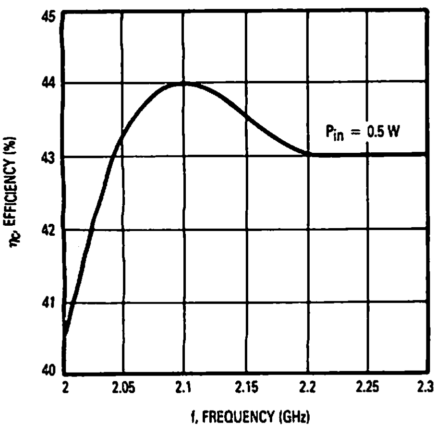


Figure 6. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS
MRAL2023-6

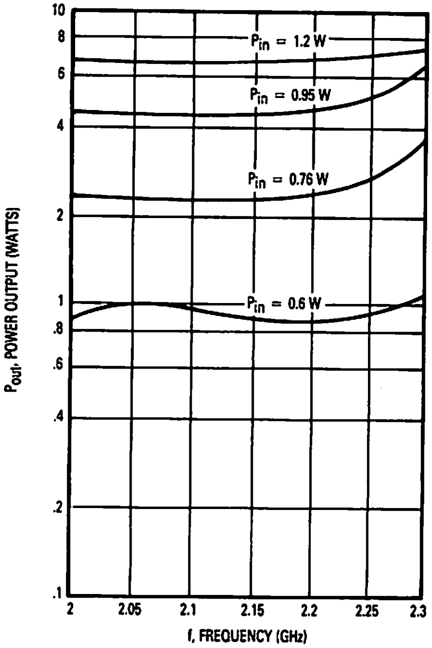


Figure 7. Power Output versus Frequency

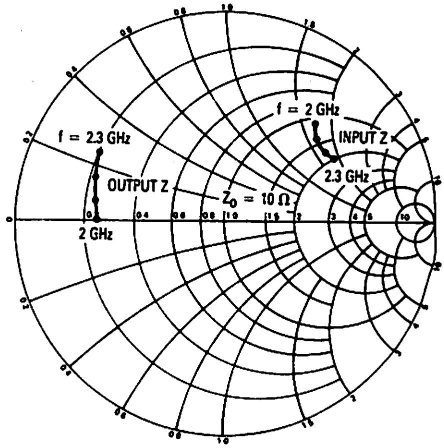


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

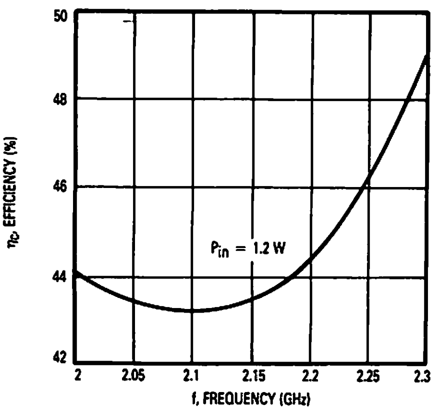


Figure 9. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS
MRAL2023-12

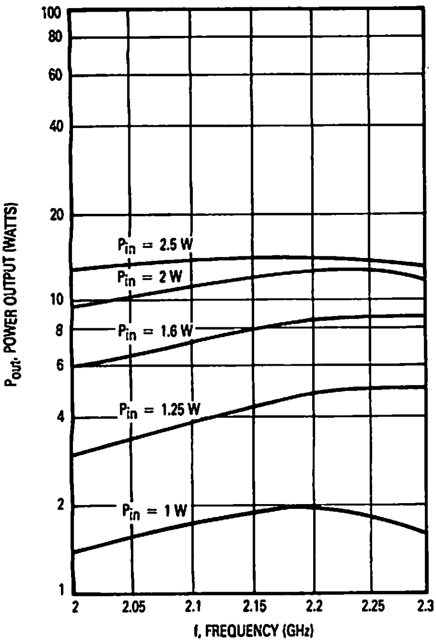


Figure 10. Power Output versus Frequency

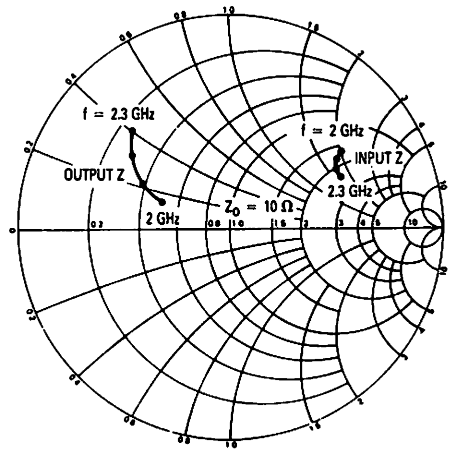


Figure 11. Series Equivalent Input/Output Impedance
V_{CC} = 22 V

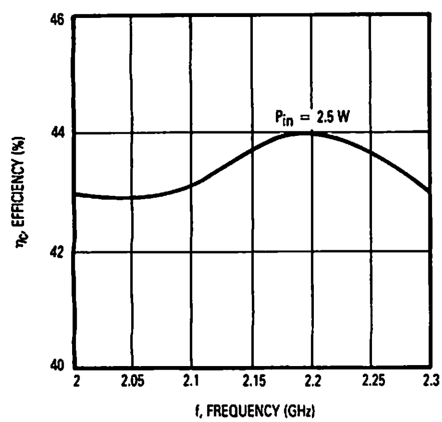
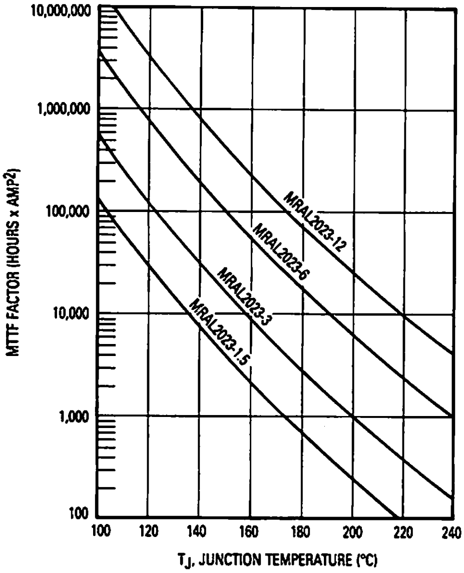


Figure 12. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ± 10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included below.



Example of MTTF for MRA2023-12 Conditions

$P_o = 12$ W

$P_{in} = 2.5$ W

$V_{CC} = 22$ V

$\eta = 40\%$

$T_{FLANGE} = 70°C$

$$I_C = I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 1.36 \text{ A}$$

$$P_{DISS} = P_{in} + V_{CC} \cdot I_C - P_o = 20.42 \text{ W}$$

$$T_{JUNC} = T_{FLANGE} + (\theta_{JF} \times P_{DISS}) = 161.89°C$$

$$MTTF = \frac{2.05 \times 10^5 \text{ Hrs. Amp}^2}{I_C^2} = 110{,}834 \text{ Hrs}$$

$$MTTF = 12.65 \text{ Yrs}$$

Figure 13. MTTF Factor versus Junction Temperature

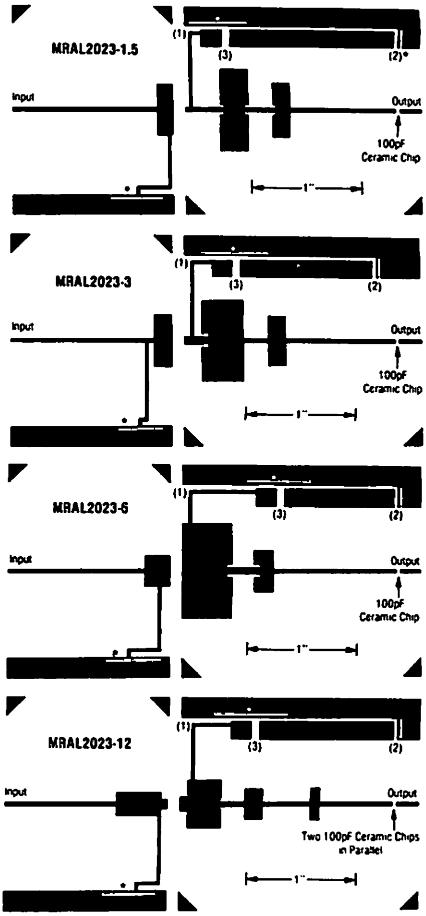


Figure 14. Test Circuit Boards (Not to Scale)

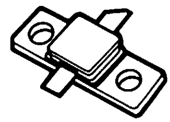
MRAL2023-18
MRAL2023-18H

The RF Line
Microwave Power Transistors

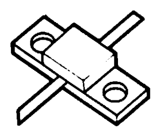
. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
  - Output Power — 18 Watts
  - Power Gain — 7 dB Min
  - *Collector Efficiency* — 35%, Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- *Hermetic Package* for Military/Space Applications

7 dB
2–2.3 GHz
18 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 393-01, STYLE 1
(HLP-11)
MRAL2023-18H



CASE 394-01, STYLE 1
(MRA .25)
MRAL2023-18

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range MRAL2023-18 MRAL2023-18H	T_{stg}	−65 to +150 −65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 160 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	4	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 800 mA, V_{CE} = 5 V)	h_{FE}	10	—	100	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 22 V, P_{out} = 18 W, f = 2.0 & 2.3 GHz)	G_{PB}	7	—	—	dB
Collector Efficiency (V_{CE} = 22 V, P_{out} = 18 W, f = 2.0 & 2.3 GHz)	η_c	35	—	—	%

TYPICAL CHARACTERISTICS

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ± 10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for MTTF in a particular application.

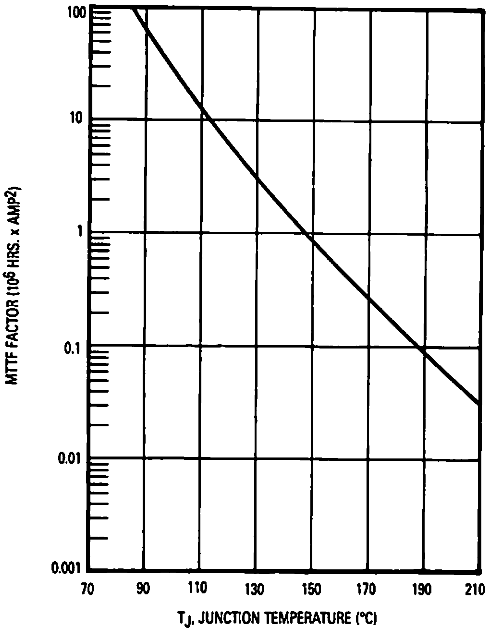
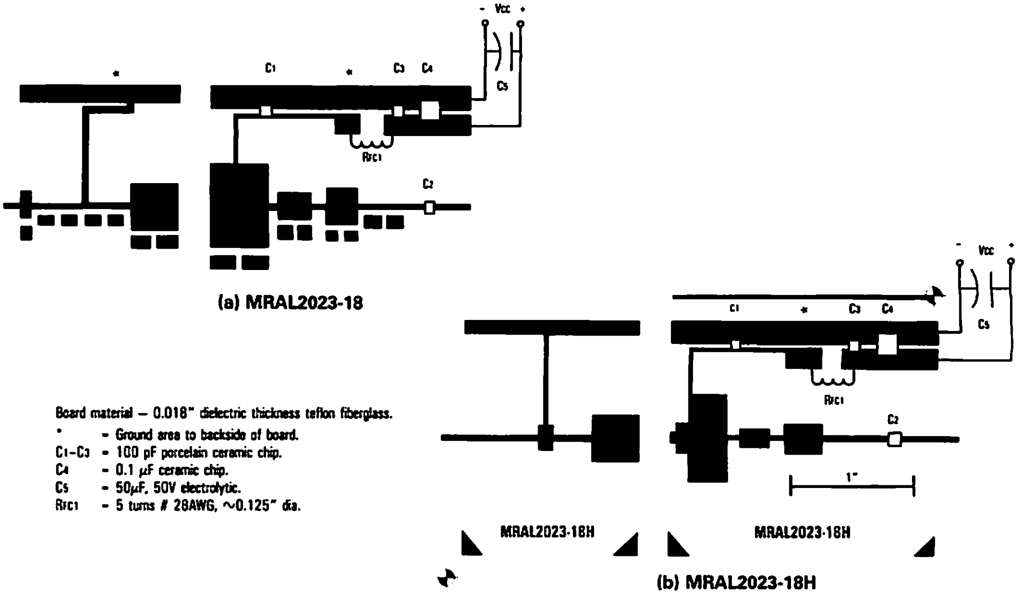


Figure 1. MTTF Factor versus Junction Temperature



Board material — 0.018" dielectric thickness teflon fiberglass.
* - Ground area to backside of board.
C1–C3 - 100 pF porcelain ceramic chip.
C4 - 0.1 μF ceramic chip.
C5 - 50μF, 50V electrolytic.
Rfc1 - 5 turns # 28AWG, ~0.125" dia.

Figure 2. Test Circuit Boards (Not to Scale)

MRAL2023H Series

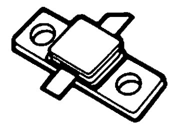
2

The RF Line
Microwave Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 2.3 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.3 GHz Characteristics:
  Output Power — 1.5 to 12 Watts
  Power Gain — 6.8 to 8 dB
  Collector Efficiency — 35 to 40%
- *Built-In* Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

6.8 to 8 dB
2–2.3 GHz
1.5 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 393-01, STYLE 1
(HLP-11)

MAXIMUM RATINGS

Rating	Symbol	-1.5H	-3H	-6H	-12H	Unit
Collector-Base Voltage	V_{CES}	42				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Collector Current — Continuous	I_C	0.25	0.5	1.25	2.5	Adc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +200				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	30	16	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRAL2023-1.5H		42	—	—	
(I_C = 20 mA, V_{BE} = 0)	- 3H		42	—	—	
(I_C = 50 mA, V_{BE} = 0)	- 6H		42	—	—	
(I_C = 100 mA, V_{BE} = 0)	- 12H		42	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.2 mA, I_C = 0)	MRAL2023-1.5H		3.5	—	—	
(I_E = 0.4 mA, I_C = 0)	- 3H		3.5	—	—	
(I_E = 1 mA, I_C = 0)	- 6H		3.5	—	—	
(I_E = 2 mA, I_C = 0)	- 12H		3.5	—	—	
Collector Cutoff Current	MRAL2023-1.5H	I_{CBO}	—	—	0.25	mAdc
(V_{CB} = 22 V, I_E = 0)	- 3H		—	—	0.5	
	- 6H		—	—	1.25	
	- 12H		—	—	2.5	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 0.1 A, V_{CE} = 5 V)	MRAL2023-1.5H		10	—	90	
(I_C = 0.2 A, V_{CE} = 5 V)	- 3H		10	—	90	
(I_C = 0.5 A, V_{CE} = 5 V)	- 6H		10	—	90	
(I_C = 1 A, V_{CE} = 5 V)	- 12H		10	—	90	
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 22 V, I_E = 0, f = 1 MHz)	MRAL2023-1.5H	C_{ob}	—	—	3.5	pF
	- 3H		—	—	5	
	- 6H		—	—	(1)	
	- 12H		—	—	(1)	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 1.5 W, f = 2.3 GHz)	MRAL2023-1.5H		8	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.3 GHz)	- 3H		8	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.3 GHz)	- 6H		6.8	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.3 GHz)	- 12H		6.8	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 22 V, P_{out} = 1.5 W, f = 2.3 GHz)	MRAL2023-1.5H		35	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.3 GHz)	- 3H		40	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.3 GHz)	- 6H		40	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.3 GHz)	- 12H		40	—	—	

Note 1. Not measurable because of output matching network.

TYPICAL CHARACTERISTICS
MRAL2023-1.5H

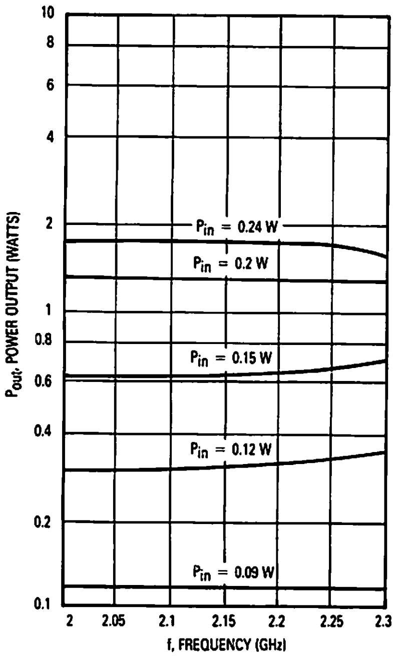


Figure 1. Power Output versus Frequency

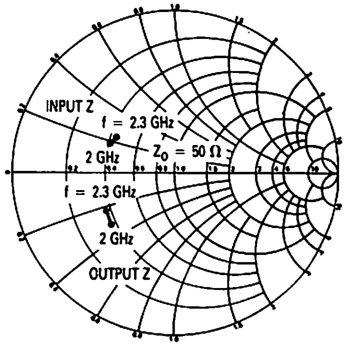


Figure 2. Series Equivalent Input/Output Impedance

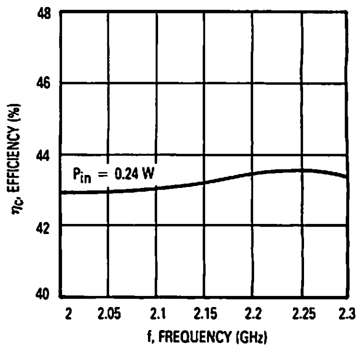


Figure 3. Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS
MRAL2023-3H

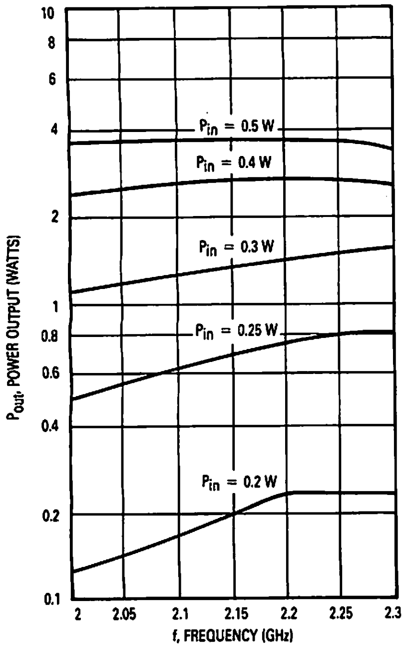


Figure 4. Power Output versus Frequency

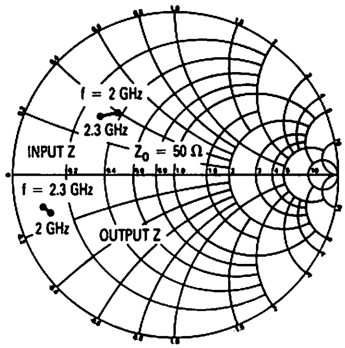


Figure 5. Series Equivalent Input/Output Impedance

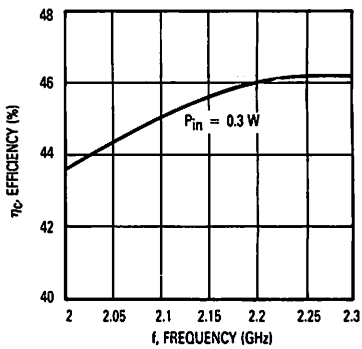


Figure 6. Efficiency versus Frequency

2

2

TYPICAL CHARACTERISTICS
MRAL2023-6H

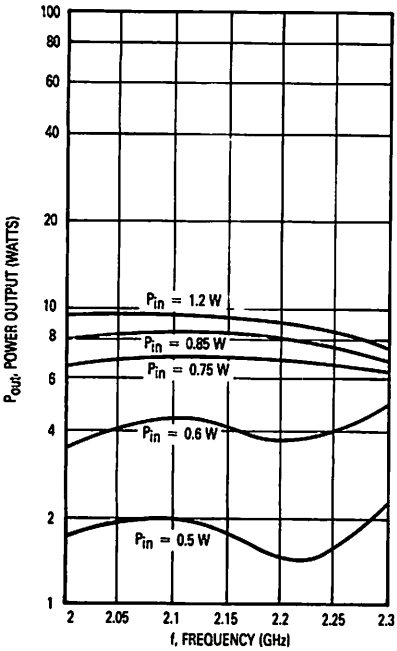


Figure 7. Power Output versus Frequency

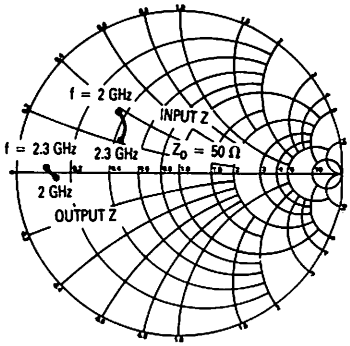


Figure 8. Series Equivalent Input/Output Impedance

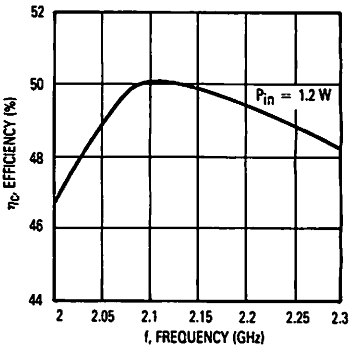


Figure 9. Efficiency versus Frequency

TYPICAL CHARACTERISTICS
MRAL2023-12H

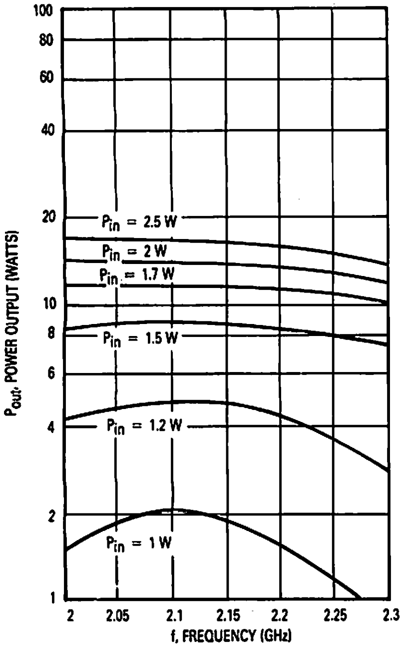


Figure 10. Power Output versus Frequency

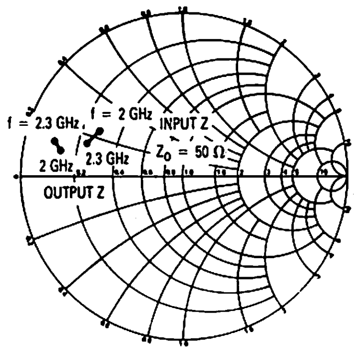


Figure 11. Series Equivalent Input/Output Impedance

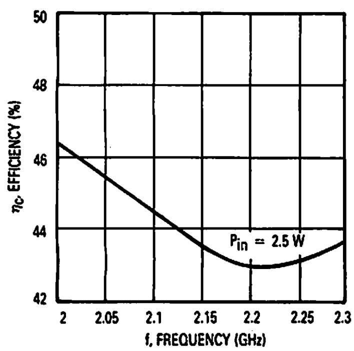


Figure 12. Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by $I_C{}^2$ for actual MTTF in a particular application.

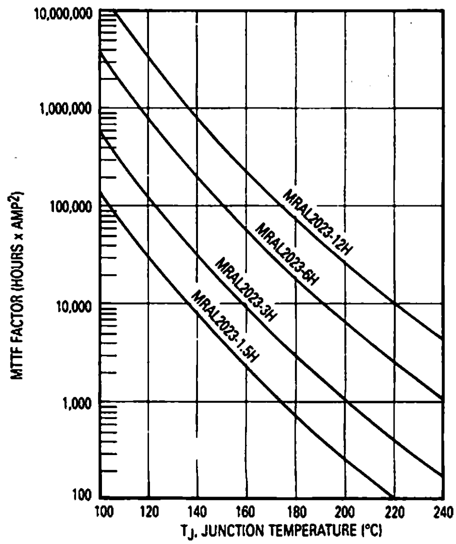


Figure 13. MTTF Factor versus Junction Temperature

2

MRAL2327 Series

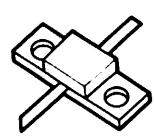
The RF Line

Microwave Power Transistors

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2.3 to 2.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.7 GHz Characteristics:
  Output Power — 1.3 to 12 Watts
  Power Gain — 5.5 to 6.8 dB Min, Common Base
  Collector Efficiency — 30 to 40% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

5.5 to 6.8 dB
2.3–2.7 GHz
1.3 TO 12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTORS



CASE 394-01, STYLE 1
(MRA .25)

MAXIMUM RATINGS

Rating	Symbol	-1.3	-3	-6	-12	Unit
Collector-Base Voltage	V_{CES}	44				Vdc
Emitter-Base Voltage	V_{EBO}	3.5				Vdc
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	30	16	8	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRAL2327-1.3		42	—	—	
(I_C = 20 mA, V_{BE} = 0)	-3		42	—	—	
(I_C = 50 mA, V_{BE} = 0)	-6		42	—	—	
(I_C = 80 mA, V_{BE} = 0)	-12		42	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 0.5 mA, I_E = 0)	MRAL2327-1.3		38	—	—	
(I_C = 1 mA, I_E = 0)	-3		38	—	—	
(I_C = 2.5 mA, I_E = 0)	-6		38	—	—	
(I_C = 8.0 mA, I_E = 0)	-12		38	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.2 mA, I_C = 0)	MRAL2327-1.3		3.5	—	—	
(I_E = 0.4 mA, I_C = 0)	-3		3.5	—	—	
(I_E = 1 mA, I_C = 0)	-6		3.5	—	—	
(I_E = 2 mA, I_C = 0)	-12		3.5	—	—	
Collector Cutoff Current	MRAL2327-1.3	I_{CBO}	—	—	0.25	mAdc
(V_{CB} = 22 V, I_E = 0)	-3		—	—	0.5	
	-6		—	—	1.25	
	-12		—	—	2.0	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRAL2327-1.3		10	—	100	
(I_C = 200 mA, V_{CE} = 5 V)	-3		10	—	100	
(I_C = 500 mA, V_{CE} = 5 V)	-6		10	—	100	
(I_C = 800 mA, V_{CE} = 5 V)	-12		10	—	100	
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 22 V, P_{out} = 1.3 W, f = 2.7 GHz)	MRAL2327-1.3		5.5	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.7 GHz)	-3		6.6	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.7 GHz)	-6		7	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.7 GHz)	-12		6.8	—	—	
Collector Efficiency		η_C				%
(V_{CE} = 22 V, P_{out} = 1.3 W, f = 2.7 GHz)	MRAL2327-1.3		30	—	—	
(V_{CE} = 22 V, P_{out} = 3 W, f = 2.7 GHz)	-3		35	—	—	
(V_{CE} = 22 V, P_{out} = 6 W, f = 2.7 GHz)	-6		35	—	—	
(V_{CE} = 22 V, P_{out} = 12 W, f = 2.7 GHz)	-12		40	—	—	

2

TYPICAL CHARACTERISTICS

MRAL2327-1.3

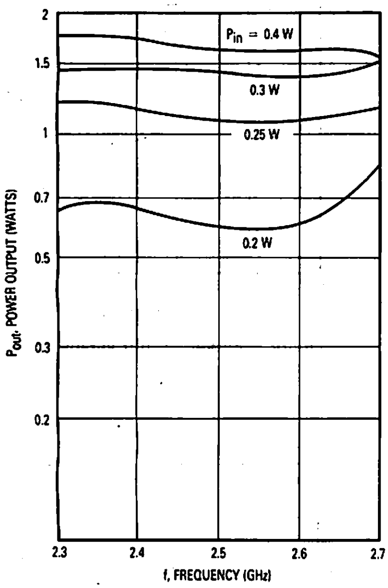


Figure 1. Power Output versus Frequency

MRAL2327-3

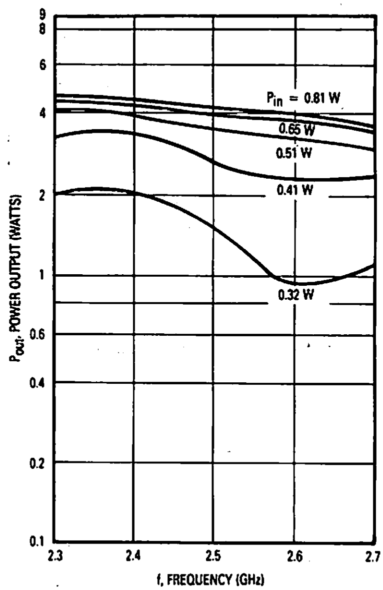


Figure 2. Power Output versus Frequency

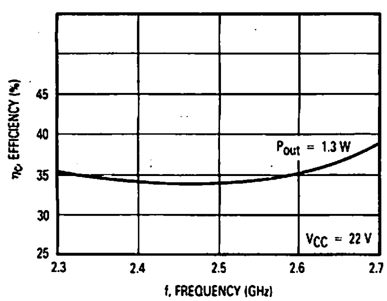


Figure 2. Collector Efficiency versus Frequency

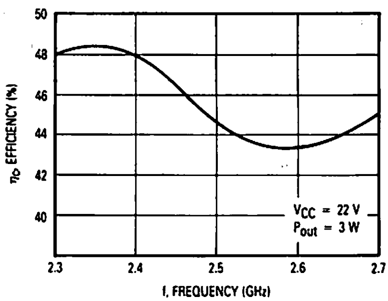


Figure 4. Collector Efficiency versus Frequency

2

TYPICAL CHARACTERISTICS

MRAL2327-6

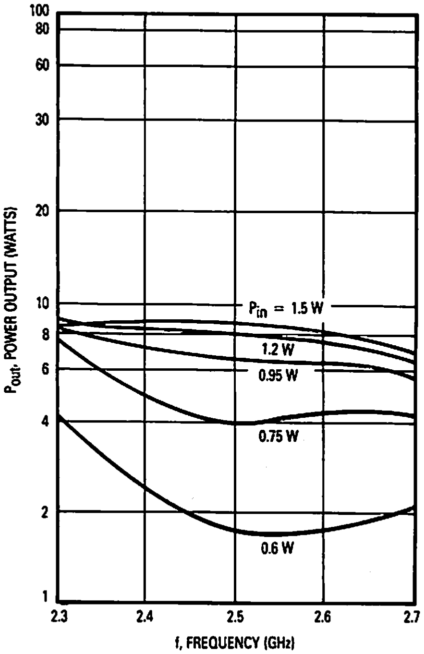


Figure 5. Power Output versus Frequency

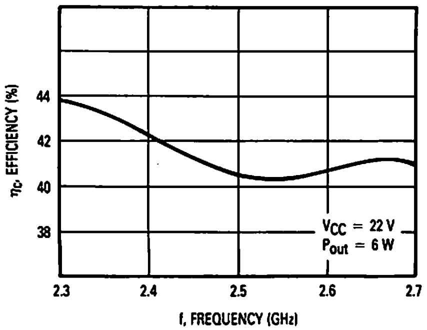


Figure 6. Collector Efficiency versus Frequency

MRAL2327-12

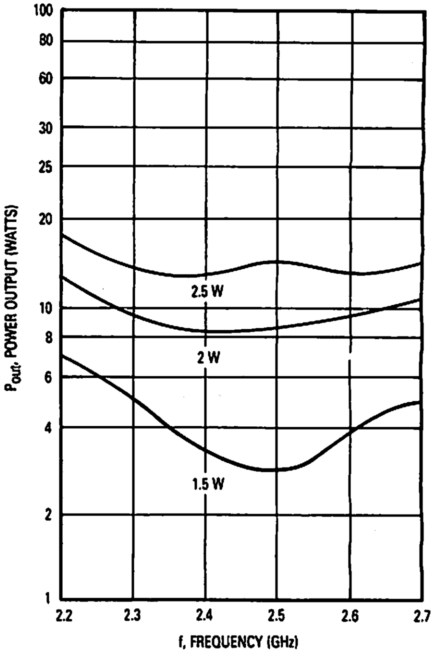


Figure 7. Power Output versus Frequency

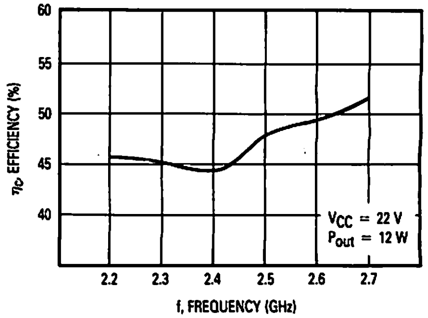


Figure 8. Collector Efficiency versus Frequency

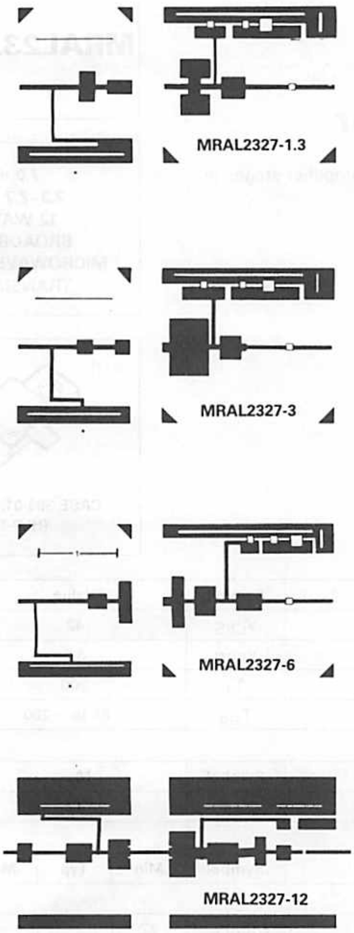


Figure 9. Circuit Boards (Not to scale.)

Board material — 0.018" dielectric thickness Teflon fiberglass
* Ground through to back side of board
C1, C3 — 100 pF porcelain ceramic chip
C4 — 0.1 μF ceramic chip
C5 — 50 μF, 50 V electrolytic
RFC1 — 5 turns #22 AWG, ~0.125 dia.

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular applications.

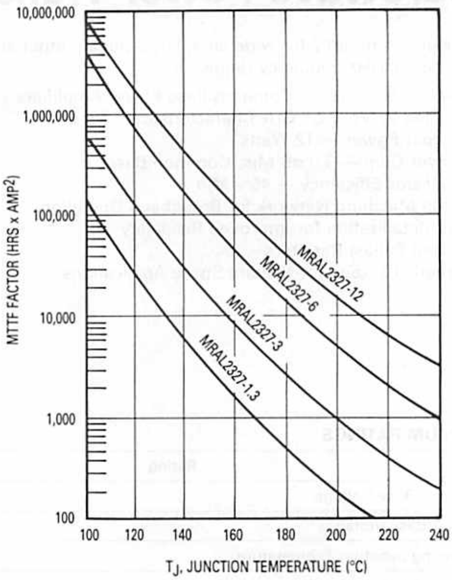


Figure 10. MTTF Factor versus Junction Temperature

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

Advance Information

The RF Line

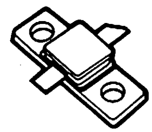
Microwave Power Transistor

MRAL2327-12H

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2.3 to 2.7 GHz frequency range.

- Designed for Class C, Common Base Power Amplifiers
- Specified 22 Volt, 2.7 GHz Characteristics:
  Output Power — 12 Watts
  Power Gain — 7.0 dB Min, Common Base
  Collector Efficiency — 45% Min
- Built-In Matching Network for Broadband Operation
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Hermetic Package for Military/Space Applications

7.0 dB
2.3–2.7 GHz
12 WATTS
BROADBAND
MICROWAVE POWER
TRANSISTOR



CASE 393-01, STYLE 1
(HLP-11)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (RF)	$R_{\theta JC}$	4.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 8.0 mA, I_E = 0)	$V_{(BR)CBO}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 800 mA, V_{CE} = 5.0 V)	h_{FE}	10	—	100	—
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 22 V, P_{out} = 12 W, f = 2.3 and 2.7 GHz)	G_{PB}	7.0	—	—	dB
Collector Efficiency (V_{CE} = 22 V, P_{out} = 12 W, f = 2.3 and 2.7 GHz)	η_c	45	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

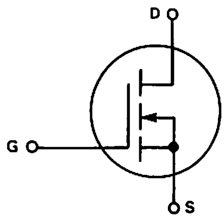
MRF134

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

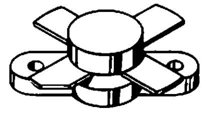
. . . designed for wideband large-signal amplifier and oscillator applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 150 MHz Performance
  Output Power = 5.0 Watts
  Minimum Gain = 11 dB
  Efficiency — 55% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 5.0 W
  Output = 10.6 dB Gain
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.0 dB (Typ) at 200 mA, 150 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation



5.0 W 2.0-400 MHz

N-CHANNEL MOS BROADBAND RF POWER FET



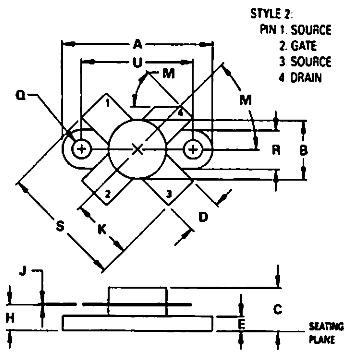
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	17.5 0.10	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

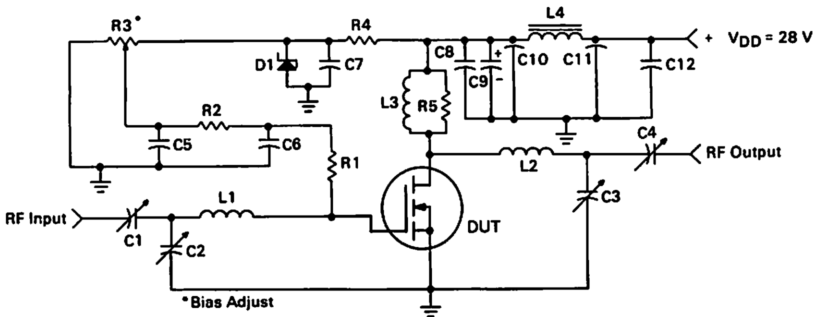
CASE 211-07

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (I_D = 10 mA, V_{DS} = 10 V)	$V_{GS(th)}$	1.0	3.5	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 100 mA)	g_{fs}	80	110	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.3	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 200 mA, f = 150 MHz)	NF	—	2.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 5.0 W, I_{DQ} = 50 mA) f = 150 MHz (Fig. 1)	G_{ps}	11	14	—	dB
f = 400 MHz (Fig. 14)		—	10.6	—	
Drain Efficiency (Fig. 1) (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 150 MHz, I_{DQ} = 50 mA)	η	50	55	—	%
Electrical Ruggedness (Fig. 1) (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 150 MHz, I_{DQ} = 50 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1, C4 — Arco 406, 15-115 pF
C2 — Arco 403, 3-35 pF
C3 — Arco 402, 1.5-20 pF
C5, C6, C7, C8, C12 — 0.1 μF Erie Redcap
C9 — 10 μF, 50 V
C10, C11 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 3 Turns, 0.310" ID, #18 AWG Enamel, 0.2" Long
L2 — 3-1/2 Turns, 0.310" ID, #18 AWG Enamel, 0.25" Long
L3 — 20 Turns, #20 AWG Enamel Wound on R5
L4 — Ferroxcube VK-200 — 19/4B
R1 — 68 Ω, 1.0 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ Beckman Instruments 8108
R4 — 1.8 kΩ, 1/2 W
R5 — 1.0 MΩ, 2.0 W Carbon
Board — G10, 62 mils

FIGURE 2 — OUTPUT POWER versus INPUT POWER

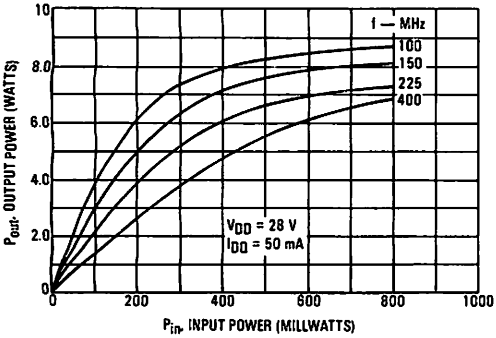


FIGURE 3 — OUTPUT POWER versus INPUT POWER

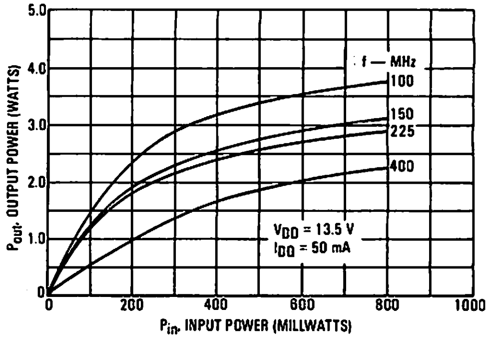


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

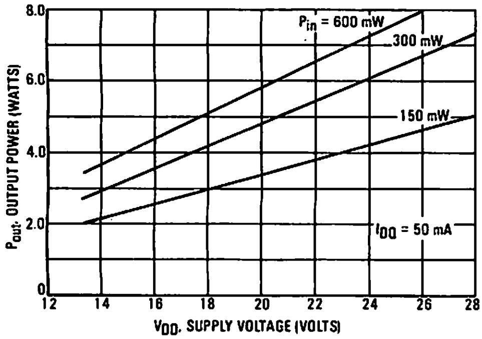


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

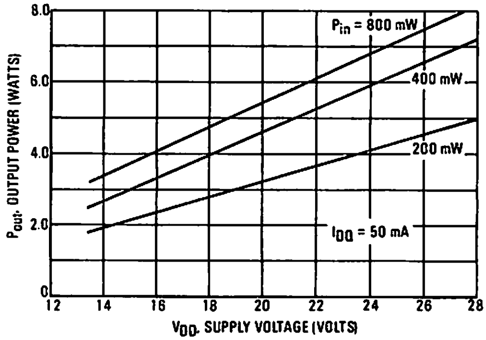


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

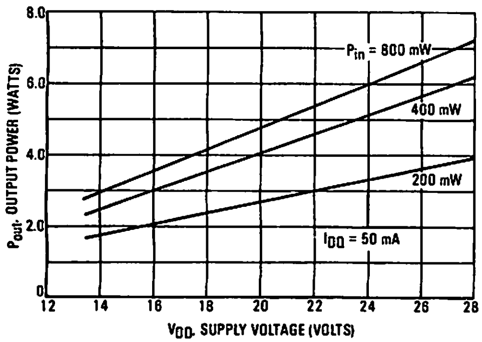


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

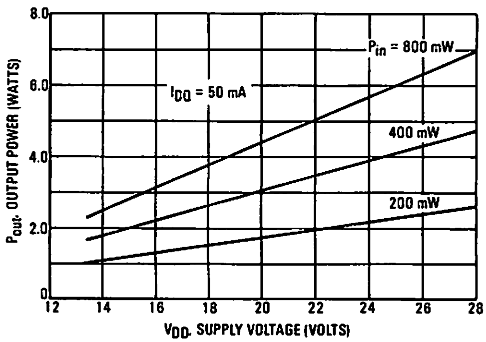


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FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

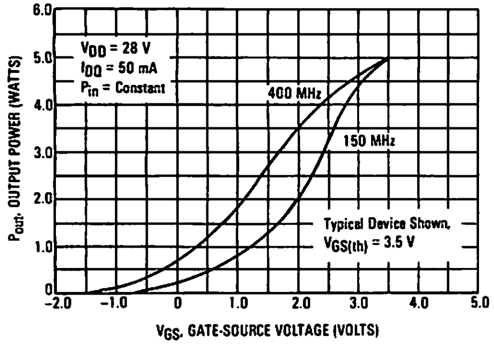


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

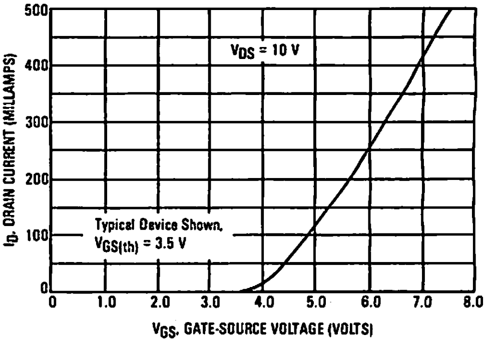


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

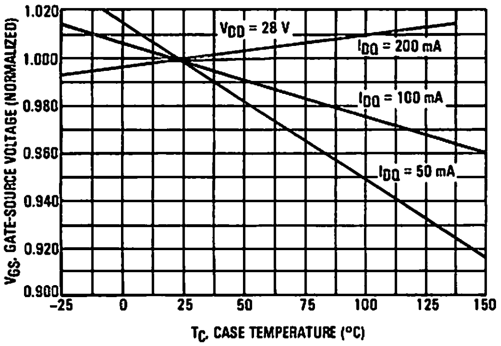


FIGURE 11 — MAXIMUM AVAILABLE GAIN versus FREQUENCY

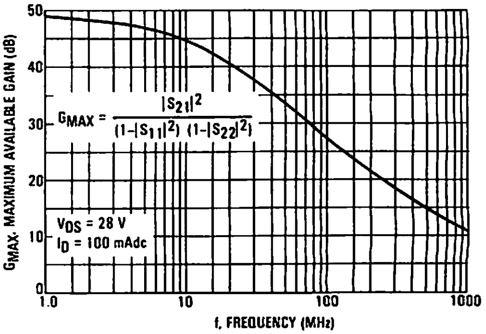


FIGURE 12 — CAPACITANCE versus VOLTAGE

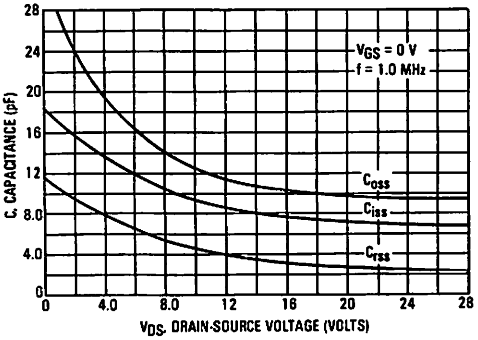


FIGURE 13 — MAXIMUM RATED FORWARD BIASED SAFE OPERATING AREA

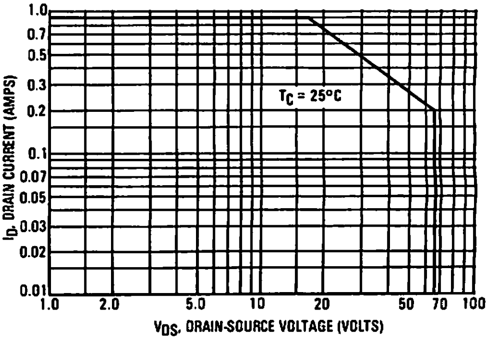
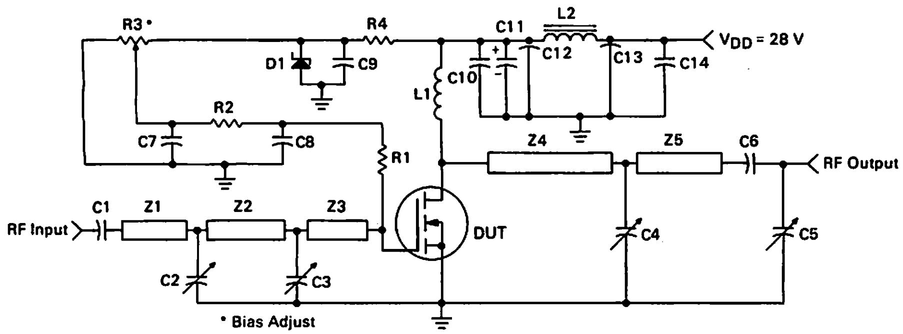
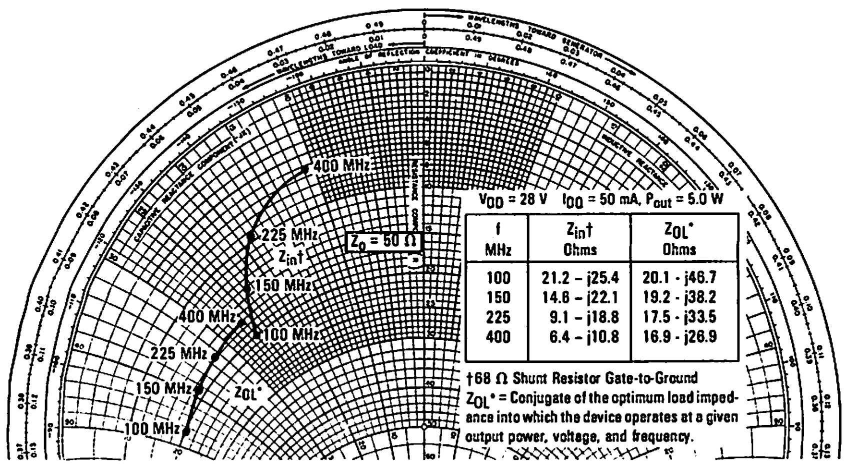


FIGURE 14 — 400 MHz TEST CIRCUIT



C1, C6 — 270 pF, ATC 100 mils
C2, C3, C4, C5 — 0-20 pF Johanson
C7, C9, C10, C14 — 0.1 μF Erie Redcap, 50 V
C8 — 0.001 μF
C11 — 10 μF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 6 Turns, 1/4" ID, #20 AWG Enamel
L2 — Ferroxcube VK-200 — 19/4B
R1 — 68 Ω, 1.0 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ Beckman Instruments 8108
R4 — 1.8 kΩ, 1/2 W
Z1 — 1.4" × 0.166" Microstrip
Z2 — 1.1" × 0.166" Microstrip
Z3 — 0.95" × 0.166" Microstrip
Z4 — 2.2" × 0.166" Microstrip
Z5 — 0.85" × 0.166" Microstrip
Board — Glass Teflon, 62 mils

FIGURE 15 — LARGE-SIGNAL SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES, Z_{in}†, Z_{OL}*



f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
100	21.2 - j25.4	20.1 - j46.7
150	14.8 - j22.1	19.2 - j38.2
225	9.1 - j18.8	17.5 - j33.5
400	6.4 - j10.8	16.9 - j26.9

†68 Ω Shunt Resistor Gate-to-Ground
Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

2

FIGURE 16 — COMMON SOURCE SCATTERING PARAMETERS
V_{DS} = 28 V, I_D = 100 mA

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
1.0	0.989	-1.0	11.27	179	0.0014	89	0.954	-1.0
2.0	0.989	-2.0	11.27	179	0.0028	89	0.954	-2.0
5.0	0.988	-5.0	11.26	176	0.0069	86	0.954	-4.0
10	0.985	-10	11.20	173	0.014	83	0.951	-9.0
20	0.977	-20	10.99	166	0.027	76	0.938	-18
30	0.965	-30	10.66	159	0.039	69	0.918	-26
40	0.950	-39	10.25	153	0.051	63	0.895	-34
50	0.931	-47	9.777	147	0.060	57	0.867	-42
60	0.912	-53	9.359	142	0.069	53	0.846	-49
70	0.892	-58	8.960	138	0.077	49	0.828	-56
80	0.874	-62	8.583	135	0.085	46	0.815	-62
90	0.855	-66	8.190	131	0.091	43	0.801	-68
100	0.833	-70	7.808	128	0.096	40	0.785	-74
110	0.827	-73	7.661	125	0.101	38	0.784	-77
120	0.821	-76	7.515	122	0.107	36	0.784	-82
130	0.814	-79	7.368	119	0.113	34	0.784	-85
140	0.808	-82	7.222	116	0.119	32	0.783	-88
150	0.802	-86	7.075	114	0.125	31	0.783	-90
160	0.788	-89	6.810	112	0.127	30	0.780	-92
170	0.774	-92	6.540	110	0.128	28	0.774	-94
180	0.763	-94	6.220	108	0.130	26	0.762	-98
190	0.751	-97	5.903	106	0.132	24	0.760	-100
200	0.740	-100	5.784	104	0.134	23	0.758	-103
225	0.719	-104	5.334	100	0.136	20	0.757	-107
250	0.704	-108	4.904	97	0.139	19	0.758	-110
275	0.687	-113	4.551	92	0.141	16	0.757	-114
300	0.673	-117	4.219	89	0.141	14	0.750	-117
325	0.668	-120	3.978	86	0.142	12	0.757	-120
350	0.669	-123	3.737	83	0.142	10	0.766	-121
375	0.662	-125	3.519	80	0.143	9.0	0.768	-123
400	0.654	-127	3.325	77	0.142	8.0	0.772	-124
425	0.650	-129	3.170	75	0.140	7.0	0.772	-125
450	0.638	-131	3.048	72	0.141	6.0	0.783	-125
475	0.614	-132	2.898	71	0.136	6.0	0.786	-126
500	0.641	-133	2.833	68	0.136	5.0	0.795	-127
525	0.638	-135	2.709	66	0.135	5.0	0.801	-127
550	0.633	-137	2.574	64	0.133	4.0	0.802	-128
575	0.628	-138	2.481	62	0.131	5.0	0.805	-128
600	0.625	-140	2.408	60	0.129	5.0	0.814	-128
625	0.619	-142	2.334	58	0.128	5.0	0.818	-129
650	0.617	-144	2.259	56	0.125	6.0	0.824	-130
675	0.618	-146	2.192	55	0.123	7.0	0.834	-130
700	0.619	-147	2.124	53	0.122	8.0	0.851	-131
725	0.618	-150	2.061	51	0.120	9.0	0.859	-132
750	0.614	-152	1.983	49	0.118	11	0.857	-133
775	0.609	-154	1.908	48	0.119	13	0.865	-133
800	0.562	-155	1.877	49	0.118	15	0.872	-133
825	0.587	-156	1.869	46	0.119	16	0.869	-134
850	0.593	-158	1.794	44	0.118	18	0.875	-135
875	0.597	-160	1.749	43	0.119	18	0.881	-135
900	0.598	-162	1.700	41	0.118	18	0.889	-136
925	0.592	-164	1.641	40	0.115	18	0.888	-138
950	0.588	-166	1.590	39	0.112	20	0.877	-138
975	0.586	-168	1.572	39	0.108	23	0.864	-137
1000	0.590	-171	1.551	37	0.107	28	0.863	-137

The Power RF characterization data were measured with a 68 ohm resistor shunting the MRF134 input port. The scattering parameters were measured on the MRF134 device alone with no external components.

2

FIGURE 17 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 100 mA

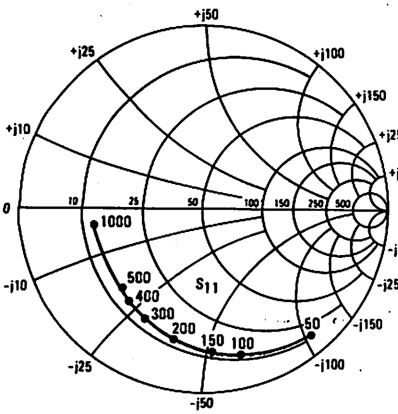


FIGURE 18 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 100 mA

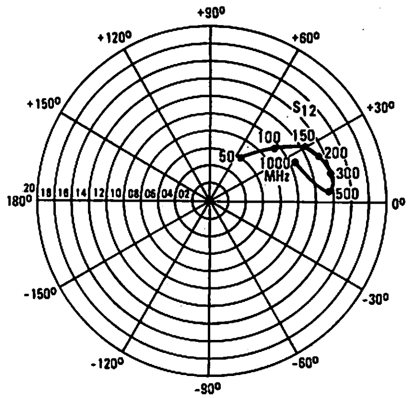


FIGURE 19 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 100 mA

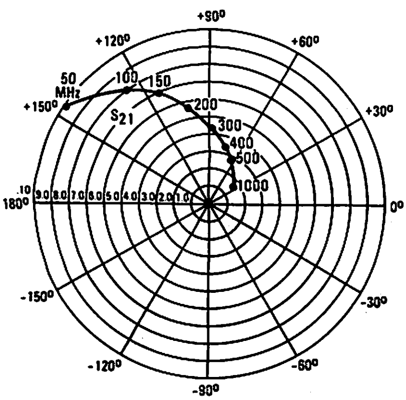
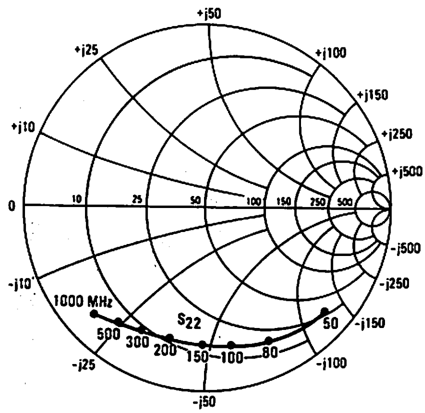


FIGURE 20 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 100 mA



2

DESIGN CONSIDERATIONS

The MRF134 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF134 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF134 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF134 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control. AGC/ALC and modulation systems. (See Figure 8.)

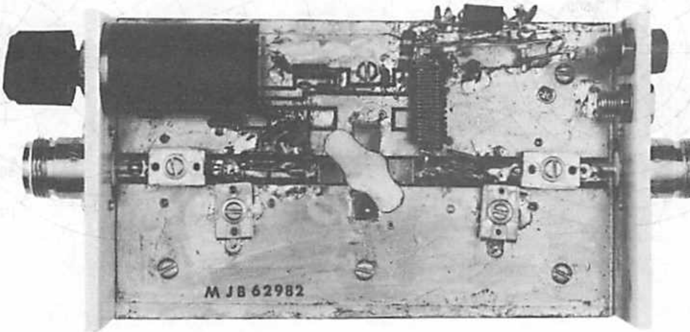
AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF134. See Motorola Application Note AN 721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-paramters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF134, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. The MRF134 was characterized with a 68-ohm input shunt loading resistor. Two port parameter stability analysis with the MRF134 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

Input resistive loading is not feasible in low noise applications. The MRF134 noise figure data was generated in a circuit with drain loading and a low loss input network.

FIGURE 21 — 150 MHz TEST CIRCUIT



MRF136
MRF136Y

The RF MOSFET Line
RF Power Field Effect Transistors
N-Channel Enhancement-Mode MOSFETs

**15 W, 30 W 2–400 MHz
N-CHANNEL
MOS BROADBAND
RF POWER FETs**

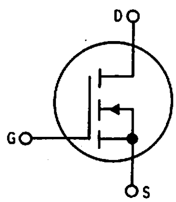
... designed for wideband large-signal amplifier and oscillator applications in the 2 to 400 MHz range, in either single ended or push-pull configuration.

- Guaranteed 28 Volt, 150 MHz Performance

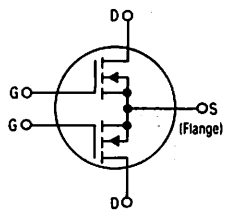
MRF136	MRF136Y
Output Power = 15 Watts	Output Power = 30 Watts
Narrowband Gain = 16 dB (Typ)	Broadband Gain = 14 dB (Typ)
Efficiency = 60% (Typical)	Efficiency = 54% (Typical)

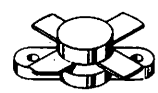
- Small-Signal and Large-Signal Characterization
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Space Saving Package For Push-Pull Circuit Applications — MRF136Y
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and *Modulation Techniques*

MRF136

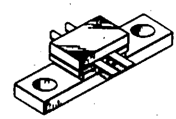


MRF136Y





CASE 211-07, STYLE 2
MRF136



CASE 319B-01, STYLE 1
MRF136Y

MAXIMUM RATINGS

Rating	Symbol	Value		Unit
		MRF136	MRF136Y	
Drain-Source Voltage	V_{DSS}	65	65	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	65	65	Vdc
Gate-Source Voltage	V_{GS}	±40		Vdc
Drain-Current — Continuous	I_D	2.5	5	Adc
Total Device Dissipation @ T_C = 25°C *Derate above 25°C*	P_D	55 0.314	100 0.571	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150		°C
Operating Junction Temperature	T_J	200		°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max		Unit
		MRF136	MRF136Y	
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	1.75	°C/W

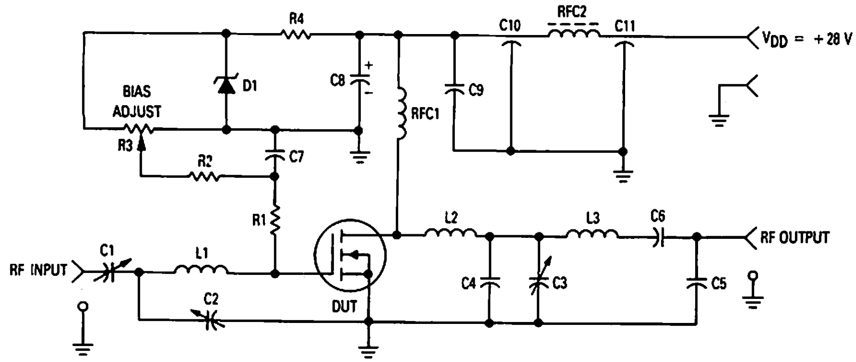
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero-Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (NOTE 1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1	3	6	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 250 mA)	g_{fs}	250	400	—	mmhos
DYNAMIC CHARACTERISTICS (NOTE 1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	24	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	5.5	—	pF
FUNCTIONAL CHARACTERISTICS (NOTE 2)					
Noise Figure MRF136 (V_{DS} = 28 Vdc, I_D = 500 mA, f = 150 MHz)	NF	—	1	—	dB
Common Source Power Gain (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA)	G_{ps}	13	16	—	dB
Common Source Power Gain (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Drain Efficiency (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA)	η	50	54	—	%
Electrical Ruggedness (Figure 1) MRF136 (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
Electrical Ruggedness (Figure 2) MRF136Y (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

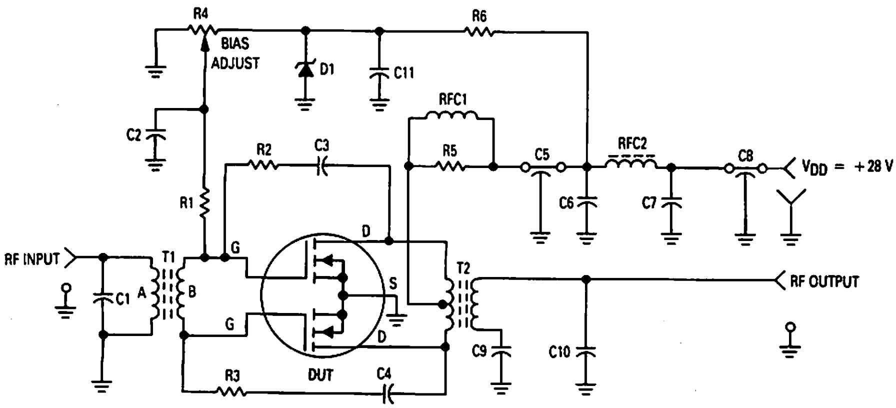
Notes: 1. For MRF136Y, each side measured separately.
2. For MRF136Y measured in push-pull configuration.



C1, C2 — Arco 406, 15–115 pF or Equivalent
C3 — Arco 404, 8–60 pF or Equivalent
C4 — 43 pF Mini-Unelco or Equivalent
C5 — 24 pF Mini-Unelco or Equivalent
C6 — 680 pF, 100 Mils Chip
C7 — 0.01 μF Ceramic
C8 — 100 μF, 40 V
C9 — 0.1 μF Ceramic
C10, C11 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29" ID, #18 AWG, 0.10" Long
L2 — 2 Turns, 0.23" ID, #18 AWG, 0.10" Long
L3 — 2-1/4 Turns, 0.29" ID, #18 AWG, 0.125" Long
RFC1 — 20 Turns, 0.30" ID, #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
R1 — 27 Ω, 1 W Thin Film
R2 — 10 kΩ, 1/4 W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, 1/2 W
Board Material — 0.062" G10, 1 oz. Cu Clad, Double Sided

Figure 1. 150 MHz Test Circuit (MRF136)



C1 — 5 pF
C2, C3, C4, C6, C7, C9, C11 — 0.1 μF Ceramic
C5, C8 — 680 pF Feedthru
C10 — 15 pF
D1 — 1N4740 Motorola Zener
RFC1 — 17 Turns, #24 AWG Wound on R5
RFC2 — Ferroxcube VK-200-19/4B or Equivalent
R1 — 10 kΩ, 1/4 W
R2, R3 — 560 Ω, 1/2 W
R4 — 10 Turns, 10 kΩ

R5 — 56 kΩ, 1 W
R6 — 1.6 kΩ, 1/4 W
T1 — Primary Winding — 3 Turns #28 Enameled Wire.
— Secondary Winding — 2 Turns #28 Enameled Wire. Both windings wound through a Fair/Rite Balun 65 core. Part #2865002402.
T2 — 1:1 Transformer Wound Bifilar — 2 Turns Twisted Pair #24 Enameled Wire through a Indiana General Balun Q1 core. Part #18006-1-Q1. Primary winding center tapped.
Board Material — 0.062" G10, 1 oz. Cu Clad, Double Sided

Figure 2. 30–150 MHz Test Circuit (MRF136Y)

MRF136

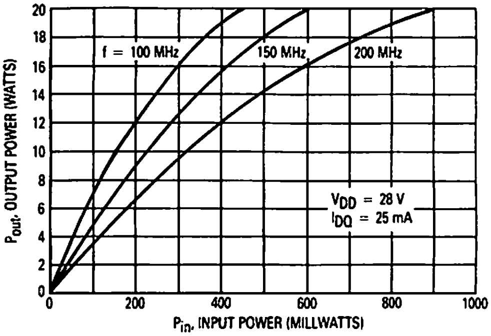


Figure 3. Output Power versus Input Power

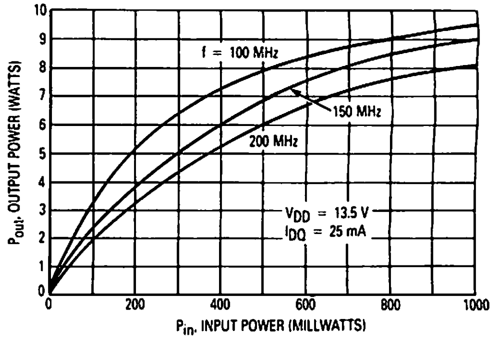


Figure 4. Output Power versus Input Power

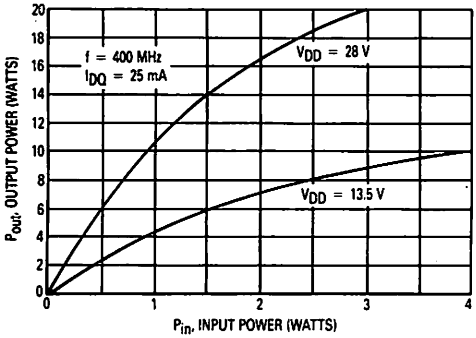


Figure 5. Output Power versus Input Power

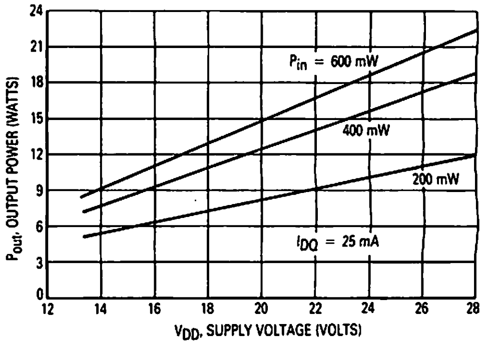


Figure 6. Output Power versus Supply Voltage f = 100 MHz

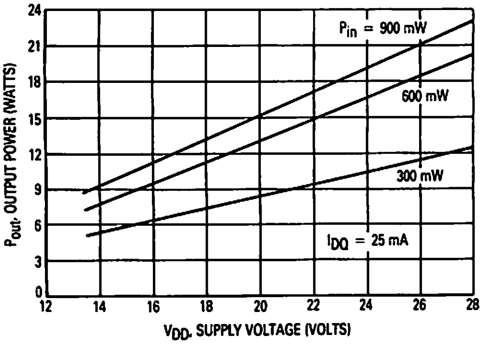


Figure 7. Output Power versus Supply Voltage f = 150 MHz

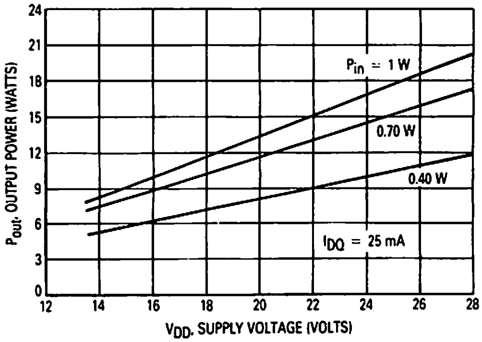


Figure 8. Output Power versus Supply Voltage f = 200 MHz

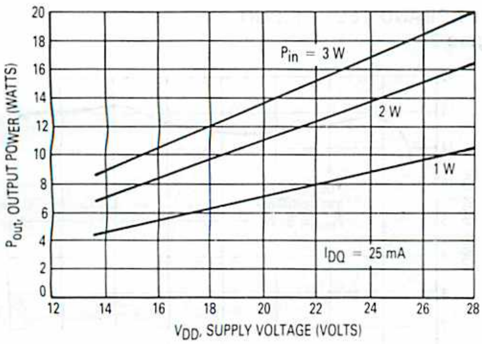


Figure 9. Output Power versus Supply Voltage
f = 400 MHz
MRF136

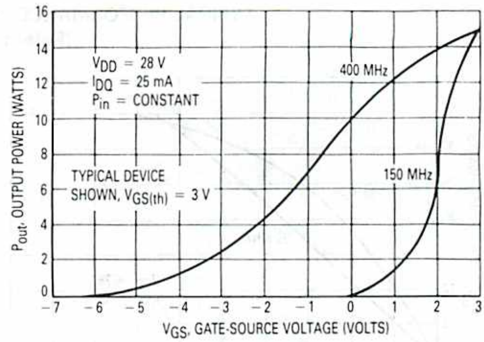


Figure 10. Output Power versus Gate Voltage
MRF136

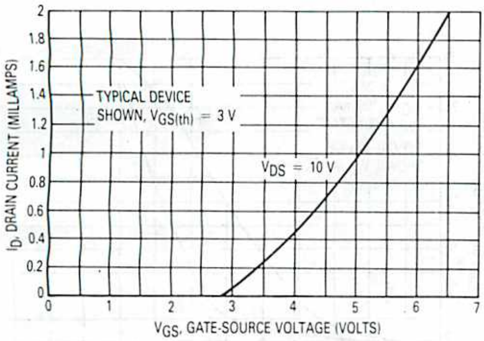


Figure 11. Drain Current versus Gate Voltage
(Transfer Characteristics)*
MRF136/MRF136Y

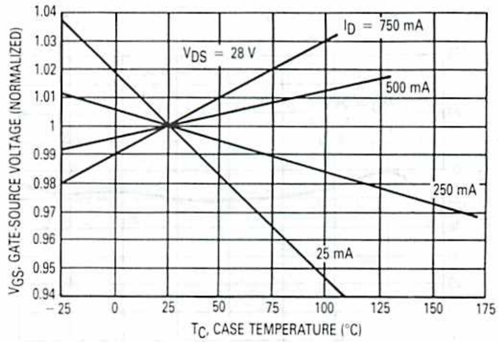


Figure 12. Gate-Source Voltage versus
Case Temperature*
MRF136/MRF136Y

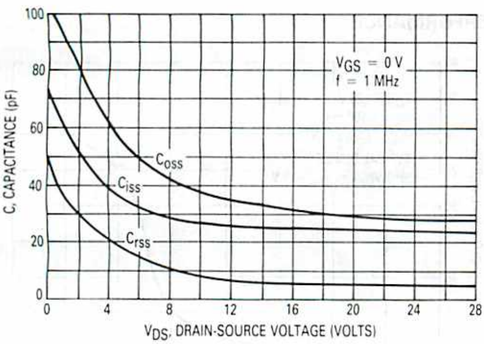


Figure 13. Capacitance versus Drain-Source Voltage*
MRF136/MRF136Y

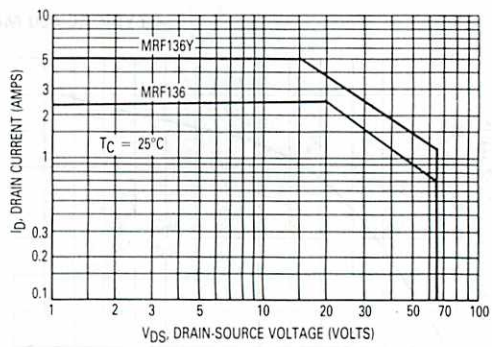


Figure 14. DC Safe Operating Area
MRF136/MRF136Y

*Data shown applies to MRF136 and each half of MRF136Y.

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MRF136Y
TYPICAL PERFORMANCE IN BROADBAND TEST CIRCUIT
(Refer to Figure 2)

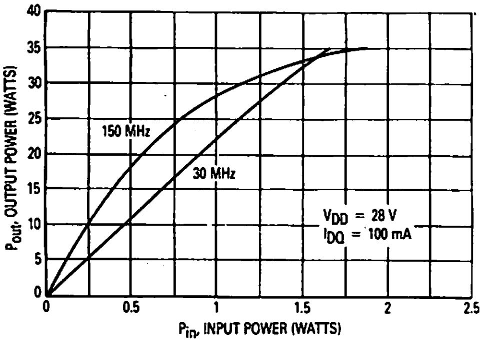


Figure 15. Output Power versus Input Power

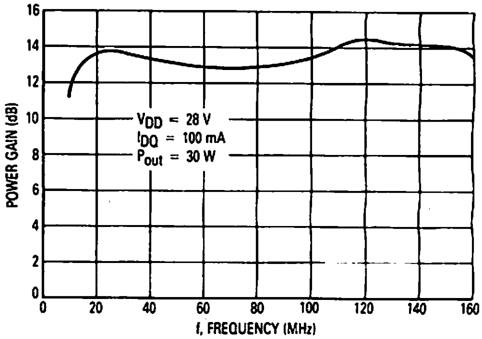


Figure 16. Power Gain versus Frequency

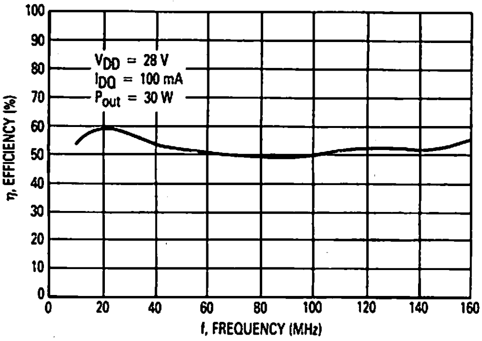


Figure 17. Drain Efficiency versus Frequency

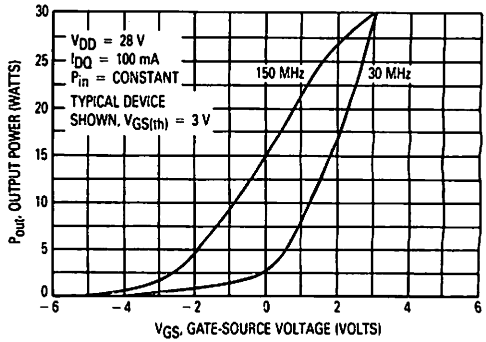


Figure 18. Output Power versus Gate Voltage

TYPICAL 400 MHz PERFORMANCE

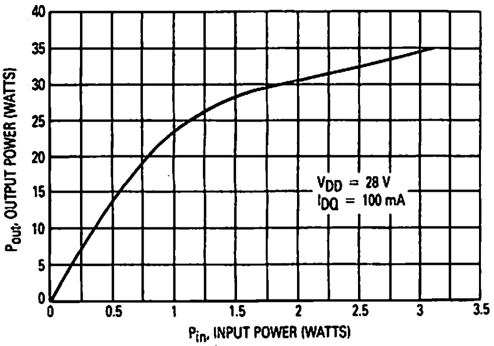


Figure 19. Output Power versus Input Power
f = 400 MHz

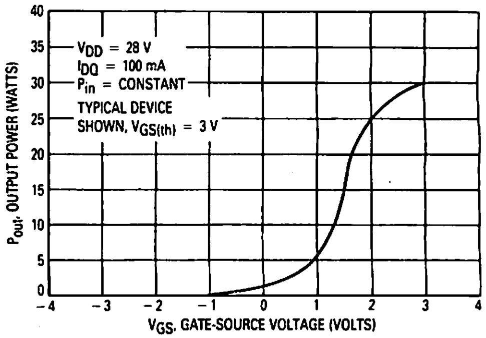
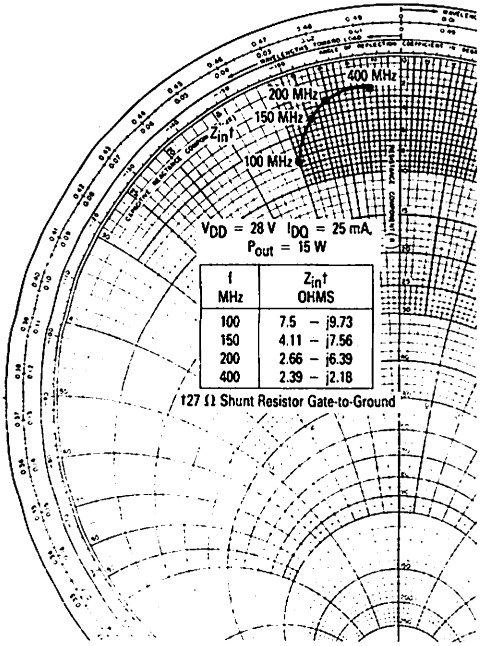
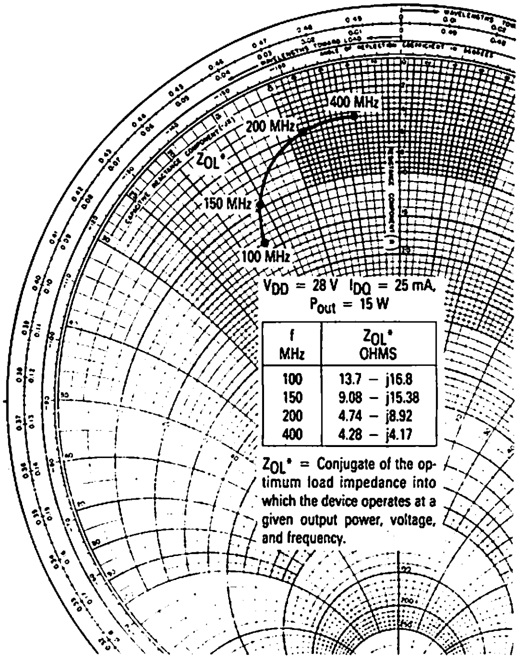


Figure 20. Output Power versus Gate Voltage
f = 400 MHz



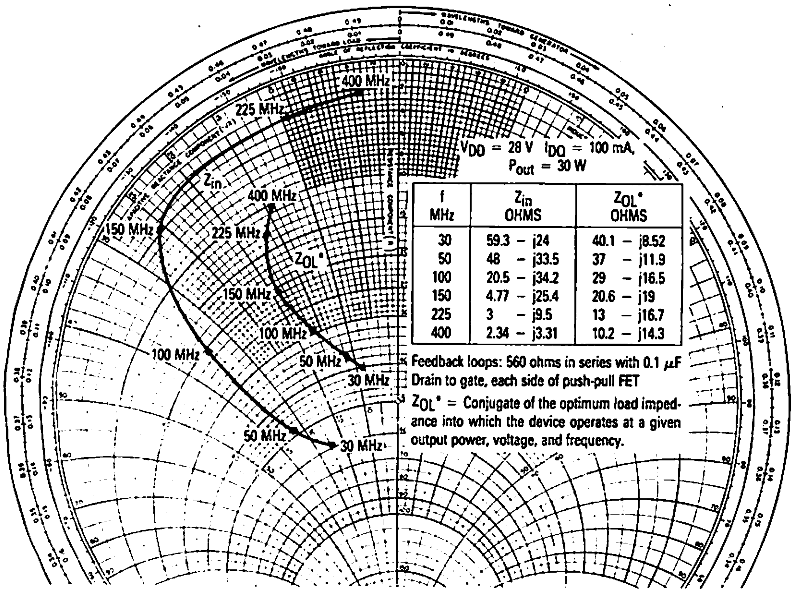
f MHz	Z_{in}† OHMS
100	7.5 – j9.73
150	4.11 – j7.56
200	2.66 – j6.39
400	2.39 – j2.18

Figure 21. Large-Signal Series Equivalent Input Impedance, Z_{in}† MRF136



f MHz	Z_{OL}* OHMS
100	13.7 – j16.8
150	9.08 – j15.38
200	4.74 – j8.92
400	4.28 – j4.17

Figure 22. Large-Signal Series Equivalent Output Impedance, Z_{OL}* MRF136



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	59.3 – j24	40.1 – j8.52
50	48 – j33.5	37 – j11.9
100	20.5 – j34.2	29 – j16.5
150	4.77 – j25.4	20.6 – j19
225	3 – j9.5	13 – j16.7
400	2.34 – j3.31	10.2 – j14.3

Figure 23. Input and Output Impedance MRF136Y

2

MRF136

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.0	0.988	-11	41.19	173	0.006	67	0.729	-12
5.0	0.970	-27	40.07	164	0.014	62	0.720	-31
10	0.923	-52	35.94	149	0.026	54	0.714	-58
20	0.837	-88	27.23	129	0.040	36	0.690	-96
30	0.784	-111	20.75	117	0.046	27	0.684	-118
40	0.751	-125	16.49	108	0.048	22	0.680	-131
50	0.733	-135	13.41	103	0.050	19	0.679	-139
60	0.720	-142	11.43	99	0.050	16	0.678	-145
70	0.709	-147	9.871	96	0.050	14	0.679	-149
80	0.707	-152	8.663	93	0.051	13	0.683	-153
90	0.706	-155	7.784	91	0.051	13	0.682	-155
100	0.708	-157	7.008	88	0.051	13	0.680	-157
110	0.711	-159	6.435	86	0.051	14	0.681	-158
120	0.714	-161	5.899	85	0.051	15	0.682	-159
130	0.717	-163	5.439	82	0.052	16	0.684	-160
140	0.720	-164	5.068	80	0.052	17	0.684	-161
150	0.723	-165	4.709	80	0.052	18	0.686	-161
160	0.727	-166	4.455	78	0.052	18	0.690	-161
170	0.732	-167	4.200	77	0.052	18	0.694	-162
180	0.735	-168	3.967	75	0.052	19	0.699	-162
190	0.738	-169	3.756	74	0.052	19	0.703	-163
200	0.740	-170	3.545	73	0.052	20	0.706	-163
225	0.746	-171	3.140	69	0.053	22	0.717	-163
250	0.742	-172	2.783	67	0.053	25	0.724	-163
275	0.744	-173	2.540	64	0.054	27	0.724	-163
300	0.751	-174	2.323	60	0.055	29	0.736	-163
325	0.757	-175	2.140	58	0.058	32	0.749	-163
350	0.760	-176	1.963	54	0.059	35	0.758	-163
375	0.762	-177	1.838	52	0.062	38	0.768	-163
400	0.774	-179	1.696	50	0.065	41	0.783	-163
425	0.775	-179	1.590	48	0.068	43	0.793	-163
450	0.781	+179	1.493	46	0.071	46	0.805	-163
475	0.787	+177	1.415	43	0.074	47	0.813	-164
500	0.792	+176	1.332	40	0.079	48	0.825	-164
525	0.797	+175	1.259	38	0.083	50	0.831	-164
550	0.801	+175	1.185	37	0.088	51	0.843	-164
575	0.810	+174	1.145	36	0.094	52	0.855	-164
600	0.816	+173	1.091	34	0.101	52	0.869	-165
625	0.818	+171	1.041	32	0.106	53	0.871	-165
650	0.825	+170	0.994	30	0.112	53	0.884	-165
675	0.834	+169	0.962	29	0.119	53	0.890	-165
700	0.837	+168	0.922	27	0.127	53	0.906	-166
725	0.836	+167	0.879	25	0.133	52	0.909	-167
750	0.841	+166	0.838	25	0.140	53	0.917	-167
775	0.844	+165	0.824	24	0.148	52	0.933	-167
800	0.846	+163	0.785	21	0.154	50	0.941	-168

Figure 24. Common Source Scattering Parameters
V_{DS} = 28 V, I_D = 0.5 A

MRF136

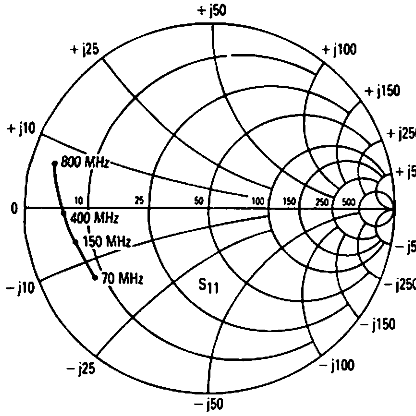


Figure 25. S_{11}, Input Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

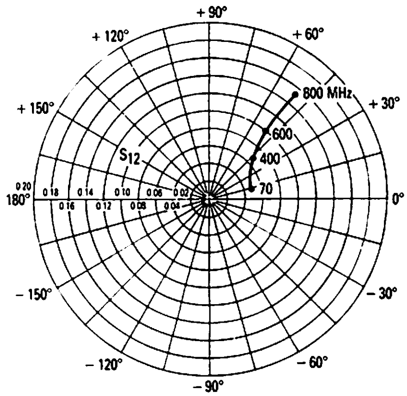


Figure 26. S_{12}, Reverse Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

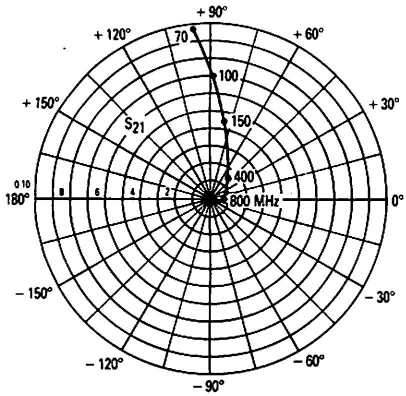


Figure 27. S_{21}, Forward Transmission Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

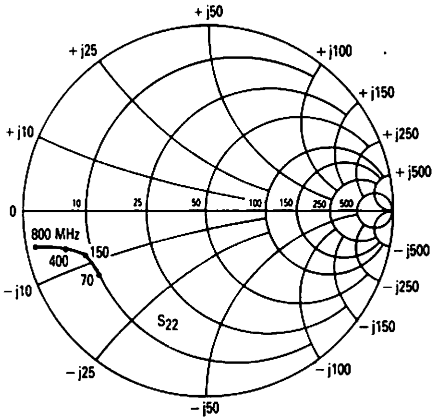


Figure 28. S_{22}, Output Reflection Coefficient versus Frequency
V_{DS} = 28 V I_D = 0.5 A

DESIGN CONSIDERATIONS

The MRF136 and MRF136Y are RF power N-Channel enhancement mode field-effect transistors (FETs) designed especially for HF and VHF power amplifier applications. Motorola RF MOS FETs feature planar design for optimum manufacturability.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF136 and MRF136Y are enhancement mode FETs and, therefore, do not conduct when drain voltage is applied without gate bias. A positive gate voltage causes drain current to flow (see Figure 11). RF power FETs require forward bias for optimum gain and power output. A Class AB condition with quiescent drain current (I_{DQ}) in the 25–100 mA range is sufficient for many applications. For special requirements such as linear amplification, I_{DQ} may have to be adjusted to optimize the critical parameters.

The MOS gate is a dc open circuit. Since the gate bias circuit does not have to deliver any current to the FET, a simple resistive divider arrangement may sometimes suffice for this function. Special applications may require more elaborate gate bias systems.

GAIN CONTROL

Power output of the MRF136 and MRF136Y may be controlled from rated values down to the milliwatt region (>20 dB reduction in power output with constant input power) by varying the dc gate voltage. This feature, not available in bipolar RF power devices, facilitates the incorporation of manual gain control, AGC/ALC and modulation schemes into system designs. A full range of power output control may require dc gate voltage excursions into the negative region.

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar transistors are suitable for the MRF136 and MRF136Y. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. Both small signal scattering parameters (MRF136 only) and large signal impedance parameters are provided. Large signal impedances should be used for network designs wherever possible. While the s parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is particularly useful at frequencies outside those presented in the large signal impedance plots.

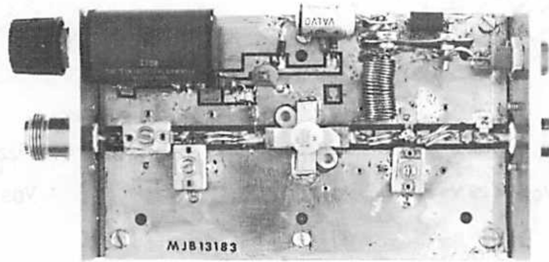
RF power FETs are triode devices and are therefore not unilateral. This, coupled with their very high gain, yields a device capable of self oscillation. Stability may be achieved using techniques such as drain loading, input shunt resistive loading, or feedback. S parameter stability analysis can provide useful information in the selection of loading and/or feedback to insure stable operation. The MRF136 was characterized with a 27 ohm input shunt loading resistor, while the MRF136Y was characterized with a resistive feedback loop around each of its two active devices.

For further discussion of RF amplifier stability and the use of two port parameters in RF amplifier design, see Motorola Application Note AN215A on page 6-204 in the RF Device Data (DL110 Rev 1).

LOW NOISE OPERATION

Input resistive loading will degrade noise performance, and noise figure may vary significantly with gate driving impedance. A low loss input matching network with its gate impedance optimized for lowest noise is recommended.

Figure 29. MRF136 Test Circuit



MRF137

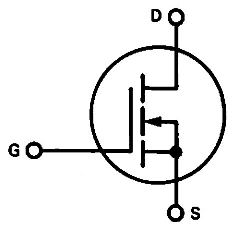
2

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

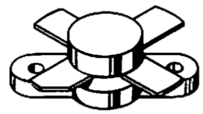
. . . designed for wideband large-signal output and driver stages in the 2.0 to 400 MHz range.

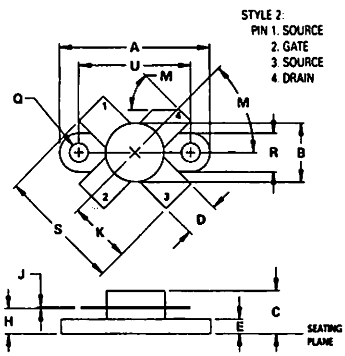
- Guaranteed 28 Volt, 150 MHz Performance
  Output Power = 30 Watts
  Minimum Gain = 13 dB
  Efficiency = 60% (Typical)
- Small-Signal and Large-Signal Characterization
- Typical Performance at 400 MHz, 28 Vdc, 30 W
  Output = 7.7 dB Gain
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Low Noise Figure — 1.5 dB (Typ) at 1.0 A, 150 MHz
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



30 W 2.0-400 MHz

N-CHANNEL MOS BROADBAND RF POWER FET





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 0.571	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

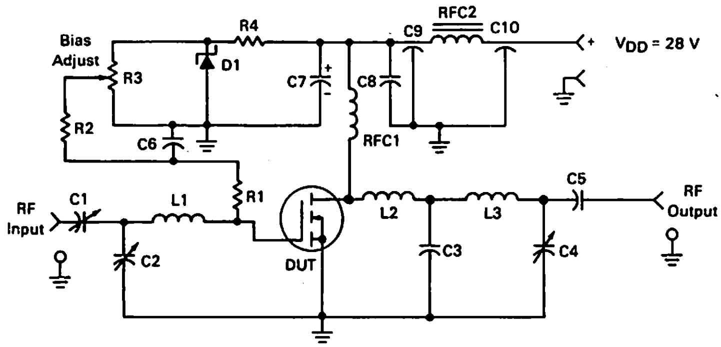
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	4.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 500 mA)	g_{fs}	500	750	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	48	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	11	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 1.0 A, f = 150 MHz)	NF	—	1.5	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 30 W, I_{DQ} = 25 mA) f = 150 MHz (Figure 1)	G_{ps}	13	16	—	dB
f = 400 MHz (Figure 14)		—	7.7	—	
Drain Efficiency (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1 — Arco 406, 15-115 pF, or equivalent
C2 — Arco 403, 3.0-35 pF, or equivalent
C3 — 56 pF Mini-Unleco, or equivalent
C4 — Arco 404, 8.0-60 pF, or equivalent
C5 — 680 pF, 100 Mils Chip
C6 — 0.01 μF, 100 V, Disc Ceramic
C7 — 100 μF, 40 V
C8 — 0.1 μF, 50 V, Disc Ceramic
C9, C10 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — 2 Turns, 0.29" ID, #18 AWG Enamel, Closewound
L2 — 1¼ Turns, 0.2" ID, #18 AWG Enamel, Closewound
L3 — 2 Turns, 0.2" ID, #18 AWG Enamel, Closewound
RFC1 — 20 Turns, 0.30" ID, #20 AWG Enamel, Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
R1 — 10 kΩ, ½ W Thin Film
R2 — 10 kΩ, ¼ W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, ½ W
Board — G10, 62 Mils

FIGURE 2 — OUTPUT POWER versus INPUT POWER

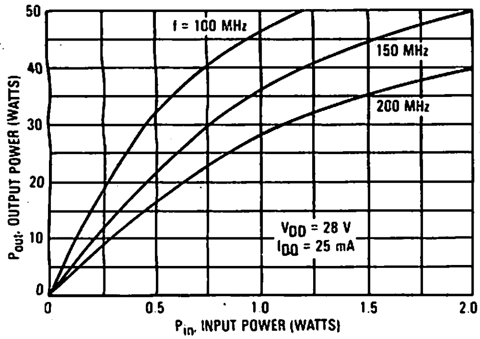


FIGURE 3 — OUTPUT POWER versus INPUT POWER

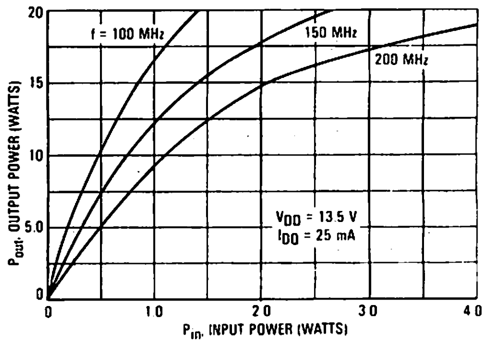


FIGURE 4 — OUTPUT POWER versus INPUT POWER

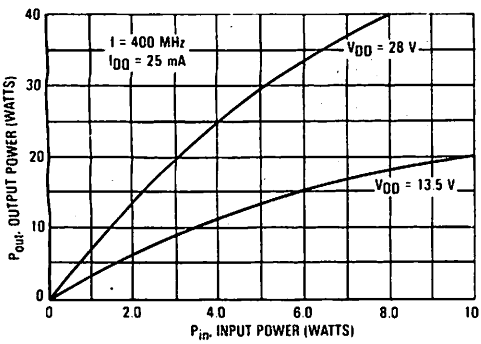


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

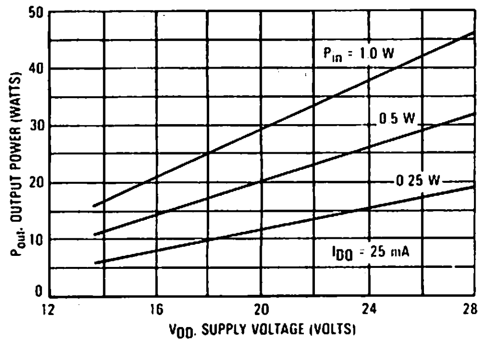


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

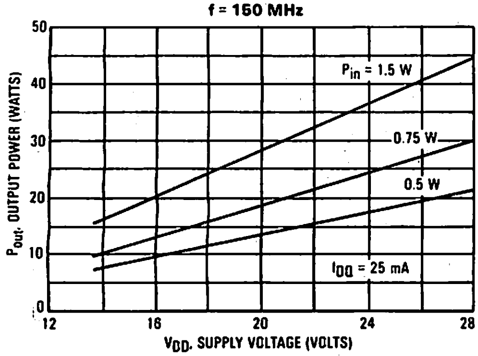
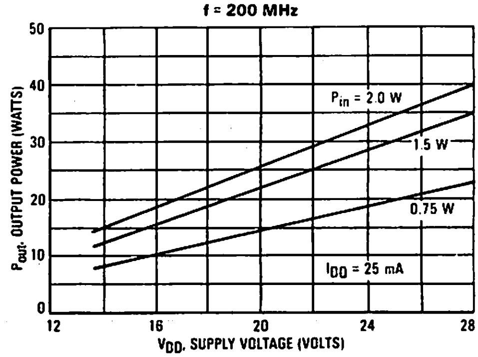


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz



2

2

FIGURE 8 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

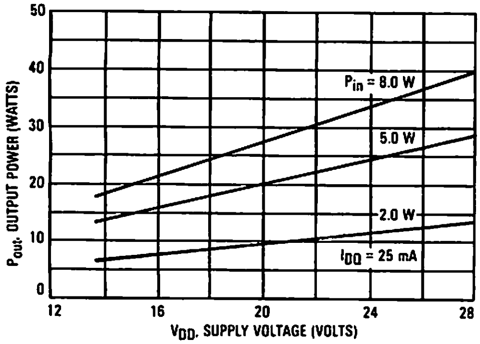


FIGURE 9 — OUTPUT POWER versus GATE VOLTAGE

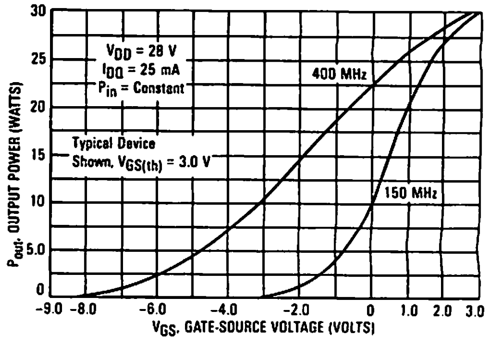


FIGURE 10 — DRAIN CURRENT versus GATE VOLTAGE
(TRANSFER CHARACTERISTICS)

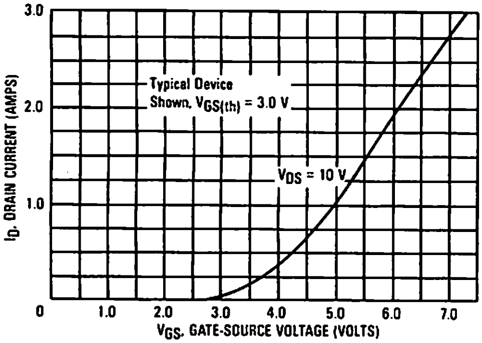


FIGURE 11 — GATE SOURCE VOLTAGE versus
CASE TEMPERATURE

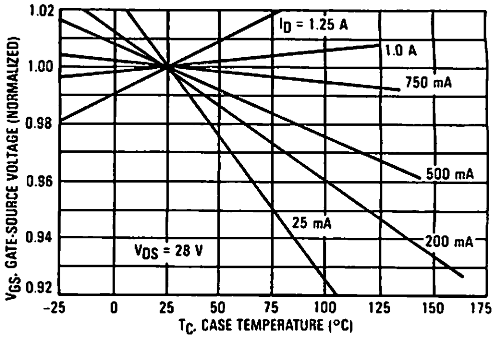


FIGURE 12 — CAPACITANCE versus
DRAIN-SOURCE VOLTAGE

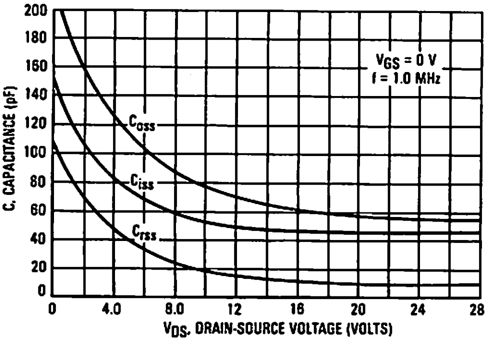


FIGURE 13 — DC SAFE OPERATING AREA

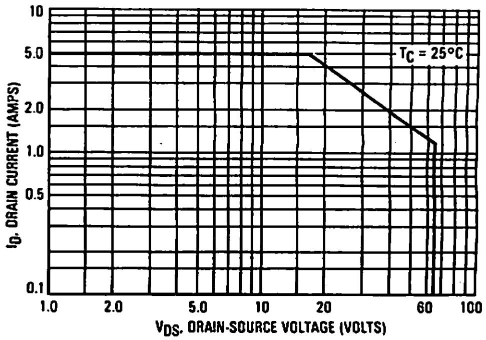
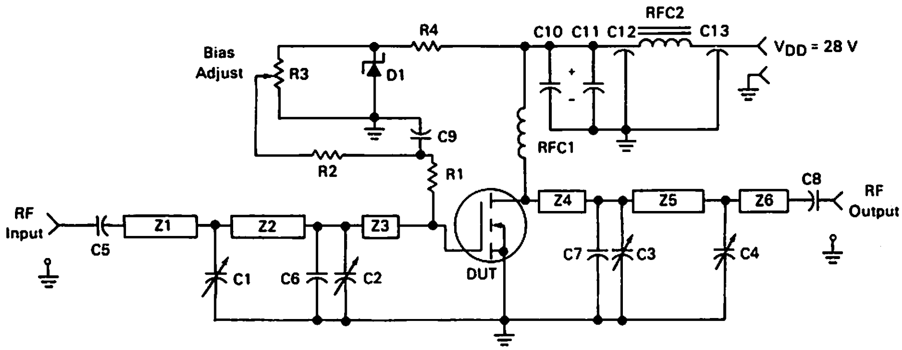
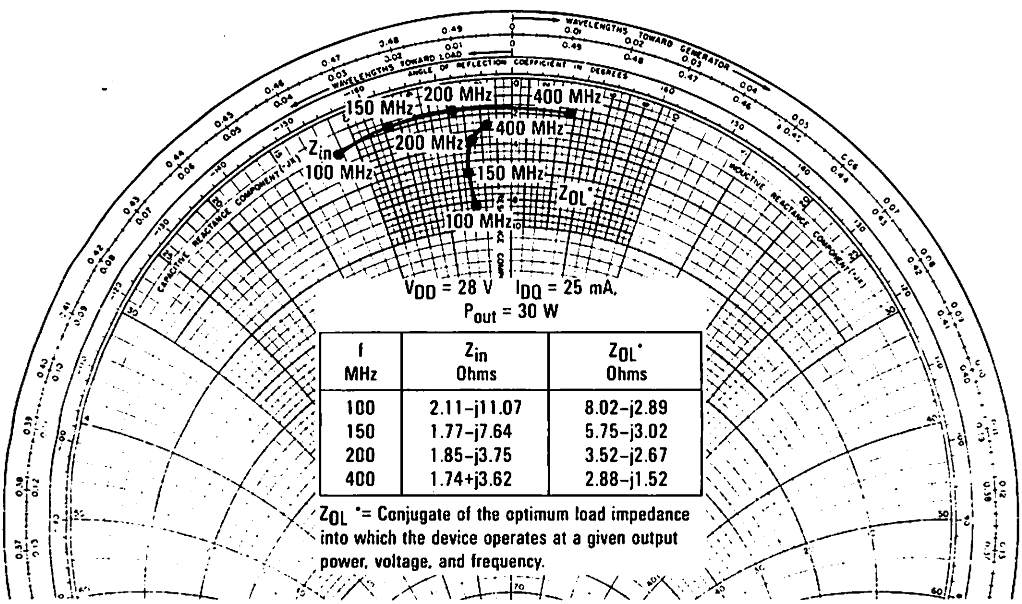


FIGURE 14 — 400 MHz TEST CIRCUIT



C1, C2, C3, C4 — 0-20 pF Johanson, or equivalent
C5, C8 — 270 pF, 100 Mil Chip
C6, C7 — 24 pF Mini-Unleco, or equivalent
C9 — 0.01 μF, 100 V, Disc Ceramic
C10 — 100 μF, 40 V
C11 — 0.1 μF, 50 V, Disc Ceramic
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
R1, R2 — 10 kΩ, ¼ W
R3 — 10 Turns, 10 kΩ
R4 — 1.8 kΩ, ½ W
Z1 — 2.9" × 0.166" Microstrip
Z2, Z4 — 0.35" × 0.166" Microstrip
Z3 — 0.40" × 0.166" Microstrip
Z5 — 1.05" × 0.166" Microstrip
Z6 — 1.9" × 0.166" Microstrip
RFC1 — 6 Turns, 0.300" ID, #20 AWG Enamel, Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Board — Glass Teflon, 62 Mils

FIGURE 15 — LARGE-SIGNAL SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE, Z_{in}, Z_{OL}*



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	2.11–j11.07	8.02–j2.89
150	1.77–j7.64	5.75–j3.02
200	1.85–j3.75	3.52–j2.67
400	1.74+j3.62	2.88–j1.52

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 16 — COMMON SOURCE SCATTERING PARAMETERS
50 Ω SYSTEM
V_{DS} = 28 V, I_D = 0.75 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.0	0.977	-32	59.48	163	0.011	67	0.661	-36
5.0	0.919	-70	48.67	142	0.024	44	0.692	-78
10	0.852	-109	33.50	122	0.032	29	0.747	-117
20	0.817	-140	19.05	106	0.037	16	0.768	-146
30	0.814	-153	13.11	99	0.038	14	0.774	-157
40	0.811	-159	9.88	95	0.038	13	0.782	-162
50	0.812	-164	7.98	92	0.038	12	0.787	-165
60	0.813	-166	6.66	89	0.038	12	0.787	-168
70	0.815	-168	5.708	86	0.038	11	0.787	-169
80	0.816	-170	5.003	84	0.038	11	0.787	-170
90	0.817	-171	4.560	83	0.038	12	0.787	-171
100	0.817	-172	4.170	81	0.039	13	0.787	-172
110	0.818	-173	3.670	80	0.039	13	0.788	-172
120	0.820	-173	3.420	79	0.039	13	0.788	-173
130	0.821	-173	3.170	79	0.039	13	0.788	-173
140	0.822	-174	2.980	78	0.039	13	0.788	-173
150	0.823	-175	2.826	77	0.039	14	0.788	-173
160	0.824	-175	2.650	76	0.039	14	0.790	-174
170	0.825	-176	2.438	75	0.039	14	0.792	-174
180	0.827	-176	2.325	73	0.039	15	0.793	-174
190	0.829	-177	2.175	72	0.039	16	0.796	-174
200	0.831	-177	2.084	71	0.039	16	0.799	-174
225	0.836	-178	1.824	69	0.039	18	0.805	-174
250	0.846	-178	1.621	66	0.039	21	0.816	-174
275	0.853	-179	1.462	64	0.039	23	0.822	-174
300	0.853	-179	1.319	61	0.040	25	0.833	-174
325	0.856	-179	1.194	59	0.040	27	0.828	-174
350	0.857	+179	1.089	56	0.040	30	0.842	-174
375	0.861	+179	1.014	54	0.042	32	0.849	-174
400	0.865	+178	0.927	51	0.043	35	0.856	-174
425	0.875	+178	0.876	49	0.045	37	0.866	-174
450	0.881	+178	0.810	46	0.046	40	0.870	-174
475	0.886	+177	0.755	44	0.046	43	0.875	-174
500	0.887	+177	0.694	41	0.051	43	0.888	-174
525	0.888	+176	0.677	39	0.052	43	0.890	-174
550	0.896	+176	0.625	36	0.055	45	0.898	-174
575	0.907	+175	0.603	34	0.058	45	0.913	-174
600	0.910	+175	0.585	32	0.061	45	0.918	-174
625	0.910	+174	0.563	30	0.065	45	0.945	-174
650	0.920	+174	0.543	28	0.069	46	0.952	-174
675	0.938	+173	0.533	26	0.074	47	0.974	-174
700	0.943	+171	0.515	24	0.078	47	0.958	-176
725	0.934	+170	0.491	22	0.079	46	0.953	-177
750	0.940	+170	0.475	22	0.084	48	0.943	-177
775	0.953	+169	0.477	21	0.090	48	0.957	-177
800	0.959	+168	0.467	17	0.093	48	0.957	-179

FIGURE 17 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.75 A

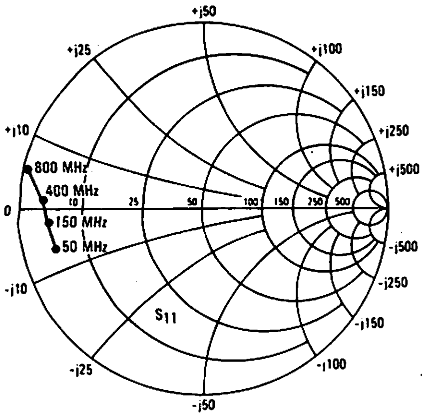


FIGURE 18 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.75 A

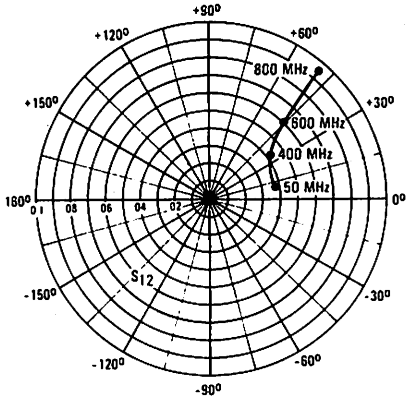


FIGURE 19 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.75 A

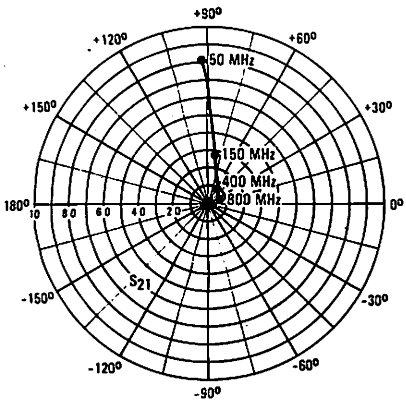
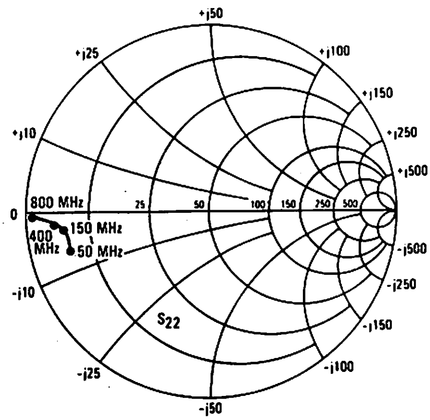


FIGURE 20 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.75 A



DESIGN CONSIDERATIONS

The MRF137 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for VHF power amplifier applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF137 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 10 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF137 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

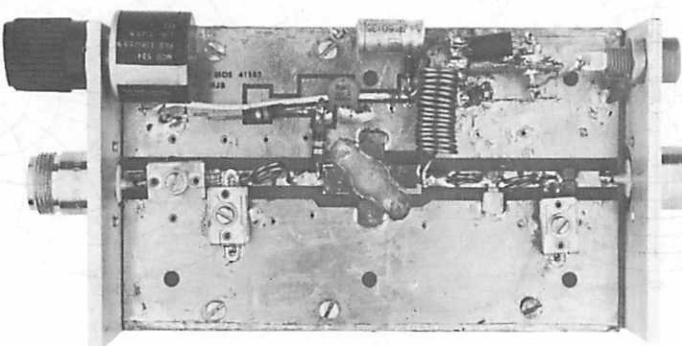
Power output of the MRF137 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 9.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar VHF transistors are suitable for MRF137. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF137, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF137 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 21 — 150 MHz TEST CIRCUIT

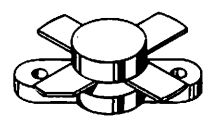


MRF138

The RF MOSFET Line

30 W 2.0-175 MHz

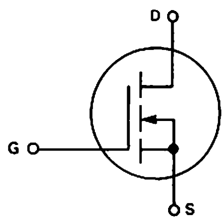
N-CHANNEL MOS LINEAR RF POWER FET

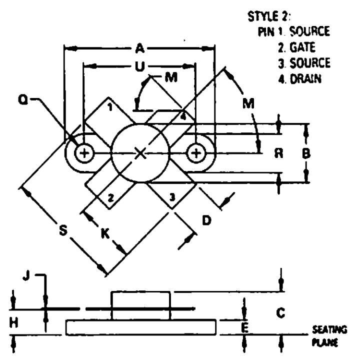


N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

...designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

- Superior High Order IMD
- Specified 28 Volts, 30 MHz Characteristics
  - Output Power = 30 Watts
  - Power Gain = 17 dB (Typ)
  - Efficiency = 40% (Typ)
- $IMD_{(d3)}$ (30 W PEP) = -30 dB (Typ)
- $IMD_{(d11)}$ (30 W PEP) = -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

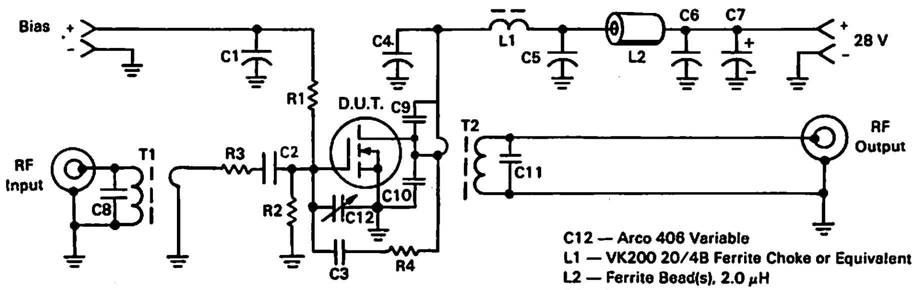
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.5 A)	$V_{DS(on)}$	—	—	2.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	0.8	1.2	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	55	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	14	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V_{DD} = 28 V, P_{out} = 30 W (PEP), I_{DQ} = 100 mA) (30 MHz) (Fig. 1) (150 MHz) (Fig. 6)	G_{ps}	— —	17 14	— —	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 V, f = 30 MHz, I_{DQ} = 100 mA) (30 W PEP) (30 W CW)	η	— —	40 50	— —	%
Intermodulation Distortion (Figure 1) (V_{DD} = 28 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	-30 -60	— —	dB
Load Mismatch (Figure 1) (V_{DD} = 28 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 28 V, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 1.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 -50 -70	— — —	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 2-50 MHz BROADBAND TEST CIRCUIT



C1, C2, C3, C4, C5, C6 — 0.1 μF Ceramic Chip or Equivalent
C7 — 10 μF, 100 V Electrolytic
C8 — 10 pF Dipped Mica
C9 — 68 pF Dipped Mica
C10, C11 — 47 pF Dipped Mica
C12 — Arco 406 Variable
L1 — VK200 20/4B Ferrite Choke or Equivalent (3.0 μH)
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 200 Ω, 1/2 W Carbon
R3 — 2.2 Ω, 1/2 W Carbon
R4 — 330 Ω, 1.0 W Carbon
T1 — 4:1 Impedance Transformer
T2 — 1:4 Impedance Transformer

FIGURE 2 — POWER GAIN versus FREQUENCY

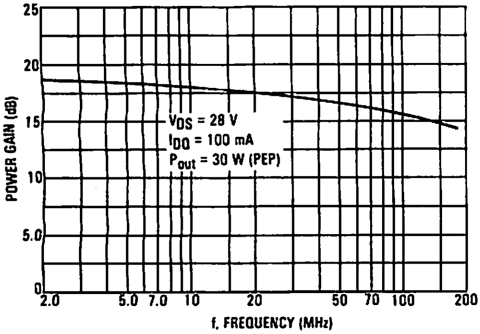


FIGURE 3 — OUTPUT POWER versus INPUT POWER

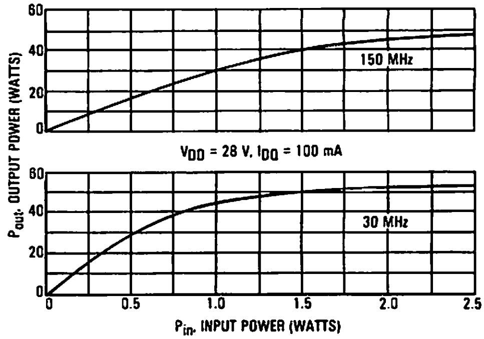


FIGURE 4 — IMD versus P_{out}

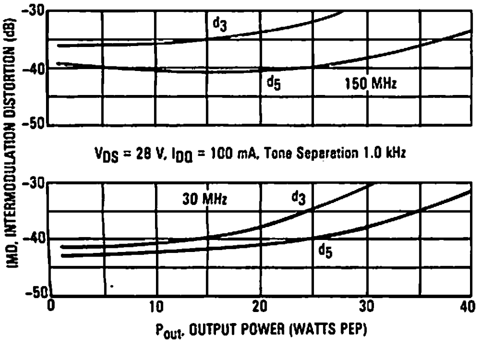


FIGURE 5 — COMMON SOURCE UNITY CURRENT GAIN FREQUENCY versus DRAIN CURRENT

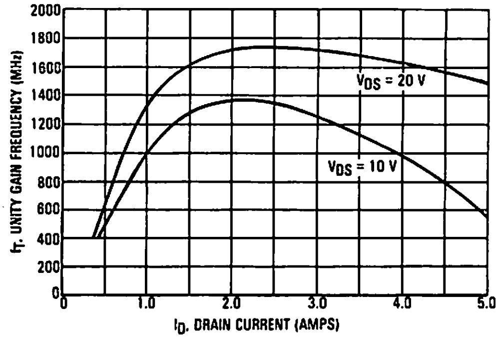
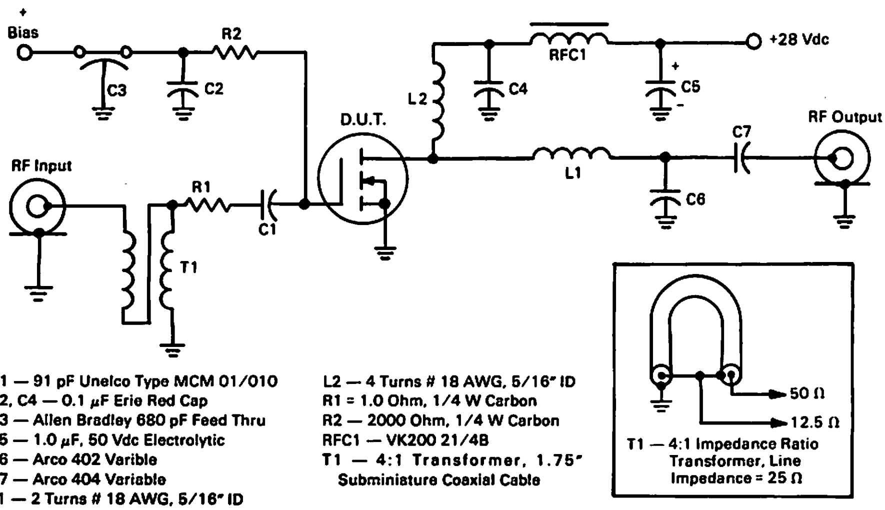


FIGURE 6 — 150 MHz TEST CIRCUIT



C1 — 91 pF Unelco Type MCM 01/010
C2, C4 — 0.1 μF Erie Red Cap
C3 — Allen Bradley 680 pF Feed Thru
C5 — 1.0 μF, 50 Vdc Electrolytic
C6 — Arco 402 Varible
C7 — Arco 404 Variable
L1 — 2 Turns # 18 AWG, 5/16″ ID
L2 — 4 Turns # 18 AWG, 5/16″ ID
R1 = 1.0 Ohm, 1/4 W Carbon
R2 — 2000 Ohm, 1/4 W Carbon
RFC1 — VK200 21/4B
T1 — 4:1 Transformer, 1.75″ Subminiature Coaxial Cable

2

FIGURE 7 — GATE VOLTAGE versus DRAIN CURRENT

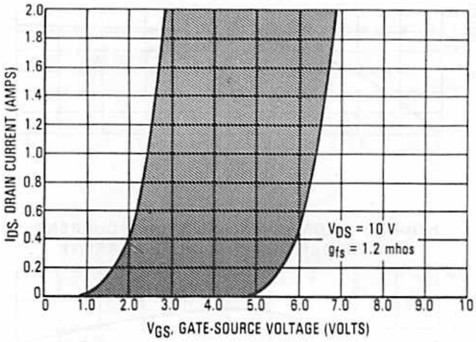


FIGURE 8 — DC SAFE OPERATING AREA

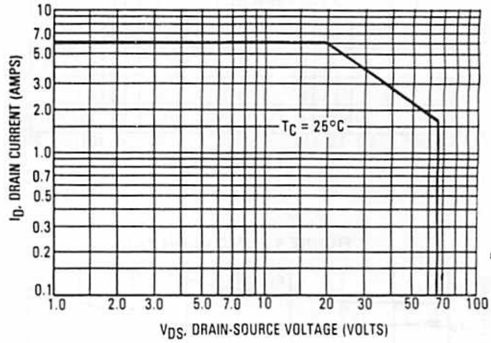
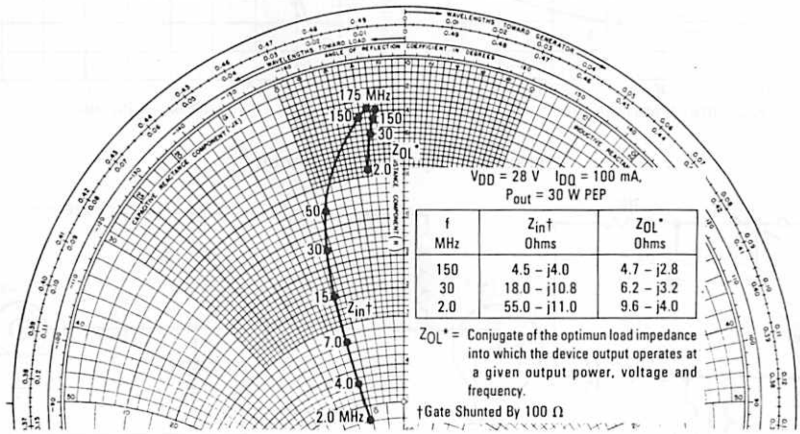


FIGURE 9 — LARGE-SIGNAL SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE, Z_{in}†, Z_{OL}*



V_{DD} = 28 V I_{DQ} = 100 mA, P_{out} = 30 W PEP

f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
150	4.5 – j4.0	4.7 – j2.8
30	18.0 – j10.8	6.2 – j3.2
2.0	55.0 – j11.0	9.6 – j4.0

Z_{OL}* = Conjugate of the optimun load impedance into which the device output operates at a given output power, voltage and frequency.

†Gate Shunted By 100 Ω

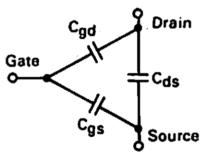
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. *Drain shorted* to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF140

The RF MOSFET Line

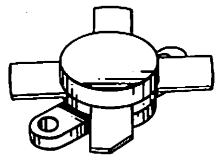
150 W 2.0-150 MHz

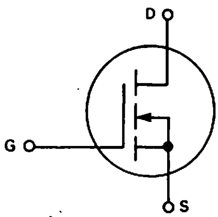
N-CHANNEL MOS
LINEAR RF POWER
FET

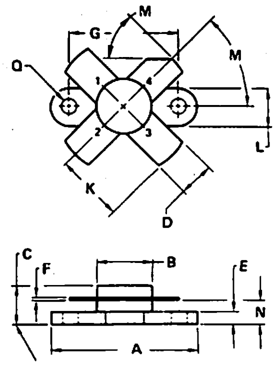
N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

. . . designed primarily for linear large-signal output stages in the 2–150 MHz frequency range.

- Specified 28 Volts, 30 MHz Characteristics
  Output Power = 150 Watts
  Power Gain = 15 dB (Typ)
  Efficiency = 40% (Typ)
- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) = −30 dB Typ
- $IMD_{(d11)}$ (150 W PEP) = −60 dB Typ
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR







STYLE 2:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.15	0.960	0.990
B	11.81	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.46	5.97	0.216	0.235
E	2.13	2.79	0.084	0.110
F	0.08	0.18	0.003	0.007
G	18.29	18.54	0.720	0.730
K	11.05	-	0.435	-
L	6.22	6.48	0.246	0.255
M	45° NOM		45° NOM	
N	3.66	4.52	0.144	0.178
Q	2.92	3.30	0.115	0.130

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage	V_{DGO}	65	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.7	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

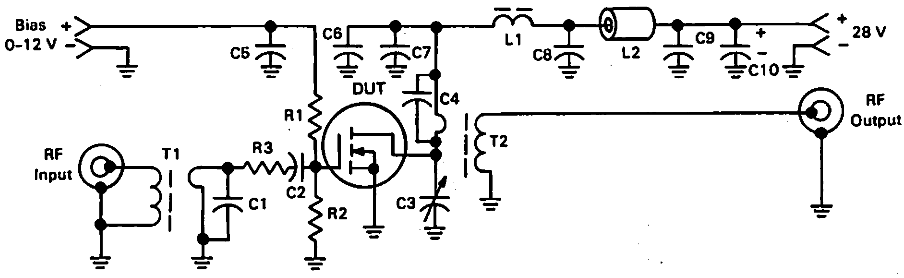
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 Vdc, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 Adc)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	4.0	—	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	450	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	450	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	100	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (30 MHz) (V_{DD} = 28 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) (150 MHz)	G_{ps}	— —	15 6.0	— —	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 6.5 A)	η	—	40	—	%
Intermodulation Distortion (1) (V_{DD} = 28 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	-30 -60	— —	dB
Load Mismatch (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT (CLASS AB)



C1 — 820 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — Arco 469
C4 — 560 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic

L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 51 Ω/1.0 W Carbon
R3 — 1.0 Ω/1.0 W Carbon
T1 — 16:1 Broadband Transformer
T2 — 1:25 Broadband Transformer

2

FIGURE 2 — POWER GAIN versus FREQUENCY

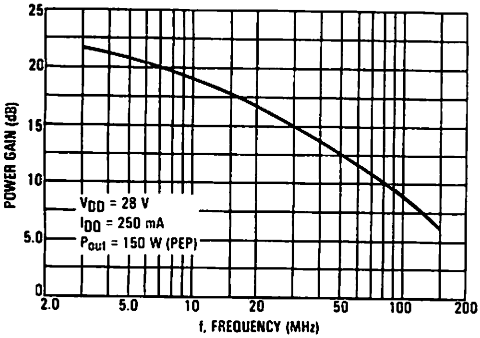


FIGURE 3 — OUTPUT POWER versus INPUT POWER

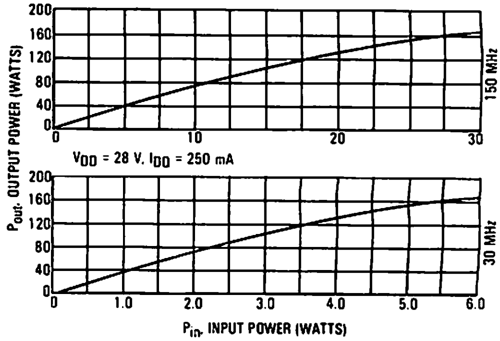


FIGURE 4 — IMD versus P_{out}

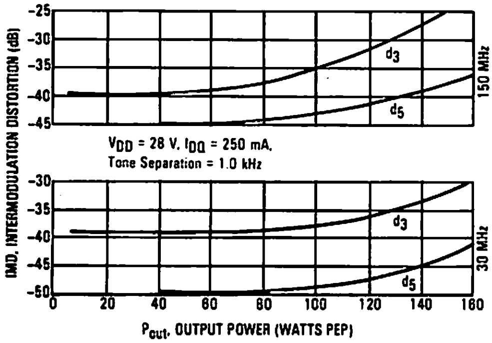


FIGURE 5 — COMMON SOURCE UNITY GAIN FREQUENCY versus DRAIN CURRENT

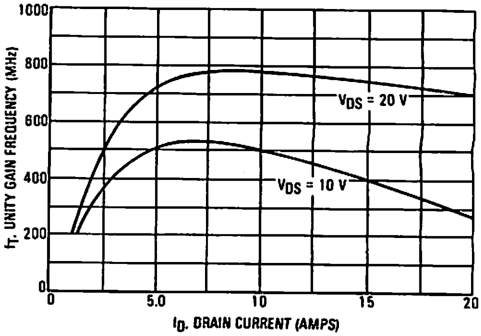


FIGURE 6 — GATE VOLTAGE versus DRAIN CURRENT

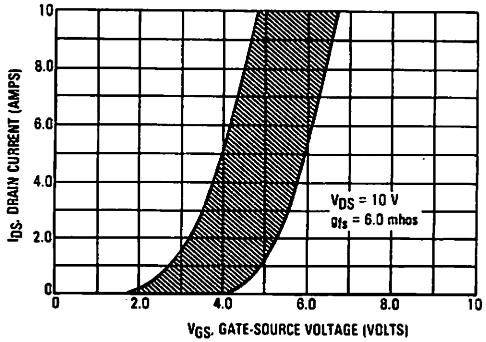
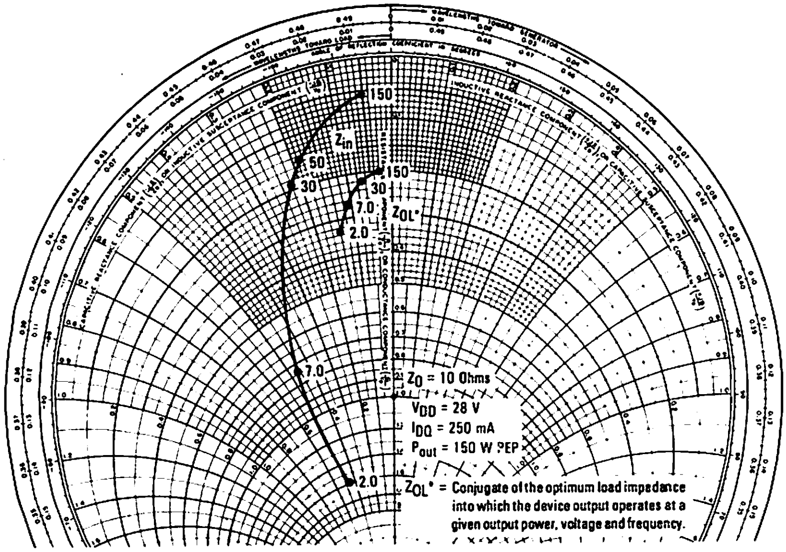
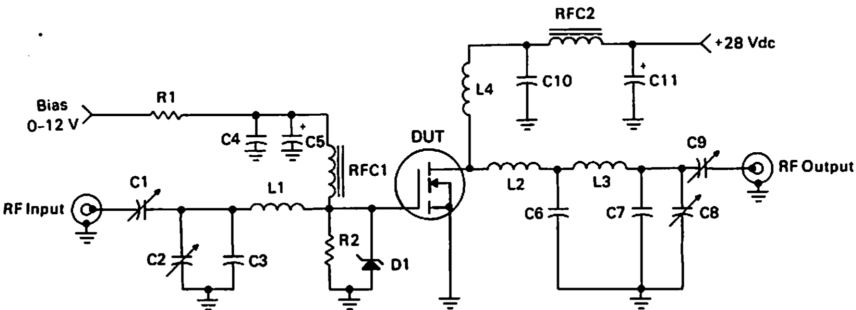


FIGURE 7 — SERIES EQUIVALENT IMPEDANCE



NOTE: Gate Shunted by 25 Ohms.

FIGURE 8 — 150 MHz TEST CIRCUIT (CLASS AB)



C1, C2, C8 — Arco 463 or equivalent
C3 — 25 pF Unelco
C4 — 0.1 μF Ceramic
C5 — 1.0 μF, 15 WV Tantalum
C6 — 150 pF Unelco J101
C7 — 25 μF Unelco J101
C9 — Arco 262 or equivalent
C10 — 0.05 μF Ceramic
C11 — 15 μF, 35 WV Electrolytic

L1 — 3/4" #18 AWG into Hairpin
L2 — Printed Line, 0.200" × 0.500"
L3 — 7/8" #16 AWG into Hairpin
L4 — 2 Turns #16 AWG, 5/16 ID
RFC1 — 5.6 μH Molded Choke
RFC2 — VK200-4B
R1, R2 — 150 Ω, 1.0 W Carbon

2

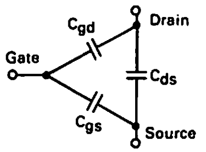
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MRF141

The RF MOSFET Line

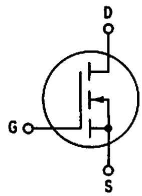
RF Power Field-Effect Transistor

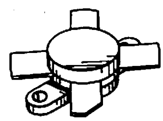
N-Channel Enhancement-Mode MOSFET

150 W, 28 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET

... designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- *Guaranteed Performance* at 30 MHz, 28 V:
  - Output Power — 150 W
  - Gain — 18 dB (22 dB Typ)
  - Efficiency — 40%
- Typical Performance at 175 MHz, 50 V:
  - Output Power — 150 W
  - Gain — 13 dB
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability





CASE 211-11, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

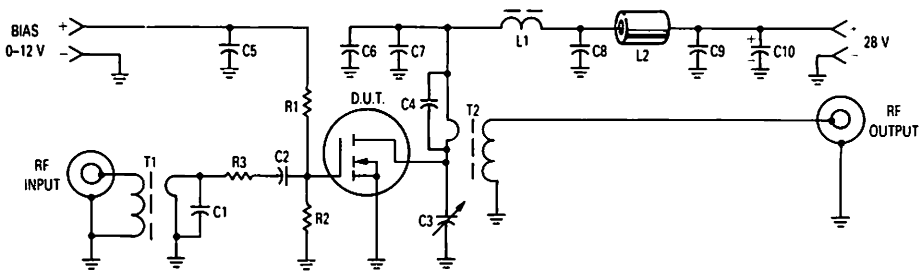
NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (Note 1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5 A)	g_{fs}	5	7	—	mhos
DYNAMIC CHARACTERISTICS (Note 1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	420	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain, f = 30; 30.001 MHz (V_{DD} = 28 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA) f = 175 MHz	G_{ps}	16 —	20 10	— —	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, I_D (Max) = 5.95 A)	η	40	45	—	%
Intermodulation Distortion (1) (V_{DD} = 28 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	-30 -60	-28 —	dB
Load Mismatch (V_{DD} = 28 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 28 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 4 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	23 -50 -75	— — —	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1 — 820 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — Arco 469
C4 — 560 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic

L1 — VK200 4B Ferrite Choke or Equivalent, 3 μH
L2 — Ferrite Bead(s), 2 μH
R1, R2 — 51 Ω 1 W Carbon
R3 — 1 Ω 1 W Carbon
T1 — 16:1 Broadband Transformer
T2 — 1:25 Broadband Transformer
Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ϵ_r = 5

Figure 1. 30 MHz Test Circuit

TYPICAL CHARACTERISTICS

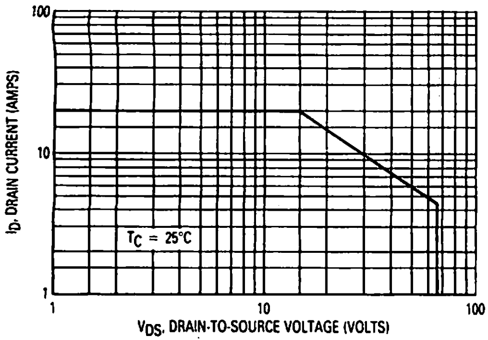


Figure 2. DC Safe Operating Area

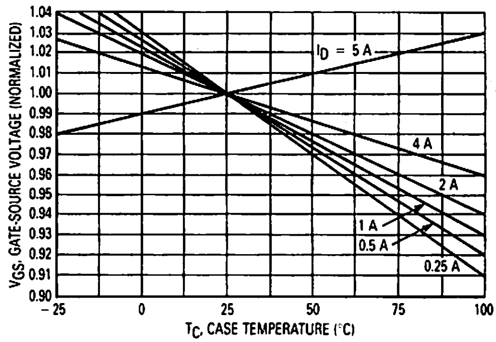


Figure 3. Gate-Source Voltage versus Case Temperature

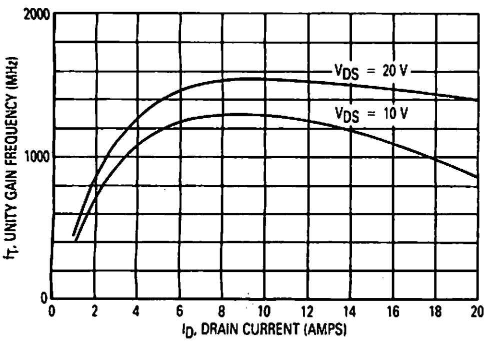


Figure 4. Common Source Unity Gain Frequency versus Drain Current

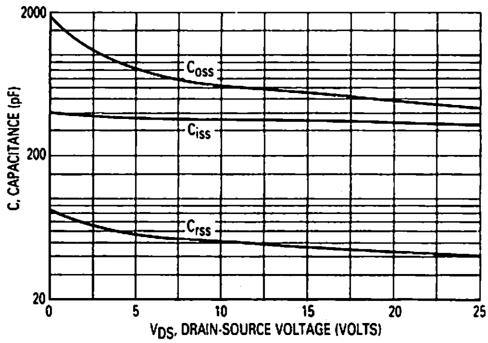


Figure 5. Capacitance versus Drain-Source Voltage

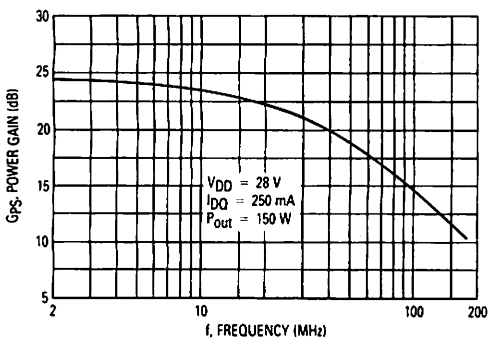


Figure 6. Power Gain versus Frequency

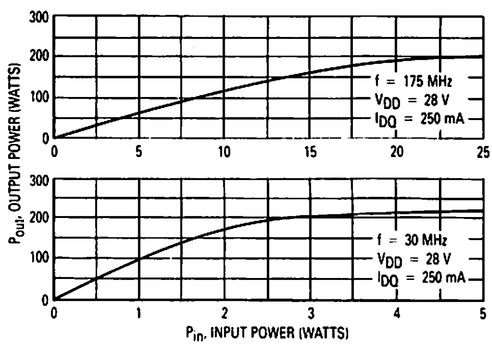


Figure 7. Output Power versus Input Power

2

TYPICAL CHARACTERISTICS

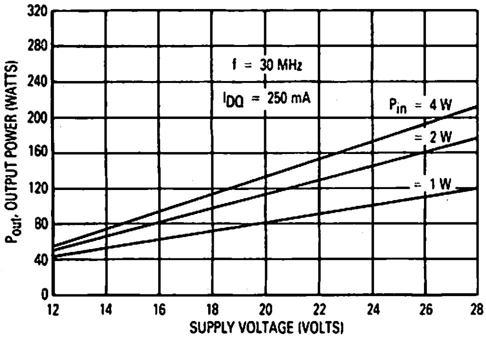


Figure 8. Output Power versus Supply Voltage

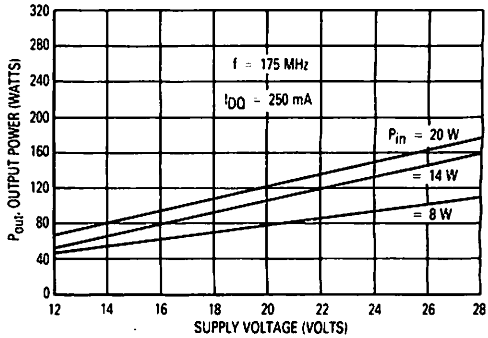


Figure 9. Output Power versus Supply Voltage

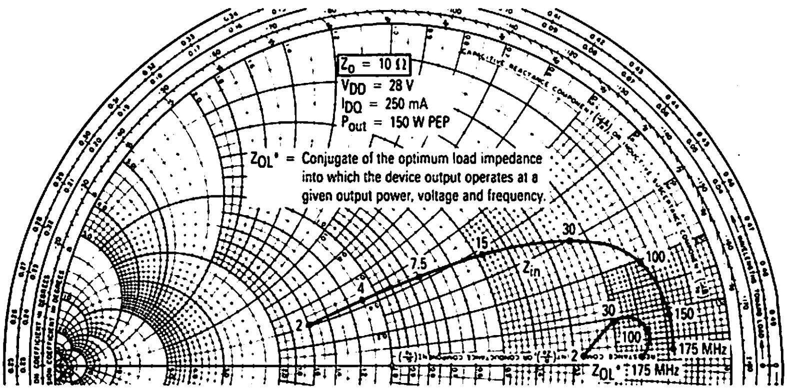


Figure 10. Input and Output Impedances

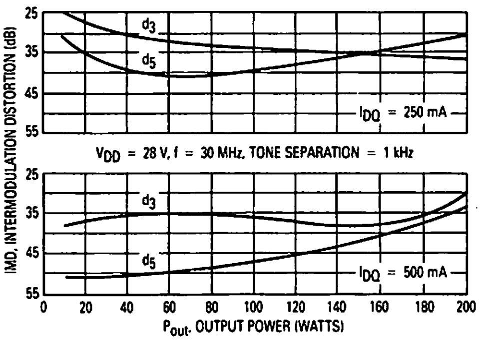


Figure 11. IMD versus P_{out} (PEP)

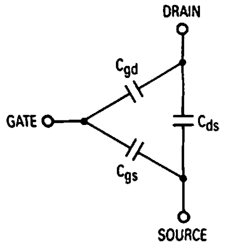
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. *Positive* voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 4 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs *in the linear region* of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF141 is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

2

DC BIAS

The MRF141 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF141 was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification. I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF141 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MRF141G

The RF MOSFET Line

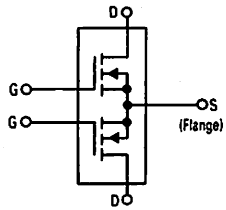
RF Power Field-Effect Transistor

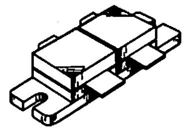
N-Channel Enhancement-Mode MOSFET

**300 W, 28 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**

... designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 175 MHz, 28 V:
  Output Power — 300 W
  Gain — 12 dB (14 dB Typ)
  Efficiency — 50%
- Low Thermal Resistance — 0.35°C/W
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability





CASE 375-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGO}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	32	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W

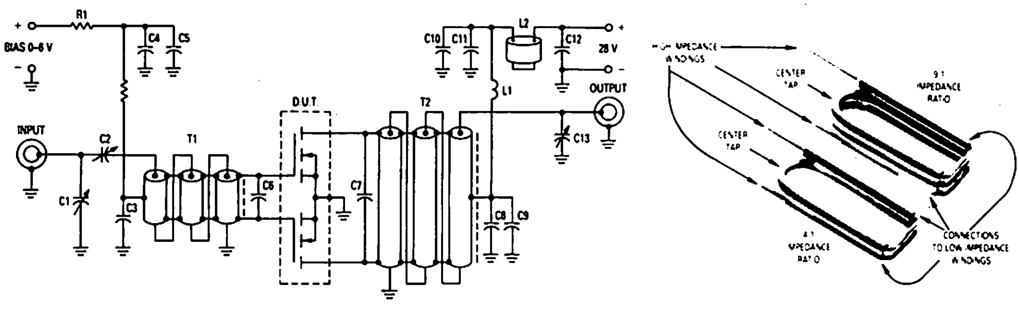
NOTE — CAUTION — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (Note 1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5 A)	g_{fs}	5	7	—	mhos
DYNAMIC CHARACTERISTICS (Note 1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	420	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL TESTS (Note 2)					
Common Source Amplifier Power Gain (V_{DD} = 28 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 V, P_{out} = 300 W, f = 175 MHz, I_D (Max) = 21.4 A)	η	50	55	—	%
Load Mismatch (V_{DD} = 28 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			

Notes: 1. Each side measured separately.
2. Measured in push-pull configuration.



R1 — 100 Ohms, 1/2 W
R2 — 1 kOhm, 1/2 W
C1 — Arco 402, 1.5–20 pF
C2 — Arco 406, 15–115 pF
C3, C4, C8, C9, C10 — 1000 pF Chip
C5, C11 — 0.1 μF Chip
C6 — 330 pF Chip
C7 — 200 pF and 180 pF Chips in Parallel
C12 — 0.47 μF Ceramic Chip, Kemet 1215 or Equivalent
C13 — Arco 403, 3–35 pF
L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, 1/4" I.D.
L2 — Ferrite Beads of Suitable Material for 1.5–2 μH Total Inductance

T1 — 9:1 RF Transformer. Can be made of 15–18 Ohm Semirigid Co-Ax, 62–90 Mils O.D.
T2 — 1:9 RF Transformer. Can be made of 15–18 Ohm Semirigid Co-Ax, 90–100 Mils O.D.

Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ϵ_r = 5

NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

See pictures for construction details.

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

Figure 1. 175 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

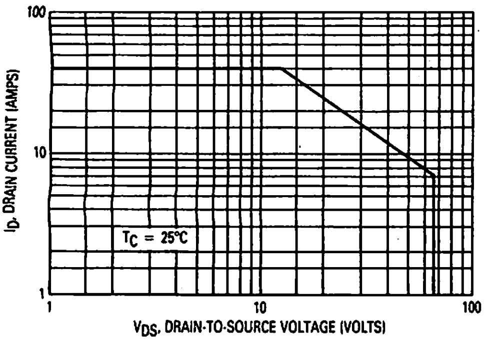
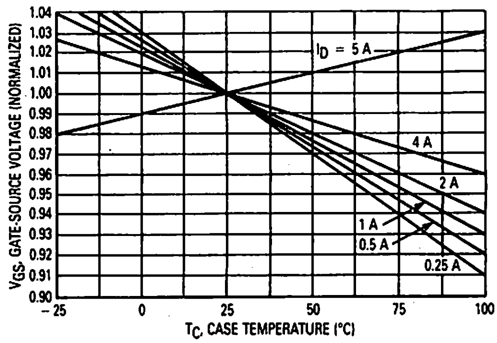
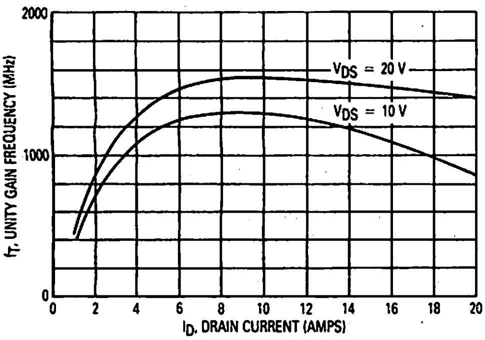


Figure 2. DC Safe Operating Area



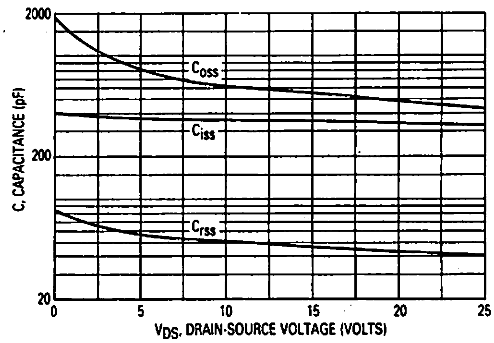
NOTE: Data shown applies to each half of MRF141G.

Figure 3. Gate-Source Voltage versus Case Temperature



NOTE: Data shown applies to each half of MRF141G.

Figure 4. Common Source Unity Gain Frequency versus Drain Current



NOTE: Data shown applies to each half of MRF141G.

Figure 5. Capacitance versus Drain-Source Voltage

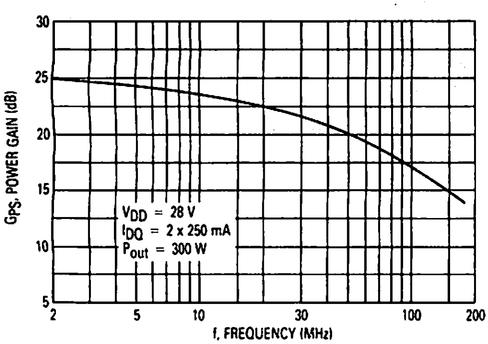


Figure 6. Power Gain versus Frequency

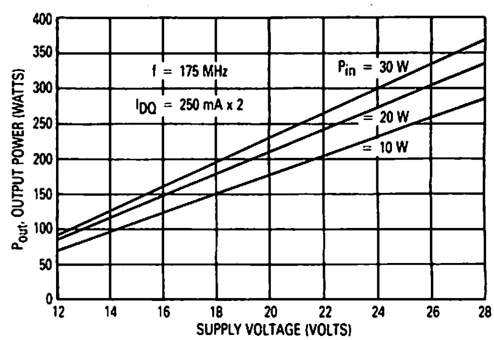
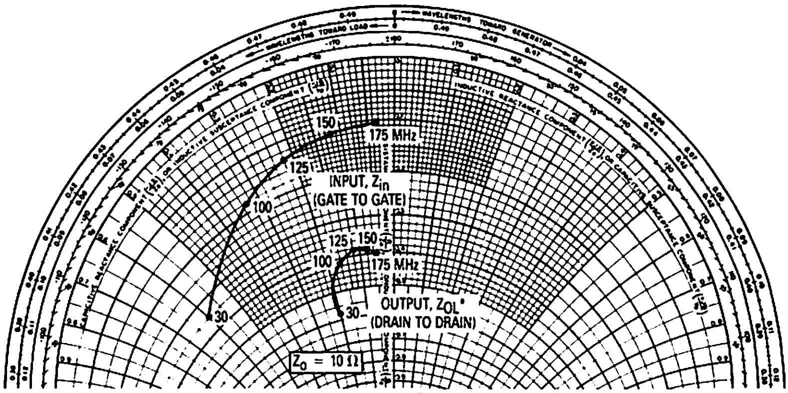


Figure 7. Output Power versus Supply Voltage

TYPICAL CHARACTERISTICS



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 8. Input and Output Impedances

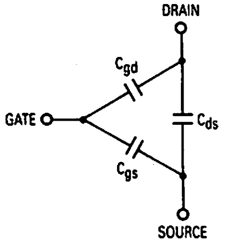
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented. Figure 4 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF141G is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF141G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF141G was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF141G may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

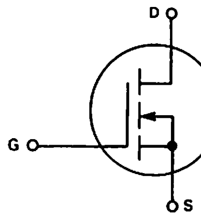
MRF148

The RF MOSFET Line

**N-CHANNEL ENHANCEMENT-MODE
RF POWER FIELD-EFFECT TRANSISTOR**

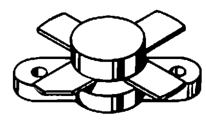
. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 175 MHz.

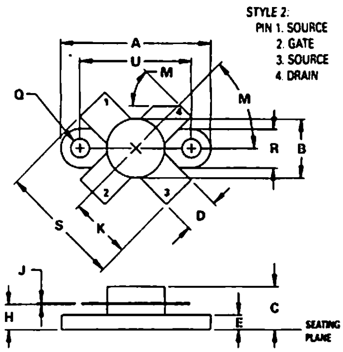
- Superior High Order IMD
- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 30 Watts
  Power Gain = 18 dB (Typ)
  Efficiency = 40% (Typ)
- $IMD_{(d3)}$ (30 W PEP) = −35 dB (Typ)
- $IMD_{(d11)}$ (30 W PEP) = −60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



30 W 2.0-175 MHz

**N-CHANNEL MOS
LINEAR RF POWER
FET**





NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2 CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.065	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	120	Vdc
Drain — Gate Voltage	V_{DGO}	120	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	6.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

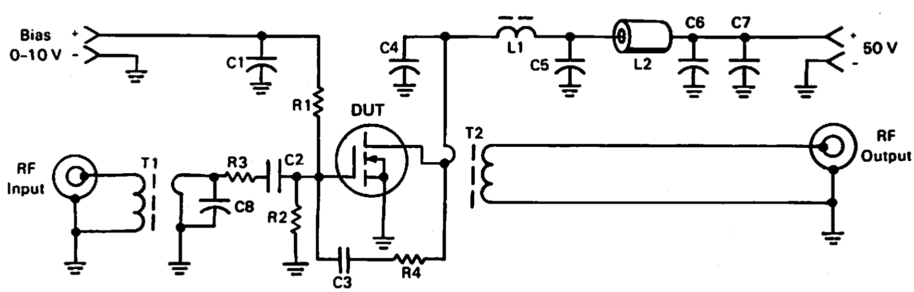
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0.)	I_{DSS}	—	—	1.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	100	nAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 2.5 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	0.8	1.2	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	50	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	35	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	8.0	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (30 MHz) (V_{DD} = 50 V, P_{out} = 30 W (PEP), I_{DQ} = 100 mA) (175 MHz)	G_{ps}	— —	18 15	— —	dB
Drain Efficiency (30 W PEP) (V_{DD} = 50 V, f = 30 MHz, I_{DQ} = 100 mA) (30 W CW)	η	— —	40 50	— —	%
Intermodulation Distortion (V_{DD} = 50 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	-35 -60	— —	dB
Load Mismatch (V_{DD} = 50 V, P_{out} = 30 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 1.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 -50 -70	— — —	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 2-50 MHz BROADBAND TEST CIRCUIT



C1, C2, C3, C4, C5, C6 — 0.1 µF Ceramic Chip or Equivalent
C7 — 10 µF, 100 V Electrolytic
C8 — 100 pF Dipped Mica
L1 — VK200 20/4B Ferrite Choke or Equivalent (3.0 µH)
L2 — Ferrite Bead(s), 2.0 µH

R1, R2 — 200 Ω, 1/2 W Carbon
R3 — 4.7 Ω, 1/2 W Carbon
R4 — 470 Ω, 1.0 W Carbon
T1 — 4:1 Impedance Transformer
T2 — 1:2 Impedance Transformer

2

FIGURE 2 — POWER GAIN versus FREQUENCY

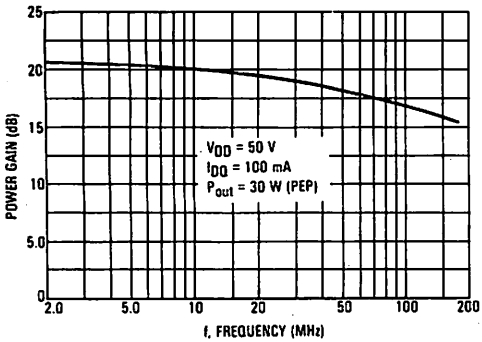


FIGURE 3 — OUTPUT POWER versus INPUT POWER

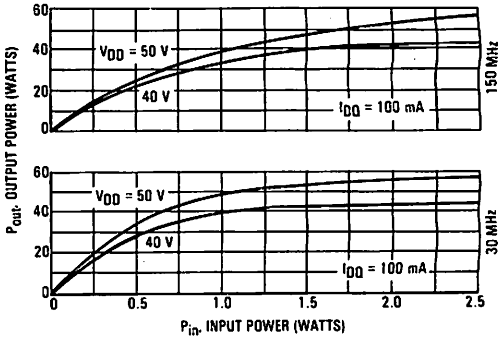


FIGURE 4 — IMD versus P_{out}

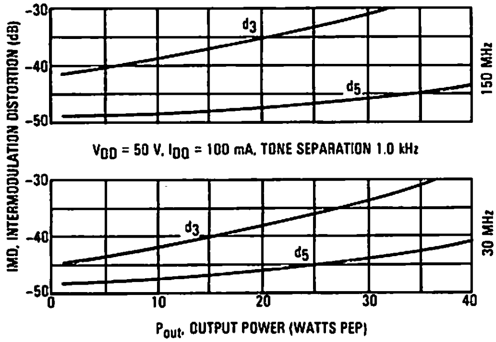


FIGURE 5 — COMMON SOURCE UNITY GAIN FREQUENCY versus DRAIN CURRENT

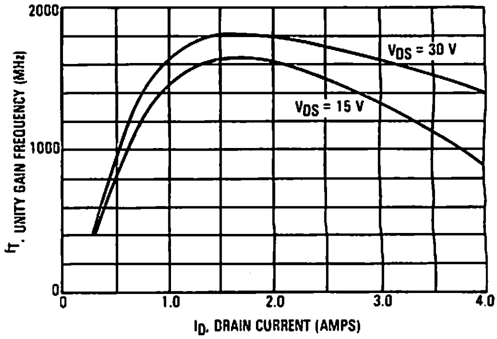
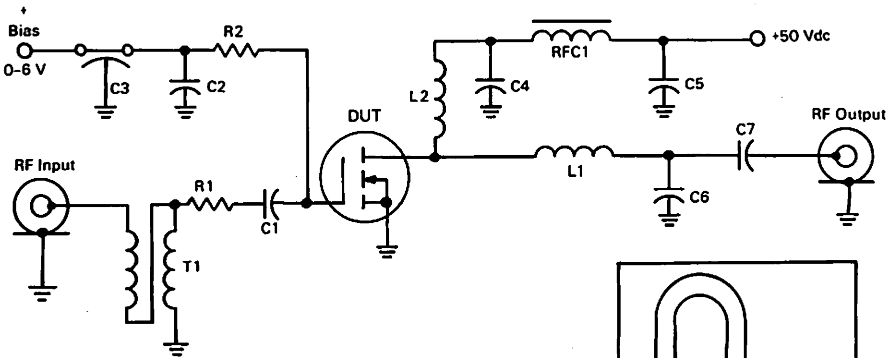
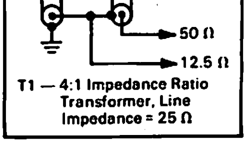


FIGURE 6 — 150 MHz TEST CIRCUIT



C1 — 91 pF Unelco Type MCM 01/010
C2, C4 — 0.1 μF Erie Red Cap
C3 — Allen Bradley 680 pF Feed Thru
C5 — 1.0 μF, 50 Vdc Electrolytic
C6 — 15 pF Unelco Type J101
C7 — 24 pF Unelco Type MCM 01/010
L1 — 2 Turns # 18 AWG, 5/16" ID

L2 — 4 Turns # 18 AWG, 5/16" ID
R1 = 1.0 Ohm, 1/4 W Carbon
R2 — 2000 Ohm, 1/4 W Carbon
RFC1 — VK200 21/4B
T1 — 4:1 Transformer, 1.75" Subminiature Coaxial Cable



T1 — 4:1 Impedance Ratio Transformer, Line Impedance = 25 Ω

FIGURE 7 — GATE VOLTAGE versus DRAIN CURRENT

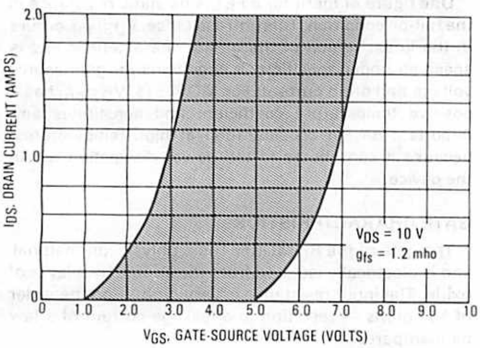


FIGURE 8 — DC SAFE OPERATING AREA (SOA)

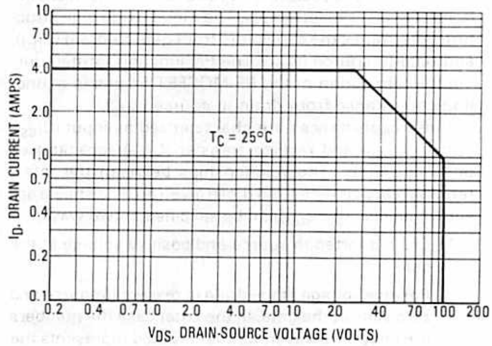
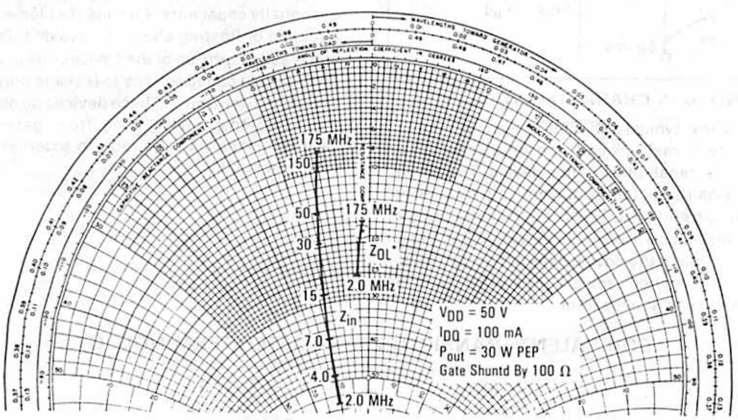


FIGURE 9 — IMPEDANCE COORDINATES — 50-OHM CHARACTERISTIC IMPEDANCE



Z_{OL}* = Conjugate of the optimun load impedance into which the device output operates at a given output power, voltage and frequency.

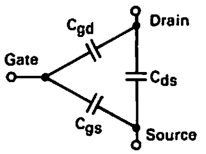
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF150

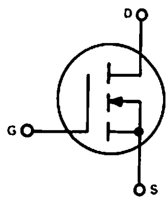
2

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

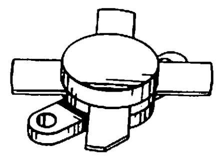
. . . designed primarily for linear large-signal output stages in the 2-175 MHz frequency range.

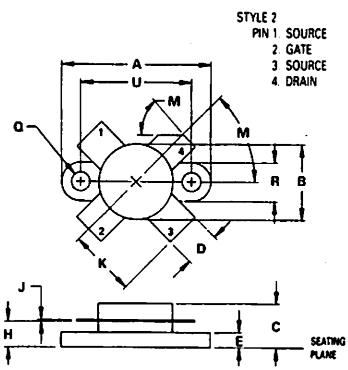
- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 150 Watts
  Power Gain = 17 dB (Typ)
  Efficiency = 45% (Typ)
- Superior High Order IMD
- $IMD_{(d3)}$ (150 W PEP) = -32 dB (Typ)
- $IMD_{(d11)}$ (150 W PEP) = -60 dB (Typ)
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR



150 W 2.0-175 MHz

N-CHANNEL MOS LINEAR RF POWER FET





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	125	Vdc
Drain — Gate Voltage	V_{DGO}	125	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

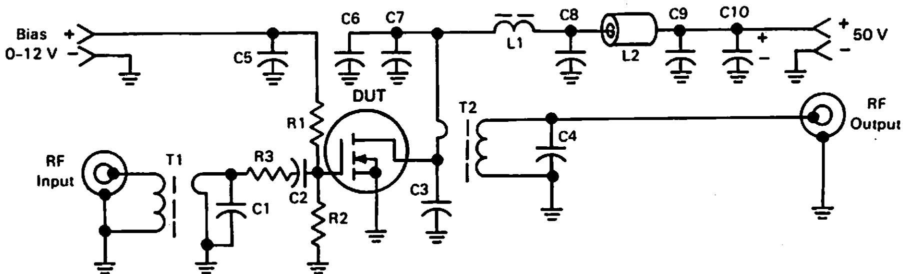
Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage ((V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	4.0	5.0	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0 V, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	250	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	50	—	pF
FUNCTIONAL TESTS (SSB)					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA)	G_{ps}	— —	17 8.0	— —	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 3.75 A)	η	—	45	—	%
Intermodulation Distortion (1) (V_{DD} = 50 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$ $IMD_{(d11)}$	— —	-32 -60	— —	dB
Load Mismatch (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 3.0 A)	G_{PS} $IMD_{(d3)}$ $IMD_{(d9-13)}$	— — —	20 -50 -75	— — —	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT (CLASS AB)



C1 — 470 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — 200 pF Unencapsulated Mica or Dipped Mica with Short Leads
C4 — 15 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3.0 μH
L2 — Ferrite Bead(s), 2.0 μH
R1, R2 — 51Ω/1.0 W Carbon
R3 — 3.3 Ω/1.0 W Carbon (or 2× 6.8 Ω/1/2 W in Parallel
T1 — 9:1 Broadband Transformer
T2 — 1:9 Broadband Transformer

2

FIGURE 2 — POWER GAIN versus FREQUENCY

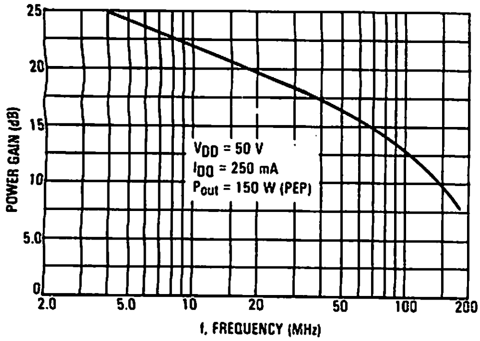


FIGURE 3 — OUTPUT POWER versus INPUT POWER

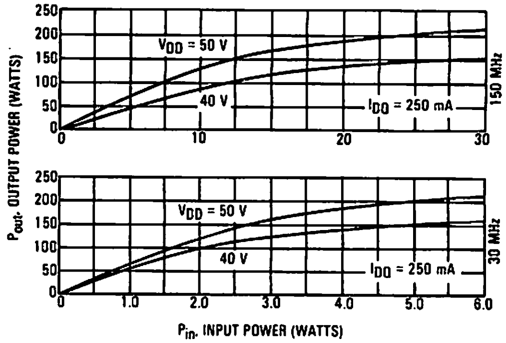


FIGURE 4 — IMD versus P_{out}

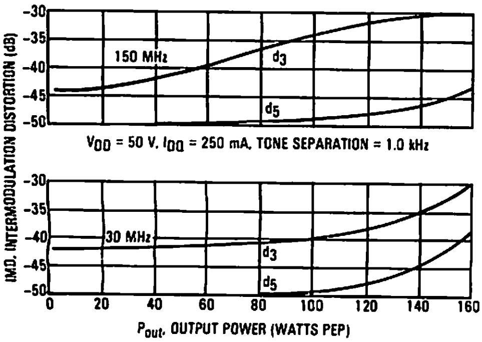


FIGURE 5 — COMMON SOURCE UNITY GAIN FREQUENCY versus DRAIN CURRENT

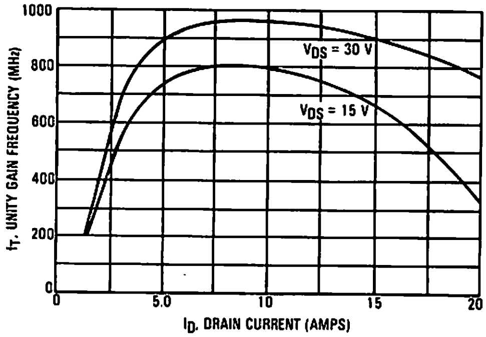


FIGURE 6 — GATE VOLTAGE versus DRAIN CURRENT

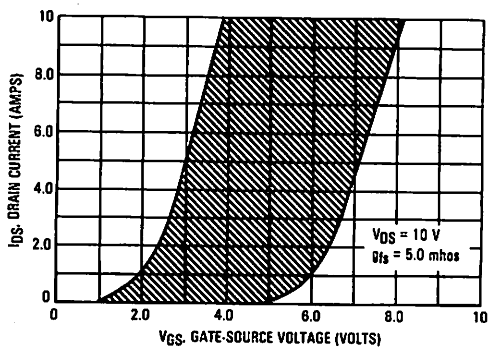


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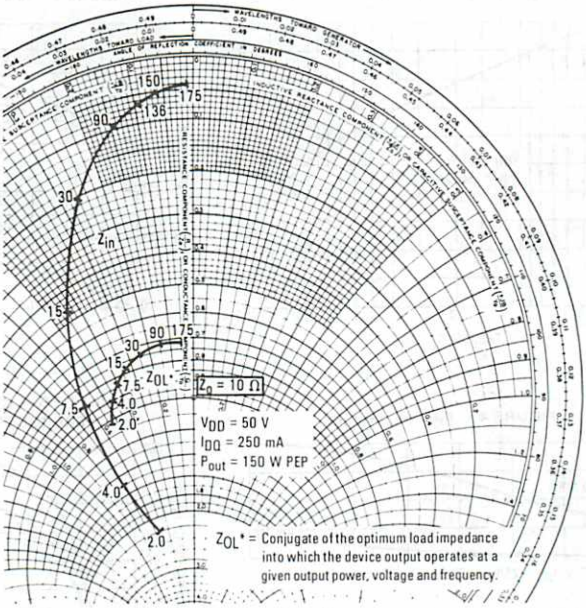
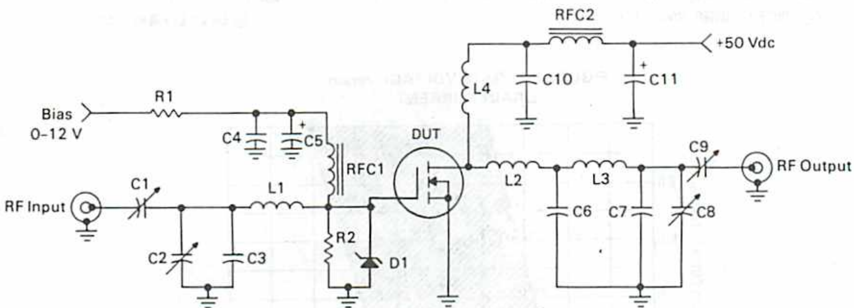
FIGURE 7 — SERIES EQUIVALENT IMPEDANCE



NOTE: Gate Shunted By 25 Ohms.

FIGURE 8 — 150 MHz TEST CIRCUIT (CLASS AB)



C1, C2, C8 — Arco 463 or equivalent
C3 — 25 pF Unelco
C4 — 0.1 μF Ceramic
C5 — 1.0 μF, 15 WV Tantalum
C6 — 250 pF Unelco J101
C7 — 25 pF Unelco J101
C9 — Arco 262 or equivalent
C10 — 0.05 μF Ceramic
C11 — 15 μF, 60 WV Electrolytic

D1 — 1N5347 Zener Diode
L1 — 3/4″ #18 AWG into Hairpin
L2 — Printed Line, 0.200″ × 0.500″
L3 — 1″ #16 AWG into Hairpin
L4 — 2 Turns #16 AWG, 5/16 ID
RFC1 — 5.6 μH Choke
RFC2 — VK200-4B
R1, R2 — 150 Ω, 1.0 W Carbon

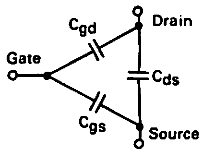
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

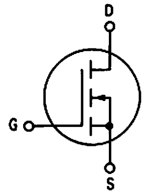
The RF MOSFET Line
RF Power Field-Effect Transistor
N-Channel Enhancement-Mode MOSFET

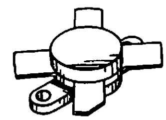
MRF151

**150 W, 50 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**

. . . designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 30 MHz, 50 V:
  - Output Power — 150 W
  - Gain — 18 dB (22 dB Typ)
  - Efficiency — 40%
- Typical Performance at 175 MHz, 50 V:
  - Output Power — 150 W
  - Gain — 13 dB
- Low Thermal Resistance
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability





CASE 211-11, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	300 1.71	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

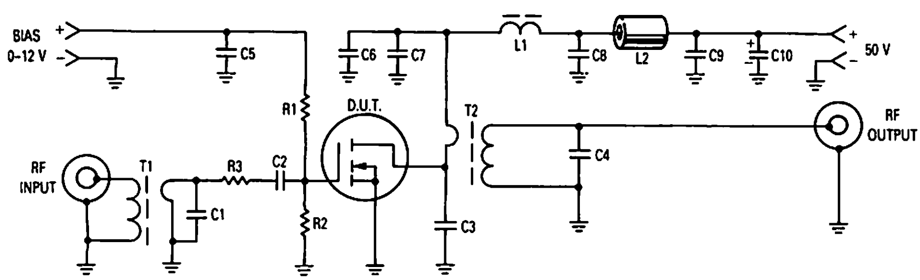
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

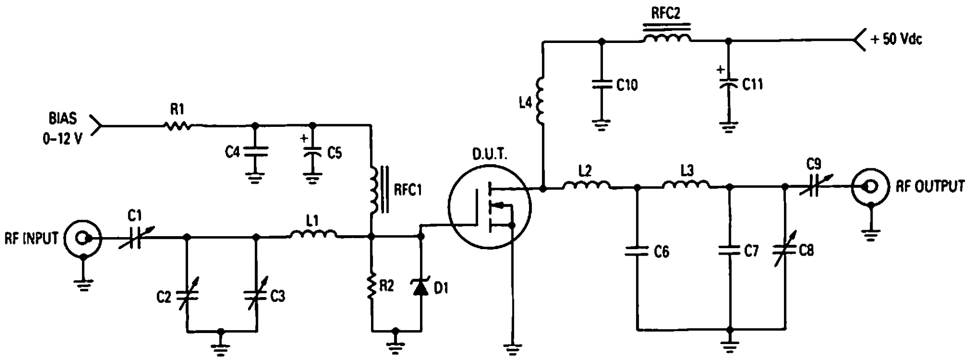
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5 A)	g_{fs}	5	7	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain, f = 30; 30.001 MHz (V_{DD} = 50 V, P_{out} = 150 W (PEP), I_{DQ} = 250 mA)	G_{ps}	18	22	—	dB
f = 175 MHz		—	13	—	
Drain Efficiency (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_D (Max) = 3.75 A)	η	40	45	—	%
Intermodulation Distortion (1) (V_{DD} = 50 V, P_{out} = 150 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 250 mA)	$IMD_{(d3)}$	—	−32	−30	dB
	$IMD_{(d11)}$	—	−60	—	
Load Mismatch (V_{DD} = 50 V, P_{out} = 150 W (PEP), f = 30; 30.001 MHz, I_{DQ} = 250 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain (V_{DD} = 50 V, P_{out} = 50 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 3 A)	G_{PS}	—	23	—	dB
	$IMD_{(d3)}$	—	−50	—	
	$IMD_{(d9-13)}$	—	−75	—	

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1 — 470 pF Dipped Mica
C2, C5, C6, C7, C8, C9 — 0.1 μF Ceramic Chip or Monolythic with Short Leads
C3 — 200 pF Unencapsulated Mica or Dipped Mica with Short Leads
C4 — 15 pF Unencapsulated Mica or Dipped Mica with Short Leads
C10 — 10 μF/100 V Electrolytic
L1 — VK200/4B Ferrite Choke or Equivalent, 3 μH
L2 — Ferrite Bead(s), 2 μH
R1, R2 — 51 Ω/1 W Carbon
R3 — 3.3 Ω/1 W Carbon (or 2 x 6.8 Ω/½ W in Parallel)
T1 — 9:1 Broadband Transformer
T2 — 1:9 Broadband Transformer
Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ϵ_r = 5

Figure 1. 30 MHz Test Circuit



C1, C2, C8 — Arco 463 or equivalent
C3 — 25 pF Unelco
C4 — 0.1 μF Ceramic
C5 — 1 μF, 15 WV Tantalum
C6 — 250 pF Unelco J101
C7 — 25 μF Unelco J101
C9 — Arco 262 or equivalent
C10 — 0.05 μF Ceramic
C11 — 15 μF, 60 WV Electrolytic

D1 — 1N5347 Zener Diode
L1 — 3/4" #18 AWG into Hairpin
L2 — Printed Line, 0.200" x 0.500"
L3 — 1" #16 AWG into Hairpin
L4 — 2 Turns #16 AWG, 5/16 ID
RFC1 — 5.6 μH Choke
RFC2 — VK200-4B
R1, R2 — 150 Ω, 1 W Carbon
Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ϵ_r = 5

Figure 2. 175 MHz Test Circuit

TYPICAL CHARACTERISTICS

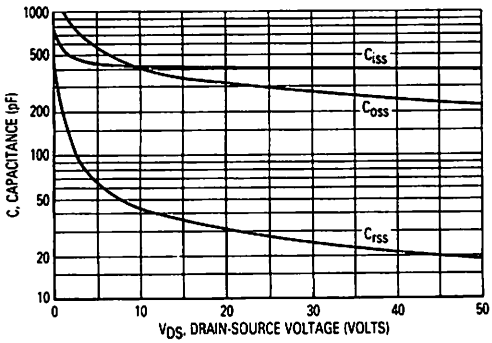


Figure 3. Capacitance versus Drain-Source Voltage

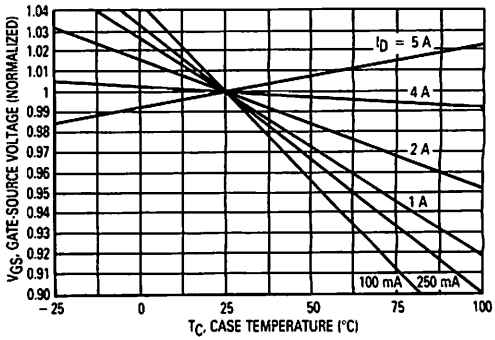


Figure 4. Gate-Source Voltage versus Case Temperature

2

TYPICAL CHARACTERISTICS

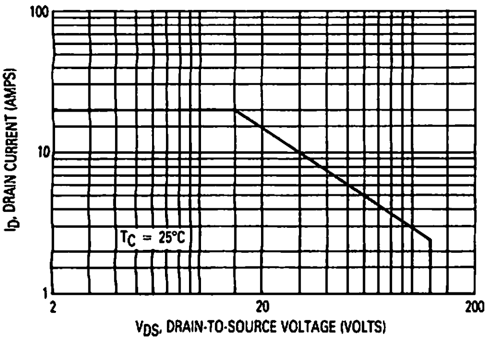


Figure 5. DC Safe Operating Area

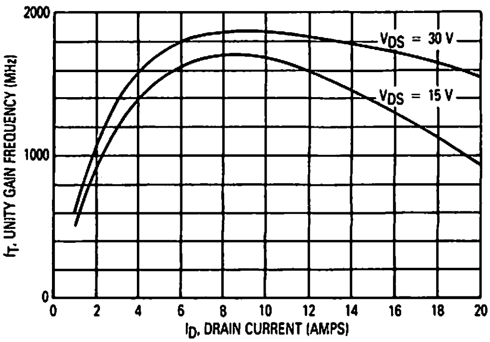


Figure 6. Common Source Unity Gain Frequency versus Drain Current

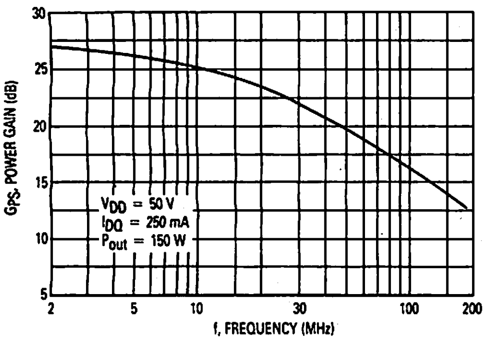


Figure 7. Power Gain versus Frequency

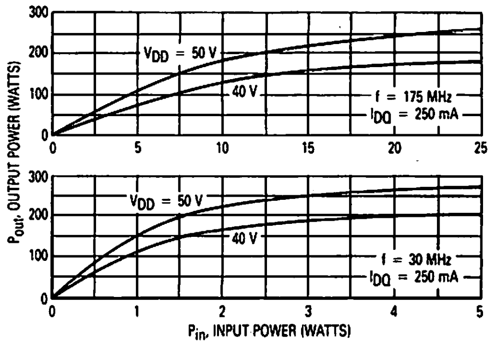


Figure 8. Output Power versus Input Power

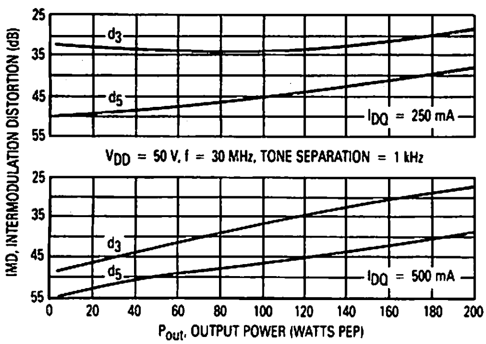


Figure 9. IMD versus P_{out}

TYPICAL CHARACTERISTICS

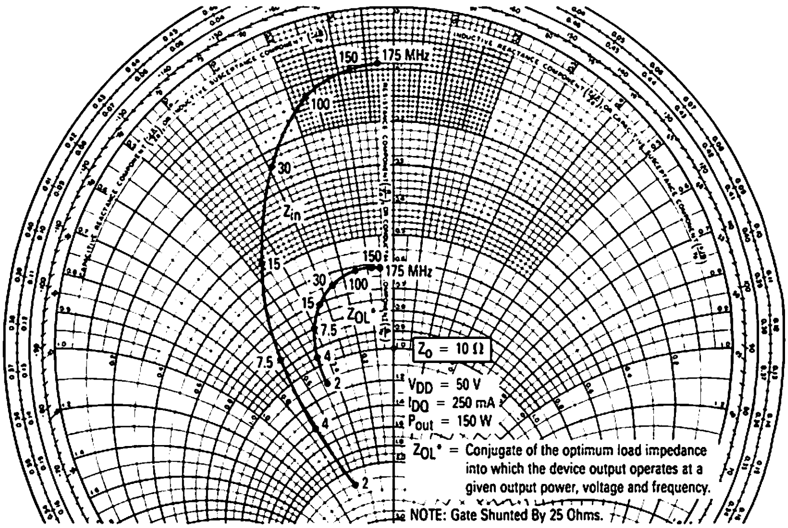


Figure 10. Series Equivalent Impedance

RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

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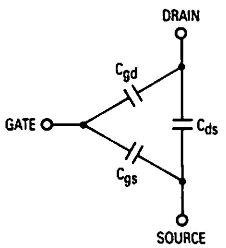
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented. Figure 6 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gate of this device is essentially capacitor. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another *important function.* Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF151 is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF151 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF151 was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification. I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF151 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

The RF MOSFET Line

RF Power Field-Effect Transistor

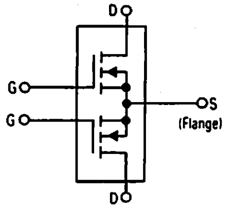
N-Channel Enhancement-Mode MOSFET

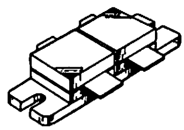
MRF151G

**300 W, 50 V, 175 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET**

... designed for broadband commercial and military applications at frequencies to 175 MHz. The high power, high gain and broadband performance of this device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance at 175 MHz, 50 V:
  - Output Power — 300 W
  - Gain — 14 dB (16 dB Typ)
  - Efficiency — 50%
- Low Thermal Resistance — 0.35°C/W
- Ruggedness Tested at Rated Output Power
- Nitride Passivated Die for Enhanced Reliability





CASE 375-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	40	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

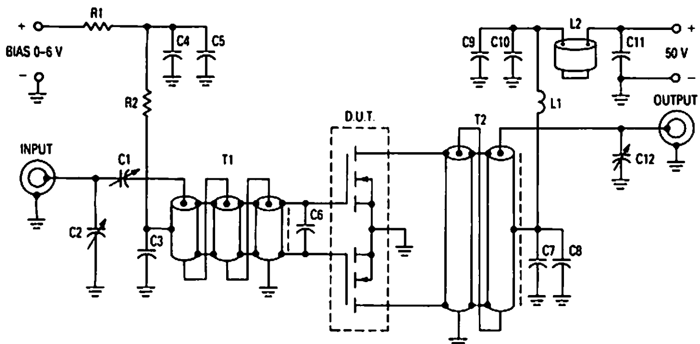
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W

NOTE — **CAUTION** — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Each Side)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	5	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (Each Side)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5 A)	g_{fs}	5	7	—	mhos
DYNAMIC CHARACTERISTICS (Each Side)					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA, f = 175 MHz)	G_{ps}	14	16	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 300 W, f = 175 MHz, I_D (Max) = 11 A)	η	50	55	—	%
Load Mismatch (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA, VSWR 5:1 at all Phase Angles)	ψ	No Degradation in Output Power			



R1 — 100 Ohms, 1/2 W
R2 — 1 kOhm, 1/2 W
C1 — Arco 406, 15–115 pF
C2 — Arco 402, 1.5–20 pF
C3, C4, C7, C8, C9 — 1000 pF Chip
C5, C10 — 0.1 μF Chip
C6 — 330 pF Chip
C11 — 0.47 μF Ceramic Chip, Kemet 1215 or Equivalent (100 V)
C12 — Arco 403, 3–35 pF
L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, 1/4" I.D.
L2 — Ferrite Beads of Suitable Material for 1.5–2 μH Total Inductance

T1 — 9:1 RF Transformer. Can be made of 15–18 Ohm Semirigid Co-Ax, 62–90 Mils O.D.
T2 — 1:4 RF Transformer. Can be made of 25–35 Ohm Semirigid Co-Ax, 90–100 Mils O.D.
Board Material — 0.062" Fiberglass (G10), 1 oz. Copper Clad, 2 Sides, ϵ_r = 5

NOTE: For stability, the input transformer T1 must be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

See Figure 6 for construction details of T1 and T2.

Unless Otherwise Noted, All Chip Capacitors are ATC Type 100 or Equivalent.

Figure 1. 175 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

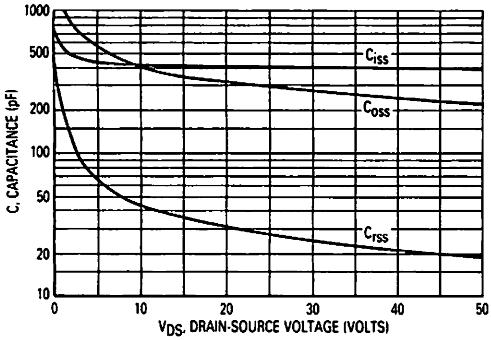


Figure 2. Capacitance versus Drain-Source Voltage*

*Data shown applies to each half of MRF151G.

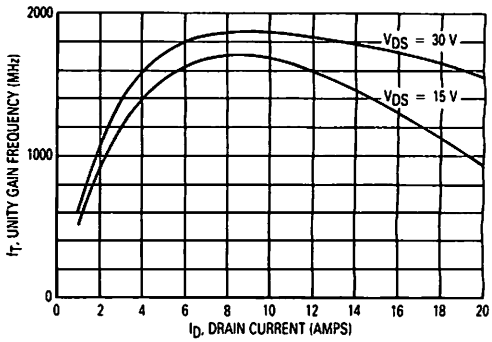


Figure 3. Common Source Unity Gain Frequency versus Drain Current*

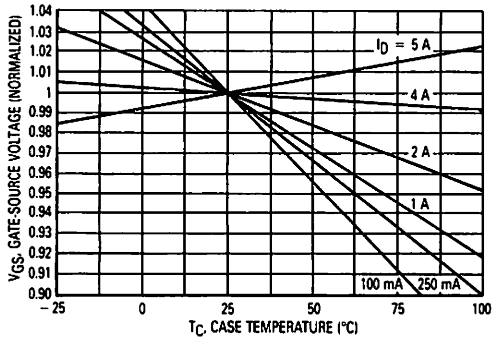


Figure 4. Gate-Source Voltage versus Case Temperature*

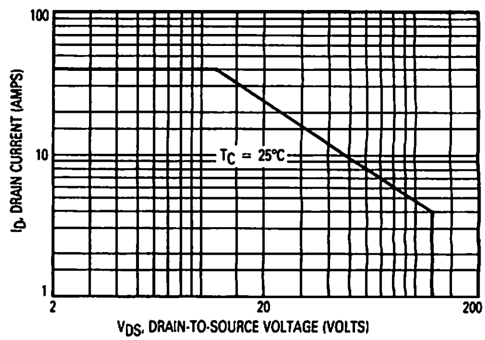


Figure 5. DC Safe Operating Area

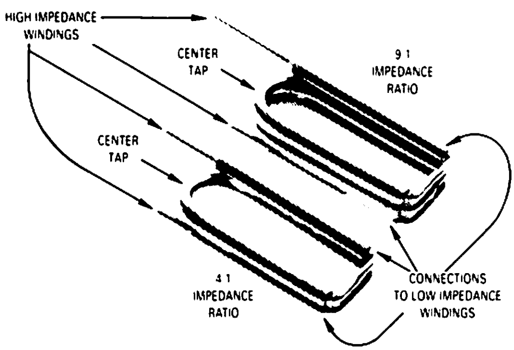


Figure 6. RF Transformer

TYPICAL CHARACTERISTICS

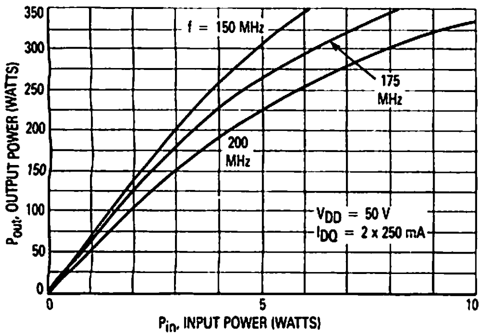


Figure 7. Output Power versus Input Power

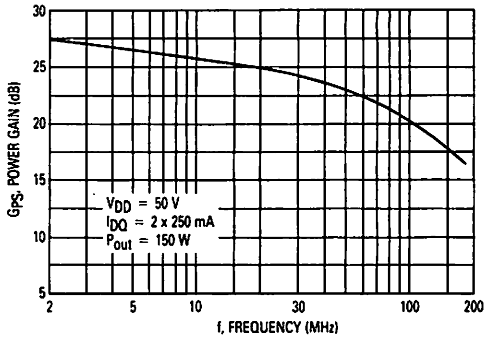
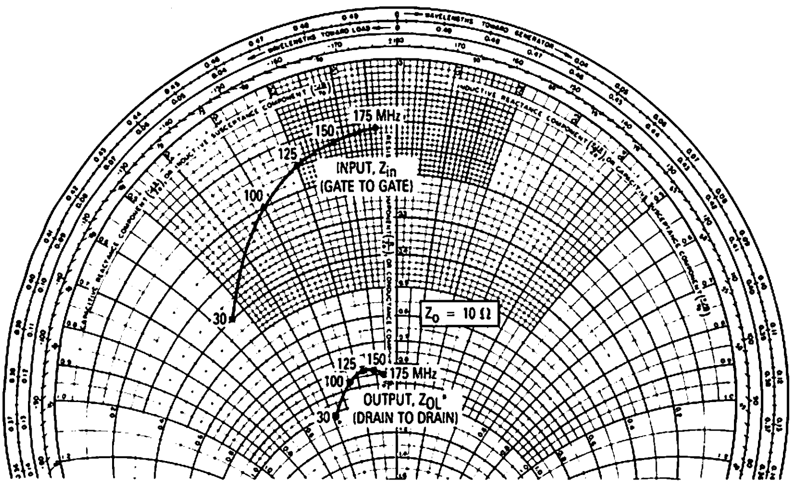


Figure 8. Power Gain versus Frequency



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 9. Input and Output Impedance

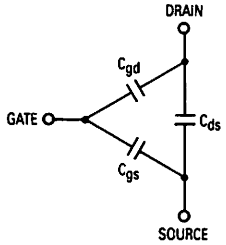
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal anode gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOS FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the inter-terminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} = C_{gs}$
$C_{oss} = C_{gd} = C_{ds}$
$C_{rss} = C_{gd}$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented. Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOS FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of this device are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the device due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF151G is an RF Power, MOS, N-channel enhancement mode field-effect transistor (FET) designed for HF and VHF power amplifier applications.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power MOSFETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF151G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF151G was characterized at I_{DQ} = 250 mA, each side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification. I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF151G may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

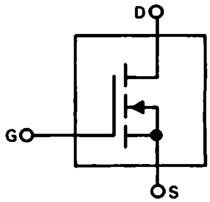
MRF154

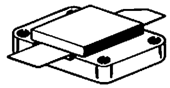
600 W, 50 V, 80 MHz
N-CHANNEL
BROADBAND
RF POWER MOSFET

The RF MOSFET Line
RF Power Field Effect Transistor
N-Channel Enhancement-Mode MOSFET

. . . designed primarily for linear large-signal output stages in the 2–100 MHz frequency range.

- Specified 50 Volts, 30 MHz Characteristics
  Output Power = 600 Watts
  Power Gain = 17 dB (Typ)
  Efficiency = 45% (Typ)





CASE 368-01, STYLE 2
(HOG PAC)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	60	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1350 7.7	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

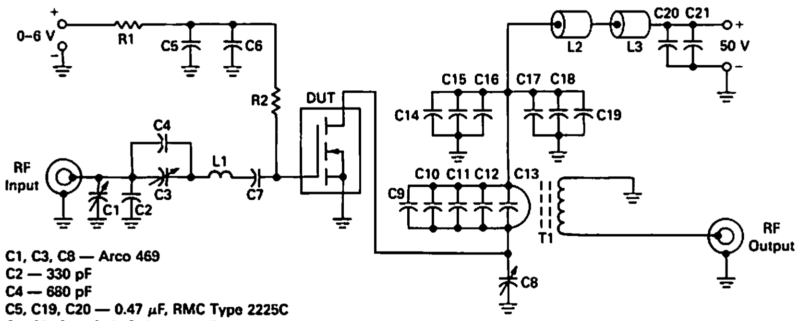
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.13	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	20	mAdc
Gate-Body Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	5	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	5	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 40 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 20 A)	g_{fs}	16	20	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0 V, f = 1 MHz)	C_{iss}	—	1600	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	1000	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	200	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 600 W, I_{DQ} = 800 mA, f = 30 MHz)	G_{ps}	—	17	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 600 W, I_{DQ} = 800 mA, f = 30 MHz)	η	—	45	—	%
Intermodulation Distortion (V_{DD} = 50 V, P_{out} = 600 W(PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{DQ} = 800 mA)	$IMD_{(d3)}$	—	−25	—	dB



C1, C3, C8 — Arco 469
C2 — 330 pF
C4 — 680 pF
C5, C19, C20 — 0.47 μF, RMC Type 2225C
C6, C7, C14, C15, C16 — 0.1 μF
C9, C10, C11 — 470 pF
C12 — 1000 pF
C13 — Two Unencapsulated 1000 pF Mica, in Series
C17, C18 — 0.039 μF
C21 — 10 μF/100 V Electrolytic
R1, R2 — 10 Ohms/2W Carbon
L1 — 2 Turns #16 AWG, 1/2" ID, 3/8" Long
L2, L3 — Ferrite Beads, Fair-Rite Products Corp. #2673000801
T1 — RF Transformer, 1:25 Impedance Ratio. See Motorola Application Note AN-749, Figure 4 for details. Ferrite Material: 2 Each, Fair-Rite Products Corp. #2667540001

All capacitors ATC type 100/200 chips or equivalent unless otherwise noted.

FIGURE 1 — 30 MHz TEST CIRCUIT

2

2

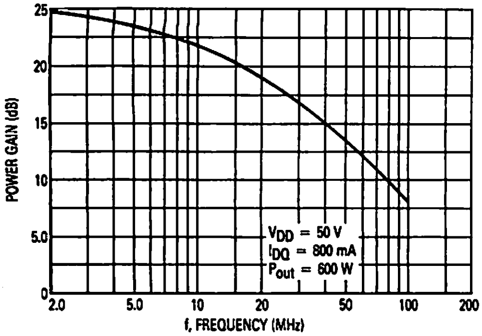


Figure 2. Power Gain versus Frequency

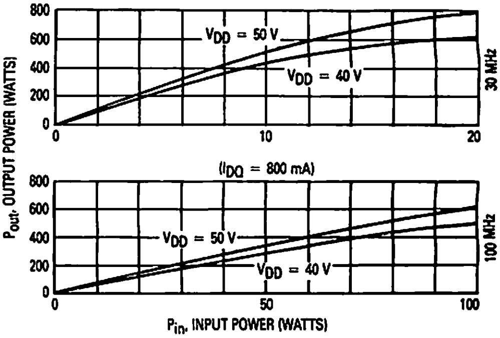


Figure 3. Output Power versus Input Power

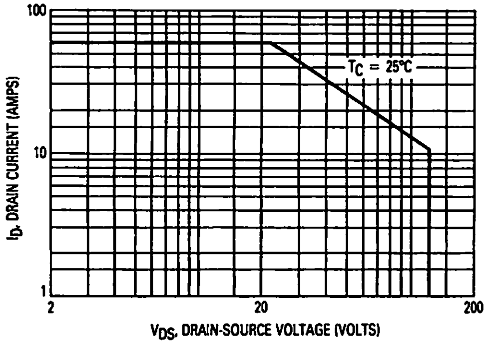


Figure 4. DC Safe Operating Area

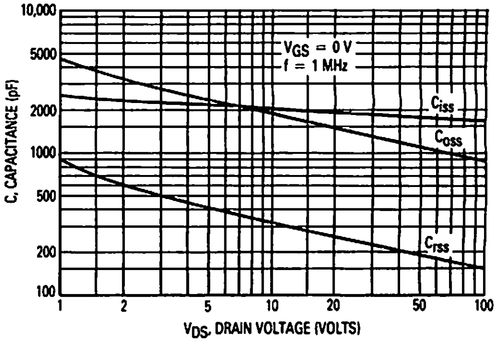


Figure 5. Capacitance versus Drain Voltage

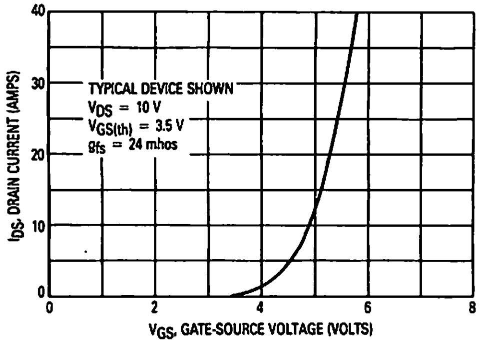


Figure 6. Gate Voltage versus Drain Current

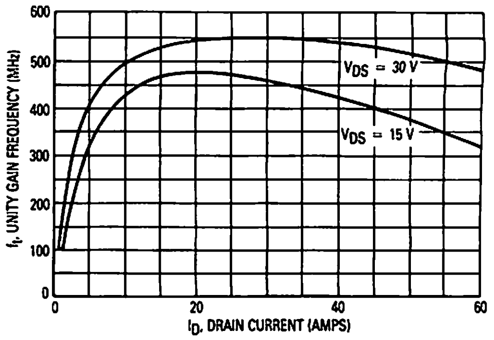


Figure 7. Common Source Unity Gain Frequency versus Drain Current

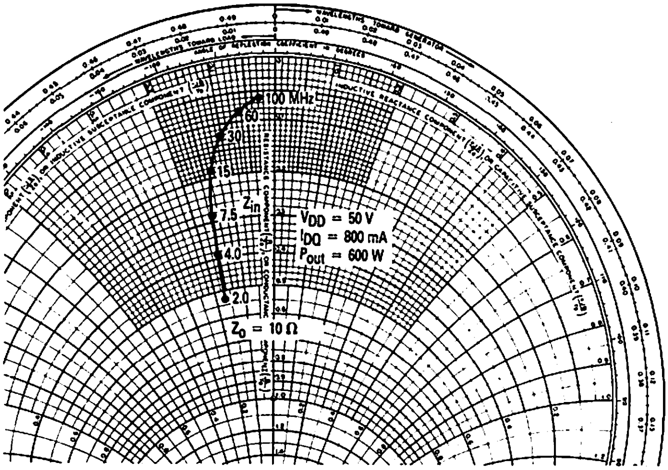
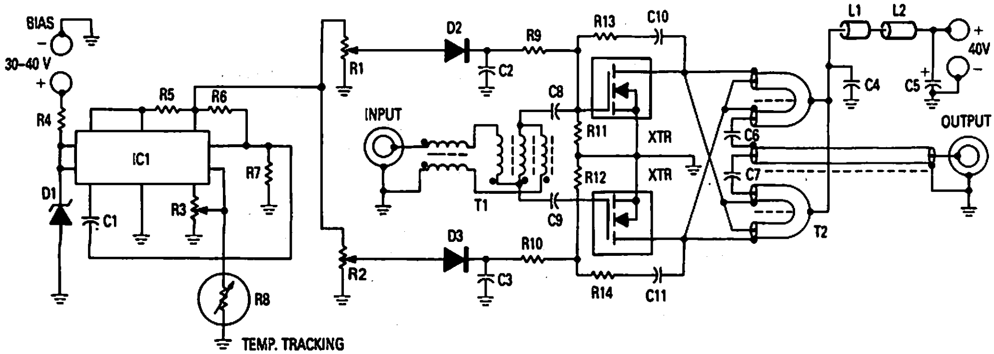


Figure 8. Series Equivalent Impedance



C1 — 1000 pF Ceramic
C2, C3, C4, C8, C9, C10, C11 — 0.1 μF Ceramic
C5 — 10 μF/100 V Electrolytic
C6, C7 — 0.1 μF Ceramic, (ATC 200/823 or Equivalent)
D1 — 28 V Zener, 1N5362 or Equivalent
D3 — 1N4148
IC1 — MC1723
L1, L2 — Fair-Rite Products Corp. Ferrite Beads #2673000801
R1, R2, R3 — 10 k Trimpot
R4 — 1.0 k / 1.0 W
R5 — 10 Ohms
R6 — 2.0 k
R7 — 10 k
R8 — Thermistor, 10 k (25°C), 2.5 k (75°C)
R9, R10 — 100 Ohms
R11, R12 — 1.0 k
R13, R14 — 50–100 Ohms, 4 x 2 W Carbon in Parallel
T1 — 9:1 Transformer, Trifilar and Balun Wound on Separate Fair-Rite Products Corp. Balun Cores #286100012, 5 Turns Each.
T2 — 1:9 Transformer, Balun 50 Ohm CO-AX Cable RG-188, Low Impedance Lines W.L. Gore 16 Ohms CO-AX Type CXN 1837.
Each Winding Threaded Through Two Fair-Rite Products Corp. #2661540001 Ferrite Sleeves (6 Each).
XTR — MRF154

Figure 9. 20–80 MHz 1 kW Broadband Amplifier

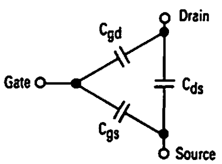
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to source (C_{gs}). The PN junction formed during the fabrication of the RF MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 5 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the RF MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ±0.0005" is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4" thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4–5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ *temperature* from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_θ for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

EQUIVALENT TRANSISTOR PARAMETER TERMINOLOGY

Collector	Drain
Emitter	Source
Base	Gate
$V_{(BR)CES}$	$V_{(BR)DSS}$
V_{CBO}	V_{DGO}
I_C	I_D
I_{CES}	I_{DSS}
I_{EBO}	I_{GSS}
$V_{BE(on)}$	$V_{GS(th)}$
$V_{CE(sat)}$	$V_{DS(on)}$
C_{ib}	C_{iss}
C_{ob}	C_{oss}
h_{fe}	g_{fs}
$R_{CE(sat)} = \frac{V_{CE(sat)}}{I_C}$	$r_{DS(on)} = \frac{V_{DS(on)}}{I_D}$

2

MRF161

2

The RF MOSFET Line

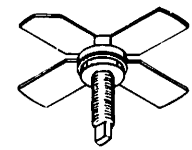
5.0 W 2.0–400 MHz

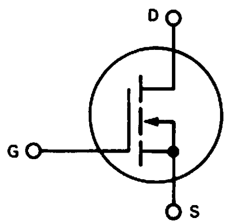
N-CHANNEL MOS
BROADBAND RF POWER
FET

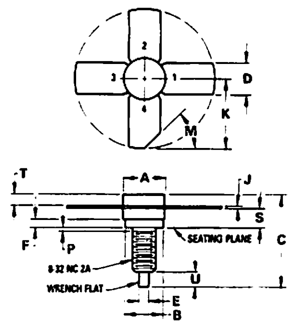
N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

. . . designed for wideband large-signal amplifier and oscillator applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 5.0 Watts
  Minimum Gain = 11 dB
  Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB (Typ) at 100 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques







STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	0.9	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	17.5 0.10	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

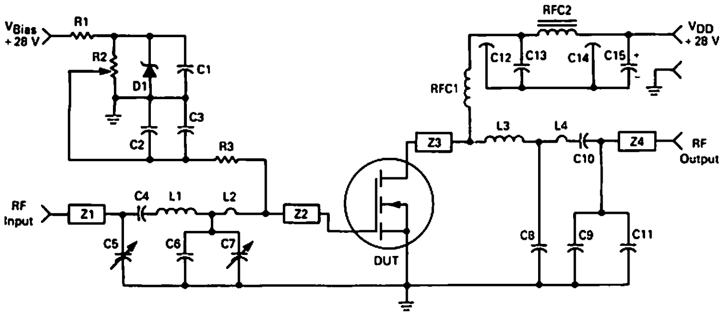
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	10	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Resonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	1.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 10 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 100 mA)	g_{fs}	80	110	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	7.0	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	9.7	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	2.3	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 100 mA, f = 400 MHz, Z_S = 67.6 + j14.1, Z_L = 14.5 + j25.7)	NF	—	3.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA)	G_{ps}	11	13.5	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz, I_{DQ} = 50 mA, VSWR 30:1 at *All* Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C13 — 0.1 μF, 50 V Disc Ceramic
C3 — 0.01 μF, 100 V Disc Ceramic
C4, C10 — 220 pF, 100 Mil Chip Cap
C5 — 1–10 pF Johanson or Equivalent
C6 — 5.0 pF Mini-Unleco or Equivalent
C7 — 1–20 pF Johanson or Equivalent
C8 — 15 pF, 100 Mil ATC Chip Cap or Equivalent
C9, C11 — 2.2, 100 Mil ATC Chip Cap or Equivalent
C12, C14 — 680 pF Feedthru
C15 — 50 μF, 35 V
R1 — 1.6 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 10 k, 1/2 W
D1 — 1N5347B Motorola Zener or Equivalent

L1 — 1-3/4 Turns, 0.185" ID 0.08" Long #20 AWG Enamel — (25 nH)
L2 — #20 AWG Enamel, Hairpin 0.353" — (10.5 nH) 0.185"
L3 — 1-3/4 Turns, 0.128" ID 0.11" Long #18 AWG Enamel — (15 nH)
L4 — #18 AWG Enamel, Hairpin 0.410" — (12.5 nH) 0.185"
RFC1 — 10 Turns, 0.300" ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200
Z1 — 0.82" x 0.164" Microstrip — (Z_O = 50 Ω)
Z2, Z3 — 0.60" x 0.25" Microstrip
Z4 — 0.76" x 0.164" Microstrip — (Z_O = 50 Ω)
Board-Glass Teflon, 62 Mils, ϵ_r = 2.56

FIGURE 2 — OUTPUT POWER versus INPUT POWER

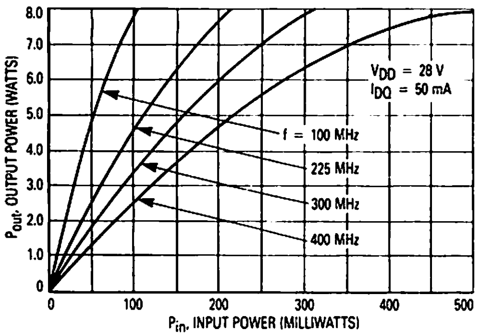


FIGURE 3 — OUTPUT POWER versus INPUT POWER

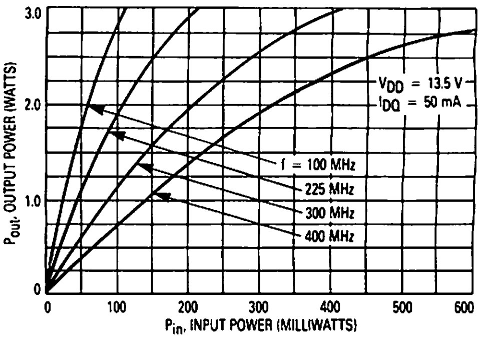


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

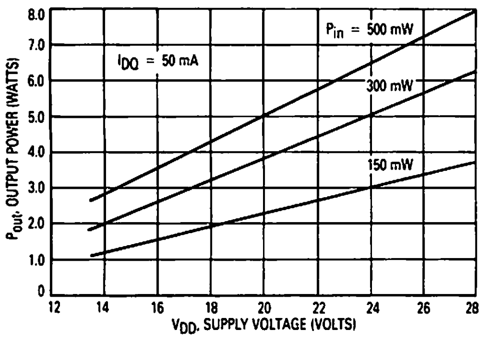


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 300 MHz

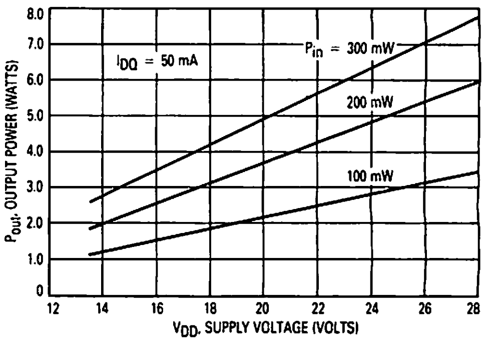


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

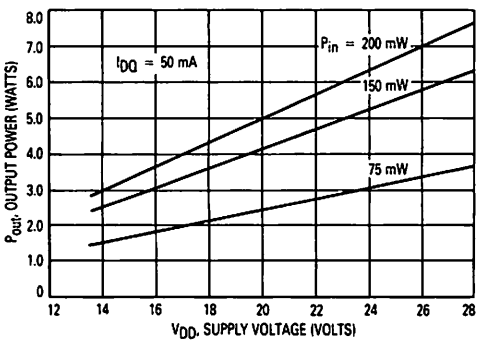


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

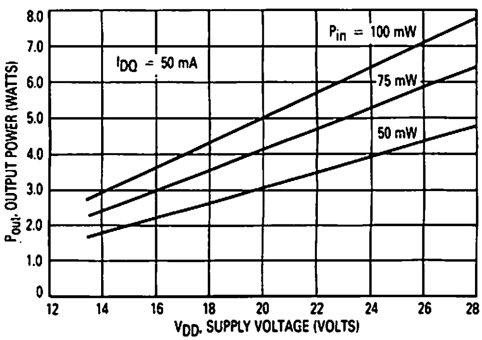


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

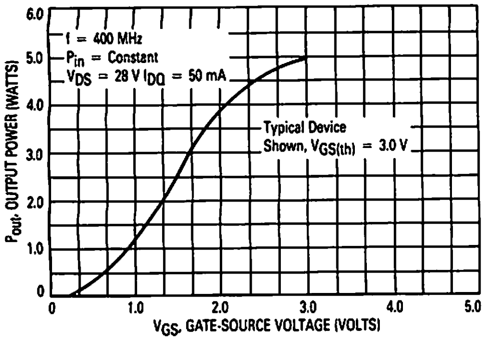


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

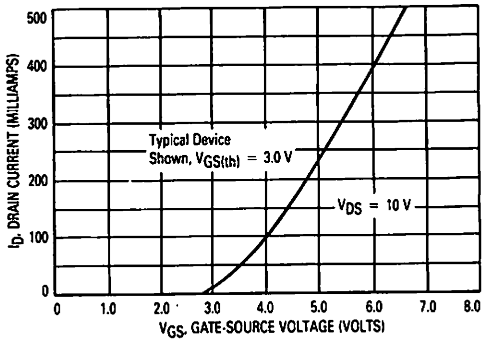


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FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

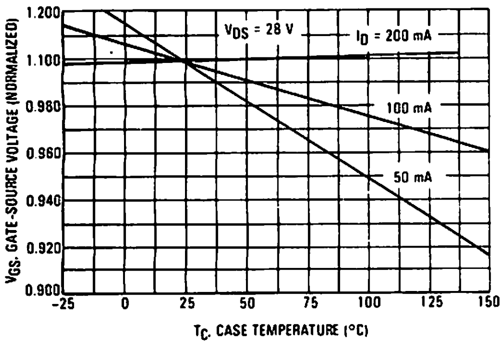


FIGURE 11 — CAPACITANCE versus VOLTAGE

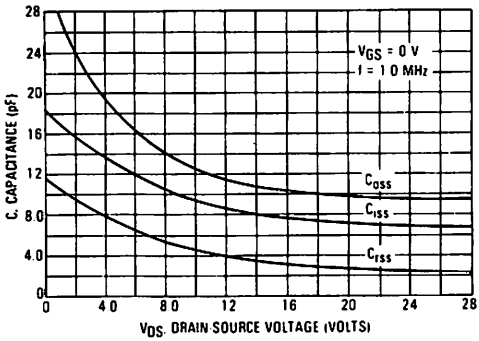


FIGURE 12 — MAXIMUM RATED FORWARD BIASED SAFE OPERATING AREA

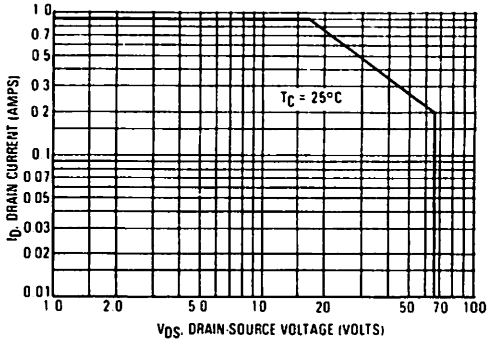
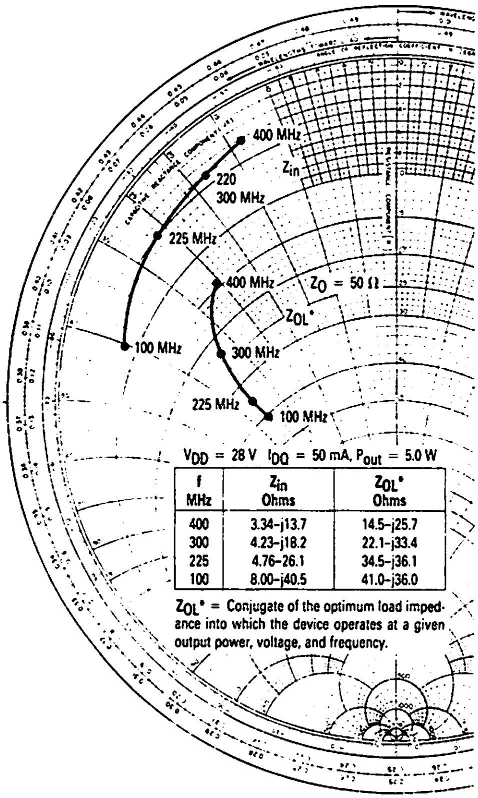


FIGURE 13 — LARGE-SIGNAL SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE, Z_{in}, Z_{OL}*



V_{DD} = 28 V I_{DQ} = 50 mA, P_{out} = 5.0 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	3.34-j13.7	14.5-j25.7
300	4.23-j18.2	22.1-j33.4
225	4.76-26.1	34.5-j36.1
100	8.00-j40.5	41.0-j36.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 14 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
V_{DS} = 28 V, I_D = 250 mA

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	∠ φ	$\|S_{21}\|$	∠ φ	$\|S_{12}\|$	∠ φ	$\|S_{22}\|$	∠ φ
2.0	1.000	−1.69	13.64	178	0.002	62	0.947	−1.84
5.0	1.000	−4.63	13.60	176	0.005	69	0.945	−4.00
10	0.997	−8.95	13.70	173	0.010	80	0.941	−7.92
20	0.989	−17.49	13.36	167	0.022	73	0.929	−15.8
30	0.977	−26	13.07	162	0.032	71	0.915	−23
40	0.968	−34	12.76	156	0.042	67	0.902	−30
50	0.949	−42	12.31	151	0.050	61	0.885	−37
60	0.930	−49	11.88	146	0.058	57	0.866	−43
70	0.913	−56	11.45	141	0.066	53	0.846	−49
80	0.897	−62	10.96	137	0.072	50	0.831	−55
90	0.885	−68	10.50	133	0.078	46	0.817	−60
100	0.867	−74	10.00	129	0.081	43	0.800	−65
110	0.853	−78	9.54	125	0.085	40	0.787	−69
120	0.838	−84	8.92	122	0.090	37	0.775	−74
130	0.819	−88	8.75	119	0.093	35	0.762	−78
140	0.812	−92	8.30	116	0.096	31	0.755	−81
150	0.800	−96	7.95	113	0.098	28	0.742	−86
160	0.785	−99	7.54	111	0.100	26	0.735	−89
170	0.775	−103	7.25	109	0.102	24	0.728	−93
180	0.765	−105	6.85	106	0.103	23	0.725	−96
190	0.755	−108	6.60	104	0.104	21	0.720	−98
200	0.740	−111	6.20	100	0.106	18	0.719	−99
225	0.735	−116	5.71	96	0.110	16	0.715	−103
250	0.723	−121	5.17	92	0.112	12	0.708	−107
275	0.720	−124	4.80	89	0.113	10	0.706	−110
300	0.716	−128	4.43	85	0.112	7.0	0.706	−113
325	0.715	−130	4.17	83	0.111	4.0	0.717	−115
350	0.715	−133	3.87	79	0.111	3.0	0.720	−117
375	0.715	−135	3.67	76	0.111	1.0	0.728	−118
400	0.711	−137	3.43	74	0.109	0	0.729	−119
425	0.714	−139	3.25	71	0.104	0	0.738	−120
450	0.717	−140	3.11	69	0.104	−2.0	0.743	−121
475	0.719	−141	2.95	67	0.103	−3.0	0.757	−122
500	0.722	−142	2.81	65	0.102	−4.0	0.770	−122
525	0.723	−144	2.69	62	0.099	−6.0	0.777	−123
550	0.727	−144	2.55	61	0.097	−6.0	0.787	−123
575	0.729	−145	2.46	59	0.097	−7.0	0.802	−124
600	0.733	−146	2.37	57	0.094	−7.0	0.814	−124
625	0.734	−147	2.29	55	0.090	−8.0	0.824	−126
650	0.740	−148	2.19	54	0.087	−8.0	0.830	−127
675	0.749	−149	2.12	53	0.085	−6.0	0.849	−127
700	0.758	−149	2.07	51	0.084	−6.0	0.879	−127
725	0.761	−150	1.99	49	0.082	−5.0	0.886	−127
750	0.763	−151	1.93	48	0.081	−4.0	0.905	−127
775	0.765	−151	1.90	48	0.079	−3.0	0.919	−128
800	0.770	−152	1.83	46	0.076	−1.0	0.921	−128

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FIGURE 15 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY V_{DS} = 28 V, I_D = 250 mA

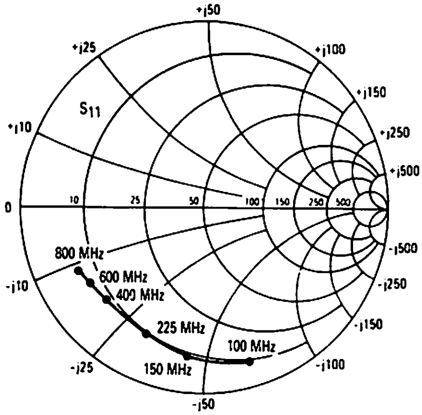


FIGURE 16 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY V_{DS} = 28 V, I_D = 250 mA

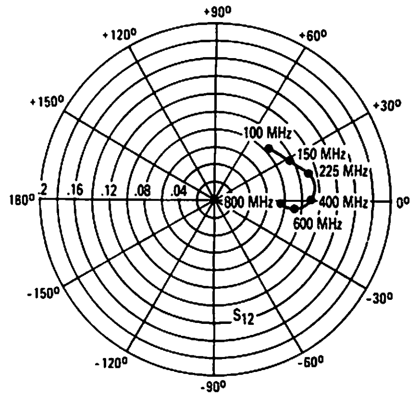


FIGURE 17 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY V_{DS} = 28 V, I_D = 250 mA

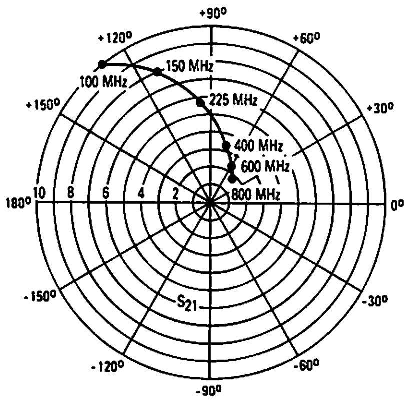
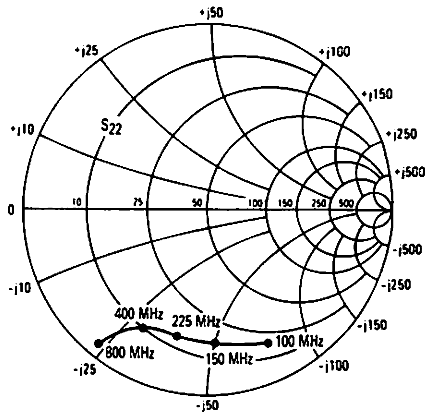


FIGURE 18 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY V_{DS} = 28 V, I_D = 250 mA



DESIGN CONSIDERATIONS

The MRF161 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF161 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF161 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

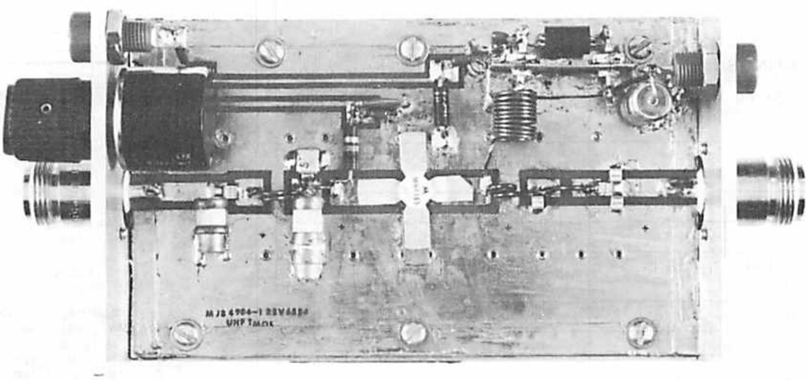
Power output of the MRF161 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF161. See Motorola Application Note AN721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF161, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF161 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN215A for a discussion of two port network theory and stability.

FIGURE 19 — 400 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

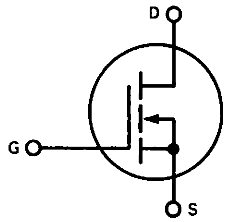
MRF162

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

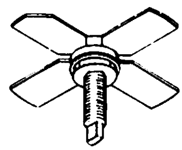
. . . designed for wideband large-signal output and driver applications in the 2.0 to 400 MHz range.

- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 15 Watts
  Minimum Gain = 11 dB
  Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure – 2.0 dB (Typ) at 300 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



15 W 2.0-400 MHz

N-CHANNEL MOS BROADBAND RF POWER FET



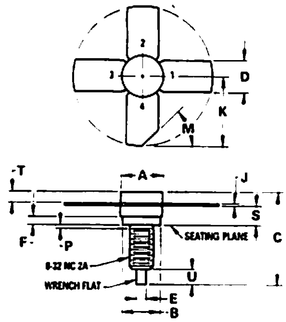
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current – Continuous	I_D	2.5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.286	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.



STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

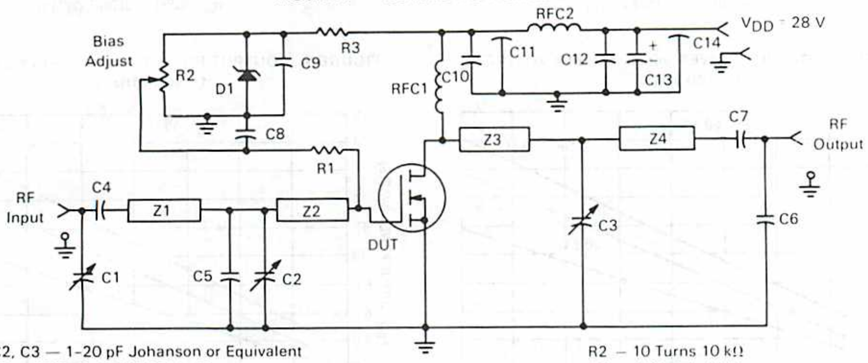
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 5.0 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 250 mA)	g_{fs}	250	400	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	24	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	27	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	5.5	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 300 mA, f = 400 MHz, Z_S = 5.9 + j7.8 Ω, Z_L = 3.78 + j5.75 Ω)	NF	—	2.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA)	G_{ps}	11	13.6		dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA)	η	45	50		%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 15 W, f = 400 MHz, I_{DQ} = 50 mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C3 — 1-20 pF Johanson or Equivalent
C4, C7 — 270 pF, 100 Mil Chip Cap
C5 — 18 pF Mini-Unleco or Equivalent
C6 — 12 pF, 100 Mil Chip Cap
C8 — 0.01 μF, 50 V Disc Ceramic
C9, C10, C12 — 0.1 μF, 50 V Disc Ceramic
C11, C14 — 680 pF Feedthru
C13 — 20 μF, 50 V
D1 — 1N5925A Motorola Zener
R1 — 10 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 1.6 kΩ, 1/4 W
RFC1 — 10 Turns, 0.300" ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Z1 — 1.5" × 0.250" Microstrip
Z2 — 0.6" × 0.250" Microstrip
Z3 — 1.3" × 0.250" Microstrip
Z4 — 0.85" × 0.250" Microstrip
Board — Glass Teflon, 62 Mils, ϵ_r = 2.56

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

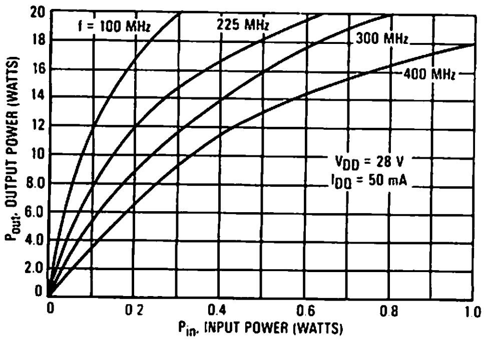


FIGURE 3 — OUTPUT POWER versus INPUT POWER

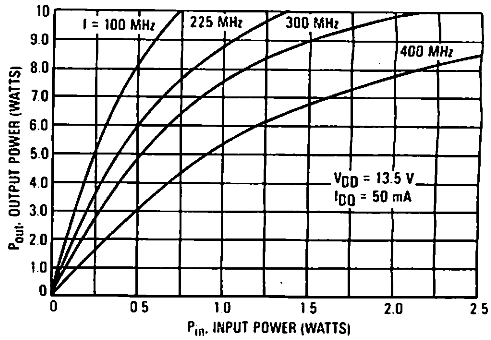


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

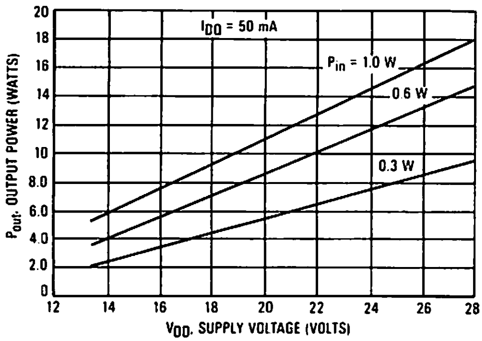


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 300 MHz

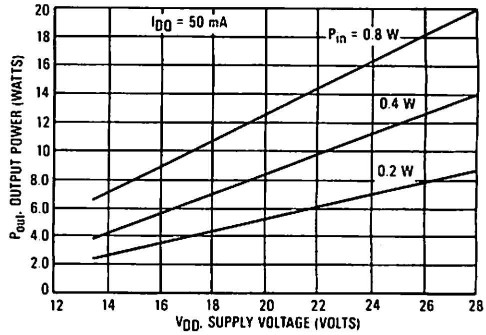


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

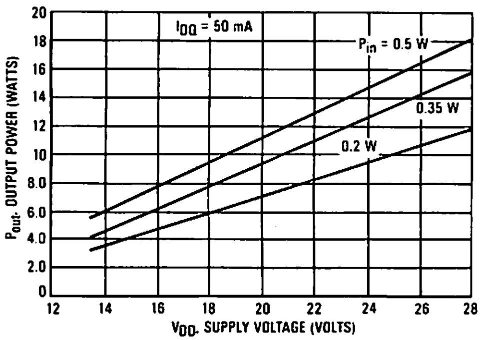


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

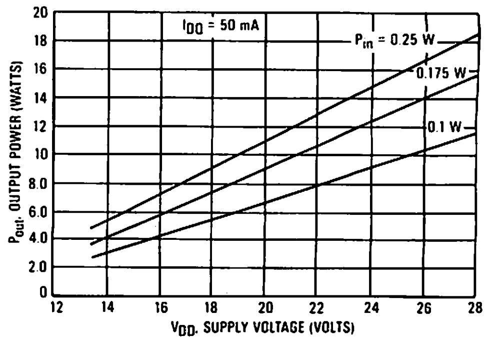


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

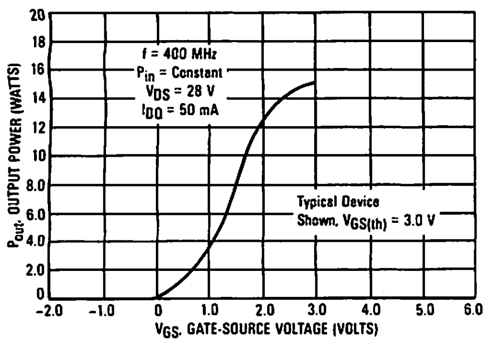


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

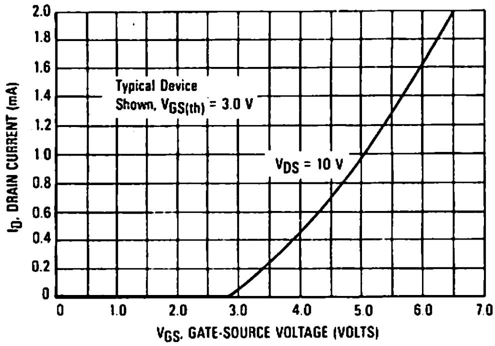


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

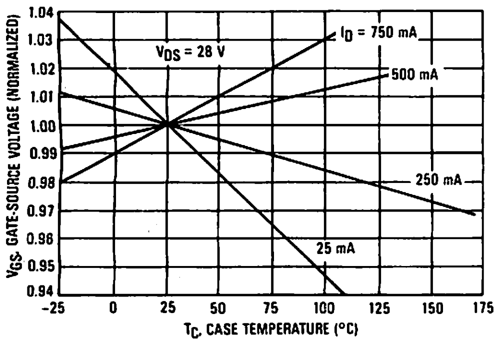


FIGURE 11 — CAPACITANCE versus DRAIN-SOURCE VOLTAGE

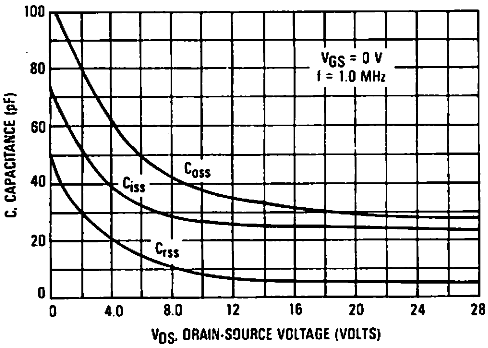


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FIGURE 12 – DC SAFE OPERATING AREA

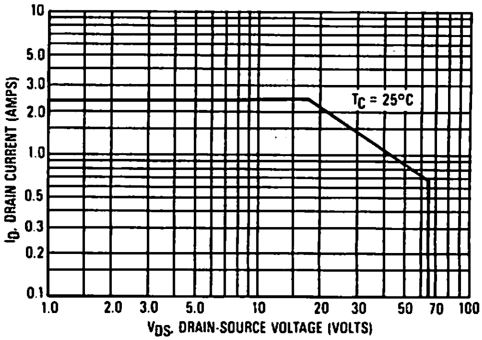
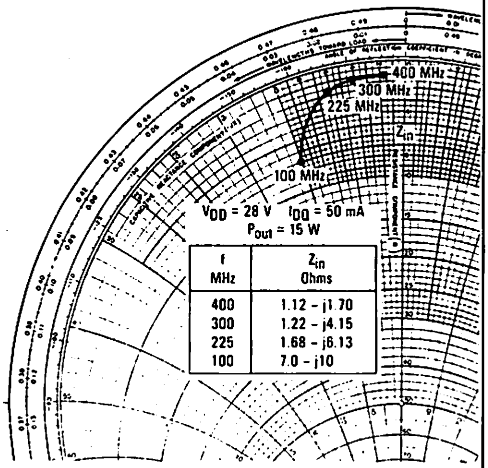


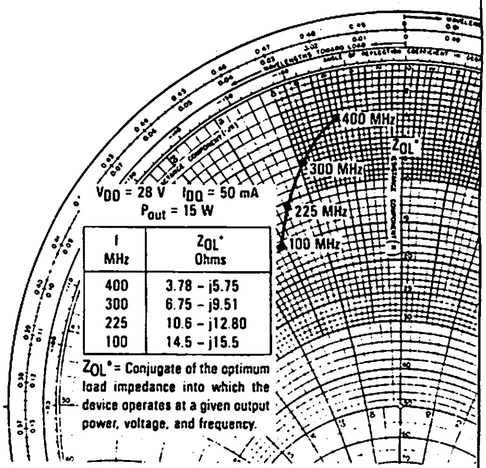
FIGURE 13 – LARGE SIGNAL SERIES EQUIVALENT INPUT IMPEDANCE, Z_{in}



V_{DD} = 28 V I_{DQ} = 50 mA
P_{out} = 15 W

f MHz	Z_{in} Ohms
400	1.12 – j1.70
300	1.22 – j4.15
225	1.68 – j6.13
100	7.0 – j10

FIGURE 14 – LARGE SIGNAL SERIES EQUIVALENT OUTPUT IMPEDANCE, Z_{OL}*



V_{DD} = 28 V I_{DQ} = 50 mA
P_{out} = 15 W

f MHz	Z_{OL}* Ohms
400	3.78 – j5.75
300	6.75 – j9.51
225	10.6 – j12.80
100	14.5 – j15.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

2

FIGURE 15 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
V_{DS} = 28 V, I_D = 0.5 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
2.0	0.996	-11	34.29	171	0.007	+80	0.730	-12
5.0	0.983	-27	33.00	159	0.016	+73	0.729	-30
10	0.943	-51	31.76	147	0.030	+60	0.728	-57
20	0.871	-86	24.38	130	0.047	+41	0.726	-94
30	0.833	-109	18.82	118	0.054	+30	0.727	-116
40	0.811	-123	14.93	110	0.058	+23	0.728	-129
50	0.796	-133	12.42	105	0.060	+18	0.729	-138
60	0.788	-140	10.45	101	0.061	+14	0.729	-143
70	0.782	-145	9.13	97	0.061	+11	0.729	-148
80	0.779	-149	8.01	94	0.062	+8.9	0.731	-151
90	0.777	-152	7.12	92	0.062	+7.1	0.733	-153
100	0.776	-155	6.48	89	0.062	+5.3	0.735	-155
110	0.775	-157	5.92	87	0.062	+3.9	0.737	-156
120	0.775	-158	5.45	85	0.062	+2.4	0.739	-158
130	0.775	-160	5.03	83	0.062	+1.5	0.741	159
140	0.775	-161	4.69	81	0.062	+0.4	0.743	-159
150	0.775	-162	4.37	80	0.061	-0.6	0.744	-160
160	0.777	-163	4.10	78	0.062	-1.3	0.746	161
170	0.777	-163	3.87	77	0.061	-2.2	0.748	161
180	0.778	-164	3.65	75	0.061	-2.8	0.750	-161
190	0.780	-165	3.46	74	0.061	-3.7	0.753	-162
200	0.781	-165	3.29	72	0.060	-4.2	0.755	-162
225	0.784	-166	2.87	69	0.060	-5.8	0.765	163
250	0.788	-166	2.57	66	0.059	-7.7	0.770	-163
275	0.790	-167	2.30	64	0.059	-9.0	0.780	163
300	0.792	-167	2.20	62	0.059	-11	0.795	163
325	0.794	-168	1.94	57	0.059	-12	0.812	-163
350	0.794	-169	1.78	56	0.058	-15	0.815	-163
375	0.799	-169	1.67	54	0.057	-16	0.826	163
400	0.805	-169	1.56	51	0.055	-17	0.836	-163
425	0.815	-169	1.45	50	0.054	-17	0.862	-163
450	0.825	-169	1.39	47	0.053	-17	0.860	162
475	0.834	-170	1.32	45	0.052	-17	0.871	162
500	0.837	-170	1.23	42	0.051	-16	0.871	-162
525	0.838	-171	1.16	41	0.050	-14	0.872	-162
550	0.843	-171	1.11	39	0.048	-13	0.883	-162
575	0.845	-172	1.07	37	0.048	-12	0.894	-162
600	0.855	-172	1.03	35	0.046	-10	0.901	-163
625	0.856	-173	0.977	33	0.045	-9.0	0.905	-163
650	0.875	-173	0.947	32	0.044	-7.0	0.921	-163
675	0.885	-173	0.914	30	0.044	-5.0	0.938	-163
700	0.888	-174	0.873	27	0.043	-4.0	0.949	-164
725	0.892	-174	0.841	27	0.042	-1.0	0.947	-164
750	0.900	-174	0.821	26	0.043	+2.0	0.970	-164
775	0.910	-175	0.814	24	0.044	+4.0	0.978	-164
800	0.918	-176	0.775	22	0.045	+8.0	0.978	-164

FIGURE 16 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

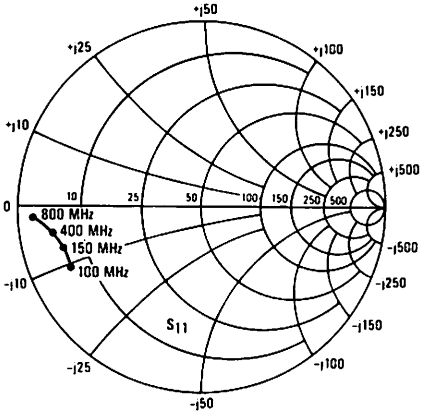


FIGURE 17 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

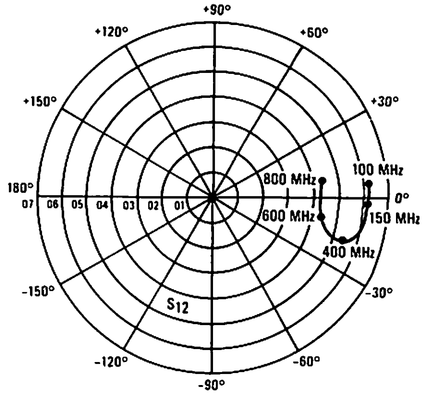


FIGURE 18 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

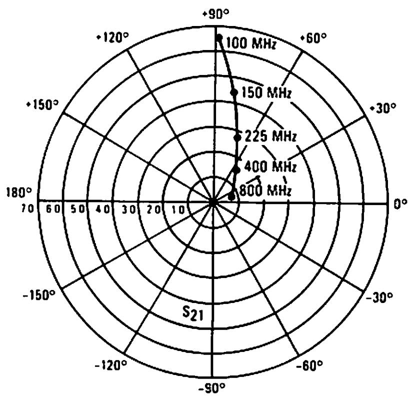
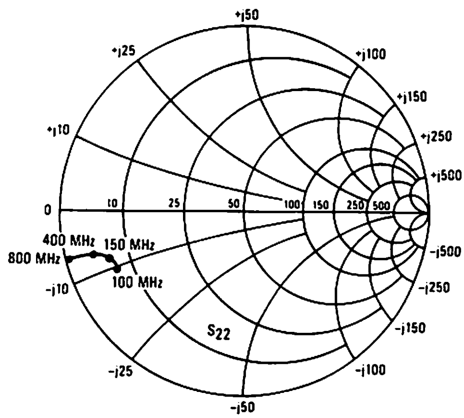


FIGURE 19 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A



DESIGN CONSIDERATIONS

The MRF162 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF162 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF162 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

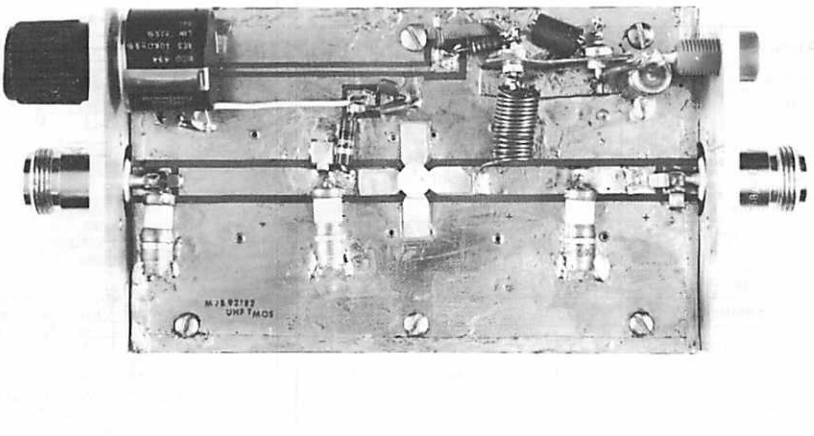
Power output of the MRF162 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF162. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF162, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF162 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 20 — 400 MHz TEST CIRCUIT



MRF163

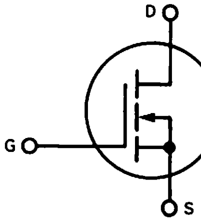
2

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

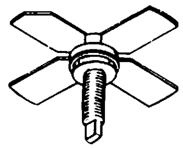
. . . designed for wideband large-signal output and driver applications in the 2.0 to 400 MHz range.

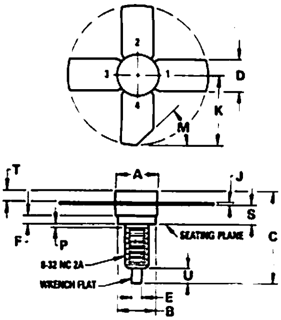
- Guaranteed 28 Volt, 400 MHz Performance
  Output Power = 25 Watts
  Minimum Gain = 10 dB
  Efficiency = 50% (Typical)
- Small-Signal and Large-Signal Characterization
- 100% Tested for Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 2.5 dB (Typ) at 500 mA, 400 MHz
- Excellent Thermal Stability, Ideally Suited For Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques



25 W 2.0-400 MHz

N-CHANNEL MOS BROADBAND RF POWER FET





STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	5.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	87.5 0.500	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

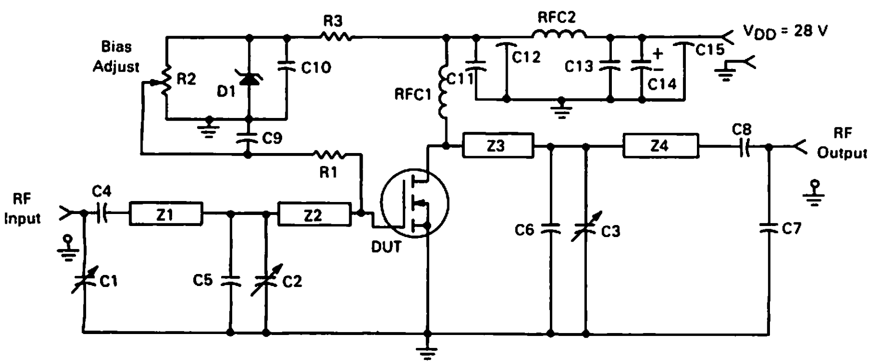
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	4.0	mAdc
Gate-Source Leakage Current (V_{GS} = 40 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 500 mA)	g_{fs}	500	750	—	mmhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	48	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	54	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	11	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DS} = 28 Vdc, I_D = 500 mA, f = 400 MHz, Z_S = 3.23 + j2.57 Ω, Z_L = 2.11 + j2.97 Ω)	NF	—	2.5	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA)	G_{ps}	10	12	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 25 W, f = 400 MHz, I_{DQ} = 25 mA, VSWR 30:1 at All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C3 — 1-20 pF Johanson or Equivalent
C4, C8 — 270 pF, 100 Mil Chip Cap
C5, C6 — 18 pF Mini-Unleco or Equivalent
C7 — 12 pF Mini-Unleco or Equivalent
C9 — 0.01 μF, 50 V Disc Ceramic
C10, C11, C13 — 0.1 μF, 50 V Disc Ceramic
C12, C15 — 680 pF Feedthru
C14 — 20 μF, 50 V
D1 — 1N5925A Motorola Zener
R1 — 10 kΩ, 1/4 W
R2 — 10 Turns 10 kΩ
R3 — 1.6 kΩ, 1/4 W
RFC1 — 10 Turns, 0.300" ID #20 AWG Enamel Closewound
RFC2 — Ferroxcube VK-200 — 19/4B
Z1 — 1.350" × 0.250" Microstrip
Z2 — 0.600" × 0.250" Microstrip
Z3 — 0.710" × 0.250" Microstrip
Z4 — 1.300" × 0.250" Microstrip
Board — Glass Teflon, 62 Mils, ϵ_r = 2.56

FIGURE 2 — OUTPUT POWER versus INPUT POWER

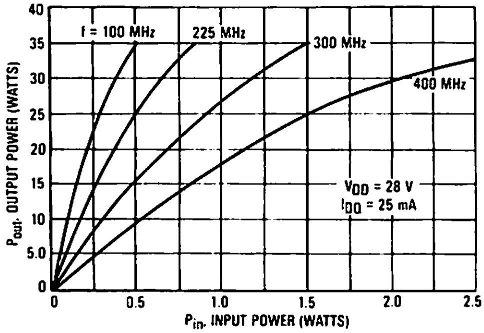


FIGURE 3 — OUTPUT POWER versus INPUT POWER

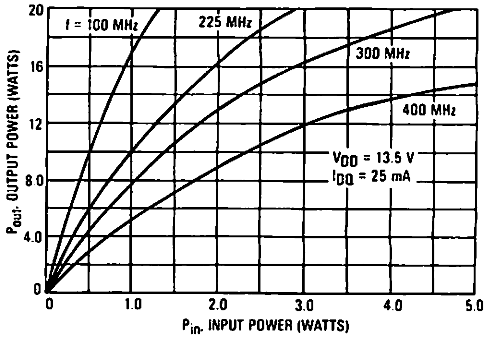


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

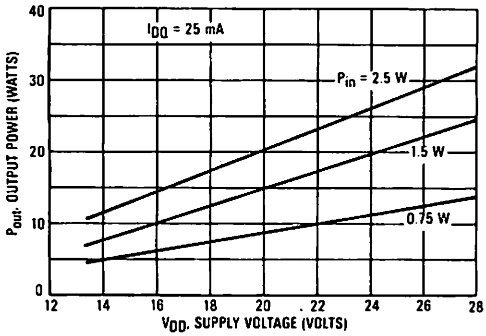


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 300 MHz

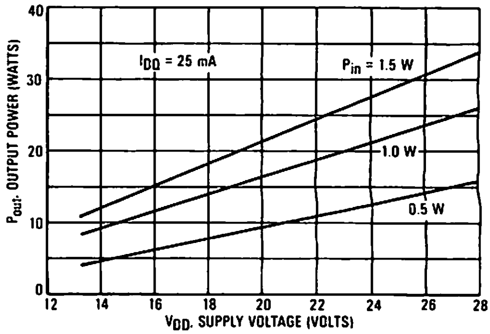


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

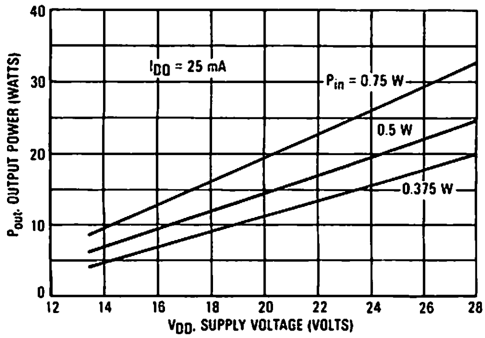


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

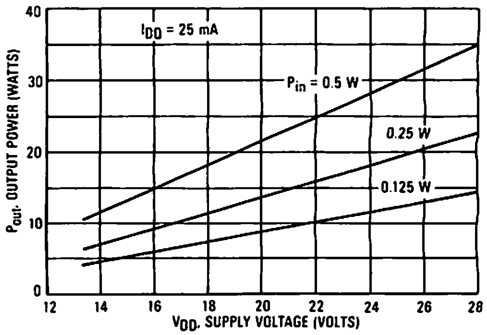


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FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

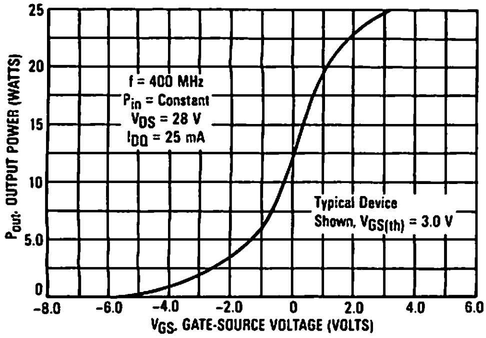


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

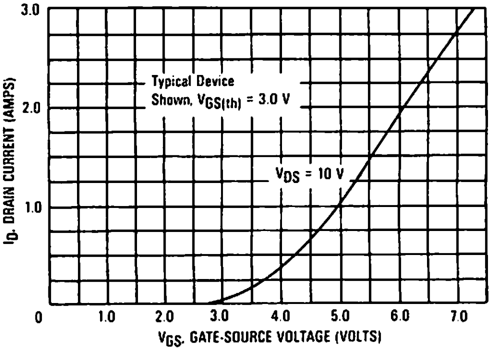


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

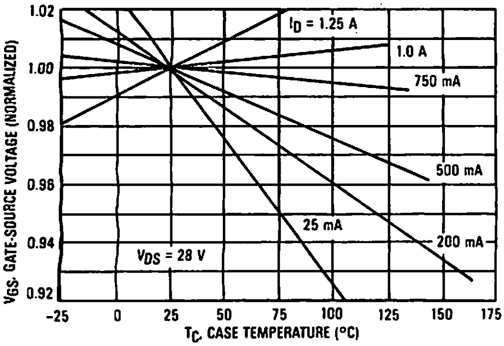
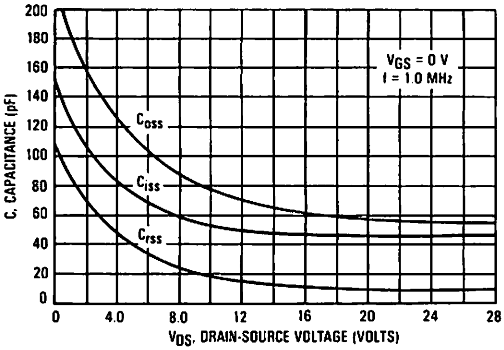


FIGURE 11 — CAPACITANCE versus DRAIN-SOURCE VOLTAGE



2

FIGURE 12 — DC SAFE OPERATING AREA

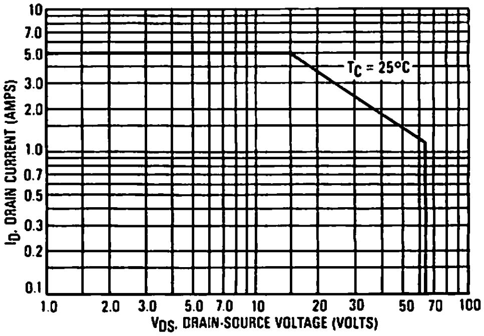
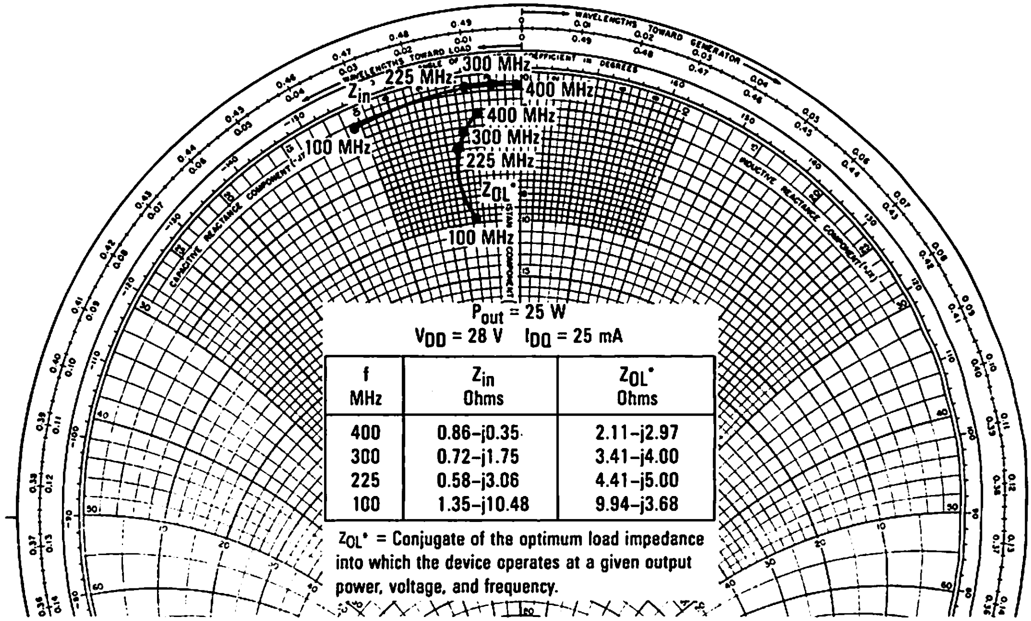


FIGURE 13 — INPUT AND OUTPUT IMPEDANCE



P_{out} = 25 W
V_{DD} = 28 V I_{DQ} = 25 mA

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	0.86–j0.35	2.11–j2.97
300	0.72–j1.75	3.41–j4.00
225	0.58–j3.06	4.41–j5.00
100	1.35–j10.48	9.94–j3.68

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

2

FIGURE 14 — COMMON SOURCE SCATTERING PARAMETERS
50 OHM SYSTEM
V_{DS} = 28 V, I_D = 0.5 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
2.0	0.985	-30	56.97	166	0.010	+63.9	0.611	-36
10	0.875	-105	34.12	125	0.032	+30.6	0.736	-116
25	0.841	-145	16.17	104	0.038	+9.2	0.798	-152
50	0.833	-162	8.201	92.7	0.038	+1.6	0.800	-165
75	0.836	-167	5.496	86.8	0.037	-2.5	0.802	-168
100	0.838	-170	4.121	82.3	0.039	-3.0	0.804	-170
125	0.838	-171	3.255	78.6	0.039	-5.8	0.809	-170
150	0.840	-172	2.718	74.3	0.037	-8.5	0.815	-171
175	0.844	-173	2.326	70.8	0.037	-9.6	0.819	-171
200	0.849	-173	2.027	67.2	0.036	-10.4	0.824	-171
225	0.851	-173	1.782	64.0	0.036	-10.3	0.833	-171
250	0.857	-173	1.593	60.9	0.034	-11.7	0.839	-171
275	0.862	-173	1.438	58.9	0.035	-11.1	0.844	-171
300	0.866	-173	1.319	55.6	0.033	-12.1	0.846	-170
325	0.872	-173	1.209	52.3	0.032	-12.7	0.861	-170
350	0.875	-173	1.110	49.0	0.031	-13.4	0.873	-170
375	0.879	-173	1.030	46.7	0.031	-12.2	0.876	-170
400	0.882	-173	0.966	44.1	0.030	-14.6	0.883	-170
425	0.888	-173	0.904	41.3	0.029	-13.4	0.888	-170
450	0.891	-173	0.836	39.4	0.028	-11.7	0.895	-170
475	0.893	-173	0.792	37.1	0.027	-8.8	0.902	-170
500	0.901	-173	0.748	35.2	0.027	-6.1	0.911	-170
525	0.906	-173	0.715	32.4	0.025	-6.0	0.921	-170
550	0.911	-173	0.679	30.2	0.024	-6.0	0.928	-170
575	0.912	-173	0.637	28.7	0.024	-3.9	0.934	-170
600	0.913	-173	0.605	26.9	0.024	-1.0	0.939	-170
625	0.919	-174	0.579	25.3	0.024	+1.0	0.947	-170
650	0.921	-174	0.566	23.0	0.025	+10.1	0.961	-170
675	0.927	-174	0.540	22.6	0.025	+12.1	0.963	-170
700	0.927	-174	0.510	19.9	0.025	+16.5	0.966	-170
725	0.927	-173	0.485	19.5	0.025	+23.1	0.967	-170
750	0.933	-174	0.481	17.4	0.026	+25.3	0.967	-170
775	0.937	-174	0.453	17.2	0.028	+28.0	0.976	-170
800	0.942	-174	0.448	16.8	0.030	+33.8	0.976	-170

FIGURE 15 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

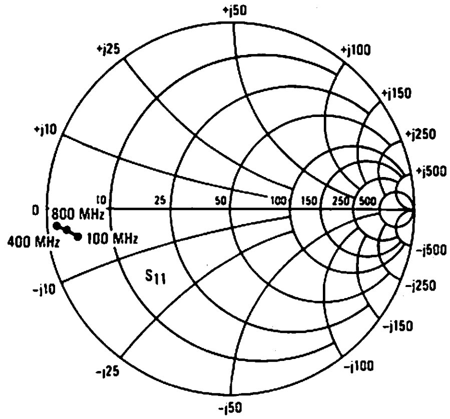


FIGURE 16 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

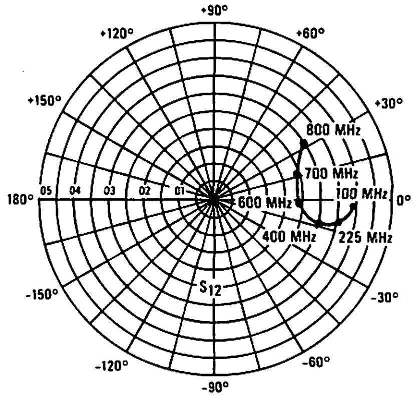


FIGURE 17 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A

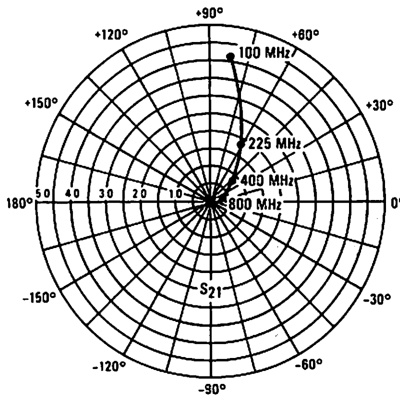
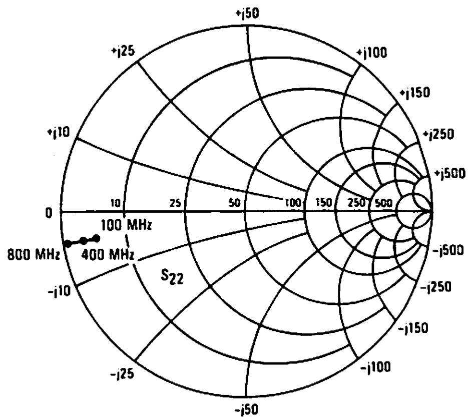


FIGURE 18 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V, I_D = 0.5 A



DESIGN CONSIDERATIONS

The MRF163 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF163 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF163 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

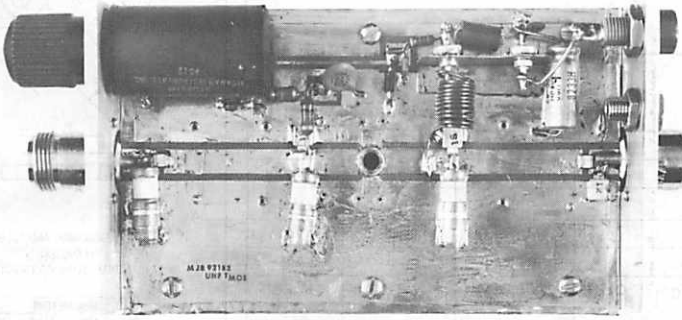
Power output of the MRF163 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF163. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF163, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF163 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

FIGURE 19 — 400 MHz TEST CIRCUIT



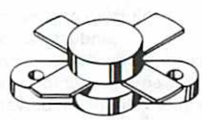
MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MRF171

The RF MOSFET Line

45 W 2.0–200 MHz

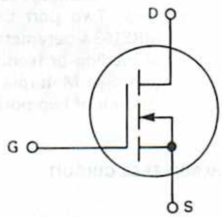
N-CHANNEL MOS BROADBAND RF POWER FET

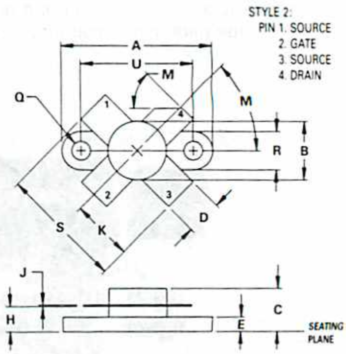


N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

. . . designed primarily for wideband large-signal output and driver stages in the 2.0–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 45 Watts
  Minimum Gain = 12 dB
  Efficiency = 50% (Min)
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Low Noise Figure — 1.5 dB Typ at 1.0 A, 150 MHz





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage	V_{DGR}*	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	4.5	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.52	°C/W

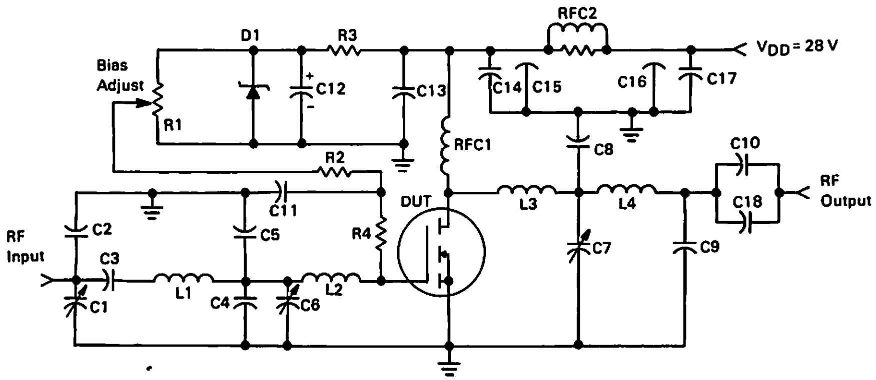
*$R_{GS} = 1.0\ M\Omega$

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 10 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 25 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 1.0 A)	g_{fs}	0.7	1.1	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	55	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	70	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	14	—	pF
FUNCTIONAL CHARACTERISTICS					
Noise Figure (V_{DS} = 28 Vdc, I_D = 1.0 A, f = 150 MHz)	NF	—	1.5	—	dB
Common Source Power Gain (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA)	G_{ps}	12	15	—	dB
Drain Efficiency (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA)	η	50	60	—	%
Electrical Ruggedness (Figure 1) (V_{DD} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, I_{DQ} = 25 mA, VSWR 30:1 *at all Phase Angles*)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1, C6, C7 — 1.0–20 pF Johanson
C2, C4, C5, C8 — 63 pF ATC Chip (100 mils)
C3, C10, C18 — 680 pF ATC Chip (100 mils)
C9 — 12 pF ATC Chip (100 mils)
C11, C13, C14, C17 — 0.1 μF Erie Redcap, 50 V
C12 — 25 μF, 50 V
C15, C16 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener
L1 — 2 Turns, #18 AWG, 0.3" ID, 0.3" Long
L2 — 1-1/4 Turns, #18 AWG, 0.21" ID
L3 — 1-1/4 Turns, #18 AWG, 0.21" ID
L4 — 2 Turns, #18 AWG, 0.23" ID, 0.15" Long
RFC1 — 20 Turns, #20 AWG Enameled, 0.3" ID, Close Wound
RFC2 — 15 Turns, #20 AWG Enameled on 2.0 W, 10 Ω Resistor
R1 — 10 kΩ, 10 Turns Helipot 7216-R10K-L.25
R2 — 10 kΩ, 1/4 W
R3 — 1.8 kΩ, 1/2 W
R4 — 47 Ω, 1/2 W

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

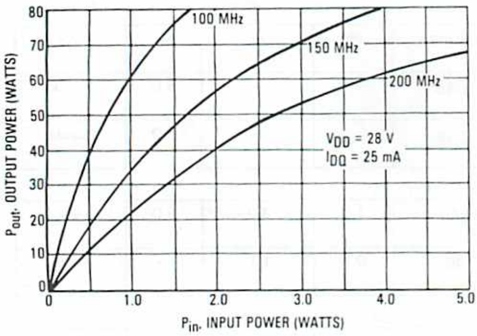


FIGURE 3 — OUTPUT POWER versus INPUT POWER

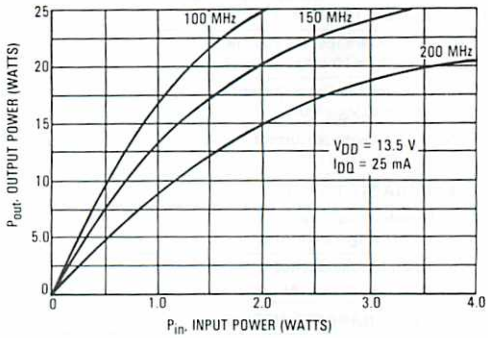


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

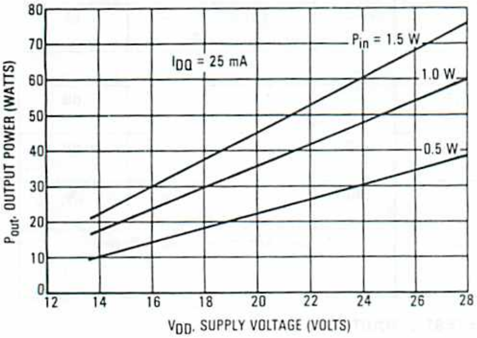


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

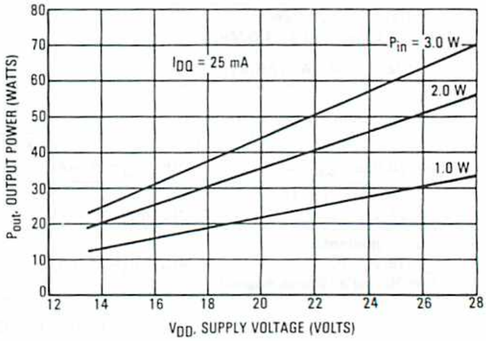


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz

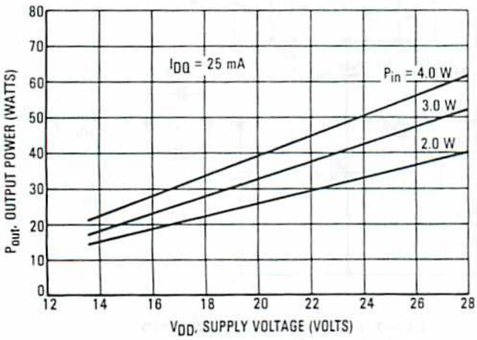


FIGURE 7 — POWER GAIN versus FREQUENCY

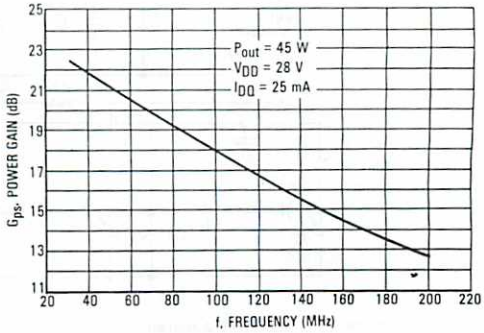


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

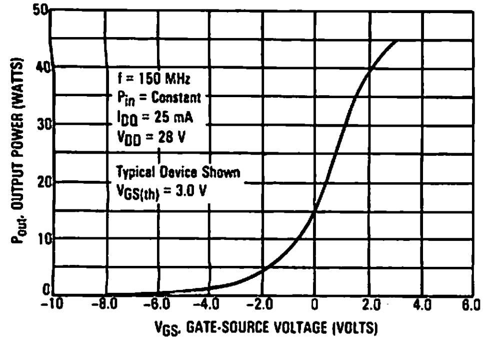


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

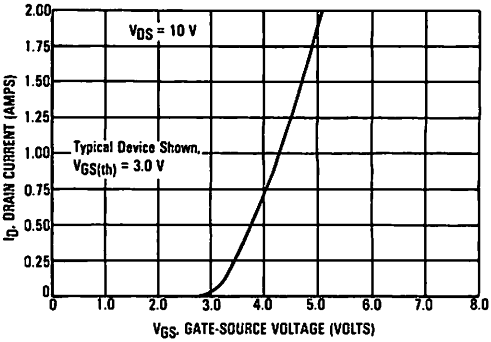


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

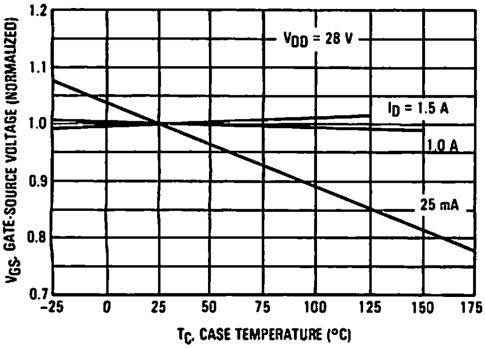


FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

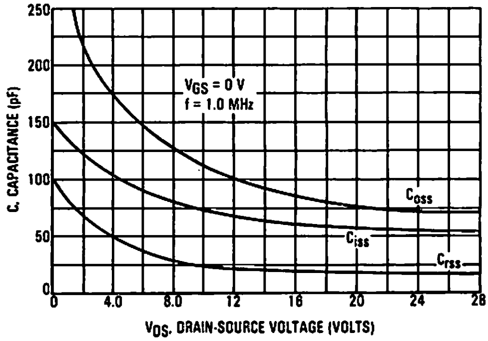


FIGURE 12 — DC SAFE OPERATING AREA

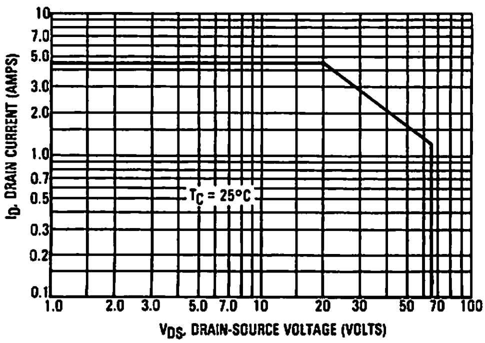


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FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
V_{DS} = 28 V, I_D = 0.5 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.0	0.966	-50	72.4	153	0.014	63	0.674	-59
5.0	0.891	-97	50.8	128	0.025	39	0.757	-109
10	0.841	-132	30.1	110	0.030	23	0.801	-141
20	0.821	-155	15.9	99	0.032	14	0.818	-160
30	0.817	-162	10.7	93	0.032	11	0.822	-166
40	0.816	-167	8.06	90	0.032	10	0.823	-169
50	0.816	-169	6.45	88	0.032	11	0.825	-171
60	0.816	-171	5.37	85	0.032	11	0.826	-172
70	0.816	-172	4.60	84	0.032	12	0.828	-173
80	0.816	-172	4.01	82	0.032	13	0.829	-174
90	0.816	-173	3.56	80	0.033	14	0.830	-174
100	0.816	-173	3.15	77	0.034	15	0.832	-174
110	0.816	-173	2.85	76	0.035	16	0.832	-175
120	0.816	-173	2.59	75	0.036	18	0.832	-175
130	0.817	-174	2.40	74	0.036	19	0.832	-175
140	0.817	-174	2.23	72	0.037	20	0.834	-175
150	0.820	-174	2.09	71	0.037	21	0.835	-175
160	0.823	-174	1.97	70	0.037	22	0.836	-175
170	0.825	-175	1.85	69	0.037	23	0.839	-175
180	0.826	-175	1.75	68	0.037	25	0.840	-175
190	0.829	-175	1.66	67	0.037	26	0.843	-175
200	0.832	-175	1.59	66	0.038	27	0.845	-175
250	0.844	-176	1.24	61	0.039	37	0.856	-175
300	0.855	-176	1.02	55	0.042	45	0.867	-174
350	0.862	-177	0.88	51	0.047	53	0.878	-174
400	0.868	-178	0.76	48	0.052	59	0.885	-174
450	0.873	-179	0.67	45	0.059	64	0.897	-174
500	0.907	+179	0.63	42	0.067	67	0.892	-175

FIGURE 14 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.5 A

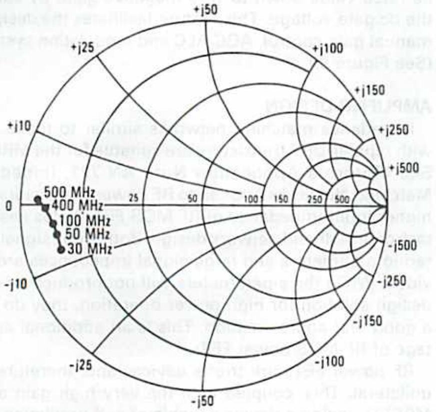


FIGURE 15 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.5 A

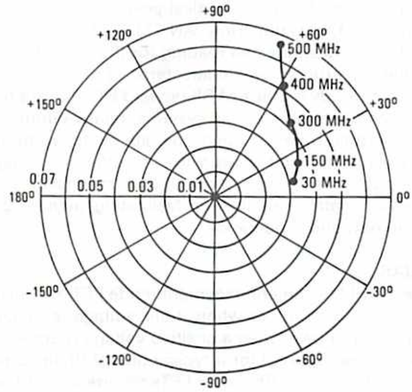


FIGURE 16 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.5 A

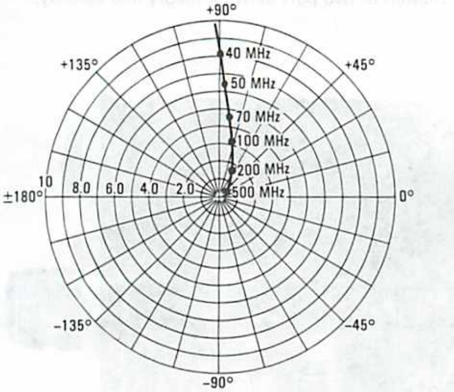
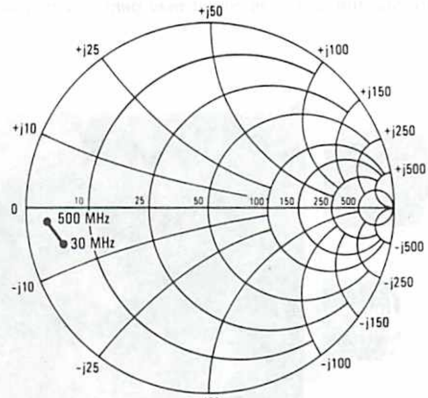


FIGURE 17 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 0.5 A



2

DESIGN CONSIDERATIONS

The MRF171 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF171 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF171 was characterized at I_{DQ} = 25 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF171 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF171. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FETs helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

RF power FETs are triode devices and, therefore, not unilateral. This, coupled with the very high gain of the MRF171, yields a device capable of self oscillation. Stability may be achieved by techniques such as drain loading, input shunt resistive loading, or output to input feedback. Two port parameter stability analysis with the MRF171 s-parameters provides a useful tool for selection of loading or feedback circuitry to assure stable operation. See Motorola Application Note AN-215A for a discussion of two port network theory and stability.

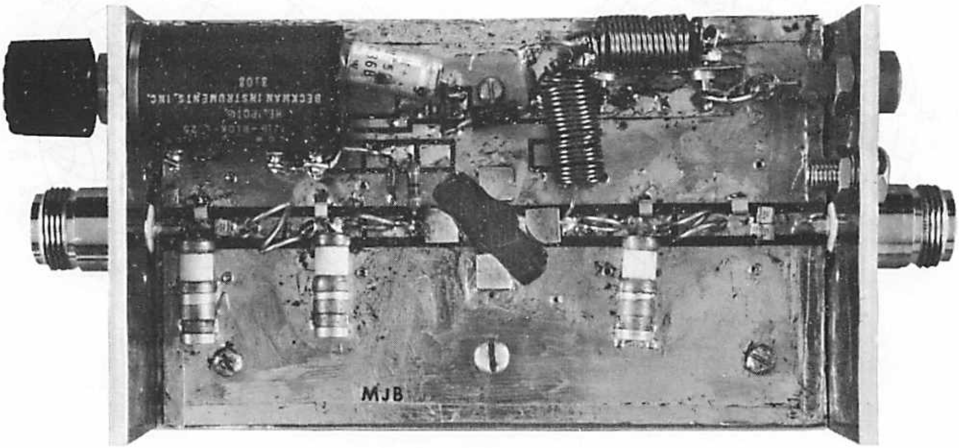
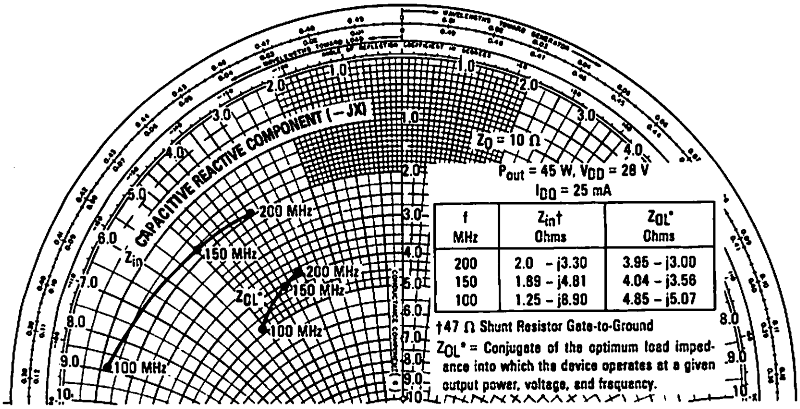


FIGURE 18 — 150 MHz TEST CIRCUIT

2

FIGURE 19 — LARGE-SIGNAL SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



P_{out} = 45 W, V_{DD} = 28 V
I_{DQ} = 25 mA

f MHz	Z_{in}† Ohms	Z_{OL}* Ohms
200	2.0 − j3.30	3.95 − j3.00
150	1.89 − j4.81	4.04 − j3.56
100	1.25 − j8.90	4.85 − j5.07

†47 Ω Shunt Resistor Gate-to-Ground

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MRF172

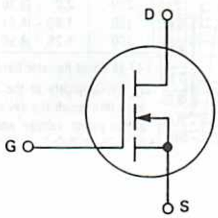
2

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

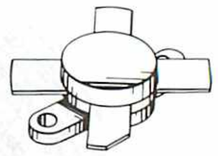
. . . designed primarily for wideband large-signal output and driver stages in the 2.0–200 MHz frequency range.

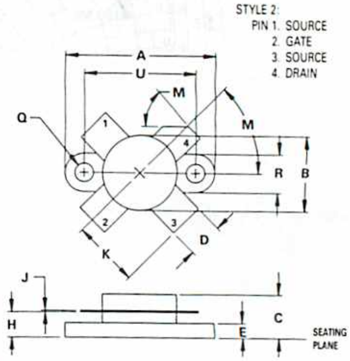
- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 80 Watts
  Minimum Gain = 10 dB
  Efficiency = 50% (Min)
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure— 1.5 dB Typ at 2.0 A, 150 MHz



80 W 2.0–200 MHz

N-CHANNEL MOS BROADBAND RF POWER FET





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	9.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	220 1.26	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

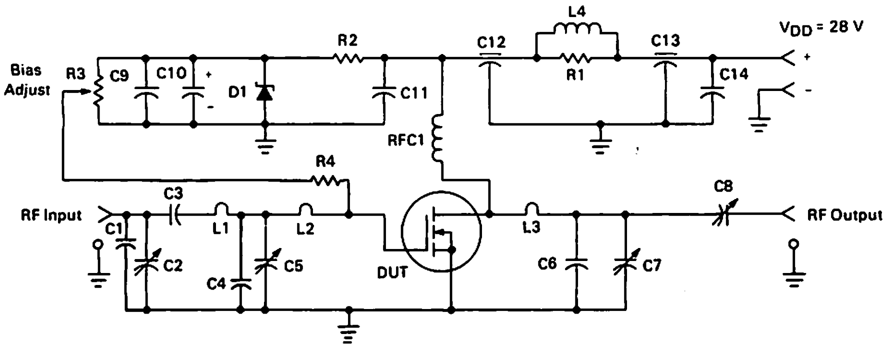
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.80	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 50 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.0 A)	g_{fs}	1.2	1.8	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	100	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	135	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	26	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DD} = 28 Vdc, I_D = 2.0 A, f = 150 MHz)	NF	—	1.5	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	G_{ps}	10	12.3	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA)	η	50	60	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 80 W, f = 150 MHz, I_{DQ} = 50 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1 — 25 pF Unleco
C2, C5, C7 — Arco 462, 5-80 pF
C3 — 100 pF Unleco
C4 — 40 pF Unleco
C6 — 60 pF Unleco
C8 — Arco 463, 9-180 pF
C9, C11, C14 — 0.1 μF Erie Redcap
C10 — 50 μF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — #16 AWG, 1-1/4 Turns, 0.213" ID
L2 — #16 AWG, Hairpin 0.25" 0.062"
L3 — #14 AWG, Hairpin 0.47" 0.2"
L4 — 10 Turns #16 AWG Enameled Wire on R1
RFC1 — 18 Turns #16 AWG Enameled Wire, 0.3" ID
R1 — 10 Ω, 2.0 W
R2 — 1.8 kΩ, 1/2 W
R3 — 10 kΩ, 10 Turn Bourns
R4 — 10 kΩ, 1/4 W

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

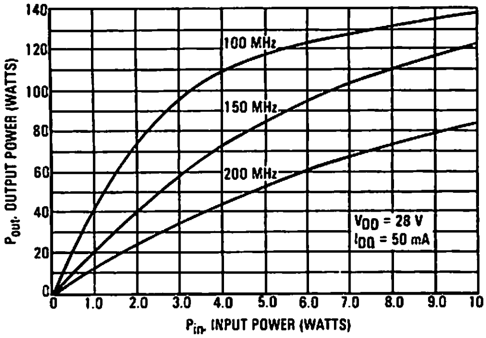


FIGURE 3 — OUTPUT POWER versus INPUT POWER

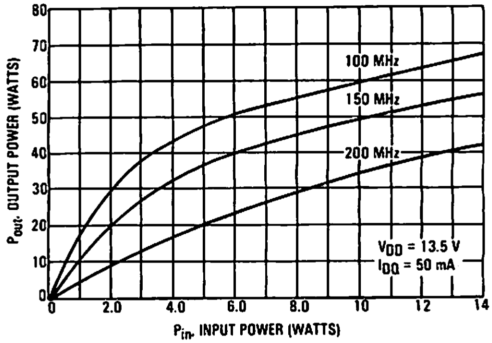


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

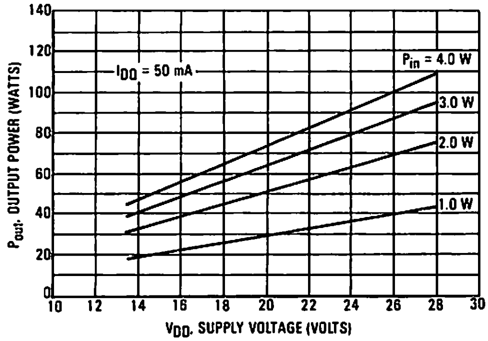


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

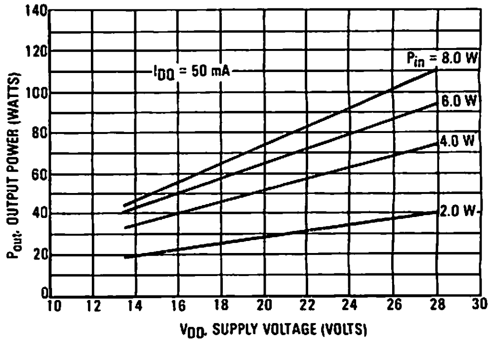


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz

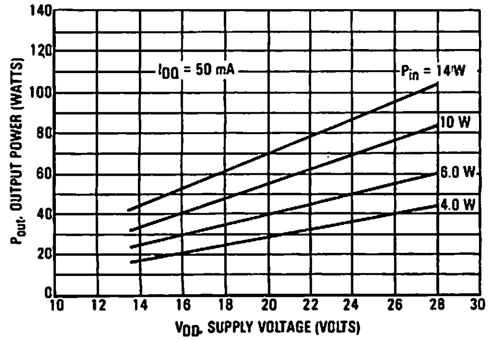


FIGURE 7 — POWER GAIN versus FREQUENCY

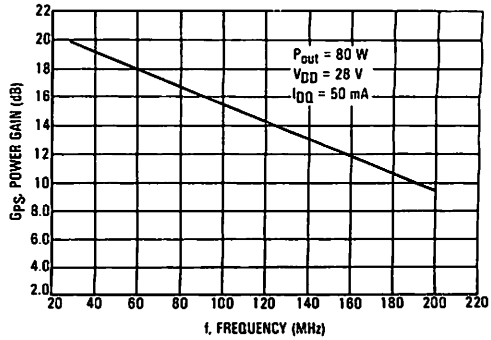


FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

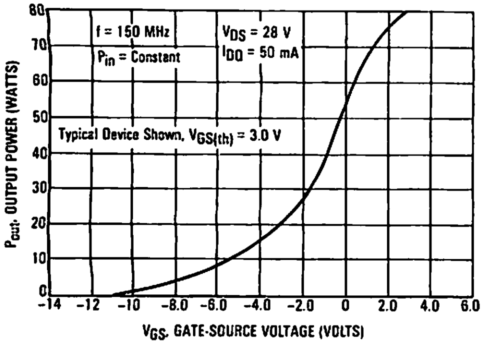


FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

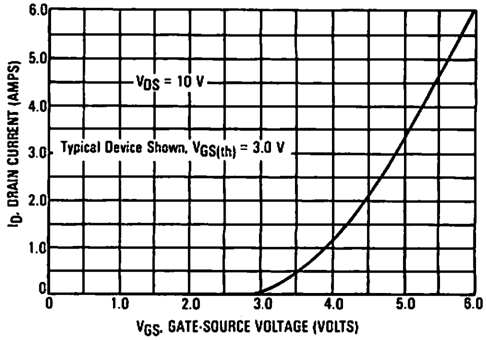


FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

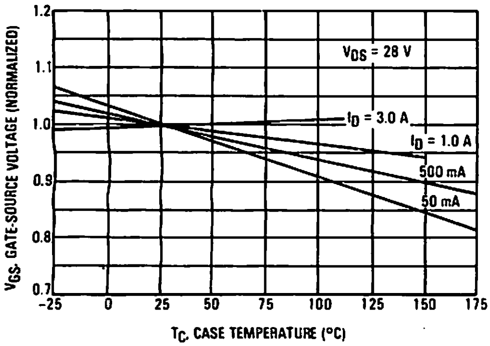


FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

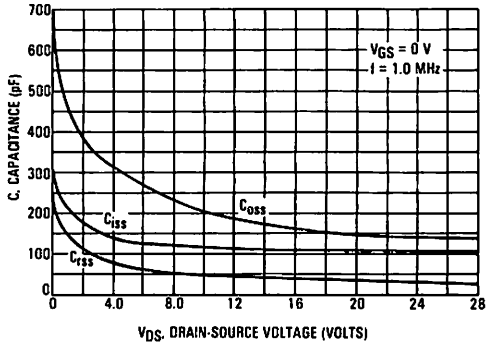


FIGURE 12 — DC SAFE OPERATING AREA

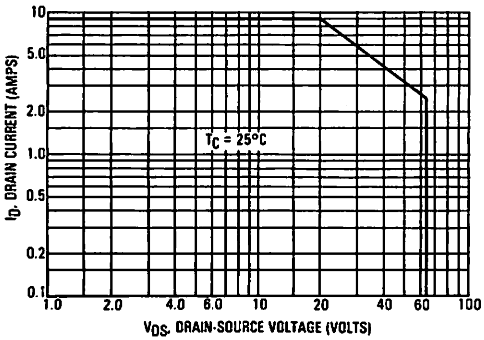


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FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
V_{DS} = 28 V, I_D = 2.0 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
2.0	0.928	-112	87.5	122	0.013	34	0.776	-128
5.0	0.902	-149	40.5	104	0.015	17	0.857	-158
10	0.897	-164	20.7	96	0.016	12	0.872	-169
20	0.896	-172	10.4	90	0.016	13	0.876	-174
30	0.896	-175	6.94	88	0.016	17	0.877	-176
40	0.896	-176	5.20	85	0.017	21	0.878	-177
50	0.897	-177	4.15	83	0.017	25	0.879	-177
60	0.897	-177	3.45	82	0.017	29	0.880	-177
70	0.898	-178	2.95	80	0.018	33	0.881	-177
80	0.899	-178	2.57	78	0.019	37	0.882	-177
90	0.901	-178	2.27	76	0.020	40	0.883	-177
100	0.903	-178	2.00	74	0.021	42	0.885	-177
110	0.905	-178	1.80	73	0.022	44	0.887	-177
120	0.907	-178	1.62	71	0.024	45	0.888	-177
130	0.908	-178	1.51	70	0.026	47	0.895	-177
140	0.909	-178	1.39	70	0.027	49	0.895	-177
150	0.910	-178	1.30	69	0.028	51	0.895	-177
160	0.911	-178	1.22	68	0.029	51	0.897	-177
170	0.912	-179	1.14	66	0.030	52	0.899	-177
180	0.921	-179	1.08	65	0.032	54	0.900	-177
190	0.921	-179	1.01	64	0.033	55	0.903	-177
200	0.922	-179	0.974	63	0.035	56	0.905	-177
210	0.920	-179	0.928	61	0.036	58	0.907	-176
220	0.915	-179	0.872	60	0.038	59	0.907	-176
230	0.915	-179	0.828	60	0.040	60	0.914	-176
240	0.917	-179	0.793	59	0.042	61	0.917	-176
250	0.922	-179	0.772	59	0.044	62	0.918	-176
260	0.927	+179	0.744	57	0.046	62	0.920	-176
270	0.928	+179	0.714	57	0.048	63	0.920	-176
280	0.929	+179	0.689	56	0.049	64	0.923	-176
290	0.929	+179	0.662	55	0.051	65	0.923	-176
300	0.938	+179	0.642	55	0.053	65	0.923	-176

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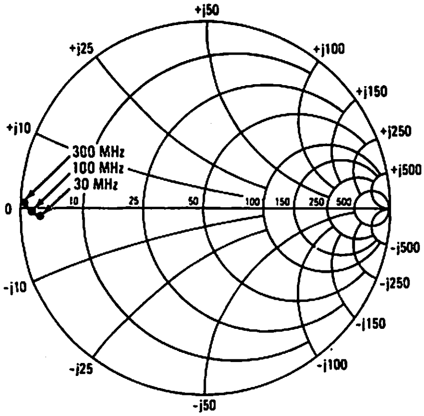
FIGURE 14 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 2.0 A



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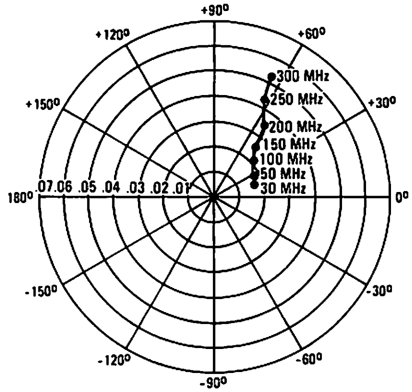

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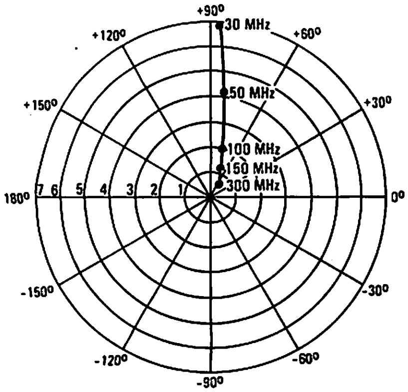

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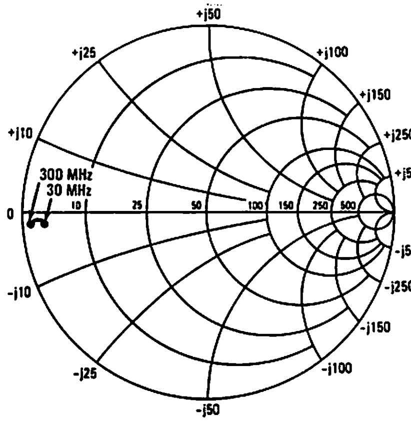
V_{DS} = 28 V I_D = 2.0 A



2

DESIGN CONSIDERATIONS

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The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF172 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF161 was characterized at I_{DQ} = 50 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF172 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF172. See Motorola Application Note AN-721, Impedance Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FET's helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

FIGURE 18 — 150 MHz TEST CIRCUIT

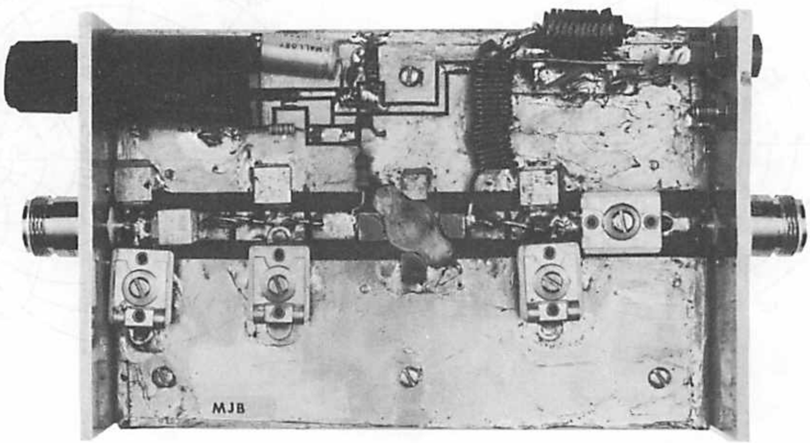
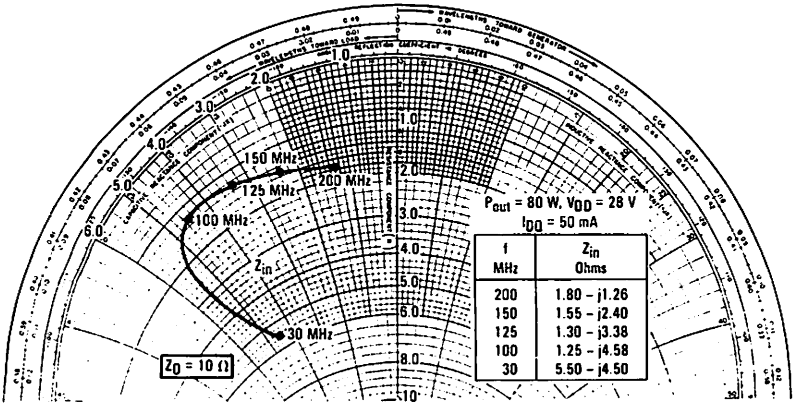
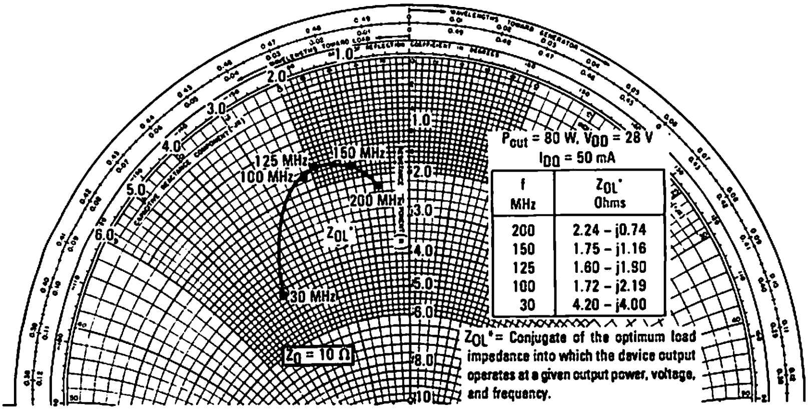


FIGURE 19 — SERIES EQUIVALENT INPUT IMPEDANCE, Z_{in}



f MHz	Z_{in} Ohms
200	1.80 - j1.26
150	1.55 - j2.40
125	1.30 - j3.38
100	1.25 - j4.58
30	5.50 - j4.50

FIGURE 20 — SERIES EQUIVALENT OUTPUT IMPEDANCE, Z_{OL}^*



f MHz	Z_{OL}^* Ohms
200	2.24 - j0.74
150	1.75 - j1.16
125	1.60 - j1.90
100	1.72 - j2.19
30	4.20 - j4.00

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

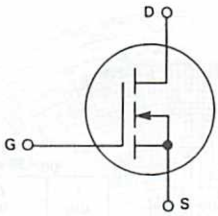
MRF174

The RF MOSFET Line

N-CHANNEL ENHANCEMENT-MODE RF POWER FIELD-EFFECT TRANSISTOR

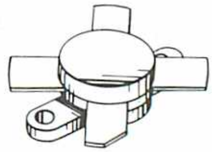
. . . designed primarily for wideband large-signal output and driver stages in the 2.0–200 MHz frequency range.

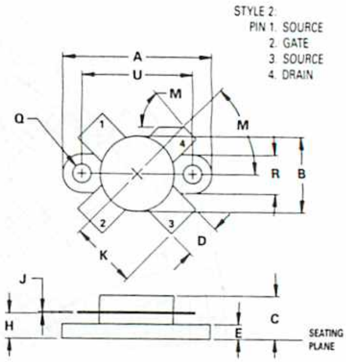
- Guaranteed Performance at 150 MHz, 28 Vdc
  - Output Power = 125 Watts
  - Minimum Gain = 9.0 dB
  - Efficiency = 50% (Min)
- Excellent Thermal Stability, Ideally Suited for Class A Operation
- Facilitates Manual Gain Control, ALC and Modulation Techniques
- 100% Tested For Load Mismatch At All Phase Angles With 30:1 VSWR
- Low Noise Figure — 3.0 dB Typ at 2.0 A, 150 MHz



125 W 2.0–200 MHz

N-CHANNEL MOS BROADBAND RF POWER FET





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain — Source Voltage	V_{DSS}	65	Vdc
Drain — Gate Voltage (R_{GS} = 1.0 MΩ)	V_{DGR}	65	Vdc
Gate — Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	13	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

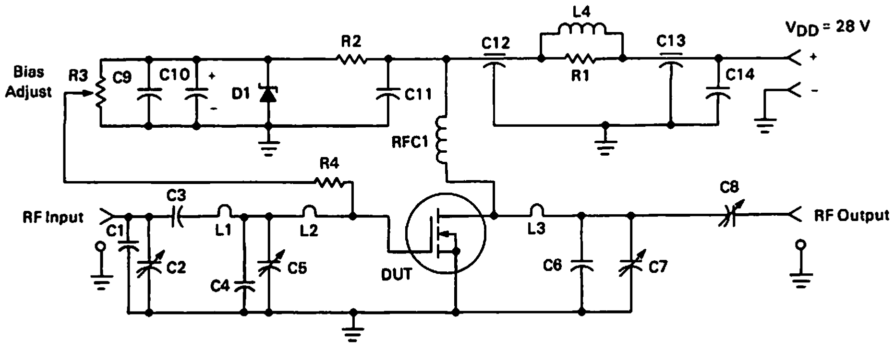
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	10	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	6.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 3.0 A)	g_{fs}	1.75	2.5	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	175	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	230	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	40	—	pF
FUNCTIONAL CHARACTERISTICS (Figure 1)					
Noise Figure (V_{DD} = 28 Vdc, I_D = 2.0 A, f = 150 MHz)	NF	—	3.0	—	dB
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA)	G_{ps}	9.0	11.8	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA)	η	50	60	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 125 W, f = 150 MHz, I_{DQ} = 100 mA, VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 150 MHz TEST CIRCUIT



C1 — 35 pF Unleco
C2, C5 — Arco 462, 5-80 pF
C3 — 100 pF Unleco
C4 — 25 pF Unleco
C6 — 40 pF Unleco
C7 — Arco 461, 2.7-30 pF
C8 — Arco 463, 9-180 pF
C9, C11, C14 — 0.1 μF Erie Redcap
C10 — 50 μF, 50 V
C12, C13 — 680 pF Feedthru
D1 — 1N5925A Motorola Zener

L1 — #16 AWG, 1-1/4 Turns, 0.213" ID
L2 — #16 AWG, Hairpin 0.25" 0.062"
L3 — #14 AWG, Hairpin 0.47" 0.2"
L4 — 10 Turns #16 AWG Enameled Wire on R1
RFC1 — 18 Turns #16 AWG Enameled Wire, 0.3" ID
R1 — 10 Ω, 2.0 W
R2 — 1.8 kΩ, 1/2 W
R3 — 10 kΩ, 10 Turn Bourns
R4 — 10 kΩ, 1/4 W

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FIGURE 2 — OUTPUT POWER versus INPUT POWER

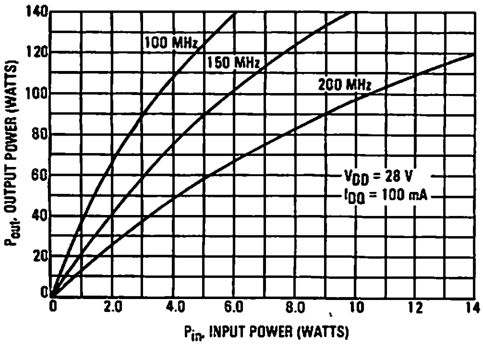

FIGURE 3 — OUTPUT POWER versus INPUT POWER

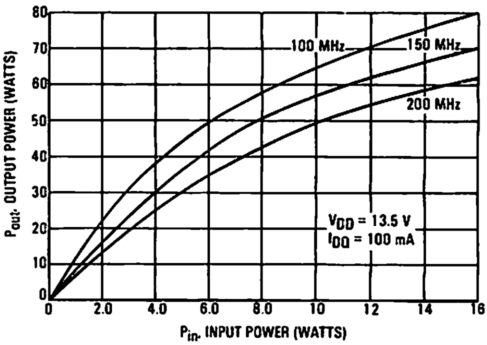

FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

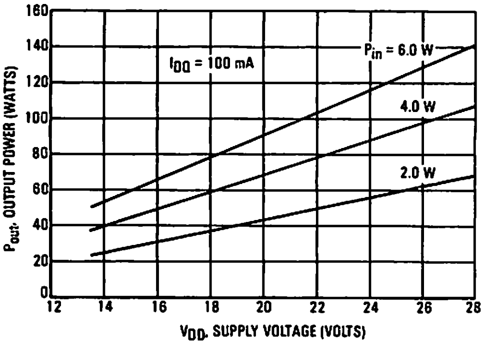

FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

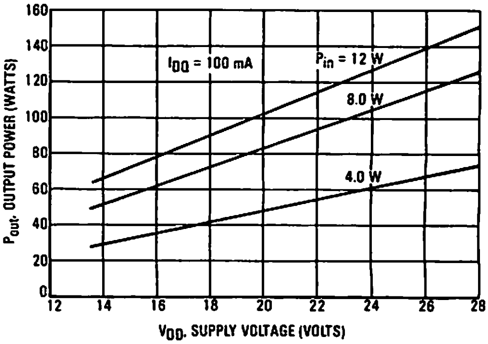

FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz

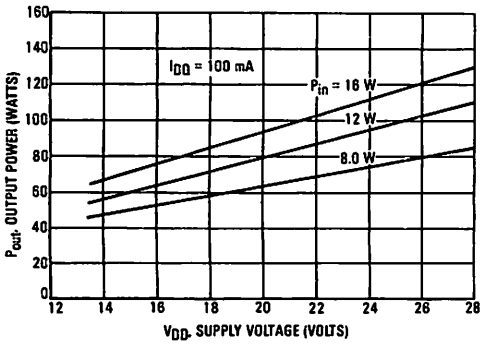

FIGURE 7 — POWER GAIN versus FREQUENCY

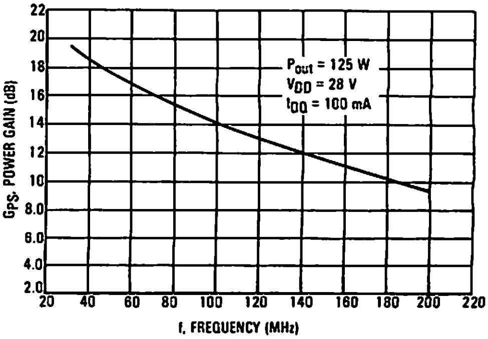

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FIGURE 8 — OUTPUT POWER versus GATE VOLTAGE

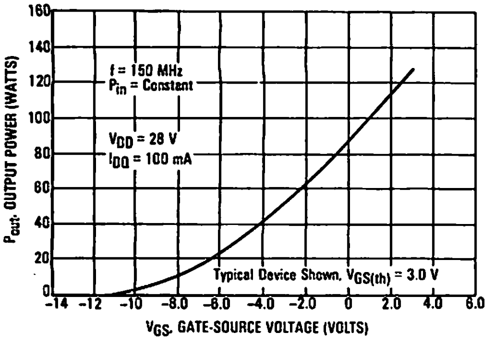

FIGURE 9 — DRAIN CURRENT versus GATE VOLTAGE (TRANSFER CHARACTERISTICS)

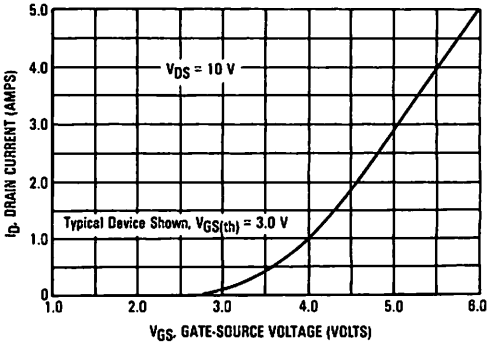

FIGURE 10 — GATE-SOURCE VOLTAGE versus CASE TEMPERATURE

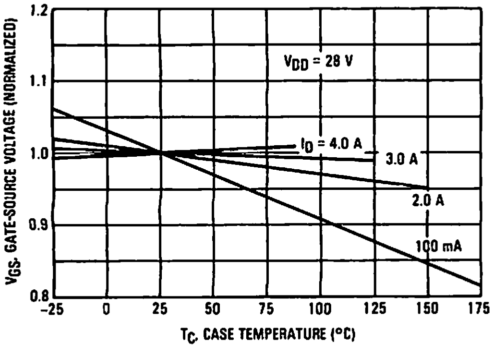

FIGURE 11 — CAPACITANCE versus DRAIN VOLTAGE

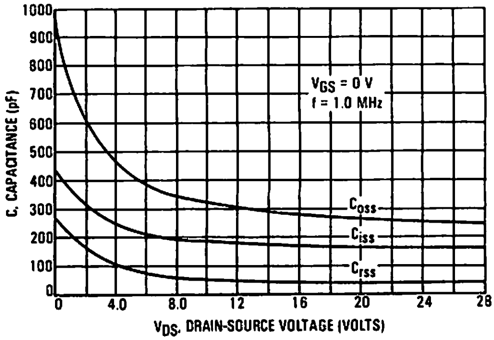

FIGURE 12 — DC SAFE OPERATING AREA

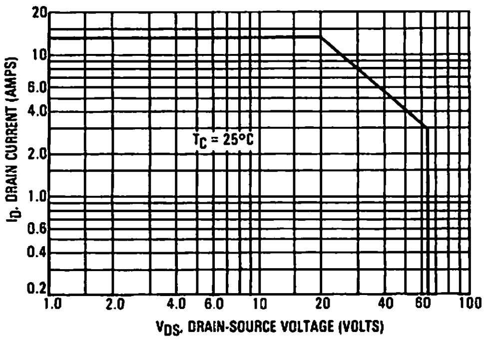

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FIGURE 13 — COMMON SOURCE SCATTERING PARAMETERS
V_{DS} = 28 V, I_D = 3.0 A

f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
	$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
2.0	0.932	-133	74.0	112	0.011	23	0.835	-151
5.0	0.923	-160	31.6	98	0.011	12	0.886	-168
10	0.921	-170	16.0	93	0.011	10	0.896	-174
20	0.921	-175	8.00	88	0.011	12	0.899	-177
30	0.921	-177	5.32	86	0.011	16	0.900	-178
40	0.921	-177	3.98	83	0.012	21	0.901	-178
50	0.922	-178	3.17	81	0.012	26	0.902	-178
60	0.923	-178	2.63	79	0.012	30	0.903	-178
70	0.924	-178	2.24	77	0.013	34	0.904	-178
80	0.925	-178	1.95	75	0.013	39	0.906	-178
90	0.927	-178	1.72	73	0.014	43	0.907	-178
100	0.930	-178	1.50	71	0.016	45	0.910	-178
110	0.930	-178	1.31	70	0.018	46	0.912	-178
120	0.931	-178	1.19	68	0.019	47	0.914	-178
130	0.942	-178	1.10	67	0.019	49	0.919	-178
140	0.936	-178	1.01	66	0.021	50	0.921	-178
150	0.938	-178	0.936	65	0.021	53	0.922	-178
160	0.938	-178	0.879	64	0.022	53	0.923	-178
170	0.940	-178	0.830	63	0.023	54	0.923	-177
180	0.942	-178	0.780	61	0.024	56	0.924	-177
190	0.942	-178	0.737	60	0.026	59	0.928	-177
200	0.952	-178	0.705	59	0.027	58	0.929	-177
210	0.950	-178	0.668	57	0.029	61	0.934	-177
220	0.942	-178	0.626	56	0.030	61	0.933	-177
230	0.943	-178	0.592	56	0.032	62	0.939	-177
240	0.946	-177	0.566	55	0.033	64	0.941	-177
250	0.952	-177	0.545	54	0.035	64	0.943	-177
260	0.958	-177	0.523	53	0.036	65	0.946	-177
270	0.956	-177	0.500	52	0.038	67	0.943	-177
280	0.960	-177	0.481	52	0.039	68	0.946	-177
290	0.956	-178	0.460	51	0.042	68	0.944	-177
300	0.955	-178	0.443	50	0.043	68	0.947	-177

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FIGURE 14 — S_{11}, INPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 3.0 A

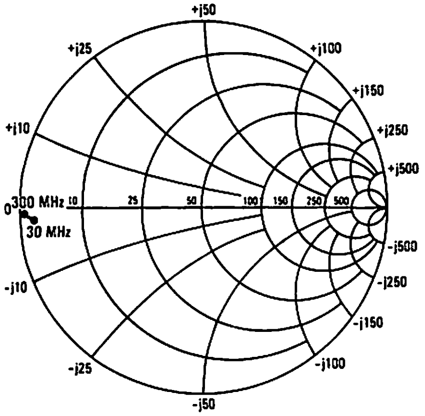


FIGURE 15 — S_{12}, REVERSE TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 3.0 A

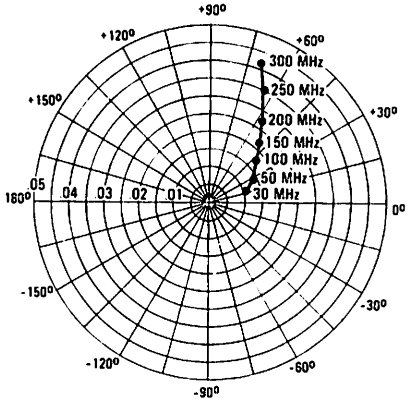


FIGURE 16 — S_{21}, FORWARD TRANSMISSION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 3.0 A

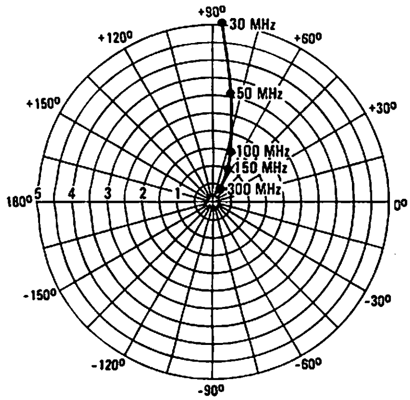
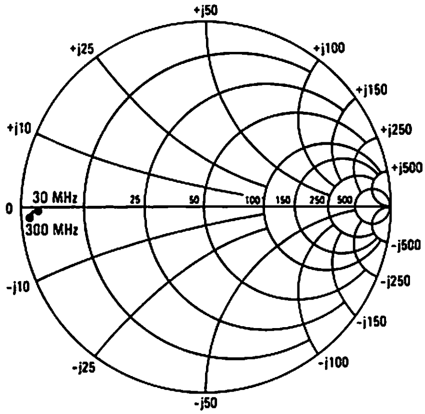


FIGURE 17 — S_{22}, OUTPUT REFLECTION COEFFICIENT versus FREQUENCY
V_{DS} = 28 V I_D = 3.0 A



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DESIGN CONSIDERATIONS

The MRF174 is a RF power N-Channel enhancement mode field-effect transistor (FET) designed especially for UHF power amplifier and oscillator applications. Motorola RF MOS FETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove vertical power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF174 is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. See Figure 9 for a typical plot of drain current versus gate voltage. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF174 was characterized at I_{DQ} = 100 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF174 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems. (See Figure 8.)

AMPLIFIER DESIGN

Impedance matching networks similar to those used with bipolar UHF transistors are suitable for the MRF174. See Motorola Application Note AN-721, *Impedance* Matching Networks Applied to RF Power Transistors. The higher input impedance of RF MOS FET's helps ease the task of broadband network design. Both small signal scattering parameters and large signal impedances are provided. While the s-parameters will not produce an exact design solution for high power operation, they do yield a good first approximation. This is an additional advantage of RF MOS power FETs.

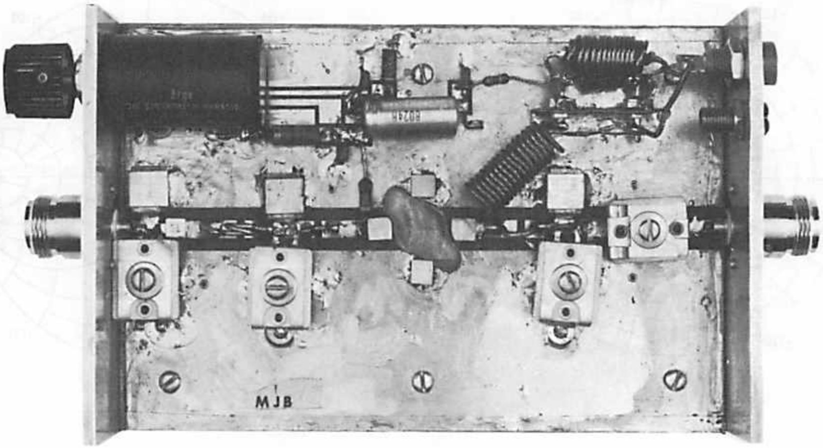

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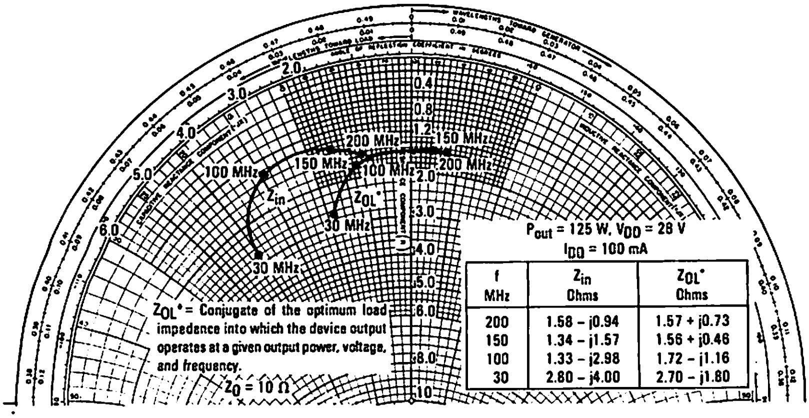
FIGURE 19 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE, Z_{in}, Z_{OL}*



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
200	1.58 - j0.94	1.57 + j0.73
150	1.34 - j1.57	1.56 + j0.46
100	1.33 - j2.98	1.72 - j1.16
30	2.80 - j4.00	2.70 - j1.80

MRF175GV
MRF175GU

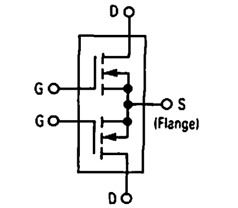
The RF MOSFET Line
RF Power Field Effect Transistors
N-Channel Enhancement-Mode

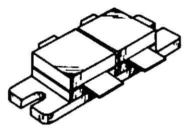
2

...designed for broadband commercial and military applications using push pull circuits at frequencies to 500 MHz. The high power, high gain and broadband performance of these devices makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance
  - MRF175GV @ 28 V, 225 MHz ("V" Suffix)
    - Output Power — 200 Watts
    - Power Gain — 14 dB Typ
    - Efficiency — 65% Typ
  - MRF175GU @ 28 V, 400 MHz ("U" Suffix)
    - Output Power — 150 Watts
    - Power Gain — 12 dB Typ
    - Efficiency — 55% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- Low C_{rss} — 20 pF Typ @ V_{DS} = 28 V

**N-CHANNEL MOS
BROADBAND
RF POWER FETs
200/150 WATTS
28 VOLTS
500 MHz**





CASE 375-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Drain-Gate Voltage (R_{GS} = 1 MΩ)	V_{DGR}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	26	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	400 2.27	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

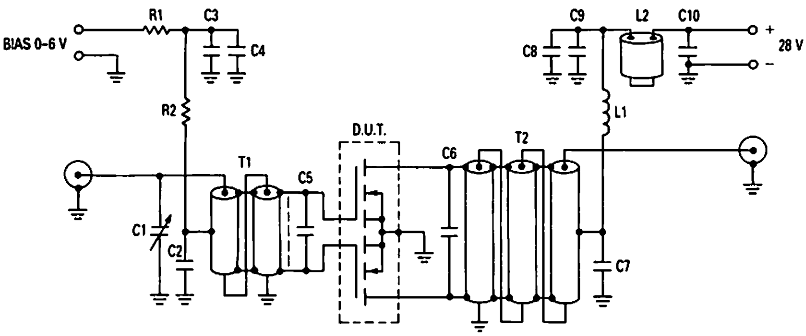
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.44	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (Note 1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2	3	—	mhos
DYNAMIC CHARACTERISTICS (Note 1)					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	200	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL CHARACTERISTICS — MRF175GV (Figure 1) (Note 2)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA)	η	55	65	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

Note 1. Each side of device measured separately.
Note 2. Measured in push-pull configuration.



C1 — Arco 404, 8-60 pF
C2, C3, C7, C8 — 1000 pF Chip
C4, C9 — 0.1 μF Chip
C5 — 180 pF Chip
C6 — 100 pF and 130 pF Chips in Parallel
C10 — 0.47 μF Chip, Kemet 1215 or Equivalent
L1 — 10 Turns AWG #16 Enamel Wire, Close Wound, 1/4" I.D.
L2 — Ferrite Beads of Suitable Material for 1.5-2 μH Total Inductance

R1 — 100 Ohms, 1/2 W
R2 — 1 k Ohm, 1/2 W
T1 — 4:1 Impedance Ratio RF Transformer. Can Be MAde of 25 Ohm Semirigid Coax, 47-52 Mils O.D.
T2 — 1:9 Impedance Ratio RF Transformer. Can Be MAde of 15-18 Ohms Semirigid Coax, 62-90 Mils O.D.

Board material — .062" fiberglass (G10), Two sided, 1 oz. copper, $\epsilon_r \approx 5$

Unless otherwise noted, all chip capacitors are ATC Type 100 or Equivalent.

NOTE: For stability, the input transformer T1 should be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

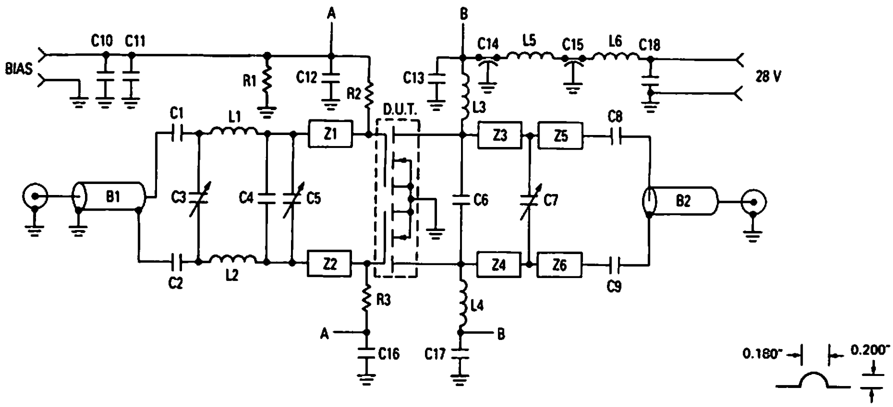
Figure 1. 225 MHz Test Circuit

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS — MRF175GU (Figure 2) (Note 1)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA)	G_{ps}	10	12	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

Note 1. Measured in push-pull configuration.



B1	Balun 50 Ω Semi Rigid Coax 0.086" O.D. 2" Long
B2	Balun 50 Ω Semi Rigid Coax 0.141" O.D. 2" Long
C1, C2, C8, C9	270 pF ATC Chip Cap
C3, C5, C7	1–20 pF Trimmer Cap
C4	15 pF ATC Chip Cap
C6	33 pF ATC Chip Cap
C10, C12, C13, C16, C17	0.01 μF Ceramic Cap
C11	1 μF 50 V Tantalum
C14, C15	680 pF Feedthru Cap
C18	20 μF 50 V Tantalum
L1, L2	Hairpin Inductor #18 Wire
L3, L4	12 Turns #18 Enameled Wire 0.340" I.D.
L5	Ferroxcube VK200 20/4B
L6	3 Turns #16 Enameled Wire 0.340" I.D.
R1	1 kΩ 1/4 W Resistor
R2, R3	10 kΩ 1/4 W Resistor
Z1, Z2	Microstrip Line 0.400" x 0.250"
Z3, Z4	Microstrip Line 0.870" x 0.250"
Z5, Z6	Microstrip Line 0.500" x 0.250"

Board material — 0.060" Teflon-fiberglass, ϵ_r = 2.55, copper clad both sides, 2 oz. copper.

Figure 2. 400 MHz Test Circuit

TYPICAL CHARACTERISTICS

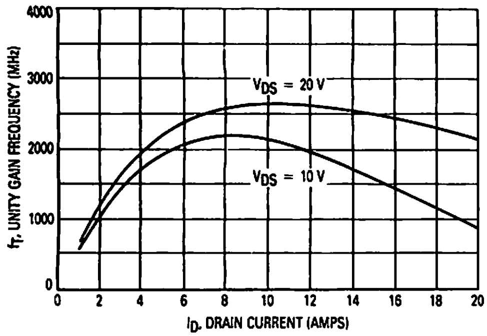


Figure 3. Common Source Unity Current Gain Frequency versus Drain Current

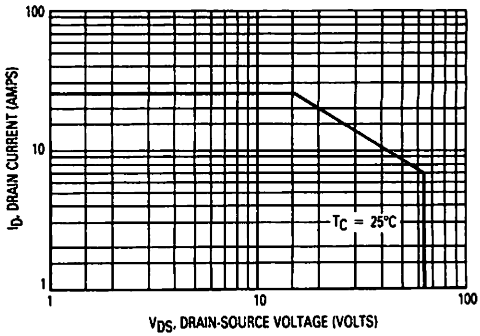


Figure 4. DC Safe Operating Area

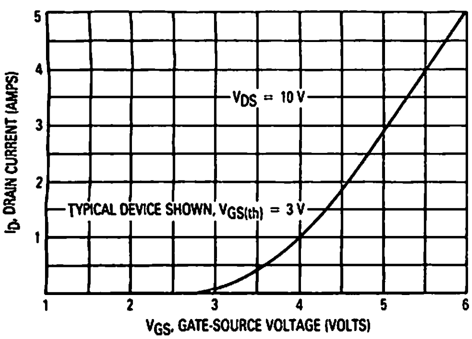


Figure 5. Drain Current versus Gate Voltage (Transfer Characteristics)

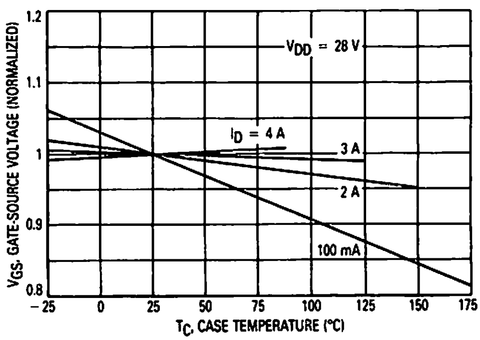


Figure 6. Gate-Source Voltage versus Case Temperature

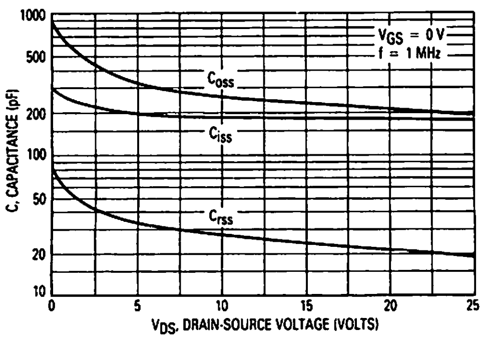


Figure 7. Capacitance versus Drain-Source Voltage*

*Data shown applies to each half of MRF175GV/GU.

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TYPICAL CHARACTERISTICS
MRF175GV

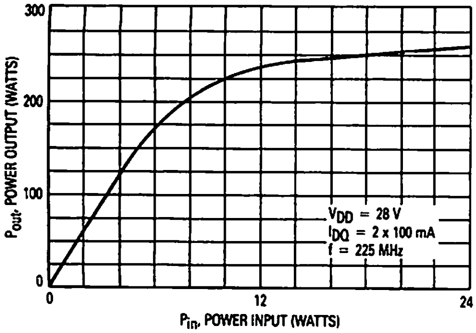


Figure 8. Power Input versus Power Output

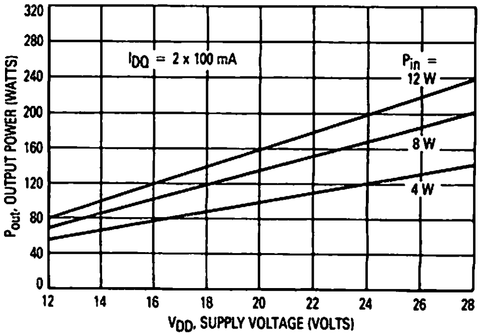


Figure 9. Output Power versus Supply Voltage
f = 225 MHz

MRF175GU

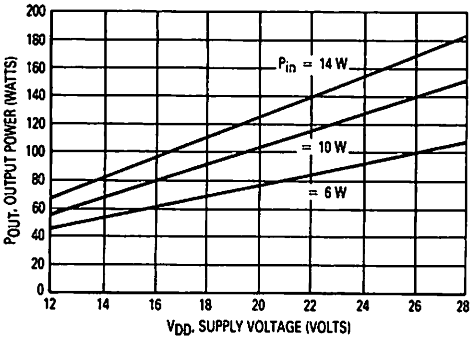


Figure 10. Output Power versus Supply Voltage
f = 400 MHz

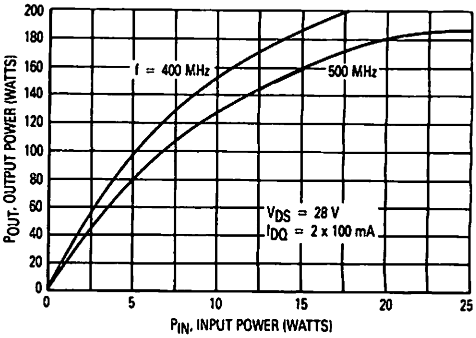


Figure 11. Output Power versus Input Power

MRF175GV

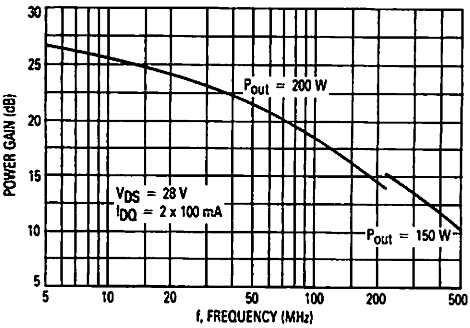
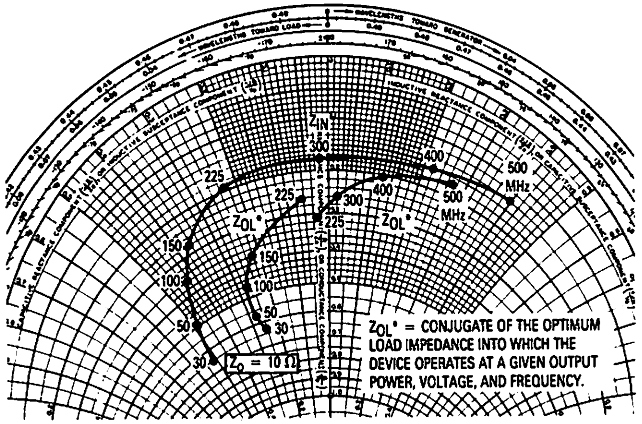


Figure 12. Power Gain versus Frequency

INPUT AND OUTPUT IMPEDANCE



V_{DD} = 28 V I_{DQ} = 2 x 100 mA

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
	(P_{out} = 150 W)	
500	1.35 + j4.00	1.70 + j2.70
400	1.60 + j2.20	2.00 + j1.20
300	1.75 − j0.20	2.60 + j0.20
225	1.95 − j2.30	3.10 − j0.25
	(P_{out} = 200 W)	
225	1.95 − j2.30	2.60 − j0.60
150	2.80 − j3.60	2.60 − j2.20
100	3.60 − j4.20	4.60 − j2.65
50	5.00 − j4.80	5.75 − j2.75
30	6.50 − j5.10	6.30 − j2.50

NOTE: Input and output impedance values given are measured from gate to gate and drain to drain respectively.

Figure 13. Series Equivalent Input/Output Impedance

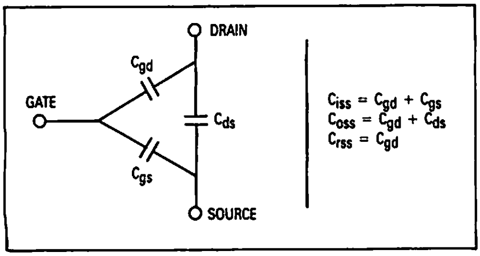
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on *data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The* C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the *actual operating* conditions in RF applications.



The C_{iss} given in the electrical characteristics table was measured using method 2 above. It should be noted that C_{iss}, C_{oss}, and C_{rss} are measured at zero drain current and are provided for general information about the device. They are not RF design parameters and no attempt should be made to use them as such.

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain, data presented in Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide.

2

The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating (or any of the maximum ratings on the front page). Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of this device are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with grounded equipment.

DESIGN CONSIDERATIONS

The MRF175G is a RF power N-channel enhancement mode field-effect transistor (FETs) designed for HF, VHF and UHF power amplifier applications. Motorola RF MOSFETs feature a vertical structure with a planar design.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF175G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF175G was characterized at I_{DQ} = 100 mA, per side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF176 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MRF175LV
MRF175LU

The RF MOSFET Line

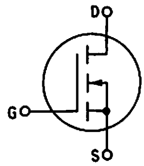
RF Power Field Effect Transistors

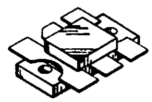
N-Channel Enhancement-Mode

N-CHANNEL BROADBAND RF POWER FETs 100 WATTS 28 VOLTS 400 MHz

. . . designed for broadband commercial and military applications using single ended circuits at frequencies to 400 MHz. The high power, high gain and broadband performance of each device makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Guaranteed Performance
  - MRF175LV @ 28 V, 225 MHz ("V" Suffix)
    - Output Power — 100 Watts
    - Power Gain — 14 dB Typ
    - Efficiency — 65% Typ
  - MRF175LU @ 28 V, 400 MHz ("U" Suffix)
    - Output Power — 100 Watts
    - Power Gain — 10 dB Typ
    - Efficiency — 55% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- All Gold Metal System For Ultra Reliability
- Low C_{rss} — 20 pF Typ @ V_{DS} = 28 V





CASE 333-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	65	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	13	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

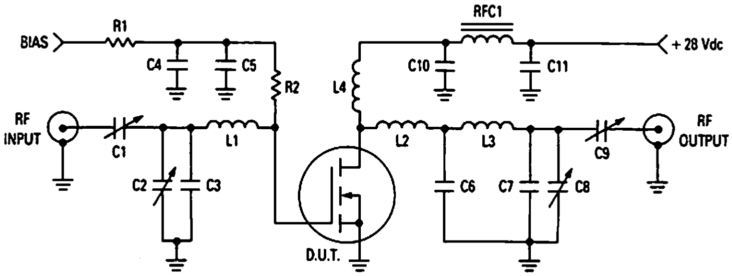
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

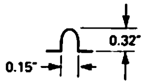
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

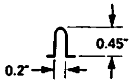
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 50 mA)	$V_{(BR)DSS}$	65	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 28 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5 A)	$V_{DS(on)}$	—	—	1.5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2	3	—	mhos
DYNAMIC CHARACTERISTICS					
Input Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	200	—	pF
Reverse Transfer Capacitance (V_{DS} = 28 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL CHARACTERISTICS — MRF175LV (Figure 1)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA)	η	55	65	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 225 MHz, I_{DQ} = 100 mA VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			
FUNCTIONAL CHARACTERISTICS — MRF175LU (Figure 2)					
Common Source Power Gain (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA)	G_{ps}	8	10	—	dB
Drain Efficiency (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 28 Vdc, P_{out} = 100 W, f = 400 MHz, I_{DQ} = 100 mA VSWR 30:1 at all Phase Angles)	ψ	No Degradation in Output Power			



C1, C2, C8	Arco 463 or Equivalent	L1	Hairpin Inductor #18 Wire
C3, C7	25 pF Unelco Cap		
C4	1000 pF Chip Cap		
C5	0.01 μF Chip Cap		
C6	250 pF Unelco Cap		
C9	Arco 462 or Equivalent		
C10	1000 pF ATC Chip Cap		
C11	10 μF 100 V Electrolytic	L2	Stripline Inductor 0.200" x 0.500"



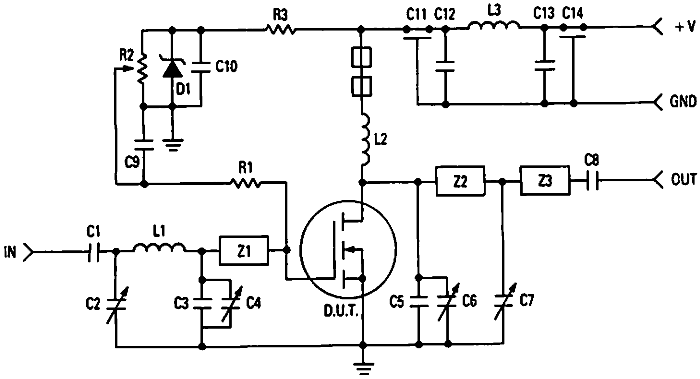
L3 Hairpin Inductor #16 Wire



L4	2 Turns #16 Wire 5/16" ID
RFC1	VK200-4B
R1	1 k 1/4 W Resistor
R2	100 Ω Resistor

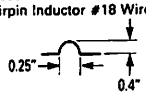
Figure 1. 225 MHz Test Circuit

2



C1, C8	270 pF ATC Chip Cap
C2, C4, C6, C7	1–20 pF Trimmer Cap
C3	15 pF Mini Unelco Cap
C5	33 pF Mini Unelco Cap
C9, C10, C12	0.1 μF Ceramic Cap
C11, C14	680 pF Feed Thru Cap
C13	50 μF Tantalum Cap

D1 1N5352 Zener Diode
L1 Hairpin Inductor #18 Wire



L2 12 Turns #18 Wire 0.450" ID
L3 Ferroxcube VK200 20/4B

R1	10 k 1/4 W Resistor
R2	10 k Variable Resistor
R3	1.5 k 1/4 W Resistor
Z1	Microstrip Line 0.950" x 0.250"
Z2	Microstrip Line 1" x 0.250"
Z3	Microstrip Line 0.550" x 0.250"

Board Material — 0.062" Teflon — fiberglass, ϵ_r = 2.56, 1 oz. copper clad both sides

Figure 2. 400 MHz Test Circuit

TYPICAL CHARACTERISTICS

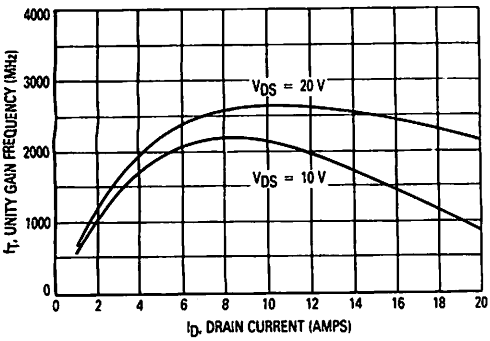


Figure 3. Common Source Unity Current Gain Frequency versus Drain Current

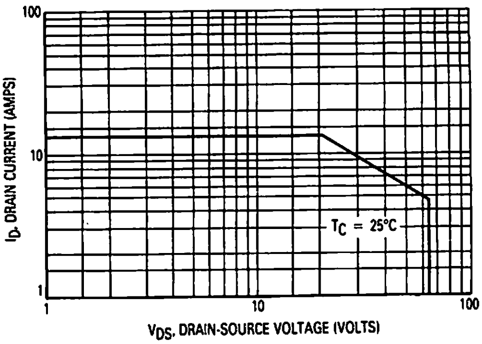


Figure 4. DC Safe Operating Area

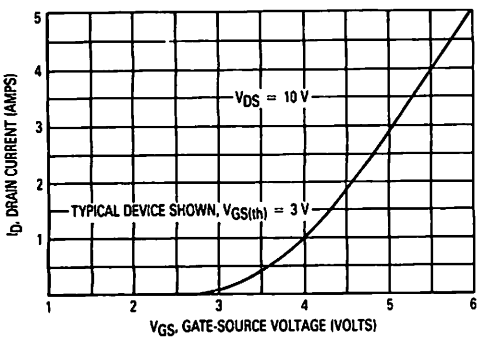


Figure 5. Drain Current versus Gate Voltage (Transfer Characteristics)

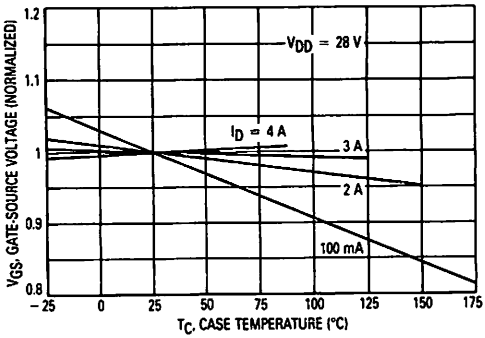


Figure 6. Gate-Source Voltage versus Case Temperature

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TYPICAL CHARACTERISTICS

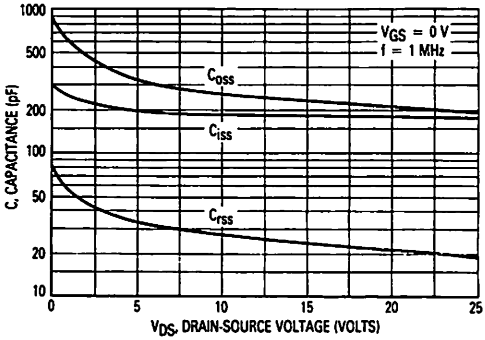


Figure 7. Capacitance versus Drain-Source Voltage

MRF175LV

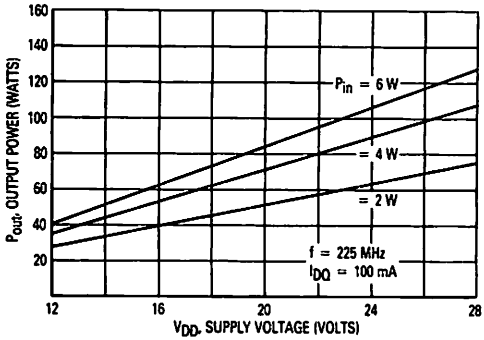


Figure 8. Output Power versus Supply Voltage

MRF175LU

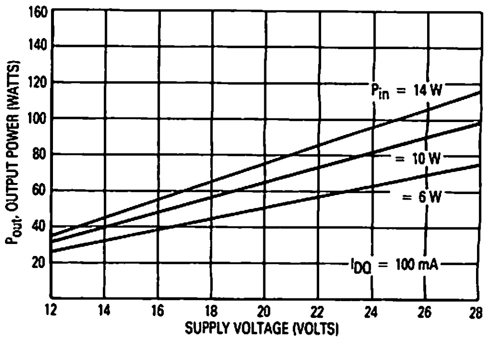


Figure 9. Output Power versus Supply Voltage
f = 400 MHz

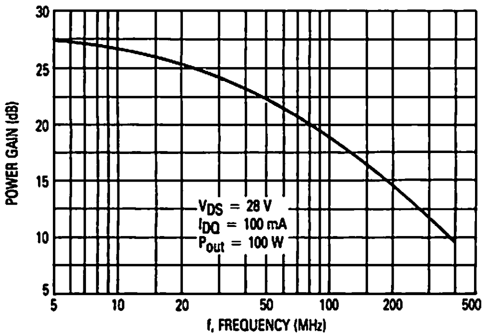


Figure 10. Power Gain versus Frequency

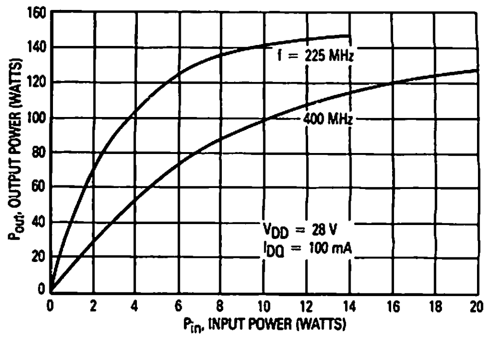
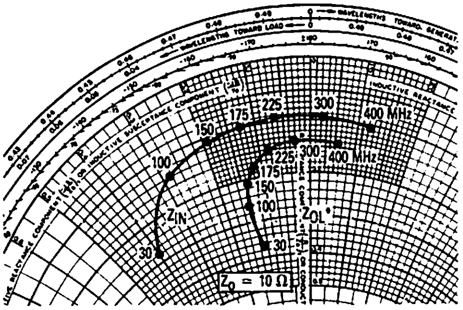


Figure 11. Output Power versus Input Power

INPUT AND OUTPUT IMPEDANCE



V_{DD} = 28 V I_{DQ} = 100 mA
(P_{out} = 100 W)

f MHz	Z_{IN} Ohms	Z_{OL}* Ohms
30	2.80 − j4.00	3.65 − j1.30
100	1.40 − j2.80	2.60 − j1.50
150	1.10 − j1.90	2.10 − j1.40
175	1.00 − j1.25	1.80 − j1.20
225	0.95 − j0.65	1.50 − j0.80
300	0.95 + j0.20	1.35 − j0.30
400	1.05 + j1.15	1.45 + j0.55

Z_{OL}* = CONJUGATE OF THE OPTIMUM LOAD IMPEDANCE INTO WHICH THE DEVICE OPERATES AT A GIVEN OUTPUT POWER, VOLTAGE, AND FREQUENCY.

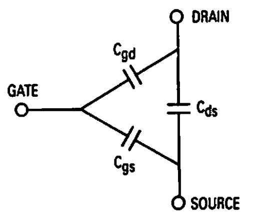
RF POWER MOSFET CONSIDERATIONS

MOSFET CAPACITANCES

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the FET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.



$C_{iss} = C_{gd} + C_{gs}$
$C_{oss} = C_{gd} + C_{ds}$
$C_{rss} = C_{gd}$

2

LINEARITY AND GAIN CHARACTERISTICS

In addition to the typical IMD and power gain data presented, Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

DRAIN CHARACTERISTICS

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

GATE CHARACTERISTICS

The gate of the FET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating. Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of these devices are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — These devices do not have an internal monolithic zener diode from gate-to-source. If gate protection is required, an external zener diode is recommended.

Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

HANDLING CONSIDERATIONS

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with a grounded iron.

DESIGN CONSIDERATIONS

The MRF175L is a RF power N-channel enhancement mode field-effect transistors (FET) designed for HF, VHF and UHF power amplifier applications. Motorola FETs feature a vertical structure with a planar design.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal.

DC BIAS

The MRF175L is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF175L was characterized at I_{DQ} = 100 mA, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may be just a simple resistive divider network. Some applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF175L may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC, and modulation systems.

MRF176GV
MRF176GU

The RF MOSFET Line

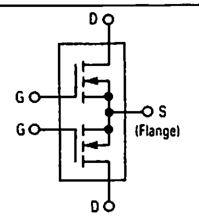
RF Power Field Effect Transistors

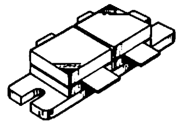
N-Channel Enhancement-Mode

... designed for broadband commercial and military applications using push pull circuits at frequencies to 500 MHz. The high power, high gain and broadband performance of these devices makes possible solid state transmitters for FM broadcast or TV channel frequency bands.

- Electrical Performance
  MRF176GV @ 50 V, 225 MHz ("V" Suffix)
  Output Power — 200 Watts
  Power Gain — 17 dB Typ
  Efficiency — 55% Typ
  MRF176GU @ 50 V, 400 MHz ("U" Suffix)
  Output Power — 150 Watts
  Power Gain — 14 dB Typ
  Efficiency — 50% Typ
- 100% Ruggedness Tested At Rated Output Power
- Low Thermal Resistance
- Low C_{rss} — 7 pF Typ @ V_{DS} = 50 V

**N-CHANNEL MOS
BROADBAND
RF POWER FETs
200/150 WATTS
50 VOLTS
500 MHz**





CASE 375-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Gate-Source Voltage	V_{GS}	±40	Vdc
Drain Current — Continuous	I_D	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	400 2.27	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

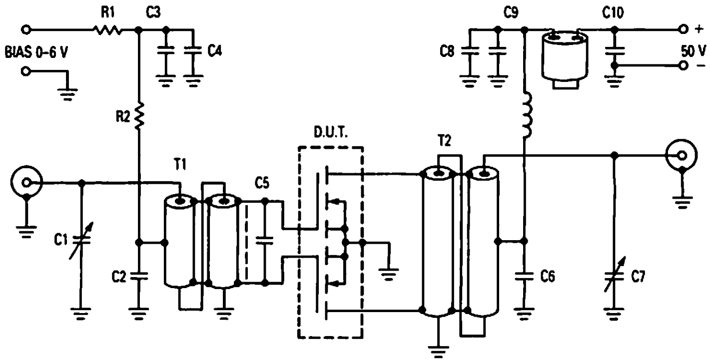
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.44	°C/W

Handling and Packaging — MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 V, V_{GS} = 0)	I_{DSS}	—	—	2.5	mAdc
Gate-Source Leakage Current (V_{GS} = 20 V, V_{DS} = 0)	I_{GSS}	—	—	1	μAdc
ON CHARACTERISTICS (Note 1)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1	3	6	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 5 A)	$V_{DS(on)}$	—	—	5	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 2.5 A)	g_{fs}	2	3	—	mhos
DYNAMIC CHARACTERISTICS (Note 1)					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{iss}	—	180	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{oss}	—	110	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1 MHz)	C_{rss}	—	7	—	pF
FUNCTIONAL CHARACTERISTICS — MRF176GV (Figure 1) (Note 2)					
Common Source Power Gain (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA)	G_{ps}	15	17	—	dB
Drain Efficiency (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA)	η	50	55	—	%
Electrical Ruggedness (V_{DD} = 50 Vdc, P_{out} = 200 W, f = 225 MHz, I_{DQ} = 2 x 100 mA VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

Notes:
1. Each side of device measured separately.
2. Measured in push-pull configuration.



R1 — 100 Ohms, ½ W
R2 — 1K Ohms, ½ W
C1 — Arco 404, 8-60 pF
C2, C3, C6, C8 — 1000 pF Chip
C4, C9 — 0.1 μF Chip
C5 — 180 pF Chip
C7 — Arco 403, 3-35 pF
C10 — 0.47 μF Chip, Kemet 1215 or Equivalent
Board material — .062" fiberglass (G10), Two sided, 1 oz. copper, $\epsilon_r \cong 5$

Unless otherwise noted, all chip capacitors are ATC Type 100 or Equivalent

L1 — 10 Turns AWG #16 Enameled Wire, Close Wound, ¼" I.D.
L2 — Ferrite Beads of Suitable Material for 1.5-2 μH, Total Inductance
T1 — 4:1 Impedance Ratio RF Transformer. Can Be Made of 25 Ohm Semirigid Co-Ax, 47-62 Mils O.D.
T2 — 1:4 Impedance Ratio RF Transformer. Can Be Made of 25 Ohm Semirigid Co-Ax, 62-90 Mils O.D.

NOTE: For stability, the input transformer T1 should be loaded with ferrite toroids or beads to increase the common mode inductance. For operation below 100 MHz. The same is required for the output transformer.

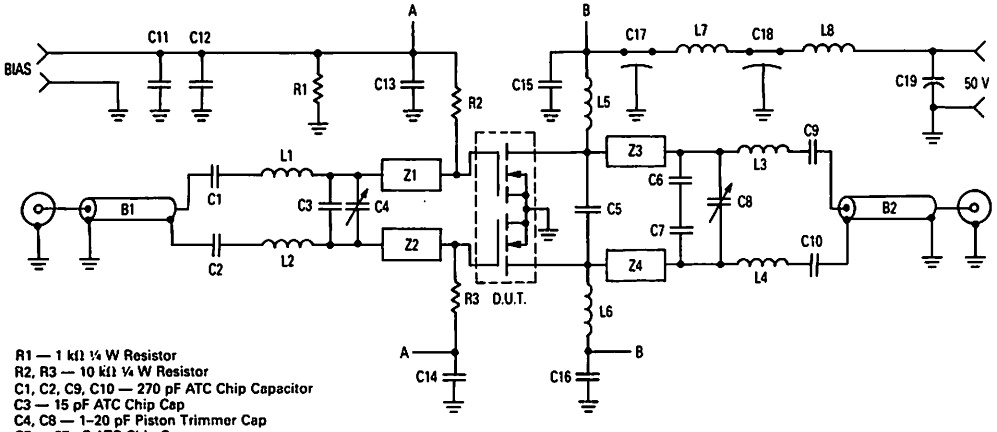
Figure 1. 225 MHz Test Circuit

2

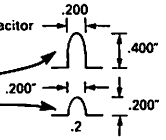
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS — MRF176GU (Figure 2) (Note 1)					
Common Source Power Gain (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA)	G_{ps}	12	14	—	dB
Drain Efficiency (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA)	η	45	50	—	%
Electrical Ruggedness (V_{DD} = 50 Vdc, P_{out} = 150 W, f = 400 MHz, I_{DQ} = 2 x 100 mA VSWR 10:1 at all Phase Angles)	ψ	No Degradation in Output Power			

Note 1. Measured in push-pull configuration.



R1 — 1 kΩ ¼ W Resistor
R2, R3 — 10 kΩ ¼ W Resistor
C1, C2, C9, C10 — 270 pF ATC Chip Capacitor
C3 — 15 pF ATC Chip Cap
C4, C8 — 1–20 pF Piston Trimmer Cap
C5 — 27 pF ATC Chip Cap
C6, C7 — 22 pF Mini Unelco Capacitor
C11, C13, C14, C15, C16 — 0.01 μF Ceramic Capacitor
C12 — 1 μF 50 V Tantalum Cap
C17, C18 — 680 pF Feedthru Capacitor
C19 — 10 μF 100 V Tantalum Cap
L1, L2 — Hairpin Inductor #18 W
L3, L4 — Hairpin Inductor #18 W



L5, L6 — 13T #18 W .250 ID
L7 — Ferroxcube VK-200 20/4B
L8 — 3T #18 W .340 ID
Z1, Z2 — Microstrip Line .400L x .250W
Z3, Z4 — Microstrip Line .450L x .250W
B1 — Balun, 50 Ω Semirigid Coax .086 OD 2" Long
B2 — Balun, 50 Ω Semirigid Coax .141 OD 2" Long

Ckt Board Material — .060" teflon-fiberglass, copper clad both sides, 2 oz. copper, ϵ_r = 2.55

Figure 2. 400 MHz Test Circuit

TYPICAL CHARACTERISTICS

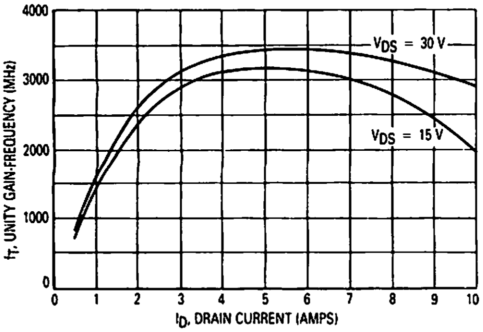


Figure 3. Common Source Unity Current* Gain-Frequency versus Drain Current

*Data shown applies to each half of MRF176GV/GU

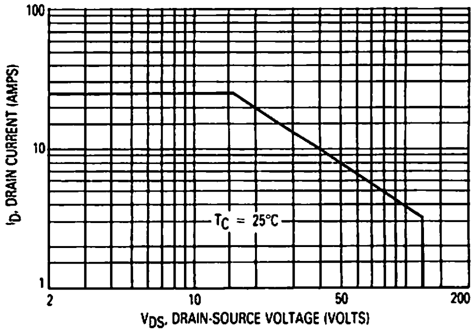
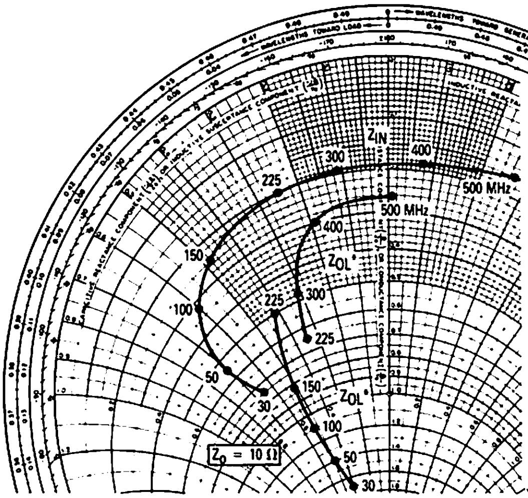


Figure 4. DC Safe Operating Area

2

TYPICAL CHARACTERISTICS



INPUT AND OUTPUT IMPEDANCE
MRF176GU/GV
V_{DD} = 50 V I_{DQ} = 2 x 100 mA

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
(P_{out} = 150 W)		
500	1.60 + j2.70	2.60 + j0.10
400	1.85 + j0.75	3.00 − j1.90
300	2.00 − j1.10	4.80 − j3.10
225	2.05 − j2.50	6.50 − j3.50
(P_{out} = 200 W)		
225	2.05 − j2.50	5.00 − j4.20
150	2.50 − j4.80	8.20 − j5.00
100	3.20 − j6.00	11.00 − j5.20
50	5.50 − j7.00	14.00 − j5.00
30	7.50 − j6.50	17.00 − j4.00

Z_{OL}* = CONJUGATE OF THE OPTIMUM LOAD IMPEDANCE INTO WHICH THE DEVICE OPERATES AT A GIVEN OUTPUT POWER, VOLTAGE, AND FREQUENCY.

NOTE: Input and output impedance values given are measured from gate to gate and drain to drain respectively.

Figure 5. Series Equivalent Input/Output Impedance

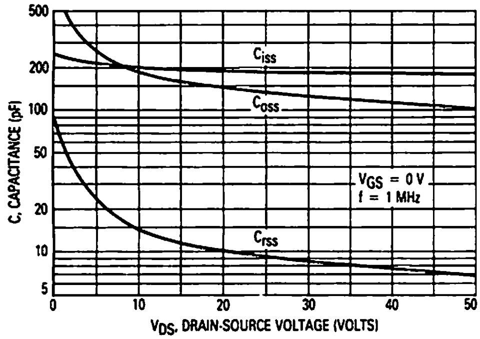


Figure 6. Capacitance versus Drain-Source Voltage*

*Data shown applies to each half of MRF176GV/GU

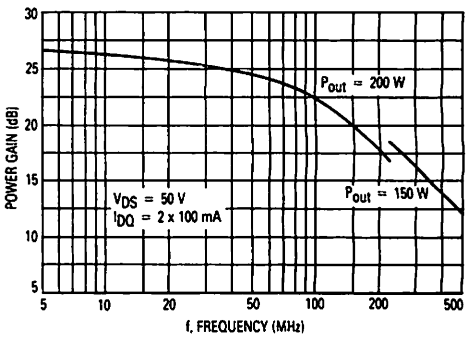


Figure 7. Power Gain versus Frequency

MRF176GV

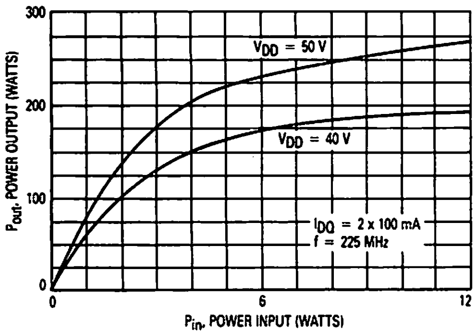


Figure 8. Power Input versus Power Output

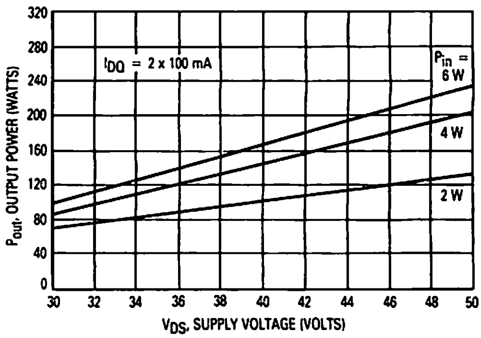


Figure 9. Output Power versus Supply Voltage
f = 225 MHz

TYPICAL CHARACTERISTICS
MRF176GU

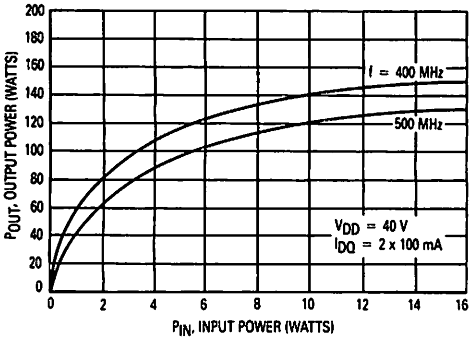


Figure 10. Output Power versus Input Power V_{DD} = 40 V

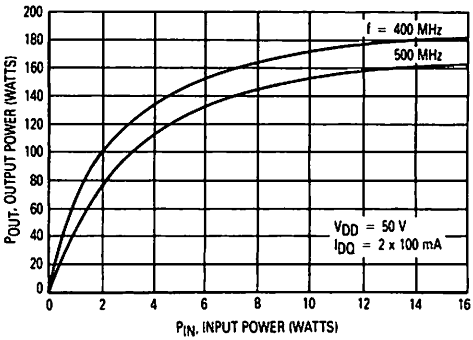


Figure 11. Output Power versus Input Power V_{DD} = 50 V

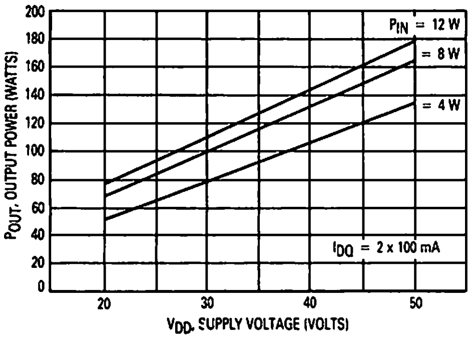


Figure 12. Output Power versus Supply Voltage f = 400 MHz

2

RF POWER MOSFET CONSIDERATIONS

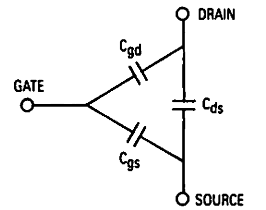
MOSFET Capacitances

The physical structure of a MOSFET results in capacitors between the terminals. The metal oxide gate structure determines the capacitors from gate-to-drain (C_{gd}), and gate-to-source (C_{gs}). The PN junction formed during the fabrication of the MOSFET results in a junction capacitance from drain-to-source (C_{ds}).

These capacitances are characterized as input (C_{iss}), output (C_{oss}) and reverse transfer (C_{rss}) capacitances on data sheets. The relationships between the interterminal capacitances and those given on data sheets are shown below. The C_{iss} can be specified in two ways:

1. Drain shorted to source and positive voltage at the gate.
2. Positive voltage of the drain in respect to source and zero volts at the gate. In the latter case the numbers are lower. However, neither method represents the actual operating conditions in RF applications.

The C_{iss} given in the electrical characteristics table was measured using method 2 above. It should be noted that C_{iss}, C_{oss}, and C_{rss} are measured at zero drain current and are provided for general information about the device. They are not RF design parameters and no attempt should be made to use them as such.



$$C_{iss} = C_{gd} + C_{gs}$$
$$C_{oss} = C_{gd} + C_{ds}$$
$$C_{rss} = C_{gd}$$

Linearity and Gain Characteristics

In addition to the typical IMD and power gain, data presented in Figure 3 may give the designer additional information on the capabilities of this device. The graph represents the small signal unity current gain frequency at a given drain current level. This is equivalent to f_T for bipolar transistors. Since this test is performed at a fast sweep speed, heating of the device does not occur. Thus, in normal use, the higher temperatures may degrade these characteristics to some extent.

Drain Characteristics

One figure of merit for a FET is its static resistance in the full-on condition. This on-resistance, $V_{DS(on)}$, occurs in the linear region of the output characteristic and is specified under specific test conditions for gate-source voltage and drain current. For MOSFETs, $V_{DS(on)}$ has a positive temperature coefficient and constitutes an important design consideration at high temperatures, because it contributes to the power dissipation within the device.

Gate Characteristics

The gate of the MOSFET is a polysilicon material, and is electrically isolated from the source by a layer of oxide. The input resistance is very high — on the order of 10^9 ohms — resulting in a leakage current of a few nanoamperes.

Gate control is achieved by applying a positive voltage slightly in excess of the gate-to-source threshold voltage, $V_{GS(th)}$.

Gate Voltage Rating — Never exceed the gate voltage rating (or any of the maximum ratings on the front page). Exceeding the rated V_{GS} can result in permanent damage to the oxide layer in the gate region.

Gate Termination — The gates of this device are essentially capacitors. Circuits that leave the gate open-circuited or floating should be avoided. These conditions can result in turn-on of the devices due to voltage build-up on the input capacitor due to leakage currents or pickup.

Gate Protection — This device does not have an internal monolithic zener diode from gate-to-source. The addition of an internal zener diode may result in detrimental effects on the reliability of a power MOSFET. If gate protection is required, an external zener diode is recommended.

HANDLING CONSIDERATIONS

The gate of the MOSFET, which is electrically isolated from the rest of the die by a very thin layer of SiO_2, may be damaged if the power MOSFET is handled or installed improperly. Exceeding the 40 V maximum gate-to-source voltage rating, $V_{GS(max)}$, can rupture the gate insulation and destroy the FET. RF Power MOSFETs are not nearly as susceptible as CMOS devices to damage due to static discharge because the input capacitances of power MOSFETs are much larger and absorb more energy before being charged to the gate breakdown voltage. However, once breakdown begins, there is enough energy stored in the gate-source capacitance to ensure the complete perforation of the gate oxide. To avoid the possibility of device failure caused by static discharge, precautions similar to those taken with small-signal MOSFET and CMOS devices apply to power MOSFETs.

When shipping, the devices should be transported only in antistatic bags or conductive foam. Upon removal from the packaging, careful handling procedures should be adhered to. Those handling the devices should wear grounding straps and devices not in the antistatic packaging should be kept in metal tote bins. MOSFETs should be handled by the case and not by the leads, and when testing the device, all leads should make good electrical contact before voltage is applied. As a final note, when placing the FET into the system it is designed for, soldering should be done with grounded equipment.

The gate of the power MOSFET could still be in danger after the device is placed in the intended circuit. If the gate may see voltage transients which exceed $V_{GS(max)}$, the circuit designer should place a 40 V zener across the gate and source terminals to clamp any potentially destructive spikes. Using a resistor to keep the gate-to-source impedance low also helps damp transients and serves another important function. Voltage transients on the drain can be coupled to the gate through the parasitic gate-drain capacitance. If the gate-to-source impedance and the rate of voltage change on the drain are both high, then the signal coupled to the gate may be large enough to exceed the gate-threshold voltage and turn the device on.

DESIGN CONSIDERATIONS

The MRF176G is a RF power N-channel enhancement mode field-effect transistor (FETs) designed for VHF and UHF power amplifier applications. Motorola RF MOSFETs feature a vertical structure with a planar design, thus avoiding the processing difficulties associated with V-groove MOS power FETs.

Motorola Application Note AN-211A, FETs in Theory and Practice, is suggested reading for those not familiar with the construction and characteristics of FETs.

The major advantages of RF power FETs include high gain, low noise, simple bias systems, relative immunity from thermal runaway, and the ability to withstand severely mismatched loads without suffering damage. Power output can be varied over a wide range with a low power dc control signal, thus facilitating manual gain control, ALC and modulation.

DC BIAS

The MRF176G is an enhancement mode FET and, therefore, does not conduct when drain voltage is applied. Drain current flows when a positive voltage is applied to the gate. RF power FETs require forward bias for optimum performance. The value of quiescent drain current (I_{DQ}) is not critical for many applications. The MRF176G was characterized at I_{DQ} = 100 mA, per side, which is the suggested minimum value of I_{DQ}. For special applications such as linear amplification, I_{DQ} may have to be selected to optimize the critical parameters.

The gate is a dc open circuit and draws no current. Therefore, the gate bias circuit may generally be just a simple resistive divider network. Some special applications may require a more elaborate bias system.

GAIN CONTROL

Power output of the MRF176 may be controlled from its rated value down to zero (negative gain) by varying the dc gate voltage. This feature facilitates the design of manual gain control, AGC/ALC and modulation systems.

MRF0211L

The RF Line

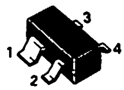
NPN Silicon High-Frequency Transistor

... designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — f_T = 5.5 GHz (Typ) @ I_C = 40 mAdc
- Low Noise Figure @ f = 1 GHz — $NF_{(matched)}$ = 1.8 dB (Typ)
- High Power Gain — $G_{pe\ (matched)}$ = 13 dB (Typ)
- Surface Mount SOT-143 Offers Improved RF Performance
  - Lower Package Parasitics
  - Higher Gain
- Tape and Reel Packaging Options
- Higher Voltage Version of MRF5711
- Electrically Similar to NEC NE 02133

2

**SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 318A-05, STYLE 1
LOW PROFILE
MRF0211L

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.58 4.64	Watts mW/°C
Total Device Dissipation @ T_C = 75°C (Note 1) Derate above 75°C	P_D	0.58 7.73	Watts mW/°C
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	130	°C/W

DEVICE MARKING

MRF0211 = 15

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc

Note 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	0.7	1	pF
Current Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_C = 40 mA, f = 1 GHz)	Figure 7	f_T	—	5.5	—	GHz
FUNCTIONAL TESTS						
Gain at Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5 mAdc)	Figure 4 f = 0.5 GHz f = 1 GHz	G_{NFmin}	 — —	 19 13	 — —	dB
Noise Figure (Tuned) (V_{CE} = 10 Vdc, I_C = 5 mAdc)	Figure 4 f = 0.5 GHz f = 1 GHz f = 2 GHz	NF_{min}	 — — —	 0.9 1.8 3	 — — —	dB
Power Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	G_{NF}	—	9.5	—	dB
Noise Figure in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	NF	—	2.7	3	dB
Insertion Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1 GHz)		$\|S_{21}\|^2$	11	13.5	—	dB
Maximum Unilateral Gain (V_{CE} = 10 Vdc, I_C = 25 mA, f = 1 GHz)		G_{Umax}	—	15.5	—	dB

TYPICAL CHARACTERISTICS

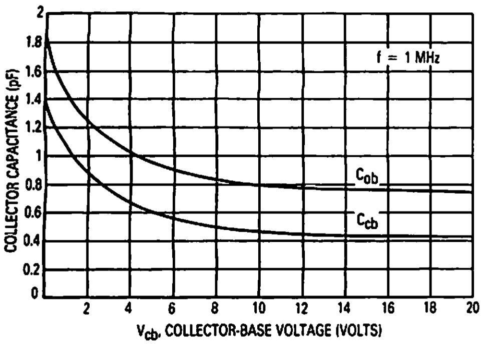


Figure 1. Device Capacitances versus Voltage

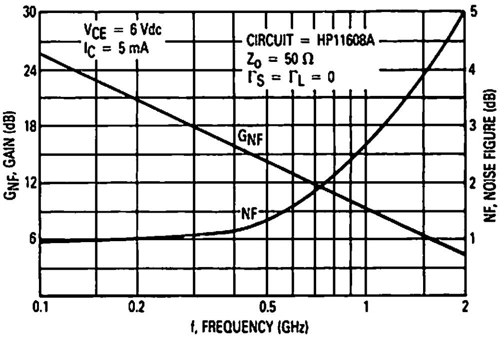


Figure 2. Gain and Noise Figure versus Frequency

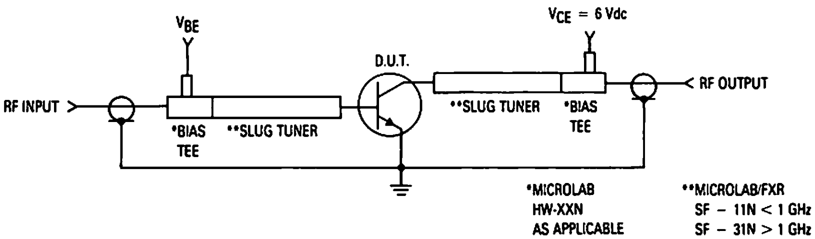


Figure 3. Functional Circuit Schematic

2

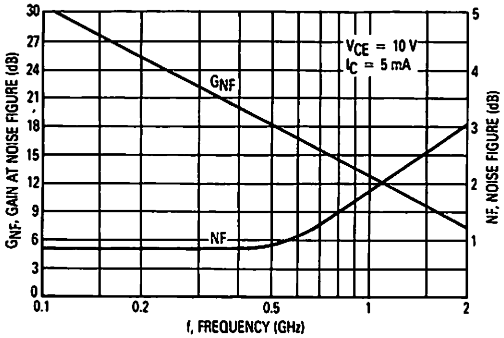


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

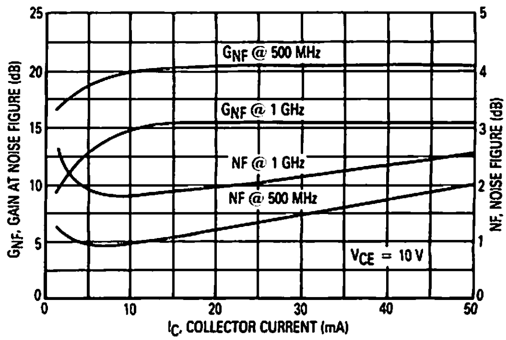


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

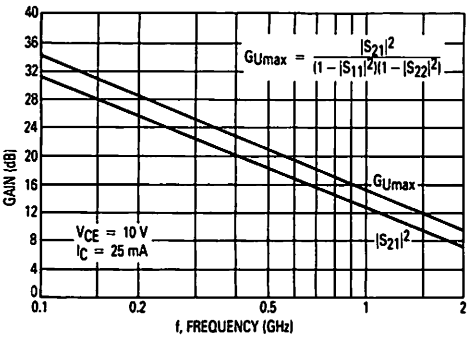


Figure 6. Unilateral-Gain and Insertion Gain versus Frequency

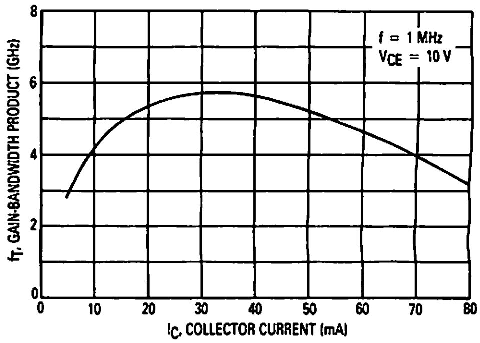


Figure 7. Gain-Bandwidth Product versus Collector Current

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5	5	100	0.84	−50	13.2	151	0.04	64	0.90	−22
		200	0.81	−87	10.4	130	0.06	49	0.74	−35
		500	0.74	−139	5.6	100	0.07	32	0.50	−48
		1000	0.68	−175	2.9	77	0.09	32	0.42	−58
		1500	0.66	167	2	61	0.09	40	0.44	−67
		2000	0.65	149	1.5	51	0.11	51	0.44	−73
	10	100	0.76	−66	20.6	144	0.03	60	0.83	−32
		200	0.73	−106	14.8	122	0.05	44	0.62	−49
		500	0.69	−153	7.1	96	0.06	37	0.36	−63
		1000	0.65	178	3.7	76	0.08	44	0.28	−71
		1500	0.62	162	2.5	63	0.09	51	0.30	−77
		2000	0.61	145	1.9	54	0.12	59	0.20	−78
	25	100	0.65	−89	28.8	134	0.03	55	0.71	−44
		200	0.67	−126	18.2	114	0.04	45	0.48	−64
		500	0.65	−163	8.3	92	0.05	45	0.27	−80
		1000	0.63	172	4.2	76	0.07	55	0.20	−90
		1500	0.60	158	2.8	64	0.10	60	0.22	−92
		2000	0.59	142	2.2	55	0.13	63	0.20	−90
	50	100	0.62	−110	30.4	126	0.02	51	0.62	−49
		200	0.66	−142	18.0	109	0.03	45	0.41	−65
		500	0.66	−171	7.9	90	0.04	52	0.25	−79
		1000	0.64	168	4.1	75	0.06	62	0.20	−91
		1500	0.62	155	2.7	62	0.10	65	0.20	−93
		2000	0.60	140	2.1	55	0.13	67	0.14	−90
10	5	100	0.86	−46	13.2	153	0.03	69	0.92	−18
		200	0.82	−81	10.6	132	0.05	51	0.80	−28
		500	0.72	−134	5.9	102	0.07	36	0.57	−38
		1000	0.65	−171	3.2	78	0.08	38	0.49	−46
		1500	0.63	169	2.1	62	0.08	47	0.52	−55
		2000	0.61	149	1.6	51	0.10	60	0.53	−61
	10	100	0.77	−60	20.7	145	0.03	62	0.85	−26
		200	0.72	−98	15.2	124	0.04	48	0.66	−38
		500	0.65	−147	7.5	97	0.06	42	0.44	−46
		1000	0.59	−177	3.9	77	0.07	48	0.37	−51
		1500	0.58	165	2.6	64	0.09	56	0.39	−59
		2000	0.56	145	2	54	0.13	65	0.40	−62
	25	100	0.67	−80	29.4	136	0.02	57	0.75	−35
		200	0.66	−118	19.3	116	0.03	47	0.53	−48
		500	0.63	−158	8.9	94	0.05	47	0.33	−55
		1000	0.61	175	4.6	77	0.07	57	0.26	−60
		1500	0.58	161	3.1	64	0.09	61	0.29	−65
		2000	0.57	144	2.3	55	0.12	66	0.30	−65
	50	100	0.65	−99	32.2	129	0.02	54	0.67	−38
		200	0.65	−135	19.5	110	0.03	44	0.45	−48
		500	0.64	−167	8.5	91	0.04	53	0.31	−51
		1000	0.61	170	4.2	75	0.06	62	0.26	−55
		1500	0.59	157	2.9	63	0.09	58	0.30	−61
		2000	0.58	141	2.3	54	0.11	71	0.31	−63

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF221 (See 2N6081)
MRF224 (See 2N6084)

MRF226

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

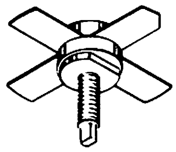
... designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating at 225 MHz.

- Specified 12.5 Volt, 225 MHz Characteristics —
  Output Power = 13 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 50%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Designed to Withstand Load Mismatch at all Phase Angles with 20:1 VSWR

13 W – 225 MHz

RF POWER TRANSISTOR

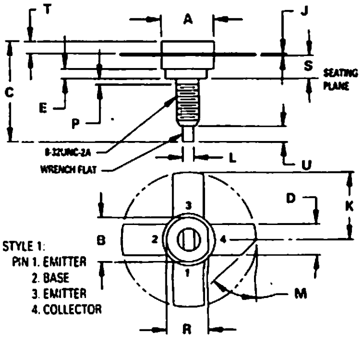
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25^\circ C$ (1) Derate above 25°C	P_D	45 257	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Stud Torque (2)	—	6.5	In. Lb.

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF amplifier.
(2) For repeated assembly, use 5 In. Lb.



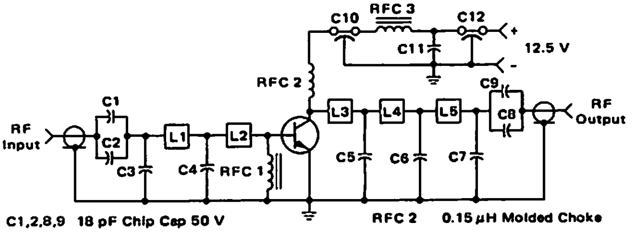
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.056	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

FIGURE 1 — 225 MHz TEST CIRCUIT SCHEMATIC



C1,2,8,9	18 pF Chip Cap 50 V	RFC 2	0.15 μH Molded Choke
C3	15 pF UNELCO	L1	0.15 x 3.15 inch Microstrip
C4,5	80 pF UNELCO	L2	0.15 x 0.55 inch Microstrip
C6	25 pF UNELCO	L3	0.15 x 1.4 inch Microstrip
C7	7.0 pF UNELCO	L4	0.15 x 2.35 inch Microstrip
C10,12	680 pF Feedthru ALLEN BRADLEY	L5	0.15 x 0.5 inch Microstrip
C11	1.0 μF, 35 V Tantalum		Board is G10 3 x 5 x 0.062 inch
RFC 1,3	Ferroxcube VK200		$\epsilon_R = 5$

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector Emitter Breakdown Voltage (I_C = 15 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	0.25	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–
FUNCTIONAL TEST (Figure 1)				
Common-Emitter Amplifier Power Gain (P_{out} = 13 W, V_{CC} = 12.5 Vdc, f = 225 MHz)	G_{PE}	9.0	–	dB
Collector Efficiency (P_{out} = 13 W, V_{CC} = 12.5 Vdc, f = 225 MHz)	η	50	–	%

FIGURE 2 – OUTPUT POWER versus INPUT POWER

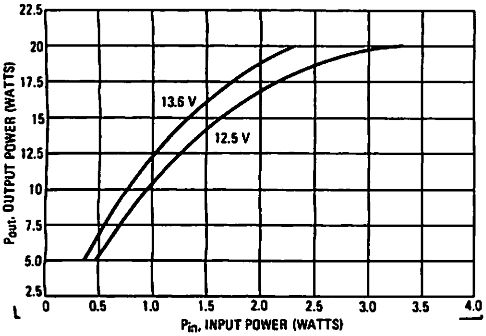
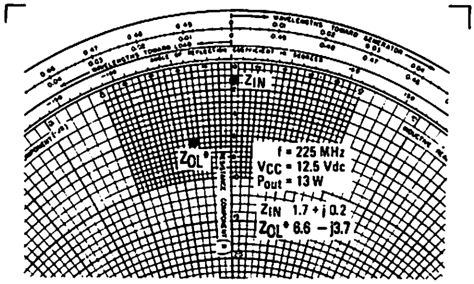


FIGURE 3 – SERIES EQUIVALENT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

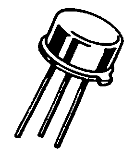
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF227

2

The RF Line

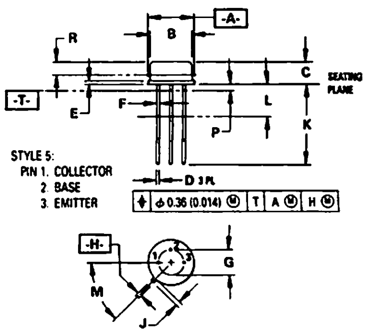
3 W – 225 MHz
RF POWER TRANSISTOR
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating at 225 MHz. Ideally suited for Class E citizens band radio.

- Specified 12.5 Volt, 225 MHz Characteristics —
  - Output Power = 3.0 Watts
  - Minimum Gain = 13.5 dB
  - Efficiency = 60%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-206AF (TO-39) Package for High Gain and Excellent Heat Dissipation
- Replaces Medium Power Stud Mount Devices



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-05
TO-206AF
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Collector Current – Continuous	I_C	600	mAdc
Total Power Dissipation @ $T_C = 25^oC$ Derate above 25°C	P_D	8.0 46	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 55°C)	I_{CES}	–	–	10	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	200	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	15	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (P_{out} = 3.0 W, V_{CC} = 12.5 Vdc, f = 225 MHz)	G_{PE}	13.5	15	–	dB
Collector Efficiency (P_{out} = 3.0 W, V_{CC} = 12.5 Vdc, f = 225 MHz)	η	60	–	–	%

FIGURE 1 — 225 MHz TEST CIRCUIT

C1,C2,C3,C4	ARCO 420
C5	1000 pF, UNELCO
C6	0.047 pF, ERIE
C7	1.0 pF, TANTALUM
L1	#18 AWG, 1" Wire Length
L2	VK200-4 Ferroxcube
L3	1 Turn, #18 AWG, 1/4" ID x 2" Wire Length
L4	0.15 μH DELEVAN Molded Choke

Board — Glass Teflon, ϵ_R = 2.56, t = 0.062"
Input/Output Connectors — Type N

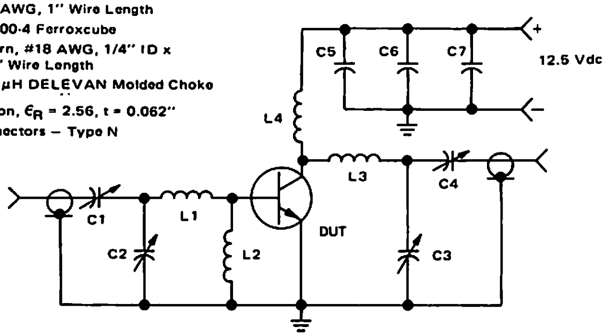


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FIGURE 2 — INPUT POWER versus OUTPUT POWER — 12.5 V

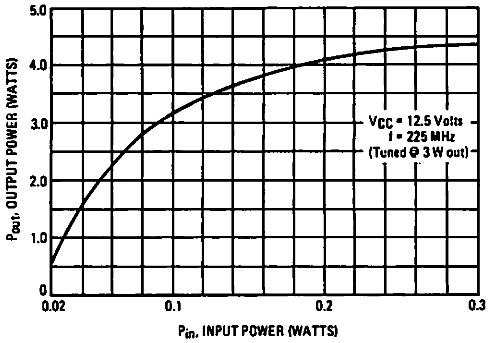

FIGURE 3 — INPUT POWER versus OUTPUT POWER — 13.6 V

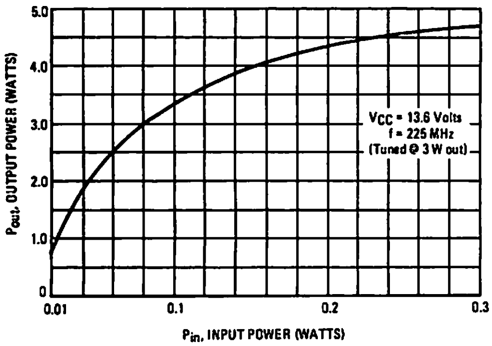

FIGURE 4 — INPUT POWER versus OUTPUT POWER — 7.5 V

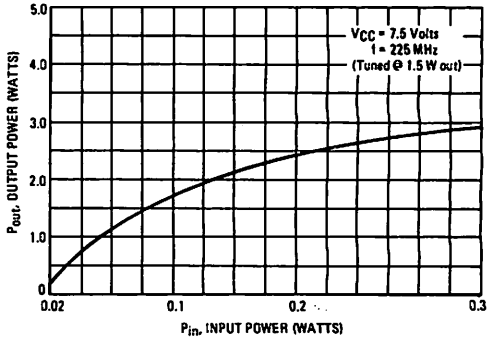

FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE

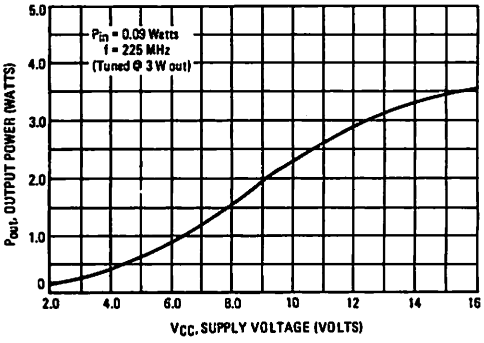

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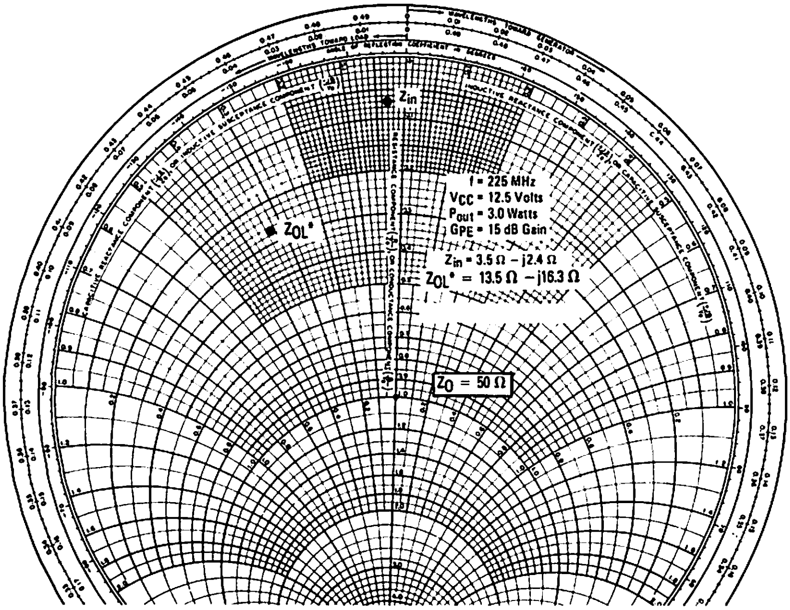
FIGURE 6 – SERIES EQUIVALENT IMPEDANCE



Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF229

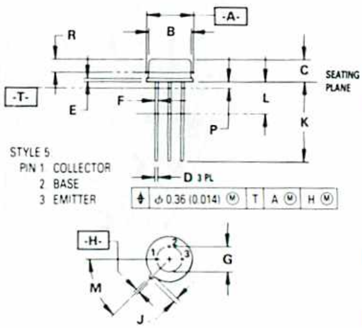
The RF Line

1.5 W – 90 MHz
RF POWER
TRANSISTOR
NPN SILICON

NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 90 MHz Characteristics –
  Output Power = 1.5 Watts
  Minimum Gain = 10 dB
  Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters
- MRF229 – Emitter Connected to Case



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-05
TO-206AF
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

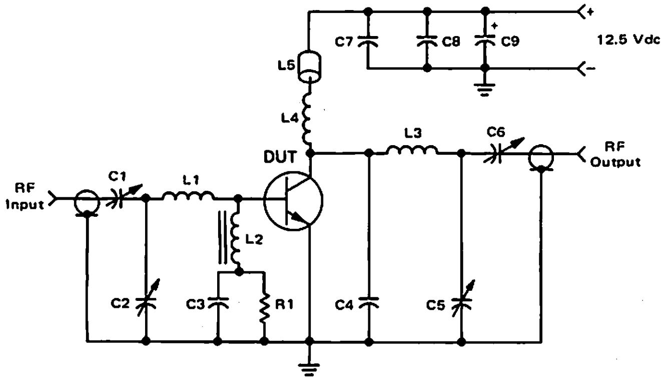
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	0.5	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	25	pF
FUNCTIONAL TESTS (Figure 1)				
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 90 MHz)	G_{PE}	10	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 90 MHz)	η	55	–	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 90 MHz, $T_C \leqslant$ 25°C)	–	No Degradation in Output Power		

FIGURE 1 — 90 MHz TEST CIRCUIT SCHEMATIC



C1	5.0-80 pF, ARCO 462	C9	20 µF, 15 Vdc TANTALUM
C2,C6	25-280 pF, ARCO 464	L1	2 Turns, #18 AWG, 3/8" I.D. 3/8" Long
C3	250 pF UNELCO	L2	2.5 Turns, #20 AWG, on Ferrite Bead. FERROXCUBE 56-590-65-3B
C4	10 pF UNELCO	L3	3 Turns, #18 AWG, 3/8" I.D., 1/2" Long
C5	9.0-180 pF, ARCO 463	L4	0.68 µH, 9230-16 MILLER Molded Choke
C7	1000 pF UNELCO	L5	Ferrite Bead, FERROXCUBE 56-590-65-3B
C8	0.47 µF ERIE Disc Ceramic	R1	4.7 OHM, 1/2 W, 10% Carbon

Input/Output Connectors — Type BNC

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

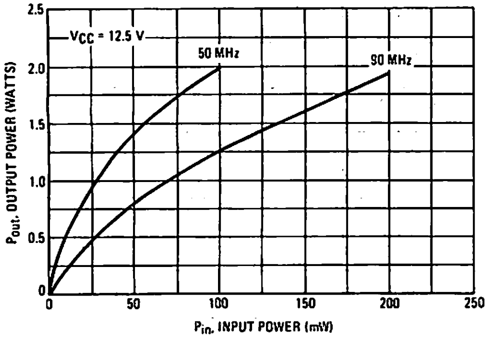


FIGURE 3 — OUTPUT POWER versus FREQUENCY

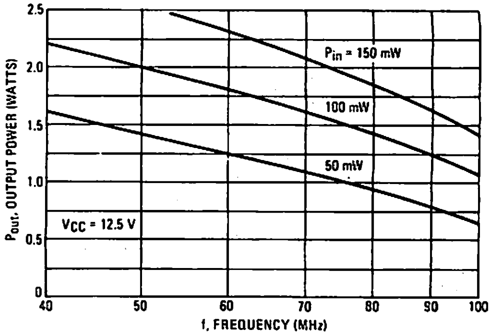


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

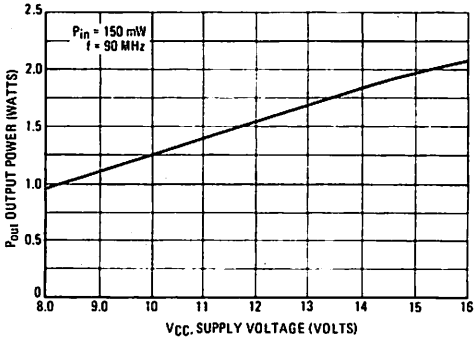
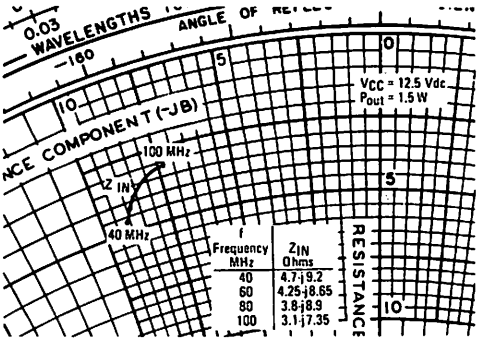
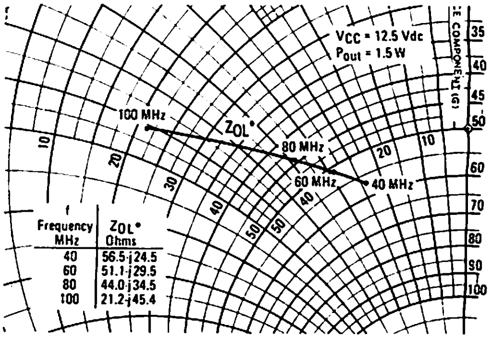


FIGURE 5

SERIES EQUIVALENT INPUT IMPEDANCE



SERIES EQUIVALENT OUTPUT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

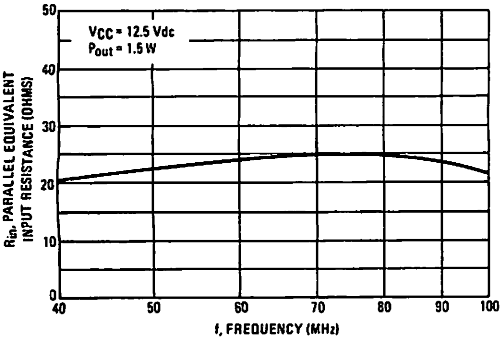


FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

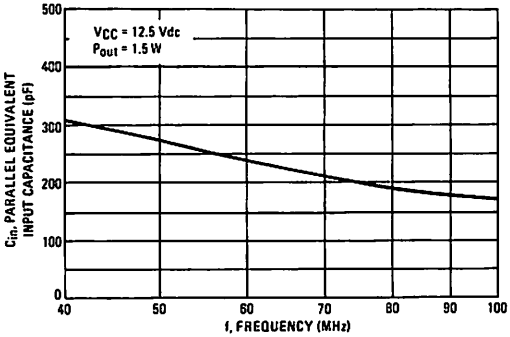


FIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE versus FREQUENCY

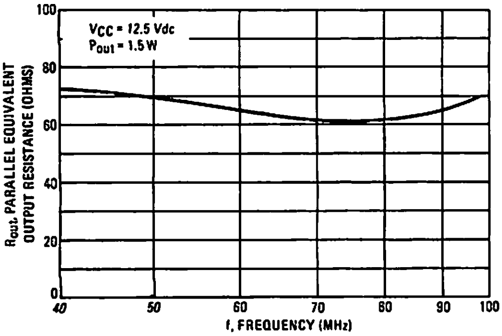
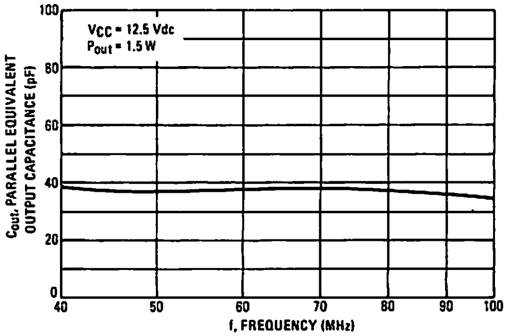


FIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY



MRF232

The RF Line

NPN SILICON RF POWER TRANSISTOR

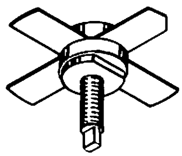
. . . designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

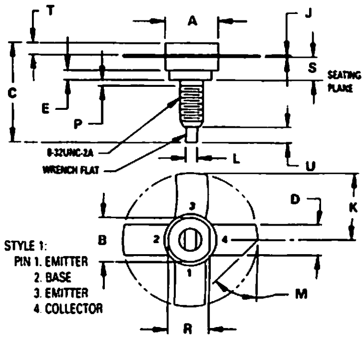
- Specified 12.5 Volt, 90 MHz Characteristics —
  Output Power = 7.5 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters

7.5 W — 90 MHz

RF POWER TRANSISTOR

NPN SILICON





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	20 114	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Stud Torque (2)	—	6.5	In. Lb.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.75	°C/W

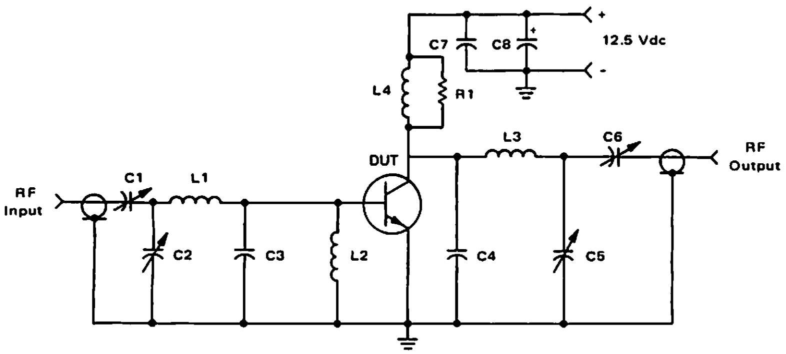
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	1.0	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	55	pF
FUNCTIONAL TESTS (Figure 1)				
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 7.5 W, f = 90 MHz)	G_{PE}	9.0	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 7.5 W, f = 90 MHz)	η	55	–	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 7.5 W, f = 90 MHz, $T_C \leqslant$ 25°C)	–	No Degradation in Output Power		

FIGURE 1 – 90 MHz TEST CIRCUIT SCHEMATIC



C1,C6	5.0-80 pF, ARCO 462	L1	3 Turns, #18 AWG, 3/8" I.D., 3/8" Long
C2,C5	9.0-180 pF, ARCO 463	L2	FERROXCUBE VK200-20-4B Ferrite Choke
C3,C4	100 pF UNELCO	L3	3 Turns, #18 AWG, 5/16" I.D., 3/8" Long
C7	1000 pF UNELCO	L4	10 Turns, #22 AWG, on R1
C8	4.7 µF, 15 Vdc, TANTALUM	R1	340 Ohm, 1 W Carbon

Input/Output Connectors – Type BNC

FIGURE 2 – OUTPUT POWER versus INPUT POWER

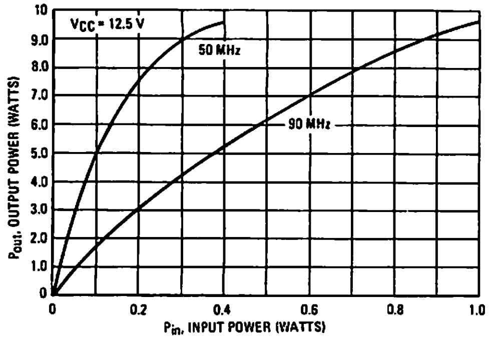


FIGURE 3 – OUTPUT POWER versus FREQUENCY

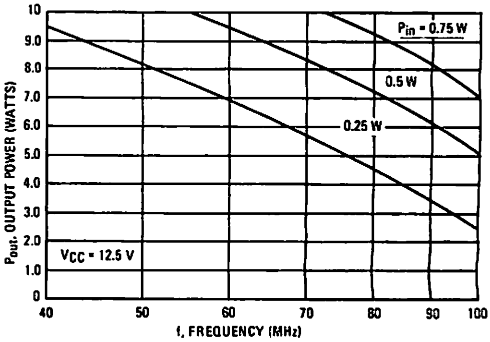


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

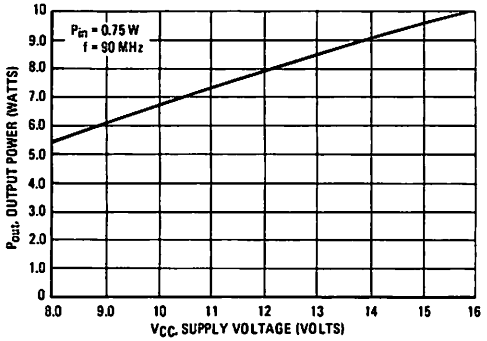
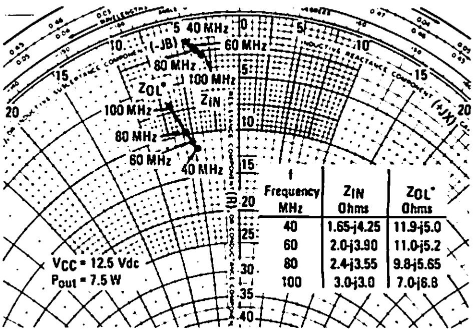


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



f Frequency MHz	Z_{IN} Ohms	Z_{OL}* Ohms
40	1.65-j4.25	11.9-j5.0
60	2.0-j3.90	11.0-j5.2
80	2.4-j3.55	9.8-j5.65
100	3.0-j3.0	7.0-j6.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

FIGURE 6 — PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

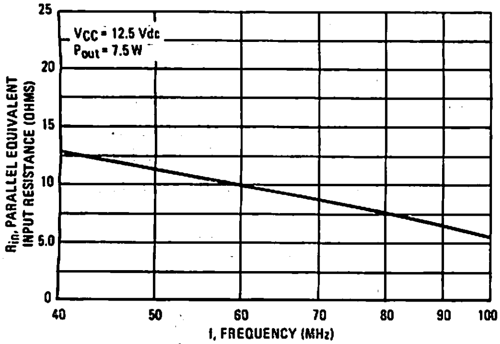


FIGURE 7 — PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

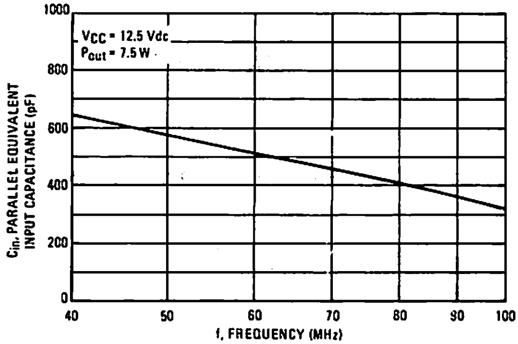


FIGURE 8 — PARALLEL EQUIVALENT OUTPUT RESISTANCE versus FREQUENCY

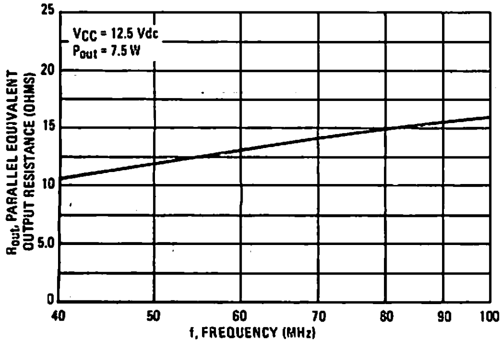
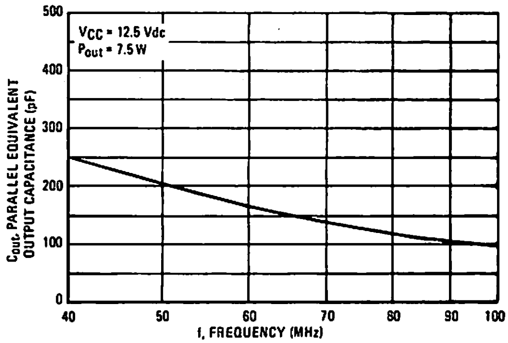


FIGURE 9 — PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY



MRF233

The RF Line

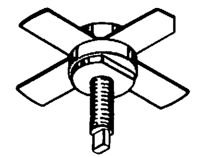
2

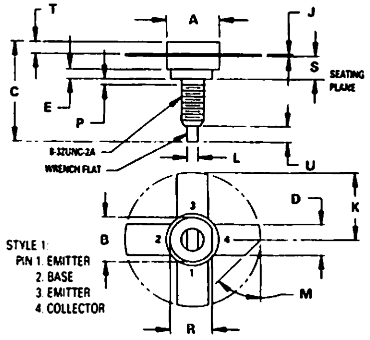
NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 90 MHz Characteristics –
  Output Power = 15 Watts
  Minimum Gain = 10 dB
  Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters

15 W – 90 MHz
RF POWER TRANSISTOR
NPN SILICON





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	3.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D –	50 285	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Stud Torque (2)	–	6.5	In-lb

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.5	°C/W

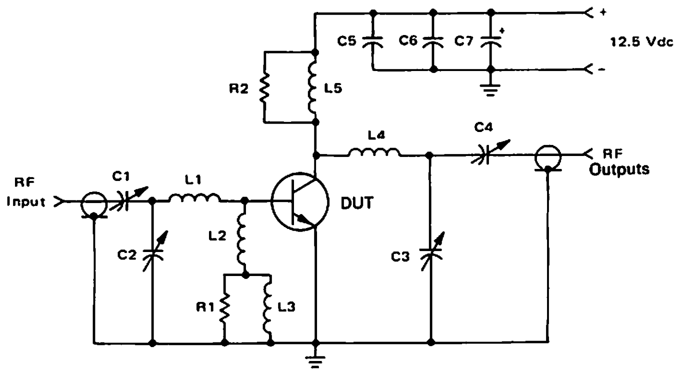
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	100	120	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 90 MHz)	G_{PE}	10	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 90 MHz)	η	55	–	–	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 90 MHz, $T_C \leqslant$ 25°C)	–	No Degradation in Output Power			

FIGURE 1 – 90 MHz TEST CIRCUIT SCHEMATIC



C1,C3	9.0-180 pF, ARCO 463	L3	2.2 µH, 9230-200 MILLER Molded Choke
C2,C4	25-280 pF ARCO 464	L4	2 Turns, #18 AWG, 3/8" I.D., 3/8" Long
C5	1000 pF UNELCO	L5	10 Turns, #16 AWG, Wound On R2.
C6	0.01 µF ERIE Disc Ceramic		
C7	1.0 µF, 35 Vdc TANTALUM	R1	15 Ohm, 1/2 W, 10% Carbon
L1	2 Turns, #18 AWG, 3/8" I.D., 1/4" Long	R2	68 Ohm, 1 Watt, 10% Carbon
L2	0.22 µH, 9230-04 MILLER Molded Choke	Input/Output Connectors – Type BNC	

FIGURE 2 — OUTPUT POWER versus INPUT POWER

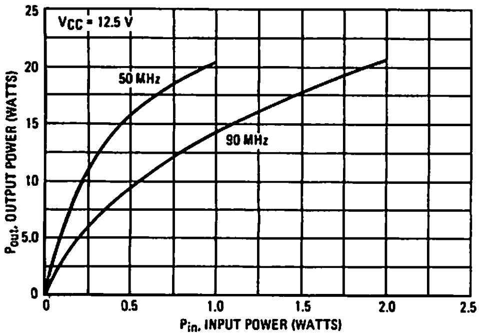


FIGURE 3 — OUTPUT POWER versus FREQUENCY

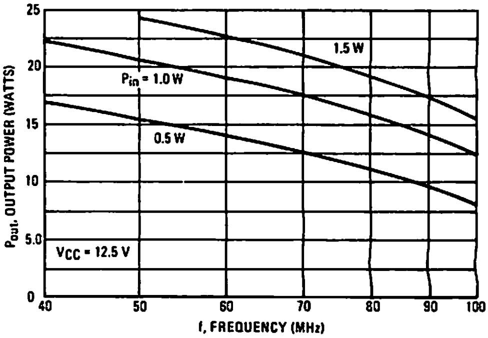


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

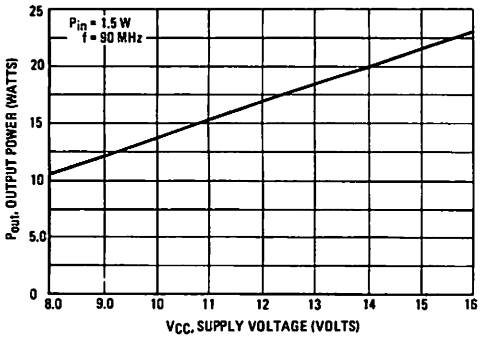
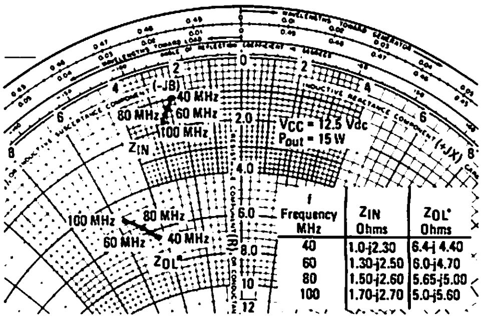


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE

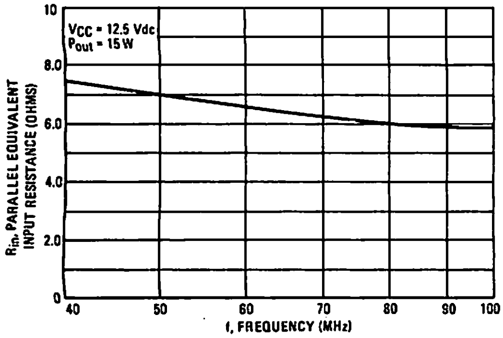


f Frequency MHz	Z_{IN} Ohms	Z_{OL}* Ohms
40	1.0-j2.30	6.4-j 4.40
60	1.30-j2.50	6.0-j4.70
80	1.50-j2.60	5.65-j5.00
100	1.70-j2.70	5.0-j5.60

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY



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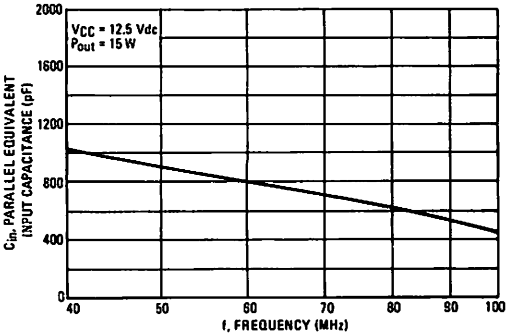

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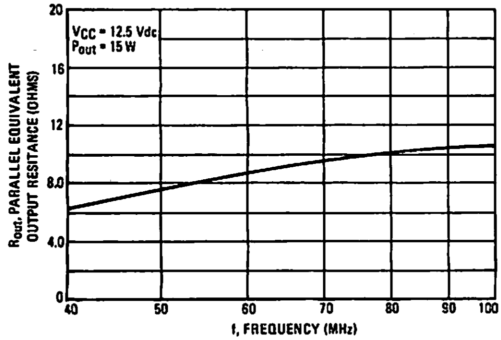

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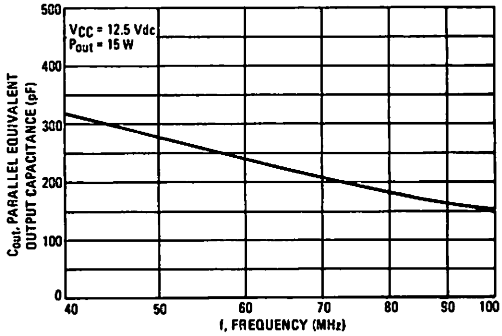
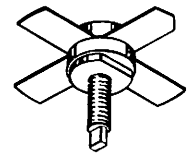


MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF234

The RF Line

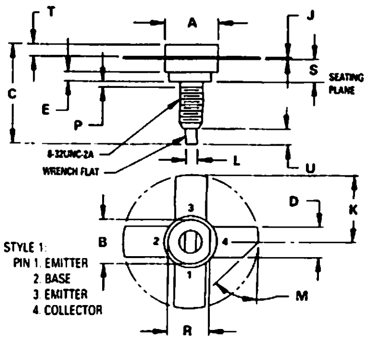
25 W – 90 MHz
RF POWER
TRANSISTOR
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt, mid-band large-signal amplifier applications in industrial and commercial FM equipment operating in the 40 to 100 MHz range.

- Specified 12.5 Volt, 90 MHz Characteristics –
  Output Power = 25 Watts
  Minimum Gain = 9.5 dB
  Efficiency = 55%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR.
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Characterized with Parallel Equivalent Large-Signal Impedance Parameters



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	70 400	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Stud Torque (2)	—	6.5	In. Lb.

THERMAL CHARACTERISTICS

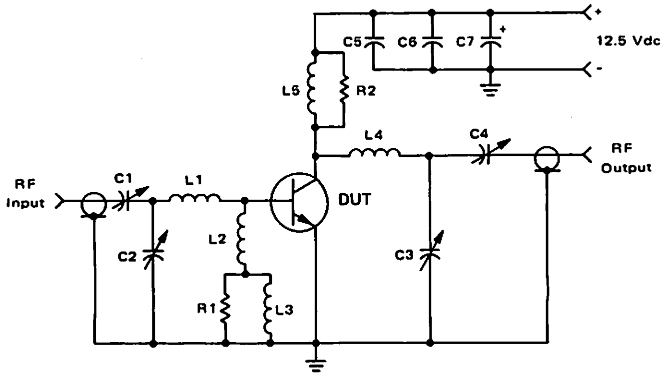
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class C RF Amplifier.
(2) For repeated assembly use 5 In. Lb.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	--	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	100	120	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 90 MHz)	G_{PE}	9.5	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 90 MHz)	η	55	–	–	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 90 MHz, $T_C \leqslant$ 25°C	–	No Degradation in Output Power			

FIGURE 1 — 90 MHz TEST CIRCUIT SCHEMATIC



C1,C4	5.0-80 pF, ARCO 462	L3	22 μH, 9230-52 MILLER Molded Choke
C2,C3	25-280 pF, ARCO 464	L4	2 Turns, #14 AWG, 3/8" I.D., 1/4" Long
C5	1000 pF UNELCO	L5	10 Turns, #18 AWG, 1/4" I.D., wound on R2
C6	0.047 μF, ERIE disc ceramic	R1	15 Ohms, 1/2 W, 10%
C7	10 μF, 15 Vdc TANTALUM	R2	47 Ohm, 1 W Carbon
L1	1 Turn, #16 AWG, 3/8" I.D., 1/8" Long		
L2	0.22 μH, 9230-04 MILLER Molded Choke		

Input/Output Connector – Type BNC

2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

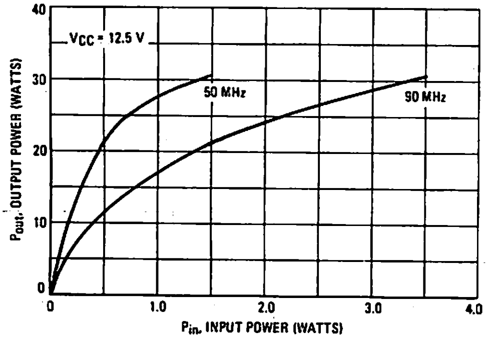


FIGURE 3 – OUTPUT POWER versus FREQUENCY

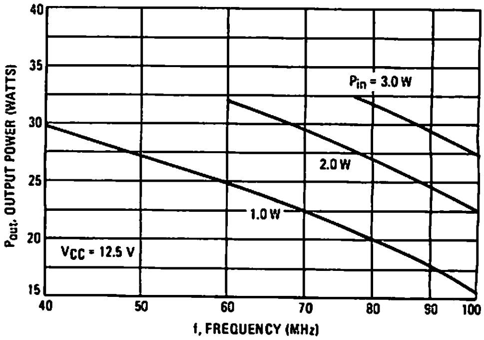


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

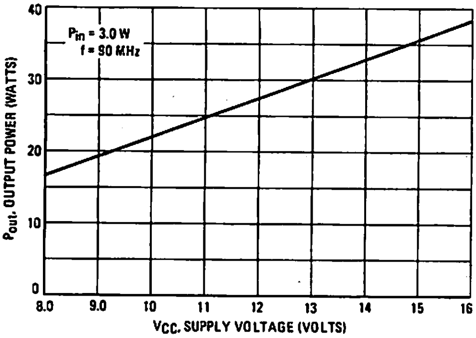
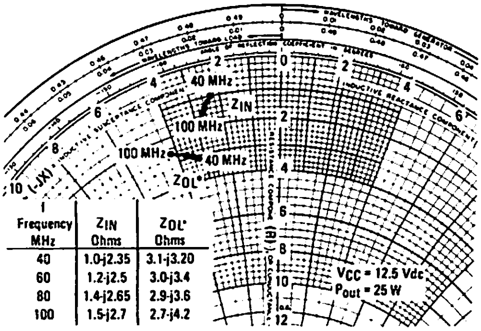


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



f Frequency MHz	Z_{IN} Ohms	Z_{OL}^* Ohms
40	1.0-j2.35	3.1-j3.20
60	1.2-j2.5	3.0-j3.4
80	1.4-j2.65	2.9-j3.6
100	1.5-j2.7	2.7-j4.2

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 6 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

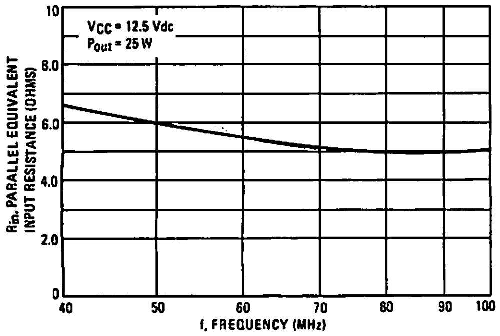


FIGURE 7 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

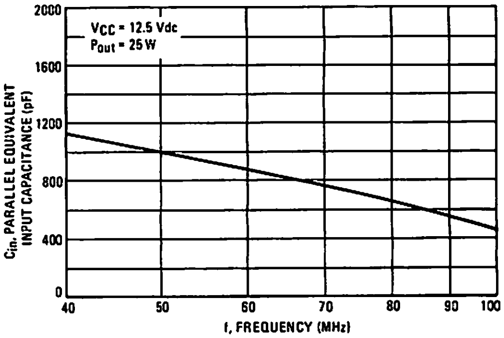


FIGURE 8 – PARALLEL EQUIVALENT OUTPUT RESISTANCE versus FREQUENCY

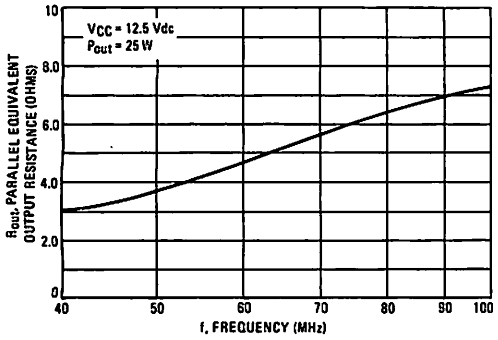
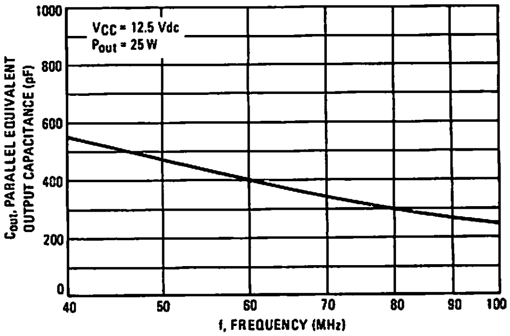


FIGURE 9 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY



MRF237

The RF Line

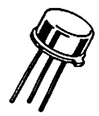
2

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt large-signal power amplifier applications in communication equipment operating to 225 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 4.0 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-39 Package for High Gain and Excellent Heat Dissipation
- Replaces Medium Power Stud Mount Devices

4 W – 175 MHz
RF POWER TRANSISTOR
NPN SILICON



MAXIMUM RATINGS

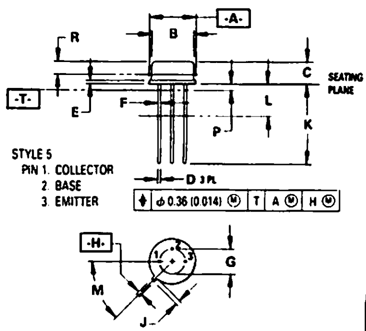
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Power Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.0 45.7	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	22	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 0.1 MHz)	C_{ob}	–	15	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (P_{out} = 4.0 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	12	14	–	dB
Collector Efficiency (P_{out} = 4.0 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	50	62	–	%

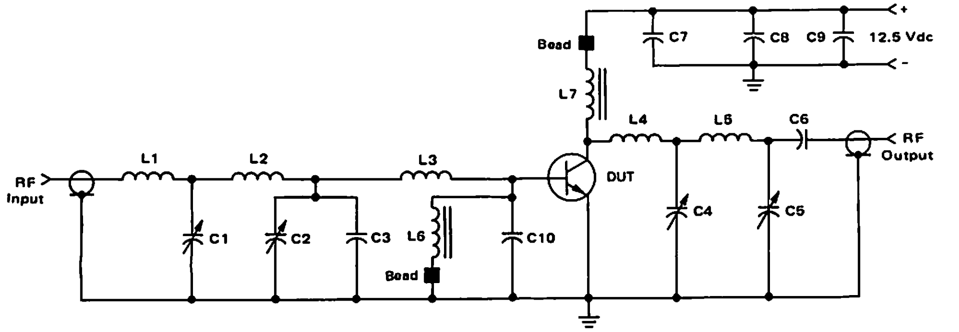


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
P	–	1.27	–	0.050
R	2.54	–	0.100	–

CASE 79-05
TO-206AF
(TO-39)

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1,C4,C5	3.0 - 180 pF, ARCO 463	L1	1/2 Turn, #16 AWG, 0.5" I.D.
C2	1.75 - 30 pF, ARCO 461	L2	1", #16 AWG
C3	40 pF, UNELCO	L3	0.75" #16 AWG
C6	0.01 μF, ERIE	L4,L5	1 Turn, #16 AWG, 0.5" I.D.
C7	0.1 μF, ERIE REDCAP	L6	0.15 μH Molded Choke
C8	1.0 μF, TANTALUM	L7	1.2 μH Molded Choke
C9	1000 pF, UNELCO	Beads	FERRITE Beads, FERROXCUBE
C10	100 pF UNELCO		#56-570-65/3B

FIGURE 2 — OUTPUT POWER versus INPUT POWER

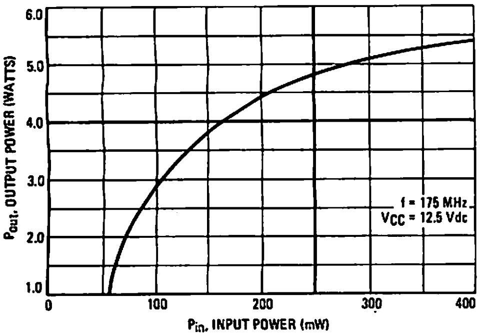


FIGURE 3 — OUTPUT POWER versus FREQUENCY

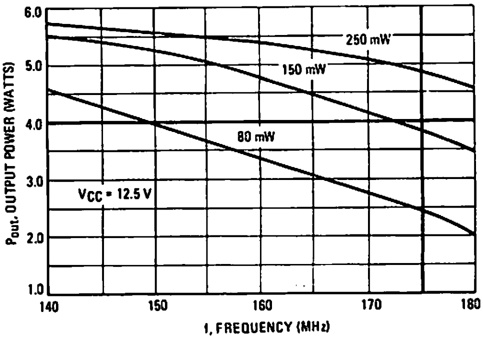


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

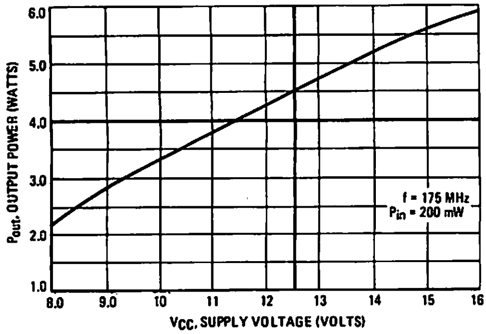
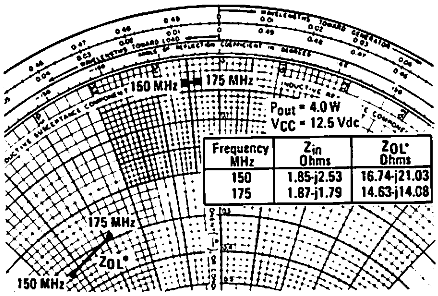


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRF240
MRF240A

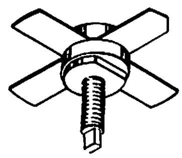
2

The RF Line

40 W — 145–175 MHz

RF POWER TRANSISTORS

NPN SILICON



NPN SILICON RF POWER TRANSISTORS

. . . designed for 13.6 volt VHF large-signal class C and class AB linear power amplifier applications in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 13.6 V, 160 MHz Performance:
  Output Power = 40 Watts
  Power Gain = 9.0 dB Min
  Efficiency = 55% Min
- Load Mismatch Capability at Rated Voltage and RF Drive
- Silicon Nitride Passivated
- Low Intermodulation Distortion, d_3 = -30 dB Typ

MAXIMUM RATINGS

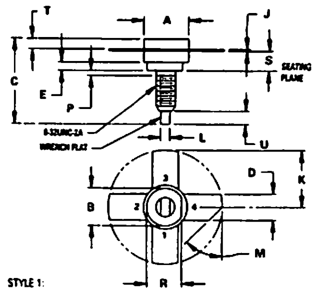
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ T_C = 25°C (1)	P_D	100	Watts
Derate above 25°C		0.57	W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.75	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(2) Thermal Resistance is determined under specified RF operating conditions by infra-red measurement techniques.

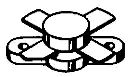


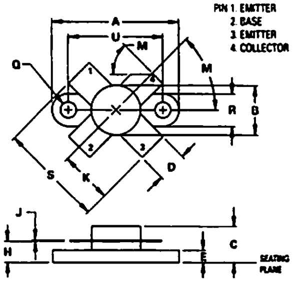
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION. INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.39	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.056	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09
MRF240





MRF240A
CASE 211-07

STYLE 1
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION. INCH

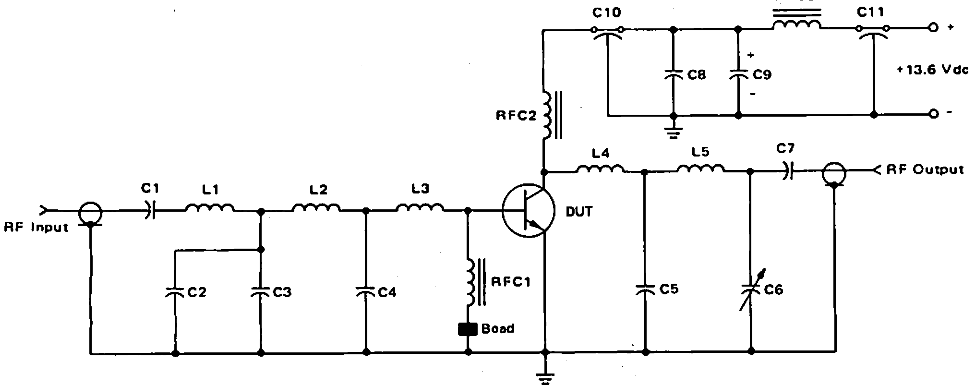
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	70	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	90	125	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 40 W, f = 160 MHz)	G_{PE}	9.0	10	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 40 W, f = 160 MHz)	η	55	–	–	%
TYPICAL SSB PERFORMANCE					
Intermodulation Distortion (1) (V_{CC} = 13.6 Vdc, P_{out} = 35 W (PEP), f1 = 146 MHz, f2 = 146.002 MHz, I_{CQ} = 50 mAdc)	IMD (d_3)	–	-30	–	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 – 160 MHz TEST CIRCUIT SCHEMATIC



C1	200 pF, 350 Vdc, UNELCO	C10,C11	680 pF ALLEN BRADLEY Feedthru	L3	1.2 x 0.6 cm Brass Pad
C2	100 pF, 350 Vdc, UNELCO	RFC1	0.15 μH Molded Choke	L4	1.2 x 0.6 cm Brass Pad and 2.0 x 0.2 cm AIRLINE Inductor
C3	40 pF, 350 Vdc, UNELCO	RFC2	10 Turns, #18 AWG on 470 Ohm, 1 Watt Resistor		
C4,C5	80 pF, 350 Vdc, UNELCO			Board:	G10, ϵ_r = 5, t = 62 mils 2 sided, 2 oz. Clad
C6	1.0–20 pF, ARCO Trimmer	Bead	FERROXCUBE Bead		
C7	100 pF 350 Vdc, UNELCO	RFC3	FERROXCUBE Choke, VK200-4B		
C8	0.1 μF ERIE Disc Ceramic	L1	3.3 x 0.2 cm AIRLINE Inductor	Connectors:	Type N
C9	1.0 μF TANTALUM	L2	1.0 x 0.2 cm AIRLINE Inductor		

2

FIGURE 2 — POWER GAIN versus FREQUENCY

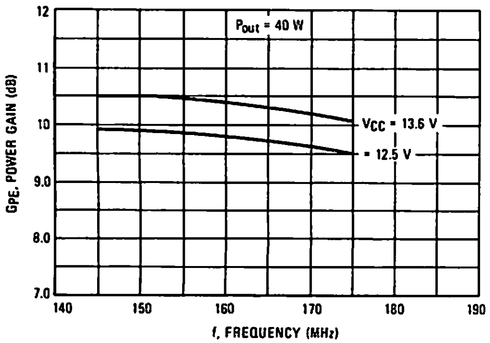


FIGURE 3 — OUTPUT POWER versus INPUT POWER

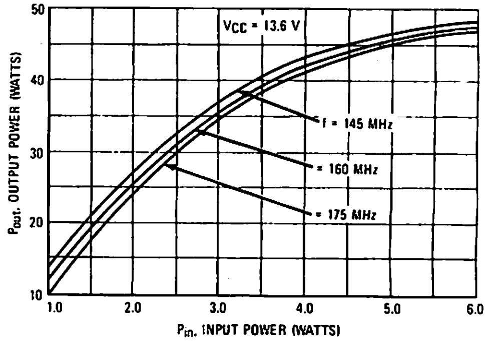


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
145 MHz

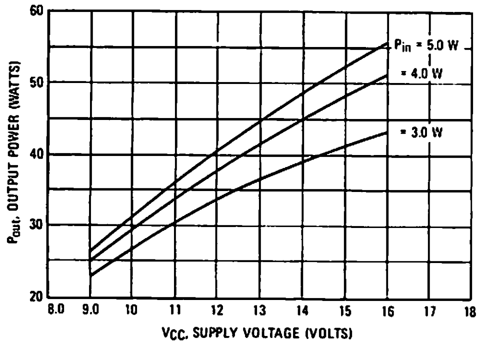


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
160 MHz

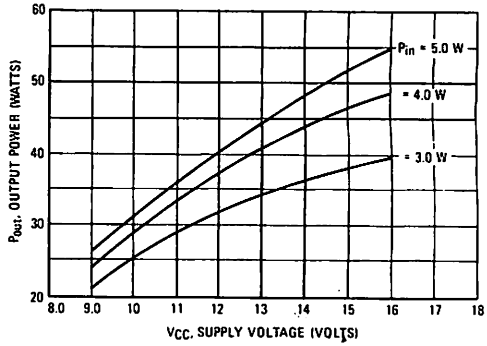


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

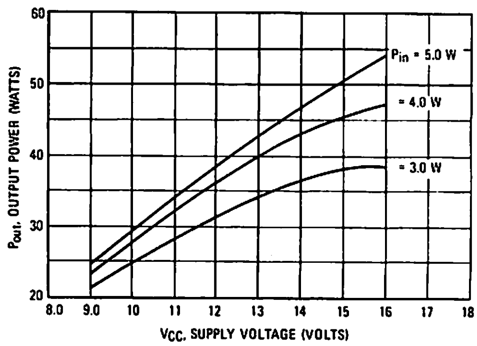
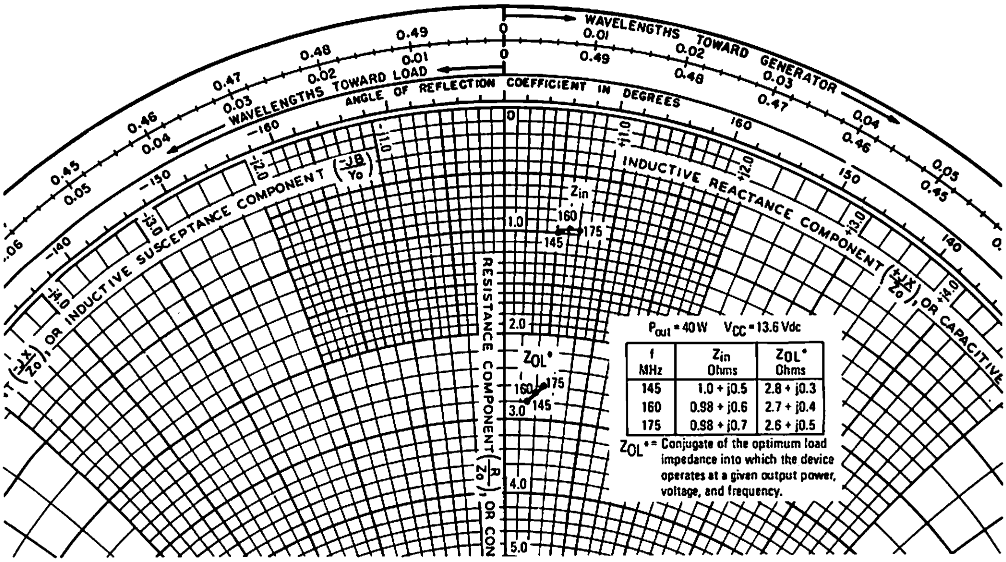


FIGURE 7 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{out} = 40 W V_{CC} = 13.6 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
145	1.0 + j0.5	2.8 + j0.3
160	0.98 + j0.6	2.7 + j0.4
175	0.98 + j0.7	2.6 + j0.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MRF247

The RF Line

2

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —

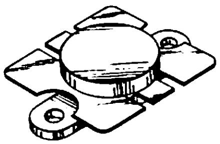
  Output Power = 75 Watts
  Minimum Gain = 7.0 dB
  Efficiency = 55%

- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Internal Matching Network Optimized for Minimum Gain Frequency Slope Response Over the Range 136 to 175 MHz
- Load Mismatch Capability at Rated P_{out} and Supply Voltage

75 W — 175 MHz

CONTROLLED Q RF POWER TRANSISTOR

NPN SILICON



MAXIMUM RATINGS

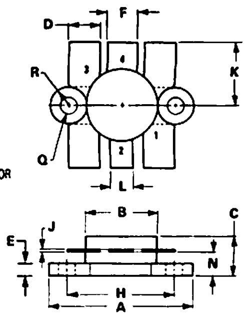
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak	I_C	20	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(2) Thermal Resistance is determined under specified RF operating conditions by infra-red measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.33	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.065	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	75	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	235	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz)	G_{PE}	7.0	8.5	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz)	η	55	60	–	%
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 75 Watts, f = 175 MHz, VSWR = 30:1 All Phase Angles)	ψ	No Degradation In Output Power			

FIGURE 1 — OUTPUT POWER versus INPUT POWER

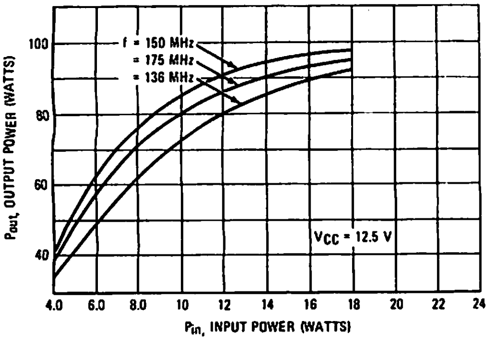


FIGURE 2 — POWER GAIN versus FREQUENCY

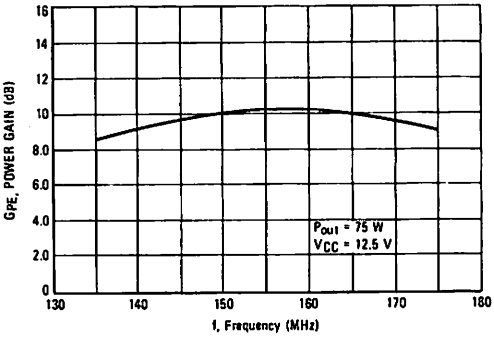


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

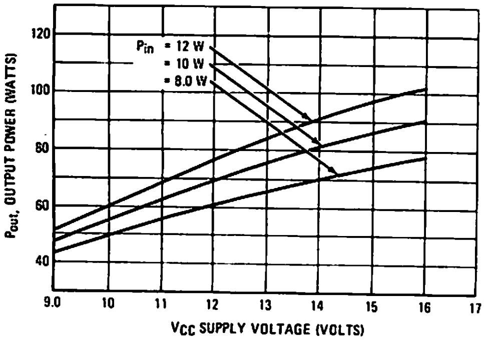


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

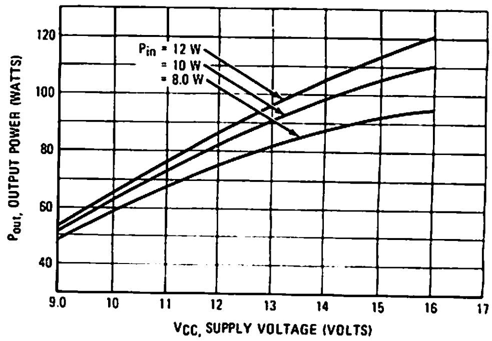


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

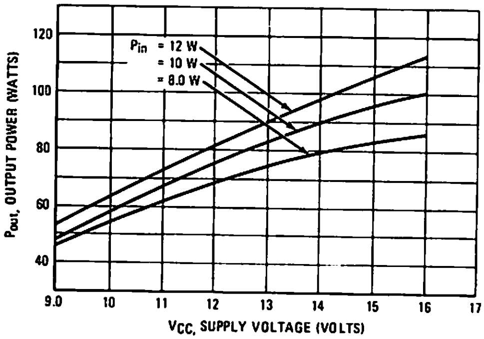
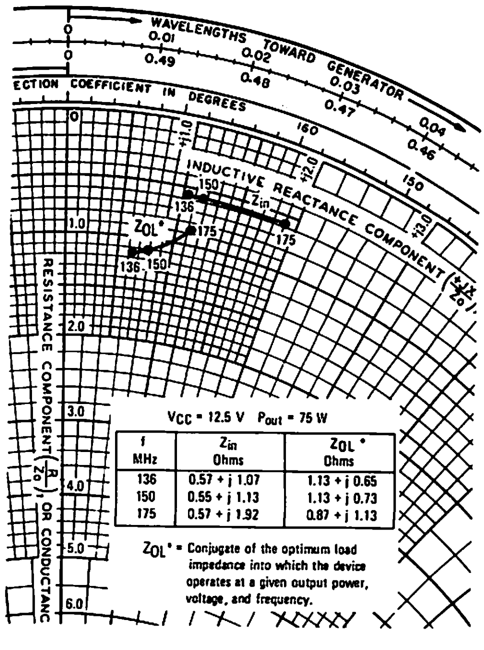


FIGURE 6 — SERIES EQUIVALENT IMPEDANCES



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	0.57 + j 1.07	1.13 + j 0.65
150	0.55 + j 1.13	1.13 + j 0.73
175	0.57 + j 1.92	0.87 + j 1.13

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MRF260

The RF Line

5 W 136–175 MHz

RF POWER TRANSISTOR

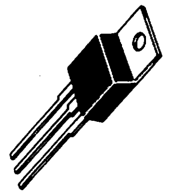
NPN SILICON

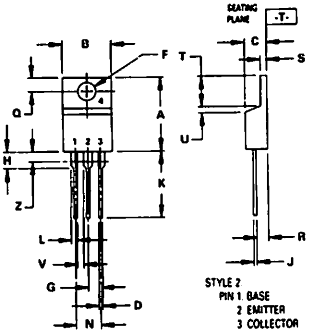
2

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance:
  - *Output Power* 5.0 Watts
  - Power Gain 10 dB Min
  - Efficiency 55% Min
- Load Mismatch Capability at High Line and Rated RF Input
- Other Devices in the Series:
  - MRF261 10 Watts
  - MRF262 15 Watts
  - MRF264 30 Watts





STYLE 2
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	12 68.5	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	14.6	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

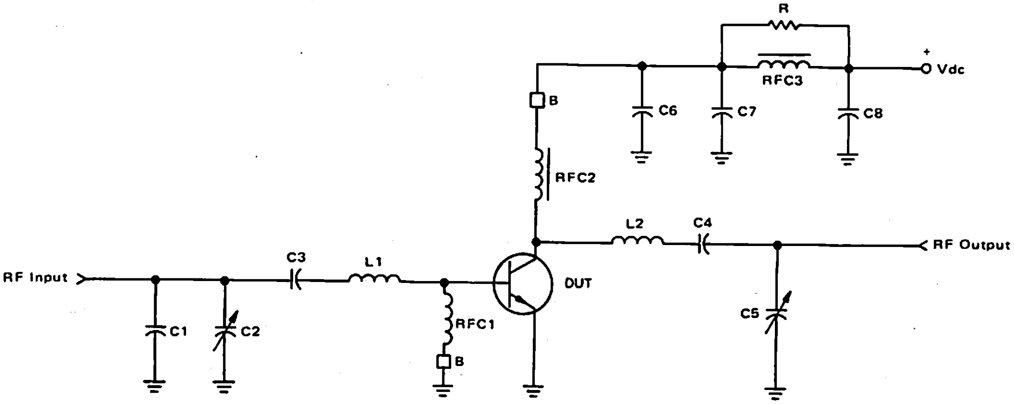
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	15	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W, f = 175 MHz)	G_{PE}	10	11	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W, f = 175 MHz)	η	55	–	–	%

FIGURE 1 — 175 MHz TEST CIRCUIT



C1 — 40 pF Underwood
C2, C5 — Johanson Trimmer #JMC-5501
C3 — 60 pF Underwood
C4 — 25 pF Underwood
C6 — 1000 pF Underwood
C7 — 0.1 μF Erie Red Cap
C8 — 100 μF Electrolytic, 15 V

L1 — 1-1/2 Turns, #18 AWG, 3/16" ID, l = 1/8"
L2 — 3 Turns, #18 AWG, 5/16" ID, l = 1/4"
R — 10 Ω, 1.0 W
B — Ferroxcube Bead 56-590-65-3B
RFC1 — 0.15 μH Molded Coil
RFC2 — 0.15 μH Molded Coil
RFC3 — Ferroxcube VK200-20-4B
Board Material:
Teflon Fiberglass — G10, thickness = 0.062 inches.

FIGURE 2 – POWER GAIN versus FREQUENCY

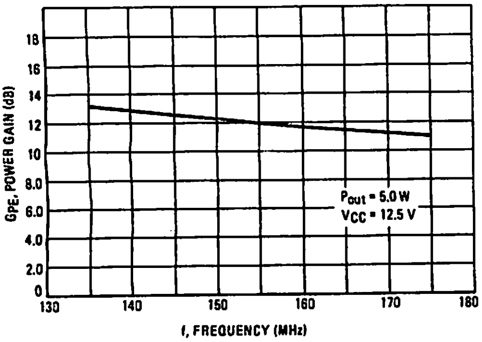


FIGURE 3 – OUTPUT POWER versus INPUT POWER

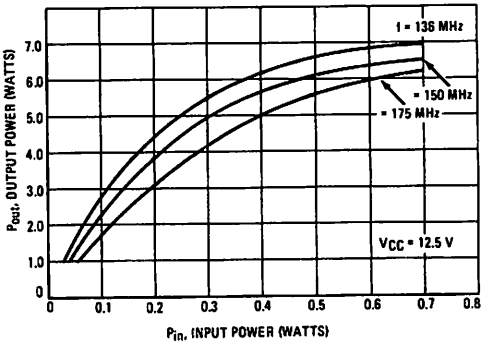


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

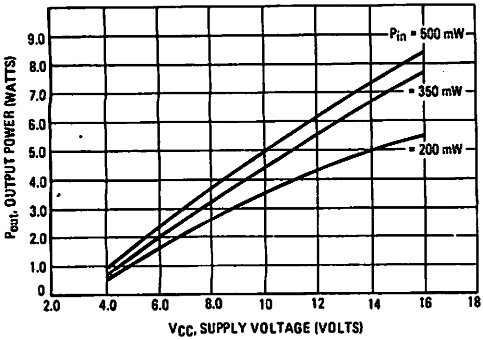


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

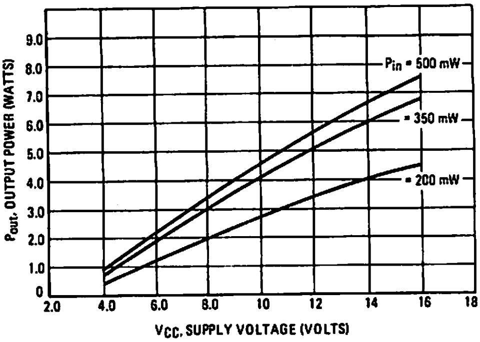


FIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

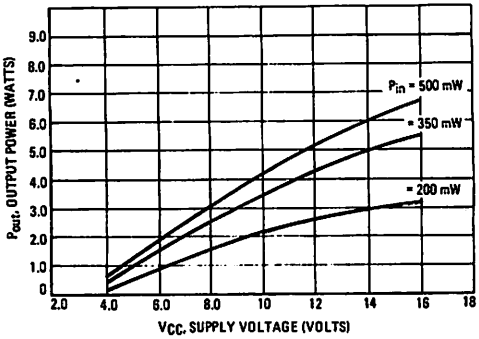
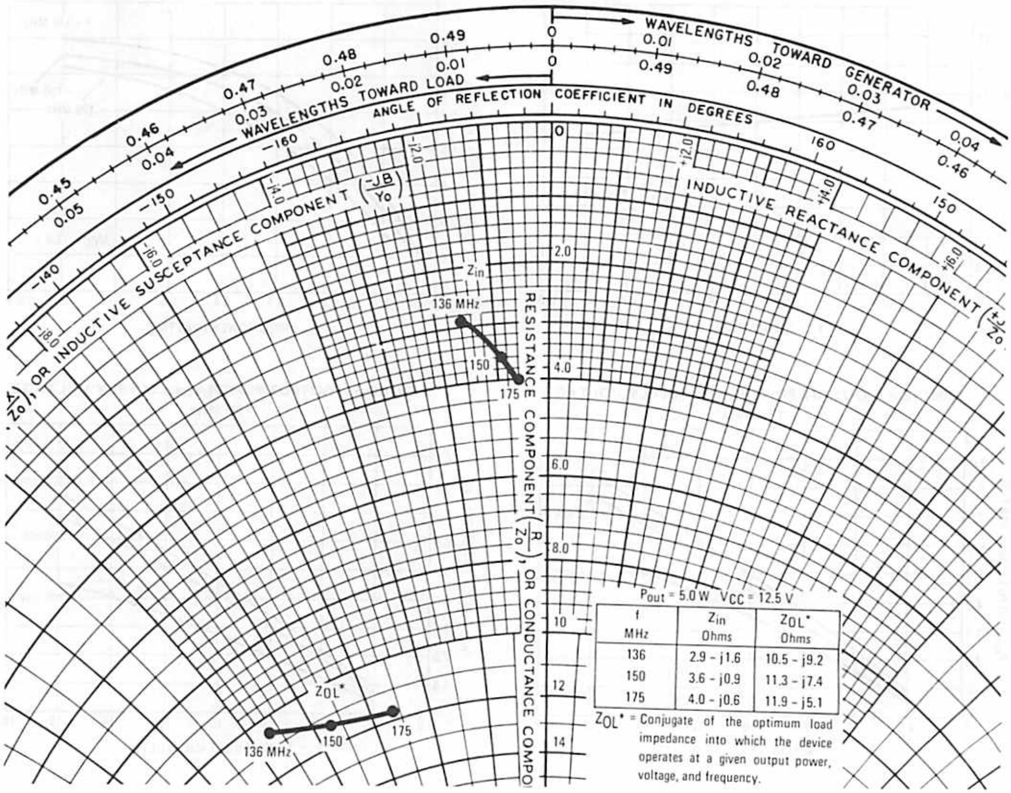


FIGURE 7 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

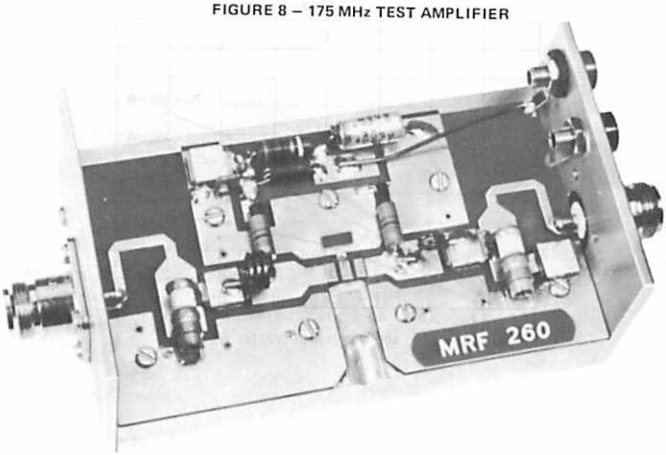


P_{out} = 5.0 W V_{CC} = 12.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	2.9 - j1.6	10.5 - j9.2
150	3.6 - j0.9	11.3 - j7.4
175	4.0 - j0.6	11.9 - j5.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 8 – 175 MHz TEST AMPLIFIER



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

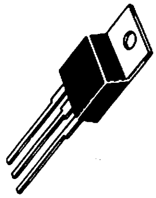
MRF261

The RF Line

10 W 136-175 MHz

RF POWER TRANSISTOR

NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance —
  Output Power = 10 Watts
  Power Gain = 5.2 dB Min
  Efficiency = 50% Min
- Load Mismatch Capability at High Line and RF Overdrive
- Other Devices in the Series —
  MRF260 5.0 Watts
  MRF262 15 Watts
  MRF264 30 Watts

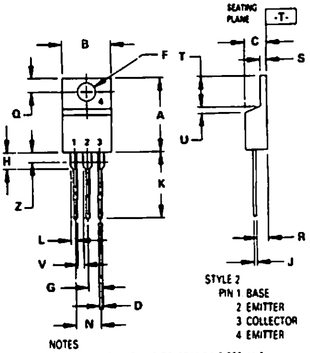
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	30 171	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.85	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

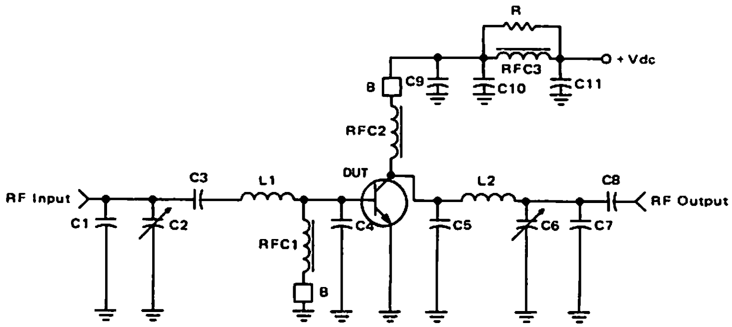
2

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	65	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	35	50	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 175 MHz)	G_{PE}	5.2	7.0	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 175 MHz)	η	50	—	—	%

FIGURE 1 — 175-MHz TEST CIRCUIT



C1 – 10 pF Underwood
C2, C6 – Johanson Trimmer #5501
C3 – 60 pF Underwood
C4 – 150 pF Underwood
C5 – 100 pF Underwood
C7, C8 – 15 pF Underwood
C9 – 1000 pF Underwood
C10 – 0.1 μF Erie Red Cap
C11 – 100 μF Electrolytic, 15 Vdc

L1 – 2 Turns, #18 AWG, 5/16" ID
L2 – 1-1/2 Turns, #18 AWG, 5/16" ID
R – 10 Ω, 1.0 W
B – Ferroxcube Bead 56-590-65-3B
RFC1 – 0.15 μH Molded Coil
RFC2 – 6 Turns #18 Wire, 5/16" ID
RFC3 – VK200-20/4B
Board Material – Teflon Fiberglass
t = 0.062"

FIGURE 2 — POWER GAIN versus FREQUENCY

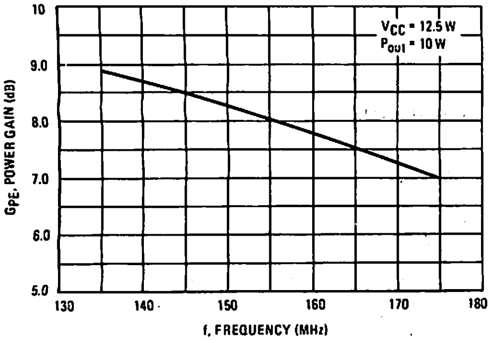


FIGURE 3 — OUTPUT POWER versus INPUT POWER

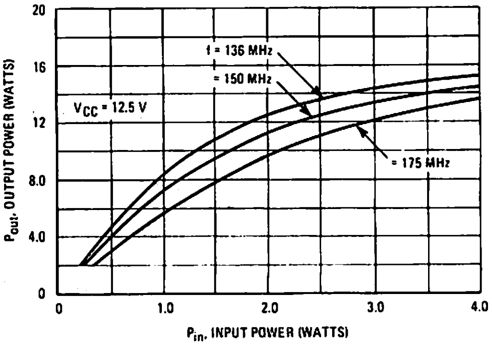


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

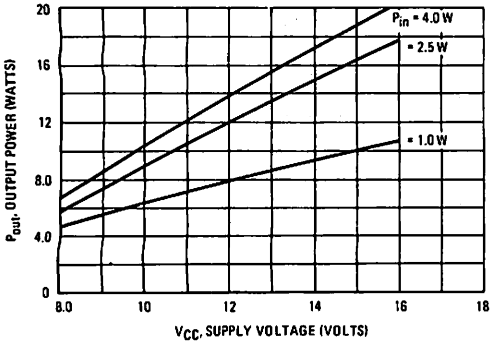


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

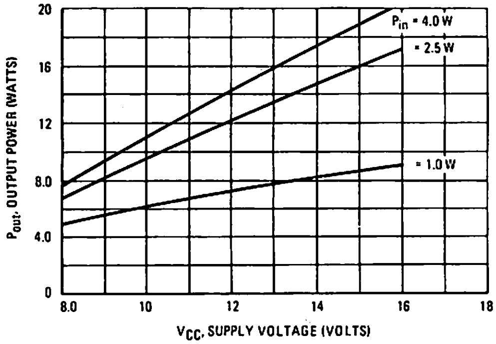
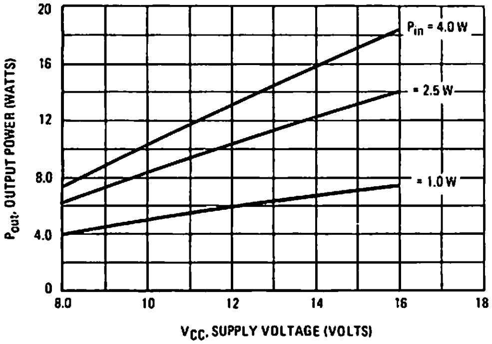
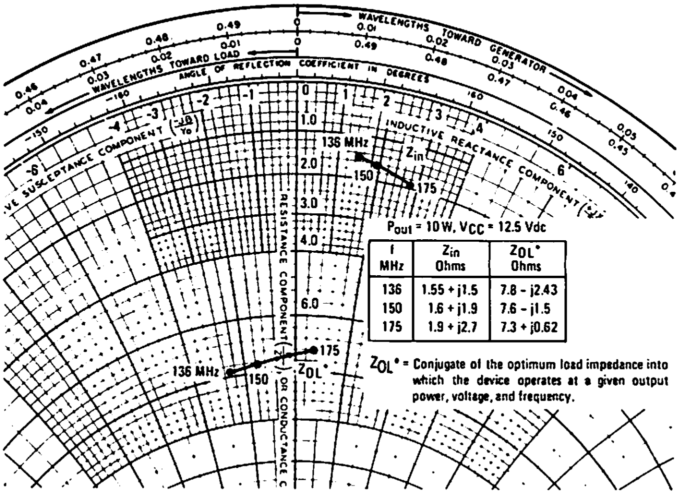


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz



2

FIGURE 7 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{out} = 10 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	1.55 + j1.5	7.8 - j2.43
150	1.6 + j1.9	7.6 - j1.5
175	1.9 + j2.7	7.3 + j0.62

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF262

2

The RF Line

15 W 136–175 MHz

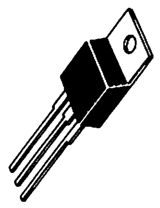
RF POWER TRANSISTOR

NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal power amplifier applications in commercial and industrial equipment.

- Low-Cost Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance:
  - Output Power 15 Watts
  - Power Gain 6.3 dB Min
  - Efficiency 55% Min
- Load Mismatch Capability at Rated Voltage and RF Drive
- Other Devices in the Series:
  - MRF260 5.0 Watts
  - MRF261 10 Watts
  - MRF264 30 Watts



MAXIMUM RATINGS

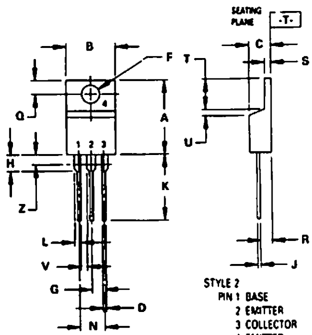
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	40 225	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4.38	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2
PIN 1 BASE
2 EMITTER
3 COLLECTOR
4 EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

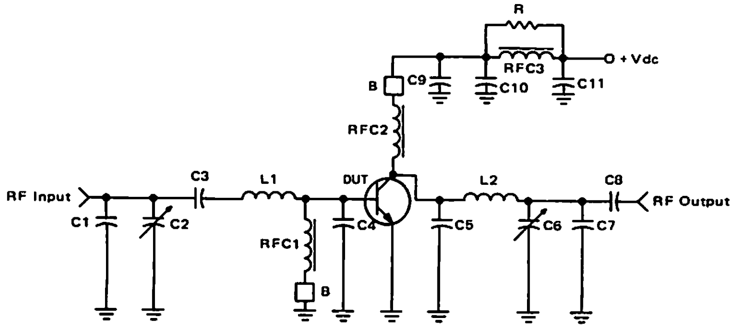
CASE 221A-04
TO-220AB

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz	C_{ob}	–	40	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	G_{PE}	6.3	8.2	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	η	55	–	–	%

FIGURE 1 – 175 MHz TEST CIRCUIT



C1 – 10 pF Underwood
C2, C6 – Johanson Trimmer #5501
C3 – 60 pF Underwood
C4 – 150 pF Underwood
C5 – 100 pF Underwood
C7, C8 – 15 pF Underwood
C9 – 1000 pF Underwood
C10 – 0.1 µF Erie Red Cap
C11 – 100 µF Electrolytic, 15 Vdc

L1 – 2 Turns, #18 AWG, 5/16" ID
L2 – 1-1/2 Turns, #18 AWG, 5/16" ID
R – 10 Ω, 1.0 W
B – Ferroxcube Bead 56-590-65-3B
RFC1 – 0.15 µH Molded Coil
RFC2 – 6 Turns #18 Wire, 5/16" ID
RFC3 – VK200-20/4B
Board Material – Teflon Fiberglass
t = 0.062"

FIGURE 2 — POWER GAIN versus FREQUENCY

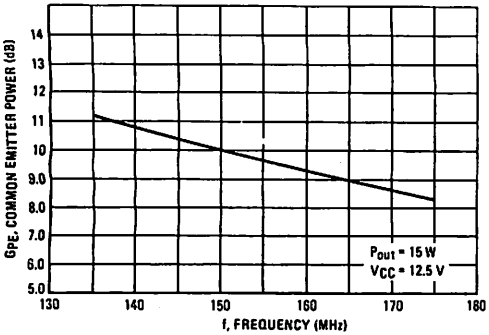


FIGURE 3 — OUTPUT POWER versus INPUT POWER

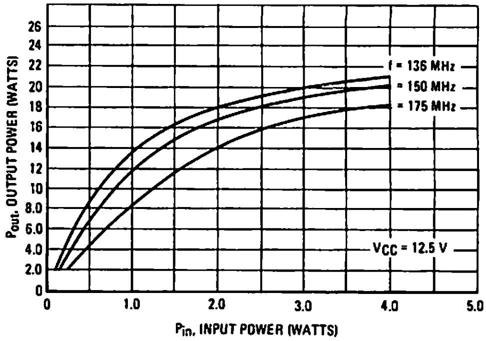


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
136 MHz

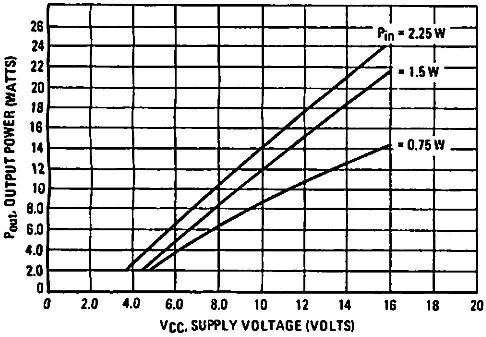


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

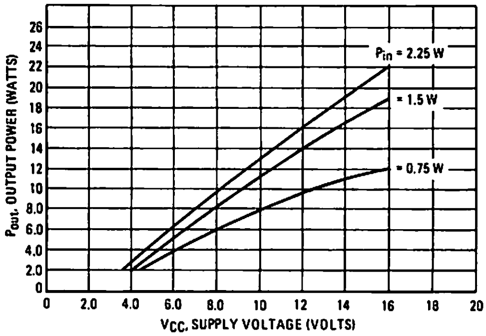


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz

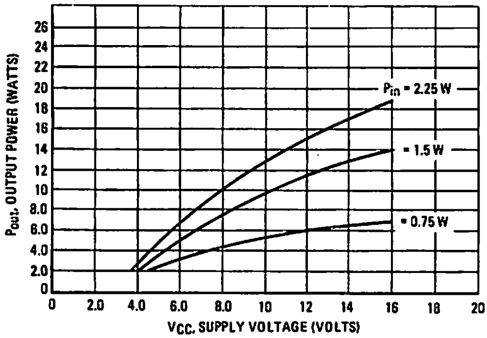
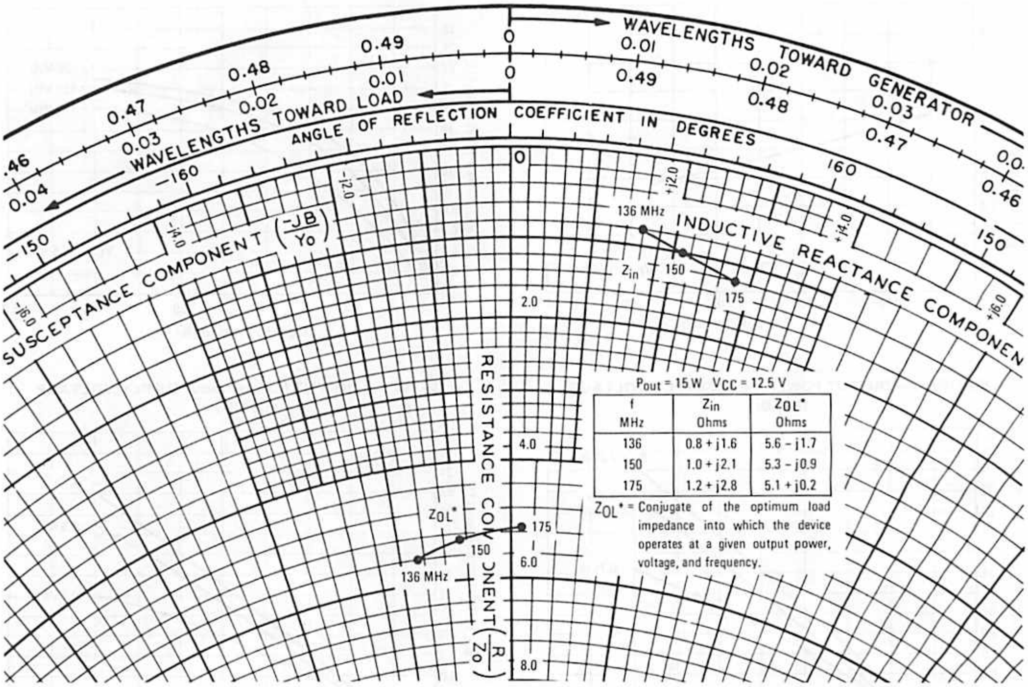


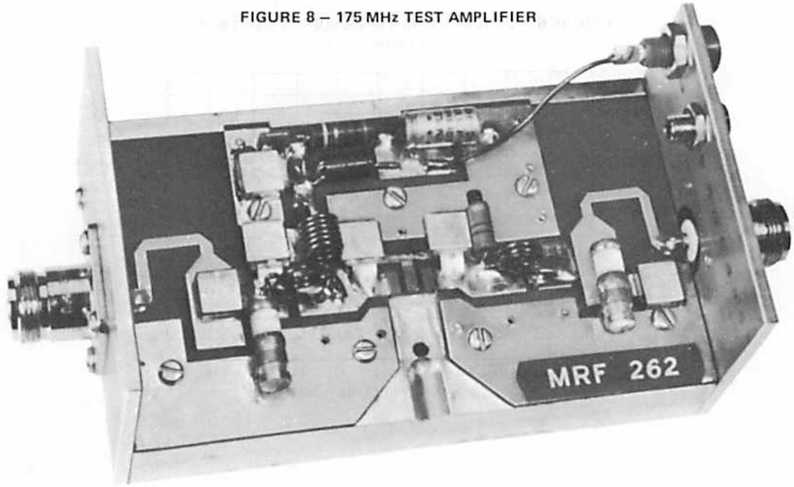
FIGURE 7 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
136	0.8 + j1.6	5.6 – j1.7
150	1.0 + j2.1	5.3 – j0.9
175	1.2 + j2.8	5.1 + j0.2

Z_{OL}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 8 – 175 MHz TEST AMPLIFIER



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF264

The RF Line

NPN SILICON RF POWER TRANSISTOR

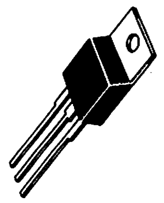
. . . designed for 12.5-volt VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 175 MHz Performance —
  Output Power = 30 Watts
  Power Gain = 5.2 dB Min
  Efficiency = 60% Min
- Load Mismatch Capability at High Line and RF Overdrive
- Other Devices in the Series —
  MRF260 5.0 Watts
  MRF261 10 Watts
  MRF262 15 Watts

30 W 136–175 MHz

RF POWER TRANSISTOR

NPN SILICON



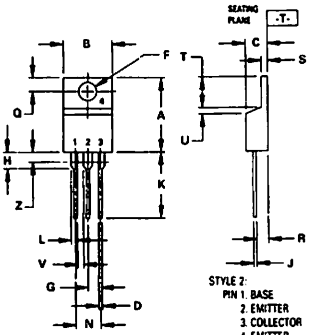
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_A = 25°C$ (1) Derate above 25°C	P_D	80 0.64	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.56	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

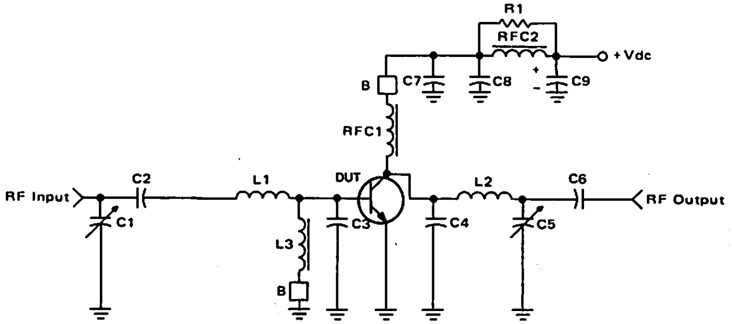
2

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	50	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	70	85	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	G_{PE}	5.2	6.0	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	η	60	—	—	%

FIGURE 1 — 175 MHz TEST CIRCUIT



C1, C5 — 1.0-20 pF Johanson
C2 — 25 pF Unelco
C3 — 120 pF Unelco
C4 — 100 pF Unelco
C6 — 15 pF Unelco
C7 — 1000 pF Unelco
C8 — 0.1 pF Erie Redcap
C9 — 100 μF, Electrolytic, 15 Vdc

L1 — 2-1/2 Turns, #16 AWG 0.35" ID
L2 — 2 Turns, #16 AWG 0.25" ID
L3 — 0.15 μH Molded Choke
RFC1 — 5 Turns, #18 AWG 0.25" ID
RFC2 — Ferroxcube VK200 21/4B
R1 — 10 Ω, 2.0 W
B — Ferroxcube Bead 56-590-65-3B

FIGURE 2 – POWER GAIN versus FREQUENCY

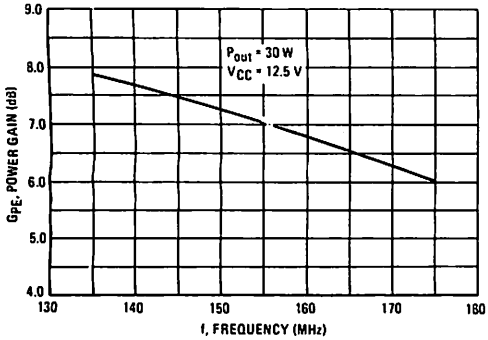


FIGURE 3 – OUTPUT POWER versus INPUT POWER

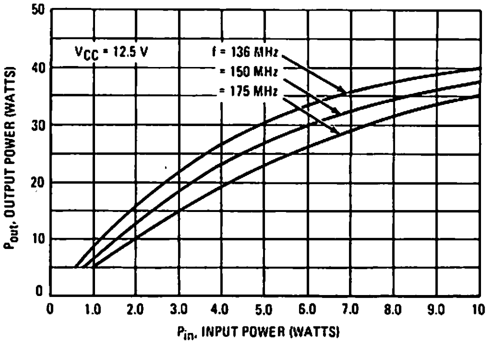


FIGURE 4 – OUTPUT POWER SUPPLY VOLTAGE
136 MHz

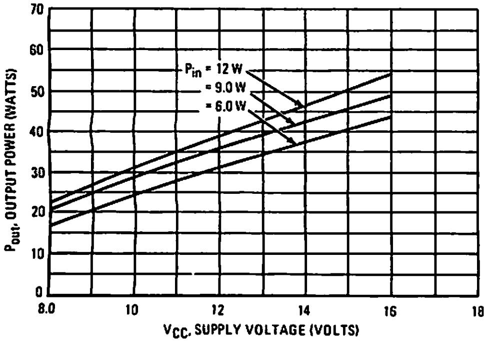


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
150 MHz

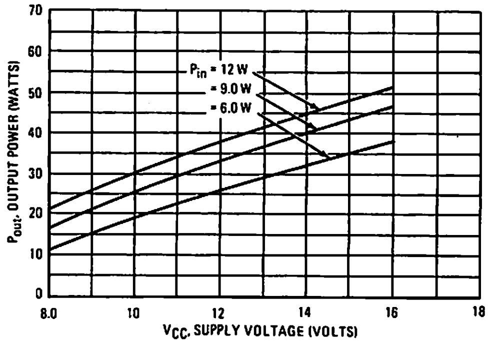
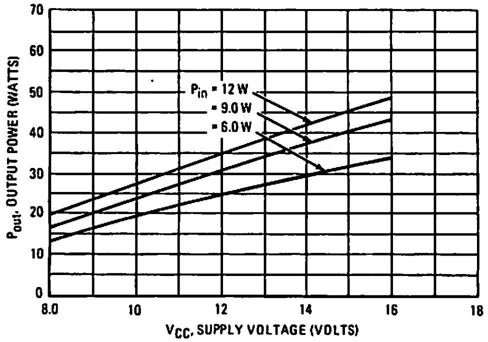


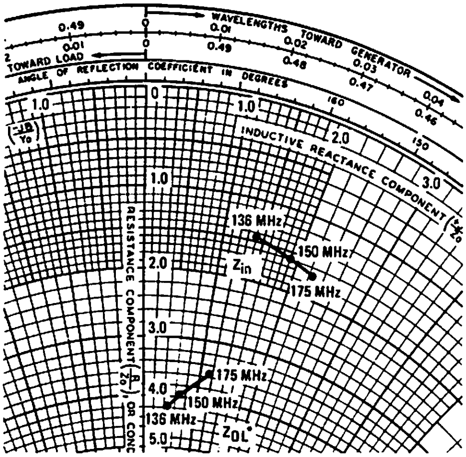
FIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
175 MHz



2

2

FIGURE 7 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{out} = 30 W, V_{CC} = 12.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	1.44 + j1.4	4.16 + j0.48
150	1.55 + j1.92	3.96 + j0.65
175	1.67 + j2.22	3.59 + j1.17

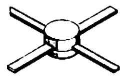
Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF313

The RF Line

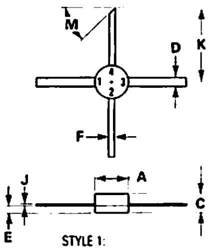
1.0 W — 400 MHz
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for wide band amplifier, driver or oscillator applications in military, mobile, and aircraft radio.

- *Specified 28 Volt, 400 MHz Characteristics —*
  Output Power = 1.0 Watt
  Minimum Gain = 15 dB
  Efficiency = 45%.
- Emitter Ballast and Low Current Density for Improved MTBF
- Common Emitter for Improved Stability



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

CASE 305A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V_{CEO}	30	Vdc
Collector – Base Voltage	V_{CBO}	40	Vdc
Emitter – Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	6.1 35	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	28.5	°C/W

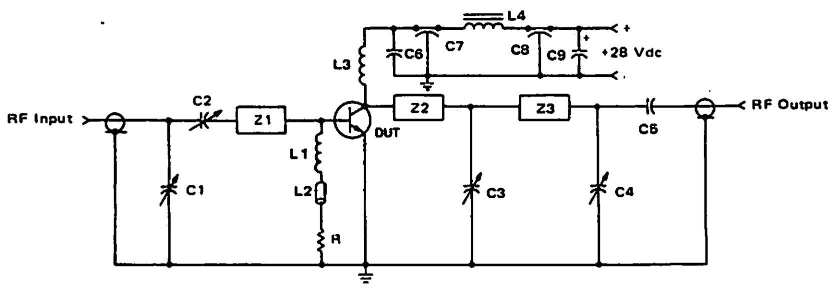
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	35	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 20 Vdc, I_B = 0)	I_{CEO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	60	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	–	2.5	–	GHz
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.5	5.0	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain(1) (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	G_{pe}	15	16	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	η	–	45	–	%
Series Equivalent Input Impedance (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	Z_{in}	–	6.4-j4.8	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 28 Vdc, P_{out} = 1.0 W, f = 400 MHz)	Z_{out}	–	75-j45	–	Ohms

(1) Class C

FIGURE 1 — 400 MHz POWER GAIN TEST CIRCUIT



C1,C2,C4 1.0-20 pF JOHANSON 9063
C3 1.0-10 pF JOHANSON
C5 150 pF Chip
C6 0.1 μF
C7,C8 680 pF Feedthru
C9 1.0 μF TANTALUM
L1,L3 5 Turns, AWG #20, ¼" I.D.
L2 Ferrite Bead, FERROXCUBE No. 56-590-65/4B
L4 FERROXCUBE VK200-20/4B
Input/Output Connectors — Type N
Board — Glass Teflon, ε = 2.56, t = 0.062"
R 4.7 Ohms, ¼ W
Z1 2.0" x 0.1" MICROSTRIP LINE
Z2,Z3 2.6" x 0.1" MICROSTRIP LINE

MRF314
MRF314A

The RF Line

NPN SILICON RF POWER TRANSISTORS

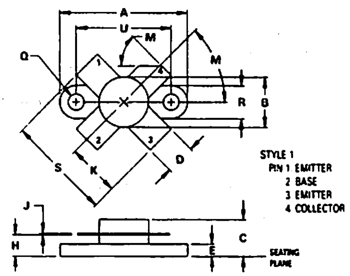
. . . designed primarily for wideband large-signal driver and output amplifier stages in the 30–200 MHz frequency range.

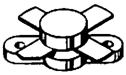
- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 30 Watts
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

30 W – 30-200 MHz

RF POWER TRANSISTORS

NPN SILICON

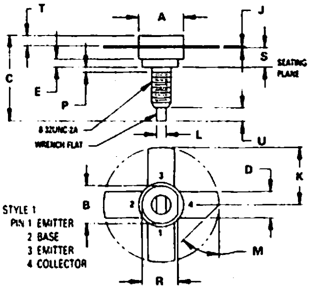


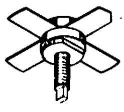


MRF314

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.87	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07





MRF314A

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.4	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	82 0.47	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	°C/W

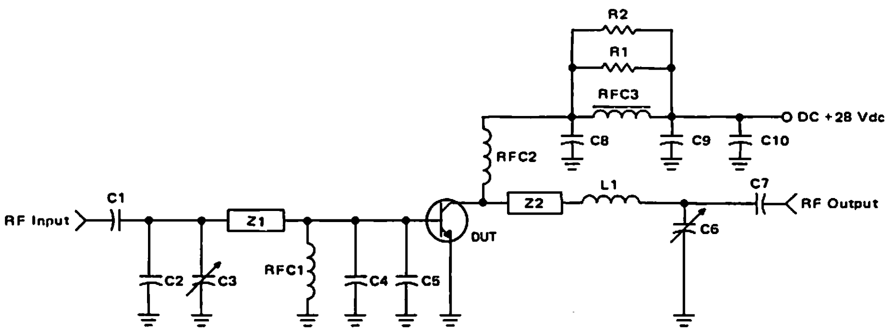
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz)	G_{PE}	10	13.5	–	db
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz)	η	50	–	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 150 MHz, VSWR = 30:1 all phase angles	–	No Degration in Power Output			

FIGURE 1 – 150 MHz TEST CIRCUIT



C1, C7 – 18 pF, 100 mil ATC
C2 – 68 pF, 100 mil ATC
C3, C6 – Johanson #JMC 5501
C4 – 270 pF, 100 mil ATC
C5 – 240 pF, 100 mil ATC
C8, C9 – 100 pF Underwood
C10 – 1.0 μF Tantalum
L1 – 2 Turns, 2.5" #20 Wire, ID = 0.275"

R1, R2 – 10 Ω, 1.0 W
RFC1 – 15 μH Molded Coil
RFC2 – 2 Turns, 2.5" #20 Wire, ID = 0.2"
RFC3 – Ferroxcube VK200–19/4B
Z1 – Microstrip 0.168" W x 1.6" L
Z2 – Microstrip 0.168" W x 1.2" L
Board – Glass Teflon $\epsilon_R \approx 2.55$

TYPICAL PERFORMANCE CURVES

FIGURE 2 – OUTPUT POWER versus INPUT POWER

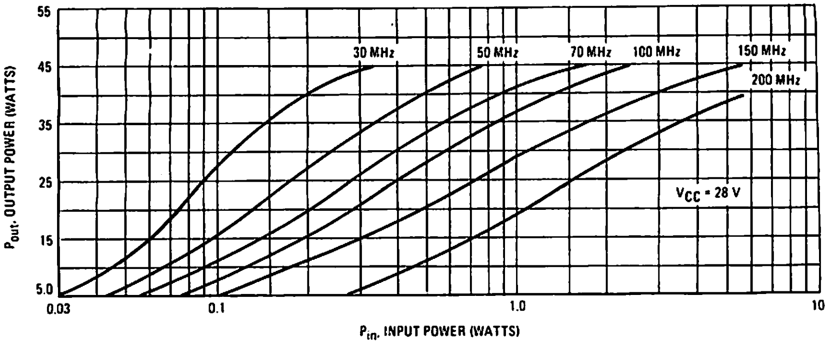


FIGURE 3 – OUTPUT POWER versus INPUT POWER

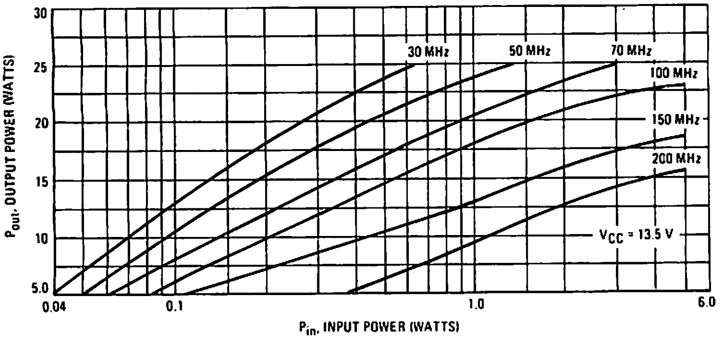


FIGURE 4 – POWER GAIN versus FREQUENCY

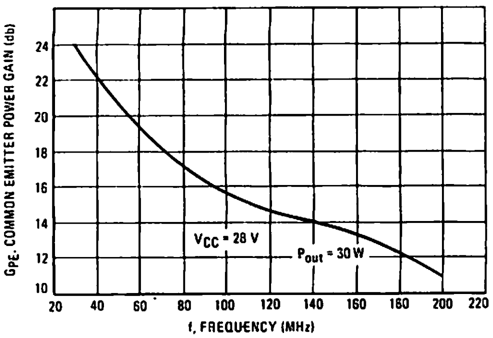


FIGURE 5 – EFFICIENCY (η%) versus FREQUENCY

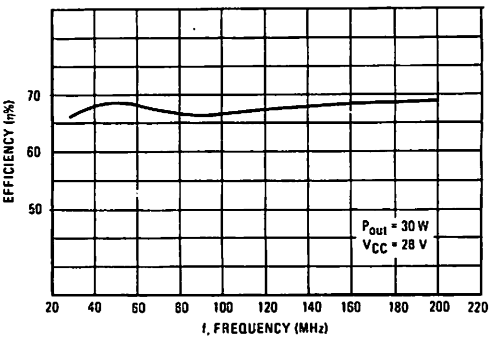
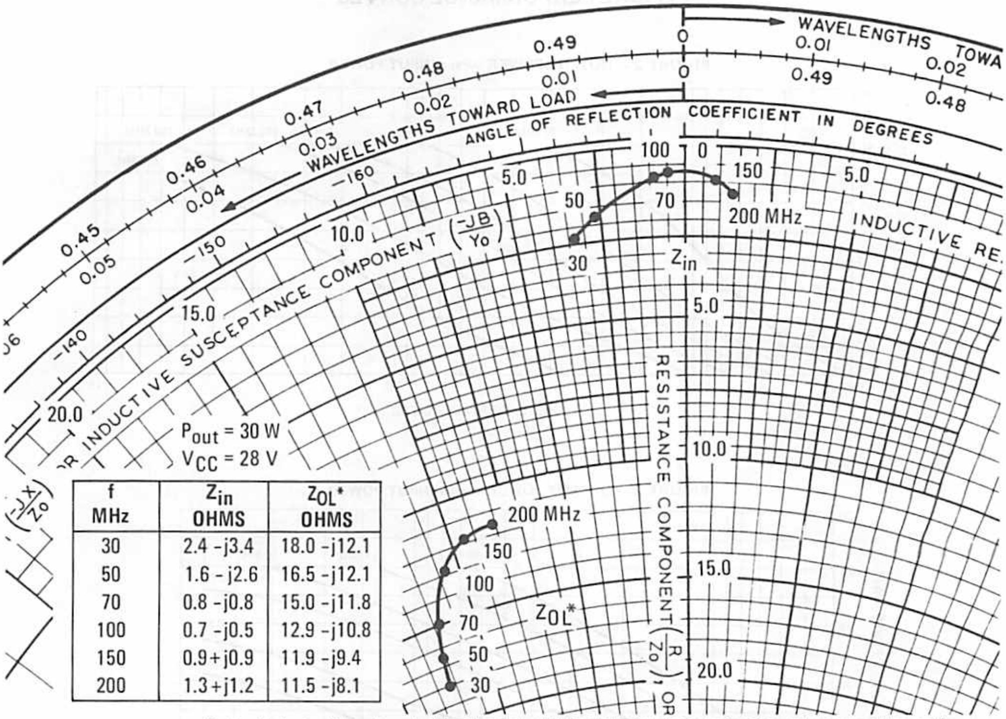


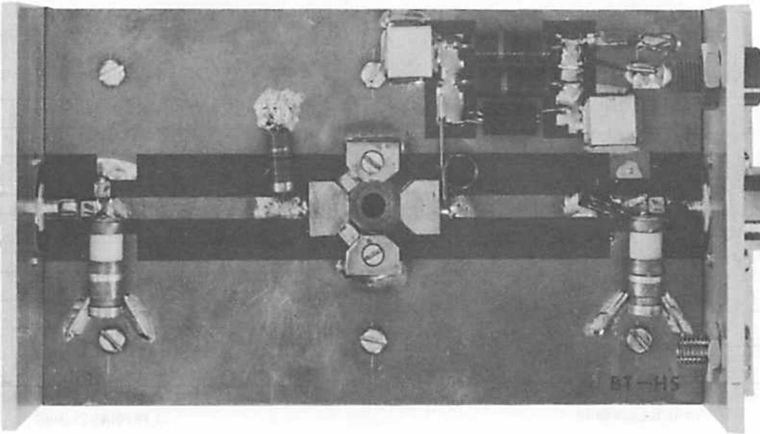
FIGURE 6 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	2.4 -j3.4	18.0 -j12.1
50	1.6 - j2.6	16.5 -j12.1
70	0.8 -j0.8	15.0 -j11.8
100	0.7 -j0.5	12.9 -j10.8
150	0.9+j0.9	11.9 -j9.4
200	1.3+j1.2	11.5 -j8.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – TEST FIXTURE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF315
MRF315A

The RF Line

NPN SILICON RF POWER TRANSISTORS

. . . designed primarily for wideband large-signal output amplifier stages in the 30–200 MHz frequency range.

- *Guaranteed* Performance at 150 MHz, 28 Vdc

  Output Power = 45 Watts
  Minimum Gain = 9.0 dB

- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR

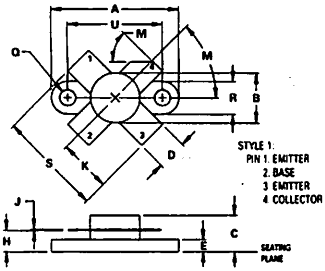
- Gold Metallization System for High Reliability Applications

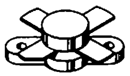
45 W – 30-200 MHz

RF POWER TRANSISTORS

NPN SILICON

2

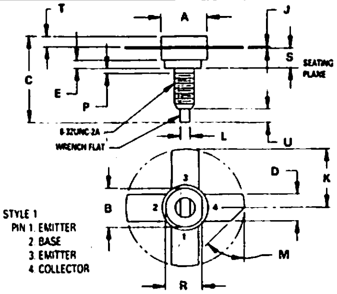


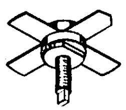


MRF315

CASE 211-07

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730





MRF315A

CASE 145A-09

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	110 0.63	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.59	°C/W

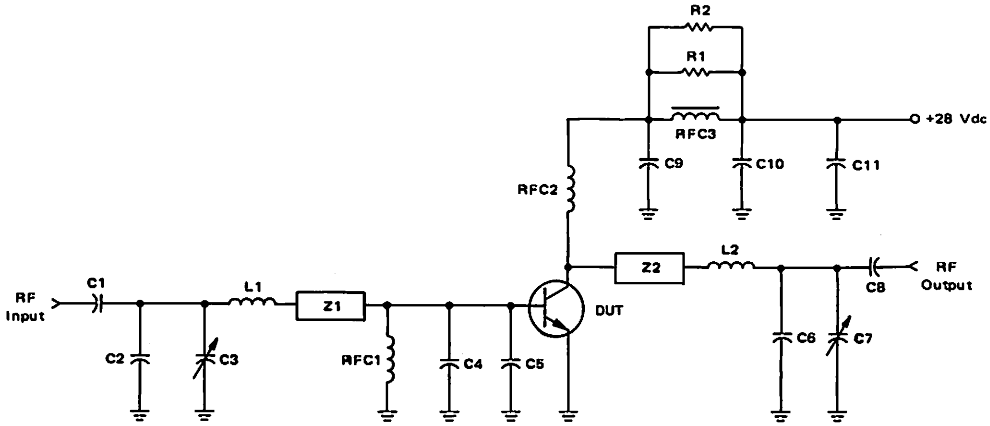
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E - 0)	I_{CBO}	–	–	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	45	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz)	G_{PE}	9.0	11	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz)	η	50	–	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 45 W, f = 150 MHz, VSWR = 30:1 all phase angles)	No Degradation in Power Output				

FIGURE 1 – 150 MHz TEST CIRCUIT



C1 – 30 pF, 100 mil ATC
C2 – 47 pF, 100 mil ATC
C3, C7 – Johanson #JMC 5501
C4, C5 – 200 pF, 100 mil ATC
C6 – 24 pF, 100 mil ATC
C8 – 27 pF, 100 mil ATC
C9, C10 – 100 pF Underwood
C11 – 1.0 μF Tantalum

L1 – 0.5" #18 Wire
L2 – 2 Turns, 1.5" #20 Wire, ID = 0.15"
Z1, Z2 – Microstrip 0.168" W x 1.25" L
RFC1 – 15 μH Molded Coil
RFC2 – 2 Turns, 2.5" #18 Wire, ID = 0.2"
RFC3 – Ferroxcube VK200–19/4B
R1, R2 – 10 Ω, 1.0 W
Board – Glass Teflon ϵ_R ≈ 2.55

TYPICAL PERFORMANCE CURVES

FIGURE 2 – OUTPUT POWER versus INPUT POWER

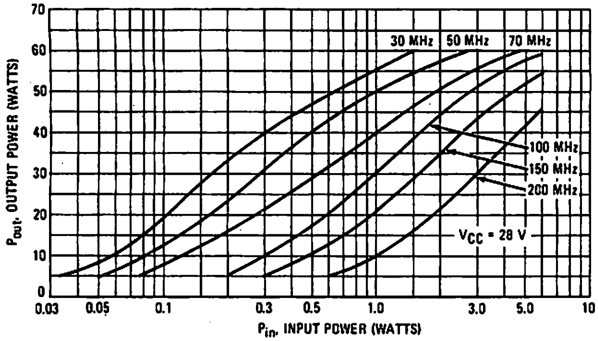


FIGURE 3 – OUTPUT POWER versus INPUT POWER

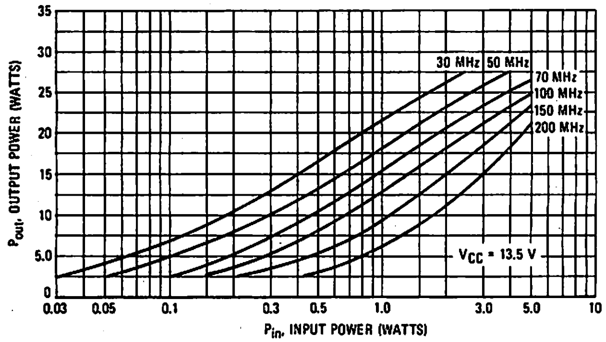


FIGURE 4 – POWER GAIN versus FREQUENCY

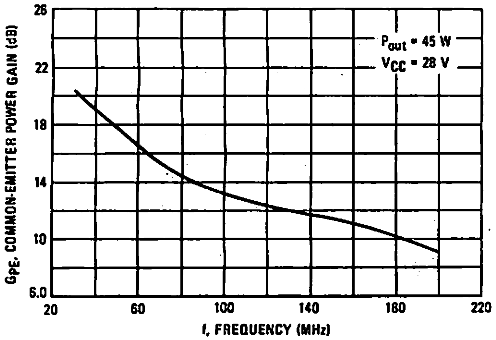


FIGURE 5 – EFFICIENCY versus FREQUENCY

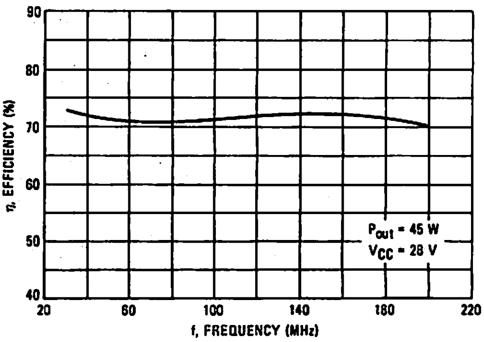
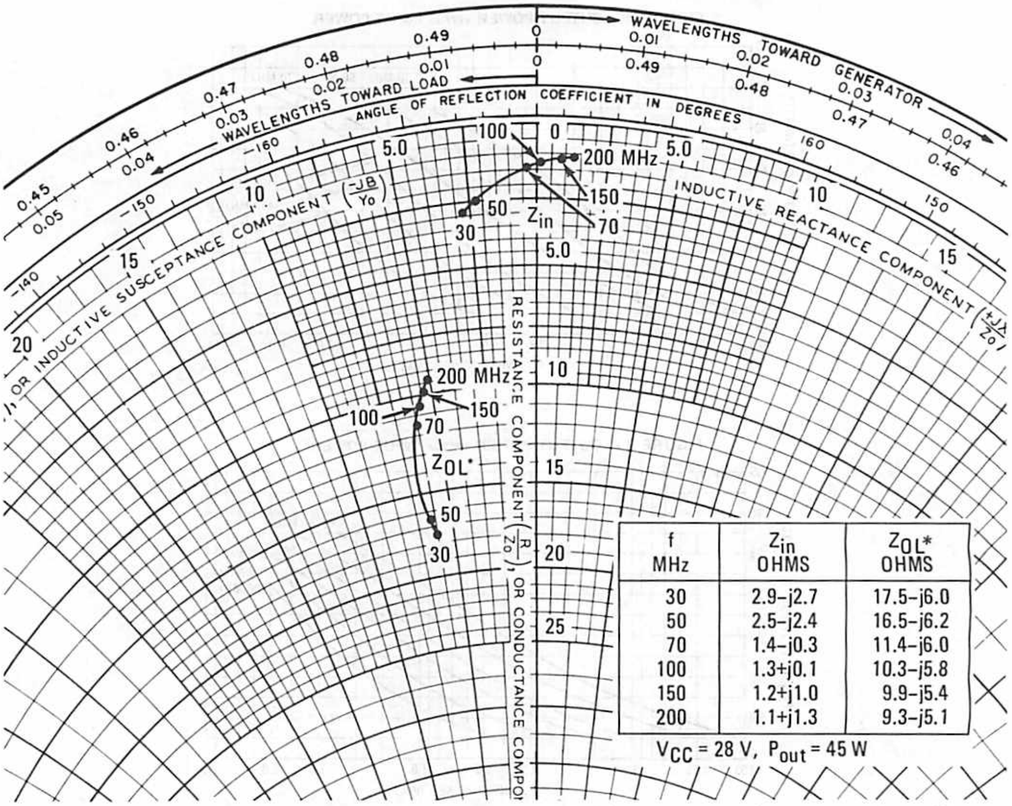


FIGURE 6 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE

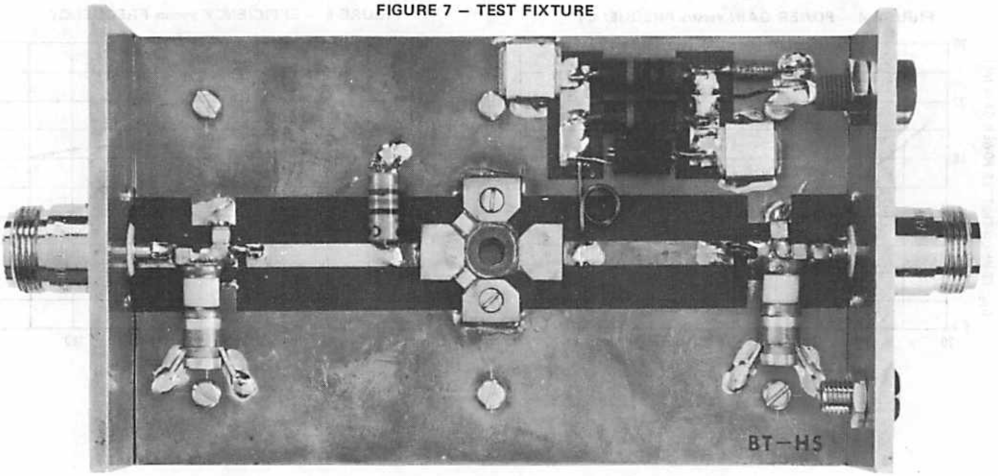


f MHz	Zin OHMS	ZOL* OHMS
30	2.9–j2.7	17.5–j6.0
50	2.5–j2.4	16.5–j6.2
70	1.4–j0.3	11.4–j6.0
100	1.3+j0.1	10.3–j5.8
150	1.2+j1.0	9.9–j5.4
200	1.1+j1.3	9.3–j5.1

V_{CC} = 28 V, P_{out} = 45 W

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – TEST FIXTURE



MRF316

The RF Line

80 W – 30-200 MHz

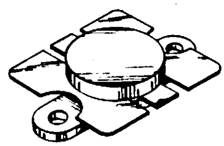
CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR

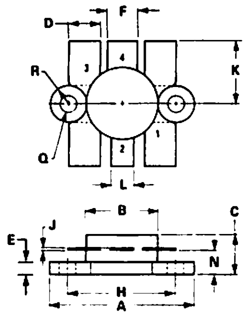
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 150 MHz, 28 Vdc
  Output Power = 80 Watts
  Minimum Gain = 10 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous Peak	I_C	9.0 13.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	220 1.26	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.8	°C/W

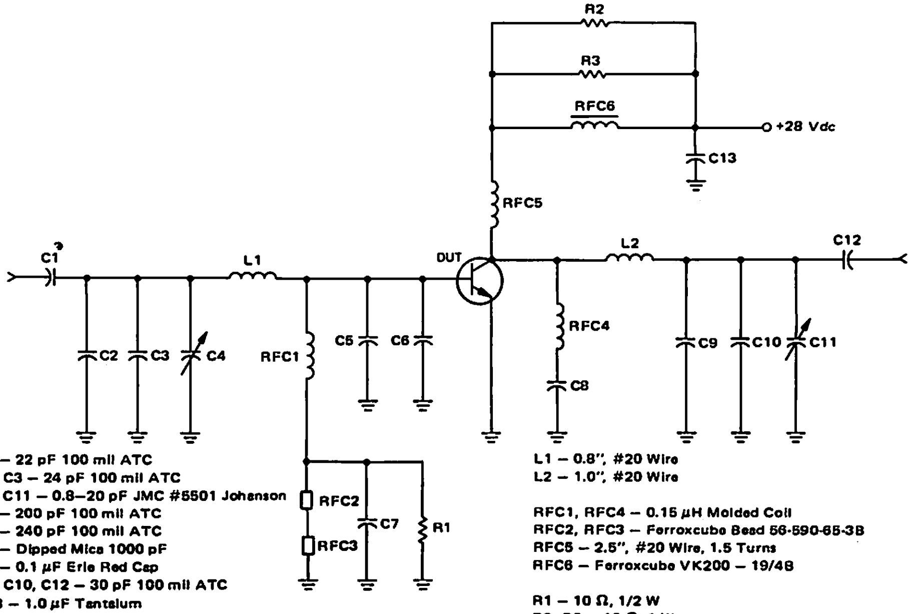
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	130	200	pF
NARROW BAND FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 150 MHz)	G_{PE}	10	13	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 150 MHz)	η	55	–	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 80 W CW, f = 150 MHz, VSWR 30:1 all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 150 MHz TEST AMPLIFIER



C1 — 22 pF 100 mil ATC
C2, C3 — 24 pF 100 mil ATC
C4, C11 — 0.8–20 pF JMC #5501 Johnson
C5 — 200 pF 100 mil ATC
C6 — 240 pF 100 mil ATC
C7 — Dipped Mica 1000 pF
C8 — 0.1 µF Erie Red Cap
C9, C10, C12 — 30 pF 100 mil ATC
C13 — 1.0 µF Tantalum

L1 — 0.8", #20 Wire
L2 — 1.0", #20 Wire

RFC1, RFC4 — 0.15 µH Molded Coil
RFC2, RFC3 — Ferroxcube Bead 56-590-65-3B
RFC5 — 2.5", #20 Wire, 1.5 Turns
RFC6 — Ferroxcube VK200 — 19/4B

R1 — 10 Ω, 1/2 W
R2, R3 — 10 Ω, 1 W

2

TYPICAL PERFORMANCE CURVES

FIGURE 2 – OUTPUT POWER versus INPUT POWER

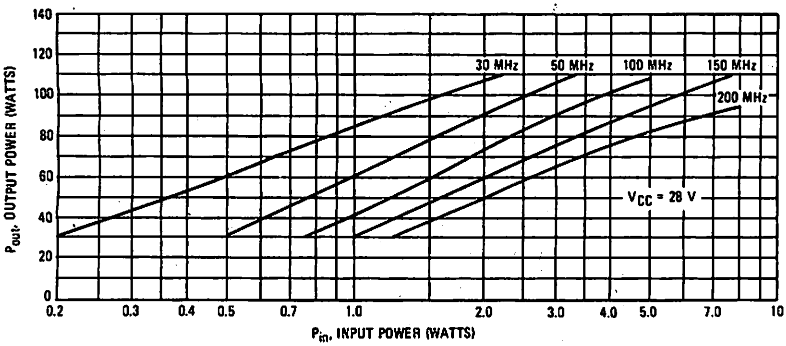


FIGURE 3 – POWER GAIN versus FREQUENCY

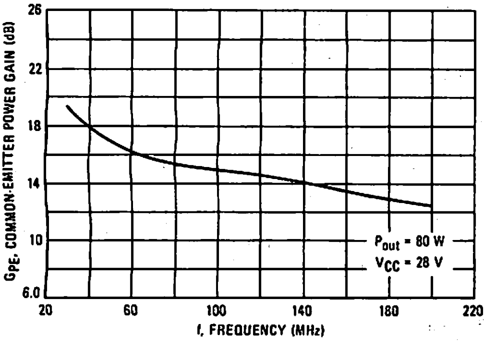


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
f = 100 MHz

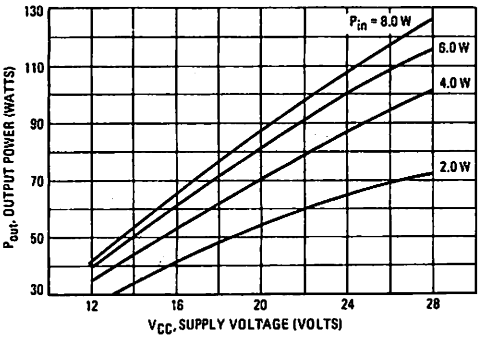


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

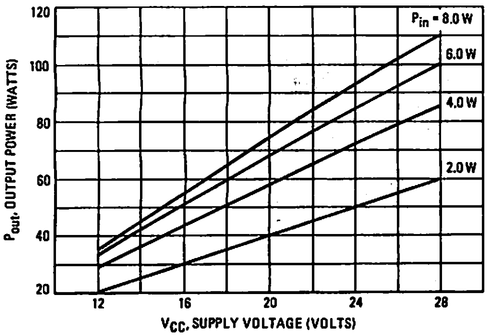
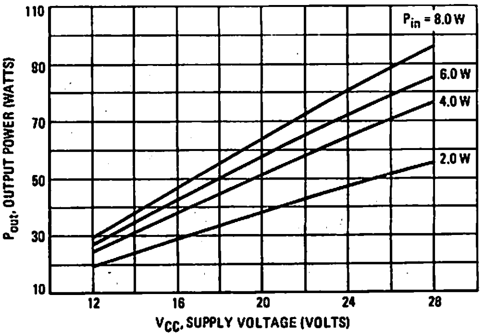
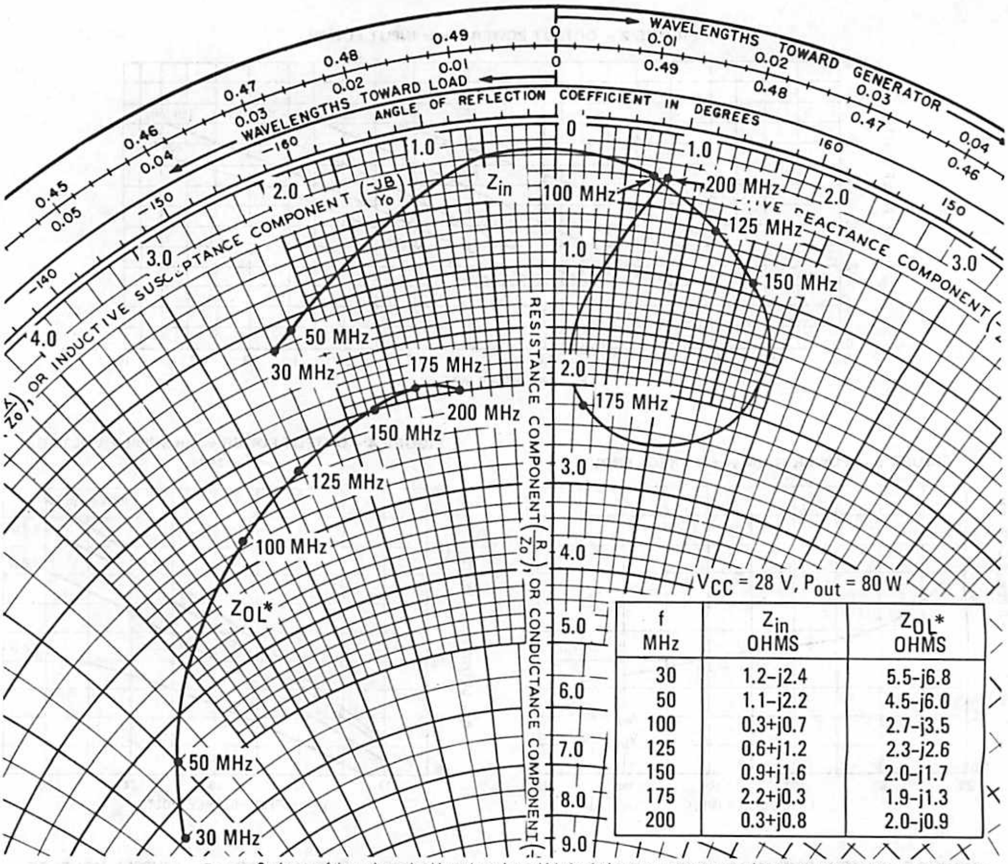


FIGURE 6 – OUTPUT POWER versus SUPPLY VOLTAGE
f = 200 MHz



2

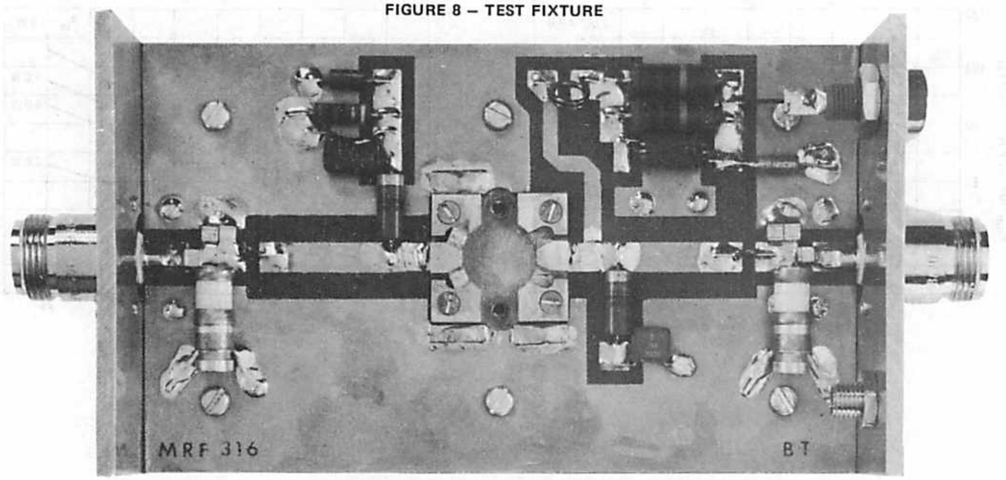
FIGURE 7 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



f MHz	Zin OHMS	ZOL* OHMS
30	1.2–j2.4	5.5–j6.8
50	1.1–j2.2	4.5–j6.0
100	0.3+j0.7	2.7–j3.5
125	0.6+j1.2	2.3–j2.6
150	0.9+j1.6	2.0–j1.7
175	2.2+j0.3	1.9–j1.3
200	0.3+j0.8	2.0–j0.9

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 8 – TEST FIXTURE



MRF317

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

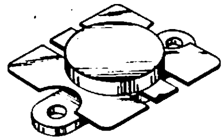
. . . designed primarily for wideband large signal output amplifier stages in 30 – 200 MHz frequency range.

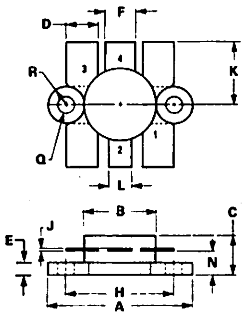
- Guaranteed Performance at 150 MHz and 28 Vdc
  Output Power = 100 W
  Minimum Gain = 9 dB
- *Built-In* Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- High Output Saturation Power — Ideally Suited for 30 W Carrier/ 120 W Peak AM Amplifier Service
- Guaranteed Performance in Broadband Test Fixture

100 W – 30 – 200 MHz

**CONTROLLED Q
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.33	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous – Peak (10 seconds)	I_C	12 18	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
THERMAL CHARACTERISTICS			
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	25	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	200	250	pF
FUNCTIONAL TESTS (FIGURE 2)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 150 MHz , I_C(Max) = 6.5 Adc)	G_{PE}	9.0	10	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 150 MHz , I_C(Max) = 6.5 Adc)	η	55	60	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W CW, f = 150 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 – BROADBAND (110-160 MHz) TEST FIXTURE

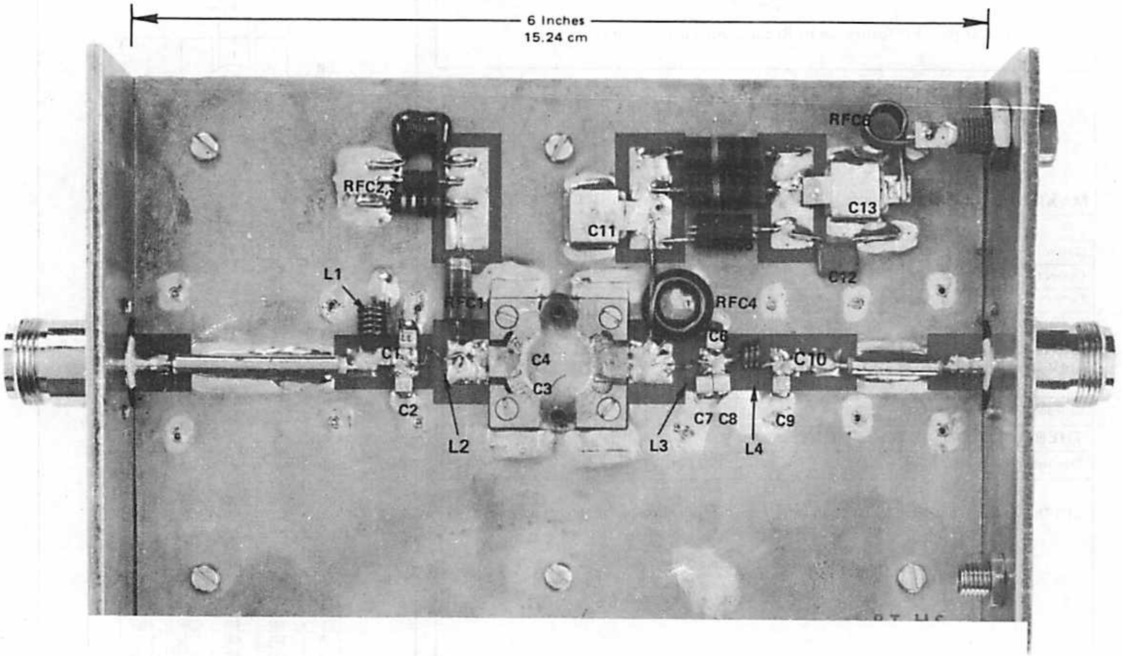


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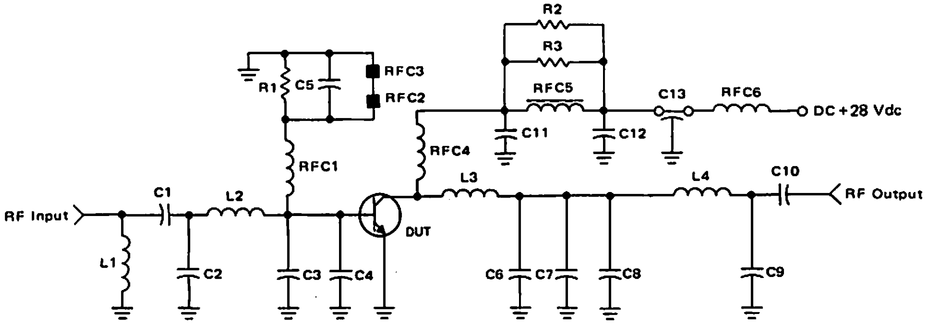
FIGURE 2 — 110-160 MHz BROADBAND AMPLIFIER — TEST FIXTURE



C1, C9 — 39 pF, 100 mil ATC
C2 — 120 pF, 100 mil ATC
C3, C4 — 360 pF, 100 mil ATC
C5 — 1000 pF Dipped Mica
C6, C7 — 100 pF, 100 mil ATC*
C8 — 18 pF, 100 mil ATC*
C10 — 43 pF, 100 mil ATC
C11 — 60 pF, Underwood
C12 — 0.1 μF Erie Redcap
C13 — 1000 pF, Underwood J102

L1 — 50 nH
L2 — 6.0 nH
L3 — 8.0 nH
L4 — 32 nH
RFC1 — 0.15 μH Molded Coil
RFC2, RFC3 — Ferroxcube Bead 56-590-65/3B
RFC4 — 1 Turn, #18 Wire, 2.0" L
RFC5 — Ferroxcube VK200 19/4B
RFC6 — 7 Turns, #18 Wire, 0.3" ID
R1 — 10 Ω 1/2 W
R2, R3 — 10 Ω 1 W
*Combination of C6, C7, C8 equals 220 pF.

FIGURE 3 — POWER GAIN versus FREQUENCY BROADBAND TEST FIXTURE

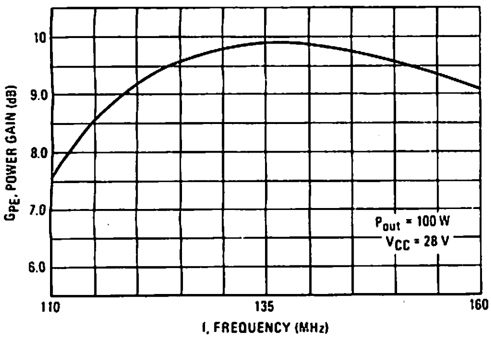
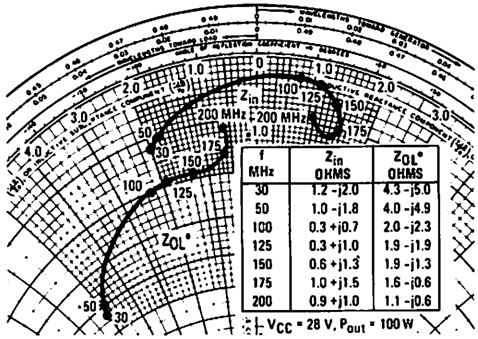


FIGURE 4 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
30	1.2 - j2.0	4.3 - j5.0
50	1.0 - j1.8	4.0 - j4.9
100	0.3 + j0.7	2.0 - j2.3
125	0.3 + j1.0	1.9 - j1.9
150	0.6 + j1.3	1.9 - j1.3
175	1.0 + j1.5	1.6 - j0.6
200	0.9 + j1.0	1.1 - j0.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 5 — EFFICIENCY versus FREQUENCY BROADBAND TEST FIXTURE

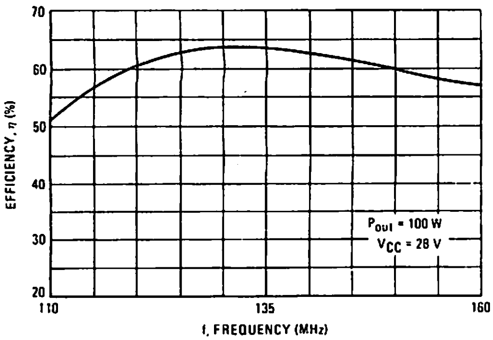
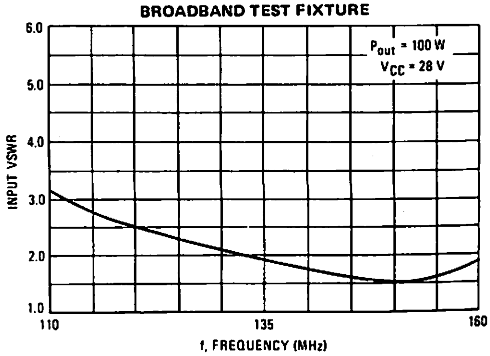


FIGURE 6 — INPUT VSWR versus FREQUENCY BROADBAND TEST FIXTURE



2

TYPICAL PERFORMANCE CURVES

FIGURE 7 – OUTPUT POWER versus INPUT POWER

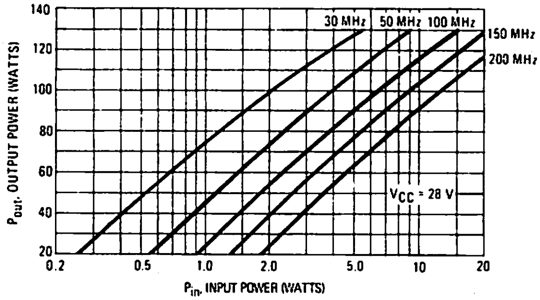


FIGURE 8 – POWER GAIN versus FREQUENCY

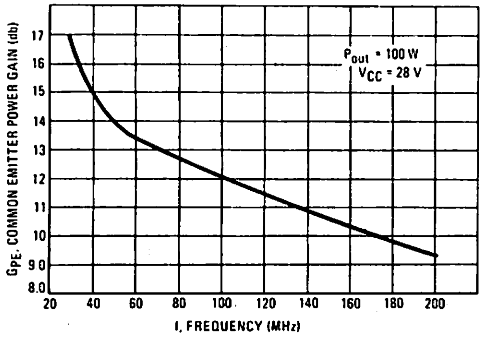


FIGURE 9 – POWER OUTPUT versus SUPPLY VOLTAGE
f = 100 MHz

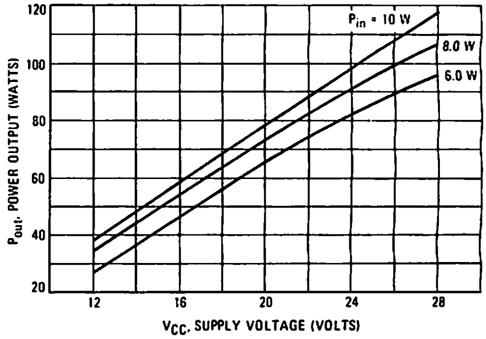


FIGURE 10 – POWER OUTPUT versus SUPPLY VOLTAGE
f = 150 MHz

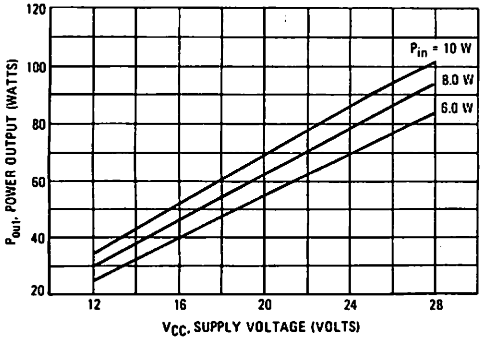
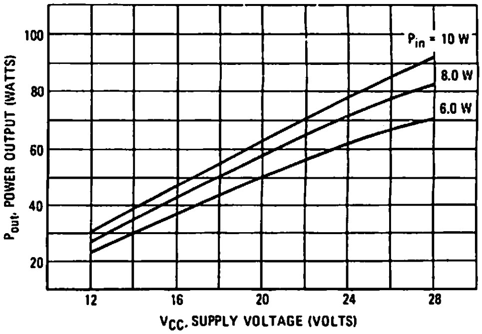


FIGURE 11 – POWER OUTPUT versus SUPPLY VOLTAGE
f = 200 MHz



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF321

The RF Line

NPN SILICON RF POWER TRANSISTOR

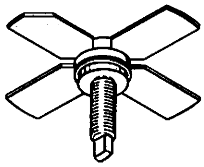
. . . *designed primarily* for wideband large-signal driver and predriver amplifier stages in the 200–500 MHz frequency range.

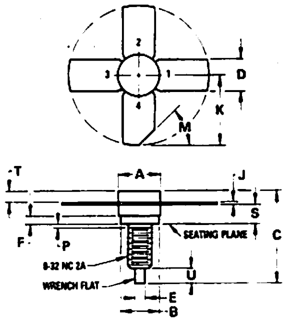
- Guaranteed Performance at 400 MHz and 28 Vdc
  Output Power = 10 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%
- 100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance

10 W – 400 MHz

RF POWER
TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous – Peak	I_C	1.1 1.5	Adc
Total Device Dissipation @ $T_A = 25°C$ (1) Derate above 25°C	P_D	27 160	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

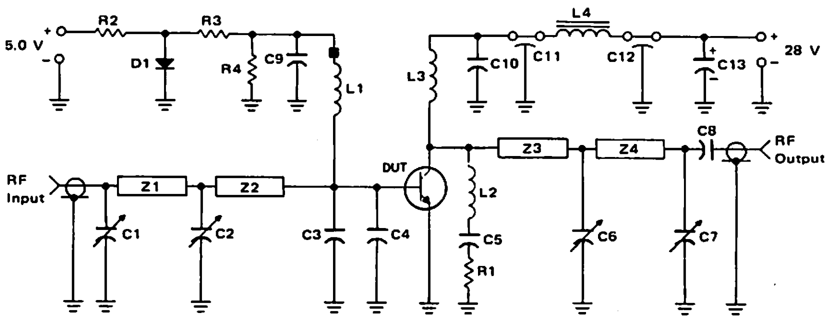
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	6.4	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	10	12	pF
FUNCTIONAL TESTS (FIGURE 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 400 MHz)	G_{PE}	12	13	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 10 W, f = 400 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 10, f = 400 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C2, C3 — 1.0–20 pF Johanson Trimmer (JMC 5501)
C3, C4 — 47 pF ATC Chip Capacitor
C5, C10 — 0.1 µF Erie Redcap
C7 — 0.5–10 pF Johanson Trimmer (JMC 5201)
C8 — 0.018 µF Vitramon Chip Capacitor
C9 — 200 pF UNELCO Capacitor
C11, C12 — 680 pF Feedthru
C13 — 1 µF, 50 Volt Tantalum Capacitor

R1 — 5.1 Ω, 1/4 Watt
R2 — 120 Ω, 1 Watt
R3 — 20 Ω, 1/2 Watt
R4 — 47 Ω, 1/2 Watt

L1 — 0.33 µH Molded Choke with Ferroxcube Bead (Ferroxcube 56-590-65/4B) on Ground End of Coil
L2 — 4 Turns #20 Enamel, 1/8" ID
L3 — 6 Turns #20 Enamel, 1/4" ID
L4 — Ferroxcube VK200-19/4B

Z1 — Microstrip 0.1" W x 1.35" L
Z2 — Microstrip 0.1" W x 0.55" L
Z3 — Microstrip 0.1" W x 0.8" L
Z4 — Microstrip 0.1" W x 1.75" L

D1 — 1N4001

Board — Glass Teflon, ϵ_R = 2.56, t = 0.062"

Input/Output Connectors — Type N

FIGURE 2 — OUTPUT POWER versus FREQUENCY

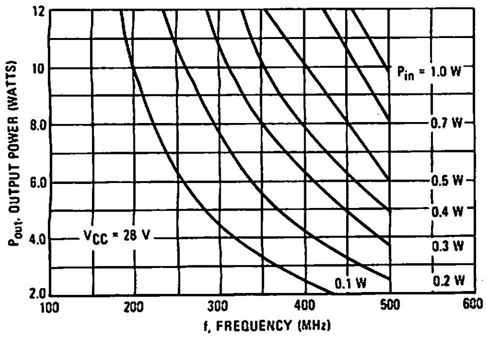


FIGURE 3 — OUTPUT POWER versus INPUT POWER

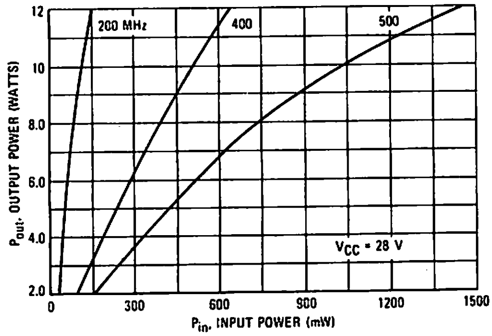


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

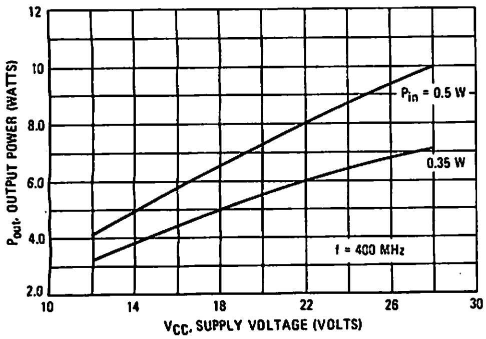


FIGURE 5 — POWER GAIN versus FREQUENCY

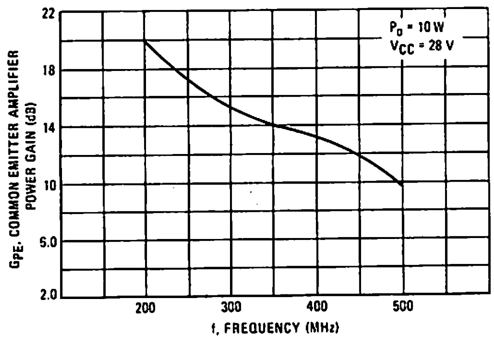
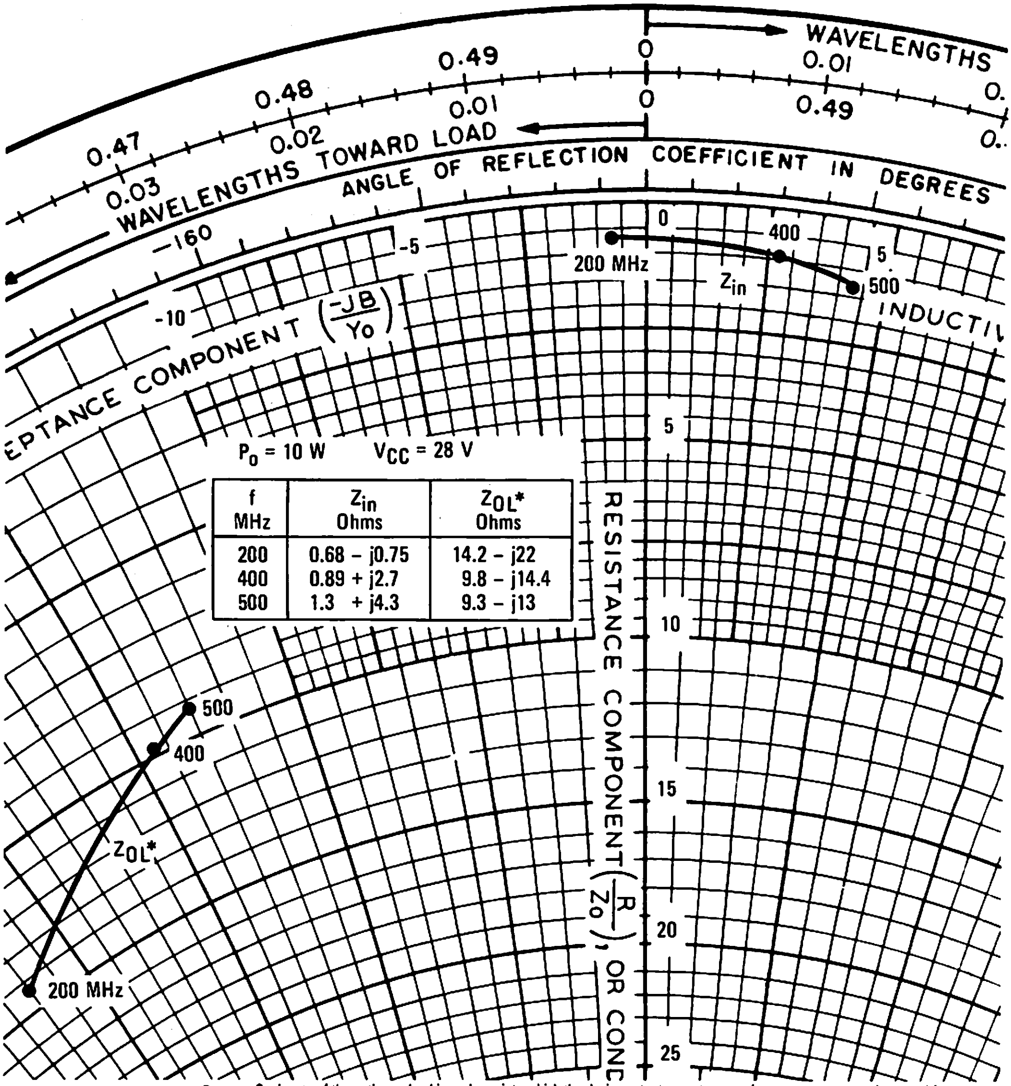


FIGURE 6 – SERIES EQUIVALENT IMPEDANCE



P_o = 10 W V_{CC} = 28 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
200	0.68 – j0.75	14.2 – j22
400	0.89 + j2.7	9.8 – j14.4
500	1.3 + j4.3	9.3 – j13

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF323

The RF Line

NPN SILICON RF POWER TRANSISTOR

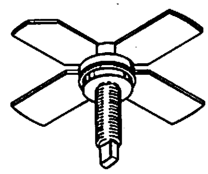
. . . designed primarily for wideband large-signal driver and predriver amplifier stages in the 200-500 MHz frequency range.

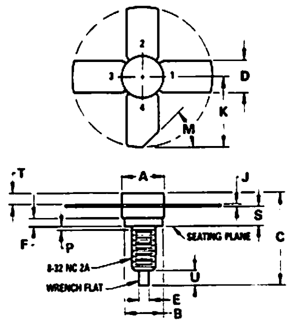
- Guaranteed Performance at 400 MHz and 28 V
  Output Power = 20 Watts
  Minimum Gain = 10 dB
  Efficiency = 50%
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability
- Computer-Controlled Wirebonding Gives Consistent Input Impedance

20 W – 400 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	2.2 3.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	55 310	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

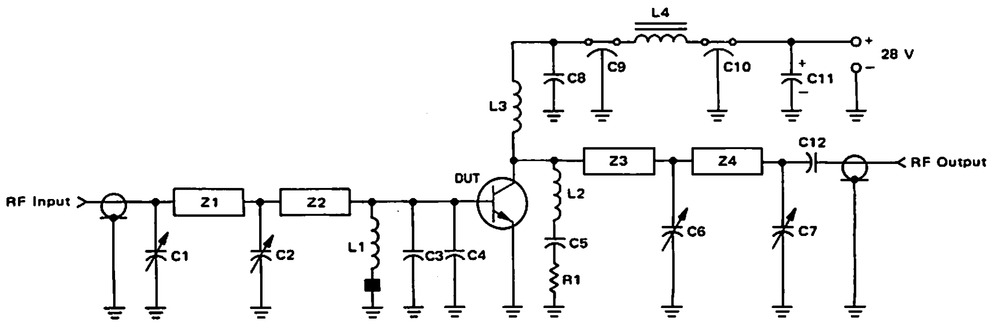
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	20	24	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 20 W, f = 400 MHz)	G_{PE}	10	11	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 20 W, f = 400 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 28 V, P_{out} = 20 W, f = 400 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 – 400 MHz TEST CIRCUIT



C1, C2, C6 – 1.0-20 pF Johanson Trimmer (JMC 5501)
C3, C4 – 47 pF ATC Chip Capacitor
C5, C8 – 0.1 μF Erie Redcap
C7 – 0.5-10 pF Johanson Trimmer (JMC 5201)
C9, C10 – 680 pF Feedthru
C11 – 1.0 μF 50 Volt Tantalum
C12 – 0.018 μF Vitramon Chip Capacitor
R1 – 5.1 Ω 1/4 Watt
L1 – 0.33 μH Molded Choke with Ferroxcube Bead (Ferroxcube 56-590-65/4B) on Ground End

L2 – 6 Turns #20 Enamel, ¼" ID, Closewound
L3 – 4 Turns #20 Enamel, 1/8" ID, Closewound
L4 – Ferroxcube VK200 – 19/4B
Z1 – Microstrip 0.1" W x 1.35" L
Z2 – Microstrip 0.1" W x 0.55" L
Z3 – Microstrip 0.1" W x 0.8" L
Z4 – Microstrip 0.1" W x 1.75" L
Board – Glass Teflon ϵ_R = 2.56 t = 0.062"
Input/Output Connectors – Type N

FIGURE 2 — OUTPUT POWER versus FREQUENCY

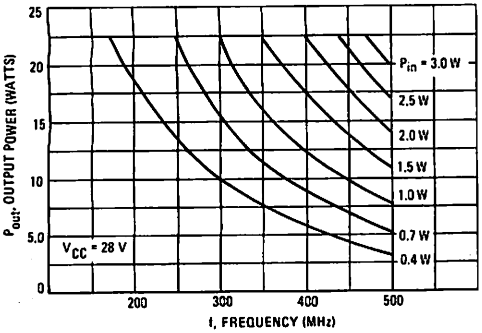


FIGURE 3 — OUTPUT POWER versus INPUT POWER

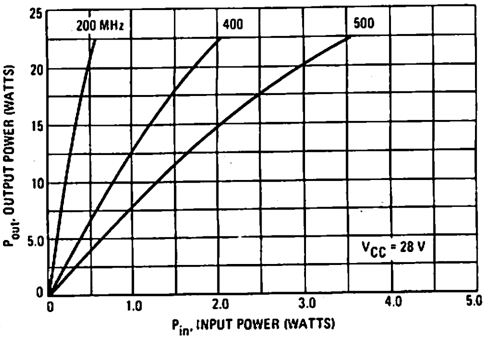


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

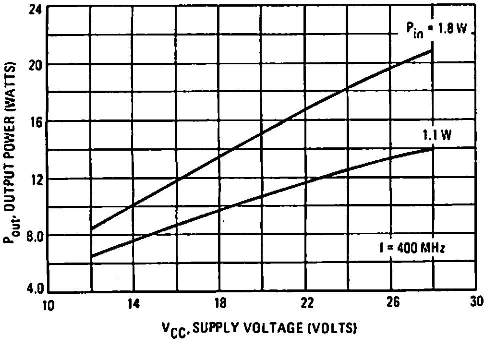


FIGURE 5 — POWER GAIN versus FREQUENCY

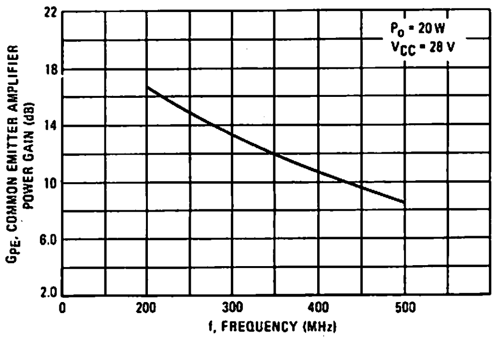


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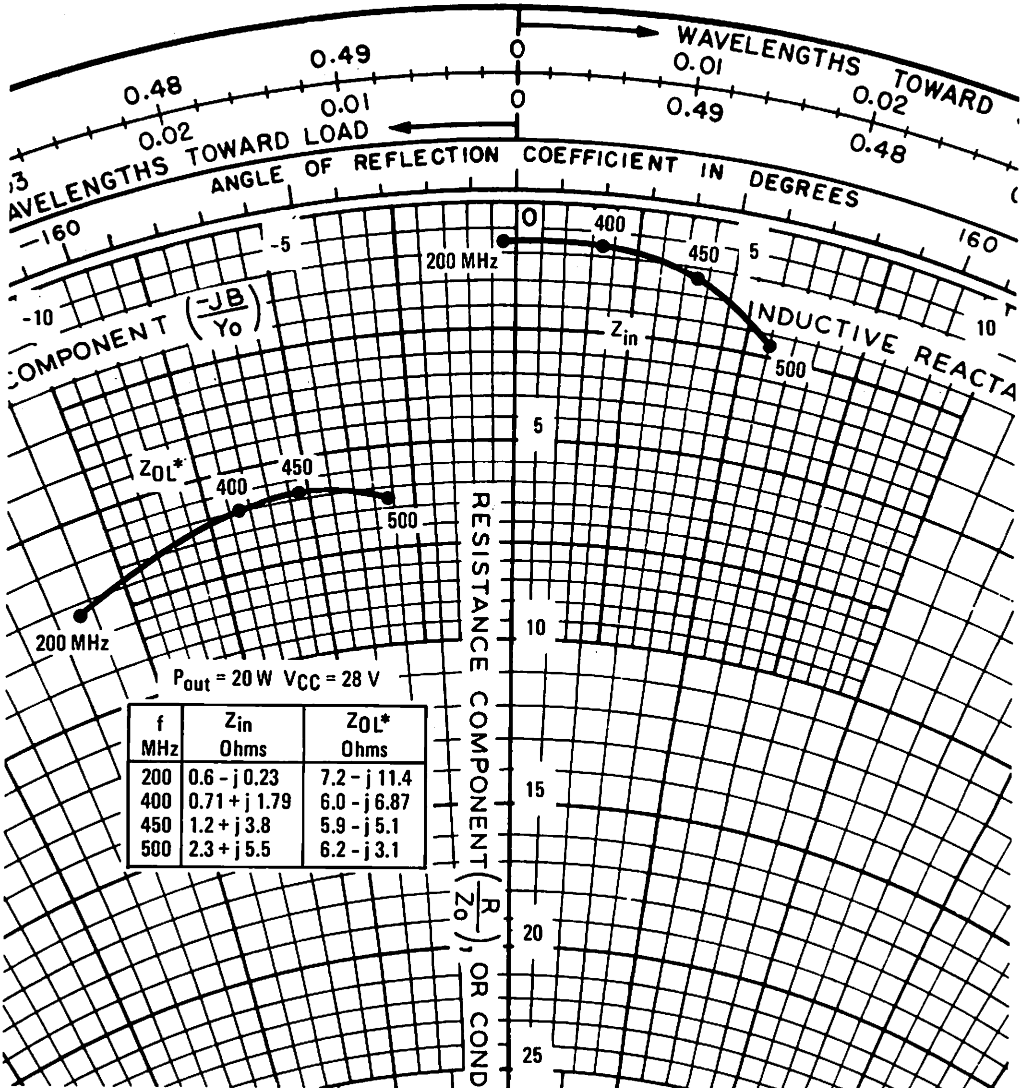
FIGURE 6 – SERIES EQUIVALENT IMPEDANCE



f MHz	Zin Ohms	ZOL* Ohms
200	0.6 - j 0.23	7.2 - j 11.4
400	0.71 + j 1.79	6.0 - j 6.87
450	1.2 + j 3.8	5.9 - j 5.1
500	2.3 + j 5.5	6.2 - j 3.1

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF325

The RF Line

NPN SILICON RF POWER TRANSISTOR

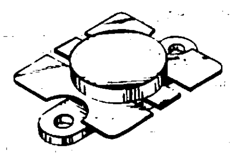
. . . designed primarily for wideband large-signal output and driver amplifier stages in the 100-500 MHz frequency range.

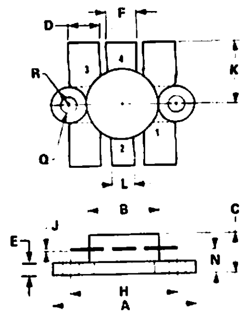
- Specified 28 Volt, 400 MHz Characteristics –
  Output Power = 30 Watts
  Minimum Gain = 8.5 dB
  Efficiency = 54% (Min)
- Built-In Matching Network for Broadband Operation Using Internal Matching Techniques
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization for High Reliability Applications

30 W – 225-400 MHz
CONTROLLED "Q"
BROADBAND RF POWER TRANSISTOR

NPN SILICON

2





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous – Peak	I_C	3.4 4.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	82 0.47	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.13	°C/W

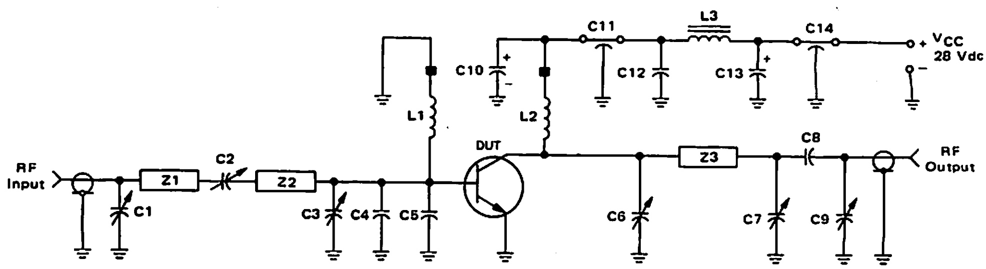
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 30 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	3.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	30	40	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz)	G_{PE}	8.5	9.5	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 30 W, f = 400 MHz, VSWR = 30:1 all angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 400 MHz TEST CIRCUIT



C1, C9 — 1.0–10 pF Johanson Capacitor (JMC 5201)
C2, C3, C6, C7 — 1.0–20 pF Johanson Capacitor (JMC 5501)
C4, C5 — 36 pF ATC 100-mil Chip Capacitor
C8 — 100 pF UNELCO
C10, C13 — 1.0 μF 50 V Tantalum
C11, C14 — 680 pF Feedthru
C12 — 0.1 μF Erie Redcap
L1 — 8 Turns #26 AWG Enameled, 1/16" ID Closewound with Ferroxcube Bead (#56-590-65/4B) on Ground End
L2 — 14 Turns, #22 AWG Enameled, Closewound on a 470 Ω, 2 Watt Resistor with Ferroxcube Bead (#56-590-65/4B) on Cold End of L2
L3 — Ferroxcube VK200-19/4B Ferrite Choke
Z1 — Microstrip 0.19" W x 0.88" L
Z2 — Microstrip 0.28" W x 1.0" L
Z3 — Microstrip 0.31" W x 1.25" L
Board — Glass Teflon ϵ_R = 2.56, t = 0.062"
Input/Output Connectors — Type N

DUT Socket Lead Frame Etched from 80-mil-Thick Copper

FIGURE 2 – OUTPUT POWER versus INPUT POWER

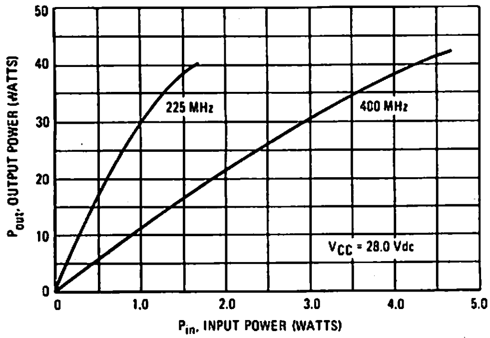


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE – 225 MHz

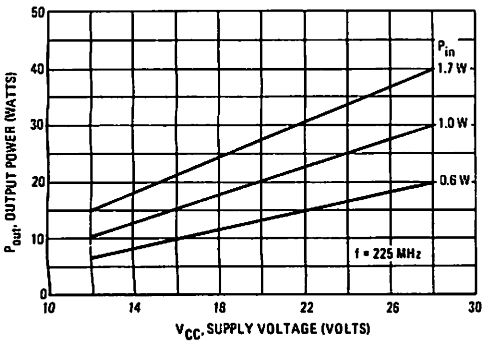


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE – 400 MHz

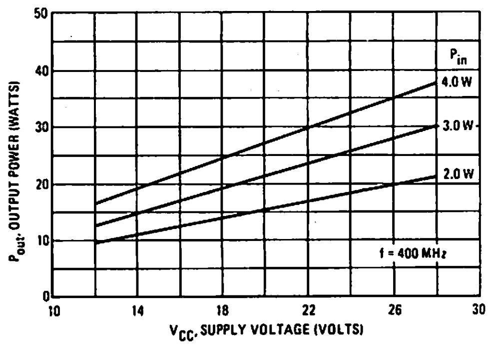


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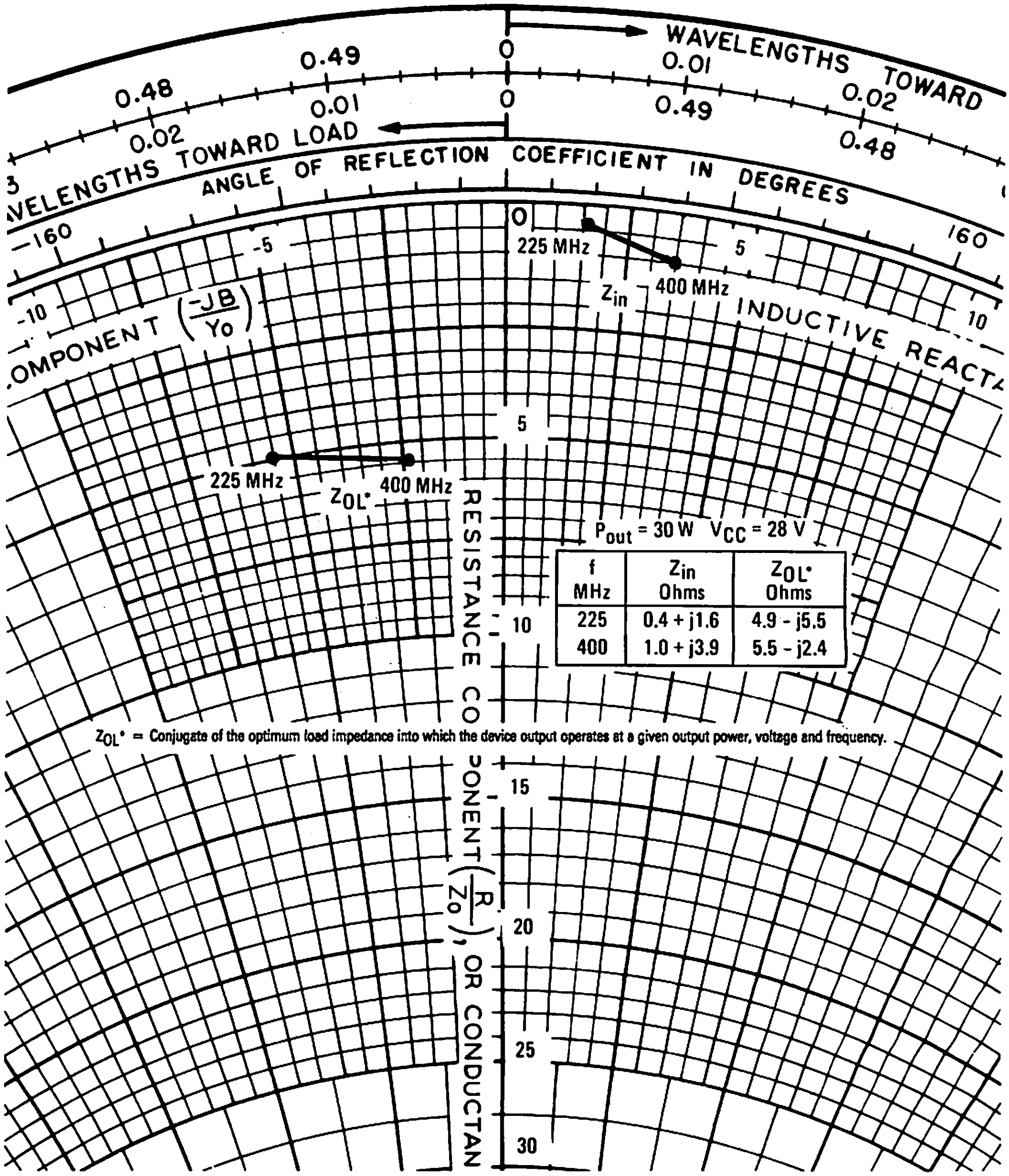
FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
225	0.4 + j1.6	4.9 - j5.5
400	1.0 + j3.9	5.5 - j2.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF326

The RF Line

NPN SILICON RF POWER TRANSISTOR

... designed primarily for wideband large-signal output amplifier stages in the 100-500 MHz frequency range.

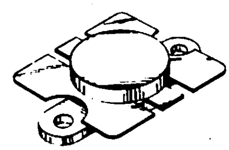
- Guaranteed Performance @ 400 MHz, 28 Vdc

  Output Power = 40 Watts
  Minimum Gain = 9.0 dB
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications

40 W – 225–400 MHz

CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR

NPN SILICON



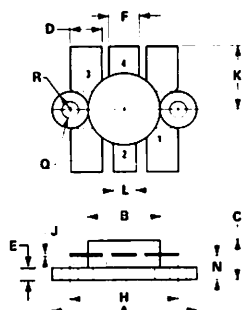
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous Peak	I_C	4.5 6.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	110 0.63	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.6	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

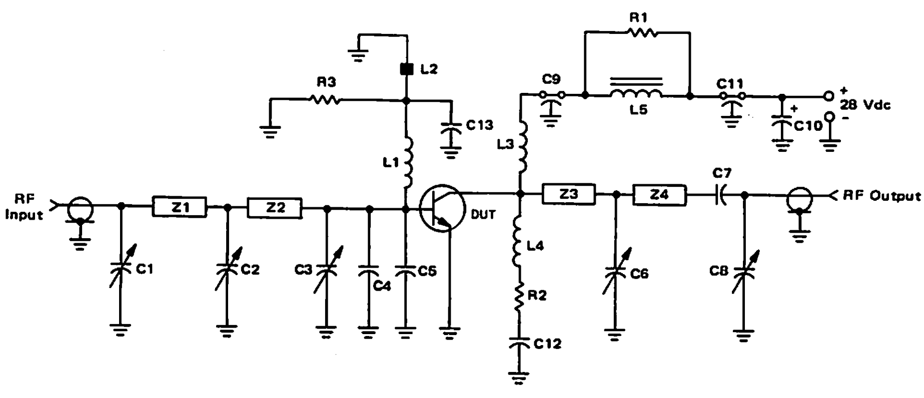
CASE 316-01

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 4.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	4.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	50	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	45	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 40 W, f = 400 MHz, I_C Max = 2.85 Adc)	G_{PE}	9.0	11	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 40 W, f = 400 MHz, I_C Max = 2.85 Adc)	η	50	–	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 40 W CW, f = 400 MHz, VSWR = 30:1 all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 400 MHz TEST AMPLIFIER



C1 — 1.0-10 pF Johanson, Capacitor (JMC 5201)
C2, C3, C6, C8 — 1.0-20 pF Johanson Capacitor
C4, C5 — 36 pF ATC "B" Style Chip Capacitor
C7, C9, C13 — 100 pF UNELCO Capacitor
C11 — 680 pF Feedthru
C10 — 1.0 µF 50 V Tantalum
C12 — 0.1 µF Erie Redcap
L1 — 8 Turns #26 AWG Enameled, 1/16" ID Closewound
L2, L5 — Ferroxcube VK200-19/4B Ferrite Choke
L3 — 8 Turns #20 AWG Enameled, 1/4" ID Closewound
L4 — 4 Turns #26 AWG 0.1" ID
R1 — 10 Ohm 2.0 W Carbon
R2, R3 — 10 Ohm 1.0 W Carbon
Z1 — Microstrip 0.19" W x 1.28" L
Z2 — Microstrip 0.28" W x 1.0" L
Z3 — Microstrip 0.31" W x 1.0" L
Z4 — Microstrip 0.31" W x 0.9" L
Board — Glass Teflon ε_R = 2.56 t = 0.062"
Input/Output Connectors — Type N UG58 A/U

FIGURE 2 — OUTPUT POWER versus INPUT POWER

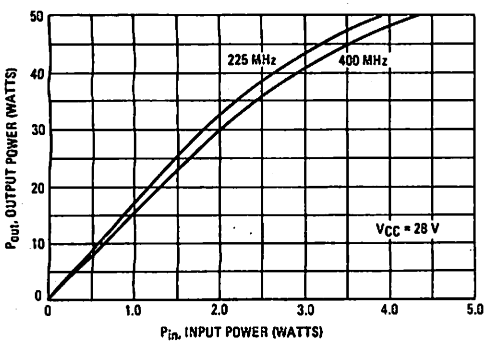


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

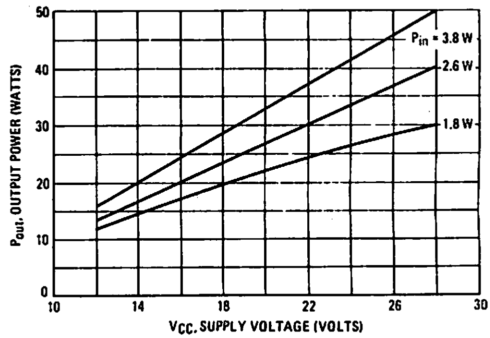


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

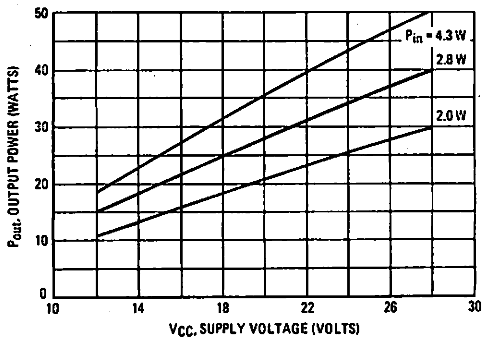


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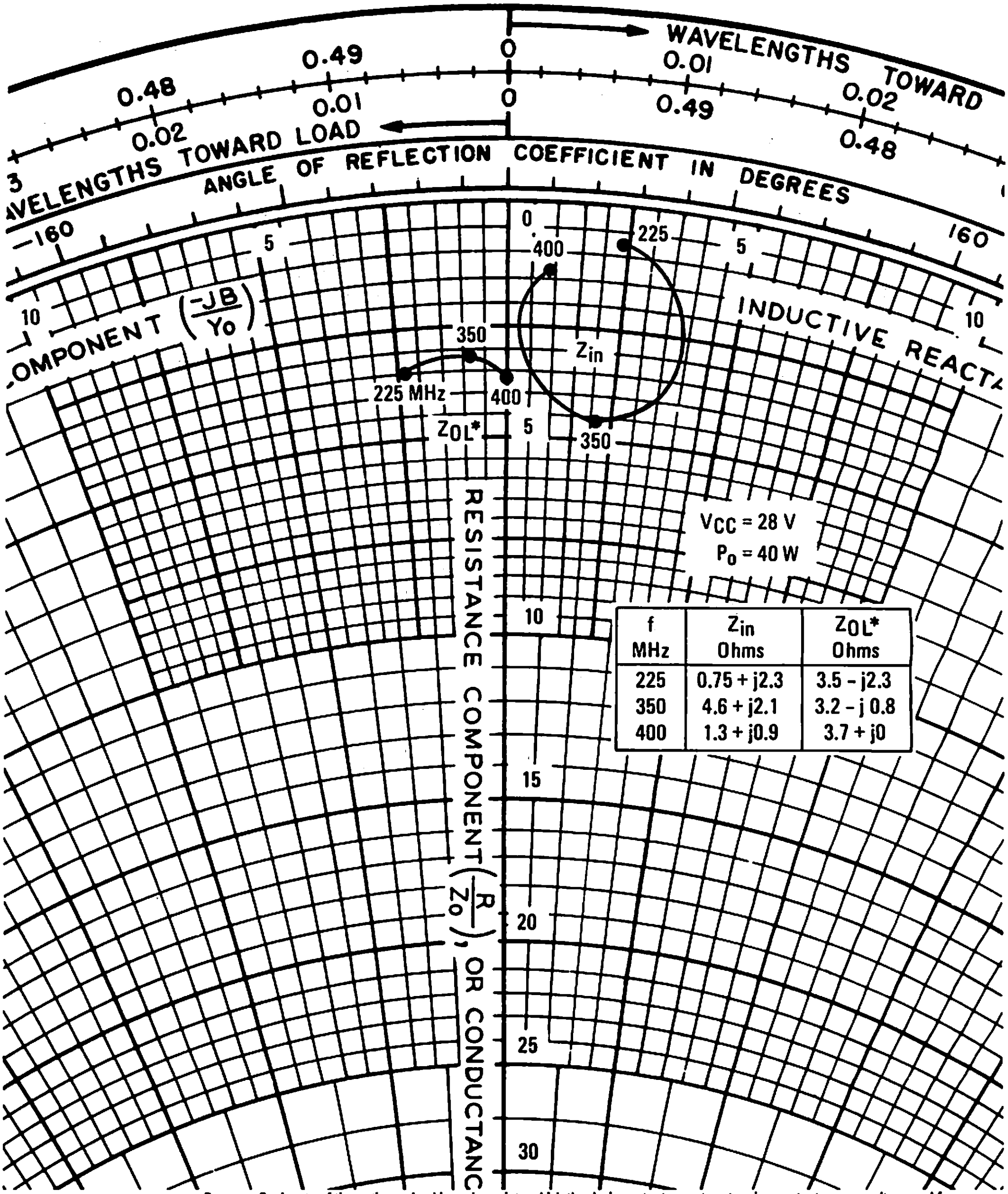
FIGURE 5 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



f MHz	Zin Ohms	ZOL* Ohms
225	0.75 + j2.3	3.5 – j2.3
350	4.6 + j2.1	3.2 – j 0.8
400	1.3 + j0.9	3.7 + j0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

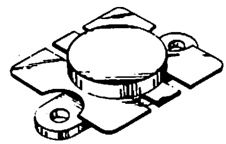
MRF327

The RF Line

80 W – 100-500 MHz

CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR

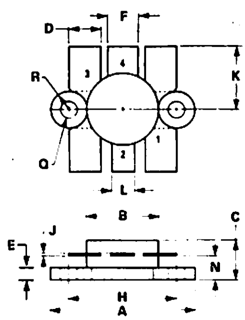
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for wideband large-signal output amplifier stages in the 100-500 MHz frequency range.

- Guaranteed Performance @ 400 MHz, 28 Vdc
  Output Power = 80 Watts over 225–400 MHz Band
  Minimum Gain = 7.3 dB @ 400 MHz
- Built-in Matching Network for Broadband Operation Using Double Match Technique
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR
- Gold Metallization System for High Reliability Applications
- Characterized for 100–500 MHz



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous – Peak	I_C	9.0 12.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to+150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

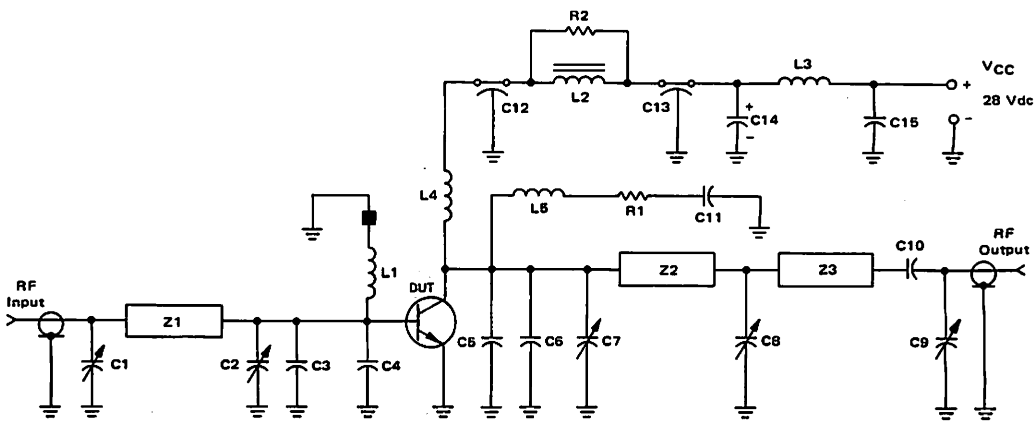
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 8.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 80 mAdc, I_C = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	100	145	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 400 MHz)	G_{PE}	7.3	9.0	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 400 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 28 V, P_{out} = 80 W, f = 400 MHz, VSWR 30:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 – 400 MHz TEST CIRCUIT



C1, C2, C7, C8, C9 – 1.0-20 pF Piston Trimmer (Johanson JMC 5501)
C3, C4 – 36 pF ATC 100 mil Chip Capacitor
C5, C6 – 43 pF ATC 100-mil Chip Capacitor
C10 – 100 pF UNELCO
C11, C15 – 0.1 μF Erie Redcap
C12, C13 – 680 pF Feedthru
C14 – 1.0 μF 50 V Tantalum
L1 – 4 Turns #22 AWG Enameled, 3/16" ID Closewound with Ferroxcube Bead (#56-590-65/4B) on Ground End of Coil
L2 – Ferroxcube VK200-19/4B Ferrite Choke
L3 – 7 Turns #18 AWG, 11/16" Long, Wound on a 100 kΩ 2 Watt Resistor
L4 – 6 Turns #20 AWG Enameled, 3/16" ID Closewound
L5 – 4 Turns #22 AWG Enameled, 1/8" ID Closewound
Z1 – Microstrip 0.2" W x 1.5" L
Z2 – Microstrip 0.17" W x 1.16" L
Z3 – Microstrip 0.17" W x 0.63" L
R1, R2 – 10 Ω 2 Watt
Board – Glass Teflon ϵ_R = 2.56, t = 0.062"
Input/Output Connectors Type N

DUT Socket Lead Frame Etched from 80-mil-Thick Copper

FIGURE 2 – POWER GAIN versus FREQUENCY

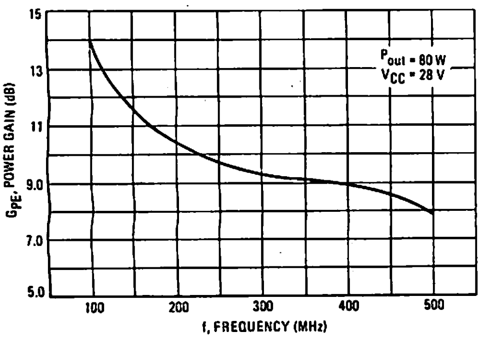


FIGURE 3 – OUTPUT POWER versus FREQUENCY

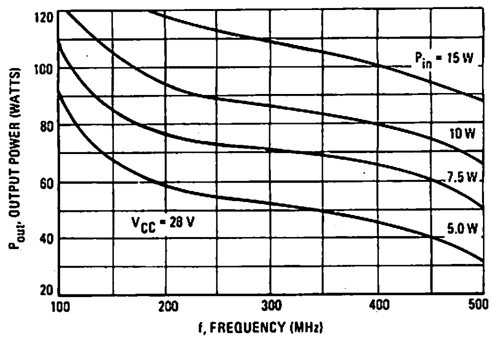


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE
f = 225 MHz

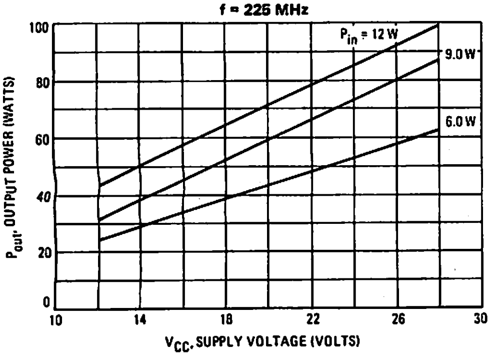


FIGURE 5 – OUTPUT POWER versus SUPPLY VOLTAGE
f = 400 MHz

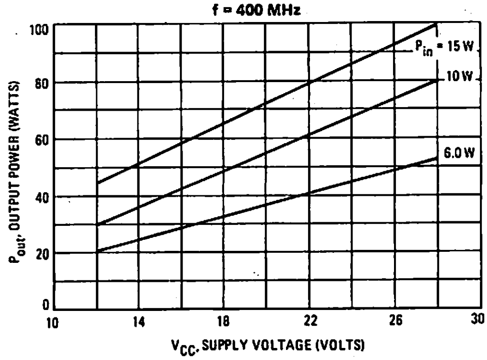


FIGURE 6 – OUTPUT POWER versus INPUT POWER

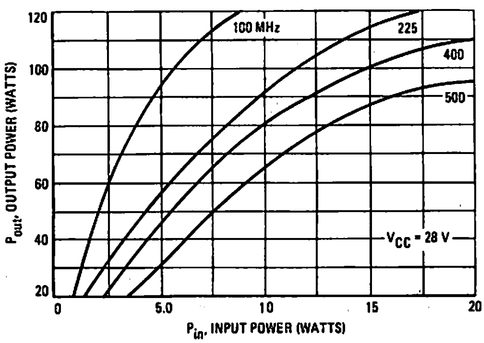
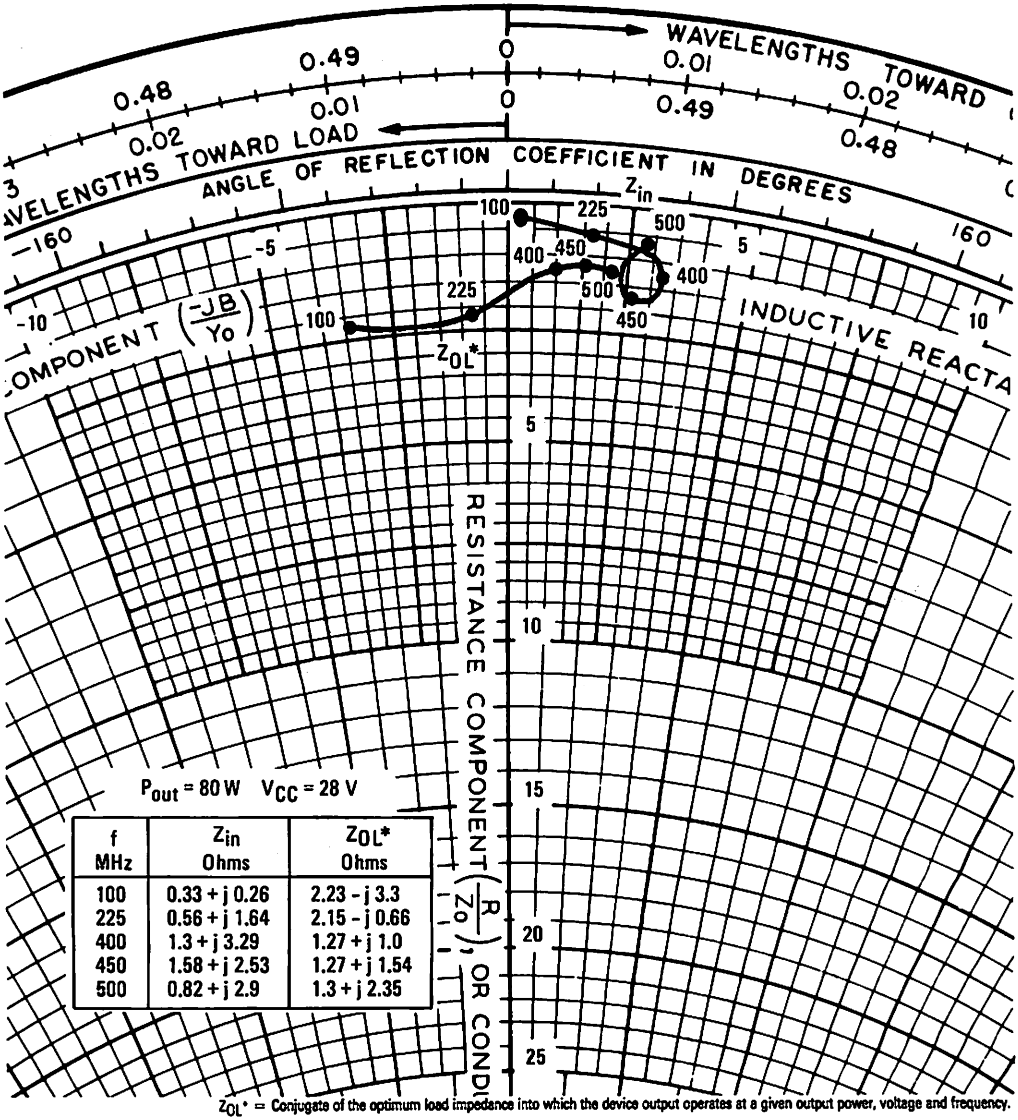


FIGURE 7 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	0.33 + j 0.26	2.23 - j 3.3
225	0.56 + j 1.64	2.15 - j 0.66
400	1.3 + j 3.29	1.27 + j 1.0
450	1.58 + j 2.53	1.27 + j 1.54
500	0.82 + j 2.9	1.3 + j 2.35

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

MRF329

The RF Line

NPN SILICON RF POWER TRANSISTOR

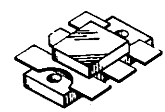
. . . designed primarily for wideband large-signal output and driver amplifier stages in the 100–500 MHz frequency range.

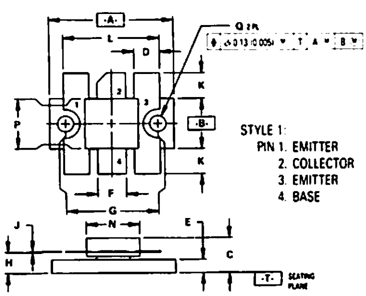
- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 100 Watts
  Minimum Gain = 7.0 dB
  Efficiency = 50% (Min)
- Built-In Matching Network for Broadband Operation
  Using Double Match Technique
- 100% Tested for Load Mismatch at All Phase Angles
  With 3:1 VSWR
- Gold Metallization System for High Reliability
- Replacement for MRF328

100 W — 100–500 MHz

**CONTROLLED "Q"
BROADBAND RF POWER
TRANSISTOR**

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.51	25.02	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.73	7.24	0.265	0.285
D	4.83	5.33	0.190	0.210
E	2.42	2.92	0.095	0.115
F	5.47	5.96	0.215	0.235
G	18.42 BSC		0.725 BSC	
H	3.94	4.44	0.155	0.175
J	0.10	0.15	0.004	0.006
K	4.95	5.21	0.195	0.205
L	18.80	19.55	0.740	0.770
N	10.54	10.80	0.415	0.425
P	9.91	10.16	0.390	0.400
Q	3.05	3.42	0.120	0.135

CASE 333-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	9.0 12.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.65	°C/W

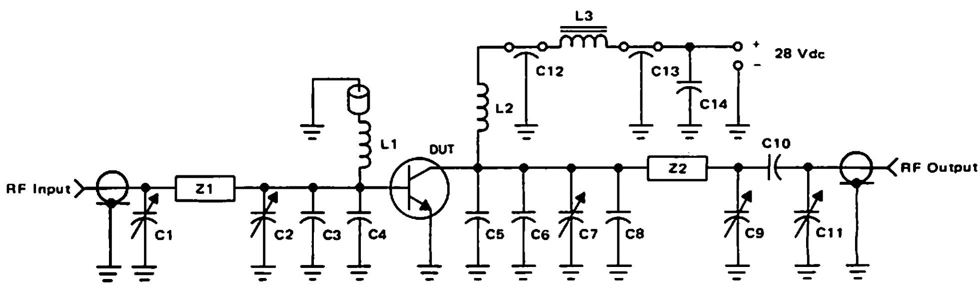
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 8.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 80 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	–	80	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	95	125	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz)	G_{PE}	7.0	9.7	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 400 MHz VSWR = 3:1 all angles)	ψ	No Degradation in Output Power			

FIGURE 1 – 400 MHz TEST CIRCUIT



C1, C2, C7, C9 – 1.0–20 pF Johanson (JMC 5501)
C3, C4 – 36 pF 100 mil Chip Cap (ATC)
C5, C6 – 50 pF 100 mil Chip Cap (ATC)
C8 – 30 pF 100 mil Chip Cap (ATC)
C10 – 2-150 pF 100 mil Chip Caps in Parallel (ATC)
C11 – 1.0-10 pF Johanson (JMC 5201)
C12, C13 – 1000 pF UNELCO Feedthru
C14 – 0.1 μF Erie Redcap

L1 – 0.15 μH Molded Choke with Ferrite Bead (Ferroxcube #56-590-65/4B) on Ground End
L2 – 4 Turns #18 AWG, 1/4" ID
L3 – Ferroxcube VK200-19/4B
Z1 – Microstrip Line 2300 mils L X 210 mils W
Z2 – Microstrip Line 2300 mils L X 280 mils W
Board – Glass Teflon, t = 0.062", ϵ_r = 2.56

FIGURE 2 — OUTPUT POWER versus INPUT POWER

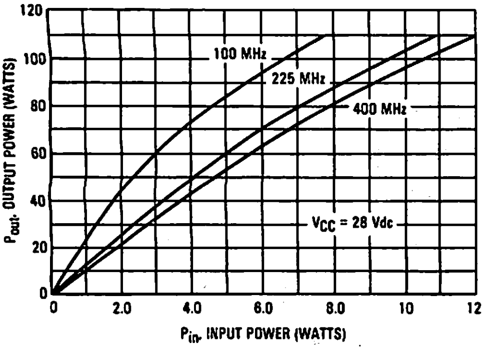


FIGURE 3 — OUTPUT POWER versus FREQUENCY

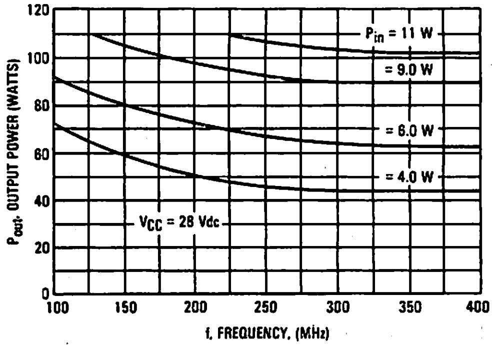


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE (225 MHz)

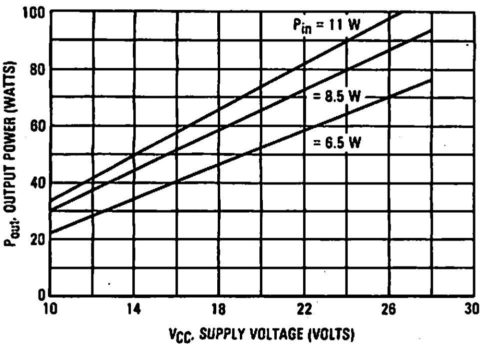


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE (400 MHz)

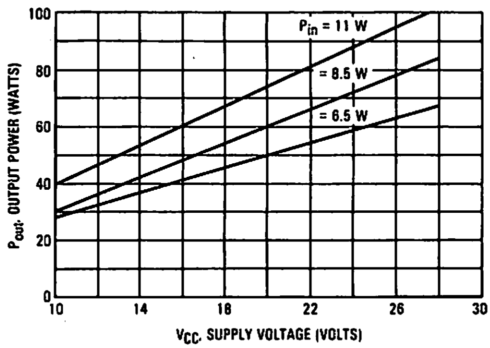


FIGURE 6 — POWER GAIN versus FREQUENCY

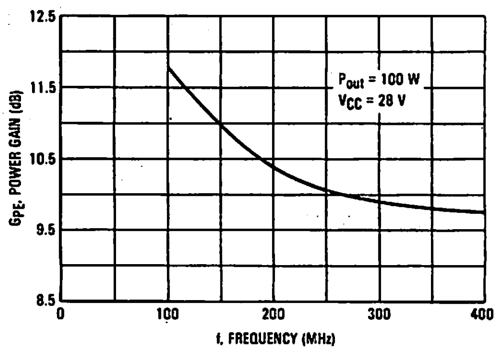


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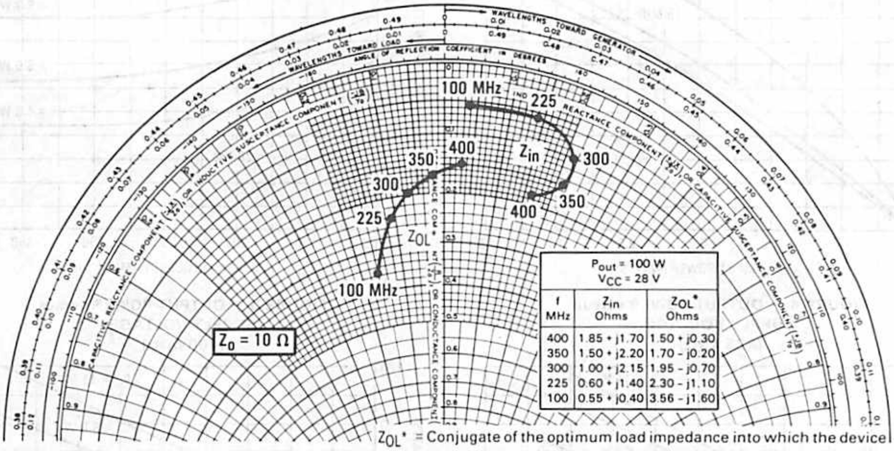
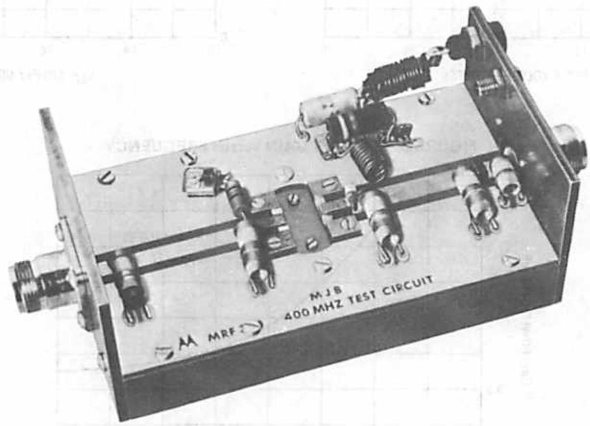
FIGURE 7 — SERIES EQUIVALENT INPUT/ OUTPUT IMPEDANCE



P_{out} = 100 W, V_{CC} = 28 V		
f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
400	1.85 + j1.70	1.50 + j0.30
350	1.50 + j2.20	1.70 - j0.20
300	1.00 + j2.15	1.95 - j0.70
225	0.60 + j1.40	2.30 - j1.10
100	0.55 + j0.40	3.56 - j1.60

Z_{OL}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 8 — TEST FIXTURE



MRF338

The RF Line

80 W — 400-512 MHz

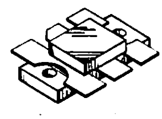
CONTROLLED "Q" BROADBAND RF POWER TRANSISTOR

NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 400-512 MHz frequency range.

- Specified 28 Volt, 470 MHz Characteristics —
  Output Power = 80 Watts
  Minimum Gain = 7.3 dB
  Efficiency = 50% (Min)
- Built-In Matching Network for Broadband Operation
- 100% Tested for Load Mismatch at All Phase Angles With 30:1 VSWR
- Gold Metallization System for High Reliability Applications



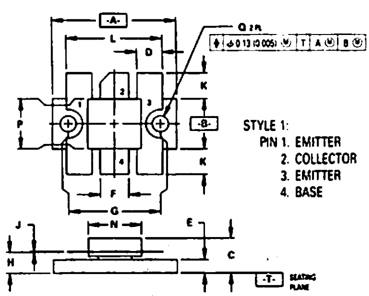
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous — Peak	I_C	9.0 12.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.51	25.02	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.73	7.24	0.265	0.285
D	4.83	5.33	0.190	0.210
E	2.42	2.92	0.095	0.115
F	5.47	5.96	0.215	0.235
G	18.42 BSC		0.725 BSC	
H	3.94	4.44	0.155	0.175
J	0.10	0.15	0.004	0.006
K	4.95	5.21	0.195	0.205
L	18.80	19.55	0.740	0.770
N	10.54	10.80	0.415	0.425
P	9.91	10.16	0.390	0.400
Q	3.05	3.42	0.120	0.135

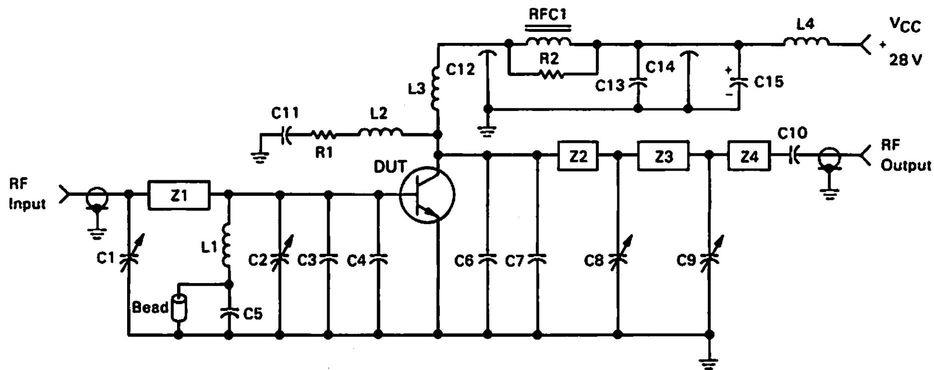
CASE 333-03

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 8.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 80 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	95	125	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 470 MHz)	G_{PE}	7.3	8.8	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 470 MHz)	η	50	60		%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 80 W, f = 470 MHz, VSWR = 30:1 all angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C8, C9 — 0.8-20 pF Johanson (JMC 5501)
C3, C4, C6, C7 — 25 pF Underwood 100 V
C5, C10 — 100 pF Underwood 100 V
C11, C13 — 0.1 μF Erie Redcap
C12, C14 — 680 pF Feedthru
C15 — 1.0 μF Tantalum
L1 — 0.15 μH Molded Choke
L2 — 5 Turns #20 AWG, 0.185" ID, Close Wound
L3 — 3 Turns #18 AWG, 0.185" ID, Close Wound
L4 — 4 Turns #18 AWG, 0.185" ID, Close Wound

RFC1 — Ferroxcube VK200 19/4B
Bead — Ferroxcube #56-590-65/3B
R1, R2 — 10 Ω 2.0 Watt Carbon
Z1 — Microstrip Line 0.190" W × 2.5" L
Z2 — Microstrip Line 0.190" W × 0.289" L
Z3 — Microstrip Line 0.190" W × 0.55" L
Z4 — Microstrip Line 0.190" W × 0.325" L
Board — Glass Teflon, ϵ_r = 2.56, t = 0.062"

FIGURE 2 — POWER OUTPUT versus POWER INPUT

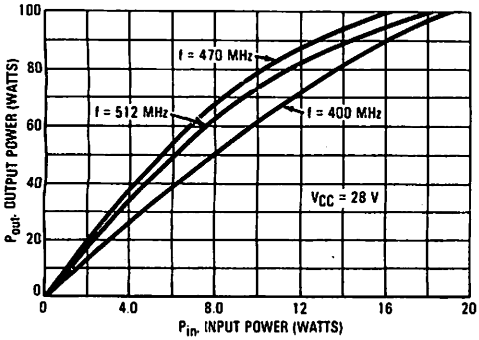


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

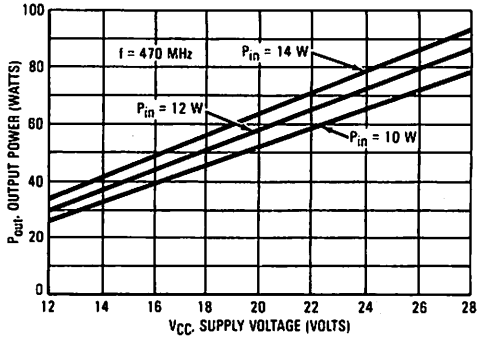


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FIGURE 4 — POWER GAIN versus FREQUENCY

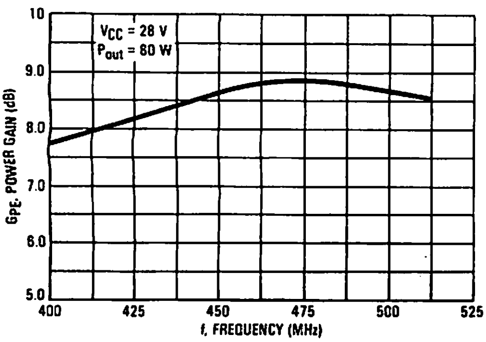


FIGURE 5 — OUTPUT POWER versus FREQUENCY

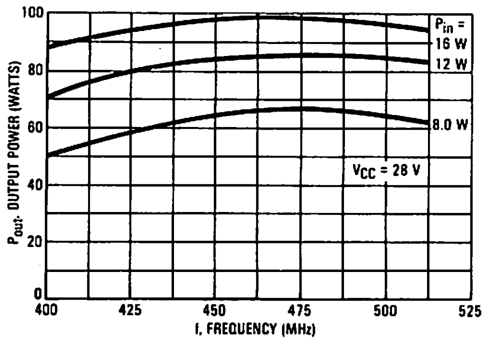
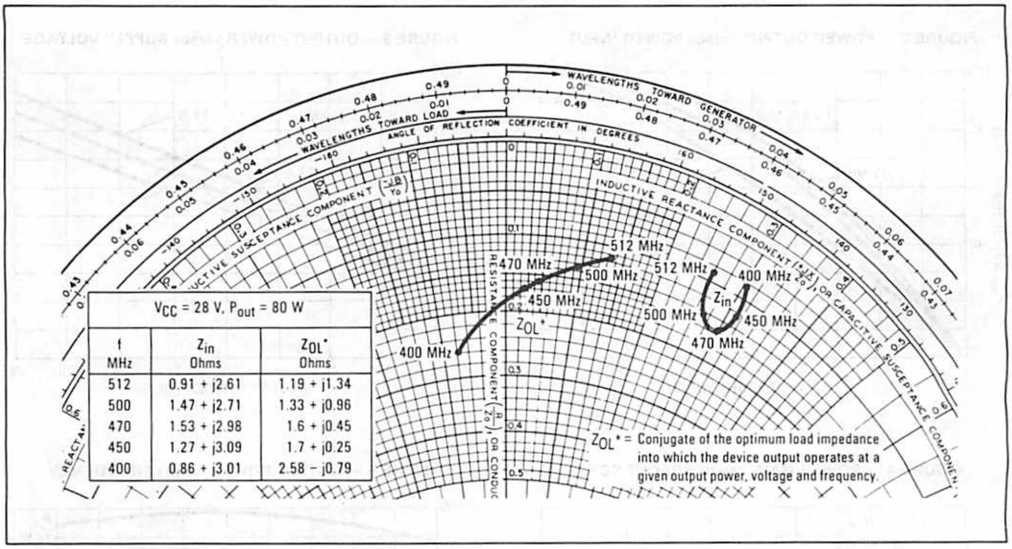


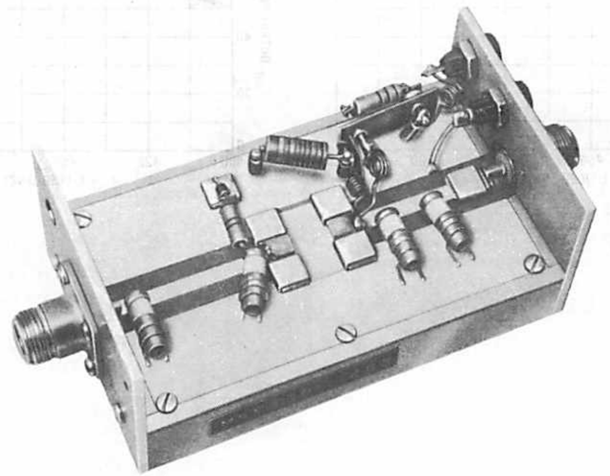
FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



V_{CC} = 28 V, P_{out} = 80 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
512	0.91 + j2.61	1.19 + j1.34
500	1.47 + j2.71	1.33 + j0.96
470	1.53 + j2.98	1.6 + j0.45
450	1.27 + j3.09	1.7 + j0.25
400	0.86 + j3.01	2.58 − j0.79

FIGURE 7 — TEST FIXTURE



MRF340

The RF Line

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

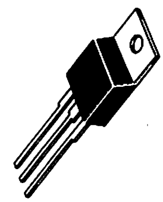
- Low Cost Common Emitter TO-220 Package
- Specified 27 V, 136 MHz Performance:
  Output Power = 8.0 W
  Power Gain = 13 dB Min
  Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- *Other Devices in the Series:*
  MRF342 24 W
  MRF344 60 W

8 W 100–150 MHz

RF POWER TRANSISTOR

NPN SILICON

2



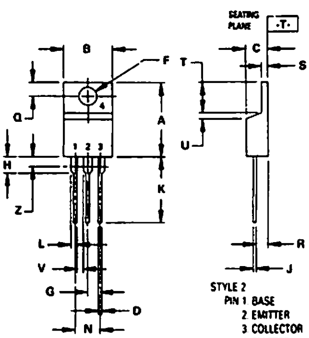
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous Peak	I_C	1.0 1.2	Adc
Total Device Dissipation — T_C = 25°C (1) Derate above 25°C	P_D	15 86	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	11.6	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



STYLE 2
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

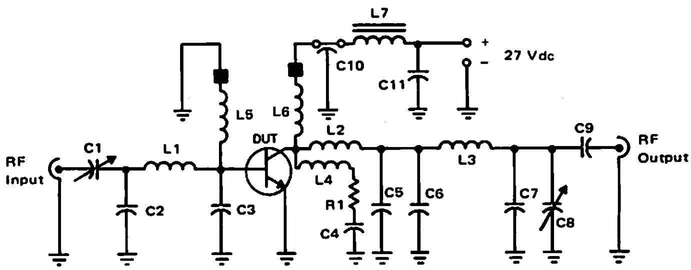
**CASE 221A-04
TO-220AB**

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 27 Vdc, V_{BE} = 0)	I_{CES}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CD} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 27 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	8.0	15	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.5 Vdc, P_{out} = 2.0 W, f = 136 MHz)	G_{PE}	9.0	10.5	–	dB
Common Emitter Amplifier Power Gain (V_{CC} = 27 Vdc, P_{out} = 8.0 W, f = 136 MHz)	G_{PE}	13.0	14.9	–	dB
Collector Efficiency (V_{CC} = 27 Vdc, P_{out} = 8.0 W, f = 136 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 27 Vdc, P_{out} = 8.0 W (peak), f = 136 MHz. Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR > 20:1, all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 136 MHz TEST CIRCUIT



C1 — Arco 404 8–60 pF
C2, C5 — 40 pF UNELCO
C3 — 80 pF UNELCO
C4, C11 — 0.1 μF Erie Redcap
C6 — 25 pF UNELCO
C7 — 5.0 pF UNELCO
C8 — Arco 403 3–35 pF
C9 — 510 pF Dipped Mica
C10 — 680 pF Feedthru

L1 — 3 Turns #18 AWG, 1/8" ID
L2, L3 — 4 Turns #18 AWG, 1/8" ID
L4 — 0.33 μH Molded Choke
L5 — 0.15 μH Molded Choke with Ferrite Bead
L6 — 0.47 μH Molded Choke with Ferrite Bead
L7 — VK-200-19/4B

R1 — 100 Ω, 1.0 Watt

FIGURE 2 — POWER GAIN versus FREQUENCY

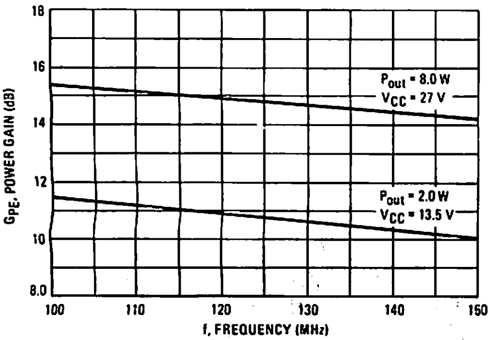
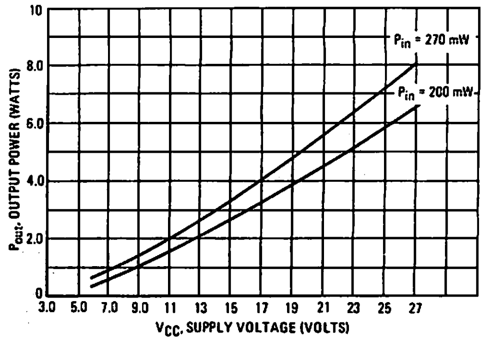


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE
(f = 136 MHz)



Circuit Tuned for P_{out} = 8.0 Watts at V_{CC} = 27 Volts

FIGURE 4 — OUTPUT POWER versus INPUT POWER
(V_{CC} = 27 V)

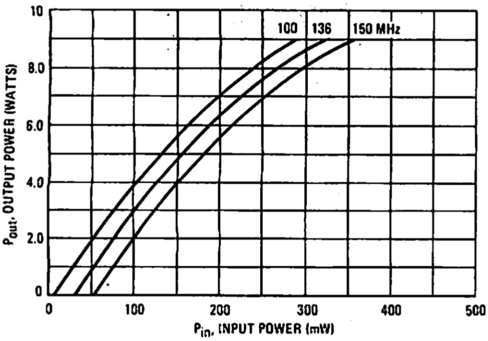


FIGURE 5 — OUTPUT POWER versus INPUT POWER
(V_{CC} = 13.5 V)

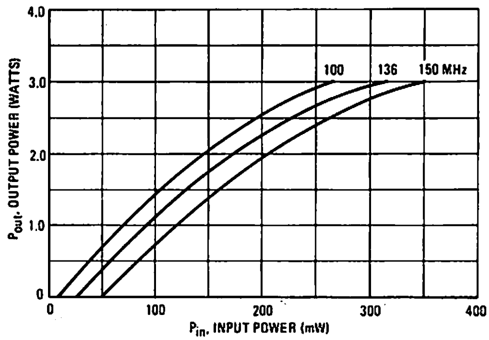
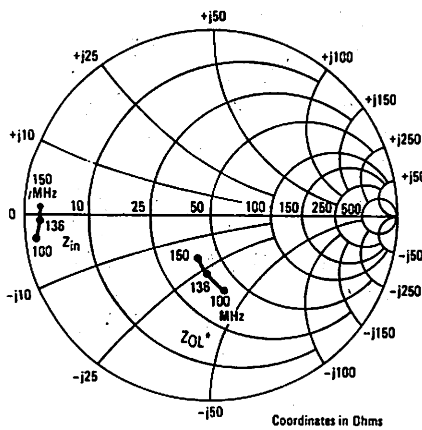


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



V_{CC} = 27 V P_{out} = 8.0 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	3.40 - j1.70	42.6 - j31.8
136	4.00 - j0.57	39.2 - j26.4
150	3.95 + j0.66	38.3 - j17.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 – 136 MHz TEST AMPLIFIER

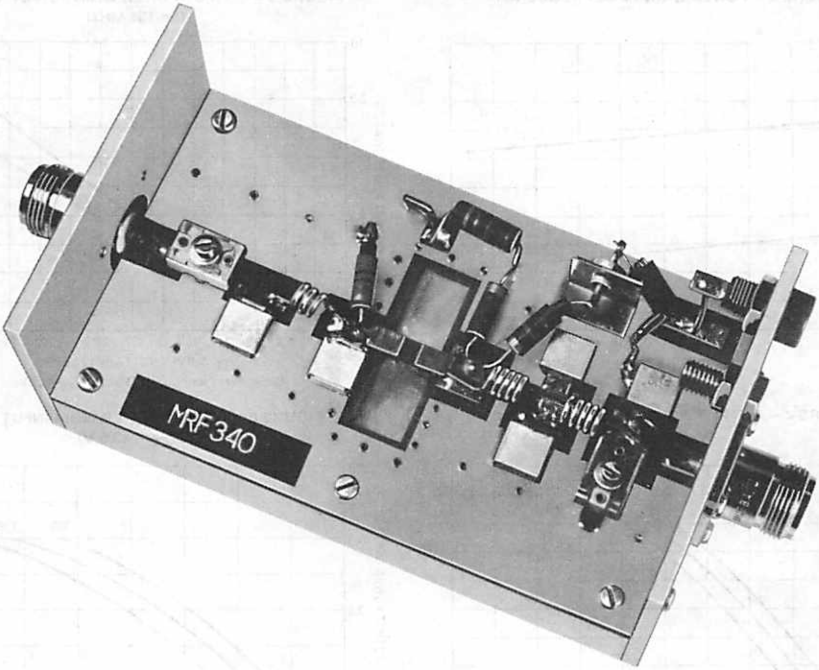
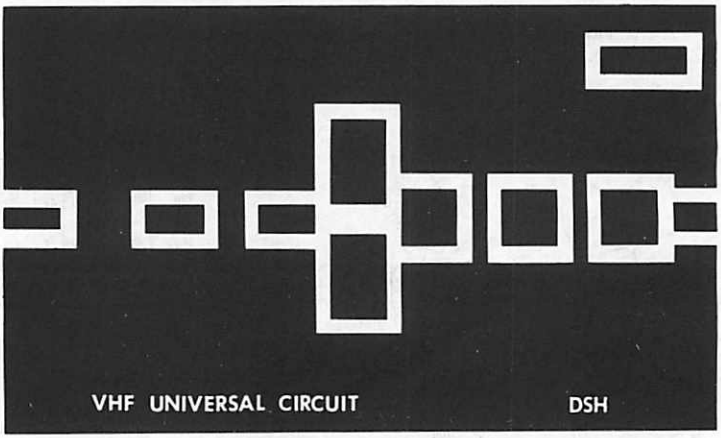


FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 136 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF342

The RF Line

24 W 100–150 MHz

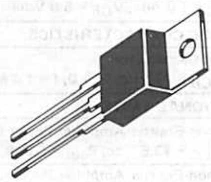
RF POWER TRANSISTOR

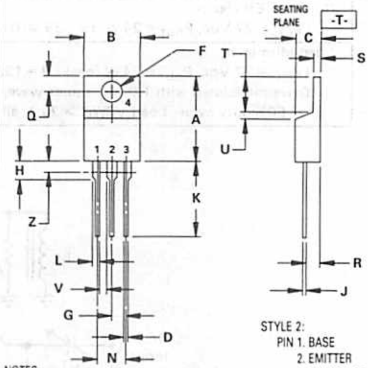
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

- Low Cost Common Emitter TO-220 Package
- Specified 27 V, 136 MHz Performance:
  Output Power = 24 W
  Power Gain = 11 dB Min
  Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Other Devices in the Series:
  MRF340 8.0 W
  MRF344 60 W





STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous Peak	I_C	2.2 3.0	Adc
Total Device Dissipation — $T_C = 25^\circ C$ (1) Derate above $25^\circ C$	P_D	55 310	Watts mW/$^\circ$C
Storage Temperature Range	T_{stg}	−65 to +150	$^\circ$C

THERMAL CHARACTERISTICS

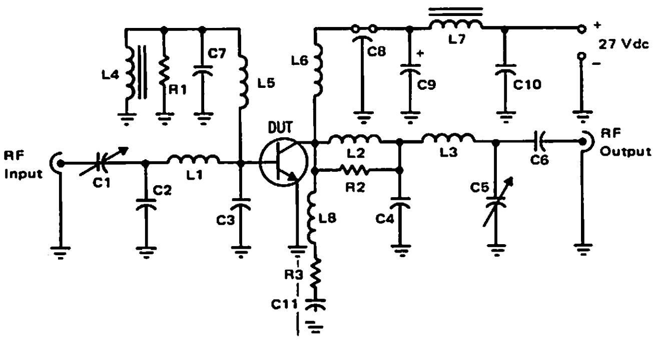
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.2	$^\circ$C/W

1. These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 27 Vdc, V_{BE} = 0)	I_{CES}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 27 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	20	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.5 Vdc, P_{out} = 6.0 W, f = 136 MHz)	G_{PE}	10	11.5	–	dB
Common-Emitter Amplifier Power Gain (V_{CC} = 27 Vdc, P_{out} = 24 W, f = 136 MHz)	G_{PE}	11	12.3	–	dB
Collector Efficiency (V_{CC} = 27 Vdc, P_{out} = 24 W, f = 136 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 27 Vdc, P_{out} = 24 W (peak), f = 136 MHz Drive modulated with 1.0 kHz square wave, 50% duty cycle. Load VSWR > 20:1, all phase angles)	ψ	No Degradation in Power Output			



C1 – Arco 404
C2 – 25 pF UNELCO
C3, C7 – 200 pF UNELCO
C4 – 40 pF UNELCO
C5 – Arco 462
C6 – 510 pF Dipped Mica
C8 – 680 pF Feedthru
C9 – 1.0 µF 50 V Tantalum
C10, C11 – 0.1 µF Erie Redcap 100 V

L1, L2 – 3 Turns #18 AWG, 1/8" ID
L3 – 5 Turns #18 AWG, 1/8 ID
L4, L7 – VK-200-19/4B
L5 – 0.15 µH Molded Choke
L6 – 0.22 µH Molded Choke
L8 – 0.47 µH Molded Choke
R1 – 22 Ω, 2 Watt
R2 – 910 Ω, 1 Watt
R3 – 12 Ω, 1 Watt

Figure 1. 136 MHz Test Circuit

FIGURE 2 — POWER GAIN versus FREQUENCY

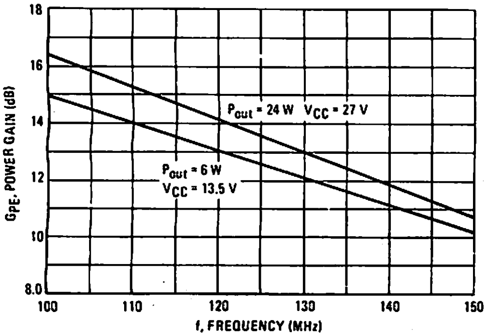


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE (f = 136 MHz)

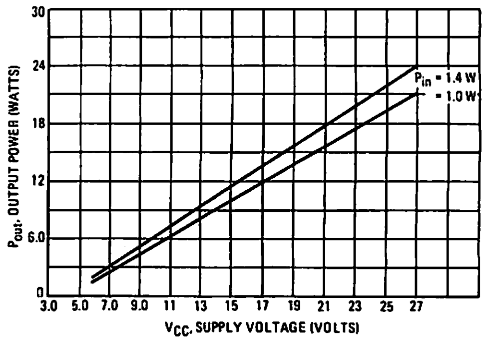


FIGURE 4 — OUTPUT POWER versus INPUT POWER (V_{CC} = 27 V)

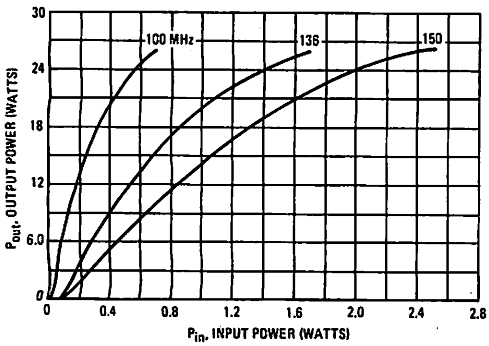


FIGURE 5 — OUTPUT POWER versus INPUT POWER (V_{CC} = 13.5 V)

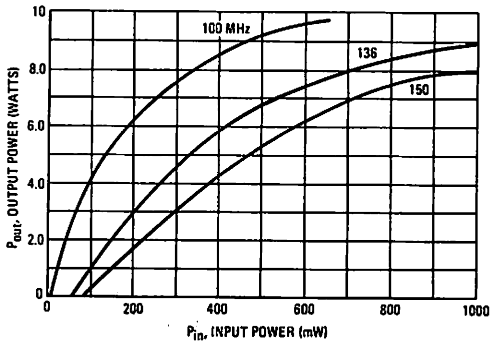
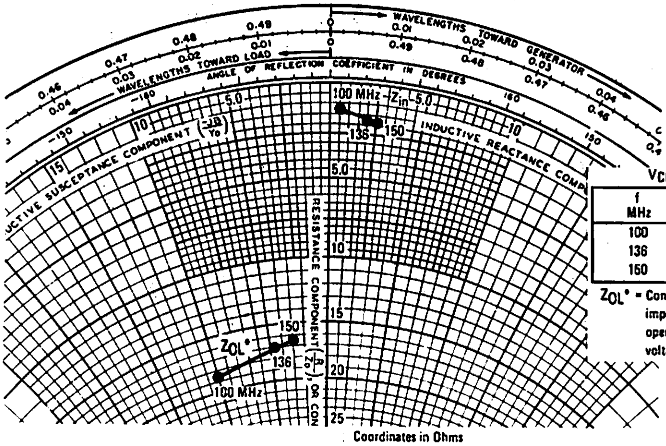


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



V_{CC} = 27 V P_{out} = 24 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	1.25 + j0.5	18.5 − j10
136	1.75 + j2.0	17 − j4.7
150	1.9 + j2.5	16.5 − j3.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

2

FIGURE 7 – 136 MHz TEST AMPLIFIER

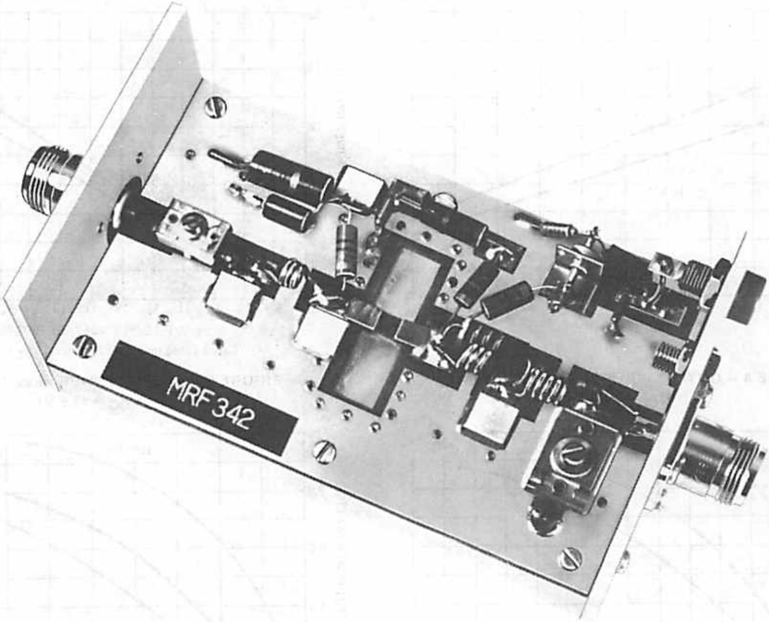
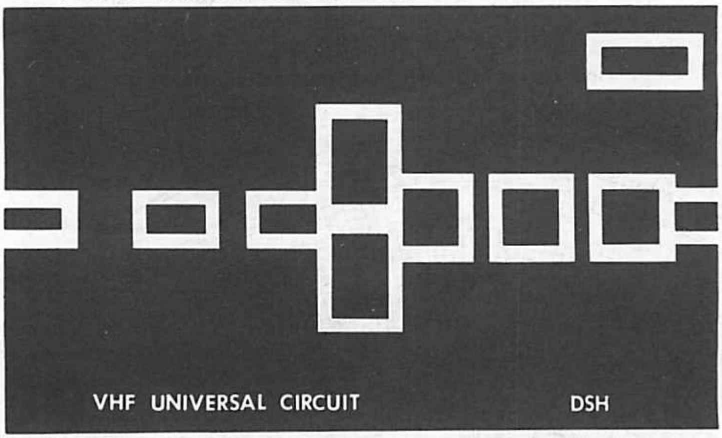


FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 136 MHz TEST CIRCUIT



Note: The Printed Circuit Board shown is 75% of the original.

MRF344

The RF Line

NPN SILICON RF POWER TRANSISTOR

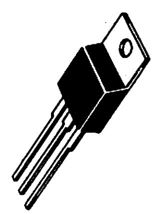
. . . designed primarily for use in VHF amplifiers with amplitude modulation and other communications equipment operating to 150 MHz.

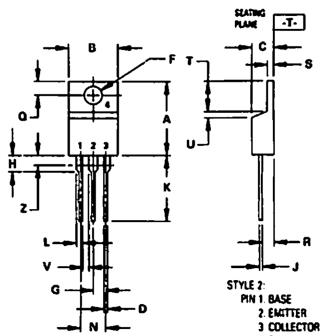
- Low Cost Common Emitter TO-220AB Package
- Specified 27 V, 136 MHz Performance:
  Output Power = 60 W
  Power Gain = 6.0 dB Min
  Efficiency = 50% Min
- 20:1 VSWR Load Mismatch Capability at Rated Peak Output Power and Supply Voltage
- Other Devices in the Series:
  MRF340 8 W
  MRF342 24 W

60 W 100–150 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

**CASE 221A-04
TO-220AB**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous Peak	I_C	5.0 6.0	Adc
Total Device Dissipation — $T_C = 25°C$ (1) Derate above 25°C	P_D	87.5 0.5	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

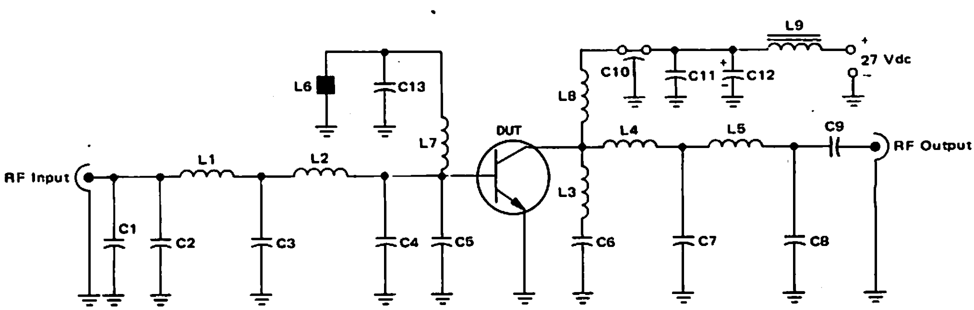
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 27 Vdc, V_{BE} = 0)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	80	-
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 27 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	130	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.5 Vdc, P_{out} = 15 W, f = 136 MHz)	G_{PE}	4.0	4.5	–	dB
Common Emitter Amplifier Power Gain (V_{CC} = 27 Vdc, P_{out} = 60 W, f = 136 MHz)	G_{PE}	6.0	6.7	–	dB
Collector Efficiency (V_{CC} = 27 Vdc, P_{out} = 60 W, f = 136 MHz)	η	50	60	–	%
Load Mismatch (V_{CC} = 27 Vdc, P_{out} = 60 W (peak), f = 136 MHz, Drive modulated with 1.0 kHz square wave, 50% duty cycle, Load VSWR = 20:1, all phase angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 136 MHz TEST CIRCUIT



C1, C2 — 10 pF UNELCO
C3, C8 — 25 pF UNELCO
C4, C5, C7 — 100 pF UNELCO
C6, C11 — 0.1 µF Erie Redcap
C9 — 1000 pF UNELCO
C10 — 1000 pF UNELCO Feedthru
C12 — 1.0 µF 50 V Tantalum
C13 — 200 pF UNELCO

L1 — 3/4" of #20 AWG
L2 — 1/2" of #20 AWG
L3 — 2 Turns, 1/8" ID #20 AWG
L4 — Copper Strap 15 mil Thick 3/16" X 1/2" L
L5 — 2 Turns #20 AWG 1/4" ID
L6 — Ferrite Bead on Lead of L7
L7, L8 — 0.15 µH Molded Choke
L9 — VK-200-19/4B

Input/Output Connectors Type N

FIGURE 2 — POWER GAIN versus FREQUENCY

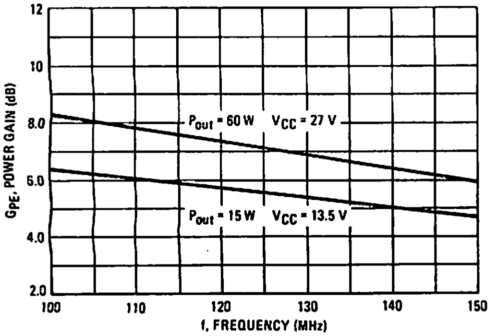


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE (f = 136 MHz)

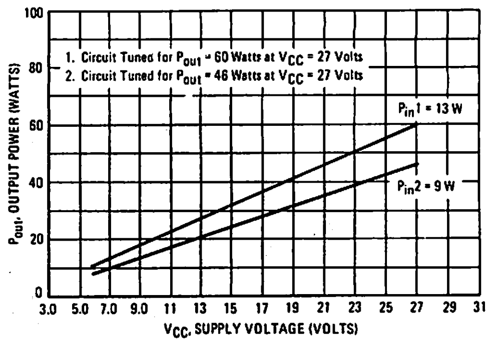


FIGURE 4 — OUTPUT POWER versus INPUT POWER (V_{CC} = 27 V)

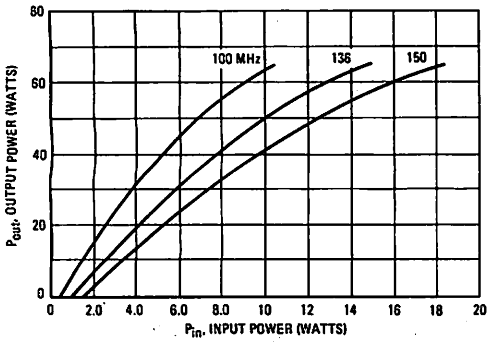


FIGURE 5 — OUTPUT POWER versus INPUT POWER (V_{CC} = 13.5 V)

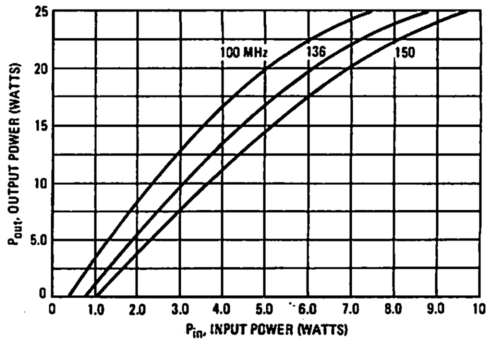
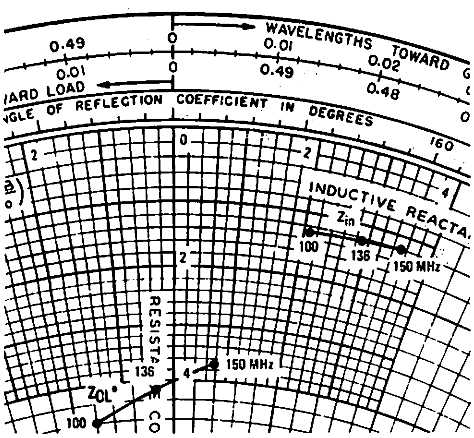


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



V_{CC} = 27 V P_{out} = 60 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
100	1.33 + j2.1	4.8 − j1.6
136	1.25 + j2.86	4.2 − j0.32
150	1.2 + j3.5	3.7 + j0.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power voltage, and frequency.

FIGURE 7 – 136 MHz TEST AMPLIFIER

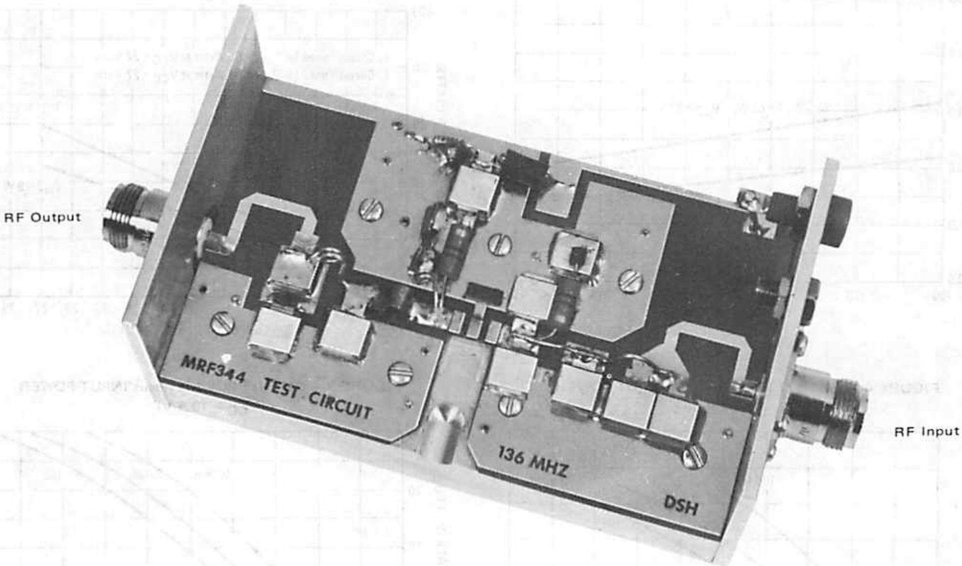
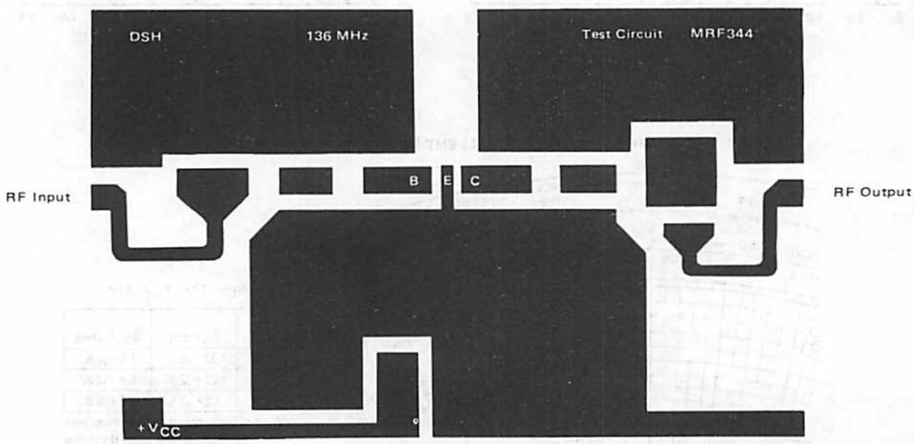


FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 136 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

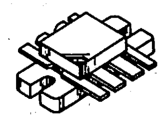
MRF390

2

The RF Line

NPN Silicon Push-Pull RF Power Transistor

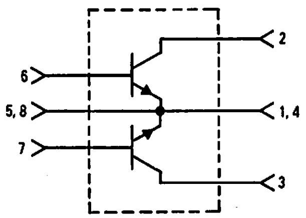
60 WATTS, 30–500 MHz CONTROLLED "Q" BROADBAND PUSH-PULL RF POWER TRANSISTOR NPN SILICON



CASE 744A-01, STYLE 1

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 60 Watts
  Typical Gain = 9.5 dB
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



The MRF390 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	7	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	140 0.80	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.25	°C/W

(1) This device is designed for RF operation. The total dissipation rating applies only when the device is operated as an RF push-pull amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	3	mAdc
ON CHARACTERISTICS (NOTE 1)					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (NOTE 1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	37	50	pF
FUNCTIONAL TEST (NOTE 2 — See Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	G_{pe}	7.5	9.5	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 60 W, f = 400 MHz VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

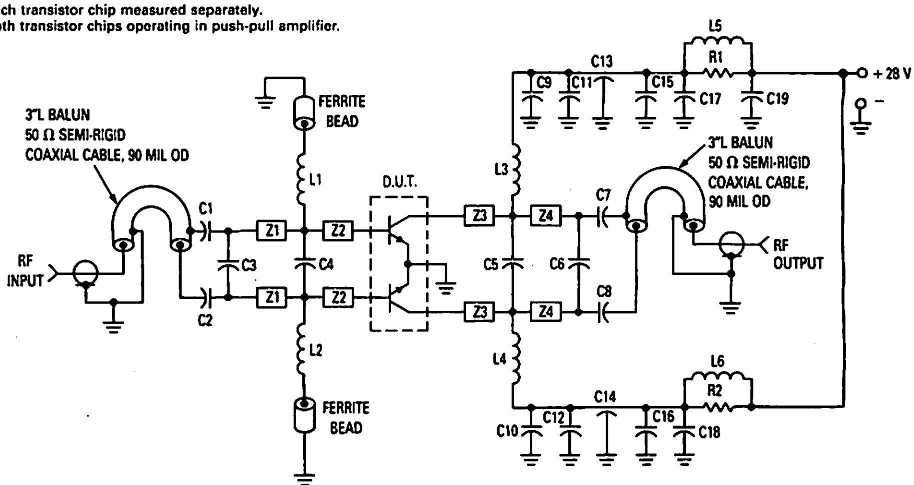


Figure 1. 400 MHz Test Circuit

C1, C2 — 240 pF, 100 Mil Chip
C3 — 12 pF, 100 Mil Chip
C5 — 20 pF, 100 Mil Chip
C4, C6 — 18 pF, 100 Mil Chip
C7, C8 — 270 pF, 100 Mil Chip
C9, C10, C11, C12 — 470 pF, 100 Mil Chip
C13, C14 — 680 pF Feedthru Capacitor
C15, C16, C19 — 0.1 µF Disc Ceramic
C17, C18 — 1 µF, 50 V Tantalum Capacitor
R1, R2 — 910 kΩ, 2 W Carbon Res.

L1, L2 — 10 µH RF Choke With Ferrite Bead
L3, L4 — 5 Turns #20 AWG, 1/4" ID
L5, L6 — 15 Turns #18 AWG Enameled, 0.35" ID Closewound Around R1, R2 Respectively
Z1 — Microstrip Line 850 Mils L x 130 Mils W
Z2, Z3 — Microstrip Line 250 Mils L x 130 Mils W
Z4 — Microstrip Line 830 Mils L x 130 Mils W
Board Material — 0.0625" Teflon Fiberglass ϵ_r = 2.5 ± 0.05, 1 oz. cu. clad, Double Sided

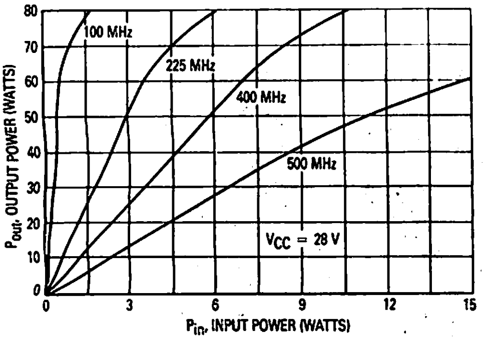


Figure 2. Output Power versus Input Power/Frequency

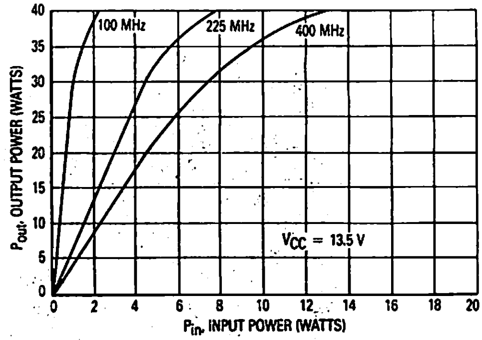


Figure 3. Output Power versus Input Power/Frequency

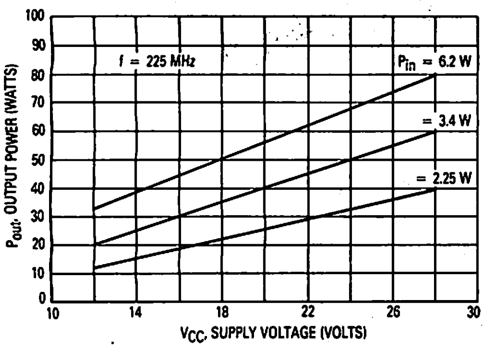


Figure 4. Output Power versus Supply Voltage — 225 MHz

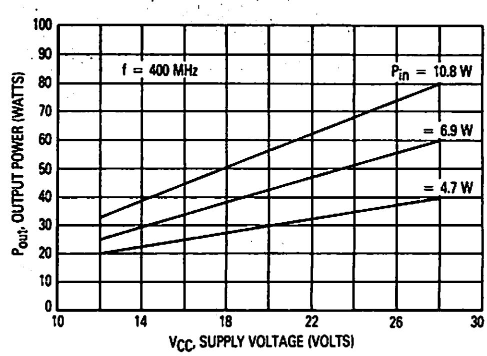
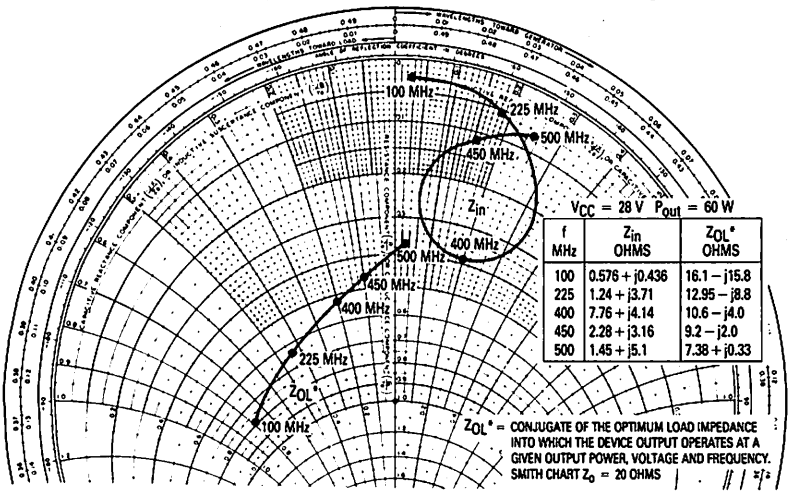
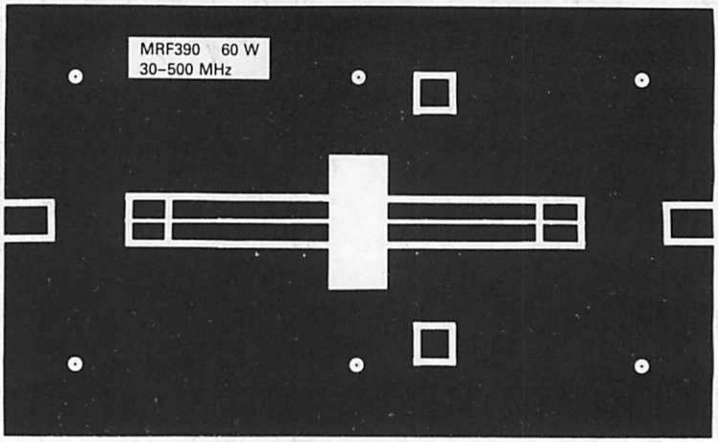


Figure 5. Output Power versus Supply Voltage — 400 MHz



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
100	0.576 + j0.436	16.1 − j15.8
225	1.24 + j3.71	12.95 − j8.8
400	7.76 + j4.14	10.6 − j4.0
450	2.28 + j3.16	9.2 − j2.0
500	1.45 + j5.1	7.38 + j0.33

Figure 6. Series Equivalent Input/Output Impedances



NOTE: The Printed Circuit Board shown is 75% of the original.

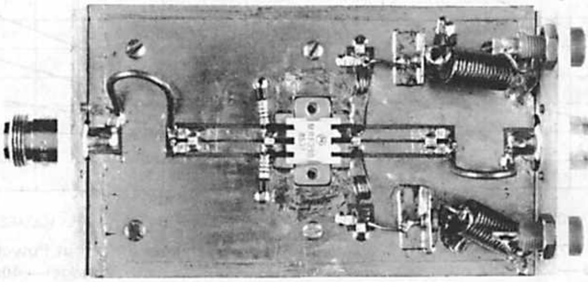


Figure 7. 400 MHz Test Circuit and Photomaster

MRF392

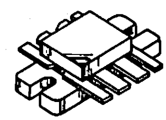
The RF Line

NPN Silicon Push-Pull RF Power Transistor

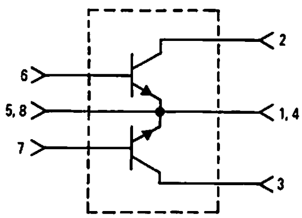
... designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

- Specified 28 Volt, 400 MHz Characteristics —
  Output Power = 125 W
  Typical Gain = 10 dB
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch.

**125 WATTS, 30–500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**



CASE 744A-01, STYLE 1



The MRF392 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

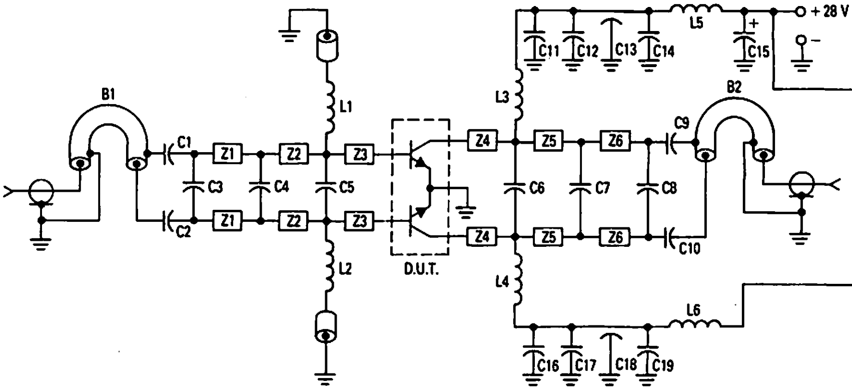
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5	mAdc
ON CHARACTERISTICS (NOTE 1)					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (NOTE 1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TEST (NOTE 2 — See Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	G_{pe}	8	10	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 125 W, f = 400 MHz VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.



C1, C2 — 240 pF, 100 Mil Chip Cap (ATC) or Equivalent
C3 — 3.6 pF, 100 Mil Chip Cap (ATC) or Equivalent
C4, C8 — 8.2 pF, 100 Mil Chip Cap (ATC) or Equivalent
C5, C6 — 20 pF, 100 Mil Chip Cap (ATC) or Equivalent
C7 — 18 pF, Mini Unelco or Equivalent
C9, C10 — 270 pF, 100 Mil Chip Cap (ATC) or Equivalent
C11, C12, C16, C17 — 470 pF 100 Mil Chip Cap (ATC) or Equivalent
C13, C18 — 680 pF Feedthru
C14, C19 — 0.1 μF Erie Redcap or Equivalent
C15 — 20 μF, 50 V

L1, L2 — 0.15 μH Molded Choke With Ferrite Bead
L3, L4 — 2-1/2 Turns #20 AWG, 0.200 ID
L5, L6 — 3-1/2 Turns #18 AWG, 0.200 ID

B1 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L
B2 — Balun, 50 Ω Semi-Rigid Coaxial Cable 86 Mil OD, 2" L

Z1 — Microstrip Line 270 Mil L x 125 Mil W
Z2 — Microstrip Line 375 Mil L x 125 Mil W
Z3 — Microstrip Line 280 Mil L x 125 Mil W
Z4 — Microstrip Line 300 Mil L x 125 Mil W
Z5 — Microstrip Line 350 Mil L x 125 Mil W
Z6 — Microstrip Line 365 Mil L x 125 Mil W

Board Material — 0.0625" Teflon Fiberglass ϵ_r = 2.5 ± 0.05 1 oz. Cu. CLAD, Double Sided

Figure 1. 400 MHz Test Fixture

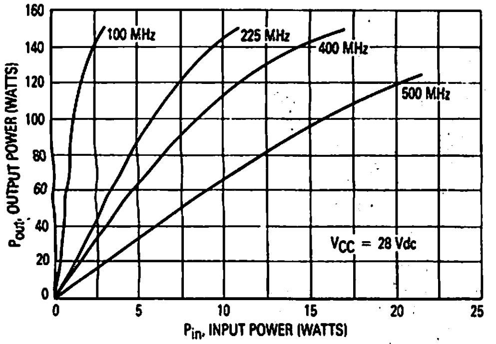


Figure 2. Output Power versus Input Power

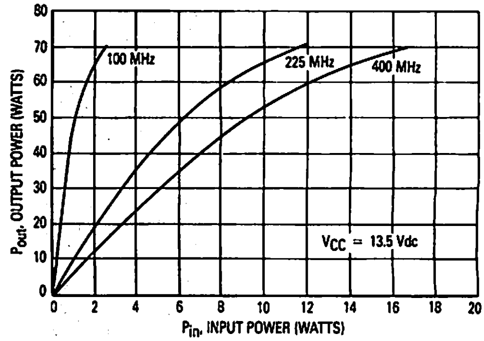


Figure 3. Output Power versus Input Power

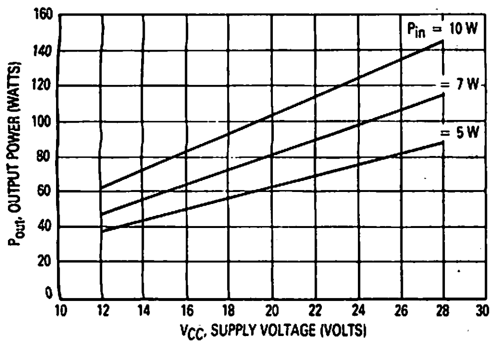


Figure 4. Output Power versus Supply Voltage — 225 MHz

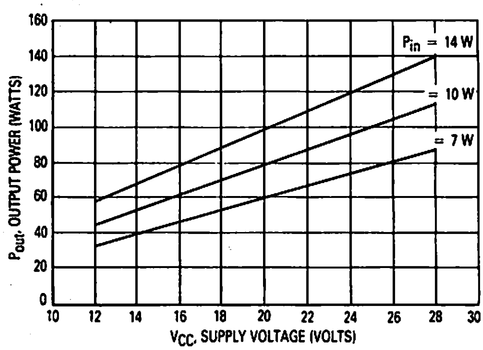
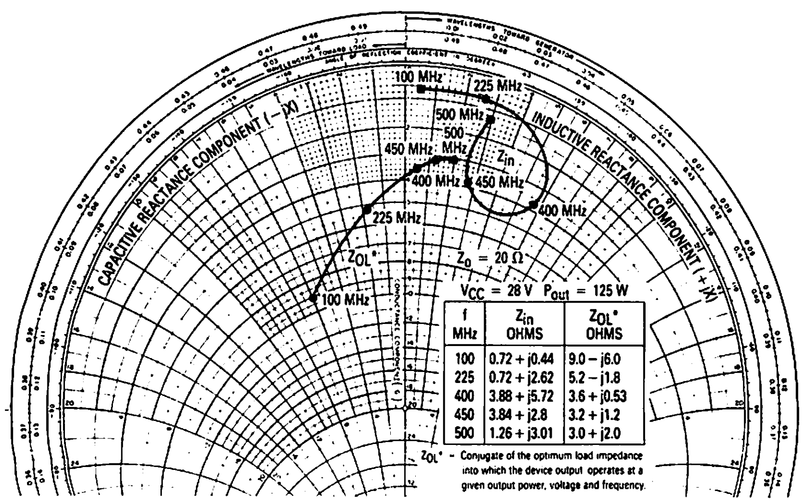


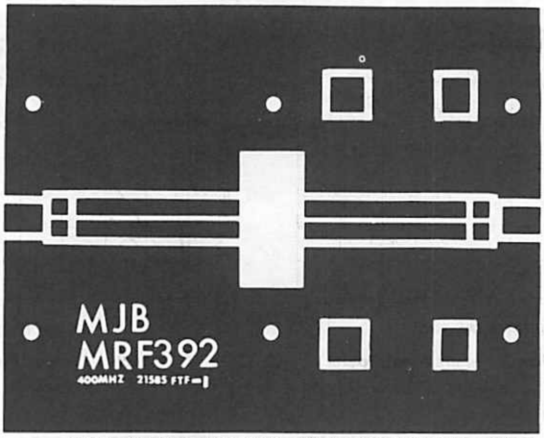
Figure 5. Output Power versus Supply Voltage — 400 MHz



f MHz	Z_{in} OHMS	Z_{OL}* OHMS
100	0.72 + j0.44	9.0 − j6.0
225	0.72 + j2.62	5.2 − j1.8
400	3.88 + j5.72	3.6 + j0.53
450	3.84 + j2.8	3.2 + j1.2
500	1.26 + j3.01	3.0 + j2.0

Z_{OL}* − Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 6. Series Equivalent Input/Output Impedance



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 7. Test Circuit Photomaster

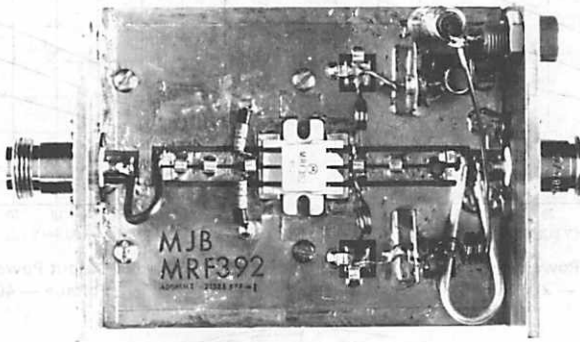


Figure 8. 400 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF393

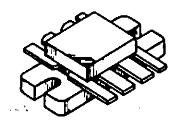
The RF Line

NPN Silicon Push-Pull RF Power Transistor

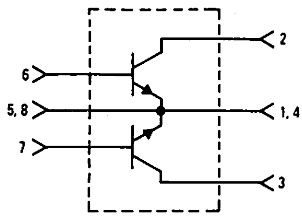
**100 WATTS, 30–500 MHz
CONTROLLED "Q"
BROADBAND PUSH-PULL
RF POWER TRANSISTOR
NPN SILICON**

. . . designed primarily for wideband large-signal output and driver amplifier stages in the 30–500 MHz frequency range.

- Specified 28 Volt, 500 MHz Characteristics —
  Output Power = 100 W
  Typical Gain = 9.5 dB (Class AB); 8.5 dB (Class C)
  Efficiency = 55% (Typ)
- Built-In Input Impedance Matching Networks for Broadband Operation
- Push-Pull Configuration Reduces Even Numbered Harmonics
- Gold Metallization System for High Reliability
- 100% Tested for Load Mismatch



CASE 744A-01



The MRF393 is two transistors in a single package with separate base and collector leads and emitters common. This arrangement provides the designer with a space saving device capable of operation in a push-pull configuration.

PUSH-PULL TRANSISTORS

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	270 1.54	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.65	°C/W

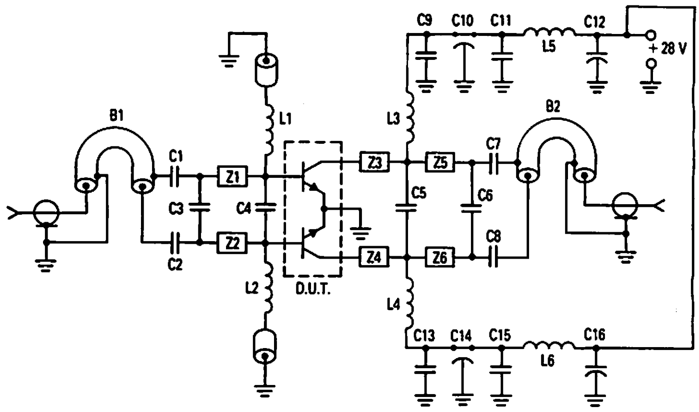
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF push-pull amplifier.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (NOTE 1)					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	5	mAdc
ON CHARACTERISTICS (NOTE 1)					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS (NOTE 1)					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	75	115	pF
FUNCTIONAL TEST (NOTE 2 — See Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	G_{pe}	7.5	8.5	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz)	η	50	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 100 W, f = 500 MHz VSWR = 30:1, all phase angles)	ψ	No Degradation in Output Power			

NOTES:
1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.



C1, C2, C7, C8 — 240 pF 100 mil Chip Cap
C3 — 15 pF 100 mil Chip Cap
C4 — 24 pF 100 mil Chip Cap
C5 — 33 pF 100 mil Chip Cap
C6 — 12 pF 100 mil Chip Cap
C9, C13 — 1000 pF 100 mil Chip Cap
C10, C14 — 680 pF Feedthru Cap
C11, C15 — 0.1 μF Ceramic Disc Cap
C12, C16 — 50 μF 50 V

L1–L2 — 0.15 μH Molded Choke with Ferrite Bead
L3–L4 — 2-1/2 Turns #20 AWG 0.200" ID
L5–L6 — 3-1/2 Turns #18 AWG 0.200" ID

B1, B2 — Balun 50 Ω Semi Rigid Coax, 86 mil OD, 2" Long

Z1, Z2 — 850 mil Long x 125 mil W. Microstrip
Z3, Z4 — 200 mil Long x 125 mil W. Microstrip
Z5, Z6 — 800 mil Long x 125 mil W. Microstrip

Board Material — 0.0325" Teflon-Fiberglass, ϵ_r = 2.56, 1 oz. Copper Clad both sides.

Figure 1. 500 MHz Test Fixture

OUTPUT POWER versus INPUT POWER CLASS C

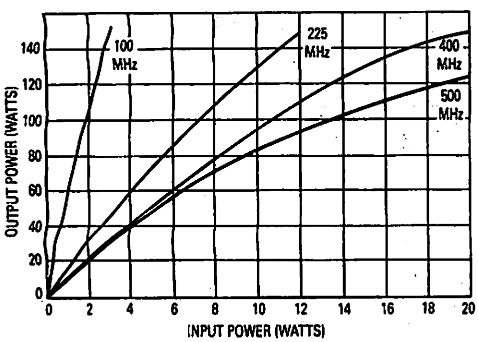


Figure 2. V_{CC} = 28 V

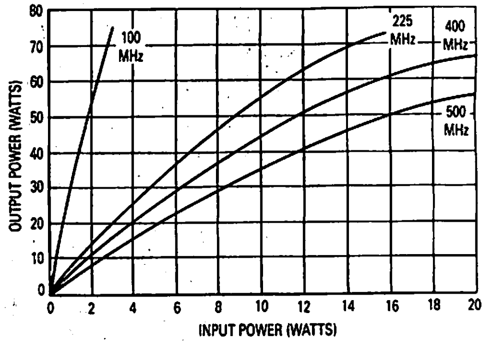


Figure 3. V_{CC} = 13.5 V

OUTPUT POWER versus SUPPLY VOLTAGE CLASS C

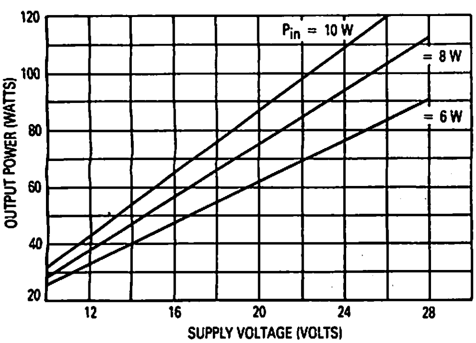


Figure 4. f = 225 MHz

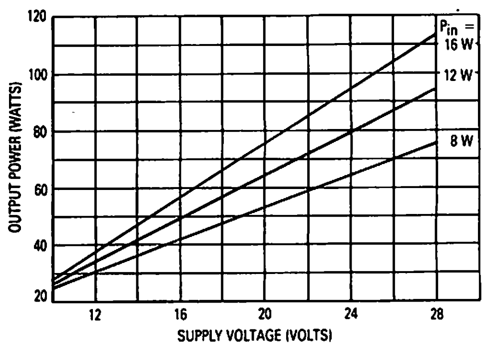
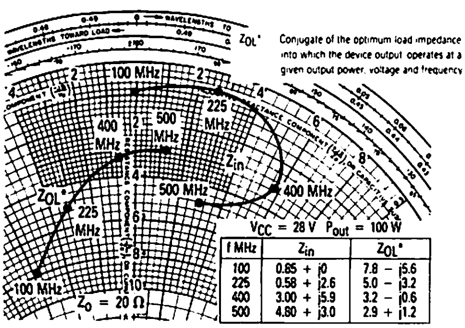


Figure 5. f = 500 MHz



f MHz	Z_{in}	Z_{OL}*
100	0.65 + j0	7.8 − j5.6
225	0.58 + j2.6	5.0 − j3.2
400	3.00 + j5.9	3.2 − j0.6
500	4.60 + j3.0	2.9 + j1.2

Figure 6. Series Equivalent Input/Output Impedance

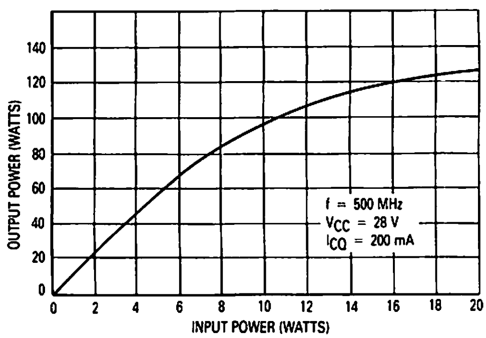
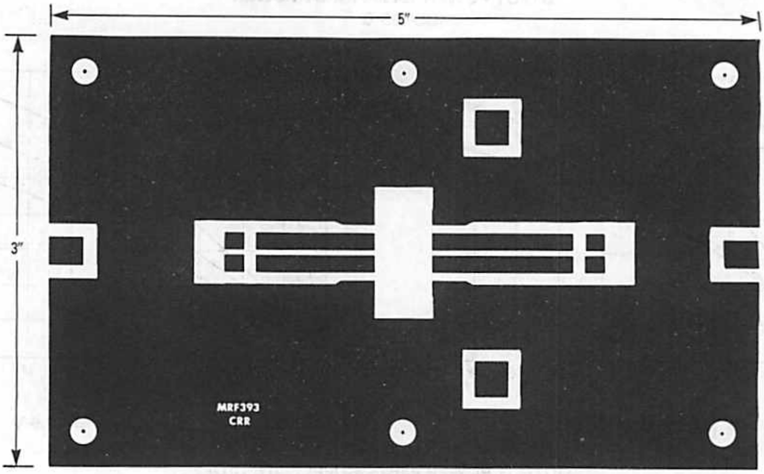


Figure 7. Class AB Output Power versus Input Power



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 8. Test Circuit Photomaster

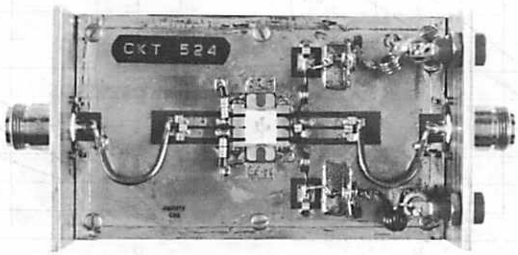


Figure 9. 500 MHz Test Circuit

MRF401

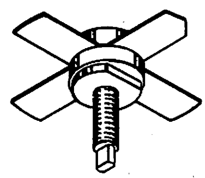
The RF Line

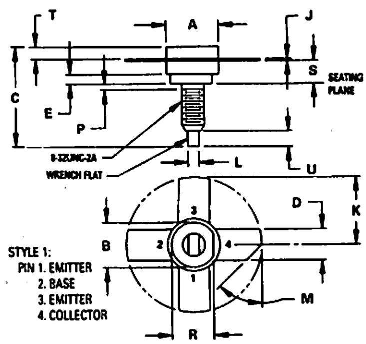
NPN SILICON RF POWER TRANSISTORS

...designed primarily for applications as a high-power linear amplifier from 2.0 to 75 MHz.

- Specified 28 Volt, 30 MHz Characteristics –
  Output Power = 25 W (PEP)
  Minimum Gain = 13 dB
  Efficiency = 40%
- Intermodulation Distortion at 25 W (PEP)
  IMD = -32 dB (Max)
- Isothermal-Resistor Design Results in Rugged Device

25 W PEP – 30 MHz
RF POWER
TRANSISTOR
NPN SILICON





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	3.3	Adc
Total Device Dissipation @ T_C = 25°C(1) Derate above 25°C	P_D	50 0.286	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as Class B or C RF amplifiers.

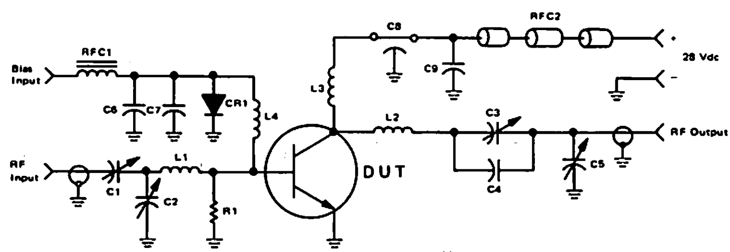
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	20	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	65	85	pF
FUNCTIONAL TEST (Figure 1)					
Common-Emitter Amplifier Power Gain (P_{out} = 25 Watts PEP, I_C (max) = 1.12 Adc, V_{CC} = 28 Vdc, f = 30 MHz)	G_{PE}	13	–	–	dB
Collector Efficiency (P_{out} = 25 Watts PEP, I_C (max) = 1.12 Adc, V_{CC} = 28 Vdc, f = 30 MHz)	η	40	–	–	%
Intermodulation Distortion (1) (P_{out} = 25 Watts PEP, I_C = 1.12 Adc, V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	IMD	–	–	-32	dB

(1) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

FIGURE 1 – 30 MHz LINEAR TEST CIRCUIT



C1, C2 – ARCO 469 190-780 pF
C3, C4 – ARCO 464 25-280 pF
C5 – 120 pF Dipped Mica
C6, C7 – 100 µF 15 Vdc
C8 – 680 pF F.T. Allen Bradley
C9 – 1.0 µF 35 V Tantalum

CR1 – 1N4997

L1 – 3 Turns #16 0.25" ID
L2 – 6 Turns #16 0.5" ID
L3 – 7 Turns #20 0.38" ID
L4 – 10 µH Molded Choke Delevan

RFC1 – Ferroxcube VK200/20-4B
RFC2 – 3-Ferroxcube 5653065-3B
RF – Input/Output Connectors UG53 A/µ
R1 – 10 Ω 1/2 Watt 10%

Adjust Bias (Base) for I_{CQ} = 20 mA with No RF Applied

2

FIGURE 2 – PARALLEL EQUIVALENT INPUT RESISTANCE versus FREQUENCY

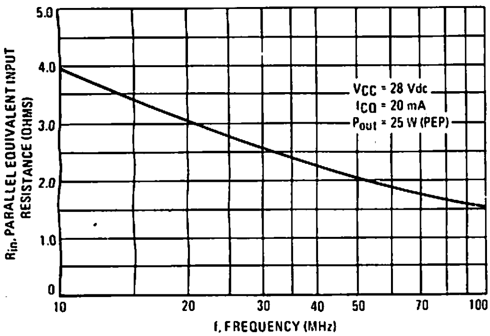


FIGURE 3 – PARALLEL EQUIVALENT INPUT CAPACITANCE versus FREQUENCY

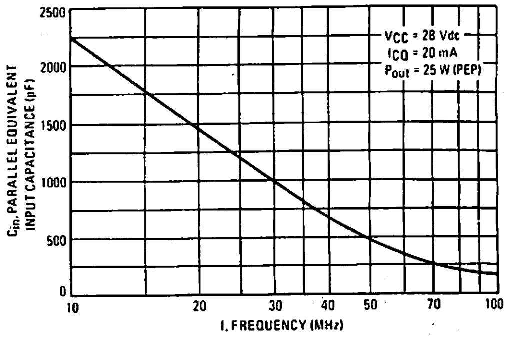


FIGURE 4 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

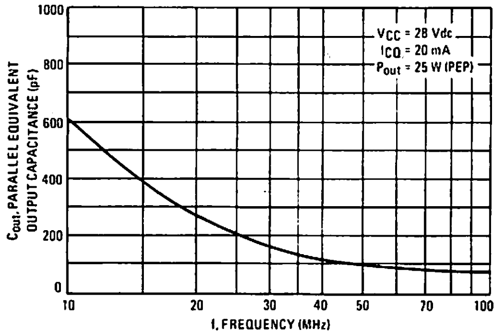


FIGURE 5 – POWER GAIN versus FREQUENCY

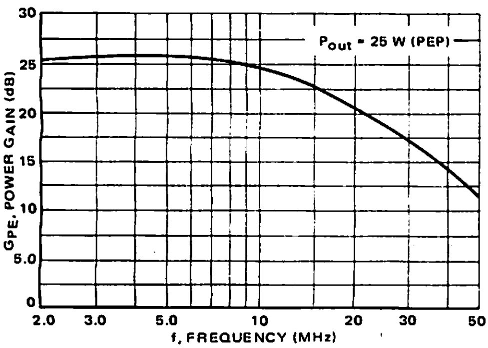
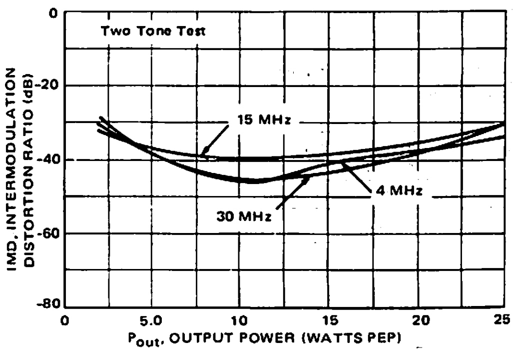


FIGURE 6 – IMD versus POWER OUTPUT



MRF406

2

The RF Line

20 W(PEP) – 30 MHz

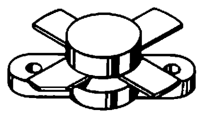
RF POWER
TRANSISTOR

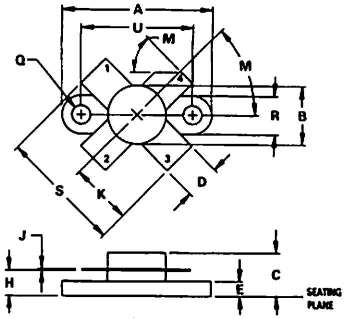
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for application as a power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 20 W(PEP)
  Minimum Gain = 12 dB
  Efficiency = 45%
- Intermodulation Distortion @ 20 W(PEP) –
  IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Withstand Current (t = 5.0 s)	—	12	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	80 0.46	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

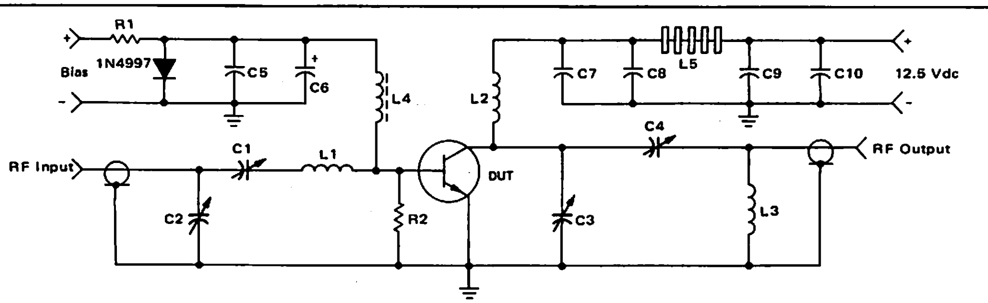
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 12.5 Vdc, V_{BE} = 0)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	35	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	150	200	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 20 W(PEP), $I_{C(max)}$ = 1.75 Adc, I_{CQ} = 25 mAdc, f = 30, 30.001 MHz)	G_{PE}	12	15	–	dB
Power Output (V_{CE} = 12.5 Vdc, f = 30 MHz)	P_{out}	20	–	–	Watts (PEP)
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 20 W(PEP), $I_{C(max)}$ = 1.75 Adc, I_{CQ} = 25 mAdc, f = 30, 30.001 MHz)	η	45	–	–	%
Intermodulation Distortion (1) (V_{CE} = 12.5 Vdc, P_{out} = 20 W(PEP), $I_{C(max)}$ = 1.75 Adc, I_{CQ} = 25 Adc, f = 30, 30.001 MHz)	IMD	—	−35	−30	dB
Load Mismatch (V_{CC} = 12.5 Vdc, P_{out} = 20 W(PEP), I_C = 1.75 Adc, I_{CQ} = 25 mAdc, f = 30, 30.001 MHz)	–	> 30:1 All Phase Angles			–

(1) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4	ARCO 466
C3	ARCO 469
C5, C8, C9	0.1 µF Disc Ceramic
C6	1000 µF, 3 V Electrolytic
C7	1000 pF, UNELCO
C10	100 µF, 15 V Electrolytic
R1	100 Ohm, 25 W, Wire Wound
R2	10 Ohm, ½ W, Carbon
L1	0.15 µH, Molded Choke
L2	15 Turns of #20 AWG Enameled Wire, 1/4" I.D., Close Wound
L3	4 Turns of #18 AWG Wire, 5/16" I.D., 3/8" Long.
L4	10 µH, Molded Choke
L5	5 Ferrite Beads, FERROXCUBE #56-590-65/3B

2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

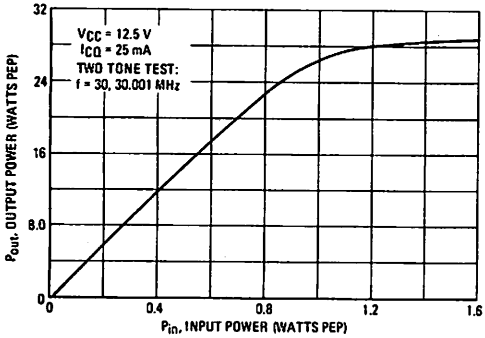


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

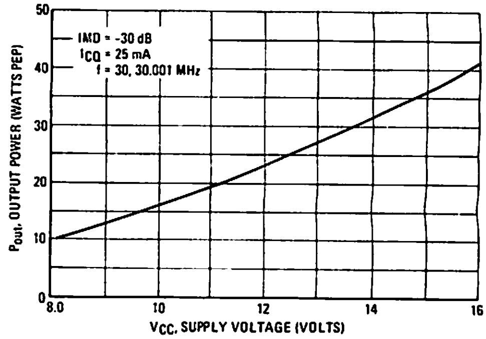


FIGURE 4 – POWER GAIN versus FREQUENCY

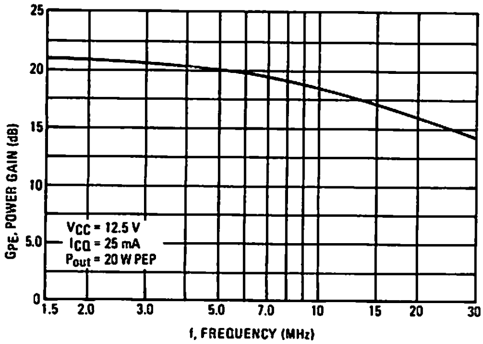


FIGURE 5 – INTERMODULATION DISTORTION versus OUTPUT POWER

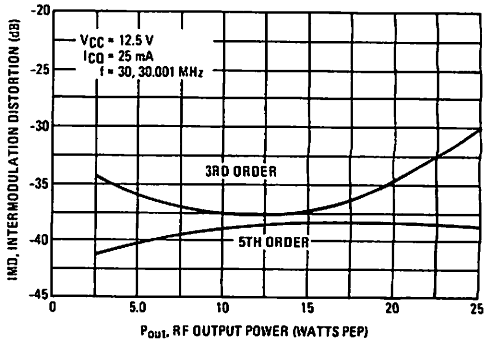
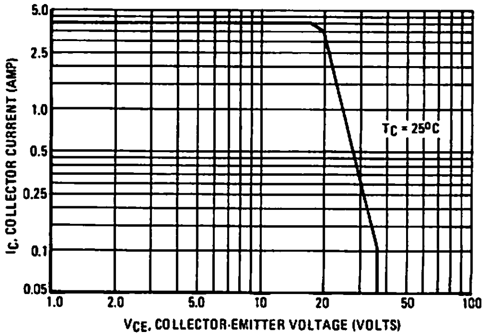


FIGURE 6 – DC SAFE OPERATING AREA



2

FIGURE 7 – SERIES EQUIVALENT IMPEDANCE

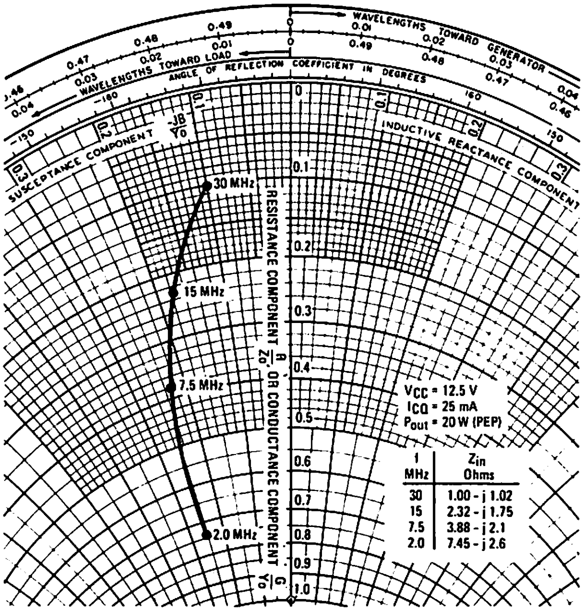


FIGURE 8 – PARALLEL EQUIVALENT OUTPUT CAPACITANCE versus FREQUENCY

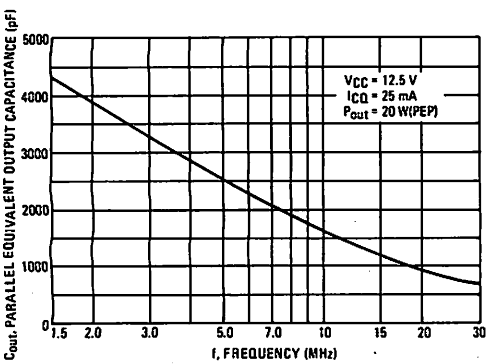
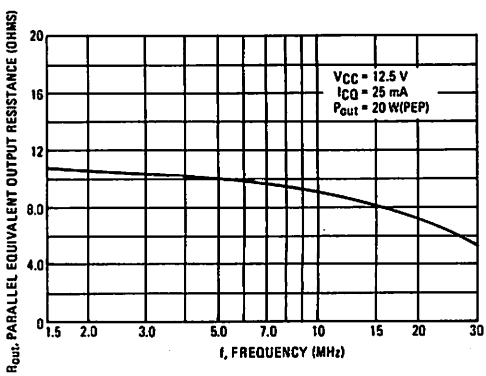


FIGURE 9 – PARALLEL EQUIVALENT OUTPUT RESISTANCE versus FREQUENCY

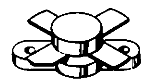


2

The RF Line
NPN Silicon
RF Power Transistor

MRF410

**10 W–30 MHz
RF POWER
TRANSISTOR
NPN SILICON**



CASE 211-07, STYLE 1
MRF410

. . . designed for high gain driver and output linear amplifier stages in 1.5 to 30 MHz HF/SSB equipment.

- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 10 W
  Minimum Gain = 13 dB
  Efficiency = 40%
- Intermodulation Distortion @ 10 W (PEP) —
  IMD = −30 dB (Max)
- 100% Tested for Load Mismatch at All Phase Angles With 30:1 VSWR
- Direct Replacement for 2N6370

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.5	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	40 0.23	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.35	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0)	I_{CES}	—	—	5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	10	35	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	85	100	pF

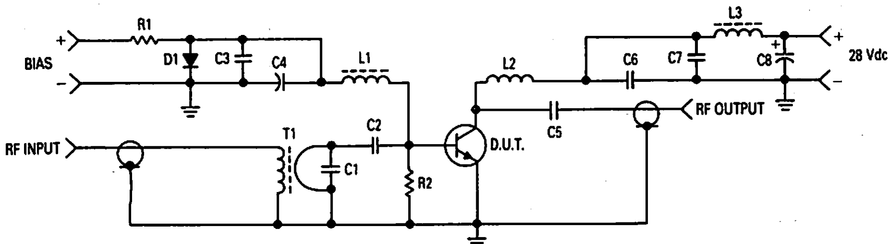
(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Gain (V_{CC} = 28 Vdc, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	G_{PE}	13	16	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	η	40	—	—	%
Intermodulation Distortion (1) (V_{CC} = 28 Vdc, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA)	$IMD_{(d3)}$	—	−35	−30	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 10 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 25 mA, VSWR 30:1 at All Phase Angles)		No Degradation in Output Power			
CLASS A PERFORMANCE					
Power Gain and Intermodulation Distortion (1) (V_{CC} = 28 Vdc, P_{out} = 4 W (PEP), I_{CQ} = 500 mA, f1 = 30 MHz, f2 = 30.001 MHz)	G_{PE} $IMD_{(d3)}$ $IMD_{(d5)}$	— — —	17 40 65	— — —	dB dB dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference each tone.



C1	— 1300 pF Dipped Mica	L1,L3	— Ferroxcube VK200 10/3B or Fair-Rite Products Corporation 2843003102
C2,C3,C5,C6	— 0.1 µF Type 1812 Chip or Equivalent	L2	— 15 Turns #22 AWG Enameled Wire, Close Wound, ¼" ID
C4	— 100 µF/16 V Electrolytic	T1	— RF Transformer 9:1 Impedance Ratio. See Motorola Application Note AN749, Figure 4 for Details. Ferrite Material: 2 each Fair-Rite Products Corporation 2643006801
C7	— 0.01 µF Type 1812 Chip or Equivalent		
C8	— 10 µF/35 V Electrolytic		
R1	— 5 Ohms/5 W		
R2	— 10 Ohms/½ W Carbon		
D1	— MR820-826 or Equivalent		

Figure 1. 30 MHz Test Circuit

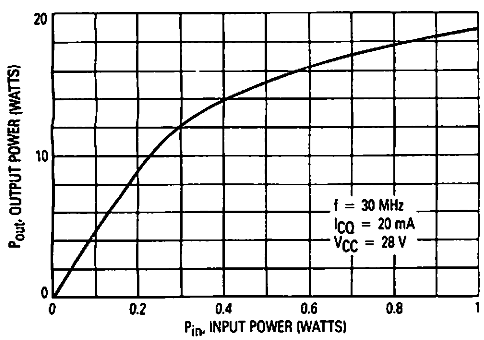


Figure 2. Output Power versus Input Power

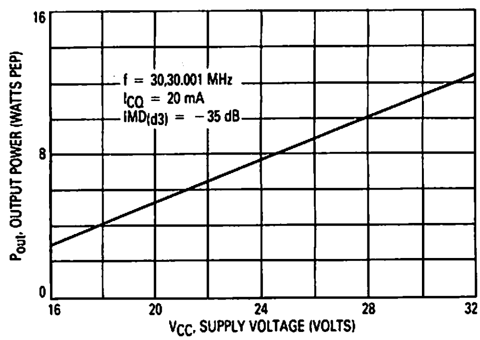


Figure 3. Output Power versus Supply Voltage

2

2

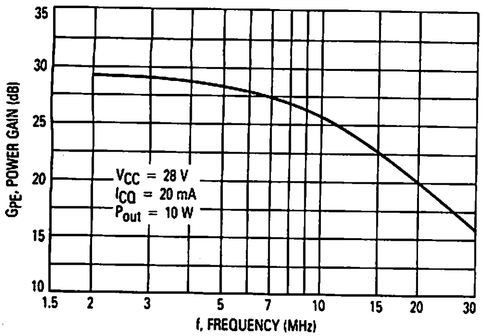


Figure 4. Power Gain versus Frequency

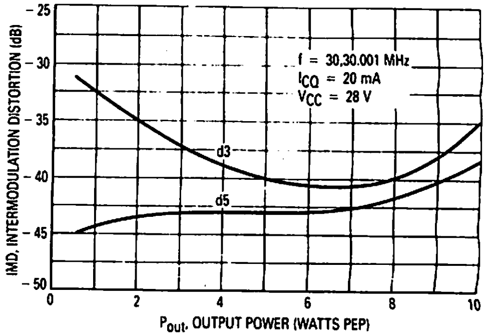


Figure 5. Intermodulation Distortion versus Output Power

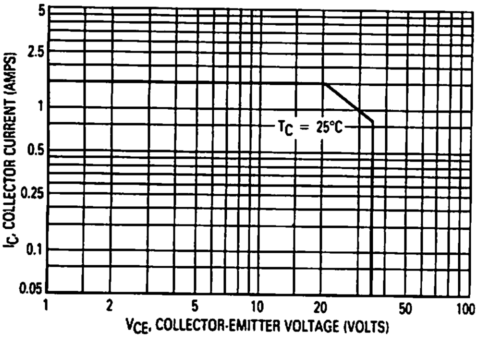


Figure 6. D.C. Safe Operating Area

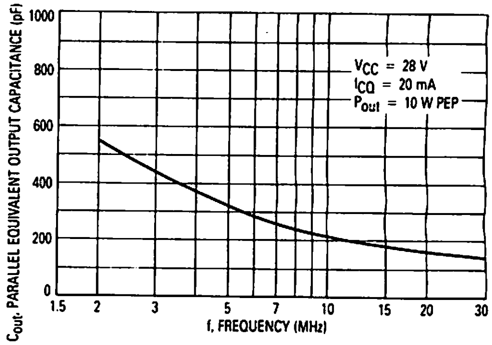


Figure 7. Output Capacitance versus Frequency

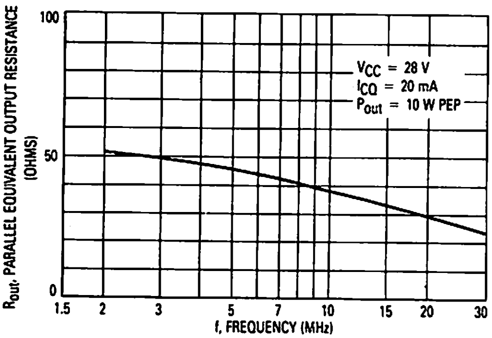


Figure 8. Output Resistance versus Frequency

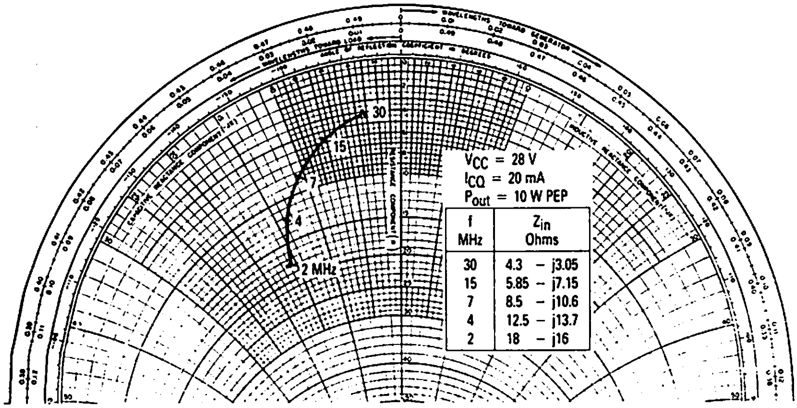


Figure 9. Series Equivalent Input Impedance

2

MRF421
MRF421MP

The RF Line

100 W(PEP) – 30 MHz

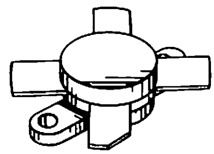
RF POWER TRANSISTORS

NPN SILICON

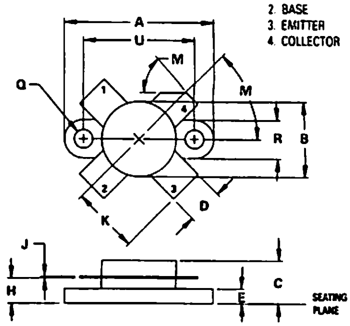
NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for application as a high-power linear amplifier from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 100 W(PEP)
  Minimum Gain = 10 dB
  Efficiency = 40%
- Intermodulation Distortion @ 100 W (PEP) –
  IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current – Continuous	I_C	20	Adc
Withstand Current – 10 s	–	30	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

MRF421MP is for ordering an h_{FE} matched pair.

THERMAL CHARACTERISTICS

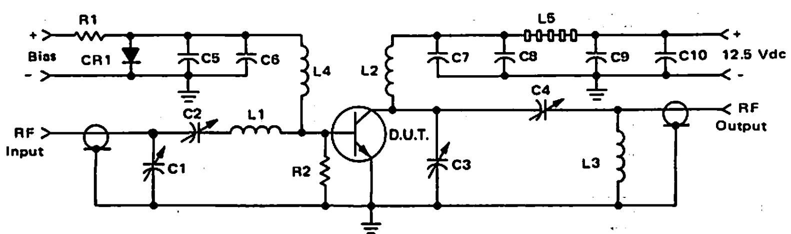
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	45	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 200 mAdc, I_E = 0)	$V_{(BR)CBO}$	45	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 16 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	650	800	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 100 W, $I_{C(max)}$ = 10 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	G_{PE}	10	12	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 100 W, $I_{C(max)}$ = 10 Adc, I_{CQ} = 150 mA, f = 30, 30.001 MHz)	η	40	–	–	%
Intermodulation Distortion (1) (V_{CE} = 12.5 Vdc, P_{out} = 100 Watts, I_C = 10 Adc, I_{CQ} = 150 mA, f = 30, 30.001 MHz)	IMD	–	-33	-30	dB

(1) To proposed EIA method of measurement. Reference peak envelope power.

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



C1,C2,C4 – 170-780 pF, ARCO 469
C3 – 80-480 pF, ARCO 466
C5,C7,C10 – ERIE 0.1 μF, 100 V
C6 – MALLORY 500 μF @ 15 V Electrolytic
C9 – 100 μF, 15 V Electrolytic
C8 – 1000 pF, 350 V UNDERWOOD
R1 – 10 Ω, 25 Watt Wirewound
R2 – 10 Ω, 1 Watt Carbon
CR1 – IN4997
L1 – 3 Turns, #16 Wire, 5/16" I.D., 5/16" Long
L2 – 12 Turns, #16 Enameled Wire Closewound, 1/4" I.D.
L3 – 1 3/4 Turns, 1/8" Tubing, 3/8" I.D., 3/8" Long
L4 – 10 μH Molded Choke
L5 – 10 Ferrite Beads - FERROXCUBE #56-590-65/3B

2

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

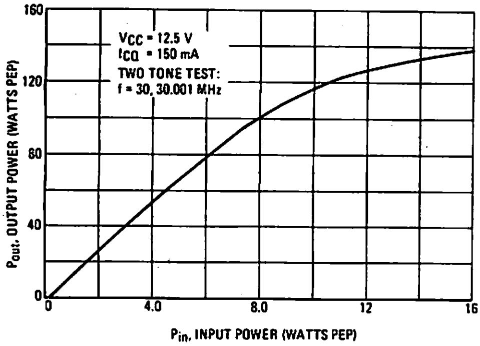


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

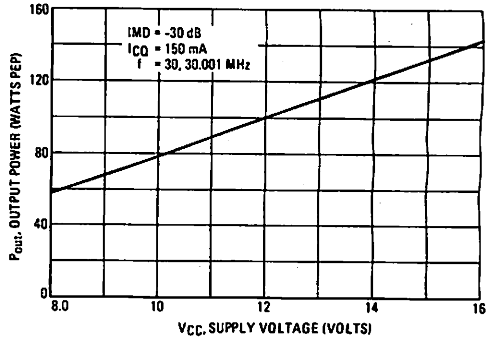


FIGURE 4 — POWER GAIN versus FREQUENCY

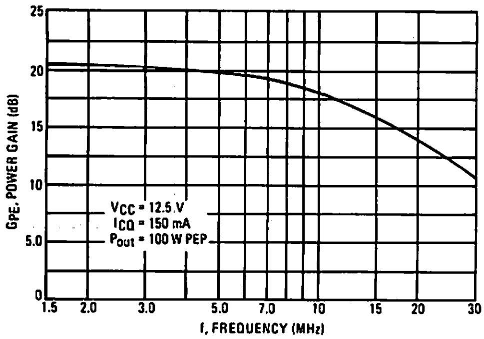


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

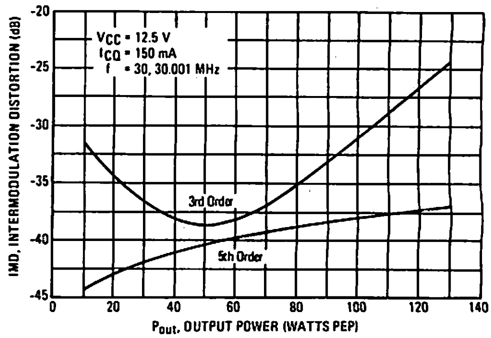


FIGURE 6 — DC SAFE OPERATING AREA

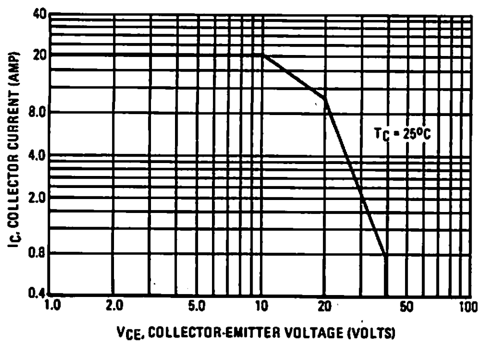
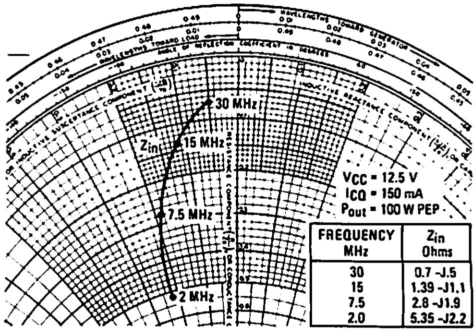


FIGURE 7 — SERIES EQUIVALENT IMPEDANCE



FREQUENCY MHz	Z_{in} Ohms
30	0.7 -J.5
15	1.39 -J1.1
7.5	2.8 -J1.9
2.0	5.35 -J2.2

FIGURE 8 – OUTPUT CAPACITANCE versus FREQUENCY

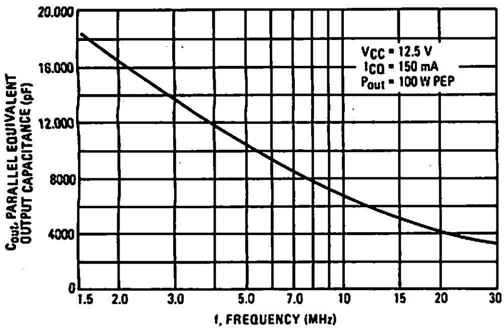
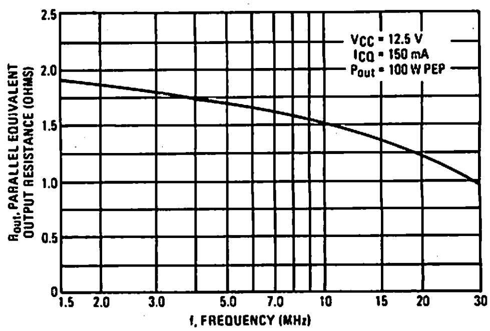


FIGURE 9 – OUTPUT RESISTANCE versus FREQUENCY



2

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MRF422
MRF422MP

The RF Line

NPN SILICON RF POWER TRANSISTORS

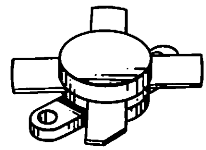
. . . designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz.

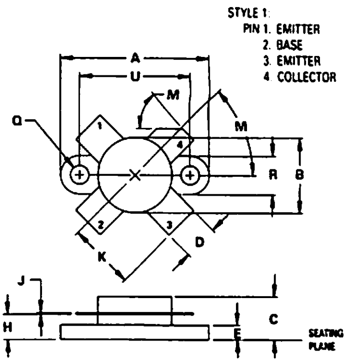
- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 150 W(PEP)
  Minimum Gain = 10 dB
  Efficiency = 40%
- Intermodulation Distortion @ 150 W(PEP) —
  IMD = -30 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR

150 W(PEP) — 30 MHz

RF POWER TRANSISTORS

NPN SILICON





NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	40	Vdc
Collector-Base Voltage	V_{CBO}	85	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstanding Current — 10 s	—	30	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

MRF422MP is for ordering a HFE matched pair.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

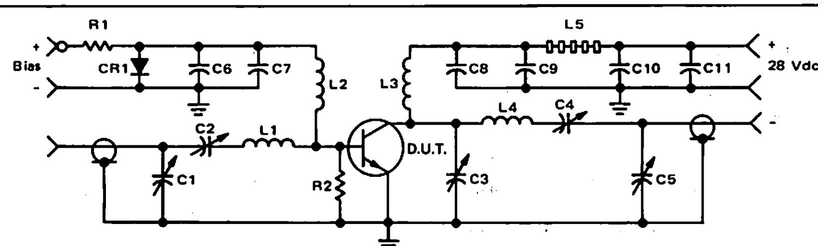
2

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	85	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	85	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0, $T_C = 25^oC$)	I_{CES}	–	–	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	420	–	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 150 W(PEP), $I_{C(max)}$ = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	G_{PE}	10	13	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 150 W(PEP), $I_{C(max)}$ = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	η	–	45	–	%
Intermodulation Distortion (1) (V_{CE} = 28 Vdc, P_{out} = 150 Watts(PEP), I_C = 6.7 Adc, I_{CQ} = 150 mAdc, f = 30, 30.001 MHz)	IMD	—	-33	-30	dB
Output Power (V_{CE} = 28 Vdc, f = 30 MHz)	P_{out}	150	–	–	Watts PEP

(1) To Mil-Std-1311 Version A, Test Method 2204, Two Tone, Reference each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1,2,3,5	— 170-680 pF, ARCO 469	L1	— 3 Turns, #16 Wire, 5/16" I.D., 5/16" Long
C4	— 80-480 pF, ARCO 466	L2	— 10 μH Molded Choke
C6,8,11	— ERIE 0.1 μF, 100 V	L3	— 12 Turns, #16 Enameled Wire, Close Wound, 1/4" Dia.
C7	— MALLORY 500 μF, 15 V Electrolytic	L4	— 5 turns, 1/8" Copper Tubing
C9	— UNDERWOOD 1000 pF, 350 V	L5	— 10 Ferrite Beads — FERROXCUBE #56-590-65/3B
C10	— 10 μF, 50 V Electrolytic		
R1	— 10 Ω, 25 Watt Wire Wound		
R2	— 10 Ω, 1 Watt Carbon		
CR1	— 1N4997		

FIGURE 2 — OUTPUT POWER versus INPUT POWER

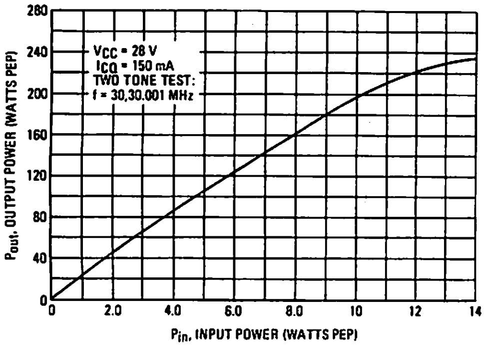


FIGURE 3 — POWER GAIN versus FREQUENCY

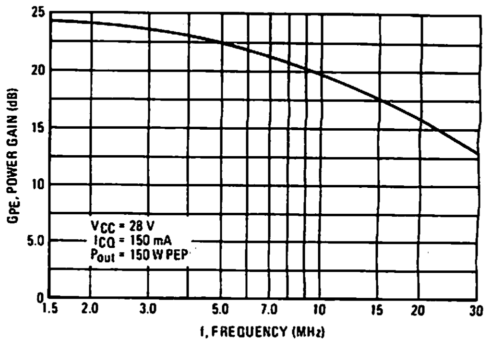


FIGURE 4 — LINEAR OUTPUT POWER versus SUPPLY VOLTAGE

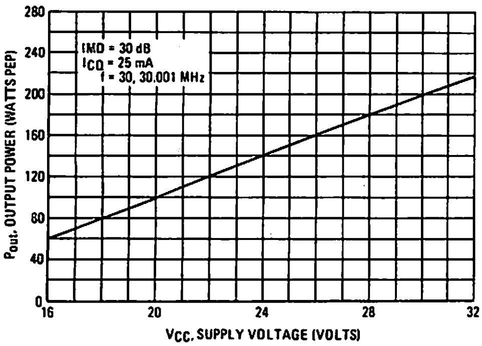


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

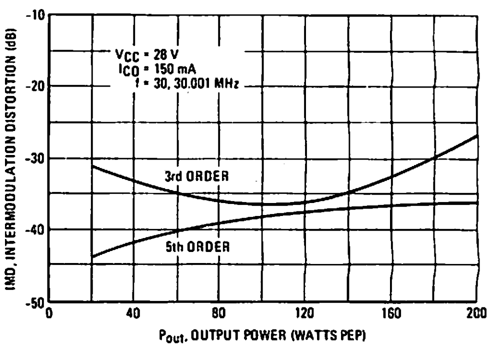


FIGURE 6 — DC SAFE OPERATING AREA

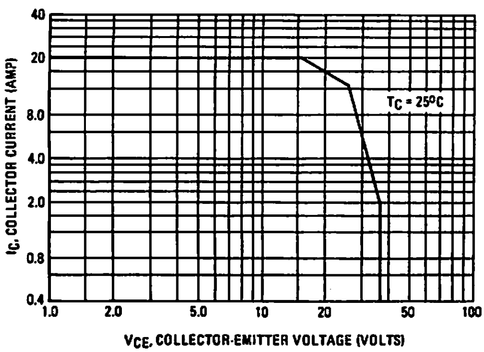
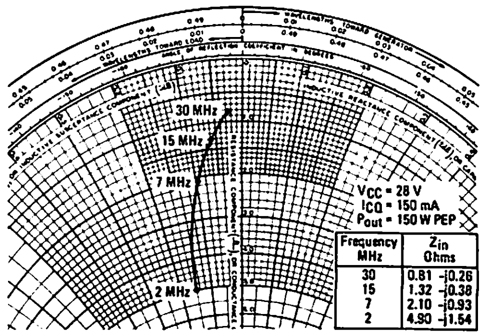


FIGURE 7 — SERIES INPUT IMPEDANCE



Frequency MHz	Z_{in} Ohms
30	0.81 -j0.26
15	1.32 -j0.38
7	2.10 -j0.93
2	4.90 -j1.54

FIGURE 8 — OUTPUT RESISTANCE versus FREQUENCY

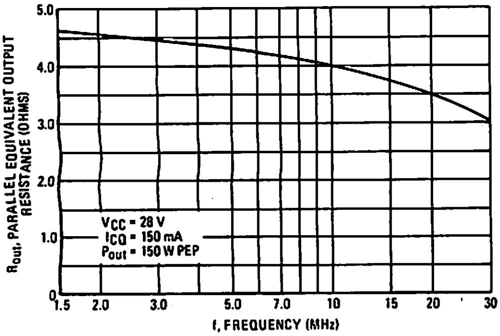
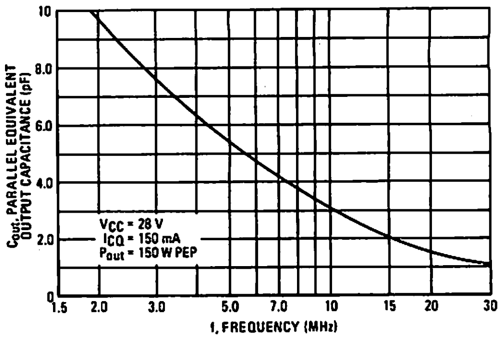


FIGURE 9 — OUTPUT CAPACITANCE versus FREQUENCY



2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

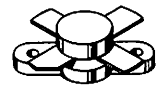
MRF426

The RF Line

25 W (PEP) — 30 MHz

RF POWER TRANSISTOR

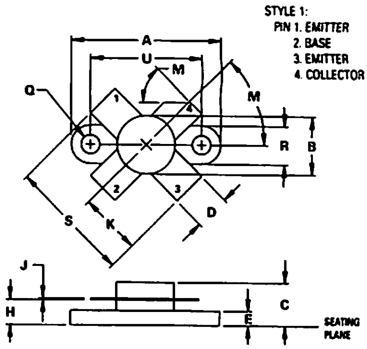
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for high gain driver and output linear amplifier stages in 1.5 to 30 MHz HF/SSB equipment.

- Specified 28 Volt, 30 MHz Characteristics —
  Output Power = 25 W (PEP)
  Minimum Gain = 22 dB
  Efficiency = 35%
- Intermodulation Distortion @ 25 W (PEP) —
  IMD = −30 dB (Max)
- 100% Tested for Load Mismatch at All Phase Angles With 30:1 VSWR
- Class A and AB Characterization
- BLX 13 Equivalent



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.930
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Withstand Current — 5 s	—	6.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	70 0.4	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

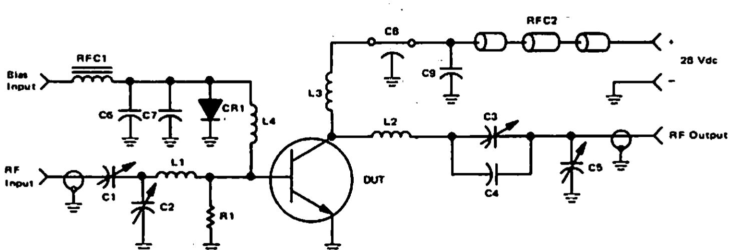
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Base Breakdown Voltage ($I_C = 50$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CE} = 28$ Vdc, $V_{BE} = 0$)	I_{CES}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc	h_{FE}	10	35	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 30$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	60	80	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Gain ($V_{CC} = 28$ Vdc, $P_{out} = 25$ W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, $I_{CQ} = 25$ mA)	G_{PE}	22	25	–	dB
Collector Efficiency ($V_{CC} = 28$ Vdc, $P_{out} = 25$ W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, $I_{CQ} = 25$ mA)	η	35	–	–	%
Intermodulation Distortion (1) ($V_{CC} = 28$ Vdc, $P_{out} = 25$ W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, $I_{CQ} = 25$ mA)	$IMD_{(d3)}$	–	−35	−30	dB
Load Mismatch ($V_{CC} = 28$ Vdc, $P_{out} = 25$ W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, $I_{CQ} = 25$ mA, VSWR 30:1 at All Phase Angles	ψ	No Degradation in Output Power			
CLASS A PERFORMANCE					
Intermodulation Distortion (1) and Power Gain ($V_{CC} = 28$ Vdc, $P_{out} = 8$ W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, $I_{CQ} = 1.2$ Adc)	G_{PE} $IMD_{(d3)}$ $IMD_{(d5)}$	– – –	23.5 −40 −55	– – –	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 – 30 MHz LINEAR TEST CIRCUIT



C1, C2 – ARCO 469 190-780 pF
C3, C4 – ARCO 464 25-280 pF
C5 – 120 pF Dipped Mica
C6, C7 – 100 µF 15 Vdc
C8 – 680 pF F.T. Allen Bradley
C9 – 1.0 µF 35 V Tantalum

CR1 – IN4997

L1 – 3 Turns #16 0.25" ID
L2 – 6 Turns #16 0.5" ID
L3 – 7 Turns #20 0.38" ID
L4 – 10 µH Molded Choke Delevan

RFC1 – Ferroxcube VK200/20-4B
RFC2 – 3-Ferroxcube 5653065-3B
RF – Input/Output Connectors UG53 A/µ
R1 – 10 Ω 1/2 Watt 10%

Adjust Bias (Base) for $I_{CQ} = 20$ mA with No RF Applied

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

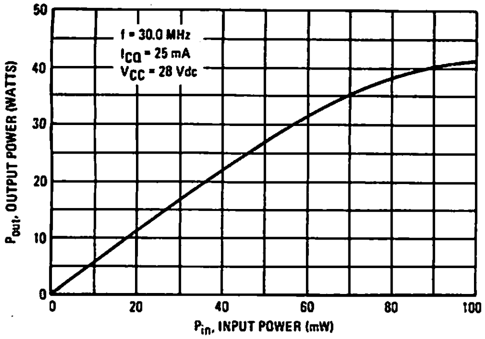


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

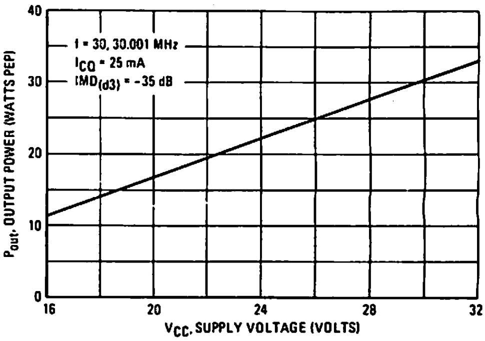


FIGURE 4 — POWER GAIN versus FREQUENCY

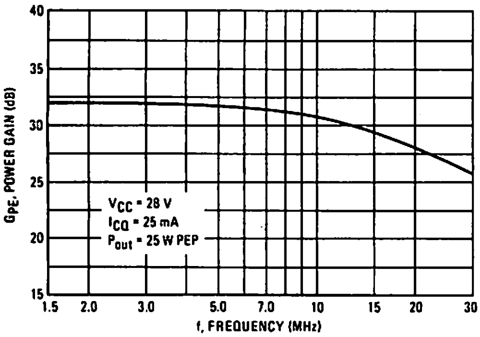


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

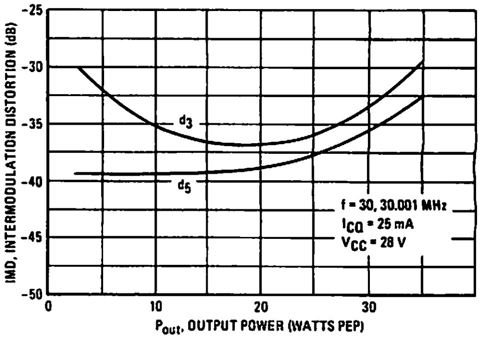
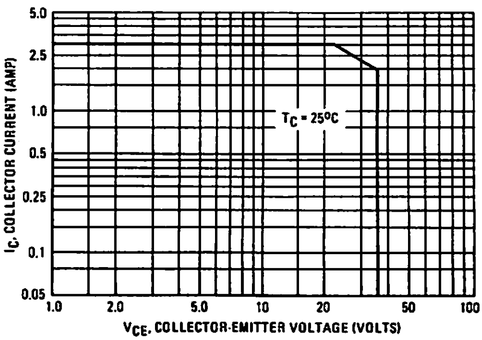


FIGURE 6 — DC SAFE OPERATING AREA



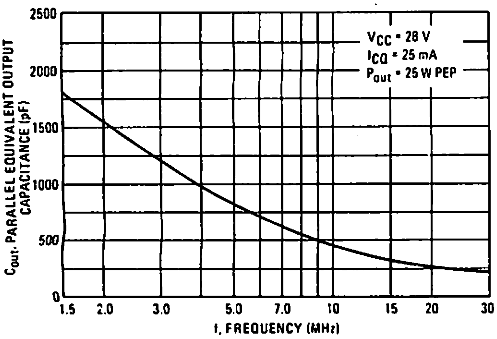


FIGURE 7 — OUTPUT CAPACITANCE versus FREQUENCY

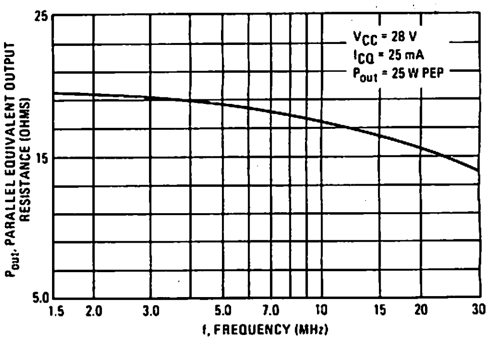
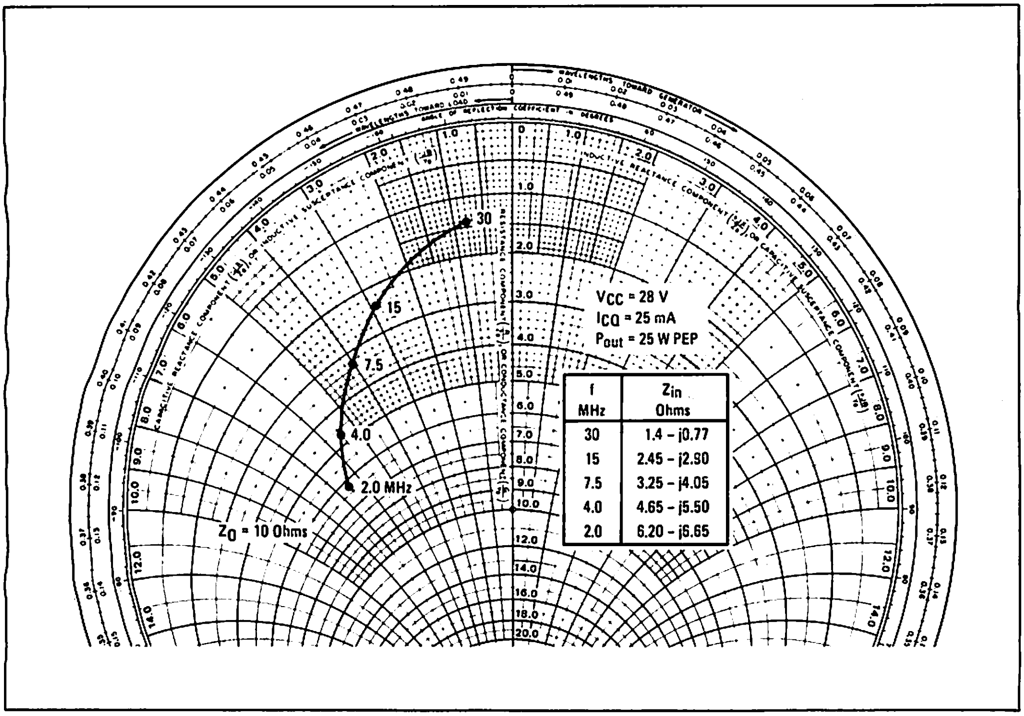


FIGURE 8 — OUTPUT RESISTANCE versus FREQUENCY

FIGURE 9 — SERIES EQUIVALENT INPUT IMPEDANCE



f MHz	Z_{in} Ohms
30	1.4 – j0.77
15	2.45 – j2.90
7.5	3.25 – j4.05
4.0	4.65 – j5.50
2.0	6.20 – j6.65

MRF427
MRF427A

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

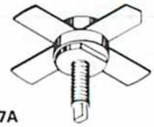
. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics –
  Output Power = 25 W(PEP)
  Minimum Gain = 18 dB
- Intermodulation Distortion @ 25 W(PEP) –
  IMD = –34 dB (Min)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR

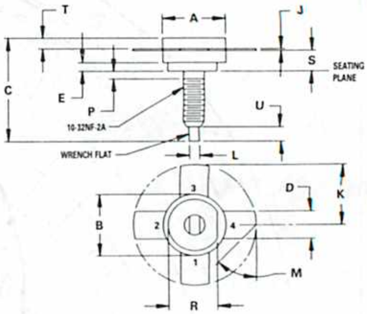
25 W (PEP) – 30 MHz

RF POWER TRANSISTOR

NPN SILICON



MRF427A



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.90	0.065	0.075
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	9.73	10.06	0.383	0.396
S	3.84	4.50	0.151	0.177
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-10

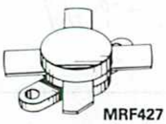
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	65	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	80 0.457	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.19	°C/W

CASE 211-11

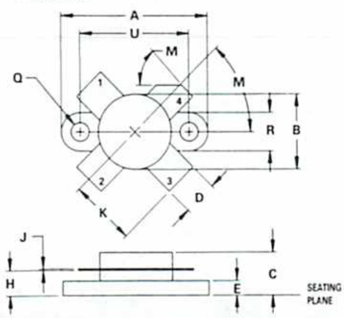


MRF427

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

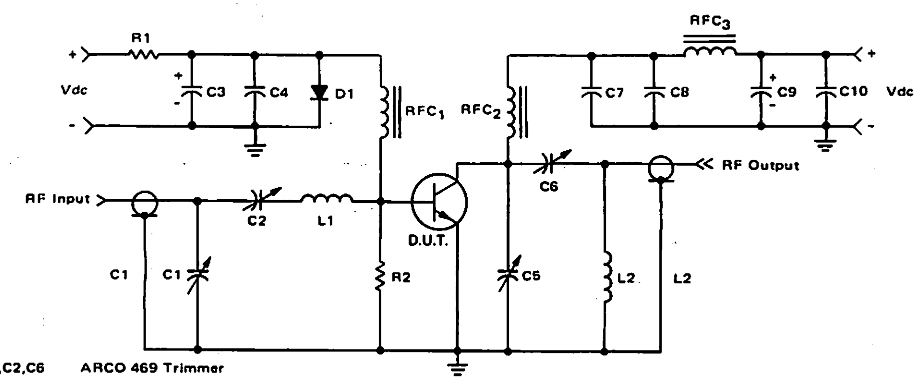


ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	65	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	110	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	110	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	15	–	90	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 25 W(PEP), f = 30 MHz)	G_{pe}	18	20	–	dB
Intermodulation Distortion (1) (V_{CC} = 50 Vdc, P_{out} = 25 W(PEP))	IMD	—	−37	−34	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 25 W(PEP), f = 30 MHz, VSWR 30:1) All Phase Angles	–	No Degradation in Output Power			

(1) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1,C2,C6	ARCO 469 Trimmer		
C3	500 μF, 3 Vdc Capacitor		
C4,C7,C10	0.1 μF ERIE REDCAP	RFC1	1 μH Molded Choke
C5	ARCO 463 Trimmer	RFC2	20 Turns, #20 AWG, Enameled Wire on 390 Ω, 1 Watt Resistor
C8	1000 pF, UNELCO Capacitor		
C9	47 μF, 50 Vdc Capacitor	RFC3	VK 200-4B FERROXCUBE Choke
R1	20 Ω, 5 Watt Resistor		
R2	10 Ω, ½ Watt Resistor		
L1	0.15 μH Inductor		
L2	0.3 μH Inductor		
D1	1N4997		

FIGURE 2 — OUTPUT POWER versus INPUT POWER

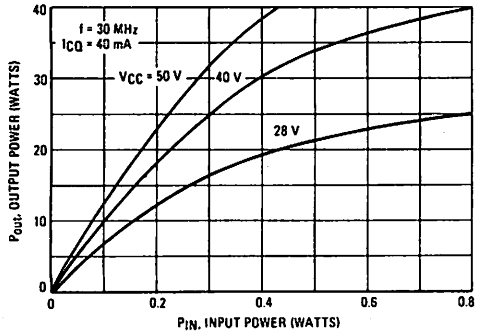


FIGURE 3 — POWER GAIN versus FREQUENCY

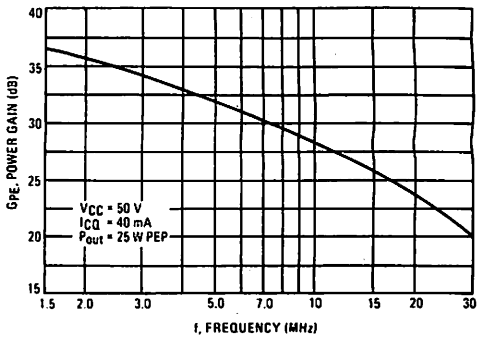


FIGURE 4 — INTERMODULATION DISTORTION versus OUTPUT POWER VCC = 50 Vdc

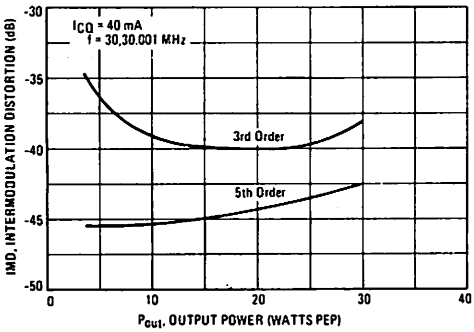


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER VCC = 40 Vdc

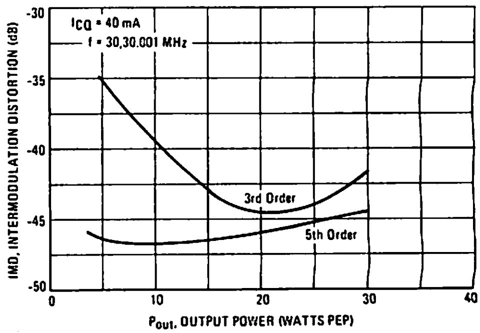


FIGURE 6 — OUTPUT RESISTANCE versus FREQUENCY

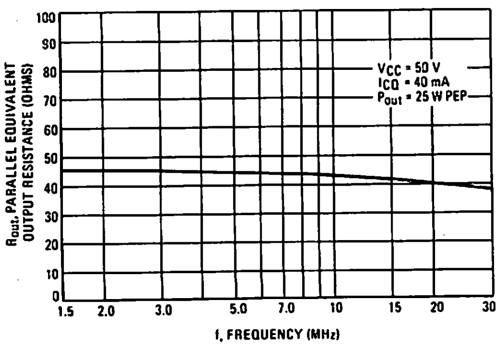


FIGURE 7 — OUTPUT CAPACITANCE versus FREQUENCY

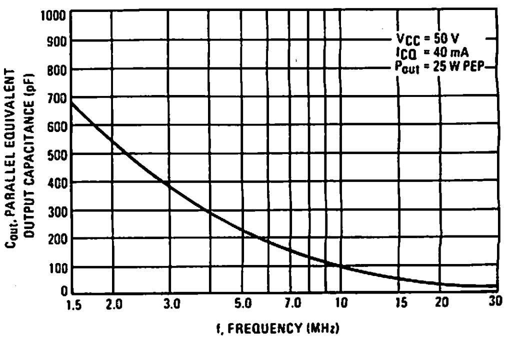


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FIGURE 8 — OUTPUT POWER versus SUPPLY VOLTAGE

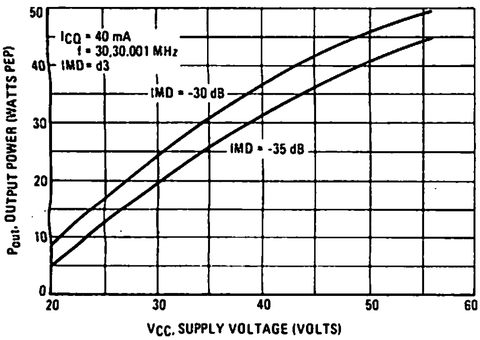


FIGURE 9 — DC SAFE OPERATING AREA

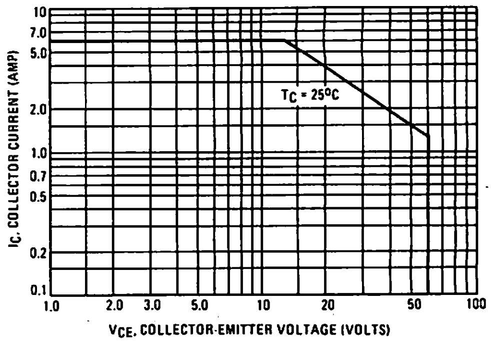
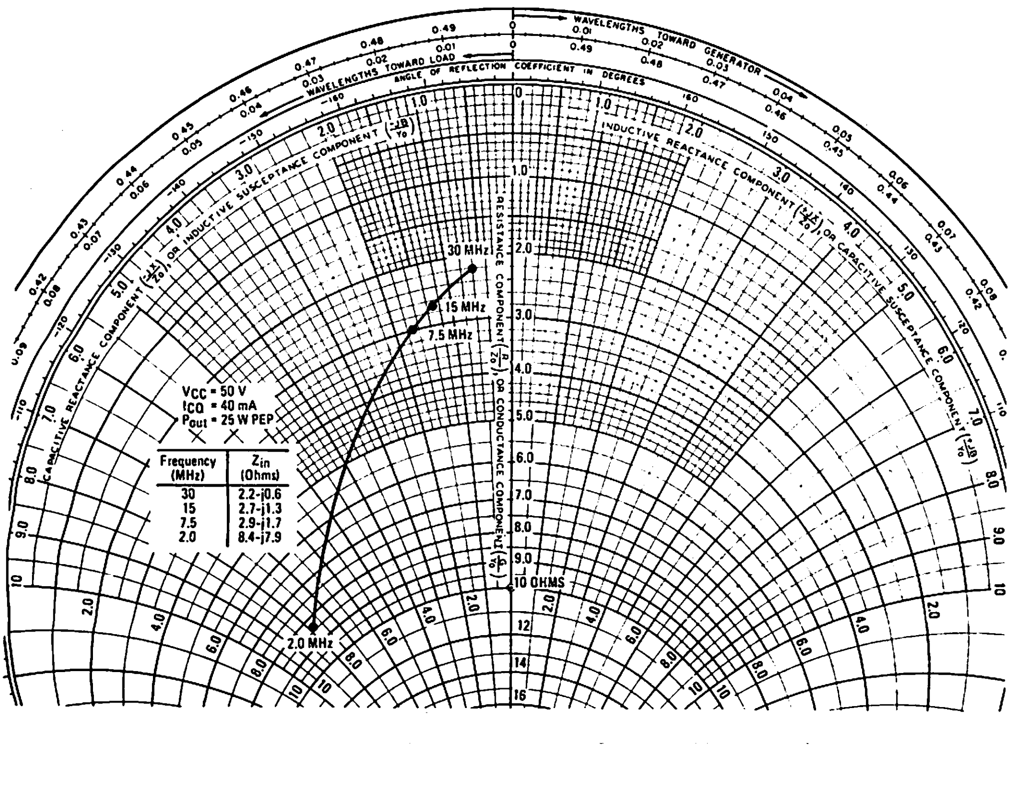


FIGURE 10 — SERIES EQUIVALENT IMPEDANCE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

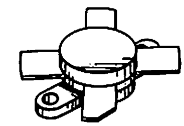
MRF428

The RF Line

150 W (PEP) — 30 MHz

RF POWER TRANSISTOR

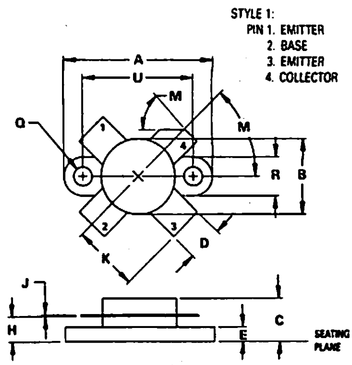
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
  Output Power = 150 W(PEP)
  Minimum Gain = 13 dB
  Efficiency = 45%
- Intermodulation Distortion @ 150 W (PEP) —
  IMD = -30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Withstand Current — 10 s	—	30	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ Derate above 25°C	P_D	320 1.83	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	°C/W

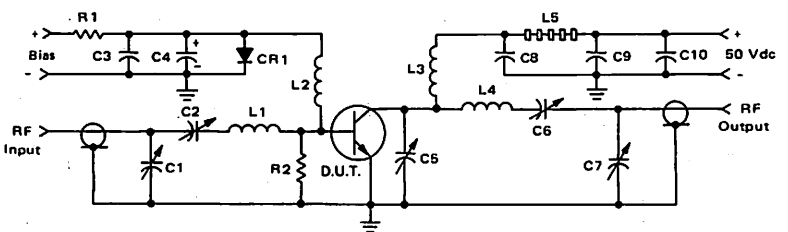
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	55	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	110	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	110	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	200	250	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP) I_C(max) = 3.32 Adc, f = 30 MHz)	G_{PE}	13	15	–	dB
Output Power (V_{CE} = 50 Vdc, f = 30 MHz)	P_{out}	150	–	–	W PEP
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP), I_C(max) = 3.32 Adc, f = 30 MHz)	η	45	–	–	%
Intermodulation Distortion (1) (V_{CE} = 50 Vdc, P_{out} = 150 W (PEP), I_C = 3.32 Adc)	IMD	–	-33	-30	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP), I_C(max) = 3.32 Adc, f = 30 MHz), VSWR 30:1 at all Phase Angles	No Degradation in Output Power				

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



C1,C2,C7	170-780 pF, ARCO 469	R2	10 Ω, 1 Watt
C3,C8,C9	0.1 μF, 100 V ERIE	CR1	1N4997
C4	500 μF @ 6 V	L1	3 Turns, #16 Wire, 5/16" I.D., 5/16" Long
C5	9.0-180 pF, ARCO 463	L2	10 μH Molded Choke
C6	80-480 pF, ARCO 466	L3	12 Turns, #16 Enameled Wire Closewound, 1/4" I.D.
C10	30 μF, 100 V	L4	5 Turns, 1/8" Copper Tubing, 9/16" I.D., 3/4" Long
R1	10 Ω, 10 Watt	L5	10 Ferrite Beads – FERROXCUBE #56-590-65/3B

2

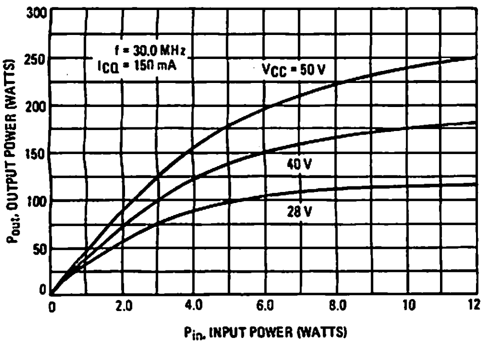


FIGURE 2 – OUTPUT POWER versus INPUT POWER

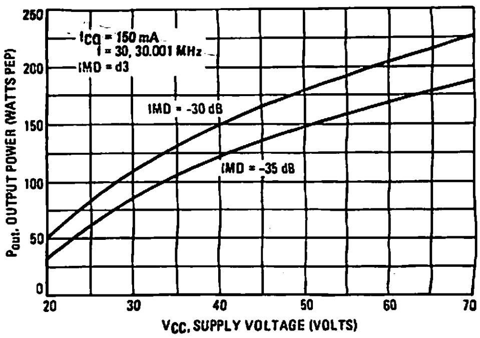


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE

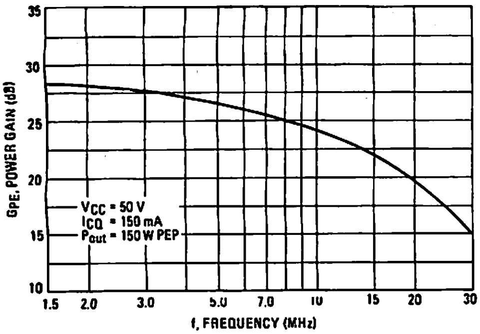


FIGURE 4 – POWER GAIN versus FREQUENCY

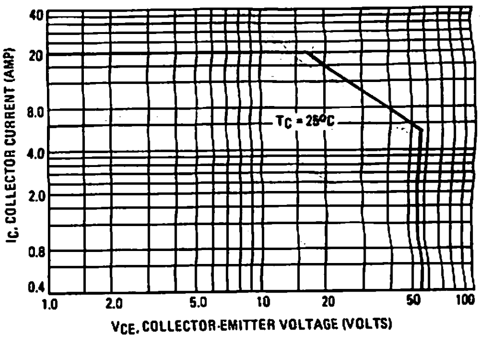


FIGURE 5 – DC SAFE OPERATING AREA

INTERMODULATION DISTORTION versus OUTPUT POWER

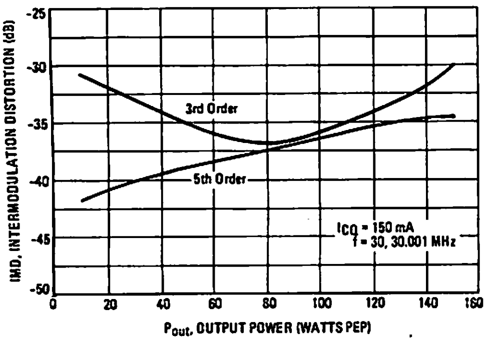


FIGURE 6 – V_{CC} = 40 Vdc

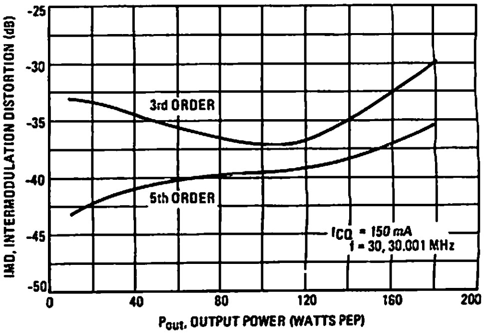


FIGURE 7 – V_{CC} = 50 Vdc

FIGURE 8 – OUTPUT CAPACITANCE versus FREQUENCY

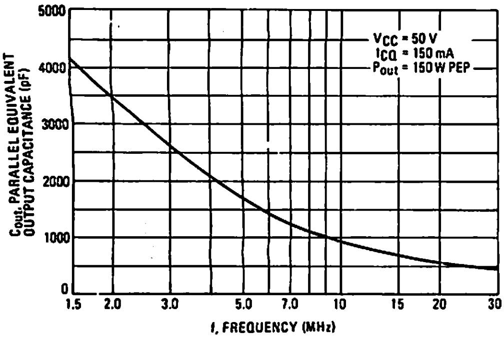


FIGURE 9 – OUTPUT RESISTANCE versus FREQUENCY

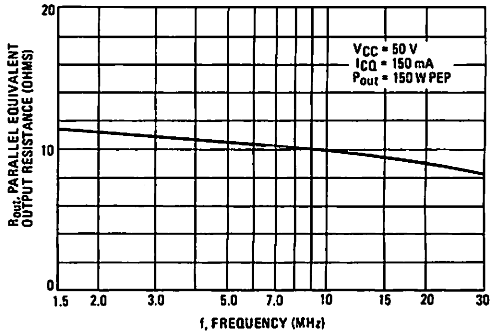
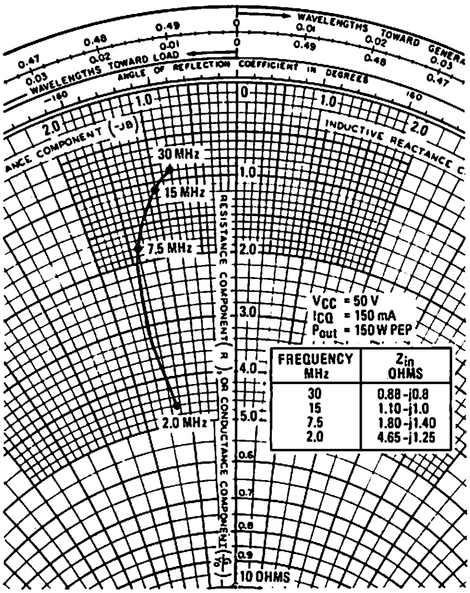


FIGURE 10 – SERIES EQUIVALENT IMPEDANCE



FREQUENCY MHz	Z_{in} OHMS
30	0.88 - j0.8
15	1.10 - j1.0
7.5	1.80 - j1.40
2.0	4.65 - j1.25

MRF429
MRF429MP

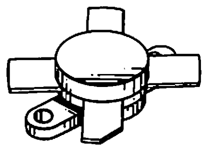
The RF Line

2

150 W (LINEAR) 30 MHz

RF POWER TRANSISTORS

NPN SILICON

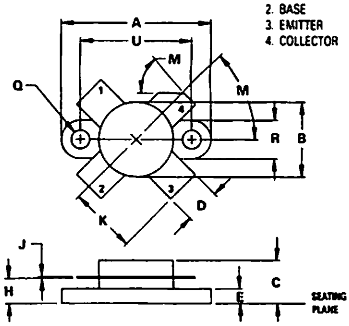


NPN SILICON RF POWER TRANSISTORS

. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics —
  Output Power = 150 W(PEP)
  Minimum Gain = 13 dB
  Efficiency = 45%
- Intermodulation Distortion @ 150 W(PEP) —
  IMD = −32 dB (Max)
- Diffused Emitter Resistors for Superior Ruggedness
- 100% Tested for Load Mismatch at all Phase Angles with 30:1 VSWR @ 150 W CW

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	233 1.33	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

MRF429MP is for ordering an h_{FE} matched pair.

THERMAL CHARACTERISTICS

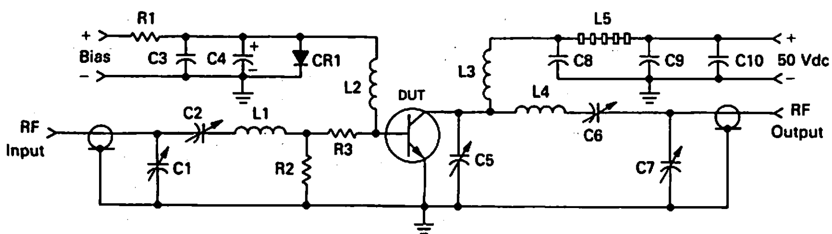
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	220	300	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Gain (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP) I_C(max) = 3.32 Adc, f = 30; 30.001 MHz)	G_{PE}	13	15	—	dB
Output Power (V_{CE} = 50 Vdc, f = 30; 30.001 MHz)	P_{out}	150	—	—	W (PEP)
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W (PEP), I_C(max) = 3.32 Adc, f = 30; 30.001 MHz)	η	45	—	—	%
Intermodulation Distortion (1) (V_{CE} = 50 Vdc, P_{out} = 150 W (PEP), I_C = 3.32 Adc)	IMD	—	−35	−32	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 150 W CW, f = 30 MHz, VSWR 30:1 at all Phase Angles)	No Degradation in Output Power				

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1,C2,C7	170-780 pF, Arco 469	R2	10 Ω, 1 Watt
C3,C8,C9	0.1 µF, 100 V Erie	R3	5-3.3 Ω 1/2 Watt Carbon Resistors in Parallel
C4	500 µF @ 6 V	CR1	1N4997
C5	9.0-180 pF, Arco 463	L1	3 Turns, #16 Wire, 5/16" I.D., 5/16" Long
C6	80-480 pF, Arco 466	L2	10 µH Molded Choke
C10	30 µF, 100 V	L3	12 Turns, #16 Enameled Wire Closewound, 1/4" I.D.
R1	10 Ω, 10 Watt	L4	5 Turns, 1/8" Copper Tubing, 9/16" I.D., 3/4" Long
		L5	10 Ferrite Beads — Ferroxcube #56-590-65/3B

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

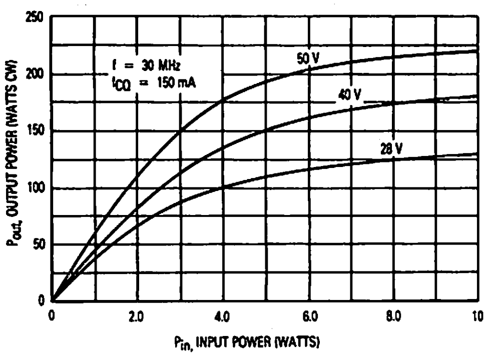


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

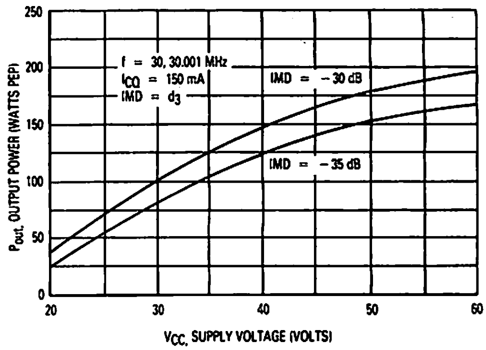


FIGURE 4 — POWER GAIN versus FREQUENCY

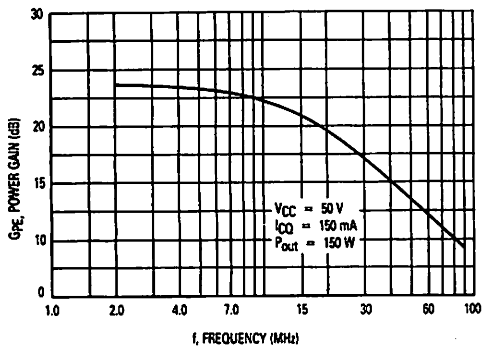


FIGURE 5 — RF SAFE OPERATING AREA (SOAR)

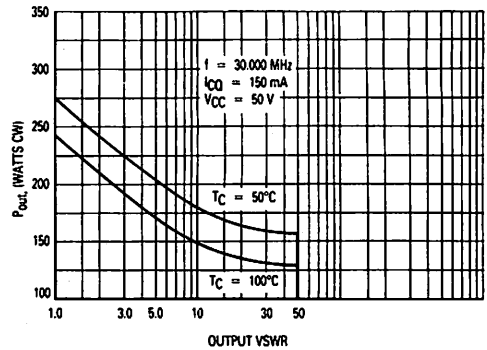


FIGURE 6 — f_T versus COLLECTOR CURRENT

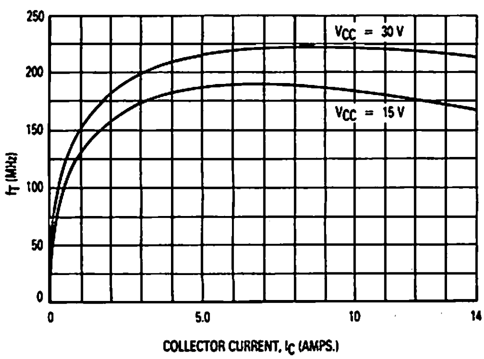


FIGURE 7 — IMD versus P_{out}

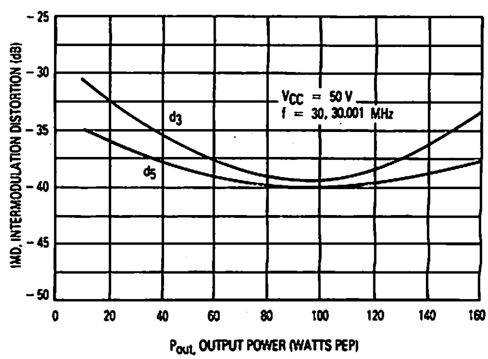


FIGURE 8 — OUTPUT CAPACITANCE versus FREQUENCY

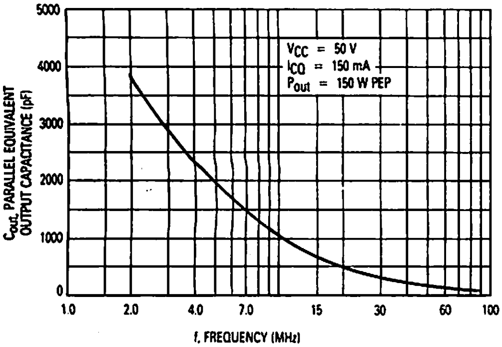


FIGURE 9 — OUTPUT RESISTANCE versus FREQUENCY

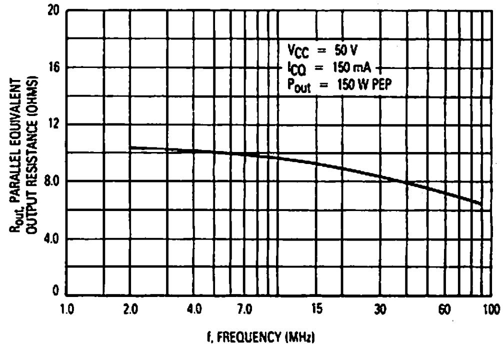
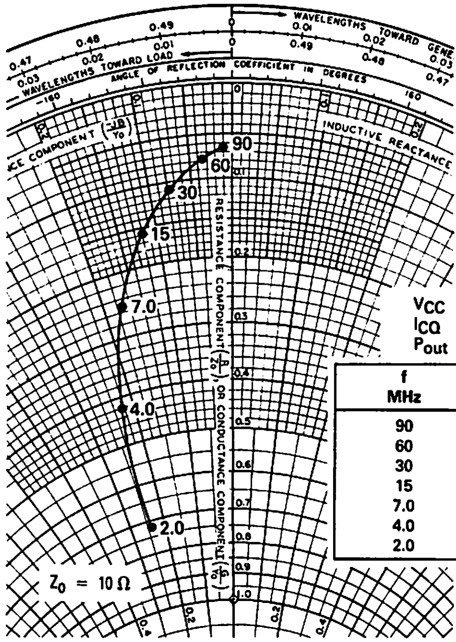


FIGURE 10 — SERIES EQUIVALENT IMPEDANCE



V_{CC} = 50 V
I_{CQ} = 150 mA
P_{out} = 150 W PEP

f MHz	Z_{in} Ohms
90	0.67 −J0.10
60	0.78 −J0.30
30	1.10 −J0.70
15	1.60 −J1.15
7.0	2.55 −J1.75
4.0	4.20 −J2.25
2.0	7.15 −J2.40

MRF430

2

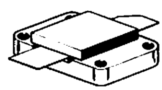
The RF Line

NPN Silicon RF Power Transistor

...designed primarily for high-voltage applications as a high-power linear amplifier from 2 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics
  - Output Power = 600 W
  - Minimum Gain = 10 dB
  - Efficiency = 40%
- Intermodulation Distortion @ 600 W(PEP) — IMD = −30 dB
- Diffused Emitter Resistors for Superior Ruggedness
- Low Thermal Resistance

**600 WATTS (LINEAR)
30 MHz
RF POWER TRANSISTOR
NPN SILICON**



CASE 368-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	60	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	875 5	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.20	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

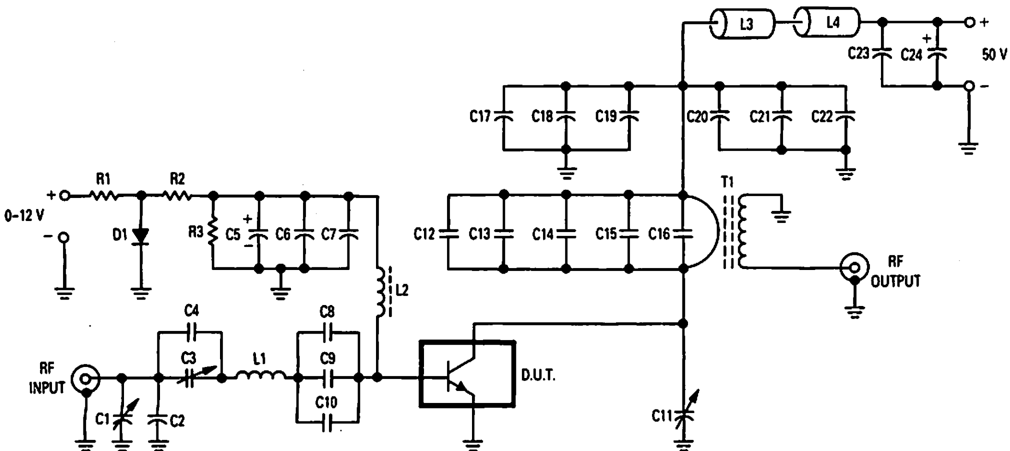
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 500 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 20 Adc, V_{CE} = 10 Vdc)	h_{FE}	10	30	80	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	900	1200	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 600 W (CW), f = 30 MHz, I_{CQ} = 600 mA)	G_{PE}	10	13	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 600 W, f = 30 MHz, I_{CQ} = 600 mA) (PEP)	η	—	40	—	%
(CW)		—	60	—	%
Intermodulation Distortion (1) (V_{CE} = 50 Vdc, P_{out} = 600 W (PEP), I_{CQ} = 600 mA, f = 30 MHz)	IMD	—	−30	—	dB

(1) To Mil Std 1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.



C1, C3, C11 — Arco 469 or equivalent
C2 — 820 pF
C4 — 330 pF
C5 — 1000 µF/3 V Electrolytic
C6, C8, C9, C10, C17, C18, C19 — 0.1 µF
C7, C22, C23 — 0.47 µF, RMC Type 2225C or equivalent
C12, C13, C14 — 470 pF
C15 — 1000 pF
C16 — Two Unencapsulated 1000 pF Mica in Series
C20, C21 — 0.039 µF
C24 — 10 µF/100 V Electrolytic
D1 — 1N4997 or equivalent
R1 — 10 Ohms/10 W
R2 — 0.1 Ohm/½ W
R3 — 2.7 Ohms/2 W

L1 — 2 Turns #14 AWG, ½" ID, ½" Long
L2 — Ohmite Z-235 or equivalent
L3, L4 — Ferrite Beads, Fair-Rite Products Corp. #2673000801 or equivalent
T1 — RF Transformer, 1:25 Impedance Ratio. See Motorola Application Note AN749, Figure 4 for details. Ferrite Material: 2 Each, Fair-Rite Product Corp. #2667540001 or equivalent

All capacitors ATC type 100/200 chips or equivalent, unless otherwise noted.

Figure 1. 30 MHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

2

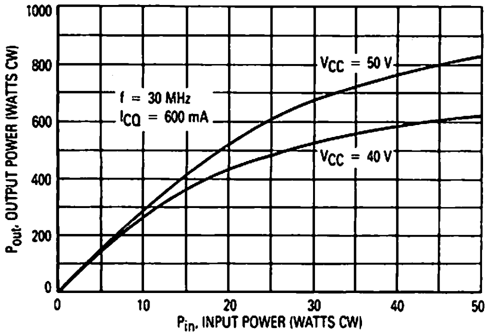


Figure 2. Output Power versus Input Power

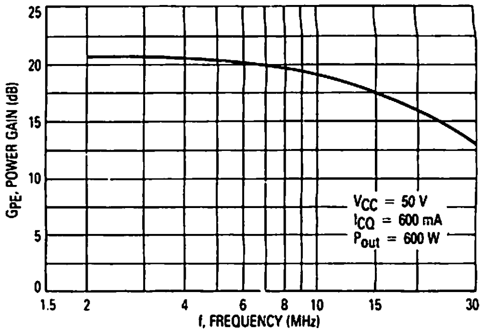


Figure 3. Power Gain versus Frequency

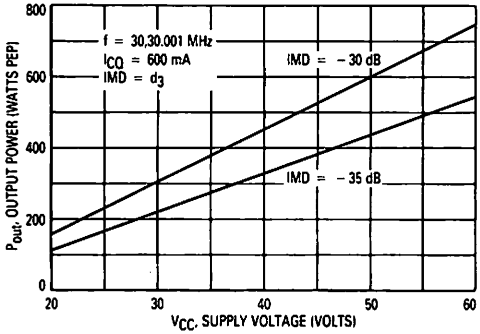


Figure 4. Output Power versus Supply Voltage

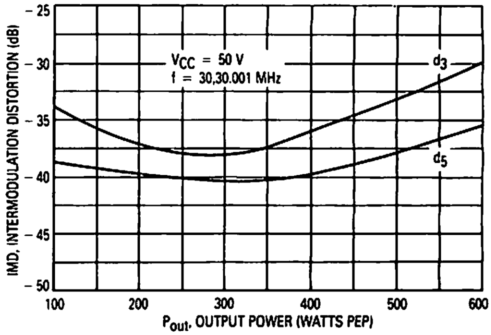


Figure 5. IMD versus Output Power

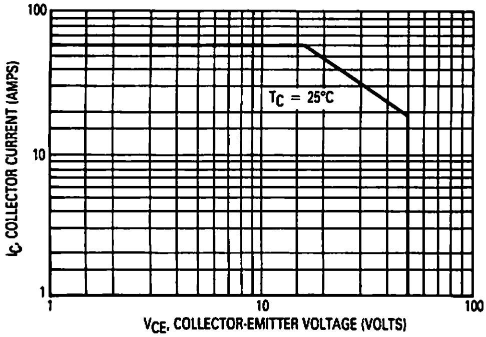


Figure 6. DC Safe Operating Area

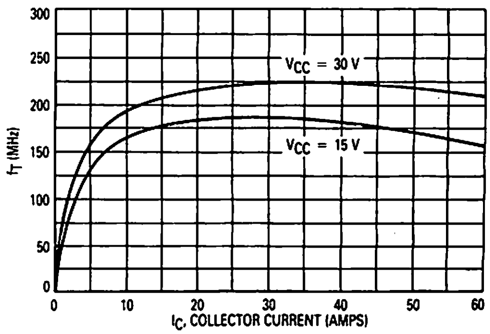


Figure 7. f_T versus Collector Current

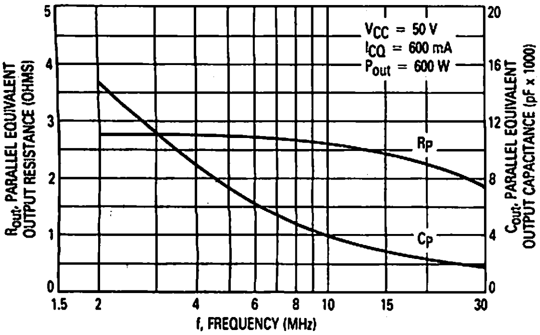
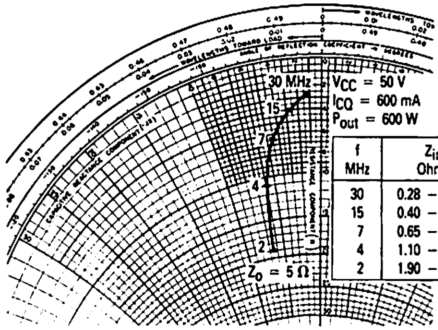


Figure 8. Output Resistance and Capacitance versus Frequency



f MHz	Z_{in} Ohms
30	0.28 – j0.12
15	0.40 – j0.27
7	0.65 – j0.45
4	1.10 – j0.60
2	1.90 – j0.65

Figure 9. Series Equivalent Input Impedance

MOUNTING OF HIGH POWER RF POWER TRANSISTORS

The package of this device is designed for conduction cooling. It is extremely important to minimize the thermal resistance between the device flange and the heat dissipator.

Since the device mounting flange is made of soft copper, it may be deformed during various stages of handling or during transportation. It is recommended that the user makes a final inspection on this before the device installation. ±0.0005″ is considered sufficient for the flange bottom.

The same applies to the heat dissipator in the device mounting area. If copper heatsink is not used, a copper head spreader is strongly recommended between the device mounting surfaces and the main heatsink. It should be at least 1/4″ thick and extend at least one inch from the flange edges. A thin layer of thermal compound in all interfaces is, of course, essential. The recommended torque on the 4-40 mounting screws should be in the area of 4–5 lbs.-inch, and spring type lock washers along with flat washers are recommended.

For die temperature calculations, the Δ temperature from a corner mounting screw area to the bottom center of the flange is approximately 5°C and 10°C under normal operating conditions (dissipation 150 W and 300 W respectively).

The main heat dissipator must be sufficiently large and have low R_{θ} for moderate air velocity, unless liquid cooling is employed.

CIRCUIT CONSIDERATIONS

At high power levels (500 W and up), the circuit layout becomes critical due to the low impedance levels and high RF currents associated with the output matching. Some of the components, such as capacitors and inductors must also withstand these currents. The component losses are directly proportional to the operating frequency. The manufacturers specifications on capacitor ratings should be consulted on these aspects prior to design.

Push-pull circuits are less critical in general, since the ground referenced RF loops are practically eliminated, and the impedance levels are higher for a given power output. High power broadband transformers are also easier to design than comparable LC matching networks.

MRF433

The RF Line

2

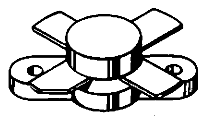
SILICON RF POWER TRANSISTORS

. . . designed primarily for application as complementary symmetry amplifiers in linear amplifiers from 2.0 to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characterisitcs –
  Output Power = 12.5 W (PEP)
  Minimum Gain = 20 dB
  Efficiency = 50%
- Intermodulation Distortion @ 12.5 W (PEP) –
  IMD = -30 dB (Max)

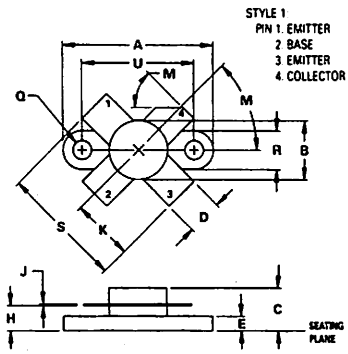
12.5 W (PEP) – 30 MHz
RF POWER TRANSISTOR

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	20 114	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.68	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

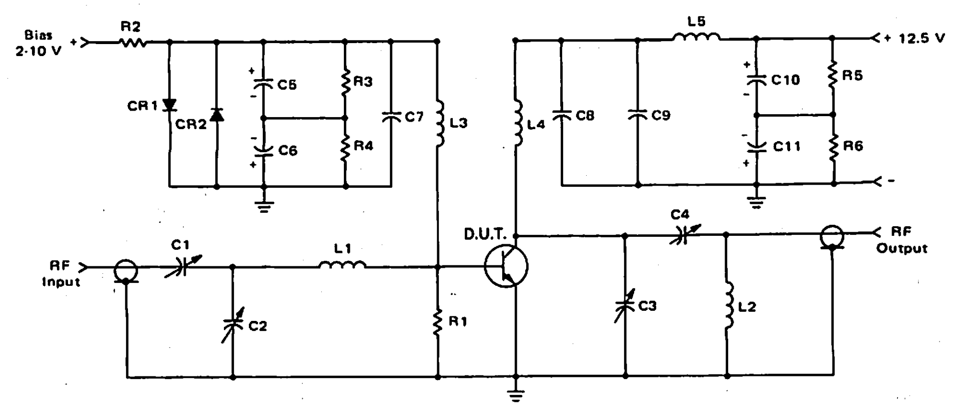
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 55°C)	I_{CES}	–	–	8.0	mAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	15	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	70	120	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain(1) (V_{CC} = 12.5 Vdc, P_{out} = 12.5 W (PEP), I_{CQ} = 100 mAdc, f = 30,30.001 MHz)	G_{pe}	20	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 12.5 W (PEP) (f = 30,30.001 MHz)	η(1) η(2)	45 40	50 45	–	%
Intermodulation Distortion(3) (V_{CC} = 12.5 Vdc, P_{out} = 12.5 W (PEP), I_{CQ} = 100 mAdc, f = 30, 30.001 MHz)	IMD	–	–	-30	dB
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 12.5 W (PEP), I_{CQ} = 100 mAdc, f = 30,30.001 MHz)	Z_{in}	–	2.50-j2.20	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 12.5 W (PEP), I_{CQ} = 100 mAdc, f = 30, 30.001 MHz)	Z_{out}	–	4.80-j3.00	–	Ohms

(1) Class AB
(2) Class A
(3) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



C1,C2,C4	170–780 pF, ARCO 469	R2	10 Ω, 5 Watt	L3	10 μH Molded Choke
C3	25–280 pF, ARCO 464	R3,R4	1 kΩ, 1/4 Watt	L4	15 Turns, #24 AWG Enameled Wire, Closewound on a 100 Ω, 1 Watt Carbon Resistor.
C5,C6	500 μF, 3 V, ELECTROLYTIC	R5,R6	10 kΩ, 1/4 Watt		
C7,C9	0.1 μF, Disc Ceramic	CR1,CR2	1N4001		
C8	1000 pF Disc Ceramic	L1	3 Turns, #18 AWG, 1/4" I.D., 3/16" Long	L5	FERROXCUBE VK200 – 20/4B
C10,C11	100 μF, 15 V, ELECTROLYTIC	L2	3 Turns, #16 AWG, 3/8" I.D., 1/4" Long		
R1	10 Ω, 1/2 Watt				

MRF448

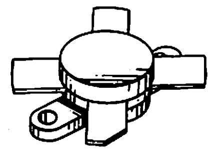
2

The RF Line

250 W — 30 MHz

RF POWER TRANSISTOR

NPN SILICON

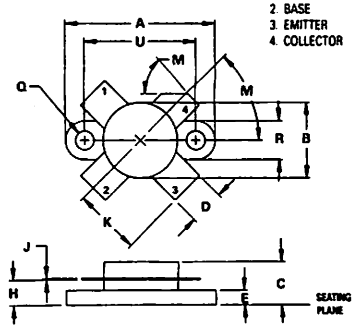


NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for high-voltage applications as a high-power linear amplifier from 2.0 to 30 MHz. Ideal for marine and base station equipment.

- Specified 50 Volt, 30 MHz Characteristics
  Output Power = 250 W
  Minimum Gain = 12 dB
  Efficiency = 45%
- Intermodulation Distortion @ 250 W (PEP) —
  IMD = −30 dB (Max)
- 100% Tested for Load Mismatch at all Phase Angles with 3:1 VSWR

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	50	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	16	Adc
Withstand Current — 10 s	—	20	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate Above 25°C	P_D	290 1.67	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.6	°C/W

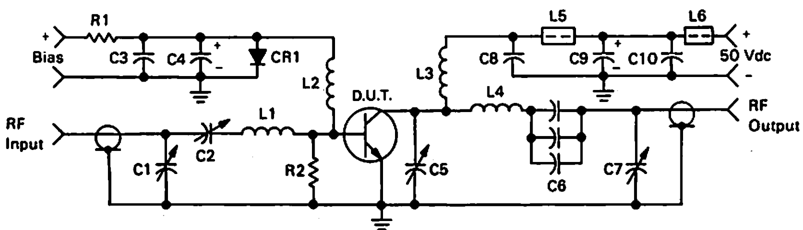
(1) P_D is a measurement reflecting short term maximum condition. See SOAR curve for operating conditions.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 200 mAdc, I_B = 0)	$V_{(BR)CEO}$	50	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	100	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	350	450	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 250 W CW, f = 30 MHz, I_{CQ} = 250 mA)	G_{PE}	12	14	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 250 W, f = 30 MHz, I_{CQ} = 250 mA)	η	— —	45 65	— —	% (PEP) % (CW)
Intermodulation Distortion (1) (V_{CE} = 50 Vdc, P_{out} = 250 W (PEP), I_{CQ} = 250 mA, f = 30 MHz)	IMD	—	-33	-30	dB
Electrical Ruggedness (V_{CC} = 50 Vdc, P_{out} = 250 W CW, f = 30 MHz, VSWR 3:1 at all Phase Angles)	No Degradation in Output Power				

(1) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C5, C7 — 170-780 pF, Arco 469
C3, C8, C9 — 0.1 μF, 100 V Erie
C4 — 500 μF @ 6.0 V
C6 — 360 pF, 3 × 120 pF 3.0 kV in parallel
C10 — 10 μF, 100 V
R1 — 10 Ω, 10 Watt
R2 — 10 Ω, 1 Watt
CR1 — 1N4997 or equivalent
L1 — 3 Turns, #16 Wire, 0.4" I.D., 0.3" Long
L2 — 0.8 μH, Ohmite Z-235 or equivalent
L3 — 12 Turns, #16 Enameled Wire Closewound 0.25" I.D.
L4 — 4 Turns, 1/8" Copper Tubing, 0.6" I.D., 1.0" Long
L5, L6 — 2.0 μH, Fair-Rite 2643021801 Ferrite bead each or equivalent.

FIGURE 2 — OUTPUT POWER versus INPUT POWER

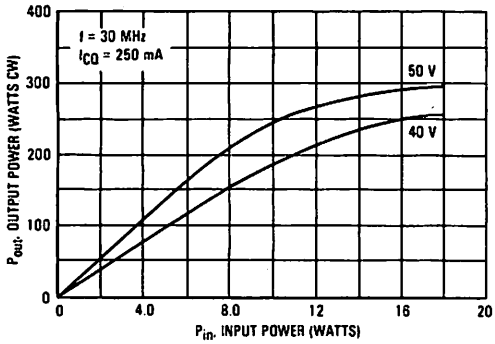


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

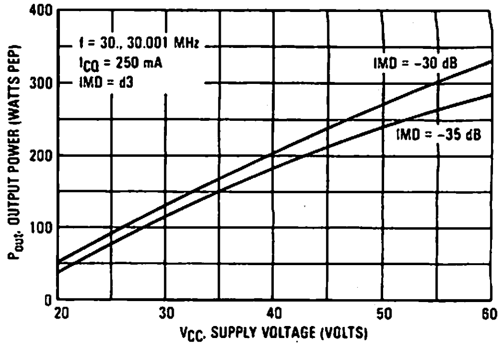


FIGURE 4 — POWER GAIN versus FREQUENCY

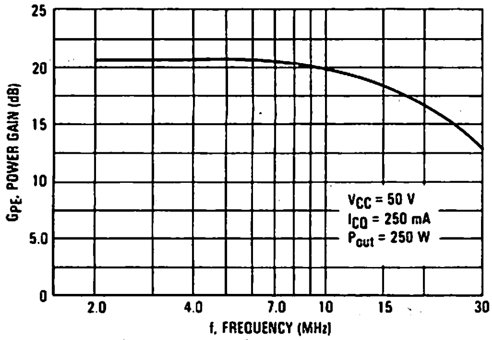


FIGURE 5 — RF SOAR (CLASS AB)
P_{out} versus OUTPUT VSWR

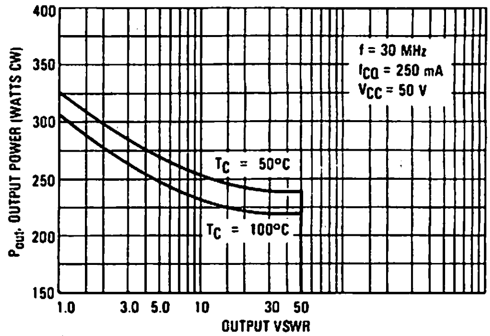


FIGURE 6 — f_T versus COLLECTOR CURRENT

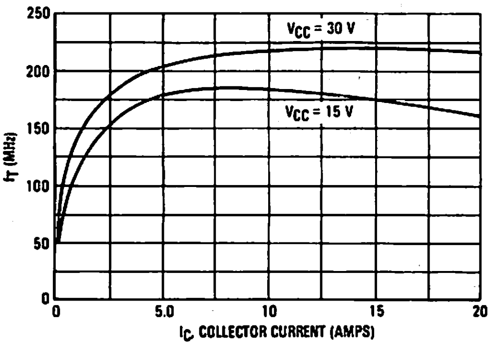


FIGURE 7 — IMD versus P_{out}

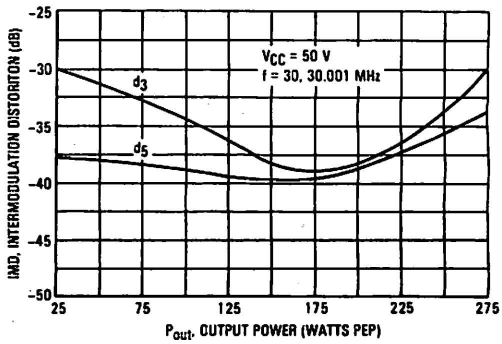


FIGURE 8 — OUTPUT RESISTANCE AND CAPACITANCE versus FREQUENCY

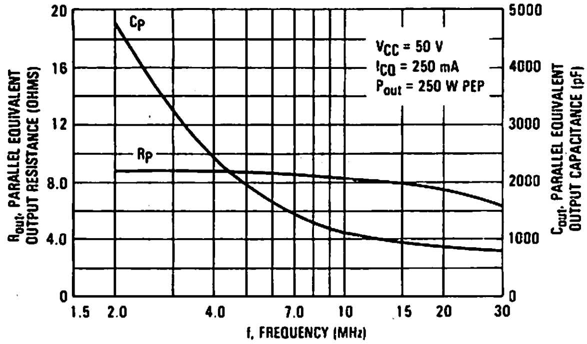
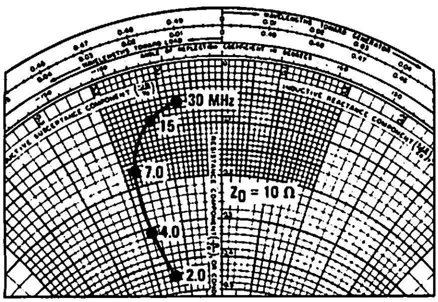


FIGURE 9—SERIES EQUIVALENT IMPEDANCE



V_{CC} = 50 V
I_{CQ} = 150 mA
P_{out} = 250 W PEP

f MHz	Z_{in} Ohms
30	0.60 -J0.75
15	0.80 -J1.25
7.0	1.70 -J1.75
4.0	3.10 -J1.80
2.0	4.50 -J1.40

MRF449A

The RF Line

NPN SILICON RF POWER TRANSISTOR

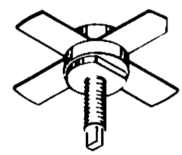
. . . designed for power amplifier application in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 30 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%

30 W – 30 MHz

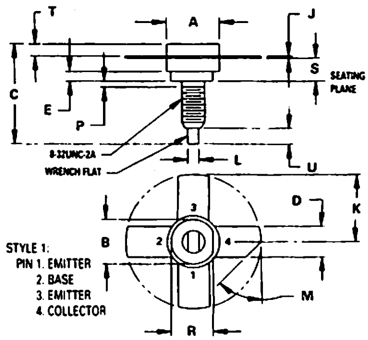
RF POWER TRANSISTOR

NPN SILICON



MAXIMUM RATINGS			
Rating	**Symbol**	**Value**	**Unit**
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	60 343	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS			
Characteristic	**Symbol**	**Max**	**Unit**
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.9	°C/W

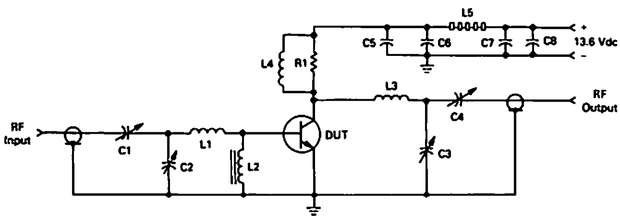


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1 — 14-150 pF, ARCO 424
C2, C3, C4 — 170-780 pF, ARCO 469
C5, C8 — ERIE 0.1 μF @ 100 V RED CAPS
C6 — 1000 pF UNELCO, 350 Vdc
C7 — 10 μF, 35 Vdc
R1 — 100 Ω, 2.0 W Carbon
L1 — 0.15 μH Molded Choke MILLER
L2 — FERROXCUBE, VK200-20-4B
L3 — 3 Turns, #14 Bare Tinned Wire, 0.3" (0.79) I.D. x 0.38" (0.97) Long
L4 — 9 Turns, #20 Enamel Wire, Close Wound on R1
L5 — FERROXCUBE #56-570-65/3B, 5 Ferrite Beads, on 1" Long #20 Wire
Input/Output Connectors — Type N
Board — Glass Teflon Mounted on a 4" x 4" x 2" SEEZAK Box

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	50	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	140	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 30 W, I_C(max) = 4.0 Adc, f = 30 MHz)	G_{PE}	12	14	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 30 W, I_C(max) = 4.0 Adc, f = 30 MHz)	η	50	–	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 30 MHz)	Z_{in}	–	2.13-j1.15	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 30 MHz)	Z_{out}	–	2.47-j0.37	–	Ohms

FIGURE 2 – POWER OUTPUT versus POWER INPUT

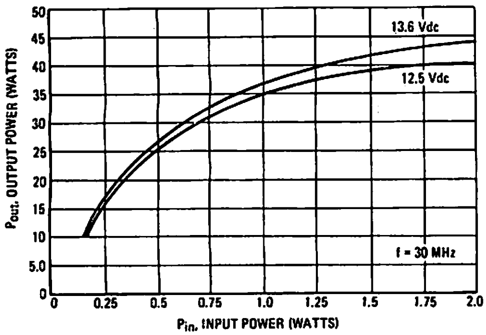
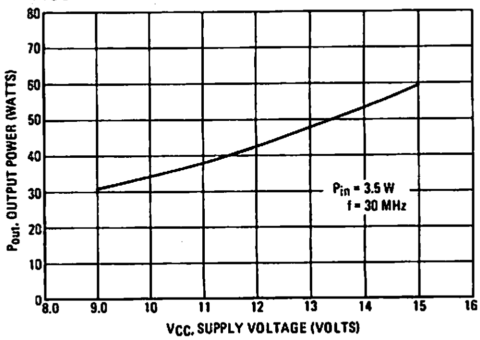


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE



MRF450
MRF450A

2

The RF Line

NPN SILICON RF POWER TRANSISTORS

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 50 Watts
  Minimum Gain = 11 dB
  Efficiency = 50%

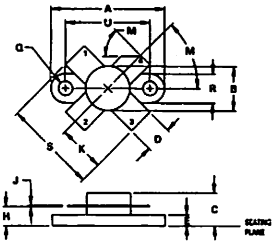
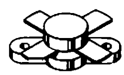
50 W – 30 MHz
RF POWER TRANSISTORS
NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	– Vdc
Collector Current – Continuous	I_C	7.5	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ Derate above $25^{\circ}C$	P_D	115 0.66	Watts $W/^{\circ}C$
Storage Temperature Range	T_{stg}	–65 to +150	$^{\circ}C$

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.53	$^{\circ}C/W$

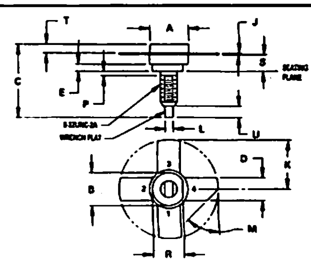
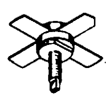



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07
MRF450

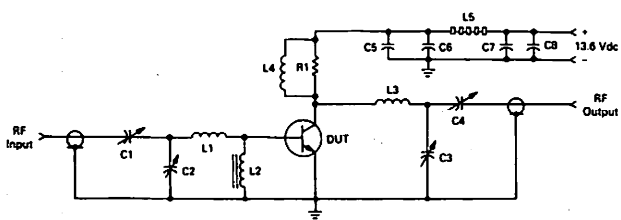
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09
MRF450A

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1 — 14–150 pF, ARCO 424
C2, C3, C4 — 170–780 pF, ARCO 469
C5, C8 — ERIE 0.1 μF @ 100 V RED CAPS
C6 — 1000 pF UNELCO, 350 Vdc
C7 — 10 μF, 35 Vdc
R1 — 100 Ω, 2.0 W Carbon
L1 — 0.15 μH Molded Choke MILLER
L2 — FERROXCUBE, VK200-20-4B
L3 — 3 Turns, #14 Bare Tinned Wire, 0.3" (0.79) I.D. x 0.38" (0.97) Long
L4 — 9 Turns, #20 Enamel Wire, Close Wound on R1
L5 — FERROXCUBE #56-570-65/3B, 5 Ferrite Beads, on 1" Long #20 Wire
Input/Output Connectors — Type N
Board — Glass Teflon Mounted on a 4" x 4" x 2" SEEZAK Box

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	40	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	200	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 50 W, I_C(max) = 6.13 Adc, f = 30 MHz)	G_{PE}	11	15	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 50 W, I_C(max) = 6.13 Adc, f = 30 MHz)	η	50	–	–	%
Series Equivalent Input Impedance (V_{CC} = 13.6 Vdc, P_{out} = 50 W; f = 30 MHz)	Z_{in}	–	1.56-j.89	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 13.6 Vdc, P_{out} = 50 W, f = 30 MHz)	Z_{out}	–	174-j.50	–	Ohms

FIGURE 2 – INPUT POWER versus OUTPUT POWER

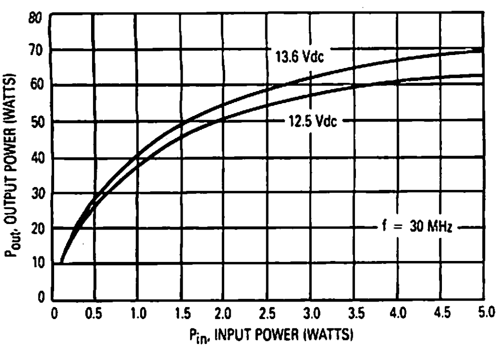
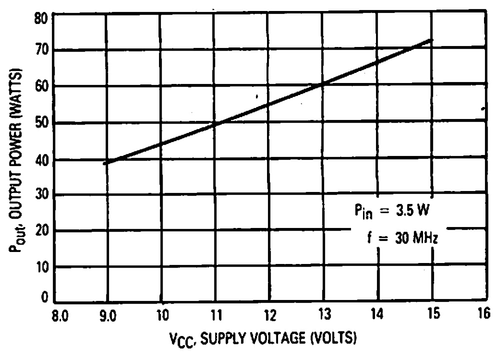


FIGURE 3 – OUTPUT POWER versus SUPPLY VOLTAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

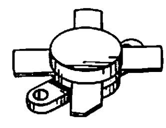
MRF454

The RF Line

80 W – 30 MHz

RF POWER TRANSISTOR

NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

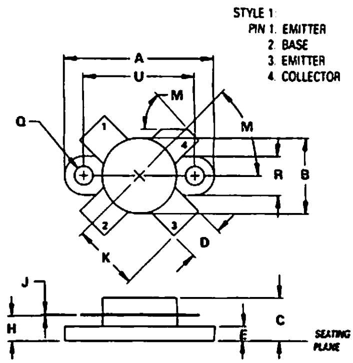
- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 80 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	20	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W



NOTES.
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

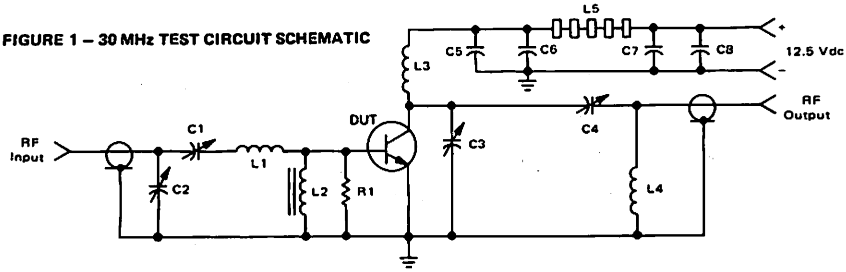
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	G_{pe}	12	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	η	50	–	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	Z_{in}	–	.938–j.341	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	Z_{out}	–	1.16–j.201	–	Ohms
Parallel Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	–	–	1.06 Ω 1817 pF	–	–
Parallel Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 80 W, f = 30 MHz)	–	–	1.19 Ω 777 pF	–	–

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4	ARCO 469	L1	3 Turns, #18 AWG, 5/16" I.D., 5/16" Long
C3	ARCO 466	L2	VK200 – 20/4B, FERROXCUBE
C5	1000 pF, UNELCO	L3	12 Turns, #18 AWG Enameled Wire, 1/4" I.D., Close Wound
C6, C7	0.1 μF Disk Ceramic	L4	3 Turns 1/8" O.D. Copper Tubing, 3/8" I.D., 3/4" Long
C8	1000 μF/15 V Electrolytic	L5	7 FERRITE Beads, FERROXCUBE #56-590-65/3B
R1	10 Ohm/1 Watt, Carbon		

FIGURE 2 — OUTPUT POWER versus INPUT POWER

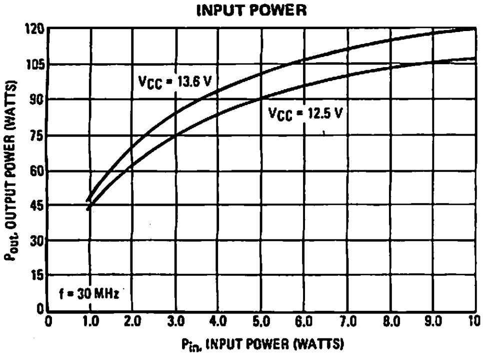
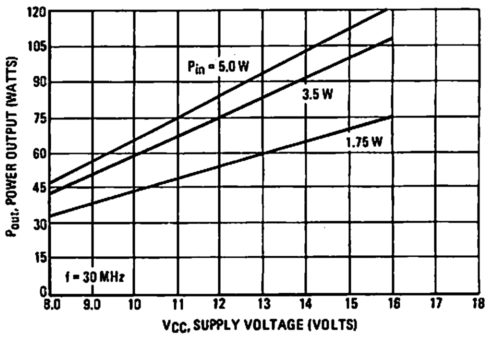


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE



2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF455
MRF455A

The RF Line

60 W – 30 MHz
RF POWER
TRANSISTORS
NPN SILICON

2

NPN SILICON RF POWER TRANSISTORS

. . . designed for power amplifier applications in industrial, commercial and amateur radio equipment to 30 MHz.

- Specified 12.5 Volt, 30 MHz Characteristics –
  Output Power = 60 Watts
  Minimum Gain = 13 dB
  Efficiency = 55%

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Emitter Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

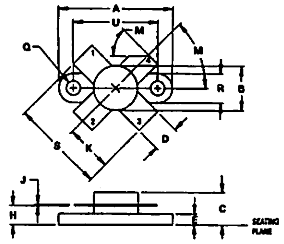
THERMAL CHARACTERISTICS

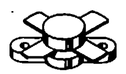
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.



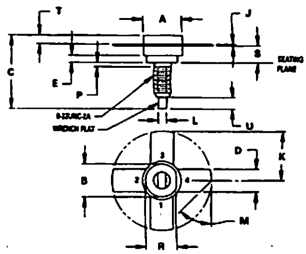


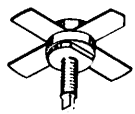
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 211-07
MRF455





NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.50	7.80	0.295	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

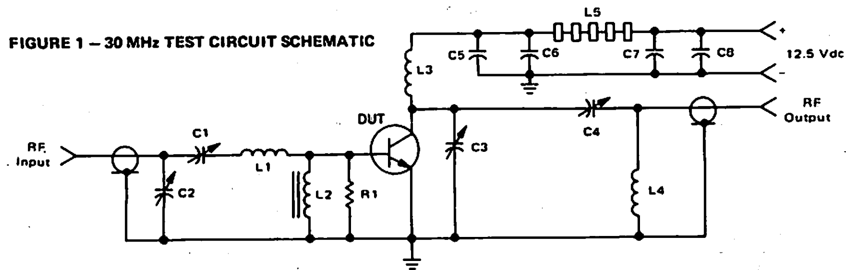
CASE 145A-09

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	250	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	G_{pe}	13	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	η	55	–	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	–	1.66-j.844	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	–	1.73-j.188	–	Ohms
Parallel Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{in}	–	2.09/1030	–	Ω/pF
Parallel Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 30 MHz)	Z_{out}	–	1.75/330	–	Ω/pF

2

FIGURE 1 — 30 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C4	ARCO 469	L1	3 Turns, #18 AWG, 5/16" I.D., 5/16" Long
C3	ARCO 466	L2	VK200 – 20/4B, FERROXCUBE
C5	1000 pF, UNELCO	L3	12 Turns, #18 AWG Enameled Wire, 1/4" I.D., Close Wound
C6, C7	0.1 μF Disk Ceramic	L4	3 Turns 1/8" O.D. Copper Tubing, 3/8" I.D., 3/4" Long
C8	1000 μF/15 V Electrolytic	L5	7 FERRITE Beads, FERROXCUBE #56-590-65/3B
R1	10 Ohm/1 Watt, Carbon		

FIGURE 2 — OUTPUT POWER versus INPUT POWER

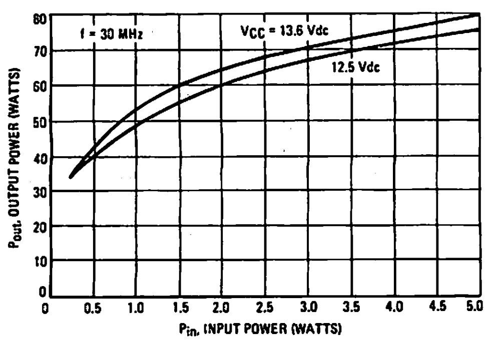
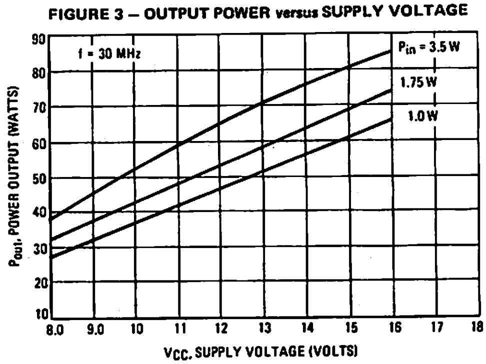


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF464
MRF464A

The RF Line

NPN SILICON RF POWER TRANSISTORS

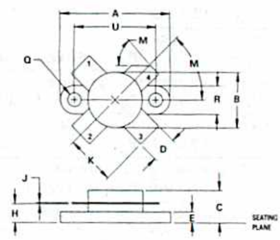
. . . designed primarily for applications as a high-power linear amplifier from 2.0 to 30 MHz, in single sideband mobile, marine and base station equipment.

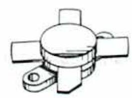
- Specified 28 Volt, 30 MHz Characteristics –
  Output Power = 80 W (PEP)
  Minimum Gain = 15 dB
  Efficiency = 40%
  Intermodulation Distortion = –32 dB (Max)

80 W (PEP) – 30 MHz

RF POWER TRANSISTORS

NPN SILICON





NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 211-11
MRF464

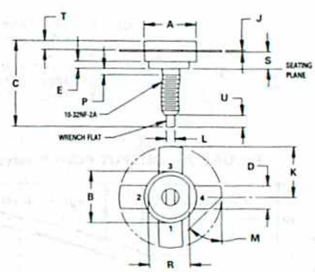
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	250 1.4	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W
Stud Torque (1)	—	8.5	In. Lb

(1) Case 145A-10 — For Repeated Assembly Use 11 In. Lb.



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.90	0.065	0.075
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	9.73	10.06	0.383	0.396
S	3.84	4.50	0.151	0.177
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-10
MRF464A

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

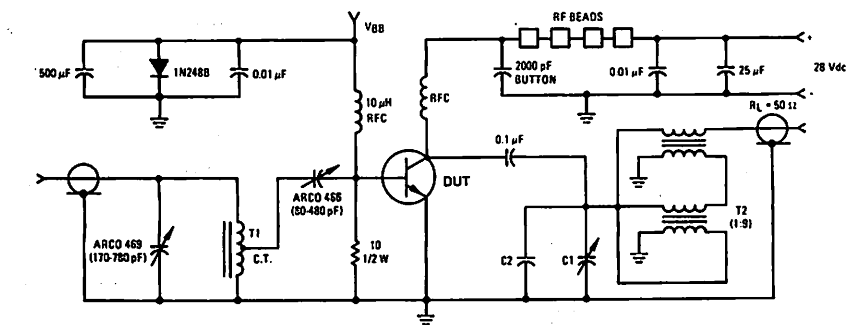
The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0, T_C = +55°C)	I_{CES}	–	10	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	200	pF
FUNCTIONAL TEST				
Common-Emitter Amplifier Power Gain (Figure 1) (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	G_{PE}	15	–	dB
Intermodulation Distortion Ratio (Figure 1) (1) (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	IMD	–	-32	dB
Collector Efficiency (P_{out} = 80 W (PEP), I_C = 3.6 Adc (Max), V_{CC} = 28 Vdc, f_1 = 30 MHz, f_2 = 30.001 MHz)	η	40	–	%

(1) To Mil-Std-1311 Version A, Test Method 2204B, Two Tone, Reference each Tone.

FIGURE 1—30 MHz TEST CIRCUIT



RFC: 20 TURNS #12 AWG ENAMELED WIRE CLOSE WOUND IN 2 LAYERS, 1/4" I.D.
T1: 20 TURNS #24 AWG WIRE WOUND ON MICRO-METALS T37-7 TOROID CORE CENTER TAPPED.
T2: 1:9 XFMR; 6 TURNS OF 2 TWISTED PAIRS OF #28 AWG ENAMELED WIRE. (8 CRESTS PER INCH) BIFILAR WOUND ON EACH OF 2 SEPARATE BALUN CORES. (Stackpole #57-1503, No. 14 Material) Interconnected as shown
RF BEADS: FERROXCUBE #56-590-65/3B

V_{BB} adjusted for I_{CQ}: 40 mAdc (I_{CQ} = Quiescent Collector Current)

C1 – 170-180 pF ARCO 469 or Equiv.

C2 – 330 pF

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

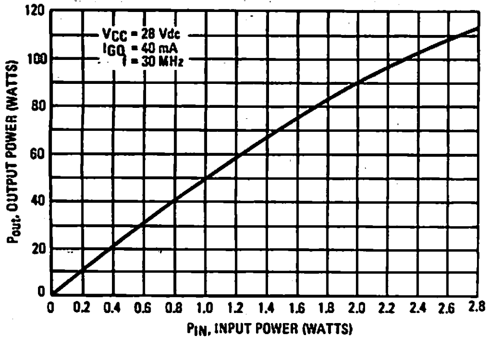


FIGURE 3 — POWER GAIN versus FREQUENCY

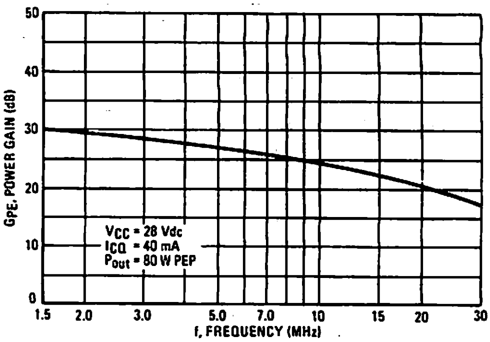


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

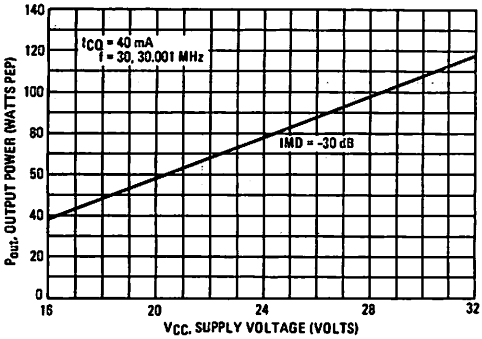


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

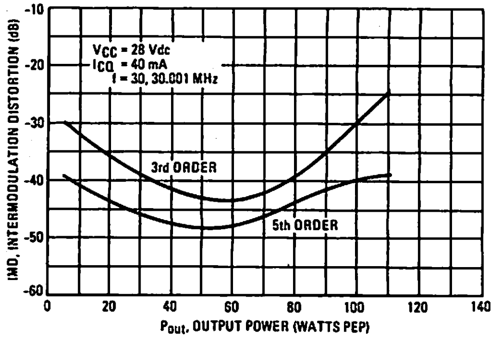


FIGURE 6 — OUTPUT CAPACITANCE versus FREQUENCY

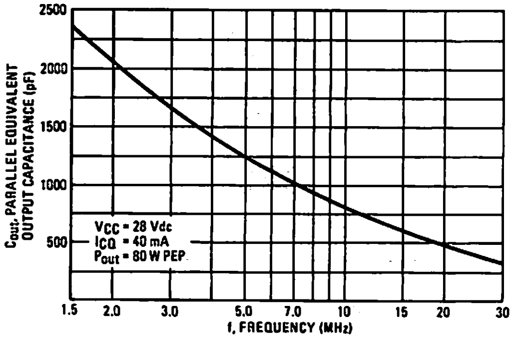


FIGURE 7 — OUTPUT RESISTANCE versus FREQUENCY

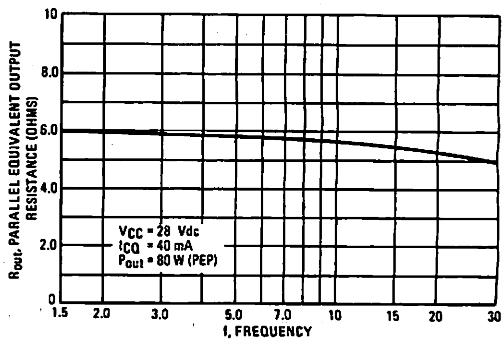


FIGURE 8 – DC SAFE OPERATING AREA

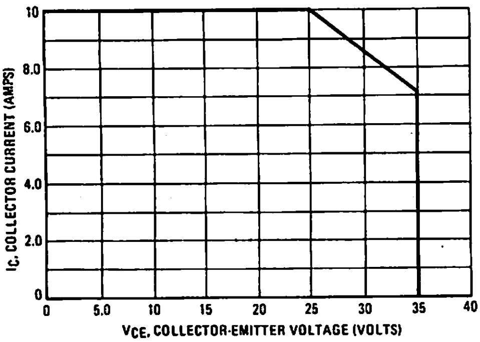
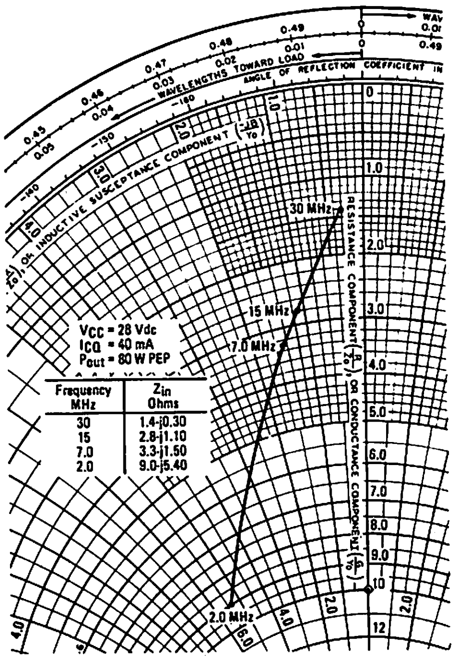


FIGURE 9 – SERIES INPUT IMPEDANCE



Frequency MHz	Zin Ohms
30	1.4-j0.30
15	2.8-j1.10
7.0	3.3-j1.50
2.0	9.0-j5.40

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF466

The RF Line

NPN SILICON RF POWER TRANSISTOR

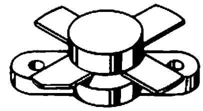
. . . designed primarily for applications as a high-power amplifier from 2.0 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Specified 28 V, 30 MHz Characteristics —
  Output Power = 40 W PEP or CW
  Minimum Gain = 15 dB
  Efficiency = 40%
  Intermodulation Distortion d_3 = -30 dB Max
- Guaranteed Ruggedness
- 2N5941 Replacement

40 W (PEP) 30 MHz

RF POWER TRANSISTOR

NPN SILICON



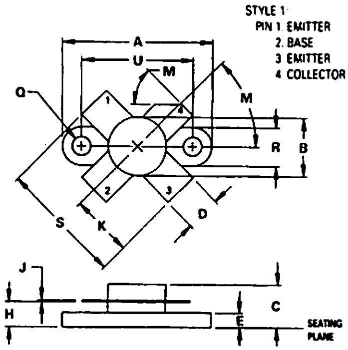
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.0	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



NOTES
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2. CONTROLLING DIMENSION: INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40	50	40	50
Q	2.68	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07

MATCHING PROCEDURE

In the push-pull circuit configuration it is preferred that the transistors are used as matched pairs to obtain optimum performance.

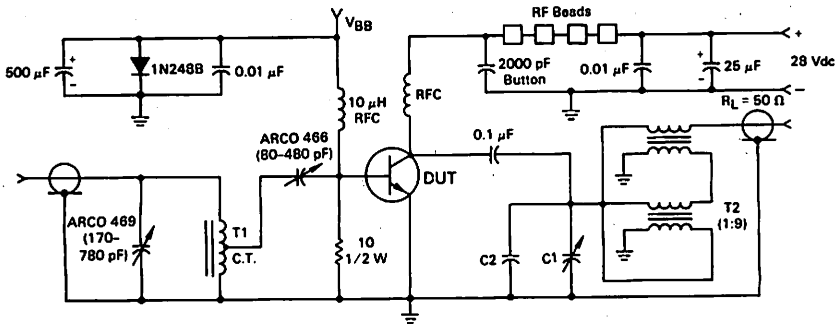
The matching procedure used by Motorola consists of measuring h_{FE} at the data sheet conditions and color coding the device to predetermined h_{FE} ranges within the normal h_{FE} limits. A color dot is added to the marking on top of the cap. Any two devices with the same color dot can be paired together to form a matched set of units.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mADC, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	125	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	G_{PE}	15	19	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz f2 = 30.001 MHz, I_{CQ} = 20 mA)	η	40	—	—	%
Intermodulation Distortion (1) (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	$IMD_{(d_3)}$	—	-40	-30	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f = 30 MHz, VSWR = 30:1 All Angles)	—	No Degradation in Poutput Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 1 — 30 MHz TEST CIRCUIT



RFC: 20 Turns #18 AWG Enameled Wire Close Wound in 2 Layers, 1/4" I.D.
T1: 20 Turns #24 AWG Wire Wound on Micro Metals T37-7 Toroid Core Center Tapped.
T2: 1:9 XFMR; 6 Turns of 2 Twisted Pairs of #28 AWG Enameled Wire (8 Crests per Inch) Bifilar Wound on each of 2 Separate Balun Cores. (Stackpole #57-1503 No. 14 Material) Interconnected as shown.
RF BEADS: Ferroxcube #56-590-65/3B

V_{BB} adjusted for I_{CQ}: 20 mAdc (I_{CQ} = Quiescent Collector Current)
C1 — 80–480 pF, ARCO 466 or Equiv
C2 — 220 pF

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

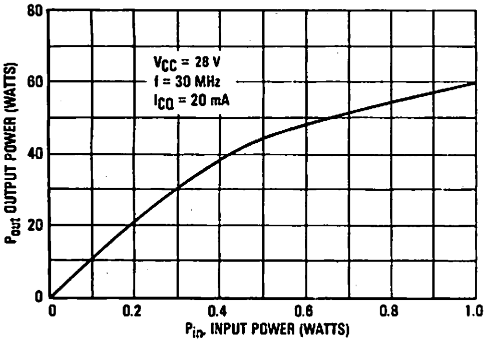


FIGURE 3 — POWER GAIN versus FREQUENCY

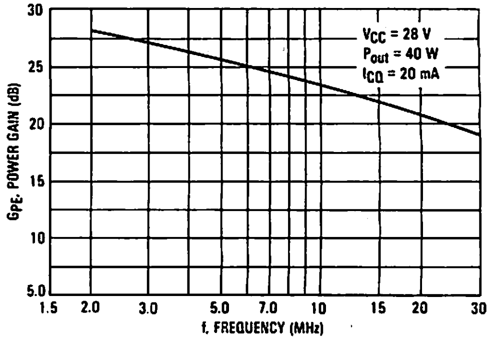


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

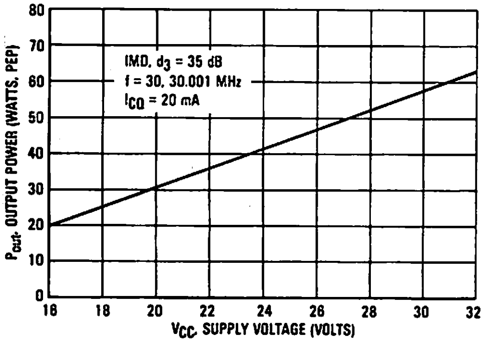


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

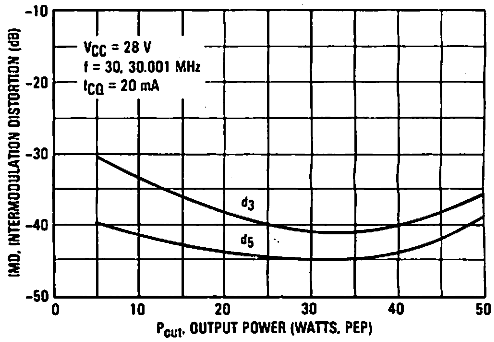


FIGURE 6 — OUTPUT CAPACITANCE versus FREQUENCY

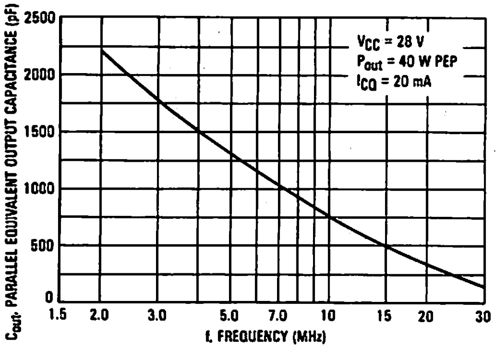


FIGURE 7 — OUTPUT RESISTANCE versus FREQUENCY

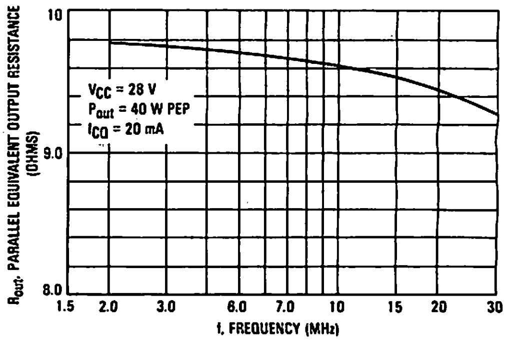


FIGURE 8 — SAFE OPERATING AREA

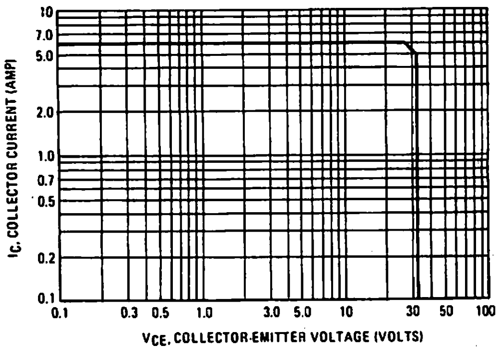
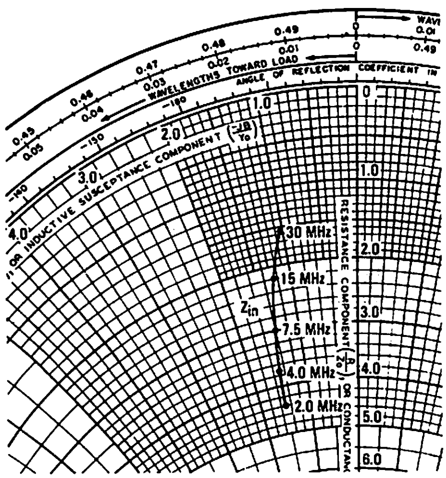


FIGURE 9 — SERIES INPUT IMPEDANCE



V_{CC} = 28 V
I_{CQ} = 20 mA
P_{out} = 40 W (PEP)

f MHz	Z_{in} Ohms
30	1.58 – j1.04
15	2.20 – j1.24
7.5	3.00 – j1.38
4.0	3.70 – j1.45
2.0	4.40 – j1.51

2

MRF475

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

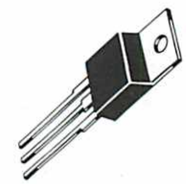
. . . designed primarily for use in single sideband linear amplifier output applications in citizens band and other communications equipment operating to 30 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 13.6 V, 30 MHz Characteristics —
  Output Power = 12 W (PEP)
  Minimum Efficiency = 40% (SSB)
  Output Power = 12 W (CW)
  Minimum Efficiency = 50% (CW)
  Minimum Power Gain = 10 dB (PEP & CW)
- Common Collector Configuration

12 W (PEP) — 12 W (CW) — 30 MHz

RF POWER TRANSISTOR

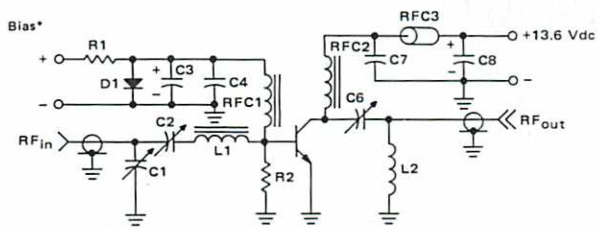
NPN SILICON



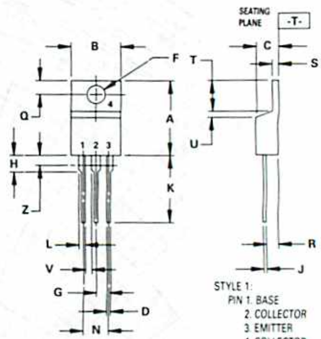
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ $T_C = 50^oC$ Derate above 50^oC	P_D	10 0.1	Watts $W/^oC$
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-65 to +150	^oC

FIGURE 1 — COMMON-EMITTER TEST CIRCUIT



C1, 2, 6	— ARCO 466 Trimmer Capacitors	RFC1	— 10 μH Molded Choke
C3	— 1000 μF, 3.0 Vdc Electrolytic	RFC2	— 15 Turns #20 AWG Wire on 5.6 kΩ, 1.0 Watt Carbon Resistor
C4, 7	— 0.1 μF Disc Ceramics		
C8	— 100 μF, 15 Vdc Electrolytic		
R1	— 10 Ω, 5.0 Watt Resistor	RFC3	— 5 Ferroxcube, #56-590-65/3B, Beads on #18 AWG Wire
R2	— 10 Ω, 1.0 Watt Resistor		
L1	— 2.2 μH Molded Choke	D1	— 1N4997
L2	— 4 Turns #18 AWG Wire, 1/2" I.D., 5/16" Long		



STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	48	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	60	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 13.6 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	125	145	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 12 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	G_{PE}	10	12	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 12 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	η	40	–	–	%
Intermodulation Distortion (1) (V_{CC} = 13.6 Vdc, P_{out} = 12 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	IMD	—	—	−30	dB
FUNCTIONAL TESTS (CW)					
Common-Emitter Amplifier Power Gain (V_{CC} = 13.6 Vdc, P_{out} = 4.0 W, f = 30 MHz)	G_{PE}	10	12	–	dB
Collector Efficiency (V_{CC} = 13.6 Vdc, P_{out} = 4.0 W, f = 30 MHz)	η	50	–	–	%
Percentage Up-Modulation (1) (4.0 W Carrier)	–	–	100	–	%
IMPEDANCE CHARACTERISTICS					
Series Equivalent Input — V_{CC} = 13.6 Vdc, P_o = 12 W (PEP), f = 30 MHz, I_{CQ} = 20 mA	Z_{in}	–	4.5–j2.4	–	Ohms
Series Equivalent Output	Z_{out}	–	5.1–j3.2	–	Ohms
Parallel Equivalent Input	Z_{in}	–	5.8/10.9	–	Ω/pF
Parallel Equivalent Output	Z_{out}	–	7.1/11.3	–	Ω/pF

(1) To proposed EIA method of measurement. Reference peak envelope power.

(2) Percentage Up-Modulation is measured in the test circuit (Figure 1) by setting the Carrier Power (P_c) to 4.0 Watts with V_{CC} = 13.6 Vdc and noting the power input. Then the Peak Envelope Power (PEP) is noted after doubling the original power input to simulate driver modulation.

$$\text{Percentage Up-Modulation} = \left[\left(\frac{PEP}{P_c}\right) - 1\right] \bullet 100$$

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

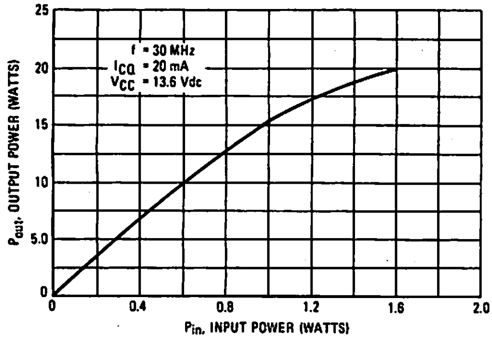


FIGURE 3 — INTERMODULATION DISTORTION versus OUTPUT POWER

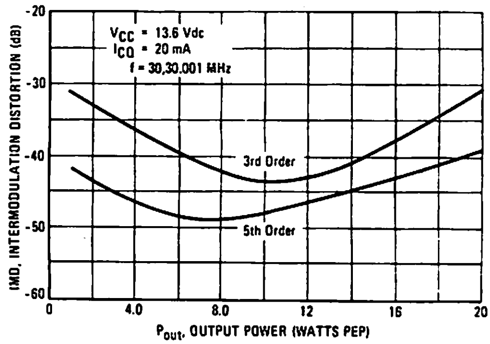


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

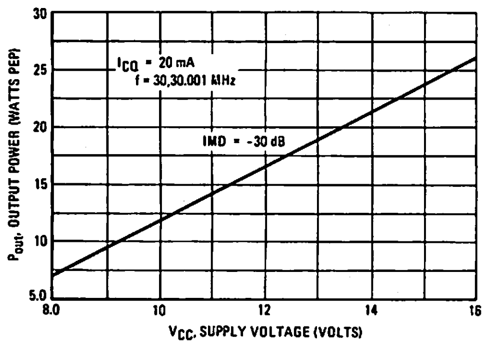


FIGURE 5 — OUTPUT CAPACITANCE versus FREQUENCY

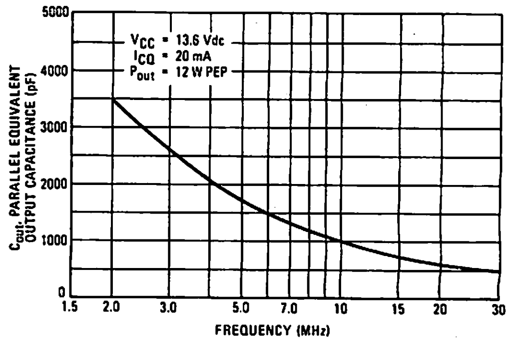


FIGURE 6 — OUTPUT RESISTANCE versus FREQUENCY

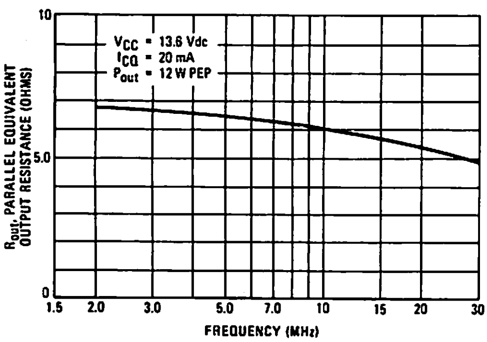


FIGURE 7 — POWER GAIN versus FREQUENCY

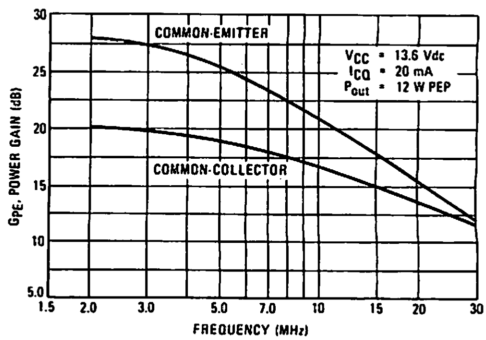
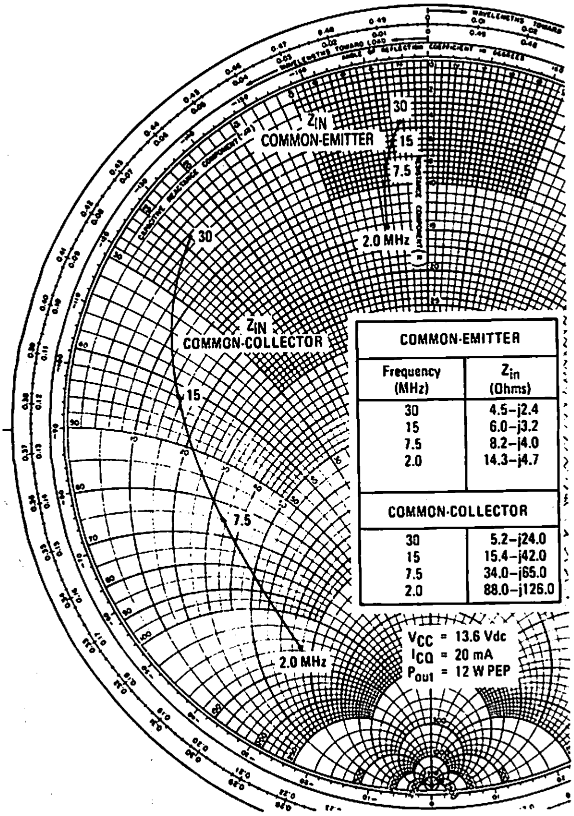
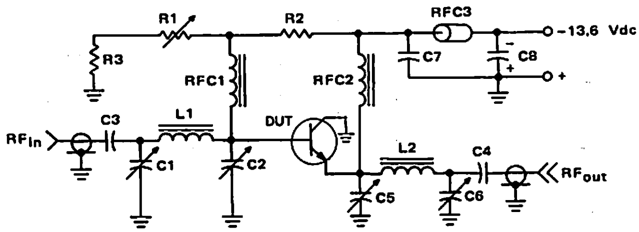


FIGURE 8 - SERIES EQUIVALENT INPUT IMPEDANCE



COMMON-EMITTER	
Frequency (MHz)	Z_{in} (Ohms)
30	4.5–j2.4
15	6.0–j3.2
7.5	8.2–j4.0
2.0	14.3–j4.7
COMMON-COLLECTOR	
30	5.2–j24.0
15	15.4–j42.0
7.5	34.0–j65.0
2.0	88.0–j126.0

FIGURE 9 — COMMON-COLLECTOR TEST CIRCUIT



C1, 5	–	ARCO 466 Trimmer Capacitors
C2	–	ARCO 463 Trimmer Capacitor
C3, 4, 7	–	0.1 µF Ceramic Disc
C6	–	ARCO 469 Trimmer Capacitor
C8	–	100 µF 15 Vdc Electrolytic
R1	–	250 Ω, 2.0 W Potentiometer
R2	–	5.1 Ω, 1/2 W Resistor
R3	–	51 Ω, 2.0 W Resistor
L1	–	0.33 µH Molded Choke
L2	–	4 Turns #18 AWG Wire, 1/8" I.D., 5/16" Long
RFC1	–	18 µH Molded Choke
RFC2	–	15 Turns #20 AWG Wire on 100 Ω, 1.0 W Carbon Resistor
RFC3	–	Ferroxcube, #56-590-65/3B, Beads on #18 AWG Wire

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

MRF476

The RF Line

NPN SILICON RF POWER TRANSISTOR

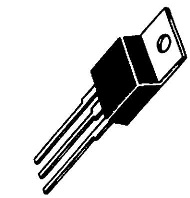
. . . designed primarily for use in single sideband linear amplifier output applications in citizens band and other communications equipment operating to 50 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 12.5 V, 30 MHz Characteristics —
  Output Power = 3.0 W (PEP)
  Minimum Efficiency = 40% (SSB)
  Output Power = 3.0 W (CW)
  Minimum Power Gain = 15 dB (PEP)
- Common-Collector Configuration

3.0 W (PEP)–3.0 W (CW) – 30 MHz

RF POWER TRANSISTOR

NPN SILICON



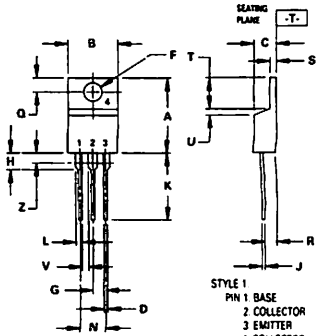
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ (1) Derate above 25°C	P_D	10 57.2	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to + 150	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	°C/W



STYLE 1
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

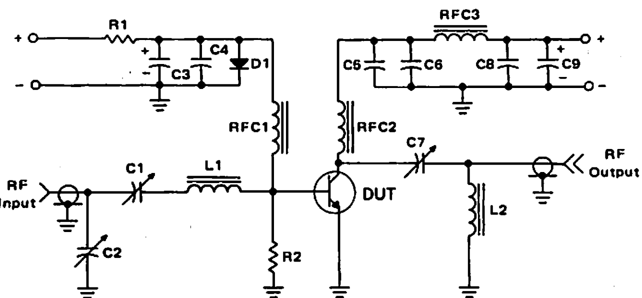
CASE 221A-04
TO-220AB

ELECTRICAL CHARACTERISTICS ($T_C = 25^\circ C$ unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 10$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 25$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 1.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISITCS					
DC Current Gain ($I_C = 250$ mAdc, $V_{CE} = 5.0$ Vdc)	h_{FE}	10	50	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	25	35	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 3.0$ W (PEP) f1 = 30 MHz, f2 = 30.001 MHz, ICQ = 20 mA)	G_{PE}	15	18	–	dB
Collector Efficiency ($V_{CC} = 12.5$ Vdc, $P_{out} = 3.0$ W (PEP) f1 = 30 MHz, f2 = 30.001 MHz, ICQ = 20 mA)	η	40	–	–	%
Intermodulation Distortion (1) ($V_{CC} = 12.5$ Vdc, $P_{out} = 3.0$ W (PEP) f1 = 30 MHz, f2 = 30.001 MHz, ICQ = 20 mA)	IMD	–	-35	-30	dB
50 MHz PERFORMANCE					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 3.0$ W, f = 50 MHz)	G_{PE}	–	15	–	dB

(1) To proposed EIA method of measurement. Reference peak envelope power.

FIGURE 1 – 30 MHz TEST CIRCUIT SCHEMATIC



C2 – Arco 466 Trimmer
C1, C7 – Arco 469 Trimmer
C3 – 500 μF, 3.0 V Electrolytic
C4, C5, C8 – 0.1 μF Erie Redcap
C6 – 1000 pF UNELCO
C9 – 100 μF, 15 V Electrolytic
R1 – 33 Ω 5 W Wire Wound
R2 – 50 Ω 1/2 W Carbon
L1 – 0.22 μH Molded Choke
L2 – 5 Turns #18 Enameled Wire, 1/4" ID

RFC1 – 10 μH Molded Choke
RFC2 – 1.9 μH Molded Choke (Ohmite Z-144)
RFC3 – 6 Ferroxcube Beads on #18 AWG Wire
D1 – MR751
Board – G10, 2-sided 2 oz. Copper Clad
Connectors – Type N

FIGURE 2 — POWER GAIN versus FREQUENCY

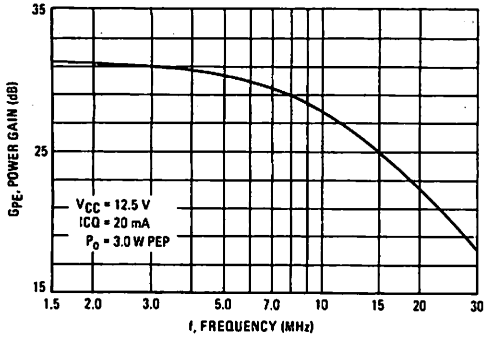


FIGURE 3 — OUTPUT POWER versus INPUT POWER

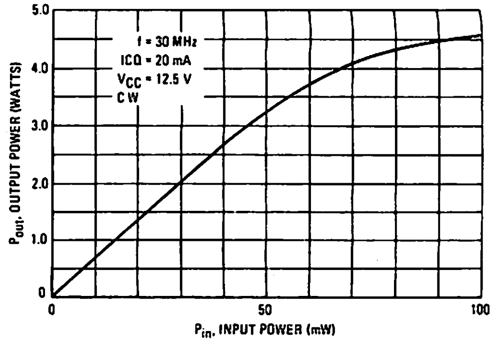


FIGURE 4 — OUTPUT POWER versus INPUT POWER

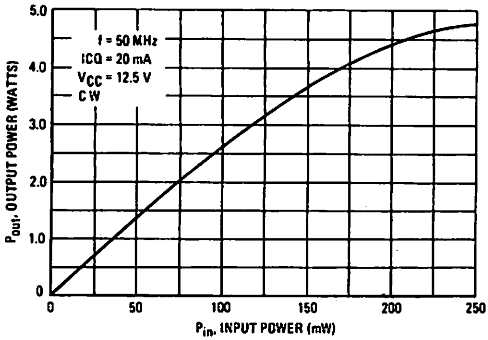


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE

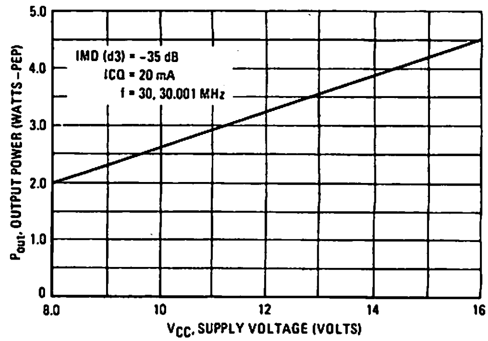


FIGURE 6 — INTERMODULATION DISTORTION versus OUTPUT POWER

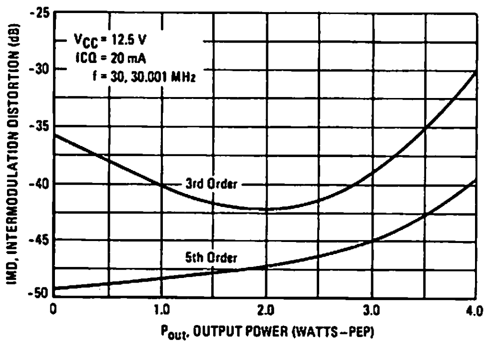


FIGURE 7 — OUTPUT CAPACITANCE versus FREQUENCY

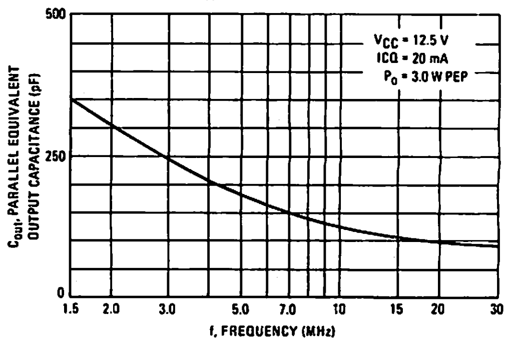


FIGURE 8 — OUTPUT RESISTANCE versus FREQUENCY

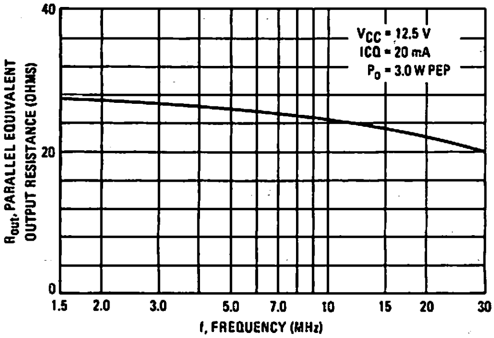
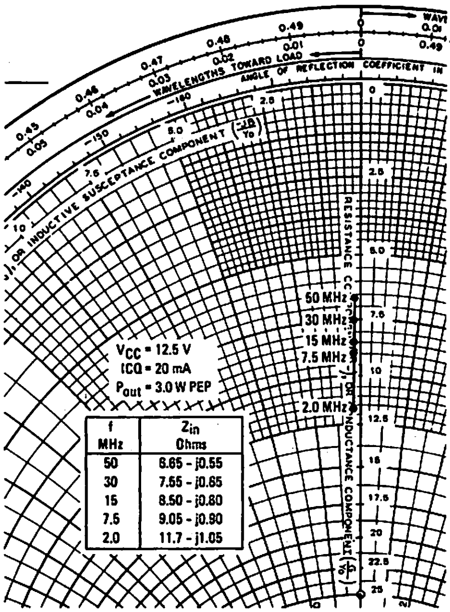


FIGURE 9 — SERIES EQUIVALENT INPUT IMPEDANCE



f MHz	Z_{in} Ohms
50	6.65 - j0.55
30	7.55 - j0.65
15	8.50 - j0.80
7.5	9.05 - j0.90
2.0	11.7 - j1.05

MRF477

The RF Line

40 W (PEP) — 30 MHz

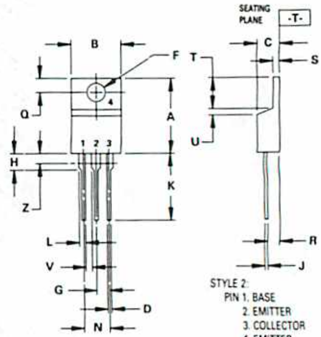
RF POWER
TRANSISTOR

NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed primarily for application as a high-power linear amplifier from 1.5 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 Volt, 30 MHz Performance —
  Output Power = 40 W CW or PEP
  Power Gain = 15 dB Min
  Efficiency = 40% Min (PEP)
- Intermodulation Distortion @ 40 W (PEP) —
  IMD = −30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage



STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	5.0	Adc
Withstand Current (t = 5.0 s)	—	8.0	Adc
Total Device Dissipation @ $T_C = 25^{\circ}C$ (1) Derate above $25^{\circ}C$	P_D	87.5 0.5	Watts $W/^{\circ}C$
Storage Temperature Range	T_{stg}	−65 to +150	$^{\circ}C$

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	$^{\circ}C/W$

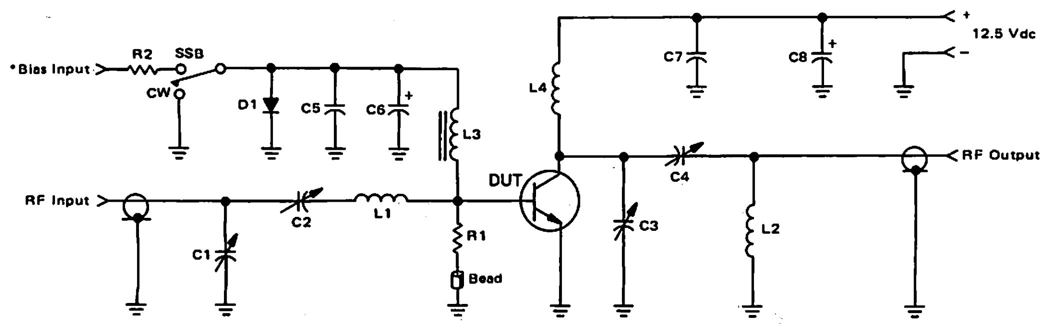
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 12.5 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	70	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	175	250	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	G_{PE}	15	17	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	η	40	45	–	%
Intermodulation Distortion (1) (V_{CC} = 12.5 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	IMD (d_3)	–	–35	–30	dB

(1) To Proposed EIA Method of Measurement. Reference Peak Envelope Power.

FIGURE 1 — 30 MHz TEST CIRCUIT



C1, C2, C4 — Arco 469, 190-780 pF
C3 — Arco 429, 90-400 pF
C5, C7 — 0.001 μF Disk Ceramics
C6 — 500 μF 3.0 Vdc Electrolytic
C8 — 100 μF 16 Vdc Electrolytic
R1 — 10 Ω 1.0 Watt Resistor
R2 — 5 Ω 5.0 Watt Resistor

L1 — 4 Turns #16 AWG 1/3″ ID, 1/3″ Long
L2 — 3 Turns #16 AWG 1/3″ ID, 1/2″ Long
L3 — 10 μH Molded Choke
L4 — 12 Turns #18 AWG 1/4″ ID
Bead — Ferroxcube #56-590-65/3B
D1 — 1N4719

*Adjust Bias (Base) Voltage for I_{CQ} = 40 mA with no RF applied.

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

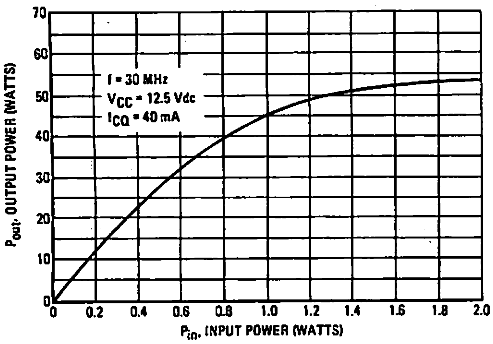


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

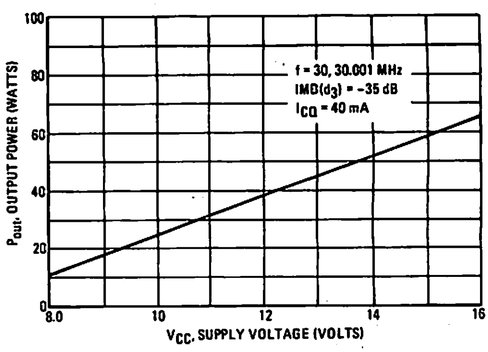


FIGURE 4 — POWER GAIN versus FREQUENCY

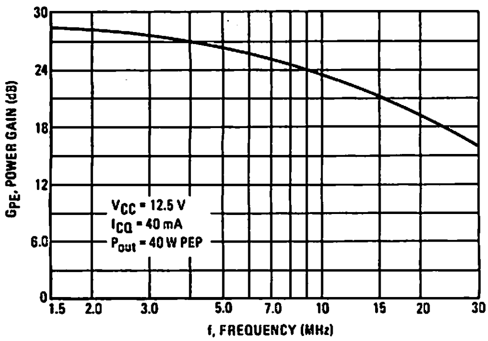


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

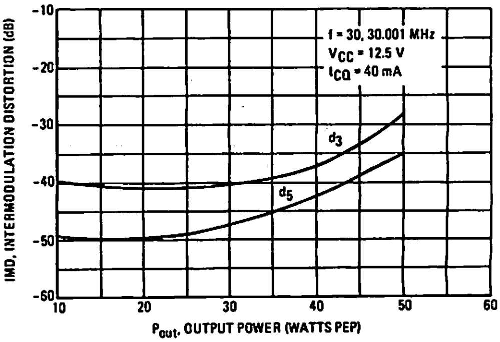


FIGURE 6 — SAFE OPERATING AREA

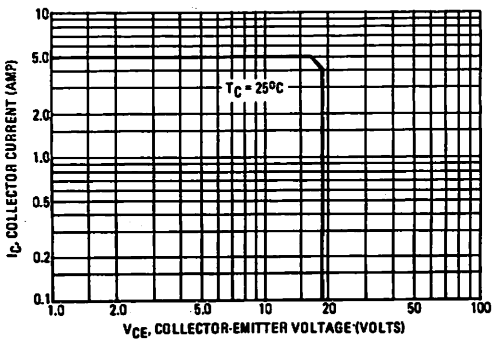
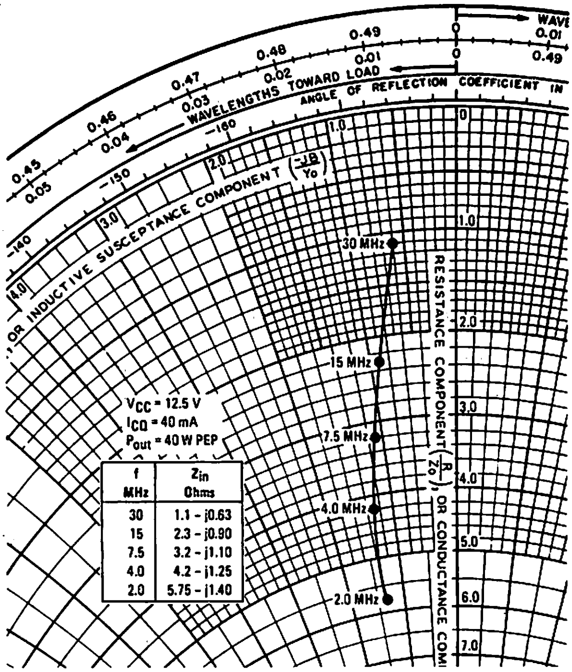


FIGURE 7 – SERIES EQUIVALENT INPUT IMPEDANCE



f MHz	Z_{in} Ohms
30	1.1 - j0.63
15	2.3 - j0.90
7.5	3.2 - j1.10
4.0	4.2 - j1.25
2.0	5.75 - j1.40

FIGURE 8 – OUTPUT CAPACITANCE versus FREQUENCY

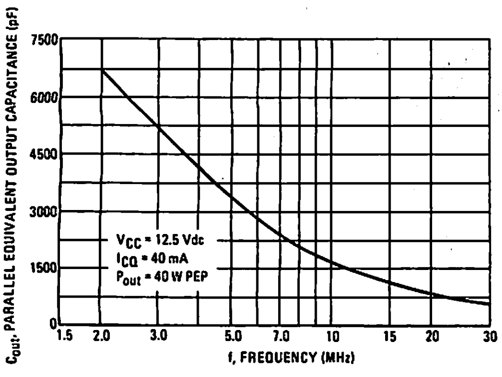
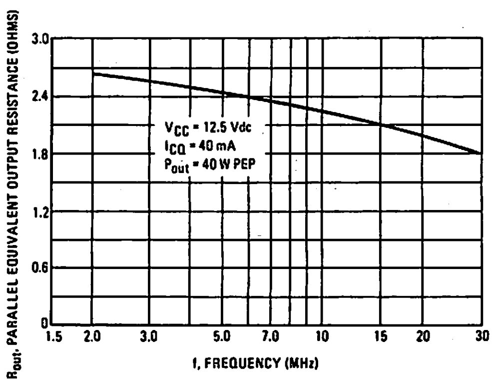


FIGURE 9 – OUTPUT RESISTANCE versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF479

The RF Line

NPN SILICON RF POWER TRANSISTOR

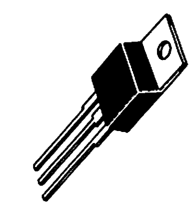
. . . designed primarily for use in single sideband linear amplifier output applications and other communications equipment operating to 50 MHz.

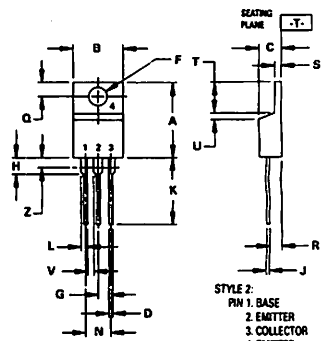
- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 30 MHz Performance —
  Output Power = 15 W (PEP) or (CW)
  Power Gain = 12 dB Min
  Efficiency = 40% Min
- Intermodulation Distortion @ 15 W (PEP) —
  IMD = −30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage
- Characterized from 2.0 to 50 MHz

15 W (PEP), 15 W (CW)—30 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	30 0.17	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.85	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

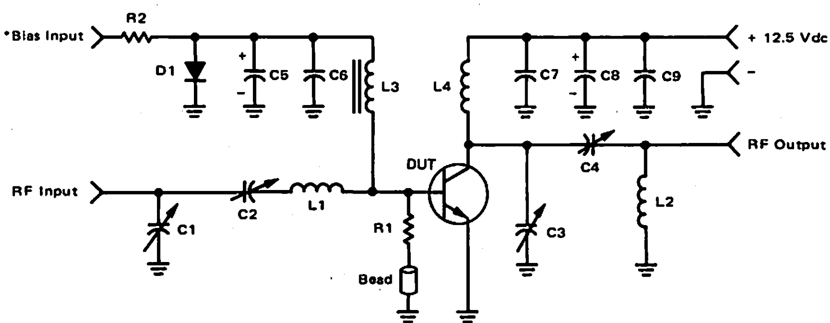
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	60	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	125	155	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W (PEP), f_1 = 30 MHz, f_2 = 30.001 MHz, I_{CQ} = 20 mA)	G_{PE}	12	14	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W (PEP), f_1 = 30 MHz, f_2 = 30.001 MHz, I_{CQ} = 20 mA)	η	40	—	—	%
Intermodulation Distortion (1) (PEP) (V_{CC} = 12.5 Vdc, P_{out} = 15 W (PEP), f_1 = 30 MHz, f_2 = 30.001 MHz, I_{CQ} = 20 mA)	d_3	—	—	-30	dB

(1) To proposed EIA method of measurement. Reference peak envelope power.

FIGURE 1 — 30-MHz COMMON EMITTER TEST CIRCUIT



C1, C2, C4 — 469 Arco 170–780 pF
C3 — 426 Arco 37–250 pF
C5 — 500 µF, 3.0 V
C6, C7 — 0.1 µF Erie Redcap
C8 — 0.01 µF Erie Redcap
C9 — 100 µF, 16 V
L1 — 4 Turns #18 AWG 0.3″ ID X 0.25″
L2 — 5 Turns #16 AWG 0.35″ ID X 0.9″
L3 — 10 µH Molded Choke
L4 — 12 Turns #18 AWG 0.25″ ID X 0.75″
R1 — 10 Ω, 1.0 W
R2 — 5.0 Ω, 5.0 W
Bead — Ferroxcube Bead #56-590-65/3B
D1 — 1N4997

*Adjust Bias (Base) Voltage for I_{CQ} = 20 mA with no RF applied.

FIGURE 2 — OUTPUT POWER versus INPUT POWER

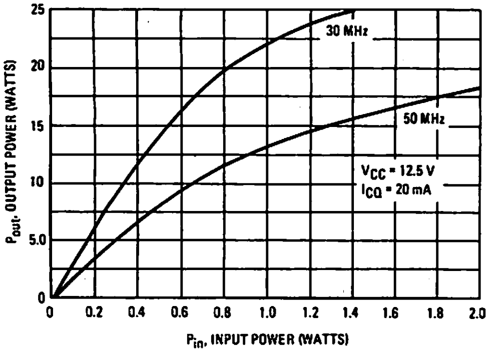


FIGURE 3 — POWER GAIN versus FREQUENCY

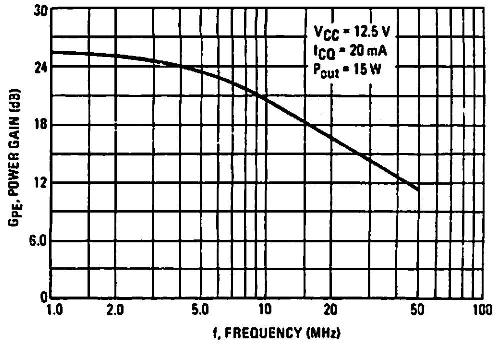


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

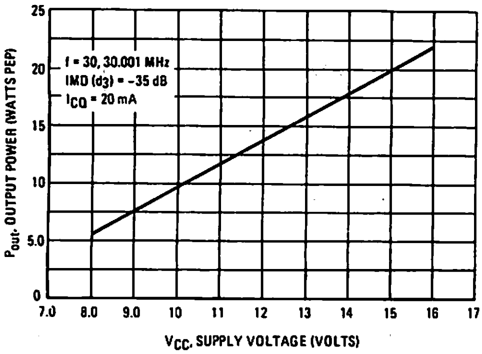


FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

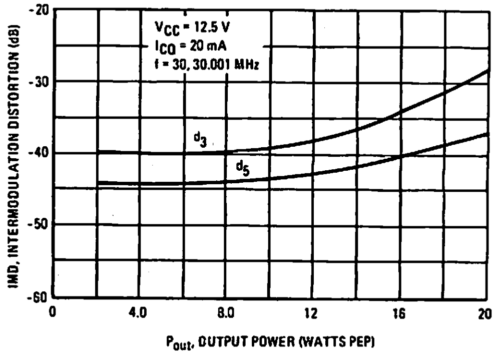


FIGURE 6 — OUTPUT CAPACITANCE versus FREQUENCY

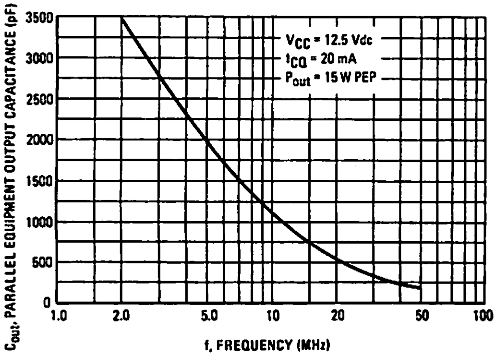


FIGURE 7 — OUTPUT RESISTANCE versus FREQUENCY

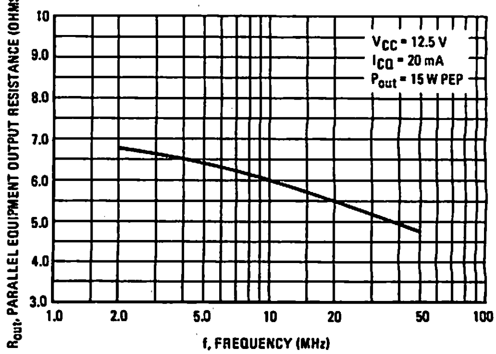
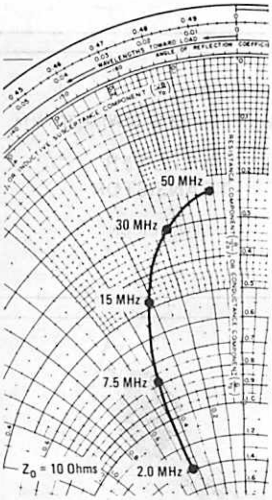


FIGURE 8 – SERIES EQUIVALENT INPUT IMPEDANCE



V_{CC} = 12.5 Vdc
I_{CQ} = 20 mA
P_{out} = 15 W PEP

f MHz	Z_{in} Ohms
50	2.35 - j0.7
30	3.0 - j1.9
15	4.8 - j3.1
7.5	7.9 - j4.1
2.0	14 - j4.7

FIGURE 9 – 30 MHz TEST AMPLIFIER

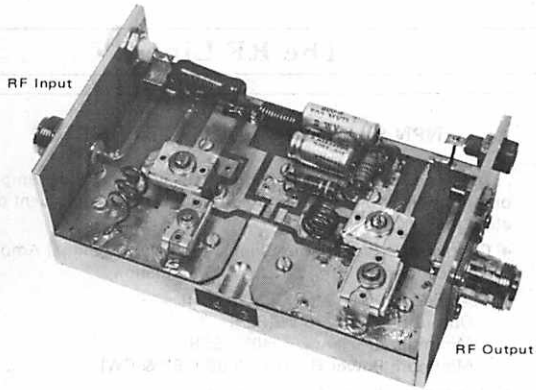
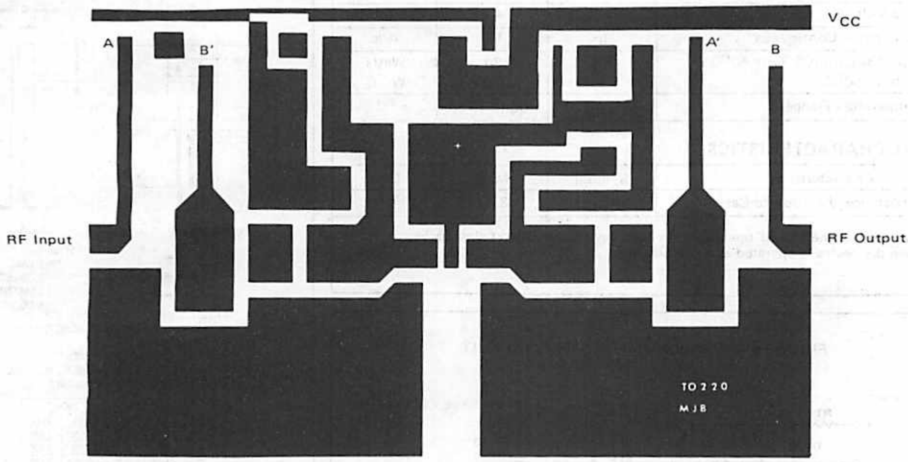


FIGURE 10 – TEST AMPLIFIER PCB PHOTOMASTER



NOTE: Points A, A' and B, B' are connected via 50 Ω coaxial cable under the PCB.
The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF485

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

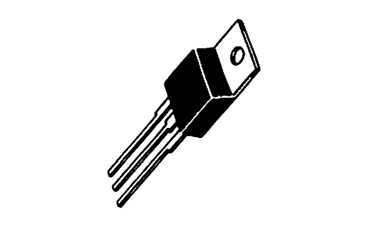
. . . designed primarily for use in single sideband linear amplifier output applications and other communications equipment operating to 30 MHz.

- Characterized for Single Sideband and Large-Signal Amplifier Applications Utilizing Low-Level Modulation
- Specified 28 V, 30 MHz Characteristics —
  Output Power = 15 W (PEP)
  Minimum Efficiency = 40% (SSB)
  Minimum Power Gain = 10 dB (PEP & CW)
- Common-Collector Configuration

15 W (PEP) — 15 W (CW) — 30 MHz

RF POWER TRANSISTOR

NPN SILICON



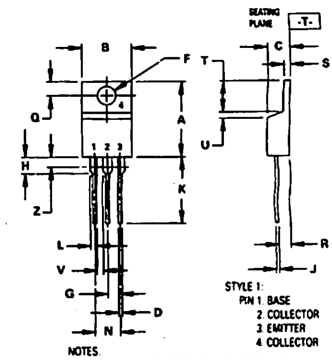
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 50°C$ (1) Derate above 50°C	P_D	30 0.3	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	3.33	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

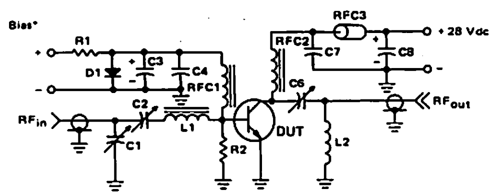


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

FIGURE 1 — COMMON-EMITTER TEST CIRCUIT



*Adjust for I_{CQ} = 20 mA

C1, 2, 6 — ARCO 466 Trimmer Capacitors
C3 — 1000 µF, 3.0 Vdc Electrolytic
C4, 7 — 0.1 µF, Disc Ceramics
C8 — 100 µF, 15 Vdc Electrolytic
R1 — 10 Ω, 5.0 Watt Resistor
R2 — 10 Ω, 1.0 Watt Resistor

L1 — 2.2 µH Molded Choke
L2 — 7 Turns #18 AWG Wire, 3/8" I.D.
RFC1 — 10 µH Molded Choke
RFC2 — 0.84 µH Molded Choke
RFC3 — 2 Ferroxcube, #56-590-65/3B, Beads on #18 AWG Wire
D1 — 1N4997

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 25 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
Collector-Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	85	100	pF
FUNCTIONAL TESTS (SSB)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 15 W (PEP, f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	G_{PE}	10	13	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 15 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	η	40	–	–	%
Intermodulation Distortion (1) (V_{CC} = 28 Vdc, P_{out} = 15 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 20 mA)	$IMD_{(d3)}$	–	−35	−30	dB
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 15 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, VSWR = 30:1 All Angles)	ψ	No Degradation in Output Power			

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 2 — OUTPUT POWER versus INPUT POWER

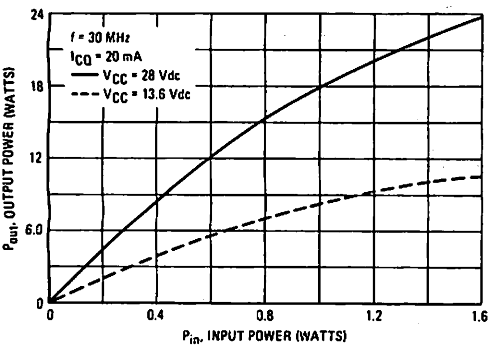
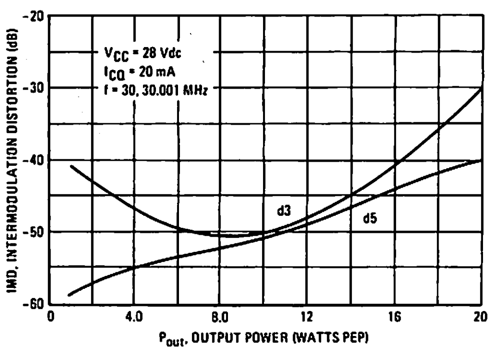


FIGURE 3 — INTERMODULATION DISTORTION versus OUTPUT POWER



2

FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

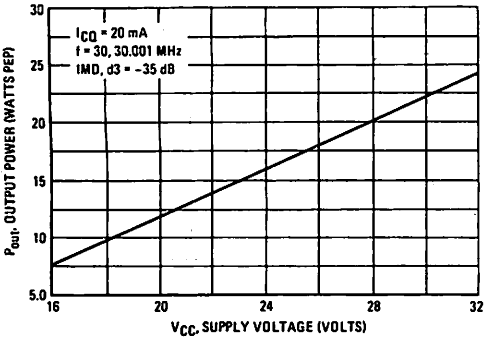


FIGURE 5 — OUTPUT CAPACITANCE versus FREQUENCY

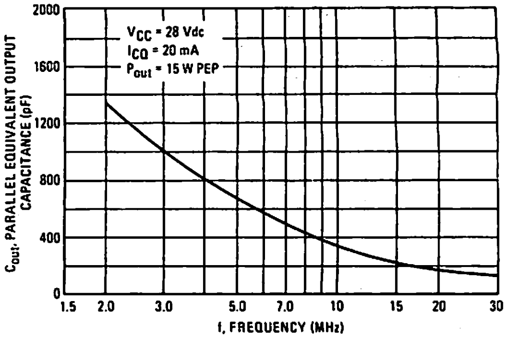


FIGURE 6 — OUTPUT RESISTANCE versus FREQUENCY

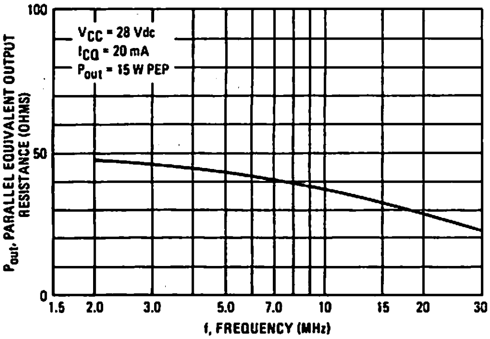


FIGURE 7 — POWER GAIN versus FREQUENCY

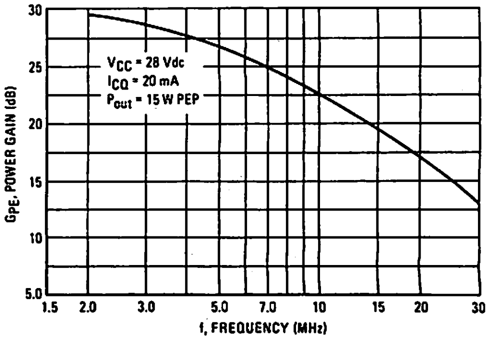
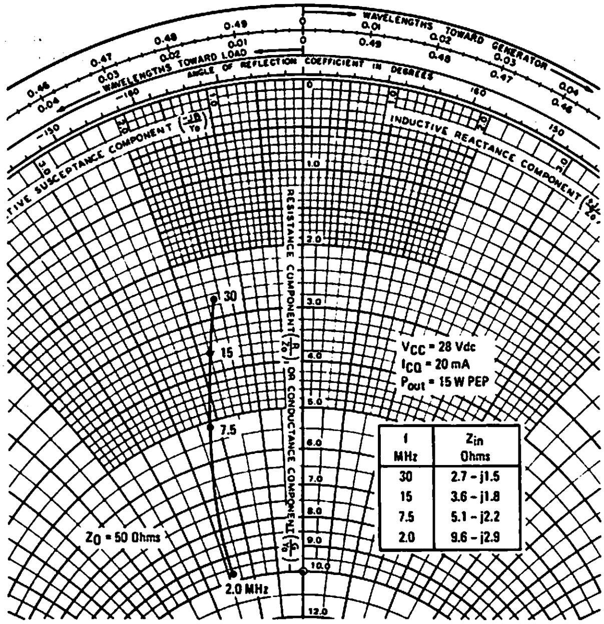


FIGURE 8 — SERIES EQUIVALENT INPUT IMPEDANCE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF486

The RF Line

NPN SILICON RF POWER TRANSISTOR

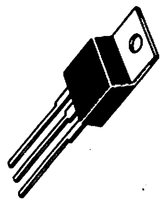
. . . designed primarily for application as a high-power linear amplifier from 1.5 to 30 MHz, in single sideband mobile, marine and base station equipment.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 28 Volt, 30 MHz Performance —
  Output Power = 40 W (PEP)
  Power Gain = 15 dB Min
  Efficiency = 40% Min
- Intermodulation Distortion @ 40 W (PEP) —
  IMD = −30 dB (Max)
- 30:1 VSWR Load Mismatch Capability at Rated Output Power and Supply Voltage

40 W (PEP) — 30 MHz

RF POWER TRANSISTOR

NPN SILICON



2

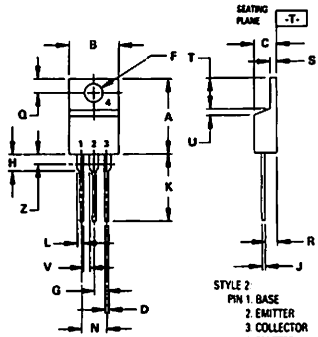
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Withstand Current (t = 5.0 s)	—	6.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	87.5 0.5	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristics	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.0	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.



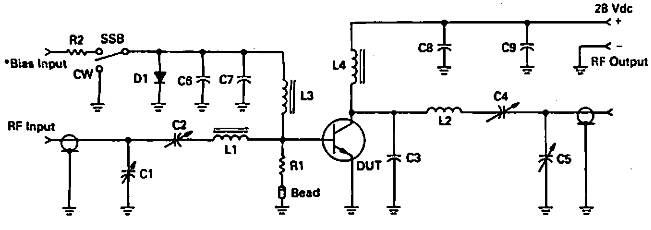
STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.89	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

FIGURE 1 — 30 MHz TEST CIRCUIT



C1, C2 — Arco 469, 190–780 pF
C3 — 150 pF ELMENCO**
C4, C5 — Arco 429, 90–400 pF
C6, C9 — 0.001 μF Disc Ceramics
C7 — 500 μF, 3.0 Vdc Electrolytic
C8 — 50 μF, 50 Vdc, Electrolytic

R1 — 10 Ω, 1.0 Watt Resistor
R2 — 5.0 Ω, 5.0 Watt Resistor
L1 — 0.15 μH Molded Choke
L2 — 7 Turns, #16 AWG Enameled Close-Wound, 1/2" ID
L3 — 10 μH Molded Choke
L4 — 1.9 μH Molded Choke
One Bead — #56-590-65/3B (Ferroxcube or equiv.)
D1 — 1N4997

*Adjust Bias (Base) Voltage for I_{CQ} = 40 mA with no RF applied.
**Type MCM01/010 or UNELCO 3 HS 0006.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	35	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	65	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	65	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 28 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 27 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	130	200	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	G_{PE}	15	17.5	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	η	40	45	–	%
Intermodulation Distortion (1) (V_{CC} = 28 Vdc, P_{out} = 40 W (PEP), f1 = 30 MHz, f2 = 30.001 MHz, I_{CQ} = 40 mAdc)	$IMD(d_3)$	–	–35	–30	dB

(1) To MIL-STD-1311 Version A, Test Method 2204B, Two Tone, Reference Each Tone.

FIGURE 2 — OUTPUT POWER versus INPUT POWER

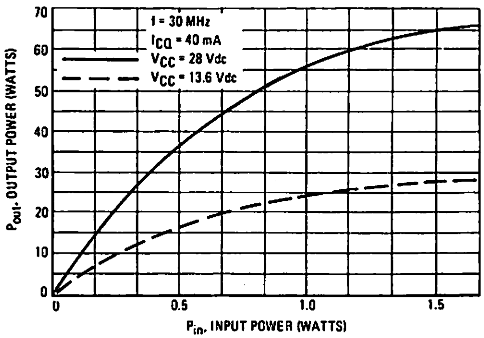


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

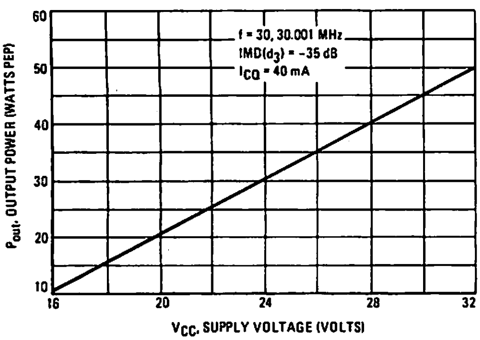
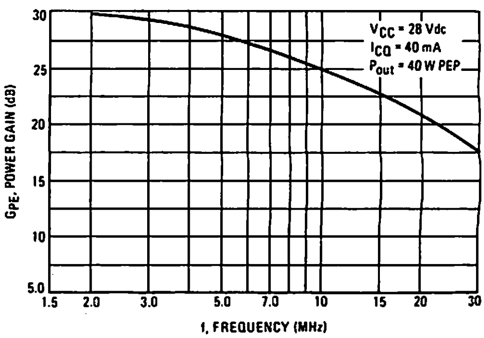


FIGURE 4 — POWER GAIN versus FREQUENCY



2

FIGURE 5 — INTERMODULATION DISTORTION versus OUTPUT POWER

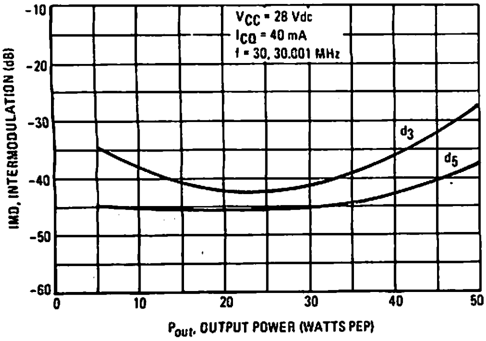


FIGURE 6 — SAFE OPERATING AREA

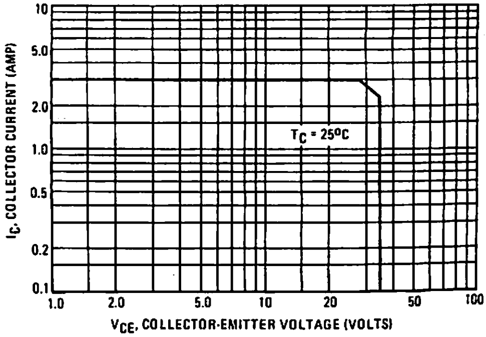


FIGURE 7 — SERIES EQUIVALENT INPUT IMPEDANCE

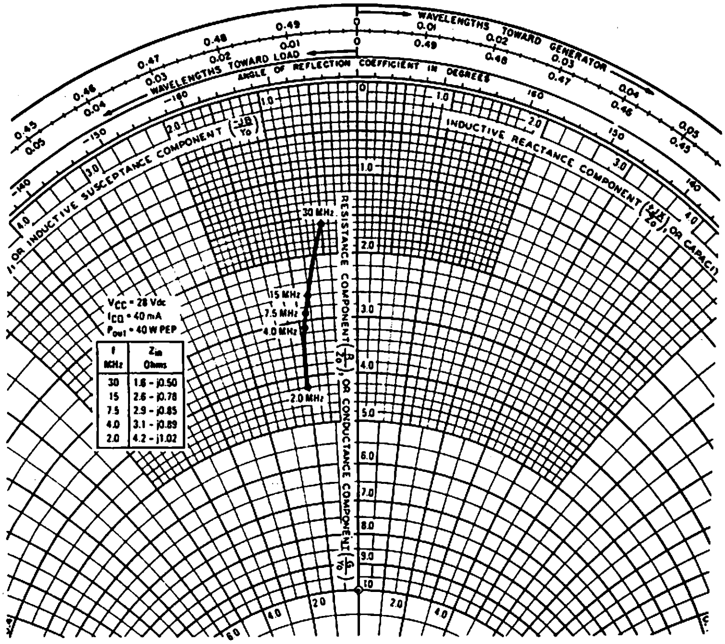


FIGURE 8 — OUTPUT CAPACITANCE versus FREQUENCY

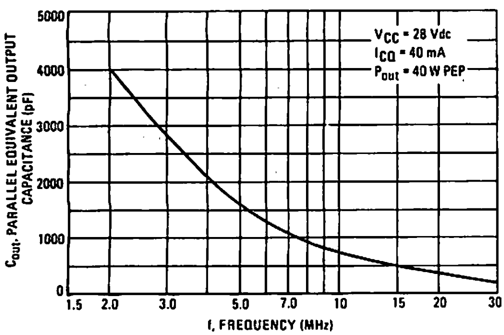
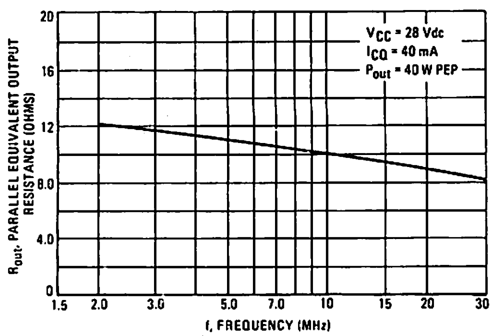


FIGURE 9 — OUTPUT RESISTANCE versus FREQUENCY



MRF492
MRF492A

The RF Line

2

70 W 50 MHz

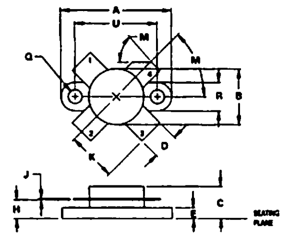
RF POWER TRANSISTOR

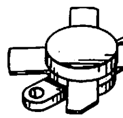
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 volt low band VHF large-signal power amplifier applications in commercial and industrial FM equipment.

- Specified 12.5 V, 50 MHz Characteristics —
  Output Power = 70 W
  Minimum Gain = 11 dB
  Efficiency = 50%
- Load Mismatch Capability at High Line and RF Overdrive



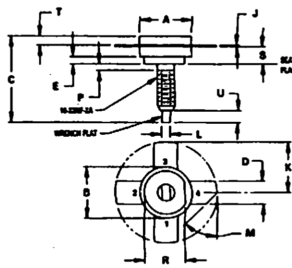


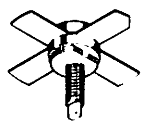
NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2 CONTROLLING DIMENSION INCH

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.465	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.92	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

STYLE 1
PIN 1 EMITTER
2 BASE
3 EMITTER
4 COLLECTOR

CASE 211-11
MRF492





NOTES:
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.90	0.065	0.075
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	9.73	10.06	0.383	0.396
S	3.84	4.50	0.151	0.177
T	2.11	2.54	0.083	0.100
U	2.43	3.35	0.096	0.132

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 145A-10
MRF492A

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	20	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

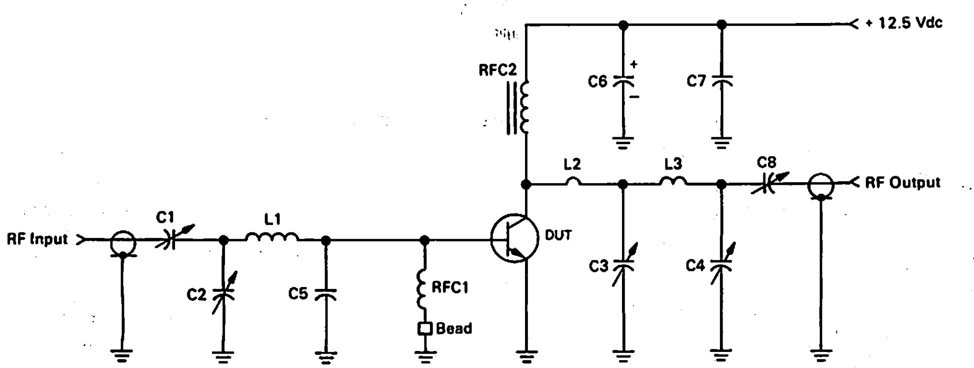
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	0.7	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 13.6 Vdc, V_{BE} = 0)	I_{CES}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	275	450	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 70 W, f = 50 MHz)	G_{PE}	11	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 70 W, f = 50 MHz)	η	50	—	—	%

FIGURE 1 — 50 MHz TEST CIRCUIT



C1, C8 — 9.0–180 pF, Arco 463
C2, C3, C4 — 80–480 pF, Arco 466
C5 — 1000 pF, 350 V, Unelco
C6 — 10 μF, 25 Vdc
C7 — 0.01 μF, Ceramic
RFC1 — 10 μH Molded Choke

RFC2 — 12 Turns, #16 AWG, Enameled Wire Closewound on a 2 W Carbon Resistor
L1 — 2 Turns, #18 AWG Enameled Wire, 0.4″ ID, 0.15″ Long
L2 — Loop, #12 AWG Wire, 0.6″ High, 0.4″ Wide
L3 — 2 Turns, #12 AWG Wire, ID 0.4″, 0.25″ Long
Bead — Ferrite Bead Ferroxcube #56-590-65/3B

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

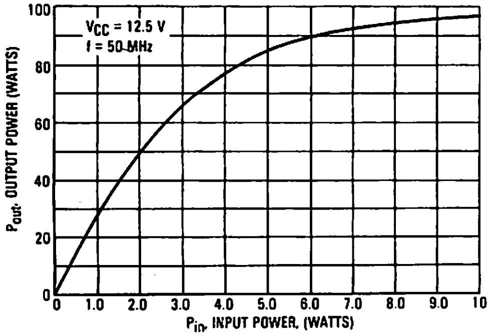


FIGURE 3 — POWER GAIN versus FREQUENCY

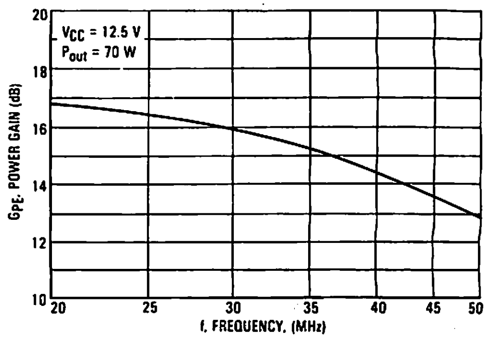


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

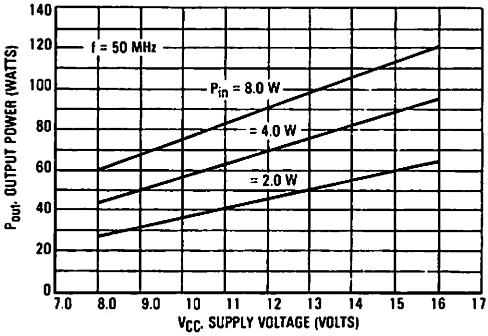
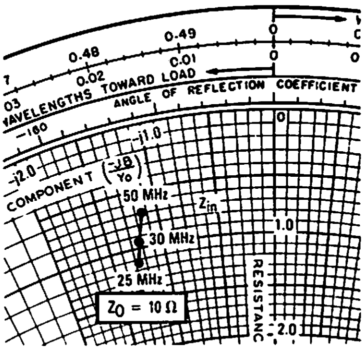


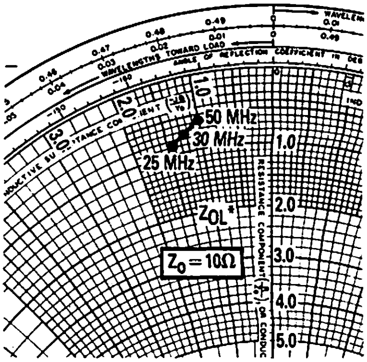
FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



V_{CC} = 12.5 V, P_{out} = 70 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
50	0.7 – j1.17	0.58 – j1.0
30	0.93 – j1.24	0.76 – j1.3
25	1.12 – j1.28	0.85 – j1.46

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF497

The RF Line

NPN SILICON RF POWER TRANSISTOR

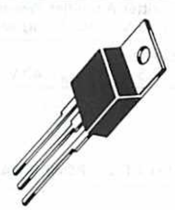
. . . designed for 12.5 volt VHF large-signal power amplifier applications in commercial and industrial equipment, operating in the 25 to 50 MHz frequency range.

- Low-Cost, Common-Emitter TO-220AB Package
- Specified 12.5 V, 50 MHz Performance —
  Output Power = 40 Watts
  Power Gain = 10 dB Min
  Efficiency = 60% Min
- Load Mismatch Capability at Rated Voltage and RF Drive

40 W 50 MHz

RF POWER TRANSISTOR

NPN SILICON



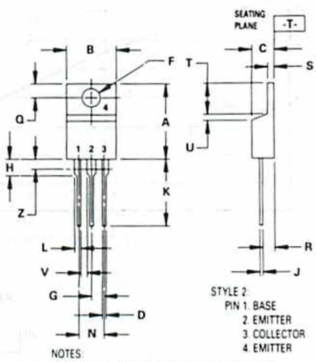
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) *Derate above 25°C*	P_D	87.5 0.5	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	2.0	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) *Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.*

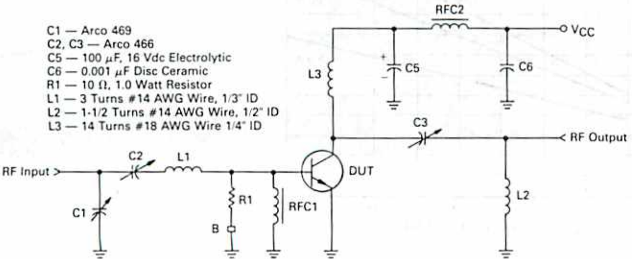


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

FIGURE 1 — 50 MHz TEST CIRCUIT



C1 — Arco 469
C2, C3 — Arco 466
C5 — 100 μF, 16 Vdc Electrolytic
C6 — 0.001 μF Disc Ceramic
R1 — 10 Ω, 1.0 Watt Resistor
L1 — 3 Turns #14 AWG Wire, 1/3" ID
L2 — 1-1/2 Turns #14 AWG Wire, 1/2" ID
L3 — 14 Turns #18 AWG Wire 1/4" ID

RFC1 — RF Choke Ferroxcube VK200-20/4B
RFC2 — 3 Ferroxcube, #55-590-65/3B, Beads on #18 AWG Wire
B — Ferroxcube #56-490-65/3B
Board Material — Epoxy Fiberglass, 0.062" thick

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	250	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 40 W, f = 50 MHz)	G_{PE}	10	11.2	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 40 W, f = 50 MHz)	η	60	—	—	%

FIGURE 2 — POWER GAIN versus FREQUENCY

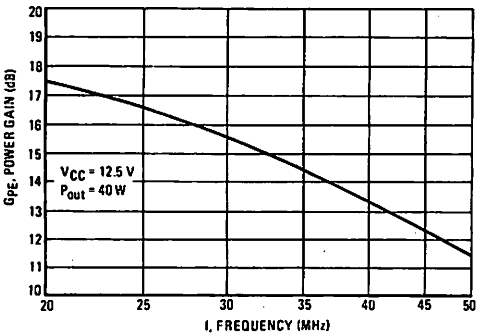


FIGURE 3 — OUTPUT POWER versus INPUT POWER

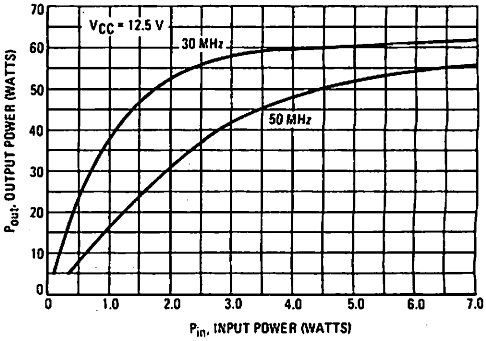


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
50 MHz

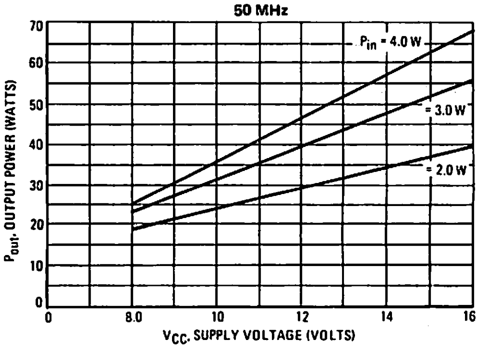
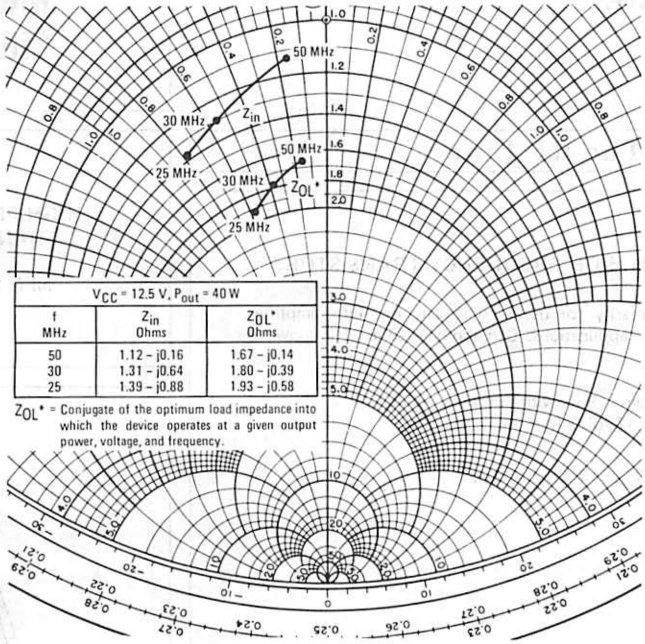


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

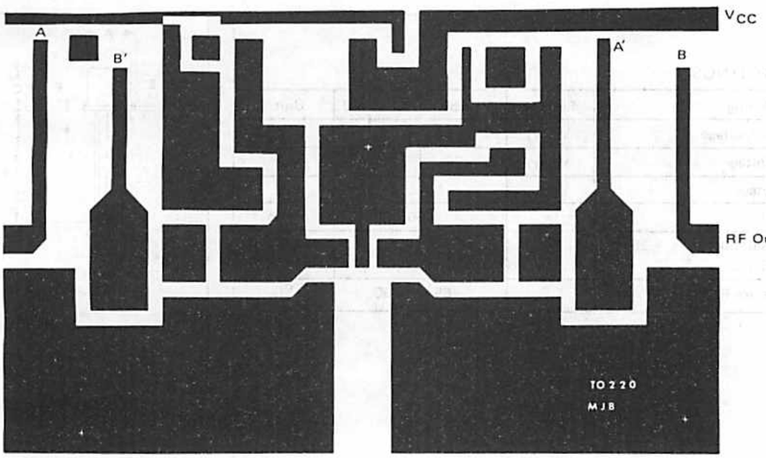


V_{CC} = 12.5 V, P_{out} = 40 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
50	1.12 – j0.16	1.67 – j0.14
30	1.31 – j0.64	1.80 – j0.39
25	1.39 – j0.88	1.93 – j0.58

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 6 — TEST AMPLIFIER PCB PHOTOMASTER



NOTE: Points A, A' and B, B' are connected via 50 Ω coaxial cable under the PCB.
The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF501
MRF502

The RF Line

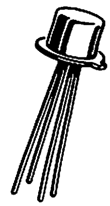
NPN SILICON HIGH-FREQUENCY TRANSISTORS

. . . designed primarily for use in high-gain, low-noise amplifier, oscillator, and mixer applications. Can also be used in UHF converter applications.

- High Current-Gain – Bandwidth Product –
  f_T = 1.2 GHz (Typ) @ I_C = 5.0 mAdc
- Low Noise Figure –
  NF = 4.0 dB (Typ) @ f = 200 MHz

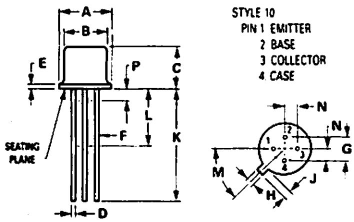
HIGH FREQUENCY TRANSISTORS

NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	MRF501	MRF502	Unit
Collector-Emitter Voltage	V_{CEO}	15		Vdc
Collector-Base Voltage	V_{CBO}	25	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5		Vdc
Collector Current	I_C	50		mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	200 1.14		mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200		°C



STYLE 10
PIN 1 EMITTER
2 BASE
3 COLLECTOR
4 CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

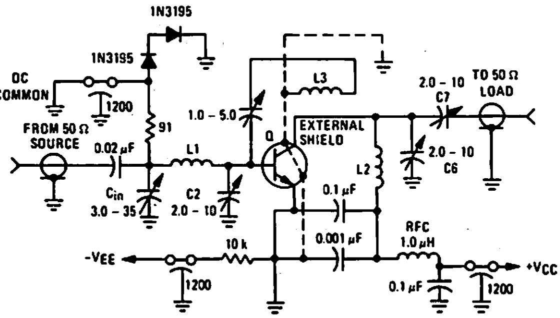
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	–	0.76	–	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	–	0.500	–
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	–	1.27	–	0.050

CASE 20-03
TO-206AF
(TO-72)

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 3.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 μAdc, I_E = 0)	MRF501	$V_{(BR)CBO}$	25	–	–	Vdc
	MRF502		35	–	–	
Emitter-Base Breakdown Voltage (I_E = 1.0 μAdc, I_C = 0)		$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CB} = 1.0 Vdc, I_E = 0)	MRF501	I_{CBO}	–	–	50	nAdc
	MRF502		–	–	20	
ON CHARACTERISTICS						
DC Current Gain (I_C = 1.0 mAdc, V_{CE} = 6.0 Vdc)	MRF501	h_{FE}	30	–	250	–
	MRF502		40	–	170	
DYNAMIC CHARACTERISTICS						
Current Gain — Bandwdith Product (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 100 MHz)	MRF501	f_T	600	1000	–	MHz
	MRF502		800	1200	–	
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 0.1 to 1.0 MHz)		C_{cb}	–	0.6	–	pF
Collector-Base Time Constant (I_E = 2.0 mAdc, V_{CB} = 6.0 Vdc, f = 31.8 MHz)		$r_b'C_c$	–	8.0	–	ps
Noise Figure (Figure 1) (I_C = 1.5 mAdc, V_{CE} = 6.0 Vdc, R_S = 50 ohms, f = 200 MHz)	MRF501	NF	–	4.5	–	dB
	MRF502		–	4.0	–	
FUNCTIONAL TEST						
Common-Emitter Amplifier Power Gain (Figure 1) (V_{CC} = 6.0 Vdc, I_C = 5.0 mAdc, f = 200 MHz)	MRF501	G_{pe}	–	15	–	dB
	MRF502		–	17	–	

FIGURE 1 — 200 MHz AMPLIFIER POWER GAIN AND NOISE FIGURE CIRCUIT



L1 13/4 Turns, #18 AWG, 0.5" Long, 0.5" Diameter
L2 2 Turns, #16 AWG, 0.5" Long, 0.5" Diameter
L3 2 Turns, #18 AWG, 0.25" Long, 0.5" Diameter, Position Approximately 0.25" from L2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF511

The RF Line

2

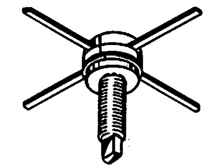
NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed specifically for broadband applications requiring low distortion characteristics and noise figure. Specified for use in CATV applications.

- Specified +50 dBmV Output, 80 mAdc Distortion Characteristics –
  Triple Beat = -65 dB (Max)
  Cross Modulation = -57 dB (Max)
  Second Order = -50 dB (Max)
- High Broadband Power Gain –
  G_{pe} = 10 dB (Min) @ f = 250 MHz
- Low Broadband Noise Figure –
  NF = 10 dB (Max) @ f = 200 MHz

HIGH FREQUENCY TRANSISTOR

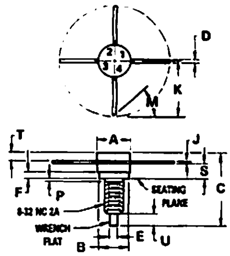
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current – Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5.0 28.6	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C
Stud Torque(1)	–	6.5	In. Lb.

(1) For Repeated Assembly use 5 In. Lb.

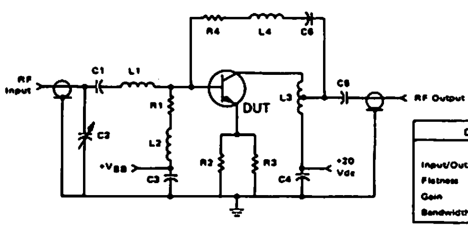


STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	15.24	16.51	0.600	0.650
D	0.66	0.86	0.026	0.034
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.10	0.15	0.004	0.006
K	11.17	—	0.440	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	2.74	3.35	0.108	0.132
T	1.40	1.78	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244A-01

FIGURE 1 — 40 to 330 MHz BROADBAND TEST CIRCUIT SCHEMATIC



CIRCUIT PERFORMANCE	Min	Typ
Input/Output Return Loss	–	18 dB
Flatness	–	+0.3 dB
Gain	10 dB	
Bandwidth	–	40-300 MHz

C1,C3,C4,C5,C6	0.002 µF Ceramic Disc
C2	0.35-3.5 pF JOHANSON 4702
L1	2 Turns, #20 AWG, 1/8" I.D., 0.2" Long
L2	5 µH, Ferrite Choke, MILLER
L3	18 Turns, #24 AWG Enamelled, on Ferrite Torrid Core FERROXCUBE 1041T060-4C7
L4	8 Turns, #20 AWG, 3/16" I.D., 0.38" Long
R1	4.7 kΩ, 1/4W, 10%
R2	27 Ω, 1W, 10%
R3	27 Ω, 1W, 10%
R4	300 Ω, 1/4W, 10%

Input/Output Connectors – Type F
Z_o – 75 Ohms

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 µAdc, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 µAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	100	µAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 80 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	50	200	–
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 10 mAdc)	$V_{CE(sat)}$	–	0.2	0.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain—Bandwidth Product (I_C = 80 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	1.5	2.1	–	GHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.2	4.5	pF
Noise Figure (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	NF	–	7.3	10	dB
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 Vdc, I_C = 80 mAdc, f = 250 MHz)	G_{pe}	10	11	–	dB
2nd Order Intermodulation Distortion (V_{CE} = 20 Vdc, I_C = 80 mAdc, V_{out} = +50 dBmV, Chn 2 + Chn 13 = 266.5 MHz)	IMD	–	-55	-50	dB
Cross-Modulation Distortion (V_{CE} = 20 Vdc, V_{out} = +50 dBmV, I_C = 80 mAdc) Chn 13	12 Chn XMD	–	-59	-57	dB
Chn R	30 Chn XMD	–	-46	–	
Triple Beat (V_{CE} = 20 Vdc, I_C = 80 mAdc, V_{out} = +50 dBmV, Chn 2 + Chn 3 + Chn E = 261.75 MHz)	TB	–	-68	-65	dB

FIGURE 2 — CURRENT-GAIN—BANDWIDTH PRODUCT

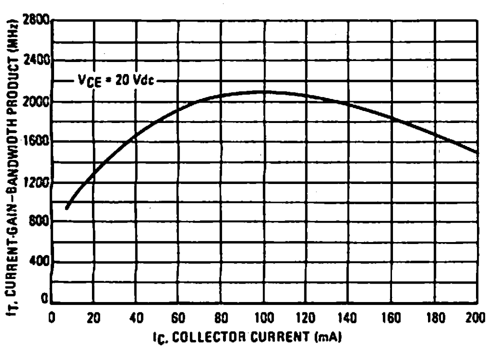
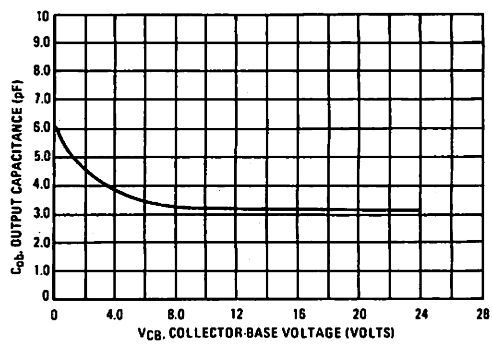


FIGURE 3 — OUTPUT CAPACITANCE



2

FIGURE 4 – INPUT CAPACITANCE

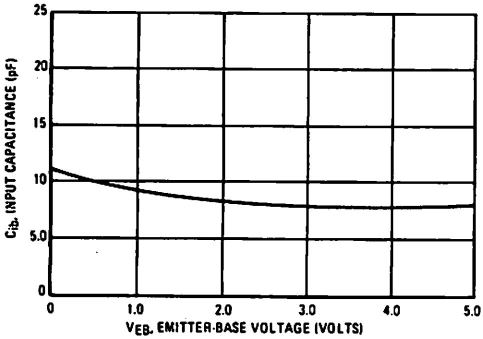


FIGURE 5 – BROADBAND NOISE FIGURE

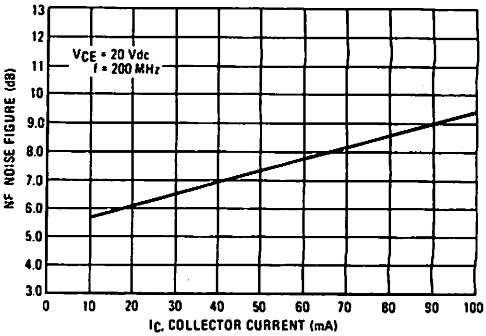


FIGURE 6 – 12 CHANNEL CROSS-MODULATION versus COLLECTOR-EMITTER VOLTAGE

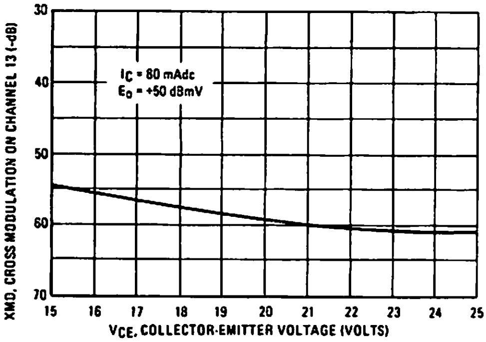


FIGURE 7 – 12 CHANNEL CROSS-MODULATION versus COLLECTOR CURRENT

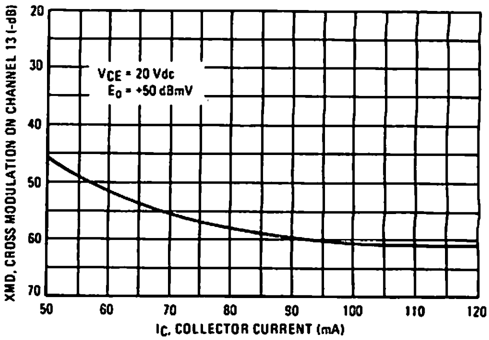


FIGURE 8 – 30 CHANNEL CROSS-MODULATION ON CHANNEL R

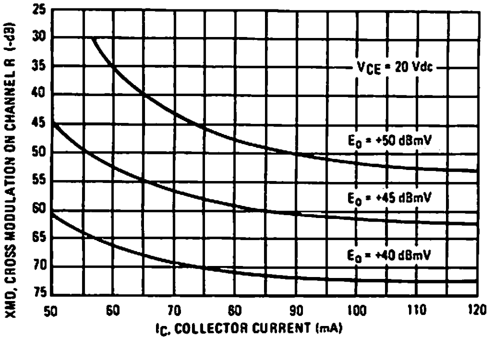


FIGURE 9 – 30 CHANNEL CROSS-MODULATION ON CHANNEL 2,13,R

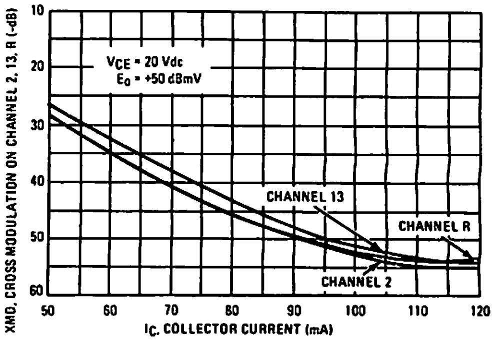


FIGURE 10 – 30-CHANNEL CROSS-MODULATION versus COLLECTOR-EMITTER VOLTAGE

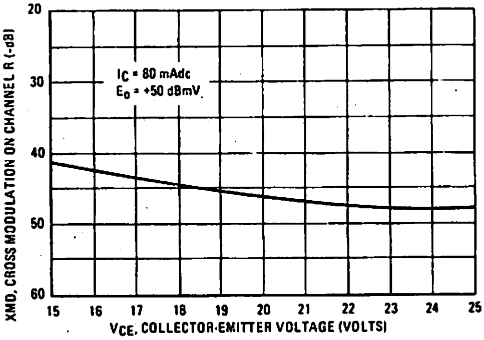


FIGURE 11 – TRIPLE BEAT versus COLLECTOR CURRENT

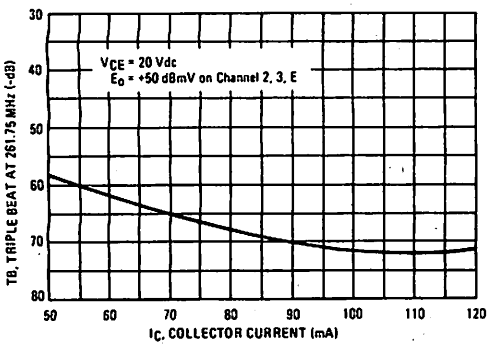


FIGURE 12 – TRIPLE BEAT versus COLLECTOR-EMITTER VOLTAGE

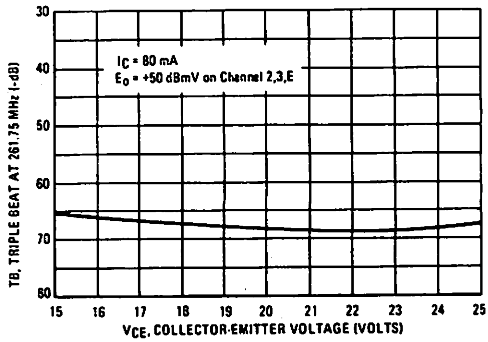


FIGURE 13 – SECOND ORDER IMD versus COLLECTOR CURRENT

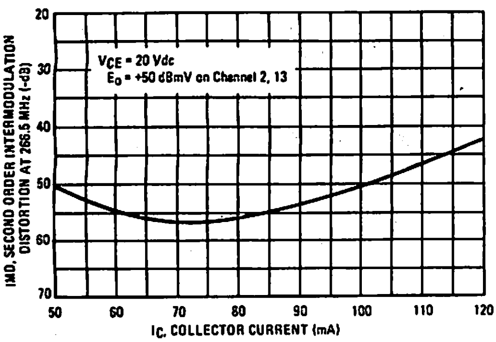
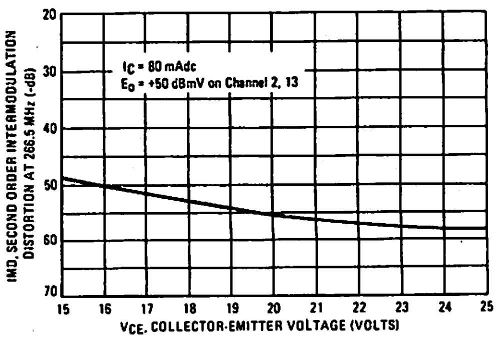


FIGURE 14 – SECOND ORDER IMD versus COLLECTOR-EMITTER VOLTAGE



2

FIGURE 15 – INPUT REFLECTION COEFFICIENT (S11) AND OUTPUT REFLECTION COEFFICIENT (S22) versus FREQUENCY

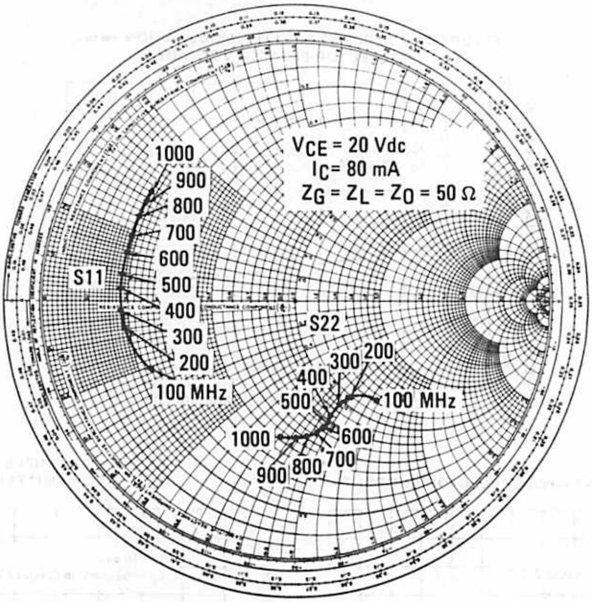


FIGURE 16 — FORWARD TRANSMISSION COEFFICIENT S_{21} versus FREQUENCY

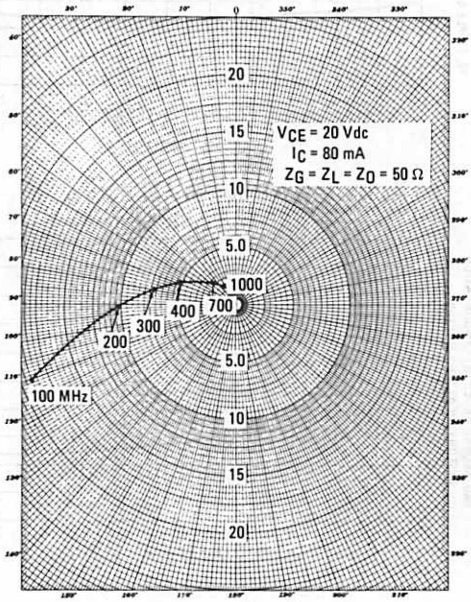
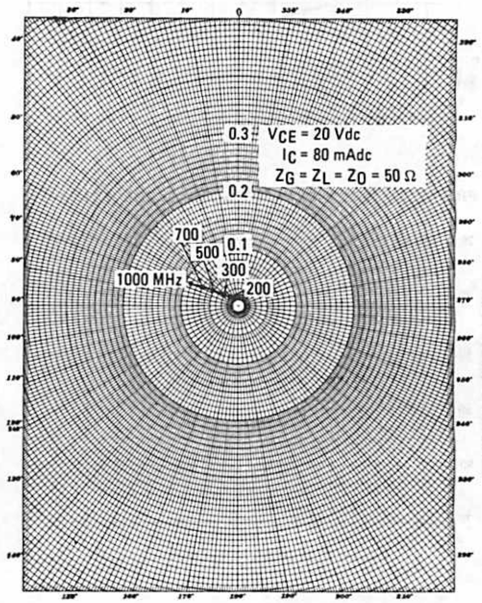


FIGURE 17 — REVERSE TRANSMISSION COEFFICIENT S_{12} versus FREQUENCY



MRF515

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications required in industrial equipment

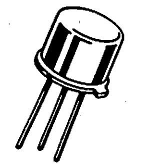
- Specified 12.5 Volt, 470 MHz Characteristics –
  Output Power = 0.75 Watts
  Minimum Gain = 8.0 dB
  Efficiency = 50%
- S Parameter Data From 100 MHz to 1.0 GHz

0.75 W – 470 MHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON

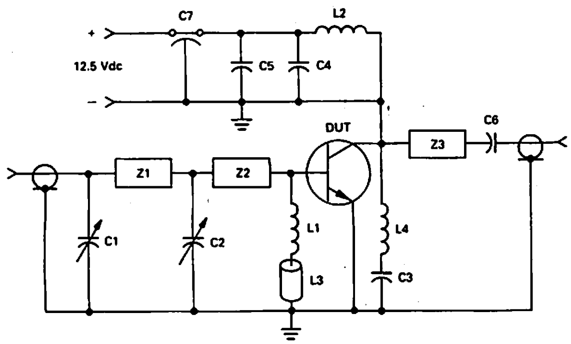
2

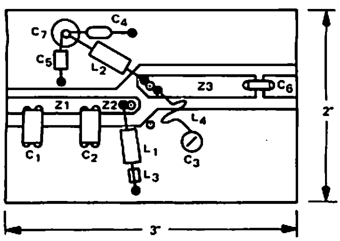


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	2.5 14.3	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

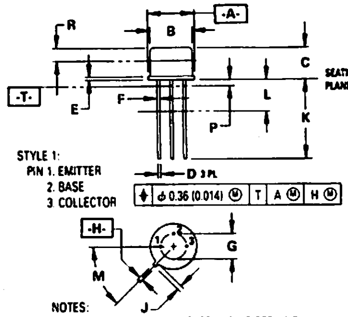
FIGURE 1 — 470 MHz TEST CIRCUIT





C1, C2, C3 — 1.0–10 pF JOHANSON
C4 — 0.1 μF disc
C5 — 1.0 μF TANTALUM
C6 — 0.018 μF chip
C7 — 1000 pF Feedthru
L1, L2 — 0.15 μF Choke
L3 — Bead Ferrite
Z1, Z2 — 0.09" x 0.5" LINE, Z_o = 100 Ω
Z3 — 0.18" x 1.0" LINE, Z_o = 50 Ω

BOARD = 0.032" TEFLONGLASS,
Σ_r = 2.5



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	60	150	–
Collector-Emitter Saturation Voltage (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{CE(sat)}$	–	–	0.5	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 200 MHz)	f_T	1800	2000	–	MHz
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.5	4.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 470 MHz)	G_{PE}	8.0	8.5	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 470 MHz)	η	50	70	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 470 MHz)	Z_{in}	–	14+j4.0	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 470 MHz)	Z_{out}	–	28-j38	–	Ohms

FIGURE 2 – OUTPUT POWER versus INPUT POWER

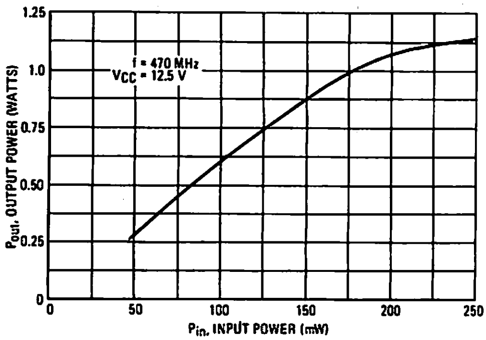


FIGURE 3 – CURRENT-GAIN – BANDWIDTH PRODUCT versus COLLECTOR CURRENT

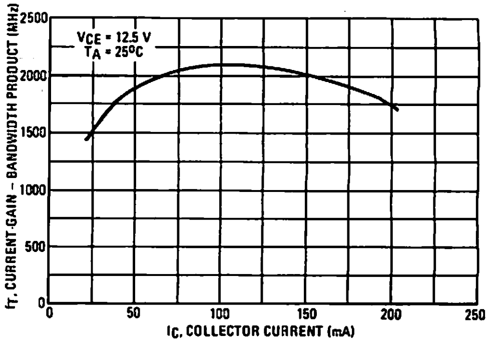


FIGURE 4 – OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE

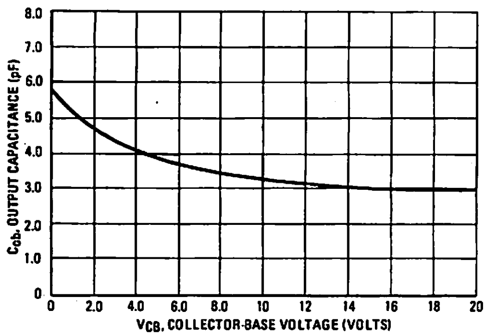


FIGURE 5 — S_{11} and S_{22} versus FREQUENCY

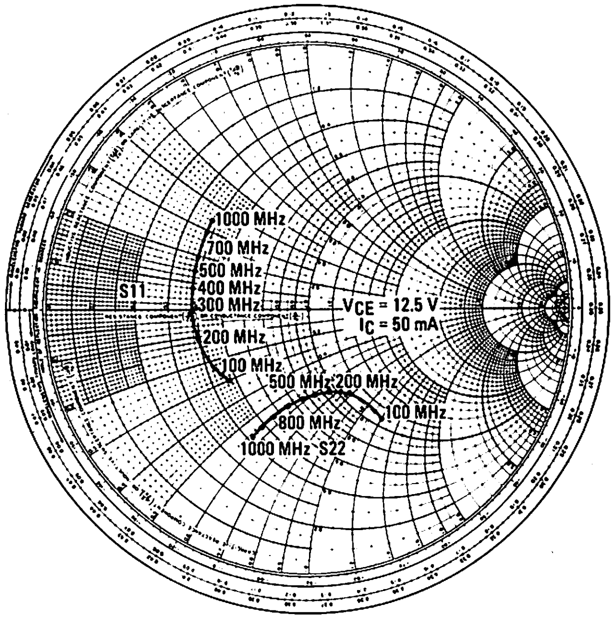


FIGURE 6 — S_{12} versus FREQUENCY

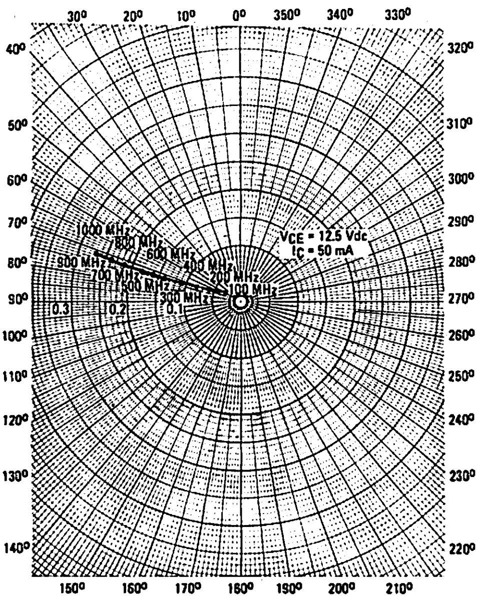
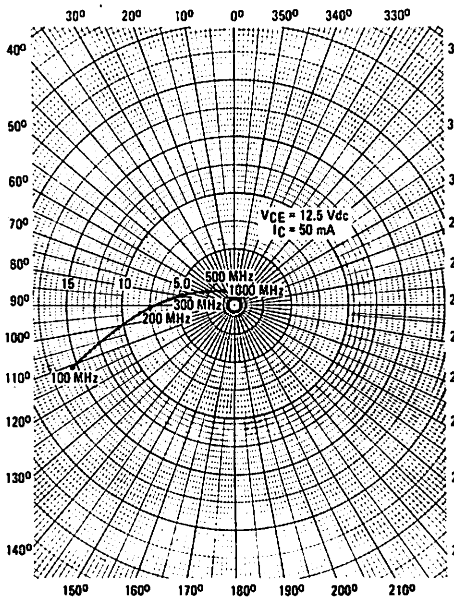


FIGURE 7 — S_{21} versus FREQUENCY



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF517

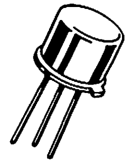
The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed specifically for broadband applications requiring low distortion characteristics. Specified for use in CATV distribution equipment.

- Specified +45 dBmV Output, 60 mA Distortion Characteristics –
  Triple Beat = -72 dB (Max)
  12 Channel Cross Modulation = -57 dB (Max)
  Second Order = -60 dB (Max)
- Broadband Power Gain –
  G_{PE} = 10 dB (Typ)
- Broadband Noise Figure –
  NF = 7.5 dB (Max) @ f = 300 MHz

HIGH FREQUENCY TRANSISTOR
NPN SILICON



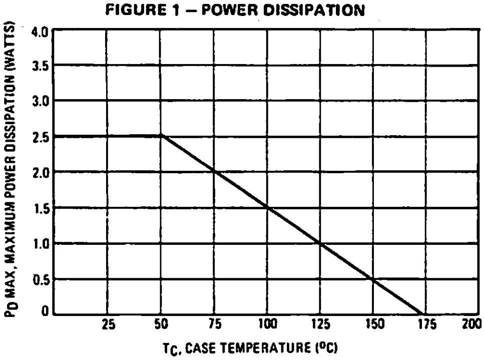
MAXIMUM RATINGS

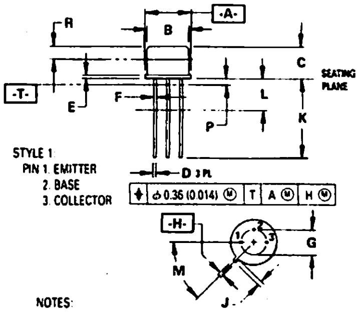
Rating	Symbol	Value	Unit
Collector-Emitter Voltage (R_{BE} = 330 Ω)	V_{CER}	25	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current – Continuous	I_C	150	mAdc
Total Power Dissipation @ T_C = 50°C Derate above 50°C	P_D	2.5 0.02	Watts W/°C
Operating Junction Temperature	T_J	+175	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	50	°C/W

FIGURE 1 – POWER DISSIPATION





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2. BASE
3. COLLECTOR

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5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

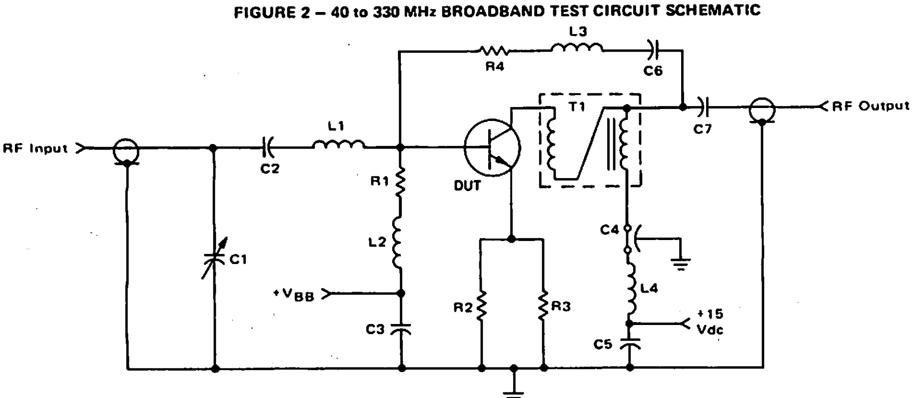
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	–	0.250	–
M	45° BSC		45° BSC	
P	–	1.27	–	0.050
R	2.54	–	0.100	–

CASE 79-04
TO-205AB
(TO-39)

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 330 Ohms)	$V_{(BR)CER}$	25	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	100	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 60 mAdc, V_{CE} = 10 Vdc)	h_{FE}	40	–	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 60 mAdc, V_{CE} = 15 Vdc, f = 200 MHz)	f_T	2200	2700	–	MHz
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	4.5	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (V_{CE} = 15 Vdc, I_C = 60 mAdc, f = 300 MHz)	G_{pe}	–	10	–	dB
Broadband Noise Figure (V_{CE} = 15 Vdc, I_C = 50 mAdc, f = 300 MHz)	NF	–	–	7.5	dB
2nd Order Distortion (V_{CE} = 15 Vdc, I_C = 60 mAdc, E_{out} = +45 dBmV, Ch 2 + Ch G = 212.5 MHz)	IMD_2	–	–	-57	dB
NCTA Cross Modulation Distortion, 12 Ch's (2-13) (V_{CE} = 15 Vdc, I_C = 60 mAdc, E_{out} = +45 dBmV, Measured at Ch's 2 and 13)	XMD_{12}	–	–	-57	dB
Triple Beat Distortion, 3 Ch's (V_{CE} = 15 Vdc, I_C = 60 mAdc, E_{out} = +45 dBmV, Ch's (4 + 5 + A) = 265 MHz)	TB_3	–	–	-72	dB

FIGURE 2 — 40 to 330 MHz BROADBAND TEST CIRCUIT SCHEMATIC



C1	1.0 – 10 pF JOHANSON	L4	VK200
C2,C6,C7	0.002 μF Ceramic Disk	T1	16:1 Bifilar Wound, #20 AWG Enameled Wire, Wound on a FERROXCUBE 1041T060-4C4 Core
C3,C5	0.1 μF, 50 Vdc Tantalum	R1	4.7 kΩ, 1/4 Watt, 10%
C4	1000 pF Button	R2,R3	27 Ω, 1/4 Watt, 5%
L1	1 Turn, #20 AWG	R4	270 Ω, 1/4 Watt, 5%
L2	5.6 μH Molded Choke		
L3	4 Turns, #20 AWG, 1/4" I.D.		

Input/Output Connectors – Type F
Z_o = 75 Ohms

FIGURE 3 — TYPICAL RESPONSE CURVE
(See Figure 2)

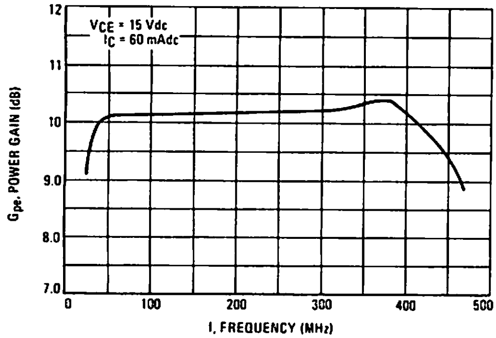


FIGURE 4 — COMMON-EMITTER POWER GAIN versus FREQUENCY

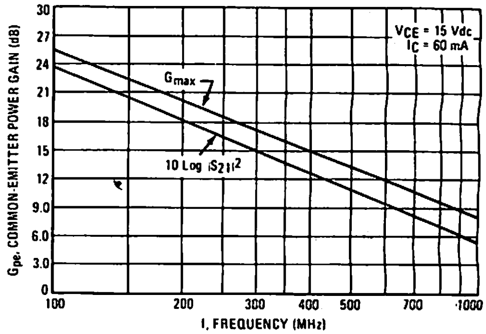


FIGURE 5 — CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT

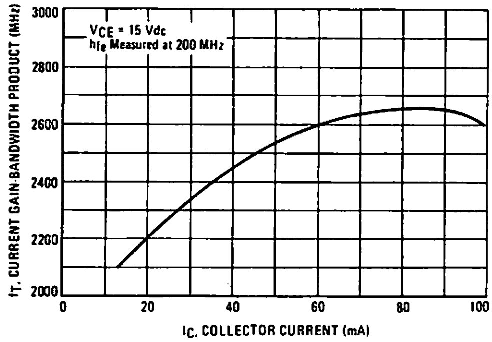


FIGURE 6 — INPUT CAPACITANCE versus EMITTER-BASE VOLTAGE

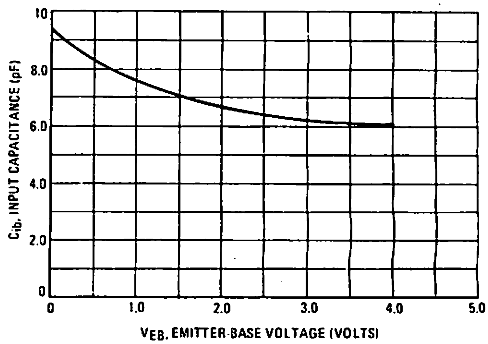


FIGURE 7 — OUTPUT CAPACITANCE versus COLLECTOR-BASE VOLTAGE

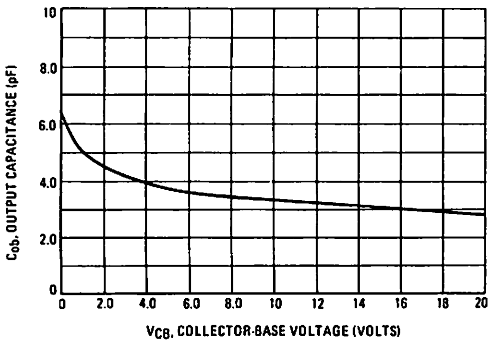


FIGURE 8 — BROADBAND NOISE FIGURE versus COLLECTOR CURRENT

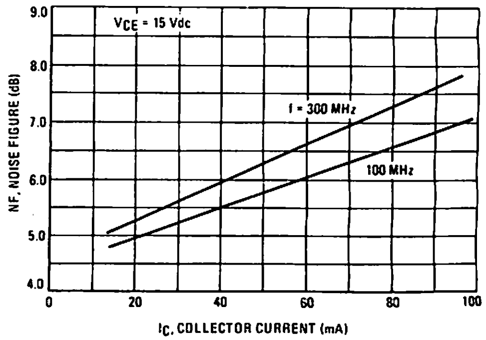


FIGURE 9 — 2nd ORDER DISTORTION ($f_1 \pm f_2$) versus COLLECTOR CURRENT

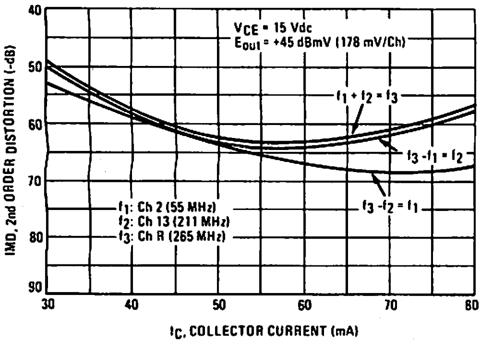


FIGURE 10 — 12-CHANNEL CROSS MODULATION DISTORTION versus COLLECTOR CURRENT

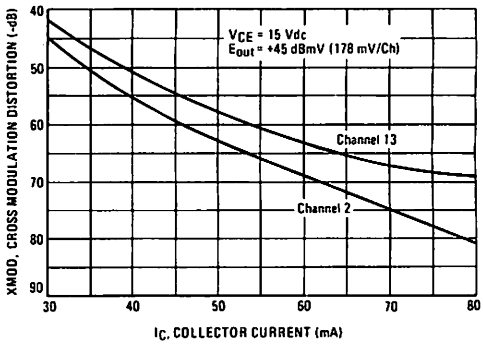


FIGURE 11 — DIN 45004 CROSS-MODULATION DISTORTION

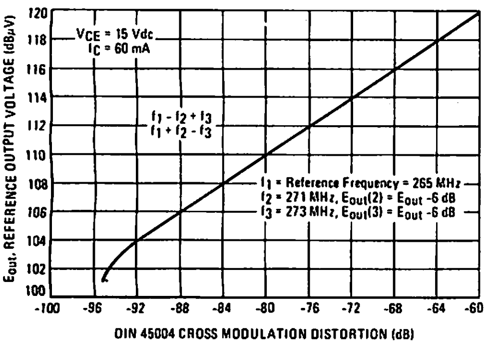


FIGURE 12 — TRIPLE BEAT DISTORTION ($f_1 + f_2 + f_3$) versus COLLECTOR CURRENT

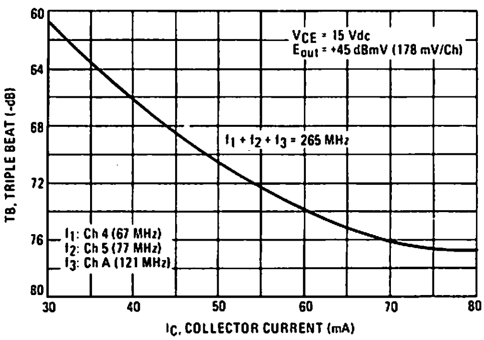
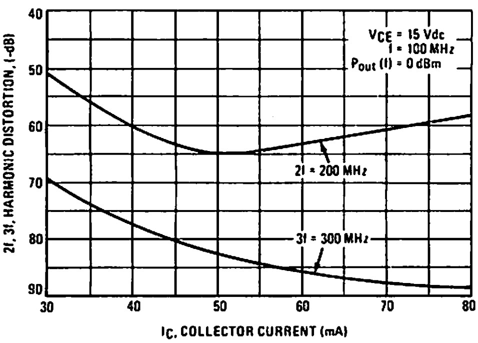


FIGURE 13 — HARMONIC DISTORTION (2f, 3f) versus COLLECTOR CURRENT



V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
5	30	100	0.538	-152	12.821	100	0.043	49	0.381	-102
		200	0.546	-173	6.612	86	0.064	55	0.314	-121
		400	0.557	163	3.440	71	0.105	60	0.315	-132
		600	0.602	147	2.357	59	0.144	61	0.360	-140
		800	0.625	136	1.872	46	0.181	59	0.437	-143
		1000	0.626	120	1.614	34	0.211	57	0.482	-144
	60	100	0.532	-160	13.475	98	0.040	54	0.362	-111
		200	0.542	-178	6.850	86	0.063	60	0.314	-130
		400	0.558	160	3.586	72	0.109	63	0.313	-140
		600	0.602	145	2.475	60	0.151	62	0.353	-146
		800	0.619	134	1.962	48	0.190	59	0.423	-147
		1000	0.616	118	1.706	35	0.221	57	0.464	-147
	90	100	0.532	-163	13.530	98	0.038	57	0.354	-115
		200	0.545	179	6.908	85	0.063	62	0.313	-133
		400	0.558	159	3.607	72	0.111	64	0.312	-143
		600	0.604	145	2.489	61	0.153	63	0.352	-148
		800	0.620	133	1.982	48	0.193	59	0.419	-149
		1000	0.614	117	1.721	35	0.224	57	0.455	-148
10	30	100	0.500	-145	14.176	102	0.040	50	0.386	-87
		200	0.502	-170	7.358	87	0.059	55	0.304	-105
		400	0.512	164	3.819	71	0.097	61	0.304	-118
		600	0.559	149	2.593	59	0.133	62	0.356	-128
		800	0.583	137	2.033	46	0.166	60	0.442	-134
		1000	0.584	122	1.724	34	0.194	59	0.497	-137
	60	100	0.487	-154	14.977	100	0.037	55	0.353	-96
		200	0.498	-174	7.715	86	0.059	60	0.287	-114
		400	0.506	161	4.009	72	0.101	63	0.294	-125
		600	0.553	146	2.731	60	0.139	63	0.341	-133
		800	0.572	135	2.158	47	0.174	60	0.422	-137
		1000	0.569	119	1.835	35	0.202	58	0.475	-139
	90	100	0.486	-157	15.192	99	0.036	57	0.337	-98
		200	0.493	-176	7.764	86	0.058	61	0.280	-116
		400	0.508	160	4.043	72	0.101	64	0.287	-126
		600	0.555	145	2.761	60	0.141	63	0.336	-134
		800	0.574	134	2.184	47	0.176	60	0.417	-138
		1000	0.568	118	1.861	35	0.204	58	0.469	-139
15	30	100	0.465	-153	15.774	100	0.035	56	0.337	-88
		200	0.475	-174	8.091	86	0.056	61	0.274	-105
		400	0.487	161	4.209	71	0.097	64	0.284	-116
		600	0.532	146	2.863	59	0.133	63	0.337	-126
		800	0.551	135	2.249	47	0.167	60	0.425	-132
		1000	0.547	119	1.909	34	0.193	58	0.482	-135
	60	100	0.468	-150	15.650	101	0.036	54	0.354	-87
		200	0.475	-172	8.088	87	0.057	60	0.282	-104
		400	0.486	163	4.178	72	0.096	63	0.290	-116
		600	0.530	147	2.846	60	0.133	63	0.341	-126
		800	0.549	136	2.228	47	0.166	60	0.429	-132
		1000	0.547	120	1.887	34	0.192	59	0.487	-135
	90	100	0.487	-141	14.773	103	0.039	50	0.391	-80
		200	0.486	-167	7.724	87	0.057	55	0.303	-97
		400	0.491	166	3.986	71	0.093	61	0.306	-110
		600	0.537	150	2.694	59	0.127	62	0.359	-122
		800	0.565	138	2.108	45	0.159	60	0.448	-129
		1000	0.566	123	1.779	33	0.185	60	0.507	-134

MRF521
MRFC521
MRF522
MRF524
MRF5211L

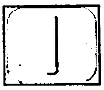
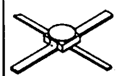
2

The RF Line
PNP Silicon
High-Frequency Transistors

$I_C = -50$ mA
HIGH FREQUENCY
TRANSISTORS
PNP SILICON

. . . designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching times.

- High Current Gain-Bandwidth Product — $f_T = 4.2$ GHz (Typ) @ $I_C = -50$ mAdc
- Low Noise Figure @ f = 1 GHz — $NF_{(matched)} = 2.8$ dB (Typ)
- High Power Gain — $G_{pe\,(matched)} = 11$ dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
  - Lower Package Parasitics
  - Higher Gain
- Tape and Reel Packaging Options

MAXIMUM RATINGS		MRFC521  Chip	MRF521  Macro-X Case 317-01 Style 2	MRF522  Case 303-01 Style 1	MRF524  Case 20-03 Style 10 (TO-72)	MRF5211L  Case 318A-05 Style 1 (SOT-143) Low Profile	
Ratings	**Symbol**	**Values**					**Unit**
Collector-Emitter Voltage	V_{CEO}	−10	−10	−10	−10	−10	Vdc
Collector-Base Voltage	V_{CBO}	−20	−20	−20	−20	−20	Vdc
Emitter-Base Voltage	V_{EBO}	−2.5	−2.5	−2.5	−2.5	−2.5	Vdc
Maximum Junction Temperature	T_{Jmax}	−200	150	200	200	150	°C
Collector Current — Continuous	I_C	−50	−70	−50	−50	−70	mA
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	— —	— —	— —	0.2 1.14	0.58 4.64	Watts mW/°C
Total Device Dissipation @ $T_C = 75°C$ Derate above 75°C (Note 1)	P_D	0.75 —	0.75 10	0.62 5	— —	0.58 7.7	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +200	−65 to +150	−65 to +200	−65 to +200	−65 to +150	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	—	—	—	870	216	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	—	100	200	—	130	°C/W

DEVICE MARKING

MRF5211 = 04

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = -1$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	−10	−12	—	Vdc
Collector-Base Breakdown Voltage ($I_C = -0.1$ mAdc, $I_E = 0$)	$V_{(BR)CBO}$	−20	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = -50$ μAdc, $I_C = 0$)	$V_{(BR)EBO}$	−2.5	—	—	Vdc
Collector Cutoff Current ($V_{CB} = -8$ Vdc, $I_E = 0$)	I_{CBO}	—	—	−10	μAdc

1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = −30 mAdc, V_{CE} = −5 Vdc)		h_{FE}	25	—	125	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = −6 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	1	1.5	pF
Current Gain — Bandwidth Product (V_{CE} = −8 Vdc, I_C = −50 mA, f = 1 GHz)	Figure 7	f_T	—	4.2	—	GHz
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure	Figure 6	G_{NFmin}				dB
(V_{CE} = −6 V, I_C = −5 mA, f = 500 MHz)	MRF524		9	—	—	
(V_{CE} = −6 V, I_C = −5 mA, f = 1 GHz)	MRF521/522/5211L		10	11	—	
Noise Figure — Minimum	Figure 6	NF_{min}				dB
(V_{CE} = −6 V, I_C = −5 mA, f = 500 MHz)	MRF524		—	—	2.5	
(V_{CE} = −6 V, I_C = −5 mA, f = 1 GHz)	MRF521/522/5211L		—	2.8	3.5	

TYPICAL CHARACTERISTICS

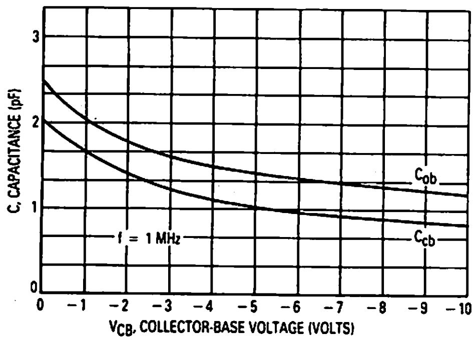


Figure 1. Junction Capacitance versus Voltage

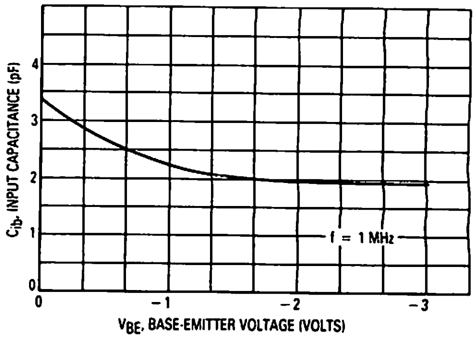


Figure 2. Input Capacitance versus Voltage

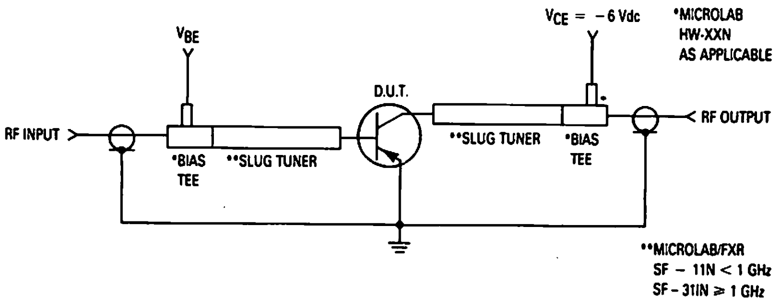


Figure 3. Functional Circuit Schematic

2

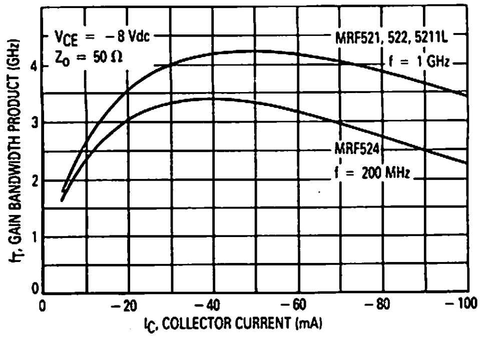


Figure 4. Gain-Bandwidth Product versus Current

GAIN AND NOISE FIGURE VERSUS FREQUENCY

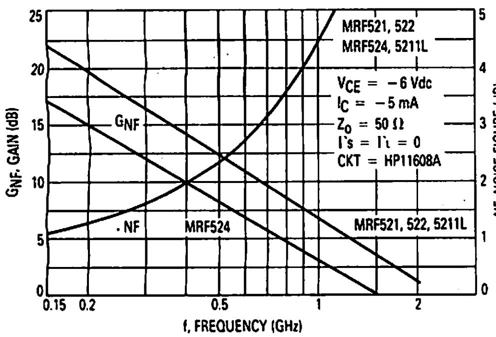


Figure 5. 50 Ohm System

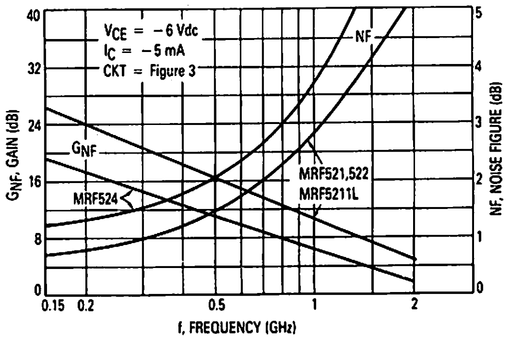


Figure 6. Tuned Circuit

GAIN AND NOISE FIGURE VERSUS CURRENT

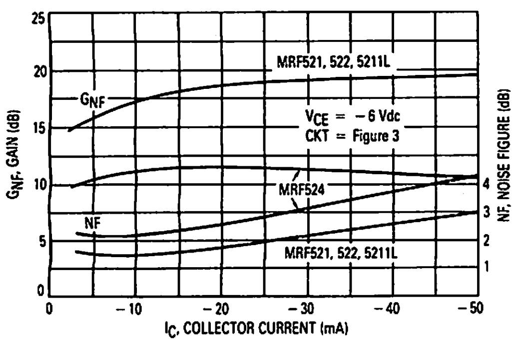


Figure 7. Tuned Circuit — Frequency 500 MHz

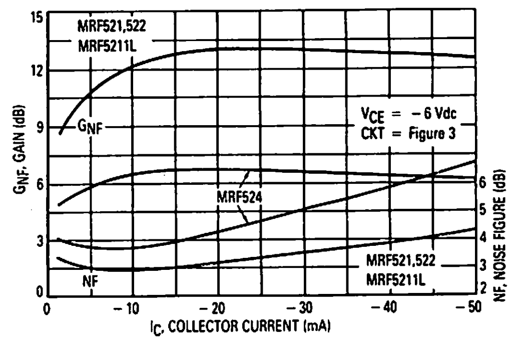


Figure 8. Tuned Circuit — Frequency 1 GHz

2

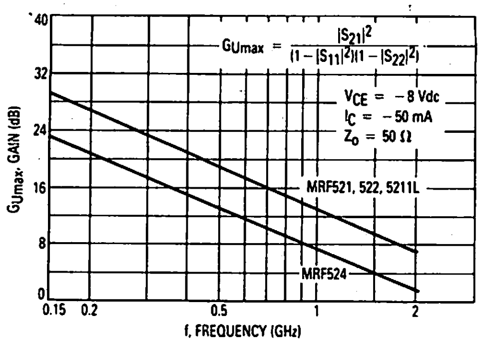


Figure 9. G_{Umax} versus Current

MRF521 COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
−6	−5	200	0.75	−116	7.6	117	0.06	36	0.59	−42
		500	0.75	−164	3.9	86	0.07	28	0.42	−51
		1000	0.74	165	2	63	0.08	37	0.37	−64
		1500	0.75	144	1.3	45	0.09	53	0.39	−85
		2000	0.74	124	1	32	0.14	61	0.43	−101
	−10	200	0.71	−138	10.7	109	0.04	37	0.45	−54
		500	0.72	−175	4.7	82	0.06	40	0.29	−61
		1000	0.72	148	2.4	63	0.08	55	0.20	−73
		1500	0.72	140	1.6	47	0.11	63	0.28	−94
		2000	0.71	122	1.2	34	0.16	61	0.31	−108
	−50	200	0.71	−172	12.9	100	0.02	59	0.26	−77
		500	0.72	170	5.3	78	0.05	68	0.15	−88
		1000	0.72	152	2.7	62	0.09	71	0.13	−99
		1500	0.72	136	1.8	46	0.13	70	0.17	−116
		2000	0.71	118	1.4	63	0.18	63	0.20	−123
−8	−5	200	0.77	−107	8.3	119	0.06	40	0.64	−38
		500	0.74	−163	4.1	88	0.07	28	0.45	−46
		1000	0.74	167	2.2	64	0.07	39	0.40	−58
		1500	0.74	146	1.4	47	0.08	54	0.42	−79
		2000	0.73	126	1.1	33	0.13	62	0.45	−95
	−10	200	0.69	−133	11.5	111	0.04	39	0.49	−49
		500	0.71	−172	5.1	83	0.05	41	0.32	−55
		1000	0.71	161	2.6	64	0.07	56	0.28	−64
		1500	0.71	142	1.7	48	0.10	64	0.30	−85
		2000	0.70	123	1.3	34	0.15	63	0.33	−98
	−50	200	0.67	−171	13.2	99	0.02	59	0.25	−70
		500	0.70	171	5.8	81	0.04	67	0.17	−74
		1000	0.69	151	2.9	62	0.08	72	0.15	−82
		1500	0.70	136	2	38	0.12	70	0.17	−100
		2000	0.68	117	1.5	33	0.17	63	0.20	−109

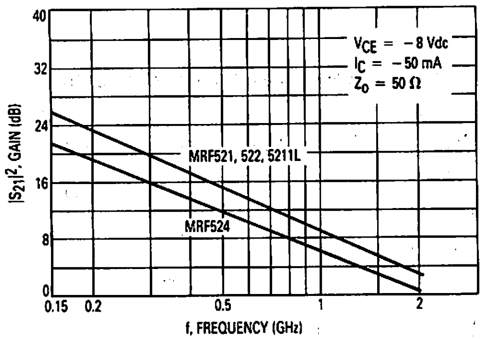


Figure 10. Insertion Gain versus Frequency

MRF522 COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} ∠φ	S_{21} $\|S_{21}\|$	S_{21} ∠φ	S_{12} $\|S_{12}\|$	S_{12} ∠φ	S_{22} $\|S_{22}\|$	S_{22} ∠φ
−6	−5	200	0.77	−113	7.5	120	0.06	34	0.60	−40
		500	0.80	−157	3.9	90	0.07	18	0.42	−51
		1000	0.83	177	2	70	0.07	14	0.36	−63
		1500	0.84	164	1.3	52	0.06	17	0.37	−88
		2000	0.88	153	1	39	0.06	27	0.41	−106
	−10	200	0.77	−138	10.4	112	0.04	32	0.47	−56
		500	0.82	−168	4.9	88	0.05	25	0.28	−65
		1000	0.85	173	2.5	71	0.05	31	0.23	−77
		1500	0.86	163	1.7	56	0.06	39	0.26	−100
		2000	0.88	153	1.3	45	0.07	47	0.30	−112
	−50	200	0.81	−169	13.2	104	0.02	43	0.30	−88
		500	0.84	177	5.8	85	0.03	53	0.17	−112
		1000	0.87	166	3	71	0.04	63	0.13	−130
		1500	0.87	158	2	57	0.06	65	0.19	−138
		2000	0.90	149	1.5	47	0.08	66	0.21	−142
−8	−5	200	0.80	−109	8	121	0.06	36	0.64	−39
		500	0.81	−153	4.1	92	0.07	20	0.43	−46
		1000	0.83	−179	2.1	72	0.07	15	0.38	−58
		1500	0.85	168	1.4	55	0.06	18	0.39	−80
		2000	0.87	157	1.1	43	0.06	28	0.42	−95
	−10	200	0.76	−133	11.1	113	0.04	33	0.49	−52
		500	0.80	−167	5.3	89	0.05	25	0.28	−60
		1000	0.83	174	2.7	71	0.05	31	0.23	−69
		1500	0.85	163	1.8	57	0.06	38	0.27	−91
		2000	0.87	153	1.4	46	0.07	46	0.30	−105
	−50	200	0.76	−160	14.4	105	0.02	44	0.30	−86
		500	0.80	178	6.4	85	0.03	52	0.16	−110
		1000	0.84	164	3.2	70	0.04	62	0.16	−125
		1500	0.85	154	2.1	55	0.06	64	0.16	−140
		2000	0.88	145	1.7	45	0.08	62	0.19	−141

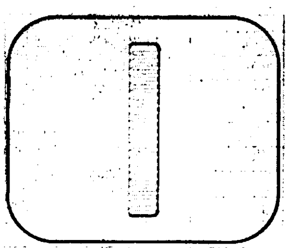
MRF524 COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−6	−5	200	0.42	−98	5.8	109	0.07	57	0.65	−26
		400	0.29	−143	3.5	84	0.10	58	0.54	−29
		600	0.27	−175	2.5	71	0.13	60	0.50	−33
		800	0.27	166	2	60	0.17	61	0.47	−42
		1000	0.25	147	1.7	49	0.21	61	0.47	−49
	−10	200	0.28	−111	7.3	100	0.06	64	0.54	−28
		400	0.21	−152	4.1	81	0.10	64	0.46	−28
		600	0.20	−179	2.9	69	0.14	63	0.41	−32
		800	0.20	167	2.3	59	0.19	61	0.39	−41
		1000	0.18	149	1.9	49	0.22	58	0.41	−47
	−50	200	0.15	−136	8.1	92	0.06	73	0.42	−26
		400	0.13	−172	4.4	77	0.12	70	0.36	−25
		600	0.15	166	3.1	66	0.17	65	0.33	−28
		800	0.15	159	2.4	56	0.21	60	0.32	−38
		1000	0.13	143	2	47	0.25	55	0.32	−45
−8	−5	200	0.45	−93	6.1	109	0.06	57	0.67	−25
		400	0.30	−137	3.7	86	0.09	58	0.57	−27
		600	0.27	−167	2.6	72	0.12	60	0.51	−32
		800	0.26	174	2.1	61	0.15	60	0.49	−40
		1000	0.23	155	1.8	51	0.19	60	0.50	−47
	−10	200	0.28	−100	7.5	101	0.06	65	0.57	−25
		400	0.18	−139	4.3	82	0.10	65	0.49	−26
		600	0.17	−171	3	70	0.13	64	0.45	−30
		800	0.16	174	2.3	60	0.18	61	0.43	−39
		1000	0.13	153	2	50	0.21	58	0.44	−45
	−50	200	0.14	−107	8.3	94	0.06	72	0.47	−23
		400	0.10	−155	4.6	78	0.11	70	0.42	−23
		600	0.10	172	3.2	67	0.16	66	0.39	−26
		800	0.10	163	2.5	57	0.20	61	0.37	−36
		1000	0.09	144	2	47	0.24	57	0.37	−42

MRF5211L COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−6	−5	200	0.82	−114	7.9	118	0.07	35	0.59	−46
		500	0.81	−158	4	88	0.08	21	0.40	−54
		1000	0.79	175	2	67	0.08	21	0.37	−68
		1500	0.76	158	1.3	50	0.07	30	0.43	−82
		2000	0.74	143	1	38	0.08	47	0.47	−95
	−10	200	0.78	−137	10.6	109	0.05	32	0.43	−63
		500	0.79	−168	4.9	84	0.06	28	0.26	−75
		1000	0.77	169	2.5	66	0.06	39	0.24	−87
		1500	0.74	155	1.6	50	0.08	49	0.29	−97
		2000	0.71	140	1.2	39	0.10	55	0.32	−106
	−50	200	0.77	−167	13.1	99	0.02	45	0.26	−108
		500	0.77	176	5.7	80	0.04	57	0.18	−132
		1000	0.76	161	2.8	65	0.06	65	0.17	−142
		1500	0.73	149	1.9	51	0.08	67	0.19	−137
		2000	0.70	136	1.4	40	0.12	65	0.20	−137
−8	−5	200	0.82	−109	8.1	119	0.07	36	0.62	−43
		500	0.80	−154	4.2	90	0.08	22	0.42	−52
		1000	0.78	175	2.2	67	0.08	22	0.38	−65
		1500	0.75	159	1.4	50	0.07	31	0.43	−78
		2000	0.72	143	1	37	0.09	43	0.46	−89
	−10	200	0.77	−132	11.2	110	0.05	33	0.45	−61
		500	0.77	−167	5.2	86	0.06	29	0.27	−70
		1000	0.76	169	2.6	67	0.06	39	0.25	−81
		1500	0.73	155	1.7	51	0.07	49	0.29	−90
		2000	0.70	140	1.3	39	0.10	54	0.31	−98
	−50	200	0.75	−164	14.2	100	0.02	43	0.26	−101
		500	0.76	178	6.1	82	0.04	55	0.17	−121
		1000	0.75	163	3.1	67	0.06	64	0.15	−131
		1500	0.72	151	2	53	0.08	67	0.18	−126
		2000	0.70	139	1.5	42	0.11	68	0.19	−127

CHIP TOPOGRAPHY



Nominal Chip Size: 0.015″ x 0.016″ x 0.005″
Front Metallization: Gold
Back Metallization: Gold
Emitter Base Bond Pad: 2.2 x 2.2 mil
#Emitter Fingers: 22
#Base Fingers: 23
Emitter Diffusion: Ion-Implanted Arsenic

MRF525

2

The RF Line

100–500 MHz BROADBAND

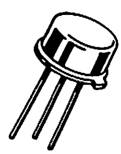
HIGH FREQUENCY TRANSISTOR

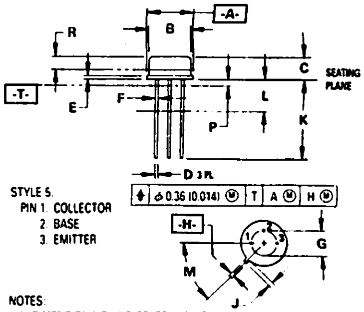
NPN SILICON

NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed specifically for broadband linear amplifier stages in the 100–500 MHz frequency range.

- Guaranteed Performance at 225–400 MHz, 26 Vdc
  Minimum Gain = 13 dB
  Maximum NF = 4.0 dB
- Third Order Intercept +35 dBm (Typ)
- Common Emitter TO-39 Type Package
- S-Parameter Characterization





STYLE 5.
PIN 1. COLLECTOR
2. BASE
3. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-05
TO-206AF
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage (R_{BE} = 330 Ω)	V_{CER}	25	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Power Dissipation @ T_A = 50°C Derate above 50°C	P_D	2.5 0.017	Watts W/°C
Operating Junction Temperature	T_J	+175	°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

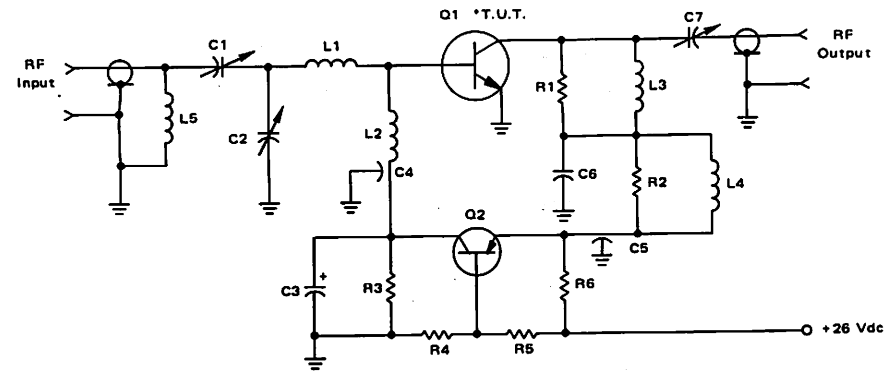
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	60	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, R_{BE} = 330 Ohms)	$V_{(BR)CER}$	25	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, I_B = 0)	I_{CEO}	–	–	100	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = 80 mAdc, V_{CE} = 10 Vdc)	h_{FE}	60	–	175	–
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 20 Vdc, f = 200 MHz)	f_T	2.2	2.5	–	GHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	4.0	pF
FUNCTIONAL TEST — BROADBAND (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 Vdc, P_{in} = 0 dBm, f = 400 MHz)	G_{PE}	13	14	–	dB
Broadband Noise Figure (V_{CE} = 26 Vdc, f = 400 MHz)	NF	–	–	4.0	dB

FIGURE 1 — 225 to 400 MHz BROADBAND TEST CIRCUIT SCHEMATIC



C1, C2 — 2.5–11 pF Erie Ceramic Variable
C3 — 47 μF 6.0 Volt Electrolytic
C4, C5 — 1000 pF Feedthru
C6 — 470 pF Ceramic Chip
C7 — 5.5–18 pF Erie Ceramic Variable
R1 — 150 Ω 1/8 Watt Carbon
R2 — 100 Ω 1/8 Watt Carbon
R3, R4 — 10 kΩ 1/8 Watt Carbon
R5 — 3.3 kΩ 1/8 Watt Carbon

R6 — 120 Ω 1/2 Watt Carbon
L1 — 1 Turn #24, 0.125 mil ID
L2, L4 — 0.47 μH Molded Choke
L3 — 2 Turns #24, 0.125 mil ID
L5 — 4 Turns #24, 0.125 mil ID
Q2 — 2N2907A
*Transistor Under Test
I_E = 47 mAdc (Nominal)

2

2

FIGURE 2 — COMMON-EMITTER POWER GAIN (G_{max}) versus FREQUENCY

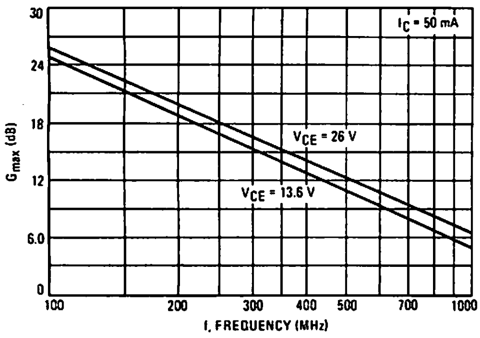


FIGURE 3 — CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT

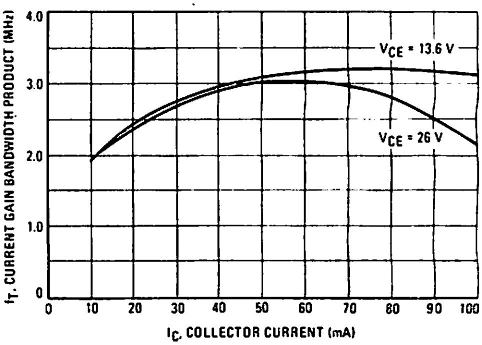


FIGURE 4 — BROADBAND AMPLIFIER RESPONSE

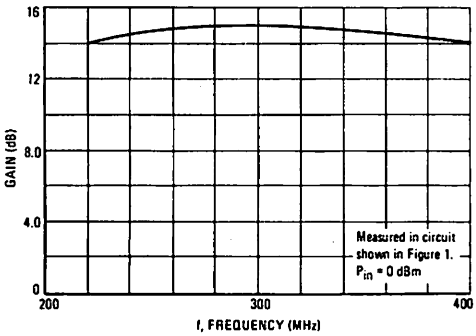


FIGURE 5 — 1.0 dB GAIN COMPRESSION OUTPUT versus FREQUENCY

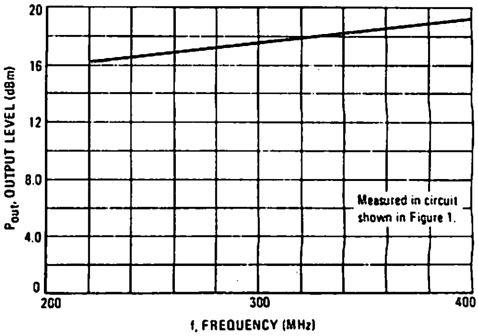
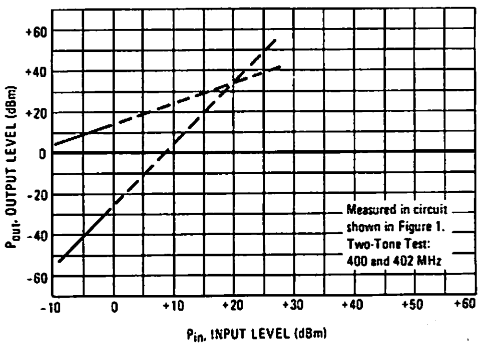


FIGURE 6 — THIRD ORDER INTERCEPT



2

S–PARAMETERS

V_{CE} (Volts)	I_C (mA)	Frequency (MHz)	S11		S21		S12		S22	
			|S11|	∠φ	|S21|	∠φ	|S12|	∠φ	|S22|	∠φ
13.6	10	100	0.388	-111	12.318	107	0.032	61	0.597	-24
		200	0.331	-151	6.768	88	0.049	68	0.480	-25
		300	0.337	-171	4.650	77	0.072	73	0.443	-31
		400	0.344	176	3.580	68	0.096	78	0.442	-40
		500	0.349	166	2.889	59	0.125	80	0.459	-47
	20	100	0.287	-125	14.160	103	0.030	67	0.516	-24
		200	0.263	-160	7.585	86	0.053	73	0.414	-23
		300	0.275	-177	5.167	76	0.078	76	0.378	-30
		400	0.288	172	3.968	68	0.104	77	0.378	-38
		500	0.293	164	3.214	60	0.135	78	0.396	-45
	50	100	0.206	-140	15.745	99	0.029	74	0.446	-24
		200	0.208	-171	8.299	84	0.056	76	0.358	-21
		300	0.226	176	5.612	75	0.084	76	0.324	-27
		400	0.235	169	4.307	68	0.113	77	0.326	-36
		500	0.243	161	3.488	60	0.114	76	0.345	-42
	100	100	0.179	-151	15.931	98	0.029	77	0.430	-22
		200	0.187	-177	8.293	85	0.058	80	0.358	-19
		300	0.203	171	5.626	77	0.087	80	0.330	-25
		400	0.212	164	4.276	70	0.115	80	0.338	-33
		500	0.213	157	3.456	63	0.147	79	0.364	-39
26	10	100	0.454	-100	13.680	105	0.027	58	0.625	-15
		200	0.313	-138	7.339	88	0.040	67	0.552	-17
		300	0.291	-161	4.989	78	0.060	76	0.532	-23
		400	0.287	-175	3.826	70	0.080	84	0.544	-30
		500	0.287	173	3.096	63	0.106	89	0.570	-36
	20	100	0.313	-105	15.191	102	0.025	62	0.566	-14
		200	0.220	-144	8.086	87	0.044	73	0.509	-15
		300	0.213	-166	5.487	77	0.067	78	0.489	-20
		400	0.215	-178	4.204	71	0.092	83	0.498	-28
		500	0.214	170	3.404	64	0.116	86	0.523	-34
	50	100	0.165	-117	16.375	102	0.026	71	0.529	-14
		200	0.139	-157	8.695	87	0.048	78	0.471	-14
		300	0.151	-176	5.882	78	0.073	80	0.449	-20
		400	0.157	173	4.494	71	0.098	82	0.458	-27
		500	0.158	164	3.659	65	0.124	84	0.485	-32
	100	100	0.215	-147	13.156	103	0.023	72	0.602	-14
		200	0.212	-176	7.220	88	0.044	82	0.536	-17
		300	0.222	171	4.951	79	0.069	84	0.507	-24
		400	0.230	164	3.851	72	0.093	87	0.513	-31
		500	0.233	156	3.123	64	0.123	89	0.534	-36

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF531

The RF Line

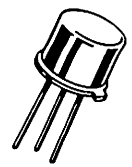
2

HIGH FREQUENCY TRANSISTOR
NPN SILICON

NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for high voltage and high current f_T switching applications. These devices are also ideal for CRT drivers.

- High Collector-Emitter Breakdown Voltage — $V_{(BR)CEO}$ = 100 Vdc (Min) @ I_C = 10 mAdc
- High Current-Gain — Bandwidth Product — f_T = 800 MHz (Typ) @ I_C = 50 mAdc
- Characterized with Safe Operating Area (SOA) Curves



MAXIMUM RATINGS

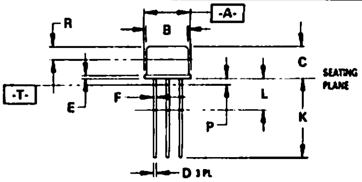
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	100	Vdc
Collector-Base Voltage	V_{CBO}	100	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.5 14	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

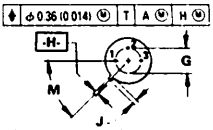
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	100	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	100	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 75 Vdc, V_{BE} = 0)	I_{CES}	–	–	10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 10 Vdc)	h_{FE}	25	–	–	–
Collector-Emitter Saturation Voltage (I_C = 10 mAdc, I_B = 1.0 mAdc)	$V_{CE(sat)}$	–	–	1.0	Vdc
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 50 mAdc, V_{CE} = 25 Vdc, f = 100 MHz)	f_T	500	800	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	4.0	pF
Input Capacitance (V_{BE} = 3.0 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	9.0	–	pF



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

FIGURE 1 — CURRENT-GAIN — BANDWIDTH PRODUCT

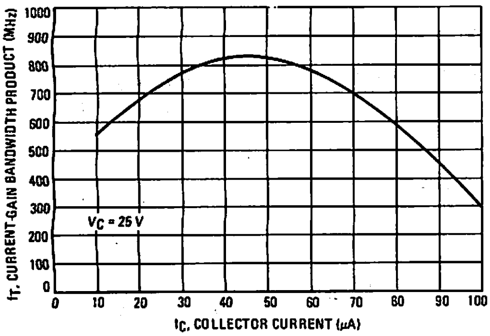


FIGURE 2 — INPUT CAPACITANCE

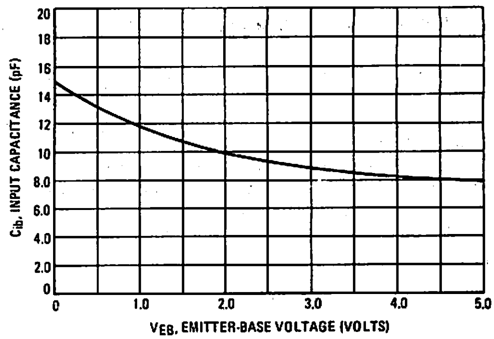


FIGURE 3 — OUTPUT CAPACITANCE

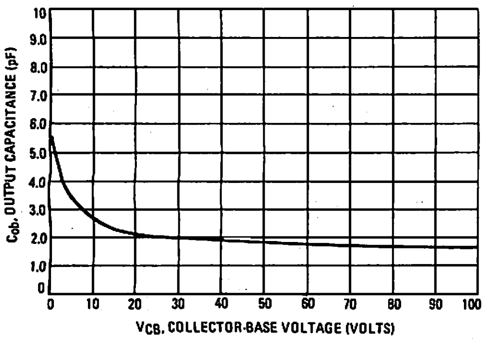
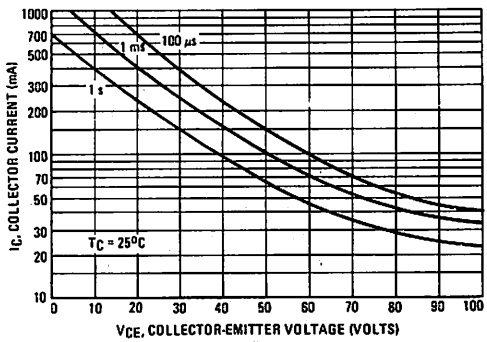


FIGURE 4 — DC SAFE OPERATING AREA



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF534
MRF536
(See MM4049)

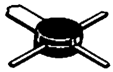
MRF542
MRF548

The RF Line
NPN Silicon High Frequency Transistors

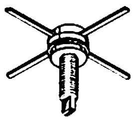
. . . designed primarily for high frequency common base amplifiers used in medium and high resolution color video display monitors.

- High Collector-Base Breakdown Voltage $V_{(BR)CBO}$ = 120 V (Min)
- Stripline Opposed Base Constiuction
- Common Base Insertion Gain = 5.5 dB (Typ)
- Package Options for Low Cost (MRF542), High Power Dissipation (MRF548)
- Die Source Same as MRF544
- Emitter Ballasted for Improved Ruggedness

HIGH FREQUENCY TRANSISTORS NPN SILICON



MRF542
CASE 317D-02, STYLE 3
PLASTIC



MRF548
CASE 244A-01, STYLE 3
(TO-117)
CERAMIC

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Emitter Voltage		V_{CEO}	70	Vdc
Collector-Base Voltage		V_{CBO}	120	Vdc
Emitter-Base Voltage		V_{EBO}	3	Vdc
Collector-Current — Continuous		I_C	400	mAdc
Operating Junction Temperature	MRF542 MRF548	T_J	150 200	°C °C
Total Device Dissipation @ T_C = 75°C (1,2) Derate above 75°C	MRF542 MRF548 MRF542/548	P_D	3 5 40	Watts mW/°C
Storage Temperature Range		T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CE} = 80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	100	μAdc
Collector Cutoff Current (V_{CB} = 80 Vdc, I_E = 0)	I_{CBO}	—	—	20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	2.9	—	pF
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	2	2.5	pF
Input Capacitance (V_{EB} = 3 Vdc, f = 1 MHz)	C_{ib}	—	12.5	—	pF
FUNCTIONAL TESTS					
Common Base Gain (V_{CB} = 10 V, I_C = 100 mA, f = 250 MHz)	$\|S_{21}\|^2$	4.5	5.5	—	dB

(1) T_C, Case temperature measured on collector lead immediately adjacent to body of package.
(2) The MRF542 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

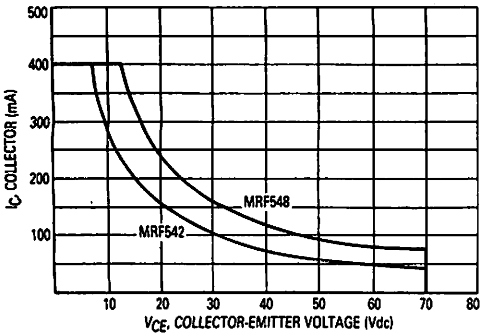


Figure 1. Safe Operating Area

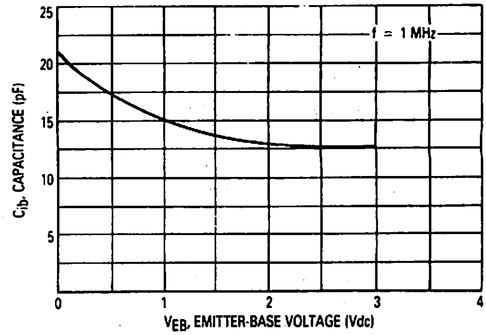


Figure 2. Input Capacitance versus Voltage

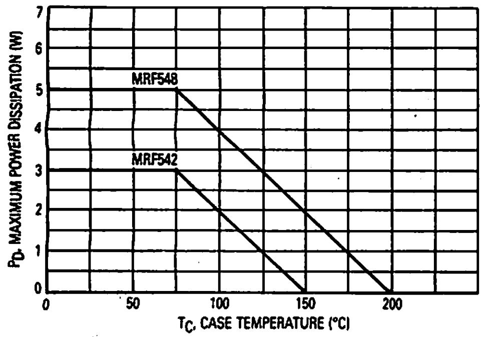


Figure 3. Power Dissipation versus Temperature

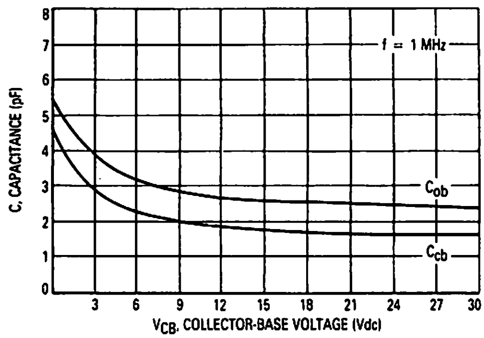


Figure 4. Junction Capacitance versus Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

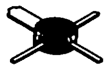
The RF Line
PNP Silicon High Frequency Transistors

MRF543
MRF549

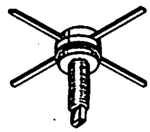
... designed primarily for high frequency *common base* amplifiers used in medium and high resolution color video display monitors.

- High Collector-Base Breakdown Voltage $V_{(BR)CBO}$ = −100 V (Min)
- Stripline Opposed Base Construction
- Common Base Insertion Gain = 5.5 dB (Typ)
- Package Options for Low Cost (MRF543), High Power Dissipation (MRF549)
- **Die Source Same As MRF545**
- Emitter Ballasted for Improved Ruggedness

I_C = −400 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTORS
PNP SILICON



CASE 317D-02, STYLE 3
PLASTIC
MRF543



CASE 244A-01, STYLE 3
(TO-117)
CERAMIC
MRF549

MAXIMUM RATINGS

Rating		Symbol	Value	Unit
Collector-Emitter Voltage		V_{CEO}	−70	Vdc
Collector-Base Voltage		V_{CBO}	−100	Vdc
Emitter-Base Voltage		V_{EBO}	−3	Vdc
Collector-Current — Continuous		I_C	−400	mAdc
Operating Junction Temperature	MRF543 MRF549	T_J	150 200	°C
Total Device Dissipation @ T_C = 75°C (1,2) Derate above 75°C	MRF543 MRF549 MRF543/549	P_D	3 5 40	Watts mW/°C
Storage Temperature Range		T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −1 mAdc, I_B = 0)	$V_{(BR)CEO}$	−70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	−100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	−3	—	—	Vdc
Collector Cutoff Current (V_{CE} = −80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	−100	μAdc
Collector Cutoff Current (V_{CB} = −80 Vdc, I_E = 0)	I_{CBO}	—	—	−20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mAdc, V_{CE} = −10 Vdc)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	2.8	—	pF
Collector-Base Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	2	2.5	pF
Input Capacitance (V_{EB} = −3 Vdc, f = 1 MHz)	C_{ib}	—	10.5	—	pF
FUNCTIONAL TESTS					
Common Base Gain (V_{CB} = −10 V, I_C = −100 mA, f = 250 MHz)	$\lvert S_{21}\rvert^2$	4.5	5.5	—	dB

Notes: 1. T_C, Case temperature for MRF543 measured on collector lead immediately adjacent to body of package.
2. The MRF543 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

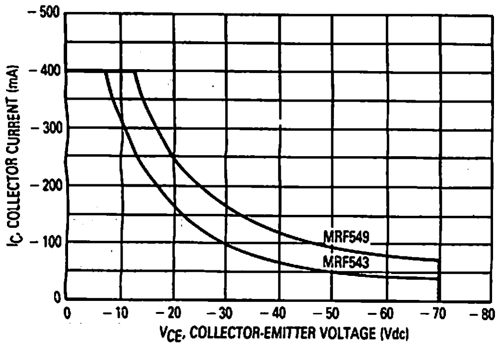


Figure 1. Safe Operating Area

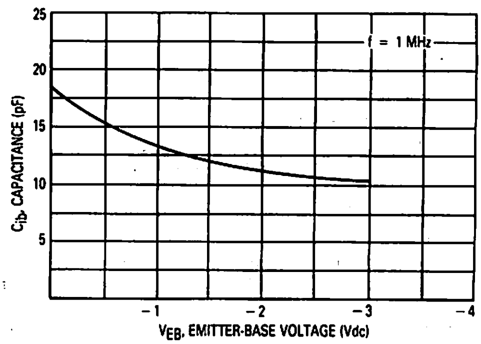


Figure 2. Input Capacitance versus Voltage

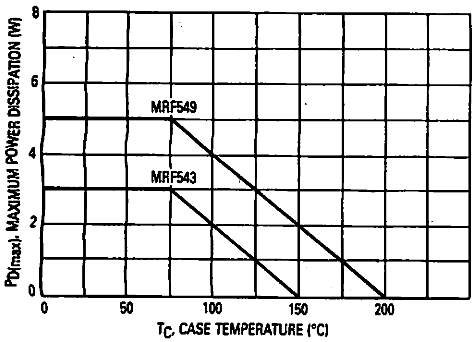


Figure 3. Power Dissipation versus Temperature

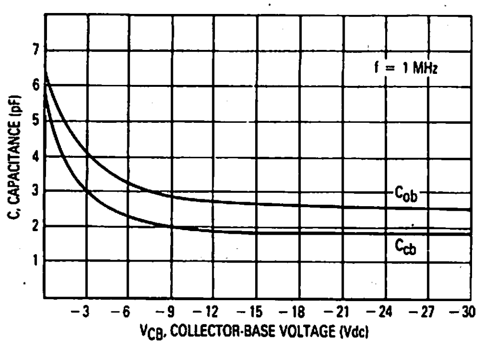


Figure 4. Junction Capacitance versus Voltage

2

MRF544
MRFC544

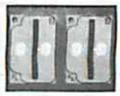
The RF Line
NPN Silicon High Frequency Transistors

I_C = 400 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTORS

. . . designed for high-frequency and medium and high resolution color video display monitors.

- Emitter Ballasting for Improved Ruggedness
- High Power Gain — $G_{U(max)}$ = 16.5 dB (Typ) @ f = 500 MHz
- Ion Implanted
- High Collector Base Breakdown Voltage — $V_{(BR)CBO}$, 120 V (Min)
- High f_T — 1400 MHz
- State-of-the-Art Technology Fine Line Geometry
- Gold Top Metallization
- Silicon Nitride Passivation
- MIL-S-19500 Processed Versions Available as MRF544MX, MRF544MXV

CASE 79-04
STYLE 1
MRF544
TO-205AD
(TO-39)



CHIP
MRFC544

MAXIMUM RATINGS

Rating	Symbol	MRFC544	MRF544	Unit
Collector-Emitter Voltage	V_{CEO}	70	70	Vdc
Collector-Base Voltage	V_{CBO}	120	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	3	Vdc
Collector Current — Continuous	I_C	400	400	mAdc
Total Device Dissipation @ T_C = 75°C Derate above 75°C	P_D	5 T_{Jmax} = 200°C	3.5 28	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CE} = 80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	100	μAdc
Collector Cutoff Current (V_{CB} = 80 Vdc, I_E = 0)	I_{CBO}	—	—	20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 10 Vdc)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	3	—	pF
Junction Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	1.8	2.5	pF
Input Capacitance (V_{EB} = 3 Vdc, I_C = 0, f = 1 MHz)	C_{ib}	—	9	—	pF
Current Gain-Bandwidth Product (I_C = 50 mA, V_{CE} = 10 V, f = 250 MHz)	f_T	1000	1400	—	MHz
FUNCTIONAL TESTS					
Maximum Available Gain (I_C = 50 mA, V_{CE} = 10 V, f = 250 MHz)	G_{max}	—	16.5	—	dB
Insertion Gain (I_C = 50 mA, V_{CE} = 10 V, f = 250 MHz)	$\lvert S_{21}\rvert^2$	—	13	—	dB

TYPICAL CHARACTERISTICS

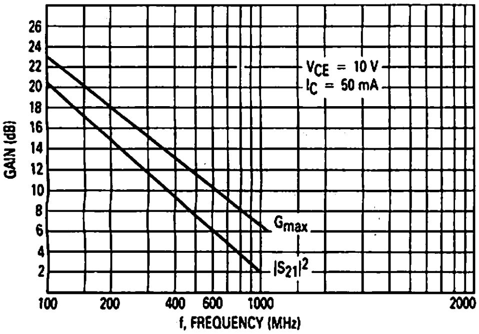


Figure 1. Power Gain versus Frequency

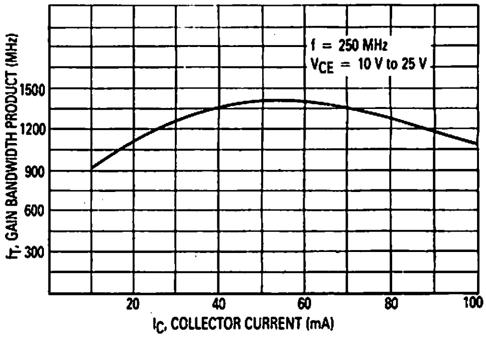


Figure 2. Gain-Bandwidth Product versus Collector Current

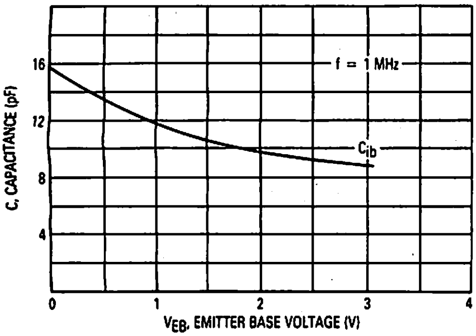


Figure 3. C_{ib} Input Capacitance versus Voltage

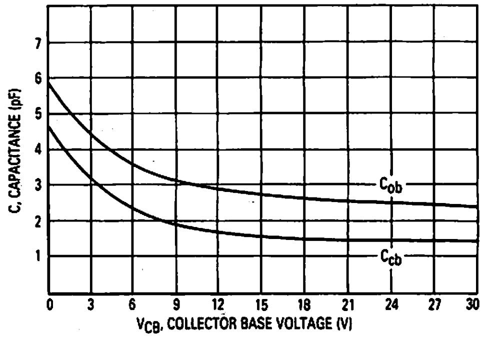


Figure 4. Junction Capacitance versus Voltage

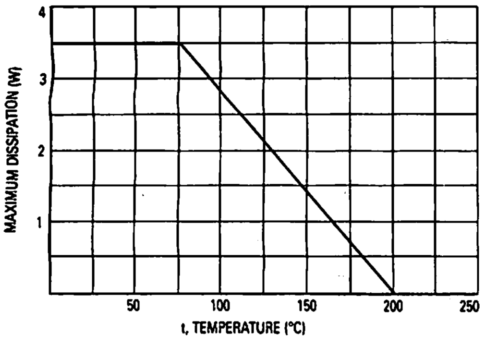


Figure 5. Dissipation versus Temperature

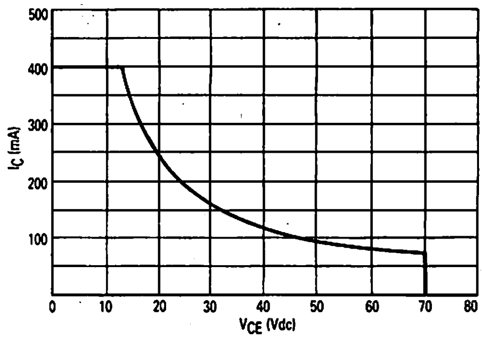


Figure 6. Safe Operating Area

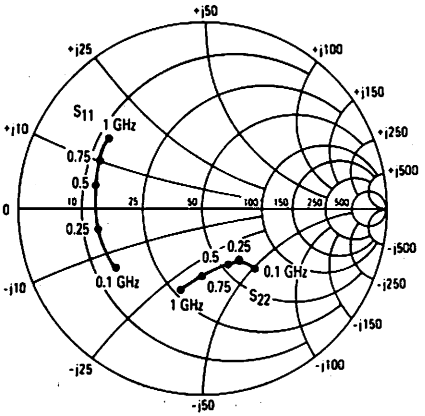


Figure 7. Input/Output Reflection Coefficient versus Frequency (GHz)
V_{CE} = 10 V I_C = 50 mA

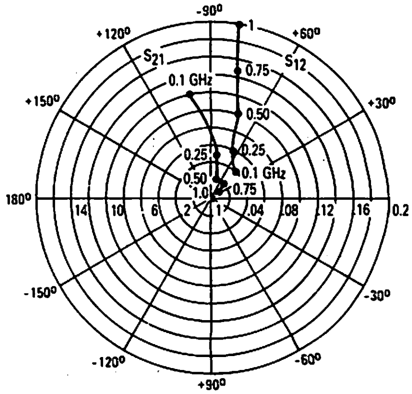


Figure 8. Forward/Reverse Transmission Coefficients versus Frequency (GHz)
V_{CE} = 10 V I_C = 50 mA

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
10	25	100	0.59	−138	11.71	106	0.04	50	0.48	−43
		250	0.59	−167	4.64	85	0.06	61	0.38	−50
		500	0.61	174	2.30	67	0.10	75	0.37	−66
		750	0.66	166	1.52	53	0.15	80	0.42	−89
		1000	0.66	157	1.17	43	0.20	82	0.50	−104
	50	100	0.58	−147	12.38	102	0.04	50	0.43	−48
		250	0.58	−171	4.85	83	0.06	63	0.34	−52
		500	0.60	170	2.43	66	0.10	74	0.33	−67
		750	0.64	163	1.61	52	0.15	78	0.39	−91
		1000	0.64	155	1.24	43	0.21	79	0.46	−105
	80	100	0.60	−151	12.15	101	0.03	49	0.39	−47
		250	0.60	−173	4.76	81	0.05	64	0.34	−55
		500	0.62	170	2.35	65	0.10	74	0.35	−72
		750	0.66	162	1.53	50	0.14	78	0.43	−96
		1000	0.65	154	1.16	40	0.20	78	0.51	−108
25	25	100	0.59	−133	12.77	110	0.03	44	0.53	−34
		250	0.59	−164	5.06	86	0.05	62	0.46	−42
		500	0.60	177	2.48	67	0.08	78	0.45	−60
		750	0.64	168	1.59	52	0.12	84	0.50	−83
		1000	0.66	159	1.20	43	0.17	87	0.57	−99
	50	100	0.56	−142	13.25	103	0.03	49	0.50	−35
		250	0.56	−169	5.21	82	0.05	64	0.44	−42
		500	0.58	172	2.60	64	0.09	76	0.43	−59
		750	0.62	163	1.68	50	0.13	82	0.48	−82
		1000	0.63	155	1.28	40	0.18	83	0.55	−97
	80	100	0.58	−143	13.87	102	0.03	52	0.54	−33
		250	0.57	−172	5.19	80	0.05	63	0.47	−39
		500	0.59	170	2.55	62	0.08	77	0.46	−58
		750	0.64	162	1.65	48	0.13	82	0.50	−81
		1000	0.64	154	1.24	37	0.18	83	0.57	−97

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF545
MRFC545

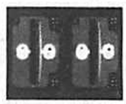
The RF Line
PNP Silicon High Frequency Transistors

. . . designed for high-frequency and medium and high resolution color video display monitors.

- Emitter Ballasting for Improved Ruggedness
- High Power Gain — $G_{U(max)}$ = 15.5 dB (Typ) @ f = 250 MHz
- Ion Implanted
- High Collector Base Breakdown Voltage — $V_{(BR)CBO}$ = −100 V (Min)
- High f_T — 1250 MHz (Typ)
- State-of-the-Art Technology
  - Fine Line Geometry
  - Gold Top Metallization
  - Silicon Nitride Passivation
- MIL-S-19500 Processed Versions Available as MRF545HX, MRF545HXV

I_C = −400 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTORS
PNP SILICON

CASE 79-04
STYLE 1
TO-205AD
(TO-39)
MRF545



CHIP
MRFC545

MAXIMUM RATINGS

Rating	Symbol	MRFC545	MRF545	Unit
Collector-Emitter Voltage	V_{CEO}	−70	−70	Vdc
Collector-Base Voltage	V_{CBO}	−100	−100	Vdc
Emitter-Base Voltage	V_{EBO}	−3	−3	Vdc
Collector Current — Continuous	I_C	−400	−400	mAdc
Operating Junction Temperature	T_J	200	200	°C
Total Device Dissipation @ T_C = 75°C Derate above 25°C	P_D	5 T_{Jmax} = 200°C	3.5 28	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	−65 to +200	°C

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −1 mAdc, I_B = 0)	$V_{(BR)CEO}$	−70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	−100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	−3	—	—	Vdc
Collector Cutoff Current (V_{CE} = −80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	−100	μAdc
Collector Cutoff Current (V_{CB} = −80 Vdc, I_E = 0)	I_{CBO}	—	—	−20	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mAdc, V_{CE} = −10 Vdc)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	3.2	—	pF
Junction Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	2	2.5	pF
Input Capacitance (V_{EB} = −3 Vdc, I_C = 0, f = 1 MHz)	C_{ib}	—	10	—	pF
Current Gain-Bandwidth Product (I_C = −50 mA, V_{CE} = −25 V, f = 250 MHz)	f_T	1000	1250	—	MHz
FUNCTIONAL TESTS					
Maximum Available Gain (I_C = −50 mA, V_{CE} = −25 V, f = 250 MHz)	G_{max}	—	15.5	—	dB
Insertion Gain (I_C = −50 mA, V_{CE} = −25 V, f = 250 MHz)	$\|S_{21}\|^2$	—	12.7	—	dB

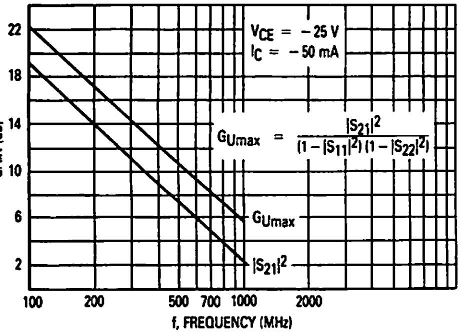


Figure 1. Power Gain versus Frequency

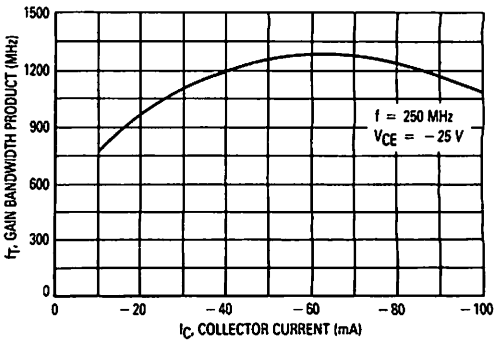


Figure 2. Gain-Bandwidth Product versus Collector Current

2

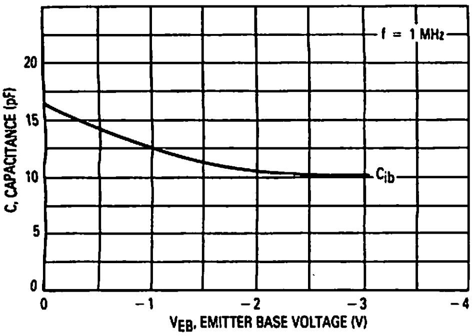


Figure 3. Input Capacitance versus Voltage

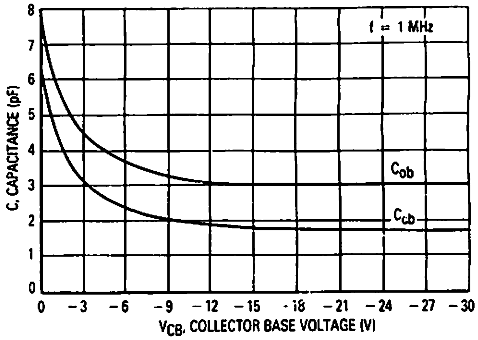


Figure 4. Junction Capacitance versus Voltage

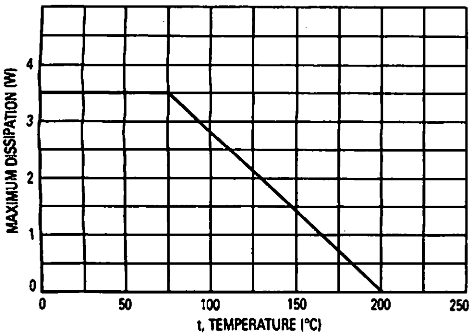


Figure 5. Dissipation versus Temperature

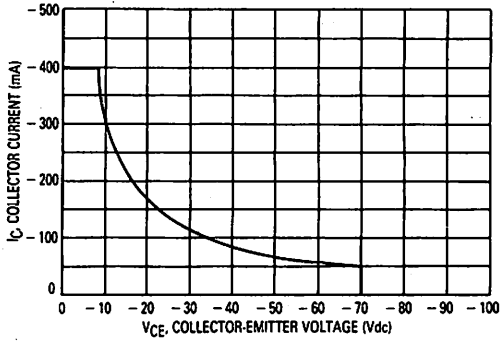


Figure 6. Safe Operating Area

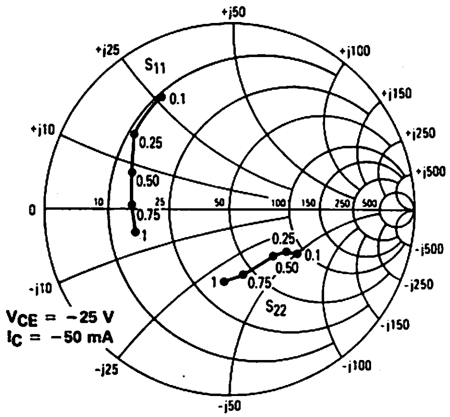


Figure 7. Input/Output Reflection Coefficient versus Frequency (GHz)

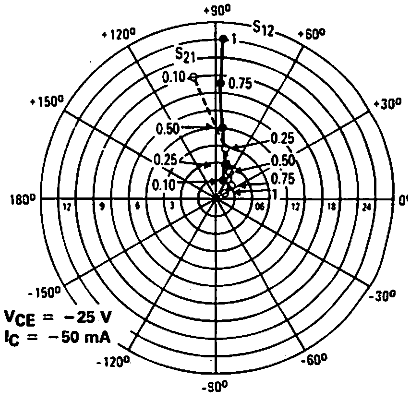


Figure 8. Forward/Reverse Transmission Coefficients versus Frequency

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−10	−25	100	0.60	−161	8.7	101	0.03	57	0.47	−34
		250	0.61	−180	3.6	81	0.06	74	0.42	−39
		500	0.66	163	1.9	62	0.12	88	0.38	−56
		750	0.72	154	1.3	50	0.19	91	0.40	−87
		1000	0.75	143	1.0	41	0.29	89	0.46	−102
	−50	100	0.61	−169	8.8	99	0.03	64	0.43	−36
		250	0.62	177	3.7	80	0.06	79	0.38	−40
		500	0.66	161	1.9	63	0.13	88	0.35	−56
		750	0.72	153	1.3	50	0.20	89	0.36	−86
		1000	0.74	142	1.0	41	0.29	87	0.42	−102
	−100	100	0.67	−178	5.6	94	0.03	68	0.40	−26
		250	0.70	170	2.3	74	0.07	81	0.36	−37
		500	0.71	155	1.2	54	0.16	89	0.39	−61
		750	0.76	142	0.9	42	0.27	87	0.40	−92
		1000	0.82	128	0.7	37	0.39	81	0.43	−117
−25	−25	100	0.55	−155	9.9	102	0.03	58	0.49	−32
		250	0.57	−176	4.2	82	0.06	72	0.43	−36
		500	0.61	165	2.1	64	0.11	87	0.38	−50
		750	0.68	156	1.4	51	0.18	90	0.41	−79
		1000	0.70	144	1.1	43	0.27	89	0.45	−96
	−50	100	0.53	−162	10.6	101	0.03	62	0.44	−35
		250	0.55	−180	4.4	82	0.06	75	0.39	−38
		500	0.59	162	2.3	65	0.12	85	0.34	−50
		750	0.65	154	1.5	51	0.19	88	0.36	−78
		1000	0.67	143	1.2	43	0.27	86	0.40	−95
	−100	100	0.48	−169	9.3	98	0.03	68	0.43	−27
		250	0.53	174	3.9	79	0.07	79	0.37	−33
		500	0.54	159	2.1	61	0.15	85	0.40	−52
		750	0.60	146	1.5	47	0.24	85	0.39	−77
		1000	0.65	132	1.1	37	0.34	81	0.41	−99

MRF546

The RF Line

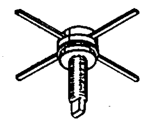
NPN Silicon High Frequency Transistor

I_C = 600 mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTOR
NPN SILICON

2

... designed for high current, high frequency common base amplifiers used in medium and high resolution color video display monitors.

- Stripline Opposed Base Construction
- **Die Source 2X Common Base MRF548**
- Common Base Insertion Gain = 6 dB (Typ)
- High Collector-Base Breakdown Voltage $V_{(BR)CBO}$ = 120 Vdc (Min)
- Emitter Ballasted For Improved Ruggedness
- Gold Top Metallization
- Silicon Nitride Passivation



CASE 244A-01, STYLE 3

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	70	Vdc
Collector-Base Voltage	V_{CBO}	120	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector-Current — Continuous	I_C	600	mAdc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 75°C Derate above 75°C	P_D	9 72	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 2 mAdc, I_B = 0)	$V_{(BR)CEO}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.2 mAdc, I_E = 0)	$V_{(BR)CBO}$	120	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.2 mAdc, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CE} = 80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	200	μAdc
Collector Cutoff Current (V_{CB} = 80 Vdc, I_E = 0)	I_{CBO}	—	—	40	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 10 Vdc)	h_{FE}	15	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	5	—	pF
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	3.6	4.5	pF
Input Capacitance (V_{EB} = 3 Vdc, f = 1 MHz)	C_{ib}	—	26	—	pF
FUNCTIONAL TESTS					
Common Base Gain (V_{CB} = 10 V, I_C = 200 mA, f = 250 MHz)	$\|S_{21}\|^2$	4.5	6	—	dB

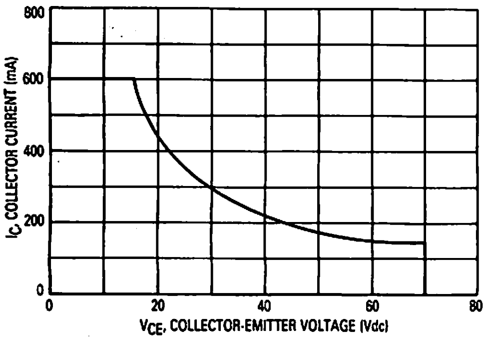


Figure 1. Safe Operating Area

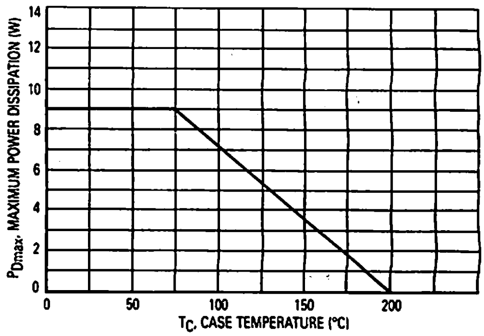


Figure 2. Power Dissipation versus Temperature

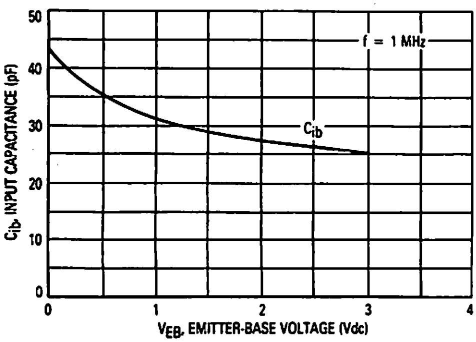


Figure 3. Input Capacitance versus Voltage

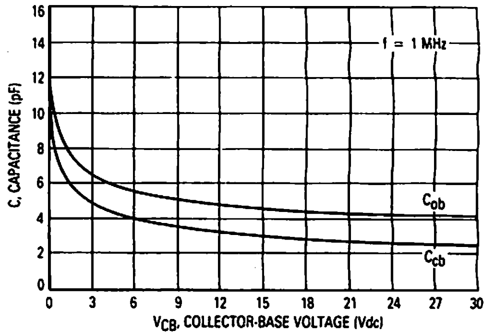


Figure 4. Junction Capacitance versus Voltage

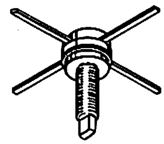
MRF547

The RF Line
PNP Silicon High Frequency Transistor

. . . designed for high-current, high-frequency common base amplifiers used in medium and high resolution color video display monitors.

- Stripline Opposed Base Construction
- **Die Source 2X Common Base MRF549**
- Common Base Insertion Gain = 5.5 dB (Typ)
- High Collector-Base Breakdown Voltage $V_{(BR)CBO}$ = −100 Vdc (Min)
- Emitter Ballasted for Improved Ruggedness
- Gold Top Metallization
- Silicon Nitride Passivation

**I_C = −600mA
HIGH FREQUENCY
HIGH VOLTAGE
TRANSISTOR
PNP SILICON**



CASE 244A-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−70	Vdc
Collector-Base Voltage	V_{CBO}	−100	Vdc
Emitter-Base Voltage	V_{EBO}	−3	Vdc
Collector-Current — Continuous	I_C	−600	mAdc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 75°C Derate above 75°C	P_D	9 72	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	13.9	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −2 mAdc, I_B = 0)	$V_{(BR)CEO}$	−70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = −0.2 mAdc, I_E = 0)	$V_{(BR)CBO}$	−100	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = −0.2 mAdc, I_C = 0)	$V_{(BR)EBO}$	−3	—	—	Vdc
Collector Cutoff Current (V_{CE} = −80 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	−200	μAdc
Collector Cutoff Current (V_{CB} = −80 Vdc, I_E = 0)	I_{CBO}	—	—	−40	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = −100 mAdc, V_{CE} = −10 Vdc)	h_{FE}	15	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	5.1	—	pF
Collector-Base Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	3.6	4.5	pF
Input Capacitance (V_{EB} = −3 Vdc, f = 1 MHz)	C_{ib}	—	20	—	pF
FUNCTIONAL TESTS					
Common Base Gain (V_{CB} = −10 V, I_C = −200 mA, f = 250 MHz)	$\|S_{21}\|^2$	4.5	5.5	—	dB

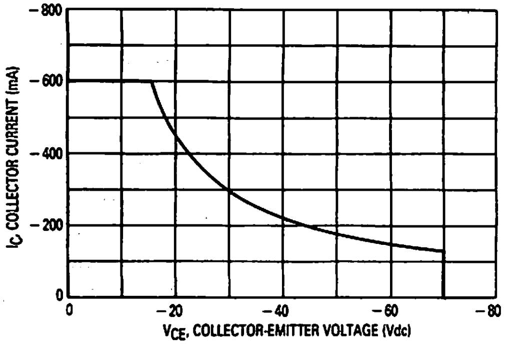


Figure 1. Safe Operating Area

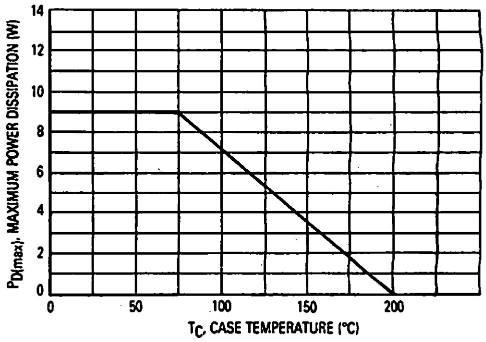


Figure 2. Power Dissipation versus Temperature

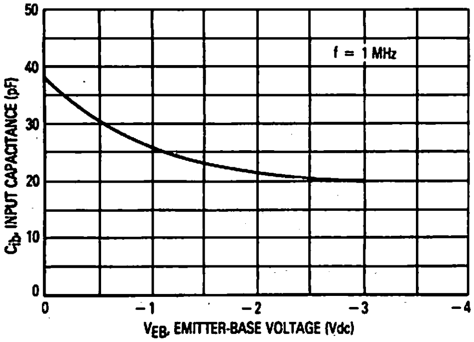


Figure 3. Input Capacitance versus Voltage

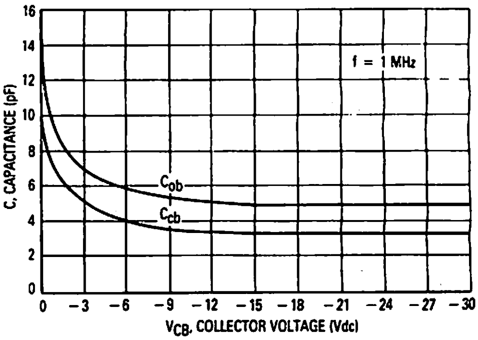


Figure 4. Junction Capacitance versus Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF548 (See MRF542)
MRF549 (See MRF543)

MRF553

The RF Line

NPN SILICON RF LOW POWER TRANSISTOR

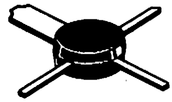
... designed primarily for wideband large signal predriver stages in the VHF frequency range.

- Specified @ 12.5 V, 175 MHz Characteristics
  Output Power = 1.5 W
  Minimum Gain = 11.5 dB
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

1.5 W 175 MHz

RF LOW POWER TRANSISTOR

NPN SILICON



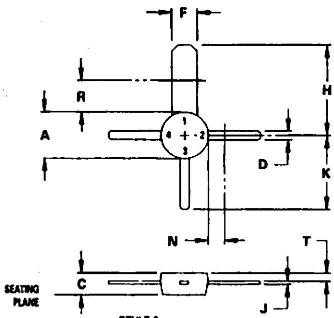
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ T_C = 75°C (1,2) Derate above 75°C	P_D	3.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

(1) T_C, Case temperature measured on collector lead immediately adjacent to body of package.
(2) The MRF553 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques for PowerMacro Transistor," discusses methods of mounting and heatsinking.



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. LEAD DIMENSIONS UNCONTROLLED WITHIN DIMENSION N AND R.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.45	5.20	0.175	0.205
C	1.91	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	2.46	2.64	0.097	0.104
H	8.84	9.72	0.348	0.383
J	0.21	0.30	0.008	0.012
K	7.24	8.12	0.285	0.320
N	—	1.65	—	0.065
R	—	3.25	—	0.128
T	0.64	1.01	0.025	0.040

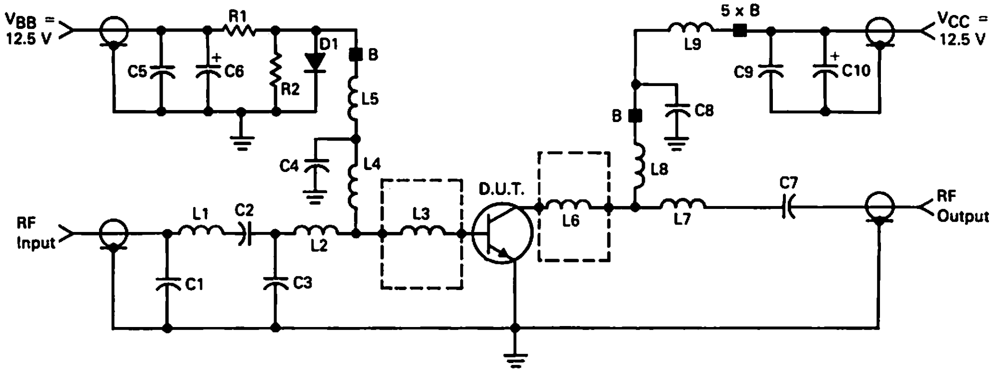
CASE 317D-02

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz) Figure 1,2	G_{pe}	11.5	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz) Figure 1,2	η	50	60	—	%
Load Mismatch Stress (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 175 MHz, VSWR ≥ 10:1 All Phase Angles)	ψ	No Degradation in Output Power			—

FIGURE 1 — 140-175 MHz BROADBAND CIRCUIT SCHEMATIC



C1 — 36 pF Mini Underwood
C2 — 47 pF Mini Underwood
C3 — 91 pF Mini Underwood
C4 — 68 pF Mini Underwood
C5, C9 — 1.0 μF Erie Red Cap Capacitor
C6, C10 — 0.1 μF, 35 V Tantulum
C7 — 470 pF Chip Capacitor
C8 — 2200 pF Chip Capacitor
R1 — 4.7 kΩ, 1/4 W
R2 — 100 Ω, 1/4 W
D1 — 1N4148 Diode

L1 — 3 Turns, #18 AWG, 0.210" ID, 3/16" Length
L2, L4, L7 — 0.62", #18 AWG Wire Bent into "V"
L3, L6 — 60 x 125 x 250 Mils Copper Pad on 27 Mils Thick Alumina Substrate
L5 — 12 μH Molded Choke
L8 — 7 Turns, #18 AWG, 0.170" ID, 7/16" Length
L9 — 1.0", #18 AWG Wire with 5 Ferrite Beads
B — Ferrite Bead
Board Material — Glass Teflon, ϵ_r = 2.56, t = 0.0625" (See Photomaster, Figure 3)

FIGURE 2 — 140–175 MHZ BROADBAND CIRCUIT

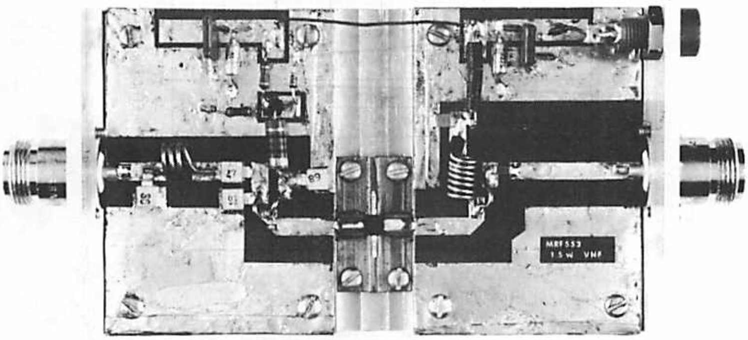
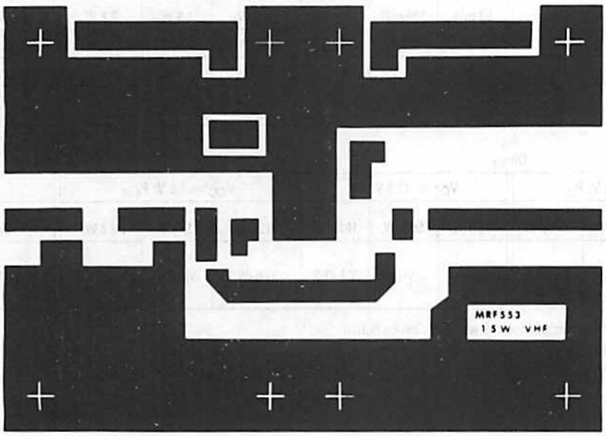


FIGURE 3 — 140–175 MHz TEST CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 4 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT

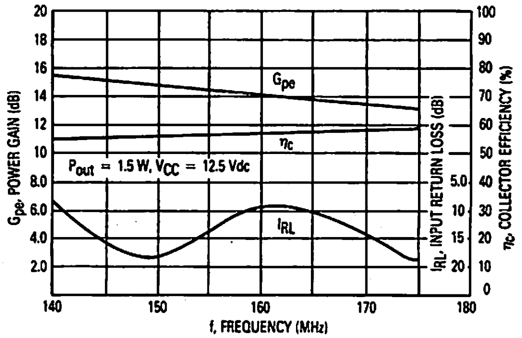


FIGURE 5 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f Frequency MHz	Z_{in} Ohms						Z_{OL}* Ohms					
	V_{CC} = 7.5 V; P_{in}			V_{CC} = 12.5 V; P_{in}			V_{CC} = 7.5 V; P_{out}			V_{CC} = 12.5 V; P_{out}		
	100 mW	200 mW	300 mW	50 mW	100 mW	150 mW	1.0 W	1.6 W	2.2 W	1.1 W	2.0 W	2.6 W
140	1.65–j3.6	2.0–j2.6	2.3–j1.2	1.7–j4.1	1.8–j3.1	1.9–j2.7	9.9–j11.1	10.6–j5.1	10–j4.9	28.3–j21.5	16–j20.5	16.3–j16.5
175	2.5–j5.6	2.3–j5.9	2.8–j4.0	2.3–j4.6	2.4–j1.2	2.4–j5.7	12.1–j14.9	7.2–j9.8	8.1–j5.4	30.8–j23.3	11.4–j20.9	11.1–j14.3

f Frequency MHz	Z_{in} Ohms						Z_{OL}* Ohms					
	V_{CC} = 7.5 V; P_{in}			V_{CC} = 12.5 V; P_{in}			V_{CC} = 7.5 V; P_{out}			V_{CC} = 12.5 V; P_{out}		
	50 mW	100 mW	200 mW	25 mW	50 mW	100 mW	1.25 W	1.5 W	2.0 W	1.5 W	2.25 W	3.0 W
90	2.5–j9.3	2.5–j6.4	2.5–j4.4	1.6–j10.7	2.5–j7.1	2.2–j1.3	31.8–j9.2	32–j8.9	30.2–j10.7	45.8–j7.2	45.2–j3.9	40–j4.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

FIGURE 6 — POWER OUTPUT versus POWER INPUT

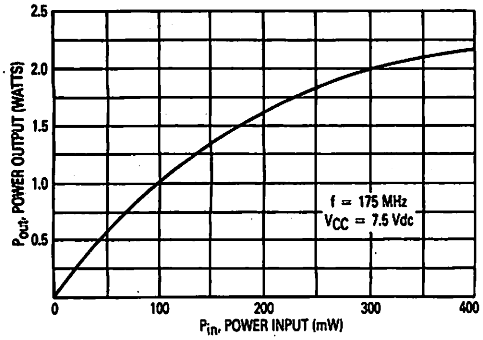


FIGURE 7 — POWER OUTPUT versus POWER INPUT

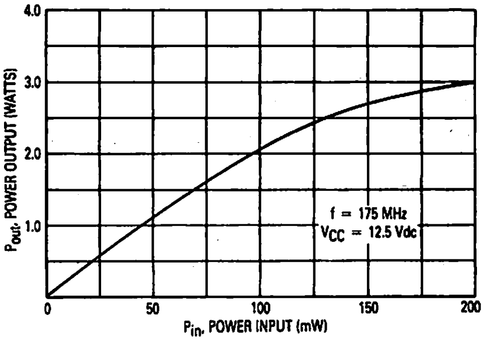


FIGURE 8 — POWER OUTPUT versus FREQUENCY

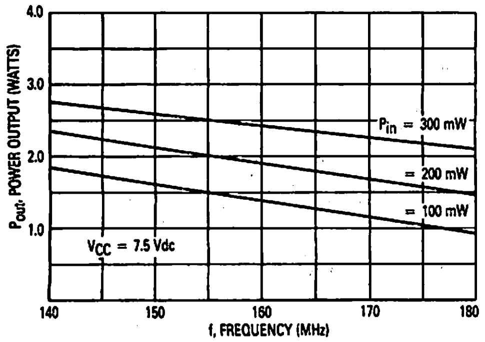


FIGURE 9 — POWER OUTPUT versus FREQUENCY

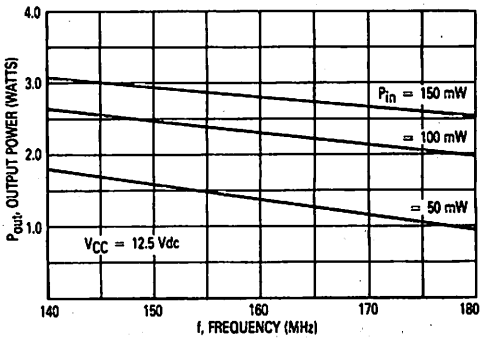


FIGURE 10 — POWER OUTPUT versus COLLECTOR VOLTAGE

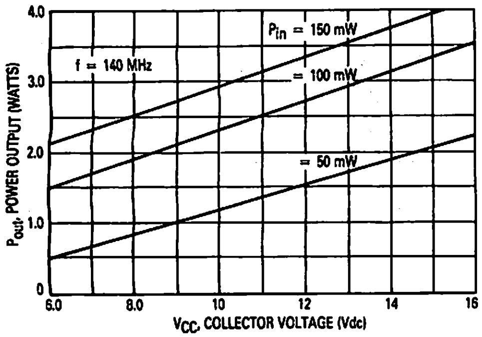
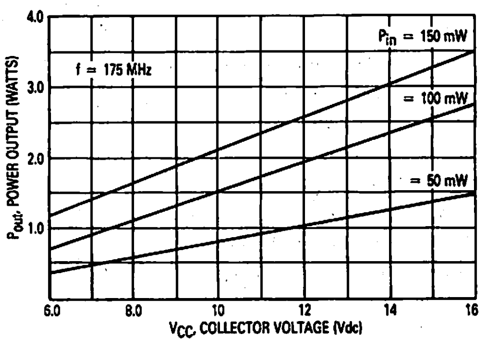


FIGURE 11 — POWER OUTPUT versus COLLECTOR VOLTAGE



2

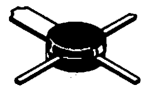
MRF555

The RF Line
NPN Silicon
RF Low Power Transistor

... designed primarily for wideband large signal predriver stages in the UHF frequency range.

- Specified @ 12.5 V, 470 MHz Characteristics @ P_{out} = 1.5 W
  Common Emitter Power Gain = 12.5 dB (Typ)
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability

**1.5 W 470 MHz
RF LOW POWER
TRANSISTOR
NPN SILICON**



CASE 317D-02, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	400	mAdc
Operating Junction Temperature	T_J	150	°C
Total Device Dissipation @ T_C = 75°C (1,2) Derate above 75°C	P_D	3 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

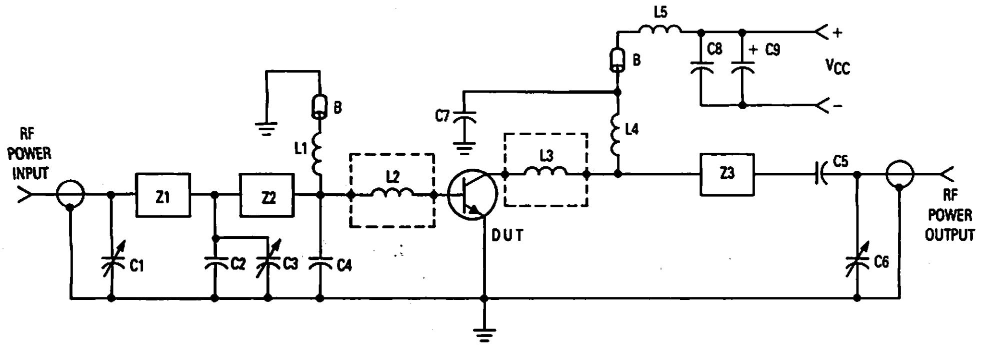
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5 Vdc)	h_{FE}	50	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	3.5	5	pF
FUNCTIONAL TESTS (f = 470 MHz)					
Common-Emitter Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W)	G_{pe}	11	12.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W)	η_c	50	60	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 125 mW, VSWR ≥ 10:1 all phase angles)	ψ	No Degradation in Output Power			

(1) T_C, Case temperature, measured on collector lead immediately adjacent to body of package.
(2) The MRF555 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.



*C1, C3, C6 — 0.8–11 pF Johanson
C2 — 15 pF Clamped Mica, Mini-Underwood
C4 — 36 pF Clamped Mica, Mini-Underwood
C5 — 470 pF Ceramic Chip Capacitor
C7 — 91 pF Clamped Mica, Mini-Underwood
C8 — 68 pF Clamped Mica, Mini-Underwood
C9 — 1 μF, 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B

*Fixed tuned for broadband response.

L1 — 5 Turns #21 AWG, 5/32" I.D.
L2, L3 — 60 x 125 x 250 Mils Copper Pad on 27 Mil Thick Alumina Substrate
L4, L5 — 7 Turns #21 AWG 5/32" I.D
Z1 — 1.29" x 0.16" Microstrip
Z2 — 0.70" x 0.16" Microstrip
Z3 — 2.18" x 016" Microstrip
PCB — 1/16" Glass Teflon, 1 oz. cu. clad, double sided, ϵ_r = 2.5
(See Figure 5 — Photomaster)

Figure 1. 400–512 MHz Broadband Circuit

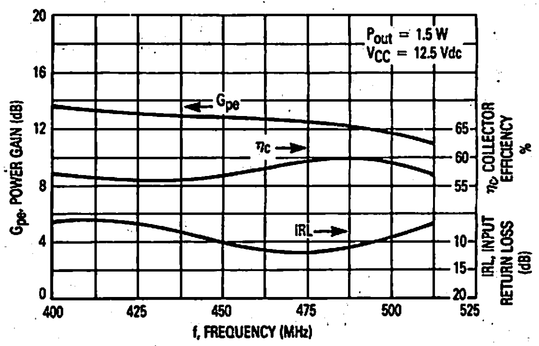


Figure 2. Performance in Broadband Circuit

f Frequency MHz	Z_{in} Ohms V_{CC} = 7.5 V P_{in} = 100 mW	Z_{in} Ohms V_{CC} = 12.5 V P_{in} = 50 mW	Z_{OL}* Ohms V_{CC} = 7.5 V P_{out} 400 MHz = 1.5 W, P_{out} 450 MHz = 1.35 W, P_{out} 512 MHz = 1.05 W	Z_{OL}* Ohms V_{CC} = 12.5 V P_{out} 400 MHz = 1.9 W, P_{out} 450 MHz = 1.45 W, P_{out} 512 MHz = 0.9 W
400	2.9 – j2.7	1.9 – j3.1	18.0 – j13.4	12.2 – j19.7
450	2.2 – j0.8	2.6 – j4.0	21.6 – j9.9	20.2 – j18.6
512	3.5 – j1.2	2.6 – j2.6	20.1 – j1.0	23.4 – j23.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 3. Z_{in} and Z_{OL} versus Collector Voltage, Input Power and Output Power

2

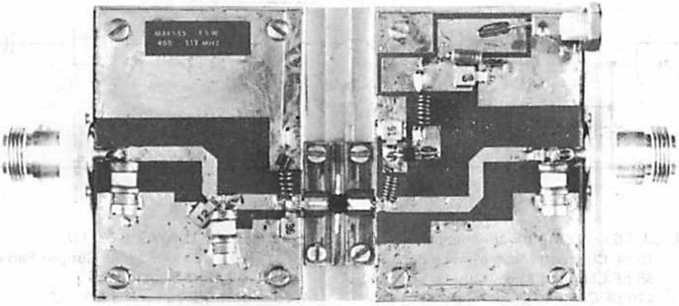
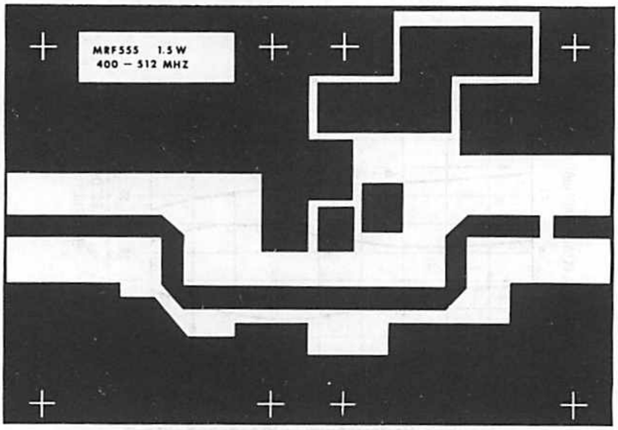


Figure 4. 400–512 MHz Broadband Circuit



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 5. 400–512 MHz Broadband Circuit Photomaster

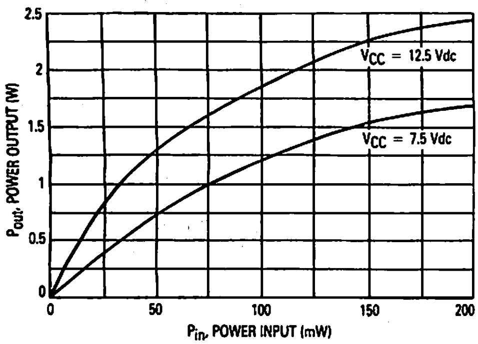


Figure 6. Power Output versus Power Input

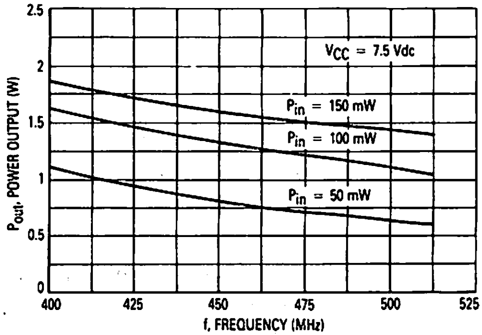


Figure 7. Power Output versus Frequency

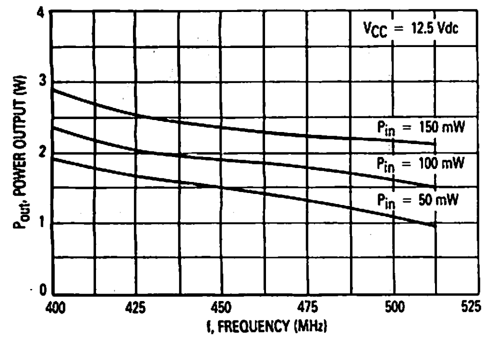


Figure 8. Power Output versus Frequency

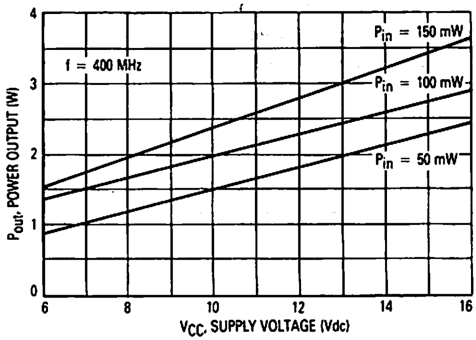


Figure 9. Power Output versus Supply Voltage

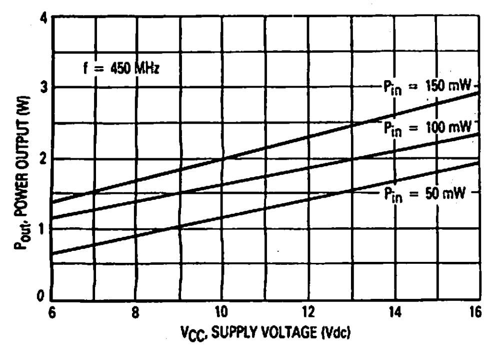


Figure 10. Power Output versus Supply Voltage

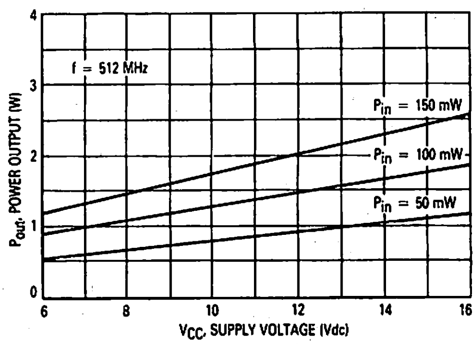


Figure 11. Power Output versus Supply Voltage

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF557

The RF Line

2

1.5 W 870 MHz

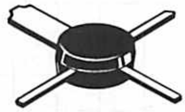
RF LOW POWER TRANSISTOR

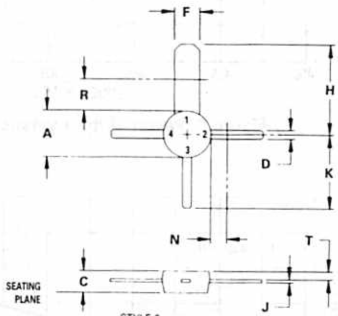
NPN SILICON

NPN SILICON RF LOW POWER TRANSISTOR

. . . designed primarily for wideband large signal predriver stages in the 800 MHz frequency range.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 1.5 W
  Minimum Gain = 8.0 dB
  Efficiency 60% (Typ)
- Cost Effective PowerMacro Package
- Electroless Tin Plated Leads for Improved Solderability





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. LEAD DIMENSIONS UNCONTROLLED WITHIN DIMENSION N AND R.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.45	5.20	0.175	0.205
C	1.91	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	2.46	2.64	0.097	0.104
H	8.84	9.72	0.348	0.383
J	0.21	0.30	0.008	0.012
K	7.24	8.12	0.285	0.320
N	—	1.65	—	0.065
R	—	3.25	—	0.128
T	0.64	1.01	0.025	0.040

CASE 317D-02

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_C = 75°C (1,2) Derate above 75°C	P_D	3.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

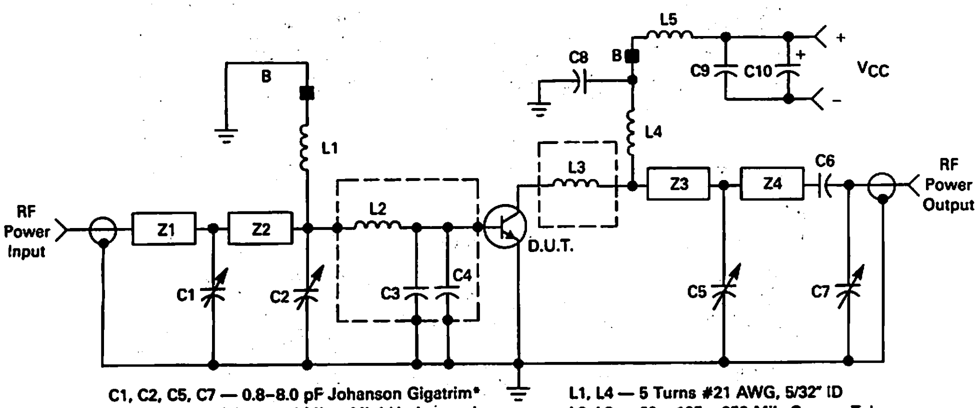
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

(1) T_C, Case temperature measured on collector lead immediately adjacent to body of package.
(2) The MRF557 PowerMacro must be properly mounted for reliable operation. AN938, "Mounting Techniques in PowerMacro Transistor," discusses methods of mounting and heatsinking.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.5	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain Figures 1, 2 (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 870 MHz)	G_{pe}	8.0	9.0	—	dB
Collector Efficiency Figures 1, 2 (V_{CC} = 12.5 Vdc, P_{out} = 1.5 W, f = 870 MHz)	η_C	55	60	—	%
Load Mismatch Stress Figures 1, 2 (V_{CC} = 15.5 Vdc, P_{in} = 225 mW, f = 870 MHz, VSWR ≥ 10:1 all phase angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 800–880 MHz BROADBAND CIRCUIT



C1, C2, C5, C7 — 0.8–8.0 pF Johanson Gigatrim*
C3, C4 — 15 pF Clamped Mica, Mini-Underwood
C6 — 27 pF Clamped Mica, Mini-Underwood
C8 — 91 pF Clamped Mica, Mini-Underwood
C9 — 68 pF Clamped Mica, Mini-Underwood
C10 — 1.0 μF, 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B
PCB — 1/16" Glass Teflon, ϵ_r = 2.56 (See Photomaster Figure 3)

L1, L4 — 5 Turns #21 AWG, 5/32" ID
L2, L3 — 60 x 125 x 250 Mils Copper Tab on 27 Mil Thick Alumina Substrate
L5 — 7 Turns #21 AWG, 5/32" ID
Z1 — 1.65 x 0.163" Microstrip, Z_o = 50 Ω
Z2 — 0.85 x 0.163" Microstrip, Z_o = 50 Ω
Z3 — 0.625 x 0.163" Microstrip, Z_o = 50 Ω
Z4 — 1.35 x 0.163" Microstrip, Z_o = 50 Ω

*Fixed tuned for broadband response.

FIGURE 2 — 800–880 MHz BROADBAND CIRCUIT

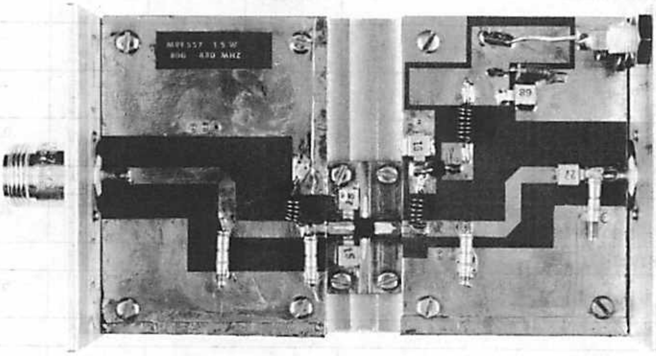
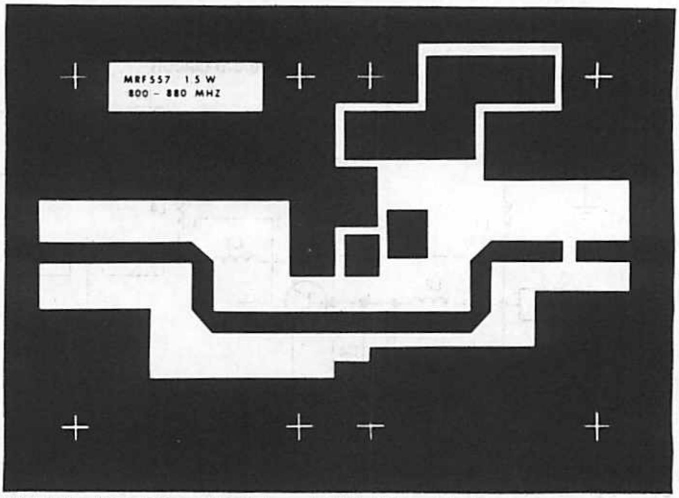
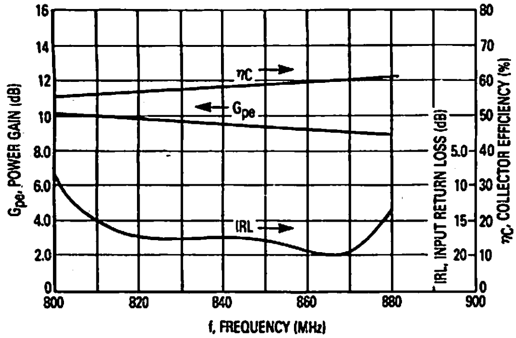


FIGURE 3 — 800–880 MHz TEST CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 4 — PERFORMANCE IN BROADBAND CIRCUIT



2

FIGURE 5 — Z_{in} and Z_{ol} versus COLLECTOR VOLTAGE, INPUT POWER AND OUTPUT POWER

f FREQUENCY MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 300 mW	P_{in} = 200 mW	P_{out} 806 MHz = 1.7 W P_{out} 870 MHz = 1.4 W P_{out} 960 MHz = 1.0 W	P_{out} 806 MHz = 2.1 W P_{out} 870 MHz = 1.8 W P_{out} 960 MHz = 1.1 W
806	2.4 + j3.9	2.4 + j3.1	14.7 − j4.4	13.6 − j12.8
870	2.5 + j4.6	2.7 + j3.7	17.2 − j8.6	16 − j13.2
960	6.1 + j7.4	6.8 + j8.3	40 − j8.3	38 − j10.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

FIGURE 6 — POWER OUTPUT versus POWER INPUT

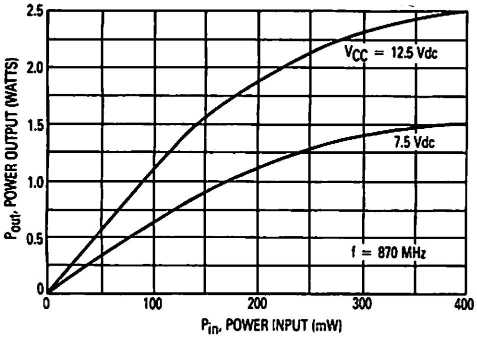


FIGURE 7 — POWER OUTPUT versus FREQUENCY

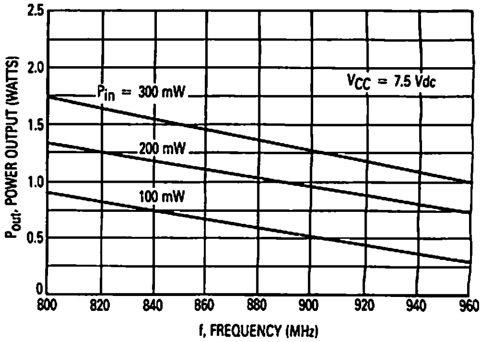


FIGURE 8 — POWER OUTPUT versus FREQUENCY

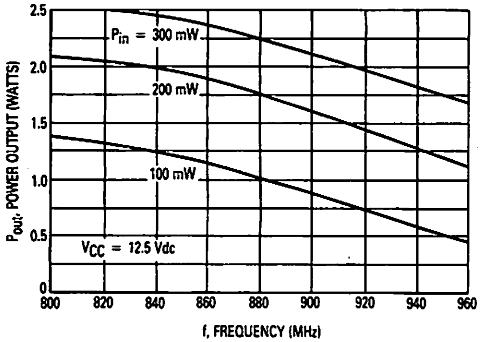


FIGURE 9 — POWER OUTPUT versus SUPPLY VOLTAGE

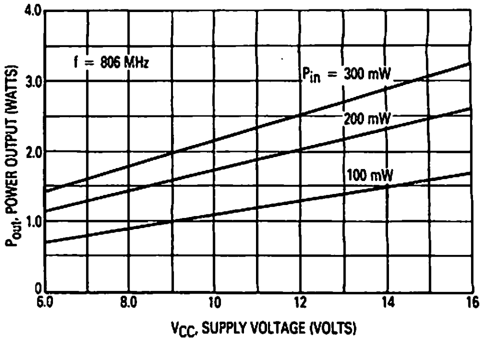


FIGURE 10 — POWER OUTPUT versus SUPPLY VOLTAGE

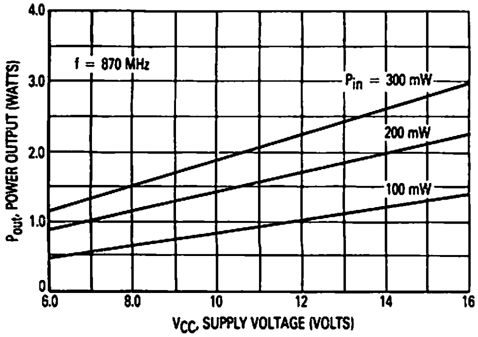
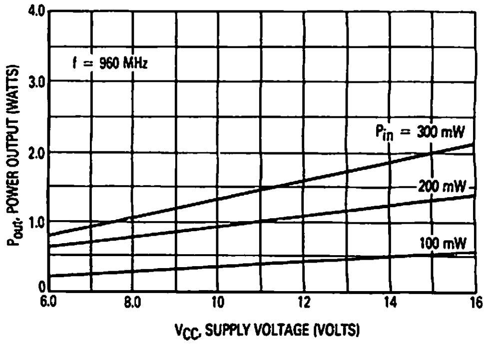


FIGURE 11 — POWER OUTPUT versus SUPPLY VOLTAGE



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF559

The RF Line

0.5 W — 870 MHz

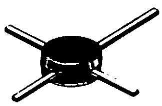
HIGH FREQUENCY TRANSISTOR

NPN SILICON

NPN SILICON HIGH FREQUENCY TRANSISTOR

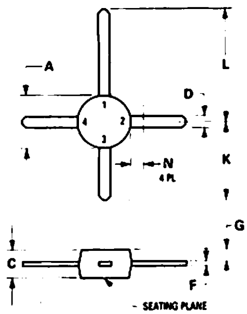
. . . designed for UHF linear and large-signal amplifier applications.

- Specified 12.5 Volt, 870 MHz Characteristics —
  Output Power = 0.5 Watts
  Minimum Gain = 8.0 dB
  Efficiency = 50%
- S Parameter Data From 250 MHz to 1.5 GHz
- 1.0 dB Compression > +20 dBm Typ
- Ideally Suited for Broadband, Class A, Low-Noise Applications
- Recommended As Driver for MHW808 and MHW820, 806–870 MHz Power Modules



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector-Current — Continuous	I_C	150	mAdc
Total Device Dissipation @ T_C = 50°C Derate above 50°C	P_D	2.0 20	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C



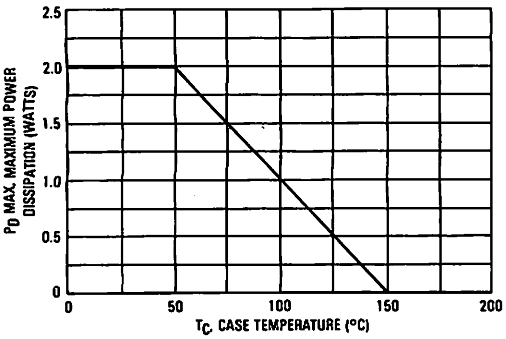
STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

POWER DISSIPATION

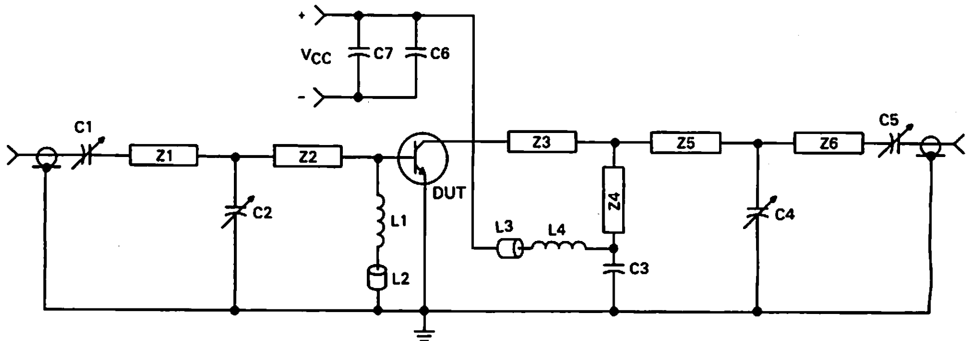


2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 200 MHz)	f_T	—	3000	—	MHz
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W) f = 870 MHz f = 512 MHz	G_{PE}	8.0 —	9.5 13	— —	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W) f = 870 MHz f = 512 MHz	η	50 —	65 60	— —	%
TYPICAL PERFORMANCE @ V_{CC} = 7.5 V					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W) f = 870 MHz f = 512 MHz	G_{PE}	— —	6.5 10	— —	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W) f = 870 MHz f = 512 MHz	η	— —	70 65	— —	%

FIGURE 1 — 870 MHz TEST FIXTURE



C1, C2, C4, C5 — 1.0-10 pF Johanson
C3, C6 — 0.001 μF Chip Capacitor
C7 — 1.0 μF Tantulam
L1, L4 — 4 Turns #26 AWG, 0.3 cm ID, 0.4 cm Long
L2, L3 — Ferrite Bead
Microstrip Elements — ϵ_r = 1.0

Z1 — 50 Ω 1.5 cm
Z2 — 30 Ω 2.5 cm
Z3 — 50 Ω 2.0 cm
Z4 — 50 Ω 1.2 cm
Z5, Z6 — 50 Ω 1.25 cm

FIGURE 2 — OUTPUT POWER versus INPUT POWER
f = 512 MHz

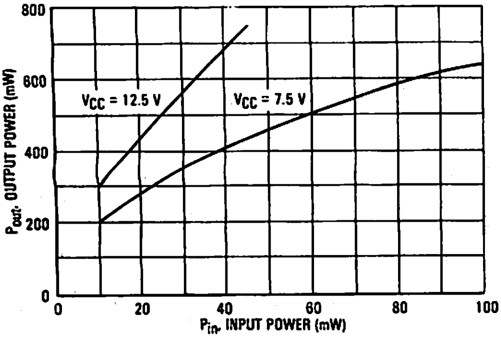


FIGURE 3 — OUTPUT POWER versus FREQUENCY
VCC = 7.5 V

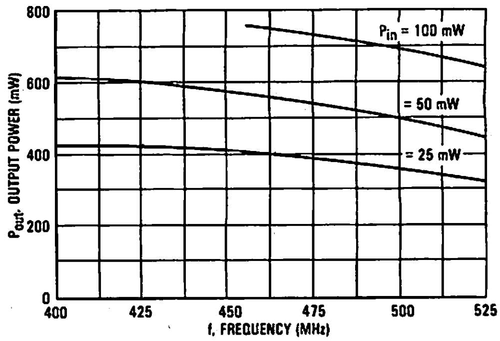


FIGURE 4 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 512 MHz

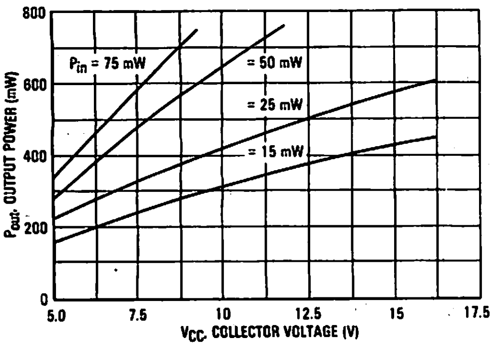


FIGURE 5 — OUTPUT POWER versus FREQUENCY
VCC = 12.5 V

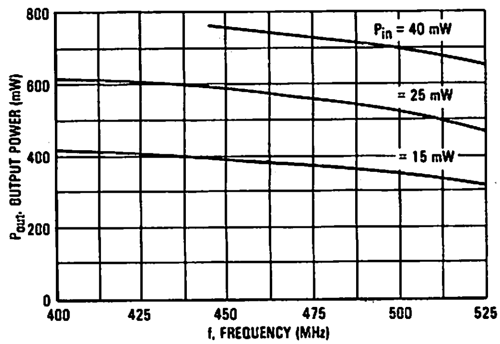


FIGURE 6 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f FREQUENCY MHz	Z_{in} OHMS			Z_{OL}* OHMS					
	V_{CC} = 7.5-12.5 V			V_{CC} = 7.5 V			V_{CC} = 12.5 V		
	15 mW	25 mW	50 mW	0.25 W	0.50 W	0.75 W	0.25 W	0.50 W	0.75 W
400	4.3 - j13.3	4.9 - j11.0	5.7 - j8.7	31 - j49	44 - j34	42 - j4.9	20 - j68	42 - j60	52 - j54
440	3.9 - j8.8	4.5 - j8.7	5.4 - j6.9	27 - j42	39 - j30	40 - j6.9	19 - j62	37 - j54	49 - j50
480	3.5 - j4.4	4.1 - j6.5	5.0 - j4.3	24 - j36	36 - j25	39 - j9.0	18 - j56	33 - j48	47 - j46
520	3.2 - j2.2	3.8 - j4.3	4.7 - j1.7	22 - j30	34 - j20	37 - j12	17 - j52	31 - j44	47 - j42

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — OUTPUT POWER versus INPUT POWER
f = 870 MHz

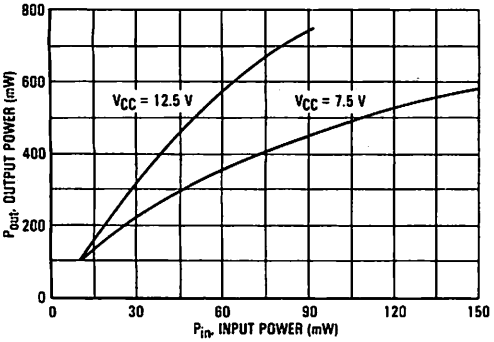


FIGURE 8 — OUTPUT POWER versus FREQUENCY
V_{CC} = 7.5 V

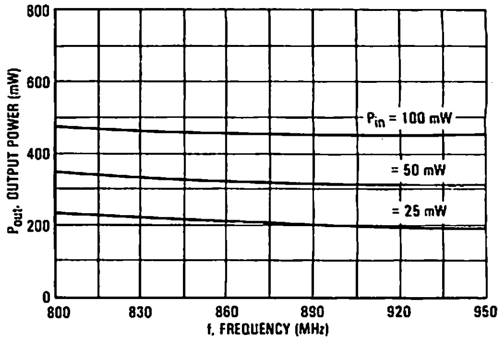


FIGURE 9 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 870 MHz

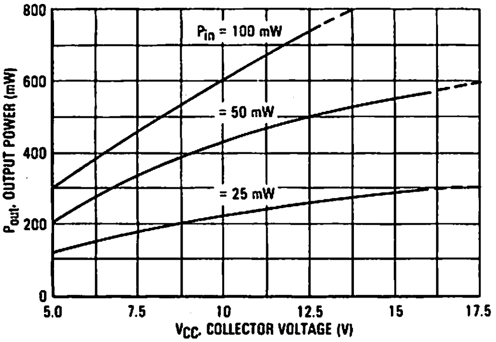


FIGURE 10 — OUTPUT POWER versus FREQUENCY
V_{CC} = 12.5 V

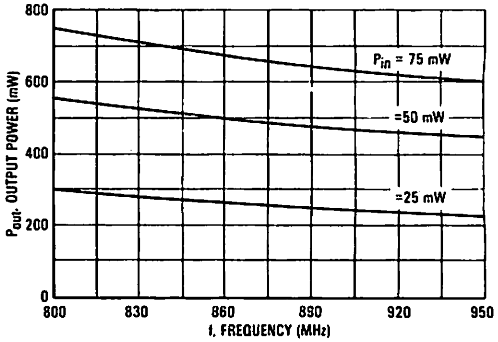
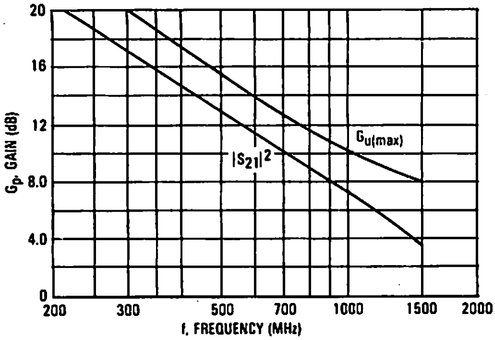


FIGURE 11 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f FREQUENCY MHz	Z_{in} OHMS			Z_{OL}* OHMS					
	V_{CC} = 7.5-12.5 V			V_{CC} = 7.5 V			V_{CC} = 12.5 V		
	25 mW	50 mW	100 mW	0.25 W	0.50 W	0.75 W	0.25 W	0.50 W	0.75 W
800	2.9 + j2.2	3.8 + j4.4	4.7 + j6.5	15.0 - j36.8	22.7 - j30.6	27.1 - j22.6	14.6 - j43.6	17.2 - j39.7	23.4 - j37.7
850	3.2 + j3.5	3.8 + j5.2	4.8 + j7.4	15.7 - j35.3	23.9 - j28.7	27.3 - j21.5	16.3 - j40.8	17.8 - j39.5	23.7 - j36.8
900	3.8 + j5.7	4.4 + j7.0	5.4 + j8.7	16.4 - j33.7	25.1 - j27.0	27.5 - j20.5	17.3 - j38.2	18.3 - j39.3	23.9 - j36.0
950	4.1 + j7.4	4.5 + j8.8	5.5 + j10.1	17.0 - j32.2	26.3 - j25.2	27.6 - j19.4	17.2 - j36.1	20.1 - j38.5	24.5 - j35.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 12 — GAIN versus FREQUENCY
V_{CE} = 10 V, I_C = 50-100 mA



$$G_{u(max)} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)\ (1-|S_{22}|^2)}$$

FIGURE 13 — GAIN versus COLLECTOR CURRENT
V_{CE} = 10 V

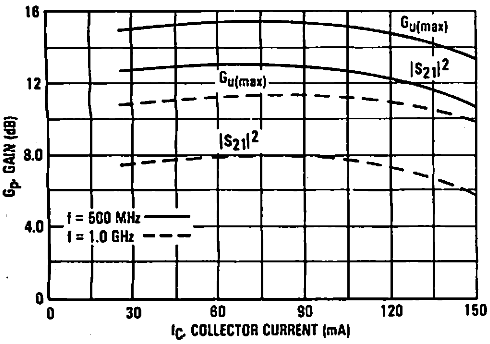


FIGURE 14 — NOISE FIGURE AND ASSOCIATED GAIN versus COLLECTOR CURRENT
V_{CE} = 10 V

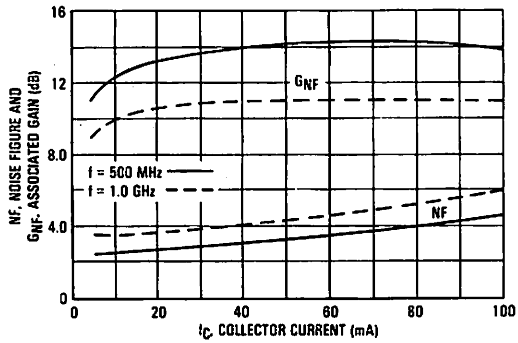


FIGURE 15 — CURRENT GAIN BANDWIDTH PRODUCT versus COLLECTOR CURRENT
V_{CE} = 10 V

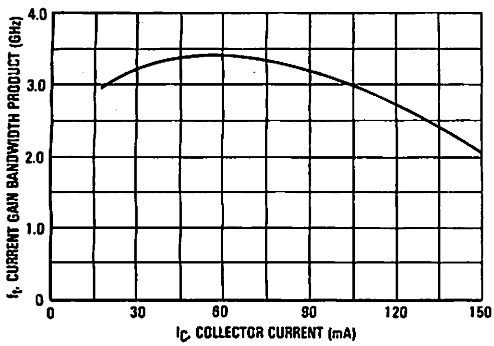


FIGURE 16 — OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE

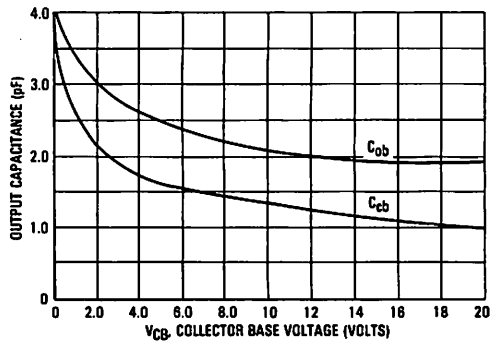


FIGURE 17 — COMMON EMITTER SCATTERING PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	10	250	0.72	-161	6.20	93	0.057	30	0.30	-91
		500	0.73	179	3.16	76	0.069	43	0.27	-94
		1000	0.76	158	1.62	55	0.105	63	0.27	-119
		1500	0.82	142	1.08	41	0.155	70	0.41	-137
	25	250	0.70	-173	7.17	89	0.045	47	0.26	-123
		500	0.70	172	3.63	75	0.073	60	0.20	-128
		1000	0.74	152	1.90	54	0.134	67	0.21	-157
		1500	0.79	136	1.32	39	0.196	66	0.32	-167
	50	250	0.72	-178	7.63	89	0.038	56	0.27	-139
		500	0.72	170	3.85	77	0.068	67	0.23	-141
		1000	0.75	153	2.01	59	0.129	72	0.23	-162
		1500	0.81	137	1.40	46	0.188	70	0.32	-164
	100	250	0.73	179	7.34	88	0.036	61	0.26	-143
		500	0.74	169	3.70	77	0.067	71	0.22	-144
		1000	0.76	153	1.94	59	0.130	74	0.24	-166
		1500	0.81	138	1.36	46	0.191	71	0.32	-167
	150	250	0.78	176	5.19	92	0.033	64	0.22	-131
		500	0.78	167	2.76	78	0.065	74	0.21	-131
		1000	0.80	151	1.49	58	0.129	77	0.24	-155
		1500	0.85	135	1.05	45	0.191	73	0.35	-161
10	10	250	0.69	-157	7.03	94	0.050	33	0.34	-67
		500	0.70	-178	3.59	77	0.060	46	0.32	-69
		1000	0.74	160	1.84	55	0.094	67	0.29	-94
		1500	0.81	142	1.20	41	0.148	76	0.42	-121
	25	250	0.67	-168	8.30	91	0.039	46	0.24	-93
		500	0.68	176	4.25	77	0.060	60	0.21	-89
		1000	0.72	158	2.19	57	0.109	71	0.19	-114
		1500	0.78	142	1.47	44	0.165	74	0.31	-134
	50	250	0.68	-174	8.88	90	0.035	55	0.21	-110
		500	0.68	172	4.49	77	0.060	67	0.18	-104
		1000	0.72	155	2.31	59	0.113	74	0.17	-128
		1500	0.77	139	1.58	46	0.169	74	0.28	-140
	100	250	0.68	-178	8.49	89	0.03	61	0.19	-104
		500	0.69	170	4.32	76	0.06	71	0.17	-97
		1000	0.72	153	2.25	58	0.12	76	0.17	-123
		1500	0.78	137	1.53	44	0.18	75	0.28	-137
	150	250	0.72	178	6.53	91	0.029	64	0.22	-71
		500	0.73	169	3.37	77	0.056	75	0.24	-75
		1000	0.76	152	1.79	57	0.112	80	0.22	-105
		1500	0.83	137	1.22	43	0.175	79	0.34	-129

FIGURE 18 — TUNABLE TEST FIXTURE

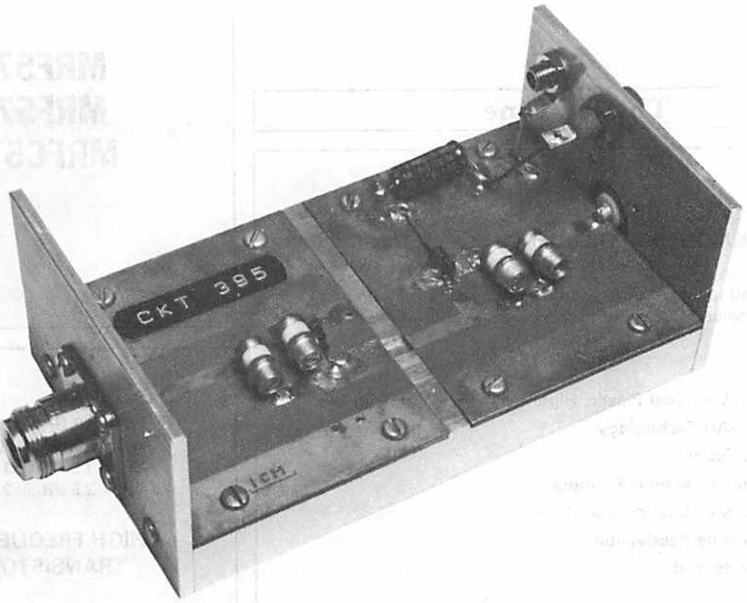
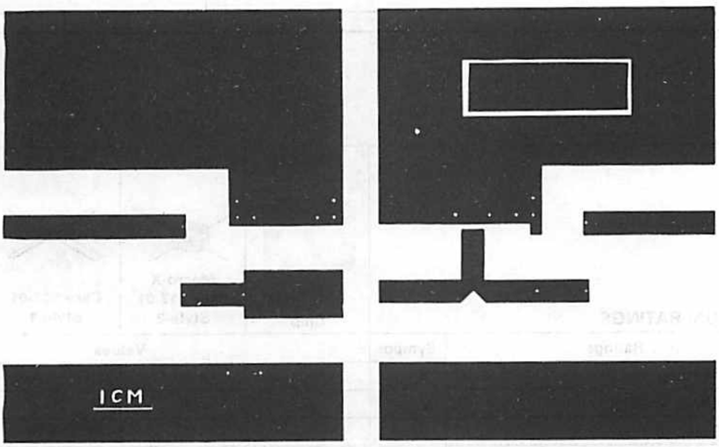


FIGURE 19 — PRINTED CIRCUIT BOARD LAYOUT



INPUT OUTPUT

NOTE: The Printed Circuit Board shown is 75% of the original.

2

MRF571
MRF572
MRFC572

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

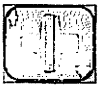
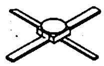
. . . designed for low-noise, wide dynamic range front end amplifiers, low-noise VCO's, and microwave power multipliers.

- Low Noise
- High Gain
- Available in Low Cost Plastic, High Reliability Ceramic or Die
- State-of-the-Art Technology
  - Fine Line Geometry
  - Ion Implanted Arsenic Emitters
  - Gold Top Metallization and Wires
  - Silicon Nitride Passivation
- Fully Characterized

f_T = 8.0 GHz @ 50 mA
NF = 1.0 dB @ 500 MHz
NF = 1.5 dB @ 1.0 GHz
NF = 2.5 dB @ 2.0 GHz

HIGH FREQUENCY TRANSISTORS

NPN SILICON

MAXIMUM RATINGS		MRFC572  Chip	MRF571  Macro-X Case 317-01 Style 2	MRF572  Case 303-01 Style 1	
Ratings	Symbol	Values			Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	3.0	3.0	Vdc
Collector Current — Continuous	I_C	70	70	70	mAdc
Total Device Dissipation @ T_C = 50°C(1) Derate above T_C = 50°C	P_D	1.5 T_J = 200°C max	1.0 10	0.75 5.0	Watts mW/°C
Storage Temperature	T_{stg}	−65 to +200	−65 to +150	−65 to +200	°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8.0 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 6.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.7	1.0	pF
Current Gain — Bandwidth Product (V_{CE} = 8.0 Vdc, I_C = 50 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz
FUNCTIONAL TESTS					
Gain @ Noise Figure (I_C = 10 mAdc, V_{CE} = 6.0 Vdc) f = 0.5 GHz	G_{NF}	—	16.5	—	dB
f = 1.0 GHz		10	12	—	
Noise Figure (I_C = 10 mAdc, V_{CE} = 6.0 Vdc) f = 0.5 GHz	NF	—	1.0	—	dB
f = 1.0 GHz		—	1.5	2.0	
MRF571 f = 2.0 GHz		—	2.8	—	
MRF572 f = 2.0 GHz		—	2.5	—	

FIGURE 1 — C_{cb}, COLLECTOR-BASE CAPACITANCE versus VOLTAGE

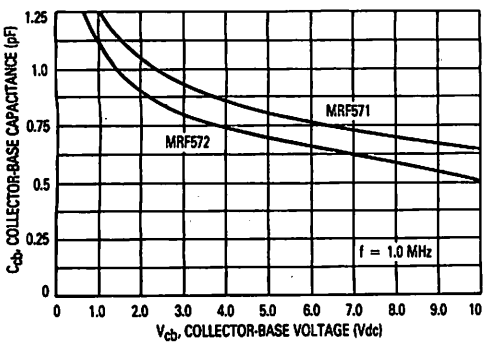


FIGURE 2 — C_{ib}, INPUT CAPACITANCE versus EMITTER BASE VOLTAGE

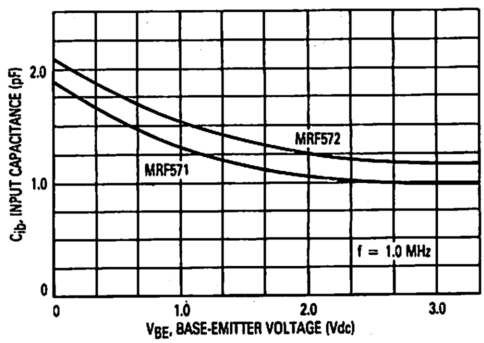


FIGURE 3 — MRF571 — GAIN AT NOISE FIGURE AND NOISE FIGURE versus FREQUENCY

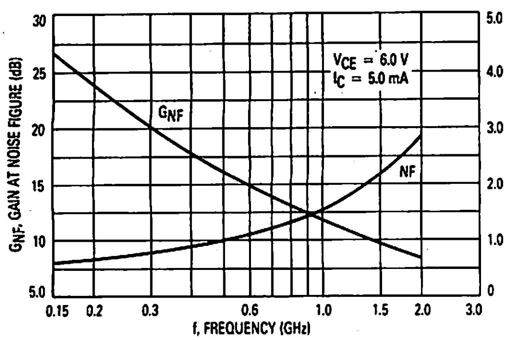


FIGURE 4 — MRF572 — GAIN AT NOISE FIGURE AND NOISE FIGURE versus FREQUENCY

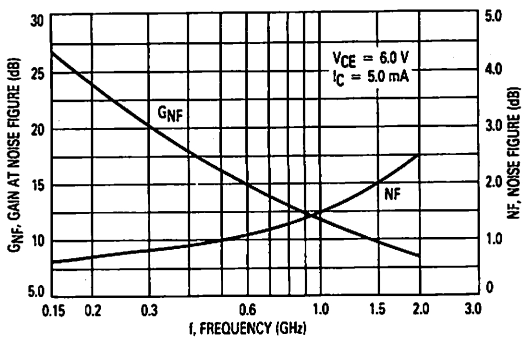


FIGURE 5 — MRF571 and MRF572 — GAIN AT NOISE FIGURE AND NOISE FIGURE versus COLLECTOR CURRENT

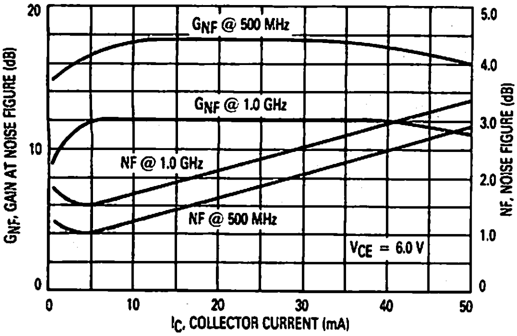
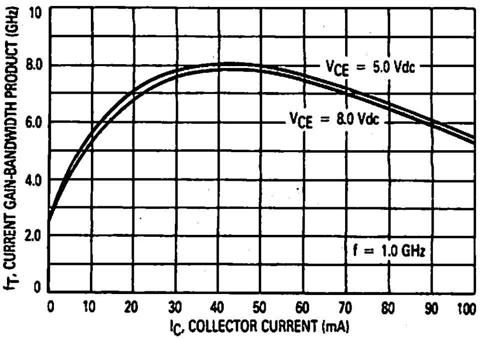


FIGURE 6 — f_T, CURRENT GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT



2

FIGURE 7 — G_{Amax}, MAXIMUM AVAILABLE GAIN versus FREQUENCY

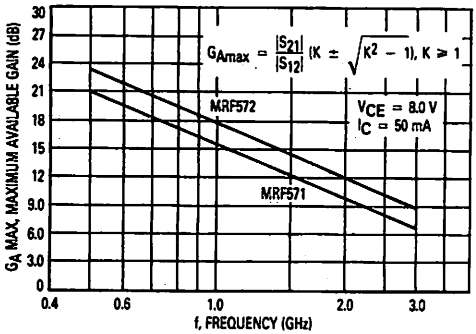


FIGURE 8 — 1.0 dB COMPRESSION PT. AND THIRD ORDER INTERCEPT

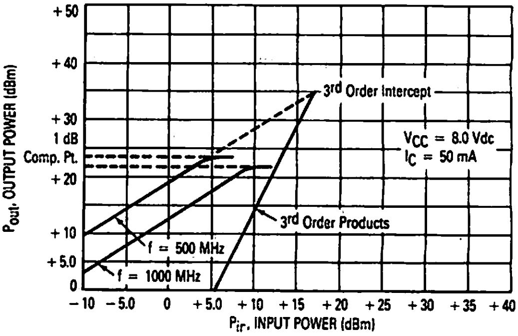


FIGURE 9 — MRF571 — G_{Umax} and $|S_{21}|^2$ versus FREQUENCY

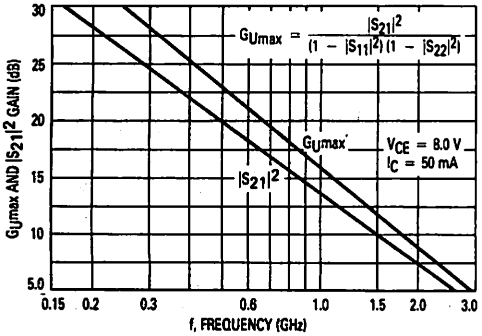
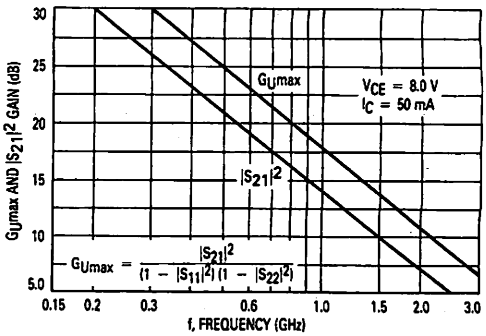
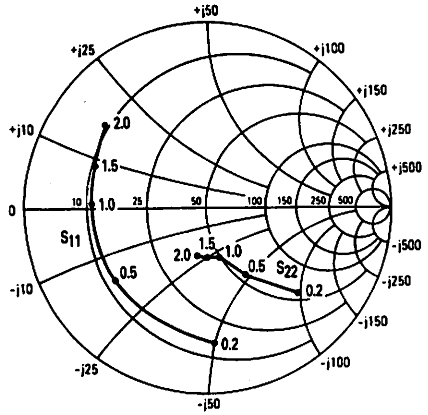


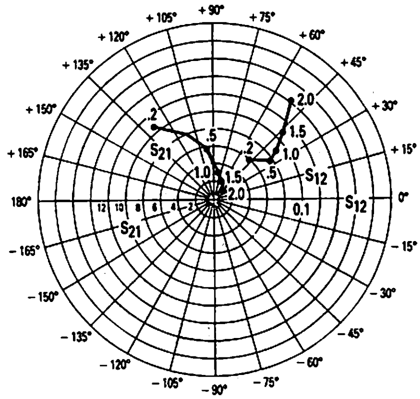
FIGURE 10 — MRF572 — G_{Umax} and $|S_{21}|^2$ versus FREQUENCY



MRF571
INPUT/OUTPUT REFLECTION COEFFICIENTS
versus FREQUENCY (GHz)
V_{CE} = 6.0 V, I_C = 5.0 mA



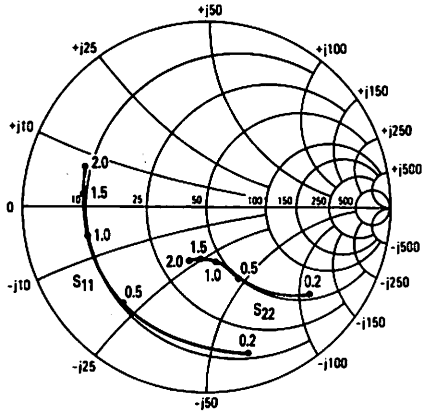
MRF571
FORWARD/REVERSE TRANSMISSION
COEFFICIENTS versus FREQUENCY (GHz)
V_{CE} = 6.0 V, I_C = 5.0 mA



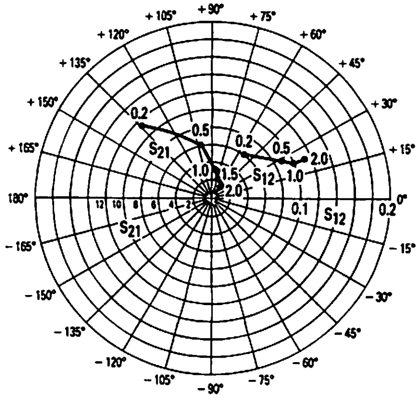
MRF571 COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6.0	5.0	200	0.74	−86	10.5	129	0.06	48	0.69	−42
		500	0.62	−143	5.5	97	0.08	33	0.41	−59
		1000	0.61	178	3.0	78	0.09	37	0.28	−69
		1500	0.65	158	2.0	62	0.11	44	0.26	−88
		2000	0.70	140	1.6	51	0.14	51	0.27	−99
	10	200	0.64	−111	15	118	0.04	44	0.53	−59
		500	0.58	−160	6.9	93	0.06	42	0.27	−77
		1000	0.59	168	3.7	77	0.09	52	0.16	−91
		1500	0.63	151	2.5	64	0.12	56	0.16	−113
		2000	0.67	134	2.0	53	0.16	57	0.16	−118
	50	200	0.56	−160	20.4	102	0.02	57	0.27	−98
		500	0.57	176	8.4	86	0.05	67	0.14	−130
		1000	0.60	156	4.4	75	0.09	70	0.11	−164
		1500	0.62	152	2.9	64	0.13	68	0.13	−175
		2000	0.66	127	2.4	53	0.18	62	0.11	−178
8.0	5.0	200	0.75	−83	10.7	129	0.06	49	0.71	−39
		500	0.62	−140	5.1	98	0.08	34	0.43	−54
		1000	0.60	−179	3.7	78	0.09	38	0.31	−62
		1500	0.64	159	2.1	62	0.10	45	0.29	−80
		2000	0.69	141	1.7	52	0.13	52	0.29	−91
	10	200	0.64	−99	15.1	120	0.05	46	0.54	−60
		500	0.52	−152	7.1	94	0.07	45	0.32	−75
		1000	0.52	170	3.7	76	0.10	54	0.15	−82
		1500	0.52	150	2.5	62	0.13	56	0.16	−108
		2000	0.57	133	2.0	51	0.18	55	0.16	−107
	50	200	0.52	−153	19.6	102	0.03	56	0.28	−92
		500	0.52	178	8.1	86	0.05	67	0.16	−98
		1000	0.56	157	4.1	73	0.10	70	0.06	−130
		1500	0.54	139	2.8	62	0.13	68	0.11	−146
		2000	0.59	126	2.2	52	0.19	63	0.10	−137

MRF572
INPUT/OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (GHz)
V_{CE} = 6.0 V, I_C = 5.0 mA



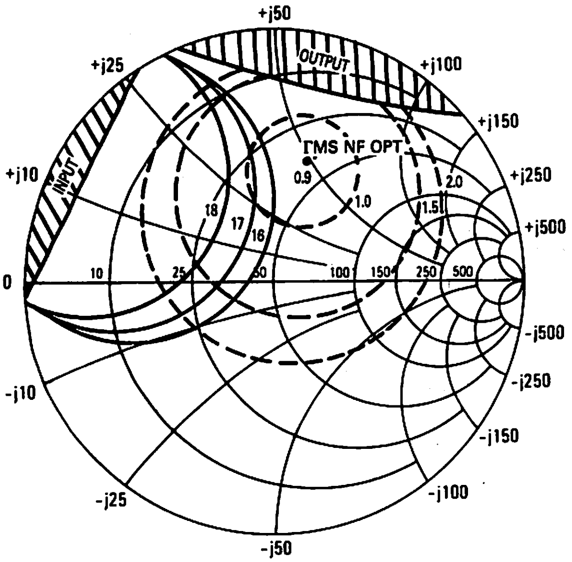
MRF572
FORWARD/REVERSE COEFFICIENTS versus FREQUENCY (GHz)
V_{CE} = 6.0 V, I_C = 5.0 mA



MRF572 COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6.0	5.0	200	0.81	−73	10.9	134	0.06	50	0.74	−40
		500	0.68	−130	6.1	102	0.09	29	0.43	−64
		1000	0.66	−167	3.3	79	0.10	22	0.29	−77
		1500	0.66	174	2.3	63	0.10	22	0.27	−94
		2000	0.68	161	1.8	49	0.11	23	0.29	−104
	10	200	0.72	−101	15.9	123	0.05	43	0.57	−58
		500	0.66	−150	7.7	95	0.06	30	0.29	−86
		1000	0.66	−178	4.0	77	0.08	33	0.19	−103
		1500	0.67	166	2.7	63	0.09	36	0.19	−122
		2000	0.69	155	2.1	51	0.10	37	0.20	−129
	50	200	0.67	−154	21.8	104	0.02	43	0.30	−94
		500	0.68	−177	9.0	87	0.03	52	0.17	−129
		1000	0.70	167	4.5	74	0.06	58	0.14	−151
		1500	0.71	157	3.0	62	0.08	59	0.16	−160
		2000	0.73	148	2.3	51	0.10	55	0.17	−161
8.0	5.0	200	0.83	−69	10.9	136	0.06	52	0.75	−36
		500	0.71	−125	6.3	103	0.08	30	0.46	−57
		1000	0.64	−164	3.5	80	0.09	24	0.31	−68
		1500	0.65	176	2.4	63	0.10	23	0.29	−84
		2000	0.66	163	1.8	49	0.11	24	0.30	−94
	10	200	0.74	−94	16.2	125	0.05	45	0.60	−51
		500	0.65	−146	7.9	96	0.06	32	0.31	−74
		1000	0.64	−176	4.2	77	0.07	33	0.20	−87
		1500	0.65	168	2.8	63	0.09	36	0.19	−104
		2000	0.67	156	2.2	50	0.10	37	0.20	−111
	50	200	0.62	−150	22.7	104	0.02	43	0.30	−81
		500	0.64	−174	9.4	86	0.03	51	0.15	−107
		1000	0.68	167	4.8	74	0.05	58	0.10	−126
		1500	0.69	160	3.2	61	0.07	58	0.13	−140
		2000	0.70	147	2.4	50	0.09	55	0.15	−140

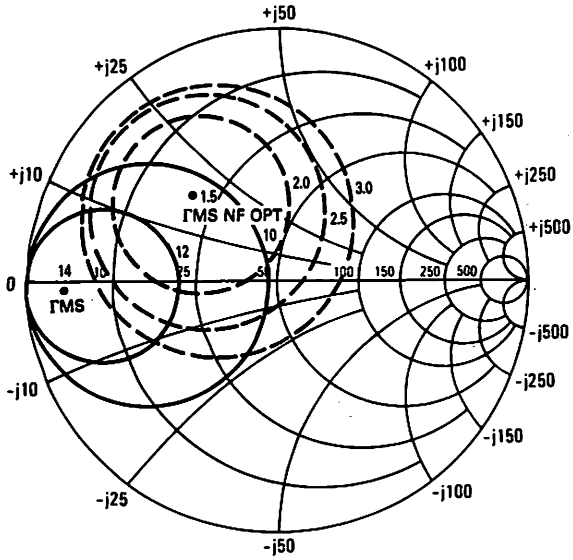
MRF571 — CONSTANT GAIN and NOISE FIGURE CONTOURS



V_{CE} = 6.0 V, I_C = 5.0 mA
f = 500 MHz
— REGION OF INSTABILITY

f(GHz)	NF OPT(dB)	Rn (Ω)	NF50 Ω (dB)
0.5	0.9	9.3	1.3

ΓMS NF OPT	K
0.49 ∠74°	0.58



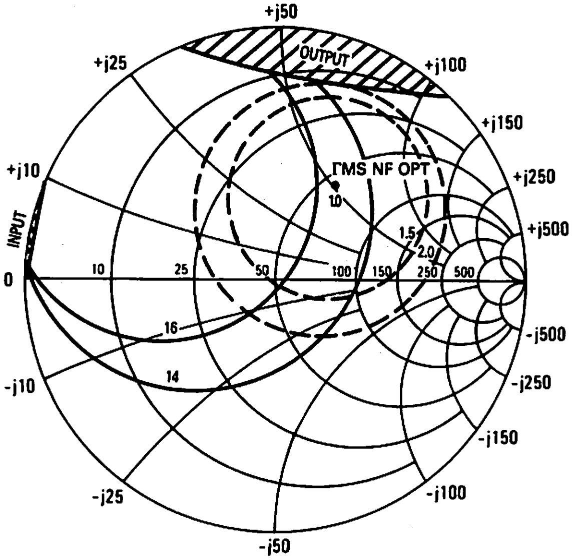
V_{CE} = 6.0 V, I_C = 5.0 mA
f = 1.0 GHz

f(GHz)	NF OPT(dB)	Rn (Ω)	NF50 Ω (dB)	ΓMS NF OPT
1.0	1.5	7.6	2.2	0.48 ∠134°

ΓMS	ΓML
0.89 ∠ −179°	0.81 ∠66°

2

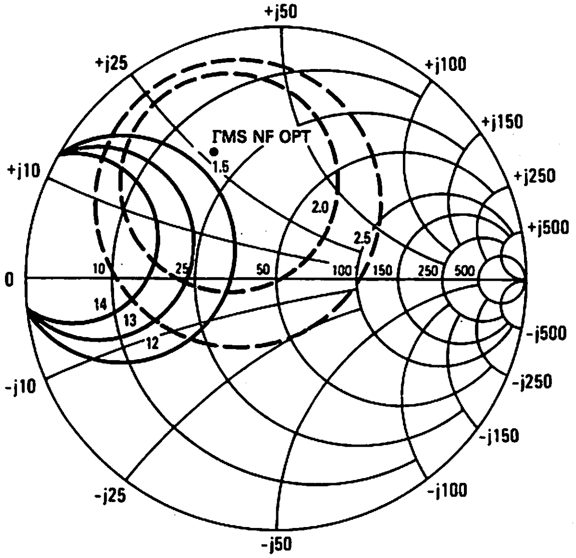
MRF572 CONSTANT GAIN and NOISE FIGURE CONTOURS



V_{CE} = 6.0 V, I = 5.0 mA
f = 500 MHz
— REGION OF INSTABILITY

f(GHz)	Rn (Ω)	NF (50Ω)	ΓMS NF OPT
0.5	17.1	1.5	0.43 ∠ 57°

K	NF OPT
0.55	1.0

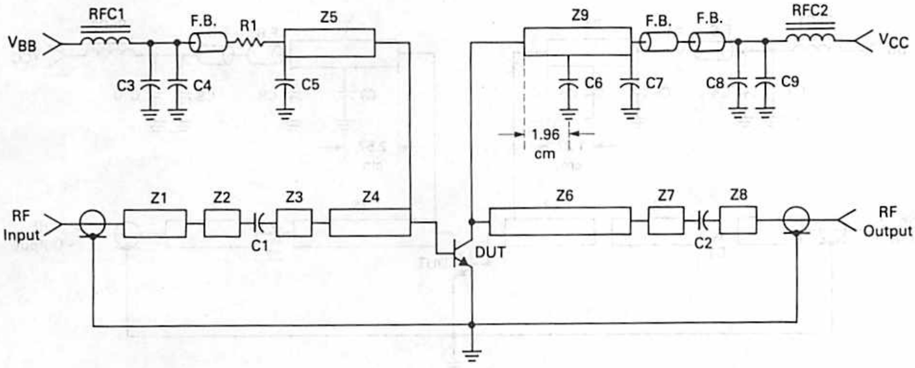


V_{CE} = 6.0 V, I_C = 5.0 mA
f = 1.0 GHz

f(GHz)	NF OPT	Rn (Ω)	NF50 (Ω) (dB)
1.0	1.5	6.0	2.0

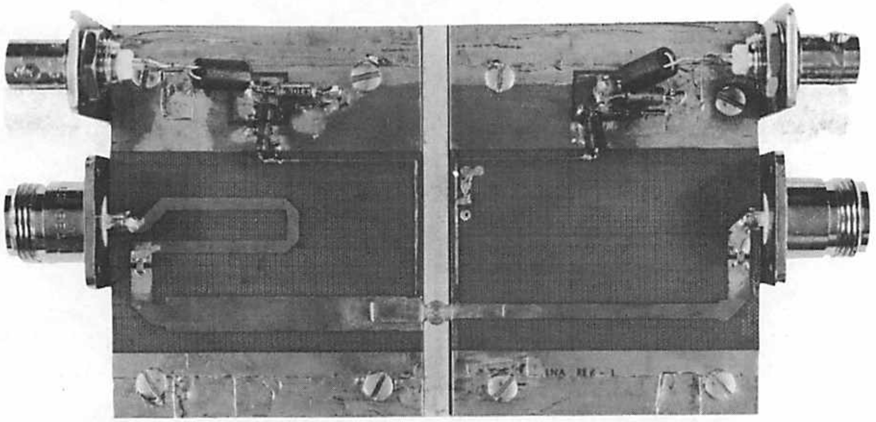
ΓMS NF OPT	K
0.56 ∠ 116°	0.93

MRF571 1.0 GHz TEST CIRCUIT

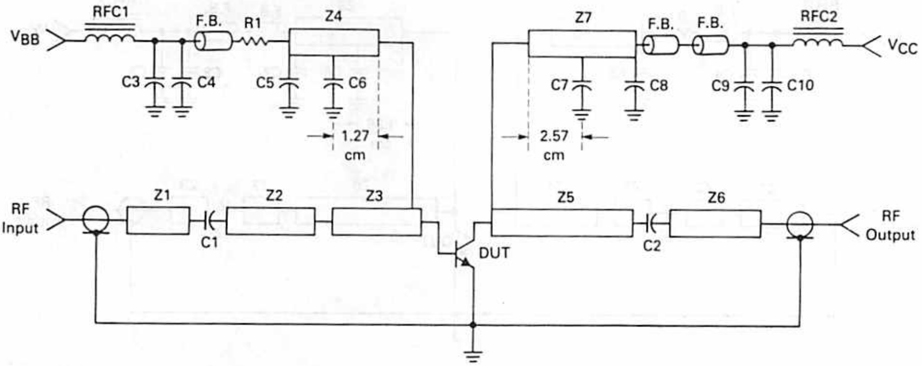


C1, C2, C6	560 pF Chip Capacitor	RFC1, RFC2	VK-200, Ferroxcube
C5, C7	0.018 μF Chip Capacitor	Z1–Z9	Microstrip, See Photomaster
C3, C8	0.1 μF Mylar Capacitor	Bead	Ferrite Bead, Ferroxcube 56-590-65/3B
C4, C9	1.0 μF Electrolytic Capacitor	Board Material	0.0625″ Teflon Fiberglass ϵ_r = 2.5 ± 0.05
R1	2.7 kΩ		

MRF571 TEST CIRCUIT

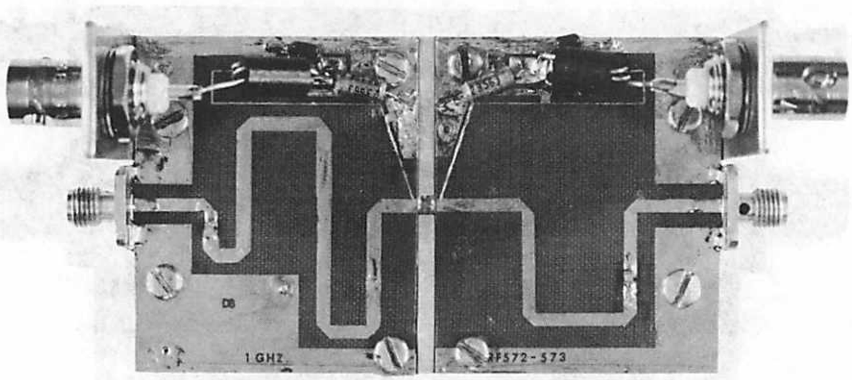


MRF572, 1.0 GHz TEST CIRCUIT

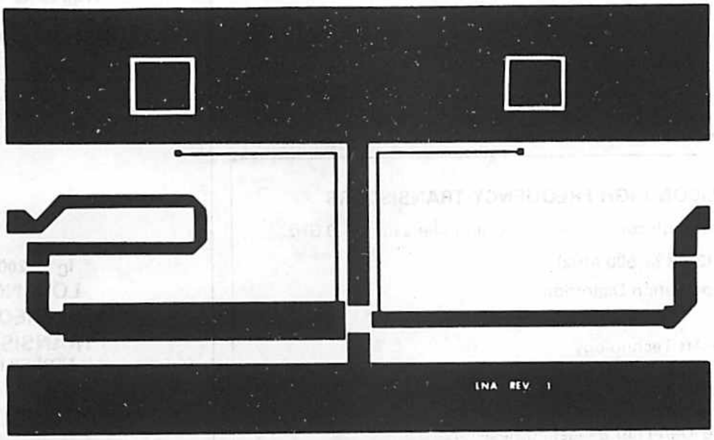


C1, C2, C6, C7	560 pF Chip Capacitor	RFC1, RFC2	VK-200, Ferroxcube
C5, C8	0.018 μF Chip Capacitor	Z1–Z7	Microstrip, See Photomaster
C3, C9	0.1 μF Mylar Capacitor	Bead	Ferrite Bead, Ferroxcube 56-590-65/3B
C4, C10	1.0 μF Electrolytic Capacitor	Board Material	0.031″ Teflon Fiberglass ϵ_r = 2.5 ± 0.05
R1	2.7 kΩ		

MRF572 TEST CIRCUIT

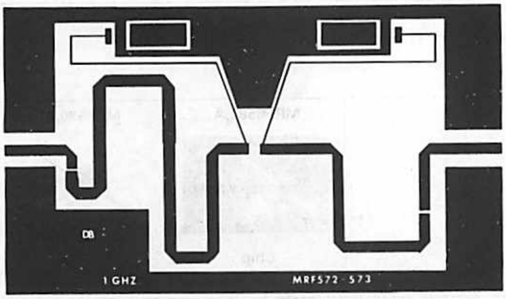


PHOTOMASTER OF MRF571 CIRCUIT LAYOUT



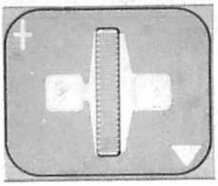
NOTE: The Printed Circuit Board shown is 75% of the original.

PHOTOMASTER OF MRF572 CIRCUIT LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRFC572 CHIP TOPOGRAPHY



Nominal Chip Size: 0.015″ x 0.016″ x 0.005″
Front Metallization: Gold
Back Metallization: Gold
Emitter/Base Bond Pad: 2.2 x 2.2 mil
#Emitter Fingers: 22
#Base Fingers: 23
Emitter Diffusion: Ion-Implanted Arsenic

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF580,A
MRF581,A
MRFC581,A

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

. . . designed for high current low power amplifiers up to 1.0 GHz.

- Low Noise (2 dB @ 500 MHz)
- Low Intermodulation Distortion
- High Gain
- State-of-the-Art Technology
  - Fine Line Geometry
  - Arsenic Emitters
  - Gold Top Metallization
  - Nicrome Thin-Film Ballasting Resistors
- Excellent Dynamic Range
- Fully Characterized
- High Current-Gain Bandwidth Product (f_T = 5 GHz @ I_C = 75 mA)

I_C = 200 mA
LOW NOISE HIGH FREQUENCY TRANSISTORS
NPN SILICON

2

MAXIMUM RATINGS

		MRFC581,A		MRF580,A		MRF581,A		
		 Chip		 Case 317A-01 Style 2		 Case 317-01 Style 2		
Ratings	**Symbol**	**MRFC581**	**MRFC581A**	**MRF580**	**MRF580A**	**MRF581**	**MRF581A**	**Unit**
Collector-Emitter Voltage	V_{CEO}	18	15	18	15	18	15	Vdc
Collector-Base Voltage	V_{CBO}	36	30	36	30	36	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5		2.5		2.5		Vdc
Collector Current — Continuous	I_C	200		200		200		mAdc
Total Device Dissipation @ T_C = 50°C(1) Derate above T_C = 50°C	P_D	1.67 T_J = 200°C max		1.2 12		1.2 12		Watts mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−65 to +200		−65 to +150		−65 to +150		°C

NOTE 1. Case temperature measured on collector lead immediately adjacent to body of package.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	MRF580/581 MRF580A/581A	$V_{(BR)CEO}$	18 15	— —	— —	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)	MRF580/581 MRF580A/581A	$V_{(BR)CBO}$	36 30	— —	— —	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.10 mAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Emitter Cutoff Current (V_{EB} = 2.0 Vdc, V_{BE} = 0)		I_{EBO}	—	—	100	μAdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	100	μAdc
ON CHARACTERISTICS						
DC Current Gain(1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	MRF580/581 MRF580A/581A	h_{FE}	50 90	— —	200 250	—
DYNAMIC CHARACTERISTICS						
Collector Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	1.4	2.0	pF
Current-Gain Bandwidth Product(2) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		f_T	—	5.0	—	GHz
FUNCTIONAL TESTS						
Noise Figure, Figure 19 (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF580/581 MRF580A/581A	NF	— —	2.0 1.8	3.0 2.5	dB
Power Gain at Optimum Noise Figure, Figure 19 (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF580,A	G_{NF}	11	14	—	dB
Power Gain at Optimum Noise Figure, Figure 19 (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A	G_{NF}	13	15.5	—	dB
Maximum Unilateral Gain (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF580,A(2)	$G_{U\,max}$	—	15	—	dB
Maximum Unilateral Gain (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	MRF581,A(2)	$G_{U\,max}$	—	17	—	dB
Intermodulation Distortion, Figure 18 (V_{CE} = 10 V, I_C = 75 mA, V_{out} = +50 dBmV)	MRF581,A(3)	IMD(d3)	—	−65	—	dB

NOTES:
1. 300 μs pulse on Tektronix 576 or equivalent.
2. Characterized on HP8542 Automatic Network Analyzer.
3. 2 Tones, f1 = 497 MHz, f2 = 503 MHz, 3rd Order Single Tone reference.

$$G_{U\,max} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$$

FIGURE 1 — C_{ib} INPUT CAPACITANCE versus VOLTAGE

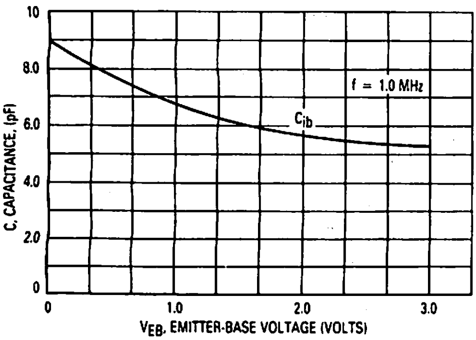


FIGURE 2 — C_{cb}, C_{ob} COLLECTOR-BASE CAPACITANCE versus VOLTAGE

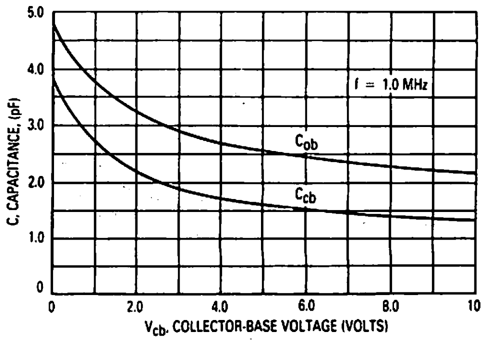


FIGURE 3 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT

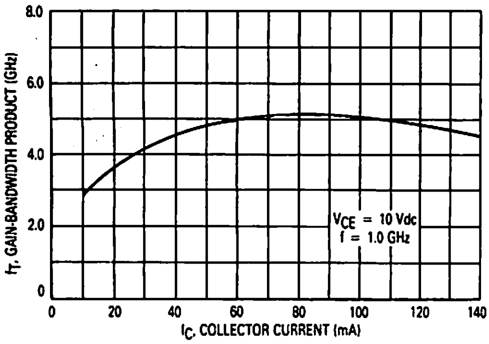
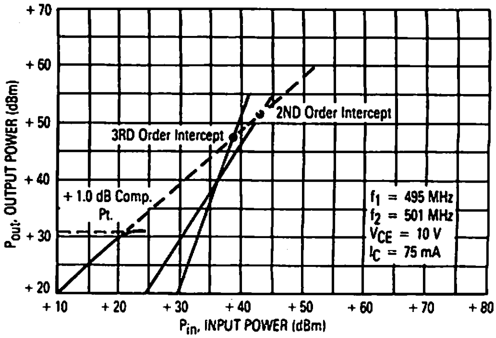


FIGURE 4 — 2ND AND 3RD ORDER INTERCEPT POINTS



MRF580,A TYPICAL PERFORMANCE

FIGURE 5 — $G_{U\,max}$-MAXIMUM UNILATERAL GAIN, $|S_{21}|^2$ versus FREQUENCY

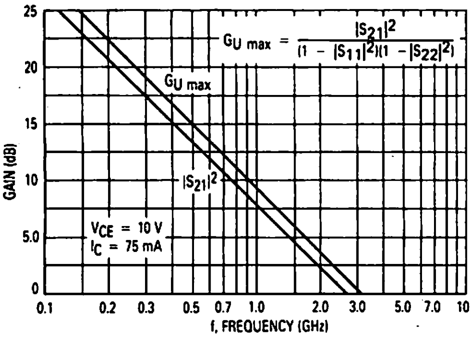


FIGURE 6 — $G_{A\,max}$, MAXIMUM AVAILABLE GAIN versus FREQUENCY

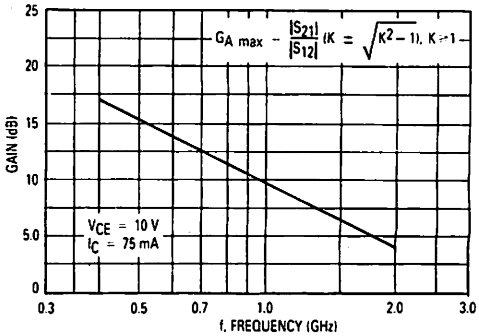


FIGURE 7 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus FREQUENCY

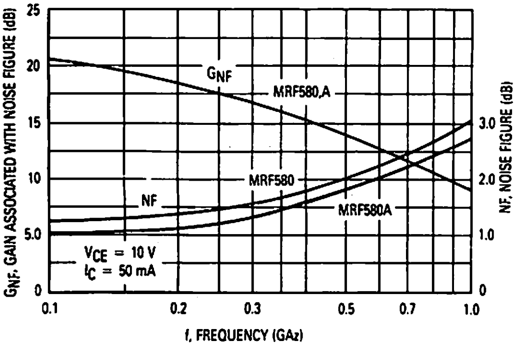


FIGURE 8 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT

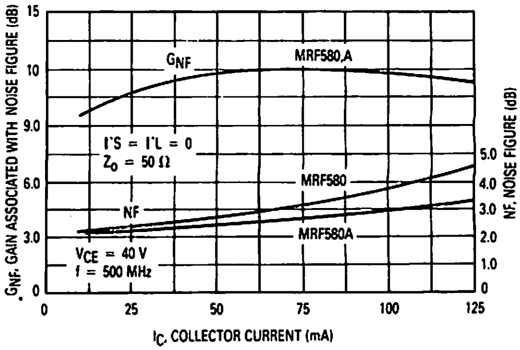
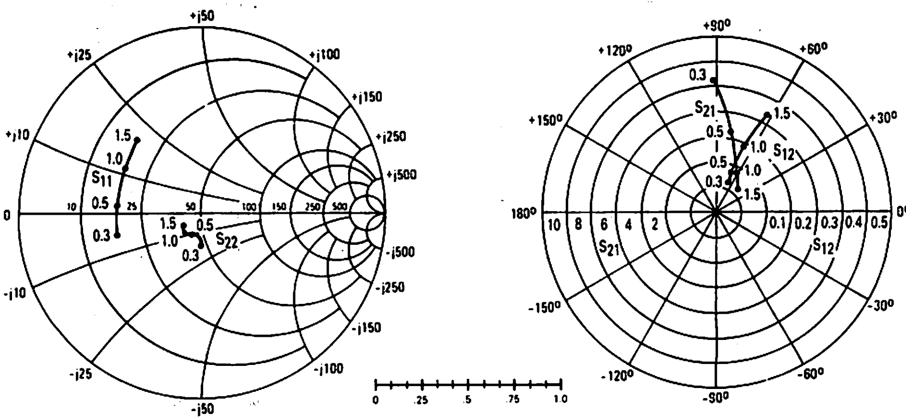


FIGURE 9 — MRF580,A COMMON EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

V_{CE} = 10 V I_C = 50 mA

FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} ∠φ	S_{21} $\|S_{21}\|$	S_{21} ∠φ	S_{12} $\|S_{12}\|$	S_{12} ∠φ	S_{22} $\|S_{22}\|$	S_{22} ∠φ
5.0	25	300	0.49	-170	5.97	91	0.083	60	0.24	-108
		500	0.52	171	3.63	78	0.127	64	0.18	-117
		1000	0.53	149	1.98	58	0.24	66	0.13	-154
		1500	0.56	125	1.46	44	0.35	60	0.19	-172
	50	300	0.48	-175	6.35	90	0.08	64	0.24	-126
		500	0.51	168	3.85	79	0.13	67	0.18	-139
		1000	0.51	148	2.10	59	0.25	66	0.16	-178
		1500	0.54	123	1.56	46	0.36	58	0.20	169
	75	300	0.48	-177	6.42	90	0.08	65	0.24	-132
		500	0.51	167	3.88	79	0.13	67	0.19	-145
		1000	0.50	147	2.12	59	0.26	65	0.17	175
		1500	0.53	123	1.57	46	0.36	58	0.21	164
	100	300	0.48	-177	6.41	89	0.08	66	0.24	-134
		500	0.51	167	3.87	78	0.13	68	0.19	-148
		1000	0.51	146	2.1	59	0.26	65	0.17	172
		1500	0.53	123	1.58	46	0.36	58	0.21	162
10	25	300	0.44	-164	6.67	92	0.07	61	0.25	-76
		500	0.47	175	4.08	79	0.11	66	0.19	-75
		1000	0.48	152	2.2	60	0.21	68	0.12	-91
		1500	0.52	126	1.56	45	0.32	64	0.15	-129
	50	300	0.47	-167	7.40	91	0.07	65	0.17	-89
		500	0.47	174	4.53	79	0.11	68	0.12	-112
		1000	0.50	149	2.38	62	0.20	67	0.13	-126
		1500	0.53	131	1.71	47	0.31	63	0.11	-147
	75	300	0.41	-171	7.24	91	0.07	66	0.20	-96
		500	0.45	171	4.39	79	0.12	69	0.13	-99
		1000	0.45	150	2.36	61	0.23	67	0.07	-130
		1500	0.48	125	1.72	47	0.33	61	0.12	-157
	100	300	0.42	-172	7.22	90	0.07	67	0.19	-97
		500	0.45	170	4.38	78	0.12	69	0.14	-98
		1000	0.45	149	2.35	60	0.23	67	0.07	-129
		1500	0.49	125	1.71	46	0.33	62	0.11	-158
15	25	300	0.48	-159	7.28	93	0.06	60	0.24	-55
		500	0.48	-179	4.44	80	0.09	66	0.17	-62
		1000	0.51	153	2.33	62	0.18	68	0.19	-82
		1500	0.54	133	1.67	46	0.27	68	0.17	-97
	50	300	0.39	-165	7.49	92	0.07	65	0.23	-71
		500	0.42	174	4.57	80	0.11	69	0.18	-67
		1000	0.43	152	2.44	61	0.21	68	0.11	-74
		1500	0.46	126	1.76	47	0.31	64	0.12	-115
	75	300	0.39	-167	7.57	91	0.07	66	0.21	-74
		500	0.42	173	4.57	79	0.11	70	0.17	-69
		1000	0.42	151	2.45	61	0.21	68	0.09	-75
		1500	0.46	126	1.76	46	0.31	64	0.11	-118
	100	300	0.39	-168	7.46	90	0.07	67	0.20	-72
		500	0.43	172	4.53	78	0.11	70	0.17	-66
		1000	0.43	151	2.41	60	0.21	69	0.10	-71
		1500	0.47	126	1.74	46	0.31	64	0.12	-113

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MRF581,A TYPICAL PERFORMANCE

FIGURE 10 — $G_{U\,max}$ — MAXIMUM UNILATERAL GAIN, $|S_{21}|^2$ versus FREQUENCY

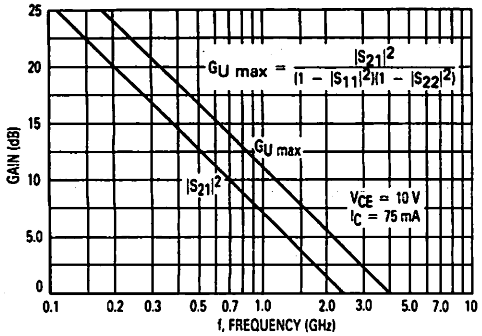


FIGURE 11 — $G_{A\,max}$, MAXIMUM AVAILABLE GAIN versus FREQUENCY

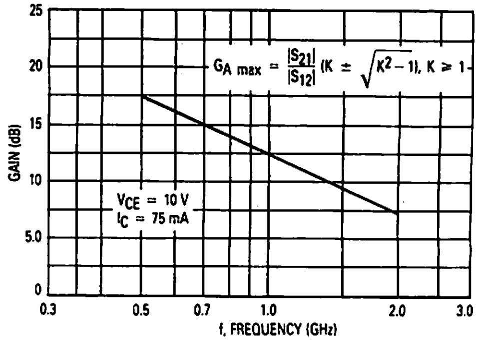


FIGURE 12 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus FREQUENCY

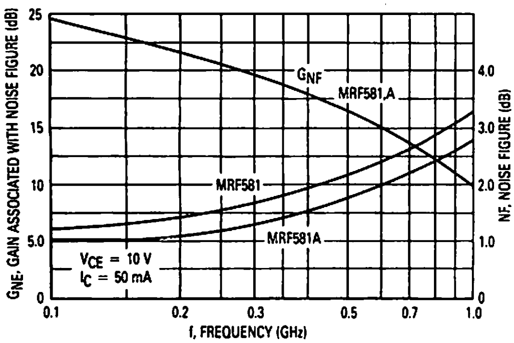


FIGURE 13 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT f = 500 MHz

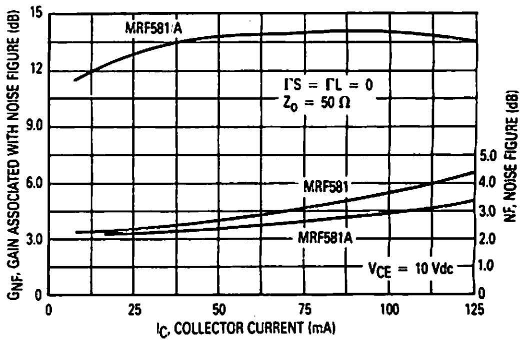


FIGURE 14 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT f = 200 MHz

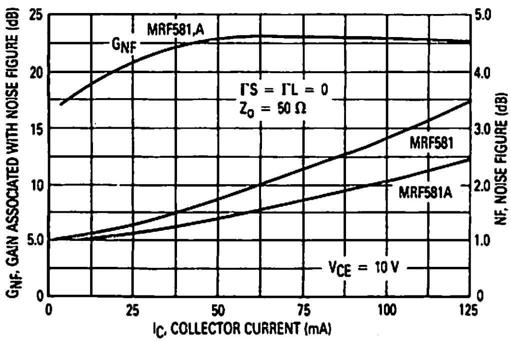


FIGURE 15 — NOISE FIGURE AND GAIN ASSOCIATED WITH NOISE FIGURE versus COLLECTOR CURRENT f = 50 MHz

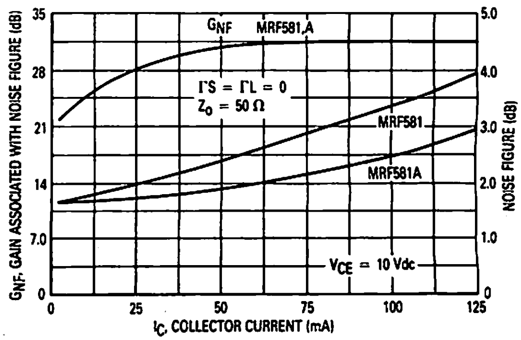
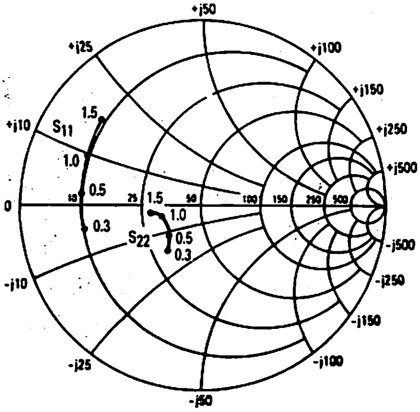


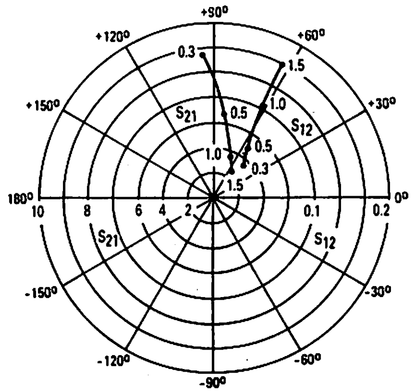
FIGURE 16 — MRF581,A COMMON EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENT versus FREQUENCY

V_{CE} = 10 V, I_C = 50 mA

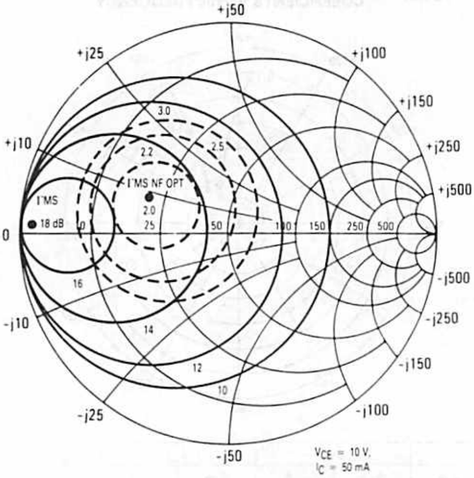


FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	∠φ	$\|S_{21}\|$	∠φ	$\|S_{12}\|$	∠φ	$\|S_{22}\|$	∠φ
5.0	25	300	0.69	-169	6.57	93	0.06	39	0.34	-129
		500	0.72	176	3.95	82	0.07	47	0.29	-142
		1000	0.73	157	2.10	62	0.12	60	0.27	-165
		1500	0.76	139	1.47	50	0.17	61	0.33	-172
	50	300	0.70	-173	7.14	93	0.05	45	0.38	-144
		500	0.72	173	4.27	82	0.07	53	0.34	-157
		1000	0.72	157	2.24	65	0.13	62	0.33	179
		1500	0.76	138	1.61	53	0.18	61	0.37	173
	75	300	0.70	-175	7.26	92	0.05	48	0.40	-148
		500	0.72	172	4.33	82	0.07	55	0.37	-161
		1000	0.72	155	2.28	65	0.13	63	0.30	176
		1500	0.76	138	1.64	53	0.19	61	0.39	170
	100	300	0.70	-176	7.30	92	0.05	48	0.40	-151
		500	0.72	172	4.34	82	0.07	56	0.37	-163
		1000	0.72	155	2.28	65	0.13	63	0.36	175
		1500	0.75	137	1.64	53	0.19	61	0.39	168
10	25	300	0.66	-165	7.58	95	0.05	40	0.29	-106
		500	0.69	178	4.56	82	0.07	48	0.23	-116
		1000	0.70	159	2.39	64	0.11	61	0.19	-141
		1500	0.74	141	1.65	50	0.16	64	0.26	-153
	50	300	0.65	-169	8.25	94	0.05	46	0.30	-126
		500	0.68	175	4.96	82	0.07	54	0.24	-138
		1000	0.69	157	2.60	65	0.12	63	0.22	-164
		1500	0.72	139	1.82	52	0.17	63	0.27	-171
	75	300	0.66	-171	8.49	93	0.05	48	0.30	-132
		500	0.68	175	5.06	82	0.07	55	0.25	-145
		1000	0.69	157	2.64	65	0.12	64	0.23	-170
		1500	0.72	139	1.86	53	0.17	63	0.27	-176
	100	300	0.66	-172	8.46	93	0.05	49	0.30	-134
		500	0.68	174	5.06	82	0.07	56	0.25	-147
		1000	0.68	157	2.64	65	0.12	64	0.23	-172
		1500	0.72	139	1.86	52	0.17	63	0.27	-177
15	25	300	0.65	-163	7.96	95	0.05	40	0.28	-92
		500	0.67	179	4.82	82	0.06	48	0.21	-98
		1000	0.68	160	2.51	63	0.11	62	0.17	-119
		1500	0.72	141	1.73	49	0.16	65	0.24	-137
	50	300	0.64	-167	8.76	94	0.0	46	0.26	-112
		500	0.66	177	5.37	82	0.06	54	0.20	-122
		1000	0.67	159	2.75	65	0.11	64	0.16	-148
		1500	0.71	141	1.91	51	0.16	64	0.22	-157
	75	300	0.64	-168	8.93	93	0.05	47	0.25	-117
		500	0.66	176	5.34	82	0.06	55	0.20	-128
		1000	0.69	158	2.78	65	0.11	65	0.16	-154
		1500	0.70	140	1.93	51	0.16	64	0.22	-162
	100	300	0.64	-169	8.91	93	0.05	48	0.25	-117
		500	0.66	176	5.33	82	0.06	56	0.19	-129
		1000	0.67	158	2.78	64	0.11	65	0.16	-154
		1500	0.70	140	1.93	51	0.16	64	0.21	-160

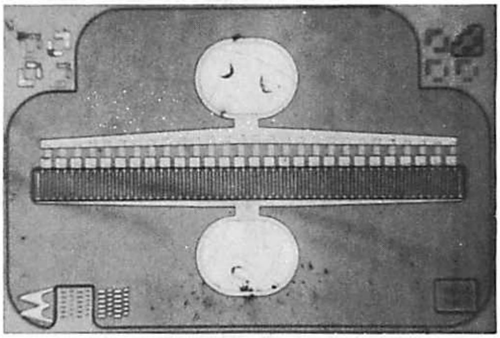
FIGURE 17 — MRF581 CONSTANT GAIN CONTOURS NOISE FIGURE CONTOURS



f(MHz)	ΓMS	ΓML	ΓMS NF OPT	G_{AMAX} (dB)	Rn (Ω)	NF OPT	NF (50 Ω)
500	0.91/176°	0.78/77°	0.39/159°	18	10.5	2.0	2.5

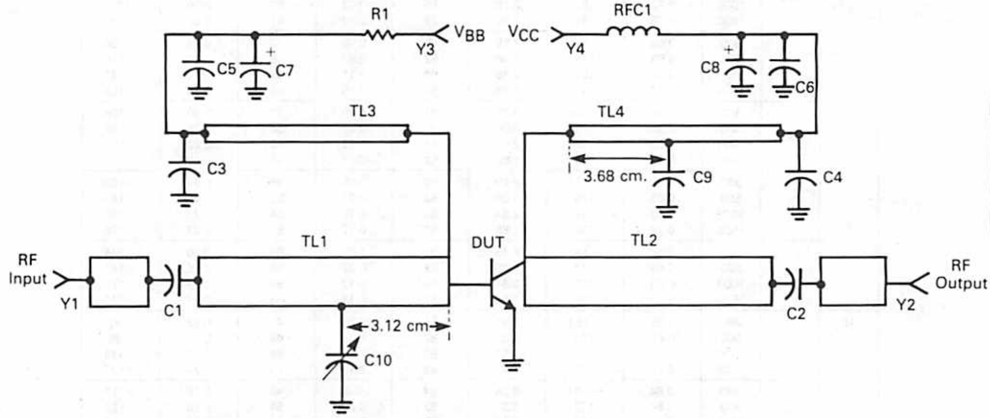
Circuit Per Figure 18

MRFC581,A CHIP TOPOGRAPHY



Nominal Chip Size: 0.017″ X 0.027″ X 0.005″
Front Metallization: Gold
Back Metallization: Gold
Emitter/Base Bond Pad: 0.003″ X 0.004″
#Emitter Fingers: 56
#Base Fingers: 57
Emitter Diffusion: Ion-Implanted Arsenic
Fabrication: Fully *Ion Implanted*
Ballasting: NiCr Resistor
Passivation: Silicon Nitride

FIGURE 18 — MRF580,A/581,A TEST FIXTURE SCHEMATIC 500 MHz



C1, C2 — 470 pF Chip (Ceramic)
C3, C4 — 0.018 μF Chip Capacitor
C5, C6 — 0.1 μF Mylar
C7, C8 — 1.0 μF, 25 Vdc Electrolytic
C9 — 91 pF Mini-Unelco (C9 Taped 3.68 cm from Collector Connection on TL4 as shown)
C10 — 35-45 pF Johanson Ceramic Capacitor, JMC 5801 or Equivalent (C10 Taped 3.12 cm from Base Connection on TL1)

R1 — 2.7 kΩ, 1½ W
RFC1 — 0.15 μH Molded Choke
TL1, TL2 — Z_0 = 26 Ω, 0.0625 TFG as shown in Photomaster
TL3, TL4 — λ/4 Microstrip, Z_0 = 100 Ω
Y1, Y2 — N-Type Connection (Female)
Y3, Y4 — BNC-Type Connector (Female)
Board Material — 0.0625″ Thick Glass Teflon ϵ_r = 2.5

FIGURE 19 — FUNCTIONAL CIRCUIT SCHEMATIC

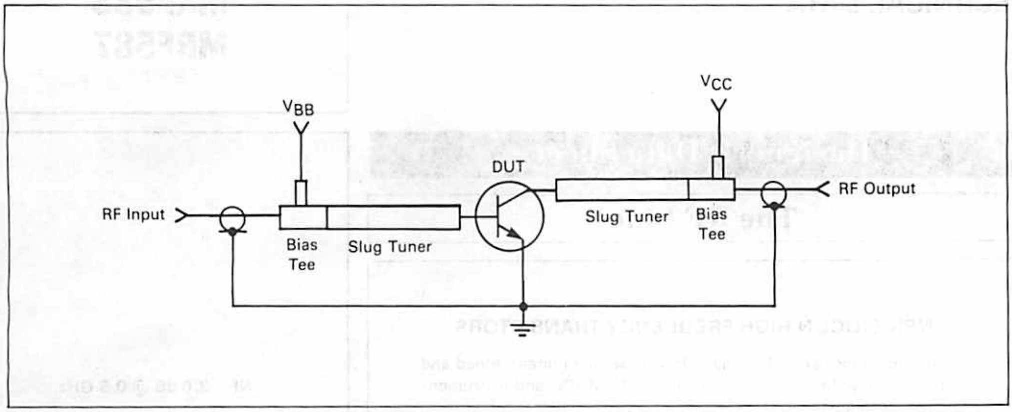


FIGURE 20 — MRF580,A/581,A TEST CIRCUIT

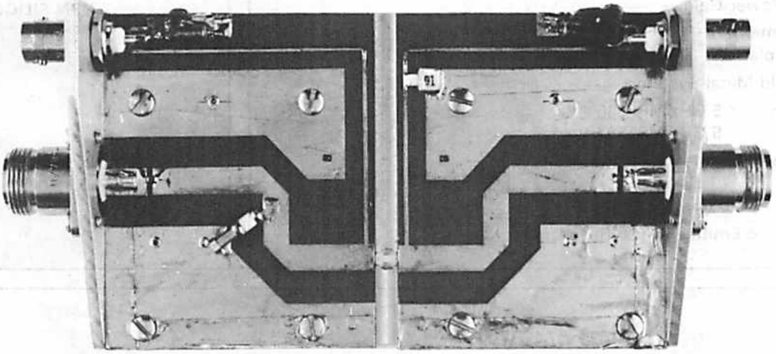
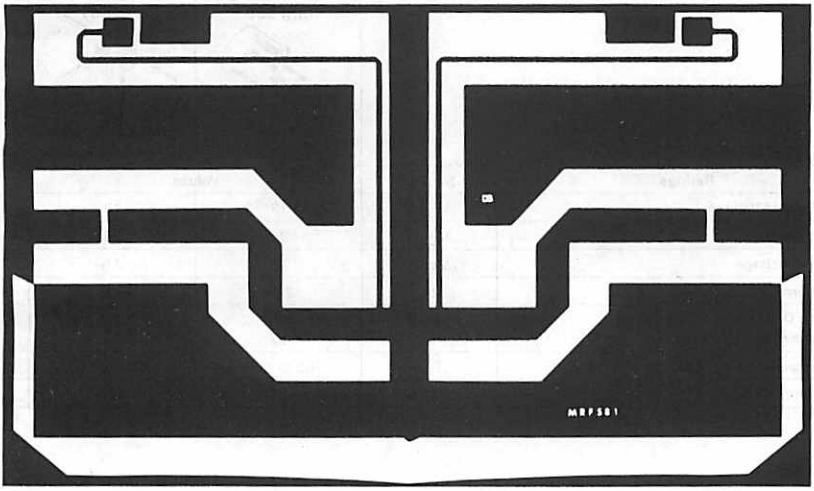


FIGURE 21 — PC BOARD PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF586
MRF587

Designer's Data Sheet

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTORS

. . . designed for use in high-gain, low-noise, ultra-linear, tuned and wideband amplifiers. Ideal for use in CATV, MATV, and instrumentation applications.

- Low Noise Figure —
  NF = 3.0 dB (Typ) @ f = 500 MHz, I_C = 90 mA
- High Power Gain —
  $G_{U(max)}$ = 16.5 dB (Typ) @ f = 500 MHz
- Ion Implanted
- All Gold Metal System
- High f_T — 4.5 GHz MRF586
  5.5 GHz MRF587
- Low Intermodulation Distortion:
  TB_3 = −70 dB
  DIN = 125 dB μV
- Nichrome Emitter Ballast Resistors.

NF = 3.0 dB @ 0.5 GHz

HIGH FREQUENCY TRANSISTORS

NPN SILICON

MAXIMUM RATINGS		MRF586  Case 79-04 Style 1	MRF587  Case 244A-01 Style 1	
Ratings	**Symbol**	**Values**		**Unit**
Collector-Emitter Voltage	V_{CEO}	17	17	Vdc
Collector-Base Voltage	V_{CBO}	34	34	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	2.5	Vdc
Collector Current — Continuous	I_C	200	200	mAdc
Total Device Dissipation @ T_C = 50°C Derate above T_C = 50°C	P_D	2.5 17	5.0 33	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	-65 to +150	°C
Junction Temperature	T_J	200	200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	17	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1.0 mAdc, I_E = 0)		$V_{(BR)CBO}$	34	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 0, I_E = 0.1 mAdc)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 Vdc, I_E = 0)		I_{CBO}	—	—	50	μAdc
ON CHARACTERISTICS						
DC Current Gain (1) (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)		h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS						
Current-Gain — Bandwidth Product (2)	MRF586	f_T	—	4.5	—	GHz
(I_C = 90 mAdc, V_{CE} = 15 Vdc, f = 0.5 GHz)	MRF587		—	5.5	—	
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)		C_{cb}	—	1.7	2.2	pF
FUNCTIONAL TESTS						
Narrow Band — Figure 23 (I_C = 90 mA, V_{CC} = 15 V, f = 0.5 GHz)						dB
Noise Figure		NF	—	3.0	4.0	
Power Gain at Optimum Noise Figure	MRF586	G_{NF}	9.0	11.0	—	
	MRF587		11.0	13.0	—	
Broad Band — Figures 24 and 25 (I_C = 90 mA, V_{CC} = 15 V, f = 0.3 GHz)						dB
Noise Figure	MRF586	NF	—	5.5	—	
	MRF587		—	6.3	—	
Power Gain at Optimum Noise Figure	MRF586	G_{NF}	—	10.0	—	
	MRF587		—	11.0	—	
Triple Beat Distortion		TB_3				dB
(I_C = 50 mA, V_{CC} = 15 V, P_{Ref} = 50 dBmV)	MRF586		—	-65	—	
(I_C = 90 mA, V_{CC} = 15 V, P_{Ref} = 50 dBmV)	MRF587		—	-70	—	
DIN 45004		DIN				dBμV
(I_C = 90 mA, V_{CC} = 15 V)	MRF586		—	120	—	
(I_C = 90 mA, V_{CC} = 15 V)	MRF587		—	125	—	
Maximum Available Power Gain (3)		G_{Umax}				dB
(I_C = 90 mA, V_{CE} = 15 Vdc, f = 0.5 GHz)	MRF586		—	14.5	—	
	MRF587		—	16.5	—	

NOTES:
1. 300 μs pulse on Tektronix 576 or equivalent.
2. Characterized on HP8542 Automatic Network Analyzer.
3. $G_{Umax} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

2

FIGURE 1 — TYPICAL NOISE FIGURE AND ASSOCIATED GAIN versus FREQUENCY

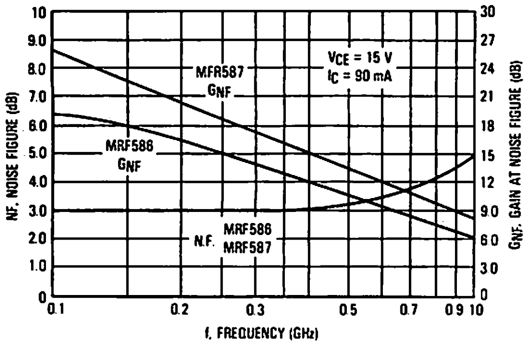


FIGURE 2 — NOISE FIGURE versus COLLECTOR CURRENT

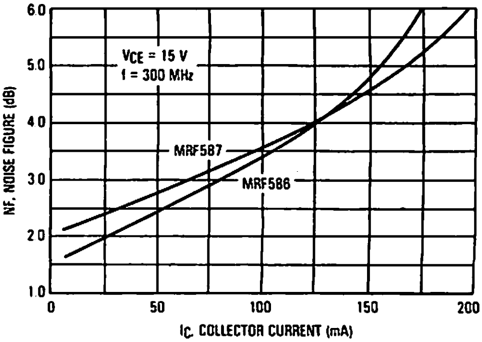


FIGURE 3 — G_{Umax} versus COLLECTOR CURRENT

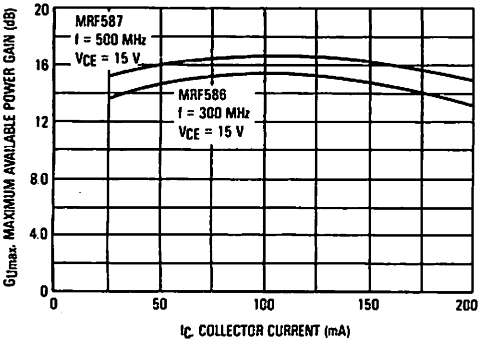
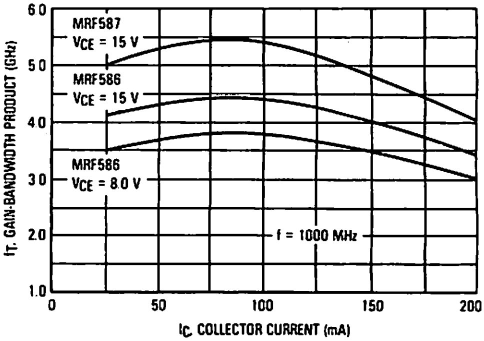


FIGURE 4 — GAIN-BANDWIDTH PRODUCT versus COLLECTOR CURRENT



MRF586 TYPICAL PERFORMANCE

FIGURE 5 — BROADBAND NOISE FIGURE MRF586

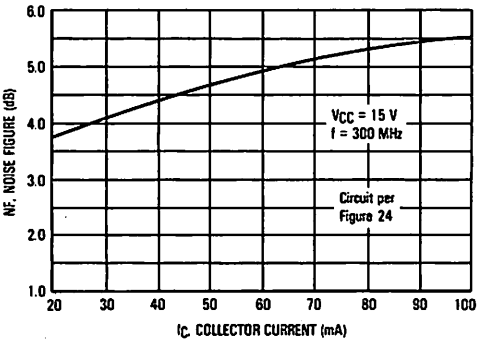
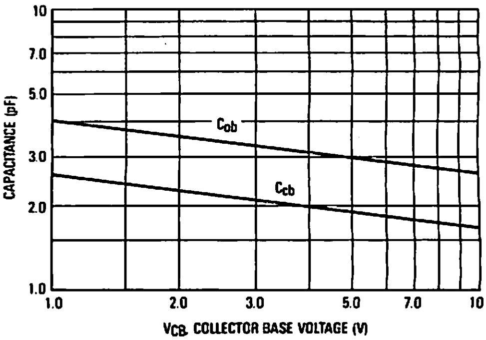


FIGURE 6 — JUNCTION CAPACITANCE versus VOLTAGE MRF586



MRF586 TYPICAL PERFORMANCE (continued)

FIGURE 7 — 1.0 dB COMPRESSION POINT versus COLLECTOR CURRENT
MRF586

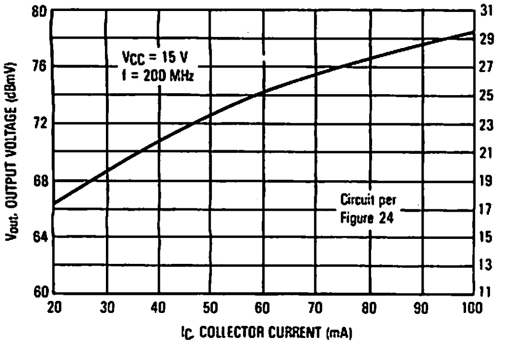


FIGURE 8 — THIRD ORDER INTERCEPT POINT
MRF586

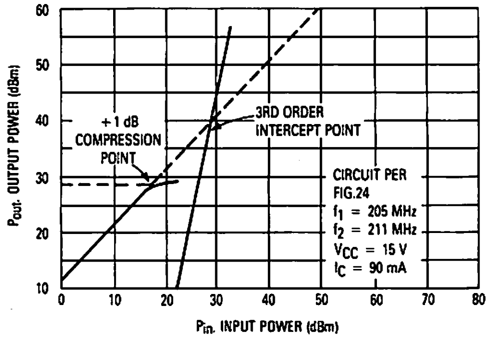


FIGURE 9 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF586

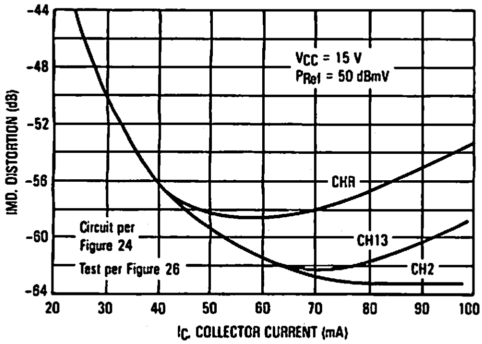


FIGURE 10 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF586

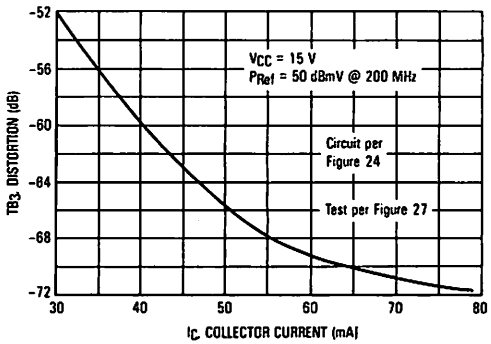


FIGURE 11 — 35-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF586

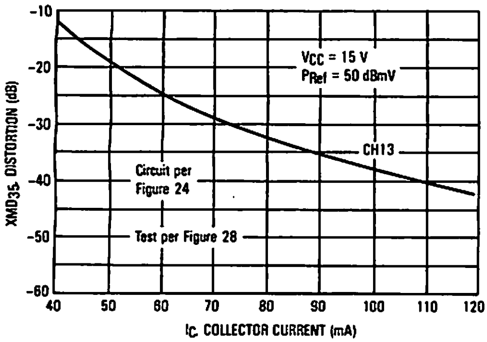
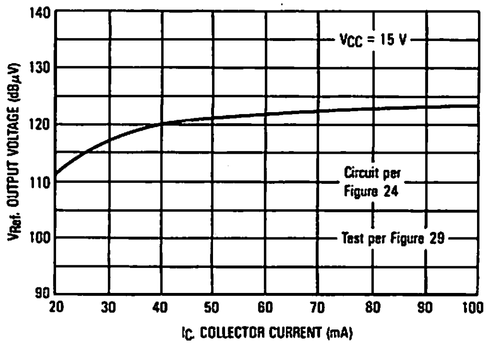


FIGURE 12 — DIN45004B versus COLLECTOR CURRENT
MRF586



2

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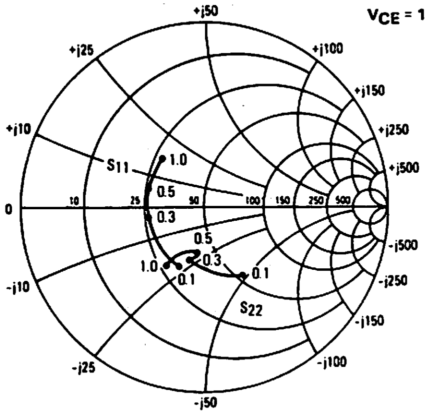
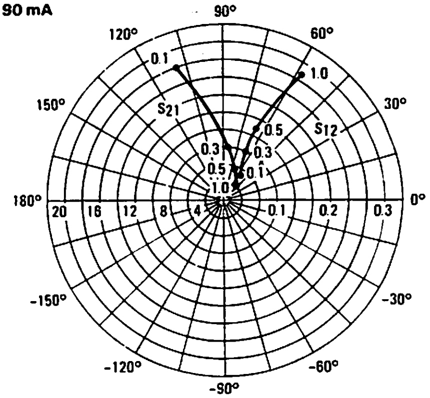
FIGURE 13 — MRF586 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENT versus FREQUENCY (GHz)



V_{CE} = 15 V I_C = 90 mA

FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (GHz)



V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	30	100	0.42	-122	13.45	109	0.05	54	0.45	-74
		300	0.39	-175	5.10	84	0.09	58	0.30	-105
		500	0.41	162	3.11	71	0.16	60	0.32	-125
		1000	0.42	131	1.68	47	0.28	56	0.38	-138
	60	100	0.39	-131	14.35	106	0.05	56	0.41	-84
		300	0.37	180	5.27	83	0.11	62	0.28	-130
		500	0.39	158	3.22	72	0.17	62	0.32	-134
		1000	0.39	127	1.75	49	0.29	55	0.36	-144
	90	100	0.39	-134	14.45	106	0.05	56	0.42	-87
		300	0.38	176	5.27	82	0.11	60	0.33	-132
		500	0.39	155	3.19	70	0.16	59	0.37	-136
		1000	0.36	120	1.70	43	0.28	49	0.45	-143
10	30	100	0.41	-112	14.40	111	0.05	55	0.48	-63
		300	0.35	-170	5.51	85	0.10	60	0.28	-100
		500	0.37	164	3.35	72	0.15	61	0.32	-109
		1000	0.38	132	1.79	47	0.26	58	0.40	-125
	60	100	0.37	-119	15.35	109	0.05	58	0.43	-70
		300	0.33	-174	5.76	84	0.10	62	0.26	-103
		500	0.35	160	3.50	73	0.16	62	0.31	-117
		1000	0.36	128	1.88	49	0.27	57	0.37	-130
	90	100	0.36	-123	15.68	107	0.05	57	0.44	-77
		300	0.33	180	5.78	83	0.10	61	0.32	-117
		500	0.34	154	3.44	70	0.15	59	0.39	-122
		1000	0.31	118	1.84	43	0.25	51	0.49	-133
15	30	100	0.42	-107	14.72	111	0.05	55	0.49	-58
		300	0.33	-167	5.64	85	0.09	60	0.28	-92
		500	0.35	166	3.48	73	0.14	61	0.32	-102
		1000	0.37	133	1.82	47	0.25	59	0.40	-119
	60	100	0.37	-112	15.80	109	0.05	57	0.45	-64
		300	0.31	-171	5.90	85	0.10	63	0.26	-100
		500	0.33	162	3.60	73	0.15	63	0.30	-108
		1000	0.35	130	1.92	49	0.27	58	0.38	-124
	90	100	0.37	-114	16.04	109	0.05	56	0.45	-67
		300	0.31	-173	5.96	84	0.10	61	0.30	-108
		500	0.32	155	3.56	70	0.15	61	0.35	-114
		1000	0.33	120	1.84	45	0.25	55	0.44	-127

MRF587 TYPICAL PERFORMANCE

FIGURE 14 — BROADBAND NOISE FIGURE
MRF587

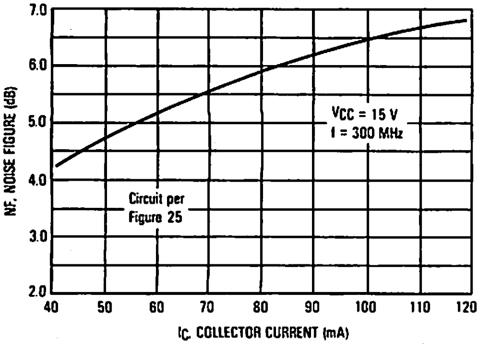


FIGURE 15 — JUNCTION CAPACITANCE versus VOLTAGE
MRF587

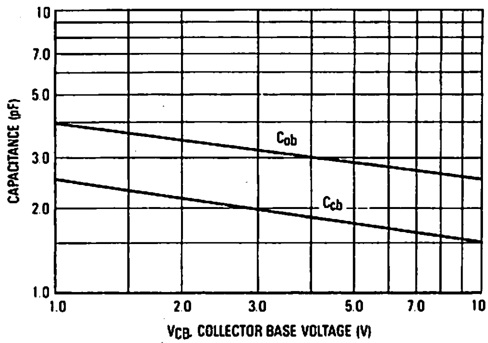


FIGURE 16 — 1.0 dB COMPRESSION POINT versus
COLLECTOR CURRENT
MRF587

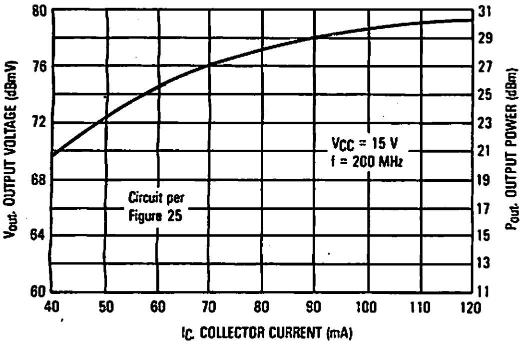
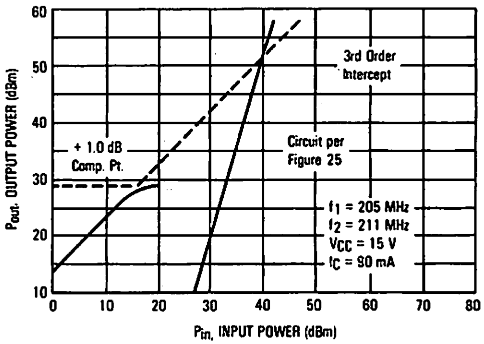


FIGURE 17 — THIRD ORDER INTERCEPT POINT
MRF587



2

MRF587 TYPICAL PERFORMANCE (continued)

FIGURE 18 — SECOND ORDER DISTORTION versus COLLECTOR CURRENT
MRF587

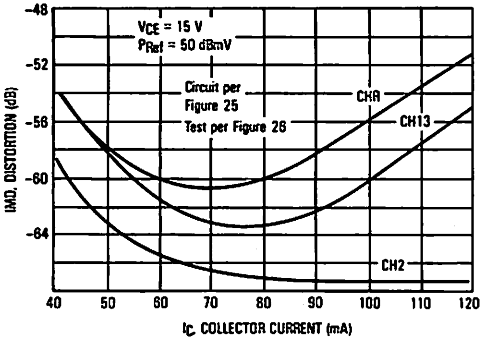


FIGURE 19 — TRIPLE BEAT DISTORTION versus COLLECTOR CURRENT
MRF587

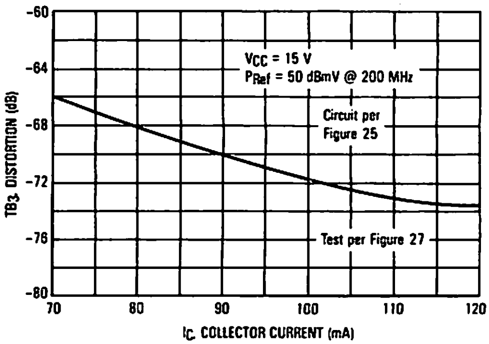


FIGURE 20 — 35-CHANNEL X-MODULATION DISTORTION versus COLLECTOR CURRENT
MRF587

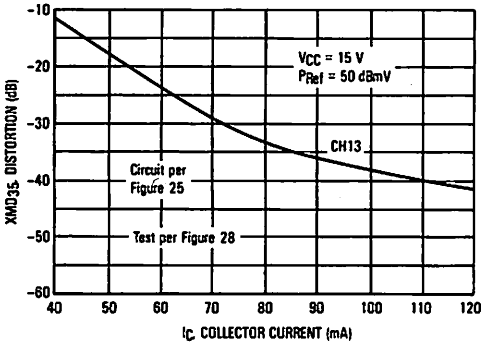


FIGURE 21 — DIN 45004B versus COLLECTOR CURRENT
MRF587

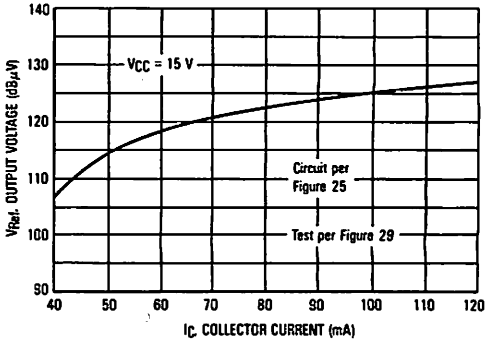
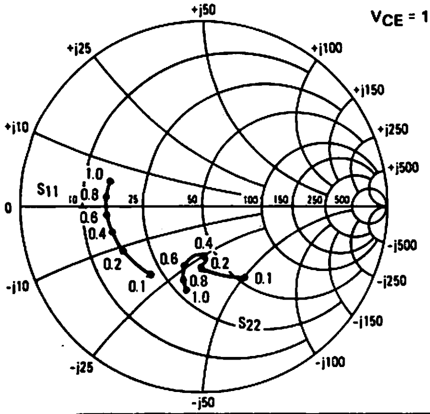


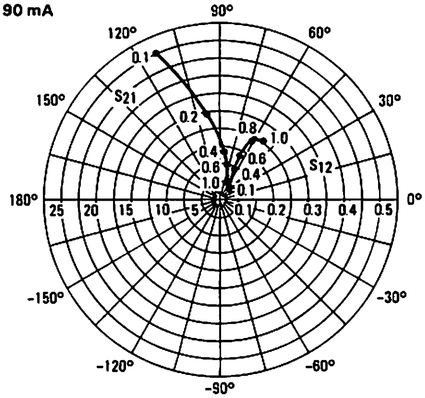
FIGURE 22 — MRF587 COMMON-EMITTER S-PARAMETERS

INPUT/OUTPUT REFLECTION COEFFICIENT versus FREQUENCY (GHz)



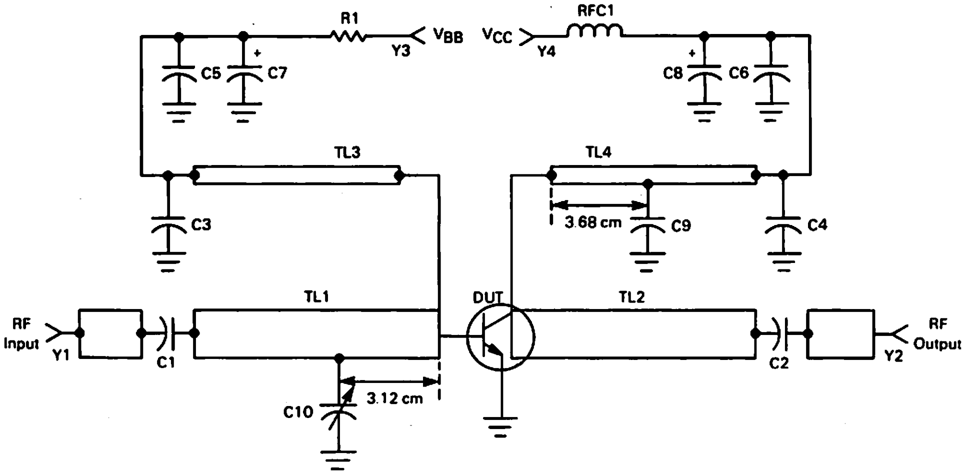
V_{CE} = 15 V I_C = 90 mA

FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (GHz)



V_{CE} (Volts)	I_C (mA)	Freq (MHz)	S_{11} $\|S_{11}\|$	S_{11} ∠φ	S_{21} $\|S_{21}\|$	S_{21} ∠φ	S_{12} $\|S_{12}\|$	S_{12} ∠φ	S_{22} $\|S_{22}\|$	S_{22} ∠φ
5.0	30	100	0.56	-131	16.45	113	0.04	45	0.49	-91
		200	0.58	-159	9.42	98	0.06	49	0.38	-116
		400	0.60	-178	5.00	86	0.08	55	0.35	-132
		600	0.64	170	3.61	76	0.11	56	0.38	-138
		800	0.67	162	2.92	67	0.14	55	0.41	-144
		1000	0.70	155	2.55	58	0.17	54	0.44	-152
	60	100	0.53	-141	17.89	110	0.04	50	0.47	-102
		200	0.56	-164	10.05	97	0.05	55	0.39	-126
		400	0.59	178	5.31	85	0.09	60	0.38	-141
		600	0.63	169	3.82	76	0.12	59	0.40	-146
		800	0.66	161	3.09	67	0.15	57	0.44	-153
		1000	0.69	155	2.67	58	0.18	55	0.47	-160
	90	100	0.52	-145	18.26	109	0.04	52	0.47	-106
		200	0.56	-166	10.20	96	0.05	57	0.39	-130
		400	0.59	177	5.38	85	0.09	62	0.39	-144
		600	0.63	168	3.86	76	0.12	60	0.41	-149
		800	0.66	161	3.12	67	0.15	58	0.45	-155
		1000	0.69	155	2.70	58	0.19	55	0.48	-162
10	30	100	0.53	-122	18.36	115	0.04	48	0.50	-75
		200	0.53	-153	10.63	100	0.05	51	0.36	-96
		400	0.55	175	5.71	87	0.08	57	0.33	-112
		600	0.59	173	4.16	78	0.10	58	0.35	-119
		800	0.62	165	3.37	68	0.13	57	0.39	-127
		1000	0.65	158	2.95	59	0.15	55	0.42	-136
	60	100	0.49	-132	20.19	112	0.03	51	0.46	-85
		200	0.51	-158	11.54	99	0.05	57	0.35	-107
		400	0.53	-178	6.12	87	0.08	61	0.33	-123
		600	0.58	171	4.43	78	0.11	60	0.36	-129
		800	0.60	164	3.58	68	0.14	59	0.40	-136
		1000	0.63	157	3.12	60	0.16	57	0.44	-144
	90	100	0.48	-135	20.82	111	0.03	53	0.45	-88
		200	0.50	-160	11.77	98	0.05	59	0.34	-111
		400	0.53	-179	6.22	86	0.08	63	0.33	-126
		600	0.57	171	4.50	78	0.11	62	0.36	-131
		800	0.60	164	3.64	68	0.14	59	0.41	-139
		1000	0.63	157	3.18	60	0.17	57	0.44	-147
15	30	100	0.49	-112	20.34	118	0.04	54	0.51	-52
		200	0.52	-145	11.51	101	0.05	56	0.36	-77
		400	0.48	-164	6.12	87	0.09	63	0.32	-74
		600	0.52	-174	4.19	75	0.12	62	0.32	-90
		800	0.53	177	3.29	68	0.16	61	0.38	-90
		1000	0.53	168	2.76	61	0.20	56	0.47	-90
	60	100	0.45	-122	22.14	115	0.03	56	0.45	-60
		200	0.49	-150	12.24	99	0.05	60	0.33	-86
		400	0.45	-166	6.45	86	0.09	65	0.30	-83
		600	0.50	-175	4.42	75	0.13	63	0.32	-99
		800	0.51	177	3.47	68	0.16	61	0.38	-98
		1000	0.51	168	2.91	62	0.20	55	0.46	-96
	90	100	0.44	-127	22.76	114	0.03	58	0.43	-62
		200	0.48	-152	12.44	98	0.05	62	0.32	-89
		400	0.44	-167	6.55	85	0.09	66	0.29	-85
		600	0.50	-176	4.47	75	0.13	64	0.32	-102
		800	0.51	176	3.51	69	0.17	61	0.38	-100
		1000	0.51	168	2.95	62	0.20	55	0.46	-98

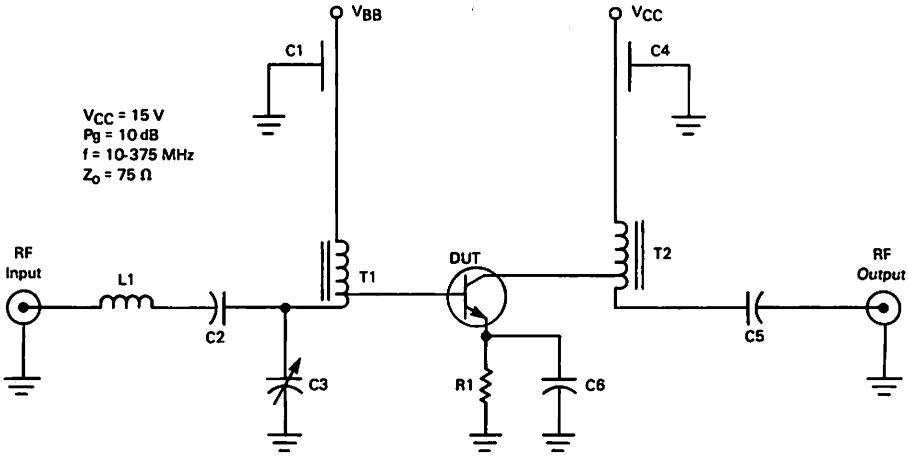
FIGURE 23 — MRF586/587 NARROW BAND TEST FIXTURE SCHEMATIC
500 MHz



C1, C2	—	470 pF Chip (Ceramic)
C3, C4	—	0.018 μF Chip Capacitor
C5, C6	—	0.1 μF Mylar
C7, C8	—	1.0 μF, 25 Vdc Electrolytic
C9	—	91 pF Mini-Unelco (C9 Taped 3.68 cm from Collector Connection on TL4 as shown)
C10	—	35-45 pF Johanson Cerami Capacitor, JMC 5801 or Equivalent (C10 Taped 3.12 cm from Base Connection on TL1)

R1 — 2.7 kΩ, 1½ W
RFC1 — 0.15 μH Molded Choke
TL1, TL2 — Z_0 = 26 Ω, 0.0625 TFG as shown in Photomaster
TL3, TL4 — λ/4 Microstrip, Z_0 = 100 Ω
Y1, Y2 — N-Type Connection (Female)
Y3, Y4 — BNC-Type Connector (Female)
Board Material — 0.0625" Thick Glass Teflon ϵ_r = 2.5

FIGURE 24 — MRF586 BROADBAND TEST CIRCUIT SCHEMATIC



C1, C4	—	0.01 μF Feedthru
C2, C5	—	0.001 μF
C3	—	0.5-10 pF
C6	—	12 pF

L1 — 1 Turn ⅛" I.D. #20 AWG
R1 — 13 Ω ½ W
T1(1) — 12 Turns Tapped at 4 Turns #30 AWG
T2(1) — 10 Turns Tapped at 2 Turns #30 AWG

(1) Ferronics 12-340-k Core

FIGURE 25 — MRF587 BROADBAND TEST CIRCUIT SCHEMATIC

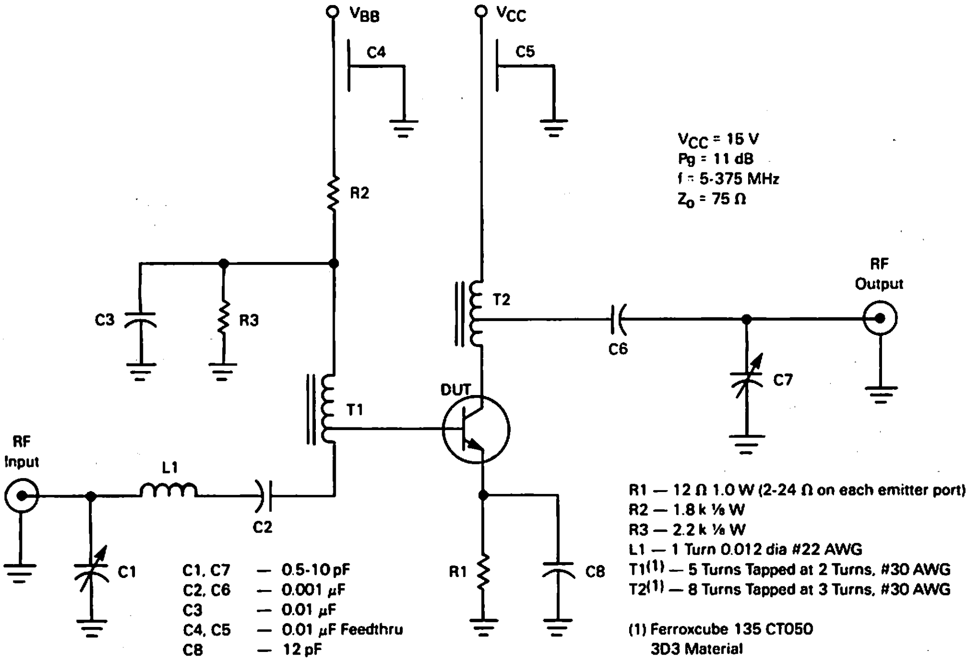


FIGURE 26 — SECOND ORDER DISTORTION TEST

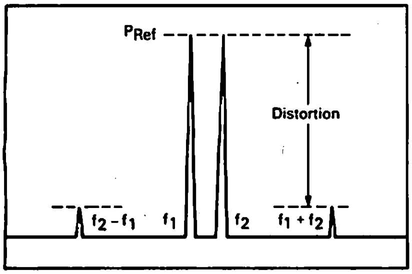


FIGURE 27 — TRIPLE BEAT DISTORTION TEST

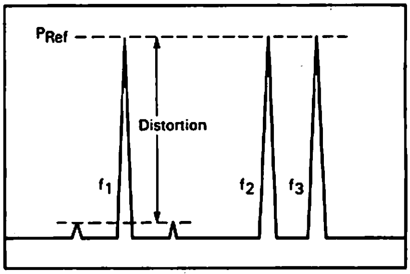


FIGURE 28 — CROSSMODULATION DISTORTION TEST

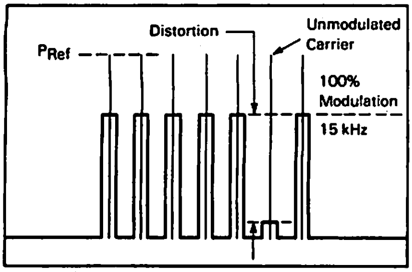
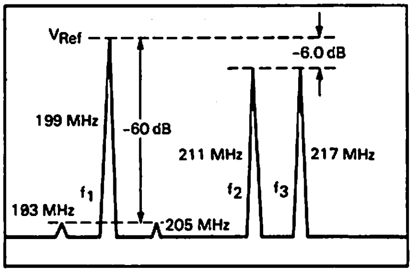


FIGURE 29 — DIN 45004B INTERMODULATION TEST



MRF604

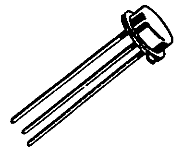
The RF Line

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal amplifier applications in industrial equipment with restricted available space.

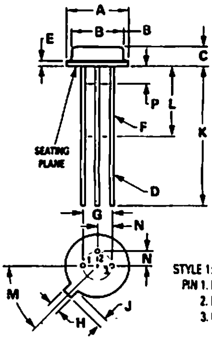
- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 1.0 Watt
  Minimum Gain = 10 dB
  Efficiency = 50%

1.0 W – 175 MHz
RF POWER
TRANSISTOR
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.0 11.0	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +200	°C

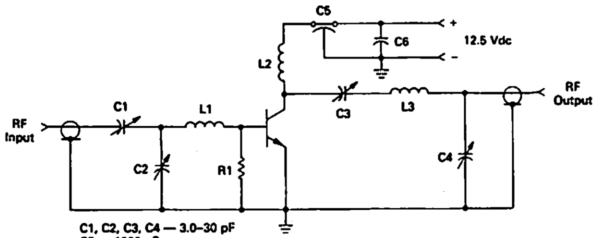


STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
TO-206AB
(TO-46)

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1, C2, C3, C4 — 3.0–30 pF
C5 — 1000 pF
C6 — 0.01 μF
L1 — 2 Turns, #16 AWG, 3/16" I.D., 1/4" Long
L2 — 0.15 μH, MOLDED CHOKE
L3 — 4 Turns, #16 AWG, 3/8" I.D., 3/8" Long
R1 — 100 Ω, 1/4 W, 10%

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 100 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	80	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 200 MHz)	f_T	800	–	–	MHz
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	3.5	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 1.0 W, f = 175 MHz)	G_{PE}	10	–	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 1.0 W, f = 175 MHz)	η	50	–	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 1.0 W, f = 175 MHz)	Z_{in}	–	7.5-j 14	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 1.0 W, f = 175 MHz)	Z_{out}	–	47-j 60	–	Ohms

FIGURE 2 — OUTPUT POWER versus INPUT POWER

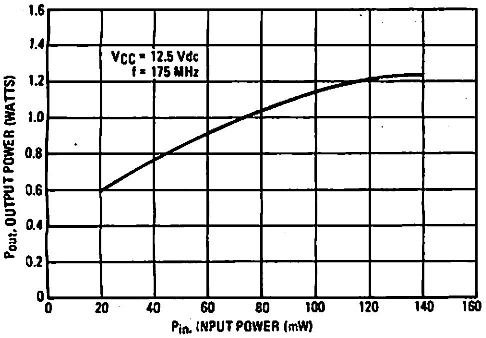


FIGURE 3 — CURRENT-GAIN BANDWIDTH PRODUCT

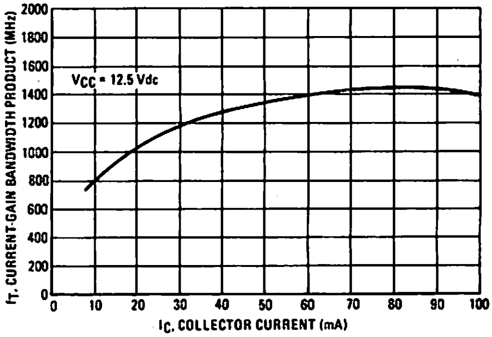
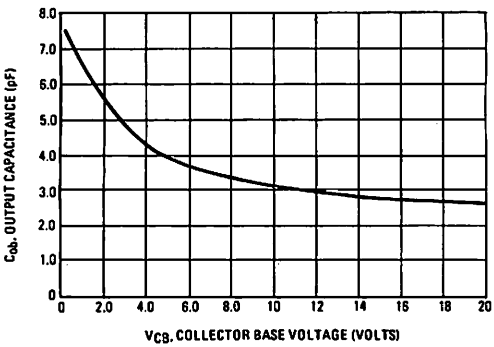


FIGURE 4 — OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE



MRF607

The RF Line

2

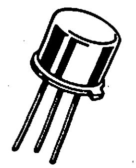
NPN SILICON RF POWER TRANSISTOR

. . . designed for amplifier, frequency multiplier, or oscillator applications in military, mobile, marine and citizens band equipment. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Specified 12.5 Volt, 175 MHz Characteristics –
  Output Power = 1.75 Watts
  Minimum Gain = 11.5 dB
  Efficiency = 50%
- Characterized through 225 MHz

1.75 W – 175 MHz

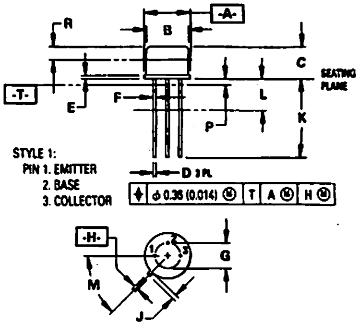
RF POWER
TRANSISTOR
NPN SILICON



MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current – Continuous	I_C	0.33	Adc
Total Device Dissipation @ $T_C = 75°C$ (1) Derate above 75°C	P_D	3.5 28	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as a Class B or C RF amplifier.



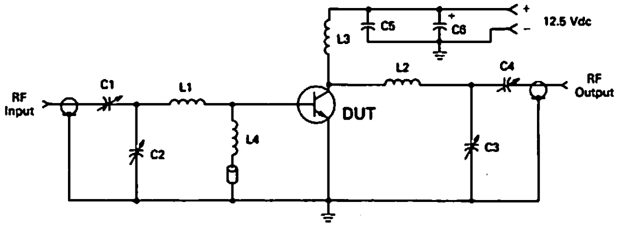
STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-04
TO-205AD
(TO-39)

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1 — 2.7–15 pF, ARCO 461
C2 — 9.0–180 pF, ARCO 463
C3, C4 — 5.0–80 pF, ARCO 462
C5 — 1000 pF UNELCO
C6 — 5.0 μF, 25 Vdc, TANTALUM

L1 — 1 Turn #20 AWG, 3/8" ID
L2 — 3 Turns #20 AWG, 3/8" ID
L3 — 0.22 μH Molded Choke
L4 — 0.15 μH Molded Choke with FERROXCUBE 56-590-65-3B Bead on ground lead

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	Vdc
Collector Cutoff Current (V_{CE} = 10 Vdc, I_B = 0)	I_{CEO}	–	0.3	mAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	150	–
DYNAMIC CHARACTERISTICS				
Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	15	pF
FUNCTIONAL TEST (Figure 1)				
Common-Emitter Amplifier Power Gain (P_{out} = 1.75 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	G_{PE}	11.5	–	dB
Collector Efficiency (P_{out} = 1.75 W, V_{CC} = 12.5 Vdc, f = 175 MHz)	η	50	–	%

TYPICAL PERFORMANCE DATA

FIGURE 2 – OUTPUT POWER versus FREQUENCY

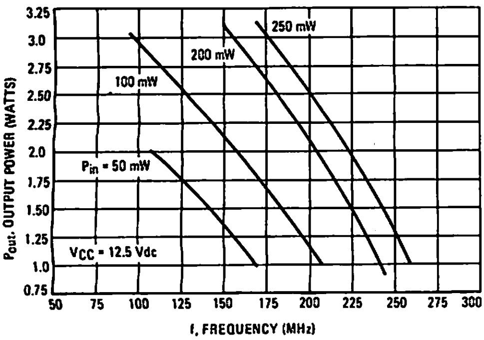


FIGURE 3 – OUTPUT POWER versus INPUT POWER

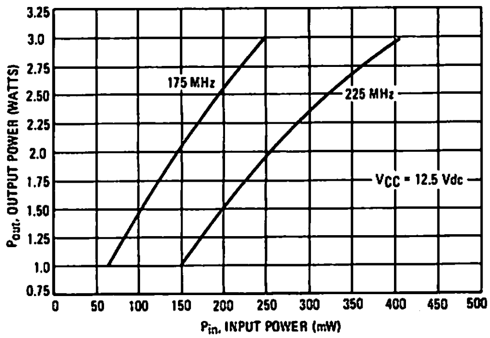


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

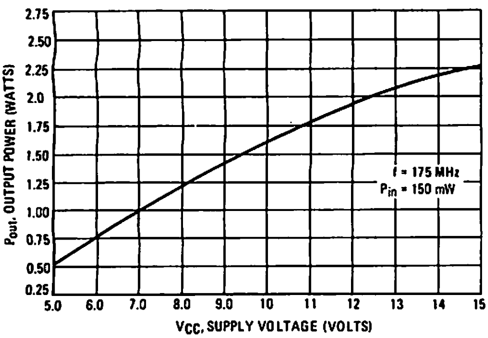
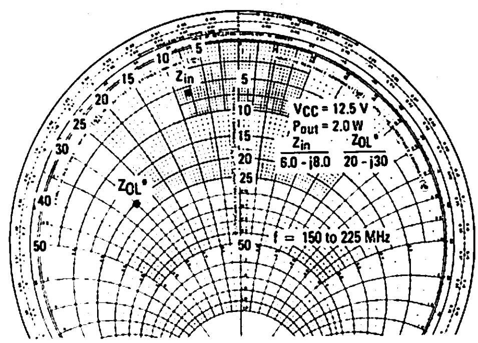


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE PARAMETERS



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

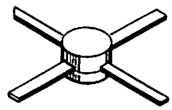
MRF627

The RF Line

0.5 W - 470 MHz

HIGH FREQUENCY TRANSISTOR

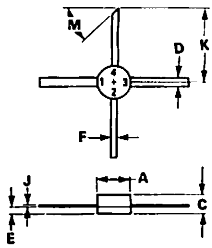
NPN SILICON



NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for requirements that specify optimum performance in a limited space.

- Specified 12.5 Volt, 470 MHz Characteristics –
  Output Power = 0.5 Watts
  Minimum Gain = 10 dB
  Efficiency = 60%



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

CASE 305A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current - Continuous	I_C	150	mAdc
Total Device Dissipation @ $T_C = 25°C$ Derate Above 25°C	P_D	2.5 35	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	28.5	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	30	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	–	–	Vdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	–	–	1.0	mAdc
Emitter Cutoff Current (V_{BE} = 3.5 Vdc, I_C = 0)	I_{EBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	15	–	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain–Bandwidth Product	f_T				GHz
(I_C = 50 mAdc, V_{CE} = 12.5 Vdc, f = 200 MHz)		–	2.5	–	
(I_C = 100 mAdc, V_{CE} = 12.5 Vdc, f = 200 MHz)		–	2.7	–	
(I_C = 150 mAdc, V_{CE} = 12.5 Vdc, f = 200 MHz)		–	2.6	–	
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	3.5	pF
Input Capacitance (V_{BE} = 1.0 Vdc, I_C = 0, f = 1.0 MHz)	C_{ib}	–	8.8	–	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	G_{PE}	10	12	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	η	–	60	–	%
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	Z_{in}	–	6.0-j4.0	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	Z_{out}	–	45-j28	–	Ohms

FIGURE 1 – OUTPUT POWER versus INPUT POWER

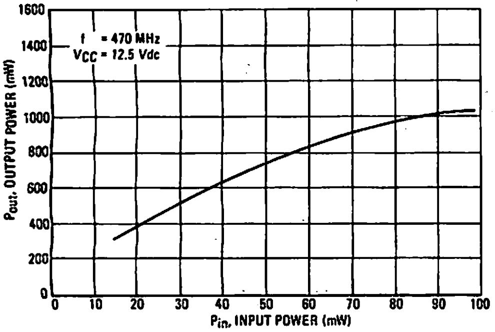


FIGURE 2 – OUTPUT CAPACITANCE versus COLLECTOR BASE VOLTAGE

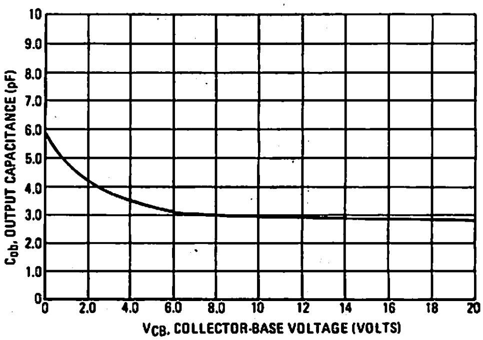
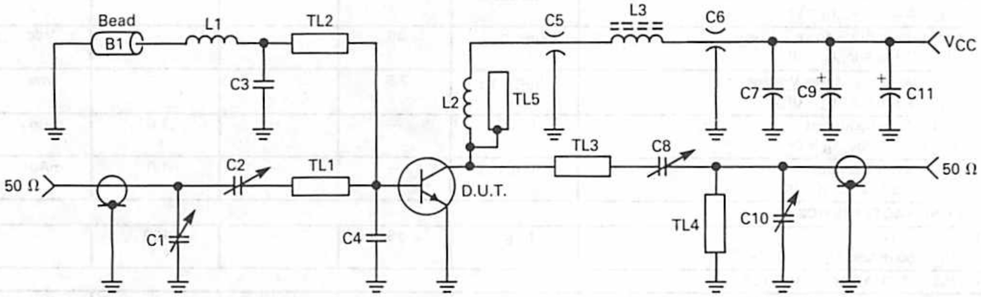


FIGURE 3 — 470 MHz TEST CIRCUIT SCHEMATIC

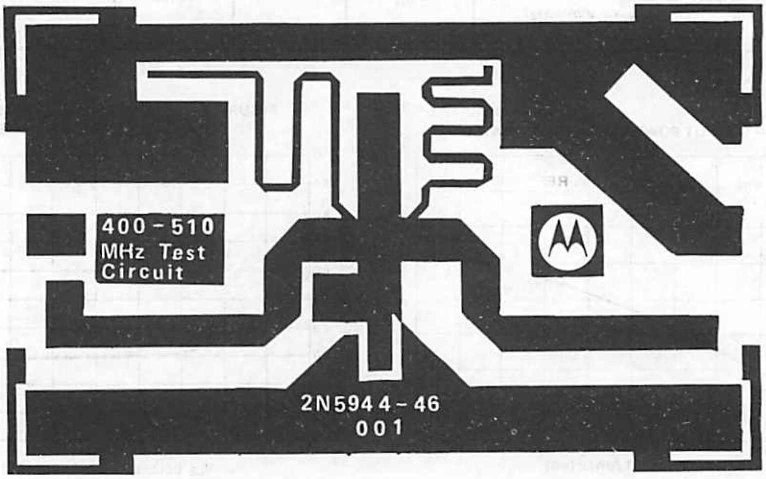


B1 — Ferroxcube Bead — 56-590-65-3B
C1, C2, C8, C10 — Johanson Trimmer, JMC #5501
C3 — 100 pF Unelco 350 Vdc J101
C4 — 15 pF Unelco
C5, C6 — 680 pF Allen Bradley, Feed-Thru
C7 — 0.1 μF Monolithic
C9 — 1 μF Tantalum Sprague ±10% 35 Vdc
C11 — 30 μF Electrolytic 25 Vdc

TL1 — Micro Strip 0.26″ x 2.9″
TL2 — Micro Strip 0.055″ x 3.9″
TL3 — Micro Strip 0.26″ x 2.9″
TL4 — Micro Strip 0.50″ x 1.2″
TL5 — Micro Strip 0.055″ x 2.9″
L1 — #18 AWG Wire 0.750″ Long
L2 — 2 Turns #18 AWG ID ≈ 0.2″
L3 — VK200 20/4B

Board — 0.062″ Glass Teflon
2 oz. Cu. CLAD
ϵ_r = 2.55

FIGURE 4 – 470 MHz TEST CIRCUIT LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 5 – TYPICAL S_{11} and S_{22} versus FREQUENCY

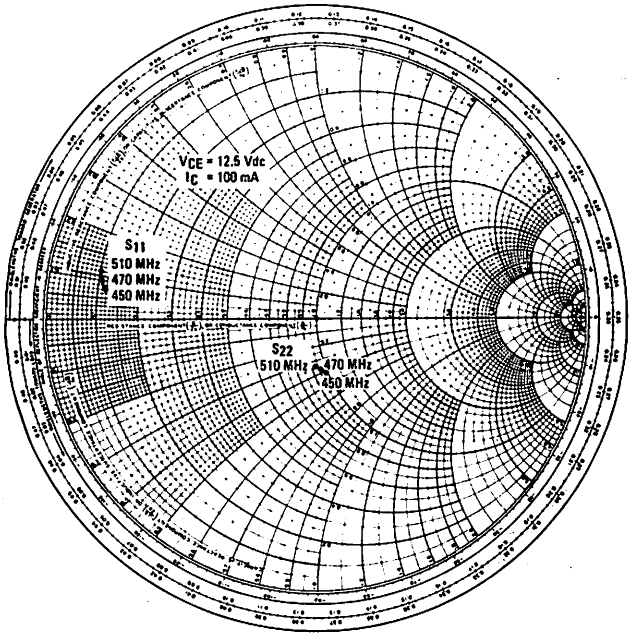


FIGURE 6 – TYPICAL S_{12} versus FREQUENCY

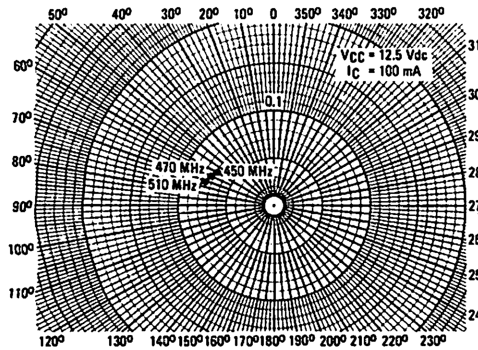
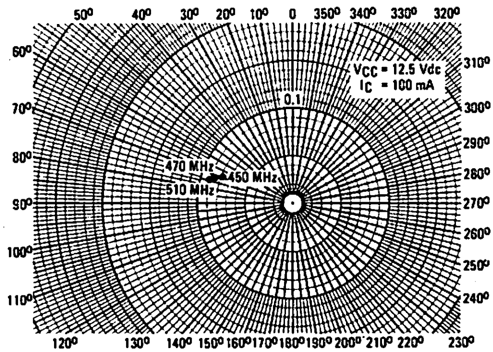


FIGURE 7 – TYPICAL S_{21} versus FREQUENCY



MRF630

The RF Line

2

3.0 W 470 MHz

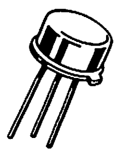
RF POWER TRANSISTOR

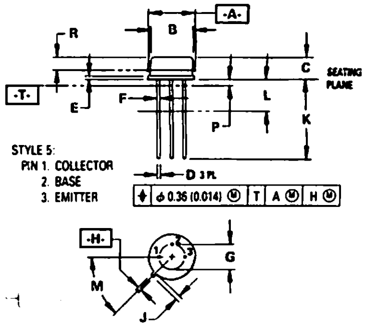
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal, amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics
  Output Power = 3.0 Watts
  Minimum Gain = 9.5 dB
  Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Grounded Emitter TO-205AD (TO-39) Type Package for High Gain and Excellent Heat Dissipation
- Replaces Medium-Power Stud Mounted Devices
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration





STYLE 5:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

CASE 79-05
TO-205AD
(TO-39)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CES}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	8.75 50	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

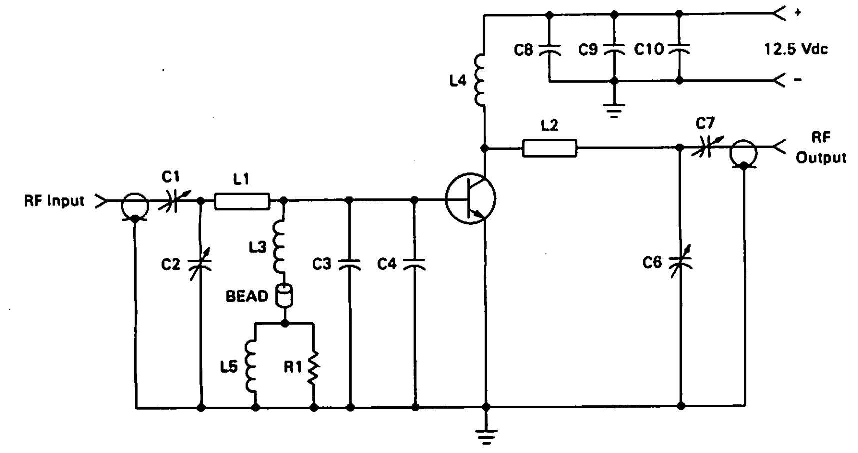
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 12.5 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	60	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	8.0	12	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (Fig. 1) (V_{CC} = 12.5 Vdc, P_{out} = 3.0 W, f = 470 MHz)	G_{PE}	9.5	10.8	—	dB
Collector Efficiency (Fig. 1) (V_{CC} = 12.5 Vdc, P_{out} = 3.0 W, f = 470 MHz)	η	—	55	—	%

FIGURE 1 — 470 MHz TEST CIRCUIT SCHEMATIC



C1, C7 — 1.5 - 20 pF Johanson
C2, C6 — 1 - 10 pF Johanson
C3, C4 — 27 pF Mini-Unelco
C8 — 250 pF Unelco
C9 — 0.047 μF Erie Disc Cap 10 V
C10 — 1.0 μF Electrolytic

L1, L2 — Copper Strap, 1" Length × 0.225 Width × 0.005" Thickness
L3 — 0.33 μH Molded Choke
L4 — 0.12 μH Molded Choke
L5 — 1.2 μH Molded Choke
R1 — 10 Ω, 1/4 W

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

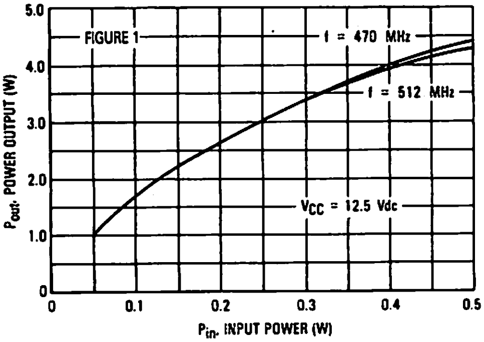


FIGURE 3 — OUTPUT POWER versus FREQUENCY

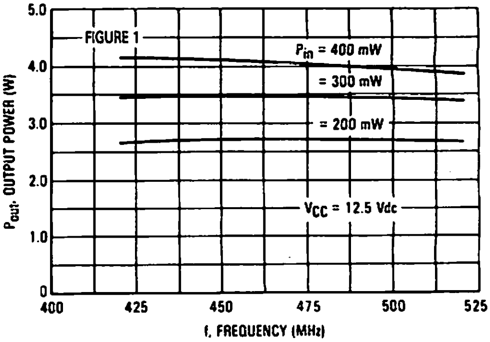


FIGURE 4 — POWER OUT versus SUPPLY VOLTAGE

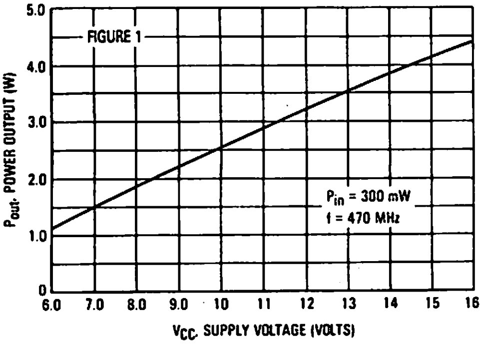
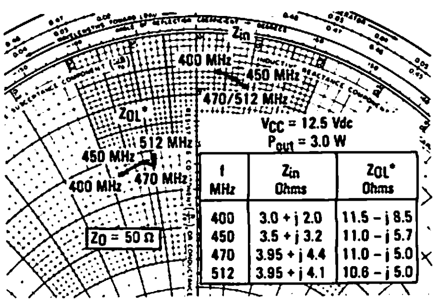


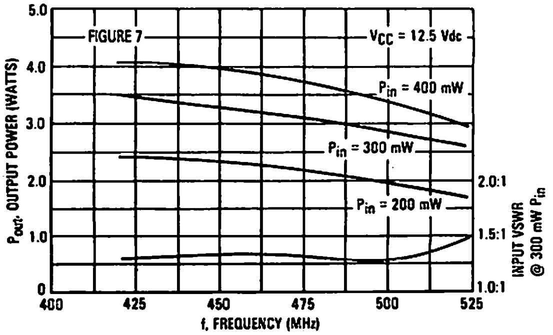
FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	3.0 + j 2.0	11.5 − j 8.5
450	3.5 + j 3.2	11.0 − j 5.7
470	3.95 + j 4.4	11.0 − j 5.0
512	3.95 + j 4.1	10.6 − j 5.0

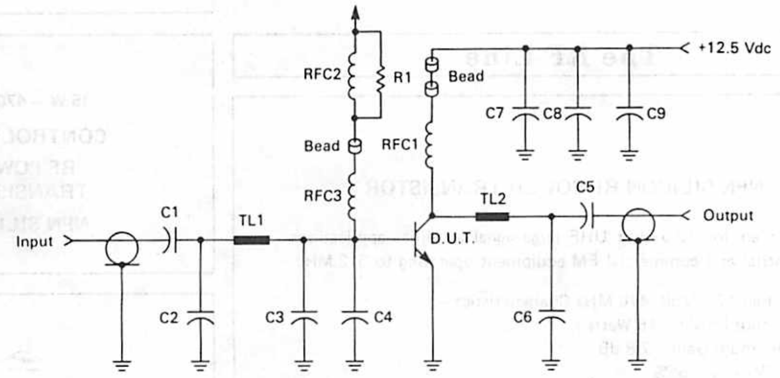
Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 6 — OUTPUT POWER versus FREQUENCY, BROADBAND CIRCUIT



2

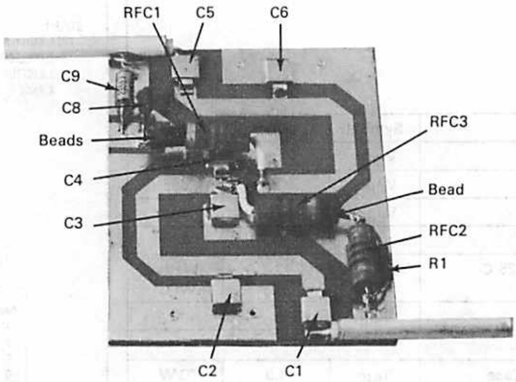
FIGURE 7 — MRF630 BROADBAND CIRCUIT
420-520 MHz



C1, C5 — 43 pF Mini-Unelco
C2 — 10 pF Mini-Unelco
C3 — 18 pF Mini-Unelco
C4 — 27 pF Mini-Unelco
C6 — 6.8 pF Mini-Unelco
C7 — 220 pF Ceramic Chip
C8 — 0.1 mF
C9 — 1.0 mF Tantalum

RFC1 — 0.47 μH Molded Choke
RFC2 — 1.0 μH Molded Choke
RFC3 — 0.3 μH Molded Choke
R1 — 12 Ω/1/4 W
TL1 — Transmission Line 0.166" × 1.85" (WXL)
TL2 — Transmission Line 0.166" × 1.77" (WXL)
Board Material — 2 oz. 0.0625" TFG

FIGURE 8 — BROADBAND CIRCUIT



MRF641

The RF Line

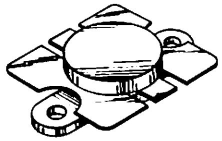
2

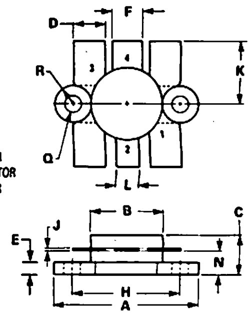
NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
  Output Power = 15 Watts
  Minimum Gain = 7.8 dB
  Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and Overdrive.

15 W — 470 MHz
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.33	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	43.7 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

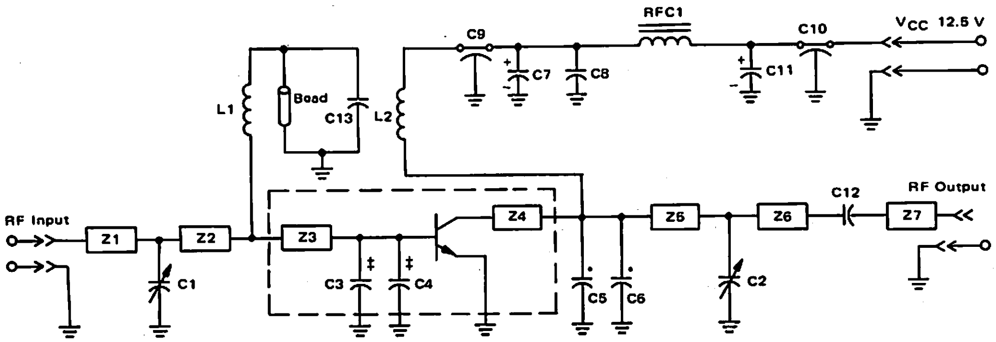
THERMAL CHARACTERISTICS

Characteristic	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	30	70	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	40	60	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 470 MHz)	G_{pe}	7.8	8.5	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 470 MHz)	η	55	60	–	%
Output Mismatch Stress (V_{CC} = 16 Vdc, P_{in} = 3.0 W, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 – TEST CIRCUIT SCHEMATIC



PARTS

Z1 = 1.225" X 0.187" Microstrip
Z2 = 0.884" X 0.187" Microstrip
Z3 = Capacitor Block (Base)
Z4 = Collector Block
Z5 = 1.1" X 0.187" Microstrip
Z6 = 0.433" X 0.187" Microstrip
Z7 = 0.4" X 0.187" Microstrip
Dotted Area – Capacitor Assembly

C1, C2 – 0.8–10 pF Johanson
C3, C4 – 24 pF Chip Caps 100 mils ATC
C5, C6 – 22 pF Chip Caps 100 mils ATC
C12 – 220 pF Chip Cap 100 mils ATC
C7, C11 – 1.0 μF Tantalum 35 Vdc
C9, C10 – 680 pF Feedthrough Allen-Bradley
C13 – 200 pF UNELCO
C8 – 0.1 μF, 50 V Erie Red Cap
RFC1 – VK 200 – 104B Ferrite Choke
L1 – 4 Turns 0.2" Dia. #16 AWG
L2 – 9 Turns 0.15" Dia. #16 AWG
Bead – Ferroxcube 56-590-65-3SEB

NOTES

**C5, C6, are mounted as close to the capacitor assembly as possible.
‡‡C3, C4 are mounted in the capacitor assembly.
Board – 62.5 mil Glass Teflon, ϵ_R = 2.55.

FIGURE 2 — POWER OUTPUT versus POWER INPUT

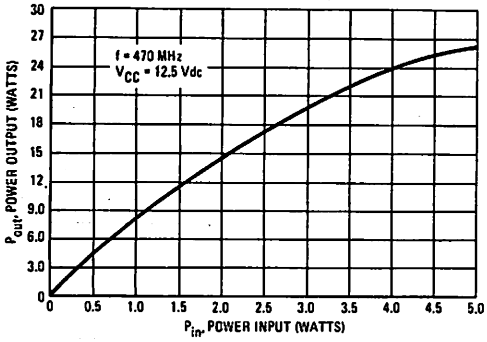


FIGURE 3 — POWER OUTPUT versus FREQUENCY

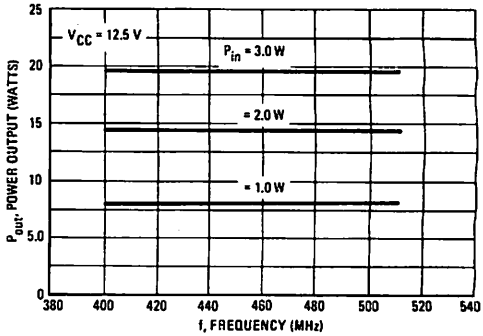


FIGURE 4 — POWER OUTPUT versus SUPPLY VOLTAGE

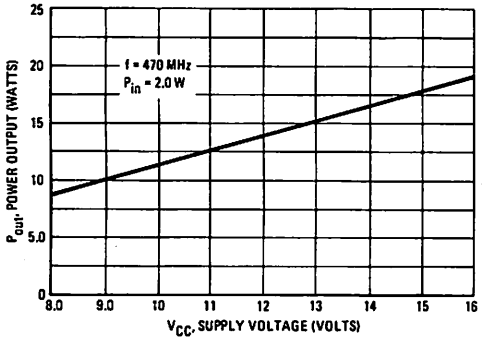


FIGURE 5 — POWER SATURATION PROFILE

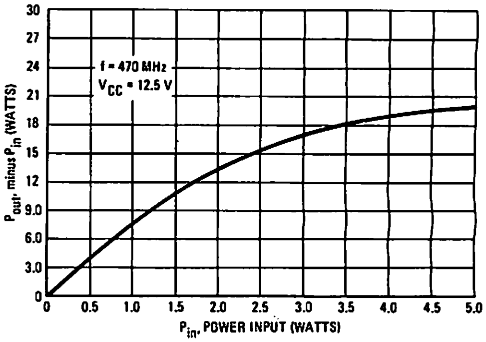
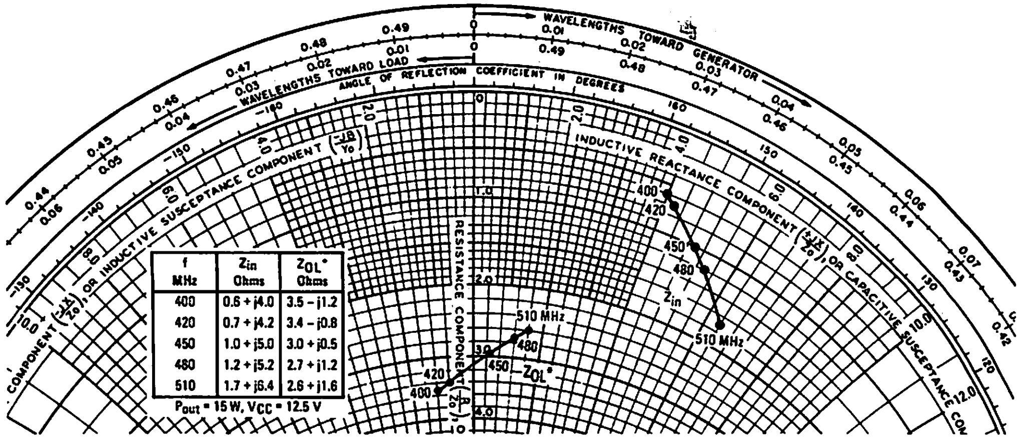


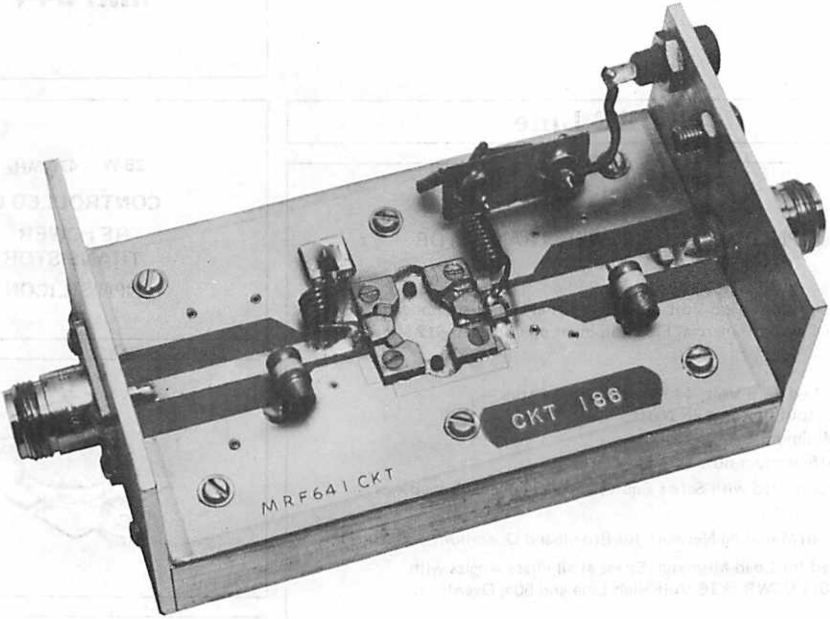
FIGURE 6 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



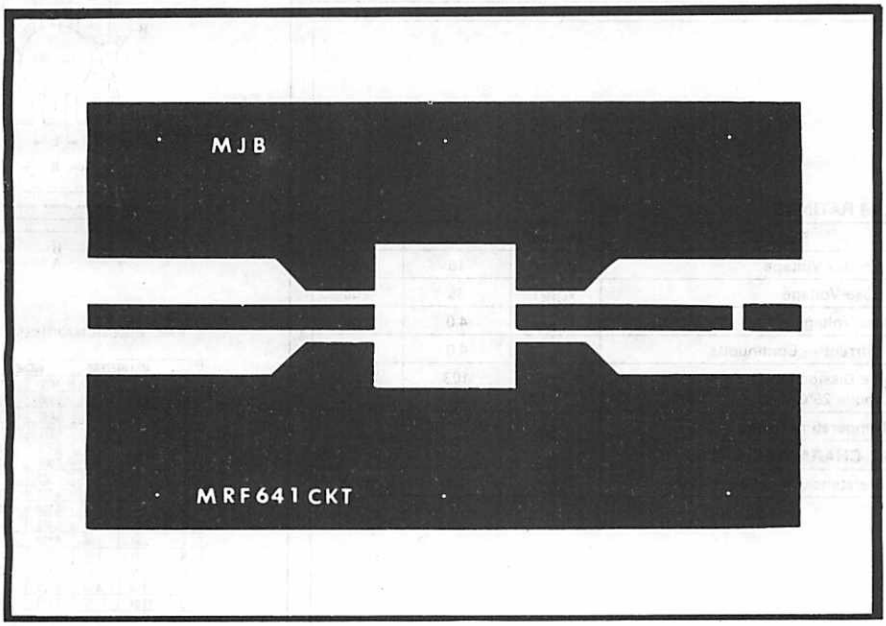
f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	0.6 + j4.0	3.5 − j1.2
420	0.7 + j4.2	3.4 − j0.8
450	1.0 + j5.0	3.0 + j0.5
480	1.2 + j5.2	2.7 + j1.2
510	1.7 + j6.4	2.6 + j1.6

P_{out} = 15 W, V_{CC} = 12.5 V

Z_{OL}* = Conjugate of the load impedance into which the device output operates at a given power, η, and frequency.



MRF641 TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF644

The RF Line

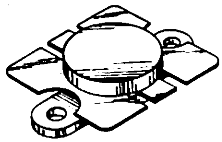
2

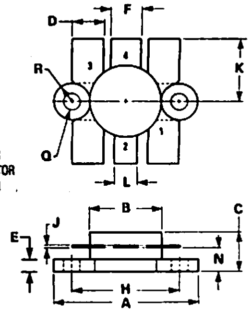
25 W — 470 MHz
CONTROLLED Q
RF POWER TRANSISTOR
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics —
  Output Power = 25 Watts
  Minimum Gain = 6.2 dB
  Efficiency = 60%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 50% Overdrive.





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	103 0.59	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

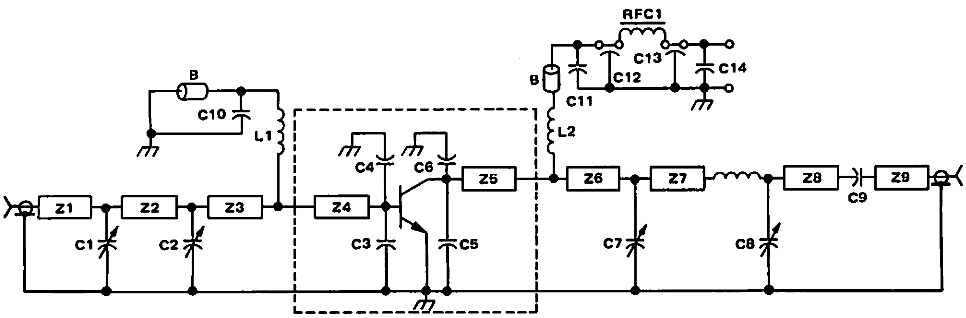
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 4.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	70	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	60	85	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 25 W, I_C (MAX) = 3.6 Adc, f = 470 MHz)	G_{pe}	6.2	7.0	–	dB
Input Power (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	P_{in}	–	5.0	6.0	Watts
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 25 W, I_C (MAX) = 3.6 Adc, f = 470 MHz)	η	55	60	–	%
Output Mismatch Stress (V_{CC} = 16 Vdc, P_{in} = Note 1, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ*	No Degradation in Output Power			
Series Equivalent Input Impedance (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	Z_{in}	–	1.2+j3.3	–	Ohms
Series Equivalent Output Impedance (V_{CC} = 12.5 Vdc, P_{out} = 25 W, f = 470 MHz)	Z_{OL}	–	1.9 + j2.1	–	Ohms

Notes:
1. P_{in} = 150% of Drive Requirement for 25 W Output at 12.5 Vdc.
* ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 — TEST CIRCUIT SCHEMATIC



C1, C2, C7, C8	1–20 pF JOHANSON Variable	C12, C13	680 pF Feedthrough	Z3	0.20" x 0.20" Microstrip
C3	27 pF 100 mil ATC	L1	5" #22 AWG 0.100" ID	Z4, Z5	1/2" #18 AWG bent in a "V" shape 1/8" Wide
C4	30 pF 100 mil ATC	L2	5" #20 AWG 0.187" ID	Z6	0.20" x 0.20" Microstrip
C5, C6	33 pF 100 mil ATC	RFC1	Ferroxcube VK200-20-4B	Z7	0.70" x 0.20" Microstrip
C9	250 pF 100 mil ATC	B	Ferroxcube Bead 56-590-65-3B	Z8	0.33" x 0.20" Microstrip
C10	100 pF UNELCO	Z1	0.25" x 0.20" Microstrip	Z9	0.50" x 0.20" Microstrip
C11, C14	1 µF 35 V TANTALUM	Z2	1.63" x 0.20" Microstrip	Board	62.5 mil Glass Teflon, ϵ_R = 2.55

FIGURE 2 — POWER OUTPUT versus POWER INPUT

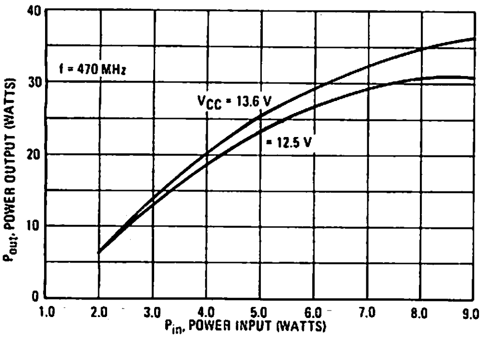


FIGURE 3 — POWER OUTPUT versus FREQUENCY

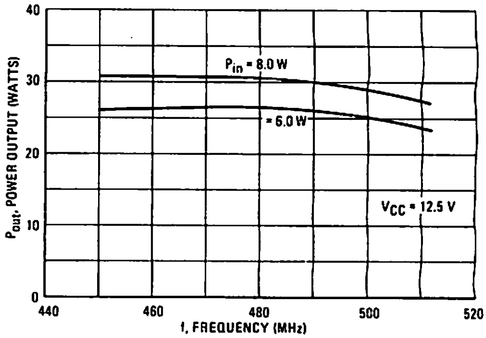


FIGURE 4 — POWER OUTPUT versus SUPPLY VOLTAGE

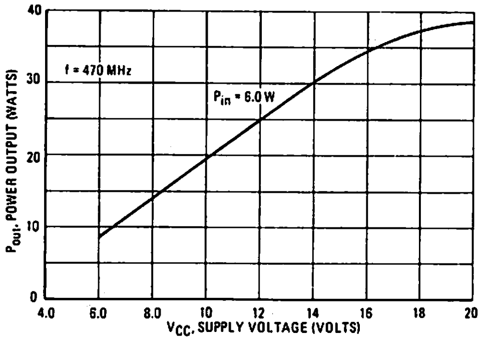


FIGURE 5 — POWER SATURATION PROFILE

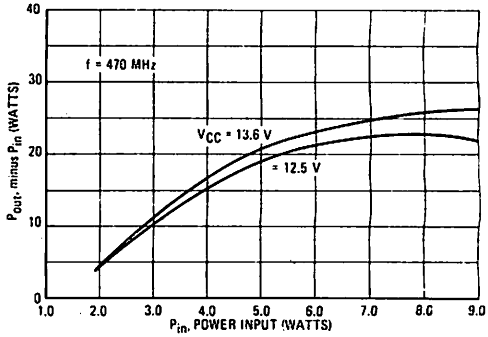
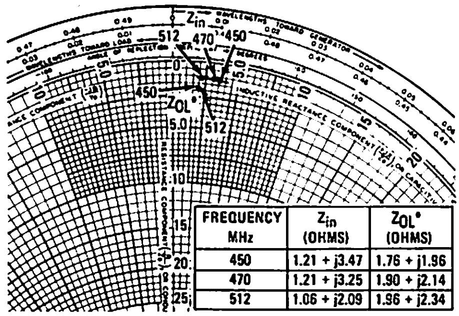


FIGURE 7 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



FREQUENCY MHz	Z_{in} (OHMS)	Z_{OL}* (OHMS)
450	1.21 + j3.47	1.76 + j1.96
470	1.21 + j3.25	1.90 + j2.14
512	1.06 + j2.09	1.96 + j2.34

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

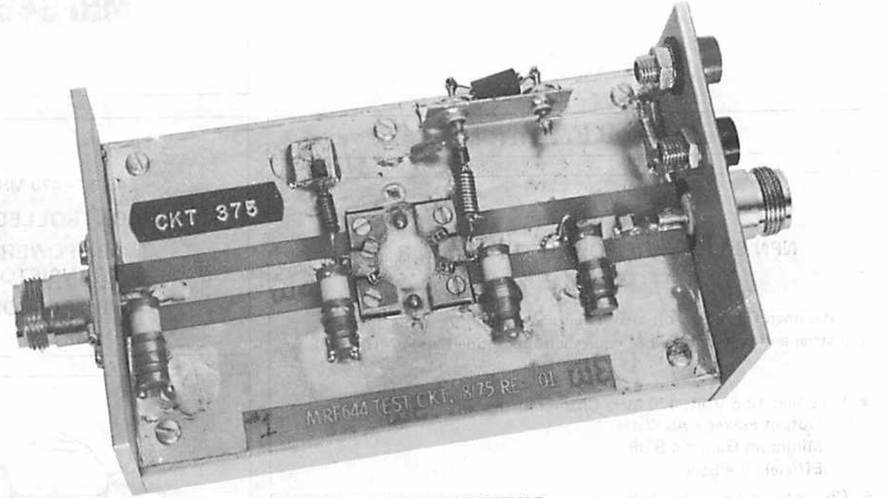
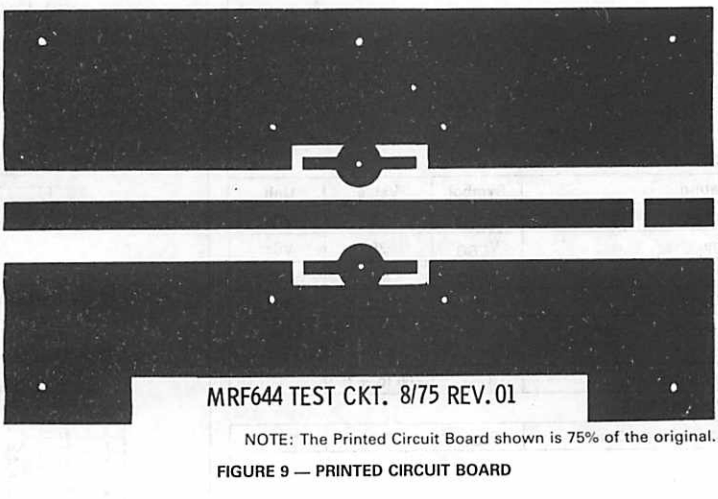


FIGURE 8 — MRF644 TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — PRINTED CIRCUIT BOARD

MRF646

2

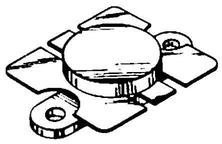
The RF Line

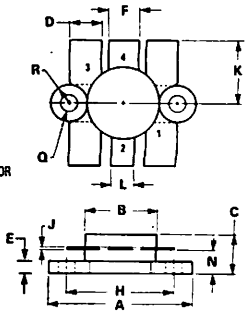
NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics –
  Output Power = 45 Watts
  Minimum Gain = 4.8 dB
  Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 50% Overdrive.

45 W — 470 MHz
CONTROLLED Q
RF POWER TRANSISTOR
NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	9.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	117 0.67	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Rating	Symbol	Value	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS ($T_C = 25^oC$ unless otherwise noted.)

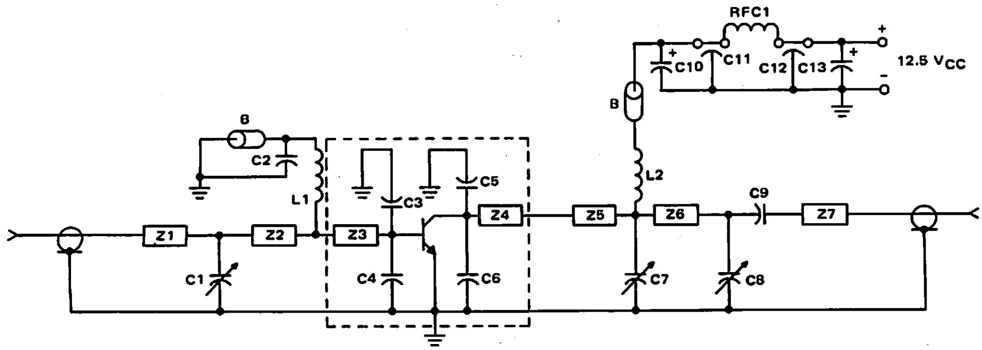
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CE} = 15$ Vdc, $V_{BE} = 0$, $T_C = 25^oC$)	I_{CES}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 4.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	20	70	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	90	125	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CC} = 12.5$ Vdc, $P_{out} = 45$ W, I_C (Max) = 5.8 Adc, f = 470 MHz)	G_{pe}	4.8	5.4	–	dB
Input Power ($V_{CC} = 12.5$ Vdc, $P_{out} = 45$ W, f = 470 MHz)	P_{in}	–	13	15	Watts
Collector Efficiency ($V_{CC} = 12.5$ Vdc, $P_{out} = 45$ W, I_C (Max) = 5.8 Adc, f = 470 MHz)	η	55	60	–	%
Load Mismatch Stress ($V_{CC} = 16$ Vdc, P_{in} = Note 1, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ*	No Degradation in Output Power			
Series Equivalent Input Impedance ($V_{CC} = 12.5$ Vdc, $P_{out} = 45$ W, f = 470 MHz)	Z_{in}	–	1.4 + j4.0	–	Ohms
Series Equivalent Output Impedance ($V_{CC} = 12.5$ Vdc, $P_{out} = 45$ W, f = 470 MHz)	Z_{OL}	–	1.2 + j2.8	–	Ohms

Notes:

1. P_{in} = 150% of Drive Requirement for 45 W output @ 12.5 V.

* ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 — TEST CIRCUIT SCHEMATIC



C1, C8	1.0–20 pF JOHANSON	L2	5" # 20 AWG, 0.1" I.D.
C2	100 pF UNELCO	RFC1	Ferroxcube VR200-20-4B
C3, C6	33 pF 100 mil ATC	Z1	0.525" x 0.190" Microstrip
C4	30 pF 100 mil ATC	Z2	1.475" x 0.190" Microstrip
C5	39 pF 100 mil ATC	Z3, Z4	(0.2 x 0.2)/0.25 Alumina
C7	1–10 pF JOHANSON	Z5	0.190" x 0.190" Microstrip
C9	100 pF 100 mil ATC	Z6	1.150" x 0.190" Microstrip
C10, C13	1 μF 35 V TANTALUM	Z7	0.660" x 0.190" Microstrip
C11, C12	680 pF Feedthrough	Board	62.5 mil Glass Teflon,
B	Ferroxcube Bead 56-590-65-3B		$\epsilon_R = 2.55$, $\lambda = 0.0018$
L1	5" # 22 AWG, 0.1" I.D.		

2

FIGURE 2 — POWER OUTPUT versus POWER INPUT

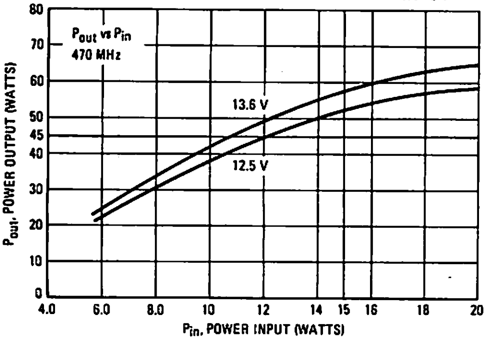


FIGURE 3 — POWER OUTPUT versus FREQUENCY

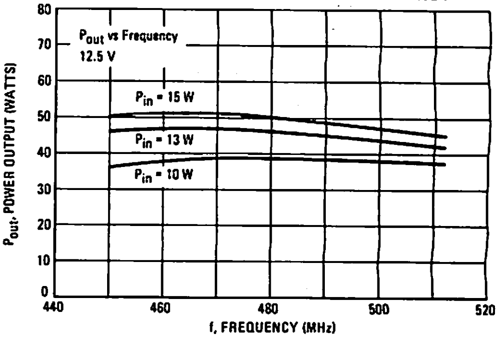


FIGURE 4 — POWER OUTPUT versus SUPPLY VOLTAGE

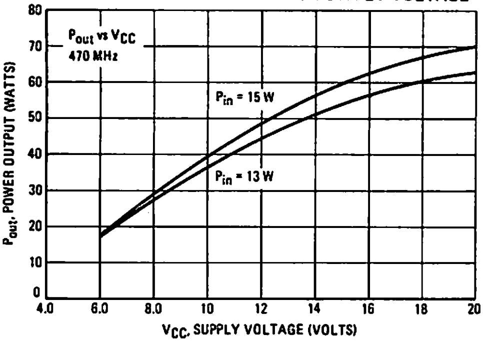


FIGURE 5 — POWER SATURATION PROFILE

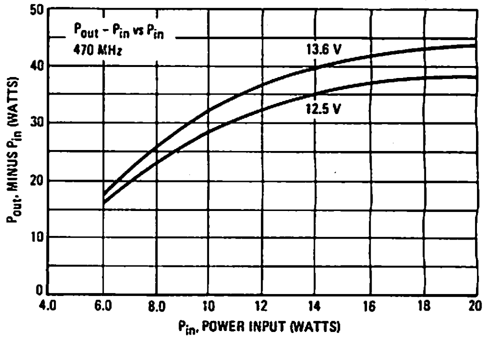
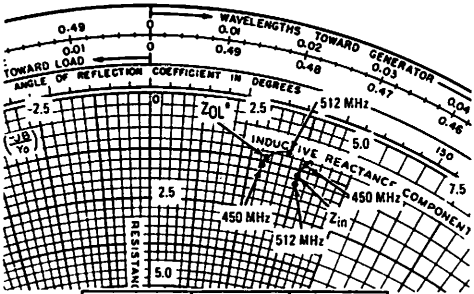


FIGURE 7 — SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



Frequency (MHz)	Zin (Ohms)	ZOL** (Ohms)
450	1.21 + j3.91	1.27 + j2.79
470	1.41 + j3.75	1.20 + j2.80
512	1.64 + j3.75	0.93 + j3.36

ZOL* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

2

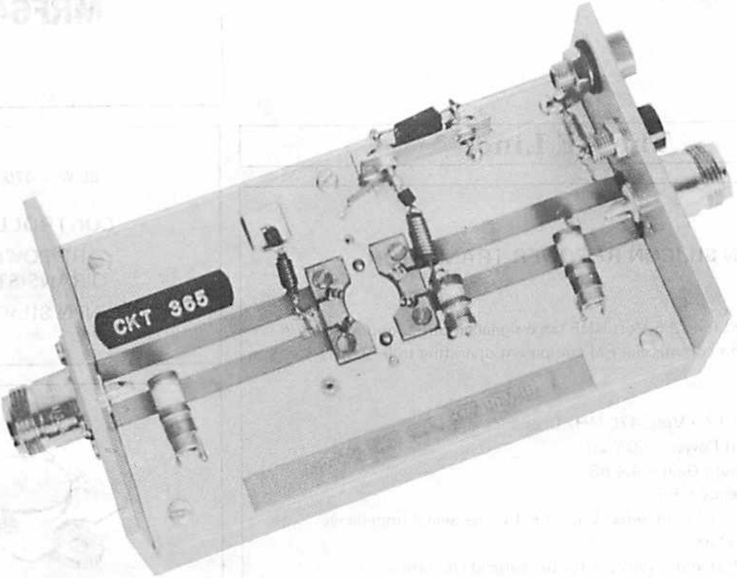
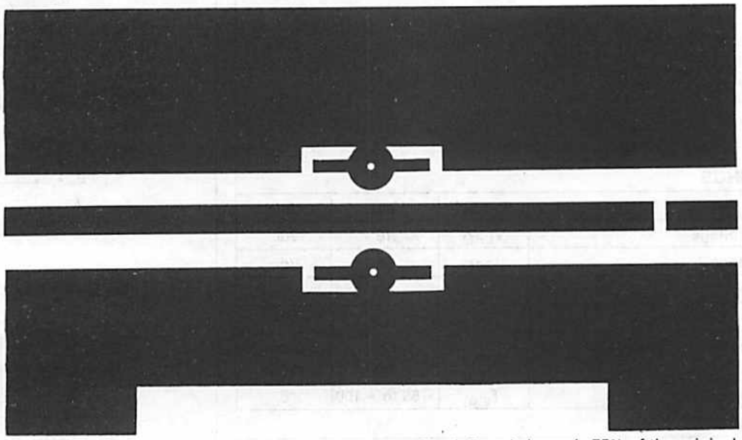


FIGURE 8 — MRF644 TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — PRINTED CIRCUIT BOARD

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF648

The RF Line

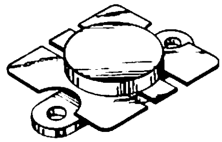
60 W – 470 MHz

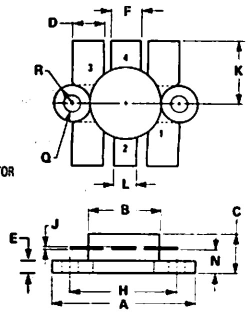
CONTROLLED Q
RF POWER
TRANSISTOR
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 470 MHz Characteristics –
  Output Power = 60 Watts
  Minimum Gain = 4.4 dB
  Efficiency = 55%
- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 16-Volt High Line and 20% Overdrive





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.33	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	11.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

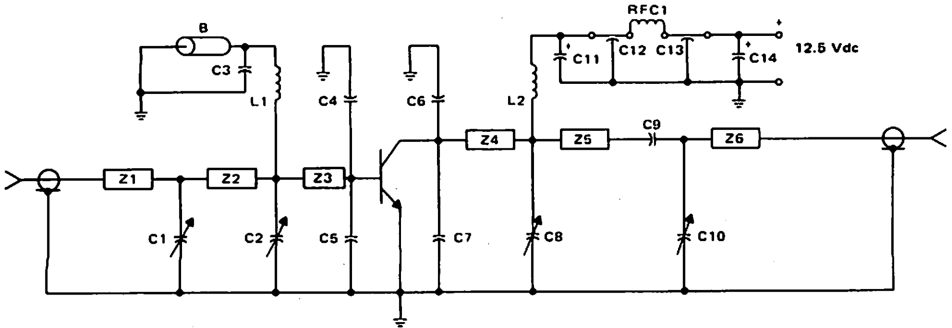
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	15	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 6.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	70	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	130	150	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 470 MHz)	G_{pe}	4.4	5.0	–	dB
Input Power (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 470 MHz)	P_{in}	–	19	22	Watts
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 60 W, f = 470 MHz)	η	55	65	–	%
Output Mismatch Stress (V_{CC} = 16 Vdc, P_{in} = 26 W, f = 470 MHz, VSWR = 20:1, All Phase Angles)	ψ*	No Degradation in Output Power			

Notes:
- * ψ = Mismatch stress factor—the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.

FIGURE 1 – TEST CIRCUIT SCHEMATIC



C1, C2, C8, C10	1-20 pF Johanson	C12, C13	680 pF Feedthrough	Z2	1.39" X 0.190" Microstrip
C3	200 pF Unelco	B	Ferroxcube Bead 56 590 65 3B	Z3, Z4	(0.2 X 0.2)/0.25 Alumina
C4, C5	33 pF 100mil ATC	L1	10 Turns #26 AWG 0.1" I.D. X 0.23"	Z5	1.30" X 0.190" Microstrip
C6, C7	36 pF 100mil ATC	L2	10 Turns #20 AWG 0.1" I.D. X 0.50"	Z6	0.330" X 0.190" Microstrip
C9	100 pF 100mil ATC	RFC1	Ferroxcube VR200 19 4B	Board	62.5mil Glass Teflon, ϵ_R = 2.55, λ = 0.0018, Dimension: 5.0" X 3.0" X 0.06"
C11, C14	1.0 µF 35 V Tantalum	Z1	0.46" X 0.190" Microstrip		

FIGURE 2 – POWER OUTPUT versus POWER INPUT

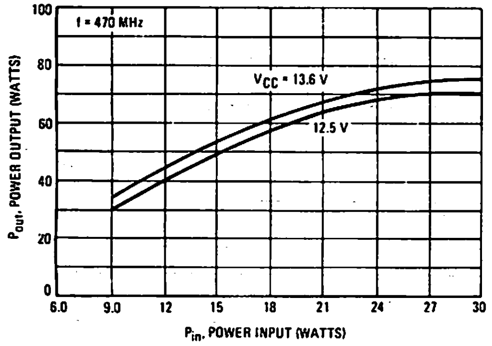


FIGURE 3 – POWER OUTPUT versus FREQUENCY

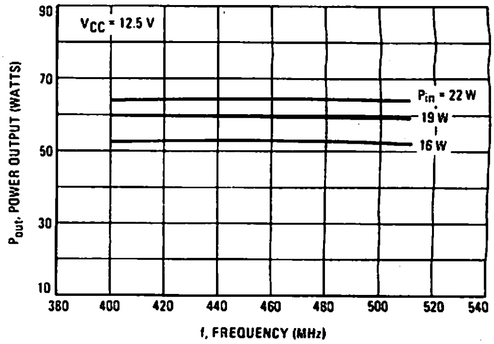


FIGURE 4 – POWER OUTPUT versus SUPPLY VOLTAGE

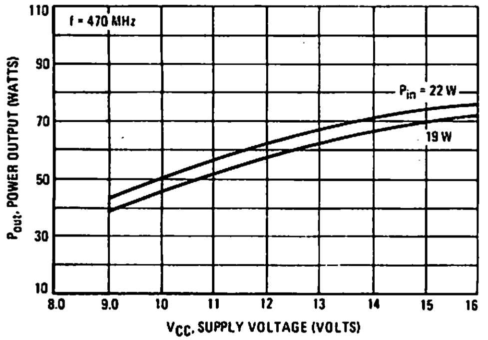


FIGURE 5 – POWER SATURATION PROFILE

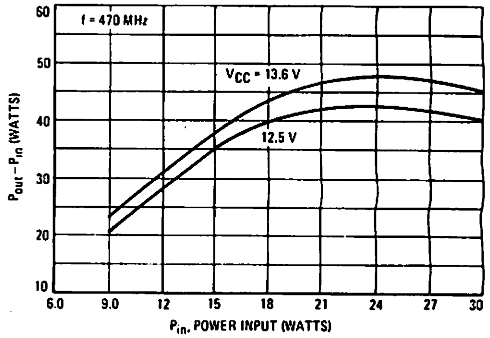
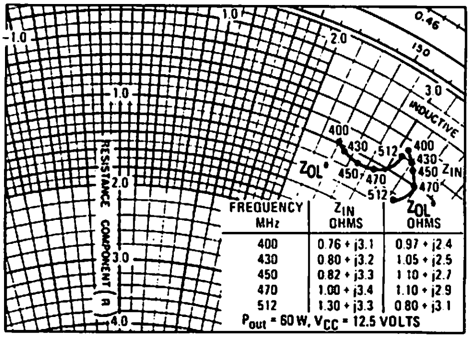


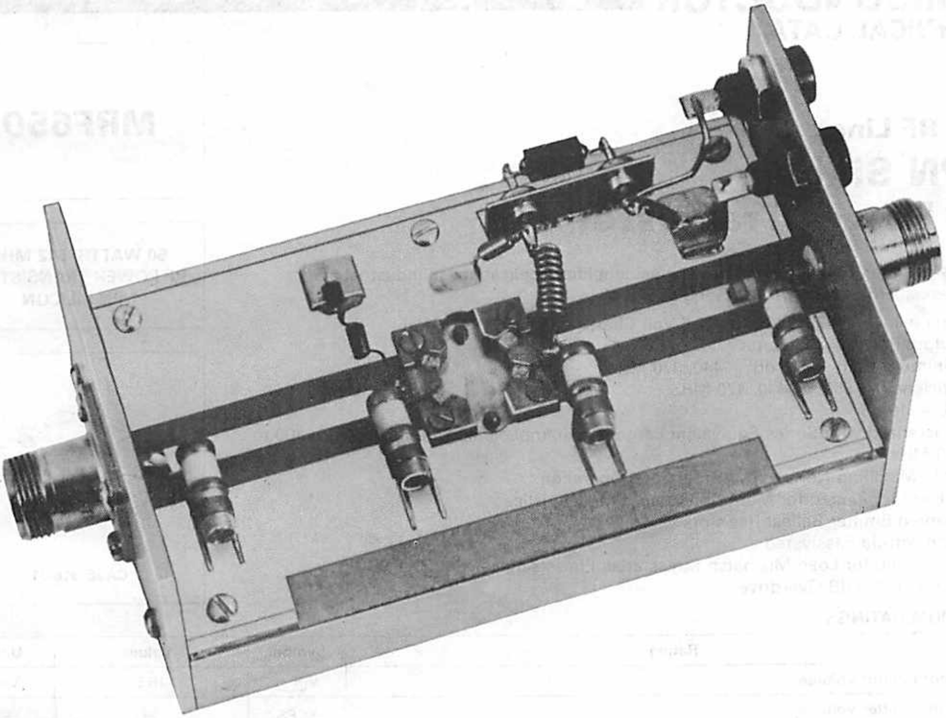
FIGURE 6 – SERIES EQUIVALENT INPUT-OUTPUT IMPEDANCE



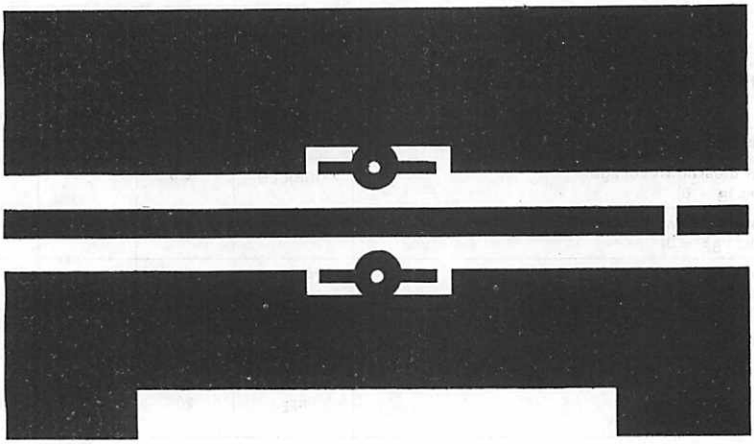
FREQUENCY MHz	Z_{IN} OHMS	Z_{OL}* OHMS
400	0.76 + j3.1	0.97 + j2.4
430	0.80 + j3.2	1.05 + j2.5
450	0.82 + j3.3	1.10 + j2.7
470	1.00 + j3.4	1.10 + j2.9
512	1.30 + j3.3	0.80 + j3.1

P_{out} = 60 W, V_{CC} = 12.5 VOLTS

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



TEST CIRCUIT TEST FIXTURE



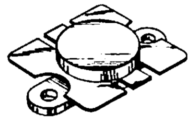
NOTE: The Printed Circuit Board shown is 75% of the original.

2

MRF650

The RF Line
NPN Silicon RF Power Transistor

**50 WATTS, 512 MHz
RF POWER TRANSISTOR
*NPN SILICON***



CASE 316-01

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 520 MHz.

- Guaranteed 440, 470, 512 MHz 12.5 Volt Characteristics
  Output Power = 50 Watts
  Minimum Gain = 5.2 dB @ 440, 470 MHz
  Efficiency = 55% @ 440, 470 MHz
  IRL = 10 dB
- Characterized with Series Equivalent Large-Signal Impedance Parameters from 400 to 520 MHz
- Built-In Matching Network for Broadband Operation
- Triple Ion Implanted for More Consistent Characteristics
- Implanted Emitter Ballast Resistors
- Silicon Nitride Passivated
- 100% Tested for Load Mismatch Stress at all Phase Angles with 20:1 VSWR @ 15.5 Vdc, 2.0 dB Overdrive

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	12	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	135 0.77	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	70	120	—

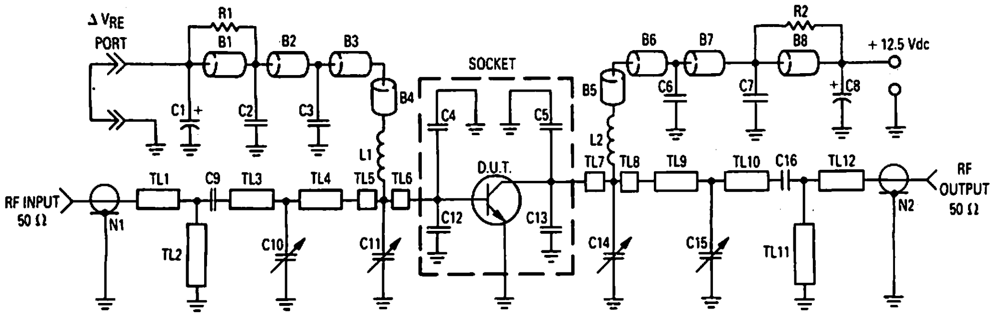
(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	135	170	pF
FUNCTIONAL TESTS (In Motorola Test Fixture. See Figure 1.)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470 MHz)	G_{pe}	5.2	6.1	—	dB
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 512 MHz)	G_{pe}	5.0	5.9	—	dB
Input Return Loss (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470, 512 MHz)	IRL	10	15	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 440, 470 MHz)	η	55	65	—	%
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 50 W, f = 512 MHz)		50	60	—	%
Output Mismatch Stress (V_{CC} = 15.5 V, 2 dB Overdrive, f = 470 MHz, VSWR = 20:1) (all phase angles) (1)	ψ (2)	No Degradation in Output Power			

(1) P_{in} = 2.0 dB above drive requirement for 50 W output at 12.5 Vdc.
(2) ψ = Mismatch stress factor — the electrical criterion established to verify the device resistance to load mismatch failure. The mismatch stress test is accomplished in the standard test fixture (Figure 1) terminated in a 20:1 minimum load mismatch at all phase angles.



B1, B8 — Ferrite Bead Ferroxcube VK200 20-4B
B2, B3, B4, B5, B6, B7 — Ferrite Bead Ferroxcube #56-590-3B

C1, C8 — 10 µF, 25 V, 25%, Electrolytic, ECS TE-1204
C2, C7 — 1000 pF, Chip Cap, 5%, ATC 100B102JC50
C3, C6 — 91 pF, 5%, Mica, SAHA 3HS0006-91
C4, C5, C12, C13 — 36 pF, 5%, SAHA 3HS0006-36
C9, C16 — 220 pF, Chip Cap, 5%, ATC 100B221JC200
C10, C11, C15 — 0.8–10 pF, Variable, Johanson JMC501 PG26J200
C14 — 1.0–20 pF, Variable, Johanson JMC5501 PG26J200

L1, L2 — 3 Turns, 18 AWG, 0.19" ID — Total Length 3.5"

N1, N2 — N Coaxial Conn., Omni-Spectra 3052-1648-10

R1, R2 — 10 Ohm, 10%, 1.0 W, Carbon, RCA 831010

TL1, TL12 — Z_o = 50 Ohm
TL2 — See Photomaster
TL3 — See Photomaster
TL4 — See Photomaster

TL5 — See Photomaster
TL6 — See Photomaster
TL7 — See Photomaster
TL8 — See Photomaster
TL9 — See Photomaster
TL10 — See Photomaster
TL11 — See Photomaster

Transmission Line Boards: 1/16" Glass-Teflon
Keene GX-0600-55-22
2 oz. Cu Clad Both Sides
ϵ_r = 2.55

Bias Boards: 1/16" G10 or Equivalent
2 oz. Cu Clad Double Sided

Figure 1. 440 to 512 MHz Broadband Test Circuit

2

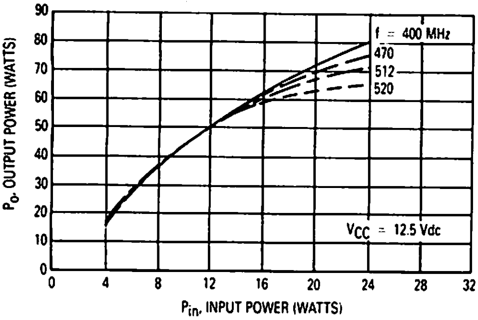


Figure 2. Output Power versus Input Power

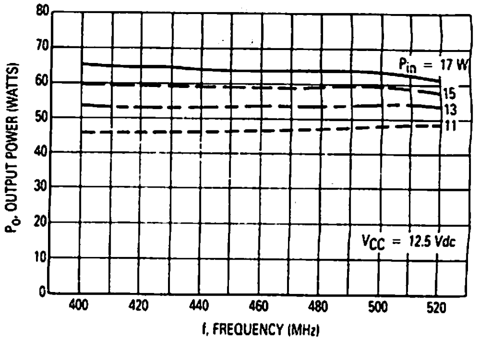


Figure 3. Output Power versus Frequency

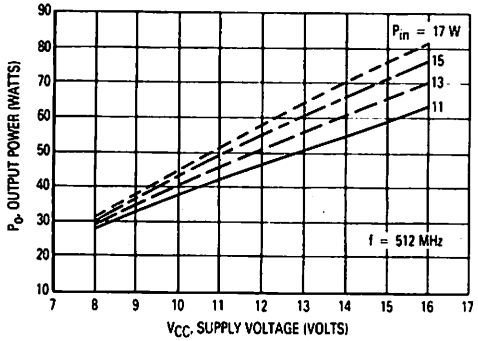


Figure 4. Output Power versus Supply Voltage

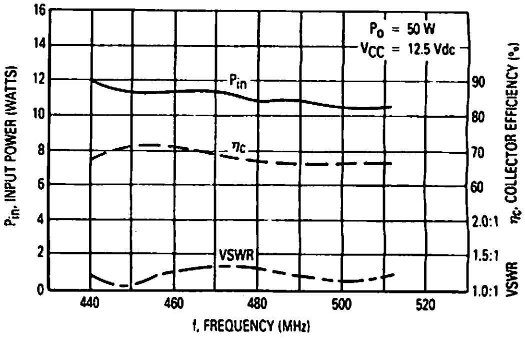
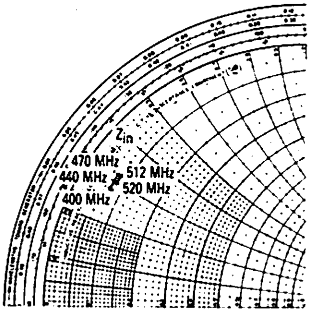


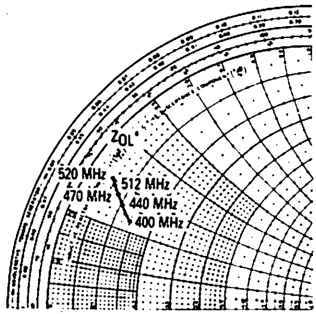
Figure 5. Broadband Performance for P_o = 50 W



P_o = 50 W, V_{CC} = 12.5 Vdc

TUNED FOR MAXIMUM GAIN AT P_o = 50 W

f (MHz)	Z_{in} Ω	Z_{OL}* Ω
400	0.7 + j2.8	1.4 + j2.3
440	0.7 + j3.2	1.1 + j2.6
470	0.8 + j3.3	0.8 + j2.7
512	0.8 + j3.2	0.7 + j2.9
520	0.7 + j3.0	0.6 + j3.0



Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Input and Output Impedance Normalized to 10 Ohms Circuit Tuned for Maximum Gain @ P_o = 50 W

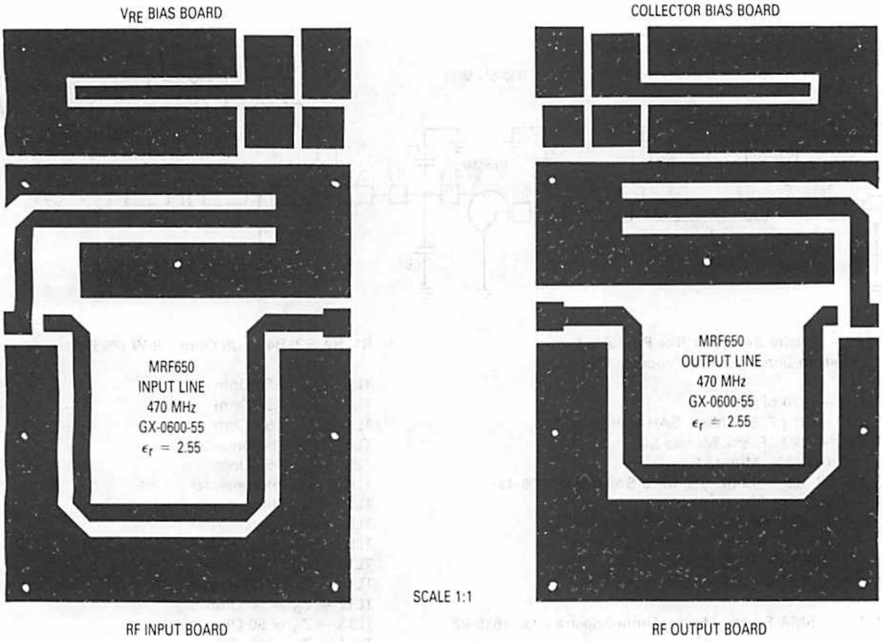


Figure 7. Photomaster for Broadband Test Circuit

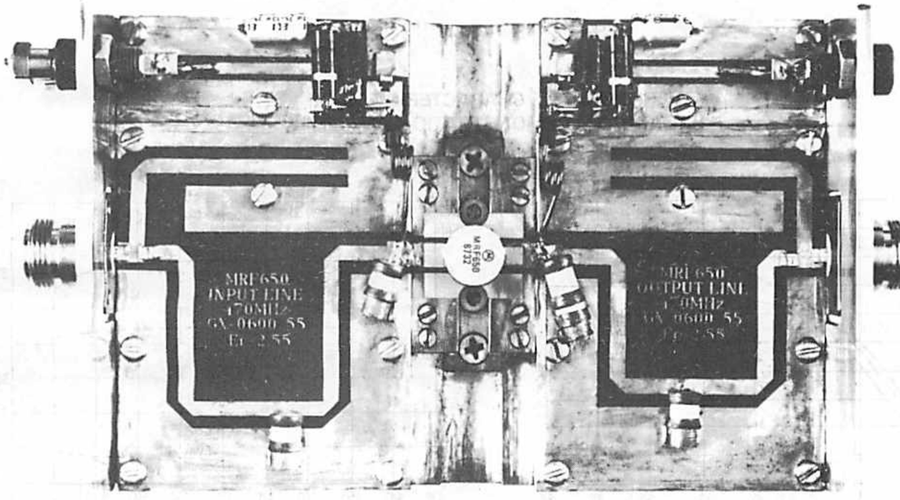
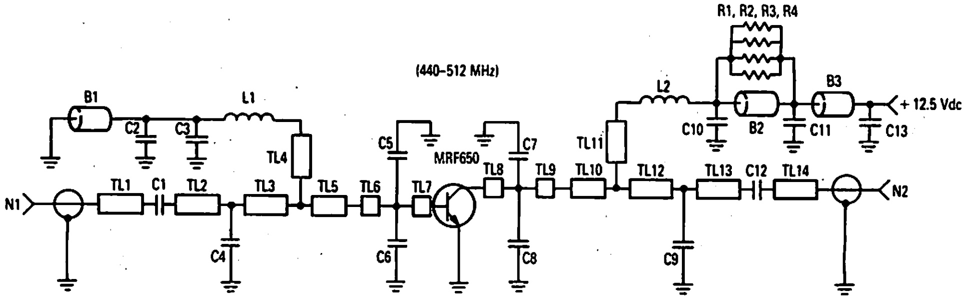


Figure 8. 440–512 MHz Broadband Test Circuit



B1, B2 — Ferrite Bead Fair Rite Products Corp.
B3 — Ferrite Bead Fair Rite Products Corp.

C2, C11 — 820 pF, 5%
C3, C10 — 91 pF, 5%, Mica, SAHA 3HS0006-91
C1, C12 — 220 pF, 5%, Murata Erie
C4 — 9.1 pF, 5%, Murata Erie
C5, C6, C7, C8 — 43 pF, 5%, Mica SAHA 3HS0006-43
C9 — 10 pF, 5%, Murata Erie
C13 — 10 μF, Electrolytic, 50 V, Panasonic

L1 — 7 Turns, 24 AWG, ID Dia. 0.116"
L2 — 5 Turns, 18 AWG, ID Dia. 0.165"

N1, N2 — SMA Flange Mount, Omni-Spectra 2052-1618-02

R1, R2, R3, R4 — 39 Ohm 1/8 W 5% Rohm

TL1 — Z_o = 50 Ohm
TL2 — Z_o = 50 Ohm
TL3 — Z_o = 50 Ohm
TL4 — See Photomaster
TL5 — Z_o = 50 Ohm
TL6 — See Photomaster
TL7 — See Photomaster
TL8 — See Photomaster
TL9 — See Photomaster
TL10 — Z_o = 50 Ohm
TL11 — See Photomaster
TL12 — Z_o = 50 Ohm
TL13 — Z_o = 50 Ohm
TL14 — Z_o = 50 Ohm

Board Material: 1/16", G10, ϵ_r = 4.5
2 oz. Cu Clad Both Sides

Figure 9. Schematic of Broadband Demonstration Amplifier (3)

PERFORMANCE CHARACTERISTICS OF BROADBAND DEMONSTRATION AMPLIFIER

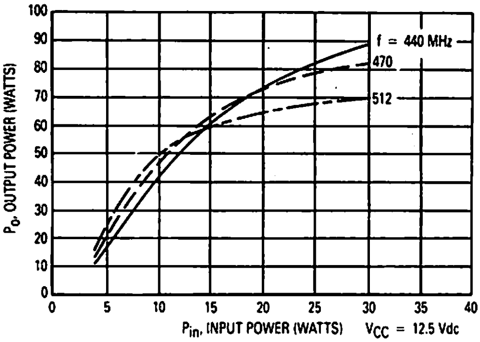


Figure 10. Output Power versus Input Power

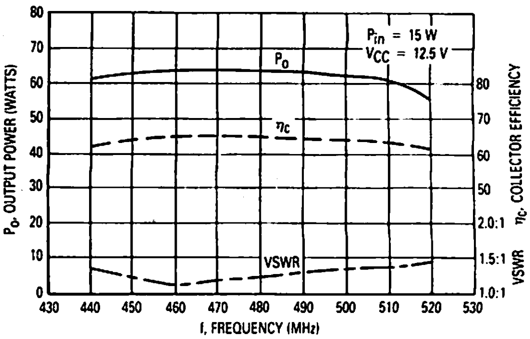


Figure 11. P_o, η_c and VSWR versus Frequency

(3) Detailed design and performance information available from Motorola upon request.

2

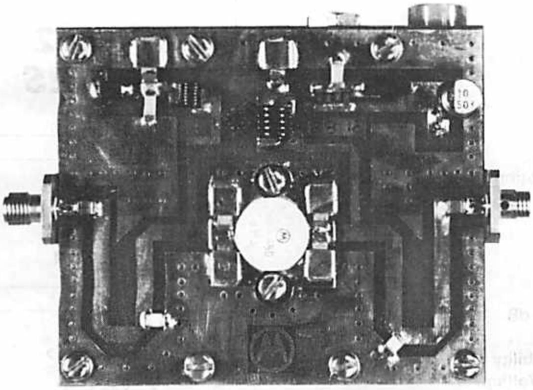
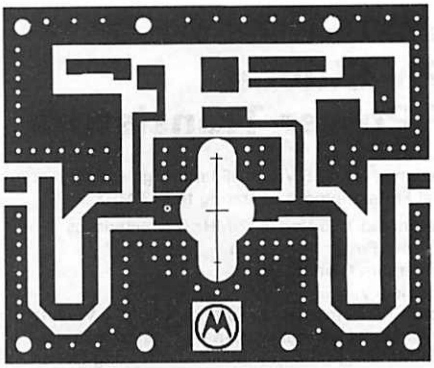


Figure 12. 440–512 MHz Broadband Demonstration Amplifier



SCALE 1:1

Figure 13. Photomaster For 440–512 MHz Broadband Demonstration Amplifier

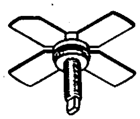
MRF652
MRF652S

The RF Line
NPN Silicon
RF Power Transistors

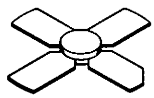
. . . designed for 12.5 Vdc UHF large-signal, amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Guaranteed 12.5 Volt, 512 MHz Characteristics
  Output Power = 5 Watts
  Minimum Gain = 10 dB
  Efficiency = 65% (Typ)
- Typical Performance at 870 MHz, 12.5 V, 5 W Output = 6 dB
- Series Equivalent Large-Signal Characterization
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 30:1 VSWR Load Mismatch at 15.5 V Supply Voltage

5 W 512 MHz
RF POWER
TRANSISTORS
NPN SILICON



CASE 244-04
MRF652



CASE 249-05
MRF652S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2	Adc
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	25 143	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

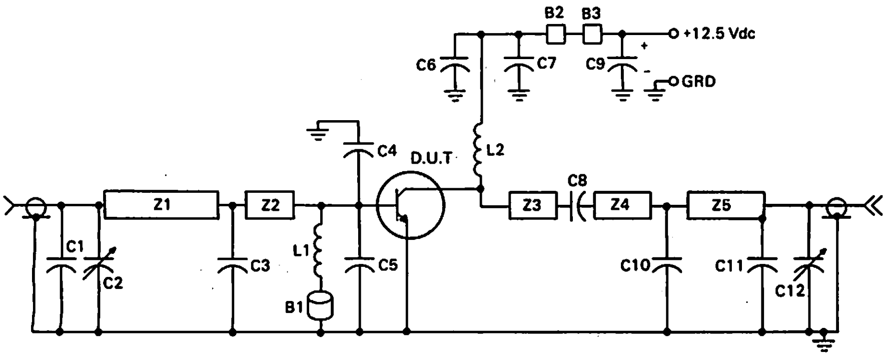
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7	°C/W

2-

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	9.5	15	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W) f = 512 MHz f = 870 MHz	G_{pe}	10 —	11 6.0	— —	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 5.0 W, f = 512 MHz)	η	—	65	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{out} = 6.0 W, f = 512 MHz, VSWR 30:1 At All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 440-512 MHz BROADBAND TEST CIRCUIT



B1-B3 — Ferrite Bead
C1 — 7.0 pF Unelco Mica
C2 — 1.0-6.0 pF Johanson Variable 5201
C3 — 15 pF Unelco Mica
C4 — 43 pF Mini-Underwood Mica
C5 — 56 pF Mini-Underwood Mica
C6 — 1000 pF Unelco Mica
C7 — 0.1 µF Ceramic
C8 — 68 pF Mini-Underwood Mica
C9 — 1.0 µF Electrolytic 25 V
C10, C11 — 5.0 pF Unelco Mica
C12 — 1.0-10 pF Johanson Variable 5501
L1, L2 — 6 Turns, 20 AWG Wire 0.125" ID
Z1, Z2 — 25 Ohm µStripline (See Photo-Mask - Figure 7)
Z3-Z5 — 50 Ohm µStripline (See Photo-Mask - Figure 7)
Board — 0.032" Glass-Teflon

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

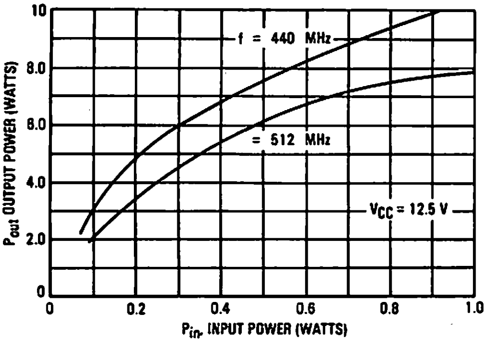


FIGURE 3 — OUTPUT POWER versus FREQUENCY

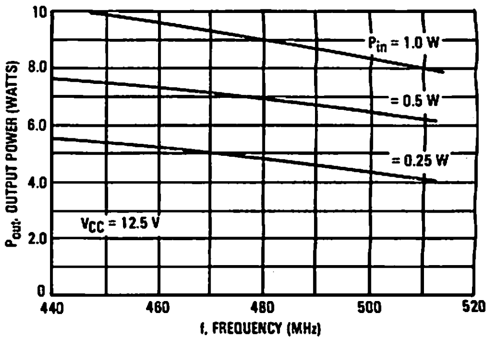


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

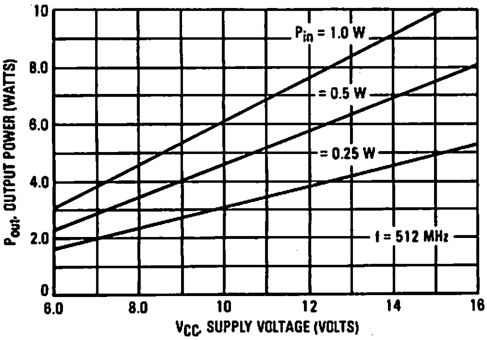


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

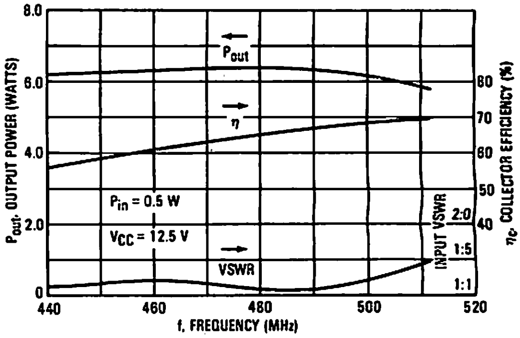
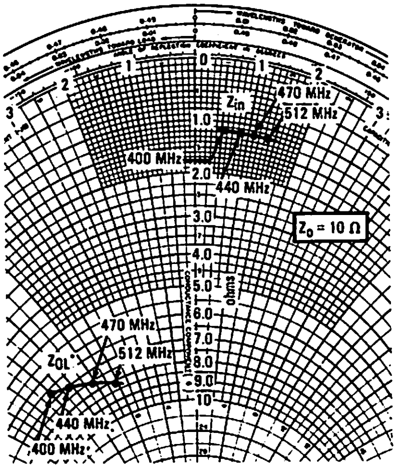


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

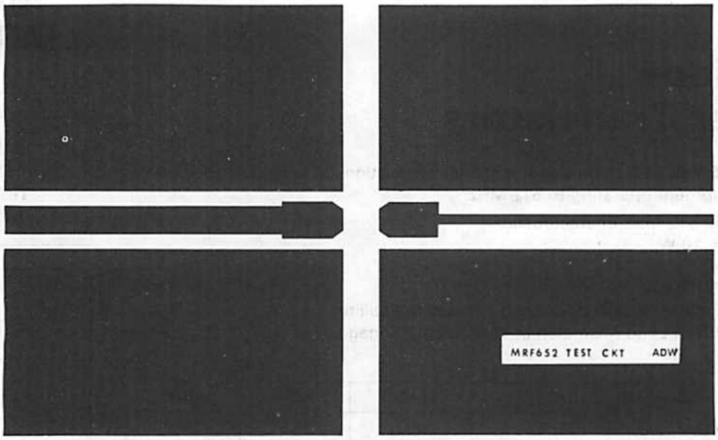


V_{CC} = 12.5 Vdc
P_{out} = 5.0 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	1.18 + j0.54	6.7 − j6.9
440	1.19 + j0.88	7.05 − j6.1
470	1.19 + j1.11	7.6 − j5.1
512	1.19 + j1.35	8.1 − j4.1

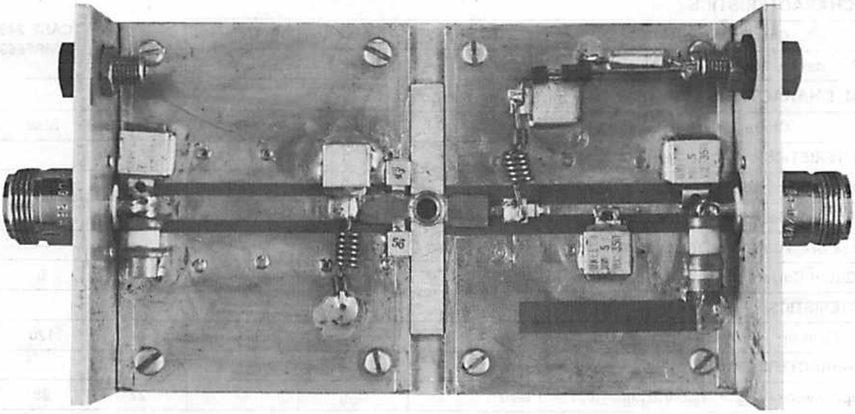
Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — PHOTOMASTER BROADBAND TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 8 — BROADBAND TEST CIRCUIT



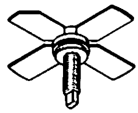
MRF653
MRF653S

The RF Line
NPN Silicon RF Power Transistors

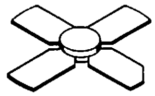
**10 W 512 MHz
RF POWER
TRANSISTORS
NPN SILICON**

... designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

- Specified 12.5 Volt, 512 MHz Characteristics
  Output Power = 10 W
  Gain = 8 dB (Typ)
  Efficiency = 65% (Typ)
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 16 V Supply Voltage



CASE 244-04
MRF653



CASE 249-05
MRF653S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	2.75	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristics	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	22	28	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 512 MHz)	G_{pe}	7	8	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 10 W, f = 512 MHz)	η_c	55	65	—	%
Load Mismatch Stress (V_{CC} = 16 Vdc, f = 512 MHz, P_{in}* = 2.6 W, VSWR = 20:1 All Phase Angles)	ψ	No Degradation in Output Power			

*P_{in} = 2 dB over the typical input power required for 10 W output power @ 12.5 Vdc

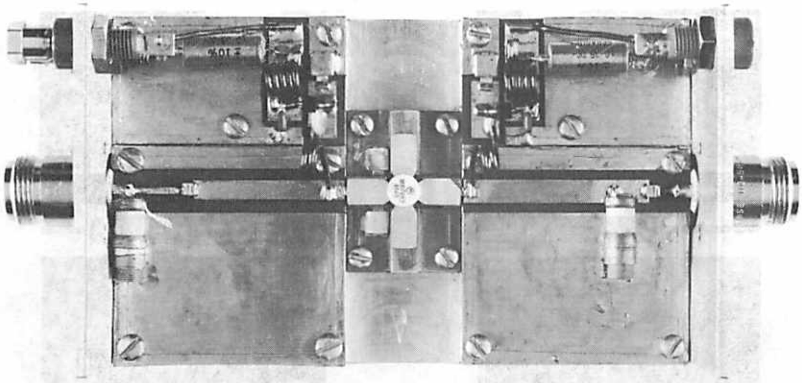
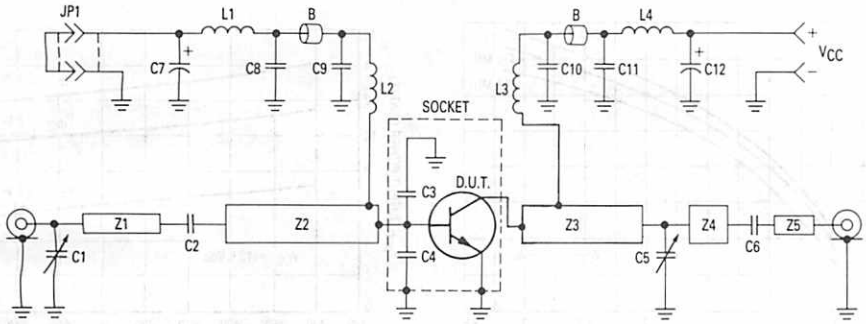


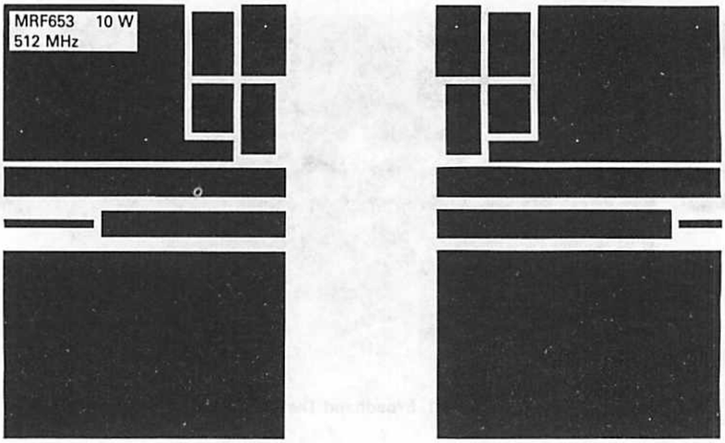
Figure 1. Broadband Test Circuit



C1, C5 — 1–20 pF, Johanson
C2, C6 — 330 pF, 100 Mil ATC
C3, C4 — 36 pF, Mini-Unelco
C7, C12 — 10 μF, 35 V, Tantalum
C8, C11 — 0.1 μF, Ceramic
C9, C10 — 91 pF, Mini-Unelco
L1, L4 — 4-1/2 Turns, #18 AWG, 0.16″ ID
L2, L3 — 2 Turns, #18 AWG, 0.16″ ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
Z1 — 51 x 630 mils
Z2 — 162 x 1300 mils
Z3 — 210 x 1350 mils
Z4 — 210 x 280 mils
Z5 — 51 x 300 mils
Board Material — 0.032″ epoxy glass G10, 1 oz., copper clad, double sided, ϵ_r = 5
JP1 — Jumper, #14 AWG w/Banana Plugs

Figure 2. Broadband Test Circuit Schematic

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 3. Photomaster

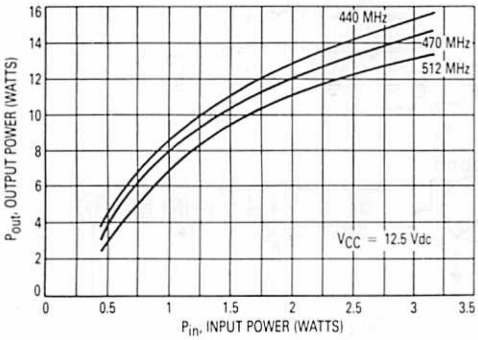


Figure 4. Output Power versus Input Power

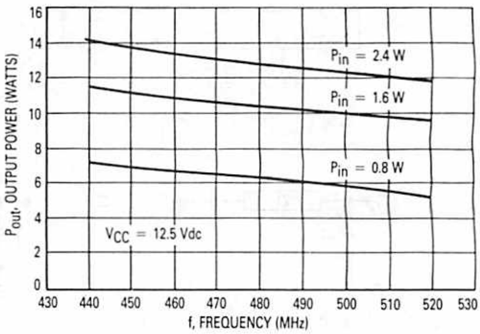


Figure 5. Output Power versus Frequency

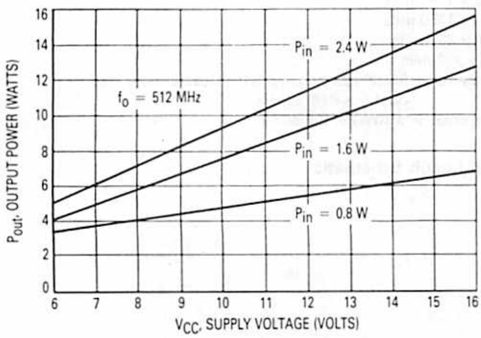


Figure 6. Output Power versus Supply Voltage

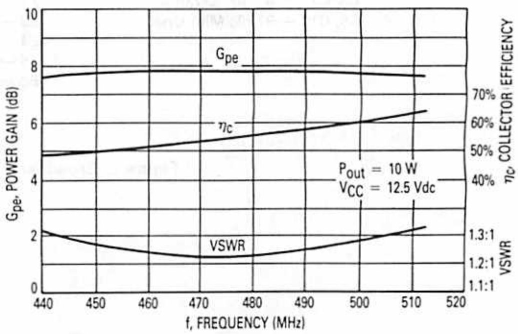
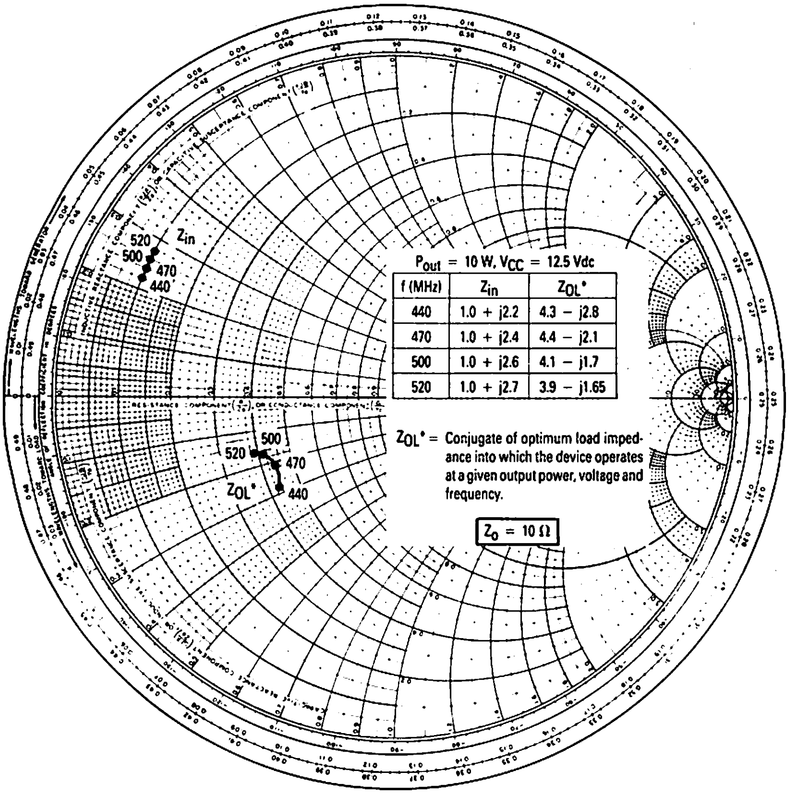


Figure 7. Typical Broadband Circuit Performance

2



f (MHz)	Z_{in}	Z_{OL}*
440	1.0 + j2.2	4.3 − j2.8
470	1.0 + j2.4	4.4 − j2.1
500	1.0 + j2.6	4.1 − j1.7
520	1.0 + j2.7	3.9 − j1.65

Figure 8. Series Equivalent Input and Output Impedance

MRF654

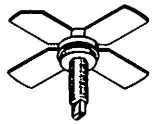
The RF Line

2

15 W 470 MHz

RF POWER TRANSISTOR

NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating to 512 MHz.

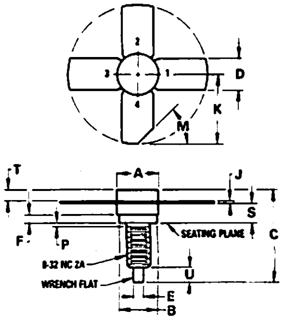
- Specified 12.5 Volt, 512 MHz Characteristics
  Output Power = 15 W
  Minimum Gain = 7.8 dB
  Efficiency = 55%
- Built-In Matching Network for Broadband Operation
- Gold Metallized, Emitter Ballasted for Long Life and Reliability
- Capable of 20:1 VSWR Load Mismatch at 15.5 V Supply Voltage

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

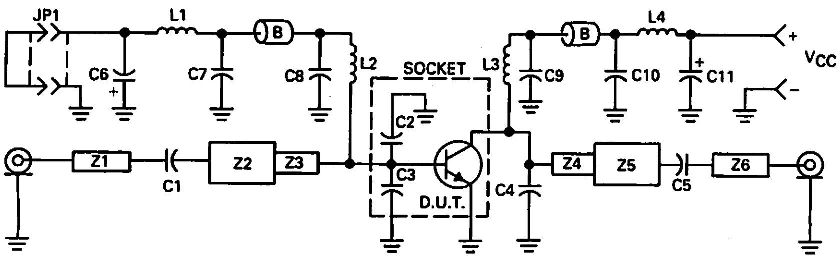
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	31	45	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 512 MHz)	G_{pe}	7.8	8.8	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 512 MHz)	η	55	63	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, f = 470 MHz, 2.0 dB Overdrive, VSWR = 20:1 All Phase Angles)	ψ	No Degradation In Output Power			

FIGURE 1 — 440-512 MHz BROADBAND TEST CIRCUIT



C1, C5 — 68 pF Mini-Unelco
C2, C3 — 33 pF, Mini-Unelco
C4 — 47 pF, Mini-Unelco
C6, C11 — 10 μF, 25 V Tantalum
C7, C10 — 0.1 μF, Ceramic
C8, C9 — 91 pF, Mini-Unelco
L1, L4 — 4½ Turns, #18 AWG, Enamel Covered, 0.16" ID
L2, L3 — 2 Turns, #18 AWG Enamel Covered, 0.16" ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
Z1-Z6 — See PCB Artwork
PCB — 1/32" G-10, E_r = 4.5 @ UHF
Socket — See Socket Drawings
JP1 — Jumper, #14 AWG w/Banana Plugs

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

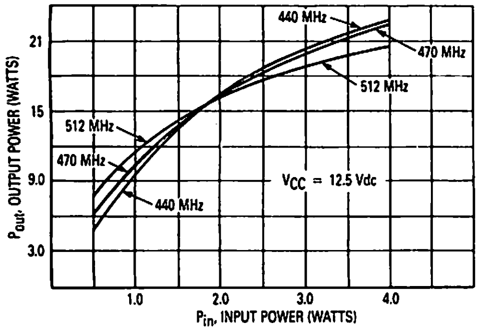


FIGURE 3 — OUTPUT POWER versus FREQUENCY

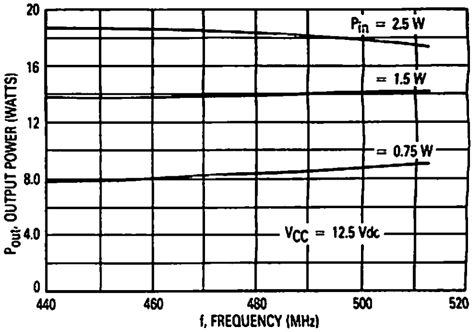


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

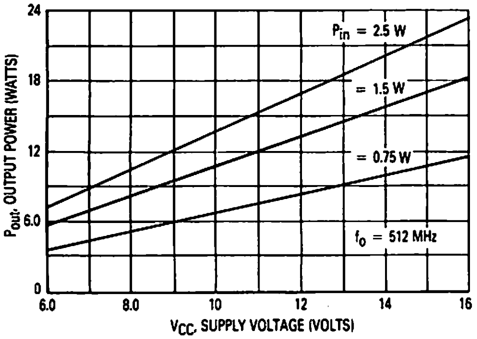


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

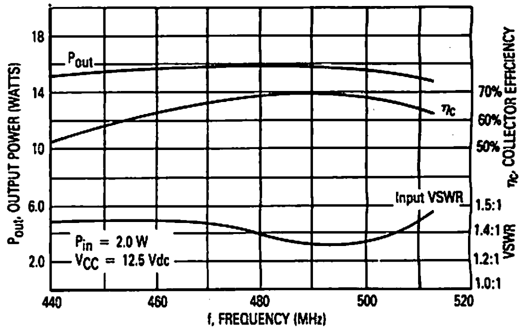
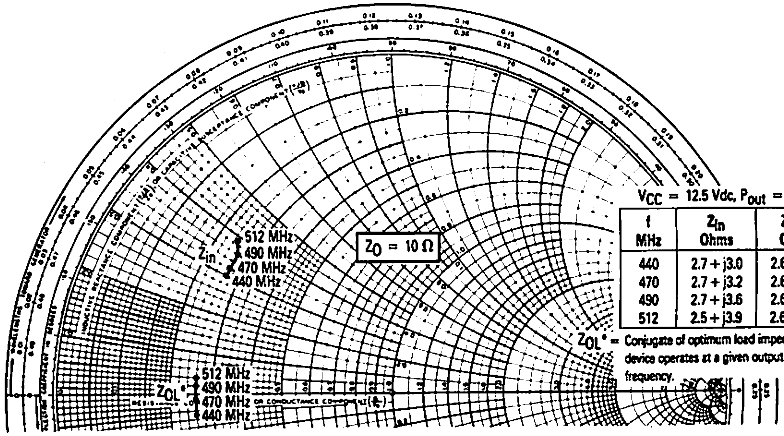


FIGURE 6 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE



V_{CC} = 12.5 Vdc, P_{out} = 15 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
440	2.7 + j3.0	2.6 − j0.5
470	2.7 + j3.2	2.6 − j0.1
490	2.7 + j3.6	2.6 + j0.2
512	2.5 + j3.9	2.6 + j0.4

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

2

FIGURE 7 — 440–512 MHz BROADBAND TEST CIRCUIT

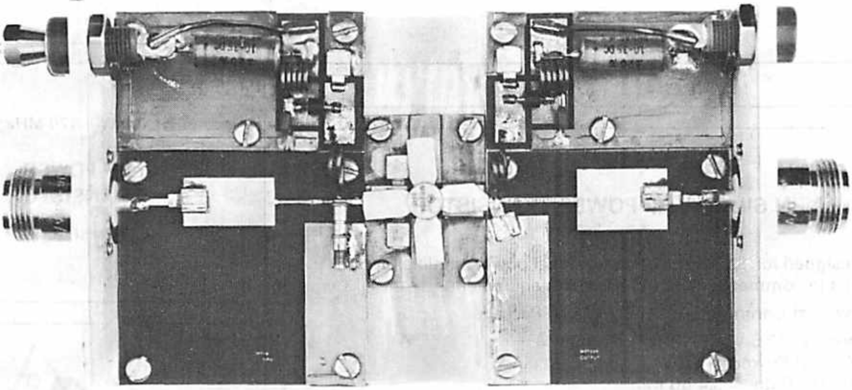
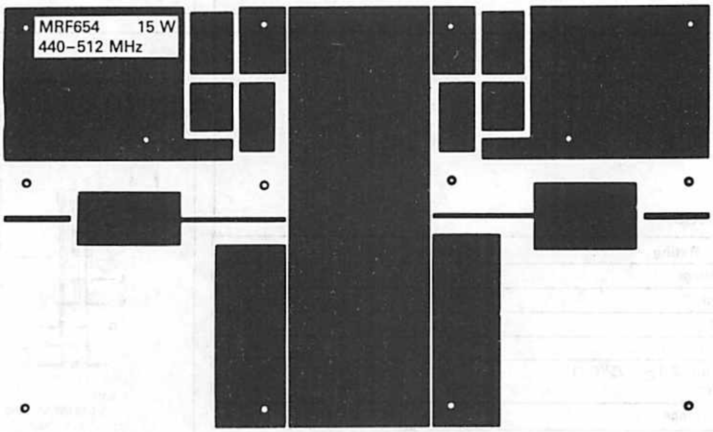


FIGURE 8 — PCB BOARD LAYOUT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF660

The RF Line

2

NPN SILICON RF POWER TRANSISTOR

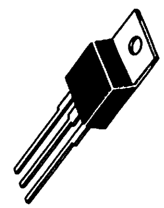
. . . designed for 12.5 volt UHF large signal power amplifier applications in commercial and industrial FM equipment.

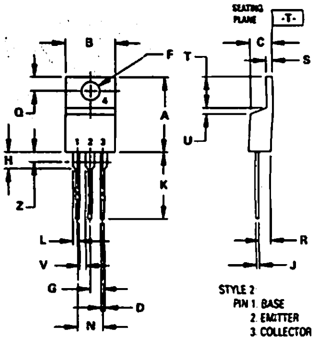
- Low Cost Common Emitter TO-220AB Package
- Specified 12.5 V, 470 MHz Performance
  Output Power = 7.0 W
  Power Gain = 5.4 dB Min
  Efficiency — 60% Min
- Load Mismatch Capability at High Line and RF Input Overdrive

7.0 W 470 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIM Z DEFINES A ZONE WHERE ALL BODY AND LEAD IRREGULARITIES ARE ALLOWED.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-04
TO-220AB

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.4	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	25 143	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

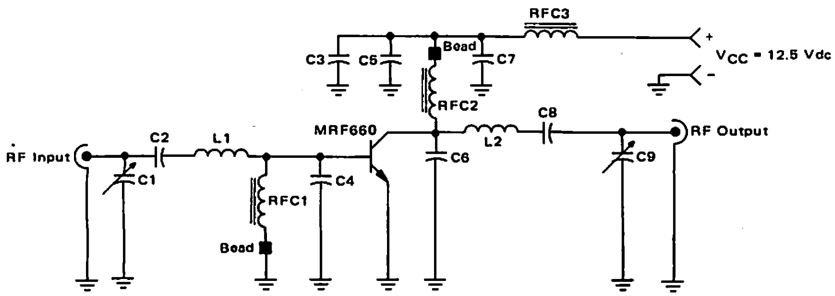
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7.0	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	90	160	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	17	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 7.0 W, f = 470 MHz)	G_{PE}	5.4	6.0	–	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 7.0 W, f = 470 Mhz)	η	60	–	–	%

FIGURE 1 — TEST CIRCUIT



C1, C9 — 1–10 pF Johanson
C2, C8 — 15 pF Underwood Elect. Co. Type J101
C3 — 270 pF, ATC Chip Capacitor Case B
C4, C6 — 24 pF ELMENCO MCN01/010
C5 — 0.1 μF Ceramic, Erie
C7 — 1.0 μF, 35 V, Tantalum
L1 — 27 nH Copper Strap 0.150" X 0.025" X 1.5" (See Note)
L2 — 16 nH Copper Strap 0.150" X 0.025" X 1.0" (See Note)
RFC1 — 0.68 μH Molded Choke, Cambion
RFC2 — 4 Turns #20 AWG, 0.312" ID X 0.25" Long
RFC3 — Ferrite Choke, Ferroxcube #VK200-20/4B
Bead — Ferrite Bead, Ferroxcube #56-590-65-3B
Printed Circuit Board Material — 3M #K6098-22062, Teflon Fiberglass or equivalent

NOTE:

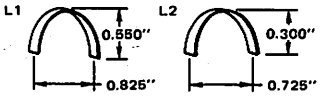


FIGURE 2 — OUTPUT POWER versus INPUT POWER

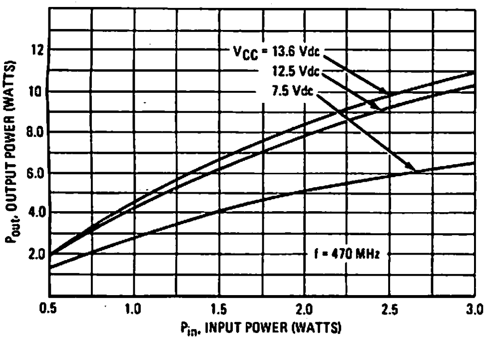


FIGURE 3 — OUTPUT POWER versus FREQUENCY

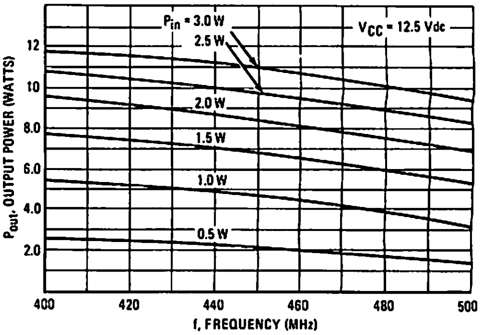


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

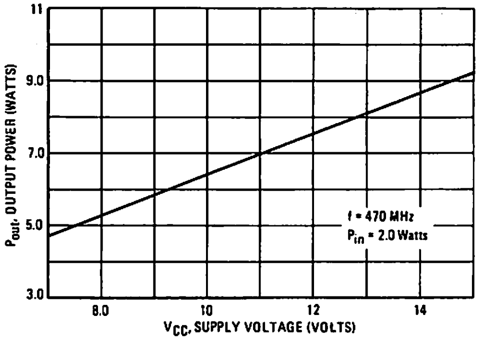
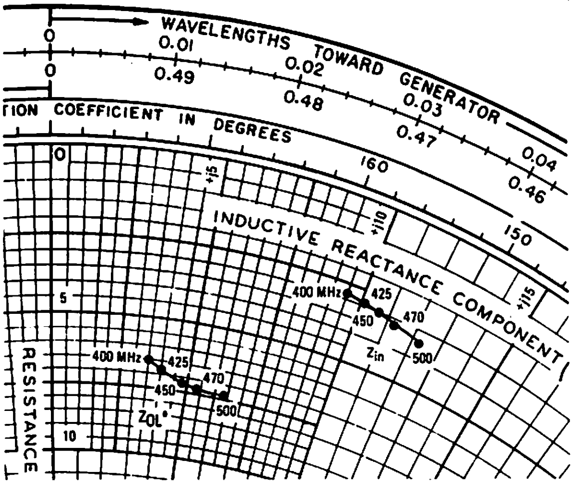


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{in} = 2.0 W, V_{CC} = 12.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
400	2.8 + j9.0	6.5 + j3.5
425	2.9 + j10.1	6.8 + j4.0
450	3.0 + j10.5	7.2 + j4.8
470	3.1 + j11.2	7.3 + j5.4
500	3.4 + j12.2	7.3 + j6.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – UHF TEST AMPLIFIER

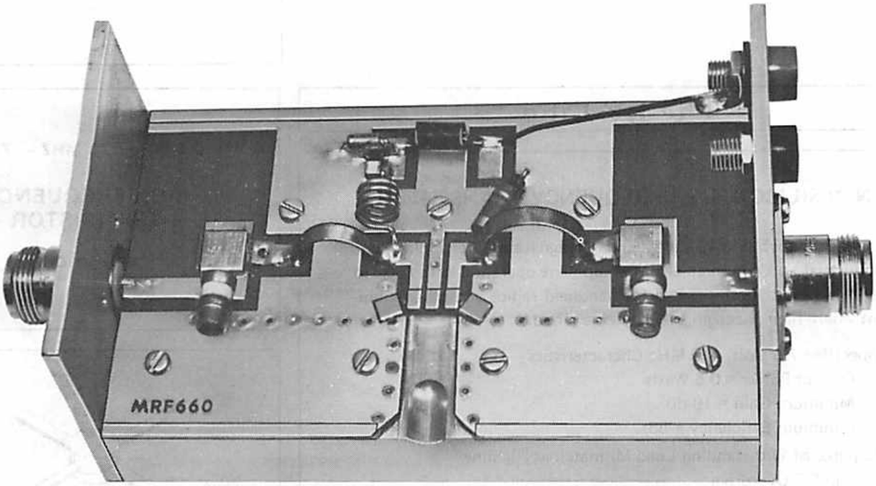
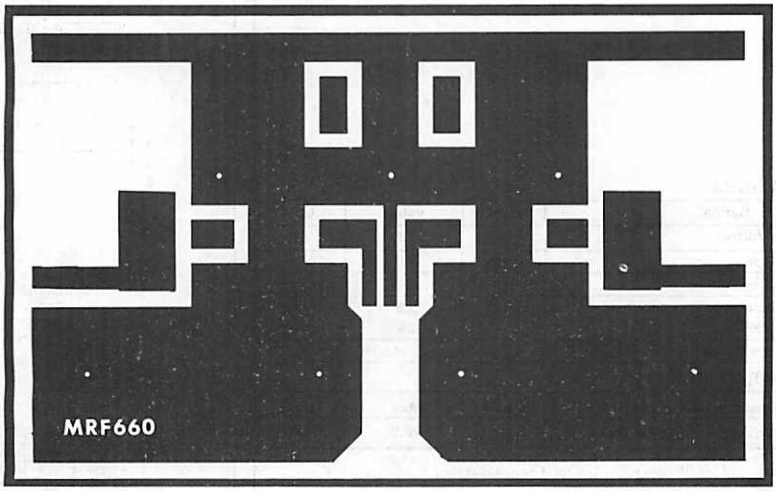


FIGURE 7 – PRINTED CIRCUIT BOARD



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF750

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

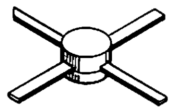
. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

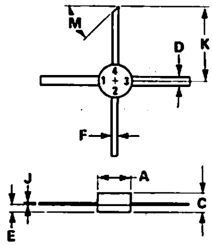
- Specified 7.5 Volt, 470 MHz Characteristics —
  Output Power = 0.5 Watts
  Minimum Gain = 10 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive
- Silicon Nitride Passivation

0.5 W — 470 MHZ — 7.5 V

HIGH FREQUENCY TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.03	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

CASE 305A-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate Above 25°C	P_D	2.5 35	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150°C	°C

THERMAL CHARACTERISTICS

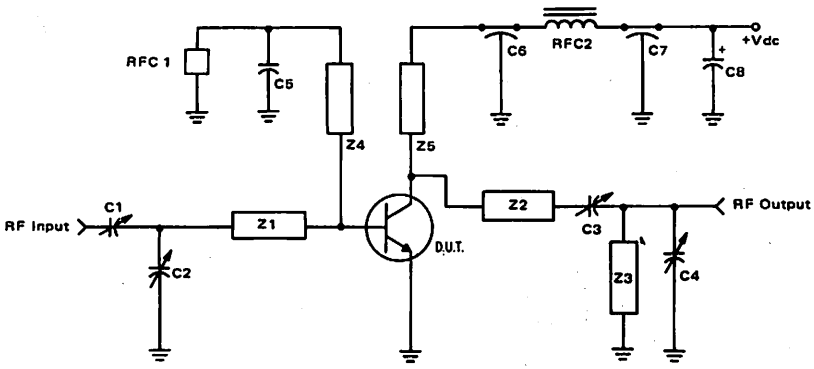
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	28.5	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	65	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	G_{PE}	10	11	–	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 0.5 W, f = 470 MHz)	η	55	–	–	%

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4, — Johanson Trimmer, JMC#5501
C5 — J101, 100 pF Unelco
C6, C7 — 680 pF Allen Bradley Feedthru
C8 — 1.0 μF Tantalum
RFC1 — Ferroxcube Bead, 56-590-65-3B
RFC2 — Choke, VK 200/4B

Z1, Z2 — Microstrip W = 0.26", L = 2.9"
Z3 — Microstrip W = 0.5", L = 1.2"
Z4 — Microstrip W = 0.055", L = 3.9"
Z5 — Microstrip W = 0.055", L = 2.9"
Board Material — Glass Teflon, t = 0.062
ϵ_r = 2.5

2

FIGURE 2 — POWER GAIN versus FREQUENCY

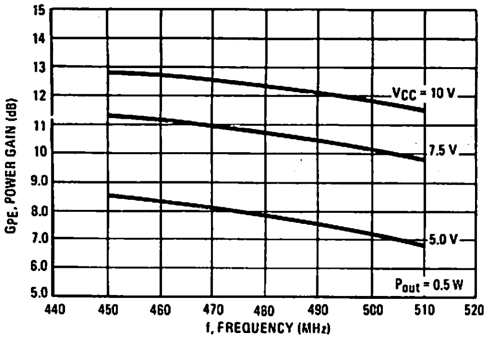


FIGURE 3 — OUTPUT POWER versus INPUT POWER 450 MHz

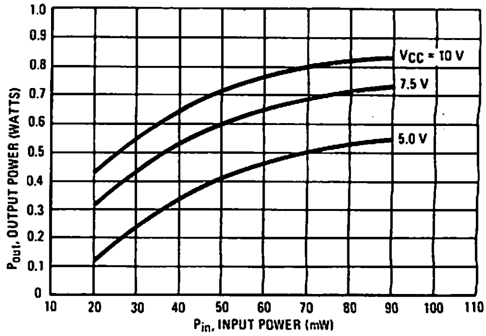


FIGURE 4 — OUTPUT POWER versus INPUT POWER 470 MHz

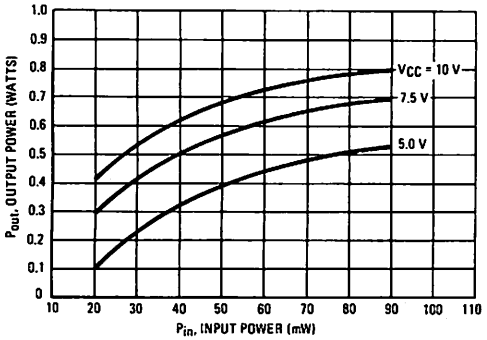


FIGURE 5 — OUTPUT POWER versus INPUT POWER 512 MHz

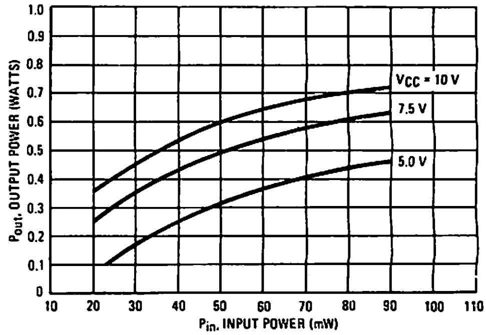
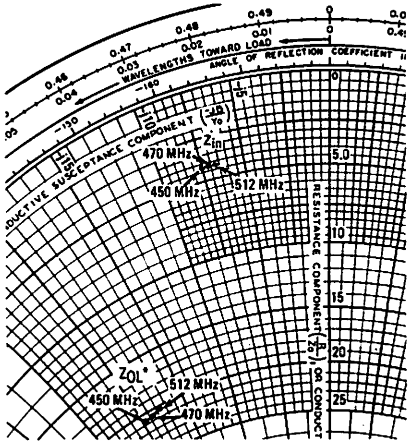


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

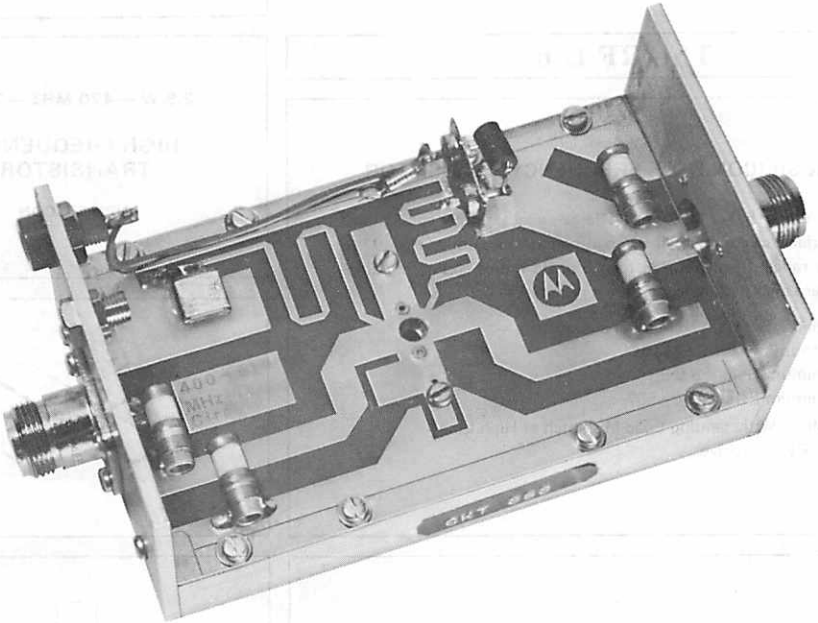


P_{out} = 0.5 W V_{CC} = 7.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	4.4 -j7.5	20.9 -j19.7
470	4.4 -j7.1	20.7 -j18.9
512	4.4 -j6.7	20.1 -j17.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — 470 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF752

2

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

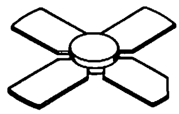
. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics –
  Output Power = 2.5 Watts
  Minimum Gain = 8.0 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at High Line and RF Overdrive

2.5 W — 470 MHZ — 7.5 V

HIGH FREQUENCY TRANSISTOR

NPN SILICON



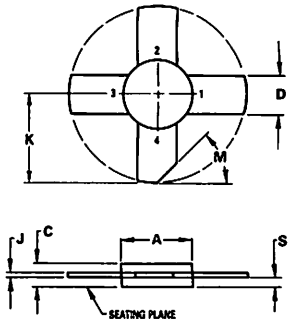
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current-Continuous	I_C	1.2	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	15 85.5	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	11.7	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applied only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

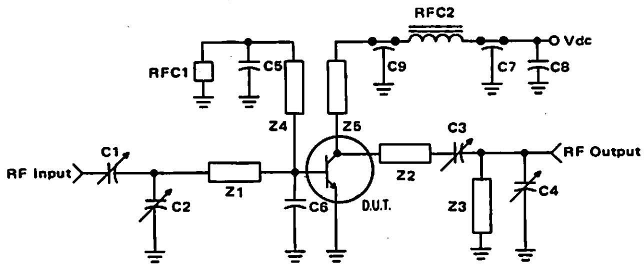
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.09	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

CASE 249-05

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	85	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	27	35	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 2.5 W, f = 470 MHz)	G_{PE}	8.0	9.0	–	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 2.5 W, f = 470 MHz)	η	55	–	–	%

FIGURE 1 – 470 MHz TEST CIRCUIT



C1, C2, C3, C4 – Johanson Trimmer JMC#5501
C5 – J101, 100 pF Unelco
C6 – J101, 15 pF Unelco
C7, C9 – 680 pF Allen Bradley Feedthru
C8 – 1.0 µF Tantalum

Z1, Z2 – Microstrip W = 0.26", L = 2.9"
Z3 – Microstrip W = 0.5", L = 1.2"
Z4 – Microstrip W = 0.055", L = 3.9"
Z5 – Microstrip W = 0.055", L = 2.9"

RFC1 – Ferroxcube Bead, 56-590-65-3B
RFC2 – Choke, VK 200/4B

Board Material – Glass Teflon
t = 0.062
ϵ_r = 2.5

2

FIGURE 2 — POWER GAIN versus FREQUENCY

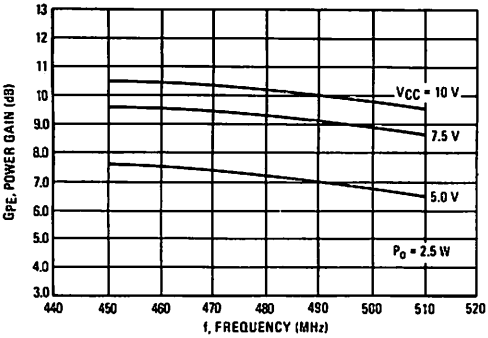


FIGURE 3 — OUTPUT POWER versus INPUT POWER
450 MHz

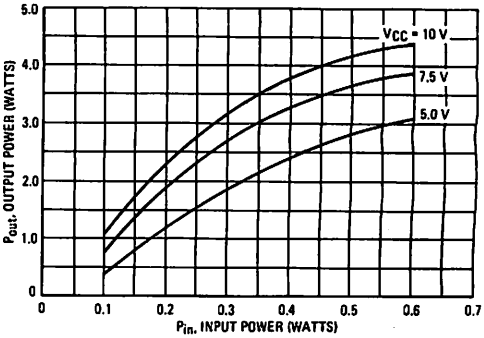


FIGURE 4 — OUTPUT POWER versus INPUT POWER
470 MHz

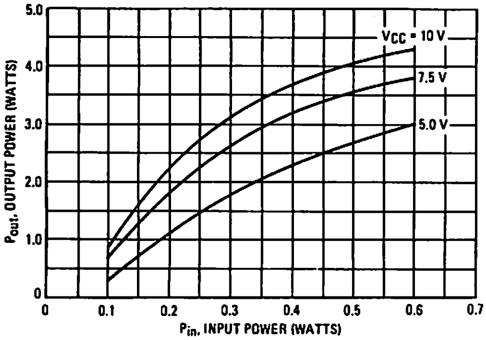


FIGURE 5 — OUTPUT POWER versus INPUT POWER
512 MHz

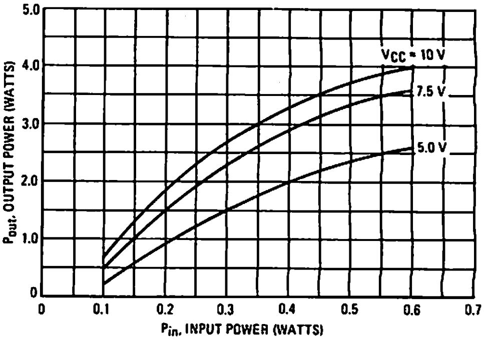
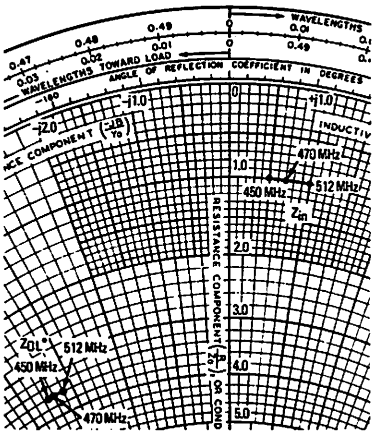


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

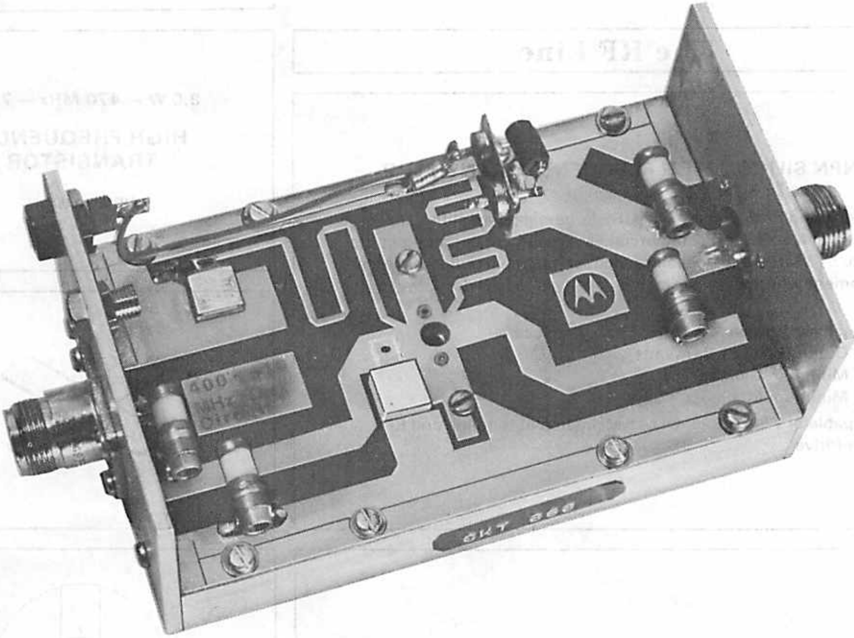


P_{out} = 2.5 W, V_{CC} = 7.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	1.0 +j0.5	3.6 -j3.5
470	1.0 +j0.7	3.6 -j3.4
512	1.0 +j1.0	3.6 -j3.2

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 – 470 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF754

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

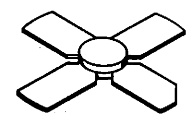
. . . designed for 5.0 to 10 Volt UHF large-signal amplifier applications in industrial and commercial FM equipment operating in the 407 to 512 MHz range. Ideally suited for handheld radios and other equipment where high packaging density is required.

- Specified 7.5 Volt, 470 MHz Characteristics —
  Output Power = 8.0 Watts
  Minimum Gain = 6.0 dB
  Minimum Efficiency = 55%
- Capable of Withstanding Load Mismatch at Highline and RF Overdrive

8.0 W — 470 MHz — 7.5 V

HIGH FREQUENCY TRANSISTOR

NPN SILICON



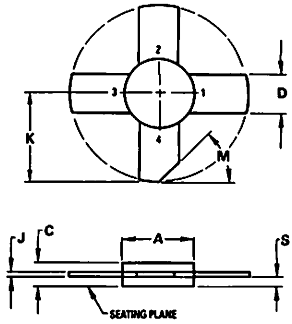
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate Above 25°C	P_D	37.0 214	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150°C	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4.7	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR
SEATING PLANE = GROUND AND IS CONNECTED TO PIN 1 AND PIN 3.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

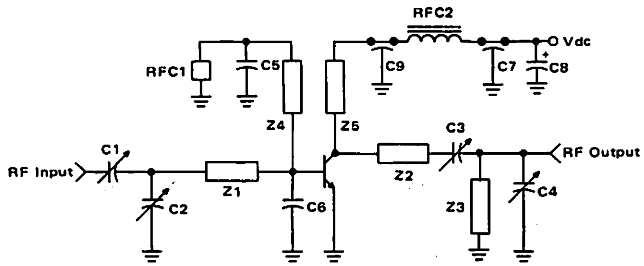
CASE 249-05

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 9.0 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	20	85	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 7.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	50	65	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 7.5 Vdc, P_{out} = 8.0 W, f = 470 MHz)	G_{PE}	6.0	7.0	—	dB
Collector Efficiency (V_{CC} = 7.5 Vdc, P_{out} = 8.0 W, f = 470 MHz)	η	55	—	—	%

2

FIGURE 1 — 470 MHz TEST CIRCUIT



C1, C2, C3, C4 — Johanson Trimmer JMC#5501
C5 — J101, 100 pF Unelco
C6 — J101, 15 pF Unelco
C7, C9 — 680 pF Allen Bradley Feedthru
C8 — 1.0 µF Tantalum

Z1, Z2 — Microstrip W = 0.26", L = 2.9"
Z3 — Microstrip W = 0.5", L = 1.2"
Z4 — Microstrip W = 0.055", L = 3.9"
Z5 — Microstrip W = 0.055", L = 2.9"

RFC1 — Ferroxcube Bead, 56-590-65-3B
RFC2 — Choke, VK 200/4B

Board Material — Glass Teflon
t = 0.062
ϵ_r = 2.5

FIGURE 2 — POWER GAIN versus FREQUENCY

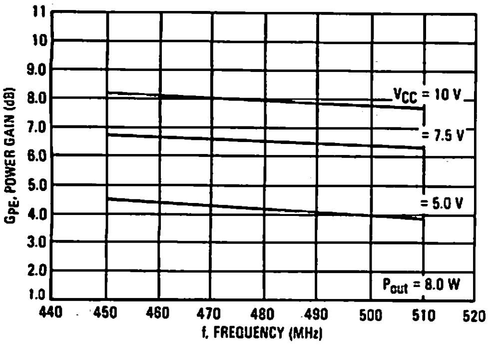


FIGURE 3 — OUTPUT POWER versus INPUT POWER
450 MHz

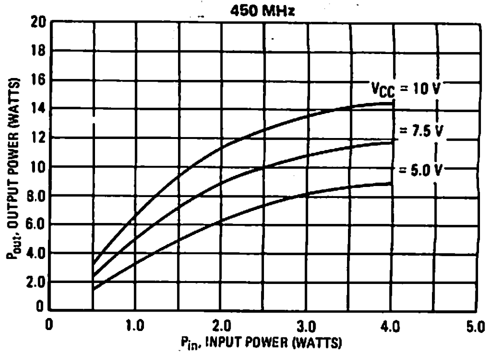


FIGURE 4 — OUTPUT POWER versus INPUT POWER
470 MHz

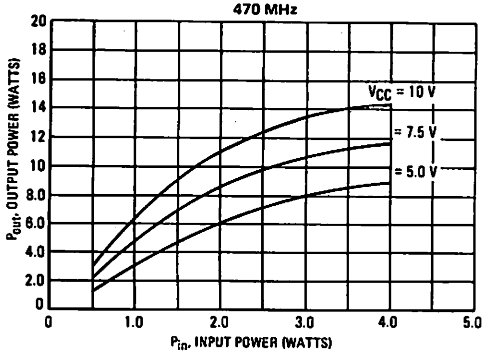


FIGURE 5 — OUTPUT POWER versus INPUT POWER
512 MHz

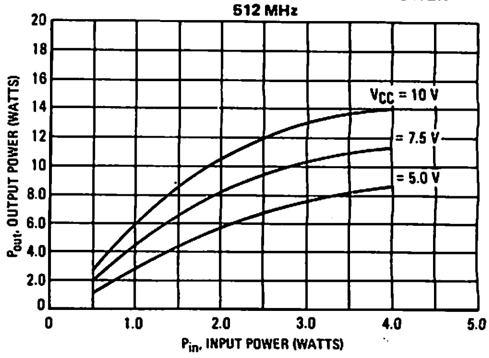
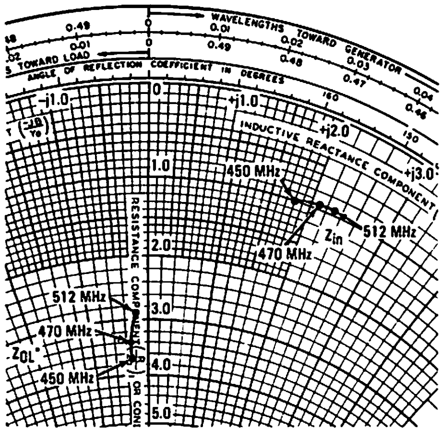


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES

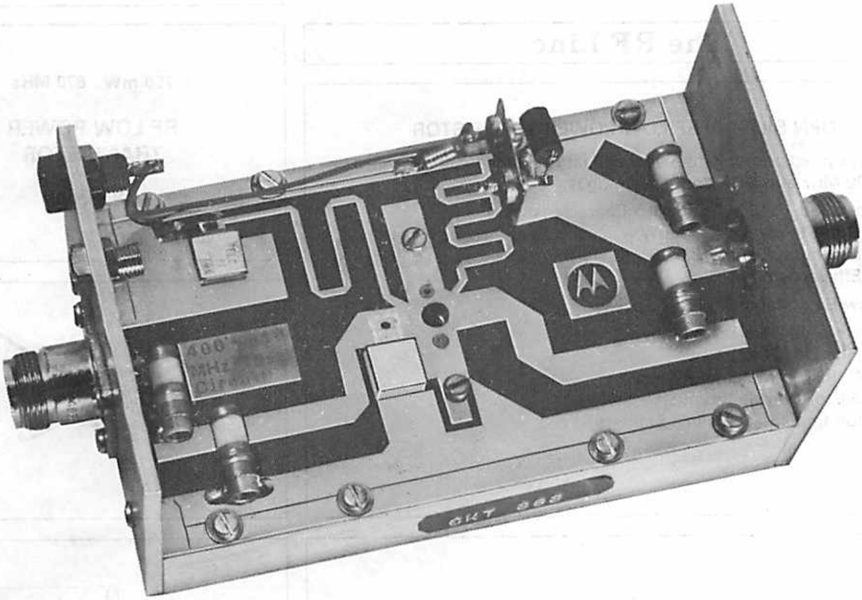


P_{out} = 8.0 W, V_{CC} = 7.5 V

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
450	1.0 + j1.8	3.7 – j0.3
470	0.9 + j2.1	3.4 – j0.3
512	0.9 + j2.3	2.9 – j0.2

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — 470 MHz TEST CIRCUIT



MRF837

The RF Line

NPN SILICON RF LOW POWER TRANSISTOR

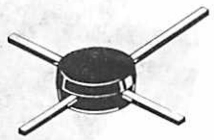
. . . designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 750 mW
  Minimum Gain = 8.0 dB
  Efficiency 60% (Typ)
- Low Cost Macro-X Plastic Package
- State-of-the-Art Technology
  Fine Line Geometry
  Gold Top Metal and Wires
  Silicon Nitride Passivated
  Ion Implanted Arsenic Emitters

750 mW 870 MHz

RF LOW POWER TRANSISTOR

NPN SILICON



Macro-X

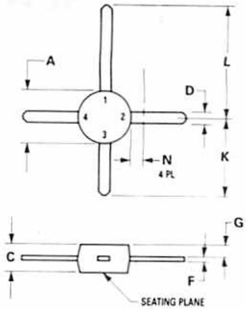
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 50°C Derate above 50°C (1)	P_D	2.5 25	Watts mW/°C
Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

(1) Case temperature measured on collector lead immediately adjacent to body of package.



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

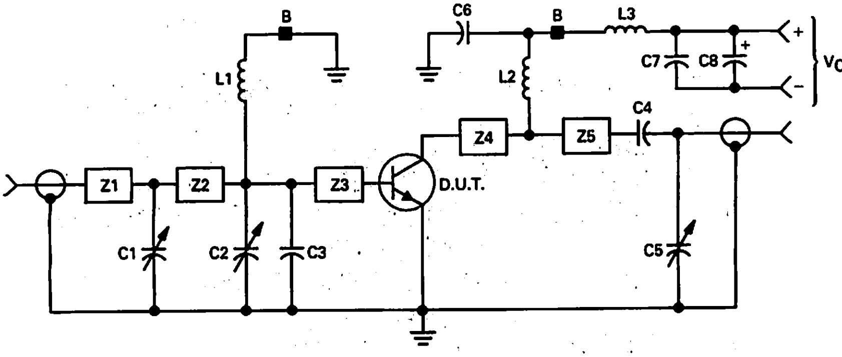
CASE 317-01

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	G_{pe}	8.0	10	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	η	55	60	—	%

FIGURE 1 — 800–880 MHz BROADBAND CIRCUIT



C1, C2, C5	— 0.8–8.0 pF Johanson Gigatrim	L1, L2	— 4 Turns, #21 AWG, 5/32" ID
C3	— 5.0 pF Clamped Mica, Mini-Underwood	L3	— 7 Turns, #21 AWG, 5/32" ID
C6	— 91 pF Clamped Mica, Mini-Underwood	Z1	— 0.80" x 0.163" Microstrip, Z_o = 50 Ω
C4	— 470 pF Ceramic Chip Capacitor	Z2	— 1.375" x 0.163" Microstrip, Z_o = 50 Ω
C7	— 68 pF Clamped Mica, Mini-Underwood	Z3, Z4	— 0.375" x 0.163" Microstrip, Z_o = 50 Ω
C8	— 1.0 μF 25 V Tantalum	Z5	— 1.35" x 0.163" Microstrip, Z_o = 50 Ω
B	— Bead, Ferroxcube 56-590-65/3B	PCB	— 1/16" Glass Teflon, ϵ_r = 2.56

2

FIGURE 2 — 800-880 BROADBAND CIRCUIT

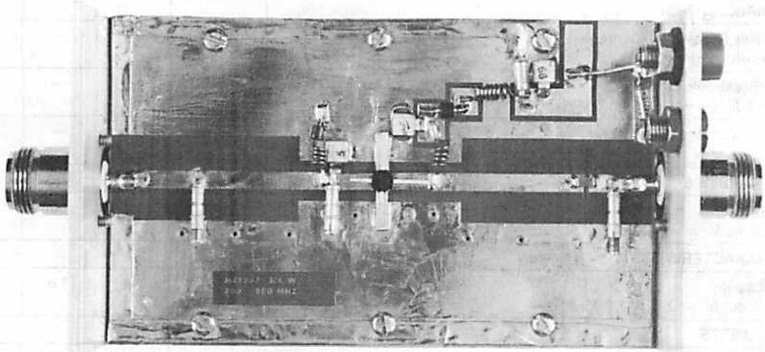
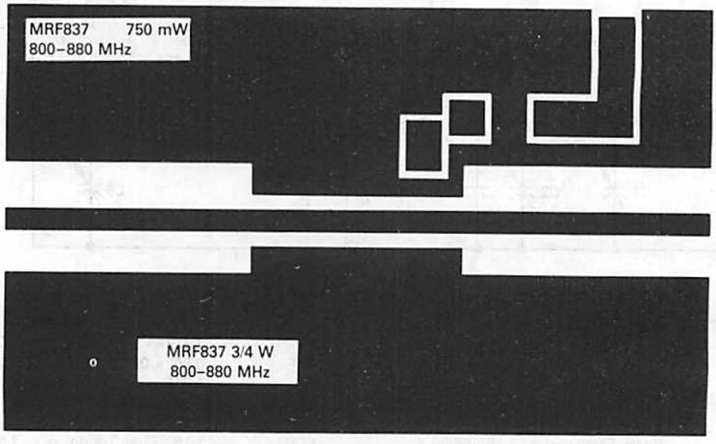


FIGURE 3 — 800-880 MHz BROADBAND CIRCUIT PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

2

800/900 MHz BAND DATA

FIGURE 4 — BROADBAND PERFORMANCE

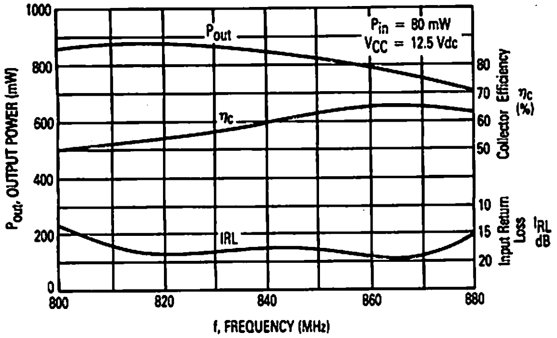


FIGURE 5 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER AND OUTPUT POWER

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 150 mW	P_{in} = 100 mW	P_{out} 806 MHz = 870 mW P_{out} 870 MHz = 820 mW P_{out} 960 MHz = 700 mW	P_{out} 806 MHz = 1.05 W P_{out} 870 MHz = 950 mW P_{out} 960 MHz = 725 mW
806	6.1 + j3.6	4.3 + j0.6	38.3 − j16.4	23.2 − j31.6
870	5.6 + j5.2	6.5 + j3.6	40.8 − j18.9	41.3 − j18.4
960	6.1 + j6.8	6.4 + j4.5	43.8 − j14.7	41.4 − j19.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

2

800/900 MHz BAND DATA (continued)

FIGURE 6 — OUTPUT POWER versus INPUT POWER
f = 870 MHz

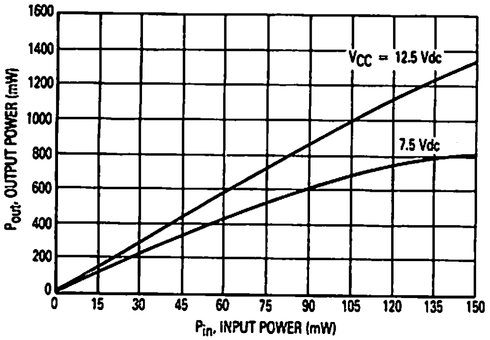


FIGURE 7 — OUTPUT POWER versus FREQUENCY
V_{CC} = 7.5 Vdc

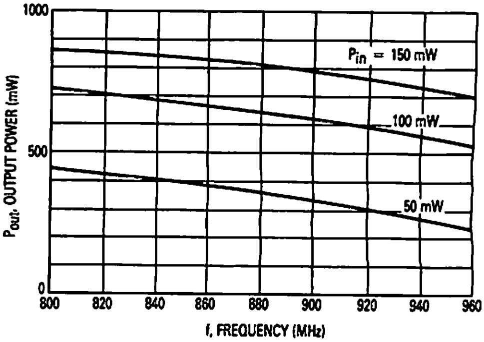


FIGURE 8 — OUTPUT POWER versus COLLECTOR VOLTAGE
f = 870 MHz

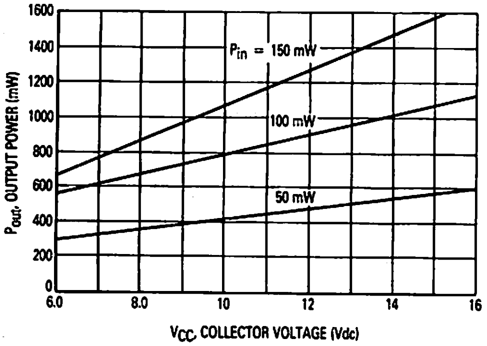
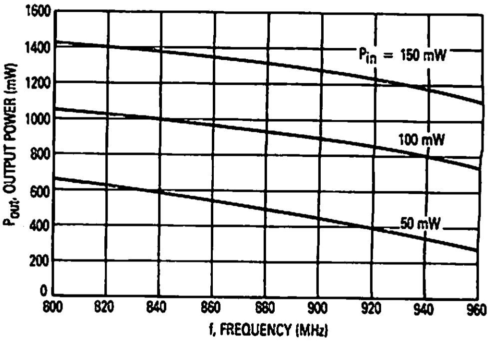


FIGURE 9 — OUTPUT POWER versus FREQUENCY
V_{CC} = 12.5 Vdc



UHF BAND DATA

FIGURE 10 — Z_{in} AND Z_{OL} versus COLLECTOR VOLTAGE, INPUT POWER, AND OUTPUT POWER

f Frequency MHz	Z_{in} Ohms		Z_{OL}* Ohms	
	V_{CC} = 7.5 V	V_{CC} = 12.5 V	V_{CC} = 7.5 V	V_{CC} = 12.5 V
	P_{in} = 75 mW	P_{in} = 50 mW	P_{out} 400 MHz = 875 mW P_{out} 450 MHz = 790 mW P_{out} 512 MHz = 675 mW	P_{out} 400 MHz = 1.25 W P_{out} 450 MHz = 1.1 W P_{out} 512 MHz = 775 mW
400	9.6 – j7.5	8.2 – j11.5	37.8 + j12.3	51.8 – j7.2
450	11.3 – j7.5	9.7 – j11	35.8 + j8.6	52.2 – j16.7
512	11.5 – j6.8	12 – j9.2	42.4 + j0.24	43.7 – j5.7

*Z_{OL} = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 11 — OUTPUT POWER versus INPUT POWER f = 512 MHz

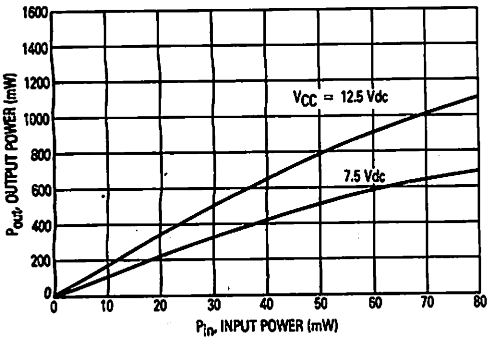


FIGURE 12 — OUTPUT POWER versus FREQUENCY V_{CC} = 7.5 Vdc

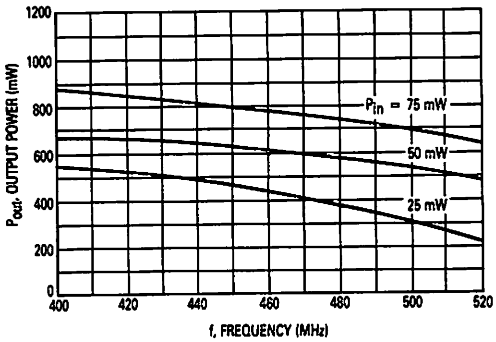


FIGURE 13 — OUTPUT POWER versus COLLECTOR VOLTAGE f = 512 MHz

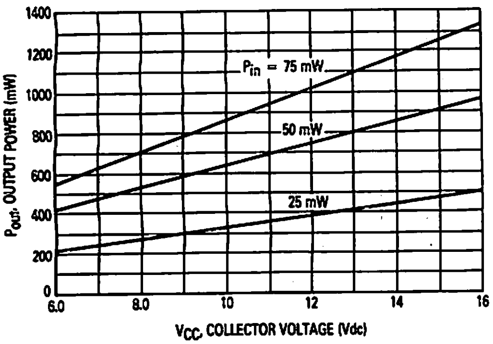
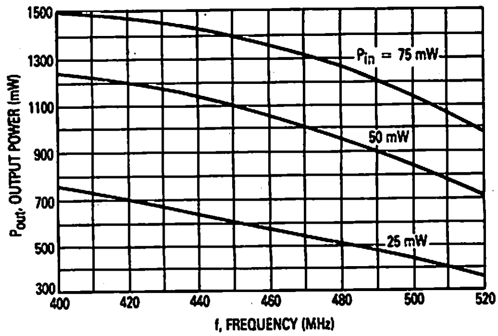


FIGURE 14 — OUTPUT POWER versus FREQUENCY V_{CC} = 12.5 Vdc



MRF838
MRF838A

2

The RF Line

1 W – 870 MHz

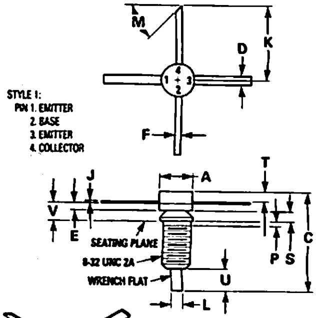
RF POWER TRANSISTORS

NPN SILICON

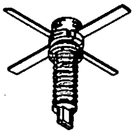
NPN SILICON RF POWER TRANSISTORS

. . . designed for 12.5 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics:
  - Output Power = 1.0 Watt
  - Minimum Gain = 6.5 dB
  - Efficiency = 60% Typ
- Series Equivalent Large-Signal Characterization



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.08	5.59	0.200	0.220
C	13.97	16.26	0.550	0.640
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
L	1.40	1.65	0.055	0.065
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	1.40	1.65	0.055	0.065
T	1.40	1.78	0.055	0.070
U	2.79	3.81	0.110	0.150
V	2.41	2.92	0.095	0.115

MRF838A
CASE 305-01

MAXIMUM RATINGS

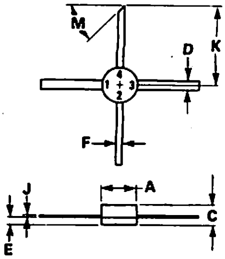
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.3	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	2.5 0.014	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

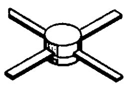
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	70	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR



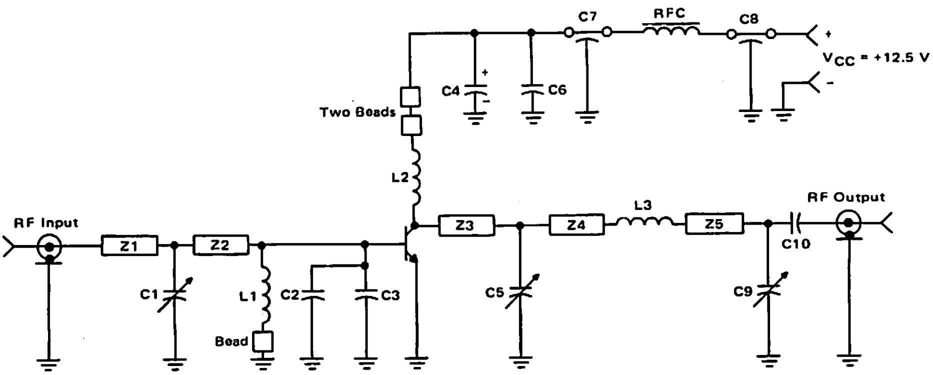
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	

MRF838
CASE 305A-01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	–	–	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	80	150	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	5.0	7.0	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 1.0 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PE}	6.5	7.5	–	dB
Collector Efficiency (P_{out} = 1.0 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	60	–	%

FIGURE 1 – 870 MHz TEST CIRCUIT



C1, C5, C9 – 0.8-8.0 pF Johanson Gigatrim #7291
C2, C3 – 10 pF ATC Chip Capacitor (Case A)
C4 – 1.0 µF 30 V Tantalum Capacitor
C6 – 0.1 µF Erie Redcap 100 V
C7, C8 – 680 pF Feedthru
C10 – 100 pF Chip Capacitor (100 mil)
L1, L2 – 1 Turn #18 AWG 1/8" Diameter
L3 – #14 AWG 1/2 Turn 0.250" Diameter

RFC – Ferroxcube VK200 20/4B
Bead – Ferroxcube #56-590-65/3B
Z1, Z2 – 1.2" X 0.155" Microstrip
Z3 – 1.05" X 0.155" Microstrip
Z4 – 0.5" X 0.155" Microstrip
Z5 – 1.5" X 0.155" Microstrip
Board Material – 0.0625" Thick Glass-Teflon, ϵ_r = 2.5

2

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

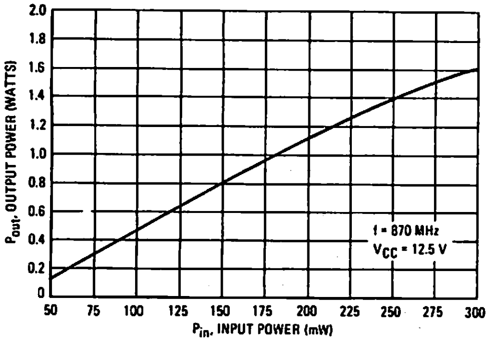


FIGURE 3 — OUTPUT POWER versus FREQUENCY

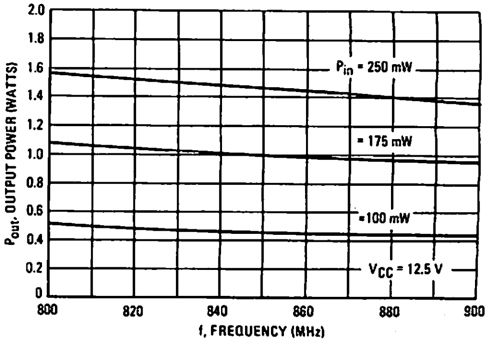


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

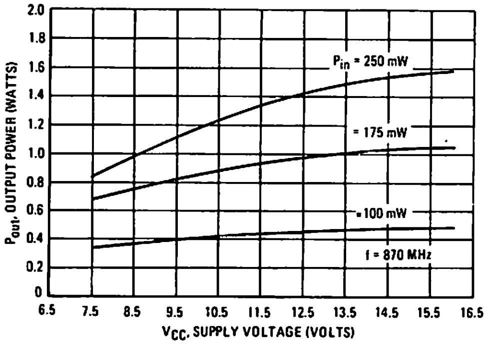
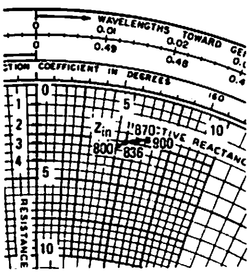


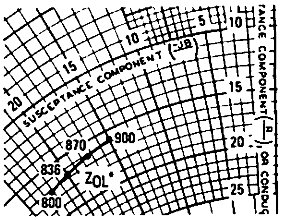
FIGURE 5 — SERIES EQUIVALENT INPUT IMPEDANCE



P_{out} = 1.0 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms
800	2.8 + j4.6
836	2.6 + j5.0
870	2.4 + j5.6
900	2.3 + j6.2

FIGURE 6 — SERIES EQUIVALENT OUTPUT IMPEDANCE

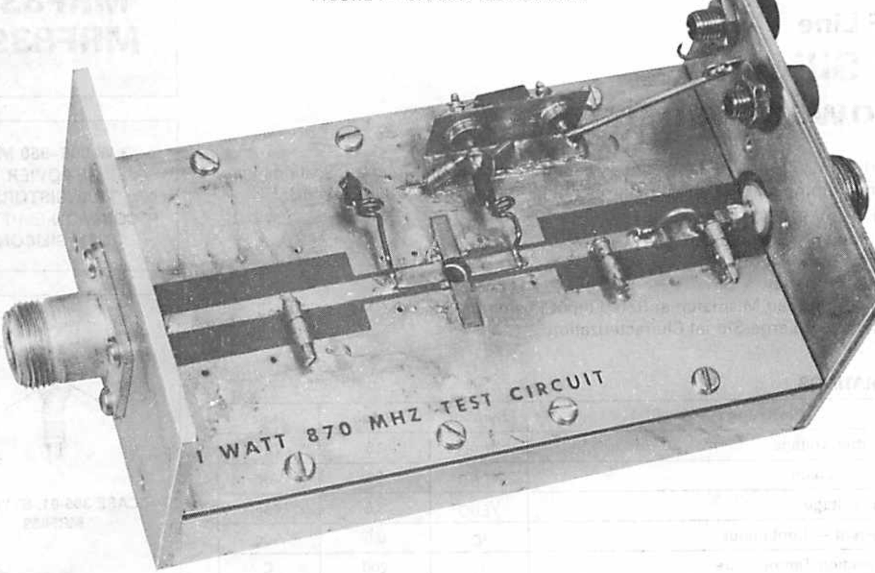


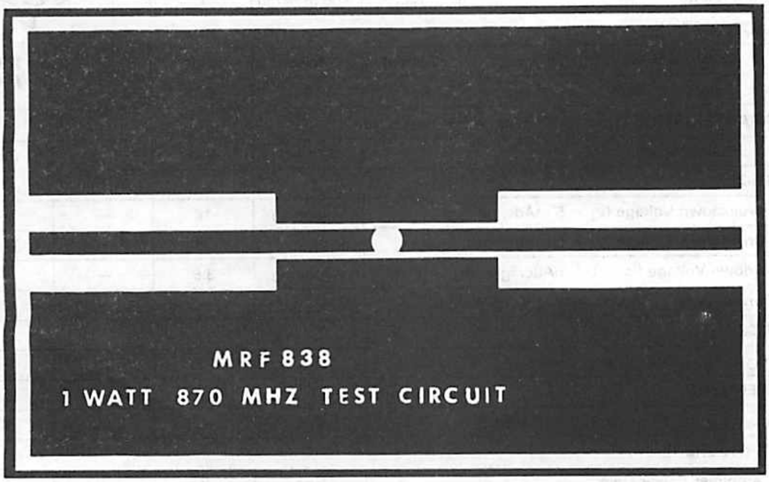
P_{out} = 1.0 W, V_{CC} = 12.5 Vdc

f MHz	Z_{OL}* Ohms
800	17.1 - j22.2
836	16.6 - j20.0
870	16.1 - j17.4
900	15.9 - j15.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given power, voltage, and frequency.

FIGURE 7 – 870 MHz TEST CIRCUIT





NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

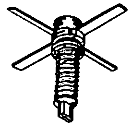
MRF839
MRF839F

The RF Line
NPN Silicon RF Power Transistors

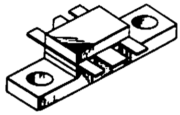
. . . designed for 12.5 Volt UHF large-signal, **common-emitter** amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 V 870 MHz Characteristics
  - Output Power = 3 Watts
  - Minimum Gain = 8 dB
  - Minimum Efficiency = 55%
- 100% Tested for Load Mismatch at Rated Input Power and 15.5 V
- Series Equivalent Large-Signal Characterization

3 W 806–960 MHz RF POWER TRANSISTORS COMMON-EMITTER NPN SILICON



CASE 305-01, STYLE 1
MRF839



CASE 319-06, STYLE 2
MRF839F

MAXIMUM RATINGS

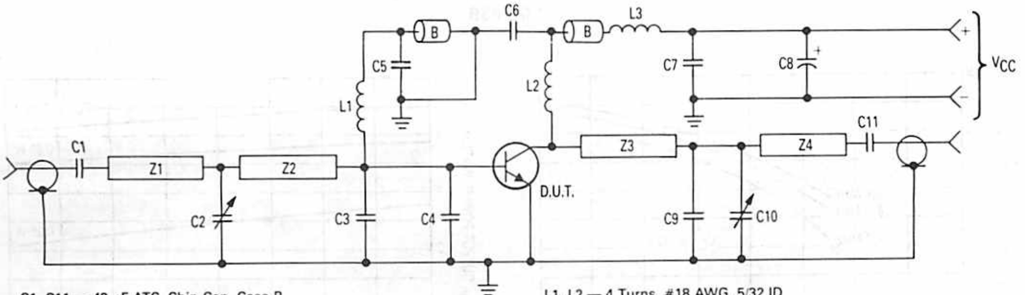
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	0.6	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_C = 110°C Derate above 110°C	P_D	10 111	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5 Vdc)	h_{FE}	10	90	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	6.5	10	pF
FUNCTIONAL TESTS (FIGURE 1)					
Common-Emitter Amplifier Power Gain (P_{out} = 3 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PE}	8	10	—	dB
Collector Efficiency (P_{out} = 3 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η_c	55	63	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 0.5 W, f = 870 MHz, VSWR = 20:1, all phase angles)	—	No Degradation in Output Power			



C1, C11 — 43 pF ATC, Chip Cap, Case B
C2, C10 — 0.8–8 Johanson Gigatrim
C3, C4 — 10 pF Clamped Mica, Mini-Underwood
C5, C6, C7 — 68 pF Clamped Mica, Mini-Underwood
C8 — 10 μF, 25 V Tantalum
C9 — 5 pF Clamped Mica, Mini-Underwood
B — Bead, Ferroxcube #56-590-65/3B

L1, L2 — 4 Turns, #18 AWG, 5/32 ID
L3 — 7 Turns, #18 AWG, 5/32 ID
Z1 — 0.850" x 0.077" Microstrip, Z_o = 50 Ω
Z2 — 1.100" x 0.077" Microstrip, Z_o = 50 Ω
Z3 — 0.920" x 0.077" Microstrip, Z_o = 50 Ω
Z4 — 1.150" x 0.077" Microstrip, Z_o = 50 Ω
Board Material — 0.032" Glass Teflon, 2 oz. Copper Clad, ϵ_r = 2.55

Figure 1. MRF839 800–880 MHz Broadband Test Circuit

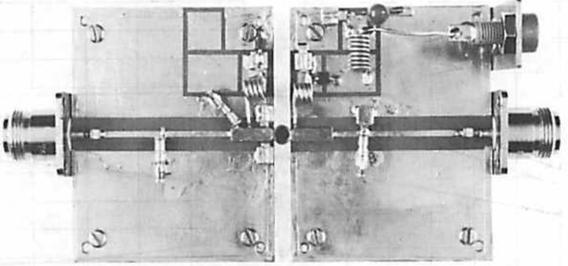


Figure 2. MRF839 Broadband Test Circuit

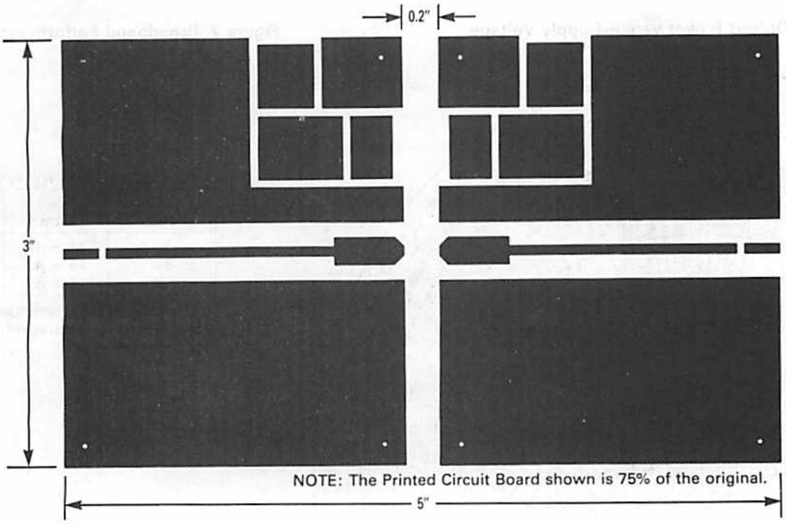


Figure 3. MRF839 Photomaster

MRF839

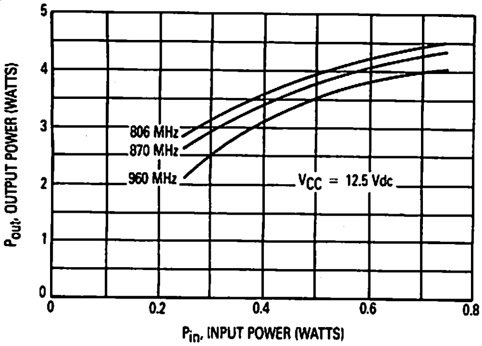


Figure 4. Output Power versus Input Power

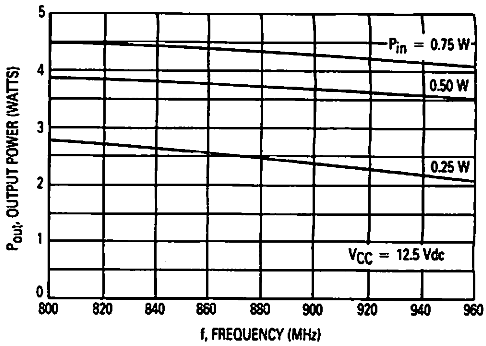


Figure 5. Output Power versus Frequency

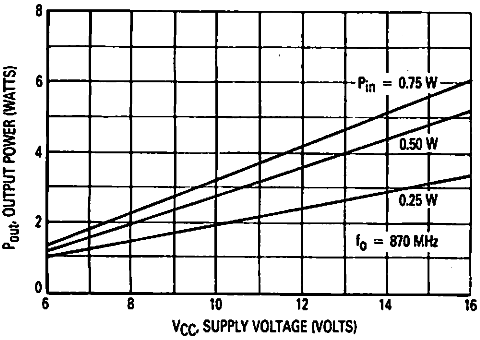


Figure 6. Output Power versus Supply Voltage

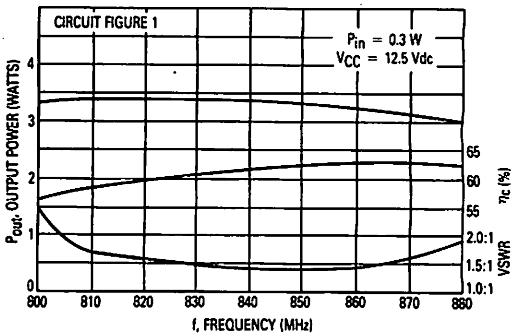
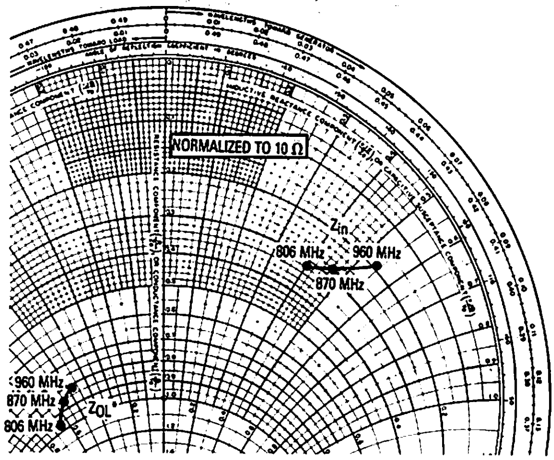


Figure 7. Broadband Performance



P_{out} = 3 Watts, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
806	3.1 + j4.0	9.6 − j6.5
870	2.8 + j4.6	8.5 − j5.6
960	1.9 + j5.4	8.1 − j4.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 8. Series Equivalent Input/Output Impedances

MRF839F

2

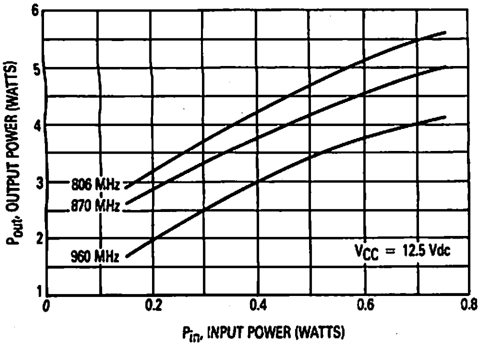


Figure 9. Output Power versus Input Power

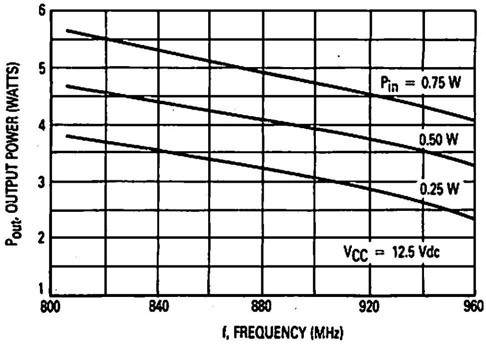


Figure 10. Output Power versus Frequency

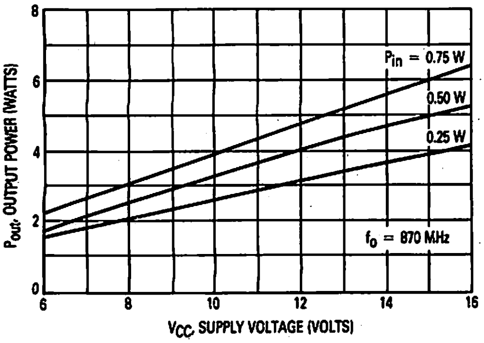


Figure 11. Output Power versus Supply Voltage

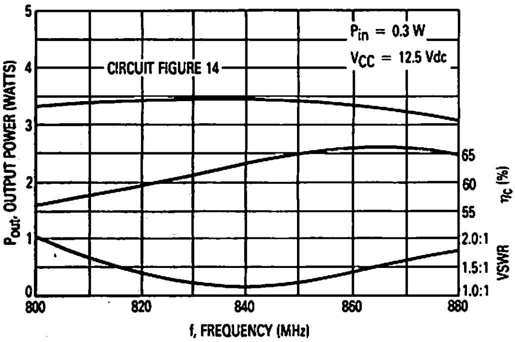
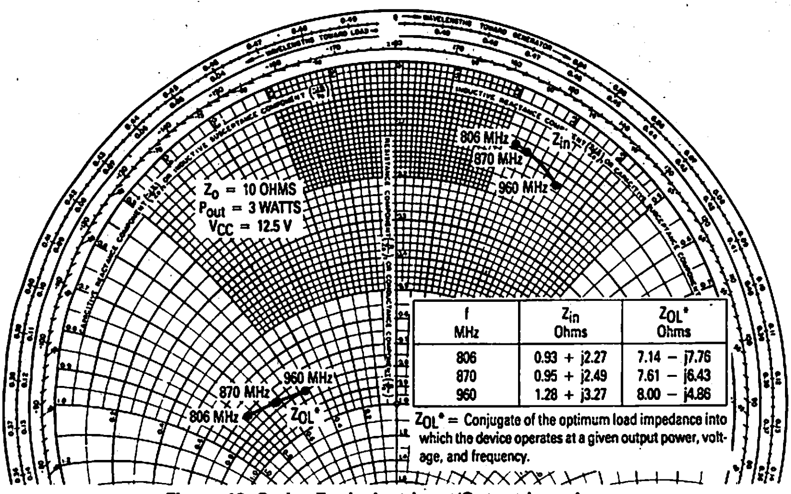


Figure 12. Broadband Performance

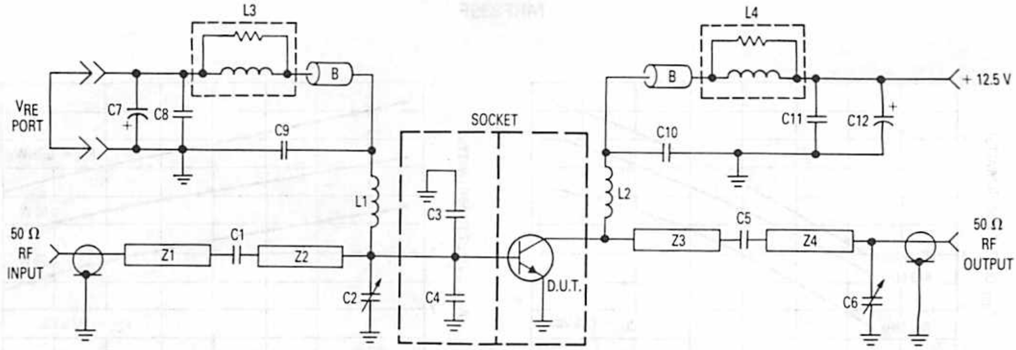


f MHz	Z_{in} Ohms	Z_{OL}* Ohms
806	0.93 + j2.27	7.14 − j7.76
870	0.95 + j2.49	7.61 − j6.43
960	1.28 + j3.27	8.00 − j4.86

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 13. Series Equivalent Input/Output Impedances

2



C1 — 47 pF Chip Cap (Murata Erie MA20470B)
C3, C4 — 13 pF Mini-Underwood
C5 — 51 pF Chip Cap (ATC 100B510JC500)
C2, C6 — 0.8–8 pF Johanson #7291
C7, C12 — 10 μF, 35 V Electrolytic Capacitor
C8, C11 — 1000 pF Unelco, J101
C9, C10 — 91 pF Mini-Underwood
B — Bead, Ferroxcube #56-590-65/3B

L1, L2 — 4 Turns, #18 Enameled, 5/32″ ID
L3, L4 — 12 Turns, #22 Enameled over 10 Ohm, 1/2 W Carbon Resistor
Z1, Z4 — 50 Ohm Stripline
Z2 — 32 Ohm Stripline (1/4 λ @ 838 MHz)
Z3 — 16 Ohm Stripline (1/4 λ @ 838 MHz)
Board Material — 0.032″ Glass Teflon, 2 oz. Copper Clad, ϵ_r = 2.55

Figure 14. MRF839F 800–880 MHz Broadband Test Circuit

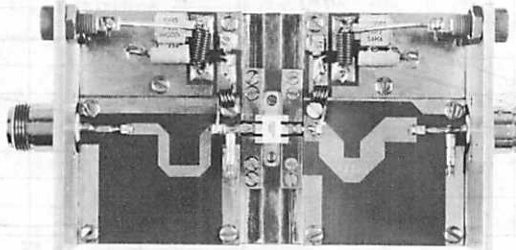


Figure 15. MRF839F Broadband Test Circuit

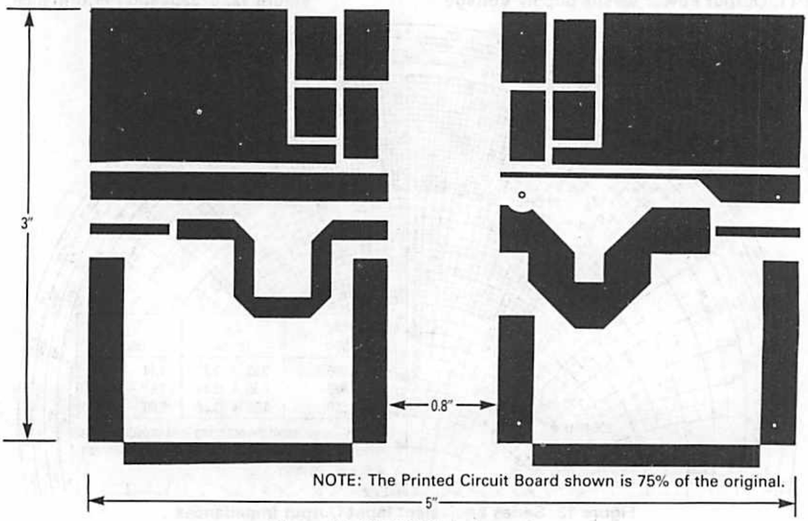


Figure 16. MRF839F Photomaster

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF840

The RF Line

NPN SILICON RF POWER TRANSISTOR

. . . *designed* for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

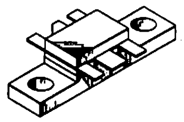
- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 10 Watts
  Minimum Gain = 6.0 dB
  Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

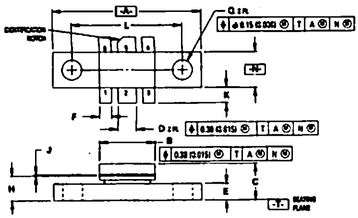
10 W – 870 MHz

RF POWER TRANSISTOR

NPN SILICON

2





STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	3.8	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	40 0.32	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.1	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

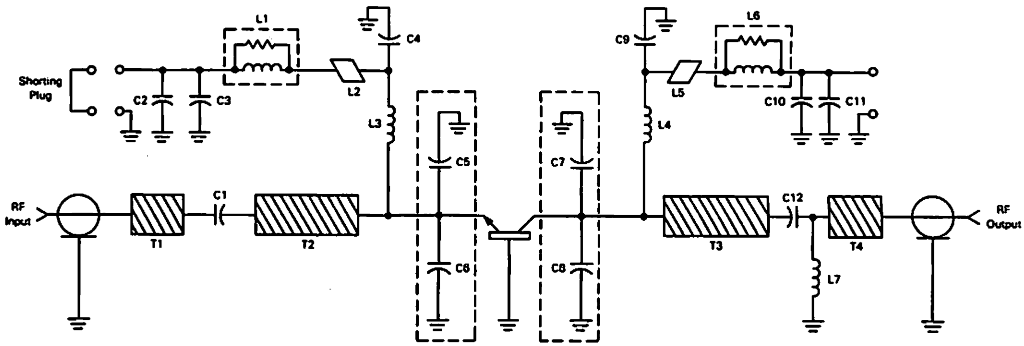
2

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5.0$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	10	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	24	35	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 10$ W, $V_{CC} = 12.5$ Vdc, f = 870 MHz)	G_{PB}	6.0	7.0	–	dB
Collector Efficiency ($P_{out} = 10$ W, $V_{CC} = 12.5$ Vdc, f = 870 MHz)	η	50	55	–	%
Load Mismatch Stress ($V_{CC} = 15.5$ Vdc, $P_{in} = 3.0$ W,* f = 870 MHz, VSWR = 20:1, all phase angles)	–	No Degradation in Output Power			

*P_{in} = 150% of the typical input power requirement for 10 W output power @ 12.5 Vdc.

FIGURE 1 – 870 MHz TEST CIRCUIT



C1, C12 — 50 pF, 100 Mil Chip Capacitor
C2, C11 — 15 μF, 20 V Tantalum
C3, C10 — 1000 pF, 350 V UNELCO
C4, C9 — 91 pF Mini-Underwood
C5 — 15 pF
C6 — 15 pF
C7 — 15 pF
C8 — 15 pF

L1, L6 — 11 Turns 20 AWG Around 10 Ω 1/2 W Resistor
L2, L5 — Ferrite Bead
L3, L4 — 4 Turn 20 AWG 0.2" I.D.
T1, T4 — $Z_0 = 50\ \Omega$
T2 — $Z_0 = 30\ \Omega$ $\ell = \lambda/4$ @ 838 MHz
T3 — $Z_0 = 13.5\ \Omega$ $\ell = \lambda/4$ @ 838 MHz
L7 — 18 AWG Wire Loop

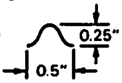


FIGURE 2 — OUTPUT POWER versus INPUT POWER

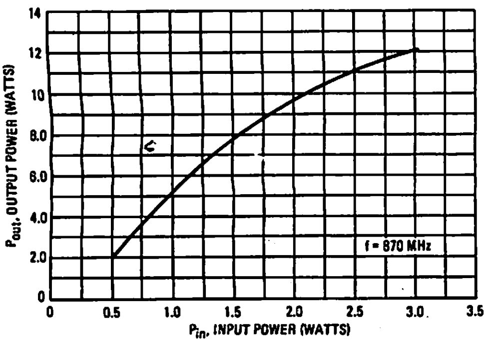


FIGURE 3 — OUTPUT POWER versus FREQUENCY

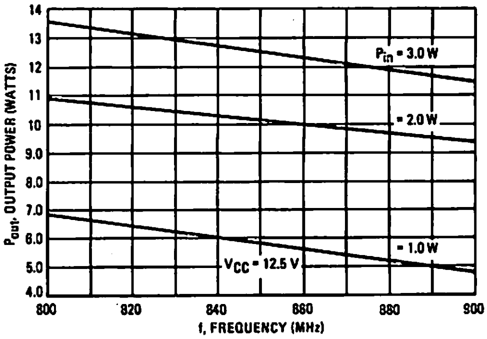


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

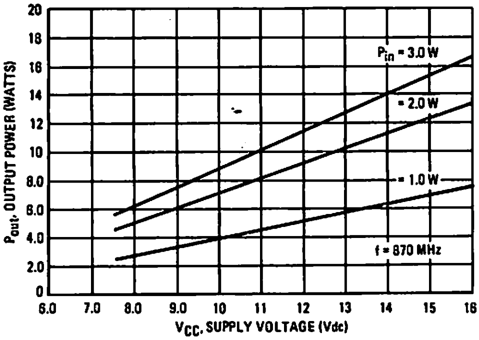
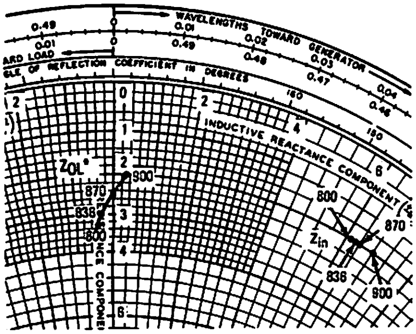


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

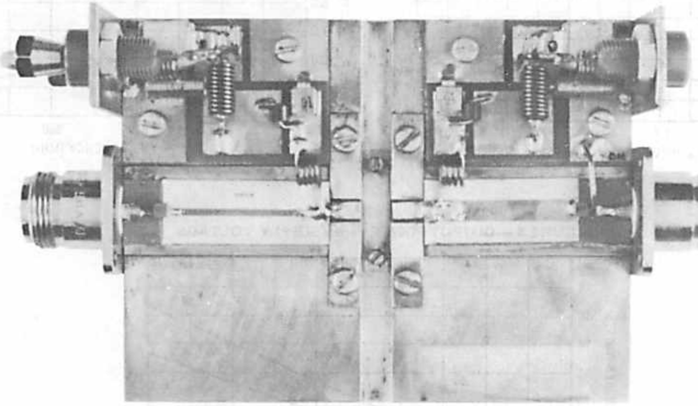


P_{out} = 10 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	2.0 + j6.1	3.3 − j0.4
836	2.0 + j6.2	3.0 − j0.3
870	2.0 + j6.4	2.5 + j0.0
900	2.0 + j6.8	2.0 + j0.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 — 870 MHz TEST CIRCUIT



2

MRF841
MRF841F

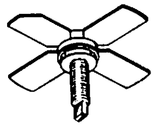
The RF Line

NPN Silicon RF Power Transistors

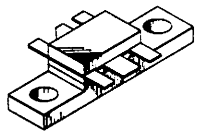
5 W 870 MHz RF POWER TRANSISTORS NPN SILICON

. . . designed primarily for wideband large-signal output and driver stages in the 806–960 MHz frequency range.

- Specified 12.5 Volt, 870 MHz Characteristics @ P_{out} = 5 W
  Common Base Gain = 10 dB (Typ)
  Efficiency = 65% (Typ)
- Internally Matched Input for Broadband Operation
- Gold Metallized and Emitter Ballasted for Improved Reliability
- 100% Tested for Load Mismatch at Rated Input Power and 15.5 V



MRF841
CASE 244-04, STYLE 4



MRF841F
CASE 319-06, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2	Adc
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	25 143	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

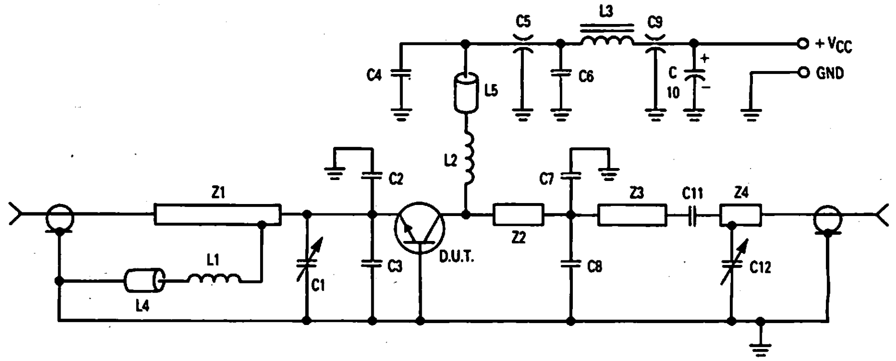
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5 Vdc)	h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	6	9.5	15	pF
FUNCTIONAL TESTS (f = 870 MHz)					
Common-Base Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 5 W)	G_{PB}	8.5	10	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 5 W)	η_c	—	65	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 710 mW, VSWR = 20:1, all Phase Angles)	ψ	No Degradation in Output Power			

2



C1, C12 — 0.8–8 pF Johanson 7290 Variable
C2 — 5 pF Mini-Underwood Mica
C3 — 8.2 pF Mini-Underwood Mica
C4 — 91 pF Mini-Underwood Mica
C5, C9 — 680 pF Feedthru
C6 — 0.1 μF Ceramic
C7, C8 — 10 pF Mini-Underwood Mica
C10 — 1 μF Electrolytic
C11 — 43 pF Mini-Underwood

L1, L2 — 4 Turns, #22 AWG Wire, 0.2-inch ID
L3 — VK200 Ferroxcube
L4, L5 — Ferrite Bead, Ferroxcube #56-590-65-3B
Z1 — 2.36" x 0.145" Microstrip 33 Ohm Line
Z2 — 0.5" x 0.175" Microstrip 28 Ohm Line
Z3 — 1.40" x 0.175" Microstrip 28 Ohm Line
Z4 — 0.40" x 0.175" Microstrip 28 Ohm Line
Board = 0.032" Glass Teflon 2 oz. cu clad ϵ_r = 2.55

MRF841
Figure 1. 800–960 MHz Broadband Power Gain Test Circuit

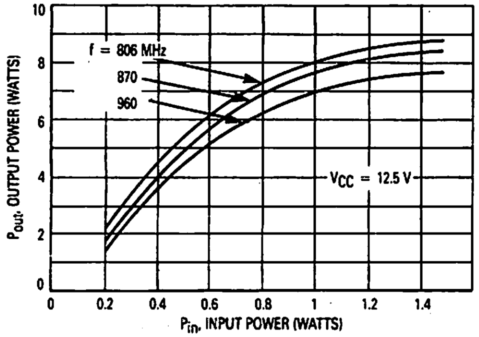


Figure 2. Output Power versus Input Power

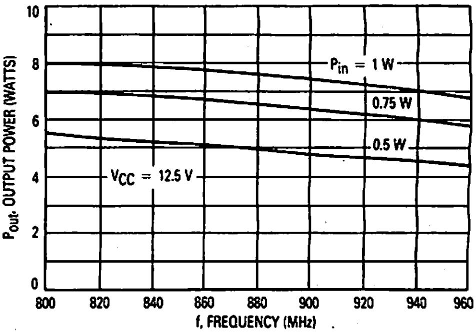


Figure 3. Output Power versus Frequency

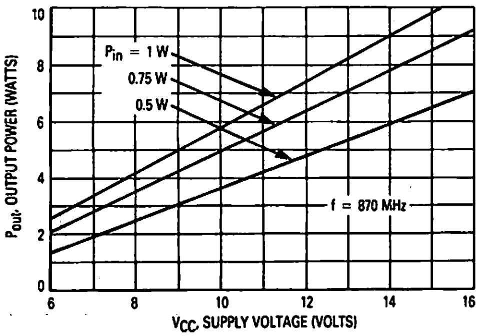


Figure 4. Power Out versus Supply Voltage

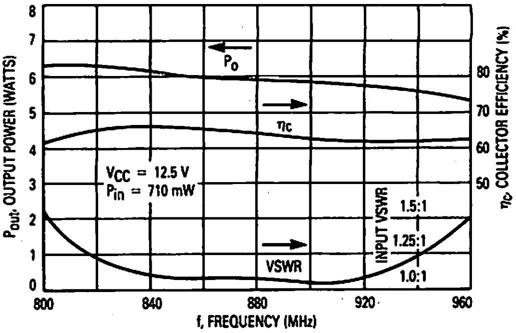


Figure 5. Typical Performance in Broadband Circuit

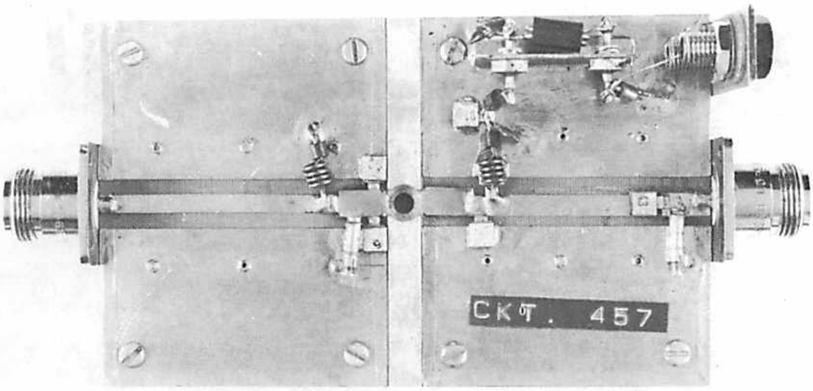


Figure 6. MRF841 Broadband Power Gain Test Circuit

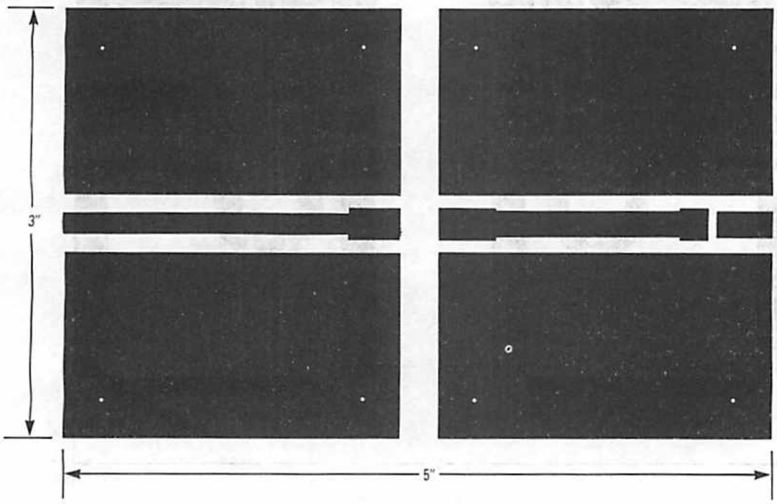


Figure 7. MRF841 Test Circuit Photomaster
NOTE: The Printed Circuit Board shown is 75% of the original.

2

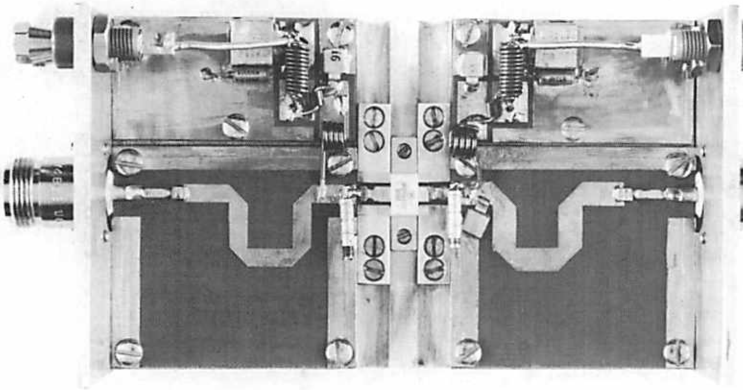


Figure 8. MRF841F Broadband Power Gain Test Circuit

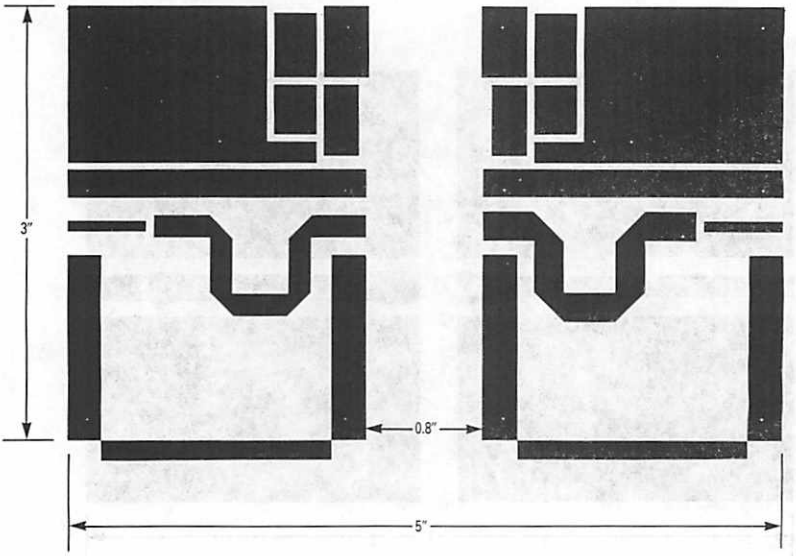
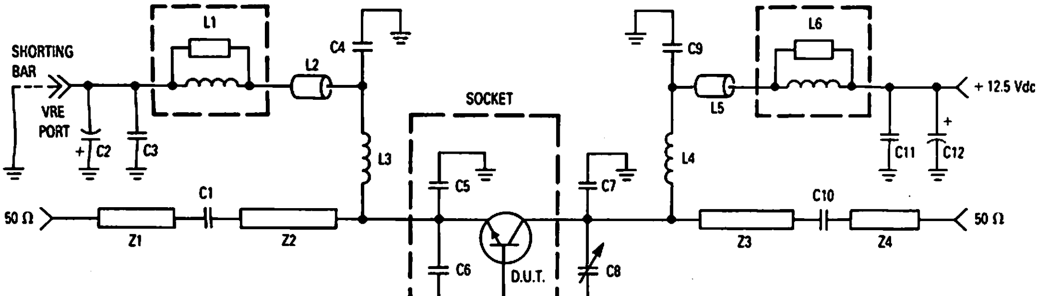


Figure 9. MRF841F Test Circuit Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.



C1, C10 = 47 pF, 100 Mil ATC
C2, C12 = 1 μF, 35 WV Tantalum
C3, C11 = 1000 pF Underwood J101
C4, C9 = 91 pF Mini Underwood
C5 = 12 pF Mini-Underwood
C6 = 10 pF Mini-Underwood
C7 = 10 pF Mini-Underwood
C8 = Johansen Giga Trim 0.8–8 pF 7290 Variable

L1, L6 = 11 Turns #20 AWG Over 10 Ω 1/2 W
L2, L5 = Ferrite Bead, Ferroxcube #56-590-65-3B
L3, L4 = 4T #18 AWG, 15" ID
Z1, Z4 = 50 Ω Printed Line
Z2 = 30 Ω Printed Line, λ/4 @ 838 MHz
Z3 = 24 Ω Printed Line, λ/4 @ 838 MHz
Board = 0.032" Glass Teflon 2 oz. cu clad ϵ_r = 2.55

NOTES: C7 and C8 mounted ≈ 250 mils down Z3 from collector edge of board

MRF841F
Figure 10. 800–960 MHz Broadband Power Gain Test Circuit

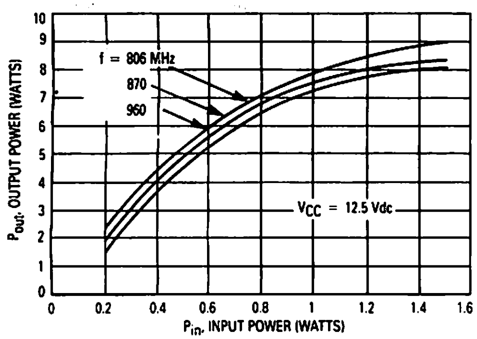


Figure 11. Output Power versus Input Power

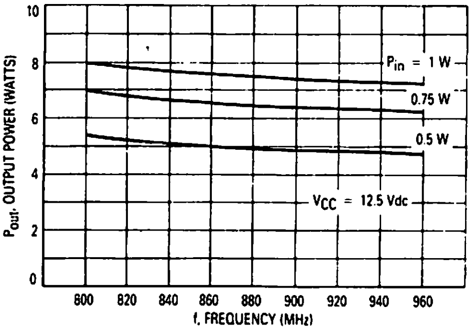


Figure 12. Output Power versus Frequency

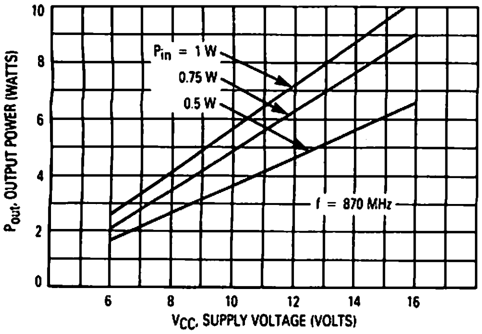


Figure 13. Output Power versus Supply Voltage

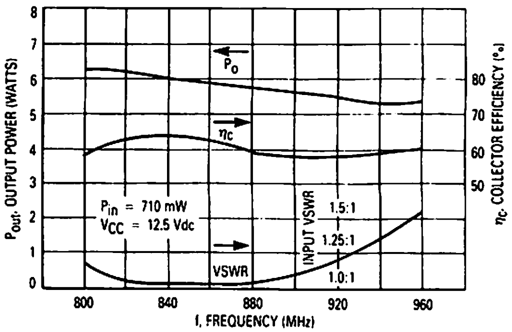
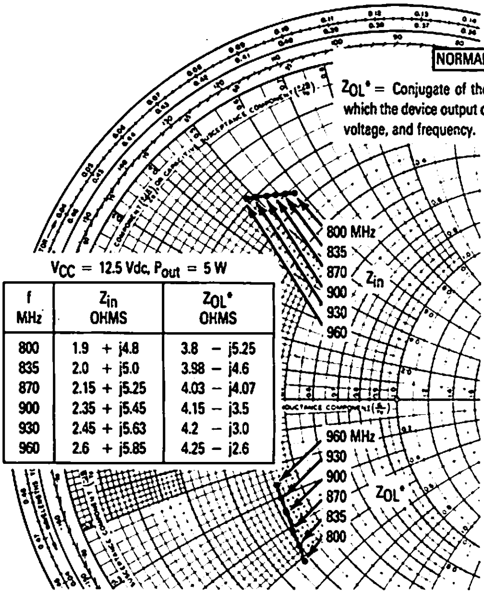


Figure 14. Typical Performance in Broadband Circuit

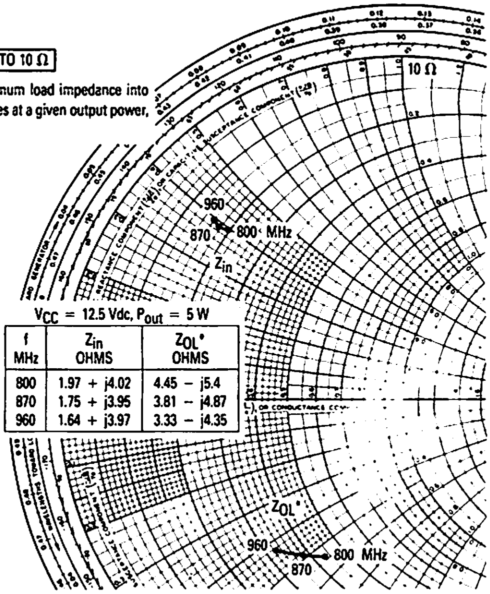
2



V_{CC} = 12.5 Vdc, P_{out} = 5 W

f MHz	Z_{in} OHMS	Z_{OL}* OHMS
800	1.9 + j4.8	3.8 − j5.25
835	2.0 + j5.0	3.98 − j4.6
870	2.15 + j5.25	4.03 − j4.07
900	2.35 + j5.45	4.15 − j3.5
930	2.45 + j5.63	4.2 − j3.0
960	2.6 + j5.85	4.25 − j2.6

Figure 15. Series Equivalent Input/Output Impedances



V_{CC} = 12.5 Vdc, P_{out} = 5 W

f MHz	Z_{in} OHMS	Z_{OL}* OHMS
800	1.97 + j4.02	4.45 − j5.4
870	1.75 + j3.95	3.81 − j4.87
960	1.64 + j3.97	3.33 − j4.35

Figure 16. Series Equivalent Input/Output Impedances

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

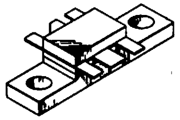
MRF842

The RF Line

20 W – 870 MHz

RF POWER TRANSISTOR

NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . *designed* for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 20 Watts
  Minimum Gain = 6.0 dB
  Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- 100% Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ 15.5 Volt Supply and 50% RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

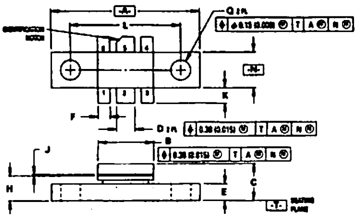
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.6	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	80 0.64	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

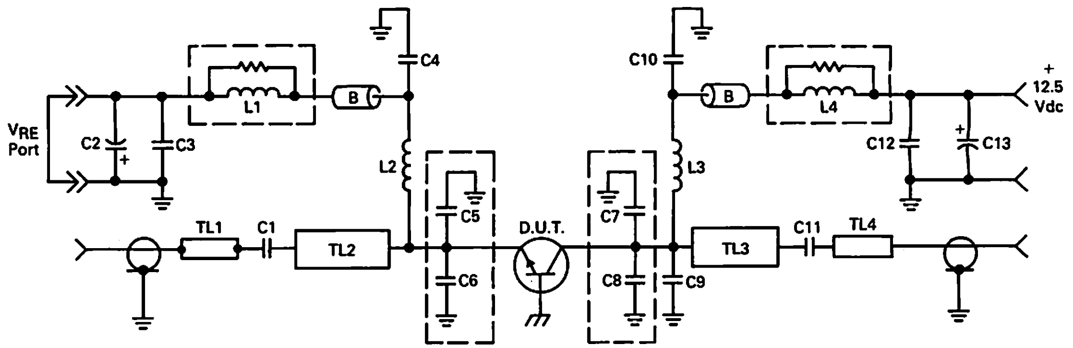
CASE 319-06

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	45	65	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain (P_{out} = 20 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PB}	6.0	7.0	–	dB
Collector Efficiency (P_{out} = 20 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	55	–	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in}* = 6.0 W, f = 870 MHz, VSWR = 20:1, all phase angles)	–	No Degradation in Output Power			

*P_{in} = 150% of the typical input power requirement for 20 W output power @ 12.5 Vdc.

FIGURE 1 — 870 MHz TEST CIRCUIT SCHEMATIC



C1, C11 — 51 pF, 100 Mil Chip Capacitor
C2, C13 — 15 µF, 20 WV Tantalum
C3, C12 — 1000 pF Unelco J101
C4, C10 — 91 pF Mini-Underwood
C5 — 15 pF Mini-Underwood
C6 — 12 pF Mini-Underwood
C7, C8 — 21 pF Mini-Underwood
C9 — 11 pF Mini-Underwood

L1, L4 — 11 Turns #20 AWG Over 10 ohm 1/2 W Carbon
L2, L3 — 4 Turns #20 AWG, 200 Mil ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
TL1, TL4 — Micro Strip, Z_o = 50 Ω
TL2 — Micro Strip, Z_o = 38 Ω, λ/4 @ 838 MHz
TL3 — Micro Strip, Z_o = 24 Ω, λ/4 @ 838 MHz
Board — 0.032″ Glass Teflon
2 oz. Cu CLAD, ϵ_r = 2.55

FIGURE 2 — OUTPUT POWER versus INPUT POWER

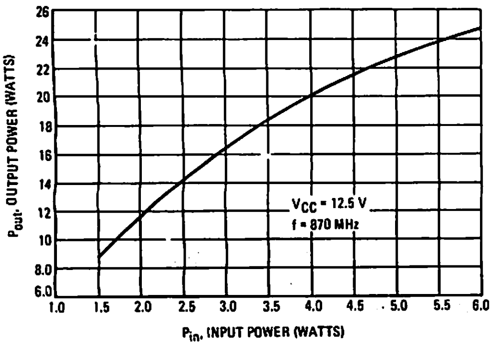


FIGURE 3 — OUTPUT POWER versus FREQUENCY

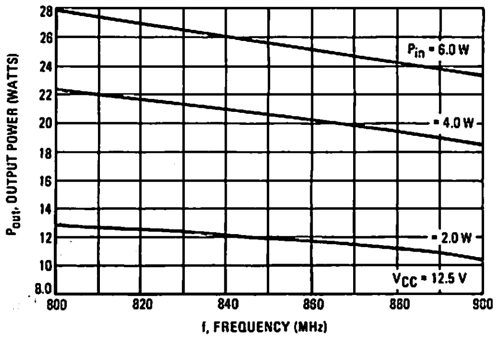


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

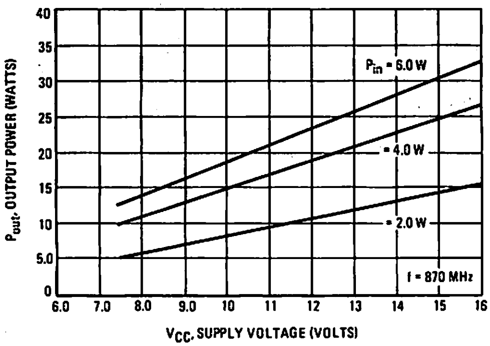
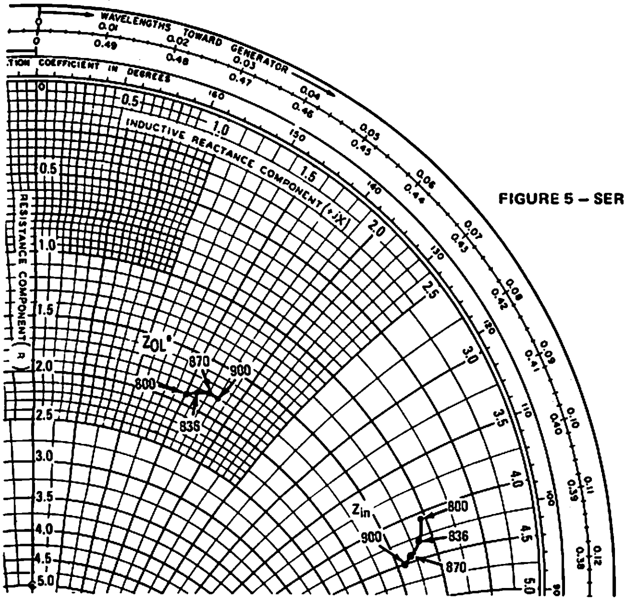


FIGURE 5 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

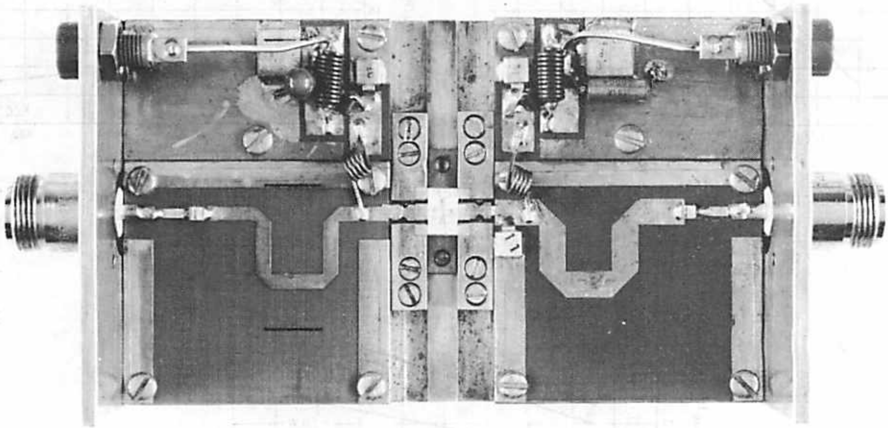


P_{out} = 20 W, V_{CC} = 12.5 Vdc

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	1.1 + j4.1	1.9 + j1.5
836	1.2 + j4.3	1.85 + j1.6
870	1.4 + j4.4	1.8 + j1.7
900	1.6 + j4.5	1.8 + j1.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – 870 MHz TEST CIRCUIT



MRF844

The RF Line

30 W–870 MHz

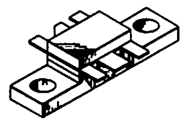
RF POWER TRANSISTOR

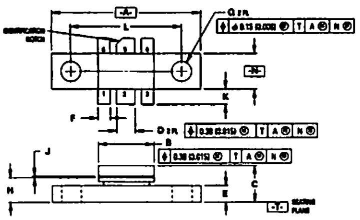
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 30 Watts
  Minimum Gain = 5.2 dB
  Efficiency = 50%
- *Series Equivalent Large-Signal Characterization*
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 20:1 VSWR @ High Line and RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated





STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	10.9	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

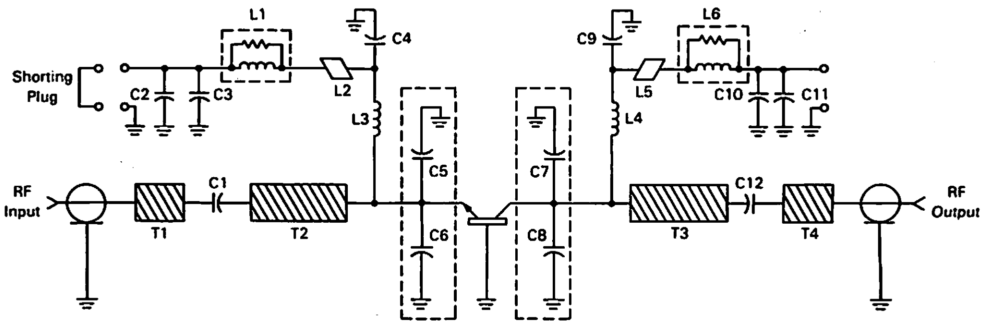
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS ($T_C = 25°C$ unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $I_B = 0$)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 50$ mAdc, $V_{BE} = 0$)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage ($I_E = 10$ mAdc, $I_C = 0$)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current ($V_{CB} = 15$ Vdc, $I_E = 0$)	I_{CBO}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 2.0$ Adc, $V_{CE} = 5.0$ Vdc)	h_{FE}	10	40	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 12.5$ Vdc, $I_E = 0$, f = 1.0 MHz)	C_{ob}	–	60	90	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain ($P_{out} = 30$ W, $V_{CC} = 12.5$ Vdc, f = 870 MHz)	G_{PB}	5.2	6.0	–	dB
Collector Efficiency ($P_{out} = 30$ W, $V_{CC} = 12.5$ Vdc, f = 870 MHz)	η	50	55	–	%
Load Mismatch Stress ($V_{CC} = 15.5$ Vdc, $P_{in} = 12$ W*, f = 870 MHz, VSWR = 20:1, all phase angles)	–	No Degradation in Output Power			

*P_{in} = 150% of the typical input power requirement for 30 W output power @ 12.5 Vdc.

FIGURE 1 – 870 MHz TEST CIRCUIT



C1, C12 — 50 pF, 100 Mil Chip Capacitor
C2, C11 — 15 μF, 20 V Tantalum
C3, C10 — 1000 pF, 350 V UNELCO
C4, C9 — 91 pF Mini-Underwood
C5 — 15 pF Mini-Underwood
C6 — 15 pF Mini-Underwood
C7 — 18 pF Mini-Underwood
C8 — 24 pF Mini-Underwood

L1, L6 — 11 Turns 20 AWG Around 10 Ω 1/2 W Resistor
L2, L5 — Ferrite Bead
L3, L4 — 4 Turn 20 AWG 0.2" I.D.
T1, T4 — $Z_0 = 50\ \Omega$
T2 — $Z_0 = 38\ \Omega$ $\ell = \lambda/4$ @ 838 MHz
T3 — $Z_0 = 26\ \Omega$ $\ell = \lambda/4$ @ 838 MHz

2

FIGURE 2 – OUTPUT POWER versus INPUT POWER

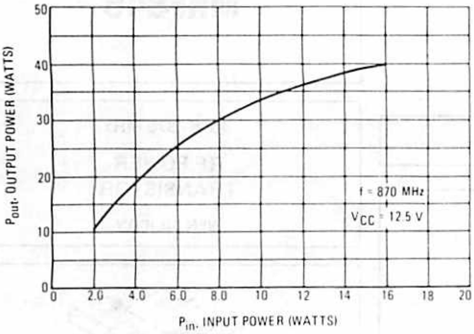


FIGURE 3 – OUTPUT POWER versus FREQUENCY

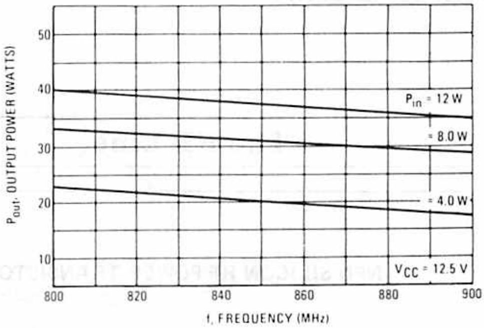


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

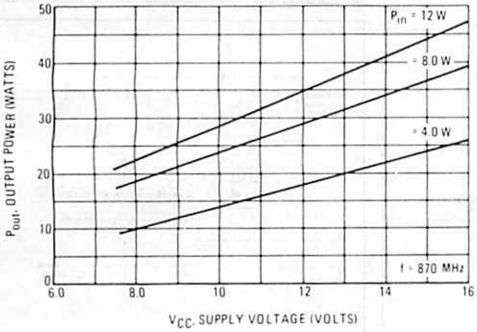
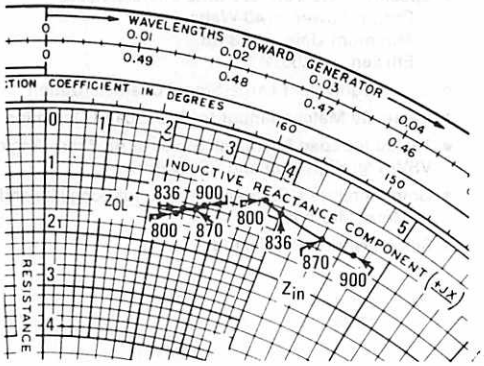


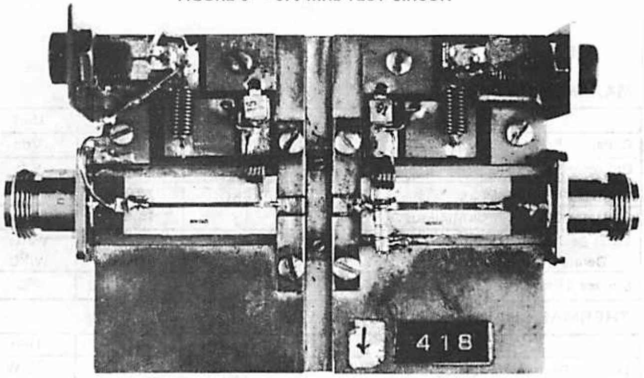
FIGURE 5 – SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



P_{in} = 7.5 W, P_{out} = 30 W, V_{CC} = 12.5 Vdc		
f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	0.8 + j3.7	1.4 + j2.3
836	0.9 + j4.0	1.3 + j2.4
870	1.0 + j4.4	1.25 + j2.6
900	1.0 + j4.7	1.2 + j2.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 — 870 MHz TEST CIRCUIT

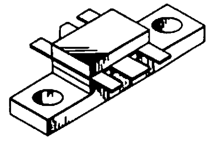


2

MRF846

The RF Line

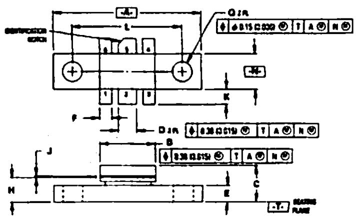
40 W–870 MHz
RF POWER TRANSISTOR
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 40 Watts
  Minimum Gain = 4.3 dB
  Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at All Phase Angles with 10:1 VSWR @ High Line and RF Overdrive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated



STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	14.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	150 0.86	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.17	°C/W

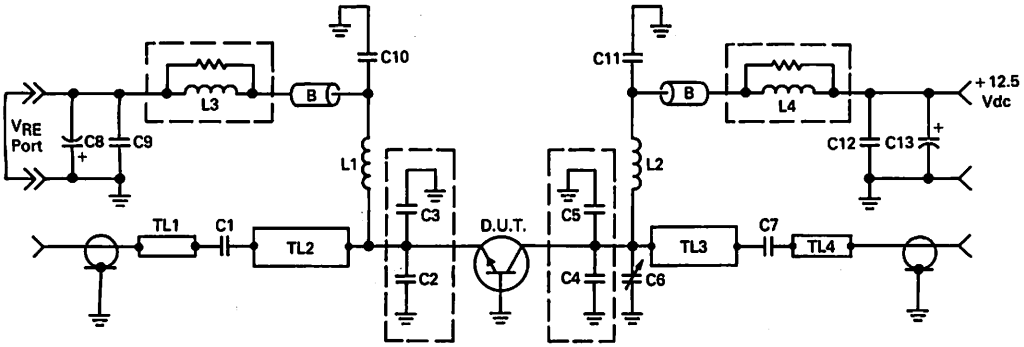
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	50	–	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	85	120	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	G_{PB}	4.3	5.2	–	dB
Collector Efficiency (P_{out} = 40 W, V_{CC} = 12.5 Vdc, f = 870 MHz)	η	50	55	–	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, P_{in} = 15 W, f = 870 MHz, VSWR = 10:1, all phase angles)	–	No Degradation in Output Power			

*P_{in} = 125% of the typical input power requirement for 40 W output power @ 12.5 Vdc.

FIGURE 1 — 870 MHz TEST CIRCUIT SCHEMATIC



C1 — 43 pF, 100 Mil Chip Capacitor
C2 — 12 pF Mini-Unelco
C3 — 15 pF Mini-Unelco
C4 — 21 pF Mini-Unelco
C5 — 18 pF Mini-Unelco
C6 — 0.8–8.0 pF Johanson Gigatrim
C7 — 47 pF, 100 Mil Chip Capacitor
C8 — 10 µF, 25 WV
C9, C12 — 1000 pF Unelco J101
C10, C11 — 91 pF Mini-Unelco
C13 — 25 µF, 25 WV

L1, L2 — 4 Turns #18 Enameled; 200 Mil ID
L3, L4 — 15 Turns #24 Enameled Over 12 ohm Carbon Resistor
B — Ferrite Bead; Ferroxcube 56-590-65-3B
TL1, TL4 — Micro Strip; 50 Ω
TL2 — Micro Strip; Z_o = 34 Ω, λ/4 @ 838 MHz
TL3 — Micro Strip; Z_o = 30 Ω, λ/4 @ 838 MHz
Board — 0.032" Glass Teflon
2 oz. Cu CLAD, ϵ_r = 2.55

FIGURE 2 – OUTPUT POWER versus INPUT POWER

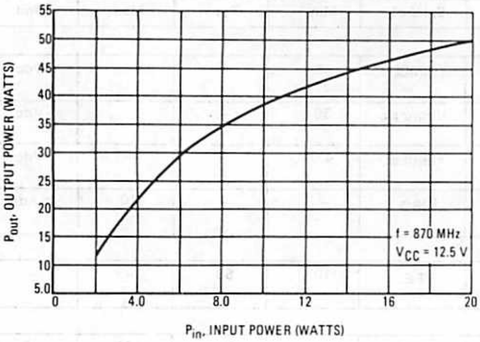


FIGURE 3 – OUTPUT POWER versus FREQUENCY

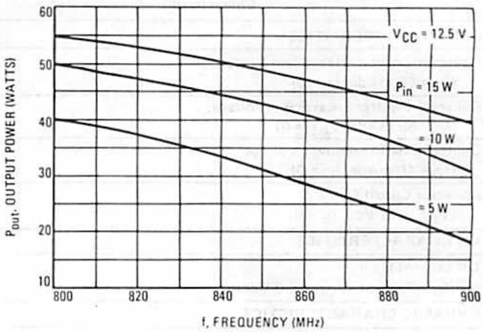


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

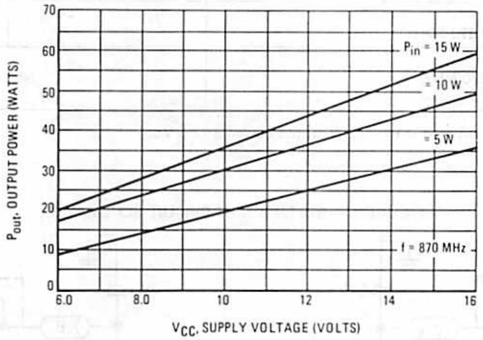
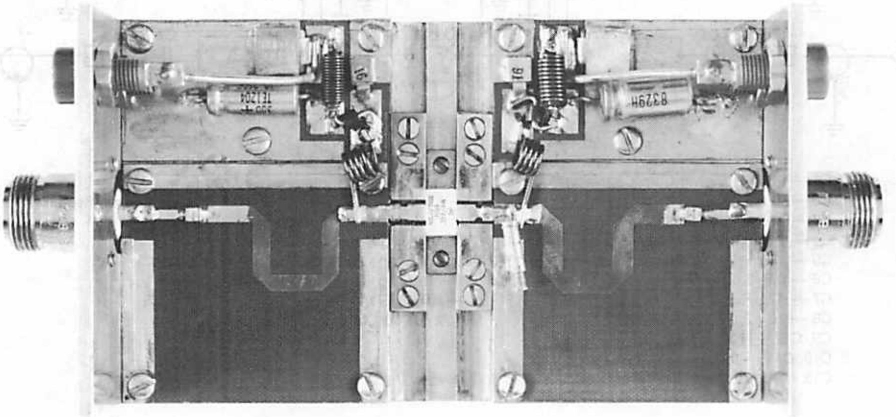


FIGURE 5 — 870 MHz TEST CIRCUIT



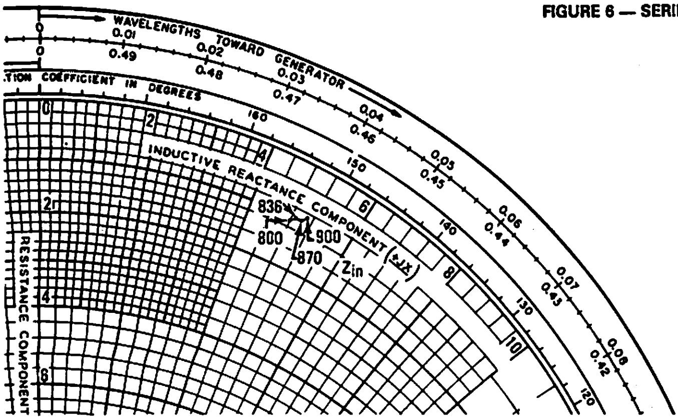


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCES

V_{CC} = 12.5 Vdc, P_{in} = 12 W

f MHz	Z_{in} Ohms
800	1.1 + j4.8
836	1.0 + j4.9
870	1.0 + j5.0
900	0.9 + j5.1

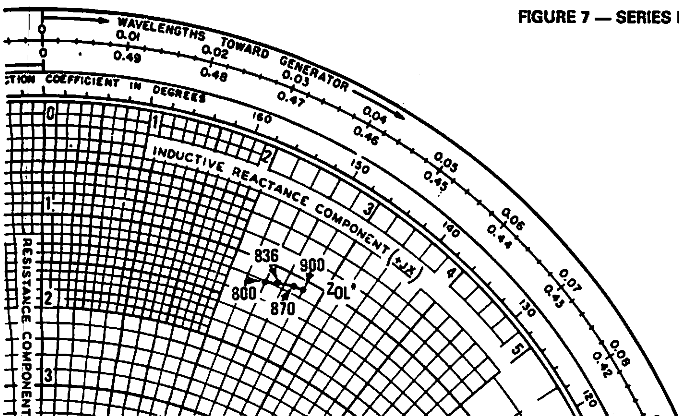


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCES

V_{CC} = 12.5 Vdc, P_{out} = 40 W

f MHz	Z_{OL}* Ohms
800	1.2 + j2.4
836	1.15 + j2.5
870	1.1 + j2.7
900	1.1 + j2.8

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

2

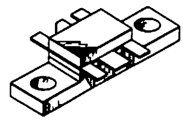
MRF847

The RF Line
NPN Silicon
RF Power Transistor

**45 WATTS, 870 MHz
RF POWER
TRANSISTOR
NPN SILICON**

... designed for 12.5 volt UHF large-signal common-base amplifier applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 45 Watts
  Minimum Gain = 4.5 dB
  Efficiency = 60%
- Series Equivalent Large-Signal Characterization
- Internally Matched Input for Broadband Operation
- Tested for Load Mismatch Stress at all Phase Angles with 10:1 VSWR @ High Line and Rated Drive
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated



CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Base Voltage	V_{CBO}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	12	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	150 0.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.17	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

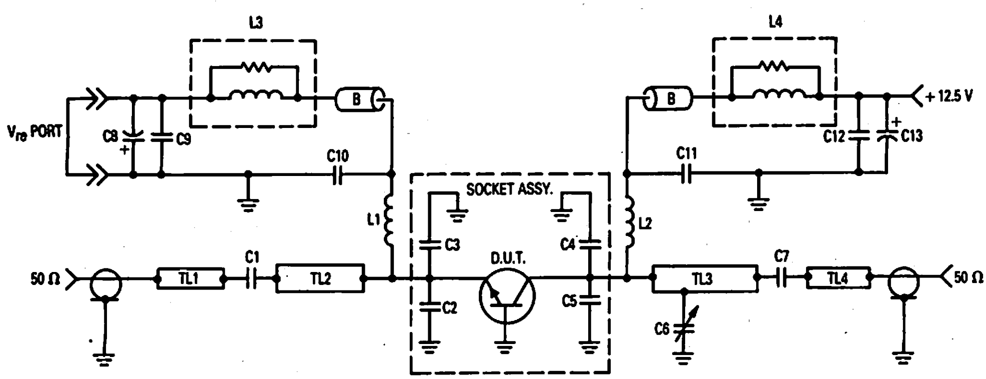
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 Adc, V_{CE} = 5 Vdc)	h_{FE}	40	65	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	75	90	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 45 W, f = 870 MHz)	G_{PB}	4.5	5.5	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 45 W, f = 870 MHz)	η_c	60	68	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 16 W, f = 870 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation In Output Power			



C1 = 51 pF, 100 mil Chip Capacitor
C2 = 12 pF, Mini-Underwood
C3 = 11 pF, Mini-Underwood
C4, C5 = 21 pF, Mini-Underwood
C6 = 0.08–8.0 pF Johansen Gigatrim
C7 = 47 pF, 100 mil Chip Capacitor
C8, C13 = 10 μF, 25 WV Electrolytic Capacitor
C9, C12 = 1000 pF Unelco J101
C10, C11 = 91 pF Mini-Underwood
L1, L2 = 4 Turns #18 Enameled, 200 mil ID
L3, L4 = 12 Turns #22 Enameled, Wound Over 10 Ω Resistor
TL1, TL4 = 50 Ω Microstrip Line
TL2 = Microstrip (Z_o = 38 ohms, λ/4 @ 838 MHz)
TL3 = Microstrip (Z_o = 28 ohms, λ/4 @ 838 MHz)
Board Material = 0.032" Glass-Teflon, 2 oz. cu. clad, ϵ_r = 2.56
B = Ferrite Bead, Ferroxcube 56-590-65-3B

Figure 1. 806–870 MHz Broadband Test Circuit

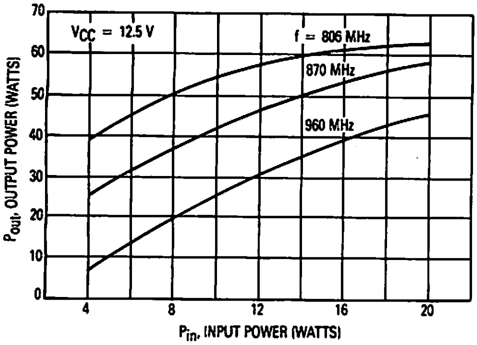


Figure 2. Output Power versus Input Power

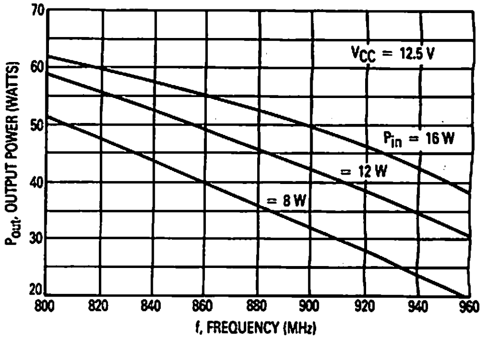


Figure 3. Output Power versus Frequency

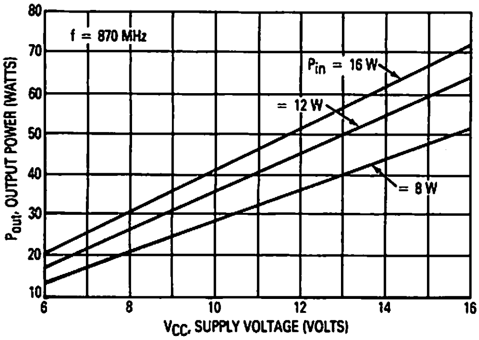


Figure 4. Output Power versus Supply Voltage

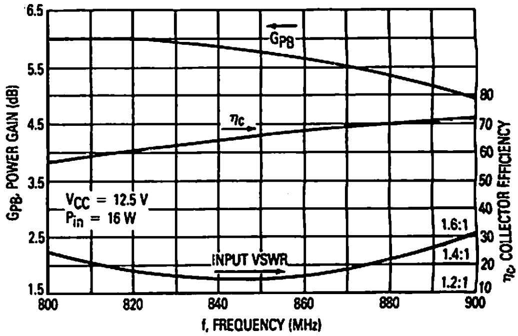
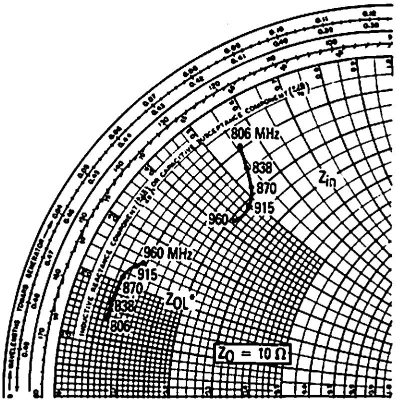


Figure 5. Typical Broadband Circuit Performance



V_{CC} = 12.5 Vdc, P_{in} = 16 W, P_{out} = 45 W

f MHz	Z_{in} (Ohms)		f MHz	Z_{OL}* (Ohms)	
806	0.99	+j5.52	806	0.67	+j1.33
838	1.48	+j5.47	838	0.68	+j1.66
870	1.79	+j5.25	870	0.72	+j2.16
915	2.12	+j4.80	915	0.83	+j2.40
960	2.11	+j4.28	960	0.99	+j2.50

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF873
MRF873S

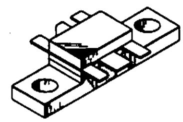
The RF Line

NPN Silicon RF Power Transistors

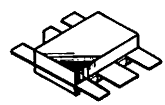
... designed for 12.5 Volt UHF large-signal, **common-emitter** applications in industrial and commercial FM equipment operating in the range of 806–960 MHz.

- Specified 12.5 Volt, 870 MHz Characteristics
  Output Power = 15 Watts
  Minimum Gain = 7 dB
  Efficiency = 60%
- Internally Matched Input for Broadband Operation
- Series Equivalent Large-Signal Characterization
- Capable of withstanding 20:1 VSWR Load Mismatch at Rated Input Power and 15.5 Vdc
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

**15 W 806-960 MHz
RF POWER
TRANSISTORS
COMMON-EMITTER
NPN SILICON**



CASE 319-06, STYLE 2



CASE 319A-02, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16.5	Vdc
Collector-Emitter Voltage	V_{CES}	38	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	2.4	Adc
Operating Junction Temperature	T_J	200	°C
Total Device Dissipation @ T_A = 25°C(1) Derate above 25°C	P_D	44 0.25	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	4	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

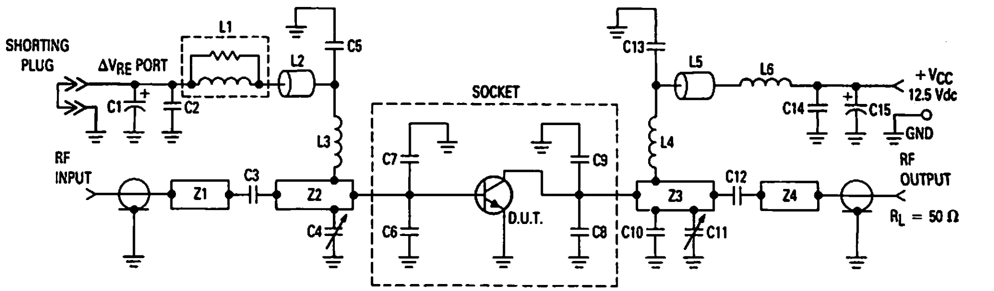
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	16.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	38	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 Adc, V_{CE} = 5 Vdc)	h_{FE}	40	—	200	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	19.5	25	pF

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Broadband) (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 870 MHz)	G_{pe}	7	8	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 870 MHz)	η	60	69	—	%
Load Mismatch Stress (V_{CC} = 15.5 Vdc, f = 870 MHz, P_{in} = 3 W, VSWR = 20:1, all phase angles)	ψ	No degradation in output power			



C1, C15 — 10 µF, 25 V Tantalum
C2, C14 — 1000 pF, 350 V Unelco
C3, C12 — 43 pF, 100 Mil ATC Chip Capacitor
C5, C13 — 91 pF, Mini-Unelco
C4, C11 — 0.8–8 pF Johansen Gigatrim 7290 Variable
C6 — 16 pF Mini-Underwood
C7, C8, C9 — 12 pF Mini-Underwood
C10 — 10 pF Mini-Underwood

NOTE: C11 ~ 0.4" down Z3 from socket edge.

L1 — 13 Turn #20 AWG Around 10 Ω 1/2 W Resistor
L2, L5 — Ferroxcube Bead #56-590-65-3B
L3, L4 — 4 Turns #20 AWG Choke ID 0.2"
L6 — 6 Turns #20 AWG Choke ID 0.2"
Z1, Z4 — 50 Ohm Microstrip
Z2 — 36 Ohm Microstrip λ/4 @ 838 MHz
Z3 — 26 Ohm Microstrip λ/4 @ 838 MHz
Board Material — 0.032" Glass Teflon 2 oz. Copper Clad ϵ_r = 2.55

Figure 1. 806–900 MHz Broadband Test Fixture

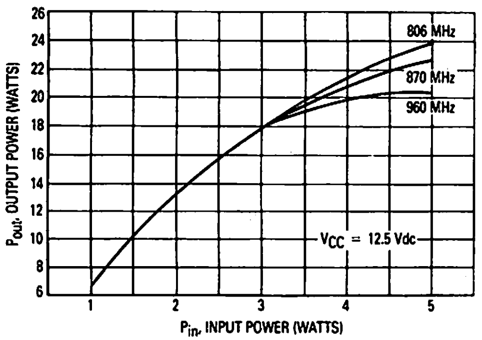


Figure 2. Output Power versus Input Power

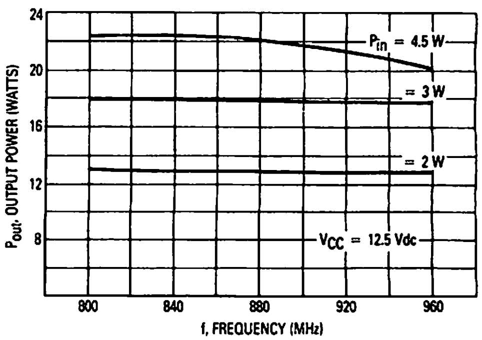


Figure 3. Output Power versus Frequency

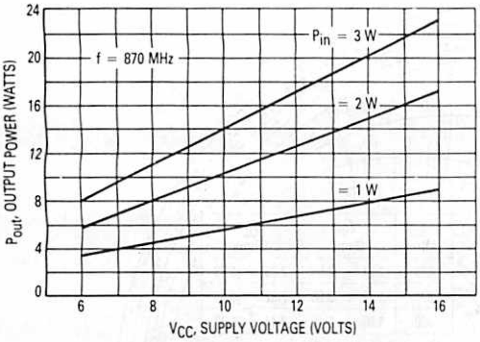


Figure 4. Output Power versus Supply Voltage

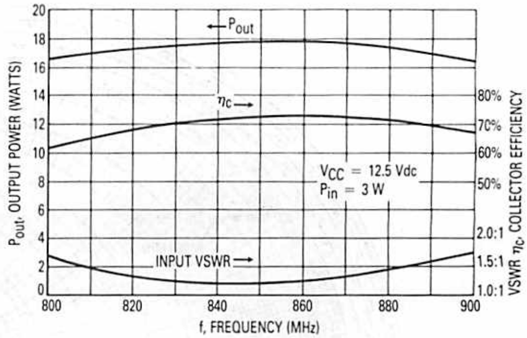


Figure 5. Typical Performance in Broadband Test Fixture

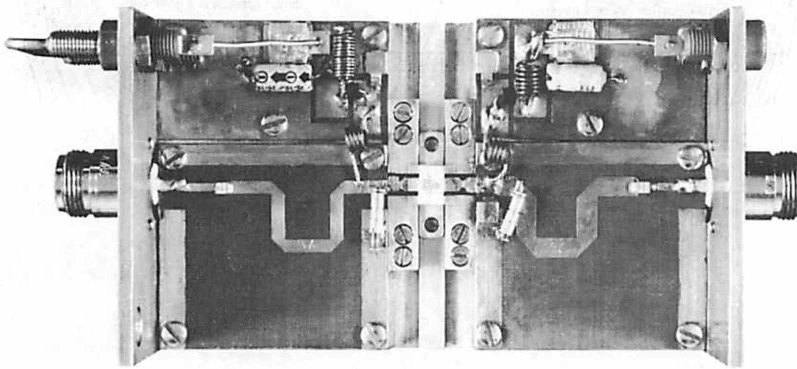


Figure 6. Photo Test Circuit

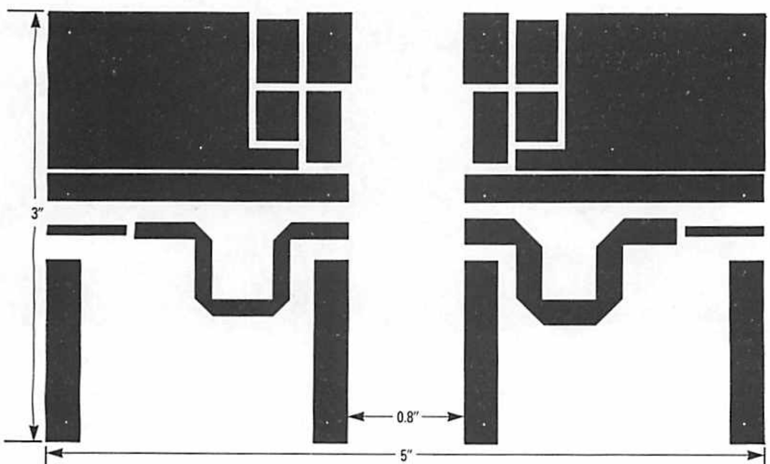
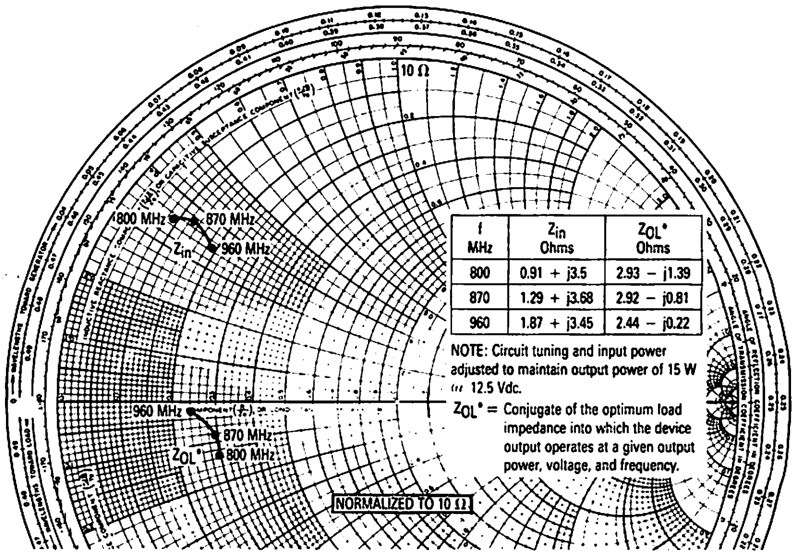


Figure 7. Photomaster

NOTE: The Printed Circuit Board shown is 75% of the original.



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
800	0.91 + j3.5	2.93 − j1.39
870	1.29 + j3.68	2.92 − j0.81
960	1.87 + j3.45	2.44 − j0.22

NOTE: Circuit tuning and input power adjusted to maintain output power of 15 W @ 12.5 Vdc.

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 8. Series Equivalent Input/Output Impedances

MRF890

The RF Line

NPN SILICON RF POWER TRANSISTOR

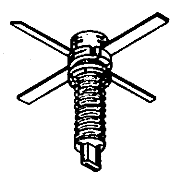
. . . designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 804 - 960 MHz.

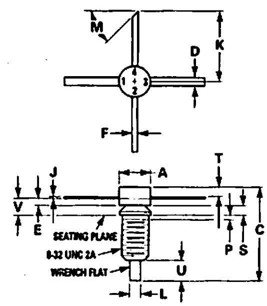
- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 2.0 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

2.0 W 900 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.08	5.59	0.200	0.220
C	13.97	16.26	0.550	0.640
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
L	1.40	1.65	0.055	0.065
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	1.40	1.65	0.055	0.065
T	1.40	1.78	0.055	0.070
U	2.79	3.81	0.110	0.150
V	2.41	2.92	0.095	0.115

CASE 305-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

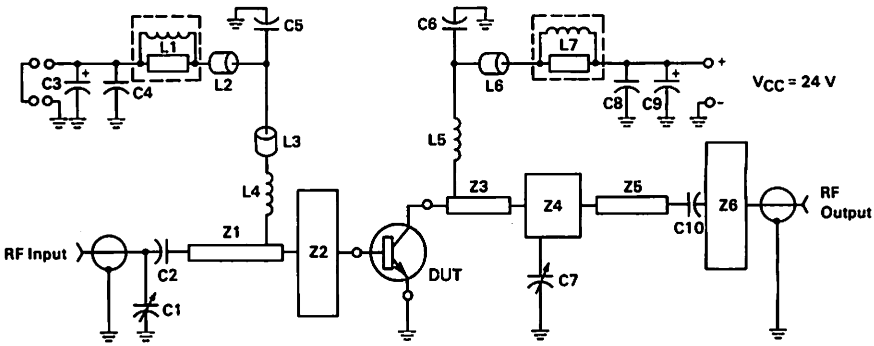
2

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	—	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{out} = 2.0 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PE}	9.0	10.5	—	dB
Collector Efficiency (P_{out} = 2.0 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	55	60	—	%

FIGURE 1 — 850 - 900 MHz TEST CIRCUIT



C1, C7 — Johanson 0.5 - 4.0 pF Giga-Trim
C2, C5, C6 — 91 pF Mini Underwood Mica
C3, C9 — 1.0 μF Electrolytic
C4, C8 — 250 pF Unelco
C10 — 39 pF Mini Underwood
L1, L7 — 10 Turns Around 10 Ω 1/2 W Resistor
L2, L3, L6 — Ferrite Bead
L4, L5 — 4 Turns 26 AWG 0.1" ID
Z1, Z2, Z3, Z4, Z5, Z6 — Distributed Microstrip Elements (see photomask)
Board Material — Glass Teflon ϵ_r = 2.55 t = 0.031"

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

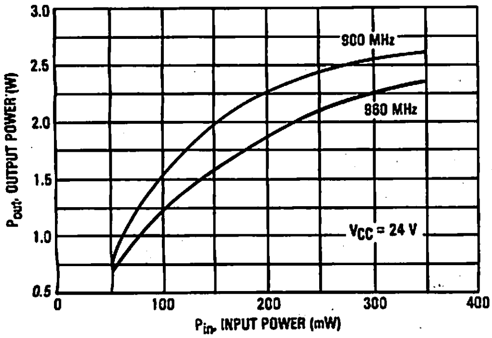


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

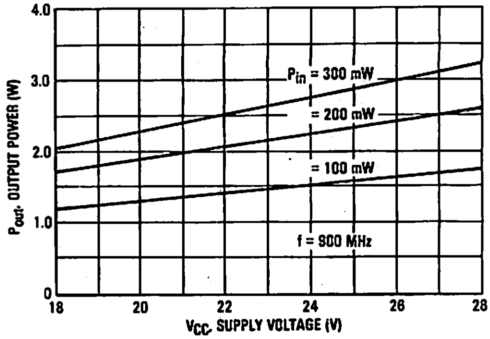


FIGURE 4 — OUTPUT POWER versus FREQUENCY

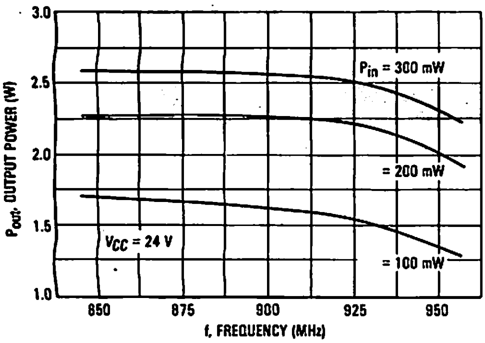


FIGURE 5 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT

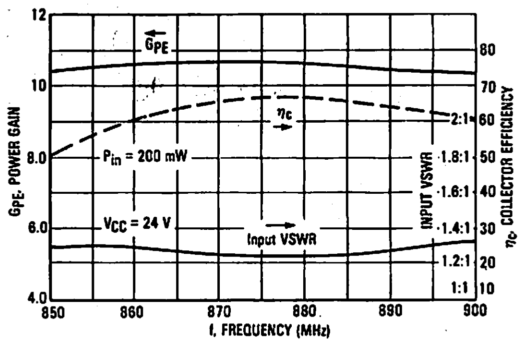
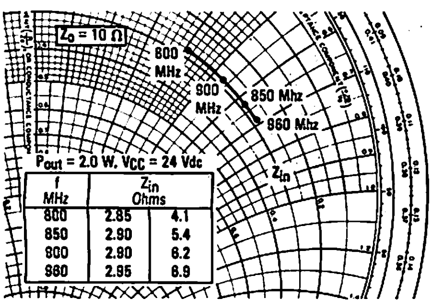


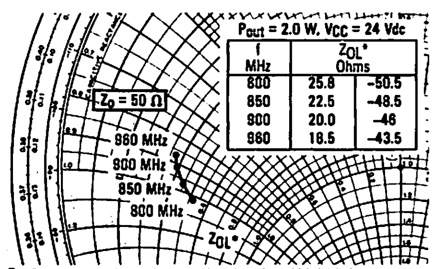
FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE



P_{out} = 2.0 W, V_{CC} = 24 Vdc

f MHz	Z_{in} Ohms	
800	2.85	4.1
850	2.90	5.4
900	2.90	6.2
960	2.95	6.9

FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE

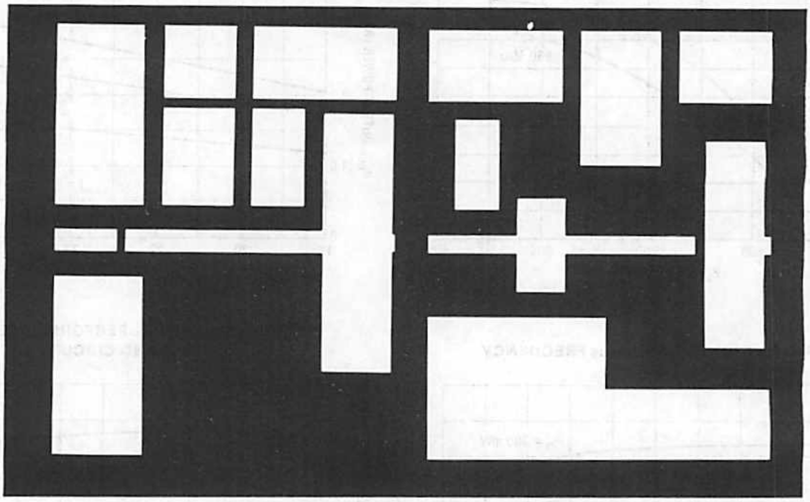


P_{out} = 2.0 W, V_{CC} = 24 Vdc

f MHz	Z_{OL}* Ohms	
800	25.8	−50.5
850	22.5	−48.5
900	20.0	−46
960	18.5	−43.5

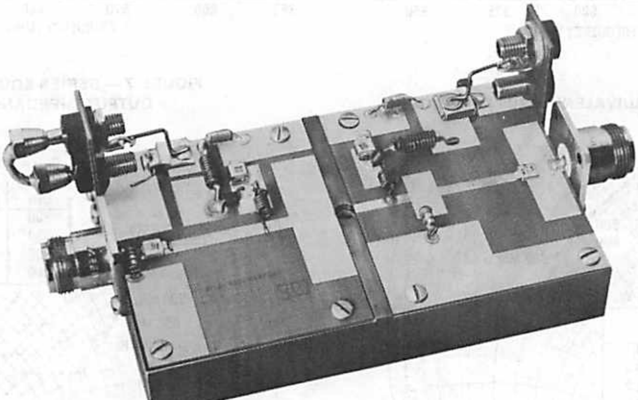
Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 8 — PHOTOMASTER FOR TEST FIXTURE



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — 850-900 MHz TEST CIRCUIT



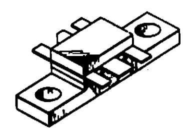
MRF891

The RF Line

5.0 W 900 MHz

RF POWER TRANSISTOR

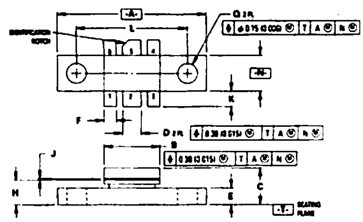
NPN SILICON



NPN SILICON RF POWER TRANSISTOR

. . . designed for 24 volt UHF large-signal, common-emitter amplifier applications in industrial and commercial FM equipment operating in the range of 800–960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 5.0 Watts
  Minimum Gain = 9.0 dB
  Efficiency = 50%
- Series Equivalent Large-Signal Characterization
- Capable of withstanding 20:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated



STYLE 2:
PIN 1. EMITTER (COMMON)
2. BASE (INPUT)
3. EMITTER (COMMON)
4. EMITTER (COMMON)
5. COLLECTOR (OUTPUT)
6. EMITTER (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Emitter Voltage	V_{CES}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	0.6	Adc
Total Device Dissipation @ T_A = 50°C Derate above 50°C (1)	P_D	18 0.143	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7.0	°C/W

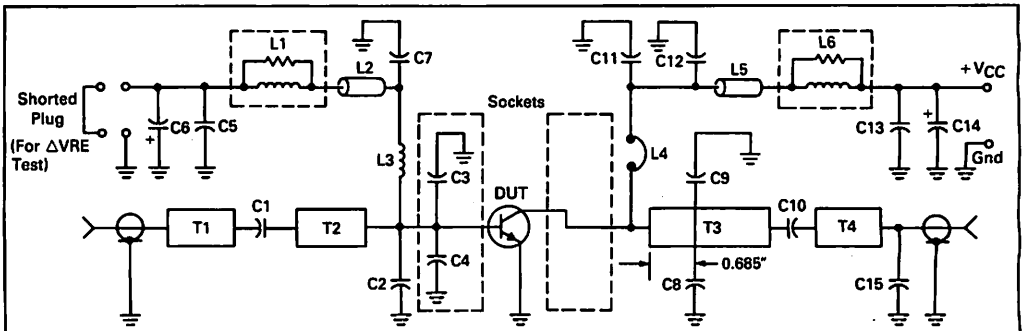
(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	6.5	8.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (Broadband) (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 900 MHz)	G_{pe}	9.0	10	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 5.0 W, f = 900 MHz)	η	50	57	—	%
Load Mismatch Stress (V_{CC} = 24 Vdc, P_{in} = 0.63 W, f = 900 MHz, VSWR = 20:1, all phase angles)	ψ	No degradation in output power			

FIGURE 1 — BROADBAND TEST FIXTURE



C1	— 39 pF, 100 Mil Chip Capacitor	L1, L6	— 10 Turns #20 AWG Around 10 Ohm 1/2 Watt Resistor
C10	— 47 pF, 100 Mil Chip Capacitor	L3	— 4 Turns #16 AWG Choke
C6, C14	— 10 μF, 25 V Tantalum	L2, L5	— Ferrite Bead
C5, C13	— 1000 pF, 350 V Unelco	L4	— 0.5", #18 AWG Wire
C7, C11, C12	— 91 pF, Mini-Unelco	T1, T4	— 50 Ohm Microstrip Line
C3, C4	— 12 pF, Mini-Unelco	T2	— W = 165 Mils, ℓ = 1946 Mils
C2, C8, C15	— 0.8–8.0 pF Johansen Gigatrim	T3	— W = 166 Mils, ℓ = 1563 Mils
C9	— 5.0 pF, Mini-Unelco	PC Board	— 0.031" Glass Teflon (ϵ_r = 2.56)

FIGURE 2 — OUTPUT POWER versus INPUT POWER

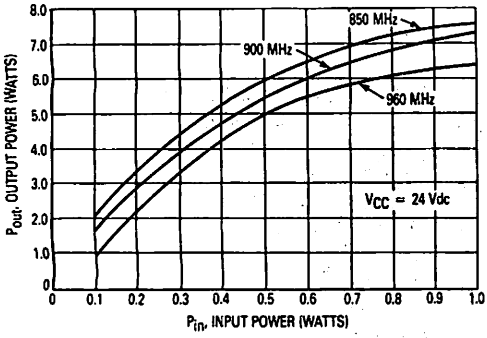


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

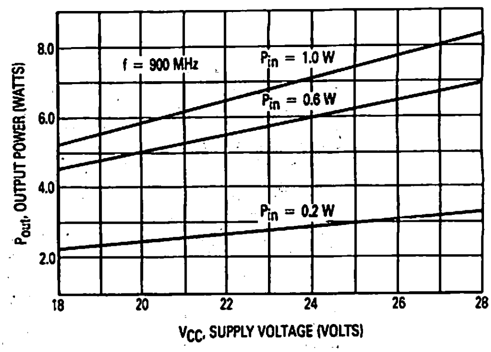


FIGURE 4 — OUTPUT POWER versus FREQUENCY

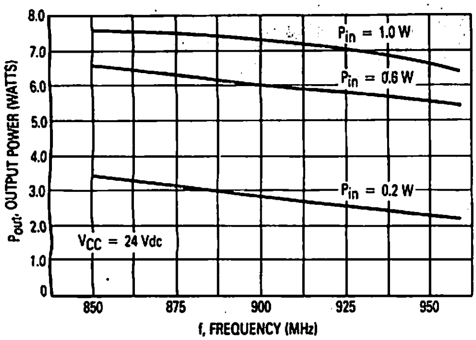


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE

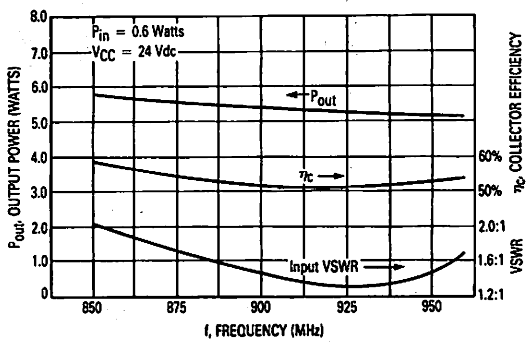


FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE

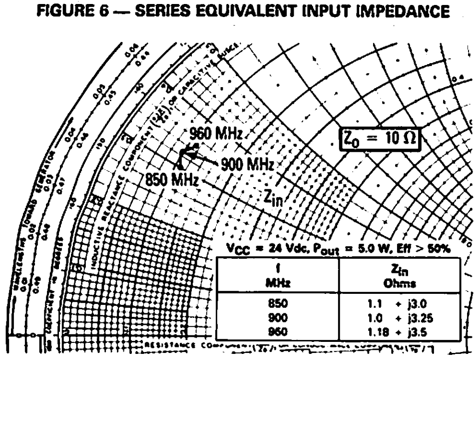


FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE

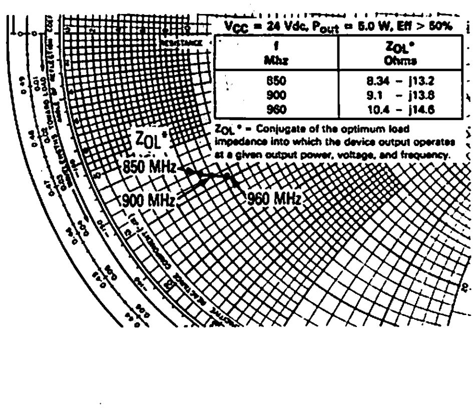


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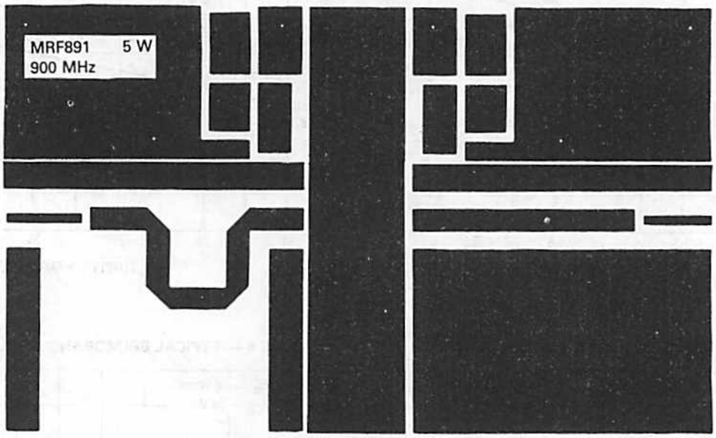
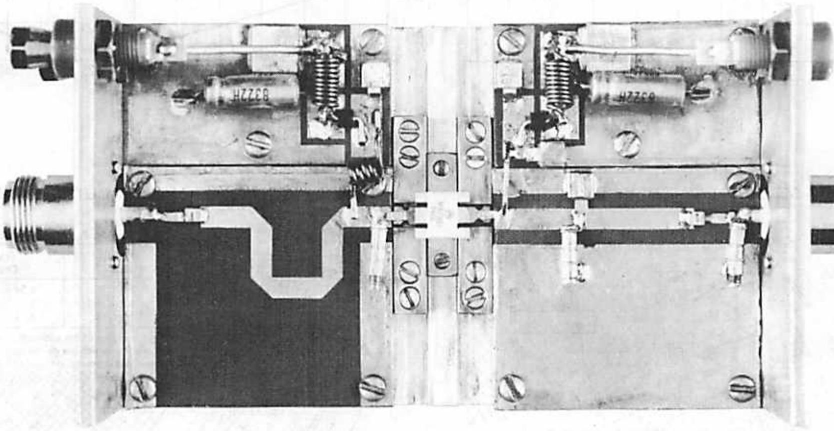
FIGURE 8 — PHOTOMASTER FOR TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

FIGURE 9 — BROADBAND TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF892

2

The RF Line

14 W 900 MHz

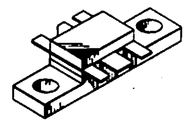
RF POWER TRANSISTOR

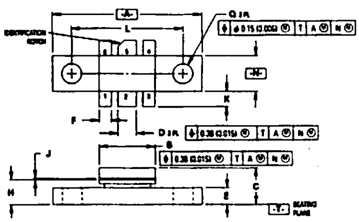
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804 – 960 MHz.

- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 14 Watts
  Minimum Gain = 8.5 dB
  Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated





STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319-06

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50.0 V	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	50 0.29	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

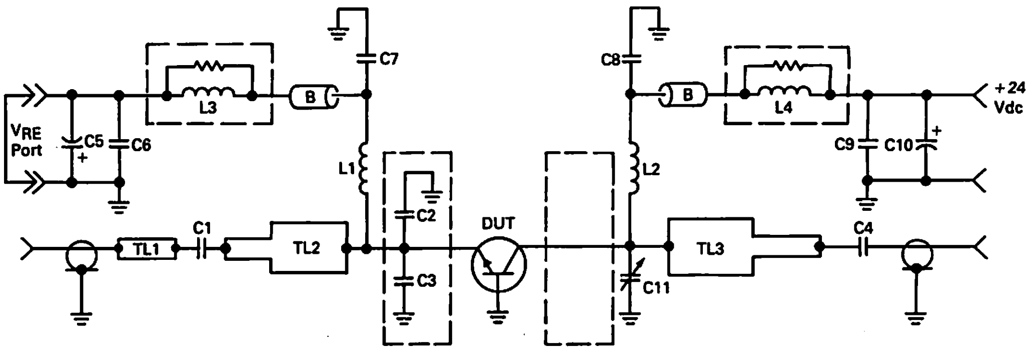
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	3.5	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12.5	—	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain (P_{out} = 14 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PE}	8.5	9.5	—	dB
Collector Efficiency (P_{out} = 14 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	55	60	—	%

FIGURE 1 — 850–900 MHz BROADBAND CIRCUIT SCHEMATIC



C1 — 51 pF, 100 Mil Chip Capacitor
C2, C3 — 13 pF Mini-Unelco
C4 — 43 pF, 100 Mil Chip Capacitor
C5, C10 — 10 μF, 35 WV
C6, C9 — 500 pF Unelco J101
C7, C8 — 91 pF Mini-Unelco
C11 — 0.8–8.0 pF Johanson Gigatrim
L1, L2 — 4 Turns #18 Enameled, 5/32" ID
L3, L4 — 14 Turns #22 Enameled Over 10 Ω Carbon Resistor

B — Ferrite Bead, Ferroxcube 56-590-65-3B
TL1 — Micro Strip, 50 Ω
TL2 — Micro Strip, Z_o = 26 Ω, λ/4 @ 875 MHz
TL3 — Micro Strip, Z_o = 14 Ω, λ/4 @ 875 MHz
Board — 0.032" Glass Teflon
2 oz. Cu CLAD, ϵ_r = 2.55

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

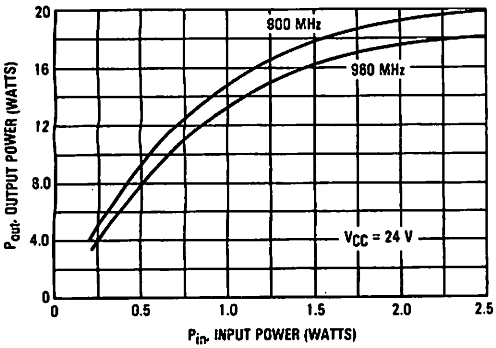


FIGURE 3 — OUTPUT POWER versus SUPPLY VOLTAGE

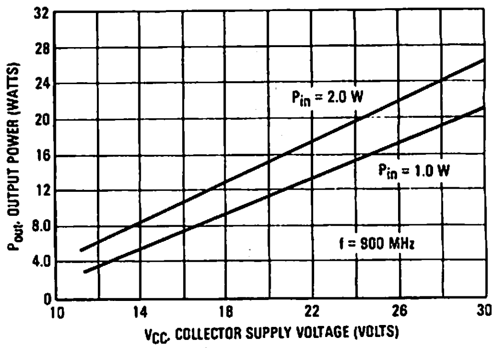


FIGURE 4 — OUTPUT POWER versus FREQUENCY

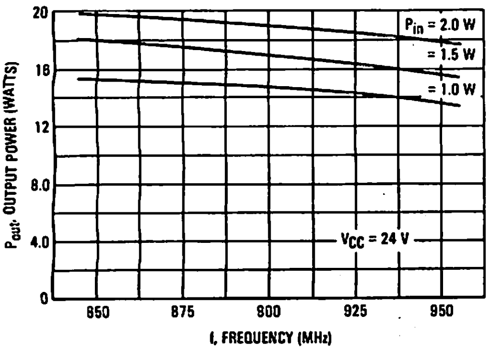
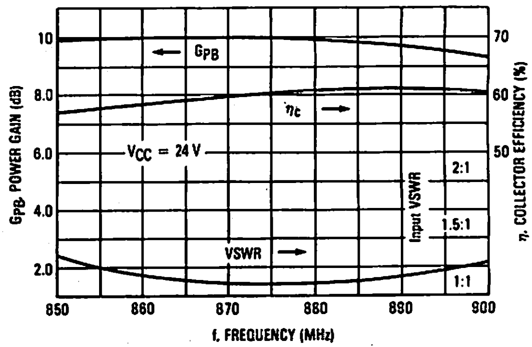
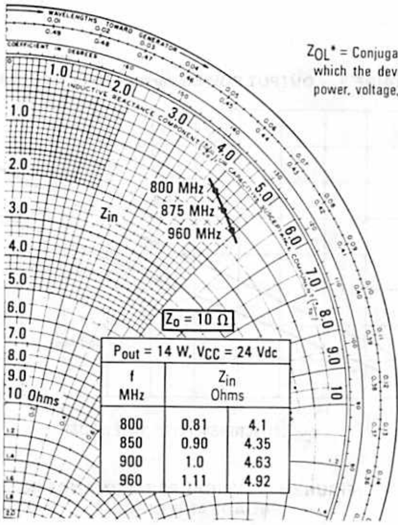


FIGURE 5 — TYPICAL PERFORMANCE IN BROADBAND CIRCUIT



2

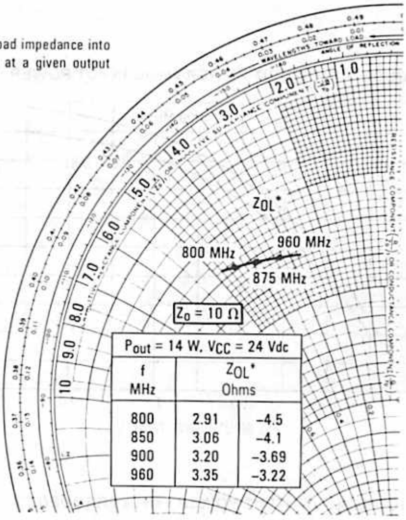
FIGURE 6 — SERIES EQUIVALENT INPUT IMPEDANCE



P_{out} = 14 W, V_{CC} = 24 Vdc		
f MHz	Z_{in} Ohms	
800	0.81	4.1
850	0.90	4.35
900	1.0	4.63
960	1.11	4.92

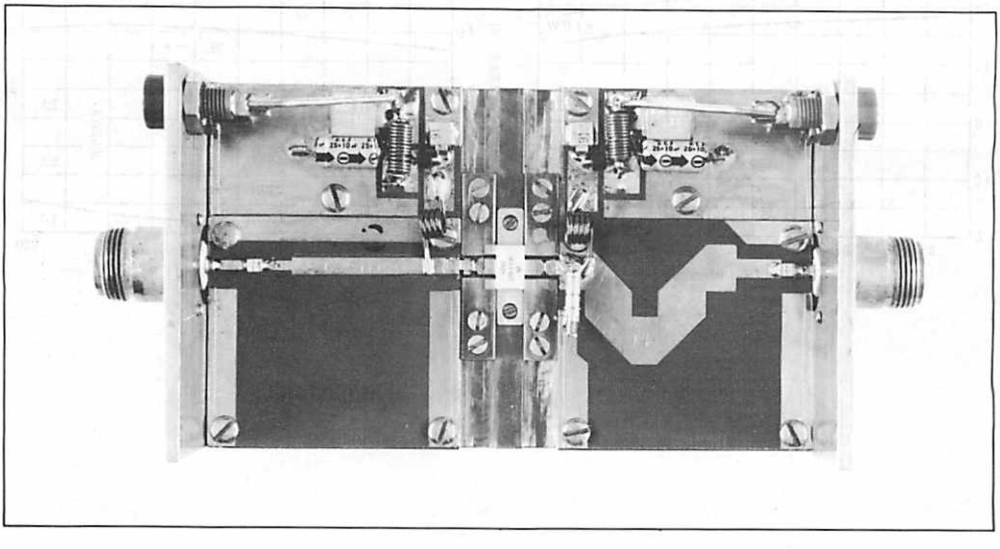
Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — SERIES EQUIVALENT OUTPUT IMPEDANCE



P_{out} = 14 W, V_{CC} = 24 Vdc		
f MHz	Z_{OL}^* Ohms	
800	2.91	−4.5
850	3.06	−4.1
900	3.20	−3.69
960	3.35	−3.22

FIGURE 8 — 850-900 MHz TEST CIRCUIT



MRF894

2

The RF Line

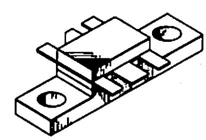
30 W 900 MHz

RF POWER TRANSISTOR

NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 24 volt UHF large-signal, common-base amplifier applications in industrial and commercial FM equipment operating in the range of 804 – 960 MHz.



- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 30 Watts
  Minimum Gain = 7.0 dB
  Efficiency = 55%
- Series Equivalent Large-Signal Characterization
- Capable of 30:1 VSWR Load Mismatch at Rated Output Power and Supply Voltage
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- *Silicon Nitride Passivated*

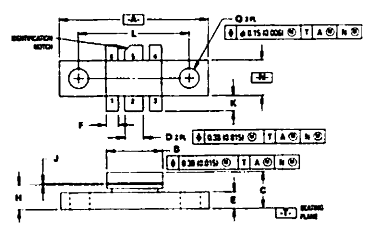
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Continuous	I_C	7.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate Above 25°C	P_D	115 0.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	1.5	°C/W

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.



STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

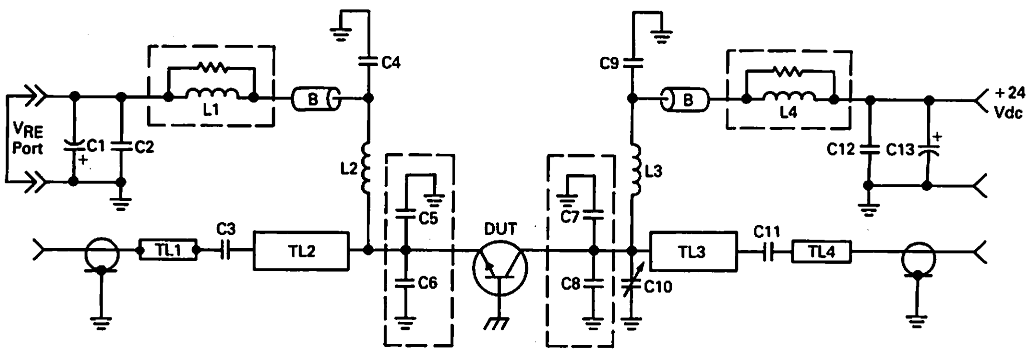
CASE 319-06

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 2.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	45	—	pF
FUNCTIONAL TEST					
Common-Base Amplifier Power Gain (P_{out} = 30 W, V_{CC} = 24 Vdc, f = 900 MHz)	G_{PB}	7.0	8.5	—	dB
Collector Efficiency (P_{out} = 30 W, V_{CC} = 24 Vdc, f = 900 MHz)	η	55	60	—	%

FIGURE 1 — 850–900 MHz BROADBAND CIRCUIT SCHEMATIC



C1, C13 — 5 μF, 50 Vdc
C2, C12 — 1000 pF Unelco
C3, C11 — 47 pF, 100 Mil Chip Capacitor
C4, C9 — 91 pF, Mini-Underwood
C5, C6 — 12 pF, Mini-Underwood
C7 — 18 pF, Mini-Underwood
C8 — 24 pF, Mini-Underwood
C10 — 0.8–8.0 pF Johanson Gigatrim

L1, L4 — 11 Turns #20 Enameled Over 10 Ω Carbon Resistor
L2, L3 — 4 Turns #20 Enameled, .15″ ID
B — Ferrite Bead, Ferroxcube 56-590-65-3B
TL1, TL4 — Micro Strip Line, 50 Ω
TL2 — Micro Strip, Z_o = 30 Ω, λ/4 @ 875 MHz
TL3 — Micro Strip, Z_o = 22 Ω, λ/4 @ 875 MHz
Board — 0.032″ Glass Teflon
2 oz. Cu CLAD, ϵ_r = 2.55

TYPICAL CHARACTERISTICS

FIGURE 2 — OUTPUT POWER versus INPUT POWER

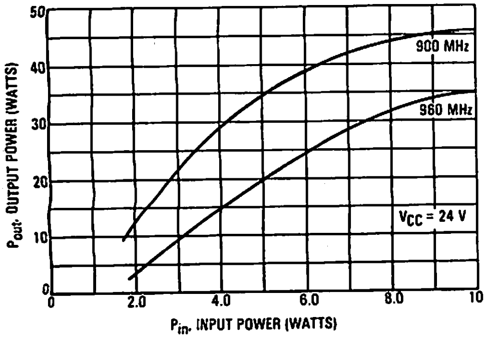


FIGURE 3 — OUTPUT POWER versus FREQUENCY

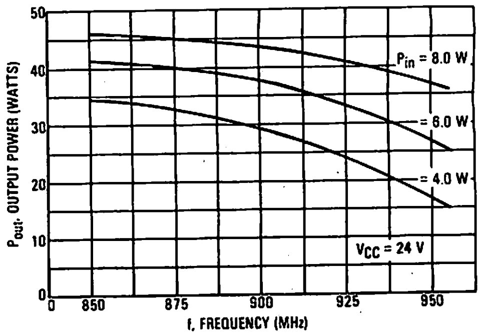


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

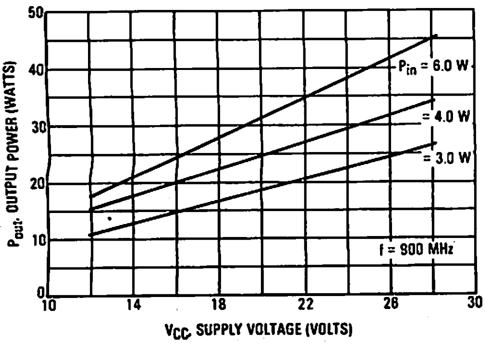
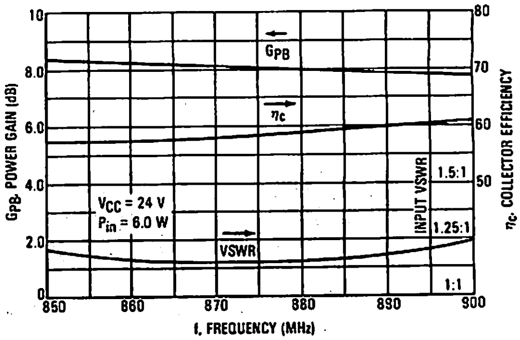
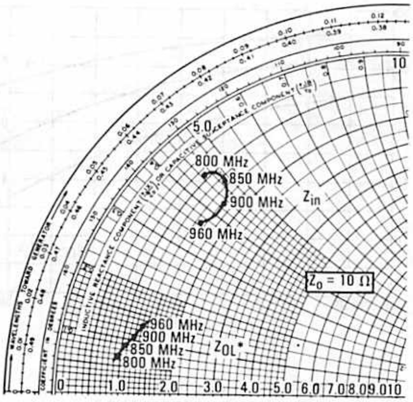


FIGURE 5 — TYPICAL BROADBAND CIRCUIT PERFORMANCE



2

FIGURE 6 — SERIES EQUIVALENT IMPEDANCE

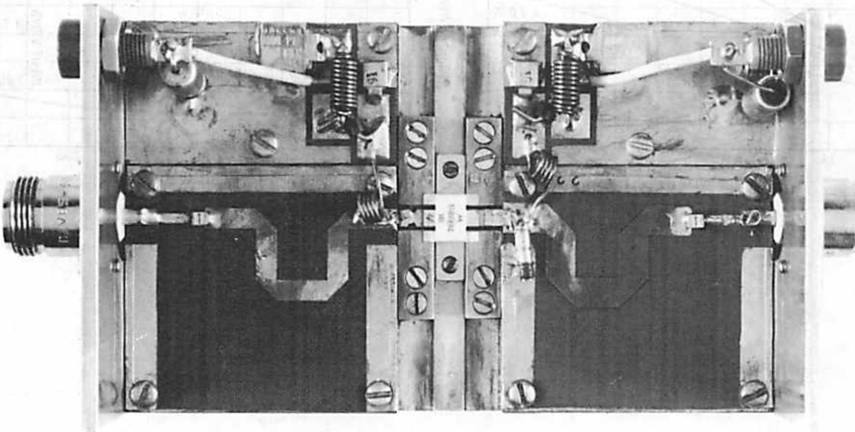


V_{CC} = 24 Vdc, P_{out} = 30 W

f Frequency MHz	Z_{in} Ohms	Z_{OL}^* Ohms
800	0.9 + j4.5	1.0 + j0.7
850	1.3 + j4.7	1.1 + j0.9
900	1.6 + j4.4	1.2 + j1.1
960	1.5 + j3.7	1.2 + j1.3

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 850-900 MHz BROADBAND CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

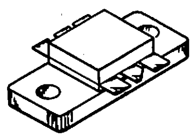
MRF898

The RF Line
NPN Silicon RF Power Transistor

... designed for 24 Volt UHF large-signal, common base amplifier applications in industrial and commercial FM equipment operating in the range 850–960 MHz.

- Motorola Advanced Amplifier Concept Package
- Specified 24 Volt, 900 MHz Characteristics
  Output Power = 60 Watts
  Minimum Gain = 7 dB
  Efficiency = 60%
- Double Input/Output Matched for Wideband Performance and Simplified External Matching
- Series Equivalent Large-Signal Characterization
- *Gold Metallized*, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Silicon Nitride Passivated

60 WATTS, 850–960 MHz
RF POWER TRANSISTOR
NPN SILICON



CASE 333A-02, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	10	mAdc

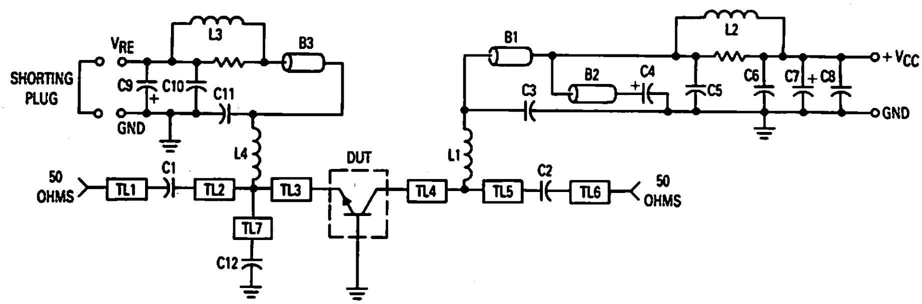
(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 2 Adc, V_{CE} = 5 Vdc)	h_{FE}	20	50	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance* (V_{CB} = 24 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	60	—	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 24 Vdc, P_{out} = 60 W, f = 900 MHz)	G_{pb}	7	7.9	—	dB
Collector Efficiency (V_{CC} = 24 Vdc, P_{out} = 60 W, f = 900 MHz)	η	60	65	—	%
Output Mismatch Stress V_{CC} = 24 V, P_{out} = 60 Watt, f = 900 MHz, VSWR = 5:1 (all phase angles)	ψ	No Degradation in Output Power			

*Value of "C_{ob}" is that of die only. It is not measurable in MRF898 because of internal matching network.



B1, B2, B3 — Bead, Ferroxcube 56-390-65/3B
C1, C2, C12 — 39 pF, 100 Mil Chip Capacitor
C3, C11 — 91 pF, Mini Underwood or Equivalent
C4, C7, C9 — 10 μF, 35 V Electrolytic
C5 — 4000 pF, 1 kV Ceramic
C6, C10 — 1000 pF, 350 V Unelco or Equivalent
C8 — 47 pF, 100 Mil Chip Capacitor
L1, L4 — 4 Turns #18 AWG Choke
L2 — 11 Turns #20 AWG Choke on 10 Ohm, 1 Watt Resistor
L3 — 3 Turns #18 AWG Choke on 10 Ohm, 1 Watt Resistor

Board — 3M Epsilam-10, 50 Mil
TL1, TL6 — 50 Ohm Microstrip
TL2 — 400 x 950 Mils
TL3, TL4 — 140 x 200 Mils
TL5 — 320 x 690 Mils
TL7 — 260 x 230 Mils
Bias Boards — 1/32" G10 or Equivalent

Figure 1. 850–960 MHz Broadband Test Circuit

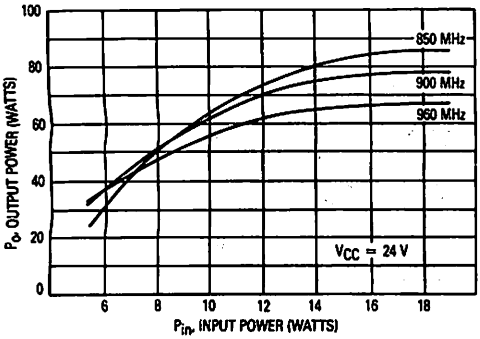


Figure 2. Output Power versus Input Power

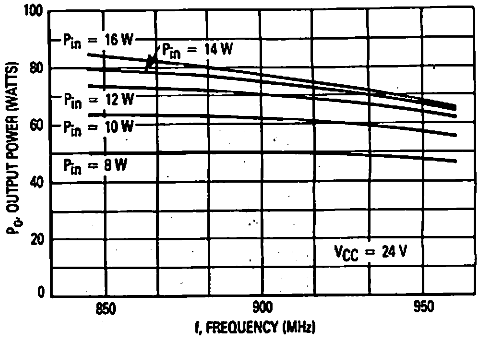


Figure 3. Output Power versus Frequency

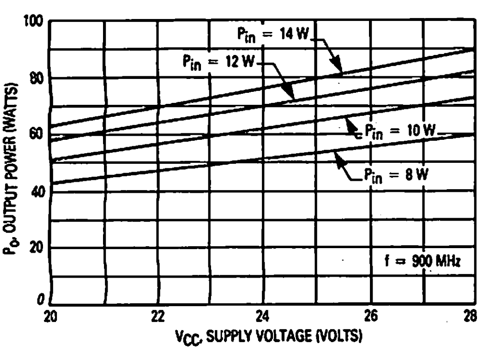


Figure 4. Output Power versus Supply Voltage

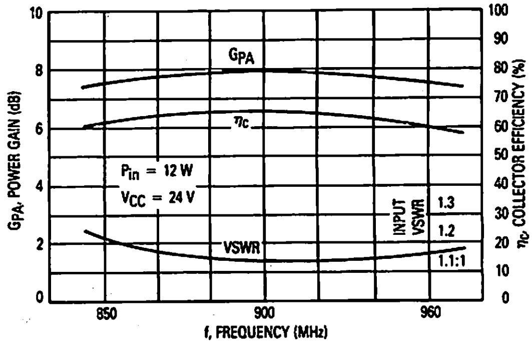
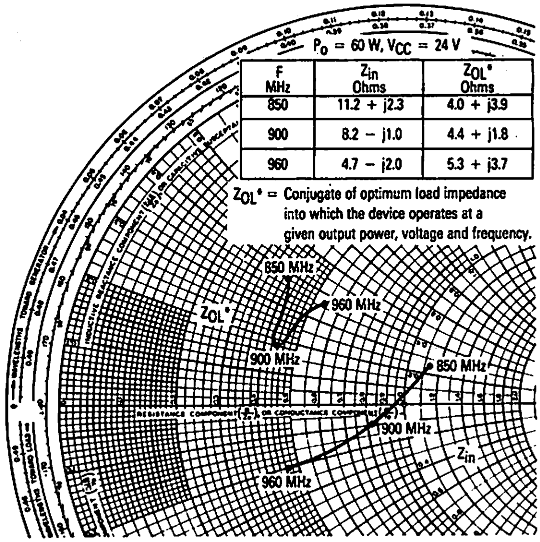


Figure 5. Typical Broadband Circuit Performance

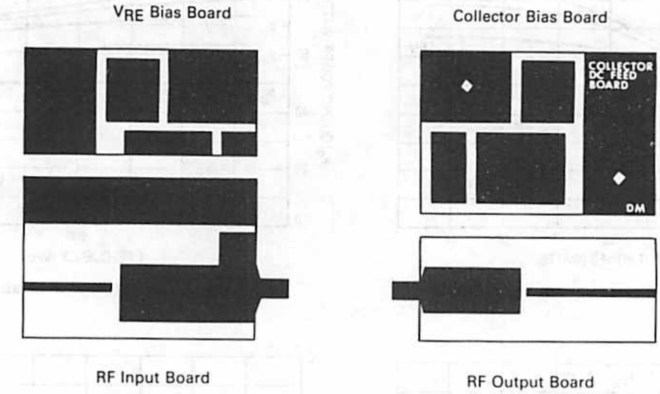


F MHz	Z_{in} Ohms	Z_{OL}* Ohms
850	11.2 + j2.3	4.0 + j3.9
900	8.2 − j1.0	4.4 + j1.8
960	4.7 − j2.0	5.3 + j3.7

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 6. Input/Output Impedance versus Frequency

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 7. Photomaster

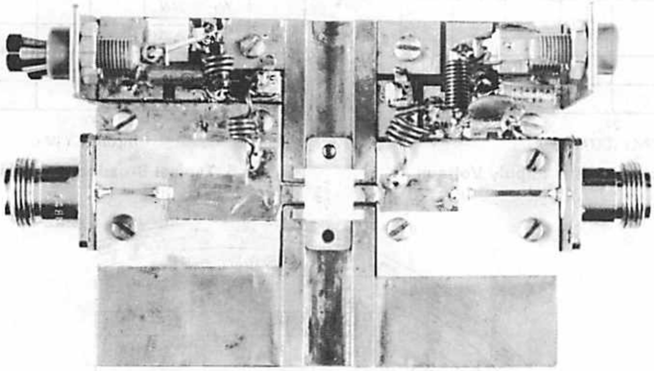


Figure 8. 850–960 Broadband Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

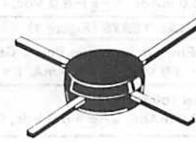
MRF901

The RF Line

2.5 dB @ 1.0 GHz

HIGH FREQUENCY TRANSISTOR

NPN SILICON



NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed primarily for use in high-gain, low-noise small-signal amplifiers. Also usable in applications requiring fast switching times.

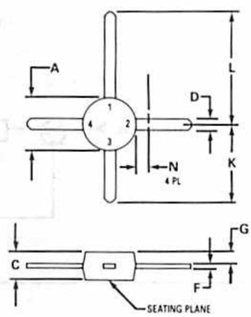
- High Current-Gain-Bandwidth Product — f_T = 4.5 GHz (Typ) @ I_C = 15 mAdc
- Low Noise Figure @ f = 1.0 GHz — NF = 2.0 dB (Typ) and 2.5 dB (Max)
- High Power Gain — G_{pe} = 10 dB (Min) @ f = 1.0 GHz
- Third Order Intercept = +23 dBm (Typ)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Continuous	I_C	30	mA
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.375 3.3	Watt mW/°C
Storage Temperature Range	T_{stg}	150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	300	°C/W



STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	80	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain-Bandwith Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	–	4.5	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.4	1.0	pF
Noise Figure (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	NF	–	2.0	2.5	dB
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 6.0 Vdc, I_C = 5.0 mA, f = 1.0 GHz)	G_{pe}	10	12	–	dB
Third Order Intercept (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 0.9 GHz)	–	–	+23	–	dBm

FIGURE 1 – 1.0 GHz TEST CIRCUIT SCHEMATIC

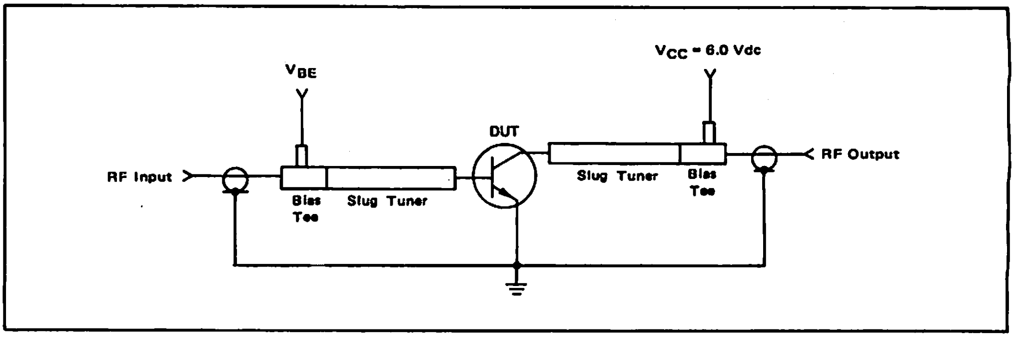


FIGURE 2 — MAXIMUM UNILATERAL GAIN versus FREQUENCY

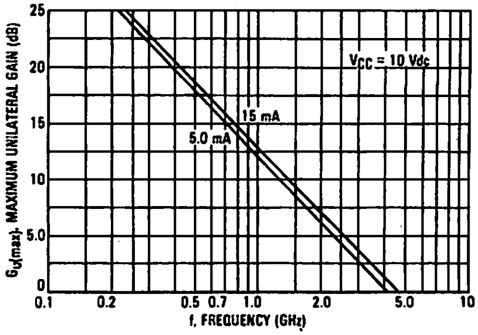


FIGURE 3 — CURRENT GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT

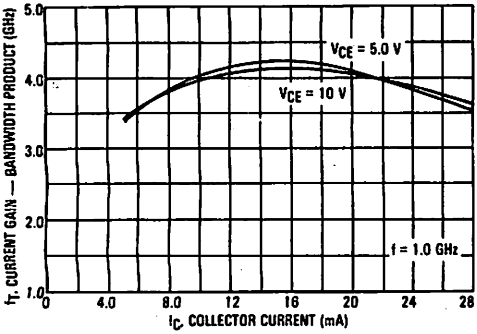


FIGURE 4 — NOISE FIGURE versus FREQUENCY

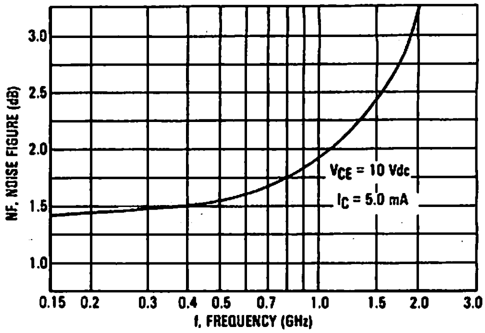


FIGURE 5 — NOISE FIGURE versus COLLECTOR CURRENT

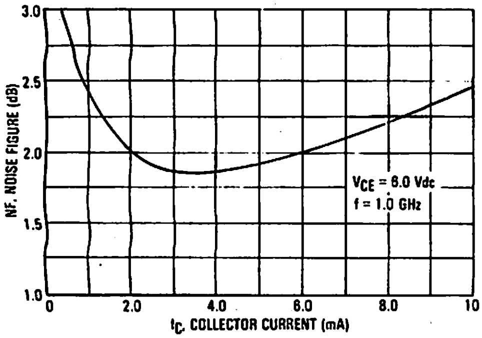


FIGURE 6 — MAXIMUM UNILATERAL GAIN versus COLLECTOR CURRENT

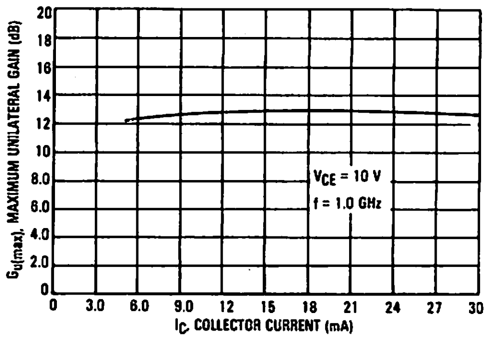


FIGURE 7 — $|S_{21}|^2$ versus FREQUENCY

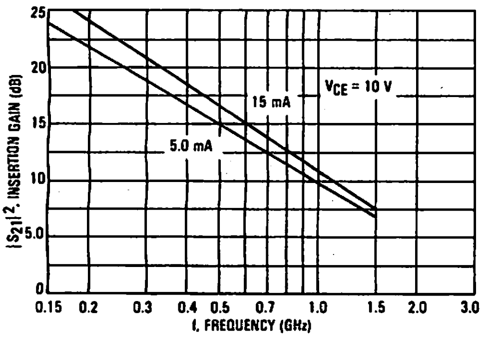
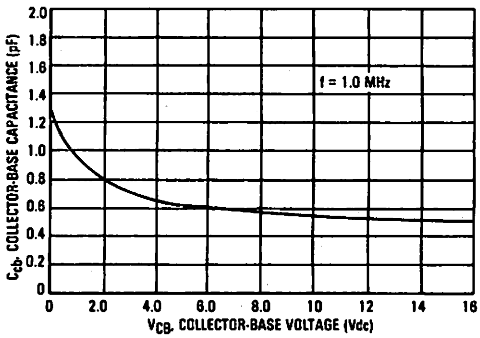


FIGURE 8 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE



2

TABLE I

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} $\angle\phi$	S_{21} $\|S_{21}\|$	S_{21} $\angle\phi$	S_{12} $\|S_{12}\|$	S_{12} $\angle\phi$	S_{22} $\|S_{22}\|$	S_{22} $\angle\phi$
5.0	5.0	100	0.71	-38	11.30	153	0.03	68	0.92	-17
		200	0.62	-75	9.48	133	0.05	55	0.76	-29
		500	0.54	-141	5.40	100	0.07	43	0.48	-44
		1000	0.53	178	2.93	76	0.09	48	0.40	-56
		2000	0.59	130	1.51	48	0.16	62	0.35	-85
	10	100	0.57	-58	16.95	145	0.03	63	0.85	-23
		200	0.51	-103	12.61	123	0.04	53	0.64	-35
		500	0.52	-161	6.24	93	0.06	50	0.38	-45
		1000	0.52	166	3.24	73	0.09	61	0.33	-54
		2000	0.59	125	1.66	47	0.17	67	0.29	-84
	15	100	0.48	-75	20.08	139	0.02	61	0.80	-27
		200	0.47	-121	13.89	117	0.04	53	0.57	-38
		500	0.53	-170	6.44	91	0.05	56	0.34	-44
		1000	0.53	162	3.33	72	0.09	66	0.31	-52
		2000	0.60	123	1.70	46	0.18	68	0.28	-82
	20	100	0.44	-88	21.62	136	0.02	60	0.76	-28
		200	0.47	-132	14.33	114	0.03	54	0.53	-38
		500	0.53	-175	6.45	89	0.05	60	0.32	-41
		1000	0.53	159	3.31	70	0.09	68	0.31	-50
		2000	0.61	122	1.69	45	0.18	70	0.28	-80
	30	100	0.43	-112	21.45	130	0.02	58	0.72	-28
		200	0.50	-148	13.38	109	0.03	57	0.51	-33
		500	0.57	178	5.82	86	0.05	65	0.35	-34
		1000	0.57	156	2.99	68	0.08	73	0.35	-46
		2000	0.65	121	1.50	42	0.18	74	0.33	-78

TABLE II

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} $\|S_{11}\|$	S_{11} $\angle\phi$	S_{21} $\|S_{21}\|$	S_{21} $\angle\phi$	S_{12} $\|S_{12}\|$	S_{12} $\angle\phi$	S_{22} $\|S_{22}\|$	S_{22} $\angle\phi$
10	5.0	100	0.73	-35	11.32	154	0.03	69	0.93	-14
		200	0.63	-69	9.69	135	0.05	57	0.79	-25
		500	0.53	-135	5.65	101	0.07	43	0.54	-38
		1000	0.51	-177	3.11	77	0.08	50	0.47	-48
		2000	0.57	132	1.58	48	0.14	66	0.41	-75
	10	100	0.59	-52	17.06	147	0.02	64	0.87	-19
		200	0.52	-95	13.06	125	0.04	54	0.69	-30
		500	0.49	-156	6.58	95	0.05	51	0.45	-37
		1000	0.50	170	3.44	74	0.08	62	0.41	-45
		2000	0.57	126	1.75	47	0.16	70	0.36	-72
	15	100	0.51	-66	20.36	141	0.02	63	0.83	-22
		200	0.47	-112	14.48	119	0.03	54	0.63	-31
		500	0.50	-166	6.81	92	0.05	57	0.41	-35
		1000	0.50	164	3.54	72	0.08	67	0.39	-43
		2000	0.58	124	1.78	46	0.16	72	0.35	-70
	20	100	0.47	-78	22.08	138	0.02	61	0.80	-23
		200	0.46	-123	15.07	116	0.03	55	0.60	-30
		500	0.50	-171	6.84	90	0.05	60	0.40	-32
		1000	0.51	162	3.51	71	0.08	69	0.39	-41
		2000	0.59	123	1.77	45	0.17	73	0.35	-68
	30	100	0.44	-98	22.70	133	0.02	59	0.76	-23
		200	0.47	-139	14.47	111	0.03	55	0.57	-27
		500	0.53	-177	6.33	87	0.04	65	0.43	-28
		1000	0.54	158	3.26	69	0.07	74	0.43	-39
		2000	0.62	122	1.61	42	0.16	77	0.39	-68

FIGURE 9 — INPUT AND OUTPUT REFLECTION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 15 mA)

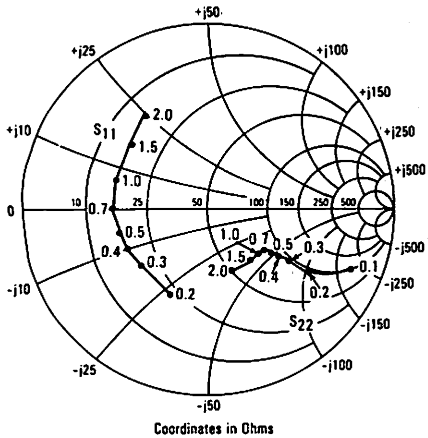


FIGURE 10 — FORWARD/REVERSE TRANSMISSION COEFFICIENTS versus FREQUENCY (V_{CE} = 10 V, I_C = 15 mA)

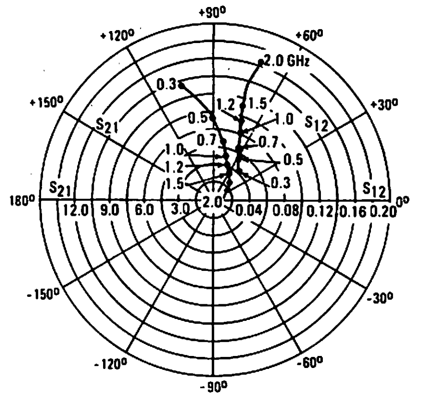


FIGURE 11 — SOURCE IMPEDANCE (Γms) FOR OPTIMUM NOISE FIGURE versus FREQUENCY (V_{CE} = 10 Vdc, I_C = 5.0 mA)

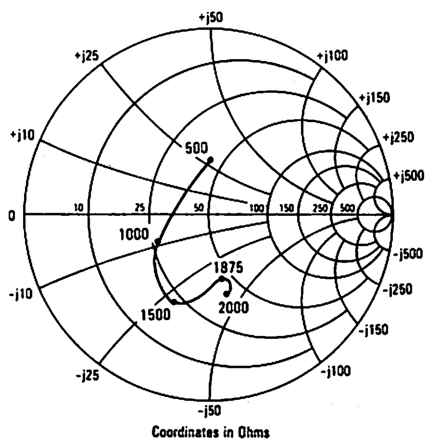


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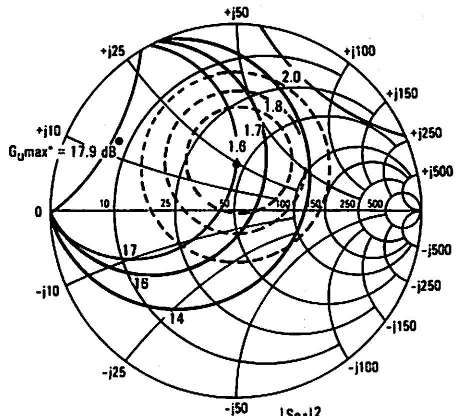
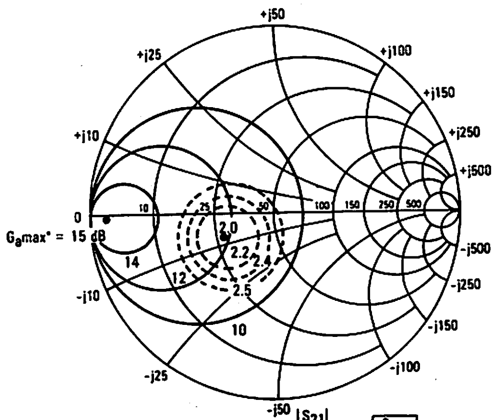
FIGURE 12 — CONSTANT GAIN AND NOISE FIGURE CONTOURS
(V_{CE} = 10 Vdc, I_C = 5.0 mA f = 500 MHz)



*Maximum Unilateral Gain, $G_u max = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$ (K < 1)

FIGURE 13 — CONSTANT GAIN AND NOISE FIGURE CONTOURS
(V_{CE} = 10 Vdc, I_C = 5.0 mA f = 1.0 GHz)



*Maximum Available Gain, $G_a max = \frac{|S_{21}|}{|S_{12}|}(K \pm \sqrt{K^2-1})$ (K > 1)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF904

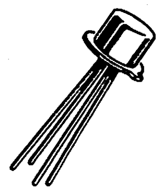
The RF Line

NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed for use as low-noise, high-gain, general purpose amplifiers.

- High Current-Gain — Bandwidth Product —
  f_T = 4.0 GHz (Typ) @ I_C = 15 mAdc
- Low Noise Figure —
  NF = 1.5 dB (Typ) @ f = 450 MHz
  = 2.5 dB (Typ) @ f = 1.0 GHz
- High Power Gain —
  G_{max} = 16 dB (Typ) @ f = 450 MHz
  = 10 dB (Typ) @ f = 1.0 GHz
- Excellent Third Order Intercept — +25 dBm (Typ)
- MIL-S-19500 Processed Versions Available as MRF904HX, MRF904HXV

I_C = 30 mA
HIGH FREQUENCY TRANSISTOR
NPN SILICON



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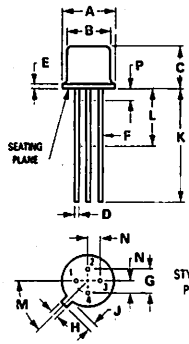
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	3.0	Vdc
Collector Current — Continuous	I_C	30	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.2 1.14	Watt mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5.0 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	30	—	200	—
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	—	4.0	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	—	—	1.0	pF
Noise Figure (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz) (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	NF	— —	1.5 2.5	— —	dB
FUNCTIONAL TEST					
Unilateralized Gain(1) (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 450 MHz) (I_C = 5.0 mAdc, V_{CE} = 6.0 Vdc, f = 1.0 GHz)	G_{max}	— —	16 10	— —	dB

(1) $G_{max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$



STYLE 10
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
TO-206AF
(TO-72)

FIGURE 1 — NOISE FIGURE versus FREQUENCY

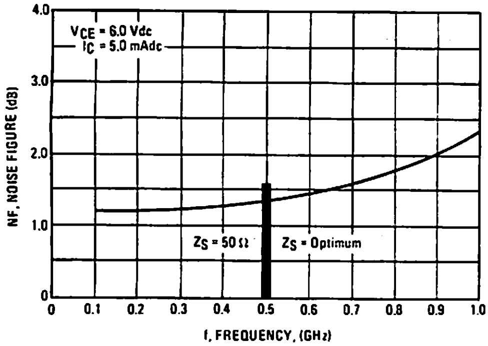


FIGURE 2 — NOISE FIGURE versus COLLECTOR CURRENT

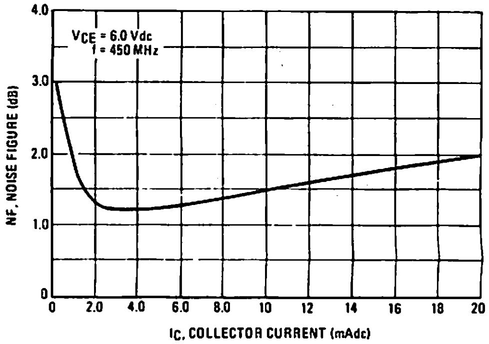


FIGURE 3 — COLLECTOR-BASE CAPACITANCE versus COLLECTOR-BASE VOLTAGE

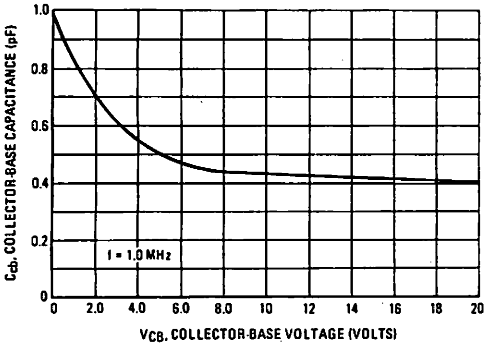


FIGURE 4 — UNILATERALIZED GAIN (G_{max}) versus FREQUENCY

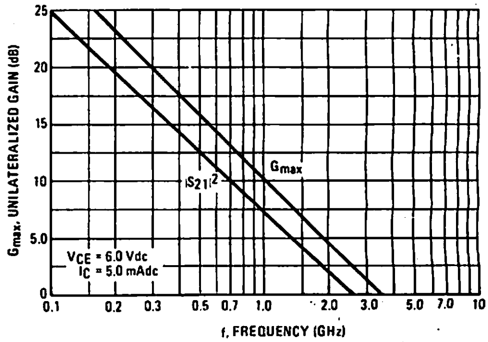


FIGURE 5 — CURRENT-GAIN — BANDWIDTH PRODUCT versus COLLECTOR CURRENT

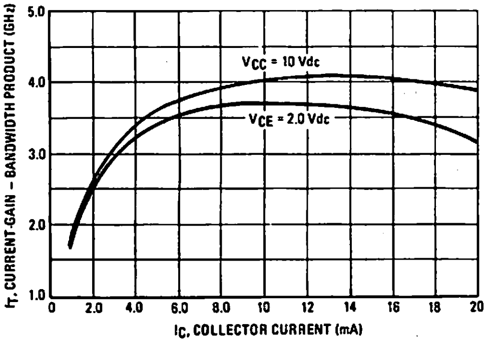


FIGURE 6 — INTERMODULATION DISTORTION versus COLLECTOR CURRENT

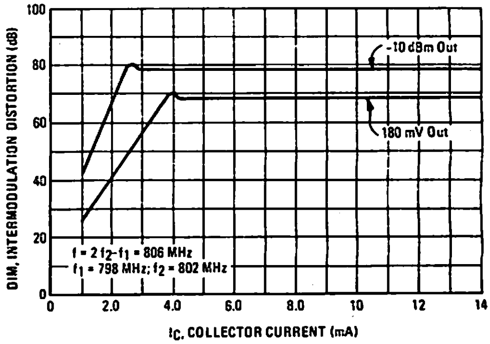


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TABLE 1 – S_{11} PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V_{CC} (Volts)	I_C (mA)	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ	S11	∠φ
1.0	1.0	0.941	-22	0.85	-43	0.57	-91	0.37	-128	0.30	-151
	2.5	0.85	-31	0.67	-57	0.35	-102	0.20	-136	0.14	-157
	5.0	0.69	-44	0.46	-71	0.21	-109	0.10	-144	0.069	-166
	10	0.45	-67	0.28	-94	0.13	-136	0.087	172	0.075	145
	15	0.37	-110	0.31	-145	0.26	170	0.27	139	0.27	122
	30	0.71	-178	0.71	169	0.68	144	0.68	121	0.65	107
3.0	1.0	0.94	-19	0.87	-37	0.61	-80	0.39	-114	0.30	-134
	2.5	0.87	-26	0.71	-47	0.39	-84	0.21	-106	0.15	-115
	5.0	0.74	-34	0.52	-55	0.25	-77	0.13	-82	0.109	-79
	10	0.55	-42	0.35	-58	0.18	-66	0.11	-60	0.105	-55
	15	0.46	-46	0.28	-59	0.15	-64	0.096	-55	0.092	-49
	30	0.28	-95	0.21	-134	0.16	175	0.17	135	0.17	116
6.0	1.0	0.95	-18	0.88	-35	0.63	-76	0.40	-108	0.30	-126
	2.5	0.89	-23	0.74	-43	0.42	-77	0.23	-94	0.17	-100
	5.0	0.77	-31	0.56	-49	0.29	-67	0.18	-69	0.15	-66
	10	0.61	-37	0.40	-50	0.23	-55	0.16	-51	0.16	-50
	15	0.52	-40	0.34	-51	0.20	-52	0.15	-47	0.15	-47
	30	0.36	-55	0.21	-70	0.098	-77	0.037	-59	0.033	-27
10	1.0	0.96	-17	0.89	-33	0.65	-73	0.41	-103	0.31	-121
	2.5	0.89	-22	0.76	-41	0.44	-73	0.25	-88	0.18	-93
	5.0	0.79	-28	0.59	-46	0.32	-63	0.20	-65	0.18	-63
	10	0.64	-34	0.44	-47	0.26	-52	0.19	-49	0.18	-49
	15	0.57	-37	0.38	-48	0.23	-49	0.18	-46	0.17	-46
	30	0.41	-51	0.24	-64	0.12	-67	0.061	-52	0.055	-36

TABLE 2 – S_{21} PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V_{CC} (Volts)	I_C (mA)	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ	S21	∠φ
1.0	1.0	5.32	156	3.06	137	2.22	97	1.65	70	1.44	56
	2.5	6.79	146	5.57	124	3.15	86	2.14	64	1.81	52
	5.0	10.97	133	7.60	110	3.62	79	2.38	61	2.00	49
	10	13.16	118	8.07	99	3.60	74	2.35	57	1.96	46
	15	9.84	108	5.66	91	2.44	67	1.63	49	1.38	38
	30	1.65	83	0.88	69	0.47	46	0.43	37	0.45	31
3.0	1.0	3.33	159	3.11	142	2.36	103	1.79	76	1.55	62
	2.5	6.89	150	5.85	129	3.48	92	2.38	70	2.00	58
	5.0	11.49	138	8.34	115	4.12	84	2.70	66	2.25	55
	10	15.71	125	9.82	104	4.39	79	2.85	63	2.34	53
	15	16.97	119	10.05	100	4.39	77	2.83	61	2.34	52
	30	12.66	108	7.02	92	2.98	70	1.94	54	1.61	44
6.0	1.0	3.31	160	3.10	144	2.41	106	1.83	79	1.60	65
	2.5	6.80	151	5.85	131	3.60	94	2.46	77	2.07	60
	5.0	11.44	140	8.54	117	4.28	86	2.83	68	2.33	57
	10	15.85	127	10.14	107	4.61	81	2.96	65	2.46	55
	15	17.20	122	10.47	102	4.60	79	2.96	63	2.45	54
	30	16.37	113	9.38	96	4.00	75	2.58	59	2.14	49
10	1.0	3.25	160	3.08	145	2.40	108	1.83	81	1.61	67
	2.5	6.73	152	5.85	132	3.63	96	2.50	74	2.10	62
	5.0	11.19	142	8.49	119	4.34	88	2.85	69	2.37	59
	10	15.59	129	10.16	108	4.66	82	3.00	66	2.47	56
	15	17.04	124	10.49	104	4.65	80	2.99	64	2.47	55
	30	16.18	115	9.38	98	4.03	96	2.60	60	2.14	50

TABLE 3 – S_{12} PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V_{CC} (Volts)	I_C (mA)	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ	S12	∠φ
1.0	1.0	0.054	73	0.097	61	0.159	41	0.184	36	0.194	37
	2.5	0.051	69	0.084	58	0.140	50	0.189	48	0.220	46
	5.0	0.046	65	0.072	60	0.137	58	0.201	53	0.239	50
	10	0.041	64	0.067	64	0.142	62	0.215	56	0.256	51
	15	0.043	61	0.070	63	0.152	62	0.230	55	0.277	50
	30	0.058	50	0.093	58	0.209	57	0.311	46	0.372	39
3.0	1.0	0.039	75	0.072	65	0.123	46	0.143	42	0.151	44
	2.5	0.037	72	0.063	62	0.110	54	0.150	53	0.174	52
	5.0	0.033	70	0.055	64	0.108	62	0.160	58	0.190	55
	10	0.030	70	0.050	68	0.109	67	0.165	61	0.199	57
	15	0.028	70	0.049	70	0.109	68	0.167	62	0.200	57
	30	0.026	68	0.046	70	0.105	69	0.165	64	0.200	61
6.0	1.0	0.032	76	0.060	66	0.106	49	0.123	45	0.131	48
	2.5	0.031	73	0.054	64	0.095	57	0.130	56	0.151	55
	5.0	0.028	71	0.048	66	0.094	64	0.139	61	0.165	58
	10	0.026	71	0.043	69	0.094	68	0.144	63	0.172	59
	15	0.024	71	0.042	71	0.093	69	0.144	64	0.172	60
	30	0.021	71	0.037	72	0.086	71	0.134	67	0.162	63
10	1.0	0.028	77	0.053	68	0.095	50	0.109	47	0.116	50
	2.5	0.027	74	0.048	65	0.085	58	0.116	57	0.134	57
	5.0	0.025	73	0.043	67	0.084	64	0.125	62	0.148	60
	10	0.023	72	0.037	69	0.084	69	0.128	64	0.153	61
	15	0.022	73	0.037	70	0.084	69	0.128	65	0.152	62
	30	0.019	72	0.033	72	0.076	72	0.119	68	0.143	66

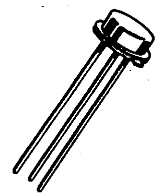
TABLE 4 – S_{22} PARAMETERS

Frequency (MHz)		100		200		500		800		1000	
V_{CC} (Volts)	I_C (mA)	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ	S22	∠φ
1.0	1.0	0.966	-12	0.893	-23	0.693	-41	0.612	-53	0.594	-59
	2.5	0.901	-18	0.760	-29	0.548	-42	0.498	-51	0.494	-56
	5.0	0.793	-24	0.619	-32	0.456	-39	0.429	-49	0.439	-54
	10	0.635	-29	0.486	-32	0.390	-36	0.377	-47	0.389	-53
	15	0.453	-29	0.364	-29	0.313	-34	0.309	-48	0.321	-14
	30	0.048	-78	0.035	-88	0.032	-135	0.031	-162	0.007	-167
3.0	1.0	0.976	-9.0	0.926	-18	0.770	-35	0.702	-46	0.683	-51
	2.5	0.935	-13	0.828	-23	0.648	-35	0.608	-43	0.608	-48
	5.0	0.853	-18	0.712	-25	0.577	-32	0.555	-41	0.565	-46
	10	0.758	-20	0.629	-23	0.539	-29	0.529	-39	0.544	-44
	15	0.711	-20	0.601	-22	0.533	-27	0.526	-38	0.540	-44
	30	0.631	-15	0.576	-16	0.548	-25	0.546	-38	0.558	-45
6.0	1.0	0.982	-8.0	0.939	-16	0.803	-31	0.742	42	0.734	-47
	2.5	0.947	-11	0.861	-20	0.699	-31	0.662	-40	0.660	-45
	5.0	0.882	-15	0.759	-21	0.633	-29	0.617	-31	0.627	-43
	10	0.801	-17	0.684	-20	0.607	-26	0.601	-35	0.610	-41
	15	0.769	-17	0.667	-19	0.602	-25	0.601	-35	0.607	-40
	30	0.737	-14	0.672	-15	0.640	-22	0.641	-33	0.655	-40
10	1.0	0.983	-7.0	0.949	-14	0.830	-29	0.774	-39	0.765	-40
	2.5	0.954	-10	0.880	-18	0.733	-29	0.698	-37	0.702	-42
	5.0	0.901	-13	0.793	-19	0.676	-27	0.659	-35	0.668	-41
	10	0.834	-15	0.725	-18	0.646	-24	0.646	-33	0.658	-39
	15	0.802	-15	0.706	-17	0.645	-23	0.648	-33	0.661	-39
	30	0.776	-13	0.712	-14	0.678	-22	0.686	-32	0.699	-38

MRF905

The RF Line

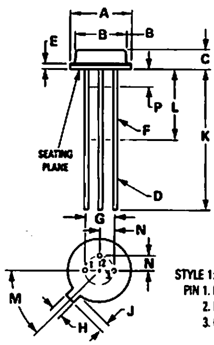
**400 mW
RF OSCILLATOR TRANSISTOR
NPN SILICON**



NPN SILICON OSCILLATOR TRANSISTOR

. . . designed for microwave communications relay links and low-cost radiosonde service.

- Emitter Ballasted
- Low Current Density for Improved Lifetime
- Collector Connected to Case



STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

**CASE 26-03
TO-206AB
(TO-46)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	150	mAdc
Total Power Dissipation @ T_C = 100°C Derate above 100°C	P_D	0.75 7.5	Watts mW/°C
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.45 2.6	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

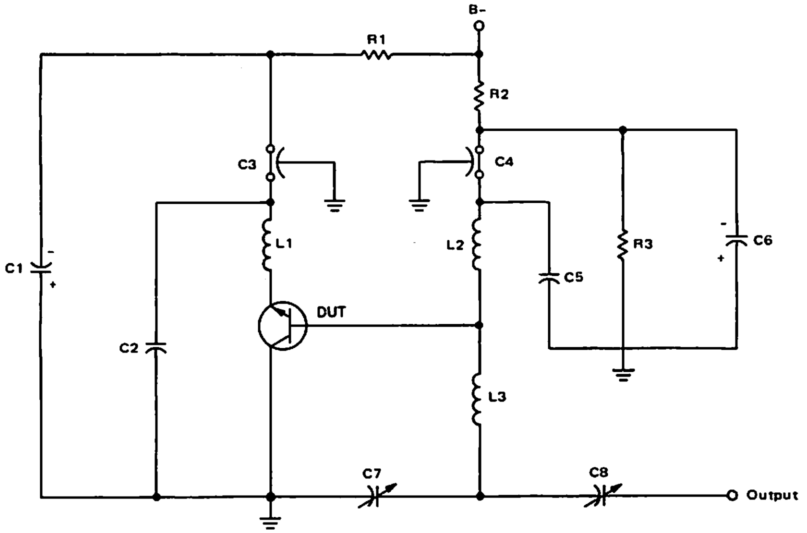
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	133	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	380	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	30	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	35	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	5.0	–	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 10 Vdc)	h_{FE}	20	60	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain – Bandwidth Product (I_C = 100 mAdc, V_{CE} = 10 Vdc, f = 200 MHz)	f_T	–	2500	–	MHz
Output Capacitance (V_{CB} = 20 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	3.0	5.0	pF
FUNCTIONAL TEST					
Common-Collector Oscillator Output Power (V_E = −20 Vdc, I_E ≅ 110 mAdc, f ≅ 1.68 GHz)	P_{out}	400	500	–	mW

FIGURE 1 – 1.68 GHz OSCILLATOR TEST CIRCUIT SCHEMATIC



C1,C6	1.0 μF, 35 Vdc TANTALUM	R1	47 Ohms, 1/4 Watt
C2,C5	0.1 μF Ceramic Disk	R2	510 Ohms, 1/4 Watt
C3,C4	680 pF Feedthru	R3	1.5 kΩ, 1/4 Watt
C7,C8	0.4-6.0 pF JOHANSON	L1,L2	5 Turns, #22 AWG, 0.125" I.D.
		L3	#20 AWG, 0.4" Length.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF911

The RF Line

NPN SILICON HIGH FREQUENCY TRANSISTOR

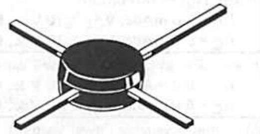
. . . designed primarily for use in high-gain, low-noise tuned and wideband small-signal amplifiers. Excellent in high-speed switching applications.

- High Current-Gain – Bandwidth Product –
  f_T = 5.0 GHz (Typ) @ f = 1.0 GHz
- High Power Gain –
  G_{max} = 12.5 dB (Typ) @ f = 1.0 GHz

f_T = 5.0 GHz @ 30 mA

HIGH FREQUENCY TRANSISTOR

NPN SILICON

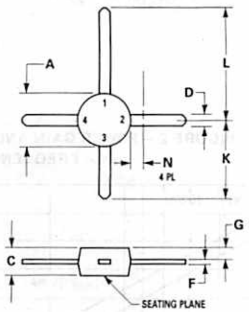


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current – Peak	I_C	40	mAdc
Total Device Dissipation @ T_L = 50°C Derate Above 50°C	P_D	400 4.0	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Lead	$R_{\theta JL}$	250	°C/W



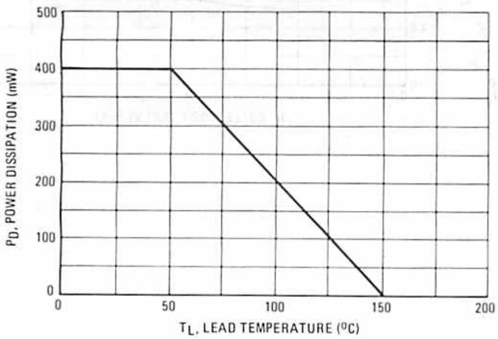
STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

FIGURE 1 – POWER DERATING



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ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 30 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	–	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)	f_T	–	5.0	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.6	1.0	pF
FUNCTIONAL TESTS					
Noise Figure (Minimum)	NF_{MIN}				dB
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	2.5	–	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 2.0 GHz)		–	4.0	–	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	10	–	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 2.0 GHz)		–	6.0	–	
Maximum Available Power Gain (1)	G_{max}				dB
(I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	12.5	–	
(I_C = 30 mAdc, V_{CE} = 10 Vdc, f = 2.0 GHz)		–	7.5	–	

(1) $G_{max} = \frac{|S_{21}|^2}{((1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 2 — POWER GAIN AND NOISE FIGURE versus FREQUENCY

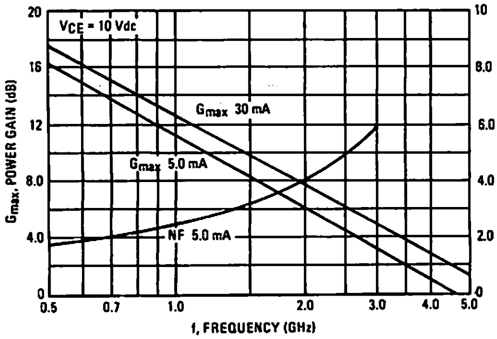


FIGURE 3 — POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

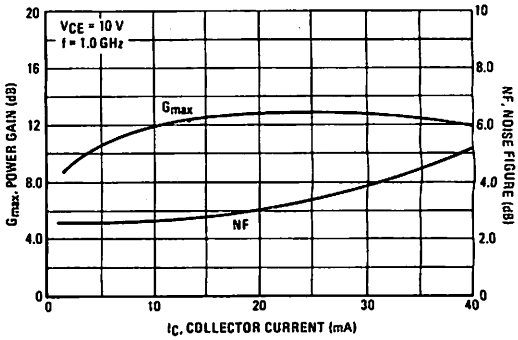


FIGURE 4 — S_{11} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
V_{CE} (Volts)	I_C (mA)	S_{11}	∠φ	S_{11}	∠φ	S_{11}	∠φ	S_{11}	∠φ
5.0	2.0	0.66	-125	0.64	-175	0.68	160	0.73	140
	5.0	0.57	-150	0.58	170	0.62	150	0.66	135
	10	0.54	-165	0.57	160	0.60	145	0.64	130
	20	0.54	-180	0.57	155	0.60	140	0.64	125
	30	0.54	175	0.57	155	0.61	140	0.65	125
10	2.0	0.66	-120	0.63	-170	0.67	160	0.71	140
	5.0	0.56	-145	0.56	175	0.60	150	0.64	135
	10	0.51	-160	0.53	165	0.57	145	0.61	130
	20	0.49	-175	0.52	160	0.57	145	0.60	130
	30	0.49	-175	0.53	160	0.57	145	0.61	130

FIGURE 5 — S_{22} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
V_{CE} (Volts)	I_C (mA)	S_{22}	∠φ	S_{22}	∠φ	S_{22}	∠φ	S_{22}	∠φ
5.0	2.0	0.61	-45	0.50	-60	0.48	-80	0.50	-100
	5.0	0.40	-55	0.31	-65	0.30	-85	0.32	-100
	10	0.27	-60	0.20	-70	0.20	-90	0.23	-105
	20	0.19	-70	0.13	-75	0.14	-95	0.17	-110
	30	0.16	-70	0.11	-75	0.13	-95	0.16	-110
10	2.0	0.66	-35	0.55	-50	0.53	-70	0.54	-90
	5.0	0.47	-45	0.38	-50	0.37	-70	0.38	-75
	10	0.35	-45	0.28	-50	0.27	-65	0.29	-85
	20	0.26	-45	0.22	-50	0.22	-65	0.24	-80
	30	0.25	-40	0.21	-45	0.22	-60	0.24	-80

FIGURE 6 — S_{21} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
V_{CE} (Volts)	I_C (mA)	S_{21}	∠φ	S_{21}	∠φ	S_{21}	∠φ	S_{21}	∠φ
5.0	2.0	3.24	100	1.84	70	1.23	50	0.96	35
	5.0	4.85	90	2.60	70	1.76	50	1.38	40
	10	5.78	85	3.04	70	2.05	50	1.61	40
	20	6.40	85	3.30	65	2.23	50	1.24	40
	30	6.47	80	3.35	65	2.26	50	1.76	40
10	2.0	3.42	100	1.95	70	1.31	50	1.01	35
	5.0	5.20	95	2.80	70	1.89	50	1.45	40
	10	6.22	90	3.28	70	2.20	55	1.71	40
	20	6.82	85	3.55	65	2.37	55	1.84	40
	30	6.90	85	3.55	65	2.36	50	1.81	40

FIGURE 7 — S_{12} PARAMETERS

Frequency (MHz)		500		1000		1500		2000	
V_{CE} (Volts)	I_C (mA)	S_{12}	∠φ	S_{12}	∠φ	S_{12}	∠φ	S_{12}	∠φ
5.0	2.0	0.11	30	0.12	25	0.11	35	0.13	50
	5.0	0.08	40	0.10	45	0.13	55	0.17	55
	10	0.07	50	0.10	55	0.14	60	0.19	60
	20	0.06	60	0.11	65	0.15	65	0.20	60
	30	0.06	65	0.11	65	0.15	65	0.20	60
10	2.0	0.10	35	0.10	30	0.10	40	0.12	55
	5.0	0.07	40	0.09	45	0.12	55	0.15	60
	10	0.06	50	0.09	55	0.13	60	0.17	60
	20	0.06	60	0.10	65	0.13	65	0.18	60
	30	0.06	60	0.10	65	0.14	65	0.18	65

MRF914

2

The RF Line

f_T = 4.5 GHz @ 20 mA

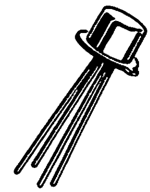
HIGH FREQUENCY TRANSISTOR

NPN SILICON

NPN SILICON HIGH FREQUENCY TRANSISTOR

. . . designed for applications requiring high-gain, low-noise and low distortion. Also excellent for high speed switching applications.

- Low Noise Figure —
  NF = 2.0 dB (Typ) @ f = 0.5 GHz
  = 2.5 dB (Typ) @ f = 1.0 GHz
- High Power Gain —
  G_{max} = 15 dB (Typ) @ f = 0.5 GHz
  = 10 dB (Typ) @ f = 1.0 GHz



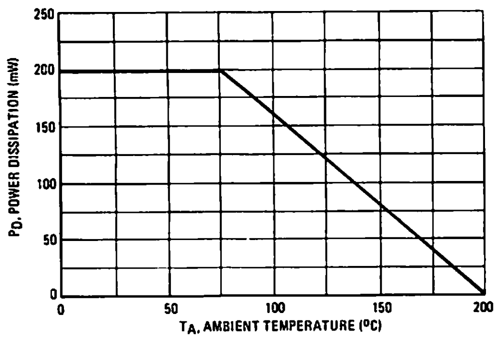
MAXIMUM RATINGS

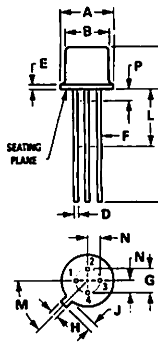
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	12	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Peak	I_C	40	mAdc
Total Device Dissipation @ T_A = 75°C Derate Above 75°C	P_D	200 1.6	mW mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	625	°C/W

FIGURE 1 — POWER DERATING





STYLE 10:
PIN 1. EMITTER
2. BASE
3. COLLECTOR
4. CASE

NOTE: ALL RULES AND NOTES ASSOCIATED WITH TO-72 OUTLINE SHALL APPLY.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

**CASE 20-03
TO-206AF
(TO-72)**

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	12	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 20 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	–	200	–
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	f_T	–	4.5	–	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.7	1.0	pF
FUNCTIONAL TESTS					
Noise Figure	NF				dB
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	2.0	–	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	2.5	–	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	12	–	
(I_C = 5.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	7.0	–	
Maximum Available Power Gain (1)	G_{max}				dB
(I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)		–	15	–	
(I_C = 20 mAdc, V_{CE} = 10 Vdc, f = 1.0 GHz)		–	10	–	

(1) $G_{max} = \dfrac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

FIGURE 2 – POWER GAIN AND NOISE FIGURE versus FREQUENCY

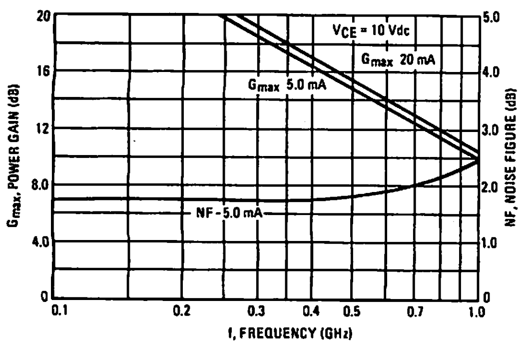


FIGURE 3 – POWER GAIN AND NOISE FIGURE versus COLLECTOR CURRENT

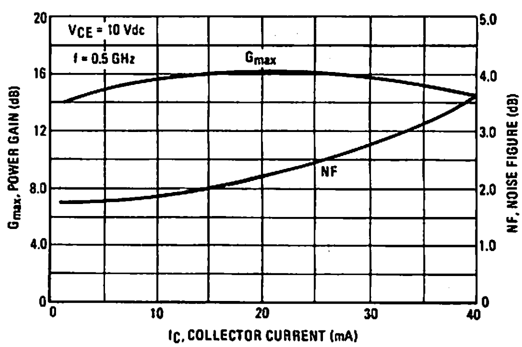


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FIGURE 4 – S_{11} PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V_{CE} (Volts)	I_C (mA)	S11	$\angle\phi$	S11	$\angle\phi$	S11	$\angle\phi$	S11	$\angle\phi$	S11	$\angle\phi$
5.0	2.0	0.84	-35	0.57	-80	0.42	-115	0.34	-140	0.27	-166
	5.0	0.65	-45	0.34	-85	0.23	-115	0.18	-130	0.16	-150
	10	0.48	-50	0.32	-85	0.14	-105	0.12	-115	0.09	-120
	20	0.33	-50	0.15	-75	0.10	-90	0.09	-100	0.09	-101
	30	0.27	-50	0.13	-70	0.09	-85	0.09	-100	0.09	-101
10	2.0	0.86	-30	0.59	-75	0.42	-105	0.34	-130	0.25	-155
	5.0	0.70	-40	0.37	-75	0.24	-95	0.18	-110	0.13	-125
	10	0.55	-45	0.26	-70	0.17	-80	0.14	-90	0.13	-90
	20	0.41	-45	0.21	-60	0.15	-65	0.13	-75	0.14	-80
	30	0.36	-45	0.19	-55	0.14	-65	0.13	-75	0.13	-80

FIGURE 5 – S_{22} PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V_{CE} (Volts)	I_C (mA)	S22	$\angle\phi$	S22	$\angle\phi$	S22	$\angle\phi$	S22	$\angle\phi$	S22	$\angle\phi$
5.0	2.0	0.94	-15	0.77	-25	0.68	-30	0.66	-35	0.64	-45
	5.0	0.85	-20	0.63	-30	0.57	-30	0.55	-35	0.55	-45
	10	0.75	-25	0.55	-25	0.51	-30	0.50	-35	0.50	-40
	20	0.66	-25	0.50	-25	0.47	-30	0.47	-35	0.48	-40
	30	0.62	-25	0.49	-25	0.46	-25	0.46	-30	0.47	-40
10	2.0	0.95	-10	0.81	-20	0.74	-30	0.72	-35	0.71	-40
	5.0	0.87	-15	0.69	-25	0.64	-25	0.63	-30	0.63	-40
	10	0.80	-20	0.63	-20	0.59	-25	0.59	-30	0.60	-40
	20	0.72	-20	0.59	-20	0.57	-23	0.57	-30	0.58	-35
	30	0.70	-20	0.59	-20	0.57	-20	0.57	-30	0.58	-35

FIGURE 6 – S_{21} PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V_{CE} (Volts)	I_C mA	S21	$\angle\phi$	S21	$\angle\phi$	S21	$\angle\phi$	S21	$\angle\phi$	S21	$\angle\phi$
5.0	2.0	5.99	150	4.06	110	2.90	90	2.27	75	1.71	55
	5.0	11.38	135	5.91	100	3.90	80	2.93	70	2.17	55
	10	15.21	125	6.78	95	4.34	80	3.23	70	2.38	55
	20	17.98	115	7.27	90	4.58	75	3.40	65	2.50	50
	30	18.78	110	7.37	85	4.64	75	3.42	65	2.50	50
10	2.0	6.05	150	4.20	115	3.04	90	2.37	75	1.75	55
	5.0	11.46	135	6.17	100	4.06	85	3.08	70	2.26	55
	10	15.45	127	7.08	95	4.56	80	3.41	70	2.50	55
	20	18.35	120	7.57	90	4.80	75	3.58	65	2.61	55
	30	19.12	115	7.63	90	4.79	75	3.56	65	2.60	55

FIGURE 7 – S_{12} PARAMETERS

Frequency (MHz)		100		300		500		700		1000	
V_{CE} (Volts)	I_C (mA)	S12	$\angle\phi$	S12	$\angle\phi$	S12	$\angle\phi$	S12	$\angle\phi$	S12	$\angle\phi$
5.0	2.0	0.04	70	0.09	50	0.11	50	0.12	50	0.16	50
	5.0	0.04	70	0.07	60	0.11	60	0.14	60	0.19	55
	10	0.03	70	0.07	70	0.11	65	0.15	65	0.20	55
	20	0.03	75	0.07	70	0.12	70	0.15	65	0.21	55
	30	0.03	75	0.07	70	0.12	70	0.16	65	0.21	57
10	2.0	0.03	70	0.07	55	0.09	50	0.10	50	0.13	55
	5.0	0.03	70	0.06	60	0.09	65	0.12	60	0.15	60
	10	0.03	70	0.06	65	0.09	65	0.12	65	0.17	60
	20	0.03	75	0.06	70	0.09	70	0.13	65	0.18	60
	30	0.03	75	0.06	70	0.10	70	0.13	65	0.17	60

MRF931

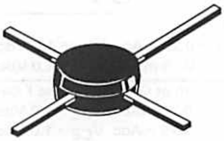
2

The RF Line

LOW CURRENT

HIGH FREQUENCY TRANSISTOR

NPN SILICON



NPN SILICON HIGH-FREQUENCY TRANSISTOR

. . . designed primarily for use in low-power amplifiers to 1.0 GHz. Ideal for pagers and other battery operated systems where low-power consumption is critical.

- Low-Power Consumption Characterized for I_E = 0.1 to 1.0 mA
- High Current-Gain — Bandwidth Product — f_T = 3.0 GHz (Typ)
- Stripline Design for Optimum Performance

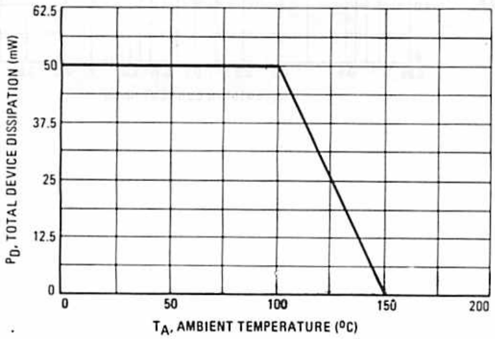
MAXIMUM RATINGS

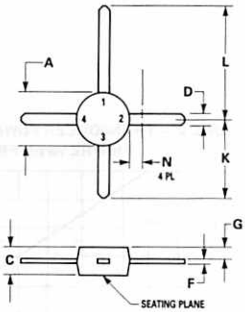
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	5.0	Vdc
Collector-Base Voltage	V_{CBO}	10	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector Current — Peak	I_C	5.0	mAdc
Total Device Dissipation @ T_A = 100°C Derate Above 100°C	P_D	50 1.0	mW mW/°C
Junction Temperature	T_J	+150	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

FIGURE 1 — POWER DERATING





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

NOTE:
DIMENSION D NOT APPLICABLE IN ZONE N.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317-01

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted).

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)	$V_{(BR)CEO}$	5.0	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	10	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 5.0 Vdc, I_E = 0)	I_{CBO}	–	–	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.25 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	30	–	150	–
DYNAMIC CHARACTERISTICS					
Current-Gain Bandwidth Product (I_E = 1.0 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)	f_T	–	3.0	–	GHz
Collector-Base Capacitance (V_{CB} = 1.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{cb}	–	0.35	0.5	pF
FUNCTIONAL TESTS					
Noise Figure	NF				dB
(I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 0.5 GHz)		–	3.8	–	
(I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)		–	4.3	–	
Power Gain at Optimum Noise Figure	G_{NF}				dB
(I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 0.5 GHz)		–	16	–	
(I_E = 0.25 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)		–	10	–	
Transducer Power Gain	G_T				dB
(I_E = 0.5 mAdc, V_{CE} = 1.0 Vdc, f = 0.5 GHz)		–	18	–	
(I_E = 0.5 mAdc, V_{CE} = 1.0 Vdc, f = 1.0 GHz)		–	12	–	

TYPICAL CHARACTERISTICS

FIGURE 2 — TRANSDUCER POWER GAIN AND NOISE FIGURE versus FREQUENCY

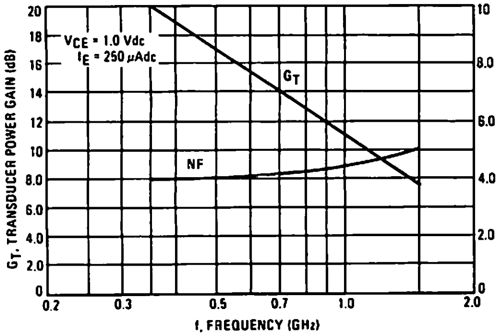
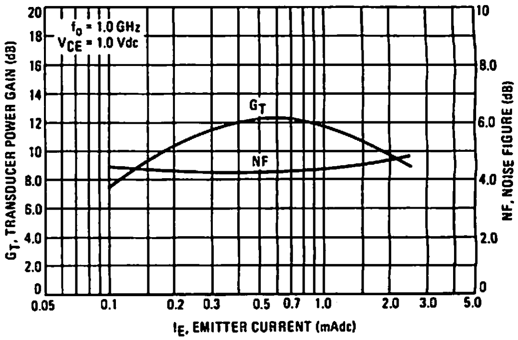


FIGURE 3 — TRANSDUCER POWER GAIN AND NOISE FIGURE versus EMITTER CURRENT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF941
MMBR941L
MRF9411L

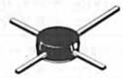
2

The RF Line
NPN Silicon Low Noise, High-Frequency Transistors

I_C = 50 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTORS

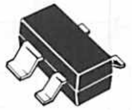
. . . designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 9 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal
- *Tape and Reel Packaging Options Available*



CASE 317-01, STYLE 2
MACRO-X
MRF941

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR941L



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE
MRF9411L

MAXIMUM RATINGS

Ratings	Symbol	MRF941	MMBR941L	MRF9411L	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation(1) T_A = 25°C	P_D	0.4	0.4	0.4	Watts
Collector Current — Continuous(2)	I_C	50	50	50	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	°C
Storage Temperature	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	312	312	312	°C/W

DEVICE MARKING

MMBR941L = 7Y
MRF 9411L = 10

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS(3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	23	—	Vdc
Emitter Cutoff Current (V_{EB} = 1 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS(3)					
DC Current Gain (V_{CE} = 6 V, I_C = 5 mA)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	0.35	—	pF
Current Gain — Bandwidth Product (V_{CE} = 6 V, I_C = 15 mA, f = 1 GHz)	f_T	—	8	—	GHz

NOTES: 1. To calculate the junction temperature use $T_J = P_D \times R_{\theta JA} + T_{AMBIENT}$.
2. I_C — Continuous (MTBF ≈ 10 years)
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF941			MRF9411L			MMBR941L			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain	$\|S_{21}\|^2$										dB
(V_{CE} = 6 V, I_C = 15 mA, f = 1 GHz)		—	16	—	—	16	—	—	14	—	
(V_{CE} = 6 V, I_C = 15 mA, f = 2 GHz)		—	10	—	—	10	—	—	8	—	
Maximum Unilateral Gain(1)	$G_{U\ max}$										dB
(V_{CE} = 6 V, I_C = 15 mA, f = 1 GHz)		—	18	—	—	18	—	—	16	—	
(V_{CE} = 6 V, I_C = 15 mA, f = 2 GHz)		—	12	—	—	12	—	—	10	—	
Noise Figure — Minimum	NF_{MIN}										dB
(V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)		—	1.3	—	—	1.3	—	—	1.3	—	
(V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz)		—	2.1	—	—	2.1	—	—	2.1	—	
Associated Gain at Minimum NF	G_{NF}										dB
(V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)		—	15	—	—	15	—	—	14	—	
(V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz)		—	9.5	—	—	9.5	—	—	8.5	—	
Noise Figure — 50 ohm Source (V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)	$NF_{50\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $GU_{max} = \frac{|S_{21}|^2}{(1-|S_{11}|^2)(1-|S_{22}|^2)}$

TYPICAL CHARACTERISTICS

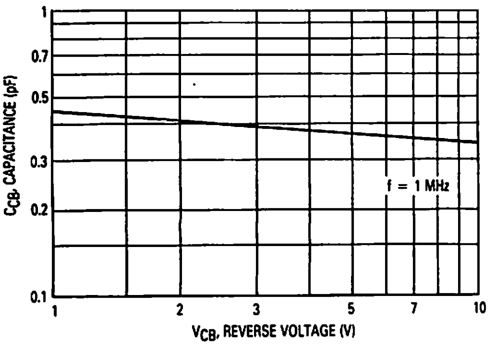


Figure 1. Collector-Base Capacitance versus Voltage

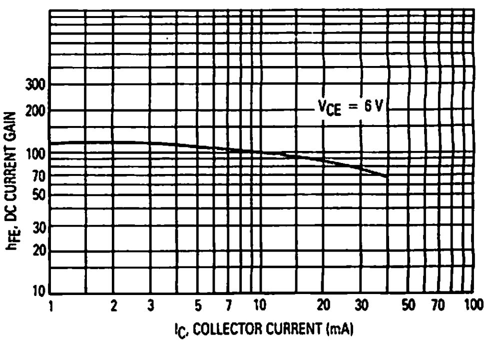


Figure 2. DC Current Gain versus Collector Current

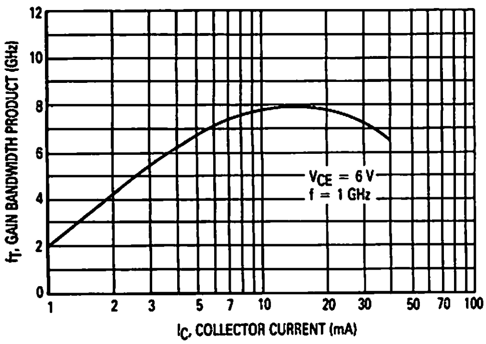


Figure 3. Gain Bandwidth Product versus Collector Current

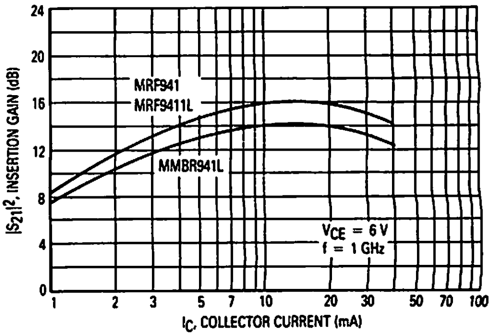


Figure 4. Insertion Gain versus Collector Current

FORWARD INSERTION GAIN AND MAXIMUM UNILATERAL GAIN versus FREQUENCY

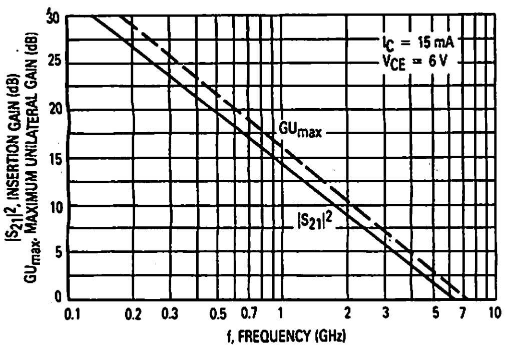


Figure 5. MMBR941L

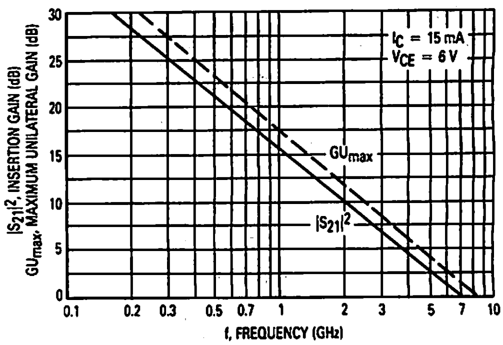


Figure 6. MRF941, MRF9411L

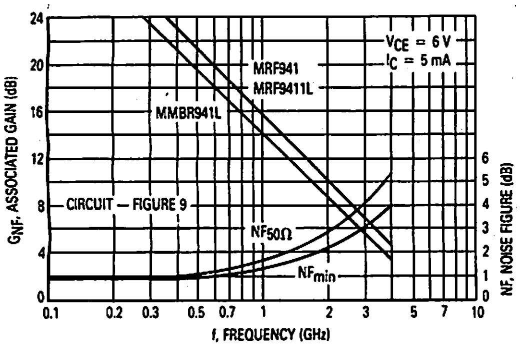


Figure 7. Noise Figure and Associated Gain versus Frequency

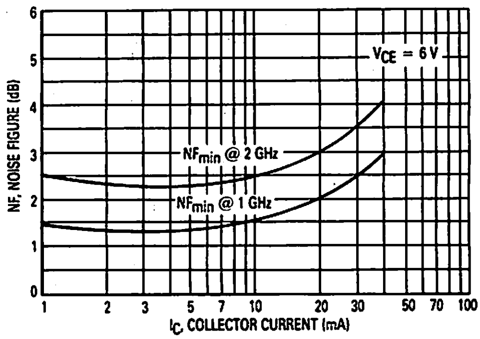


Figure 8. Noise Figure versus Collector Current

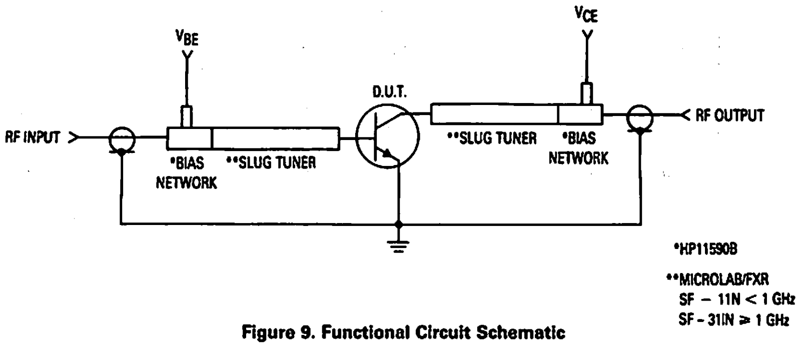


Figure 9. Functional Circuit Schematic

MRF941
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
6	5	100	0.82	−24	14.5	162	0.02	81	0.96	−11
		200	0.77	−47	13.2	147	0.03	68	0.89	−21
		400	0.62	−84	10.3	124	0.04	53	0.73	−33
		600	0.54	−110	8.1	108	0.06	49	0.63	−39
		800	0.46	−131	6.4	98	0.06	49	0.58	−44
		1000	0.42	−148	5.3	90	0.07	52	0.55	−46
		1500	0.36	177	3.6	74	0.09	56	0.51	−53
		2000	0.34	145	2.7	61	0.11	59	0.50	−61
		2500	0.36	118	2.2	51	0.14	60	0.49	−69
		3000	0.42	90	1.9	44	0.16	56	0.46	−75
		3500	0.51	77	1.7	35	0.22	53	0.41	−90
		4000	0.58	58	1.6	28	0.23	47	0.37	−100
		5000	0.72	44	1.5	9	0.26	33	0.39	−151
		6000	0.86	35	1.4	−14	0.30	24	0.55	167
	10	100	0.67	−37	24.4	154	0.02	88	0.91	−17
		200	0.48	−67	20	135	0.02	55	0.79	−29
		400	0.45	−111	13.4	112	0.03	56	0.59	−37
		600	0.40	−136	9.8	99	0.04	57	0.50	−41
		800	0.44	−155	7.5	90	0.06	61	0.47	−43
		1000	0.35	−170	6.1	84	0.06	62	0.45	−44
		1500	0.31	159	4.1	70	0.08	66	0.45	−50
		2000	0.32	130	3.1	59	0.11	66	0.44	−58
		2500	0.34	107	2.4	50	0.15	65	0.44	−66
		3000	0.41	82	2.1	43	0.17	59	0.41	−71
		3500	0.49	72	1.9	35	0.21	54	0.36	−85
		4000	0.55	54	1.7	27	0.23	46	0.33	−93
		5000	0.68	42	1.6	10	0.27	32	0.32	−144
		6000	0.82	34	1.5	−12	0.30	23	0.48	−169
	15	100	0.57	−47	30.1	149	0.02	63	0.87	−20
		200	0.48	−83	23.2	128	0.02	64	0.72	−31
		400	0.40	−126	14.4	107	0.03	65	0.52	−37
		600	0.36	−150	10.2	95	0.04	65	0.46	−39
		800	0.34	−167	7.8	87	0.05	66	0.43	−42
		1000	0.33	180	6.3	81	0.06	67	0.42	−42
		1500	0.27	151	4.2	69	0.08	72	0.43	−49
		2000	0.32	124	3.1	59	0.12	69	0.42	−56
		2500	0.34	103	2.5	49	0.15	67	0.42	−64
		3000	0.41	80	2.1	42	0.17	59	0.40	−69
		3500	0.49	70	1.9	34	0.20	54	0.35	−84
		4000	0.55	52	1.7	27	0.28	47	0.32	−90
		5000	0.68	41	1.7	9	0.26	33	0.31	−143
		6000	0.82	33	1.5	−13	0.29	23	0.46	169
	30	100	0.41	−74	37.8	139	0.01	69	0.79	−24
		200	0.37	−116	25.8	118	0.01	65	0.62	−32
		400	0.37	−152	14.7	100	0.02	72	0.47	−32
		600	0.36	−170	10.1	90	0.03	70	0.43	−33
		800	0.35	176	7.7	83	0.04	71	0.42	−36
		1000	0.35	167	6.1	78	0.06	75	0.42	−38
		1500	0.34	142	4.1	65	0.08	72	0.44	−44
		2000	0.36	118	3.1	55	0.11	71	0.43	−53
		2500	0.38	100	2.4	46	0.14	68	0.44	−62
		3000	0.45	77	2.1	40	0.17	61	0.42	−68
		3500	0.53	68	1.8	32	0.21	58	0.37	−82
		4000	0.59	51	1.6	25	0.24	48	0.34	−92
		5000	0.72	40	1.5	7	0.26	34	0.33	−143
		6000	0.85	31	1.4	−15	0.30	24	0.48	171

MMBR941L
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
6	5	100	0.82	−25	14.6	159	0.02	77	0.94	−13
		200	0.75	−47	12.6	142	0.04	68	0.85	−22
		400	0.55	−79	9.2	120	0.05	61	0.69	−31
		600	0.42	−98	6.9	106	0.07	60	0.60	−32
		800	0.33	−114	5.3	97	0.08	61	0.56	−33
		1000	0.28	−129	4.5	90	0.09	62	0.52	−33
		1500	0.25	−155	3.1	77	0.13	67	0.51	−37
		2000	0.16	176	2.4	66	0.16	68	0.51	−36
		2500	0.21	151	2	57	0.20	69	0.48	−40
		3000	0.18	122	1.7	50	0.23	68	0.48	−44
		3500	0.30	108	1.5	42	0.27	66	0.45	−46
		4000	0.29	91	1.4	37	0.32	64	0.42	−53
	10	100	0.67	−37	23.5	149	0.02	74	0.88	−18
		200	0.54	−64	18.1	129	0.03	68	0.73	−28
		400	0.37	−96	11.3	108	0.05	67	0.56	−31
		600	0.26	−114	8	98	0.06	67	0.50	−30
		800	0.21	−130	6	91	0.08	70	0.47	−30
		1000	0.18	−147	5.1	85	0.09	70	0.45	−30
		1500	0.18	−167	3.4	74	0.13	72	0.46	−34
		2000	0.11	159	2.6	64	0.17	71	0.46	−34
		2500	0.17	140	2.2	56	0.21	69	0.44	−38
		3000	0.15	107	1.8	59	0.25	67	0.45	−41
		3500	0.27	100	1.7	42	0.28	65	0.42	−42
		4000	0.26	85	1.5	37	0.33	61	0.39	−49
	15	100	0.56	−46	28.6	143	0.02	73	0.83	−22
		200	0.43	−75	20.2	122	0.03	67	0.65	−30
		400	0.29	−107	11.8	104	0.04	70	0.50	−30
		600	0.22	−125	8.2	95	0.06	74	0.46	−28
		800	0.18	−141	6.2	88	0.08	74	0.45	−27
		1000	0.16	−158	5.1	83	0.09	74	0.43	−28
		1500	0.17	−174	3.4	72	0.13	73	0.44	−32
		2000	0.11	150	2.6	63	0.17	72	0.45	−33
		2500	0.17	138	2.2	55	0.21	70	0.43	−37
		3000	0.15	102	1.9	49	0.25	67	0.44	−39
		3500	0.28	98	1.7	42	0.29	65	0.40	−41
		4000	0.25	82	1.5	37	0.32	61	0.38	−47
	20	100	0.49	−52	31.5	139	0.01	70	0.79	−23
		200	0.36	−84	21.1	118	0.02	69	0.60	−29
		400	0.25	−115	12.1	101	0.04	73	0.48	−29
		600	0.20	−134	8.3	93	0.06	74	0.45	−26
		800	0.16	−150	6.2	87	0.07	75	0.44	−26
		1000	0.15	−166	5.1	82	0.09	75	0.42	−26
		1500	0.16	−176	3.5	75	0.14	74	0.44	−31
		2000	0.12	144	2.6	63	0.17	73	0.45	−32
		2500	0.17	133	2.2	55	0.22	70	0.43	−36
		3000	0.16	101	1.9	49	0.25	68	0.44	−39
		3500	0.28	98	1.6	41	0.29	65	0.41	−40
		4000	0.26	82	1.5	36	0.33	61	0.39	−47
	30	100	0.41	−65	34.3	134	0.01	70	0.74	−25
		200	0.30	−99	21.6	113	0.02	70	0.56	−28
		400	0.23	−131	11.9	98	0.04	76	0.47	−25
		600	0.20	−147	8.1	91	0.06	76	0.45	−24
		800	0.18	−163	6.1	84	0.07	78	0.44	−23
		1000	0.17	−177	5	80	0.09	78	0.43	−24
		1500	0.18	174	3.4	70	0.13	76	0.45	−30
		2000	0.14	141	2.5	61	0.17	74	0.47	−31
		2500	0.20	131	2.1	54	0.21	71	0.45	−36
		3000	0.18	104	1.8	47	0.25	69	0.46	−39
		3500	0.31	100	1.6	40	0.29	65	0.42	−42
		4000	0.29	84	1.5	35	0.33	62	0.40	−48

MRF9411L
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
6	5	100	0.73	−24	14	164	0.02	92	0.96	−11
		200	0.74	−47	12.9	150	0.03	65	0.90	−20
		400	0.66	−83	10.4	129	0.05	56	0.75	−32
		600	0.62	−108	8.4	115	0.06	45	0.65	−40
		800	0.56	−127	6.7	105	0.07	46	0.60	−43
		1000	0.54	−141	5.6	96	0.07	51	0.57	−46
		1500	0.46	−166	3.9	82	0.08	55	0.52	−50
		2000	0.43	172	2.9	70	0.09	56	0.50	−54
		2500	0.41	151	2.3	62	0.11	61	0.48	−60
		3000	0.44	128	1.9	55	0.14	62	0.49	−65
		3500	0.49	117	1.6	47	0.15	61	0.46	−74
		4000	0.57	101	1.4	42	0.16	62	0.47	−81
		5000	0.60	92	1.2	32	0.21	60	0.46	−105
		6000	0.58	88	1	20	0.25	61	0.51	−137
	10	100	0.64	−39	23.6	157	0.01	59	0.91	−16
		200	0.60	−71	20	139	0.02	70	0.80	−27
		400	0.54	−112	13.9	117	0.03	57	0.61	−39
		600	0.52	−135	10.3	104	0.04	50	0.51	−43
		800	0.49	−151	8	96	0.05	54	0.46	−44
		1000	0.47	−161	6.5	89	0.06	60	0.46	−46
		1500	0.41	177	4.4	77	0.08	62	0.44	−47
		2000	0.40	158	3.2	67	0.09	65	0.43	−52
		2500	0.39	139	2.6	60	0.11	68	0.41	−56
		3000	0.44	118	2.1	53	0.13	69	0.43	−62
		3500	0.49	110	1.8	47	0.15	67	0.39	−72
		4000	0.54	96	1.6	42	0.18	65	0.41	−78
		5000	0.63	88	1.3	32	0.23	61	0.40	−101
		6000	0.58	86	1.1	20	0.26	62	0.44	−136
	15	100	0.56	−51	29.5	152	0.01	78	0.87	−20
		200	0.53	−88	23.5	131	0.02	63	0.73	−31
		400	0.51	−128	15.1	111	0.03	63	0.54	−40
		600	0.49	−148	11.8	99	0.04	56	0.46	−42
		800	0.48	−161	8.3	92	0.04	59	0.42	−41
		1000	0.46	−170	6.7	86	0.05	59	0.41	−44
		1500	0.41	−171	4.4	75	0.07	70	0.42	−45
		2000	0.40	152	3.3	66	0.09	71	0.41	−50
		2500	0.39	135	2.6	59	0.11	71	0.41	−55
		3000	0.45	116	2.2	53	0.14	73	0.42	−61
		3500	0.50	108	1.9	46	0.17	70	0.39	−70
		4000	0.55	94	1.6	41	0.19	67	0.41	−76
		5000	0.61	87	1.3	32	0.22	62	0.34	−114
		6000	0.58	85	1.1	21	0.27	63	0.43	−135
	30	100	0.45	−82	36.3	142	0.01	62	0.79	−23
		200	0.48	−121	25.5	121	0.01	48	0.62	−31
		400	0.49	−152	14.6	103	0.02	58	0.47	−33
		600	0.50	−166	10.2	93	0.03	60	0.44	−34
		800	0.49	−175	7.7	87	0.04	65	0.42	−34
		1000	0.48	177	6.1	81	0.05	76	0.43	−37
		1500	0.45	162	4.1	71	0.07	75	0.45	−39
		2000	0.45	145	3	62	0.09	78	0.44	−46
		2500	0.44	130	2.4	56	0.11	79	0.44	−53
		3000	0.50	113	1.9	50	0.13	79	0.45	−58
		3500	0.55	105	1.8	43	0.15	75	0.44	−70
		4000	0.61	92	1.5	39	0.19	73	0.45	−76
		5000	0.65	84	1.2	30	0.24	68	0.43	−100
		6000	0.61	82	1	19	0.28	64	0.48	−135

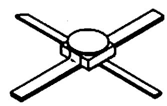
MRF942

2

The RF Line

NPN Silicon Low Noise, High-Frequency Transistor

**I_C = 40 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTOR**



CASE 303-01

... designed for use in high gain, low noise small-signal amplifiers. This device features excellent broadband linearity and is offered in a metal-ceramic hermetic package suitable for high-reliability applications.

- Low Noise Figure — 1.3 dB Typ @ f = 1.0 GHz
- Associated Gain — 16 dB Typ @ f = 1.0 GHz
- Fully Implanted Base and Emitter Structure
- 9 Finger, 1.25 Micron Geometry with Gold Top Metal
- High Reliability Processing Available

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Power Dissipation (1) @ T_C = 125°C Derate above 125°C	P_D	300 4.0	mWatts mW/°C
Collector Current — Continuous (2)	I_C	40	mA
Junction Temperature	T_J	200	°C
Storage Temperature	T_{stg}	−65 to +200	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	250	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS (3)					
DC Current Gain (V_{CE} = 8.0 V, I_C = 5.0 mA)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.2	—	pF
Current Gain — Bandwidth Product (V_{CE} = 6.0 V, I_C = 15 mA)	f_T	—	8.0	—	GHz

NOTES: 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. To calculate the junction temperature use $T_J = P_D \times R_{\theta JC} + T_{CASE}$.
2. I_C — Continuous (MTBF ≈ 10 years)
3. Pulse width ≤ 300 μs, duty cycle ≤ 2.0% pulsed.

2

PERFORMANCE CHARACTERISTICS

Conditions		Symbol	Min	Typ	Max	Units
Insertion Gain $\lvert S_{21}\rvert^2$ (V_{CE} = 6.0 V, I_C = 15 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	$\lvert S_{21}\rvert^2$	— — —	18 12 6.0	— — —	dB
Output Power $P_{1\,dB}$ (V_{CE} = 6.0 V, I_C = 15 mA)	f = 1.0 GHz	$P_{1\,dB}$	—	16	—	dBm
1.0 dB Compressed Gain $G_{1\,dB}$ (V_{CE} = 6.0 V, I_C = 15 mA)	f = 1.0 GHz	$G_{1\,dB}$	—	21	—	dB
Minimum Noise Figure NF_{min} (V_{CE} = 6.0 V, I_C = 3.0 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	NF_{min}	— — —	1.3 2.0 2.9	1.8 — —	dB
Associated Gain G_{NF} (V_{CE} = 8.0 V, I_C = 5.0 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	G_{NF}	14 — —	16 11 8.0	— — —	dB

TYPICAL NOISE PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	NF_{min} (dB)	G_{NF} (dB)	Γ_o (MAG, ANG)	R_N (ohms)	$NF_{50\,\Omega}$ (dB)
6	3	1000	1.3	16	.36 ∠ 94	17.5	1.7
		2000	2.0	11	.37 ∠ −145	15.5	2.6
		4000	2.9	8.0	.50 ∠ −134	21.5	4.3
	15	1000	2.1	19	.25 ∠ 150	13	2.6
		2000	2.7	14	.26 ∠ −173	16.5	3.1
		4000	4.3	9.0	.48 ∠ −96	47	5.4

TYPICAL CHARACTERISTICS

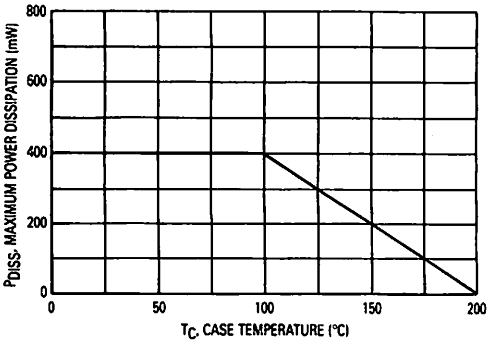


Figure 1. Maximum Power Dissipation versus Case Temperature

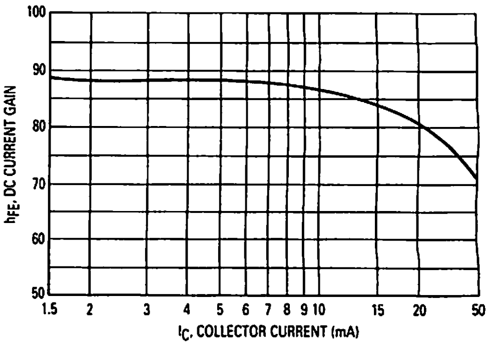


Figure 2. DC Current Gain versus Current

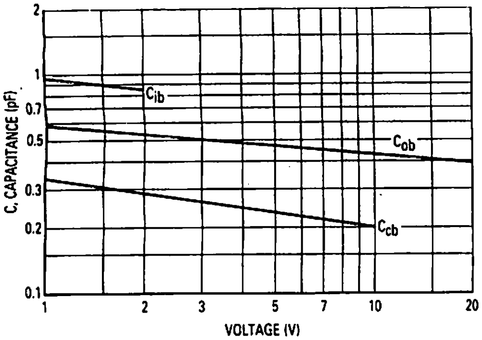


Figure 3. Capacitance versus Voltage

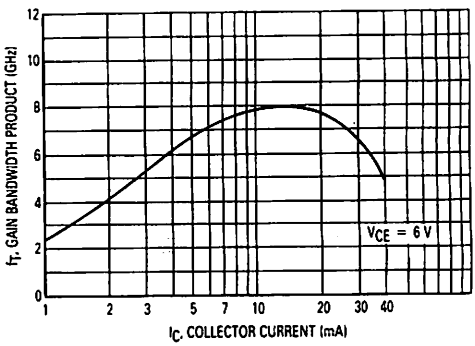


Figure 4. Gain-Bandwidth Product versus Collector Current

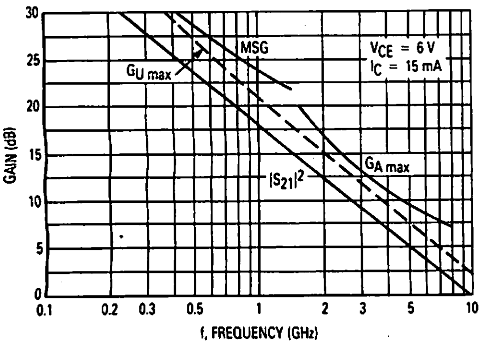


Figure 5. Gain versus Frequency

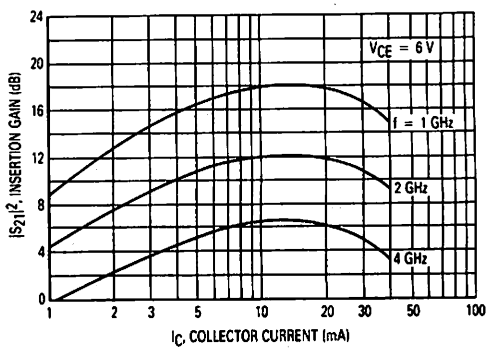


Figure 6. Insertion Gain versus Current

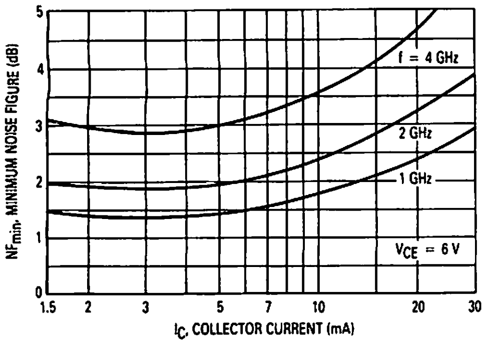


Figure 7. Minimum Noise Figure versus Current

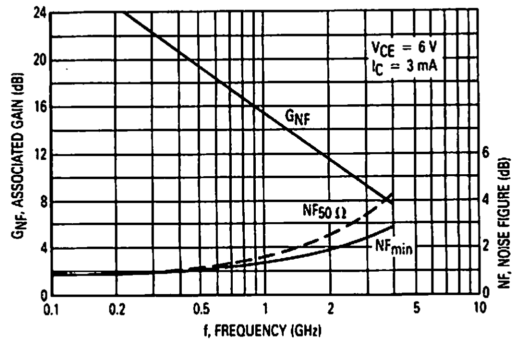


Figure 8. Noise Figure and Associated Gain versus Frequency

2

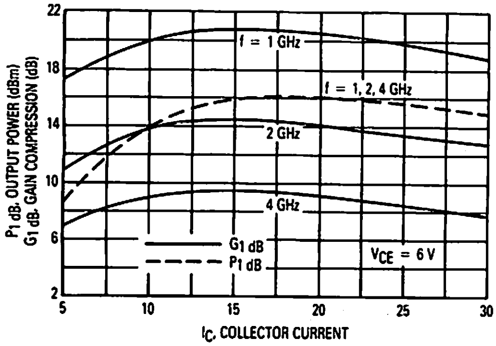


Figure 9. Output Power and 1 dB Gain Compression versus Current

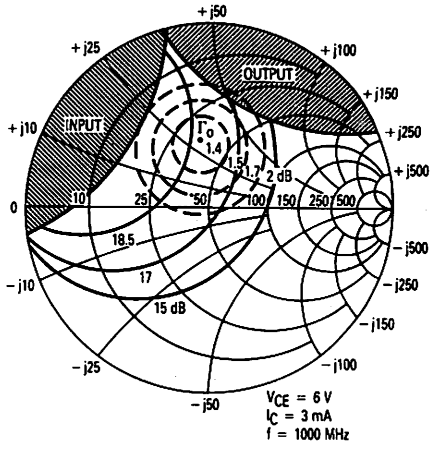


Figure 10. Gain and Noise Figure Contours f = 1 GHz

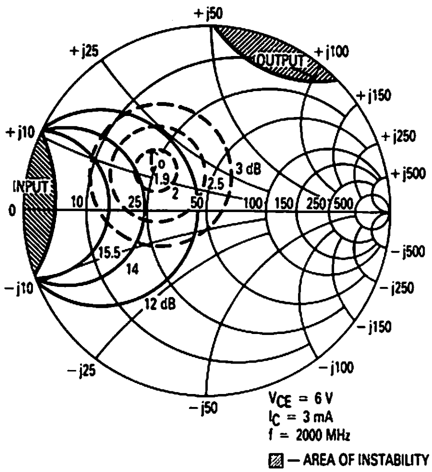


Figure 11. Gain and Noise Figure Contours f = 2 GHz

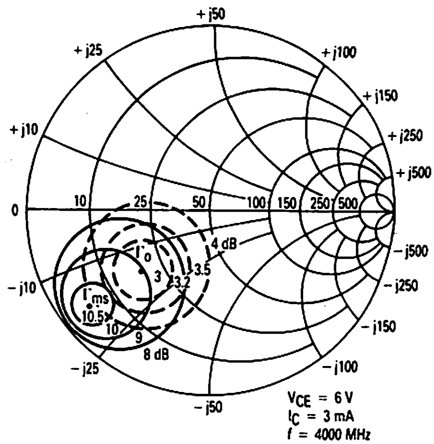


Figure 12. Gain and Noise Figure Contours f = 4 GHz

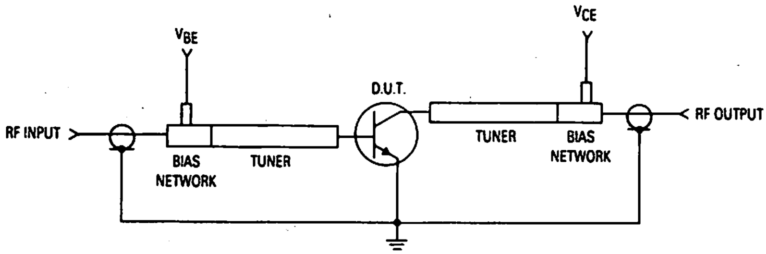


Figure 13. Functional Circuit Schematic

2

Figure 14. Typical Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
6	3	100	0.89	−17	9.93	171	0.01	84	0.99	−7
		500	0.79	−72	7.71	134	0.05	52	0.86	−29
		1000	0.69	−122	5.31	102	0.07	35	0.72	−42
		1500	0.67	−145	3.96	87	0.07	27	0.66	−52
		2000	0.59	−166	2.90	73	0.08	25	0.65	−58
		3000	0.52	162	2.07	52	0.08	26	0.65	−73
		4000	0.55	135	1.56	32	0.09	30	0.65	−92
		5000	0.60	113	1.28	20	0.10	32	0.63	−112
		6000	0.69	92	1.17	1	0.11	34	0.62	−133
		7000	0.66	73	0.99	−15	0.13	32	0.69	−150
		8000	0.62	57	0.86	−38	0.16	32	0.76	−163
	5	100	0.83	−23	15.04	168	0.01	79	0.98	−9
		500	0.71	−89	10.34	125	0.04	50	0.77	−33
		1000	0.63	−138	6.47	96	0.06	35	0.62	−44
		1500	0.60	−157	4.64	82	0.06	32	0.58	−53
		2000	0.54	−178	3.42	70	0.07	32	0.58	−58
		3000	0.49	152	2.41	50	0.08	37	0.59	−73
		4000	0.53	129	1.83	31	0.09	39	0.60	−90
		5000	0.57	107	1.50	19	0.11	38	0.58	−110
		6000	0.66	85	1.36	0	0.12	36	0.59	−132
		7000	0.64	70	1.13	−15	0.14	32	0.66	−148
		8000	0.60	52	0.99	−37	0.17	31	0.73	−162
	10	100	0.69	−34	24.58	162	0.01	74	0.95	−13
		500	0.60	−116	13.41	114	0.03	45	0.64	−37
		1000	0.56	−157	7.54	89	0.04	42	0.52	−43
		1500	0.55	−173	5.23	77	0.05	45	0.50	−52
		2000	0.52	168	3.90	66	0.06	46	0.51	−56
		3000	0.47	141	2.68	47	0.06	49	0.54	−70
		4000	0.54	121	2.03	30	0.09	48	0.56	−88
		5000	0.57	102	1.68	18	0.12	43	0.54	−108
		6000	0.66	82	1.52	−1	0.13	39	0.55	−130
		7000	0.62	66	1.25	−16	0.15	34	0.63	−147
		8000	0.59	47	1.11	−39	0.17	32	0.70	−161
	15	100	0.61	−45	30.33	157	0.01	71	0.92	−15
		500	0.57	−131	14.35	108	0.03	48	0.58	−37
		1000	0.56	−160	7.77	85	0.03	48	0.49	−41
		1500	0.54	179	5.32	74	0.04	51	0.48	−49
		2000	0.51	161	3.98	64	0.05	54	0.50	−54
		3000	0.48	137	2.72	45	0.07	54	0.54	−69
		4000	0.55	117	2.06	28	0.10	52	0.55	−87
		5000	0.59	99	1.68	16	0.12	46	0.54	−107
		6000	0.67	81	1.52	−2	0.13	41	0.55	−129
		7000	0.63	64	1.25	−18	0.16	36	0.63	−146
		8000	0.63	45	1.10	−40	0.18	33	0.70	−161
	30	100	0.46	−77	36.83	148	0.01	66	0.86	−18
		500	0.57	−156	13.51	100	0.02	53	0.55	−35
		1000	0.58	−180	7.01	81	0.03	59	0.51	−35
		1500	0.55	169	4.76	70	0.04	62	0.51	−45
		2000	0.55	155	3.61	60	0.05	64	0.54	−51
		3000	0.52	131	2.42	42	0.07	63	0.58	−67
		4000	0.58	113	1.82	24	0.10	60	0.60	−86
		5000	0.64	95	1.47	12	0.12	52	0.58	−109
		6000	0.75	76	1.32	−6	0.14	46	0.59	−131
		7000	0.69	57	1.08	−21	0.16	40	0.66	−147
		8000	0.66	39	0.94	−44	0.19	38	0.73	−161

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF951
MMBR951L
MRF9511L

The RF Line

NPN Silicon Low Noise, High-Frequency Transistors

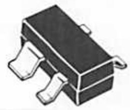
. . . designed for use in high gain, low noise small-signal amplifiers. This series features excellent broadband linearity and is offered in a variety of packages.

- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- Gold Sintered Back Metal
- Tape and Reel Packaging Options Available

I_C = 100 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTORS

CASE 317-01, STYLE 2
MACRO-X
MRF951

CASE 318-07, STYLE 6
SOT-23
LOW PROFILE
MMBR951L



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE
MRF9511L

MAXIMUM RATINGS

Ratings	Symbol	MRF951	MMBR951L	MRF9511L	Unit
Collector-Emitter Voltage	V_{CEO}	10	10	10	Vdc
Collector-Base Voltage	V_{CBO}	20	20	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	1.5	1.5	Vdc
Power Dissipation(1)	P_D	1	0.58	0.5	Watts
Collector Current — Continuous(2)	I_C	100	100	100	mA
Maximum Junction Temperature	T_{Jmax}	150	150	150	°C
Storage Temperature	T_{stg}	−65 to +150	−65 to +150	−65 to +150	°C
Thermal Resistance, Junction to Case	$R_{\theta JC}$	100	130	130	°C/W

DEVICE MARKING

MRF9511L = 11

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS(3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current (V_{EB} = 1 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS(3)					
DC Current Gain (V_{CE} = 6 V, I_C = 5 mA)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{cb}	—	0.45	—	pF
Current Gain(4) — Bandwidth Product (V_{CE} = 8 V, I_C = 30 mA, f = 1 GHz)	f_T	—	8	—	GHz

NOTES: 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. To calculate the junction temperature use $T_J = P_D \times R_{\theta JC} + T_{CASE}$.
2. I_C — Continuous (MTBF = 10 years)
3. Pulse width ≤ 300 μs, duty cycle ≤ 2% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions	Symbol	MRF951			MRF9511L			MMBR951L			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Insertion Gain	$\lvert S_{21}\rvert^2$										dB
(V_{CE} = 8 V, I_C = 30 mA, f = 1 GHz)		—	14.5	—	—	14.5	—	—	12.5	—	
(V_{CE} = 8 V, I_C = 30 mA, f = 2 GHz)		—	9.5	—	—	9	—	—	7	—	
Maximum Unilateral Gain(1)	$G_{U\,max}$										dB
(V_{CE} = 8 V, I_C = 30 mA, f = 1 GHz)		—	17	—	—	17	—	—	14	—	
(V_{CE} = 8 V, I_C = 30 mA, f = 2 GHz)		—	11	—	—	10.5	—	—	8	—	
Noise Figure — Minimum	$NF_{MIN.}$										dB
(V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)		—	1.3	—	—	1.3	—	—	1.3	—	
(V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz)		—	2.1	—	—	2.1	—	—	2.1	—	
Associated Gain at Minimum NF	G_{NF}										dB
(V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)		—	14	—	—	14	—	—	13	—	
(V_{CE} = 6 V, I_C = 5 mA, f = 2 GHz)		—	9	—	—	9	—	—	7.5	—	
Noise Figure — 50 Ohm Source (V_{CE} = 6 V, I_C = 5 mA, f = 1 GHz)	$NF_{50\Omega}$	—	1.9	2.8	—	1.9	2.8	—	1.9	2.8	dB

NOTE: 1. Maximum Unilateral Gain is $GU_{max} = \frac{\lvert S_{21}\rvert^2}{(1-\lvert S_{11}\rvert^2)(1-\lvert S_{22}\rvert^2)}$

TYPICAL CHARACTERISTICS

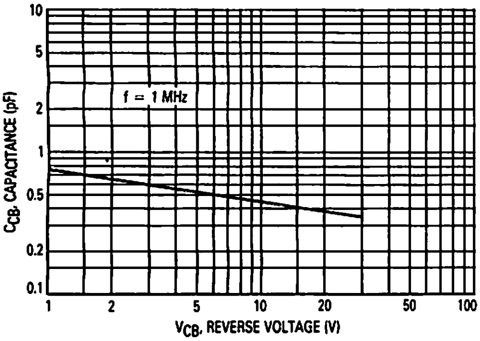


Figure 1. Collector-Base Capacitance versus Voltage

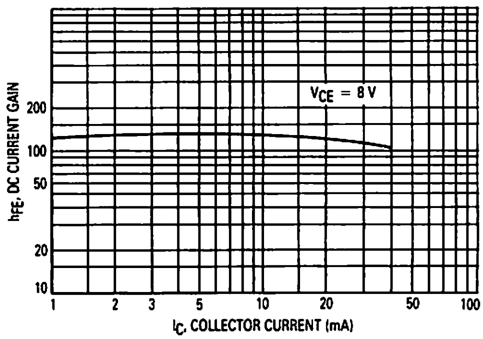


Figure 2. DC Current Gain versus Collector Current

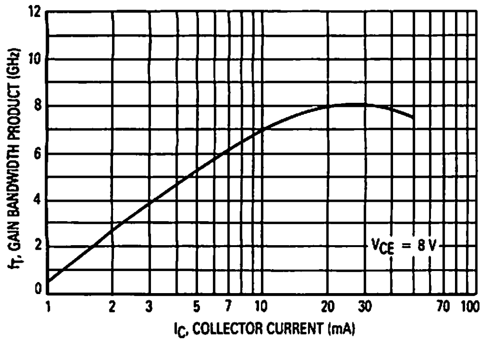


Figure 3. Gain Bandwidth Product versus Collector Current

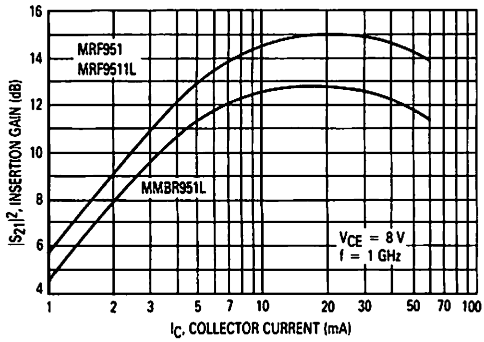


Figure 4. Insertion Gain versus Collector Current

2

TYPICAL FORWARD INSERTION GAIN AND MAXIMUM UNILATERAL GAIN versus FREQUENCY

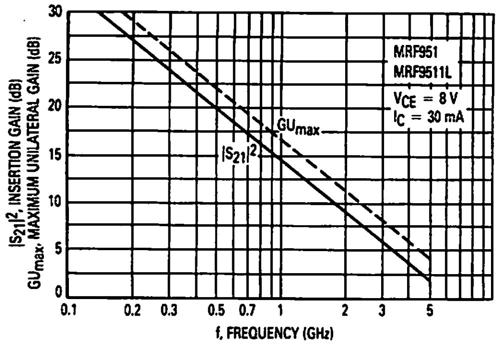


Figure 5. MRF951, MRF9511L

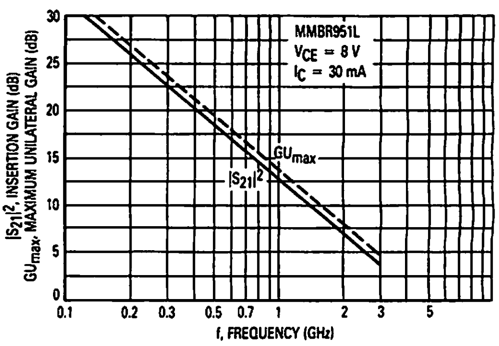


Figure 6. MMBR951L

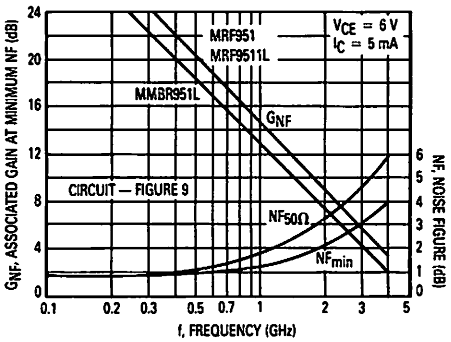


Figure 7. Typical Noise Figure and Associated Gain versus Frequency

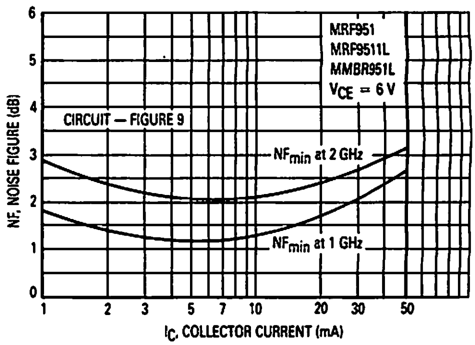
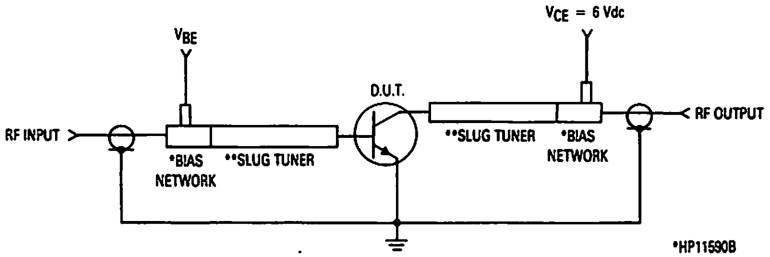


Figure 8. Typical Noise Figure versus Collector Current



*HP11590B
**MICROLAB/FXR
SF – 11N < 1 GHz
SF - 31N ≥ 1 GHz

Figure 9. Functional Circuit Schematic

MRF951
TYPICAL COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6	5	100	0.81	−36	13.89	156	0.03	72	0.94	−17
		500	0.58	−122	7.23	105	0.07	42	0.55	−46
		1000	0.53	−165	4.06	78	0.08	41	0.42	−57
		1500	0.54	172	2.78	61	0.10	44	0.40	−67
		2000	0.55	155	2.13	46	0.12	47	0.40	−79
		2500	0.56	140	1.74	32	0.15	48	0.41	−92
		3000	0.59	127	1.46	21	0.18	47	0.43	−105
		3500	0.61	115	1.28	9	0.22	44	0.45	−119
		4000	0.62	104	1.13	−1	0.26	40	0.48	−132
	10	100	0.67	−41	22.99	147	0.02	67	0.86	−26
		500	0.50	−85	8.94	97	0.05	49	0.41	−53
		1000	0.48	−34	4.75	75	0.08	54	0.31	−61
		1500	0.49	163	3.26	60	0.11	55	0.29	−71
		2000	0.51	148	2.47	46	0.14	53	0.30	−83
		2500	0.52	135	2.03	34	0.17	50	0.31	−97
		3000	0.55	123	1.72	22	0.20	46	0.34	−109
		3500	0.56	112	1.50	11	0.24	41	0.36	−122
		4000	0.59	101	1.33	1	0.28	37	0.39	−135
	20	100	0.52	−77	32.50	137	0.02	62	0.75	−34
		500	0.46	−96	10.00	92	0.05	60	0.30	−56
		1000	0.47	172	5.20	73	0.08	63	0.24	−63
		1500	0.48	156	3.50	59	0.11	61	0.24	−74
		2000	0.49	143	2.70	46	0.15	57	0.24	−86
		2500	0.51	131	2.20	34	0.18	52	0.26	−100
		3000	0.53	121	1.90	23	0.22	47	0.29	−112
		3500	0.55	110	1.60	13	0.25	41	0.31	−125
		4000	0.57	100	1.40	3	0.28	35	0.34	−137
	30	100	0.45	−95	36.80	132	0.02	64	0.68	−38
		500	0.46	−170	10.20	89	0.04	65	0.27	−55
		1000	0.47	169	5.30	72	0.08	66	0.22	−62
		1500	0.48	154	3.60	58	0.11	63	0.22	−73
		2000	0.50	142	2.80	45	0.15	58	0.23	−86
		2500	0.51	132	2.30	36	0.18	54	0.25	−97
		3000	0.53	119	1.90	23	0.22	47	0.28	−113
		3500	0.55	109	1.60	12	0.25	41	0.30	−125
		4000	0.57	99	1.50	2	0.29	35	0.33	−137
	60	100	0.41	−129	38.90	123	0.01	63	0.58	−40
		500	0.49	−35	9.70	86	0.04	71	0.26	−44
		1000	0.50	164	4.90	70	0.07	71	0.24	−53
		1500	0.52	151	3.30	56	0.11	67	0.24	−66
		2000	0.53	140	2.50	43	0.15	61	0.26	−79
		2500	0.55	128	2.10	31	0.18	56	0.28	−94
		3000	0.57	118	1.70	21	0.21	50	0.31	−108
		3500	0.59	108	1.50	10	0.25	44	0.33	−121
		4000	0.61	98	1.30	0	0.29	38	0.36	−134

(continued)

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MRF951
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
8	5	100	0.82	−34	13.71	157	0.03	74	0.94	−16
		500	0.59	−119	7.35	106	0.07	42	0.57	−44
		1000	0.52	−162	4.14	78	0.08	41	0.44	−54
		1500	0.52	174	2.86	61	0.10	46	0.41	−65
		2000	0.54	156	2.19	46	0.12	48	0.41	−76
		2500	0.55	141	1.78	32	0.15	50	0.42	−90
		3000	0.58	128	1.49	21	0.18	48	0.45	−103
		3500	0.59	116	1.31	9	0.22	45	0.47	−116
		4000	0.62	104	1.15	−1	0.26	41	0.50	−129
	10	100	0.68	−50	23.16	148	0.02	67	0.86	−24
		500	0.49	−142	9.19	98	0.05	50	0.43	−49
		1000	0.47	−177	4.87	75	0.07	54	0.33	−56
		1500	0.48	164	3.33	60	0.10	56	0.32	−66
		2000	0.50	149	2.56	46	0.13	54	0.32	−77
		2500	0.51	136	2.08	34	0.16	52	0.34	−91
		3000	0.54	124	1.76	23	0.20	48	0.36	−103
		3500	0.55	113	1.54	11	0.23	43	0.38	−117
		4000	0.58	103	1.36	1	0.27	39	0.41	−129
	20	100	0.53	−73	32.78	138	0.02	65	0.76	−32
		500	0.45	−160	10.25	92	0.04	60	0.33	−50
		1000	0.45	174	5.33	73	0.07	62	0.27	−57
		1500	0.46	161	3.96	62	0.10	61	0.26	−65
		2000	0.48	144	2.74	46	0.14	57	0.27	−79
		2500	0.50	132	2.24	34	0.17	54	0.29	−93
		3000	0.52	121	1.90	23	0.21	48	0.31	−106
		3500	0.54	111	1.66	12	0.24	42	0.33	−118
		4000	0.56	101	1.48	3	0.28	37	0.36	−131
	30	100	0.45	−90	37.27	132	0.01	62	0.70	−36
		500	0.45	−102	10.50	90	0.04	65	0.30	−48
		1000	0.45	170	5.41	72	0.07	66	0.25	−55
		1500	0.47	155	3.66	58	0.11	64	0.25	−66
		2000	0.48	142	2.81	46	0.14	59	0.26	−78
		2500	0.50	131	2.27	34	0.18	55	0.27	−92
		3000	0.52	120	1.93	23	0.21	49	0.30	−105
		3500	0.54	110	1.69	12	0.25	43	0.32	−118
		4000	0.56	100	1.50	2	0.28	38	0.35	−131
	60	100	0.42	−124	38.02	124	0.01	63	0.60	−35
		500	0.49	−106	9.54	87	0.04	70	0.31	−38
		1000	0.50	165	4.92	70	0.07	71	0.29	−47
		1500	0.51	152	3.36	57	0.10	68	0.29	−60
		2000	0.52	140	2.55	44	0.14	62	0.30	−74
		2500	0.54	129	2.08	32	0.17	58	0.32	−88
		3000	0.56	118	1.76	21	0.21	52	0.34	−102
		3500	0.58	108	1.53	10	0.24	46	0.37	−116
		4000	0.61	98	1.35	0	0.28	40	0.39	−129

MMBR951L
COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6	5	100	0.82	−36.6	14.0	153	0.04	44.7	0.88	−18.2
		500	0.50	−119	6.6	104	0.07	48.2	0.52	−40
		1000	0.39	−162	3.5	81	0.11	55	0.43	−43
		2000	0.32	150	1.9	57	0.21	66	0.42	−50
		3000	0.36	110	1.4	40	0.31	66	0.40	−67
	10	100	0.66	−54	22.6	142	0.03	60	0.78	−29
		500	0.38	−138	7.8	96	0.07	55	0.40	−42
		1000	0.32	−176	4.0	78	0.13	71	0.34	−47
		2000	0.26	142	2.2	57	0.22	70	0.36	−46
		3000	0.31	105	1.6	41	0.32	64	0.33	−62
	20	100	0.49	−76	30	131	0.01	85	0.67	−37
		500	0.32	−153	8.3	92	0.08	76	0.34	−39
		1000	0.29	175	4.3	77	0.11	67	0.29	−44
		2000	0.24	137	2.3	57	0.24	71	0.32	−48
		3000	0.28	102	1.6	42	0.34	63	0.29	−60
	30	100	0.40	−94	33	125	0.03	87	0.58	−42
		500	0.30	−162	8.4	90	0.07	84	0.31	−35
		1000	0.29	170	4.3	76	0.12	80	0.27	−39
		2000	0.24	134	2.3	56	0.23	71	0.33	−48
		3000	0.30	101	1.6	41	0.35	66	0.30	−60
	60	100	0.38	−126	31	116	0.03	74	0.49	−37
		500	0.37	−176	7.3	77.6	0.05	84	0.34	−26
		1000	0.36	163	3.7	73.4	0.12	84	0.34	−37
		2000	0.33	130	2.0	52	0.22	78	0.37	−48
		3000	0.38	98	1.4	37	0.34	69	0.34	−62
8	5	100	0.83	−35	13.9	154	0.04	92	0.90	−19
		500	0.51	−117	6.7	104	0.08	51	0.55	−38
		1000	0.38	−160	3.6	82	0.10	72	0.44	−42
		2000	0.31	151	1.9	58	0.20	73	0.46	−47
		3000	0.35	110	1.4	41	0.32	71	0.43	−63
	10	100	0.67	−52	23	143	0.02	96	0.81	−28
		500	0.37	−135	7.9	97	0.07	64	0.43	−38
		1000	0.30	−173	4.1	80	0.11	78	0.37	−41
		2000	0.25	143	2.2	57	0.21	74	0.38	−47
		3000	0.30	105	1.6	42	0.31	67	0.34	−60
	20	100	0.51	−72	30	131	0.02	68	0.68	−35
		500	0.31	−150	8.5	92	0.07	75	0.36	−36
		1000	0.28	177	4.3	77	0.13	76	0.32	−39
		2000	0.23	138	2.3	57	0.22	72	0.35	−45
		3000	0.27	103	1.6	42	0.31	64	0.31	−58
	30	100	0.42	−87	33	125	0.02	71	0.61	−38
		500	0.31	−159	8.6	90	0.07	71	0.33	−33
		1000	0.27	172	4.4	76	0.11	74	0.32	−39
		2000	0.23	135	2.3	57	0.22	73	0.34	−42
		3000	0.28	102	1.6	41	0.31	65	0.33	−55
	60	100	0.39	−119	32	117	0.02	31	0.52	−31
		500	0.36	−174	7.4	87	0.06	84	0.37	−25
		1000	0.35	164	3.8	74	0.11	78	0.35	−33
		2000	0.32	131	2.0	53	0.22	81	0.42	−41
		3000	0.37	100	1.4	38	0.33	70	0.40	−62

MRF9511L
TYPICAL COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6	5	100	0.81	−48	13.69	152	0.04	66	0.88	−22
		500	0.67	−122	7.58	92	0.07	41	0.57	−50
		1000	0.61	−157	4.65	76	0.09	40	0.45	−62
		1500	0.57	86	2.87	70	0.10	44	0.42	−71
		2000	0.54	156	2.14	60	0.12	52	0.42	−75
		2500	0.55	121	1.72	51	0.14	57	0.40	−86
		3000	0.57	121	1.48	44	0.17	59	0.39	−97
		3500	0.65	110	1.28	38	0.21	60	0.37	−112
		4000	0.67	100	1.14	33	0.24	54	0.38	−130
	10	100	0.71	−56	24.07	149	0.03	66	0.86	−28
		500	0.60	−143	9.47	101	0.05	46	0.41	−62
		1000	0.56	−176	4.97	81	0.07	51	0.30	−73
		1500	0.53	167	3.35	69	0.10	57	0.31	−78
		2000	0.50	148	2.54	60	0.13	63	0.30	−78
		2500	0.52	132	2.02	52	0.16	63	0.29	−89
		3000	0.54	116	1.75	45	0.19	61	0.29	−78
		3500	0.60	106	1.53	39	0.22	60	0.26	−115
		4000	0.64	97	1.35	34	0.26	57	0.28	−133
	20	100	0.59	−80	33.51	138	0.02	61	0.75	−38
		500	0.56	−159	10.39	95	0.04	54	0.31	−69
		1000	0.54	175	5.36	79	0.07	62	0.23	−79
		1500	0.51	161	3.58	68	0.10	66	0.25	−82
		2000	0.49	142	2.75	60	0.13	68	0.25	−80
		2500	0.52	128	2.18	52	0.16	66	0.23	−91
		3000	0.53	112	1.88	45	0.20	63	0.23	−99
		3500	0.60	103	1.65	39	0.24	62	0.21	−117
		4000	0.63	95	1.46	34	0.27	57	0.22	−137
	30	100	0.54	−97	37.48	133	0.02	57	0.67	−43
		500	0.56	−166	10.60	63	0.04	59	0.27	−70
		1000	0.54	171	5.45	78	0.07	68	0.21	−80
		1500	0.51	158	3.62	67	0.10	69	0.24	−81
		2000	0.50	140	2.73	60	0.13	70	0.23	−79
		2500	0.52	126	2.19	51	0.17	68	0.23	−90
		3000	0.53	111	1.89	45	0.20	64	0.23	−97
		3500	0.60	102	1.65	38	0.24	62	0.20	−115
		4000	0.63	94	1.47	33	0.27	58	0.22	−136
	60	100	0.54	−128	36.66	123	0.01	57	0.56	−43
		500	0.60	−177	8.97	89	0.03	67	0.27	−50
		1000	0.59	166	4.62	75	0.06	73	0.25	−59
		1500	0.56	153	3.05	64	0.09	75	0.29	−68
		2000	0.55	136	2.29	56	0.13	76	0.30	−71
		2500	0.57	125	1.85	48	0.16	74	0.29	−83
		3000	0.59	110	1.59	42	0.20	69	0.30	−92
		3500	0.65	102	1.41	36	0.23	67	0.27	−108
		4000	0.69	93	1.22	31	0.27	62	0.29	−130

(continued)

MRF9511L
TYPICAL COMMON EMITTER S-PARAMETERS (continued)

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
8	5	100	0.84	−36	14.65	158	0.03	72	0.94	−18
		500	0.68	−120	7.79	110	0.07	42	0.58	−48
		1000	0.60	−161	4.32	86	0.08	41	0.44	−60
		1500	0.56	88	2.95	71	0.10	45	0.44	−68
		2000	0.53	157	2.19	60	0.11	53	0.44	−71
		2500	0.55	140	1.76	51	0.14	58	0.42	−82
		3000	0.56	122	1.50	44	0.17	60	0.42	−92
		3500	0.63	112	1.33	39	0.18	62	0.38	−107
		4000	0.68	105	1.18	33	0.21	63	0.36	−125
	10	100	0.73	−53	24.04	150	0.02	68	0.87	−26
		500	0.60	−140	9.68	101	0.05	46	0.43	−58
		1000	0.55	−174	5.10	82	0.07	52	0.32	−66
		1500	0.52	169	3.42	69	0.09	58	0.33	−72
		2000	0.49	149	2.59	61	0.12	63	0.33	−73
		2500	0.51	133	2.06	52	0.15	63	0.32	−83
		3000	0.53	116	1.78	45	0.19	63	0.32	−91
		3500	0.64	109	1.60	38	0.20	62	0.28	−108
		4000	0.67	101	1.39	34	0.23	60	0.29	−131
	20	100	0.61	−76	33.76	139	0.02	60	0.76	−36
		500	0.56	−157	10.72	96	0.04	54	0.32	−63
		1000	0.53	176	5.53	79	0.07	62	0.29	−70
		1500	0.50	162	3.69	68	0.10	66	0.27	−75
		2000	0.48	143	2.79	60	0.13	68	0.27	−74
		2500	0.51	129	2.22	52	0.16	68	0.26	−84
		3000	0.52	112	1.92	46	0.19	65	0.26	−91
		3500	0.59	104	1.75	40	0.21	64	0.24	−109
		4000	0.63	98	1.54	35	0.24	59	0.25	−131
	30	100	0.57	−89	37.35	134	0.02	58	0.71	−40
		500	0.55	−163	10.82	94	0.04	57	0.29	−63
		1000	0.53	128	5.54	78	0.07	65	0.24	−69
		1500	0.50	159	3.69	67	0.10	69	0.26	−73
		2000	0.49	141	2.77	59	0.13	70	0.27	−71
		2500	0.51	127	2.23	51	0.16	69	0.26	−82
		3000	0.52	112	1.93	45	0.19	66	0.26	−89
		3500	0.61	106	1.68	40	0.21	64	0.21	−110
		4000	0.66	97	1.51	34	0.24	60	0.23	−130
	60	100	0.55	−122	34.92	126	0.01	52	0.59	−37
		500	0.59	−175	8.71	91	0.03	65	0.33	−42
		1000	0.58	167	4.52	76	0.06	73	0.30	−53
		1500	0.55	154	3.04	65	0.09	75	0.34	−62
		2000	0.54	138	2.28	56	0.12	77	0.35	−66
		2500	0.57	125	1.82	48	0.16	76	0.34	−78
		3000	0.59	110	1.56	42	0.19	72	0.35	−88
		3500	0.66	104	1.28	36	0.22	70	0.32	−105
		4000	0.70	95	1.14	32	0.26	66	0.32	−132

2

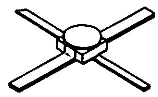
MRF952

The RF Line
NPN Silicon Low Noise, High-Frequency Transistor

I_C = 75 mA
LOW NOISE
HIGH FREQUENCY
TRANSISTOR

... designed for use in high gain, low noise small-signal amplifiers. This device features excellent broadband linearity and is offered in a metal-ceramic hermetic package suitable for high-reliability applications.

- Low Noise Figure — 1.3 dB Typ @ f = 1.0 GHz
- Associated Gain — 16 dB Typ @ f = 1.0 GHz
- High Output Power — 20 dBm Typ @ 1.0 dB Compression, f = 1.0 GHz
- Fully Implanted Base and Emitter Structure
- 18 Finger, 1.25 Micron Geometry with Gold Top Metal
- High Reliability Processing Available



CASE 303-01

MAXIMUM RATINGS

Ratings	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	1.5	Vdc
Power Dissipation (1) Derate above 125°C	P_D	600 8.0	mWatts mW/°C
Collector Current — Continuous (2)	I_C	75	mA
Junction Temperature	T_J	200	°C
Storage Temperature	T_{stg}	−65 to +200	°C
Thermal Resistance Minimum, Junction to Case	$R_{\theta JC}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (3)					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mA, I_B = 0)	$V_{(BR)CEO}$	10	13	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mA, I_E = 0)	$V_{(BR)CBO}$	20	25	—	Vdc
Emitter Cutoff Current (V_{EB} = 1.0 V, I_C = 0)	I_{EBO}	—	—	0.1	μAdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	0.1	μAdc
ON CHARACTERISTICS (3)					
DC Current Gain (V_{CE} = 8.0 V, I_C = 5.0 mA)	h_{FE}	50	—	200	—
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 10 V, I_E = 0, f = 1.0 MHz)	C_{cb}	—	0.36	—	pF
Current Gain — Bandwidth Product (V_{CE} = 8.0 V, I_C = 30 mA, f = 1.0 GHz)	f_T	—	8.0	—	GHz

NOTES: 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package. To calculate the junction temperature use $T_J = P_D \times R_{\theta JC} + T_{CASE}$.
2. I_C — Continuous (MTBF ~ 10 years)
3. Pulse width ≤ 300 μs, duty cycle ≤ 2.0% pulsed.

PERFORMANCE CHARACTERISTICS

Conditions		Symbol	Min	Typ	Max	Units
Insertion Gain (1) $\lvert S_{21}\rvert^2$ (V_{CE} = 8.0 V, I_C = 30 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	$\lvert S_{21}\rvert^2$	— — —	17 11 5	— — —	dB
Output Power $P_{1\,dB}$ (V_{CE} = 8.0 V, I_C = 30 mA)	f = 1.0 GHz	$P_{1\,dB}$	—	20	—	dBm
1.0 dB Gain Compression (2) $G_{1\,dB}$ (V_{CE} = 8.0 V, I_C = 30 mA)	f = 1.0 GHz	$G_{1\,dB}$	—	20	—	dB
Minimum Noise Figure NF_{min} (V_{CE} = 8.0 V, I_C = 5.0 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	NF_{min}	— — —	1.3 2.0 2.6	1.8 — —	dB
Associated Gain (3) G_{NF} (V_{CE} = 8.0 V, I_C = 5.0 mA)	f = 1.0 GHz f = 2.0 GHz f = 4.0 GHz	G_{NF}	14.5 — —	16 11 8	— — —	dB

TYPICAL NOISE PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	NF_{min} (dB)	G_{NF} (dB)	Γ_o (MAG, ANG)	R_N (ohms)	$NF_{50\,\Omega}$ (dB)
8	5	1000	1.3	16	.30 ∠ 130	7.5	1.7
		2000	2.0	11	.40 ∠ −179	10	2.9
		4000	2.6	8	.67 ∠ −104	46	5.2
	10	1000	1.4	18	.29 ∠ 148	7.0	1.8
		2000	2.1	13	.38 ∠ −173	11.5	3.0
		4000	2.8	10	.66 ∠ −100	47.5	5.3

(1) In 50 Ohm System, Unmatched.
(2) In 50 Ohm System, Input and Output Tuned for Max. Gain.
(3) In 50 Ohm System, Input and Output Tuned for Max. Gain with Min. Noise Figure.

TYPICAL CHARACTERISTICS

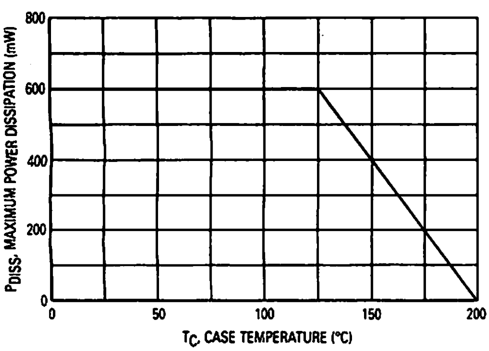


Figure 1. Maximum Power Dissipation versus Case Temperature

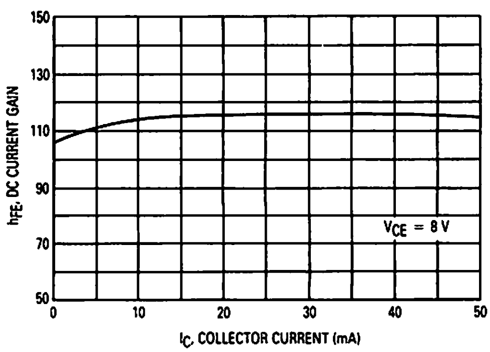


Figure 2. DC Current Gain versus Current

2

TYPICAL CHARACTERISTICS

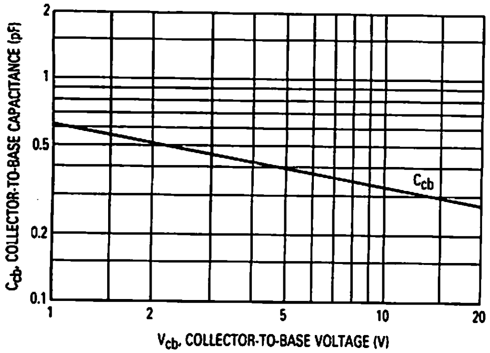


Figure 3. Collector-Base Capacitance versus Voltage

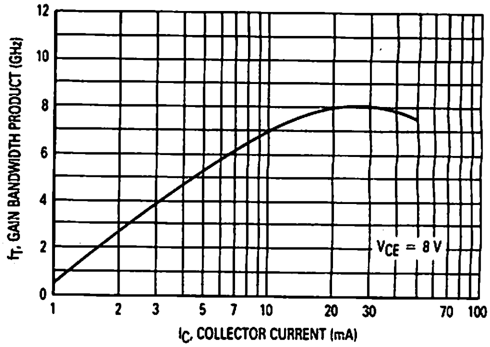


Figure 4. Typical Gain-Bandwidth Product versus Collector Current

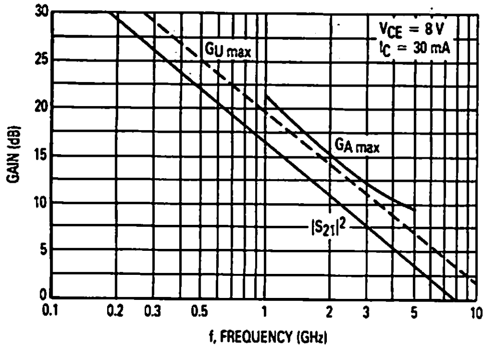


Figure 5. Gain versus Frequency

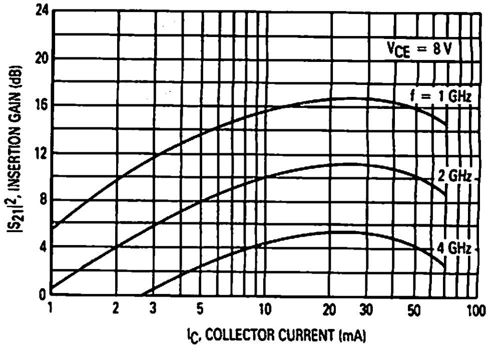


Figure 6. Insertion Gain versus Current

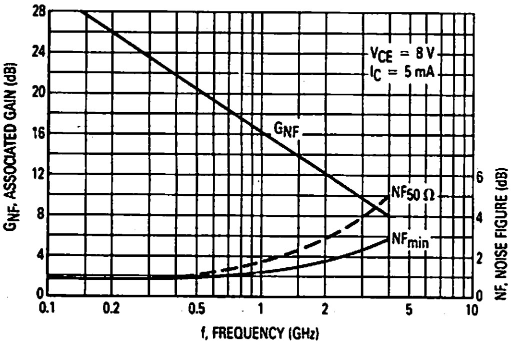


Figure 7. I_C = 5 mA

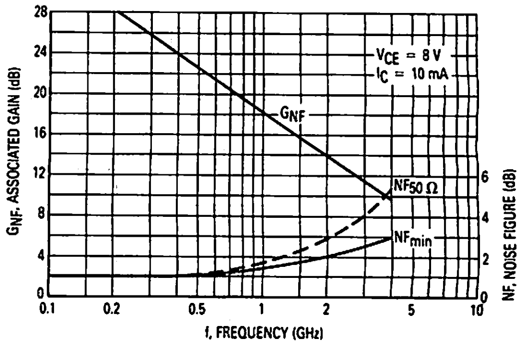


Figure 8. I_C = 10 mA

Noise Figure and Associated Gain versus Frequency

2

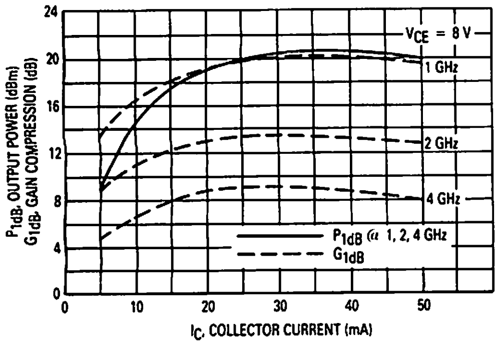


Figure 9. Output Power and 1 dB Gain Compression versus Current and Frequency

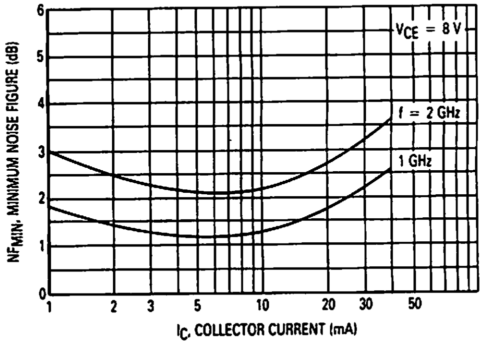


Figure 10. Minimum Noise Figure versus Current

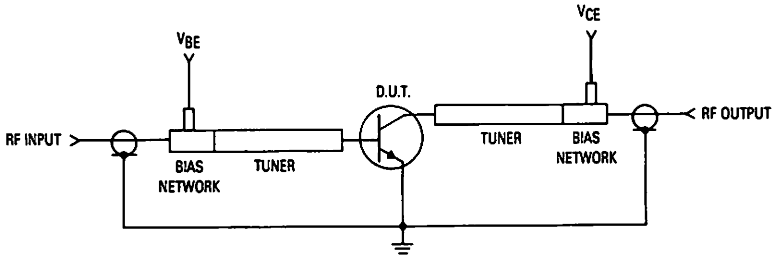


Figure 11. Functional Circuit Schematic

Figure 12. Typical Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
8	5	100	0.85	−32	15.1	160	0.02	56	0.96	−13
		200	0.82	−61	13.6	143	0.04	57	0.87	−24
		400	0.76	−101	10.0	119	0.06	41	0.69	−37
		600	0.73	−127	7.5	104	0.06	33	0.58	−43
		800	0.71	−142	5.9	93	0.06	27	0.53	−47
		1000	0.70	−155	4.9	85	0.07	22	0.48	−51
		1500	0.69	−173	3.3	68	0.07	16	0.46	−59
		2000	0.69	173	2.5	54	0.07	19	0.46	−68
		2500	0.69	164	2.1	44	0.08	21	0.47	−76
		3000	0.69	154	1.7	32	0.08	27	0.49	−85
		3500	0.69	145	1.5	20	0.08	24	0.52	−95
		4000	0.69	134	1.3	10	0.10	30	0.55	−104
		4500	0.70	126	1.2	0	0.10	24	0.57	−113
		5000	0.70	117	1.1	−10	0.11	26	0.59	−122
		5500	0.70	108	0.9	−19	0.13	23	0.62	−130
		6000	0.70	99	0.9	−28	0.14	24	0.65	−138
	10	100	0.72	−49	25.5	155	0.02	72	0.92	−19
		200	0.67	−87	20.3	135	0.03	56	0.78	−32

Figure 12. Typical Common Emitter S-Parameters

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
8	10	400	0.67	−124	13.3	113	0.04	39	0.56	−45
		600	0.68	−144	9.7	99	0.05	31	0.46	−48
		800	0.68	−158	7.3	90	0.04	34	0.41	−52
		1000	0.71	−167	6.2	84	0.04	35	0.38	−54
		1500	0.70	177	4.1	69	0.05	38	0.37	−61
		2000	0.64	168	3.1	56	0.06	34	0.38	−71
		2500	0.67	155	2.5	44	0.07	36	0.40	−79
		3000	0.67	151	2.2	35	0.08	34	0.41	−85
		3500	0.64	139	1.9	25	0.09	34	0.43	−94
		4000	0.67	131	1.7	16	0.11	32	0.47	−105
		4500	0.68	124	1.4	6.0	0.12	29	0.48	−112
		5000	0.69	113	1.3	−5.0	0.13	31	0.51	−118
		5500	0.66	102	1.2	−11	0.15	27	0.55	−127
		6000	0.65	97	1.1	−25	0.16	23	0.57	−133
	15	100	0.66	−59	30.5	149	0.02	51	0.86	−24
		200	0.66	−98	23.9	128	0.03	53	0.68	−39
		400	0.66	−137	15.2	106	0.03	42	0.47	−51
		600	0.67	−154	10.4	95	0.04	36	0.37	−55
		800	0.67	−165	8.0	87	0.04	38	0.33	−57
		1000	0.67	−172	6.4	80	0.04	41	0.31	−58
		1500	0.67	175	4.4	67	0.05	43	0.29	−64
		2000	0.68	165	3.4	55	0.06	42	0.30	−72
		2500	0.68	156	2.7	44	0.08	39	0.32	−85
		3000	0.67	148	2.3	34	0.08	43	0.34	−92
		3500	0.67	140	2.0	24	0.10	40	0.36	−98
		4000	0.67	131	1.7	15	0.11	35	0.39	−107
		4500	0.67	124	1.6	5.0	0.13	34	0.42	−115
		5000	0.67	115	1.4	−4.0	0.14	31	0.44	−123
		5500	0.67	107	1.3	−13	0.15	28	0.48	−130
		6000	0.67	98	1.2	−23	0.17	23	0.52	−138
	30	100	0.56	−85	41.3	140	0.01	61	0.77	−31
		200	0.62	−124	28.6	119	0.02	45	0.56	−46
		400	0.65	−154	16.3	100	0.03	40	0.37	−55
		600	0.67	−166	11.2	91	0.03	45	0.29	−57
		800	0.67	−174	8.5	83	0.03	49	0.26	−58
		1000	0.67	−180	6.8	78	0.04	51	0.25	−58
		1500	0.67	170	4.6	65	0.05	56	0.25	−65
		2000	0.68	161	3.5	54	0.06	51	0.26	−73
		2500	0.67	153	2.8	44	0.08	50	0.28	−87
		3000	0.67	145	2.4	34	0.09	48	0.30	−93
		3500	0.67	138	2.1	24	0.11	46	0.33	−98
		4000	0.67	129	1.8	15	0.12	42	0.35	−108
		4500	0.67	122	1.6	5.0	0.13	38	0.39	−115
		5000	0.67	114	1.5	−4.0	0.14	35	0.41	−123
		5500	0.67	105	1.4	−13	0.16	29	0.46	−130
		6000	0.67	96	1.3	−22	0.18	24	0.48	−137
	60	100	0.55	−115	43.2	131	0.01	59	0.67	−33
		200	0.64	−145	26.7	111	0.02	44	0.48	−41
		400	0.68	−166	14.5	96	0.02	45	0.35	−43
		600	0.69	−174	9.9	88	0.02	59	0.31	−44
		800	0.69	180	7.5	82	0.03	60	0.29	−46
		1000	0.69	177	6.0	78	0.03	59	0.29	−48
		1500	0.70	167	4.1	64	0.04	61	0.29	−55
		2000	0.70	159	3.1	53	0.06	57	0.30	−67
		2500	0.70	151	2.5	42	0.07	57	0.32	−82
		3000	0.70	143	2.1	32	0.09	54	0.34	−88
		3500	0.70	136	1.8	22	0.10	51	0.36	−95
		4000	0.70	127	1.6	13	0.11	44	0.40	−105
		4500	0.70	120	1.4	3.0	0.13	41	0.44	−113
		5000	0.70	111	1.3	−6.0	0.14	37	0.46	−122
		5500	0.70	103	1.2	−15	0.17	33	0.50	−130
		6000	0.70	94	1.1	−24	0.18	24	0.52	−138

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF961
MRF962
MRF965
(See BFR96)

MRF966
MRFC966

2

The RF Line

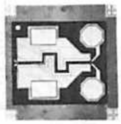
N-Channel Dual-Gate GaAs Field-Effect Transistor

... depletion mode dual-gate MES FET designed for high frequency amplifier and mixer applications.

- Excellent Receiver Front End
- Low Noise Figure — NF = 1.2 dB, 1 GHz (Typ)
- High Power Gain — G_p = 17 dB, 1 GHz (Typ)
- Low Reverse Transfer Capacitance — C_{rss} = 40 fF (Typ)
- High Transconductance — g_m = 20 mS (Typ)
- Fully Characterized
- Gold Metallization

N-CHANNEL DUAL-GATE GaAs FIELD-EFFECT TRANSISTOR

MRF966
CASE 317-01, STYLE 1



CHIP
MRFC966

MAXIMUM RATINGS

Rating	Symbol	MRFC966	MRF966	Unit
Drain-Source Voltage	V_{DS}	10	10	Vdc
Gate-Source Voltage — Reverse	V_{G1S} V_{G2S}	−8 −8	−8 −8	Vdc
Gate-Source Voltage — Forward	V_{G1S} V_{G2S}	+1 +1	+1 +1	Vdc
Drain Current — Continuous	I_D	80	80	mAdc
Total Power Dissipation @ T_A = 25°C Derate above 25°C	P_D	350 T_J = 125°C Max	350 3.5	mW mW/°C
Storage Channel Temperature Range	T_{stg}	−65 to +125	−65 to +125	°C
Junction Temperature Range	T_J	−65 to +125	−65 to +125	°C

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Drain-Source Breakdown Voltage (V_{G1S} = V_{G2S} = −4.5 Vdc, I_D = 100 μA)	$V_{(BR)DSX}$	10	—	—	Vdc
Gate 1-to-Source Cutoff Voltage (V_{DS} = 5 Vdc, V_{G2S} = 0, I_D = 500 μA)	$V_{G1S(off)}$	−2	—	−4.5	Vdc
Gate 2-to-Source Cutoff Voltage (V_{DS} = 5 Vdc, V_{G1S} = 0, I_D = 500 μA)	$V_{G2S(off)}$	−2	—	−4.5	Vdc
Gate 1 Leakage Current (V_{G1S} = −5 Vdc, V_{G2S} = V_{DS} = 0)	I_{G1SS}	—	—	10	μAdc
Gate 2 Leakage Current (V_{G2S} = −5 Vdc, V_{G1S} = V_{DS} = 0)	I_{G2SS}	—	—	10	μAdc
ON CHARACTERISTICS					
Zero-Gate Voltage Drain Current (V_{DS} = 5 Vdc, V_{G1S} = V_{G2S} = 0)	I_{DSS}	30	50	80	mAdc
SMALL-SIGNAL CHARACTERISTICS					
Transconductance (V_{DS} = 5 Vdc, V_{G2S} = 0, I_D = 10 mA, f = 1 kHz)	g_m	18	20	—	mS
Input Capacitance (V_{DS} = 5 Vdc, V_{G2S} = 0, I_D = 10 mA, f = 1 MHz)	C_{iss}	—	1.5	—	pF
Reverse Transfer Capacitance (V_{DS} = 5 Vdc, V_{G2S} = 0, I_D = 10 mA, f = 1 MHz)	C_{rss}	—	0.04	—	pF

Handling and Packaging — MES devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MES devices should be observed.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL CHARACTERISTICS					
Noise Figure(1) (V_{DS} = 5 Vdc, V_{G2S} = 0, I_{DS} = 10 mA, f = 1 GHz)	NF	—	1.2	1.5	dB
Common Source Power Gain(1) (V_{DS} = 5 Vdc, V_{G2S} = 0, I_{DS} = 10 mA, f = 1 GHz)	G_{ps}	15	17	—	dB
Intermodulation Distortion (V_{DS} = 5 Vdc, I_{DS} = 10 mA, f_1 = 995 MHz, f_2 = 1001 MHz, V_{G2} = 0, P_{in} = −40 dBm)	IMD_3	—	−65	—	dB
Linear Power Point(2) (V_{DS} = 5 Vdc, I_{DS} = 10 mA, f_1 = 995 MHz, f_2 = 1001 MHz, V_{G2} = 0)	P_L	—	+1	—	dBm
Output Power at 1 dB Compression Point (V_{DS} = 5 Vdc, I_{DS} = 10 mA, f = 1 GHz)	P_{out}	—	10	—	dBm

NOTES:
1. Data taken using a 50 Ω test fixture, Microlab SF31N slug tuners, HP11590B bias networks and the HP8970A or Eaton 2075 noise figure meter. Note: V_{G2S} = 0. Refer to Figure 11.
2. The linear power point is the output power level at which either the signal $2f_1 \pm f_2$ or $2f_2 \pm f_1$ are 30 dB below f_1 or f_2.

TYPICAL CHARACTERISTICS

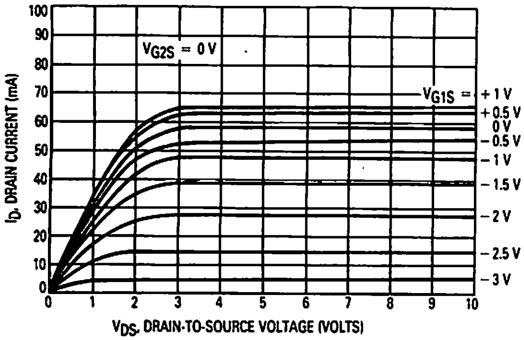


Figure 1. Drain Current versus Drain-To-Source Voltage

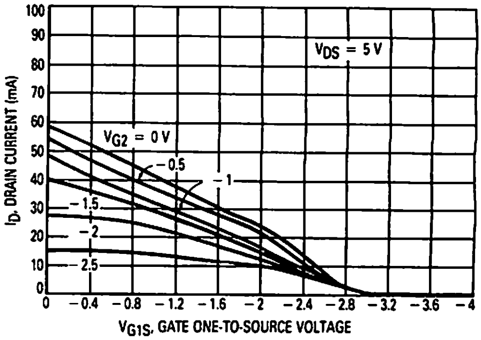


Figure 2. Drain Current versus Gate One-To-Source Voltage

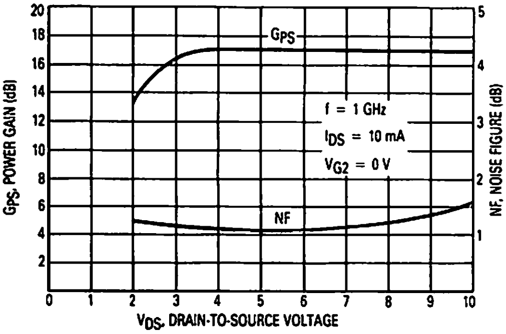


Figure 3. Power Gain and Noise Figure versus Drain-To-Source Voltage

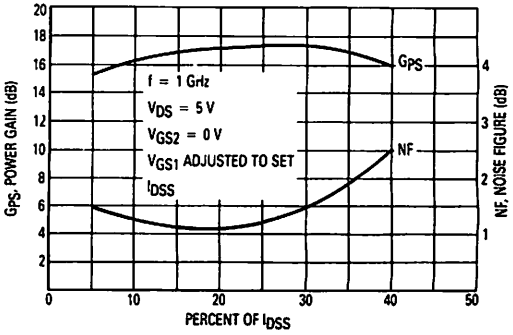


Figure 4. Power Gain and Noise Figure versus Percent of I_{DSS}

TYPICAL CHARACTERISTICS

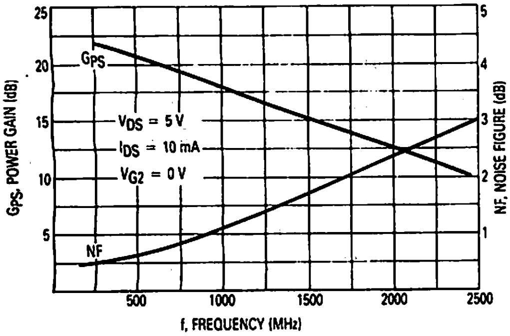


Figure 5. Power Gain and Noise Figure versus Frequency

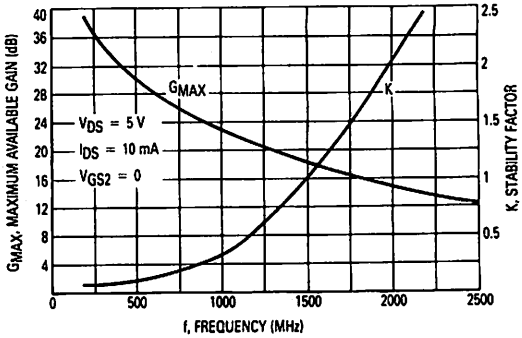


Figure 6. Maximum Available Gain and Stability Factor versus Frequency

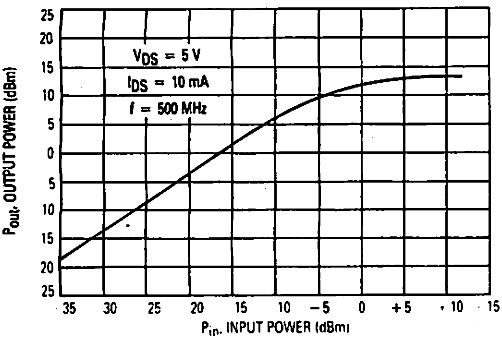


Figure 7. Output Power versus Input Power @ 500 MHz

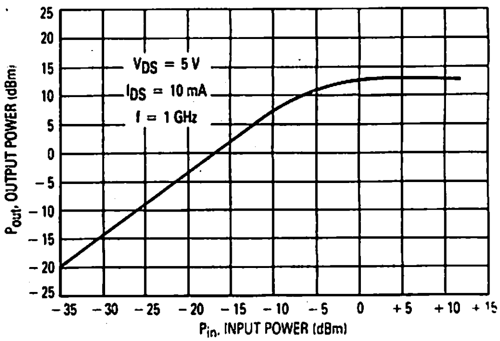


Figure 8. Output Power versus Input Power @ 1 GHz

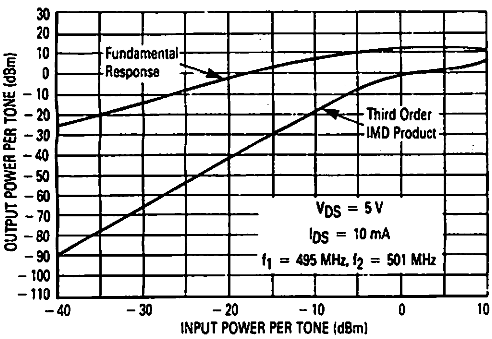


Figure 9. Third Order Intermodulation Distortion @ 500 MHz

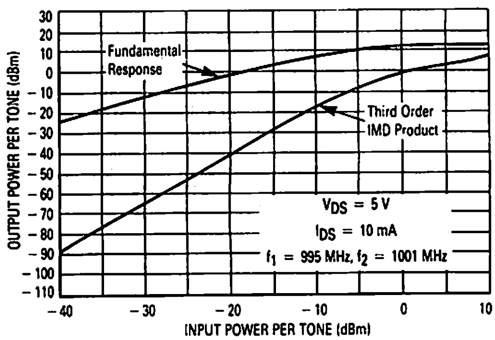


Figure 10. Third Order Intermodulation Distortion @ 1 GHz

COMMON SOURCE S-PARAMETERS

V_{DS} (Volts)	I_{DS} (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
3	5	200	0.997	−5.7	1.251	172.1	0.003	88.3	0.944	−6.4
		500	0.983	−14.3	1.23	161.2	0.007	84.6	0.931	−16
		1000	0.941	−28.3	1.201	142.4	0.013	78.5	0.9	−32.2
		1500	0.866	−42.3	1.133	122	0.016	70.4	0.836	−49.6
		2000	0.762	−55.4	1.011	101.1	0.018	56.2	0.744	−67.5
		2500	0.642	−66.4	0.819	77.4	0.015	25.5	0.608	−87.5
	10	200	0.995	−6.2	1.60	172.0	0.002	84.1	0.93	−6.3
		500	0.981	−15.1	1.58	161.3	0.007	82.5	0.92	−15.8
		1000	0.928	−29.9	1.55	142.9	0.013	81.5	0.90	−31.8
		1500	0.838	−44.4	1.46	122.3	0.016	74.7	0.84	−49.4
		2000	0.716	−57.7	1.31	101.2	0.018	60.1	0.76	−68.4
		2500	0.584	−67.5	1.06	77.4	0.015	26.7	0.63	−89.8
	15	200	0.996	−6.3	1.83	172.0	0.002	76.4	0.93	−6.3
		500	0.979	−15.7	1.80	161.2	0.006	91.5	0.92	−15.6
		1000	0.921	−30.9	1.76	142.3	0.012	82.3	0.90	−31.6
		1500	0.820	−45.9	1.66	121.7	0.016	76.1	0.85	−49.1
		2000	0.689	−58.7	1.48	100.6	0.016	64.1	0.77	−68.2
		2500	0.552	−67.4	1.20	76.7	0.013	28.9	0.65	−90.3
	20	200	0.995	−6.5	1.97	171.9	0.003	85.7	0.92	−6.2
		500	0.977	−16.2	1.93	160.7	0.007	89.0	0.91	−15.3
		1000	0.910	−32.0	1.89	141.7	0.011	84.0	0.89	−31.0
		1500	0.804	−47.1	1.79	120.9	0.016	78.3	0.85	−48.4
		2000	0.669	−59.7	1.59	99.6	0.017	66.2	0.78	−67.4
		2500	0.531	−67.7	1.29	75.8	0.012	32.7	0.66	−89.2
5	5	200	0.997	−5.8	1.27	172.8	0.002	102.6	0.97	−3.8
		500	0.983	−14.3	1.26	162.6	0.004	82.3	0.97	−9.4
		1000	0.939	−28.4	1.24	146.0	0.006	93.4	0.96	−18.8
		1500	0.866	−42.6	1.21	128.4	0.008	102.6	0.95	−28.3
		2000	0.765	−5.3	1.14	111.6	0.007	137.7	0.93	−37.6
		2500	0.642	−68.4	1.05	93.1	0.012	−179.0	0.92	−47.0
	10	200	0.966	−6.0	1.61	172.8	0.002	88.1	0.97	−3.8
		500	0.982	−15.1	1.59	162.8	0.004	85.8	0.97	−9.4
		1000	0.928	−29.9	1.57	146.1	0.006	94.6	0.96	−18.6
		1500	0.841	−44.6	1.53	128.7	0.006	110.4	0.94	−28.0
		2000	0.724	−58.3	1.42	111.6	0.008	152.6	0.93	−37.0
		2500	0.589	−69.4	1.30	93.3	0.014	179.1	0.92	−46.3
	15	200	0.997	−6.2	1.82	172.6	0.001	103.2	0.97	−3.7
		500	0.979	−15.6	1.80	162.5	0.003	85.3	0.96	−9.3
		1000	0.920	−30.8	1.77	145.6	0.005	92.4	0.95	−18.4
		1500	0.824	−45.8	1.72	127.9	0.007	116.3	0.94	−27.3
		2000	0.699	−59.2	1.59	110.8	0.008	154.1	0.93	−36.3
		2500	0.560	−69.6	1.44	92.6	0.017	176.2	0.92	−45.4
	20	200	0.995	−6.5	1.96	172.4	0.002	85.9	0.97	−3.7
		500	0.977	−16.1	1.93	162.1	0.004	80.9	0.96	−9.1
		1000	0.913	−31.7	1.90	144.9	0.005	92.1	0.95	−17.9
		1500	0.810	−47.0	1.83	126.9	0.007	121.4	0.94	−26.9
		2000	0.679	−60.4	1.69	109.7	0.009	153.4	0.93	−35.6
		2500	0.538	−70.0	1.53	91.4	0.017	176.0	0.93	−44.6

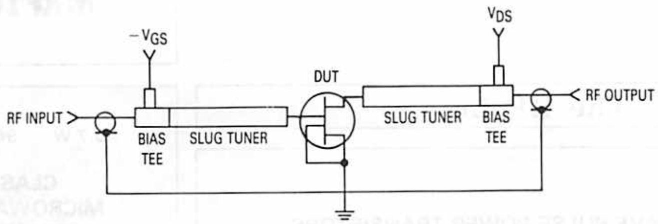
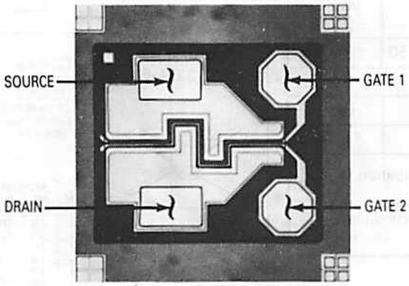


Figure 11. 1 GHz Test Circuit Schematic

TYPICAL CHARACTERISTICS

f (MHz)	G_{NF} (dB)	NF (dB)	$\Gamma MS\ NF_{opt}$	$\Gamma ML\ NF_{opt}$
450	20	0.6	$0.82 \angle 21°$	$0.80 \angle 11°$
1000	17	1.2	$0.74 \angle 21°$	$0.77 \angle 12°$

Figure 12. Source and Load Impedance for Optimum Noise Figure



MRFC966 Chip Topography

Nominal Chip Size: 0.017" x 0.020" x 0.005"
Drain/Source Bond Pad: 0.003" x 0.004"
Gate 1/Gate 2 Bond Pad: 0.0035" x 0.0035"

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1000MA
MRF1000MB

The RF Line

0.7 W 960-1215 MHz

CLASS A/AB
MICROWAVE POWER
TRANSISTORS

NPN SILICON

2

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class A and AB *common emitter* amplifier applications in the low-power stages of IFF, DME, TACAN, radar transmitters, and CW systems.

- Guaranteed Performance @ 1090 MHz, 18 Vdc — Class A
  Output Power = 0.2 Watt
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1000M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

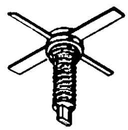
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

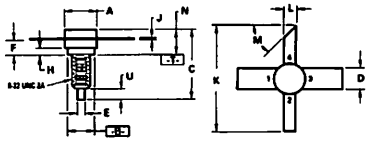
MRF1000MA
CASE 332-04



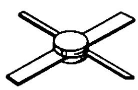
NOTES
1. DIM [-B-] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS
   [⌖ | 0.76 (0.030) Ⓜ | T | B Ⓜ]
3. [-T-] IS SEATING PLANE
4. DIMENSION K APPLIES TWO PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

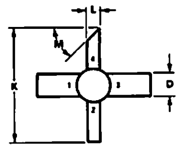


MRF1000MB
CASE 332A-01

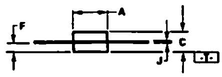


NOTES
1. DIM [-A-] IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS
   [⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ]
3. [-T-] IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

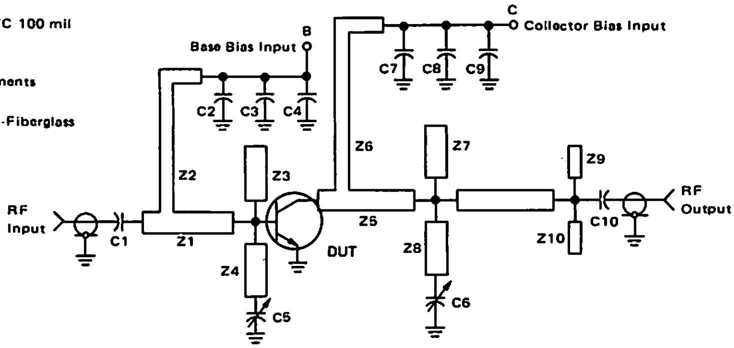


ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

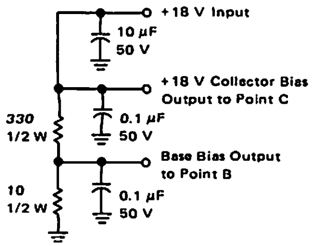
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	2.0	5.0	pF
FUNCTIONAL TESTS					
Common-Emitter Power Gain — Class A (V_{CE} = 18 Vdc, I_C = 100 mAdc, f = 1090 MHz, P_{out} = 200 mW)	G_{PE}	10	12	—	dB
Common-Emitter Power Gain — Class AB (V_{CE} = 18 Vdc, I_{CQ} = 10 mAdc, f = 1090 MHz, P_{out} = 0.7 W)	G_{PE}	—	10.7	—	dB
Load Mismatch — Class A (V_{CE} = 18 Vdc, I_C = 100 mAdc, f = 1090 MHz, P_{out} = 200 mW, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 1090 MHz TEST CIRCUIT

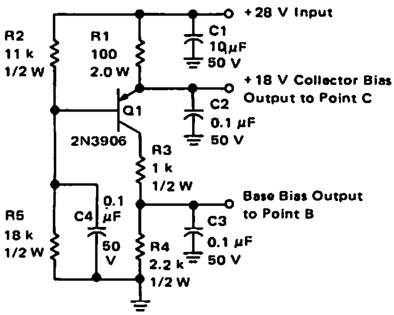
C1, C2, C3, C7, C8, C10 — 220 pF ATC 100 mil
C4, C9 — 4.7 μF 50 V Tantalum
C5, C6 — 0.8-.8 pF Johanson #7290
Z1-Z10 — Distributed Microstrip Elements — See Figure 8
Board Material — 0.031" Thick Teflon-Fiberglass ϵ_r = 2.56



Class AB Bias Control Circuit
18 V Output I_{CQ} 10 mA Nominal



Class A Constant Current Bias Control Circuit
I_C = 100 mA, V_{CE} = 18 V.



2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

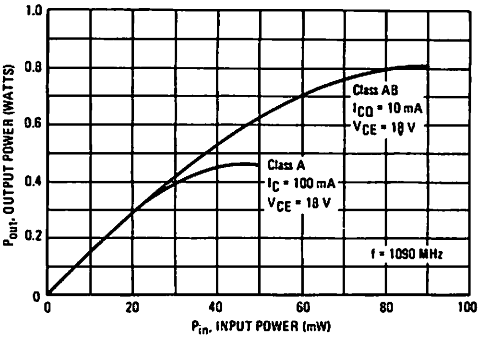


FIGURE 3 — OUTPUT POWER versus FREQUENCY

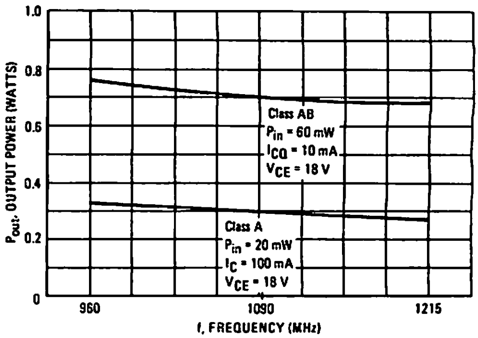


FIGURE 4 — DC SAFE OPERATING AREA

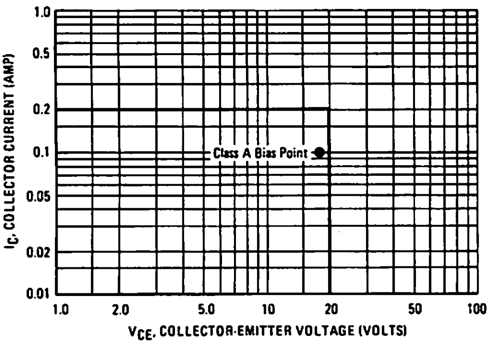


FIGURE 5 — POWER GAIN versus FREQUENCY

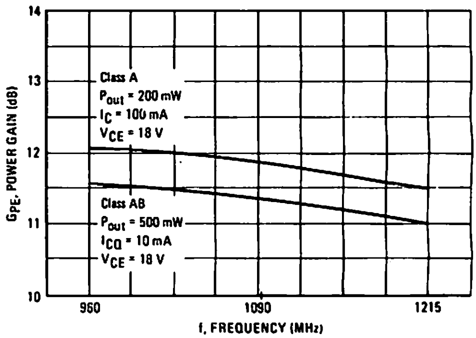
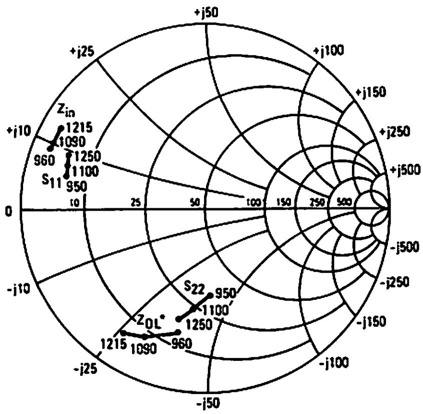


FIGURE 6 — COMMON-EMITTER S-PARAMETERS AND SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



SERIES EQUIVALENT IMPEDANCES
P_{out} = 0.5 W, V_{CE} = 18 Vdc,
I_{CQ} = 10 mAdc, Class AB

f MHz	Z_{in} Ohms	Z_{OL}^* Ohms
960	3.0 + j9.0	16 − j40
1090	3.2 + j10	8.5 − j31
1215	2.8 + j12	7.0 − j26

Z_{OL}^* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

S-PARAMETERS — V_{CE} = 18 Vdc, I_C = 100 mAdc, Class A

f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	$\lvert S_{11}\rvert$	$\angle\phi$	$\lvert S_{21}\rvert$	$\angle\phi$	$\lvert S_{12}\rvert$	$\angle\phi$	$\lvert S_{22}\rvert$	$\angle\phi$
950	0.77	166	2.42	40	0.016	42	0.48	-87
1000	0.78	165	2.36	38	0.016	48	0.50	-90
1050	0.77	163	2.31	33	0.016	46	0.51	-94
1100	0.77	162	2.31	28	0.016	46	0.54	-97
1150	0.78	161	2.20	23	0.015	46	0.57	-100
1200	0.78	159	2.20	19	0.016	47	0.59	-103
1250	0.78	158	2.12	12	0.016	42	0.61	-106

FIGURE 7 – 1090 MHz TEST AMPLIFIER

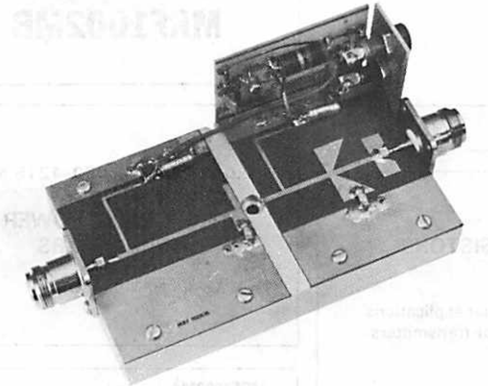
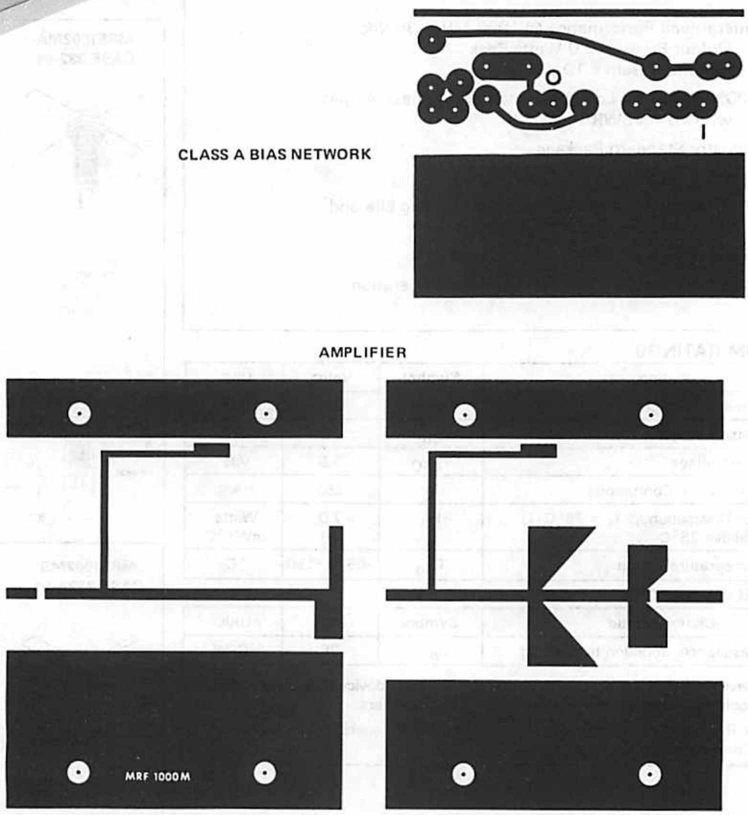


FIGURE 8 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1002MA
MRF1002MB

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz , 35 Vdc
  Output Power = 2.0 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1002M Types
- Internal Input Matching for Broadband Operation

2.0 W PEAK 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

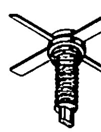
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

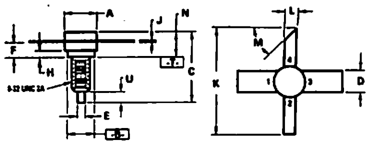
MRF1002MA
CASE 332-04



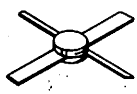
NOTES:
1. DIM -B- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.87	4.32	0.135	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

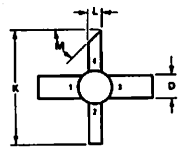


MRF1002MB
CASE 332A-01



NOTES:
1. DIM -A- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T A Ⓜ
3. -T- IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.289
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

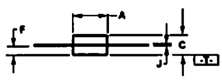


FIGURE 7 – 1090 MHz TEST AMPLIFIER

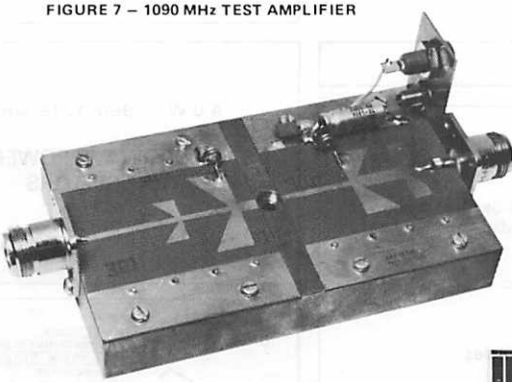


FIGURE 8 – TYPICAL LONG PULSE PERFORMANCE

P_{out} = 2.0 W pk
V_{CC} = 35 V
tp = 1.0 ms
D = 10%
f = 1090 MHz

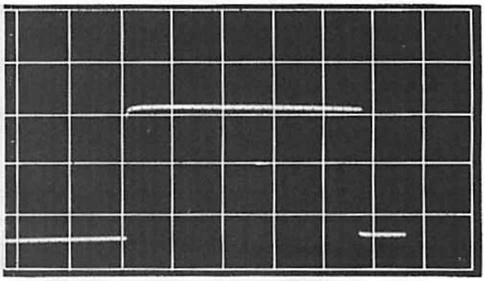
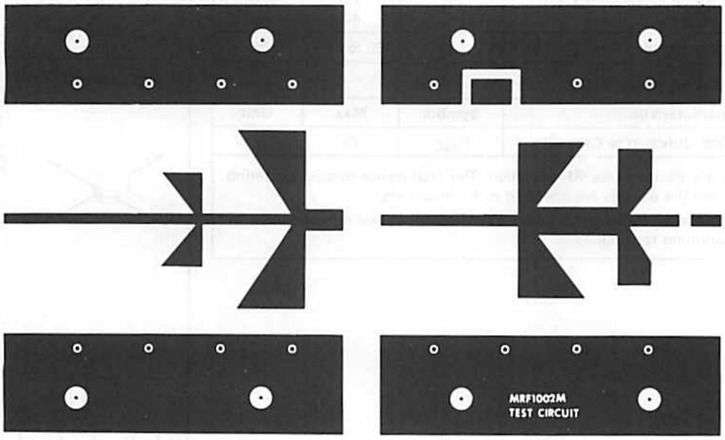


FIGURE 9 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1004MA
MRF1004MB

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz , 35 Vdc
  Output Power = 4.0 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1004M Types
- Internal Input Matching for Broadband Operation

4.0 W 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	250	mAdc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	7.0 40	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

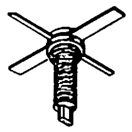
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	25	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

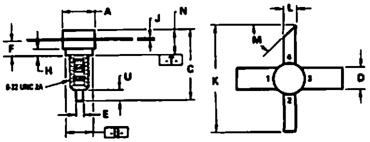
MRF1004MA
CASE 332-04



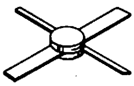
NOTES:
1. DIM -B- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS: 0.76 (0.030) Ⓜ T B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

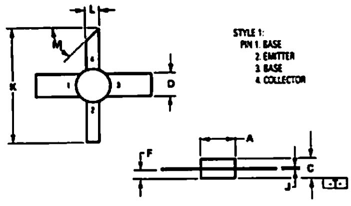


MRF1004MB
CASE 332A-01



NOTES:
1. DIM -A- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS: 0.76 (0.030) Ⓜ T A Ⓜ
3. -T- IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



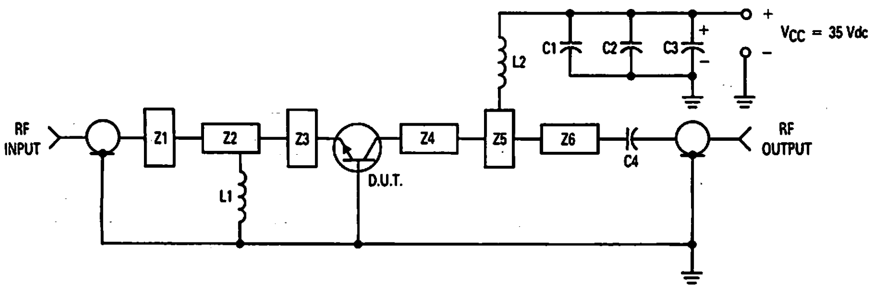
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 75 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 35 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.3	5.0	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz)	G_{PB}	10	11	—	dB
Collector Efficiency (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz)	η	40	45	—	%
Load Mismatch (V_{CC} = 35 Vdc, P_{out} = 4.0 W pk, f = 1090 MHz VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1. 1090 MHz TEST CIRCUIT



L1, L2 — 3 Turns #18 AWG, ⅛" ID
C1 — 0.1 μF
C2, C4 — 220 pF Chip Capacitor
C3 — 20 μF, 50 V Electrolytic
Board Material — 0.031" Thick Glass Teflon
Z1–Z6 Distributed Microstrip Elements — See Figure 9

FIGURE 2 — OUTPUT POWER versus INPUT POWER

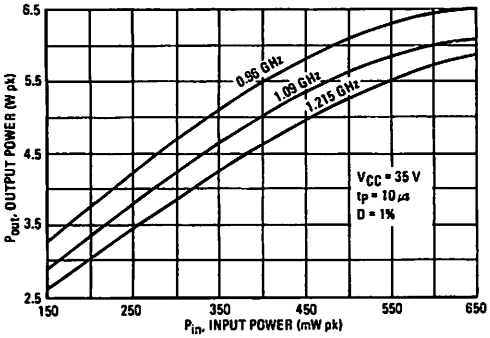


FIGURE 3 — OUTPUT POWER versus FREQUENCY

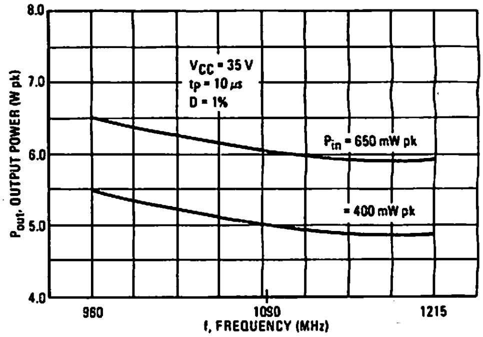


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

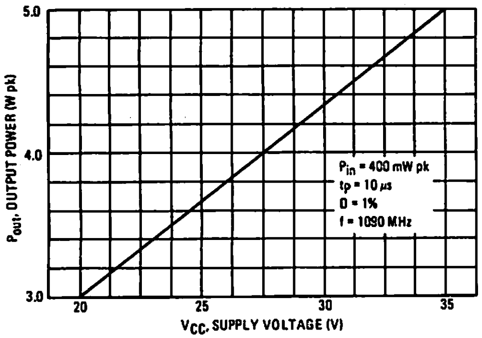


FIGURE 5 — POWER GAIN versus FREQUENCY

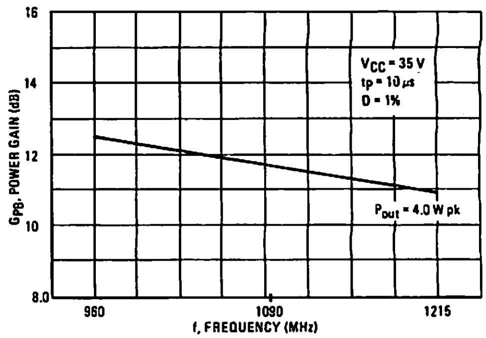
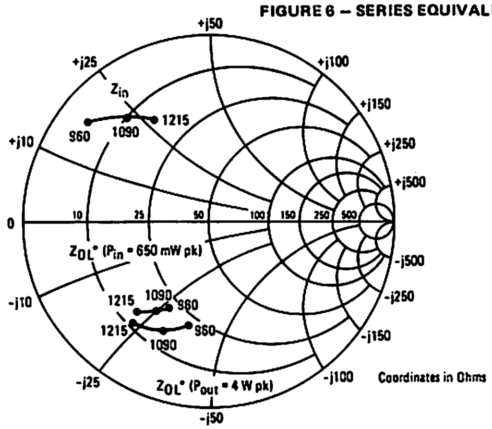


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



f MHz	Z_{in} Ohms	Z_{OL}* (P_{in} = 400 mW pk) Ohms	Z_{OL}* (P_{out} = 4 W pk) Ohms
960	5.0 + j17.5	23.5 − j26	22.5 − j36
1090	10 + j23	18.5 − j25	15 − j32.5
1215	16 + j29.5	15.5 − j23.5	11 − j23

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 – 1090 MHz TEST AMPLIFIER

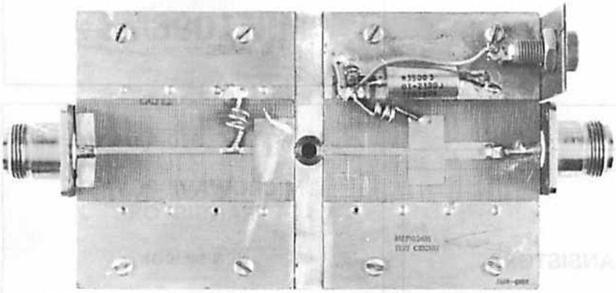


FIGURE 8 – TYPICAL LONG PULSE PERFORMANCE

P_{out} = 4.0 W pk
V_{CC} = 35 V
tp = 1.0 ms
D = 10%
f = 1090 MHz

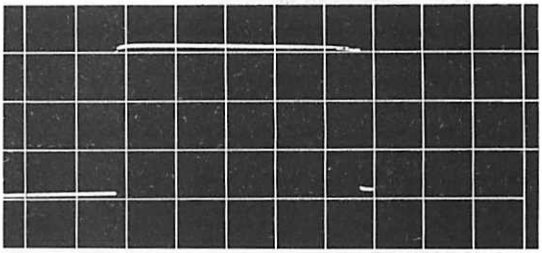
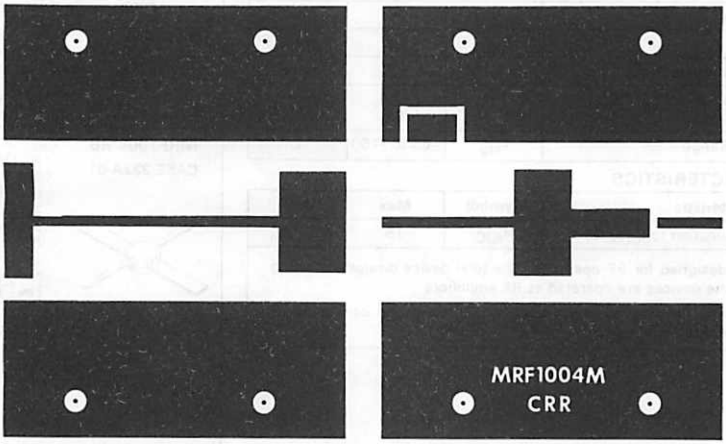


FIGURE 9 – PRINTED CIRCUIT BOARD LAYOUT – 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

2

MRF1008MA
MRF1008MB

The RF Line

8.0 W PEAK 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common-base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 35 Vdc
  Output Power = 8.0 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1008M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	500	mAdc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	11.6 67	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

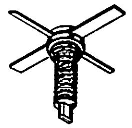
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	15	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.

(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

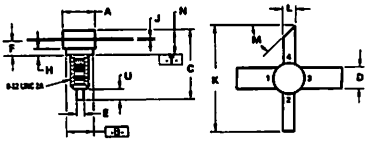
MRF1008MA
CASE 332-04



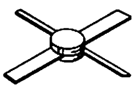
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

NOTES:
1. DIM -B- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS: ⌖ 0.76 (0.030) Ⓜ T B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

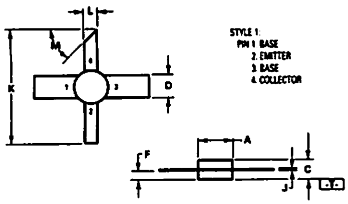


MRF1008MB
CASE 332A-01



NOTES:
1. DIM -A- IS DATUM.
2. POSITIONAL TOLERANCE FOR LEADS: ⌖ 0.76 (0.030) Ⓜ T A Ⓜ
3. -T- IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.24	0.270	0.285
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



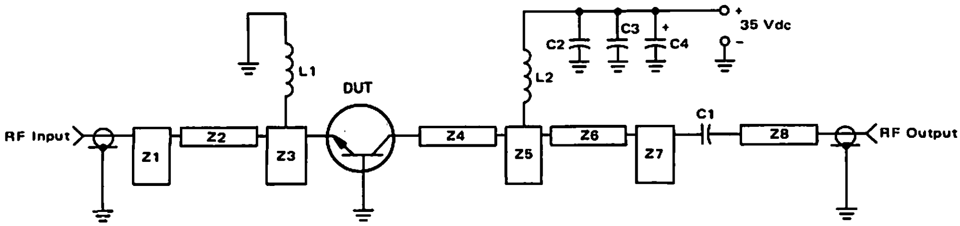
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5.0 mAdc, I_E = 0)	$V_{(BR)CBO}$	50	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 35 Vdc, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 150 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 35 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	3.5	6.0	pF
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain (V_{CC} = 35 Vdc, P_{out} = 8.0 W Peak, f = 1090 MHz)	G_{PB}	10	12	—	dB
Collector Efficiency (V_{CC} = 35 Vdc, P_{out} = 8.0 W Peak, f = 1090 MHz)	η	40	45	—	%
Load Mismatch (V_{CC} = 35 Vdc, P_{out} = 8.0 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 µF
C4 — 10 µF/50 V Electrolytic Capacitor

L1, L2 — 3 Turns #18 AWG, 1/8" ID
Z1 — Z8 — Microstrip, See Photomaster
Board Material — 0.031" Glass Teflon, ϵ_r = 2.5

FIGURE 2 — OUTPUT POWER versus INPUT POWER

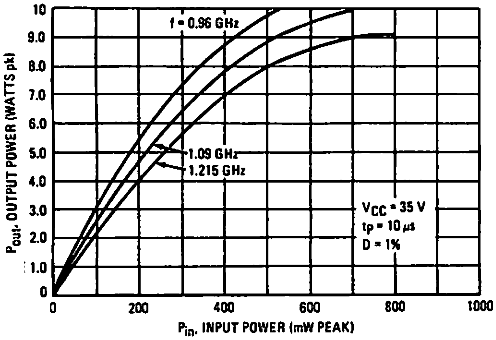


FIGURE 3 — OUTPUT POWER versus FREQUENCY

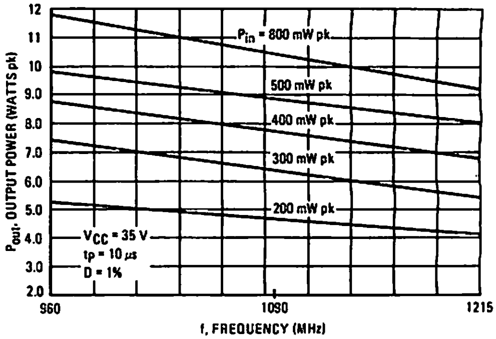


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

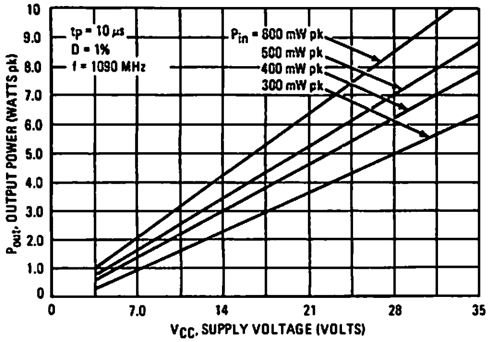


FIGURE 5 — POWER GAIN versus FREQUENCY

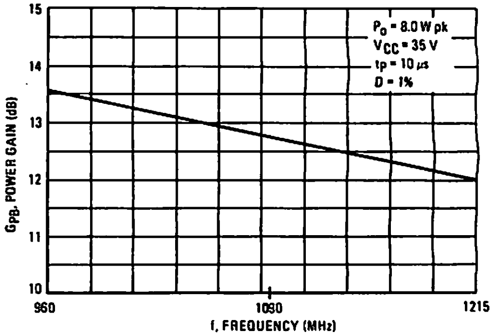
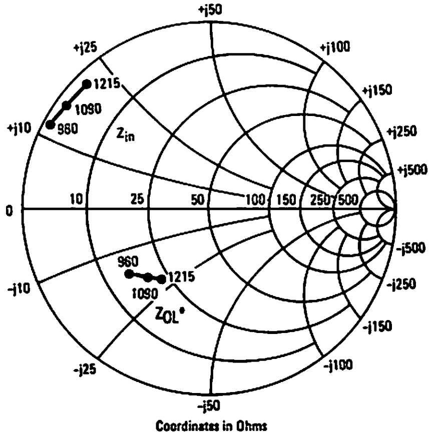


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



V_{CC} = 35 V
P_o = 8.0 W pk

f MHz	Z_{in} Ohms	$^*Z_{OL}$ Ohms
960	1.5 + j13	17 - j16
1090	2.0 + j17	20 - j18.5
1215	3.0 + j20	23 - j20

Z_{OL}^* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7–1090 MHz TEST AMPLIFIER

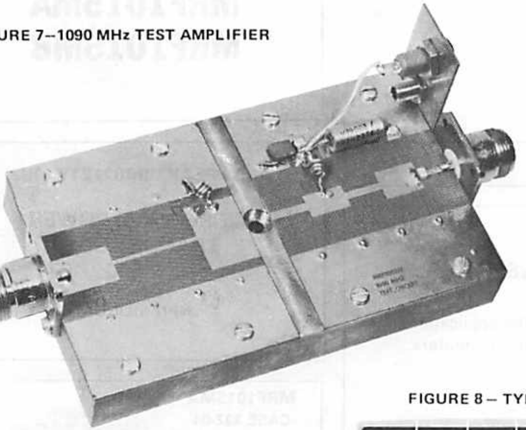


FIGURE 8 – TYPICAL LONG PULSE PERFORMANCE

P_{out} = 8.0 W peak
V_{CC} = 35 V
t_P = 1 ms
D = 10%
f = 1090 MHz

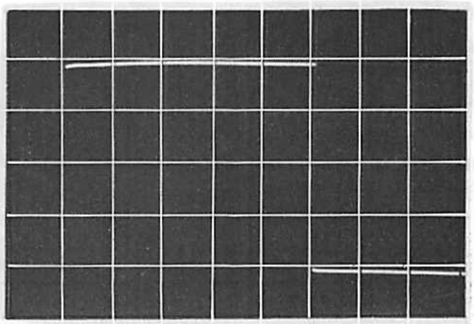
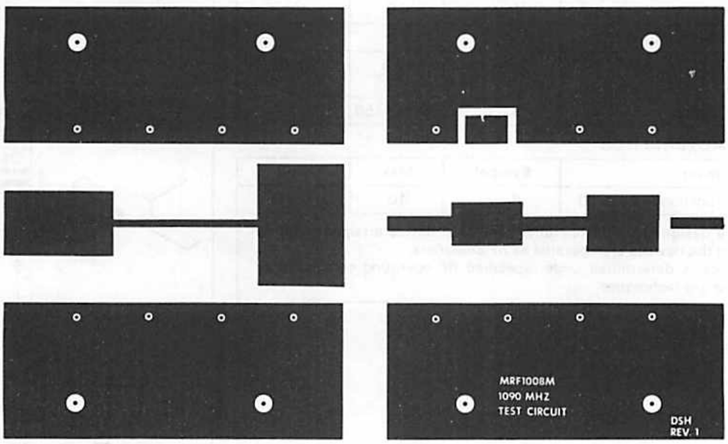


FIGURE 9–PRINTED CIRCUIT BOARD LAYOUT–1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

o Soldered Eyelet

MRF1015MA
MRF1015MB

2

The RF Line

15 W PEAK 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output power = 15 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1015M Types
- Internal Input Matching for Broadband Operation

MAXIMUM RATINGS

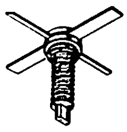
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_C = 25°C$ (1) Derate above 25°C	P_D	17.5 100	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	10	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

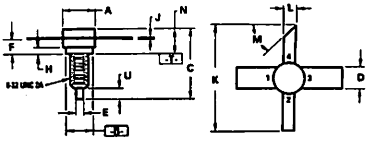
MRF1015MA
CASE 332-04



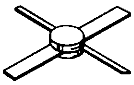
NOTES:
1. DIM -B- IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T B Ⓜ
3. -T- IS SEATING PLANE.
4. DIMENSION K APPLIES TWO PLACES.
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

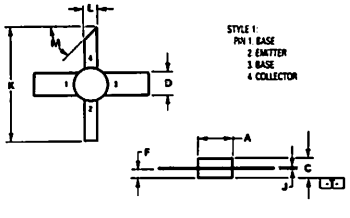


MRF1015MB
CASE 332A-01



NOTES:
1. DIM -A- IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T A Ⓜ
3. -T- IS SEATING PLANE
4. DIM K APPLIES 2 PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.289
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	

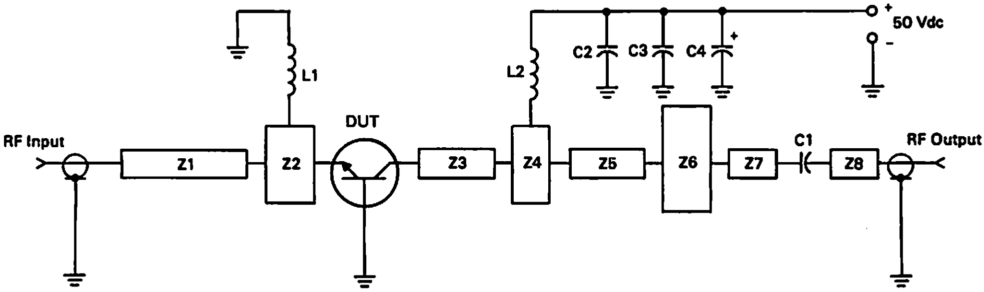


STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	5.0	7.5	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz)	G_{PB}	10	12.5	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz)	η	30	35		%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 15 W Peak, f = 1090 MHz) (VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 μF
C4 — 47 μF/75 V Electrolytic Capacitor
L1, L2 — 3 Turns #18 AWG, 1/8" ID
Z1-Z8 — Microstrip, See Photomaster, Figure 8
Board Material — 0.032" Glass Teflon
ϵ_r = 2.5

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

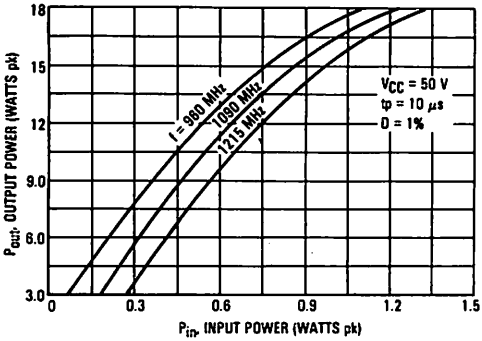


FIGURE 3 — OUTPUT POWER versus FREQUENCY

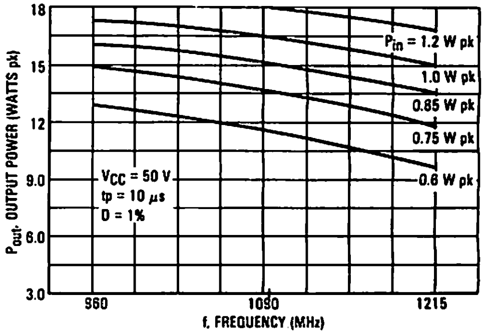


FIGURE 4 - OUTPUT POWER versus SUPPLY VOLTAGE

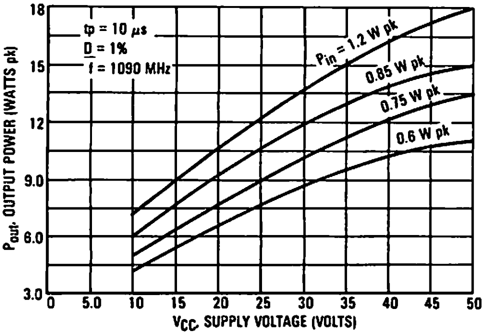


FIGURE 5 — POWER GAIN versus FREQUENCY

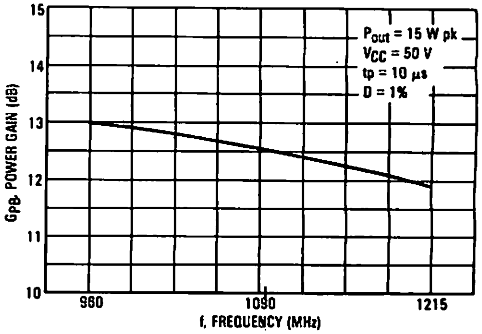
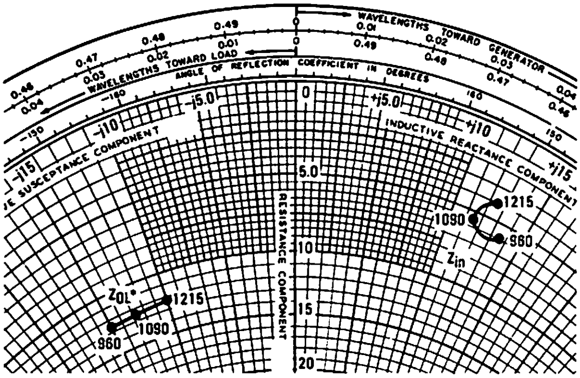


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



Coordinates in Ohms

P_{out} = 15 W pk V_{CC} = 50 V
tp = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	5.9 + j13.6	12.5 – j15
1090	5.5 + j11.5	12.4 – j12.8
1215	4.0 + j12.5	12.1 – j10

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

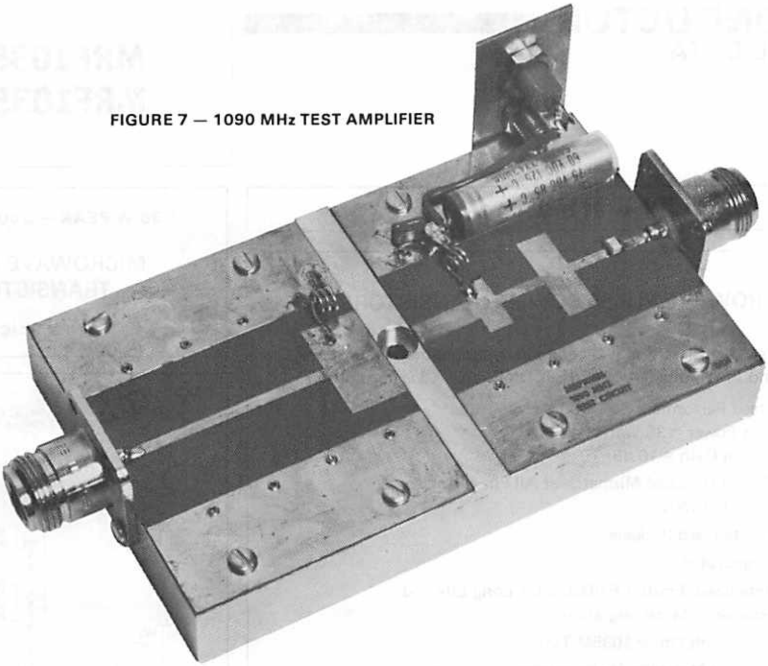
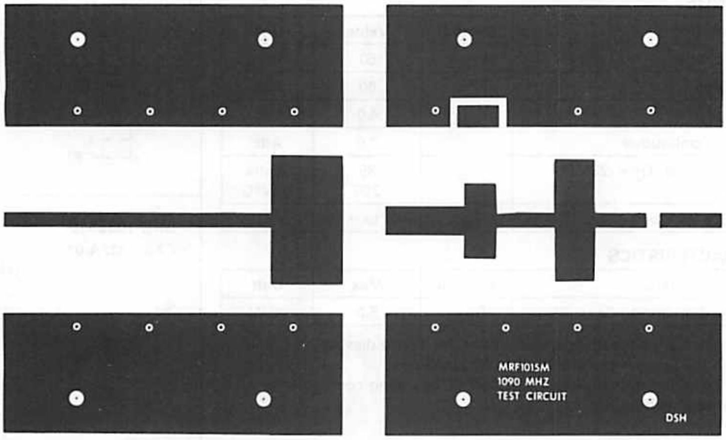


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet
⊙ 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

MRF1035MA
MRF1035MB

2

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common-base* amplifier applications in short and long pulse TACAN, IFF, DME, and radar transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 35 Watts Peak
  Minimum Gain = 10 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1035M Types
- Internal Input Matching for Broadband Operation

35 W PEAK — 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

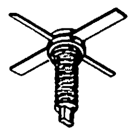
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	60	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C(1) Derate above 25°C	P_D	35 200	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	5.0	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

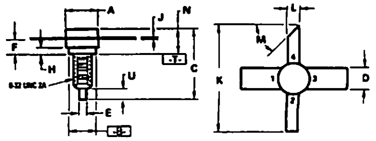
MRF1035MA
CASE 332-04



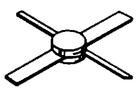
NOTES:
1. DIM [-A-] IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   [⌖ | 0.76 (0.030) Ⓜ | T | B Ⓜ]
3. [-T-] IS SEATING PLANE
4. DIMENSION K APPLIES TWO PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR



MRF1035MB
CASE 332A-01



NOTES:
1. DIM [-A-] IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   [⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ]
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DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
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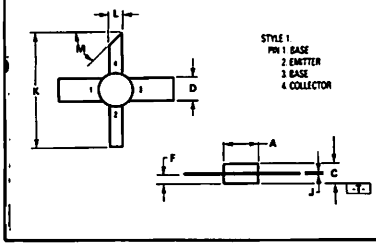
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



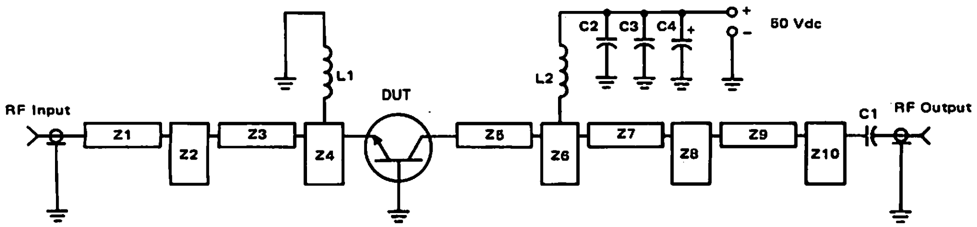
STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mAdc, I_E = 0)	$V_{(BR)CBO}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	–	–	2.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	40	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	10	15	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz)	G_{PB}	10	12.4	–	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz)	η	30	34	–	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 35 W Peak, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 μF
C4 — 10 μF/75 V Electrolytic
L1, L2 — 3 Turns #18 AWG, 1/8" ID

Z1–Z10 — Microstrip, See Photomaster
Board Material — 0.031" Glass Teflon
ϵ_R = 2.5

FIGURE 2 — OUTPUT POWER versus INPUT POWER

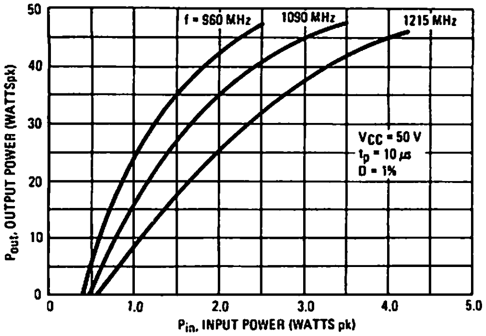


FIGURE 3 — OUTPUT POWER versus FREQUENCY

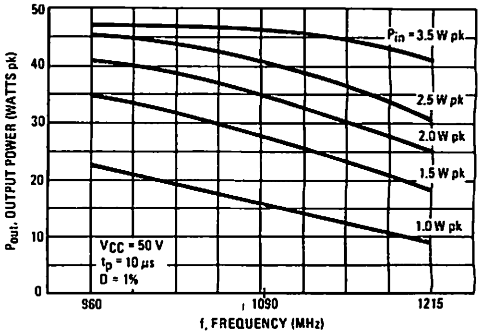


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

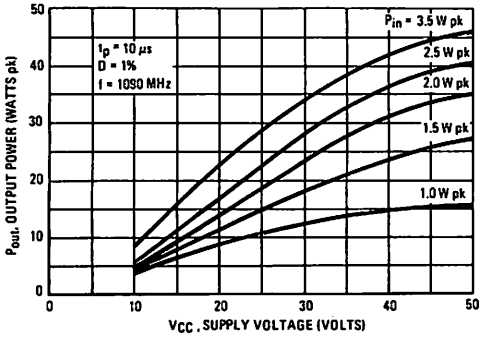


FIGURE 5 — POWER GAIN versus FREQUENCY

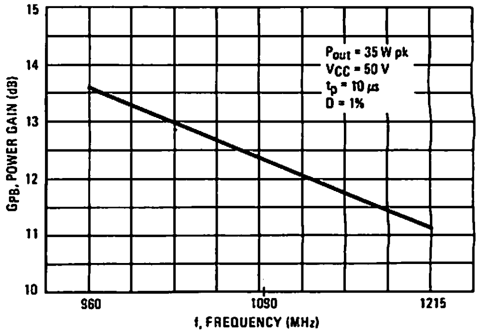
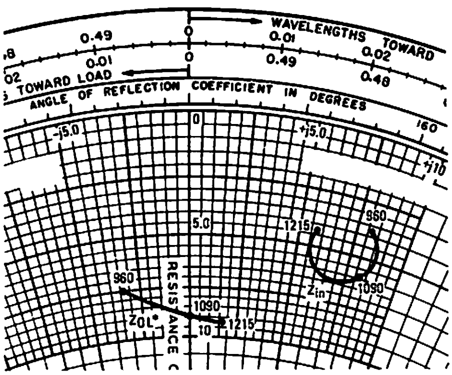


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCES



P_{out} = 35 W Pk V_{CC} = 50 V
t_p = 10µs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	3.8 + j 8.2	7.5 − j 3.3
1090	6.0 + j 8.2	9.0 + j 0
1215	4.2 + j 5.7	9.1 + j 1.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

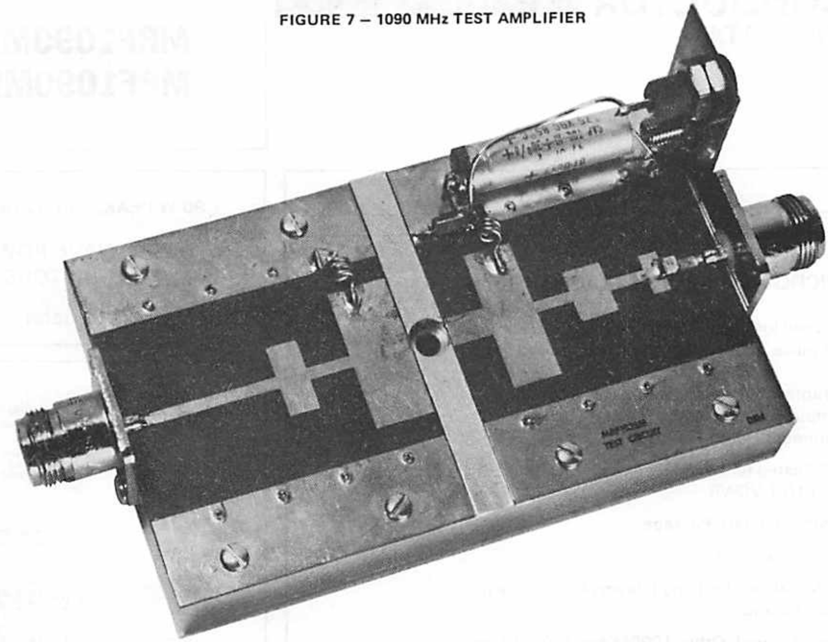
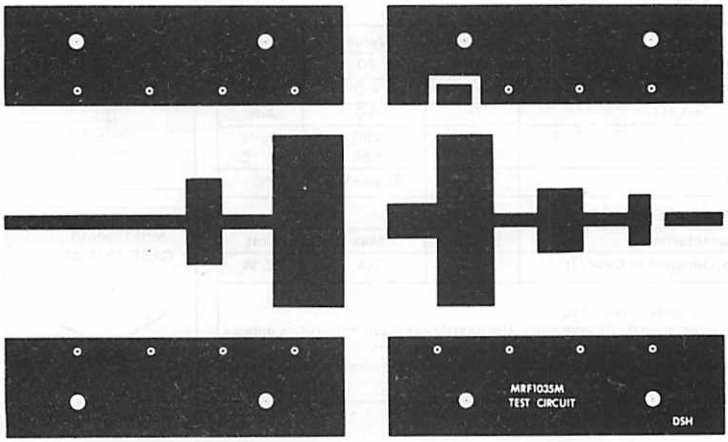


FIGURE 8 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelets

NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1090MA
MRF1090MB

2

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output power = 90 Watts Peak
  Minimum Gain = 8.4 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1090M and 1075M Types
- Internal Input Matching for Broadband Operation

90 W PEAK, 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

MAXIMUM RATINGS

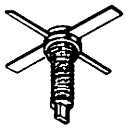
Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1)	I_C	6.0	Adc
Peak Device Dissipation @ T_C = 25°C (1) (2) Derate above 25°C	P_D	290 1.66	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.6	°C/W

(1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF short pulse amplifiers.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

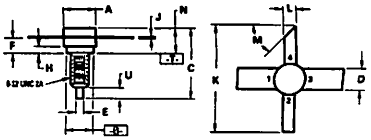
MRF1090MA
CASE 332-04



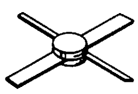
NOTES:
1. DIM -B- IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T B Ⓜ
3. -T- IS SEATING PLANE
4. DIMENSION K APPLIES TWO PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.87	4.32	0.155	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

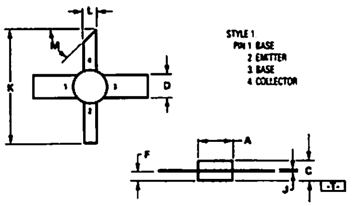


MRF1090MB
CASE 332A-01



NOTES:
1. DIM -A- IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
   ⌖ 0.76 (0.030) Ⓜ T A Ⓜ
3. -T- IS SEATING PLANE.
4. DIM K APPLIES 2 PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.289
C	3.33	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	



STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

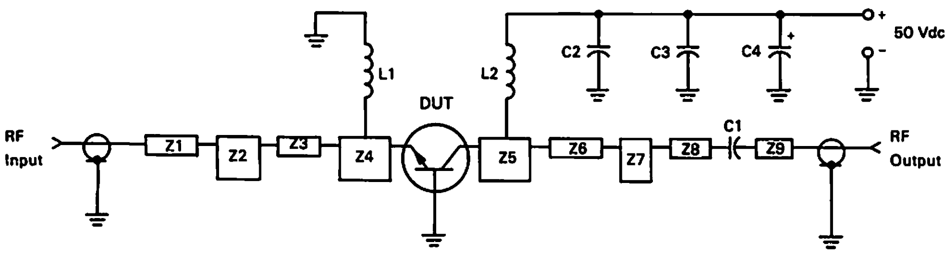
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 2.5 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	12	16	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz)	G_{PB}	8.4	10.8	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz)	η	35	40	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 90 W pk, f = 1090 MHz VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

* 80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
C3 — 0.1 μF
C4 — 47 μF, 75 V
L1, L2 — 3 Turns, #18 AWG, 1/8" ID
Z1-Z9 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.031" Thick Glass Teflon, ϵ_r = 2.5

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

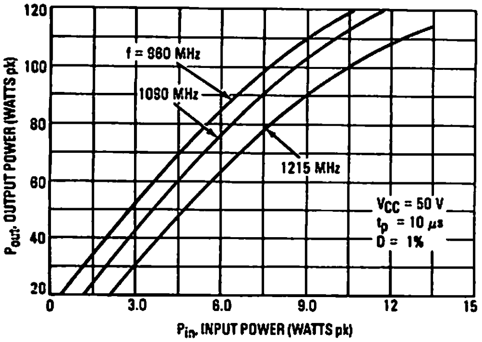


FIGURE 3 — OUTPUT POWER versus FREQUENCY

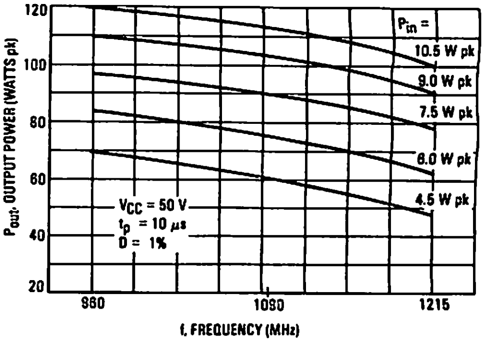


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

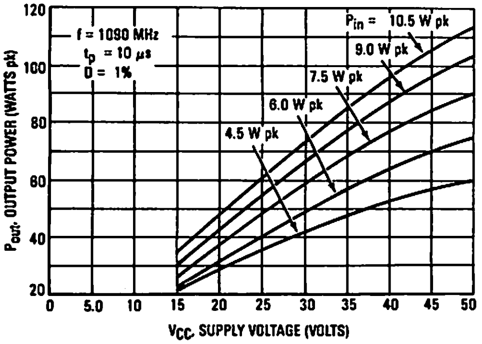


FIGURE 5 — POWER GAIN versus FREQUENCY

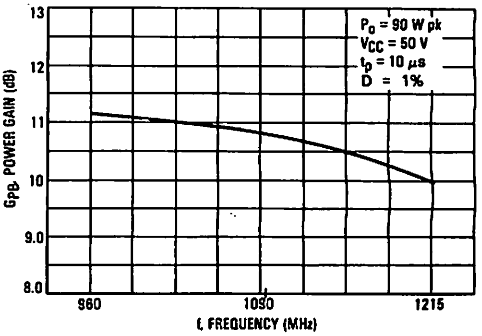
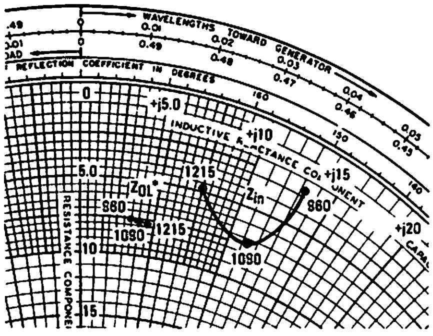


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



Coordinates in Ohms

P_{out} 90 W pk V_{CC} = 50 V
t_p = 10 µs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	2.8 + j13.2	7.6 + j3.5
1090	7.4 + j11.4	7.6 + j4.0
1215	4.7 + j7.5	7.7 + j4.5

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

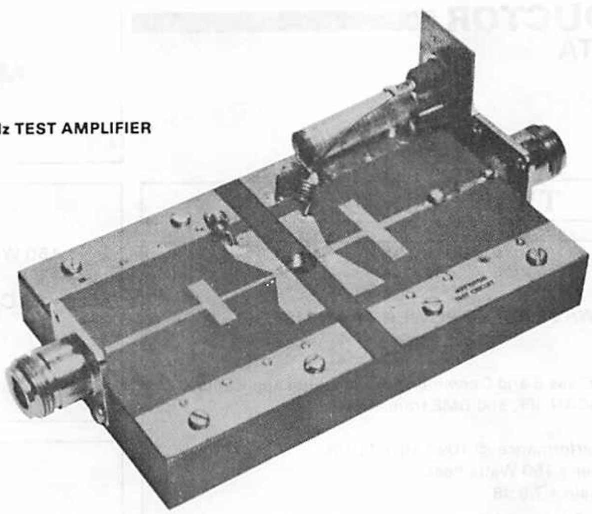


FIGURE 8 — TYPICAL PULSE PERFORMANCE

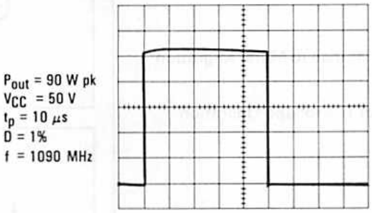
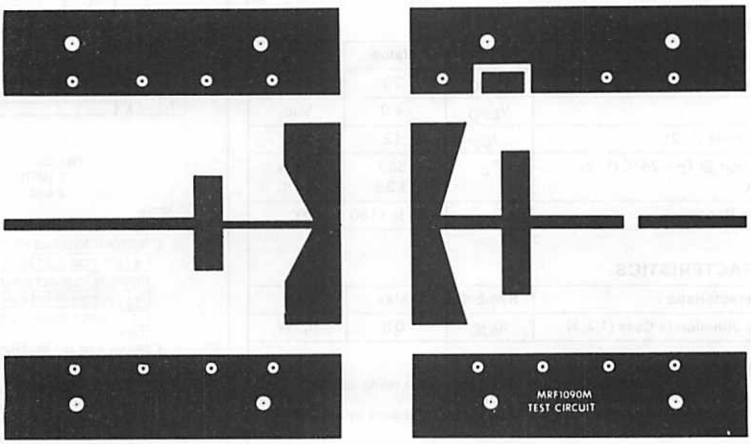


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet
⊙ 4-40 Screw Placement

NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1150M

The RF Line

MICROWAVE PULSE POWER TRANSISTOR

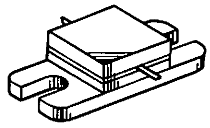
. . . designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

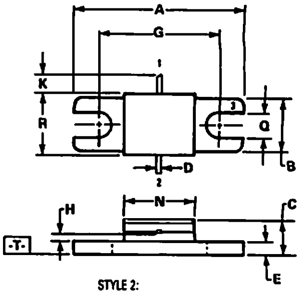
- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 150 Watts Peak
  Minimum Gain = 7.8 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1150M Types
- Internal Input and Output Matching for Broadband Operation

150 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTES:
1. DIMENSIONS A, B AND R ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
   | ⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ | B Ⓜ |
   POSITIONAL TOLERANCE FOR LEADS:
   | ⌖ | 0.25 (0.010) Ⓜ | T | A Ⓜ | R Ⓜ |
3. -T- IS BOTH A SEATING PLANE AND A DATUM SURFACE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0.142
R	9.91	10.41	0.390	0.410

CASE 336-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1, 2)	I_C	12	Adc
Peak Device Dissipation @ T_C = 25°C (1, 2) Derate above 25°C	P_D	583 3.33	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	$R_{\theta JC}$	0.3	°C/W

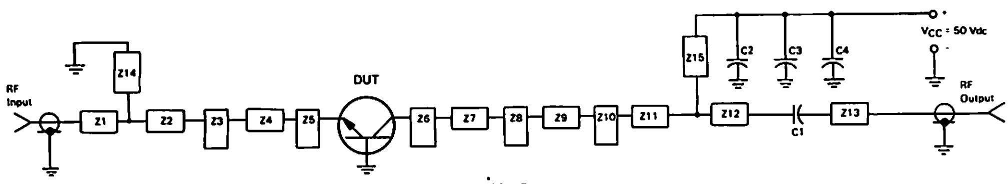
(1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	G_{PB}	7.8	8.7	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 150 pF
C3 — 0.1 μF/100 V
C4 — 47 μF/75 V, Electrolytic
Z1-Z15 — Distributed Microstrip Elements
Board Material — 0.0031" Thick Teflon-Fiberglass
ϵ_r = 2.55

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

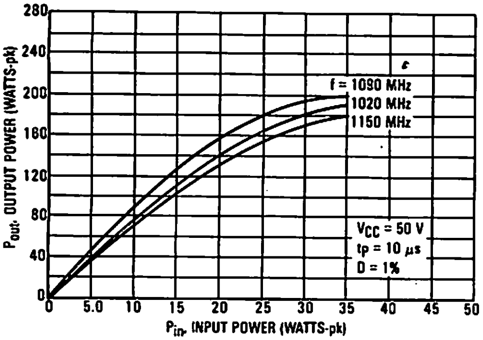


FIGURE 3 — OUTPUT POWER versus FREQUENCY

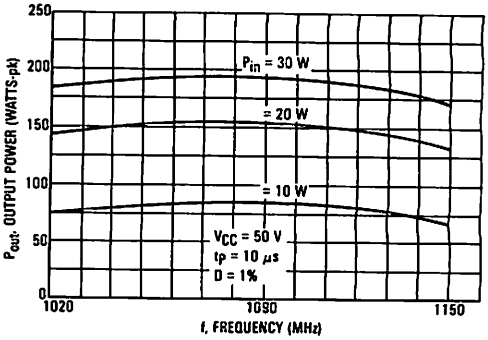


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

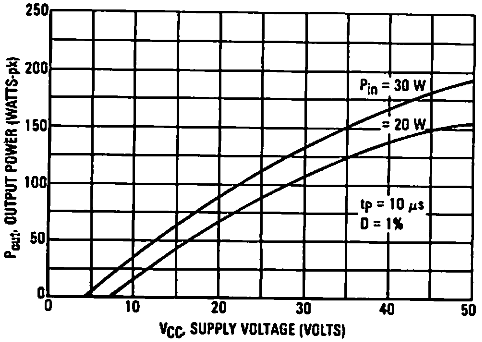
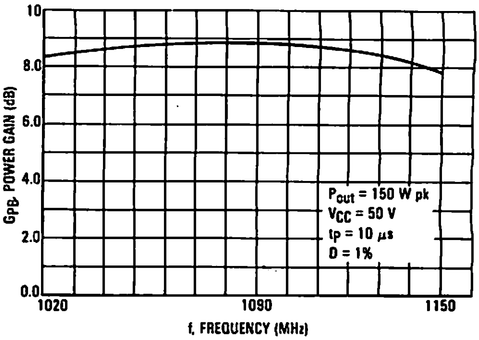


FIGURE 5 — POWER GAIN versus FREQUENCY



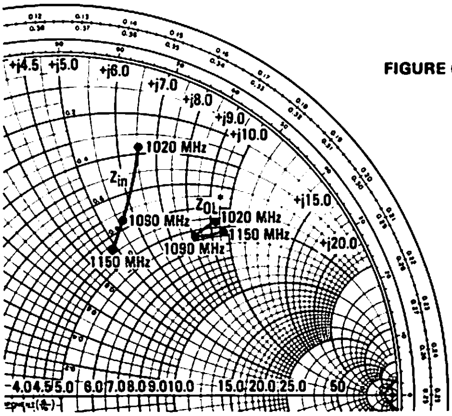


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE

P_{out} = 150 W-pk V_{CC} = 50 V
tp = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
1020	1.85 + j6.6	4.6 + j9.4
1090	3.5 + j5.7	5.3 + j8.1
1150	4.4 + j4.8	5.2 + j9.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

2

FIGURE 7 — OUTPUT POWER, INPUT VSWR, POWER GAIN versus FREQUENCY

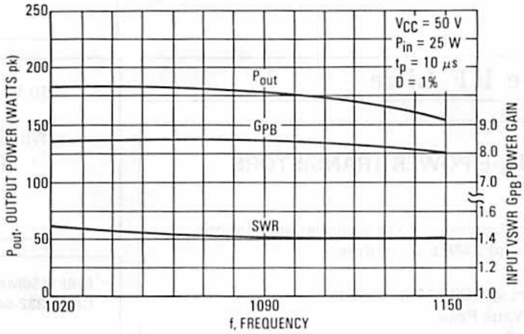


FIGURE 8 — 1090 MHz TEST CIRCUIT

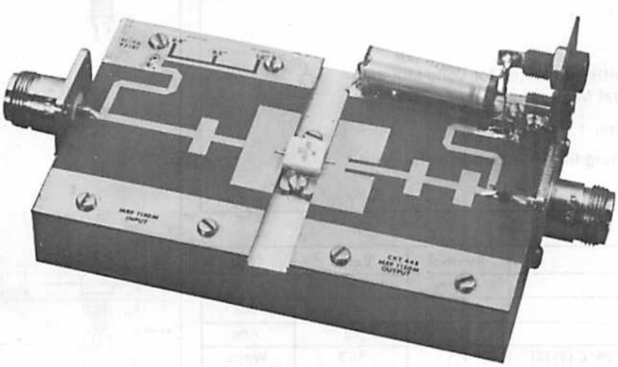
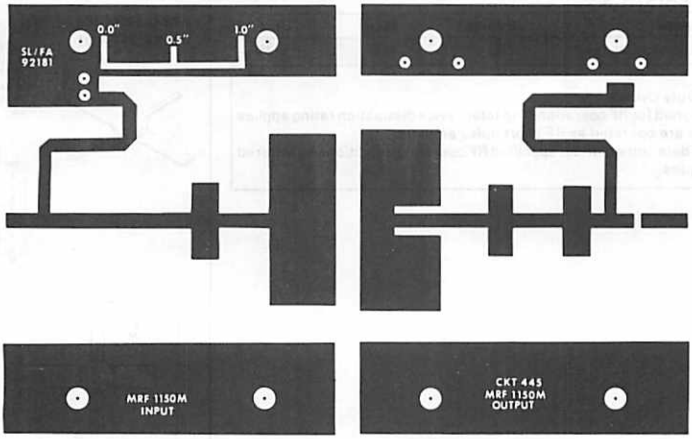


FIGURE 9 — 1090 MHz PHOTOMASTER



NOTE: The Printed Circuit Board shown is 75% of the original.

2

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1150MA
MRF1150MB

The RF Line

MICROWAVE PULSE POWER TRANSISTORS

. . . designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

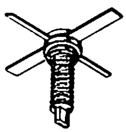
- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output power = 150 Watts Peak
  Minimum Gain = 7.8 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Compatible with Other 1150M Types
- Internal Input Matching for Broadband Operation

150 W PEAK, 960-1215 MHz

MICROWAVE POWER TRANSISTORS

NPN SILICON

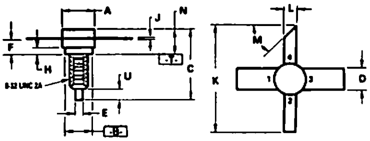
MRF1150MA
CASE 332-04



NOTES
1. DIM [-B-] IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
[⌖ | 0.76 (0.030) Ⓜ | T | B Ⓜ]
3. [-T-] IS SEATING PLANE
4. DIMENSION K APPLIES TWO PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y 14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR



MAXIMUM RATINGS

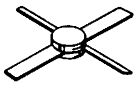
Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1)	I_C	12	Adc
Peak Device Dissipation @ T_C = 25°C (1) (2) Derate above 25°C	P_D	583 3.33	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	0.3	°C/W

(1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF short pulse amplifiers.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

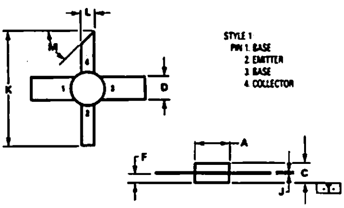
MRF1150MB
CASE 332A-01



NOTES
1. DIM [-A-] IS DATUM
2. POSITIONAL TOLERANCE FOR LEADS
[⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ]
3. [-T-] IS SEATING PLANE
4. DIM K APPLIES 2 PLACES
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

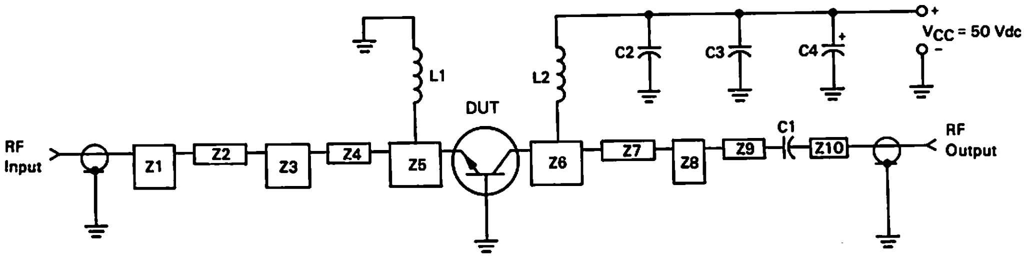


ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 5.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 50 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	25	32	pF
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	G_{PB}	7.8	9.8	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz)	η	35	40	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 150 W pk, f = 1090 MHz) VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 220 pF Chip Capacitor, 100-mil ATC
C3 — 0.1 μF/100 V
C4 — 47 μF/75 V Electrolytic
L1, L2 — 3 Turns, #18 AWG, 1/8" ID
Z1-Z10 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.031" Thick Teflon-Fiberglass, ϵ_r = 2.5

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

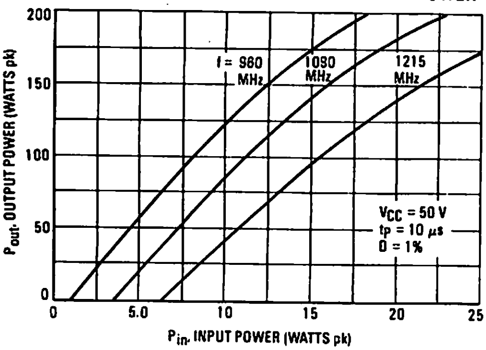


FIGURE 3 — OUTPUT POWER versus FREQUENCY

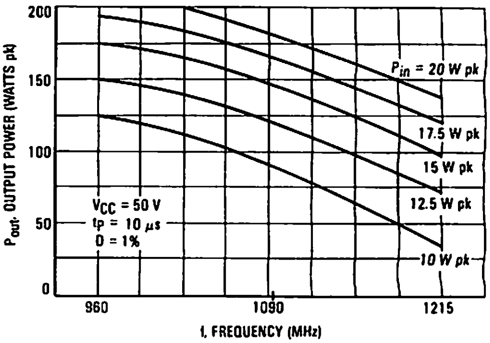


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

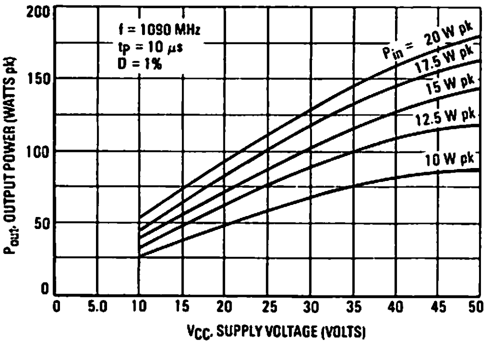


FIGURE 5 — POWER GAIN versus FREQUENCY

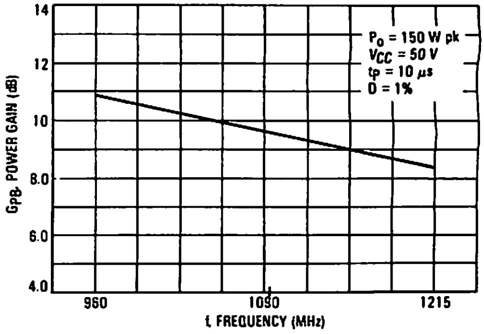
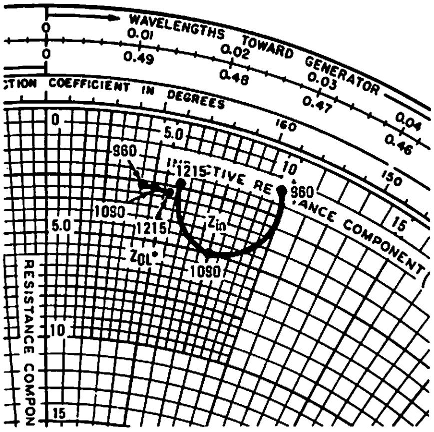


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



P_{out} = 150 W pk V_{CC} = 50 V
tp = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
960	1.5 + j9.6	2.6 + j4.1
1090	5.0 + j7.5	2.7 + j4.6
1215	2.4 + j5.6	2.8 + j5.3

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

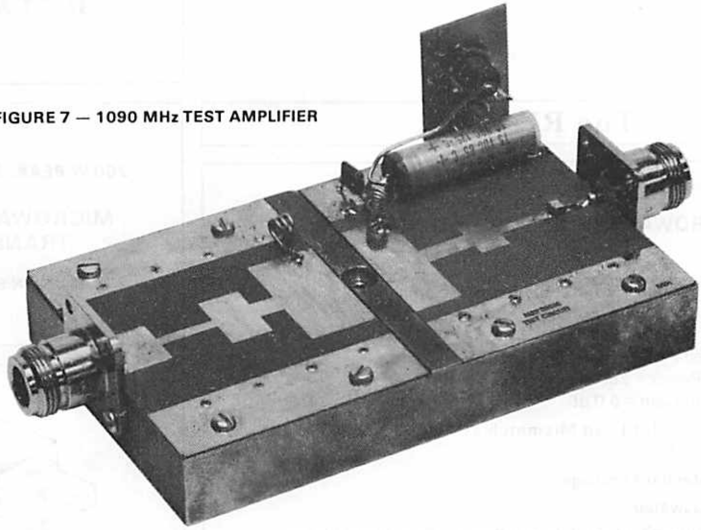
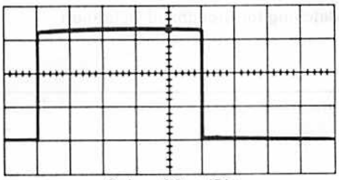


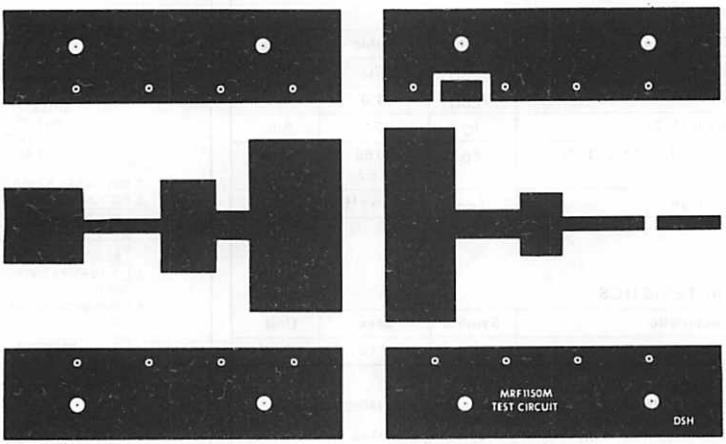
FIGURE 8 — TYPICAL PULSE PERFORMANCE

P_{out} = 150 W pk
V_{CC} = 50 V
tp = 10 μs
D = 1%



Scale — 2.0 μs/Div

FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet

NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF1250M

The RF Line

MICROWAVE PULSE POWER TRANSISTOR

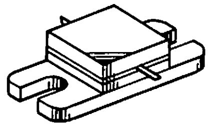
. . . designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

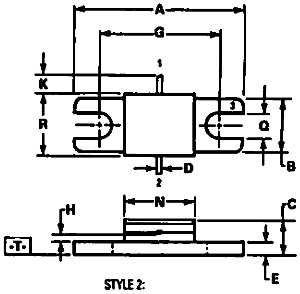
- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 250 Watts Peak
  Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1250M Types
- Internal Input and Output Matching for Broadband Operation

250 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTES:
1. DIMENSIONS A, B AND R ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
   ⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ | B Ⓜ
   POSITIONAL TOLERANCE FOR LEADS:
   ⌖ | 0.25 (0.010) Ⓜ | T | A Ⓜ | R Ⓜ
3. -T- IS BOTH A SEATING PLANE AND A DATUM SURFACE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0.142
R	9.91	10.41	0.390	0.410

CASE 336-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1, 2)	I_C	24	Adc
Peak Device Dissipation @ T_C = 25°C (1, 2) Derate above 25°C	P_D	1166 6.67	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	$R_{\theta JC}$	0.15	°C/W

(1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

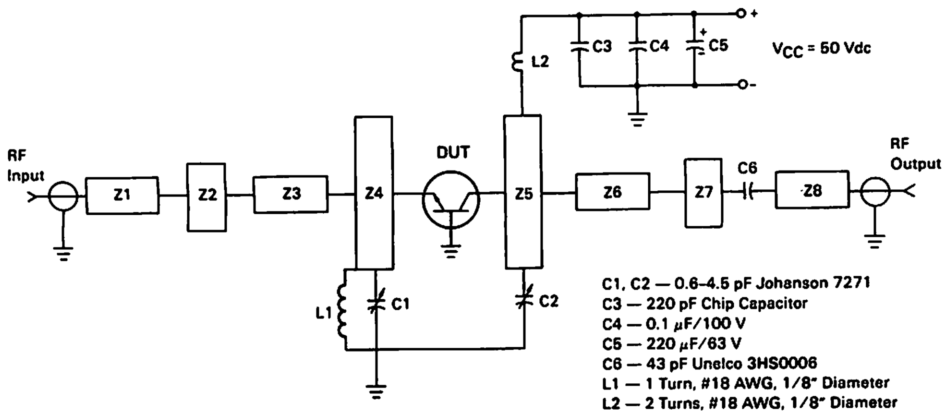
2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 10 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
FUNCTIONAL TESTS (Pulse Width = 10 µs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 250 W pk, f = 1090 MHz)	G_{PB}	6.0	7.2	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 250 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 250 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 µs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 0.6–4.5 pF Johanson 7271
C3 — 220 pF Chip Capacitor
C4 — 0.1 µF/100 V
C5 — 220 µF/63 V
C6 — 43 pF Unelco 3HS0006
L1 — 1 Turn, #18 AWG, 1/8" Diameter
L2 — 2 Turns, #18 AWG, 1/8" Diameter
Z1-Z8 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.062" Thick Teflon*-Fiberglass, ϵ_r = 2.55

*Registered Trademark of DuPont

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

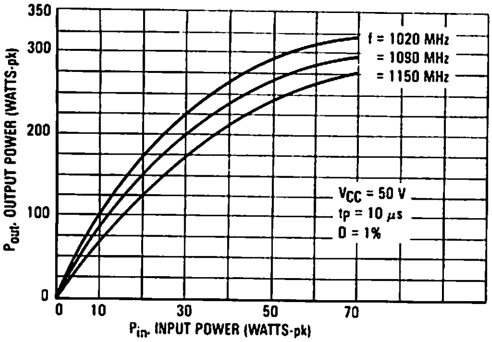


FIGURE 3 — OUTPUT POWER versus FREQUENCY

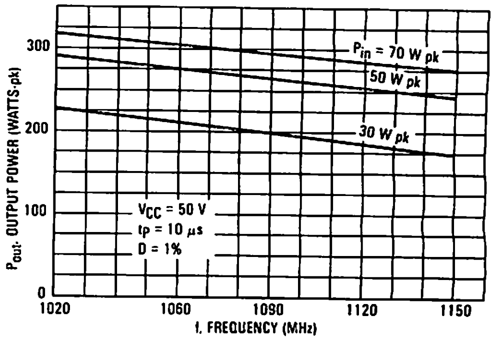


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

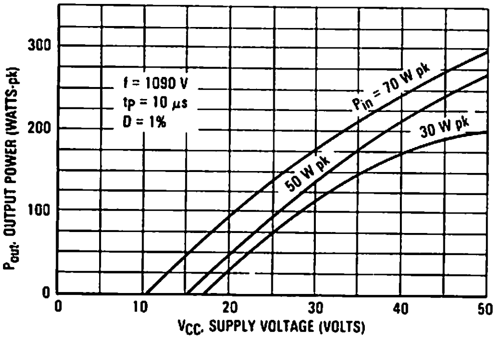


FIGURE 5 — POWER GAIN versus FREQUENCY

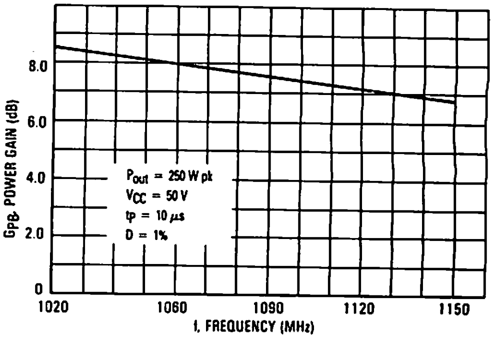
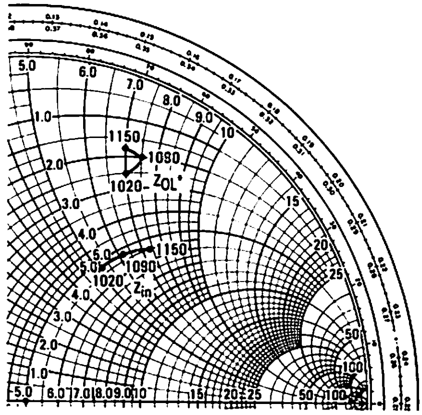


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



P_{out} = 250 W-pk V_{CC} = 50 V
t_p = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
1020	5.2 + j5.2	2.5 + j7.0
1090	5.2 + j6.2	2.0 + j7.5
1150	5.5 + j7.3	1.8 + j7.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

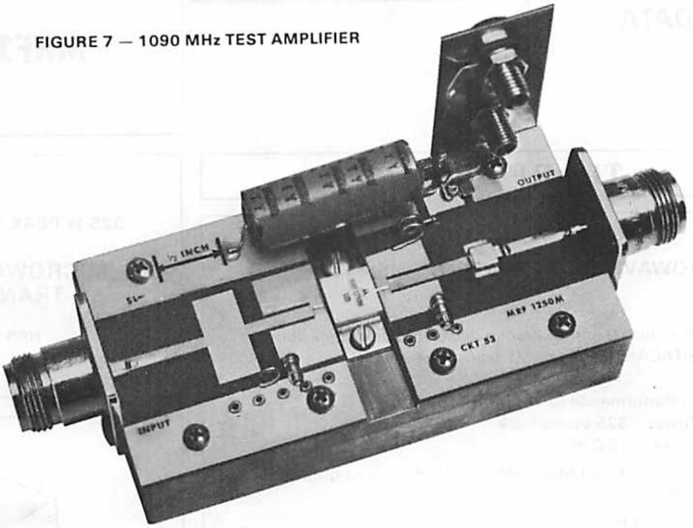


FIGURE 8 — TYPICAL PULSE PERFORMANCE

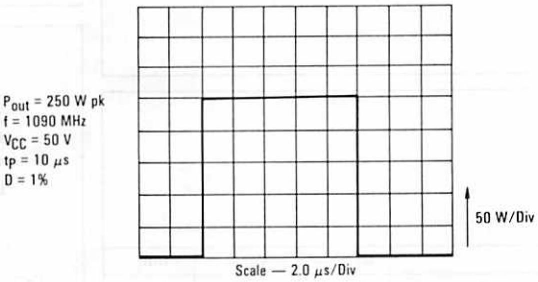
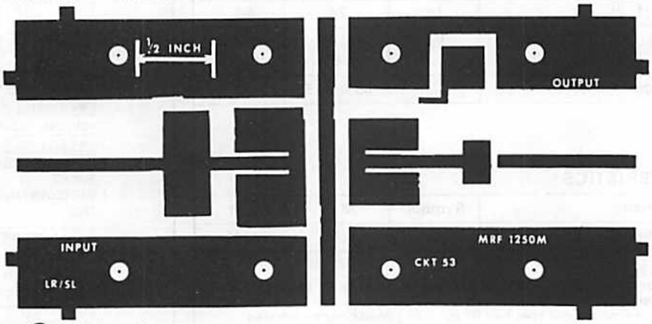


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



⊙ Soldered Eyelet

NOTE: The Printed Circuit Board shown is 75% of the original.

MOTOROLA SEMICONDUCTOR TECHNICAL DATA

MRF1325M

The RF Line

2

MICROWAVE PULSE POWER TRANSISTOR

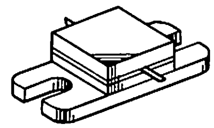
. . . designed for Class B and C *common base* amplifier applications in short pulse TACAN, IFF, and DME transmitters.

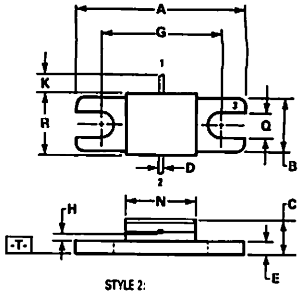
- Guaranteed Performance @ 1090 MHz, 50 Vdc
  Output Power = 325 Watts Peak
  Minimum Gain = 6.0 dB
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Industry Standard Package
- Nitride Passivated
- Gold Metallized for Long Life and Resistance to Metal Migration
- Compatible with Other 1325M Types
- Internal Input and Output Matching for Broadband Operation

325 W PEAK, 1020-1150 MHz

MICROWAVE POWER TRANSISTOR

NPN SILICON





STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

NOTES:
1. DIMENSIONS A, B AND R ARE DATUMS.
2. POSITIONAL TOLERANCE FOR MOUNTING HOLES:
| ⌖ | 0.76 (0.030) Ⓜ | T | A Ⓜ | B Ⓜ |
POSITIONAL TOLERANCE FOR LEADS:
| ⌖ | 0.25 (0.010) Ⓜ | T | A Ⓜ | R Ⓜ |
3. -T- IS BOTH A SEATING PLANE AND A DATUM SURFACE.
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1973.

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.61	0.118	0142
R	9.91	10.41	0.390	0.410

CASE 336-03

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	70	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Peak (1, 2)	I_C	24	Adc
Peak Device Dissipation @ $T_C = 25°C$ (1, 2) Derate above 25°C	P_D	1166 6.67	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1,2,3)	$R_{\theta JC}$	0.15	°C/W

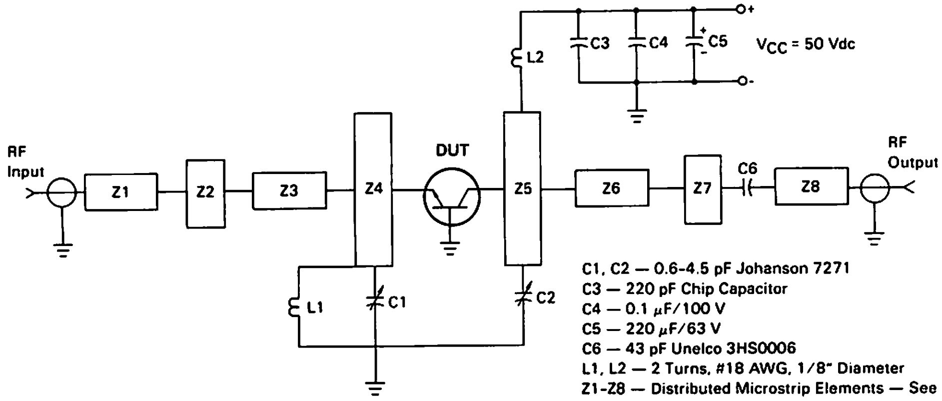
(1) Pulse Width = 10 μs, Duty Cycle = 1%.
(2) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF short pulse amplifier.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	70	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mAdc, I_E = 0)	$V_{(BR)CBO}$	70	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 50 Vdc, I_E = 0)	I_{CBO}	—	—	20	mAdc
ON CHARACTERISTICS					
DC Current Gain* (I_C = 10 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	10	30	—	—
FUNCTIONAL TESTS (Pulse Width = 10 μs, Duty Cycle = 1.0%)					
Common-Base Amplifier Power Gain (V_{CC} = 50 Vdc, P_{out} = 325 W pk, f = 1090 MHz)	G_{PB}	6.0	7.2	—	dB
Collector Efficiency (V_{CC} = 50 Vdc, P_{out} = 325 W pk, f = 1090 MHz)	η	33	—	—	%
Load Mismatch (V_{CC} = 50 Vdc, P_{out} = 325 W pk, f = 1090 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Power Output			

*80 μs Pulse on Tektronix 576 or equivalent.

FIGURE 1 — 1090 MHz TEST CIRCUIT



C1, C2 — 0.6-4.5 pF Johanson 7271
C3 — 220 pF Chip Capacitor
C4 — 0.1 μF/100 V
C5 — 220 μF/63 V
C6 — 43 pF Unelco 3HS0006
L1, L2 — 2 Turns, #18 AWG, 1/8" Diameter
Z1-Z8 — Distributed Microstrip Elements — See Figure 9
Board Material — 0.062" Thick Teflon*-Fiberglass, ϵ_r = 2.55

*Registered Trademark of DuPont

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

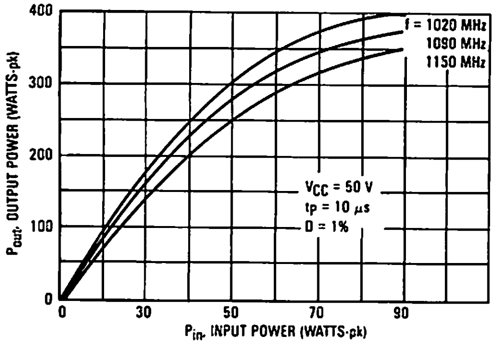


FIGURE 3 — OUTPUT POWER versus FREQUENCY

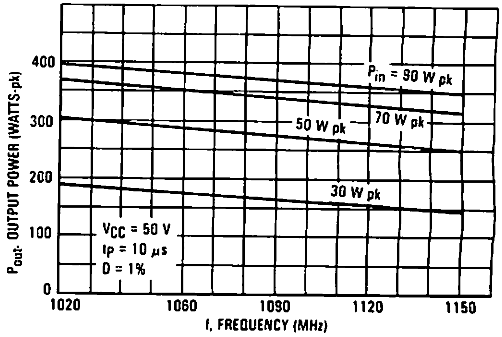


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE

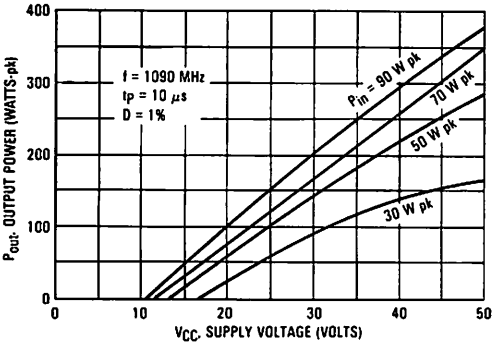


FIGURE 5 — POWER GAIN versus FREQUENCY

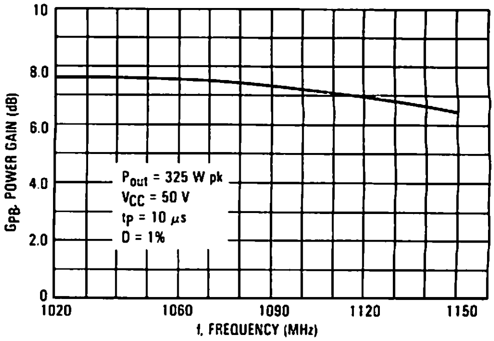
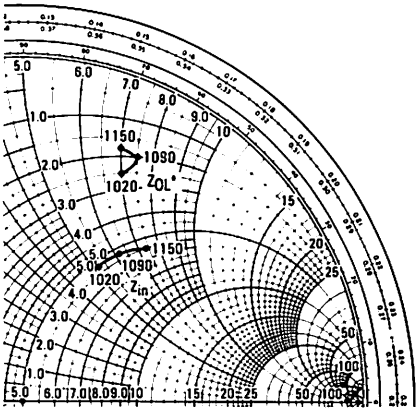


FIGURE 6 — SERIES EQUIVALENT INPUT/OUTPUT IMPEDANCE



P_{out} = 325 W-pk V_{CC} = 50 V
tp = 10 μs D = 1%

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
1020	5.2 + j5.2	2.5 + j7.0
1090	5.2 + j6.2	2.0 + j7.5
1150	5.5 + j7.3	1.8 + j7.0

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 7 — 1090 MHz TEST AMPLIFIER

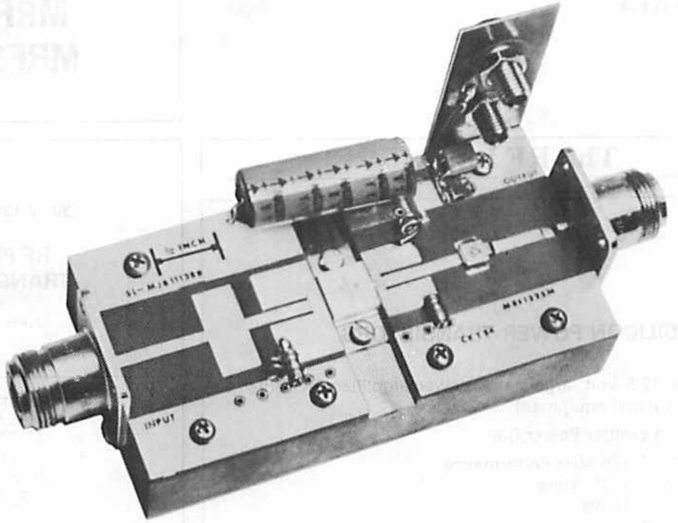


FIGURE 8 — TYPICAL PULSE PERFORMANCE

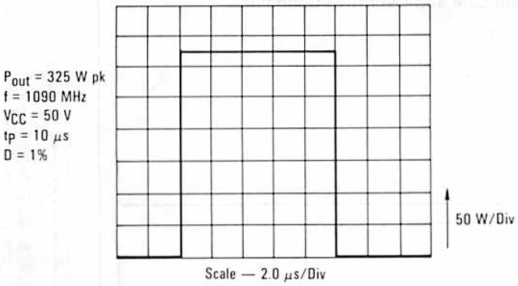
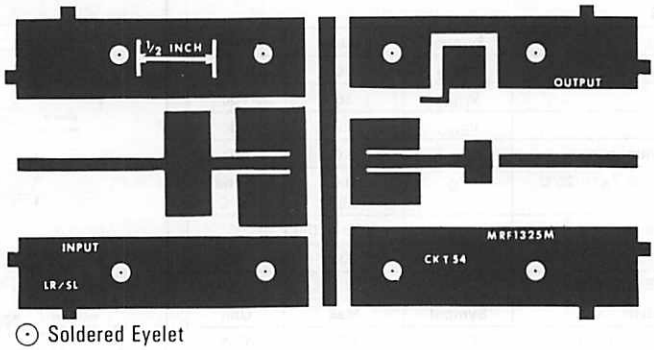


FIGURE 9 — PRINTED CIRCUIT BOARD LAYOUT — 1090 MHz TEST CIRCUIT



NOTE: The Printed Circuit Board shown is 75% of the original.

MRF1946
MRF1946A

The RF Line

2

NPN SILICON POWER TRANSISTORS

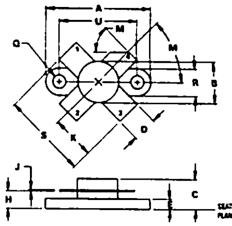
Designed for 12.5 volt large-signal power amplifiers in commercial and industrial equipment.

- High Common Emitter Power Gain
- Specified 12.5 V, 175 MHz Performance
  Output Power = 30 Watts
  Power Gain = 10 dB
  Efficiency = 60%
- Diffused Emitter Resistor Ballasting
- Characterized to 220 MHz
- Load Mismatch at High Line and Overdrive Conditions

30 W 136–220 MHz

RF POWER TRANSISTORS

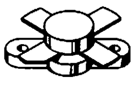
NPN SILICON



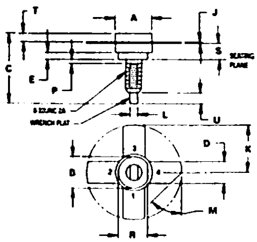
NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2 CONTROLLING DIMENSION: INCH

STYLE 1
PIN 1 EMITTER
2 BASE
3 EMITTER
4 COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730



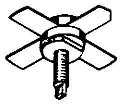
CASE 211-07
MRF1946



NOTES
1 DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982
2 CONTROLLING DIMENSION: INCH

STYLE 1
PIN 1 EMITTER
2 BASE
3 EMITTER
4 COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132



CASE 145A-09
MRF1946A

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	100 0.57	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

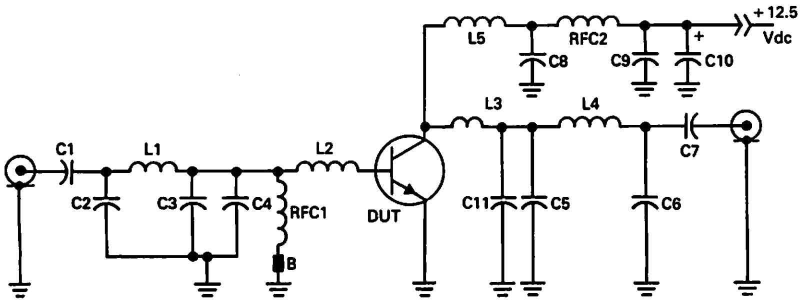
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.75	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	5.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	40	75	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	75	100	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	G_{pe}	10	11	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 30 W, f = 175 MHz)	η	60	70	—	%
Load Mismatch (V_{CC} = 15.5 Vdc, P_{in} = 2.0 dB Overdrive, Load VSWR = 30:1)	ψ	No Degradation in Output Power			

FIGURE 1 — BROADBAND TEST CIRCUIT SCHEMATIC



C1 = 56 pF Mini-Unelco, 3HS0006-56
C2 = 47 pF Mini-Unelco, 3HS0006-47
C3, C4 = 180 pF Chip Cap, ATC 100B181JC500
C5 = 150 pF Unelco, J101-150
C6 = 39 pF Mini-Unelco, 3HS0006-39
C7, C8 = 1000 pF Chip Cap, ATC 100B102JC50
C9 = 0.1 μF Ceramic Capacitor
C10 = 10 μF, 25 V Electrolytic Capacitor
C11 = 56 pF Mini-Unelco, 3HS0006-56

L1 = 2 Turns #18 AWG, 0.125" ID
L2, L3 = Circuit Board and Mounting Pad Inductance
L4 = 3 Turns #18 AWG, 0.125" ID
L5 = 6 Turns #16 Enameled, 0.250" ID

RFC1 = 0.15 μH Molded Choke w/Ferrite Bead
RFC2 = Ferrite Choke, Fair Rite VK200-4B

Board Material = 1/32" Glass Teflon, 1 oz. Cu Plating

Bead — Ferroxcube

FIGURE 2 — OUTPUT POWER versus INPUT POWER

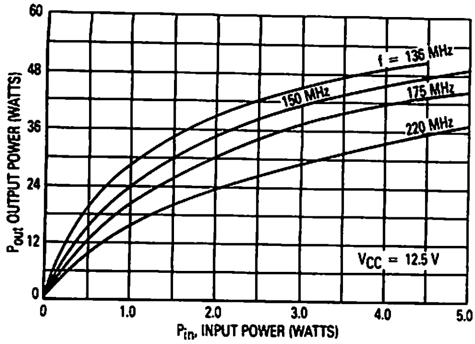


FIGURE 3 — OUTPUT POWER versus FREQUENCY

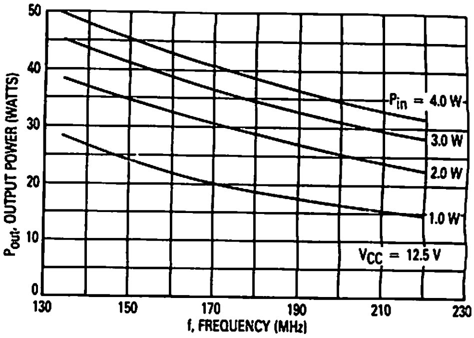


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 220 MHz

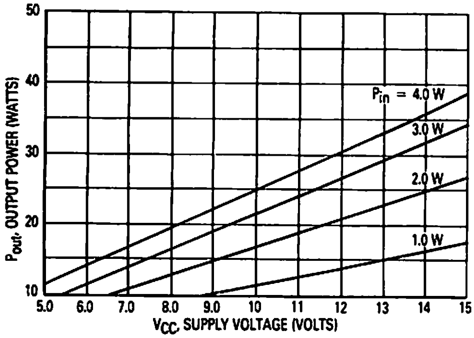


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 175 MHz

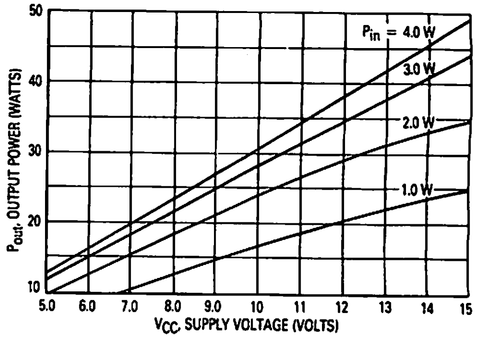


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

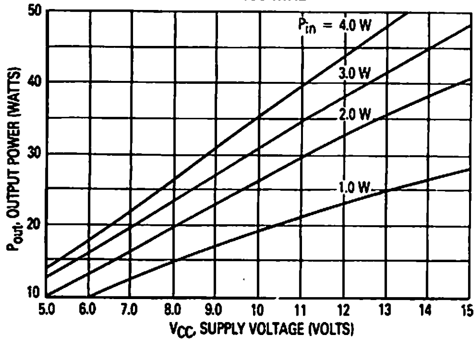


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 136 MHz

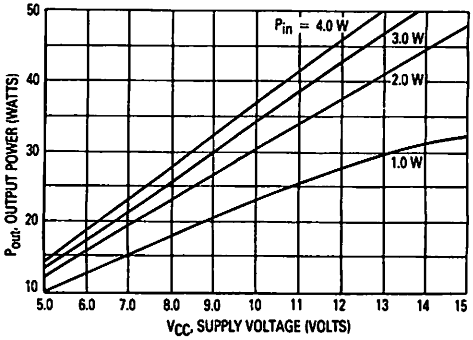


FIGURE 8 — TYPICAL PERFORMANCE IN A BROADBAND CIRCUIT

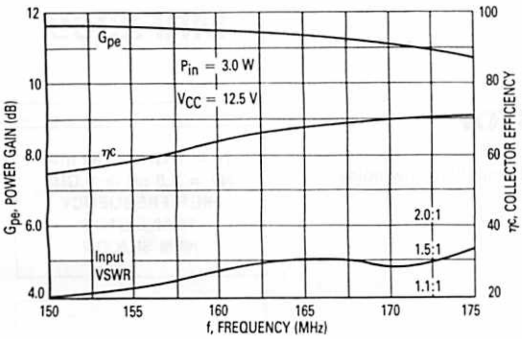
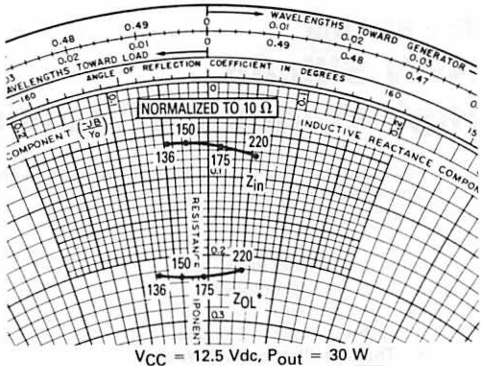


FIGURE 9 — SERIES EQUIVALENT INPUT AND OUTPUT IMPEDANCE

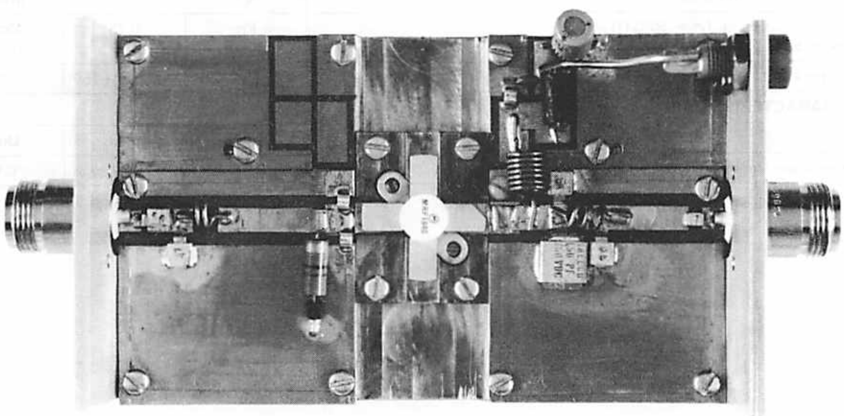


V_{CC} = 12.5 Vdc, P_{out} = 30 W

f MHz	Z_{in} Ohms	Z_{OL}* Ohms
136	0.60 − j0.48	2.22 − j0.74
150	0.63 − j0.26	2.30 − j0.40
175	0.62 + j0.13	2.35 − j0.04
220	0.73 + j0.57	2.20 + j0.43

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a given output power, voltage and frequency.

FIGURE 10 — BROADBAND TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

The RF Line
NPN Silicon High Frequency Transistor

MRF2369

... designed for low-noise, wide dynamic range front end amplifiers, low-noise VCO's and microwave power multipliers.

- Low Noise
- High Gain
- Available in Low Cost Plastic
- State-of-the-Art Technology
  - Fine Line Geometry
  - Ion Implanted Arsenic Emitters
  - Gold Top Metallization and Wires
  - Silicon Nitride Passivation
- Fully Characterized
- Higher Voltage Version of MRF571
- Internally Ballasted for Improved Ruggedness

f_T = 6 GHz @ 50 mA
NF = 1.5 dB @ 1 GHz
HIGH FREQUENCY TRANSISTOR
NPN SILICON

MACRO-X
CASE 317-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_C = 50°C (1) Derate above 50°C	P_D	0.75 7.5	Watt mW/°C
Storage Temperature	T_{stg}	−65 to +150	°C

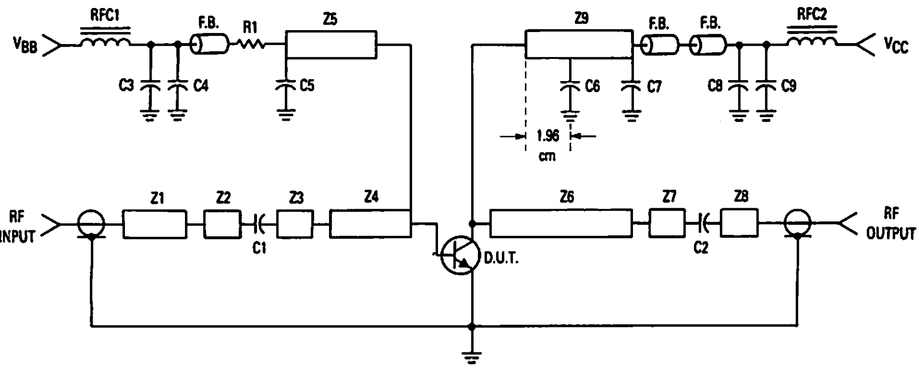
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	133	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

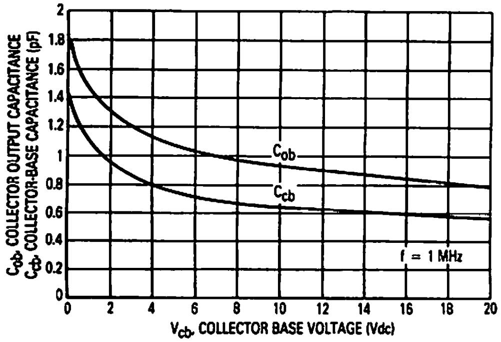
Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)		$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)		$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)		$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)		I_{CBO}	—	—	10	μAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)		C_{cb}	—	0.7	1	pF
Current Gain — Bandwidth Product (V_{CE} = 10 Vdc, I_C = 40 mA, f = 1 GHz)		f_T	—	6	—	GHz
FUNCTIONAL TESTS						
Gain @ Noise Figure (I_C = 5 mAdc, V_{CE} = 10 Vdc)	f = 0.5 GHz	G_{NF}	—	16.5	—	dB
	f = 1 GHz		10	12	—	
Noise Figure (I_C = 5 mAdc, V_{CE} = 10 Vdc)	f = 0.5 GHz	NF	—	1	—	dB
	f = 1 GHz		—	1.5	2	
	f = 2 GHz		—	2.8	—	



C1, C2, C6	560 pF Chip Capacitor	RFC1, RFC2	VK-200, Ferroxcube
C5, C7	0.018 μF Chip Capacitor	Z1–Z9	Microstrip, See Photomaster
C3, C8	0.1 μF Mylar Capacitor	Bead	Ferrite Bead, Ferroxcube 56-590-65/3B
C4, C9	1 μF Electrolytic Capacitor	Board Material	0.0625″ Teflon Fiberglass ϵ_r = 2.5 ± 0.05
R1	2.7 kΩ		

Figure 1. 1 GHz Test Circuit

TYPICAL CHARACTERISTICS



C_{ob}, Collector Output Capacitance
Figure 2. C_{cb}, Collector-Base Capacitance versus Voltage

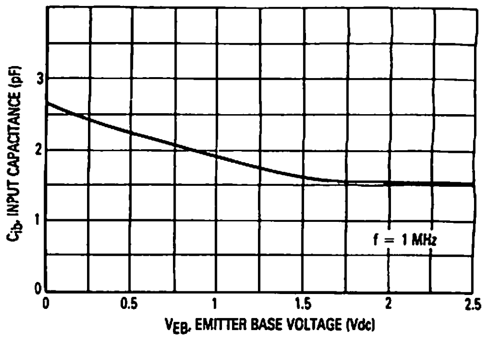


Figure 3. C_{ib}, Input Capacitance versus Emitter Base Voltage

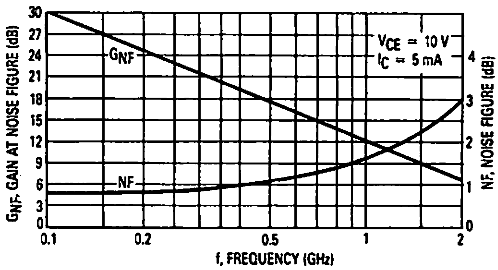


Figure 4. Gain at Noise Figure and Noise Figure versus Frequency

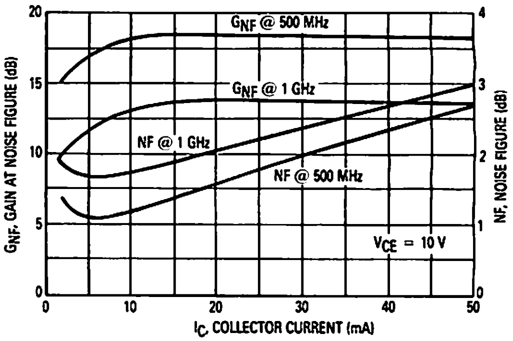


Figure 5. Gain at Noise Figure and Noise Figure versus Collector Current

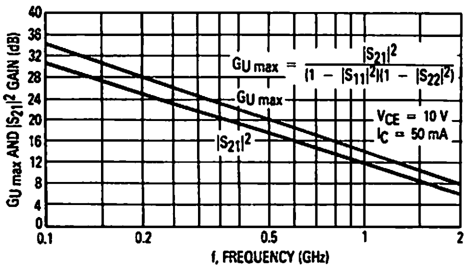


Figure 6. $G_{U\,max}$ and $|S_{21}|^2$ versus Frequency

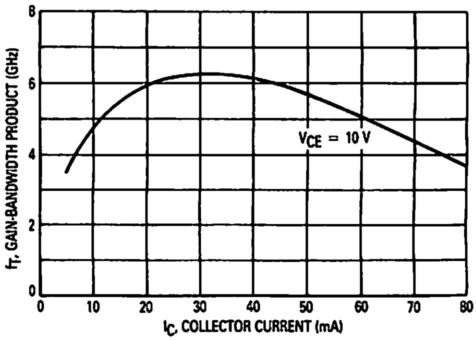
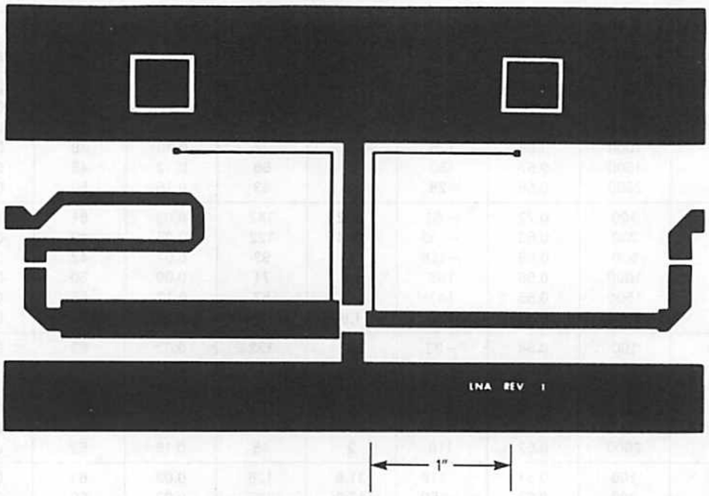


Figure 7. Gain-Bandwidth Product versus Collector Current

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5	5	100	0.83	−45	14.1	152	0.03	69	0.88	−24
		200	0.70	−81	10.5	130	0.06	51	0.74	−37
		500	0.63	−140	5.7	98	0.08	35	0.47	−57
		1000	0.59	175	3	72	0.10	38	0.36	−68
		1500	0.57	150	2	56	0.12	45	0.35	−85
		2000	0.56	128	1.5	43	0.15	50	0.37	−96
	10	100	0.72	−63	21.2	142	0.03	61	0.83	−33
		200	0.63	−103	14.4	122	0.05	49	0.60	−51
		500	0.59	−156	7	93	0.07	42	0.35	−69
		1000	0.56	166	3.6	71	0.09	50	0.24	−79
		1500	0.55	143	2.4	57	0.12	55	0.24	−95
		2000	0.53	123	1.8	45	0.16	55	0.26	−101
	25	100	0.54	−93	29.1	132	0.02	63	0.68	−47
		200	0.57	−132	17.9	111	0.03	50	0.45	−66
		500	0.57	−173	7.9	88	0.05	53	0.23	−83
		1000	0.55	157	3.9	70	0.09	62	0.15	−93
		1500	0.54	137	2.6	57	0.13	62	0.16	−109
		2000	0.52	118	2	46	0.18	59	0.18	−109
	50	100	0.51	−118	31.6	126	0.02	63	0.58	−52
		200	0.57	−150	17.9	106	0.03	50	0.36	−66
		500	0.59	178	7.6	85	0.05	61	0.19	−76
		1000	0.58	153	3.7	68	0.09	67	0.15	−82
		1500	0.57	135	2.5	55	0.13	67	0.16	−100
		2000	0.55	116	1.9	44	0.17	63	0.19	−103
10	5	100	0.87	−39	14	155	0.03	70	0.89	−22
		200	0.75	−74	10.8	133	0.05	55	0.78	−32
		500	0.64	−134	6.1	100	0.08	37	0.53	−47
		1000	0.57	179	3.2	73	0.09	40	0.42	−57
		1500	0.56	153	2.1	56	0.11	47	0.41	−73
		2000	0.54	130	1.6	44	0.13	54	0.44	−83
	10	100	0.76	−57	21.9	145	0.02	70	0.83	−28
		200	0.64	−95	15.1	124	0.04	52	0.64	−43
		500	0.57	−151	7.5	94	0.06	43	0.40	−55
		1000	0.54	169	3.8	72	0.08	52	0.30	−61
		1500	0.53	146	2.5	57	0.11	57	0.30	−76
		2000	0.51	125	1.9	45	0.15	59	0.33	−84
	25	100	0.60	−82	30.4	133	0.02	60	0.73	−40
		200	0.56	−123	19.1	114	0.03	49	0.48	−53
		500	0.54	−168	8.5	89	0.05	54	0.28	−60
		1000	0.52	159	4.3	70	0.08	63	0.21	−64
		1500	0.52	139	2.8	57	0.12	64	0.22	−79
		2000	0.50	120	2.1	46	0.16	63	0.25	−84
	50	100	0.54	−104	33.5	127	0.01	60	0.63	−44
		200	0.55	−141	19.4	107	0.02	51	0.40	−51
		500	0.55	−177	8.3	85	0.04	61	0.26	−52
		1000	0.54	155	4.1	68	0.08	68	0.22	−56
		1500	0.54	137	2.7	55	0.11	69	0.23	−73
		2000	0.52	118	2	45	0.16	66	0.27	−81

Figure 8. Common Emitter S-Parameters

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 9. Photomaster of Circuit Layout

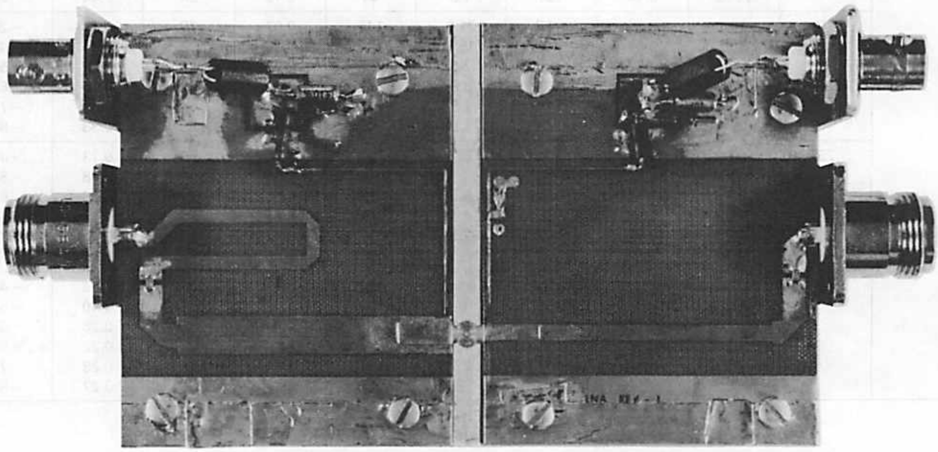


Figure 10. Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF2628

The RF Line

NPN SILICON RF POWER TRANSISTOR

Designed for 12.5 volt VHF large-signal power amplifiers in commercial and industrial FM equipment.

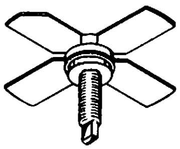
- Compact .280 Stud Package
- Specified 12.5 V, 175 MHz Performance
  Output Power = 15 Watts
  Power Gain = 12 dB Min
  Efficiency = 60% Min
- Characterized to 220 MHz
- Load Mismatch Capability at High Line and Overdrive

15 W 136–220 MHz

RF POWER TRANSISTOR

NPN SILICON

2

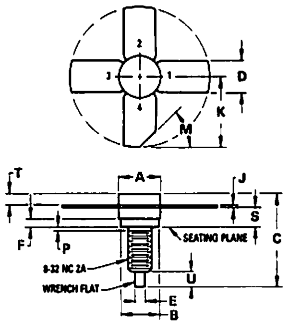


MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.5	Adc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	40 0.23	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

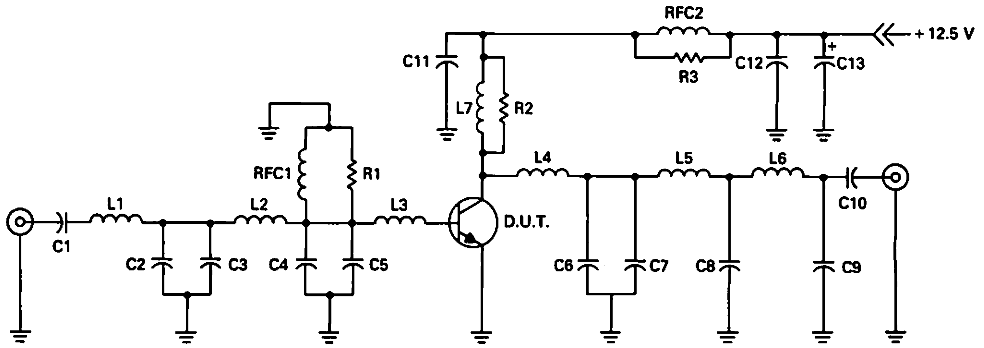
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	1.0	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	70	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	33	60	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	G_{pe}	12	13	—	dB
Collector Efficiency (V_{CC} = 12.5 Vdc, P_{out} = 15 W, f = 175 MHz)	η	60	68	—	%
Load Mismatch (V_{CC} = 15.5 V, P_{in} = 2.0 dB Overdrive, Load VSWR = 30:1)	ψ	No Degradation in Output Power			

FIGURE 1 — BROADBAND CIRCUIT



C1, C10, C11 = 1000 pF Ceramic Chip Capacitor
C2 = 27 pF Mini Unelco Capacitor
C3 = 33 pF Mini Unelco Capacitor
C4, C5 = 270 pF Unelco J101 Capacitor
C6, C9 = 18 pF Mini Unelco Capacitor
C7 = 91 pF Mini Unelco Capacitor
C8 = 68 pF Mini Unelco Capacitor
C12 = 0.1 μF Monolythic Capacitor
C13 = 100 μF, 15 V Electrolytic
L1 = 3 Turns #18 AWG, 3/16" ID
L2 = 1 1/8" #18 AWG into 1/2" High Loop
L3 = Copper Pad, 0.200 x 0.400 x 0.060
L4 = 1/4" #18 AWG into 1/8" High Loop
L5 = 3 Turns #24 AWG Enameled, 3/32" ID
L6 = 6 Turns #24 AWG Enameled, 3/32" ID
L7 = 1 3/4" #16 AWG into 3/4" High Loop
R1 = 12 Ω, 1/2 W Carbon
R2 = 100 Ω, 1.0 W Carbon
R3 = 10 Ω, 1.0 W Carbon
RFC1 = 0.15 μH Molded Choke
RFC2 = Ferrocube Choke, VK200-4B

FIGURE 2 — OUTPUT POWER versus FREQUENCY

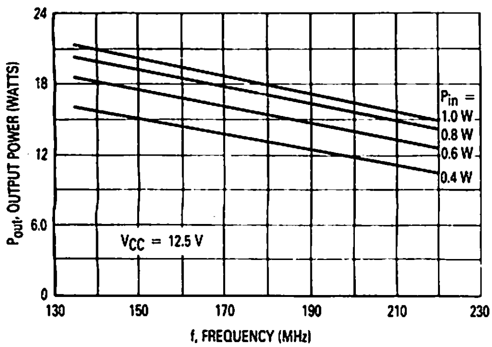


FIGURE 3 — OUTPUT POWER versus INPUT POWER

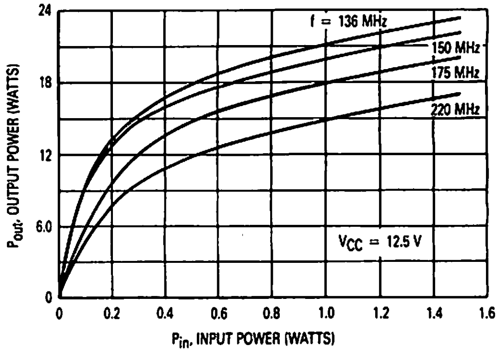


FIGURE 4 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 220 MHz

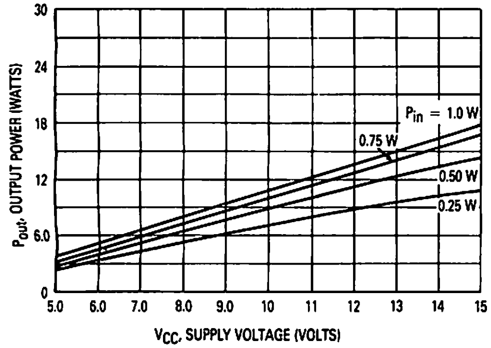


FIGURE 5 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 175 MHz

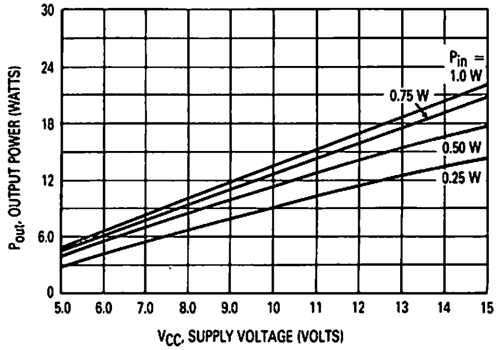


FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 150 MHz

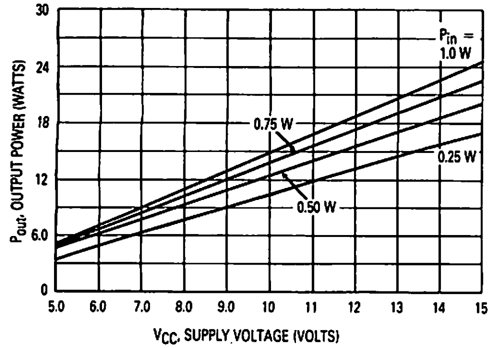


FIGURE 7 — OUTPUT POWER versus SUPPLY VOLTAGE
f = 136 MHz

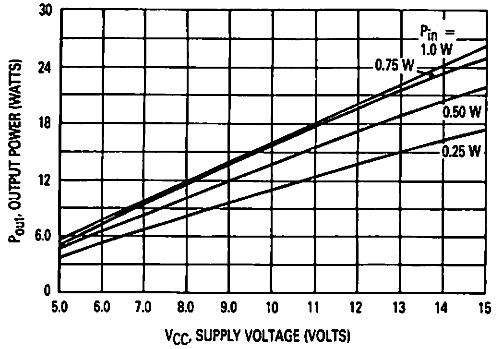


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FIGURE 8 — TYPICAL PERFORMANCE IN A BROADBAND CIRCUIT

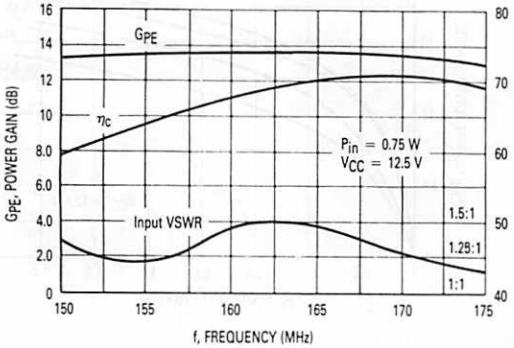
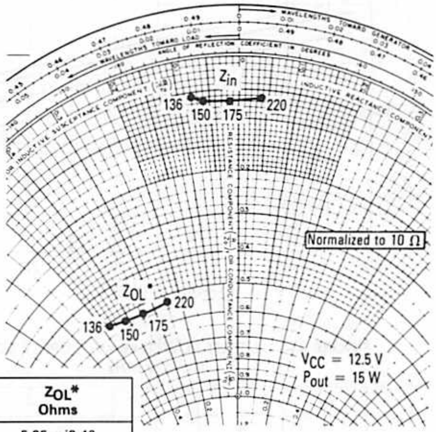


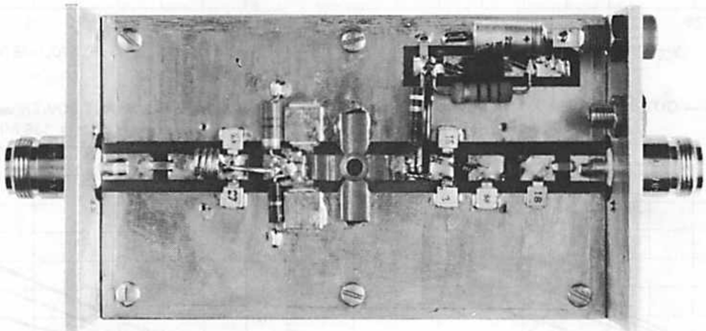
FIGURE 9 — SERIES EQUIVALENT IMPEDANCE



f MHz	Z_{in} Ohms	Z_{OL}* Ohms
220	0.62 + j0.39	5.25 – j2.46
175	0.69 – j0.17	5.26 – j3.46
150	0.68 – j0.61	5.23 – j4.14
136	0.59 – j0.80	5.07 – j4.76

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

FIGURE 10 — BROADBAND TEST CIRCUIT



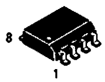
MRF3866

The RF Line
NPN Silicon
High Frequency Transistor

**SURFACE MOUNT
RF TRANSISTOR
NPN SILICON**

... designed for amplifier and oscillator applications in industrial equipment constructed with surface mount components.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Complement to MRF5160
- Tape and Reel Packaging Options Available



CASE 751-03, STYLE 1
(SO-8)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	55	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current — Continuous	I_C	0.4	A
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	55	—	—	V
Collector-Base Sustaining Voltage (I_E = 5 mA)	$V_{CEO(sus)}$	30	—	—	V
Collector-Base Breakdown Voltage (I_C = 0.1 mA)	$V_{(BR)CBO}$	55	—	—	V
Emitter-Base Breakdown Voltage (I_E = 0.1 mA)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current (V_{CE} = 28 V)	I_{CEO}	—	—	20	μA
Collector Cutoff Current (V_{CE} = 55 V, V_{BE} = −1.5 V Reverse)	I_{CEX}	—	—	100	μA
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.36 A, V_{CE} = 5 V) (I_C = 0.05 A, V_{CE} = 5 V)	h_{FE}	 5 10	 — —	 — 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 20 mA)	$V_{CE(sat)}$	—	—	250	mV
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 15 V, f = 200 MHz)	f_T	500	800	—	MHz
Output Capacitance (V_{CB} = 30 V, f = 1 MHz)	C_{obo}	—	—	3	pF

2

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			S_{11}	∠φ	S_{21}	∠φ	S_{12}	∠φ	S_{22}	∠φ
15	50	100	0.67	−166	13.75	92	0.016	44	0.32	−27
		200	0.69	−176	6.93	81	0.024	53	0.30	−24
		300	0.70	177	4.57	73	0.032	57	0.32	−31
		400	0.71	172	3.38	67	0.042	59	0.34	−37
		500	0.72	168	2.66	61	0.049	59	0.37	−45
		600	0.72	164	2.17	54	0.056	61	0.40	−53
		700	0.72	160	1.85	49	0.061	63	0.43	−60
		800	0.72	155	1.61	44	0.068	65	0.47	−66
		900	0.71	151	1.40	39	0.075	64	0.50	−73
		1000	0.70	146	1.25	34	0.084	68	0.53	−79

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF4070

The RF Line

70 W 175 MHz

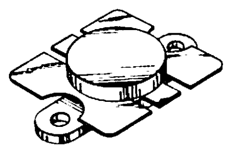
CONTROLLED Q
RF POWER
TRANSISTOR

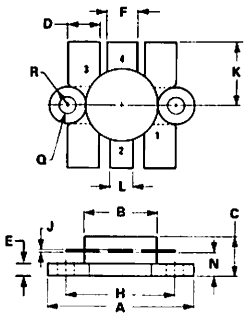
NPN SILICON

NPN SILICON RF POWER TRANSISTOR

. . . designed for 12.5 Volt VHF large-signal amplifier applications in industrial and commercial FM equipment operating to 175 MHz.

- Specified 12.5 Volt, 175 MHz Characteristics —
  Output Power = 70 Watts
  Minimum Gain = 5.0 dB
  Efficiency = 55%
- Characterized With Series Equivalent Large-Signal Impedance Parameters
- Built-In Matching Network for Broadband Operation
- Capable of Withstanding VSWR of 20:1 at Rated P_{out} and 15.5 V





STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

NOTE:
FLANGE IS ISOLATED IN ALL STYLES

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current — Peak	I_C	20	Adc
Total Device Dissipation @ T_C = 25°C Derate Above 25°C	P_D	250 1.43	Watts W/°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

THERMAL CHARACTERISTICS

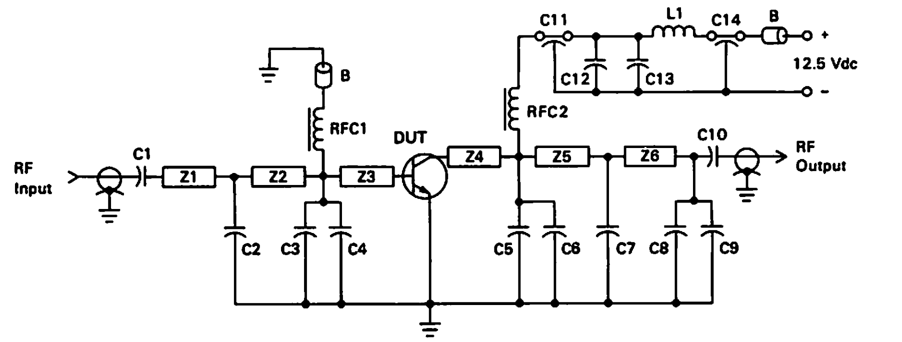
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mAdc, V_{BE} = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CE} = 12.5 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	5.0	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	275	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 Vdc, P_{out} = 70 Watts, F = 175 MHz)	G_{PE}	5.0	—	—	dB
Input Power (V_{CC} = 12.5 Vdc, P_{out} = 70 Watts, f = 175 MHz)	P_{in}	—	—	20	Watts
Collector Efficienty (V_{CC} = 12.5 Vdc, P_{out} = 70 Watts, f = 175 MHz)	η	55	—	—	%

FIGURE 1 — 175 MHz TEST CIRCUIT SCHEMATIC



C1, C10 — 470 pF Unelco
C2 — 40 pF Unelco
C3, C4, C5, C6 — 150 pF Unelco
C7 — 80 pF Unelco
C8 — 25 pF Unelco
C9 — 15 pF Unelco
C11, C14 — 1000 pF Unelco
C12 — 0.05 μF Erie Disc Ceramic
C13 — 10 μF Electrolytic

Z1 = Microstrip 0.5 cm W × 3.5 cm L
Z2 = Microstrip 0.5 cm W × 9.0 cm L
Z3 = Microstrip 0.5 cm W × 1.0 cm L
Z4 = Microstrip 0.5 cm W × 1.0 cm L
Z5 = Microstrip 0.5 cm W × 1.0 cm L
Z6 = Microstrip 0.5 cm W × 9.0 cm L

RFC1 = 0.15 μH Molded Choke
RFC2 = 10 Turns #18 AWG Enameled Wire on 470 Ω, 2.0 W Resistor
L1 = 2.0 cm AWG #16 Wire
B = Fairite #2643021801, Ferrite Bead
Board Material = G10
$\epsilon_r \approx 5$
t = 62 mils

2

FIGURE 2 — OUTPUT POWER versus INPUT POWER

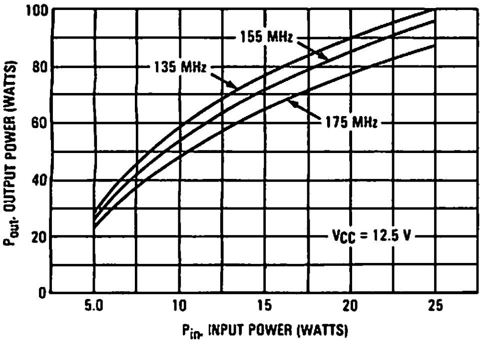


FIGURE 3 — OUTPUT POWER versus INPUT POWER

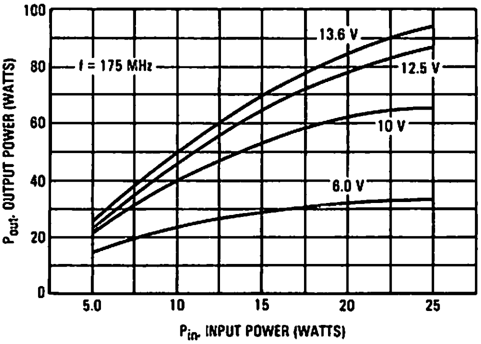


FIGURE 4 — OUTPUT POWER versus FREQUENCY

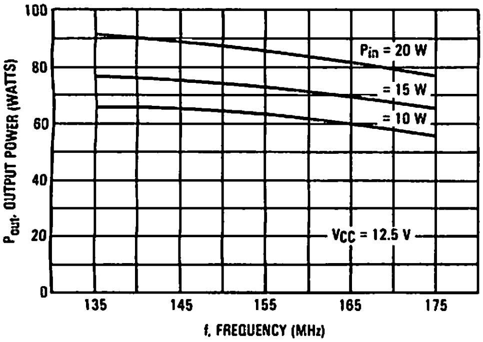
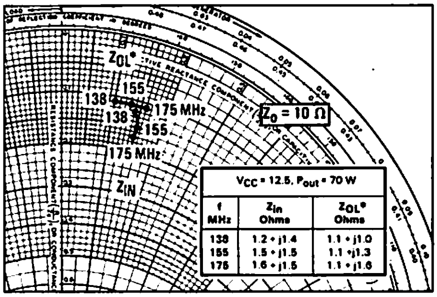


FIGURE 5 — SERIES EQUIVALENT IMPEDANCE



V_{CC} = 12.5, P_{out} = 70 W		
f MHz	Z_{in} Ohms	Z_{OL}* Ohms
138	1.2 + j1.4	1.1 + j1.0
155	1.5 + j1.5	1.1 + j1.3
175	1.6 + j1.5	1.1 + j1.6

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 — OUTPUT POWER versus SUPPLY VOLTAGE

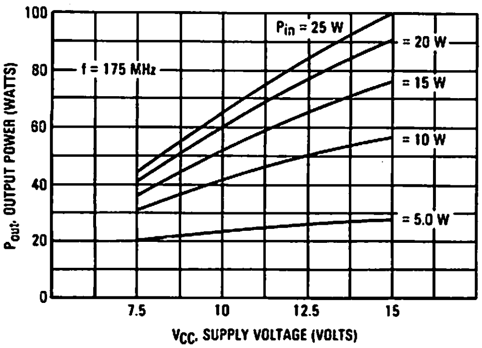


FIGURE 7 — OUTPUT POWER versus VOLTAGE

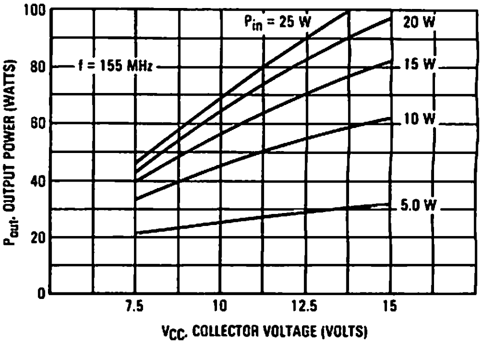


FIGURE 8 — OUTPUT POWER versus VOLTAGE

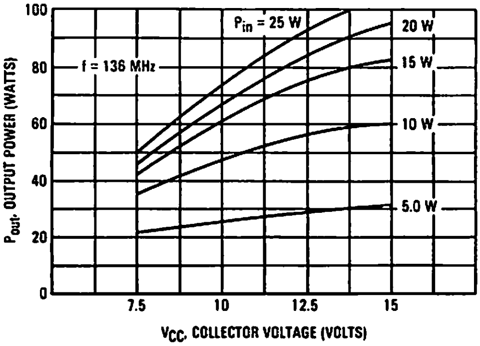
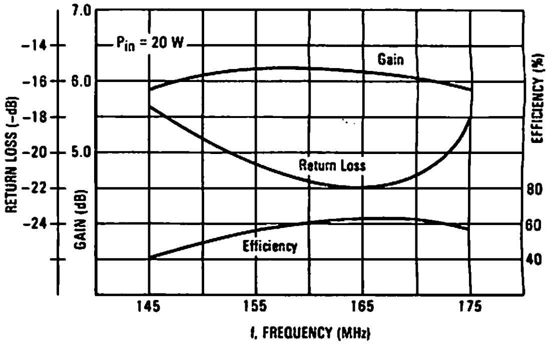


FIGURE 9 — BROADBAND PERFORMANCE GAIN, RETURN LOSS, EFFICIENCY versus FREQUENCY



MRF4427

DIE SOURCE SAME AS 2N4427

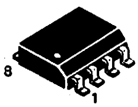
The RF Line

NPN Silicon RF Low Power Transistor

. . . designed for amplifier, frequency multiplier, or oscillator applications in industrial equipment constructed with surface mount components. Suitable for use as output driver or pre-driver stages in VHF and UHF equipment.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Low Voltage Version of MRF3866
- Tape and Reel Packaging Options Available

**1.0 W — 175 MHz
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



CASE 751-03
SORF
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	2.0	Vdc
Collector-Current — Continuous	I_C	400	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	1.5 12.5	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	125	°C/W

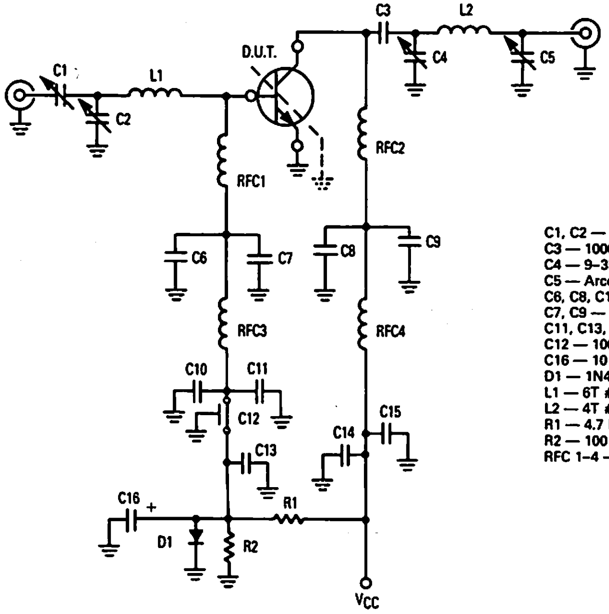
ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	20	—	Vdc
Collector-Emitter Sustaining Voltage (I_C = 5.0 mAdc, R_{BE} = 10 ohms)	$V_{(BR)CER}$	40	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 100 μAdc)	$V_{(BR)EBO}$	2.0	—	Vdc
Collector Cutoff Current (V_{CE} = 12 Vdc, I_B = 0)	I_{CEO}	—	20	μAdc

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc) (I_C = 360 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10 5.0	50 —	200 —	—
Collector-Emitter Saturation Voltage (I_C = 100 mAdc, I_B = 20 mAdc)	$V_{CE(sat)}$	—	60	—	mVdc
DYNAMIC CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mAdc, V_{CE} = 12 Vdc, f = 200 MHz)	f_T	—	1600	—	MHz
Output Capacitance (V_{CB} = 12 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	3.0	pF
FUNCTIONAL TEST					
Common-Emitter Amplifier Power Gain (P_{in} = 15 mW, V_{CC} = 12 Vdc, f = 175 MHz)	G_{pe}	—	18	—	dB
Collector Efficiency (Figure 1) (P_{out} = 1.0 W, V_{CC} = 12 Vdc, f = 175 MHz)	η	—	60	—	%
Insertion Gain (V_{CE} = 12 V, I_C = 50 mA, f = 200 MHz)	$\|S_{21}\|^2$	14	16.4	—	dB



C1, C2 — 5.5–18 pF Erie ceramic trimmer
C3 — 1000 pF ATC 100 mil chip cap.
C4 — 9–35 pF Erie ceramic trimmer
C5 — Arco 405 mica trimmer
C6, C8, C10, C14 — 0.1 μF Erie blue cap.
C7, C9 — 470 pF ATC 100 mil chip cap.
C11, C13, C15 — 1.0 μF Erie blue cap. non-polar
C12 — 1000 pF feedthru
C16 — 10 μF, 25 V tantalum
D1 — 1N4148 or 1N914
L1 — 6T #20 AWG on #2 drill bit
L2 — 4T #20 AWG on #4 drill bit
R1 — 4.7 kΩ 1/8 watt carbon
R2 — 100 Ω 1/8 watt carbon
RFC 1–4 — 10 μH molded choke

Figure 1. 175 MHz RF Amplifier Circuit for Functional Tests

TYPICAL CHARACTERISTICS

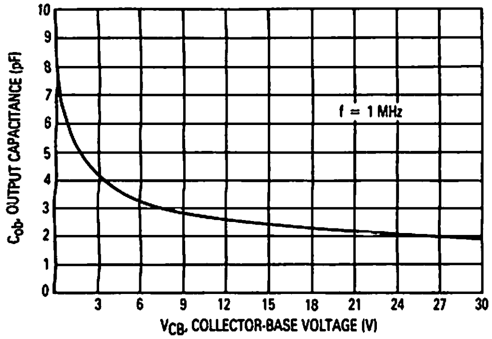


Figure 2. **Collector-Base Capacitance versus Voltage**

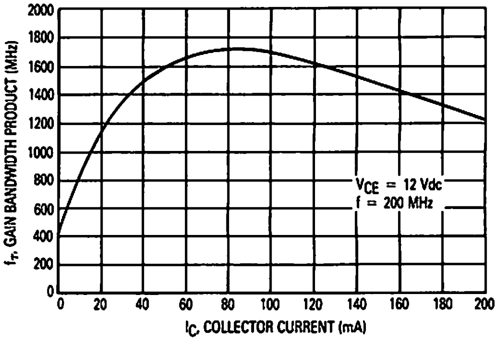


Figure 3. Gain Bandwidth Product versus Collector Current

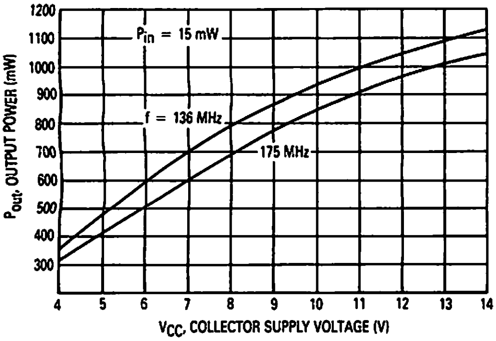


Figure 4. Output Power versus Voltage

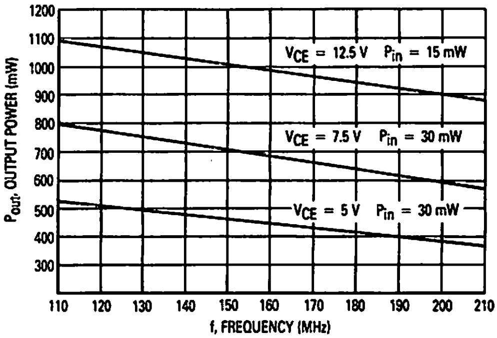


Figure 5. Output Power versus Frequency

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5.0	5.0	50	0.82	-104	10.3	125	0.05	38	0.68	-34
		100	0.83	-141	6.1	103	0.06	26	0.51	-40
		200	0.81	-165	3.2	85	0.07	21	0.44	-46
		500	0.80	169	1.3	57	0.07	32	0.49	-73
		750	0.79	156	0.8	42	0.08	49	0.58	-94
		1000	0.76	144	0.6	30	0.11	61	0.65	-114
	25	50	0.77	-151	19	107	0.02	36	0.35	-75
		100	0.79	-168	9.9	94	0.03	37	0.21	-87
		200	0.79	-180	5.0	82	0.04	49	0.16	-97
		500	0.78	163	2.0	61	0.07	62	0.22	-106
		750	0.77	152	1.3	48	0.10	66	0.31	-115
		1000	0.74	141	0.9	36	0.13	66	0.37	-127
	50	50	0.77	-163	21.1	103	0.02	37	0.29	-98
		100	0.79	-174	10.7	92	0.02	50	0.19	-119
		200	0.79	177	5.4	82	0.03	62	0.16	-134
		500	0.78	162	2.2	62	0.07	67	0.20	-131
		750	0.77	151	1.4	50	0.10	69	0.26	-130
		1000	0.74	140	1.1	38	0.13	67	0.32	-139
12	5.0	50	0.83	-97	11	129	0.04	46	0.75	-26
		100	0.82	-135	6.8	107	0.05	29	0.61	-29
		200	0.81	-162	3.6	88	0.05	24	0.54	-34
		500	0.79	171	1.4	60	0.06	37	0.57	-57
		750	0.78	157	0.9	44	0.07	55	0.64	-76
		1000	0.75	145	0.7	32	0.09	68	0.70	-95
	25	50	0.73	-143	22.1	111	0.02	38	0.43	-52
		100	0.76	-164	11.7	96	0.02	39	0.29	-52
		200	0.77	-177	6.0	84	0.03	48	0.22	-53
		500	0.76	165	2.4	63	0.06	64	0.27	-69
		750	0.75	154	1.6	49	0.08	67	0.35	-84
		1000	0.72	143	1.1	38	0.11	69	0.42	-98
	50	50	0.73	-156	25.5	106	0.02	41	0.32	-67
		100	0.75	-171	13.1	94	0.02	49	0.20	-69
		200	0.76	59	6.6	83	0.03	60	0.15	-71
		500	0.75	164	2.6	64	0.06	69	0.20	-81
		750	0.74	153	1.7	51	0.09	70	0.27	-92
		1000	0.71	142	1.2	38	0.12	70	0.34	-104

Figure 6. Common Emitter S-Parameters

Freq. MHz	P_{in} mW	P_{out} mW	V_{CC} Volts	Z_{in} Ohms	Z_{OL}* Ohms
136	15	—	12.5	6.2 − j11.6	—
175	15	—	12.5	4.6 − j10.4	—
136	—	1000	12.5	—	47.7 + j41.7
175	—	1000	12.5	—	47.4 − j34.4
136	30	—	7.5	5.65 − j12.6	—
175	30	—	7.5	6.25 − j12.2	—
136	—	650	7.5	—	27.6 − j32.4
175	—	650	7.5	—	27.9 − j27.6
136	30	—	5.0	6.1 − j13.3	—
175	30	—	5.0	5.9 − j12.22	—
136	—	450	5.0	—	24.8 − j22.8
175	—	450	5.0	—	28.3 − j29.3

Z_{OL}* = Conjugate of optimum load impedance into which the device operates at a gain output power, voltage and frequency.

Figure 7. Series Input/Output Impedances

MRF5160

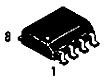
2

The RF Line
PNP Silicon High Frequency Transistor

. . . designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in *VHF and UHF.*

- Complement to MRF3866
- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- *S-Parameter Characterization*
- Tape and Reel Packaging Options Available

**I_C = −400 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
PNP SILICON**



**CASE 751-03, STYLE 1
(SO-8)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−40	Vdc
Collector-Base Voltage	V_{CBO}	−60	Vdc
Emitter-Base Voltage	V_{EBO}	−4	Vdc
Collector-Current — Continuous	I_C	−0.4	A
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Sustaining Voltage (I_C = −5 mA)	$V_{CEO(sus)}$	−40	—	—	V
Emitter-Base Breakdown Voltage (I_E = −0.1 mA)	$V_{(BR)EBO}$	−4	—	—	V
Collector Cutoff Current (V_{CB} = −28 V)	I_{CBO}	—	—	−1	µA
Collector Cutoff Current (V_{CE} = −60 V)	I_{CES}	—	—	−0.1	mA
Emitter Cutoff Current (V_{CE} = −28 V)	I_{CEO}	—	—	−20	µA
ON CHARACTERISTICS					
DC Current Gain (I_C = −50 mA, V_{CE} = −5 V)	h_{FE}	10	—	—	—
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = −50 mA, V_{CE} = −15 V, f = 200 MHz)	f_T	—	800	—	MHz
Insertion Gain (V_{CE} = −15 V, I_C = −50 mA, f = 400 MHz)	$|S_{21}|^2$	8	9.8	—	dB

2

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−15	−50	100	0.78	−172	12.27	93	0.011	38	0.34	−29
		200	0.79	178	6.24	82	0.017	54	0.31	−31
		300	0.79	172	4.12	74	0.025	64	0.31	−39
		400	0.80	167	3.07	68	0.031	66	0.33	−48
		500	0.80	163	2.45	61	0.039	70	0.35	−56
		600	0.79	159	2.01	55	0.047	71	0.38	−64
		700	0.78	155	1.71	49	0.054	74	0.40	−71
		800	0.78	151	1.49	44	0.064	75	0.43	−79
		900	0.77	146	1.30	38	0.073	76	0.46	−86
		1000	0.76	142	1.16	33	0.083	77	0.50	−92

MRF5174

The RF Line

NPN SILICON RF POWER TRANSISTOR

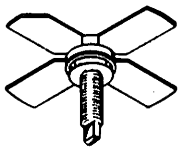
. . . designed primarily for wideband large-signal driver and pre-driver amplifier stages in the 260-600 MHz frequency range.

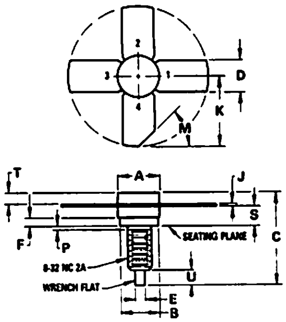
- Specified 28-Volt, 400-MHz Characteristics –
  Output Power = 2.0 Watts
  Minimum Gain = 12 dB
  Efficiency = 50%
- Characterized from 200 to 600 MHz
- Includes Series Equivalent Impedances

2 W – 400 MHz

RF POWER TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	–	0.060	–
J	0.08	0.17	0.003	0.007
K	11.05	–	0.435	–
M	45° NOM		45° NOM	
P	–	1.27	–	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	0.5	Adc
Total Device Dissipation @ $T_A = 25°C$ (1) *Derate above 25°C*	P_D	5.0 28	Watts mW/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

THERMAL CHARACTERISTICS

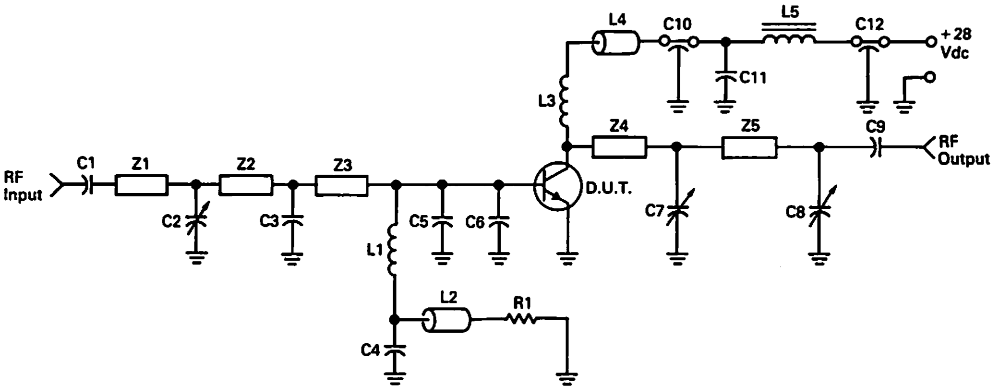
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	25	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	8.0	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 2.0 W, f = 400 MHz)	G_{PE}	12	–	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 2.0 W, f = 400 MHz)	η	50	–	–	%

FIGURE 1 – 400 MHz TEST CIRCUIT SCHEMATIC



C1, 9 — 0.02 μF Chip
C2 — 0.0–10 pF Johanson 2951
C3 — 15 pF Unelco
C4 — 100 pF Unelco
C5, 6 — 5.1 pF ATC 100 mil Chip
C7, 8 — 0.8–20 pF Johanson 3906
C10, 12 — 680 pF Feedthru
C11 — 1.0 μF Tantalum 35 V

R1 — 2.7 Ohm 1/2 Watt

L1 — 3.9 μH Molded Choke
L2, 4 — Ferrite Bead Ferroxcube 56-590-65-38
L3 — 0.15 μH Molded Choke
L5 — Ferrite Choke VK200-20-4B

Z1–Z5 — Microstrip, See Photomaster

Board Material — 0.062" Glass Teflon

FIGURE 2 – OUTPUT POWER versus FREQUENCY

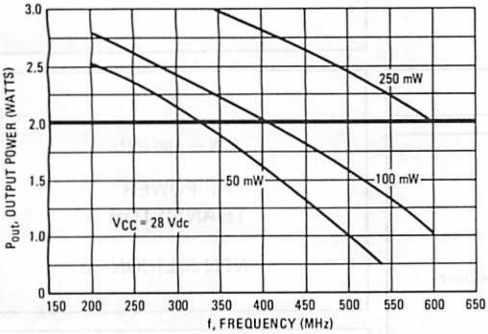


FIGURE 3 – OUTPUT POWER versus INPUT POWER

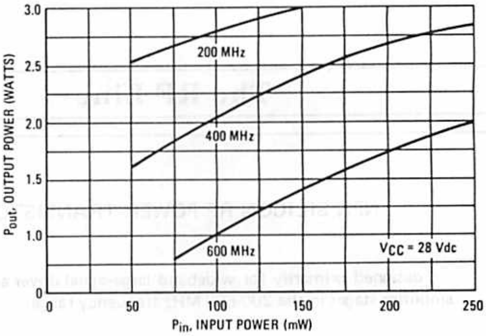


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

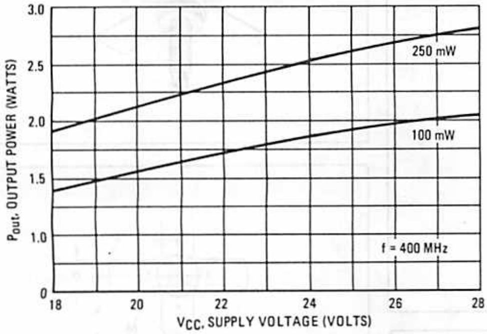
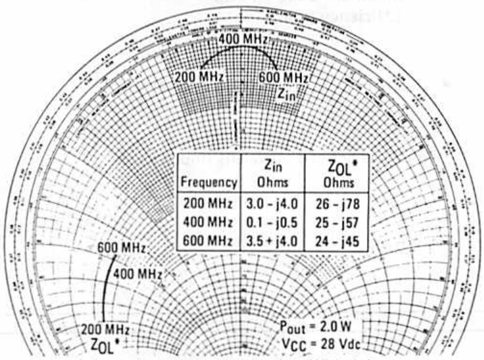


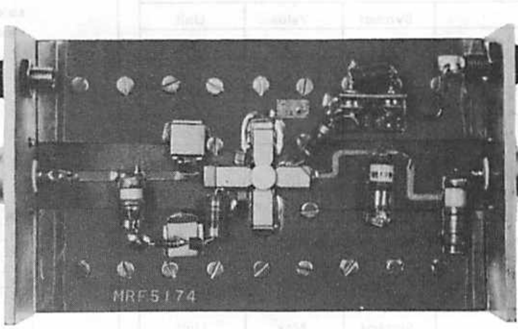
FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



Frequency	Z_{in} Ohms	Z_{OL}* Ohms
200 MHz	3.0 - j4.0	26 - j78
400 MHz	0.1 - j0.5	25 - j57
600 MHz	3.5 + j4.0	24 - j45

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

FIGURE 6 – 400 MHz TEST CIRCUIT



MRF5175

2

The RF Line

NPN SILICON RF POWER TRANSISTOR

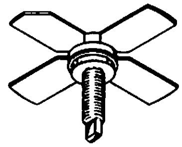
. . . designed primarily for wideband large-signal driver and predriver amplifier stages in the 200-600 MHz frequency range.

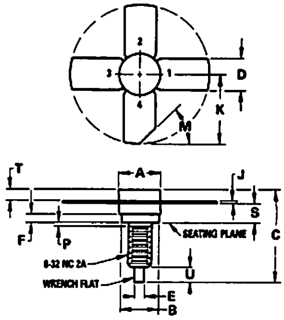
- Specified 28-Volt, 400-MHz Characteristics –
  Output Power = 5.0 Watts
  Minimum Gain = 11 dB
  Efficiency = 50%
- Characterized from 200 to 600 MHz
- Includes Series Equivalent Impedances

5 W – 400 MHz

RF POWER
TRANSISTOR

NPN SILICON





STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	33	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector Current – Continuous	I_C	1.0	Adc
Total Device Dissipation @ $T_A = 25°C$ (1) Derate above 25°C	P_D	12 69	Watts mW/°C
Storage Temperature Range	T_{stg}	-65 to +200	°C

(1) This device is designed for RF operation. The total device dissipation rating applies only when the device is operated as an RF amplifier.

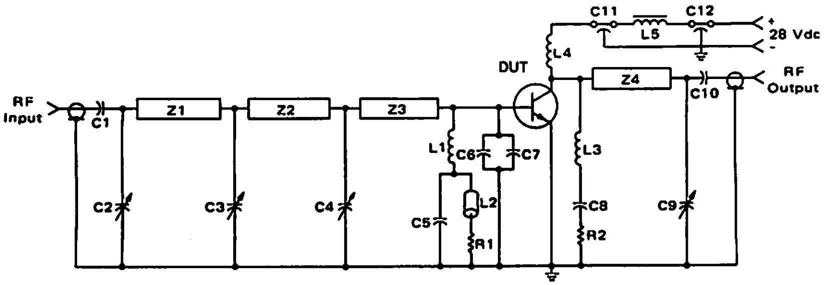
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, I_B = 0)	$V_{(BR)CEO}$	33	–	–	Vdc
Collector-Emitter Breakdown Voltage (I_C = 30 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	60	–	–	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.0 mAdc, I_C = 0)	$V_{(BR)EBO}$	4.0	–	–	Vdc
Collector Cutoff Current (V_{CB} = 30 Vdc, I_E = 0)	I_{CBO}	–	–	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mAdc, V_{CE} = 5.0 Vdc)	h_{FE}	10	–	100	–
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 Vdc, I_E = 0, f = 1.0 MHz)	C_{ob}	–	–	15	pF
FUNCTIONAL TESTS (Figure 1)					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz)	G_{PE}	11	–	–	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 5.0 W, f = 400 MHz)	η	50	–	–	%

FIGURE 1 – 400 MHz TEST CIRCUIT SCHEMATIC



C1,C10	0.018 μF VITRAMON Chip	L4	6 Turns, #20 AWG, 1/8" ID
C2,C3,C9	1.0-10 pF JOHANSON Type 2951	L5	Ferrite Choke, FERROXCUBE VK200-20-4B
C4	1.0-20 pF JOHANSON Type 3906	R1	2.7 Ohm, 1/8 Watt, 10%
C5	100 pF UNDERWOOD (UNELCO)	R2	5.1 Ohm, 1/8 Watt, 10%
C6,C7	5.0 pF ATC Chip	Z1,Z3	Microstrip Line, 0.1" W x 0.5" L
C8	0.1 μF ERIE Disc Ceramic	Z2	Microstrip Line, 0.1" W x 0.4" L
C11,C12	680 pF ALLEN BRADLEY Feedthru	Z4	Microstrip Line, 0.075" W x 2.5" L
L1	3.9 μH Molded Choke		
L2	Ferrite Bead, FERROXCUBE 56-590-65-3B		
L3	4 Turns, #22 AWG, 0.1" ID		

Board – Glass Teflon, ϵ_R = 2.56, t = 0.062"

Input/Output Connectors – Type N

2

FIGURE 2 – OUTPUT POWER versus FREQUENCY

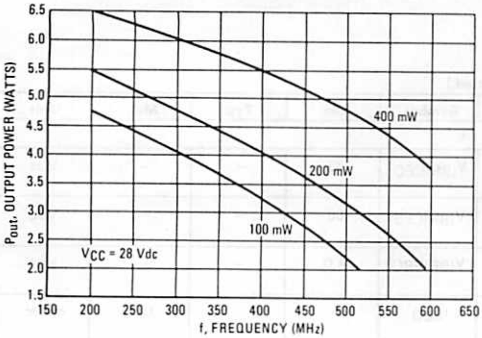


FIGURE 3 – OUTPUT POWER versus INPUT POWER

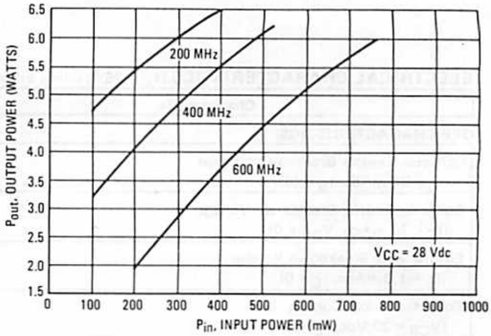


FIGURE 4 – OUTPUT POWER versus SUPPLY VOLTAGE

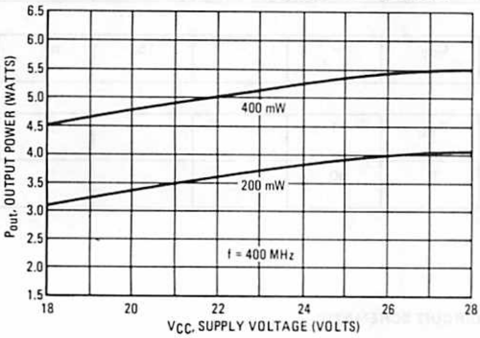
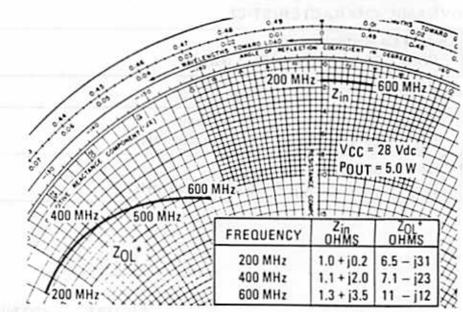
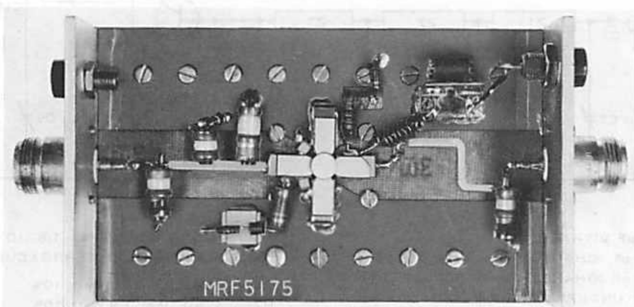


FIGURE 5 – SERIES EQUIVALENT IMPEDANCE



Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

FIGURE 6 – 400 MHz TEST CIRCUIT



MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF5211L
(See MRF521)

MRF5583

DIE SOURCE SAME AS 2N5583

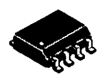
2

The RF Line
PNP Silicon High Frequency Transistor

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

I_C = −500 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
PNP SILICON



CASE 751-03, STYLE 1
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	−30	V
Collector-Base Voltage	V_{CBO}	−30	V
Emitter-Base Voltage	V_{EBO}	−3	V
Collector Current — Continuous	I_C	−500	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = −10 mA)	$V_{(BR)CEO}$	−30	—	—	V
Collector-Base Breakdown Voltage (I_C = −10 μA)	$V_{(BR)CBO}$	−30	—	—	V
Emitter-Base Breakdown Voltage (I_E = −100 μA)	$V_{(BR)EBO}$	−3	—	—	V
Collector Cutoff Current (V_{CB} = −20 V)	I_{CBO}	—	—	−50	nA
Emitter Cutoff Current (V_{EB} = −2 V)	I_{EBO}	—	—	−0.5	μA

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = −40 mA, V_{CE} = −2 V)	h_{FE}	20	—	—	—
(I_C = −100 mA, V_{CE} = −2 V)		25	—	100	
(I_C = −300 mA, V_{CE} = −5 V)		15	—	—	
Collector-Emitter Saturation Voltage (I_C = −100 mA, I_B = −10 mA)	$V_{CE(sat)}$	—	—	0.8	V
Base-Emitter On Voltage (I_C = −100 mA, V_{CE} = −2 V)	$V_{BE(on)}$	—	—	1.8	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = −35 mA, V_{CE} = −15 V, f = 100 MHz)	f_T	—	2100	—	MHz
Insertion Gain (V_{CE} = −15 V, I_C = −35 mA, f = 250 MHz)	$\|S_{21}\|^2$	12.5	15.5	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
−15	−35	10	0.47	−57	64.7	155	0.01	60	0.83	−26
		30	0.59	−116	42.2	126	0.02	44	0.56	−58
		50	0.63	−140	28.8	113	0.02	39	0.39	−74
		70	0.64	−151	21.4	105	0.02	42	0.3	−82
		100	0.65	−161	15.4	97	0.02	45	0.24	−90
		300	0.67	179	5.23	79	0.05	58	0.13	−109
		500	0.67	168	3.11	66	0.07	60	0.2	−114
		700	0.67	160	2.24	57	0.09	60	0.24	−116
		1000	0.66	146	1.54	44	0.13	60	0.3	−123

2

MRF5711L
BF430L*

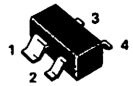
*European Part Number

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in the high-gain, low-noise small-signal amplifiers for operation up to 3.5 GHz. Also usable in applications requiring fast switching *times.*

- High Current-Gain-Bandwidth Product — f_T = 7.5 GHz (Typ) @ I_C = 50 mAdc
- Low Noise Figure @ f = 1 GHz — $NF_{(matched)}$ = 1.6 dB (Typ)
- High Power Gain — $G_{pe\ (matched)}$ = 13.5 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
  - Lower Package Parasitics
  - Higher Gain
- Tape and Reel Packaging Options

I_C = 70 mA
SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	10	Vdc
Collector-Base Voltage	V_{CBO}	20	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	70	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	0.58 4.64	Watts mW/°C
Total Device Dissipation(1) @ T_C = 75°C Derate above 75°C	P_D	0.58 7.73	Watts mW/°C
Maximum Junction Temperature	T_{Jmax}	150	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	216	°C/W
Thermal Resistance. Junction to Case	$R_{\theta JC}$	130	°C/W

DEVICE MARKING

MRF5711 = 02

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	10	12	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	20	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 50 μAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 8 Vdc, I_E = 0)	I_{CBO}	—	—	10	μAdc

Note 1. Case Temperature is measured on the collector lead where it first contacts the printed circuit board closest to the package.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 30 mAdc, V_{CE} = 5 Vdc)		h_{FE}	50	—	300	—
DYNAMIC CHARACTERISTICS						
Collector-Base Capacitance (V_{CB} = 6 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	0.75	1	pF
Current Gain — Bandwidth Product (V_{CE} = 8 Vdc, I_C = 50 mA, f = 1 GHz)	Figure 7	f_T	—	8	—	GHz
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 6 Vdc, I_C = 10 mA, f = 1 GHz)	Figure 5	G_{NFmin}	—	13.5	—	dB
Noise Figure (V_{CE} = 6 Vdc, I_C = 10 mA, f = 1 GHz)	Figure 5	NF_{min}	—	1.6	—	dB
Power Gain in 50 Ω System (V_{CE} = 6 Vdc, I_C = 10 mA, f = 1 GHz)	Figure 2	$\|S_{21}\|^2$	9	10	—	dB
Noise Figure (V_{CE} = 6 Vdc, I_C = 10 mA, f = 1 GHz)	Figure 2	NF	—	2.2	3	dB

TYPICAL CHARACTERISTICS

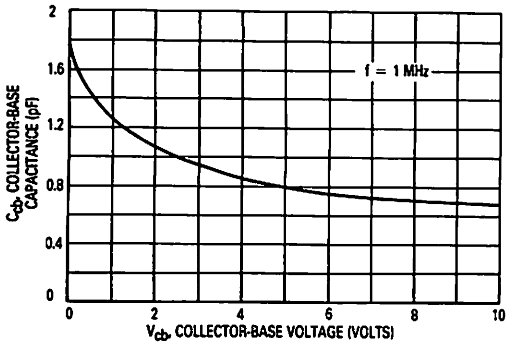


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

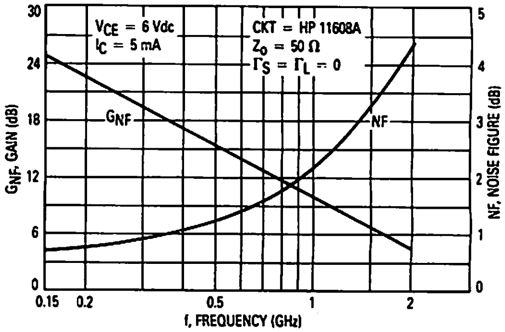


Figure 2. Gain and Noise Figure versus Frequency

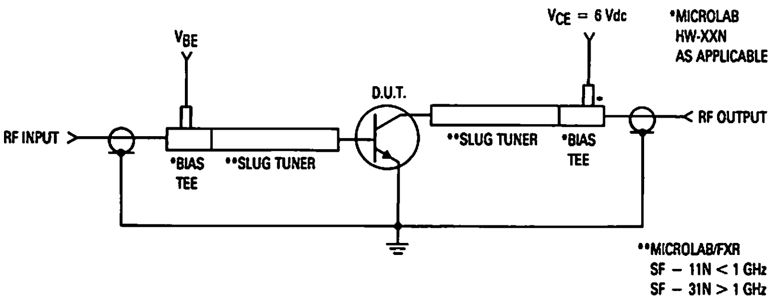


Figure 3. Functional Circuit Schematic

TYPICAL CHARACTERISTICS

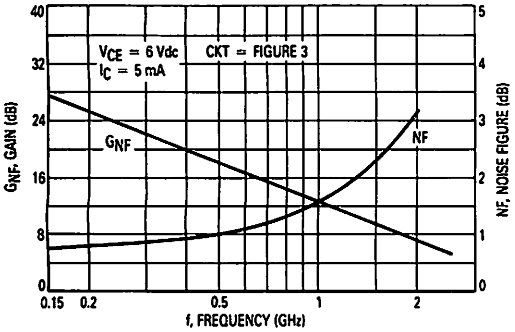


Figure 4. Gain and Noise Figure versus Frequency

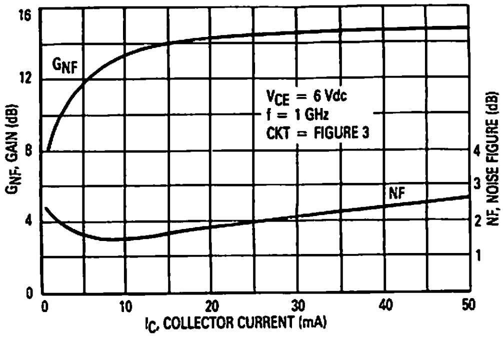


Figure 5. Gain and Noise Figure versus Collector Current

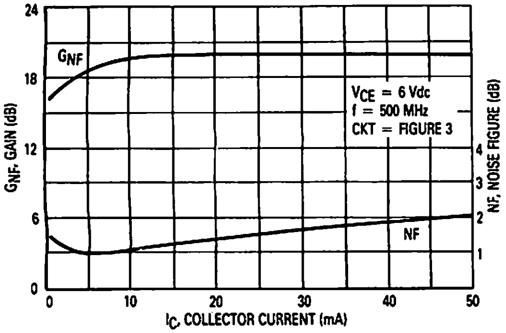


Figure 6. Gain and Noise Figure versus Collector Current

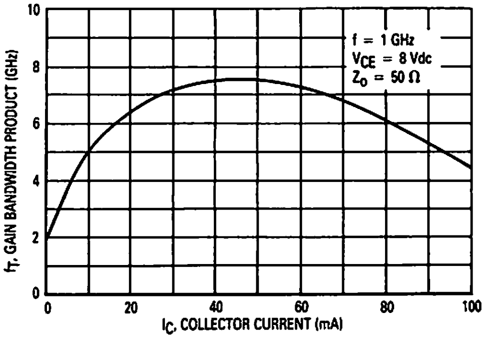


Figure 7. Gain Bandwidth Product versus Collector Current

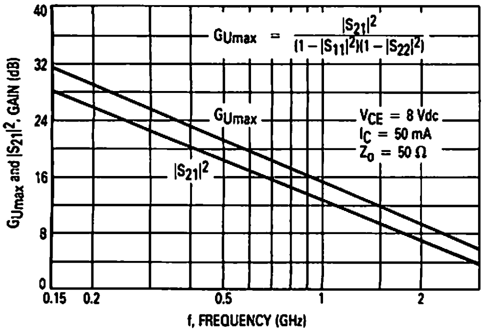


Figure 8. G_{Umax} and $|S_{21}|^2$ versus Frequency

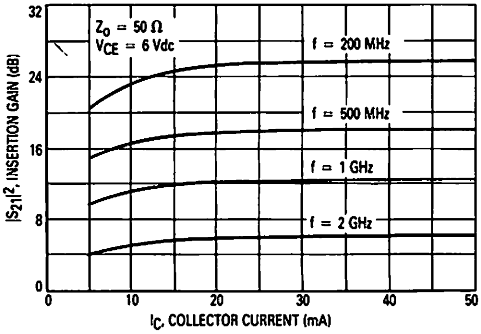


Figure 9. Insertion Gain versus Collector Current

2

2

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
6	5	200	0.79	−90	10.9	128	0.06	46	0.70	−45
		500	0.72	−144	5.7	96	0.08	28	0.42	−66
		1000	0.69	−177	3	75	0.09	28	0.31	−77
		1500	0.66	164	2	59	0.10	32	0.34	−89
		2000	0.65	147	1.6	47	0.12	38	0.32	−94
	10	200	0.72	−115	15.2	118	0.05	41	0.55	−66
		500	0.69	−160	6.9	92	0.06	34	0.30	−92
		1000	0.67	174	3.6	74	0.08	42	0.21	−108
		1500	0.64	159	2.4	60	0.10	46	0.23	−114
		2000	0.64	143	1.8	49	0.12	50	0.20	−116
	50	200	0.67	−159	20	102	0.02	48	0.33	−111
		500	0.67	179	8.2	85	0.04	58	0.33	−142
		1000	0.66	174	3.8	72	0.07	65	0.21	−158
		1500	0.63	151	2.7	61	0.10	64	0.22	−158
		2000	0.58	138	2.1	51	0.14	62	0.17	−165
8	5	200	0.80	−87	11.1	130	0.06	47	0.71	−42
		500	0.72	−141	5.9	97	0.08	30	0.44	−60
		1000	0.70	−177	3.1	75	0.09	28	0.33	−68
		1500	0.66	166	2.1	60	0.10	32	0.35	−80
		2000	0.61	149	1.6	47	0.12	39	0.35	−85
	10	200	0.72	−113	15.6	119	0.05	42	0.56	−61
		500	0.68	−159	7.2	92	0.06	34	0.31	−82
		1000	0.66	175	3.7	74	0.08	41	0.21	−92
		1500	0.64	160	2.5	61	0.09	47	0.23	−101
		2000	0.60	144	2	49	0.13	50	0.21	−103
	50	200	0.66	−156	20.9	103	0.02	48	0.31	−101
		500	0.65	−179	8.6	85	0.04	58	0.19	−128
		1000	0.64	164	4.3	72	0.07	65	0.16	−144
		1500	0.61	153	2.9	61	0.10	65	0.17	−142
		2000	0.58	137	2.3	51	0.13	64	0.14	−145

Figure 10. Common Emitter S-Parameters

MRF5812
BF433*

*European Part Number

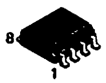
The RF Line

NPN Silicon RF Low Power Transistor

. . . designed for high current, low power amplifiers up to 2 GHz.

- *High Current* Gain-Bandwidth Product — f_T = 5.5 GHz (Typ) @ I_C = 75 mA
- Low Noise — 2 dB (Typ) @ 500 MHz
- Low Intermodulation Distortion
- High Gain — 15.5 dB (Typ) @ 500 MHz
- Low Cost SORF Plastic Surface Mount Package
- State-of-the-Art Technology
  - Fine Line Geometry
  - Gold Top Metal and Wires
  - Silicon Nitride Passivated
  - Ion Implanted Arsenic Emitters
- Die Same as MRF581,A

I_C = 200 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 751-03, STYLE 1
SORF
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	2.5	Vdc
Collector-Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 110°C (1) Derate above 110°C	P_D	1.0 25	Watts mW/°C
Total Device Dissipation @ T_A = 25°C Derate above 25°C (2)	P_D	1.0 8.0	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CBO}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—

(1) Case temperature is measured on the collector lead where the lead contacts the printed circuit board closest to the body of the package.
(2) Free air.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Collector Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	C_{cb}	—	1.2	2	pF
Current-Gain Bandwidth Product (1) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 1 GHz)	f_T	—	5.5	—	GHz
FUNCTIONAL TESTS					
Noise Figure (Minimum) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 4	NF_{MIN}	—	2	—	dB
Noise Figure (50 Ohm Insertion) (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 5	$NF_{50\,\Omega}$	—	2.5	3	dB
Power Gain Associated with Noise Figure (I_C = 50 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz) Figure 5	$\|S_{21}\|^2$	13	15.5	—	dB
Maximum Unilateral Gain (1) (I_C = 75 mAdc, V_{CE} = 10 Vdc, f = 0.5 GHz)	G_{Umax}	—	17	—	dB
Intermodulation Distortion (2) Figure 1 (V_{CE} = 10 V, I_C = 75 mA, V_{out} = +50 dBmV)	IMD(d3)	—	−65	—	dB

Notes: (1) Characterized on HP8542 Automatic Network Analyzer. $G_{Umax} = \frac{|S_{21}|^2}{(1 - |S_{11}|^2)(1 - |S_{22}|^2)}$

(2) 2 Tones, f1 = 497 MHz, f2 = 503 MHz, 3rd Order Single Tone Reference.

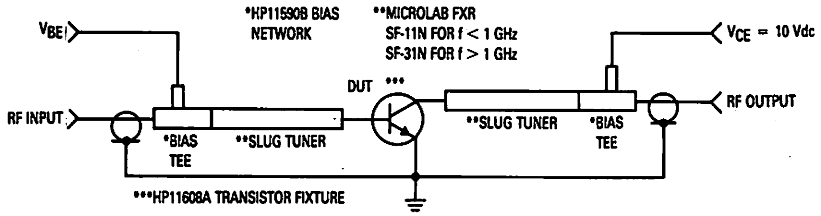


Figure 1. Functional Circuit Schematic

TYPICAL CHARACTERISTICS

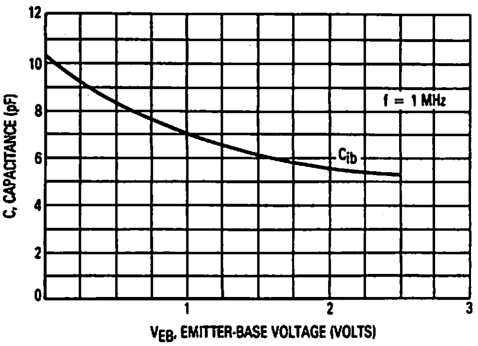


Figure 2. C_{ib} Input Capacitance versus Voltage

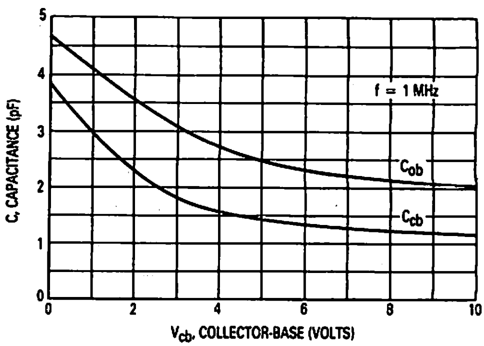


Figure 3. C_{cb}, C_{ob} Collector-Base Capacitance versus Voltage

2

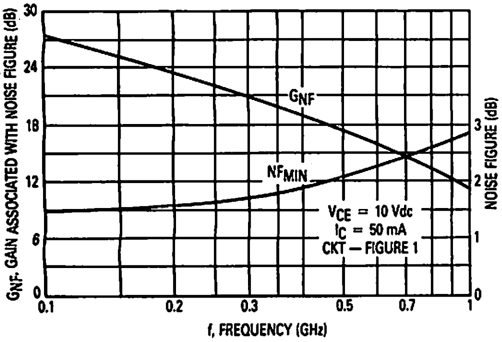


Figure 4. Noise Figure and Gain Associated with Noise Figure versus Frequency

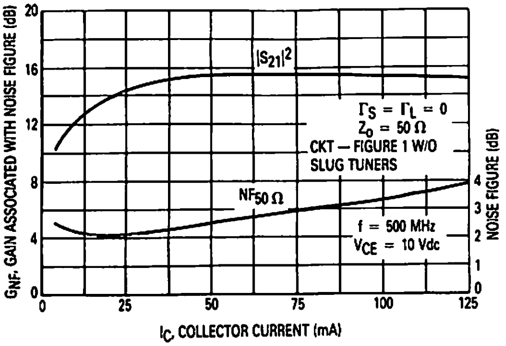


Figure 5. Noise Figure and Gain Associated with Noise Figure versus Collector Current

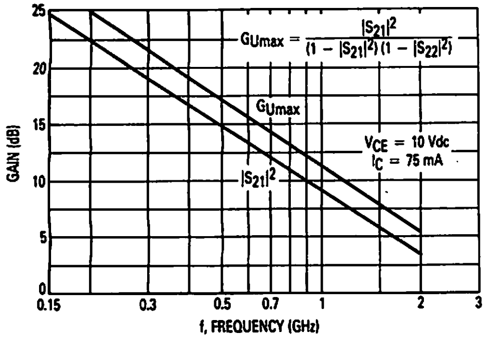


Figure 6. G_{Umax} — Maximum Unilateral Gain, $|S_{21}|^2$ versus Frequency

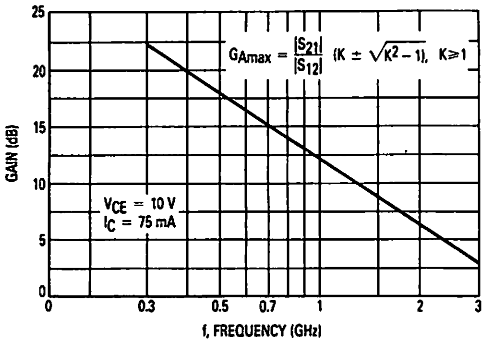


Figure 7. G_{Amax}, Maximum Available Gain versus Frequency

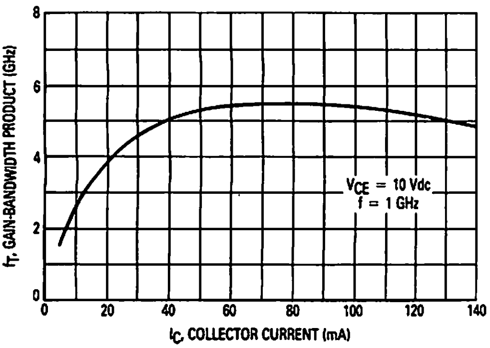


Figure 8. Gain-Bandwidth Product versus Collector Current

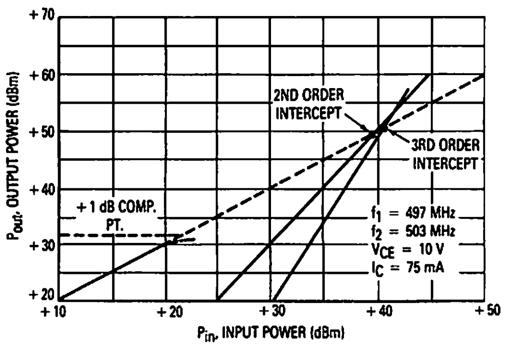


Figure 9. 2nd and 3rd Order Intercept Points and 1 dB Compression Point

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\lvert S_{11} \rvert$	$\angle\phi$	$\lvert S_{21} \rvert$	$\angle\phi$	$\lvert S_{12} \rvert$	$\angle\phi$	$\lvert S_{22} \rvert$	$\angle\phi$
5	25	100	0.66	−123	18.3	118	0.04	43	0.53	−79
		300	0.66	−167	7	92	0.06	44	0.31	−120
		500	0.65	178	4.3	81	0.08	52	0.28	−133
		1000	0.62	154	2.2	63	0.13	61	0.28	−141
		2000	0.57	109	1.3	39	0.28	57	0.31	−148
		3000	0.55	68	1	23	0.41	41	0.34	−164
	50	100	0.64	−133	20.2	114	0.04	44	0.51	−93
		300	0.65	−171	7.6	91	0.06	50	0.34	−137
		500	0.65	175	4.6	81	0.08	56	0.31	−148
		1000	0.61	152	2.3	63	0.13	63	0.28	−149
		2000	0.56	109	1.3	39	0.28	57	0.3	−150
		3000	0.52	70	1	23	0.41	39	0.29	−169
	75	100	0.64	−137	20.8	113	0.04	44	0.5	−99
		300	0.66	−173	7.7	91	0.06	52	0.35	−142
		500	0.64	174	4.7	82	0.08	59	0.32	−154
		1000	0.61	151	2.4	65	0.14	64	0.3	−164
		2000	0.54	107	1.4	42	0.3	55	0.27	−167
		3000	0.52	69	1.1	24	0.42	37	0.25	−172
	100	100	0.64	−140	20.8	112	0.03	44	0.5	−103
		300	0.65	−174	7.6	90	0.06	53	0.36	−145
		500	0.64	173	4.7	81	0.08	60	0.33	−156
		1000	0.61	151	2.4	65	0.15	64	0.31	−166
		2000	0.54	107	1.4	42	0.3	54	0.27	−169
		3000	0.52	65	1.1	24	0.42	37	0.25	−174
10	25	100	0.65	−112	20.2	121	0.04	46	0.56	−62
		300	0.63	−162	8	93	0.05	46	0.29	−93
		500	0.62	−178	5	82	0.07	52	0.25	−102
		1000	0.6	157	2.5	63	0.11	63	0.26	−112
		2000	0.55	112	1.4	39	0.25	61	0.35	−125
		3000	0.55	69	1	23	0.39	47	0.4	−145
	50	100	0.63	−122	22.9	117	0.03	46	0.5	−74
		300	0.62	−167	8.8	92	0.05	51	0.28	−112
		500	0.6	178	5.3	82	0.07	58	0.24	−122
		1000	0.58	154	2.7	64	0.12	65	0.23	−129
		2000	0.51	111	1.5	40	0.26	59	0.28	−132
		3000	0.5	70	1.2	24	0.39	44	0.34	−144
	75	100	0.63	−126	23.8	116	0.03	45	0.49	−80
		300	0.63	−168	9	92	0.05	51	0.28	−120
		500	0.62	177	5.5	82	0.07	58	0.24	−130
		1000	0.58	154	2.8	65	0.12	65	0.23	−137
		2000	0.52	111	1.5	41	0.26	58	0.27	−135
		3000	0.5	70	1.2	24	0.39	42	0.32	−145
	100	100	0.62	−128	23.8	114	0.03	46	0.46	−82
		300	0.62	−169	8.9	91	0.05	54	0.26	−120
		500	0.6	176	5.4	81	0.07	61	0.23	−130
		1000	0.57	152	2.8	64	0.12	66	0.21	−136
		2000	0.51	109	1.5	40	0.27	59	0.26	−134
		3000	0.5	68	1.2	24	0.39	43	0.32	−145
15	25	100	0.66	−106	21	123	0.03	47	0.57	−54
		300	0.63	−159	8.5	94	0.05	46	0.3	−77
		500	0.61	−177	5.2	82	0.06	52	0.26	−84
		1000	0.58	156	2.6	62	0.11	64	0.28	−96
		2000	0.54	110	1.4	36	0.23	63	0.39	−115
		3000	0.56	68	1	22	0.37	49	0.46	−137
	50	100	0.62	−114	24	119	0.03	46	0.51	−64
		300	0.6	−163	9.2	93	0.05	51	0.26	−92
		500	0.58	−179	5.7	81	0.07	58	0.22	−100
		1000	0.56	154	2.9	63	0.12	66	0.23	−109
		2000	0.52	109	1.5	39	0.25	60	0.32	−118
		3000	0.52	67	1.1	22	0.37	46	0.39	−137
	75	100	0.62	−118	24.6	117	0.03	46	0.48	−67
		300	0.59	−165	9.4	92	0.05	53	0.24	−96
		500	0.58	179	5.7	81	0.07	60	0.21	−104
		1000	0.56	154	2.9	63	0.12	66	0.22	−111
		2000	0.5	109	1.5	38	0.25	60	0.31	−118
		3000	0.52	67	1.1	22	0.37	46	0.38	−136
	100	100	0.62	−121	24.8	116	0.03	46	0.46	−68
		300	0.6	−165	9.3	91	0.05	53	0.23	−96
		500	0.58	179	5.7	81	0.07	61	0.2	−102
		1000	0.56	155	2.9	63	0.12	65	0.22	−109
		2000	0.5	111	1.5	39	0.25	62	0.32	−117
		3000	0.5	68	1.1	23	0.37	47	0.39	−136

Figure 10. Common Emitter S-Parameters

MRF5943

DIE SOURCE SAME AS 2N5943

2

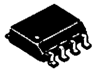
The RF Line

NPN Silicon High Frequency Transistor

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

I_C = 400 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 751-03, STYLE 1
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	3.5	V
Collector Current — Continuous	I_C	400	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA)	$V_{(BR)CEO}$	30	—	—	V
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage (I_E = 100 μA)	$V_{(BR)EBO}$	3.5	—	—	V
Collector Cutoff Current (V_{CE} = 20 V)	I_{CEO}	—	—	50	μA
Collector Cutoff Current (V_{CB} = 15 V)	I_{CBO}	—	—	10	μA

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 15 V)	h_{FE}	25	—	300	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	—	0.2	V
Base-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{BE(sat)}$	—	—	1.0	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 35 mA, V_{CE} = 15 V, f = 100 MHz)	f_T	—	1550	—	MHz
Insertion Gain (V_{CE} = 15 V, I_C = 35 mA, f = 250 MHz)	$\|S_{21}\|^2$	12	15	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
15	35	10	0.37	−63	53.7	157	0.01	59	0.91	−18
		30	0.52	−120	36.5	128	0.01	48	0.64	−38
		50	0.58	−142	25.4	113	0.02	45	0.47	−44
		70	0.59	−154	19	105	0.02	46	0.38	−44
		100	0.60	−162	13.6	97	0.02	49	0.32	−43
		300	0.64	178	4.6	77	0.05	59	0.28	−49
		500	0.65	168	2.8	64	0.07	60	0.32	−62
		700	0.65	159	2	53	0.09	63	0.38	−76
		1000	0.64	144	1.4	38	0.13	63	0.46	−93

MRF8372

2

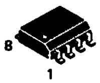
The RF Line

NPN Silicon High Frequency Transistor

... designed primarily for wideband large signal predriver stages in 800 MHz and UHF frequency ranges.

- Specified @ 12.5 V, 870 MHz Characteristics
  Output Power = 750 mW
  Common Emitter Power Gain = 10 dB (Typ)
  Efficiency 60% (Typ)
- Low Cost SORF Plastic Surface Mounted Package
- State-of-the-Art Technology
  Fine Line Geometry
  Gold Top Metal and Wires
  Silicon Nitride Passivated
  Ion Implanted Arsenic Emitters

**750 mW — 870 MHz
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 751-03, STYLE 1
SORF
(SO-8)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector-Current — Continuous	I_C	200	mAdc
Total Device Dissipation @ T_C = 90°C (1) Derate above 90°C	P_D	1.0 17	Watts mW/°C
Total Device Dissipation @ T_A = 25°C (2) Derate above 25°C	P_D	1.0 8	Watts mW/°C
Operating Junction and Storage Temperature Range	T_J, T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	45	°C/W
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	85	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 Vdc, V_{BE} = 0, T_C = 25°C)	I_{CES}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mAdc, V_{CE} = 10 Vdc)	h_{FE}	30	90	200	—

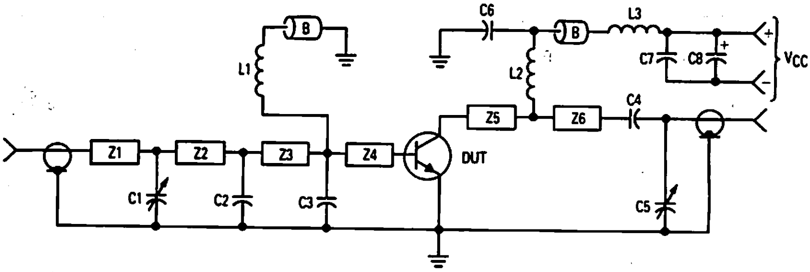
(1) Case temperature is measured on the collector lead where the lead contacts the printed circuit board closest to the body of the package.
(2) Free air.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	1.8	2.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain Figures 1, 3 (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	G_{pe}	8	10	—	dB
Collector Efficiency Figures 1, 3 (V_{CC} = 12.5 Vdc, P_{out} = 0.75 W, f = 870 MHz)	η	55	60	—	%



C1,C5 — 0.8–8 pF Johanson Gigatrim
C2,C3 — 10 pF Ceramic Chip Capacitor
C6 — 91 pF Clamped Mica, Mini-Underwood
C4 — 47 pF Ceramic Chip Capacitor
C7 — 91 pF Clamped Mica, Mini-Underwood
C8 — 1 μF 25 V Tantalum
B — Bead, Ferroxcube 56-590-65/3B

L1,L2 — 4 Turns, #21 AWG, 5/32" ID
L3 — 7 Turns, #21 AWG, 5/32" ID
Z1,Z2 — 1" x 0.078" Microstrip, Z_o = 50 Ohms
Z3 — 0.25" x 0.078" Microstrip, Z_o = 50 Ohms
Z4 — 0.15" x 0.078" Microstrip, Z_o = 50 Ohms
Z5 — 0.30" x 0.078" Microstrip, Z_o = 50 Ohms
Z6 — 1.63" x 0.078" Microstrip, Z_o = 50 Ohms
PCB — 1/32" Glass Teflon, ϵ_r = 2.56

Figure 1. 800–900 MHz Broadband Circuit

800/900 MHz BAND DATA

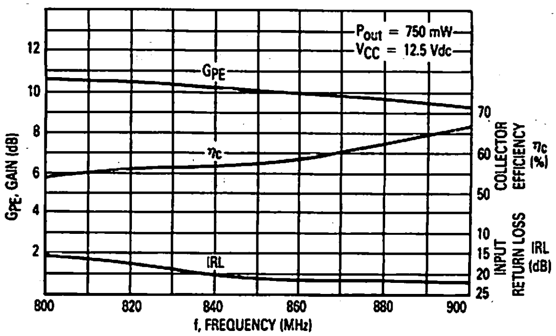


Figure 2. Typical Broadband Performance

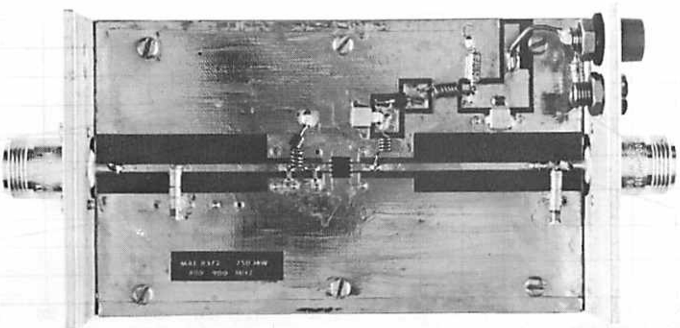
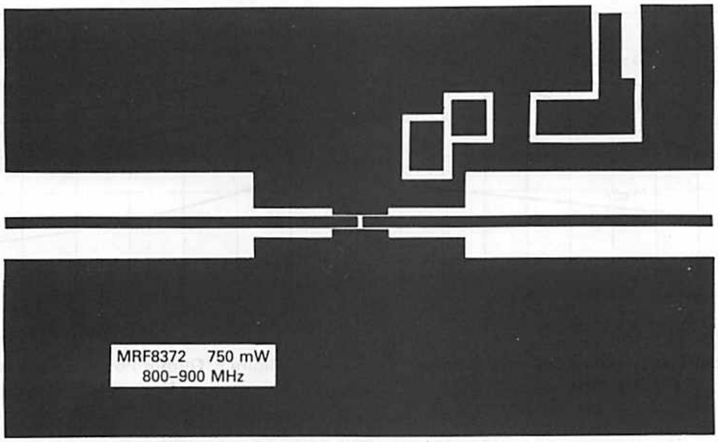


Figure 3. 800–900 Broadband Circuit



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 4. 800–900 MHz Broadband Circuit Photomaster

f Frequency MHz	Z_{in} Ohms, V_{CC} = 7.5 V, P_{in} = 150 mW	Z_{in} Ohms, V_{CC} = 12.5 V, P_{in} = 100 mW	Z_{OL}* Ohms, V_{CC} = 7.5 V, P_{out} 806 MHz = 820 mW, P_{out} 870 MHz = 635 mW, P_{out} 960 MHz = 530 mW	Z_{OL}* Ohms, V_{CC} = 12.5 V, P_{out} 806 MHz = 1.05 mW, P_{out} 870 MHz = 855 mW, P_{out} 960 MHz = 580 mW
806	8.0 + j1.9	4.0 + j1.2	24.7 − j19.2	20.9 − j31.0
870	5.2 + j3.5	6.0 + j1.9	36.9 − j20.5	32.1 − j26.6
960	6.8 + j4.0	6.1 + j2.5	39.3 − j18.5	36.3 − j25.7

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage, and frequency.

Figure 5. Series Equivalent Input/Output Impedance

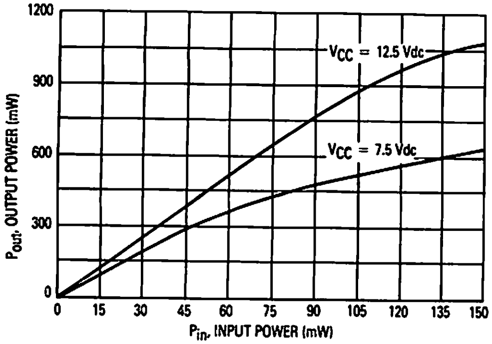


Figure 6. Output Power versus Input Power
f = 870 MHz

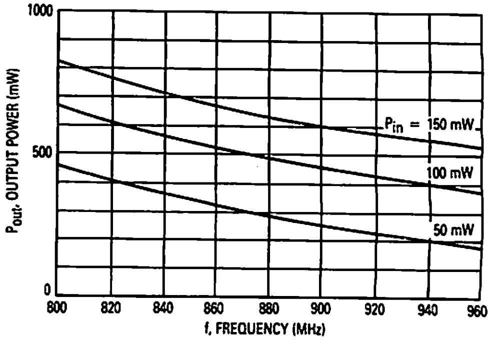


Figure 7. Output Power versus Frequency
V_{CC} = 7.5 Vdc

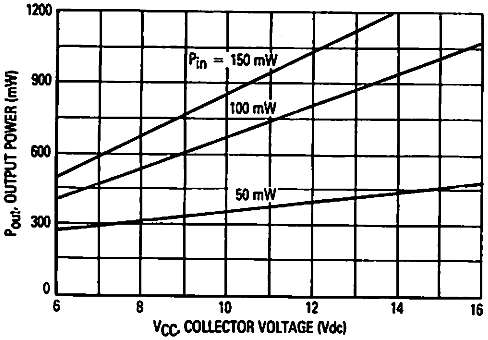


Figure 8. Output Power versus Collector Voltage
f = 870 MHz

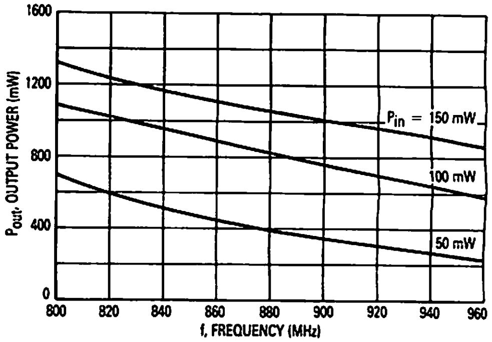


Figure 9. Output Power versus Frequency
V_{CC} = 12.5 Vdc

MRF9011L
BF431L*

*European Part Number

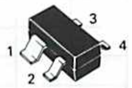
2

The RF Line
NPN Silicon High-Frequency Transistor

. . . designed primarily for use in high-gain, low-noise small-signal amplifiers for operation up to 2.5 GHz. Also usable in applications requiring fast switching times.

- High Current-Gain-Bandwidth Product — f_T = 3.8 GHz (Typ) @ I_C = 15 mAdc
- Low Noise Figure @ f = 1 GHz — $NF_{(matched)}$ = 1.8 dB (Typ)
- High Power Gain — $G_{pe(matched)}$ = 13.5 dB (Typ) @ f = 1 GHz
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
  Lower Package Parasitics
  High Gain
- Tape and Reel Packaging Options

I_C = 30 mA
SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	Vdc
Collector-Base Voltage	V_{CBO}	25	Vdc
Emitter-Base Voltage	V_{EBO}	2	Vdc
Collector-Current — Continuous	I_C	30	mAdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	0.30 3.3	Watt mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	300	°C/W

DEVICE MARKING

MRF9011 = 01

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 1 mAdc, I_B = 0)	$V_{(BR)CEO}$	15	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.1 mAdc, I_E = 0)	$V_{(BR)CBO}$	25	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mAdc, I_C = 0)	$V_{(BR)EBO}$	2	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5 mAdc, V_{CE} = 5 Vdc)	h_{FE}	30	80	200	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain-Bandwidth Product (I_C = 15 mAdc, V_{CE} = 10 Vdc, f = 1 GHz)	Figure 6	f_T	—	3.8	—	GHz
Collector-Base Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	0.55	1	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 5	G_{NFmin}	—	13.5	—	dB
Noise Figure (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 5	NF_{min}	—	1.8	—	dB
Power Gain in 50 Ω System (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	G_{NF}	9	10.2	—	dB
Noise Figure (V_{CE} = 10 Vdc, I_C = 5 mA, f = 1 GHz)	Figure 2	NF	—	2.3	3	dB

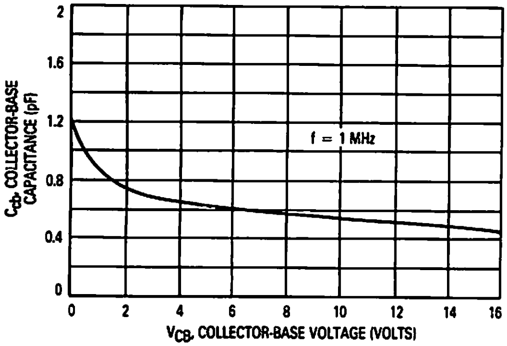


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

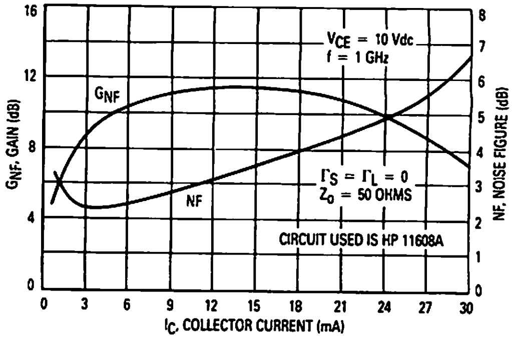


Figure 2. Gain and Noise Figure versus Collector Current

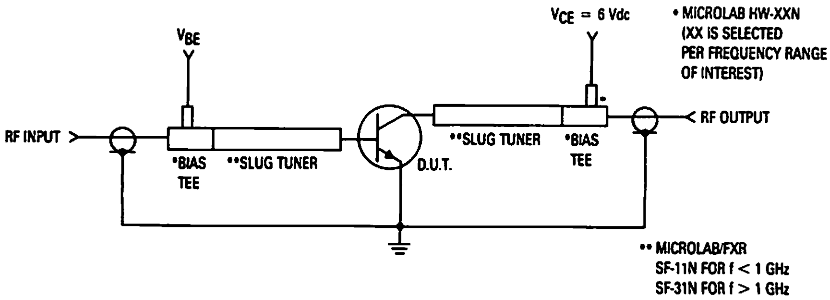


Figure 3. Functional Circuit Schematic

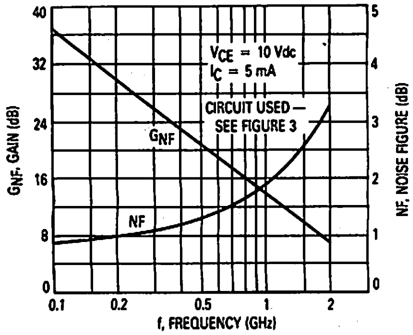


Figure 4. Gain and Noise Figure versus Frequency

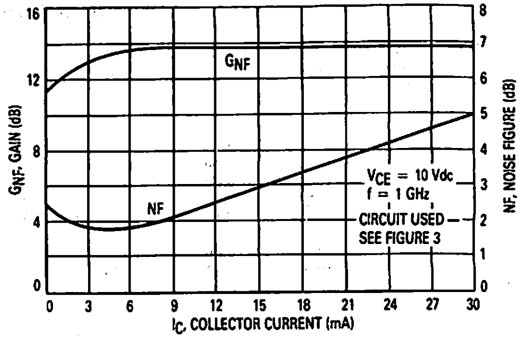


Figure 5. Gain and Noise Figure versus Collector Current

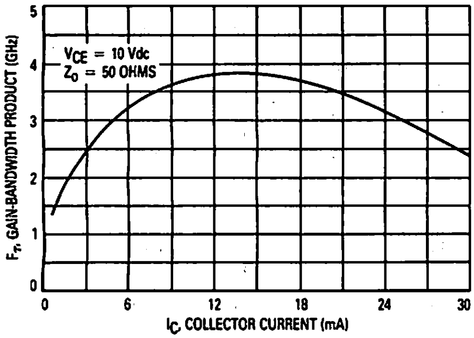


Figure 6. Gain-Bandwidth Product versus Collector Current

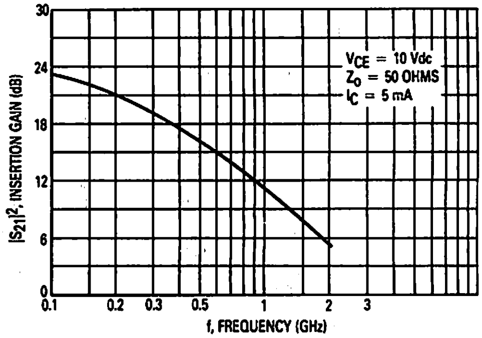


Figure 7. Insertion Gain versus Frequency

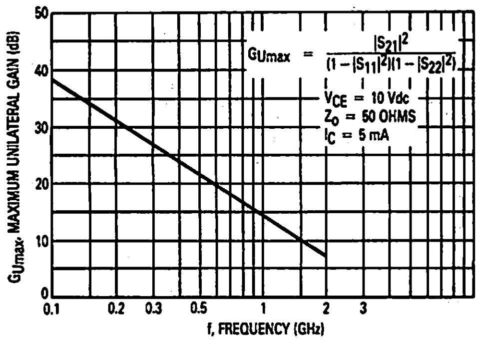


Figure 8. Maximum Unilateral Gain versus Frequency

COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
5	5	100	0.85	−41	13.64	153	0.03	65	0.93	−17
		200	0.78	−76	10.77	134	0.05	54	0.80	−29
		500	0.71	−131	6.10	102	0.08	35	0.55	−42
		1000	0.66	−169	3.22	77	0.08	33	0.45	−48
		2000	0.60	152	1.65	47	0.11	46	0.47	−63
	10	100	0.72	−59	20.01	145	0.03	62	0.87	−23
		200	0.70	−100	14.31	123	0.04	49	0.67	−36
		500	0.66	−150	7.03	94	0.06	38	0.44	−43
		1000	0.63	179	3.57	73	0.07	45	0.37	−46
		2000	0.58	147	1.79	46	0.11	57	0.41	−60
	15	100	0.65	−75	23.44	138	0.02	57	0.81	−27
		200	0.66	−118	15.56	116	0.04	46	0.59	−38
		500	0.65	−159	7.10	90	0.05	42	0.40	−40
		1000	0.63	174	3.57	71	0.06	52	0.35	−43
		2000	0.59	144	1.77	45	0.11	62	0.40	−58
	20	100	0.61	−89	24.32	133	0.02	51	0.77	−28
		200	0.66	−130	15.11	111	003	43	0.55	−35
		500	0.66	−166	6.68	88	0.04	46	0.41	−34
		1000	0.65	171	3.32	69	0.06	56	0.39	−39
		2000	0.61	143	1.65	43	0.10	65	0.44	−56
	30	100	0.63	−132	13.18	118	0.02	47	0.72	−15
		200	0.68	−157	7.07	104	0.02	44	0.66	−16
		500	0.69	−177	3.23	90	0.03	55	0.62	−24
		1000	0.70	165	1.78	71	0.05	65	0.59	−38
		2000	0.66	138	0.93	42	0.09	79	0.62	−62
10	5	100	0.85	−38	13.67	155	0.03	70	0.93	−14
		200	0.80	−71	10.97	136	0.05	56	0.83	−24
		500	0.70	−126	6.35	104	0.07	37	0.60	−35
		1000	0.65	−166	3.39	78	0.07	36	0.51	−40
		2000	0.58	154	1.74	48	0.10	50	0.54	−55
	10	100	0.75	−55	20.12	147	0.02	66	0.88	−19
		200	0.71	−94	14.60	125	0.04	50	0.72	−30
		500	0.65	−145	7.33	96	0.05	39	0.50	−35
		1000	0.62	−177	3.74	74	0.06	46	0.45	−38
		2000	0.57	149	1.88	47	0.10	60	0.49	−53
	15	100	0.68	−68	23.53	140	0.02	61	0.85	−22
		200	0.67	−110	15.90	119	0.03	49	0.65	−31
		500	0.64	−155	7.45	92	0.04	42	0.47	−32
		1000	0.62	177	3.74	71	0.06	53	0.44	−35
		2000	0.58	146	1.90	45	0.09	65	0.50	−51
	20	100	0.64	−79	24.77	135	0.02	56	0.81	−23
		200	0.64	−122	15.81	114	0.03	46	0.62	−29
		500	0.64	−161	7.10	89	0.04	46	0.48	−28
		1000	0.62	174	3.53	70	0.05	56	0.46	−33
		2000	0.59	145	1.75	44	0.09	68	0.53	−50
	30	100	0.61	−114	16.25	123	0.01	48	0.79	−15
		200	0.63	−147	9.10	107	0.02	49	0.71	−15
		500	0.65	−172	4.22	90	0.03	53	0.66	−22
		1000	0.66	168	2.27	71	0.05	63	0.63	−33
		2000	0.63	140	1.15	41	0.08	79	0.67	−53

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRF9331L
BF432L*

*European Part Number

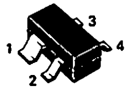
2

The RF Line
NPN Silicon
High-Frequency Transistor

. . . designed primarily for use in low power amplifiers to 1 GHz. Ideal for pagers and other battery operated systems where low power consumption is critical.

- Low Power Consumption Characterized for I_E = 0.1 to 1 mA
- High Current-Gain-Bandwidth Product — f_T = 5 GHz (Typ) @ I_C = 1 mAdc
- Low Noise Figure and High Power Gain @ f = 1 GHz — NF(matched) = 2.5 dB (Typ) & GNF(matched) = 12.5 dB (Typ)
- Guaranteed RF Parameters
- Surface Mounted SOT-143 Offers Improved RF Performance
  Lower Package Parasitics
  High Gain
- Tape and Reel Packaging Options

I_C = 1 mA
SURFACE MOUNTED
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 318A-05, STYLE 1
SOT-143
LOW PROFILE

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	8	Vdc
Collector-Base Voltage	V_{CBO}	15	Vdc
Emitter-Base Voltage	V_{EBO}	2	Vdc
Collector-Current — Continuous	I_C	2	mAdc
Total Device Dissipation @ T_C = 100°C Derate above 100°C	P_D	50 1	mW mW/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	500	°C/W

DEVICE MARKING

MRF9331,L = 05

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 0.1 mAdc, I_B = 0)	$V_{(BR)CEO}$	8	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 0.01 mAdc, I_E = 0)	$V_{(BR)CBO}$	15	—	—	Vdc
Emitter-Base Leakage Current (V_{EB} = 2 Vdc, I_C = 0)	I_{EBO}	—	—	0.1	mAdc
Collector Cutoff Current (V_{CB} = 5 Vdc, I_E = 0)	I_{CBO}	—	—	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 mAdc, V_{CE} = 1 Vdc)	h_{FE}	30	80	200	—

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted.)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Current-Gain-Bandwidth Product (I_C = 1 mAdc, V_{CE} = 1 Vdc, f = 1 GHz)	Figure 2	f_T	3.5	5	—	GHz
Collector-Base Capacitance (V_{CB} = 1 Vdc, I_E = 0, f = 1 MHz)	Figure 1	C_{cb}	—	0.21	0.3	pF
FUNCTIONAL TESTS						
Power Gain at Minimum Noise Figure (V_{CE} = 1 Vdc, I_C = 0.5 mA, f = 1 GHz)	Figure 5, 3	G_{NFmin}	—	12.5	—	dB
Noise Figure (V_{CE} = 1 Vdc, I_C = 0.5 mA, f = 1 GHz)	Figure 5, 3	NF_{min}	—	2.5	—	dB

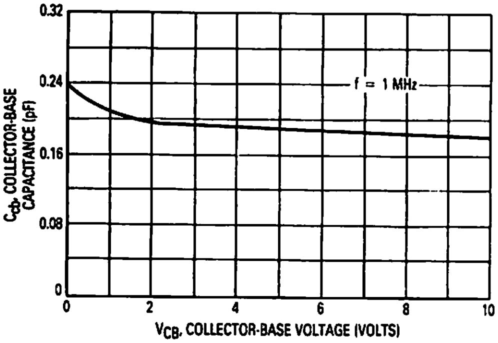


Figure 1. Collector-Base Capacitance versus Collector-Base Voltage

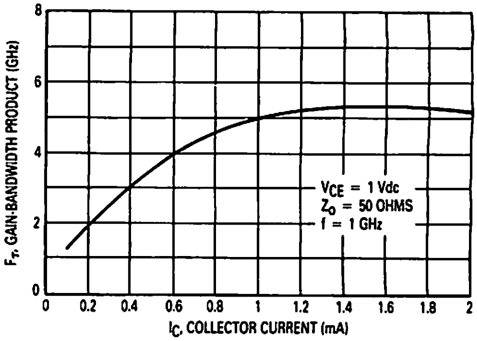


Figure 2. Current Gain-Bandwidth Product versus Collector Current

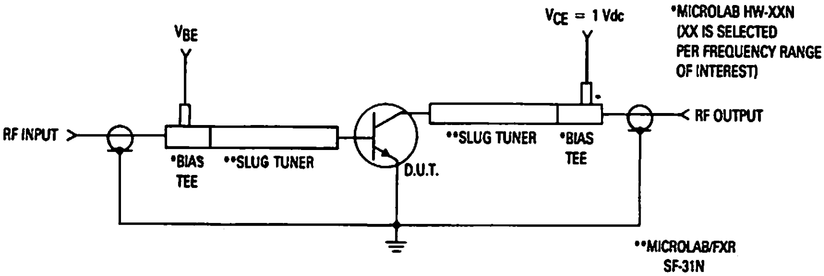


Figure 3. Functional Circuit Schematic

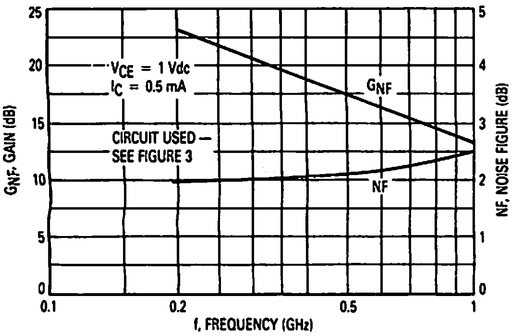


Figure 4. Gain and Noise Figure versus Frequency

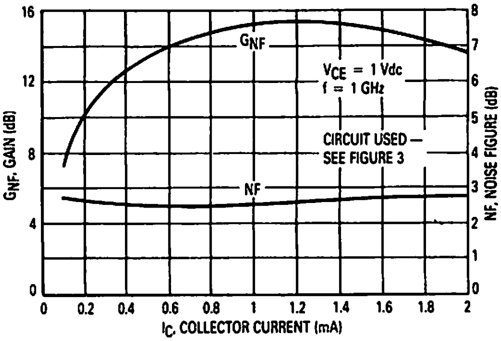


Figure 5. Gain and Noise Figure versus Collector Current

2

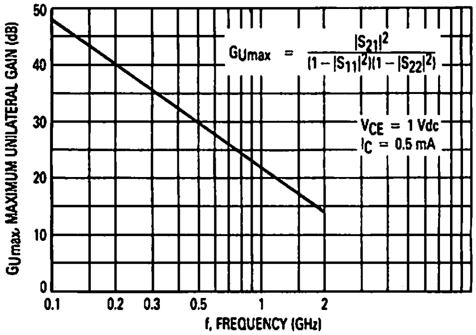


Figure 6. Maximum Unilateral Gain versus Frequency

COMMON EMITTER S-PARAMETERS

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
1	0.1	100	0.99	−1	0.35	174	0.01	87	1	−1
		200	1	−3	0.35	171	0.03	86	1	−4
		500	0.97	−9	0.34	156	0.07	81	1	−9
		1000	0.98	−19	0.38	134	0.13	72	1	−21
		2000	0.98	−36	0.45	103	0.22	59	1	−38
	0.25	100	0.99	−1	0.77	175	0.01	86	1	−1
		200	1	−4	0.77	173	0.03	86	1	−4
		500	0.96	−11	0.73	160	0.06	79	0.99	−11
		1000	0.96	−23	0.75	140	0.13	70	0.98	−23
		2000	0.94	−42	0.77	110	0.21	56	0.93	−42
	0.5	100	0.99	−2	1.43	174	0.01	86	1	−1
		200	0.99	−5	1.42	172	0.03	84	1	−5
		500	0.95	−13	1.33	158	0.06	77	0.99	−12
		1000	0.92	−28	1.3	137	0.13	67	0.95	−25
		2000	0.83	−51	1.2	107	0.19	54	0.91	−43

COMMON EMITTER S-PARAMETERS (Continued)

V_{CE} (Vdc)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
1	1	100	0.97	−3	2.68	173	0.01	85	1	−2
		200	0.97	−8	2.68	169	0.03	83	1	−6
		500	0.91	−19	2.42	152	0.06	74	0.96	−15
		1000	0.82	−37	2.22	128	0.11	62	0.89	−29
		2000	0.63	−59	1.74	97	0.17	53	0.8	−46
	2	100	0.93	−6	4.55	169	0.01	84	0.99	−4
		200	0.92	−13	4.3	163	0.03	81	0.98	−9
		500	0.81	−29	3.8	142	0.06	69	0.91	−19
		1000	0.62	−52	3.1	115	0.1	59	0.81	−31
		2000	0.4	−66	2	85	0.14	55	0.75	−44
3	0.1	100	0.99	−1	0.34	175	0.01	88	1	−1
		200	1	−3	0.34	172	0.03	86	1	−3
		500	0.99	−8	0.32	157	0.06	81	1	−9
		1000	0.99	−18	0.36	137	0.11	73	1	−20
		2000	1	−34	0.43	107	0.2	61	1	−37
	0.25	100	0.99	−1	0.76	175	0.01	86	1	−1
		200	1	−4	0.76	173	0.03	86	1	−4
		500	0.98	−10	0.72	161	0.06	80	1	−10
		1000	0.98	−21	0.75	143	0.11	72	0.99	−22
		2000	0.97	−40	0.75	113	0.19	59	0.98	−39
	0.5	100	0.99	−2	1.4	175	0.01	86	1	−1
		200	0.99	−5	1.42	172	0.03	84	1	−4
		500	0.96	−12	1.3	159	0.06	78	0.99	−11
		1000	0.93	−25	1.3	141	0.11	68	0.96	−23
		2000	0.87	−47	1.2	111	0.18	57	0.93	−41
	1	100	0.97	−3	2.67	174	0.01	85	1	−2
		200	0.98	−7	2.67	170	0.02	84	1	−6
		500	0.93	−17	2.42	154	0.06	76	0.97	−14
		1000	0.84	−34	2.29	133	0.1	65	0.91	−26
		2000	0.67	−55	1.82	101	0.16	56	0.85	−43
	2	100	0.95	−5	4.64	172	0.01	85	1	−3
		200	0.94	−10	4.62	166	0.02	81	0.99	−8
		500	0.85	−25	4	147	0.05	72	0.94	−17
		1000	0.69	−44	3.4	122	0.09	63	0.84	−29
		2000	0.48	−61	2.3	91	0.13	57	0.78	−42
5	0.1	100	1	0	0.36	175	0.01	85	1	−1
		200	1	−3	0.34	172	0.02	87	1	−3
		500	0.99	−8	0.32	158	0.06	82	1	−9
		1000	1	−17	0.36	138	0.11	74	1	−19
		2000	0.94	−35	0.42	108	0.2	63	1	−36
	0.25	100	1	−1	0.76	176	0.01	86	1	−1
		200	1	−3	0.76	174	0.02	86	1	−4
		500	0.97	−9	0.71	161	0.06	80	1	−10
		1000	0.97	−20	0.74	143	0.11	73	0.99	−21
		2000	0.97	−38	0.75	115	0.18	61	0.99	−38
	0.5	100	0.99	−1	1.4	175	0.01	86	1	−1
		200	1	−5	1.41	173	0.02	85	1	−4
		500	0.98	−12	1.3	159	0.06	79	0.99	−11
		1000	0.93	−25	1.3	141	0.1	70	0.97	−23
		2000	0.87	−45	1.2	111	0.17	58	0.94	−40
	1	100	0.98	−3	2.7	174	0.01	86	1	−2
		200	0.98	−7	2.7	170	0.02	84	1	−5
		500	0.93	−17	2.42	155	0.05	76	0.97	−13
		1000	0.85	−33	2.3	134	0.09	66	0.92	−26
		2000	0.67	−55	2	103	0.15	57	0.85	−42
	2	100	0.95	−4	4.6	172	0.01	86	1	−3
		200	0.94	−10	4.6	166	0.02	83	1	−7
		500	0.86	−24	3.9	148	0.05	73	0.94	−16
		1000	0.7	−43	3.4	123	0.09	64	0.86	−28
		2000	0.5	−60	2.3	92	0.13	59	0.8	−40

**MRF9411L
(See MRF941)
MRF9511L
(See MRF951)**

The RF Line

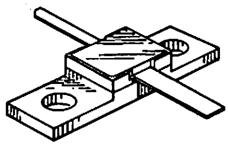
Microwave Power Transistor

MRF10005

... designed for CW and long pulsed common base amplifier applications, such as JTIDS and Mode S, in the 0.96 to 1.215 GHz frequency range at high overall duty cycles.

- *Guaranteed Performance @ 1.215 GHz, 28 Vdc*
  Output Power = 5 Watts CW
  Minimum Gain = 8.5 dB, 10.3 dB (Typ)
- RF Performance Curves given for 28 Vdc and 36 Vdc Operation
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**5 WATTS
960–1215 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 336E-02, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous (1)	I_C	1.25	Adc
Total Device Dissipation @ T_C = 25°C (1) Derate above 25°C	P_D	25 143	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C

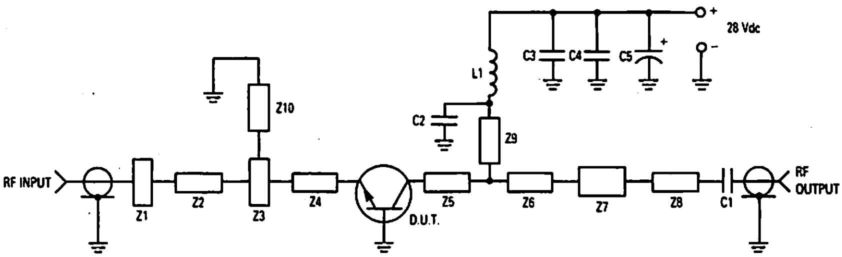
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (2)	$R_{\theta JC}$	7	°C/W

(1) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as RF amplifiers.
(2) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 Vdc, I_E = 0)	I_{CBO}	—	—	1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5 Vdc)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	7	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CC} = 28 Vdc, P_{out} = 5 W, f = 1215 MHz)	G_{PB}	8.5	10.3	—	dB
Collector Efficiency (V_{CC} = 28 Vdc, P_{out} = 5 W, f = 1215 MHz)	η	45	55	—	%
Load Mismatch (V_{CC} = 28 Vdc, P_{out} = 5 W, f = 1215 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1, C2, C3 — 220 pF 100 mil Chip Capacitor
C4 — 0.1 µF
C5 — 47 µF/50 V Electrolytic
L1 — 3 turn #18 AWG, 1/8" ID, 0.18" Long

Z1–Z10 — Microstrip, see details below
Board Material — 0.030" Glass Teflon, 2.0 oz. Copper, ϵ_R = 2.55

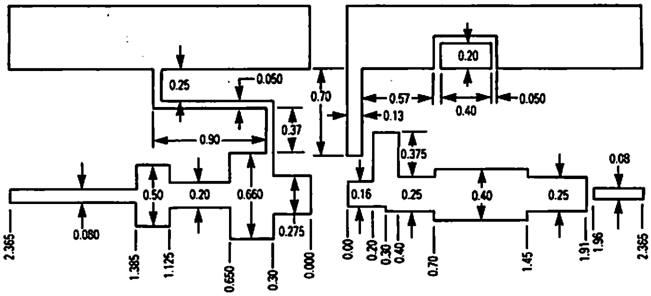


Figure 1. Test Circuit

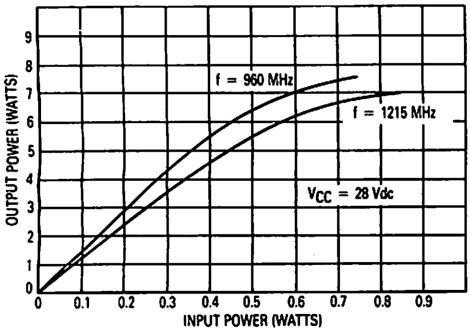


Figure 2. Output Power versus Input Power

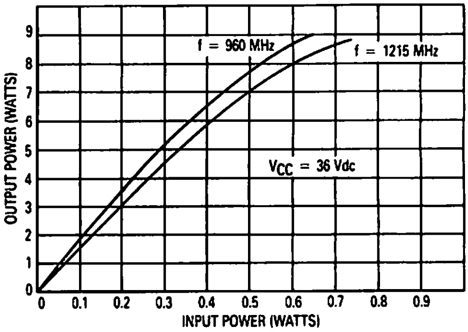
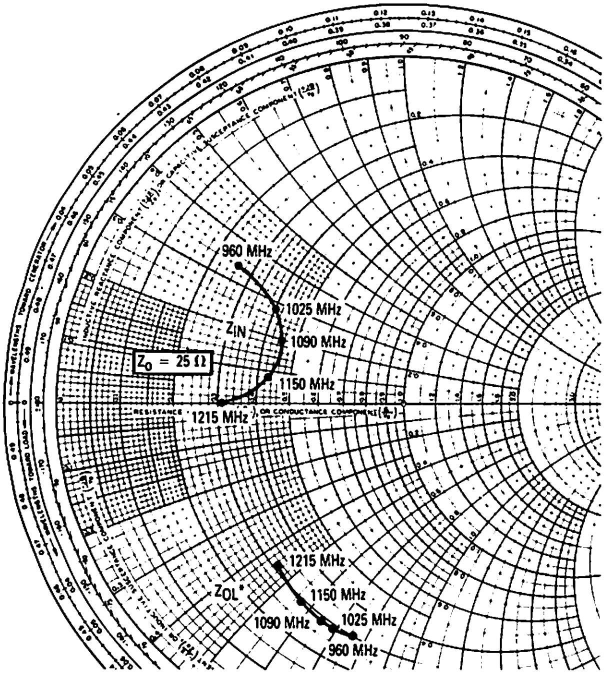


Figure 3. Output Power versus Input Power

2



P_{OUT} = 5 W V_{CC} = 28 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
960	6.5 + j8.5	7.4 – j18.9
1025	10.0 + j7.0	7.2 – j17.4
1090	11.2 + j4.9	7.1 – j16.3
1150	10.8 + j2.0	7.15 – j14.3
1215	7.8 + j0.0	7.8 – j11.2

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage and frequency.

Figure 4. Series Equivalent Input/Output Impedances

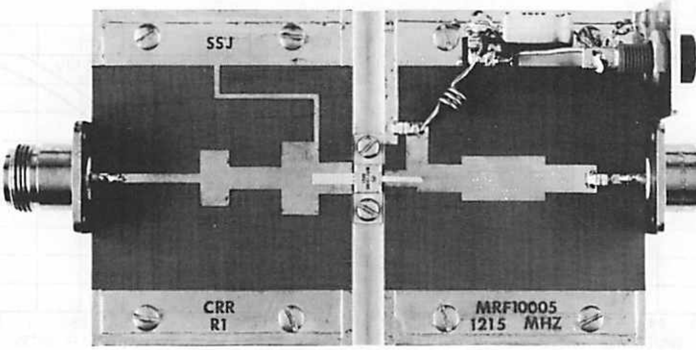
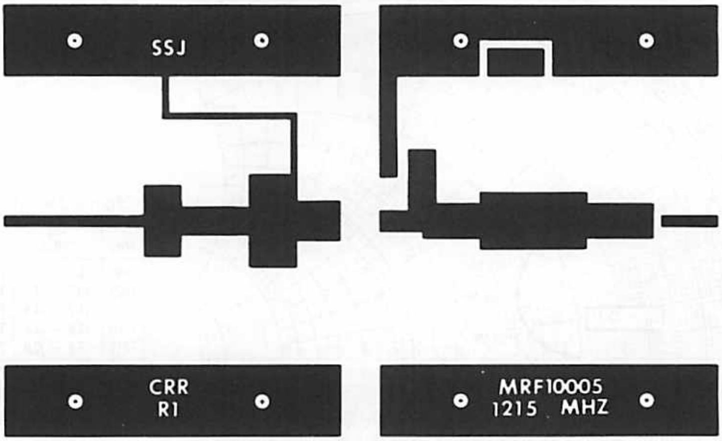


Figure 5. Test Amplifier



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 6. Printed Circuit Board Layout

MRF10030

2

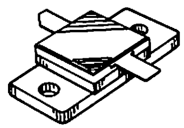
The RF Line

Microwave Long Pulse Power Transistor

. . . designed for 960 to 1215 MHz long pulse common base amplifier applications such as JTIDS and Mode S transmitters.

- Guaranteed Performance @ 1.215 GHz, 36 Vdc
  - Output Power = 30 Watts Peak
  - Minimum Gain = 9.5 dB, 11.5 dB (Typ)
- 100% Tested for Load Mismatch at All Phase Angles with 10:1 VSWR
- Hermetically Sealed Industry Standard Package
- Silicon Nitride Passivated
- Gold Metallized, Emitter Ballasted for Long Life and Resistance to Metal Migration
- Internal Input Matching for Broadband Operation

**30 WATTS PEAK
960–1215 MHz
MICROWAVE POWER
TRANSISTOR
NPN SILICON**



CASE 376A-02, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CES}	55	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Peak (1)	I_C	5	Adc
Total Device Dissipation @ T_C = 25°C (1), (2) Derate above 25°C	P_D	58.3 333	Watts mW/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C
Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

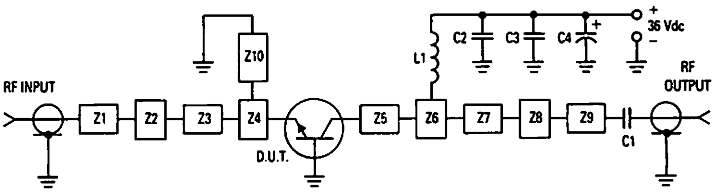
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (3)	$R_{\theta JC}$	3	°C/W

(1) Under pulse RF operating conditions.
(2) These devices are designed for RF operation. The total device dissipation rating applies only when the devices are operated as pulsed RF amplifiers.
(3) Thermal Resistance is determined under specified RF operating conditions by infrared measurement techniques.

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mAdc, V_{BE} = 0)	$V_{(BR)CES}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 25 mAdc, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mAdc, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 36 Vdc, I_E = 0)	I_{CBO}	—	—	2	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mAdc, V_{CE} = 5 Vdc)	h_{FE}	20	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 36 Vdc, I_E = 0, f = 1 MHz)	C_{ob}	—	21	30	pF
FUNCTIONAL TESTS (10 μs Pulses @ 50% duty cycle for 3.5 ms; overall duty cycle −25%)					
Common-Base Amplifier Power Gain (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 1215 MHz)	G_{PB}	9.5	11.5	—	dB
Collector Efficiency (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 1215 MHz)	η	45	55	—	%
Load Mismatch (V_{CC} = 36 Vdc, P_{out} = 30 W Peak, f = 1215 MHz, VSWR = 10:1 All Phase Angles)	ψ	No Degradation in Output Power			



C1, C2 — 220 pF 100 mil Chip Capacitor
C3 — 0.1 μF
C4 — 10 μF/75 V Electrolytic
L1 — 3 Turns #18 AWG, 1/8" ID

Z1–Z10 — Microstrip, see details below
Board Material — 0.030" Glass Teflon, 2.0 oz. Copper, ϵ_R = 2.55

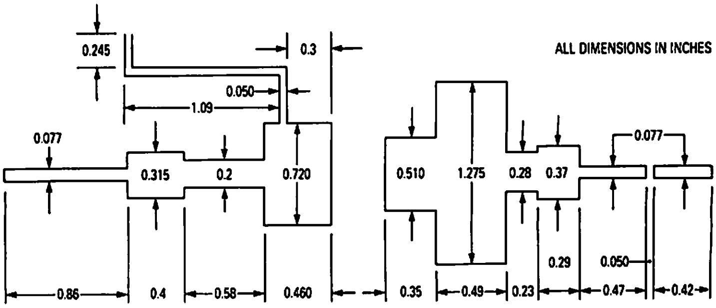


Figure 1. Test Circuit

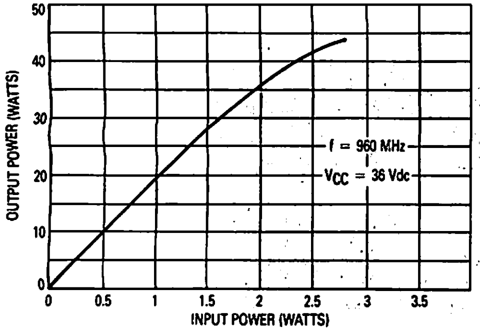


Figure 2. Output Power versus Input Power

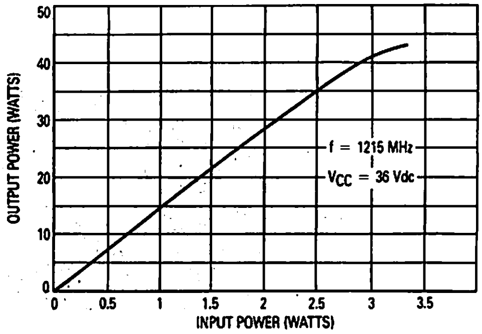
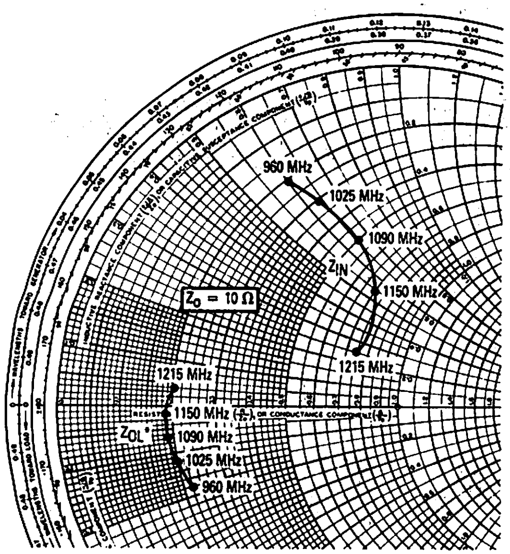


Figure 3. Output Power versus Input Power



P_{OUT} = 30 W Pk V_{CC} = 36 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
960	2.1 + j6.0	2.2 − j1.8
1025	3.1 + j6.4	2.0 − j1.2
1090	5.0 + j6.55	1.9 − j0.7
1150	7.0 + j5.4	1.85 − j0.2
1215	7.5 + j2.5	2.0 + j0.4

Z_{OL}* = Conjugate of the optimum load impedance into which the device operates at a given output power, voltage, and frequency.

Figure 4. Series Equivalent Input/Output Impedances

2

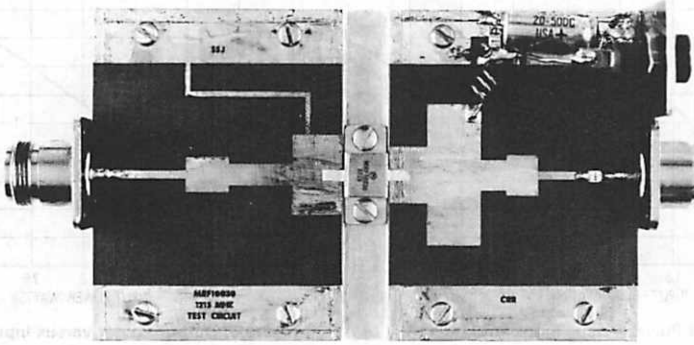
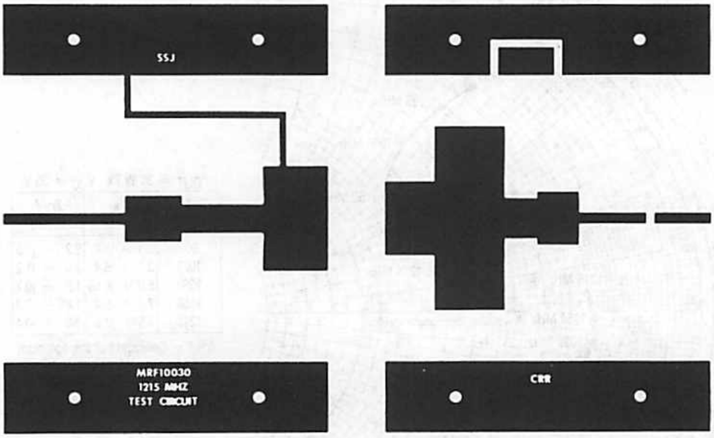


Figure 5. Test Amplifier



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 6. Printed Circuit Board Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRFQ17

DIE SOURCE SAME AS BFQ17

2

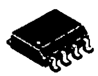
The RF Line

NPN Silicon High Frequency Transistor

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

**I_C = 300 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON**



**CASE 751-03, STYLE 1
(SO-8)**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	V
Collector-Base Voltage	V_{CBO}	40	V
Emitter-Base Voltage	V_{EBO}	2	V
Collector Current — Continuous	I_C	300	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	25	—	—	V
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	40	—	—	V
Emitter-Base Breakdown Voltage (I_E = 100 μA)	$V_{(BR)EBO}$	2	—	—	V
Collector Cutoff Current (V_{CB} = 20 V)	I_{CBO}	—	—	100	nA
Emitter Cutoff Current (V_{EB} = 1 V)	I_{EBO}	—	—	100	nA

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V) (I_C = 150 mA, V_{CE} = 5 V)	h_{FE}	25 25	— —	200 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	—	0.5	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 12.5 V, f = 500 MHz)	f_T	—	2250	—	MHz
Insertion Gain (V_{CE} = 12.5 V, I_C = 50 mA, f = 500 MHz)	$\|S_{21}\|^2$	10	12.2	—	dB

COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
12.5	50	10	0.32	−72	38.2	165	0.005	47	0.97	−13
		20	0.36	−103	37.8	151	0.007	48	0.88	−23
		50	0.60	−139	33.0	124	0.013	40	0.62	−42
		75	0.66	−152	25.0	112	0.014	36	0.49	−47
		100	0.69	−159	19.6	105	0.016	38	0.43	−49
		200	0.72	−174	10.3	91	0.021	47	0.32	−51
		500	0.72	168	4.1	68	0.040	65	0.37	−70
		750	0.70	157	2.8	57	0.059	72	0.43	−83
		1000	0.69	146	2.1	45	0.081	76	0.47	−95

MRFQ19

DIE SOURCE SAME AS BFQ19

2

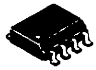
The RF Line

NPN Silicon High Frequency Transistor

... designed for amplifier, oscillator or frequency multiplier applications in industrial equipment. Suitable for use as a Class A, B or C output driver or pre-driver stages in VHF and UHF.

- Low Cost SORF Plastic Surface Mount Package
- Guaranteed RF Specification — $|S_{21}|^2$
- S-Parameter Characterization
- Tape and Reel Packaging Options Available

I_C = 150 mA
SURFACE MOUNT
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 751-03, STYLE 1
(SO-8)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	15	V
Collector-Base Voltage	V_{CBO}	20	V
Emitter-Base Voltage	V_{EBO}	3	V
Collector Current — Continuous	I_C	150	mA
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Total Device Dissipation, T_A = 25°C Derate above 25°C	P_D	1 8	Watt mW/°C
Storage Temperature	T_{stg}	150	°C
Thermal Resistance Junction to Ambient	$R_{\theta JA}$	125	°C/W

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA)	$V_{(BR)CEO}$	15	—	—	V
Collector-Base Breakdown Voltage (I_C = 100 μA)	$V_{(BR)CBO}$	20	—	—	V
Emitter-Base Breakdown Voltage (I_E = 100 μA)	$V_{(BR)EBO}$	3	—	—	V
Emitter Cutoff Current (V_{EB} = 1 V)	I_{EBO}	—	—	100	nA
Collector Cutoff Current (V_{CB} = 10 V)	I_{CBO}	—	—	100	nA

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted.)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 10 V) (I_C = 75 mA, V_{CE} = 10 V)	h_{FE}	25 25	— —	200 200	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_B = 10 mA)	$V_{CE(sat)}$	—	—	0.2	V
SMALL-SIGNAL CHARACTERISTICS					
Current-Gain — Bandwidth Product (I_C = 50 mA, V_{CE} = 10 V, f = 500 MHz) (I_C = 75 mA, V_{CE} = 10 V, f = 500 MHz)	f_T	— —	5300 5500	— —	MHz
Insertion Gain (V_{CE} = 10 V, I_C = 50 mA, f = 500 MHz)	$\|S_{21}\|^2$	13	14.6	—	dB
Noise Figure (V_{CE} = 10 V, I_C = 50 mA, f = 500 MHz)	NF	—	3.5	—	dB

TYPICAL COMMON EMITTER S-PARAMETERS

V_{CE} (Volts)	I_C (mA)	f (MHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			$\|S_{11}\|$	$\angle\phi$	$\|S_{21}\|$	$\angle\phi$	$\|S_{12}\|$	$\angle\phi$	$\|S_{22}\|$	$\angle\phi$
10	50	50	0.46	−149	41.5	128	0.013	47	0.66	−63
		100	0.55	−164	29.8	110	0.02	51	0.44	−90
		200	0.60	−177	13.2	95	0.04	58	0.29	−112
		500	0.60	165	5.4	76	0.07	73	0.27	−146
		750	0.57	158	3.6	71	0.10	62	0.30	−100
		1000	0.55	143	2.6	59	0.13	59	0.43	−144
		1300	0.52	133	2.0	48	0.16	49	0.44	−136

MRW2000 Series

2

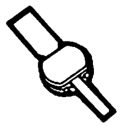
The RF Line

Microwave Power Transistors

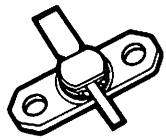
. . . designed primarily for large-signal output and driver amplifier stages in the 1 to 2.3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 28 Volt, 2 GHz Characteristics:
  - Output Power — 1 to 20 Watts
  - Power Gain — 5.2 to 9 dB, Min
  - Collector Efficiency — 40%, Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW2000 Series

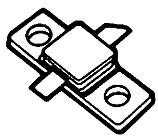
5.2 TO 9 dB
1–2.3 GHz
1 TO 20 WATTS
MICROWAVE
POWER TRANSISTORS



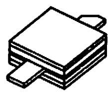
CASE 328F-01, STYLE 1
(GP-13)
MRW2001, 2003, 2005, 2010



CASE 328E-01, STYLE 1
(GP-13F)
MRW2001F, 2003F, 2005F, 2010F



CASE 393-01, STYLE 1
(HLP-11)
MRW2015, 2020



CASE 393A-01, STYLE 1
(HLP-11F)
MRW2015F, 2020F

MAXIMUM RATINGS

Rating	Symbol	2001,F	2003,F	2005,F	2010,F	2015,F	2020,F	Unit
Collector-Base Voltage	V_{CES}	50						Vdc
Emitter-Base Voltage	V_{EBO}	3.5						Vdc
Collector Current — Continuous	I_C	0.25	0.5	1	2	3	4	Adc
Operating Junction Temperature	T_J	200						°C
Storage Temperature Range	T_{stg}	−65 to +200						°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max						Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	25	15	8.5	6	3.5	3	°C/W

2

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRW2001,F		50	—	—	
(I_C = 20 mA, V_{BE} = 0)	MRW2003,F		50	—	—	
(I_C = 40 mA, V_{BE} = 0)	MRW2005,F		50	—	—	
(I_C = 80 mA, V_{BE} = 0)	MRW2010,F		50	—	—	
(I_C = 120 mA, V_{BE} = 0)	MRW2015,F		50	—	—	
(I_C = 160 mA, V_{BE} = 0)	MRW2020,F		50	—	—	
Emitter-Base Breakdown Voltage		$V_{(BR)EBO}$				Vdc
(I_E = 0.2 mA, I_C = 0)	MRW2001,F		3.5	—	—	
(I_E = 0.25 mA, I_C = 0)	MRW2003,F		3.5	—	—	
(I_E = 0.5 mA, I_C = 0)	MRW2005,F		3.5	—	—	
(I_E = 1 mA, I_C = 0)	MRW2010,F		3.5	—	—	
(I_E = 1.5 mA, I_C = 0)	MRW2015,F		3.5	—	—	
(I_E = 2 mA, I_C = 0)	MRW2020,F		3.5	—	—	
Collector Cutoff Current	MRW2001,F	I_{CBO}	—	—	0.5	mAdc
(V_{CB} = 28 V, I_E = 0)	MRW2003,F		—	—	0.5	
	MRW2005,F		—	—	0.5	
	MRW2010,F		—	—	0.5	
	MRW2015,F		—	—	1.5	
	MRW2020,F		—	—	2	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRW2001,F		10	—	120	
(I_C = 100 mA, V_{CE} = 5 V)	MRW2003,F		10	—	100	
(I_C = 200 mA, V_{CE} = 5 V)	MRW2005,F		10	—	100	
(I_C = 400 mA, V_{CE} = 5 V)	MRW2010,F		10	—	100	
(I_C = 600 mA, V_{CE} = 5 V)	MRW2015,F		10	—	100	
(I_C = 800 mA, V_{CE} = 5 V)	MRW2020,F		10	—	100	
DYNAMIC CHARACTERISTICS						
Output Capacitance	MRW2001,F	C_{ob}	—	—	4	pF
(V_{CB} = 28 V, I_E = 0, f = 1 MHz)	MRW2003,F		—	—	5	
	MRW2005,F		—	—	7	
	MRW2010,F		—	—	12	
	MRW2015,F		—	—	21	
	MRW2020,F		—	—	24	

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 1 W, f = 2 GHz)	MRW2001,F		9	—	—	
(V_{CE} = 28 V, P_{out} = 10 W, f = 2 GHz)	MRW2010,F		7	—	—	
Common-Base Amplifier Power Gain		G_{PB}				dB
(V_{CE} = 28 V, P_{out} = 3 W, f = 2 GHz)	MRW2003,F		8	—	—	
(V_{CE} = 28 V, P_{out} = 5 W, f = 2 GHz)	MRW2005,F		8	—	—	
(V_{CE} = 28 V, P_{out} = 15 W, f = 2 GHz)	MRW2015,F		6	—	—	
(V_{CE} = 28 V, P_{out} = 20 W, f = 2 GHz)	MRW2020,F		5.2	—	—	
Collector Efficiency		η	40	—	—	%
(V_{CE} = 28 V, P_{out} = 1 W, f = 2 GHz)	MRW2001,F					
(V_{CE} = 28 V, P_{out} = 3 W, f = 2 GHz)	MRW2003,F					
(V_{CE} = 28 V, P_{out} = 5 W, f = 2 GHz)	MRW2005,F					
(V_{CE} = 28 V, P_{out} = 10 W, f = 2 GHz)	MRW2010,F					
(V_{CE} = 28 V, P_{out} = 15 W, f = 2 GHz)	MRW2015,F					
(V_{CE} = 28 V, P_{out} = 20 W, f = 2 GHz)	MRW2020,F					
Load Mismatch (V_{CE} = 28 V, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
P_{out} = 1 W	MRW2001,F					
P_{out} = 3 W	MRW2003,F					
P_{out} = 5 W	MRW2005,F					
P_{out} = 10 W	MRW2010,F					
P_{out} = 15 W	MRW2015,F					
P_{out} = 20 W	MRW2020,F					
Saturated Output Power						W
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2001,F	P_{sat1}	—	1	—	
(V_{CE} = 28 V, f = 1.5 GHz)		P_{sat2}	—	1.2	—	
(V_{CE} = 28 V, f = 1 GHz)		P_{sat3}	—	1.3	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2003,F		—	3	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	3.7	—	
(V_{CE} = 28 V, f = 1 GHz)			—	4	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2005,F		—	5	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	6.5	—	
(V_{CE} = 28 V, f = 1 GHz)			—	7.5	—	
(V_{CE} = 28 V, f = 2.3 GHz)	MRW2010,F		—	10	—	
(V_{CE} = 28 V, f = 1.5 GHz)			—	13	—	
(V_{CE} = 28 V, f = 1 GHz)			—	15	—	
(V_{CE} = 28 V, f = 1.5 GHz)	MRW2015,F		—	22	—	
(V_{CE} = 28 V, f = 1 GHz)			—	30	—	
(V_{CE} = 28 V, f = 1.5 GHz)	MRW2020,F		—	30	—	
(V_{CE} = 28 V, f = 1 GHz)			—	40	—	

TYPICAL CHARACTERISTICS

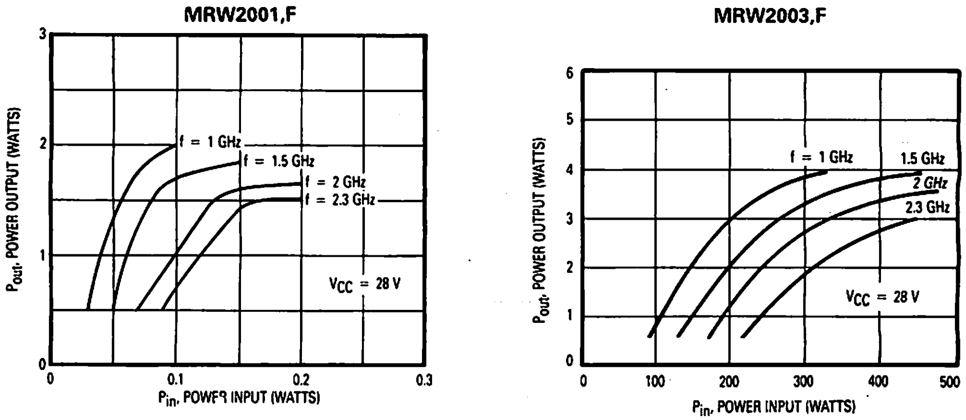


Figure 1. Output Power versus Input Power

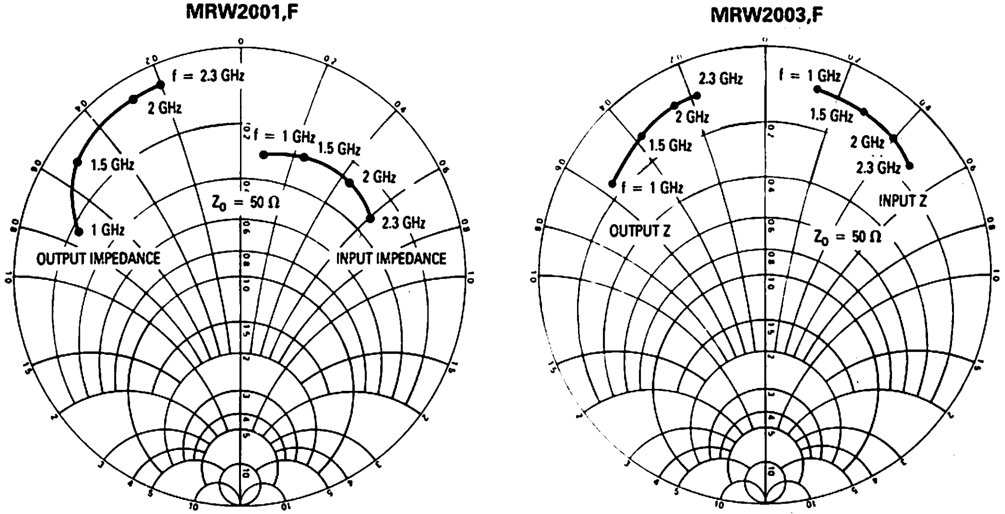


Figure 2. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

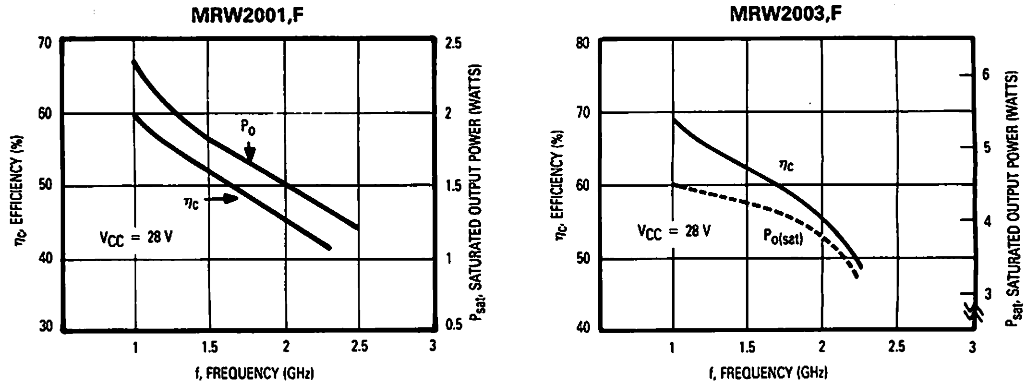


Figure 3. Power Output and Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRW2005,F — MRW2010,F

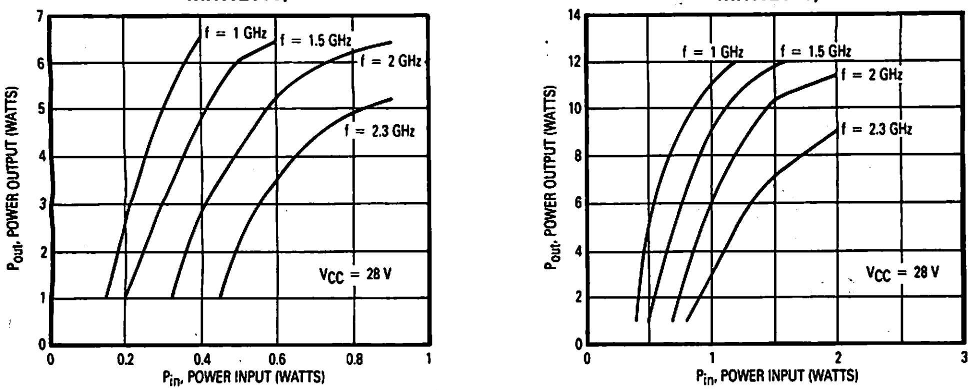


Figure 4. Output Power versus Input Power

MRW2005,F — MRW2010,F

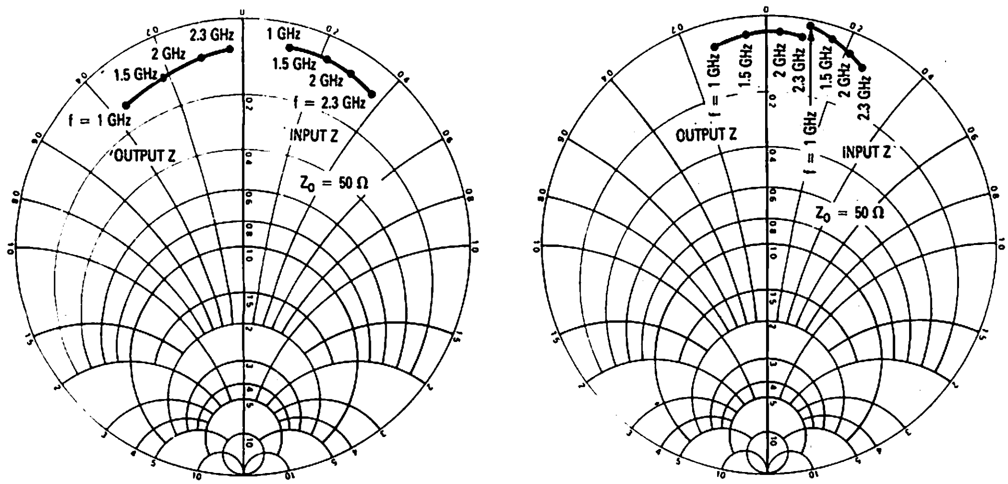


Figure 5. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

MRW2005,F — MRW2010,F

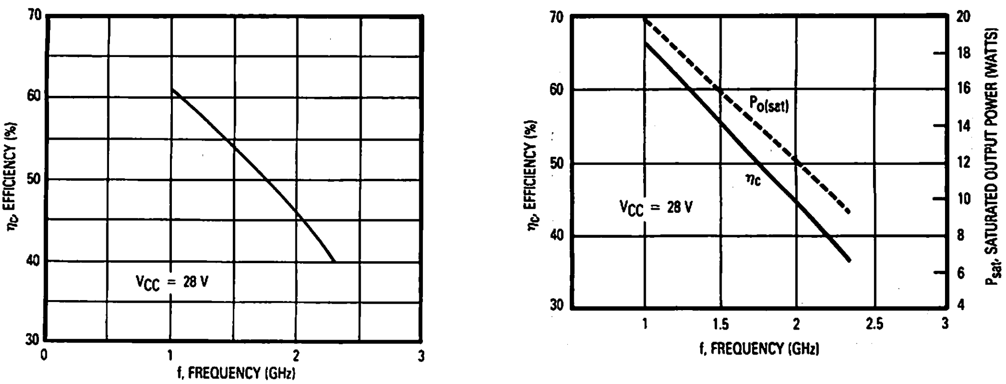
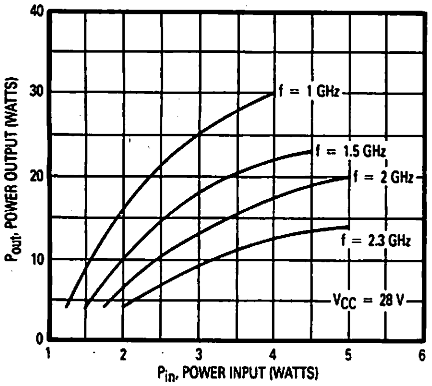


Figure 6. Power Output and Efficiency versus Frequency

TYPICAL CHARACTERISTICS

MRW2015



MRW2020

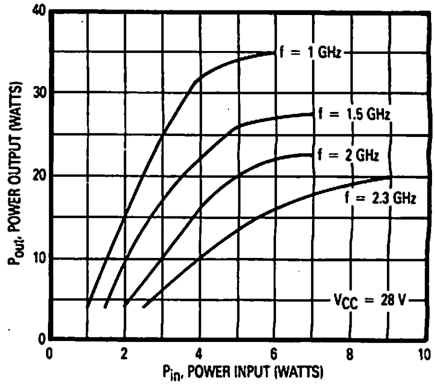
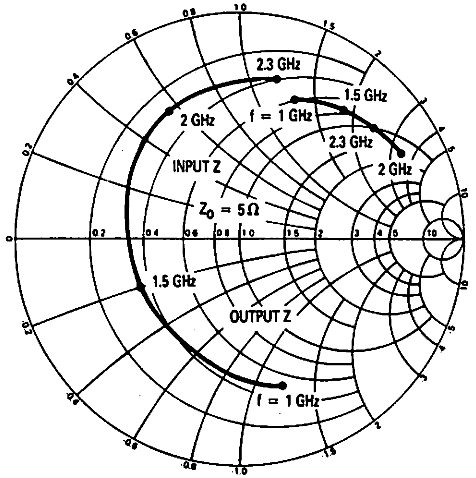


Figure 7. Output Power versus Input Power

MRW2015



MRW2020

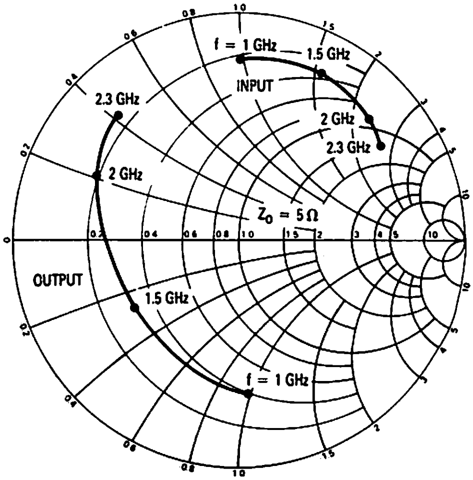
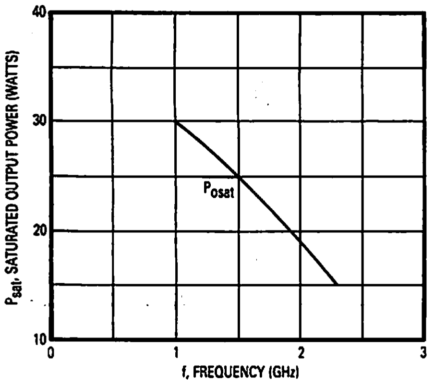


Figure 8. Series Equivalent Input/Output Impedance
V_{CC} = 28 V

MRW2015



MRW2020

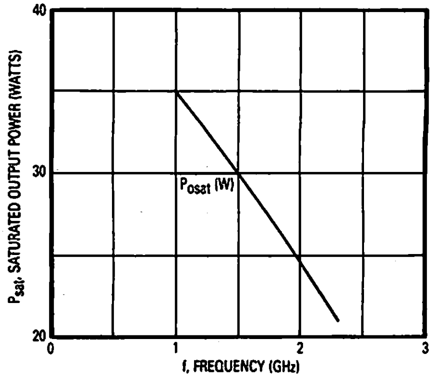


Figure 9. Power Output and Efficiency versus Frequency

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the "Super 2 GHz" devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Sample MTTF calculations based on operating conditions are included on the graph.

Example for MRW2010

$P_o = 10$ W
$P_{in} = 2$ W
$V_{CC} = 28$ V
$\eta_c = 40\%$
$T_{FLANGE} = 70°C$

$$I_C \approx I_E = \frac{100 \times P_o}{\eta_c \times V_{CC}} = 0.892$$

$$P_{DISS} = P_{in} + V_{CC} \cdot I_C - P_o = 16.9 \text{ W}$$

$$T_J = T_{FLANGE} + \theta_{JC} \times P_{DISS} = 171°C$$

$$MTTF = \frac{0.065 \times 10^6 \text{ Hrs} \times \text{Amp}^2}{I_C^2} = 81{,}692 \text{ Hrs}$$

$$= 9.32 \text{ Yrs}$$

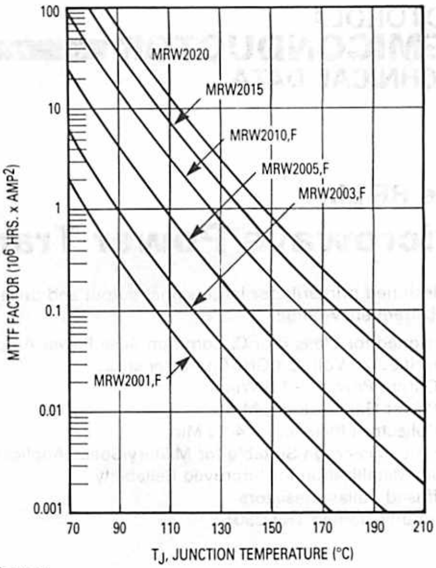


Figure 10. MTTF Factor

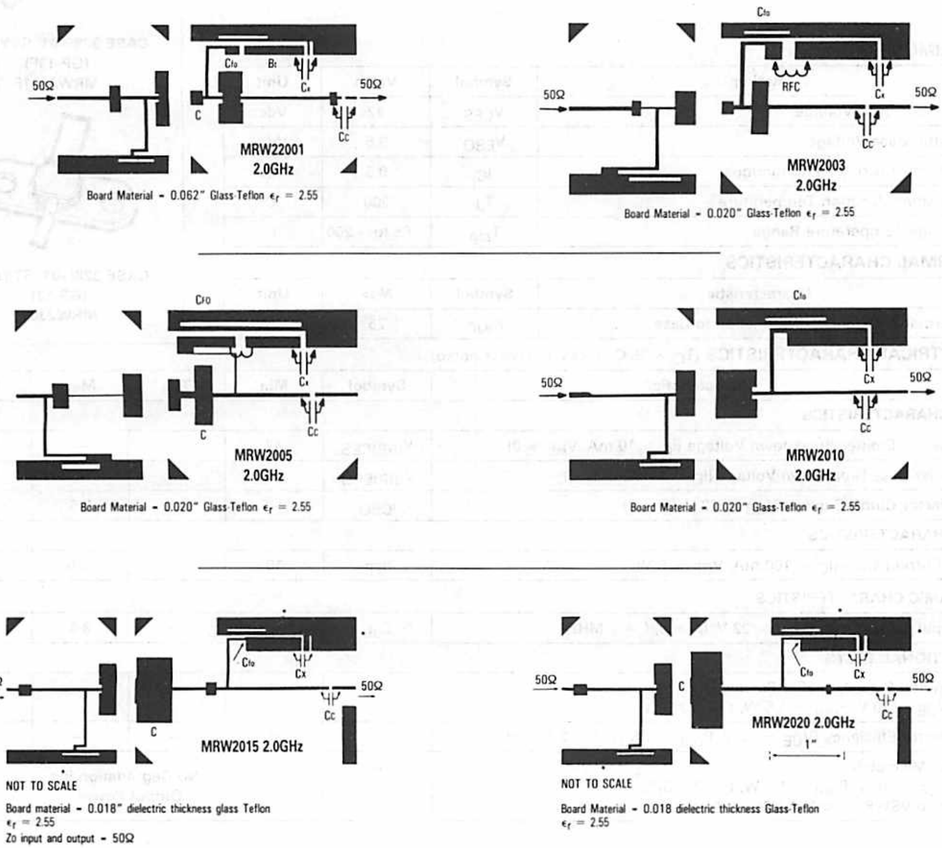


Figure 11. PC Board Layouts

MRW2301
MRW2301F

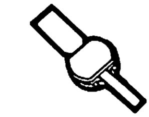
2

The RF Line
Microwave Power Transistors

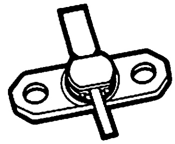
. . . designed primarily for large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  Output Power — 1.5 Watts
  Power Gain — 8 dB, Min
  Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW2301/F

8 dB
1.5–3 GHz
1.5 WATTS
MICROWAVE
POWER
TRANSISTORS



CASE 328E-01, STYLE 1
(GP-13F)
MRW2301F



CASE 328F-01, STYLE 2
(GP-13)
MRW2301

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 22 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3.5	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.5 W, f = 2.3 GHz)	G_{PB}	8	—	—	dB
Collector Efficiency (V_{CE} = 20 V, P_{out} = 1.5 W, f = 2.3 GHz)	η_c	40	—	—	%
Load Mismatch (V_{CE} = 20 V, P_{out} = 1.5 W, f = 2.3 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

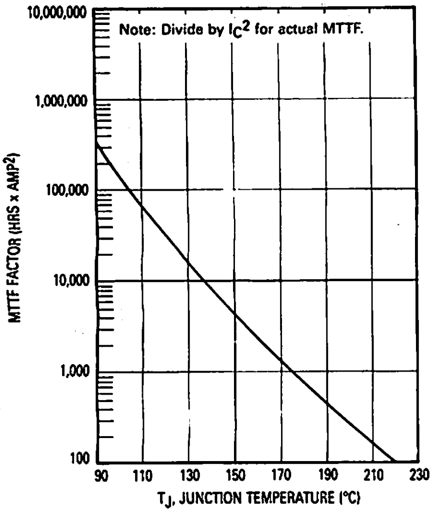


Figure 1. MTTF Factor versus Junction Temperature

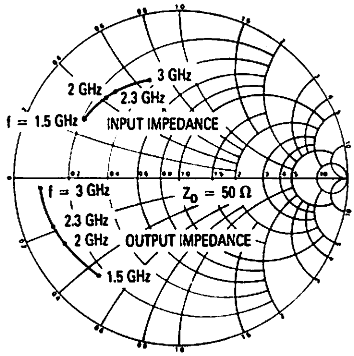


Figure 2. Series Equivalent Input/Output Impedance

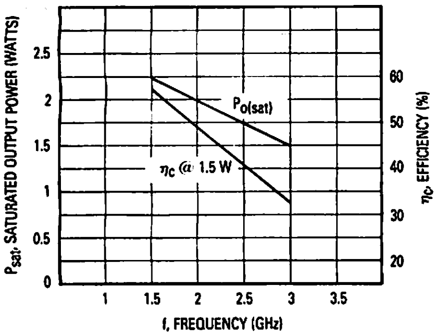


Figure 3. P_{sat} and Efficiency versus Frequency

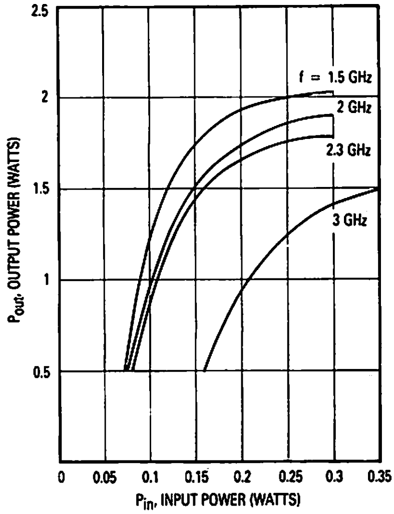


Figure 4. Output Power versus Input Power

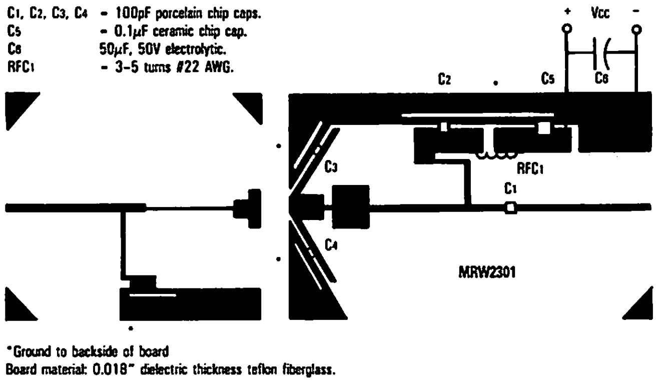


Figure 5. PC Board Layout (Not to Scale), 2.3 GHz

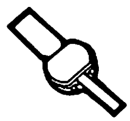
MRW2304
MRW2304F

The RF Line
Microwave Power Transistors

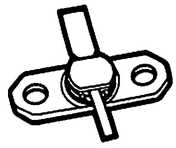
... designed primarily for large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  - Output Power — 4 Watts
  - Power Gain — 8 dB, Min
  - Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW2304,F

8 dB
1.5–3 GHz
4 WATTS
MICROWAVE
POWER
TRANSISTORS



CASE 328E-01, STYLE 1
(GP-13F)
MRW2304F



CASE 328F-01, STYLE 2
(GP-13)
MRW2304

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	17	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	0.75	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 300 mA, V_{CE} = 5 V)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 22 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 4 W, f = 2.3 GHz)	G_{PB}	8	—	—	dB
Collector Efficiency (V_{CE} = 20 V, P_{out} = 4 W, f = 2.3 GHz)	η_c	40	—	—	%
Load Mismatch (V_{CE} = 20 V, P_{out} = 4 W, f = 2.3 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

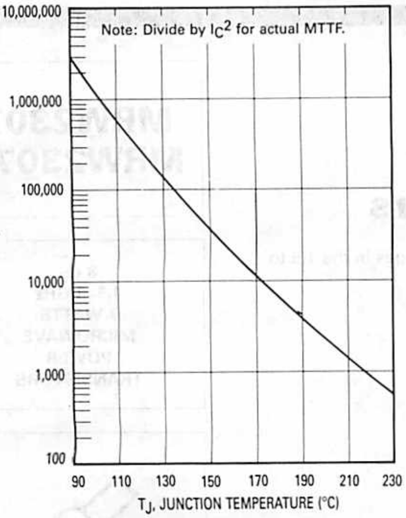


Figure 1. MTTF Factor versus Junction Temperature

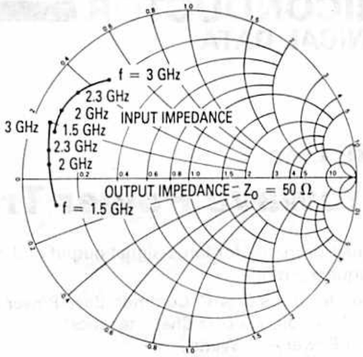


Figure 2. Series Equivalent Input/Output Impedance

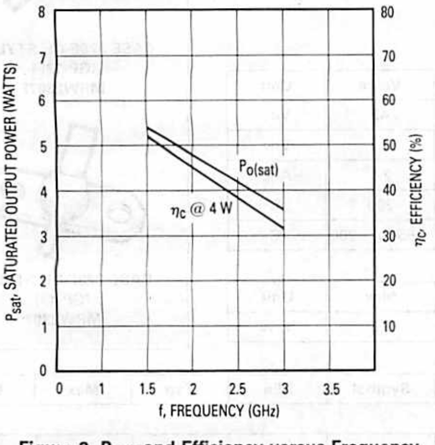


Figure 3. P_{sat} and Efficiency versus Frequency

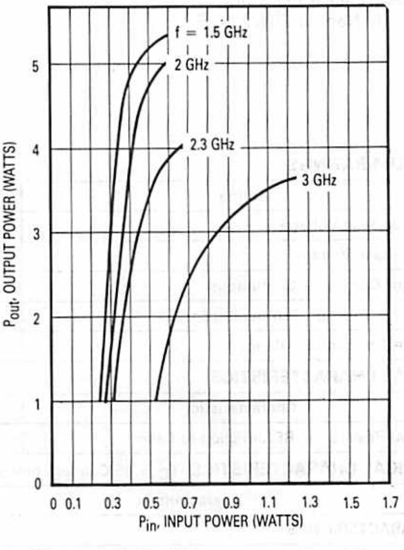
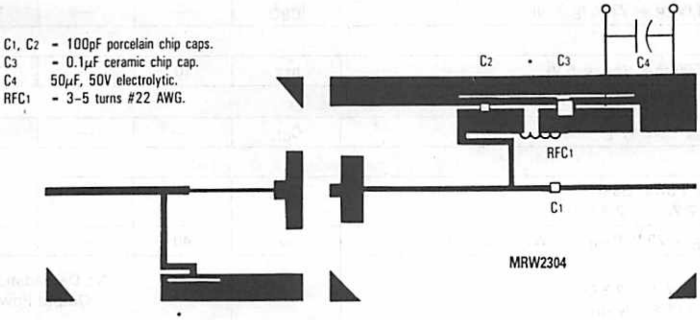


Figure 4. Output Power versus Input Power



*Ground to backside of board
Board material: 0.018″ dielectric thickness teflon fiberglass.

Figure 5. PC Board Layout (Not to Scale) f = 2.3 GHz

MRW2307
MRW2307F

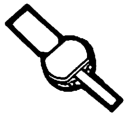
2

The RF Line
Microwave Power Transistors

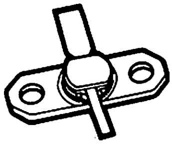
... designed primarily for large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Power Amplifiers
- Specified 20 Volt, 2.3 GHz Characteristics:
  - Output Power — 7 Watts
  - Power Gain — 8 dB, Min
  - Collector Efficiency — 40% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW2307,F

8 dB
1.5–3 GHz
7 WATTS
MICROWAVE
POWER
TRANSISTORS



CASE 328E-01, STYLE 1
(GP-13F)
MRW2307F



CASE 328F-01, STYLE 2
(GP-13)
MRW2307

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CES}	42	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	2.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	8.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, V_{BE} = 0)	$V_{(BR)CES}$	42	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 22 V, I_E = 0)	I_{CBO}	—	—	1.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5 V)	h_{FE}	10	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 22 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	10	pF
FUNCTIONAL TESTS					
Common-Base Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 7 W, f = 2.3 GHz)	G_{PB}	8	—	—	dB
Collector Efficiency (V_{CE} = 20 V, P_{out} = 7 W, f = 2.3 GHz)	η_c	40	—	—	%
Load Mismatch (V_{CE} = 20 V, P_{out} = 7 W, f = 2.3 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

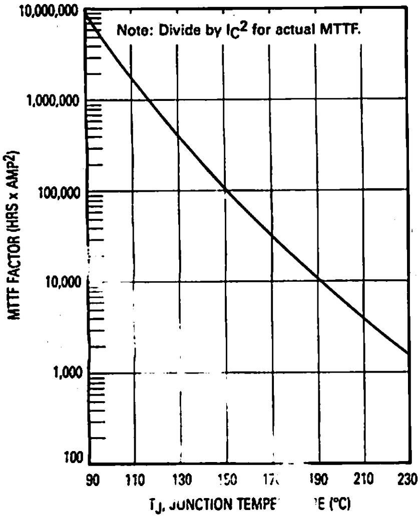


Figure 1. MTTF Factor versus Junction Temperature

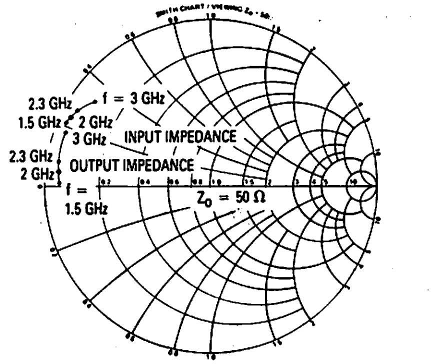


Figure 2. Series Equivalent Input/Output Impedance

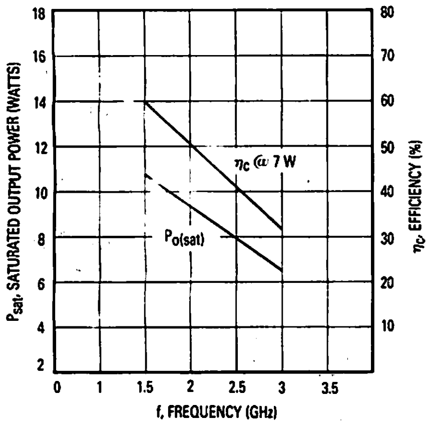


Figure 3. P_{sat} and Efficiency versus Frequency

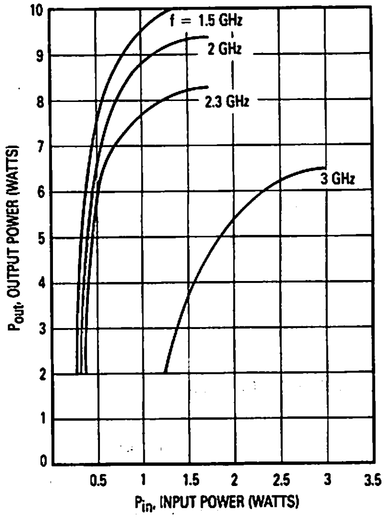
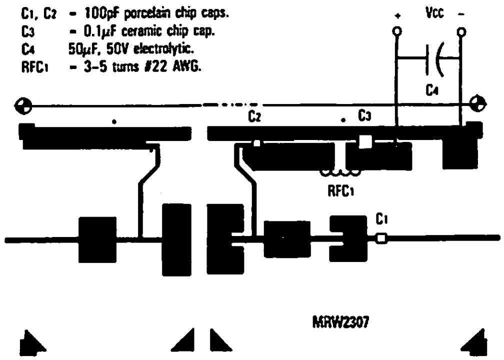


Figure 4. Output Power versus Input Power



*Ground to backside of board
Board material: 0.018" dielectric thickness teflon fiberglass.

Figure 5. PC Board Layout (Not to Scale), f = 2.3 GHz

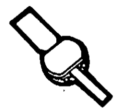
MRW3000 Series

The RF Line
Microwave Power Transistors

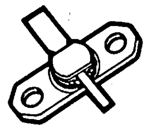
. . . designed primarily for large-signal output and driver amplifier stages in the 1.5 to 3 GHz frequency range.

- Designed for Class B or C, Common Base Linear Power Amplifiers
- Specified 28 Volt, 3 GHz Characteristics:
  - Output Power — 1 to 5 Watts
  - Power Gain — 5 to 7 dB Min
  - Collector Efficiency — 30% Min
- Hermetic Package Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW3000 Series

**5 TO 7 dB
1.5–3 GHz
1 TO 5 WATTS
MICROWAVE
POWER
TRANSISTORS**



CASE 328E-01, STYLE 1
(GP-13F)
MRW3001F, 3003F, 3005F



CASE 328F-01, STYLE 2
(GP-13)
MRW3001, 3003, 3005

MAXIMUM RATINGS

Rating	Symbol	3001,F	3003,F	3005,F	Unit
Collector-Base Voltage	V_{CBO}	45			Vdc
Emitter-Base Voltage	V_{EBO}	3.5			Vdc
Operating Junction Temperature	T_J	200			°C
Storage Temperature Range	T_{stg}	−65 to +200			°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max			Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	35	17	8.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage		$V_{(BR)CES}$				Vdc
(I_C = 10 mA, V_{BE} = 0)	MRW3001,F		50	—	—	
(I_C = 30 mA, V_{BE} = 0)	3003,F		50	—	—	
(I_C = 50 mA, V_{BE} = 0)	3005,F		50	—	—	
Collector-Base Breakdown Voltage		$V_{(BR)CBO}$				Vdc
(I_C = 1 mA, I_E = 0)	MRW3001,F		45	—	—	
(I_C = 3 mA, I_E = 0)	3003,F		45	—	—	
(I_C = 5 mA, I_E = 0)	3005,F		45	—	—	
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)		$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	MRW3001,F	I_{CBO}	—	—	0.5	mAdc
	3003,F		—	—	0.75	
	3005,F		—	—	1.25	
ON CHARACTERISTICS						
DC Current Gain		h_{FE}				—
(I_C = 100 mA, V_{CE} = 5 V)	MRW3001,F		10	—	120	
(I_C = 300 mA, V_{CE} = 5 V)	3003,F		10	—	120	
(I_C = 500 mA, V_{CE} = 5 V)	3005,F		10	—	120	

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	MRW3001,F 3003,F 3005,F	C_{ob}	— — —	3.5 5.7 8.4	4 7 10	pF
FUNCTIONAL TESTS						
Common-Base Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 1 W, f = 3 GHz) (V_{CE} = 28 V, P_{out} = 3 W, f = 3 GHz) (V_{CE} = 28 V, P_{out} = 5 W, f = 3 GHz)	 MRW3001,F 3003,F 3005,F	G_{PB}	 7 6 5	 — — —	 — — —	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 1 W, f = 3 GHz) (V_{CE} = 28 V, P_{out} = 3 W, f = 3 GHz) (V_{CE} = 28 V, P_{out} = 5 W, f = 3 GHz)	 MRW3001,F 3003,F 3005,F	η_c	 30 30 30	 — — —	 — — —	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 1 W, f = 3 GHz, P_{out} = 3 W P_{out} = 5 W Load VSWR = ∞:1, All Phase Angles)	 MRW3001,F 3003,F 3005,F	ψ	No Degradation in Output Power			

MRW3001,F
TYPICAL CHARACTERISTICS

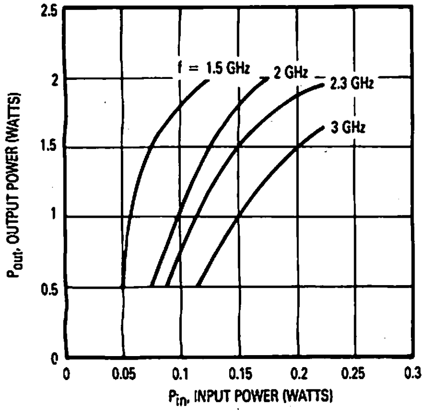


Figure 1. Output Power versus Input Power

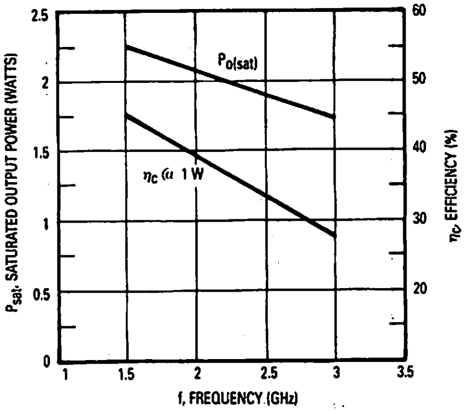


Figure 2. P_{sat} and η versus Frequency

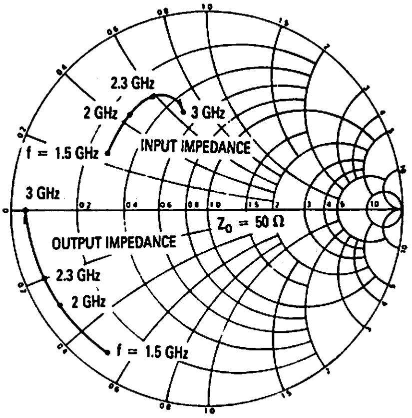
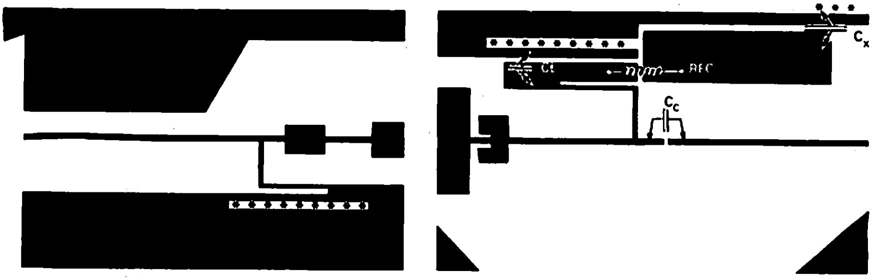


Figure 3. Series Equivalent Input/Output Impedance

2

2



Board material = 0.018" dielectric thickness Glass teflon (ϵ_r = 2.55).
• = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 μF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
R_{FC} = 8 turns #28 AWG, 0.010 dia.

Figure 4. MRW3001 PC Board Layout, f = 3 GHz (Not to Scale)

MRW3003,F
TYPICAL CHARACTERISTICS

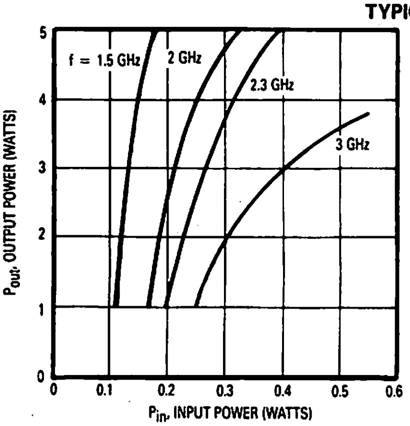


Figure 5. Output Power versus Input Power

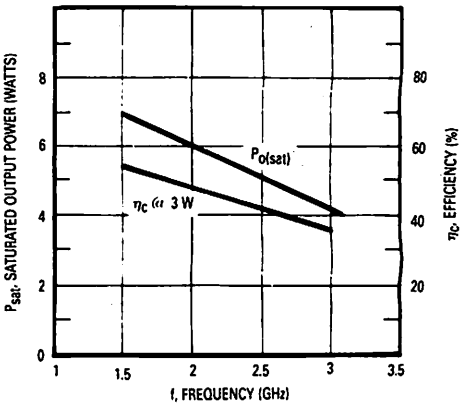


Figure 6. P_{sat} and η versus Frequency

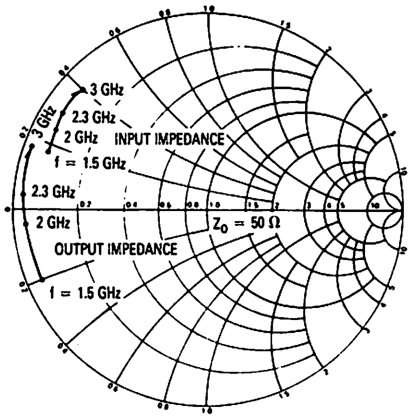
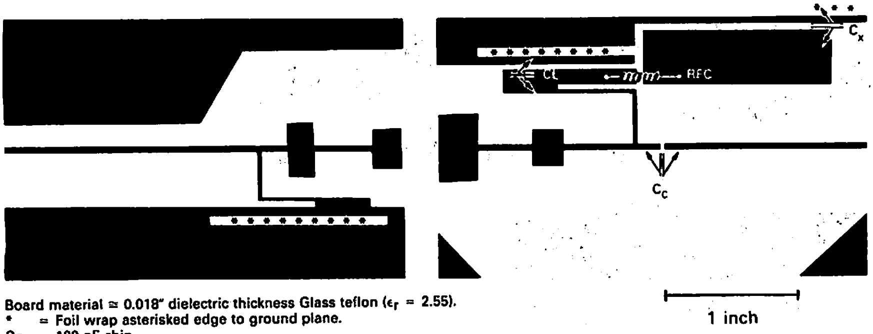


Figure 7. Series Equivalent Input/Output Impedance



Board material ≅ 0.018″ dielectric thickness Glass teflon (ϵ_r = 2.55).
* = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 μF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
R_{FC} = 8 turns #28 AWG, 0.010 dia.

Figure 8. MRW3003 PC Board Layout, f = 3 GHz (Not to Scale)

MRW3005,F TYPICAL CHARACTERISTICS

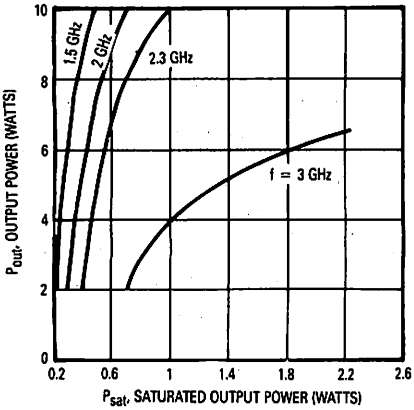


Figure 9. Output Power versus Input Power

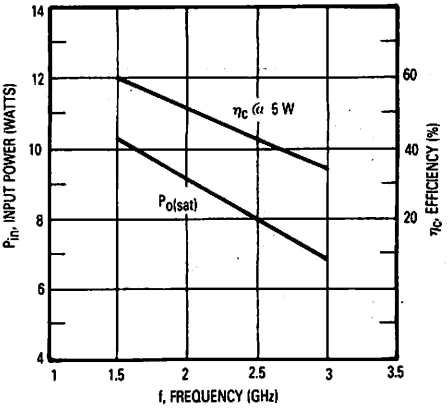


Figure 10. P_{sat} and η versus Frequency

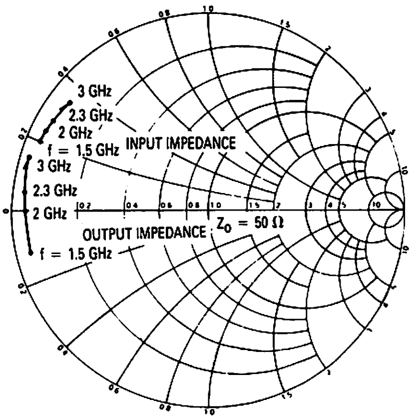
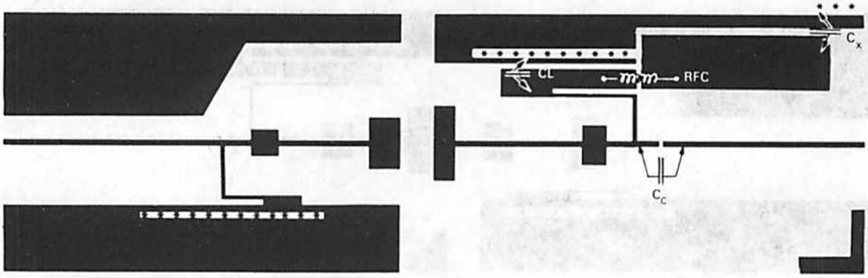


Figure 11. Series Equivalent Input/Output Impedance



Board material ≅ 0.018″ dielectric thickness Glass teflon (ϵ_r = 2.55).
* = Foil wrap asterisked edge to ground plane.
C_C = 100 pF chip.
C_X = 100 pF chip capacitor and 10 μF electrolytic.
C_L = 100 pF chip capacitor. The capacitor position can be tuned.
R_{FC} = 8 turns #28 AWG, 0.010 dia.

Figure 12. MRW3005 PC Board Layout, f = 3 GHz (Not to Scale)

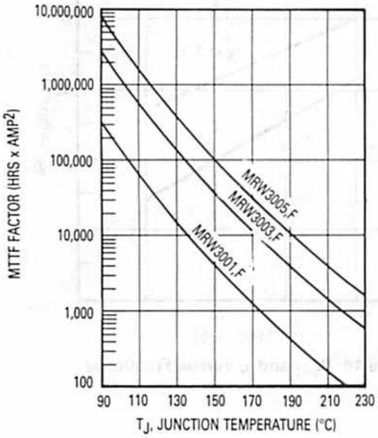


Figure 13. MTTF Factor versus Junction Temperature

MTTF Factor
(Normalized to 1 ampere^2 Continuous Duty)

The graph shown displays MTTF in hours x ampere^2 emitter current for each of the 3 GHz devices. Life tests at elevated temperatures have correlated to better than ± 10% to the theoretical prediction for metal failure. **CAUTION** — A calculation is required to obtain actual metal life. Sample MTTF calculations based on operating conditions are shown below.

Junction Temperature — °C

To calculate metal lifetime under any set of conditions, obtain actual data or estimate from typical performance curves. Solve for T_J (°C):

$$(1)\ T_J = \theta_{JF}\left(\frac{P_{out} \times 100}{\eta_C\ \%} + P_{in} - P_{out}\right) + T_{FLANGE}$$

Enter graph of MTF factor versus T_J. Obtain MTF factor. Calculate metal life by:

$$(2)\ \text{Metal Life in Hours} = \frac{\text{MTF Factor}}{I_C^2\ (\text{Amps})}$$

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRW52001 Series

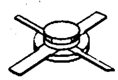
2

The RF Line
Microwave Linear Power Transistors

...designed primarily for large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

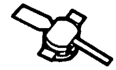
- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  Output Power — 1.5 Watts
  Power Gain — 5 to 6 dB, Min
- Variety of Package Options, All Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW52001 Series

6 dB
1 TO 2 GHz
1.5 WATTS
MICROWAVE
LINEAR POWER
TRANSISTORS

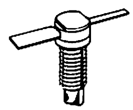


CASE 400-01, STYLE 1
(TW-200)
MRW52001

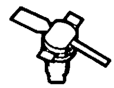
CASE 328E-01, STYLE 2
(GP-13F)
MRW52101



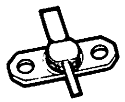
CASE 401A-01, STYLE 1
(GP-14S)
MRW52201



CASE 328G-01, STYLE 1
(GP-13S)
MRW52401



CASE 401-01, STYLE 1
(GP-14)
MRW52501



CASE 328F-01, STYLE 1
(GP-13)
MRW52601

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RJ, Junction to Case	$R_{\theta JC}$	16	°C/W
Thermal Resistance, DC, Junction to Case		18	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45 V	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.125	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.5 W, f = 2 GHz, I_E = 220 mA)	MRW52001 MRW52101 MRW52601	G_{PE}	6	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.5 W, f = 2 GHz, I_E = 220 mA)	MRW52201 MRW52401 MRW52501	G_{PE}	5	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 220 mA, P_{out} = 1.5 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)		f_T	—	2.7	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 220 mA, f = 2 GHz, P_{o1} = 1.5 W, P_{o2} = 1.5 mW)		L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 220 mA, P_o (PEP) = 1.5 W, Tones at 2.05 GHz and 2.1 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

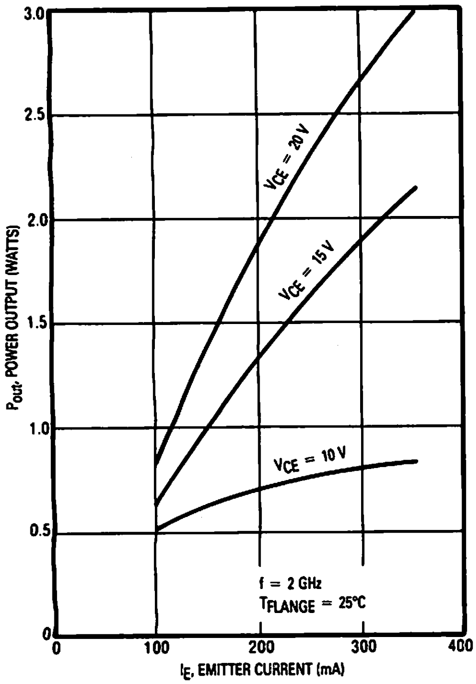


Figure 1. 1 dB Compression Point versus Emitter Current

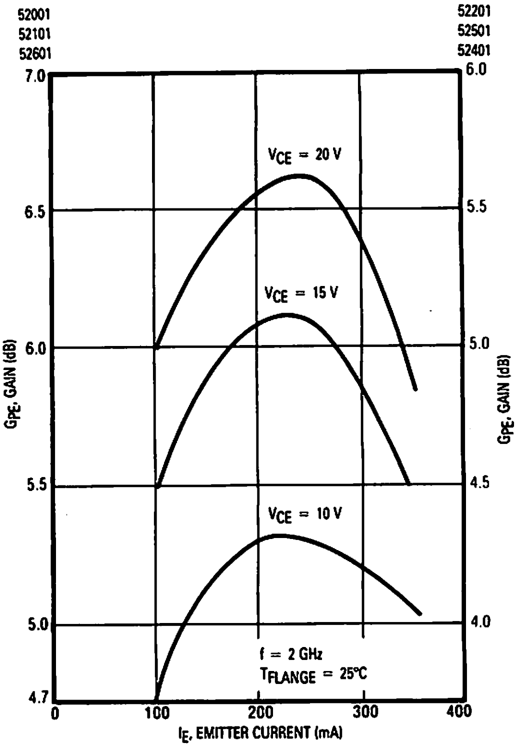


Figure 2. Gain versus Emitter Current

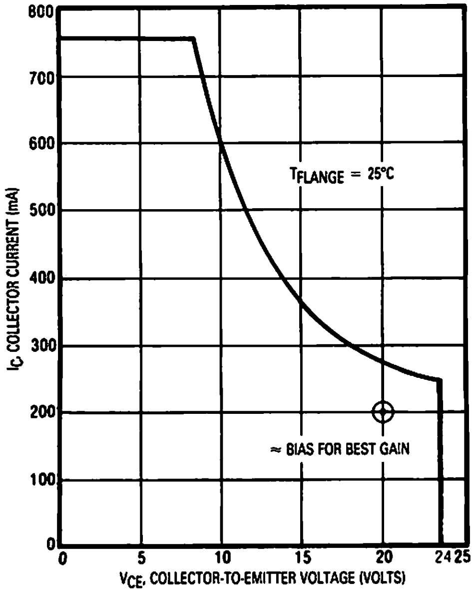


Figure 3. Safe Operating Area

2

MRW52001

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
20	220	0.5	0.85	176	3.44	78	0.04	48	0.23	−142
		1	0.87	163	1.77	63	0.06	62	0.28	−147
		1.3	0.89	157	1.32	55	0.08	68	0.33	−155
		1.5	0.87	154	1.15	48	0.09	71	0.38	−156
		1.7	0.85	149	1.02	41	0.1	70	0.41	−157
		2	0.87	140	0.92	35	0.12	70	0.45	−161
		2.5	0.94	130	0.73	30	0.15	72	0.54	−170
		3	0.87	116	0.6	18	0.19	68	0.59	−177

MRW52101, 52601

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
20	220	0.5	0.85	172	3.65	67	0.04	24	0.34	−149
		1	0.84	152	1.8	35	0.06	29	0.41	−159
		1.3	0.84	142	1.4	18	0.07	28	0.48	−166
		1.5	0.83	136	1.17	7	0.08	25	0.52	−172
		1.7	0.83	129	1.03	−3	0.09	24	0.56	−178
		2	0.83	119	0.87	−16	0.11	21	0.6	176
		2.5	0.81	103	0.7	−42	0.11	1	0.68	160
		3	0.79	83	0.6	−62	0.14	−11	0.74	147

Figure 4. Common Emitter S-Parameters

MRW52001 MRW52101, MRW52601

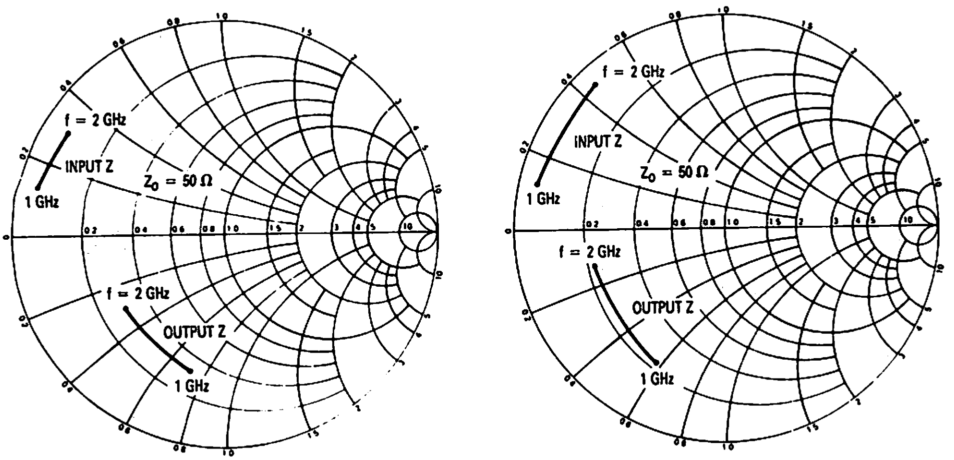


Figure 5. Series Equivalent Input/Output Impedance
Conditions: V_{CE} = 20 V, I_E = 220 mA,
T_{FLANGE} = 25°C

The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

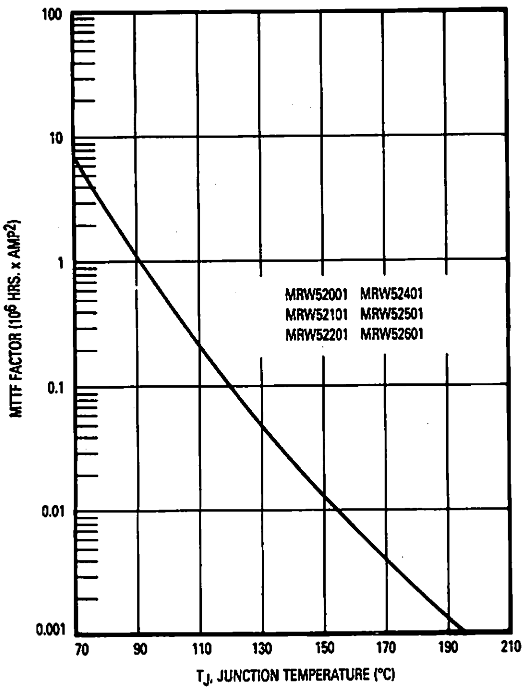


Figure 6. MTTF Factor versus Junction Temperature

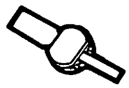
MRW52102 Series

The RF Line
Microwave Linear Power Transistors

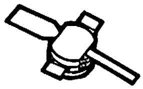
. . . designed primarily for large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 3 Watts
  - Power Gain — 5 to 6 dB
- Variety of Package Options, All Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW52102 Seires

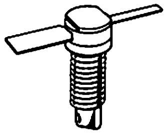
**6 dB
1–2 GHz
3 WATTS
MICROWAVE
LINEAR POWER
TRANSISTORS**



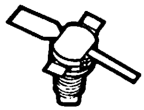
CASE 328E-01, STYLE 2
(GP-13F)
MRW52102



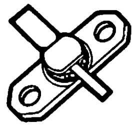
CASE 401A-01, STYLE 1
(GP-14S)
MRW52202



CASE 328G-01, STYLE 1
(GP-13S)
MRW52402



CASE 401-01, STYLE 1
(GP-14)
MRW52502



CASE 328F-01, STYLE 1
(GP-13)
MRW52602

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	8.5	°C/W
Thermal Resistance, DC, Junction to Case		10.0	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 3 W, f = 2 GHz, I_E = 440 mA)	MRW52102 MRW52602	G_{PE}	6	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 3 W, f = 2 GHz, I_E = 440 mA)	MRW52202 MRW52402 MRW52502	G_{PE}	5	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 440 mA, P_{out} = 3 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)		f_T	—	2.7	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 440 mA, f = 2 GHz, P_{o1} = 3 W, P_{o2} = 3 mW)		L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 440 mA, P_o (PEP) = 3 W, Tones at 2 GHz and 2.005 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

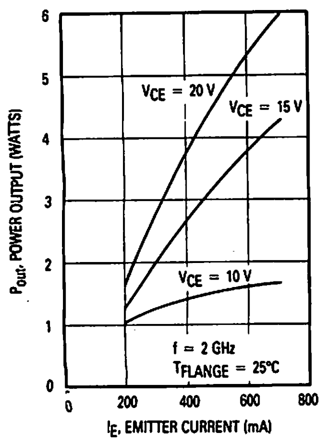


Figure 1. 1 dB Compression Point versus Emitter Current

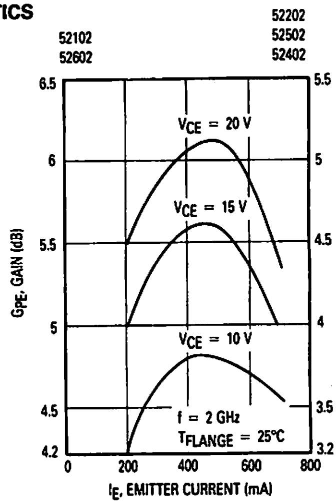


Figure 2. Gain versus Emitter Current

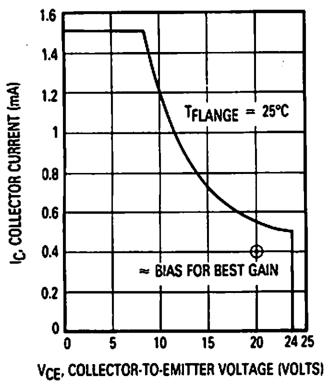


Figure 3. DC Safe Operating Area

2

MRW52102/52602

VCE (Volts)	IC (mA)	f (GHz)	S11 Mag	S11 ∠φ	S21 Mag	S21 ∠φ	S12 Mag	S12 ∠φ	S22 Mag	S22 ∠φ
20	440	0.5	0.94	170	2.57	64	0.03	24	0.49	−173
		1	0.92	156	1.23	35	0.04	30	0.55	−179
		1.3	0.92	148	0.93	18	0.05	30	0.6	177
		1.5	0.91	144	0.78	8	0.05	28	0.62	172
		1.7	0.92	139	0.68	0	0.06	27	0.66	168
		2	0.92	131	0.57	−12	0.07	24	0.68	163
		2.5	0.91	120	0.43	−35	0.08	14	0.75	150
		3	0.93	108	0.36	−49	0.1	7	0.79	138

Figure 4. Common Emitter S-Parameters

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

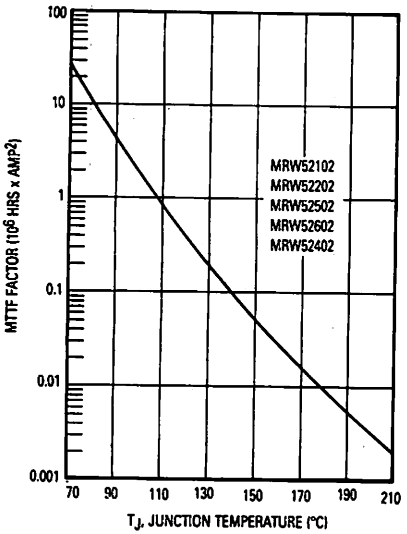
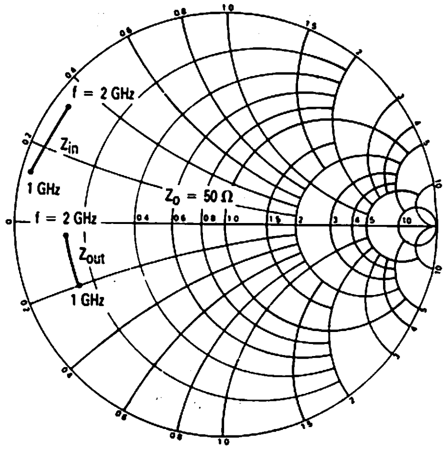


Figure 5. MTTF Factor versus Junction Temperature



V_{CE} = 20 V, P_O = 3 W

Figure 6. Series Equivalent Input/Output Impedance

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRW52104 Series

2

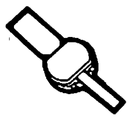
The RF Line

Microwave Linear Power Transistors

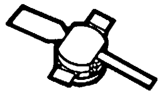
. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A, or AB Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  Output Power — 6 Watts
  Power Gain — 4.8 dB, Min
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly named TRW52104 Series

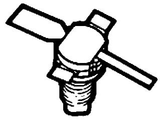
4.8 dB
1 TO 2 GHz
6 WATTS
MICROWAVE
LINEAR POWER
TRANSISTORS



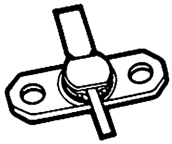
CASE 328E-01, STYLE 2
(GP-13F)
MRW52104



CASE 401A-01, STYLE 1
(GP-14S)
MRW52204



CASE 401-01, STYLE 1
(GP-14)
MRW52504



CASE 328F-01, STYLE 1
(GP-13)
MRW52604

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	6	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	9.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 80 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 4 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 400 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	12	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 6 W, f = 2 GHz, I_E = 880 mA)	G_{PE}	4.8	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 880 mA, P_{out} = 6 W, f = 2 GHz, Load VSWR = 3:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)	f_T	—	2.7	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 880 mA, f = 2 GHz, P_{o1} = 6 W, P_{o2} = 6 mW)	L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 880 mA, P_o (PEP) = 6 W, Tones at 1 GHz and 1.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

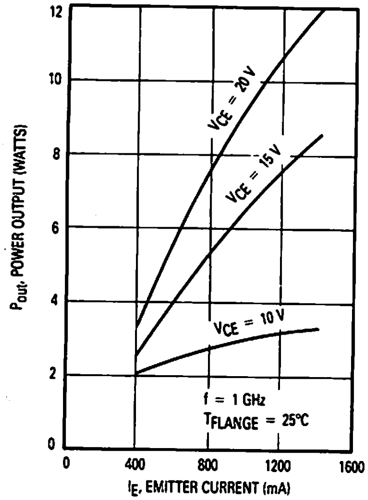


Figure 1. 1 dB Compression Point versus Emitter Current

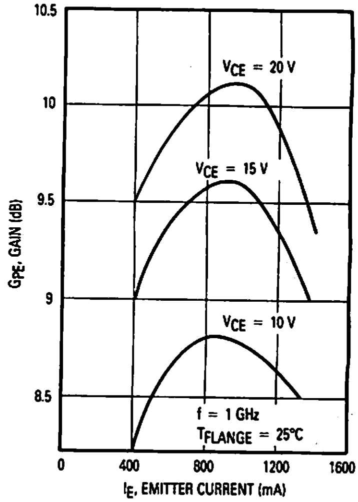


Figure 2. Gain versus Emitter Current

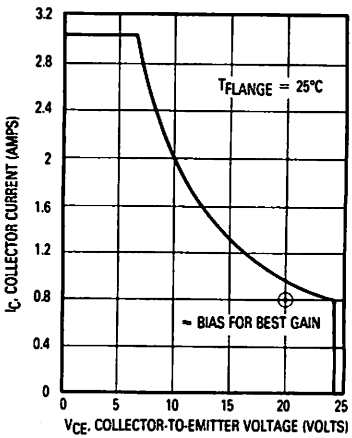


Figure 3. DC Safe Operating Area

MRW52604, 104 S-PARAMETERS

Large Signal Impedance Data (5Ω Center)

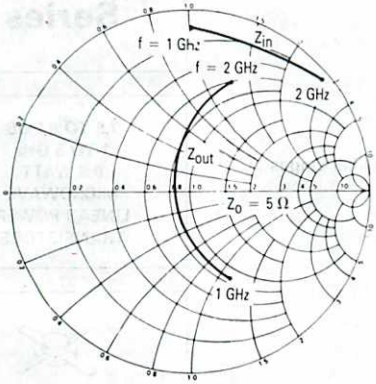


Figure 4. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ± 10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

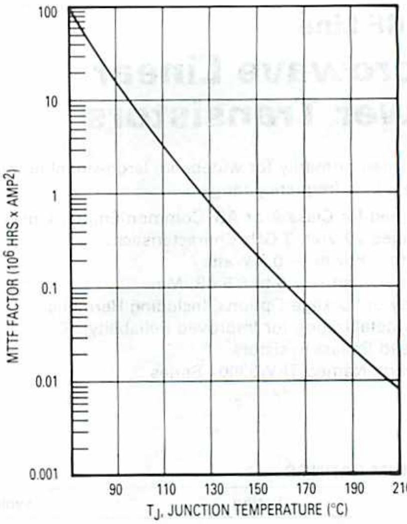


Figure 5. MTTF Factor versus Junction Temperature

MRW52104, 52604

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
20	600	0.5	0.96	170	1.45	66	0.02	33	0.73	175
		1	0.95	158	0.71	40	0.04	41	0.75	167
		1.3	0.95	151	0.56	26	0.04	39	0.77	163
		1.5	0.94	147	0.47	18	0.05	37	0.77	158
		1.7	0.95	143	0.42	11	0.05	37	0.79	155
		2	0.96	136	0.35	0	0.06	34	0.79	150
		2.5	0.95	127	0.28	−17	0.08	25	0.83	140
		3	0.98	118	0.24	−27	0.09	19	0.85	131

Figure 6. Common Emitter S-Parameters

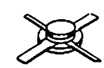
MRW53001 Series

The RF Line
Microwave Linear Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 1 to 3 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 3 GHz Characteristics:
  Output Power — 0.8 Watts
  Power Gain — 7.5 to 8.5 dB, Min
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW53001 Series

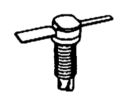
**7.5 TO 8.5 dB
1 TO 3 GHz
0.8 WATT
MICROWAVE
LINEAR POWER
TRANSISTORS**



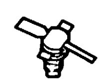
CASE 400-01, STYLE 1
MRW53001
(TW-200)

CASE 328E-01, STYLE 2
MRW53101
(GP-13F)

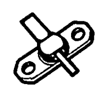
CASE 401A-01, STYLE 1
MRW53201
(GP-14S)



CASE 328G-01, STYLE 1
MRW53401
(GP-13S)



CASE 401-01, STYLE 1
MRW53501
(GP-14)



CASE 328F-01, STYLE 1
MRW53601
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	31	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	35	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.8 W, f = 3 GHz)	MRW53001 MRW53101 MRW53601	G_{PE}	8.5	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.8 W, f = 3 GHz)	MRW53201 MRW53401 MRW53501	G_{PE}	7.5	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.8 W, f = 3 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)		f_T	—	3	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 120 mA, f = 3 GHz, P_{o1} = 0.8 W, P_{o2} = 0.8 mW)		L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 120 mA, P_o (PEP) = 0.8 W, Tones at 3 GHz and 3.005 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

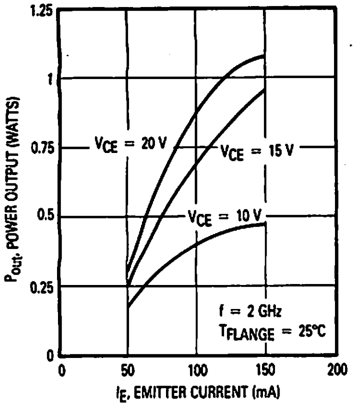


Figure 1. 1 dB Compression Point versus Emitter Current

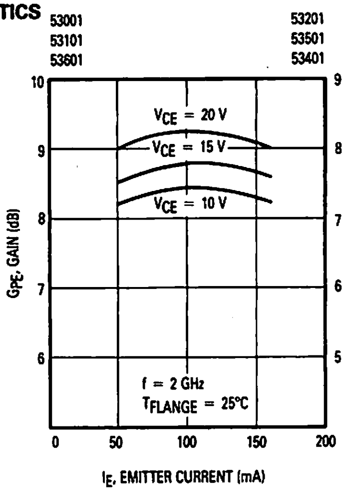


Figure 2. Gain versus Emitter Current

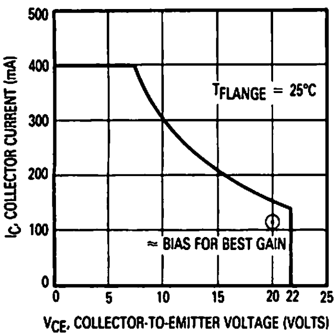


Figure 3. DC Safe Operating Area

2

MRW53001

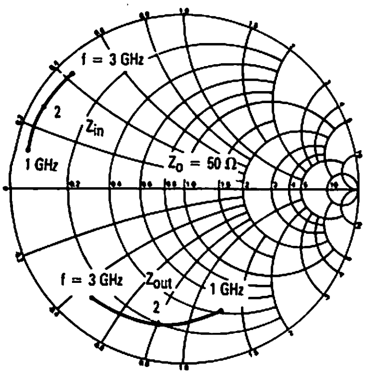
V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
20	120	0.5	0.8	179	4.49	74	0.03	43	0.31	-59
		1	0.82	166	2.27	50	0.05	54	0.34	-93
		1.3	0.84	159	1.69	36	0.06	56	0.38	-102
		1.6	0.84	153	1.37	23	0.08	57	0.46	-115
		2	0.84	144	1.05	10	0.1	55	0.52	-124
		2.3	0.85	137	0.9	1	0.12	53	0.55	-135
		2.5	0.86	134	0.82	-4	0.13	51	0.59	-143
		2.7	0.85	128	0.73	-8	0.15	49	0.64	-148
		3	0.83	121	0.65	-16	0.17	45	0.68	-152
		3.3	0.85	113	0.58	-23	0.2	38	0.68	-158

MRW53601/101

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ	Mag	∠ϕ
20	120	0.5	0.83	-177	4.91	71	0.03	22	0.36	-82
		1	0.82	170	2.48	42	0.04	25	0.46	-108
		1.3	0.81	162	1.87	28	0.04	26	0.54	-122
		1.6	0.8	155	1.45	11	0.05	23	0.62	-132
		2	0.78	141	1.17	-6	0.06	20	0.67	-142
		2.3	0.83	132	1.02	-20	0.07	15	0.69	-151
		2.5	0.84	130	0.91	-29	0.07	11	0.72	-158
		2.7	0.79	125	0.85	-35	0.08	10	0.76	-160
		3	0.64	110	0.79	-43	0.1	6	0.8	-168
		3.3	0.61	82	0.77	-57	0.12	-2	0.79	-174

Figure 4. Common Emitter S-Parameters

MRW53001



MRW53601

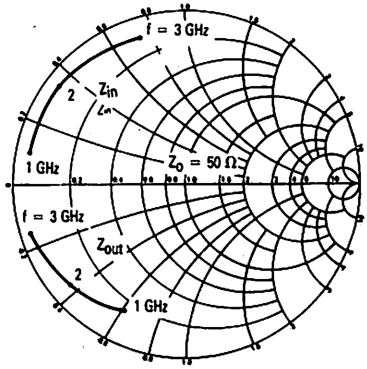


Figure 5. Series Equivalent Input/Output Impedance Conditions: V_{CE} = 20 V, I_E = 120 mA, T_{FLANGE} = 25°C

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

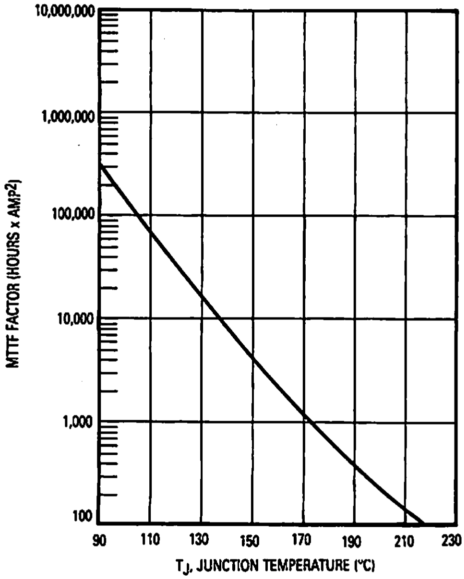


Figure 6. MTTF Factor versus Junction Temperature

MRW53102 Series

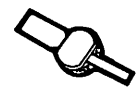
2

The RF Line
Microwave Linear Power Transistors

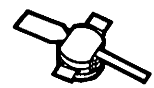
**7 TO 8 dB
1–3 GHz
1.6 WATTS
MICROWAVE
LINEAR POWER
TRANSISTORS**

... designed primarily for large-signal output and driver amplifier stages in the 1 to 3 GHz frequency range.

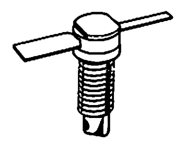
- Designed for Class A, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  - Output Power — 1.6 Watts
  - Power Gain — 7 to 8 dB
- Variety of Package Options, Including Hermetic
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW53102 Series



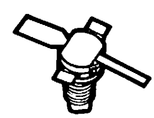
CASE 328E-01, STYLE 2
(GP-13F)
MRW53102



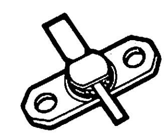
CASE 401A-01, STYLE 1
(GP-14S)
MRW53202



CASE 328G-01, STYLE 1
(GP-13S)
MRW53402



CASE 401-01, STYLE 1
(GP-14)
MRW53502



CASE 328F-01, STYLE 1
(GP-13)
MRW53602

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	17	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.6 W, f = 2 GHz, I_E = 230 mA)	MRW53102 MRW53602	G_{PE}	8	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1.6 W, f = 2 GHz, I_E = 230 mA)	MRW53202 MRW53402 MRW53502	G_{PE}	7	—	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 1.6 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)		f_T	—	3	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 230 mA, f = 2 GHz, P_{o1} = 1.6 W, P_{o2} = 1.6 mW)		L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 230 mA, P_o (PEP) = 1.6 W, Tones at 2 GHz and 2.005 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

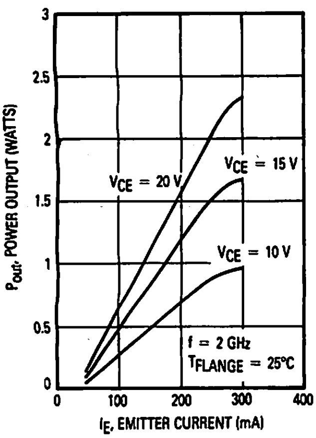


Figure 1. 1 dB Compression Point versus Emitter Current

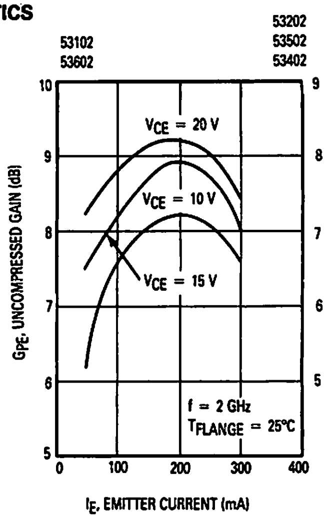


Figure 2. Gain versus Emitter Current

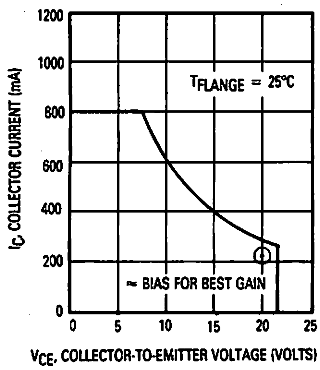


Figure 3. DC Safe Operating Area

2

2

MRW53102, 53602

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
20	230	0.5	0.87	175	3.65	65	0.03	17	0.34	−133
		1	0.87	159	1.72	33	0.04	25	0.48	−149
		1.3	0.88	151	1.28	15	0.04	27	0.56	−159
		1.5	0.87	146	1.06	5	0.05	27	0.6	−166
		1.7	0.89	141	0.9	−4	0.05	27	0.65	−173
		2	0.89	134	0.74	−17	0.06	26	0.69	179
		2.3	0.88	127	0.61	−32	0.07	19	0.75	166
		2.5	0.88	122	0.55	−40	0.08	16	0.76	160
		2.7	0.88	117	0.49	−46	0.09	15	0.78	154
		3	0.87	110	0.43	−56	0.1	9	0.81	146
		3.3	0.86	102	0.38	−66	0.11	2	0.94	139

Figure 4. Common Emitter S-Parameters

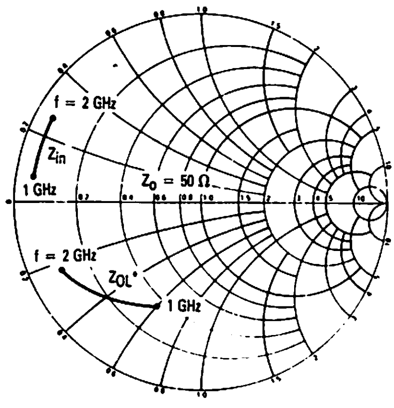


Figure 5. Series Equivalent Input/Output Impedance

The graph shown below displays MTTF in hours x ampere² emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

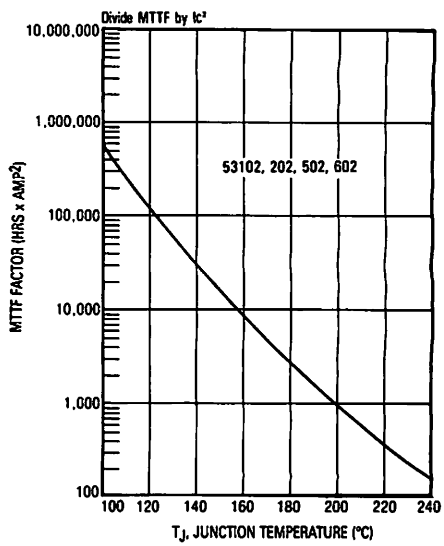


Figure 6. MTTF Factor versus Junction Temperature

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

MRW53505
MRW53605

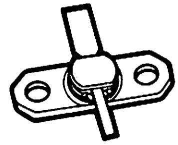
The RF Line

Microwave Linear Power Transistors

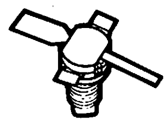
. . . designed primarily for large-signal output and driver amplifier stages in the 1 to 2 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  Output Power — 4 Watts
  Power Gain — 6 to 7 dB, Min
- Hermetic Packages Suitable for Military/Space Applications
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly called TRW53505/605

**6 TO 7 dB
1–2 GHz
4 WATTS
MICROWAVE
LINEAR POWER
TRANSISTORS**



CASE 328F-01, STYLE 1
(GP-13)
MRW53605



CASE 401-01, STYLE 1
(GP-14S)
MRW53505

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, RF, Junction to Case	$R_{\theta JC}$	10	°C/W
Thermal Resistance, DC, Junction to Case	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 5 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	1.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5 V)	h_{FE}	20	35	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	7	10	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 4 W, f = 2 GHz, I_E = 600 mA)	MRW53605 MRW53505	G_{PE}	7 6	— —	— —	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 4 W, f = 2 GHz, Load VSWR = 3:1, All Phase Angles)		ψ	No Degradation in Output Power			
Cutoff Frequency (Basic cell design)		f_T	—	3	—	GHz
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 600 mA, P_o (PEP) = 2 W, Tones at 2 GHz and 2.005 GHz)		IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

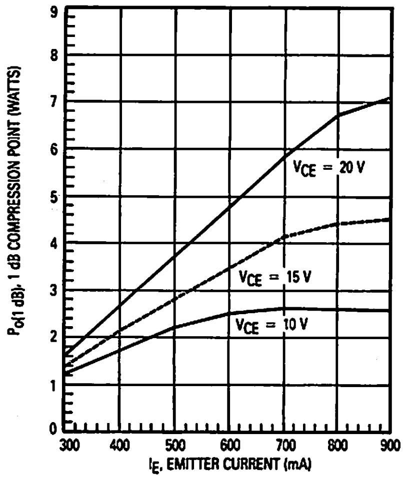


Figure 1. 1 dB Compression Point versus Emitter Current @ 2 GHz

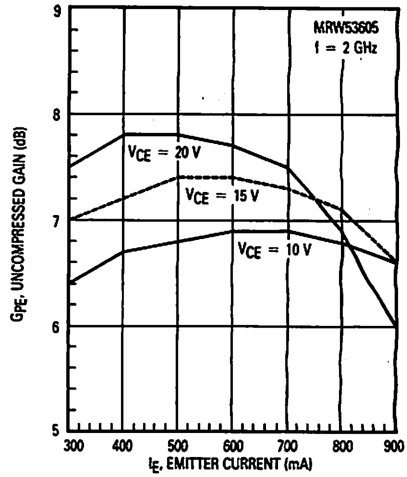


Figure 2. Uncompressed Gain versus Emitter Current

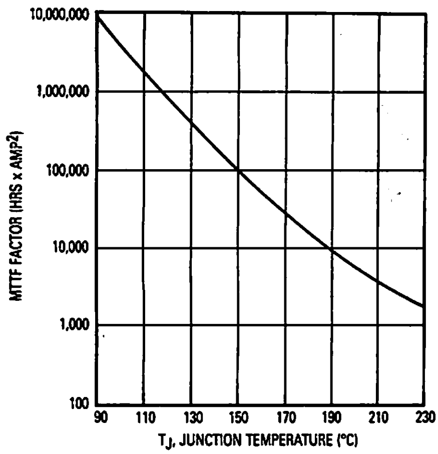


Figure 3. MTTF Factor versus Junction Temperature

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

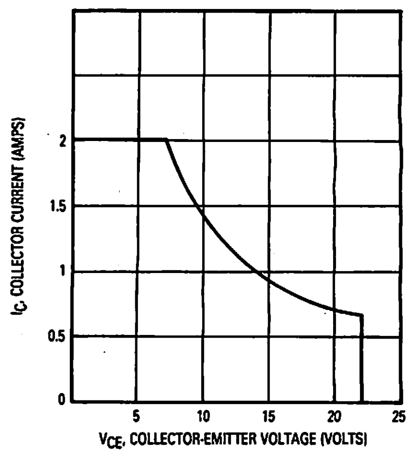


Figure 4. DC Safe Operating Area

2

MRW53605

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
20	500	0.5	0.94	172	2.11	68	0.03	14	0.66	−179
		1	0.92	161	1.01	39	0.04	19	0.69	171
		1.3	0.92	155	0.76	25	0.04	21	0.73	164
		1.5	0.89	152	0.63	17	0.04	21	0.75	161
		1.7	0.92	147	0.56	7	0.05	21	0.76	157
		2	0.92	142	0.47	−5	0.05	19	0.79	150
		2.5	0.93	131	0.36	−21	0.06	18	0.81	140
		3	0.93	122	0.29	−38	0.07	11	0.86	130
		3.3	0.92	117	0.26	−45	0.08	6	0.87	122

Figure 5. Common Emitter S-Parameters

2

MRW54001 Series

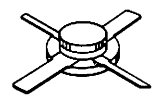
The RF Line

Microwave Linear Power Transistors

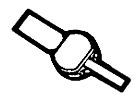
. . . designed primarily for large-signal output and driver amplifier stages in the 1 to 4 GHz frequency range.

- Designed for Class A or AB, Common-Emitter Linear Power Amplifiers
- Specified 20 Volt, 2 GHz Characteristics:
  Output Power — 0.5 Watt
  Power Gain — 10 to 11 dB
- 100% Tested for Load Mismatch at All Phase Angles with ∞:1 VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors
- Formerly Named TRW54001 Series

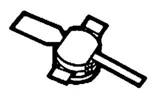
10 TO 11 dB
1–4 GHz
0.5 WATT
MICROWAVE
LINEAR POWER
TRANSISTORS



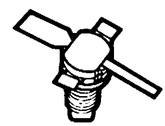
CASE 400-01, STYLE 1
(TW200)
MRW54001



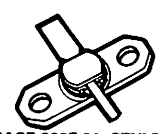
CASE 328E-01, STYLE 2
(GP-13F)
MRW54101



CASE 401A-01, STYLE 1
(GP-14F)
MRW54201



CASE 401-01, STYLE 1
(GP-14S)
MRW54501



CASE 328F-01, STYLE 1
(GP-13)
MRW54601

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CES}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	50	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3.5	pF

(continued)

MRW54001

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
20	100	0.5	0.76	-177	6.65	74	0.03	20	0.43	-73
		1	0.76	159	3.24	39	0.03	24	0.5	-104
		1.3	0.76	148	2.46	21	0.04	25	0.56	-120
		1.5	0.75	141	2.07	9	0.04	24	0.6	-130
		1.7	0.76	134	1.8	-1	0.05	24	0.64	-140
		2	0.76	124	1.51	-14	0.06	22	0.68	-152
		2.3	0.74	113	1.27	-33	0.06	13	0.74	-167
		2.5	0.73	106	1.15	-43	0.07	9	0.76	-173
		2.7	0.72	98	1.06	-52	0.07	5	0.77	179
		32	0.69	85	0.95	-67	0.08	-4	0.82	170
		3.3	0.64	71	0.86	-81	0.09	-14	0.85	161
		3.5	0.61	60	0.81	-94	0.1	-22	0.87	155
		3.7	0.57	47	0.77	-103	0.1	-30	0.89	149
		4	0.51	24	0.7	-119	0.11	-44	0.92	141

MRW54101, 54601

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
20	100	0.5	0.77	-178	6.17	84	0.04	32	0.32	-57
		1	0.79	159	3.11	56	0.05	38	0.28	-75
		1.3	0.8	149	2.4	44	0.05	41	0.29	-88
		1.5	0.81	144	2.06	34	0.06	41	0.3	-98
		1.7	0.82	138	1.81	28	0.06	43	0.32	-108
		2	0.83	130	1.52	16	0.08	42	0.35	-121
		2.3	0.85	127	1.29	7	0.09	41	0.39	-135
		2.5	0.86	123	1.17	-1	0.1	39	0.41	-142
		2.7	0.87	119	1.06	-5	0.1	39	0.43	-150
		3	0.89	113	0.96	-16	0.12	35	0.48	-162
		3.3	0.89	105	0.83	-25	0.13	31	0.53	-172
		3.5	0.91	102	0.76	-31	0.14	27	0.57	-178
		3.7	0.93	98	0.7	-35	0.15	25	0.59	176
		4	0.89	90	0.62	-44	0.17	19	0.66	166

Figure 5. Common Emitter S-Parameters

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 2 GHz, I_E = 120 mA) MRW54001 MRW54201 MRW54501	G_{PE}	10	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 2 GHz, I_E = 120 mA) MRW54101 MRW54601	G_{PE}	11	—	—	dB
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.5 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)	f_T	4	4.5	—	GHz
Gain Linearity (V_{CE} = 20 V, I_E = 120 mA, f = 2 GHz, P_{o1} = 0.5 W, P_{o2} = 0.5 mW)	L_G	— —	— —	−0.2 +1	dB
Intermodulation Distortion, 3rd Order (V_{CE} = 20 V, I_E = 120 mA, P_o (PEP) = 0.5 W, Tones at 2 GHz and 2.005 GHz)	IMD	—	−30	—	dB

TYPICAL CHARACTERISTICS

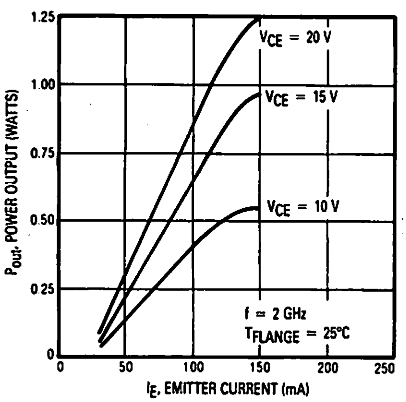


Figure 1. 1 dB Compression Point versus Emitter Current

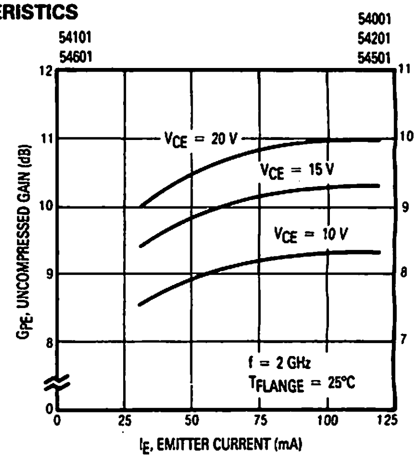


Figure 2. Gain versus Emitter Current

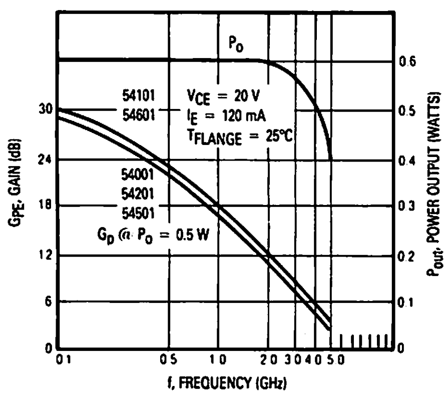


Figure 3. Gain and 1 dB Compressed Power versus Frequency

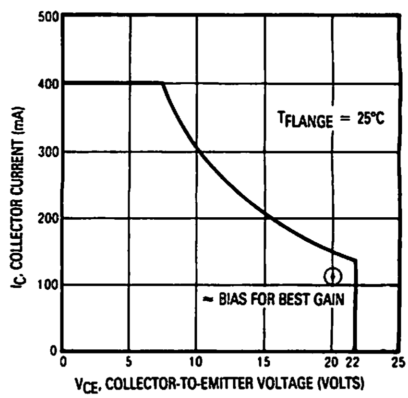


Figure 4. DC Safe Operating Area

The graph shown below displays MTTF in hours x ampere^2 emitter current for each of the devices. Life tests at elevated temperatures have correlated to better than ±10% to the theoretical prediction for metal failure. Divide MTTF by I_C^2 for MTTF in a particular application.

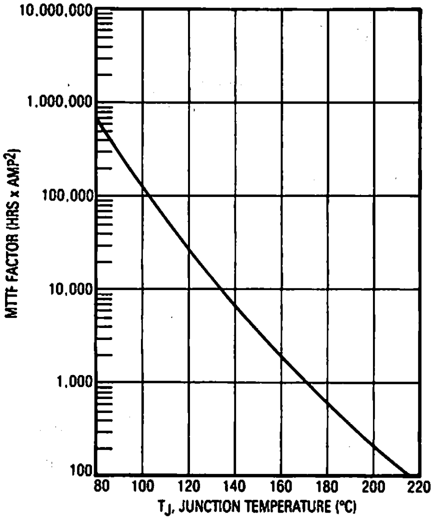


Figure 6. MTTF Factor versus Junction Temperature

2

PT4572A

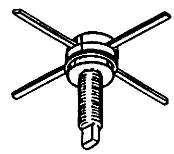
The RF Line

NPN Silicon High Frequency Transistor

... designed for broadband class A applications requiring high output, low distortion and low noise. Primarily used in intermediate or output stages of MATV or CATV amplifiers.

- Low Noise — 2.3 dB Typ @ f = 300 MHz
- High Output — $P_{o1\ dB}$ = 27 dBm Typ @ f = 500 MHz
- Low Distortion — ITO = 45 dBm Typ @ f = 500 MHz

I_C = 200 mA
HIGH FREQUENCY
TRANSISTOR
NPN SILICON



CASE 244D-01, STYLE 1
(TO-117A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	200	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	—	200	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	50	130	300	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_C/I_B = 2)	$V_{CE(sat)}$	—	400	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 8 V, I_E = 0, f = 1 MHz)	C_{cb}	—	2.2	—	pF
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	2.3	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	2.5	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$G_{U_{MAX}}$	—	16	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$\|S_{21}\|^2$	—	14	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	$P_{o1\ dB}$	—	27	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 500 MHz)	ITO	—	45	—	dBm

TYPICAL CHARACTERISTICS

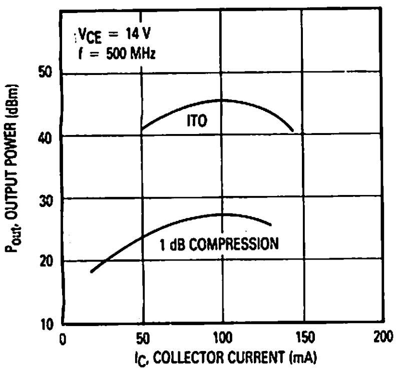


Figure 1. Third Order Intercept and 1 dB Compression

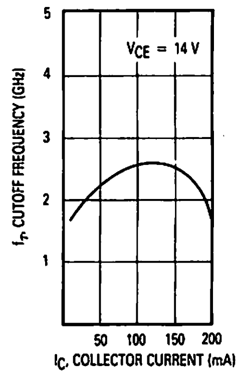


Figure 2. Gain-Bandwidth Product versus Collector Current

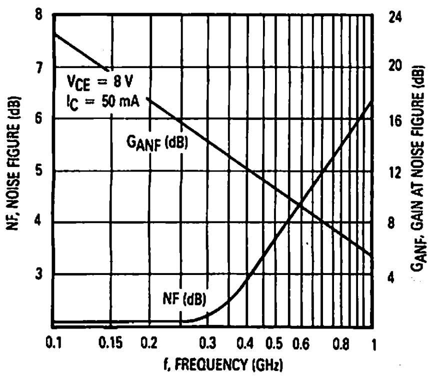


Figure 3. Noise Figure and Associated Gain versus Frequency

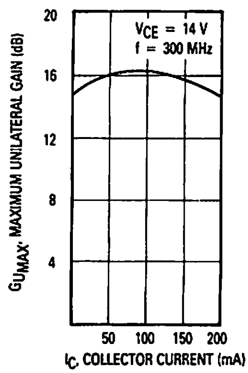


Figure 4. GU_{MAX} versus Collector Current

2

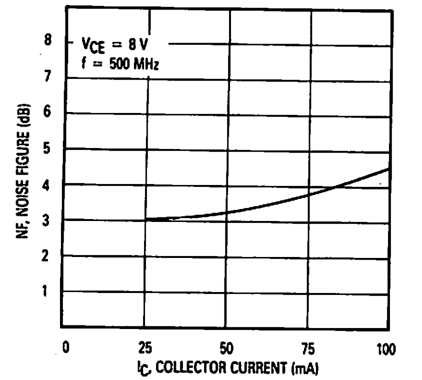


Figure 5. Noise Figure versus Collector Current

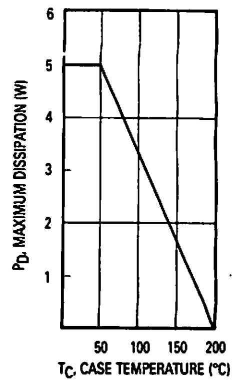


Figure 6. Dissipation versus Temperature

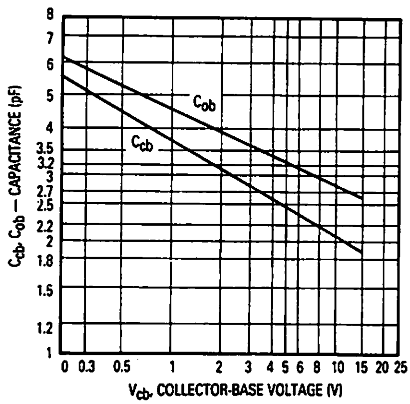


Figure 7. Junction Capacitance versus Voltage

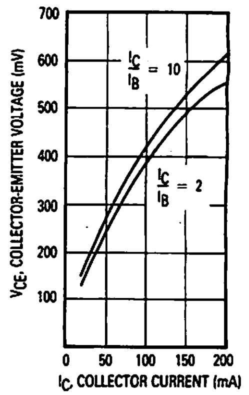


Figure 8. Collector Saturation Characteristics

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
8	50	0.1	0.59	−173	12.69	96	0.03	61	0.15	−108
		0.2	0.6	170	7.19	85	0.05	67	0.1	−124
		0.3	0.61	156	4.89	74	0.07	67	0.13	−132
		0.4	0.61	147	3.72	65	0.09	66	0.12	−129
		0.5	0.61	137	2.96	58	0.11	64	0.16	−129
		0.6	0.63	128	2.48	50	0.13	60	0.16	−143
		0.7	0.62	121	2.11	44	0.15	58	0.18	−142
		0.8	0.62	113	1.83	37	0.16	56	0.24	−158
		0.9	0.63	106	1.6	31	0.18	53	0.24	−166
		1	0.62	100	1.42	26	0.2	51	0.25	−170
14	90	0.1	0.6	−177	17.1	84	0.02	66	0.15	−87
		0.2	0.59	167	7.89	76	0.05	71	0.1	−93
		0.3	0.6	157	5.19	69	0.07	71	0.1	−100
		0.4	0.61	148	3.88	63	0.09	70	0.12	−110
		0.5	0.62	138	3.08	57	0.11	68	0.14	−118
		0.6	0.63	130	2.55	50	0.13	66	0.16	−127
		0.7	0.63	124	2.19	45	0.14	63	0.19	−138
		0.8	0.63	115	1.87	39	0.16	61	0.22	−146
		0.9	0.63	108	1.63	34	0.18	59	0.24	−153
		1	0.62	102	1.44	31	0.19	57	0.26	−161

Figure 9. Common Emitter S-Parameters

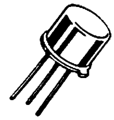
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

The RF Line
NPN Silicon High Frequency Transistor

PT4579

I_C = 200 mA
HIGH FREQUENCY TRANSISTOR
NPN SILICON



CASE 79-04, STYLE 1
(TO-39)

. . . designed for ultra-linear communications or instrumentation applications requiring high output and low noise. Low noise figure combined with high-output capability gives this device an exceptional dynamic range. Gold metallization is used to achieve the high *reliability* demanded by the most severe communications requirements. High gain makes this transistor ideal for broadband applications.

- Low Noise — 2.3 dB Typ @ f = 300 MHz
- High Output — $P_{o1\ dB}$ = 26 dBm Typ @ f = 300 MHz
- Low Distortion — ITO = 46 dBm Typ @ f = 300 MHz
- Gold Metallization

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	200	mAdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 10 V, I_E = 0)	I_{CBO}	—	100	—	μAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	50	150	300	—
Collector-Emitter Saturation Voltage (I_C = 100 mA, I_C/I_B = 2)	$V_{CE(sat)}$	—	400	—	mV
DYNAMIC CHARACTERISTICS					
Collector-Base Capacitance (V_{CB} = 8 V, I_E = 0, f = 1 MHz)	C_{cb}	—	2.5	—	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure, Minimum (V_{CE} = 8 V, I_C = 50 mA, f = 300 MHz)	NF_{MIN}	—	2.3	—	dB
Cutoff Frequency (V_{CE} = 14 V, I_C = 90 mA)	f_T	—	2.5	—	GHz
Maximum Unilateral Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	GU_{MAX}	—	13.5	—	dB
Insertion Gain (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$\|S_{21}\|^2$	—	12	—	dB
Output Power @ 1 dB Compression (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	$P_{o1\ dB}$	—	26	—	dBm
Third Order Intercept (V_{CE} = 14 V, I_C = 90 mA, f = 300 MHz)	ITO	—	46	—	dBm

TYPICAL CHARACTERISTICS

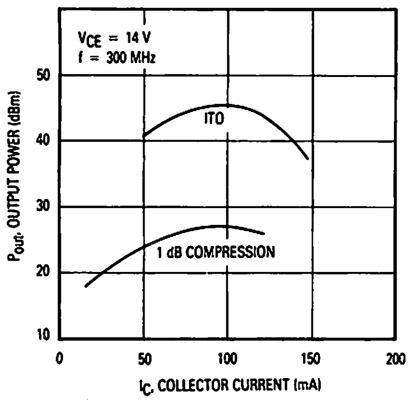


Figure 1. Third Order Intercept and 1 dB Compression

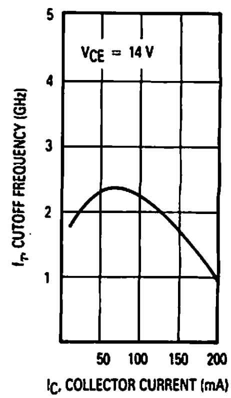


Figure 2. Gain-Bandwidth Product versus Collector Current

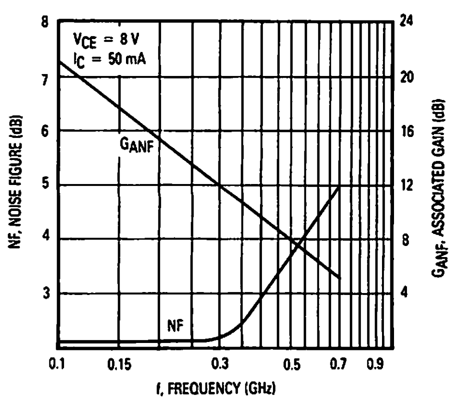


Figure 3. Noise Figure and Associated Gain versus Frequency

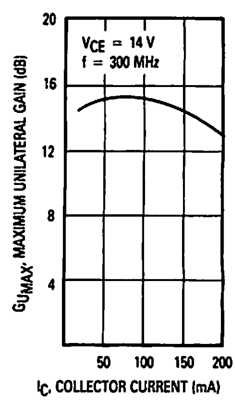


Figure 4. GU_{MAX} versus Collector Current

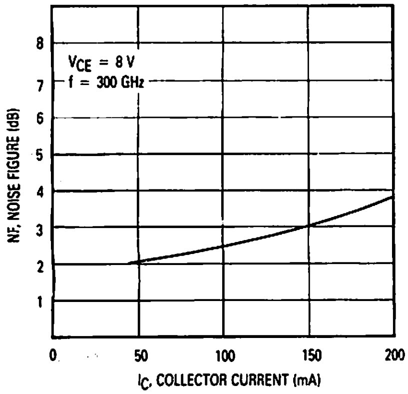


Figure 5. Noise Figure versus Collector Current

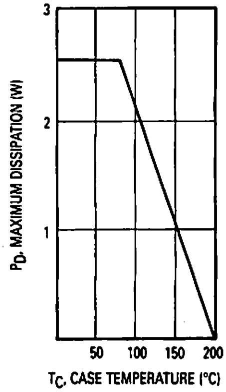


Figure 6. Dissipation versus Temperature

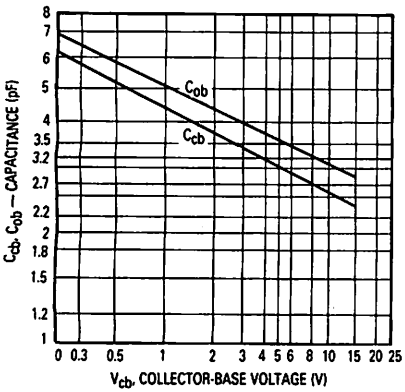


Figure 7. Junction Capacitance versus Voltage

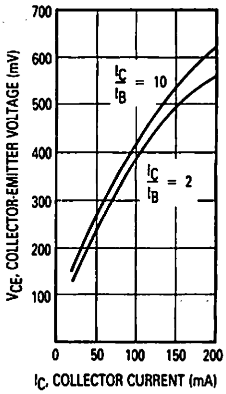


Figure 8. Collector Saturation Characteristics

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} $\angle\phi$	S_{21} Mag	S_{21} $\angle\phi$	S_{12} Mag	S_{12} $\angle\phi$	S_{22} Mag	S_{22} $\angle\phi$
8	50	0.1	0.51	−171	9.41	96	0.05	67	0.17	−113
		0.2	0.52	171	5.24	83	0.08	71	0.13	−130
		0.3	0.52	159	3.63	74	0.12	71	0.14	−135
		0.4	0.52	148	2.81	66	0.16	70	0.17	−140
		0.5	0.53	138	2.29	58	0.2	69	0.17	−144
		0.6	0.54	128	1.96	51	0.23	67	0.2	−148
		0.7	0.54	118	1.72	46	0.27	65	0.23	−150
		0.8	0.53	110	1.55	40	0.3	63	0.27	−157
		0.9	0.53	101	1.41	35	0.33	61	0.29	−162
		1	0.52	91	1.3	30	0.36	59	0.32	−169
14	90	0.1	0.49	−165	11.8	92	0.04	65	0.18	−100
		0.2	0.5	−179	6.06	81	0.07	70	0.17	−113
		0.3	0.51	173	4.07	75	0.1	70	0.19	−116
		0.4	0.51	167	3.09	68	0.13	70	0.21	−115
		0.5	0.51	162	2.53	62	0.15	69	0.24	−114
		0.6	0.5	157	2.13	56	0.18	69	0.28	−113
		0.7	0.49	151	1.85	51	0.2	67	0.31	−114
		0.8	0.49	146	1.63	46	0.22	67	0.34	−115
		0.9	0.48	141	1.47	42	0.25	66	0.37	−116
		1	0.49	134	1.33	38	0.27	66	0.4	−119

Figure 9. Common Emitter S-Parameters

2

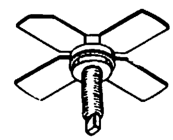
PT9700B Series

The RF Line
UHF Power Transistors

. . . designed primarily for wideband, large-signal output and driver amplifier stages in the 200 to 500 MHz frequency range.

- Designed for Class C or Class AB Power Amplifiers
- Specified 28 Volt, 400 MHz Characteristics:
  Output Power — 5 to 30 Watts
  Power Gain — 7 to 9 dB, Min
  Collector Efficiency — 55 to 60%, Min
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

TO 400 MHz
5 TO 30 WATTS
UHF POWER
TRANSISTORS
NPN SILICON



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	9701B	9703B	9702B	9704B	Unit
Collector-Emitter Voltage	V_{CEO}	30				Vdc
Collector-Base Voltage	V_{CES}	60				Vdc
Emitter-Base Voltage	V_{EBO}	4				Vdc
Collector Current — Continuous	I_C	0.75	1.25	2	5	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 0.057	20 0.114	40 0.228	70 0.4	Watts W/°C
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	8.8	4.4	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	PT9701B	$V_{(BR)CEO}$	30	—	—	Vdc
(I_C = 10 mA, I_B = 0)	PT9703B		30	—	—	
(I_C = 20 mA, I_B = 0)	PT9702B		30	—	—	
(I_C = 30 mA, I_B = 0)	PT9704B		30	—	—	
Collector-Emitter Breakdown Voltage (I_C = 5 mA, V_{BE} = 0)	PT9701B	$V_{(BR)CES}$	60	—	—	Vdc
(I_C = 10 mA, V_{BE} = 0)	PT9703B		60	—	—	
(I_C = 20 mA, V_{BE} = 0)	PT9702B		60	—	—	
(I_C = 30 mA, V_{BE} = 0)	PT9704B		60	—	—	
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	PT9701B	$V_{(BR)EBO}$	4	—	—	Vdc
(I_E = 1 mA, I_C = 0)	PT9703B		4	—	—	
(I_E = 2 mA, I_C = 0)	PT9702B		4	—	—	
(I_E = 3 mA, I_C = 0)	PT9704B		4	—	—	
Collector Cutoff Current (V_{CB} = 30 V, I_E = 0)	PT9701B	I_{CBO}	—	—	0.5	mAdc
	PT9703B		—	—	1	
	PT9702B		—	—	2	
	PT9704B		—	—	3	

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS						
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)		h_{FE}	10	—	150	—
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	PT9701B	C_{ob}	—	—	6	pF
	PT9703B		—	—	12	
	PT9702B		—	—	24	
	PT9704B		—	—	36	
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain		G_{PE}				dB
(V_{CE} = 28 V, P_{out} = 5 W, f = 400 MHz)	PT9701B		9	—	—	
(V_{CE} = 28 V, P_{out} = 10 W, f = 400 MHz)	PT9703B		8.2	—	—	
(V_{CE} = 28 V, P_{out} = 20 W, f = 400 MHz)	PT9702B		7	—	—	
(V_{CE} = 28 V, P_{out} = 30 W, f = 400 MHz)	PT9704B		7	—	—	
Collector Efficiency		η_c				%
(V_{CE} = 28 V, P_{out} = 5 W, f = 400 MHz)	PT9701B		55	—	—	
(V_{CE} = 28 V, P_{out} = 10 W, f = 400 MHz)	PT9703B		60	—	—	
(V_{CE} = 28 V, P_{out} = 20 W, f = 400 MHz)	PT9702B		60	—	—	
(V_{CE} = 28 V, P_{out} = 30 W, f = 400 MHz)	PT9704B		60	—	—	
Load Mismatch (V_{CE} = 28 V, f = 400 MHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
P_{out} = 5 W	PT9701B					
P_{out} = 10 W	PT9703B					
P_{out} = 20 W	PT9702B					
P_{out} = 30 W	PT9704B					
Saturated Output Power (V_{CE} = 28 V, f = 400 MHz)	PT9701B	P_{sat}	6	—	—	W
	PT9703B		12	—	—	
	PT9702B		24	—	—	
	PT9704B		36	—	—	

TYPICAL CHARACTERISTICS

PT9701B — 5 WATTS

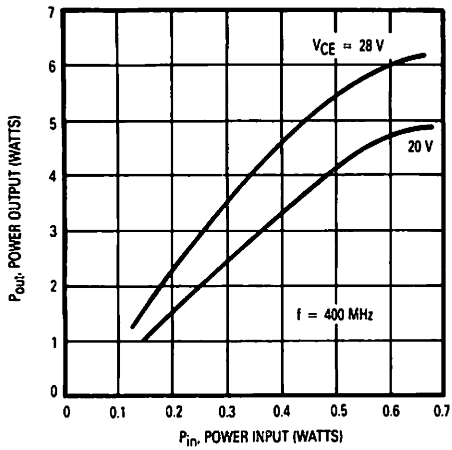


Figure 1. Output Power versus Input Power

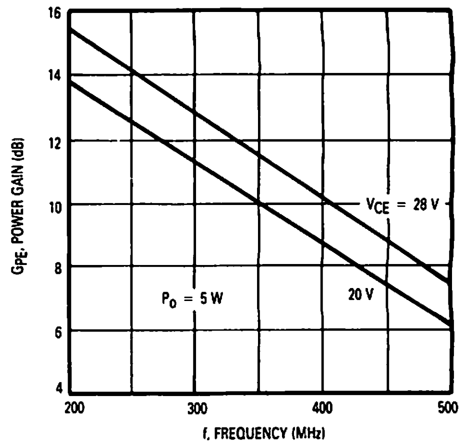


Figure 2. Power Gain versus Frequency

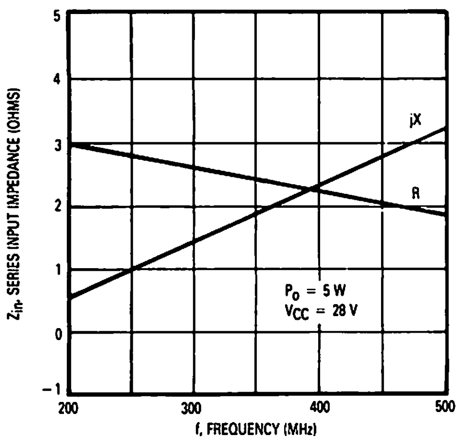


Figure 3. Series Input Impedance versus Frequency

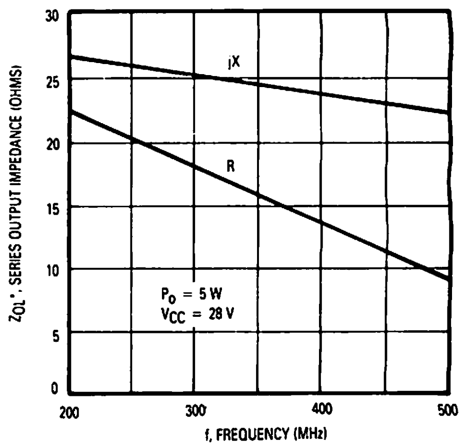


Figure 4. Series Output Impedance versus Frequency

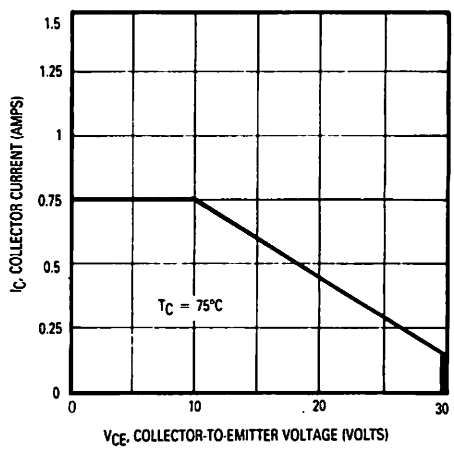


Figure 5. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9703B — 10 WATTS

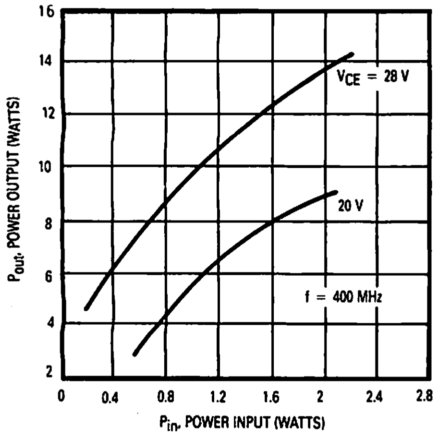


Figure 6. Output Power versus Input Power

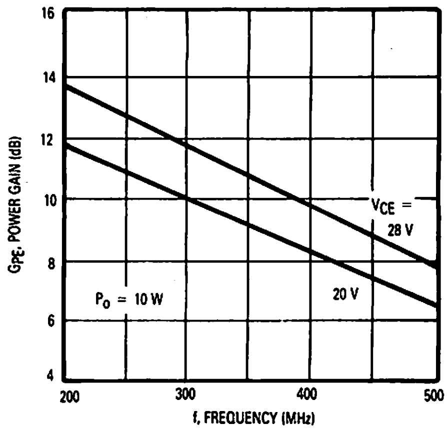


Figure 7. Power Gain versus Frequency

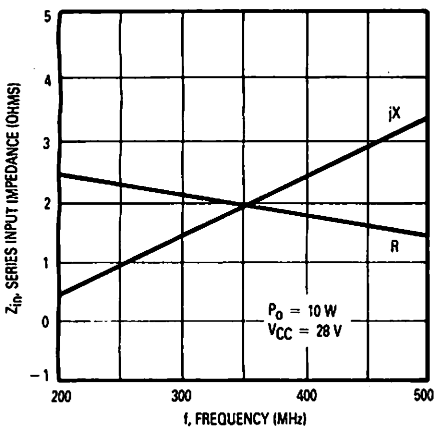


Figure 8. Series Input Impedance versus Frequency

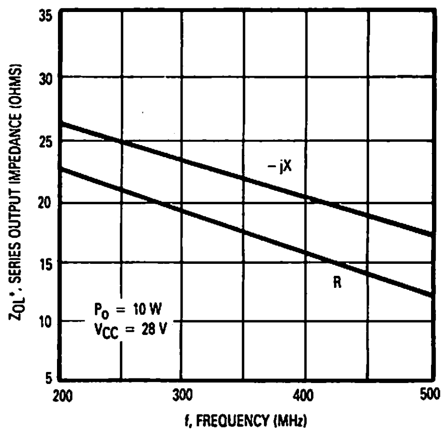


Figure 9. Series Output Impedance versus Frequency

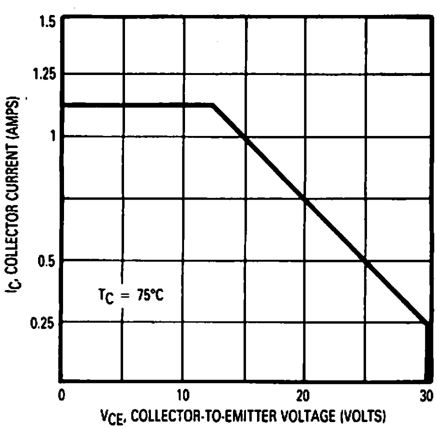


Figure 10. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9702B — 20 WATTS

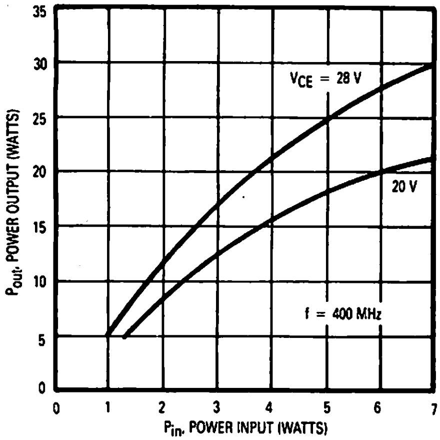


Figure 11. Output Power versus Input Power

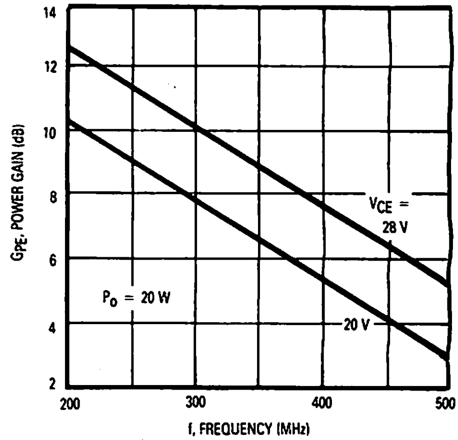


Figure 12. Power Gain versus Frequency

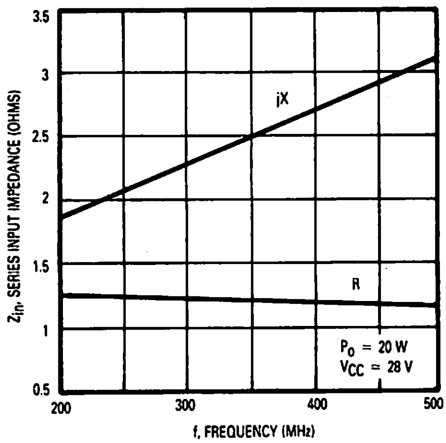


Figure 13. Series Input Impedance versus Frequency

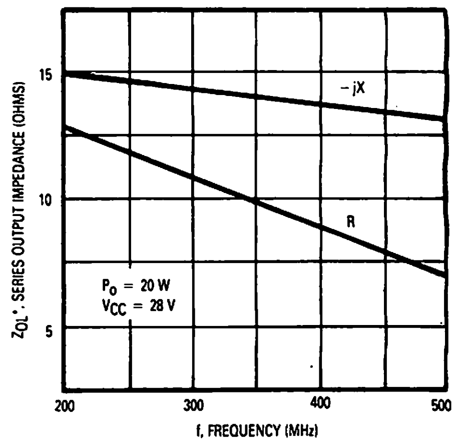


Figure 14. Series Output Impedance versus Frequency

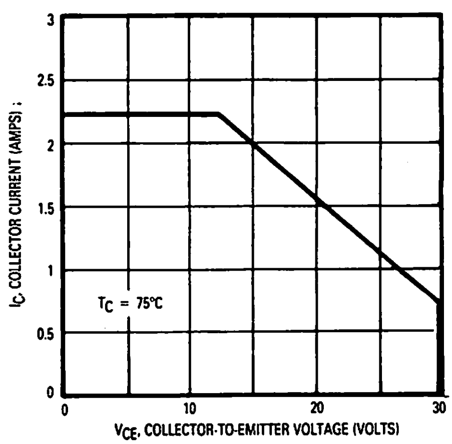


Figure 15. Safe Operating Area

TYPICAL CHARACTERISTICS

PT9704B — 30 WATTS

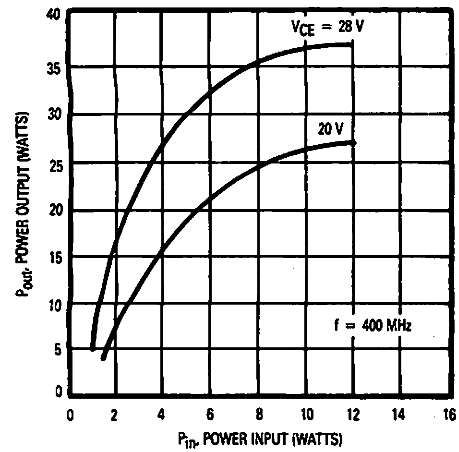


Figure 16. Output Power versus Input Power

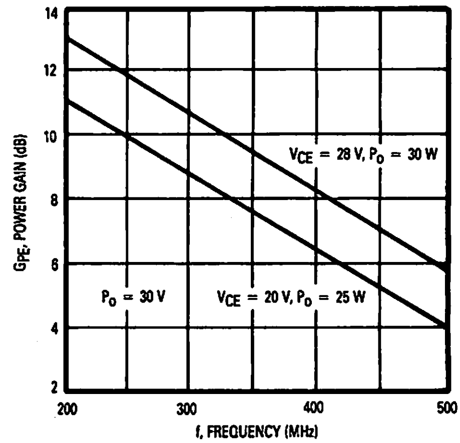


Figure 17. Power Gain versus Frequency

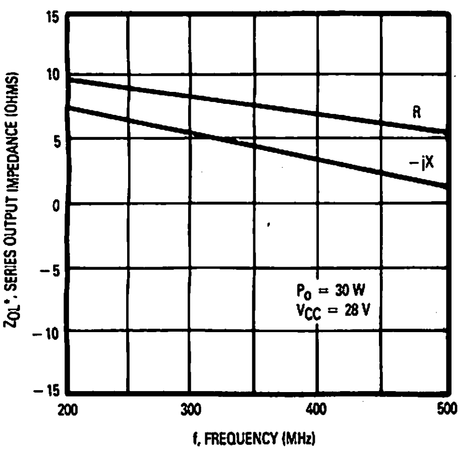


Figure 18. Output Impedance versus Frequency

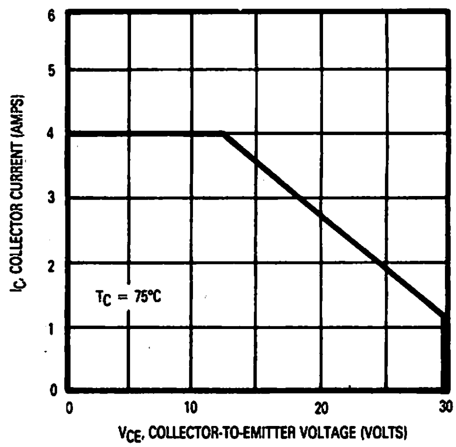
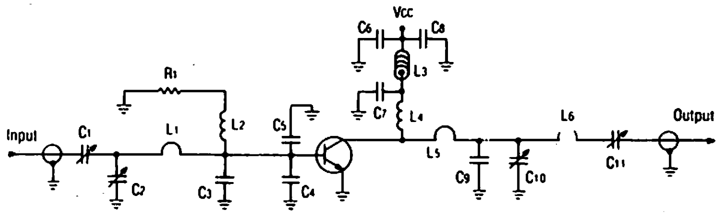


Figure 19. Safe Operating Area

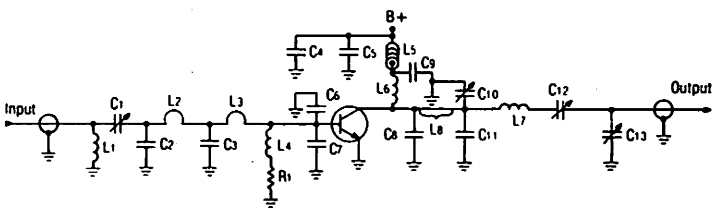
2

2



C1 — 3-35 pF ARCO #403	L1 — #22 AWG, 1/2"
C10 — 0.9-7 pF ARCO #400	L2 — 4 turns #22 AWG, 0.1" I.D.
C3, C9 — 10 pF UNELCO	L3 — 3 Ferrite beads
C4, C5 — 30 pF UNELCO	L4 — 2 turns #22 AWG, 0.1" I.D.
C6, C7 — 1000 pF UNELCO	L5 — #22 AWG, 0.5" hairpin
C8 — 100 μF electrolytic	L6 — 3 turns #22 AWG, 0.1" I.D.
C11 — 0-18 pF ARCO #402	R1 — 1 ohm, 1/4 watt carbon resistor

Figure 20. 400 MHz Test Circuit (for PT9701B and PT9703B)



C1, C12 — 1.5-20 pF ARCO #402	L1 — 6 turns #22 AWG, 1/8" I.D.
C2 — 15 pF UNELCO	L2 — #22 AWG, 3/8" hairpin
C3, C6, C7 — 30 pF UNELCO	L3 — 1/8" by 1/4" strap
C4, C9 — 1000 pF UNELCO	L4 — 2 turns on resistor lead
C5 — 100 μF electrolytic	L5 — 3 Ferrite beads
C8 — 35 pF UNELCO	L6, L7 — 2 turns #22 AWG, 1/8" I.D.
C10, C13 — 0.9-7 pF ARCO #400	L8 — #22 AWG, 0.3"
C11 — 10 pF UNELCO	R1 — 1 ohm, 1/2 watt carbon resistor

Figure 21. 400 MHz Test Circuit (for PT9702B and PT9704B)

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

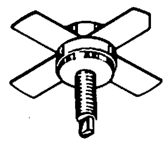
PT9730 Series

The RF Line
VHF Power Transistors

... designed primarily for wideband, large-signal output amplifier stages in the 30–200 MHz frequency range.

- Guaranteed Performance at 175 MHz, 28 Vdc
  Output Power — 4 to 25 Watts
  Minimum Gain — 10 to 13 dB
  Collector Efficiency — 60%, Min
- *100% Tested for Load Mismatch at All Phase Angles with 30:1 VSWR*
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**TO 200 MHz
4 TO 25 WATTS
VHF POWER
TRANSISTORS
NPN SILICON**



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	9730	9732	9734	9731	Unit
Collector-Emitter Voltage	V_{CEO}	35				Vdc
Collector-Base Voltage	V_{CES}	60				Vdc
Emitter-Base Voltage	V_{EBO}	4				Vdc
Collector Current — Continuous	I_C	1	1.25	2.5	4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	10 0.06	20 0.114	30 0.173	45 0.257	Watts W/°C
Operating Junction Temperature	T_J	200				°C
Storage Temperature Range	T_{stg}	−65 to +150				°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max				Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17.5	8.8	5.8	3.9	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic		Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS						
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)		$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, V_{BE} = 0)		$V_{(BR)CES}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)		$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 25 V, V_{BE} = 0)	PT9730 PT9732 PT9734 PT9731	I_{CES}	— — — —	— — — —	0.5 1 1.5 2	mAdc
ON CHARACTERISTICS						
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)		h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS						
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	PT9730 PT9732 PT9734 PT9731	C_{ob}	— — — —	— — — —	12 18 24 40	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = Rated, f = 175 MHz)	PT9730	G_{PE}	13	—	—	dB
	PT9732		12	—	—	
	PT9734		11.8	—	—	
	PT9731		10	—	—	
Collector Efficiency (V_{CE} = 28 V, P_{out} = Rated, f = 175 MHz)		η_c	60	—	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = Rated, f = 175 MHz, Load VSWR = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Saturated Output Power (V_{CE} = 28 V, f = 175 MHz)	PT9730	P_{sat}	6	—	—	W
	PT9732		10	—	—	
	PT9734		18	—	—	
	PT9731		30	—	—	

TYPICAL CHARACTERISTICS
PT9730 — 4 WATTS

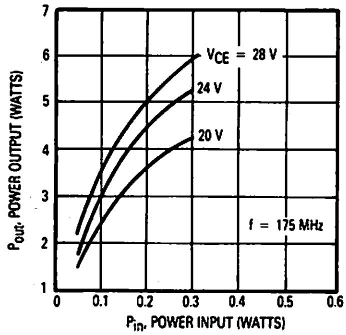


Figure 1. Power Input versus Power Output

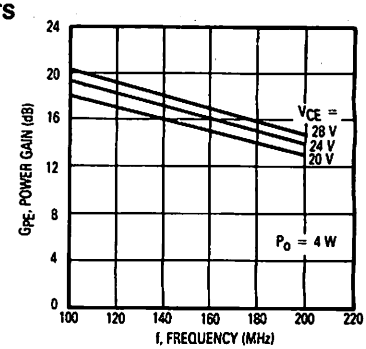


Figure 2. Power Gain versus Frequency

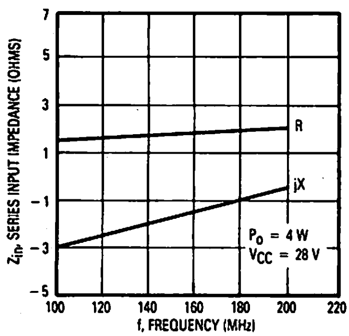


Figure 3. Series Input Impedance versus Frequency

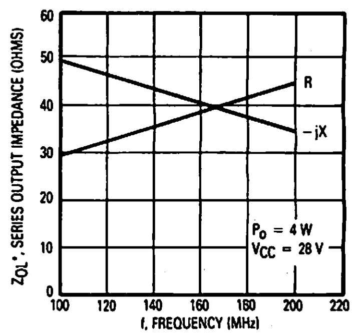


Figure 4. Series Output Impedance versus Frequency

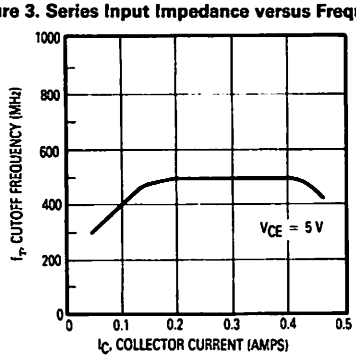


Figure 5. Cutoff Frequency versus Current

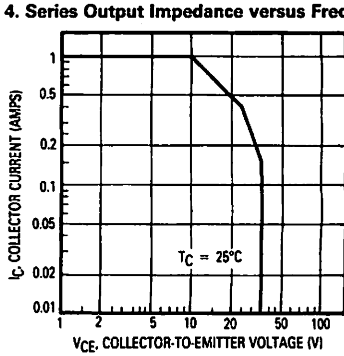


Figure 6. Safe Operating Area

TYPICAL CHARACTERISTICS
PT9732 — 8 WATTS

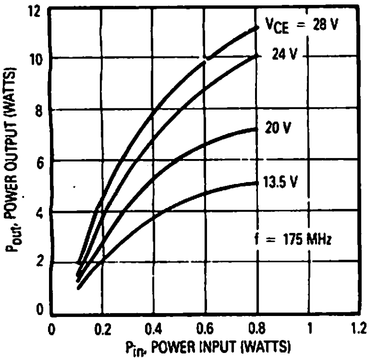


Figure 7. Power Output versus Power Input

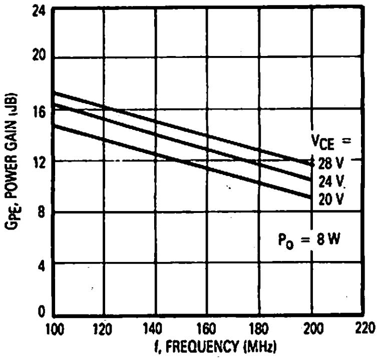


Figure 8. Power Gain versus Frequency

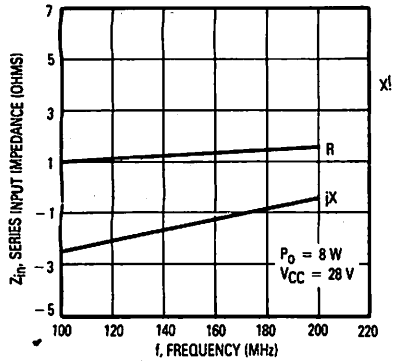


Figure 9. Series Input Impedance versus Frequency

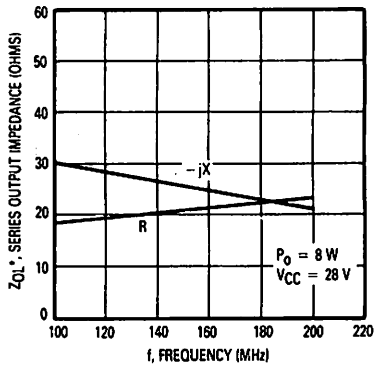


Figure 10. Series Output Impedance versus Frequency

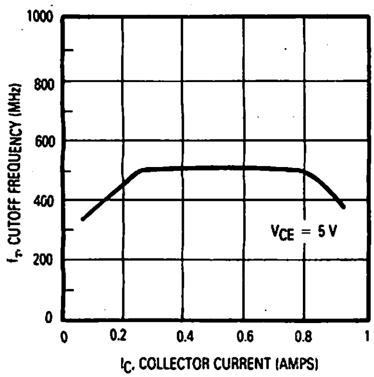


Figure 11. Cutoff Frequency versus Current

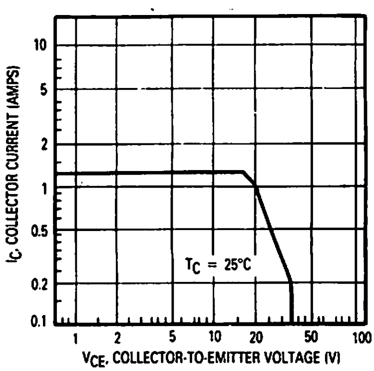


Figure 12. Safe Operating Area

2

TYPICAL CHARACTERISTICS
PT9734 — 15 WATTS

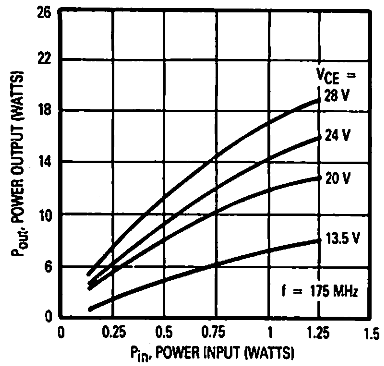


Figure 13. Power Output versus Power Input

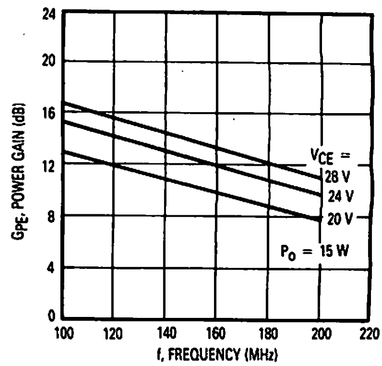


Figure 14. Power Gain versus Frequency

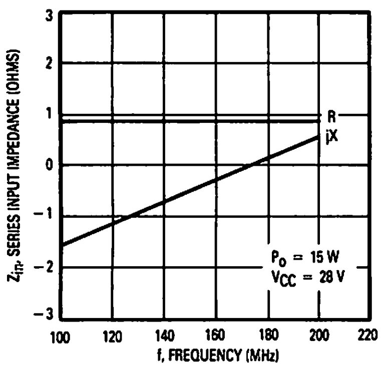


Figure 15. Series Input Impedance versus Frequency

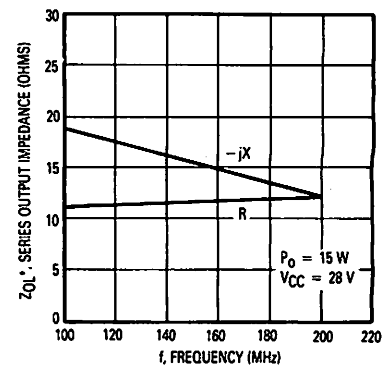


Figure 16. Series Output Impedance versus Frequency

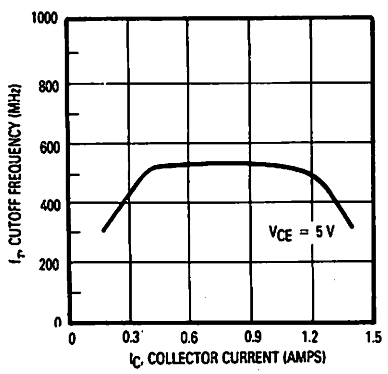


Figure 17. Cutoff Frequency versus Current

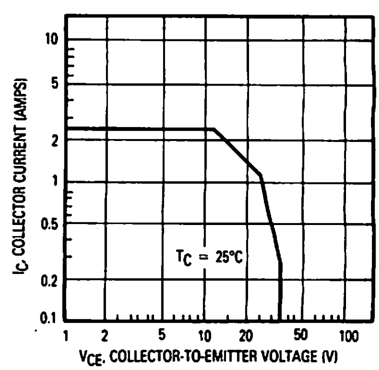


Figure 18. Safe Operating Area

TYPICAL CHARACTERISTICS
PT9731 — 25 WATTS

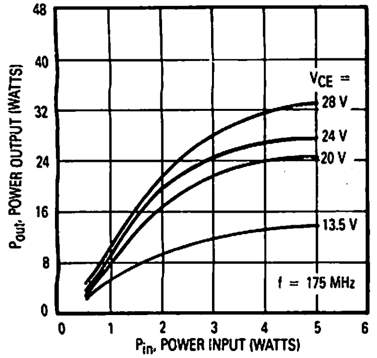


Figure 19. Power Output versus Power Input

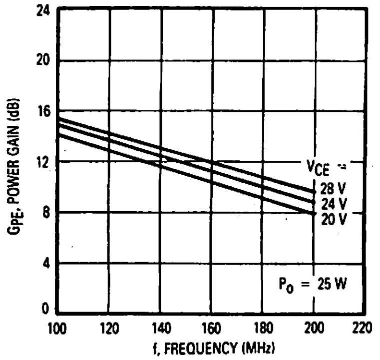


Figure 20. Power Gain versus Frequency

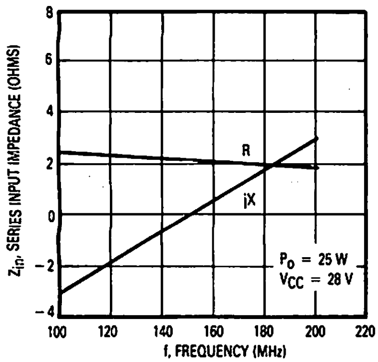


Figure 21. Series Input Impedance versus Frequency

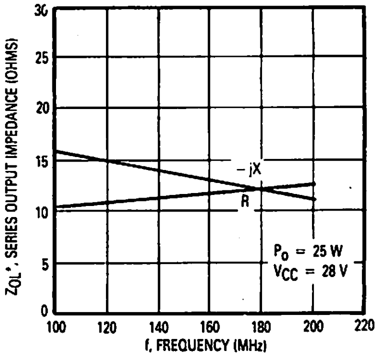


Figure 22. Series Output Impedance versus Frequency

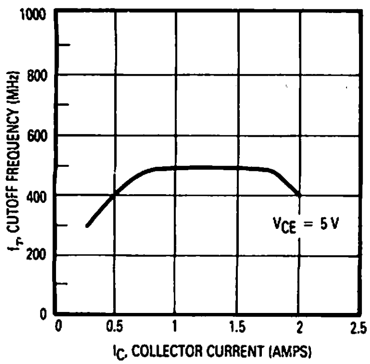


Figure 23. Cutoff Frequency versus Current

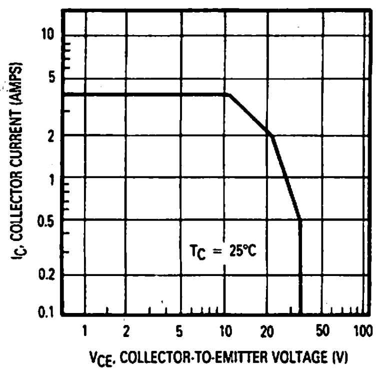
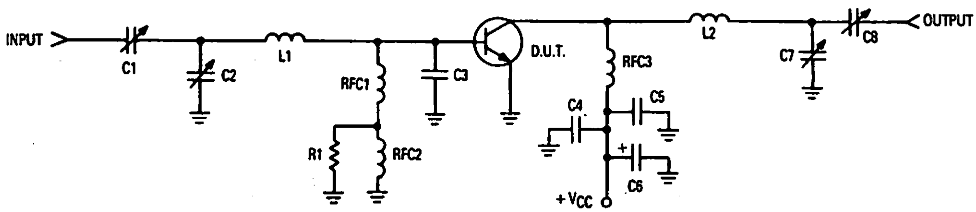


Figure 24. Safe Operating Area



C1, C8 — 7–100 pF ARCO #423
C2 — 8–60 pF ARCO #404
C3 — 90 pF UNELCO
C4 — 1000 pF UNELCO
C5 — 0.1 mF disc capacitor
C6 — 5 mF, 50 V electrolytic
C7 — 5–80 pF ARCO #462

L1 — 2 turns, 0.1" wide by 0.02" thick copper strip, 1/4" I.D.
L2 — 4 turns, 0.1" wide by 0.02" thick copper strip, 1/4" I.D.

R1 — 10 ohms, 0.5 W carbon resistor

RFC1 — 150 nH molded inductor
RFC2 — 10,000 nH molded inductor
RFC3 — 4 turns #16 AWG, 5/16" I.D.

Figure 25. 175 MHz Test Circuit (PT9731)

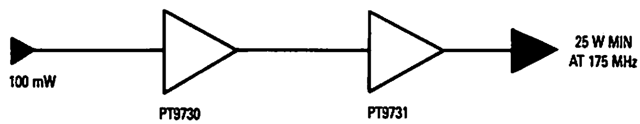
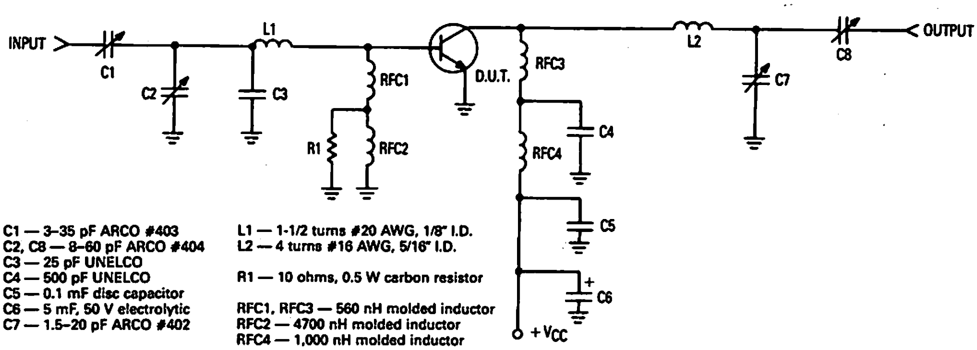


Figure 26. Typical Application
25 Watt VHF 24 V Power Amplifier



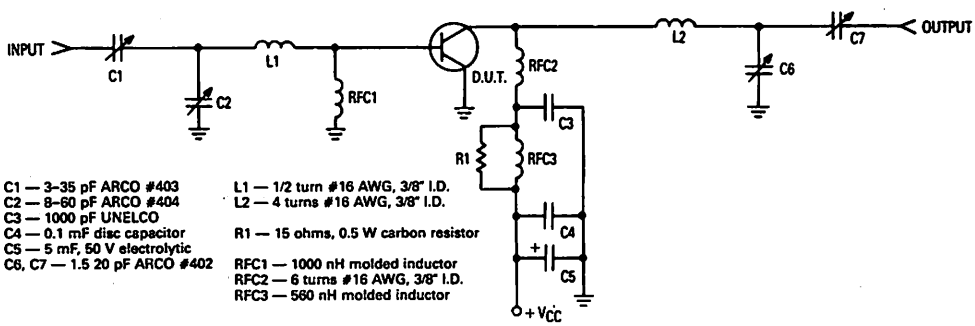
C1 — 3–35 pF ARCO #403
C2, C8 — 8–60 pF ARCO #404
C3 — 25 pF UNELCO
C4 — 500 pF UNELCO
C5 — 0.1 mF disc capacitor
C6 — 5 mF, 50 V electrolytic
C7 — 1.5–20 pF ARCO #402

L1 — 1-1/2 turns #20 AWG, 1/8" I.D.
L2 — 4 turns #16 AWG, 5/16" I.D.

R1 — 10 ohms, 0.5 W carbon resistor

RFC1, RFC3 — 560 nH molded inductor
RFC2 — 4700 nH molded inductor
RFC4 — 1,000 nH molded inductor

Figure 27. 175 MHz Test Circuit (PT9730 and PT9732)



C1 — 3–35 pF ARCO #403
C2 — 8–60 pF ARCO #404
C3 — 1000 pF UNELCO
C4 — 0.1 mF disc capacitor
C5 — 5 mF, 50 V electrolytic
C6, C7 — 1.5 20 pF ARCO #402

L1 — 1/2 turn #16 AWG, 3/8" I.D.
L2 — 4 turns #16 AWG, 3/8" I.D.

R1 — 15 ohms, 0.5 W carbon resistor

RFC1 — 1000 nH molded inductor
RFC2 — 6 turns #16 AWG, 3/8" I.D.
RFC3 — 560 nH molded inductor

Figure 28. 175 MHz Test Circuit (PT9734)

PT9790

2

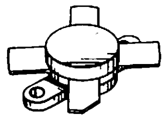
The RF Line

SSB Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 50 Volt, 28 MHz Characteristics:
  Output Power — 150 Watts PEP
  Power Gain — 15 dB Min, Class AB
- *100% Tested for Load* Mismatch at all Phase Angles with ∞:1 VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

**2–30 MHz
150 WATTS PEP
50 VOLTS
SSB POWER
TRANSISTOR
NPN SILICON**



CASE 211-11, STYLE 1
(.500 SOE F)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ $T_C = 25°C$ *Derate above 25°C*	P_D	300 2	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mA, I_E = 0)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	60	—
DYNAMIC CHARACTERISTCS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	200	—	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 50 V, P_{out} = 150 W PEP, f = 28 MHz, I_{CQ} = 50 mA)	G_{PE}	15	—	—	dB
Load Mismatch (V_{CE} = 50 V, I_Q = 50 mA, P_{out} = 150 W PEP, f = 28 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion (V_{CE} = 50 Vdc, P_{out} = 150 W PEP, I_{CQ} = 50 mA, f = 28 MHz)	IMD	—	—	−32	dB

TYPICAL CHARACTERISTICS

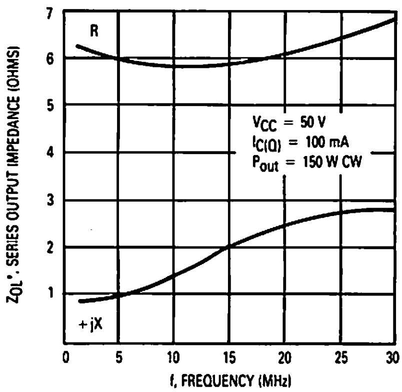


Figure 1. Series Output Impedance versus Frequency

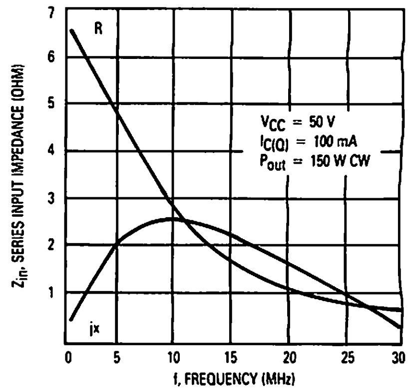


Figure 2. Series Input Impedance versus Frequency

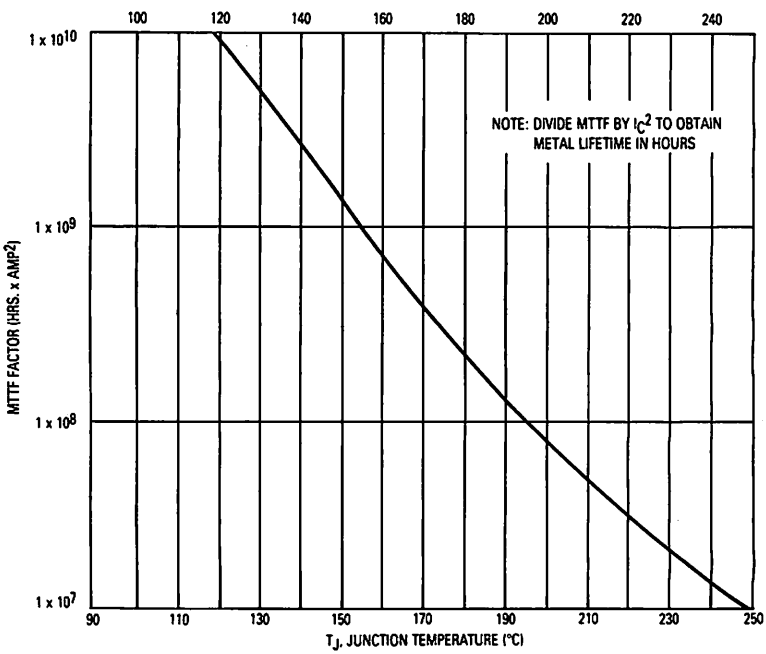
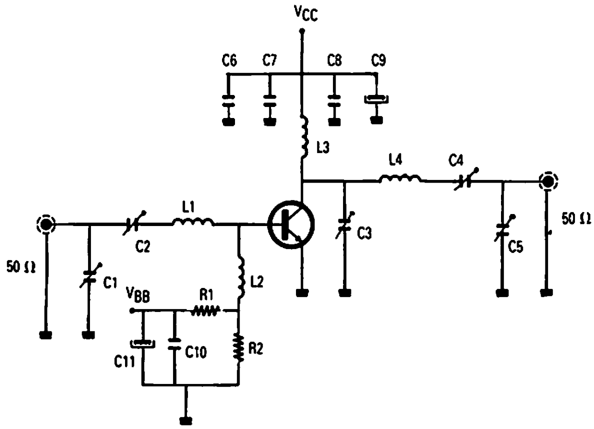


Figure 3. MTTF Factor versus Junction Temperature



C1, C5 — 170–780 pF, ARCO 469 Trimmer capacitor
C2, C4 — 80–480 pF, ARCO 466 Trimmer capacitor
C3 — 55–300 pF, ARCO 427 Trimmer capacitor
C6 — 1000 pF Mica Capacitor UNELCO
C7 — 10 μF Ceramic Disc
C8, C10 — 0.1 μF Ceramic Disc
C9, C11 — 470 μF/63 V Electrolytic

L1 — 5 turns 15/10 mm Silvered wire, 10 mm ID, 25 mm length
L2 — 10 turns 8/10 mm Enameled wire, 10 mm ID
L3 — 4 turns 12/10 mm Enameled wire, 10 mm ID, 10 mm length
L4 — 7 turns 15/10 mm Enameled wire, 10 mm ID, 20 mm length

R1 — 1 Ω, 2 W
R2 — 2.7 Ω, 2 W

Figure 4. 28 MHz Test Circuit

2

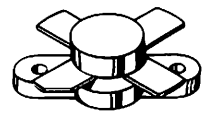
PT9798

The RF Line
SSB Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages in the 2 to 30 MHz frequency range.

- Designed for Class A, AB or C Power Amplifiers
- Specified 50 Volt, 28 MHz Characteristics:
  Output Power — 75 Watts
  Power Gain — 15 dB Min
- 100% Tested for Load Mismatch at all Phase Angles with ∞:1 VSWR
- Gold Metallization for Improved Reliability
- Diffused Ballast Resistors

2–30 MHz
75 WATTS
50 VOLT
SSB POWER
TRANSISTOR
NPN SILICON



CASE 211-07, STYLE 1
(.380 SOE F)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	55	Vdc
Collector-Base Voltage	V_{CBO}	110	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	150 1	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	55	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mA, I_E = 0)	$V_{(BR)CBO}$	110	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	70	—
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 50 V, P_{out} = 75 W, f = 28 MHz)	G_{PE}	15	—	—	dB
Load Mismatch (V_{CE} = 50 V, P_{out} = 75 W PEP, f = 28 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion (V_{CE} = 50 Vdc, P_{out} = 75 W, f = 28 MHz)	IMD	—	—	−32	dB

TYPICAL CHARACTERISTICS

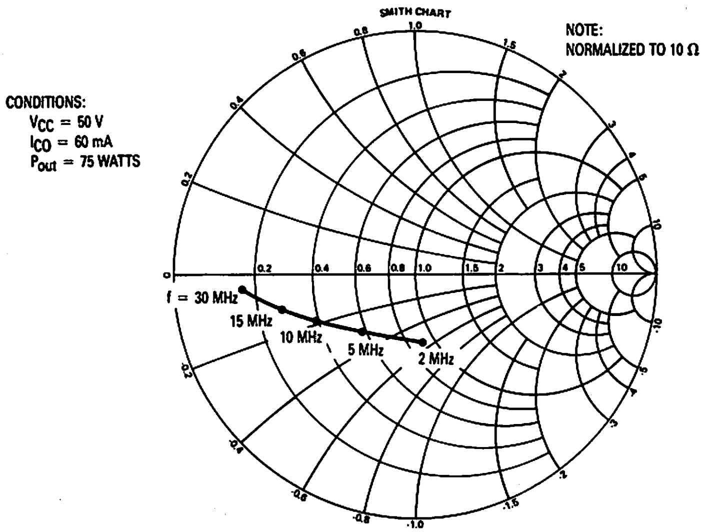


Figure 1. Series Equivalent Input Impedance

RF1029

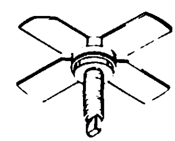
The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 1.5 Watts
  Power Gain — 8 dB Min, Class AB
- Gold Metallization for Improved Reliability

2

TO 1 GHz
1.5 WATTS
LINEAR
UHF POWER
TRANSISTOR
NPN SILICON



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	14.5 0.084	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mA, V_{CE} = 5 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	4.75	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 1.5 W, f = 900 MHz, I_C = 0.2 A)	G_{PE}	8	9.3	—	dB
Load Mismatch (V_{CE} = 25 V, I_C = 0.2 A, P_{out} = 1.5 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

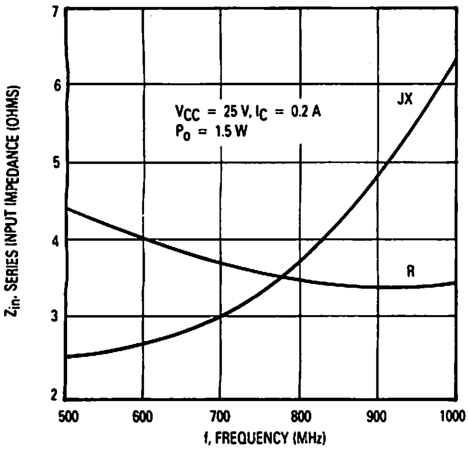


Figure 1. Input Impedance versus Frequency

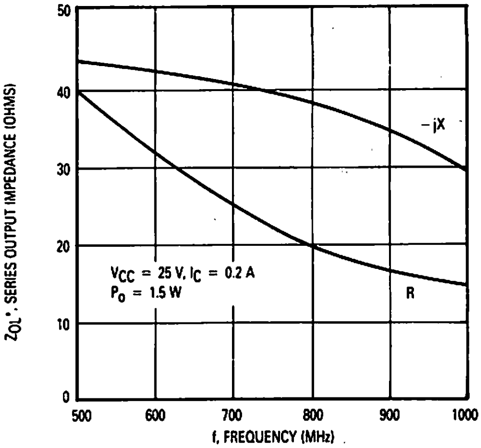


Figure 2. Output Impedance versus Frequency

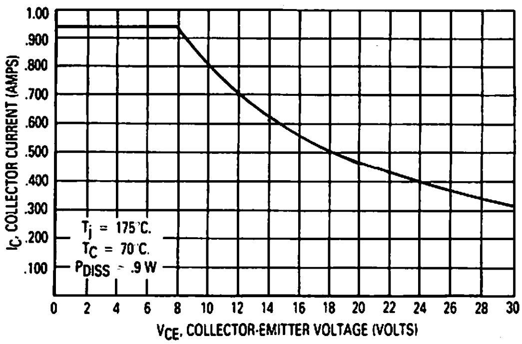


Figure 3. RF Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
25	200	0.4	0.86	178	10.43	74	0.04	35	0.43	143
		0.45	0.86	177	9.7	80	0.04	32	0.41	149
		0.5	0.86	175	9.03	78	0.04	35	0.41	151
		0.55	0.86	174	8.11	76	0.05	37	0.42	150
		0.6	0.86	172	7.46	72	0.05	38	0.43	149
		0.65	0.86	171	6.9	71	0.05	41	0.43	151
		0.7	0.86	170	6.04	69	0.05	41	0.43	150
		0.75	0.85	168	5.71	66	0.05	43	0.45	149
		0.8	0.85	167	5.16	64	0.05	46	0.45	150
		0.85	0.85	165	4.48	61	0.06	47	0.46	149
		0.9	0.85	164	4.36	59	0.06	49	0.47	148
		0.95	0.85	162	3.64	56	0.06	51	0.47	149
		1	0.84	160	3.48	54	0.06	51	0.48	148

Figure 4. S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

RF1030

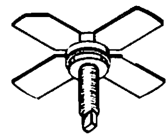
2

The RF Line
UHF Power Transistor

... designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 3 Watts
  Power Gain — 7.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

TO 1 GHz
3 WATTS
LINEAR
UHF POWER
TRANSISTOR
NPN SILICON



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	29 0.167	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	6	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 15 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 15 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	2	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	9.8	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 3 W, f = 900 MHz, I_C = 0.4 A)	G_{PE}	7.5	8.5	—	dB
Load Mismatch (V_{CE} = 25 V, I_C = 0.4 A, P_{out} = 3 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

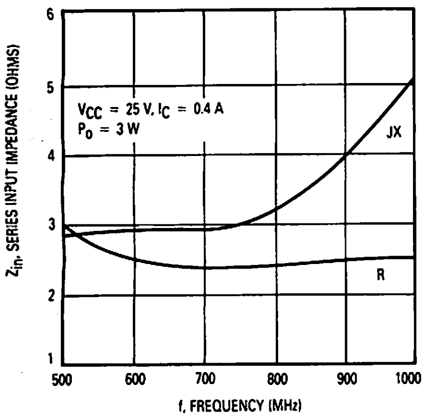


Figure 1. Input Impedance versus Frequency

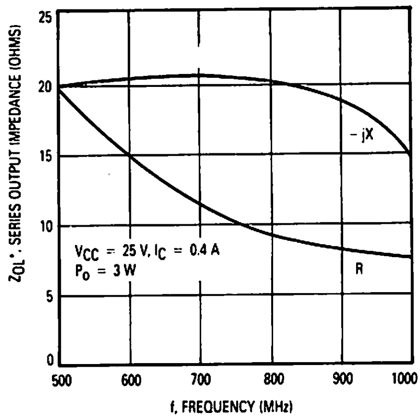


Figure 2. Output Impedance versus Frequency

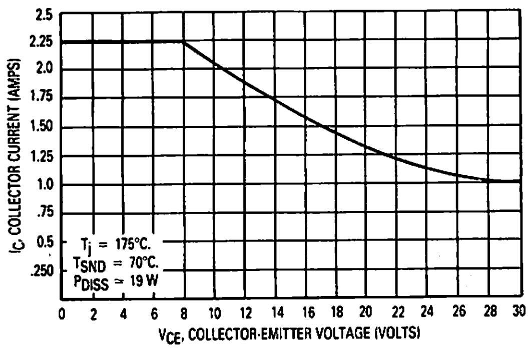


Figure 3. RF Safe Operating Area

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11} Mag	S_{11} ∠φ	S_{21} Mag	S_{21} ∠φ	S_{12} Mag	S_{12} ∠φ	S_{22} Mag	S_{22} ∠φ
25	400	0.4	0.92	178	2.05	73	0.03	48	0.62	171
		0.45	0.92	177	1.9	81	0.03	46	0.63	169
		0.5	0.92	176	1.75	80	0.03	48	0.63	170
		0.55	0.92	175	1.57	79	0.04	51	0.63	170
		0.6	0.92	175	1.47	75	0.04	53	0.63	169
		0.65	0.92	174	1.38	74	0.04	57	0.64	170
		0.7	0.92	173	1.25	72	0.04	57	0.64	170
		0.75	0.92	172	1.2	70	0.05	59	0.64	169
		0.8	0.92	172	1.13	68	0.05	62	0.64	170
		0.85	0.91	171	1.05	66	0.05	63	0.64	169
		0.9	0.91	170	1.04	64	0.06	64	0.64	169
		0.95	0.91	169	0.96	64	0.06	67	0.65	169
		1	0.91	168	0.95	61	0.06	66	0.65	169

Figure 4. S-Parameters

2

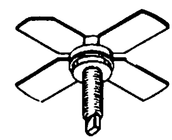
RF1031

The RF Line
UHF Power Transistor

. . . designed primarily for wideband, large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 4.5 Watts
  Power Gain — 7 dB Min, Class AB
- Gold Metallization for Improved Reliability

TO 1 GHz
4.5 WATTS
LINEAR
UHF POWER
TRANSISTOR
NPN SILICON



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 0.286	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	3.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, V_{BE} = 0)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 25 V, I_E = 0)	I_{CBO}	—	—	2.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	14	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 4.5 W, f = 900 MHz, I_C = 0.6 A)	G_{PE}	7	8	—	dB
Load Mismatch (V_{CE} = 25 V, I_C = 0.6 A, P_{out} = 4.5 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

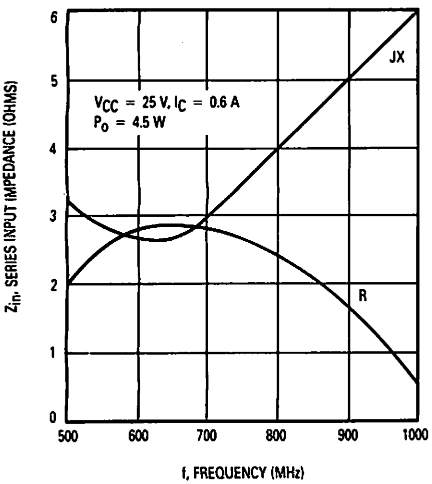


Figure 1. Input Impedance versus Frequency

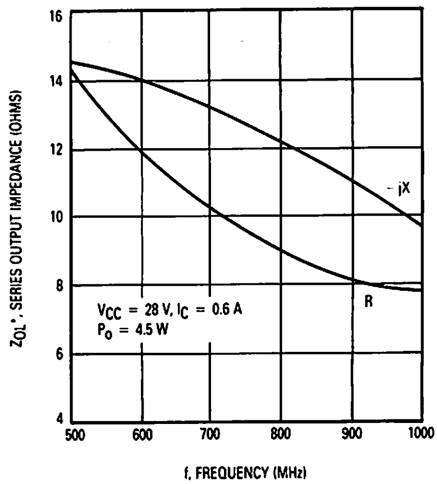


Figure 2. Output Impedance versus Frequency

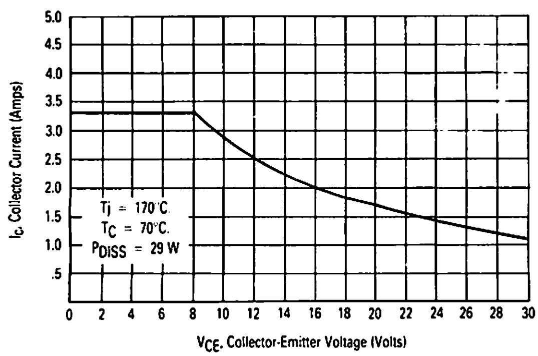


Figure 3. RF Safe Operating Area

2

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
25	500	0.4	0.95	178	1.54	81	0.02	62	0.67	−171
		0.45	0.96	178	1.35	79	0.03	62	0.68	−170
		0.5	0.95	177	1.24	77	0.03	64	0.69	−170
		0.55	0.95	177	1.12	75	0.03	67	0.69	−170
		0.6	0.96	176	1.04	72	0.03	68	0.69	−169
		0.65	0.95	176	0.97	72	0.04	72	0.7	−170
		0.7	0.95	175	0.88	69	0.04	72	0.7	−170
		0.75	0.95	175	0.84	68	0.04	74	0.7	−169
		0.8	0.95	174	0.79	66	0.04	77	0.71	−170
		0.85	0.95	174	0.73	64	0.05	78	0.71	−170
		0.9	0.95	173	0.72	62	0.05	77	0.72	−169
		0.95	0.95	172	0.67	62	0.05	81	0.72	−170
		1	0.95	172	0.65	59	0.05	79	0.72	−169

Figure 4. S-Parameters

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

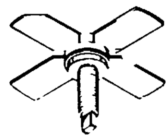
RF1032

The RF Line
UHF Power Transistor

. . . designed primarily for large-signal output and driver amplifier stages to 1 GHz.

- Designed for Class A Linear Power Amplifiers
- Specified 25 Volt, 900 MHz Characteristics:
  Output Power — 6 Watts
  Power Gain — 6.5 dB Min, Class AB
- Gold Metallization for Improved Reliability

TO 1 GHz
6 WATTS
LINEAR
UHF POWER
TRANSISTOR
NPN SILICON



CASE 244C-01, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	50 0.286	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_C = 70°C$)	$R_{\theta JC}$	3.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Emitter Breakdown Voltage ($I_C = 20$ mA, $V_{BE} = 0$)	$V_{(BR)CES}$	60	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 20$ mA, $I_E = 0$)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current ($V_{CB} = 25$ V, $I_E = 0$)	I_{CBO}	—	—	3	mAdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	80	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, f = 1 MHz)	C_{ob}	—	—	19.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 25$ V, $P_{out} = 6$ W, f = 900 MHz, $I_C = 0.85$ A)	G_{PE}	6.5	7.5	—	dB
Load Mismatch ($V_{CE} = 25$ V, $P_{out} = 6$ W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

2

V_{CE} (Volts)	I_C (mA)	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
25	850	0.4	0.97	178	1.01	82	0.03	85	0.74	179
		0.5	0.96	177	0.99	74	0.03	69	0.78	−179
		0.6	0.96	176	0.84	77	0.03	73	0.78	−179
		0.7	0.97	175	0.68	75	0.04	76	0.77	−177
		0.8	0.96	174	0.62	69	0.05	77	0.78	178
		0.9	0.96	173	0.60	67	0.05	78	0.78	−178
		1	0.96	172	0.54	66	0.06	77	0.78	−177

Figure 1 — S-Parameters

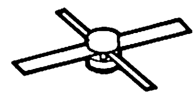
TP251

The RF Line
UHF Power Transistor

. . . designed primarily for portable radio applications requiring low battery voltage. These parts have been designed and characterized for operation in the frequency range of 400–512 MHz.

- 400–512 MHz
- 0.2 W — P_{out}
- 7.5 V — V_{CC}
- 13 dB Gain
- Gold Metallization for Reliability

200 mW — 512 MHz
UHF POWER TRANSISTOR
NPN SILICON



CASE 305C-01, STYLE 1
(.200 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	18	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	2.9 0.02	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	60	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	18	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	20	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}	—	1.6	2.5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 7.5 V, P_{out} = 175 mW, f = 470 MHz, I_Q = 10 mA)	G_{PE_1}	12.4	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 9.6 V, P_{out} = 200 mW, f = 470 MHz, I_Q = 10 mA)	G_{PE_2}	13	—	—	dB
Collector Efficiency (V_{CE} = 7.5 V, P_{out} = 175 mW, f = 470 MHz, I_Q = 10 mA)	η_c	35	40	—	%
Input Impedance, Common Emitter (Typ) (V_{CE} = 7.5 V, I_Q = 10 mA, P_{out} = 175 mW, f = 470 MHz)	Z_{in} = 5 + j0.5 Ohms				
Load Impedance, Common Emitter (Typ) (V_{CE} = 7.5 V, I_Q = 10 mA, P_{out} = 175 mW, f = 470 MHz)	Z_{Load} = 47 + j45 Ohms				

TYPICAL CHARACTERISTICS

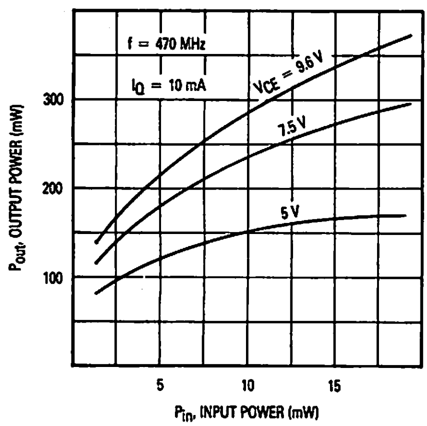


Figure 1. Output Power versus Input Power

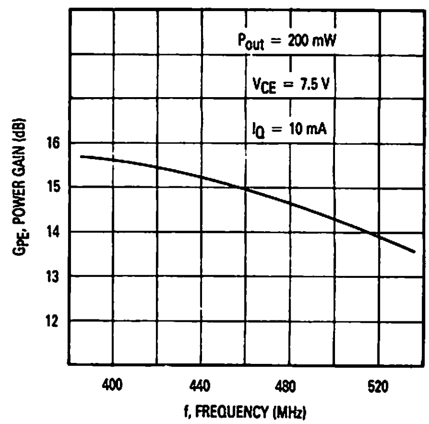


Figure 2. Power Gain versus Frequency

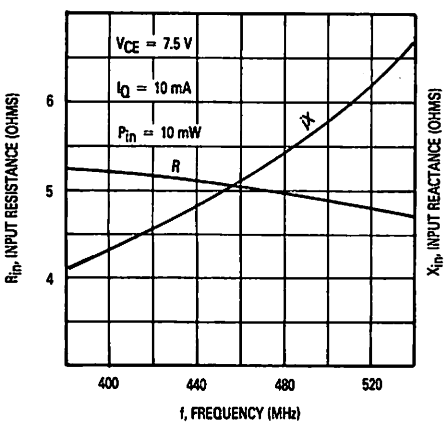


Figure 3. Input Impedance versus Frequency

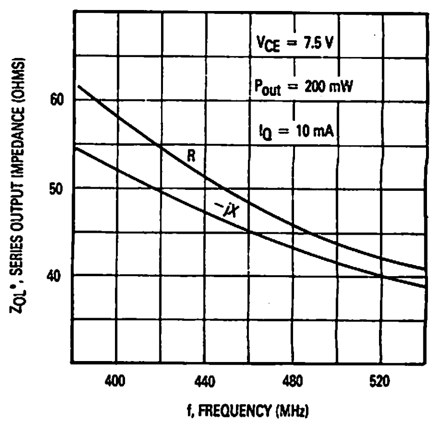
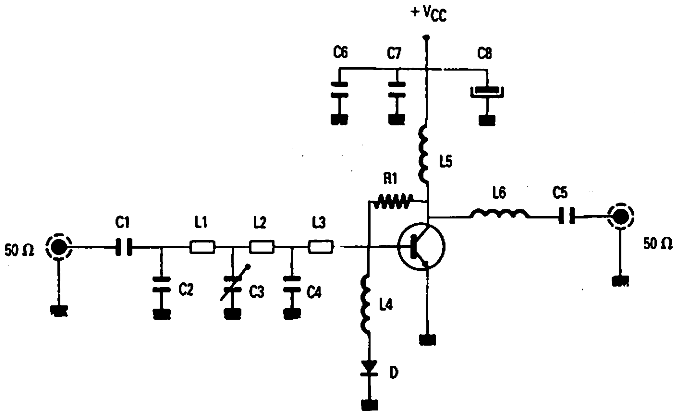


Figure 4. Output Impedance versus Frequency



C1 — 27 pF Ceramic 632 RTC
C2 — 8.2 pF Ceramic 632 RTC
C3 — 3–20 pF Trimmer Capacitor
C4 — 22 pF Ceramic 632 RTC
C5, C6 — 1000 pF Ceramic 629 RTC
C7 — 10 nF Ceramic 629 RTC
C8 — 10 μF/25 V Electrolytic

L1 — Stripline Z_o = 70 ohms l = 0.061 λ
L2 — Stripline Z_o = 70 ohms l = 0.026 λ f_{ref} = 480 MHz
L3 — Stripline Z_o = 50 ohms l = 0.031 λ

L4, L5 — 0.15 μH Molded Coil
L6 — 3 turns, Silvered Wire 6/10 mm, 4 mm I.D., 8 mm length

R1 — 510 Ω Carbon Composition 1/4 W

Figure 5. 400–512 MHz Test Circuit

TP1940

300 W, 50 V, 108 MHz
N-CHANNEL
MOS BROADBAND
RF POWER FET

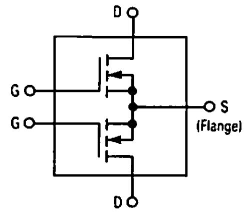
The RF MOSFET Line

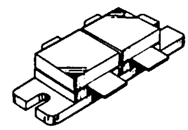
RF Power Field-Effect Transistor

N-Channel Enhancement-Mode

The high power, high gain and broadband performance of each device makes possible solid-state transmitters for FM broadcast above 5.0 kW fully solid state.

- Push-Pull Package for Broadband Circuits
- Low Thermal Resistance — 0.35°C/W Max
- Ruggedness Tested at Rated Output Power
- Nitride Passivation





CASE 375-01, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Drain-Source Voltage	V_{DSS}	125	Vdc
Drain-Gate Voltage	V_{DGO}	125	Vdc
Gate-Source Voltage	V_{GS}	±20	Vdc
Drain-Current — Continuous	I_D	40	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	500 2.85	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.35	°C/W

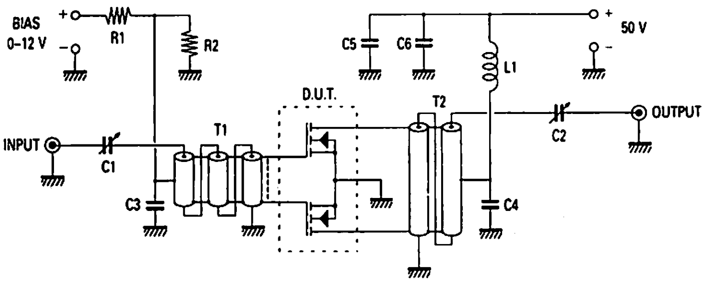
Handling and Packaging MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Each Side)					
Drain-Source Breakdown Voltage (V_{GS} = 0, I_D = 100 mA)	$V_{(BR)DSS}$	125	—	—	Vdc
Zero Gate Voltage Drain Current (V_{DS} = 50 Vdc, V_{GS} = 0)	I_{DSS}	—	—	5.0	mAdc
Gate-Body Leakage Current (V_{GS} = 20 Vdc, V_{DS} = 0)	I_{GSS}	—	—	1.0	μAdc
ON CHARACTERISTICS (Each Side)					
Gate Threshold Voltage (V_{DS} = 10 V, I_D = 100 mA)	$V_{GS(th)}$	1.0	3.0	5.0	Vdc
Drain-Source On-Voltage (V_{GS} = 10 V, I_D = 10 A)	$V_{DS(on)}$	—	—	5.0	Vdc
Forward Transconductance (V_{DS} = 10 V, I_D = 5.0 A)	g_{fs}	5.0	7.0	—	mhos

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
DYNAMIC CHARACTERISTICS (Each Side)					
Input Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{iss}	—	350	—	pF
Output Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{oss}	—	225	—	pF
Reverse Transfer Capacitance (V_{DS} = 50 V, V_{GS} = 0, f = 1.0 MHz)	C_{rss}	—	20	—	pF
FUNCTIONAL TESTS					
Common Source Amplifier Power Gain (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA) (f = 108 MHz)	G_{ps}	20	22	—	dB
Drain Efficiency (V_{DD} = 50 V, P_{out} = 300 W, f = 108 MHz)	η_D	60	70	—	%
Load Mismatch (V_{DD} = 50 V, P_{out} = 300 W, I_{DQ} = 500 mA) (VSWR 7:1 at all Phase Angles, f = 108 MHz)	ψ	No degradation in Output Power			



R1, R2	Resistor	1.0 kΩ 1/2 Watt	
C1	Capacitor	16 to 100 pF	GMC 70300
C2	Capacitor	95 to 350 pF	GMC 70800
C3, C4	Capacitor	1000 pF	UNELCO
C5	Capacitor	1000 pF	
C6	Capacitor	0.1 μF	
L1	8 Turns enameled Cu Wire (1.7 mm) ID 4 mm. length 16 mm		
T1*	9-1 RF Transformer 25 Ω semi-rigid Co-Ax 2.3 mm O.D.		
T2	4-1 RF Transformer 25 Ω semi-rigid Co-Ax 3.2 mm O.D.		
*Loaded with ferrite toroid R.T.C. Type 4C6			
Circuit Board — 1/16", Epoxy Glass			

Figure 1. 108 MHz Test Circuit

2

TYPICAL CHARACTERISTICS

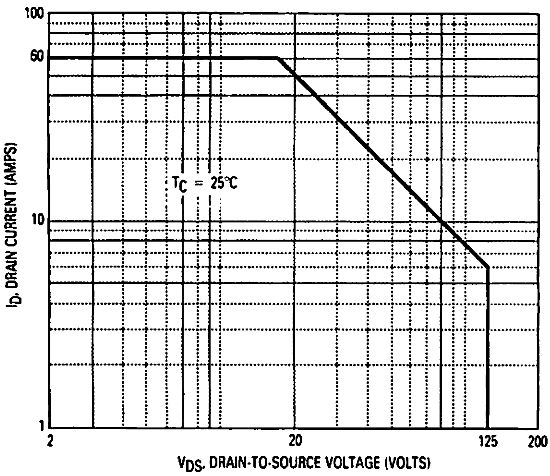


Figure 2. DC Safe Operating Area

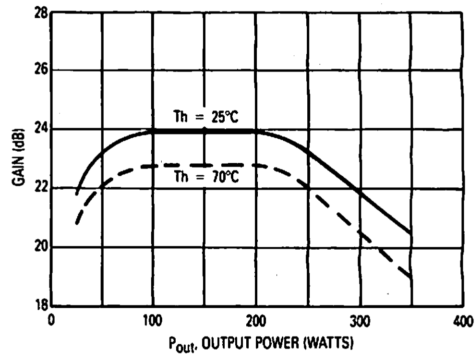


Figure 3. Power Gain versus Output Power

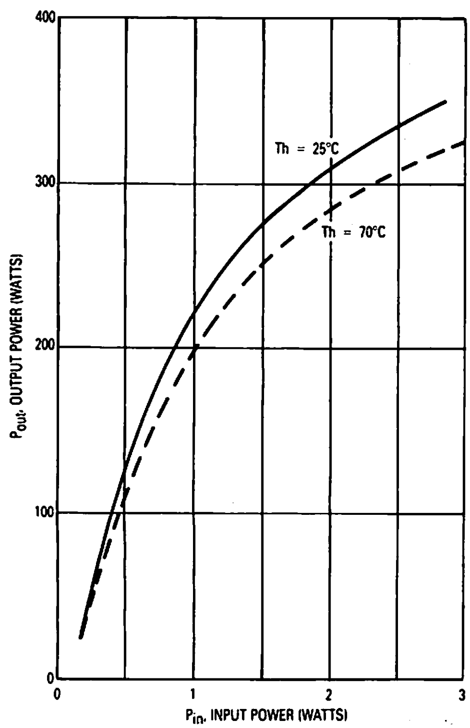


Figure 4. Output Power versus Input Power

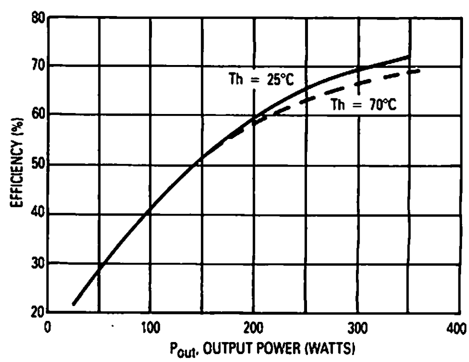


Figure 5. Efficiency versus Output Power

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
108	1.16 − j2.8	3.6 − j7.3

Note: Input and output impedance values given are measured from gate-to-gate and drain-to-drain respectively.

V_{DS} = 50 V, I_{DQ} = 500 mA, P_{out} = 300 Watts

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

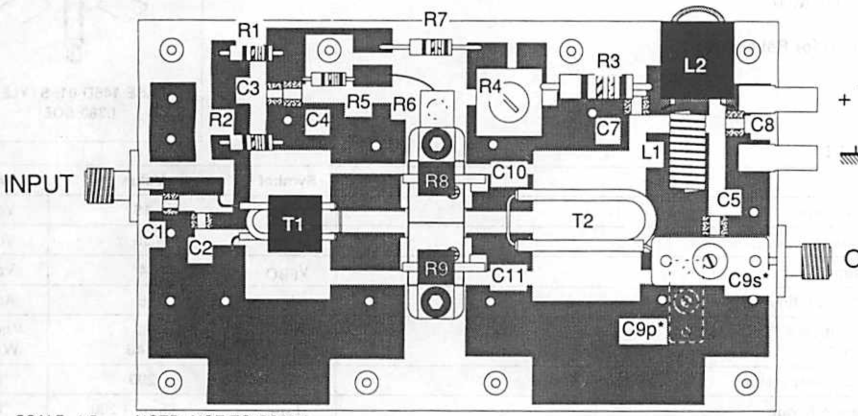
Figure 6. Series Equivalent Input/Output Impedance

P_{out} = 300 W, V_{DD} = 50 V
I_{DQ} = 2 x 200 mA

f (MHz)	OPTION 1 (With C9p and without C9s) G_A dB	OPTION 1 (With C9p and without C9s) η %	OPTION 2 (With C9s and without C9p) G_A dB	OPTION 2 (With C9s and without C9p) η %
108	19.2	62	18.3	65.4
98	19.7	62.6	19.1	68
88	19.4	64	19.6	66.6

NOTE:
1. Bias increases counter clockwise with R4.
2. Bias set now for 200 mA at 50 V.
3. Copper heat spreader must be mounted to or laid on top of a heatsink with thermal grease interface.
4. Drain efficiency can be increased by:
   a. Lowering drain idle current (power gain will be reduced by 1–2 dB.
   b. Increasing the value of feedback resistors R8 & R9. This will change the gain versus frequency slope and input VSWR. The value of C1 must be made higher.
5. In addition of the normal cooling of the units, some air flow is recommended over the top side of the amplifier boards as well.

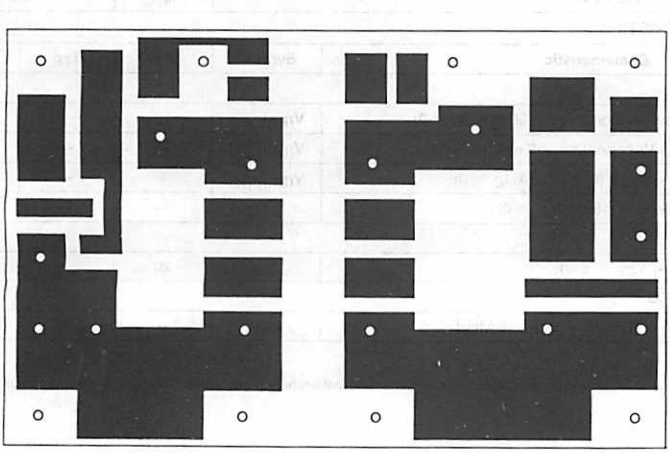
Figure 7. Typical Performance of Test Circuit



SCALE: 1.5 NOTE: NOT TO SCALE

(C9s* : Option 1)
(C9p* : Option 2)

Figure 8. Test Circuit — Component Locations



SCALE: 1.1

Figure 9. Test Circuit — Photomaster

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP2033

Advance Information

The RF Line

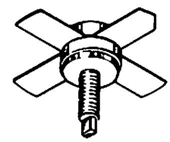
VHF Power Transistor

30 W — 225 MHz
VHF POWER
TRANSISTOR
NPN SILICON

The TP2033 has been specifically designed and characterized for 12.5 V operation in 225 MHz high power amplifiers.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to withstand infinite VSWR at all phase angles at rated output power. It can be operated under Class A, B or C.

- 30 W
- High Gain
  - 10 dB Min @ 175 MHz
  - 9 dB Min @ 225 MHz
- 12.5 V — V_{CC}
- Gold Metallization for Reliability



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	80 0.46	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{ob}	—	70	100	pF

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 30 W, f = 225 MHz)	G_{PE_1}	9	—	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz)	G_{PE_2}	10	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 30 W, f = 225 MHz)	η_c	60	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 30 W, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 30 W, f = 225 MHz)	Z_{in} = 1.05 + j0.6 Ohms				
Load Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 30 W, f = 225 MHz)	Z_{load} = 2.5 + j0.15 Ohms				

2

2

TP2037

Advance Information

The RF Line

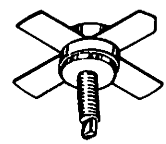
VHF Power Transistor

**35 W — 225 MHz
VHF POWER
TRANSISTOR
NPN SILICON**

The TP2037 has been specifically designed and characterized for 12.5 V operation in 225 MHz high power amplifiers.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to withstand infinite VSWR at all phase angles at rated output power. It can be operated under Class A, B or C.

- 225 MHz
- 35 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	80 0.46	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 20 V, I_E = 0, f = 1 MHz)	C_{ob}	—	70	100	pF

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 35 W, f = 225 MHz)	G_{PE}	8.9	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 35 W, f = 225 MHz)	η_c	60	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 40 W, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 40 W, f = 225 MHz)	Z_{in} = 1 + j0.6 Ohms				
Output Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 40 W, f = 225 MHz)	Z_{output} = 2.6 − j0.13 Ohms				

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP2317

The RF Line
VHF Power Transistor

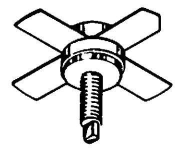
2

The TP2317 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction, which incorporates gold metallization and diffused ballast resistors, enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 20 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability

20 W — 175 MHz VHF POWER TRANSISTOR NPN SILICON



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	35	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	—	—
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 20 W, f = 175 MHz)	G_{PE}	7	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 20 W, f = 175 MHz)	η_c	55	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 20 W, f = 175 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

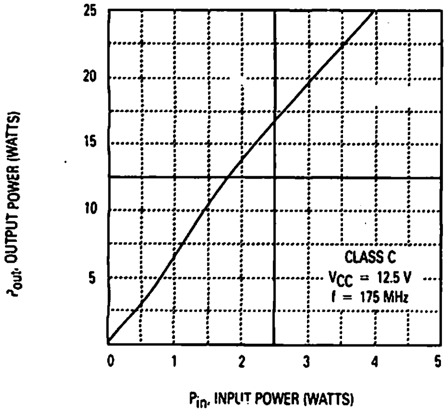


Figure 1. Power Transfer

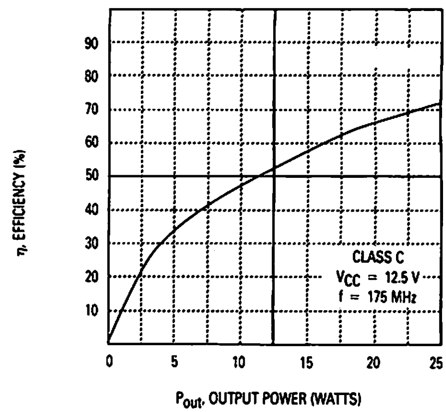


Figure 2. Collector Efficiency

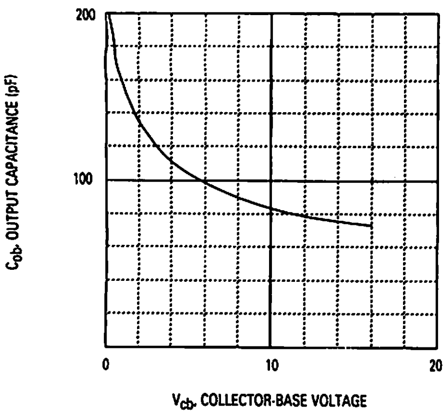


Figure 3. Output Capacitance (Typical)

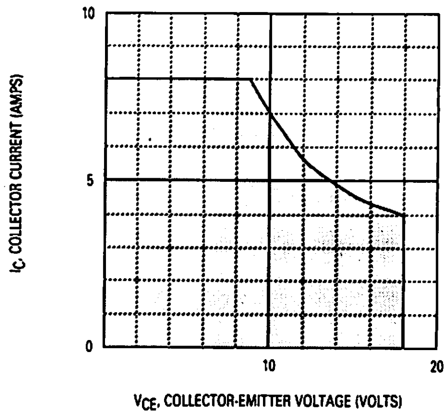


Figure 4. Safe Operating Area

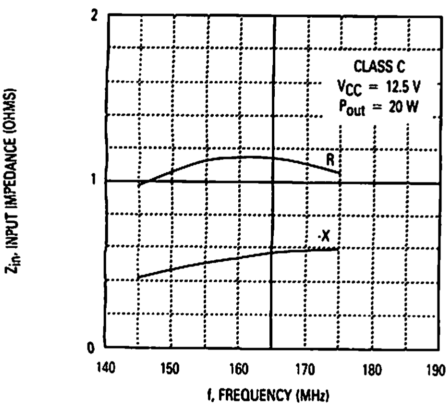


Figure 5. Input Series Impedance

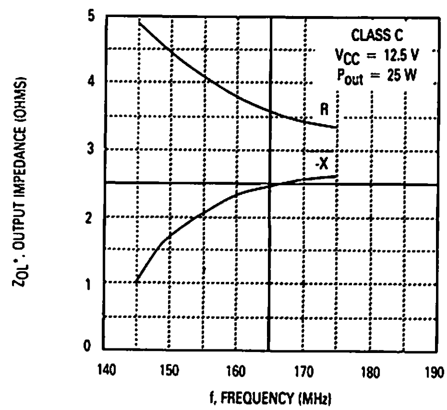


Figure 6. Output Series Impedance

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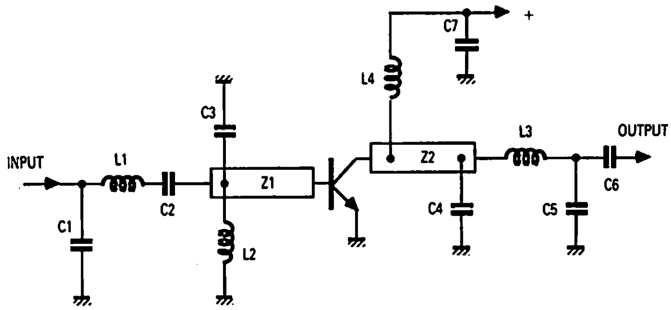


C1 — ARCO 4-40 pF Trimmer Capacitor
C2 — ARCO 4-40 pF Trimmer Capacitor
C3 — UNELCO 200 pF
C4 — UNELCO 120 pF
C5 — ARCO 7-120 pF Trimmer Capacitor
C6 — ARCO 24-200 pF Trimmer Capacitor
C7 — 1 nF + 0.1 μF + 47 μF
L1 — 3 turns 16 AWG 0.16" I.D.
L2 — 0.47 μH Molded Coil
L3 — 1 turn 16 AWG 0.16" I.D.
L4 — 6 turns 12 AWG On 380 Ω 2 W Carbon
Z1 — Base pad 0.06" single sided PC board 0.55" Lx0.28" W
Z2 — Collector pad 0.06" single sided PC board 0.58" Lx0.28" W
PC Board: Double Sided PC Board 0.06"

Figure 7. 175 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP2325

Advance Information

The RF Line

VHF Power Transistor

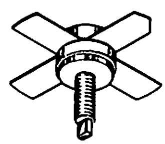
25 W — 175 MHz
VHF POWER
TRANSISTOR
NPN SILICON

2

The TP2325 is designed for use in 12.5 V VHF amplifiers operating under Class A, B or C conditions.

Its construction which incorporates gold metallization and diffused ballast resistors enables the part to be used at its maximum ratings and be able to withstand an infinite VSWR at all phase angles.

- 175 MHz
- 25 W — P_{out}
- 12.5 V — V_{CC}
- Gold Metallization for Reliability



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	5	mAdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	35	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	10	—	—	—
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 25 W, f = 175 MHz)	G_{PE}	6.2	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 25 W, f = 175 MHz)	η_c	60	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

TP2330
TP2330F

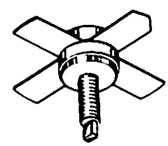
The RF Line
VHF Power Transistors

30 W — 175 MHz
VHF POWER
TRANSISTORS
NPN SILICON

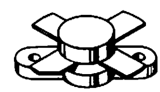
The TP2330 device is intended for use in VHF transmitter output stages where high gain is desired.

Use of gold metallization and diffused emitter ballast resistors result in enhanced reliability and ruggedness.

- 175 MHz
- 30 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 10 dB @ 175 MHz



CASE 145D-01, STYLE 1
(.380 SOE)
TP2330



CASE 211-07, STYLE 1
(.380 SOE F)
TP2330F

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	80 0.46	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	250	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{ob}	—	70	100	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS						
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz)	TP2330 TP2330F	G_{PE}	10 9	— —	— —	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz)		η_c	60	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz, *Load VSWR* = ∞:1, All Phase Angles)		ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz)		Z_{in} = 1.05 + j0.5 Ohms				
Load Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 30 W, f = 175 MHz)		Z_{Load} = 2.7 + j0.2 Ohms				

TYPICAL CHARACTERISTICS

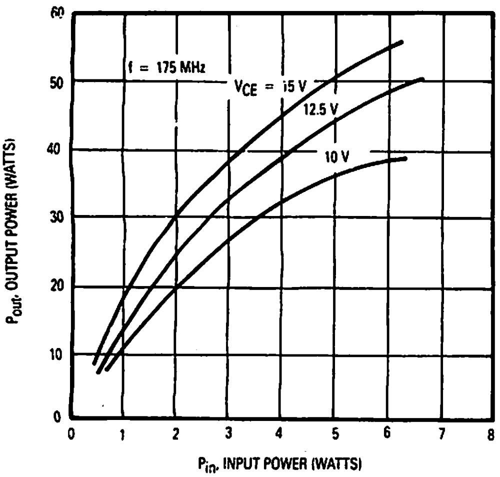


Figure 1. Output Power versus Frequency

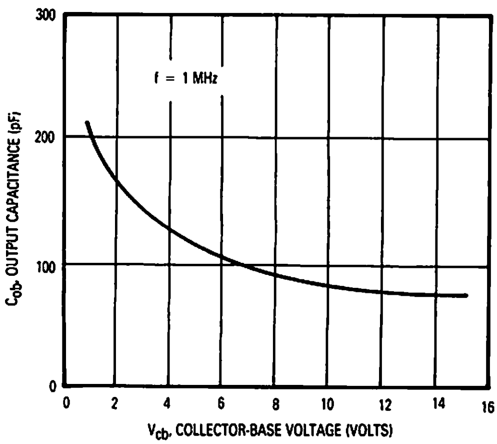
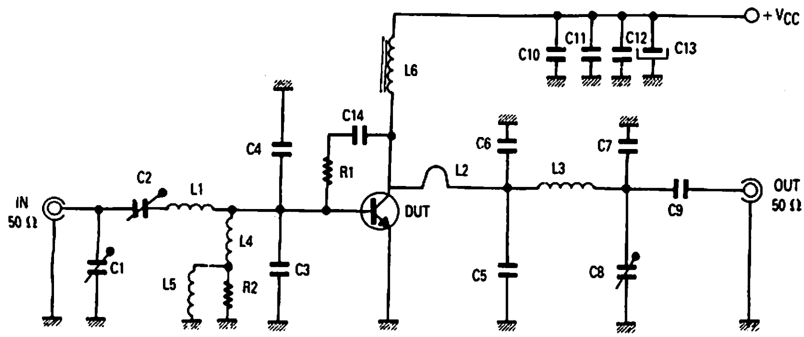


Figure 2. Output Capacitance versus Voltage



C1, C2 — 100 pF ARCO 423 trimmer capacitor
C3 — 200 pF UNELCO mica capacitor
C4 — 150 pF UNELCO mica capacitor
C5 — 120 pF UNELCO mica capacitor
C6 — 100 pF UNELCO mica capacitor
C7 — 25 pF UNELCO mica capacitor
C8 — 40 pF ARCO 403 trimmer capacitor
C9 — 1000 pF ceramic disc capacitor

C10 — 1000 pF UNELCO mica capacitor
C11, C14 — 100 nF ceramic capacitor
C12 — 10 nF ceramic capacitor
C13 — 47 μF 25 V electrolytic capacitor

L1 — 3 turns, 1 mm enameled wire, ID = 6 mm
L2 — Copper lead 8 x 6 mm
L3 — 1.5 mm wire, 30 mm length

L4 — 6 turns, 1 mm enameled wire, ID = 6 mm
L5 — 10 μH molded coil
L6 — 8 turns enameled wire wound on ferrite core 4C6 9 x 15 mm, μr = 120

R1 — 100 Ω 1 W Carbon composition resistor
R2 — 10 Ω 1/2 W Carbon composition resistor

Figure 3. 175 MHz Test Circuit

2

TP2335

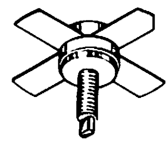
The RF Line
VHF Power Transistor

The TP2335 device is intended for use in VHF transmitter output stages where high gain is desired.

Use of gold metallization and diffused emitter ballast resistors result in enhanced reliability and ruggedness.

- 175 MHz
- 35 W — P_{out}
- 12.5 V — V_{CC}
- High Gain — 11 dB Min @ 175 MHz

**35 W — 175 MHz
VHF POWER
TRANSISTOR
NPN SILICON**



CASE 145D-01, STYLE 1
(.380 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	36	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	8	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	80 0.46	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	36	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 15 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{ob}	—	70	100	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 35 W, f = 175 MHz)	G_{PE}	11.1	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 35 W, f = 175 MHz)	η_c	60	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 35 W, f = 175 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Input Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 35 W, f = 175 MHz)	Z_{in} = 1.05 + j0.5 Ohms				
Load Impedance, Common Emitter (Typ) (V_{CE} = 12.5 V, P_{out} = 35 W, f = 175 MHz)	Z_{Load} = 2.7 + j0.2 Ohms				

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TYPICAL CHARACTERISTICS

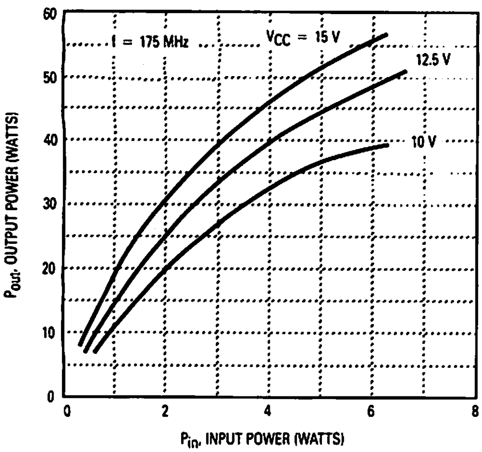


Figure 1. Output Power versus Input Power

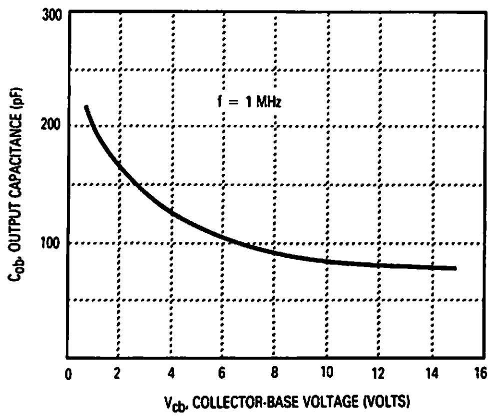
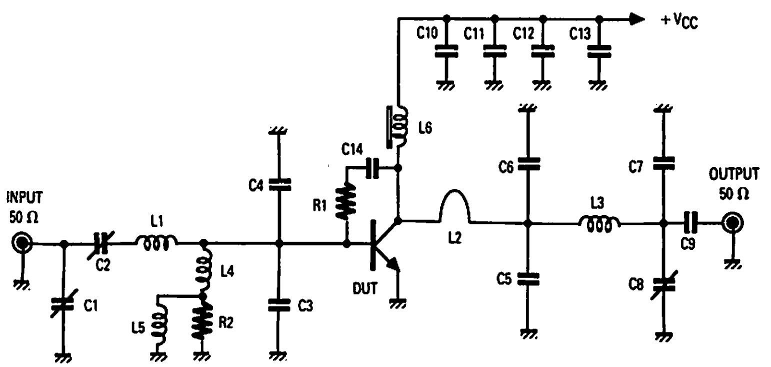


Figure 2. Collector-Base Capacitance versus Voltage



C1, C2 — ARCO 100 pF 423 Trimmer Capacitor
C3 — UNELCO 200 pF Mica Capacitor
C4 — UNELCO 150 pF Mica Capacitor
C5 — UNELCO 120 pF Mica Capacitor
C6 — UNELCO 100 pF Mica Capacitor
C7 — UNELCO 25 pF Mica Capacitor
C8 — ARCO 40 pF 403 Trimmer Capacitor
C9 — 1 nF Ceramic disc Capacitor
C10 — UNELCO 1 nF Mica Capacitor
C11, C14 — 100 nF Ceramic Capacitor
C12 — 10 nF Ceramic Capacitor
C13 — 47 μF 25 V Electrolytic Capacitor
L1 — 3 turns 1 mm enameled wire ID 6 mm
L2 — Copper lead 8 x 6 mm
L3 — 1.5 mm wire, 30 mm length
L4 — 6 turns 1 mm enameled wire ID = 6 mm
L5 — 10 μH molded coil
L6 — 8 turns enameled wire wound on ferrite core 4C6 9 x 15 mm μr = 120
R1 — 100 Ω 1 W Carbon composition resistor
R2 — 10 Ω 1/2 W Carbon composition resistor
PC Board: Double Sided PC Board 0.06"

Figure 3. 175 MHz Test Circuit

TP2502

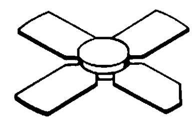
The RF Line
UHF Power Transistor

2

. . . designed for UHF large-signal amplifier applications in industrial and commercial FM equipment.

- 470 MHz
- 2 W — P_{out}
- 12.5 V — V_{CC}
- Rugged

**2 W — 470 MHz
UHF POWER
TRANSISTOR
NPN SILICON**



CASE 249A-01, STYLE 1
(.280 SOE S)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	17	Vdc
Collector-Base Voltage	V_{CBO}	40	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	14.5 0.083	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	12	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	17	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mA, I_E = 0)	$V_{(BR)CBO}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.45	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 15 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 2 W, f = 470 MHz)	G_{PE}	10	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 2 W, f = 470 MHz)	η_c	50	—	—	%
Load Mismatch (V_{CE} = 12.5 V, P_{out} = 2 W, f = 470 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

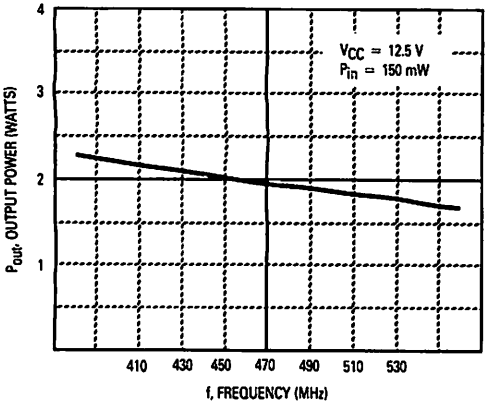


Figure 1. Output Power versus Frequency

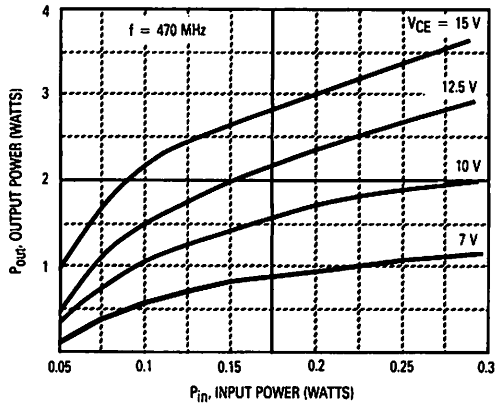


Figure 2. Output Power versus Input Power

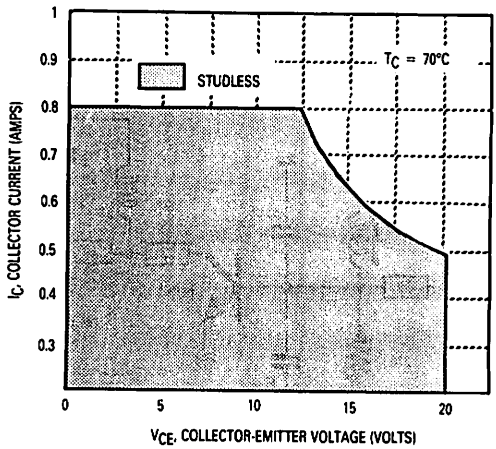
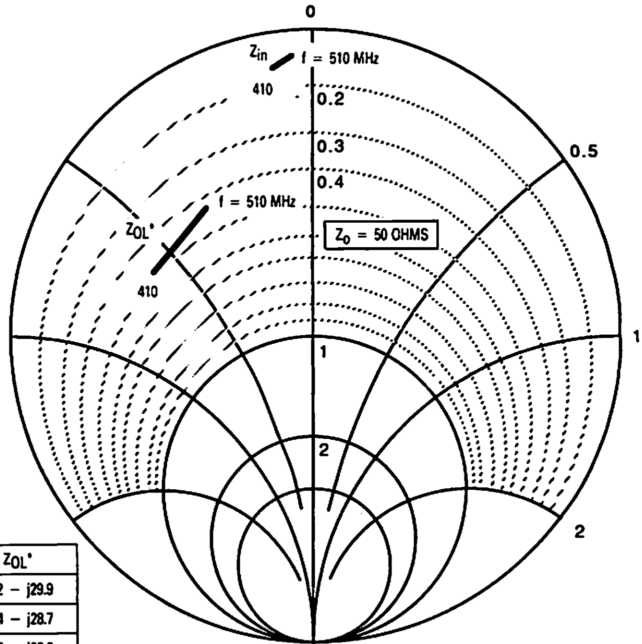


Figure 3. Safe Operating Area

2

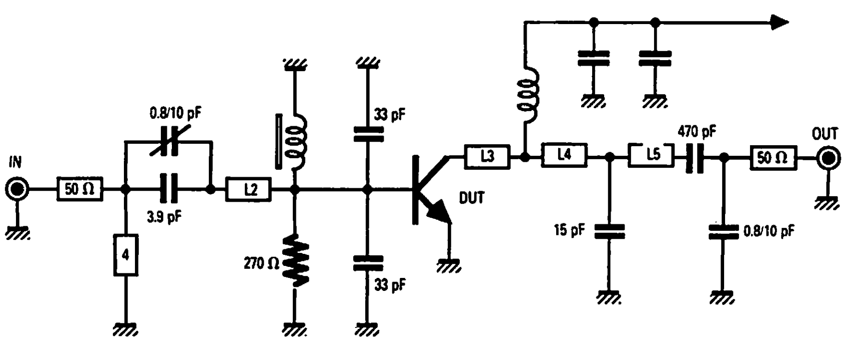


f (MHz)	Z_{in}	Z_{OL}*
410	2.7 − j3.6	19.2 − j29.9
430	2.6 − j3.4	19.4 − j28.7
450	2.1 − j3.3	19.5 − j28.3
470	2.0 − j3.2	17.6 − j21.9
490	1.9 − j2.7	16.5 − j18.7
510	1.8 − j2.5	16.4 − j16.7

P_{out} = 2 WATTS
V_{CC} = 12.5 V
CLASS C

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 4. Series Equivalent Input/Output Impedances



L1 — 0.059 λ / 50 Ω
L2 — 0.030 λ / 25 Ω
L3 — 0.030 λ / 25 Ω
L4 — 0.074 λ / 50 Ω
L5 — 0.103 λ / 50 Ω

All transmission lines references at 480 MHz

Figure 5. 470 MHz Test Circuit

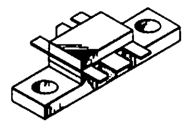
TP3004

The RF Line
UHF Power Transistor

5.0 W–900 MHz
UHF POWER
TRANSISTOR
NPN SILICON

The TP3004 is designed for 900 MHz bases stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 26 Volts, 900 MHz Characteristics
  Output Power = 5.0 Watts
  Minimum Gain = 9.0 dB
  Class AB
  I_Q = 60 mA



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 3.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 15 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	3.0	mA

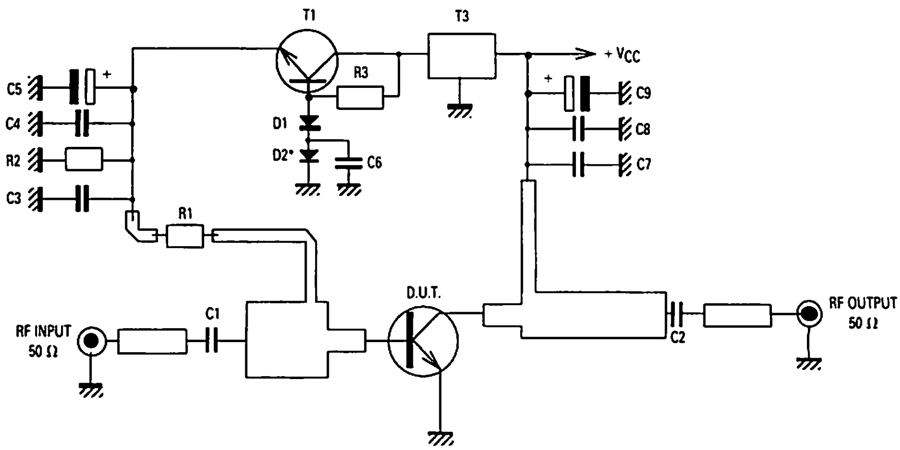
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	7.5	—	12.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 5.0 W, I_{CQ} = 60 mA) (f = 900 MHz)	G_p	9.0	10	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 5.0 W, I_{CQ} = 60 mA) No degradation in Output Power	ψ	5:1	—	—	VSWR
Collector Efficiency (V_{CC} = 26 V, P_{out} = 5.0 W, f = 900 MHz)	η_c	50	55	—	%
Power Saturation Pin = 1.0 W	P_{sat}	8.0	—	—	W



*Contact with RF Transistor

C1 — Capacitor Chip 0805 22 pF 5%
C2, C3, C6, C8 — Capacitor Chip 0805 330 pF 5%
C4, C7 — Capacitor Chip 0805 15 nF 5%
C5, C9 — Capacitor Chip 0805 6.0, 8.0 nF 35 V
R1 — Chip Resistor 2.2 Ω 1206 5%
R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 560 Ω 0805 5%
T1 — SMD Transistor BCX54 or Similar
T3 — Voltage Regulator 7805
D1, D2 — SMD Diode
Board Material — 0.8 mm, Epoxy Glass, Cu Clad, 2 Sides, 35 μm Thick

Figure 1. 900 MHz Test Circuit

TYPICAL CHARACTERISTICS

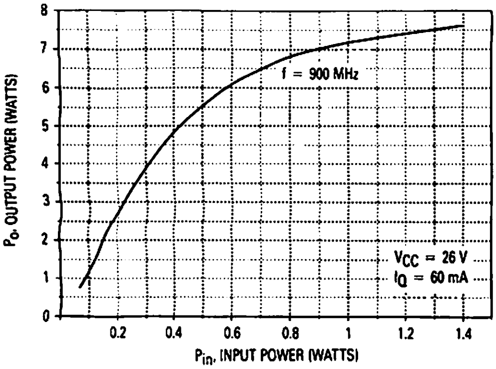


Figure 2. Output Power versus Input Power

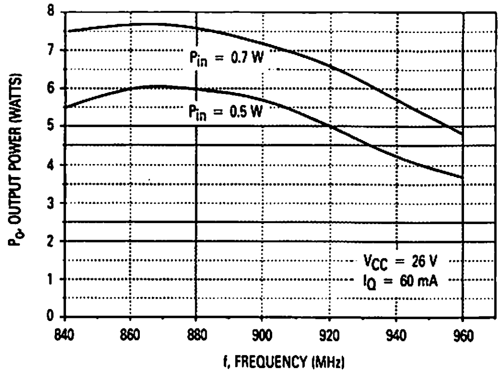


Figure 3. Output Power versus Frequency

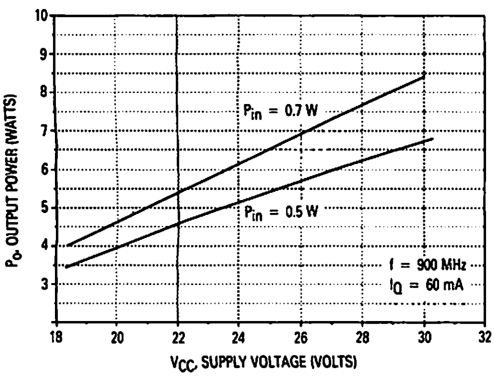


Figure 4. Output Power versus Supply Voltage

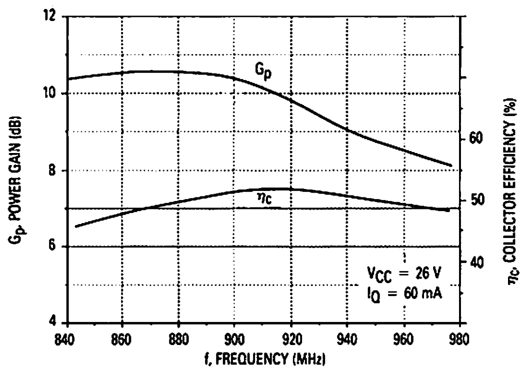
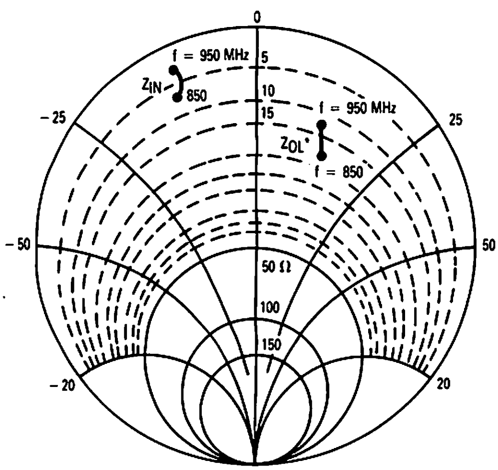


Figure 5. Typical Broadband Circuit Performance



P_{out} = 5 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	15.1 + j17	6.7 − j8.9
900	13 + j16.4	4.5 − j8.6
950	10.8 + j15.2	2.32 − j10.2

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

2

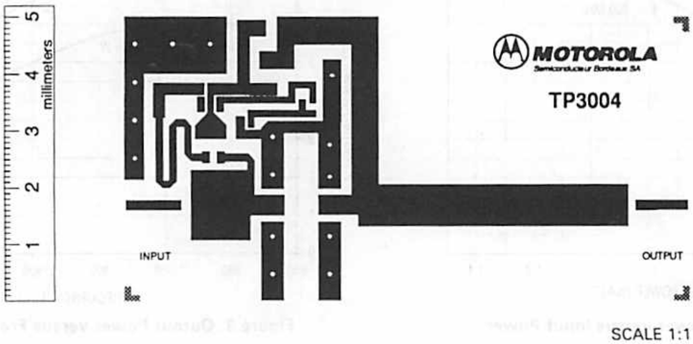


Figure 7. Test Circuit — Photomaster

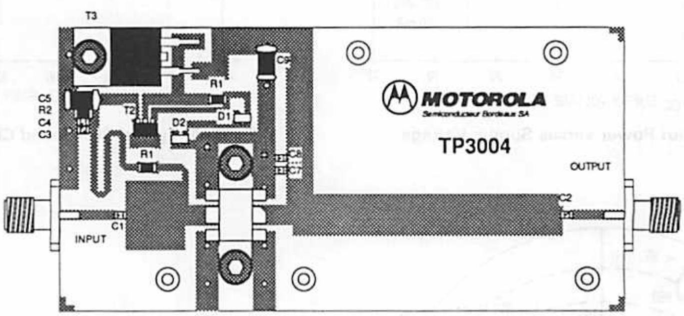


Figure 8. Test Circuit — Component Locations

TP3005

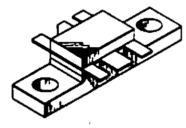
The RF Line
UHF Power Transistor

2

The TP3005 is designed for 960 MHz base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 4.0 Watts
  Minimum Gain = 8.5 dB
  Class AB
  I_Q = 60 mA

**4.0 W–960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	25 0.2	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	7.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 15 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 3.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 15 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	3.0	mA

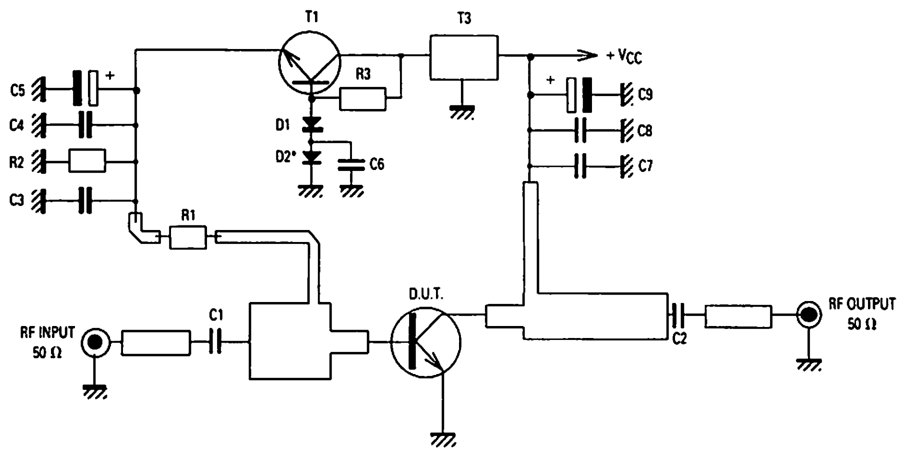
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 0.5 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	7.5	—	12.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 4.0 W, I_{CQ} = 60 mA) (f = 960 MHz)	G_p	8.5	9.5	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 4.0 W, I_{CQ} = 60 mA) No degradation in Output Power	ψ	5:1	—	—	VSWR
Collector Efficiency (V_{CC} = 26 V, P_{out} = 4.0 W, f = 960 MHz)	η_c	50	55	—	%
Power Saturation Pin = 1.0 W	P_{sat}	7.0	—	—	W



*Contact with RF Transistor

C1 — Capacitor Chip 0805 22 pF 5%
C2, C3, C6, C8 — Capacitor Chip 0805 330 pF 5%
C4, C7 — Capacitor Chip 0805 15 nF 5%
C5, C9 — Capacitor Chip 0805 6.0, 8.0 nF 35 V
R1 — Chip Resistor 2.2 Ω 1206 5%
R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 470 Ω 0805 5% to be adjusted for I_Q = 60 mA
T1 — SMD Transistor BCX54 or Similar
T3 — Voltage Regulator 7805
D1, D2 — SMD Diode
Board Material — 0.8 mm, Epoxy Glass, Cu Clad, 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

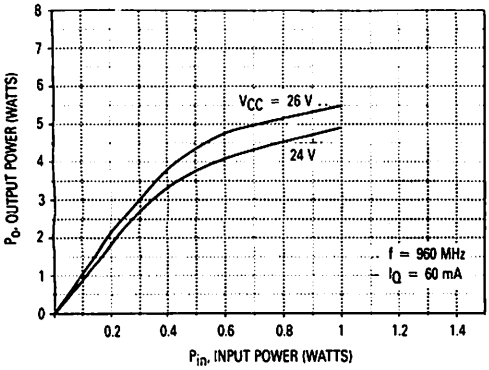


Figure 2. Output Power versus Input Power

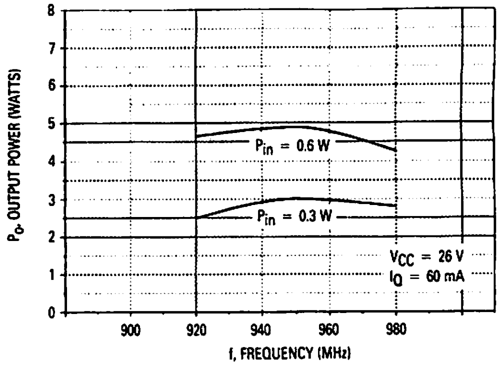


Figure 3. Output Power versus Frequency

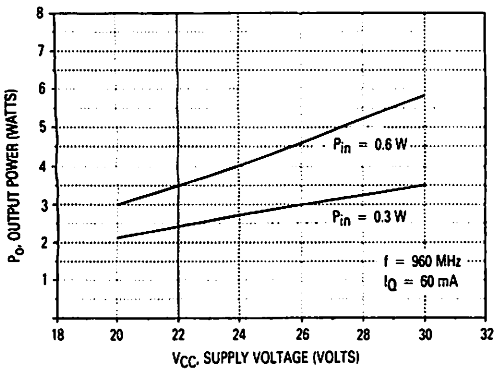


Figure 4. Output Power versus Supply Voltage

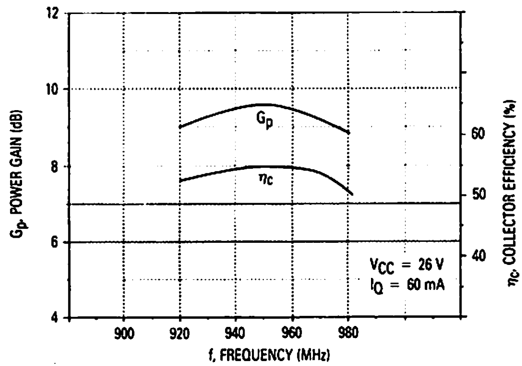
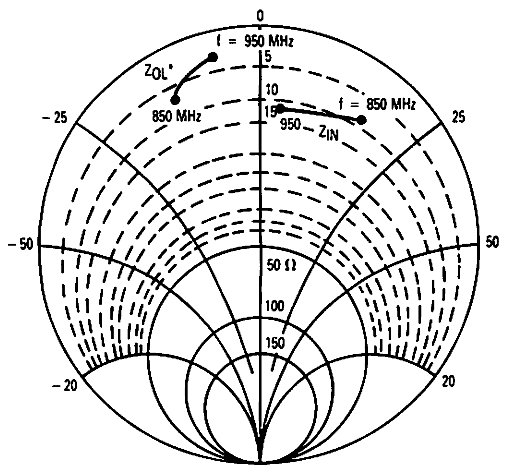


Figure 5. Typical Broadband Circuit Performance



P_{out} = 4 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	8.1 + j17	6.7 − j11
900	9.1 + j12.7	4.0 − j10
950	13.9 + j4.4	3.2 − j6.1

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

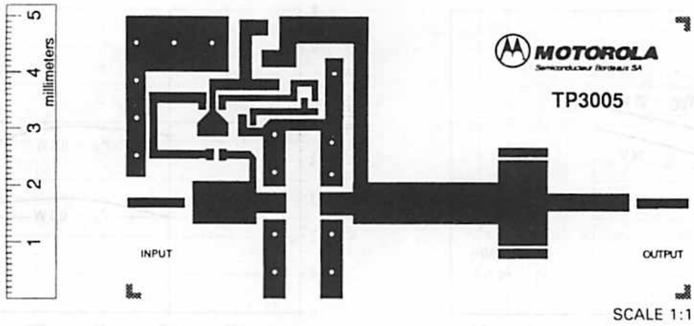


Figure 7. Test Circuit — Photomaster

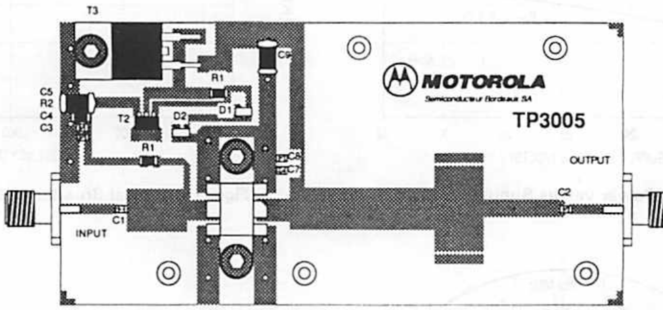


Figure 8. Test Circuit — Component Locations

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP3009
TP3009S

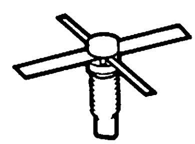
2

The RF Line
UHF Power Transistors

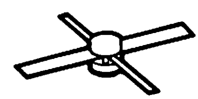
The TP3009/S is designed for 12.5 V, 900 MHz common-emitter amplifier operating in the 820–960 MHz frequency region.

- 900 MHz
- 0.75 W — P_{out}
- 12.5 V — V_{CC}
- 7.5 dB Min Gain

0.75 W — 900 HMz
UHF POWER
TRANSISTORS
NPN SILICON



CASE 305B-01, STYLE 1
(.200 SOE)
TP3009



CASE 305C-01, STYLE 1
(.200 SOE S)
TP3009S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.75	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	26	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	0.1	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 90 mA, V_{CE} = 10 V)	h_{FE}	25	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	2	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 0.75 W, f = 900 MHz)	G_{PE}	7.5	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 0.75 W, f = 900 MHz)	η_C	55	—	—	%
Load Mismatch (V_{CE} = 16 V, P_{out} = 0.75 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

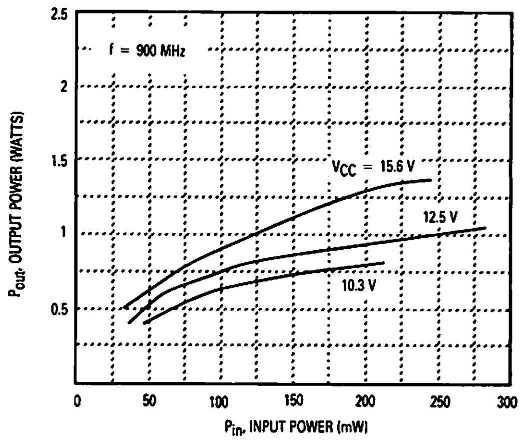
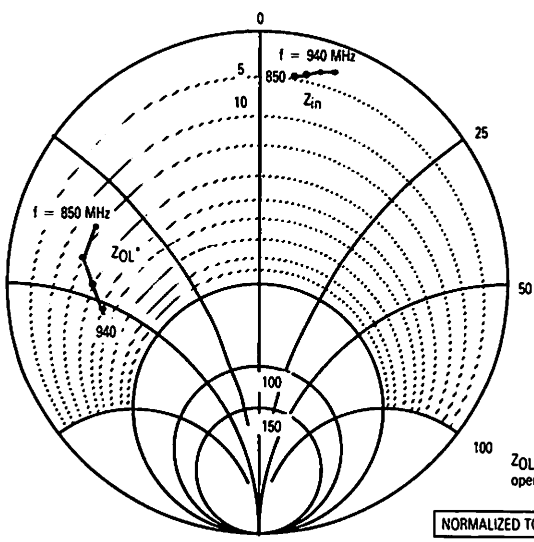


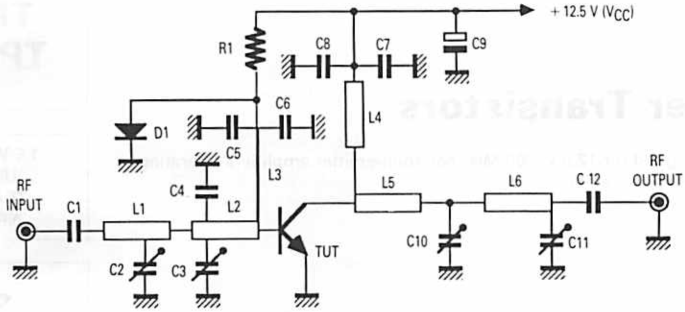
Figure 1. Output Power versus Input Power



f (MHz)	Z_{in} (Ohm)	Z_{OL}* (Ohms)
850	5.1 + j4.3	11 − j34
880	4.5 + j5.6	15 − j41
900	3.9 + j7	21 − j47
940	3.4 + j8.7	25 − j52

Z_{OL}* − Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

Figure 2. Series Equivalent Input/Output Impedances

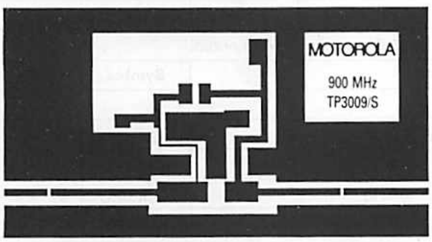


C1 C5 C7 C12	CAPA CHIP 330 pF CGO SMT
C2 C3 C10 C11	0.5-5 pF GKU Trimmer Capacitor
C4	CAPA CHIP 3.9 pF
C6 C8	15 nF Chip Capacitor 0805
C9	ELECTROLITIC CAPACITOR 10MF 16V
R1	RESISTOR // 2 X 270Ω 1/2 W
D1	0.57 for Class B Operation
Board Material	TEFLON GLASS 1/50 inch ϵ_r = 2.55 Cu 35 μm

L1	50Ω Line L=15mm
L2	25Ω Line L=7mm
L3	75Ω Line L=27mm
L4	50Ω Line L=20mm
L5	25Ω Line L=7mm
L6	50Ω Line L=28mm

Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz Typ.

Figure 3. Broadband Amplifier Circuit



Board Material: .020 In. Glass Teflon ϵ_r = 2.55

Figure 4. Printed Circuit Board Layout (Not to Scale)

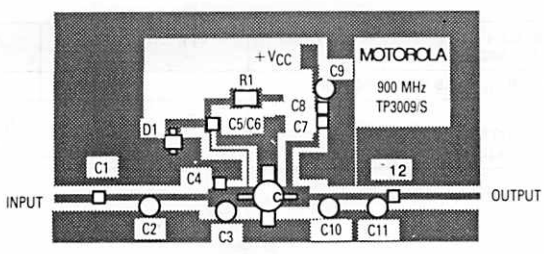


Figure 5. Component Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

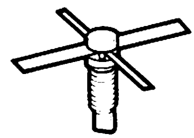
TP3010
TP3010S

The RF Line
UHF Power Transistors

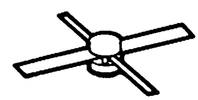
The TP3010/S are designed for 12.5 V, 900 MHz common-emitter amplifiers operating in the 820–960 MHz frequency region.

- 900 MHz
- 1.5 W — P_{out}
- 12.5 V — V_{CC}
- 7 dB Min Gain

1.5 W to 900 MHz
UHF POWER
TRANSISTORS
NPN SILICON



CASE 305B-01, STYLE 1
(.200 SOE)
TP3010



CASE 305C-01, STYLE 1
(.200 SOE S)
TP3010S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	16	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	14	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 4 mA, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	0.4	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 320 mA, V_{CE} = 10 V)	h_{FE}	25	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12.5 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	8	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 12.5 V, P_{out} = 1.5 W, f = 900 MHz)	G_{PE}	7	—	—	dB
Collector Efficiency (V_{CE} = 12.5 V, P_{out} = 1.5 W, f = 900 MHz)	η_c	55	—	—	%
Load Mismatch (V_{CE} = 16 V, P_{out} = 1.5 W, f = 900 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

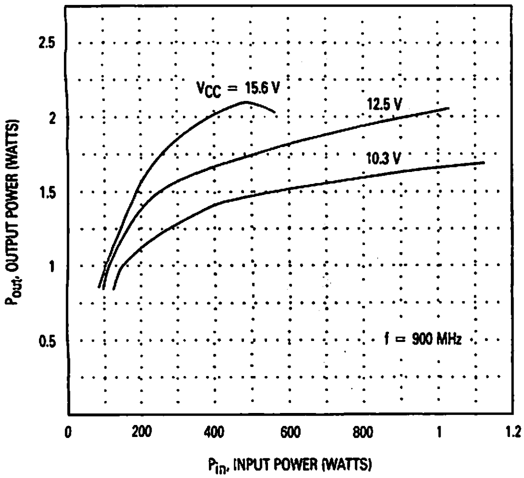
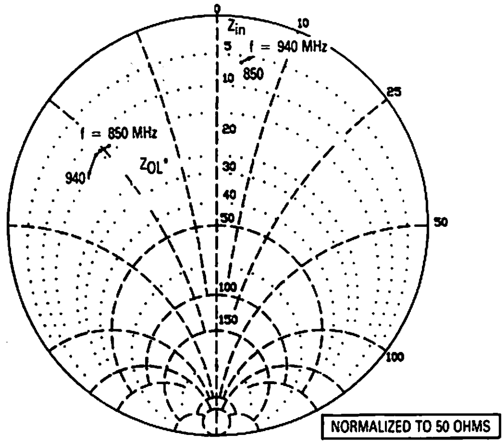


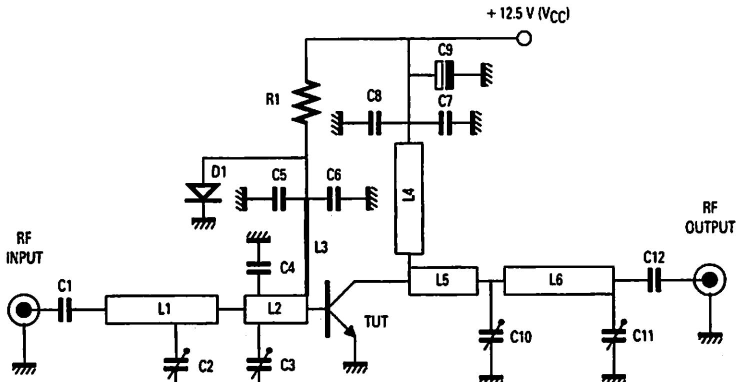
Figure 1. Output Power versus Input Power



f (MHz)	Z_{in} (Ohm)	Z_{OL}* (Ohms)
850	6.6 + j3.4	14 − j24
880	5.9 + j4.7	13.9 − j26
900	5.4 + j5.6	13.8 − j27
940	4.7 + j7.85	15.2 − j32

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

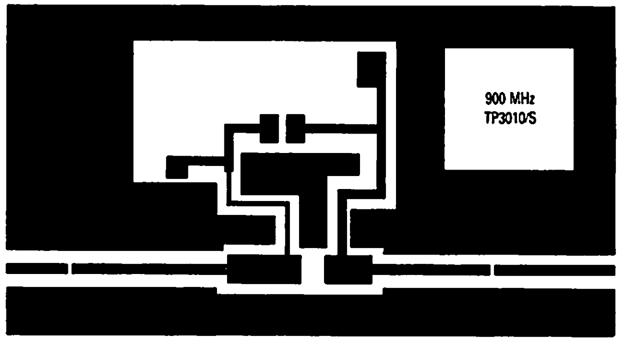
Figure 2. Series Equivalent Input/Output Impedances



Note: Amplifier tunable from 820 to 960 MHz.
Instantaneous Bandwidth — 40 MHz Typ.

C1, C5, C7, C12	Capacitor Chip 330 pF CGO SMT
C2, C3, C10, C11	0.5–5 pF GKU Trimmer Capacitor
C4	Capacitor Chip 3.9 pF
C6, C8	Capacitor Chip 15 nF
C9	Electrolytic Capacitor 10 MF 16 V
R1	Resistor // 2 x 270 Ohms 1/2 W
D1	0.57 for Class B Operation
L1	15 mm Z_o = 50 Ohm
L2, L5	7 mm Z_o = 25 Ohm
L3	27 mm Z_o = 75 Ohm
L4	20 mm Z_o = 50 Ohm
L6	28 mm Z_o = 50 Ohm
Board Material	.020 In. ϵ_r = 2.55, Teflon Glass

Figure 3. Broadband Amplifier Circuit



Board Material: .020 In. Glass Teflon ϵ_r = 2.55

Figure 4. Printed Circuit Board Layout (Not to Scale)

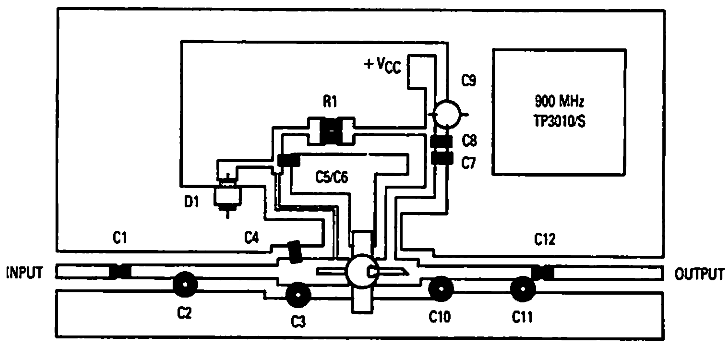


Figure 5. Component Layout

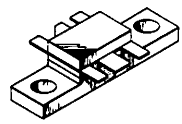
TP3012

**10 W–915 MHz
UHF POWER
TRANSISTOR
NPN SILICON**

The RF Line
UHF Power Transistor

The TP3012 is designed for 900 MHz mobile stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 12.5 Volts, 915 MHz Characteristics
  Output Power = 10 Watts
  Minimum Gain = 8.0 dB
  Class AB
  I_Q = 60 mA



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	17	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	3.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	40 0.4	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	4.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

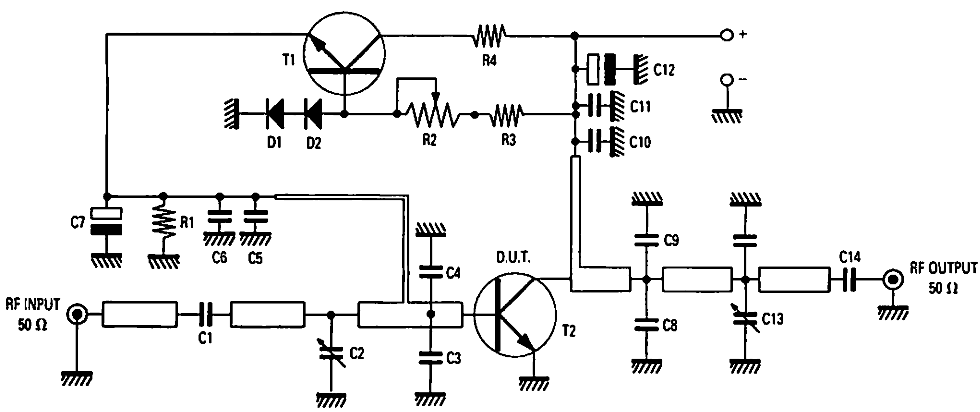
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	16	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 25 mAdc)	$V_{(BR)CBO}$	30	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 17 V, R_{BE} = 75 Ω)	I_{CE}	—	—	5.0	mA

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 V, P_{out} = 10 W, I_{CQ} = 60 mA) (f = 915 MHz)	G_p	8.0	9.0	—	dB
Load Mismatch (V_{CC} = 12.5 V, P_{out} = 10 W, I_{CQ} = 60 mA) (VSWR 10:1 at all Phase Angles)	ψ	No degradation in Output Power			
Collector Efficiency (V_{CC} = 12.5 V, P_{out} = 10 W, f = 915 MHz)	η	50	55	—	%



C2 — Variable Capacitor 0.4 4.0 pF HQ
C13 — Variable Capacitor 0.4 4.0 pF HQ
+ Capacitor Chip 3.9 pF HQ
C3, C4 — Capacitor Chip 5.6 pF HQ
C8, C9 — Capacitor Chip 6.8 pF HQ
C1, C5, C10, C14 — Capacitor Chip 0805 330 pF 5%
C6, C11 — Capacitor Chip 0805 15 nF 5%

R2 — Trimmer Resistor 1.0 kΩ
R3 — Chip Resistor 470 Ω 0805 5%
R4 — Power Resistor 51 Ω 3.0 W
C7, C12 — Capacitor Chip 6.8 μF 35 V
R1 — Chip Resistor 0805 51 Ω 5%
T1 — BD135
T2 — TP3012
D1, D2 — 1N4148 Diode
Board Material — 0.5 mm, Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. Test Circuit

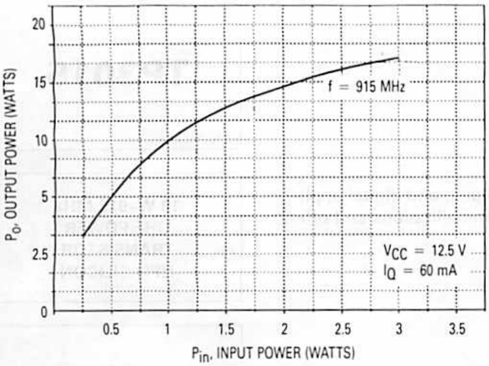
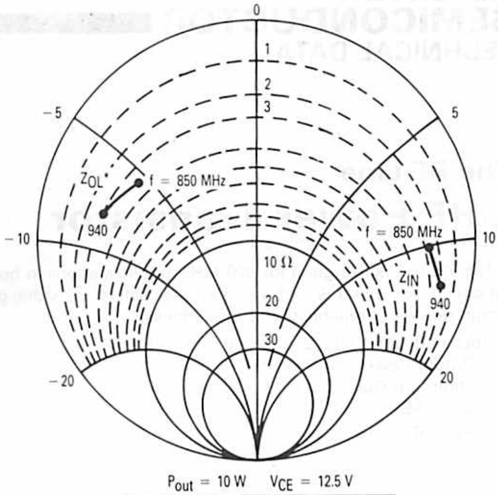


Figure 2. Output Power versus Input Power



P_{out} = 10 W V_{CE} = 12.5 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	2.6 + j10	3.4 − j5.2
880	2.4 + j10.6	3.3 − j6.1
900	2.3 + j11.5	3.1 − j6.4
940	1.8 + j12.9	3.0 − j7.8

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

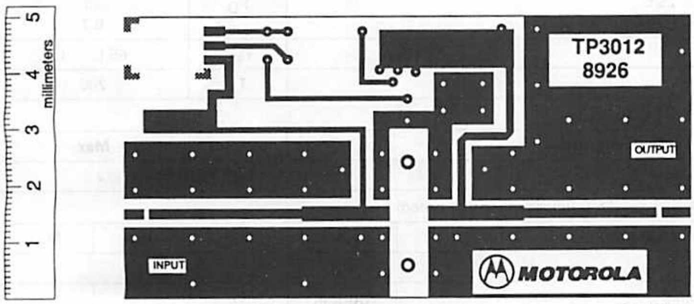


Figure 4. Photomaster of Test Fixture SCALE 1:1

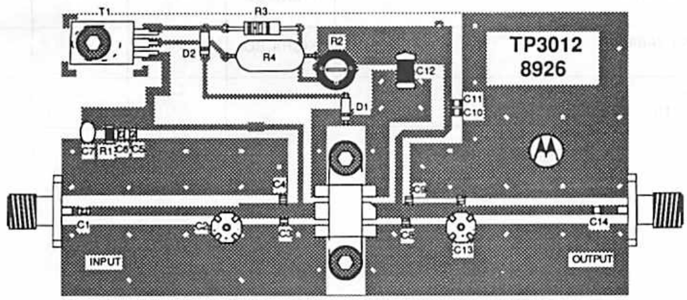


Figure 5. Test Fixture — Components Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

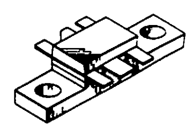
TP3015

The RF Line
UHF Power Transistor

18 W–915 MHz
UHF POWER
TRANSISTOR
NPN SILICON

The TP3015 is designed for 900 MHz mobile stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 12.5 Volts, 915 MHz Characteristics
  Output Power = 18 Watts
  Minimum Gain = 7.5 dB
  Class AB
  I_Q = 100 mA



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	17	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	6.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 0.7	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

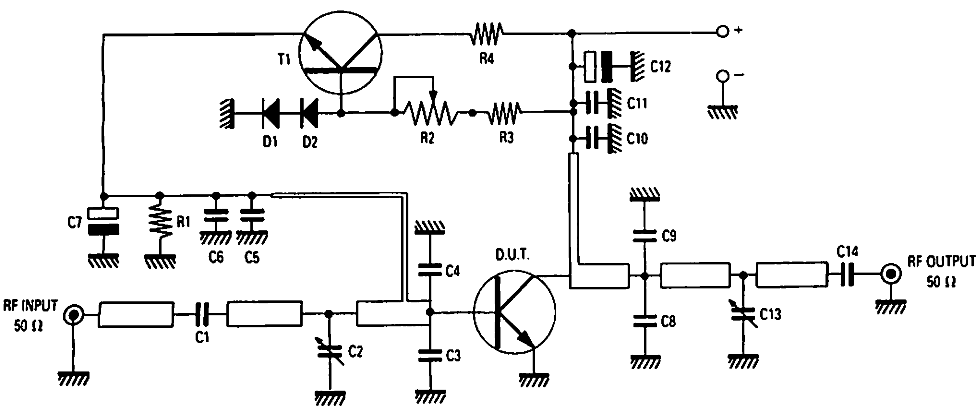
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	17	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 6.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	30	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 17 V, R_{BE} = 75 Ω)	I_{CER}	—	—	10	mA

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C · 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	15	—	135	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 12 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 12.5 V, P_{out} = 18 W, I_{CQ} = 100 mA) (f = 915 MHz)	G_p	7.5	8.6	—	dB
Load Mismatch (V_{CC} = 12.5 V, P_{out} = 18 W, I_{CQ} = 100 mA) (VSWR 10:1 at all Phase Angles)	ψ	No degradation in Output Power			
Collector Efficiency (V_{CC} = 12.5 V, P_{out} = 18 W, f = 915 MHz)	η_c	50	55	—	%



C2, C13 — Variable Capacitor 0.4 4.0 pF HQ
C3, C4 — Capacitor Chip 15 pF HQ
C8, C9 — Capacitor Chip 10 pF HQ
C1, C5, C10, C14 — Capacitor Chip 0805 330 pF 5%
C6, C11 — Capacitor Chip 0805 15 nF 5%
C7, C12 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Chip Resistor 51 Ω 1206 5%
R2 — Trimmer Resistor 1.0 kΩ
R3 — Chip Resistor 470 Ω 0805 5%
R4 — Power Resistor 51 Ω 3.0 W
T1 — BD135
D1, D2 — 1N4148 Diode
Board Material — 0.5 mm, Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. Test Circuit

2

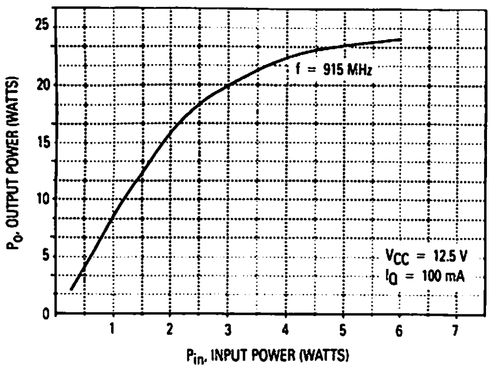


Figure 2. Output Power versus Input Power

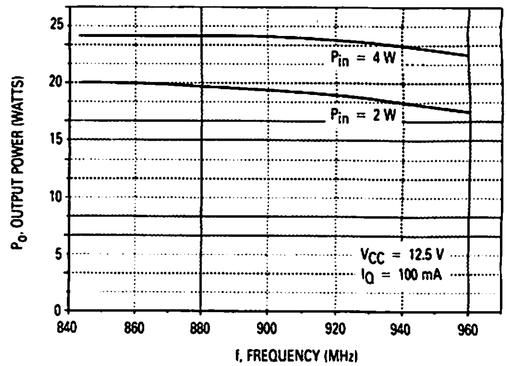


Figure 3. Output Power versus Frequency

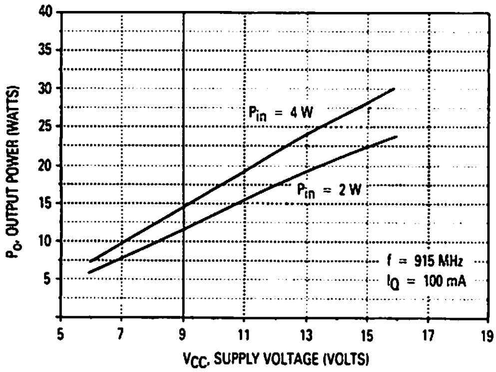


Figure 4. Output Power versus Supply Voltage

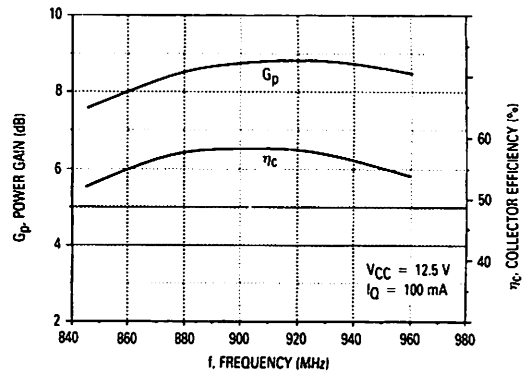
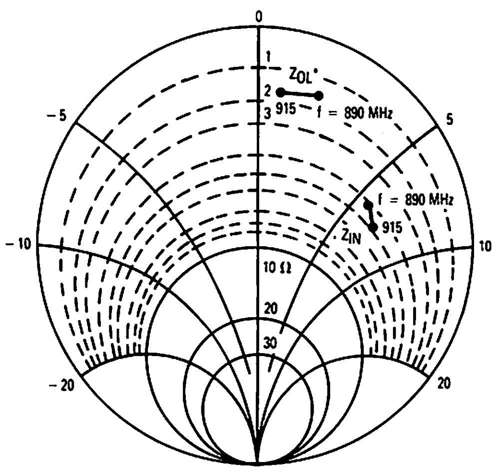


Figure 5. Typical Broadband Circuit Performance



P_{out} = 18 W V_{CE} = 12.5 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
890	4.5 + j5.6	1.4 - j2.1
900	4.8 + j5.7	1.4 - j1.5
915	5 + j5.8	1.43 - j1.4

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

TEFLON GLASS 0.5 mm - Double side 35µm Cu.

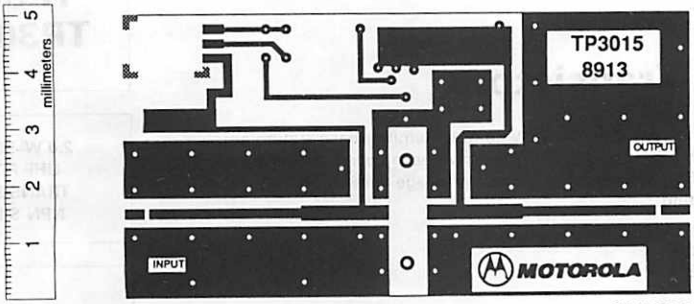


Figure 7. Test Circuit — Photomaster

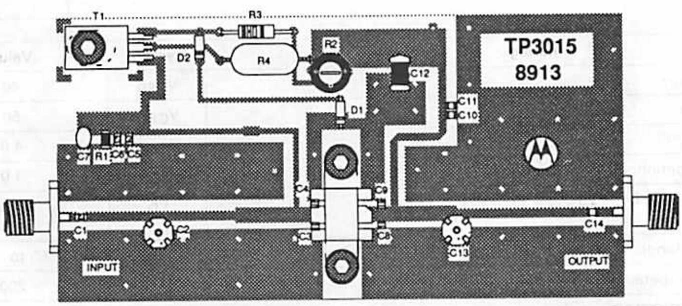


Figure 8. Test Fixture — Component Locations

TP3019
TP3019S

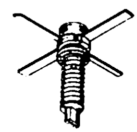
2

The RF Line
UHF Power Transistors

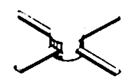
**2.0 W–960 MHz
UHF POWER
TRANSISTORS
NPN SILICON**

The TP3019 and TP3019S are designed for 24 V common emitter base station amplifiers. Operating in the 820–960 MHz bandwidth, they have been specifically designed for use in analog and digital (GSM) systems. The studless package version offers a good possibility for surface mounting.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power = 2.0 Watts
  Minimum Gain = 9.0 dB
  Class AB
  I_Q = 20 mA



CASE 305A-01, STYLE 1
TP3019S



CASE 305-01, STYLE 1
TP3019

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	1.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	12.5 0.15	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	14	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5.0 mA, I_B = 0)	$V_{(BR)CER}$	28	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 1.0 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 5.0 mAdc)	$V_{(BR)CBO}$	50	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 20 V)	I_{CES}	—	—	2.0	mA

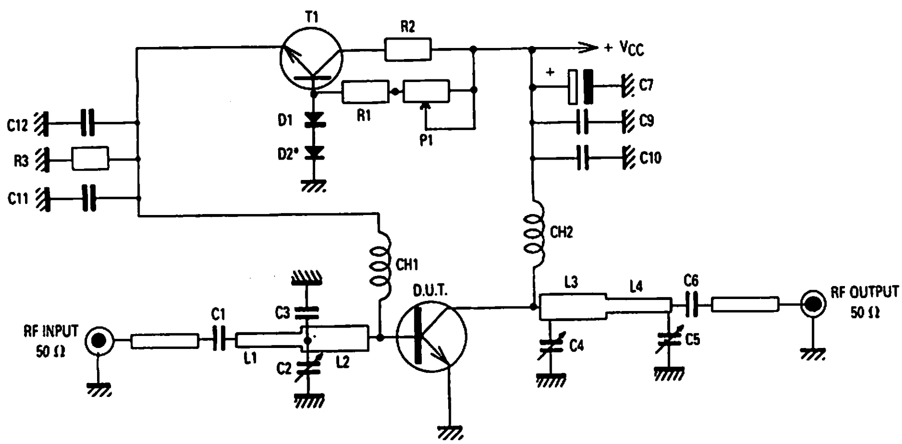
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 5.0 Vdc)	h_{FE}	15	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	—	4.0	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 2.0 W, I_{CQ} = 20 mA) (f = 960 MHz)	G_p	9.0	—	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 24 V, P_{out} = 2.0 W, I_{CQ} = 20 mA) No degradation in Output Power	ψ	20:1	—	—	VSWR
Collector Efficiency (V_{CC} = 24 V, P_{out} = 2.0 W, f = 960 MHz)	η_c	50	55	—	%



*Contact with RF Transistor

C2, C4, C5 — Trimmer Capacitor 0.5–4.0 pF
C1, C6, C10, C11 — Capacitor Chip 0805 330 pF 5%
C9, C12 — Capacitor Chip 0805 15 nF 5%
C3 — Capacitor Chip 0805 3.9 pF 5%
C7 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Resistor 1.0 kΩ 5%
L1 — Microstrip Line 50 Ω L = 12 mm
L2 — Microstrip Line 25 Ω L = 6 mm
R2 — Resistor 100 Ω 2.0 W
R3 — Chip Resistor 75 Ω 0805 5%
P1 — Trimmer 5.0 kΩ
T1 — Transistor BD135 or Similar
CH1 — Microstrip Line 80 Ω L = 23 mm
CH2 — 3 Turns Wire 8/10 ID 4 mm
D1, D2 — Diode 1N4148
L3 — Microstrip Line 25 Ω L = 6 mm
L4 — Microstrip Line 50 Ω L = 28 mm
Board Material — 1 50", Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

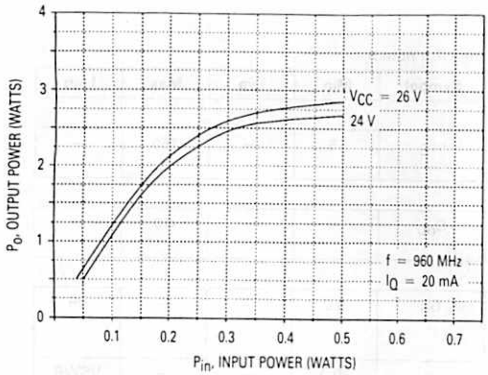
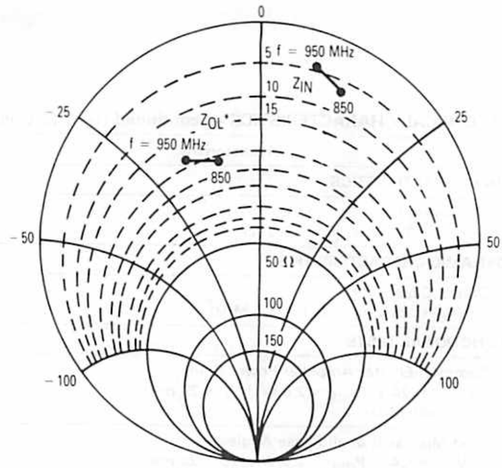


Figure 2. Output Power versus Input Power



P_{out} = 2 W V_{CE} = 24 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	5.8 + j9.8	21.3 − j10
900	5.4 + j9	21 − j11
950	4.8 + j7.9	20 − j14

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

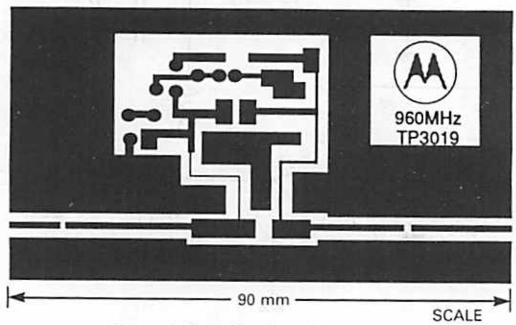


Figure 4. Test Circuit — Photomaster

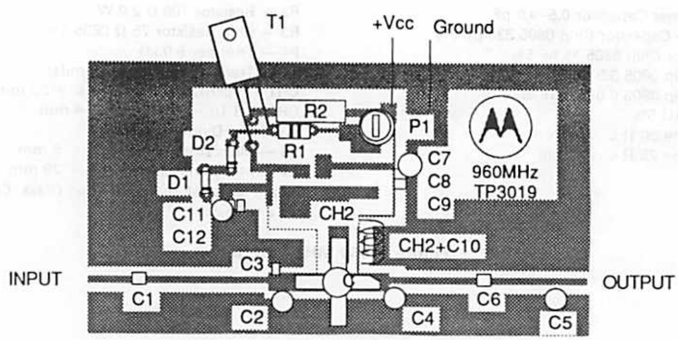


Figure 5. Test Circuit — Component Locations

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP3020A

2

Advance Information

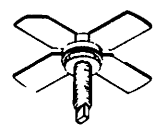
The RF Line

UHF Power Transistor

2.2 W — 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON

The TP3020A is designed for use in the 900 MHz mobile radio band. Its high gain and ability to operate Class A makes it an ideal choice as a driver operating Class A, Class B or Class C.

- 960 MHz
- 2.2 W — P_{out}
- 26 V — V_{CC}
- High Gain — 9 dB, Class A



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 0.05	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CB} = 24 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 2.2 W, f = 960 MHz, I_Q = 200 mA)	G_{PE}	9.1	—	—	dB

This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

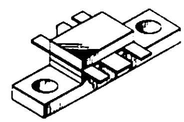
TP3021

The RF Line
UHF Power Transistor

**10 W–960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**

The TP3021 is designed for 24 V common emitter base station amplifiers. Operating in the 820–960 MHz bandwidth, it has been specifically designed for use in analog and digital (GSM) systems. This device has been conceived for use either as a medium power output device or as a driver for the TP3040.

- Specified 24 Volts, 960 MHz Characteristics
  Output Power = 10 Watts
  Minimum Gain = 10 dB
  Class AB
  I_Q = 60 mA



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	2.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	35 0.35	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	5.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 25 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	5.0	mA

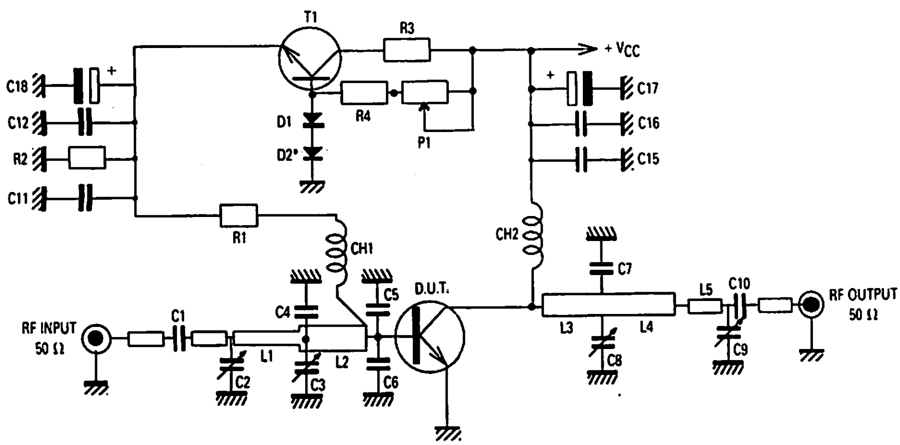
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	15	—	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 10 W, I_{CQ} = 60 mA) (f = 960 MHz)	G_p	10	—	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 10 W, I_{CQ} = 60 mA) No degradation in Output Power	ψ	20:1	—	—	VSWR
Collector Efficiency (V_{CC} = 24 V, P_{out} = 10 W, f = 960 MHz)	η_c	50	55	—	%



*D2 is in Physical Contact with RF Transistor

C2, C4, C8, C9 — Trimmer Capacitor 0.5–4.0 pF
C1, C10, C11, C15 — Capacitor Chip 0805 330 pF 5%
C12, C16 — Capacitor Chip 0805 15 nF 5%
C4 — Capacitor Chip 0805 3.9 pF 5%
C17, C18 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
C5, C6 — Capacitor Chip 15 pF HQ
C7 — Chip Resistor 0805 8.2 pF
R4 — Resistor 1.0 kΩ 5%
L1 — Microstrip Line 50 Ω L = 20 mm
L2 — Microstrip Line 25 Ω L = 13 mm
R3 — Resistor 100 Ω 2.0 W
R2 — Chip Resistor 75 Ω 0805 5%
R1 — Chip Resistor 2.2 Ω 1206 5%
P1 — Trimmer 5.0 kΩ
T1 — Transistor BD135 or Similar
CH1 — Microstrip Line 80 Ω L = 40 mm
CH2 — Microstrip Line 80 Ω L = 23 mm
D1, D2 — Diode 1N4148
L3 — Microstrip Line 25 Ω L = 10 mm
L4 — Microstrip Line 50 Ω L = 5 mm
L5 — Microstrip Line 50 Ω L = 7 mm
Board Material — 1/50", Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

2

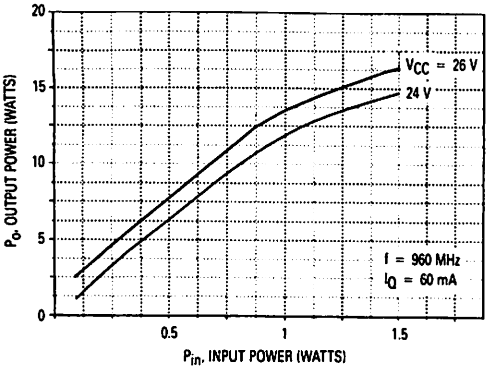
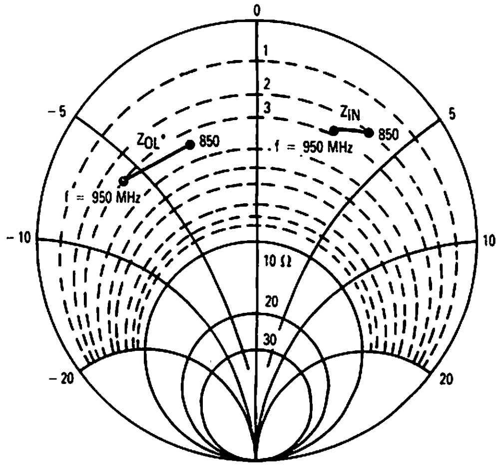


Figure 2. Output Power versus Input Power



P_{out} = 10 W V_{CE} = 24 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	2.4 + j3.5	3.4 − j3.2
900	2.6 + j3.4	3.1 − j4.4
950	2.8 + j3.4	2.7 − j6.2

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 3. Series Equivalent Input/Output Impedances

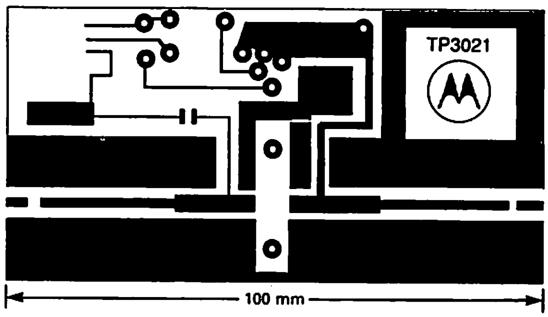


Figure 4. Test Circuit — Photomaster

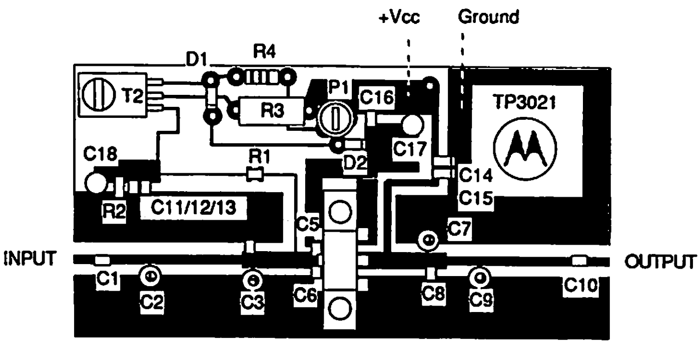


Figure 5. Test Circuit — Component Locations

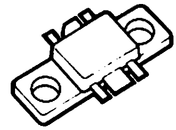
TP3022A

Advance Information

The RF Line

UHF Power Transistor

15 W — 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 319-06, STYLE 2
(EB)

... designed for common-emitter operation in the 900 MHz mobile radio band. Use of gold metallization and silicon diffused ballast resistors results in a medium power output/driver transistor with state-of-the-art ruggedness and reliability.

- 960 MHz
- 15 W — P_{out}
- 26 V — V_{CC}
- High Gain — 8.5 dB, Class AB

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	6	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ohms)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ohms)	I_{CER}	—	—	5	mA
Emitter-Base Breakdown Voltage (I_C = 5 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Leakage (V_{BE} = 2.5 V)	I_{EBO}	—	—	1	mA
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	17	25	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 15 W, f = 960 MHz, I_Q = 50 mA)	G_{PE}	8.5	—	—	dB
Collector Efficiency (V_{CE} = 26 V, P_{out} = 15 W, f = 960 MHz, I_Q = 50 mA)	η_c	45	—	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

TP3024A

Advance Information

The RF Line

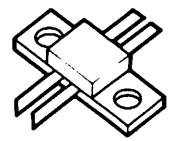
UHF Linear Power Transistor

**35.5 W — 960 MHz
UHF LINEAR POWER
TRANSISTOR
NPN SILICON**

The TP3024A is a balanced transistor designed specifically for use in cellular radio systems.

This device permits the design of a Class AB push-pull, high gain, broadband amplifier having a high degree of linearity without the need for complicated biasing circuitry.

- 960 MHz
- 35.5 W — P_{out}
- 26 V — V_{CC}
- 7.5 dB Gain
- Push-Pull Configuration



CASE 395-01, STYLE 1
(BMA2)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 75°C)	$R_{\theta JC}$	3	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ohms)	$V_{(BR)CER}$	40	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ohms)	I_{CER}	—	—	5	mA
Emitter-Base Breakdown Voltage (I_C = 5 mAdc)	$V_{(BR)EBO}$	4	—	—	Vdc
Emitter-Base Leakage (V_{BE} = 2.5 V)	I_{EBO}	—	—	1	mA
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	17	25	pF
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 26 V, P_{out} = 35.5 W, f = 960 MHz, $I_{Q total}$ = 150 mA)	G_{PE}	7.5	—	—	dB
Collector Efficiency (V_{CE} = 26 V, P_{out} = 35.5 W, f = 960 MHz, $I_{Q total}$ = 150 mA)	η_c	45	—	—	%

Notes: 1. Each transistor chip measured separately.
2. Both transistor chips operating in push-pull amplifier.

This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP3030

2

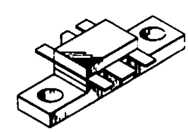
The RF Line

UHF Power Transistor

The TP3030 is designed for 900 MHz base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 26 Volts, 900 MHz Characteristics
  Output Power = 23 Watts
  Minimum Gain = 8.0 dB
  Class AB
  I_Q = 100 mA

23 W–900 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 0.6	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	10	mA

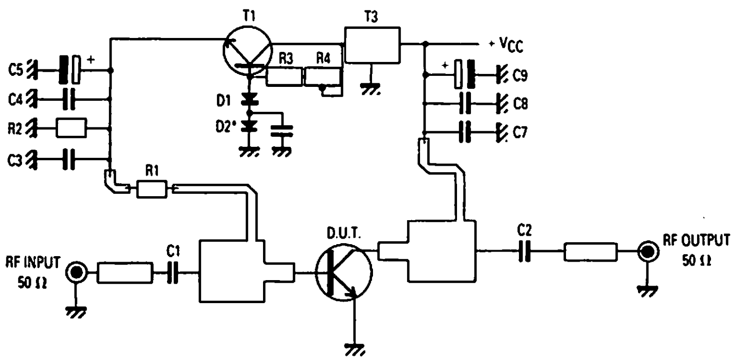
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25 C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	30	—	50	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 23 W, I_{CQ} = 100 mA) (f = 900 MHz)	G_p	8.0	9.0	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 23 W, I_{CQ} = 100 mA) No degradation in Output Power	ψ	5:1	—	—	VSWR
Collector Efficiency (V_{CC} = 26 V, P_{out} = 23 W, f = 900 MHz)	η_c	50	55	—	%
Power Saturation Pin = 7.0 W	P_{sat}	28	—	—	W



C1 — Capacitor Chip 0805 27 pF 5%
C2, C3, C6, C8 — Capacitor Chip 0805 330 pF 5%
C4, C7 — Capacitor Chip 0805 15 nF 5%
C5, C9 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Chip Resistor 2.2 Ω 1206 5%
R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 220 Ω 0805 5%
R4 — Resistor Trimmer 1.0 kΩ
T1 — SMD Transistor BCX54 or Similar
T3 — Voltage Regulator 7805
D1, D2 — SMD Diode
Board Material — 0.8 mm, Epoxy Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 900 MHz Test Circuit

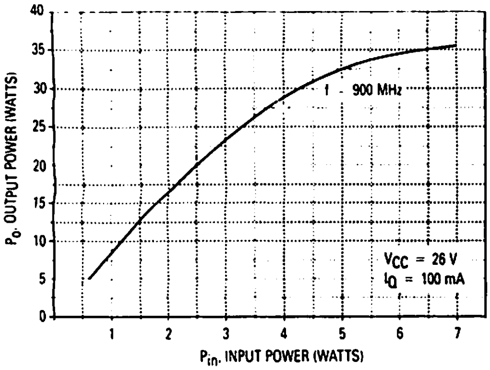


Figure 2. Output Power versus Input Power

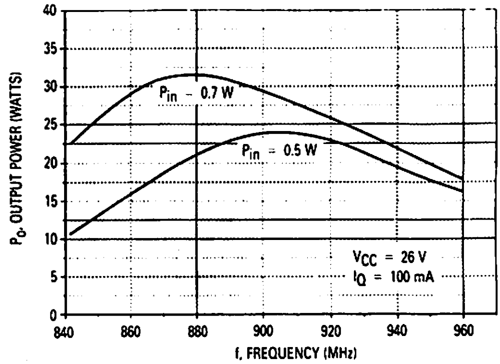


Figure 3. Output Power versus Frequency

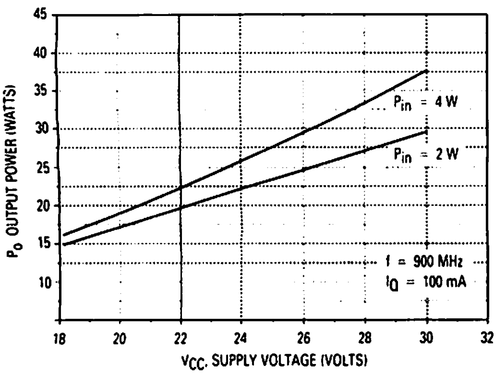


Figure 4. Output Power versus Supply Voltage

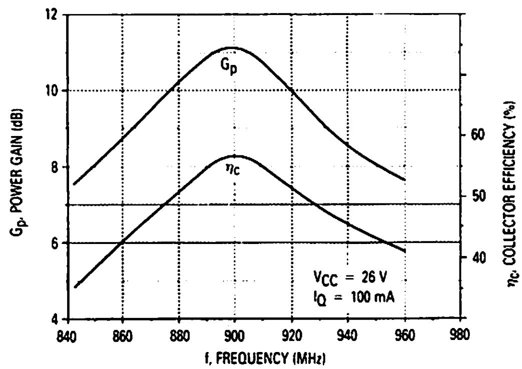
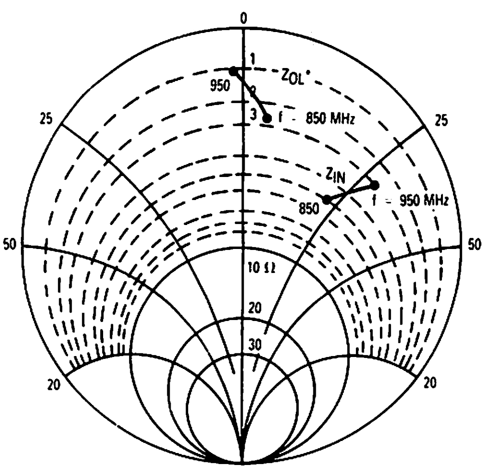


Figure 5. Typical Broadband Circuit Performance



P_{out} = 23 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	5.28 + j6.9	2.94 + j1.84
900	4.2 + j5.7	2.23 + j1.06
950	2.9 + j4.2	1.19 − j0.28

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

2

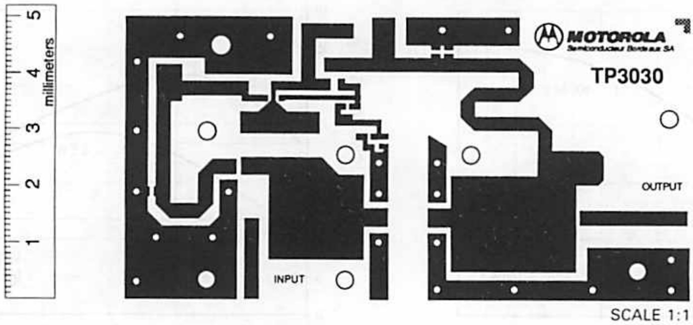


Figure 7. Test Circuit — Photomaster

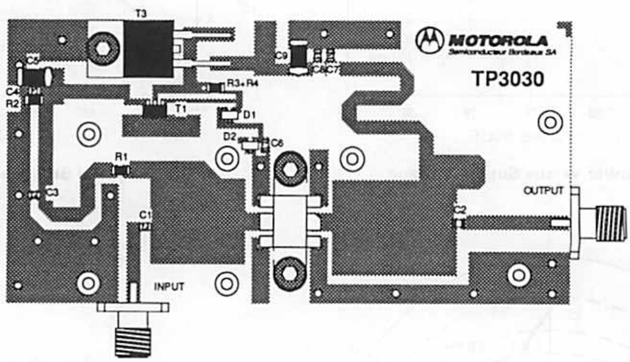


Figure 8. Test Fixture — Component Locations

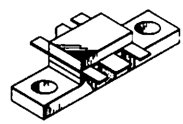
TP3031

The RF Line
UHF Power Transistor

25 W–960 MHz
UHF POWER
TRANSISTOR
NPN SILICON

The TP3031 is designed for 960 MHz base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness.

- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 25 Watts
  Minimum Gain = 8.0 dB
  Class AB
  I_Q = 100 mA



CASE 319-06, STYLE 2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	4.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 0.6	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	55	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	10	mA

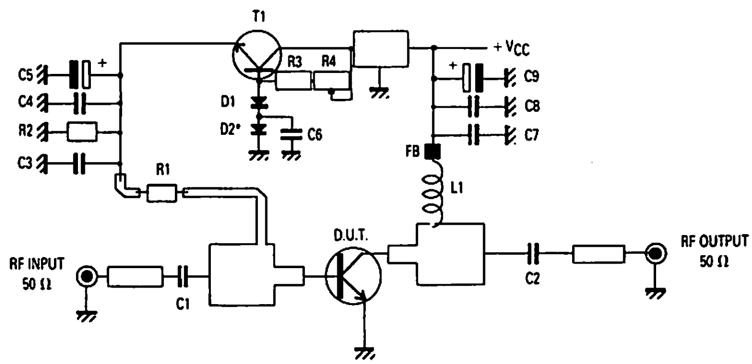
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	30	—	50	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 25 W, I_{CQ} = 100 mA) (f = 960 MHz)	G_p	8.0	9.0	—	dB
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 25 W, I_{CQ} = 100 mA) No degradation in Output Power	ψ	5:1	—	—	VSWR
Collector Efficiency (V_{CC} = 26 V, P_{out} = 25 W, f = 960 MHz)	η	50	55	—	%
Power Saturation Pin = 7.0 W	P_{sat}	27	—	—	W



C1 — Capacitor Chip 0805 39 pF 5%
C2, C3, C6, C8 — Capacitor Chip 0805 330 pF 5%
C4, C7 — Capacitor Chip 0805 15 nF 5%
C5, C9 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Chip Resistor 2.2 Ω 1206 5%
FB Bead Ferroxcube 56-590-65-EB

R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 220 Ω 0805 5%
R4 — Resistor Trimmer 1.0 kΩ
T1 — SMD Transistor BCX54 or Similar
T3 — Voltage Regulator 7805
D1, D2 — SMD Diode
Board Material — 0.5 mm, Teflon Glass, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

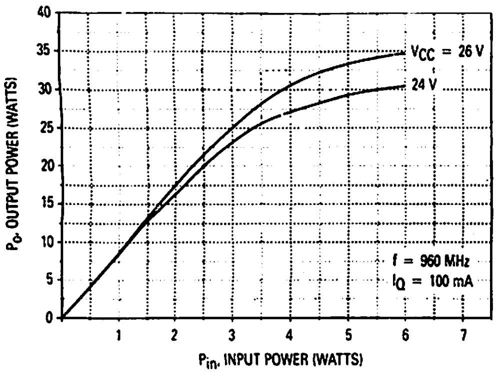


Figure 2. Output Power versus Input Power

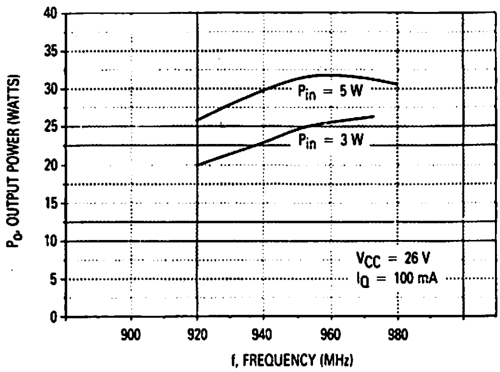


Figure 3. Output Power versus Frequency

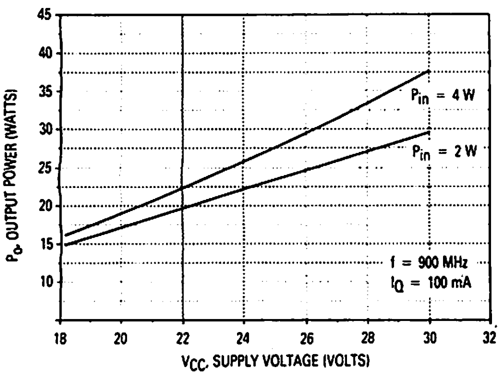


Figure 4. Output Power versus Supply Voltage

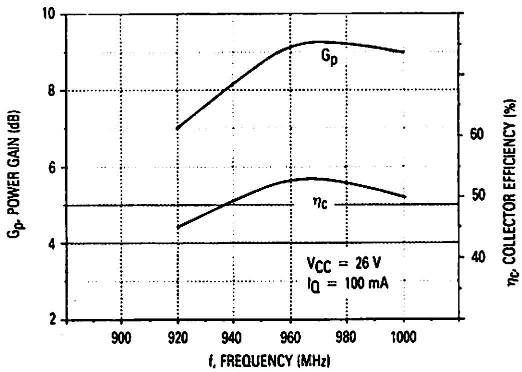
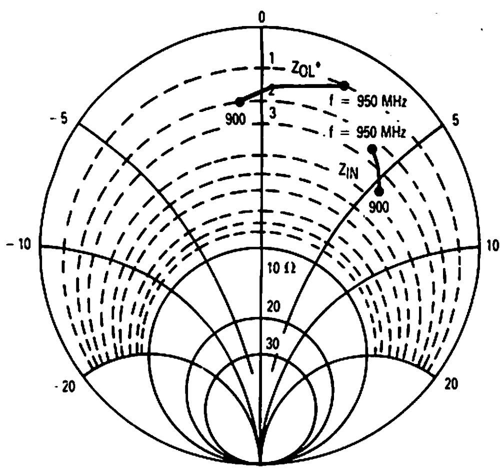


Figure 5. Typical Broadband Circuit Performance



P_{out} = 25 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
900	4.2 + j5.2	1.9 − j0.8
950	2.3 + j3.9	1.0 + j2.9

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

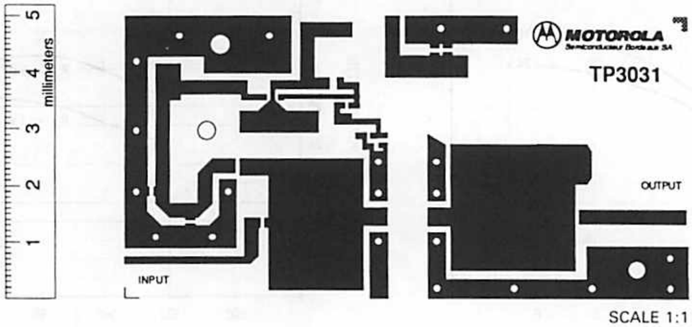


Figure 7. Test Circuit — Photomaster

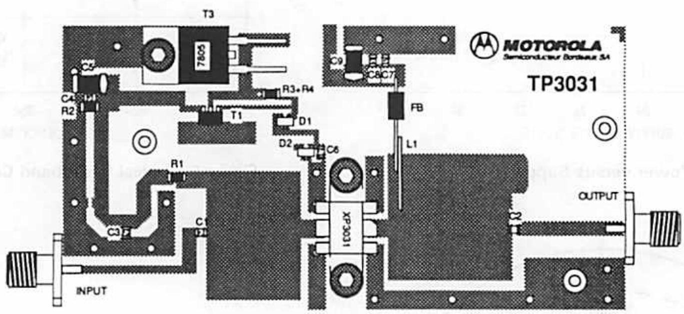


Figure 8. Test Circuit — Component Locations

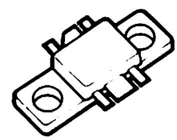
TP3040

**40 W — 960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**

The RF Line
UHF Power Transistor

The TP3040 is specifically designed for operation as the final stage in 960 MHz mobile base station amplifiers. Utilization of emitter ballast resistors and gold metallization results in a transistor having a high degree of reliability and ruggedness.

- 960 MHz
- 40 W — P_{out} @ T_C = 70°C
- 26 V — V_{CC}
- 8 dB Gain, Class AB



CASE 319C-01, STYLE 2
(EB)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	70 0.56	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.8	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 70 mA, I_B = 0)	$V_{(BR)CEO}$	28	30	—	Vdc
Collector-Base Breakdown Voltage (I_C = 70 mA, I_E = 0)	$V_{(BR)CBO}$	50	55	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CB} = 24 V, I_E = 0)	I_{CBO}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C 1A, V_{CE} 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} 26 V, I_E 0, f 1 MHz)	C_{ob}	—	42	62	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} 26 V, P_{out} = 40 W, f 960 MHz, T_C 70 C, I_Q 150 mA)	G_{PE}	8	—	—	dB
Collector Efficiency (V_{CE} 26 V, P_{out} 40 W, f 960 MHz, T_C 70 C, I_Q 150 mA)	η_c	55	—	—	%

TYPICAL CHARACTERISTICS

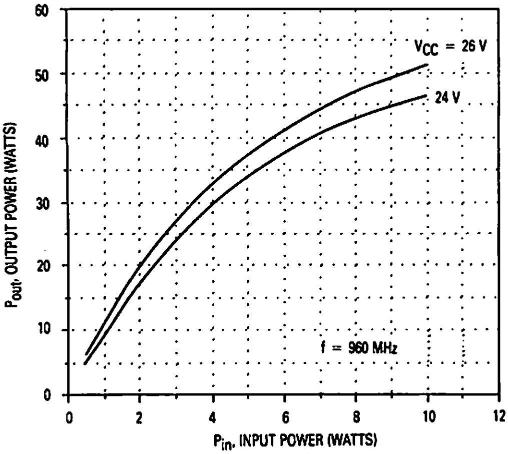
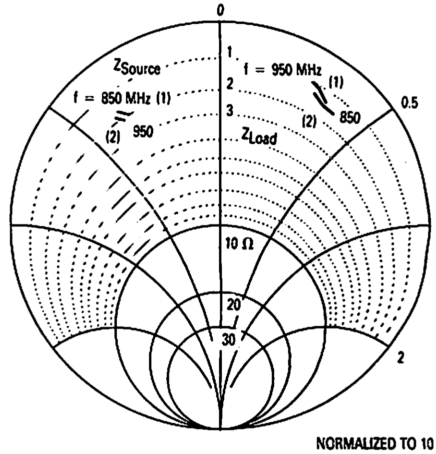
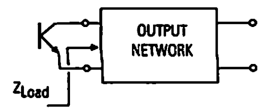


Figure 1. Output Power versus Input Power



(2) P_{out} = 30 W, V_{CE} = 26 V

f (MHz)	Z_{Source}	Z_{Load}
850	1.7 − j3.7	1.2 + j3.6
900	1.8 − j3.6	1.1 + j3.16
950	2 − j3.5	1 + j2.76



(1) P_{out} = 40 W, V_{CE} = 26 V

f (MHz)	Z_{Source}	Z_{Load}
850	1.7 − j3.8	1.5 + j4.0
900	1.75 − j3.7	1.3 + j3.4
950	1.9 − j3.6	1.2 + j3.2

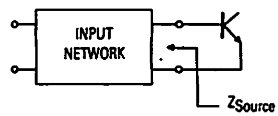
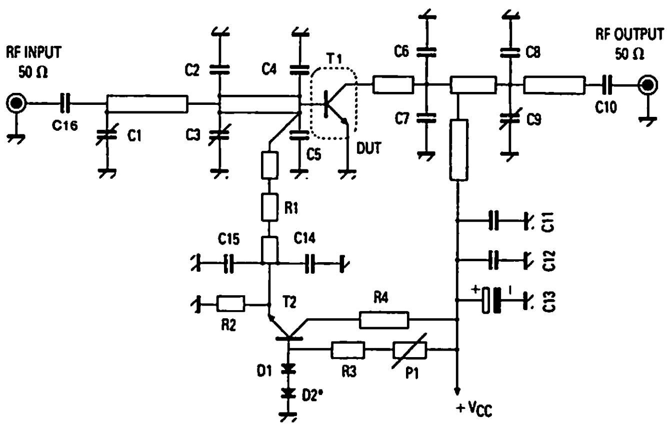


Figure 2. Series Equivalent Input/Output Impedances



*CONTACT WITH RF TRANSISTOR

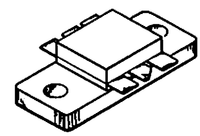
C1, C10, C11, C14 — Capacitor Chip 330 pF 5%
C2 — Capacitor Chip 4.7 pF 5%
C3 — Capacitor Ajust. 1–4 pF
C4, C5 — Capacitor Chip 18 pF
C6, C7 — Capacitor Chip 10 pF
C8 — Capacitor Chip 4.7 pF
C9 — Capacitor Ajust. 1–4 pF
C13 — Capacitor 10 μF 35 V
C15, C12 — 15 nF
D1, D2 — 1N4148
R1 — 2.2 Ohms
R2 — 47 Ohms
R3 — 1.2 k Ohms
R4 — 100 Ohms 3 W
P1 — 10 k Ohms
T2 — BD135 on heatsink
Board Material: .020 In., ϵ_r = 2.55, Teflon Glass

Figure 3. 960 MHz Test Circuit

2

TP3060

60 W–900 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 333A-02, STYLE 2

The RF Line
UHF Power Transistor

The TP3060 is designed for 900 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. Including double input and output matching networks, the TP3060 features high impedances and is easy to match.

- Motorola Advanced Amplifier Concept Package
- Specified 26 Volts, 900 MHz Characteristics
  Output Power = 60 Watts
  Minimum Gain = 7.5 dB
  Efficiency = 50%

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 15 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 60 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA

NOTE: 1. Thermal resistance is determined under specified RF operating condition.

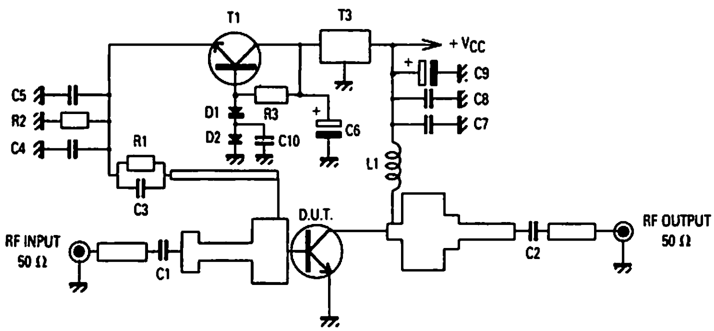
(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (1) (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	45	60	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA) (f = 900 MHz)	G_p	7.5	8.5	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 60 W, f = 900 MHz)	η	50	55	—	%
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA)	ψ	5:1	—	—	VSWR
Overdrive V_{CC} = 26 V, P_{in} = 20 W, f = 900 MHz	OD	No degradation in Output Power			

NOTE: 1. Value of "C_{ob}" is that of die only. It is not measurable in TP3060 because of internal matching network.



C1, C3, C4, C7, C10 — Capacitor Chip 0805 330 pF 5%
C2 — Capacitor Chip 82 pF ATC
C5, C8 Capacitor Chip 0805 15 nF 5%
C6, C9 Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Chip Resistor 2.2 Ω 1206 5%
L1 — 1.5 Turns #18 AWG Choke
R2 — Chip Resistor 51 Ω 0805 5%
R3 — Chip Resistor 500 to 1.0 kΩ to be adjusted for correct quiescent current I_Q = 200 mA
T1 — SMD Transistor MJD31C or Similar
T3 — Voltage Regulator 7805
D1, D2 — SMD Diode
Board Material — 1/50", Teflon Glass, ϵ_r = 2.5, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 900 MHz Test Circuit

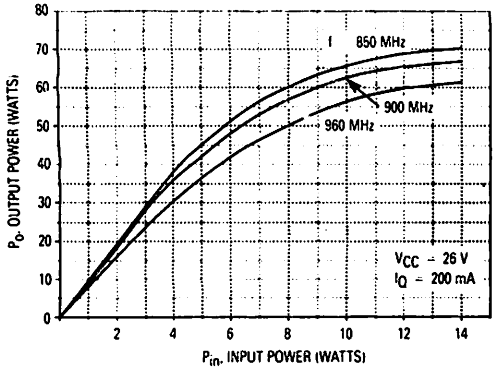


Figure 2. Output Power versus Input Power

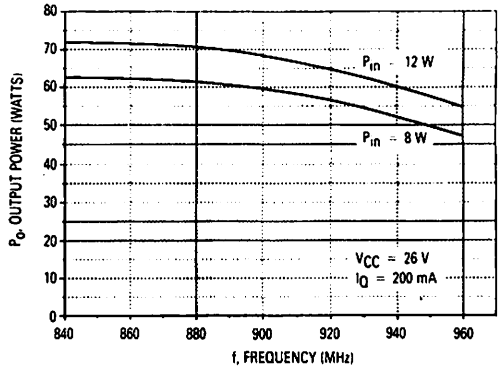


Figure 3. Output Power versus Frequency

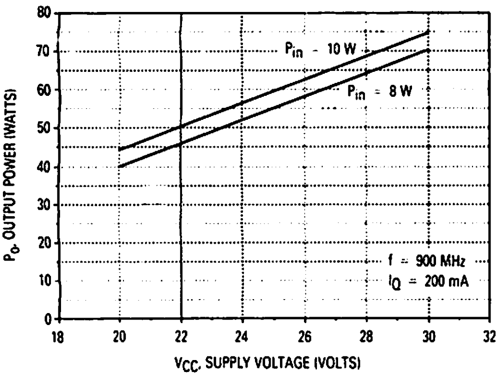


Figure 4. Output Power versus Supply Voltage

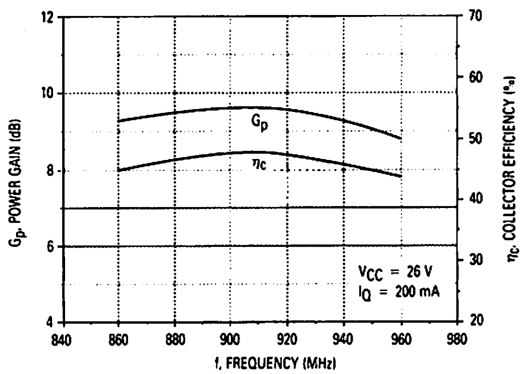
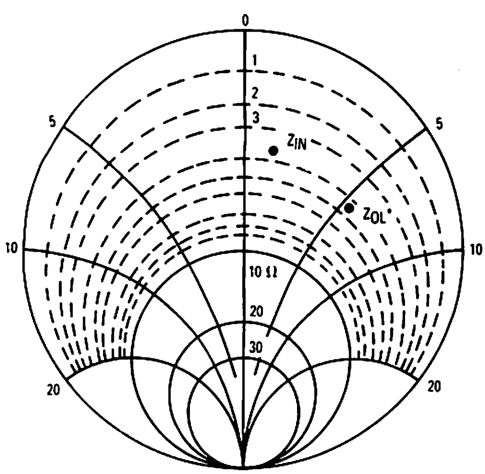


Figure 5. Typical Broadband Circuit Performance



P_{out} = 60 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	—	—
900	3.4 + j2.7	4.2 + j6.9
950	—	—

Z_{OL}* = Conjugate of the optimum load impedance, into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

2

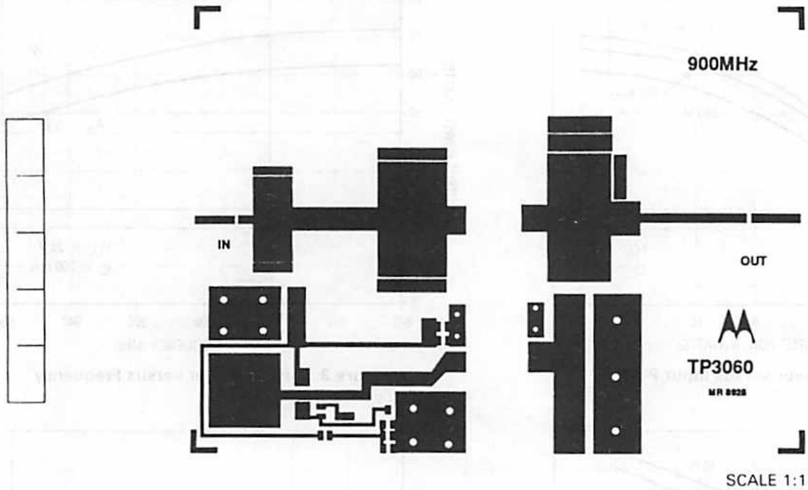


Figure 7. Test Circuit — Photomaster

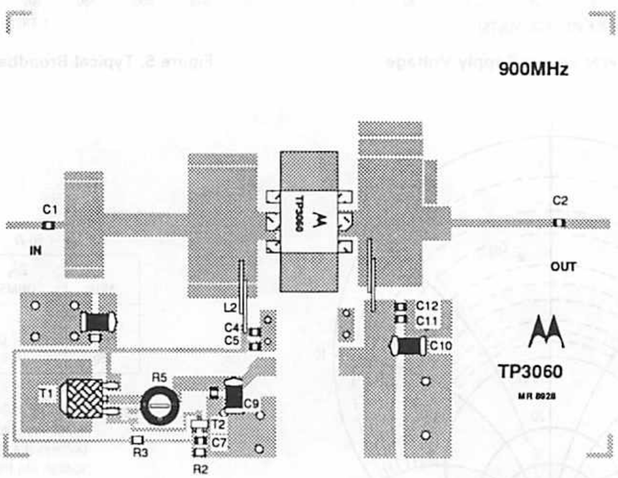


Figure 8. Test Circuit — Component Locations

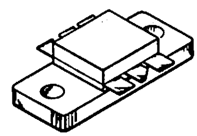
TP3061

The RF Line
UHF Power Transistor

The TP3061 is designed for 960 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. Including double input and output matching networks, the TP3060 features high impedances and is easy to match.

- Motorola Advanced Amplifier Concept Package
- Oxynitride Passivation
- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 45 Watts
  Minimum Gain = 8.0 dB
  Efficiency = 50%

45 W–960 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 333A-02, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	175 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 15 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 60 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA

NOTE: 1. Thermal resistance is determined under specified RF operating condition.

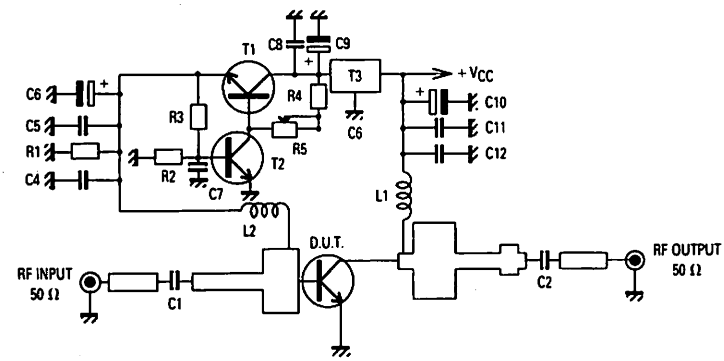
(continued)

2

ELECTRICAL CHARACTERISTICS — continued (T_C 25 C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance* (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	45	60	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 45 W, I_{CQ} = 200 mA) (f = 960 MHz)	G_p	8.0	8.8	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 45 W, f = 960 MHz)	η	50	53	—	%
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 45 W, I_{CQ} = 200 mA)	ψ	5:1	—	—	VSWR
Overdrive V_{CC} = 26 V, P_{in} = 15 W, f = 960 MHz	OD	No degradation in Output Power			

*Value of "C_{ob}" is that of die only. It is not measurable in XP3061 because of internal matching network.



C1, C4, C7, C12 — Capacitor Chip 0805 330 pF 5%
C2 — Capacitor Chip 82 pF ATC
C5, C11, C8 Capacitor Chip 0805 15 nF 5%
C6, C9, C10 — Capacitor Chip 0805 6.0, 8.0 μF 35 V
R1 — Chip Resistor 47 Ω 1206 5%
L1, L2 — 1.5 Turns #18 AWG Choke

R2 — Chip Resistor 270 Ω 0805 5%
R3 — Chip Resistor 47 Ω 0805 5%
R4 — Chip Resistor 100 Ω 0805 5%
R5 — Trimmer 1.0 kΩ
T1 — SMD Transistor MJD31C or Similar
T2 — SMD Transistor
T3 — Voltage Regulator 7805
T4 — TP3061
Board Material — 1 50", Teflon Glass, ϵ_r = 2.5, Cu Clad 2 Sides, 35 μm Thick

Figure 1. 960 MHz Test Circuit

TYPICAL CHARACTERISTICS

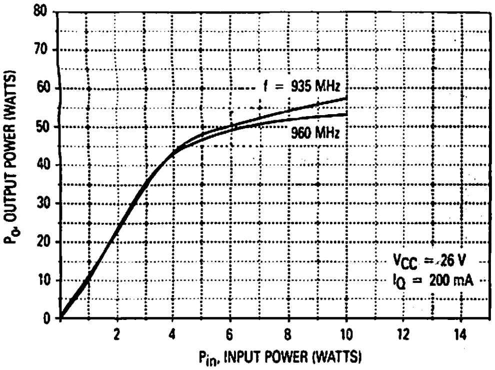


Figure 2. Output Power versus Input Power

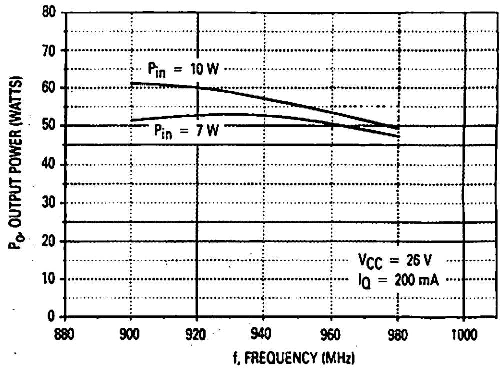


Figure 3. Output Power versus Frequency

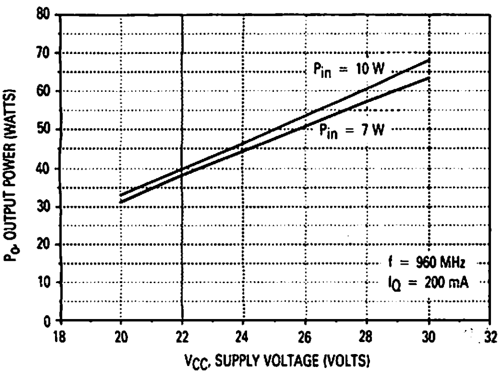


Figure 4. Output Power versus Supply Voltage

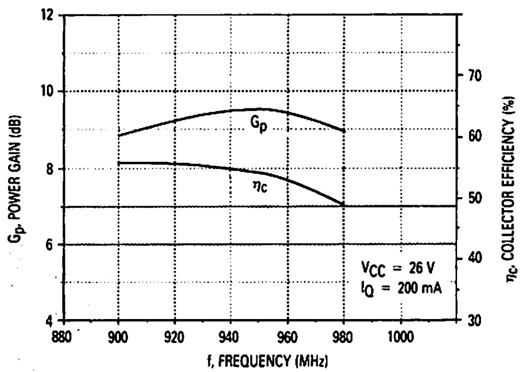
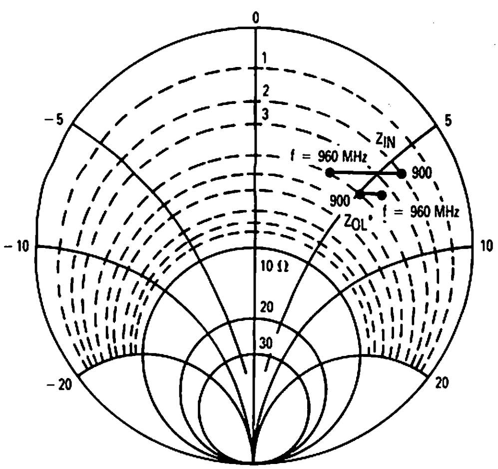


Figure 5. Typical Broadband Circuit Performance



P_{out} = 45 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
850	—	—
900	2.8 + j6	4.1 + j5
950	3.95 + j3.55	3.7 + j5.2

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 6. Series Equivalent Input/Output Impedances

2

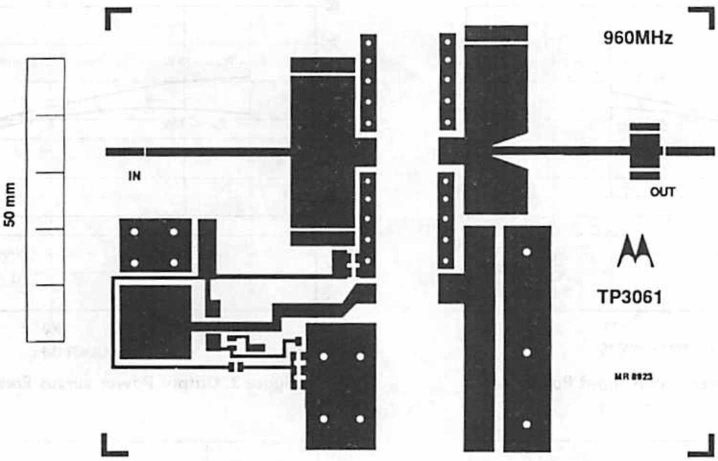


Figure 7. Test Circuit — Photomaster

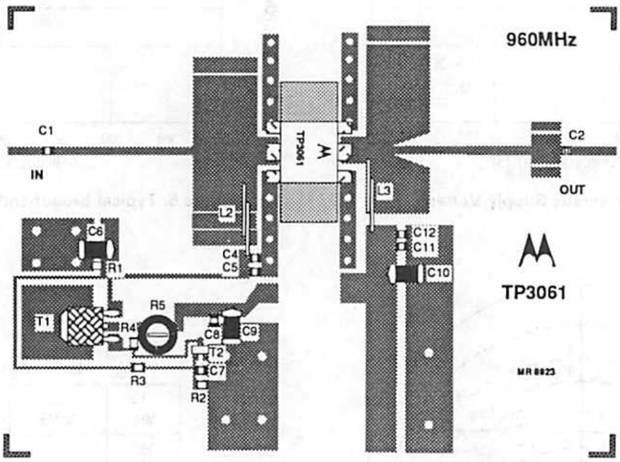


Figure 8. Test Circuit — Component Locations

TP3062

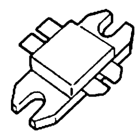
2

The RF Line
UHF Power Transistor

The TP3062 is designed for 960 MHz mobile base stations in both analog and digital applications. It incorporates high value emitter ballast resistors, gold metallizations and offers a high degree of reliability and ruggedness. Including double input and output matching networks, the TP3062 features high impedances. It can easily operate in a full 860 MHz to 960 MHz bandwidth in a single circuit and without any tuning.

- Motorola Advanced Amplifier Concept Package
- To Be Used Class AB for FM, GSM, Digital
- Specified 26 Volts, 960 MHz Characteristics
  Output Power = 60 Watts
  Minimum Gain = 7.5 dB
  Efficiency = 50%

**60 W–960 MHz
UHF POWER
TRANSISTOR
NPN SILICON**



CASE 398-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	48	Vdc
Emitter-Base Voltage	V_{EBO}	4.0	Vdc
Collector-Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	145 1.0	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	1.2	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 15 mAdc)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	15	mA

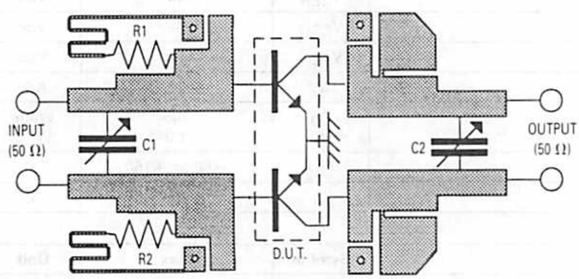
NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (1) (V_{CB} = 26 V, I_E = 0, f = 1.0 MHz)	C_{ob}	30	35	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA) (f = 960 MHz)	G_p	7.5	8.0	—	dB
Collector Efficiency (V_{CC} = 26 V, P_{out} = 60 W, f = 960 MHz)	η	48	50	—	%
Load Mismatch at all Phase Angles (V_{CC} = 26 V, P_{out} = 60 W, I_{CQ} = 200 mA)	ψ	5:1	—	—	VSWR

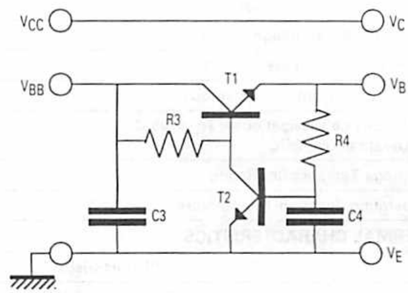
NOTE: 1. Value of "C_{ob}" is that of die only. It is not measurable in TP3062 because of internal matching network.



Bias is adjusted by varying V_{BB}

R1 — Chip Resistor 22 Ω 0805 5%
R2 — Chip Resistor 22 Ω 0805 5%
C1, C2 — Adjustable Capacitor 1.0–4.0 pF

Figure 1. 960 MHz Test Circuit



C2, C4 — Capacitor Chip 15 nF 5%
R3 — Chip Resistor 330 Ω 0805 5%
R4 — Chip Resistor 51 Ω 0805 %
T1 — Transistor Type BD135
T2 — Transistor Type BD135
Board Material — 1 50", Teflon Glass, ϵ_r = 2.5, Cu Clad 2 Sides, 35 μm Thick

Figure 2. Bias Current

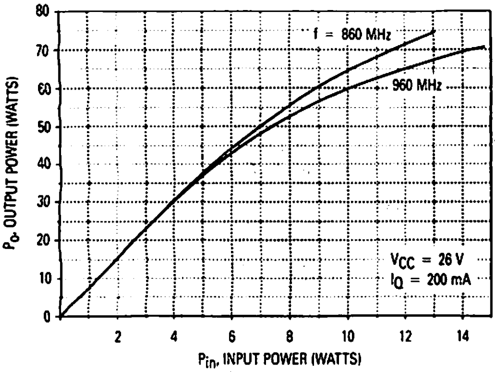


Figure 3. Output Power versus Input Power

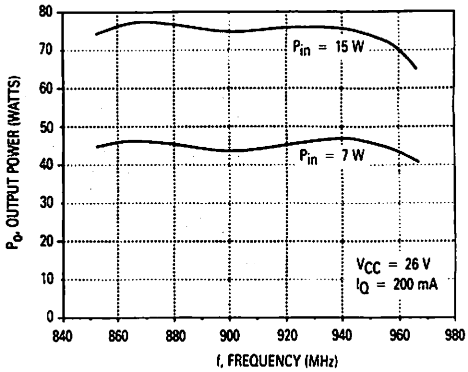


Figure 4. Output Power versus Frequency

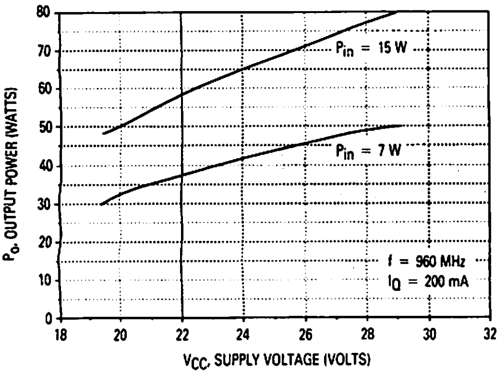


Figure 5. Output Power versus Supply Voltage

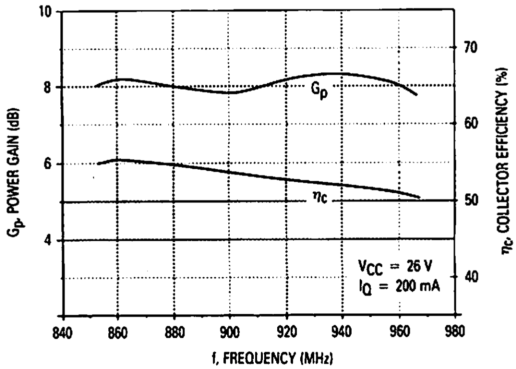
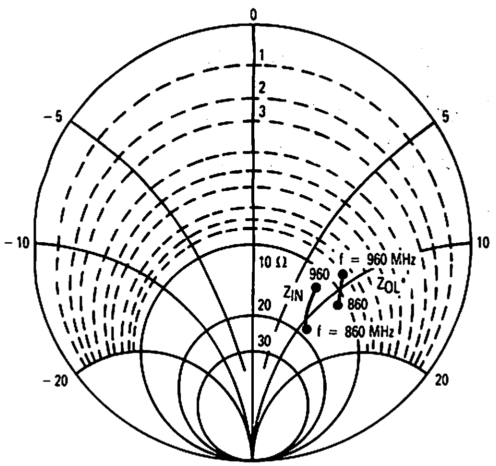


Figure 6. Typical Broadband Circuit Performance



P_{out} = 60 W V_{CE} = 26 V

f MHz	Z_{IN} OHMS	Z_{OL}* OHMS
860	17.3 + j10.4	11.5 + j11.5
910	15.0 + j9.50	10.2 + j10.2
960	12.7 + j8.10	8.70 + j8.90

Z_{OL}* = Conjugate of the optimum load impedance. Into which the device operates at a given output power, voltage, and frequency.

Figure 7. Series Equivalent Input/Output Impedances

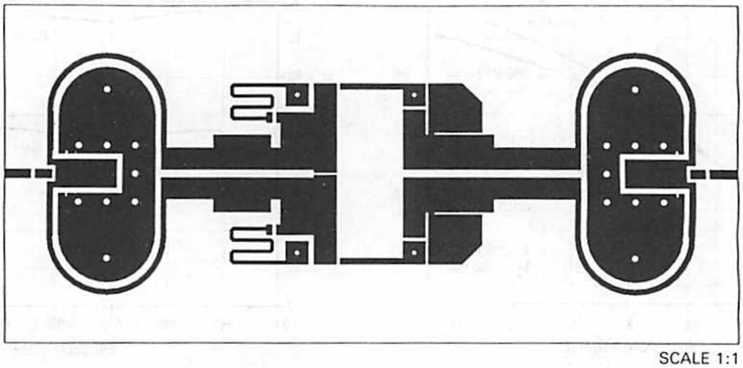


Figure 8. Test Circuit — Photomaster

Figure 9. Printed Circuit Board for Bias Current

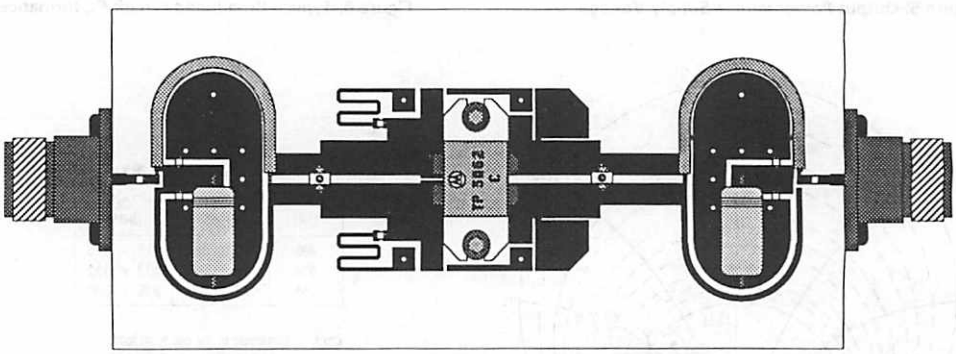


Figure 10. Test Circuit — Component Locations

TP3098

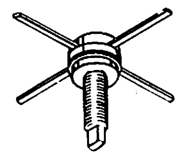
I_C = 200 mA
UHF LINEAR
TRANSISTOR
NPN SILICON

The RF Line

UHF Linear Power Transistor

. . . designed for UHF broadband linear amplification such as in high level 1 Volt MATV Amplifiers up to 860 MHz or low power 200 mW TV Transposer stages. The TP3098 features gold metallization, diffused emitter ballast resistors and a high cutoff frequency.

- High Output
- 1 V (DIN 45004/B)
- 200 mW (DIN 45004/K)
- 10 dB Gain @ 860 MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors



CASE 244D-01, STYLE 1
(TO-117A)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	30	Vdc
Emitter-Base Voltage	V_{EBO}	3	Vdc
Collector Current — Continuous	I_C	0.2	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5 0.03	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	35	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	30	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3	—	—	Vdc
Collector Cutoff Current (V_{CB} = 15 V, I_E = 0)	I_{CBO}	—	—	0.2	mAdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	25	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 90 mA, V_{CE} = 10 V)	h_{FE}	60	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}	—	2.5	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure (V_{CE} = 15 V, I_C = 40 mA, f = 500 MHz)	NF	—	—	6.5	dB
Cutoff Frequency (V_{CE} = 15 V, I_C = 100 mA, f = 500 MHz)	f_T	—	2.6	—	GHz
Maximum Unilateral Gain (V_{CE} = 15 V, I_C = 100 mA, f = 500 MHz)	$G_{U_{MAX}}$	—	13.5	—	dB
Insertion Gain (V_{CE} = 15 V, I_C = 100 mA, f = 500 MHz)	$\|S_{21}\|^2$	—	11.5	—	dB
Intermodulation Distortion 3 Tone — DIN 45004/B (f = 500 MHz, R_{Load} = 75 Ohms, V_{CE} = 15 V, I_C = 100 mA, V_{out} = 700 mV)	IMD	—	−65	−60	dB

2

TYPICAL CHARACTERISTICS

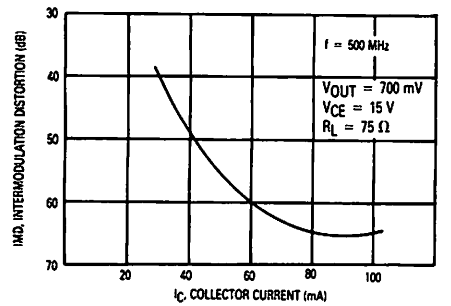


Figure 1. IMD (DIN 45004 B) versus Collector Current

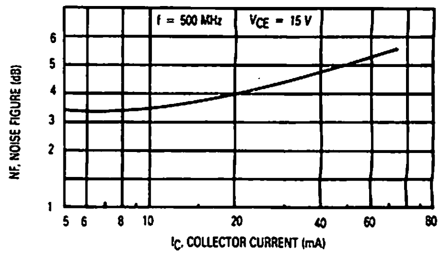


Figure 2. Noise Figure versus Collector Current

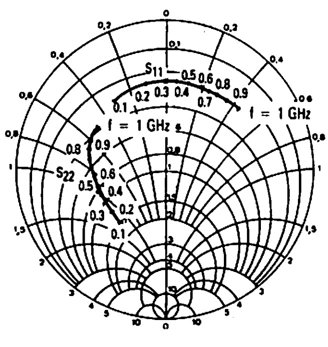


Figure 3. S_{11} — S_{22} Parameters versus Frequency
V_{CE} = 15 V
I_C = 100 mA

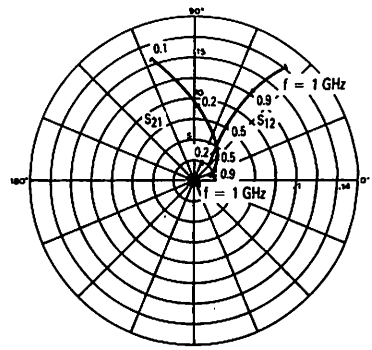
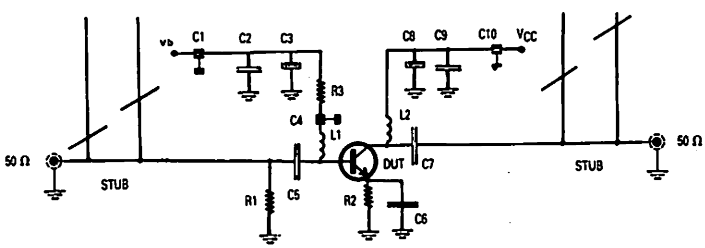


Figure 4. S_{21} — S_{12} Parameters versus Frequency
V_{CE} = 15 V
I_C = 100 mA



L1, L2 — 0.1 nH molded coil

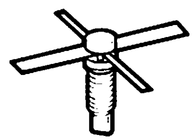
C1, C4, C10 — 1000 pF by pass
C2, C9 — 470 pF ceramic disc
C5, C7 — 220 pF ceramic chip
C3, C8 — 47 μF 40 V electrolytic
C6 — 2 x 220 pF chip one at each emitter lead

R1 — 100 ohms 1/4 W carbon resistor
R2 — 39 ohms 1/4 W carbon resistor
R3 — 1.5 k ohms 1/4 W carbon resistor

Figure 5. 500 MHz Test Fixture

TP3400

I_C = 400 mA
UHF LINEAR
TRANSISTOR
NPN SILICON



CASE 305B-01, STYLE 1
(.200 SOE)

The RF Line
UHF Linear Power Transistor

The TP3400 is a NPN transistor gold metallized for reliability.
The transition frequency of 3 GHz make this transistor a high gain — high output power part ideal for MATV — CATV linear amplification over the band 40–900 MHz.

- 3 GHz f_T
- 1.2 Volt DIN 45004 B
- 13.5 dB Gain @ 860 MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	35	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	30	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 20 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Noise Figure (V_{CE} = 10 V, I_C = 125 mA, f = 500 MHz)	NF	—	7	—	dB
Cutoff Frequency (V_{CE} = 18 V, I_C = 125 mA)	f_T	2.5	—	—	GHz
Intermodulation Distortion 3 Tone — DIN 45004/B (f = 860 MHz, R_{Load} = 75 Ohms, V_{CE} = 18 V, I_C = 125 mA, V_{out} = 1.2 V)	IMD	—	−60	—	dB
Power Gain (f = 860 MHz, I_C = 125 mA, V_{CE} = 18 V, V_{out} = 1.2 V)	Gp	13.5	—	—	dB

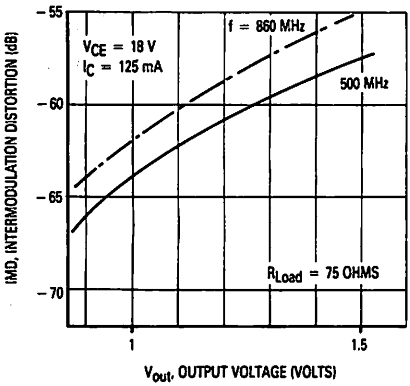


Figure 1. IMD (DIN 45004 B) versus Output Voltage

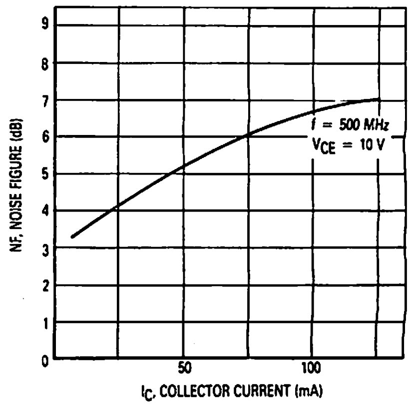


Figure 2. Noise Figure versus Collector Current

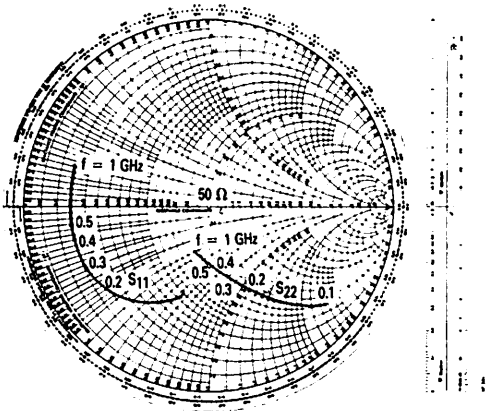


Figure 3. S_{22} — S_{11} Parameters versus Frequency
V_{CE} = 15 V
I_C = 125 mA

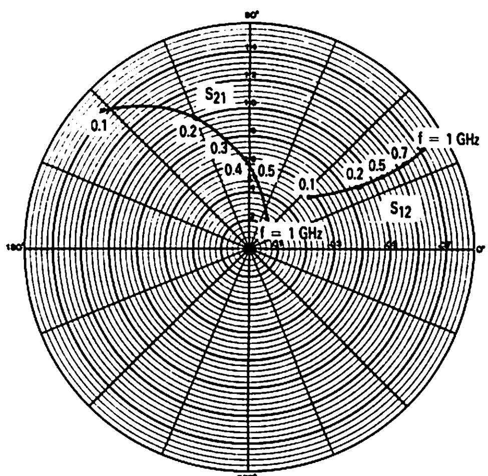
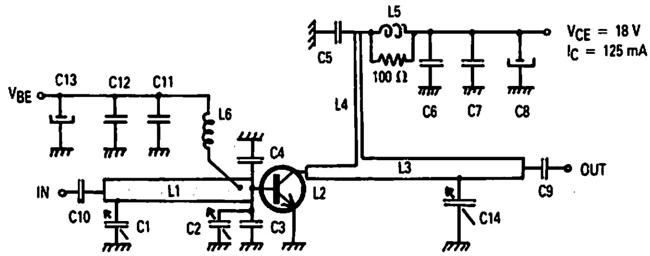


Figure 4. S_{21} — S_{12} Parameters versus Frequency
V_{CE} = 15 V
I_C = 125 mA



L1 — 50 Ω line l = 10% λg at 860 MHz
L2 — 100 Ω line l = 12% λg at 860 MHz
L3 — 50 Ω line l = 7% λg at 860 MHz
L4 — 120 Ω line l = 10% λg at 860 MHz
L5 — 6 turns ID 3 mm wire 0.5 mm
L6 — 6 turns ID 3 mm wire 0.5 mm

C1, C2, C14 — variable AIRTRONIC C max 4.7 pF AT 7275
C3, C4 — ATC chip 10 pF
C5 — 680 pF ATC chip
C6, C11 — 1 nF
C7, C12 — 10 nF
C8 — 10 μF 63 V
C13 — 10 μF 25 V
C9, C10 — 1 nF chip

Figure 5. 860 MHz Test Fixture

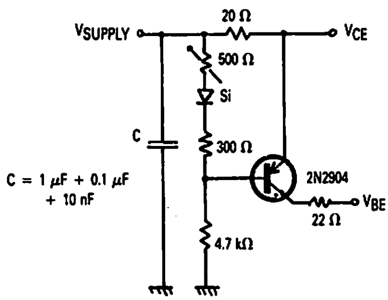


Figure 6. Bias Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP3401
TP3401S

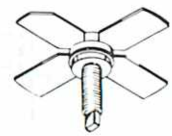
The RF Line
UHF Linear Power Transistors

I_C = 200 mA
UHF LINEAR
TRANSISTORS
NPN SILICON

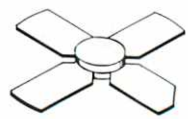
The TP3401/S are NPN transistors, gold metallized for reliability. They use diffused emitter ballast resistors for linearity and ruggedness.

The transition frequency of 5 GHz makes these transistors ideal for UHF broadband linear amplification such as in high level 1.2 Volts MATV amplifiers up to 860 MHz, low power TV transposer stages or instrumentation.

- High Output — 1.2 V (DIN 45004/B)
- 5 GHz f_T
- High Gain — 16 dB Typ @ 500 MHz



CASE 244C-01, STYLE 1
(.280 SOE)
TP3401



CASE 249A-01, STYLE 1
(.280 SOE S)
TP3401S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	5 25	Watts mW/°C
Collector Current — Continuous		200	mA
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 5 mA, I_B = 0)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.1 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CE} = 9 V, I_B = 0)	I_{CEO}	—	—	0.6	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 50 mA, V_{CE} = 5 V)	h_{FE}	70	—	190	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}	—	3.5	4.5	pF
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = 12.5 V, I_C = 150 mA, f = 500 MHz)	f_τ	4.5	5	—	GHz
Maximum Unilateral Gain (V_{CE} = 12.5 V, I_C = 150 mA, f = 500 MHz)	GU_{MAX}	15	16.3	—	dB
Insertion Gain (V_{CE} = 12.5 V, I_C = 150 mA, f = 500 MHz)	$\lvert S_{21}\rvert^2$	12.5	14	—	dB
Intermodulation Distortion 3 Tone — DIN 45004/B (f_{vision} = 800 MHz, R_{Load} = 75 Ohms, V_{CE} = 12.5 V, I_C = 150 mA, V_{out} = 1.2 V)	IMD	—	−60	−58	dB

TYPICAL CHARACTERISTICS

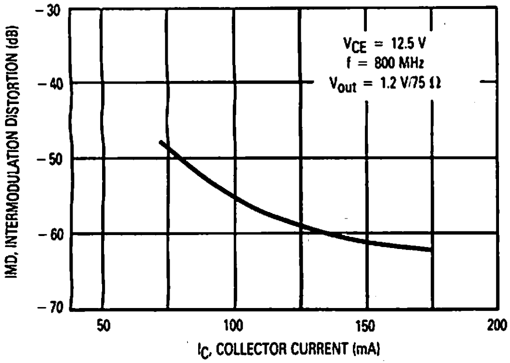


Figure 1. 3rd Order Intermodulation (DIN 45004 B)

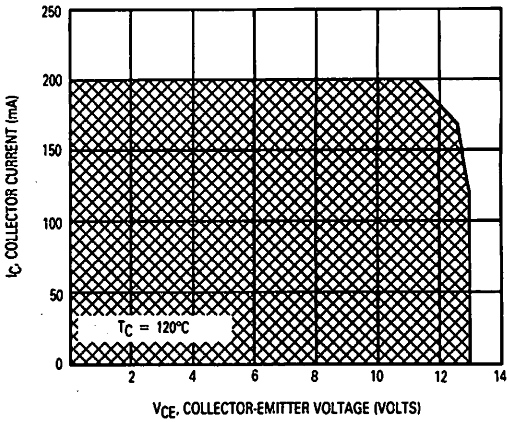


Figure 3. DC Safe Operating Area

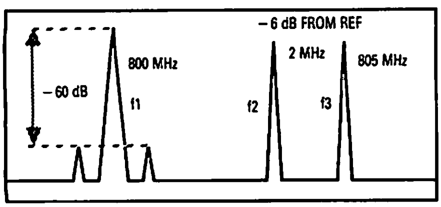
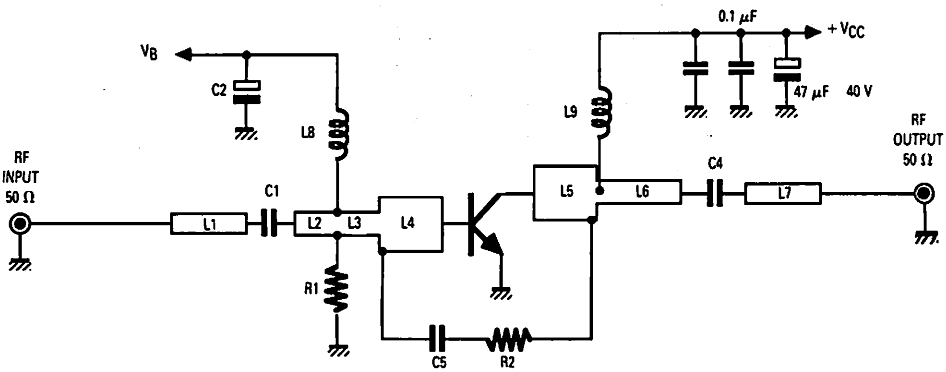


Figure 2. Intermodulation Distortion Test



L1 — 50 Ω Line, L = 10 mm
L2 — 50 Ω Line, L = 27 mm
L3 — 50 Ω Line, L = 0.8 mm
L4 — 17.5 Ω Line, L = 10 mm
L5 — 17.5 Ω Line, L = 10 mm
L6 — 50 Ω Line, L = 33 mm
L7 — 50 Ω Line, L = 12 mm
L8 — Ferrite Bead ≥ 30 μH
L9 — Ferrite Bead ≥ 30 μH
R1 — 56 Ω
R2 — 180 Ω

Circuit Board Teflon Glass 1/16″
All Dimensions in Millimeters

C1 — 120 pF, Chip Capacitor
C2 — 10 μF, Electrolytic Capacitor
C3 — 10 μF, Electrolytic Capacitor
C4 — 50 Ω Line, Chip Capacitor
C5 — 10 μF, Electrolytic Capacitor
C6, C7 — 0.1 μF
C8, C9 — 15 nF
C10, C11 — 1 nF

Figure 4. 800 MHz Test Circuit

2

S-PARAMETERS (TYPICAL)

V_{CE} = 7.5 V, I_C = 100 mA, Z_o = 50 Ω, T_C = 25°C

F (MHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
200	0.605	-156.9	10.19	+92.1	0.046	42.8	0.437	-137.7
300	0.636	-167.6	7.52	80.9	0.059	46.1	0.438	-149.2
400	0.600	-174.9	5.56	72.6	0.070	47.9	0.415	-155.1
500	0.585	-179.0	4.68	66.1	0.083	49.1	0.426	-157.5
600	0.562	+177.2	4.02	60.0	0.095	49.4	0.396	-158.7
700	0.536	+174.5	3.45	53.9	0.107	48.7	0.402	-159.3
800	0.535	+171.6	3.02	47.1	0.118	45.9	0.399	-159.5
900	0.517	+169.5	2.78	39.8	0.131	43.8	0.392	-159.6
1000	0.504	+167.7	2.43	33.4	0.149	40.1	0.397	-159.6

V_{CE} = 12.5 V, I_C = 150 mA, Z_o = 50 Ω, T_C = 25°C

F (MHz)	S11		S21		S12		S22	
	MAG	ANG	MAG	ANG	MAG	ANG	MAG	ANG
200	0.559	-156.8	10.8	93.8	0.044	43.5	0.38	-136.3
300	0.594	-166.9	7.807	84.5	0.058	47.2	0.395	-147.5
400	0.584	-173.8	6.138	74.1	0.069	48.5	0.385	-152.9
500	0.561	-177.9	5.046	67.3	0.08	49.6	0.375	-155.1
600	0.546	+178.3	4.345	61.0	0.094	49.6	0.369	-156.5
700	0.515	+175.8	3.648	54.7	0.103	48.9	0.372	-156.0
800	0.514	+173.0	3.217	48	0.113	46.2	0.369	-155.8
900	0.502	+170.0	3.000	40.9	0.129	44.0	0.364	-155.5
1000	0.484	+169.1	2.812	34.2	0.145	40.4	0.368	-154.9

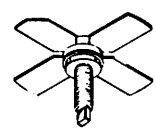
TP3402

Advance Information

The RF Line

UHF Linear Power Transistor

**1.6 VOLT/75 OHMS
UHF LINEAR
TRANSISTOR
NPN SILICON**



CASE 244C-01, STYLE 1
(.280 SOE)

2

The TP3402 is an NPN transistor gold metallized for reliability. It uses diffused emitter ballast resistors for linearity and ruggedness.

The transition frequency of 5 GHz makes this transistor ideal for UHF broadband linear amplification such as in high level 1.2 Volts MATV amplifiers up to 860 MHz, low power TV transposer stages or instrumentation.

- High Output — 1.6 V (DIN45004B)
- 5 GHz f_T
- *High Gain* — 16 dB Typ @ 500 MHz
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	13	Vdc
Collector-Base Voltage	V_{CBO}	24	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	9.5 0.048	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	21	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	13	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	24	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.2 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CE} = 9 V, I_B = 0)	I_{CEO}	—	—	1.2	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	70	—	190	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 10 V, I_E = 0, f = 1 MHz)	C_{ob}	—	7	9	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Cutoff Frequency (V_{CE} = 12.5 V, I_C = 300 mA, f = 500 MHz)	f_T	4.5	5	—	GHz
Maximum Unilateral Gain (V_{CE} = 12.5 V, I_C = 300 mA, f = 500 MHz)	GU_{MAX}	15	16	—	dB
Insertion Gain (V_{CE} = 12.5 V, I_C = 300 mA, f = 500 MHz)	$\|S_{21}\|^2$	9	10.5	—	dB
Intermodulation Distortion 3 Tone — DIN45004/B (f_{vision} = 800 MHz, R_{load} = 75 Ohms, V_{CE} = 12.5 V, I_C = 300 mA, V_{out} = 1.6 V)	IMD	—	−60	−58	dB

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP5002
TP5002S

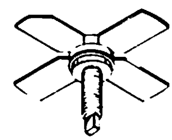
The RF Line
UHF Linear Power Transistors

1.5 W — 380 to 512 MHz
UHF LINEAR
POWER TRANSISTORS
NPN SILICON

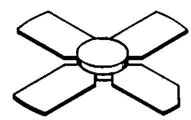
2

The TP5002/S are NPN gold metallized transistors using diffused ballast resistors for reliability and ruggedness. They are specifically designed as low power drivers, having high gain and can be operated in Class A, B or C.

- 380–512 MHz
- 1.5 W — P_{out}
- 24 V — V_{CC}
- High Gain — 13 dB Min, Class A @ 470 MHz



CASE 244C-01, STYLE 1
(.280 SOE)
TP5002



CASE 249A-01, STYLE 1
(.280 SOE S)
TP5002S

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	7 0.045	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	21	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2.0 mA, I_C = 0)	$V_{(BR)EBO}$	4.0	—	—	Vdc
Collector Cutoff Current (V_{CB} = 24 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	4.5	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 23 V, P_{out} = 1.5 W, f = 470 MHz, I_C = 200 mA)	G_{PE}	13	—	—	dB
Saturated Output Power (V_{CE} = 23 V, f = 470 MHz, I_C = 200 mA)	P_{sat}	—	2.2	—	W

2

TYPICAL CHARACTERISTICS

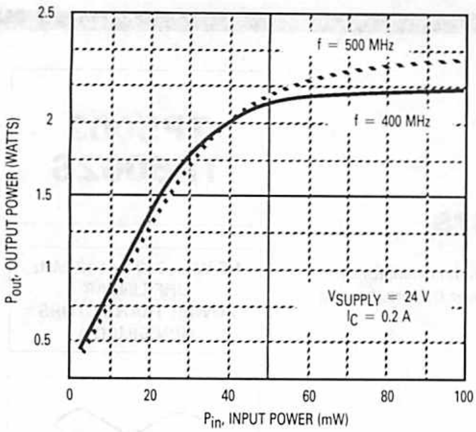


Figure 1. Output Power versus Input Power

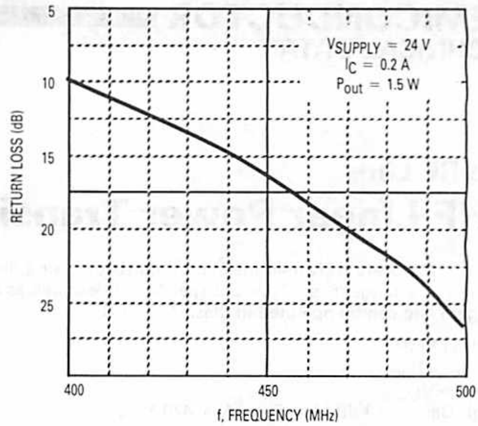


Figure 2. Return Loss versus Frequency

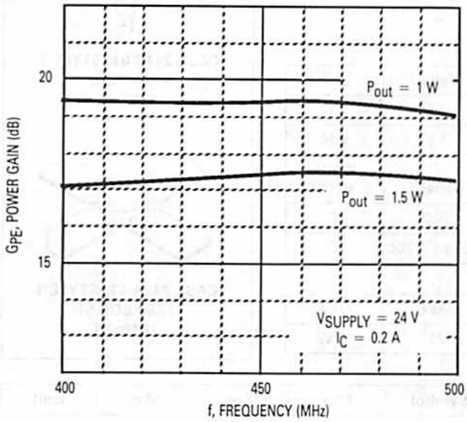


Figure 3. Power Gain versus Frequency

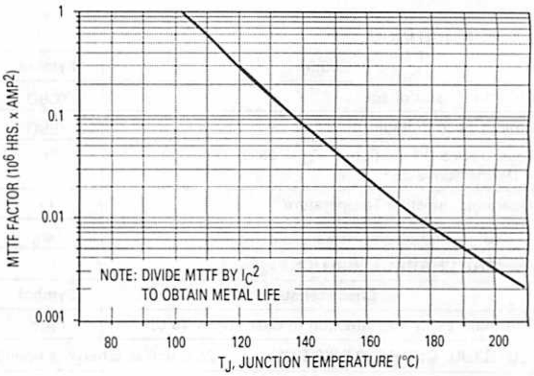


Figure 4. MTTF Factor versus Junction Temperature

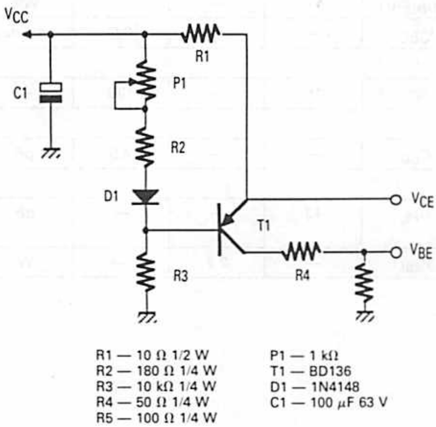


Figure 5. Class A Bias Circuit

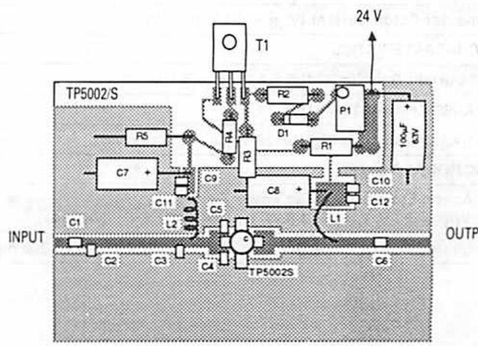
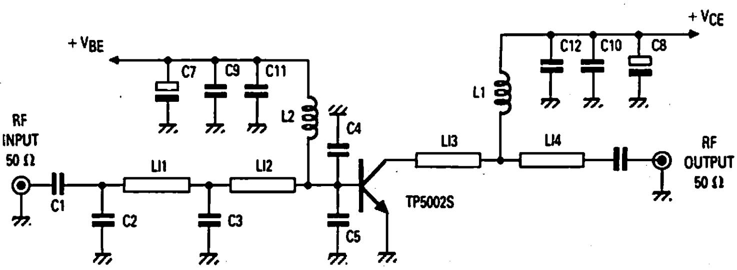


Figure 6. Component Layout



C1, C6 — 220 pF 0805 681C Sprague
C2 — 8.2 pF ATC100A8R2DP50
C3 — 10 pF ATC100A100DP50
C4, C5 — 27 pF ATC100A8R2DP50
C7 — 10 μF 35 V
C8 — 100 μF 63 V
C9, C10 — 1 nF 0805 681C Sprague
C11, C12 — 220 pF 0805 681C Sprague

LI1 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 6% λg at 470 MHz
LI2 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 3% λg at 470 MHz
LI3 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 5% λg at 470 MHz
LI4 — Microstrip Line W = 2.5 mm Z_o = 70 Ω, L = 3% λg at 470 MHz

Board Material: 1/16 In. Teflon Glass, ϵ_r = 2.55, h = 1.59 mm

L1 — Hairpin wire 1.1 mm L = 33 mm
L2 — 4 turns, ID 2.5 mm, 0.5 mm wire

Figure 7. 400–500 MHz Broadband Amplifier

FREQUENCY (MHz)	400	410	420	430	440	450	460	470	480	490	500
RE(Zin)Ω	2.5	2.5	2.5	2.3	2.4	2.3	2.2	2.2	2.1	2.1	2.0
IM(Zin)Ω	2.0	2.2	2.7	3.2	3.5	3.8	3.9	4.0	4.2	4.9	5.0
RE(Zload)Ω	33.4	35.5	36.5	37.0	38.4	39.5	40.4	41.4	42.4	43.4	44.4
IM(Zload)Ω	48.3	48.9	49.4	49.9	50.8	50.9	51.3	51.7	52.2	52.6	53.0

Impedance Data
V_{CC} = 23 Volts
I_C = 200 mA
P_{out} = 1.5 Watts

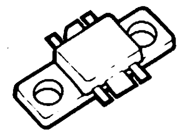
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

Advance Information
The RF Line
UHF Linear Power Transistor

TP5015

15 W — 380–512 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON



CASE 319C-01, STYLE 2
(EB)

. . . designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- 380–512 MHz
- 15 W — P_{out}
- 24 V — V_{CC}
- High Gain — 11 dB Min, Class AB
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	18 0.143	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	7	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 75 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CE} = 26 V, R_{BE} = 75 Ω)	I_{CER}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 10 V)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	16	24	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 24 V, P_{out} = 15 W, f = 470 MHz, I_Q = 50 mA)	G_{PE}	11	—	—	dB
Collector Efficiency (V_{CE} = 24 V, P_{out} = 15 W, f = 470 MHz, I_Q = 50 mA)	η_c	50	60	—	%

This document contains information on a new product. Specifications and information herein are subject to change without notice.

TP5025

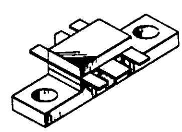
The RF Line

UHF Power Transistor

Designed for 24 Volts UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- 380–512 MHz
- 25 W — P_{out}
- 24 V — V_{CC}
- 9.0 dB Min, Class AB

25 W — 380–512 MHz
UHF POWER
TRANSISTOR
NPN SILICON



CASE 319-06, STYLE 2

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CER}	40	Vdc
Collector-Base Voltage	V_{CBO}	50	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector-Current — Continuous	I_C	8.0	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	45 0.3	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Operating Junction Temperature	T_J	200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (1) at 70°C Case	$R_{\theta JC}$	4.0	°C/W

ELECTRICAL CHARACTERISTICS (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 30 mA, I_B = 0)	$V_{(BR)CER}$	40	—	—	Vdc
Emitter-Base Breakdown Voltage (I_C = 5.0 mAdc)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Base Breakdown Voltage (I_E = 50 mAdc)	$V_{(BR)CBO}$	48	—	—	Vdc
Collector-Emitter Leakage (V_{CE} = 30 V, R_{BE} = 75 Ω)	I_{CER}	—	—	5.0	mA

NOTE: 1. Thermal resistance is determined under specified RF operating condition.

(continued)

ELECTRICAL CHARACTERISTICS — continued (T_C = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
ON CHARACTERISTICS					
DC Current Gain (I_C = 1.0 Adc, V_{CE} = 10 Vdc)	h_{FE}	15	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1.0 MHz)	C_{ob}	—	22	30	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 24 V, P_{out} = 25 W, I_{CQ} = 60 mA) (f = 470 MHz)	G_p	9.0	10	—	dB
Collector Efficiency (V_{CC} = 24 V, P_{out} = 25 W, f = 470 MHz)	η_c	50	55	—	%
Load Mismatch at all Phase Angles (V_{CC} = 24 V, P_{out} = 25 W, I_{CQ} = 60 mA)	ψ	5:1	—	—	VSWR

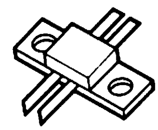
TP5040

The RF Line
UHF Power Transistor

40 W — 380 to 512 MHz
UHF POWER
TRANSISTOR
NPN SILICON

... designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 380 to 512 MHz frequency range, i.e., cellular radio base stations.

- *380–512 MHz*
- 40 W — P_{out}
- 24 V — V_{CC}
- High Gain — 9 dB Min, Class AB
- Gold Metallization for Reliability



CASE 395-01, STYLE 1
(BMA-2)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 70°C (Note 1) Derate above 70°C	P_D	65 0.5	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2	°C/W

Note 1. These devices are designed for RF operation. The total dissipation rating applies only when the device is operated in an RF push-pull amplifier.

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 47 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 500 mA, V_{CE} = 10 V)	h_{FE}	15	120	—	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	40	pF

Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 24 V, P_{out} = 40 W, f = 470 MHz, I_Q = 2 x 50 mA)	G_{PE}	9	—	—	dB
Collector Efficiency (V_{CE} = 24 V, P_{out} = 40 W, f = 470 MHz, I_Q = 2 x 50 mA)	η_c	45	50	—	%

Note 2. Both transistor chips operating in push-pull amplifier.

TYPICAL CHARACTERISTICS

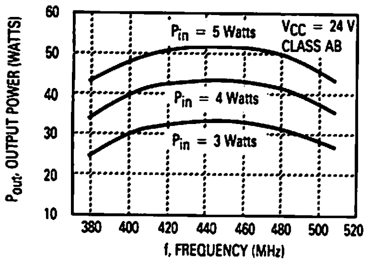


Figure 1. Output Power versus Frequency

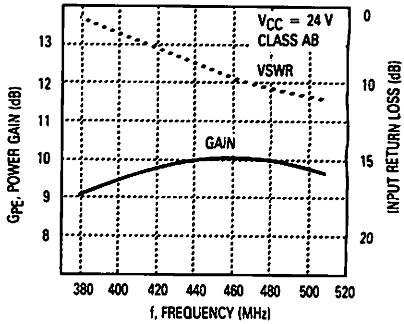


Figure 2. Gain versus Frequency

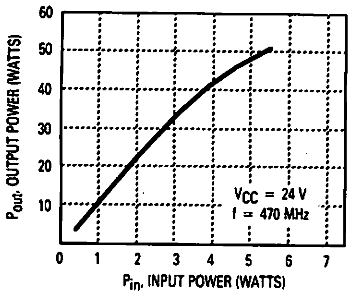
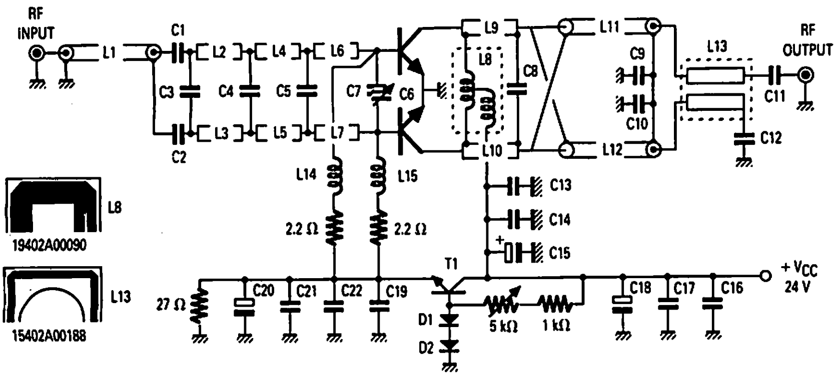


Figure 3. Output Power versus Input Power

F (MHz)	400	430	470	500
Input Impedance Ω	2.5 + j1.0	2.75 + j2.0	3.0 + j3.1	3.25 + j4.25
Output Impedance Ω	8.5 - j6.5	7 - j6.5	6.0 - j6.25	4.75 - j6.0

Figure 4. Series Equivalent Input/Output Impedances

CONDITIONS:
V_{CE} = 24 V
I_Q = 2 x 50 mA — Class AB
P_{out} = 40 W
Collector-to-Collector



L1 — 50 Ω Coaxial Cable, 20% λg @ 470 MHz
L2, L3 — Wire Dia. 0.5 mm, L = 5 mm
L4, L5 — Microstrip Line 7.5 mm 1679 Ω, 1.7% λg @ 470 MHz
L6, L7 — Microstrip Line 7.5 mm 39 Ω, 1.7% λg @ 470 MHz
L8 — Collector/Collector Inductor, 1/50" Teflon Glass
L9, L10 — Microstrip Line 7 mm 50 Ω, 1.7% λg @ 470 MHz
L11, L12 — 25 Ω Coaxial Cable, 56 mm
L13 — Balun 50 Ω, 12.5% λg @ 470 MHz
L14, L15 — 3 Turns ID 3 mm Wire 1 mm
C1, C2, C7 — 47 pF ATC100A470JP50 Capacitor
C3 — 4.7 pF ATC100A4R7DP50 Capacitor
C4 — 5.6 pF ATC100A5R6DP50 Capacitor
C5 — 15 pF ATC100A150DP50 Capacitor
C6 — Trimmer 1–4 pF/Johanson 9401-4
C8 — 12 pF ATC100A120DP50 Capacitor
C9 — 1 nF Chip 0805 Sprague/Vitramon Capacitor
C10 — 15 nF Chip 0805 Sprague/Vitramon Capacitor
C11, C12 — 100 pF ATC100A101KP50 Capacitor
C13, C17, C21 — 100 pF ATC100A101KP50 Capacitor
C14, C16, C22 — 10 nF 0805 Sprague/Vitramon Capacitor
C19 — 0.1 nF 0805 Sprague/Vitramon Capacitor
C18, C20 — 100 μF 40 V Capacitor
C15 — 10 μF 63 V Capacitor
D1, D2 — 1N4007 Diode
T1 — BD135 Transistor

Board Material: .020 In., Teflon Glass

Figure 5. 380–512 MHz Broadband Test Circuit

2

2

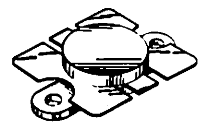
The RF Line
UHF Linear Power Transistor

TP5050

**50 W — 470 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON**

... designed for 24 Volt UHF large-signal common emitter amplifier applications in industrial and commercial FM equipment operating in the 440 to 470 MHz frequency range, i.e., cellular radio base stations.

- 440–470 MHz
- 50 W — P_{out}
- 28 V — V_{CC}
- Rugged
- Gold Metallization for Reliability



CASE 316A-01, STYLE 1
(.500 J ZERO)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	32	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	65 0.67	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	32	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 5 A, V_{CE} = 5 V)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	70	—	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 470 MHz, I_Q = 100 mA)	G_{PE}	6.5	7	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 50 W, f = 470 MHz, I_Q = 100 mA)	η_c	60	65	—	%
Load Mismatch (V_{CE} = 28 V, I_Q = 100 mA, P_{out} = 50 W, f = 470 MHz, Load VSWR = 20:1, All Phase Angles)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

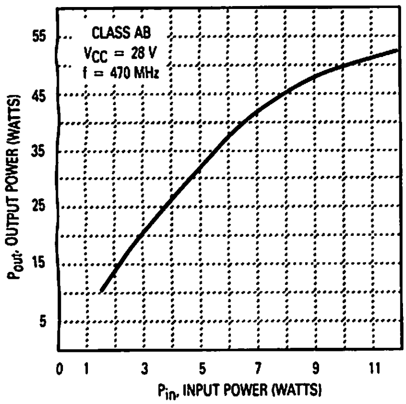


Figure 1. Output Power versus Input Power

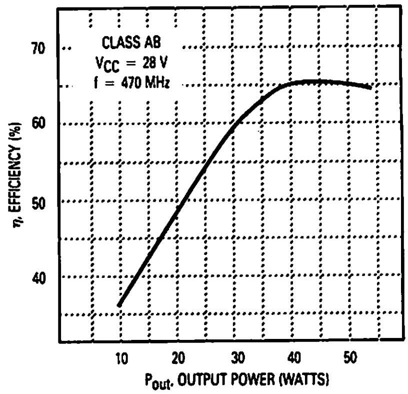


Figure 2. Efficiency versus Power Output

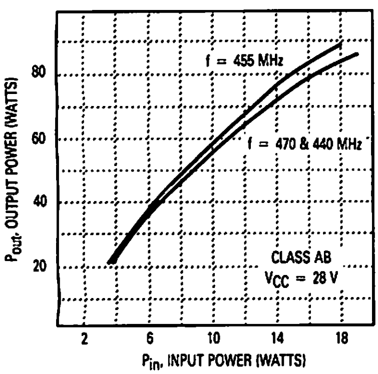


Figure 3. Output Power versus Input Power

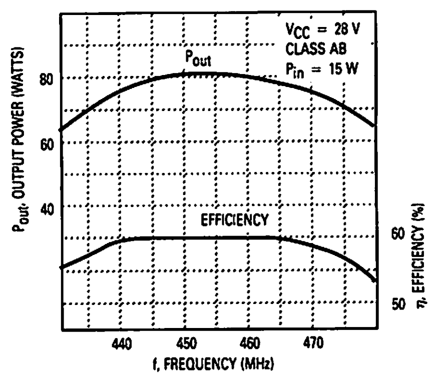


Figure 4. Output Power and Efficiency versus Frequency

2

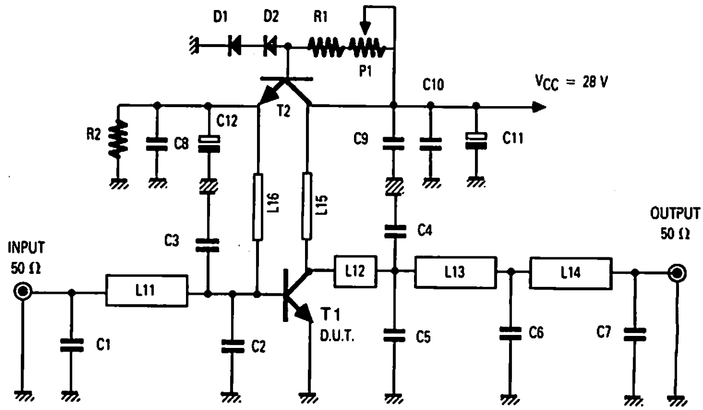


Figure 5. 440–470 MHz Test Circuit

C1 — 6.8 pF ATC100A
C2, C4, C5 — 39 pF ATC100A
C3 — 27 pF ATC100A
C6 — 15 pF ATC100A
C7 — 8.2 pF ATC100A

C8, C9 — 1 nF Sprague
C10 — 100 nF Sprague
C11 — 100 μF 63 V
C12 — 4.7 μF 12 V
R1 — 2.2 kΩ R2 51 Ω
P1 — 1 kΩ

L11 — Microstrip Line W = 3.2 mm L = 12 mm
L12 — Microstrip Line W = 3.2 mm L = 4 mm
L13 — Microstrip Line W = 3.2 mm L = 12 mm
L14 — Microstrip Line W = 3.2 mm L = 22 mm
L15 — Microstrip Line W = 1.8 mm L = 85 mm
L16 — Microstrip Line W = 8 mm L = 70 mm
T2 — BD135

Board Material: 1/16 Inch, Epoxy Glass, ϵ_r = 4.5

TP5060

Advance Information

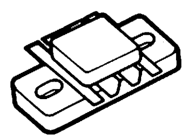
The RF Line

UHF Linear Power Transistor

60 W — 470 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON

. . . designed for 24–28 Volt UHF large-signal common emitter amplifier applications in *industrial and* commercial FM equipment operating in the 430 to 470 MHz frequency range, i.e., cellular radio base stations.

- 430–470 MHz
- 60/50 W — P_{out}
- 28/24 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability
- Guaranteed Ruggedness at Rated P_O



CASE 827-01, STYLE 1
(MRP 7)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Total Device Dissipation @ T_C = 70°C (Note 1) Derate above 70°C	P_D	160 1.43	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−60 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 2)					
Collector-Emitter Breakdown Voltage (I_C = 45 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 45 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 45 mA, R_{BE} = 15 Ω)	$V_{(BR)CER}$	55	—	—	Vdc
ON CHARACTERISTICS (Note 2)					
DC Current Gain (I_C = 500 mA, V_{CE} = 28 V)	h_{FE}	20	—	—	—
DYNAMIC CHARACTERISTICS (Note 2)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	60	—	pF

Notes: 1. These devices are designed for RF operation. The total dissipation rating applies only when the devices are operated as RF push-pull amplifiers.
2. Each transistor chip measured separately.

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 1)					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 60 W, f = 470 MHz, I_Q = 2 x 100 mA)	G_{PE_1}	6.5	7	—	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 24 V, P_{out} = 50 W, f = 470 MHz, I_Q = 2 x 100 mA)	G_{PE_2}	6	6.5	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 60 W, f = 470 MHz, I_Q = 2 x 100 mA)	η_c	45	50	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 60 W, f = 470 MHz, Load VSWR = 25:1, All Phase Angles)	ψ	No Degradation in Output Power			

Note 1: Both transistor chips operating in push-pull amplifier.

TP9380

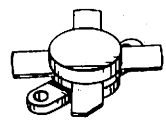
The RF Line
VHF Power Transistor

75 W to 108 MHz
VHF POWER
TRANSISTOR

. . . designed for use in the new generation of VHF-FM broadcast transmitters operating from a 28 V supply in Class A, B or C.

Its construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 108 MHz
- 75 W — P_{out}
- 28 V — V_{CC}
- High Gain — 11 dB, Class C
- Gold Metallization for Improved Reliability
- Diffused Emitter Ballast Resistors for Ruggedness



CASE 211-11, STYLE 1
(.500 SOE F)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 70°C	P_D	100 0.67	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	85	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 75 W, f = 108 MHz)	G_{PE}	10.3	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 75 W, f = 108 MHz)	η_c	70	75	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 75 W, f = 108 MHz, Load VSWR = 4:1, All Phase Angles)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

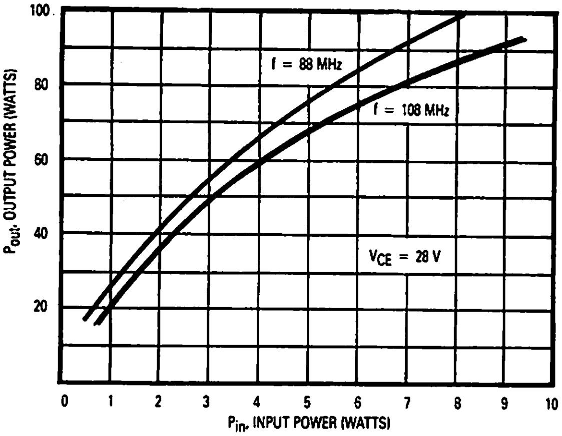


Figure 1. Power Output versus Power Input

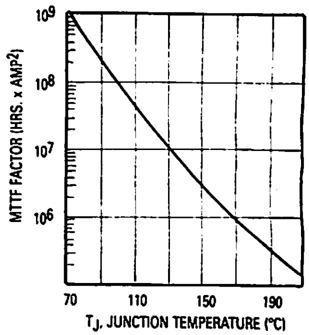


Figure 2. MTTF Factor versus Junction Temperature

Note: Divide by I_C^2 to obtain metal lifetime in hours

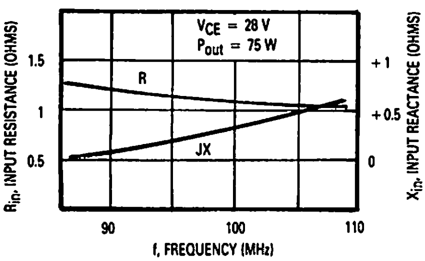


Figure 3. Series Input Impedance versus Frequency

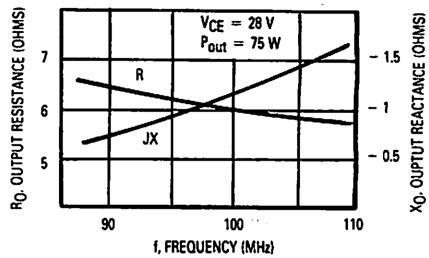


Figure 4. Series Output Impedance versus Frequency

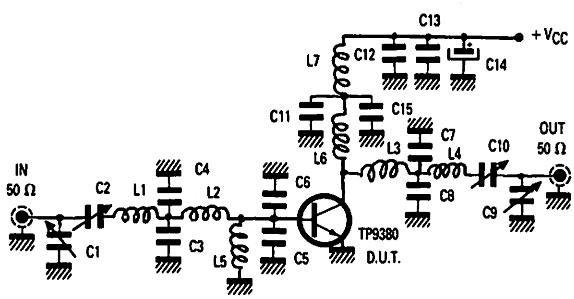


Figure 5. 88–108 MHz Narrowband Test Fixture

C1 — Arco 425 Variable capacitor (24–200 pF)
C2 — Arco 425 Variable capacitor (24–200 pF)
C3 — 60 pF UNELCO
C4 — 60 pF UNELCO (108 MHz)
100 pF UNELCO (88 MHz)
C5 — 330 pF chip capacitor (closed to the transistor)
C6 — 330 pF chip capacitor (closed to the transistor)
C7 — 40 pF UNELCO
C8 — 40 pF UNELCO (108 MHz)
80 pF UNELCO (88 MHz)
C9 — Arco 423 Variable capacitor (7–100 pF)
C10 — Arco 425 Variable capacitor (24–200 pF)
C11 — 1000 pF UNELCO
C12 — 1000 pF UNELCO
C13 — 0.1 μF disc capacitor
C14 — 100 μF/40 V capacitor
C15 — 10 nF disc capacitor

L1 — 3 turns ID = 6 mm 1 mm wire
L2 — « Hair pin » made with a 1.4 mm wire L = 15 mm
L3 — « Hair pin » made with a 2 mm wire L = 20 mm for 108 MHz
« Hair pin » made with a 2 mm wire L = 30 mm for 88 MHz
L4 — 3 turns ID = 8 mm 1.4 mm wire
L5 — 0.7 μH choke
L6 — 6 turns ID = 6 mm 1.2 mm wire L = 15 mm
L7 — 4 turns 1.2 mm wire on ferrite

TP9383

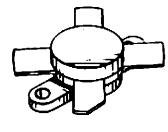
The RF Line
VHF Power Transistor

... designed for use in the new generation of VHF-FM broadcast transmitters operating from a 28 V supply in Class A, B or C.

Its construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 108 MHz
- 150 W — P_{out}
- 28 V — V_{CC}
- High Gain — 10 dB Typ
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

**150 W — 108 MHz
VHF POWER
TRANSISTOR**



CASE 211-11, STYLE 1
(.500 SOE F)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Total Device Dissipation @ T_C = 25°C Derate above 70°C	P_D	150 1	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 100 mA, I_E = 0)	$V_{(BR)CBO}$	60	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	55	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	150	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 150 W, f = 108 MHz)	G_{PE}	9.2	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 150 W, f = 108 MHz)	η_c	70	75	—	%
Load Mismatch (V_{CE} = 28 V, P_{out} = 150 W, f = 108 MHz, Load VSWR = 4:1, All Phase Angles) (V_{CE} = 28 V, P_{out} = 100 W, f = 108 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

TYPICAL CHARACTERISTICS

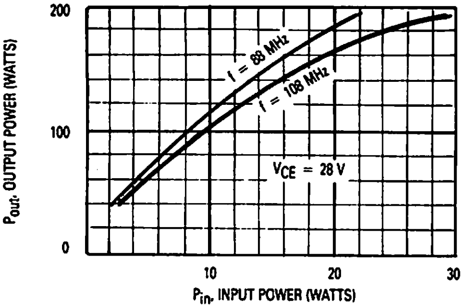


Figure 1. Output Power versus Input Power

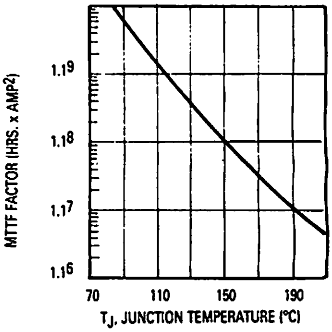


Figure 2. MTTF Factor versus Junction Temperature

NOTE: Divide by I_C^2 to obtain metal lifetime in hours

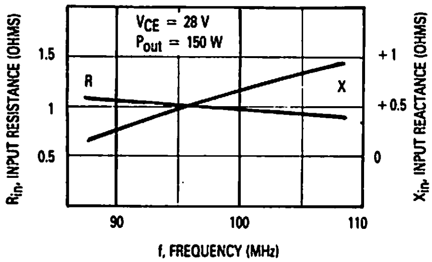


Figure 3. Series Input Impedance versus Frequency

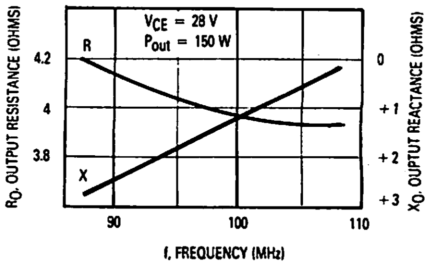


Figure 4. Output Impedance versus Frequency

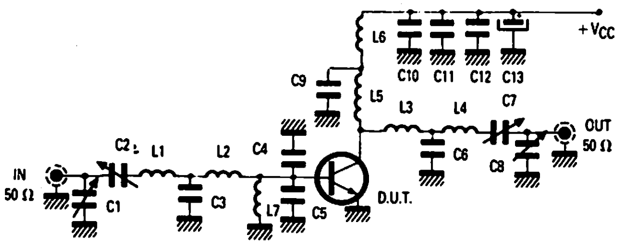


Figure 5. 108 MHz Test Circuit

C1 — Arco 425 Variable capacitor 24–200 pF
C2 — Arco 425
C3 — 150 pF UNELCO
C4 — 470 pF Chip capacitor (very close to the transistor) ATC
C5 — 470 pF Chip capacitor (very close to the transistor) ATC
C6 — 300 pF UNELCO
C7 — ARCO 425
C8 — ARCO 425
C9 — 1000 pF UNELCO
C10 — 1000 pF UNELCO
C11 — 10000 pF
C12 — 0.1 μF
C13 — 100 μF/40 V electrolytic

L1 — 3 turns 6 mm ID 1.2 mm wire
L2 — 2 cm wire 1.2 mm Ω (hair pin)
L3 — 1.2 cm wire 1.2 mm Ω (hair pin)
L4 — 3 turns 6 mm ID 1.2 mm wire
L5 — 6 turns 8 mm ID 1.5 mm wire
L6 — 6 turns 1.5 mm wire on ferrite core
L7 — 10 μF choke

TP9386

The RF Line

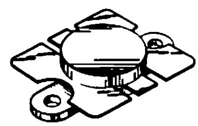
VHF Power Transistor

... designed for use in VHF transmitters. Operation is in Class A, B or C from a 28 V supply.

Construction, which now incorporates gold metallization and diffused ballast resistors, ensures a long operational life even when run at its maximum ratings.

- 100–175 MHz
- 150 W — P_{out}
- 28 V — V_{CC}
- High Gain — 10 dB Min @ f = 175 MHz
- Gold Metallization for Reliability
- Diffused Emitter Ballast Resistors for Ruggedness

**150 W — 175 MHz
VHF POWER
TRANSISTOR**



CASE 316A-01, STYLE 1
(.500 J ZERO)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	15	Adc
Total Device Dissipation @ T_C = 25°C Derate above 70°C	P_D	250 1.43	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	0.7	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	15	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	150	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 150 W, f = 175 MHz, I_Q = 50 mA)	G_{PE}	10	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 150 W, f = 175 MHz, I_Q = 50 mA)	η_c	60	—	—	%

TYPICAL CHARACTERISTICS

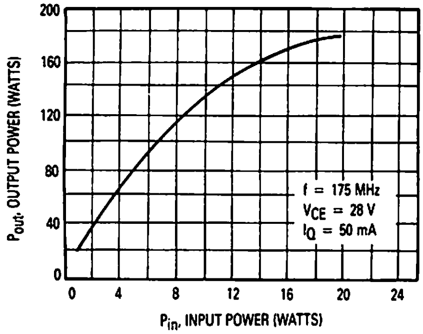


Figure 1. Output Power versus Input Power

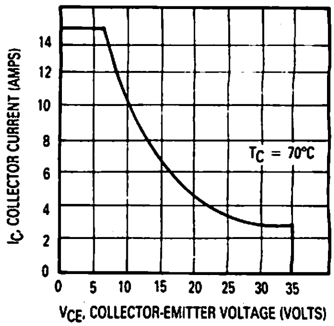
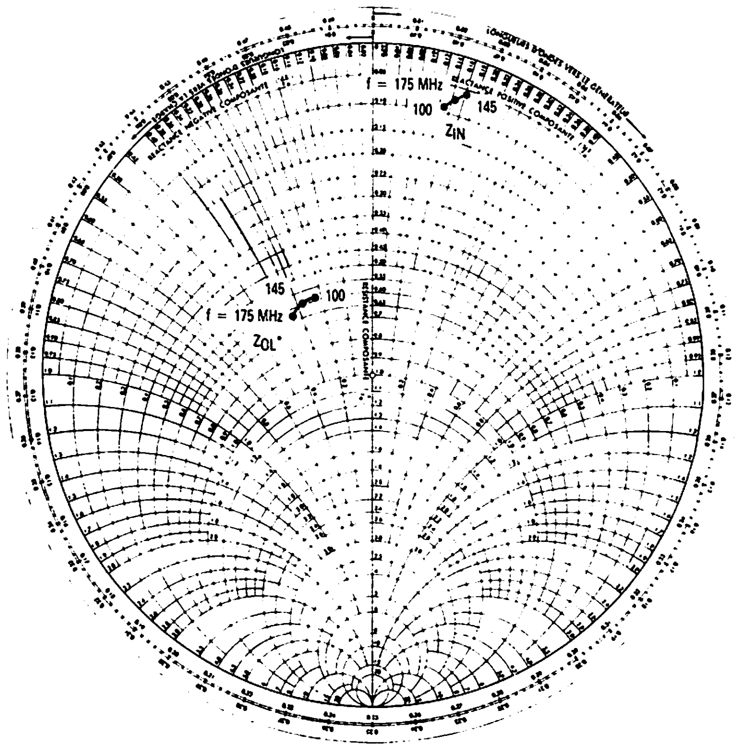


Figure 2. DC Safe Operating Area



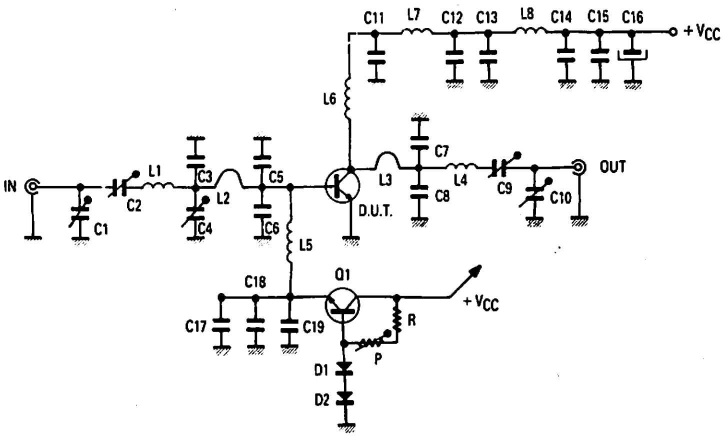
Conditions

V_{CE} = 28 V, I_Q = 50 mA, P_{out} = 150 W

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
100	0.43 + j0.65	2.88 − j1.13
145	0.40 + j0.7	2.88 − j1.22
175	0.29 + j0.87	3.16 − j1.39

Figure 3. Series Equivalent Input/Output Impedances

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



C1, C2 — ARCO 403
C3 — 30 pF
C4 — ARCO 404
C5, C6 — 80 pF
C7, C8 — 100 pF
C9, C10 — ARCO 425 (24–200 pF)
C11, C12, C14, C17 — 1000 pF
C13, C15, C18 — 10 nF
C16, C19 — 47 μF

L1 — 2 turns, ø 8 mm 1 mm wire
L2 — Hair pin, Copper foil 15 x 3 mm, 0.3 mm thick
L3 — Hair pin, Copper foil 12 x 5 mm, 0.3 mm thick
L4 — 3 turns, ø 5 mm, 1.5 mm wire
L5 — 10 turns, ø 5 mm, 0.5 mm wire
L6 — 3 turns, ø 6 mm, 1.5 mm wire
L7 — 3 turns, ø 6 mm, 1.5 mm wire
L8 — 10 turns, 1 mm wire on core (μi = 120)

R — 1.5 Ω 1/2 W
P — 5 kΩ
D1, D2 — 1N4007
Q1 — BD135

Figure 4. 175 MHz Test Fixture

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TP62601

The RF Line

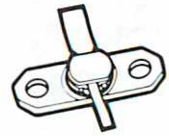
Microwave Power Oscillator Transistor

2

MICROWAVE POWER OSCILLATOR TRANSISTOR

. . . designed for use as power oscillators at frequencies to 3 GHz with typical output power of over 1 watt.

- Operation to 3 GHz
- High Output Power (1.2 W Typ @ 2.5 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistors
- Common Collector Configuration
- Formerly named TRW62601



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.5	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	15	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.125	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 2 GHz, I_E = 220 mA)	P_{out}	1.25	—	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 220 mA, P_{out} = 1.25 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 220 mA)	f_T	—	2.7	—	GHz

TYPICAL CHARACTERISTICS

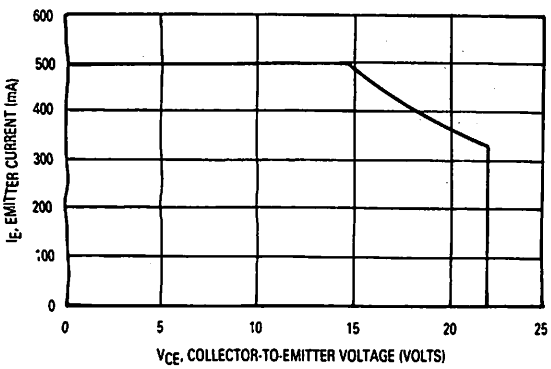


Figure 1. DC Safe Operating Area

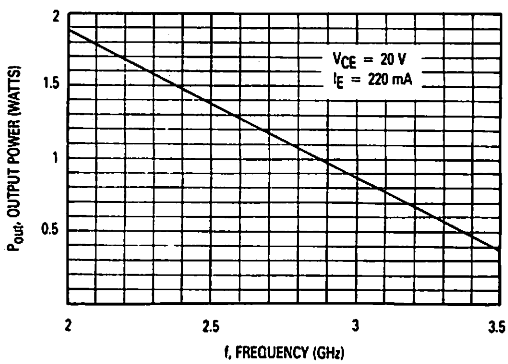


Figure 2. Output Power versus Frequency

C1 — 220 pF (chip)
C2 — 220 pF (chip) + 10 nF
C3 — 220 pF (chip) + 10 nF + 10 μF
C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

θ — 0.115 λg for f_o = 2.3 GHz
θ — 0.06 λg for f_o = 3 GHz

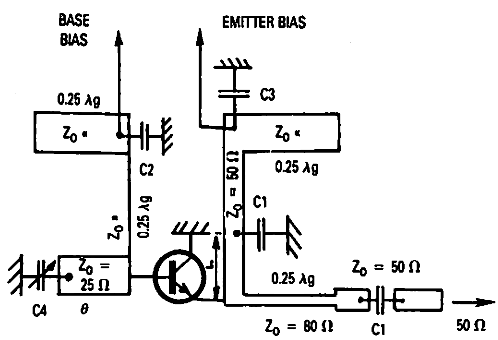


Figure 3. Test Circuit

2

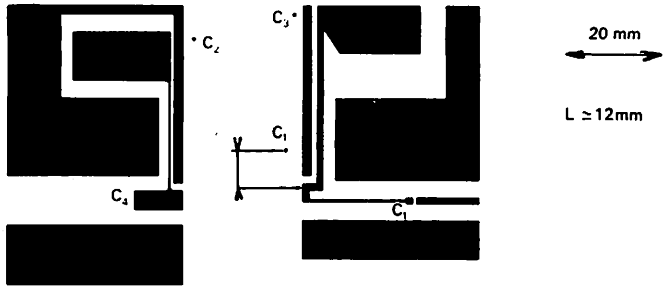
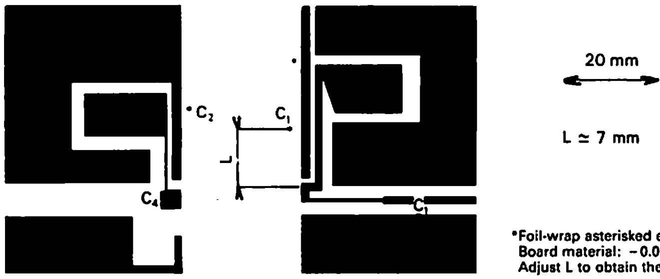


Figure 4. PC Board Layout for f_o = 2.3 GHz (BW = 500 MHz)



*Foil-wrap asterisked edge to ground plane.
Board material: −0.020" Glass teflon (ϵ_r = 2.55)
Adjust L to obtain the maximum output power

Figure 5. PC Board Layout for f_o = 3 GHz (BW = 500 MHz)

TYPICAL CHARACTERISTICS

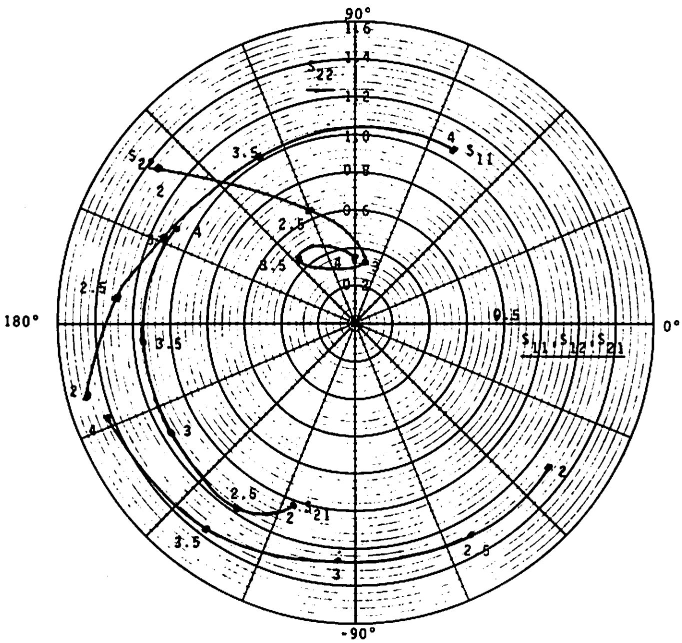


Figure 6. Small Signal S-Parameters
(V_{CE} = 20 V, I_E = 220 mA)

TP62602

2

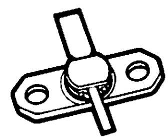
The RF Line

Microwave Power Oscillator Transistor

MICROWAVE POWER OSCILLATOR TRANSISTOR

... designed for use as power oscillators at frequencies to 3 GHz with guaranteed output power of 2.5 W @ 2 GHz.

- *Operation to 3 GHz*
- High Output Power (2 W Typ @ 2.5 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistors
- Common Collector Configuration
- Formerly named TRW62602



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	8.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
Collector-Emitter Breakdown Voltage (I_C = 40 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 2 GHz, I_E = 440 mA)	P_{out}	2.5	—	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 440 mA, P_{out} = 2.5 W, f = 2 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 440 mA)	f_T	—	2.7	—	GHz

2

TYPICAL CHARACTERISTICS

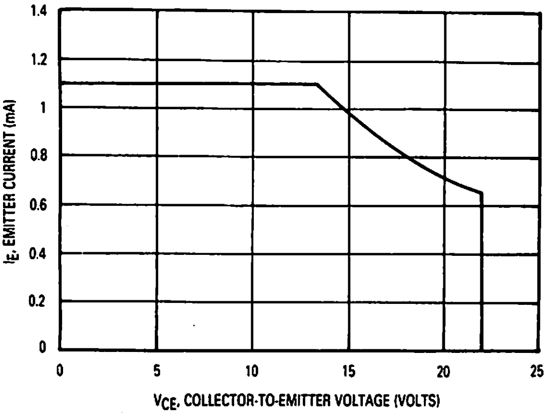


Figure 1. DC Safe Operating Area

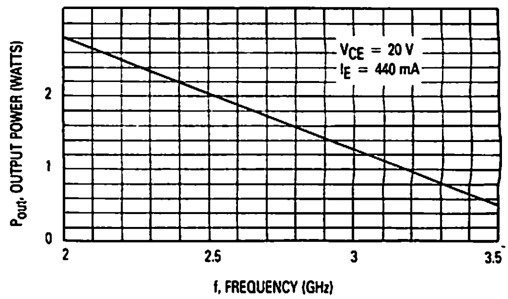


Figure 2. Output Power versus Frequency

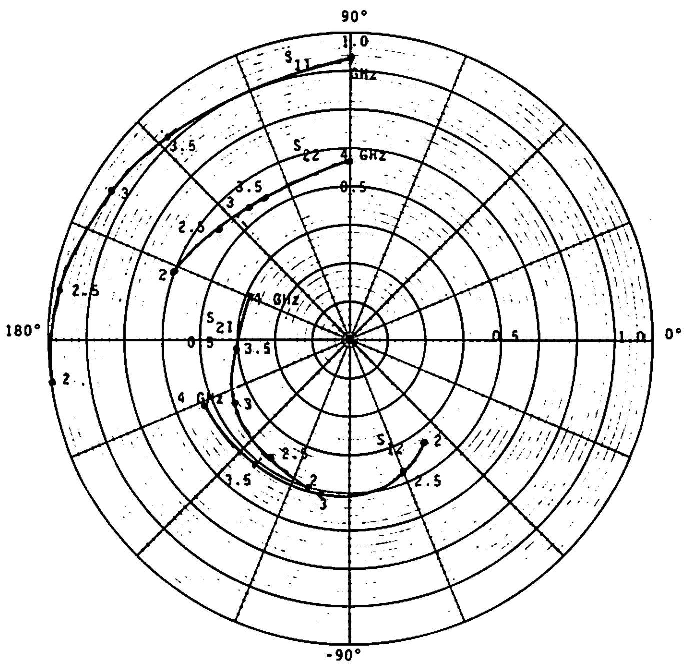


Figure 3. Small Signal S-Parameters
(V_{CE} = 20 V, I_E = 440 mA)

C1 — 220 pF (chip)
C2 — 220 pF (chip) + 10 nF
C3 — 220 pF (chip) + 10 nF + 10 μF
C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

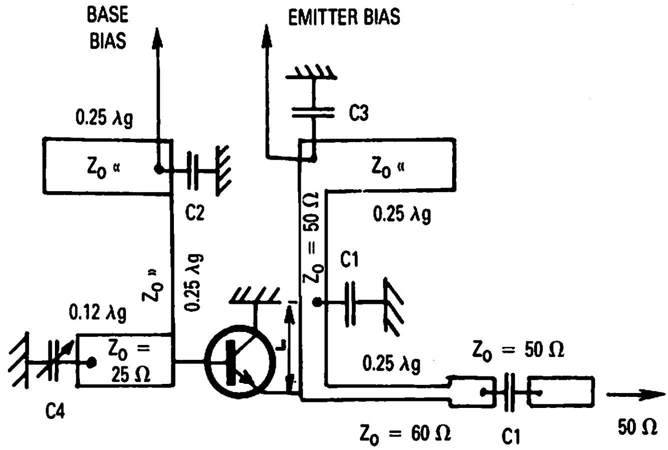
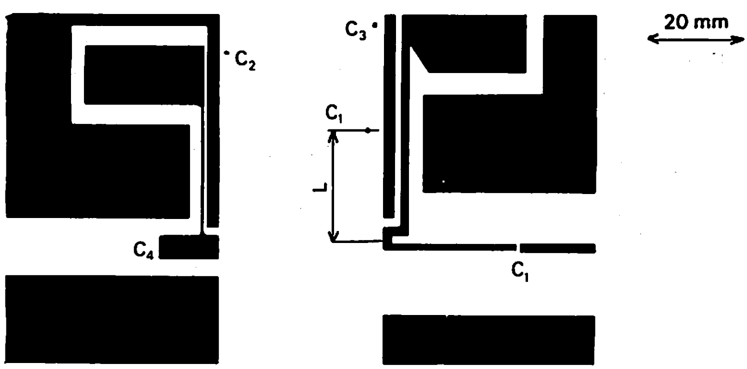


Figure 4. Test Circuit



*Foil-wrap asterisked edge to ground plane.
Board material: −0.020" Glass teflon (ϵ_r = 2.55)
Adjust L to obtain the maximum output power

For f = 2 GHz L = 24 mm
f = 2.3 GHz L = 19 mm
f = 2.5 GHz L = 14 mm

Figure 5. PC Board Layout for f_0 = 2.3 GHz (BW = 500 MHz)

2

TP63601

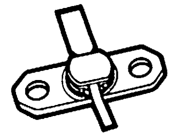
The RF Line

Microwave Power Oscillator Transistor

MICROWAVE POWER OSCILLATOR TRANSISTOR

. . . designed for use as power oscillators at frequencies to 3.5 GHz with guaranteed output power of 0.6 W @ 2.3 GHz.

- Operation to 3.5 GHz
- High Output Power (0.43 W Typ @ 3 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration
- Formerly named TRW63601



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	32	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3.5	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 2.3 GHz, I_E = 120 mA)	P_{out}	0.6	—	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.6 W, f = 2.3 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)	f_T	—	3	—	GHz

2

TYPICAL CHARACTERISTICS

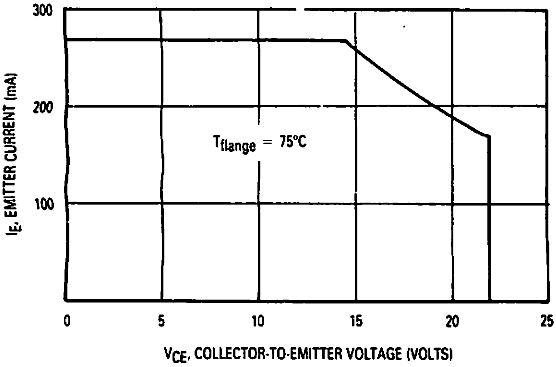


Figure 1. DC Safe Operating Area

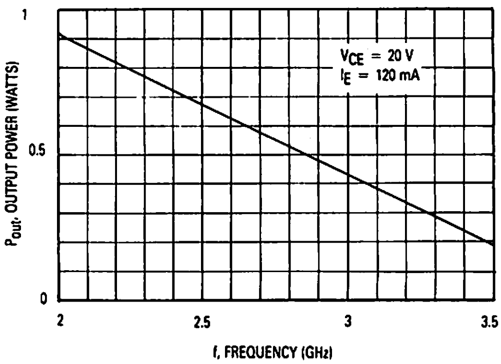


Figure 2. Output Power versus Frequency

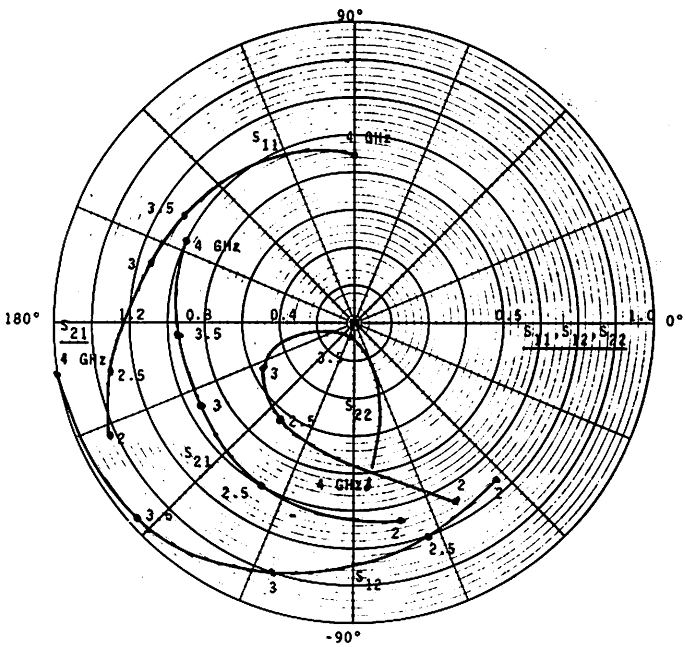


Figure 3. Small Signal S-Parameters
(V_{CE} = 20 V, I_E = 120 mA)

C1 — 220 pF (chip)
C2 — 220 pF (chip) + 10 nF
C3 — 220 pF (chip) + 10 nF + 10 μF
C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

θ — 0.115 λg for f_o = 2.3 GHz
θ — 0.06 λg for f_o = 3 GHz

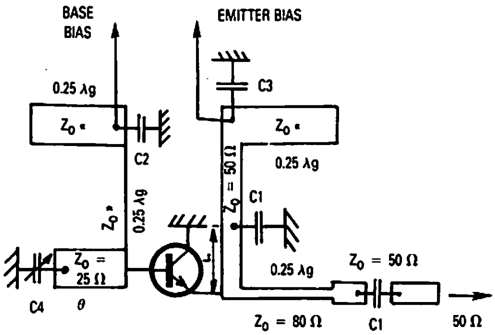


Figure 4. Test Circuit

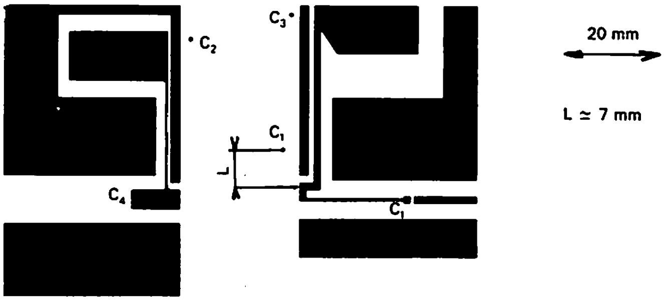


Figure 5. PC Board Layout for f_o = 2.3 GHz (BW = 500 MHz)

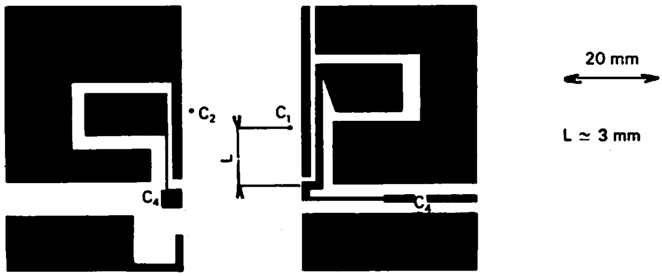


Figure 6. PC Board Layout for f_o = 3 GHz (BW = 500 MHz)

*Foil-wrap asterisked edge to ground plane.
Board material: – 0.020" Glass teflon (ϵ_r = 2.55)
Adjust L to obtain the maximum output power

TP63602

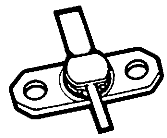
The RF Line

Microwave Power Oscillator Transistor

MICROWAVE POWER OSCILLATOR TRANSISTOR

... designed for use as power oscillators at frequencies to 3.5 GHz with guaranteed output power of 1.2 W @ 2.3 GHz.

- Operation to 3.5 GHz
- High Output Power (0.85 W Typ @ 3 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration
- Formerly named TRW63602



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	20	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	17	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	20	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5.5	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 2.3 GHz, I_E = 230 mA)	P_{out}	1.2	—	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 230 mA, P_{out} = 1.2 W, f = 2.3 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 230 mA)	f_T	—	3	—	GHz

2

TYPICAL CHARACTERISTICS

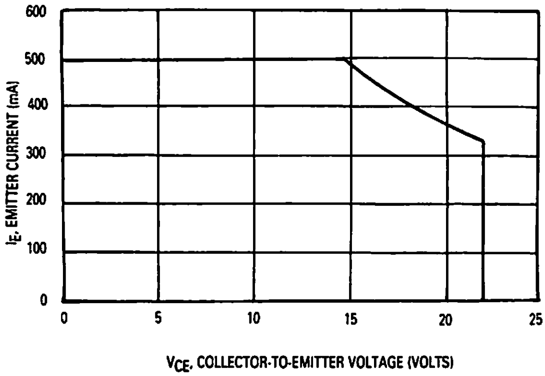


Figure 1. DC Safe Operating Area

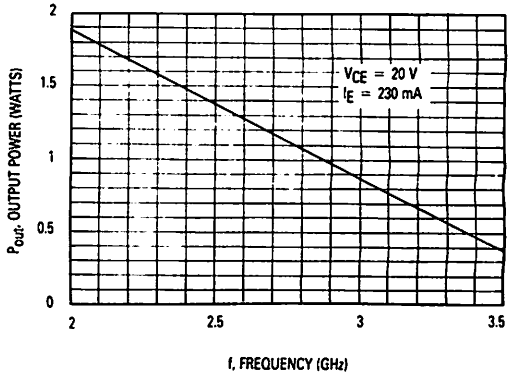


Figure 2. Output Power versus Frequency

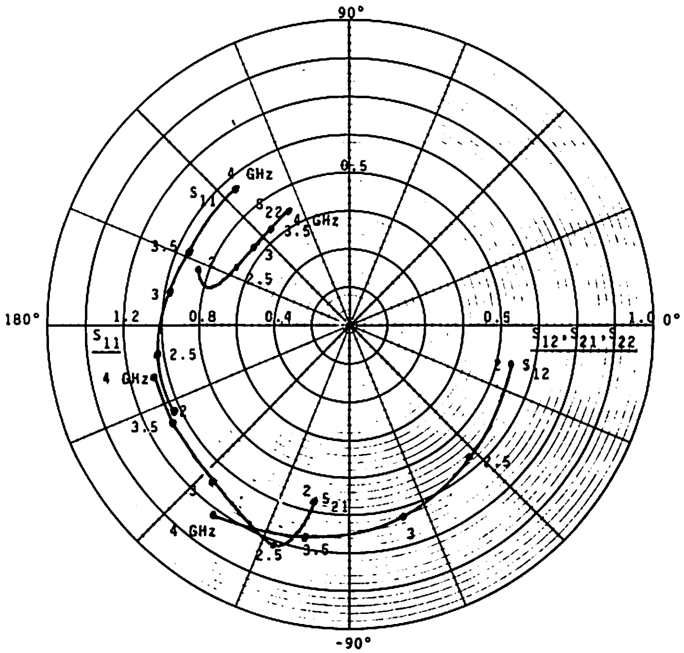
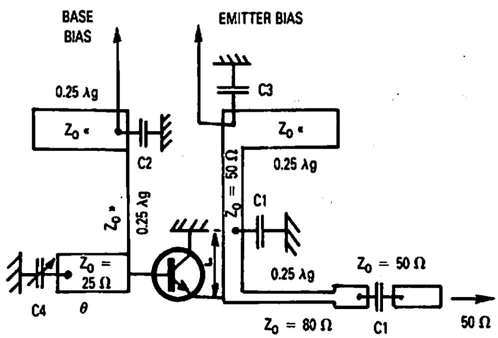


Figure 3. Small Signal S-Parameters
(V_{CE} = 20 V, I_E = 230 mA)

C1 — 220 pF (chip)
C2 — 220 pF (chip) + 10 nF
C3 — 220 pF (chip) + 10 nF + 10 μF
C4 — 0.6–4.5 pF (Frequency tuning)

L — adjust to obtain the maximum output power

θ — 0.115 λg for f_o = 2.3 GHz
θ — 0.06 λg for f_o = 3 GHz



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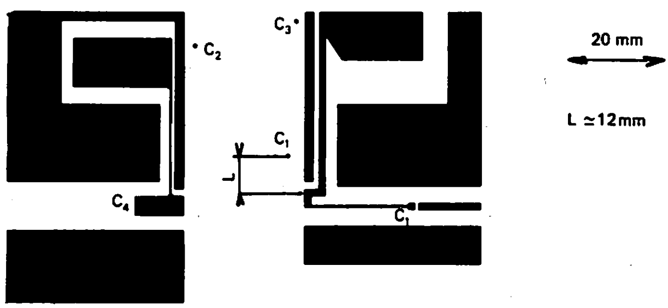


Figure 5. PC Board Layout for f_o = 2.3 GHz (BW = 500 MHz)

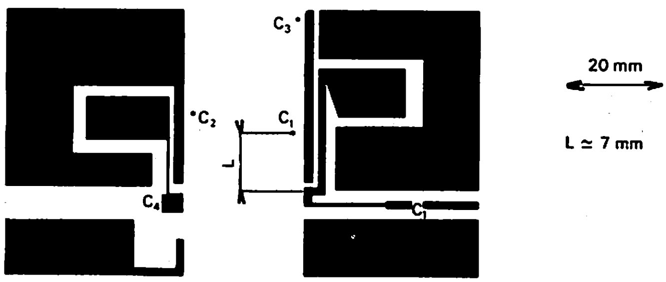


Figure 6. PC Board Layout for f_o = 3 GHz (BW = 500 MHz)

*Foil-wrap asterisked edge to ground plane.
Board material: – 0.020" Glass teflon (ϵ_r = 2.55)
Adjust L to obtain the maximum output power

TP64601

2

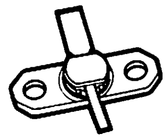
The RF Line

Microwave Power Oscillator Transistor

MICROWAVE POWER OSCILLATOR TRANSISTOR

... designed for use as power oscillators at frequencies to 5 GHz with guaranteed output power 0.3 W @ 4 GHz.

- Operation to 5 GHz
- High Output Power (0.35 W Typ @ 4 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- Gold Metallization
- Diffused Emitter Ballast Resistor
- Common Collector Configuration
- Formerly named TRW64601



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	40	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3.5	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 4 GHz, I_E = 120 mA)	P_{out}	0.3	0.35	—	W
Load Mismatch (V_{CE} = 20 V, I_E = 120 mA, P_{out} = 0.3 W, f = 4 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Cutoff Frequency (V_{CE} = 20 V, I_E = 120 mA)	f_T	—	4	—	GHz

2

TYPICAL CHARACTERISTICS

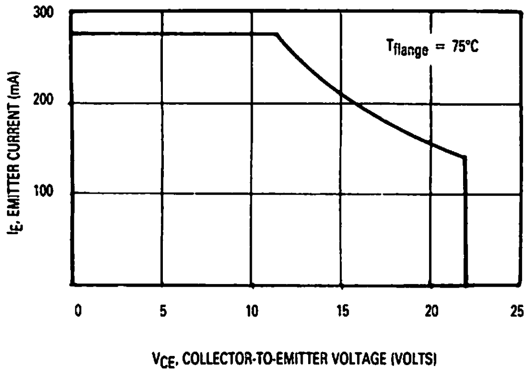


Figure 1. DC Safe Operating Area

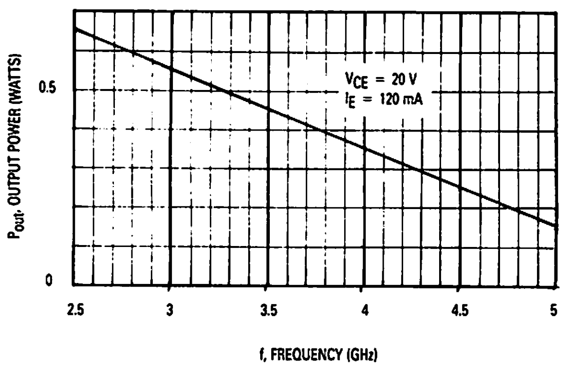


Figure 2. Output Power versus Frequency

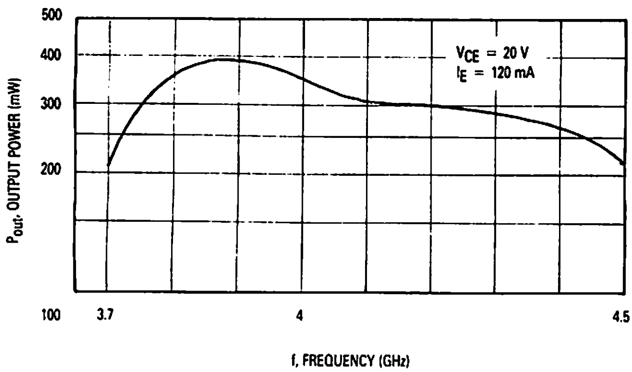
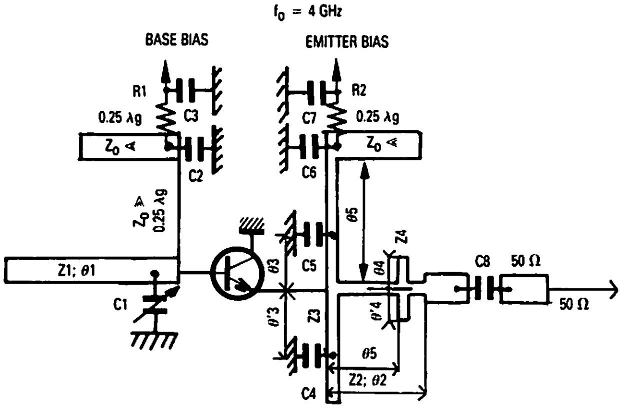


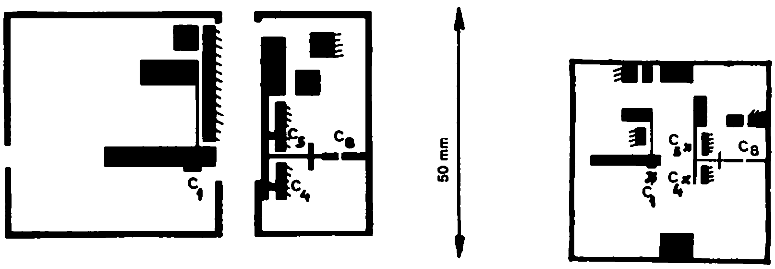
Figure 3. Output Power versus Frequency with a Fixed Tuned Output Circuit



Z1 — 23.5 Ω θ1 — 0.52 λg
Z2 — 80/67 Ω θ2 — 0.25 λg
Z3 — 50 Ω θ3 — 0.095 λg; θ'3 — 0.140 λg
Adjust θ3 and θ3 to obtain the maximum output power
Z4 — 62 Ω θ4 — 0.05 λg
θ5 — 0.18 λg
R1 — 160 Ω
R2 — 1 Ω

C1 — 0.4-2.5 pF
C2, C6 — 100 pF (chip) + 10 nF
C3, C7 — 10 nF
C4, C5, C8 — 33 pF (chip)

Figure 4. Test Circuit



//// Foil wrap edge to ground plane

Board Material: 0.020" Glass teflon;
ϵ_r = 2.55
Board Material: 0.025"
Epsilan 10; ϵ_r = 10.2

Figure 5. PC Board Layout for f_0 = 4 GHz (BW = 700 MHz)

TP64602

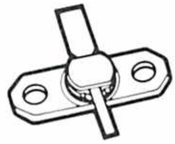
The RF Line

Microwave Power Oscillator Transistor

. . . designed for use as power oscillators at frequencies to 5 GHz with guaranteed output power of 0.55 W @ 4 GHz.

- Operation to 5 GHz
- *High Output Power* (65 W Typ @ 4 GHz)
- Rugged — Capable of Withstanding High Load VSWR
- High Reliability
- Hermetic Package
- *Gold Metallization*
- Diffused Emitter Ballast Resistor
- Formerly named TRW64602

MICROWAVE POWER OSCILLATOR TRANSISTOR



CASE 328F-01, STYLE 3
(GP-13)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	22	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	22	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5.5	pF
FUNCTIONAL TESTS					
Oscillator Output Power (V_{CE} = 20 V, f = 4 GHz, I_C = 240 mA)	G_{PE}	550	650	—	mW
Load Mismatch (V_{CE} = 20 V, I_C = 240 mA, P_{out} = 550 mW, f = 4 GHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			

2

TYPICAL CHARACTERISTICS

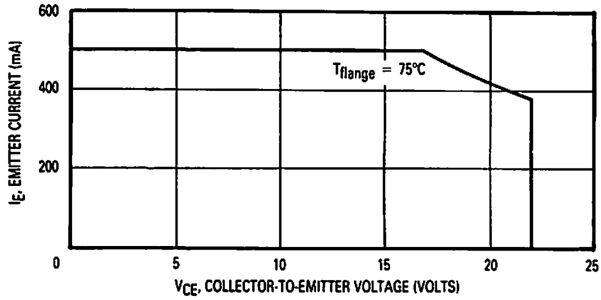


Figure 1. DC Safe Operating Area

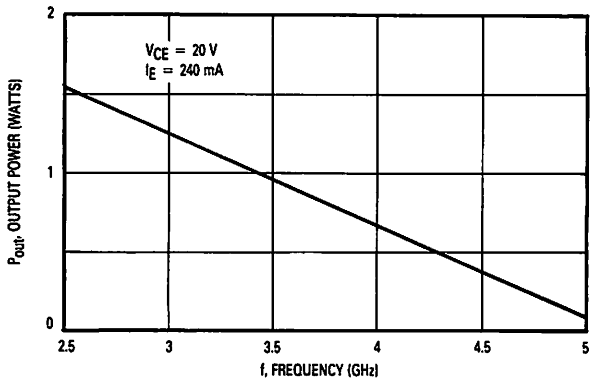


Figure 2. Output Power versus Frequency

TPM401

The RF Line

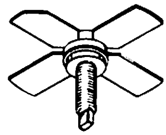
UHF Power Transistor

. . . designed as an NPN gold metallized transistor using diffused emitter ballast resistors for operation in Class A, B or C conditions.

The high gain reduces the need for complex broadband circuits and is ideally suited for 100–400 MHz broadband amplifier applications.

- 100–400 MHz
- 1 W — P_{out}
- 20 V — V_{CC}
- High Gain — 13 dB Min @ f = 400 MHz
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability

1 W — 400 MHz
UHF POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 0.05	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_{case} = 70°C)	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.3 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.4	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class A (V_{CE} = 20 V, P_{out} = 0.5 W, f = 400 MHz, I_E = 200 mA)	G_{PE}	13	—	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 1 W, I_C = 220 mA, f = 400 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power — Class A (f = 400 MHz, V_{CE} = 20 V, I_E = 200 mA)	P_{sat}	1.3	—	—	W
Cutoff Frequency (V_{CE} = 20 V, I_E = 200 mA)	f_T	2.2	—	—	GHz

V_{CE} = 20 V — I_C = 200 mA — Class A

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100 MHz	0.67	203°	12.6	112°	0.037	32°	0.41	− 90°
200 MHz	0.78	186°	7.6	93°	0.042	31°	0.33	−122°
300 MHz	0.79	183°	5.5	82.5°	0.047	30°	0.34	−135°
400 MHz	0.78	170°	4.21	72°	0.053	30°	0.34	−137°
500 MHz	0.76	165°	3.39	66°	0.061	35°	0.33	−138°

100–400 MHz AMPLIFIER PERFORMANCE
Class A 20 V 200 mA

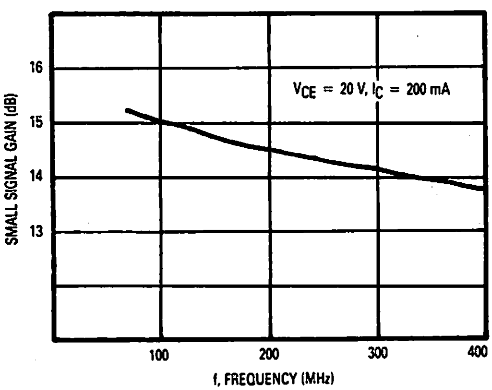


Figure 1. Small Signal Gain Variation

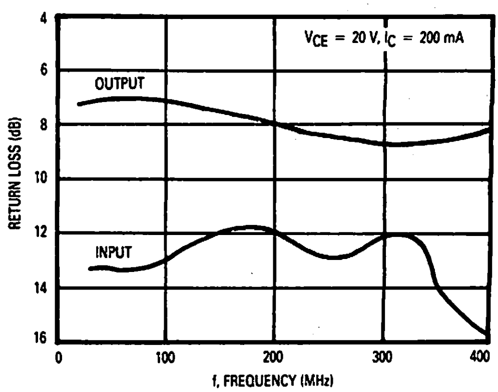


Figure 2. Input and Output VSWR

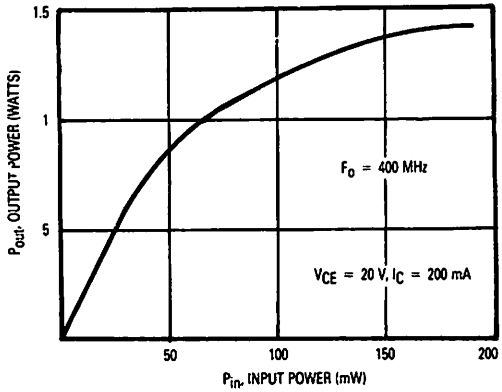


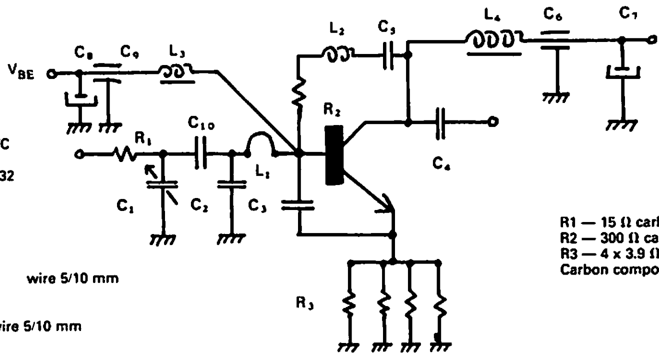
Figure 3. Output Power versus Input Power

C1 — 1-9 pF variable RTC
C2 — 8.2 pF RTC C 330
C3 — 2 x 2.2 pF RTC C 632
C4 — 10 nF RTC C 331
C5, C10 — 1 nF C 331
C6, C9 — 1 nF by-pass
C7, C8 — 10 μF 25 V

L1 — 5 mm 55 mm wire 5/10 mm

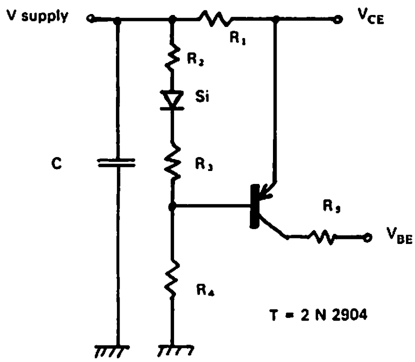
L2 — 4 turns ID 4 mm wire 5/10 mm

L3, L4 — choke



R1 — 15 Ω carbon composition
R2 — 300 Ω carbon composition
R3 — 4 x 3.9 Ω 1/4 W
Carbon composition

Figure 4. 1 W — 100-400 MHz Class A Amplifier



R1 — 11 Ω 1/2 W
R2 — 500 Ω
R3 — 220 Ω
R4 — 4.7 kΩ
R5 — 22 Ω

Figure 5. Bias Circuit

2

The RF Line
UHF Power Transistor

TPM405

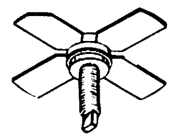
**5 W — 400 MHz
UHF POWER TRANSISTOR**

... designed as an NPN gold metallized transistor using diffused emitter ballast resistors for operation in Class A, AB and C.

High gain reduces the complexity of the broadband stages and make the TPM405 ideal for 100–400 MHz applications.

A 100–400 MHz push-pull amplifier is described in the two last pages of this data sheet.

- 400 MHz
- 5 W — P_{out}
- High Gain — 16 dB Min @ f = 400 MHz
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_{case} = 70°C)	$R_{\theta JC}$	9.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.45	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain — Class AB (V_{CE} = 24 V, P_{out} = 5 W, f = 400 MHz, I_Q = 50 mA)	G_{PE}	16	—	—	dB
Collector Efficiency (V_{CE} = 24 V, P_{out} = 5 W, f = 400 MHz, I_Q = 50 mA)	η_c	50	—	—	%
Load Mismatch (V_{CE} = 24 V, P_{out} = 3 W, f = 400 MHz, I_Q = 50 mA, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Saturated Output Power (V_{CE} = 24 V, f = 400 MHz, I_Q = 50 mA)	P_{sat}	7	—	—	W

CLASS A - V_{CE} = 20 V - I_C = 440 mA - Small Signal

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Asgl°	Magn	Angl°
100 MHz	0.871	190	6.130	108	0.028	17	0.537	205
200 MHz	0.902	182	4.9	90	.03	18	0.562	191
300 MHz	0.907	178	3.35	80	0.033	20	0.562	189
400 MHz	0.902	175	2.66	72	0.035	22	0.562	188
500 MHz	0.905	175	2.21	71	0.034	30	.540	192

Large Signal Impedances

Class AB I_Q = 50 mA F_O = 400 MHz

P_{out} = 5 W V_{CE} = 20 V

Z_{in}	Z_{OL}*
(1,5— J 1) ohm	(15,5 — J 21,4) ohm

Z_{OL}* – Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

PUSH-PULL PERFORMANCE

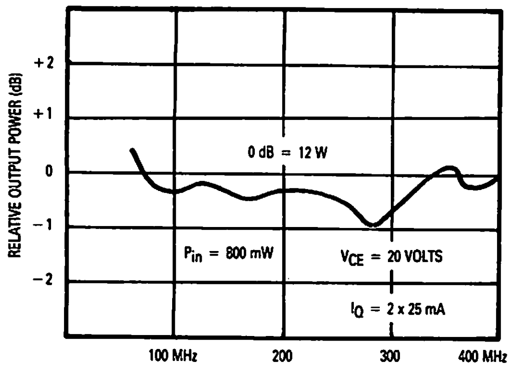


Figure 1. Output Power versus Frequency

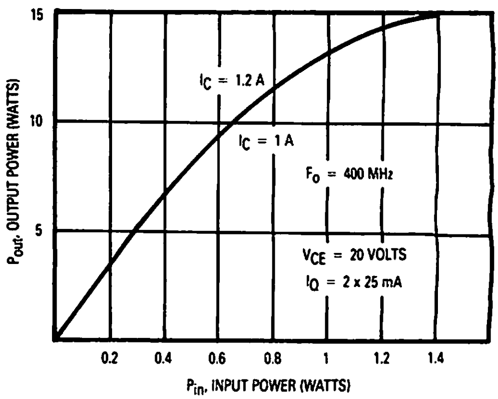


Figure 2. Output Power versus Input Power

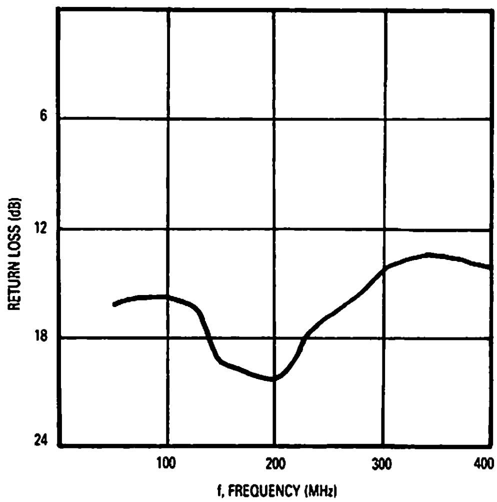
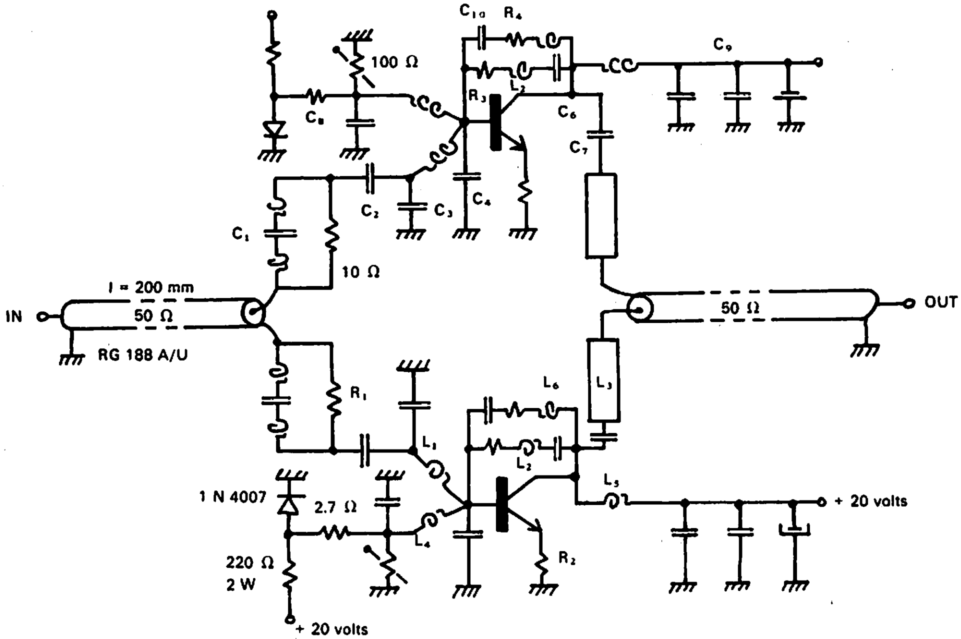


Figure 3. Input Return Loss



L1 — 1/2 turn 5 mm 5/10 mm
5 mm
L2 — 6 turns Ø 3 mm 5/10 mm
L3 — 25 Ω line 2% λg at 400 MHz
L4 — Moiled coil 0.47 μF
L5 — Moiled coil 4.7 μH
L6 — 17 turns Ø 3 mm 5/10 mm

C1 — 27 pF C 300 RTC with 12 mm leads
C2, C7 — 10 nF chip
C3 — 27 pF ATC 100 A
C4 — 2 x 1.3 pF ATC 100 A
C6, C10 — 10 nF RTC C 331
C8, C9 — 1 nF + 10 nF + 0.1 μF + 10 μF decoupling

R1 — 10 Ω 1/4 W carbon
R2 — 4 x 1 Ω 1/4 W carbon
R3, R4 — 300 Ω 1/4 W carbon

Figure 4. Push-Pull Amplifier 100–400 MHz

2

TPM425

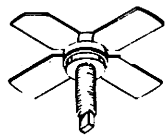
The RF Line
UHF Power Transistor

. . . designed for use in 100–400 MHz broadband amplifiers.

Construction utilizes the new standard, gold metallization and diffused emitter ballast resistors, allowing Class A, B or C operation and a high degree of ruggedness.

- 400 HMz
- 25 W — P_{out}
- 24 V — V_{CC}
- High Gain — 8 dB
- Diffused Emitter Ballast Resistors for Ruggedness
- Gold Metallization for Reliability

25 W — 400 MHz
UHF POWER TRANSISTOR
NPN SILICON



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

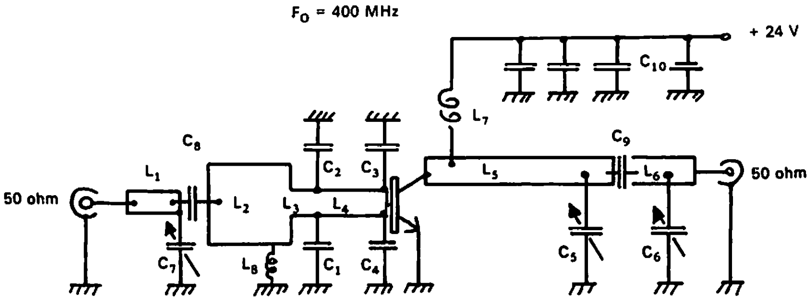
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 24 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Out (V_{CE} = 24 V, P_{in} = 4 W, f = 400 MHz)	P_{out}	25	—	—	W
Collector Efficiency (V_{CE} = 24 V, P_{out} = 25 W, f = 400 MHz)	η_c	60	70	—	%



L1 — 50 ohm line
L2 — 22 ohm line 3% λg at 400 MHz
L3 — 30 ohm line 0.5% λg at 400 MHz
L4 — 30 ohm line 1% λg at 400 MHz
L5 — 50 ohm line 5.5% λg at 400 MHz
L6 — 50 ohm line 3.5% λg at 400 MHz

L7 — 2 turns — ID 7 mm — wire 1 mm
L8 — 0.68 μH — Molded — RFC

C1, C2 — 18 pF — ATC — 100 A
C3, C4 — 10 pF — ATC — 100 A
C5 — AT 5501 — 1-20 pF — Tekelec
C6, C7 — AT 5601 — 1-30 pF — Tekelec
C8, C9 — 1 nF
C10 — 1 nF + 10 nF + 0.1 μF + 10 μF Decoupling

Figure 1. Test Circuit

POLAR S-PARAMETERS 50 OHM SYSTEM								
FREQ. MHz	S 11		S 21		S 12		S 22	
	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl
100	0.957	181	3.89	99	0.019	35	0.707	190
200	0.957	178	1.97	95	0.019	45	0.724	186
300	0.957	176	1.29	75	0.025	45	0.741	184
400	0.957	174	1.06	68	0.032	50	0.749	184
500	0.957	172	0.86	63	0.035	57	0.746	183

V_{CE} = 25 V I_C = 850 mA

TPM4040

The RF Line
UHF Power Transistor

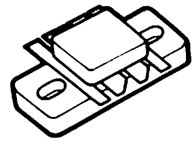
2

The TPM4040 is an internally matched transistor in a push-pull package specially designed for multi-octave bandwidth high gain and power applications. Its internal matching and package configuration lead to high input and output impedances.

Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are guaranteed by use of diffused silicon ballast resistors and gold metallization.

- 30–400 MHz
- 40 W — P_{out}
- 28 V — V_{CC}
- Gold Metallization for Reliability
- Push-Pull Transistor
- Diffused Emitter Ballast Resistors for Ruggedness

**40 W — 400 MHz
UHF POWER TRANSISTOR**



**MRP 7
CASE 827-01, STYLE 1**

MAXIMUM RATINGS

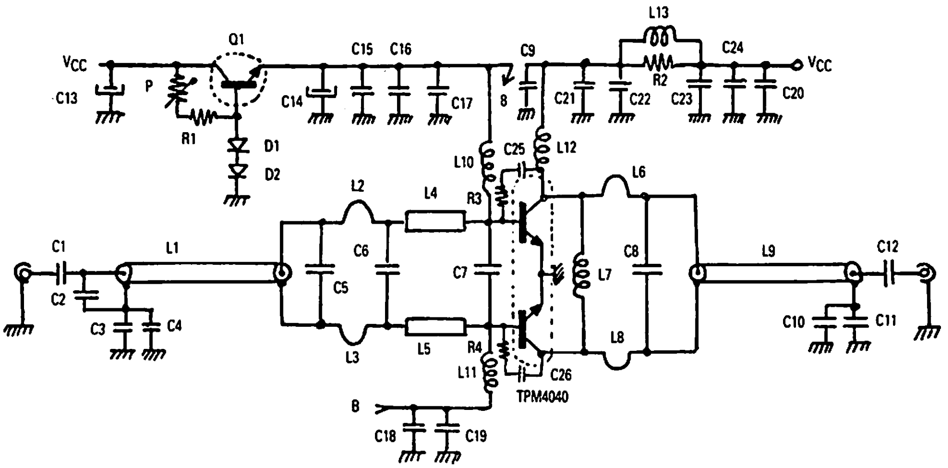
Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Total Device Dissipation @ T_C = 25°C Derate above 25°C (T_{case} = 70°C)	P_D	65 0.5	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_{case} = 70°C)	$R_{\theta JC}$	2	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 40 W, f = 400 MHz)	G_{PE}	10	—	—	dB
Collector Efficiency (V_{CC} = 28 V, P_{out} = 40 W, f = 400 MHz)	η_c	50	—	—	%
Load Mismatch (P_{out} = 40 W, I_{CQ} = 2 x 50 mA, f = 400 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			



C1, C6, C12 — 39 pF chip capacitor
C2 — 3.9 pF chip capacitor
C3, C10, C15, C18, C21, C23 — 1000 pF chip capacitor
C4, C11, C16, C19, C22, C24 — 15 nF chip capacitor
C5 — 22 pF chip capacitor
C7 — 68 pF chip capacitor
C8 — 15 pF chip capacitor
C25, C26 — 10 nF ceramic disc capacitor
C14 — 10 μF/5 V Electrolytic capacitor
C13 — 100 μF/40 V Electrolytic capacitor
C9, C13, C17, C20 — 0.1 μF Tantal

L1, L9 — 100 mm, 50 ohms teflon coaxial cable
L2, L3 — hair pin L = 17 mm, 0.8 mm wire
L4, L5 — 6 mm x 3 mm line on substrate
L6, L8 — hair pin L = 12 mm, 0.8 mm wire
L7 — 3 turns Ø 5 mm, 0.8 mm wire
L10, L11, L12 — 15 turns Ø 3 mm 0.5 mm craneled wire
L13 — 6 turns Ø 5 mm 1.2 mm wire

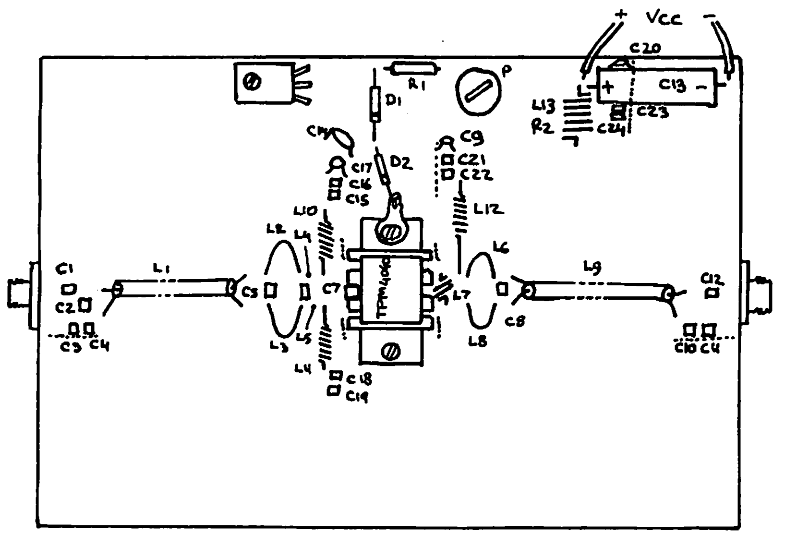
R1 — 1.2 k ohms 1/2 W
R2 — 15 ohms 1/2 W
R3, R4 — 1 k ohms 1/4 W

D1, D2 — 1N4007 or equivalent

Q1 — BD135 or equivalent

Substrate — teflon glass 1/50"

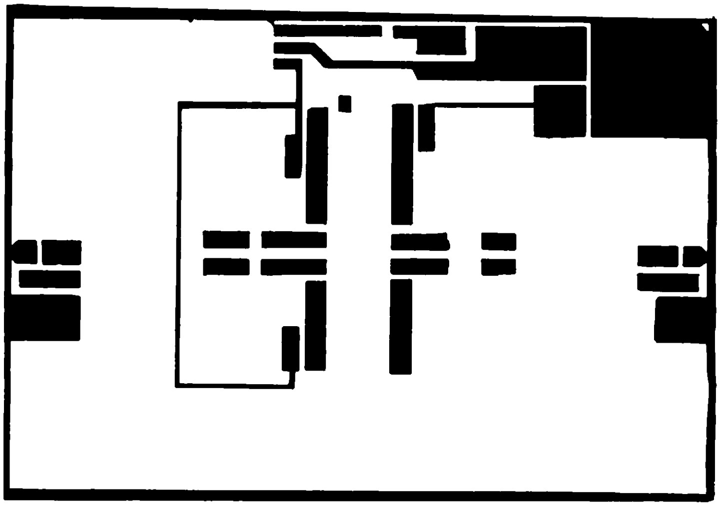
Figure 1. 100–400 MHz 40 W Amplifier (Class AB)



- - - - - = grounding foil

Figure 2. Components Layout

2



NOTE: The Printed Circuit Board shown is 75% of the original.

Figure 3. Printed circuit Board

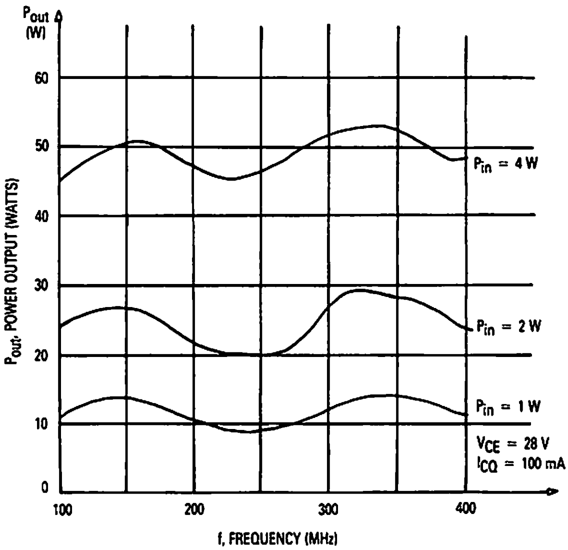


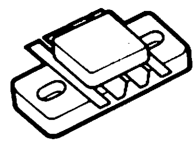
Figure 4. Typical Output Power versus Frequency

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TPM4100

The RF Line
UHF Power Transistor

100 W — 400 MHz
UHF POWER TRANSISTOR



MRP 7
CASE 827-01, STYLE 1

2

The TPM4100 is an internally matched transistor in a push-pull package specially designed for multi-octave bandwidth high power applications. Its internal matching and package configuration lead to high input and output impedances.

Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are enhanced by use of diffused silicon ballast resistors and gold metallization.

- 100–400 MHz
- 100 W — P_{out}
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	60	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	210 0.11	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_{case} = 60°C)	$R_{\theta JC}$	0.85	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 5 V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	60	85	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 100 W, f = 400 MHz)	G_{PE}	7.5	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 100 W, f = 400 MHz)	η_c	50	—	—	%

TPM4130

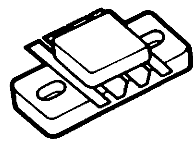
2

The RF Line
UHF Power Transistor

... specially designed for multi-octave bandwidth high power applications. Its internal matching and package configuration lead to high input and output impedances. Multi-cell die design and ultra thin beryllium oxide header allow optimum heat dissipation and operating efficiency. Long term reliability and ruggedness are guaranteed by use of diffused silicon ballast resistors and gold metallization.

- 225–400 MHz
- 130 W — P_{out}
- 28 V — V_{CC}
- Push-Pull Transistor

**130 W — 400 MHz
UHF POWER TRANSISTOR**



MRP 7
CASE 827-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	210 0.11	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case ($T_{case} = 60°C$)	$R_{\theta JC}$	0.85	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage ($I_C = 50$ mA, $I_B = 0$)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage ($I_C = 100$ mA, $I_E = 0$)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage ($I_E = 5$ mA, $I_C = 0$)	$V_{(BR)EBO}$	3.5	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain ($I_C = 1$ A, $V_{CE} = 5$ V)	h_{FE}	20	—	150	—
DYNAMIC CHARACTERISTICS					
Output Capacitance ($V_{CB} = 28$ V, $I_E = 0$, f = 1 MHz)	C_{ob}	—	60	70	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain ($V_{CE} = 28$ V, $P_{out} = 130$ W, f = 400 MHz)	G_{PE}	7.2	—	—	dB
Collector Efficiency ($V_{CC} = 28$ V, $P_{out} = 130$ W, f = 400 MHz)	η_c	60	—	—	%

TYPICAL PERFORMANCE

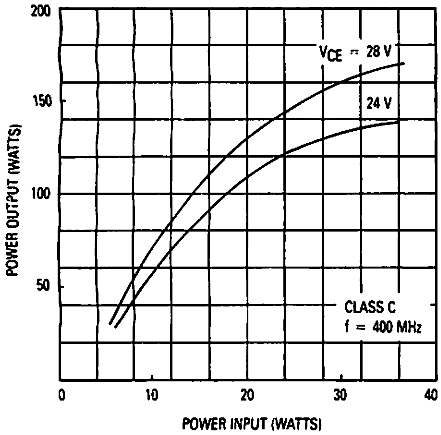


Figure 1. Power Output versus Power Input

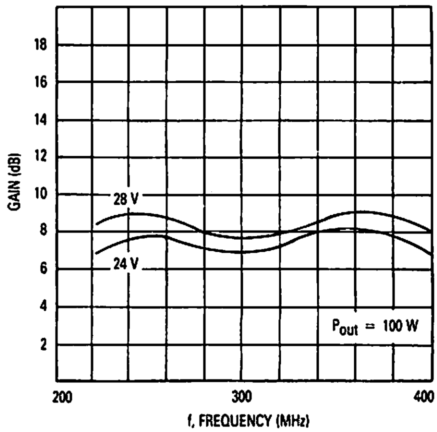


Figure 2. Gain versus Frequency

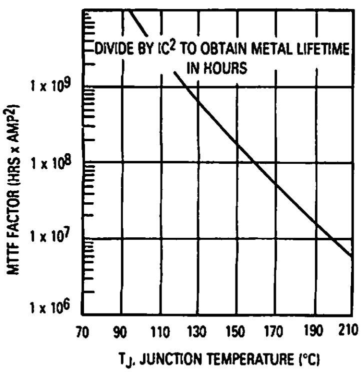


Figure 3. MTTF Factor versus T_j

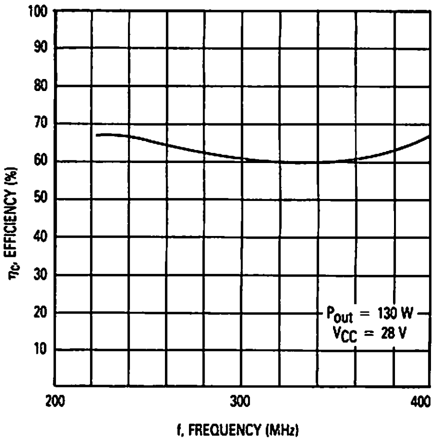
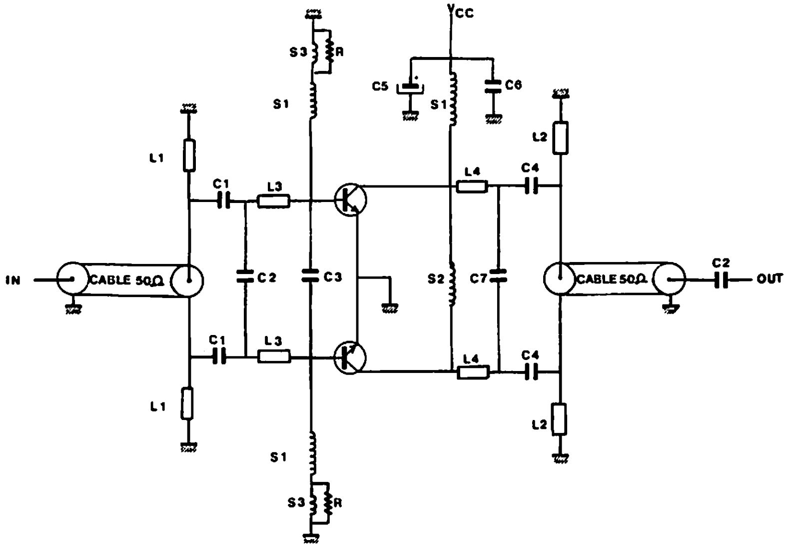


Figure 4. Efficiency versus Frequency



L1, L4 — 30 mm 50 Ω teflon coaxial cable soldered on L2 and L12
L2, L3 — 24 mm x 1,5 mm on substrate
L4, L6 — 6 x 2.5 mm on substrate
L9 — hair pin made with 24 mm of 5 mm wire (as close to the collectors as possible)
L8 — 0.1 μH
L10, L11 — 8 x 1.5 mm on substrate
L12, L13 — 30 mm x 2.5 mm on substrate

Substrate teflon-glass 1/16" (ϵ_r = 2.55)

C1 — ATC 100B 39 pF capacitors
C2 — ATC 100B 27 pF capacitors
C3 — ATC 100B 47 pF capacitor
C4 — ATC 100B 33 pF capacitor
C5 — Electrolytic capacitor 10 μF 63 V
C6 — Chip capacitor 100 nF
C7 — ATC 100B 22 pF capacitor
S1 — Inductor 0.8 mm wire 3.6 mm ID
S2 — Inductor 0.5 mm wire 24 mm long
S3 — Inductor 1 μH
R — Resistor 10 Ω ±10% 1/4 W
L1 — Microstrip lines 28.5 mm x 1.5 mm
L2 — Microstrip lines 30 mm x 2.5 mm
L3 — Microstrip lines 11 mm x 2.5 mm
L4 — Microstrip lines 12 mm x 2 mm

Teflon coaxial 50 Ω Ø 1.8 mm 27.5 mm

Figure 5. 225–400 MHz Test Circuit

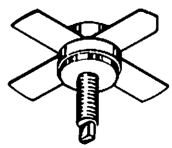
MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

The RF Line

VHF Linear Power Transistor

TPV364

10 W — 230 MHz
VHF LINEAR
POWER TRANSISTOR



CASE 145D-01, STYLE 1
(.380 SOE)

2

The TPV364 is a NPN gold metallized transistor using diffused ballast resistors for improved linearity. This transistor is designed for high power band III TV transposers and transmitters.

The TPV364 is used in the final stages of 20 W transposers or in the driver stages of 100 W plus transposers and transmitters.

- Band III (170–230 MHz)
- 10 W — P_{ref} @ −55 dB IMD
- 25 V — V_{CC}
- High Gain — 10 dB Min

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	9	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	70 0.5	Watts W/°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_{case} = 70°C)	$R_{\theta JC}$	2	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 V, I_E = 0, f = 1 MHz)	C_{ob}	—	58	85	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Load Mismatch (V_{CE} = 25 V, P_{out} = 15 W, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 25 V, I_E = 1.6 A, P_{ref} = 10 W, Vision Carrier = −8 dB Ref., Sound Carrier = −7 dB Ref., Sideband Signal = −16 dB Ref., Specification TV05001)	IMD_1	—	—	−54	dB
Intermodulation Distortion (IDEM) (f = 225 MHz, V_{CE} = 25 V, I_E = 1.6 A, P_{ref} = 15 W, Vision Carrier = −8 dB, Sound Carrier = −10 dB, Sideband Signal = −16 dB)	IMD_2	—	—	−52	dB
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 10 W, f = 225 MHz, I_E = 1.6 A)	G_{PE}	10	—	—	dB

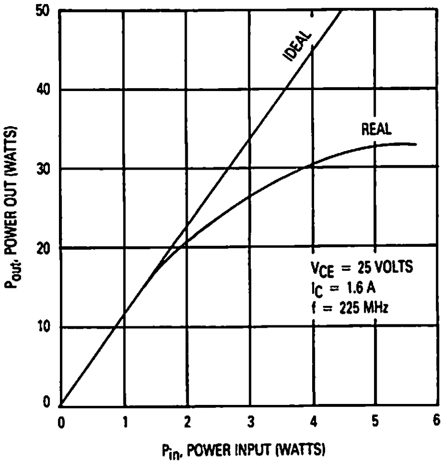


Figure 1. Power Input versus Power Output

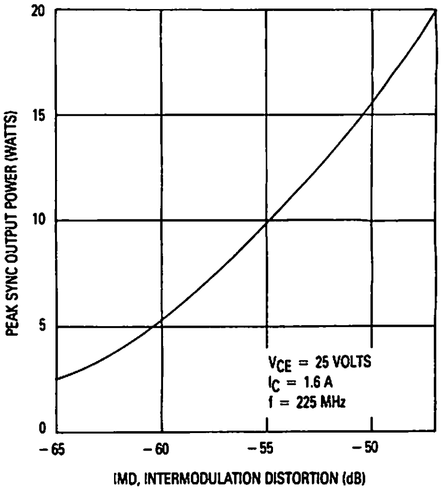


Figure 2. IMD versus Peak Sync Output Power

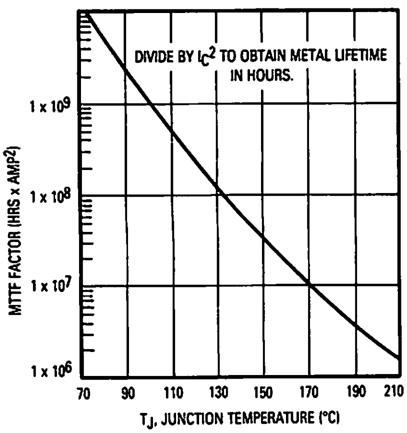


Figure 3. MTTF Factor versus T_J

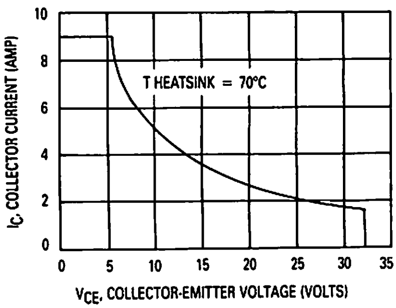


Figure 4. Safe Operating Area

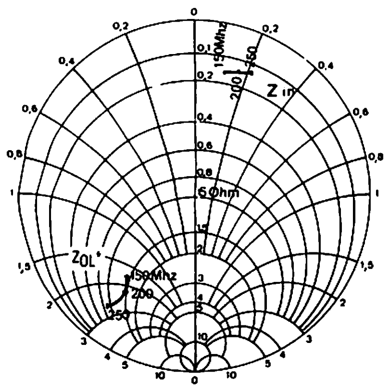


Figure 5. Large Signal Impedance versus Frequency

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

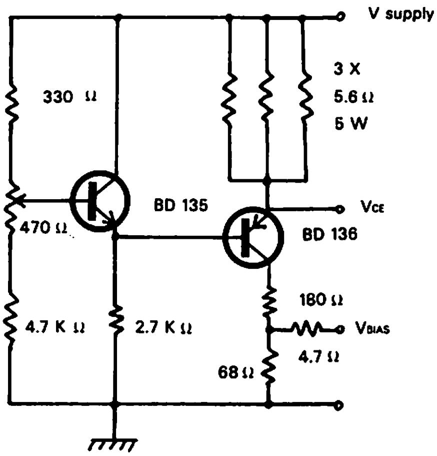
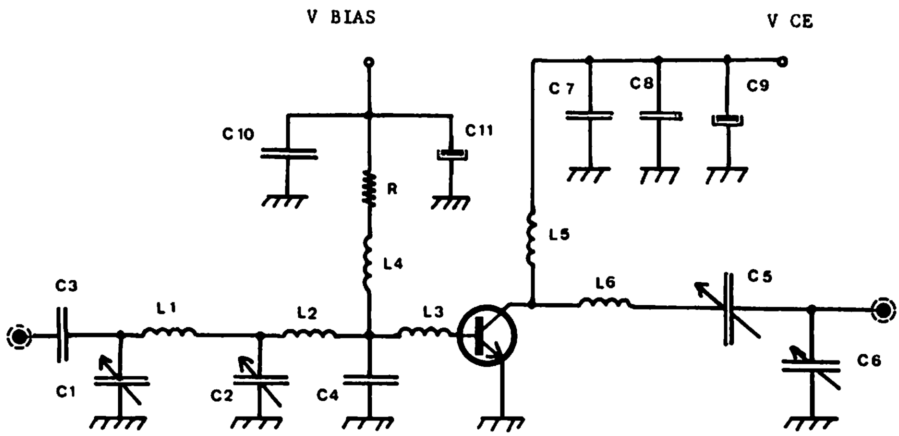


Figure 6. Bias Circuit



C1 — ARCO 403
C2, C6 — ARCO 404
C5 — ARCO 423
C3, C7 — Chip capacitor 470 pF
C4 — UNELCO-capacitor 80 pF
C8, C10 — UNELCO-capacitor 1000 pF
C9, C11 — 100 μF electrolytic — 63 V

R — 4.7 ohms — 1/2 W

L1 — 1.5 turns closely wound — Cu wire 1 mm — I.D. 5 mm
L2 — 2.5 cm — 50 ohms line
L3 — length of the base lead
L6 — Cu wire 1.5 mm

10
10

L5 — 3 cm — 50 ohms line
L4 — 5 turns closely wound — Cu wire 8 mm — I.D. 5 mm

Figure 7. 225 MHz Test Circuit

2

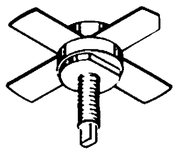
The RF Line
VHF Linear Power Transistor

TPV375

The TPV375 is a NPN gold metallized transistor using diffused ballast resistors for super linearity. The TPV375 is specifically designed for high power band III. TV transposers and transmitters amplifiers. Due to its high saturation power (over 70 watts), the TPV375 shows good linearity characteristics at powers over 25 W.

- Band III (170–230 MHz)
- 20 W — P_{ref} @ −51 dB IMD
- 14 W — P_{ref} @ −55 dB IMD
- 28 V — V_{CC}
- High Gain — 9 dB Typ

14/20 W — 170 to 230 MHz
VHF LINEAR
POWER TRANSISTOR



CASE 145A-10, STYLE 1
(.500 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	100 —	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.25	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 V, I_E = 0, f = 1 MHz)	C_{ob}	—	58	85	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 20 W, f = 225 MHz, I_E = 2.5 A)	G_{PE}	8	9	—	dB
Load Mismatch (V_{CE} = 28 V, P_{out} = 20 W, I_E = 2.5 A, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 28 V, I_E = 2.5 A, P_{ref} = 14 W, Vision Carrier = −8 dB ref., Sound Carrier = −7 dB ref., Sideband Signal = −16 dB ref., Specification TV05001)	IMD_1	—	—	−55	dB
Intermodulation Distortion (IDEM) (f = 225 MHz, V_{CE} = 28 V, I_E = 2.5 A, P_{ref} = 20 W, Vision Carrier = −8 dB, Sound Carrier = −10 dB, Sideband Carrier = −16 dB)	IMD_2	—	—	−51	dB

2

TYPICAL CHARACTERISTICS

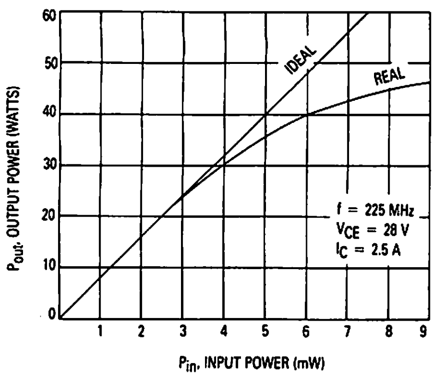


Figure 1. Power Output versus Power Input

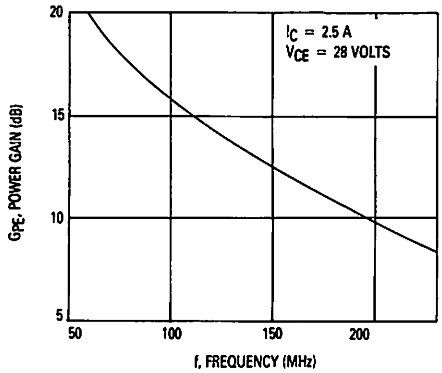


Figure 2. Power Gain versus Frequency

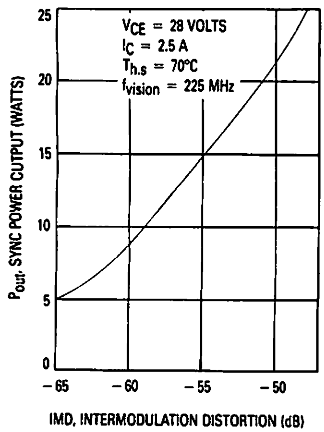


Figure 3. Intermodulation Distortion versus Peak Sync Power

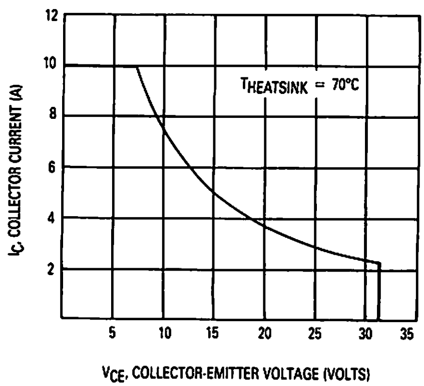


Figure 4. Safe Operating Area

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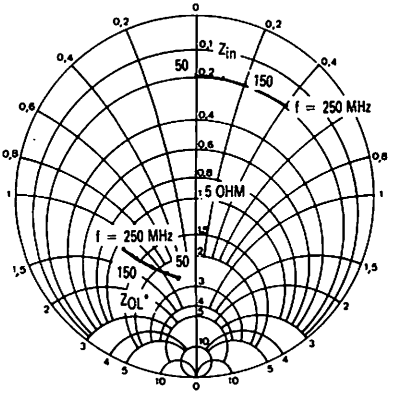


Figure 5. Large Signal Impedances versus Frequency
V_{CE} = 28 V — I_C = 2.5 A

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

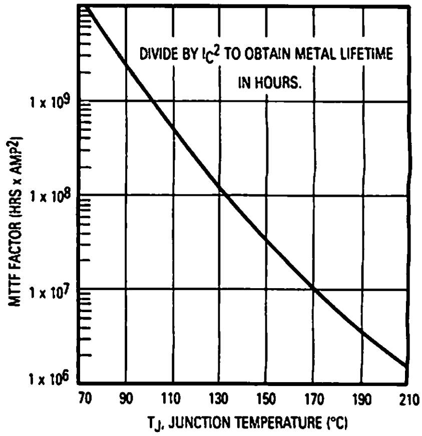
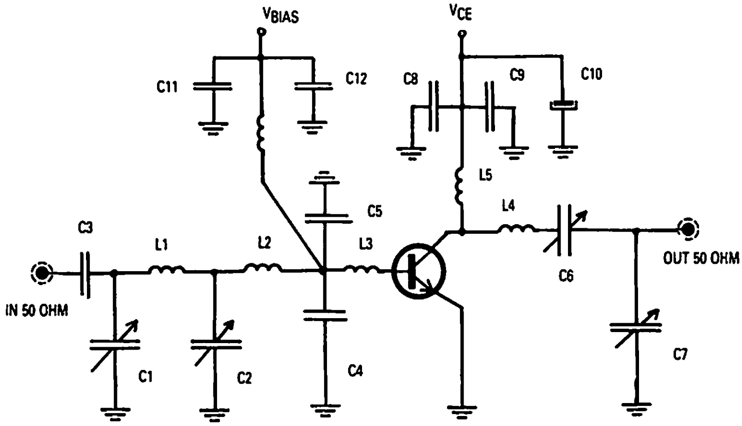


Figure 6. MTTF Factor versus T_J



C1, C7 — ARCO 403
C2 — ARCO 404
C3, C8 — chip capacitor 470 pF
C4, C5 — UNELCO 80 pF
C6 — ARCO 423
C9, C11 — UNELCO 1000 pF
C10 — 470 μF electrolytic
C12 — 10 nF

L1 — 1.5 turns closely wound. Cu wire 0.7 mm I.D. 4.5 mm
L2 — 2.1 cm — 50 ohms — line
L3 — length of the base lead
L4 — Cu wire 1.6 mm

10 < 8 >

L5 — 3.5 cm — 50 ohms line
L6 — 4 turns closely wound Cu wire 0.8 mm I.D. 4.5 mm

Figure 7. 225 MHz Test Circuit

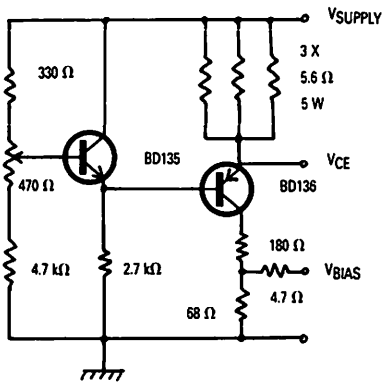


Figure 8. Bias Circuit

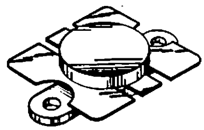
The RF Line
VHF Linear Power Transistor

TPV385

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV385 is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 14 W — P_{ref} @ −53 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Min

**28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR**



**.500 J ZERO
CASE 316A-01, STYLE 1**

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	10	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

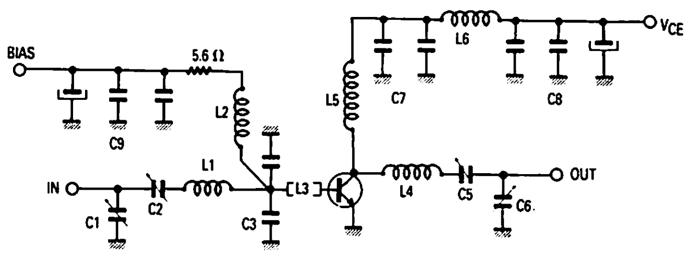
Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 50 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	2	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 V, I_E = 0, f = 1 MHz)	C_{ob}	—	65	85	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 V, P_{out} = 14 W, f = 225 MHz, I_E = 2.5 A)	G_{PE}	14	15	—	dB
Load Mismatch (V_{CC} = 28 V, P_{out} = 14 W, I_E = 2.5 A, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 28 V, I_E = 2.5 A, P_{ref} = 14 W, Vision Carrier = −8 dB ref., Sound Carrier = −7 dB ref., Sideband Signal = −16 dB ref., Specification TV05001)	IMD_1	—	—	−53	dB



C1, C6 — ARCO 404
C2, C5 — ARCO 423
C3, C4 — UNELCO 80 pF
C7 — 1 nF + 47 nF
C8, C9 — 1 nF + 0.1 μF + 47 μF
L1 — 2 turns, ID 6 mm, wire 1 mm
L1 — 1 turn, ID 10 mm, wire 1 mm
L2 — 6 turns, ID 6 mm, wire .6 mm
L3 — base inductance PAD, L = 10 mm W = 5 mm
L5 — 1 turn, ID 6 mm, wire 1.5 mm
L6 — 2 turns on ferrite core, wire 1.5 mm

Figure 1. 225 MHz Test Circuit

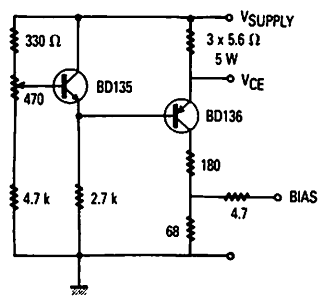


Figure 2. Bias Circuit

TPV387

Advance Information

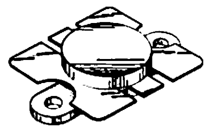
The RF Line

VHF Linear Power Transistor

**28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR**

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV387 is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 24 W — P_{ref} @ −50 dB IMD
- 28 V — V_{CC}
- High Gain — 13 dB Min, Class A



.500 J ZERO
CASE 316A-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	35	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	16	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 100 mA, I_B = 0)	$V_{(BR)CEO}$	35	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 50 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 100 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	60	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	20	—	100	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 30 V, I_E = 0, f = 1 MHz)	C_{ob}	—	130	150	pF

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 28 V, P_{out} = 24 W, f = 225 MHz, I_E = 3.5 A)	G_{PE}	13	—	—	dB
Load Mismatch (V_{CC} = 28 V, P_{out} = 24 W, I_E = 3.5 A, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 28 V, I_E = 3.5 A, P_{ref} = 24 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−50	dB
Output Power, 1 dB Compression Point (V_{CE} = 28 V, f = 225 MHz, I_Q = 200 mA)	$P_{o1\ dB}$	90	—	—	W

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

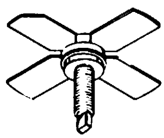
TPV394A

The RF Line
VHF Linear Power Transistor

... designed specifically for band III TV transposers and transmitter amplifiers. The TPV394A is internally matched and uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band III (170–230 MHz)
- 5 W — P_{ref} @ −55 dB IMD
- 28 V — V_{CC}
- High Gain — 16 dB Typ, Class A

28 V — 170–230 MHz
VHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	55	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	50 1	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2.5	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	1	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 50 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	55	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 2 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	55	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	35	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 5 W, f = 225 MHz, I_E = 1 A)	G_{PE}	15	16	—	dB
Load Mismatch (V_{CE} = 28 V, P_{out} = 5 W, I_E = 1 A, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 28 V, I_E = 1 A, P_{ref} = 5 W, Vision Carrier = −8 dB ref., Sound Carrier = −7 dB ref., Sideband Signal = −16 dB ref., Specification TV05001)	IMD_1	—	—	−55	dB

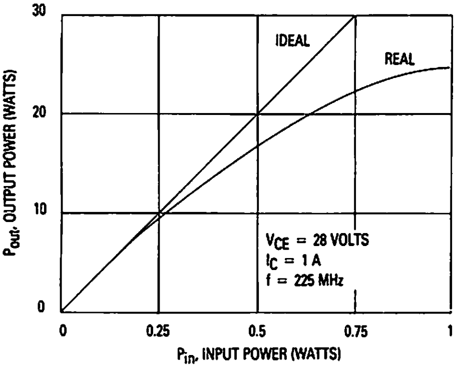


Figure 1. Output Power versus Input Power

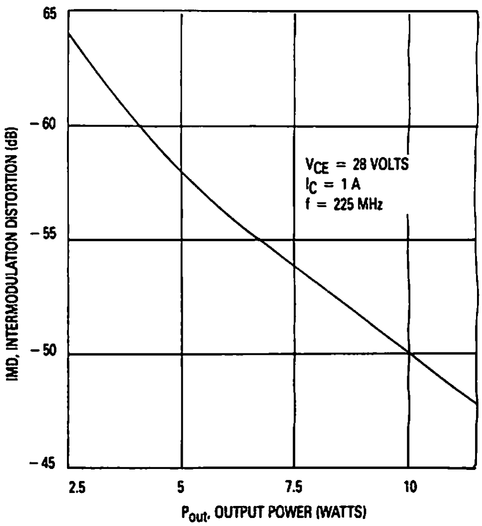


Figure 2. Intermodulation Distortion versus Output Power

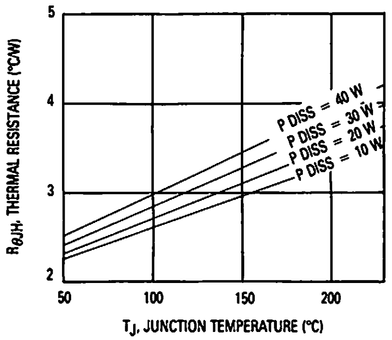


Figure 3. Thermal Resistance Junction Heatsink versus Temperature of Junction for Various Power's Dissipated

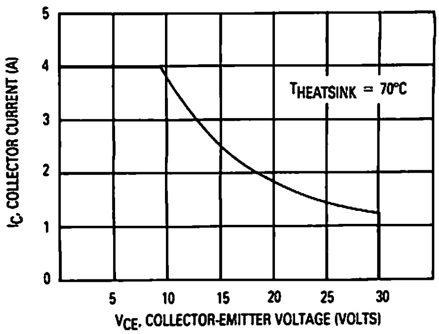


Figure 4. Safe Operating Area

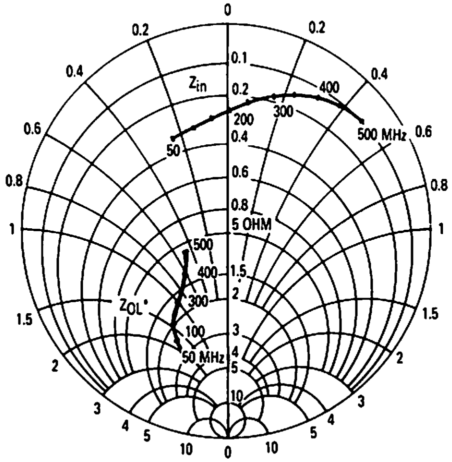
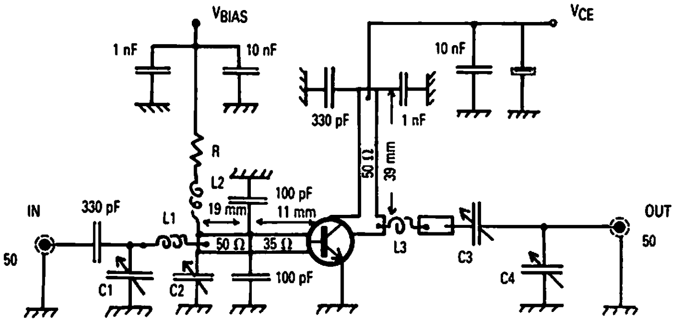


Figure 5. Large Signal Impedances versus Frequency
V_{CE} = 28 V — I_C = 1 A

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.



C1, C4 — ARCO 403
C2 — ARCO 404
C3 — ARCO 423

L1 — 1 turn 1/2 I.D. = 5 mm
L2 — RFC 10 turns I.D. = 5 mm
L3 — 1.5 mm shaped:
Material — G10 Epoxy Board.

Figure 6. 225 MHz Test Circuit

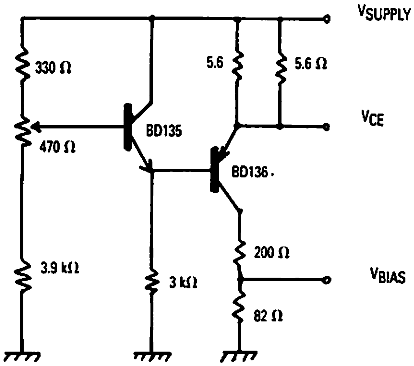


Figure 7. Class A Bias Circuit

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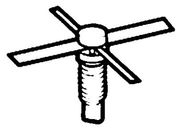
TPV590

The RF Line
UHF Linear Power Transistor

. . . designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV590 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.25 W — P_{ref} @ −58 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Min, Class A @ f = 860 MHz
- Gold Metallization for Reliability

**28 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR**



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.4	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	30	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.25	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 100 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 20 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	3	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.25 W, f = 860 MHz, I_E = 75 mA)	G_{PE}	14	14.5	—	dB
Load Mismatch (V_{CC} = 20 V, P_{out} = 0.25 W, I_E = 75 mA, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 75 mA, P_{ref} = 0.25 W, Vision Carrier = −8 dB ref., Sound Carrier = −7 dB ref., Sideband Signal = −16 dB ref., Specification TV05001)	IMD_1	—	−60	−58	dB
Cutoff Frequency (V_{CE} = 20 V, I_E = 75 mA)	f_T	3	—	—	GHz

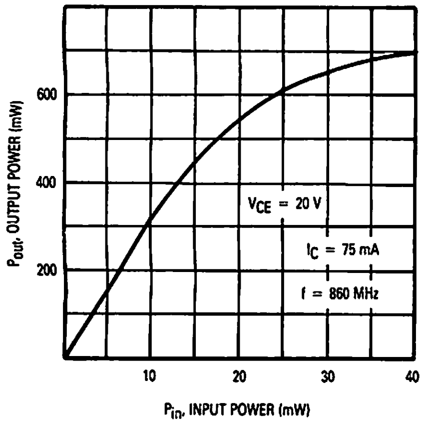


Figure 1. Output Power versus Input Power

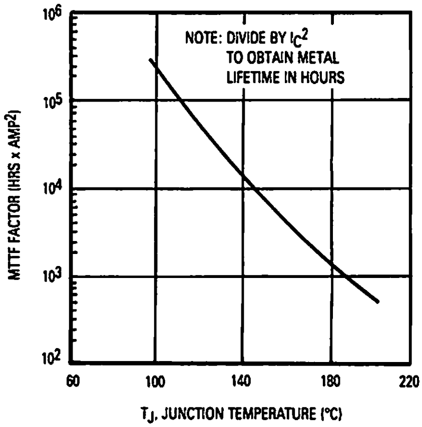


Figure 2. MTTF Factor versus Junction Temperature

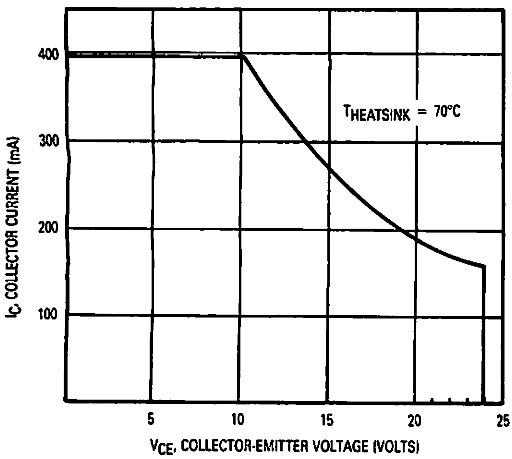


Figure 3. DC Safe Operating Area

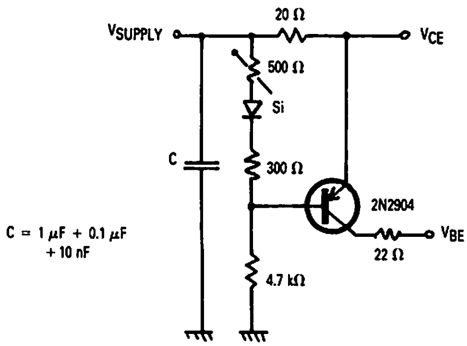


Figure 4. Bias Circuit

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TPV590 S-PARAMETERS
V_{CE} = 20 V — I_C = 100 mA

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
F	S 11		S 21		S 12		S 22	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100 MHz	0.613	226°	17.78	126°	0.0199	35°	0.530	320°
200 MHz	0.732	203°	12.88	103°	0.028	33°	0.316	305°
300 MHz	0.767	192.5°	9.22	93°	0.029	33°	0.266	297°
400 MHz	0.767	185°	6.91	84°	0.033	33°	0.266	295°
500 MHz	0.754	179.5°	5.16	79°	0.033	38°	0.266	300°
600 MHz	0.776	174°	4.67	72°	0.035	42°	0.237	300°
700 MHz	0.776	170°	4.02	66°	0.039	43°	0.237	290°
800 MHz	0.767	167°	3.34	61°	0.044	44°	0.266	285°
900 MHz	0.767	163°	3.16	56°	0.047	44°	0.237	290°
1 GHz	0.776	160°	2.786	52°	0.053	45°	0.266	280°

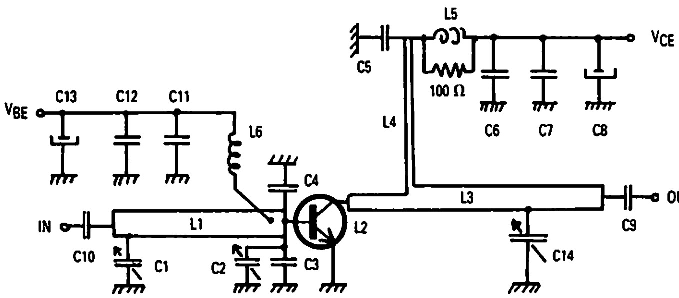


Figure 5. 860 MHz Test Circuit
V_{CE} = 20 V — I_C = 75 mA

L1 — 50 Ω line l = 10% λg at 860 MHz
L2 — 100 Ω line l = 12% λg at 860 MHz
L3 — 50 Ω line l = 7% λg at 860 MHz
L4 — 120 Ω line l = 10% λg at 860 MHz
L5 — 6 turns ID 3 mm wire .5 mm
L6 — 6 turns ID 3 mm wire .5 mm

C1, C2, C14 — variable AIRTRONIC C max 4.7 pF AT7275
C3, C4 — ATC chip 10 pF
C5 — 680 pF ATC chip
C6, C11 — 1 nF
C7, C12 — 10 nF
C8 — 10 μF 63 V
C13 — 10 μF 25 V
C9, C10 — 1 nF chip

TPV591

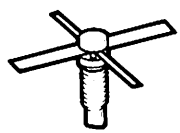
The RF Line

UHF Linear Power Transistor

... designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV591 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 0.5 W — P_{ref} @ −58 dB IMD
- 28 V — V_{CC}
- High Gain — 14 dB Typ @ f = 860 MHz
- Gold Metallization for Reliability

**28 V — 470-860 MHz
UHF LINEAR
POWER TRANSISTOR**



.200 SOE
CASE 305B-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.8	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	16	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	20	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 20 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5.5	pF

(continued)

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 20 V, P_{out} = 0.5 W, f = 860 MHz, I_C = 150 mA)	G_{PE}	13	14	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 0.5 W, I_C = 150 mA, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 150 mA, P_{ref} = 0.5 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	−60	−58	dB
Cutoff Frequency (V_{CE} = 20 V, I_E = 75 mA)	f_T	3	—	—	GHz

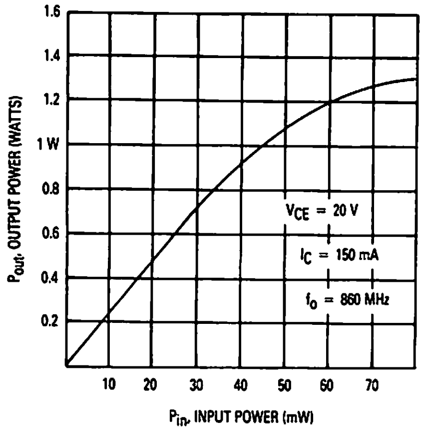


Figure 1. Output Power versus Input Power

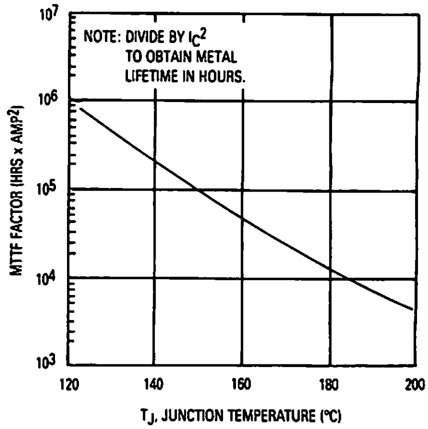


Figure 2. MTTF Factor versus Junction Temperature

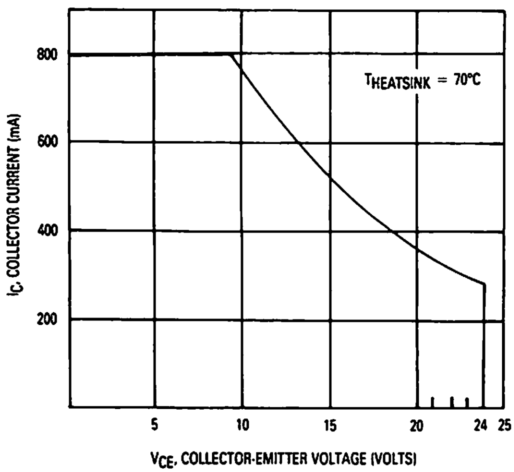


Figure 3. DC Safe Operating Area

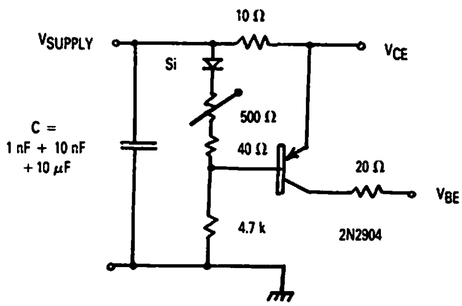
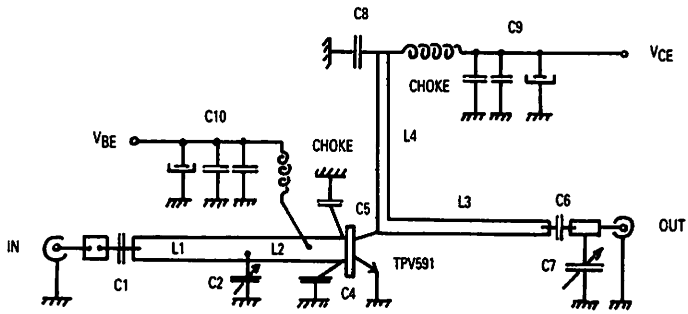


Figure 4. Bias Circuit

TPV591 S-PARAMETERS
V_{CE} = 20 V — I_C = 150 mA

POLAR S-PARAMETERS IN 50 OHM SYSTEM								
f	S_{11}		S_{21}		S_{12}		S_{22}	
MHz	Magn	Angl°	Magn	Angl°	Magn	Angl°	Magn	Angl°
100	0.733	190	13.8	117	0.025	27	0.365	280
200	0.841	187	8.13	100	0.028	27	0.266	241
300	0.861	181	5.62	88	0.033	27	0.266	241
400	0.861	177	4.27	79	0.035	30	0.282	225
500	0.861	173	3.47	72	0.040	36	0.282	225
600	0.865	169	2.82	68	0.045	36	0.282	218
700	0.865	167	2.44	61	0.045	37	0.316	214
800	0.866	163	2.15	54	0.050	40	0.316	216
860	0.866	162	2.03	54	0.050	43	0.331	218
900	0.866	160	1.94	52	0.053	44	0.331	217
1,000	0.876	158	1.66	46	0.056	44	0.376	214



C1, C6 — 1 nF
C2, C7 — Variable Airtronic AT7285 — max 2.5 pF
C4 — ATC 100 A 10 pF
C5 — ATC 100 A 6.8 pF + 4.7 pF
C8 — 1 nF
C9, C10 — 1 nF + 10 nF + 10 μF

Choke: 8 turns — ID 6 mm — wire .5 mm

L1 — 50 line — ℓ = 10% λg qt 860 MHz
L2 — 50 line — ℓ = 5% λg at 860 MHz
L3 — 80 line — ℓ = 13% λg at 860 MHz
L4 — 100 line — ℓ = 8% λg at 860 MHz

Figure 5. 860 MHz Test Circuit
V_{CE} = 20 V — I_C = 150 mA

2

TPV593

Advance Information

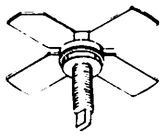
The RF Line

UHF Linear Power Transistor

**25 V — 470–860 Mhz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON**

. . . designed for pre-driver and driver stages in band IV and V TV transposers and transmitter amplifiers. The TPV593 uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 2 W — P_{ref} @ −60 dB IMD
- 25 V — V_{CC}
- High Gain — 9 dB Typ, Class A, f = 860 MHz



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	25	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	1.2	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	11	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 80 mA, I_B = 0)	$V_{(BR)CEO}$	25	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 250 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	10	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CC} = 25 V, P_{out} = 2 W, f = 860 MHz, I_C = 450 mA)	G_{PE}	8.5	9	—	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 450 mA, P_{ref} = 2 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−58	dB

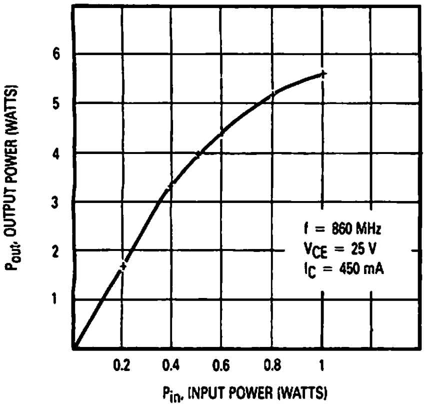


Figure 1. Output Power versus Input Power

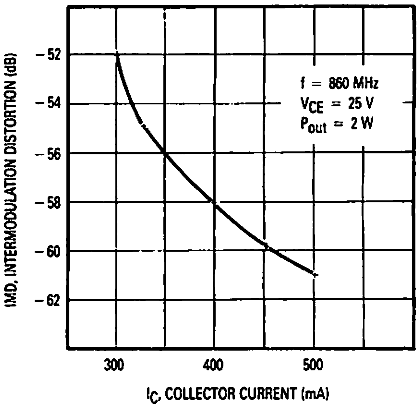


Figure 2. IMD versus Collector Current

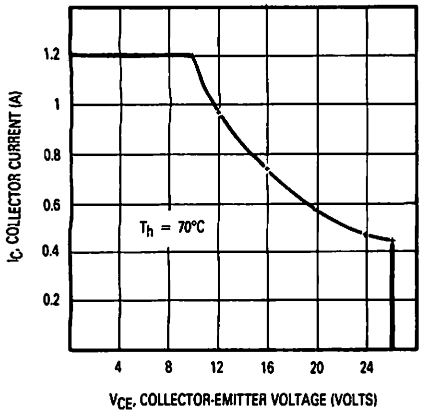


Figure 3. DC Safe Operating Area

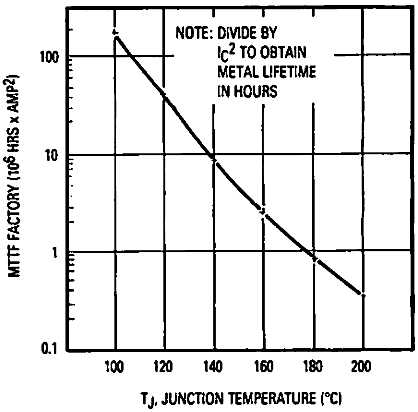


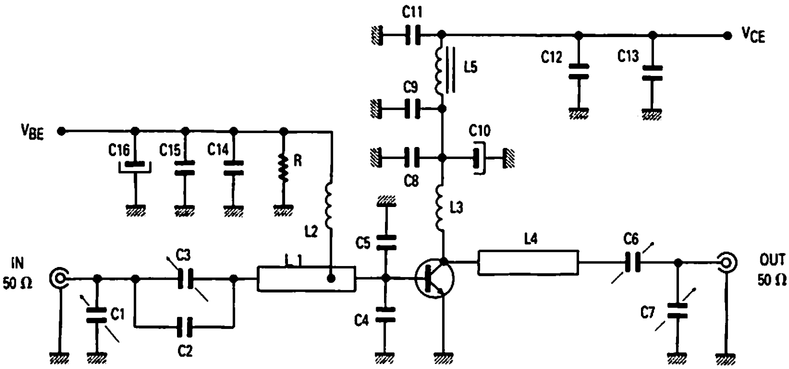
Figure 4. MTTF versus Junction Temperature

POLAR « S » PARAMETERS IN 50 OHMS SYSTEM

F	S11		S21		S12		S22		S21	K
MHz	MAGN	ANGL	MAGN	ANGL	MAGN	ANGL	MAGN	ANGL	dB	FACTOR
470	0.93	170°	1.5	63	0.04	50°	0.55	— 166°	3.52	1.01
650	0.93	165°	1.06	50	0.05	54°	0.60	— 169°	0.51	1.04
860	0.92	162°	0.79	38	0.06	54°	0.65	— 169°	— 2	1.15

NOTE : V_{CE} = 25 Volts — I_C = 450 mA — Class A

2



C1 — AIR TRIMMER AT 5201 0.8–10 pF TEKELEC
C2 — CHIP ATC 4.7 pF
C3 — AIR TRIMMER AT 5751 0.6–6 pF TEKELEC
C4, C5 — CHIP ATC 3.3 pF
C6, C7 — AIR TRIMMER AT 5501 1–20 pF TEKELEC
C8, C13, C14 — 1 nF CHIP CAPACITOR
C9, C11, C15 — 10 nF RTC
C12 — 0.1 μF RTC
C10, C16 — 10 μF 63 V electrolytic

L1 — 30 Ω line 1 = 6.5% λg
L2 — choke 0.47 μH
L3 — 1 turn — ID 6 mm — wire 10/10
L4 — 30 Ω line 1 = 19% λg
L5 — 8 turns on a CN 20 FERRITE BEAD — CERAMICL — MAGNETICS
R — 43 Ω 1/4 Watt

Figure 5. 860 MHz Test Circuit

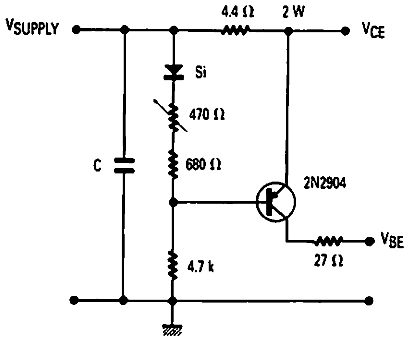


Figure 6. Bias Circuit

POLAR COORDINATES OF SIMULTANEOUS CONJUGATE MATCH IN 50 OHMS SYSTEM

F	SOURCE REFL. COEFF.		LOAD REFL. COEFF.		G MAX
MHz	MAGN	ANGLE	MAGN	ANGLE	dB
470	0.99	— 173°	0.91	124°	15.2
650	0.99	— 168°	0.83	134°	12.0
860	0.95	— 165°	0.79	146°	9.2

NOTE : V_{CE} = 25 Volts — I_C = 450 mA — Class A

TPV595A

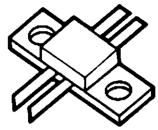
25 V — 470–860 MHz
UHF LINEAR
POWER TRANSISTOR

The RF Line

UHF Linear Power Transistor

... designed for driver and output stages in band IV and V TV transposers and transmitter amplifiers. The TPV595A uses gold metallized die with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 14 W — P_{ref} @ −47 dB IMD
- 25 V — V_{CC}
- High Gain — 9 dB Typ, Class A, f = 860 MHz
- Push-Pull Package



CASE 395-01, STYLE 1
(BMA2)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	5	Adc
Total Device Dissipation @ T_C = 70°C Derate above 70°C	P_D	50 0.4	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	2.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 3 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 51 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CB} = 20 V, I_E = 0)	I_{CBO}	—	—	5	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 25 V, I_C = 2 x 900 mA)	G_{SSE}	8.5	—	—	dB
Load Mismatch (V_{CC} = 25 V, P_{out} = 15 W, I_{CQ} = 2 x 900 mA, f = 470 MHz, 2 Tones, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (no degradation) (f_o = 470 MHz, V_{CE} = 25 V, 2 Tones, I_{CQ} = 2 x 900 mA)	$P_{in_{over}}$	15	—	—	W
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_{CQ} = 2 x 900 mA, P_{ref} = 14 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−47	dB
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 25 V, I_{CQ} = 2 x 900 mA, P_{ref} = 14 W, Vision Carrier = −8 dB, Sound Carrier = −10 dB, Sideband Carrier = −16 dB)	IMD_2	—	—	−50	dB

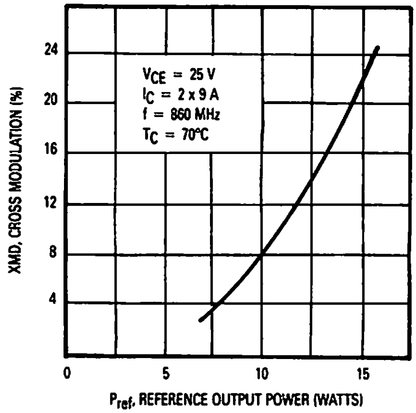


Figure 1. Cross-mod* versus Output Power

*Cross-mod: Δ% sound (−7 dB) — vision O → PEAK

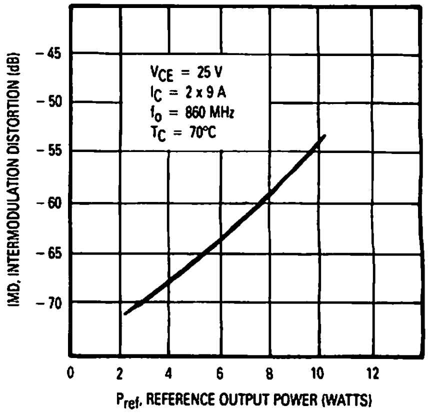


Figure 2. IMD* versus Output Power

*IMD: 3 tones −7 dB, −8 dB, −16 dB

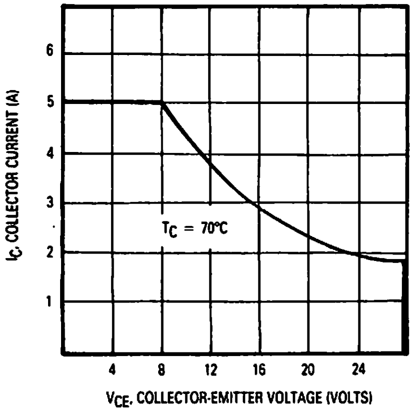


Figure 3. DC Safe Operating Area

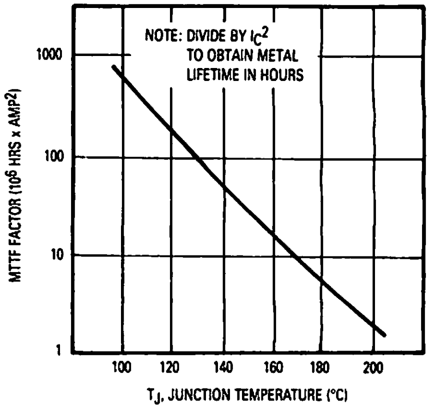


Figure 4. MTTF versus Junction Temperature

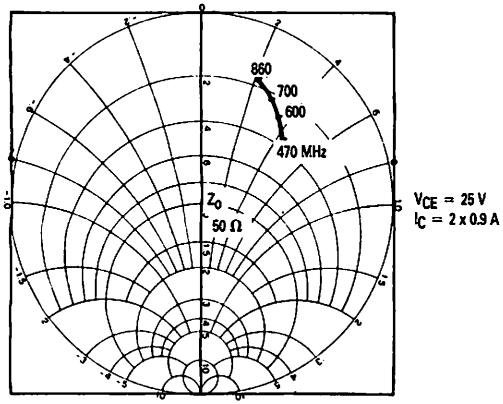


Figure 5. Z Load For Best IMD (8 W) and Cross-Modulation (12 W) Collector-to-Collector

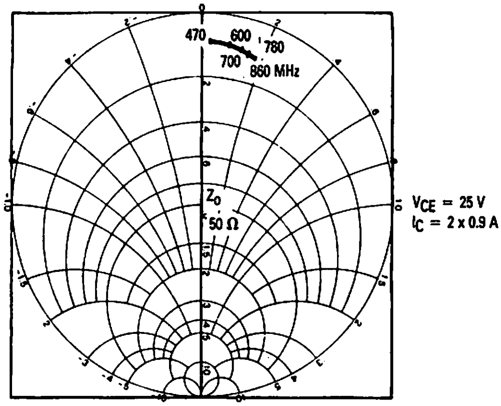
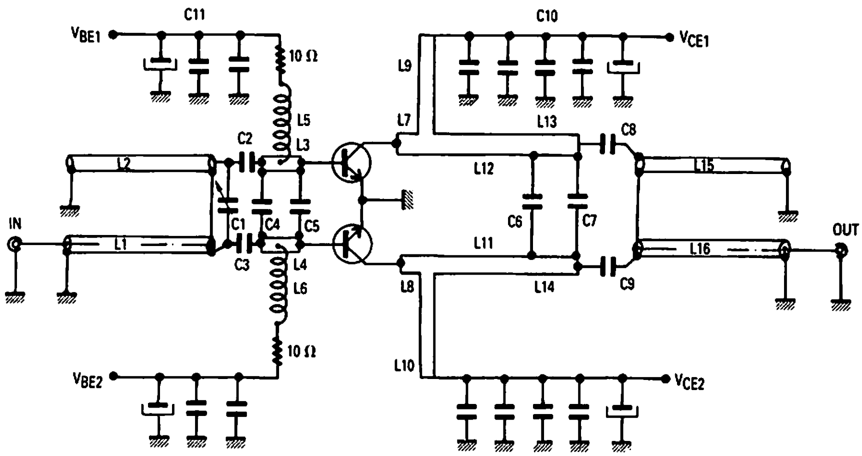


Figure 6. Z_{in} For Best Input VSWR Base-to-Base



L1, L2, L15, L16 — 60 mm of 50 Ω — 2.2 mm semi rigid coax
L3, L4 — 50 Ω line — 5.5% λg at 860 MHz
L5, L6 — 3 turns ID 2 mm
L7, L8 — 50 Ω line — 1.5% λg at 860 MHz
L9, L10 — 50 Ω line — 4.9% λg at 860 MHz
L11, L12 — 50 Ω line — 2% λg at 860 MHz
L13, L14 — 50 Ω line — 1.5% λg at 860 MHz

C1 — 0.5–4.5 pF GIGATRIM TRIMMER
C2, C3 — 27 pF ATC 100 A
C4 — 6.8 pF ATC 100 A
C5 — 18 pF ATC 100 A
C6 — 3.3 pF ATC 100 A
C7 — 4.7 pF ATC 100 A
C8, C9 — 27 pF ATC 100 A
C10 — + 330 pF ATC 100 B
+ 1 nF + 10 nF + 47 μF
C11 — 1 nF + 10 nF + 10 μF

Figure 7. 470–860 MHz Broadband Amplifier

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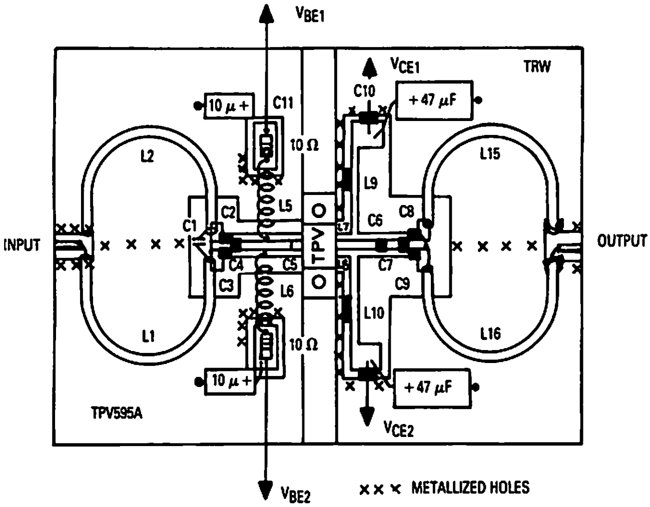
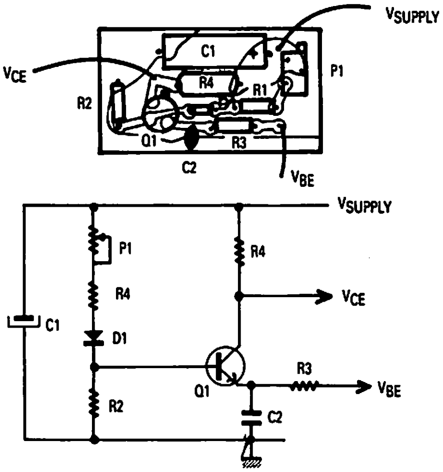


Figure 8. 470–860 MHz Broadband Amplifier



C1 — 100 mF	R2 — 5.6 kΩ	D1 — 1N4148
C2 — 10 nF	R3 — 100 Ω	Q1 — 2N2904
R1 — 150 Ω	R4 — 2.7 Ω 2 W	P1 — 1 kΩ

Figure 9. Bias Circuit

TPV596A

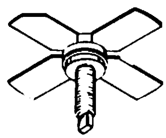
The RF Line

UHF Linear Power Transistor

... designed for very high output 1.5 V MATV amplifiers up to 860 MHz and 500 mW Band V TV transposer stages. Gold metallization and diffused emitter ballast resistors are used to enhanced reliability, ruggedness and linearity.

- *Band IV and V (470–860 MHz)*
- 0.5 W — P_{ref} @ −58 dB IMD
- High Gain — 12 dB Typ, Class A @ f = 860 MHz
- Gold Metallization for Reliability

0.5 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



CASE 244C-01, STYLE 1
(.280 SOE)

2

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	0.7	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	8.75 0.05	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	20	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 1 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.25 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.45	mAdc
Collector-Emitter Breakdown Voltage (I_C = 20 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	5	pF

(continued)

FUNCTIONAL TESTS

Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 0.5 W, f = 860 MHz, I_E = 0.22 A)	G_{PE}	11.5	12	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 1 W, I_E = 0.22 A, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 0.22 A, P_{ref} = 1 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−50	dB
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 20 V, I_E = 0.22 A, P_{ref} = 0.5 W, Vision Carrier = −8 dB, Sound Carrier = −10 dB, Sideband Carrier = −16 dB)	IMD_2	—	−60	−58	dB

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TYPICAL CHARACTERISTICS

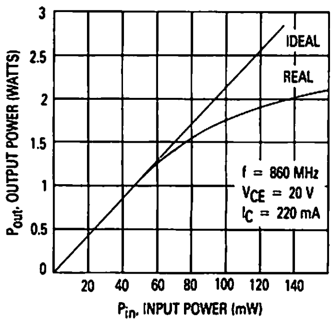


Figure 1. Power Output versus Power Input

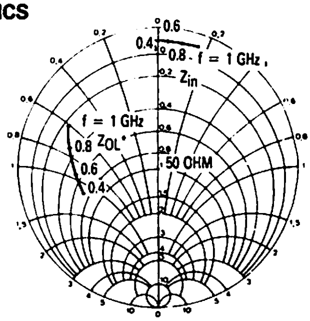


Figure 2. Large Signal Impedances
V_{CE} = 20 V — I_C = 220 mA

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

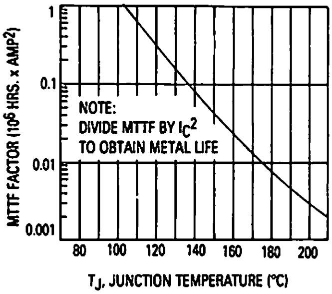


Figure 3. MTTF Factor versus Junction Temperature

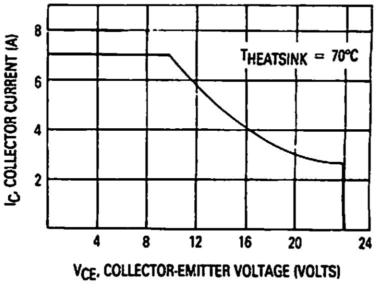
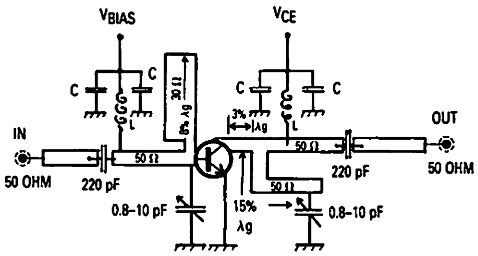


Figure 4. DC Safe Operating Area



L = 6 turns ID = 1 mm Wire diameter = 0.6 mm
The lengths are given for f = 860 MHz

Figure 5. 860 MHz Test Circuit

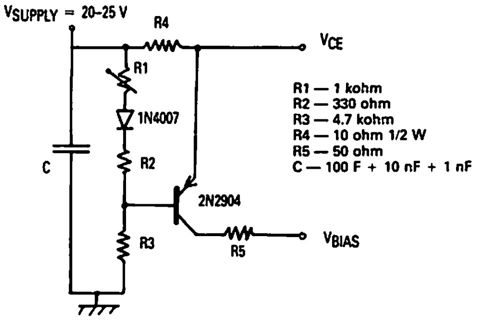


Figure 6. Class A Bias Circuit

TPV597

2

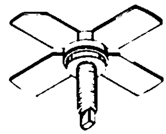
The RF Line

UHF Linear Power Transistor

1 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR

...designed for 1 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 1 W — P_{ref} @ −58 dB IMD
- 20 V — V_{CC}
- High Gain — 11 dB Typ, Class A @ f = 860 MHz
- Gold Metallization for Reliability



CASE 244C-01, STYLE 1
(.280 SOE)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	24	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	3.5	Vdc
Collector Current — Continuous	I_C	1.4	Adc
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	19 0.11	Watts W/°C
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	9	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	24	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 2 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 0.5 mA, I_C = 0)	$V_{(BR)EBO}$	3.5	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 40 mA, R_{BE} = 10 Ω)	$V_{(BR)CER}$	50	—	—	Vdc
Collector Cutoff Current (V_{CB} = 28 V, I_E = 0)	I_{CBO}	—	—	0.45	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 200 mA, V_{CE} = 5 V)	h_{FE}	15	—	120	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	7	pF

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 20 V, P_{out} = 1 W, f = 860 MHz, I_E = 0.44 A)	G_{PE}	10.5	11	—	dB
Load Mismatch (V_{CE} = 20 V, P_{out} = 2 W, I_E = 0.44 A, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 20 V, I_E = 0.44 A, P_{ref} = 1 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	−60	−58	dB
Cutoff Frequency (V_{CE} = 20 V, I_E = 0.44 A)	f_T	2.2	2.5	—	GHz
Intermodulation Distortion (IDEM) (f = 860 MHz, V_{CE} = 20 V, I_E = 0.44 A, P_{ref} = 2 W, Vision Carrier = −8 dB, Sound Carrier = −10 dB, Sideband Signal = −16 dB)	IMD_2	—	—	−51	dB

2

TYPICAL CHARACTERISTICS

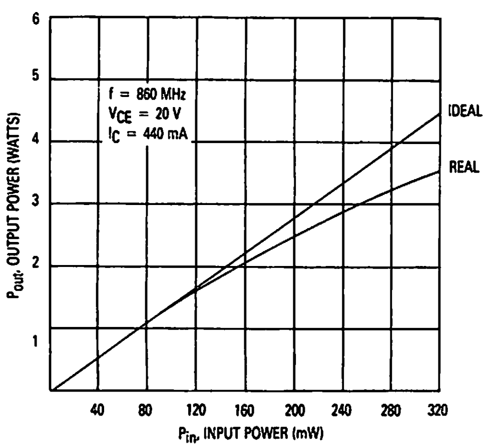


Figure 1. Power Output versus Power Input

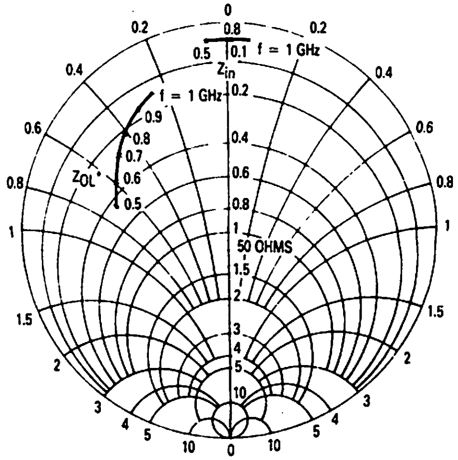


Figure 2. Large Signal Impedances
V_{CE} = 20 V — I_C = 440 mA

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

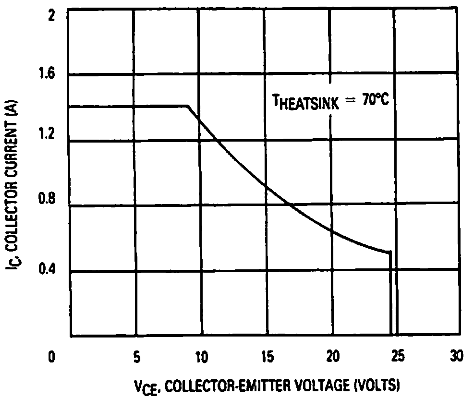


Figure 3. Safe Operating Area

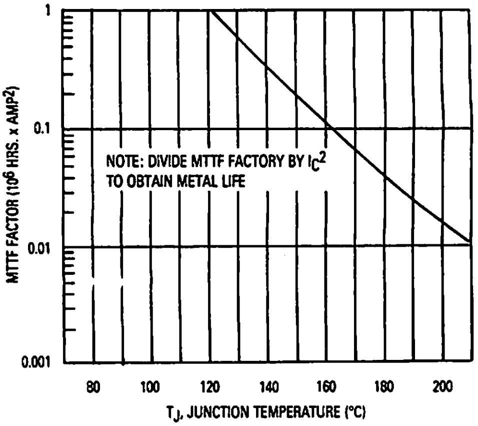
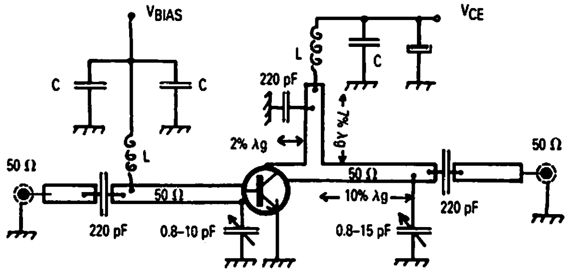
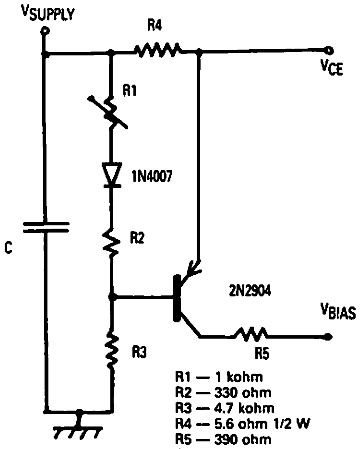


Figure 4. MTTF Factor versus Junction Temperature



L = 6 turns ID = 1 mm Wire diameter = 0.6 mm
The lengths are given for f = 860 MHz

Figure 5. 860 MHz Test Circuit



R1 — 1 kohm
R2 — 330 ohm
R3 — 4.7 kohm
R4 — 5.6 ohm 1/2 W
R5 — 390 ohm
C — 100 μF + 10 nF + 1 nF

Figure 6. Class A Bias Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

2

TPV598

Advance Information

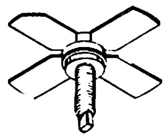
The RF Line

UHF Linear Power Transistor

. . . designed for 4 watt stages in Band V TV transposer amplifiers. Gold metallized dice and diffused emitter ballast resistors are used to enhance reliability, ruggedness and linearity.

- Band IV and V (470–860 MHz)
- 4 W — P_{ref} @ −60 dB IMD
- 25 V — V_{CC}
- High Gain — 7 dB Min, Class A @ f = 860 MHz
- Gold Metallization for Reliability

4 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR



.280 SOE
CASE 244C-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	27	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	6.2	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.4 Typ	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	27	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 10 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 1 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 500 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 25 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	20	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 4 W, f = 860 MHz, I_C = 850 mA)	G_{PE}	7	—	—	dB
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 850 mA, P_{ref} = 4 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−60	dB
Cutoff Frequency (V_{CE} = 25 V, I_C = 850 mA)	f_T	—	2	—	GHz

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS					
Common-Emitter Amplifier Small-Signal Gain (V_{CE} = 28 V, P_{out} = 28 W, f = 225 MHz, I_C = 2 x 2.25 A)	G_{PE}	14	—	—	dB
Load Mismatch (V_{CE} = 28 V, P_{out} = 28 W, f = 225 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Intermodulation Distortion, 3 Tone (f = 225 MHz, V_{CE} = 28 V, I_E = 2 x 2.25 A, P_{ref} = 28 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−51	dB
Output Power, 1 dB Compression Point (V_{CE} = 28 V, f = 225 MHz, I_Q = 2 x 100 mA, P_{ref} = 28 W)	$P_{o1\ dB}$	100	—	—	W

CLASS A TYPICAL VALUES

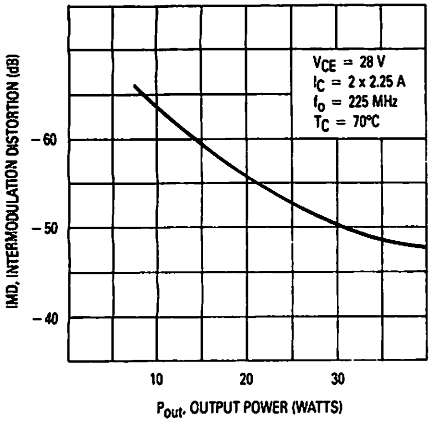


Figure 1. IMD versus Output Power

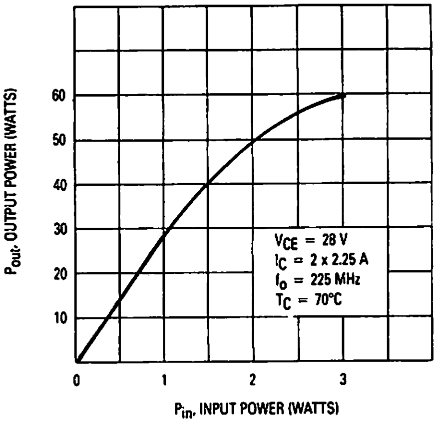


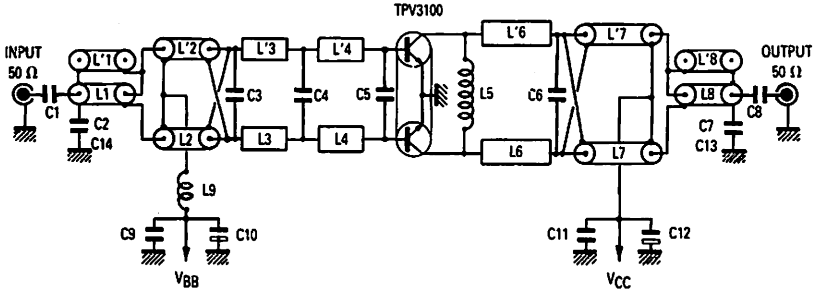
Figure 2. Output Power versus Input Power (CW)

Class A Large Signal Impedances

f_o (MHz)	Z_{in} (Ohms)	Z_{Load} (Ohms)
170	1 + j0.6	14.5 + j10
200	0.9 + j1	12.5 + j7
230	1.2 + j2	10.5 + j8.2

NOTES: V_{CE} = 28 V I_C = 2 x 2.25 A
Z_{in}: Values for optimum input return loss.
Z_{Load}: Values for best IMD at 28 W ref.

2



L1, L8 — 80 mm teflon coaxial cable 50 ohms
L2, L7 — 80 mm teflon coaxial cable 25 ohms
L3 — 25 mm line W = 1.5 mm on substrate
L4 — 5 mm line W = 1.5 mm on substrate
L5 — 5 turns dia 5 mm, 0.8 mm wire, L = 5 mm
L6 — 33 mm line W = 2 mm on substrate
L9 — 10 turns dia 3 mm, 0.5 mm wire

C1, C2 — 4700 pF chip capacitor
C7, C8 — 4700 pF chip capacitor
C3 — 68 pF chip capacitor
C4 — 100 pF chip capacitor
C5 — 220 pF + 22 pF chip capacitor
C6 — 33 pF chip capacitor
C9, C11 — 1000 pF + 10 nF + 0.1 μF chip capacitor
C10 — 1000 μF 5 V
C12 — 1000 μF 6 V
C13, C14 — 0.1 μF chip capacitor substrate teflon-glass 1/50 inch.

Figure 3. 225 MHz Test Fixture

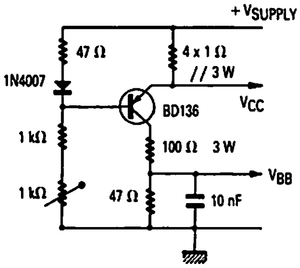


Figure 4. Biasing Circuit

2

CLASS AB TYPICAL VALUES

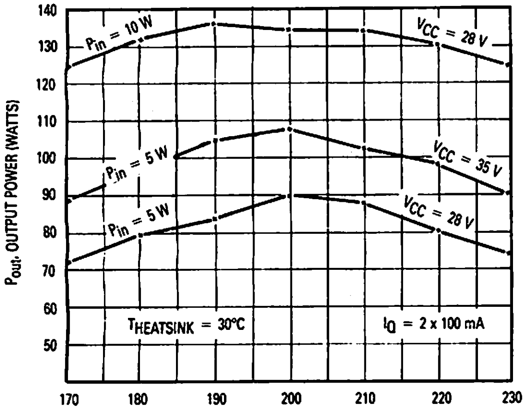


Figure 5. Output Power versus Frequency

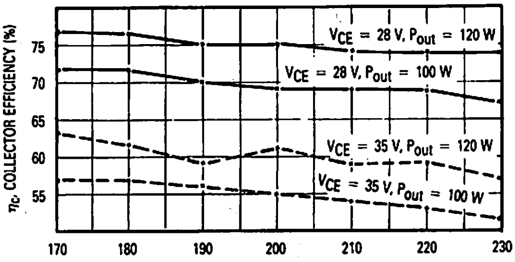


Figure 6. Collector Efficiency versus Frequency

Class AB Large Signal Impedances

Frequency (MHz)	Z_{in} (Ω)	Z_{Load} (Ω)
170	1.25 + j0.5	10 + j10
200	0.9 + j0.9	9.5 + j7
230	1 + j2	6.5 + j6.5

NOTES: V_{CE} = 28 Volts I_Q = 2 x 100 mA P_{out} = 100 W
— Z_{in} values to get optimum input return loss
— Z_{Load} values to get optimum output power and efficiency

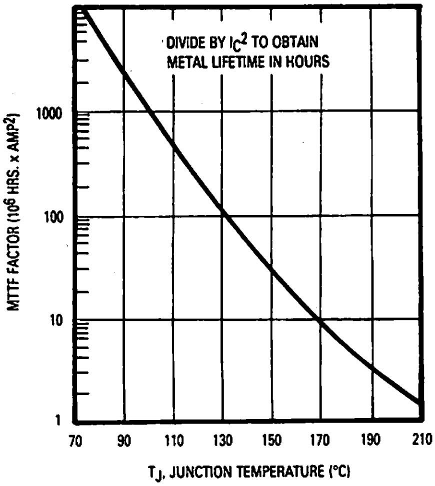
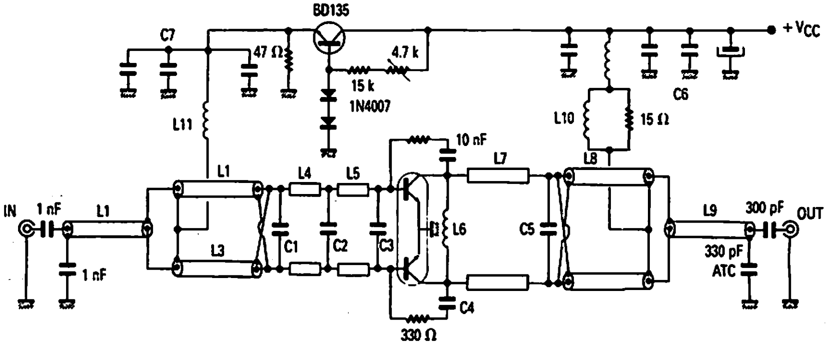


Figure 7. MTTF versus Junction Temperature



L1, L9 — 50 ohms coaxial 1 = 80 mm
L2, L3, L8 — 25 ohms coaxial cable or semi-rigid 1 = 80 mm
L4 — 40 ohms line 2.5% of λg 225 MHz or 1 = 23 mm sub 1/50 inch teflon glass
L5 — 40 ohms line 65% λg 225 MHz or 1 = 6 mm
L6 — 3 turns ID 4 mm wire 1 mm ø leads 5 mm long
L7 — 40 line 3.5% λg 225 MHz or 1 = 32 mm 1/50 teflon glass
L10 — 11 turns ID 4 mm wire 1 mm ø
L11 — 0.22 μH molded inductor

C1 — 68 pF ATC 100B
C2 — 100 pF ATC 100B
C3 — 220 pF ATC 100B
C5 — 27 pF + 33 pF ATC 100A
C6, C7 — 1 nF + 10 nF + 0.1 μF + electrolytic

L4 has to be adjusted for Gain
L6 and L7 have to be adjusted for the best lead

Figure 8. 170–230 MHz Broadband Amplifier, Class AB

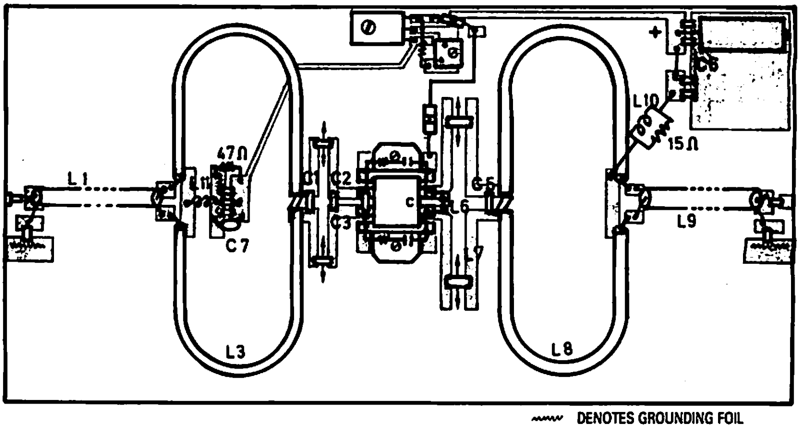


Figure 9. Components Layout

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TPV5051

Advance Information

The RF Line

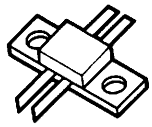
UHF Linear Power Transistor

50 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR

2

. . . specifically designed for high power vision or sound TV amplifiers operating Class *AB in Band IV* and V. The TPV5051 incorporates push-pull package technology, gold metallized dice with diffused emitter ballast resistors to enhance reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 50 W — P_{out}, Class AB
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability



BMA-2
CASE 395-01, STYLE 1

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Collector Current — Continuous	I_C	9	Adc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.8	°C/W
Thermal Resistance, Case to Heatsink	$R_{\theta CH}$	0.2 Typ	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 60 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector-Emitter Breakdown Voltage (I_C = 10 mA, R_{BE} = 50 Ω)	$V_{(BR)CER}$	40	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 V, I_B = 0)	I_{CEO}	—	—	10	mAdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 800 mA, V_{CE} = 20 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	40	pF

Note 1. Each transistor chip measured separately.

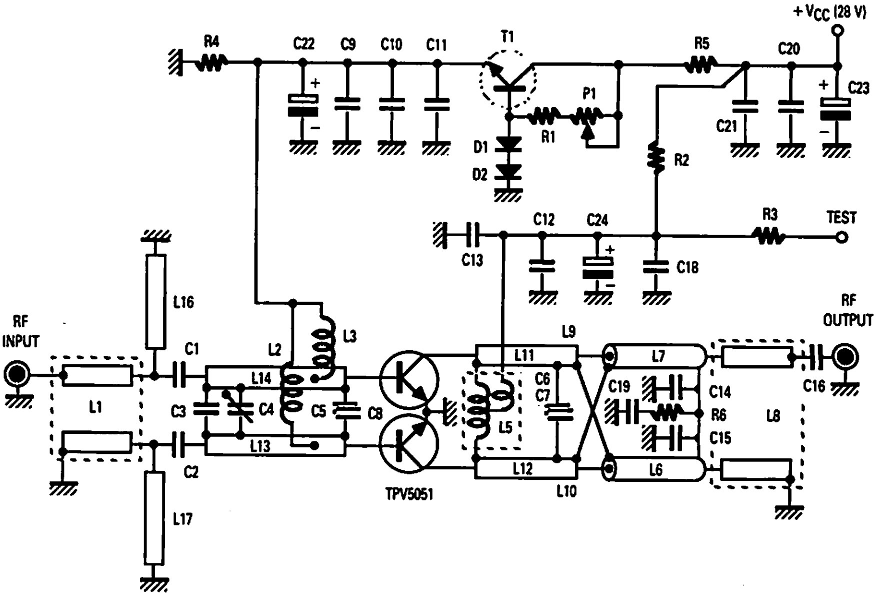
(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_Q = 2 x 50 mA)	G_{PE}	6.5	—	8	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_Q = 2 x 50 mA)	η_c	45	—	—	%
Load Mismatch (V_{CE} = 25 V, I_Q = 2 x 50 mA, P_{out} = 30 W, f = 860 MHz, Load VSWR = 10:1, All Phase Angles)	ψ	No Degradation in Output Power			

Note 2. Both transistor chips operating in push-pull amplifier.



L9, L10 — 0.05 λ @ 665 MHz, Z_o = 37 Ω
L13, L14 — 0.0156 λ @ 665 MHz, Z_o = 50 Ω
L11, L12 — 0.014 λ @ 665 MHz, Z_o = 50 Ω
L16, L17 — 0.13 λ @ 665 MHz, Z_o = 50 Ω

C1, C2 — Capacitor Chip 15 pF 5%
C3 — Capacitor Chip 5.6 pF 5%
C4, C8 — Capacitor Ajust. 1-4 pF
C5 — Capacitor Chip 22 pF
C6 — Capacitor Chip 12 pF 5%
C7 — Capacitor Chip 4.7 pF 5%
C9, C10, C13, C15 — Capacitor Chip 330 pF
C11, C12, C14, C20 — Capacitor Chip 0.1 μF
C16, C17 — Capacitor Chip 100 pF 10%
C18, C21 — Capacitor Chip 15 nF
C19 — Capacitor Chip 1 nF

C22, C23 — Capacitor, Electrolytic 100 μF
C24 — Capacitor, Electrolytic 10 μF

R1 — Resistor 1/2 W 1 kΩ
R2 — Resistor 0.1 Ω 1%
R3, R5 — Resistor 1/2 W 100 Ω
R4 — Resistor 1/2 W 33 Ω
R6 — Resistor 1/4 W 10 Ω

L1 — Bifilar Inductor
L2, L3 — Inductor, Molded 0.47 μH
L5 — Inductor
L6, L7 — Cable, Coaxial 25 Ω
L8 — Bifilar Inductor

T1 — Transistor BD135

Figure 1. 860 MHz Test Circuit

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

TPV5055B

2

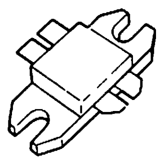
The RF Line
UHF Linear Power Transistor

... designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 50 W — P_{out}, Class AB
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability

50 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR
NPN SILICON



CASE 398-01, STYLE 1
(BMA-4)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−65 to +200	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS					
Collector-Emitter Breakdown Voltage (I_C = 40 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
Collector Cutoff Current (V_{CE} = 28 V, V_{BE} = 0)	I_{CES}	—	—	10	mAdc
ON CHARACTERISTICS					
DC Current Gain (I_C = 1 A, V_{CE} = 10 V)	h_{FE}	10	—	—	—
DYNAMIC CHARACTERISTICS					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	38	—	pF
FUNCTIONAL TESTS					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_{CQ} = 2 x 200 mA)	G_{PE}	7	—	—	dB
Collector Efficiency (V_{CE} = 28 V, P_{out} = 50 W, f = 860 MHz, I_{CQ} = 2 x 200 mA)	η	45	50	—	%
Output Power, 1 dB Compression Point (V_{CE} = 28 V, f = 860 MHz, I_{CQ} = 2 x 200 mA, P_{ref} = 12.5 W)	$P_{o1\ dB}$	50	—	—	W

2

TYPICAL BROADBAND RESULTS
V_{CC} = 28 V I_{CQ} = 2 x 200 mA
FREQUENCY: 470–860 MHz

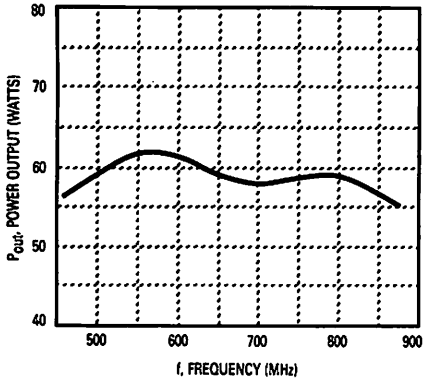


Figure 1. Power Output at 1 dB Compression versus Frequency

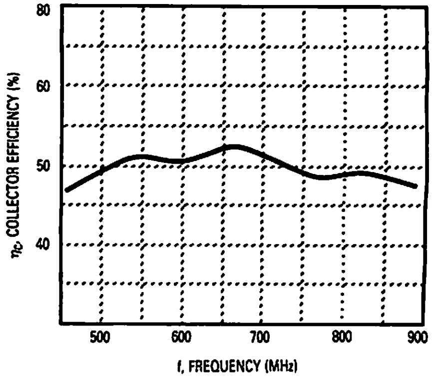


Figure 2. Collector Efficiency versus Frequency

TYPICAL CHARACTERISTICS

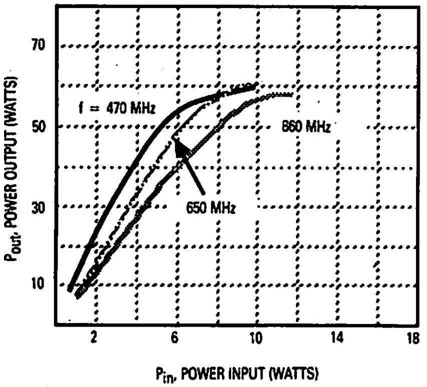
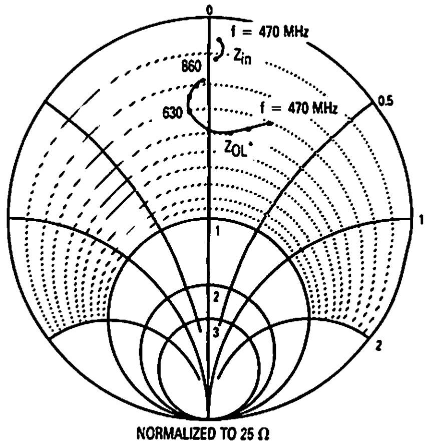


Figure 3. Power Output versus Power Input



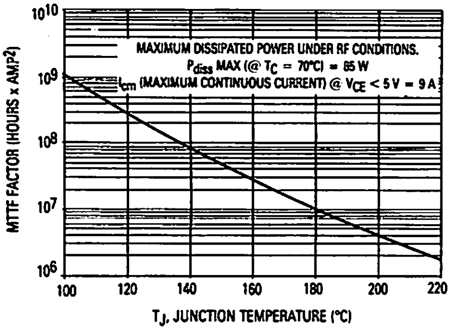


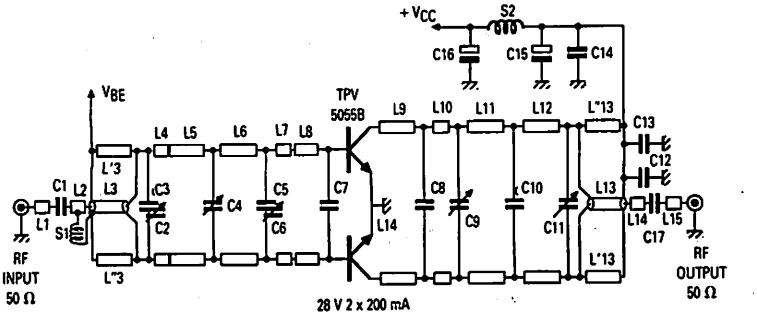
Figure 4. MTTF Factor versus Junction Temperature (MTTF — Hrs. x A² — Divide by I_C^2 to obtain MTTF in hours)

f (MHz)	Z_{in} (Ω)	Z_{OL}* (Ω)
470	1.5 + j0.65	7.8 + j5.3
520		9 + j4.5
565	1.9 + j1	10 + j2.5
590		10 + j0
630	2.5 + j1	7.8 − j2
680		6 − j1.7
765	2.9 + j0.8	5 − j1
860	3 + j0.5	4.5 − j0.5

P_{out} = @ 1 dB Compression
V_{CC} = 28 V, I_{CQ} = 2 x 200 mA

Figure 5. Z_{IN} and Z_{OL}* versus Frequency (Each side)

Z_{OL}* = Conjugate of the optimum load impedance into which the device output operates at a given output power, voltage and frequency.

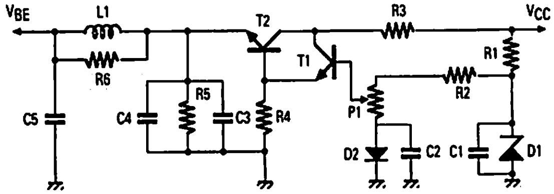


L1 — 50 Ω Printed Line
L2 — 50 Ω Printed Line
L3 — Coaxial Cable 50 Ω 85 mils L = 75 mm
L'3 — 70 Ω Printed Line; Length 75 mm
L4 — 25 Ω Printed Line; Length 2 mm
L5 — 35 Ω Printed Line; Length 22 mm
L6 — 35 Ω Printed Line; Length 12 mm
L7 — 35 Ω Printed Line; Length 2 mm
L8 — 25 Ω Printed Line; Length 8 mm
L9 — 25 Ω Printed Line; Length 16 mm
L10 — 25 Ω Printed Line; Length 7 mm
L11 — 35 Ω Printed Line; Length 15 mm
L12 — 35 Ω Printed Line; Length 15 mm
L13 — Coaxial Cable 50 Ω 85 mils L = 75 mm
L'13 — 70 Ω Printed Line; Length 75 mm
L"13 — 70 Ω Printed Line; Length 75 mm
L14 — 40 Ω Printed Line; Length 7 mm

S1 — 4 Turns Wire 0.8 mm ID 3 mm
S2 — 4 Turns Wire 0.8 mm ID 3 mm

C1 — Chip Capacitor 100 pF ATC 100A101JP50
C2 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC
C3 — Chip Capacitor 1.3 pF ATC 100A1R3BP50
C4 — Trimmer Capacitor 1-4 pF GKU 4RO
C5 — Chip Capacitor 5.6 pF ATC 100A5R6CP50
C6 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC
C7 — Chip Capacitor 18 pF ATC 100A180DP50
C8 — Chip Capacitor 6.8 pF ATC 100A6R8CP50
C9 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC
C10 — 6 mm Coaxial Line 50 Ω Dia. 070
C11 — Trimmer Capacitor 0.5/4 pF Ref. 37275 TEKELEC
C12 — Chip Capacitor 100 pF ATC 100A101JP50
C13 — Chip Capacitor 100 pF ATC 100A101JP50
C14 — Chip Capacitor 1 nF
C15 — Chip Tantalum Capacitor 6.8 µF 35 V
C16 — Capacitor 100 µF 40 V
C17 — Chip Capacitor 100 pF ATC 100A101JP50
RF Substrate, Teflon Glass 1/50 inch 35 µ
Note: L3 & L13 soldered on 70 Ω printed line L'3/L'13

Figure 6. 470–860 MHz Test Circuit, Class AB



R1b — 2.2 kΩ 1/4 W
R2b — 1.5 kΩ 1/4 W
R3b — 15 Ω 3 W SFERNICE
R4b — 1 kΩ 1/4 W
R5b — 47 Ω 1/2 W
R6b — 150 Ω 1/4 W
T1b — Transistor BC337
T2b — Transistor BD135 fixed on the heatsink
D1b — Zener Diode 9.1 V
D2b — Diode 1N4007 (fixed in the heatsink next to the RF Transistor Flange)
C1b — 22 µF 35 V Tantalum Capacitor
C2b — 6.8 µF 35 V Tantalum Capacitor + 1 nF Chip Capacitor
C3b — 6.8 µF 35 V Tantalum Capacitor
C4b — 1 nF Chip Capacitor
C5b — 100 pF ATC 100A101JP50
P1b — 500 Ω Trimmer
L1b — 10 Turns Wire ø 30/100 around R6

Figure 7. Bias Circuit, Class AB

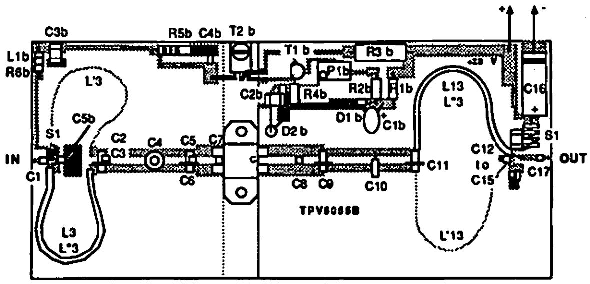


Figure 8. PC Board Layout

2

The RF Line
UHF Linear Power Transistor

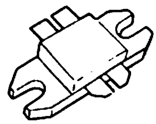
TPV7025

25 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR

. . . designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 25 W — P_{ref} @ −45 dB IMD
- 25 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability



CASE 398-01, STYLE 1
(BMA-4)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	28	Vdc
Collector-Base Voltage	V_{CBO}	45	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−50 to +200	°C
Operating Case Temperature	T_C	70	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_C = 70°C)	$R_{\theta JC}$	1.5	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 120 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 6 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 1 A, V_{CE} = 20 V)	h_{FE}	10	—	60	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	64	—	80	pF

Note 1. Each transistor chip measured separately.

(continued)

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 25 V, P_{out} = 25 W, f = 860 MHz, I_{CQ} = 3.2 A)	G_{PE}	9	—	10.5	dB
Load Mismatch (V_{CE} = 25 V, P_{out} = 24 W, f = 860 MHz, Load VSWR = ∞:1, All Phase Angles)	ψ	No Degradation in Output Power			
Overdrive (f = 470 MHz, 2 tones, V_{CE} = 25 V, I_C = 3.2 A) (No Degradation)	$P_{in_{over}}$	24	—	—	W
Intermodulation Distortion, 3 Tone (f = 860 MHz, V_{CE} = 25 V, I_E = 3.2 A, P_{ref} = 25 W, Vision Carrier = −8 dB, Sound Carrier = −7 dB, Sideband Signal = −16 dB, Specification TV05001)	IMD_1	—	—	−45	dB
Cross Modulation Distortion (P_{ref} = 25 W, f = 860 MHz, Δ% Sound = (−7 dB), Vision 0 — Peak)	X_{MOD}	—	—	20	%

Note 2. Both transistor chips operating in push-pull amplifier.

2

TYPICAL CHARACTERISTICS

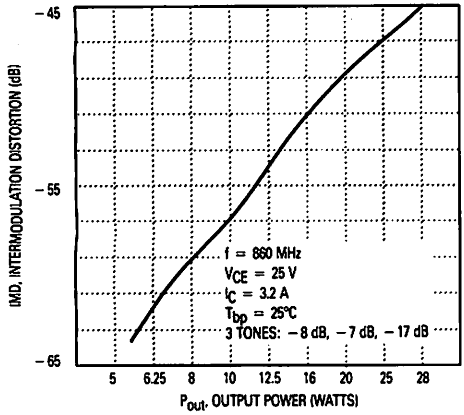


Figure 1. IMD versus Output Power

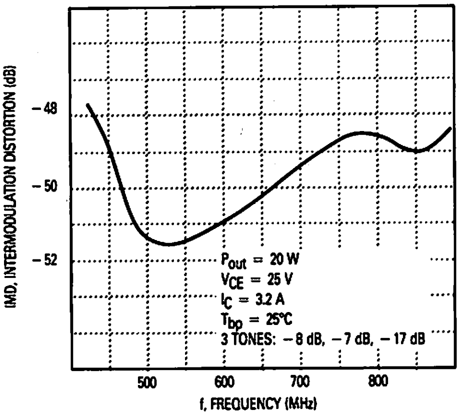
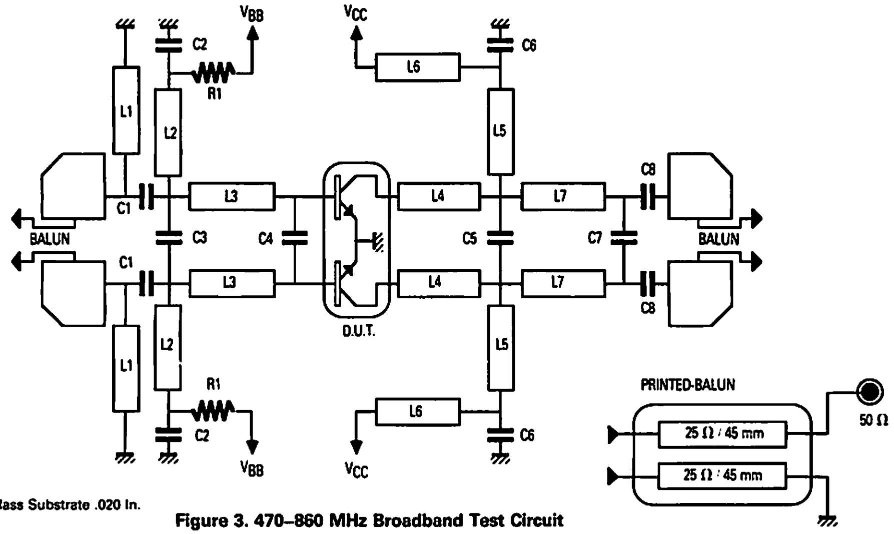


Figure 2. IMD versus Frequency



L1 — 90 / 16 mm
L2 — 90 / 16 mm
L3 — 35 / 10 mm
L4 — 25 / 7 mm
L5 — 70 / 6 mm
L6 — 70 / 26 mm
L7 — 60 / 16 mm

C1 — 15 pF
C2 — 180 pF
C3 — 10 pF
C4 — 15 pF
C5 — 15 pF
C6 — 180 pF
C7 — 4.7 pF
C8 — 100 pF

R1 — 3.3 Ω

Board Material: Teflon Glass Substrate .020 In.

Figure 3. 470–860 MHz Broadband Test Circuit

2

V_{CE} (Volts)	I_C A	f (GHz)	S_{11}		S_{21}		S_{12}		S_{22}	
			Mag	∠φ	Mag	∠φ	Mag	∠φ	Mag	∠φ
25	2 × 1.8	0.44	1	178	1.25	80	0.02	29	0.89	156
		0.46	1	176	1.25	84	0.02	31	0.78	151
		0.48	1	174	1.3	81	0.02	30	0.7	148
		0.5	0.99	173	1.39	75	0.02	29	0.65	145
		0.52	0.98	171	1.42	70	0.03	26	0.59	142
		0.54	0.97	173	1.52	65	0.03	17	0.53	140
		0.56	0.97	171	1.67	67	0.03	12	0.46	139
		0.58	0.94	169	1.77	49	0.03	8	0.39	138
		0.6	0.92	164	1.93	40	0.04	0	0.31	142
		0.62	0.89	163	2.05	30	0.04	-9	0.23	157
		0.64	0.86	163	2.19	18	0.05	-19	0.21	-173
		0.66	0.82	164	2.29	4	0.05	-30	0.3	-150
		0.68	0.79	166	2.29	-11	0.05	-42	0.43	-147
		0.7	0.79	169	2.16	-26	0.05	-55	0.57	-150
		0.72	0.79	171	1.99	-40	0.05	-66	0.68	-155
		0.74	0.82	172	1.8	-52	0.05	-76	0.77	-161
		0.76	0.84	172	1.59	-63	0.04	-87	0.83	-168
		0.78	0.86	172	1.38	-74	0.04	-96	0.86	-173
		0.8	0.88	171	1.23	-82	0.03	-102	0.88	-178
		0.82	0.89	170	1.1	-88	0.03	-106	0.88	178
		0.84	0.9	170	0.99	-94	0.03	-110	0.89	175
		0.86	0.9	169	0.89	-100	0.03	-115	0.88	172
		0.88	0.9	168	0.8	-107	0.03	-119	0.87	170

Figure 4. Common Emitter S-Parameters

TPV8100B

Advance Information

The RF Line

UHF Linear Power Transistor

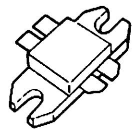
25 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR

2

. . . designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 110 Watts C.W.
- 25 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability



CASE 398-01, STYLE 1
(BMA-4)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	−40 to +100	°C
Operating Case Temperature Range	T_C	−20 to +70	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_J = 200°C)	$R_{\theta JC}$	0.6	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 10 mA, I_B = 0)	$V_{(BR)CEO}$	30	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 20 mA, I_E = 0)	$V_{(BR)CBO}$	65	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 10 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 2 A, V_{CE} = 10 V)	h_{FE}	30	—	—	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz)	C_{ob}	—	—	50	pF

Note 1. Each transistor chip measured separately.

(continued)

This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 100 W, f = 860 MHz, I_{CQ} = 2 x 100 mA)	G_{PE}	9	—	—	dB
Output Power @ 1 dB Compression Point (V_{CE} = 28 V, f = 860 MHz, I_{CQ} = 2 x 100 mA)	P_{1dB}	110	—	—	W
Collector Efficiency (V_{CE} = 28 V, P_o = 100 W, f = 860 MHz, I_{CQ} = 2 x 100 mA)	η_c	60	—	—	%

Note 2. Both transistor chips operating in push-pull amplifier.

Advance Information

The RF Line

UHF Linear Power Transistor

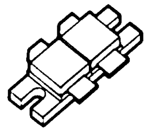
TPV8200B

**180 W — 470 to 860 MHz
UHF LINEAR
POWER TRANSISTOR**

... designed for output stages in Band IV & V TV transmitter amplifiers. Internal matching of both input and output along with use of a push-pull package configuration aids broadband amplifier designs.

Gold metallized dice with diffused emitter ballast resistors enhances reliability, ruggedness and linearity.

- Band IV & V (470–860 MHz)
- 180 Watts C.W.
- 28 V — V_{CC}
- Push-Pull Package
- Gold Metallization for Reliability



CASE 397-01, STYLE 1
(HDA2)

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	30	Vdc
Collector-Base Voltage	V_{CBO}	65	Vdc
Emitter-Base Voltage	V_{EBO}	4	Vdc
Operating Junction Temperature	T_J	200	°C
Storage Temperature Range	T_{stg}	–40 to +100	°C
Operating Case Temperature Range	T_C	–20 to +70	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Case (T_J = 200°C)	$R_{\theta JC}$	0.4	°C/W

ELECTRICAL CHARACTERISTICS

Characteristic	Symbol	Min	Typ	Max	Unit
OFF CHARACTERISTICS (Note 1)					
Collector-Emitter Breakdown Voltage (I_C = 20 mA, I_B = 0)	$V_{(BR)CEO}$	28	—	—	Vdc
Collector-Base Breakdown Voltage (I_C = 40 mA, I_E = 0)	$V_{(BR)CBO}$	45	—	—	Vdc
Emitter-Base Breakdown Voltage (I_E = 20 mA, I_C = 0)	$V_{(BR)EBO}$	4	—	—	Vdc
ON CHARACTERISTICS (Note 1)					
DC Current Gain (I_C = 2 A, V_{CE} = 10 V)	h_{FE}	30	—	—	—
DYNAMIC CHARACTERISTICS (Note 1)					
Output Capacitance (V_{CB} = 28 V, I_E = 0, f = 1 MHz) Note 2	C_{ob}	—	—	95	pF

Note 1. Each transistor chip measured separately.
Note 2. Value cannot be measured because of internal matching network.

(continued)

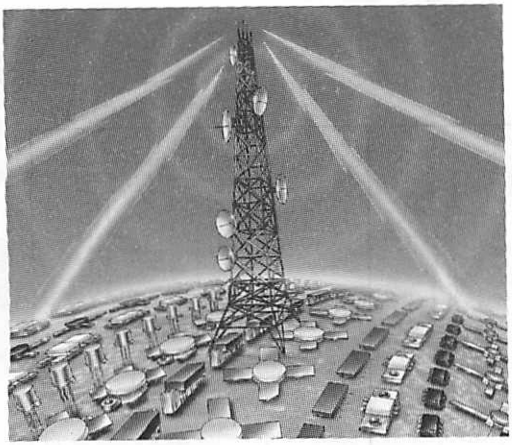
This document contains information on a new product. Specifications and information herein are subject to change without notice.

2

ELECTRICAL CHARACTERISTICS — continued

Characteristic	Symbol	Min	Typ	Max	Unit
FUNCTIONAL TESTS (Note 2)					
Common-Emitter Amplifier Power Gain (V_{CE} = 28 V, P_{out} = 175 W, f = 860 MHz, I_{CQ} = 2 x 100 mA)	G_{PE}	8.5	—	—	dB
Output Power @ 1 dB Compression Point (V_{CE} = 28 V, f = 860 MHz, I_{CQ} = 2 x 100 mA)	P_{1dB}	180	—	—	W
Collector Efficiency (V_{CE} = 28 V, P_{out} = 175 W, f = 860 MHz, I_{CQ} = 2 x 100 mA)	η_c	55	—	—	%

Note 2. Both transistor chips operating in push-pull amplifier.

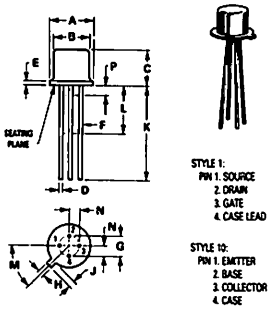


Volume I

Case Dimensions

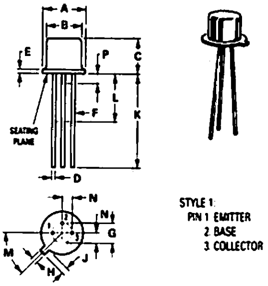
3

Case Dimensions



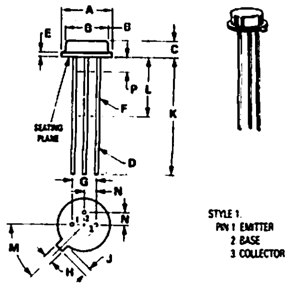
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.41	0.53	0.016	0.021
E	—	0.76	—	0.030
F	0.41	0.48	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.91	1.17	0.036	0.046
J	0.71	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 20-03
(TO-206AF)



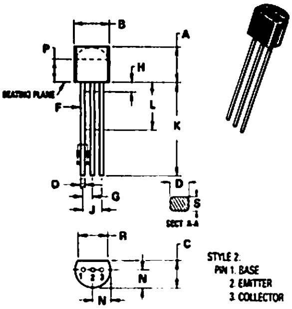
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	4.32	5.33	0.170	0.210
D	0.406	0.533	0.016	0.021
E	—	0.762	—	0.030
F	0.406	0.483	0.016	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 22-03
(TO-206AA)



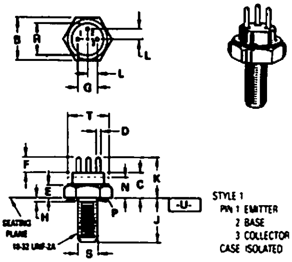
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.31	5.84	0.209	0.230
B	4.52	4.95	0.178	0.195
C	1.65	2.16	0.065	0.085
D	0.406	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.305	0.483	0.012	0.019
G	2.54 BSC		0.100 BSC	
H	0.914	1.17	0.036	0.046
J	0.711	1.22	0.028	0.048
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	1.27 BSC		0.050 BSC	
P	—	1.27	—	0.050

CASE 26-03
(TO-206AB)



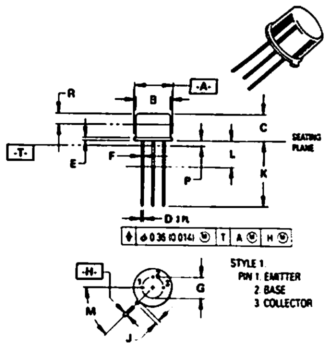
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

CASE 29-04
(TO-226AA)



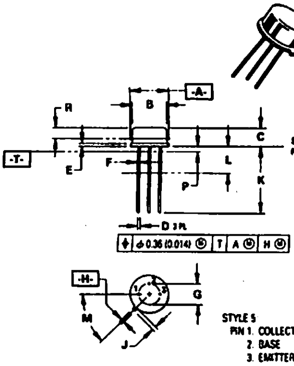
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
B	10.77	11.10	0.424	0.437
C	6.22	7.49	0.245	0.295
D	0.89	1.52	0.035	0.060
E	2.54	3.42	0.100	0.135
F	3.55	4.06	0.140	0.160
G	5.08 BSC		0.200 BSC	
H	—	1.98	—	0.078
J	10.41	11.56	0.410	0.455
K	9.65	12.19	0.380	0.480
L	2.54 BSC		0.100 BSC	
M	—	4.19	—	0.165
P	4.14	4.80	0.163	0.189
R	8.13	9.14	0.320	0.360
S	4.650	4.803	0.1831	0.1891
T	9.14	11.10	0.360	0.437

CASE 36-03
(TO-60)



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.50	0.305	0.335
C	6.10	6.60	0.240	0.260
D	0.41	0.53	0.016	0.021
E	0.23	1.04	0.009	0.041
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

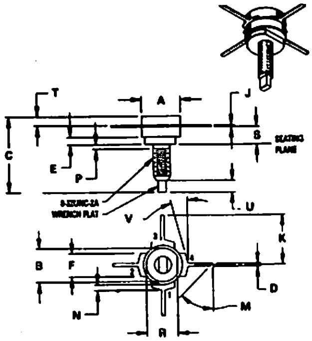
CASE 79-04
(TO-205AD)



STYLE 5
PIN 1. COLLECTOR
2. BASE
3. EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

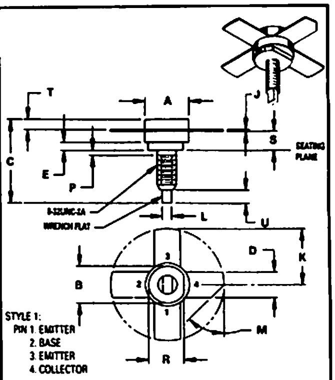
CASE 79-05
(TO-39 CE)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	0.64	0.89	0.025	0.035
E	1.78	—	0.070	—
F	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
M	45° NOM		45° NOM	
N	1.27	1.52	0.050	0.060
P	—	1.27	—	0.050
R	7.59	7.80	0.299	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132
V	10°	20°	10°	20°

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

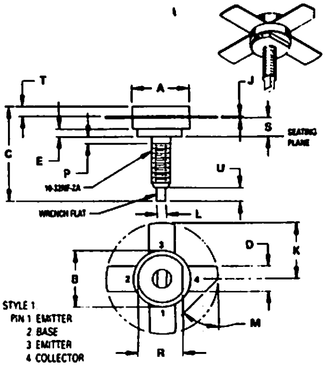
CASE 144B-05
(.380" STUD)



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.40	9.78	0.370	0.385
B	8.13	8.38	0.320	0.330
C	17.02	20.07	0.670	0.790
D	5.46	5.97	0.215	0.235
E	1.78	—	0.070	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.40	1.78	0.055	0.070
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	7.59	7.80	0.293	0.307
S	4.01	4.52	0.158	0.178
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-09
(.380" STUD)

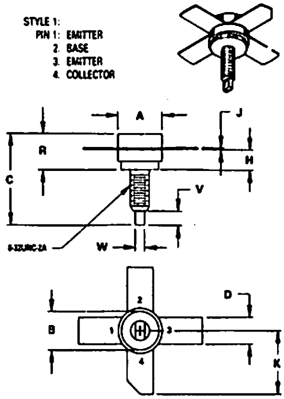


STYLE 1
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	12.45	12.95	0.490	0.510
B	10.54	10.80	0.415	0.425
C	19.68	22.73	0.775	0.895
D	5.46	5.97	0.215	0.235
E	1.83	—	0.072	—
J	0.08	0.18	0.003	0.007
K	12.45	—	0.490	—
L	1.65	1.90	0.065	0.075
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
R	9.73	10.06	0.383	0.396
S	3.84	4.50	0.151	0.177
T	2.11	2.54	0.083	0.100
U	2.49	3.35	0.098	0.132

CASE 145A-10
(.500" STUD)

STYLE 1:
PIN 1: EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

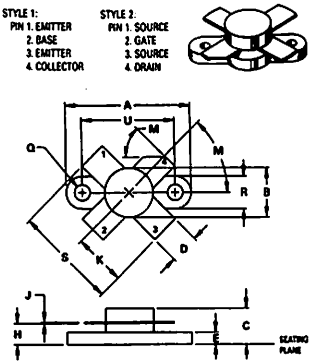


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.28	9.77	0.365	0.385
B	8.13	8.39	0.320	0.330
C	17.78	19.76	0.700	0.778
D	5.59	5.84	0.220	0.230
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	12.45	13.20	0.490	0.520
R	6.74	7.23	0.265	0.285
V	2.54	3.30	0.100	0.130
W	1.53	1.77	0.060	0.070

CASE 145D-01
(.380 SOE)

STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

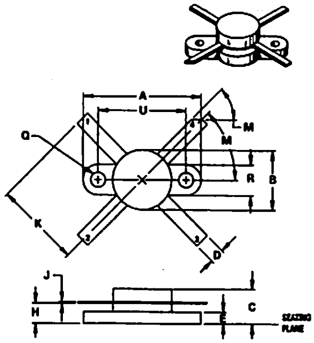


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	9.40	9.90	0.370	0.390
C	5.82	7.13	0.229	0.281
D	5.47	5.96	0.215	0.235
E	2.16	2.66	0.085	0.105
H	3.81	4.57	0.150	0.180
J	0.11	0.15	0.004	0.006
K	10.04	10.28	0.395	0.405
M	40°	50°	40°	50°
Q	2.88	3.30	0.113	0.130
R	6.23	6.47	0.245	0.255
S	20.07	20.57	0.790	0.810
U	18.29	18.54	0.720	0.730

CASE 211-07
(.380" FLANGE)

3

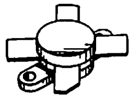
3



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.495	0.510
C	5.82	6.98	0.229	0.275
D	2.16	3.93	0.085	0.155
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	17.78	—	0.700	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.23	6.47	0.245	0.255
U	18.29	18.54	0.720	0.730

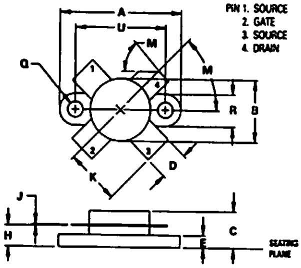
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 211-10



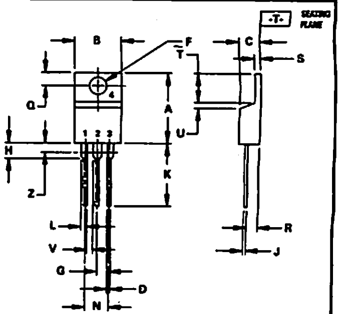
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN



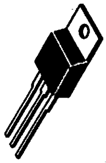
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.39	25.14	0.960	0.990
B	11.82	12.95	0.495	0.510
C	5.82	6.98	0.229	0.275
D	5.49	5.96	0.216	0.235
E	2.14	2.79	0.084	0.110
H	3.66	4.52	0.144	0.178
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
Q	2.93	3.30	0.115	0.130
R	6.25	6.47	0.246	0.255
U	18.29	18.54	0.720	0.730

CASE 211-11
(.500" FLANGE)



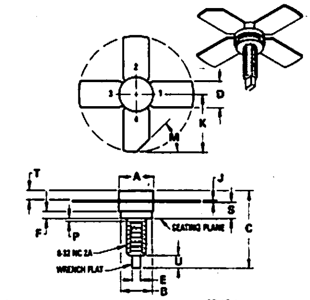
STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. BASE
2. EMITTER
3. COLLECTOR
4. EMITTER



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.48	15.75	0.570	0.620
B	9.66	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.46	0.64	0.018	0.025
K	12.70	14.27	0.500	0.562
L	1.15	1.52	0.045	0.060
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

CASE 221A-06
(TO-220AB)



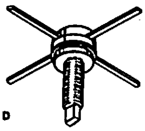
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

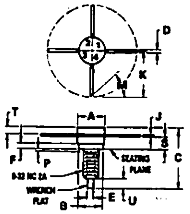
STYLE 3:
PIN 1. SOURCE
2. GATE
3. SOURCE
4. DRAIN

STYLE 4:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	14.99	16.51	0.590	0.650
D	5.46	5.96	0.215	0.235
E	1.40	1.65	0.055	0.065
F	1.52	—	0.059	—
J	0.08	0.17	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	3.00	3.25	0.118	0.128
T	1.40	1.77	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244-04
(.280" STUD)





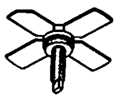
STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

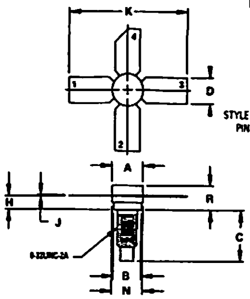
STYLE 2:
PIN 1. COMMON
2. OUTPUT
3. COMMON
4. INPUT

STYLE 3:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
B	6.20	6.50	0.244	0.256
C	15.24	16.51	0.600	0.650
D	0.66	0.86	0.026	0.034
E	1.40	1.65	0.055	0.065
F	1.52	—	0.060	—
J	0.10	0.15	0.004	0.006
K	11.17	—	0.440	—
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	2.74	3.35	0.108	0.132
T	1.40	1.78	0.055	0.070
U	2.92	3.68	0.115	0.145

CASE 244A-01
(TO-117)

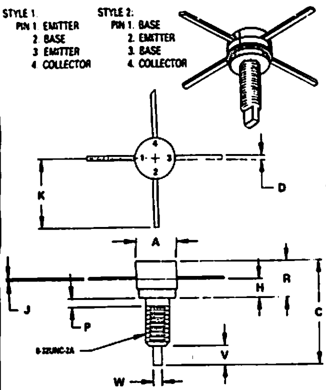




STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

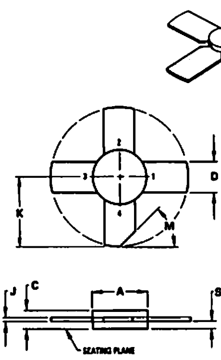
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.99	7.23	0.275	0.285
B	6.23	6.47	0.245	0.255
C	11.18	11.68	0.440	0.460
D	5.59	5.84	0.220	0.230
H	2.83	3.12	0.113	0.123
J	0.11	0.15	0.004	0.006
K	26.80	27.05	1.055	1.065
N	6.81	7.31	0.268	0.283
R	—	5.46	—	0.215

CASE 244C-01
(.280 SOE)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.74	7.23	0.265	0.285
C	14.94	16.23	0.588	0.639
D	0.64	0.88	0.025	0.035
H	2.65	3.40	0.104	0.134
J	0.11	0.15	0.004	0.006
K	11.18	11.68	0.440	0.460
P	1.40	1.65	0.055	0.065
R	5.21	6.35	0.205	0.250
V	2.93	3.68	0.115	0.145
W	1.40	1.65	0.055	0.065

CASE 244D-01
(TO-117A)

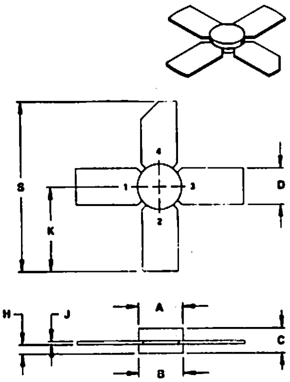


STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR
SEATING PLANE = GROUND AND IS CONNECTED TO PIN 1 AND PIN 3.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.285
C	2.84	3.45	0.112	0.136
D	5.46	5.97	0.215	0.235
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45° NOM		45° NOM	
S	1.40	1.65	0.055	0.065

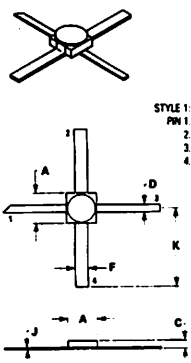
CASE 249-05
(.280" PILL)



STYLE 1
PIN 1 EMITTER
2 BASE
3 EMITTER
4 COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.86	7.36	0.270	0.290
B	6.99	7.23	0.275	0.285
C	3.18	3.70	0.125	0.146
D	5.59	5.84	0.220	0.230
H	1.35	1.60	0.053	0.063
J	0.11	0.17	0.004	0.007
K	11.05	11.93	0.435	0.470
S	25.65	26.16	1.010	1.030

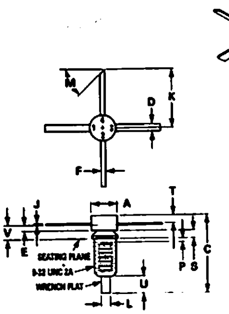
CASE 249A-01
(.280 SOE S)



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	2.29	2.67	0.090	0.105
C	0.89	1.40	0.035	0.055
D	0.41	0.61	0.016	0.024
F	0.89	1.09	0.035	0.043
J	0.08	0.15	0.003	0.006
K	4.45	5.84	0.175	0.230

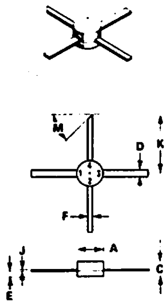
CASE 303-01
(.100" CERAMIC)



STYLE 1:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	13.97	16.26	0.550	0.640
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
L	1.40	1.65	0.055	0.065
M	45° NOM		45° NOM	
P	—	1.27	—	0.050
S	1.40	1.65	0.055	0.065
T	1.40	1.78	0.055	0.070
U	2.79	3.81	0.110	0.150
V	2.41	2.92	0.095	0.115

CASE 305-01
(.204" STUD)



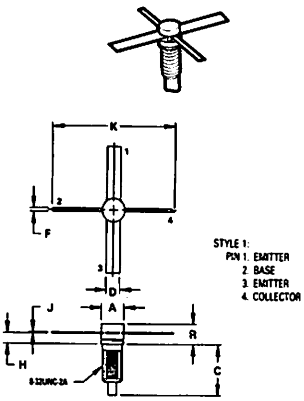
STYLE 1.
PIN 1. EMITTER
2 BASE
3 EMITTER
4 COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.59	0.200	0.220
C	2.41	3.30	0.095	0.130
D	1.40	1.65	0.055	0.065
E	1.02	1.27	0.040	0.050
F	0.64	0.89	0.025	0.035
J	0.08	0.18	0.003	0.007
K	11.05	—	0.435	—
M	45 NOM		45 NOM	

CASE 305A-01
(.204" PILL)

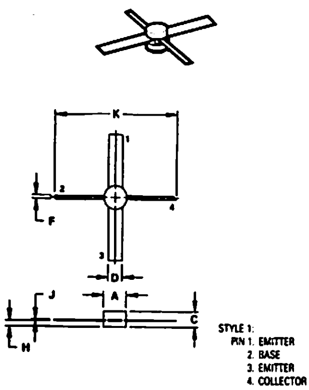
3

3



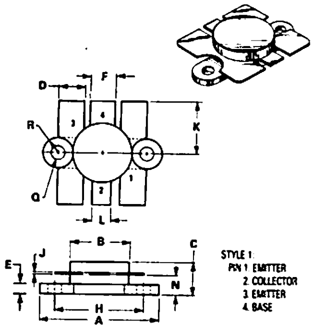
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.33	0.200	0.210
C	11.31	11.55	0.445	0.455
D	3.05	3.30	0.120	0.130
F	0.64	0.89	0.025	0.035
H	2.29	2.54	0.090	0.100
J	0.11	0.15	0.004	0.006
K	25.40	30.48	1.000	1.200
R	—	4.57	—	0.180

CASE 305B-01
(.200 SOE)



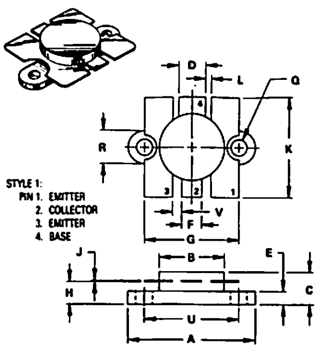
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.08	5.33	0.200	0.210
C	—	3.17	—	0.125
D	3.18	3.42	0.125	0.135
F	0.64	0.89	0.025	0.035
H	1.15	1.39	0.045	0.055
J	0.11	0.15	0.004	0.006
K	30.10	30.35	1.185	1.195

CASE 305C-01
(.200 SOE NS)



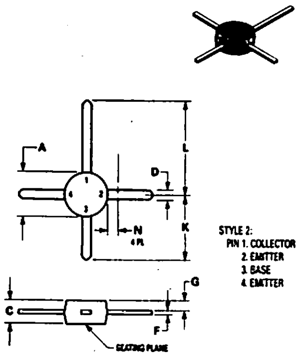
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.38	25.14	0.960	0.990
B	12.45	12.95	0.490	0.510
C	5.97	7.62	0.235	0.300
D	5.33	5.58	0.210	0.220
E	2.16	3.04	0.085	0.120
F	5.08	5.33	0.200	0.210
H	18.29	18.54	0.720	0.730
J	0.10	0.15	0.004	0.006
K	10.29	11.17	0.405	0.440
L	3.81	4.06	0.150	0.160
N	3.81	4.31	0.150	0.170
Q	2.92	3.30	0.115	0.130
R	3.05	3.30	0.120	0.130
U	11.94	12.57	0.470	0.495

CASE 316-01
(.500" CQ)



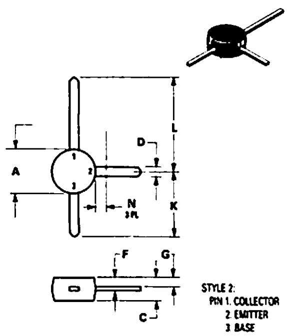
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.64	24.89	0.970	0.980
B	12.58	12.82	0.495	0.505
C	—	7.62	—	0.300
D	5.08	5.33	0.200	0.210
E	2.42	2.66	0.095	0.105
F	3.81	4.06	0.150	0.160
G	18.29	18.54	0.720	0.730
H	4.07	4.57	0.160	0.180
J	0.11	0.15	0.004	0.006
K	19.05	—	0.750	—
L	1.02	1.27	0.040	0.050
Q	2.93	3.30	0.115	0.130
R	6.23	6.47	0.245	0.255
U	18.29	18.54	0.720	0.730
V	1.65	1.90	0.065	0.075

CASE 316A-01
(.500 J ZERO)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

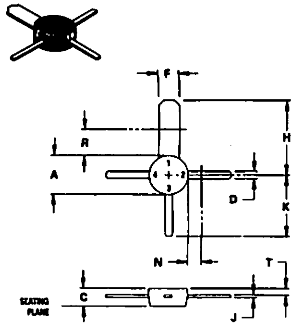
CASE 317-01
(MACRO-X)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.44	5.21	0.175	0.205
C	1.90	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	0.20	0.30	0.008	0.012
G	0.76	1.14	0.030	0.045
K	7.24	8.13	0.285	0.320
L	10.54	11.43	0.415	0.450
N	—	1.65	—	0.065

CASE 317A-01
(MACRO-T)

3

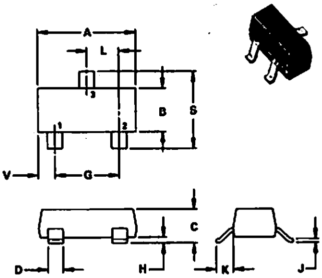


STYLE 2:
PIN 1. COLLECTOR
2. EMITTER
3. BASE
4. EMITTER

STYLE 3:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.45	5.20	0.175	0.205
C	1.91	2.54	0.075	0.100
D	0.84	0.99	0.033	0.039
F	2.46	2.64	0.097	0.104
H	8.84	9.72	0.348	0.383
J	0.21	0.30	0.008	0.012
K	7.24	8.12	0.285	0.320
N	—	1.65	—	0.065
R	—	3.25	—	0.128
T	0.64	1.01	0.025	0.040

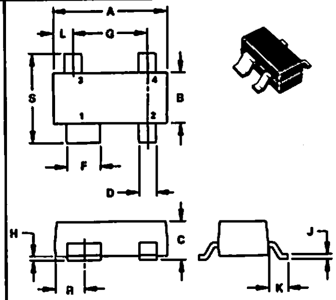
CASE 317D-02



STYLE 6:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.80	3.04	0.1102	0.1197
B	1.20	1.40	0.0472	0.0551
C	0.99	1.26	0.0385	0.0498
D	0.37	0.50	0.0150	0.0200
G	1.78	2.04	0.0701	0.0807
H	0.10	0.25	0.0040	0.0098
J	0.085	0.177	0.0034	0.0070
K	0.45	0.60	0.0180	0.0236
L	0.89	1.02	0.0350	0.0401
S	2.10	2.50	0.0830	0.0984
V	0.45	0.60	0.0177	0.0236

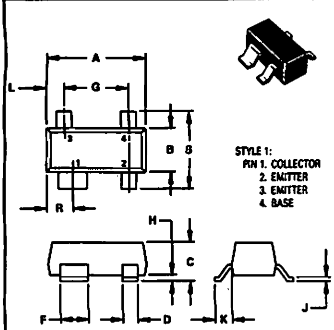
CASE 318-06
STANDARD PROFILE
(TO-236AA)



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. EMITTER
4. BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.80	3.04	0.110	0.120
B	1.20	1.39	0.047	0.055
C	0.84	1.14	0.033	0.045
D	0.39	0.50	0.015	0.020
F	0.79	0.93	0.031	0.037
G	1.78	2.03	0.070	0.080
H	0.013	0.10	0.0005	0.004
J	0.08	0.15	0.003	0.006
K	0.46	0.60	0.018	0.024
L	0.445	0.60	0.0175	0.024
R	0.72	0.83	0.028	0.033
S	2.11	2.48	0.083	0.098

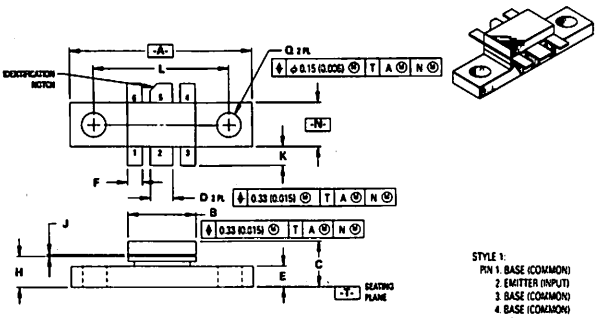
CASE 318A-05
LOW PROFILE
(SOT-143)



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. EMITTER
4. BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	2.80	3.04	0.110	0.120
B	1.20	1.39	0.047	0.055
C	1.05	1.24	0.041	0.049
D	0.38	0.50	0.015	0.020
F	0.79	0.93	0.031	0.037
G	1.78	2.03	0.070	0.080
H	0.10	0.25	0.004	0.010
J	0.08	0.15	0.003	0.006
K	0.46	0.60	0.018	0.024
L	0.445	0.60	0.0175	0.024
R	0.71	0.83	0.028	0.033
S	2.11	2.48	0.083	0.098

CASE 318B-04
STANDARD PROFILE
(SOT-143)

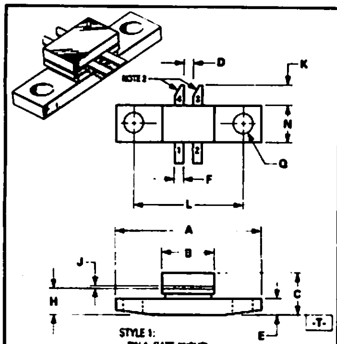


STYLE 1:
PIN 1. BASE (COMMON)
2. EMITTER (INPUT)
3. BASE (COMMON)
4. BASE (COMMON)
5. COLLECTOR (OUTPUT)
6. BASE (COMMON)

STYLE 2:
PIN 1. EMITTER (COMMON)
2. BASE (INPUT)
3. EMITTER (COMMON)
4. EMITTER (COMMON)
5. COLLECTOR (OUTPUT)
6. EMITTER (COMMON)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.85	6.60	0.230	0.260
D	2.93	3.17	0.115	0.125
E	2.70	2.94	0.106	0.116
F	1.91	2.15	0.075	0.085
H	4.07	4.31	0.160	0.170
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

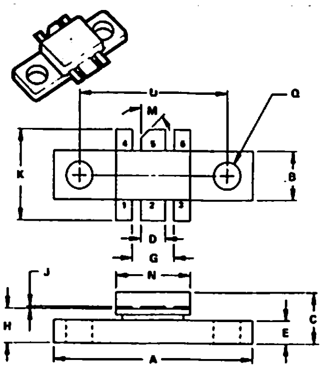
CASE 319-06
(CS-12)



STYLE 1:
PIN 1. GATE (INPUT)
2. GATE (INPUT)
3. DRAIN (OUTPUT)
4. DRAIN (OUTPUT)
SOURCE IS FLANGE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.51	25.02	0.965	0.985
B	9.02	9.52	0.355	0.375
C	5.84	6.60	0.230	0.260
D	1.40	1.65	0.055	0.065
E	2.69	2.94	0.106	0.116
F	1.4	1.65	0.055	0.065
H	4.06	4.31	0.160	0.170
J	0.10	0.15	0.004	0.006
K	3.05	3.55	0.120	0.140
L	18.42 BSC		0.725 BSC	
N	5.72	6.12	0.225	0.241
Q	3.18	3.42	0.125	0.135

CASE 319B-01

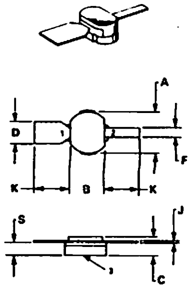


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.64	24.89	0.970	0.980
B	5.72	5.96	0.225	0.235
C	6.10	6.60	0.240	0.260
D	2.93	3.17	0.115	0.125
E	2.72	2.97	0.107	0.117
G	4.83	5.33	0.190	0.210
H	4.07	4.57	0.160	0.180
J	0.11	0.15	0.004	0.006
K	10.80	11.43	0.425	0.450
M	45 NOM		45 NOM	
N	9.02	9.77	0.355	0.385
Q	3.05	3.30	0.120	0.130
U	18.29	18.54	0.720	0.730

STYLE 1
PIN 1 BASE
2 EMITTER
3 BASE
4 BASE
5 COLLECTOR
6 BASE

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. EMITTER
5. COLLECTOR
6. EMITTER

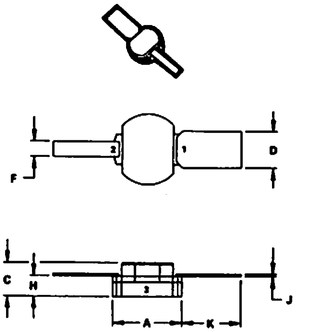
CASE 319C-01
(EB)



STYLE 1
PIN 1 EMITTER
2 COLLECTOR
3 BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.72	5.97	0.225	0.235
B	4.44	4.70	0.175	0.185
C	2.29	2.74	0.090	0.108
D	2.92	3.18	0.115	0.125
F	1.14	1.40	0.045	0.055
J	0.08	0.15	0.003	0.006
K	—	9.52	—	0.375
S	1.52	1.78	0.060	0.070

CASE 328-02

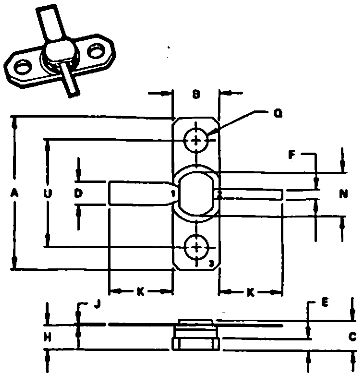


DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.72	5.96	0.225	0.235
C	2.29	2.79	0.090	0.110
D	2.93	3.17	0.115	0.125
F	1.15	1.39	0.045	0.055
H	1.65	1.90	0.065	0.075
J	0.08	0.15	0.003	0.006
K	5.72	6.98	0.225	0.275

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 2:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

CASE 328E-01
(GP-13 FLANGELESS)



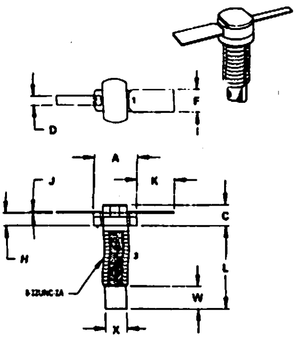
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.07	20.57	0.790	0.810
B	6.10	6.60	0.240	0.260
C	3.66	4.31	0.144	0.170
D	2.93	3.17	0.115	0.125
E	1.40	1.65	0.055	0.065
F	1.15	1.39	0.045	0.055
H	2.93	3.42	0.115	0.135
J	0.08	0.15	0.003	0.006
K	5.72	6.98	0.225	0.275
N	5.59	6.09	0.220	0.240
Q	3.18	3.42	0.125	0.135
U	14.03	14.52	0.552	0.572

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

STYLE 2:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

STYLE 3:
PIN 1. BASE
2. EMITTER
3. COLLECTOR

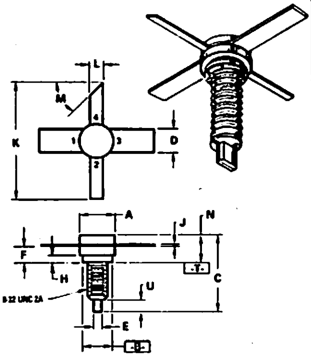
CASE 328F-01
(GP-13)



STYLE 1
PIN 1 BASE
2 COLLECTOR
3 EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.72	6.09	0.225	0.240
C	—	2.79	—	0.110
D	1.15	1.39	0.045	0.055
F	2.93	3.17	0.115	0.125
H	1.53	1.90	0.060	0.075
J	0.08	0.17	0.003	0.007
K	5.08	—	0.200	—
L	10.67	11.68	0.420	0.460
W	2.80	3.30	0.110	0.130
X	2.80	3.04	0.110	0.120

CASE 328G-01
(GP-13 S)

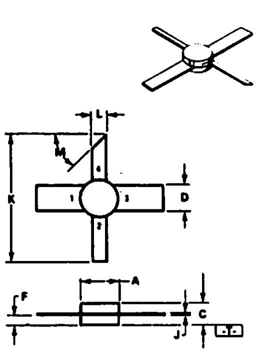


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.86	7.62	0.270	0.300
B	6.10	6.60	0.240	0.260
C	16.26	16.76	0.640	0.660
D	4.95	5.21	0.195	0.205
E	1.40	1.65	0.055	0.065
F	2.67	4.32	0.105	0.170
H	1.40	1.65	0.055	0.065
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° Nom		45° Nom	
N	4.57	6.22	0.180	0.245
U	2.92	3.68	0.115	0.145

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

CASE 332-04
(.380" STUD)

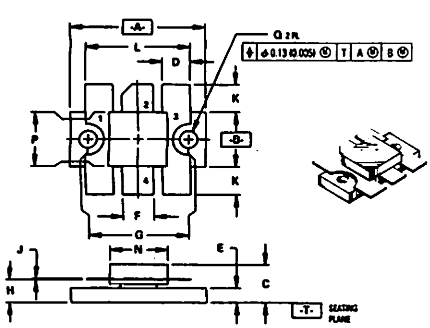


STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. COLLECTOR

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. COLLECTOR

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	6.85	7.34	0.270	0.290
C	3.30	3.81	0.130	0.150
D	4.95	5.21	0.195	0.205
F	1.40	1.78	0.055	0.070
J	0.08	0.18	0.003	0.007
K	15.24	—	0.600	—
L	2.41	2.67	0.095	0.105
M	45° NOM		45° NOM	

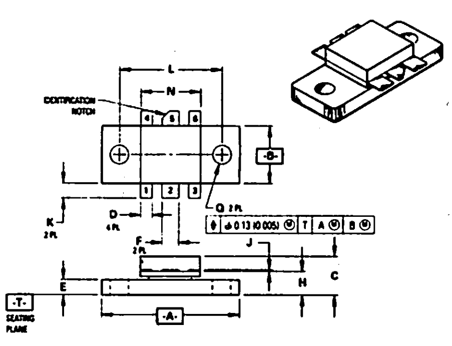
CASE 332A-01
(.280" PILL)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.51	25.02	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.73	7.36	0.250	0.290
D	4.83	5.33	0.190	0.210
E	2.42	2.92	0.095	0.115
F	5.47	5.96	0.215	0.235
G	18.42 BSC		0.725 BSC	
H	3.94	4.44	0.155	0.175
J	0.10	0.15	0.004	0.006
K	4.95	5.21	0.195	0.205
L	18.80	19.55	0.740	0.770
N	10.54	10.80	0.415	0.425
P	9.91	10.16	0.390	0.400
Q	3.05	3.42	0.120	0.135

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. EMITTER
4. BASE

CASE 333-04



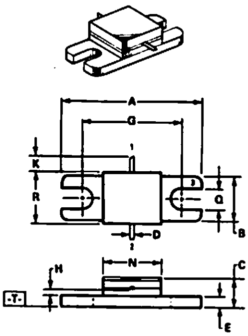
DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.52	25.01	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.35	7.36	0.250	0.290
D	1.91	2.28	0.075	0.090
E	2.42	2.92	0.095	0.115
F	2.80	3.30	0.110	0.130
H	3.94	4.44	0.155	0.175
J	0.11	0.15	0.004	0.006
K	2.29	2.94	0.090	0.116
L	18.41 BSC		0.725 BSC	
N	10.55	11.04	0.415	0.435
Q	3.05	3.42	0.120	0.135

STYLE 1:
PIN 1. BASE
2. EMITTER
3. BASE
4. BASE
5. COLLECTOR
6. BASE

STYLE 2:
PIN 1. EMITTER
2. BASE
3. EMITTER
4. EMITTER
5. COLLECTOR
6. EMITTER

CASE 333A-02
(MAAC PAC)

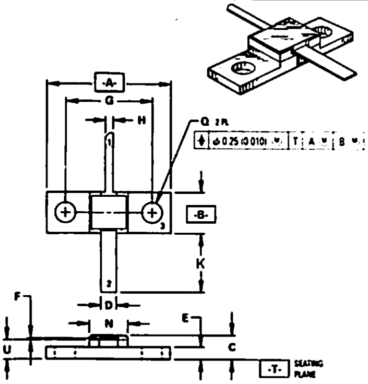
3



STYLE 2
PIN 1 COLLECTOR
2 EMITTER
3 BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.65	9.91	0.380	0.390
C	4.06	5.84	0.160	0.230
D	0.51	0.76	0.020	0.030
E	1.40	1.65	0.055	0.065
G	16.51 BSC		0.650 BSC	
H	1.14	1.77	0.045	0.070
K	2.54	—	0.100	—
N	9.91	10.41	0.390	0.410
Q	3.00	3.81	0.118	0.142
R	9.91	10.41	0.390	0.410

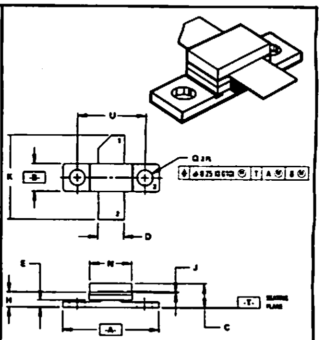
CASE 336-03



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.43	6.78	0.253	0.267
C	3.66	4.06	0.144	0.160
D	2.37	2.71	0.093	0.107
E	1.88	2.03	0.074	0.080
F	0.05	0.15	0.002	0.006
G	14.22 BSC		0.560 BSC	
H	1.10	1.44	0.043	0.057
K	8.79	10.10	0.346	0.394
N	6.18	6.52	0.243	0.257
Q	3.18	3.42	0.125	0.135
U	2.98	3.25	0.117	0.128

STYLE 1
PIN 1 COLLECTOR
2 EMITTER
3 BASE

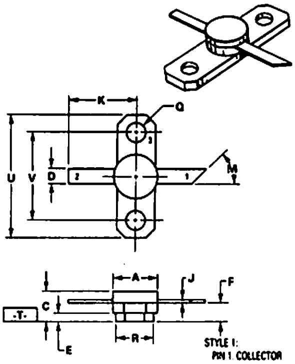
CASE 336E-02



STYLE 1
PIN 1 COLLECTOR
2 EMITTER
3 BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.19	20.45	0.795	0.805
B	5.71	5.97	0.225	0.235
C	4.67	5.49	0.184	0.216
D	5.33	5.59	0.210	0.220
E	1.40	1.65	0.055	0.065
H	2.92	3.43	0.115	0.135
J	0.10	0.15	0.004	0.006
K	17.02	18.54	0.670	0.730
N	8.76	9.02	0.345	0.355
Q	3.18	3.43	0.125	0.135
U	14.22 BSC		0.560 BSC	

CASE 360A-01

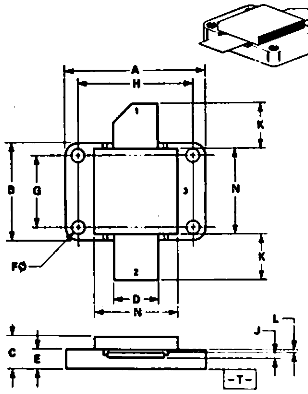


STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

STYLE 2:
PIN 1 COLLECTOR
2. BASE
3 EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.06	7.26	0.278	0.286
C	4.44	5.20	0.175	0.205
D	2.36	2.71	0.093	0.107
E	1.39	1.77	0.055	0.070
F	2.66	3.42	0.105	0.135
J	0.10	0.15	0.004	0.006
K	11.04	—	0.435	—
M	45° NOM		45° NOM	
Q	3.04	3.42	0.120	0.135
R	6.09	6.66	0.240	0.260
U	20.06	20.57	0.790	0.810
V	14.27 BSC		0.562 BSC	

CASE 361A-01

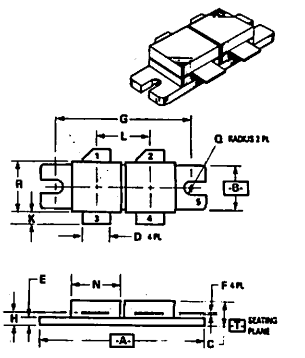


DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	37.85	38.35	1.490	1.510
B	25.15	25.65	0.990	1.010
C	8.39	8.89	0.330	0.350
D	12.45	12.95	0.490	0.510
E	4.95	5.21	0.195	0.205
F	3.05	3.30	0.120	0.130
G	19.05 BSC		0.750 BSC	
H	31.75 BSC		1.250 BSC	
J	1.14	1.39	0.045	0.055
K	10.54	11.05	0.415	0.435
L	0.10	0.15	0.004	0.006
N	22.87	23.11	0.890	0.910

STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER

STYLE 2:
PIN 1. DRAIN
2. GATE
3. SOURCE

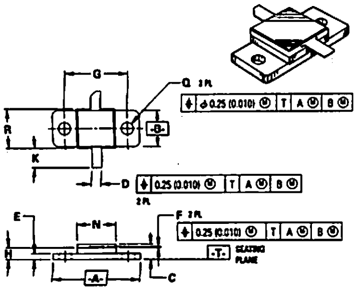
CASE 368-01
(HOG PAC)



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	33.79	34.29	1.330	1.350
B	9.40	10.41	0.370	0.410
C	4.83	5.84	0.190	0.230
D	5.47	5.96	0.215	0.235
E	1.27	1.77	0.050	0.070
F	0.11	0.15	0.004	0.006
G	27.94 BSC		1.100 BSC	
H	2.29	2.92	0.090	0.115
K	2.29	2.79	0.090	0.110
L	11.05 BSC		0.435 BSC	
N	10.55	11.04	0.415	0.435
Q	1.35	1.87	0.053	0.074
R	9.91	10.41	0.390	0.410

STYLE 2.
PIN 1. DRAIN
2. DRAIN
3. GATE
4. GATE
5. SOURCE

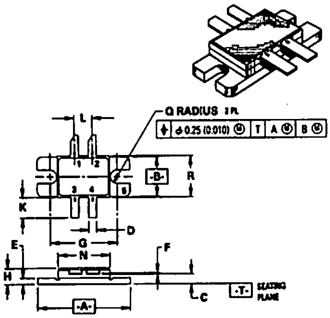
CASE 375-01



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.40	10.16	0.370	0.400
C	3.69	4.19	0.145	0.165
D	2.29	2.79	0.090	0.110
E	1.40	1.65	0.055	0.065
F	0.08	0.15	0.003	0.006
G	16.51 BSC		0.650 BSC	
H	2.80	3.30	0.110	0.130
K	4.57	5.59	0.180	0.220
N	9.91	10.41	0.390	0.410
Q	2.93	3.42	0.115	0.135
R	9.91	10.41	0.390	0.410

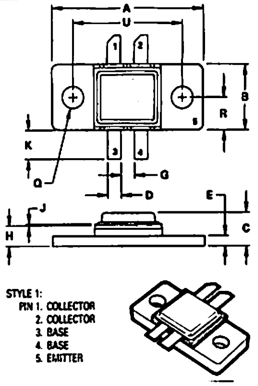
CASE 376A-02



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.40	10.16	0.370	0.400
C	2.67	3.42	0.105	0.135
D	1.66	2.15	0.065	0.085
E	1.40	1.65	0.055	0.065
F	0.08	0.15	0.003	0.006
G	16.51 BSC		0.650 BSC	
H	3.81	4.44	0.150	0.175
K	4.83	5.33	0.190	0.210
L	3.94	4.82	0.155	0.190
N	12.45	12.95	0.490	0.510
Q	1.53	1.77	0.060	0.070
R	9.91	10.41	0.390	0.410

STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

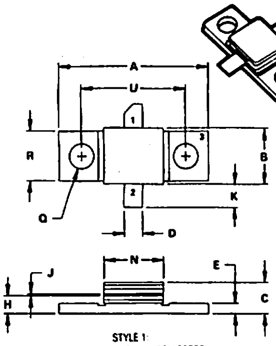
CASE 382-01



STYLE 1:
PIN 1. COLLECTOR
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.61	23.11	0.890	0.910
B	9.99	10.23	0.393	0.403
C	4.81	5.33	0.189	0.210
D	1.78	2.28	0.070	0.090
E	1.40	1.65	0.055	0.065
G	1.78	2.28	0.070	0.090
H	3.43	3.68	0.135	0.145
J	0.11	0.15	0.004	0.006
K	3.94	4.44	0.155	0.175
Q	3.13	3.37	0.123	0.133
R	4.32	4.57	0.170	0.180
U	16.26	16.76	0.640	0.660

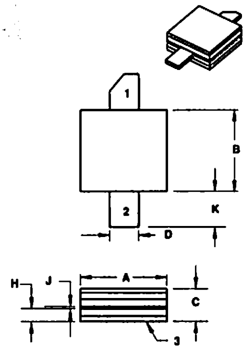
CASE 391-01
(HLP-42)



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.69	0.790	0.815
B	7.12	7.62	0.280	0.300
C	3.48	4.31	0.137	0.170
D	2.29	2.79	0.090	0.110
E	1.40	1.65	0.055	0.065
H	2.29	2.84	0.090	0.112
J	0.08	0.12	0.003	0.005
K	3.56	4.06	0.140	0.160
N	7.83	8.39	0.310	0.330
Q	3.18	3.42	0.125	0.135
R	6.35	6.85	0.250	0.270
U	14.03	14.52	0.552	0.572

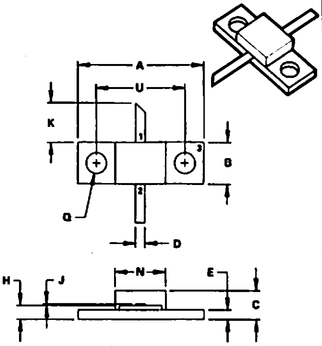
CASE 393-01
(HLP-11)



STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	7.88	8.38	0.310	0.330
B	7.12	7.62	0.280	0.300
C	2.08	2.67	0.082	0.105
D	2.29	2.79	0.090	0.110
H	0.89	1.19	0.035	0.047
J	0.08	0.12	0.003	0.005
K	3.56	4.06	0.140	0.160

CASE 393A-01
(HLP-11F)

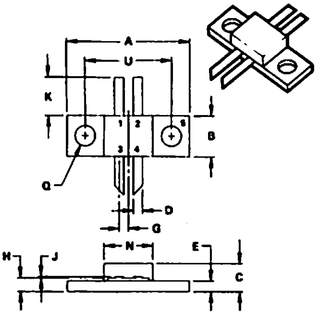


STYLE 1:
PIN 1. COLLECTOR
2. EMITTER
3. BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	20.07	20.57	0.790	0.810
B	6.35	6.85	0.250	0.270
C	4.15	4.69	0.163	0.185
D	1.27	1.77	0.050	0.070
E	1.40	1.65	0.055	0.065
H	1.94	2.43	0.076	0.096
J	0.05	0.11	0.002	0.004
K	6.35	7.62	0.250	0.300
N	8.03	8.28	0.316	0.326
Q	3.18	3.42	0.125	0.135
U	14.03	14.52	0.552	0.572

CASE 394-01
(.25 MRA)

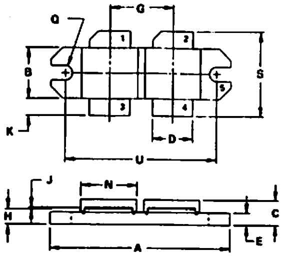
3



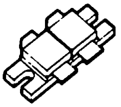
STYLE 1
PIN 1 BASE
2 BASE
3 COLLECTOR
4 COLLECTOR
5 EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	20.07	20.57	0.790	0.810
B	6.35	6.85	0.250	0.270
C	4.20	5.02	0.165	0.198
D	1.40	1.65	0.055	0.065
E	1.40	1.65	0.055	0.065
G	1.27	1.77	0.050	0.070
H	1.94	2.43	0.076	0.096
J	0.08	0.12	0.003	0.005
K	4.83	5.33	0.190	0.210
N	6.56	6.80	0.258	0.268
Q	3.18	3.42	0.125	0.135
U	14.03	14.52	0.552	0.572

**CASE 395-01
(BMA-2)**

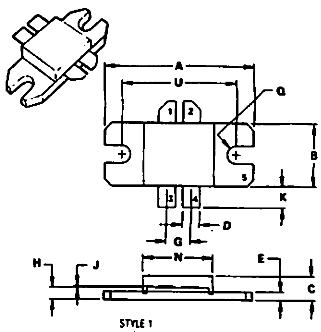


STYLE 1
PIN 1 COLLECTOR
2 COLLECTOR
3 BASE
4 BASE
5 EMITTER



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	42.30	42.69	1.665	1.681
B	11.51	11.70	0.453	0.461
C	5.57	5.81	0.219	0.229
D	9.48	9.72	0.373	0.383
E	2.75	2.84	0.108	0.112
G	14.79	15.03	0.582	0.592
H	3.33	3.58	0.131	0.141
J	0.11	0.15	0.004	0.006
K	3.84	4.08	0.151	0.161
N	13.09	13.33	0.515	0.525
Q	3.18	3.42	0.125	0.135
S	19.28	19.53	0.759	0.769
U	35.69	35.89	1.405	1.413

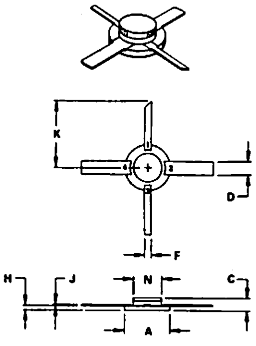
**CASE 397-01
(HPA-1)**



STYLE 1
PIN 1. COLLECTOR
2 COLLECTOR
3. BASE
4 BASE
5. EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	27.79	28.19	1.094	1.110
B	11.61	11.81	0.457	0.465
C	4.37	4.62	0.172	0.182
D	3.08	3.32	0.121	0.131
E	1.40	1.65	0.055	0.065
G	4.50	4.69	0.177	0.185
H	2.11	2.36	0.083	0.093
J	0.06	0.10	0.002	0.004
K	3.94	4.03	0.155	0.159
N	13.11	13.30	0.516	0.524
Q	3.18	3.42	0.125	0.135
U	21.37	21.61	0.841	0.851

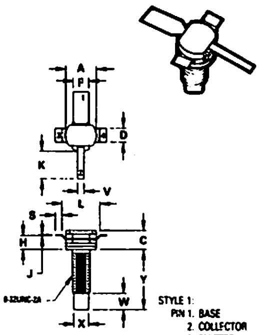
**CASE 398-01
(BMA-4)**



STYLE 1
PIN 1 COLLECTOR
2 EMITTER
3 BASE
4 EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.16	5.25	0.203	0.207
C	1.25	1.65	0.049	0.065
D	1.40	1.65	0.055	0.065
F	0.64	0.88	0.025	0.035
H	0.44	0.58	0.017	0.023
J	0.06	0.10	0.002	0.004
K	7.12	8.12	0.280	0.320
N	3.13	3.37	0.123	0.133

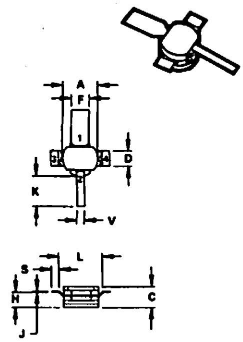
**CASE 400-01
(TW-200)**



STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.72	6.09	0.225	0.240
C	—	4.44	—	0.175
D	2.42	2.66	0.095	0.105
F	2.93	3.17	0.115	0.125
H	2.93	3.42	0.115	0.135
J	0.08	0.17	0.003	0.007
K	5.08	—	0.200	—
L	7.12	7.62	0.280	0.300
S	1.27	—	0.050	—
V	1.15	1.39	0.045	0.055
W	2.80	3.30	0.110	0.130
X	2.80	3.04	0.110	0.120
Y	10.67	11.68	0.420	0.450

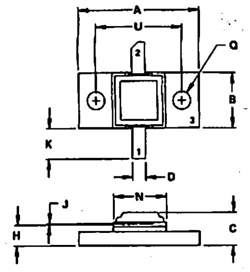
**CASE 401-01
(GP-14 S)**

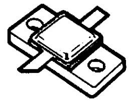


STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER
4. EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	5.72	6.09	0.225	0.240
C	—	4.44	—	0.175
D	2.42	2.66	0.095	0.105
F	2.93	3.17	0.115	0.125
H	2.93	3.42	0.115	0.125
J	0.08	0.17	0.003	0.007
K	5.08	—	0.200	—
L	7.12	7.62	0.280	0.300
S	1.27	—	0.050	—
V	1.15	1.39	0.045	0.055

**CASE 401A-01
(GP-14 NS)**

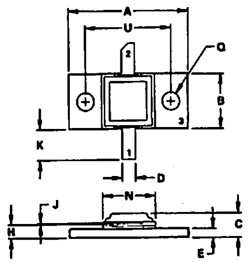


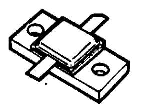


STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.84	23.24	0.895	0.915
B	10.04	10.41	0.395	0.410
C	—	6.24	—	0.246
D	2.42	2.66	0.095	0.105
H	4.07	4.31	0.160	0.170
J	0.08	0.12	0.003	0.005
K	5.59	5.84	0.220	0.230
N	10.04	10.28	0.395	0.405
Q	3.23	3.37	0.127	0.133
U	16.26	16.51	0.640	0.650

CASE 402-01
(HLP-15M)

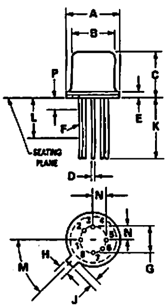


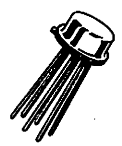


STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. EMITTER

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	22.84	23.24	0.895	0.915
B	10.04	10.41	0.395	0.410
C	—	4.57	—	0.180
D	2.42	2.66	0.095	0.105
E	1.45	1.70	0.057	0.067
H	2.29	2.79	0.090	0.110
J	0.06	0.10	0.002	0.004
K	5.59	5.84	0.220	0.230
N	10.04	10.28	0.395	0.405
Q	3.23	3.37	0.127	0.133
U	16.26	16.51	0.640	0.650

CASE 402A-01
(HLP-19)

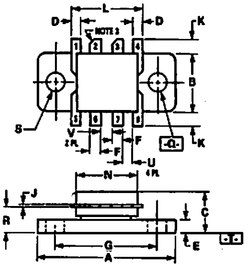


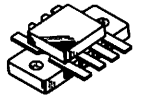


STYLE 1:
PIN 1. COLLECTOR
2. BASE
3. EMITTER
4. OMITTED
5. EMITTER
6. BASE
7. COLLECTOR
8. OMITTED

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.40	0.335	0.370
B	7.75	8.51	0.305	0.335
C	4.19	4.70	0.165	0.185
D	0.41	0.53	0.016	0.021
E	—	1.02	—	0.040
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.71	0.86	0.028	0.034
J	0.74	1.14	0.029	0.045
K	12.70	—	0.500	—
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
N	2.54 BSC		0.100 BSC	
P	—	1.27	—	0.050

CASE 654-02





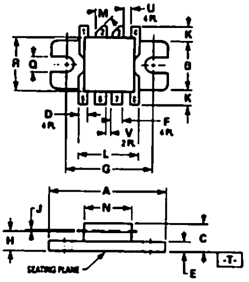
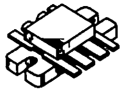
STYLE 1:
PIN 1. EMITTER (COMMON)
2. COLLECTOR
3. COLLECTOR
4. EMITTER (COMMON)
5. EMITTER (COMMON)
6. BASE
7. BASE
8. EMITTER (COMMON)

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	24.51	25.15	0.965	0.985
B	9.91	10.41	0.390	0.410
C	6.22	7.24	0.245	0.285
D	1.65	1.90	0.065	0.075
E	2.16	2.41	0.085	0.095
F	1.91	2.16	0.075	0.085
G	18.42 BSC		0.725 BSC	
H	—	—	—	—
J	0.08	0.18	0.003	0.007
K	2.29	2.79	0.090	0.110
L	12.55	12.85	0.494	0.506
N	9.51	10.42	0.415	0.435
P	—	—	—	—
Q	3.18	3.43	0.125	0.135
R	3.94	4.45	0.155	0.175
S	3.18	3.43	0.125	0.135
U	1.02	1.27	0.040	0.050
V	0.64	0.89	0.025	0.035

CASE 744-02

3

3

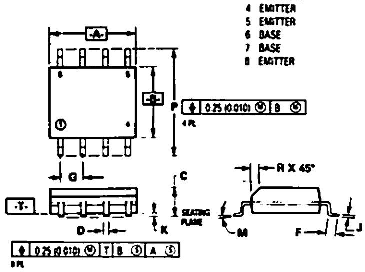



STYLE 1:
PIN 1. EMITTER (COMMON)
2. COLLECTOR
3. COLLECTOR
4. EMITTER (COMMON)
5. EMITTER (COMMON)
6. BASE
7. BASE
8. EMITTER (COMMON)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.60	23.11	0.890	0.910
B	9.52	10.03	0.375	0.395
C	6.65	7.16	0.262	0.282
D	1.60	1.95	0.063	0.077
E	2.94	3.40	0.116	0.134
F	2.87	3.22	0.113	0.127
G	16.51 BSC		0.650 BSC	
H	4.01	4.36	0.158	0.172
J	0.07	0.15	0.003	0.006
K	4.34	4.90	0.171	0.193
L	12.44	12.95	0.490	0.510
M	45° NOM		45° NOM	
N	10.51	11.02	0.414	0.434
Q	3.04	3.35	0.120	0.132
R	9.90	10.41	0.390	0.410
U	1.02	1.27	0.040	0.050
V	0.64	0.89	0.025	0.035

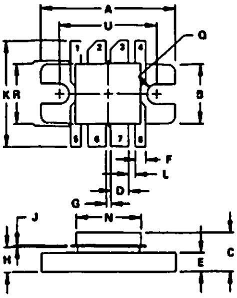
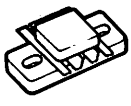
CASE 744A-01

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.18	0.25	0.007	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

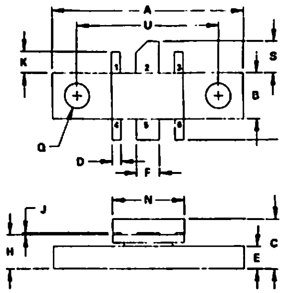
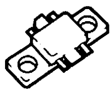
CASE 751-03
(SO-8)

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.66	23.06	0.892	0.908
B	9.61	10.00	0.378	0.394
C	6.25	6.75	0.246	0.266
D	2.80	3.30	0.110	0.130
E	2.93	3.42	0.115	0.135
F	1.53	2.03	0.060	0.080
G	0.51	1.01	0.020	0.040
H	3.99	4.39	0.157	0.173
J	0.11	0.15	0.004	0.006
K	15.85	19.50	0.624	0.768
L	0.89	1.39	0.035	0.055
N	10.75	11.25	0.423	0.0443
Q	3.05	3.55	0.120	0.140
R	9.76	10.26	0.384	0.404
U	16.26	16.76	0.640	0.660

CASE 827-01
(MRP-7)

STYLE 1:
PIN 1. BASE
2. COLLECTOR
3. BASE
4. BASE
5. EMITTER
6. BASE

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	24.52	25.01	0.965	0.985
B	5.72	5.96	0.225	0.235
C	5.97	6.60	0.235	0.260
D	1.40	1.90	0.055	0.075
E	2.67	2.92	0.105	0.115
F	2.80	3.30	0.110	0.130
H	4.07	4.57	0.160	0.180
J	0.11	0.15	0.004	0.006
K	2.29	2.79	0.090	0.110
N	8.89	9.39	0.350	0.370
Q	3.18	3.42	0.125	0.135
S	3.56	4.06	0.140	0.160
U	18.17	18.66	0.715	0.735

CASE 828-01
(EA)

Volume I

Volume II

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