



MOTOROLA INC.
Communications
Sector

POWER AMPLIFIER DECK

MODELS: TLD2691A (132–158 MHz)
TLD2692A (146–174 MHz)

1. GENERAL

The VHF Power Amplifier (PA) is designed for continuous duty operation over the full -30°C to $+60^{\circ}\text{C}$ range of ambient temperatures. The amplifier employs ceramic hybrid modules with 50 ohm interfaces between all stages.

2. THEORY OF OPERATION

The input signal to the PA comes from the IPA. Under nominal operating conditions, the input level to the PA is 3 to 5 W. The signal is split two ways and applied to the final amplifier modules (Q552 and Q553). After combining the outputs of the final amplifier modules, the power passes through a directional coupler which produces a dc voltage proportional to the forward and reflected power. The forward power is then delivered to the low pass filter from which the output is 125 W.

Operating temperature of the PA is sensed by a thermistor (RT551). The temperature information is used by the power control circuit to control the PA.

3. SERVICING

3.1 GENERAL

Repair of the microstrip ceramic substrates is not recommended and should be avoided. The modules are built and tested at the factory employing special fixtures and processes to ensure proper operation. The repair procedure consists of replacing a defective module rather than components on the module.

IMPORTANT

All four cover screws must be tight to ensure optimum performance.

3.2 MODULE ASSEMBLY REMOVAL

The rf power modules consist of an rf power transistor and associated circuits bonded to a copper heat spreader.

This assembly should be removed as a unit by first unsoldering the dc and rf connections to the module. Next, remove the two M4 x 18 hold-down screws. Long nose pliers can now be used to grasp the copper heat spreader and remove the module. The large surface area of the copper heat spreader may cause the surface tension of the thermal compound to exert a large amount of force on the module; rocking the module from side to side may be necessary to overcome the force.

During servicing of the transmitter, it may be necessary to defeat the transmitter shutdown section of the power control. Under normal operation, the transmitter shutdown circuit signals the station control to turn off the transmitter when power control cannot level power. For stations with an analog station control board, transmitter shutdown can be prevented by installation of the service jumper JU1, located on the Station Control board. If the radio is an MSF digital style radio, refer to paragraph 5.4.2 Power Control Servicing (located in the DESCRIPTION AND OPERATION section of this manual) for details regarding enabling/disabling the Power Control Service Mode.

3.3 INTERSTAGE POWER MEASUREMENT AND "OMEGA" STRAP REPLACEMENT

If it is desirable to measure rf power at any of the 50 ohm interfaces in the transmitter, care should be exercised in removal of the "Omega" straps between modules and their reinstallation. Care should be exercised when soldering the "Omega" strap interconnects between hybrid modules. The "Omega" straps (Motorola part no. 42-84510M04 & 42-83680N01) absorb mechanical stresses caused during temperature excursions of the station and therefore must remain flexible after installation. When soldering these connections, do not allow solder to bridge over the top or to fill the underside of the "Omega" strap. Figure 1a shows how a correctly soldered "Omega" strap should look. Incorrect soldering is shown in Figure 1b. Furthermore, do not substitute any rigid material or attempt to replace an "Omega" strap by "solder bridging". If proper soldering techniques are not observed during installation of "Omega" straps, premature failure of the hybrid module can result.

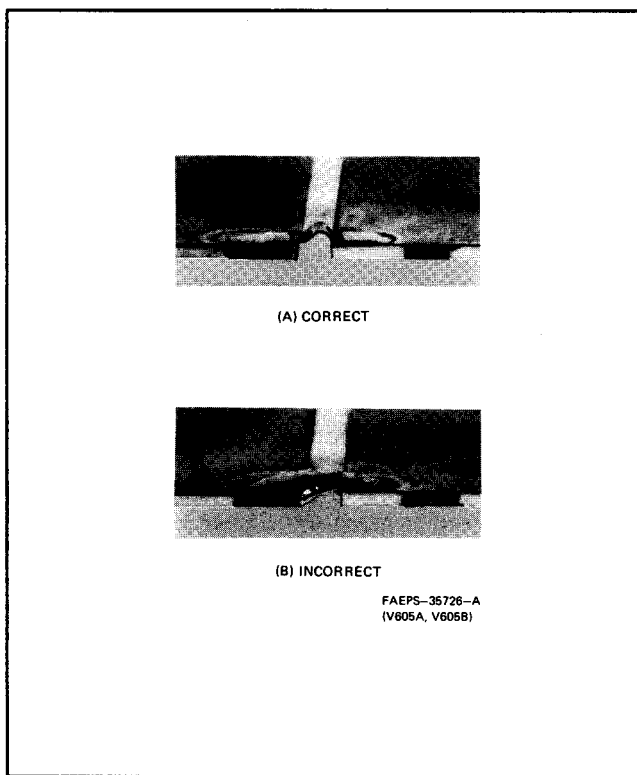


Figure 1. "Omega" Strap Replacement Soldering Technique

IMPORTANT

Power measurements of the individual *final* amplifier modules should *not* be attempted. The splitter and combiner circuits serve to prevent imbalances in drive and output of the two final amplifier stages. If input or output connections to the individual final modules are broken, power measurements will be incorrect.

Balance between the finals should be checked by metering their currents (M1 and M2). The balance in meter readings between the final amplifiers should be within $5 \mu\text{A}$ of one another. If greater than $5 \mu\text{A}$ imbalance is indicated, the lower of the device meter readings is probably the bad module(s). When replacing any of the final amplifier modules, unsolder the connections to the balancing resistors TRN7065A (input and output) and measure their value. Both resistors should be between 80 and 100 ohms.

3.4 INTERMITTENT ISOLATION RESISTOR TEST

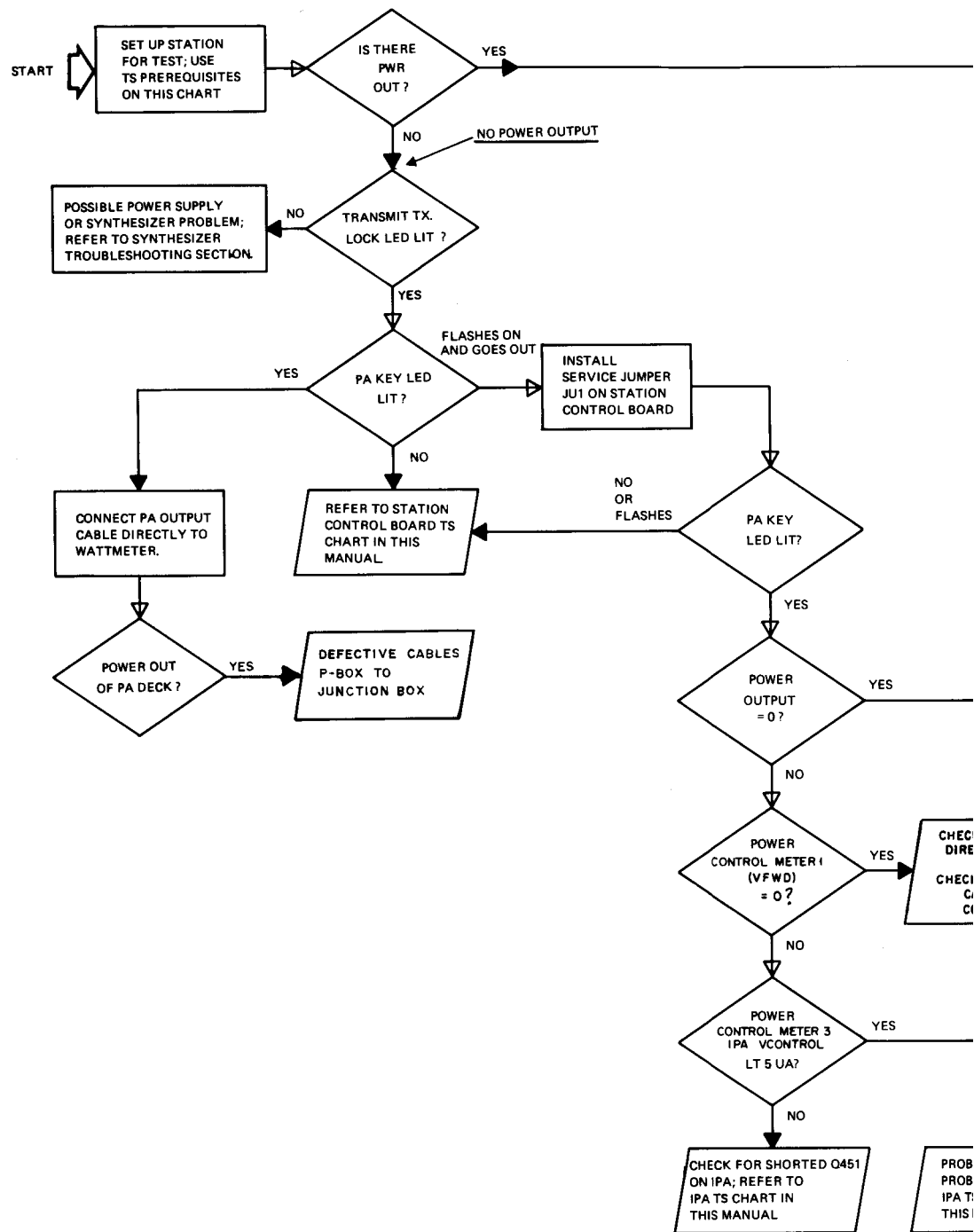
Isolation resistors (TRN7065A) under the splitter and combiner boards minimize the interaction between modules. In the event of a module failure or degradation, the resulting mismatch will be isolated from the other modules. See paragraph for testing procedures.

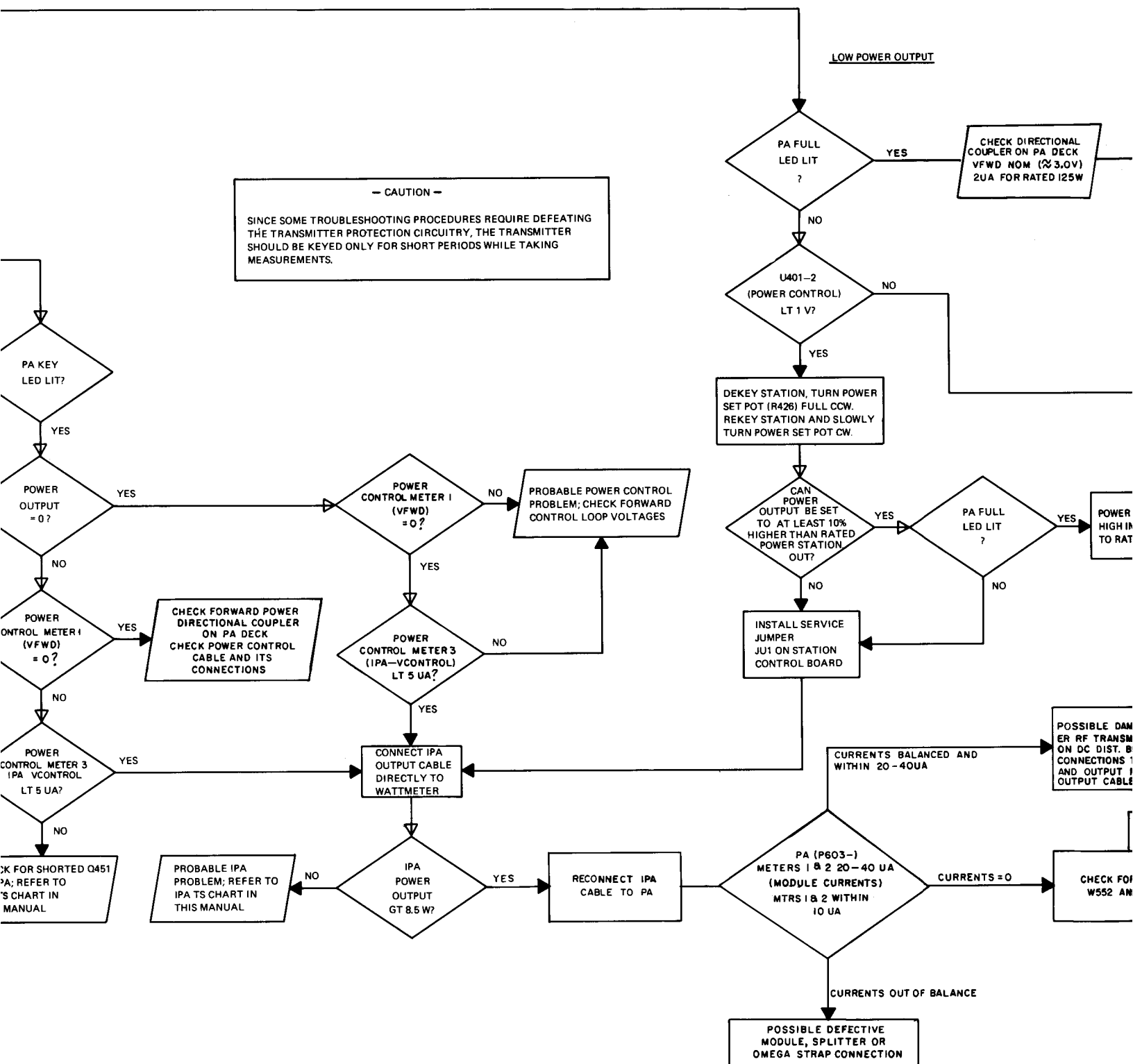
CAUTION

Use only an **insulated** probe to apply pressure to the splitter or combiner board. Under **no** circumstances should any metallic object directly contact the splitter or combiner board during this procedure.

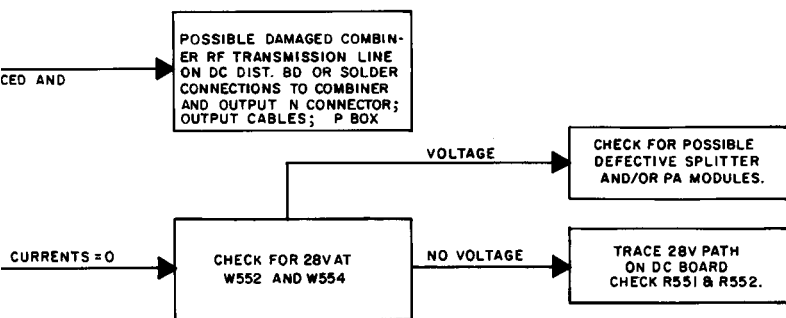
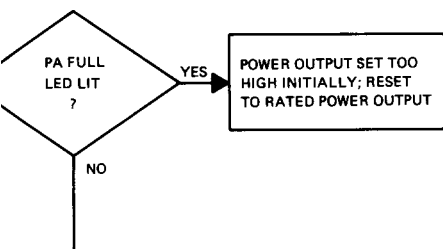
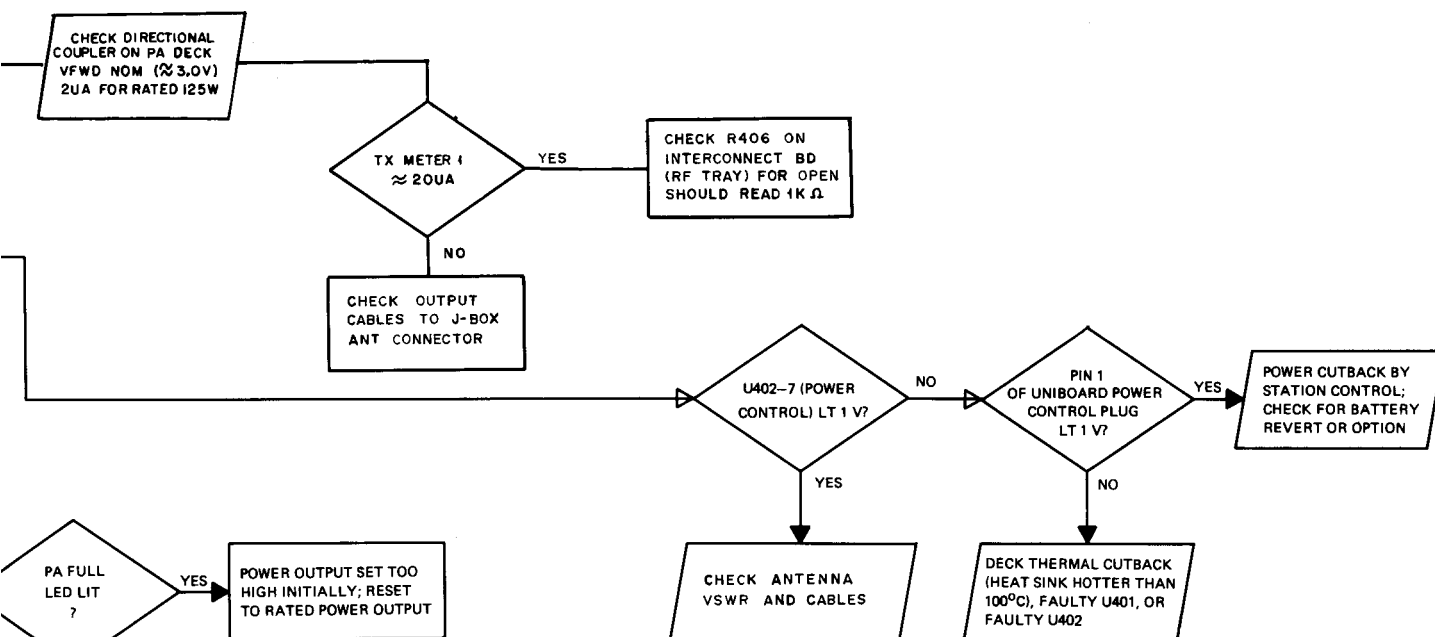
Step 1. Connect meter cable to J504 for testing the splitter isolation or the combiner isolation resistor.

Step 2. With the transmitter keyed, and while monitoring meters 1 and 2, perform the following procedure. Using an **insulated** tuning tool, apply downward pressure on the splitter or combiner board directly above the isolation resistor. The insulated end of the tuning tool should contact the board **between** rf runners. Any change in meters 1 or 2 greater than $3 \mu\text{A}$ as pressure is applied and relieved is indicative of a defective isolation resistor which should be replaced.





POWER TRANSMITTER



SYMBOLS AND ABBREVIATIONS USED IN THE CHART

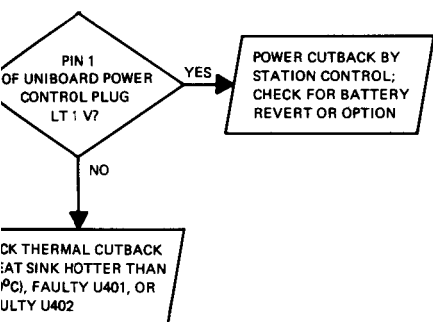
U401-2	= PIN 2 OF U401
TS	= TROUBLESHOOTING
LT	= LESS THAN
GT	= GREATER THAN
→	= TRANSMITTER UNKEYED
→	= TRANSMITTER KEYED
○	= ALTERNATE TROUBLESHOOTING PATH DEPENDING UPON OPTIONS IN STATION
◇	= DECISION
▭	= ACTION TO BE TAKEN
▭	= POSSIBLE SOURCE OF MALFUNCTION CHECK POTENTIAL DEFECTIVE ITEMS

TROUBLESHOOTING

1. CONNECT OUTPUT (WATTMET)
2. CONNECT
3. USE A TEST AND MOT

POWER AMPLIFIER DECK

TRANSMITTER TROUBLESHOOTING CHART



ABBREVIATIONS USED IN THE CHART

1-2	= PIN 2 OF U401
S	= TROUBLESHOOTING
T	= LESS THAN
T	= GREATER THAN
→	= TRANSMITTER UNKEYED
→	= TRANSMITTER KEYED
U	= ALTERNATE TROUBLESHOOTING PATH DEPENDING UPON OPTIONS IN STATION
>	= DECISION
□	= ACTION TO BE TAKEN
▭	= POSSIBLE SOURCE OF MALFUNCTION CHECK POTENTIAL DEFECTIVE ITEMS

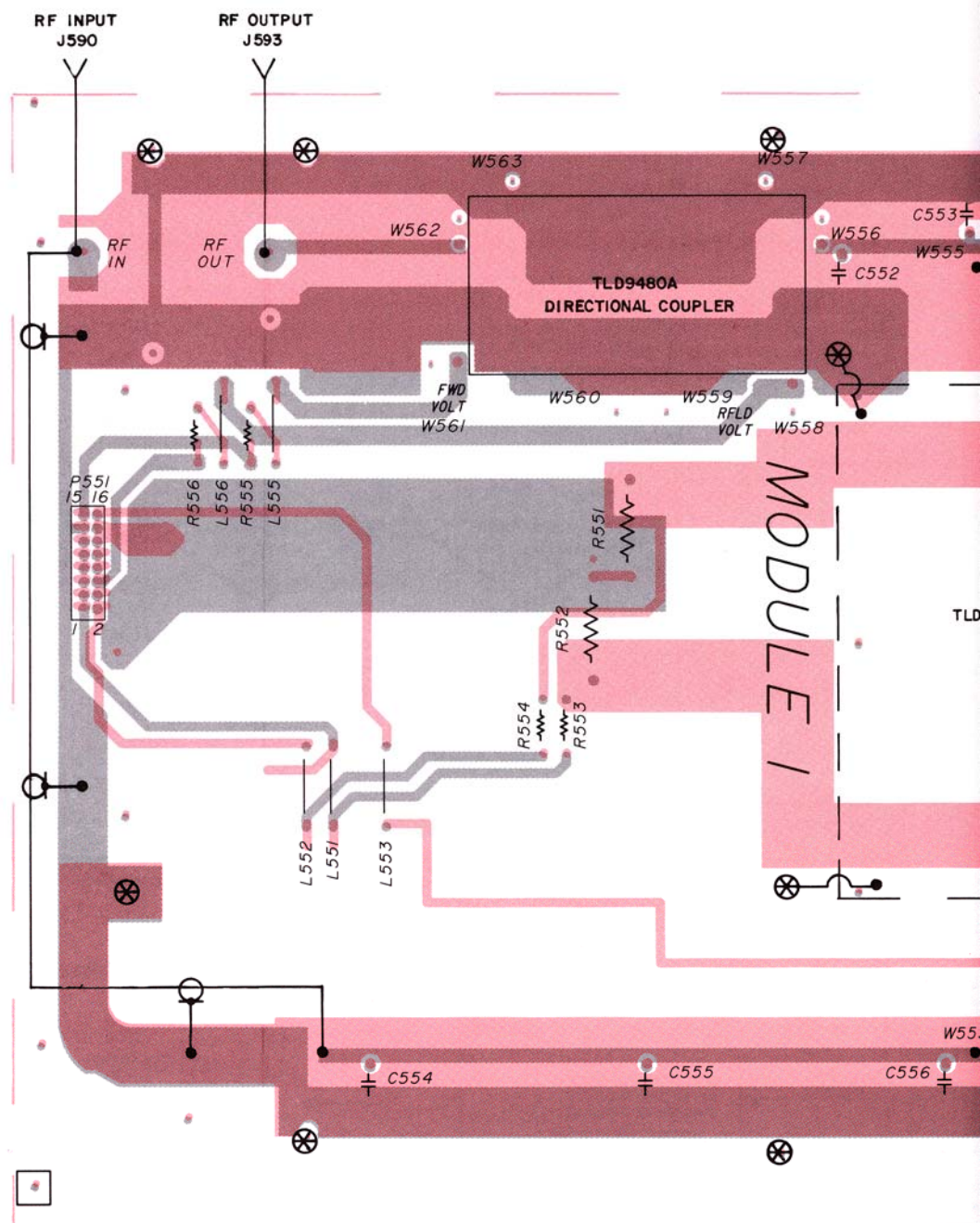
TROUBLESHOOTING PREREQUISITES:

1. CONNECT THE STATION ANTENNA CONNECTOR (OR TRANSMITTER OUTPUT CONNECTOR ON STANDARD REPEATER MODELS) TO A WATTMETER TERMINATED WITH A 150 WATT DUMMY LOAD.
2. CONNECT THE STATION TO ITS POWER SOURCE (AC OR BATTERY).
3. USE A TEK-37A TEST SET ADAPTER WITH RPX4221A CABLES AND MOTOROLA S1056 PORTABLE TEST SET FOR METERING.





EEPS-47589-0

RF AMPLIFIER DECK BOARD DETAIL

TRN99



LEGEND:

-  = OMEGA STRAP (NOTE 1)
-  = WIRE INTERCONNECTION
-  = GROUND STRAP (NOTE 2) WITH SLOTTED STAR SCREW (SEE FOLLOWING DETAIL)
-  = SLOTTED STAR SCREW DETAIL

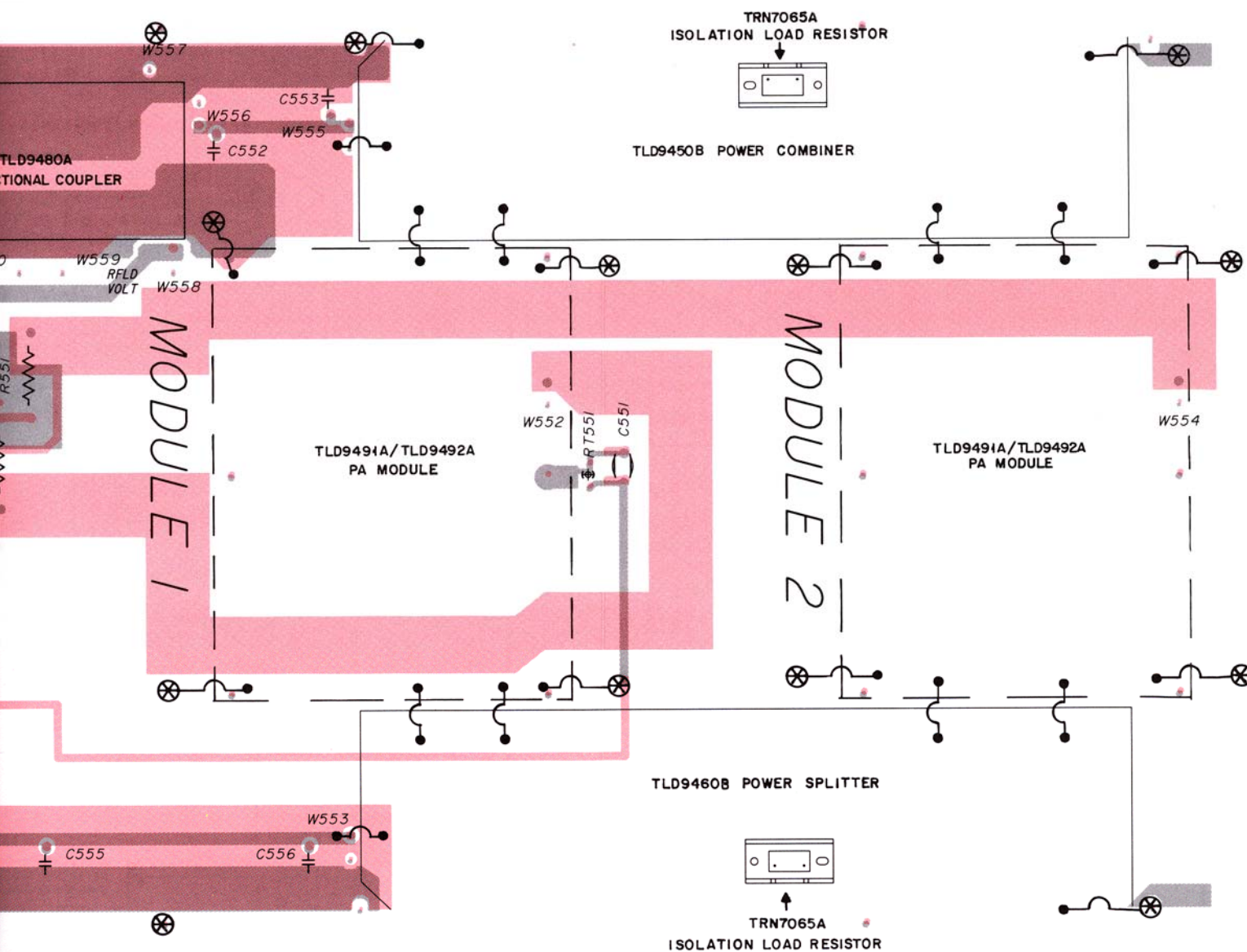
NOTES:

1. OMEGA STRAPS PART OF MODULE ASSEMBLIES. REFER TO MODULE DETAILS.
2. GROUND STRAPS PART OF PA HARDWARE KIT.
3. OMEGA STRAPS FOR SPLITTER OR COMBINER GND CONNECTIONS ARE PART OF PA HARDWARE KIT.

P551

N.C.	15	16	THERMISTER
GND	13	14	A+
N.C.	11	12	A+
N.C.	9	10	N.C.
N.C.	7	8	N.C.
N.C.	5	6	VREV
N.C.	3	4	N.C.
MOD 1 DRAIN	1	2	MOD 2 DRAIN

TRN9987A DC DISTRIBUTION BOARD

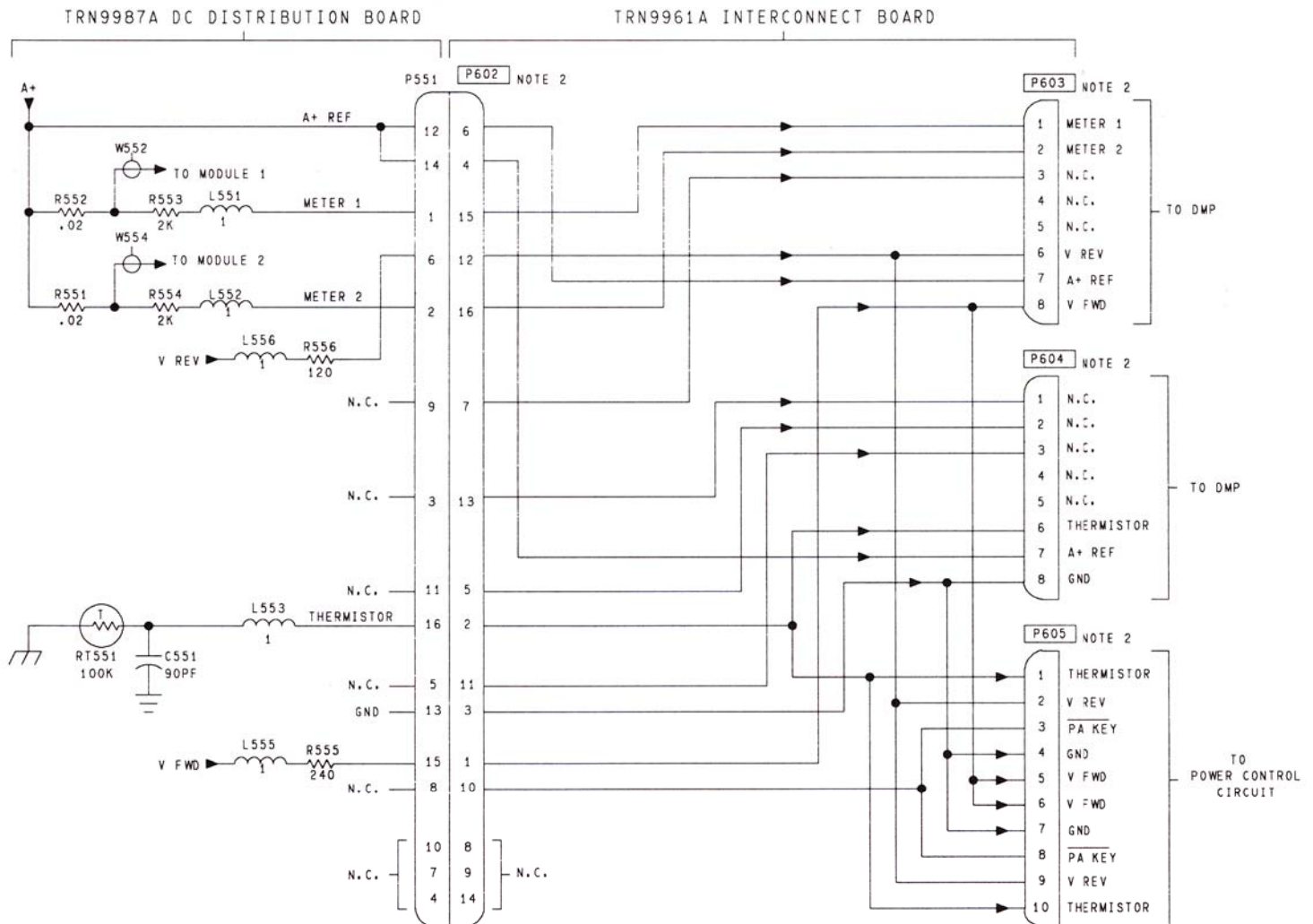


COMPONENT SIDE BD-CEPS-47591-0
SOLDER SIDE  BD-CEPS-47592-0
OL-CEPS-47593-A

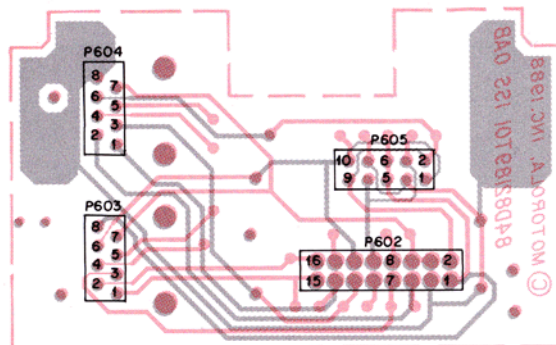
P551		
N.C.	15	16 THERMISTER
GND	13	14 A+
N.C.	11	12 A+
N.C.	9	10 N.C.
N.C.	7	8 N.C.
N.C.	5	6 V REV
N.C.	3	4 N.C.
DRAIN	1	2 MOD 2 DRAIN

SHOWN FROM COMPONENT SIDE

TRN9961A INTERCONNECT POCKET BOARD



TEPS-47590-0

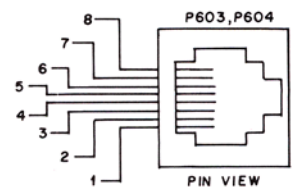


COMPONENT SIDE ● BD-CEPS-46205-0
SOLDER SIDE ● BD-CEPS-46206-0
OL-CEPS-47596-0

SHOWN FROM COMPONENT SIDE

P605		
VREV	2	1 THERMISTOR
GND	4	3 PA KEY
V FWD	6	5 V FWD
PA KEY	8	7 GND
THERMISTOR	10	9 VREV

PIN VIEW



PIN VIEW

P602		
THERMISTOR	2	1 V FWD
A+ REF	4	3 GND
A+ REF	6	5 METER 5
NOT USED	8	7 METER 3
N.C.	10	9 N.C.
VREV	12	11 METER 6
N.C.	14	13 METER 4
METER 2	16	15 METER 1

PIN VIEW

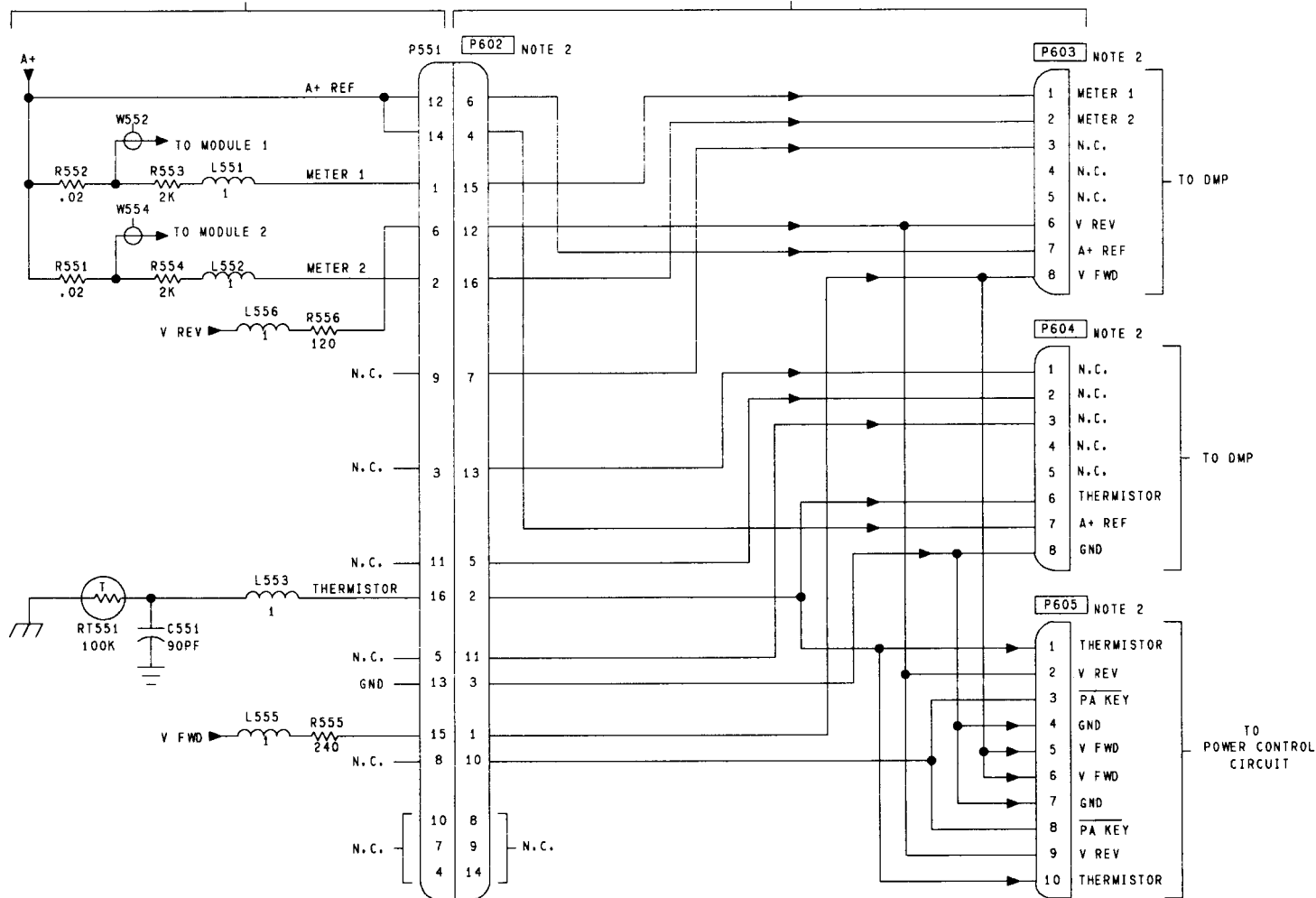
PA METERING		
PIN	P603	P604
1	METER 1	METER 4
2	METER 2	METER 5
3	METER 3	METER 6
4	NOT USED	NOT USED
5	NOT USED	NOT USED
6	VREV	THERMISTOR
7	A+ REF	A+ REF
8	V FWD	GND

NOTE: METER 3,4,5,6 NOT USED WITH TLD2690A P.A. DECK.

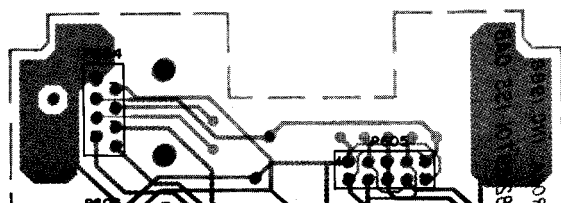
TRN9961A INTERCONNECT POCKET BOARD

TRN9987A DC DISTRIBUTION BOARD

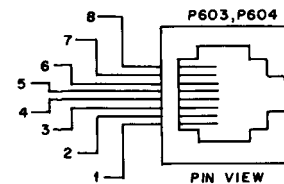
TRN9961A INTERCONNECT BOARD

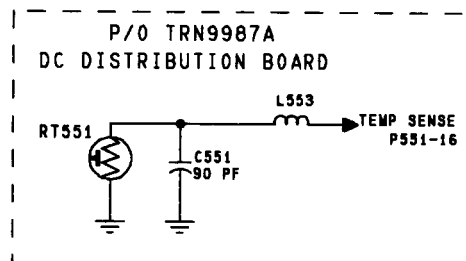
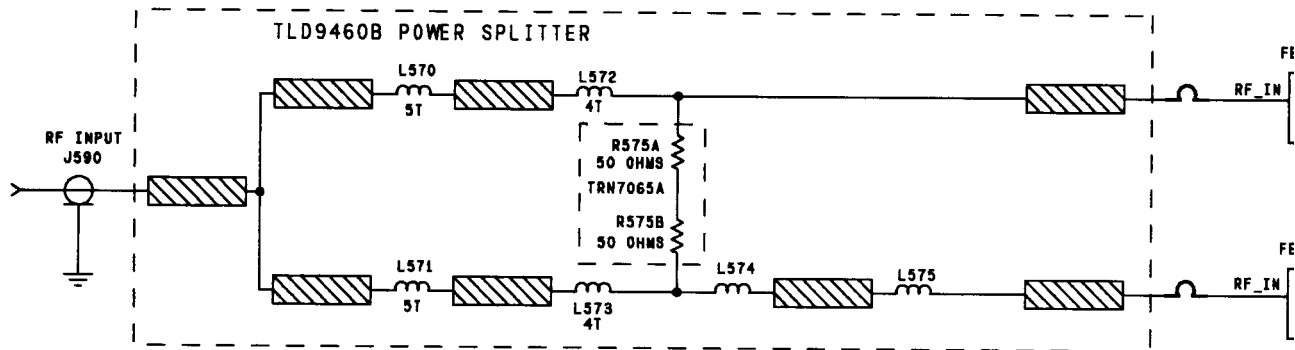


TEPS-47590-0






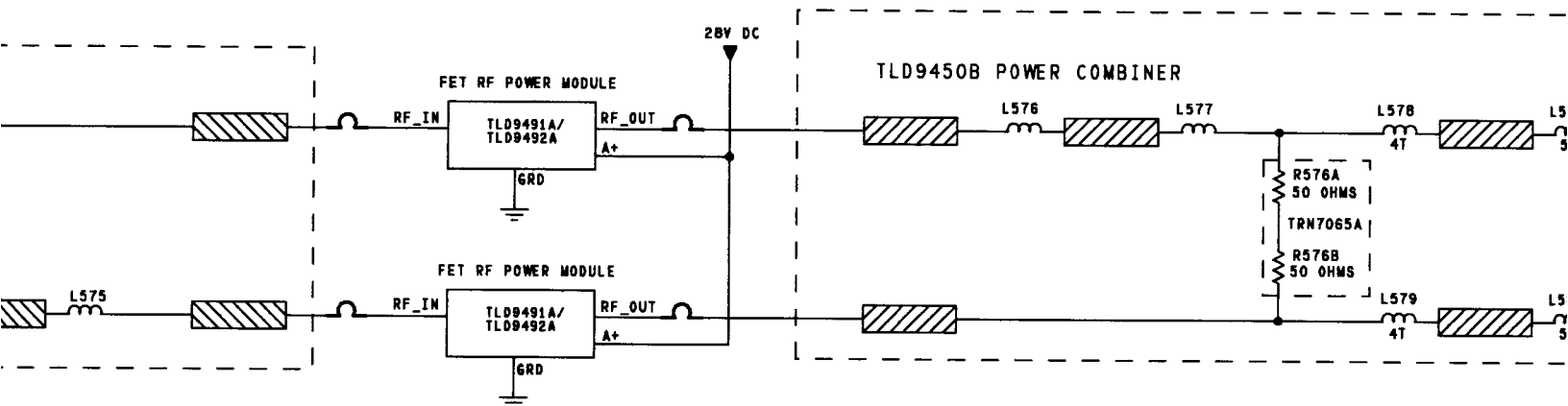
P605			
VREV	2	1	THERMISTOR
GND	4	3	PA KEY
V FWD	6	5	V FWD
PA KEY	8	7	GND
THERMISTOR	10	9	VREV
PIN VIEW			



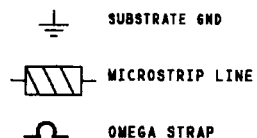


LEGEND:

-  SUBSTRATE GND
-  MICROSTRIP LINE
-  OMEGA STRAP



LEGEND:

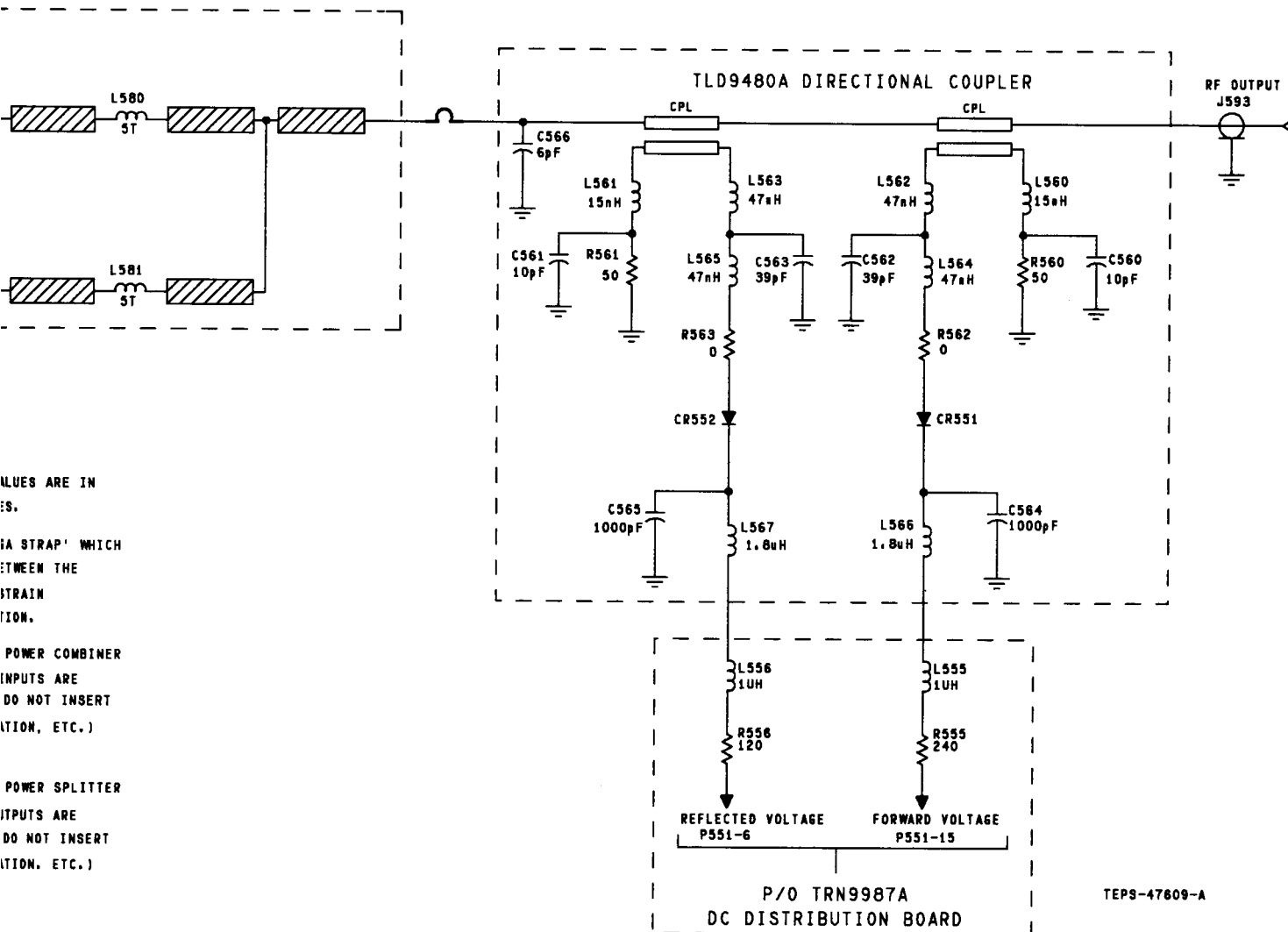


NOTES:

1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, CAPACITOR VALUES ARE IN MICROHENRIES.
2. THE GREEK SYMBOL (ω) DENOTES AN 'OMEGA STRAP' WHICH IS USED TO PROVIDE CIRCUIT CONNECTIONS BETWEEN THE PA SUBSTRATES AND PROVIDE THE NECESSARY STRAIN RELIEF FOR THERMAL EXPANSION AND CONTRACTION.
3. TRANSMISSION LINE LENGTHS BETWEEN THE POWER COMBINER STAGE OUTPUTS AND FINAL AMPLIFIER STAGE INPUTS ARE CRITICAL TO PROPER AMPLIFIER OPERATION. DO NOT INSERT TEST INSTRUMENTS (WATTMETER, LOAD TERMINATION, ETC.) AT THESE LOCATIONS.
4. TRANSMISSION LINE LENGTHS BETWEEN THE POWER SPLITTER STAGE INPUTS AND FINAL AMPLIFIER STAGE OUTPUTS ARE CRITICAL TO PROPER AMPLIFIER OPERATION. DO NOT INSERT TEST INSTRUMENTS (WATTMETER, LOAD TERMINATION, ETC.) AT THESE LOCATIONS.

POWER AMPLIFIER DECK

SCHEMATIC DIAGRAM



VALUES ARE IN
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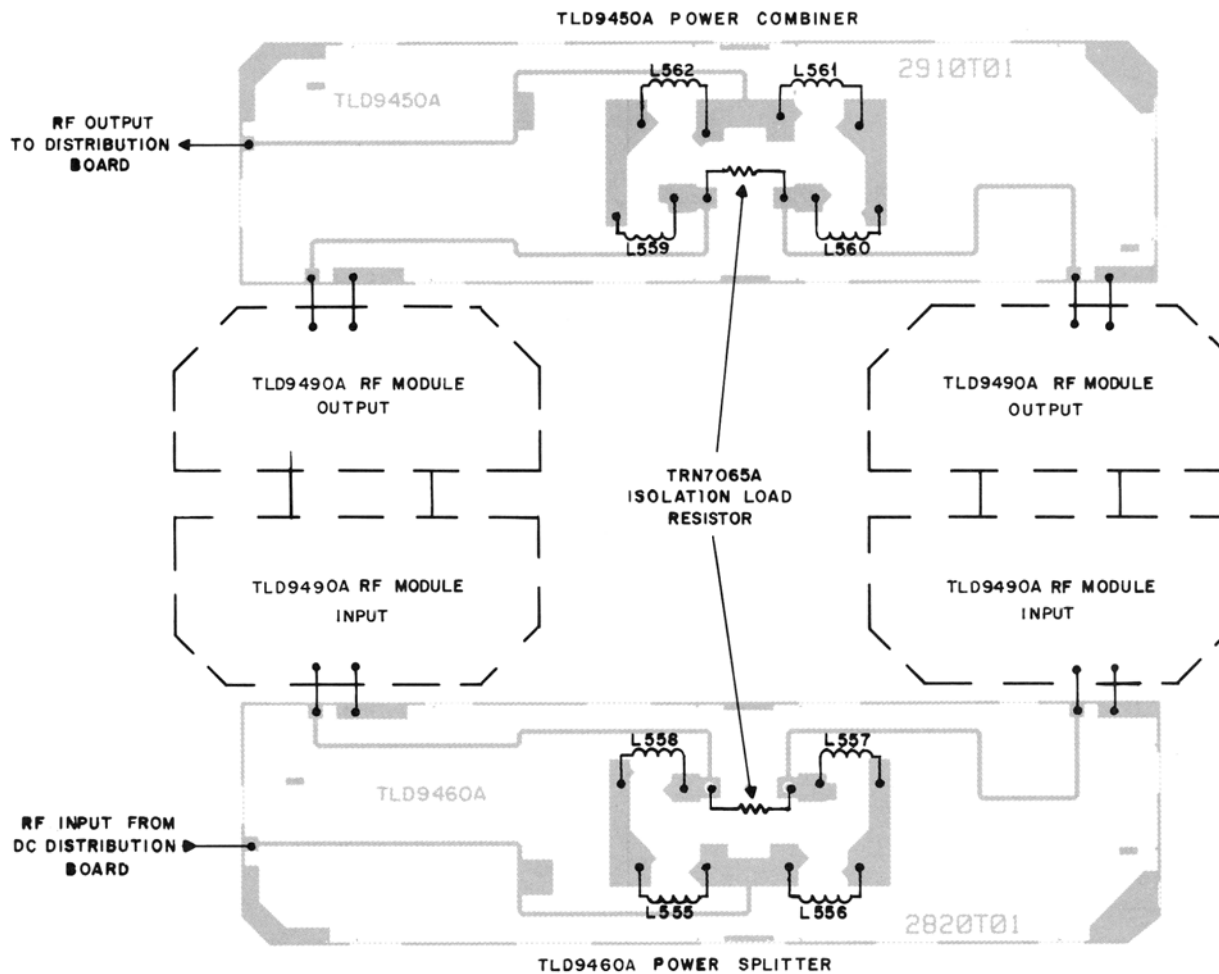
POWER COMBINER
INPUTS ARE
DO NOT INSERT
ATION, ETC.)

POWER SPLITTER
INPUTS ARE
DO NOT INSERT
ATION, ETC.)

POWER AMPLIFIER DECK

CIRCUIT BOARD DETAIL

TLD9450A POWER COMBINER TLD9460A POWER SPLITTER



SHOWN FROM COMPONENT SIDE

BD-CEPS-46833-A
OL-CEPS-47610-0

parts list

TRN9987A DC Distributi

REFERENCE SYMBOL	M P
C551	2182
L551 thru 556	2482
P551	0984
R551,552 R553,554 R555 R556	1782 0611 0611 0611
RT551	0683
W552 thru 563	1000

TLD9480A Directional Co

REFERENCE SYMBOL	M P
C560,561 C562,563 C564,565 C566	2113 2113 2113 2184
CR560,561	4882
L560,561 L562 thru 565 L566,567	2411 2484 2411
R560,561 R562,563	0683 0611

note: For optimum performance, the parts should be ordered by Motorola part number.

TRN7065A Hybrid Isolati

REFERENCE SYMBOL	M P
	0783 0784

TRN7077A Power Amplifier

REFERENCE SYMBOL	MO PA
	01826 01827 03109 03109 03109 03834 03836 04000 04001

07800
07839

parts list

TRN9987A DC Distribution Board

PL-11288-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C551	2182610C71	capacitor, fixed: 90pF $\pm 5\%$; 200V
L551 thru 556	2482835G14	coil: 1uH
P551	0984865R06	connector: receptacle: 16-contact
R551,552	1782620B04	resistor, fixed: $\pm 5\%$; 1/4W unless otherwise stated
R553,554	0611009A56	.02 $\pm 3\%$; 3W
R555	0611009A34	2000
R556	0611009A27	240
RT551	0683600K05	120
		thermistor: (see note)
		100K
		jumper: wire
W552 thru 563	1000000518	

TLD9480A Directional Coupler

PL-11337-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C560,561	2113740B25	capacitor, fixed: pF $\pm 5\%$ 50V: unless otherwise stated
C562,563	2113740B39	10
C564,565	2113740B73	39
C566	2184366F18	1000
		6 250V
CR560,561	4882106T01	diode: (see note)
		Schottky type
L560,561	2411087A04	coil:
L562 thru 565	2484331M43	.015uH
L566,567	2411087A29	4 turns
		1.8uH
R560,561	0683854P02	resistor, fixed:
R562,563	0611077A01	50 $\pm 2\%$ 1W
		0-ohm jumper

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

TRN7065A Hybrid Isolation Load, 2-Way

PL-11294-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	0783108N01	BRACKET, resistor
	0784102N01	FRAME, low density

TRN7077A Power Amplifier Hardware Kit

PL-11492-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
non-referenced items		
	0182691T02	ASSEMBLY, feedthru plate
	0182722T01	ASSEMBLY, metering board cable
	0310943J10	SCREW, tapping: TT3 \times 0.5 \times 8; 10 used
	0310943J21	SCREW, tapping: TT4 \times 0.7 \times 10; 8 used
	0310943R68	SCREW, tapping: TT4 \times 0.7 \times 13; 2 used
	0383498N06	SCREW, tapping: M4 \times 0.7 \times 16; 8 used
	0383678N03	SCREW, tapping: M3 \times 0.5 \times 9; 30 used
	0400007657	WASHER, #8 external lock
	0400139423	WASHER, flat: 0.125 \times 0.218 \times .018; 12 used
	0780078A01	BRACKET, thermister mounting
	0783990P01	BRACKET, right-hand PA mounting
	0783990P03	BRACKET, left-hand PA mounting
	0900816159	CONNECTOR, N-type female
	1582584T01	COVER, power amplifier pocket
	1583177N01	COVER, power amplifier
	2683223T01	HEAT SINK, power amplifier
	3282796H02	GASKET, 49.25"
	3282796H03	GASKET, 8.75"
	4210217A02	STRAP, tie: .091 \times 3.62
	4283150N01	STRAP, ground: 12 used

TKN8549A PA DC Power Cable

PL-11292-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
E561	2983897M02	terminal: terminal, wire grip
W502	3000831572	cable: #10 gauge stranded black battery: 9.5"
W503	3000813233	#10 gauge stranded red battery: 8.5"
non-referenced item		
	2982907N05	TERMINAL, ring: yellow

TRN9961A Interconnect Board

PL-11134-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
P602	0984865R06	connector: receptacle: 16-contact
P603, 604	0983365N01	receptacle: 8-contact
P605	2810773A05	plug: 10-contact

TLD9450A Power Combiner

PL-11332-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L576	2483035N73	coil, rf: 2 turns
L577 thru 579	2483035N59	4 turns
L580, 581	2483035N60	5 turns

TLD9460A Power Splitter

PL-11333-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L572 thru 574	2483035N59	coil, rf: 4 turns
L570, 571	2483035N60	5 turns
L575	2483035N73	2 turns