OPERATING AND SERVICE MANUAL

MODULAR POWER SUPPLIES

L AND M SERIES

MODELS 62605L, 62605M, AND 62615M

HEWLETT hp PACKARD

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OPERATING AND SERVICE MANUAL FOR:
MODEL 62605L, SERIALS 1519A-00101 AND ABOVE
MODEL 62605M, SERIALS 1518A-00322 AND ABOVE
MODEL 62615M, SERIALS 1519A-00101 AND ABOVE

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SECTION I
GENERAL INFORMATION

1-1 DESCRIPTION

1-2 These modular power supplies employ a switching-regulator design for a high degree of efficiency and compactness. All models are completely solid state, utilizing high-reliability transistors and integrated circuits. The units all feature constant voltage/current limit operation as well as overvoltage protection. The output voltage can be adjusted between ±5% of nominal, while providing full rated output current. Current limit activation is adjustable to any load current from 75% to 107% of maximum rated output. The overvoltage trip point is fixed at 120 ±6% of the nominal voltage rating.

1-3 Either the positive or negative output bus bar may be grounded or the output may be floated off ground.

1-4 The power supplies are packaged in cases of uniform dimension and can be bench operated or rack-mounted individually or side-by-side. These supplies are 1/2 rack width units.

1-5 SCOPE

1-6 This manual provides installation procedures, operating instructions, principles of operation, maintenance data, and replaceable parts information for the Hewlett-Packard modular power supplies listed in the adjacent chart. Note that the last two digits in the model number indicate the nominal output voltage of that supply.

1-7 SCHEMATIC

1-8 The modular power supplies covered in this manual are of similar design differing mainly in component values rather than in circuit operation. Hence, in general, the information presented in this manual applies to all of the power supply models with any significant differences among the supplies described as applicable. The common schematic diagram at the rear of this manual includes notes and tables to identify the differences (mainly in component values) among the supplies.

1-9 SPECIFICATIONS

1-10 Detailed specifications for the power supplies are given in Table 1-1.

MODEL	DC OUTPUT	
	NOMINAL VOLTAGE (Adj. Span)	CURRENT AT 40°C
62605M	5V (±0.25V)	100A
62615M	15V (±0.75V)	40A
62605L	5V (±0.25V)	60A

1-11 OPTIONS

1-12 Options are factory modifications of a standard instrument that are requested by the customer. The following option is available for the instruments covered by this manual.

OPTION NO.	DESCRIPTION
106	187-250Vac, 48–63Hz, single phase input: factory modification consists of various component changes. (Refer to Section II for details).

1-13 ACCESSORIES

1-14 The accessories listed below may be ordered with the power supply or separately from your local Hewlett-Packard field sales office (refer to list at rear of manual for addresses).

HP Part No.	Description
62410A	Rack Mounting Tray for mounting any combination of supplies. 19" wide, 5 1/4" high, and 17" deep. (Refer to Section II for details.)
62411A	Rack Tray Blank Front Panel, 16 1/2" wide, 5-3/16" high, 1/8" thick.
62412A	Rack Tray Blank Rear Panel, mounts on rear of rack mounting tray and allows installation of custom input/output connectors or other hardware.
62414A	Rack Tray Slides provide easy access to rack mounting tray and its supplies.

Table 1-1. Specifications

INPUT:
104-127Vac, single phase, 48-63Hz. See Option 106.

OUTPUT:
See chart, Page 1-1.

LOAD REGULATION:
Less than 0.05% for a load current change equal to the current rating of the supply.

LINE REGULATION:
Less than 0.05% for any change within the specified input voltage rating.

RIPPLE AND NOISE:
Models 62605L, 62605M: Less than 15mVrms and 50mV p-p (20Hz to 20MHz).
Model 62615M: Less than 15mVrms and 65mVp-p (20Hz to 20MHz).

TEMPERATURE RANGES:
Operating: 0 to 40°C ambient. Output current derated linearly for temperatures greater than 40°C.
Storage: −55°C to +85°C.
Cooling: Built-in fan.

TEMPERATURE COEFFICIENT:
Less than 0.02% output voltage change per degree Centigrade over the operating range from 0 to 40°C at constant load and line voltage after 30 minutes warmup.

THERMAL PROTECTION:
Heat sink mounted thermostat shuts-off output if supply overheats due to high ambient temperature. Thermostat automatically opens when temperature cools to safe operating level.

STABILITY:
Less than 0.1% total drift for 8 hours after an initial warm-up time of 30 minutes at constant ambient, constant line voltage, and constant load.

LOAD TRANSIENT RECOVERY:
Output voltage returns to within 1% of nominal in less than 600μsec (62605M) 500μsec (62605L) or 300μsec (62615M), following a full to half load change.

CURRENT LIMIT PROTECTION:
Screwdriver adjustment, factory set to approximately 105% of rated current maximum. Current is cutback to approximately 70% under short circuit conditions. Minimum adjustment range is approximately 75 to 107% of rated output current.

OVERVOLTAGE PROTECTION:
Trip Level: The trip voltage is fixed at 120 ±6% of nominal output voltage.
Trip Input: A contact closure between terminals A1 and +S can be used to remotely trip the overvoltage circuit.
Trip Output: The potential across terminals A1 and +S falls to approximately 0.8V when the overvoltage circuit trips.

VOLTAGE CONTROL:
Screwdriver adjustment accessible through hole in front panel. Minimum adjustment range is ±5%.

REMOTE SENSING:
Separate remote sensing terminals are provided which will correct for load lead voltage drops of up to 0.25V total (Models 62605M, 62605L) or 0.75V total (62615M). Load is protected if sensing terminals are inadvertently opened.

DIMENSIONS:
Refer to Figure 2-1.

WEIGHT (net/shipping):
14 lbs. (6.4kg)/18 lbs. (8.2kg)

1-15 INSTRUMENT/MANUAL IDENTIFICATION

1-16 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.

1-17 If the serial number prefix on your instrument does not agree with that 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.

1-18 ORDERING ADDITIONAL MANUALS

1-19 One manual is shipped with each power supply. Additional manuals may be purchased from your local Hewlett-Packard field office. Specify the model number, serial number prefix, and HP Part Number provided on the title page.

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 is found, a claim should be filed with the carrier immediately. Also, your Hewlett-Packard Sales and Service office should be notified.

2-3 Mechanical Check

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

2-5 Electrical Check

2-6 The instrument can be checked against its electrical specifications by using the comprehensive performance tests of Section V. Section III contains a quick check of power supply operation which can be used in lieu of the performance tests, if desired.

2-7 INSTALLATION DATA

2-8 The instrument is shipped ready for 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 Temperature

2-10 This unit is fan cooled. The space in front of the air inlet must be clear of obstruction for at least 1-inch to permit a free air flow. Although clearance along the side or bottom surfaces is not critical, at least 3/4 inch clearance above the unit is required to avoid derating.

2-11 Mounting Orientation

2-12 Figure 2-1 shows outline and dimension information. As shown, four mounting holes are provided on the bottom of the supply. The unit can be mounted in any position except upside down.

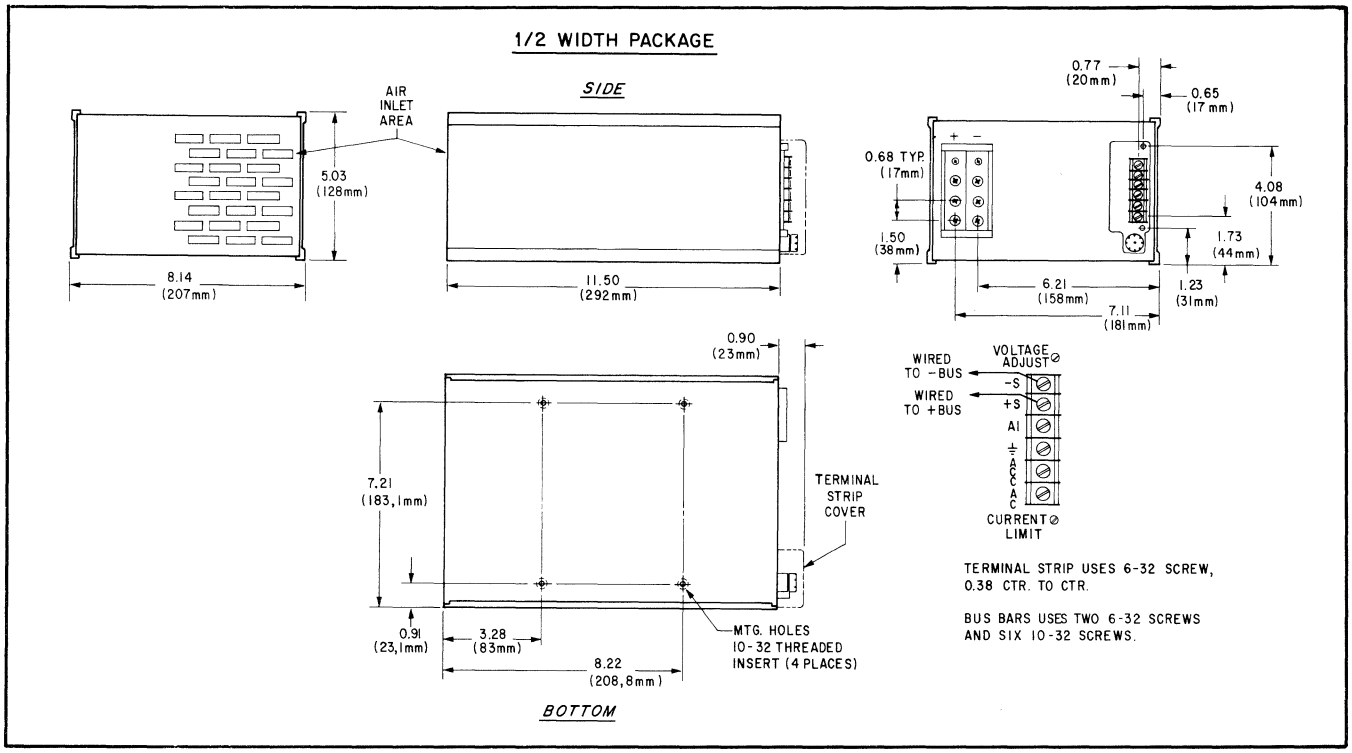


Figure 2-1. Outline Diagram

2-13 Rack Mounting

2-14 All modular power supplies can be readily mounted in any combination in a standard 19 inch rack using the Hewlett-Packard Rack Mounting Tray, Model 62410A. M and L series supplies are attached to the tray using the four 10-32 threaded mounting holes located in the bottom of the supply case. A maximum of two of these supplies can be mounted in the tray.

2-15 INPUT POWER REQUIREMENTS

2-16 The standard supply (no options) is shipped from the factory wired for 120Vac (nominal) operation and requires the input current and power shown on the following chart. Also included are the input current and power requirements for option 106 units (refer to next paragraph).

MODEL	AC INPUT		
	CURRENT (Max)		POWER (Max)
	127Vac	250Vac	@ 127Vac
62605M	11.5A	6.3A	750W
62615M	12.5A	6.8A	840W
62605L	8A	4A	450W

WARNING

Ensure that the size of the ac ground wire is at least equal to that of the other two ac input wires. This minimizes the possibility of an ungrounded chassis.

2-17 Option, 106, 187-250Vac Input

2-18 For these higher input voltages, Option 106 (a factory modification) must be ordered with your supply. This modification includes removal of rectifier jumper A2W1, described in Note 4 of the schematic, and several parts changes (fuse, transformer, cooling fan, etc.). All of the parts changes are listed in Section VI of this manual. Aside from the input rectifier configuration change associated with jumper A2W1, circuit operation for an Option 106 unit is identical to that of a standard unit and no special operating instructions are necessary.

2-19 REPACKAGING FOR SHIPMENT

2-20 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. 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.

SECTION III
OPERATING INSTRUCTIONS

3-1 TURN-ON CHECKOUT PROCEDURE

3-2 The following checkout procedures describes the use of the voltage control and ensures that the supply is operational.

a. Before connecting input power to unit, connect external voltmeter across +S and –S terminals at terminal board.

b. Connect unit to input power source using AC, ACC, and ground terminals. (Use proper wire size in accordance with the input AC current rating listed in Section II).

c. Observe output voltage of supply on external meter. Output is factory set to nominal voltage. If desired, VOLTAGE ADJUST (screwdriver control, accessible through cut out above terminal board) potentiometer can be used to set output to any voltage within ±5% adjustment span.

d. To verify operation of current limit circuit, disconnect input power and remove voltmeter. Connect low resistance current shunt (refer to Table 5-1) across output bus bars. Connect voltmeter to sampling terminals of shunt and reconnect input power. Observe that voltmeter indicates voltage proportional to 70 ±7% of the rated output current.

e. Remove shunt and voltmeter. Before connecting actual load to supply, read the following paragraphs.

3-3 OPERATION

3-4 The supply can be operated in one of two basic operating modes; normal or remote sensing. Parallel and series operation are also feasible with this supply. The following paragraphs describe all of these operating modes plus supplementary operating information. More theoretical descriptions regarding the operational features of power supplies in general are given in Application Note 90A, DC Power Supply Handbook (available at no charge from your local HP sales office).

3-5 Normal Operating Mode

3-6 The power supply is shipped with the rear terminals connected for Constant Voltage/Current Limiting, local sensing operation. This strapping pattern is illustrated in Figure 3-1. Before connecting a load to the supply, check the rear terminals to ensure that the connections are correct and that the connecting straps are tightened securely.

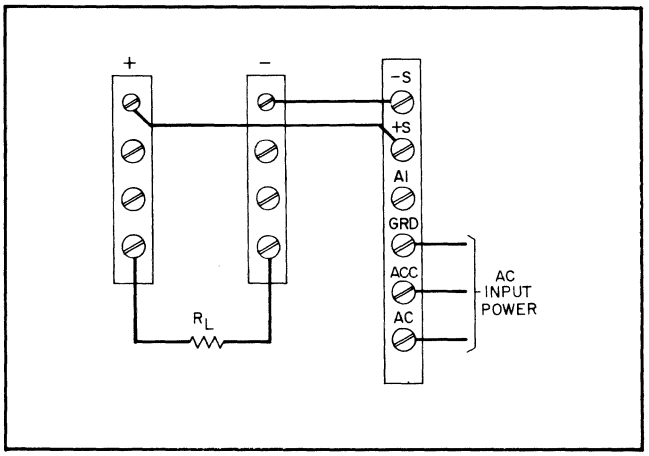


Figure 3-1. Normal Strapping

3-7 Current Limit

3-8 Figure 3-2 shows typical current limiting characteristics for this supply. As indicated on the drawing, the current limit point varies in accordance with the output voltage. As received from the factory, the initial current limit point is set to 105 ±1% of the current rating with the output voltage set at nominal value. As shown on Figure 3-2, the initial current limit point will be approximately 107% of current rating if the output voltage is set to 5% above nominal. If the factory current limit setting is not compatible with anticipated load requirements, the limit can be adjusted by means of the CURRENT LIMIT control (screwdriver adjust directly below terminal strip) as outlined in Section V. The minimum adjustment range of the current limit potentiometer is approximately 75% to 107% of the current rating. Of course, if the initial current limit point is changed, the entire cutback line will shift accordingly. For example, a current limit setting of 75% of rating will result in a short circuit cutback point of approximately 40%.

3-9 Before altering the current limit, ensure that the new current limit point is at least 1 Ampere above the expected operating current. Operating the supply too close to the current limit crossover point may result in performance degradation. In addition, it is not advisable to set the current limit point above 107% of the rated output current. Prolonged operation at these high currents could cause excessive internal heating and possible damage to the supply.

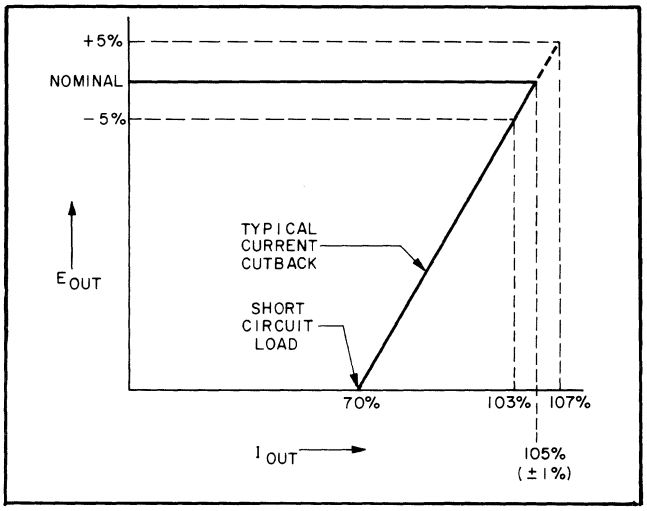


Figure 3-2. Typical Current Limiting Characteristics

3-10 Overvoltage Protection

3-11 This supply contains an overvoltage protection circuit which monitors the output voltage and turns off the supply if a fixed trip voltage is exceeded. The trip voltage, determined by fixed components in the overvoltage protection circuit, is 120 ± 6% of the supply's nominal voltage rating. The circuit is activated within 30μsec of the overvoltage condition and reduces the output voltage to near zero (less than 50mV).

3-12 Resetting. If the overvoltage circuit trips (output voltage falls to near zero) during normal operation, the circuit latches and input power must be removed to reset the supply. After removal of the ac power, disconnect any load from the power supply. Re-apply input power and determine if the overvoltage circuit again trips. If it does, there is a problem in the power supply. Refer to the troubleshooting procedures to isolate the cause of the overvoltage condition. If the supply does not trip when the load is removed, check the load circuit.

3-13 External Overvoltage Connections. Terminals A1 and +S on the rear terminal strip provide a status output indication if the overvoltage circuit trips or; conversely, can receive an external input which can be used to turn off the supply.

3-14 Output Status Signal. Terminal A1 is at approximately +15V with respect to +S under normal (no overvoltage) conditions. If an overvoltage occurs, terminal A1 falls to approximately +0.8V. Terminal A1 sources about 0.1mA in the high (normal) state and can sink 10mA in the low (overvoltage) state.

3-15 Input Trip Signal. A contact closure, or other low resistance path, bewteen terminals A1 and +S will remotely turn-off the output of the supply. Notice that the external "trip" input does not actually trip the overvoltage circuit and, therefore, the circuit does not latch. Thus, when the contact closure across terminals A1 and +S is removed, the output voltage returns to normal.

3-16 Connecting Load

3-17 Each load should be connected to the proper supply output buses 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 power supply. Each pair of connecting wires should be as short as possible and twisted or shielded to reduce noise pick-up. (If a shield is used, connect one end to power supply ground terminal and leave the other end unconnected.)

3-18 If load considerations require that the output power distribution terminals be remotely located from the power supply, then the power supply output buses should be connected to the remote distribution terminals via a pair of twisted or shielded wires and each load separately connected to the remote distribution terminals. For this case, remote sensing should be used (Paragraph 3-20).

CAUTION

When connecting load lines to output bus bars, use lockwashers and tighten securely (to within 28 to 35 inch-pounds). A loose connection will cause undue heating at the bus bars.

3-19 Grounding. Positive or negative voltages can be obtained from this supply by grounding either output line at the load (see warning below). The ac ground terminal on the supply can be used, if desired, provided it is run out to the load. This supply can also be operated at up to 40Vdc above ground, if neither output line is grounded. (Please consult your local HP sales engineer if you have a special application that requires floating the output at more than 40Vdc off ground.)

WARNING

Ground at the load only 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 result in an ungrounded chassis.

3-20 Remote Sensing (See Figure 3-3)

3-21 Remote sensing is used to maintain good regulation at the load by reducing the degradation that would occur due

to the voltage drop in the leads between the power supply and the load. Remote sensing is accomplished by utilizing the strapping pattern shown in Figure 3-3. The power supply should be turned off before changing strapping patterns. The leads from the sensing terminals to the load will carry much less current than the load leads and it is not required that these leads be as heavy as the load leads. However, they must be twisted or shielded to minimize noise pick-up.

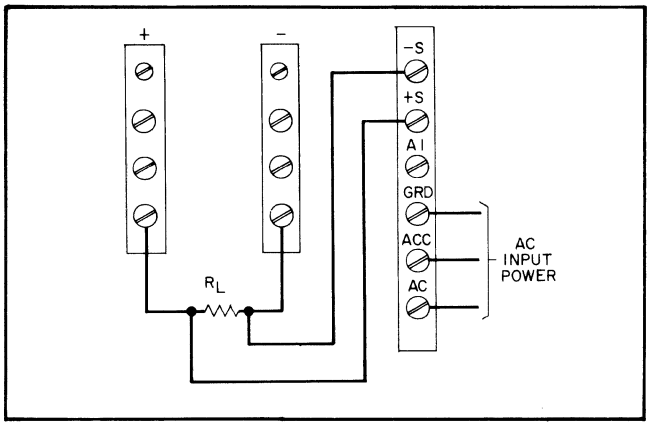


Figure 3-3. Remote Sensing

3-22 For reasonable load 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. Notice that the voltage drop in the load leads subtracts directly from the available output voltage and also reduces the amplitude of the feedback error signals that are developed within the unit. Because of these factors it is recommended that the total drop in both load leads not exceed 0.25V (0.75V for Model 62615M). If a larger drop must be tolerated, please consult your local HP sales engineer. In planning your load hook-up ensure that the load wire size is taken into account since the diameter of the load wires is related to the IT drop.

NOTE

Due to the voltage drop in the load leads, it may be necessary to readjust the current limit. Refer to Paragraoh 3-7.

3-23 Parallel Operation (Figure 3-4)

3-24 Two supplies (Maximum) can be connected in straight parallel to obtain a total output current greater than that available from one power supply. The total output current is the sum of the output currents of both supplies. The output voltage of one power supply should be set to the desired output voltage; the other power supply should be set for a slightly larger output voltage. The supply set to the higher output voltage 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.

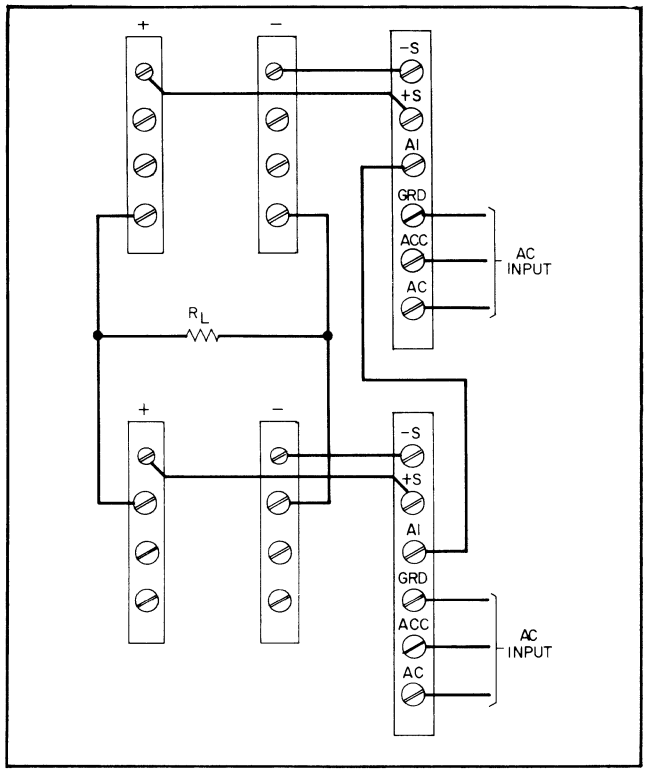


Figure 3-4. Straight Parallel Connections

3-25 The A1 Terminals on both units are connected together to permit complete overvoltage protection for the load. If an overvoltage condition occurs, the first supply that trips will then turn off the other supply via terminal A1 (Paragraph 3-15).

3-26 Two units can be connected in auto-parallel provided that certain internal circuit changes are made at the factory on a special order basis. The advantages of auto-parallel operation over straight parallel operation are equal current sharing by both units and complete control of the output current by one "master" supply.

3-27 Series Operation (Figure 3-5)

3-28 Two or more supplies (up to 40Vdc above ground) can be operated in straight series to obtain a higher voltage than that available from a single supply. When this connection is used, the output voltage is the sum of the voltages of the individual supplies. Auto-Series operation is not feasible with this type of supply.

3-29 Notice that series operation creates the possibility

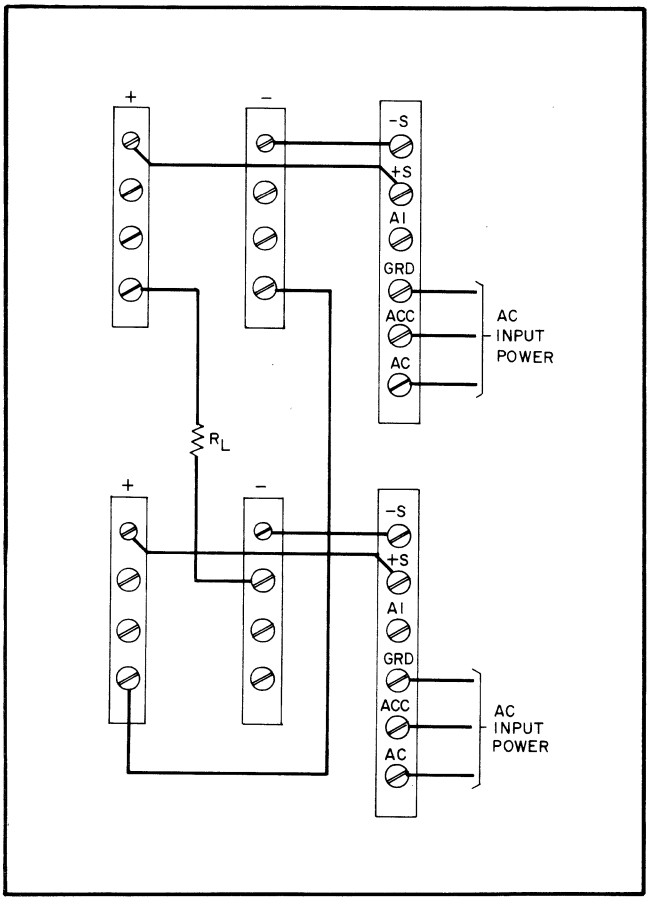


Figure 3-5. Straight Series Connections

of a reverse voltage being applied across the output terminals of the supply. If this occurs, the resultant reverse current flows through the output rectifiers (A4CR1, CR2) and the secondary of A4T1. If the unit is receiving input power, the fan is operating and no damage will occur. However, if the unit is off (no input power applied) a reverse current of more than 25% of rating will damage A4CR1, CR2 if applied for a sustained time period (approximately 25 seconds). Thus, observe the following precaution when turning on series connected units.

CAUTION

When applying ac input power to series connected units, ensure that all units are turned on within 25 seconds. Reverse current flow for more than 25 seconds will damage the output rectifiers.

3-30 The A1 overvoltage terminals cannot be connected together for series operation, as they are in parallel operation, because the common point for each overvoltage circuit is always its own + output bus. Thus, each overvoltage circuit operates independently and the supply with the lowest trip point in the series ensemble will be the first (and possibly the only) supply to trip if an overvoltage occurs.

3-31 SPECIAL OPERATING CONSIDERATIONS

3-32 Temperature

3-33 The normal operating temperature for this supply is from 0 to 40°C, ambient. Beyond 40°C, the output current is linearly derated to 60% at 70°C (derated to 50% at 70°C for Model 62605L). Additional information on temperature is given in Section II.

3-34 Overtemperature protection is provided by temperature switch (TS1) which is mounted on the tunnel assembly heat sink. This switch closes if the heat sink temperature exceeds a safe value, turning down the supply to near 0V in the same manner as the overvoltage protection circuit (Paragraph 3-11). Reset of the supply is automatic after the supply cools down so that the temperature switch can reopen. Opening and closing temperatures for the switch are given in the replaceable parts list (Section VI). The switch requires approximately 3 minutes to reopen if the cooling fan is on.

3-35 Regulator Overcurrent Protection

3-36 This supply contains a fast acting protection circuit which monitors the current flowing through the regulator switch transistors, A3Q5 and Q6. If the regulator current rises to a level that could damage the switches, the circuit becomes activated and either reduces or turns-off the output of the supply. For short duration overloads, the output is reduced; for long duration overloads, the output is turned completely off. After the regulator current drops to a safe value, the overcurrent protection circuit deactivates and allows the output to rise to normal. Hence, if the overcurrent was of a transient nature, the output will remain at normal. However, if the overcurrent condition is being caused by a faulty component, the protection circuit will be reactivated and the above process will be repeated causing the output of the supply to oscillate. If this condition occurs, proceed to Section V, Table 5-2.

SECTION IV
PRINCIPLES OF OPERATION

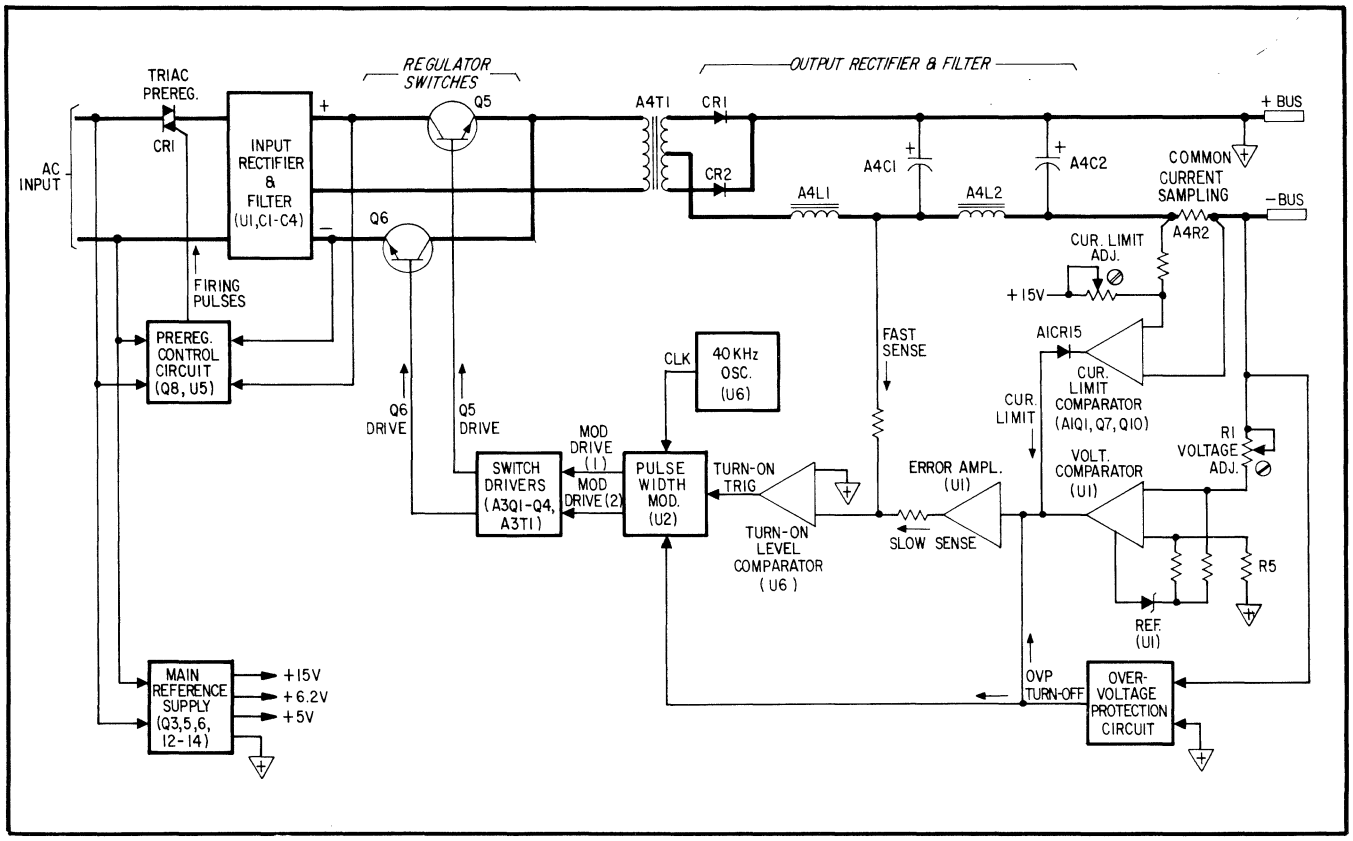


Figure 4-1. Typical Modular Switching Supply, Block Diagram

4-1 INTRODUCTION

4-2 This section contains principles of operation for the modular switching supplies. Theory is presented on both a block diagram and schematic circuit level.

4-3 BLOCK DIAGRAM THEORY

4-4 Figure 4-1 is a simplified block diagram showing the major elements of the supply. For simplification, some of the less important circuits have been omitted from the diagram. Each supply is made up of seven major elements: a preregulator triac, input rectifier-filter, a pair of push-pull switching transistors, an isolation transformer, an output rectifier-filter, a preregulator control circuit, and a pulse-width modulated feedback network which controls the regulator switches. Three supplementary circuits; current limit, overvoltage protection, and a reference voltage supply are important parts of the supply and are also shown on Figure 4-1.

4-5 Preregulator Loop

4-6 The ac input voltage is first applied to the preregulator triac which operates in conjunction with a control circuit to form a feedback loop. The preregulator feedback loop minimizes the power dissipated by the regulator switches (Q5 and Q6) by keeping the input rectifier voltage at a relatively low and constant level. To accomplish this, the control circuit issues a phase adjusted firing pulse to the triac once during each half cycle of the input ac. The control circuit continuously samples the voltage across the rectifier (for load compensation) and the input line voltage (for line voltage compensation). On the basis of these inputs, the circuit then determines at what time each firing pulse is generated.

4-7 Switching Regulator Loop

4-8 The phase adjusted output of the triac is rectified and filtered and then applied to the switching regulator transistors. These transistors, together with the switch

drivers, pulse width modulator, 40kHz oscillator, turn-on comparator, and voltage comparator, form another feedback loop which exercises a fine and "rapid" control of the output. The preregulator loop of the previous paragraph handles the large, relatively slow, regulation demands.

4-9 The feedback elements control the ON/OFF periods of the switching transistors in order to adjust the duty cycle of the rectangular waveform delivered to the output rectifier-filter. For example, if the output voltage attempted to decrease, the feedback network would sense the change and hold the switch transistors ON for longer periods of their switching cycles. An attempted increase is corrected by reducing the ON periods of the switching transistors. The output rectifier-filter rectifies and averages the bi-polar switch waveform to produce a dc output level which is proportional to the duty cycle of the waveform.

4-10 The 40kHz oscillator establishes the switching frequency of the loop with the asymetrical waveform shown on Figure 4-2. The 4μsec positive portion of the clock signal serves two purposes within the pulse width modulator. First, it alternates routing of turn-on triggers to the switching transistors; and second, it establishes a 4μsec "safety band" which clamps off both drive signals, and thus insures that the switching transistors will not both turn on at the same time. Any time during the 21μsec "operating frame" a drive signal can be started by a turn-on trigger pulse, but it will always be terminated at the next 4μsec period. From the timing relationships shown in Figure 4-2, it can be seen that the period of the drive signals (and thus the ON times of the switching transistors) depends on the position of the turn-on trigger pulse in the 21μsec frame; if it occurs early in the frame, the drive pulses will be wide; if it occurs late in the frame, the drive pulses will be narrow.

4-11 The turn-on trigger pulses are generated by a level comparator in U6. This circuit compares the output voltage at the + terminal (circuit common) with a summation of the fast and slow sense signals. The fast sense signal has the greatest effect on circuit operation and will be discussed first. This signal, taken just after the first L-C filter, has a triangular ripple component, sloping negatively when a switching transistor is ON and positively when both transistors are OFF. When the sensed voltage reaches the + output potential, (firing threshold) the comparator generates a turn-on trigger pulse. Immediately, one of the switching transistors turns ON and the output starts to slope negatively again. If the load demand increases, the sensed voltage will rise more rapidly, the trigger pulses will be generated earlier, and the switching transistors will stay ON for longer periods to supply the increased demand. Conversely, a reduced load will lengthen the positive slope, causing the turn-on trigger to occur later, and the switching transistors will conduct for shorter periods.

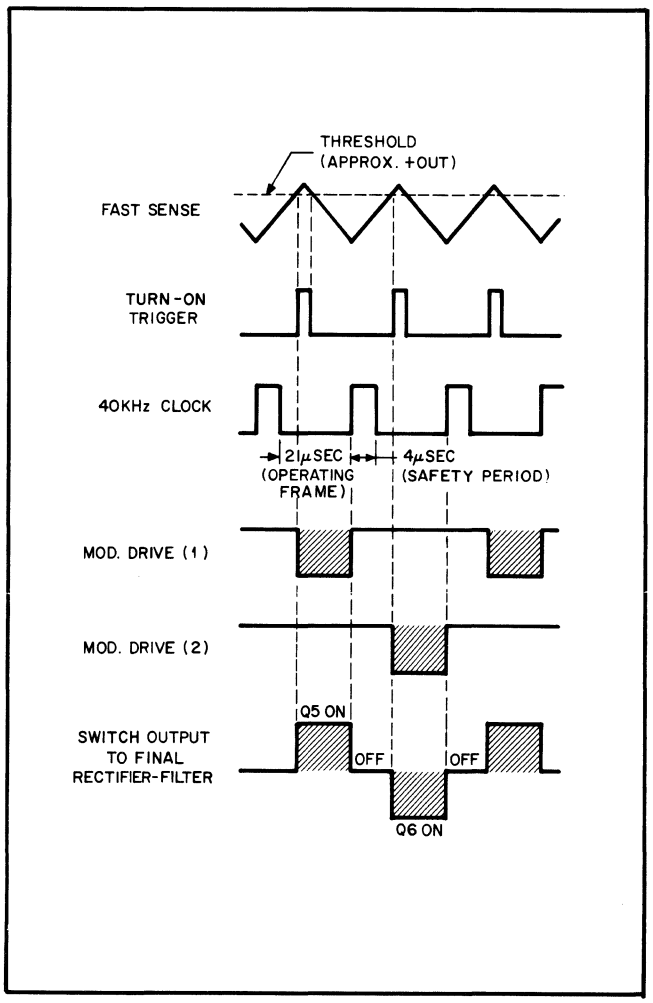


Figure 4-2. Switching Regulator Loop Waveforms

4-12 The slow sense input improves the regulation of the supply by including in the level comparison, the losses occuring between the fast sense point and the final dc output. This input is actually a slowly varying dc "bias" voltage which provides a means of making a slight correction to the fast sense waveform. A positive going slow sense voltage moves the entire fast sense waveform closer to the + out threshold resulting in the generation of an "earlier" turn-on trigger. A negative going slow sense input has the opposite effect. The slow sense voltage is produced by voltage comparator, U1, which compares the output voltage with a Zener reference voltage. Any difference between the two voltages is amplified and slowly varies the slow sense input to the level comparator.

4-13 Current Limiting Circuit

4-14 The current limit comparator monitors the output current of the supply by sensing the IR drop across a low value sampling resistor. If the load current exceeds a preset limit, (established by the current limit adjust potentiometer and the output voltage), the current limiting circuit becomes

energized and reduces the slow sense voltage applied to the level comparator. This in turn cuts back the output current.

4-15 Overvoltage Protection Circuit

4-16 This circuit monitors the output voltage of the supply. If the output voltage exceeds a preset limit (120% of the nominal rated output voltage) the overvoltage circuit will activate, clamping off the drive pulses at the pulse width modulator and turning down the slow sense voltage. This reduces the output to approximately 0-volts. Once tripped, the overvoltage circuit latches and ac power must be removed in order to reset the circuit.

4-17 SCHEMATIC THEORY

4-18 The following paragraphs contain a brief description of all of the power supply circuits. Throughout this discussion refer to the schematic diagram, Figure 7-8.

4-19 Preregulator Control

4-20 Preregulation is accomplished by means of a phase control circuit utilizing triac CR1 as the switching element. These circuits maintain a constant output voltage across rectifier package U1 by controlling the firing time of the triac.

4-21 To compute the triac firing time, the control circuit monitors two inputs; a rectified ac input ("line compensation" applied to the gate input of CR12) and the rectifier output ("E rectifier" applied to pin 4 of differential amplifier U5). The ac input compensates for variations in the ac line, while the rectifier input compensates for variations in the rectifier load (regulator switches, etc.). The rectifier input voltage is divided down and then compared with +3.6V reference voltage at pin 2 of the differential amplifier. Error voltages at the collector (pin 1) are used to control the conduction of current source Q8; which, in turn, controls the charging rate of ramp capacitor, C14. The positive end of C14 is connected to the anode (A) input of a programmable unijunction transistor CR12. This device is similar to a conventional unijunction transistor except that its firing point can be more closely controlled.

4-22 When the ramp voltage at the anode of CR12 becomes more positive (about 0.5V) than the ac gate potential (see Figure 4-3), CR12 conducts. The conduction of CR12 allows ramp capacitor C14 to discharge through pulse transformer T2 resulting in the generation of a triac firing pulse. Notice that C14 discharges rapidly, turning off CR12 and returning the ramp voltage to its starting point. At this time, the ramp capacitor begins charging up again and the previous cycle is repeated, ending with the generation of another firing pulse of a smaller amplitude. Although two,

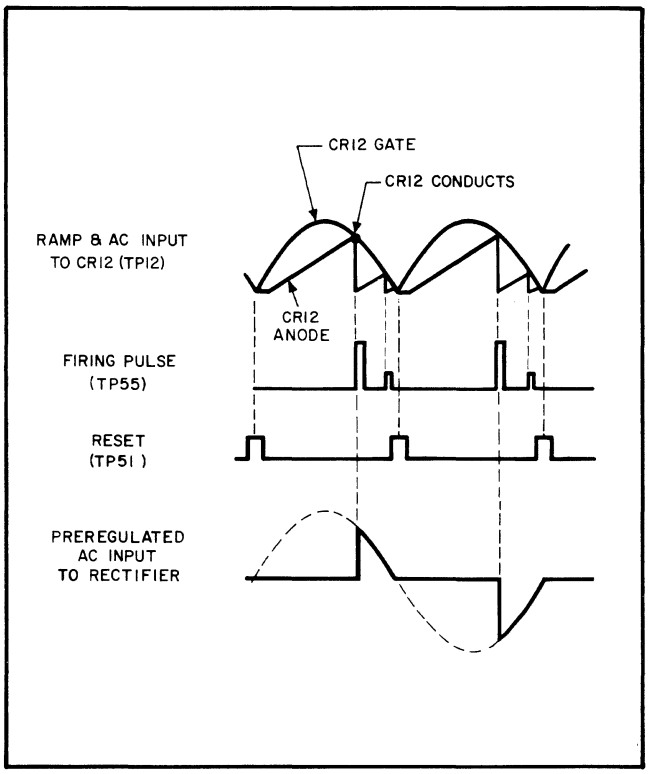


Figure 4-3. Preregulator Waveforms

or even more, firing pulses can be generated during each half cycle of the input ac, only the first firing pulse affects the operation of the preregulator. Once the triac is fired, it remains in conduction until that particular half cycle is completed. At the end of the half cycle the circuit is reset (TP51) by the conduction of U5 (pins 13 and 14) which discharges C14, ensuring that the ramp voltage always starts at the same point near the beginning of each half cycle.

4-23 How the preregulator control circuit compensates for load and line variations, can be seen by examining the ramp and ac input voltages at TP12. Notice that the slope of the ramp voltage affects the firing time of the triac. For example, a steeper ramp will result in an earlier firing time and momentary boost in the ac voltage applied to the rectifier. The magnitude of the ac input voltage applied to the gate input of CR12 also affects the triac firing time. At high line, the gate input is of course, higher, and the anode voltage of CR12 takes a longer time to reach the gate voltage. This results in a later triac firing time. The triac is fired earlier during the half cycle, if the ac input is at low line. In this manner, the preregulated ac voltage applied to the rectifier is maintained constant despite line variations.

4-24 The preregulator control circuit has its own regulated bias supply which develops the +12V and +3.6V reference voltages used by this circuit. The reference supply consists of step-down transformer T1, bridge rectifier (CR3-CR6), filter capacitor C16, series regulator Q4 and

error amplifier U5. The error amplifier senses a portion of the +12V output at its emitter (pin 9) and compares it with a +7.32V zener reference voltage connected to its emitter (pin 10). Error signals are applied directly to series regulator Q4.

4-25 Input Rectifier-Filter

4-26 The ac input to the supply is coupled through line fuse F1, an RFI filter, and triac CR1 to the input rectifier-filter circuit. This circuit consists of bridge rectifier module U1, filter capacitors A2C1 and C2, and equalization resistors A2R1 and R2. Components A2L1, L2 and C5 provide additional RFI filtering. When the supply is operated from a 120Vac source, jumper W1 is installed and the circuit functions as a voltage doubler. With a 187 to 250Vac input, the jumper wire is removed and the circuit becomes a full-wave bridge rectifier and filter. In this way, the dc voltage supplied to the switching transistors is the same (approximately 220Vdc) regardless of the ac input. (Other changes are required for a 187-250Vac input, refer to Section II, Option 106.

4-27 Regulator Switches and Drivers

4-28 The regulator switches, part of the switching regulator loop, were previously discussed in paragraph 4-7. All of these components are located on Driver Board A5A3, inside the tunnel assembly.

4-29 The driver circuit consists basically of predrivers Q1 and Q2, drivers Q3 and Q4, and a center-tapped isolation transformer, T1. As shown previously, on Figure 4-2, when the "modulator drive 1" input switches low, switching transistor Q5 conducts. Diodes CR9 and CR17 prevent Q5 from saturating too heavily by keeping the collector-emitter voltage at approximately 1.5V during conduction. The "modulator drive 2" input controls an identical switch circuit composed of Q6 and associated components.

4-30 When the modulator drive 1 signal is low, predriver Q2 is off and Q4 is on. Diode CR7 prevents Q4 from going too far into saturation. During the safety band period, when both modulator drive signals are high, driver Q4 is turned off. Filter C7 and L1 and CR4, CR8 prevent transformer overshoot from possibly turning on one of the switching transistors during the safety period.

4-31 Output Rectifier-Filter

4-32 This circuit consists of a full-wave rectifier (A5A4CR1, CR2) and a two section L-C filter A5A4L1, C1 and L2, C2. The circuit receives a bi-directional pulse-width modulated signal from the secondary of isolation transformer A4T1 and provides the necessary rectification and filtering to produce a smooth dc output voltage. Inductor L3 helps to shape the fast sense signal applied to the turn-on level comparator.

4-33 Pulse Width Modulation Circuits

4-34 This circuit generates pulse-width modulated drive signals to control the swtiching transistors. The frequency of the drive pulses is fixed at 40kHz but their width varies as a function of the position of turn-on trigger pulses received from the turn-on level comparator circuit.

4-35 Idealized waveforms for this circuit, are shown on Figure 4-4. The circuit consists of 40kHz oscillator, a buffer stage (U6), two inverters (U3), two D-type, positive-edge triggered flip-flops (U2), and two NAND gates (U3). F/F2 generates the modulated drive pulses and also controls F/F1. Two signals, the turn-on trigger pulses from U3-3 and the $\overline{CLK}$ output from U6-13, control F/F2. The 40kHz $\overline{CLK}$ signals are applied to the CLK input and each time the pulse switches low it forces the Q-output low, initiating a new 25μsec frame. The Q-output remains low until the CLK input of F/F2 is strobed by a positive turn-on trigger occurring sometime during the 21μsec "window". From the timing diagram of Figure 4-4 it can be seen that the width of the drive pulses at the Q-output of F/F2 depends on how soon a trigger pulse appears in the window. For heavy power supply loads, the trigger will occur early and widen the pulses; for light loads the trigger will occur later and reduce the pulse width.

4-36 The $\overline{Q}$-output of F/F2 controls F/F1. F/F1 is connected in a toggling configuration ($\overline{Q}$ connected back to D) so that each time the $\overline{Q}$-output of F/F2 switches high, the Q and $\overline{Q}$ outputs reverse state. The Q and $\overline{Q}$ outputs of F/F1 are logically NANDed with the Q-output of F/F2 and the results of this operation become the modulated drive signals for the switching transistors.

4-37 Notice that the CLK pulses from U3-11 are fed to inverter U3 (pin 1) where they are ORed with the turn-on triggers. These clock pulses provide the transitions necessary to ensure that F/F2 will continue to switch during periods when the supply is experiencing loading transients.

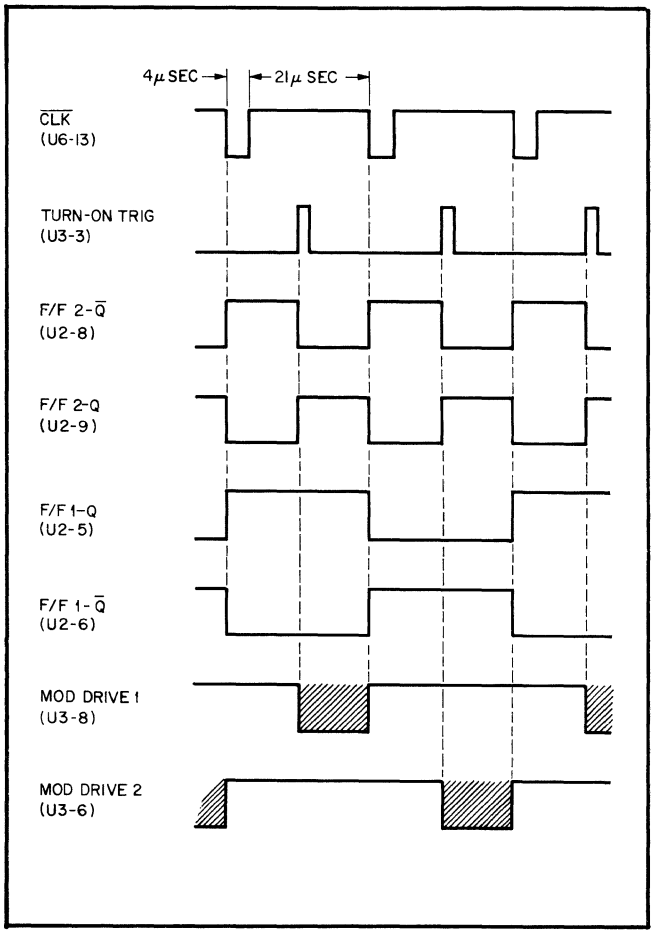


Figure 4-4. Pulse Width Modulator Waveforms

4-38 Turn-On Trigger Generation Circuits

4-39 This circuit group consists of constant voltage comparison amplifier U1, turn-on level comparator U6, and associated components. All circuits are located on card A1.

4-40 Voltage comparator U1 senses a portion of the output voltage of the supply (at the junction of R2 and R3) and compares it with a +3.6V reference voltage (junction of R4, R5). The reference voltage is obtained from a Zener diode inside the U1 package. Difference voltages are applied to the level comparator via a non-inverting error amplifier; also part of U1.

4-41 Turn-on comparator U6 performs a level comparison between a +0.6Vdc potential (forward voltage drop across CR16) at pin 7 and a voltage at pin 6 which consists of the fast sense signal from the output filter, the slow sense bias from U1, and a stabilizing signal from the equalization circuit. These three inputs are summed across resistors R9, R8, and R25 with the fast sense signal having the major influence on circuit operation. As previously shown on Figure 4-2, a turn-on trigger is initiated when the fast sense voltage rises above the +0.6V threshold potential. The trigger is terminated when the sense voltage falls below the threshold point.

4-42 Equalization Circuit

4-43 A characteristic of switching loops such as this, is that for duty cycles of less than 50% (where the OFF periods of the switching transistors become greater than the ON periods) the loop becomes unstable and will oscillate. This condition is corrected by generating an equalization ramp and summing it with the fast sense voltage to increase the positive slope of the fast sense signal during short duty cycles.

4-44 The circuit consists of an integrating capacitor (C7) and a "reset" transistor (Q2). Two input signals control the circuit; the CLK input from inverter U3 and the pulse-width modulated output of F/F2 which serves as a reset signal. As shown on Figure 4-5, when both inputs are low, Q2 is cut off and C7 is allowed to charge through R24. When either input goes high, Q2 conducts, discharging C7. The level to which C7 can charge depends on when the reset input goes high. For duty cycles of 50% or greater, C7 has little time to charge. For shorter duty cycles, C7 is allowed to charge for a longer period and the stabilizing signal becomes more positive.

4-45 Current Limiting Circuit

4-46 This circuit ensures that the output current of the supply does not exceed the level set by the CURRENT LIMIT adjust potentiometer, R15. During normal (constant voltage) operation. Q10B is on holding Q1 and CR15 off. Current limiting occurs if the output current becomes high enough to turn on Q10A. Transistor Q1 is then allowed to

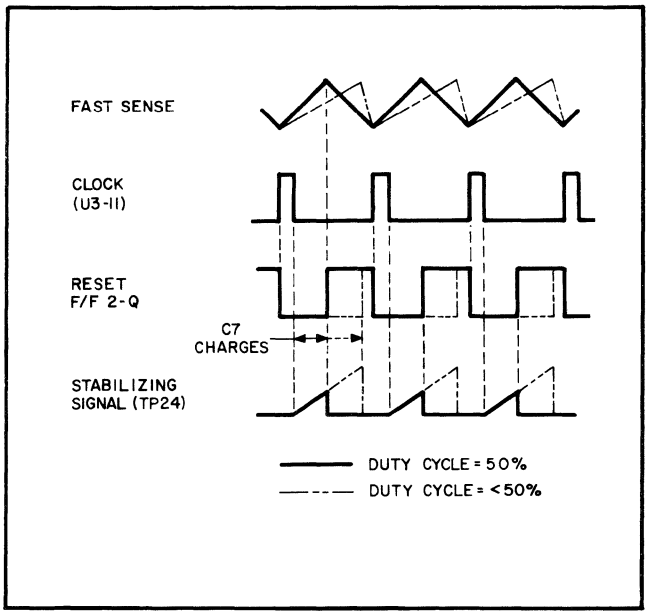


Figure 4-5. Equalization Waveforms

conduct, forward biasing isolation diode CR15, and applying a negative going signal to pin 13 of error amplifier U1. The feedback network then causes the output voltage of the supply to decrease and thus limit the load current.

4-47 Transistor Q7 speeds-up the action of the current limiting circuit during severe (short circuit) overload conditions. This transistor conducts for a short period (due to the heavy conduction of Q1) at the beginning of the overload, discharging capacitors C12 and C5. After the capacitors have been discharged, Q7 turns-off and remains off unless the supply is again short circuited.

4-48 The current limiting circuit contains a current cutback feature which minimizes power dissipation in the switching transistors. As the load resistance decreases, the output current is cutback linearly to approximately 70% of rated output current under short circuit conditions (see Figure 3-2). Cutback is made possible by R11 and R12 which are connected across the output of the supply. Under short circuit conditions, the current flow through R11, R12 decreases, driving the emitter of Q10A more negative. Q10A and Q1 then conduct even harder, further increasing the OFF periods of the switching transistors and thus cutting back the output current.

4-49 Overvoltage Protection Circuit

4-50 This circuit consists of comparator A1U5 and driver A1Q9. When the output voltage of the supply is below the trip voltage (120% of nominal), Q9 is off and associated isolation diodes CR27 and CR28 are reverse biased.

4-51 Comparator U5 continuously compares a portion of the output voltage (pin 4) with a 3.1Vdc reference voltage at pin 5. If the output voltage exceeds the trip level (established by voltage divider resistors R64-R67) the output of U5 becomes sufficiently positive to turn-on Q9. With Q9 on, its collector voltage drops to near 0V. Diode CR19 couples this low level back to U5, pin 4, to latch the circuit in the tripped state. With Q9 latched in the on state, diode CR27 becomes forward biased holding F/F2 (in the pulse width modulator) in the clear state. This removes the drive pulses, cutting off the switch transistors and decreasing the output voltage to approximately 0 volts. To avoid a recovery overshoot when the unit is reset, a "turn-down" signal is also sent to the slow sense circuitry via CR28, CR20, and R69.

4-52 External trip inputs are coupled to both the pulse width modulator (CR21) and the slow sense circuits (CR20) in the same manner as the internal trip signal. However, isolation diode CR28 is reverse biased at this time and the overvoltage circuit will not latch due to an external trip input.

4-53 Regulator Overcurrent Protection Circuit

4-54 This circuit ensures that the internal current flowing through regulator switches A5A3Q5 and Q6 does not exceed a level (approximately 130% of normal) which could damage the switches. The circuit monitors the switch current by means of input transformer A5A6T1. This transformer serves as the secondary winding of the transformer, while the wire that is in series with power transformer A4T1 serves as the primary of the input transformer. The wire is run physically through the center of the A6T1 core and, thus, induces the current flowing along the wire into the secondary winding. The rectangular input current is rectified by CR1-CR4 and the magnitude of the resultant voltage across R3 is proportional to the current through the regulator switches. During normal operation, the voltage across R3 is not high enough to break down Zener diode VR1 and transistor Q1 is therefore held off. However, if the regulator current exceeds the 130% threshold, VR1 breaks down allowing Q1 to conduct. The output of Q1 is fed to both the pulse width modulator (via diode A1CT21) and to the slow sense circuitry (via A1CR20) turning off the supply in the same manner as the overvoltage protection output (Paragraph 4-51). Once the regulator current drops below the threshold, Q1 turns off and the supply resumes normal operation unless the overload was caused by a component failure.

4-55 Main Reference and Driver Bias Supplies

4-56 The main reference supply produces three operating voltages (+15V, +6.2V, and +5V) for the other circuits of the supply. It also provides a +14V start-up bias for the driver circuits until the driver bias supply can begin to produce the +17V takeover bias. The main reference supply has a turn-on delay of approximately one-second before it begins to provide any of the above operating voltages. The delay period permits the preregulator to stabilize before the switching transistors and other control circuitry are allowed to operate. The one-second delay is obtained by capacitor C20 which controls the conduction of current source, Q6. When power is first applied, C20 begins charging through R72. Switch transistor Q13 is off at this time, holding off differential error amplifier (Q3, Q12) and series regulator Q5. As the charge on C20 increases, Q6 conducts more heavily until Zener diode VR4 breaks-down and Q13 turns-on. With the emitter path to Q3 and Q12 completed, Q5 is allowed to conduct and the reference supply begins to product its output voltages. Transistor Q14, which acts as a control switch, also conducts at this time. Diode CR22 is then forward biased providing a start-up voltage of approximately +14V to the switch driver circuits. As the regulator switches begin to cycle, the driver bias supply begins operating and quickly provides the +17V takeover bias to the driver circuits. When this occurs, CR22 becomes

reverse biased and the start-up bias voltage is removed.

4-57 Additional Protection Features

4-58 Aside from the normal protection provided by the current limit, overvoltage, and regulator overcurrent protection circuits, the supply also contains several special purpose components which protect the supply in case of unusual circumstances. One of these components is thermal switch TS1 which closes if the heat sink temperature exceeds a safe value (approximately 200°F). With TS1 closed, diode CR21 becomes forward biased shutting off the modulator drive pulses in the same manner as the overvoltage and overcurrent protection circuits, (Paragraphs 4-51 and 4-54). The switch automatically opens after the supply has cooled sufficiently (nominally 140°F) and normal operation resumes, unless TS1 closed as a result of a failure.

4-59 Sensing protection resistors A1R73 and R74 prevent the load from receiving a higher than normal voltage if the connections between the output bus bars and the sensing terminals (+S and −S) are removed inadvertently.

4-60 The output rectifier diodes, A4CR1-CR2, provide a path for any reverse currents which could be injected into the supply by an active load. The supply can sink up to 25% of rated output current under steady state conditions; or 100% of rated output current for shorter time periods (approximately 25 seconds).

SECTION V
MAINTENANCE

5-1 INTRODUCTION

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

5-3 If a fault is detected in the power supply while making the performance check or during normal operation, proceed to the troubleshooting procedures (Paragraph 5-33). After troubleshooting and repair (Paragraph 5-44) repeat the performance check to ensure that the fault has been properly corrected and that no other faults exist. Before performing any maintenance checks, 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.

Table 5-1. Test Equipment Required

TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
Digital Voltmeter	Sensitivity: 100mV full scale (min.). Input impedance: 10 megohms (min.).	Measure DC voltages: calibration procesures and troubleshooting.	HP 3450A
Variable Voltage Transformer	Range: 90–130Vac (Higher for option 106). Equipped with voltmeter accurate within 1 Volt.	Vary ac input for line regulation test.	– – –
Oscilloscope	Sensitivity: 10mV/cm. Differential input.	Display waveforms for testing and trouble-shooting.	HP 140B plus 1400B plug-in. 1402A plug-in for noise measurements.
Frequency Counter	Freq: 100kHz Accuracy: 0.01% Input Imp: 1 Meg.	Adjust oscillator frequency.	HP 5300A counter plus 5301A plug-in.
Resistive Load	Value: See Paragraph 5-11 Tolerance: ±5%	Power supply load resistor. (Fixed resistor or Rheostat.)	James G. Biddle Carbon Pile Rheostat Number 10.
Current Sampling Resistor (Shunt)	Value: See Paragraph 5-13. Accuracy: 1% (minimum).	Measure output current.	62605M: Simpson Shunt, Model 06713, 5mV @ 100A. 62605L: Simpson Shunt, Model 06711, 50mV @ 75A. 62615M: Simpson Shunt, Model 06709, 50mV @ 50A.

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 5-33).

5-8 Measurement Techniques

5-9 Connecting Monitoring Device. For the following Constant Voltage measurements, the measuring device must be connected across the rear sensing terminals of the supply in order to achieve valid indications. A measurement made across the load includes the impedance of the leads to the load and such lead lengths can easily have an impedance that is greater than the supply impedance, thus invalidating the measurement. To avoid mutual coupling effects, each monitoring device must be connected directly to the sensing terminals by separate pairs of leads.

5-10 Avoid Current Limiting. When measuring the constant voltage performance specifications, the current limit point should be set at least 1 Ampere above the maximum output current which the supply will draw, since the onset of current limiting action will cause a drop in output voltage, increased ripple, and other changes not properly ascribed to the constant voltage operation of the supply. The current limit potentiometer is factory set to 105±1% of the rated output current.

5-11 Selecting A Load Resistor. Constant voltage specifications are checked with varying amounts of load resistance connected across the supply. Where a "full" load resistance is required, the value and wattage of the resistor must permit operation of the supply at its rated (100%) output voltage and current. For example, a supply that is rated at 5 volts at 100A (Model 62605M) would require a load resistance of 0.05 ohm. The wattage rating of the 0.05 ohm resistor would have to be 500 watts, minimum.

5-12 Either fixed or variable resistors (rheostat type) can be used as load resistors. A rheostat is convenient when changing load resistances and when measuring the output current of the supply. A rheostat of the type recommended in Table 5-1 is adequate for any supply covered by this manual. This device is used in conjunction with a sampling resistor and voltmeter to accurately set the output current (refer to next paragraph). If fixed load resistors are used, their tolerances must be accounted for in evaluating the test results.

5-13 Output Current Measurements. For accurate output current measurements a current sampling resistor should be inserted between the load resistor(s) and the output of the supply. An accurate voltmeter is then placed across the sampling resistance and the output current at any time can be calculated by dividing the voltage across the sampling resistor by its ohmic value. The total resistance of the series combination (sampling resistor and load resistor) should be equal to the desired load resistance as outlined in the preceding paragraphs. Of course, if the value of the sampling resistance is very low when compared to the full load resistance, the value of the sampling resistance may be ignored. The meter shunt recommended in Table 5-1, for example, is only 0.5 milliohm and can be neglected when calculating the load resistance of the supply.

5-14 Figure 5-1 shows a four terminal meter shunt. The load current is fed to the extremes of the wire leading to the resistor while the sampling terminals are located as close as possible to the resistance portion itself.

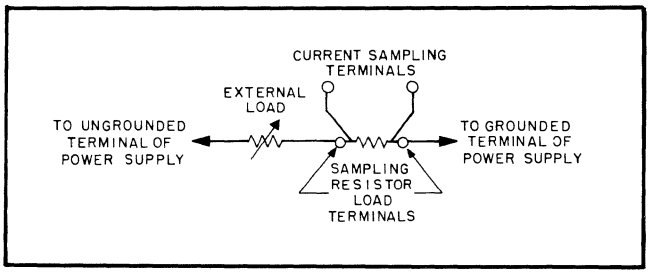


Figure 5-1. Current Sampling Resistor Connections

5-15 Rated Output

5-16 Voltage. To ensure that the supply will furnish rated output voltage, proceed as follows:

a. Connect digital voltmeter across +S and -S terminals of supply observing correct polarity.

b. Apply input power to supply.

c. With no load connected, set output voltage of supply to any value desired within adjustment span. This output voltage can be used for all remaining constant voltage tests.

d. With supply off, connect full load resistance across + and - output terminals of supply (see Paragraph 5-11).

e. Reconnect input power to supply. Voltmeter should read output voltage set in Step c (within tolerances of load resistor and meter).

5-17 Current. To ensure that the supply will furnish the maximum rated output current, proceed as follows:

a. Connect test setup shown in Figure 5-2. Select load and current sampling resistor values according to Paragraphs 5-11 and 5-13.

b. Apply input power to supply and adjust R_L until digital voltmeter indicates a voltage drop which is

proportional to the maximum rated output current.

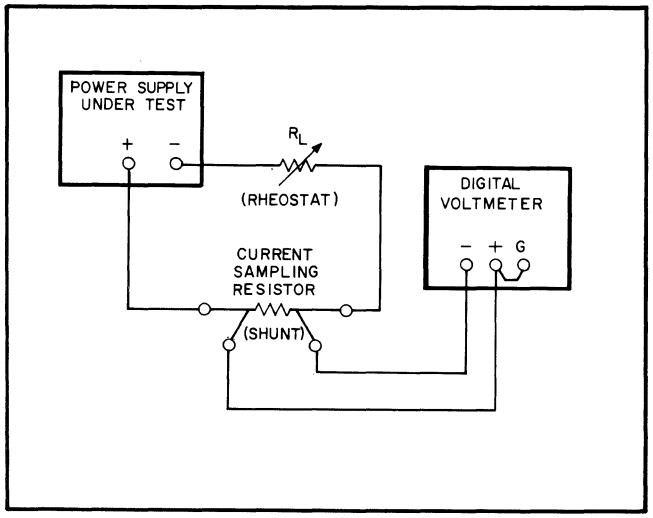


Figure 5-2. Output Current, Test Setup

5-18 Load Regulation

Definition: The change, ΔE_{OUT}, in the static value of dc output voltage resulting from a load change from 0 to 100% (or vice versa) of rated output current.

5-19 To check load regulation, proceed as follows:

a. Connect full load resistance across output bus bars (Paragraph 5-11).

b. Connect digital voltmeter across ±S terminals.

c. Apply input power and record output voltage on voltmeter.

d. Disconnect load resistance.

e. Reading on voltmeter should not vary from reading of step c by more than 0.05%.

5-20 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 (usually 104 Volts) to high line (usually 127 Volts), or from high line to low line.

5-21 To test the line regulation, proceed as follows:

a. Connect variable auto transformer between input power source and power supply power input terminals.

b. Connect load resistance and digital voltmeter across output of supply.

c. Adjust variable auto transformer for low line input.

d. Turn on setup. Read and record output voltage on digital voltmeter.

e. Adjust variable auto transformer for high line input.

f. Reading on digital voltmeter should not vary from reading recorded in step d by more than 0.05%.

5-22 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 (preferably) its peak-to-peak value.

5-23 Ripple and noise measurement can be made at any input AC line voltage combined with any DC output voltage and load current within rating.

5-24 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 magniture 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.

5-25 The same ground current and pickup problems can exist if an RMS voltmeter is substituted in place of the oscilloscope in Figure 5-3. However, the oscilloscope display, unlike the true RMS meter reading tells the observer immediately whether the fundamental period of the signal displayed in 8.3 milliseconds or 16.7 milliseconds (10 or 20 milliseconds for a 50Hz input). Since the fundamental ripple frequency present on the output of an HP supply is 120Hz (due to full-wave rectification), an oscilloscope display showing a 120Hz fundamental component is indicative of a "clean" measurement setup, while the presence of a 60Hz fundamental usually means that an improved setup will result in a more accurate (and lower) value of measured ripple.(For a 50Hz power input, the frequencies would be 100Hz or 50Hz.)

5-26 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. Note that to ensure that no potential difference exists between the supply and the

oscilloscope, it is recommended that whenever possible 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. The terminating resistor (R_T) must be physically connected as close as possible to the output terminals of the supply and its value should match that of the coaxial cable.

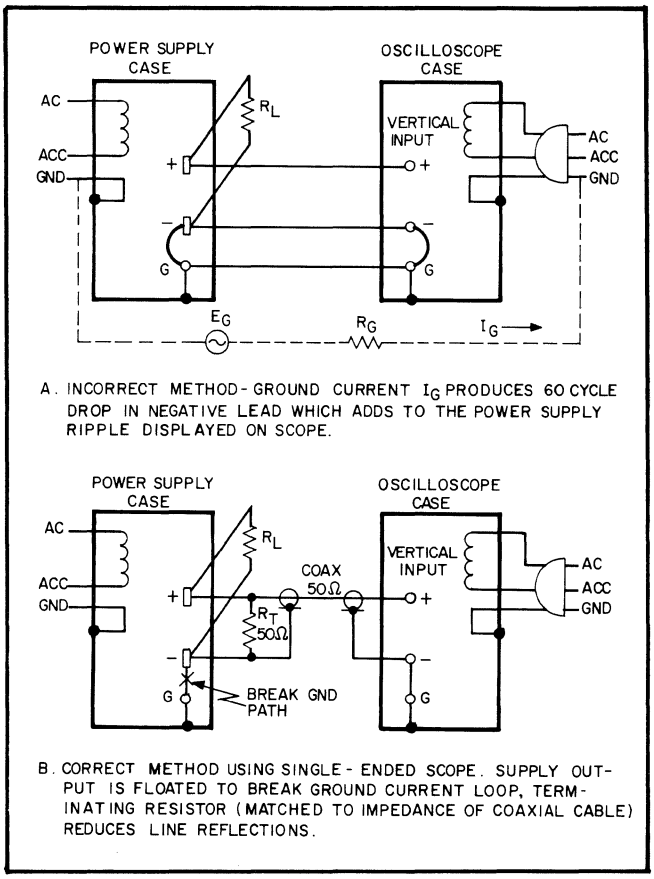


Figure 5-3. Ripple and Noise, Test Setup

5-27 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.

5-28 Ripple and/or noise output measurement procedures are given in the following steps. If a high frequency noise measurement is desired, an oscilloscope with sufficient bandwidth (20MHz) must be used. To measure the ripple/noise output, proceed as follows:

a. Connect oscilloscope or RMS voltmeter as shown in Figure 5-3B.

b. Connect full load resistance across supply (Paragraph 5-11).

c. Connect input power and observe ripple or noise. It should be less than 15mV rms or 50mV p-p (65mV p-p for Model 62615M).

5-29 Load Transient Recovery

Definition: The time "X" for output voltage recovery to within "Y" millivolts of the nominal output voltage following a "Z" amp step change in load current — where: "X" = time given in Figure 5-5, "Y" = 1%, and "Z" is the specified load current change, equal to half of the current rating of the supply. The nominal output voltage is defined as the DC level half way between the static output voltage before and after the imposed load change.

5-30 Transient recovery time may be measured at any input line voltage combined with any output voltage and load current within rating.

5-31 As shown in Figure 5-4, a hand-operated switch is used to switch between half and full load operation. The resultant one-shot displays are observed on an oscilloscope. A storage type oscilloscope, such as the HP Model 181A, is useful when attempting to observe the single shot events. Each load resistor is twice the normal full load resistance (Paragraph 5-11). The switch must be capable of handling at least half of the supply's output current and care should be taken so that contact "bounce" does not mask the true transient recovery waveform.

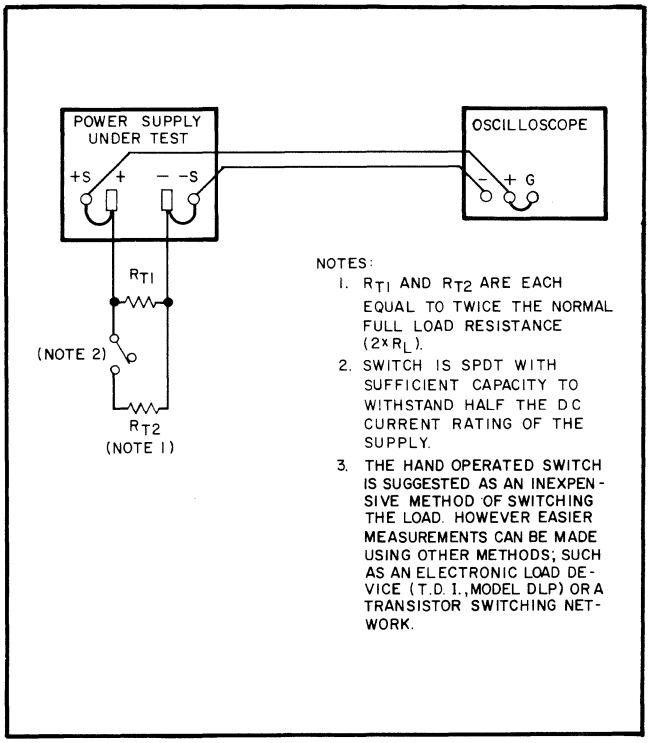


Figure 5-4. Transient Recovery Time, Test Setup

5-32 To check the load transient recovery, proceed as follows:

a. Connect test setup shown in Figure 5-4.

b. Close then open switch and observe oscilloscope display.

c. Recovery should be within the tolerances given in Figure 5-5.

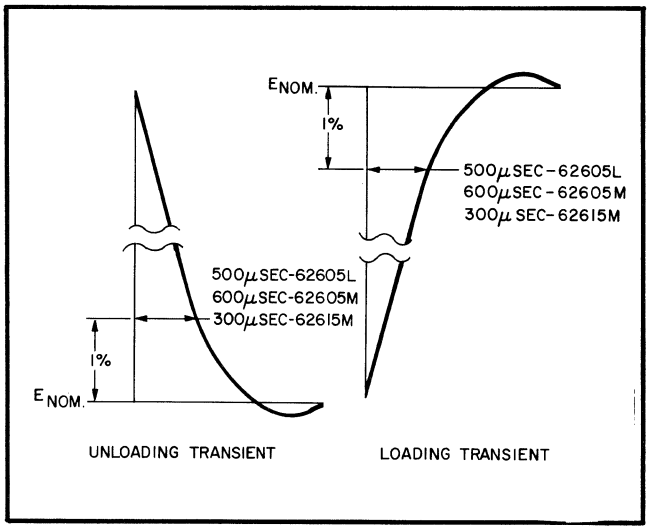


Figure 5-5. Transient Recovery Waveforms

5-33 TROUBLESHOOTING

5-34 Before attempting to troubleshoot this instrument, ensure that the fault is with the instrument itself and not with an associated circuit. The performance test enables this to be determined without having to remove the covers from the supply.

5-35 A good understanding of the principles of operation is a helpful aid in troubleshooting, and it is recommended that the reader review Section IV of the manual before attempting to troubleshoot the unit in detail. Once the principles of operation are understood, refer to the following paragraphs in sequential order.

5-36 Initial Troubleshooting Procedures

5-37 If a malfunction occurs, proceed as follows:

(1) Note output condition of supply (0V output, low output voltage, etc.); then disconnect input power and remove all loads from unit.

(2) Reconnect input power and proceed to appropriate troubleshooting procedure according to following symptoms:

a. 0V output (most common failure sympton); proceed to Figure 5-6.

b. Low output voltage (below minimum rating); proceed to Figure 5-7.

c. Normal output voltage; unit was in overvoltage or thermal protection mode. Allow unit to run for about 30 minutes. If output falls to 0V again, proceed to Figure 5-6. If output remains normal, line or load transient may have tripped overvoltage circuit. Connect load and operate unit normally.

NOTE

If overvoltage circuit continually trips during operation, check load circuit for element causing severe unloading transient, e.g., full load to no load changes in output current.

d. High output voltage (above maximum rating); this symptom is unlikely to occur because it requires a failure both in the overvoltage protection circuit and one of the regulation circuits. If this failure does occur, repair inoperative overvoltage circuit (Q9 open, U6 faulty) first; then proceed to Figure 5-6.

e. Excessive ripple; proceed to Table 5-3.

f. Poor load regulation; proceed to Paragraph 5-42.

WARNING

Various components on the chassis, A1 control board, and tunnel assembly are operated at ac line potential. The following paragraphs list these components and describe a method of removing the input ac before troubleshooting the A1 board.

5-38 Avoiding Safety Hazards. The following components (or circuits) are tied directly, or indirectly, to the ac power line: A1L1, L2, A5B1, CR1, U1, A5A3Q5, Q6 and all parts in the power leads on the primary side of isolation transformer A5A3T1 (see schematic). Also tied to the power line are the preregulator control and reference supply circuits on the A1 control board.

5-39 When troubleshooting the preregulator feedback loop, ac must be applied to the unit and the repairman must exercise extreme caution when working in the areas designated above. However, if a trouble is isolated to the switching regulator loop, ac can be removed from the unit and the switching regulator control circuitry can be powered with an external dc source. The external source must be capable of providing 20V at 2 Amperes and is connected as shown in Figure 5-9. With this setup, all of the A1 control circuits (pulse width modulator, 40KHz oscillator, etc.,) are operational and troubleshooting of these circuits can proceed without ac hazards. Notice that the switching transistors (A5A3Q5 Q6) are not operational with this setup (no input

from filter board A2). However, troubles isolated to this area can be localized by means of the resistance checks given in Table 5-2.

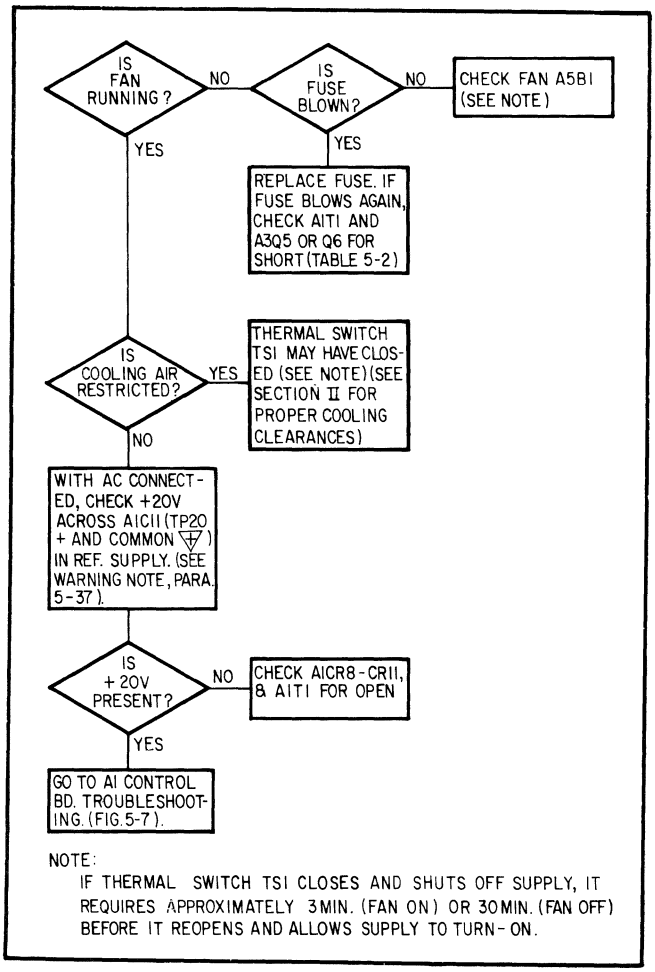


Figure 5-6. 0V Output Troubleshooting

5-40 Tunnel Assembly Troubleshooting

5-41 Component failures in tunnel assembly A5 can be quickly found with ohmmeter checks at the semiconductor junctions. Normal indications are either one silicon diode forward drop or an open circuit as indicated in Table 5-2. If a shorted junction is found, associated components should also be checked in case of multiple failures.

WARNING

Disconnect ac input power before performing the resistance checks of Table 5-2.

5-42 Poor Load Regulation Troubleshooting

5-43 Before troubleshooting the supply, recheck the load regulation test setup as outlined in the performance measurements portion of this section. Also, ensure that the supply is not going into current limit under loaded conditions. The current limiting point must be at least 1 Ampere above the operating current. If the unit still does not regulate properly, proceed as follows:

a. Ensure sense lead connections are snug.

b. Check for noisy voltage pot (A1R1) and drifting components in the voltage comparison amplifier circuit.

c. Check A1U1.

d. Check main reference voltage circuit (+ 15V, + 6.2V and + 5V).

5-44 REPAIR AND REPLACEMENT

5-45 Cover Removal

5-46 To remove the top-end cover, proceed as follows:

a. Remove screw attaching plastic terminal strip cover.

b. With unit off, remove sense leads (±S) from output bus bars.

c. Remove three remaining screws at end corners of unit and remove top-end cover.

5-47 A1 Board And Side Panel Removal

5-48 To remove the side panel and the A1 board from the side panel, proceed as follows:

a. Remove top-end cover.

b. Remove two screws fastening left side panel to chassis.

c. Rock left panel gently back and forth while pulling away from A2 board. This disconnects A1 board from A2 filter board connector and disengages chassis edge from slot in side panel.

d. To remove A1 board from panel, pull off red, orange, and black wires from triac CR1.

e. Pull red, black, and tracer wires from rectifier U1, by depressing clip spring through center terminal hole.

f. Unscrew two 6-32 screws near center of left side panel.

g. Slide A1 board forward into keyhole slots and lift out board for access to solder side.

5-49 Removal of A5A3, A5A4 From Tunnel

5-50 To remove the driver board and output power assembly from Tunnel assembly A5, proceed as follows:

a. Remove top-end cover.

b. Remove two fan wires from A2 board.

c. Remove two screws attaching right side panel to chassis.

d. Gently rock side panel back and forth so that A2 filter board disconnects from A5A3 board and slot in panel disengages from chassis edge.

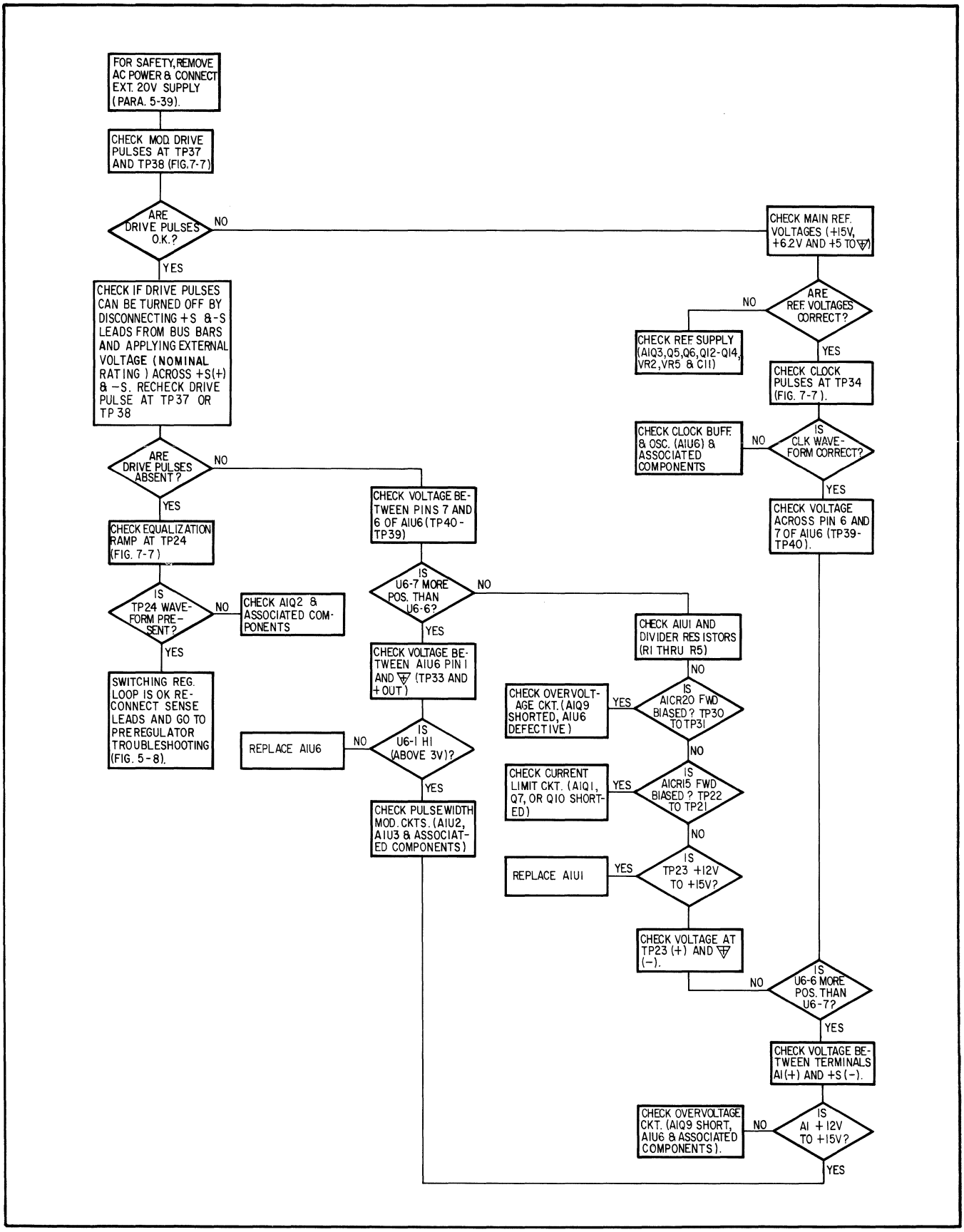


Figure 5-7. A1 Control Board Troubleshooting

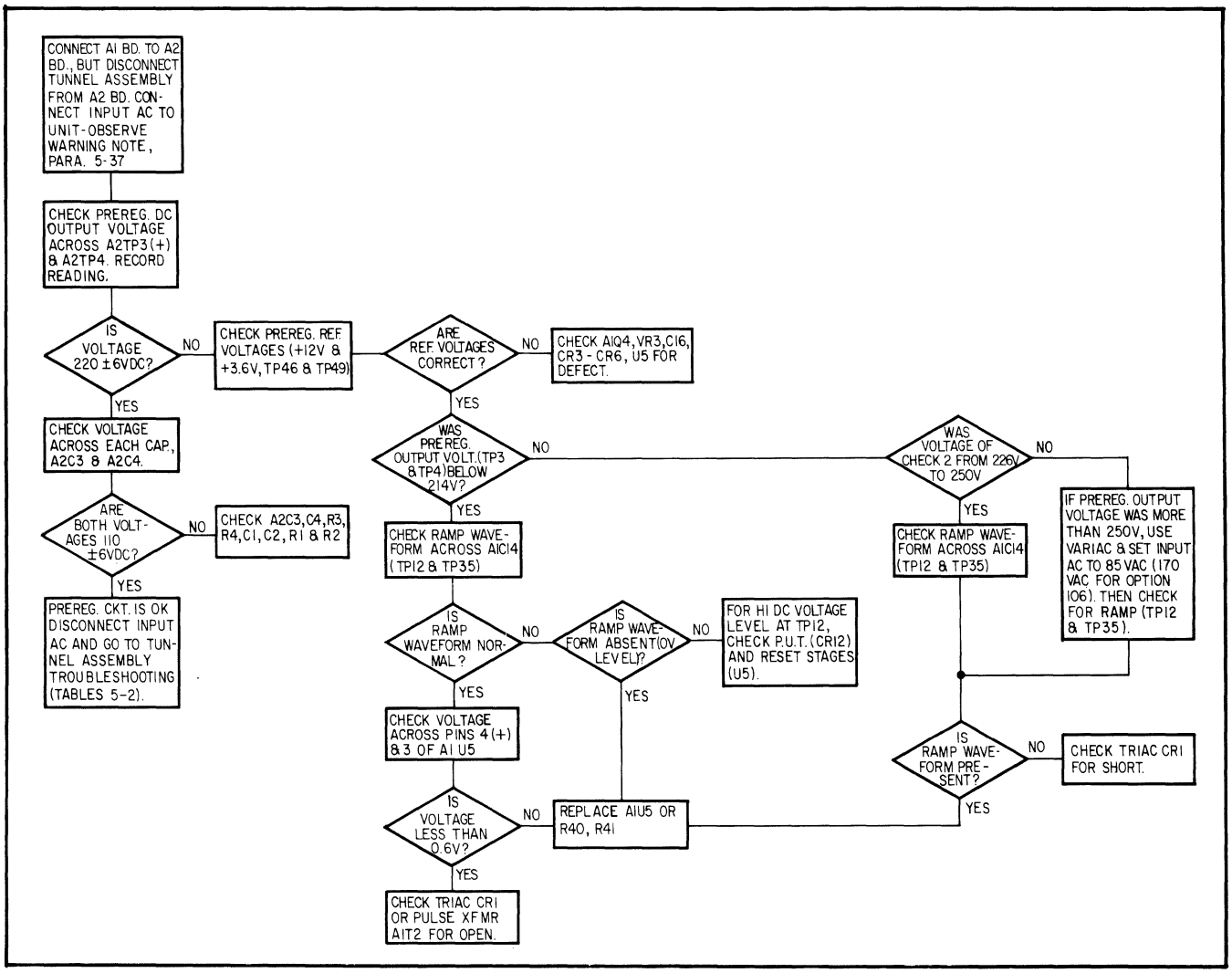


Figure 5-8. Preregulator Troubleshooting

Table 5-2. Tunnel Assembly Resistance Checks

Neg. Lead	Pos. Lead	Normal Indication	Probable Cause
A3TP26 (pin M of connector)	A3Q1 base (TP25)	one drop	A3Q1
	A3Q2 base (TP27)	one drop	A3Q2
	A3Q3 base (TP16)	one drop	A3Q3
	A3Q4 base (TP7)	one drop	A3Q4
	A3Q3 coll. (TP18)	> 100 Ω (Note 1)	A3Q3
	A3Q4 coll. (TP8)	> 100 Ω (Note 1)	A3Q4
A3TP18 (A3Q3 collector)	A3Q3 base (TP16)	one drop	A3Q3
	A3Q4 base (TP7)	one drop	A3Q4
A3TP13 (A3Q5 emitter)	CR9 Cathode (TP9)	one drop	A3Q5 (Note 2)
	CR17 Cathode (TP17)	open	A3Q5 or CR11
	CR10 Cathode (TP10)	one drop	A3Q6 (Note 2)
A3TP17	CR9 Cathode (TP9)	one drop	A3Q5 (Note 2)

Table 5-2. Tunnel Assembly Resistance Checks (Continued)

Neg. Lead	Pos. Lead	Normal Indication	Probable Cause
A3TP11	CR10 Cathode (TP10) CR12 Cathode (TP13)	one drop open	A3Q6 (Note 2) A3Q6 or CR12
A6Q1 - Emitter	A6Q1 collector	open	A6Q1 or TS1
A4CR1 and CR2 Cathodes	A4CR1, CR2 anodes	one drop (Note 3)	A4CR1 or CR2
– Output Bus	+ Output Bus	4.5 Ω	A4R1, C2, C5 or A4CR1, CR2, leaky

NOTES:

1. Readings apply only if ohmmeter open circuit voltage is less than 2 Volts.
2. If A5A3Q5 or Q6 are shorted, check A5A4CR1 and CR2 for short.
3. Shottky diodes forward drops are slightly less than those for silicon diodes.

e. To remove the A3 and A4 assemblies from the tunnel, first remove two each 6-32 screws from top and bottom of tunnel.

f. Carefully slide A5A3 and A4 out of the tunnel by grasping black plastic bus bar shield with one hand and holding tunnel assembly with the other.

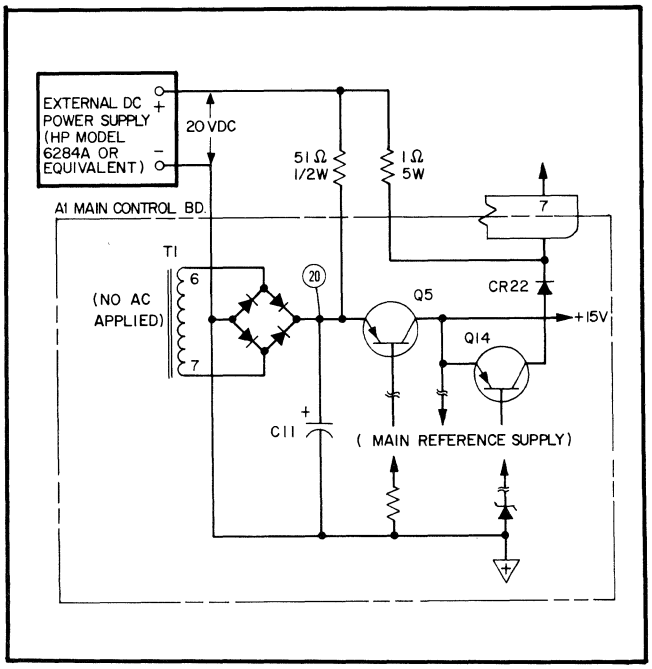


Figure 5-9. Substitute Bias Source, A1 Board Troubleshooting

g. Access is now gained to switching and driver transistors on the A5A3 board and components on the A5A4 assembly.

h. To replace some components on A5A4 assembly, A3 and A4 must be separated by removing screw in center attaching board to threaded spacer. Then lift up A5A3 board (save fiber shield).

i. To remove tunnel assembly from right side panel, push panel forward into keyhole slots and remove from tunnel.

5-51 Switching Transistor Replacement

5-52 If one of the switching transistors (A5A3Q5 or A5A3Q6) fails, it usually causes failure of the other transistor. Therefore, check both transistors as outlined in Table 5-4, before starting the following replacement procedures.

a. Clean heat sink and transistor mounting surfaces. Clean mica insulator (not required on 62605L).

b. Apply thin coating of silicone compound (Dow Corning 340 or HP 8500-0059) to all mating surfaces.

c. Insert mounting screws and lockwashers into TO-3 mounting holes on transistor.

d. Position mica insulator (if used) and transistor on heat sink.

e. Install TO-3 plastic insulators (insulators not used on 62605L) into bottom of heat sink and onto protruding mounting screws.
place.

g. Tighten four screws to 10 inch-pounds.

Table 5-3. Excessive Ripple or Noise Troubleshooting

Symptom	Probable Cause
Excessive 120Hz ripple	Check preregulator output voltage across A2C3, and C4 as shown in Figure 5-8. If output is incorrect, check for open components on A2 board before continuing with preregulator troubleshooting.
Excessive 40kHz ripple	a. Check A4C1, C2 including tightness of mounting screws. b. Check A4L1, L2 for shorts or loose connections.
Excessive noise spikes	a. Recheck measurement technique. b. Ensure that A4T1 shield is connected properly. c. Check A4C3 – C6, R3 & R4, open or short. d. Check A4C1, C2 mounting screw tightness.
Erratic output at no load	a. Check equalization circuit, A1Q2. b. Check A1U1 for defect.

5-53 ADJUSTMENTS

5-54 Current Limit

5-55 The current limit point is factory set to 105 ±1% of the current rating with the output voltage set at nominal. The current limit must be checked and adjusted if any one of the following components are replaced: A4R2, A1VR1, R12, R15, R16, or Q10. Before making the adjustment, refer to Paragraphs 3-8 and 3-9 and then proceed as follows:

a. With power disconnected make setup shown in Figure 5-10.

b. Connect ac input power and decrease R_L (from maximum) until current limit is reached (ripple observed on scope increases substantially). Reading on voltmeter is equivalent to current limit point.

c. To change current limit, first increase current limit setting (below terminals on end panel). Decrease R_L until voltmeter reads value equivalent to desired output at current limit point.

d. Decrease current limit setting until current limit is reached (ripple increases on scope).

5-56 40kHz Clock

5-57 The frequency of the 40kHz oscillator is factory set to 40kHz ±200Hz and does not require adjustment unless an oscillator component is replaced. To adjust frequency, proceed as follows:

a. With input power disconnected, remove top-end cover to gain access to A1 board.

b. To prevent possible damage to the regulator switches, remove tunnel assembly A5, as previously described.

c. Connect frequency counter between TP34 (U6-13) and +S.

d. Connect input power and adjust A1R31 for 40kHz ±200Hz.

e. Remove input power and replace tunnel assembly.

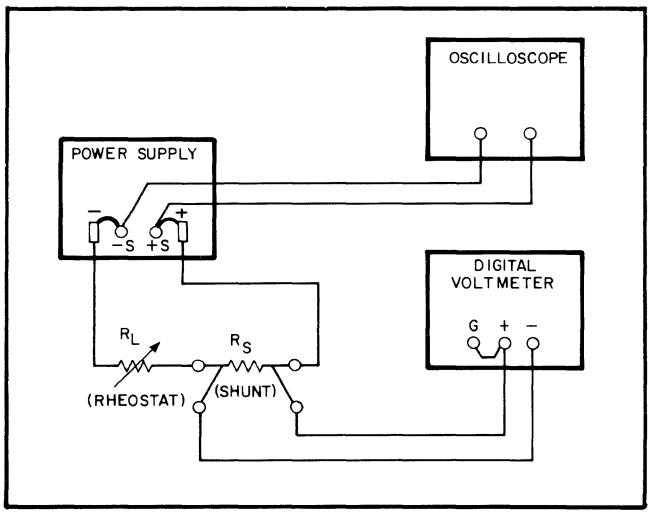


Figure 5-10. Current Limit Adjustment Setup

SECTION VI
REPLACEABLE PARTS

6-1 INTRODUCTION

6-2 This section contains information for ordering replacement parts. Table 6-4 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. Refer to Table 6-3 for manufacturer's name and address.

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 6-4 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 6-4, 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		
R	= resistor	VR	= zener diode
S	= switch	X	= socket
T	= transformer	Z	= integrated circuit or network
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
°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
°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. Code List of Manufacturers

CODE	MANUFACTURER	ADDRESS
00629	EBY Sales Co., Inc.	Jamaica, N.Y.
00656	Aerovox Corp.	New Bedford, Mass.
00853	Sangamo Electric Co. S. Carolina Div.	Pickens, S.C.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Ind.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc.	Dallas, Texas
01686	RCL Electronics, Inc.	Manchester, N.H.
01930	Amerock Corp.	Rockford, Ill.
02107	Sparta Mfg. Co.	Dover, Ohio
02114	Ferroxcube Corp.	Saugerties, N.Y.
02606	Fenwal Laboratories	Morton Grove, Ill.
02660	Amphenol Corp.	Broadview, Ill.
02735	Radio Corp. of America, Solid State and Receiving Tube Div.	Somerville, N.J.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03797	Eldema Corp.	Compton, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04072	ADC Electronics, Inc.	Harbor City, Calif.
04213	Caddell & Burns Mfg. Co. Inc.	Mineola, N.Y.
04404	*Hewlett-Packard Co. Palo Alto Div.	Palo Alto, Calif.
04713	Motorola Semiconductor Prod. Inc.	Phoenix, Arizona
05277	Westinghouse Electric Corp. Semiconductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	Grand Junction, Colo.
05820	Wakefield Engr. Inc.	Wakefield, Mass.
06001	General Elect. Co. Electronic Capacitor & Battery Dept.	Irmo, S.C.
06004	Bassik Div. Stewart-Warner Corp.	Bridgeport, Conn.
06486	IRC Div. of TRW Inc. Semiconductor Plant	Lynn, Mass.
06540	Amatom Electronic Hardware Co. Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co.	Penacook, N.H.
06666	General Devices Co.	Indianapolis, Ind.
06751	Semoor Div. Components, Inc.	Phoenix, Arizona
06776	Robinson Nugent, Inc.	New Albany, N.Y.
06812	Torrington Mfg. Co.	Van Nuys, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp.	Elmira, N.Y.
07263	Fairchild Camera and Instrument	Mountain View, Calif.
07387	Birtcher Corp., The	Los Angeles, Calif.
07397	Sylvania Electric Prod. Inc.	Mountainview, Calif.
07716	IRC Div. of TRW Inc.	Burlington, Iowa
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Co. Components Div.	Mountain View, Calif.
08484	Breeze Corporations, Inc.	Union, N.J.
08530	Reliance Mica Corp.	Brooklyn, N.Y.
08717	Sloan Company, The	Sun Valley, Calif.
08730	Vemaline Products Co. Inc.	Wyckoff, N.J.
08806	General Elect. Co. Minature Lamp Dept.	Cleveland, Ohio
08863	Nylomatic Corp.	Norrisville, Pa.
08919	RCH Supply Co.	Vernon, Calif.
09021	Airco Speer Electronic Components	Bradford, Pa.
09182	*Hewlett-Packard Co. New Jersey Div.	Rockaway, N.J.
09213	General Elect. Co. Semiconductor Prod. Dept.	Buffalo, N.Y.
09214	General Elect. Co. Semiconductor Prod. Dept.	Auburn, N.Y.
09353	C & K Components Inc.	Newton, Mass.
09922	Burndy Corp.	Norwalk, Conn.
11115	Wagner Electric Corp. Tung-Sol Div.	Bloomfield, N.J.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of Cal. Inc.	So. Pasadena, Calif.
11502	IRC Div. of TRW Inc.	Boone, N.C.
11711	General Instrument Corp.	Newark, N.J.
12136	Philadelphia Handle Co.	Camden, N.J.
12615	U.S. Terminals, Inc.	Cincinnati, Ohio
12617	Hamlin Inc.	Lake Mills, Wisconsin
12697	Clarostat Mfg. Co. Inc.	Dover, N.H.
13103	Thermalloy Co.	Dallas, Texas
14493	*Hewlett-Packard Co.	Loveland, Colo.
14655	Cornell-Dubilier Electronics Div. Federal Pacific Electric Co.	Newark, N.J.
14936	General Instrument Corp. Semiconductor Prod. Group	Hicksville, N.Y.
15801	Fenwal Elect.	Framingham, Mass.
16299	Corning Glass Works	Raleigh, N.C.

*Use Code 28480 assigned to Hewlett-Packard Co., Palo Alto, California

Table 6-3. Code List of Manufacturers

CODE	MANUFACTURER ADDRESS
16758	Delco Radio Div. of General Motors Corp. Kokomo, Ind.
17545	Atlantic Semiconductors, Inc. Asbury Park, N.J.
17803	Fairchild Camera and Instrument Corp. Mountain View, Calif.
17870	Daven Div. Thomas A. Edison Industries McGraw-Edison Co. Orange, N.J.
18324	Signetics Corp. Sunnyvale, Calif.
19315	Bendix Corp. The Navigation and Control Div. Teterboro, N.J.
19701	Electra/Midland Corp. Mineral Wells, Texas
21520	Fansteel Metallurgical Corp. No. Chicago, Ill.
22229	Union Carbide Corp. Electronics Div. Mountain View, Calif.
22753	UID Electronics Corp. Hollywood, Fla.
23936	Pamotor, Inc. Pampa, Texas
24446	General Electric Co. Schenectady, N.Y.
24455	General Electric Co. Nela Park, Cleveland, Ohio
24655	General Radio Co. West Concord, Mass.
24681	LTV Electrosystems Inc. Memcor/Components Operations Huntington, Ind.
26982	Dynacool Mfg. Co. Inc. Saugerties, N.Y.
27014	National Semiconductor Corp. Santa Clara, Calif.
28480	Hewlett-Packard Co. Palo Alto, Calif.
28520	Heyman Mfg. Co. Kenilworth, N.J.
28875	IMC Magnetics Corp. Rochester, N.H.
31514	SAE Advance Packaging, Inc. Santa Ana, Calif.
31827	Budwig Mfg. Co. Ramona, Calif.
33173	G.E. Co. Tube Dept. Owensboro, Ky.
35434	Lectrohm, Inc. Chicago, Ill.
37942	P.R. Mallory & Co. Indianapolis, Ind.
42190	Muter Co. Chicago, Ill.
43334	New Departure-Hyatt Bearings Div. General Motors Corp. Sandusky, Ohio
44655	Ohmite Manufacturing Co. Skokie, Ill.
46384	Penn Engr. and Mfg. Corp. Doylestown, Pa.
47904	Polaroid Corp. Cambridge, Mass.
49956	Raytheon Co. Lexington, Mass.
55026	Simpson Electric Co. Div. of American Gage and Machine Co. Chicago, Ill.
56289	Sprague Electric Co. North Adams, Mass.
58474	Superior Electric Co. Bristol, Conn.
58849	Syntron Div. of FMC Corp. Homer City, Pa.
59730	Thomas and Betts Co. Philadelphia, Pa.
61637	Union Carbide Corp. New York, N.Y.
63743	Ward Leonard Electric Co. Mt. Vernon, N.Y.
70563	Amperite Co. Inc. Union City, N.J.
70901	Beemer Engrg Co. Fort Washington, Pa.
70903	Belden Corp. Chicago, Ill.
71218	Bud Radio, Inc. Willoughby, Ohio
71279	Cambridge Thermionic Corp. Cambridge, Mass.
71400	Bussmann Mfg. Div.of McGraw & Edison Co. St. Louis, Mo.
71450	CTS Corp. Elkhart, Ind.
71468	I.T.T. Cannon Electric Inc. Los Angeles, Calif.
71590	Globe-Union Inc. Milwaukee, Wis.
71700	General Cable Corp. Cornish Wire Co. Div. Williamstown, Mass.
71707	Coto Coil Co. Inc. Providence, R.I.
71744	Chicago Miniature Lamp Works Chicago, Ill.
71785	Cinch Mfg. Co. and Howard B. Jones Div. Chicago, Ill.
71984	Dow Corning Corp. Midland, Mich.
72136	Electro Motive Mfg. Co. Inc. Willimantic, Conn.
72619	Dialight Corp. Brooklyn, N.Y.
72699	General Instrument Corp. Newark, N.J.
72765	Drake Mfg. Co. Harwood Heights, Ill.
72962	Elastic Stop Nut Div. of Amerace Esna Corp. Union, N.J.
72982	Erie Technological Products Erie, Pa.
73096	Hart Mfg. Co. Hartford, Conn.
73138	Beckman Instruments Fullerton, Calif.
73168	Fenwal, Inc. Ashland, Mass.
73293	Hughes Aircraft Co. Electron Dynamics Div. Torrance, Calif.
73445	Amperex Electronic Hicksville, N.Y.
73506	Bradley Semiconductor Corp. New Haven, Conn.
73559	Carling Electric, Inc. Hartford, Conn.
73734	Federal Screw Products, Inc. Chicago, Ill.
74193	Heinemann Electric Co. Trenton, N.J.
74545	Hubbell Harvey Inc. Bridgeport, Conn.
74868	Amphenol Corp. Amphenol RF Div. Danbury, Conn.
74970	E.F. Johnson Co. Waseca, Minn.

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ.	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
	A1 Main Control Board					
C1						
62605M, 05L	fxd, elect 1.8μF, 20V	1			0180-0405	
62615M	fxd, elect 1μF, 35V	2		56289	0180-0291	1
C2						
62605M, 05L	fxd, elect 10μF, 20V	2	150D106X9020B2	56289	0180-0374	1
62615M	fxd, elect 22μF, 15V	2	150D226X9015B2	56289	0180-0228	1
C3	fxd, mica 470pF, 300V	1	DM15F471J0300WV1	72136	0140-0149	1
C4	fxd, mica 820pF, 300V	1	DM15F821G0300WV1	72136	0140-0151	1
C5	fxd, elect 1μF, 35V	2	150D105X9035A2-DYS	56289	0180-0291	1
C6	fxd, cer .01μF, 100V	2	obd	91418	0150-0093	1
C7	fxd, mylar .047μF, 200V	1	Type 27	09134	0170-0040	1
C8, 9	fxd, cer .001μF, 1KV	3	C067B102E102ZS26	56289	0150-0050	1
C10	fxd, cer .02μF, 100V	1	C023B101H203MS27	56289	0180-1943	1
C11	fxd, elect 1000μF, 25V	1	39D108G025GLU	56289	0180-1943	1
C12	fxd, elect .22μF, 35V	1	150D224X9035A2	56289	0180-1735	1
C13	fxd, elect 10μF, 20V		150D106X9020B2	56289	0180-0374	
C14	fxd, elect 1.8μF, 35V	1	150D185X9035B2	56289	0180-0101	1
C15	fxd, cer .01μF, 100V		obd	91418	0150-0093	
C16	fxd, elect 47μF, 25V	1	476H025CC5B	56289	0180-0587	1
C17	fxd, cer .02μF, 2KV	2	41C321-CDH	56289	0160-2569	1
C18A, B	fxd, cer 7200pF (dual), 250V	1	41C407-CDH	56289	0160-3611	1
C19	fxd, cer .02μF, 2KV		41C321-CDH	56289	0160-2569	
C20	fxd, elect 22μF, 15V		150D226X9015B2	56289	0180-0228	
C21	fxd, cer .1μF, 50V	2	5C50B1-CML	56289	0150-0121	1
C22	fxd, cer .47μF, 25V	1	316-000-R3A-211K	72982	0160-0174	1
C23	fxd, mica 220pF, 300V	1	obd	09023	0160-0134	1
C24	fxd, cer .001μF, 1KV		C067B102E102ZS26	56289	0150-0050	
C25, 26	Not Assigned					
C27						
62605M	Not Used					
62605L, 15M	fxd, cer 0.1μF, 50V		5C50B1-CML	56289	0150-0121	
C28						
62605M	Not Used					
62605L, 15M	fxd, cer .05μF, 400V	1			0150-0052	1
CR1-7	diode, switching 80V, 200mA	13	1N4148	07263	1901-0050	7
CR8-11	diode, rectifier 400V, 750mA	5	SR1358-9	04713	1901-0028	5
CR12	Unijunction Transistor	1	2N6027	03508	1855-0314	1
CR13	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
CR14	diode, Schottky barrier	4		28480	1901-0518	4
CR15, 16	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
CR17	diode, stabistor 15V, 150mA	2	STB-523	03508	1901-0460	2
CR18	Not Assigned					
CR19	diode, rectifier 200V, 1A	1	1N5059	03508	1901-0327	
CR20	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
CR21	diode, Schottky barrier			28480	1901-0518	
CR22	diode, rectifier 400V, 750mA	5	SR1358-9	04713	1901-0028	
CR23	Not Assigned					
CR24	diode, Schottky barrier			28480	1901-0518	
CR25	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
CR26	diode, stabistor 15V, 150mA		STB-523	03508	1901-0460	
CR27	diode, Schottky barrier			28480	1901-0518	

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
CR28	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
L1, 2	fxd, inductor 20μH	2		28480	5080-1786	1
L3	fxd, inductor 680μH	1			9100-0415	1
P1	Connector, PC edge 30-pin	1	252-15-30-340	71785	1251-1886	1
Q1-4	S. S. NPN Si	8	2N3417	03508	1854-0087	6
Q5	S. S. PNP Si	1	2N2904A	04713	1853-0012	1
Q6	S. S. NPN Si		2N3417	03508	1854-0087	
Q7, 8	S. S. PNP Si	3	TZ173	56289	1853-0099	3
Q9	S. S. NPN Si		2N3417	03508	1854-0087	
Q10	S. S. dual NPN Si	1	TD203	56289	1854-0375	1
Q11	Not Assigned					
Q12, 13	S. S. NPN Si		2N3417	03508	1854-0087	
Q14	S. S. PNP Si		TZ173	56289	1853-0099	
R1	Var. cer 2K, 10%	2	72X	73138	2100-3273	1
R2	fxd, film 8.25K, 1%, 1/8W	3	MF4C, T-0	19701	0757-0441	1
R3						
62605M, 05L	fxd, film 3.92K, 0.5%, 1/8W	5	MF4C, T-0	19701	0698-3327	1
62615M	fxd, film 1.78K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0274	1
R4, 5	fxd, film 3.92K, 0.5%, 1/8W	4	MF4C, T-0	19701	0698-3327	
R6						
62605M, 05L	fxd, comp 100, 5%, 1/4W	1	CB-1015	01121	0683-1015	1
62615M	fxd, comp 390, 5%, 1/4W	3	CB-3915	01121	0683-3915	1
R7	fxd, comp 1K, 5%, 1/4W	4	CB-1025	01121	0683-1025	1
R8	fxd, comp 3.3K, 5%, 1/4W	1	CB-3325	01121	0683-3325	1
R9						
62605M, 05L	fxd, comp 10K, 5%, 1/4W	6	CB-1035	01121	0683-1035	1
62615M	fxd, comp 30K, 5%, 1/4W	1	CB-3035	01121	0683-3035	1
R10	fxd, comp 68K, 5%, 1/4W	1	CB-6835	01121	0683-6835	1
R11						
62605M, 05L	fxd, film 1.62K, 1%, 1/8W	2	MF4C, T-0	19701	0757-0428	1
62615M	fxd, film 6.19K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0290	1
R12	fxd, film 10, 1%, 1/8W	1	CEA, T-0	07716	0757-0346	1
R13						
62605M, 05L	fxd, comp 1K, 5%, 1/2W	1	EB-1025	01121	0686-1025	1
62615M	fxd, comp 1K, 5%, 1W	1	GB-1025	01121	0689-1025	1
R14	fxd, comp 2K, 5%, 1/4W	2	CB-2025	01121	0683-2025	1
R15	var. cer 2K, 10%		72X	73138	2100-3273	
R16						
62605M	fxd, film 1.5K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0427	1
62605L, 15M	fxd, film 1.62K, 1%, 1/8W		MF4C, T-0	19701	0757-0428	
R17	fxd, comp 360, 5%, 1/4W	1	CB-3615	01121	0683-3615	1
R18, 20	fxd, film 21.5K, 1%, 1/8W	3	MF4C, T-0	19701	0757-0199	1
R19, 21	Not Assigned					
R22	fxd, comp 5.1K, 5%, 1/4W	3	CB-5125	01121	0683-5125	1
R23	fxd, comp 10K, 5%, 1/4W		CB-1035	01121	0683-1035	
R24	fxd, comp 3.9K, 5%, 1/4W	1	CB-3925	01121	0683-3925	1
R25	fxd, comp 10K, 5%, 1/4W		CB-1035	01121	0683-1035	1
R26						
62605M, 05L	fxd, comp 51, 5%, 1/4W	3	CB-5105	01121	0683-5105	1
62615M	fxd, comp 200, 5%, 1/4W	1	CB-2015	01121	0683-2015	1

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R27	fxd, comp 10K, 5%, 1/4W		CB-1035	01121	0683-1035	
R28	fxd, film 5.6K, 2%, 1/8W	1	MF4C, T-0	19701	0757-0942	1
R29	fxd, film 2.15K, 1%, 1/8W	1	MF4C, T-0	19701	0698-0084	1
R30	fxd, film 8.25K, 1%, 1/8W		MF4C, T-0	19701	0757-0441	
R31	var, trmr 5K, 10%	1	62-208-1	73138	2100-2216	1
R32	fxd, film 13.3K, 1%, 1/8W	1	CEA T-0	07716	0757-0289	1
R33	fxd, film 11.3K, 1%, 1/8W	1	CEA T-0	07716	0698-4121	1
R34	fxd, comp 5.1K, 5%, 1/4W		CB-5125	01121	0683-5125	
R35	fxd, comp 3.9K, 5%, 1/4W			01121	0683-3925	1
R36	fxd, comp 2K, 5%, 1/4W		CB-2025	01121	0683-2025	
R37, 38	fxd, comp 68, 5%, 1/4W	2	CB-6805	01121	0683-6805	1
R39	fxd, comp 360, 5%, 1/2W	1	CB-3615	01121	0686-3615	1
R40	fxd, film 7.5K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0440	1
R41	fxd, film 464K, 1%, 1/8W	1	MF4C, T-0	19701	0698-3260	1
R42	fxd, comp 1.5K, 5%, 1/4W	1	CB-1525	01121	0683-1525	1
R43	fxd, comp 7.5K, 1%, 1/8W	2			0757-0440	1
R44	fxd, film 10K, 1%, 1/8W	2	MF4C, T-0	19701	0757-0442	1
R45	fxd, film 825, 1%, 1/8W	1	MF4C, T-0	19701	0757-0421	1
R46	fxd, film 4.64K, 1%, 1/8W	2	MF4C, T-0	19701	0698-3155	1
R47	fxd, comp 1K, 5%, 1/4W		CB-1025	01121	0683-1025	
R48	fxd, film 4.53K, 1%, 1/8W				0698-4443	
R49	fxd, film 3.65K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0434	1
R50	fxd, comp 20K, 5%, 1/4W	3	CB-2035	01121	0683-2035	1
R51	fxd, comp 15K, 5%, 1/4W	1	CB-1535	01121	0683-1535	1
R52	fxd, comp 1K, 5%, 1/4W		CB-1025	01121	0683-1025	
R53	fxd, comp 20K, 1%, 1/8W			01121	0757-0449	
R54	fxd, comp 10K, 1%, 1/8W	1		01121	0757-0442	1
R55	fxd, comp 10, 5%, 1/4W	1	CB-1005	01121	0683-1005	1
R56	fxd, comp 100, 5%, 1W	1	GB-1015	01121	0689-1015	1
R57	fxd, film 5.11K, 1%, 1/8W	3	MF4C, T-0	19701	0757-0438	1
R58	fxd, comp 680, 5%, 1/4W		CB-6815	01121	0683-6815	
R59	fxd, film 5.11K, 1%, 1/8W		MF4C, T-0	19701	0757-0438	
R60	fxd, film 21.5K, 1%, 1/8W		MF4C, T-0	19701	0757-0199	
R61	fxd, film 1.21K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0274	1
R62						
62605M, 05L	fxd, comp 27, 5%, 1/4W	1	CB-2705	01121	0683-2705	1
62615M	fxd, film 12.1, 1%, 1/8W	1			0757-0379	1
R63	fxd, comp 750, 5%, 1/4W	1	CB-7515	01121	0683-7515	1
R64	fxd, film 3.92K, 0.5%, 1/8W		MF4C, T-0	19701	0698-3327	
R65	fxd, film 8.25K, 1%, 1/8W		MF4C, T-0	19701	0757-0441	
R66						
62605M, 05L	fxd, film 24.3K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0451	1
62615M	fxd, film 56.2K, 1%, 1/8W	1	MF4C, T-0	19701	0757-0459	1
R67	fxd, film 3.92K, 0.5%, 1/8W		MF4C, T-0	19701	0698-3327	
R68	fxd, comp 20K, 5%, 1/4W		CB-2035	01121	0683-2035	
R69	fxd, comp 680, 5%, 1/4W		CB-6815	01121	0683-6815	
R70	fxd, film 5.11K, 1%, 1/8W		MF4C, T-0	19701	0757-0438	
R71	fxd, film 1K, 1%, 1/8W	1	CEA T-0	07716	0757-0280	1
R72	fxd, film 118K, 1%, 1/8W	1	MF4C, T-0	19701	0698-3265	1
R73, 74	fxd, comp 51, 5%, 1/4W		CB-5105	01121	0683-5105	

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R75	fxd, comp 10K, 5%, 1/4W		CB-1035	01121	0683-1035	
R76	fxd, comp 4.3K, 5%, 1/4W	1	CB-4325	01121	0683-4325	1
R77	fxd, comp 680, 5%, 1/4W		CB-6815	01121	0683-6815	
R78	fxd, comp 5.1K, 5%, 1/4W		CB-5125	01121	0683-5125	
R79	fxd, comp 10, 1%, 1/8W		CEA T-0	07716	0757-0346	
R80, 81	Not Assigned					
R82	fxd, comp 7.5K, 5%, 1/4W		CB-7525	01121	0683-7525	
R83	Not Assigned					
R84	fxd, comp 390, 5%, 1/4W		CB-3915	01121	0683-3915	1
R85	fxd, film 23K, 1%, 1/8W	1	MF4C, T-0	19701	0698-3269	1
R86	fxd, film 10K, 1%, 1/8W		MF4C, T-0	19701	0757-0442	
R87	fxd, comp 390, 5%, 1/4W		CB-3915	01121	0683-3915	
R88	fxd, 47, 5%, 1/4W	1	CB-4705	01121	0683-4705	1
R89	fxd, comp 90.9K, 1%, 1/8W	1			0757-0464	
T1	Bias Transformer	1		28480	62605-80094	1
T2	Pulse Transformer	1		28480	5080-1785	1
U1	Linear voltage regulator IC	1	SL22310	07263	1826-0049	1
U2	Dual D flip-flop IC	1	DM74L74N	27014	1820-0596	1
U3	Quad 2-input NAND IC	1	SD12955	27014	1820-0583	1
U4	Not Assigned					
U5	Transistor Array IC	1	CA3046	02735	1821-0001	1
U6	quad. comparator	1	MC 3302P	04956	1826-0241	1
VR1	diode, zener 7.32V 2%	2	CD35668	15818	1902-0045	2
VR2	diode, zener 4.99V 2%	1	CD35620	15818	1902-3092	1
VR3	diode, zener 7.32V 2%		CD35668	15818	1902-0045	
VR4, 5	diode, zener 6.19V 2%	2		04713	1902-3114	2
	A2 Filter Board					
C1, 2						
62605M, 15M	fxd, elect 3300μF, 125V	2	049518	56289	0180-0588	1
62605L	fxd, elect 2000μF, 200V	2			0180-0653	1
C3, 4						
62605M, 15M	fxd, elect 320μF, 200V	2	601D632	56289	0180-0590	1
62605L	fxd, elect 32μF, 200V	2				1
C5A, B	fxd, cer 7200pF, (dual), 250V	1	41C407-CDH	56289	0160-3611	1
L1A, B	inductor, 20μH	2		28480	5080-1787	1
R1-4	fxd, met oxide, 7.5K, 5%, 2W	4	RG42	11502	0764-0002	1
	A5 Tunnel Assembly Includes					
	115V Cooling Fan, B1			28480	5060-2653	1
	A5A3 Driver Board					
C1	fxd, cer .01μF, 100V	5		91418	0150-0093	1
C2	fxd, elect 47μF, 25V	1	476H025CC5B	56289	0180-0587	1
C3	fxd, cer .01μF, 100V			91418	0150-0093	
C4, 5	fxd, cer .02μF, 100V	2			0160-0818	2
C6	fxd, cer .01μF, 100V			91418	0150-0093	
C7	fxd, elect 4.7μF, 35V	1	150D475X9035B2	56289	0180-0100	1
C8, 9	fxd, cer 2.2μF, 25V	2	5C15C2-CML	56289	0160-0128	1
C10-12	fxd, cer .01μF, 1KV	4	C023A102J103MS38	56289	0150-0012	1
C13, 14	fxd, cer 5000pF, 1KV	2	C023B102G502ZS31	56289	0160-0899	1
C15, 16	fxd, cer 470pF, 1KV	2	DD-471	71590	0160-2496	1
C17, 18	fxd, cer .22μF, 50V	2	5C52B-CML	56289	0160-0263	1

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
C19	fxd, cer .01μF, 1KV		5C15C2-CML	56289	0150-0012	
CR1	diode, stabistor	2		28480	1901-0701	2
CR2	Not Assigned					
CR3	diode, switching 80V, 200mA	3	1N4148	07263	1901-0050	3
CR4	diode, rectifier 200V, 1A	4	1N5059	03508	1901-0327	2
CR5	diode, stabistor			28480	1901-0701	
CR6	Not Assigned					
CR7	diode, switching 80V, 200mA		1N4148	07263	1901-0050	
CR8	diode, rectifier 200V, 1A		1N5059	03508	1901-0327	
CR9, 10						
62605M, 15M	diode, rectifier 400V, 1.5A	2	SR1846-12	04713	1901-0418	2
62605L	diode, rectifier 200V, 1A	2	1N5059	03508	1901-0327	2
CR11-14	diode, rectifier 400V, 1A	4	1N4936	04713	1901-1065	2
CR15, 16	Not Assigned					
CR17, 18						
62605M, 15M	diode, rectifier, 400V, 3A	2	MR854	28480	1901-0719	2
62605L	diode, rectifier, 400V, 1A	2	1N4936	28480	1901-1065	
L1	inductor, 2mH	1		28480	5080-1788	1
L2	inductor, 15μH	1		28480	62605-80099	1
P1	Connector, PC edge 30-pin	1	252-15-30-300	71785	1251-2035	1
Q1, 2	S. S. NPN Si	2	2N3417	03508	1854-0087	2
Q3, 4						
62605M, 15M	Power NPN Si	2		28480	1854-0672	2
62605L	Power NPN Si	2	MJE-182	04713	1854-0585	2
Q5, 6						
62605M, 15M	Power NPN Si	2		28480	1854-0673	2
62605L		2				
R1	fxd, comp 3K, 5%, 1/4W	2	CB-3025	01121	0683-3025	1
R2, 3	fxd, comp 10K, 5%, 1/4W	2	CB-1035	01121	0683-1035	1
R4	fxd, comp 10, 5%, 1/4W	4	CB-1005	01121	0683-1005	1
R5	fxd, comp 3K, 5%, 1/4W		CB-3025	01121	0683-3025	
R6, 7						
62605M, 15M	fxd, ww 250, 5%, 5W	2	243E	56289	0811-1856	1
62605L	fxd, ww 300, 5%, 5W	2	243E	56289	0811-1215	1
R8	fxd, comp 10, 5%, 1/4W		CB-1005	01121	0683-1005	
R9	fxd, comp 4.7, 5%, 1/4W	2	CB-0475	01121	0683-0475	1
R10						
62605M, 15M	fxd, 1.25, 1%, 4W	2			0811-2556	1
62605L	fxd, 1.5, 5%, 3W	2			0811-1220	1
R11	fxd, comp 4.7, 5%, 1/4W		CB-0475	01121	0683-0475	
R12						
62605M, 15M	fxd, 1.25, 1%, 4W				0811-2556	
62605L	fxd, 1.5, 5%, 3W				0811-1220	
R13	fxd, ww, 22, 5%, 2W	1	243E	56289	0698-3609	1
R14, 15	fxd, comp 150, 5%, 1/4W	2	CB-1515	01121	0683-1515	1
R16	Not Assigned					
R17						
62605M, 15M	fxd, ww, 25, 5%, 10W	1	247E	56289	0698-3609	1
62605L	Not Used					
R18	Not Assigned					

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R19						
62605M, 15M	Not Used					
62605L	fxd, comp 3.3, 5%, 1/2W	1			0686-0335	
T1	Driver Transformer	1		28480	5080-1789	1
TS1	Thermal Switch	1	430-1062	80089	3103-0038	1
62605M, 15M	(closes 200 ±6°F, Opens 140 ±5°F)					
	A5A4 Output Power Assembly					
C1, 2						
62605M	fxd, elect 40,000μF, 7.5V	2	602D462	56289	0180-0589	1
62605L	fxd, elect 21,000μF, 7.5V	2				1
62615M	fxd, elect 15,000μF, 20V	2				1
C5	fxd, cer 2.2μF, 25V	1		56289	0160-0128	1
C6	fxd, cer .05μF, 400V	1	33C17A3-CDH	56289	0150-0052	1
CR1, 2						
62605M	Schottky, rectifier 30V, 55A	2		28480	1901-1082	
62605L	Schottky, rectifier	2				
62615M	Diode, rectifier 40A, 100V	2			5080-1844	
L1						
62605M	inductor, 4μH	1		28480	62605-80097	1
62605L	inductor, 8μH	1		28480	62605-80104	1
62615M	inductor, 15μH	1		28480	62615-80095	1
L2						
62605M, 05L	inductor, 2μH	1		28480	62605-80098	1
62615M	inductor, 4μH	1		28480	5080-1840	1
L3						
62605M, 05L	inductor, 270μH	1	2500-00	99800	9100-1642	1
62615M	inductor, 1000μH	1			9100-1798	1
R1						
62605M, 05L	fxd, ww, 5, 5%, 10W	1	247E	56289	0811-1893	1
62615M	fxd, ww, 35, 5%, 10W	1			0811-1900	1
R2						
62605M	fxd, .00075 ohms	1		28480	62605-80002	1
62605L, 15M	fxd, .0017 ohms	1		28480	62605-80003	1
R3						
62605M, 05L	fxd, comp 43, 5%, 1/2W	1	EB-4305	01121	0686-4305	1
62615M	fxd, comp 620, 5%, 1/2W	1	EB-6215	01121	0686-6215	1
T1						
62605M, 05L	Power Transformer	1		28480	62605-80096	1
62615M	Power Transformer	1		28480	62615-80094	1
TS1	Thermal Switch	1	430-1062	80089	3103-0038	1
(62605L)	(closes 200 ±6°F, Opens 140 ±5°F)					
	A5A6 Regulator Overcurrent Board					
C1, 2						
62605M, 05L	fxd, cer 0.1μF, 50V	2	5C50B1-CML	56289	0150-0121	1
62615M	fxd, cer .01μF, 1KV	2			0150-0012	1
C3	fxd, cer 5,000pF, 1KV	1	C023B102G502ZS	56289	0160-0899	1
CR1-4	diode, rectifier, 80V, 200mA	4	1N4148	07263	1901-0050	4
Q1	S. S. NPN Si	1	2N3417	03508	1854-0087	1

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
R1, 2						
62605M, 05L	fxd, comp 1.8, 5%, 1/2W	2	CEA T-0	07716	0698-6254	1
62615M	fxd, comp 13, 5%, 1/2W	2	EB-1305	01121	0686-1305	1
R3						
62605M, 15M	fxd, film 100, 1%, 1/8W	1	CEA, T-0	07716	0757-0401	1
62605L	fxd, film 162, 1%, 1/8W	1			0757-0405	1
R4	fxd, comp 200, 5%, 1/4W	1	CB-2015	01121	0683-2015	1
R5	fxd, comp 2.7K, 5%, 1/4W	1	CB-2725	01121	0683-2725	1
T1	Transformer, overcurrent	1		28480	5080-1805	1
VR1	diode, zener 6.19V 2%	1		04713	1902-3114	1
	Chassis Electrical					
CR1	triac, 15A	1		28480	1884-0243	1
F1						
62605M, 15M	fuse, 15A, 250V	1	314015	75915	2110-0054	5
62605L	fuse, 10A, 250V	1			2110-0051	5
L1						
62605M, 15M	inductor, 1.75mH	1		28480	62605-80095	1
62605L	inductor, 4mH	1		28480	62605-80106	1
U1	diode, assembly	1	SDA 10254-5	04713	1906-0018	1
	A1 Mechanical					
	Terminal block	1	206206	0082M	0360-0590	
	Heat Dissipator, TO5 (A1Q5)	1	207-CB	05820	1205-0206	
	A3 Mechanical					
	Transistor Heat Sink (Q5, 6)					
	62605M, 15M	1		28480	5020-2501	
	Transistor Pin Socket (Q5, 6)	4		28480	1251-2913	
	Transistor Insulator, plastic (Q5, 6)	2		28480	0340-0503	
	Mica Insulator (Q5, 6)	2		28480	0340-0174	
	Transistor Pin Insulator (CR9, 10)	2		28480	0340-0167	
	Transistor Heat Sink (Q5, 6)					
	62605L	2	IERC LAT 03 B3CB	28480	1205-0267	
	Transistor Pin Socket (Q5, 6)	4		28480	1251-2913	
	A4 Mechanical					
	Positive Output Bus (A4 Chassis)	1		28480	5000-3081	
	Bracket (rear C1 and C2)	1		28480	5000-3083	
	Mounting Strap (T1 and L1)	2		28480	5000-3082	
	Standoff 1.875 in.	1		28480	0380-0572	
	Standoff 1.000 in.	2		28480	0380-0173	
	Negative Output Bus	1		28480	5000-3080	
	Terminal Strip (3-lug)	2	332-14-03-010	71785	0360-0364	
	Lug Assembly (A4C6)	1		28480	5060-2641	
	Rectifier Heat Sink (S)					
	62605M, 15M	1		28480	5020-2293	
	62605L	1		28480	62605-20005	
	62605L	1		28480	62605-20006	
	Grommet .375 OD	1	SB-375-4	28520	0400-0064	

Table 6-4. Replaceable Parts

REF. DESIG.	DESCRIPTION	TQ	MFR. PART NO.	MFR. CODE	HP PART NO.	RS
	Insulator (between output buses)	1		28480	5000-3095	
	Insulator (under A3)	1		28480	5000-3079	
	Shoulder Washer .375 OD .15 ID	3		28480	2190-0490	
	Output Terminal Insulator (molded plastic)	1		28480	0340-0549	
	Miscellaneous					
	Chassis	1		28480	5000-3074	
	Side	2		28480	5020-2292	
	Cover	1		28480	5000-3075	
	ID Plate Bracket	1		28480	5000-3076	
	Capacitor Clamp (A2C1, C2)	1		28480	5000-3077	
	Fuse Holder (F1)	1	342014	75915	1400-0084	
	Terminal Block Cover, Plastic	1		28480	0360-0551	
	Identification Label					
	62605M	1		28480	7120-4232	
	62615M				7120-4903	
	62605L				7120-4893	
	Packing Carton	1		28480	9211-0615	
	Floater Pad, Packing Carton	1		28480	9220-1409	
	Option 106 187-250Vac Input					
F1						
62605M, 15M	fuse 8A, 250V	1	ABC-8	71400	2110-0342	5
62605L	fuse 6A, 250V	1	MTH-6	71400	2110-0056	5
L1						
62605M, 15M	Inductor, 5.25mH	1		28480	62605-80100	1
62605L	Inductor, 9.3mH	1		28480	62605-80108	1
A1T1	Bias Transformer	1		28480	5080-1803	1
A2W1	Remove jumper					
A5	Tunnel Assy. (complete with 230V cooling fan)	1		28480	5060-2662	1
	Identification Label					
	62605M	1		28480	7120-4357	
	62615M	1			7120-4902	
	62605L	1			7120-4892	

SECTION VII
CIRCUIT DIAGRAMS AND COMPONENT LOCATION DIAGRAMS

This section contains the circuit diagrams necessary for the operation and maintenance of this power supply. Included are:

a. Component location diagrams (Figures 7-1 through 7-6), showing the physical location and reference designators of parts mounted on the printed circuit boards and chassis.

b. Circuit waveforms (Figure 7-7), showing the waveforms found at key points in the circuits. These waveforms are used in conjunction with the troubleshooting procedures of Section V.

c. Schematic diagram (Figure 7-8), illustrating the circuitry for the entire power supply. Test points are identified by encircled numbers.

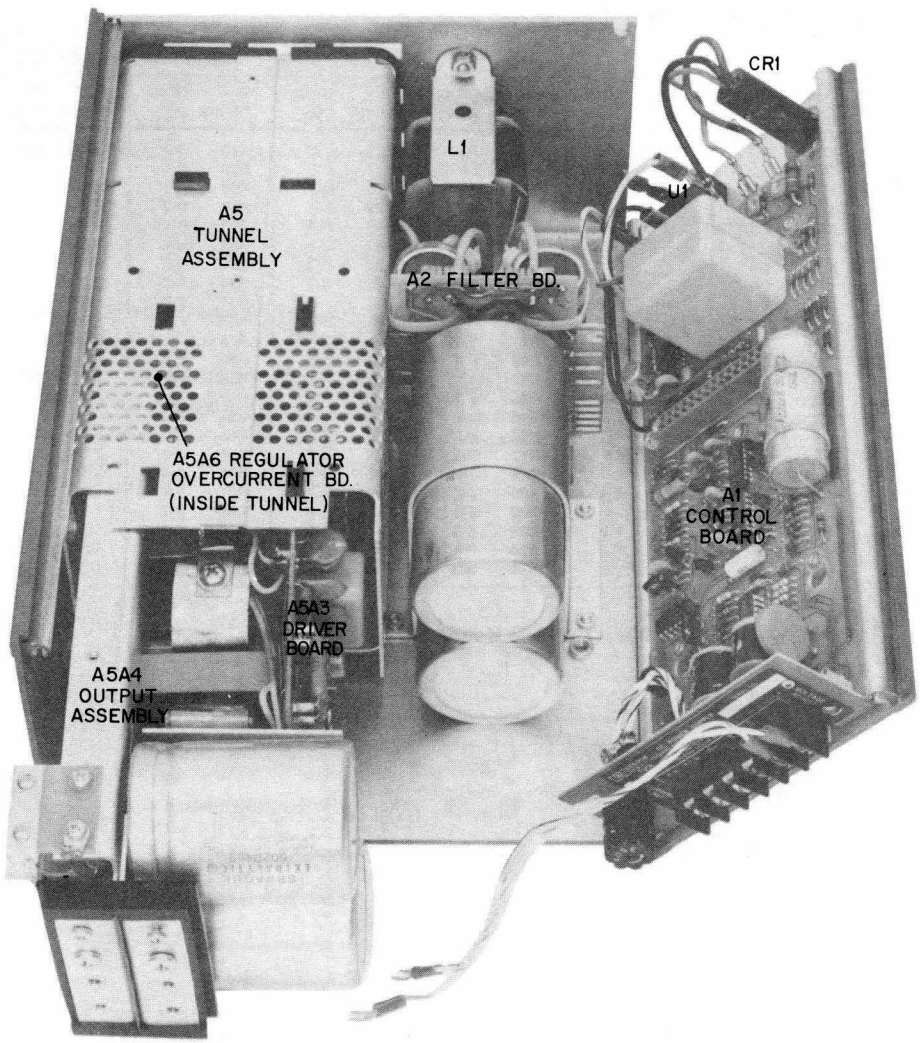
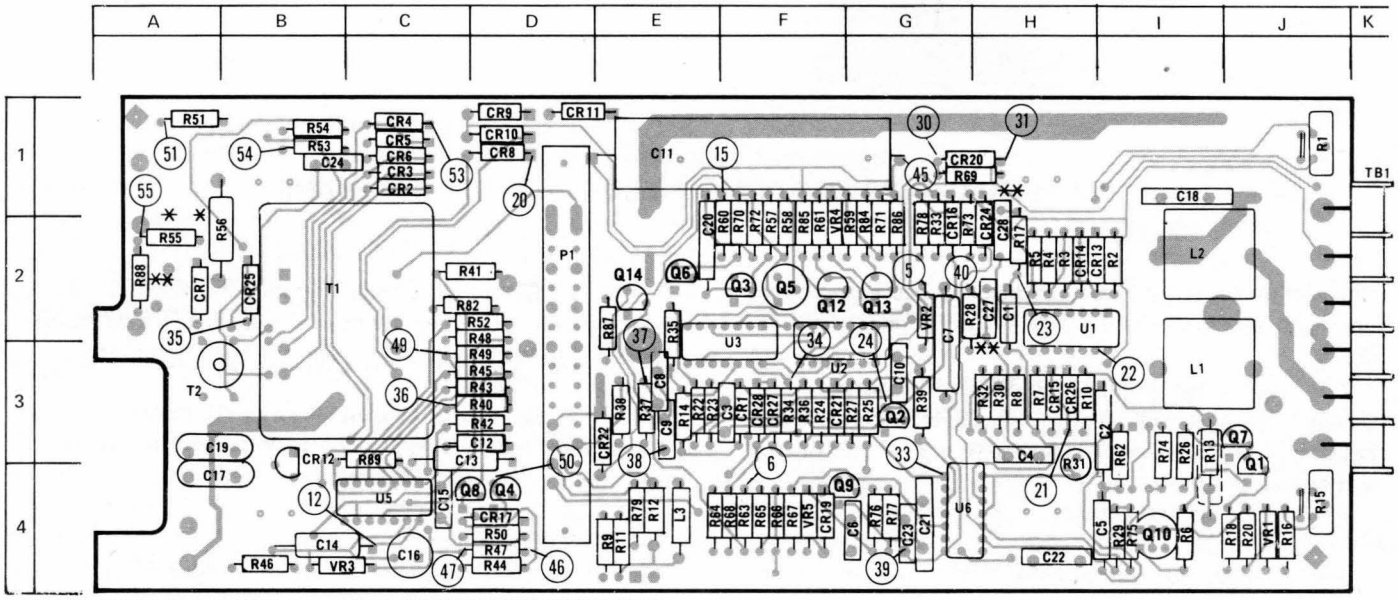


Figure 7-1. Overall View, Subassembly Location



* R55, R56 ARE LOCATED IN SLIGHTLY DIFFERENT POSITIONS ON 62605M
** C27, C28, R88 ARE NOT USED ON 62605M

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	H-2	C24	B-1	CR22	E-3	R1	J-1	R26	I-3	R49	D-3	R72	F-2	VR1	J-4
C2	I-3	C27	H-2	CR24	H-2	R2	I-2	R27	G-3	R50	D-4	R73	G-2	VR2	G-2
C3	F-3	C28	H-2	CR25	B-2	R3	H-2	R28	G-2	R51	A-1	R74	I-3	VR3	B-4
C4	H-3	CR1	F-3	CR26	H-3	R4	H-2	R29	I-4	R52	D-2	R75	I-4	VR4	F-2
C5	I-4	CR2	C-1	CR27	F-3	R5	H-2	R30	H-3	R53	B-1	R76	G-4	VR5	F-4
C6	G-4	CR3	C-1	CR28	F-3	R6	I-4	R31	H-3	R54	B-1	R77	G-4		
C7	G-2	CR4	C-1	L1	I-3	R7	H-3	R32	H-3	R55	A-2	R78	G-2		
C8	E-3	CR5	C-1	L2	I-2	R8	H-3	R33	G-2	R56	A-2	R79	E-4		
C9	E-3	CR6	C-1	L3	E-4	R9	E-4	R34	F-3	R57	F-2	R82	C-2		
C10	G-3	CR7	A-2	P1	D-2	R10	H-3	R35	E-2	R58	F-2	R84	G-2		
C11	E-1	CR8	D-1	Q1	J-3	R11	E-4	R36	F-3	R59	G-2	R85	F-2		
C12	D-3	CR9	D-1	Q2	G-3	R12	E-4	R37	E-3	R60	F-2	R86	G-2		
C13	C-3	CR10	D-1	Q3	F-2	R13	I-3	R38	E-3	R61	F-2	R87	E-2		
C14	B-4	CR11	D-1	Q4	D-4	R14	E-3	R39	G-3	R62	I-3	R88	A-2		
C15	C-4	CR12	B-3	Q5	F-2	R15	J-4	R40	D-3	R63	F-4	R89	C-3		
C16	C-4	CR13	H-2	Q6	E-2	R16	J-4	R41	C-2	R64	E-4	T1	B-2		
C17	A-4	CR14	H-2	Q7	J-3	R17	H-2	R42	D-3	R65	F-4	T2	A-3		
C18	I-1	CR15	H-3	Q8	C-4	R18	J-4	R43	D-3	R66	F-4	TB1	K-2		
C19	A-3	CR16	G-2	Q9	F-4	R20	J-4	R44	D-4	R67	F-4	U1	H-2		
C20	E-2	CR17	D-4	Q10	I-4	R22	E-3	R45	D-3	R68	F-4	U2	F-2		
C21	G-4	CR19	F-4	Q12	F-2	R23	E-3	R46	B-4	R69	G-1	U3	F-3		
C22	H-4	CR20	G-1	Q13	G-2	R24	F-3	R47	D-4	R70	F-2	U5	C-4		
C23	G-4	CR21	F-3	Q14	E-2	R25	G-3	R48	D-2	R71	G-2	U6	G-4		

Figure 7-2. Main Control Board (A1), Component Location

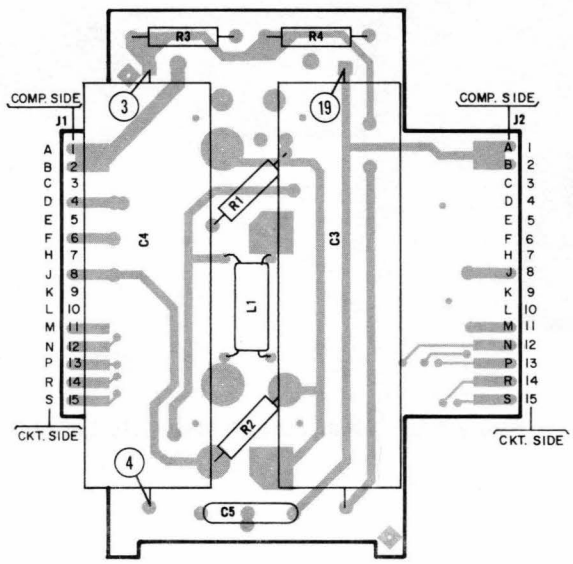
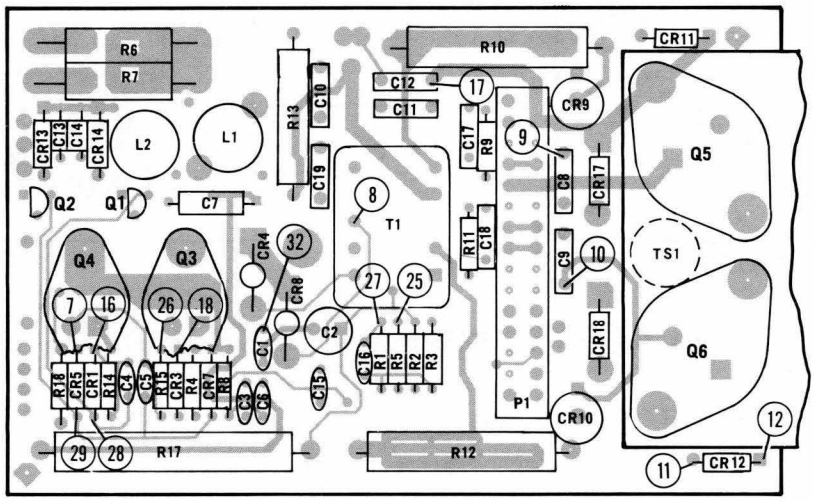
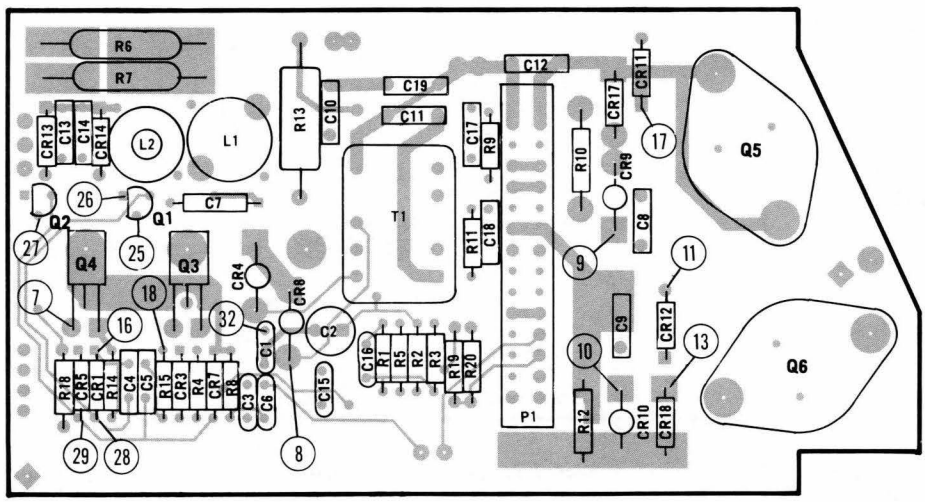


Figure 7-3. Filter Board (A2), Component Location



62605M, 62615M



62605L

Figure 7-4. Driver Board (A5A3), Component Location

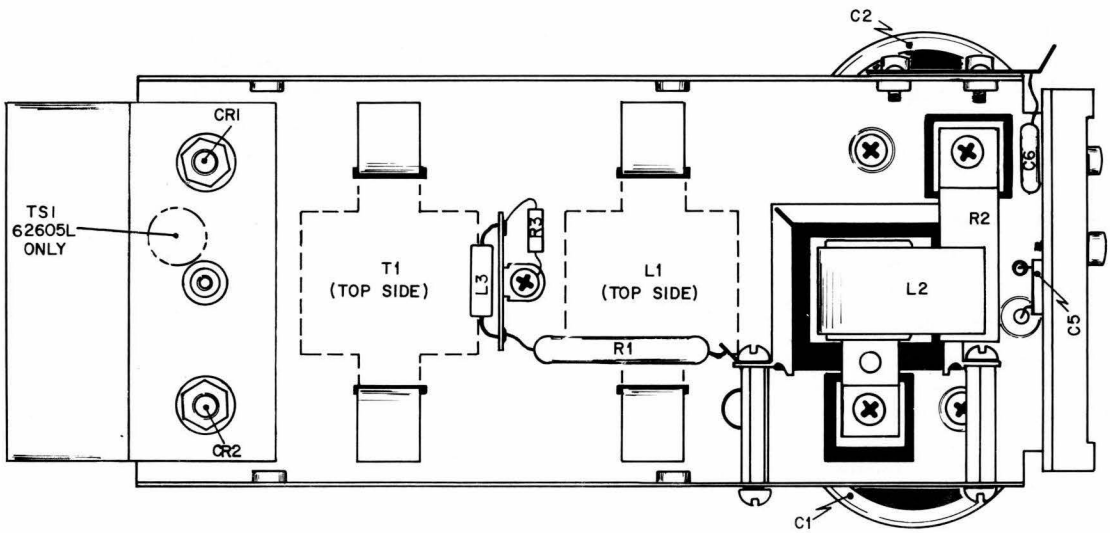


Figure 7-5. Output Power Assy. (A5A4), Component Location

Figure 7-6. Regulator Overcurrent Bd. (A5A6), Component Location

MEASUREMENT CONDITIONS

1. OSCILLOSCOPE DC COUPLED AND REFERENCED TO ⏚ UNLESS OTHERWISE INDICATED. AMPLITUDES ARE TYPICAL.
2. PREREGULATOR WAVEFORMS TAKEN WITH AC APPLIED AND NO LOAD CONNECTED. OTHER A1 BOARD WAVEFORMS (IN THE SWITCHING REGULATOR LOOP) TAKEN WITH A1 BOARD DISCONNECTED.

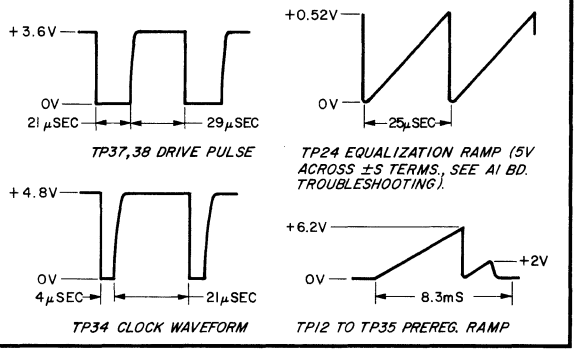


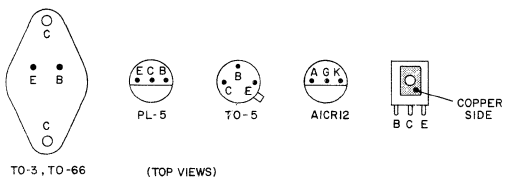
Figure 7-7. Circuit Waveforms

SCHEMATIC TABLE

MODEL	OUTPUT VOLTAGE (VDC)	OUTPUT CURRENT (ADC)	SCHEMATIC COMPONENTS																																			
			A1													A2		A3				A5A4							A5A6				CHASSIS						
			C1	C2	C27	C28	R3	R6	R9	R11	R16	R26	R62	R66	C1 C2	C3 C4	R6 R7	R10 R12	R17	R19	C1 C2	L1	L2	L3	R1	R2	R3	C1 C2	R1 R2	R3	F1	L1
62605M	5±0.25	100	1.8 20V	10 25V	NOT USED	NOT USED	3.92K 0.5%	100 5% 1/4W	10K 5% 1/4W	1.62K 1% 1/8W	1.5K 1% 1/8W	51 5% 1/4W	27 5% 1/4W	243K 1% 1/8W	3300 125V	320 200V	250 5% 5W	1.25 1% 1/4W	25 5% 1/2W	NOT USED	40,000 7.5V	4μH	2μH	270μH	5 5% 10W	0.75mΩ	43 5% 1/2W	0.1 50V	1.8 5% 1/2W	100 1% 1/8W	15A 250V	1.75mH
62605L	5±0.25	60			0.1 50V	.05 400V					1.62K 1% 1/8W				2000 200V	32 200V	300 5% 5W	1.5 5% 3W	NOT USED	3.3 5% 1/2W	21,000 7.5V	8μH				1.7mΩ			162 1% 1/8W	10A 250V	4mH
62615M	15±0.75	40	1 35V	22 15V			1.78K 1% 1/8W	390 5% 1/4W	30K 5% 1/4W	6.81K 1% 1/8W		200 5% 1/4W	12.1 1% 1/8W	56.2K 1% 1/8W	3300 125V	320 200V	250 5% 5W	1.25 1% 4W	25 5% 1/2W	NOT USED	15,000 20V	15μH	4μH	1000μH	35 5% 10W		620 5% 1/2W	.01 1KV	13 5% 1/2W	100 1% 1/8W	15A 250V	1.75mH

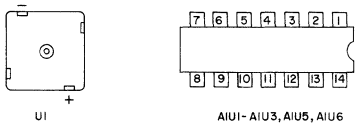
SCHEMATIC NOTES

1. ✱ DENOTES CHASSIS MOUNTED COMPONENTS.
2. ALL RESISTORS IN OHMS, ±5%, 1/4W UNLESS OTHERWISE INDICATED.
3. ALL CAPACITORS IN MICROFARADS, UNLESS OTHERWISE INDICATED.
4. JUMPER A2W1 IS CONNECTED WITH A 120VAC INPUT RECTIFIER-FILTER IS CONFIGURED AS A VOLTAGE DOUBLER. WITH A 187-250VAC INPUT (OPTION 106 UNITS), A2W1 IS REMOVED RESULTING IN A CONVENTIONAL BRIDGE RECTIFIER CONFIGURATION. (ADDITIONAL CHANGES ARE REQUIRED FOR OPTION 106 UNITS - REFER TO SECTION II).
5. TEST POINT VOLTAGES MEASURED UNDER THE FOLLOWING CONDITIONS:
   A. HP 427A OR EQUIVALENT.
   B. 120VAC INPUT.
   C. VOLTAGES REFERENCED TO ⏚ OR ▽, AS INDICATED.
   D. READINGS ARE TYPICAL ±10%.
   E. ALL READINGS TAKEN IN CONSTANT VOLTAGE OPERATION.
6. PIN LOCATIONS FOR SEMICONDUCTORS ARE SHOWN BELOW:



(TOP VIEWS)

7. PIN LOCATIONS FOR INTEGRATED CIRCUITS ARE SHOWN BELOW:



(TOP VIEWS)

8. THE SQUARE PLATED PADS ON ALL P.C. BOARDS INDICATE ONE OF THE FOLLOWING:
   A. PIN 1 OF AN I.C. OR TRANSFORMER.
   B. POSITIVE END OF A POLARIZED CAPACITOR.
   C. CATHODE OF A DIODE OR EMITTER OF A TRANSISTOR.

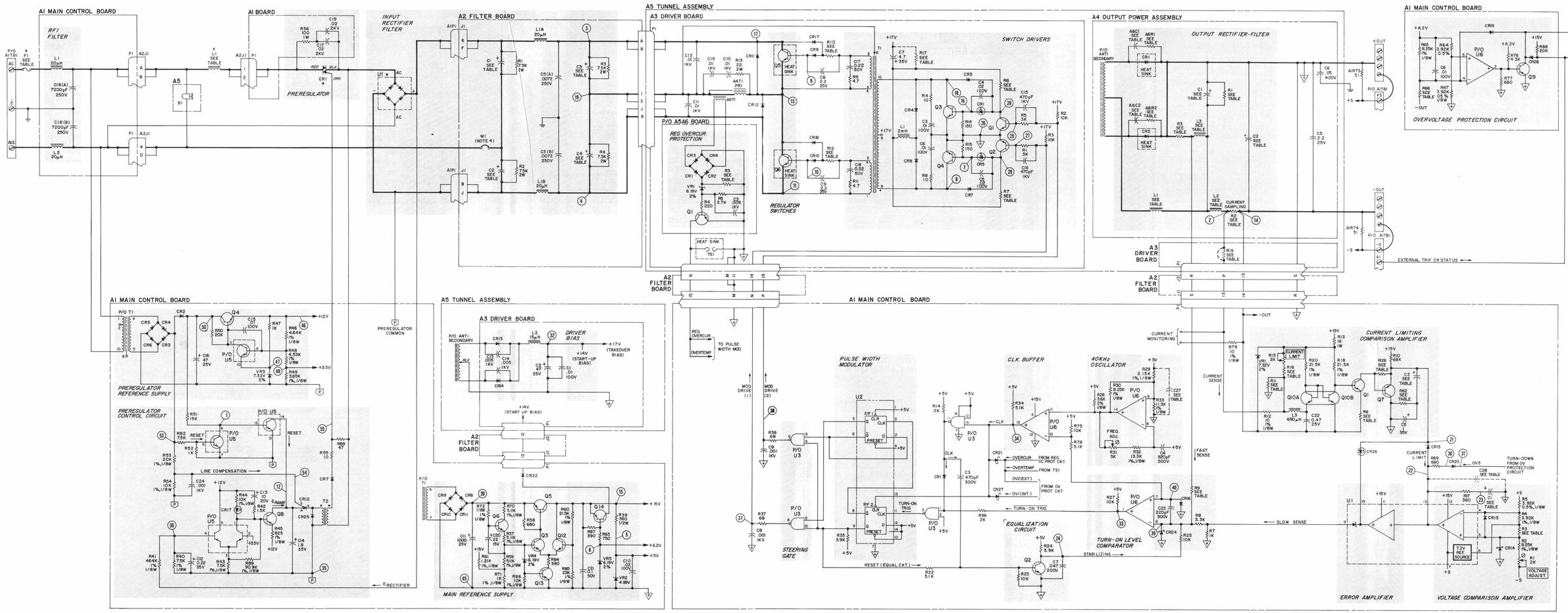


Figure 7-8. Modular Supplies, L and M Series, Schematic Diagram

February 13, 1978

POWER SUPPLY MODIFICATION

Convert Model 62605M to 62605M-P31

PURPOSE:

To provide current limit adjustment range of 50% to 100% of the 100A maximum rated output current.

FACTORY MODIFICATIONS:

1. Change A1R11 to 2.61k 1%, 1/8W, HP Part No. 0698-0085.
2. Change A1R13 to 820Ω, 5%, 1/2W, HP Part No. 0686-8215.
3. Change A1R15 to 10k pot., 10%, HP Part No. 2100-3274.
4. Change A1R16 to 1.21k, 1%, 1/8W, HP Part No. 0757-0274.

MANUAL CHANGES

Models 62605L, 62605M, and 62615M
Modular Power Supplies
Manual HP Part No. 5950-1756

Make all corrections in the manual according to errata below, then check the following table for your power supply serial number and enter any listed change(s) in the manual.

Model	Serial Prefix	Serial Number	Make Changes
62605L	1531A	00121-00140	1
	1541A	00141-00206	1, 2
	1633A	00207-00259	1, 2, 6
	1648A	00260-00563	1, 2, 6, 8
	1724A	00564-00877	1, 2, 6, 8, 10
	1740A	00878-01094	1,2,6,8,10,11
	1749A	01095-01329	1,2,6,8,10-12
	1811A	01330-01429	1,2,6,7,10-13
	1821A	01430-01579	1,2,6,7,10-15
	1830A	01580-01879	1,2,6,7,10-15 17
	1841A	01880-01929	1,2,6,7,10-15 17,19
	1845A	01930-02679	1,2,6,7,10-15 17-19
	1919A	02680-02874	1,2,6,7,10-15 17-20
	1931A	02875-03914	1,2,6,7,10-15 17-21
	2017A	03915-04094	1,2,6,7,10-15, 17-21,23
	2023A	04095-04309	1,2,6,7,10-15, 17-21, 23, 24
	2029A	04310 up	1,2,6,9,10-15, 17-21,23-25
62605M	1530A	00372-00471	1
	1539A	00472-00521	1, 2
	1543A	00522-00661	1, 2, 3
	1550A	00662-00711	1-4
	1604A	00712-01211	1-5
	1633A	01212-01513	1-6
	1639A	01514-01644	1-7
	1648A	01645-02438	1-8
	1724A	02439-03395	1-8, 10
	1746A	03396-04095	1-8,10-12
	1808A	04096-04665	1-8,10,12,13
	1828A	04766-04805	1-8,10-14,16
	1828A	04806-05455	1-8,10-14,16, 17
	1840A	05456-06354	1-8,10-14, 16-18
	1923A	06355-06824	1-8,10-14, 16-18,20
	1930A	06825-07124	1-8,10-14, 16-18,20,21
	1937A	07125-08474	1-8,10-14, 16-18,20,21
	2013A	08475-09009	1-8,10-14, 16-18,20-22
	2018A	09010-09409	1-8, 10-14, 16-18, 20-23
	2029A	09410-09559	1-8,10-14, 16-18, 20-23,25
	2033A	09560-up	1-8, 10-14, 16-18, 20-23, 25,26

Model	Serial Prefix	Serial Number	Make Changes
62615M	1528A	00121-00190	1
	1543A	00191-00230	1, 2, 4
	1544A	00231-00236	1, 2, 4, 5
	1633A	00237-00244	1, 2, 4-6
	1648A	00245-00252	1, 2, 4-6, 8
	1712A	00253-00326	1, 2, 4-6, 8, 9
	1726A	00327-00365	1, 2, 4-6, 8-10
	1742A	00366-00395	1,2 4,6,8-10-12
	1808A	00396-00415	1,2,4,6 8,10-12,13
	1816A	00416-00430	1,2,4,6,8,10-12,13,14
	1825A	00431-00460	1,2,4,6,8, 10-15,17
	1836A	00461-00528	1,2,4,6,8, 10-15,17,18
	1922A	00529-00563	1,2,4,6,8 10-15,17,18,20
	1938A	00564-00613	1,2,4,6,8,10-15 17,18,20,21
	2025A	00614-00628	1,2,4,6,8,10-15, 17,18,20,21,23
	2029A	00629-up	1,2,4,6 8 10-15 17 18 20 21 23 25

ERRATA:

Make the following changes to the parts list and to the Figure 7-8 schematic or the schematic table:

Change the part number of A1C10 to 0160-0818.

Add the following part numbers:

A2C3, C4 in the 62605L is 0180-2601.

A5A4C1, C2 in the 62605L is 0180-2600.

A5A4C1, C2 in the 62615M is 0180-2605.

For the Models 62605M and 62615M, change the part number of A5A3R17 to 0811-1899.

Under Miscellaneous on Page 6-12, change the chassis part number to 5000-3111.

Add this note to the top of Table 5-2:

NOTE: One silicon junction drop equals about 0.7 volts ac.

CHANGE 1:

Add to the parts list under A1 Mechanical, IC socket 14-contact, part number 1200-0508, quantity 5, (for U1, U2, U3, U5, and U6).

Make the following schematic and parts list changes to the Model 62605L only. On Driver Board Assembly A5A3: Change R19 to 4.7 ohms, 0698-0001. Change C7 to 0.47μF 0180-0376. Change R6 and R7 to 250 ohms, 0811-1856.

CHANGE 2:

The serial prefix of the Model 62615M has been changed to 1543A.

In the parts list and in the component table accompanying the schematic, change A1R16 in the Model 62605L to 1.5kΩ 1%, 1/8W, HP Part No. 0757-0427.

In Table 1-1, change the load transient recovery specification for the Model 62605M to 750μsec.

CHANGE 3:

In Model 62605M, change capacitors A2C3 and A2C4 on the filter board to 45μF, 150V, HP Part No. 0180-2627.

CHANGE 4:

In the parts list and on schematic, make the following changes:

Under A5A4 Output Power Assembly: Change L2 in the Model 62605M to 1.1μH, HP Part No. 62605-80109.

Under A1 Main Control Board, for Models 62605L and 62605M: Change C2 to 22μF, 15V, HP Part No. 0180-0228.

Change R6 to 390Ω, 5%, 1/4W, HP Part No. 0683-3915.

Designate that R11, 1.6k, 1%, 1/8W, (HP Part No. 0757-0428), is selected for optimum performance.

Change R26 to 200Ω, 5%, 1/4W, HP Part No. 0683-2015.

Change R62 to 12.1Ω, 1%, 1/8W, HP Part No. 0757-0379.

Under A5A6 Regulator Overcurrent Board for Models 62605M and 62615M: Add capacitor C4, 220pF, 500V, HP Part No. 0150-0111. Connect C4 from the collector to the emitter of A5A6Q1.

CHANGE 5:

Change the serial prefix for Model 62605M to 1604A. In Model 62615M, change capacitors A2C3 and A2C4 on the filter board to 45μF, 200V, HP Part No. 0180-2627.

ERRATA:

In paragraphs 4-50 and 4-51, change the reference designator of the comparator from "A1U5" to "A1U6".

In parts list, under A5A4 Output Power Assembly, HP Part No. of CR1 and CR2 in Model 62605L should read 1901-0748.

In Table 5-1, correct the description of the recommended current sampling resistor for the Model 62605M to read "Model 06713, 50mV @ 100A".

Make this addition to note 3 following Table 5-2: "These Schottky diodes will normally exhibit a certain amount of reverse leakage. This is not cause for replacement".

CHANGE 6:

On page 6-5 of the parts list and the Figure 7-8 schematic, delete capacitors A1C8 and A1C9.

CHANGE 7:

Under A5A4 on page 6-10, change the HP Part No. of CR1 and CR2 for the Model 62605M to 1901-0727.

CHANGE 8:

The value of A5A6R3 on the A5A6 Regulator Overcurrent Protection Board has been changed to improve operation of the peak current limit circuit. In the Models 62605M and 62615M, A5A6R3 is 90.9 ohms, 1%, 1/8W, HP Part No. 0757-0400. In the Model 62605L, A5A6R3 is 150 ohms, 1%, 1/8W, HP Part No. 0757-0284. In the Model 62605L only, A3R19 has been changed back to its original value of 3.3 ohms, 5%, 1/2W, HP Part No. 0686-0335 to optimize the range of CURRENT LIMIT control A1R15. Make these changes to pages 6-11 and 6-10 of the parts list and to the table accompanying the Figure 7-8 schematic diagram.

ERRATA:

Delete from the parts list the five 14-contact IC sockets added to the A1 Board by Change 1.

Add this caution notice to the outline diagram on page 2-1:

CAUTION

The length of the 10-32 screws that mount these supplies must not exceed the thickness of the mounting surface by more than 3/8 of an inch. Longer screws can short the supply internally.

CHANGE 9:

In the schematic table for Fig. 7-8 and on page 6-11 of the parts list, change the value of snubber resistors A5A6R1 and A5A6R2 in the Model 62615M only to 3.9 ohms, 5%, 1/2W, HP Part No. 0698-5139.

In Table 1-1, change the ripple and noise specification for the Model 62615M only to read: Less than 15mV rms and 85mV p-p (20Hz to 20MHz).

ERRATA:

On page 6-9, add the part number for transistors A5A3Q5 and Q6 in the Model 62605L, which is 1854-0710.

On page 6-12, change the part number of the packing carton floater pad to 9220-1418 and the quantity to two.

CHANGE 10:

Make the following changes to pages 6-5 through 6-8 of the parts list and to the Figure 7-8 schematic. Change 10 affects the A1 board of all L- and M-Series models.

A1R73, 74: Change these sensing protection resistors (near output terminals on schematic) to 51 ohms, 5%, 1/2W, HP Part No. 0686-5105.

A1C25: Add C25 (0.01μF, 0150-0093) to the voltage comparison amplifier circuit. This capacitor is connected between pins 7 and 12 of U1.

A1P1: Change the part number to 1251-2035.

CHANGE 10 (Continued)

A1R92: Add R92 (4.7 ohms, 5%, 1/4W, HP Part No. 0683-0475) to the voltage comparison amplifier circuit. R92 is connected in series with the negative terminal of A1C1.

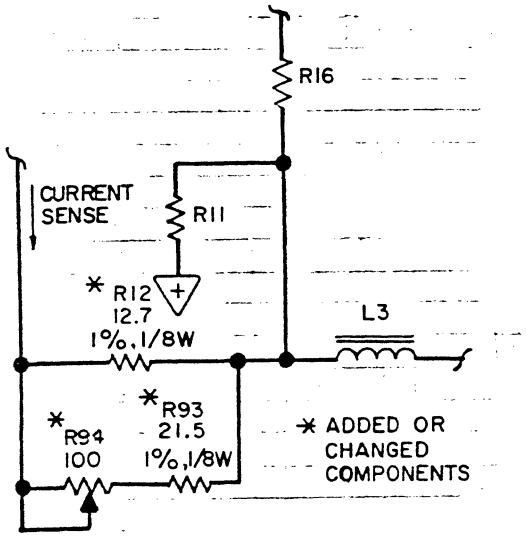
A1C26: Add C26 (0.05μF, 400V, HP Part No. 0150-0052) to the preregulator control circuit. C26 is connected between TP52 (+ terminal) and preregulator common (P).

A1R55: Replace R55 in the preregulator control circuit with a jumper.

A1R12: Change R12 in the CL comparison amplifier to 12.7 ohms, 1%, 1/8W, HP Part No.0698-4356.

A1R93: Add R93 (21.5 ohms, 1%, 1/8W, HP Part No. 0698-3430) to the CL comparison amplifier as shown below.

A1R94: R94 is a 100-ohm trimmer, HP Part No. 2100-3349, and is a factory adjustment used to set the adjustment range of CURRENT LIMIT adjust R15. Add it to the CL comparison amplifier as shown below.



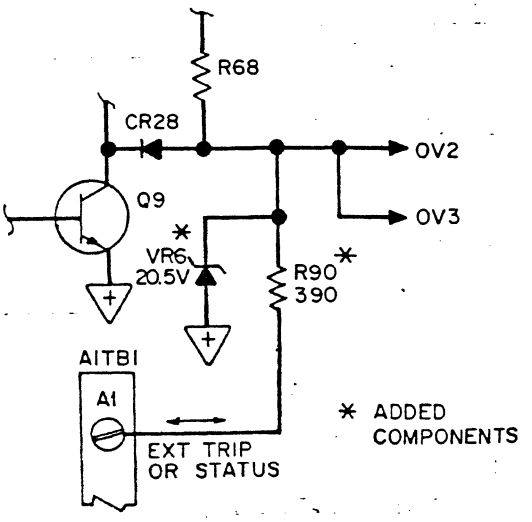
Current Limiting Comparison Amplifier Changes (Change 10)

A1R90: Add R90 (390 ohms, 5%, 1/4W, HP Part No. 0683-3915) to the overvoltage protection circuit as shown below.

A1VR6: Add zener diode VR6 (20.5V, 5%, 400mW, HP Part No. 1902-0182) to the overvoltage protection circuit as shown below.

A1R69: Resistor R69 is now connected to TP23 as shown below instead of to TP22.

In addition to the above circuit changes, the A1 circuit board has been modified to allow automated component insertion.



Overvoltage Protection Circuit Changes (Change 10)

CHANGE 11:

The following changes have been made to the A5A3 Driver Board in the Model 62605L in order to allow the same blank A5A3 Board to be used in all three L- and M-Series models:

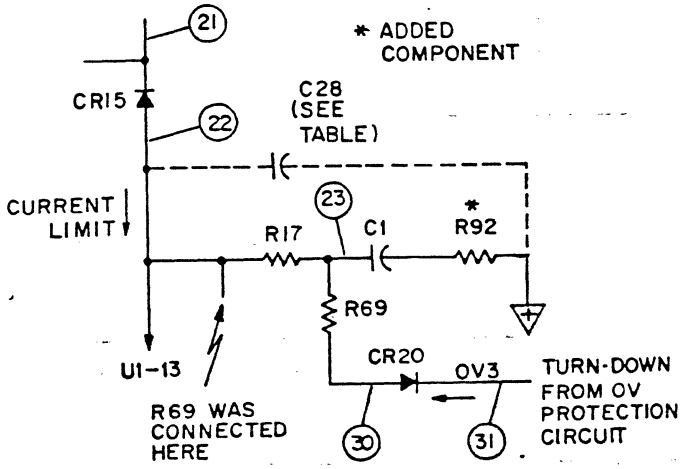
Delete the two heatsinks for A5A3Q5 and Q6 (two HP Part No. 1205-0267) and replace them with a single cast aluminum heatsink (5020-2501). Add two transistor insulators (0340-0503) for Q5 and Q6, and relocate thermal switch TS1 from the A5A4CR1 and CR2 heatsink to the new Q5/Q6 heatsink. Also on the A5A3 Board in the 62605L, change the part number for CR9 and CR10 to 1901-0418, and change R19 to 4.7 ohms, 5%, 1/4W, HP Part No. 0683-0475.

In the A5A4 Output Power Assembly of the Model 62605L, delete the two heatsinks for A5A4CR1 and CR2 (62605-20005 and 62605-20006) and replace them with a single heatsink, HP Part No. 5020-2293.

Add capacitor C4 to the A5A6 Regulator Overcurrent Board in the Model 62605L. A5A6C4 is a 220pF, 500V, disc capacitor, HP Part No. 0150-0111, and is connected between the emitter and collector of A5A6Q1.

CHANGE 12:

On page 6-11 of the parts list under Chassis Electrical, change the HP Part No. of triac CR1 to 1884-0269.



CHANGE 13:

Replace A2C1, C2 capacitor clamp, HP Part No. 5000-3077 with capacitor clamp HP Part No. 5000-3167. Add 8 inch long polyurethane foam tape, HP Part No. 0460-0105, to underside of new capacitor. Solder lug, HP Part No. 0360-0007 is added to the minus side of capacitor C2.

CHANGE 14:

Change A1R32 to 16.2k, ±1%, 1/8W, HP Part No. 0757-0447.

Change HP Part No. of A1U6 to 1826-0138.

ERRATA:

Effective in all models:

Change bridge rectifier (U1 Chassis Electrical) to HP Part No. 1906-0224. Add warning label, "Warning for continued protection against fire hazard . . . ", HP Part No. 7120-4627

Replace diode CR24 (p. 6-5) with HP Part No. 1901-0841.

In model 62605M, change Schottky rectifier to HP Part No. 1901-0851.

CHANGE 15:

In Models 62605L,62615M

Replace fuse holder HP Part No. 1400-0084 and nut, HP Part No. 2950-0038 with fuse holder body HP Part No. 2110-0464 and fuse holder cap, HP Part No. 2110-0465. Add hex nut, HP Part No. 2110-0467.

CHANGE 16:

In Models 62605M:
Delete fuseholder HP Part No. 1400-0084. Delete nut, HP Part No. 2950-0038. Add fuse holder body, HP Part No. 2110-0464. Add fuse cap, HP Part No. 2110-0465. Add nut (metallic) HP Part No. 2110-0467.

CHANGE 17:

Delete diode CR16, HP Part No. 1901-0050. Add resistor R95 in place of the deleted diode. This resistor is fixed composition, 2.2kΩ, 1/4W, HP Part No. 0683-2225.

CHANGE 18:

Add resistor R96 to the A1 Control Board. This 6.8MΩ 5% 1/4W resistor (HP Part No. 0683-6855) is connected from pin 1 to pin 7 of turn-on level comparator U6.

CHANGE 19:

Change the part number of Schottky diodes A4CR1 and CR2 to 1901-0851. This new diode is completely interchangeable with the 1901-0748 used formerly.

CHANGE 20

Dual capacitor C18A and B in the input RFI filter has been changed to two individual 4700pF 250 Vac capacitors designated C18A and C18B. Their HP part no. is 0160-4439. Make this change to the Fig. 7-8 schematic and on page 6-5 of the parts list.

CHANGE 21:

Dual capacitor A2C5 has been replaced by two individual capacitors designated C5 and C6. These are 0.01μF 250Vac HP part no. 0160-4355. Also on the A2 board, R1 through R4 have been changed to 7.5kΩ 3W, HP part no. 0811-1815.
The capacitor clamp for A2C1 and C2 (changed by Change 13) has been changed to HP part no. 5000-3174. The foam tape used with this clamp has been changed to HP part no. 0460-1027.

CHANGE 22:

This change does not require a change to the manual.

CHANGE 23:

In Table 6-4 under Miscellaneous, add C.S.A. (Canadian Standards Association) identification label, HP Part No. 7120-8627. The models 62605L, 62605M, and 62615M are now C.S.A. certified for "component type custom rectifiers."

In the Model 62615M only, diodes A5A4CR1 and A5A4CR2 have been changed to HP Part No. 1901-0904. The new part is interchangeable with the old one.

CHANGE 24:

In the Model 62605L, A2 Filter Board capacitors C1 and C2 have been changed to HP Part No. 0180-3058.

CHANGE 25.

Change capacitor A5A3C2 to 110μF 300V, HP Part No. 0180-2771.

▶CHANGE 26

This change adds a field-selectable choice of line voltage ranges to the Model 62605M. A front panel slide switch can select an input range of either 104 to 127Vac or 187 to 250Vac. The supply is shipped with the switch set to the 187 to 250Vac range. Most of Change 26 affects the A1 Main Control Board Assembly, for which a partial schematic is provided. Correct the parts list and schematic in the manual to reflect the following component and wiring changes.

Add line voltage selector switch A1S1 (HP Part No. 3101-0419), and change bias transformer A1T1 to HP Part No. 5080-1908. The attached figure shows the associated wiring changes. Notice that the terminals of A1T1 have been renumbered and that the wiring to fan A5B1 has been affected. Also shown in the figure are new component designations for the two capacitors formerly designated C18(A) and C18(B). (These were a dual capacitor until Change 20). A1C18(A) is now designated A1C30 and A1C18(B) is now A1C31; both keep the former HP Part No. 0160-4439.

Other changes not shown in the figure include the following: In the preregulator circuit delete A1C19 and change A1C17 to 0.01μF, HP Part No. 0160-4065. Also change A1R56 to 51Ω, 5% 1/2W, HP Part No. 0686-5105.

A1C16 in the preregulator reference supply has been changed to 47μF 40V, HP Part No. 0180-2827.

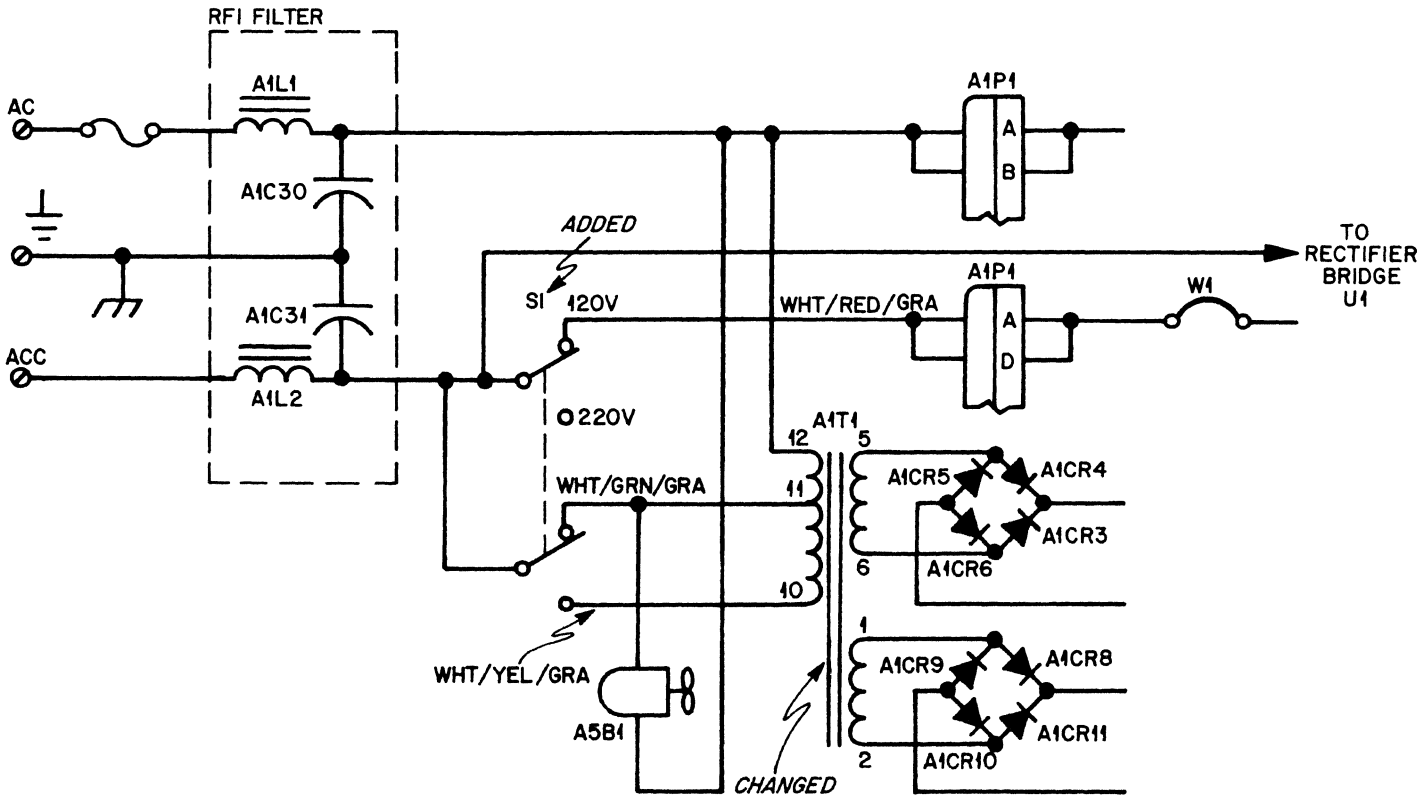
Delete ID plate bracket 5000-3076, and add angle bracket 5000-3147. Also change the cover to HP Part No. 62605-00008.

Due to the elimination of a need for Option 106 for the Model 62605M, paragraphs 1-12 and 2-18, and the Option 106 portion of the parts list no longer apply to this model. The new dual-input-voltage Model 62605M uses the same size fuse in both input ranges as was formerly used in the 104 to 127V range: an HP Part No. 2110-0054 rated at 15A and 250 volts.

Add the following caution notice to the beginning of Section III:

CAUTION

Do not connect the ac input terminals until you have checked that the line voltage selector switch has been set to the proper range.



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