RF TRAY
MODEL TUE1761A
MODEL TUE1762A
MODEL TUE1901A

1. GENERAL

The rf tray is a compartmentalized casting that houses and provides shielding for various radio assemblies as shown in Figures 1 and 2.

The rf tray also provides mounting for the receiver preselector filter as shown in Figure 2. A detailed description of the rf tray interconnect board as well as uniboard parts information is included in this section. All other assemblies are described in their respective sections of this manual.

2. INTERCONNECTIONS

2.1 INTERCABLING

The rf tray cabling shown in Figure 3, routes various signals and control functions throughout the station. Refer to the simplified functional block diagram in the Description section of this manual for specific connection details.

2.2 INTERCONNECT BOARD

The interconnect board, mounted beneath the rf tray casting (see Figure 3), provides connections between circuit boards and assemblies located in the rf tray. Feedthrough plates mounted in the rf tray as shown in Figure 4, provide isolation between the interconnect board, circuit boards, and assemblies contained in the rf tray casting. Additional shielding and isolation are provided by covers over critical circuit areas and compartments, by metal braid between compartments, and by the rf tray cover. A connection chart and interconnect circuit board detail are included at the end of this section.

3. UNIBOARD

The uniboard contains portions of the station receiver and transmitter circuits. These portions include:

- Receive Synthesizer Circuitry
- Receiver I-F Amplifier and Detector
- Transmit Synthesizer Circuitry
- Power Control Circuitry
- Synthesizer Reference Oscillator

Refer to Figure 7 for circuit location and interconnect details. All of these circuits are described in detail in related sections of the manual. Complete parts list information is included in this section.

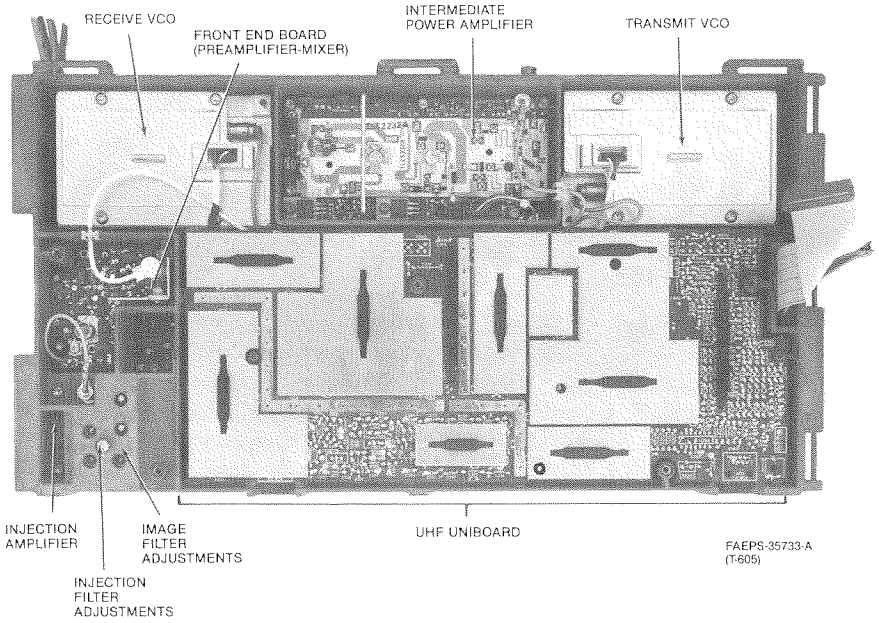


Figure 1. RF Tray Assembly Location Detail (Top View)

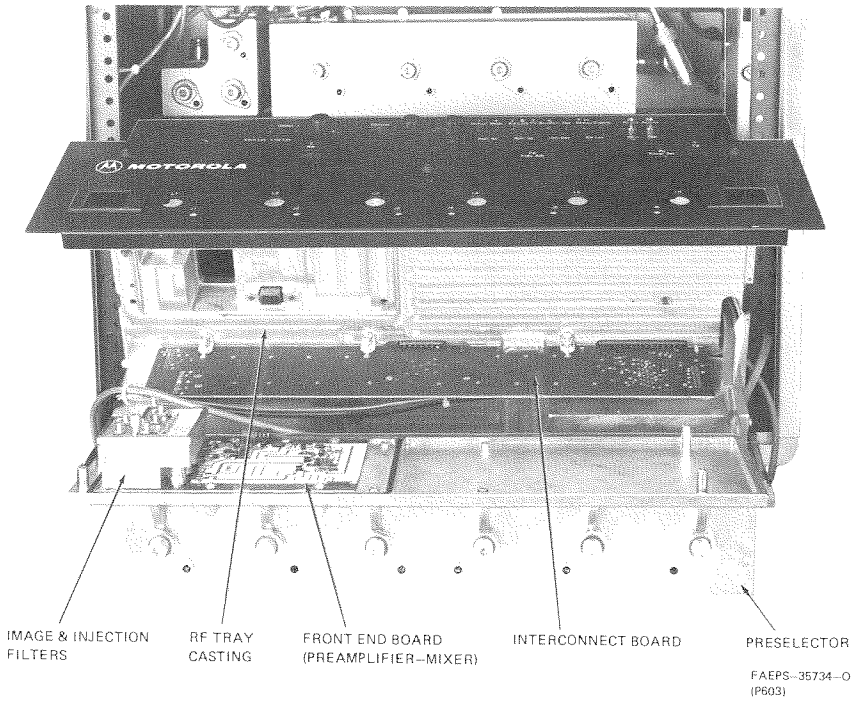


Figure 2. RF Tray Assembly Location Detail (Bottom View)

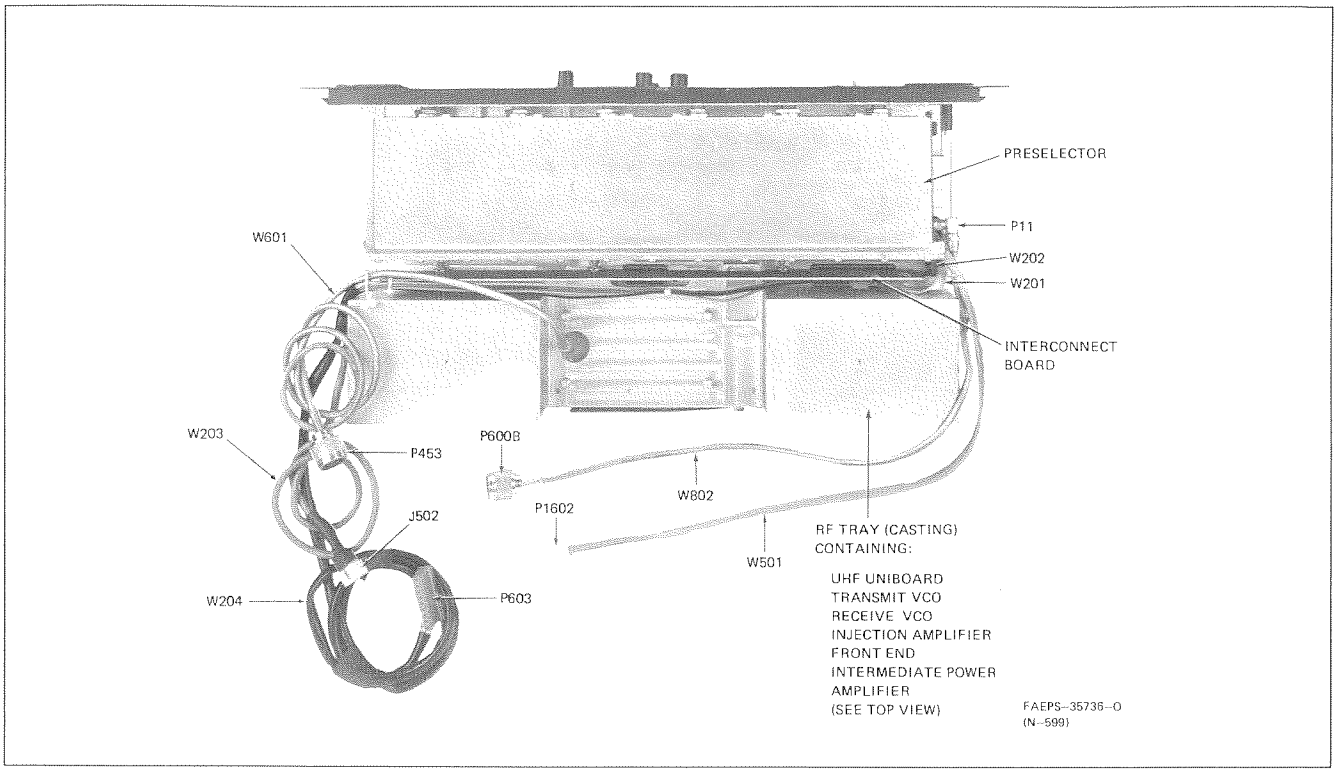


Figure 3. RF Tray Bottom View

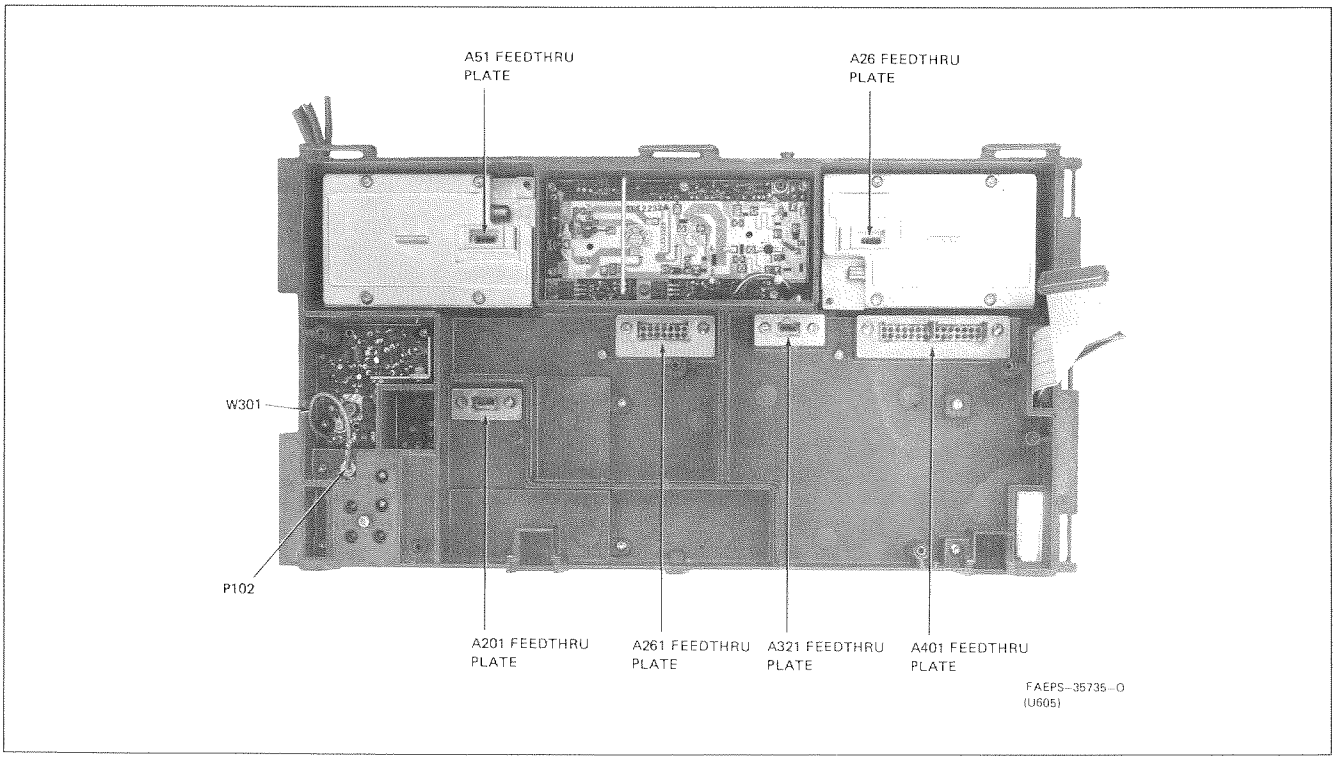
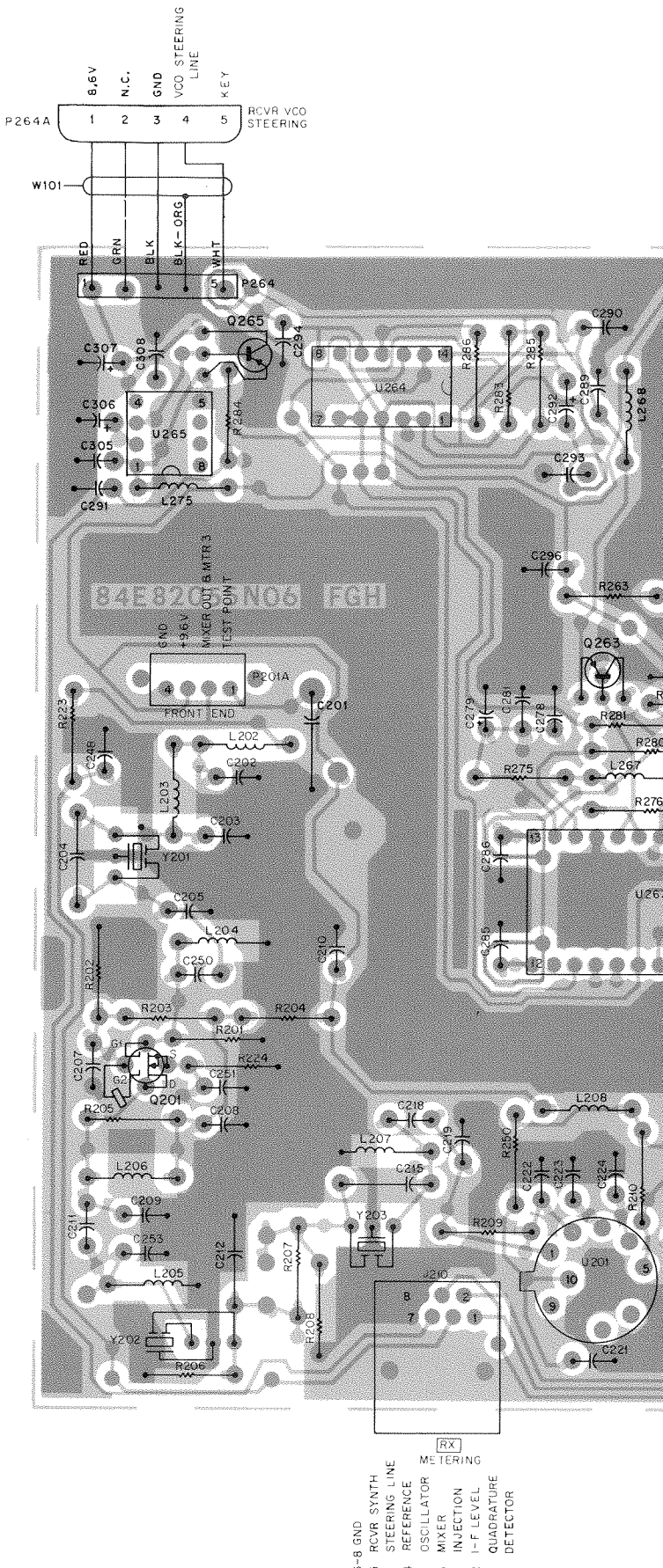


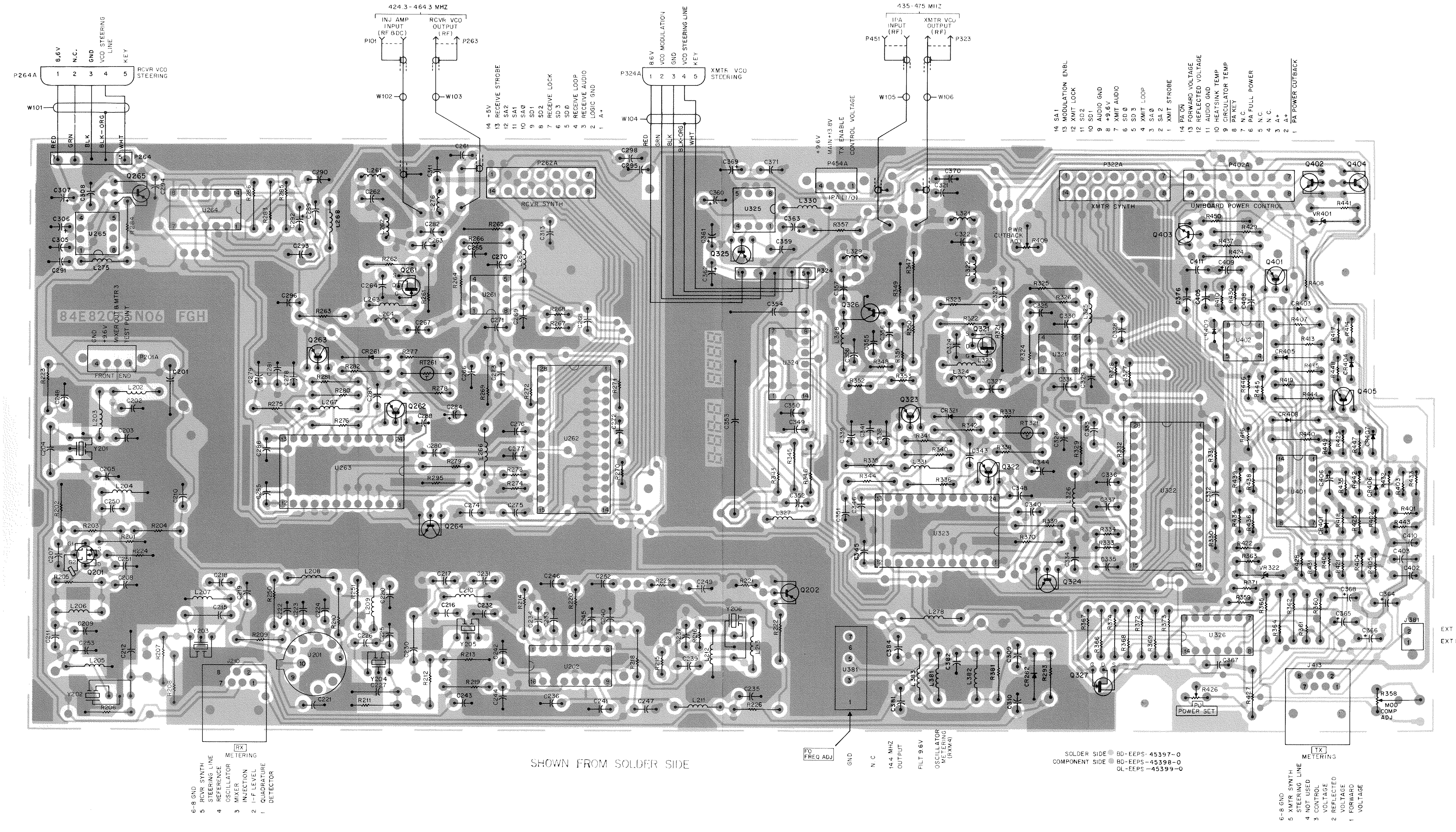
Figure 4. RF Tray Assembly Feedthru Detail (Uniboard Removed)

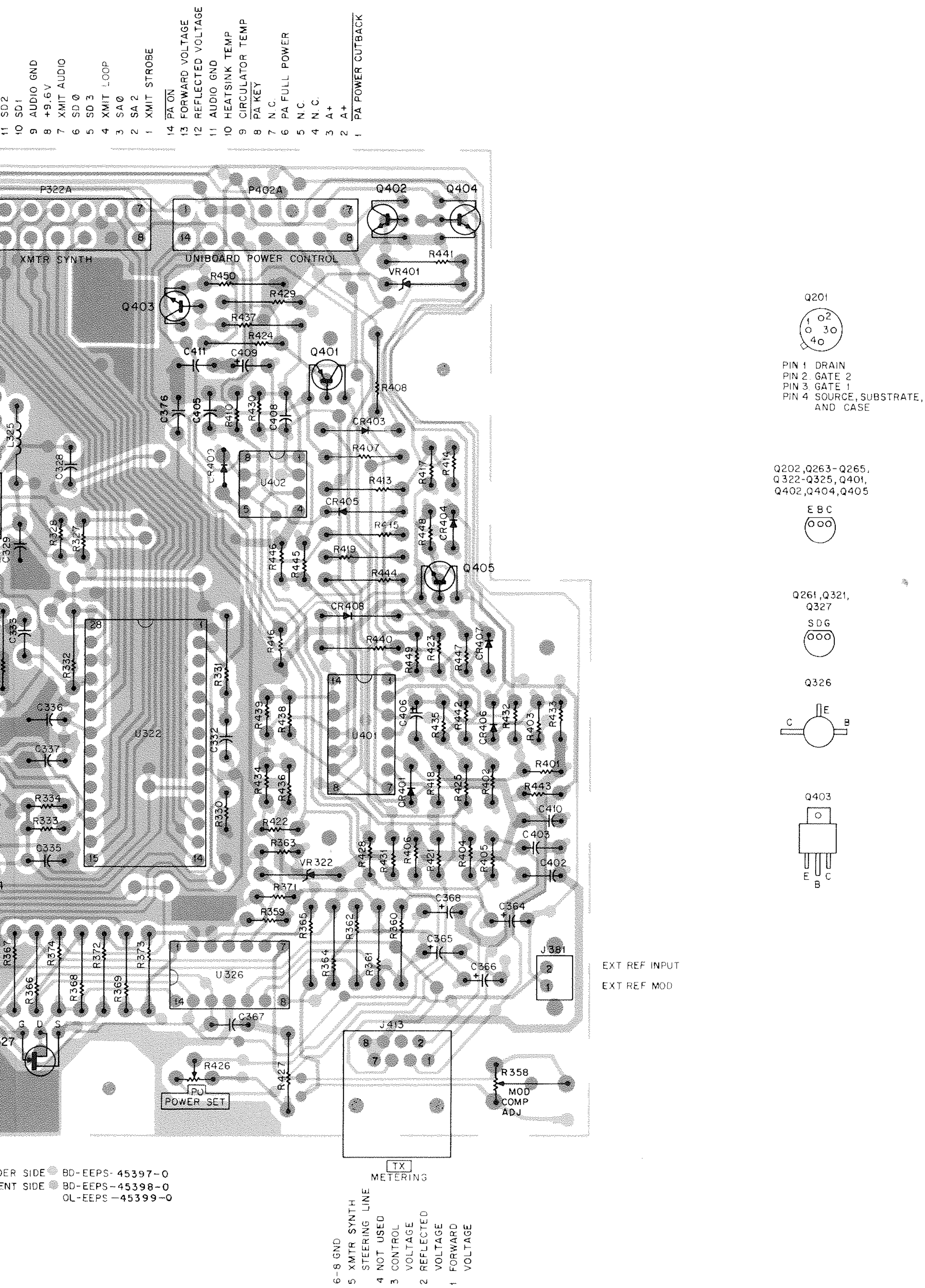
UNIBOARD

COMPONENT SIDE DETAIL
MODEL TRN9880A



REFER TO APPROPRIATE MANUAL SECTION FOR SCHEMATIC DIAGRAMS


8.6V
N.C.
GND
VCO STEERING LINE
KEY
P264A
RCVR VCO STEERING
W101
RED
GRN
BLK
BLK-ORG
WHT
P264
424.3-464.3 MHZ
INJ AMP INPUT (RF BDC)
RCVR VCO OUTPUT (RF)
P101
P263
W102
W103
14 +5V
13 RECEIVE STROBE
12 SA2
11 SA1
10 SA0
9 SD1
8 SD2
7 RECEIVE LOCK
6 SD3
5 SD0
4 RECEIVE LOOP
3 RECEIVE AUDIO
2 LOGIC GND
1 A+
P262A
RCVR SYNTH
8.6V
VCO MODULATION
GND
VCO STEERING LINE
KEY
P324A
XMTR VCO STEERING
W104
+9.6V
MAIN+13.8V
TX ENABLE
CONTROL VOLTAGE
P454A
IPA (1/O)
435-475 MHZ
IPA INPUT (RF)
XMTR VCO OUTPUT (RF)
P451
P323
W105
W106
14 SA1
13 MODULATION ENBL
12 XMIT LOCK
11 SD2
10 SD1
9 AUDIO GND
8 +9.6V
7 XMIT AUDIO
6 SD0
5 SD3
4 XMIT LOOP
3 SA0
2 SA2
1 XMIT STROBE
P322A
XMTR SYNTH
14 PA ON
13 FORWARD VOLTAGE
12 REFLECTED VOLTAGE
11 AUDIO GND
10 HEATSINK TEMP
9 CIRCULATOR TEMP
8 PA KEY
7 N.C.
6 PA FULL POWER
5 N.C.
4 N.C.
3 A+
2 A+
1 PA POWER CUTBACK
P402A
UNIBOARD POWER CONTROL
PWR CUTBACK ADJ
84E820 N06 FGH
GND
+9.6V
MIXER OUT & MTR3
TEST POINT
P201A
FRONT END
J210
RX METERING
6-8 GND
5 RCVR SYNTH STEERING LINE
4 REFERENCE OSCILLATOR
3 MIXER INJECTION
2 I-F LEVEL
1 QUADRATURE DETECTOR
SHOWN FROM SOLDER SIDE
FO FREQ ADJ
U381
GND
N.C.
14.4 MHZ OUTPUT
FILT 9.6V
OSCILLATOR METERING (RXM4)
SOLDER SIDE BD-EEPS-45397-0
COMPONENT SIDE BD-EEPS-45398-0
OL-EEPS-45399-0
PO POWER SET
J413
TX METERING
6-8 GND
5 XMTR SYNTH STEERING LINE
4 NOT USED
3 CONTROL VOLTAGE
2 REFLECTED VOLTAGE
1 FORWARD VOLTAGE
J381
R358 MOD COMP ADJ
EXT R
EXT R


11 SD2
10 SD1
9 AUDIO GND
8 +9.6V
7 XMIT AUDIO
6 SD Ø
5 SD 3
4 XMIT LOOP
3 SA Ø
2 SA 2
1 XMIT STROBE
14 PA ON
13 FORWARD VOLTAGE
12 REFLECTED VOLTAGE
11 AUDIO GND
10 HEATSINK TEMP
9 CIRCULATOR TEMP
8 PA KEY
7 N.C.
6 PA FULL POWER
5 N.C.
4 N.C.
3 A+
2 A+
1 PA POWER CUTBACK
P322A
XMTR SYNTH
P402A
UNIBOARD POWER CONTROL
Q402
Q404
Q403
Q401
Q405
U402
U401
U322
U326
VR401
VR322
J381
EXT REF INPUT
EXT REF MOD
J413
TX
METERING
R426
POWER SET
R358
MOD COMP ADJ
6-8 GND
5 XMTR SYNTH STEERING LINE
4 NOT USED
3 CONTROL VOLTAGE
2 REFLECTED VOLTAGE
1 FORWARD VOLTAGE
ER SIDE BD-EEPS-45397-0
ENT SIDE BD-EEPS-45398-0
OL-EEPS-45399-0
Q201
PIN 1 DRAIN
PIN 2 GATE 2
PIN 3 GATE 1
PIN 4 SOURCE, SUBSTRATE, AND CASE
Q202,Q263-Q265,
Q322-Q325,Q401,
Q402,Q404,Q405
E B C
Q261,Q321,
Q327
S D G
Q326
C E B
Q403
E B C

UNIBOARD
CIRCUIT LOCATION AND INTERCONNECT DETAIL MODEL TRN9880A

OTOROLA ART NO.	DESCRIPTION
3498F05	HOUSING, shell
1301K03	HOUSING, 5-contact
1302K01	PLUG, key
3499F01	TERMINAL, contact; 5 used
1204N01	CABLE, 4-conductor; 6.63" lg
2717M01	CONTACT, female; 4 used
1751D89	IPA RF Input includes:
1365D02	CONNECTOR,male; coaxial
1859004	CABLE, coaxial; 6" lg
1011N01	CLIP, coaxial connector
1751D85	XMTR VCO RF Output includes:
1365D02	CONNECTOR,male; coaxial
1859004	CABLE, coaxial; 6" lg
	crystal:(see note)
1396k08	10.796MHZ
1011E05	10.7MHZ
1011E05	10.7MHZ
1011E05	10.7MHZ
1011E05	10.7MHZ
1011E05	10.7MHZ
non-referenced items	
1365R01	LABEL, bar code
1300B01	HANDLE
1950N01	SHIELD, circuit board (top); 2 used
1121N01	SHIELD, transmitter
1120N02	SHIELD, circuit board (top); 2 used
1122N03	SHIELD, circuit board (top); 3 used
1949N01	SHIELD, circuit board (top); 2 used
1122N04	SHIELD, circuit board (top)
1121N03	SHIELD, transmitter
1122N01	SHIELD, circuit board (top); 5 used
1198N02	SHIELD, I-F
1100B02	HANDLE; 7 used
1123N01	SHIELD, circuit board (bottom)
1126N02	SHIELD, circuit board (bottom)
1125N01	SHIELD, circuit board (bottom)
1100B05	HANDLE
1127N01	SHIELD, circuit board (bottom)
1197N01	SHIELD, transmitter (solder side)
1199N02	SHIELD, transmitter
1124N01	SHIELD, circuit board (bottom)
1121N02	SHIELD, transmitter
49854	WASHER, spacer (used with U201)
1302K01	INSULATOR, crystal; 6 used
1214A01	TERMINAL, coaxial; 4 used

nance, diodes, transistors, and integrated circuits must rt numbers.

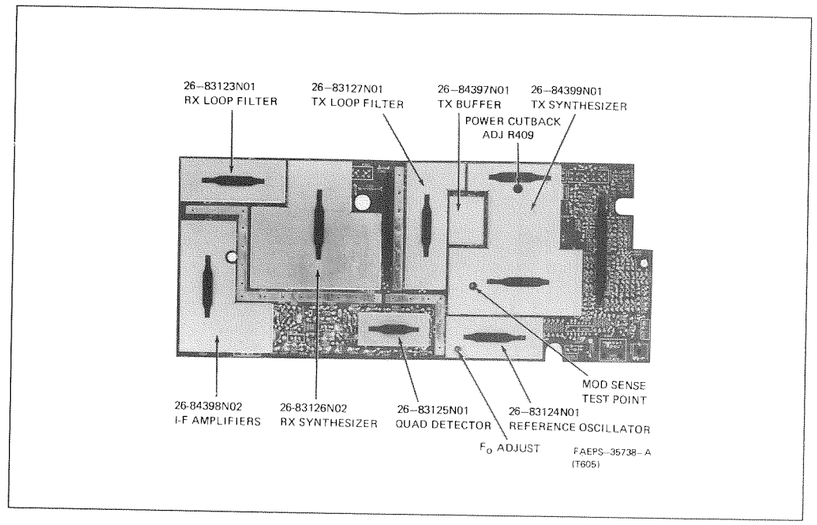


Figure 5. Uniboard Shield Detail (Solder Side

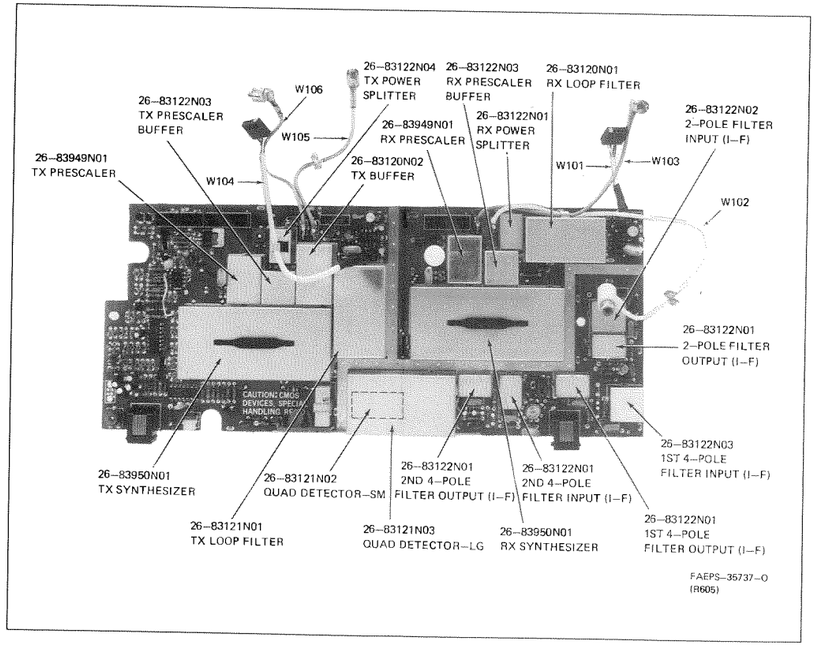


Figure 6. Uniboard Shield Detail (Component Side)

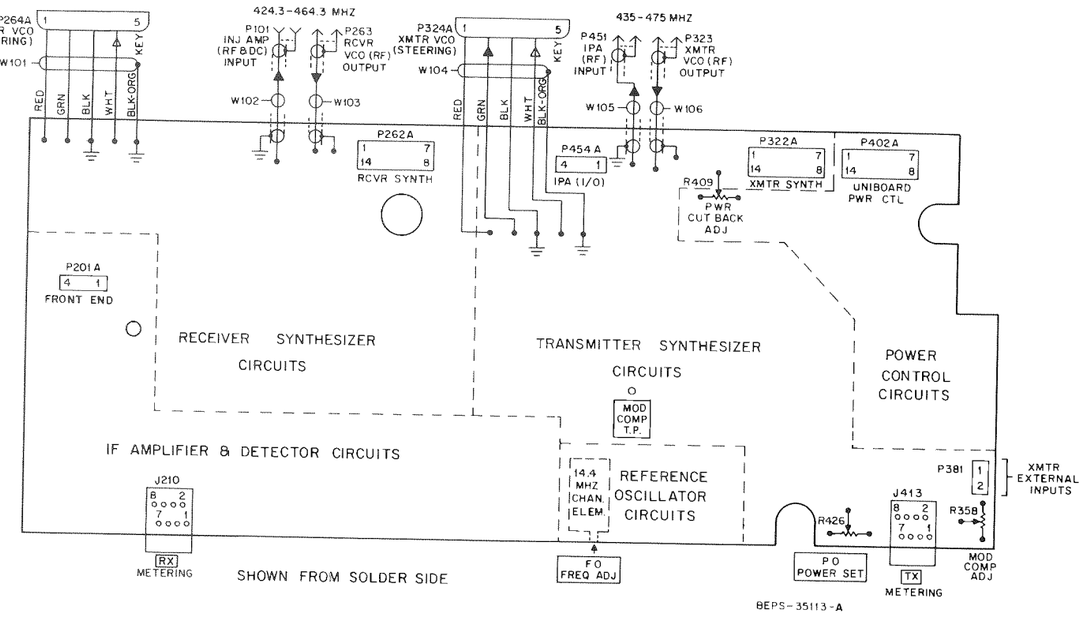


Figure 7.
Uniboard Circuit Location and Interconnect Detail

REFER TO APPROPRIATE MANUAL SECTION FOR SCHEMATIC DIAGRAMS AND CIRCUIT BOARD DETAILS

parts list

TRN9880A Uniboard PL-10850-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ±5%; 100V unless otherwise stated
C201	2384538G06	47 ±20%; 20V
C202	2111014H50	110pF
C203	2111014H27	12pF
C204	2182450B62	0.2pF; 500V
C205	2111014H20	6.2pF ±.5pF
C207,208	0811044A24	.01; 63V
C209	2111014H25	10pF ±.5pF
C210	0811044A24	.01; 63V
C211	2111014H27	12pF
C212	2182450B44	0.82; 500V
C215	2182450B07	0.39pF; 500V
C216	2111014H13	3.3pF ±.25pF
C217	2111014H32	20pF
C218	2111014H30	16pF
C219	2111014H28	13pF
C220	0811044A24	.01; 63V
C221	0811044A27	0.1; 50/63V
C222,223,224	0811044A24	.01; 63V
C225	2111014H33	22pF
C226	2111014H29	15pF
C227	2182450B61	1pF; 500V
C230	2182450B29	0.51; 500V
C231	2111014H38	36pF
C232	2111014H42	51pF
C233,234,235	0811044A24	.01; 63V
C236	0811044A27	0.1; 50/63V
C237	2111014H22	7.5pF ±.5pF
C239	2111014H20	6.2pF ±.5pF
C240 thru 244	0811044A24	.01; 63V
C245,246	2111015B05	220pF ±10%
C247,248	0811044A24	.01; 63V
C249	2311054H08	10 ±10%; 25V
C250,251,252	0811044A24	.01; 63V
C253	2111014H05	1.5pF ±.25pF
C261	2111014H32	20pF
C262	2111014H08	2pF ±.25pF
C263,264,265	2111014H32	20pF
C266	0811044A27	0.1; 50/63V
C267	2111014H32	20pF
C268	0811044A27	0.1; 50/63V
C269,270	2111014H32	20pF
C271	2111015B05	220pF ±10%
C272	0811051A03	.0022; 63V
C273,274	2111015B05	220pF ±10%
C275, 276	0811044A27	0.1; 50/63V
C277	2111015B05	220pF ±10%
C278	0811044A24	.01; 63V
C279	2311019A40	47 ±20%; 25V
C280	2111014H49	100pF
C281,282	2111014H32	20pF
C283	0811051A06	.0068; 63V
C284	2311019A40	47 ±20%; 25V
C285	0811051A01	.001; 63V
C286	0811051A05	.0047; 63V
C288	0811051A01	.001; 63V
C289	0811044A24	.01; 63V
C290	2111014H32	20pF
C291	0811044A24	.01; 63V
C292	2311013F03	0.15 ±10%; 35V
C293	0811044A32	0.68; 50/63V
C294	0811044A12	.047; 63V
C295	0811044A24	.01; 63V
C296,298	2111014H32	20pF
C305	0811044A27	0.1; 50/63V
C306	2311019A20	10 ±20%; 25V
C307	2311054L14	4.7 ±10%; 50V
C308	2311019A49	150 ±20%; 16V
C309	2111014H32	20pF
C310	0811044A24	.01; 63V
C311,313,321	2111014H32	20pF
C322	2111014H08	2pF ±.25pF
C323,324,325	2111014H32	20pF
C326	0811044A27	0.1; 50/63V
C327	2111014H32	20pF
C328	0811044A27	0.1; 50/63V
C329,330	2111014H32	20pF
C331	2111015B05	220pF ±10%
C332	0811051A03	.0022; 63V
C333,334	2111015B05	220pF ±10%
C335,336	0811044A27	0.1; 50/63V
C337	2111015B05	220pF ±10%
C338	0811044A24	.01; 63V
C339	2311019A40	47 ±20%; 25V
C340	2111014H49	100pF
C341	2111014H32	20pF
C343	0811051A06	.0068; 63V
C344	2311019A40	47 ±20%; 25V
C345	0811051A01	.001; 63V
C346	0811051A05	.0047; 63V
C348	2183162H07	.002 ±10%; 50V
C349	0811044A24	.01; 63V
C350	2111014H32	20pF
C351	0811044A24	.01; 63V
C352	2311054L02	0.47 ±10%; 50V
C353	0883862M02	2 ±10%
C354	0811044A26	.022; 63V
C355 thru 358	2111014H32	20pF
C359	0811044A27	0.1; 50/63V
C360	2311019A20	10 ±20%; 25V
C361	2311054L14	4.7 ±10%; 50V
C362,363	2311019A40	47 ±20%; 25V
C364	2311019A20	10 ±20%; 25V
C365,366	2311054H08	10 ±10%; 25V
C367	0811044A24	.01; 63V
C368	2311019A20	10 ±20%; 25V
C369	2311019A46	100 ±20%; 25V
C370,371	2111014H32	20pF
C372	0811044A24	.01; 63V
C376	0811044A30	0.33; 50/63V
C381,382	0811044A24	.01; 63V
C384	2111014H25	10pF ±.5pF
C402,403	2111014H38	36pF
C405	0811044A24	.01; 63V
C406	2311054K06	1.0 ±20%; 50V
C408	0811051A03	.0022; 63V
C409	2311054L04	0.68 ±10%; 50V
C410	2111014H38	36pF
C411	0811044A12	.047; 63V
		diode:(see note)
CR261	4883329G02	silicon
CR262	4882139G01	germanium
CR321	4883329G02	silicon
CR401	4883654H01	silicon
CR403	4811034A01	silicon
CR404	4883654H01	silicon
CR405	4811034A01	silicon
CR406,407	4883654H01	silicon
CR408	4811034A01	silicon
CR409	4883654H01	silicon
		connector:
J210	0983112N02	female, 8-contact
J413	0983112N02	female, 8-contact
		coil:
L201	7683960B01	ferrite bead
L202	2411047B31	1.8UH
L203	2411047C53	15UH
L204	2482549D24	15UH
L205,206,207	2411047C53	15UH
L208	2482723H35	23UH (red)
L209,210	2411047C53	15UH
L211	2482723H35	23UH (red)
L212	2411047B58	24UH
L213	2482549D24	15UH
L261	2411030A06	86.6NH (violet)
L262	2411030A02	21.3NH (orange)
L263	2482723H28	0.29 UH (yellow)
L264	2411030C05	choke (green)
L265 thru 268,275	2482723H33	14UH (orange)
L276	2411030A06	86.6NH (violet)
L278	2482835G32	0.6UH (blu/yellow/silver)
L321	2411030A06	86.6NH (violet)
L322	2411030A02	21.3NH (orange)
L323	2482723H28	0.29 UH (yellow)
L324	2411030C05	choke (green)
L325,326,327	2482723H33	14UH (orange)
L328	2482723H28	0.29 UH (yellow)
L329	2411030A02	21.3NH (orange)
L330,331,381,382,383	2482723H33	14UH (orange)
		connector:
P201A	0983109N02	female, 4-contact
P262A	0983110N01	female, 14-contact
P264A	2883441F05	male, 5-contact
P322A	0983110N01	female, 14-contact
P324A	2883441F05	male, 5-contact
P402A	0983110N01	female, 14-contact
P454A	0983109N02	female, 4-contact
		transistor:(see note)
Q201	4800869687	MOSFET
Q202	4800869643	PNP
Q261	4800869839	JFET
Q262,263	4800869643	PNP
Q264	4800869642	NPN
Q265	4800869681	PNP
Q321	4800869839	JFET
Q322,323	4800869643	PNP
Q324	4800869642	NPN
Q325	4800869681	PNP
Q326	4884411L83	NPN
Q327	4800869725	JFET
Q401	4800869643	PNP
Q402	4800869642	NPN
Q403	4800869640	NPN
Q404,405	4800869642	NPN
		resistor, fixed: ±5%; l/4W unless otherwise stated
R201	0611009A63	3900
R202,203	0611009A73	10K

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R204	0611009A17	47
R205	0611009A41	470
R206	0611009A91	56K
R207	0611009A41	470
R208	0611009A87	39K
R209	0611009A41	470
R210	0611009A29	150
R211	0611009A91	56K
R212	0611009A41	470
R213	0611009A87	39K
R214	0611009A45	680
R215	0611009E49	1000
R216	0611009E65	4700
R218	0611009B04	180K
R219	0611009A99	120K
R220	0611009A49	1000
R221	0611009E79	18K
R222	0611009A47	820
R223	0611009A99	120K
R224	0611009A25	100
R225	0611009E89	47K
R226	0611009A33	220
R250	0611009A17	47
R251	0611009A33	220
R261	0611009A25	100
R262	0611009A17	47
R263	0611009A25	100
R264	0611009A19	56
R265	0611009A73	10K
R266	0611009A49	1000
R267,268	0611009E65	4700
R269	0611009A41	470
R270	0611009E65	4700
R271	0611009A41	470
R272	0611009A49	1000
R273	0611009E67	5600
R274	0611009A65	4700
R275	0611009A01	10
R276	0611009A29	150
R277	0611009A39	390
R278	0611009A33	220
R279	0611009A89	47K
R280	0611009A01	10
R281	0611009A56	2000
R282	0611009A59	2700
R283	0611009A92	62K
R284	0611009B05	200K
R285	0611009A71	8200
R286	0611009A61	3300
R293	0611009A81	22K
R295	0611009A99	120K
R321	0611009A25	100
R322	0611009A17	47
R323	0611009A25	100
R324	0611009A19	56
R325	0611009A73	10K
R326	0611009A49	1000
R327,328	0611009E65	4700
R329	0611009A41	470
R330	0611009E65	4700
R331	0611009A41	470
R332	0611009A49	1000
R333	0611009E67	5600
R334	0611009E65	4700
R335	0611009A01	10
R336	0611009A29	150
R337	0611009A39	390
R338	0611009A33	220
R339	0611009A89	47K
R340	0611009A01	10
R341	0611009A56	2000
R342	0611009A59	2700
R343	0611009B18	680K
R344	0611009B05	200K
R345	0611009A77	15K
R346	0611009A61	3300
R347	0611009A11	27
R348	0611009E56	2000
R349	0611009A14	36
R350	0611009A11	27
R351	0611009A67	5600
R352	0611009E58	2400
R353	0611009E35	270
R357	0611009A73	10K
R358	1884248R09	variable; 10K 20 1/2W
R359	0611009E41	470
R360	0611009A99	120K
R361	0611009A92	62K
R362	0611009A99	120K
R363	0611009E32	200
R364	0611009A33	220
R365	0611009A49	1000
R366	0611009A73	10K
R367	0611009A81	22K
R368	0611009A73	10K
R369	0611009A71	8200
R370	0611009A99	120K
R371	0611009E65	4700

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R372	0611009A73	10K
R373	0611009A80	20K
R374	0611009A99	120K
R381	0611009A25	100
R401	0611009E81	22K
R402	0611009E49	1000
R403	0611009E09	22
R404	0611009E97	100K
R405	0611009E99	120K
R406	0611009E49	1000
R407	0611009A61	3300
R408	0611009A64	4300
R409	1884248R09	variable; 10K 20 1/2W
R410	0611009E73	10K
R413	0611009A29	150
R414	0611009E49	1000
R415	0611009A81	22K
R416	0611009E73	10K
R417	0611009E65	4700
R418	0611009E97	100K
R419	0611009A42	510
R421	0611009E66	5100
R422	0611009E97	100K
R423	0611009E65	4700
R424	0611009A73	10K
R425	0611009E69	6800
R426	1884248R26	variable; 10K 20 1/2W
R427	0611009A49	1000
R428	0611009E65	4700
R429	0611009A57	2200
R430	0611009E97	100K
R431	0611009E81	22K
R432	0611009E93	68K
R433,434	0611009E73	10K
R435	0611009E81	22K
R436	0611009E66	5100
R437	0611009A57	2200
R438,439	0611009F18	680K
R440	0611009A65	4700
R441	0611009A73	10K
R442	0611009E69	6800
R443	0611009F18	680K
R444	0611009B06	220K
R445,446	0611009E65	4700
R447,448	0611009E73	10K
R449	0611009F06	220K
R450	0611009A01	10
		thermistor:
RT261	0600858402	1K @25C
RT321	0600858402	1K @25C
		integrated circuit:(see note)
U201	5183629M47	Operational Amplifier
U202	5184561L84	Limiter/Quadrature Detector
U261	5180235C10	Prescaler
U262	5184768F63	Divider
U263	5183977M36	Phase Detector
U264	5184887K84	Quad Analog Gate
U265	5184768F65	Super Filter
U321	5180235C10	Prescaler
U322	5184768F63	Divider
U323	5183977M36	Phase Detector
U324	5184887K84	Quad Analog Gate
U325	5184768F65	Super Filter
U326	5184621K32	Quad Op Amplifier
U381	5180291B02	Oscillator
U401	5184621K74	Quad Comparator
U402	5184621K89	Dual Op Amplifier
		voltage regulator: (see note)
VR322	4882256C03	4.7V
VR401	4882256C15	5.1V
		cable assembly:
W101	0180711E54	Receiver VCO Steering includes:
	1583498F05	HOUSING, shell
	1584301K03	HOUSING, 5-contact
	2884302K01	PLUG, key
	2983499F01	TERMINAL, contact; 5 used
	3084204N01	CABLE, 4-conductor; 3" lg
	3982717M01	CONTACT, female; 4 used
W102	0180751D84	Injection Amplifier RF & DC Input includes:
3084158N01	CABLE, coaxial (incls connector P101)	
	4284011N01	CLIP, coaxial connector
W103	0180751D87	RCVR VCO RF Output includes:
P263	2882365D02	CONNECT,male; coaxial
	3000859004	CABLE, coaxial; 7.25" lg
W104	0180711E53	XMTR VCO Steering includes:

REFE
SYM

W105

P451

W106

P323

Y201
Y202
Y203
Y204
Y205
Y206

note: For
be ordere

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R372	0611009A73	10K
R373	0611009A80	20K
R374	0611009A99	120K
R381	0611009A25	100
R401	0611009E81	22K
R402	0611009E49	1000
R403	0611009E09	22
R404	0611009E97	100K
R405	0611009E99	120K
R406	0611009E49	1000
R407	0611009A61	3300
R408	0611009A64	4300
R409	1884248R09	variable; 10K 20 1/2W
R410	0611009E73	10K
R413	0611009A29	150
R414	0611009E49	1000
R415	0611009A81	22K
R416	0611009E73	10K
R417	0611009E65	4700
R418	0611009E97	100K
R419	0611009A42	510
R421	0611009E66	5100
R422	0611009E97	100K
R423	0611009E65	4700
R424	0611009A73	10K
R425	0611009E69	6800
R426	1884248R26	variable; 10K 20 1/2W
R427	0611009A49	1000
R428	0611009E65	4700
R429	0611009A57	2200
R430	0611009E97	100K
R431	0611009E81	22K
R432	0611009E93	68K
R433,434	0611009E73	10K
R435	0611009E81	22K
R436	0611009E66	5100
R437	0611009A57	2200
R438,439	0611009F18	680K
R440	0611009A65	4700
R441	0611009A73	10K
R442	0611009E69	6800
R443	0611009F18	680K
R444	0611009B06	220K
R445,446	0611009E65	4700
R447,448	0611009E73	10K
R449	0611009F06	220K
R450	0611009A01	10
		thermistor:
RT261	0600858402	1K @25C
RT321	0600858402	1K @25C
		integrated circuit:(see note)
U201	5183629M47	Operational Amplifier
U202	5184561L84	Limiter/Quadrature Detector
U261	5180235C10	Prescaler
U262	5184768F63	Divider
U263	5183977M36	Phase Detector
U264	5184887K84	Quad Analog Gate
U265	5184768F65	Super Filter
U321	5180235C10	Prescaler
U322	5184768F63	Divider
U323	5183977M36	Phase Detector
U324	5184887K84	Quad Analog Gate
U325	5184768F65	Super Filter
U326	5184621K32	Quad Op Amplifier
U381	5180291B02	Oscillator
U401	5184621K74	Quad Comparator
U402	5184621K89	Dual Op Amplifier
		voltage regulator: (see note)
VR322	4882256C03	4.7V
VR401	4882256C15	5.1V
		cable assembly:
W101	0180711E54	Receiver VCO Steering includes:
	1583498F05	HOUSING, shell
	1584301K03	HOUSING, 5-contact
	2884302K01	PLUG, key
	2983499F01	TERMINAL, contact; 5 used
	3084204N01	CABLE, 4-conductor; 3" lg
	3982717M01	CONTACT, female; 4 used
W102	0180751D84	Injection Amplifier RF & DC Input includes:
3084158N01	CABLE, coaxial (incls connector P101)	
	4284011N01	CLIP, coaxial connector
W103	0180751D87	RCVR VCO RF Output includes:
P263	2882365D02	CONNECT,male; coaxial
	3000859004	CABLE, coaxial; 7.25" lg
W104	0180711E53	XMTR VCO Steering includes:
	1583498F05	HOUSING, shell
	1584301K03	HOUSING, 5-contact
	2884302K01	PLUG, key
	2983499F01	TERMINAL, contact; 5 used
	3084204N01	CABLE, 4-conductor; 6.63" lg
	3982717M01	CONTACT, female; 4 used
W105	0180751D89	IPA RF Input includes:
P451	2882365D02	CONNECTOR,male; coaxial
	3000859004	CABLE, coaxial; 6" lg
	4284011N01	CLIP, coaxial connector
W106	0180751D85	XMTR VCO RF Output includes:
P323	2882365D02	CONNECTOR,male; coaxial
	3000859004	CABLE, coaxial; 6" lg
		crystal:(see note)
Y201	4884396k08	10.796MHZ
Y202	9180011E05	10.7MHZ
Y203	9180011E05	10.7MHZ
Y204	9180011E05	10.7MHZ
Y205	9180011E05	10.7MHZ
Y206	9180011E05	10.7MHZ
		non-referenced items
	5483865R01	LABEL, bar code
	5584300B01	HANDLE
	2683950N01	SHIELD, circuit board (top); 2 used
	2683121N01	SHIELD, transmitter
	2683120N02	SHIELD, circuit board (top); 2 used
	2683122N03	SHIELD, circuit board (top); 3 used
	2683949N01	SHIELD, circuit board (top); 2 used
	2683122N04	SHIELD, circuit board (top)
	2683121N03	SHIELD, transmitter
	2683122N01	SHIELD, circuit board (top); 5 used
	2684398N02	SHIELD, I-F
	5584300B02	HANDLE; 7 used
	2683123N01	SHIELD, circuit board (bottom)
	2683126N02	SHIELD, circuit board (bottom)
	2683125N01	SHIELD, circuit board (bottom)
	5584300B05	HANDLE
	2683127N01	SHIELD, circuit board (bottom)
	2684397N01	SHIELD, transmitter (solder side)
	2684399N02	SHIELD, transmitter
	2683124N01	SHIELD, circuit board (bottom)
	2683121N02	SHIELD, transmitter
	0400049854	WASHER, spacer (used with U201)
	1484602K01	INSULATOR, crystal; 6 used
	2980014A01	TERMINAL, coaxial; 4 used

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

INTERCONNECT BOARD

CIRCUIT BOARD DETAIL AND CONNECTION CHART MODEL TRN5382A

CONNECTOR DESCRIPTION	REF. DES.	AUDIO GROUND (GROUND A)	GROUND B	LOGIC GROUND	MAIN +13.8 V (A+)	AUX +13.8 V (A++)	+5 V	+9.6 V	ANTENNA RELAY ENABLE	BATTERY REVERT (AC FAIL)	CIRCULATOR TEMPERATURE	FORWARD VOLTAGE	HEATSINK TEMPERATURE	MODULATION ENABLE	NO CONNECTION	OVERVOLTAGE ALARM	PA FULL POWER	PA KEY	PA ON	PA POWER CUTBACK	RECEIVE AUDIO	RECEIVER LOCK	RECEIVE LOOP	RECEIVE STROBE	NOT USED	REMOTE EQUALIZE	SAØ (SYNTH ADRS BIT Ø)	SA1 (SYNTH ADRS BIT 1)	SA2 (SYNTH ADRS BIT 2)	SDØ (SYTH DATA BIT Ø)	SD1 (SYNTH DATA BIT 1)	SD2 (SYNTH DATA BIT 2)	SD3 (SYTH DATA BIT 3)	SPARE 1	SPARE 2	SPARE 3	TRANSMIT MODULATION AUDIO	TRANSMIT LOCK	TRANSMIT LOOP	TRANSMIT STROBE
ANTENNA RELAY	J500							2	1,3																														
PA POWER CONTROL	J502	5									2*	4*	1*		3											6*													
RECEIVER SYNTHESIZER	P262B			2	1		14														3*	7*	4*	13			10	11	12	5	9	8	6						
TRANSMIT SYNTHESIZER	P322B	9						8*						13													3	14	2	6	10	11	5				7	12*	4*	1
UNIBOARD POWER CONTROL	P402B	11		2, 3							9	13	10				6*	8	14*	1					12									5	7	4				
MAIN POWER SUPPLY	P603	3*	4*		2*	1*				6*					8, 9	5*										7*													
STATION CONTROL DC POWER	P701		5			1				4					2	3										6													
RADIO INTERFACE	P801	2, 4, 6		11*			9*	1	7*								10	14*	12	16*	5	15	13	25*			24*	22*	20*	17*	19*	21*	23*				3*	8	18	26*

DEPS-35095-B

HOW TO READ CHART

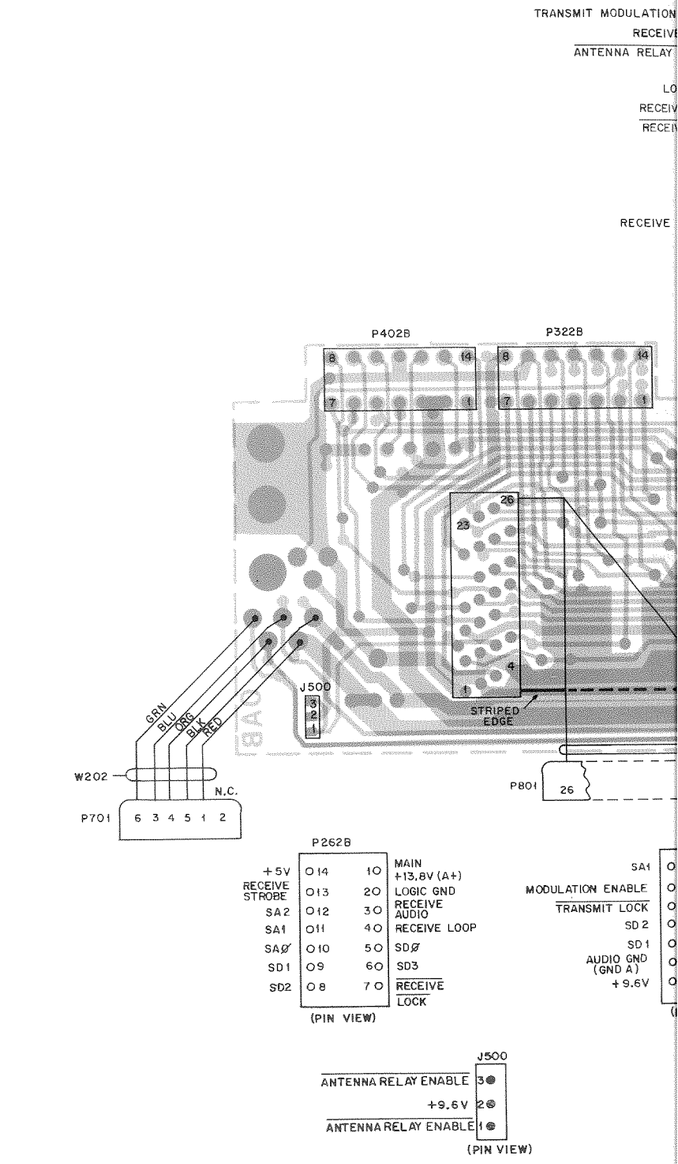
1. This chart shows all interconnections made by the plating on both sides of the interconnect board and includes cabling where applicable.
2. All pin numbers in each vertical column are electrically common.
3. To trace interconnections from any starting point to all other common points proceed as follows:

   Step 1. Find the connector description or reference designation in the left hand column of the chart.

   Step 2. Find the desired pin number. All pins of a specific connector are listed in the row that extends to the right.

   Step 3. Note the function of the desired pin. The function is listed at the top of the column in which the pin number appears. All other pins listed in the same column have the same function. Trace back to the left hand column to find the descriptions and reference designations of other connectors having electrically common pins.
4. (*) indicates function source.

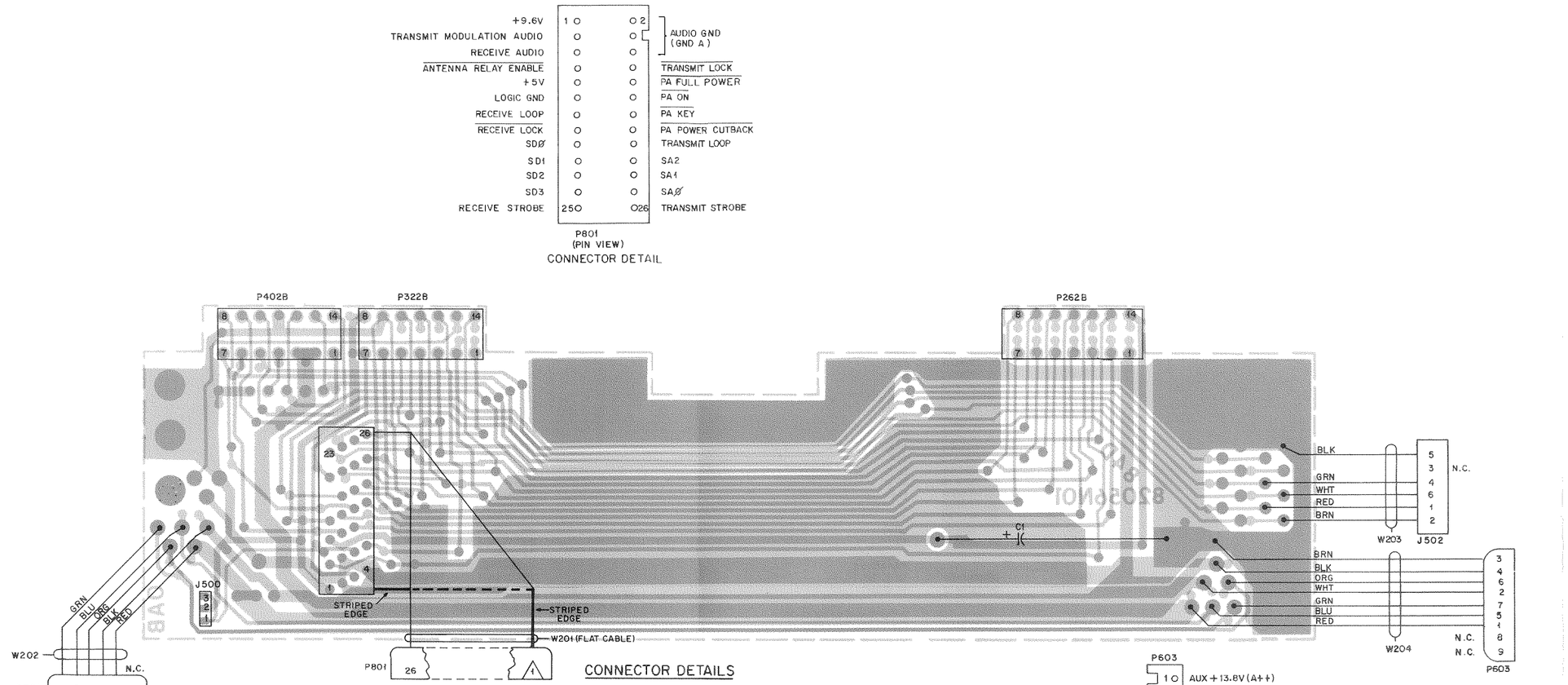
EXAMPLE:
Radio Interface Connector, P801, pin 24 provides the SAØ (synthesizer address bit Ø) input to the Interconnect Board for distribution to the Transmit Synthesizer Connector P322B, pin 3 and to Receiver Synthesizer Connector P262B, pin 10.



SHOW

SD1 (SYNTH DATA BIT 1)	SD2 (SYNTH DATA BIT 2)	SD3 (SYTH DATA BIT 3)	SPARE 1	SPARE 2	SPARE 3	TRANSMIT MODULATION AUDIO	$\overline{\text{TRANSMIT LOCK}}$	TRANSMIT LOOP	TRANSMIT STROBE
9	8	6							
10	11	5				7	12*	4*	1
			5	7	4				
19*	21*	23*				3*	8	18	26*

DEPS-35095-B



CONNECTOR DETAILS

P262B

+5V	14	1	MAIN +13.8V (A+)
RECEIVE STROBE	13	2	LOGIC GND
SA2	12	3	RECEIVE AUDIO
SA1	11	4	RECEIVE LOOP
SAØ	10	5	SDØ
SD1	9	6	SD3
SD2	8	7	$\overline{\text{RECEIVE LOCK}}$

(PIN VIEW)

P322B

SA1	14	1	TRANSMIT STROBE
MODULATION ENABLE	13	2	SA2
$\overline{\text{TRANSMIT LOCK}}$	12	3	SAØ
SD2	11	4	TRANSMIT LOOP
SD1	10	5	SD3
AUDIO GND (GND A)	9	6	SDØ
+9.6V	8	7	TRANSMIT MOD AUDIO

(PIN VIEW)

P402B

$\overline{\text{PA ON}}$	14	1	$\overline{\text{PA POWER CUTBACK}}$
FORWARD VOLTAGE	13	2	MAIN +13.8V (A+)
REFLECTED VOLTAGE	12	3	MAIN +13.8V (A+)
AUDIO GND (GND A)	11	4	SPARE 3
HEATSINK TEMPERATURE	10	5	SPARE 1
CIRCULATOR TEMPERATURE	9	6	$\overline{\text{PA FULL POWER}}$
$\overline{\text{PA KEY}}$	8	7	SPARE 2

(PIN VIEW)

P603

1	AUX +13.8V (A++)	
2	MAIN +13.8V (A+)	
3	AUDIO GND (GND A)	
4	GND B	
5	$\overline{\text{OVERVOLTAGE ALARM}}$	
6	$\overline{\text{BATTERY REVERT}}$ (AC FAIL)	
7	$\overline{\text{REMOTE EQUALIZE}}$	
8	N.C.	
9	N.C.	

(PIN VIEW)

P701

1	AUX +13.8V (A++)	
2	PLUG KEY	
3	$\overline{\text{OVERVOLTAGE ALARM}}$	
4	$\overline{\text{BATTERY REVERT}}$ (AC FAIL)	
5	GND B	
6	$\overline{\text{REMOTE EQUALIZE}}$	

(PIN VIEW)

J500

$\overline{\text{ANTENNA RELAY ENABLE}}$	3	
+9.6V	2	
$\overline{\text{ANTENNA RELAY ENABLE}}$	1	

(PIN VIEW)

J502

NOT USED	6	3	N.C.
AUDIO GND (GND A)	5	2	CIRCULATOR TEMPERATURE
FORWARD VOLTAGE	4	1	HEATSINK TEMPERATURE

(PIN VIEW)

COMPONENT SIDE ⊛ BD-CEPS-35395-O
SOLDER SIDE ⊛ BD-CEPS-35396-O
OL-DEPS-35397-A

SHOWN FROM COMPONENT SIDE

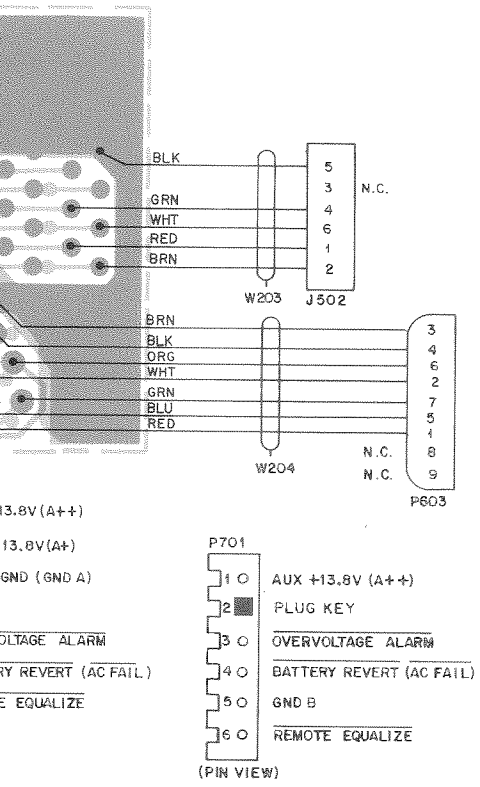
parts list

TRN5382A Interconnect Board — PL-8141-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C1	23-82747L26	1000 uF + 100-10%; 12 V
		connector, receptacle:
J500	28-84315N01	3-contact; male
J502	—	consists of:
	15-84954L01	HOUSING, 6-position
	29-84706E05	TERMINAL, crimp; 6 used
		connector, plug:
P262B, 322B, 402B	9-83111N02	14-contact; female
P603	—	consists of:
	9-83360N02	HOUSING; 9-position
	29-83499F01	TERMINAL; contact; 7 used
P701	—	consists of:
	15-83498F37	HOUSING, 6-position
	29-83499F01	TERMINAL, contact; 5 used
P801	—	26-contact; p/o W201
		cable, assembly:
W201	30-84213N01	26-conductor, flat; 9.5" used (Radio Interface); includes ref. item P801 and PCB header
W202	1-80752D19	5-conductor; 12" used (Station Control DC Power); includes ref. item P701, and
W203	1-80751D55	5-conductor; 11.25" used (PA Power Control); includes ref. item J502
W204	1-80752D20	7-conductor; 48" used (Main Power Supply); includes ref. item P603
		non-referenced items
	3-83498N10	SCREW, tapping; slotted star; 2 used
	7-83104N01	BRACKET, board mounting; 2 used
	42-10217A02	STRAP, tie; 3 used

TRN5142A RF Tray Hardware Kit — PL-8252-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		cable:
A201	1-80752D47	I-F RF tray feedthru plate, includes: J201 A and B
	7-83162N01	SUPPORT, feedthru 4 pin
	91-84012M03	FILTER, RF1; 2 used
	91-84012M06	FILTER, RF1; 2 used
A261	1-80752D14	receiver synth. RF tray feedthru plate includes: J262A and B
	7-83164N01	SUPPORT, feed-thru 14 pin
	91-84012M06	FILTER, RFI; 14 used
A321	1-80752D15	IPA RF tray feedthru plate includes: J454A and B
	7-83162N01	SUPPORT, feedthru 4 pin
	91-84012M06	FILTER, RF1; 4 used
A401	1-80752D23	RF tray feedthru plate xmtr synth includes: J322A and B, J402A and B
	7-83143N01	SUPPORT, feedthru 28 pin
	64-83161N01	PLATE, mag. 2 spacer
	91-84012M06	FILTER, RFI; 28 used
		mechanical parts
	3-10943M17	SCREW, tapping TT3.5 x 0.6 x 13"; 19 used
	3-10943M60	SCREW, tapping TT3.5 x 0.6 x 8; 3 used
	3-83498N10	SCREW, tapping M3.5 x 0.6 x 8; 6 used
	15-83133N02	TRAY, rod cost
	15-83176N01	COVER, LL amplifier core
	15-83176N02	COVER, LL amplifier core
	15-83180N01	COVER, rod tray
	32-82796H02	GASKET
	42-10217A10	CLAMP, cable
	42-82387D08	CLAMP, cable
	42-83501N01	RETAINER, E ring
	42-83501N02	RETAINER, E ring
	42-84244N01	CLAMP, wire tie; 2 used
	45-83153N01	CAM, 1††4 turns lock; 2 used
	47-83154N01	BAR, control support
	55-83354M01	HANDLE, power supply
	64-83159N01	PANEL, front



TRANSMIT FREQUENCY SYNTHESIZER

p/o MODEL TRN9880A UNIBOARD

1. INTRODUCTION

The *MSF 5000* transmit frequency synthesizer generates the transmit carrier. The synthesizer employs a phase-locked loop (PLL) to lock a voltage-controlled oscillator (VCO) to a reference oscillator to produce the desired frequency. Major functional blocks which are located on the uniboard, are: a 14.4 MHz reference oscillator, programmable divider, phase detector, and adaptive loop filter. An isolation buffer stage and DPL signal compensation circuit are included with the synthesizer circuits. The transmit VCO is a separate assembly located in the RF Tray.

2. THEORY OF OPERATION

2.1 PHASE-LOCKED LOOP OPERATION

2.1.1 Various output frequencies are generated by the synthesizer by using a single negative-feedback loop, wherein the phase difference between two signals at the phase detector is used to control the VCO output frequency. The input waveforms compared are the reference signal and the loop pulse signal.

2.1.2 The reference signal is created by dividing the output of a 14.4 MHz high-stability crystal oscillator down to a 5 kHz or 6.25 kHz square wave, us ing the reference divider. The loop pulse signal is the negative feedback component of the PLL, created by dividing the VCO rf output frequency by the programmable loop divide number, N.

2.1.3 Both the loop and reference signals are applied to the phase detector, which issues a dc control voltage proportional to the phase difference between the loop and reference frequencies. The phase error output is passed through the adaptive loop filter, which damps the loop transient response and attenuates noise and spurs, to drive the VCO steering line. The steering line increases or decreases the VCO output frequency as its voltage level rises or falls. If, for instance, the VCO output frequency increases, the loop signal frequency also increases, causing a phase change at the phase detector. The phase detector then drops its dc output in accordance with the phase slippage, and the steering line moves the VCO frequency back down.

2.2 DIVIDER

2.2.1 The 14.4 MHz signal produced by the reference oscillator is acted upon by the programmable reference divider in U322. The internal bits R_1 and R_2 in U322 determine the reference signal frequency (5 kHz or 6.25 kHz).

2.2.2 The VCO output frequency is divided by the programmable loop divider to produce the loop pulse signal. The divisor, N, is created by two dual modulus dividers. The first is a divide-by-3 or -4 prescaler U321. With the rising edge of the loop pulse signal, this prescaler divides the VCO frequency by four for 1, 2, or 3 counts of its internal "C" counter programmed by the C_1 and C_0 bits latched from U322. When the prescaler's "C" counter reaches zero, the VCO frequency is divided by three for the rest of the cycle which restarts with the rising edge of the next loop pulse. When the loop pulse goes low, the "C" counter is reset for the next cycle.

2.2.3 The other dual modulus divider, divides by 63 or 64 and is located, along with the reference divider, in U322. Divide-by-64 is started with the rising edge of the loop pulse and continues until the internal "A" counter reaches zero. The loop pulse is then sent low and the divider divides by 63 until the internal "B" counter goes to zero. The loop pulse then goes high and another cycle begins. If no input signal is seen from the divide-by-3 or -4 prescaler, then U322 issues a free-running loop pulse.

2.3 SYNTHESIZER PROGRAMMING FROM MICROPROCESSOR

2.3.1 For data loading into primary divider U322, the microprocessor reads data from the code plug on the station control board, and multiplexes the information into six 4-bit words. Each word is loaded into U322 as four lines of data (SD_0 through SD_3) and a corresponding three lines of address (SA_0 through SA_2), so that the words are properly demultiplexed in U322.

2.3.2 The received data bits inform primary divider U322 and divide-by-3 or 4 prescaler U321 of the appropriate numbers for the "A", "B", and "C" counters for the desired PLL output frequency. The data bits also program the synthesizer to disable or enable its DPL modulation compensation signal or to go into its "change frequency" mode for fast lock.

2.4 PHASE DETECTOR

2.4.1 Phase detector U323 issues a dc output signal proportional to the phase difference between the reference and loop pulse signals sent from divider U322. The phase difference is measured by the phase detector. It turns ramp current source Q322 on when the reference signal goes high and switches Q322 off at the leading edge of the loop pulse signal. The current generated during this interval charges C348, forming a voltage ramp.

2.4.2 The ramp voltage is then held constant for a time interval determined by C343, allowing two hold capacitors C345 and C346 to charge to the ramp voltage level. Ramp capacitor C348 is discharged at the end of the hold interval in preparation for another ramp sequence that begins with the next reference signal leading edge.

2.4.3 The hold capacitors are discharged through a push-pull output transistor pair via a high-to-low impedance output buffer. This creates the phase detector output signal.

2.4.4 When the reference-to-loop-pulse phase slippage is too great for the ramp capability, the ramp remains at a high or low limit. The VCO cannot be steered to the intended frequency and an unlocked state occurs. The phase detector then issues an "adapt" signal (on the ADAPT and $\overline{\text{ADAPT}}$ lines). The ADAPT line control voltage switches the analog gates in the adaptive filter to the "normal" or "adapt" mode, as well as forcing lock indicator Q324 into a no-lock, open-collector condition. The "adapt" mode is automatically attained whenever the phase detector encounters a "change-frequency" positive pulse from U322. The duration of a single adapt duration is 12 msec, which is hard-wire controllable at the phase detector. Adapt cycles continue until reference and loop pulse signals are again locked in frequency.

2.4.5 For fast lock, the synthesizer must be loaded when the loop pulse is low (i.e., only counter "B" is in operation). The phase detector sends a SYN THESIZER SYNC signal, at the loop pulse rate, to the microprocessor for loading synchronization.

2.5 ADAPTIVE LOOP FILTER

2.5.1 The adaptive loop filter is used for effective loop lock. When the PLL is unlocked, or when a "change frequency" pulse is sent to the synthesizer from control, the ADAPT and $\overline{\text{ADAPT}}$ lines are sent high and low, respectively, by the phase detector. Analog gates U324A, B, and C are switched closed, shorting the phase detector output to the steering line, keeping C352 uncharged, and charging C353 quickly to the new steering voltage. Gate U324D is switched open, detaching the loop filter output from the steering line. In this mode, the loop filter is essentially out of the PLL and fast lock, due to reduced damping, is possible.

2.5.2 When the loop reaches its new frequency, (at the end of the last adapt cycle), ADAPT goes low and $\overline{\text{ADAPT}}$ goes high. Analog gates U324A, B, and C are then switched open, returning the loop filter to its normal connection to the output of U323 and breaking the direct connection between this output and the steering line. Gate U324D reconnects the loop filter output to the steering line. During this switching, C354 remains charged to the new phase detector output voltage, keeping the VCO tuned to the new frequency.

2.5.3 The transmit loop filter, when in normal operation, has a natural frequency of 75 Hz and a third order Integral-Times-Absolute-Value-of-Error response, a method for minimization of transients. The filter damps steering line excursion due to voltage increments of the phase detector output and attenuates reference signal spurs and noise.

2.6 SUPER FILTER

2.6.1 Because of the VCO requirements for a very pure dc supply voltage, an ultra-low-pass filter U325 is used to provide the VCO with a low noise +8.6 output voltage. Any ripple or noise present on the +9.6 V supply line is removed by the filter, preventing unwanted modulation of the VCO. A 1 V drop occurs across the filter. The output voltage is +8.6 V.

2.6.2 The super filter consists of a low-pass filter, an error amplifier, and external series-pass transistor Q325. The +9.6 V supply is connected to U325-1 as well as to the emitter of Q325. Internally, the input from U325-1 passes through a low-pass filter to the noninverting input of the error amplifier. Capacitor C360, connected to U325-2, forms part of the low-pass filter. The output line (also connected to the collector of Q325) is fed back to the inverting input of the error amplifier through U325-4. The error amplifier output is connected to the base of Q325 via U325-3 and is used to control the conduction of this transistor. These connections enable the super filter to compare the output line voltage with the filtered input line voltage and to increase or decrease the conduction of Q325 to remove any ripple or noise present on the VCO supply line. The super filter output itself is filtered by C361 and C362 before being routed from the synthesizer to the VCO.

2.7 ISOLATION BUFFER

The isolation buffer stage applies the transmit VCO rf signal to the first stage of the intermediate power amplifier (IPA). The buffer stage consists of input and output matching circuits and an active device (Q326), biased for class A operation. The buffer ensures isolation between the VCO output and the IPA, and prevents pulling of the VCO output frequency during IPA key-up.

2.8 DPL MODULATION COMPENSATION

2.8.1 The DPL modulation compensation circuit of the transmit synthesizer enables low-frequency modulation (DPL) to be transmitted without being "tracked out" by the loop. When the VCO is modulated by DPL, the modulation appears as an error signal at the phase detector, after it is divided down and compared to the reference signal. Unless compensated, this error signal passes through the loop filter and modulates the steering line, distorting the intended DPL modulation.

2.8.2 The DPL modulation compensation circuit sends a cancellation signal to the phase detector output buffer summing point (U323-11). This cancellation signal is the original low-frequency DPL signal, after being integrated, delayed, and inverted. Thus, DPL modulation of the VCO results without loop tracking interference.

2.9 VOLTAGE-CONTROLLED OSCILLATOR (VCO)

2.9.1 Each *MSF 5000* radio contains a transmit VCO that provides the frequency modulated (FM) transmit excitation frequency. The transmit VCO has a mechanical tuning range from 435 MHz to 475 MHz. Over this mechanical tuning range, the transmit VCO has an associated operational electronic bandwidth of 6.1 MHz, minimum.

2.9.2 Oscillator Circuit

The VCO uses a grounded-gate Colpitts oscillator that contains JFET Q26 as the amplifying element. The drain and source of the JFET are capacitively coupled to a resonant cavity via an encapsulated probe assembly. This coupling network provides the positive feedback necessary for oscillation.

2.9.3 Oscillator Output Amplifier/Low-Pass Filter Circuit

A second probe assembly (power output probe) is used to bring the oscillator signal out of the cavity and into output amplifier Q27. The output amplifier is a common emitter stage that is low-pass filtered. The output of the low-pass filter is then applied to the VCO's output phono connector J323. The output of the VCO drives 10:1 power tap on the uniboard, via coaxial cable W106.

2.9.4 Steering Line Circuit

The steering line, in conjunction with the tuning screw, determines the VCO operating frequency. The steering line is driven by phase detector U323 and is coupled to the VCO via the adaptive loop filter. The phase detector provides a dc output voltage to maintain the VCO output at the desired frequency. When the oscillator frequency is changed, the phase detector dc output voltage shifts to change the oscillator frequency and then maintains this new frequency. The steering line is coupled from the uniboard via P324A-4 of VCO interconnect cable W104 to the VCO feedthru plate A26. This plate contains rf filters that decouple the VCO circuits from the uniboard. The steering line dc voltage determines the capacitance of diodes CR29 through CR34, which electronically control the oscillator's frequency. An increase in the steering line voltage causes the capacitance of these diodes to decrease and the oscillator frequency to increase. Conversely, a decrease in the steering line voltage causes an increase in the capacitance of the diodes and a reduction in the oscillator frequency.

2.9.5 Modulation Line

The VCO is directly modulated by the transmit audio signals. This is achieved by using a second varactor circuit that employs CR27 and CR28. The transmit audio signal is coupled, via P324A-2 of VCO interconnect cable W104, to CR27 whose function is to modulate the oscillator frequency. The second device, CR28, is used to maintain the modulation level constant throughout the radio operating frequency range. Without CR28, the VCO modulation sensitivity would naturally increase as the steering line increased the oscillator frequency. With CR28 in use, the series combination (of CR27 and CR28) decreases in capacitance with increasing steering line voltage, since a sample of the steering line biases CR28. Thus, modulation sensitivity is level across the VCO electronic bandwidth.

3. SYNTHESIZER TROUBLESHOOTING PROCEDURE

3.1 Refer to the Transmit Frequency Synthesizer Troubleshooting Chart at the end of this section for a comprehensive procedure for troubleshooting the transmit frequency synthesizer.

3.2 The major problems that may occur in the transmit frequency synthesizer are:

- synthesizer does not lock
- synthesizer locks on wrong frequency
- excessive reference frequency feedthrough (spurs)
- noisy frequency lock
- slow switching response.

3.3 A summary of the problems and possible causes in the frequency synthesizer is provided in Table 1. Also refer to the other tables that provide pin connections and voltages for the phase detector, divider, prescaler, and super filter.

3.4 VCO TESTS

3.4.1 VCO Electronic Bandwidth Test

Step 1. Remove the wire from P324A-4 to open the steering line. Connect a 1 kilohm resistor to the positive terminal of a 0-10 V adjustable power supply and connect the other end of the resistor to P324-A. Connect the negative terminal to VCO ground. This power supply will serve as a steering line in this test. Connect a frequency counter to VCO output connector J323.

Step 2. Adjust the power supply for 8.0 V and record the frequency.

Step 3. Adjust the power supply for 3.0 V and subtract this frequency from the frequency obtained in Step 2. The difference is the electronic bandwidth (EBW) of the VCO. The EBW should be a minimum of 10 ± 0.5 MHz for the transmit VCO. If the EBW is less than specified or if the VCO does not steer at all, refer to the VCO steering line short/open test.

3.4.2 Steering Line Short/Open Test

Step 1. Check the varactor stack for a short (with an ohmmeter) by placing the positive lead on the steering line and the negative lead on the VCO ground. The reading should be greater than 20 megohms. A reading of less than 20 megohms indicates a defective or shorted component in the steering line circuit.

Step 2. Reverse the ohmmeter leads. This reading should be 500 to 1000 ohms.

Step 3. Lift one end of L30 and repeat Steps 1 and 2. If unit now passes 1 and 2, check CR28 and test EBW; otherwise, continue.

Step 4. Lift one end of L31 and one end of L32. Individually check CR29 and CR30 for a short or open and make necessary repairs.

Step 5. Reconnect L30, L31, and L32.

Step 6. Repeat Steps 3 through 5 for the following groups of varactors and chokes.

L33, L34 & CR31, CR32
L39, L40 & CR33, CR34

Step 7. If the unit still does not pass Steps 1 and 2, remove C34 and C41, one at a time, and repeat Steps 1 and 2. If the VCO is still defective, replace the VCO.

3.4.3 VCO Steering Line Leakage

The VCO steering line leakage can be checked by removing the wire to P324A-4 and connecting one end of a 1 megohm resistor in its place. The free end of the resistor should be connected to an adjustable power supply set to 9.5 V. A high impedance voltmeter (greater than 10 megohms) should be used to verify that the voltage drop across the resistor is less than 10 mV. A higher voltage (greater than 10 mV) is an indication of either a leaky VCO feedthru assembly A26 or defective VCO steering line varactors CR29 through CR34. To determine which is defective, remove the VCO cover from the VCO and perform the same test again (with the VCO interconnect cable connected to the cover). If the voltage drop becomes less than 10 mV, the steering line varactors are leaky and need replacement. If the voltage across the resistor is still greater than 10 mV, feedthru assembly A26 is defective and requires replacement.

Table 1. Problems and Their Possible Causes in a MSF 5000 Transmit Synthesizer

Problems	Possible Source of Trouble
Synthesizer does not lock	Refer to Transmit Synthesizer Troubleshooting Chart.
Synthesizer does not lock all channels	Refer to Transmit Synthesizer Troubleshooting Chart.
Synthesizer locks on wrong frequency	Refer to Transmit Synthesizer Troubleshooting Chart.
Excessive reference frequency feedthru (spurs)	Defective hold capacitors (open or leaky) C345, C346
	Defective ramp capacitor C348.
	Defective phase detector U323.
	Adaptive filter in ADAPT mode or shorted input to output; guard band shorted to VCO steering line or other adaptive filter mode.
Noisy frequency lock	Leaky VCO varactor diodes.
	Marginal input level to prescaler U321-1, loop divider U322-25 or reference divider U322.
	Loose connection, cold solder joint, or faulty component.
	Noisy Q322.
	Defective phase detector U323.
	Defective reference divider U322 or prescaler U321 (jittery).
	Noisy 5 V or 9.6 V supplies, noisy super filter output.
	Defective adaptive filter (open capacitors).
Slow frequency switching response	Malfunctioning adaptive filter, check U324.
	Phase detector U323 gain too low (overdamped response) or too high (underdamped response); check R336, R337, R338, RT321, Q322.
	Check ramp slope at U323-24.
	Leaky adaptive filter capacitors or transmission gates C353, C352, C354 or U324.
	Leaky VCO varactor diodes.

Table 2. Phase Detector U323 Pin Connections and Voltages

Pin No.	Function	To/From	Nominal Voltage
1	high current ground	—	0 V dc.
2	REFERENCE IN	from U322-5	0 to 4.3 V square wave (160 usec period); U323-17, 5 V dc transmit.
3	adapt select	—	0 V dc
4	SYNTHESIZER SYNC	to microcomputer	60 usec positive pulse, 0-5 V at loop pulse rate; equal to pin 2 if pin 7 is low.
5	FREQUENCY CHANGE	from U322-18	0.5 V, 11.1 usec when frequency changes.
6	N.C.	—	—
7	ADAPT	to lock transistor via R339	9.6 to 0.6 V single pulse, 12 msec.
8	N.C.	—	—
9	N.C.	—	—
10	ADAPT	to adaptive filter	0 to 9 V single pulse; 12 msec Tx (U232).
11	mod input	from R369 (U323 only)	4.9 to 0.62 V dc (use high impedance).
12	HOLD 1	to C345	1.4 to 8 V dc (use high input impedance voltmeter).
13	HOLD 2	to C346	1.4 to 8 V dc (use high input impedance voltmeter).
14	A+	—	9.6 V dc
15	PHASE DET OUTPUT	to adaptive filter	1.2 to 9.5 V dc (depending on loop output frequency).
16	low current ground	—	0 V dc.
17	EXT PNP BASE	to Q323 base	8.9 V dc
18	V_{cc}	from regulator	9.6 V dc
19	RAMP BASE	to Q322 base (ramp generator)	9.1 V dc
20	FILTERED 9.1 V	to R336, RT321, R337, C344	9.1 V dc
21	ramp resistor	to R378, U322 emitter	8 to 8.7 V dc rectangular wave at reference rate.
22	SAMPLE TIMING CAP.	to C343	0 to 2 V sawtooth wave at loop pulse rate.
23	LOOP IN PULSE	from U322-9 via C340	1.4 V pulse riding on 1.6 V dc (160 usec, typical period)
24	RAMP CAP.	from C348 and ramp Q322 collector	flat top ramp waveform at reference rate, top voltage 1.4 to 7 V (depending on loop output frequency).

Table 3. Divider U322 Pin Connections and Voltages

Pin No.	Function	To/From	Nominal Voltage
1*	GND	—	0 V dc.
2	REF IN	from U268 (reference oscillator)	1.5 V dc +0.6 V pp ac (14.4 MHz).
3	N.C.	—	—
4	N.C.	—	—
5*	REFERENCE OUT	to U323 (phase detector)	0 to 4.3 V square wave (5.0 kHz to 6.25 kHz).
6	N.C.	—	—
7	N.C.	—	—
8	N.C.	—	—
9*	LOOP OUT	to phase detector and prescaler	2.9 V to 4.3 V narrow pulse (1.4 V_{pp}) (160 usec nominal period).
10*	V_{CC}	from regulator	5 V dc.
11	DØ	from microcomputer	0 to 5 V pulse train.
12	D1	from microcomputer	0 to 5 V pulse train.
13	D2	from microcomputer	0 to 5 V pulse train.
14	D3	from microcomputer	0 to 5 V pulse train.
15	CØ	to prescaler	0 to 5 V dc
16	C1	to prescaler	0 to 5 V dc.
17	VCO3	to Q327 gate	0 to 5 V dc.
18	FREQ CHANGE	to phase detector U323-5	0 to 5 V dc.
19	VC01	N.C.	—
20	VC02	N.C.	—
21	N.C.	—	—
22	V_{BB}	R331, C337, R271, C277	1.5 V dc.
23	AØ	from microcomputer	0 to 5 V pulse train.
24	A1	from microcomputer	0 to 5 V pulse train.
25	F_{IN}	from prescaler U321-3	1.5 V dc +0.7 V_{pp} ac (approx 150 MHz).
26	A2	from microcomputer	0 to 5 V pulse train.
27*	STROBE	from microcomputer	0 to 5 V pulse train (7 pulses/train).

* should be checked first

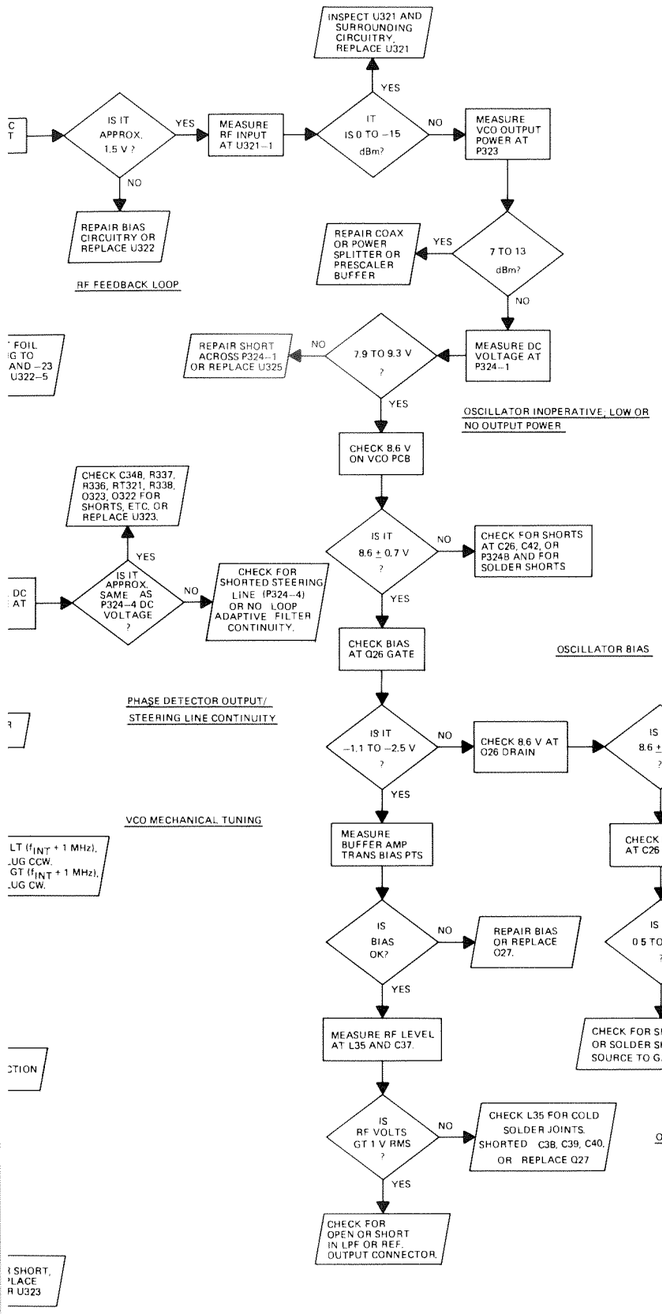
Table 4. Prescaler U321 Pin Connections and Voltages

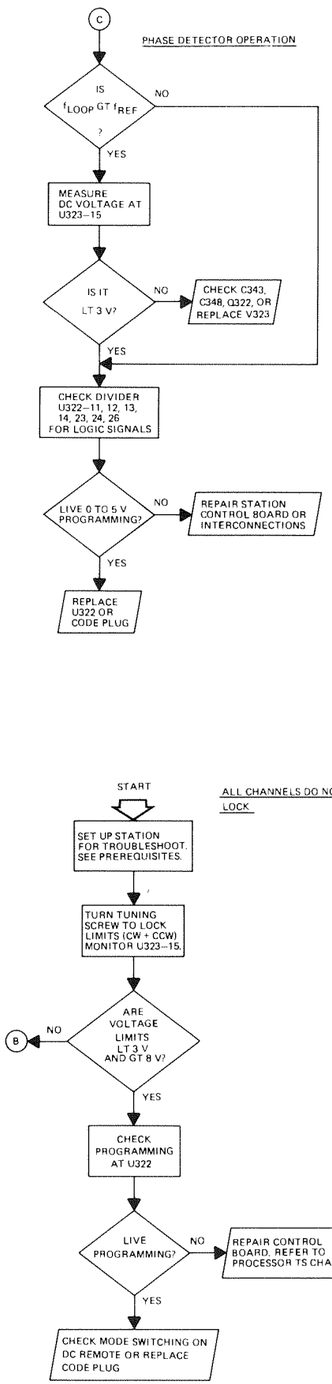
Pin No.	Function	To/From	Nominal Voltage
1	F_{IN}	from VCO buffer	-15 dBm to 0 dBm riding on 3.8 V dc.
2	V_{BB}	—	3.8 V dc, bypassed for rf.
3	PRESCALER OUT	to divider U322-25	0.6 V_{pp} riding on dc level of 3.6 V dc at approx one-third VCO freq (±10%).
4	GND	—	0 V dc
5	F_V	from divider U322-9	1.4 V_{pp} narrow pulse at reference freq (6.25 kHz) riding on 3.4 V dc.
6	C1	from divider U322-16	dc level (programming bit) 0 or 5 V dc.
7 8	C0 V_{CC}	from divider U322-15 from regulator	dc level (programming bit) 0 or 5 V dc. +5 ±0.1 V

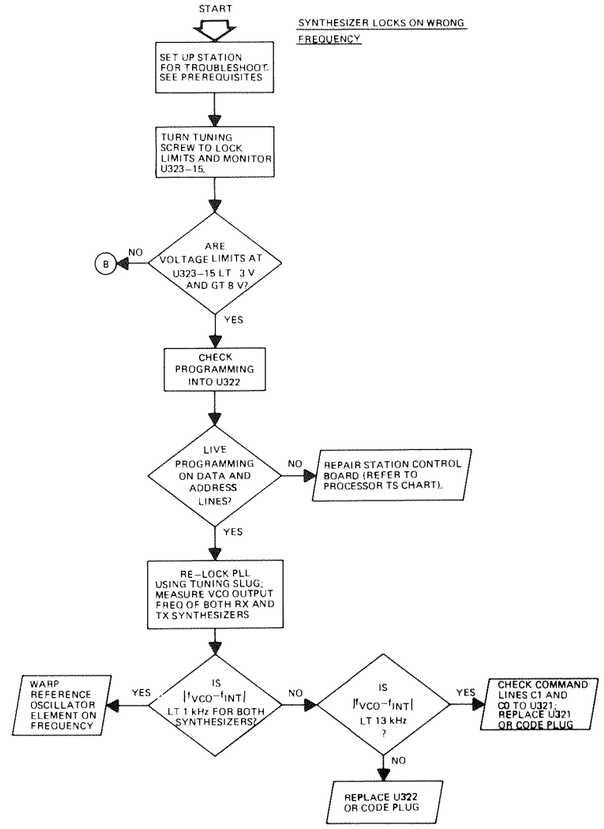
Table 5. Super Filter Pin Connections and Voltages

Pin No.	Function	To/From	Nominal Voltage
1	V_{CC}	from 9.6 V regulator	9.6 V dc
2	FILTER CAP.	C360	7.1 V dc
3	EXT. DRIVER CONTROL	Q325	8.9 V dc
4	8.6 V OUT	to VCO	8.6 V dc
5	Ground (internal NPN emitter)	from regulator	0 V dc
6	N.C.	—	—
7	N.C.	—	—
8	N.C.	—	—

TRANSMIT FREQUENCY SYNTHESIZER
TROUBLESHOOTING CHART







TROUBLESHOOTING PREREQUISITES:

1. THE FOLLOWING TEST EQUIPMENT IS REQUIRED FOR TROUBLESHOOTING THE SYNTHESIZER CIRCUITS: AN RF FREQUENCY COUNTER, RF PROBE, DC VOLTMETER, 30 MHZ BANDWIDTH OSCILLOSCOPE, OHM METER, 270 OHM ±5%, 1/4 W RESISTOR (MOTOROLA NO. 8–11009C35), VCO TUNING TOOL, REFERENCE OSCILLATOR TUNING TOOL, AND RF POWER METER.
2. WITH STATION POWERED AND DE–KEYED, UNLATCH AND SLIDE RF TRAY OUT, TILT UP STATION CONTROL TRAY, AND THEN REMOVE RF TRAY COVER.
3. REMOVE SOLDER SIDE SHIELDS FROM MALFUNCTIONING SYNTHESIZER CIRCUIT AREA ON UNIBOARD.

SYMBOLS AND ABBREVIATIONS USED IN THE CHART

ALL VOLTAGE MEASUREMENTS ARE DC, UNLESS OTHERWISE STATED

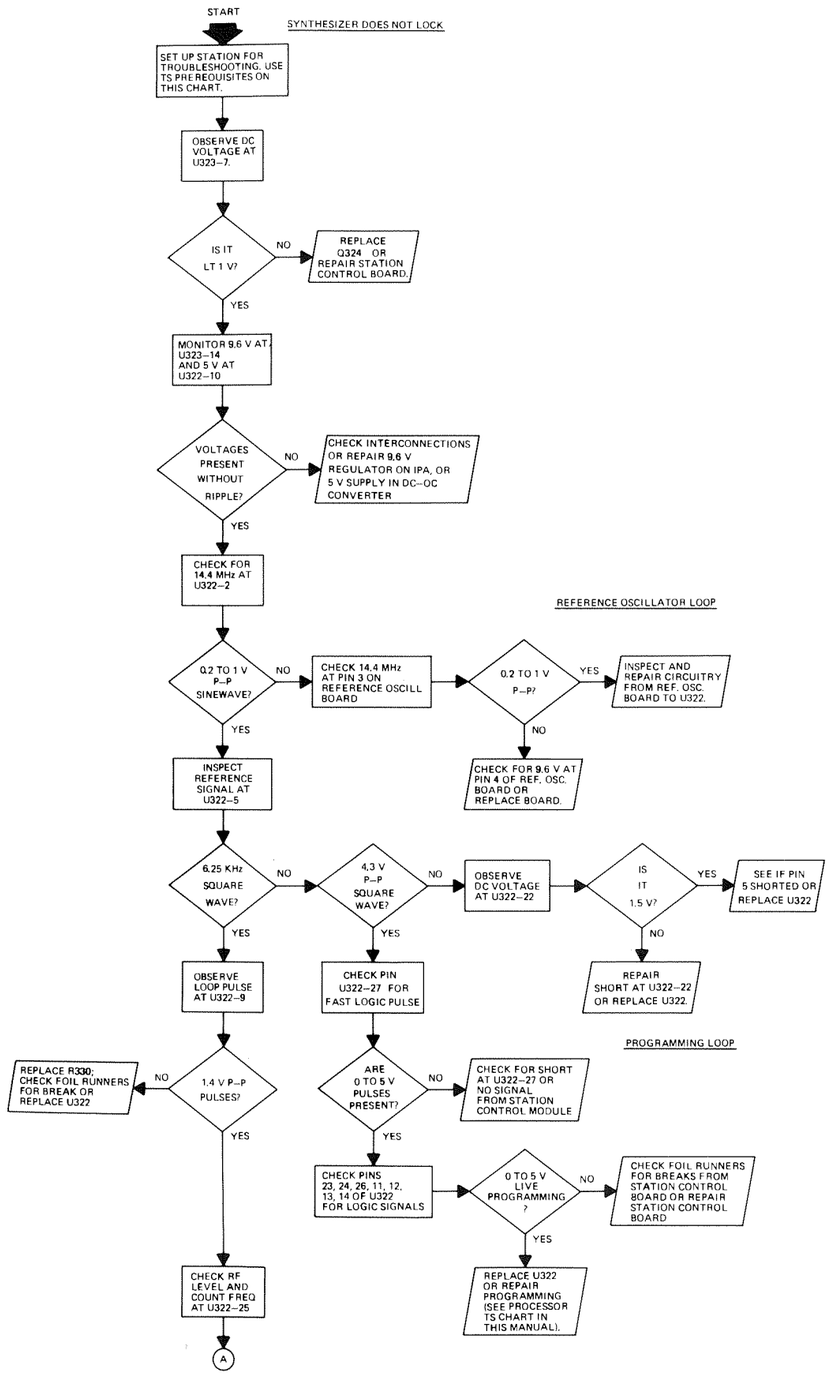
= TEST TO BE DONE

= DECISION

= SOURCE OF FAULT

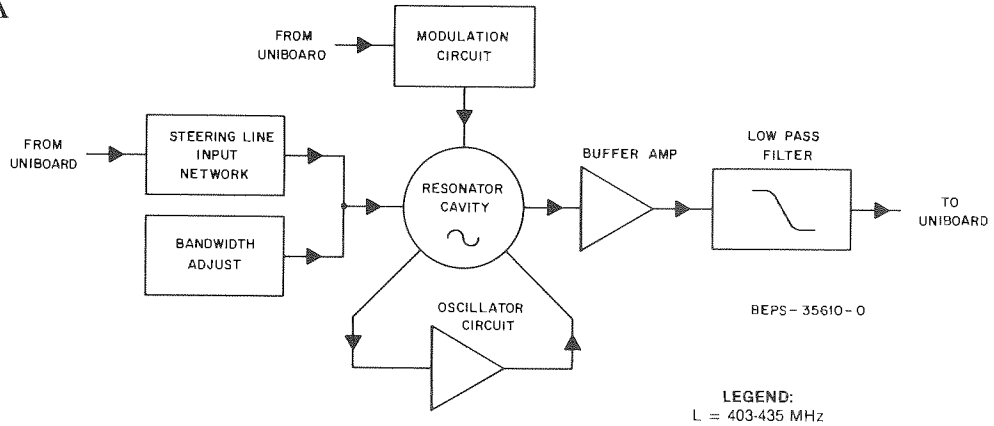
U323–7	= PIN NO. 7 OF U323
P–P	= PEAK–TO–PEAK
f_{VCO}	= VCO OUTPUT FREQUENCY
f_{INT}	= INTENDED FREQUENCY
f_L	= LOOP PULSE FREQUENCY
f_R	= REFERENCE FREQUENCY
PCB	= PRINTED–CIRCUIT BOARD
GT	= GREATER THAN
LT	= LESS THAN
TS	= TROUBLESHOOTING
PLL	= PHASE–LOCK LOOP

EEPS–35637–0


START
SYNTHESIZER DOES NOT LOCK
SET UP STATION FOR TROUBLESHOOTING. USE TS PREREQUISITES ON THIS CHART.
OBSERVE DC VOLTAGE AT U323–7.
IS IT LT 1 V?
NO
REPLACE Q324 OR REPAIR STATION CONTROL BOARD.
YES
MONITOR 9.6 V AT U323–14 AND 5 V AT U322–10
VOLTAGES PRESENT WITHOUT RIPPLE?
NO
CHECK INTERCONNECTIONS OR REPAIR 9.6 V REGULATOR ON IPA, OR 5 V SUPPLY IN DC–DC CONVERTER
YES
CHECK FOR 14.4 MHz AT U322–2
REFERENCE OSCILLATOR LOOP
0.2 TO 1 V P–P SINEWAVE?
NO
CHECK 14.4 MHz AT PIN 3 ON REFERENCE OSCILL BOARD
0.2 TO 1 V P–P?
YES
INSPECT AND REPAIR CIRCUITRY FROM REF. OSC. BOARD TO U322.
NO
CHECK FOR 9.6 V AT PIN 4 OF REF. OSC. BOARD OR REPLACE BOARD.
YES
INSPECT REFERENCE SIGNAL AT U322–5
6.25 KHz SQUARE WAVE?
NO
4.3 V P–P SQUARE WAVE?
NO
OBSERVE DC VOLTAGE AT U322–22
IS IT 1.5 V?
YES
SEE IF PIN 5 SHORTED OR REPLACE U322
NO
REPAIR SHORT AT U322–22 OR REPLACE U322.
YES
OBSERVE LOOP PULSE AT U322–9
CHECK PIN U322–27 FOR FAST LOGIC PULSE
PROGRAMMING LOOP
1.4 V P–P PULSES?
NO
REPLACE R330; CHECK FOIL RUNNERS FOR BREAK OR REPLACE U322
YES
ARE 0 TO 5 V PULSES PRESENT?
NO
CHECK FOR SHORT AT U322–27 OR NO SIGNAL FROM STATION CONTROL MODULE
YES
CHECK PINS 23, 24, 26, 11, 12, 13, 14 OF U322 FOR LOGIC SIGNALS
0 TO 5 V LIVE PROGRAMMING ?
NO
CHECK FOIL RUNNERS FOR BREAKS FROM STATION CONTROL BOARD OR REPAIR STATION CONTROL BOARD
YES
REPLACE U322 OR REPAIR PROGRAMMING (SEE PROCESSOR TS CHART IN THIS MANUAL).
CHECK RF LEVEL AND COUNT FREQ AT U322–25
A
A
150 MHZ ±10% AT APPROX. 600 mV P–P
NO
CHECK DC LEVEL AT U322–25
IS IT APPROX. 1.5 V ?
YES
MEASURE RF INPUT AT U321–1
IT IS 0 TO –15 dBm?
YES
INSPECT U321 AND SURROUNDING CIRCUITRY. REPLACE U321
NO
MEASURE VCO OUTPUT POWER AT P323
NO
REPAIR BIAS CIRCUITRY OR REPLACE U322
RF FEEDBACK LOOP
YES
7 TO 13 dBm?
YES
REPAIR COAX OR POWER SPLITTER OR PRESCALER BUFFER
NO
MEASURE DC VOLTAGE AT P324–1
OBSERVE LOOP WAVEFORM AT U323–23 AND REFERENCE WAVEFORM AT U323–2
4 V P–P SQ. WAVE REF. SIGNAL AND SPIKED LOOP SIGNAL?
NO
INSPECT FOIL RUNNING TO U323–2 AND –23 AND TO U322–5 AND –9
YES
7.9 TO 9.3 V ?
NO
REPAIR SHORT ACROSS P324–1 OR REPLACE U325
YES
OSCILLATOR INOPERATIVE, LOW OR NO OUTPUT POWER
B
B
SET RADIO TO HIGHEST CHANNEL; UNPLUG P323; MONITOR VCO OUTPUT FREQUENCY AND DC VOLTAGE AT P324–4
CHECK 8.6 V ON VCO PCB
CHECK C348, R337, R336, RT321, R338, Q323, Q322 FOR SHORTS, ETC. OR REPLACE U323.
IS P324–4 GT 8 V?
NO
MEASURE DC VOLTAGE AT U323–15
YES
IS IT APPROX. SAME AS P324–4 DC VOLTAGE ?
NO
CHECK FOR SHORTED STEERING LINE (P324–4) OR NO LOOP ADAPTIVE FILTER CONTINUITY.
YES
IS IT 8.6 ± 0.7 V ?
NO
CHECK FOR SHORTS AT C26, C42, OR P324B AND FOR SOLDER SHORTS
YES
CHECK BIAS AT Q26 GATE
OSCILLATOR BIAS
IS P324–4 OR U323–15 SHORTED 9.6 V LINE?
YES
REPAIR SHORT
NO
PHASE DETECTOR OUTPUT/ STEERING LINE CONTINUITY
IS IT –1.1 TO –2.5 V ?
NO
CHECK 8.6 V AT Q26 DRAIN
IS IT 8.6 ± 0.7 V ?
NO
CHECK L26 FOR OPEN; REPLACE
YES
MEASURE BUFFER AMP TRANS BIAS PTS
CHECK BIAS AT C26 SOURCE
IS f_{VCO} AT P232 APPROX. EQUAL TO (f_{INT} + 1 MHZ) ?
NO
IF f_{VCO} LT (f_{INT} + 1 MHz), TUNE SLUG CCW. IF f_{VCO} GT (f_{INT} + 1 MHz), TUNE SLUG CW.
VCO MECHANICAL TUNING
YES
IS BIAS OK?
NO
REPAIR BIAS OR REPLACE Q27.
YES
IS IT 0.5 TO 0.7 V ?
NO
CHECK FOR SHORTED C31; SOLDER SHORT FROM SOURCE TO GND; SHORT IN GATE CIRCUIT OR OPEN L28; REPLACE Q26.
YES
CHECK FOR SHORTED CR26 OR SOLDER SHORT FROM SOURCE TO GATE.
INSERT 270–OHM SHUNT RESISTOR P324–4 TO GROUND.
MEASURE RF LEVEL AT L35 AND C37.
IS f_{VCO} LT f_{INT}?
NO
GO TO TEST SECTION 3.4.2
YES
IS RF VOLTS GT 1 V RMS ?
NO
CHECK L35 FOR COLD SOLDER JOINTS. SHORTED C38, C39, C40, OR REPLACE Q27
OUTPUT BUFFER
YES
CHECK FOR OPEN OR SHORT IN LPF OR REF. OUTPUT CONNECTOR.
REMOVE 270–OHM SHUNT RESISTOR AND RECONNECT P323; MONITOR U323–22
2 V PEAK SAWTOOTH AT LOOP PULSE RATE?
NO
REPAIR SHORT, OR REPLACE C343 OR U323
YES
MEASURE WAVEFORM PERIODS AT U323–2 AND U323–23
C
C
IS f_{LOOP} GT f_{REF} ?
NO
PHASE DETEC
YES
MEASURE DC VOLTAGE AT U323–15
IS IT LT 3 V?
NO
YES
CHECK DIVIDER U322–11, 12, 13, 14, 23, 24, 26 FOR LOGIC SIGNALS
LIVE 0 TO 5 V PROGRAMMING?
NO
YES
REPLACE U322 OR CODE PLUG
START
SET UP STATION FOR TROUBLESHOOT. SEE PREREQUISITES.
TURN TUNING SCREW TO LOCK LIMITS (CW + CCW) MONITOR U323–15.
ARE VOLTAGE LIMITS LT 3 V AND GT 8 V?
NO
B
YES
CHECK PROGRAMMING AT U322
LIVE PROGRAMMING?
NO
YES
CHECK MODE SWITCHING ON DC REMOTE OR REPLACE CODE PLUG

SERIES TRANSMIT VCO

CIRCUIT BOARD DETAIL, BLOCK DIAGRAM, AND PARTS LISTS MODEL TTE1470A



LEGEND:
L = 403-435 MHz
M = 435-480 MHz
No Code = 403-480 MHz

parts list

IMPORTANT
The resonator cavity (Z26) is not repairable. If defective, the entire VCO assembly must be replaced.

CAUTION
Do NOT remove circuit board from VCO assembly. To do so will destroy proper VCO operation.

TLE5371A Transmit VCO Hardware Kit (403-435 MHz)
TLE5372A Transmit VCO Hardware Kit (435-480 MHz) PL-8140-D

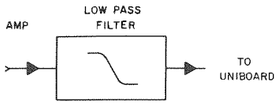
REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		feedthru plate assembly:
A26	1-80752D21	transmit VCO
		connector, receptacle:
J323	9-84135B02	phono, female
J324A, 324B	p/o A26	
		resonator cavity:
Z26	not-repairable	replace entire VCO
		non-referenced items
	2-83718N01	NUT, tension
	3-10932M09	SCREW, tapping: 3 x 0.6 x 6 mm; 5 used
	3-10943M16	SCREW, tapping: 3.5 x 0.6 x 10 mm; 4 used
	3-83100N05	SCREW, tuning (TLE5372A)
	3-83100N10	SCREW, tuning (TLE5271A)
	3-83677N02	SCREW, captive; 4-used
	4-84081N01	WASHER, shoulder; 3-used
	32-82796H02	GASKET, rf mesh
	41-83147N01	SPRING; 4 used
	42-83517N01	RETAINER, spring; 4-used
	15-83190N01	HOUSING; VCO resonator
	15-83191N01	CASTING; VCO resonator

TTE6111A Transmit VCO Board; L
TRE6112A Transmit VCO Board; M PL-8139-E

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ±5%; 50 V: unless otherwise stated
C26	21-11035B21	100
C27	21-11059B05	.01 uF; ±20%
C28	21-11035B21	100
C29	21-11035B12	39
C30	21-11035B21	100
C31L	21-11035B16	10
C31M	21-11035B29	7.5
C32 thru 37	21-11035B21	100
C38	21-11035B19	4.7 ± 0.25 pF
C39	21-11035B15	12
C40	21-11035B19	4.7 ± 0.25 pF
C41, 42	21-11035B21	100
C43	21-11078A21	4.7 ± 0.25 pF
C44	21-11031A01	1
		diode: (see note)
CR26	48-84616A01	silicon, hot carrier
CR27, 28	48-82190H60	silicon, varactor
CR29 thru 34	48-82190H59	silicon, varactor
		coil, rf: nH: unless otherwise stated
L26, 27, 28	24-82723H40	290
L29	24-82723H41	140
L30	24-82723H40	290
L31L	24-84331M03	5-turns
L31M	24-84331M26	8-turns
L32, 33, 34	24-82723H40	290
L35L	24-84331M03	5-turns
L35M	24-84331M04	4-turns
L36L	24-84331M03	5-turns
L36M, 37	24-84331M02	5-turns
L38 thru 41	24-82723H40	290
L42	24-82723H40	290
L43, 44L	76-83960B01	ferrite bead
		connector, plug:
P324B	9-83730M04	4-contact; female
		transistor: (see note)
Q26	48-869839	FET, N-channel; type M9839
Q27	48-84411L83	NPN; type M1183
		resistor, fixed: ±5% 1/8 W: unless otherwise stated
R26	6-11024A97	100k
R27	6-11024A29	150
R28	6-11024A73	10k
R29	6-11024A55	1.8k
R30L	6-11024A51	1.2k
R30M	6-11024A63	3.9k
R31	6-11024A59	2.7k
R32	6-11024A35	270
R33L	6-11041C67	1.2k
R33M, 34	6-11024A49	1k
R35L	6-11024A13	33
		thermistor:
RT26	6-82990E22	190 ohms @ 25C

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

TTE1471A TRANSMIT VCO (403-435 MHz)



BEPS-35610-O

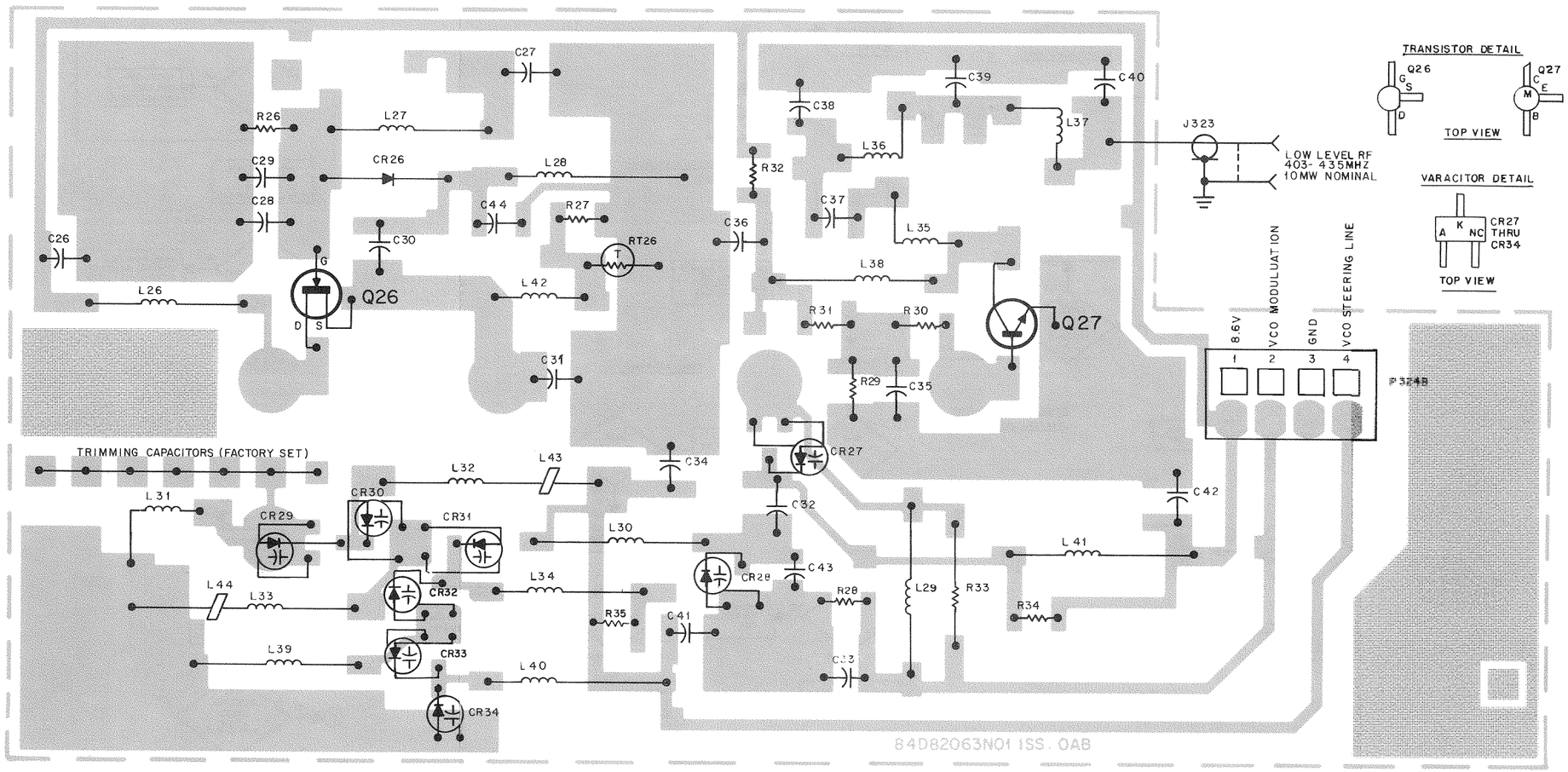
LEGEND:
L = 403-435 MHz
M = 435-480 MHz
No Code = 403-480 MHz

CAUTION
circuit board from VCO assembly. To do so will
CO operation.

oard; L
oard; M PL-8139-E

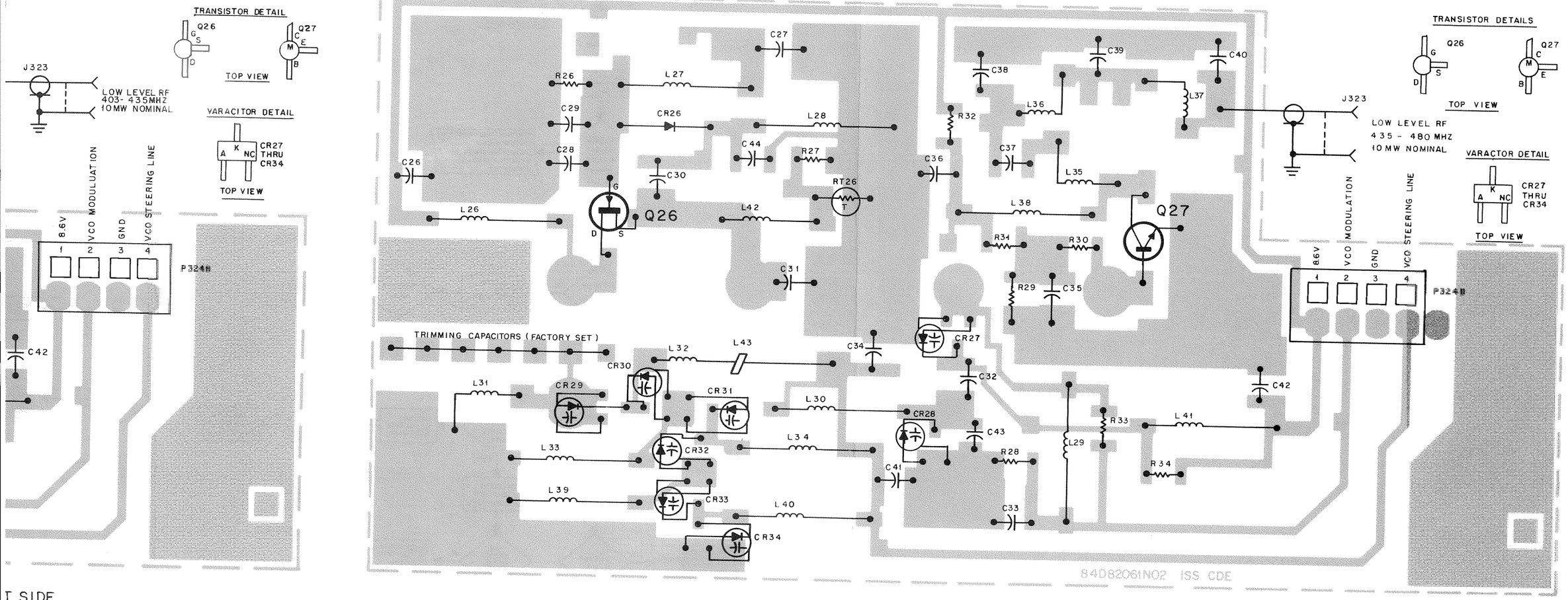
ORT NO.	DESCRIPTION
	capacitor, fixed: pF ±5%; 50 V: unless otherwise stated
35B21	100
59B05	.01 uF; ±20%
35B21	100
35B12	39
35B21	100
35B16	10
35B29	7.5
35B21	100
35B19	4.7 ± 0.25 pF
35B15	12
35B19	4.7 ± 0.25 pF
35B21	100
78A21	4.7 ± 0.25 pF
31A01	1
	diode: (see note)
16A01	silicon, hot carrier
90H60	silicon, varactor
90H59	silicon, varactor
	coil, rf: nH: unless otherwise stated
23H40	290
23H41	140
23H40	290
31M03	5-turns
31M26	8-turns
23H40	290
31M03	5-turns
31M04	4-turns
31M03	5-turns
31M02	5-turns
23H40	290
23H40	290
90B01	ferrite bead
	connector, plug:
0M04	4-contact; female
	transistor: (see note)
839	FET, N-channel; type M9839
1L83	NPN; type M1183
	resistor, fixed: ±5% 1/8 W: unless otherwise stated
A97	100k
A29	150
A73	10k
A55	1.8k
A51	1.2k
A63	3.9k
A59	2.7k
A35	270
C67	1.2k
A49	1k
A13	33
	thermistor:
E22	190 ohms @ 25C

ance, diodes, transistors, and integrated circuits must
numbers.



COMPONENT SIDE 8D-CEPS-40588-O
OL-CEPS-40590-O SHOWN FROM COMPONENT SIDE

TTE1472A TRANSMIT VCO (435-480 MHz)



T SIDE

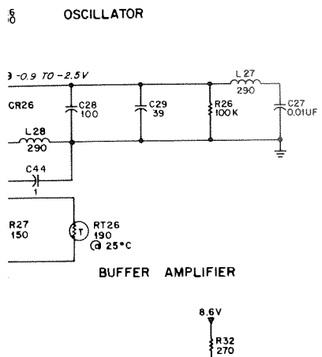
COMPONENT SIDE

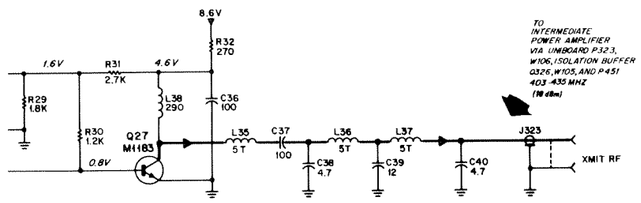
BD-CEPS-35200-A
OL-CEPS-35201- C

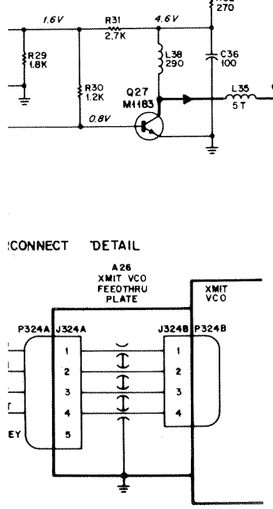
SHOWN FROM COMPONENT SIDE

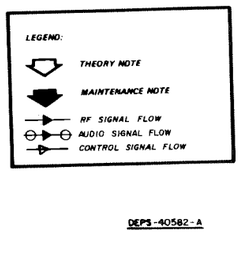
SERIES TRANSMIT VCO
SCHEMATIC DIAGRAMS
MODEL TTE1470A

TTE1472A TRANSMIT VCO (435-475 MHz)

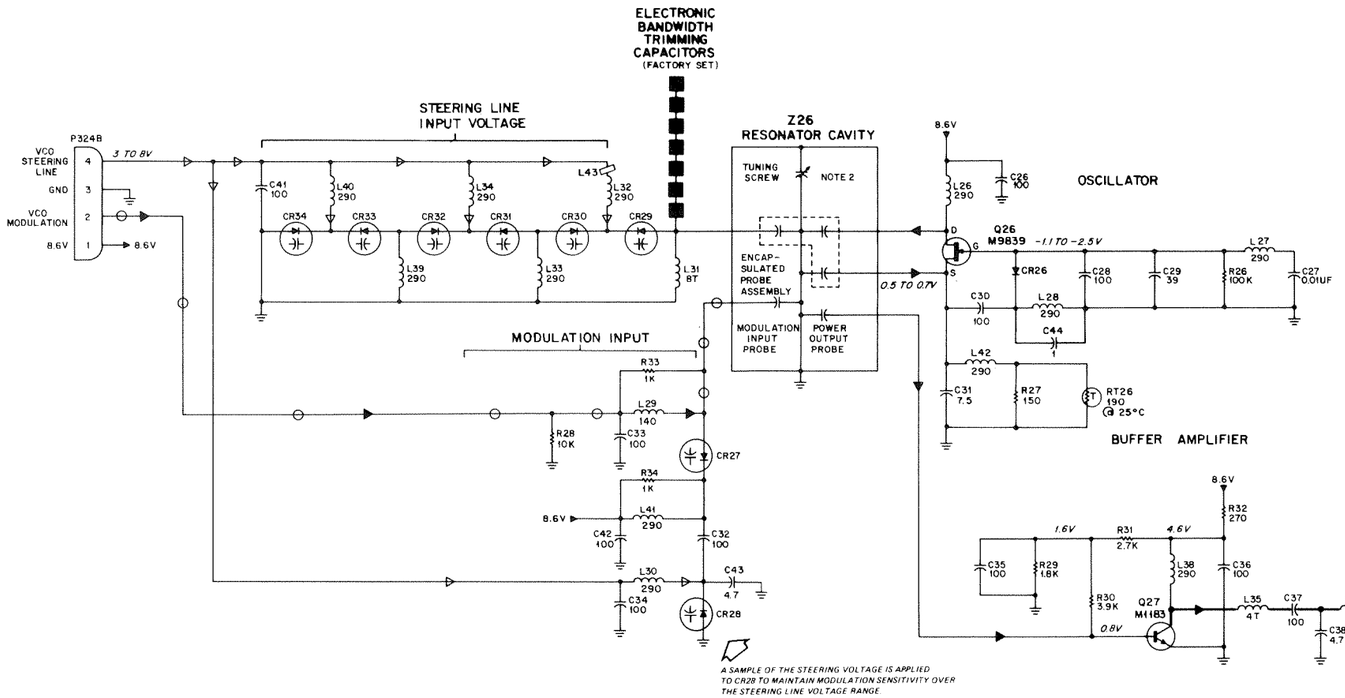








DEPS-40582-A

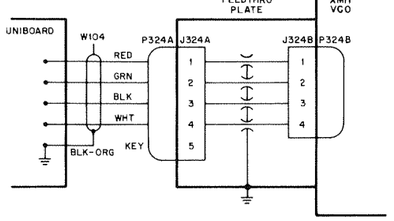


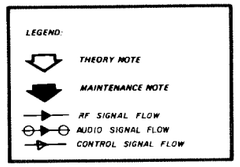
NOTES:

1. UNLESS OTHERWISE SPECIFIED, ALL RESISTOR VALUES ARE IN OHMS, ALL CAPACITORS IN PICOFARADS, AND ALL INDUCTORS IN NANOHENERIES.
2. THE TUNING SCREW IS FACTORY SET FOR THE PROPER RANGE OF FREQUENCIES.

TTE1472A MODEL BREAKDOWN CHART
TLE5372A TRANSMIT VCO HARDWARE KIT
TTE6112A TRANSMIT VCO BOARD

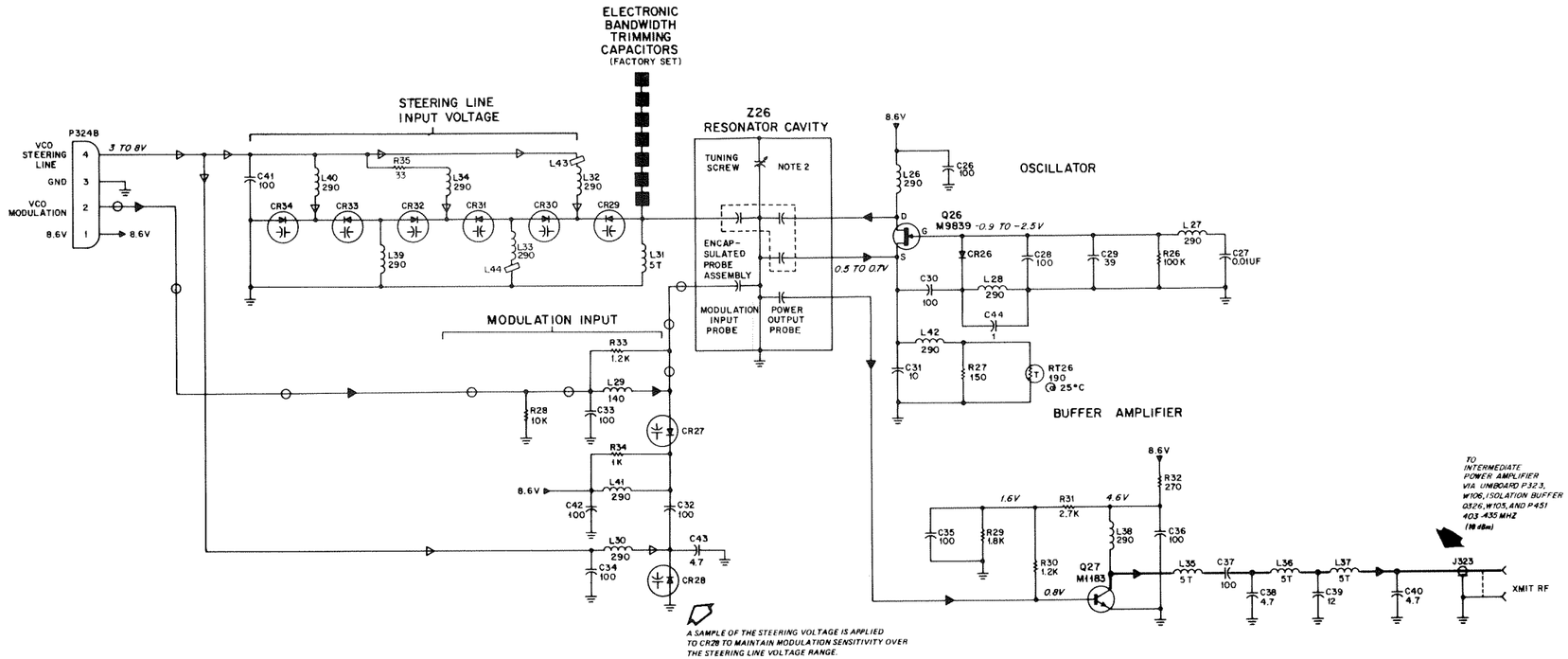
INTERCONNECT DETAIL





DEPS-35083-C

TTE1471A TRANSMIT VCO (403-435 MHz)



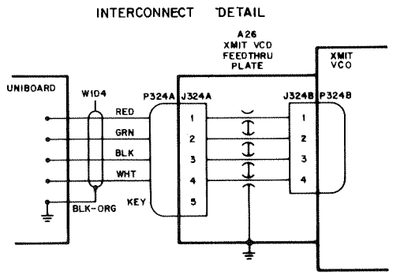
NOTES:

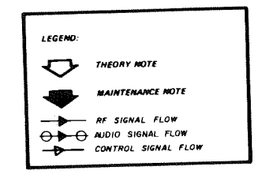
1. Unless otherwise specified, all resistor values are in ohms, all capacitors in picofards, and all inducators in nanohenries.
2. The tuning screw is factory set for the proper range of frequencies.

TTE1471A Model Breakdown Chart

TLE5371A TTE6111A	VCO Hardware Kit VCO Board

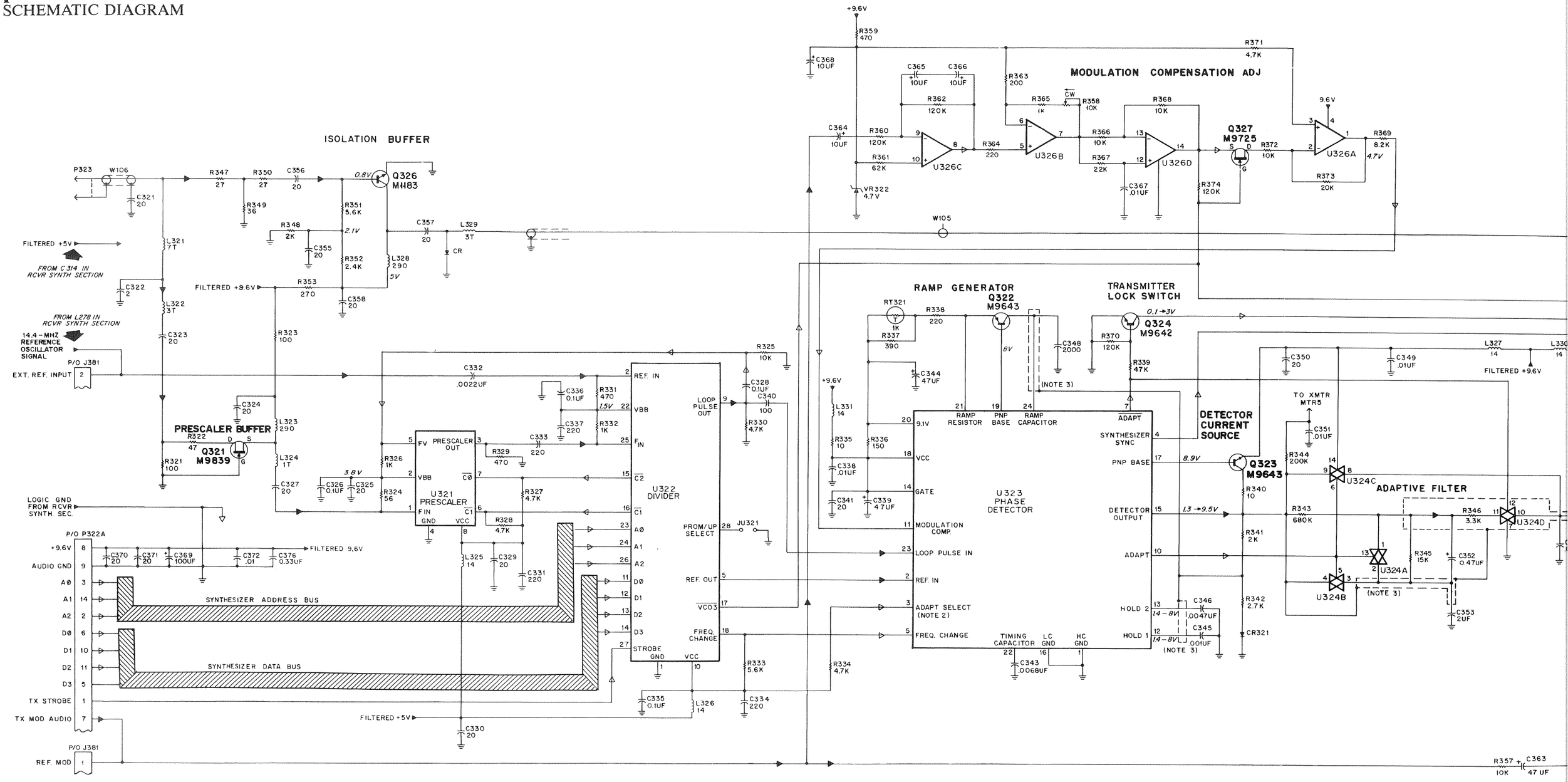
INTERCONNECT DETAIL



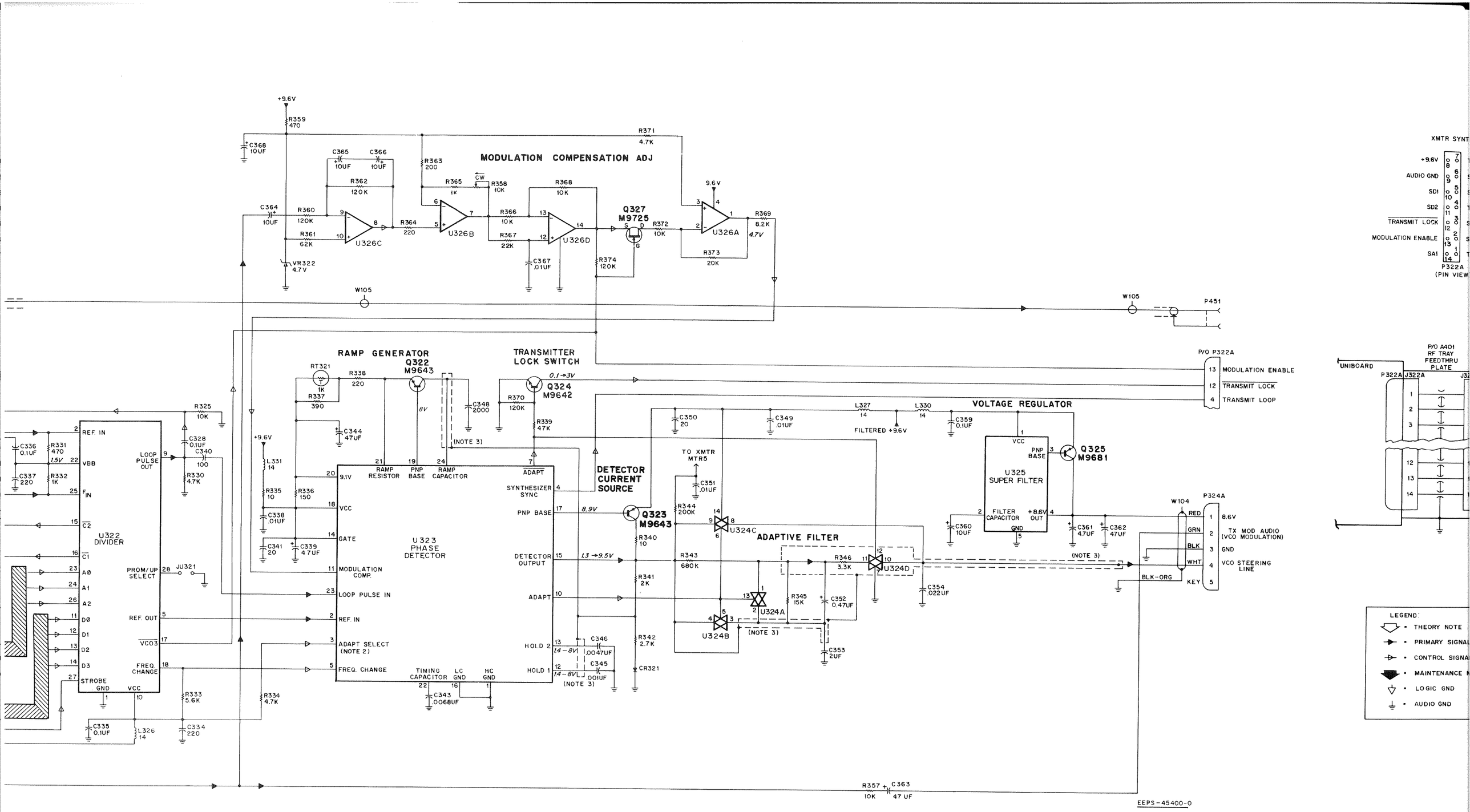


DEPS-40582-A

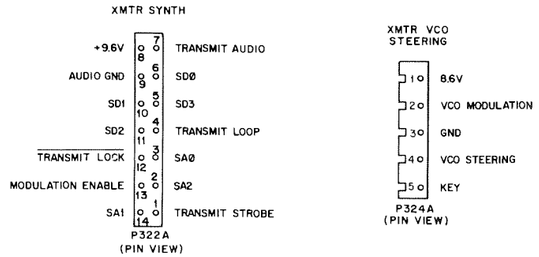
TRANSMIT SYNTHESIZER
p/o TRN9880A UNIBOARD
SCHEMATIC DIAGRAM



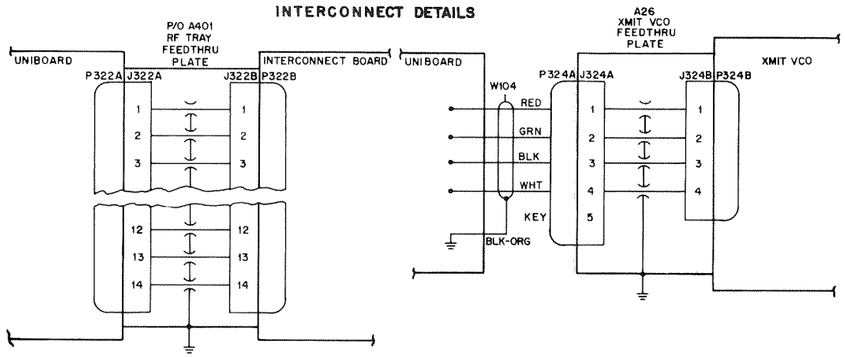
SEE RF TRAY SECTION FOR
CIRCUIT BOARD DETAIL AND PARTS LIST

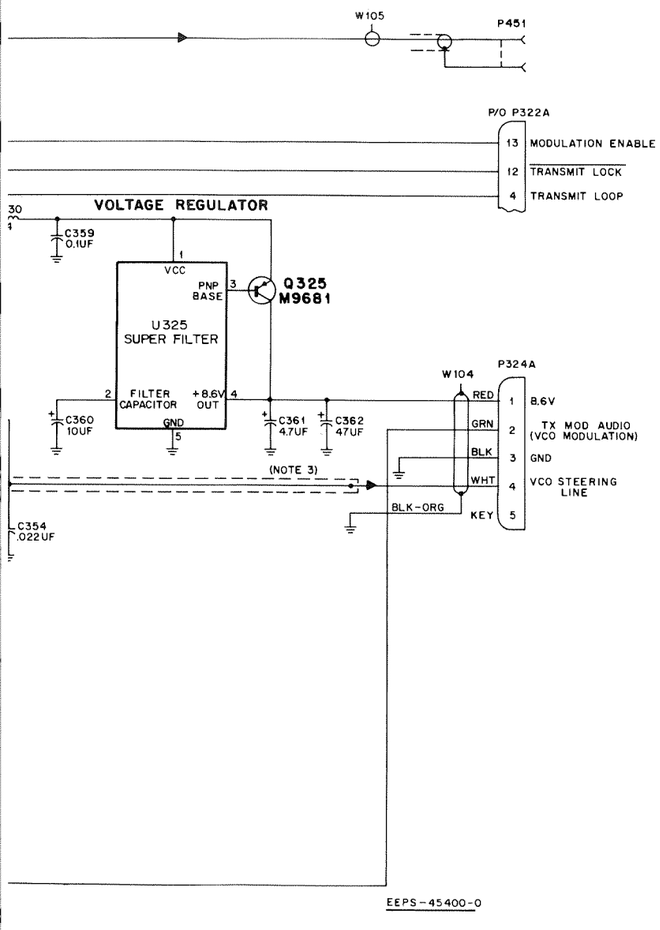

MODULATION COMPENSATION ADJ
RAMP GENERATOR
Q322 M9643
TRANSMITTER LOCK SWITCH
Q324 M9642
VOLTAGE REGULATOR
Q325 M9681
DETECTOR CURRENT SOURCE
Q323 M9643
Q327 M9725
ADAPTIVE FILTER
U322 DIVIDER
U323 PHASE DETECTOR
U325 SUPER FILTER
U326A
U326B
U326C
U326D
U324A
U324B
U324C
U324D
TO XMTR MTR5
FILTERED +9.6V
XMTR SYNT
P322A (PIN VIEW)
P/O P322A
MODULATION ENABLE
TRANSMIT LOCK
TRANSMIT LOOP
P/O A401 RF TRAY FEEDTHRU PLATE
UNIBOARD
P324A
8.6V
TX MOD AUDIO (VCO MODULATION)
GND
VCO STEERING LINE
LEGEND:
THEORY NOTE
PRIMARY SIGNAL
CONTROL SIGNA
MAINTENANCE
LOGIC GND
AUDIO GND
EEPS-45400-0

CONNECTOR DETAILS

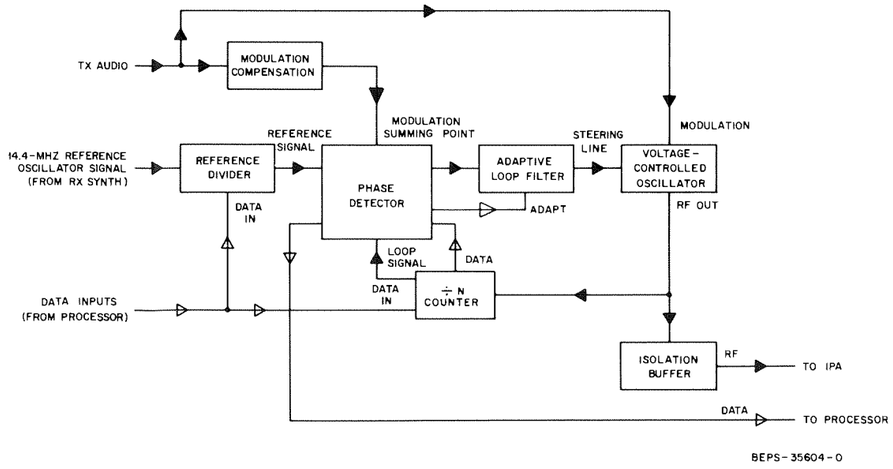


INTERCONNECT DETAILS





LEGEND:
- THEORY NOTE
- PRIMARY SIGNAL FLOW
- CONTROL SIGNAL
- MAINTENANCE NOTE
- LOGIC GND
- AUDIO GND



BEPS-35604-O

Notes:

1. Unless otherwise specified, all resistor values are in ohms, all capacitor values in picofarads, and all inductor values are in microhenries.
2. Long Adapt Signal Period (Slow Lock) is 12 ms.
3. Copper guard bands connected to phase detector U323 output circuit (denoted by dashed lines) surround pins 12, 13, and 24, as well as portions of adaptive filter U324 and the steering line

Ref. Desig.	+5 V (Pin)	+9.6 V (Pin)	Gnd (Pin)	IC Type Description
U321	8	—	4	Prescaler
U322	10		1	Divider
U323		18, 14	1,16	Phase Detector
U324		14	7	Analog Gate
U325		1	5	Super Filter
U326		4	11	Quad Op. Amplifier

INTERMEDIATE POWER AMPLIFIER (IPA) AND 9.6 V REGULATOR

TLE2230A SERIES

1. IPA THEORY OF OPERATION

1.1 The *MSF 5000* IPA consists of four cascaded amplifier stages. The four stages are incorporated onto a single ceramic substrate using micro-strip line design. The IPA input and output impedance is 50 ohms.

1.2 The rf output generated by the XMIT VCO (at least 10 mW), at the required transmit frequency, is applied to the first stage of the IPA (Q459), a class A amplifier with a fixed supply voltage, A+. The remaining three amplifiers operate with a variable control voltage. The power output from the IPA depends upon the level of control voltage. Therefore, the power output of the radio can be smoothly varied by changing the IPA control voltage. DC power for the IPA is routed from the uniboard through cable W701 to P452. The IPA module has a rated power output of 0 to 9 watts.

1.3 Since the transmit VCO operates whether the radio is in the transmit mode or receive mode, it is possible for rf energy at the transmit frequency to be conducted through the IPA to the antenna even when the radio is operating as a receiver. An IPA attenuation circuit reduces this undesirable signal to a very low level by turning the IPA "off" (saturating it) . That is, the attenuation circuit is composed of transistor switches Q453, Q454, and Q455. When in the receive mode, each of these transistors provides a direct current that forward biases the base-emitter junctions of each of the first three IPA amplifier stages. In this saturated condition very little rf energy can be conducted through the amplifiers. Therefore, the VCO transmit signal is effectively reduced during receiver operation. During transmit, the three attenuation transistors are switched off and the IPA amplifier stages operate normally.

2. 9.6 V REGULATOR THEORY OF OPERATION

The 9.6 volt output is obtained from a series regulator circuit on the IPA carrier circuit board (TRN5145A). The 9.6 volt regulator uses the A+ output from the ferroresonant power supply as a source voltage. A 9.6 volt sensing circuit regulates the amount of current that is allowed to pass through the series regulator, thus controlling the voltage across the load. Filtering of the 9.6 volt regulator's output is done on the uniboard.

3. MAINTENANCE

3.1 IPA REMOVAL

The *MSF 5000* IPA assembly can be removed as follows, after removal of the rf tray cover.

Step 1. Disconnect IPA input cable W105 rf connector P451.

Step 2. Disconnect IPA output cable W601 connector P453 from prefilter (p/o FL500 transmitter filtering option) or straight adapter CP451 (standard models). Remove cable restraint(s) holding the IPA output cable W601 to the station chassis.

Step 3. Disconnect IPA dc interconnect cable W701 connector P452.

Step 4. Loosen five captivated IPA mounting screws. The IPA assembly (hybrid + carrier board + heat sink) can now be lifted from the rf tray.

Step 5. Remove IPA assembly handle with a pair of needlenose pliers.

CAUTION
Do not stress the IPA hybrid when removing the IPA handle.

Step 6. Remove the nuts from the two stud-mounted transistors (Q461 and Q462) wiith a 1/4" nut driver.

Step 7. Carefully unsolder the two grounding straps and center conductor of IPA output cable W601.

Step 8. Carefully unsolder the four Omega straps connecting the IPA hybrid to the IPA carrier board.

CAUTION

Excessive heating during the unsoldering operation can cause the microstrip solder lugs to become loose.

Step 9. Carefully unsolder the seven wire jumpers from the solder lugs on the IPA hybrid.

Step 10. The IPA hybrid can now be lifted from the IPA printed-circuit board and replaced.

3.2 IPA REPLACEMENT

Use the following procedure to replace the IPA ceramic hybrid:

Step 1. All steps relating to the removal of the IPA can be reversed, with particular attention being paid to the following items:

- Wakefield Thermal Compound should be applied as required around the clearance holes in the IPA heat sink for the studded transistors.
- Follow the proper procedure for installing Omega straps, as described in the Maintenance section of this manual.
- Before placing the IPA assembly back into the rf tray, a coating of Wakefield Thermal Compound should be applied to the IPA mounting surface of the rf tray.

CAUTION

Application of a thick coating of thermal compound or the presence of foreign material on the mounting surface may cause poor thermal contact and may result in early transistor failure.

4. IPA TROUBLESHOOTING PROCEDURE

4.1 POWER OUTPUT

Refer to the IPA Troubleshooting Chart at the end of this section while performing these procedures. Also, refer to the Station Functional Block Diagram in the Description section of this manual.

Step 1. With station powered up, put station in transmit mode (set S802 to XMIT). Measure IPA power output. Power output should be at least 8 W.

Step 2. If power output is low or zero, check for IPA control voltage at the collectors of Q460, Q461, Q462, and A+ on the collector of Q459.

Step 3. If control voltage is at least 11 volts on all three controlled stages and A+ is available to Q459, check the VCO buffer amplifier gain (greater than 1 dB) and the VCO output (greater than 7 mW). If the buffer amp or VCO are operating incorrectly, then refer to the Synthesizer Troubleshooting Charts in this manual.

Step 4. If the control voltage is below 11 volts, check Q451 for an open circuit. If Q451 is defective, replace it.

Step 5. Check the IPA attenuation circuit, as follows:

Step 6. If all voltage levels on the amplifier and attenuation circuit are within limits, replace IPA. See IPA removal procedure.

4.2 ATTENUATION CIRCUIT

The attenuation circuit can be tested in either the receive mode or the transmit mode. The following steps are applicable to both modes, but with information relating to the transmit mode in parentheses; e.g. (transmit).

Step 1. Make sure station is in the receive (transmit) mode.

Step 2. Measure the voltage at the collector of Q455. Measure the voltage at the emitter of Q453 and Q454. These voltages should be at least 11 volts (approximately 0 volts).

Step 3. If Q455 is less than 11 volts (approximately 0 volts), check P452-2. It should be approximately 0 volts (A+). If P452-2 voltage is OK, replace Q455. If voltage is incorrect, check the power control troubleshooting guide.

Step 4. If Q453 or Q454 is less than 11 volts (approximately 0 volts), check the collector of Q452. It should be A+ volts (approximately 0 volts). If not, replace Q452. If Q452 is at A+ (approximately 0 volts), replace either Q453 or Q454 as required.

5. 9.6 V REGULATOR TROUBLESHOOTING PROCEDURE

Step 1. Check that A+ is available at the emitter of Q456.

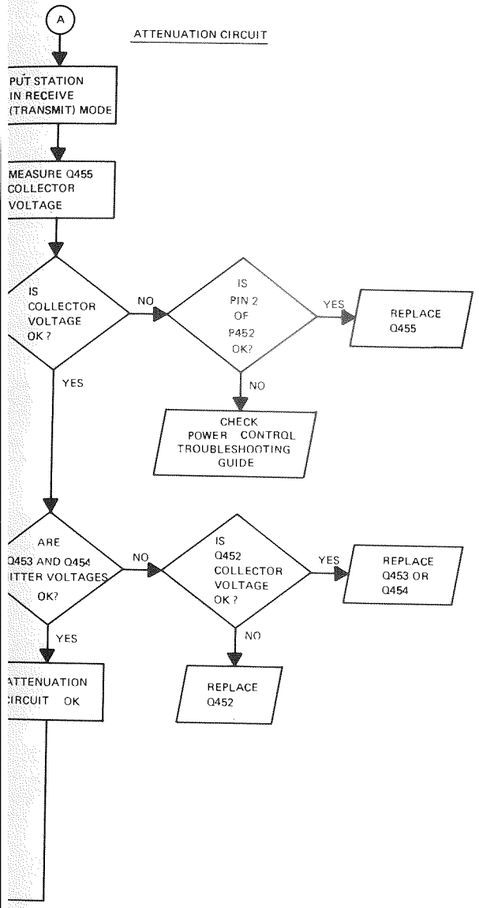
Step 2. Check that the regulator output is not shorted. Regulator output is shorted if CR453 is forward biased. If the regulator is shorted, investigate and repair.

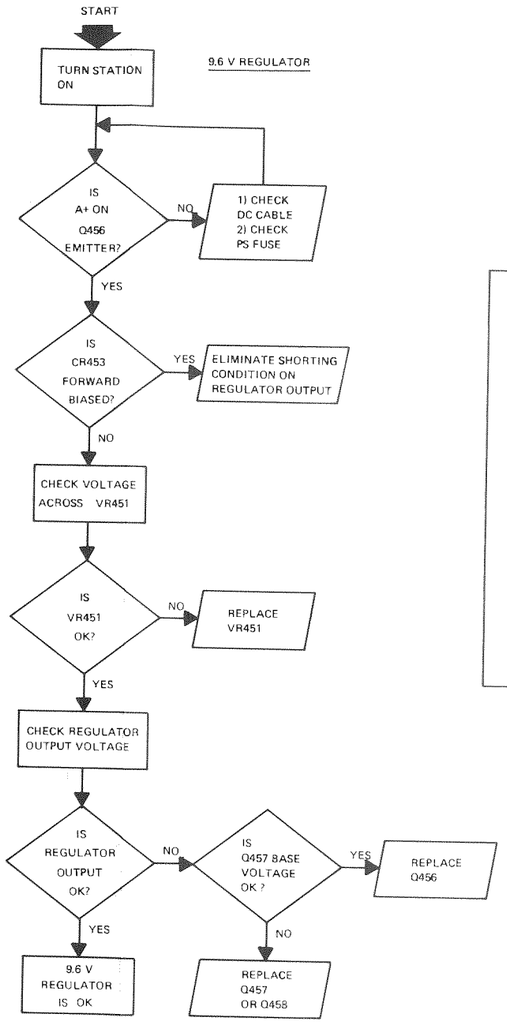
Step 3. Check the voltage across VR451. If regulator output is above 9 volts, the voltage across VR451 should be approximately 8.2 volts. If regulator voltage is below 9 volts, the regulator output and diode voltage should be identical. If not, replace VR451.

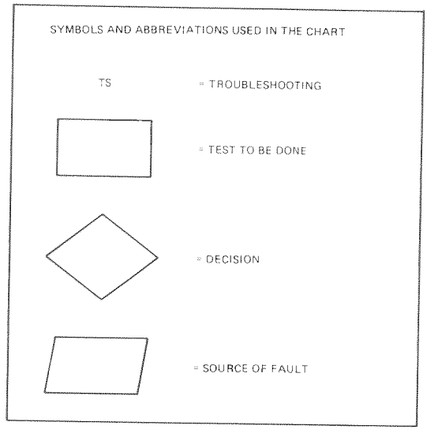
Step 4. If the voltage is above 10.5 volts, check the voltage on the base of Q457. It should be under 4 volts. If it is under 4 volts, replace Q456. If it is under 4 volts, replace Q456. If it above 4 volts, replace Q458 or Q457.

Step 5. If the output voltage is too low (less than 8.5 volts), check the voltage on base of Q457. It should be above 4 volts. If it is above 4 volts, replace Q458 or Q457.

IPA AND 9.6 V REGULATOR
TROUBLESHOOTING CHART







TROUBLESHOOTING PREREQUISITES

STEP 1. INSTALL STATION CONTROL BOARD SERVICE JUMPER (JU1) ONTO ITS SERVICE INSTALLATION POSITION.

IMPORTANT
WHEN TROUBLESHOOTING IS COMPLETED, RETURN JU1 TO ITS ORIGINAL POSITION.

STEP 2. DISCONNECT THE IPA OUTPUT CABLE (W601) BY UNSCREWING P453 FROM THE STRAIGHT ADAPTER CP451.

STEP 3. CONNECT W601 (VIA P453) TO A WATTMETER TERMINATED IN A 50-OHM LOAD. BE SURE THE WATTMETER AND LOAD ARE RATED FOR USE AT UHF.

DEPS-35642-O

MODEL COMPLEMENT

MODEL	DESCRIPTION
p/o TUE1761A	RF Tray; 403-435 MHz
p/o TUE1762A	RF Tray; 435-475 MHz
p/o TUE1901A	RF Tray (T/R = 3-20 MHz); 403-435 MHz

LEGEND:
X = one item supplied

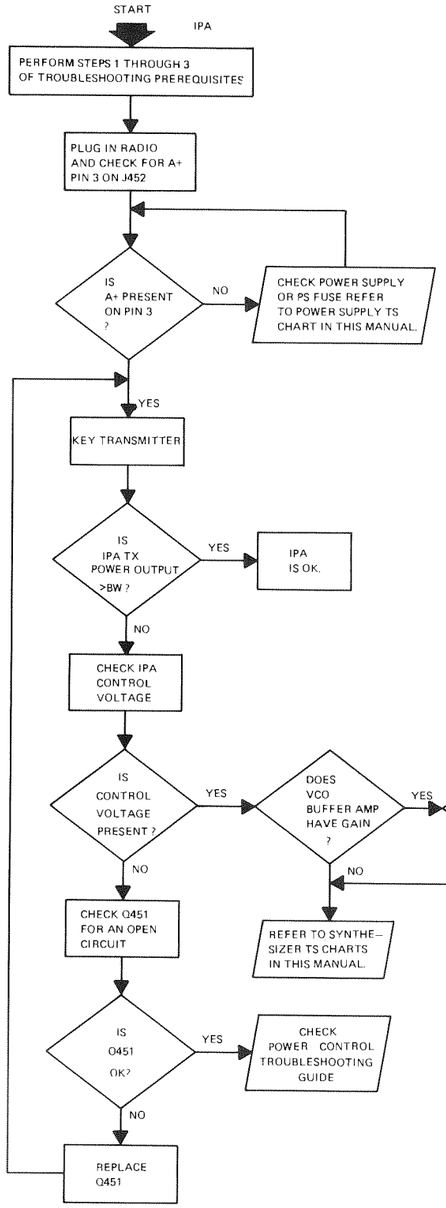
			KIT	DESCRIPTION
X		X	TFE6481A	Injection/Image Filters; 403-435 MHz
	X		TFE6482A	Injection/Image Filters; 435-475 MHz
X		X	TLE5321A	Injection/Amplifier Board; 403-435 MHz
	X		TLE5322A	Injection/Amplifier Board; 435-475 MHz
X			TLE5391A	Preselector; 403-435 MHz
	X		TLE5392A	Preselector; 435-475 MHz
X			TLE5401A	Front End; 403-435 MHz
	X		TLE5402A/B	Front End; 435-475 MHz
		X	TLE5701A	Front End (T/R = 3-20 MHz); 403-435 MHz
		X	TLE5711A	Preselector (T/R = 3-20 MHz); 403-435 MHz

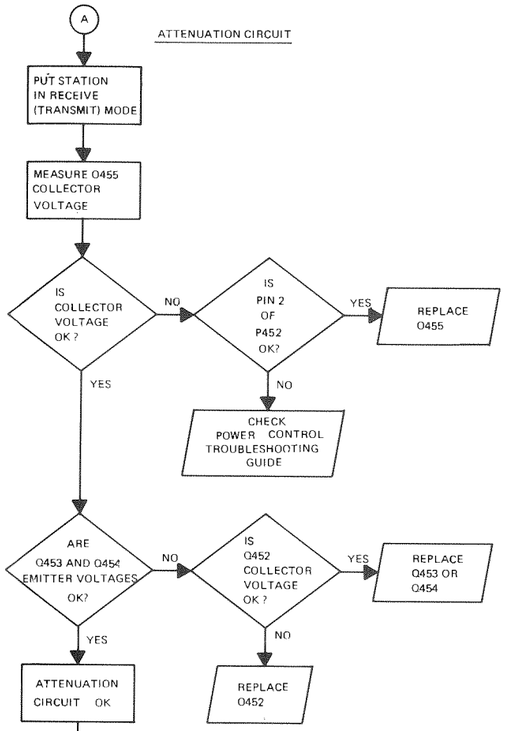
MODEL COMPLEMENT BREAKDOWN

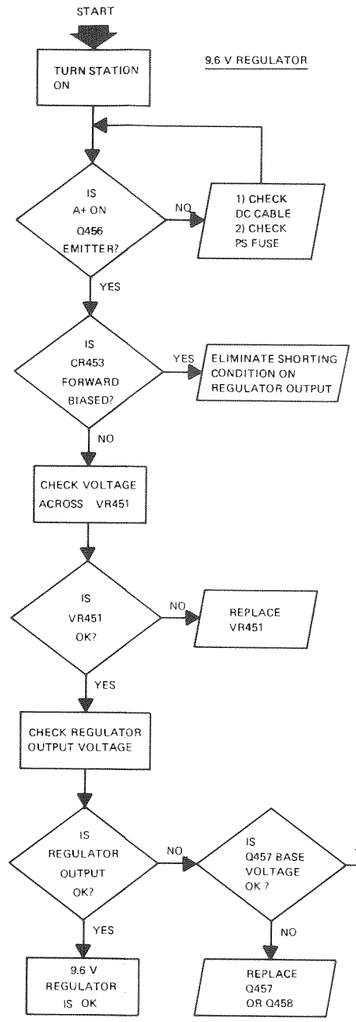
MODEL	DESCRIPTION
TLE2231A	Intermediate Power Amplifier; 403-435 MHz
TLE2232A	Intermediate Power Amplifier; 435-475 MHz

LEGEND:
X = one item supplied

		KIT	DESCRIPTION
X	X	TKN8843A	IPA Output Cable Kit
X		TLE5331A	IPA Hybrid Circuit Kit (403-435 MHz)
	X	TLE5332A	IPA Hybrid Circuit Kit (435-475 MHz)
	X	TRN5145A	IPA Carrier Board Kit (435-475 MHz)
X	X	TRN5146A	IPA Hardware Kit
X		TRN9667A	IPA Carrier Board Kit (435-475 MHz)







SYMBOLS AND ABBREVIATIONS USED IN THE

TS = TROUBLESHOOT

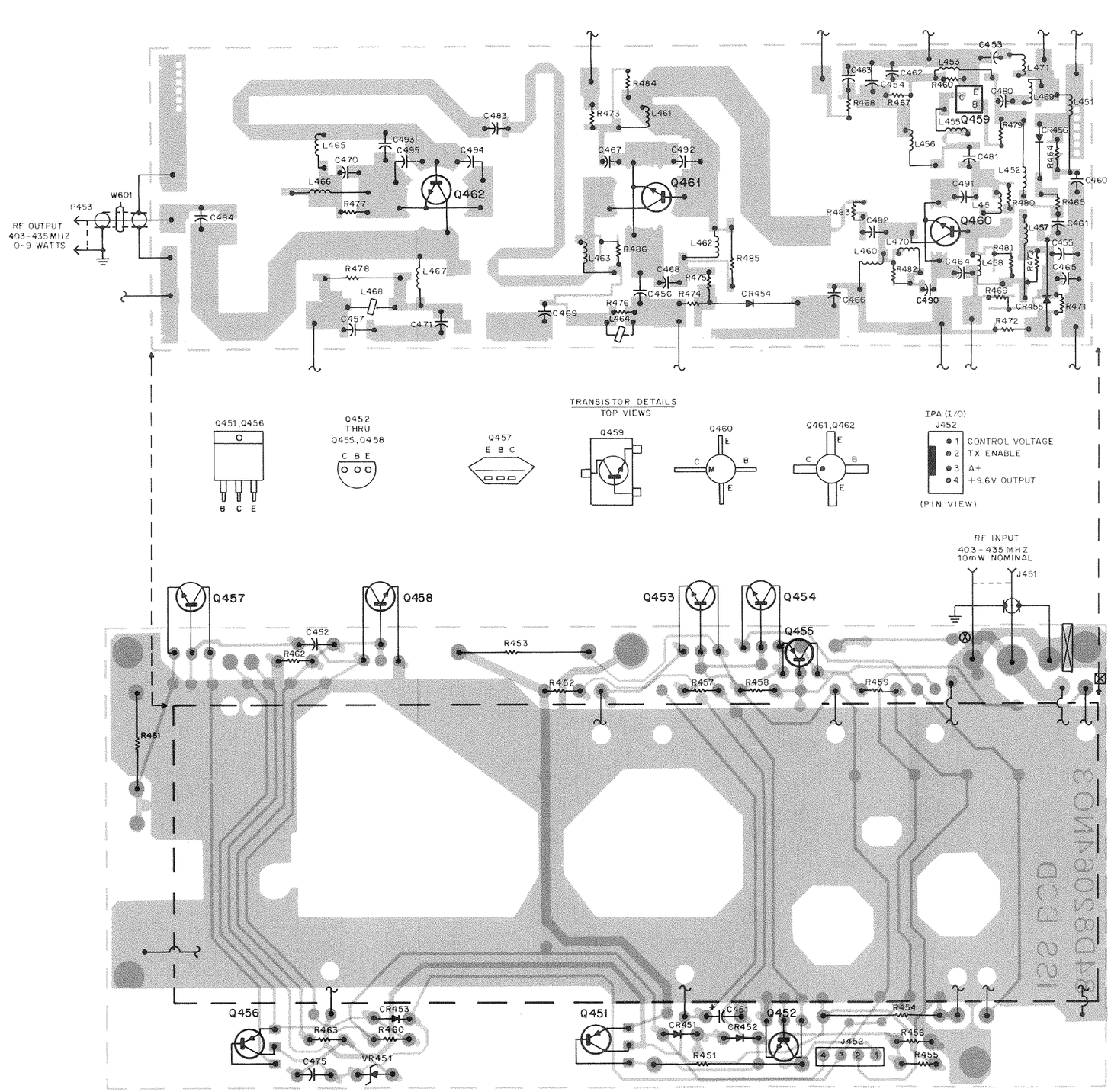
= TEST TO BE DON

= DECISION

= SOURCE OF FAU

IPA AND 9.6 V REGULATOR (403-435 MHz)

CIRCUIT BOARD DETAIL AND PARTS LISTS



parts list

Field repair of these
replaced in their en
erence purposes or

TRN5145A IPA Carrier Board
TRN9667A IPA Carrier Board

REFERENCE NUMBER	MOTO PART
C451	23-84538
C452	8-11017B
C453 thru 473	not p/o k
C474M	21-85129
C475	21-11014
CR451,452	48-82466
CR453	48-11034
CR454	not p/o k
CR455M	48-11034
CR456M	48-83654
J452	28-83143
J451	9-84231B
Q451	48-86980
Q452,453,454	48-86964
Q455	48-86964
Q456	48-86980
Q457	48-86964
Q458	48-86964
R451	17-82291
R452	6-11009E
R453L	17-82036
R453M	17-82291
R454L	6-11045A
R454M	17-82291
R455	6-11009E
R456	6-11009E
R457	6-11009E
R458	6-11009E
R459,460	6-11009E
R461	6-126C29
R462,463	6-10621A
R464M	6-11009E
VR451	48-83461

TRN5146A IPA Hardware Kit

REFERENCE NUMBER	MOTO PART
	2-7007
	2-8364
	3-83677N
	3-83678N
	4-7691
	4-82345A
	10-10043
	14-83820
	42-83680
	54-84697
	55-83679
	64-83132
	75-10605

TKN8842A IPA Feedthru Cabl

REFERENCE NUMBER	MOTO PART
P452	15-83142
P454B	15-84301
	39-82717
	42-10217

TKN8843A Coaxial Cable wit

REFERENCE NUMBER	MOTO PART
P453	28-8447
	30-8417
	33-8808
	43-8315

parts list

LEGEND:
L = 403-435 MHz
M = 435-475 MHz
No Code = 403-475 MHz

IMPORTANT
Field repair of these kits is not recommended. They should be replaced in their entirety. The following parts are listed for reference purposes only.

TRN5145A IPA Carrier Board Kit; M
TRN9667A IPA Carrier Board Kit; L — PL-8132-C

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C451	23-84538G23	15 uF ±20%; 20 V
C452	8-11017B11	.022 uF ±5%; 50 V
C453 thru 473	not p/o kits	
C474M	21-851299	600 pF ±10%; 600 V
C475	21-11014H32	20 pF ±5%; 100 V
		diode: (see note)
CR451,452	48-82466H18	silicon
CR453	48-11034D01	silicon
CR454	not p/o kits	
CR455M	48-11034D01	silicon
CR456M	48-83654H01	silicon
		connector:
J452	28-83143M05	male, 4 contact
J451	9-84231B02	female, single contact
		transistor: (see note)
Q451	48-869807	PNP; type M9807
Q452,453,454	48-869642	NPN; type M9642
Q455	48-869643	PNP; type M9643
Q456	48-869807	PNP; type M9807
Q457	48-869640	NPN; type M9640
Q458	48-869642	NPN; type M9642
		resistor, fixed; ±5% 1/4 W: unless otherwise stated
R451	17-82291B21	100; 3 W
R452	6-11009E41	470
R453L	17-82036G24	0.13 ±5%; 2 W
R453M	17-82291B29	0.20 ±1%; 2 W
R454L	6-11045A12	30; 1/2 W
R454M	17-82291B43	82 ±10%; 3 W
R455	6-11009E57	2.2k
R456	6-11009E65	4.7k
R457	6-11009E57	2.2k
R458	6-11009E73	10k
R459,460	6-11009E57	2.2k
R461	6-126C29	150 ±10%; 1 W
R462,463	6-10621A60	41.2 ±1%; 1/8 W
R464M	6-11009E49	1k
		voltage, regulator:
VR451	48-83461E32	Zener; 8.2 V

TRN5146A IPA Hardware Kit — PL-8131-C

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		non-referenced items
	2-7007	NUT, hex 8-32 x 1/4 x 3/32"; 2-used
	2-8364	NUT, hex 3/8-32 x 1/2 x 3/32"
	3-83677N02	SCREW, captive; 5-used
	3-83678N03	SCREW, tapping, 2-used
	4-7691	WASHER, lock; 3/8"; internal
	4-82345A18	WASHER, shoulder; 2-used
	10-10043A02	STRAP, tie-wrap; 6-used
	14-83820M02	INSULATOR, thermoconductive; 2-used
	42-83680N04	STRAP, omega; 4 used
	54-84697B01	LABEL
	55-83679N01	HANDLE
	64-83132N01	PLATE, heatsink
	75-10605A04	CUSHION, plastic foam; 12"-used

TKN8842A IPA Feedthru Cable — PL-8251-A

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		connector, receptacle:
P452	15-83142M05	housing, 4-position
P454B	15-84301K02	housing, 4-position
		non-referenced items
	39-82717M01	CONTACT, receptacle; 8-used
	42-10217A02	STRAP, tie-wrap;, 2-used

TKN8843A Coaxial Cable with Connector — PL-8277-A

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		connector, plug:
P453	28-84476G01	male, single contact
		non-referenced items
	30-84173E01	CABLE, coaxial; double shield; 36"-used
	33-88083C06	DECAL, color strip; BLU
	43-83152N02	BUSHING, cable

LEGEND:
L = 403-435 MHz
M = 435-475 MHz
No Code = 403-475 MHz

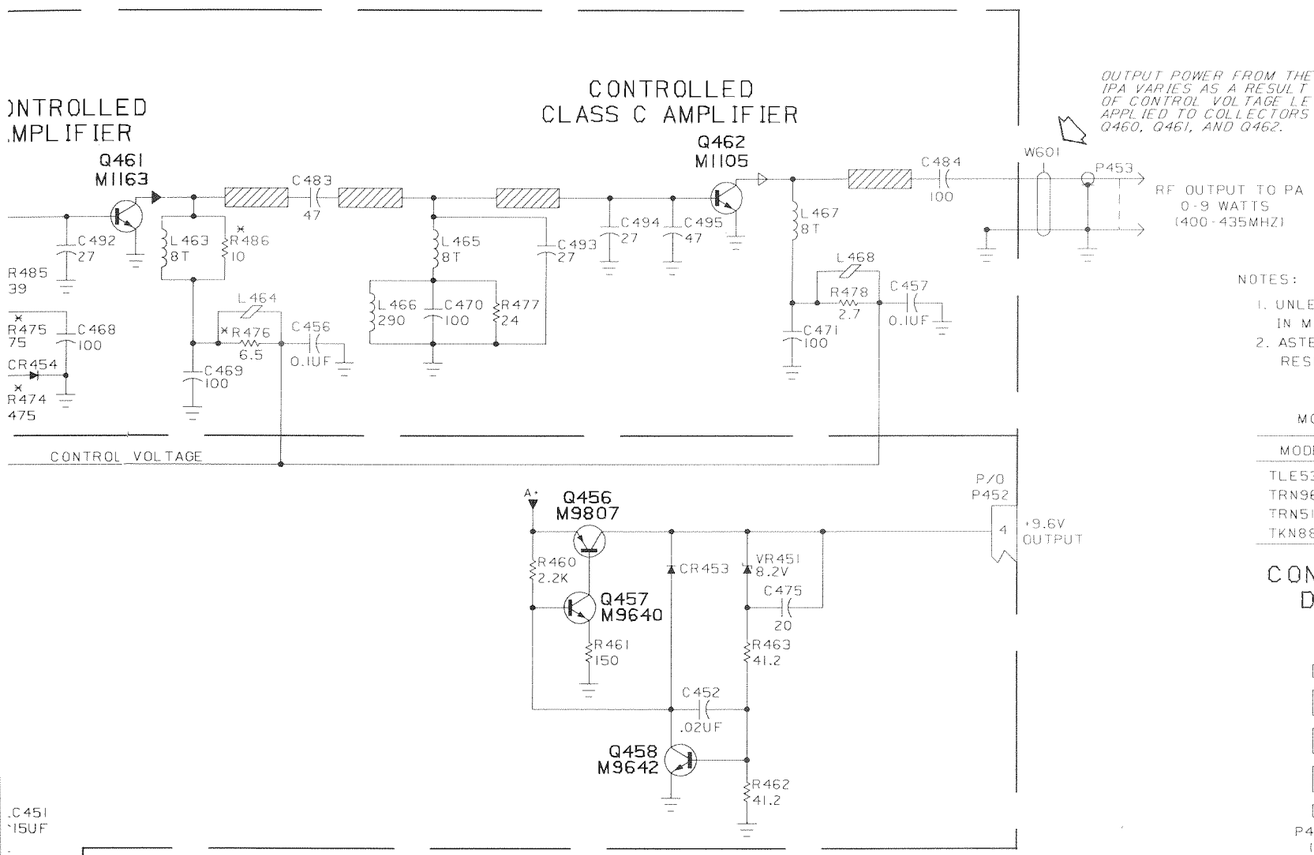
IMPORTANT
Field repair of these kits is not recommended. They should be replaced in their entirety. The following parts are listed for reference purposes only.

TLE5331A IPA Hybrid Circuit; L
TLE5332A IPA Hybrid Circuit; M — PL-8130-C

REFERENCE NUMBER	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ±5% 50 V: unless otherwise stated
C453L	21-11059D59	100
C453M,454,455L	21-11059B13	0.1 uF ±10%
C456,457,458M	21-11059B13	0.1 uF ±10%
C459M	21-11059D60	2.7 ± 0.25 pF
C460 thru 470	21-11059D59	100
C471L	21-11059D59	100
C471M	21-11078827	30
C472M,473M	21-11078B34	47
C474 thru 479	not p/o kits	
C480L	21-11059D59	100
C481L,482L	21-11059C21	100
C483L	21-11078B34	47
C484L	21-11059C21	100
C485 thru 489	not p/o kits	
C490L	21-11059D59	100
C491L	21-11078B19	16
C492L,493L,494L	21-11078B25	27
C495L	21-11078B34	47
		diode: (see note)
CR454,455L	48-82392B05	silicon
CR456L	48-83654H01	silicon
		coil, rf:
L451L	24-82723H40	290 nH; YEL-BLK
L451M	1-80702T04	assembly, wire and bead includes:
	76-83960B01	BEAD, ferrite
L452L	24-82723H40	290 nH; YEL-BLK
L452M	24-80202B01	assembly; choke; 3-turns and bead
L453L	24-82723H40	290 nH; YEL-BLK
L454	not p/o kits	
L455L	24-83035N27	8-turns
L456L	24-84331M25	8-turns
L457L	24-82723H40	290 nH; YEL-BLK
L458L	24-84331M25	8-turns
L459L	24-83035N12	3-turns
L460Lthru 463L	24-84331M25	8-turns
L464L	1-80702T04	assembly, wire and bead includes:
	76-83960B01	BEAD, ferrite
L465L	24-84331M25	8-turns
L466L	24-82723H40	290 nH; YEL-BLK
L467L	24-84331M25	8-turns
L468M	1-80702T04	assembly, wire and bead includes:
	76-83960B01	BEAD, ferrite
L469L	24-83035N12	3-turns
L470L	24-83035N27	8-turns
L471L	24-83035N09	7-turns
		transistor: (see note)
Q459	48-84939C31	NPN; type M3931
Q460	48-84411L37	NPN; type M1137
Q461	48-84411L63	NPN; type M1163
Q462	48-84411L05	NPN; type M1105
		resistor, fixed: ohms ±5%; 1/4 W: unless otherwise stated
R464L	screened	nominal value on schematic
R465 thru 470	screened	nominal values on schematic
R471L	screened	nominal value on schematic
R471M	6-124B57	3.3
R472	screened	nominal value on schematic
R473L	6-11024A37	330; 1/8 W
R473M	screened	nominal value on schematic
R474,475,476	screened	nominal values on schematic
R477L	6-11024A10	24; 1/8 W
R477M	screened	nominal value on schematic
R478L	6-83070E56	2.7
R478M	screened	nominal value on schematic
R479L	screened	nominal value on schematic
R479M	6-11009C25	1k
R480L	screened	nominal value on schematic
R480m	6-124B57	3.3
R481L thru 484L	screened	nominal values on schematic
R485L	6-11041C31	39; 1/8 W
R486L	screened	nominal value on schematic
		non-referenced items
	29-83208M01	LUG, solder; 7-used
	42-83680N03	STRAP, omega; 4-used

note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

IPA AND 9.6 V REGULATOR (403-435 MHz)
SCHEMATIC DIAGRAM



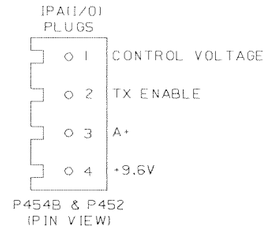
NOTES:

1. UNLESS STATED OTHERWISE, ALL CAPACITORS ARE IN MICROFARADS AND ALL RESISTORS ARE IN OHMS.
2. ASTERISK (*) INDICATES THICK FILM RESISTOR, NOMINAL VALUE SHOWN.

MODEL COMPLEMENT

MODEL	DESCRIPTION
TLE5331A	HYBRID CIRCUIT
TRN9667A	CARRIER BOARD
TRN5146A	HARDWARE KIT
TKN8843A	OUTPUT CABLE

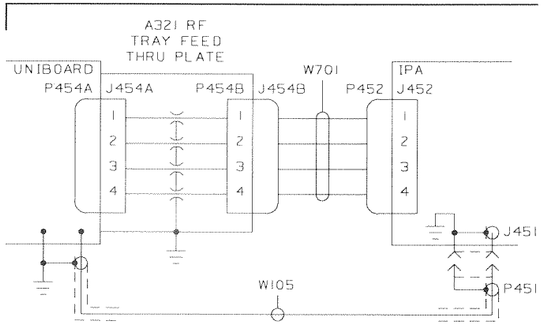
CONNECTOR DETAIL

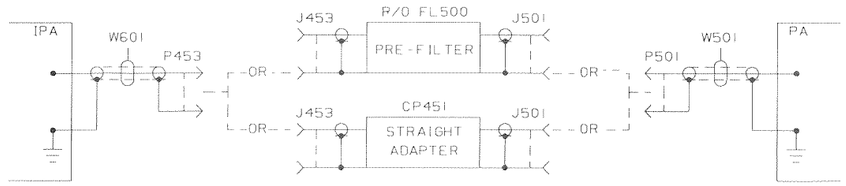


LEGEND:

- THEORY NOTE
- MICRO STRIPLINE
- RF SIGNAL FLOW
- CONTROL SIGNAL FLOW

INTERCONNECT DETAILS





EEPS-40757-A

NON CONTROLLED
CLASS A AMPLIFIER

CONTROLLED
AMPLIFIER

CONTROLLED
AMPLIFIER

CONTROLLED
CLASS C AMPLIFIER

RF INPUT
FROM VCO
10MW WATTS
NOMINAL

J451

Q459
M3931

Q460
M1137

Q461
M1163

Q462
M1105

L471 7T
L451 290
L469 3T
C480 100
L452 290
R479 39
L453 290
L455 8T
C481 100
L456 8T
R480 39
L459 3T
C491 16
R481 10
L458 8T
R483 10
C482 100
L460 8T
L470 8T
R482 220
C490 100
L461 8T
R484 39
C467 100
L462 8T
R485 39
R473 330
C492 27
L463 8T
R486 10
C483 47
L465 8T
C493 27
C494 27
C495 47
L467 8T
L468
R478 2.7
C471 100
L466 290
C470 100
R477 24
L464
R476 6.5
C456 0.1UF
C469 100
C453 100
C460 100
R464 1K
C461 100
R465 450
R466 180
R467 390
C462 100
C454 0.1
C463 100
R468 240
CR456
R470 27
L457 290
R469 450
C465 100
C455 0.1
R471 75
C464 100
R472 475
CR455
C466 100
R454 30
CR454
R474 475
R475 75
C468 100
CONTROL VOLTAGE

TLE5331A
SUBSTRATE

WHEN NOT IN THE TRANSMIT CONDITION Q453, Q454, AND Q455 ARE TURNED ON TO SUPPLY ADDITIONAL BASE CURRENT TO Q461, Q460, AND Q459, RESPECTIVELY. UNDER THIS CONDITION Q461, Q460, AND Q459 ARE SATURATED, FUTHER REDUCING ANY LOW LEVEL TRANSMIT VCO ENERGY FED THROUGH THE IPA.

Q453
M9642

Q454
M9642

R457
2.2K

Q452
M9642

ATTENUATOR
DRIVER

Q451
M9807

R455
2.2K

R456
4.7K

CONTROL VOLTAGE
SERIES PASS

C451
150UF

TRANSMIT
ENABLE SWITCH

P/O
J452

TX ENABLE 2
A+ 3
CONTROL VOLTAGE 1

R459
2.2K

Q455
M9643

R458
10K

R453
0.13

R452
470

CR451
CR452

R451
100

TRN9667A
CARRIER BOARD

A+

Q456
M9807

R460
2.2K

Q457
M9640

R461
150

CR453

VR451
8.2V

C475
20

R463
41.2

C452
.02UF

Q458
M9642

R462
41.2

INTERCONNECT D

A321 RF
TRAY FEED
THRU PLATE

UNIBOARD
P454A
J454A
P454B
J454B
W701
P452
IPA
J452

1
2
3
4

J451

P451

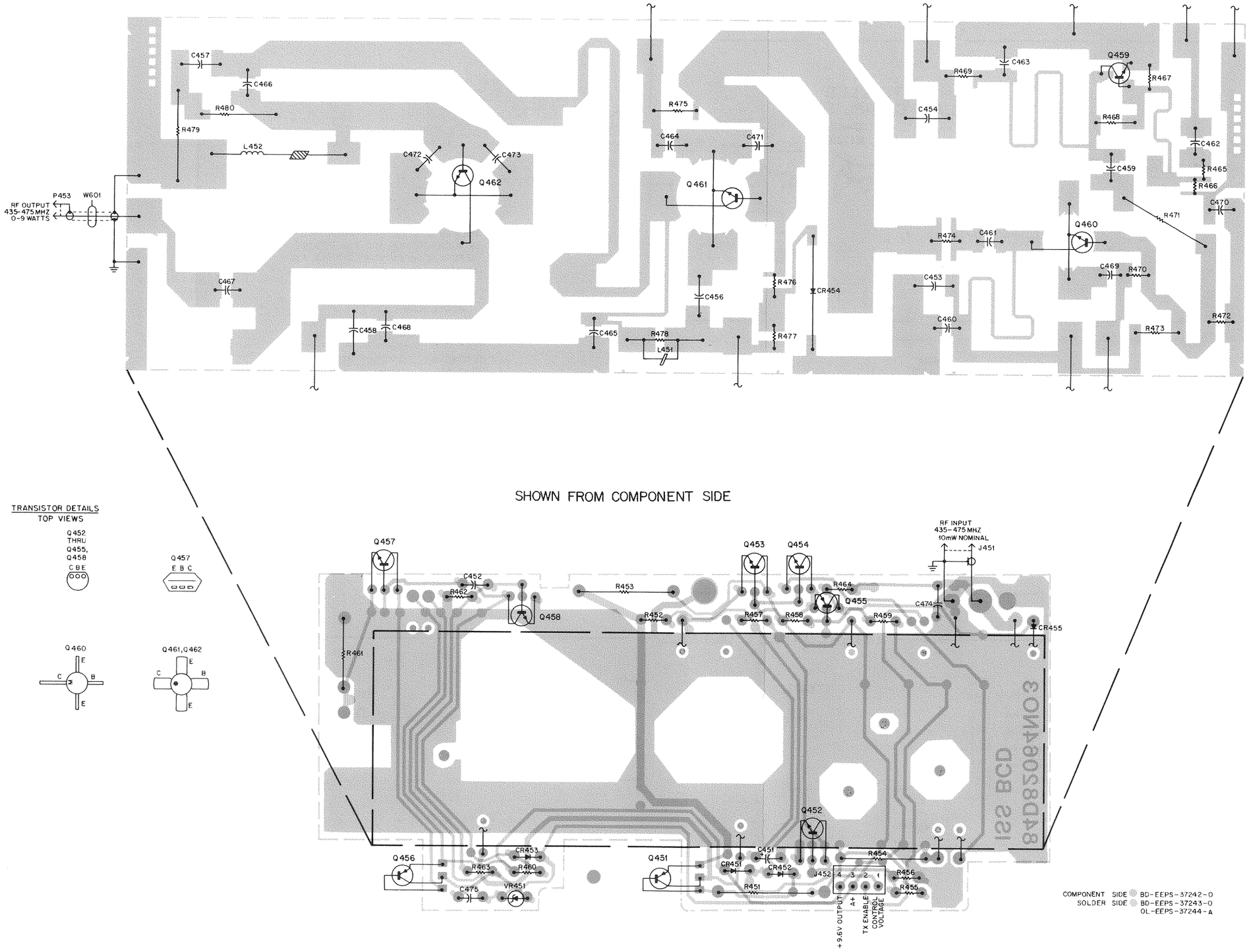
W105

IPA

W601

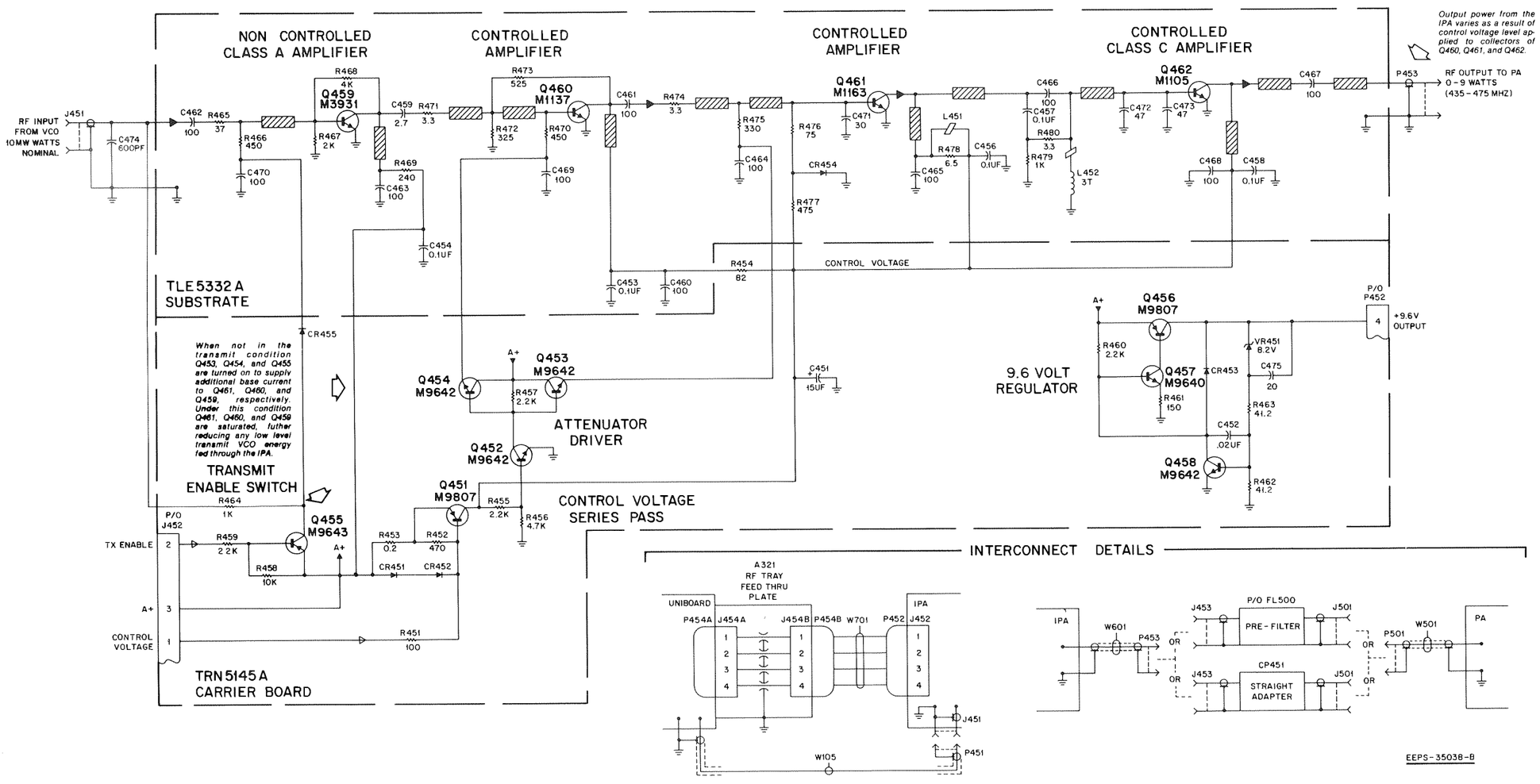
IPA AND 9.6 V REGULATOR (435-475 MHz)

CIRCUIT BOARD DETAILS



TRANSISTOR DETAILS
TOP VIEWS

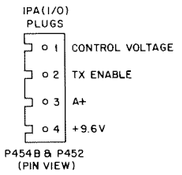
IPA AND 9.6 V REGULATOR (435-475 MHz)
SCHEMATIC DIAGRAM



INTERCONNECT DETAILS

EEPS-35038-B

CONNECTOR DETAIL



NOTES:

1. Unless stated otherwise, all capacitors are listed in picofarads, all resistors in ohms.

Model Complement

Model	Description	Version
TLE5332A	Hybrid	O
TRN5145A	Carrier Board	O
TRN5146A	Hardware Kit	O

POWER CONTROL CIRCUIT

1. GENERAL

The power control circuit can be functionally divided into three main parts:

- RF power leveling
- Power cutback
- Transmitter shutdown

Throughout this discussion, refer to the rf power control loop block and schematic diagrams at the end of this section. In normal operation, power output from the station is controlled by the rf power leveling circuit. This circuit maintains station output power constant over variations in supply voltage and power amplifier temperature. The power cutback circuit reduces station output power under conditions of high temperature, high VSWR, or as directed by station control. If power control is unable to level the power output from the station, a situation exists that is potentially damaging to the station. The transmitter shutdown circuit senses this condition and signals station control to turn off the transmitter.

2. RF POWER LEVELING

When a push-to-talk (PTT) signal is generated, the PA KEY line from station control goes low. This turns off Q402 in the power control circuit and enables the IPA for transmission. The low PA KEY signal also causes Q401 to conduct and apply the power set voltage to operational amplifier U402B driving Q403, which produces the control voltage input to the IPA and turns on series pass device Q451. The IPA output drives the power amplifier (PA) and the forward power sensor, located on the PA signal combiner stage senses PA output. The forward power sensor provides a dc signal, FORWARD VOLTAGE, which is proportional to PA output power. The FORWARD VOLTAGE signal is applied to operational amplifier U402B which varies its drive until the FORWARD VOLTAGE is equal to the power set voltage and maintains the two equal. The status of normal power leveling is indicated by the PA ON and PA FULL POWER lines being low and their respective front panel LED's being on.

3. POWER CUTBACK

3.1 Station output power is reduced under the following conditions:

1. Station control can generate a power cutback signal by pulling down the PA POWER CUTBACK line. This causes the power set voltage to decrease and reduce station output power. The level of reduction can be varied from 20 percent of rated output to 50 percent of rated output by adjusting R409 in the power control circuit.

2. When the PA heat sink temperature exceeds 100°C, thermistor RT501, (located in the PA), reduces the voltage on the HEAT SINK temperature line. This causes CR403 to conduct and decrease the power set voltage.

3.2 To prevent damage to the PA circulator load when high VSWR's are applied to the station at high ambient temperatures, thermistor RT571 pulls the positive (+) input of comparator U402A below the 3-volt reference on the (—) input, and the output of U402A latches low. In this situation, the station output power is dropped to below 20 percent of the power setting, by the conduction of CR405 pulling down the power set voltage. In the standby mode, Q401 turns off and removes the 3-volt reference from the inverting (—) input of U402A, resetting the comparator.

3.3 Anytime station output power is reduced to 50 percent or less of its set value, the noninverting (+) input of power cutback detector U401B falls below the inverting input, causing its output to go low. This turns off Q404 and signals station control of the reduced power level. Front panel LED, PA FULL, also turns off.

4. TRANSMITTER SHUTDOWN

Comparators U401C and U401D detect conditions where power control cannot level the station output power. The output of U401C goes low if the signal on the inverting (—) input of U402B is greater than the power set voltage, indicating station output power is

greater than its set value. If the output of U402B goes to full drive limit (8 volts), the inverting (—) input of U401D rises to 4 volts and the output of U401D goes low. Both comparator outputs are tied together; if either goes low, Q405 turns off and the PA ON signal rises to 3.5 volts, signaling the processor that a control loop failure has occurred. However, when PA ON rises, CR406 stops conducting and the inverting (—) input of comparator U401A rises to 3 volts, latching its output low. This pulls the power set voltage down and reduces station output by 50 percent in an attempt to correct the leveling problem. If the problem is not corrected by this attempt, station control detects that the PA ON signal has remained high and, after 30 msec, removes the PA KEY signal, shutting down the transmitter.

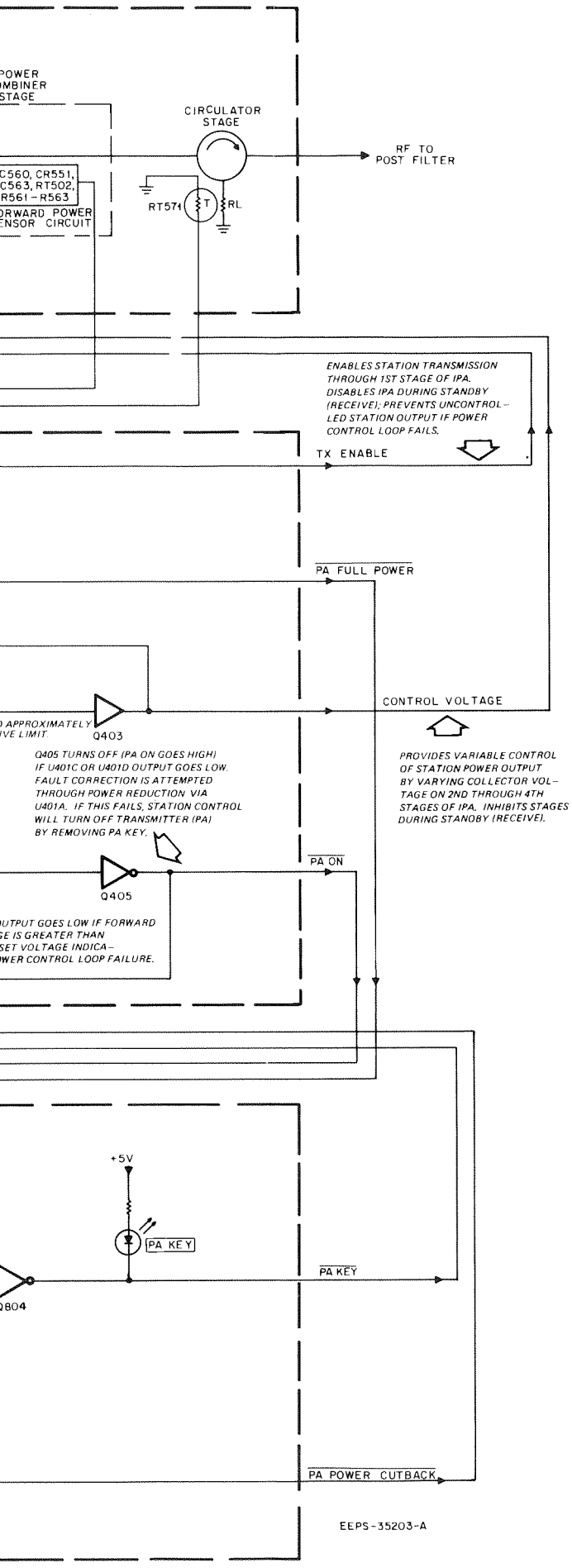
5. BATTERY REVERT POWER SET PROCEDURE

Step 1. Set the power output to the rated level by adjusting front panel power set control R426.

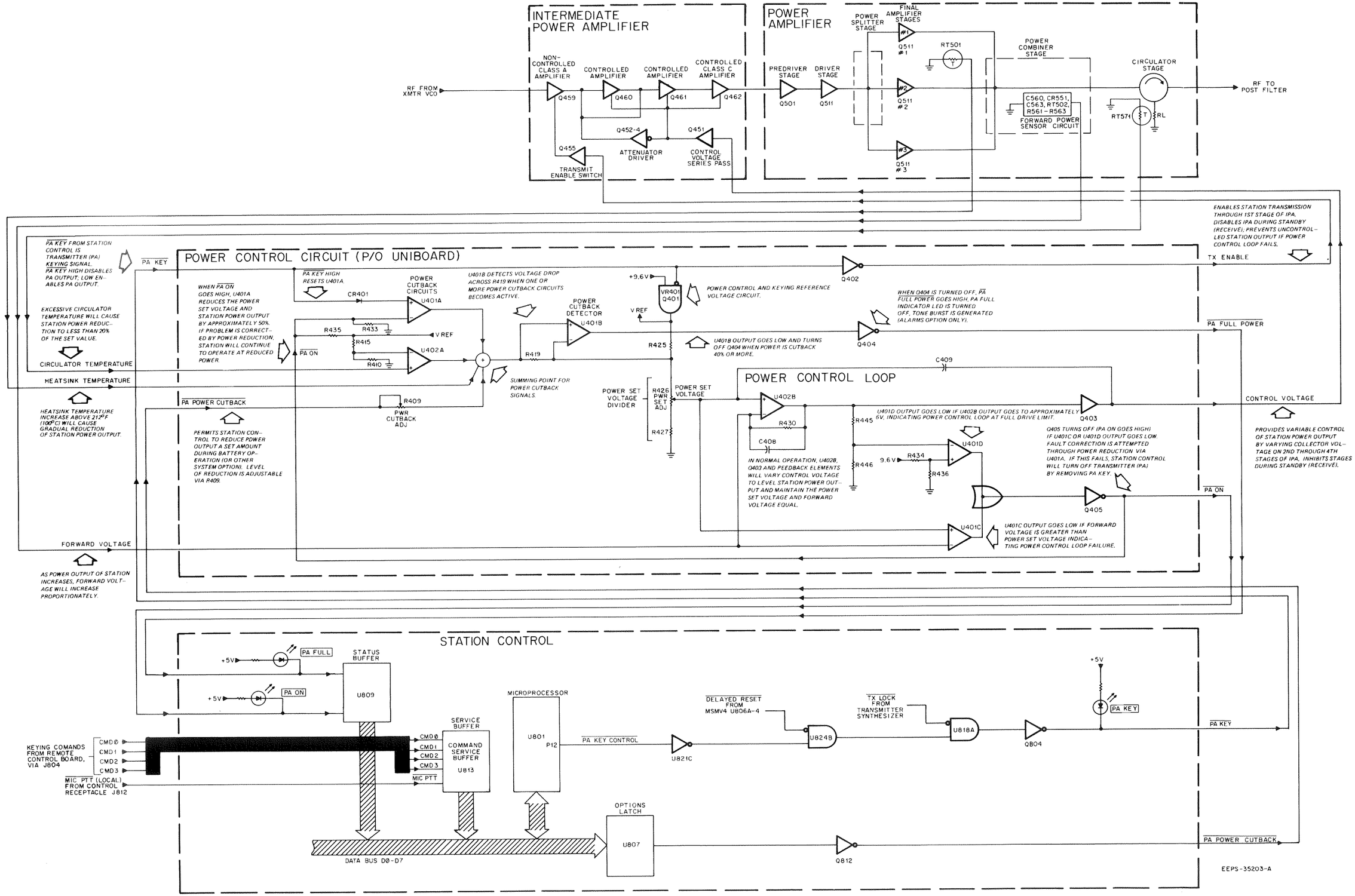
Step 2. With the batteries connected to the station, remove ac power from the station and adjust power cutback potentiometer R409 for a 50§ reduction in power. To access R409, the rf tray cover must be removed to expose the uniboard. R409 is adjustable from the solder side, through the synthesizer shield. (It is not necessary to remove the shield.) Insert tuning tool through shield hole labeled "R409" and adjust.

POWER CONTROL CIRCUIT

p/o TRN9880A UNIBOARD RF POWER CONTROL LOOP BLOCK DIAGRAM

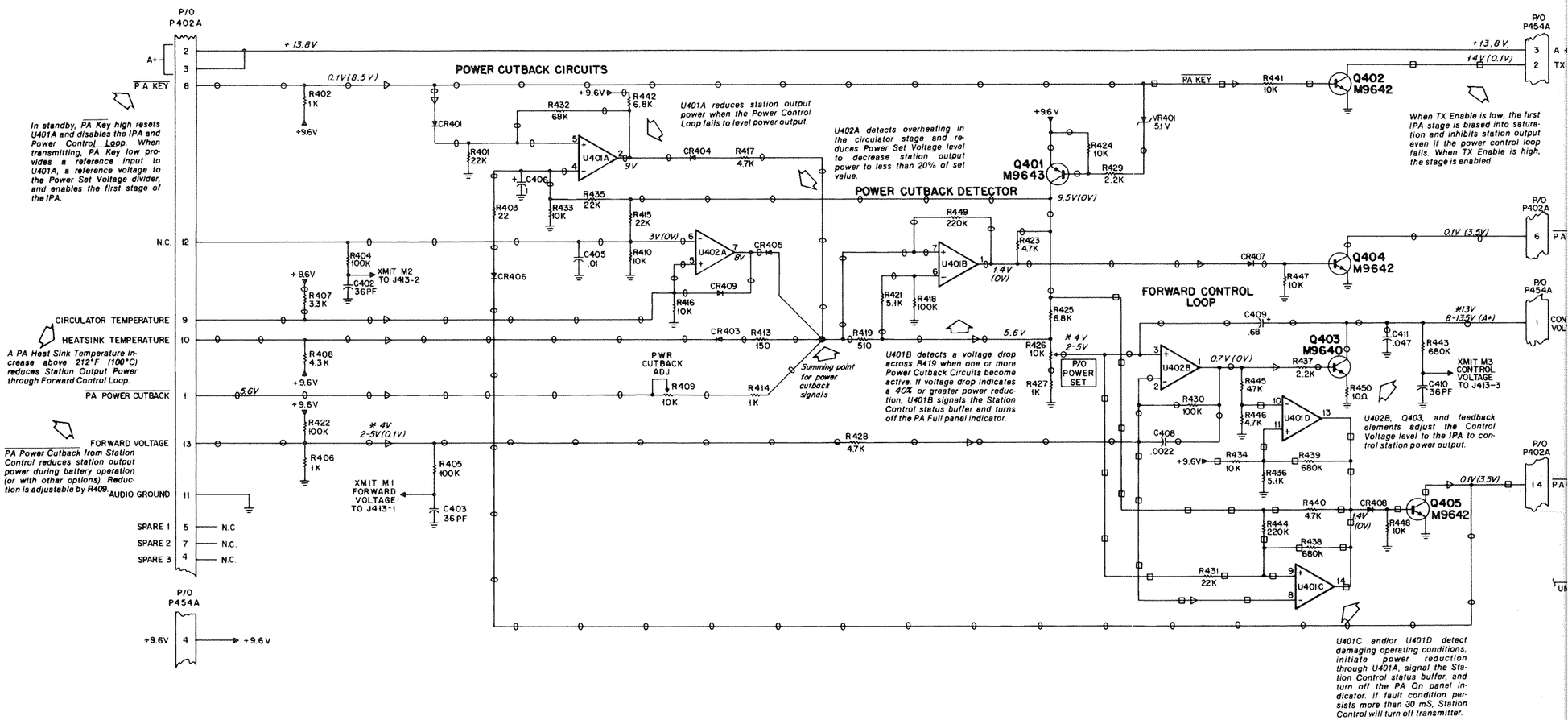


SEE RF TRAY SECTION FOR CIRCUIT BOARD DETAIL AND PARTS LIST


INTERMEDIATE POWER AMPLIFIER
NON-CONTROLLED CLASS A AMPLIFIER
CONTROLLED AMPLIFIER
CONTROLLED AMPLIFIER
CONTROLLED CLASS C AMPLIFIER
Q459
Q460
Q461
Q462
Q452-4
ATTENUATOR DRIVER
Q451
CONTROL VOLTAGE SERIES PASS
Q455
TRANSMIT ENABLE SWITCH
RF FROM XMTR VCO
POWER AMPLIFIER
PREDRIVER STAGE
DRIVER STAGE
Q501
Q511
POWER SPLITTER STAGE
FINAL AMPLIFIER STAGES
#1
Q511 #1
#2
Q511 #2
#3
Q511 #3
RT501
POWER COMBINER STAGE
C560, CR551, C563, RT502, R561 – R563
FORWARD POWER SENSOR CIRCUIT
CIRCULATOR STAGE
RT571
RL
RF TO POST FILTER
PA KEY FROM STATION CONTROL IS TRANSMITTER (PA) KEYING SIGNAL. PA KEY HIGH DISABLES PA OUTPUT; LOW ENABLES PA OUTPUT.
PA KEY
POWER CONTROL CIRCUIT (P/O UNIBOARD)
EXCESSIVE CIRCULATOR TEMPERATURE WILL CAUSE STATION POWER REDUCTION TO LESS THAN 20% OF THE SET VALUE.
CIRCULATOR TEMPERATURE
HEATSINK TEMPERATURE
HEATSINK TEMPERATURE INCREASE ABOVE 212°F (100°C) WILL CAUSE GRADUAL REDUCTION OF STATION POWER OUTPUT.
PA POWER CUTBACK
PERMITS STATION CONTROL TO REDUCE POWER OUTPUT A SET AMOUNT DURING BATTERY OPERATION (OR OTHER SYSTEM OPTION). LEVEL OF REDUCTION IS ADJUSTABLE VIA R409.
FORWARD VOLTAGE
AS POWER OUTPUT OF STATION INCREASES, FORWARD VOLTAGE WILL INCREASE PROPORTIONATELY.
WHEN PA ON GOES HIGH, U401A REDUCES THE POWER SET VOLTAGE AND STATION POWER OUTPUT BY APPROXIMATELY 50%. IF PROBLEM IS CORRECTED BY POWER REDUCTION, STATION WILL CONTINUE TO OPERATE AT REDUCED POWER.
PA KEY HIGH RESETS U401A.
CR401
POWER CUTBACK CIRCUITS
U401A
R435
R433
R415
R410
U402A
VREF
PA ON
R409
PWR CUTBACK ADJ
U401B DETECTS VOLTAGE DROP ACROSS R419 WHEN ONE OR MORE POWER CUTBACK CIRCUITS BECOMES ACTIVE.
POWER CUTBACK DETECTOR
U401B
R419
SUMMING POINT FOR POWER CUTBACK SIGNALS.
+9.6V
VR401
Q401
POWER CONTROL AND KEYING REFERENCE VOLTAGE CIRCUIT.
VREF
R425
U401B OUTPUT GOES LOW AND TURNS OFF Q404 WHEN POWER IS CUTBACK 40% OR MORE.
POWER SET VOLTAGE DIVIDER
R426 PWR SET ADJ
R427
POWER SET VOLTAGE
POWER CONTROL LOOP
C409
U402B
R430
C408
IN NORMAL OPERATION, U402B, Q403 AND FEEDBACK ELEMENTS WILL VARY CONTROL VOLTAGE TO LEVEL STATION POWER OUTPUT AND MAINTAIN THE POWER SET VOLTAGE AND FORWARD VOLTAGE EQUAL.
U401D OUTPUT GOES LOW IF U402B OUTPUT GOES TO APPROXIMATELY 6V, INDICATING POWER CONTROL LOOP AT FULL DRIVE LIMIT.
R445
R446
9.6V
R434
R436
U401D
U401C
U401C OUTPUT GOES LOW IF FORWARD VOLTAGE IS GREATER THAN POWER SET VOLTAGE INDICATING POWER CONTROL LOOP FAILURE.
Q405 TURNS OFF (PA ON GOES HIGH) IF U401C OR U401D OUTPUT GOES LOW. FAULT CORRECTION IS ATTEMPTED THROUGH POWER REDUCTION VIA U401A. IF THIS FAILS, STATION CONTROL WILL TURN OFF TRANSMITTER (PA) BY REMOVING PA KEY.
Q405
PA ON
WHEN Q404 IS TURNED OFF, PA FULL POWER GOES HIGH, PA FULL INDICATOR LED IS TURNED OFF. TONE BURST IS GENERATED (ALARMS OPTION ONLY).
Q404
PA FULL POWER
Q403
CONTROL VOLTAGE
PROVIDES VARIABLE CONTROL OF STATION POWER OUTPUT BY VARYING COLLECTOR VOLTAGE ON 2ND THROUGH 4TH STAGES OF IPA. INHIBITS STAGES DURING STANDBY (RECEIVE).
ENABLES STATION TRANSMISSION THROUGH 1ST STAGE OF IPA. DISABLES IPA DURING STANDBY (RECEIVE); PREVENTS UNCONTROLLED STATION OUTPUT IF POWER CONTROL LOOP FAILS.
TX ENABLE
Q402
STATION CONTROL
+5V
PA FULL
PA ON
STATUS BUFFER
U809
SERVICE BUFFER
COMMAND SERVICE BUFFER
U813
MICROPROCESSOR
U801
P12
PA KEY CONTROL
U821C
DELAYED RESET FROM MSM4 U806A-4
U824B
TX LOCK FROM TRANSMITTER SYNTHESIZER
U818A
Q804
PA KEY
KEYING COMMANDS FROM REMOTE CONTROL BOARD, VIA J804
CMD0
CMD1
CMD2
CMD3
MIC PTT (LOCAL) FROM CONTROL RECEPTACLE J812
MIC PTT
DATA BUS D0-D7
OPTIONS LATCH
U807
Q812
PA POWER CUTBACK
EEPS-35203-A

POWER CONTROL CIRCUIT

p/o TRN9880A UNIBOARD
SCHEMATIC DIAGRAM



NOTES:

1. Unless otherwise specified, resistor values are in ohms and capacitor values are in microfarads.
2. Voltage references are identified as follows:

a. Asterisk (*) indicates voltage is dependent upon station output level or A— voltage level. Ranges are typical.

b. ( ) indicate voltage measured in standby (receive) conditon.

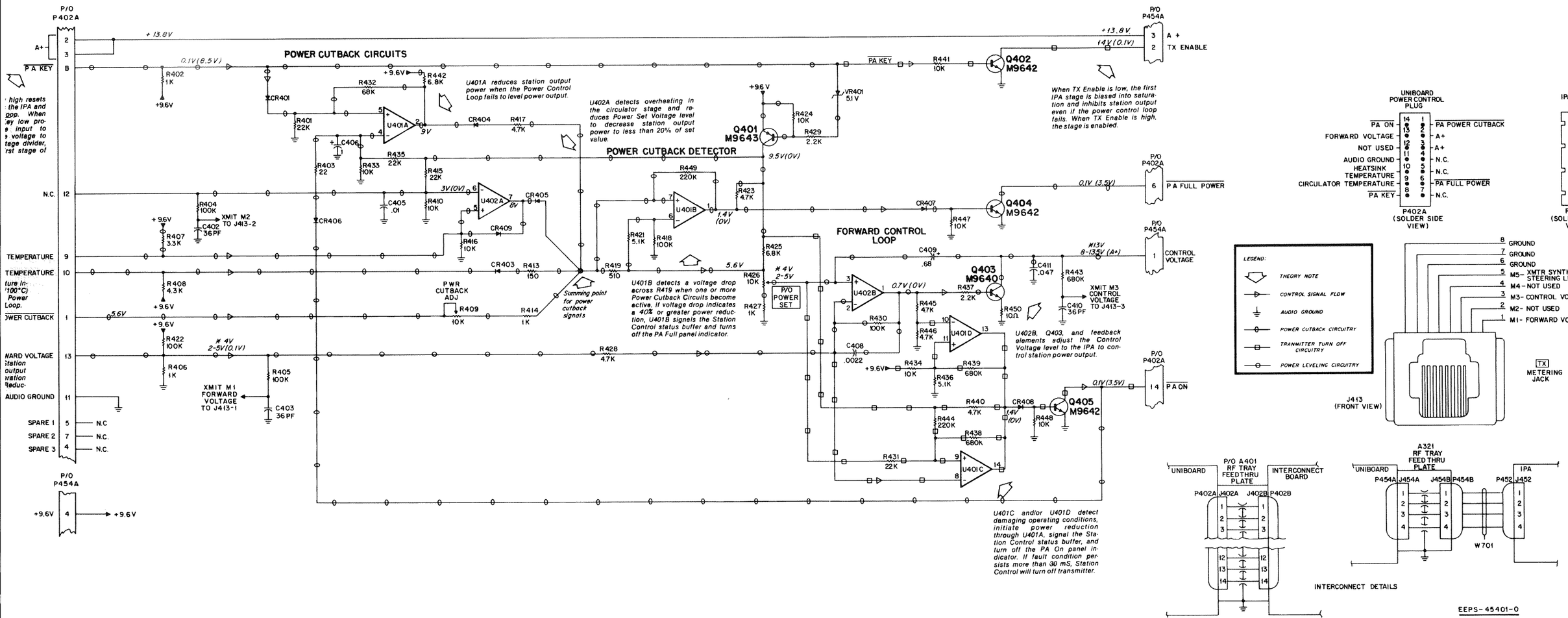
c. All other voltages measured in transmit condition.

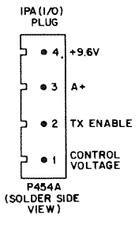
3. Battery charging option may cause control voltage level to decrease 2 to 3 volts in receive condition.

Integrated Circuit Data Chart

Ref. Desig.	-9.5 V (Pin)	Audio Gnd (Pin)	Description
U401	3	12	Quad Comparator
U402	8	4	Dual Op-Amp

SEE RF TRAY SECTION FOR CIRCUIT BOARD DETAIL AND PARTS LISTS





INTERCONNECT DETAILS

EEPS-45401-0