

TEN-TEC

**OWNER'S
MANUAL**

**Model
444**

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Carefully remove your HERCULES from the packing carton and examine it for signs of shipping damage. Should any damage be apparent, notify the delivering carrier or dealer immediately, stating the full extent of the damage. Retain all damaged cartons. Liability for shipping damage rests with the carrier.

It is recommended that you keep the shipping carton and fillers, especially the transformer shipping plate. In the event that storage, moving or reshipment becomes necessary, they come in handy. Accessory hardware, etc. are packed with the HERCULES. Make sure that you have not overlooked anything.

The HERCULES is a full break-in, solid state kW linear amplifier. It features a no tune, broadbanded design and covers amateur bands from 160-15 meters plus four auxiliary band positions for future expansion.

The Model 444S power supply contains a patented automatic line voltage correcting circuit which prevents damage to the final transistors from incorrect line voltage. The 45 VDC, 24 ampere supply is housed in a utility type enclosure and is furnished with interconnecting cables long enough to allow the supply to sit under the operating surface if desired. The supply is factory wired for 110 volts and requires a 15 to 20 AMP circuit. Modification instructions for 220 volts are in section II of this manual.

As you become more familiar with your HERCULES, you will value the well thought out design. From the clean, yet full-featured front panel to the six built-in protection circuits, we think you will find the HERCULES an outstanding, high performance linear amplifier.

SPECIFICATIONS

BAND COVERAGE - 1.8-2.0, 3.5-4, 7.0-7.3, 14.0-14.35, 21.0-21.45 MHz and provision for four user modified auxiliary bands.

MAXIMUM POWER INPUT - CW: 1000 Watts; SSB: 1200 Watts PEP

DRIVING POWER REQUIRED - 50 watts typical.

DUTY CYCLE - SSB: Continuous voice modulation; CW/RTTY: 50% continuous (key down not to exceed 5 minutes). Continuous carrier operation possible at reduced output.

THIRD ORDER DISTORTION - -30 dB from peak output at 1 kW input or 600 W. output, whichever comes first.

OUTPUT IMPEDANCE - 50 ohms unbalanced, maximum reflected power 75 watts. (SWR = 2.3 @ 500 W. output)

INPUT IMPEDANCE - 50 ohms unbalanced. Broad-band input requires no tuning. (SWR less than 2:1).

METER FUNCTIONS - 0-30A collector current continuously metered.

SWITCH SELECTED: 0-60V collector voltage
0-1000 watts forward power
0-100 watts reverse power

FRONT PANEL CONTROLS - POWER: OFF, ON
MODE: STANDBY, OPERATE
METER: VOLTS, FORWARD POWER, REVERSE POWER
BAND: REMOTE, 1.8, 3.5, 7.0, AUX-1, 14.0, AUX-2, 21.0,
AUX-3, AUX-4

CABINET SIZE/WT-AMPLIFIER - 5.8" x 16" x 15½' HWD 22 lbs.
PWR SUPPLY - 7.4" x 15.7" x 13½" HWD 50 lbs.

OPERATION

CONDENSED OPERATING INSTRUCTIONS

With only four controls on the front panel of the Model 444, operation is simple and logical. Following is the proper control sequence for tune-up.

INITIAL SETTINGS

POWER-OFF

MODE-STANDBY

METER-VOLTS

BAND-Desired band of operation or REMOTE if remote control cable is connected to OMNI bandswitch.

TUNE-UP PROCEDURE (CW)

1. Power to ON. Meter lights should come on and power switch is illuminated green. Internal band positioning mechanism may cycle. Voltmeter should read 45-50 volts.
2. BAND-Select desired band operation or insure that bandswitch is in REMOTE if connected to OMNI.
3. MODE to OPERATE-Mode switch should illuminate amber. Voltmeter should read 45-50 volts. Ammeter should read 0.
4. METER to FORWARD POWER.

EXCITER

5. Insure that exciter drive control is at minimum.
6. Place exciter in tune (LOCK) mode.
7. Increase drive from the exciter until DC AMMETER of Model 444 reads 24 amps. or 600 W. forward power, whichever comes first. Voltmeter should read approximately 42-45 volts.
8. If exciter has a variable ALC threshold, adjust the ALC so that driver output is limited at 24 amps. or 600 watts indicated on the Model 444.

SSB TUNE-UP FOR EXCITERS WITH VARIABLE ALC THRESHOLD

1. Follow tune-up procedure for CW above. Steps 1 through 8.
9. Return exciter drive control to minimum and key exciter in SSB mode. While speaking normally into microphone increase drive until normal ALC action is obtained.
10. If the Model 444 occasionally trips out with an over drive or over current indication, reduce the exciter DRIVE and ALC setting slightly to reduce peaks.

SSB TUNE-UP FOR EXCITERS WITH NEGATIVE ALC INPUT

amps or 600 watts indicated on the Model 444. This adjustment may vary between bands necessitating a compromise setting.

NOTE: SSB operation with exciters which do not have either variable ALC or provision for -ALC input is not recommended since high level drive peaks can cause repeated activation of the safety circuits in the Model 444.

FAULT STATUS INDICATORS

The Model 444 is equipped with six safety circuits which are designed to protect the final amplifier transistors in the event of improper operation or a fault in the transmitting system. When a fault condition is sensed, the amplifier automatically removes itself from the operate mode and provides an indication of what condition caused the safety to trip. Action should be taken to remove the fault from the system before returning the amplifier to the operate mode. When resetting the mode switch to "OPERATE" after a fault indication, move the switch SLOWLY from the standby to the operate position. This gives the display time to reset and prevents re-tripping of the breaker. Following is a description of each fault condition.

OVR DRV - OVERDRIVE

The overdrive safety sets a lower limit on the operating gain of the amplifier. It continuously monitors gain by comparing drive power to the resulting output power in a "LINEARITY DETECTOR". If drive power increases without a proportional increase in output, the overdrive safety will trip the mode switch to standby and display an OVR DRV fault indication.

The most common cause of an overdrive fault is attempting to operate with exciter and amplifier bandswitches on different bands. If the amplifier bandswitch is set to a band lower than the exciter, no output will be obtained due to the characteristics of the selected low pass filter, and an overdrive fault will occur at less than 5 watts drive. Similarly, if a defect in the amplifier such as a loose connector or defective component causes a reduction in gain, an overdrive indication will occur at low drive levels.

To correct an overdrive fault condition, insure that the bandswitch is properly positioned, and/or reduce the drive power supplied by the exciter. It is best to limit the exciter output to a lower level by reducing its ALC threshold. This will prevent output spikes from tripping the overdrive safety.

CTL - CONTROL FAULT

This safety senses an ambiguous condition in the bandswitching control. If the bandswitch is indexed to the remote mode and no positioning information is supplied by an external switch a continuous control fault will be generated and the amplifier will reject the operate mode. Also, a control fault is generated when switching between bands or when no low pass filter is installed for the selected band.

To correct a control fault condition, insure that the remote control cable is properly connected to the OMNI if remote band selection is used, and attempt operation only on those bands for which low pass filters are installed.

TMP - HIGH HEATSINK TEMPERATURE

A thermostat senses excessive temperature of the final transistor heat sink assembly and locks the amplifier out of the operate mode until the heat sink cools. The trip temperature is fixed at 75° C and should only be reached during continuous carrier operation at high ambient temperatures or low efficiency operation caused by antenna SWR.

To prevent re-occurrence of a TMP fault, reduce power output and/or antenna SWR

Maximum collector current is factory set at 28A by an adjustment in the power supply. The over-voltage trip point is fixed at approximately 56 volts.

Excessive current can be caused by too much drive or by antenna SWR. High collector voltage may be caused by loss of regulation in the power supply or by an ac line voltage above 125 or 250 volts.

BAL - AMPLIFIER BALANCE

The Model 444 linear contains two separate push-pull power amplifiers. The outputs of these amplifiers are combined in a hybrid combiner. To keep efficiency high and dissipation in the combiner low, the amplifier outputs must be equal. Combiner imbalance is detected by a diode network and locks the amplifier out of the operate mode.

A balance fault indicates a problem inside the Model 444 itself and must be corrected by trouble shooting and repair.

DETAILED OPERATING INSTRUCTIONS

CONNECTIONS FOR QSK OPERATION WITH TEN-TEC OMNI TRANSCEIVER

The Model 444 Linear Amplifier is designed to operate with TEN-TEC transceivers in a "QSK" or fast break-in mode. Refer to Figure 1 for rear panel connections to an OMNI transceiver.

Use the 12 pin remote cable supplied to connect the linear "CONTROL" connector to the OMNI "LINEAR" connector. The ends of this cable are interchangeable.

Use the RG-58 AU jumper supplied to connect the OMNI "ANTENNA" connector to the amplifier "TRANSCEIVER" connector.

Use the RG-174 jumper supplied to connect the amplifier "RECEIVER" connector to the "RECEIVE ANTENNA" connector of the OMNI transceiver. Place the RECEIVE/TRANSCEIVE switch on the OMNI rear panel to the "RECEIVE" position.

Check to be sure that the factory installed shorting plug is in the "RELAY" jack on the amplifier rear panel.

Connect the station antenna to the "ANTENNA" connector on the amplifier.

Use the 9 conductor power cable supplied to connect the amplifier and power supply "POWER" connectors. This cable has a different connector at each end and will only plug in one way.

Connect all equipment grounding lugs together with "14 or larger wire or braid (the power supply ground wire is supplied). Connect the station ground to the amplifier.

The 115/230 VAC input cord has a standard 115V, 15 ampere connector installed at the factory. For operation from a 230V source, see page 1-10.

QSK OPERATION WITH TEN-TEC 540/544 or 580 TRANSCEIVERS - (Refer to Figure 2 or 3.)

The QSK hookup for the TEN-TEC 540/544 or 580 is the same as for the OMNI except that a control cable must be fabricated by the user. The control cable consists of a single length of RG174/U or similar coax connected as shown between the linear "CONTROL" connector and the transceiver accessories connector. This fabricated control cable carries the transceiver "T" voltage to the linear but does not carry any bandswitch information. Consequently, the band of operation must be selected manually at the

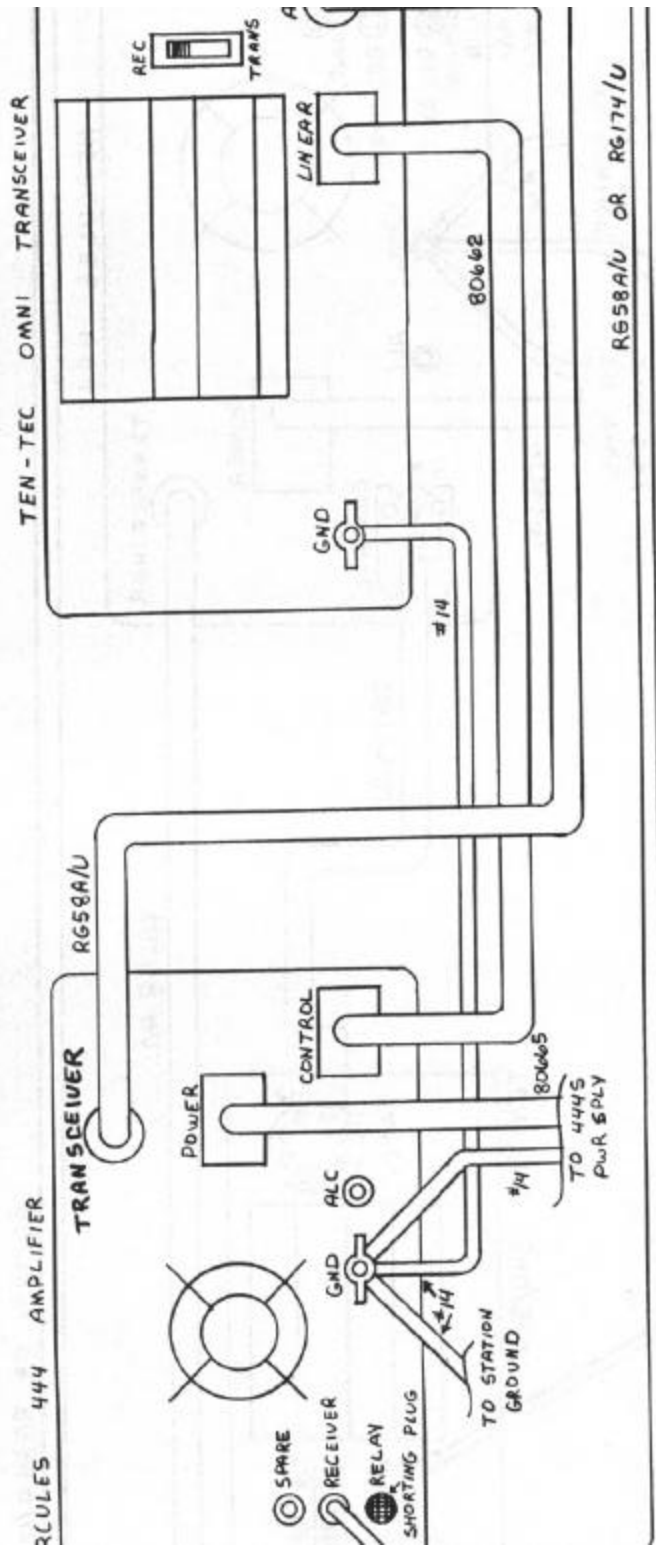


FIGURE 1 - HERCULES/OMNI CONNECTIONS

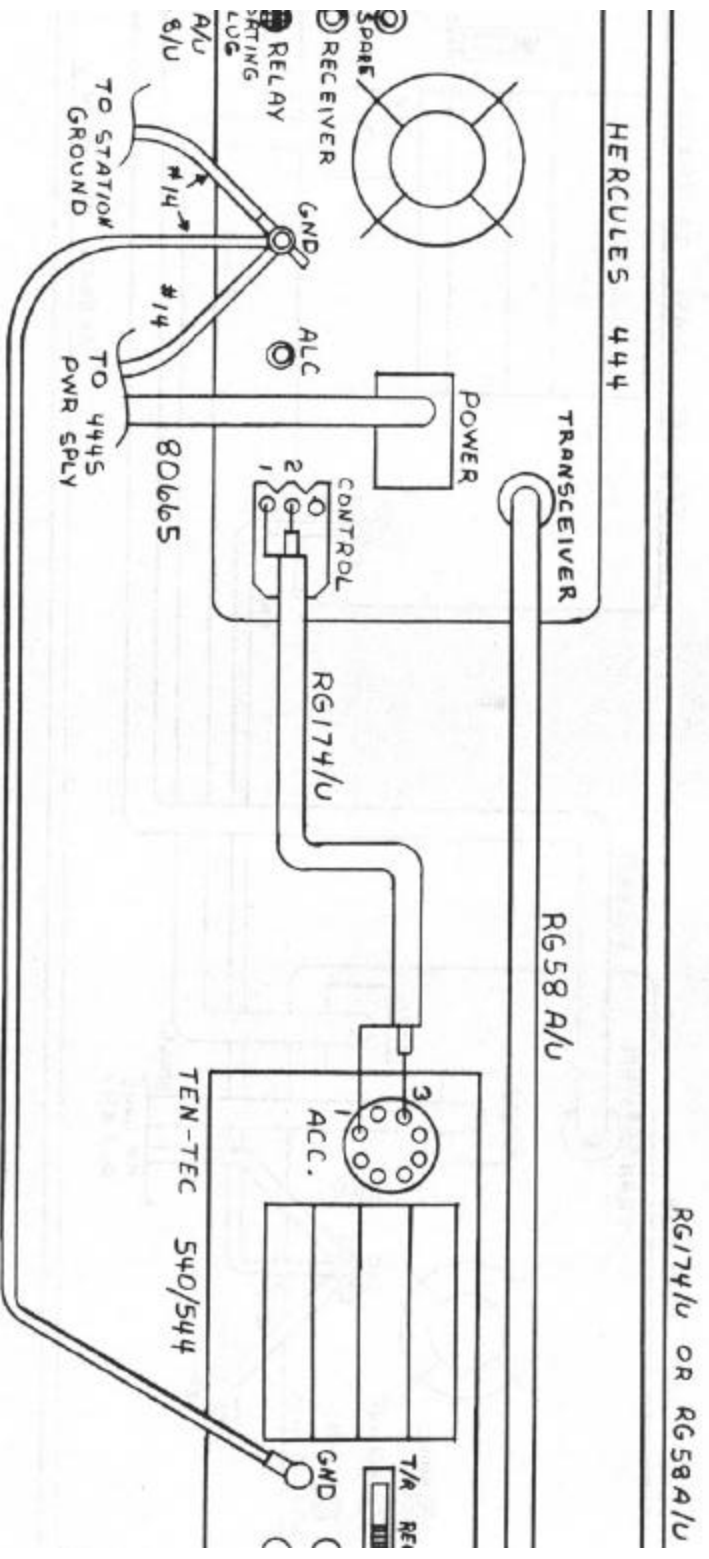


FIGURE 2 -- HERCULES/540-544 CONNECTIONS

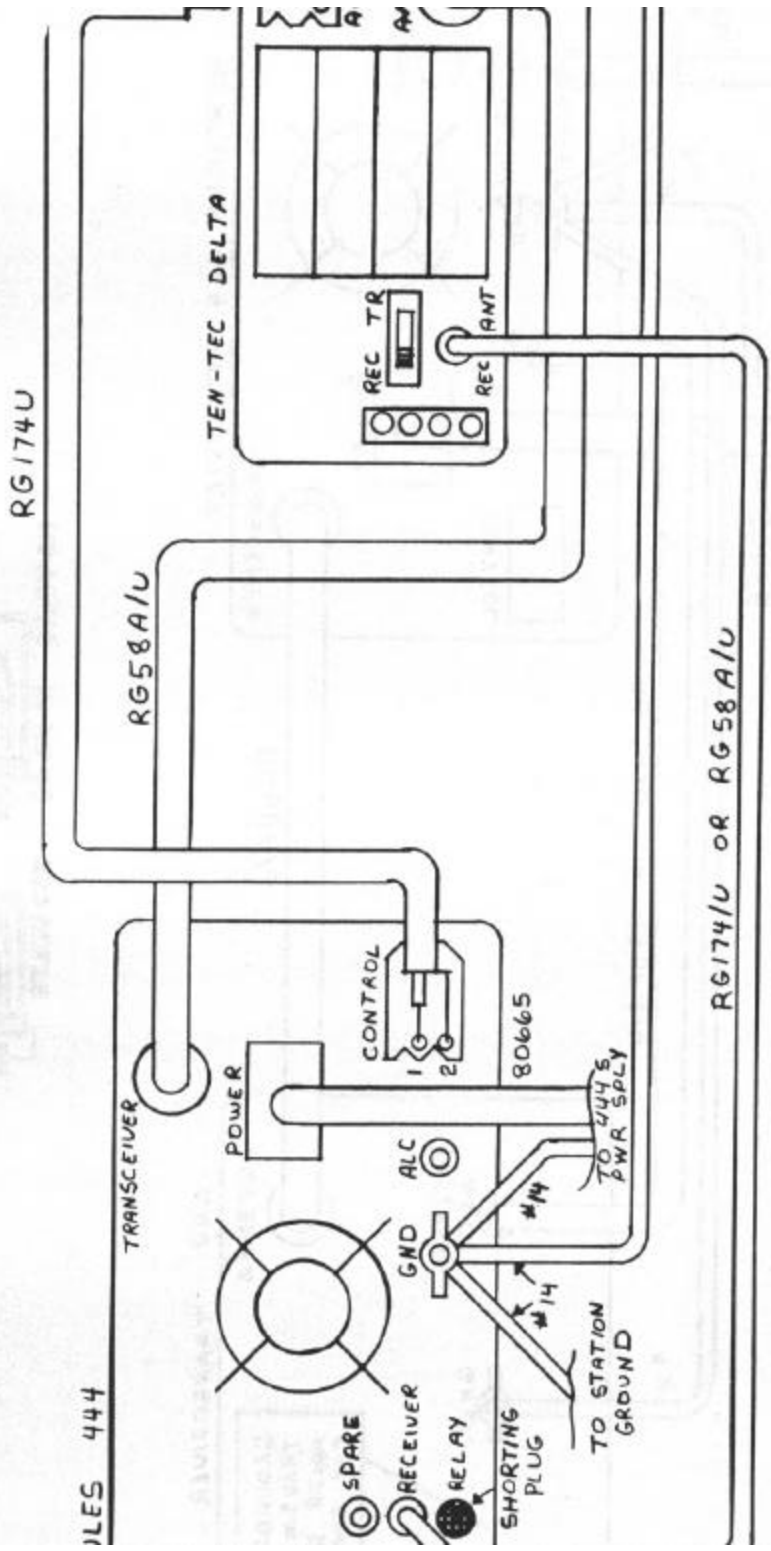


FIGURE 3 - HERCULES/DELTA CONNECTIONS

FIGURE 5-WIRING CHANGE FOR 230 VOLTS

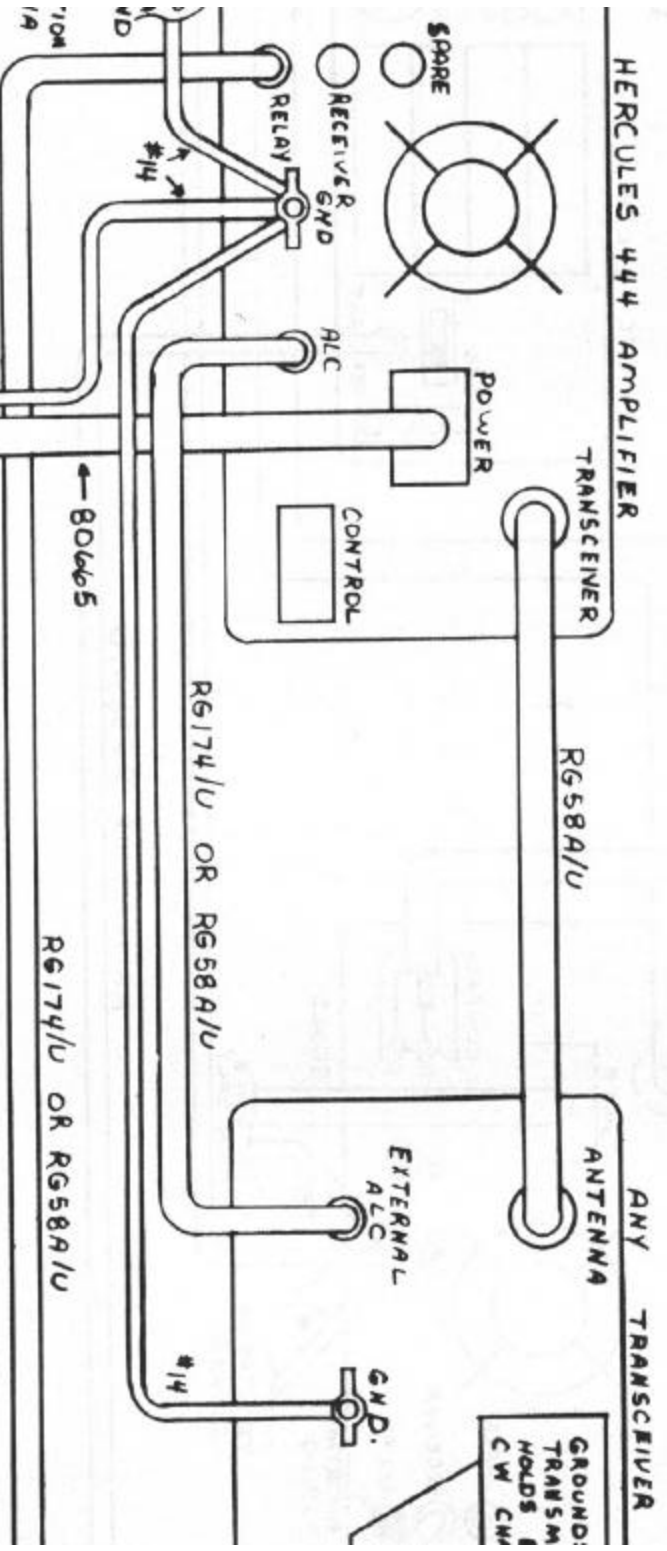
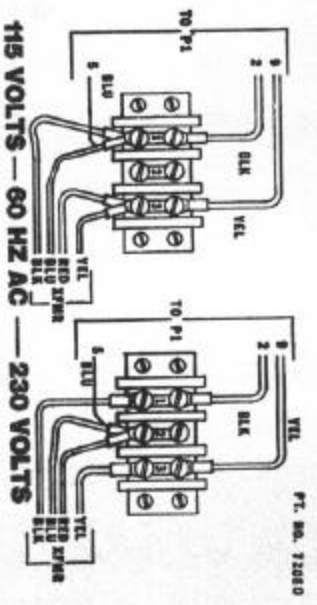


FIGURE 4 - HERCULES/OTHER TRANSCIEVERS CONNECTIONS

ceiver. If the operator does not wish to have the linear on even in the standby mode, the RECEIVE/TRANSCIVE switch on the transceiver rear panel may be set to the "TRANSCIVE" position, returning the receiver input to its normal connection inside the transceiver.

NON-QSK OPERATION WITH ANY TRANSCEIVER

For NON-QSK operation with any transceiver, the Model 444 is controlled via the RLY connector. This connector must be grounded during transmit, open during receive. The RLY line presents an open circuit voltage of approximately +12 volts DC and a short circuit current of approximately 150 mA. Most transceivers have an extra relay contact provided for control of linear amplifiers. This spare contact should be wired to provide a closure to ground during transmit for proper control of the RLY line.

Refer to Figure 4 for rear panel connections.

When the Model 444 is controlled in this way via the RLY line, the amplifier bypass relays cycle each time the transceiver switches between transmit and receive (when the 444 is in the OPERATE mode). During receive (or in STANDBY mode) the antenna is bypassed through the amplifier to the transceiver. For CW operation, the exciter control relay should hold in between transmitted characters, returning to receive only after long pauses to prevent excessive wear of the bypass relays in the Model 444.

OUT OF BAND OPERATION

The Model 444 is designed to operate only within the following frequency bands:

<u>BANDSWITCH</u>	<u>FREQUENCY RANGE</u>
1.8 (160 meters)	1.8 - 2.0 MHz
3.5 (80 meters)	3.5 - 4.0 MHz
7.0 (40 meters)	7.0 - 7.3 MHz
14.0 (20 meters)	14.0-14.35 MHz
21.0 (15 meters)	21.0-21.450 MHz

Operation outside the frequency range which has been selected by the band-switch may result in illegal spurious radiation. The Model 444 should not be used on non-amateur band frequencies unless an accurate spectral analysis can be performed on the transmitted signal to determine spurious responses. It cannot be over-stressed that the amplifier and exciter band-switches must be set to the same band to prevent excessive and illegal spurious radiation. If the amplifier is remotely controlled by an OMNI transceiver, the proper band is selected automatically. If the amplifier band is being selected manually, however, the bandswitch position should be double checked each time the amplifier is placed into operation.

Also, when operating the exciter "BARE FOOT" (through the amplifier bypass with the mode switch in standby), the amplifier and exciter bandswitches should be on the same band. Again this is accomplished automatically if the amplifier is remotely controlled by an OMNI transceiver and the amplifier power switch is on. Otherwise, the operator should turn the amplifier power switch on momentarily to bring the amplifier to the same band as the OMNI, or select the proper band manually (with the amplifier power switch on) when remote bandswitch control is not being used.

OUT OF BAND PROTECTION

The Model 444 is prevented from operating on any frequency higher than the selected band by a fault condition detected by the overdrive safety.

The overdrive safety is basically a "linearity detector", i.e., its function is to insure that the amplifier output is an accurately amplified replica of the input

AUXILIARY BANDS

The Model 444 amplifier has been designed with provisions for four additional frequency ranges which can be added by the amateur. These provisions were made to allow operation on additional amateur bands which may be available in the future.

ALIGNMENT AND SERVICE

AMPLIFIER DISASSEMBLY

REMOVAL OF TOP - Remove the upper two of the four screws located on each side of the amplifier. Slide top back and out from under rear lip of extruded aluminum frame.

REMOVAL OF BOTTOM - Remove the lower two of the four screws on each side. Loosen, by two turns, two counterbored screws securing extruded aluminum frame. Slide bottom cover back and out from under lip of aluminum frame.

REMOVAL OF AMPLIFIER MODULE - Remove the RF compartment cover plate. Disconnect all cables from the amplifier module which are accessible from the top. Note the location of all cables for re-assembly. Remove four pan-head bolts and nuts which secure the rear fan and finger guard to the rear panel. The lower nuts are accessible through cut-outs in the chassis bottom. Remove four pan-head bolts from the chassis bottom which secure the heatsink assembly. Disconnect all remaining cables and lift the amplifier module out of the chassis.

REMOVAL OF TOP - Remove the upper two of four screws on each side. Lift top off of unit.

INSTALLATION OF POWER TRANSFORMER

Remove the four transformer mounting bolts, nuts and washers from the shipping plate mounted to the transformer bottom. Retain the small plate in the event re-shipment of it is ever necessary. Position the power transformer over the mounting holes with the 12 pin connector toward the heatsink end of the power supply. Insert the mounting bolts from either side of the chassis deck and secure with washers and nuts. Connect the mating 12 pin connectors by forcing them completely together with proper indexing.

115/230 V WIRING

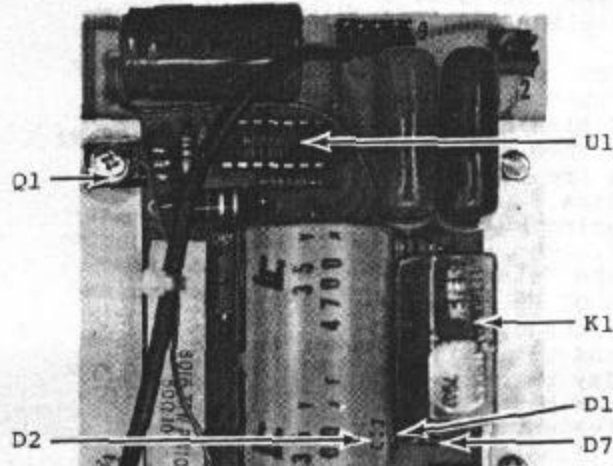
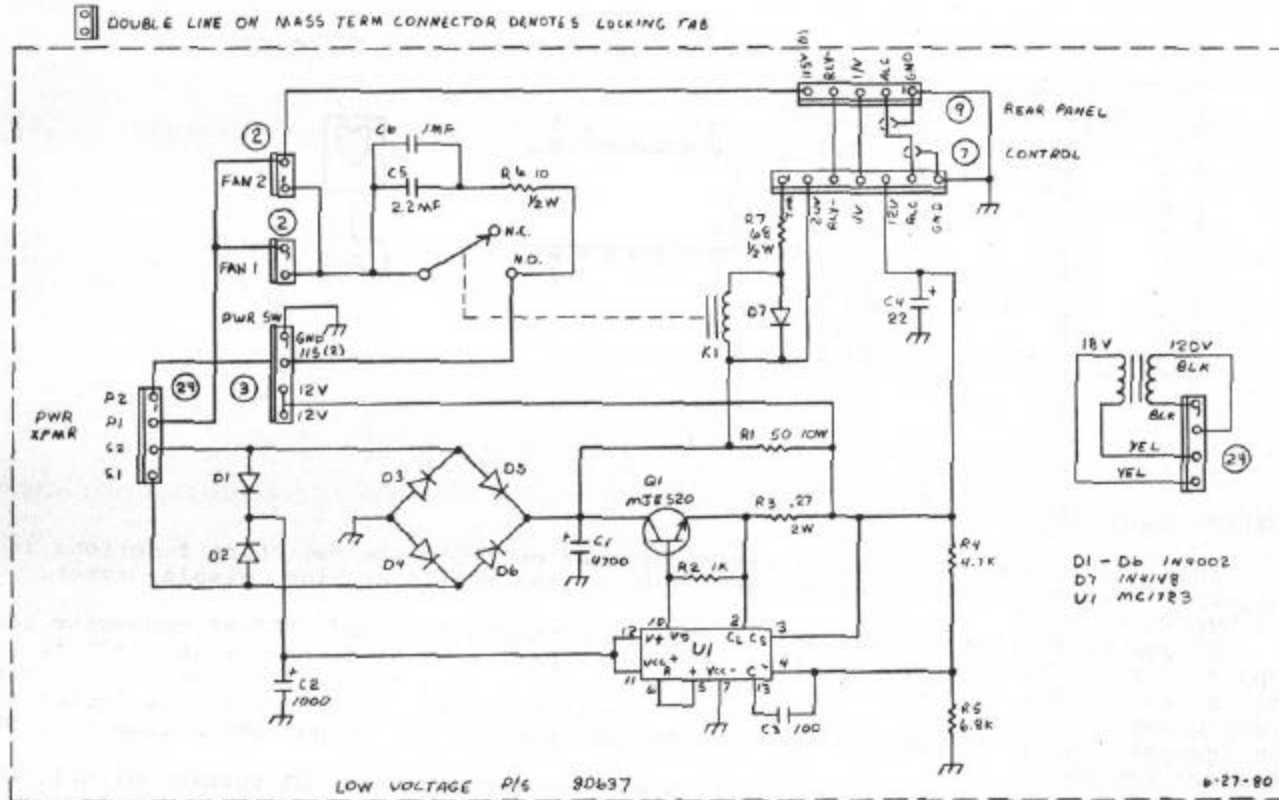
The Model 444 is shipped from the factory wired for 115 volts. The power cord is supplied with a standard 115V/15 amp connector wired per NEMA standards (Green wire: Equipment ground, White wire: Power "NEUTRAL" conductor, Black wire: Power "HOT" conductor).

To rewire the power supply for 230 volt power, refer to Figure 5 or the label inside panel of the supply. The Yellow, Red, Black and Blue wires coming to the terminal block from the power transformer have slotted terminals and can be moved after loosening the binding screws.

For operation from a 210-250V line, the Black wire from the power transformer socket connects to terminal 1 of TB1, Blue and Red wires to terminal 2, and Yellow wire to terminal 3. Note that the Black and Yellow wires from the rear panel power connector remain on terminals 1 and 3 respectively. Also the small Blue wire from

Diodes D1 thru D6 form a double bridge circuit to supply DC voltage to regulator U1 and pass transistor Q1. R4 and R5 set the output voltage to approximately 12 volts at the "12V" pins of connectors 1 and 3 establishes a current limit of 2 amps.

K1, C5, C6 and R6 form the fan speed control circuit. At low heatsink temperature, K1 is de-energized connecting C5 and C6 in series with the fans reducing their speed. When heatsink temperature reaches 60 degrees C., a thermostat on amplifier card #1 grounds pin 1 of connector 7 energizing K1. K1's contacts short C5 and C6 allowing the fans to speed up. R6 reduces the current surge through the contacts of K1.



80637 LV POWER SUPPLY BOARD

PARTS LIST			QTY
C2	23042	CAP-FXD, 1000MF, 25V, EL	1
C4	23060	CAP-FXD, 22MF, 35V, EL	1
C3	23139	CAP-FXD, 100PF, 100V, 5%, N750	1
C5	23177	CAP-FXD, 2.2MF, 20%, 200V, FILM	1
C6	23180	CAP-FXD, 1MF, 20%, 400V, FILM	1
C1	23191	CAP-FXD, 4700 MF, 35V, EL	1
Q1	25002	TRANSISTOR-POWER, MJE520	1
U1	25050	TRANSISTOR-MC1723CL	1
D1-6	28000	DIODE-POWER, 1N4002, SIL	6
D7	28001	DIODE-1N4148/1N914, SIL	1
K1	32034	RELAY SPDT 12VDC	1

LOW VOLTAGE POWER SUPPLY

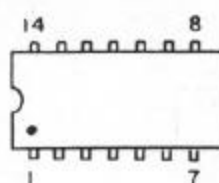
Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1	16.5	20	12.8	12.5	12.1	11.9

U1

Pin	Transmit	Receive
1,7-9,14	0	0
2	11.9	11.9
3	11.8	11.8
4	6.6	7
5	7	7
6	7	7
10	12.8	12.5
11	17.1	20.7
12	17.1	20.7
13	13.5	13.8

Pins viewed from top of PC board



CONTROL BOARD 80632

This assembly contains logic circuitry that controls the switching functions in the amplifier. Functions controlled are: T/R switch, amplifier bias, display reset, and bypass relays.

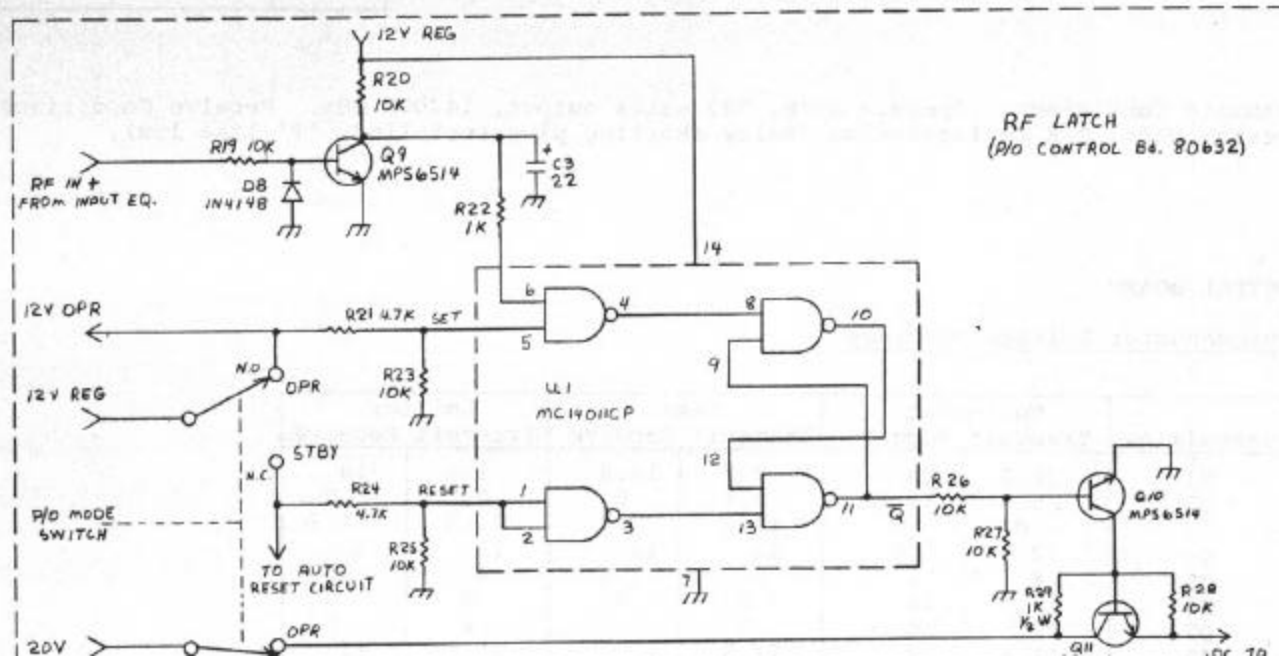
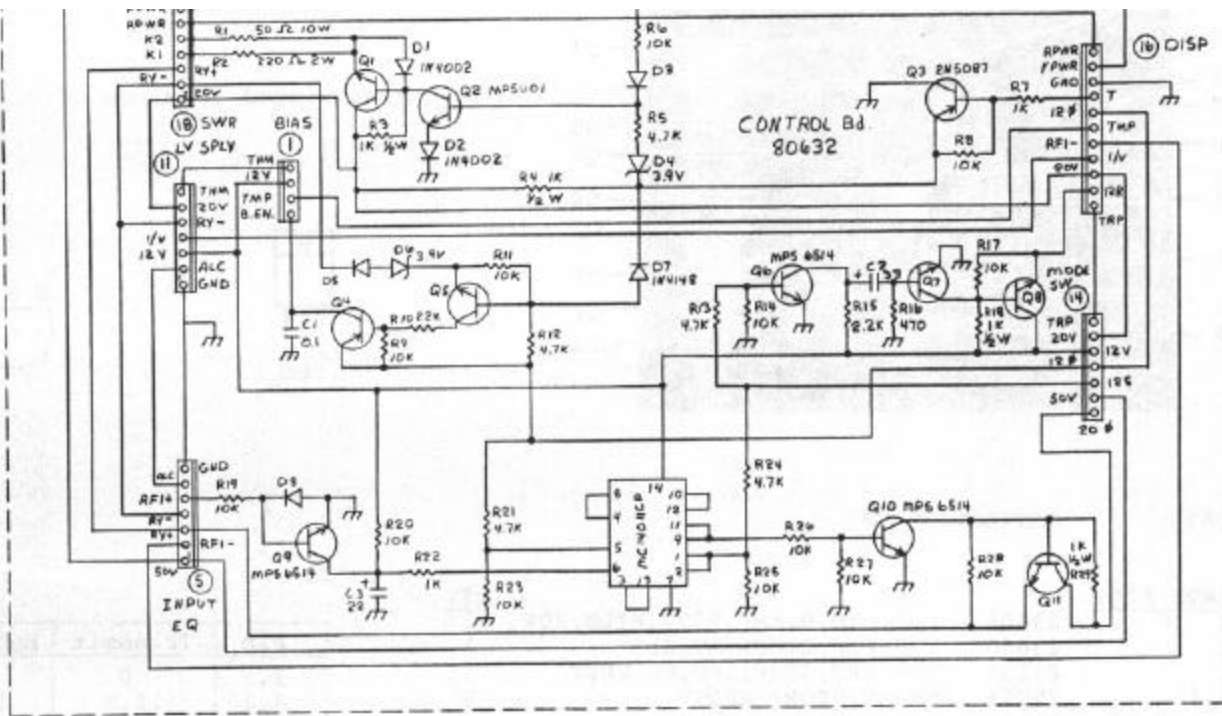
Q1 and Q2 control the T/R switch through contacts "K2" and "K1" of connector 18. Inputs to the T/R circuitry are from "T" and "F PWR" pins of connector 16. "T" is the exciter T line when the amplifier is connected with a TEN-TEC transceiver for QSK (Fast break-in) operation. Otherwise "T" floats high and the T/R switch is locked in the transmit mode. "F PWR" is from the forward port of the output SWR bridge (see SWR/TR board 80631).

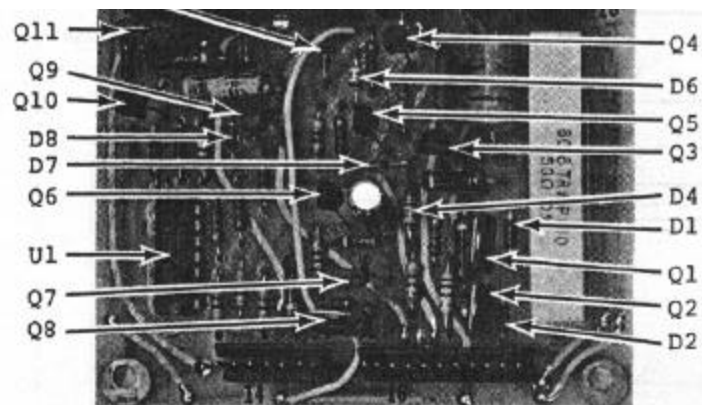
When "T" or "F PWR" is high, Q2 is biased on through D4 or D3 turning Q1 off, D1 and D2 on. On the SWR/TR board, K1 is energized and K2 is de-energized disconnecting and shorting the receiver input. When "T" and "F PWR" are low, Q2 is off and Q1 is biased on by R3. K1 is de-energized and K2 is energized connecting the receiver input to the antenna.

Q4 and Q5 control amplifier bias via the "B.EN" pin of connector 1. Inputs are T voltage from Q3 emitter and relay keyline from "RY-" of connector 18. If "T" is low (indicating receive) Q5 base is held low by D7 biasing Q5 and Q4 off. In this condition the final amplifier bias is turned off. When "T" is high (or not connected) and the relay keyline (RY-) is grounded, Q5 and Q4 are on and bias enable voltage is switched to "B.EN" turning on the final bias supplies.

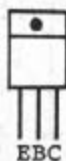
Transistors Q6, Q7 and Q8 develop a negative-going pulse to reset the status display each time the mode switch is set to "operate". The input from "12s" of connector 14 turns Q6 off when the mode switch (S2) leaves the "standby" position. Capacitor C2 charges through R15 and R16 momentarily turning Q7 on and Q8 off, interrupting the supply voltage to any latched indicators in the status display.

Transistor Q9, I.C. U1, and transistors Q10 and Q11 control power to the bypass relays at the input and output of the linear. Relay power is available only when the mode switch is set to "operate" while no RF input is present. This prevents "Hot Switching" the amplifier to operate mode while drive power is applied. RF input is sampled on the input equalizer board and turns on transistor Q9 via the "RFI" pin of





Pins viewed from top of PC board



80632 CONTROL BOARD

PARTS LIST

			QTY
C1	23006	CAP-FXD, 0.1MF, 250V, FILM, 20%	1
C3	23060	CAP-FXD, 22MF, 35V, EL	1
C2	23182	CAP-FXD, 33MF, 16V, EL VERT	1
Q3,4	25001	TRANSISTOR-2N5087	2
Q1,2,8,11	25053	TRANSISTOR-MPSU01	4
Q5,7,9,10	25054	TRANSISTOR-MPS6514	5
	25091	IC-MC14011	1
D1,2	28000	DIODE-POWER, 1N4002, SIL	2
D3,5,7,8	28001	DIODE-1N4148/1N914, SIL	4
D4,6	28021	DIODE-ZENER, 3.9V, 1N748	2

U1

Pin	Transmit	Receive
1,2	0	0
3,13	11.8	12
4,8	12	0
5	8	8
6	0	12
7	0	0
9,11	0	0
10,12	11.8	12
14	11.8	12

Transmit Conditions: Operate Mode, 500 watts output, 14.000 MHz. Receive Conditions: Operate Mode, QSK Configuration (Relay shorting plug installed, "T" line low).

CONTROL BOARD

Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1	16.2	20	0.7	18.8	1.4	18
Q2	0.7	18.8	1.4	0	0.7	0
Q3	0	0	10.8	.3	11.5	1.1
Q4	12	0	11	12	12	12
Q5	4	12	5	1.5	4	1.5
Q6	12	12	0	0	0	0
Q7	12	12	0	0	0	0
Q8	12	12	11.8	12	11	11

time.

Q1 is turned on when an ambiguous setting of the bandswitch allows the "CTL" pin of connector 7 to float high. The CTL indicator is illuminated by current through R1 and the mode switch is "tripped out" by current through diode D8. Switching between bands grounds the "CTL A" pin of connector 7 generating a momentary control fault via diode D7.

SCR Q2 is fired by a voltage from the hybrid combiner on the "Bal" pin of connector 7. This "Bal" voltage is generated in the combiner when an imbalance exists in the outputs of the two push pull amplifier modules. SCR Q2 remains latched until the voltage on the "12R" line is momentarily removed by the reset circuit on the control board as the mode switch is returned to operate.

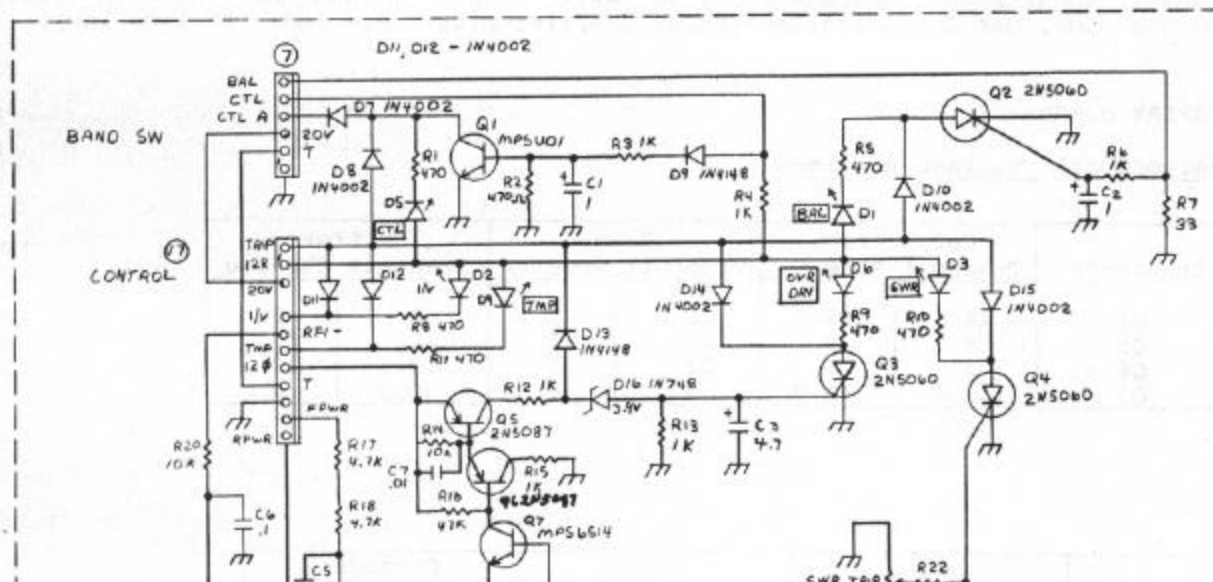
When the power supply current or voltage limit is exceeded, an SCR on the shunt board in the supply grounds the "I/V" line tripping the mode switch through D11 and illuminating I/V indicator D2. Reset is the same as above.

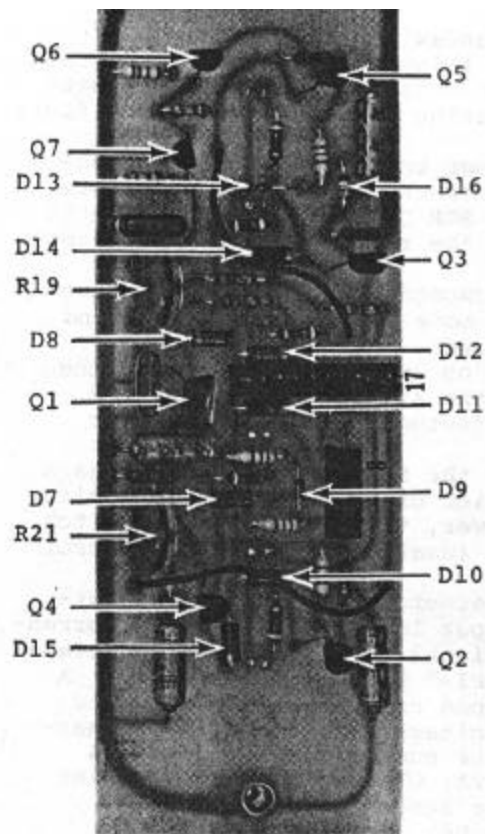
A temperature fault is generated when a thermostat on amplifier #2 grounds the "TMP" line. D12 trips the mode switch and D4 provides the status indication. D4 will remain illuminated and the operate mode will be rejected until the amplifier heatsink temperature returns to normal.

Output reflected power is monitored by a bridge on the SWR/TR board and appears as a voltage on the "RPWR" pin of connector 17. A portion of this voltage is applied to the gate of SCR Q4. Q4 fires at 75 watts reverse power, tripping the mode switch via D15 and illuminating D3. Reset is by action of the reset circuit on the control board via the "12R" line.

The overdrive safety is essentially a "linearity detector" which compares output power to input power and becomes active when the input increases without a corresponding increase in output. A negative voltage proportional to input power is developed on the input equalizer board and appears at the "RFI-" pin of connector 17. A positive voltage proportional to output power is developed on the SWR/TR board and appears at the "FPWR" pin of connector 17. These two voltages are added in the network R17 -R20 and applied to the emitter of Q7. When the sum of the two voltages becomes sufficiently negative, indicating excessive drive, Q7 is biased on, turning on Q6 and Q5. When Q5 is conducting enough to avalanche zener diode D16, SCR Q3 fires tripping the mode switch via D14 and illuminating D6. Reset action is the same as above.

Please note that the adjustments on this assembly are factory sealed and are not to be reset by the user under penalty of voiding the warranty.





PARTS LIST

Part No.	Quantity	Description	QTY
C5,6	2	CAP-FXD, 0.1MF, 250V, FILM, 20%	2
C1,2,4	3	CAP-FXD, 1MF, 16V, EL	3
C3	1	CAP-FXD, 4.7MF, 25V, EL	1
C7	1	CAP-FXD, .01MF, 100V, CER, 25V	1
Q5,6	2	TRANSISTOR-2N5087	2
Q2-4	3	SCR-2N5060/C1034	3
Q1	1	TRANSISTOR-MPSU01	1
Q7	1	TRANSISTOR-MPS6514	1
D7,8,10-12,14,15	7	DIODE-POWER, 1N4002, SIL	7
D9,13	2	DIODE-1N4148/1N914, SIL	2
D16	1	DIODE-ZENER, 1N748, 3.9V	1
R22	2	RES-VAR, 10K, LIN, PC MOUNT	2

Pins viewed from top of PC board



Transmit Conditions: Operate Mode, 500 watts output, 14.000 MHz. Receive Conditions: Operate Mode, QSK Configuration (Relay shorting plug installed, "T" line low).

DISPLAY BOARD

Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1	16	19.5	0	0	0	0
Q5	0	0	12	12	12	12
Q6	0	0	12	12	12	12
Q7	11.8	11.8	0	0	0.8	0

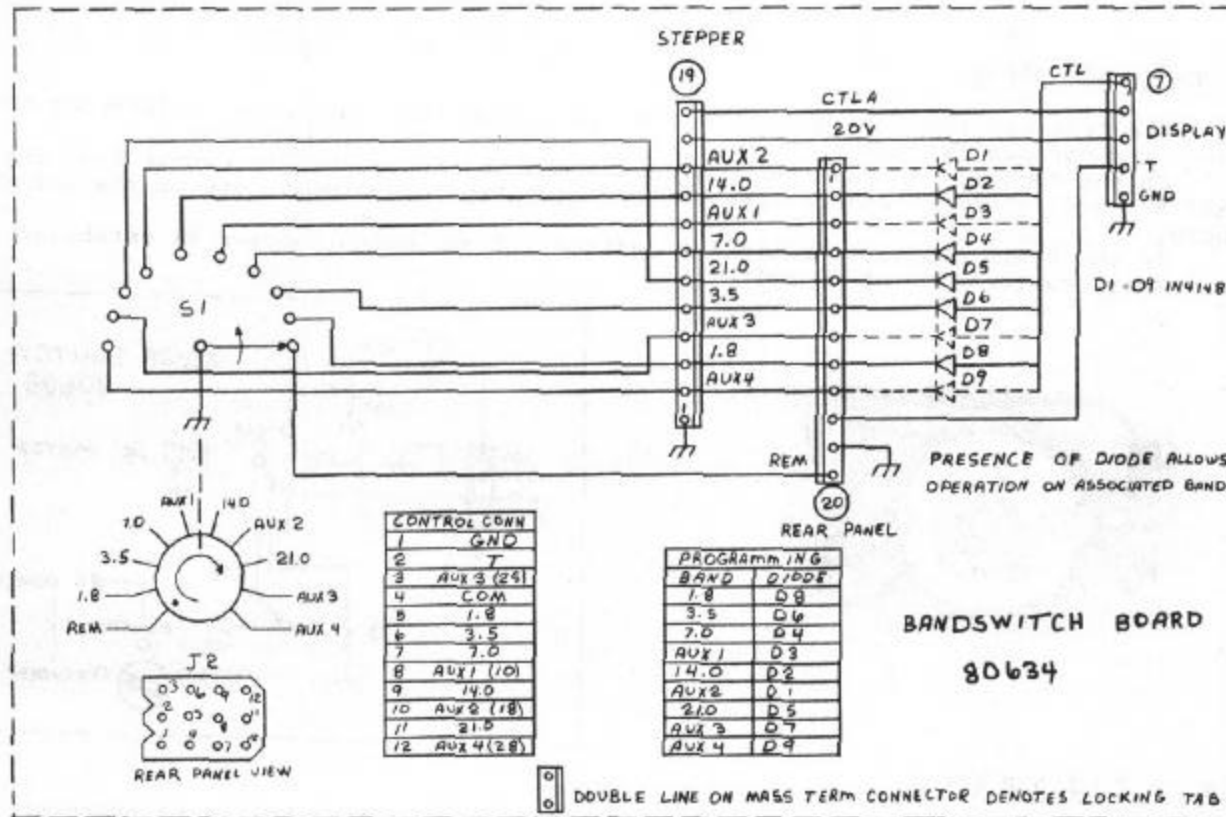
	Anode	Gate	Cathode
--	-------	------	---------

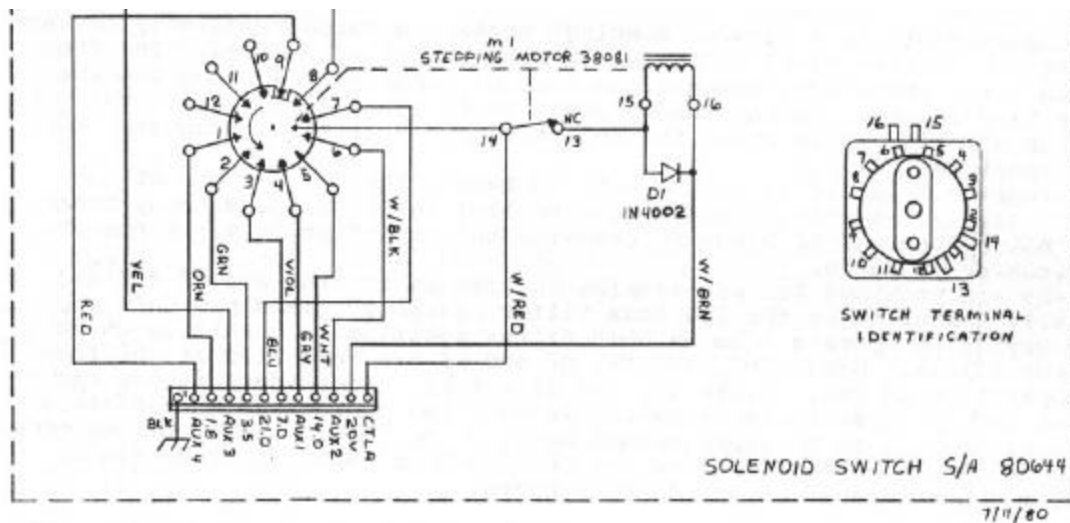
the rear panel.

The stepping solenoid is a "ground seeking" mechanism which repeatedly advances its shaft one step at a time until it finds a ground on one of 9 wires. The front panel bandswitch (S1), therefore, grounds one wire of connector 19, steering the solenoid to the band in use. In the remote position S1 grounds the wiper of an external bandswitch allowing it to steer the solenoid thru 9 wires of connector 20 and rear panel connector J2.

When the stepping solenoid is moving between bands, the "CTL A" pin of connectors 19 and 7 is held at ground signaling a control fault to the display board. This prevents "hot switching" of bands by removing the amplifier from the operate mode during switching of bands.

Diodes D1-D9 are provided for programming the system for the set of filters which are actually installed in the low pass filter assembly. This prevents the amplifier from trying to operate into an open filter position, a condition which could destroy the finals. Diodes D2, D4, D5, D6 and D8 are installed at the factory allowing operation on 160, 80, 80 20, and 15 meters. Additional diodes can be added only after the low pass filter assembly is modified to include more filters. Positioning the bandswitch to an unprogrammed band, or to "REMOTE" when the external switch is on an unprogrammed band, allows the "CTL" pin of connector 7 to float high generating a control fault at the display board.



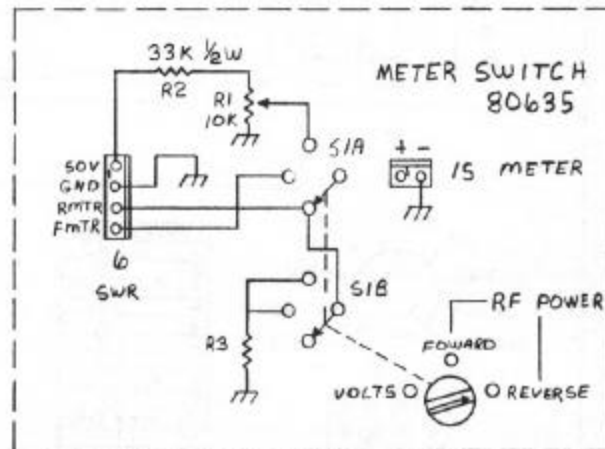
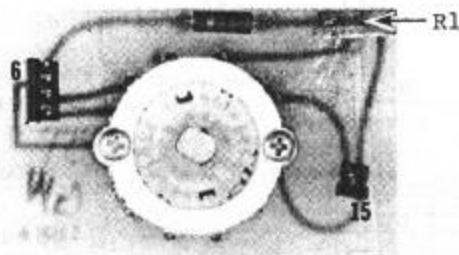


METER SWITCH 80635

The meter switch provides a means of switching the front panel multimeter between its various functions.

In the forward and reverse power positions the meter accepts output from the SWR/TR board. Forward and reverse power calibration adjustments are on the SWR/TR board.

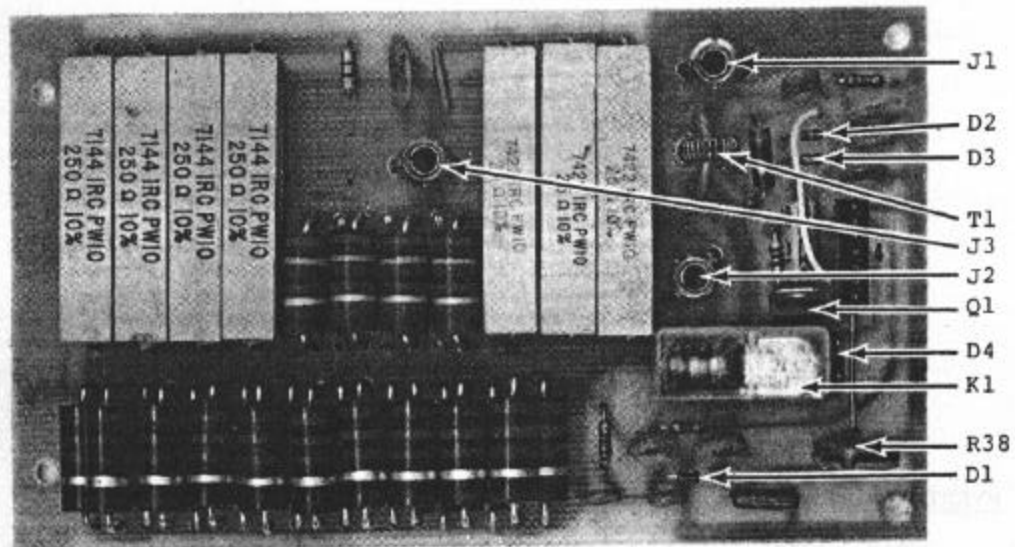
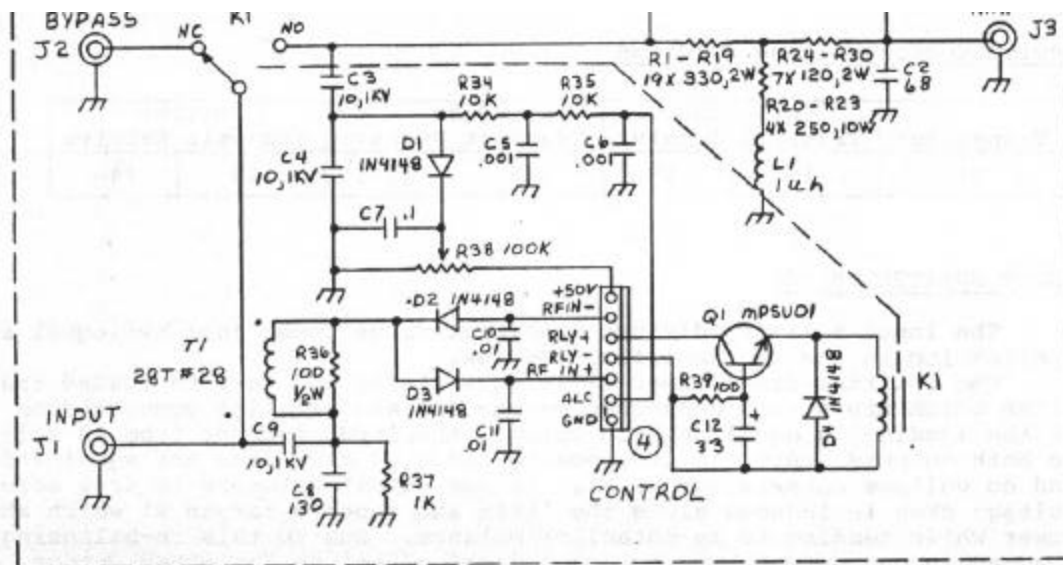
In the VOLTS position multiplier resistor R2 and potentiometer R1 establish a full scale calibration of 60 volts.



INPUT EQUALIZER 80630

Because of the frequency roll-off common to all emitter ballasted transistors, a wide band amplifier built with these devices requires some circuitry to equalize the gain over the band of interest. In the Hercules, part of this gain slope is compensated in each push-pull amplifier by means of RF feedback. The remaining gain variation is compensated for in the input equalizer.

Resistors R1 through R30 form a tee attenuator which, when modified in a frequency dependent way by C1, C2, L1 and R31-R33, maintains the overall gain of the amplifier at an approximate 10 dB over the frequency range of 1.8-30 MHz.



80630 INPUT EQUALIZER BOARD

PARTS LIST			QTY
L1	21064	CHOKE-RF, 1UH, 750MA	1
C7	23006	CAP-FXD, 0.1MF, 250V, FILM, 20%	1
C12	23022	CAP-FXD, 33MF, 16V, EL	1
C3, 4, 9	23044	CAP-FXD, 10PF, 1KV, CER, 5%	3
C2	23124	CAP-FXD, 68PF, 1KV, CER, 5%, N470	1
C1	23129	CAP-FXD, 220PF, 1KV, CER, 5%, N1500	1
C10, 11	23132	CAP-FXD, .01MF, 100V, CER, Z5V	2
C5, 6	23133	CAP-FXD, .001MF, 500V, CER, 5%, Z5F	2
C8	23155	CAP-FXD, 130PF, 500V, 5%, N1500	1
Q1	25053	TRANSISTOR-MPSU01	1

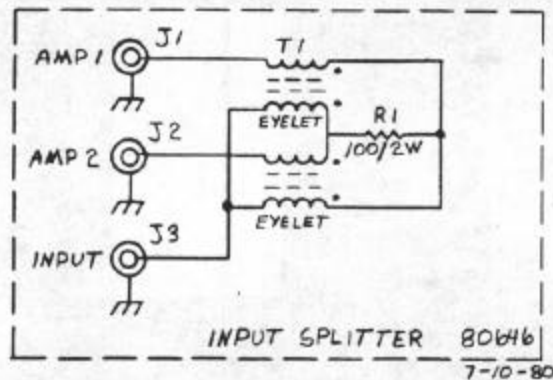
Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1	16	19	16	18.5	18	14

INPUT SPLITTER 80646

The input splitter divides the input drive power into two equal signals for application to the two amplifier modules.

The splitter transformer T1 is essentially two ferrite loaded transmission lines which are series connected on one end and parallel connected on the other. If the loading is equal on each output, the input current from J3 splits equally to both outputs, currents in opposite sides of each line are equal and opposite, and no voltage appears across R1. If one output attempts to draw more current, a voltage drop is induced along the lines and appears across R1 which absorbs some power while tending to re-establish balance. Due to this re-balancing effect, changes in one output have a much reduced effect on the other output, and the input impedance remains fairly constant.



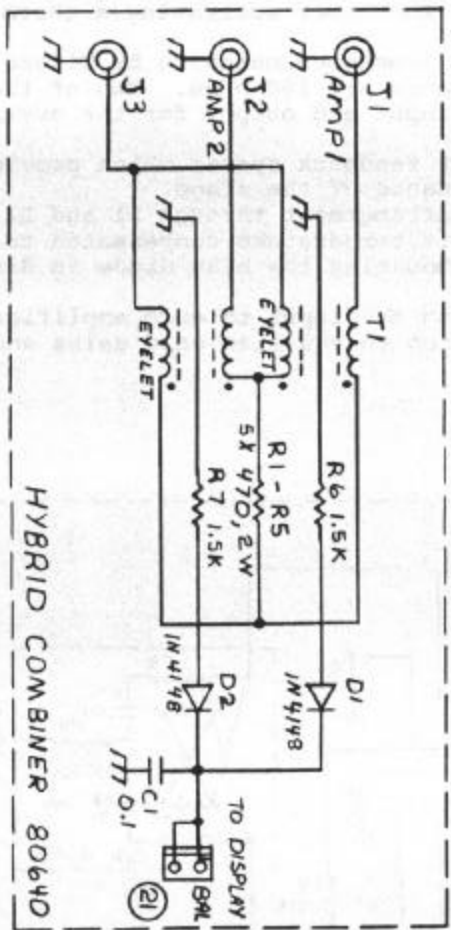
HYBRID COMBINER 80640

This assembly has two functions, the most important of which is to combine the outputs of the two amplifier modules into one signal with minimum interaction between amplifiers. The secondary function is to provide an output indication an unbalanced condition when one amplifier output level is much higher than the other.

The combiner is essentially two ferrite loaded transmission lines connected in series on one end and in parallel on the other. A power dump resistor is connected across the parallel wired end to absorb any small imbalance that might exist.

Under perfectly balanced conditions, the currents into J1 and J2 are equal. It can be seen that currents are then equal and opposite in each transmission line and no flux is induced in the ferrite cores of T1. Both currents add at J3 and all the input power flows to the 50 ohm impedance at J3. In this case there is no voltage developed across the dump resistors (R1-R5) and no voltage induced into the flux sensing windings feeding resistors R6 and R7.

When one amplifier output is higher than the other, the currents in opposite sides of each transmission line are no longer equal and a voltage is induced along the line. This voltage appears across the dump resistors R1-R5 which absorb the



HYBRID COMBINER 80640

DOUBLE LINE ON MASS TERM CONNECTOR DENOTES LOCKING TAB

RF AMPLIFIER

HYBRID COMBINER

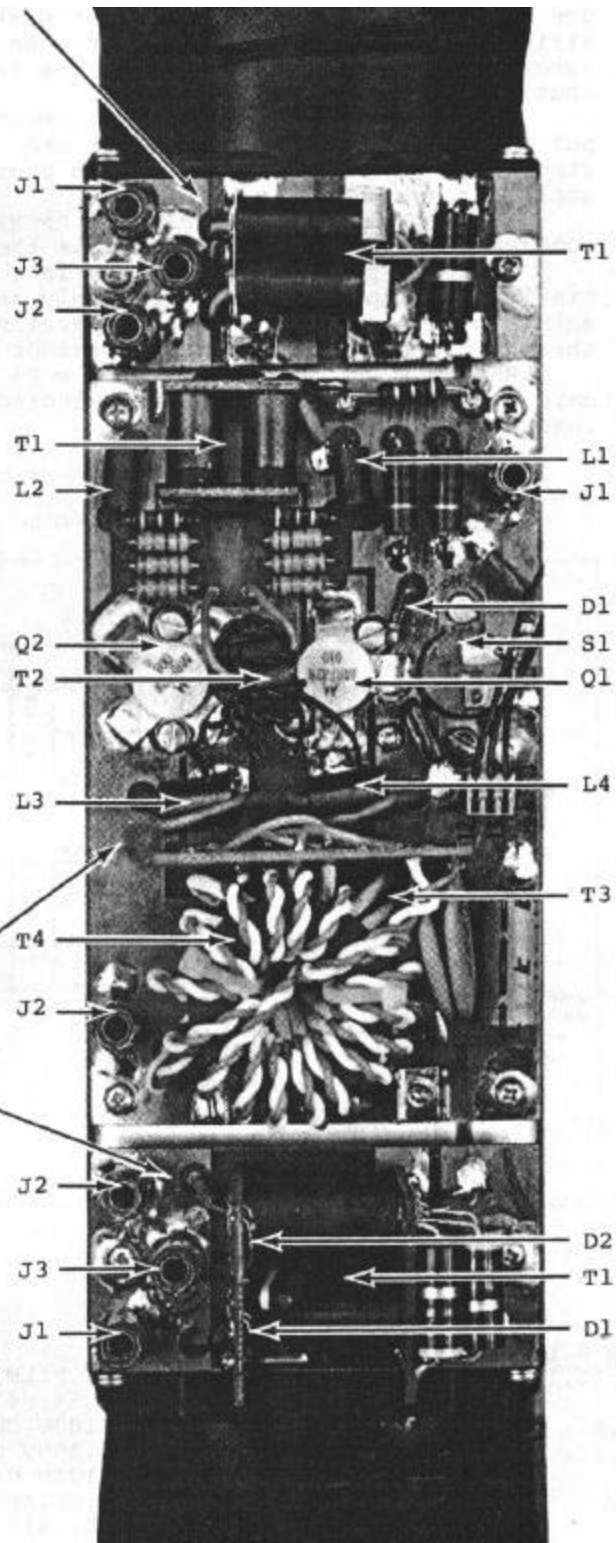
80640 HYBRID COMBINER BOARD

PARTS LIST

C1	23006	CAP-FXD, 0.1MF, 250V, FILM, 20%
D1, 2	28001	DIODE-1N4148/1N914, SIL
J1-3	35062	RECEPTACLE-MOLEX PC PHONO

QTY

1
2
3



are bolted to copper heat spreader plates which distribute the heat from each amplifier over a large area of the exchanger surface. A thermostat is mounted to each spreader plate, one controlling the fan speed and the other activating a thermal shut down.

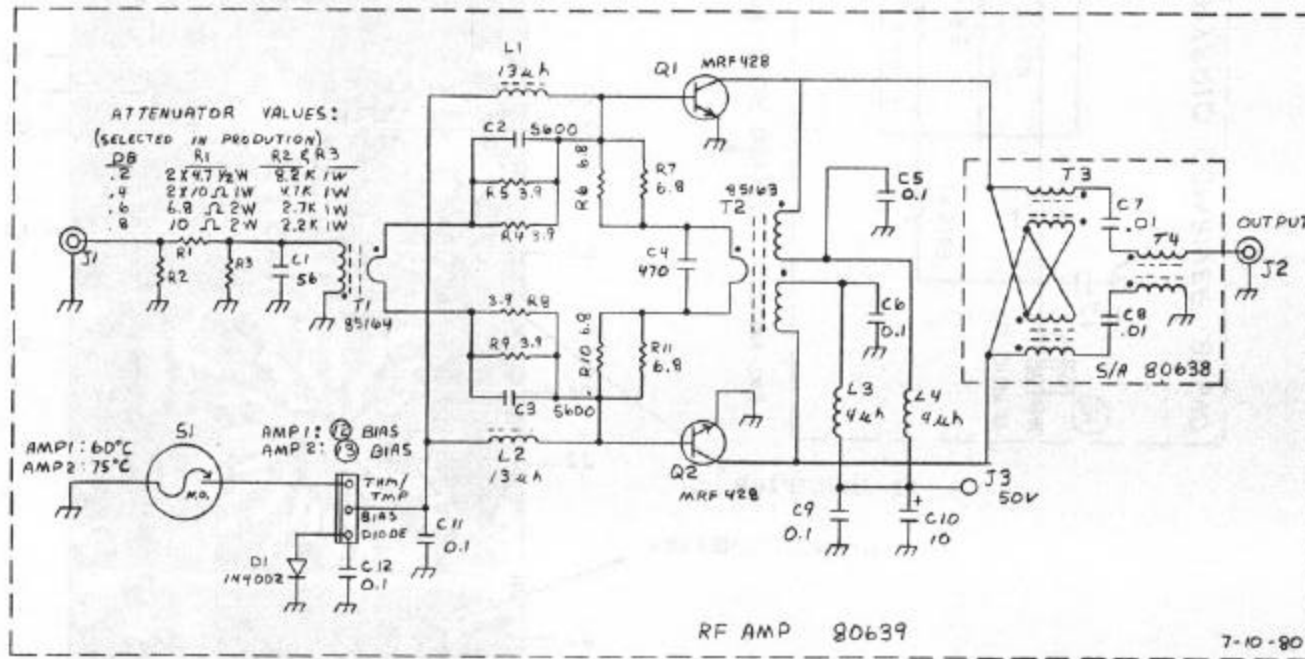
Q1 and Q2 form the push-pull stage with input impedance matching by T1 and output matching by T3 and T4. Input and output impedance are 100 ohms. Two of these stages are combined in parallel to provide 50 ohm input and output for the overall amplifier system.

T2 and the network including R5-R11 form an RF feedback system which provides some gain equalization and controls the input impedance of the stage.

Bias is applied to the bases in a shunt feed arrangement through L1 and L2. Bias is developed in the bias supply assembly and is temperature compensated to maintain a relatively constant operating point by mounting the bias diode in direct thermal contact with the heat spreader plate.

Resistor R1, R2, and R3 form a PI attenuator on the input to each amplifier card. The resistor values are selected in production to equalize card gains and insure system balance.

DOUBLE LINE ON MASS TERM CONNECTOR DENOTES LOCKING TAB



80639 AMPLIFIER BOARD

PARTS LIST

QTY	DESCRIPTION
C9,11,12	23006 CAP-FXD, 0.1MF, 250V, FILM, 20%
C1	23142 CAP-FXD, 56PF, 100V, 5%, N470
C5,6	23184 CAP-FXD, .1MF 20%, 100V CER CHIP
C2,3	23185 CAP-FXD, 5600PF, 5%, 100V CERAMIC
C4	23186 CAP-FXD, 470PF, 5%, 100V CERAMIC
C10	23220 CAP-FXD, 10MF, 160V, EL, AXIAL
D1	28000 DIODE-POWER, 1N4002, SIL

PARTS LIST

QTY	DESCRIPTION
3	
1	
2	80638 OUTPUT TRANSFORMER BOARD
2	
1	
1	
1	
1	23221 CAP-FXD, .01MF, 1KV, Z5F

QTY
2



RF AMP (Left and Right Card)

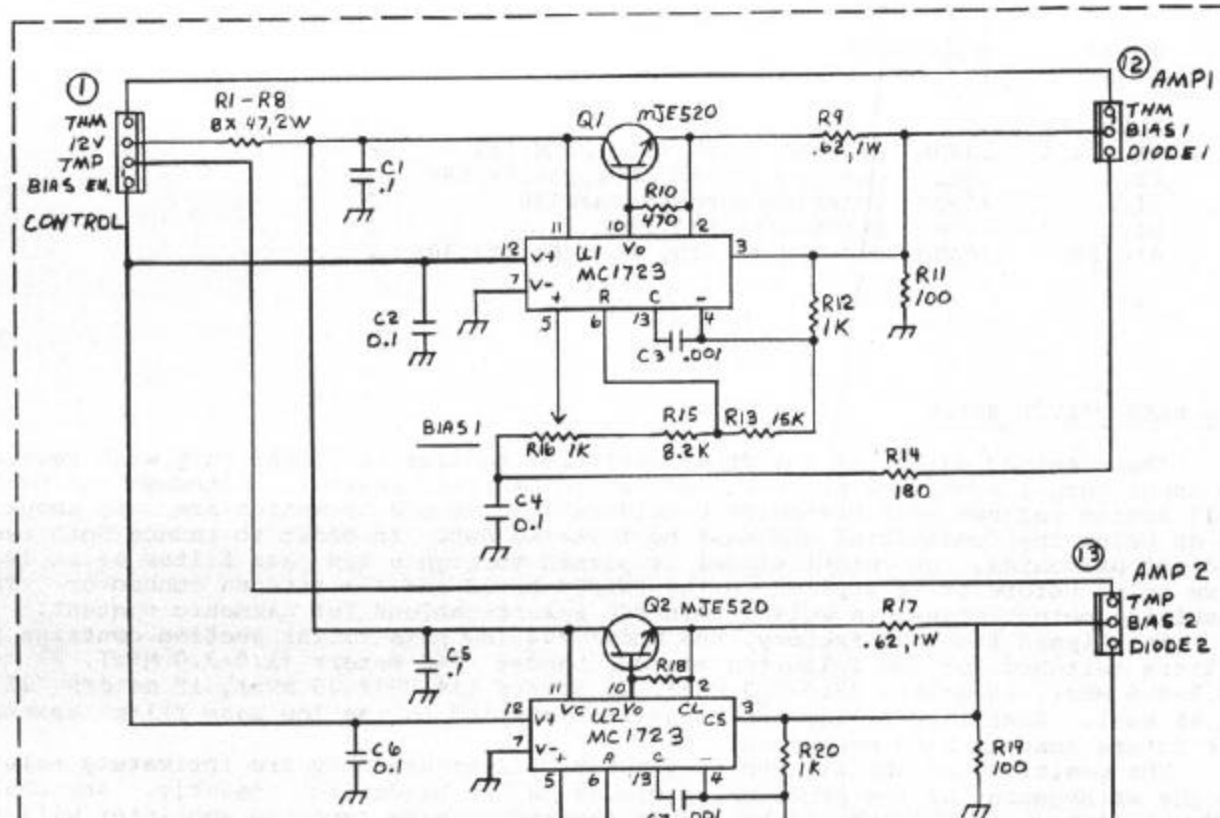
Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1, Q2	47.5	48	0	.8	0	0

BIAS SUPPLY 80633

This assembly contains a bias regulator for each of the RF final amplifiers. The regulators are switched on by an enabling voltage at Pin 1 of Connector 1. The output voltage of each regulator is independantly adjustable by R16 and R24. Temperature compensation is accomplished by a diode which is thermally connected to each final amplifier heat sink and electrically connected as part of the reference voltage for the integrated circuit regulators U1 and U2. U1 and U2 drive pass transistors Q1 and Q2 in a configuration which current limits at about 1 amp of output bias current.

To adjust bias, insert A 0-1 AMP DC ammeter in series with the 0-30 AMP collector current. Meter in the Hercules Model 444. Place the mode switch in the operate position and key the exciter with the drive turned all the way down. Start with both R16 and R24 in the fully counter clockwise position. Turn R16 clockwise until the ammeter reads 0.3 AMP. Now turn R24 until the ammeter reads 0.6 AMP. Turn the power off and remove the 1 AMP meter.

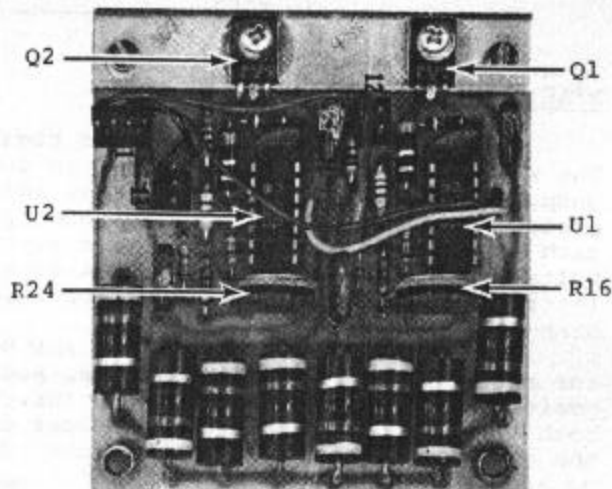
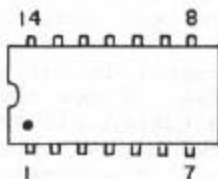


Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1,2	2	0	4	12	.8	0

U1, U2

Pin	Transmit	Receive
1	0	0
2	1	0
3	.5	0
4,5	1	0
6	6.5	0
7-9	0	0
10	1.5	0
11	4	12
12	12	0
13	2.5	0
14	.5	0



80633 BIAS CARD

PARTS LIST

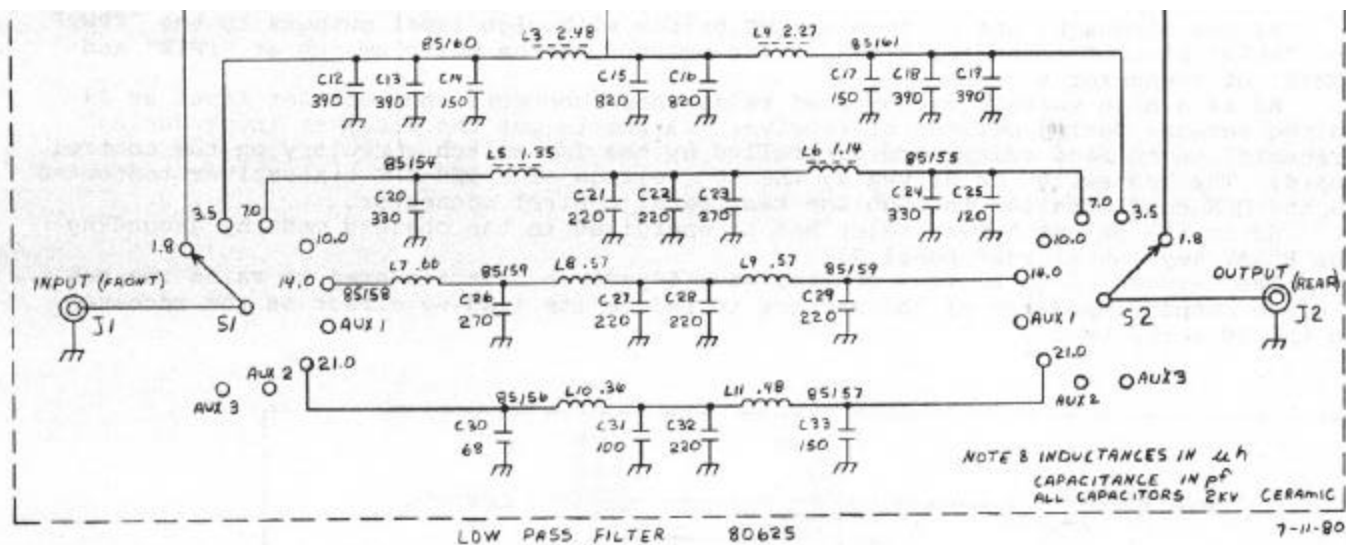
			QTY
C1,2,4,6	23006	CAP-FXD, 0.1MF, 250V, FILM, 20%	5
C3,7	23133	CAP-FXD, .001MF, 500V, CER, 5%, Z5F	2
Q1,2	25002	TRANSISTOR-POWER, MJE520	2
U1,2	25050	TRANSISTOR-MC1723CL	2
R16,24	30070	RFS-VAR, 1K, LIN, PC VERT MTG, 30%	2

LOW PASS FILTER 80625

The combined output of the final amplifier modules is linear only with regard to input/output power and not with respect to harmonic content. Although the push-pull design reduces even harmonics considerably, the odd harmonics are only about 13 dB below the fundamental and must be filtered out. In order to reduce both even and odd harmonics, the output signal is passed through a low pass filter of at least five poles before it is applied to the SWR/TR board and the antenna connector. The resulting output signal is well within FCC specifications for harmonic content.

As shipped from the factory, the Model 444 low pass filter section contains five filters switched for the following amateur bands: 160 meters (1.8-2.0 MHz), 80 meters (3.5-4.0 MHz), 40 meters (7.0-7.3 MHz), 20 meters (14.0-14.35 MHz), 15 meters (21.0-21.45 MHz). Auxiliary filter positions are provided on the low pass filter assembly for future amateur band expansion.

The positions of the filters on the L.P. filter assembly are intimately related to the arrangement of the programming diodes on the bandswitch assembly. Any changes made to either assembly should be double checked to make sure the amplifier will not



80626 LP FILTER FRONT

PARTS LIST

Part No.	Qty	Description	QTY
C30	23208	CAP-FXD, 68PF, 2KV, N750	1
C14	23212	CAP-FXD, 150PF, 2KV, N750	1
C26	23215	CAP-FXD, 270PF, 2KV, N1500	1
C1-3, 20	23216	CAP-FXD, 330PF, 2KV, N1500	4
C4, 12, 13	23217	CAP-FXD, 390PF, 2KV, N1500	3
J1	35062	RECEPTACLE-MOLEX PC PHONO	1
L7	85158	COIL-RF, AIR, 8 1/2T #14	1

80627 LP FILTER REAR

PARTS LIST

Part No.	Qty	Description	QTY
C11, 25	23211	CAP-FXD, 120PF, 2KV, N750	2
C17, 33	23212	CAP-FXD, 150PF, 2KV, N750	2
C29	23214	CAP-FXD, 220PF, 2KV, N1500	1
C24	23216	CAP-FXD, 330PF, 2KV, N1500	1
C18, 19	23217	CAP-FXD, 390PF, 2KV, N1500	2
C9, 10	23219	CAP-FXD, 820PF, 2KV, N2200	2
J2	35062	RECEPTACLE MOLEX PC PHONO	1

80628 LP FILTER, LEFT SIDE

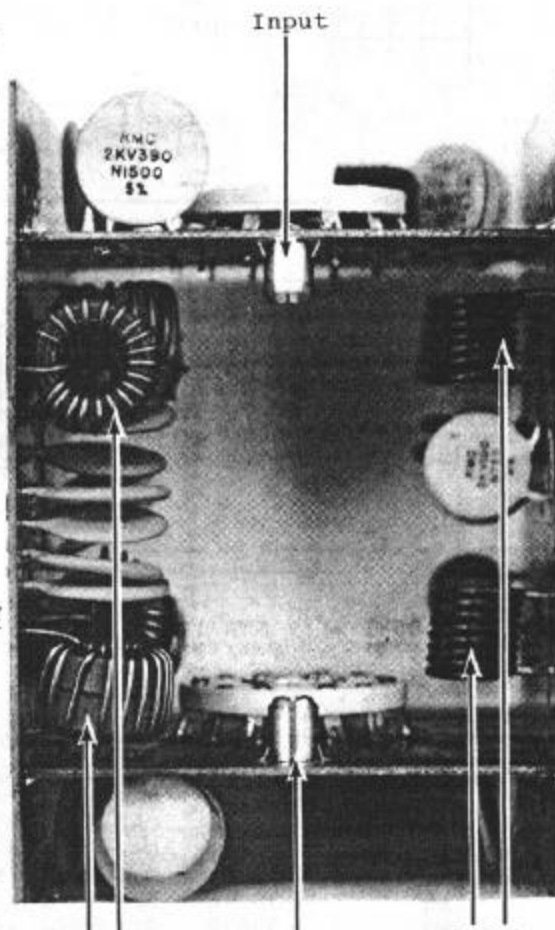
PARTS LIST

Part No.	Qty	Description	QTY
C31	23210	CAP-FXD, 100PF, 2KV, N750	1
C27, 28, 32	23214	CAP-FXD, 220PF, 2KV, N1500	3
L10	85156	COIL-RF 6 1/2T, #14, .75L AIR	1
L11	85157	COIL-RF, AIR, 7 1/2T, #14, .75L	1
L8, 9	85159	COIL-RF, AIR, 7 1/2T, #14	2

80629 LP FILTER, RIGHT SIDE

PARTS LIST

Part No.	Qty	Description	QTY
C21, 22	23214	CAP-FXD, 220PF, 2KV, N1500	2
C23	23215	CAP-FXD, 270PF, 2KV, N1500	1

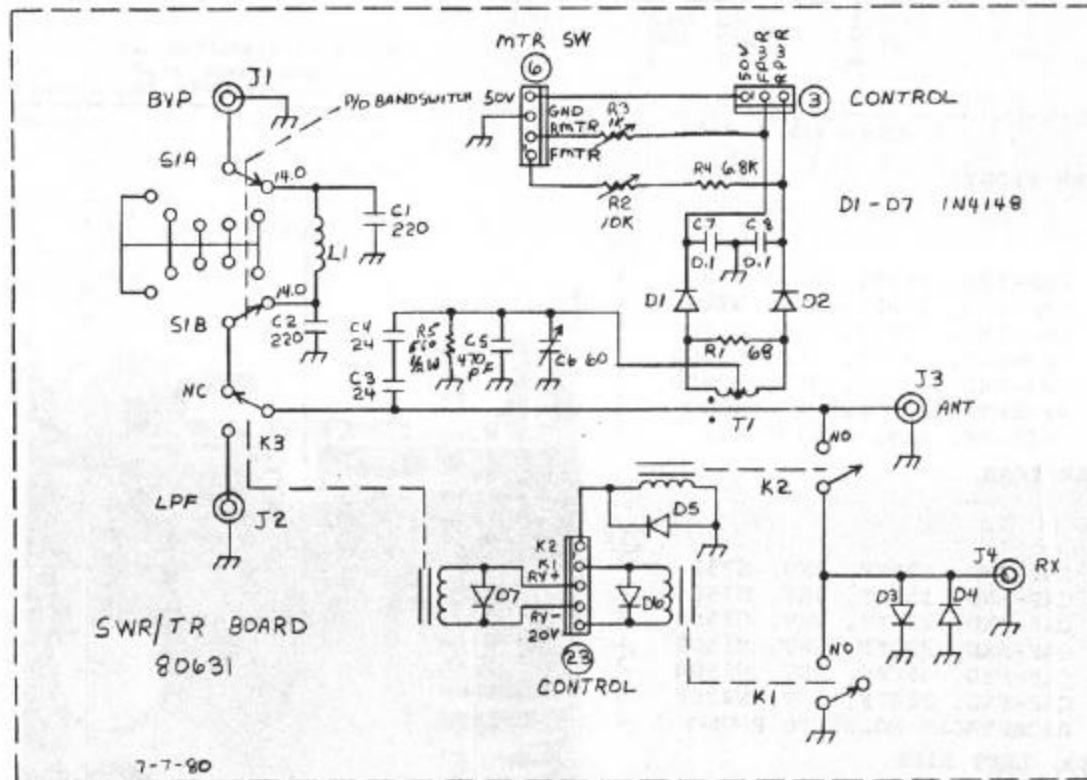


T1 and Diodes D1 and D2 form an SWR bridge with high level outputs to the "FPWR" and "RPWR" pins of connector 3 and scaled outputs to the meter switch at "FMTR" and "RMTR" of connector 6.

K2 is a high voltage vacuum reed relay which connects the receiver input at J4 to the antenna during periods of receive. K1 shorts out the receiver input during transmit. Both reed relays are controlled by the T/R switch circuitry on the control board. The T/R switch is driven by the "T" voltage of a TEN-TEC transceiver connected in the QSK configuration through the rear panel control connector.

K3 is the output bypass relay and is energized in the operate mode by grounding the RELAY keyline at rear panel J3.

The network C1-C2-L1 is a quarter wave impedance inverter used to raise the reflected output impedance of the exciter to reduce its loading effect on the receiver in the 20 meter band.

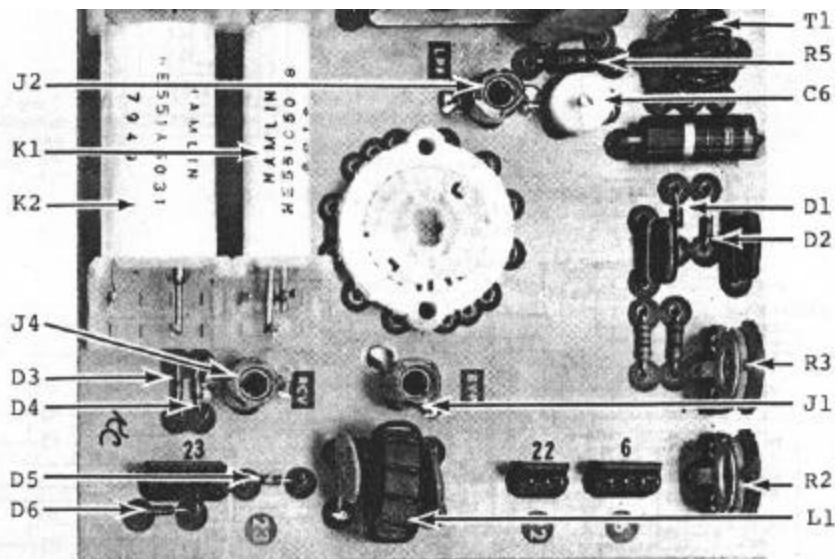


80631

SWR/TR BOARD

PARTS LIST

QTY	PARTS LIST	DESCRIPTION	QTY
2	C7,8	CAP-FXD, 0, 1MF, 250V, FILM, 20%	2
2	C6	CAP-VAR, 5/6PF, TRIMMER	2
1	C3,4	CAP-FXD, 24PF, 1KV, CER, 5%, N470	1
2	C1,2	CAP-FXD, 220PF, 1KV, CER, 5%, N1500	2
2	C5	CAP-FXD, 470PF, 100V, 5%, N2200	2
1	D1-7	DIODE-1N4148/1N914, SIL	1
7	R2	RES-VAR, 10K, LIN, PC MOUNT	7
1	R3	RES-VAR, 1K, LIN, PC VERT MTG, 30%	1



444 S POWER SUPPLY

The high voltage power supply section is a unique combination (Reg. U.S. Pat. Off. #1,134,503) of two different types of circuit. By combining a choke input supply with a series regulated supply, high efficiency is obtained at high line voltages, while a minimum output voltage is assured at low line voltages.

Rectifier bridges D1 and D4, in conjunction with choke L1 and capacitor C1, form a choke input supply with positive output at P3 Pin 8 and negative output at chassis ground through diodes D6 and D6.

Rectifier assemblies D2 and D3 are tapped down 13% on the transformer secondary and, together with the positive side of D1 and D4, form a full wave rectifier circuit which charges C2 to about 70 volts at high line voltage.

The voltage at the negative terminal of C2 (Pins 4 and 5 of P3) is the difference between the voltage on C1 (45-50V) and the voltage on C2 (56-70V). This voltage is always negative and ranges from 11 to 20 volts depending on line voltage.

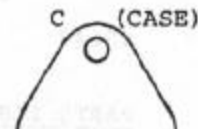
The power supply pass transistors Q1-Q5, driven by transistor Q6, operate on P3 pins 4 and 5. By pulling P3 pins 4 and 5 closer to ground potential, the pass transistors can boost the output voltage of the supply by up to 20 volts. The pass transistors are controlled by a voltage regulator on the regulator card which monitors the output voltage of the supply and drives Q6 into conduction when the output drops below 45 volts. The boost obtained from C2 and the pass transistors is sufficient to hold the output up to 42 volts at full load current and low line voltage.

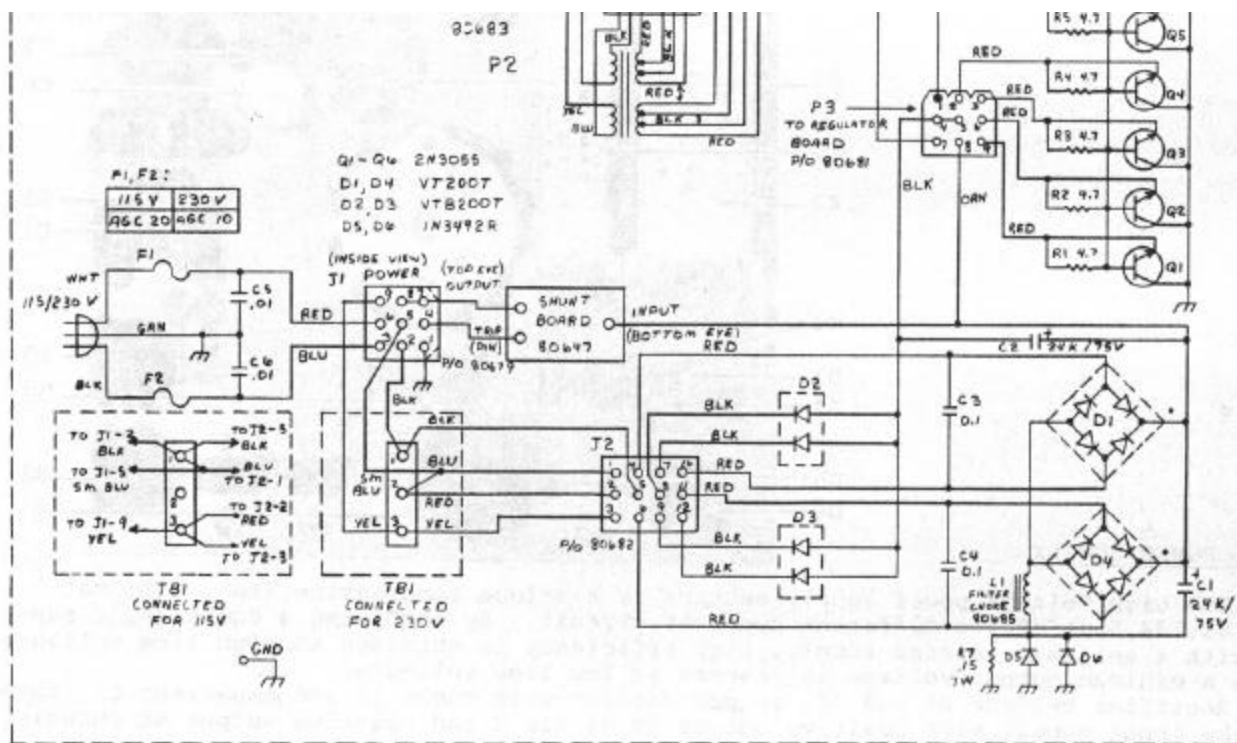
Transmit Conditions: Operate Mode, 500 watts output, 14.000 MHz. Receive Conditions: Operate Mode, QSK Configuration (Relay shorting plug installed, "T" line low).

POWER SUPPLY CHASSIS

Semiconductor Voltage Readings

Transistor	Collector		Base		Emitter	
	Transmit	Receive	Transmit	Receive	Transmit	Receive
Q1-5	0	0	-4	-18	-5.6	-18
Q6	0	0	-3.4	-17	-4	-18





REGULATOR BOARD 80648

This assembly contains a regulator circuit to stabilize the power supply output voltage, bleeder resistors to reduce no-load output, and ballast resistors to equalize currents in the pass transistors.

Integrated circuit U1 is a negative 24 volt three terminal regulator which supplies current to the base of the driver transistor Q6 to regulate the power supply output voltage to approximately 45 volts. U1 will pass current from its output (pin 2) to its input (pin 3) until the voltage between its common (pin 1) and output pin is greater than 24 volts. Part of the power supply output voltage at J3 pin 8 is applied to the common pin of U1 by divider R21, R22, R23. Therefore, if the supply output attempts to fall below 45 volts, U1 senses less than 24 volts at its output and conducts through R20 and the base of Q6, causing the pass transistors Q1-Q5 to conduct enough to hold the power supply output up to 45 volts. R22 sets the voltage at which this hold up action occurs.

Resistors R1-R10 establish a minimum load for the supply by shunting 1/2 amp to ground through diodes D1-D4. The drop across D1-D4 is used to bias U1's output 2.4 volts above ground to compensate for U1's dropout voltage and the V_{be} of Q6.

Resistors R13-R17 are emitter ballasts which provide degeneration to equalize the collector currents of pass transistors Q1-Q5.

Resistors R11 and R12 form the bleeder for chassis capacitor C2.

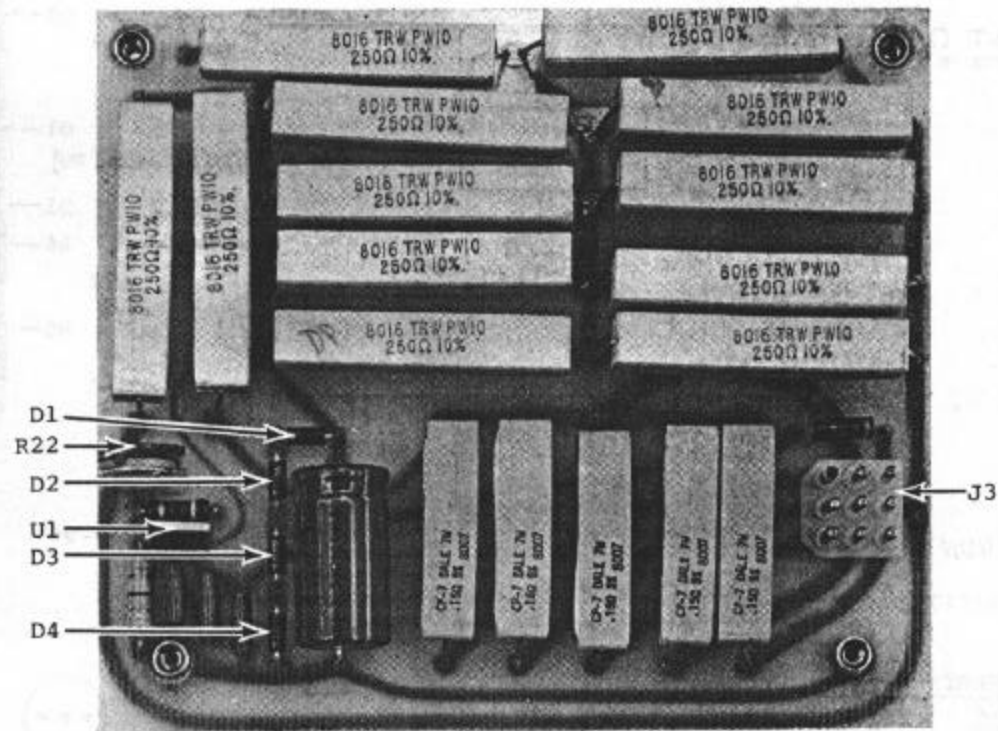
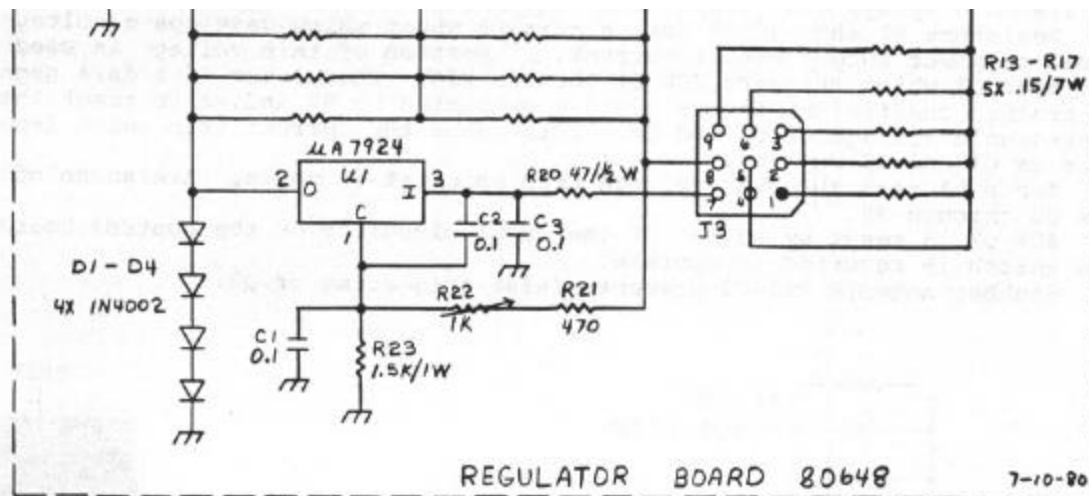
80648 REGULATOR BOARD

PARTS LIST

Q1 Q2 2N3055 CAB-PVD 0 1ME 250V RTLM 202

QTY

2

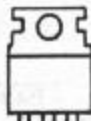


Transmit Conditions: Operate Mode, 500 watts output, 14.000 MHz. Receive Conditions: Operate Mode, QSK Configuration (Relay shorting plug installed, "T" line low).

REGULATOR BOARD

Semiconductor Voltage Readings

U1

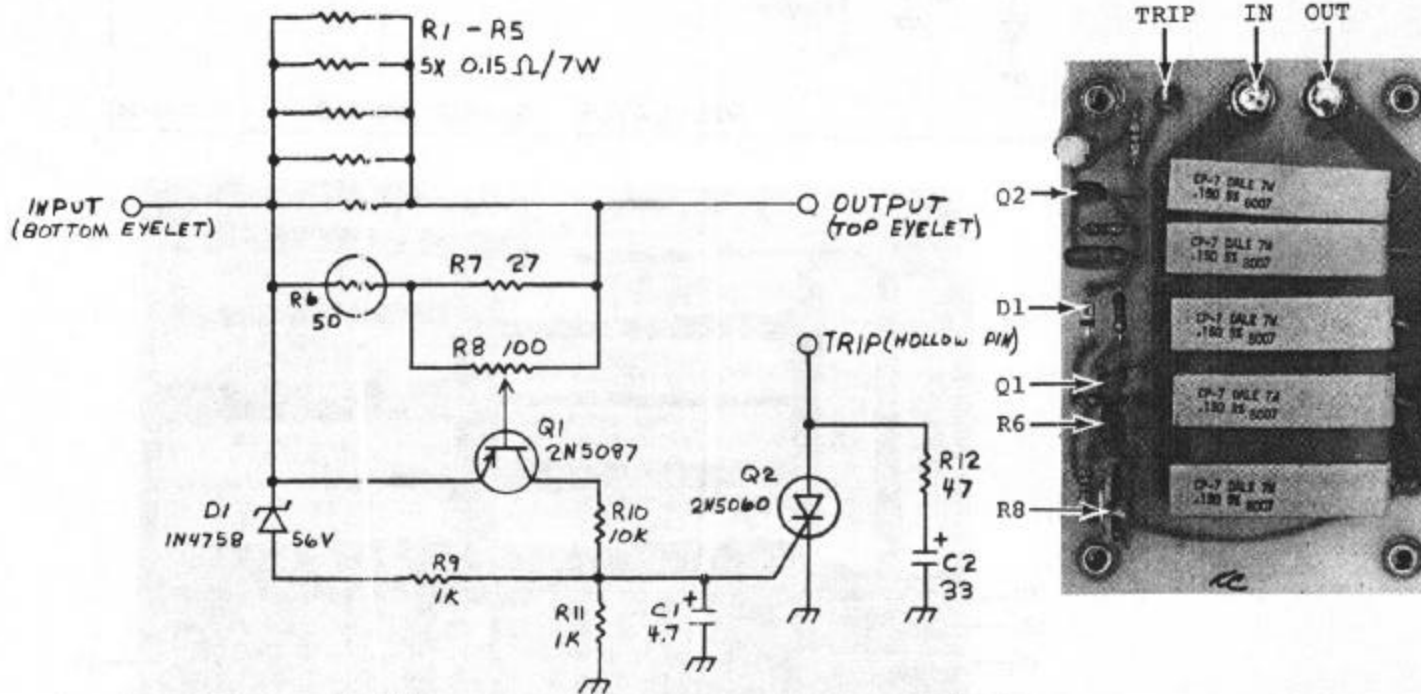


Resistors R1 through R5 form a current shunt which develops a voltage proportional to power supply output current. A portion of this voltage is used to forward bias Q1 which triggers SCR Q2 through R10. Thermistor R6 adds a negative temperature coefficient to the divider completed by R7 and R8 to track the drift of threshold voltage of Q1 and Q2. This keeps the current trip point from drifting lower as Q1 and Q2 warm up.

Zener D1 sets the over-voltage trip point at 56 volts. Avalanche of D1 triggers Q2 through R9.

SCR Q2 is reset by action of the reset circuitry on the control board when the mode switch is returned to operate.

Snubber network R12-C2 prevents false triggering of Q2.



SHUNT BOARD 80647

7-10-80

80647 SHUNT BOARD

PARTS LIST			QTY
C2	23182	CAP-FXD, 33MF, 16V, EL VERT	1
C1	23188	CAP-FXD, 4.7 MF, 25V, EL VERT	1
Q1	25001	TRANSISTOR-2N5087	1
Q2	25039	SCR-2N5060/C1034	1
D1	28037	DIODE-ZENER, 56V, 10%, 1N4758	1
R6	30052	RES-THERMISTOR, 50 OHMS, 20%, 1W	1
R8	30071	RES-VAR, 100, LIN, PC VERT, 30%	1



Semiconductor Voltage Readings

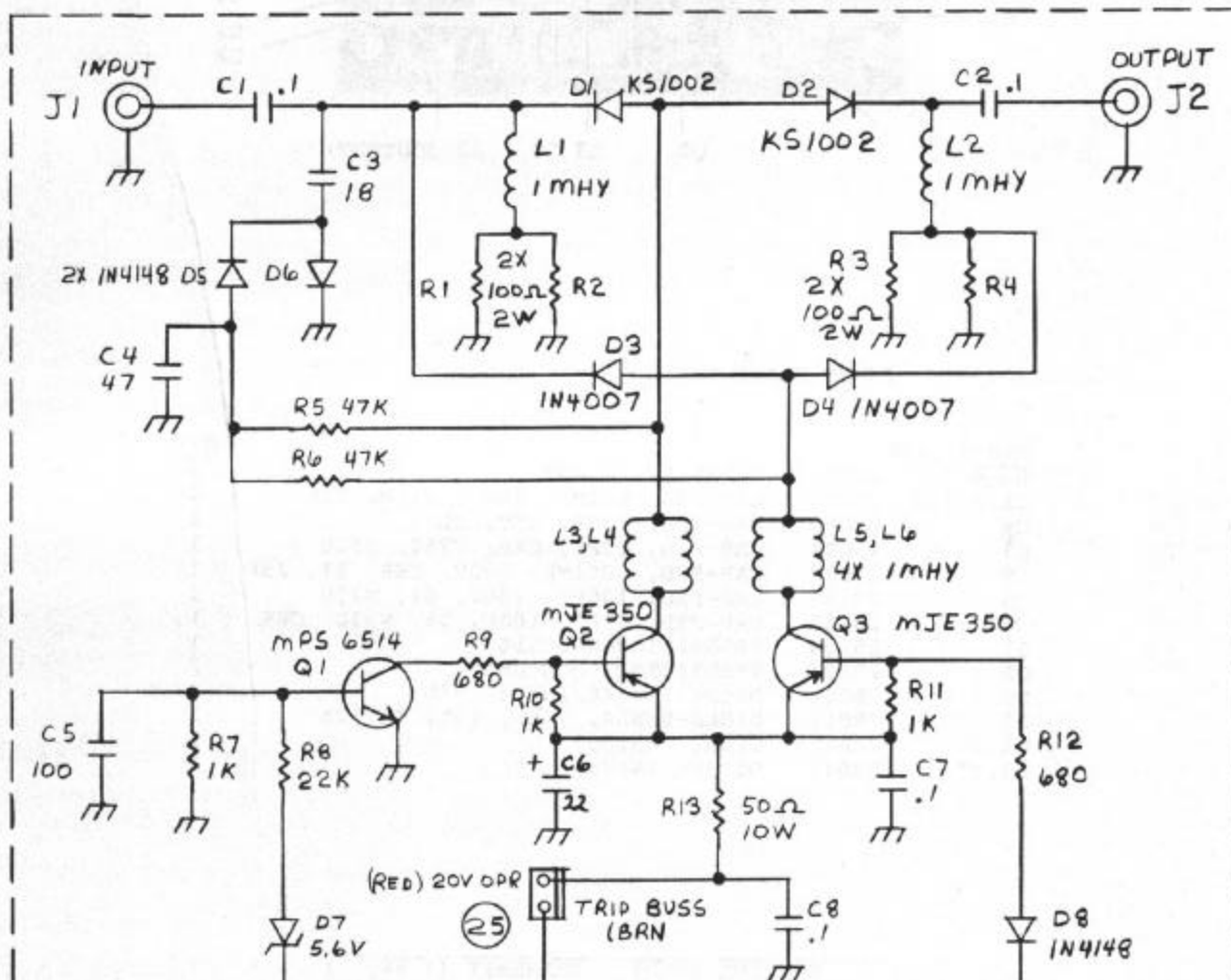
	Collector	Base	Emitter
Transistor	Transmit Receive	Transmit Receive	Transmit Receive

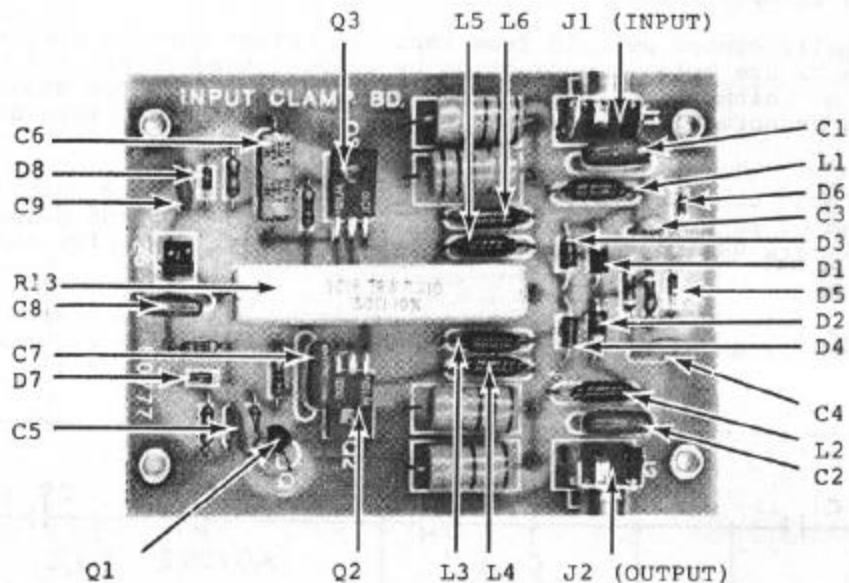
to remove drive from the final amplifiers in less than a millisecond after a fault condition is sensed. The input drive is diverted to a 50 ohm load for a few milliseconds until the amplifier bypass relays can drop out to connect the driver directly to the station antenna.

The normally closed path is from input to output through pin diodes D1 and D2. Diodes D1 and D2 are held in conduction by current through R13 and Q2. Q2 is biased on by Q1 which conducts whenever the trip buss is above about 7.5 volts. The trip buss is normally 16-20 volts unless a fault occurs, then drops to about 2 volts.

When a fault condition causes the trip line to fall to 2 volts, Q1 and Q2 are turned off and Q3 is biased on. Current through diodes D3 and D4 connects the input to resistors R3 and R4 which dissipate the drive power for about 10 milliseconds.

To assure that the diodes in the open path remain off, a small portion of the input rf is rectified by diodes D5 and D6 and applied as reverse bias through R5 or R6.

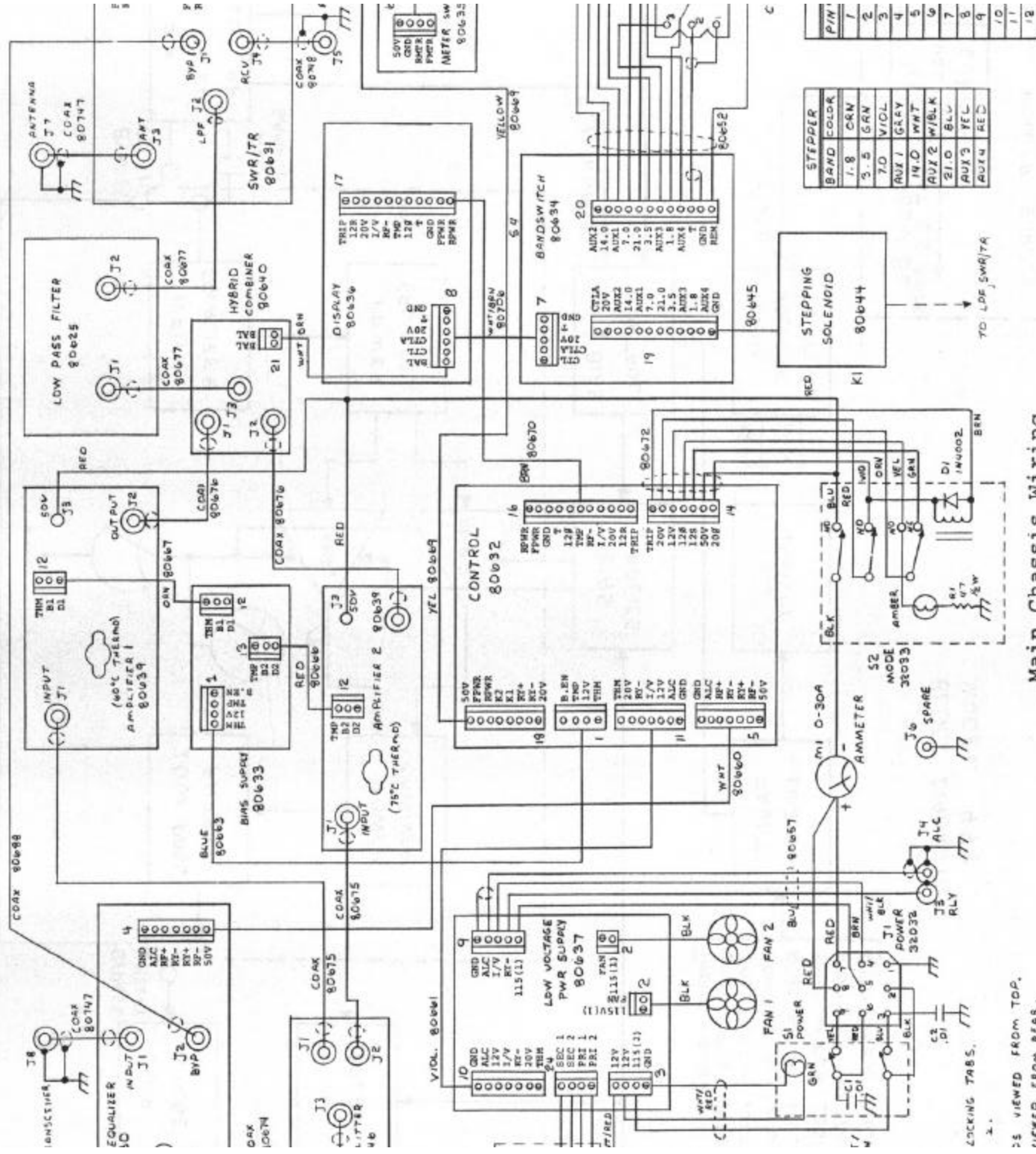




80631 INPUT CLAMP

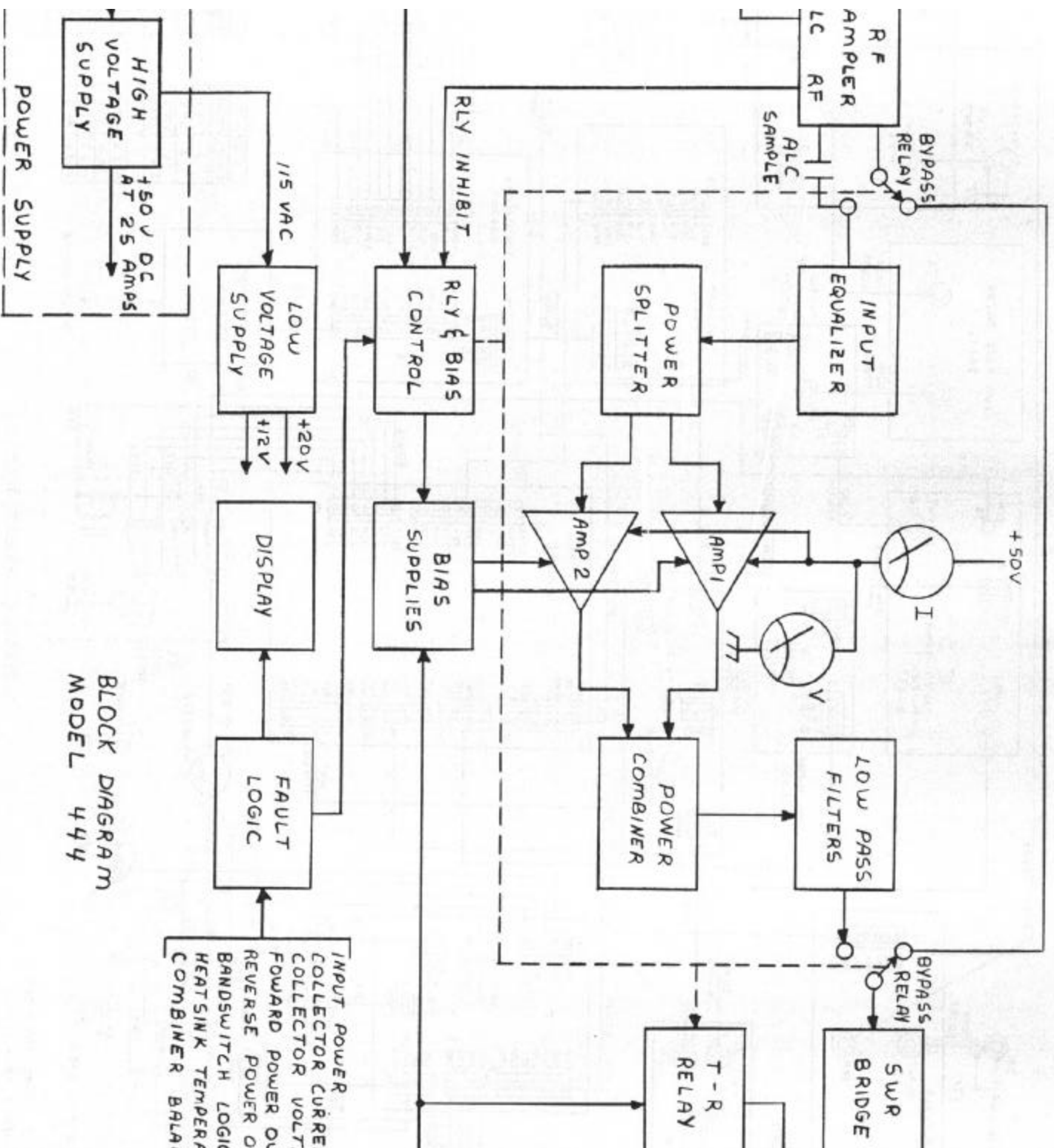
PARTS LIST			QTY
L1-6	21007	CHOKE-RF, 1 MHY	6
C1,2,7,8	23006	CAP-FXD, 0.1MF, 250V, FILM, 20%	4
C6	23060	CAP-FXD, 22MF, 35V, EL	1
C3	23091	CAP-FXD, 18PF, CER, N750, 500V	1
C9	23133	CAP-FXD, .001MF, 500V, CER, 5%, Z5F	1
C5	23139	CAP-FXD, 100PF, 100V, 5%, N750	1
C4	23152	CAP-FXD, 47PF, 500V, 5%, N330, CER	1
Q1	25054	TRANSISTOR-MPS6514	1
Q2,3	25104	TRANSISTOR, MJE-350	2
D5,6,8	28001	DIODE-1N4148/1N914, SIL	3
D7	28011	DIODE-ZENER, 5.6V, 10%, 1N752A	1
D1,2	28042	DIODE, KS1002	2
D3,4	28043	DIODE, 1N4007	2

RECEIVE (OPR) TRANSMIT (1 kW)



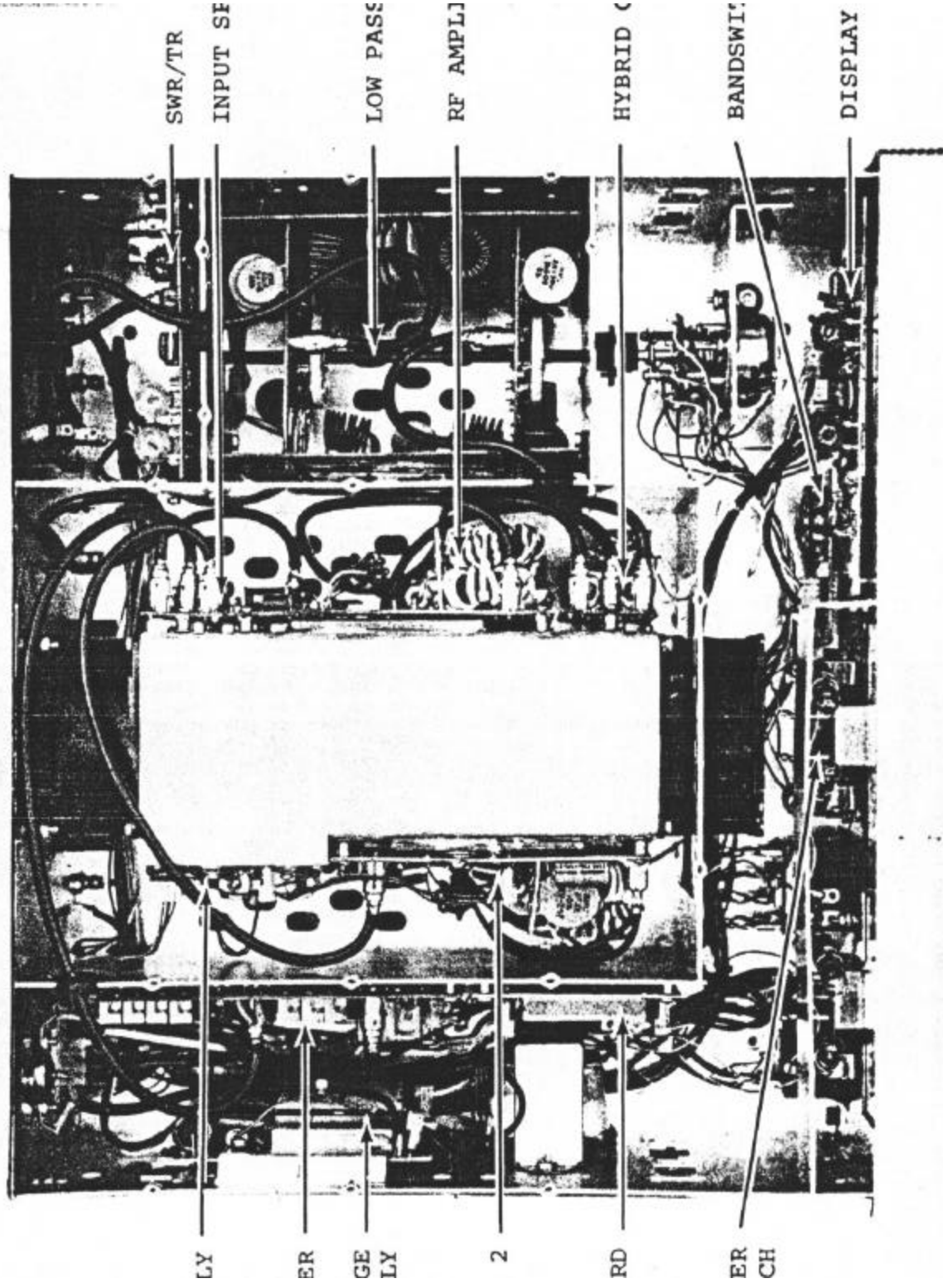
Main Chassis Wiring

25 VIEWED FROM TOP.
VIEWED FROM REAR.

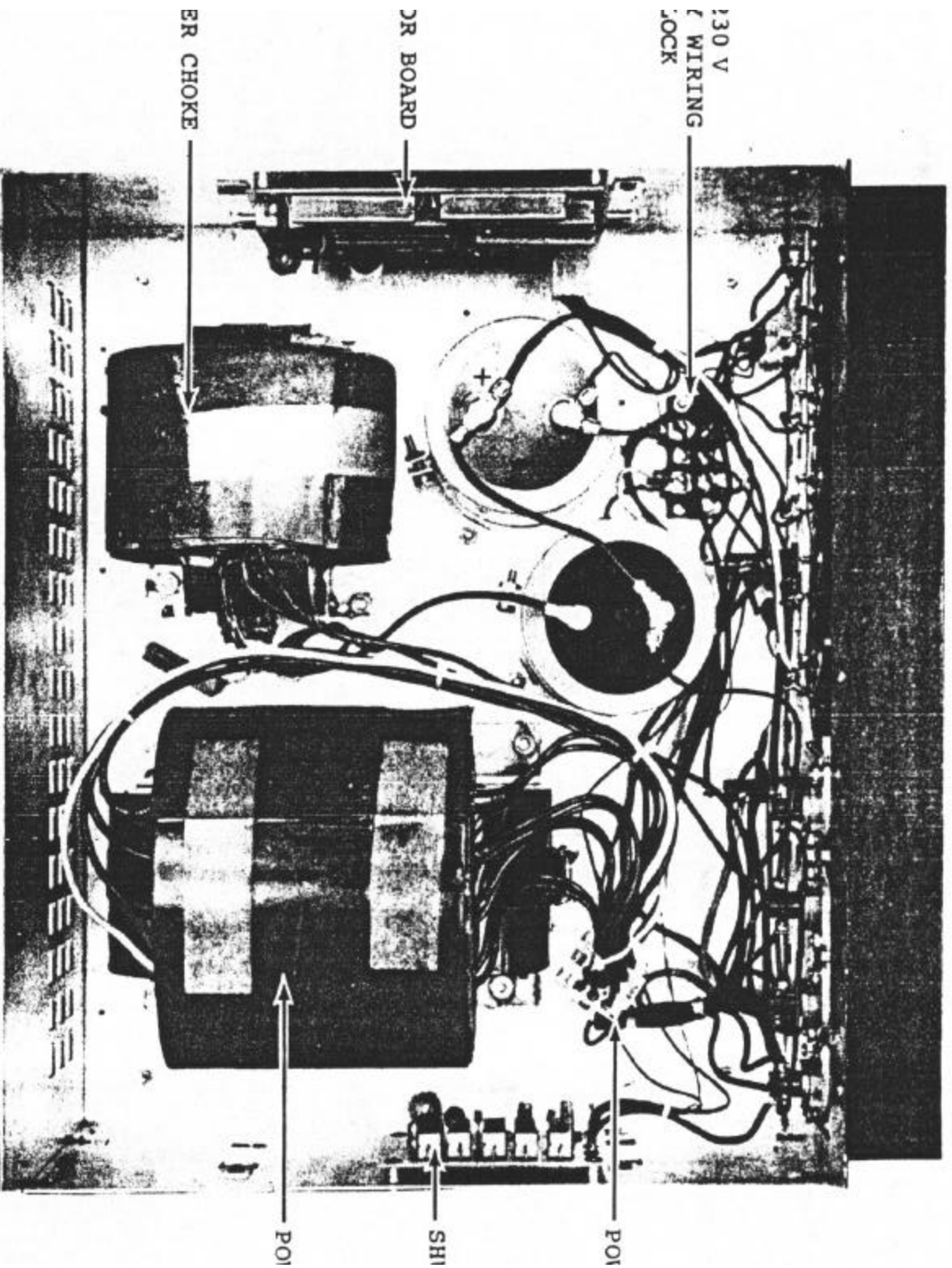


BLOCK DIAGRAM
MODEL 444

INPUT POWER
COLLECTOR CURRE
COLLECTOR VOLT
FORWARD POWER O
REVERSE POWER O
BANDSWITCH LOGIC
HEATSINK TEMPERA
COMBINER BALA



MODEL 444-TOP VIEW
 RF COMPARTMENT COVER REMOVED



MODEL 444S-TOP VIEW