10 W DRIVER AMPLIFIER BOARD

TLD1950A SERIES

MODEL TABLE

MODEL	FREQUENCY RANGE
TLD1951A	136-150.8 MHz
TLD1952A	150.8-162 MHz
TLD1953A	162-174 MHz

TECHNICAL CHARACTERISTICS*

RF Power In	400 mW
Input Impedance	50 ohms
RF Power Out	10 watts
Output Impedance	50 ohms
Power Requirements	13.0 volts @1.8 amps

*All values are typical

1. DESCRIPTION

Motorola's TLD1950A Series Driver Amplifier Boards provide the following features:

--10 W rf output.

--All circuitry contained on one double-sided circuit board.

--RF connections made through two coaxial connections which plug directly into the input and output.

--DC power supplied via two feedthrough capacitors that also provide filtering.

--Input, output and most other critical interstage matching is accomplished by the use of rf transformers wound around ferrite cores. Only one tuning adjustment is required due to the relatively broadband matching characteristics of the ferrite transformers and the low inductance leads of the silicon opposed emitter transistors.

--One metering socket which is accessible from the component side of the circuit board allows four major test points to be monitored.

--Due to the heat sink mounting requirements for this board, servicing is accomplished from the component side of the board.

--Diode protection against reverse polarity voltage (board mounted diode).

--Output protection provided by a control stage transistor driven by the power control circuit (Controls gain of the first stage).

2. FUNCTIONAL OPERATION

2.1 Refer to the block diagram, Figure 1, and the schematic diagram. This series of driver amplifiers requires a 400 mW rf input from the exciter board. This input is passed through a bandpass filter assembly and a ferrite step-down transformer (to match the input impedance to the first stage) to the gain-controlled

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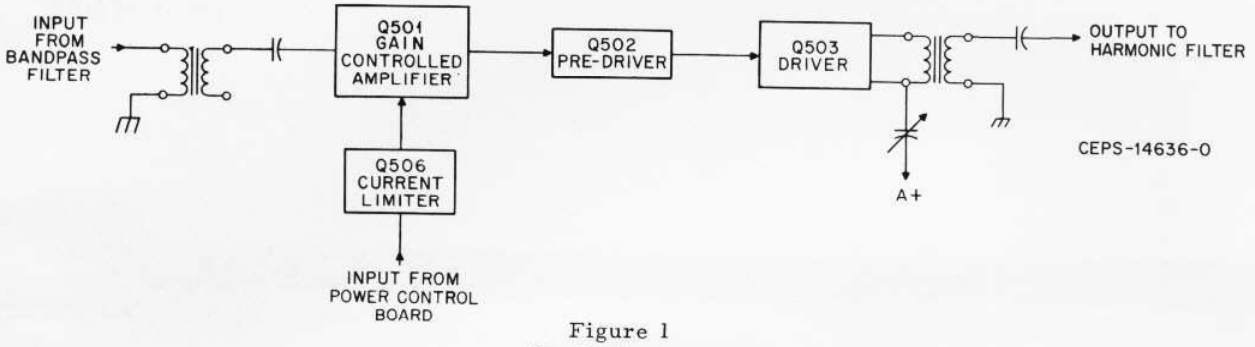


Figure 1
Block Diagram

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 stage of the driver amplifier and the load condition.

2.2 The output of the gain-controlled amplifier is passed through a fixed-tuned broadband, matching network and applied to the pre-driver stage. A parallel capacitor network couples the output of the pre-driver to the base of the driver stage. The output of the driver stage is stepped up in impedance by a ferrite transformer to provide the 50-ohm output impedance to match the input impedance of the harmonic filter.

2.3 Pin 1 of the metering receptacles 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. Pin 3 permits observation of the drive output of the pre-driver stage and an indication of the operation of the driver stage. Pin 5 permits observation of the collector currents of the final amplifier stage. 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.

3. MAINTENANCE

3.1 GENERAL

NOTE

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

This section of the manual provides the maintenance shop procedures for the driver board. It assumes that preliminary tests have already localized the trouble to the driver board. These procedures include measurements with built-in station metering, a vom, a complete set of performance tests, and extensive troubleshooting procedures.

CAUTION

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

3.2 RECOMMENDED TEST EQUIPMENT

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

3.2.1 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. Built-in station metering, when incorporated, takes the place of the portable test set for some meter readings.

3.2.2 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.

3.2.3 Motorola T1013A RF Load Resistor (dummy load) or equivalent.

3.3 METERING

The driver board is equipped with a metering receptacle which allows four major test points to be measured. Driver metering can be made at each of the four test points by merely rotating a selector switch on the built-in

station metering kit or on the test set. A failure in almost any portion of the driver will produce a low or zero meter reading for one or more of the test points. Improper alignment will also cause improper meter readings.

3.3.1 Using the Built-In Station Meter

Step 1. The entire transmitter is necessary for testing driver boards including the power control board for proper control.

Step 2. The output of the station must be terminated in one of two types of loads:

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

--An RF Wattmeter.

Step 3. Turn the station ON.

Step 4. With the meter panel selector switch set to the XCTR position and the exciter/driver chassis selector switch set to PA position 1, key the transmitter and observe the meter. Unkey the transmitter. Set the switch to position 5, key station and note reading. On multi-frequency stations, repeat the reading for each frequency. An analysis of the meter readings for determining whether each circuit is good or bad is given in the MINIMUM PA METER READINGS table.

3.3.2 Using the Portable Test Set

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.

Step 3. Set the selector switch of the test set to position 1 and reference position A.

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 chassis circuit board. Connect the white "metering" plug of the adapter cable to the receptacle on the driver ampl. circuit board.

Step 6. The entire transmitter is necessary for testing driver boards including the power control board for proper control.

Step 7. The output of the station must be terminated in one of two types of loads:

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

--An RF Wattmeter.

Step 8. Turn the station ON.

Step 9. Key the transmitter with the XMTR ON button the test set. Observe the meter. Unkey the transmitter.

Step 10. Set the selector switch to positions 2 & 3, then switch to reference position B and meter position 5 respectively, keying the transmitter and observing the meter reading for each. 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.

Each time maintenance is performed on the driver board 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 an impending failure and corrective action may be taken before the circuit fails entirely.

3.4 PERFORMANCE TESTS

3.4.1 No performance test of the driver amplifier is required other than rf power output from the exciter/driver 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.

3.4.2 Key the transmitter and observe power out, which should be 10 watts.

3.4.3 If necessary, adjust POWER SET control for rated power output.

CAUTION

The PA shield must always be in place during operation of the station and should be kept in place as much as possible while testing and troubleshooting. The circuit board must

MINIMUM PA METER READINGS

SELECTOR SWITCH POSITION (See Metering Note)	REFERENCE SWITCH POSITION Portable Test Set Usage Only	MINIMUM METER READING	CIRCUIT METERED	IF LOW, THE DEFECTIVE CIRCUIT IS
1	A	15 uA	RF drive from exciter.	Exciter
2	A	5 uA	Controlled amplifier output	Controlled amplifier or pre-driver
3	A	5 uA	Pre-driver output	Pre-driver or driver
5	B	8 uA min. 18 uA max.	Final amplifier output current	Final amplifier
6	B	12 V(0-30 V scale)	Final amplifier voltage	Final amplifier A+ or A- input

METERING NOTE

When built-in station metering is used in continuous duty stations, only exciter output (driver input), final driver current, and final driver voltage functions may be checked.

CAUTION (Cont'd)
always be secured in place with all mounting screws. The transistors (including the control stage transistor mounted on the inner wall) must be secured in place to provide proper heat sinking, and the feedthrough connectors must be soldered in place to provide dc power and good rf grounding.

4. TROUBLESHOOTING

If a problem has been localized to the driver board, several checks can be made prior to extensive troubleshooting.

4.1 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.

4.2 VOLTAGE CHECKS

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

4.3 TROUBLESHOOTING

If meter 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 driver is from A- referenced to A+ (not to chassis ground).

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 driver 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.

5. REPAIR NOTES

5.1 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 desoldering device.

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

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

5.2 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.

5.3 PROCEDURES FOR RESISTANCE MEASUREMENTS OF PNP TRANSISTORS

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

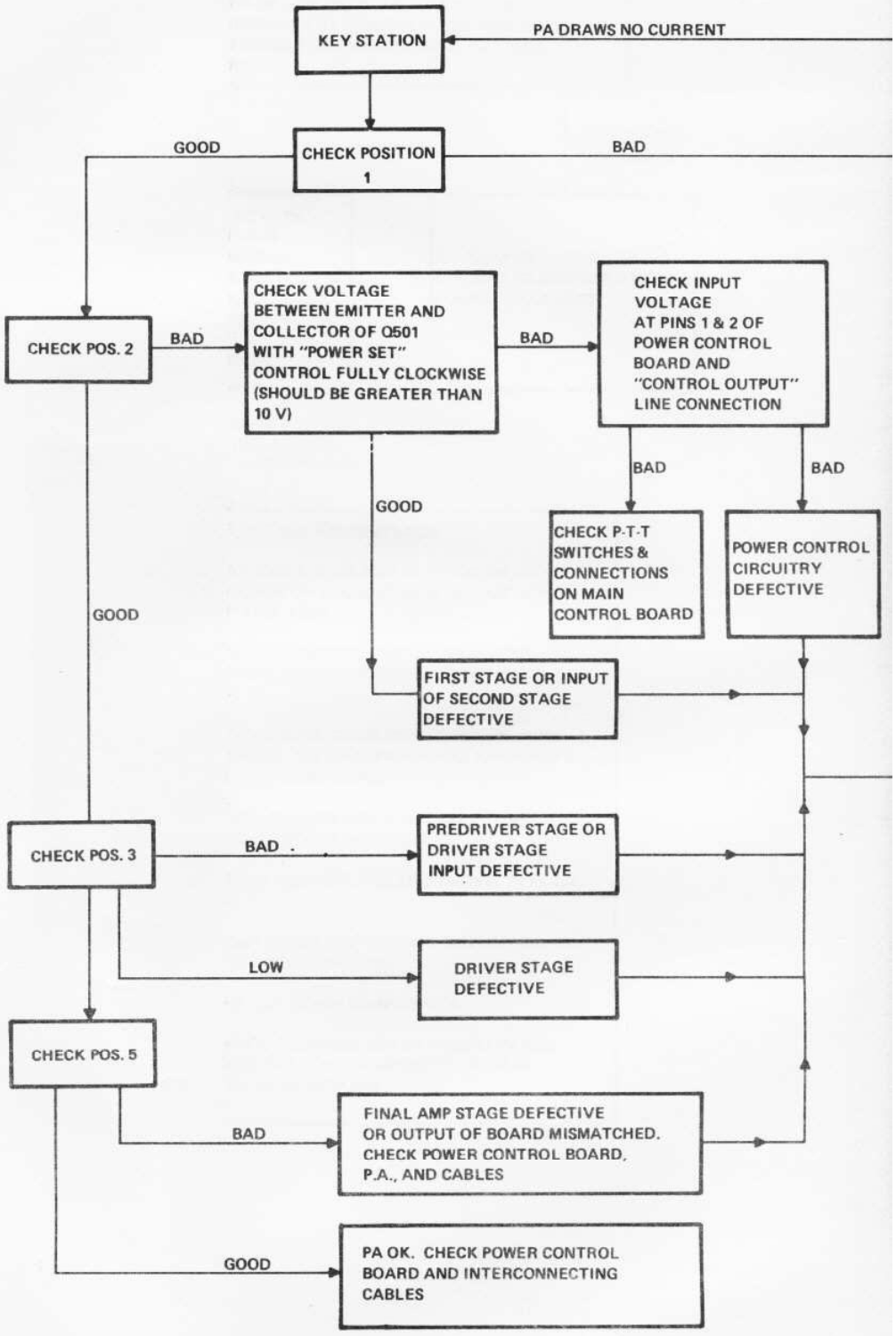
Step 2. Measure the resistance from lead to lead as described:

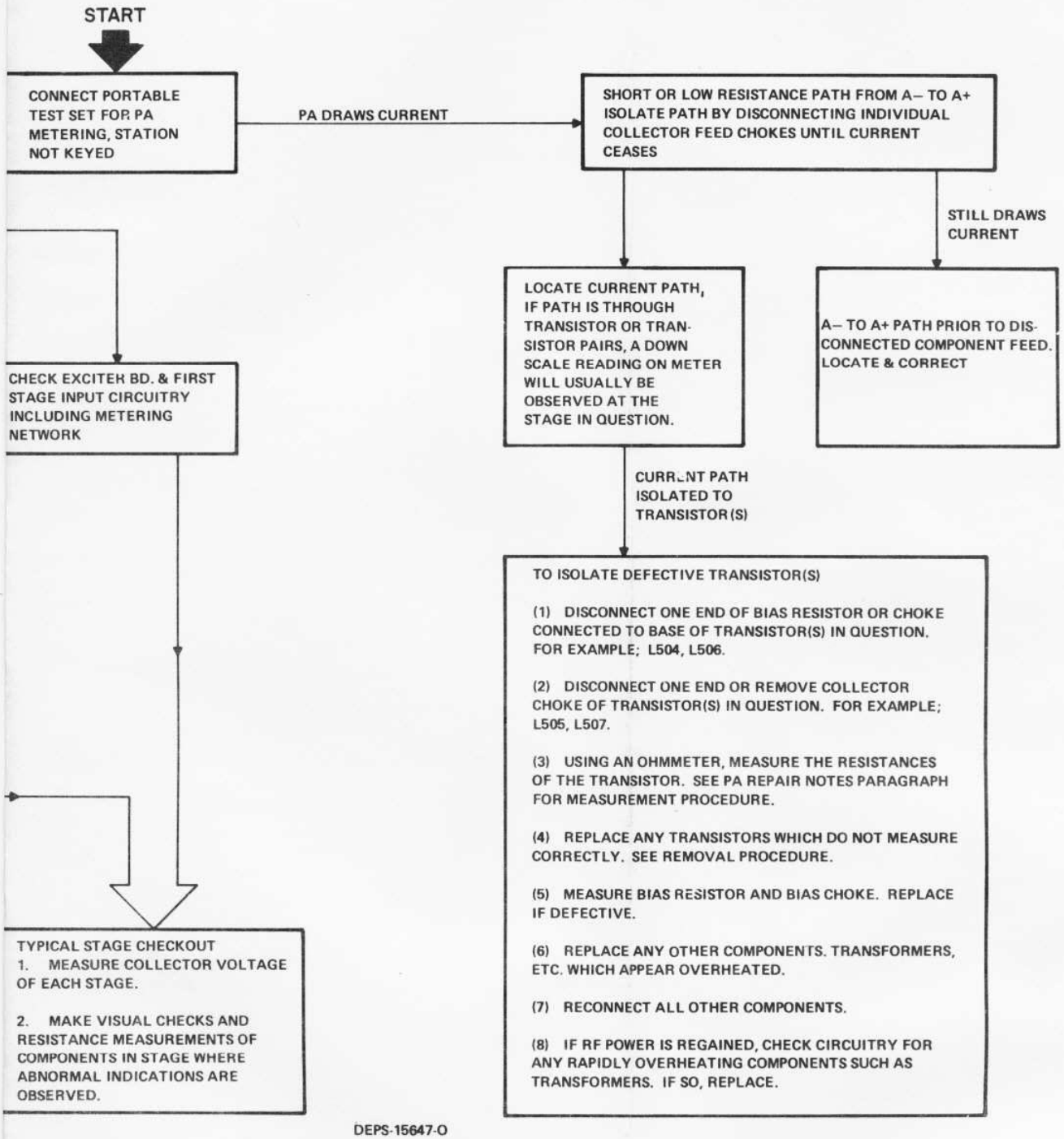
(a) With the positive probe on the base, no indication (very high impedance) should be observed when the negative probe is touched to the collector or emitter. (Reverse drop measurement.)

(b) 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).

(c) No indication should be observed from collector to emitter regardless of the polarity of the ohmmeter probes.

Step 3. Should any indication be observed in measurements (a) or (c), the transistor is defective and should be replaced. For NPN transistors, reverse the lead polarity when making the measurements of (a) and (b).


KEY STATION
PA DRAWS NO CURRENT
CHECK POSITION 1
GOOD
BAD
CHECK POS. 2
BAD
CHECK VOLTAGE BETWEEN EMITTER AND COLLECTOR OF Q501 WITH "POWER SET" CONTROL FULLY CLOCKWISE (SHOULD BE GREATER THAN 10 V)
BAD
CHECK INPUT VOLTAGE AT PINS 1 & 2 OF POWER CONTROL BOARD AND "CONTROL OUTPUT" LINE CONNECTION
BAD
BAD
GOOD
CHECK P-T-T SWITCHES & CONNECTIONS ON MAIN CONTROL BOARD
POWER CONTROL CIRCUITRY DEFECTIVE
GOOD
FIRST STAGE OR INPUT OF SECOND STAGE DEFECTIVE
CHECK POS. 3
BAD
PREDRIVER STAGE OR DRIVER STAGE INPUT DEFECTIVE
LOW
DRIVER STAGE DEFECTIVE
CHECK POS. 5
BAD
FINAL AMP STAGE DEFECTIVE OR OUTPUT OF BOARD MISMATCHED. CHECK POWER CONTROL BOARD, P.A., AND CABLES
GOOD
PA OK. CHECK POWER CONTROL BOARD AND INTERCONNECTING CABLES



10 W DRIVER AMPLIFIER BOARD

10 W Driver Amplifier
Troubleshooting Chart
Motorola No. DEPS-15647-A
10/22/76-UP

EXCERPTS FROM FCC REGULATIONS

FCC Regulations state that:

1. Radio transmitters may be tuned or adjusted only by persons holding a first or second class commercial radiotelephone operator's license or by personnel working directly under their immediate supervision.

2. The power input to the final radio frequency stage shall not exceed the maximum figure specified on the current station authorization. This power input shall be measured and the results recorded:

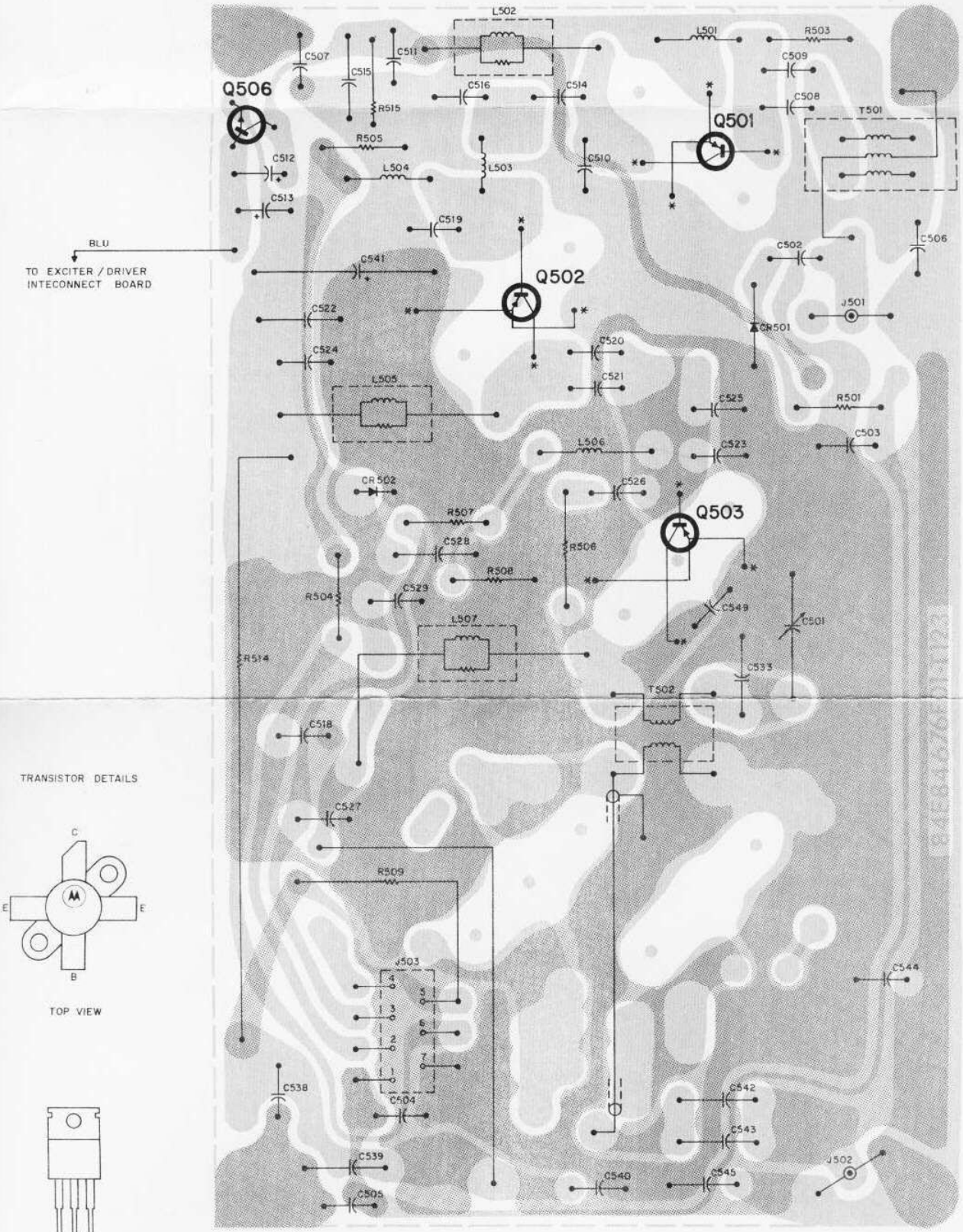
   a. When the transmitter is initially installed.
   b. When any change is made in the transmitter which may increase the power input.
   c. At intervals not to exceed one year.

3. Frequency and deviation of a transmitter must be checked:

   a. When it is initially installed.
   b. When any change is made in the transmitter which may affect the carrier frequency or modulation characteristics.
   c. At intervals not to exceed one year.

ALIGNMENT PROCEDURE DRIVER - AMPLIFIER

STEP	ADJUST	METERING CHASSIS SELECTOR SWITCH POSITION	EXCITER/DRIVER CHASSIS SELECTOR SWITCH POSITION	STAGE AND PROCEDURE
1				Align the exciter.
2	C501 R610 (POWER LIMIT) R611 (POWER SET)			PRE-ALIGNMENT: Adjust C501 fully clockwise. Adjust R610 on the Power Control Board to the end of its travel by rotating the edge of the knob toward the top of the chassis. Adjust R611 on the Power Control Board fully clockwise.
3				Connect a wattmeter and 50Ω rf load to the Exciter-Driver output terminal.
4	C501	XCTR	PA5	OUTPUT: Key the station without modulation and tune C501 counterclockwise for peak power output.
5	R610 (POWER LIMIT)	XCTR	PA5	Adjust R610 gradually toward the bottom of the chassis until the power output just starts to drop.
6	R611 (POWER SET)	XCTR	PA5	OUTPUT: Adjust R611 counterclockwise until power output drops to 10 Watts.
7	C501	XCTR	PA5	Tune C501 clockwise for a meter 5 dip. The power output should stay constant at 10 Watts.
8		XCTR	PA5	DRIVER COLLECTOR CURRENT: The relationship between the meter 5 reading and driver collector current is 10 uA = 1 A. The meter 5 reading should be between 10-18 uA.
9				Disconnect the wattmeter and the rf load. Reconnect the coaxial cable to the driver amplifier output.



TRANSISTOR DETAILS

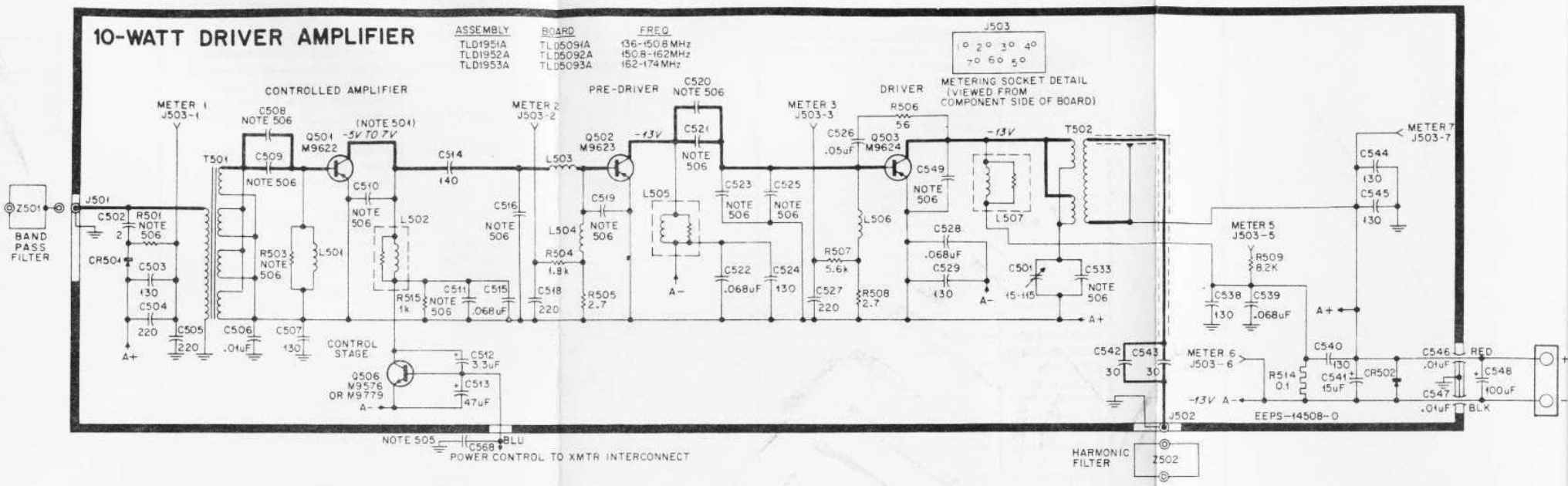
TOP VIEW

FRONT VIEW

* THESE TRANSISTOR LEADS ARE CONNECTED TO ONLY THE COMPONENT SIDE OF THE BOARD.

COMPONENT SIDE BD-DEPS-15581-0
OL-DEPS-15580-0

SHOWN FROM COMPONENT SIDE



10 W DRIVER AMPLIFIER 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.
504. THE CONTROL STAGE TRANSISTOR IS BOARD-MOUNTED FOR INTERMITTENT DUTY OPERATION AND CHASSIS-MOUNTED FOR CONTINUOUS DUTY OPERATION.
505. C568 IS PART OF TRANSMITTER CHASSIS & HARDWARE KIT.
506. FOR COMPONENT VALUES NOT STATED ON THE SCHEMATIC DIAGRAM, REFER TO THE ACCOMPANYING TABLE.

10 W DRIVER AMPLIFIER COMPONENT VALUES			
REFERENCE SYMBOL	136-150.8 MHz	150.8-162 MHz	162-174 MHz
C508	62	51	60
C509	62	49	34
C510	19	15	13
C511	130	130	OMIT
C516	10	19	39
C519	75	43	75
C520	49	39	34
C521	49	39	30
C523	100	75	60
C525	49	39	34
C533	30	20	15
C549	10	OMITTED	OMITTED
R501	150 K	100 K	100 K
R503	10	10	47

PARTS LIST

TLD5091A, TLD5092A, TLD5093A
Driver-Amplifier

PL-2845-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		CAPACITOR, fixed: pF; ±5% 500 V; unless otherwise stated
C501	20C83201B07	variable; 1.5-18; 100 V
C502	21D83406D52	2 ±0.25 pF; NP0
C503	21D84494B26	130
C504	21D83596E10	220 ±20%
C505	21D83596E10	220 ±20%
C506	21D82428B59	.01 uF +80-20%; 200 V
C507	21D84494B26	130
C508	21-84494B02	62 (TLD5091A)
	21D84494B01	51 (TLD5092A)
	21D84494B35	60 (TLD5093A)
C509	21-84494B02	62 (TLD5091A)
	21D84494B25	49 (TLD5092A)
	21D84494B30	34 (TLD5093A)
C510	21-84494B39	19 ±3% (TLD5091A)
	21D84494B38	15 (TLD5092A)
	21D84494B36	13 (TLD5093A)
C511	21D84494B26	130 (TLD5091A, TLD5092A)
C512	23D83214C17	3.3 uF ±20%; 25 V
C513	23D83214C10	47 uF ±20%; 25 V
C514	21D84494B27	140
C515	8D83813H05	.068 uF ±10%; 100 V
C516	21-84494B29	10 (TLD5091A)
	21D84494B39	19 ±3% (TLD5092A)
	21D84494B24	39 (TLD5093A)
C517		NOT USED
C518	21D83596D10	220 ±20%
C519	21D84494B28	43 (TLD5092A)
	21D84494B31	75 (TLD5091A, TLD5093A)
C520	21-84494B25	49 (TLD5091A)
	21D84494B24	39 (TLD5092A)
	21D84494B30	34 (TLD5093A)
C521	21-84494B25	49 (TLD5091A)
	21D84494B24	39 (TLD5092A)
	21D84494B33	30 (TLD5093A)
C522	8D83813H05	.068 uF ±10%; 100 V
C523	21-84494B04	100 (TLD5091A)
	21D84494B31	75 (TLD5092A)
	21D84494B35	60 (TLD5093A)
C524	21D84494B26	130
C525	21-84494B25	49 (TLD5091A)
	21D84494B24	39 (TLD5092A)
	21D84494B30	34 (TLD5093A)
C526	21C82372C04	.05 uF +80-20%; 25 V
C527	21D83596E10	220 ±20%
C528	8D83813H05	.068 uF ±10%; 100 V
C529	21D84494B26	130
C533	21-84936A06	30 ±1.5 pF; 200 V (TLD5091A)
	21D84936A03	20 ±1 pF; 2000 V; (TLD5092A)
	21D84936A07	15; 2000 V; (TLD5093A)
C538	21D84494B26	130
C539	8D83813H05	.068 uF ±10%; 100 V
C540	21D84494B26	130
C541	23D83210A21	15 uF +150-10%; 25 V
C542	21D84936A06	30 ±1.5 pF; 2000 V; P120
C543	21D84936A06	30 ±1.5 pF; 2000 V; P120
C544	21D84494B26	130
C545	21D84494B26	130
		SEMICONDUCTOR DEVICE, diode: (SEE NOTE)
CR501	48C82139G01	germanium
CR502	48C82525G01	silicon
		CONNECTOR, receptacle:
J501	28C84227B01	male; coaxial; miniature type
J502	28C84227B01	male; coaxial; miniature type
J503	9C84207B01	female; 7-contact
		COIL, RF:
L501	24C83961B01	choke; consists of a ferrite core with a 3-turn winding
L502	24C84392B03	choke; consists of a resistor (82 Ohms ±10%; 1 Watt) covered with a 6-turn winding (TLD5091A, TLD5092A)
	24C84392B01	choke; consists of a resistor (120 Ohms ±10%; 1 Watt) covered with a 6-turn winding (TLD5093A)

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
L503	7C84400B03	"square U" inductor (3/16" high) (TLD5091A, TLD5092A)
	7C84400B01	"square U" inductor (1/8" high) (TLD5093A)
L504	24C83961B01	choke; consists of a ferrite core with a 3-turn winding
L505	24C84392B02	choke; consists of a resistor (39 Ohms ±10%; 2 Watt) covered with a 4-turn winding
L506	24B83977B01	choke; 1-1/2 turns on ferrite body
L507	24C84392B09	choke; consists of a resistor (100 Ohms ±10%; 2 Watt) covered with a 4-turn winding
		RESISTOR, fixed: ±10%;1/4 W; unless otherwise stated
R501	6S129146	150k (TLD5091A)
	6S129226	100k (TLD5092A, TLD5093A)
R503	6S124A01	10 ±5% (TLD5091A, TLD5092A)
	6S129233	47 (TLD5093A)
R504	6S129269	1.8k
R505	6S124B55	2.7 ±5%
R506	6S5614	56; 1/2 W
R507	6S129433	5.6k
R508	6S124B55	2.7 ±5%
R509	6S128686	8.2k
R514	17-82586H05	0.1 ±5%; 5 W
		TRANSFORMER, RF:
T501	25C84396B01	pri: 5 turns sec: 4 windings, 1 turn each
T502	24-84571F01	pri: 2 windings, 1-3/4 turns each: sec: 1 winding; 5 turns

NOTE: For optimum performance, replacement diodes and transistors must be ordered by Motorola part numbers.

TLN5741A Xmtr Chassis & Heat Sink PL-2846-O

		CAPACITOR, fixed:
C546, 547	21-84211B01	.01 uF +100-0%; 250 V
C548	23-83210A08	100 uF +150-10%; 25 V
C568	21-82880E19	500 pF ±10%; 1000 V
		TRANSISTOR: (SEE NOTE)
Q501	48-869622	PNP; type M9622
Q502	48-869623	PNP; type M9623
Q503	48-869624	PNP; type M9624
Q504	48-869779	NPN; type M9779
	NON-REFERENCED ITEMS	
	26-84050C01	SHIELD, screened
	41-84889G01	SPRING, retaining
	43-84219C01	SPACER; 4 req'd.
	42-83493F01	RING, retaining; 10 req'd.
	14-84210A01	INSULATOR, transistor
	55-84300B01	HANDLE
	14-83241F01	INSULATOR
	42-10438A02	RING, retaining (.625)
	14-84020C01	INSULATOR
	27-84350D01	CHASSIS, right
	7-84221B01	BRACKET
	26-84198B03	HEAT SINK
	27-84349D01	CHASSIS, left
	7-84948D01	BRACKET

Exciter Filter Kits PL-2848-O

		FILTER, bandpass:
Z501	TFD6111A	132-150.799 MHz
	TFD6112A	150.8-174 MHz

Harmonic Filter Kit PL-2849-O

		FILTER, rf:
Z502	TLD6101A	132-150.799 MHz
	TLD6102A	150.8-174 MHz

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION

TLN5074A Terminal Bracket Kit PL-2847-O

		CAPACITOR, fixed:
C546, 547	21-84211B01	.01 uF +100-0%; 250 V
NON-REFERENCED ITEMS:		
	7-84354D01	BRACKET
	31-50378	TERMINAL BOARD