POWER AMPLIFIER DECK

MODEL TLE2280A SERIES

1. GENERAL

The Model TLE2280A Series Power Amplifier Deck consists of the power amplifier deck casting and associated hardware, which contains the power amplifier substrates and the power control board. Refer to the power amplifier deck model chart, shown in Figure 1, for a cross reference of the power amplifier deck kits. The following paragraphs 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 provided in the Transmitter section of this manual.

2. THEORY OF OPERATION

2.1 POWER AMPLIFIER CIRCUITRY

2.1.1 The output from the exciter is applied, via J802, to the power amplifier substrates. The 350 mW (nominal) exciter output signal is amplified by Q801 and Q802, on the low level amplifier substrate, to approximately 1.5 watts.

2.1.2 The low level amplifier output signal is applied to predriver Q803 and driver Q804, which together develop up to 45 watts of rf power. The driver output is split into three portions and applied to three parallel final amplifiers, Q805, Q806, and Q807. The three parallel final amplifier output signals are combined to provide a PA deck rf power output (minimum) of 110 watts (at 450-470 MHz), or 95 watts (at 470-512 MHz).

2.1.3 The PA deck rf power output signal is routed through a harmonic filter substrate and, via a directional coupler on the power control board, passed on to the station antenna connector, J803.

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 controls the low level amplifier output to provide the proper level for optimum power amplifier operation.

2.2.1.2 The resistive voltage divider comprising 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 R913 and R914.

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 3.7 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-

MODEL CHART
FOR
TLE2280A SERIES
UHF POWER AMPLIFIER DECK
VARIABLE RF POWER OUTPUT
450-470 MHz: 100 TO 50 WATTS
470-494 MHz: 85 TO 45 WATTS
494-512 MHz: 85 TO 45 WATTS

CODE:

● = ONE ITEM SUPPLIED

* = NOT PART OF MODEL SERIES, LISTED FOR REFERENCE ONLY

ITEM	DESCRIPTION	TLE2283A (100 TO 45 WATT PA DECK (450-494 MHz))	TLE2284A (85 TO 45 WATT PA DECK (494-512 MHz))
HFE4014A	HARMONIC FILTER	●	●
HLE4060A	LOW LEVEL AMPLIFIER	●	●
HLE4065A	COMBINER (450-494 MHz)	●	
HLE4066A	COMBINER (494-512 MHz)		●
HLE4070A	SPLITTER	●	●
HLE4074A	DRIVER INPUT SUBSTRATE	●	●
HLE4079A	PRE-DRIVER SUBSTRATE	●	●
HLE4083A	POWER TRANSISTOR KIT (450-494 MHz)	●	
HLE4084A	POWER TRANSISTOR KIT (494-512 MHz)		●
TKN8871A	INTERNAL PA CABLE	●	●
TLE5623A	PA MISCELLANEOUS PARTS (450-494 MHz)	●	
TLE5624A	PA MISCELLANEOUS PARTS (494-512 MHz)		●
*TRN5428A	POWER CONTROL BOARD COVER	●	●
TRN5696A	POWER CONTROL BOARD	●	●
TRN5706A	DISTRIBUTION BOARD	●	●
TRN5708A	PA HARDWARE	●	●

EPS-36951-O

Figure 1. Power Amplifier Deck Model Complement

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 1. If the specific cause of the transmitter failure is not covered in Table 1, the service person is directed to Table 2 (for power control board problems) or to paragraph 3.2 (for power amplifier problems).

3.2 POWER AMPLIFIER SUBSTRATE TROUBLESHOOTING PROCEDURE

3.2.1 Visual Checks

Inspect all transmitter microstrips for obvious physical defects such as broken leads, broken or disconnected components, cracked microstrips, or leached chip capacitors. Microstrip cracks are usually hard to see but can often be found by sliding the tip of a modeling knife or some other sharp object along the surface of the ceramic substrate. Usually, a noticeable "bump" will be felt as the sharp object passes over the crack in the microstrip. Slide the knife in both directions. An ohmmeter can also be used to locate cracks.

Checks and tests in the following paragraphs and Table 1 may be used to locate defects isolated to the power amplifier substrates. The following checks assume 13.8 volts dc is applied to the PA and that the amplifier is driven with a 250-400 mW rf source. Set all power control potentiometers (R911, R931, R939) fully clockwise.

WARNING
Key station intermittently until problem is repaired.

3.2.2 DC Voltage Checks

Step 1. Check the voltage between the C870 A+ feed-thru capacitor (red lead) and the C871 A− feed-thru capacitor (black lead). If the voltage is not the same as the power supply voltage, check the cabling.

Step 2. Measure the dc voltage at the collectors of the final amplifier (Q805-Q807) with respect to A− on the power amplifier. The readings should be greater than +12 volts with the transmitter keyed or unkeyed. If not, check R801 (located on the power distribution board), the A+ collector feed coils, the feed pins, and the combiner substrate for continuity.

Step 3. Similarly, check the dc voltages at the collectors of Q803 and Q804. The readings should be greater than +12 volts. If not, check the A+ collector feed coils, the feed pins, the substrates, and the power distribution board for continuity.

Step 4. The low level amplifier operates from a controlled voltage supplied by the power control circuitry. This voltage normally varies between approximately +3 volts and +10 volts. Key the transmitter and check the control voltage at the collectors of Q801 and Q802. If the readings are less than +10 volts, check the collector feed coils, the feed pins, the low level amplifier substrate, and the power distribution board for continuity or shorts. If these checks fail to isolate the problem, proceed to Table 2.

Table 1. 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 15 uA	Go to 2b.	No Indication — Perform Transmitter Control and Protection Troubleshooting Procedure. Meter 1 indication, no Meter 5 indication — go to 2e.
		b. Measure dc voltage across antenna relay coil during transmit.	5 V	Go to 2c.	Check coil continuity (dc resistance approximately 160 ohms).
		c. Check reed switch continuity.	Continuous during transmit	Go to 2d.	Replace.
		d. Check harmonic filter and output cable for shorts and discontinuities.	See schematic diagram	Perform Power Amplifier Substrate Troubleshooting Procedure.	Repair Defect.
		e. Measure rf power at the exciter output.	300 mW minimum	Perform Power Amplifier Substrate 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 3b.	Perform Power Amplifier Control and Protection Troubleshooting Procedure.
		b. Measure rf power at exciter output.	300 mW minimum	Perform Power Amplifier Substrate Troubleshooting Procedure.	Refer to Exciter section of manual.

Table 2. 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 1b.	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 1c.
		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 2b.
		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	Control voltage limit (R931), current limit (R939) and reflected power (VSWR) protection inoperative	Q905 and associated resistors probably defective. Analyze and repair.	—	—	—

Table 2. Power Amplifier Control and Protection Troubleshooting Procedure (Cont'd.)

Step	Symptom	Procedure	Normal Indication	If Normal	If Abnormal
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.	—	—	—

3.2.3 Low Power Output

Step 1. Remove the exciter output cable at J802. Connect the exciter to a UHF-rated wattmeter with a 50-ohm (resistive) dummy load. Key the transmitter. If the power is less than 300 milliwatts, refer to the exciter troubleshooting procedure. If it is greater than 300 milliwatts, replace the exciter cable and continue.

Step 2. Remove the strap connecting the driver output stripline to the splitter substrate. Solder the center conductor of an 8-inch (or shorter) 50-ohm coaxial test cable to the driver output stripline and the shield of the coaxial cable to the adjacent ground pad. With the coaxial cable terminated with a 50 watt, 50-ohm (resistive) dummy load and a UHF-rated wattmeter, key the transmitter. If the driver output is less than 40 watts, the low level amplifier control stage must be checked (Step 3). Remove the coaxial cable and replace the strap.

Step 3. Remove the strap connecting the output stripline (at the output of C809) of the low level amplifier to the input of the pre-driver stage. Remove the coaxial cable from the driver output and solder it in similar fashion to the low level amplifier output. With the transmitter keyed, the power measured at the output of C809 should be at least 2 watts. If not, replace the low level amplifier as instructed in paragraph 3.3.1. Replace the removed straps and realign the transmitter.

Step 4. If the measured power is greater than 2 watts, note the current drawn by the radio set when keyed. Replace the strap between low level amplifier and pre-driver stages and return the coaxial cable to the driver output. With the transmitter keyed, if the increase in the current drawn (over that previously noted) is less than 1.5 amperes, replace the pre-driver (Q803) module. If greater than 1.5 amperes, replace the driver (Q804) module. The power output should now be greater than 40 watts.

Step 5. If amplifier output is still low, the fault can now be attributed to either the final amplifier, or harmonic filter, or directional coupler (on power control board), or associated cables. Carefully unsolder the coaxial cable from the combiner substrate. In its place, carefully solder an 8 inch (or shorter) 50-ohm coaxial test cable connected to a UHF-rated wattmeter with a 200 watt, 50-ohm (resistive) dummy load.

Step 6. Key the transmitter. If the power output is greater then 130 watts (450-470 MHz range) or 100 watts (470-512 MHz range), the harmonic filter, or directional coupler (on power control board), or associated cables are defective. Replace the faulty component and recheck the power output.

Step 7. If the power output of the final amplifier is low, one (or more) of the final amplifier modules is defective. Alternately unsolder the base tab of each final amplifier (Q805-Q807) module from the splitter substrate. Note the power output each time. Replace the module that degrades the output power the least when the base tab is lifted. Repeat this process if the power output (as specified in Step 6) is not obtained.

3.3 TRANSISTOR MODULE REPLACEMENT

NOTE

Transistors are replaced as part of a module assembly. There are six module assemblies in each power amplifier; low level amplifier (controlled stage), pre-driver, driver, and three finals.

3.3.1 Whenever the low level amplifier, or Q804, or Q805, or Q807 is replaced, the additional parts contained in the PA miscellaneous parts kit (TLE5623A for 450-494 MHz or TLE5624A for 494-512 MHz) should also be replaced. When the low level amplifier is replaced, the following parts should be added: C865, C869, R860 and R861. When replacing Q804, C857 and C858 should be added. Add C860 when replacing Q805, and add C861 when changing Q807. Refer to Figure 2.

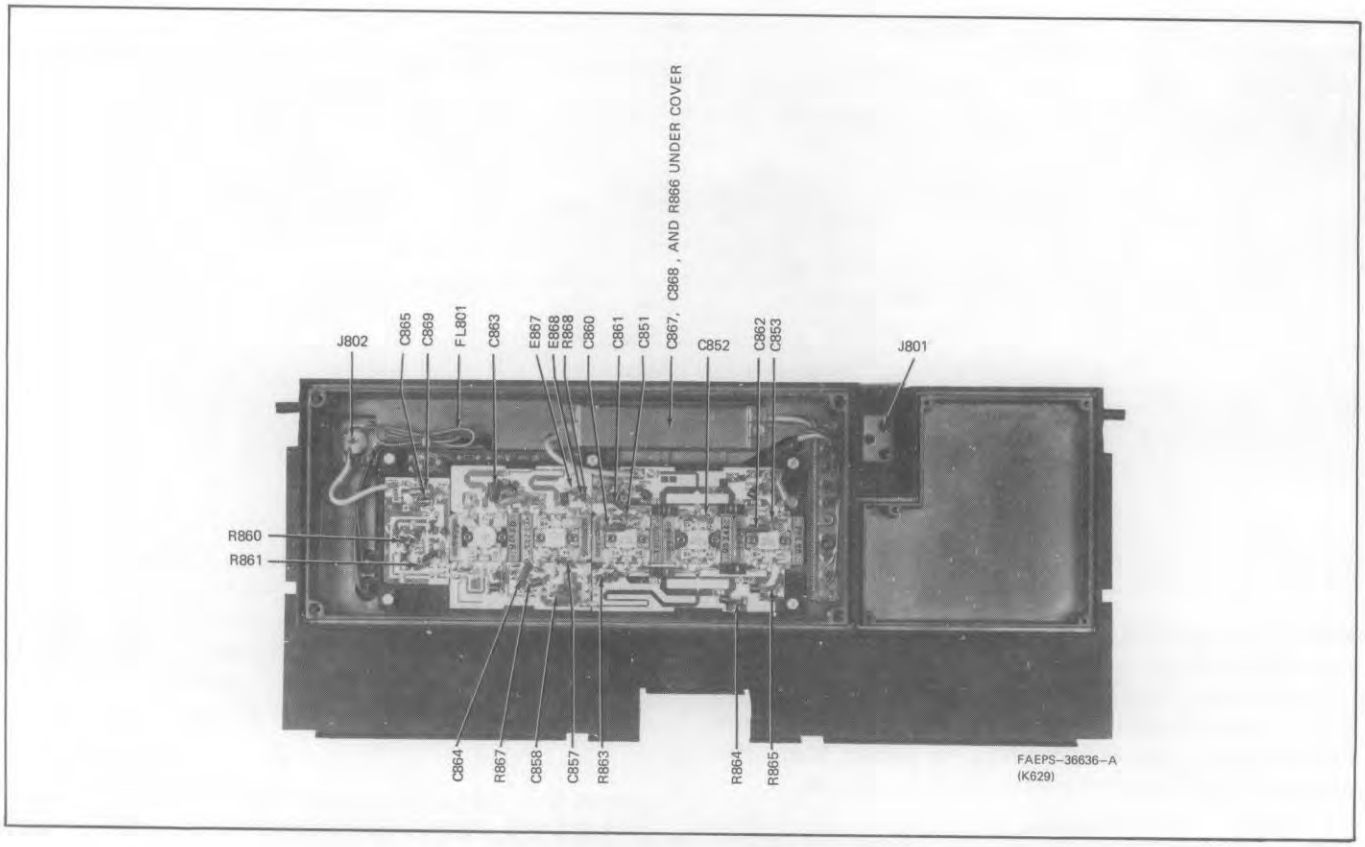


Figure 2. PA Miscellaneous Parts Location Detail

3.3.2 To remove the low level amplifier (control stage), unsolder the input coax, output strap, and the bias pin. Using C805 as a handle, carefully pull up on the module until Q802 is released from its heat sink clip. Before installing a new module, apply a light coating of heat sink thermal compound to Q802. Care must be exercized in installing the new module to avoid breaking the substrate. When Q802 is aligned with the heat sink clip, apply pressure to Q802 only until the module is firmly seated.

3.3.3 To remove any of the other modules, unsolder the tabs from the ceramic substrates (8 tabs on driver module and 6 on the predriver module and on each of the final stage modules). Remove transistor mounting screws and extract module. Before installing the new module apply a thin coating of heat sink thermal compound to the mounting surface. Be sure that the module output (as indicated by the beveled corner) is facing the proper direction.

CAUTION

The transistor mounting screws must be tightened before the transistor tabs are soldered to the circuit board. *Do not tighten more than 6-7 inch pounds,* or damage to the transistor may result.

Solder the module tabs to the substrate so that the connection covers the entire surface of the tab.

3.4 RF POWER AMPLIFIER ASSEMBLY AND A+ DISTRIBUTION BOARD REMOVAL

3.4.1 Unless access to the A+ distribution board is required, there should be no need to remove the power amplifier assembly. If access is required, the following procedure should be followed.

Step 1. Unsolder bias pin connections from substrates (total of 7).

Step 2. Unsolder input and output coaxial cables.

Step 3. Remove 10 transistor mounting screws.

Step 4. Remove 5 hex head screws holding the plastic carrier.

Step 5. Remove amplifier (note special precautions in paragraph 3.3.1).

If it is necessary to remove the A+ distribution board, unsolder the 7 feed-thru capacitor connections and remove the 3 mounting screws.

3.4.2 To replace the assembly, reverse the removal procedure. When replacing the power amplifier assembly, note the special handling of the low level amplifier (paragraph 3.3.1). Apply a thin coating of heat sink thermal compound to the transistor mounting surfaces. Start transistor mounting screws to insure pro-

per alignment then insert and tighten the hex head screws in the plastic carrier. Tighten the transistor mounting screws.

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 8 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.

Step 2. Set Current Limit (R939) fully counterclockwise. Key transmitter and observe M5. Meter 5 should indicate less than 8 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) for 110 watt output (450-470 MHz), or 95 watt output (470-512 MHz). Using a short length, (6 inches) of 22 AWG solid wire, short Temp Sense Hi, P901-6, to Temp Sense Lo, P901-7, 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 110 watt output (450-470 MHz), or 95 watt output (470-512 MHz). Remove cable from the station antenna connector, J803.

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 23 uA.

3.5.4 Power Amplifier Deck Test

Step 1. Disconnect PA from station antenna connector, 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.

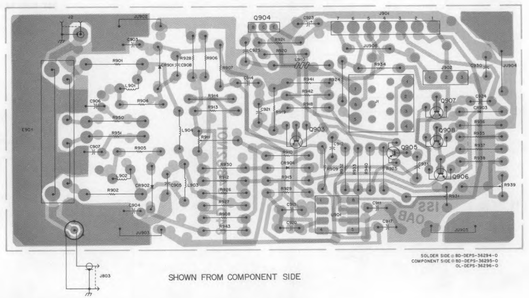
Step 4. Key transmitter and observe the wattmeter. Power output should exceed 125 watts.

parts list

TRN5696A Power Control Board — PL-8447-O

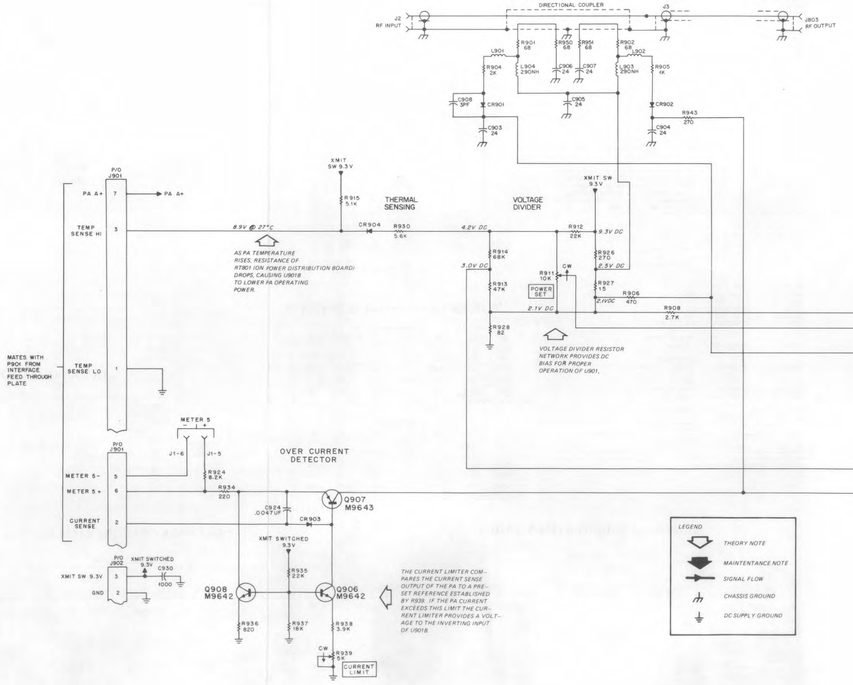
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
		capacitor, fixed: pF ± 10%; 50 V: unless otherwise stated
C903 thru 907	21-11022G39	24 ± 5%
C908	21-82450B11	3
C911	21-11022G39	24 ± 5%
C912	8-11017B10	.018 uF
C913	21-11022G09	24 ± 5%
C914	8-11017B08	.01 uF
C917	21-11022G39	24 ± 5%
C920	21-11021F04	.01 uF
C921	8-11017B11	.022 uF
C923	23-11019A09	1 uF ± 20%
C924	21-11021E21	4700
C925	21-11015B13	.001 uF ± 10%; 100 V
C930	21-11015B13	.001 uF ± 10%; 100 V
C931	21-11022G39	24 ± 5%
		diode: (see note)
CR901, 902	48-84616A01	hot carrier
CR903, 904	48-11034A01	silicon
		directional coupler:
E901	—	Assembly, includes:
	14-82071P01	INSULATOR, coupler; 2 used
	26-80279B01	SHIELD, coupler
	30-80280B01	THROUGH LOOP, coupler
	30-84959N01	PICK-UP LOOP, coupler;2 used
		connector, receptacle:
J1	9-84207B01	female; 7-contact (metering)
J2	9-84231B03	female; phono
J3	42-80259A01	clip, coax terminal
		connector, plug:
J901	28-83441F08	male; 7-contact (WHT)
J902	28-83441F18	male; 3-contact (WHT)
		jumper:
JU902-906	6-11009B23	0 Ohms
		coil, rfc
L901, 902	24-84393B04	wire, bare; 0.19" used
L903, 904	24-82723H04	choke; 0.29 uH
L910	76-83969B01	ferrite bead; 3 used
		transistor: (see note)
Q903	48-869642	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
		resistor, fixed ± 5%; 1/4 W: unless otherwise stated
R901, 902	6-125A21	68; 1/2 W
R904	6-11009A56	2k
R905	6-11009A49	1k
R906	6-11009A51	1.2k
R907	6-11009A85	33k
R908	6-11009A59	2.7k
R909	6-11009A87	39k
R910	6-11009A85	33k
R911	18-80268B03	variable; 10k
R912	6-11009A81	22k
R913	6-11009A89	47k
R914	6-11009A83	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	6-11009A05	15
R928	6-11009A23	82
R929	6-11009A71	8.2k
R930	6-11009A67	5.6k
R931	18-80268B02	variable; 5k
R932	6-11009A27	120
R933	6-11009A49	1k
R934	6-11009A33	220
R935	6-11009A81	22k
R936	6-11009A47	820
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
R950, 951	6-125A21	68; 1/2 W
U901	51-80067C03	**integrated circuit: (see note)** dual operational amplifier
		mechanical part
	9-80028A01	SOCKET, transistor (Q904)

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



SHOWN FROM COMPONENT SIDE

SOLDER SIDE = 80-0EPS-36284-O
COMPONENT SIDE = 80-0EPS-36284-O
DL-0EPS-36284-O



NOTES:
1. UNLESS OTHERWISE SPECIFIED RESISTOR VALUES ARE IN OHMS, CAPACITOR VALUES ARE IN PICOFARADS (PF) AND INDUCTOR VALUES ARE IN MICROHENRIES (UH).
2. JU902 - JU905 ARE ALWAYS IN.
3. JU906 ALWAYS IN; JU907 ALWAYS OUT.

EEPS-36293-A

POWER AMPLIFIER DECK

MODEL TLE2280A SERIES

TRN5696A Power Control Board Schematic Diagram, Circuit Board Detail, and Parts List
Motorola No. PEPS-36282-O
(Sheet 1 of 3)
8/18/83-PHI

POWER AMPLIFIER DECK

POWER AMPLIFIER DECK

MODEL TLE2280A SERIES

parts list

TKN9871A Internal PA Cable — PL-8645-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C881 thru 887	21-82812H03	**capacitor, fixed:** .001 uF ÷ 100 – 0%
C891 thru 897	21-821474	470 pF ± 20%; 500 V feed-thru
C951, 952, 953	21-82812H03	.001 uF ÷ 100 – 0%
J803	9-82442E01	**connector, receptacle:** female, single contact
J901	15-83498F28	housing, 3 contact
J902	15-83498F15	housing, 7 contact
P2	28-82331G01	**connector, plug:** male, single contact
P902	15-83498F15	housing, 7 contact
R960a, 960b	17-82177B02	**resistor, fixed:** .32 ± 5%; 5 W
		mechanical parts
	1-80775D04	ASSEMBLY, rf output cable ; includes: ref. item P2
	29-5370	LUG, soldering
	30-83794C04	CABLE, coaxial; 8-1/4" used
	1-80748D92	ASSEMBLY, power control cable includes: ref. item J803
	15-483599	HOOD, receptacle
	30-83794C01	CABLE, coaxial; 4-1/2" used
	42-10217A02	STRAP, tie
	1-80775D01	ASSEMBLY, UHF interface cable UHF includes: refer J902
	29-83499F01	TERMINAL; 7 used
	30-83678K01	CABLE, shielded: 7-conductor; 0.63" used
	4-83755H01	WASHER, shoulder; 10 used
	29-83499F01	TERMINAL; 3 used
	30-83678K01	CABLE, shielded: 7-conductor; 12-1/2" used
	31-490141	TERMINAL, strip
	42-10217A02	STRAP, tie; 2 used
	64-82406N01	PLATE, rfq
	64-82404N01	PLATE, rf
	64-80005A01	PLATE, feed-thru

RN5706A A + Distribution Board — PL-8451-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
R801	17-82155M01	**resistor, fixed:** .012 shunt
R802	6-11009A49	1k ± 5%; 1/4 W
R806	6-11009A33	220 ± 5%; 1/4 W
JU2	6-11009B23	**jumper:** "0" ohms
RT801	6-83600K09	**theristor:** 100k @ 25 ° C
		mechanical part
	9-80155A02	CONNECTOR, flat wafer; 7 used

Non-Repairable Item, Parts Listed for Reference Only

HFE4014A Harmonic Filter Assembly — MXW-0779-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
	30-80080B01	WIRE, inductor
	64-80067B01	PLATE, harmonic filter carrier
	84-80318A01	SUBSTRATE, plated

Power Amplifier Equipment Circuit Board and Substrate Details, and Parts Lists
Motorola No. PEPS-36282-O
(Sheet 2 of 3)
9/19/83- PHI

parts list

TLE5623A PA Miscellaneous Parts (450-494 MHz)
TLE5624A PA Miscellaneous Parts (494-512 MHz) — PL-8452-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C851, 852, 853	21-84493B31	**capacitor, fixed: uf ± 5%; 50 V:** unless otherwise stated 57 pF
C857	21-852259	3 ±0.5 pF; 500 V
C858	8-82987E02	.047 ± 10%; 200 V
C860	8-82905G40	.03
C861	8-82905G40	.03 (TLE5623A only)
C862, 863	8-82905G40	.03
C864	8-82905G14	.01 uF ± 10%; 100 V
C865	21-10320Q25	8 pF ± 5%; 50 V
C866	8-82905G40	.03 (TLE5624A only)
C867	21-11014H05	1.5 ± 0.25 pF; 100 V (TLE5623A only)
C868	21-11014H13	3.3 ± 0.25 pF; 100 V (TLE5623A only)
C869	23-82783B24	15 ± 10%; 25 V
E867, 868	76-84069B08	**coil:** ferrite bead
		resistor, fixed: ± 5%; 1/4 W: unless otherwise stated
R860	6-125A39	390; 1/2 W
R861	6-11009A05	15
R863, 864, 865	6-124B61	4.7
R866	6-11009A97	100k
R867	6-124B61	4.7

TRN5708A Power Amplifier Hardware — PL-8646-O

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C870, 871	21-84211B01	**capacitor, fixed:** 10k pF; feed-thru; 500 V
E881 thru 887	76-80117D01	**coil:** core, ferrite bead
J802	9-82442E01	**connector, receptacle:** female, single contact
FL801	30-83661G01	**filter:** cable, coaxial; 9-1/16" used
Q904	48-84411L10	**transistor (see note)** PNP, type M1110
		mechanical parts
	2-131435	NUT, 4-40 × 1/4 × 3/32"; 2 used
	3-3375	SCREW, tapping: 6-32 × 5/16"; 11 used
	3-3398	SCREW, tapping: 6-32 × 3/8"; 6 used
	3-115213	SCREW, machine: 3-48 × 1/4"; 4 used
	3-129842	SCREW, machine: 4-40 × 1/4"
	3-129890	SCREW, machine: 10-32 × 3/8", 6 used
	3-131195	SCREW, machine: 6-32 × 3/8"; 3 used
	3-134186	SCREW, tapping: 6-32 × 5/16"; 4 used
	3-138294	SCREW, tapping: 6-32 × 5/8"; 2 used
	3-138810	SCREW, machine: 4-40 × 5/8"; 2 used
	3-138813	SCREW, machine: 4-40 × 3/8"; 10 used
	3-488006	SCREW, machine: 6-32 × 1/2"; 4 used
	4-7681	LOCKWASHER, #3 internal; 4 used
	4-858060	WASHER, insulator; 4 used
	4-84180C01	WASHER, shoulder
	14-80142A02	INSULATOR
	14-82406N01	INSULATOR, control
	14-82407N01	INSULATOR, feed-thru
	14-84391F01	INSULATOR, transistor
	15-80066B01	COVER, filter
	15-82406N01	COVER, PA
	26-80254A01	HEAT SINK, LL amp
	26-82323N02	HEAT SINK, PA
	26-83200P01	PLATE, spacer
	26-83374N01	SHIELD, filter; 3 used
	29-5347	LUG, soldering
	30-83361G01	CABLE, coaxial; 9-1/16" used
	30-83794C01	CABLE, coaxial (WHT); 3.38" used
	30-83794C01	CABLE, coaxial (WHT); 4" used
	31-50378	TERMINAL, board
	32-80074B01	GASKET, filter; 2 used
	32-83291N01	GASKET, rf; 55" used
	42-10217A02	WRAP, tie
	42-80137A02	CLIP
	42-84510M02	STRAP, PA; 7 used
	43-83199P01	SPACER, plate
	64-82986N01	PANEL, PA
	29-5370	LUG

HLE4069A Splitter (Range 1)
HLE4070A Splitter (Ranges 2 – 4) — PL-6269-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C827, 828	21-84736E21	**capacitor, fixed** 100 pF ± 5%, 50 V
E809 – 811	76-83960B01	**ferrite bead** .138 OD x .118 LG
L809 – 811	24-80090G01	**coil** choke, 6 turns
R810, 811	6-126C01	**resistor, fixed** 10 ± 10%, 1 W

HLE4074A Driver Input Substrate — PL-6270-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C816	21-84547A05	**capacitor, fixed** .01 µF ± 20%, 50 V
C818	21-5157A07	100 pF ± 20%
C850, 860	23-82783B24	15 µF ± 20%, 25 V
E806, 807	76-83960B01	**ferrite bead** .138 OD x .118 LG
L806, 807	24-80090G01	**coil** choke, 6 turns
R820	6-11009C18	**resistor** 51 Ω ± 5%, ¼ W

HLE4060A Low-Level Amplifier — PL-6267-D

TLE-5791A-Specified P.D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C801	21-84547A13	**capacitor, fixed, pF ±20%, 25 V** unless otherwise stated 0.1 µF ± 10%, 50 V
C802	21-5157A07	100
C803	21-5632D37	7.7 ± .25%
C804	21-84547A05	.01 µF ± 20%, 50 V
C805	23-8321-KC04	1.0 µF
C806	21-5157A07	100
C807	21-84673K06	12 ± .10%
C808	21-5632D37	7.7 ± .25%
C809	21-5157A07	100
E802 – 804	76-83960B01	**ferrite bead** .138 OD x .118 LG
L802	24-80092G60	**coil** choke
L803, 804	24-80090G02	choke, 7 turns
Q801	48-869657	**transistor (see note)** NPN, type M9657
Q802	48-80196C01	NPN, UHF power amplifier
R816	6-11009C05	**resistor, fixed** 15 ± 5%, ¼ W

HLE4155A Combiner (L) 403 – 430 MHz
HLE4065A Combiner (M) 450 – 494 MHz
HLE4066A Combiner (H) 494 – 512 MHz — PL-6268-D

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C841, 842	21-84736E21	**capacitor, fixed, pF ±5%, 50 V** unless otherwise stated 100
C843L	21-84736E31	56 ±10%
C843 M, H	21-84736E21	100
C844, 845	21-84736E21	100
C846	21-5157A01	100
C847	21-84547A13	0.1 µF ± 10%
C848	21-5157A01	100
C849	21-84547A13	0.1 µF ± 10%
C855, 856	23-82783B24	15 µF, 25 V
E812 – 814	76-83960B01	**ferrite bead** .138 OD x .118 LG
L812 – 814	24-80090G01	**coil** choke, 6 turns
R807, 808	6-126D63	**resistor, fixed** 5.6 ± 10%, 1 W

HLE4082A Power Transistor Kit (403 – 430 MHz) L
HLE4083A Power Transistor Kit (450 – 494 MHz) M
HLE4084A Power Transistor Kit (494 – 512 MHz) H — PL-6857-B

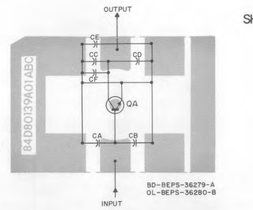
REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C810, 811	21-84366F04	**capacitor, fixed, pF ±5%, 250 V** unless otherwise stated 30
C812	21-84736E33	30
C819 – 821	21-84366F04	30
C822	21-84366F06	45
C829 – 834	21-84366F04	30
C835, 837, 839	21-84366F04	30
C836, 838, 840	21-84366F06	45
Q803	1-80701T78	**transistor (see note)** module kit includes references C810 – 812
Q804 – 807L, M	1-80703T04	module kit includes references C819 – 822 and C829 – 840
	or 1-80705T41	module kit includes references C819 – 822 and C829 – 840
Q804 – 807H	1-80701T77	module kit includes references C819 – 822 and C829 – 840
	or 1-80705T42	module kit includes references C819 – 822 and C829 – 840

note
Transistors Q804 – 807 must be the same module kit number and cannot be intermixed. When ordering a replacement transistor in a power transistor kit, it must be ordered by its appropriate module kit number (stamped on module) and not by its transistor number.

HLE4078A Predriver Substrate (L) Range 1
HLE4078A Predriver Substrate (M, H) Ranges 2 – 4 — PL-6271-C

REFERENCE SYMBOL	MOTOROLA PART NO.	DESCRIPTION
C817L	21-84736E15	**capacitor, fixed, pF ±5%, 50 V** unless otherwise stated 12
C817M, H	21-84736E19	4.7 ± .25 pF
C823	21-5157A61	100
C824	21-84547A13	0.1 µF ± 10%
C825L	21-84736E29	7.5
C825M, H	21-84736E21	100
C826	21-5632D43	1.8 ± .25 pF
CR805	48-84616A01	**diode (see note)** hot carrier
E805, 808	76-83960B01	**ferrite bead** .138 OD x .118 LG
L805, 808	24-80090G01	**coil** choke, 6 turns
L815	24-82723H28	choke, 29 µH
R817M, H	6-124A03	**resistor, fixed** 12 Ω ±5%, ½ W
		mechanical parts
	55-80065B01	driver strap
	55-80335A01	driver line strap

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



POWER TRANSISTOR SUBSTRATE

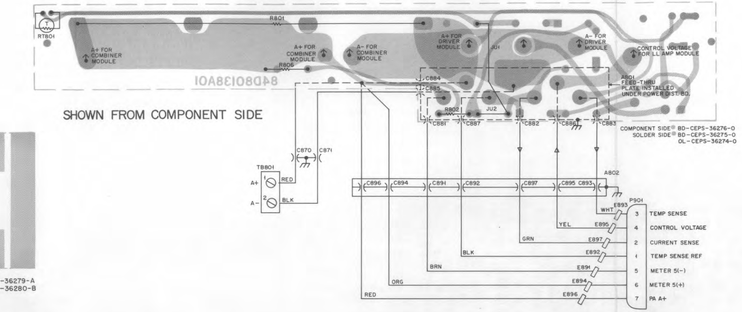
450-494 MHz						
QA	CA	CB	CC	CD	CE*	CF*
Q803	C810	C811	C812			
Q804	C819	C820	C821	C822		
Q805	C829	C830	C835	C836	C851	C860
Q806	C831	C832	C837	C838	C852	
Q807	C833	C834	C839	C840	C853	C862

*Part of TLE5623A.

494-512 MHz						
QA	CA	CB	CC	CD	CE*	CF*
Q803	C810	C811	C812			
Q804	C819	C820	C821	C822		
Q805	C829	C830	C835	C836	C851	C860
Q806	C831	C832	C837	C838	C852	C866
Q807	C833	C834	C839	C840	C853	C862

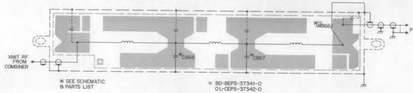
*Part of TLE5624A.

TRN5706A A + DISTRIBUTION BOARD

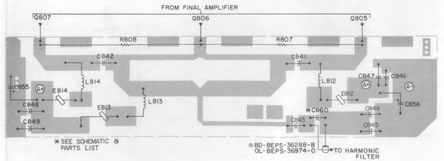


SHOWN FROM COMPONENT SIDE

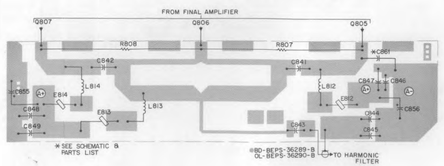
HFE4014A HARMONIC FILTER



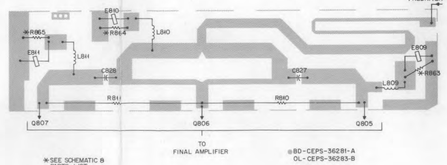
HLE4066A COMBINER (494-512 MHz)



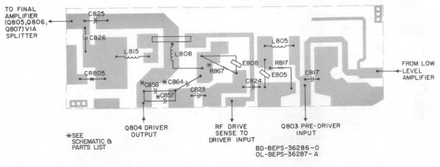
HLE4065A COMBINER (450-494 MHz)



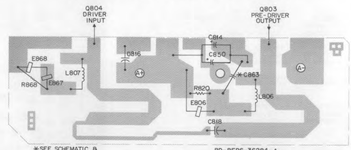
HLE4070A SPLITTER (450-512 MHz)



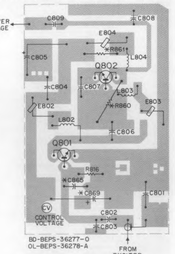
HLE4079A PRE-DRIVER SUBSTRATE



HLE4074A DRIVER INPUT SUBSTRATE



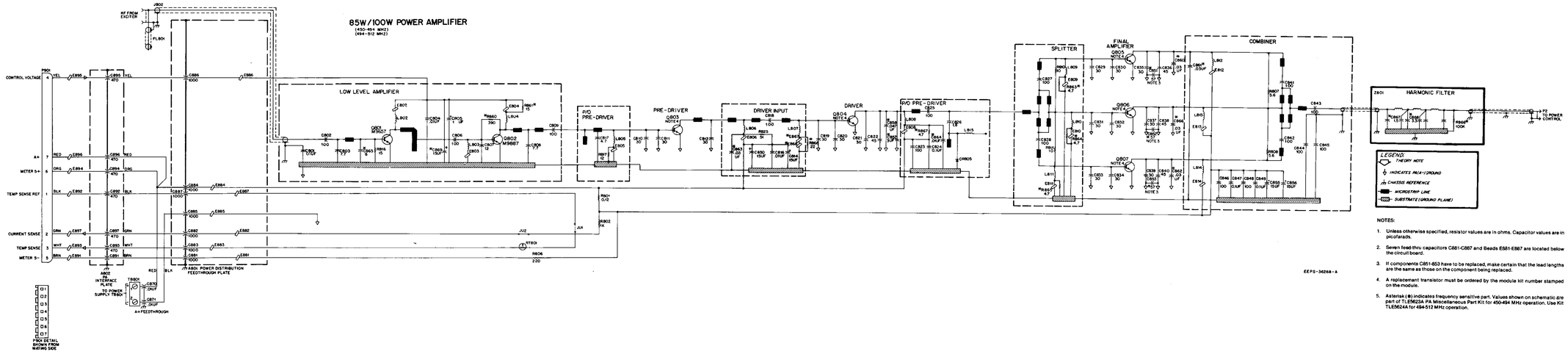
HLE4060A LOW LEVEL AMPLIFIER



Part Ref.	Frequency Range MHz	Parts p/o
C865	450-494	TLE5623A
	494-512	TLE5624A

POWER AMPLIFIER DECK

MODEL TLE2280A SERIES



EEPS-36268-A

NOTES:

1. Unless otherwise specified, resistor values are in ohms. Capacitor values are in picofarads.
2. Seven feed-thru capacitors C881-C887 and Beads E881-E887 are located below the circuit board.
3. If components C851-853 have to be replaced, make certain that the lead lengths are the same as those on the component being replaced.
4. A replacement transistor must be ordered by the module kit number stamped on the module.
5. Asterisk (*) indicates frequency sensitive part. Values shown on schematic are part of TLE5623A PA Miscellaneous Part Kit for 450-494 MHz operation. Use Kit TLE5624A for 494-512 MHz operation.

Power Amplifier Equipment
Schematic Diagram
Motorola No. PEPS-36282-O
(Sheet 3 of 3)
8/19/83- PHI

POWER AMPLIFIER DECK