

**MAINTENANCE MANUAL
ORION™
POWER AMPLIFIER BOARD**

B19/CAH-505AL	60 WATTS	29-42 MHz
B19/CAH-505BL	60 WATTS	35-50 MHz
B19/CAH-505AH	110 WATTS	29-42 MHz
B19/CAH-505BH	110 WATTS	35-50 MHz

TABLE OF CONTENTS

	Page
COMPONENT IDENTIFICATION CHART	Front Page
DESCRIPTION	1
CIRCUIT ANALYSIS	1
EXCITER	1
POWER AMPLIFIER BOARD	1
RF Amplifiers	1
Power Amplifier	1
Power Control Circuit	1
PARTS LIST	2
IC DATA	3
ASSEMBLY DIAGRAM	4
OUTLINE DIAGRAM	4
SCHEMATIC DIAGRAM	5

SYMBOL	CAH-505AL	CAH-505BL	CAH-505AH	CAH-505BH
C8	330 pF	150 pF	150 pF	150 pF
C9	--	--	2200 pF	2200 pF
C16	--	--	470pF	390pF
C17	1200 pF	1200 pF	--	470 pF
C18	330 pF	270 pF	390 pF	470 pF
C20, C22	390 pF	220 pF	220 pF	220 pF
C23	--	--	470 pF	330 pF
C31	39 pF	27 pF	36 pF	27 pF
C32	47 pF	33 pF	39 pF	33 pF
C33	100 pF	39 pF	43 pF	39 pF
C34	36 pF	24 pF	30 pF	24 pF
C35	100 pF	47 pF	47 pF	47 pF
C36	30 pF	24 pF	30 pF	24 pF
C37	91 pF	82 pF	91 pF	82 pF
C38	24 pF	24 pF	27 pF	24 pF
C58	--	--	820 pF	820 pF
C63	--	39 pF	47 pF	39 pF
C64	--	47 pF	47 pF	47 pF
C72	15 pF	33 pF	30 pF	33 pF
C73	100 pF	43 pF	68 pF	43 pF
C74	82 pF	82 pF	100 pF	82 pF
C75	--	22 pF	20 pF	22 pF
C76	39 pF	47 pF	62 pF	47 pF
C84	200 pF	120 pF	--	120 pF
C163	56 pF	47 pF	56 pF	47 pF
C164	100 pF	82 pF	100 pF	82 pF
C165	27 pF	22 pF	27 pF	22 pF
C166	68 pF	47 pF	68 pF	47 pF
C167	39 pF	33 pF	39 pF	33 pF
L8	4.5T (R)	3.5T (R)	4.5T (R)	3.5T (R)
L9	5.5T (R)	4.5T (R)	5.5T (R)	4.5T (R)
L10	5.5T (R)	4.5T (R)	5.5T (R)	4.5T (R)
L11	5.5T (L)	4.5T (L)	5.5T (L)	4.5T (L)
L18	2.5T (R)	3.5T (R)	3.5T (R)	3.5T (R)
L19	5.5T (R)	4.5T (R)	5.5T (R)	4.5T (R)
L153	120 nH	100 nH	120 nH	100 nH
L154	180 nH	150 nH	180 nH	150 nH
R6	4.7 ohms	4.7 ohms	2.2 ohms	2.2 ohms
R8	18 ohms	22 ohms	22 ohms	22 ohms
R10	2.2 ohms	4.7 ohms	4.7 ohms	4.7 ohms
R11	2.2 ohms	4.7 ohms	4.7 ohms	4.7 ohms
R42	4.7 ohms	4.7 ohms	--	--
R46	15 ohms	22 ohms	22 ohms	22 ohms
T5	H-6LHLD00011	H-6LHLD00011	H-6LHLD00012	H-6LHLD00012
TR3, TR4	2SC2540	2SC2540	2SC2694	2SC2694

(DDO2-CAH-505 2/2)



Ericsson Inc.
Private Radio Systems
Mountain View Road
Lynchburg, Virginia 24502
1-800-528-7711 (Outside USA, 804-528-7711)

Printed in U.S.A.

DESCRIPTION

The RF Power Amplifiers for the Ericsson ORION low band mobile radio is available in two power levels and two frequencies ranges designated as:

- 29-42 MHz , 60 Watts
- 35-50 MHz , 60 Watts
- 29-42 MHz , 110 Watts
- 35-50 MHz , 110 Watts

The circuitry on the Power Amplifier Board consists of an Exciter circuit, an RF Power Amplifier circuit, a Power Control circuit, an Antenna Switch and Limiter Circuit (see Figure 1 - Block Diagram). The Exciter circuit consists of two wide band amplifier stages operating over a frequency range of 29-50 MHz without any tuning. This circuit amplifies the one milliwatt input signal from the Voltage Controlled Oscillator, on the Synthesizer/IF board, to 300 milliwatts to drive the Power Amplifier.

The Power Amplifier circuit uses a driver and three RF power transistors to provide rated output power. The output power is adjustable over a range of 55 to 110 and 30 to 60 watts

for the two power versions. Two transistors and three IC's are used in the power control circuit.

Supply voltage for the PA is provided by power leads from the power cable connector J1002 to J3 (A+) and (A-) on the Power Amplifier board.

CIRCUIT ANALYSIS

EXCITER

The 29-50 MHz Tx injection input from the Tx VCO is applied to **AMPLIFIER-1** transistor TR151 through an **ATTENUATOR** pad consisting of resistors R151, R152 and R153. Vcc voltage (+9 Vdc) is applied through a Vcc feed network consisting of resistor R158 and transformer T151. Capacitor C156 is used to bypass the supply line. The +9 Vdc is supplied by 3-terminal voltage regulator IC3.

The output of TR151 drives **AMPLIFIER-2** transistor TR152 through impedance matching components consisting of transformers T151 and T152, coupling capacitors C157 and C158. Resistors R152, R154 and diode CD151 set the bias voltage for TR152.

Collector voltage (+9 Vdc) of TR152 is applied through collector feed network resistor R165 and inductor L152. Capacitors C160 and C161 are bypass capacitors.

The output of TR152 is coupled to **EX OUT** through the **LOW-PASS FILTER** consisting of capacitors C163 through C167, and inductors L153 and L154. Resistor R163 provides negative feedback for TR152 through capacitor C159. Transistor TR152 amplifies the 15 milliwatts input level to 300 milliwatts.

A+, supplied from the J1003 connector through transistor TR11 and the Tx Power Switch is regulated to 9 Vdc by voltage regulator IC3. Vcc (+9 Vdc) is applied to TR151 and TR152. When **TX ENBL** is high (receive mode), +9 Vdc is not applied.

The exciter is energized by pressing the PTT switch. Regulated +9 Vdc is present on all exciter stages when the radio is turned on.

POWER AMPLIFIER BOARD

The four power amplifiers which cover the frequency ranges of 29-42 MHz and 35-50 MHz and power levels of 60 watts and 110 watts, are very similar in construction and operation. The only differences are in the transistor types and some component values. The following description applies to all four versions.

RF Amplifiers

The Exciter RF output (EX OUT) is coupled to the PA input. The RF is then coupled through an **ATTENUATOR** pad consisting of resistors R1, R2 and R3, impedance matching transformer T1 and decoupling capacitor C1 to the base of **PRE-AMPLIFIER** transistor TR1. Inductor L1, diode CD1 and resistor R5 set the bias of TR1. Capacitor C4 and resistors R4 and R45 provide negative feedback to improve the stability of TR1. Collector voltage on TR1 is controlled by the power control circuit and is applied through a decoupling network consisting of capacitors C5, C6 and C7.

The output of TR1 is coupled to the base of **DRIVER AMPLIFIER** transistor TR2 through impedance matching transformer T2 and a frequency compensator consisting of capacitor C9 and resistor R6. Capacitor C8 provides matching between T2 and the base of TR2. Capacitor C10 and resistor R7 provide negative feedback and R8 and R46 maintains stability of TR2.

Collector voltage to driver amplifier TR2 is supplied through a decoupling network consisting of capacitors C12 to C14 and inductor L4.

The RF output from TR2 is coupled to **POWER AMPLIFIER** transistors TR3 and TR4 through impedance matching transformer T4 and capacitors C17 and C56.

Power Amplifier

The **POWER AMPLIFIER**, consisting of transistors TR3 and TR4, and transformers T4 and T5 is a class-c push-pull power amplifier. Transformer T4 provides impedance-matching and power splitting to the bases of TR3 and TR4. Capacitors C17 and C56 provide impedance-matching elements to T4. Resistors R10 and R11 provide the base loading to TR3 and TR4. Capacitors C19 and C21, and resistors R9 and R12 are negative feedback elements to maintain the stability of TR3 and TR4. Transformer T5 provides impedance-matching and power combining for the collectors of TR3 and TR4. Capacitors C16 and C23 provide matching elements to T5. Capacitors C20 and C22 provide impedance matching elements to the collector of TR3 and TR4.

Operating voltage for the power amplifier is supplied from the DC input through transformer T5 and a decoupling network consisting of capacitors C24 through C26 and inductor L5.

The output of the **POWER AMPLIFIER** passes through T5 to the **LOW-PASS FILTER** consisting of capacitors C72 through C76, and inductors L18 and L19.

NOTE

This is a 50 ohm point and may be used for checking power levels.

The RF power passes through a 50 ohm microstrip and transmit/receive **ANTENNA SWITCH** diode CD5 to the **LOW-PASS FILTER**

Power Control

When high VSWR load conditions are sensed the **POWER CONTROL** circuit provides closed-loop RF power leveling and power turndown.

When the transmitter is keyed, Tx 9V turns on and supplies current to a **DC AMPLIFIER** consisting of transistors TR5, TR6 and IC1-1. This amplifier supplies voltage to the collector of TR1. The setting of RV1 determines the current supplied to the negative input of IC1-1. As the detected RF power increases, the current to the negative input of IC1-1 increases causing IC1-1 to pull current away from the base of TR5. This cuts back the drive to TR5 and TR6, which reduces

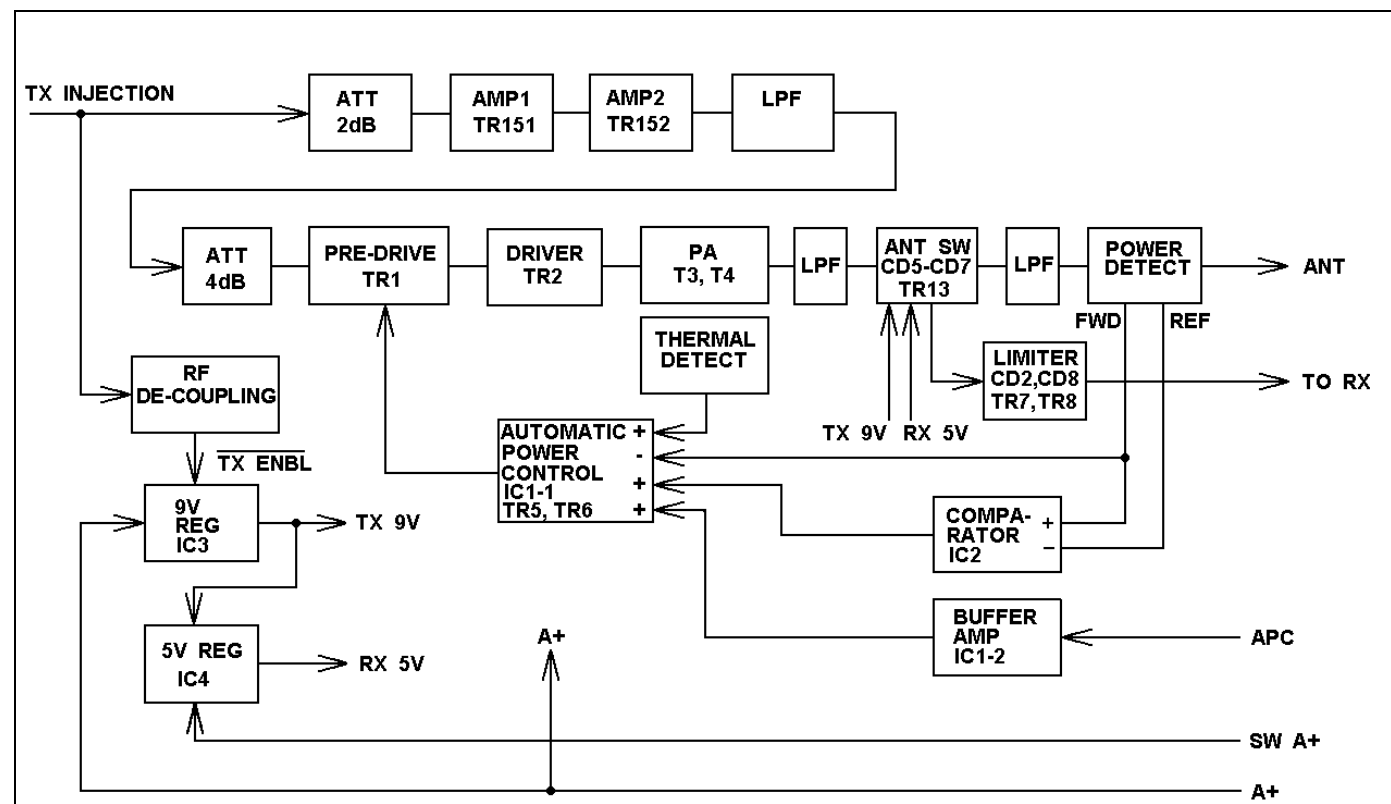


Figure 1 - Block Diagram Low Band Power Amplifier

the voltage at the collector of TR1, decreasing RF output power.

RF power is sensed by directional POWER COUPLER T6 and associated elements. Forward power is sensed by diode CD9 and reflected power by diode CD10. Forward power is determined by the setting of RV1. Resistors R21 and R22 set the level of reflected RF power at which the control circuit reduces the RF output.

Thermal protection is provided by "posistor" R41 and associated elements. Posistor R41 is thermally connected to the body of transistor TR3. As the temperature of TR3 rises above 100-degrees Centigrade, the resistance of R41 increases and TR9 turns on. This diverts output current of IC102 from R27 to TR9, which lowers the voltage at the collector of TR1, reducing the power output.

CAUTION

DO NOT operate the transmitter at levels higher than rated output. Operating at higher than rated output will shorten the life of the RF power transistors.

Antenna Switch

The ANTENNA SWITCH consists of PIN diodes CD5, CD6 and CD7 and associated components. When the transmitter is keyed, Tx 9V switch TR11 and the Tx 9V regulator IC3 turn on. Rx 5V (Rx bias) turns off and Tx 9V provides forward-bias to CD5. This results in low impedance on CD5 and high impedance on CD6 and CD7 isolating the transmitted power from the receiver.

Limiter

The limiter on the PA board consists of diode CD2, transistors TR6, TR7 and the associated components. During Rx if the receiving signal level exceeds +10 dBm, the rectified currents of the CD2 can provide the forward-bias to TR6, TR7 and CD8 proportionally to the receiving signal level. This causes a tap-down circuit (CD6, CD7 and CD8) to turn on when the receiving signal exceeds +10 dBm and protects the receiver from excessively high receiving signal levels.

In the Rx mode, signals from the antenna are coupled through this limiter to the receiver input.

POWER AMPLIFIER BOARD
CAH-505AL(Used in P1),CAH-505AL(Used in P2)
CAH-505AH(Used in P3),CAH-505BH(Used in P4)

Issue 3

Table with columns: SYMBOL, PART NO., DESCRIPTION. Contains detailed list of components and their specifications.

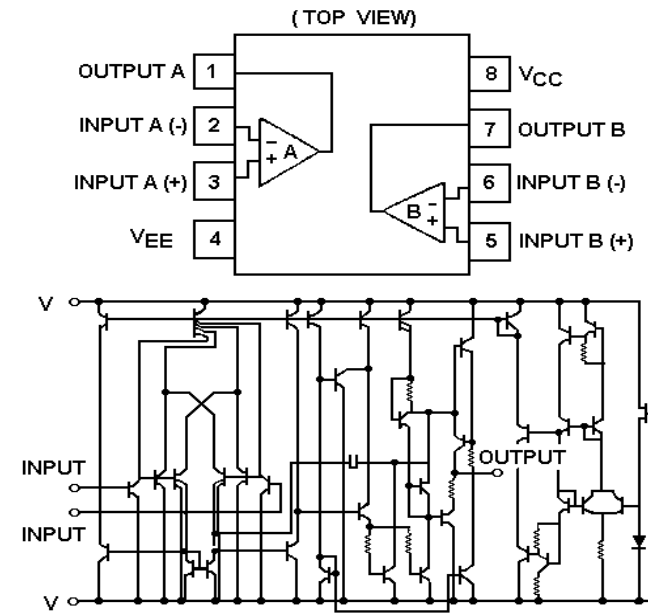
Table with columns: SYMBOL, PART NO., DESCRIPTION. Contains detailed list of components and their specifications.

Table with columns: SYMBOL, PART NO., DESCRIPTION. Contains detailed list of components and their specifications.

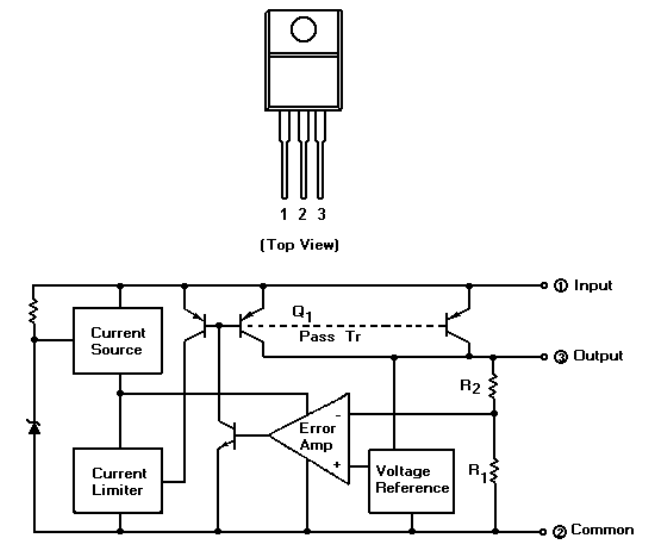
SYMBOL	PART NO.	DESCRIPTION
L9		Coil:RF (Used in AL,AH).
L9		Coil:RF (Used in BL,BH).
L10		Coil:RF (Used in AL,AH).
L10		Coil:RF (Used in BL,BH).
L11		Coil:RF (Used in AL,AH).
L11		Coil:RF (Used in BL,BH).
L12 And L13		Coil: 4.7 uH.
L14 Thru L17		Coil: 4.7 uH.
L18		Coil: RF (Used in AL).
L18		Coil: RF (Used in BL,AH,BH).
L19		Coil: RF (Used in AL,AH).
L19		Coil: RF (Used in BL,BH).
L151 And L152		Coil: 4.7 uH.
L153		Coil: RF 120 nH (Used in AL,AH).
L153		Coil: RF 100 nH (Used in BL,BH).
L154		Coil: RF 180 nH (Used in AL,AH).
L154		Coil: RF 150 nH (Used in BL,BH).
PC1		PCB: H-6PCLD00277C.
----- RESISTORS -----		
R1		Metal film: 270 ohms 5% 200 VDCW 1/8W.
R2		Metal film: 22 ohms 5% 200 VDCW 1/8W.
R3		Metal film: 270 ohms 5% 200 VDCW 1/8W.
R4		Metal film: 390 ohms 5% 200 VDCW 1/8W.
R5		Metal film: 1K ohms 5% 200 VDCW 1/8W.
R6		Metal film: 4.7 ohms 10% 200 VDCW 1/8W (Used in AL,BL).
R6		Metal film: 2.2 ohms 5% 200 VDCW 1/8W (Used in AH,BH).
R7		Metal film: 47 ohms 1% 500 VDCW 1.5W.
R8		Metal film: 18 ohms 5% 200 VDCW 1/8W (Used in AL).
R8		Metal film: 22 ohms 5% 200 VDCW 1/8W (Used in BL,AH,BH).
R9		Metal film: 47 ohms 1% 500 VDCW 1.5W.
R10		Metal film: 2.2 ohms 10% 250 VDCW 1W (Used in AL).
R10		Metal film: 4.7 ohms 10% 250 VDCW 1W (Used in BL,AH,BH).
R11		Metal film: 2.2 ohms 10% 250 VDCW 1W (Used in AL).
R11		Metal film: 4.7 ohms 10% 250 VDCW 1W (Used in BL,AH,BH).
R12		Metal film: 47 ohms 1% 500 VDCW 1.5W.
R13 And R14		Metal film: 47 ohms 5% 250 VDCW 1W.
R15		Metal film: 47K ohms 5% 200 VDCW 1/4W.
R16 And R17		Metal film: 47 ohms 5% 200 VDCW 1/2W.
R18		Metal film: 10K ohms 5% 100 VDCW 1/10W.
R19		Metal film: 100 ohms 5% 250 VDCW 1W.
R20		Metal film: 47 ohms 5% 250 VDCW 1W.
R21		Metal film: 22K ohms 5% 100 VDCW 1/10W.
R22		Metal film: 15K ohms 5% 100 VDCW 1/10W.
R23 And R24		Metal film: 220K ohms 5% 100 VDCW 1/10W.
R25		Metal film: 2.2K ohms 5% 100 VDCW 1/10W.
R26		Metal film: 2.2 ohms 10% 250 VDCW 1W.
R27		Metal film: 12K ohms 5% 100 VDCW 1/10W.
R28		Metal film: 3.3K ohms 5% 100 VDCW 1/10W.
R29 And R30		Metal film: 27K ohms 5% 100 VDCW 1/10W.
R31 And R32		Metal film: 1K ohms 5% 100 VDCW 1/10W.
R33		Metal film: 27K ohms 5% 100 VDCW 1/10W.
R34		Metal film: 1K ohms 5% 100 VDCW 1/10W.
R35		Metal film: 390 ohms 5% 200 VDCW 1/4W.
R36		Metal film: 470 ohms 5% 200 VDCW 1/4W.

SYMBOL	PART NO.	DESCRIPTION
R37		Metal film: 3.3K ohms 5% 100 VDCW 1/10W.
R38		Metal film: 4.7K ohms 5% 100 VDCW 1/10W.
R39 And R40		Metal film: 47K ohms 5% 100 VDCW 1/10W.
R41		Posistor: sim to MURATA PTH9C22BB471Q-T.
R42		Metal film: 4.7 ohms 10% 200 VDCW 1/8W (Used in AL,BL).
R45		Metal film: 390 ohms 5% 200 VDCW 1/8W.
R46		Metal film: 15 ohms 5% 200 VDCW 1/8W (Used in AL).
R46		Metal film: 22 ohms 5% 200 VDCW 1/8W (Used in BL,AH,BH).
R47		Metal film: 2.2 ohms 10% 250 VDCW 1W.
R48		Metal film: 10K ohms 5% 100 VDCW 1/10W.
R151		Metal film: 470 ohms 5% 100 VDCW 1/10W.
R152		Metal film: 10 ohms 5% 100 VDCW 1/10W.
R153		Metal film: 470 ohms 5% 100 VDCW 1/10W.
R154		Metal film: 1K ohms 5% 100 VDCW 1/10W.
R155		Metal film: 470 ohms 5% 100 VDCW 1/10W.
R156		Metal film: 5.6K ohms 5% 100 VDCW 1/10W.
R157		Metal film: 10 ohms 5% 100 VDCW 1/10W.
R158		Metal film: 100 ohms 5% 100 VDCW 1/10W.
R159		Metal film: 270 ohms 5% 100 VDCW 1/10W.
R160		Metal film: 18 ohms 5% 100 VDCW 1/10W.
R161		Metal film: 270 ohms 5% 100 VDCW 1/10W.
R162		Metal film: 120 ohms 5% 100 VDCW 1/10W.
R163		Metal film: 150 ohms 5% 100 VDCW 1/10W.
R164		Metal film: 1.2K ohms 5% 100 VDCW 1/10W.
R165		Metal film: 10 ohms 5% 200 VDCW 1/4W.
RV1		Variable: 10K ohms.
----- TRANSFORMERS -----		
T1		RF TRANSFORMER.
T2		RF TRANSFORMER.
T4		RF TRANSFORMER.
T5		RF TRANSFORMER.
T5-1		FERRITE CORE: 10-15-20 (Used in AL,BL).
T5		RF TRANSFORMER.
T5-1		FERRITE CORE: 16-16-32 (Used in AH,BH).
T6		RF TRANSFORMER FOR COUPLER.
T151 And T152		RF TRANSFORMER.
----- TERMINALS -----		
TB2		Terminal Plate.
----- TRANSISTORS -----		
TR1		Silicon,NPN: MITSUBISHI 2SC1971.
TR2		Silicon,NPN: MITSUBISHI 2SC1729.
TR3		RF POWER TRANSISTOR: 2SC2540 MITSUBISHI (Used in AL,BL).
TR3		RF POWER TRANSISTOR: 2SC2694 MITSUBISHI (Used in AH,BH).
TR4		RF POWER TRANSISTOR: 2SC2540 MITSUBISHI (Used in AL AND BL).
TR4		RF POWER TRANSISTOR: 2SC2694 MITSUBISHI (Used in AH,BH).
TR5		Silicon,PNP: sim to PANASONIC 2SB953A.
TR6		Silicon,NPN: sim to NEC 2SD596-T1B DV3.
TR7		Silicon,PNP: sim to PANASONIC 2SB624-T1B BV3.
TR8 And TR9		Silicon,NPN: sim to NEC 2SD596-T1B DV3.
TR11		Silicon,PNP: sim to PANASONIC 2SB624-T1B BV3.
TR12		Silicon,NPN: sim to NEC 2SD596-T1B DV3.
TR13		Silicon,NPN: sim to PANASONIC 2SB624-T1B BV3.
TR151		Silicon,NPN: sim to NEC 2SC3357-T1 RF.
TR152		Silicon,NPN: sim to MOTOROLAR MRF559.

Linear OP amplifier IC1
(JRC NJM3404AM-T1)

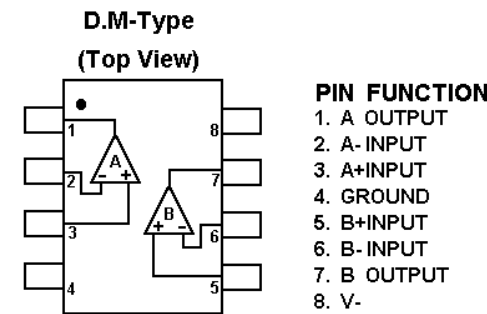


9 V Voltage Regulator IC3
(PANASONIC AN6541)

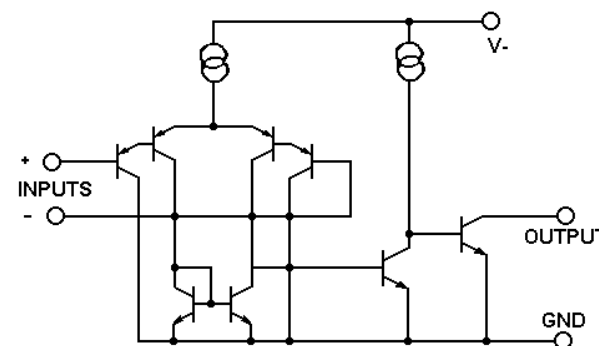


Comparator IC2
(JRC NJM2404M-T1)

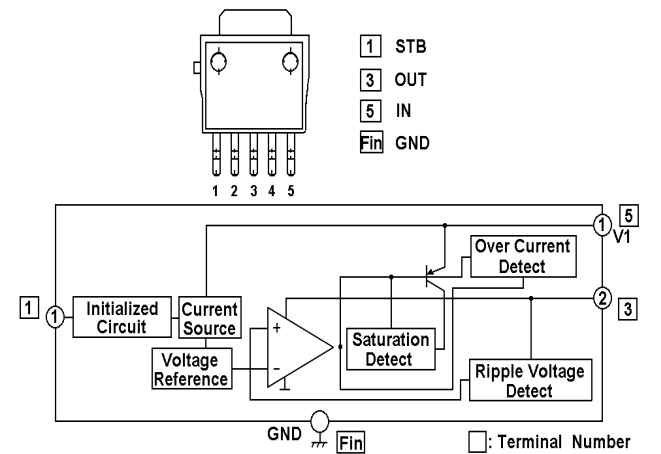
Connection Diagram

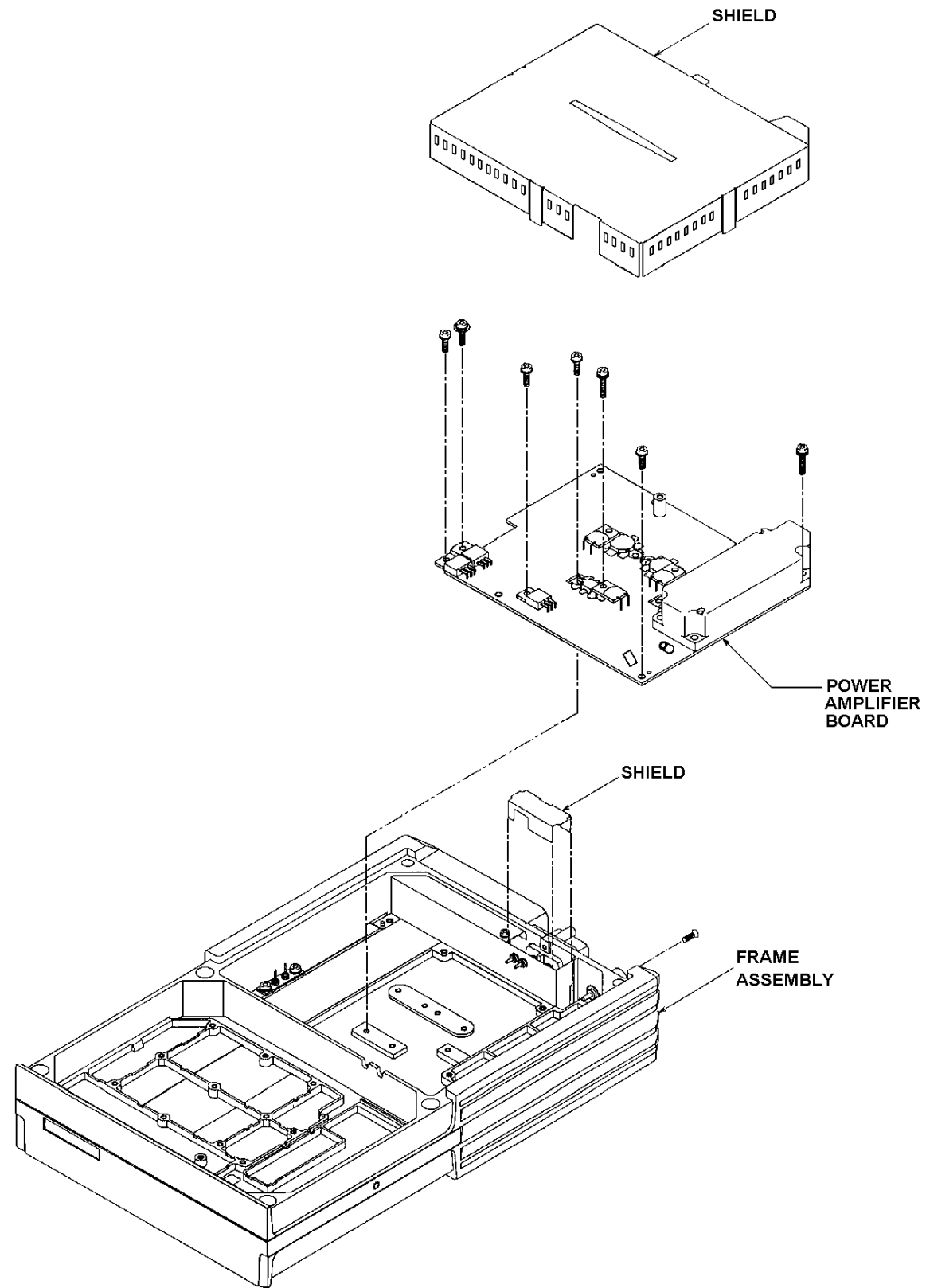


Equivalent Circuit (1/2 Shown)



Voltage Regulator IC4
(PANASONIC AN6545SP)



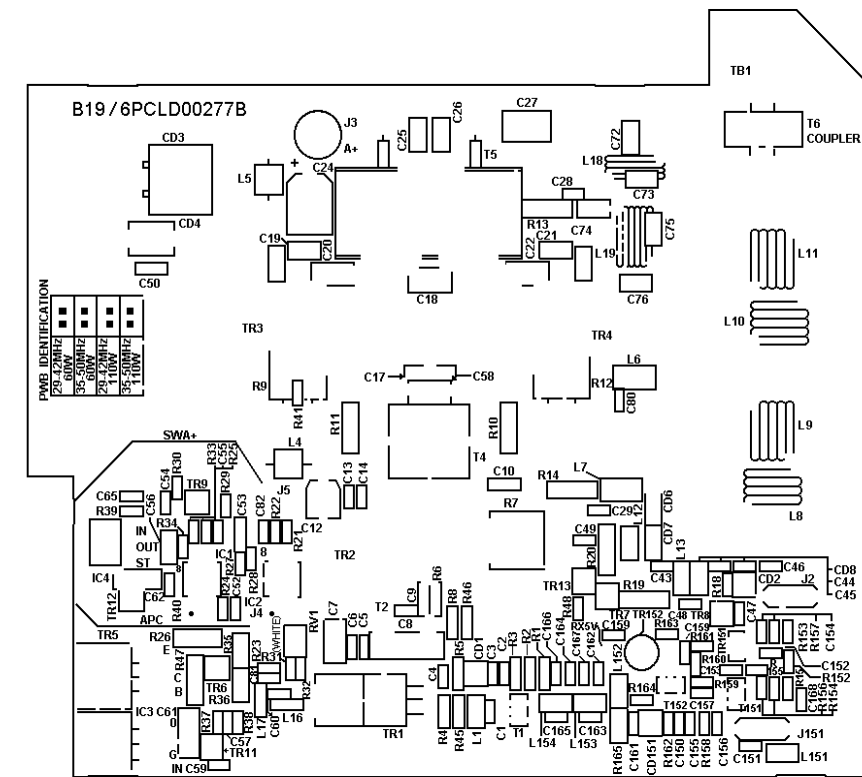


29.0-50 MHz 60/110 Watts
POWER AMPLIFIER

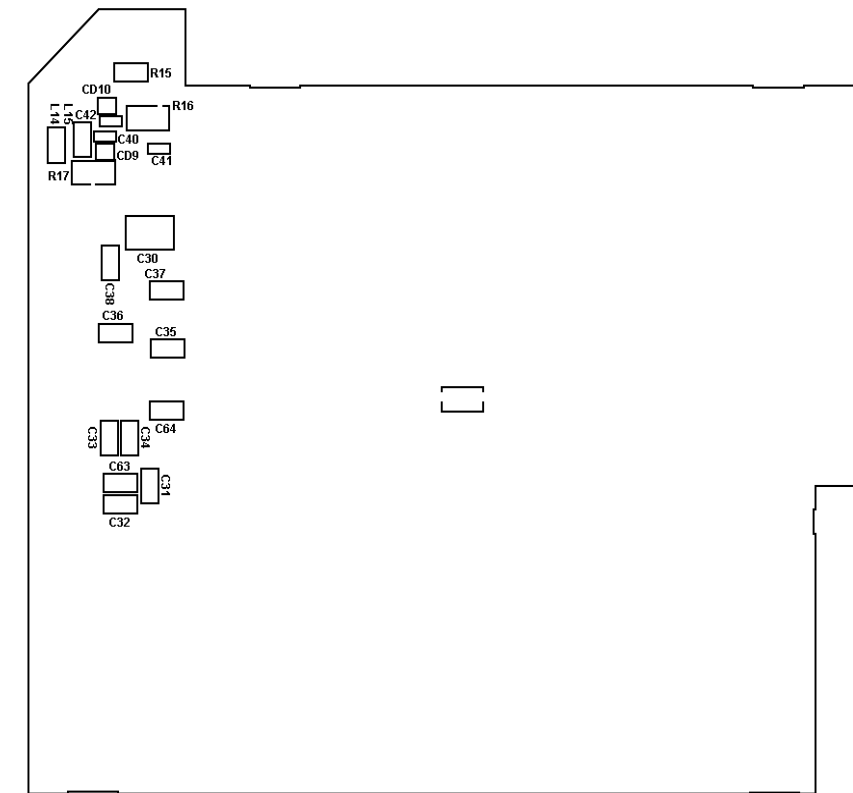
29.0-50 MHz 60/110 WATTS
POWER AMPLIFIER

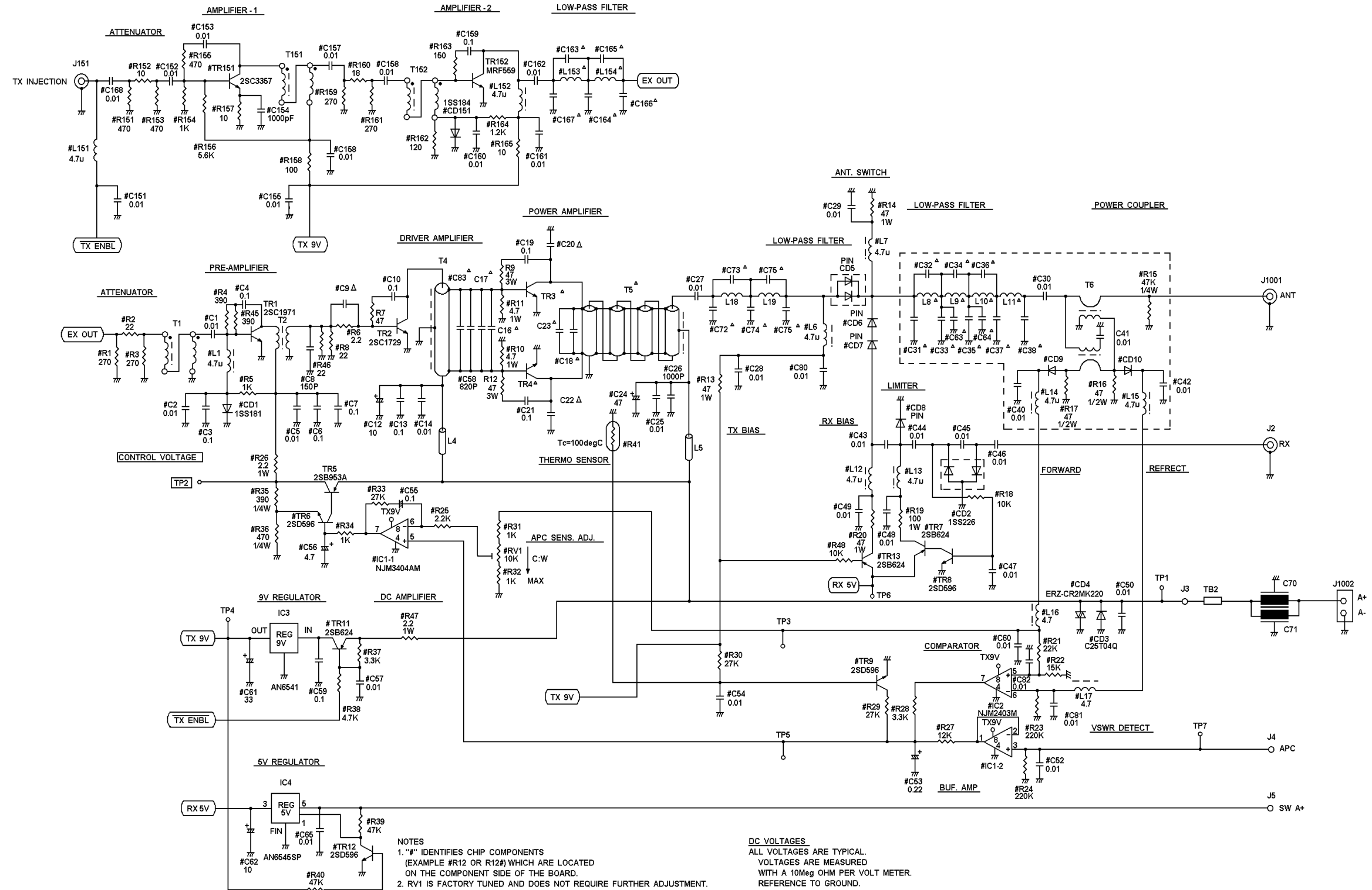
(DD00-CAH-505 1/2)

COMPONENT SIDE



SOLDER SIDE





NOTES
 1. "*" IDENTIFIES CHIP COMPONENTS
 (EXAMPLE #R12 OR R12#) WHICH ARE LOCATED
 ON THE COMPONENT SIDE OF THE BOARD.
 2. RV1 IS FACTORY TUNED AND DOES NOT REQUIRE FURTHER ADJUSTMENT.
 ALL RESISTORS ARE 1/10 OR 1/8 WATT UNLESS OTHERWISE SPECIFIED.
 RESISTOR VALUES IN Ω UNLESS FOLLOWED BY MULTIPLIER K OR M.
 CAPACITOR VALUES IN μ UNLESS FOLLOWED BY MULTIPLIER P.
 INDUCTANCE VALUES IN H UNLESS FOLLOWED BY MULTIPLIER m OR u.

DC VOLTAGES
 ALL VOLTAGES ARE TYPICAL.
 VOLTAGES ARE MEASURED
 WITH A 10meg OHM PER VOLT METER.
 REFERENCE TO GROUND.
 VOLTAGE READINGS ARE TAKEN
 WITH THE TRANSMITTER
 UNKEYED/KEYED. EX. 45(UNKEYED)/0.5 (KEYED).

29.0-50 MHz 60/110 WATT
 POWER AMPLIFIER

(DD02-CAH-505 1/2)