TRANSMITTER

Model Chart for Intermittent Duty Transmitter

Item	Description
TLD2532A	110 W Power Amplifier
TKN8313A	Internal Cable Kit
TFD6452A	Harmonic Filter
TLD9252A	Power Amplifier Board
TLD9272A	Power Control Board
TRN5141A	PA Hardware
TRN5378A	Closing Hardware
TLD9232A/B	Simplex Exciter Board (Simplex Stations Only)
TLD9242A/B	Duplex Exciter Board (Duplex Stations Only)

Model Chart for Continuous Duty Transmitter

	Frequency Coverage Chart	
Item	Description	Frequency
TLD2601A	100 Watt Power Amplifier Deck	132-150.8 MHz
TLD2602A	100 Watt Power Amplifier Deck	150.8-162 MHz
TLD2603A	100 Watt Power Amplifier Deck	162-174 MHz
TLD9231A	Simple Exciter Board	132-150.8 MHz
TLD9232A/B	Simplex Exciter Board	146-174 MHz
TLD9241A	Duplex Exciter Board	132-150.8 MHz
TLD9242A/B	Duplex Exciter Board	146-174 MHz

Assembly Breakdown Chart

TLD2601A	TLD2602A	TLD2603A	Item	Description
X			TFD6101A	Harmonic Filter, 132-150.8 MHz
	X	X	TFD6102A	Harmonic Filter, 150.8-174 MHz
X			TLD5952A	Power Amplifier Board, 132-150.8 MHz
	X		TLD5953A	Power Amplifier Board, 150.8-162 MHz
		X	TLD5954A	Power Amplifier Board, 162-174 MHz
X	X	X	TLD5960A	Power Control Board
X	X	X	TLN2424A includes includes includes	Power Amplifier Input Bracket Assembly TRN5566A PA Input Bracket TRN5585A Exciter Control Voltage Regulator TKN8336A PA Cable Kit
X	X	X	TRN5577A	PA Casting & Hardware
X	X	X	TRN5586A	PA Hardware
X	X	X	TRN8069A	Suppression Network

PERFORMANCE SPECIFICATIONS

Frequency Separation	3 MHz
Number of Channels	1, 2, 3, or 4
Frequency Stability	± .0005% from -30°C to +60°C (25°C reference) ± .0002% optional*
Power Output	Intermittent duty transmitter: 60 to 110 watts continuously variable, into 50 ohm load (EIA intermittent duty cycle) Continuous duty transmitter: 50 to 100 watts, continuously variable, into 50 ohm load (EIA continuous duty cycle)
Maximum Frequency Deviation	± 5 kHz @1 kHz
Sideband Spectrum	± 30 kHz 90 dB below carrier ± 1 MHz 105 dB below carrier
Hum and Noise	55 dB below 60% deviation @1 kHz
Audio Response	+1, -3 dB from 6 dB/octave, 300-3000 Hz, referenced to 1000 Hz
Spurious: Conducted Radiated	85 dB below carrier -13 dBm (dipole substitution method)
Audio Distortion	Less than 2% @1000 Hz, 60% system deviation

*Available with option C601, C602, C603, or C604.

1. GENERAL

The 110 watt intermittent duty and 100 watt continuous duty transmitters used in the Motorola *MSR 2000* VHF Base Station consist of the exciter board, mounted in the rf control chassis, and the power amplifier enclosed in a casting mounted at the top of the cabinet.

2. EXCITER

2.1 Two versions of the exciter are available. The TLD9230A Series Simplex Exciter is intended for use with stations operating in simplex (nonsimultaneous transmit/receive) mode. The TLD9240A Series Duplex Exciter contains additional interconnection filtering, and is intended for use with stations operating in duplex mode, i.e., repeater stations.

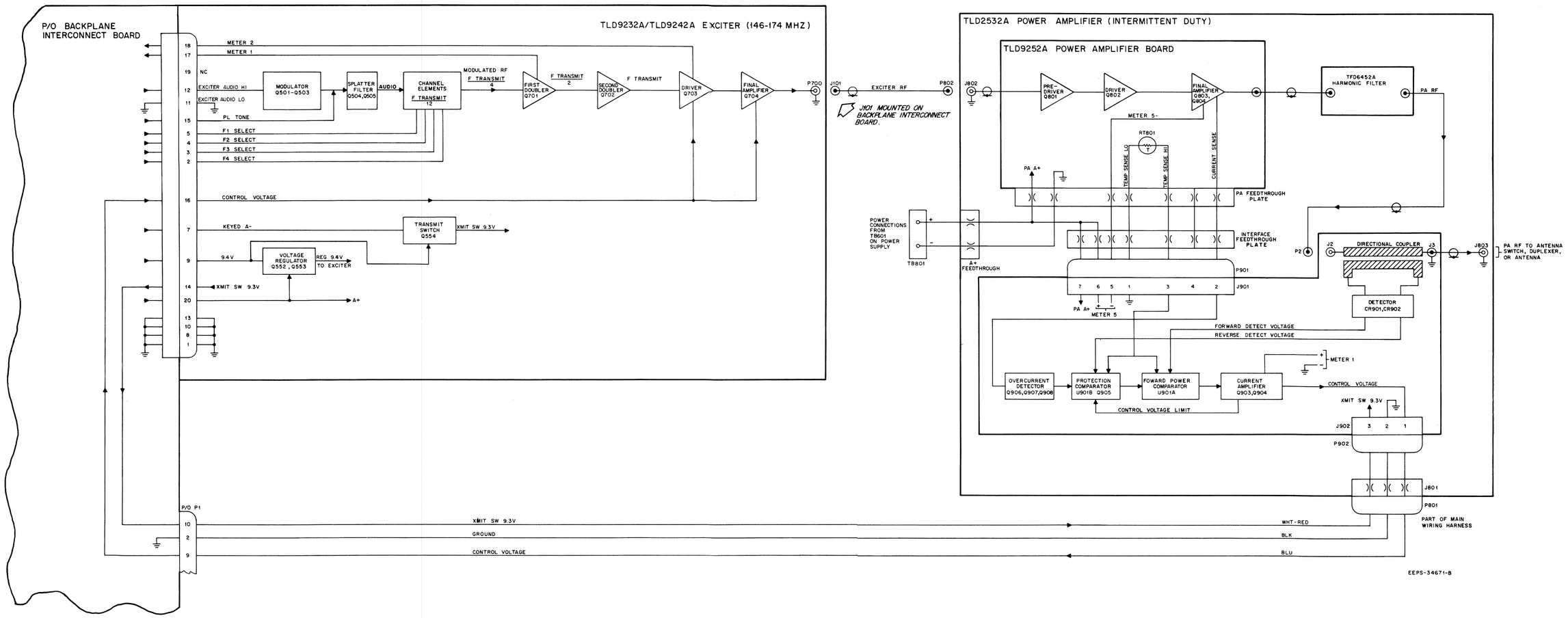
2.2 The exciter board is easily accessed for alignment by swinging the rf control chassis out and down. Refer to the Maintenance section of this manual for service access procedures.

3. POWER AMPLIFIER

The TLD2532A and TLD2600A Series Power Amplifiers consist of the power amplifier board, power control board, and harmonic filter, mounted in a rugged aluminum casting. All circuitry is fully shielded, and is easily accessed for alignment and servicing without removing the PA chassis from the base station. Refer to the Maintenance section of this manual for service access procedure.

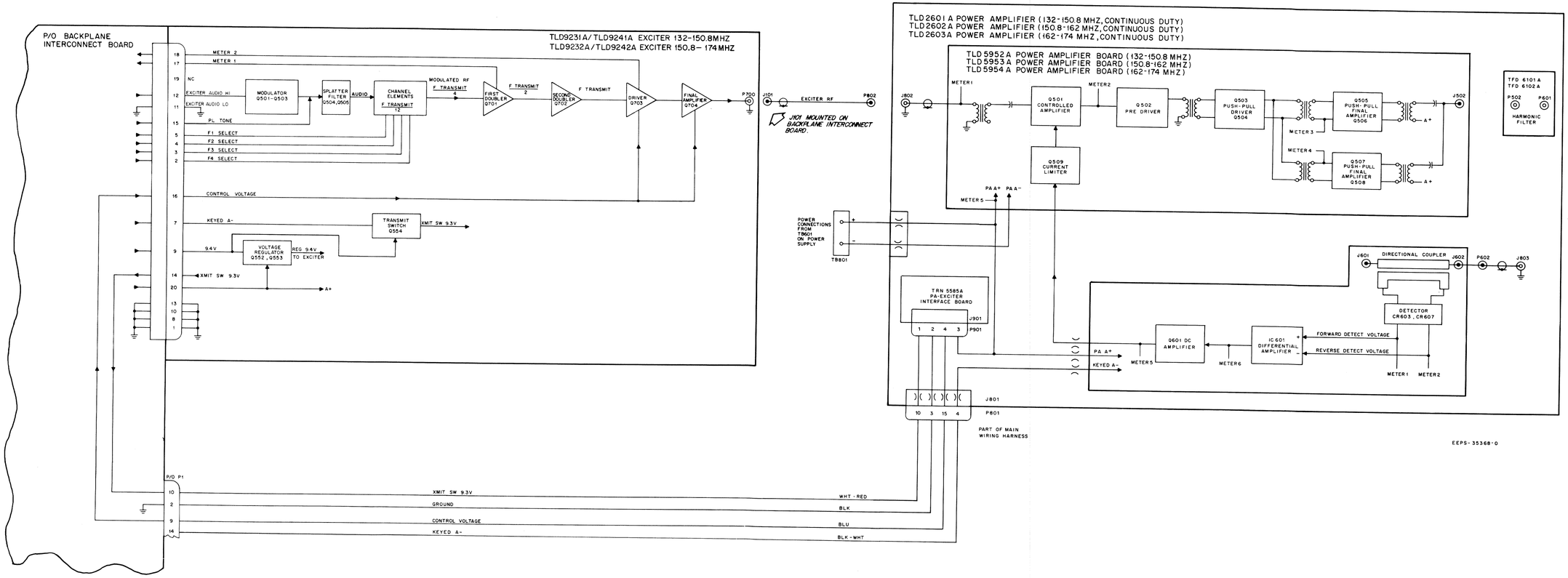
4. ALIGNMENT

The transmitter alignment procedure involves adjustments on the exciter board and on the power control board. The alignment procedure given is for use with the Motorola TEK-5 Meter Panel, S1056B Test Set, or optional station metering (TRN5080A DC Metering Chassis). When performing a complete alignment, perform the alignment procedures (exciter/PA/power control, oscillator frequency, deviation) in the order given.

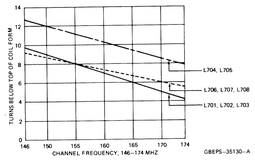

P/O BACKPLANE INTERCONNECT BOARD
TLD9232A/TLD9242A EXCITER (146-174 MHZ)
METER 2
METER 1
NC
EXCITER AUDIO HI
EXCITER AUDIO LO
PL TONE
F1 SELECT
F2 SELECT
F3 SELECT
F4 SELECT
CONTROL VOLTAGE
KEYED A-
9.4V
XMIT SW 9.3V
A+
MODULATOR Q501-Q503
SPLATTER FILTER Q504,Q505
AUDIO
CHANNEL ELEMENTS
F TRANSMIT 12
MODULATED RF
F TRANSMIT 4
FIRST DOUBLER Q701
F TRANSMIT 2
SECOND DOUBLER Q702
F TRANSMIT
DRIVER Q703
FINAL AMPLIFIER Q704
P700
VOLTAGE REGULATOR Q552,Q553
REG 9.4V TO EXCITER
TRANSMIT SWITCH Q554
XMIT SW 9.3V
J101
EXCITER RF
P802
J101 MOUNTED ON BACKPLANE INTERCONNECT BOARD.
TLD2532A POWER AMPLIFIER (INTERMITTENT DUTY)
TLD9252A POWER AMPLIFIER BOARD
J802
PRE-DRIVER Q801
DRIVER Q802
FINAL AMPLIFIER Q803, Q804
TFD6452A HARMONIC FILTER
PA RF
METER 5-
RT801
TEMP SENSE LO
TEMP SENSE HI
CURRENT SENSE
PA A+
PA FEEDTHROUGH PLATE
INTERFACE FEEDTHROUGH PLATE
POWER CONNECTIONS FROM TB601 ON POWER SUPPLY
TB801
A+ FEEDTHROUGH
P901
J901
7 6 5 1 3 4 2
PA A+
METER 5
P2
J2
DIRECTIONAL COUPLER
J3
J803
PA RF TO ANTENNA SWITCH, DUPLEXER, OR ANTENNA
DETECTOR CR901,CR902
FORWARD DETECT VOLTAGE
REVERSE DETECT VOLTAGE
METER 1
OVERCURRENT DETECTOR Q906,Q907,Q908
PROTECTION COMPARATOR U901B Q905
FOWARD POWER COMPARATOR U901A
CURRENT AMPLIFIER Q903,Q904
CONTROL VOLTAGE
CONTROL VOLTAGE LIMIT
XMIT SW 9.3V
J902
3 2 1
P902
J801
P801
PART OF MAIN WIRING HARNESS
P/O P1
10
2
9
XMIT SW 9.3V
GROUND
CONTROL VOLTAGE
WHT-RED
BLK
BLU
EEPS-34671-B

CONTINUOUS DUTY

TRANSMITTER FUNCTIONAL INTERCONNECT DIAGRAM



COIL PRESET CHART



NOTE

The tuning procedure should be performed using the TRN5080A DC Metering Chassis, Motorola TEK-5 Meter Panel (set to position "D" for exciter or "E" for PA) or Motorola S1056-1059 Portable Test Set (used with TEK-37A Test Set Adapter).

CAUTION

Do not key transmitter for more than a few seconds at a time until it is properly tuned. Key transmitter for brief periods while reading meter and making adjustments.

Exciter-PA Alignment Procedure

Step	Metering Cable Connection	Test Switch Position (Meter)	Adjustment	Procedure
1	None	None	Frequency Select	Set to lowest frequency transmit channel (multi-channel radios only).
			L701-L708	See Preset table
			R911,R931, R939	Set fully clockwise.
			C759	Preset fully clockwise
2	Exciter	M1	L701, L702, L703	Peak L702, then peak L701, L702, L703 in order until no further improvement is obtained.
3	Exciter	M1	L704, L705	Dip L704, peak L705.
4	Exciter	M2	L706, L707, L708, L704, L705	Peak L706, L707, L708, L704, L705 in order.
If tuning 1-frequency transmitter, or if overall channel separation is less than 500 kHz, skip to Step 12.				
5	Exciter	M1	L702	Peak on highest frequency channel.
6	Exciter	M2	L704,L706	Peak on highest frequency channel.
7	Exciter	M1	L701,L702	Peak on lowest frequency channel.
8	Exciter	M2	L705, L707	Peak on lowest frequency channel.
9	Transmit Antenna Connector	Wattmeter	C759	Adjust for highest power output at the lowest frequency. If a definite peak is not evident, i.e. if the same amount of power is obtained over a wide range of tuning of C759, turn R931 counterclockwise until output power drops by 10 watts then peak C759.
10	Exciter	Wattmeter and M2	L708	See R931 fully clockwise. Adjust L708 for equal M2 readings on highest and lowest frequency channels. If balanced M2 readings are not possible, peak L708 on channel with lowest M2 reading.
11	Go to Step 15			
12	Transmit Antenna Connector	Wattmeter	C759	Adjust for highest possible power output.
13	Exciter	M2	L707,L708	Peak.
14	Transmit Antenna Connector	Wattmeter	C759	Adjust for highest possible power output. If a definite peak is not evident, i.e. if the same amount of power is obtained over a wide range of turning of C759, turn R931 counterclockwise until power output drops by 10 watts, then peak C759.
15	Transmit Antenna Connector	Wattmeter	R931, R911	Set R931 fully clockwise. Adjust R911 for 120 watts rf output (any channel).
16	Power Control Board J1	M1,M5	Frequency Select	On each channel note M1 and M5 readings for reference.
17	Power Control Board J1	M1	R911,R931	Adjust R911 fully clockwise. On the channel with the highest initial M1, reading, adjust R931 for a reading 4 uA above that recorded in step 16.
18	Power Control Board J1	M5	R939	On the channel with the highest M5 reading, adjust for reading 2 uA above M5 reading recorded in Step 16. If a full 2 uA rise cannot be obtained, return R939 fully clockwise, read M5, and adjust R939 for a 0.5 uA drop in M5 reading.
NOTE Disconnect test set metering cables before performing Step 19.				
19	Transmit Antenna Connector	Wattmeter	R911	Adjust R911 so that minimum power output is 120 watts on all channels.

OSCILLATOR FREQUENCY ADJUSTMENT

Setting oscillator frequency should be done *after* exciter/power amplifier alignment, but *before* transmitter deviation is set. To set oscillator on frequency, perform the following procedure:

Step 1. Select transmitter operating frequency F1. Connect frequency meter to antenna connector via dummy load (refer to instructions provided with meter).

Step 2. Key transmitter with no modulation.

NOTE

On stations equipped with *Private-Line* or *Digital Private-Line* signaling, the PL/DPL encoder must be disabled. This is accomplished by grounding pin 14 of the PL/DPL board position on the backplane interconnect board.

Step 3. Adjust F1 FREQ control for proper reading on frequency meter. If the frequency, as indicated on the frequency meter is too low, turn the control counterclockwise. If the frequency is too high, turn the control clockwise. Set frequency within ± 75 Hz.

NOTE

Omit Steps 4 and 5 for 1-frequency stations.

Step 4. Select transmitter operating frequency F2, and repeat Step 3 using F2 FREQ control.

Step 5. Repeat Step 4 for F3 and F4 using F3 FREQ and F4 FREQ controls respectively.

INSTANTANEOUS DEVIATION CONTROL (IDC) ADJUSTMENT

NOTE

The oscillator frequency adjustment must be made prior to this adjustment.

Step 1. Connect the output leads of an audio oscillator, through a .33 uF capacitor, to exciter pins 12 (EXCITER AUDIO HI) and 11 (EXCITER AUDIO LO).

Step 2. Connect an ac voltmeter across the same terminals and adjust the audio oscillator output to 350 mV rms at 1000 Hz.

Step 3. Key transmitter and adjust F1 IDC while observing deviation monitor. Adjust control for 4.7 kHz deviation.

Step 4. Repeat Step 3 for each frequency used, adjusting IDC adjustment corresponding to each channel.

NOTE

If radio set transmits *Private-Line* or *Digital Private-Line* signals, PL/DPL deviation with audio oscillator disconnected should now be between 0.5 and 1.0 kHz.

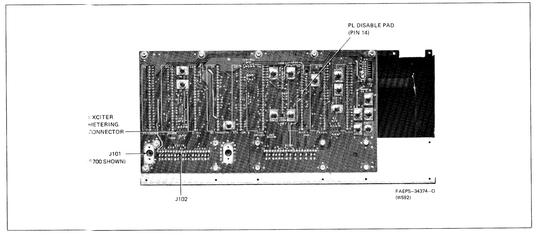


Figure 1. Basic Chassis Exciter Metering Connection Detail

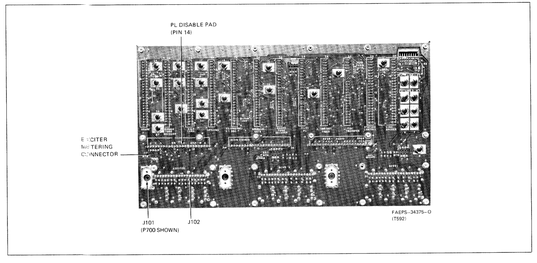


Figure 2. Fully Optionable Chassis Exciter Metering Connection Detail

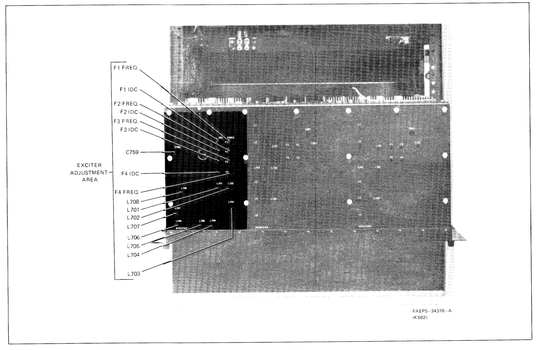


Figure 3. Exciter Adjustment Location Detail

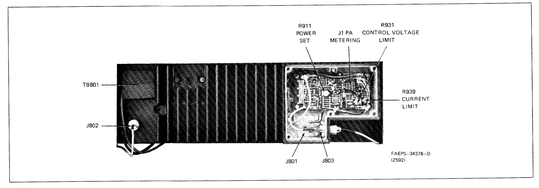
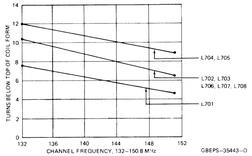


Figure 4. PA Adjustment Location Detail

COIL PRESET CHARTS



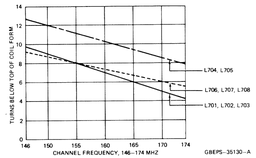


Table 1. Control Voltage Set (R901)

Model	Frequency (MHz)	Voltage*
TLD9231A or TLD9241A	132-141	5.5 V
	141-150.8	6.0 V
TLD9232A/B or TLD9242A/B	146-160	6.0 V
	160-174	6.5 V

*Voltage is measured at pin 16 of exciter.

Table 2. Meter Limit Specifications

Metering Cable Connection	Test Switch Position (Meter)	Min (uA)	Max (uA)
Exciter	M1	10	50
Exciter	M2	15	50
Power Amplifier	M1	10	
Power Amplifier	M2	5	
Power Amplifier	M3	10	
Power Amplifier	M4	10	
Power Amplifier	M5		29
Power Control Board	M1	15	45
Power Control Board	M2		10
Power Control Board	M5		50

* Limit specifications are applicable after the transmitter has been aligned and is operating into a 50 ohm load.

NOTE

The tuning procedure should be performed using the TRN5080A DC Metering Chassis, Motorola TEK-5 Meter Panel (set to position "D" for exciter, "C" for PA, and "E" for Power Control) or Motorola S1056-1059 Portable Test Set (used with TEK-37A Test Set Adapter).

CAUTION

Do not key transmitter for more than a few seconds at a time until it is properly tuned. Key transmitter for brief periods while reading meter and making adjustments.

Exciter-PA Alignment Procedure

Step	Metering Cable Connection	Test Switch Position (Meter)	Adjustment	Procedure
1	None	None	Frequency Select	Turn the FREQUENCY SELECT switch to the lowest frequency channel.
			L701, L702, L703	Preset coil slugs per coil preset chart.
			L704, L705	Preset coil slugs per coil preset chart.
			L706, L707, L708	Preset coil slugs per coil preset chart.
			C759	Preset fully clockwise (CW).
			R611 — Power Set on Power Control Board	Preset fully counterclockwise (CCW).
			R901 — Exciter Level Control on Power Input Bracket	Preset fully clockwise (CW).
2	Exciter	M1	L701, L702, L703	Peak L702, then peak L701, L702, L703 in order until no further improvement is obtained.
3	Exciter	M1	L704, L705	Dip L704, then peak L705.
4	Exciter	M2	L706, L707, L708, L704, L705	Peak L706, L707, L708, L704, and L705 in that order.
If transmitter is to be tuned for a single frequency, or frequencies with a separation of less than 500 kHz, skip to Step 12.				
5	None	None	Frequency Select	Turn the FREQUENCY SELECT switch to the highest channel frequency.
6	Exciter	M1	L702	Peak L702.
7	Exciter	M2	L704,L706	Peak L704 and L706.
8	None	None	Frequency Select	Turn the FREQUENCY SELECT switch to the lowest channel frequency.
9	Exciter	M1	L701,L703	Peak L701 and L703.
10	Exciter	M2	L705, L707	Peak L705 and L707.
11	Power Amplifier	M1	C759	Peak C759 (Exciter). If M1 is greater than 50 uA, reduce exciter control voltage (R901) until a peak can be obtained.
12	Exciter (pin 16)	Voltmeter	R901	Set control voltage according to Table 1.
If the transmitter is to be tuned for a single frequency or frequencies with a separation of less than 500 kHz, skip to Step 15.				
13	Exciter	M2	L708	Adjust L708 for equal M2 readings on the lowest channel frequency and on the highest channel frequency. If M2 cannot be equalized, peak L708 on the channel with the lowest 2 reading.
14	Power Amplifier	M1	C759	Peak C759 (exciter) on the lowest channel frequency. If M1 is greater than 50 uA, reduce the exciter control voltage (R901) until a peak is observed. After peaking C759, reset exciter control voltage to the value in Step 12. Then go to Step 17.
15	Exciter	M2	L707, L708	Peak L707 and L708.
16	Power Amplifier	M1	C759	Peak C759 (exciter). If M1 is greater than 50 uA, reduce the exciter control voltage (R901) until a peak can be observed. After peaking C759, reset exciter control voltage to the value in Step 12.
17	Power Amplifier		R611	If power amplifier is to be re-aligned *greater* than ±1 MHz from original frequency proceed with Step 18. If power amplifier is to be re-aligned less than ±1 MHz from original frequency, remove power control board shield, move metering plug to power control board. Set R611, Power Set, fully clockwise (CW) and go to Step 22.

Exciter-PA Alignment Procedure (Cont'd.)

Step	Metering Cable Connection	Test Switch Position (Meter)	Adjustment	Procedure
18	Power Amplifier		C501, C502, R610	REALIGNMENT—Set cap. C501 fully clockwise. Set cap. C502 to maximum capacity (plates fully meshed). Remove power control board shield and move metering plug to power control board. Use tuning tool Motorola No. 66A82846D01 or equivalent to prealign POWER LIMIT control R610, located on the component side of the board. Access to this control is provided by a small slot located approximately 3/4" from the POWER SET access hole. The tuning tool rotates the outer edge of a serrated knob. Adjust R610, the POWER LIMIT control, to the end of its travel by rotating the edge of the knob toward the front of the station with the PA in the tilted out position.
19	Power Control Board		R611	TRANSMITTER OUTPUT—Adjust R611 (POWER SET) control to maximum clockwise (CW) position.
20	Power Control Board	M5	C501	PA (DRIVER) OUTPUT—Observe M5. If this indication is *less* than 50 uA (full scale), proceed with Step 21. If this indication is *greater* than 50 uA tune C501 for on-scale reading.
21	Power Control Board	Wattmeter	R610	TRANSMITTER OUTPUT—Adjust R610 (POWER LIMIT control) *toward* back of station until no further increase in power output is observed. Adjust POWER LIMIT control for an approximate 5 W to 10 W reduction to obtain an unsaturated meter 5 reading.
22	Power Control Board	M5	C501, C502	PA DRIVER OUTPUT—Tune C501 *then* C502 for a minimum M5 reading.
NOTE Repeat Steps 21 and 22 until no further dip in meter 5 can be obtained.				
23	Power Control Board	Wattmeter	R610	TRANSMITTER OUTPUT—Adjust the POWER LIMIT control (R610) for 115 W.
24	Power Control Board	M5 Wattmeter	R610	Replace the power control board shield. If M5 exceeds 50 uA when shield is replaced, remove shield and adjust POWER LIMIT control (R610) slightly (turn knob toward front of station) until an on-scale reading (50 uA or less) is observed when shield is replaced. Power output shall be at least that specified in Step 23.
25	Power Control Board	Wattmeter	R611	TRANSMITTER OUTPUT—Remove the meter cable and adjust POWER SET control (R611) for rated power output.
26	Power Amplifier	M5		FINAL COLLECTOR CURRENT—Move the metering plug to the PA. Measure the final collector current (Ic). Ic, in amperes is the M5 reading: (0-50) × 1/2.
This completes transmitter tuning. Refer to Table 2 for metering limits.				

OSCILLATOR FREQUENCY ADJUSTMENT

Setting oscillator frequency should be done *after* exciter/power amplifier alignment, but *before* transmitter deviationis set. To set oscillator on frequency, perform the following procedure:

Step 1. Select transmitter operating frequency F1. Connect frequency meter to antenna connector via dummy load (refer to instructions provided with meter).

Step 2. Key transmitter with no modulation.

NOTE

On stations equipped with *Private-Line* or *Digital Private-Line* signaling, the PL/DPL encoder must be disabled. This is accomplished by grounding pin 14 of the PL/DPL board position on the backplane interconnect board.

Step 3. Adjust F1 FREQ control for proper reading on frequency meter. If the frequency, as indicated on the frequency meter is too low, turn the control counterclockwise. If the frequency is too high, turn the control clockwise. Set frequency within ±75 Hz.

NOTE

Omit Steps 4 and 5 for 1-frequency stations.

Step 4. Select transmitter operating frequency F2, and repeat Step 3 using F2 FREQ control.

Step 5. Repeat Step 4 for F3 and F4 using F3 FREQ and F4 FREQ controls respectively.

INSTANTANEOUS DEVIATION CONTROL (IDC) ADJUSTMENT

NOTE

The oscillator frequency adjustment must be made prior to this adjustment.

Step 1. Connect the output leads of an audio oscillator, through a .33 uF capacitor, to exciter pins 12 (EXCITER AUDIO HI) and 1 (EXCITER AUDIO LO).

Step 2. Connect an ac voltmeter across the same terminals and adjust the audio oscillator output to 350 mV rms at 1000 Hz.

Step 3. Key transmitter and adjust F1 IDC while observing deviation monitor. Adjust control for 4.7 kHz deviation.

Step 4. Repeat Step 3 for each frequency used, adjusting IDC adjustment corresponding to each channel.

NOTE

If radio set transmits *Private-Line* or *Digital Private-Line* signals, PL/DPL deviation with audio oscillator disconnected should now be between 0.5 and 1.0 kHz.

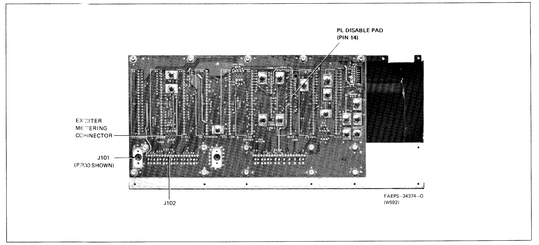


Figure 1. Basic Chassis Exciter Metering Connection Detail

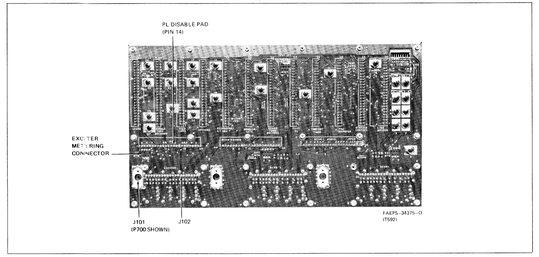


Figure 2. Fully Optionable Chassis Exciter Metering Connection Detail

CONTINUOUS DUTY TRANSMITTER ALIGNMENT

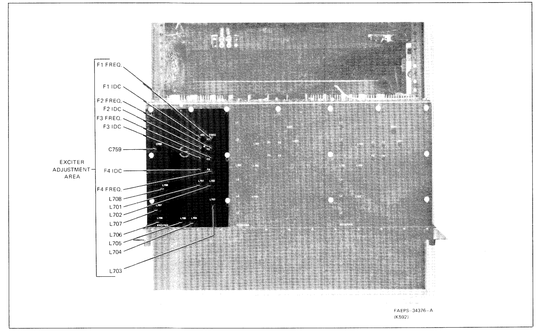


Figure 3. Exciter Adjustment Location Detail

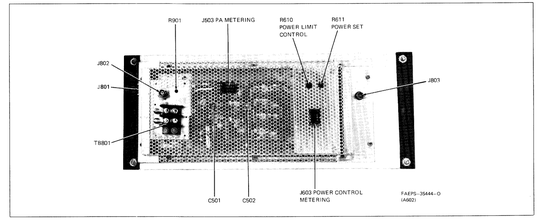


Figure 4. PA Adjustment Location Detail

Continuous Duty Transmitter Alignment
Motorola No. ***PEPS-35367-A***
9/30/85-UP

EXCITER

MODELS TLD9231A AND TLD9232B SIMPLEX
TLD9241B AND TLD9242C DUPLEX

1. DESCRIPTION

1.1 The Model TLD9230 Series or TLD9240 Series Exciters provide the low power excitation for the FM transmitter. Up to four plug-in channel elements, one for each transmitter operating frequency, are used to develop a direct FM carrier signal of at least 1.5 watts.

1.2 The exciter is direct frequency-modulated for crystal-controlled frequency operation in the 132-174 MHz range. It consists of a modulator amplifier and clipper, emitter-follower splatter filter, channel element(s) (voltage-controlled crystal oscillator), first doubler, second doubler, driver, and final amplifier. The fundamental crystal frequency is multiplied by twelve to provide the transmitter carrier frequency.

1.3 When the exciter is used in PL/DPL coded stations, the PL/DPL encoding signals are inserted into the transmit audio at the input to the splatter filter stage.

2. THEORY OF OPERATION

Refer to the transmitter functional block diagram (in Transmitter section of this manual) and the exciter schematic diagram included in this section.

2.1 TRANSMIT AUDIO CIRCUIT

Exciter audio from the station control module (or test microphone) is applied to audio amplifier Q501, then routed to the clipper/pre-emphasis circuit of Q502 and Q503. This amplitude limited audio is combined with the PL or DPL code audio (if present) and routed via active splatter filter Q504-Q505, to the channel element(s).

2.2 CHANNEL ELEMENTS

2.2.1 Each channel element is comprised of a highly stable, frequency modulated crystal controlled oscillator. The channel element is a factory-sealed plug-in module, using an unheated crystal in an oscillator circuit that is temperature-compensated over an ambient temperature range of -30°C to +60°C (-22°F to +140°F). The oscillator operates at 1/12 of the transmitted carrier frequency.

2.2.2 The channel element contains a series combination of a varactor diode, a warping coil, and the crystal. A change in the series inductance or capacitance causes the crystal to vary its resonant frequency in proportion to the change. The audio voltage from the IDC circuitry (within the channel element) is applied to the varactor diode to cause a change in capacitance; this variation causes the carrier frequency to change (deviate) at the same audio rate. The variable warp coil and IDC potentiometer are accessible through holes in the top of each channel element, for fine frequency and IDC adjustments.

2.2.3 The exciter accepts up to four channel elements; one is required for each transmit frequency. A power input of +9.4 volts is applied continuously to all channel elements while the station is turned on. Channel element output is developed when a switched ground from the station control module is routed to the enable pin.

2.3 MULTIPLIERS AND AMPLIFIERS

2.3.1 The multipliers develop an output signal that is 12 times the channel element frequency, and the final amplifier provides power gain, as controlled by the power control board on the power amplifier.

2.3.2 The output of the activated channel element is routed through three tuned circuits in series. The tuned circuits (L701, L702, L703, and associated components) are tuned to the approximate third harmonic of the channel element frequencies. The signal from the tuned circuit is routed to first doubler Q701. First doubler Q701 and second doubler Q702 multiply the filtered output to 12 times the crystal frequency.

2.3.3 Driver and final amplifier Q703 and Q704 provide two stages of amplification at the transmit frequency. The power output level of the driver and final amplifier is controlled by varying the dc collector volt-

age on the transistors. For intermittent duty stations, the CONTROL VOLTAGE is developed on the power control board in the power amplifier. The CONTROL VOLTAGE changes as required to maintain correct PA output level and operating parameters. For continuous duty stations, the CONTROL VOLTAGE is developed on the exciter control voltage regulator board. The CONTROL VOLTAGE is set by the Exciter Level Control (R901).

3. EXCITER FUNCTIONAL TESTS

The tests in this section should be performed *after* servicing but *before* alignment, to verify that the exciter circuitry is operating correctly.

3.1 EXCITER POWER OUTPUT TEST

3.1.1 Intermittent Duty Station

Step 1. Disconnect exciter output cable from power amplifier chassis, and connect to rf wattmeter and dummy load.

Step 2. Set Power Set (R911) and Current Limit (R939) controls to mid-rotation. These controls are located on the power control board in the PA chassis. (Refer to Power Amplifier section for exact location.)

Step 3. Set Control Voltage Limit (R931) fully clockwise. This control is also located on the power control board.

Step 4. Key transmitter and observe wattmeter. Power output is normally at least 1.5 watts.

3.1.2 Continuous Duty Station

Step 1. Disconnect exciter output cable from power amplifier chassis, and connect to rf wattmeter and dummy load.

Step 2. Set Exciter Level Control (R901) fully clockwise (CW). This control is located on the power amplifier.

Step 3. Key the transmitter and observe the wattmeter. Power output is normally at least 0.75 watts.

3.2 FREQUENCY TEST

Step 1. Terminate the transmitter in an antenna or dummy load and measure the radiated signal frequency with a Motorola digital frequency meter or other highly accurate frequency measuring device (±.00005% or better) when the transmitter is keyed in the following steps.

Step 2. Key the transmitter to produce an unmodulated carrier signal. In stations equipped with PL or DPL signaling, disable the encoder by shorting the disable pin to ground (pin 14 on the PL/DPL position on the backplane interconnect board).

NOTE

Do not use microphone push-to-talk switch to key station. Background noise can modulate the transmitter.

Step 3. Read transmitter output frequency. Repeat for each channel on multi-frequency stations.

3.3 DEVIATION TEST

Step 1. Terminate transmitter with an antenna or dummy load and measure the radiated signal deviation using a Motorola deviation monitor when the transmitter is keyed in the following steps.

Step 2. (PL/DPL models only.) Remove PL/DPL inhibit jumper (if installed during previous test). Key transmitter without voice modulation. Normal PL/DPL deviation is 0.5 to 1 kHz.

Step 3. Connect audio oscillator to exciter board pins P501-12 (EXCITER AUDIO HI) and P501-11 (EXCITER AUDIO LO). Set audio oscillator to 1000 Hz at 350 mV rms output. Normal deviation is 4.7 kHz.

Step 4. Adjust audio oscillator over 300-3000 Hz range, keeping audio level at 1 volt. Normally, deviation never exceeds ±5 kHz, nor is less than ±2.5 kHz.

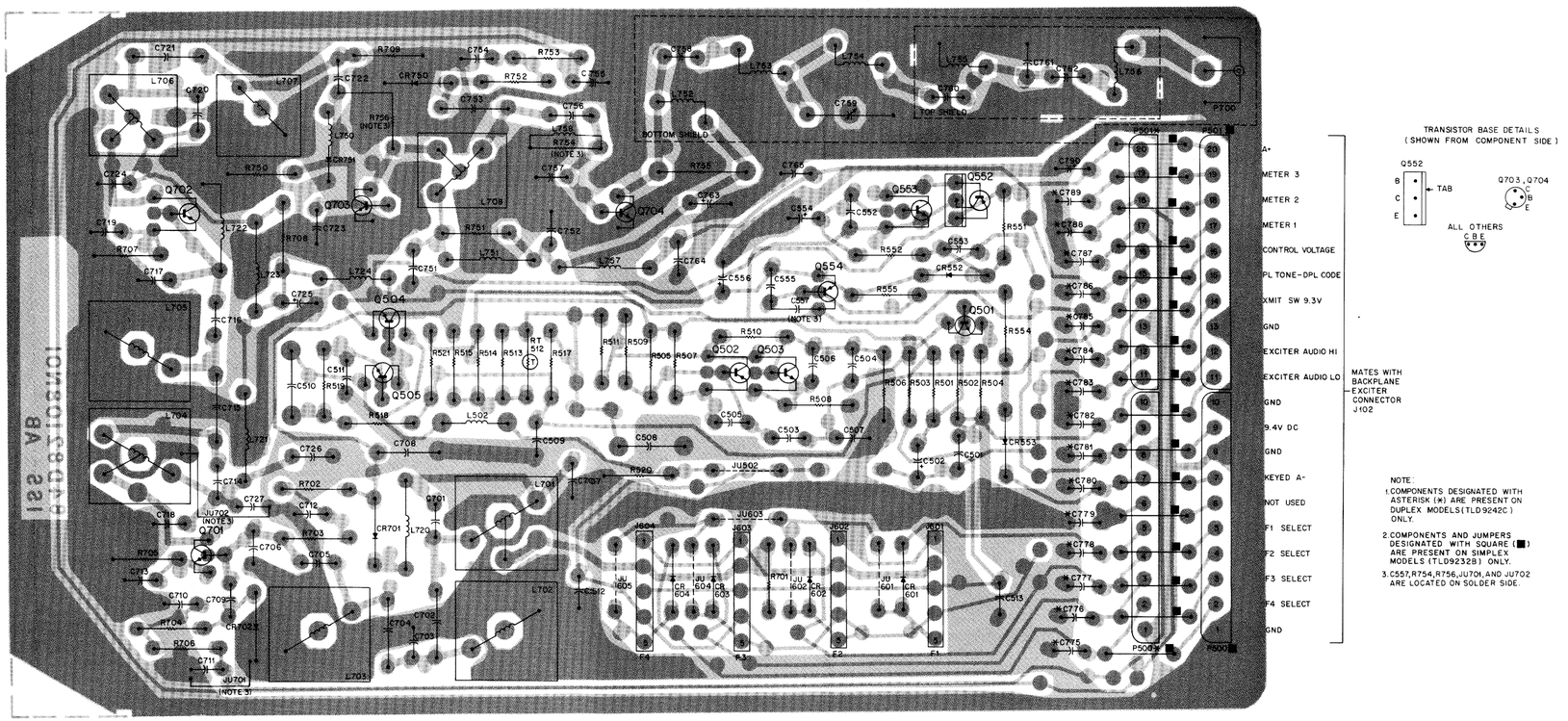
4. TROUBLESHOOTING

Refer to Table 1 for exciter troubleshooting procedure.

Table 1. Exciter Troubleshooting Procedure

Symptom	Cause	Test or Correction
No Meter 1 Reading	1. Unused or out-of-frequency range channel selected	1. Ground channel element enable pin for active channel
	2. No XMIT SWITCHED 9.3 V	2. Check for presence of keyed A-, check or replace Q554
	3. No REG 9.4 V	3. Check circuitry of Q552
	4. Bad channel element	4. Try different channel or replace
	5. L701, L702, L703 mis-tuned	5. Perform Exciter/PA Alignment
No Meter 2 Reading	1. Bad Q701, Q702, and/or Q703	1. Check and replace
	2. Improper control voltage	2. Troubleshoot PA Power control Board or Exciter Control Voltage Regulator Board
	3. L704, L705, L706, L707 and/or L708 mistuned	3. Perform Exciter/PA Alignment
Low or No Output Power	1. Bad Q703 or Q704	1. Check and Replace
	2. Improper control voltage	2. Troubleshoot PA Power Control Board or Exciter Control Voltage Regulator Board
	3. Mis-tuned C759	3. Retune for highest possible power output
Insufficient Deviation	1. Bad Q501	1. Check and replace
	2. Wrong jumpers installed	2. Check that JU501 is out and JU502 is in for non-*DVP* stations

EARLIER VERSION EXCITER

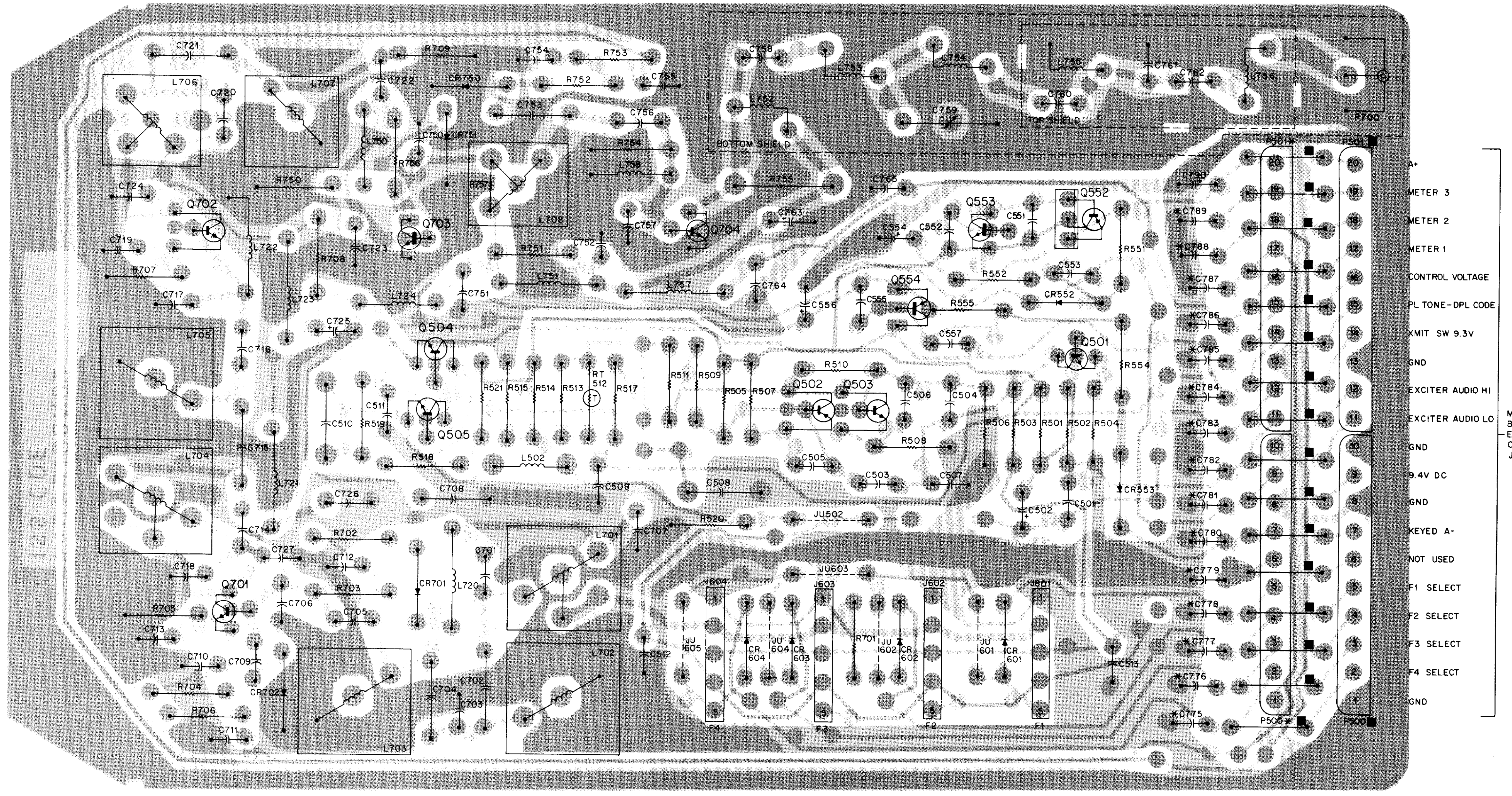


SHOWN FROM COMPONENT SIDE

SOLDER SIDE ■ BD-EEPS-34369-O
COMPONENT SIDE ■ BD-EEPS-34368-O
OL-EEPS-34370-B

CIRCUIT BOARD DETAIL AND PARTS LISTS

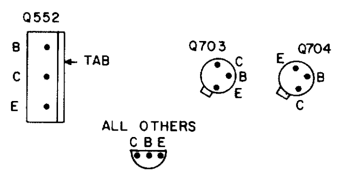
LATER VERSION EXCITER



SHOWN FROM COMPONENT SIDE

SOLDER SIDE: BD-DEPS-35241-O
COMPONENT SIDE: BD-DEPS-35242-O
OL:EEPS-35243-O

TRANSISTOR BASE DETAILS
(SHOWN FROM COMPONENT SIDE)



NOTE:
1. COMPONENTS DESIGNATED WITH ASTERISK (*) ARE PRESENT ON DUPLEX MODELS (TLD9242A, 41A) ONLY.
2. COMPONENTS AND JUMPERS DESIGNATED WITH SQUARE (■) ARE PRESENT ON SIMPLEX MODELS (TLD9232A, 31A) ONLY.

Exciter Range

Kit No.	Range	Frequency (MHz)	Type
TLD9231A	Low (L)	132-150.8	Simplex
TLD9232B	High (H)	146-174	Simplex
TLD9241B	Low (L)	132-150.8	Duplex
TLD9242C	High (H)	146-174	Duplex

parts list

TLD9231A/TLD9232B Simplex Exciter
TLD9241B/TLD9242C Duplex Exciter PL-7934-E

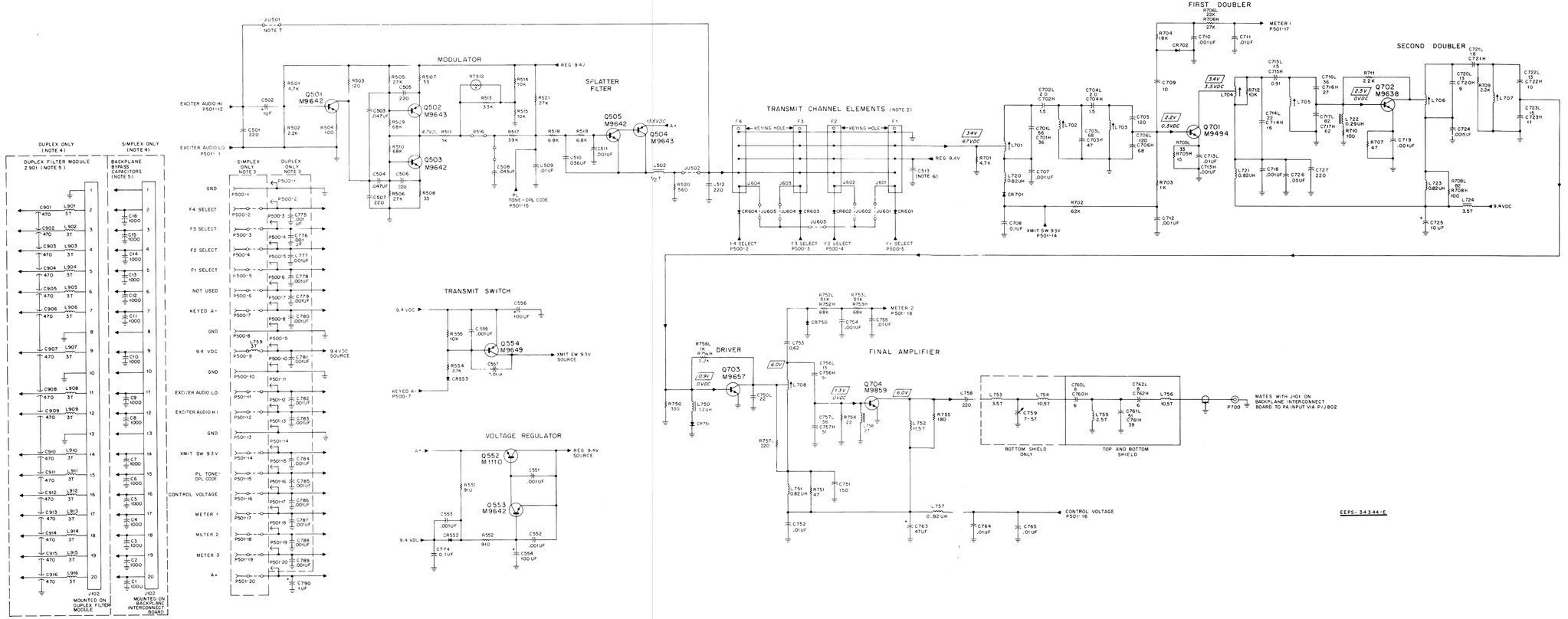
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: uF ±5%; 50 V: unless otherwise stated
C501	21-11015B05	220 pF ±10%; 100 V
C502	23-11019A09	1 ±20%
C503, 504	8-11017B14	.047
C505, 506, 507	21-11015B05	220 pF ±10%; 100 V
C508	8-83813H14	.043 uF; 5%; 50 V
C509	8-11017A08	.01
C510	8-83813H24	.036
C511	8-11017A01	.001
C512	21-11015B05	220 pF ±10%; 100 V
C513	21-11021H03	.01 +80-20%, 50 V (TLD9231A, 32B only)
C513	23-11019A09	1 ±20%, 50 V (TLD9241B, 42C only)
C551, 552, 553	21-11015B13	.001 ±10%; 100 V
C554	23-11019A46	100 ±20%; 25 V
C555	21-11015B13	.001 ±10%; 100 V
C556	23-11019A46	100 ±20%; 25 V
C557	21-11021H03	.01 +80-20%
C701L	21-11022G48	56 pF
	or 21-11014H43	56 pF; 100 V
C701H	21-11022G44	39 pF
C702L	21-82450B18	2 pF; 500 V
C702H	21-82450B13	1.5 pF; 500 V
C703L	21-11022G50	68 pF
	or 21-11014H45	68 pF; 100 V
C703H	21-11022G46	47 pF
C704L	21-82450B18	2 pF; 500 V
C704H	21-82450B13	1.5 pF; 500 V
C705	21-11022G57	120 pF
C706L	21-11022E57	120 pF
C706H	21-11022G50	68 pF
C707	21-11015B13	.001 ±10%; 100 V
C708	21-82372C09	0.1 ±80-20%; 25 V
C709	21-11022G30	10 pF
C710	21-11015B13	.001 ±10%; 100 V
C711	21-11021H03	.01 +80-20%; 50 V
C712	21-11015B13	.001 ±10%; 100 V
C713L	21-11021F04	.01 uF
C713H	21-11015B13	.001 uF ±10%; 100 V
C714L	21-11022G38	22 pF
C714H	21-11022K23	16 pF
C715L	21-82450B13	1.5 pF; 500 V
C715H	21-82450B39	0.91 pF; 500 V
C716L	21-11022G43	36 pF
C716H	21-11022G40	27 pF
C717L	21-11022G53	82 pF
C717H	21-11014H44	62 pF
C718, 719	21-11015B13	.001 ±10%; 100 V
C720L	21-11022G33	13 pF
	or 21-11014H28	13 pF; 100 V
C720H	21-11022G27	9 pF ±0.5 pF
C721L	21-82450B19	1.8 pF; 500 V
C721H	21-82450B47	1 pF; 500 V
C722L	21-11022G33	13 pF ±0.5 pF
C722H	21-11022G30	10 pF ±0.5 pF
C723L	21-11022G34	15 pF
C723H	21-11022G31	11 pF
C724	21-11015B15	.0015
C725	23-11019A20	10 ±10%; 25 V
C726	21-82372C10	.05 ±20%; 25 V
C727	21-11015B05	220 pF ±10%; 100 V
C750L	21-11022G38	22 pF
C751	21-11022G59	150 pF
C752	21-11021H03	.01 +80-20%; 50 V
C753	21-82450B46	0.62 pF; 500 V
C754	21-11015B13	.001 ±10%; 100 V
C755	21-11021H03	.01 +80-20%; 50 V
C756L	21-82610C74	13 pF; N150
C756H	21-80171A25	9.1 pF ±.25 pF
C757L	21-11022G48	56 pF
	or 21-11014H43	56 pF; 100 V
C757H	21-11022G47	51 pF
C758	21-11015B05	220 pF ±10%; 100 V
C759	20-84579B11	variable; 7-57 pF
C760L	21-11022G25	8 pF ±0.5 pF
	or 21-851846	8 pF ±.25 pF
C760H	21-11022G20	6 pF ±0.5 pF
C761L	21-11022G47	51 pF
C761H	21-11022G44	39 pF
C762L	21-11022G25	8 pF ±0.5 pF
	or 21-851846	8 pF ±.25 pF
C762H	21-11022G20	6 pF ±0.5 pF
C763	23-84538G06	47 ±20%; 20 V
C764, 765	21-11021H03	.01 +80-20%
C774	8-11017B17	0.1 ±10%
C775 thru 789	21-11015B13	.001 ±10%; 100 V (TLD9242C, 41B only)
C790	23-11019A09	1 ±20%
		diode: (see note)
CR552	48-83654H02	silicon
CR553	48-83654H01	silicon
CR601 thru 604	48-83654H01	silicon
CR701	48-82466H13	silicon

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
CR702	48-83654H01	silicon
CR750	48-83654H01	silicon
CR751	48-82139G01	germanium
		connector, receptacle:
J601 thru 604	28-80096A02	male; 5-contact
		coil, rf:
L502	24-80036A02	choke; 1/2 turn
L701	24-83377G11	choke; 6-1/2 turns coded (VIO)
L702, 703	24-80068A17	6-1/2 turns; coded (YEL)
L704	24-80068A18	4-1/2 turns; coded (ORG)
L705	24-80068A19	4-1/2 turns; coded (WHT)
L706	24-80034A02	3-1/2 turns; coded (WHT)
L707	24-80034A03	3-1/2 turns; coded (RED)
L708	24-80034A01	3-1/2 turns; coded (ORG)
L720, 721	24-82835G13	choke; 0.82 uH
L722	24-82723H04	0.29 uH
L723	24-82835G13	choke; 0.82 uH
L724	24-83961B01	3-1/2 turns
L750	24-82723H27	choke; 1.2 uH
L751	24-82835G13	choke; 0.82 uH
L752	24-84411B03	11-1/2 turns; coded (BRN)
L753	24-83884G01	3-1/2 turns; coded (PINK)
L754	24-84411B04	10-1/2 turns; coded (ORG)
L755	24-83884G07	2-1/2 turns; coded (GRN)
L756	24-84411B04	10-1/2 turns; coded (ORG)
L757	24-82835G13	choke; 0.82 uH
L758	24-83961B07	choke; 2 turns
L759	24-83861B01	choke; 3 turns; (TLD9231A, 32B only)
		connector, plug:
P500, 501	28-83254N01	male; 10-contact (TLD9241B, 42C only)
	9-83497F05	female; 10-contact (TLD9231A, 32B only)
P700	9-82872N01	female; phono
		transistor: (see note)
Q501	48-869642	NPN; type M9642
Q502	48-869643	PNP; type M9643
Q503	48-869642	NPN; type M9642
Q504	48-869643	PNP; type M9643
Q505	48-869642	NPN; tpe M9642
Q552	48-84411L10	PNP; type M1110
Q553	48-869642	NPN; type M9642
Q554	48-869649	PNP; type M9649
Q701	48-869494	NPN; type M9494
Q702	48-869638	NPN; type M9638
Q703	48-869657	NPN; type M9657
Q704	48-869859	NPN; type M9859
		resistor, fixed: ±5%; 1/4 W: unless otherwise stated
R501	6-11009A65	4.7k
R502	6-11009A57	2.2k
R503	6-11009A27	120
R504	6-11009A25	100
R505, 506	6-11009A83	27k
R507, 508	6-11009A13	33
R509, 510	6-11009A93	68k
R511	6-10621B94	1000 precison
R513	6-11009A85	33k
R514	6-11009A73	10k
R515	6-11009A73	10k
R517	6-11009A63	3.9k
R518, 519	6-10621C75	6.8k ±1%
R520	6-11009A43	560
R521	6-11009A83	27k
R551, 552	6-11009A48	910
R554	6-11009A59	2.7k
R555	6-11009A73	10k
R701	6-11009A65	4.7k
R702	6-11009A92	62k
R703	6-11009A49	1k
R704	6-11009A79	18k
R705L	6-11009A13	33
R705H	6-11009A05	15
R706L	6-11009A81	22k
R706H	6-11009A83	27k
R707	6-11009A17	47
R708L	6-11009A23	82
R708H	6-11009A25	100
R709	6-11009A57	2.2k
R710	6-11009A25	100
R711	6-11009A57	2200
R712	6-11009A73	10k
R750	6-11009A37	330
R751	6-11009A17	47
R752L	6-11009A90	51k
R752H	6-11009A93	68k
R753L	6-11009A90	51k
R753H	6-11009A93	68k

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R754	6-11009A09	222
R755	6-125C31	180 ±10%; 1/2 W
R756	6-11009A57	2.2k
R756L	6-11009A49	1k
R756H	6-11009A57	2.2k
R757L	6-11009E33	220
		thermistor:
RT512	6-84259H02	44k ±10% -25°C
		mechanical parts
	3-84256M01	SCREW, tapping; 2 used
	5-84220B01	GROMMET; 2 used
	6-11009B23	JUMPERS; 15 used (TLD9231A, 32B only)
	14-861196	INSULATOR; 2 used
	26-80039A01	CAN, coil; 3 used
	26-80150B01	HEAT SINK Q704
	26-80196A01	CAN, coil; 5 used
	26-83283N01	SHIELD, exciter top
	26-83284N01	SHIELD, exciter bottom
	42-82160N01	CLIP, shield mounting; 3 used
	45-83824N01	EJECTOR, card; 2 used
	5-84220B01	GROMMET; 2 used
	42-82160N01	CLIP, shield mounting; 3 used

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

SCHEMATIC DIAGRAM



NOTES:

1. Unless otherwise indicated: resistor values are in ohms and capacitor values are in picofarads.
2. Transmitter frequency calculation:
   $F_{oscillator} = F_{channel}/12$
3. TLD9231A/TLD9232B Simplex Exciter uses jumpers shown, with female edge connectors P500/P501. TLD9241/TLD9242 Duplex Exciter uses C775-C789 shown, with male edge connectors P500/P501.
4. Simplex exciter is connected to male backplane connector J102. Duplex exciter is connected to female filter module connector J102.
5. Backplane bypass capacitors C1-C16 and duplex filter module are part of backplane interconnect board assembly. Refer to associated Control and Applications manual for replacement parts information and location.
6. Refer to parts list for component values.
7. JU501 always out on standard models.

Exciter Range

Kit No.	Range	Frequency (MHz)	Type
TLD9231A	Low (L)	132-150.8	Simplex
TLD9232B	High (H)	146-174	Simplex
TLD9241B	Low (L)	132-150.8	Duplex
TLD9242C	High (H)	146-174	Duplex

POWER AMPLIFIER INTERMITTENT DUTY
MODEL TLD2532A

1. GENERAL

The TLD2532A Power Amplifier consists of the power amplifier chassis and associated hardware, and contains two circuit boards, the power control board and the power amplifier board. The following sections detail the theory of operation and troubleshooting information for the power amplifier circuitry. Because the setting of power levels is affected by the alignment of the exciter, the power set procedure is part of the overall transmitter alignment procedure given in the Transmitter section of this manual.

Table 1. Power Amplifier Kits

TLD2532A Power Amplifier
TFD6452A Harmonic Filter
TKN8313A Power Amplifier Cable
TLD9252A Power Amplifier Board
TLD9272A Power Control Board
TRN5141A Power Amplifier Hardware Kit
TRN5378A PA Transistor and Hardware Kit

2. THEORY OF OPERATION

2.1 POWER AMPLIFIER BOARD

2.1.1 The output from the exciter is applied to the power amplifier board via J802. This 1.5 watt (nominal) signal is attenuated approximately 2.8 dB by the resistive network comprised of R807-R810. Predriver Q801 amplifies the exciter signal to a level of approximately 11 watts.

2.1.2 The predriver output is applied to driver Q802, which develops up to 25 watts of rf power. The final amplifier stage of Q803/Q804 provides the power output of 110 watts (nominal). The power output signal is routed through the harmonic filter and through the directional coupler to the station antenna circuitry.

2.2 POWER CONTROL CIRCUITRY

2.2.1 General

2.2.1.1 The power control board provides power amplifier protection and power regulation. Output impedance match, final amplifier current and temperature, control voltage level, and power output are monitored by the power control circuit. In turn, the power control circuit sets the exciter power output to the proper level for optimum power amplifier operation.

2.2.1.2 The resistive voltage divider comprised of R926, R927, and R928 provides dc biasing voltages to improve directivity of the directional coupler, and set the operating point of the directional coupler inputs to the forward power and protection comparators. The reference voltage for forward power detector U901A is developed across Power Set control R911. The reference voltage for protection comparator U901B is developed at the junction of R914 and R913.

2.2.2 Thermal Protection

As the temperature of the power amplifier board increases, the resistance of RT801 decreases, causing the voltage on the TEMP SENSE HI line to decrease. When this voltage reaches approximately 5 volts, CR904 conducts, dropping both the forward power detector and protection comparator reference voltages. This causes the comparators to reduce the voltage on the CONTROL VOLTAGE line, which reduces exciter drive to the power amplifier. The net effect of this is to lower power amplifier output and heat, keeping operating temperature within safe operating limits.

2.2.3 Forward Power Level Control

Forward output power, sampled by the directional coupler, is rectified and filtered by the circuitry associated with CR901. The detected voltage is applied to the inverting input of forward power detector U901A, where it is compared to the set level at the non-inverting input. If the two levels are not the same, the output level of U901A changes in a direction that raises or lowers the voltage on the CONTROL VOLTAGE line, until the inputs to U901A are matched. This provides a constant rf power output from the PA.

2.2.4 Reverse Power Protection

Reverse (reflected) power sampled by the directional coupler is rectified and filtered by the circuitry associated with CR902. The output voltage across R908 is applied to the inverting input of U901B, and compared to the reference voltage. Under normal operating conditions with the transmitter feeding a 50-ohm load, the reference voltage is higher than the directional coupler voltage. This keeps the output of U901B at maximum, keeping Q905 turned off. If the reflected power increases to the point that the voltage across R908 exceeds the reference voltage, the output of U901B drops, turning on Q905. Increased collector voltage on Q905 causes an increase in the voltage applied to the inverting input of U901A, to force the control voltage and the power output to drop until the inputs to U901A equalize.

2.2.5 Over-Current Protection

Final amplifier current in the power amplifier is sensed through R801. The voltage drop across R801 is applied to the base at Q907. As the voltage at Q907 decreases, Q907 turns on, increasing the voltage across R908. The power cutback occurs in the same manner as described in the Reverse Power Protection paragraph.

2.2.6 Control Voltage Limit

The circuit of Q905 compares the voltage on the CONTROL VOLTAGE line to the voltage set by the position of the wiper on R931. When the control voltage exceeds the set limit, Q905 conducts, raising the voltage at the inverting input of U901A. U901A, in turn, reduces the control voltage until both inputs are balanced.

3. POWER AMPLIFIER SERVICING

3.1 GENERAL

Troubleshooting information for the *MSR 2000* station power amplifier is presented in several levels. It is best to begin by following the power amplifier troubleshooting procedure given in Table 4. If the specific cause of the transmitter failure is not covered in Table 4, the service person is directed to Table 5 (for power control board problems) or to paragraph 3.2 (for power amplifier board problems).

3.2 POWER AMPLIFIER BOARD TROUBLESHOOTING PROCEDURE

Checks and tests in the following paragraphs may be used to locate defects isolated to the power amplifier board. The following checks assume 13.8 volts dc is applied to the PA and that the amplifier is operating closed-loop with the exciter. Set all power control potentiometers (R911, R931, R939) fully clockwise.

3.2.1 No Power Output or Power Output Less Than 20% of Rated Power

3.2.1.1 VOLTAGE CHECKS

With the radio unkeyed and the receiver audio at a minimum, check for +13.3 V dc on the power amplifier collectors. If one or more stages has zero voltage, check associated dc feed circuits for an open circuit.

3.2.1.2 INDIVIDUAL STAGE CURRENT CHECKS

Check the collector currents drawn by all stages to determine if the normal value shown in Table 2 is drawn.

Table 2. Minimum Normal Current Reading (all power control potentiometers set fully clockwise)

	Ic	146-155 MHz	155-165 MHz	165-174 MHz
Q801	Direct	1.7A	1.2A	0.75A
Q802	Direct	3.0A	2.4A	2.1A
	Drop across R822	300 mV	240 mV	210 mV
Q803-4	Direct	20A	17A	18A
	Drop across R801	20 mV	170 mV	180 mV
	MTR 5	20 uA	17 uA	18 uA

Step 1. If a stage is found with less than minimum I_c (see Table 2), check for shorts or defective components in that stage, then in the preceding and following stages.

Step 2. Where more than one stage indicates low current, check the earliest defective stage (toward the PA input) first.

Step 3. If all stages give a low current indication, check the exciter output. The exciter is defective if the output is less than 1.5 W.

3.2.2 Power Output Does Not Exceed the Rated Radio Power by 20% at Maximum Power Settings

3.2.2.1 Check A+ and A- voltages at the collectors with the power amplifier operating. Use ***only*** a passive voltmeter or a VOM with 1.2 uH series chokes at the probe tips. With the power supply accurately set for 13.8 V dc, voltages on the transistor collectors should exceed the Table 3 values (all voltages measured with respect to the A- plating on the power amplifier board).

Step 1. If all voltages are low, recheck the power supply. If the power supply is satisfactory, check the feedthrough capacitors for poor solder connections and the A+ and A- connections for good contact.

Step 2. If only one or two stages have low voltages, trace back through the dc-feeds of that stage, checking for bad connections or defective components. The maximum normal voltage drops are 0.3 V dc for R801, 0.5 V

dc for R822, and less than 0.1 V dc for all other components in the dc feed circuits.

Table 3. PA Collector Voltages (@13.8 V A+/A- Supply)

Q801	13.0 V dc
Q802	12.6 V dc
Q803, 804	12.8 V dc

3.2.2.2 Check the stage currents as outlined in paragraph 3.2.1.2.

3.2.2.3 If trouble in the final amplifier transistor stage (Q803, 804) is indicated, or other approaches have failed, check the balance in the final amplifier by soldering a 2.7 V lamp (type 338, Motorola Part No. 65-82671G01) between the collectors of Q803 and Q804 using #14 wire or a 0.1 inch wide copper strap or braid. If the lamp lights up to greater than half its normal brilliance, or flashes and burns out, there is a defect in one side of the parallel final amplifier circuitry. If such imbalance is indicated, the defective section can usually be isolated by shorting the base to emitter of one transistor (at the transistor body) with a screwdriver blade. The section that shows the least drop in power output (when shorted) is the one to be checked for defective components. If no obviously defective passive components, misconnections, or shorts can be located, make the following tests prior to considering the replacement of Q803 or Q804.

NOTE

Remove all power from the PA for the following tests.

Step 1. Check in-circuit base-emitter resistance on the suspect transistor(s). If *greater* than 1 ohm, coil L809 or L810 is bad.

NOTE

Place the negative potential lead from the ohmmeter on the transistor base for this test.

Step 2. If the resistance check shows that L809 and L810 are not defective, remove the base capacitors, C825 and C827 (for Q803) or C826 and C828 (for Q804), and check for shorts, both internal (with an ohmmeter), and external (visual check for solder shorts on the capacitor or printed circuit board). If a capacitor or its connection is suspect, replace it and recheck the power output and balance before proceeding.

Step 3. If the capacitor is not defective, replace transistor (Q803 or Q804) and reassemble the power amplifier.

NOTE

In any case where gross imbalance is found and suspected faulty components are replaced, ***always*** recheck balance after replacing components. Continue the investigation if imbalance has not been fully corrected.

3.2.2.4 With all power removed from the radio set, check for open base return on Q801 and Q802 by measuring in-circuit base-emitter resistance. The resistance should be less than 1 ohm on Q801 and less than 2.5 ohms on Q802.

NOTE

Place negative potential lead of ohmmeter on transistor base(s) for this test.

3.3 POWER AMPLIFIER TRANSISTOR REPLACEMENT

3.3.1 To remove the power transistors, remove two transistor mounting screws, or one stud nut (accessible from the chassis bottom). Unsolder and remove the clamped mica capacitors, unsolder and remove the transistors. (Special soldering iron tips ST1160 and ST1161 are available from the Motorola National Parts Department to aid in the capacitor and transistor removal.)

3.3.2 When replacing rf power transistors several precautions ***must*** be observed. First remove all thermal compound and residue from *both the chassis and the transistor* using a soft cloth or paper towel. Apply a thin film of silicone thermal compound to the bottom of the transistor mounting flange. Place the transistor in the center of the printed circuit board cutout and tighten the mounting hardware to 6-7 inch pounds ***maximum.*** Solder leads using a low power (40-60 W) iron using enough solder to completely cover the lead and solder pad. ***Make sure*** that the solder is flowing freely both *over* and *under* the lead before removing the heat. If a lead tends to spring away from the printed circuit board, hold down the far end of the lead against the board (using the tip of pliers) until the solder hardens. *Be sure* to replace the clamped mica capacitors in the *exact* original position with respect to the transistor body after replacing the transistors.

3.3.3 When removing components from the power amplifier printed circuit board it is ***essential*** that the solder be *completely molten* around the lead(s) to be removed ***before*** attempting to remove any component(s). Failure to exercise this precaution *could result* in removal of through-plating in component holes and/or top side metal on the printed circuit board which may necessitate removal of the printed circuit board for repair. To ensure proper performance of the rf power amplifier, it is ***essential*** (when replacing board-mounted parts) that the parts be mounted vertically and with the

bottom of the component(s) flush against the printed circuit board.

3.4 POWER AMPLIFIER BOARD REMOVAL

3.4.1 Under normal maintenance conditions, there should be no need to remove the PA board. If, however, it should become necessary, the following procedure should be used. Unsolder and remove the input and output coaxial cables, unsolder feedthrough capacitors, remove hex head screws, transistor mounting screws, and stud nut(s) (accessible from the bottom). Lift the board out of the chassis.

3.4.2 To replace the PA board, reverse the removal procedure. PA power transistors should be installed after the circuit board installation has been completed. Refer to paragraph 3.3.

3.5 POWER AMPLIFIER FUNCTIONAL TESTS

3.5.1 General

The tests in this section should be performed *after* servicing but *before* alignment, to verify that the power amplifier and control circuitry are operating correctly.

3.5.2 Set-Up

Step 1. Connect radio to proper dummy load through a wattmeter.

Step 2. Plug metering connector of DC Metering Chassis, TEK 5 Metering Panel (set to position E) or S1056-59 Portable Test Set, into J1 on power control board.

CAUTION
Key transmitter only while making test or adjustment.

3.5.3 Control and Protection Tests

3.5.3.1 CONTROL VOLTAGE LIMITING

Step 1. Set Current Limit (R939) and Power Set (R911) fully clockwise.

Step 2. Set Control Voltage Limit (R931) fully counterclockwise. Key transmitter and observe meter 1. Meter 1 should read approximately 4 uA.

Step 3. Rotate Control Voltage Limit Set (R931) clockwise. Near mid-rotation the reading of M1 should begin increasing to a maximum of approximately 25 uA at maximum clockwise rotation.

3.5.3.2 CURRENT LIMITING

Step 1. Set Power Set (R911) and Control Voltage Limit (R931) fully clockwise.

Table 4. Power Amplifier Troubleshooting Procedure

Step	Symptom	Procedure	Normal Indication	If Normal	If Abnormal
1	Suspected Transmitter Failure	Measure rf output power at antenna connector.	Rated power	Transmitter OK.	High Power — perform Power Amplifier Control and Protection Troubleshooting Procedure. Low Power — go to 3. No Power — go to 2.
2	No Output Power	**a.** Set all controls fully clockwise and observe meters 1 and 5.	Both greater than 10 uA	Go to b.	No indication — Perform Transmitter Control and Protection Troubleshooting Procedure. Meter 1 indication, no Meter 5 indication — Go to e.
		b. Measure dc voltage across antenna relay coil during transmit.	5 V	Go to c.	Check coil continuity (dc resistance approximately 160 ohms).
		c. Check reed switch continuity.	Continuous during transmit	Go to d.	Replace.
		d. Check harmonic filter and output cable for shorts and discontinuities.	See schematic diagram	Perform Power Amplifier Board Troubleshooting Procedure.	Repair defect.
		e. Measure rf power at the exciter output.	1.5 W minimum	Perform Power Amplifier Board Troubleshooting Procedure.	Refer to Exciter section of manual.
3	Low Output Power	**a.** Set all controls fully clockwise and observe Meter 1.	Greater than 20 uA	Go to b.	Perform Power Amplifier Control and Protection Troubleshooting Procedure.
		b. Measure rf power at exciter output.	1.5 W minimum	Perform Power Amplifier Board Troubleshooting Procedure.	Refer to Exciter section of manual

Table 5. Power Amplifier Control and Protection Troubleshooting Procedure

Step	Symptom	Procedure	Normal Indication	If Normal	If Abnormal
1	No meter 1 or 5 with all controls clockwise	a. Disconnect PA from exciter J802. Check for keyed 9.3 V at U901-8.	9.3 V	Go to b.	Check Q554 (in exciter) keyed 9.3 V switch.
		b. Measure output voltage of U901A, pin 1.	Greater than 3.3 V	Repair fault in control voltage amplifiers Q903 & Q904.	Go to c.
		c. Measure voltages to input of U901A, pins 2 & 3.	Pin 3 greater than Pin 2	U901 defective.	Check for shorts or opens in resistive feed circuits to pins 2 & 3.
2	Meter 1 reads max of about 10 uA with all controls fully clockwise. Little or no output power	a. Disconnect PA from exciter at J802. Measure voltage of protection comparator output, at U901B-7.	Greater than 7 V	Troubleshoot Q905 circuit.	Go to b.
		b. Measure voltages to input of U901B, pins 5 & 6.	Pin 5 greater than Pin 6	U901 defective.	Analyze and repair current limiter circuitry Q906, Q907 & Q908.
3	All controls inoperative and meter 1 approx. 25 uA	a. Disconnect PA from exciter at J802. Observe meter 1 in RX mode.	0 uA	Go to b.	Repair fault in control voltage amplifiers Q903 & Q904.
		b. Set all controls counterclockwise. Measure pins 2 & 3, U901A in TX mode.	Pin 2 greater than Pin 3	U901 defective	Look for defect in voltage reference network R926, U927, R928, R912, R911.
4	Q905 and associated resistors probably defective. Analyze and repair.	Control voltage limit (R931), current limit (R939) and reflected power (VSWR) protection inoperative			
5	Current limit (R939) inoperative	Disconnect PA from exciter at J802. Pull current sense line (green) from C897. Observe meter 1.	15 uA	Check for short to A+ of current sense line.	Analyze fault in current limit circuit Q906, Q907 & Q908 and repair.
6	Reflected power (VSWR) protection inoperative	Check and repair defect in reflected power detector components R902, CR902, etc.			
7	Thermal protection inoperative	Check and repair defect in thermal protection components RT801, R915, R930 and CR904.			
8	Power set (R911) inoperative	Check and repair defect in forward power detector components R901, CR901, etc.			

Step 2. Set Current Limit (R939) fully counterclockwise. Key transmitter and observe M5. Meter 5 should indicate less than 10 uA. Rotate Current Limit clockwise. Meter 5 should increase to a maximum indication of no more than 28 uA before maximum clockwise rotation is reached.

3.5.3.3 POWER SET

Step 1. Set Control Voltage Limit (R931) and Current Limit (R939) fully clockwise.

Step 2. Set Power Set (R911) fully counterclockwise.

Step 3. Key transmitter and observe wattmeter. Power output should be zero. Power output should increase as Power Set is rotated clockwise.

3.5.3.4 THERMAL PROTECTION

Step 1. Set Control Voltage Limit (R931) and Current Limit (R934) fully clockwise.

Step 2. Adjust Power Set (R911) to 120 watts output. Using a short length (6 inches), of 22 AWG solid wire, short Temp Sense Hi, pin 6 of P901, to Temp Sense Lo, pin 7 of P901, with P901 connected to J901 on the

power control board. Power output should drop to less than 50% of set power.

3.5.3.5 REFLECTED POWER PROTECTION

Step 1. Set Control Voltage Limit (R931) and Current Limit (R939) fully clockwise.

Step 2. Adjust Power Set (R911) for 120 watts output. Remove cable from the output of the station.

CAUTION

As the following step requires transmitting without a dummy load, key transmitter long enough to verify operation only.

Step 3. Key transmitter and observe meter 5. Meter 5 should indicate less than 10 uA.

3.5.4 Power Amplifier Board Test

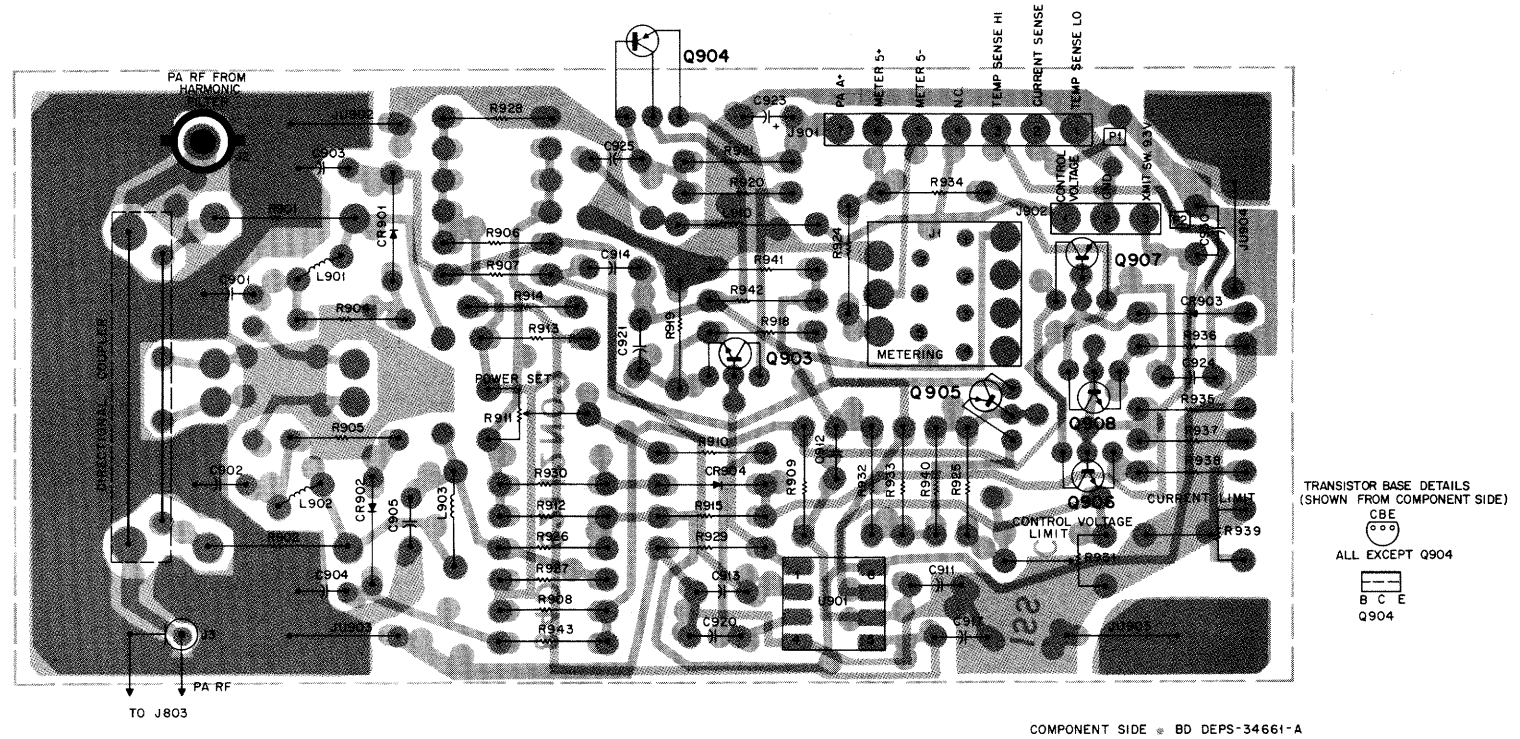
Step 1. Disconnect PA from antenna switch/duplexer at J803.

Step 2. Connect the PA directly to a wattmeter and dummy load via J803.

Step 3. Set Power Set (R911), Control Voltage Limit (R931), and Current Limit (R939) fully clockwise.

Step 4. Key transmitter and observe the wattmeter. Power output should exceed 145 watts.

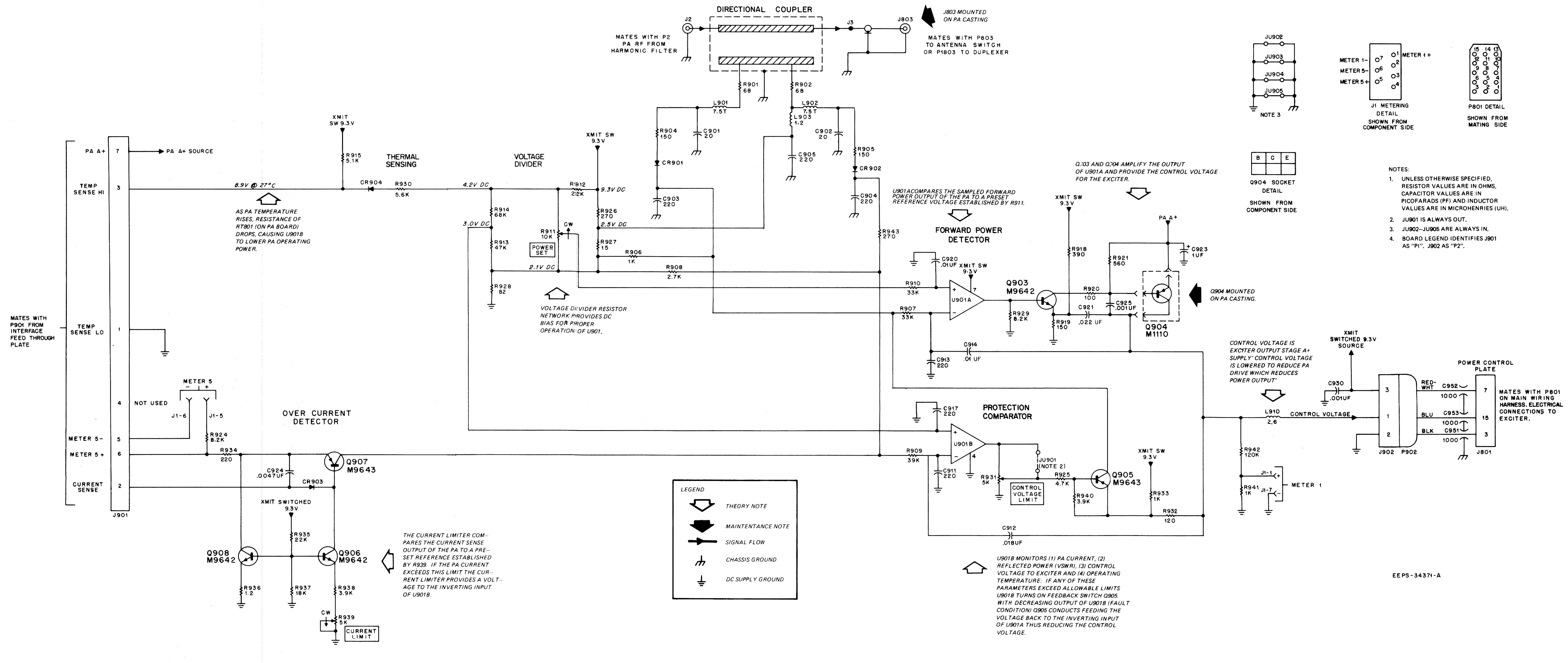
POWER CONTROL BOARD



SHOWN FROM COMPONENT SIDE

COMPONENT SIDE = BD DEPS-34661-A
SOLDER SIDE = BD DEPS-34662-A
OL DEPS-34663-A

POWER CONTROL BOARD



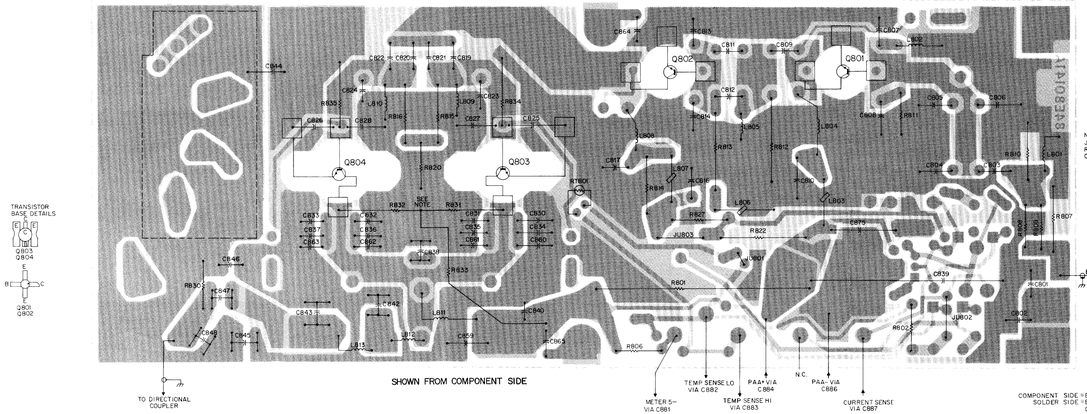
NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTOR VALUES ARE IN OHMS, CAPACITOR VALUES ARE IN PICOFARADS (PF) AND INDUCTOR VALUES ARE IN MICROHENRIES (UH).
2. JU901 IS ALWAYS OUT.
3. JU902–JU905 ARE ALWAYS IN.
4. BOARD LEGEND IDENTIFIES J901 AS "P1", J902 AS "P2".

EEPS-34371-A

CIRCUIT BOARD DETAIL AND PARTS LISTS

POWER AMPLIFIER BOARD



TLD2532A Power Amplifier
Schematic Diagrams, Circuit Board Details, and Parts Lists
Motorola No. PEPS-34790-B
(Sheet 2 of 3)
1/14/83- UP

parts list

TLD5252A Power Amplifier Board — PL-7938-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ±5%; 500 V: unless otherwise stated
C801	21-863629	330 ±10%; 600 V
C802	21-823722C10	.05 uF ±20%; 25 V
C803	21-83406D77	30
C804	21-84493B59	39
C805, 806	21-83406D77	30
C807, 808	21-84493B65	100
C809	21-84493B66	150
C810	21-83596E10	220 ±20%
C811, 812	21-84715F26	56
C813, 814	21-84493B64	91
C816	8-846371,14	0.1 uF ±10%; 100 V
C817	21-83596E10	220 ±20%
C819	21-83406D56	24
C820, 821	21-84493B35	19
C822	21-83406D56	24
C823, 824	21-84715F26	56
C830 thru 837	21-84715F26	56
C838	21-863566K16	150
C839	23-83210A22	660 uF +150-10%; 25 V
C840	21-863629	330 ±10%; 600 V
C842	21-84395B18	44; 250 V
C843	21-84395B15	15 ±10%; 250 V
C844	21-84493B59	39
C845	21-84395B35	240 ±10%; 350 V
C846	21-863629	330 ±10%; 600 V
C847	21-84395B35	240 ±10%; 350 V
C848	21-84395B45	12 ±10%; 250 V
C859	8-852939D2	0.22 uF ±10%; 50 V
C860 thru 863	21-83406D97	15
C864	21-82187B07	470 ±10%
C865	21-83596E10	220 ±20%
C875	8-829050G02	.022 uF ±10%; 50 V
L801	24-83884G01	**coil, rf:** 3-1/2 turns; coded (PINK)
L802	24-82723H27	choke; 1.2 uH
L803	24-83036A02	choke; 1/2 turn
L804	24-80277A10	12-1/2 turns
L805	7-80062B02	bracket; large 1/2 turn
L806, 807	24-80036A02	choke; 1/2 turn
L808	24-80277A14	1-1/2 turns
L809, 810	24-82723H27	choke; 1.2 uH
L811	24-80277A13	7-1/2 turns
L812, 813	7-80062B04	bracket, small; 1/2 turn
R801	17-80165C01	**resistor, fixed: ± 5%; 1/2 W:** unless otherwise stated .01 ±20% bracket type
R802	6-11009C49	1k; 1/4 W
R806	6-11009C33	220; 1/4 W
R807	6-125A37	330
R808, 809	6-11009C13	33; 1/4 W
R810	6-125A37	330
R811	6-125C01	10 ± 10%
R812	6-127C17	47 ±10%; 2 W
R813	17-82036G07	1.5 ±10%; 2 W
R814	6-125B61	4.7
R815, 816	6-125A09	22
R820	6-125A15	39
R822	17-82291B24	0.1 ±5%; 3 W
R830	6-11009C97	100k; 1/4 W
R834, 835	6-125A21	68
RT801	6-83600K09	**thermistor:** 100k -25°C
	29-80014A01	**mechanical parts** CLIP, coax terminal

TFD6452A PA Harmonic Filter — PL-7935-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C1	21-83366K33	**capacitor, fixed:** 15 pF ±5%; 850 V
C3, 5	21-82785H52	30 pF ±1 pF; 850 V
C7	21-83366K33	15 pF ±5%; 850 V
L2	24-80066A04	**coil, rf:** 5-1/2 turns
L4	24-80066A03	6-1/2 turns
L6	24-80066A04	5-1/2 turns
P2	28-82231G01	**connector, plug:** male; single contact
		mechanical parts
	1-80748D72	ASSEMBLY; cable input includes:
	29-5370	LUG; solder
	30-83794C01	CABLE, coaxial (WHT); 8" used
	1-80748D73	ASSEMBLY; cable output includes:
	5-136977	EYELET
	30-83794C01	CABLE, coaxial (WHT); 8-1/2 used
	7-83373N01	FRAME

TLD9272A Power Control Board — PL-7940-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ±10%; 50 V: unless otherwise stated
C901	21-11022G37	20 ±5%
C902	21-11022G37	20 ±5%
C903, 904, 905	21-11015B05	220
C911	21-11015B05	220
C912	8-11017B10	.018 uF
C913	21-11015B05	220
C914	8-11017B09	.01 uF
C917	21-11015B05	220
C920	21-11021F04	.01 uF
C921	8-11017B11	.022 uF
C923	23-11019A09	1 uF ±20%; 50 V
C924	21-11021E21	4700
C925	21-11015B13	.001 uF ±10%; 100 V
C930	21-11015B13	.001 uF ±10%; 100 V
CR901, 902	48-84616A01	**diode: (see note)** hot carrier
CR903, 904	48-83654H01	silicon
J1	9-84207B01	**connector, receptacle:** female; 7-contact (metering)
J2	9-84231B03	female; phono
J3	42-80259A01	clip, coax terminal
J901	28-83441F08	**connector, plug:** male; 7-contact (WHT)
J902	28-83441F18	male; 3-contact (WHT)
JU902 thru 905	6-11009B23	**jumper:** 0 ohms
L901, 902	24-84393B04	**coil, rf:** 7-1/2 turns
L903	24-82723H01	choke; 1.2 uH
L910	24-82835G08	choke; 2.6 uH
Q903	48-869642	**transistor: (see note)** NPN; type M9642
Q905	48-869643	PNP; type M9643
Q906	48-869642	NPN; type M9642
Q907	48-869643	PNP; type M9643
Q908	48-869642	NPN; type M9642
R901, 902	6-125A21	**resistor, fixed ±5%; 1/4 W:** unless otherwise stated 68 ±5%; 1/2 W
R904, 905	6-11009A29	150
R906	6-11009A49	1k
R907	6-11009A85	33k
R908	6-11009A59	2.7k
R909	6-11009A87	39k
R910	6-11009A85	33k
R911	18-82374N12	variable; 10k
R912	6-11009A81	22k
R913	6-11009A89	47k
R914	6-11009A93	68k
R915	6-11009A66	5.1k
R918	6-11009A39	390
R919	6-11009A29	150
R920	6-11009A25	100
R921	6-11009A43	560
R924	6-11009A71	8.2k
R925	6-11009A65	4.7k
R926	6-11009A35	270
R927	6-11009A25	15
R928	6-11009A23	82
R929	6-11009A71	8.2k
R930	6-11009A67	5.6k
R931	18-82374N13	variable; 5k
R932	6-11009A27	120
R933	6-11009A49	1k
R934	6-11009A33	220
R935	6-11009A81	22k
R936	6-11009A51	1.2k
R937	6-11009A79	18k
R938	6-11009A63	3.9k
R939	18-80268B02	variable; 5k
R940	6-11009A63	3.9k
R941	6-11009A49	1k
R942	6-11009A99	120k
R943	6-11009A35	270
U901	51-80067C03	**integrated circuit: (see note)** dual operational amplifier
		mechanical parts
	14-80276B01	INSULATOR, coupler; 2 used
	26-80279B01	SHIELD, coupler
	9-80028A01	SOCKET, transistor (Q901)
	30-80280B01	THROUGH LOOP, coupler
	30-80280B02	PICK-UP LOOP, coupler

TKN8313A Internal Cable Kit — PL-8318-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C881 thru 887	21-82812H03	1000 pF + 100-0%; 500 V (feed-thru)
C891 thru 897	21-821474	470 pF ±20%; 500 V (feed-thru)
C951, 952, 953	21-82812H03	1000 pF + 100-0%; 500 V (feed-thru)
J801	1-80748D81	**connector, feed-through:** ASSEMBLY POWER control plate; includes:
	C951, 952, 953	
	64-82405N01	PLATE, plug
		connector, receptacle:
J803	9-82442E01	RECEPTACLE, PA rf out
P901	15-83498F15	HOUSING, 7-contact
P902	15-83498F28	HOUSING, 3-contact
		mechanical parts
	1-80748D80	ASSEMBLY, control cable; includes:
	P902	
	29-83499F01	TERMINAL; 3 used
	42-10217A02	STRAP, tie; 2 used
	1-80748D82	ASSEMBLY, power control feed-thru; includes:
	30-83678K01	CABLE, 7-conductor shield; 12" used
	1-80748D83	ASSEMBLY, PA feed-thru plate; includes:
	C881 thru 887	
	64-80005A01	PLATE, feed-thru
	1-80748D92	ASSEMBLY, cable power out; includes:
	J803	
	15-483599	HOOD, receptacle
	30-83794C01	CABLE, coaxial WHT; 4-1/2"
	1-80748D84	ASSEMBLY, cable interface; includes:
	P901	
	29-83499F01	TERMINAL; 6 used
	30-83678K01	CABLE, 7-conductor shielded; 9-1/2"
	1-80753D16	ASSEMBLY, interface plate; includes:
	C891	
	thru 897	
	64-82404N01	PLATE, RF

TRN5141A Power Amplifier Hardware — PL-7939-B

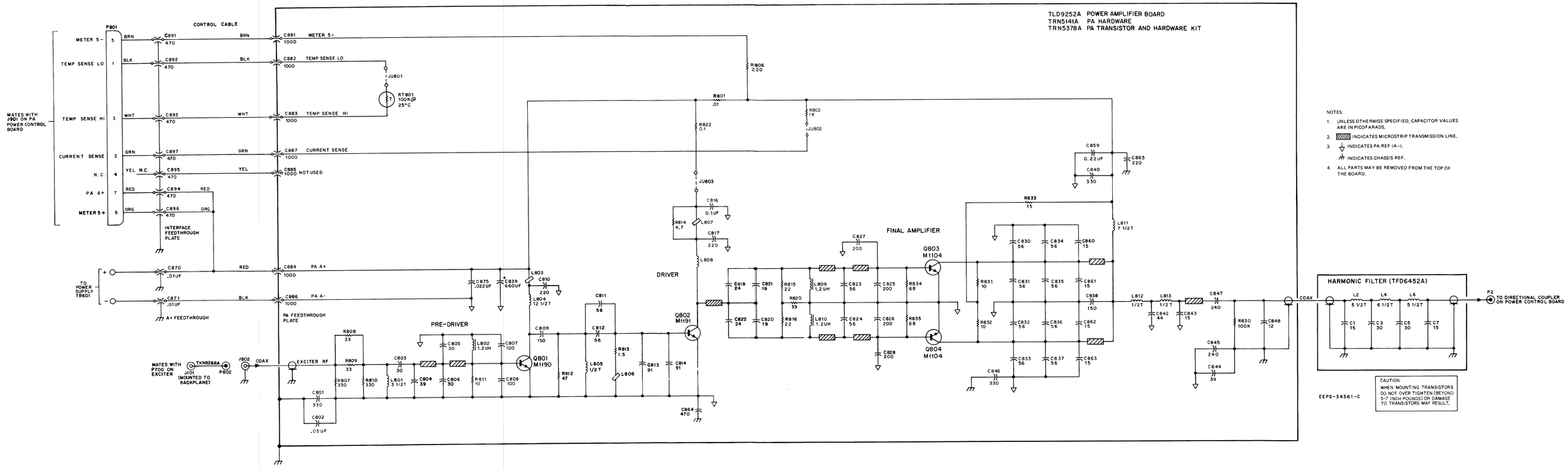
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C870, 871	21-84211B01	.01 uF, GMV; 250 V (feed-thru)
J802	9-82442E01	**connector, receptacle:** RECEPTACLE, PA rf in
TB801	31-503781	**strip, terminal:** barrier type; 2 terminal
		mechanical parts
	2-131435	NUT, 4-40 x 1/4 x 3/32"; 2 used
	3-3375	SCREW, tapping; 6-20 x 5/16"; 4 used
	3-115213	SCREW, machine; 3-48 x 1/4"; 4 used
	3-129890	SCREW, machine; 10-32 x 3/8"; 6 used
	3-131195	SCREW, machine; 6-32 x 3/8"; 2 used
	3-139294	SCREW, tapping; 8-32 x 5/8"; 2 used
	3-138810	SCREW, machine; 4-40 x 5/8"; 2 used
	4-7681	LOCKWASHER, #3 internal; 4 used
	14-801434A04	INSULATOR, HB, LB
	14-824059N01	INSULATOR, control
	14-82407N01	INSULATOR
	26-82323N02	HEATSINK, PA
	29-129883	LUG, soldering
	30-83794C01	CABLE, coaxial (WHT); 4" used
	43-82275C01	SPACER
	43-82416N01	SPACER, feed-thru
	64-82986N01	PANEL, PA
	15-84166N01	COVER, feedthru
	29-83997M02	TERM, wire receptacle; 2 used

TRN5376A PA Transistor and Hardware Kit — PL-7937-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C825 thru 828	21-84366F12	200 pF ±5%; 250 V
Q801	48-84411L90	**transistor: (see note)** NPN; type M1190
Q802	48-84411L91	NPN; type M1191
Q803, 804	48-84411L04	NPN; type M1104
Q904	48-84411L10	PNP; type M1110
R831, 832	6-126C01	**resistor, fixed:** 10 ±10%; 1 W
R833	6-127C05	15 ±10%; 2 W
		mechanical parts
	2-7003	NUT, 8-32 x 5/16"; 2 used
	3-3375	SCREW, tapping; 6-20 x 5/16"; 9 used
	3-3398	SCREW, tapping; 6-20 x 3/8"
	3-129997	SCREW, machine; 4-40 x 1/4"
	3-134186	SCREW, tapping; 6-32 x 5/16"; 4 used
	3-138813	SCREW, machine; 4-40 x 3/8"; 4 used
	3-488006	SCREW, machine; 6-32 x 1/2"; 4 used
	4-858060	WASHER, insulator; 4 used
	4-84180C01	WASHER, shoulder; 1 used
	14-83820M02	INSULATOR, transistor
	15-80066B01	COVER, harmonic filter
	15-82400N01	COVER, PA
	26-83374N04	SHIELD, harmonic filter
	5-129977	EYELET

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

POWER AMPLIFIER BOARD



POWER AMPLIFIER CONTINUOUS DUTY
MODEL TLD2600A SERIES

1. GENERAL

The TLD2600A Series Power Amplifier (refer to Table 1) consists of the power amplifier chassis and associated hardware, and contains three circuit boards: the power control board, the power amplifier board, and the exciter control voltage regulator board. The following sections detail the theory of operation and maintenance information for the power amplifier circuitry. Because the setting of the power levels is affected by the alignment of the exciter, the power set procedure is a part of the overall transmitter alignment procedure given in the Transmitter section of this manual.

Table 1.
Power Amplifier Frequency Range

Model	Frequency Range (MHz)
TLD2601A	132-150.8
TLD2602A	150.8-162
TLD2603A	162-174

2. THEORY OF OPERATION

2.1 POWER AMPLIFIER BOARD
(Refer to Figure 1 and schematic diagram)

2.1.1 This series of power amplifiers requires a 400 mW rf input from the exciter board. This input is passed through a ferrite step-down transformer (to match the input impedance to the first stage) to the gain-controlled amplifier stage. The external power control circuit which drives the control stage transistor determines the gain of this stage. The power control circuit monitors the output of the final stages of the power amplifier and the load condition.

2.1.2 The output of the gain-controlled amplifier is passed through a fixed-tuned broadband matching network and applied to the pre-driver stage. A second ferrite transformer is utilized to match the singleended output of the pre-driver stage to the input of the push-pull driver stage. The output of the driver stage is split by a pair of transformers to drive each of the pushpull final power amplifier stages. The output from each final stage is stepped up in impedance by ferrite transformers and paralleled to provide the 50 ohm output impedance to match the input impedance of the harmonic filter.

2.1.3 Pin 1 of the metering receptacle provides a means of checking the incoming signal from the exciter. Pin 2 permits observation of the drive output of the first stage and an indication of the operation of the pre-driver stage. Pins 3 and 4 reflect the output drive signal and operation of the two push-pull power amplifier stages. Reference position A on a Motorola Portable Test Set uses pin 7 of the metering socket as an A+ reference against which the outputs of pins 1, 2, 3, and 4 are checked. Switch the test set to reference position B which uses pin 6 as a reference and then switch to meter position 5. This provides a reading across a calibrated resistor through which the current is drawn by the final amplifier stages.

2.2 POWER CONTROL BOARD FUNCTIONAL THEORY OF OPERATION

2.2.1 Refer to the loop block diagram, Figure 2. The circuitry operates as a control loop which continually monitors the output from the final stages of the transmitter power amplifier and controls that output by regulating the gain of the first stage of the power amplifier.

2.2.2 Refer to the block diagram, Figure 3. The output of the integrated circuit differential amplifier, amplified by the dc amplifier, is the controlling input to the power amplifier board.

2.2.3 The output of the differential amplifier is determined by the potentials present on the non-inverting (+) and inverting (-) inputs. These potentials are developed by the power control board circuitry in the following manner.

2.2.4 When the impedances of the antenna circuitry (load) and the power amplifier are matched (a VSWR of 1:1), a bias voltage produced by the dc reference bias circuitry is placed on the inverting input (also called the "reference input") of the differential amplifier (see Figure 6).

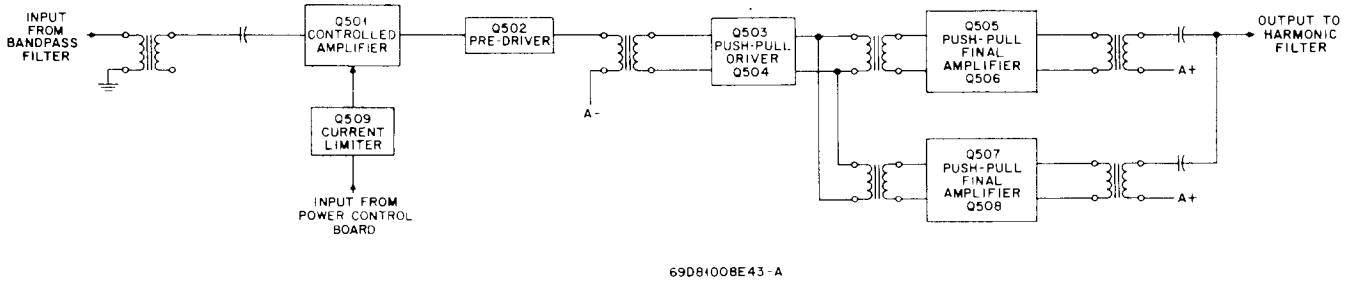


Figure 1. Block Diagram

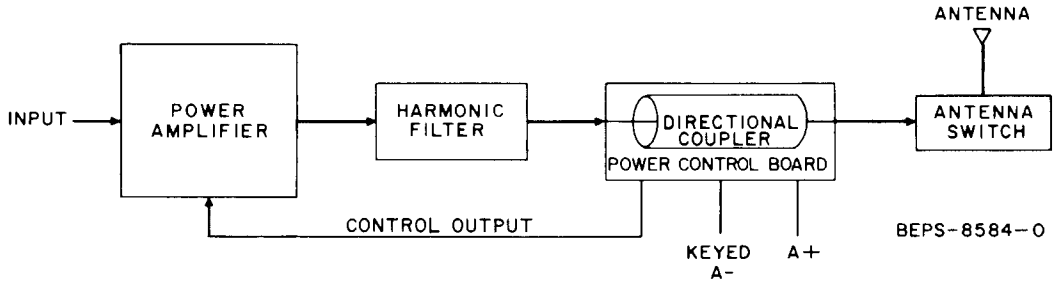


Figure 2. Loop Block Diagram

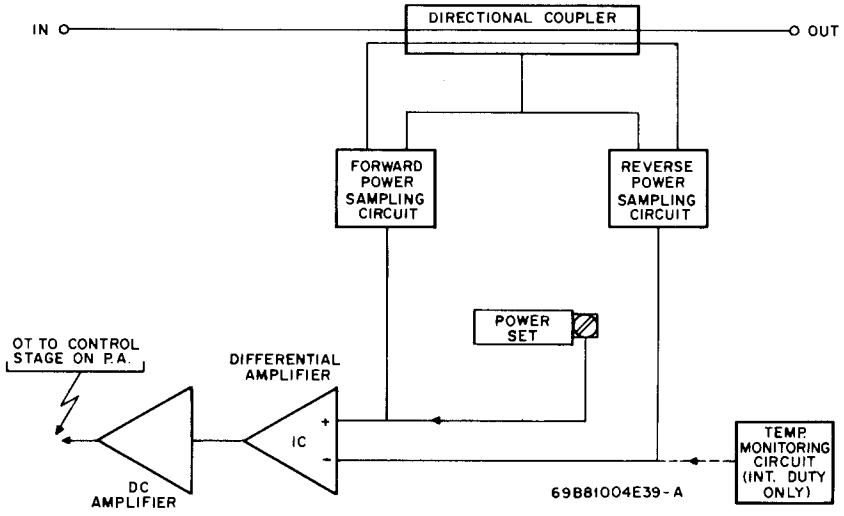


Figure 3. Power Control Board Block Diagram

2.2.5 When the transmitter is keyed, the forward (output) power from the final stages of the power amplifier is fed through the directional coupler to the antenna circuit. This flow of power is sampled by the forward power sampling circuitry and places a bias, proportional to the forward power, on the noninverting input (pin 5) of the differential amplifier. The POWER SET potentiometer is then adjusted, changing the potential on the non-inverting input. As this voltage changes, relative to the reference input voltage, the output of the differential amplifier changes, in turn changing the loop control level and therefore the output of the power amplifier.

2.2.6 Once the power has been set to the proper level, any change in the output power will be instantly corrected by the circuitry. If the power increases, the increase causes the differential amplifier output voltage to increase, decreasing the output from the dc amplifier which decreases the gain of the power amplifier until the output returns to the preset level. A decrease in transmitter power amplifier output causes the reverse action.

2.2.7 Any power reflected back from the antenna circuit is detected by the reverse power sampling circuit. Reverse power causes a negative current to flow, which, in turn, decreases the potential on the reference input of the differential amplifier. Therefore, increasing levels of reflected power will cause the transmitter power output to be decreased to a safe level.

2.3 POWER CONTROL BOARD DETAILED THEORY OF OPERATION

2.3.1 Bias Circuitry

Since the power control board has the capability to regulate the output of the transmitter power amplifier from a completely cut-off state to above the rated output power, a definite controlled output level is necessary whenever the transmitter is keyed. The desired controlled output level is determined by bias voltages present on the inverting and non-inverting inputs of the differential amplifier 1C601 (see Figure 4). Under normal oeprating conditions (1:1 VSWR; 100% rated power out) the bias on the differential amplifier inputs are developed as described in the following paragraphs.

2.3.1.1 Voltage Regulator and Main Divider Line

Refer to Figure 5. The A+ supply to the board is regulated by a series regulator circuit providing a nominal voltage of 8.0 volts. The Zener diode holds the base of the series pass transistor at a fixed potential. The series pass transistor operates as a variable resistor to hold the input to the reference circuitry constant. The divider consisting of the two resistors and the diode provides the proper voltage tap points for the secondary voltage divider networks. All 220 pF capacitors in the board are used as rf bypasses.

2.3.1.2 Reference Bias Circuit

Refer to Figure 6. The reference bias is developed (with a 1:1 VSWR) by the voltage divider made up of two resistors and a diode between the regulated supply voltage and the switched A- source. Since A+ is applied to the board continuously and A- is only applied when the transmitter is keyed by the push-to-talk switch, the larger capacitor connected between the inverting input and keyed A- provides a time constant which allows the inverting input bias to build up slowly when power is first applied. This prevents full power output from occurring until the leveling circuitry can react and reach a quiescent level.

2.3.2 Directional Coupler

The directional coupler measures the voltage and the current traveling in both directions. The detection of forward (output) power causes a proportional voltage bias that is combined with the voltage-divider generated bias to set the potential on the non-inverting input of the differential amplifier. Any reverse power detected causes the VSWR circuitry to decrease the power output.

2.3.3 Protection Circuitry

2.3.3.1 Forward Power Bias and Detection Circuit

Refer to Figure 7. The forward power reference voltage divider comprised of two resistors and two potentiometers provides a stable potential that supplies a dc bias to the non-inverting input of the differential amplifier. With an approximately correct power output from the final stages of the power amplifier, a dc level proportional to that power is produced by the forward power detector circuit, which, in combination with the voltage developed by the voltage divider, produces a bias on the non-inverting input that can be adjusted by the POWER SET potentiometer. The POWER LIMIT control is preset to prevent over-dissipation if the POWER SET control should be set to maximum. (Refer to the CAUTION preceding maintenance information in this section.) The dc bias value will be determined by the power amplifier output and, with no reflected power (VSWR 1:1), balanced against the reference bias present on the inverting input of the differential amplifier. Once the bias has been set, and change in power output will change the bias on the non-inverting input causing the differential amplifier to compensate for the deviation. The forward power detector circuit (refer to Figure 8) detects rf power flowing through the directional coupler when the transmitter is keyed, and causes a small proportional current flow in the forward power sampling circuit. The diode converts the rf sample into a pulsating dc voltage and the dc filter removes the ripple. This is the dc voltage which is added to the dc bias already applied to the non-inverting input of the differential amplifier from the secondary divider circuitry.

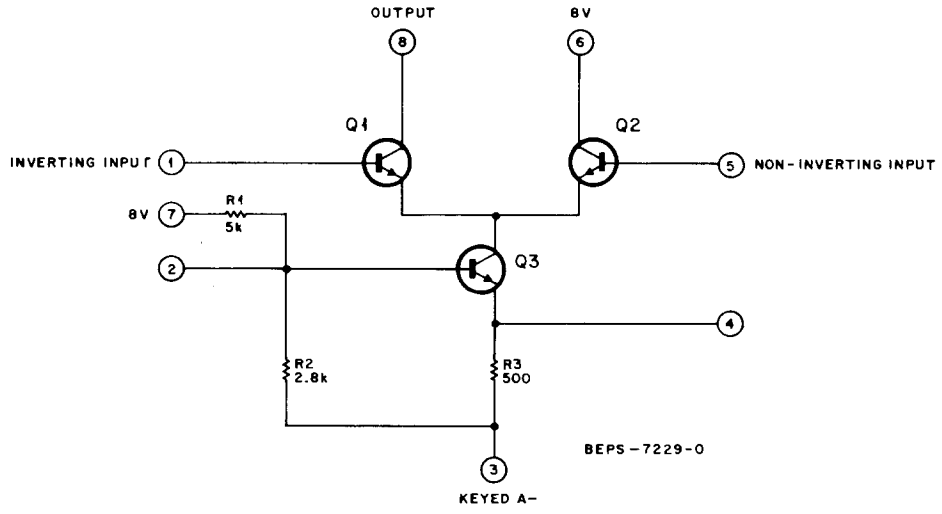


Figure 4. IC601 Schematic Diagram

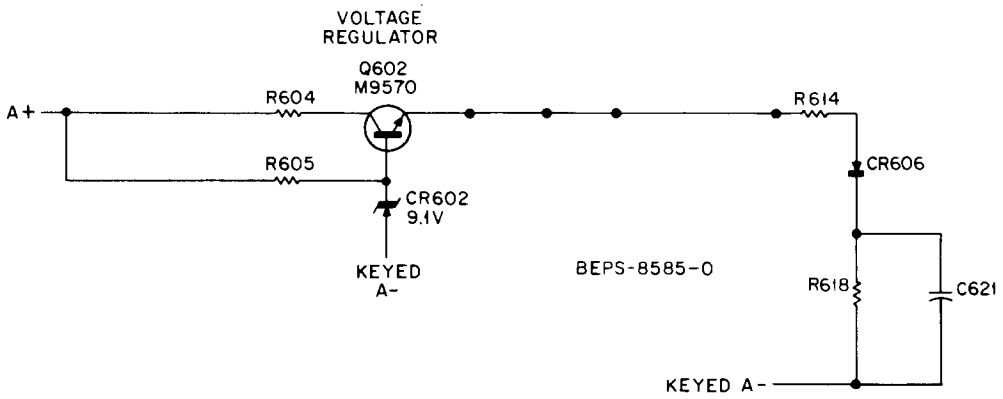


Figure 5. Voltage Regulator and Main Divider Line

2.3.3.2 VSWR — Reverse Power Detection Circuit

Since the power control board is now operating correctly with the proper amount of forward power and the correct biases, the detection of reflected power causes a decrease in the power amplifier's output in the following manner.

Refer to Figure 9. The components of the reverse power detector circuit function the same as those in the forward power detector. The voltage divider develops a bias voltage that isn't quite enough to forward bias the diode that makes up one-half of a diode "OR" gate. When reflected power is detected, the resultant negative-going dc level lowers the dc bias level and the combination of the two forward bias the diode. The negative-going dc level on the inverting input increases the output voltage of the differential amplifier, decreasing the dc control output to protect the final stages of the power amplifier.

2.3.3.3 DC Level Output Amplification

The output of the differential amplifier is applied to the base of a voltage-inverting transistor amplifier whose output supplies the output control current. As the forward power increases above the normal value, the output of the differential amplifier increases proportionally. Since the dc level is increasing the base, the PNP transistor conducts less and the potentials across the output load resistor, and on the control output line, decrease.

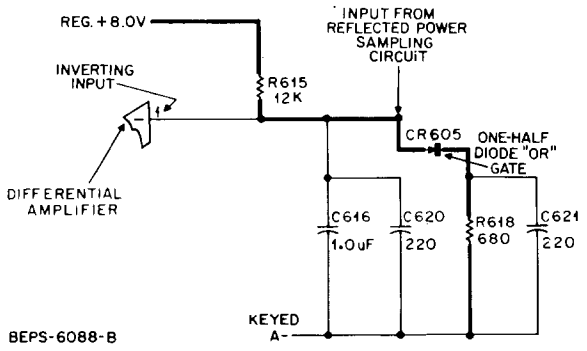


Figure 6. Reference Power Bias Circuit

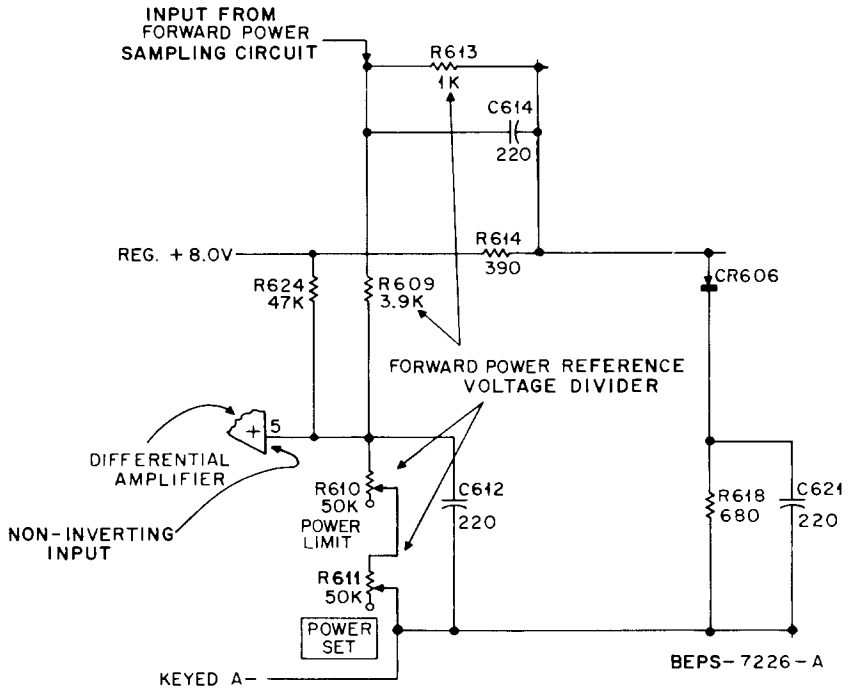


Figure 7. Forward Power Bias Circuit

3. MAINTENANCE

3.1 POWER AMPLIFIER BOARD

3.1.1 General

NOTE

Because of the complexity involved and time required to remove the PA board, compared to plug-in boards, it is not recommended that the PA board be removed. Proper troubleshooting techniques will usually locate defective components "on the spot."

NOTE (Cont'd.)

This section of the manual provides the maintenance shop procedures for the PA board. It assumes that preliminary tests have already localized the trouble to the PA board. These procedures include measurements with a Motorola portable test set, a VOM, a complete set of performance tests, and extensive troubleshooting procedures.

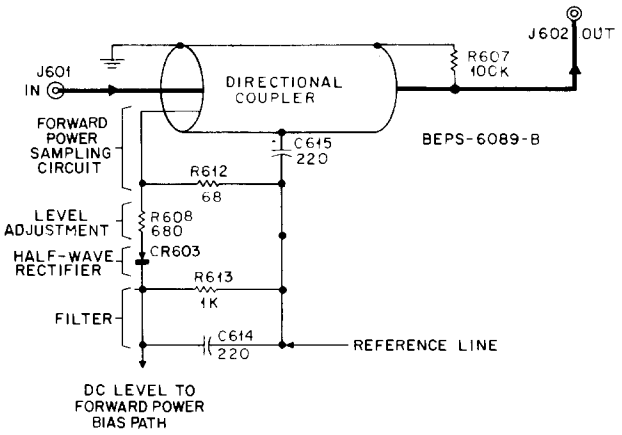


Figure 8. Forward Power Detector Circuit

CAUTION

The PA board must be installed in the transmitter for testing to provide the necessary power, ground, control, heat sinking and signal connections.

3.1.2 Recommended Test Equipment

The following test equipment is the minimum required for troubleshooting and adjusting the PA.

- Motorola S1056B through S1059B Portable Test Set and Model TEK-37 or TEK-37A Adapter Cable. The portable test set is required for checking each stage for proper operation.
- A Motorola Solid-State DC Multimeter or a 20,000 ohm-per-volt multimeter should be used, however a low impedance multimeter is acceptable for dc voltage measurements only.
- Motorola T1013A RF Load Resistor (dummy load) or equivalent.

3.1.3 Test Set Metering

The PA is equipped with a metering receptacle which allows five major test points to be measured. PA metering can be made at each of the five test points by merely rotating a selector switch on the optional station meter kit or on the test set. A failure in almost any portion of the PA will produce a low or zero meter reading for one or more of the test points. Improper alignment will also cause improper meter readings.

3.1.4 Using the Portable Test Set

3.1.4.1 To make the measurements, the portable test set must be connected to the station as follows.

Step 1. Set the function selector switch of the portable test set to the XMTR position.

Step 2. Set the meter reversing switch of the test set to the METER REV position, the selector switch to position 1, and REF switch to position A.

Step 3. Connect the 20-pin meter cable plug to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve battery life. The plug acts as an on-off switch completing the battery circuit.

Step 4. Connect the red "control" plug of the adapter cable to the control receptacle on the remote control board. Connect the white "metering" plug of the adapter cable to the receptacle on the PA circuit board.

Step 5. The entire transmitter *is* necessary for testing PA boards including the power control board for proper control.

Step 6. The output of the station must be terminated in one of three types of loads:

- The antenna load.
- A dummy load such as Motorola's T1013A RF Load Resistor.
- An RF wattmeter.

NOTE

A dummy load is preferred to the antenna to eliminate the possibility of shutback by the power control board due to a defective antenna.

Step 7. Turn the station ON.

Step 8. Key the transmitter with the XMTR ON button on the test set. Observe the meter. Unkey the transmitter.

Step 9. Set the selector switch to positions 2, 3, & 4; then switch to reference position B and meter position 5 respectively, keying the transmitter and observing the meter reading for each. Refer to Table 2. On multi-frequency stations, repeat the readings for each frequency. An analysis of the meter readings for determining whether each circuit is good or bad follows.

3.1.4.2 Each time maintenance is performed on the PA the readings should be compared with the previous set of readings. Any degradation of performance will quickly be noted. Often, a lower reading may indicate

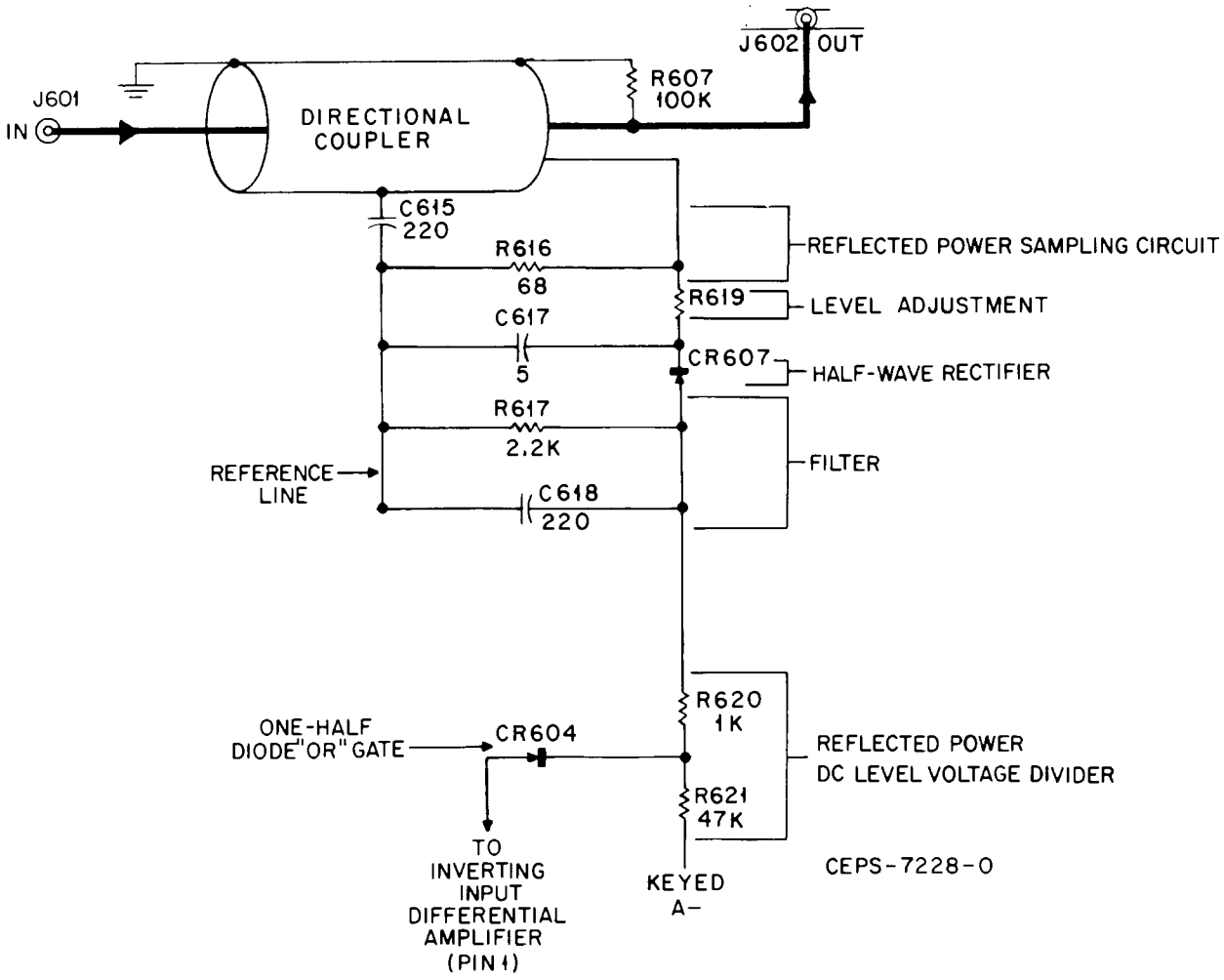


Figure 9. Reverse Power Detector Circuit

an impending failure and corrective action may be taken before the circuit fails entirely.

3.1.5 Performance Tests

Step 1. No performance test of the power amplifier is required other than rf power output from the station as a whole. Before checking power output:

- The exciter board should be known to be operating normally.
- The power control board should be known to be functioning normally.

Step 2. Key the transmitter and observe power out, which should be 100 watts or value set from 50 to 100 watts depending upon licensing.

3.2 POWER CONTROL BOARD

CAUTION

The power control board is incorporated in the transmitter to provide protection for the rf power transistors under environmental conditions such as voltage, load variation, and device variations. In order for the circuitry to operate properly and provide protection it is necessary to set the power output control (POWER SET) in accordance with the station alignment procedure.

3.2.1 General

3.2.1.1 Two basic maintenance approaches may be used for localizing and replacing trouble in these radio sets.

Table 2. Power Amplifier Board Metering

Selector Switch Position	Reference Switch Position Portable Test Set Only	Minimum Meter Readings	Circuit Metered	If Low, Defective Circuit Is: (See Troubleshooting Charts)
1	A	10 uA	Exciter Output (input to Controlled Amplifier Q501)	Exciter output, input circuitry of controlled amplifier stage Q501.
2	A	5 uA	Input of Pre-driver Stage (Q502)	Output of controlled amplifier stage input circuitry of predriver stage.
3	A	10 uA	Input of Final Amplifier Stage Q505, Q506	Input of Q505, Q506 stages, output of driver stage (Q502, Q503), output of pre-driver stage Q502.
4	A	10 uA	Input of Final Amplifier Stage Q507, Q508	Input of Q507, Q508 stage output of driver stage Q502, Q503. Output of pre-driver stage Q502.
5 (or 2)	B	29 uA max. 105 W	Total Current in Final Amplifier Stages Q505, Q506, Q507, Q508	Output of final amplifier stages Q505-Q508, power control board antenna switch, antenna.
6 (or 3)	B	12 V (0-30 V scale)	Final Amplifier Stage	Final amplifier stage A+ or A- input.

- Replace the defective circuit board with a spare and return the defective board to a maintenance shop for repair.

- Isolate and repair the trouble on the spot. This approach must be used if spares are not available.

3.2.1.2 Regardless of the maintenance approach used, a few simple tests on the overall radio set will localize the trouble to the power control board if it is defective. These procedures are given elsewhere in the manual. This section of the manual provides the maintenance shop level procedures for the power control circuitry. It assumes that preliminary tests have already localized the trouble to the power control board. These bench test type procedures inlcude measurements with a Motorola portable test set, a simple set of performance tests, and complete troubleshooting procedures including step-by-step circuit check-out.

3.2.2 Recommended Test Equipment

The following test equipment is the minimum required for troubleshooting and adjusting the board. All such equipment is battery operated. When ac operated equipment is used, the ground lead must not be electrically connected to ac line ground.

- Optional station metering or Motorola S1056B through S1059B Portable Test Set and Model TEK-37 or TEK-37A Adapter Cable. (The meter or portable test set is necessary to monitor forward and reverse power detectors.)

- Motorola Solid-State DC Multimeter or equivalent. A 20,000 ohm-per-volt multimeter may be used but a low impedance volt-ohm meter may not be used. This meter is used for measuring dc voltages and resistance.

- Motorola T1013A RF Load Resistor (Dummy Load) or equivalent.

3.2.3 Metering

The power control board is equipped with a metering receptacle which allows three major test points (forward power, reflected power and control current) to be measured. Refer to the troubleshooting charts or the schematic diagram for the correct meter indications.

3.2.4 Using Portable Test Set

Step 1. Set the function selector switch of the portable test set to the XMTR position.

Step 2. Set the meter reversing switch of the test set to the METER REV position.

Step 3. Set the REF switch to position A or B.

Step 4. Connect the 20-pin meter cable plug to the test set. When the test set is not in use, disconnect the 20-pin plug to conserve battery life. The plug acts as an on-off switch completing the battery circuit.

Step 5. Connect the red "control" plug of the adapter cable to the control receptacle on the remote control circuit board. Connect the white "metering" plug of the adapter cable to the receptacle on the power control-board.

Step 6. The output of the power control board must be terminated in one of three types of loads.

- The antenna load.

- A dummy load such as Motorola's T1013A RF Load Resistor.

- An RF wattmeter.

NOTE
A dummy load is preferred to the antenna to eliminate the possibility of shutback due to a defective antenna.

Step 7. Turn the station ON.

Step 8. Set the selector switch of the test set to position 1 and key the transmitter with the XMTR ON button on the test set. Observe the wattmeter, or the meter reading if a dummy load is used or if the antenna is used. Unkey the transmitter. Under normal conditions at rated power out, meter 1 should read between 15 uA and 45 uA typically. Refer to Table 3.

3.2.5 Performance Test, Power Set Control

This control allows the power output of the radio set to be varied from zero (0) power out with the control fully counterclockwise to greater than the rated output.

CAUTION
For proper operation of the protection circuitry, it is imperative that the POWER SET control never be left in a position that exceeds rated power output.

Refer to the power amplifier tune-up procedure.

Step 1. Key the transmitter.

Step 2. Adjust the POWER SET control until the rated power output is reached.

Step 3. Unkey the transmitter.

4. TROUBLESHOOTING PROCEDURES

4.1 GENERAL

If a problem has been localized to either the power amplifier or power control board decks, several checks can be made prior to extensive troubleshooting.

4.2 VISUAL

Visually check for obvious physical defects such as broken leads, broken plating, broken or disconnected components or overheated parts. Before any attempt is made to change parts, the circuit should be checked to insure that the problem causing the original failure has been identified and corrected, otherwise damage to the new part may occur.

4.3 VOLTAGE CHECKS

Check for A+ and A- at the feedthrough connections and for proper voltages at the collectors of each transistor. Certain defects such as broken plating, broken leads etc. may not be obvious to a visual inspection.

4.4 TROUBLESHOOTING

4.4.1 If test set readings are abnormal or tests indicate subnormal performance, a logical troubleshooting procedure is required to isolate the defective component efficiently. The accompanying troubleshooting chart summarizes these results in a logical sequence. A few voltage and resistance checks in the suspected circuit should readily isolate the defective component. Note that all power for the circuits in the PA and power control board is from A- referenced to A+ (not to chassis ground, this feature allows operation from positive or negative ground power sources when an optional positive ground converter is used).

CAUTION
Due to the voltage requirements of PNP transistors, all "rf ground" plating is A+ and is "hot" with respect to chassis ground in negative ground applications. Because of this, caution should be used to prevent connection of "ground" plating on the PA board to chassis ground, either directly or by the use of test equipment ground leads. If ac operated test equipment is used, the ground lead must not be electrically connected to ac line ground.

Table 3. Power Control Board Metering

Selector Switch Position	Reference Switch Position (See Note)	Normal Meter Readings	Function
1	A (Meter Reverse On)	15-45 uA	Indicates forward power output.
2	A	10 uA max.	A meter reading higher than the normal range indicates reflected power caused by a defective antenna, antenna switch, or cables.
5	B (Meter Reverse On)	50 uA max.	Indicates the relative level of drive sent to the PA on the blue control lead. A reading of greater than 35 uA indicates the power control board is set for a higher power than the radio is capable of supplying.

METERING NOTE
Alignment may be performed using a Motorola S1056B thru S1059B Portable Test Set. The OSC. & METER REV. SWITCH column refers to portable test set usage.

4.4.2 The schematic diagrams of the PA board and power control board contain the voltage readings required for troubleshooting. The readings are typical for normal operating conditions at rated power output for the radio. Refer to the troubleshooting charts and the schematics when a defect is suspected.

5. REPAIR PROCEDURES

5.1 RESISTANCE MEASUREMENT OF TRANSISTORS IN PUSH-PULL PAIRS

Due to the fact that transistors in push-pull pairs are dc connected at both base and emitter, BOTH devices should be measured when a defect in the pair is suspected.

5.2 TRANSISTOR REMOVAL PROCEDURE

Step 1. Unscrew both mounting screws from the base of the transistors. The nuts (for the mounting screws) on the reverse side of the shelf are captivated and will not fall out.

Step 2. Remove excess solder from around transistor tabs with a vacuum bulb type de-soldering device.

Step 3. Gently lift each lead, one at a time while applying heat.

Step 4. When all four leads are loose from the board carefully lift out the transistor.

5.3 TRANSISTOR INSTALLATION PROCEDURE

Step 1. Pre-tin underside of each transistor lead.

Step 2. Apply a light coat of Wakefield Thermal Compound to the underside of the transistor mounting base and to the heat sink.

Step 3. Install the transistor making sure that all collector leads face the proper direction. Refer to the circuit board detail.

Step 4. Screw down the two mounting screws securely.

Step 5. Solder each transistor lead one at a time to the circuit board. The use of a generous amount of solder will insure a good contact of the entire tab to the board. Use care that solder does not bridge to other plating or that solder does not flow into the cutout in the circuit board.

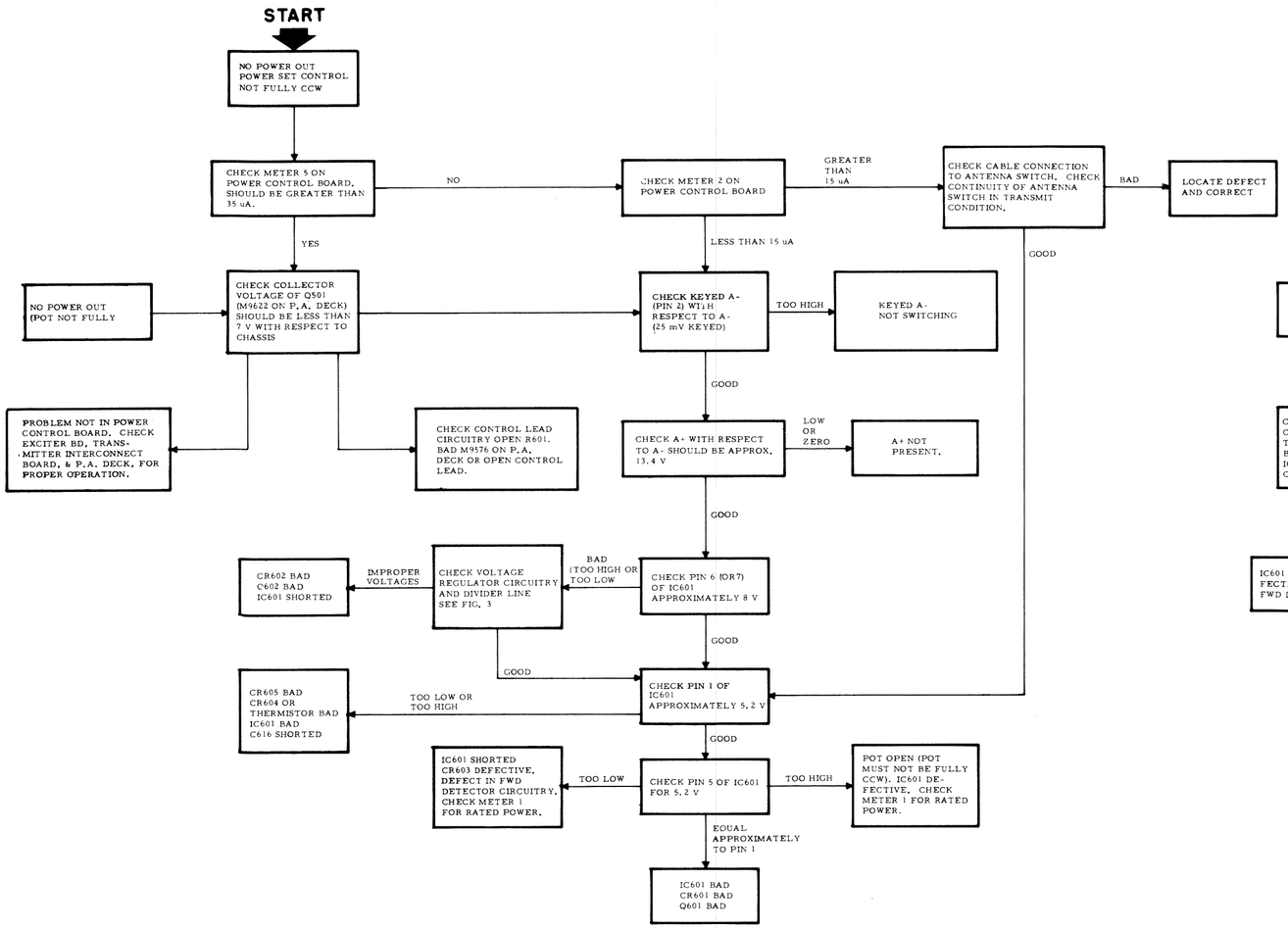
5.4 PROCEDURES FOR RESISTANCE MEASUREMENTS OF TRANSISTORS

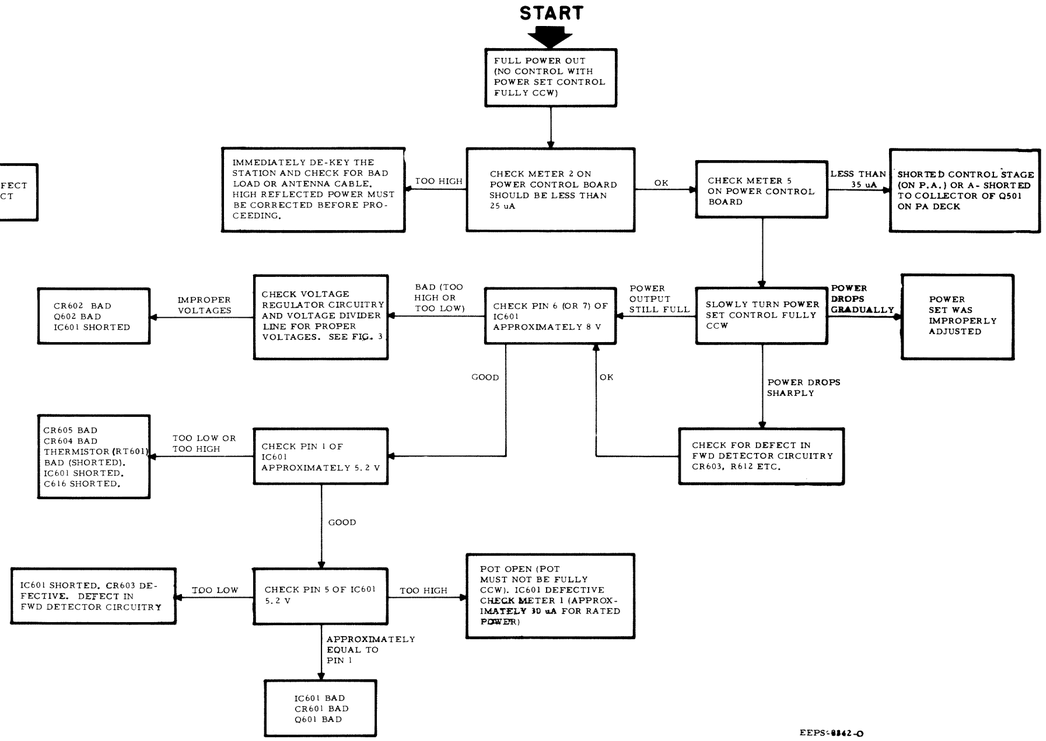
Step 1. Set ohmmeter to RX1, RX10 or RX100 scale (preferably RX10 if available).

Step 2. Measure the resistance from lead to lead as described in (a) thru (c). Should any indication be observed in measurements (a) or (c), the transistor is defective and should be replaced.

- With the positive probe on the base, no indication (very high impedance) should be observed when the negative probe is touched to the collector or emitter. (Reverse drop measurement.)
- With the negative probe on the base, a relatively low impedance should be observed when touching the positive probe to the collector and emitter. (Forward drop measurement.)
- No indication should be observed from collector to emitter regardless of the polarity of the ohmmeter probes.

POWER CONTROL BOARD TROUBLESHOOTING CHART

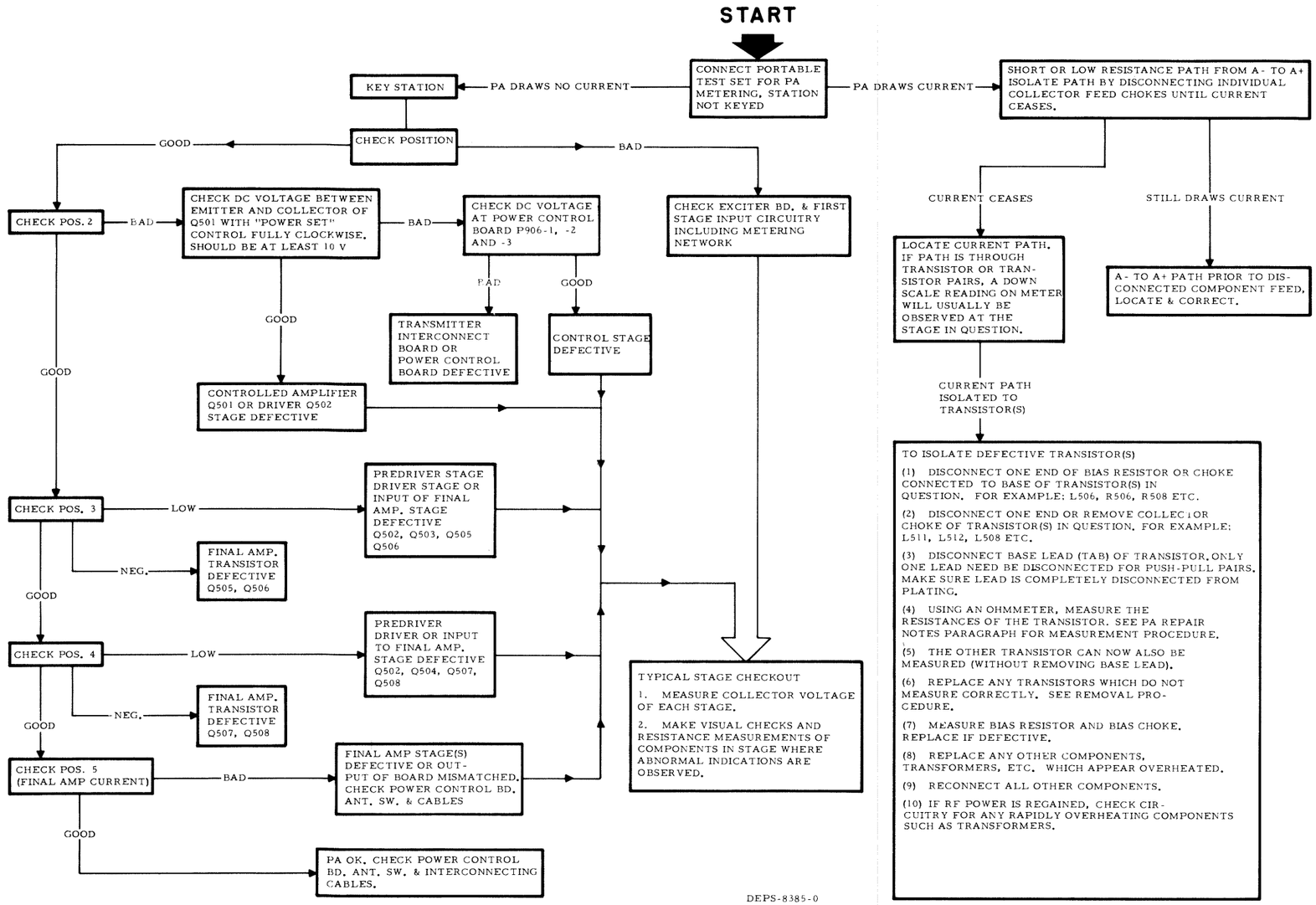




EEPS-0842-O

POWER AMPLIFIER TROUBLESHOOTING CHART

POWER AMPLIFIER TROUBLESHOOTING CHART



parts list

TRN5566A Input Bracket — PL-8193-B

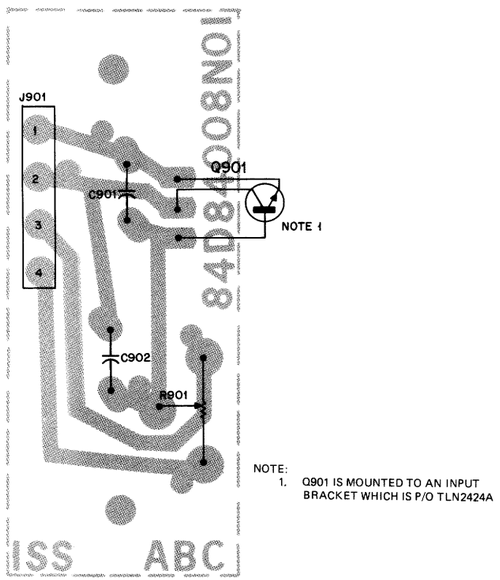
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: +100-0%: unless otherwise stated
C560, 561, 562	21-410115	220 pF ±20%; 500 V
C565, 566	21-84211B01	.01 uF; 250 V
C950 thru 953	21-82812H03	1000 pF; 500 V (feed-thru)
		connector, receptacle:
J501	9-84968D01	female; single-contact
J801	1-80764D32	assembly bracket; includes: C950, 951, 952, 953
	7-84355N01	BRACKET, PA input
	9-84935D01	SOCKET, transistor
	4-83755H01	WASHER, solder; 4 used
		connector, plug; includes:
P901	15-83498F41	HOUSING, 4-position
	29-83499F01	TERMINAL; 4 used
		transistor: (see note)
Q509	48-869627	type M9627
Q901	48-869806	NPN; type M9806
		terminal board:
TB1	31-50378	barrier type-2 terminals
		assembly cable:
W501	1-80727B92	assembly rf-input, includes: J501
	30-83794C01	CABLE, coaxial, WHT; 8" used
		mechanical parts
	2-115968	NUT; 1/4-28 x 3/8 x 1/8"; 2 used
	3-3360	SCREW, tapping; 6-20 x 1/2"; 2 used
	3-139905	SCREW, tapping; 8-15 x 3/4"; 2 used
	3-129841	SCREW, machine; 4-40 x 1/4"
	4-7557	WASHER, flat; .172 x .375 x .033"; 2 used
	4-7678	WASHER, lock; 1/4" external; 2 used
	4-84180C01	WASHER, insulator
	14-865875	INSULATOR, transistor
	14-84391F01	INSULATOR, transistor
	29-5223	LUG, soldering; 2 used
	43-82980N01	STANDOFF; 2 used
	75-10605A04	CUSHION; foam

TRN5585A Exciter Control Voltage Regulator — PL-8192-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor; +80-20%; 50 V:
C301, 302	21-11021H06	.033 uF
		connector, plug:
J901	28-82984N04	male; 4-contact
		resistor, variable:
R304	18-83083G11	2.5k
		mechanical parts
	9-80028A01	SOCKET, 3 pin

TKN8336A Cable Power Amplifier — PL-8191-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		connector:
J803	9-844509	female; single-contact (BNC)
P602	28-82365D03	male; single-contact (phono)
W601	1-80727B96	assembly rf output includes: J803 and P602
	30-82921H01	CABLE, coaxial, WHT; 5" used



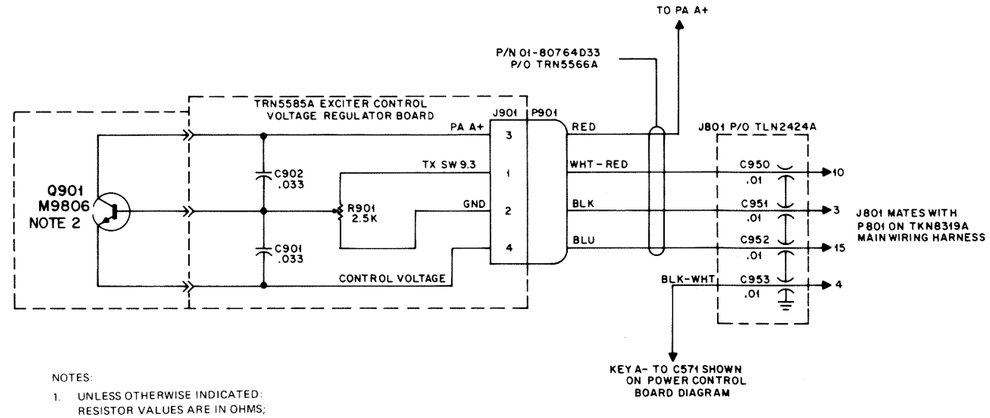
NOTE:
1. Q901 IS MOUNTED TO AN INPUT BRACKET WHICH IS P/O TLN2424A

SOLDER SIDE = BD-BEPS-35245-O
OL-BEPS-35246-O

SHOWN FROM SOLDER SIDE

TRN5585A EXCITER CONTROL VOLTAGE REGULATOR

SCHEMATIC DIAGRAM, CIRCUIT BOARD DETAIL, & PARTS LIST



NOTES:
1. UNLESS OTHERWISE INDICATED: RESISTOR VALUES ARE IN OHMS; CAPACITOR VALUES ARE IN MICROFARADS.
2. Q901 IS MOUNTED TO AN INPUT BRACKET WHICH IS P/O TLN2424A.

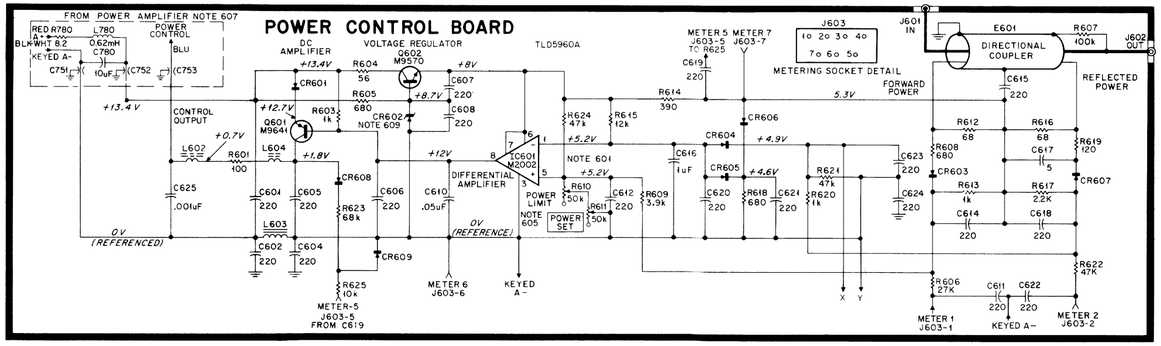
BEPS-35244-O

Model Complement

Model	Kit	Description
TLN2424A		Power Amplifier Input Bracket Assembly
	TRN5566A	PA Input Bracket
	TKN8336A	Power Amplifier Cable
	TRN5585A	Exciter Control Voltage Regulator

TLD5960A POWER CONTROL BOARD

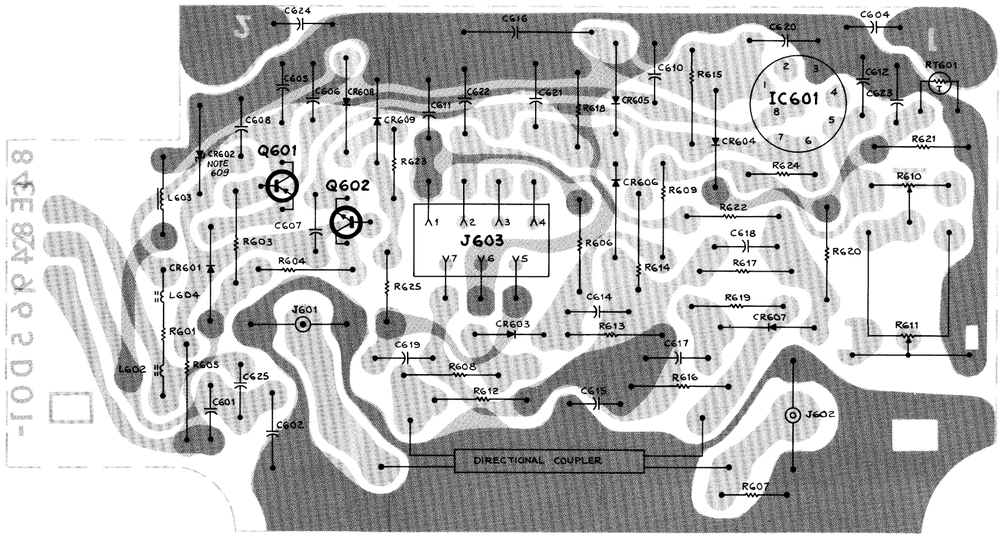
SCHEMATIC DIAGRAM,
CIRCUIT BOARD DETAIL, & PARTS LIST



EEPS-35250-0

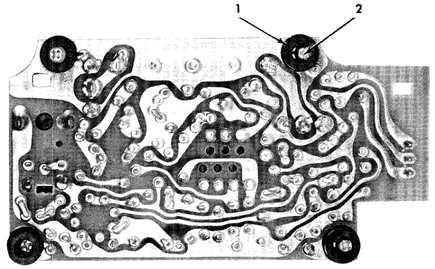
NOTES:

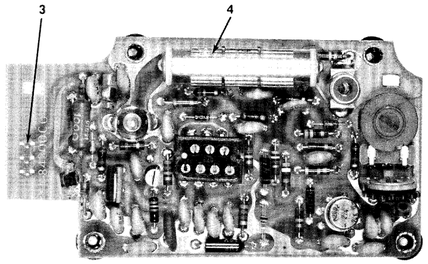
601. Voltages at pins 1 and 5 should differ by less than 50 mV.
603. Typical Voltages under normal operating conditions.
604. Unless otherwise stated: capacitor values are in picofarads.
605. Factory adjustment.
607. Not part of or mounted on power control board. Part of Model TRN5577A P.A. casing and hardware.
609. On model TLD5960A CR602 is a hybrid assembly.



COMPONENT SIDE
SOLDER SIDE
OL-CEPS-16813-C

SHOWN FROM SOLDER SIDE





BEPS-6542-O

electrical parts list

TLD5960A Power Control Board (High Power) PL-8266-A

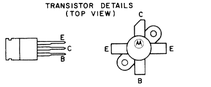
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: ± 20% 500 V: unless otherwise stated
C601, 602, 604 thru 608	21-83596E10	220 pF
C610	21-82372C04	.05 uF +80-20%; 25 V
C611, 612, 614, 615	21-83596E10	220 pF; 500 V
C616	23-83214C04	1.0 uF ± 20%; 15 V
C617	21-82133G53	5 pF ± 0.5 pF; 500 V; NP0
C618 thru 624	21-83596E10	220 pF ± 20%; 500 V
C625	21-82187E14	.001 uF ± 10%; 100 V
		semiconductor device, diode:
CR601	48-83654H01	silicon
CR602	48-83696E04 or 1-80709D68	Zener (9.1 V) hybrid assembly
CR603	48-84616A01	silicon
CR604, 605, 606	48-82392B11	silicon
CR607	48-84616A01	silicon
CR608	48-82392B03	silicon
CR609	48-82392B18	silicon
		coupler, line:
E601	58-84685B01	dual
		integrated circuit:
IC601	51-84320A02	M2002
		connector, receptacle:
J601	28-84227B02	male; single-contact
J602	9-84231B02	female; single-contact
J603	9-84207B01	female; 7-contact
		coil, rf:
L602	76-83960B01	ferrite bead
L603	24-83961B01	choke
L604	76-83960B01	ferrite bead
		transistor:
Q601	48-869641	PNP; type M9641
Q602	48-869570	NPN; type M9570
		resistor, fixed ± 10%; 1/4 W: unless otherwise stated
R601	17-82291B21	100 ± 5%; 3 W
R603	6-124C49	1k
R604	6-124C19	56
R605	6-124A45	680 ± 5%
R606	6-124A83	27k ± 5%
R607	6-124C97	100k
R608	6-124A45	680 ± 5%
R609	6-124A63	3.9k ± 5%
R610	18-83083G26	variable; 50k
R611	18-83083G20	vaiable; 50k
R612	6-124A21	68 ± 5%
R613	6-124A49	1k ± 5%
R614	6-124A39	390 ± 5%
R615	6-124C75	12k
R616	6-124A21	68 ± 5%
R617	6-124A57	2.2k ± 5%
R618	6-124A45	680 ± 5%
R619	6-124A27	120 ± 5%
R620	6-124C49	1k
R621	6-124A89	47k
R622	6-124A89	47k ± 5%
R623	6-185A93	68k ± 5%; 1/8 W
R624	6-185B99	47k; 1/8
R625	6-185A73	10k ± 5%; 1/8 W
		mechanical parts
	3-138162	SCREW, tapping; 4-40 x 3/8"; 4 used
	42-84284B01	RETAINER; 4 used
	55-84300B04	HANDLE

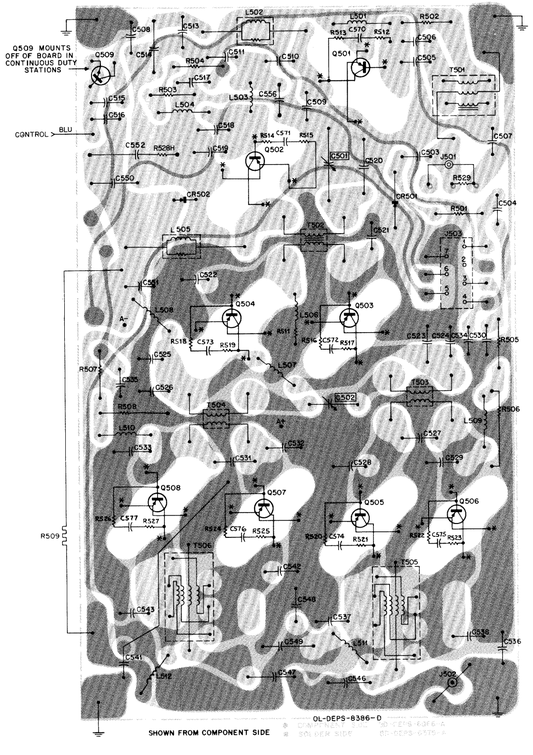
Mechanical Parts List PL-854-D

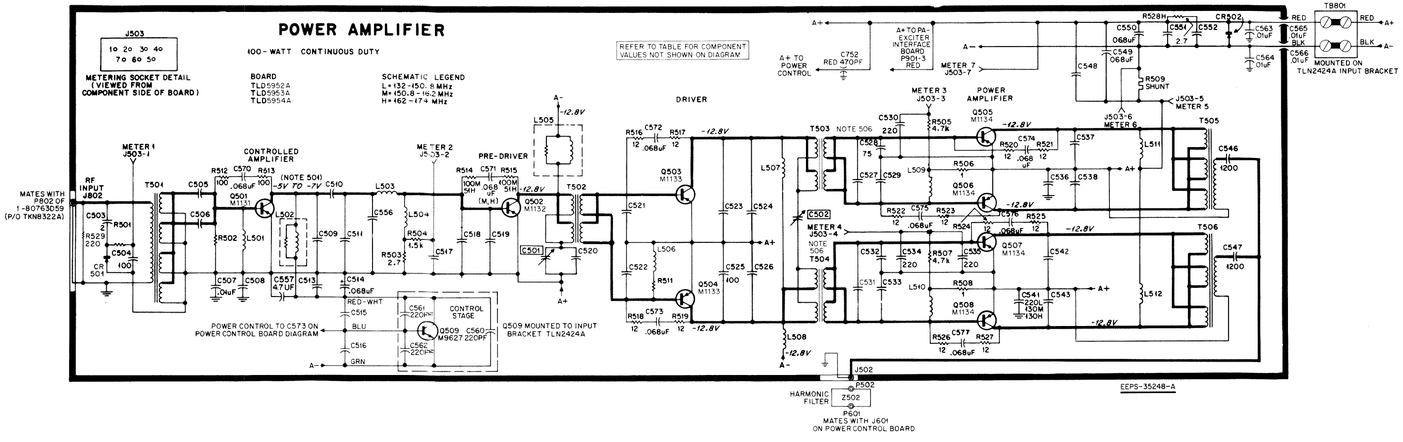
CODE	MOTOROLA PART NO.	DESCRIPTION
1	42-84284B01	RETAINER; 4 used
2	3-139506	SCREW, tapping: 4-40 x 5/16"
3	29-84028H01	TERMINAL, male; 3 used
4	42-84678B01	CLIP, component
		non-coded items
	55-84300B04	HANDLE, plastic
	1-80797B34	CABLE ASSEMBLY (TLD8610AV & TLD8620AV only) includes:
	42-10217A02	STRAP, tie

PA Component Values

Ref	136-150.8 MHz	150.8-162 MHz	162-174 MHz
C501	4-40	1.5-18	1.5-18
C502	2.4-27	2-19.3	2-19.3
C505	62	49	62
C506	62	51	34
C508	160	130	130
C509	15	15	10
C510	175	51	39
C511	62	51	39
C513	160	130	130
C515	—	3.3 uF	3.3 uF
C518	49	60	49
C519	49	60	43
C520	30	25	20
C521	62	43	43
C522	56	39	51
C523	80	100	120
C524	—	.01 uF	.05 uF
C526	—	.01 uF	.05 uF
C527	43	30	24
C528	75	75	80
C529	60	51	51
C531	43	30	24
C532	75	75	80
C533	62	60	68
C536	220	390	—
C537	130	150	100
C538	130	150	120
C541	220	130	130
C542	130	150	100
C543	120	130	100
C546	1200	1200	1200
C547	1200	1200	1200
C548	160	130	130
C551	160	130	130
C552	15 uF	100 uF	100 uF
C556	30	10	6
C557	—	—	4.7 uF
C571	—	.068 uF	.068 uF
L503	7-84400B03	1-1/2 turns	1-1/2 turns
L504	1 turn	1 turn	85
L506	.039 uH	.039 uH	290 nH
L507	2-1/2 turns	4-1/2 turns	4-1/2 turns
L508	2-1/2 turns	4-1/2 turns	4-1/2 turns
L509	0.29 uH	.039 uH	290 nH
L510	0.29 uH	.039 uH	290 nH
L511	4-1/2 turns	4-1/2 turns	0.29 nH
L512	4-1/2 turns	4-1/2 turns	0.29 nH
R501	100k	150k	150k
R502	10	10	49
R511	2.7	2.7	—
R514	—	100	51
R515	—	100	51
R528	—	—	2.7
T503	25-84859L01	25-84854L02	24-82060L01
T504	25-84859L02	25-84854L02	24-82060L01
T505	25-84860L01	25-84860L01	25-82061L01
T506	25-84860L01	25-84860L01	25-82061L01







NOTES

501. Voltages dependent upon amount of cutback from power control board.
502. Voltages measured in respect to A+ unless otherwise specified.
503. Unless otherwise specified Capacitor values are in picofarads.
506. For frequency range 162-174 MHz air-core transformers.

PARTS LISTS SHOWN ON BACK OF THIS DIAGRAM

parts list

TRN5577A PA Casting and Hardware Kit — PL-8218-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed:
C563, 564	21-84211B02	.01 uF +100-0%; 250 V
C780	23-83214C20	10 uF ±20%; 20 V
		coil, rf:
L780	24-80900A61	choke; 0.62 mH
		resistor; fixed:
R780	6-124B67	8.2 ±5%; 1/4 W
		mechanical parts
	2-119913	NUT, 8-32 x 11/32 x 1/8"; 2 used
	3-131195	SCREW, machine; 6-32 x 3/8"; 18 used
	3-134184	SCREW, tapping; 4-40 x 5/16"; 8 used
	3-134185	SCREW, tapping; 6-32 x 1/4"; 4 used
	3-136930	SCREW, tapping; 4-40 x 1/2"; 4 used
	3-83677N04	SCREW, capture; 4 used
	4-7557	WASHER, flat, 0.172 x 0.375 x .033; 6 used
	4-801846	WASHER, insulator; 3/8"; 2 used
	7-84347N01	BRACKET, mounting; (RH)
	7-84347N02	BRACKET, mounting (LH)
	15-84403D01	COVER, power control
	26-84404D03	HEAT EXCHANGE, PA
	31-131744	TERMINAL, strip; 2 insulated #2 mounting
	42-84328E01	CLIP
	66-106515	WRENCH, Allen

TRN5586A PA Hardware — PL-8219-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: ±20%; 500 V:
C751, 752, 753	21-821474	470 pF; (feed-thru)
		transistor: (see note)
Q501	48-84411L31	PNP; type M1131
Q502	48-84411L32	PNP; type M1132
Q503, 504	48-84411L33	PNP; type M1133
Q500 thru 508	48-84411L34	PNP; M1134
		mechanical parts
	3-114406	SCREW, cap; 4-40 x 5/16"; 20 used
	3-134309	SCREW, tapping; 4-40 x 5/16"; 3 used
	14-84290B02	INSULATOR
	26-84911L01	SHIELD, PA
	42-10217A02	STRAP, tie: .091 x 3.62 nylon; 3 used
	54-84429N01	LABEL, PA
	4-83755H01	WASHER, solder; 7 used
	7-82379M01	BRACKET
	9-84234E10	CONNECTOR, receptacle; 3 used

PA Output (Harmonic) Filter — PL-1722-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		filter, rf; low pass:
Z502L	TFD6101A	132-150.8 MHz
Z502M, 502H	TFD6102A	150.8-174 MHz

LEGEND:
L = 132-150.8 MHz
M = 150.8-162 MHz
H = 162-174 MHz

TLD5952A PA Board (132-150.8 MHz)
TLD5953A PA Board (150.8-162 MHz)
TLD5954A PA Board (162-174 MHz) — PL-6100-B

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF; ±5%; 500 V: unless otherwise stated
C501L	20-83201B09	variable; 4-40
C501M, 501H	20-83201B07	variable; 1.5-18
C502L	19-83491E08	variable; 2.4-27 (voltage not stated)
C502M, 502H	19-83491E07	variable; 2-19.3 (voltage not stated)
C503	21-83406D52	2
C504	21-84494B04	100
C505L	21-84494B02	62
C505M	21-84494B25	49
C505H, 506L	21-84494B02	62
C506M	21-84494B01	51
C506H	21-84494B30	34
C507	21-82428B59	.01 uF +80-20%; 200 V
C508L	21-84494B51	160
C508M, 508H	21-84494B26	130
C509L, 509M	21-84494B38	15
C509H	21-84494B29	10
C510L	21-84494B09	175
C510M	21-84494B01	51
C510H	21-84494B24	39
C511L	21-84494B02	62
C511M	21-83366K20	51
C511H	21-84494B24	39
C513L	21-84494B51	160
C513M, 513H	21-84494B26	130
C514, 549, 550	8-83813H05	.068 uF ±10%; 100 V
C515L		NOT USED
C515M	23-11019A16	4.7 uF; 35 V
C516M	23-83908L01	100 uF; 25 V
C516L, 516H	23-83214C10	47 uF ±20%; 6 V
C517	21-83596E10	220
C518L	21-84494B25	49
C518M	21-84494B35	60
C518H, 519L	21-84494B25	49
C519M	21-84494B35	60
C519H	21-84494B28	43
C520L	21-84936A06	30 ±1.5 pF; 2000 V
C520M	21-83034P04	25; 2000 V
C520H	21-84936A03	20; 2000 V
C521L	21-84494B02	62
C521M, 521H	21-84494B28	43
C522L	21-84494B45	56
C522M	21-84494B24	39
C522H	21-84494B01	51
C523L	21-83366K12	80; 250 V
C523M	21-83364K13	100; 250 V
C523H	21-83366K14	120; 250 V
C524L, 526L		NOT USED
C524M, 526M	21-82428B59	.01 uF +80-20%; 200 V
C524H, 526H	21-82372C04	.05 uF +80-20%; 25 V
C525	21-83366K13	100; 250 V
C527L	21-83366K19	43
C527M	21-83366K18	30
C527H	21-83366K17	24
C528L, 528M	21-83366K24	75
C528H	21-83366K25	80
C529L	21-83366K21	60
C529M, 529H	21-83366K20	51
C530	21-83596E10	220
C531L	21-83366K19	43
C531M	21-83366K18	30
C531H	21-83366K17	24
C532L, 532M	21-83366K24	75
C532H	21-83366K25	80
C533L	21-83366K22	62
C533M	21-83366K21	60
C533H	21-83366K23	68
C534, 535	21-83596E10	220
C536L	21-84494B12	220
C536M	21-84494B18	390
C536H		NOT USED
C537L	21-83366K15	130; 250 V
C537M	21-83366K16	150; 250 V
C537H	21-83366K13	100; 250 V
C538L	21-83366K15	130; 250 V
C538M	21-83366K16	150; 250 V
C538H	21-83366K14	120; 250 V
C541L	21-84494B12	220
C541M, 541H	21-84494B26	130
C542L	21-83366K15	130; 250 V
C542M	21-83366K16	150; 250 V
C542H	21-83366K13	100; 250 V
C543L	21-83366K14	120; 250 V
C543M	21-83366K15	130; 250 V
C543H	21-83366K13	100; 250 V
C546, 547	21-84426B36	1200
C548L	21-84494B51	160
C548M, 548H	21-84494B26	130
C551L	21-84494B51	160
C551M, 551H	21-84494B26	130
C552L	23-83214C02	15 uF ±20%; 25 V
C552M	23-84669A19	100 uF +150-20%; 20 V
C552H	23-82783B04	100 uF ±20%; 25 V
C556L	21-84494B33	30
C556M	21-84494B29	10
C556H	21-84494B74	6
C557H	23-82783B25	4.7 uF ±10%; 25 V
		semiconductor device, diode: (see note)
CR501	4882139G01	germanium
CR502	48-82525G01	silicon
		connector, receptacle; female:
P501, 502	28-84227B01	coaxial, miniature type
J503	9-84207B01	7-contact
		coil, rf:
L501	24-83961B01	choke; 3 turns; coded BRN
L502	24-84392B03	choke; 6 turns
L503L	7-84400B03	inductor "bracket"
L503M, 503H	24-83884G03	1-1/2 turns
L504L, 504M	24-83961B03	choke; 1 turns; coded WHT
L504H	24-82723H18	choke; 85 nH
L505	24-84392B02	choke; 4 turns
L506L, 506M	24-82723H02	choke; 39 nH
L506H	24-82723H20	choke; 290 nH
L507L, 508L	24-8547G10	choke; 2-1/2 turns
L507M, 507H, 508M, 507H	24-84393B02	choke; 4-1/2 turns
L509L, 510L	24-82723H04	choke; 0.29 uH
L509M, 510M	24-82723H02	choke; 39 nH
L509H, 510H	24-82723H20	choke; 290 nH
L511L, 511M	24-84393B02	4-1/2 turns
L511H	24-82723H04	choke; 0.29 uH
L512L, 512M	24-84393B02	4-1/2 tuns
L512H	24-82723H04	choke; 0.29 uH
E101M, 102M	76-83960B01	ferrite bead
		resistor, fixed: ±10%; 1/4 W: unless otherwise stated
R501L	6-124C97	100k
R501M, 501H	6-124D02	150k
R502L, 502M	6-124A01	10 ±5%
R502H	6-124C17	47
R503	6-124B55	2.7 ±5%
R504	6-124C53	1.5k
R505, 507	6-124C65	4.7k
R506, 508	6-125D70	1; 1/2 W
R509	6-84232B01	(meter shunt)
R511L, 511M	6-124D55	2.7 ±5%
R528H	6-124D55	2.7 ±5%
R529	6-11009A33	220 ±5%
		transformer, rf:
T501	25-84396B01	pri: 5 turns sec: 4 windings, 1 turn each
T502	25-84397B01	pri: 2 windings, 1-3/4 turns each sec: 2 windings, 1-3/4 turns each
T503L	25-84859L01	pri: 2 windings, 2-3/4 turns each sec: 2 windings, 2-3/4 turns each NOTE: ("left hand" windings)
T503M	25-84854L01	pri: 3-3/4 turns sec: 3-3/4 turns
T503H	24-82060L01	pri: 2 windings, 2 turns each sec: 2 windings, 2 turns each
T504L	25-84859L02	pri: 2 windings, 2-3/4 turns each sec: 2 windings, 2-3/4 turns each NOTE: ("right hand" windings)
T504M	25-84854L02	pri: 3-3/4 turns sec: 3-3††4 turns
T504H	24-82060L01	pri: 2 windings, 2 turns each sec: 2 windings, 2 turns each
T505L, 505M	25-84860L01	pri: 3 windings, 1-1/2 turns each sec: 6 turns
T505H	25-84861L01	pri: 3 windings, 1-1/2 turns each sec: 5 turns
T506L, 506M	25-84860L01	pri: 3 windings, 1-1/2 turns each sec: 6 turns
T506H	25-84861L01	pri: 3 windings, 1-1/2 turns each sec: 5 turns

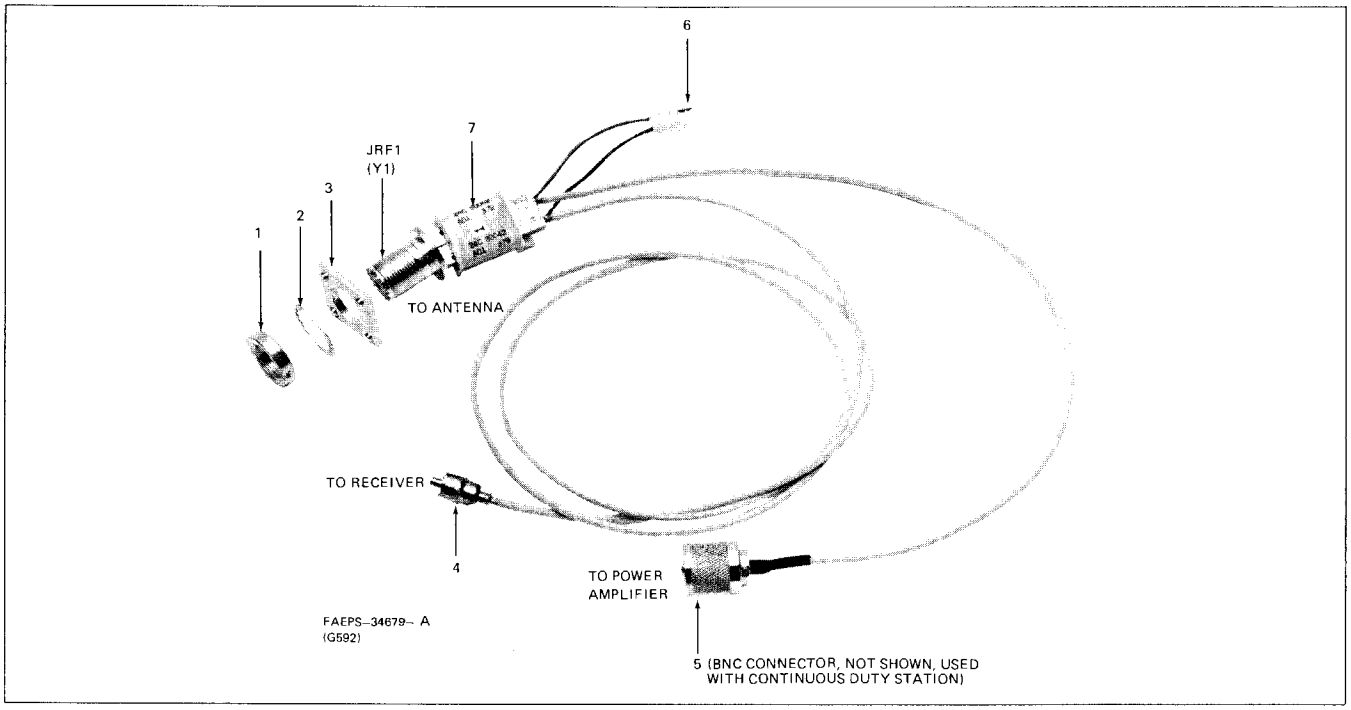
note: For optimum performance, diodes, transistors, and integrated circuits must be ordered by Motorola part numbers.

TRN8069A Resistor-Capacitor Network Kit (132-150.8 MHz)
TRN6445A Resistor-Capacitor Network Kit (150.8-162 MHz)
TLD5502A Resistor-Capacitor Network Kit (162-174 MHz) — PL-5396-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed; ±10%; 100 V: unless otherwise stated
C570, 572 thru 577	8-83813H05	.068 uF
C571L		NOT USED
C571M, 571H	8-83813H05	.068 uF
		resistor, fixed: ±10%; 1/2 W: unless otherwise stated
R512, 513	6-125C25	100
R514L, 515L		NOT USED
R514M, 515M	6-125C25	100
R514H, 515H	6-125A18	51 ±5%; 1/2 W
R516 thru 527	6-125C03	12

MOTOROLA INC.
Communications Sector

ANTENNA SWITCH
MODEL TRN5864A (INTERMITTENT DUTY)
MODEL TRN5571A (CONTINUOUS DUTY)



ANTENNA SWITCH REPLACEMENT

1. Remove the card cage per manual instructions in the maintenance section.

2. Note the positions of the tie wraps and cable clamps, and pay attention to cable routing.

3. Remove the appropriate cable clamps, and clip the necessary tie wraps.

4. Remove the antenna switch:

4.1 Unfasten the receiver antenna connector from the card cage chassis (2 screws).

4.2 Disconnect the rf connector from the PA output

4.3 Unfasten the 2 pin molex connector.

4.4 Remove the antenna switches spanner nut from the junction box.

5. Installation is the reverse of the above. Remember to fasten the cables with new tie wraps.

parts list

TRN9168A Antenna Switch
TRN5864A Antenna Switch PL-8685-A

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
1	2-80006A01	NUT, spanner
2	4-114522	LOCKWASHER, 5/8"
3	43-82895N01	SPACER
4	28-82875N01	CONNECTOR, receiver (TRN5864A)
	or 28-82331G01	CONNECTOR, preamp (TRN9618A)
5	28-84579F01	CONNECTOR, PA (P03) Intermittent Duty
	28-83099K01	CONNECTOR, PA (P803) Continuous Duty
6		J801 consists of 15-84861K02 Housing 29-84706E05 TERMINALS
7		ANTENNA SWITCH, non-serviceable