MODULAR POWER SUPPLIES

MODELS 63005C AND 63315D

OPERATING AND SERVICE MANUAL FOR:
MODEL 63005C, SERIALS 1528A-00101 AND ABOVE
MODEL 63315D, SERIALS 1528A-00101 AND ABOVE

*** For serials above 1528A-00101 a change page may be included.**

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SECTION I
GENERAL INFORMATION

1-1 DESCRIPTION

1-2 The two power supplies covered by this manual employ switching regulation for high efficiency and compactness. Both models have a maximum output power of 110 watts. In the Model 63005C, this power is delivered by a single 5V ±0.25V output with a 22-amp load capacity. The Model 63315D also provides an adjustable 5V output and, in addition, a pair of dual tracking outputs that can be set within a ±11.4 to ±15.75V range by a single screwdriver adjustment. The Model 63315D's three outputs have individual current restrictions of 18 amps, 2 amps, and 2 amps, respectively, and within these limits can be operated at any combination of currents that does not exceed the supply's 110W total output rating. (See Figure 3-5 for the load sharing tradeoff for the Model 63315D.)

1-3 Both models are SCR preregulated and use an advanced design 20kHz transistor switching regulator for their 5V outputs. The ±11.4 to ±15.75V outputs of the Model 63315D have two independent linear transistor series regulators.

1-4 Adjustable foldback current limit circuits protect all outputs against overload or short circuit damage by limiting the outputs to between 65% and 130% of their maximum ratings. Fixed overvoltage protection crowbar circuits are activated at 6 to 7 volts on the 5V output and at 16 to 18 volts on the ±11.4 to ±15.75V outputs. They reduce all outputs to less than 2 volts if any one output exceeds its trip voltage.

1-5 The 5V and ±11.4 to ±15.75V outputs are isolated from the chassis and from each other and may be grounded to the ground terminal provided or floated at up to 42 volts above ground.

1-6 SPECIFICATIONS

1-7 Table 1-1 lists detailed specifications for these power supplies.

1-8 Accessories

1-9 Accessories are available for mounting these supplies in a standard 19-inch equipment rack. Consult the factory for information.

1-10 INSTRUMENT AND MANUAL IDENTIFICATION

1-11 Hewlett-Packard power supplies are identified by a two-part serial number. The first part is the serial number prefix, a number-letter combination that denotes the date of a significant design change and the country of manufacture. The first two digits indicate the year (10=1970, 11=1971, etc.), the second two digits indicate the week, and the letter "A" designates the U.S.A. as the country of manufacture. The second part is the power supply serial number; a different sequential number is assigned to each power supply, starting with 00101.

1-12 If the serial number on your instrument does not agree with those on the title page of the manual, Change Sheets supplied with the manual or Manual Backdating Changes define the differences between your instrument and the instrument described by this manual.

1-13 ORDERING ADDITIONAL MANUALS

1-14 One manual is shipped with each power supply. Additional manuals may be purchased from your local Hewlett-Packard field office (see list at rear of this manual for addresses). Specify the model number, serial number prefix, and HP Part number provided on the title page.

Table 1-1. Specifications, Models 63005C and 63315D

INPUT: 87/127Vac or 180-250Vac, single-phase, 48-63Hz. Voltage range field changeable on terminal block. Internally fused at 5A. AC INRUSH CURRENT: Less than 20A peak at turnon.	LOAD EFFECT: Less than 0.1% for a load current change equal to the current rating of the supply. SOURCE EFFECT: Less than .02% for any change within the specified input voltage rating.

Table 1-1. Specifications, Models 63005C and 63315D (Continued)

OUTPUT:
Model 63005C: 5V ±0.25V, 22A
Model 63315D: 5V ±0.25V, 18A*
+11.4 to +15.75V, 2A*
−11.4 to 15.75V, 2A*
(Screwdriver voltage adjustments are accessible through holes in the panel.)
*Maximum load currents cannot be obtained simultaneously. See Figure 3-5 for load sharing tradeoff.

TRACKING ACCURACY (Model 63315D dual output):
±2%.

PARD (Ripple and Noise):
All outputs: Less than 5mV rms and 40mV p-p (20Hz to 20MHz).

EMI CHARACTERISTICS:
Conducted EMI complies with VDE 0875/7.71, Level N.

SAFETY STANDARDS:
Designed to conform to recommendations of IEC 348. Approved by UL for inclusion in their Recognized Component Index under Guide QQFU2, File E51529.

DIELECTRIC WITHSTAND VOLTAGE:
Primary to case, 1500V rms for 1 minute.
Primary to output(s), 1500V rms for 1 minute.
Output(s) to case, 500 Vdc for 1 minute.

INSULATION RESISTANCE:
At least 10 megohms from any output to case or from 5V output to ±12 to ±15V outputs.

LOAD TRANSIENT RECOVERY:
Less than 1.0msec (5V output) or 25μsec (±12 to ±15V outputs) for output recovery to within 1% of nominal output voltage following a load change from full to half load or vice versa.

CARRYOVER TIME:
Output voltage remains within 2% of specified nominal for more than 20msec while delivering full load current following removal of ac input power.

TEMPERATURE COEFFICIENT:
Less than .015% output voltage change per degree Celsius over the operating range from 0 to 40°C at constant load and line voltage after 30 minutes warmup.

TEMPERATURE RANGES:
Operating: 0 to 40°C ambient. For temperatures greater than 40°C, output current must be derated linearly to 50% of maximum at 70°C ambient.
Storage: −55°C to +85°C.

COOLING:
Convection cooled. (In some applications, can be conduction cooled through surface at end of case after removing finned heatsink. Consult factory for recommendations.)

THERMAL PROTECTION:
Heatsink-mounted thermostat shuts off output(s) if supply overheats due to high ambient temperature. Thermostat automatically resets when unit cools to safe operating temperature.

CURRENT LIMIT PROTECTION:
Accessible screwdriver adjustment(s) are factory set to limit load current to approximately 120% (5V output) or 130% (±12 to ±15V outputs) of rated maximum current. Foldback current limit characteristics are shown in Figures 3-6 and 3-7. Adjustment range is approximately 65 to 130% of rated load current in Model 63005C and 65 to 150% in Model 63315D.

OVERVOLTAGE PROTECTION:
Non-adjustable overvoltage crowbar reduces output(s) to less than 2V when trip level of 6 to 7V is exceeded at the 5V output or 16 to 18V is exceeded on either 12 to 15V output. In the Model 63315D, an overvoltage trip at any one output shuts down all three outputs.

REVERSE VOLTAGE PROTECTION:
Output(s) are protected from damage due to the application of a reverse polarity voltage.

REMOTE SHUTDOWN:
A contact closure or TTL (low) input between the 5V output's (−) or (− SEN) terminal and terminal E6 reduces all supply outputs to zero volts. The outputs return to normal on opening the contact or switching to a high logic level.

REMOTE SENSING:
Remote sensing terminals are provided which will correct for a load lead voltage drop of up to 5% while maintaining nominal voltage at the load. The load is protected if sensing leads are inadvertently opened.

DIMENSIONS:
Refer to Figure 2-1 or 2-2.

WEIGHT (Net/Shipping):
Model 63005C: 3.2kg (7 lbs)/4.1kg (9 lbs)
Model 63315D: 4.1kg (9 lbs)/5.0kg (11 lbs)

SECTION II
INSTALLATION

2-1 INITIAL INSPECTION

2-2 Before shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the instrument is unpacked, inspect for any damage that may have occurred in transit. Save all packing materials until the inspection is completed. If damage if found, a claim should be filed with the carrier immediately. Also, a Hewlett-Packard Sales and Service office should be notified.

2-3 Mechanical Check

2-4 This check should confirm that there are no broken connectors and that the panel surfaces are free of dents and scratches.

2-5 Electrical Check

2-6 The instrument should be checked against its electrical specifications. Section V includes an "in-cabinet" performance check to verify proper instrument operation.

2-7 INSTALLATION DATA

2-8 The instrument is shipped ready for permanent installation or bench operation. It is necessary only to connect the instrument to a source of power and it is ready for operation.

2-9 Location and Cooling

2-10 This instrument is air cooled. Sufficient space should be allotted so that a free flow of cooling air can reach the instrument when it is in operation. At least 1/2 inch clearance at the bottom of the unit is recommended to permit proper air flow. The supply should be used in an area where the ambient temperature does not exceed 40°C. If operated at an ambient greater than 40°C, the supply's output current must be linearly derated down to 50% at 70°C.

2-11 It is also possible to cool this supply through conduction by removing its finned heatsink and mounting the rear surface of the supply to a suitable heat-conducting surface. Consult the factory for specific recommendations.

2-12 Mounting Orientation

2-13 Figures 2-1 and 2-2 show outline and dimension information. As shown in these figures, four mounting holes are provided on the bottom of the supply and four more are available at the rear if the heat sink is removed. If these supplies are cooled by natural convection, the upright position is the only orientation recommended. If they are cooled by forced air or if the heatsink is removed and the supply is mounted to a heat-conducting surface, they may be mounted in any position.

2-14 Input Power Requirements

2-15 The Models 63005C and 63315D may be operated from an 87 to 127Vac or a 180 to 250Vac, single-phase, 48 to 63Hz power source and can be adapted for either of these input voltage ranges by the positioning of jumpers on terminals E1 through E5 on TB1. For 87 to 127V operation, jumper E1 to E2 and E4 to E5. For 180 to 250V operation, jumper E3 to E4 only. (When it is shipped, the supply's input jumpers are connected for 87 to 127Vac operation.) Both models draw a maximum input current of 4 amps. The maximum input power is 190 watts for the Model 63005C and 220 watts for the Model 63315D.

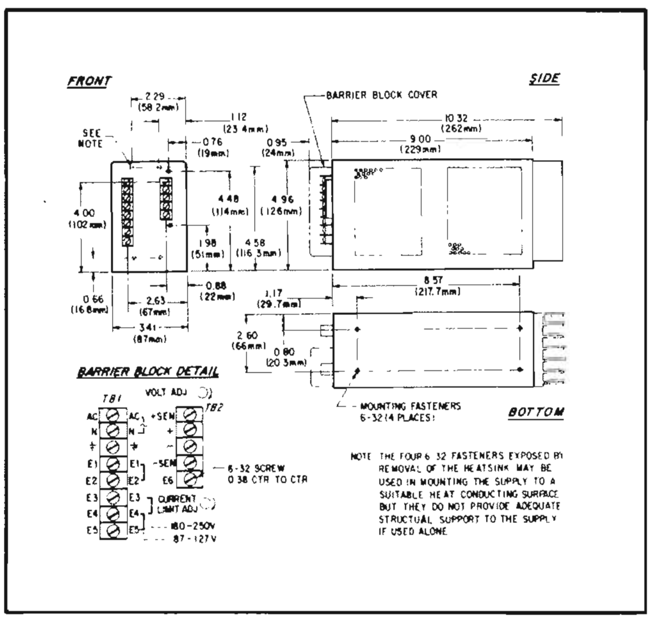


Figure 2-1. Outline Diagram, Model 63005C

2-16 REPACKAGING FOR SHIPMENT

2-17 To insure safe shipment of the instrument, it is recommended that the package designed for the instrument be used. The original packaging material is reusable. If it is not available, contact your local Hewlett-Packard field office to obtain the materials. This office will also furnish the address of the nearest service office to which the instrument can be shipped and provide the Authorized Return label necessary to expedite the handling of your instrument return. Be sure to attach a tag to the instrument which specifies the owner, model number, full serial number, and service required, or a brief description of the trouble.

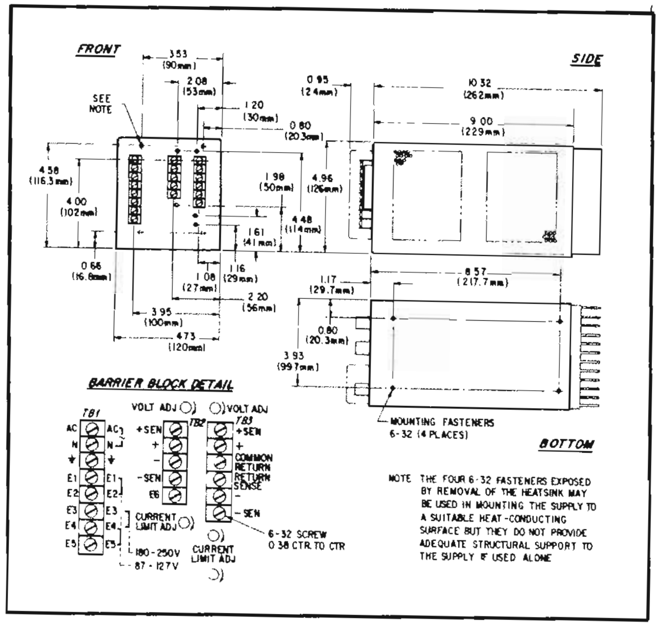


Figure 2-2. Outline Diagram, Model 63315D

SECTION III
OPERATING INSTRUCTIONS

3-1 TURN-ON CHECKOUT PROCEDURE

3-2 The following checkout procedure serves as a brief check that the supply is operational. This procedure or the more detailed performance test of paragraph 5-6 should be followed when the instrument is received and before it is connected to any load equipment.

PREPARATION

a. Before connecting input power, check that jumpers on terminals E1 through E5 of TB1 are connected appropriately for the ac supply voltage to be used. (See paragraph 2-16.)

b. Connect all remote sensing terminals to the corresponding output terminals as shown in Figure 3-1.

c. Connect unit to input power source using AC, N, and ground (⏚) terminals of TB1.

VOLTAGE CHECKS

d. Check the voltage of the 5V output between terminals (+) and (−) on TB2 and, using a small screwdriver to turn the VOLT ADJ control, set the output to the desired value within its 4.75 to 5.25V range.

e. (Model 63315D only). Check the voltages of the positive and negative 11.4 to 15.75V outputs by measuring from (+) to COMMON RETURN and from COMMON RETURN to (−) on TB3. They should differ from each other by no more than ±2%. Turn the VOLT ADJ control to set these outputs to the desired voltage.

CURRENT LIMIT CHECKS

f. To check the operation of the current limit circuit for the 5V output, connect the test setup shown in Figure 5-2 to the output, using a variable load resistor for R_L that can be adjusted from about 0.15Ω to about 0.5Ω. The load resistor must be able to dissipate 110 watts. Set R_L to its maximum resistance and apply power to the supply. Decrease the resistance of R_L gradually while observing the output current indicated by the DVM. The current should increase to some maximum value, which is the current limit setting, and then begin to decrease. To adjust the current limit setting, see paragraph 5-46.

g. (Model 63315D only). Check the operation of the current limit circuit for the positive 11.4 to 15.75V output by the method described in (f) above, but using a variable load resistor with an adjustment range of about 4Ω to 15Ω and a 50W power rating. Repeat for the negative output. To adjust the current limit settings, see paragraph 5-46.

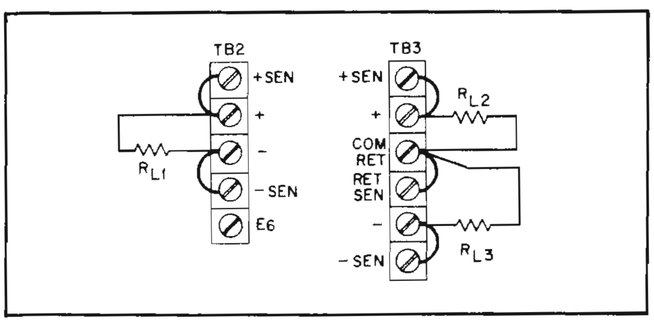


Figure 3-1. Load Connections, Local Sensing

OVERVOLTAGE PROTECTION CHECKS

h. Because the supply's output voltage adjustment ranges are limited and the overvoltage trip circuits are not adjustable, checking the overvoltage trip circuits requires the use of an external power supply. The supply needed for checking the overvoltage trip for the 5V output should be able to supply 5 to 7 Vdc at a current of at least 2 amps. To avoid causing damage to the supply under test, the external supply's maximum available current should be no more than 5 amps. To check that the overvoltage trip circuit for the 5V output is operational, energize the external supply and adjust its output to 7 volts. Energize the 63005C or 63315D supply and then momentarily connect the output of the external supply across its 5V output terminals, negative to negative and positive to positive. After disconnecting the external supply, check for the presence of voltage at the outputs of the supply under test. All outputs should be at zero volts. Deenergize the supply under test for 10 seconds and then restore power. Check that all outputs have returned to normal.

i. (Model 63315D only). A similar method is used for checking the ±11.4 to ±15.75V outputs of the Model 63315D. An external supply is needed that can provide 15 to 18 Vdc at a current of at least 0.5 amps. Its maximum available current should be no more than 5 amps. To check the overvoltage trip circuit for the positive 11.4 to 15.75V output, energize the external supply and adjust its output to 18 volts. Energize the 63315D supply and then momentarily connect the output of the external supply across the (+) and COMMON RETURN output terminals of the 63315D, positive to positive. After disconnecting the external supply, check that all outputs of the supply under test have dropped to zero volts and that deenergizing the supply for 10 seconds restores the outputs to normal.

j. (Model 63315D only). To check the overvoltage trip circuit for the negative 11.4 to 15.75V output, repeat the procedure given in step (i) above, except connect the external supply across the (–) and COMMON RETURN output terminals of the 63315D, negative to negative.

REMOTE SHUTDOWN

k. Verify that connecting a jumper between terminals E6 and (– SEN) on TB2 reduces all outputs of the supply to zero volts and that disconnecting the jumper restores all outputs to their normal voltages.

3-3 If this brief checkout procedure or later use of the supply reveals a possible malfunction, see Section V of this manual for detailed test, troubleshooting, and adjustment procedures.

3-4 OPERATION

CAUTION

Before applying power to the supply, make certain that jumpers E1 through E5 on TB1 are connected appropriately for the ac line voltage to be used.

3-5 The following paragraphs discuss the various operating modes and features of the Model 63005C and 63315D supplies. Their 5V outputs can be used with local or remote voltage sensing. The ±11.4 to ±15.75V outputs of a Model 63315D supply can be used as a dual output supplying positive and negative voltages or they can be connected to provide a single output providing 22.8 to 31.5 volts. Local or remote sensing can be used with both the dual and single load connections. The 5V outputs of two single output supplies can be connected in parallel and two or more of them can be connected in series.

3-6 The DC Power Supply Handbook, Application Note 90A, contains a considerable amount of general information on using regulated dc power supplies effectively and is available at no charge from your local HP sales office.

3-7 Connecting Loads

3-8 Figure 3-1 shows the strapping arrangement for connecting loads to the supply using local voltage sensing and supplying two separate loads from the ±11.4 to ±15.75V outputs. The positive (master) supply powers R_{L2} and the negative (slave) supply powers R_{L3}. As the VOLT ADJ control for the dual outputs is adjusted, the slave supply's output tracks that of the master within ±2%. Either terminal of the 5V output and any one terminal of the dual output may be grounded, if desired, either at the supply's ground (⏚) terminal or at the load. (See paragraph 3-12.)

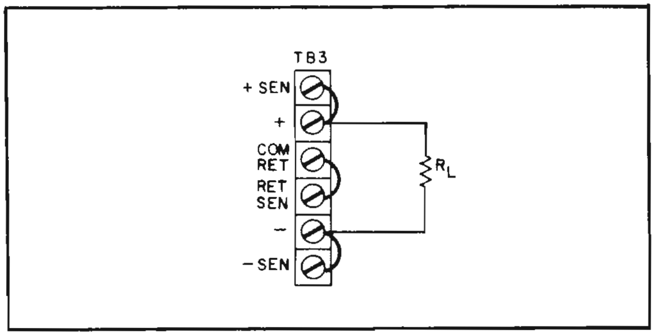


Figure 3-2. Single Load, Local Sensing

3-9 To use the dual outputs to supply 22.8 to 31.5 volts to a single load, use the strapping arrangement shown in Figure 3-2. Either the (+) or (–) output terminal may be grounded, as required. (See paragraph 3-12.)

3-10 Each load should be connected to the proper supply output terminals using separate pairs of connecting wires. This will minimize mutual coupling effects between loads and will retain full advantage of the low output impedance of the supply. Each pair of connecting wires should be as short as possible, should be of adequately heavy gage, and should be twisted or shielded to reduce noise pickup. If shield is used, connect one end to the power supply ground terminal and leave the other end unconnected.

3-11 If load considerations require that the output power distribution terminals be remotely located from the power supply, then the power supply output terminals should be connected to the remote distribution terminals by a pair of twisted or shielded wires and each load separately connected to the remote distribution terminals. Remote sensing should be used under these circumstances. (See paragraph 3-14.)

3-12 Grounding

3-13 The 5V output can be used either as a positive or a negative supply by grounding one of its output terminals or one end of the load.

WARNING

Ground at only one point in the setup and always use two wires to connect the load to the supply. This eliminates the possibility of load current return paths through the ac ground line which could open the chassis ground path and create a hazardous condition.

This supply can also be operated at up to 42 Vdc above ground, if neither output bus is grounded.

3-14 Remote Sensing

3-15 Remote sensing is used to maintain good regulation at the load by reducing the degradation in regulation that would occur due to the voltage drop in the leads between the power supply and the load. For reasonable load lead lengths, remote sensing greatly improves the performance of the supply. However, if the load is located a considerable distance from the supply, added precautions must be observed to obtain satisfactory operation. Because the voltage drop in the load leads subtracts directly from the available output voltage, it is recommended that the total drop in both load leads not exceed 5% of the supply's nominal output voltage.

3-16 The leads from the sensing terminals to the load carry much less current than the load leads, so these leads need not be as heavy as the load leads. However, they must be twisted or shielded to minimize noise pickup.

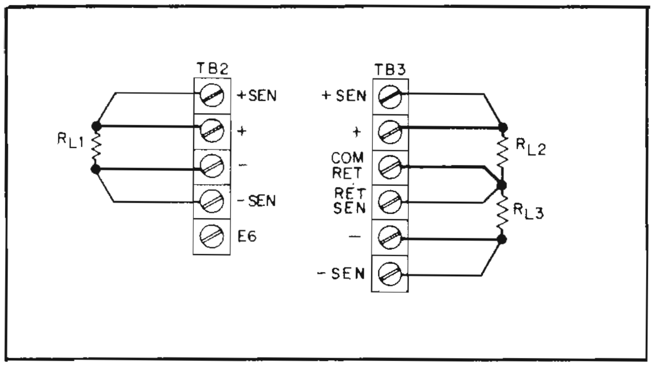


Figure 3-3. Load Connections, Remote Sensing

3-17 Figure 3-3 shows the strapping arrangement for connecting loads to the supply using remote sensing. When the loads on the dual outputs of a Model 63315D are located a considerable distance from each other, the COMMON RETURN load lead and the RETURN SENSE lead should be connected together at a remote sensing point that is equidistant from the two loads. This ensures that the regulation characteristics of both outputs will be equal.

3-18 Figure 3-4 shows the connections necessary for powering a single load from the dual output using remote sensing. The (+ SEN) and (– SEN) sensing leads should be connected as close as possible to the load.

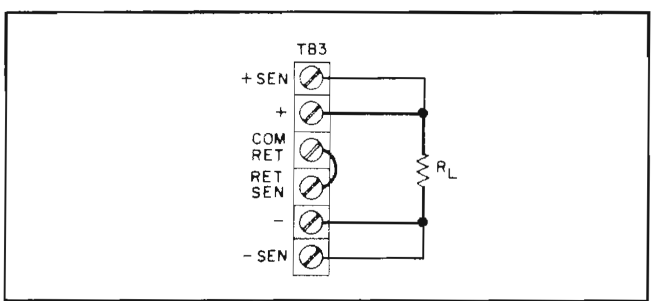


Figure 3-4. Single Load, Remote Sensing

3-19 Output Ratings

3-20 **Model 63005C.** The Model 63005C is capable of providing 22 amps at 5V ±0.25V at ambient temperatures up to 40°C. Above 40°C, the output current must be linearly derated to 50% at the maximum operating temperature of 70°C.

3-21 **Model 63315D.** Individually, the maximum output currents of the Model 63315D are 18 amps at the 5V ±0.25V output and 2 amps at each of the 11.4 to 15.75V outputs. These maximum currents are not available simultaneously, though, due to the 110W total output rating of the supply. Figure 3-5 illustrates the load sharing tradeoff between the 5V and the ±11.4 to ±15.75V outputs. Above 40°C, these output currents must be linearly derated to 50% at the maximum operating temperature of 70°C.

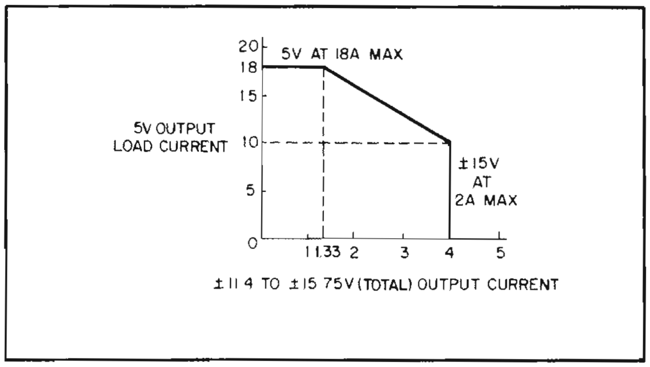


Figure 3-5. Load Sharing Tradeoff, Model 63315D

3-22 Current Limiting

3-23 The current limiting characteristics of these supplies are shown in Figures 3-6 and 3-7. The current limit circuits in these supplies provide foldback limiting, which reduces the output current as the voltage decreases. This results in a short-circuit current that is less than the maximum available at the rated output voltage. The circuits are self-restoring and return the output voltage to normal when the overload is removed. Figures 3-6 and 3-7 show the approximate factory settings and adjustment ranges for the current limiting circuits. Changing the setting of the control affects the maximum output current as shown but has no effect on the short circuit current. Procedures for adjusting the operating points of the current limit circuits are given in paragraph 5-46.

3-24 When adjusting the current limit, ensure that the new set point is at least 20% above the expected operating current. Operating the supply too close to the current limit set point may degrade performance.

3-25 Since, in the dual outputs of the Model 63315D, the voltage of the slave (negative) supply depends on that of the master (positive) supply, the occurance of current limiting in the master supply reduces the voltage of both outputs. If a single load is connected across both outputs as shown in Figures 3-2 and 3-4, the initial current limit point is determined by the current limit circuit with the lower setting and the short circuit current is governed by the master supply.

3-26 Overvoltage Protection

3-27 Each output of this supply has an independent fixed crowbar circuit to protect sensitive loads from excessive voltages. The circuit for the 5V output is activated between 6 and 7 volts and the ones for the dual outputs of the Model 63315D are activated between 16 and 18 volts. After a crowbar circuit fires, all outputs of the supply fall to zero volts. To restore normal operation after an overvoltage shutdown has occurred, ac power must be removed from the supply for at least 10 seconds. If the crowbar trips again when power is restored, refer to the troubleshooting information in Section V of this manual.

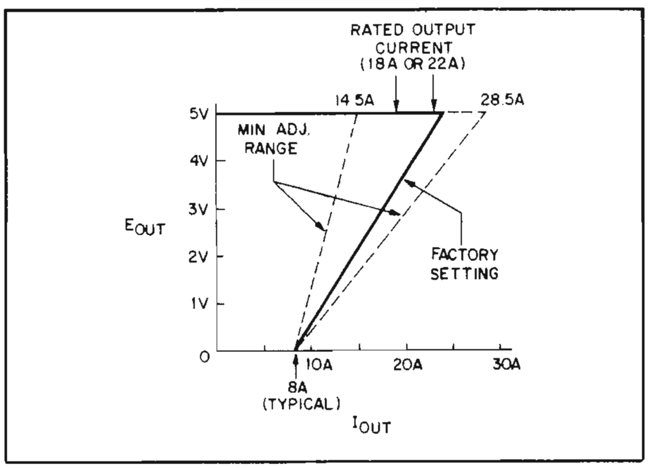


Figure 3-6. 5V Output, Current Limit Characteristics

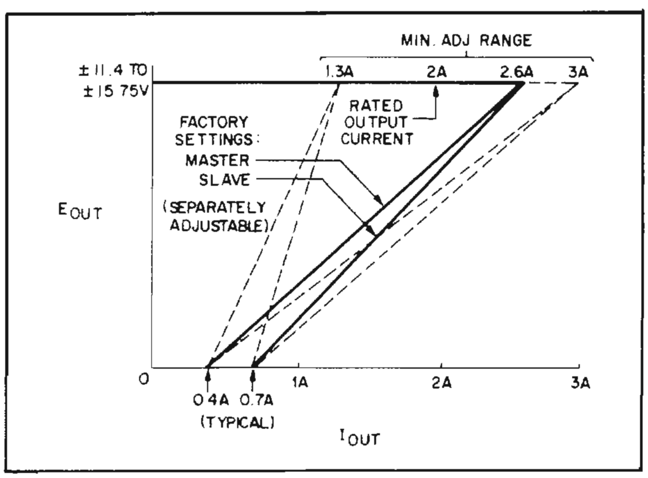


Figure 3-7. Model 63315D, Dual Output, Current Limit Characteristics

3-28 Remote Shutdown

3-29 If remote control of the power supply is required, all outputs of the supply can be operated remotely through a contact connected from terminal E6 on TB2 to either the (–) or the (– SEN) terminal of the 5V output. Closing this contact reduces all outputs to zero volts; opening it restores all output voltages to normal.

3-30 The remote shutdown input can also be controlled by a TTL digital input signal. Use the (–) or (– SEN) terminal of the 5V output as the common input and apply TTL logic levels to terminal E6. A low logic level shuts down the supply; a high logic level input resotres the outputs.

3-31 Parallel Operation

3-32 The 5V outputs of two Model 63005C supplies can be operated in parallel. Set the output of one supply to the desired voltage, and set the other supply for a slightly higher voltage. The supply set to the lower output voltage will act as a constant voltage source, while the supply set to the higher output will act as a current-limited source, dropping its output voltage until it equals that of the other supply The constant voltage source will deliver only that fraction of its total rated output current which is necessary to fulfill the total current demand.

3-33 Series Operation

3-34 Either the 5V or the ±11.4 to ±15.75V outputs of two or more supplies can be connected in series to obtain a higher voltage than is available from a single supply. The restriction against operating these supplies with their outputs at a potential greater than 42 volts above ground limits the number which can be connected in series.

3-35 Notice that series operation creates the possibility of a reverse voltage being applied across the output terminals of a deenergized supply that is in series with an energized one. If this occurs, the resulting reverse current flows through A2U4 in the 5V supply or diodes A3CR1 or CR16, which protect the ±15V outputs against reverse voltage.

CAUTION

When operating these supplies in series, turn them on and off simultaneously if possible. If this cannot be done, ensure that all units are turned on or off within 25 seconds to minimize the possibility of damage to the output diodes.

SECTION IV
PRINCIPLES OF OPERATION

4-1 INTRODUCTION

4-2 This section presents the principles of operation for the Models 63005C and 63315D switching-regulated modular power supplies. The Model 63005C single-output supply employs just two of the circuit boards shown in the simplified schematic of Figure 4-1, A1 and A2. The A1 board contains an SCR preregulator whose dc output is filtered to provide a regulated 100V dc input to a single-transistor switching regulator. On the A2 board, the 20kHz output from a switching regulator transformer secondary is rectified and filtered to produce a regulated 5V dc output at a maximum current of 22 amps. Also on the A2 board are the voltage control, output current limit, and over-voltage protection circuits for the 5V output.

4-3 In the Model 63315D, A1 and A2 boards very similar to those in the Model 63005C produce a 5V output with a maximum current rating of 18 amps, and an additional A3 board contains a dual linear regulator which produces two tracking outputs with an output voltage range of ±11.4 to ±15.75 volts at a maximum current of 2 amps. The maximum load currents for the ±15V (nominal) outputs and the 5V output cannot be obtained simultaneously but are interdependent as shown in Figure 3-5. The ±15V outputs draw power from two additional secondaries on the 20kHz switching regulator transformer and are regulated by two series-transistor regulators connected in a master-slave configuration. These outputs are individually protected against overcurrent and overvoltage. An overvoltage condition at any one of the supply's three outputs shuts down all three outputs.

4-4 SIMPLIFIED SCHEMATIC DIAGRAM DISCUSSION

4-5 The following discussion of the overall circuit operation of the Models 63005C and 63315D is based on the simplified schematic of Figure 4-1.

4-6 AC-DC Converter Assembly (A1 Board)

4-7 **Preregulator.** The ac input to the A1 board is connected through an RFI filter directly to the input of a preregulator bridge composed of two diodes and two SCRs. The firing angle of the SCRs is controlled by the preregulator control circuit so that their full-wave rectified output, after being filtered by a 2-section LC filter, averages 100 volts dc. The preregulator control circuit consists of a comparator-amplifier which compares the voltage at its input to a zener reference voltage and controls the firing delay of a programmable unijunction transistor in the firing circuit. During each half-cycle of the ac line input, one output pulse from the unijunction is coupled to the SCR gates by pulse transformer A1T1. If the 100V output tends to increase, the comparator-amplifier reduces the conduction angle of the SCRs. If the voltage tends to decrease, the conduction angle is increased. The reset switch discharges the timing capacitor in the firing circuit at the end of each half-cycle of the ac line input.

4-8 The supply is designed for two ac line voltage ranges (87 to 127Vac and 180 to 250Vac) and can easily be converted from one to the other by changing jumper positions on terminals E1 through E5 on an external terminal block.

4-9 **20kHz Switching Regulator.** The supply's 5V output is regulated by a single-transistor switching regulator connected in series with the 100V output of the pre regulator and the primary winding of power transformer A2T2, on the A2 board. The 5V output is regulated by controlling the percentage of the time that switching transistor A1Q5 conducts. The transistor's switching rate is controlled by an IC timer in the 20kHz clock circuit. The on-time of the switching transistor is controlled by a pulse width modulator located on the A2 board.

4-10 The clock establishes the basic timing cycle for the regulator by generating an alternating sequence of switching transistor turn-on and turn-off pulses which are conducted to the base of A1Q5 through pulse transformer A1T2. The maximum duty cycle of the switching transistor is 60%. Each time that a turn-on clock pulse switches A1Q5 on, a base drive pulse produced by a regenerative bias winding of A2T2 keeps A1Q5 on until a turn-off signal appears.

4-11 Following each clock turn-on pulse, there are three signals that can turn off the switching transistor. They are:

1. a voltage control pulse from the pulse width modulator,
2. a primary peak current limit pulse from a current limit comparator in the switching regulator,
3. a turn-off pulse from the clock.

The first of these three signals to appear after each clock turn-on pulse turns A1Q5 off until the next clock turn-on pulse initiates the next operating cycle.

4-12 Normally, it is the voltage control pulse that turns off A1Q5. An optically coupled isolator in its signal path provides electrical isolation between primary and secondary circuits. The timing of this pulse controls the voltage of the 5V output. A tendency for the output voltage to decrease is compensated by an increase in the delay between the clock turn-on pulse and the subsequent turn-off pulse from the pulse width modulator. If the output tends to increase, the delay is reduced. Slow turn-on control, output current limit, and remote shutdown signals are also communicated through this path from the A2 board. The generation of these signals is covered in the discussion of the A2 board.

4-13 The second switching transistor turn-off signal listed in paragraph 4-11 is produced by a fixed current limit comparator that monitors the peak current through A1R37 during each pulse that A1Q5 conducts and immediately turns off A1Q5 if this current exceeds a preset level. This current limit circuit on the primary side of the transformer serves as a backup to the protection provided by an adjustable output current limit circuit on the secondary side. The primary peak current limit circuit has a higher set point than the one on the secondary side and functions solely to protect the switching transistor.

4-14 The third turn-off signal listed in paragraph 4-11, the clock turn-off pulse, limits the maximum on-time of A1Q5 to 30 microseconds of each 50μsec operating cycle to avoid transformer saturation.

4-15 Between the time a turn-off signal ends A1Q5's conduction interval and the time the clock turn-on pulse turns A1Q5 on again, the collapsing field of transformer A2T2 generates a current pulse in a flyback winding which CR18 conducts to return this energy to capacitor A1C13 at the input to the switching regulator. This keeps the transformer core out of saturation by resetting it before the next operating cycle begins.

4-16 The clock receives its +14.7V operating bias from a shunt zener regulator composed of R21 and VR2. An

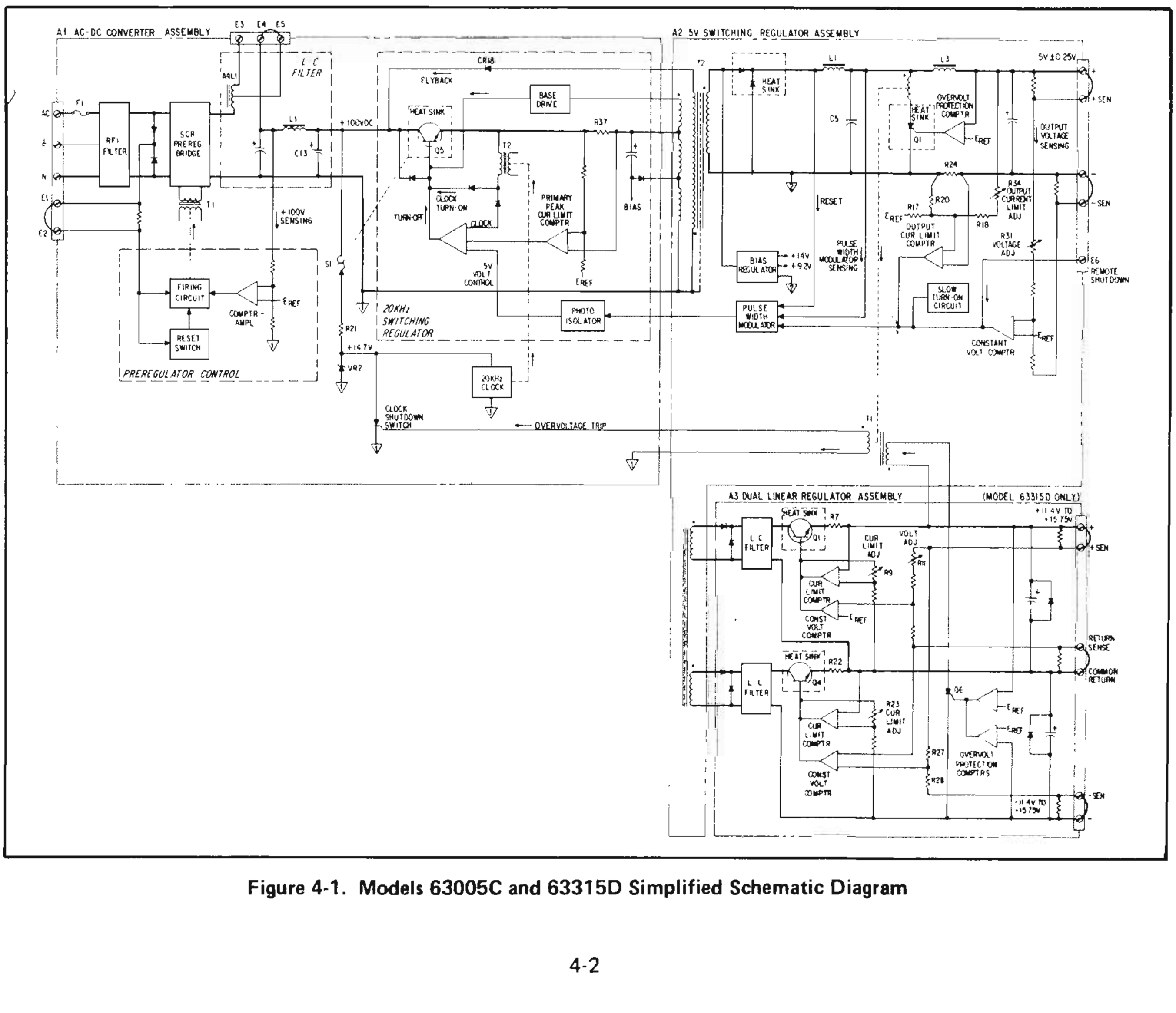


Figure 4-1. Models 63005C and 63315D Simplified Schematic Diagram

excessive A1Q5 switching transistor heatsink temperature opens thermal switch S1 to interrupt the 100V supply to the clock bias regulator. This stops the clock to leave A1Q5 safely turned off. S1 remains open until the heatsink has cooled to a safe operating temperature.

4-17 In case of an overvoltage condition at the 5V output of the Model 63005C or at any of the outputs of the triple output model, an overvoltage trip pulse fires an SCR connected as a clock shutdown switch which shorts the 14.7V bias supply to the clock to shut down the switching regulator.

4-18 5V Switching Regulator Assembly (A2 Board)

4-19 On the A2 board, the 20kHz ac voltage at one secondary of switching regulator power transformer A2T2 is half-wave rectified and then filtered by a 2-section LC filter to provide a regulated 5V dc output. This board also contains circuits that regulate the output voltage, turn on the switching regulator slowly when power is first applied, limit the output current, and shut down the supply if an overvoltage occurs at the 5V output. The output voltage regulation, slow turn-on, and output current limit functions are controlled through input signals to the pulse width modulator, whose output is transmitted through the optically coupled isolator on the A1 board to the switching transistor.

4-20 Voltage Regulation. Each output pulse from the pulse width modulator causes switching transistor A1Q5 in the switching regulator to stop conducting. Thus, the output voltage is regulated by controlling the duration of Q5's conduction intervals. The pulse width modulator controls the timing of its output pulses by comparing two input signals. One of them is a dc level received from the output of the constant voltage comparator. This signal varies depending on the difference between the supply's output voltage and that of a fixed reference. An increase in the supply's output voltage changes this dc level in the negative direction. The pulse width modulator compares this dc level to a combined dc and ripple signal taken from the output of the first section of the LC filter.

4-21 When the clock on the A1 board turns A1Q5 on, the positive voltage at the secondary of transformer A2T2 begins charging A2C5 through inductor A2L1. The positive-going ramp voltage waveform on these capacitors and the dc level from the constant voltage comparator are both attenuated and applied to two inputs of a comparator within the pulse width modulator. The pulse width modulator's output pulse to the isolator is produced each time the dc plus ripple voltage input from A2C5 exceeds the dc level input from the constant voltage comparator. The input pulse to the isolator turns on a light emitting diode (LED) which turns on a phototransistor. When the phototransistor conducts, it turns off switching transistor A1Q5.

4-22 Now that A1Q5 has been turned off, the negative-going voltage at the input to inductor A2L1 resets the pulse width modulator for the next operating cycle, which begins when the clock turns on A1Q5 again.

4-23 If the voltage at the 5V output tends to decrease, the dc level input to the pulse width modulator increases. As a result, it takes slightly longer for the ramp waveform of the ripple voltage to exceed this higher dc level at the comparator inputs. Thus, the delay before A1Q5 is turned off is increased slightly to increase A1Q5's conduction time and compensate for the decreased output.

4-24 Slow Turn-on Control. The slow turn-on control circuit prevents an output voltage overshoot from occuring and actuating the overvoltage trip circuit when ac power is first applied to the supply. The circuit consists of an r-c network that slows down the initial rise in voltage of the dc level input to the pulse width modulator from the constant voltage comparator. This causes the switching regulator to bring up the output voltage smoothly to its nominal value.

4-25 Output Current Limiting. The 5V output is protected against an overload or short circuit by an adjustable foldback current limit circuit which reduces the output voltage and current as an overload increases. The current limit characteristics of the 5V output are shown in Figure 3-6 or 3-7. To obtain these current limit characteristics, the output current limit comparator compares the voltage developed across current sampling resistor R24 to a reference voltage developed across R20. When the voltage across R24 exceeds this reference, the output of the comparator reduces the dc level input to the pulse width modulator to reduce the supply's output. The resulting reduction in output voltage decreases the contribution made to the reference voltage across R20 by current from the positive output line through R34 and R18. This reduces the output current limiting point as the output voltage decreases. If the output is short-circuited, the circuit reduces the output current to the value determined by the reference voltage developed by the current through R17 alone. For this reason, output current limit adjust R34 affects the maximum output current while leaving the short-circuit current fixed.

4-26 Remote Shutdown. A contact closure or TTL input signal applied between remote shutdown terminal E6 and either the negative output or the negative sensing terminal of the 5V supply reduces all outputs of the supply to zero. This input signal shuts down the outputs by lowering the dc level input to the pulse width modulator. The outputs of the supply return to normal on removal of the remote shutdown input signal.

4-27 **Overvoltage Protection.** An overvoltage protection circuit monitors the 5V output and fires SCR A2Q1 if the voltage exceeds a preset trip level of 6 to 7 volts. When A2Q1 fires, it immediately discharges the filter capacitors across the 5V output to reduce the output to less than 2 volts. At the same time, a current pulse from A2T1 fires the clock shutdown switch SCR on the A1 board to remove power from the clock and shut off A1Q5. This reduces all output voltages to zero. In order to restore the supply to operation, its ac input must be removed for a minimum of 10 seconds and then reapplied.

4-28 Dual Linear Regulator Assembly (A3 Board) (Model 63315D only)

4-29 Two series-transistor regulators on the A3 board provide dual tracking outputs of ±11.4 to ±15.75 volts. The input power to these regulators is obtained from two additional secondary windings of transformer A2T2 and is half-wave rectified and filtered on the A3 board.

4-30 **Voltage Regulation.** The regulators for the positive and negative outputs are similar except that the one for the positive output compares its output voltage to that of a zener reference while the one for the negative output compares the voltage at the COMMON RETURN output terminal to the voltage at the junction of two equal resistors, A3R27 and A3R28, which are connected across the positive and negative outputs. This is why the output voltage of the negative (or slave) supply matches that of the positive (or master) supply within a ±2% tolerance and a single voltage adjustment control, A3R11, controls both outputs. The constant voltage comparators regulate the outputs of the supply by controlling the conductance of series regulator transistors A3Q1 and A3Q4.

4-31 **Output Current Limiting.** A current limit comparator for each regulator monitors the voltage drop across current sampling resistor R7 or R22 and compares it to an adjustable reference voltage across R9 or R23 that is derived from the regulator's output. If the voltage drop across the current sampling resistor exceeds the reference voltage, the comparator's output signal to the series regulator causes the output voltage and current to be reduced. This reduction in the output voltage reduces the current limit circuit's reference voltage to produce the foldback current limit characteristic shown in Figure 3-8. Because of the dual tracking interconnection between the positive and negative supplies, the output voltages of both are reduced if the positive output is overloaded.

4-32 **Overvoltage Protection.** To protect loads on the ±15V outputs against overvoltage, an overvoltage protection comparator monitors each output and fires an SCR connected across the ±15V outputs if either exceeds the preset trip level of 16 to 18 volts. When SCR A3Q6 fires, it shorts the ±15V outputs and simultaneously sends an overvoltage trip pulse through A2T1 to the clock shutdown switch on the A1 board to shut down the clock. Thus an overvoltage condition at any of the triple output supply's three outputs will shut down the entire supply.

SECTION V
MAINTENANCE

5-1 INTRODUCTION

5-2 Upon receipt of the power supply, the performance test of paragraph 5-6 can be made. This test is suitable for incoming inspection. Section III contains a quick but less comprehensive checkout procedure which can be used in lieu of the performance test if desired.

5-3 If a fault is detected in the power supply while making the performance test or during normal operation, proceed to the troubleshooting procedure in paragraph 5-27. After troubleshooting and repair, repeat the performance test to ensure that the fault has been properly corrected and that no other faults exist. Before performing any maintenance check, turn on the power supply and allow a half-hour warm-up.

5-4 TEST EQUIPMENT REQUIRED

5-5 Table 5-1 lists the test equipment required to perform the various procedures described in this section.

5-6 PERFORMANCE TEST

5-7 The following test can be used as an incoming inspection check and appropriate portions of the test can be repeated to check the operation of the instrument after repairs. The tests are performed using the specified nominal input voltage for the unit. If the correct result is not obtained for a particular check, proceed to troubleshooting (paragraph 5-27).

CAUTION

Before applying power to the supply, make certain that jumpers E1 through E5 on TB1 are connected appropriately for the ac line voltage to be used.

Table 5-1. Test Equipment Required

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Digital Voltmeter	Sensitivity: 100μV full scale (min.). Input impedance: 10 megohms (min.).	Measure DC voltages: calibration procedures	HP 3450A
Variable Voltage Transformer	Range: 90-130Vac Equipped with voltmeter accurate within 1 volt	Vary AC input	------
Oscilloscope	Sensitivity: 5mV/cm. Bandwidth: 20MHz (min.) Differential input	Display transient response and ripple and noise waveforms.	HP 180A with 1821A, and 1801A or 1803A plug-ins.
Repetitive Load Sw.	Rate: 60Hz, 2μsec rise and fall time	Measure transient response.	See Figure 5-4
Resistive Loads	Tolerance: ±5%	Power supply load resistor (fixed resistor or rheostat).	James G. Biddle ("Lubri-Tact" Rheostat)
Current Sampling Resistor (Shunt)	Accuracy: 1%	Measure 5V output current; Measure ±15V output current	Empro Shunt, A-50-50; 0.1Ω resistor HP No. 0811-2061

5-8 General Measurement Techniques

5-9 Connecting Measuring Devices. To achieve valid results when measuring the load effect, PARD (ripple and noise), and transient recovery time of the supply, measuring devices must be connected across the supply's sensing terminals. If a measurement were made across the load, it would include the impedance of the leads to the load. This impedance can easily be several orders of magnitude greater than the supply impedance, and would thus invalidate the measurement. To avoid mutual coupling effects, each measuring device must be connected directly to the supply's sensing terminals by separate pairs of wires.

5-10 Output Current Measurements. Accurate output current measurements can be made by inserting a low resistance current sampling resistor in series with a load resistor of appropriate resistance and wattage. Table 5-1 recommendes two four-terminal resistors suitable for use as current sampling resistors for the 5V and ±15V outputs. Figure 5-1 shows a four-terminal meter shunt. The load current through a shunt must be fed to the extremes of the wire leading to the resistor while the sampling connections are made as close as possible to the resistance portion itself.

NOTE

Output current limiting would interfere with accurate measurements of the supply's performance. Avoid current limiting by making certain that the current limit adjustments are set sufficiently above the rated output current.

5-11 Rated Output

5-12 To check that the supply will furnish its rated output voltage(s) and current(s), proceed as follows:

a. Connect in series across the (+) and (–) terminals of the 5V output a suitable load resistor, a current sampling resistor, and a switch, as shown in Figure 5-2. The load resistor must be of the proper value and of adequate wattage to draw full rated current from the 5V output.

b. Connect a digital voltmeter across the (+ SEN) and (– SEN) terminals of the 5V output, observing correct polarity.

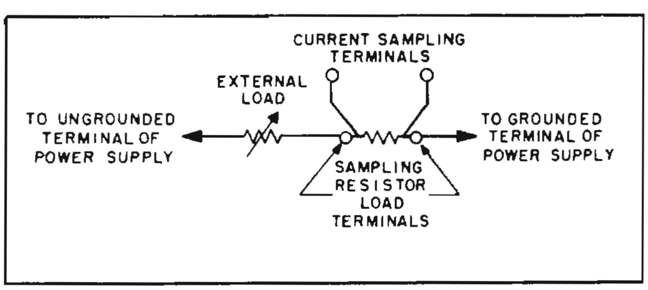


Figure 5-1. Current Sampling Resistor Connections

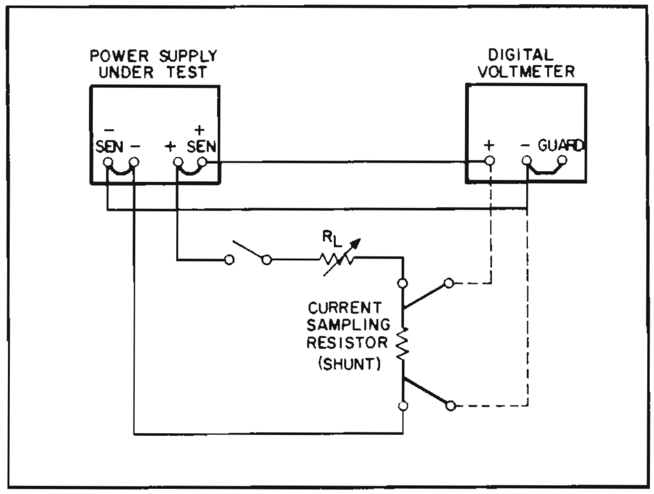


Figure 5-2. Rated Output, Test Setup

c. Apply input power to the supply and, with the load switch open, set the voltage of the 5V output to any desired value within the adjustment range. This output voltage can be used for all remaining 5V performance tests.

d. Connect the voltmeter across the current sampling terminals of the current sampling resistor, close the load switch, and adjust R_L until the voltmeter indicates a voltage drop corresponding to the 5V output's maximum rated current.

e. Reconnect the voltmeter across the (+ SEN) and (– SEN) terminals of the 5V output and recheck its output voltage. It should be within 0.1% of the value set in step (c).

f. Steps (f) and (g) apply only to the Model 63315D. Use the same procedure described in steps (a) through (e) above to check the +11.4 to +15.75V output. Connect a switch, a load resistor of appropriate value, and a current sampling resistor in series between the (+) and the COMMON RETURN terminals and monitor the output voltage across the (+ SEN) and RETURN SENSE terminals.

g. Check the –11.4 to –15.75V output by using the procedure described in steps (a) through (e) above. Load the COMMON RETURN and (–) terminals and monitor the output voltage across the RETURN SENSE and (– SEN) terminals. Do not readjust the output voltage; the voltage of the negative supply should be within 2% of the positive supply's voltage.

5-13 Load Effect (Load Regulation)

Definition: The change ΔE_{OUT} in the static value of dc output voltage resulting from a change in load resistance from open circuit to a value which yields maximum rated output current (or vice versa).

5-14 To test the load effect:

a. Connect a full load resistance and a digital voltmeter across the (+) and (–) terminals of the 5V output, as shown in Figure 5-2.

b. Turn on the supply and record the voltage across the 5V output's sensing terminals.

c. Disconnect the load resistor and recheck the DVM indication. It should be within 0.1% of the reading in step (c).

d. Repeat steps (a) through (c) for each of the remaining supply outputs.

5-15 Source Effect (Line Regulation)

Definition: The change ΔE_{OUT}, in the static value of dc output voltage resulting from a change in ac input voltage over the specified range from low line to high line or from high line to low line.

5-16 To test the source effect:

a. Connect a variable autotransformer between the input power source and the power supply ac input.

b. Connect a full load resistance and a digital voltmeter across the 5V output of the supply.

c. Adjust the autotransformer for a low line input.

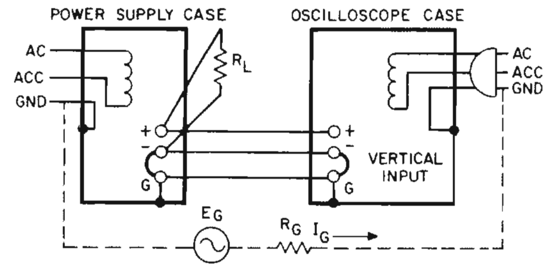
d. Turn on the power and record the DVM indication.

e. Adjust the autotransformer for a high line input and recheck the DVM indication. It should be within .02% of the reading in step (d).

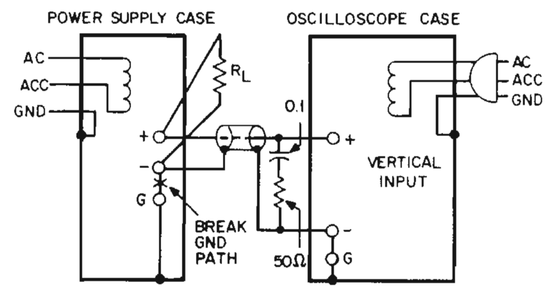
f. Repeat steps (b) through (e) for each of the remaining supply outputs.

5-17 PARD (Ripple and Noise)

Definition: The residual ac voltage which is superimposed on the dc output of a regulated power supply. Ripple and noise may be specified and measured in terms of its rms or peak-to-peak value.



A. INCORRECT METHOD - GROUND CURRENT I_G PRODUCES 60 CYCLE DROP IN NEGATIVE LEAD WHICH ADDS TO THE POWER SUPPLY RIPPLE DISPLAYED ON SCOPE



B. A CORRECT METHODE USING A SINGLE ENDED SCOPE OUTPUT FLOATED TO BREAK GROUND CURRENT LOOP, TWISTED PAIR REDUCES STRAY PICKUP ON SCOPE LEADS.

Figure 5-3. Ripple and Noise, Test Setup

5-18 **Measurement Techniques.** Figure 5-3A shows an incorrect method of measuring p-p ripple. Note that a continuous ground loop exists from the third wire of the input power cord of the supply to the third wire of the input power cord of the oscilloscope via the grounded power supply case, the wire between the negative output terminal of the power supply and the vertical input of the scope, and the grounded scope case. Any ground current circulating in this loop as a result of the difference in potential E_G between the two ground points causes an IR drop which is in series with the scope input. This IR drop, normally having a 60Hz line frequency fundamental, plus any pickup on the unshielded leads interconnecting the power supply and scope, appears on the face of the CRT. The magnitude of this resulting signal can easily be much greater than the true ripple developed between the plus and minus output terminals of the power supply and can completely invalidate the measurement.

5-19 Figure 5-3B shows a correct method of measuring the output ripple of a constant voltage power supply using a single-ended scope. The ground loop path is broken by floating the power supply output. To ensure that no potential difference exists between the supply and the oscilloscope, it is recommended that they both be plugged into the same ac power bus. If the same bus cannot be used, both ac grounds must be at earth ground potential.

5-20 To verify that the oscilloscope is not displaying ripple that is induced in the leads or picked up from the grounds, the (+) scope lead should be shorted to the (–) scope lead at the power supply terminals. The ripple value obtained when the leads are shorted should be subtracted from the actual ripple measurement.

5-21 **Measurement Procedure.** To measure the ripple and noise on each supply outputs, follow the steps below. If a high frequency noise measurement is desired, an oscilloscope with sufficient bandwidth (20MHz) must be used. Ripple and noise measurements can be made at any input ac line voltage combined with any dc output voltage and load current within rating.

a. Connect an oscilloscope or rms voltmeter across an output of the supply as shown in Figure 5-3B.

b. Energize the supply and observe the oscilloscope or meter indication. The ripple and noise should not be greater than 5mV rms or 40mV peak-to-peak.

c. Repeat for the remaining supply outputs.

5-22 Load Transient Recovery Time

Definition: The time it takes for the output voltage to recover to within 1% of the nominal output following a step change in output current from full to half load or vice versa.

5-23 **±11.4 to ±15.75-Volt Outputs.** To test the load transient recovery time, a repetitive load switch with a fast switching time is required for loading and unloading the supply. Figure 5-4 shows one way of constructing one using a relay with mercury-wetted contacts. When this load switch is connected to a 60Hz ac input, the mercury relay opens and closes 60 times per second. The 25kΩ control adjusts the duty cycle of the load current switching to reduce jitter in the oscilloscope display. This load switch can also be used with a 50Hz ac input.

5-24 To check the load transient recovery time of each of the ±11.4 to ±15.75V outputs of the Model 63315D, proceed as follows:

a. Connect test setup as shown in Figure 5-4. Each load resistor (R_T) is twice the normal full load resistance.

b. Turn on the supply and close the line switch on the repetitive load switch.

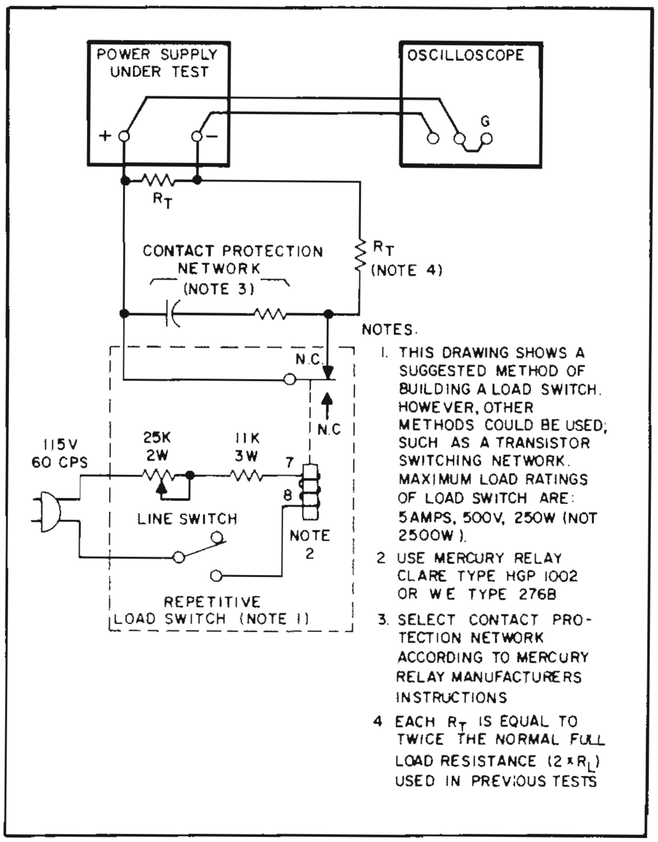


Figure 5-4. Load Transient Recovery Time, Test Setup

c. Adjust the oscilloscope to display the loading and the unloading transients produced by the operation of the load switch. Recovery to within 1% of the nominal output voltage should occur within 25 microseconds as shown in Figure 5-5.

5-25 **5-Volt Output.** The mercury-wetted relays recommended for use in the repetitive load switch described in Figure 5-4 have a maximum current limitation of 5 amps. For this reason, some other type of repetitive load switch with a higher current capacity is required for testing the load transient recovery time of the 5V output. The use of a solid state electrical load with pulse modulation capabilities such as the Transistor Devices Dynaload DLP 50-60-1000 is one way to avoid the rise time and switching noise limitations of mechanical switches at currents above 5 amps.

5-26 To check the load transient recovery time of the 5V output, proceed as follows:

a. Connect test setup as shown in Figure 5-4, but in place of the load switch and contact protection network shown, substitute a solid state repetitive load switch with a current capacity of at least half of the supply's rated output and a rise time of less than 100 microseconds. (Since the supply's recovery time is specified for a change between half and full load, the switch conducts only half of the supply's rated output.) Each load resistor (R_T) is twice the normal full load resistance.

b. Turn on the supply and the load switch.

c. Adjust the oscilloscope to display the loading and the unloading transients produced by the operation of the load switch. Recovery to within 1% of the nominal output voltage should occur within 1 millisecond as shown in Figure 5-5.

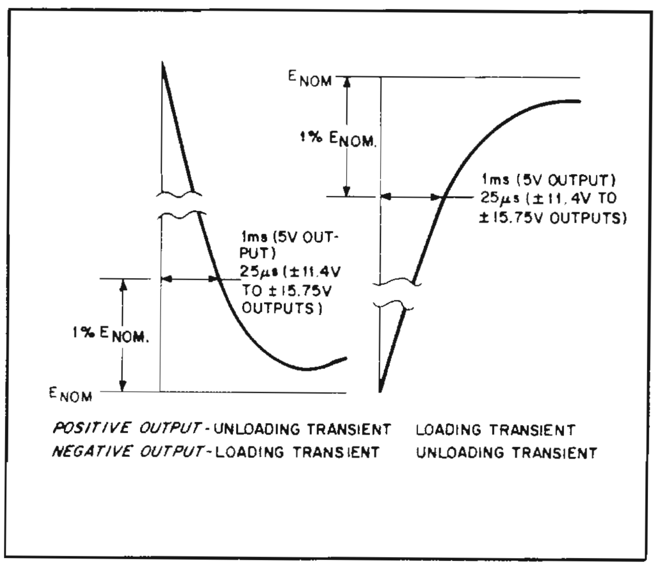


Figure 5-5. Load Transient Recovery Time Waveforms

5-27 TROUBLESHOOTING

5-28 Before attempting to troubleshoot this instrument, ensure that the fault is in the instrument itself and not in an associated piece of equipment. You can determine this without removing the covers from the instrument by using the appropriate portions of the performance test of paragraph 5-6.

5-29 A good understanding of the principles of operation is a helpful aid in troubleshooting, and the reader is advised to review Section IV of the manual before beginning detailed troubleshooting. Once the principles of operation are understood, proceed to the initial troubleshooting procedures in paragraph 5-30.

5-30 Initial Troubleshooting Procedures

WARNING

All circuits on the A1 board as well as the primary windings of transformer T2 on the A2 board are connected directly to the input ac line. Exercise extreme caution when working on energized circuits. Also, energize the supply through an isolation transformer to avoid shorting ac line energized circuits to ground through the test instrument's input leads.

CAUTION

Before applying power to the supply, make certain that jumpers E1 through E5 on TB1 are connected appropriately for the ac line voltage to be used.

All loads should be disconnected while troubleshooting. If checks must be made that require loading the supply while the circuit boards are detached from the main heatsink, restrict the time the output is loaded to avoid overheating.

5-31 If a malfunction occurs that causes an output voltage to be high, low, or zero, proceed to the circuit board isolation procedure of Figure 5-6. This procedure identifies the board on which troubleshooting must begin. The A1 board must be operating properly before troubleshooting of the A2 board can proceed, and both the A1 and A2 boards must be operating properly before troubleshooting the A3 board. Follow all steps in the order in which they are given.

5-32 If the unit's output voltages are normal but difficulties exist with its ripple, noise, or regulation, proceed to Ripple and Regulation Troubleshooting, Table 5-2.

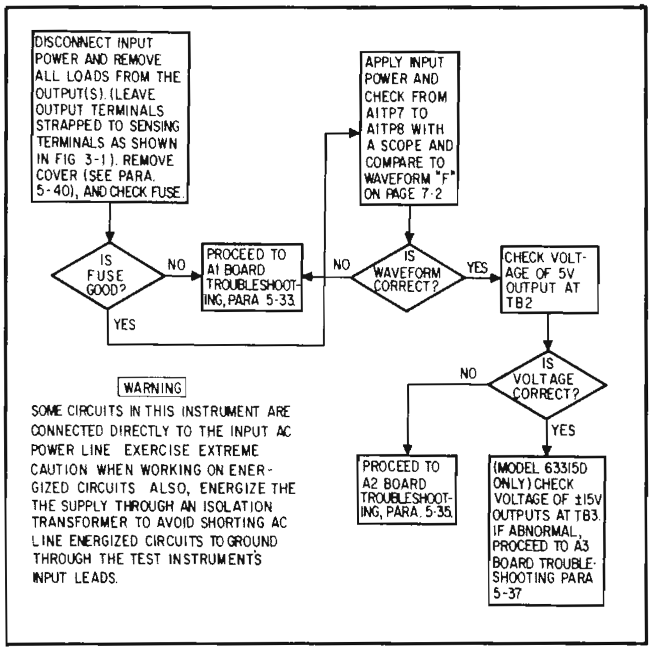


Figure 5-6. Circuit Board Isolation Procedure

5-33 A1 Board Troubleshooting

5-34 To troubleshoot the A1 board it must be disconnected from the A2 and A3 boards. Complete the disassembly procedure given in paragraph 5-40 and then proceed to A1 Board Troubleshooting, Figure 5-7.

5-35 A2 Board Troubleshooting

5-36 While checking the A2 board for troubles, it must be connected to a properly operating A1 board. Detach the A3 board, if present, from the A2 board and plug the A1 and A2 boards together. Then proceed to A2 Board Troubleshooting, Figure 5-8.

5-37 A3 Board Troubleshooting

5-38 While checking the A3 Board for troubles, it must be connected to A1 and A2 boards that are operating properly. In addition, problems in the positive 15-volt supply must be corrected before it is possible to troubleshoot the negative (slave) supply. The troubleshooting procedure for the A3 board is given in Figure 5-9.

5-39 REPAIR AND REPLACEMENT

5-40 Disassembly

5-41 Follow the steps below to disassemble the unit for troubleshooting and repair.

a. Before removing the cover, remove the plastic barrier block cover and disconnect all input and output connections.

b. Remove six screws at the bottom edge of the cover and two at the top. Then it can be slid off the supply.

c. Detach the finned heatsink by removing its four screws.

d. Remove the two spacer rods from the top of the circuit boards.

e. Remove one screw from the bottom of the unit that attaches the A3 board to the chassis in the Model 63315D.

f. Now, removing the four or six flat-head screws that were exposed by the removal of the heatsink and the three screws along the bottom edge of the A1 board will permit all boards to be detached from the chassis as a single assembly. Three A4L1 leads and one ground wire still connect the A1 board to the chassis.

g. The A1 board can be detached from the A2/A3 assembly by pulling straight apart to unplug the pins at the top of A2T2 from A1J1.

h. To separate the A2 and A3 boards, remove the two screws at opposite corners.

5-42 Reassembly

5-43 To reassemble the unit after repairs have been completed, reverse the above disassembly steps. Before reassembling the A1 and A2 boards to the main heatsink, clean the mating surfaces and both sides of the sheet of insulating material that goes between them and apply a coating of silicone grease (HP Part No. 6040-0265 or Dow Corning 340) to these surfaces.

CAUTION

After reassembly and before reconnecting input power to the supply, perform a high pot insulation test between primary and case, primary and output(s), and output(s) and case. Test voltages are specified in Table 1-1.

5-44 Replacing Power Semiconductors

5-45 Replace heatsink mounted power transistors and diodes by removing their mounting screws and unsoldering their pins. Use mica insulators under A2Q1, A2U2, A3Q1, and A3Q4, but do not use one under A1Q5. (The mica insulator for A2Q1 is supplied with the replacement device). When replacing power semiconductors, coat the heat transfer surfaces with silicone grease.

NOTE

When replacing any wirewound power resistors of 3W rating or greater, allow a 1/4-inch clearance between the resistor and the circuit board.

5-46 ADJUSTMENTS

NOTE

Before adjusting an output current limit, the voltage of that output must be set to the desired value.

5-47 To adjust the setting of one of the output current limit circuits, proceed as follows:

a. Before energizing the supply, connect across the output an oscilloscope and a load resistor equal in value to the desired output voltage divided by the desired current limit. (For example, to set the current limit of the 5V output to 20 amps when the output is set for 5.20 volts, a 260-milliohm 100-watt load resistor is required.)

b. Turn the current limit adjusting pot for the output being adjusted fully clockwise (CW) to its maximum setting.

c. Energize the supply and monitor the output ripple while turning the current limit adjusting pot gradually counterclockwise (CCW) until the ripple begins to increase substantially. Set the pot to the point where the increase in ripple begins.

Table 5-2. Ripple and Regulation Troubleshooting

Symptom	Probable Cause
Excessive 120Hz ripple.	Check voltage and ripple at preregulator output (A2TP1 to TP2). Voltage should be +100 ±6Vdc. Ripple should not exceed 12V p-p with the supply fully loaded. Check A1C2-C7.
Excessive 20kHz ripple or noise spikes.	Check all board mounting screws tightened securely and the following components. 5V Output: Check A2C3, C5, C6, C12, C13, C16-19, L1, L3. ±15V Outputs: Check A3C1, C2, C8-C11, C16-18, C20, C21, L1, L2, L5, L6.
Erratic output at some value of load current.	Check A2CR3, C4, R7, R8, R11.
Poor regulation.	a. Check remote sensing connections. b. Check the settings of current limit controls A2R34, A3R9, and A3R23. c. Check change in preregulator dc output (A1TP1 to TP12) as the supply is loaded. Troubleshoot preregulator if voltage change exceeds 6Vdc. d. Check bias voltages: A2TP1 to TP2 (+12 to +16Vdc), A2TP1 to TP3 (+8 to +10Vdc). e. Check reference voltages: A2TP13 to TP20 (+6.8 to +7.5Vdc), and COMMON RETURN on TB3 to A3TP8 (+6.8 to +7.5Vdc). f. Check regulator IC's (A2U4, A3U1, A3U2) and pulse width modulator (A2U1).

Table 5-3. Switching Regulator Resistance Checks

All resistance readings taken on A1 board with A2 board disconnected. One silicon junction drop equals about 0.7 volts dc.

Negative Lead	Positive Lead	Normal Indication	Probable Cause of Abnormal Indication
Q8 emitter (TP8)	Q5 base Q5 collector U3 pin 4 Q8 collector Q8 base Q10 base CR21 anode Q10 collector	47Ω open one drop + 165Ω one drop + 600Ω two drops > 5kΩ one drop > 5kΩ	Q5 shorted Q5 shorted U3 shorted, Q7 open Q8 shorted CR16-17, Q8 shorted Q9, Q10 shorted CR21 defective Q10, CR19 shorted
Q7 emitter	CR20 cathode Q7 collector	open 440Ω	CR20 shorted Q6, Q7 shorted
Q10 collector	CR19 anode	one drop	CR19 shorted
▽1 (TP1)	VR3 anode	two drops	VR3 or VR4 defective

Table 5-3. Switching Regulator Resistance Checks (Continued)

Negative Lead	Positive Lead	Normal Indication	Probable Cause of Abnormal Indication
U3 pin 2 (Note 1)	U3 pin 1	two drops	U3 defective
CR13 cathode	CR13 anode	three drops (Note 2)	CR13 defective
CR14 cathode	CR15 anode CR11 anode	two drops one drop	CR14 or CR15 defective CR11 defective
CR12 cathode	CR12 anode	one drop	CR12 defective
Q5 collector	CR14 cathode CR18 anode Q5 base	one drop one drop one drop	CR22 defective CR18 defective Q5 open
CR20 cathode	CR20 anode	one drop	CR20 defective
Q6 base	Q6 collector Q6 emitter	one drop one drop	Q6 open Q6 open
Q7 emitter	Q7 base	one drop	Q7 open
Q7 collector	Q7 base	one drop	Q7 open
Q8 base	Q8 emitter Q8 collector	one drop one drop	Q8 open Q8 open
Q9 base	Q9 emitter Q10 emitter Q10 collector	one drop one drop one drop	Q9 open Q10 open Q10 open
U3 pin 5	U3 pin 6	one drop	U3 open
U3 pin 4	U3 pin 6	one drop	U3 open

Notes: 1. Not a silicon junction. Do not apply more than 7 volts in testing.
2. May appear open on low ohmmeter range. Requires minimum of 3 volts to test.

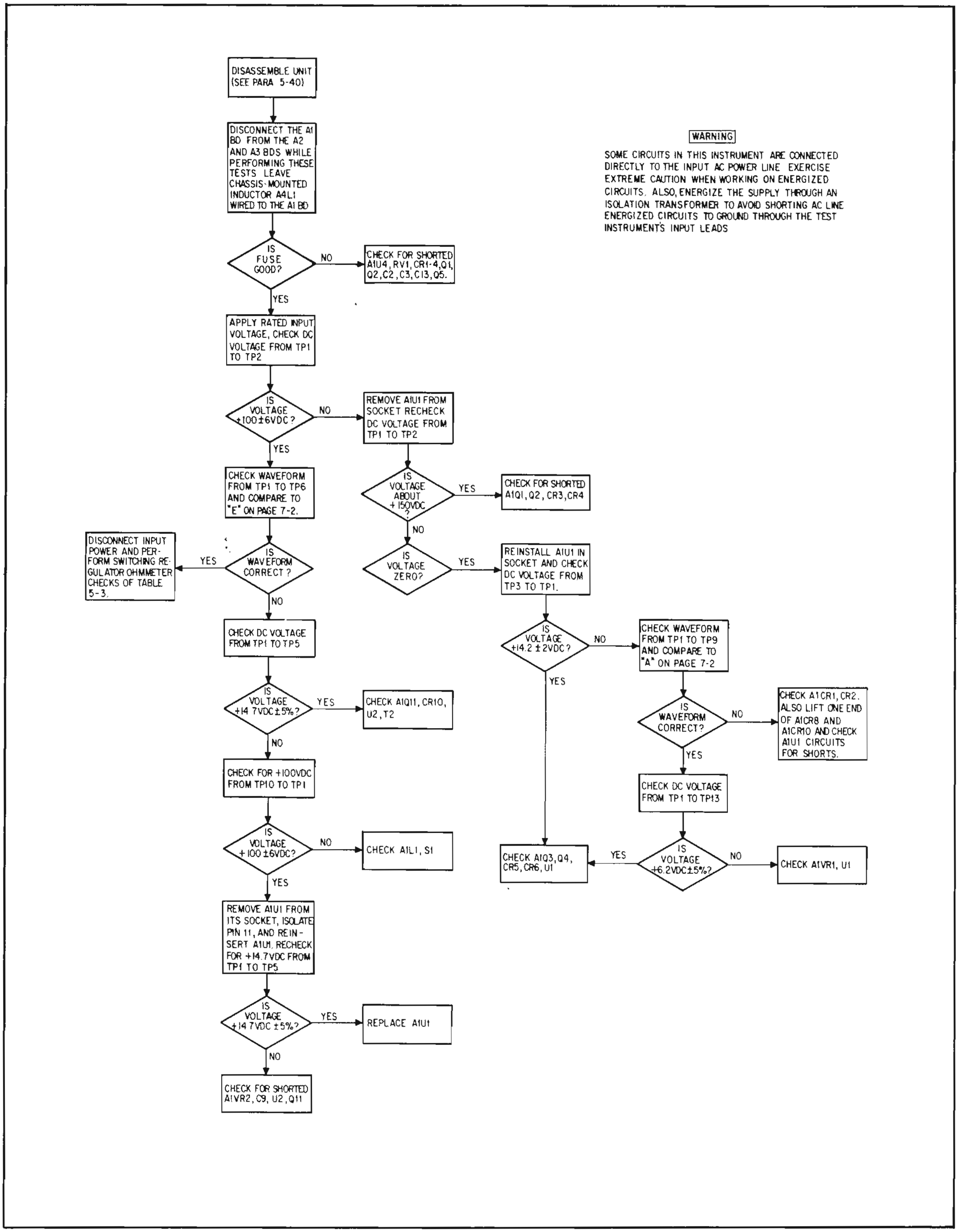


Figure 5-7. A1 Board Troubleshooting Procedure

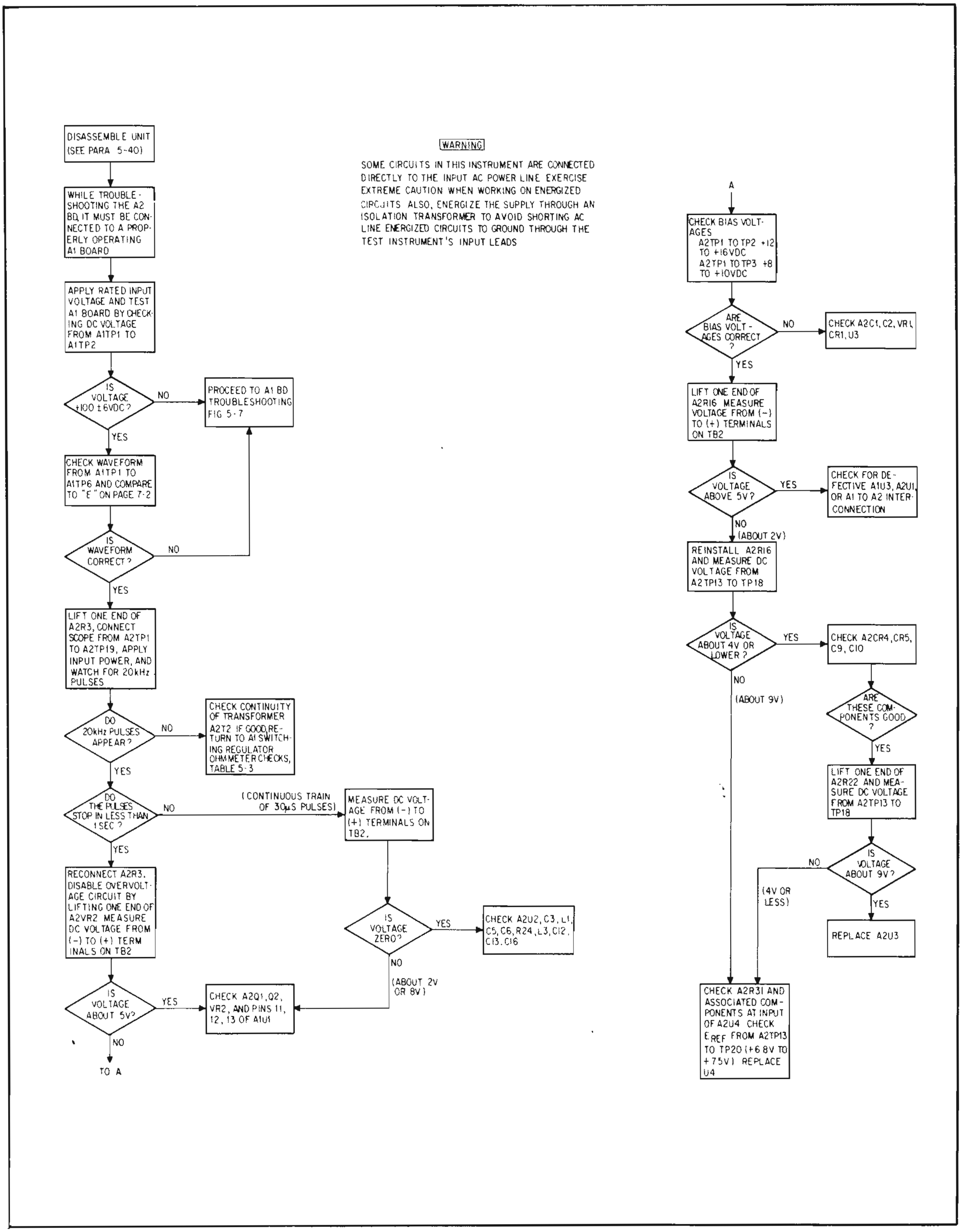


Figure 5-8. A2 Board Troubleshooting Procedure

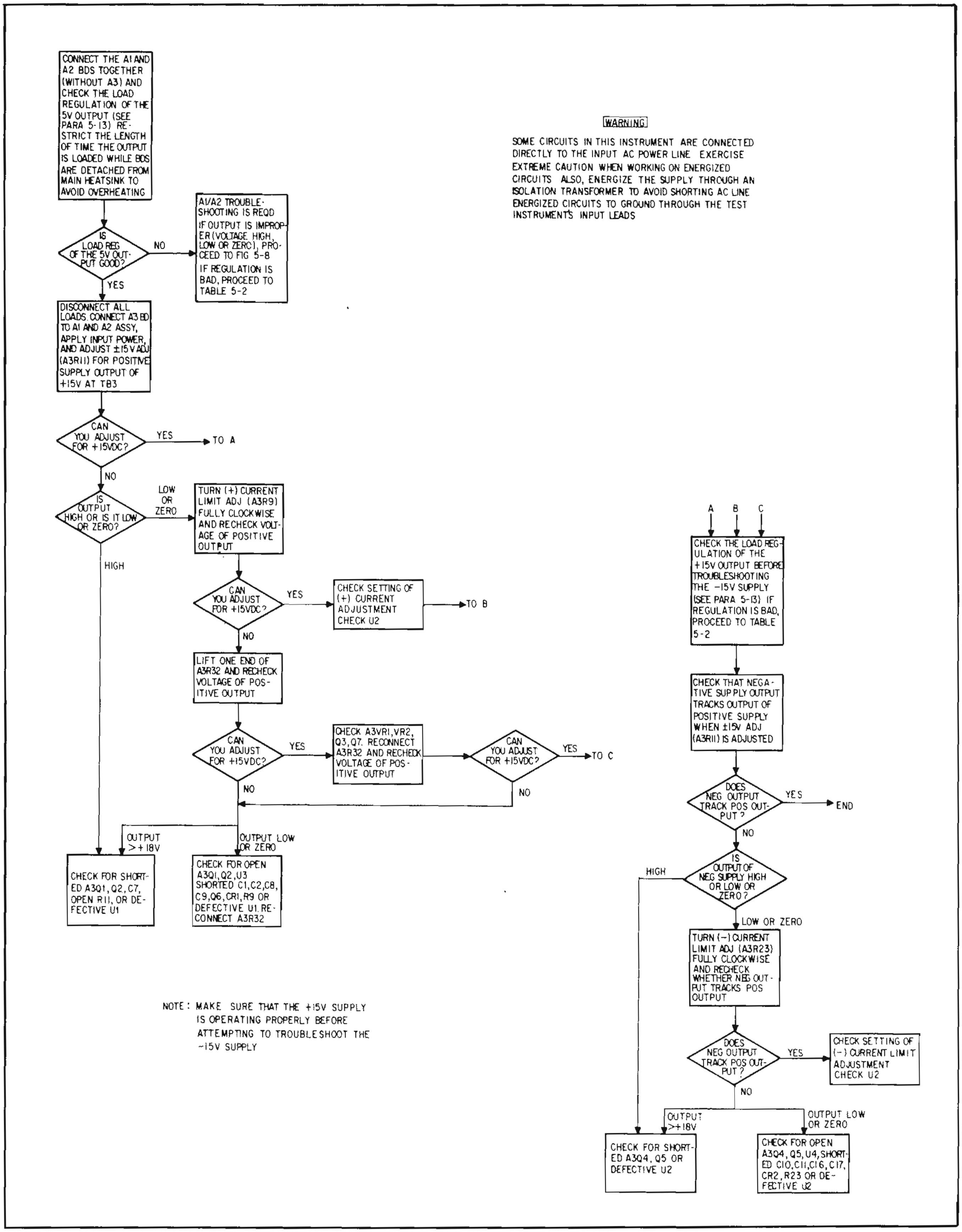


Figure 5-9. A3 Board Troubleshooting Procedure

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-3 lists parts in alpha-numeric order by reference designators and provides the following information:

a. Reference Designators. Refer to Table 6-1.
b. Description. Refer to Table 6-2 for abreviations.
c. Total Quantity (TQ). Given only the first time the part number is listed except in instruments containing many sub-modular assemblies, in which case the TQ appears the first time the part number is listed in each assembly.
d. Manufacturer's Part Number or Type.
e. Manufacturer's Federal Supply Code Number.

f. Hewlett-Packard Part Number.
g. Recommended Spare Parts Quantity (RS) for complete maintenance of one instrument during one year of isolated service.
h. Parts not identified by a reference designator are listed at the end of Table 6-3 under Mechanical and/or Miscellaneous. The former consists of parts belonging to and grouped by individual assemblies; the latter consists of all parts not immediately associated with an assembly.

6-3 ORDERING INFORMATION

6-4 To order a replacement part, address order or inquiry to your local Hewlett-Packard sales office (see lists at rear of this manual for addresses). Specify the following information for each part: Model, complete serial number, and any Option or special modification (J) numbers of the instrument; Hewlett-Packard part number; circuit reference designator; and description. To order a part not listed in Table 6-3, give a complete description of the part, its function, and its location.

Table 6-1. Reference Designators

A	= assembly	E	= miscellaneous electronic part
B	= blower (fan)	F	= fuse
C	= capacitor	J	= jack, jumper
CB	= circuit breaker	K	= relay
CR	= diode	L	= inductor
DS	= device, signaling (lamp)	M	= meter

Table 6-1. Reference Designators (Continued)

P	= plug	V	= vacuum tube, neon bulb, photocell, etc.
Q	= transistor	VR	= zener diode
R	= resistor	X	= socket
S	= switch	Z	= integrated circuit or network
T	= transformer		
TB	= terminal block		
TS	= thermal switch		

Table 6-2. Description Abbreviations

A	= ampere	mod.	= modular or modified
ac	= alternating current	mtg	= mounting
assy.	= assembly	n	= nano = 10^{-9}
bd	= board	NC	= normally closed
bkt	= bracket	NO	= normally open
^{o}C	= degree Centigrade	NP	= nickel-plated
cd	= card	Ω	= ohm
coef	= coefficient	obd	= order by description
comp	= composition	OD	= outside diameter
CRT	= cathode-ray tube	p	= pico = 10^{-12}
CT	= center-tapped	P.C.	= printed circuit
dc	= direct current	pot.	= potentiometer
DPDT	= double pole, double throw	p-p	= peak-to-peak
DPST	= double pole, single throw	ppm	= parts per million
elect	= electrolytic	pvr	= peak reverse voltage
encap	= encapsulated	rect	= rectifier
F	= farad	rms	= root mean square
^{o}F	= degree Farenheit	Si	= silicon
fxd	= fixed	SPDT	= single pole, double throw
Ge	= germanium	SPST	= single pole, single throw
H	= Henry	SS	= small signal
Hz	= Hertz	T	= slow-blow
IC	= integrated circuit	tan.	= tantulum
ID	= inside diameter	Ti	= titanium
incnd	= incandescent	V	= volt
k	= kilo = 10^3	var	= variable
m	= milli = 10^{-3}	ww	= wirewound
M	= mega = 10^6	W	= Watt
μ	= micro = 10^{-6}		
met.	= metal		
mfr	= manufacturer		

Table 6-3. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
A1	AC-DC Converter Assy.				5060-2475	
C1	(not assigned)					
C2, 3	fxd, elect. 500μF 150V	2	(Type 68D) D40701	56289	0180-1889	1
C4	fxd, cer .01μF 100V	2	TA	91418	0150-0093	1
C5	fxd, elect 1μF 50V	1	150D105X0050A2	56289	0180-0230	1
C6	fxd, elect 10μF 20V	2	150D106X9020B2	56289	0180-0374	1
C7	fxd, elect 22μF 15V	1	150D226X9015B2	56289	0180-0228	1
C8	fxd, cer .001μF 1KV	1	C067B102E102ZS26	56289	0150-0050	1
C9	fxd, elect 10μF 20V		150D106X9020B2	56289	0180-0374	
C10	fxd, mica .002μF 100V	1	obd	72136	0160-2301	1
C11	fxd, cer .01μF 100V		TA	91418	0150-0093	
C12	fxd, mylar .068μF 200V	1	292P68392	56289	0160-0166	1
C13	fxd, elect 69μF 150V	1		28480	0180-2607	1
C14	fxd, mylar .0022μF 200V	1	AE12C222KT	06001	0160-0154	1
C15	fxd, elect 180μF 40V	1		28480	0180-2606	1
CR1, 2	diode, si. 600V 750mA	2	SR1358-10	04713	1901-0029	2
CR3, 4	diode, si. 400V 1.5A	2	SR1846-12	04713	1901-0418	2
CR5-10	diode, si. 80V 200mA	11	FDH 6308	07263	1901-0050	6
CR11	diode, si. 100V 1A	2	1N4934	04713	1901-0693	2
CR12	diode, si. 400V 750mA	3	SR1358-9	04713	1901-0028	3
CR13	diode, stabistor 150mA 15V	1	STB523	03508	1901-0460	1
CR14-17	diode, si. 80V, 200mA		FDH 6308	07263	1901-0050	
CR18	diode, si. 400V 750mA		SR1358-9	04713	1901-0028	
CR19	diode, si. 80V 200mA		FDH 6308	07263	1901-0050	
CR20	diode, si. 100V 1A		1N4934	04713	1901-0693	
CR21	diode, si. 400V 750mA		SR1358-9	04713	1901-0028	
CR22	diode, si. 100ns 400V 1A	1	1N4936	04713	1901-1065	1
F1	fuse, normal blow 5A 250V	1	312005	75915	2110-0010	5
J1, 2	Connector, 10 pin	2	09-52-3103	27264	1251-0628	1
L1	inductor, 370μH	1		28480	5080-1807	1
Q1, 2	silicon controlled rectifier	2	40869	02735	1884-0233	2
Q3, 4	SS NPN Si	4	2N2222A	14433	1854-0477	4
Q5	power NPN Si	1	2N6306 (Selected)	28480	1854-0657	1
Q6	power PNP Si	1	MJE-210	04713	1853-0398	1
Q7	SS NPN Si		2N2222A	14433	1854-0477	
Q8-10	SS PNP Si	3	2N2907A	14433	1853-0281	3
Q11	SS NPN Si		2N2222A	14433	1854-0477	
R1, 2	fxd, comp 10 5% 1/2W	2	EB-1005	01121	0686-1005	1
R3	Not assigned					
R4	fxd, ww 6k 5% 5W	1	243E	56289	0811-1559	1
R5	fxd, ww 3k 5% 3W	2	VAL-3	24681	0812-0010	1
R6	fxd, film 4.32k 1% 1/8W	1	MF4C-1	19701	0757-0436	1
R7	fxd, film 9.09k 1% 1/8W	1	MF7C-1	19701	0757-0288	1
R8	fxd, comp 270k 5% 1/4W	1	CB-2745	01121	0683-2745	1
R9	fxd, comp 20 5% 1/4W	1	CB-2005	01121	0683-2005	1
R10	fxd, comp 1.6k 5% 1/4W	1	CB-1625	01121	0683-1625	1
R11	fxd, comp 6.2k 5% 1/4W	1	CB-6225	01121	0683-6225	1
R12	fxd, comp 160k 5% 1/4W	2	CB-1645	01121	0683-1645	1
R13	fxd, comp 4.3k 5% 1/4W	1	CB-4325	01121	0683-4325	1
R14	fxd, comp 160k 5% 1/4W		CB-1645	01121	0683-1645	

Table 6-3. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R15	fxd, comp 1k 5% 1/4W	2	CB-1025	01121	0683-1025	1
R16, 17	fxd, comp 10k 5% 1/4W	3	CB-1035	01121	0683-1035	1
R18	fxd, film 39k 1% 1/8W	1	CMF-55-1, T-1	91637	0698-6076	1
R19	fxd, film 100k 1% 1/8W	1	MF4C-1	19701	0757-0465	1
R20	fxd, film 6.49k 1% 1/8W	1	MF4C-1	19701	0698-3226	1
R21	fxd, ww, 3k 5% 5W	1	243E	56289	0812-0050	1
R22	fxd, comp 100 5% 1/2W	1	EB-1015	01121	0686-1015	1
R23	fxd, comp 100 5% 1/4W	2	CB-1015	01121	0683-1015	
R24	fxd, film 3.83k 1% 1/8W	1	MF4C-1	19701	0698-3153	1
R25	fxd, film 16.2k 1% 1/8W	1	MF4C-1	19701	0757-0447	1
R26	fxd, comp 100 5% 1/4W	1	CB-1015	01121	0683-1015	1
R27	fxd, comp 47 5% 1/4W	1	CB-4705	01121	0683-4705	1
R28	fxd, comp 18 5% 1/2W	2	EB-1805	01121	0686-1805	1
R29	fxd, comp 820 5% 1/4W	1	CB-8215	01121	0683-8215	1
R30	fxd, comp 18 5% 1/2W		EB-1805	01121	0686-1805	
R31	fxd, comp 1k 5% 1/4W		CB-1025	01121	0683-1025	
R32	fxd, comp 430 5% 1/4W	1	CB-4315	01121	0683-4315	1
R33	fxd, ww 3 5% 3W	1	242 E	56289	0811-1224	1
R34, 35	fxd, ww 1.5 5% 3W	3	7/16-A-54-F	44655	0811-1220	1
R36	fxd, comp 10k 5% 1/4W		CB-1035	01121	0683-1035	
R37	fxd, ww 0.1 10% 3W	1	K46505	14841	0811-1827	1
R38	fxd, film 30.1 1% 1/8W	1	MF4C-1	19701	0757-0388	1
R39	fxd, film 5.11k 1% 1/8W	2	MF4C-1	19701	0757-0438	1
R40	fxd, film 243 1% 1/4W	1	MF52C-1	19701	0757-0720	1
R41	fxd, film 5.11k 1% 1/8W		MF4C-1	19701	0757-0438	
R42	fxd, ww 1.5 5% 3W		7/16-A-54-F	44655	0811-1220	
R43	fxd, ww 3k 5% 3W		VAL-3	24681	0812-0010	
R44	fxd, comp 10 5% 1/4W	1	CB-1005	01121	0683-1005	1
RV1	varistor, metal oxide	1		28480	0837-0129	1
S1	switch, thermal (opens at 110°C)	1		28480	3103-0049	1
T1	transformer, pulse, preregulator	1		28480	5080-1808	1
T2	transformer, pulse, clock	1		28480	5080-1809	1
U1	IC, thyristor-transistor array	1	CA3097E	02735	1858-0046	1
U2	IC, linear timer	1	NE555T	18324	1826-0119	1
U3	photo-isolator	1	IL-1	50579	1990-0543	1
U4	filter, RFI	1	F1798	05245	9135-0036	1
VR1	diode, zener 6.19V	1	CD35646	15818	1902-0049	1
VR2	diode, zener 14.7V	1	CD35754	15818	1902-3203	1
VR3	diode, zener 75V	1	SZ11213-392	04713	1902-0661	1
VR4	diode, zener 150V	1	SZ11213-440	04713	1902-0586	1
A2	**5V Switching Regulator Assy.**					
C1	fxd, elect 47μF 25V	1	672D476H025CC5B	56289	0180-0587	1
C2	fxd, elect 2.2μF 20V	4	150D225X0020A2	56289	0180-0155	1
C3	fxd, cer 0.1μF 50V	2	5C50B1-CML	56289	0150-0121	1
C4	fxd, mylar .022μF 200V	1	AE17C223KT	06001	0160-0162	1
C5	fxd, elect 2000μF 10V	2				1
C7, 8	fxd, elect 2.2μF 20V		150D225X0020A2	56289	0180-0155	
C9	fxd, elect 22μF 15V	1	150D226X9015B2	56289	0180-0228	1
C10	fxd, elect 4.7μF 35V	1	150D475X9035B2	56289	0180-0100	1

Table 6-3. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
C11	fxd, elect 2.2μF 20V		150D225X0020A2	56289	0180-0155	
C12	fxd, elect 2000μF 10V					
C14	fxd, mylar .068μF 200V	1	292P68392-PTS	56289	0160-0166	1
C15	fxd, cer 0.1μF 50V		5C50B1-CML	56289	0150-0121	
C16	fxd, cer 1μF 25V	1	5C15C2-CML	56289	0160-0127	1
C17-19	fxd, cer .05μF 400V	3	33C17A3-CDH	56289	0150-0052	1
CR1-5	diode, silicon	5	FDH 6308	07263	1901-0050	5
L1	inductor, 123μH	1		28480	5080-1810	1
L2	inductor, 8.2μH	1	1537-34	99800	9140-0105	1
L3	inductor, 5μH	1		28480	5080-1811	1
P1	connector, male, 10-cond. (Model 63315D)	1	09-64-1103	27264	1251-0629	1
Q1	SCR (including mica insulator)	1	2N4441	04713	1884-0082	1
Q2	SS PNP Si	1	2N2907A	14433	1853-0281	1
R1	fxd, comp 10 5% 1/4W	2	CB-1005	01121	0683-1005	1
R2	fxd, comp 470 5% 1/4W	3	CB-4715	01121	0683-4715	1
R3	fxd, comp 75 5% 1/2W	1	EB-7505	01121	0686-7505	1
R4	fxd, comp 1.3k 5% 1/4W	1	CB-1325	01121	0683-1325	1
R5	fxd, comp 4.7k 5% 1/4W	1	CB-4725	01121	0683-4725	1
R6	fxd, comp 6.2k 5% 1/4W	1	CB-6225	01121	0683-6225	1
R7	fxd, comp 3k 5% 1/4W	1	CB-3025	01121	0683-3025	1
R8	fxd, comp 180 5% 1/4W	1	CB-1815	01121	0683-1815	1
R9	fxd, comp 3.3 5% 1/4W	1	CB-33G5	01121	0683-0335	1
R10	fxd, film 2.37k 1% 1/8W	1	MF4C-1	19701	0698-3150	1
R11	fxd, comp 47k 5% 1/4W	1	CB-4735	01121	0683-4735	1
R12	fxd, film 4.32k 1% 1/8W	1	MF4C-1	19701	0757-0436	1
R13	fxd, film 3k 1% 1/8W	2	MF4C-1	19701	0757-1093	1
R14	fxd, comp 150k 5% 1/4W	1	CB-1545	01121	0683-1545	1
R15	fxd, film 3k 1% 1/8W		MF4C-1	19701	0757-1093	
R16	fxd, comp 470 5% 1/4W		CB-4715	01121	0683-4715	
R17	fxd, film 21.5k 1% 1/8W	1	MF4C-1	19701	0757-0199	1
R18	fxd, film 1.5k 1% 1/8W	1	MF4C-1	19701	0757-0427	1
R19	fxd, comp 22k 5% 1/4W	2	CB-2235	01121	0683-2235	1
R20	fxd, film 12.7 1% 1/8W	1	CEA-993	07716	0698-4356	1
R21	fxd, comp 22k 5% 1/4W		CB-2235	01121	0683-2235	
R22	fxd, comp 2.2k 5% 1/4W	1	CB-2225	01121	0683-2225	1
R23	fxd, comp 470 5% 1/4W		CB-4715	01121	0683-4715	
R24	fxd, alloy .002 ohms	1		28480	5020-2519	1
R25	fxd, comp 82k 5% 1/4W	1	CB-8235	01121	0683-8235	1
R26	fxd, comp 100 5% 1/4W	1	CB-1015	01121	0683-1015	1
R27	fxd, ww 5 5% 10W	1	247E	56289	0811-1893	1
R28	fxd, film 3.32k 1% 1/8W	2	MF4C-1	19701	0757-0433	1
R29	fxd, alloy .025 ohms	1		28480	5080-1814	1
R30	fxd, film 3.32k 1% 1/8W		MF4C-1	19701	0757-0433	
R31	var, 2k	1	72XR2K	73138	2100-3273	1
R32	fxd, film 1.33k 1% 1/8W	1	CEA-993	07716	0757-0317	1
R33	fxd, film 5.62k 1% 1/8W	1	MF4C-1	19701	0757-0200	1
R34	var, 5k	1	3386X-502	32997	2100-3207	1
R35	fxd, comp 1k 5% 1/4W	1	CB-1025	01121	0683-1025	1
R36	fxd, comp 330 5% 1/4W	1	CB-3315	01121	0683-3315	1

Table 6-3. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R37	fxd, comp 10 5% 1/4W		CB-1005	01121	0683-1005	
R38-39	fxd, comp 27 5% 1/4W	2	CB-2705	01121	0683-2705	1
T1	magnetic core, toroid (use with W1,W2)	1	57-1590	78488	9170-0567	1
T2	transformer, power (Model 63005C)	1		28480	63005-80095	1
T2	transformer, power (Model 63315D)	1		28480	63315-80090	1
U1	IC, linear timer	1	NE555T	18324	1826-0119	1
U2	diode, assy.	1		28480	1906-0067	1
U3	IC, linear transistor array	1	CA3046	02735	1821-0001	1
U4	IC, linear voltage regulator	1	723HC	07263	1820-0196	1
VR1	diode, zener 10V, 5W	1	CD35706	15818	1902-0025	1
VR2	diode, zener 5.9V 2W	1	CD35641	15818	1902-3110	1
W1, 2	jumpers (windings 2-3, 4-5 of T1)	2		28480	8150-3271	
A3	**Dual Linear Regulator Assy. (Model 63315D only)**					
C1	fxd, cer .02μF 500V	2	C023B501J203ZS25	56289	0160-0468	1
C2	fxd, elect 180μF 40V	4	672D	56289	0180-2606	1
C3	fxd, cer 0.1μF 50V	2	5C50B1-CML	56289	0150-0121	1
C4	fxd, mylar .022μF 200V	2	AE17C223KT	06001	0160-0162	1
C5	fxd, elect 2.2μF 20V	2	150D225X0020A2	56289	0180-0155	1
C6, 7	fxd, cer .01μF 100V	4	TA	91418	0150-0093	1
C8	fxd, elect 180μF 40V		672D	56289	0180-2606	
C9	fxd, cer 0.47μF 25V	2	5C11B7-CML	56289	0160-0174	1
C10	fxd, cer .02μF 500V		C023B501J203ZS25	56289	0160-0468	
C11	fxd, elect 180μF 40V		672D	56289	0180-2606	
C12	fxd, mylar .022μF 200V		AE17C223KT	06001	0160-0162	
C13, 14	fxd, cer .01μF 100V		TA	91418	0150-0093	
C15	fxd, elect 2.2μF 20V		150D225X0020A2	56289	0180-0155	
C16	fxd, elect 180μF 40V		672D	56289	0180-2606	
C17	fxd, cer 0.47μF 25V		5C11B7-CML	56289	0160-0174	
C18	fxd, cer .01μF 1KV	1	C023A102J103MS38	56289	0150-0012	1
C19	fxd, cer 0.1μF 50V		5C50B1-CML	56289	0150-0121	
C20, 21	fxd, cer .05μF 400V	2	33C17A3-CDH	56289	0150-0052	1
CR1, 2	diode, si. 400V 750mA	2	SR1358-9	04713	1901-0028	1
J1	connector, female, 10-cond.	1		28480	1251-3361	1
L1, 2	inductor	2		28480	63315-80091	1
L3, 4	inductor, ferrite bead (Q2,Q5 emitters)	2	56-590-65/4A6	02114	9170-0894	1
L5, 6	inductor, toroidal, 2-winding	2		28480	5080-1808	1
Q1	power NPN Si	2	see note, page 6-7		1854-0563	2
Q2, 3	SS PNP Si	4	2N2907A	14433	1853-0281	4
Q4	power NPN Si		see note, page 6-7		1854-0563	
Q5	SS PNP Si		2N2907A	14433	1853-0281	
Q6	silicon controlled rectifier	1	2N4441	04713	1884-0082	1
Q7	SS PNP Si		2N2907A	14433	1853-0281	
R1	fxd, comp 6.8 5% 1/2W	2	EB-68G5	01121	0698-5525	1
R2, 3	fxd, comp 39 5% 1/2W	2	EB-3905	01121	0686-3905	1
R4	fxd, comp 10K 5% 1/2W	2	EB-1035	01121	0686-1035	1
R5	fxd, comp 56 5% 1/2W	2	EB-5605	01121	0686-5605	1
R6	fxd, comp 18K 5% 1/2W	2	EB-1835	01121	0686-1835	1
R7	fxd, ww 0.39 10% 5W	2		28480	0811-3416	1
R8	fxd, comp 100 5% 1/2W	2	EB-51G5	01121	0686-1015	1

Table 6-3. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R9	var. trmr 2K	3	72XR2K	73138	2100-3273	1
R10	fxd, comp 2.2K 5% 1/2W	1	EB-2225	01121	0686-2225	1
R11	var. trmr 2K		72XR2K	73138	2100-3273	
R12	fxd, film 1K 1% 1/8W	1	CEA-993	07716	0757-0280	1
R13	fxd, film 2K 1% 1/8W	1	CEA-993	07716	0757-0283	1
R14	fxd, comp 1K 5% 1/2W	2	EB-1025	01121	0686-1025	1
R15	fxd, comp 18 5% 1/2W	2	EB-1805	01121	0686-1805	1
R16	fxd, comp 22 5% 1/2W	3	EB-2205	01121	0686-2205	1
R17	fxd, ww 220 5% 2W	2	BWH	75042	0811-1763	1
R18	fxd, comp 6.8 5% 1/2W		EB-68G5	01121	0698-5525	
R19	fxd, comp 10K 5% 1/2W		EB-1035	01121	0686-1035	
R20	fxd, comp 56 5% 1/2W		EB-5605	01121	0686-5605	
R21	fxd, comp 18K 5% 1/2W		EB-1835	01121	0686-1835	
R22	fxd, ww 0.39 10% 5W			28480	0811-3416	
R23	var. trmr 2K		72XR2K	73138	2100-3273	
R24	fxd, comp 100 5% 1/2W		EB-51G5	01121	0686-1015	
R25	fxd, comp 5.6K 5% 1/2W	1	EB-5625	01121	0686-5625	1
R26	fxd, comp 270 5% 1/2W	2	EB-2715	01121	0686-2715	1
R27, 28	fxd, film 3.83K 1% 1/8W	2	MF4C-1	19701	0698-3153	1
R29	fxd, comp 3.3K 5% 1/2W	1	EB-3325	01121	0686-3325	1
R30	fxd, comp 270 5% 1/2W		EB-2715	01121	0686-2715	
R31	fxd, comp 470 5% 1/2W	1	EB-4715	01121	0686-4715	1
R32	fxd, comp 150 5% 1/2W	1	EB-1515	01121	0686-1515	1
R33	fxd, comp 1K 5% 1/2W		EB-1025	01121	0686-1025	
R34	fxd, comp 330 5% 1/2W	1	EB-3315	01121	0686-3315	1
R35	fxd, comp 22 5% 1/2W		EB-2205	01121	0686-2205	
R36	fxd, ww 220 5% 2W		BWH	75042	0811-1763	
R37	fxd, comp 22 5% 1/2W		EB-2205	01121	0686-2205	
R38	fxd, comp 18 5% 1/2W		EB-1805	01121	0686-1805	
U1, 2	IC, linear regulator	2	723HC	07263	1820-0196	2
U3, 4	diode, assy.	2		28480	1906-0067	2
VR1, 2	diode, zener 16.2V 2W	2	CD35767	15818	1902-3214	2
A4	**Chassis-Electrical**					
L1	inductor, 16.7mH	1		28480	5080-1806	1
	A1-Mechanical					
	heatsink bracket assembly					
	heatsink bracket (Q5, S1)	1		28480	5020-2512	
	insulator (bracket mounting)	2		28480	5020-2528	
	expanding insert, brass, 6-32	2		28480	0590-0193	
	IC socket, 16-pin (U1)	1	ICN-163-S3W	06776	1200-0507	
	heat dissipators, (Q1, 2)	2	6025D	13103	1205-0282	
	transistor insulator, molded (Q5)	1		28480	0340-0503	
TB1	barrier block, 8-term	1		28480	0360-0680	
	barrier block jumper	2		28480	0360-0523	
XF1	fuseholder clips	2	6008-32CN	13060	2110-0269	
	terminal tab (A4L1 connections)	3		28480	1251-4180	

Table 6-3. Replaceable Parts

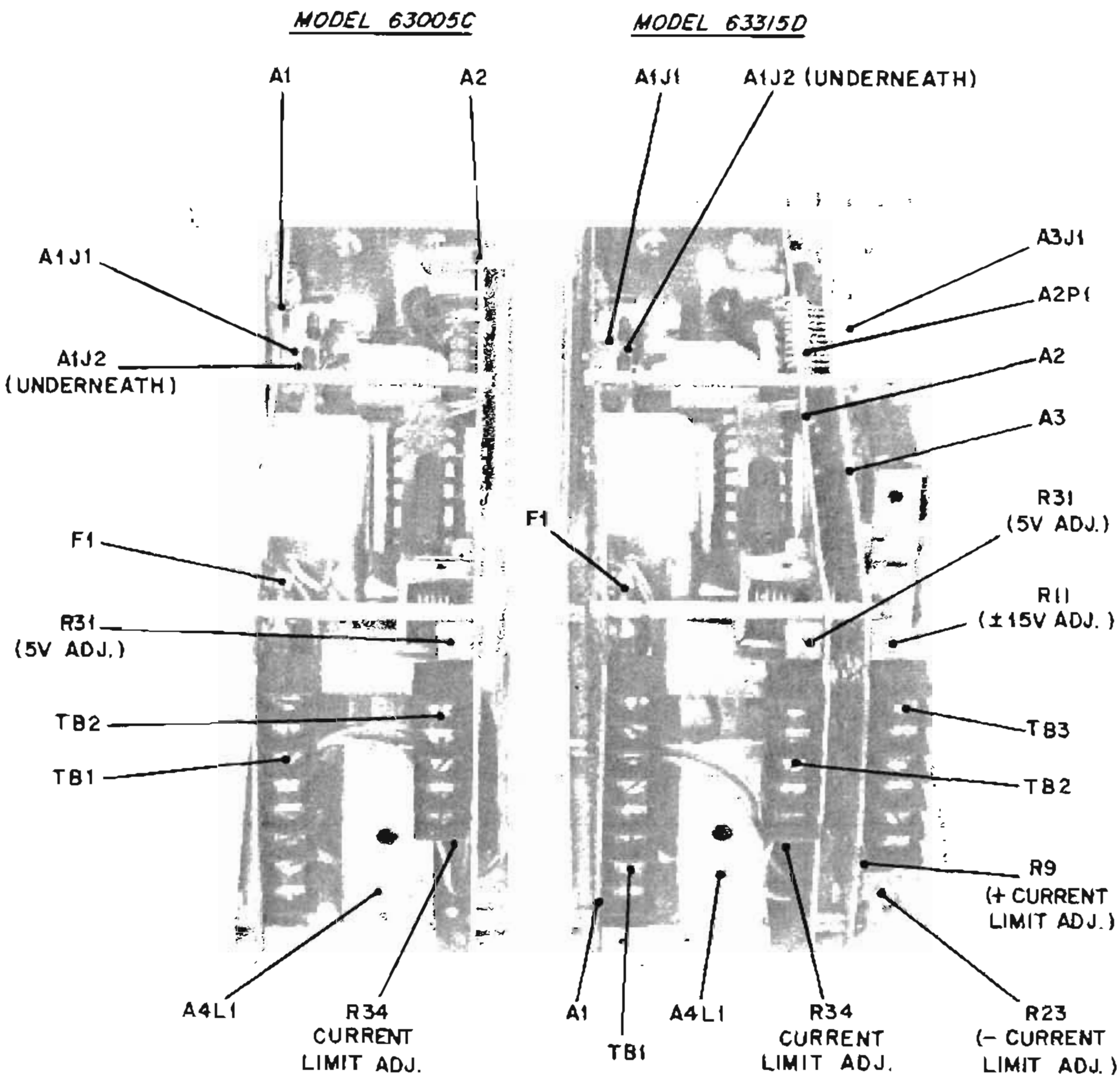
REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
	A2-Mechanical					
	heatsink bracket assembly					
	heatsink bracket (U2, Q1)	1		28480	5020-2513	
	insulator (bracket mtg)	2		28480	5020-2528	
	expanding insert, brass, 6-32	2		28480	0590-0193	
	transistor insulator, molded (U2)	1		28480	0340-0503	
	transistor insulator, mica (U2)	1	734	08530	0340-0174	
	stand off .75" (L1 mount)	1		28480	0380-0091	
	shoulder washer (L1 mount)	1		28480	2190-0360	
	felt washer (L1 mount)	2		28480	3050-0397	
	terminal tab (near R31, 34)	2		28480	1251-4180	
TB2	barrier block, 5-term	1		28480	0360-0681	
	barrier block, jumper	2		28480	0360-0523	
	A3-Mechanical (Model 63315D only)					
	heat sink bracket (Q1, Q4)	1		28480	63315-20001	
	transistor insulator, molded (Q1, Q4)	2		28480	0340-0503	
	transistor insulator, mica (Q1, Q4)	2	734	08530	0340-0174	
	heat dissipator (Q2, Q5)	2	TXBF-019-025B	98978	1205-0037	
	terminal tab (near R9, 11, 23)	3		28480	1251-4180	
TB3	barrier block, 6-term	1		28480	0360-0590	
	barrier block jumper	3		28480	0360-0523	
	Chassis-Mechanical					
	chassis (Model 63005C)	1		28480	5000-3112	
	chassis (Model 63315D)	1		28480	5000-3113	
	cover (Model 63005C)	1		28480	5000-3114	
	cover (Model 63315D)	1		28480	5000-3115	
	cover label (Model 63005C)	1		28480	7120-4975	
	cover label (Model 63315D)	1		28480	7120-4974	
	heatsink (Model 63005C)	1		28480	5020-2510	
	heatsink (Model 63315D)	1		28480	5020-2511	
	circuit board spacer rod (Model 63005C)	2		28480	5020-2515	
	circuit board spacer rod (Model 63315D)	2		28480	5020-2516	
	heat sink insulator (plastic film)	1		28480	5020-2527	
	barrier block cover	1		28480	0360-0551	
	Miscellaneous					
	packing carton	1		28480	9211-1175	
	carton filler	1		28480	9220-1421	
	carton filler (Model 63005C only)	1		28480	9220-1422	
	floater pad	4		28480	9220-1423	

NOTE: Power transistors A3Q1 and A3Q4 have no direct commercial replacements. For these transistors, the Model 63315D uses RCA 2N3055 transistors that have been selected for the following characteristics:

h_{FE} = 35 min. to 90 max. at I_C of 4A
BV_{CEO} = 75V min.
f_T = 500kHz at I_C of 40mA

SECTION VII
CIRCUIT DIAGRAMS AND COMPONENT LOCATION DIAGRAMS

This section contains the component location and schematic diagrams for power supply Models 63005C and 63315D. The first two sheets of the Figure 7-1 schematic covers the A1 and A2 boards of both models and sheet 3 covers the A3 board used in the 63315D only. Adjoining each sheet of the schematic is a circuit board component location diagram which shows the locations of the components on that board and also of the circled test points which appear on the schematic. (The most important test points are also marked directly on the backs of the circuit boards). Major waveforms are also provided as a troubleshooting aid.



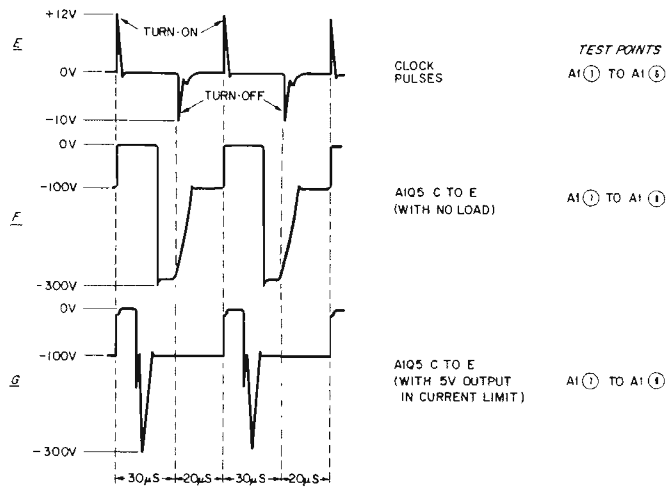
MEASUREMENT CONDITIONS

THESE WAVEFORMS WERE MEASURED BETWEEN THE INDICATED TEST POINTS WITH THE SUPPLY ENERGIZED FROM A 115VAC 60Hz LINE EXCEPT FOR WAVEFORM "G", ALL WERE MEASURED WITH THE OUTPUT OF THE SUPPLY UNLOADED THE OSCILLOSCOPE INPUT WAS DC-COUPLED ALL INDICATED AMPLITUDES ARE APPROXIMATE

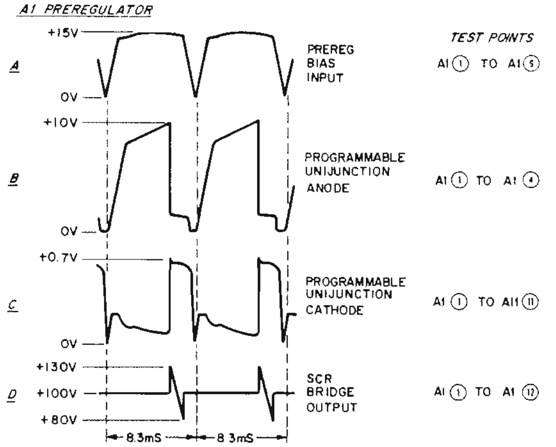
WARNING

SOME CIRCUITS IN THIS INSTRUMENT ARE CONNECTED DIRECTLY TO THE INPUT AC POWER LINE ENERGIZE THE SUPPLY THROUGH AN ISOLATION TRANSFORMER TO AVOID SHORTING AC LINE ENERGIZED CIRCUITS TO GROUND THROUGH THE TEST INSTRUMENT'S INPUT LEADS EXERCISE EXTREME CAUTION WHEN WORKING ON ENERGIZED CIRCUITS

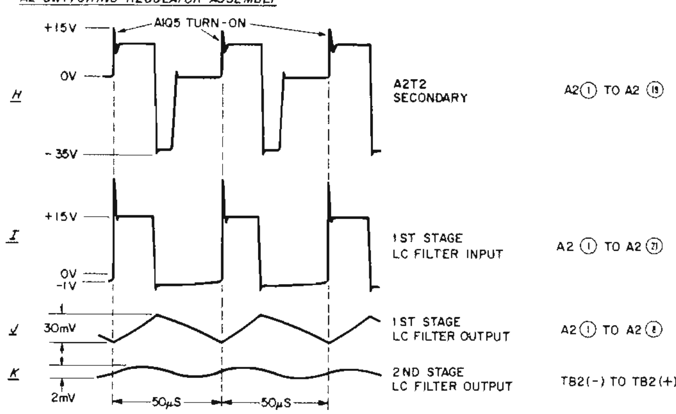
A1 CLOCK AND SWITCHING TRANSISTOR



A1 PREREGULATOR



A2 SWITCHING REGULATOR ASSEMBLY



SCHEMATIC NOTES:

1 THE MODEL 63005C IS COMPLETE ON SHEETS 1 AND 2 OF THE SCHEMATIC; THE MODEL 63315D IS COVERED BY SHEET 1 THRU 3

2 ALL COMPONENTS ARE MOUNTED ON P.C. BOARDS EXCEPT FOR ONE CHASSIS MOUNTED INDUCTOR, A4L1.

3 ——————— DENOTES CONSTANT VOLTAGE FEEDBACK PATH

4 ALL RESISTORS ARE IN OHMS, 5% 1/2W, UNLESS OTHERWISE INDICATED

5 ALL 1/8W RESISTORS ARE 1% UNLESS OTHERWISE INDICATED

6 ALL CAPACITORS ARE IN MICROFARADS

7 THE SQUARE PLATED PADS ON THE P.C BOARDS INDICATE ONE OF THE FOLLOWING

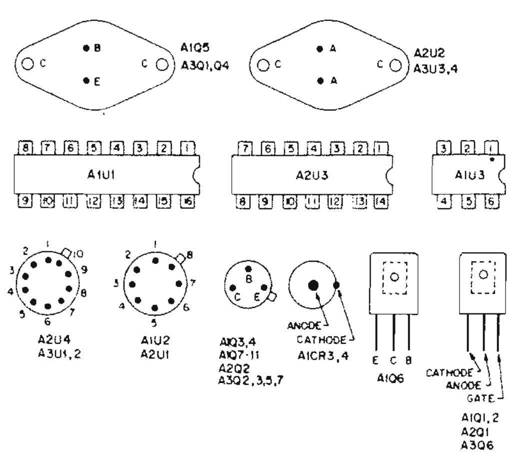
A PIN 1 OF AN I C OR TRANSFORMER
B THE POSITIVE END OF A POLARIZED CAPACITOR
C THE CATHODE OF A DIODE OR EMITTER OF A TRANSISTOR

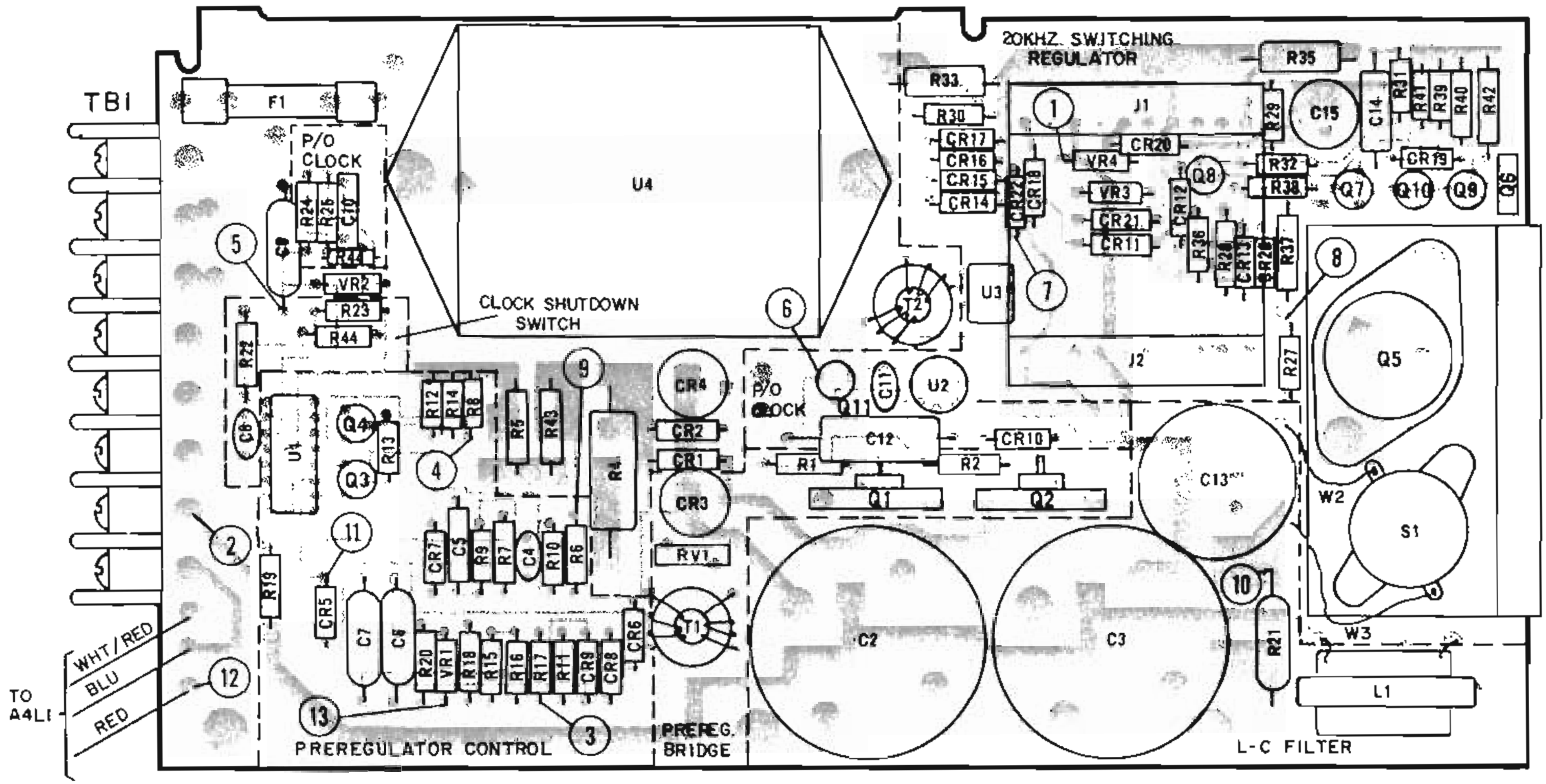
8 TO OPERATE WITH AN 87 TO 127 VAC INPUT, CONNECT JUMPERS FROM E1 TO E2 AND FROM E4 AND E5 ON TB1 FOR 180 TO 250 VAC OPERATION, JUMPER FROM E3 TO E4 ONLY

9 A CONTACT CLOSURE OR TTL CONTROL SIGNAL BETWEEN TERMINALS E6 AND THE (-SEN) OR (-) TERMINAL ON TB2 WILL SHUT DOWN ALL OUTPUTS (SEE PARA 3-28)

10 THE 5V WINDING OF A2T1 CONSISTS OF THE ANODE LEAD OF A2Q1 LOOPED THRU THE MAGNETIC CORE. THE OTHER TWO WINDINGS ARE SINGLE-TURN JUMPERS OF INSULATED WIRE DESIGNATED W1 AND W2 IN THE PARTS LIST

11 PIN LOCATIONS FOR SEMICONDUCTORS ARE SHOWN BELOW (TOP VIEWS)





Component Locations, A1 Board

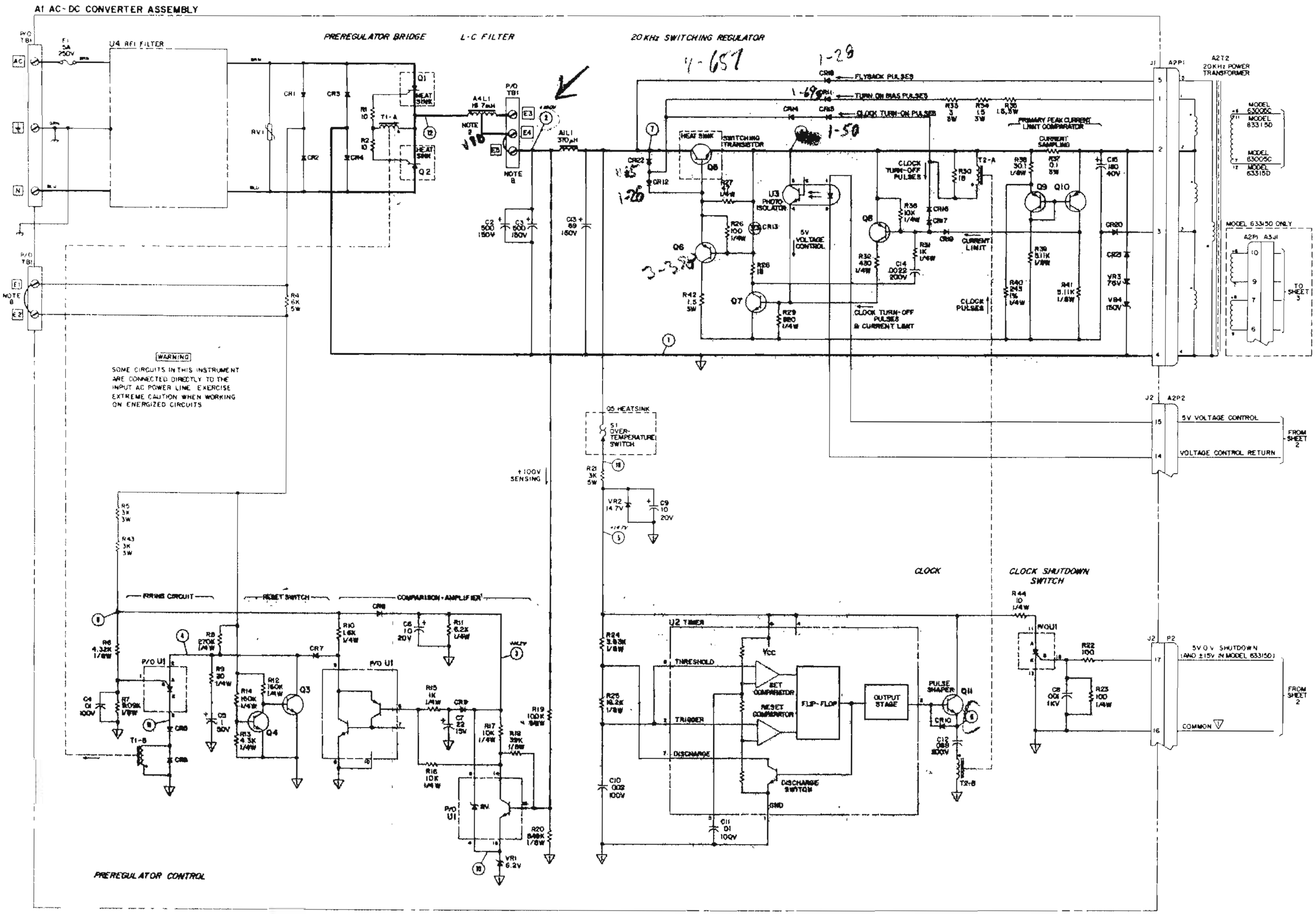
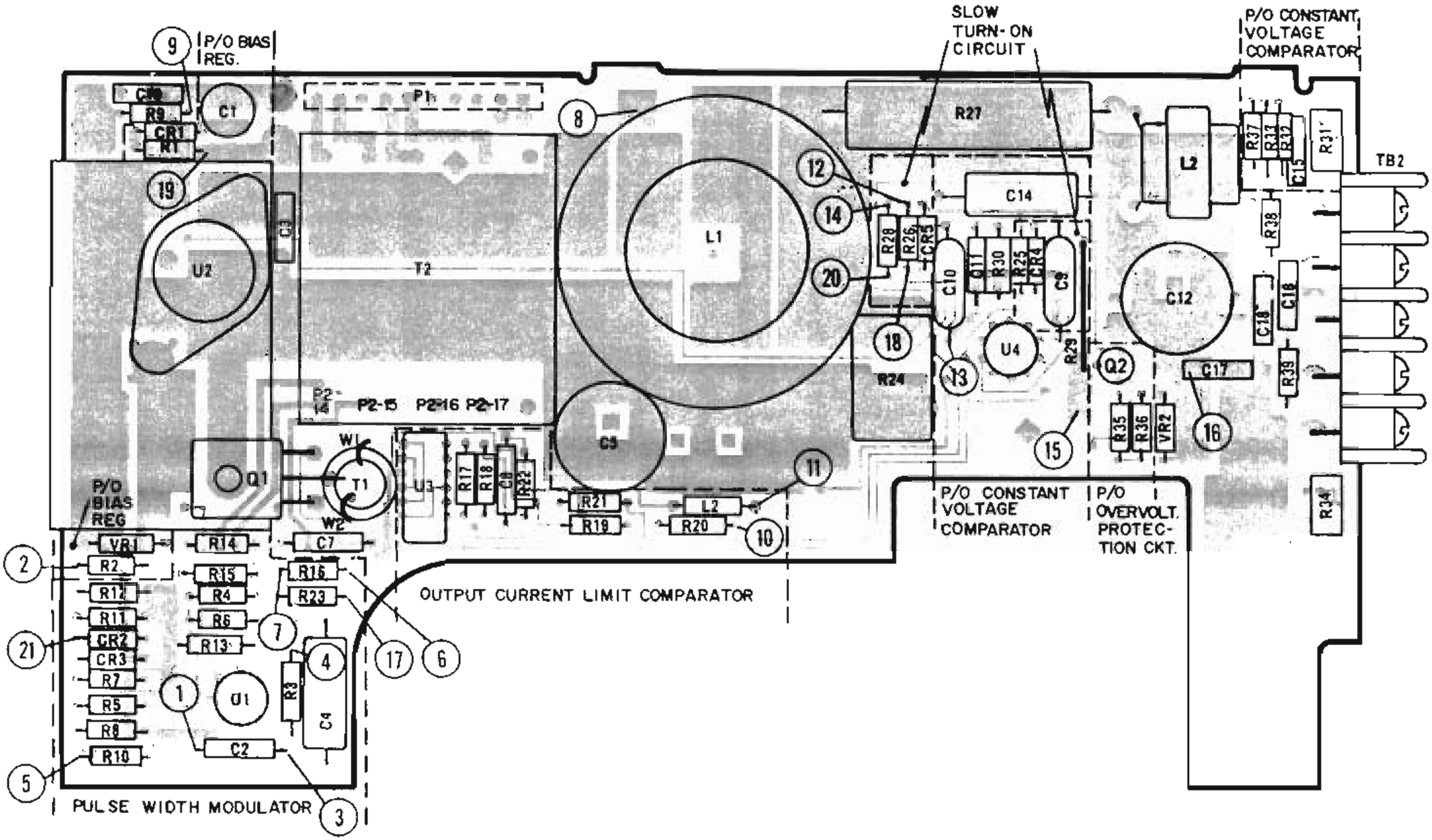


Figure 7-1 (Sheet 1). A1 Board



Component Locations, A2 Board

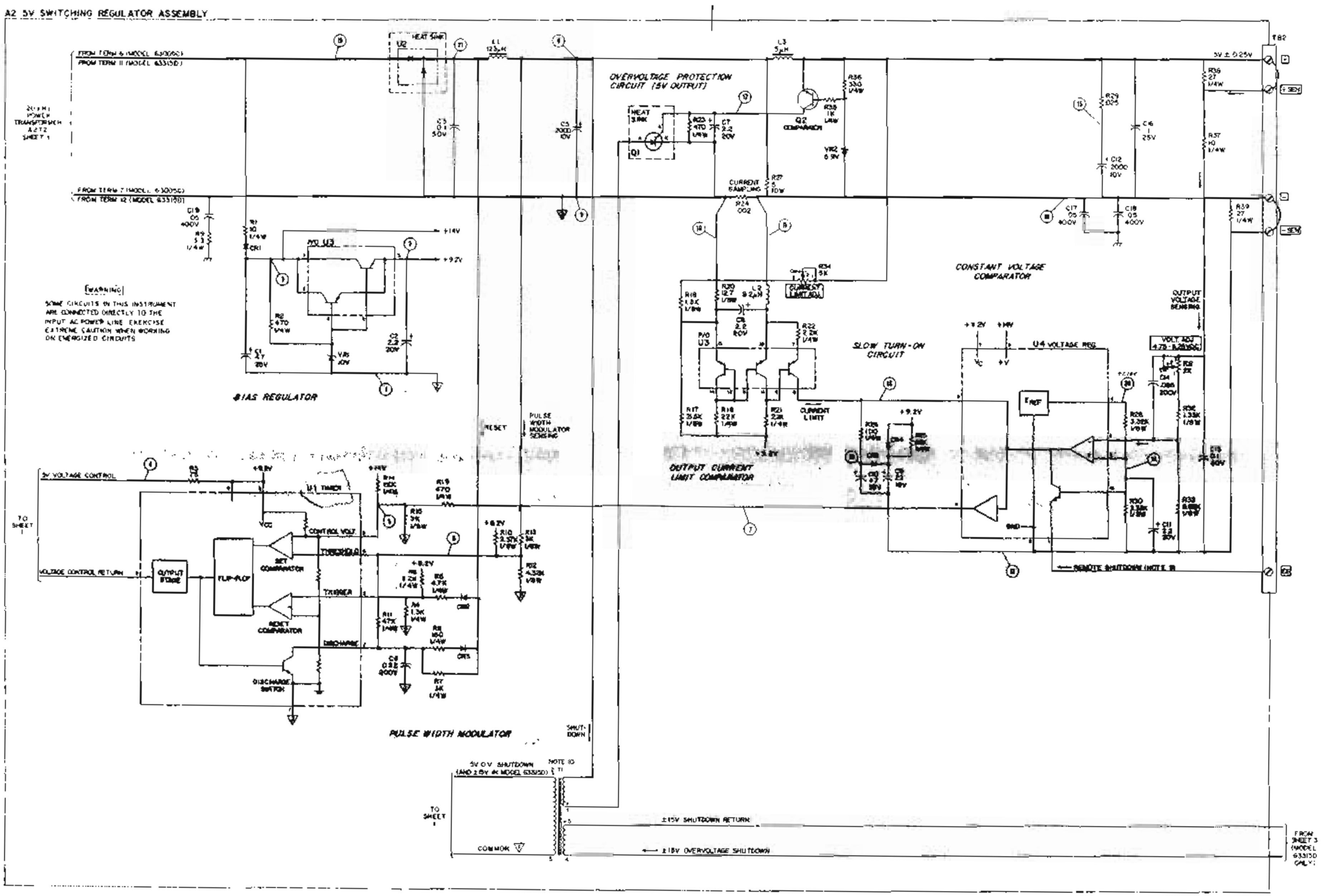
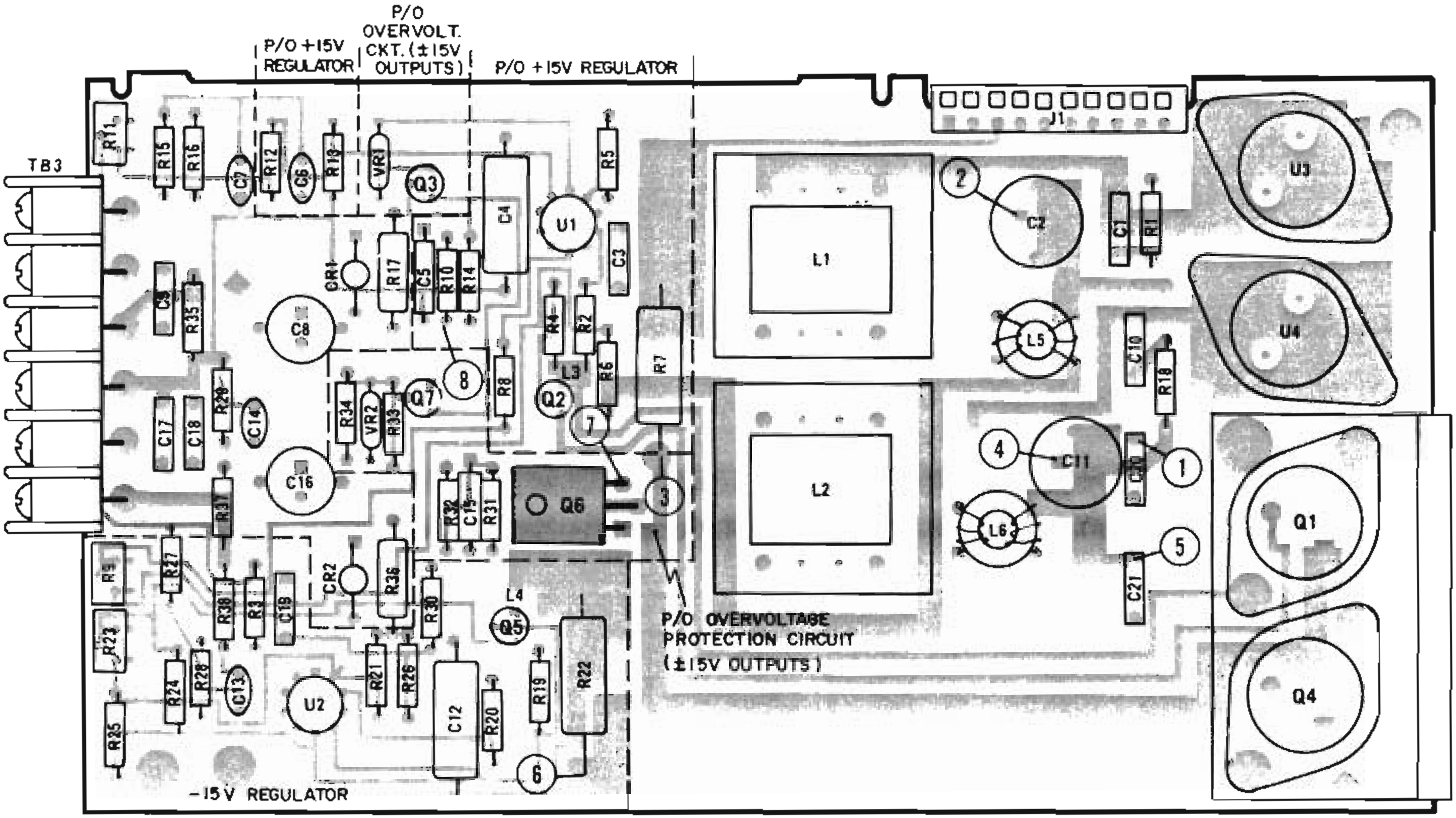


Figure 7-1 (Sheet 2). A2 Board



Component Locations, A3 Board

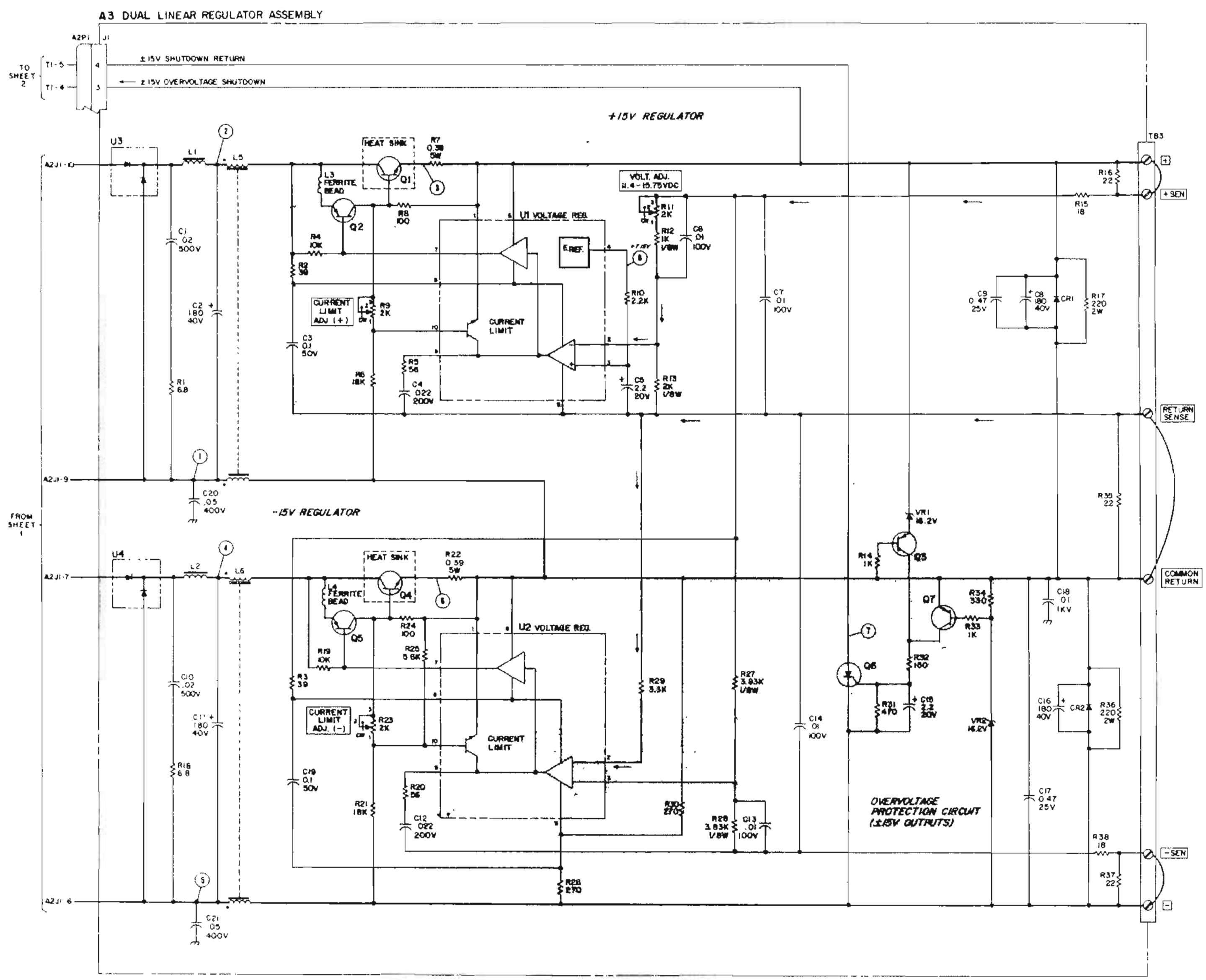


Figure 7-1 (Sheet 3). A3 Board

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