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# INSTRUCTION MANUAL

# FOR

# REGULATED POWER SUPPLIES

## LGS-EEA SERIES

This manual provides instructions intended for the operation of Lambda power supplies, and is not to be reproduced without the written consent of Lambda Electronics. All information contained herein applies to all LGS-EEA models unless otherwise specified.

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IM-LGS-EEA

6/85

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## SPECIFICATIONS AND FEATURES

DC OUTPUT — Voltage regulated for line and load. See table I for voltage and current ratings.

TABLE I
VOLTAGE AND CURRENT RANGES

| MODELS | VOLTAGE RANGE | MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE | | | |
|---|---|---|---|---|---|
| | | 40°C | 50°C | 60°C | 71°C |
| LGS-EEA-5-OV-R | 5 ± 5% | 150.0 | 135.0 | 116.0 | 96.0 |
| LGS-EEA-6-OV-R | 6 ± 5% | 135.0 | 122.0 | 104.0 | 86.0 |
| LGS-EEA-12-OV-R | 12 ± 5% | 81.0 | 73.0 | 63.0 | 51.0 |
| LGS-EEA-15-OV-R | 15 ± 5% | 65.0 | 59.0 | 51.0 | 41.0 |
| LGS-EEA-20-OV-R | 20 ± 5% | 47.0 | 42.5 | 36.5 | 30.0 |
| LGS-EEA-24-OV-R | 24 ± 5% | 40.0 | 36.0 | 31.0 | 26.0 |
| LGS-EEA-28-OV-R | 28 ± 5% | 35.0 | 32.0 | 27.0 | 22.0 |
| LGS-EEA-48-OV-R | 48 ± 5% | 20.0 | 18.0 | 15.5 | 12.5 |

Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range.

REGULATED VOLTAGE OUTPUT

Regulation . . . . . 0.1% line or load with input variations from 105-132 or 132-105 volts AC and load variations from no load to full load.

Ripple and Noise . . . . . 10mV RMS, 35mV peak-to-peak for LGS-EEA-5-OV-R -6-OV-R models; 15mV RMS, 100mV peak-to-peak for LGS-EEA-12-OV-R, -15-OV-R, -20-OV-R, -24-OV-R, -28-OV-R models; 35mV RMS, 150mV peak-to-peak for LGS-EEA-48-OV-R with either positive or negative terminal grounded.

Temperature Coefficient . . . . . Change in output voltage 0.03%/°C max.

Remote Programming

External Resistor . . . . . Nominal 1000 ohms/volt output.

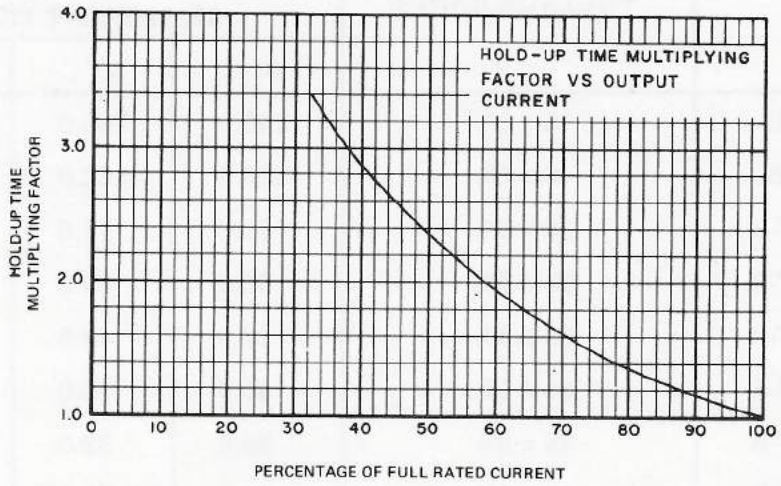
Programming Voltage . . . . . One-to-one voltage change.

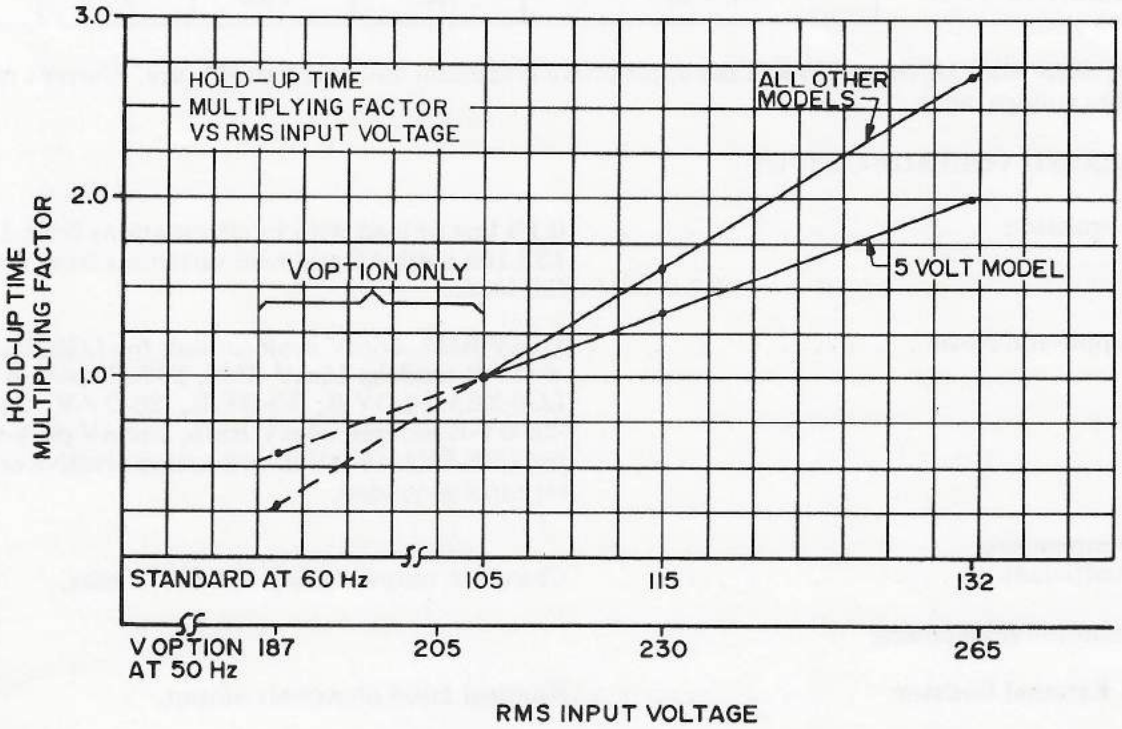
Remote Sensing . . . . . Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.

HOLD-UP TIME — Determine hold-up time regulation after input power failure as follows:

1. Find hold-up time at full rated current from chart below.
2. Determine percentage of full rated current for desired application.
3. Find multiplying factor on graph below.
4. Apply hold-up time formula: S = (F) (M)

where S = hold-up time, F = hold-up time at full rated current (see chart), M = multiplying factor (see graph)




Hold-up time for each model at maximum output power and 105V RMS @60 Hz (or 210V RMS @50 Hz for V option) is listed below

| LGS-EEA MODEL | 5V | 6V | 12V | 15V | 20V | 24V | 28V | 48V |
|---|---|---|---|---|---|---|---|---|
| HOLD-UP TIME IN MSEC | 24 | 16.5 | 13 | 13 | 13 | 13 | 13 | 13 |

INPUT

AC Input . . . . . 105-132, or 187-265 ("V" option) VAC at 47-440 Hz.

Input power . . . . . 1350 Watts*. Input current: 15 amps**. For operation at frequencies above 63 Hz, consult factory. Derate 10% for operation below 57 Hz.

*With output loaded to full current rating.
**With output loaded to full current rating and input voltage 105 VAC, 60 Hz.

DC Input . . . . . 290 VDC ±10%. Input power 1350 watts†. Input current: 4.65 Amps.††.

†With output loaded to full current rating.
††With output loaded to full current rating and input voltage 290 VDC.

INPUT FUSE — Fuse F1 protects the input wiring to the power supply. Overload to power supply does not cause fuse failure.

SOFT START CIRCUIT . . . . . Limits in-rush current at turn-on to 50A max.

OVERSHOOT . . . . . No overshoot under conditions of power turn-on, turn-off on power failure.

OVERLOAD PROTECTION

Thermal . . . . . Thermostat resets automatically when over-temperature condition is eliminated.

Electrical

External . . . . . Automatic electronic current limiting circuit, limits output current to a preset safe value. Automatic current limiting protects the load and power supply when external overloads and direct shorts occur.

OVERVOLTAGE PROTECTION — All LGS-EEA models include fixed built-in overvoltage protection circuits which prevent damage to the load caused by excessive power supply output voltage. When preset output voltage is exceeded, the overvoltage protector crowbars the output and removes the inverter drive. See table below for overvoltage protector firing ranges.

| MODEL | OVERVOLTAGE PROTECTOR TRIP-POINT RANGE (VOLTS) |
|---|---|
| LGS-EEA-5-OV-R | 6.3 — 6.9 |
| LGS-EEA-6-OV-R | 7.1 — 7.7 |
| LGS-EEA-12-OV-R | 13.3 — 14.3 |
| LGS-EEA-15-OV-R | 16.5 — 17.5 |
| LGS-EEA-20-OV-R | 22.1 — 23.5 |
| LGS-EEA-24-OV-R | 26.5 — 28.1 |
| LGS-EEA-28-OV-R | 30.9 — 32.9 |
| LGS-EEA-48-OV-R | 52 — 54 |

INPUT CONNECTIONS — Terminal block on rear of chassis.

OUTPUT CONNECTIONS — 1/4-28 studs on rear of chassis.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE — Continuous duty from 0°C to 71°C ambient with corresponding load current ratings for all modes of operation.

STORAGE TEMPERATURE (non-operating) — -55°C to 85°C

FUNGUS — All LGS-EEA power supplies are fungus inert.

VDC ADJ. Control — Voltage adjust control permits adjustment of DC output over entire operating range.

PHYSICAL DATA

| | |
|---|---|
| Size | 7-1/2" x 4-15/16" x 16-1/2" |
| Weight | 26 lbs. net; 31 lbs. shipping |
| Finish | Gray, FED. STD. 595 No. 26081 |

MOUNTING — One surface with tapped mounting holes can be utilized for mounting this unit. LGS-EEA power supplies must be mounted with Top facing up. Top must be in a horizontal plane. Refer to figure 10 for mounting details.

"V" OPTION — Standard LGS-EEA power supplies can be obtained for 187-265 VAC input. See nameplate for AC input rating. For operation at frequencies above 63 Hz, consult factory. No derating required for operation of "V" option LGS-EEA units below 57 Hz.

ACCESSORIES

| | |
|---|---|
| Rack adapters | Rack adapter LRA-17 used for ruggedized mounting with or without chassis slides, is available. |

EMI — The LGS-EEA is designed to meet FCC Docket 20780 Class A and MIL-I-6181D conducted emissions.

UL/CSA — All LGS-EEA power supplies are designed for underwriters laboratories recognized component index and CSA certification.

MILITARY SPECIFICATIONS — The LGS-EEA series is designed to meet the following tests in accordance with MIL-STD-810C.

1. Low Pressure — Method 500.1, Procedure I.
2. High Temperature — Method 501.1, Procedure I & II.
3. Low Temperature — Method 502.1, Procedure I.
4. Temperature Shock — Method 503.1, Procedure I.
5. Temperature — Altitude — Method 504.1, Procedure I. Class 2 (0°C operating).
6. Humidity — Method 507.1, Procedure I.
7. Fungus — Method 508.2, Procedure I.
8. Vibration — Method 514.2, Procedures X & XI.
9. Shock — Method 516.2, Procedures I & III.

## THEORY OF OPERATION

### GENERAL

The Lambda power supply consists of an input circuit; two auxiliary power circuits; a main output rectifier and filter circuit and a regulator circuit consisting of a master control chip, operational amplifier and comparator circuits.

The circuit arrangement is shown in block diagram form in figure 8. The circuit is discussed with referenct to the block diagram and the schematic diagram.

### FUNCTIONAL DESCRIPTON

#### Input Circuit

Single phase AC input power is applied to the input rectifier CR1 & CR2 in a voltage doubler configuration for 105 to 132 VAC input and CR1 thru CR4 in a bridge configuration for 187-265 VAC input. R1 and TR1 prevent excessive input surge current during turn on. Fuse F1 protects the power supply against excessive currents due to internal failure.

#### Auxiliary Power and Start Up

Power for start up is supplied through R6, R11, CR134, Q105 and Q106 to the primary auxiliary circuit with Q109, R168, R165, R166, R167 and comparator IC101-1 providing regulation of this power.

Voltage across C1 and C2 is sensed by R106, R109, R112, R110, R111, R113, R175, C104 and comparator IC101-3. When the input voltage is equivalent to 90 VAC (180 VAC bridge input, V option) IC101-3 turns on, applying power to IC102 thru Q108, Q101, Q102, Q103 and Q104 thru CR135. This provides pulses to Q1, Q2, Q3 and Q4 thru T101 and T102 thus starting the switcher.

After the switcher starts up, auxiliary power is provided by transformer T1 winding at terminals 17, 18 and 19 on the P.C. Board thru CR115, CR116, R118 and C108, regulated by Q107, C110, R119 and CR117.

When the voltage from this source exceeds that thru Q105 and Q106, IC101-1 shuts these transistors off.

CR141, 144, 145, 146, 147, R172 and R12 provide turn on of the power supply at zero crossing to prevent excessive inrush current when the line voltage at terminal 1 swings negative with reference to terminal 2, R12, and CR146 prevent IC101-3 from switching on (Q108 being turned off) thus locking off the power supply for anything beyond 50V below crossover.

When the line voltage at terminal 1 swings positive with reference to terminal 2, R12, R172 & CR144 prevent IC101-3 from switching on (IC101-3 output being high, Q108 being off) thus locking off the power supply for anything beyond 50V above crossover.

After the power supply turns on, CR145, 147, and 148 inhibit the zero crossing circuit from operating.

#### Pulse Width Modulated Inverter

Transformer drive is accomplished by Q1 - Q4 in a bridge configuration with Q1 and Q4 conducting at one time and Q2 and Q3 conducting at another time thus providing alternate pulses to T1.

Q1 thru Q4 are turned on by the flyback operation of T101 & T102. CR127, CR137 and CR138 limit the maximum voltage applied to Q101 and Q104. When Q101 is turned off, the polarity on transformer T101 is such that Q1 and Q4 are turned on. As collector current starts to flow in Q1 and Q4, this current also flows in the one turn winding of T101 thus providing a regenerative action, holding Q1 and Q4 on. To turn these transistors off, Q101 is turned on reversing the voltage on transformer T101 thereby turning off Q1 and Q4. R107 limits the maximum, cuttent in T1 when Q101 is conducting. The same analogy holds true for the other halfcycle on the other side of the bridge circuit with Q104, Q2 and Q3.

IC102 contains a free-running oscillator, with C114 and R130 acting as timing components. C114 controls the dead-time or reset time of the ramp generator, which is approximately 4 microseconds. R130 controls the rise-time of the ramp generator, which is approximately 23 microseconds. The ramp measured at terminal 10 rises a total of 1.0 volt, from 1.3 to 2.3 volts. The output timing pulses can be measured at terminal 9.

The error operational amplifier input is thru terminals 5 and 6 of IC102 and the output is at terminal 7. Compensation components C115 and R140 with R148 provide an approximate gain of 2 at the pulse rate and is primarily used for current balance. R149 and R145 provide a reference voltage to terminal 5, with the error voltage from IC103 terminal 4 being applied to negative input terminal 6. C118 working with R148 also provide frequency compensation.

Current balance and current limit information is developed across R2. The balance information is referenced to the emitters of Q1 thru the one-turn windings on T101 and T102. The balance signal across R2 is then AC coupled and superimposed on the DC reference signal at terminal 5 of IC102.

The current-limit section of IC102 requires a pulse to activate the function. When a pulse is applied, the current limiter latches on and remains on, thus inhibiting pulses at terminals 2 and 4. At the end of each 27 microsecond period the internal sync pulse resets the current limit latch.

The current limit information is developed across R2 and applied to terminals 10 and 11 of comparator IC101-4. When activated, output terminal 13 goes positive and is applied to terminal 4 of IC102. When terminal 4 exceeds 2.4 volts positive, the current limit function is activated and latched.

R143 decreases the offset voltage when rotated counterclockwise thereby reducing the maximum current available at the output terminals of the power supply.

When the current limit is activated, a time-delay of 1 to 3 microseconds is encountered before Q1&4 or Q2&3 are actually turned off due to inherent transistor characteristics. Thus a frequency-shift circuit is required and activated when the pulse width is reduced to approximately 6 microseconds. This frequency shift is necessary to prevent excessive short-circuit current at the output of the power supply. R116, R124, R125, R126, R173, R178, Q110, C137, IC101-2, CR124 & CR136 are the frequency shift components.

When the output of either pin 2 or 14 of IC102 goes positive, C137 starts charging thru R124. When the voltage across C137 reaches that value developed by R116 & R173 at pin 7 of IC101-2 the comparator switches state & the output of pin 1 is then controlled by R126. If the power supply is not in current limit, terminal 11 of IC102 remains clamped to ground internally and no frequency shift occurs. However, if IC102 is in current, pin 11 of IC102 is unclamped & R126 applies a positive voltage to pin 11. This bypasses some of the current that charges C114 thus providing frequench shift. The circuit is designed such that if the pulse width is approximately 6us or less, the frequency shift circuit is enabled after the power supply has gone into current limit.

C117, R147 and CR123 prevent output voltage overshoot on initial turn-on with CR123 providing fast recovery of C117 when power is interrupted. The components also prevent Q1-Q4 from turning on after the switching circuit is turned off.

Voltage sense information is fed thru R160, R4, R171, R159, R162 and R161 to terminal e of IC104. This signal is developed across R155 and is compared with the 2.5 volt reference voltage at terminal 2. The operational amplifier provides about 75 db gain. The output at terminal 6 is applied to terminal 1 of IC103 diode section.

IC103 is an opto coupler which isolates the input and output sections of the power supply from each other. C120, C119, C122, R151, R152, R153, R180, and C129 function as frequency compensation components. R153 & R150 provide a voltage divider network that limits current applied to the diode section of IC103.

## Output Circuit

Positive and negative pulses supplied by T1 secondary are rectified by full-wave rectifiers CR5, CR6 and, as applicable, CR7 and CR8. Filtering is accomplished by L1, C3, and associated E.M.I. components.

## Overvoltage Operation

When the output voltage reaches the trip-point of the over voltage module, the module fires, crowbarring the output of the supply. The current through the module is sensed by current sensor L101. The output of L101 triggers SCR101, shutting off the power to T101, T102, and the start-up circuitry thru diodes CR127, CR137 and CR139.

## Output Voltage Control

The unit output voltage is changed by adjusting R4, which is accessible thru the front panel of the power supply. Clockwise rotation of R4 increases output voltage and counter clockwise rotation of R4 decreases output voltage.

## BASIC MODE OF OPERATION

This power supply operates as a constant voltage source provided the load current does not exceed the rated value at 40° C. For continuous operation, load current must not exceed the rating for each ambient temperature. When rated load current is exceeded, voltage decreases towards zero and the current at short circuit is held to a safe value.

## CONNECTIONS FOR OPERATION

NOTE: Make all connections to the unit before applying input power.

Ground Connections. The Lambda power supply can be operated either with negative or positive output terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. Apply input power to terminals 1 and 2; always connect the ungrounded AC lead to terminal 1.

The supply positive terminal is brought out to terminal 6. The supply negative terminal is brought out to terminal 4. Recommended wiring of the power supply to the load and selection of wiring is shown in figures 1 through 9. Selection of proper wiring is made on the basis of load requirements. Make all performance checks and measurements of current or voltage at the rear output terminals. Connect measuring devices directly to terminals or use the shortest leads possible.

## SUPPLY LOAD CONNECTIONS

### Connections for Operation as a Constant Voltage Source

The output impedance and regulation of the power supply at the load may change when using the supply as a constant voltage source and connecting leads of practical length are used. To minimize the effect of the output leads on these characteristics, remote sensing is used. Recommended types of supply-load connections with local or remote sensing are described in the following paragraphs.

Refer to figure 1 to determine voltage drop for particular cable length, wire size and current conditions. Lead lengths must be measured from supply terminals to laod terminals as shown in figure 2.

Local Sensing Connection, Figure 3. Local sensing is the connection suitable for applications with relatively constant load or for applications with short power output leads.

Remote Sensing Connection, Figure 4. Remote sensing provides complete compensation for the DC voltage drops in the connecting cables. Sensing leads should be a twisted pair to minimize AC pick-up. A 2.5 mf elect., capacitor may be required between output terminals and sense terminals to reduce noise pick-up.

Programmed Voltage Connections, Using External Resistor, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at a nominal 1000 ohms/volt change and a shorting-type switch as shown in figure 5. When continuous voltage variations are required, use a variable resistor with the same 1000 ohms/volt ratio in place of the resistive voltage divider and shorting-type switch. Use a low temperature coefficient resistor to assure most stable operation.

Before programming, adjust programming resistor for zero resistance and set voltage adjust control to the minimum rated output voltage. Output voltage of programmed supply will nominally be minimum output voltage plus 1 volt per 1000 ohms.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.

Programmed Voltage Connections Using Programming Voltage, Figure 6. The power supply voltage output can be programmed with an externally connected programming power supply. The output voltage change of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply. If the output voltage control of the programmed supply is set to minimum output voltage, output voltage of the programmed supply will be minimum output voltage plus voltage of programming supply.

The programming supply must have a reverse current capability of 1 ma. minimum.

Alternatively, when supplies with less than 1 ma. reverse current capability are used, a resistor capable of drawing 1 ma. at the minimum programming voltage must be connected across the output terminals of the programming supply. This programming supply must be rated to handle all excess resistor current at the maximum programming voltage.

Connections For Series Operation, Figure 7.

The voltage capability of LGS-EEA power supplies can be extended by series operation. Figure 7 shows the connections for either local or remote sensing in a series connection where the voltage control of each unit functions independently to control the output.

A diode, having a current carrying capability equal to or greater than the maximum current rating of the supply, must be used and connected as shown in figure 7. The diode blocking voltage should be at least twice the maximum rated output voltage of the supply. See table I, of SPECIFICATIONS AND FEATURES, for power supply current and voltage ratings.

## OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown. The thermostat shuts down inverter operation only when the temperature of the switching transistors exceed a maximum safe value. The thermostat will automatically reset when the temperature of the heat sink decreases to a safe operating value.

Fuse Shutdown. Fuse will blow when the maximum rated current value for the fuse is exceeded. Fatigue failure of fuses can occur when mechanical vibrations from the installation combine with thermally induced stresses to weaken the fuse metal. Many fuse failures are caused by a temporary condition and replacing the blown fuse will make the fuse protected circuit operative.

Overvoltage Shutdown. When the power supply output voltage increases above the overvoltage limit, HC1 will short circuit output of the supply and SCR101 will shut down inverter operation. After eliminating the cause(s) for overvoltage, resume operation of the supply by interrupting the AC input circuit for a period of 3 minutes. (Refer to TROUBLE SHOOTING CHART)

## GENERAL

This section describes trouble analysis routine, calibration and test procedures that are useful for servicing the Lambda power supply. A trouble chart is provided as an aid for the troubleshooter. Refer to the section on SPECIFICATIONS AND FEATURES for the minimum performance standards.

## TROUBLE ANALYSIS

Whenever trouble occurs, systematically check all fuses, primary power lines, external circuit elements, and external wiring for malfunction before troubleshooting the equipment. Failures and malfunctions often can be traced to simple causes such as improper jumpers and supply-load connections or fuse failure due to metal fatigue.

Use the electrical schematic diagram and block diagram, figure 8, as an aid to locating trouble causes. The schematic diagram contains various circuit voltages that are averages for normal no load operation. Measure these voltages using the conditions for measurement specified on the schematic diagram. Use measuring probes carefully to avoid causing short circuits and damaging circuit components.

## CHECKING TRANSISTORS AND CAPACITORS

Check transistors with an in-circuit transistor checker. If no checker is available, transistors can be checked with an ohmmeter that has a highly limited current capability. Observe proper polarity for PNP or NPN to avoid error in measurement. The forward transistor resistance is low but never ZERO; backward resistance is always higher than the forward resistance.

Do not assume trouble is eliminated when only one part is replaced. This is especially true when one transistor fails, causing other transistors to fail. Replacing only one transistor and turning power on, before checking for additional faulty components could damage the replaced component.

When soldering semi-conductor devices, hold the lead being soldered with a pair of pliers or a commercial heat sink device placed between the component and the solder joint.

NOTE: The leakage resistance obtained from a simple resistance check of a capacitor is not always an indication of a faulty capacitor. In all cases the capacitors are shunted with resistances, some of which have low values. Only a dead short is a true indication of a shorted capacitor.

## PRINTED CIRCUIT BOARD MAINTENANCE TECHNIQUES

1. If foil is intact, but not covered with solder, it is a good contact. Do not attempt to cover with solder.
2. Voltage measurements can be made from either side of the board. Use a needle-point probe to penetrate to the wiring whenever a protective coating is used on the wiring. A brass probe can be soldered to an alligator clip adapted to measuring instrument.
3. Always use a heat sink when soldering transistors; a transistor pad with mounting feet is an effective heat sink.
4. Broken or damaged printed wiring is usually the result of an imperfection, strain or careless soldering. To repair small breaks, tin a short piece of hook-up wire to bridge the break, and holding the wire in place, flow solder along the length of wire so that it becomes part of the circuitry.
5. When unsoldering components from the board never pry or force loose the part; unsolder the component by using the wicking process described below:
   a) Select a 3/16 inch tinned copper braid for use as a wick; if braid is not available, select AWG No. 14 or No. 16 stranded wire with 1/2 inch insulation removed.
   b) Dip the wick in liquid rosin flux.
   c) Place the wick onto the soldered connection and apply soldering iron onto the wick.
   d) When sufficient amount of solder flows onto the wick, freeing the component, simultaneously remove iron and wick.

## TROUBLE CHART

The trouble chart is intended as a guide for locating trouble causes and is used along with the schematic diagram.

The operating conditions assumed for the trouble chart are as follows:

a) AC power of proper voltage and frequency is present at input terminals.

b) No load is applied to the DC output (unless otherwise noted).

c) The power supply is connected for constant voltage with local sensing. See schematic; dotted lines indicate jumpers connected for local sensing operation.

### SAFETY NOTICE

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT. OBSERVE THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SERVICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

### TROUBLESHOOTING CHART

| Symptom | Possible Cause | Corrective Action |
|---|---|---|
| 1. Zero volts DC output, voltages across C1 and C2 read zero. | F1, R1, L9, L10 Open CR1, CR2, CR3, CR4, TR1 defective | Check and replace as necessary. If R1 is hot/open refer to Symptom 2. |
| 2. Zero volts DC and voltages across C1 and C2 read less than 130 volts DC each, or R1 Hot/open, or F1 repeatedly opens. | C1, C2, TR1 defective R3 open | Check and replace as necessary. |
| | Q1, Q2, Q3, Q4 CR101, CR102, CR103, CR104, CR105, CR109, CR113, CR120 T1 shorted. | Check and if defective also check R101, R102, R103, R104 open, Q101, Q102, Q103, Q104, leakage or otherwise defective, 1C102* defective. Replace as necessary. |
| 3. Zero Volts DC output, voltages across C1 and C2 are correct, voltage across C112 is less than 13 volts DC | Thermostat S1 closed | Refer to table 1 of specifications and features for current rating at given ambient temperature. After allowing time for the power supply to cool, resume operation of the supply. |
| | SCR101 fired due to over voltage condition | Interrupt AC input for 3 minutes. If supply operates normally, a transient has occurred in line or load, check wiring (switches etc). If supply fails to reach full output, remove AC input, disconnect +V terminal of HC1, and refer to symptoms 8 or 9. |

## TROUBLESHOOTING CHART

| Symptom | Possible Cause | Corrective Action |
|---|---|---|
| | CR117, CR130, SCR101, HC1, 1C102*, C108, C110, S1, SCR101 shorted Q105, Q106, Q107, Q108 R6 open 1C101 defective | Check and replace as necessary |
| 4. Zero volts DC output, voltages across C1 and C2 are correct, voltage across C112 is greater than 14 volts DC | Q107 shorted CR117 defective | Check and replace as necessary, then check 1C102* and 1C101. Replace if necessary. |
| 5. Zero volts DC output, voltages across C1, C2, and C112 are correct. | 1C102 defective Q1, Q2, Q3, Q4, T1 R101, R102, R103, R104 open | Check and replace as necessary. |
| 6. Zero volts DC output, and unit makes audible squeal | Output terminals, HC1, CR5, CR6, CR7, CR8, C3, T1 shorted | Check and replace as necessary. |
| 7. Output voltage correct at no load, unit audible squeals with no load or light load | Q101, Q102, Q103, Q104 leakage. R5 open 1C102*, C101, C102 defective. | Check and replace as necessary |
| 8. Output voltage too high, 12 volts DC across CR126 | Sense leads, R4, 1C104, 1C103, 1C102 open. | Check and replace as necessary. |
| 9. Output voltage too high, less than 12 volts DC across CR126. | CR126, C124 shorted, R156, R157 open, CR125 defective. | Check and replace as necessary. |
| 10. Output voltages too low (may be with or without load on DC output) | 1C104, 1C102*, 1C101 R143 defective. | Check and replace as necessary. |
| 11. Excessive output current | 1C101, CR131, CR133, CR122 open CR132 shorted | Check and replace as necessary. If symptom remains, replace 1C102. |
| 12. Excessive Ripple | 1C103, C108 defective | Check and replace as necessary. |
| 13. Poor voltage regulation | 1C103, 1C104, 1C102 defective | Check and replace as necessary. |

*1C102 may be partially tested in circuit by removing Q108 and applying +12 VDC (current limited) to terminal 16 with reference to terminal 8 while observing terminals 2 and 14 for 11 volt pulses of about 25us duration at approximately 54us intervals.

Supply current for this test will be less than 40 ma DC. This procedure does not test current limit sections of 1C102. For excessive output current refer to symptom 11.

## PERFORMANCE CHECKS

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 9. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC DVM (John Fluke Model 891A or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the no load to load condition. Long load leads should be a twisted pair to minimize AC pick-up.

Use a 25A Variac to vary the line voltage from 105-132 or 132-105 volts AC and check the power supply line regulation accuracy on the DVM differential meter.

Use a VTVM, Ballantine 320 or equivalent, to measure rms ripple voltage of the power supply DC output. Use oscilloscope to measure peak-to-peak ripple voltage of the power supply DC output.

## ADJUSTMENT OF CALIBRATION CONTROL R143

Whenever R2, R143, R144, or R105 are replaced, and voltage and current indications do not reflect maximum ratings, adjust R143 as follows. The adjustment procedure requires that the power supply is removed from associated equipment, is at an ambient temperature of 25-30° C, and is stabilized and not operating.

1. Remove AC input power to the supply.
2. Break seal on wiper of R143 from resistor housing and turn to full CW position.
3. Operate power supply for constant voltage with local sensing connected as shown in figure 3, with no external load, and with AC input of nominal line voltage at 60 Hz.
4. Turn voltage adjust control until minimum rated output voltage is obtained.
5. Apply load so that output current is 110% of 40° C rating for the unit.
6. Using an oscilloscope, Tektronix 465 or equivalent, observe output voltage while adjusting R143 in CCW direction. Adjust R143 until output voltage decreases sharply and the unit emits an audible noise. Readjust R143 in CW direction until output ripple is restored to its original value and the noise ceases.
7. After adjustment is completed, remove AC power input to the supply and use glyptol sealant to seal wiper of R143 to resistor housing.
8. After sealing, check setting and repeat adjustment procedure if required.

## SERVICE

When additional instructions are required or repair service is desired, contact the nearest Lambda office where trained personnel and complete facilities are ready to assist you.

Please include the power supply model and serial number together with complete details of the problem. On receipt of this information, Lambda will supply service data or advise shipping for factory repair service.

All repairs not covered by the warranty will be billed at cost and an estimate forwarded for approval before work is started.

## PARTS ORDERING

Standard components and special components used in the Lambda power supply can be obtained from the factory. In case of emergency, critical spare parts are available through any Lambda office.

The following information must be included when ordering parts:

1. Model number and serial number of power supply and purchase date.
2. Lambda part number.
3. Description of part together with circuit designation.
4. If part is not electronic part, or is not listed, provide a description, function, and location, of the part.

## PERFORMANCE CHECKS

Check the ripple and regulation of the power supply using the test connection diagram shown in figure 9. Use suggested test equipment or equivalent to obtain accurate results. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Set the differential meter, DC DVM (John Fluke Model 891A or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the no load to load condition. Long load leads should be a twisted pair to minimize AC pick-up.

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8. After sealing, check setting and repeat adjustment procedure if required.

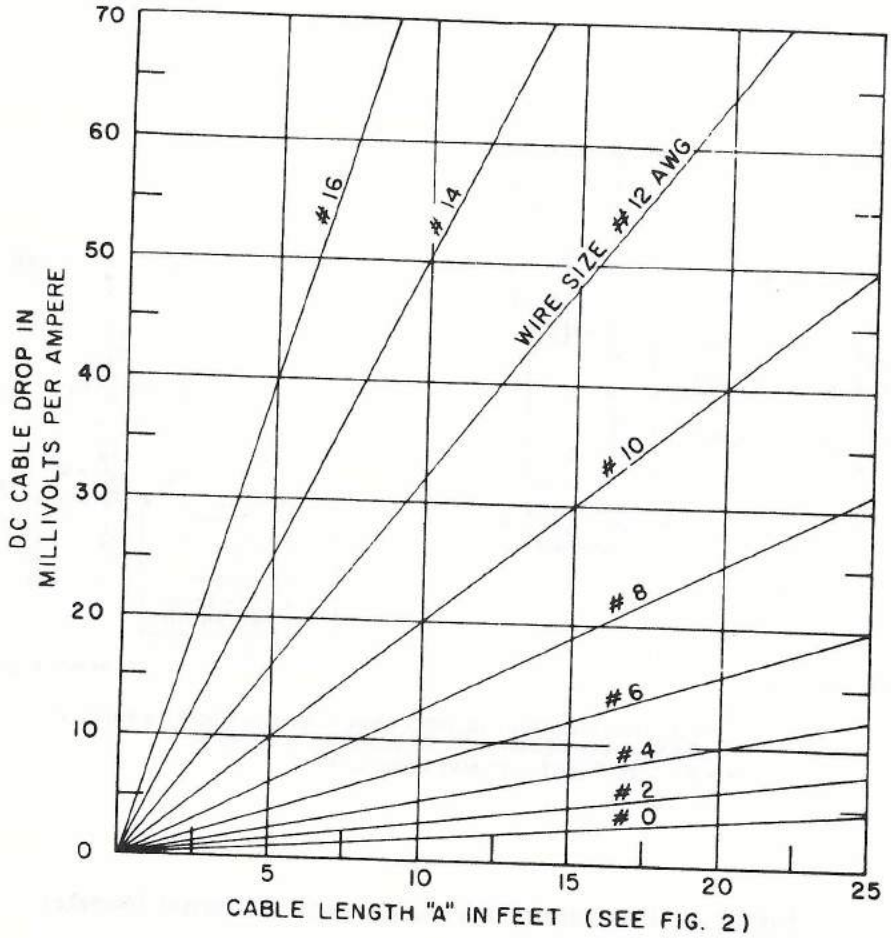



Figure 1. Cable Connection Chart

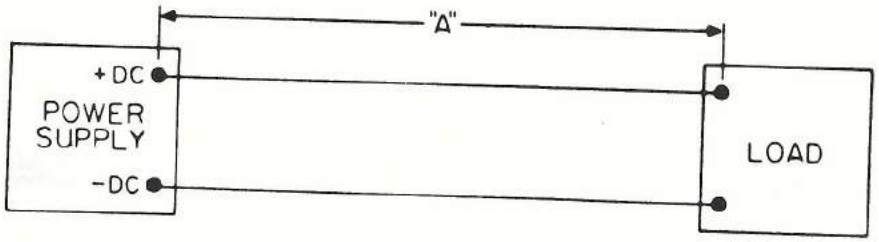



Figure 2. Cable Length "A" in Feet

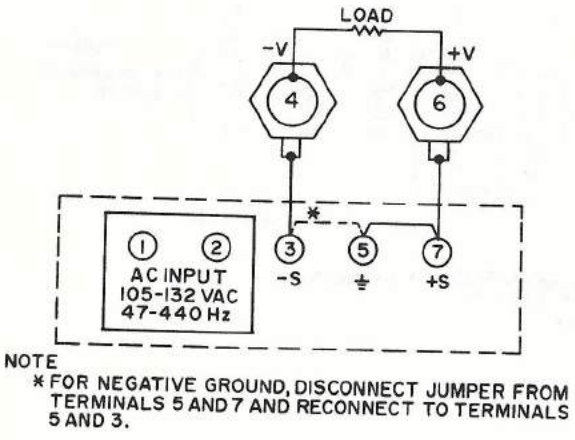



Figure 3. Local Sensing Connections

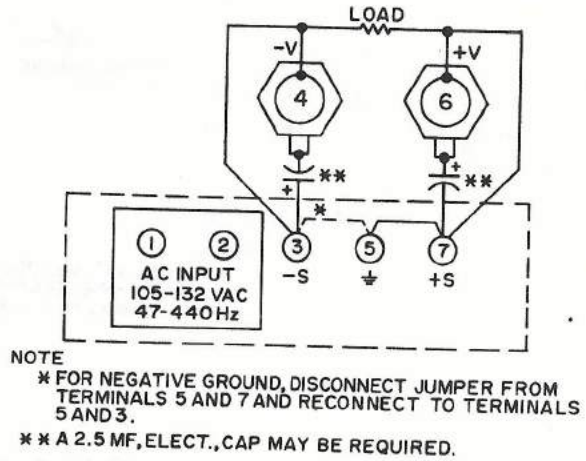
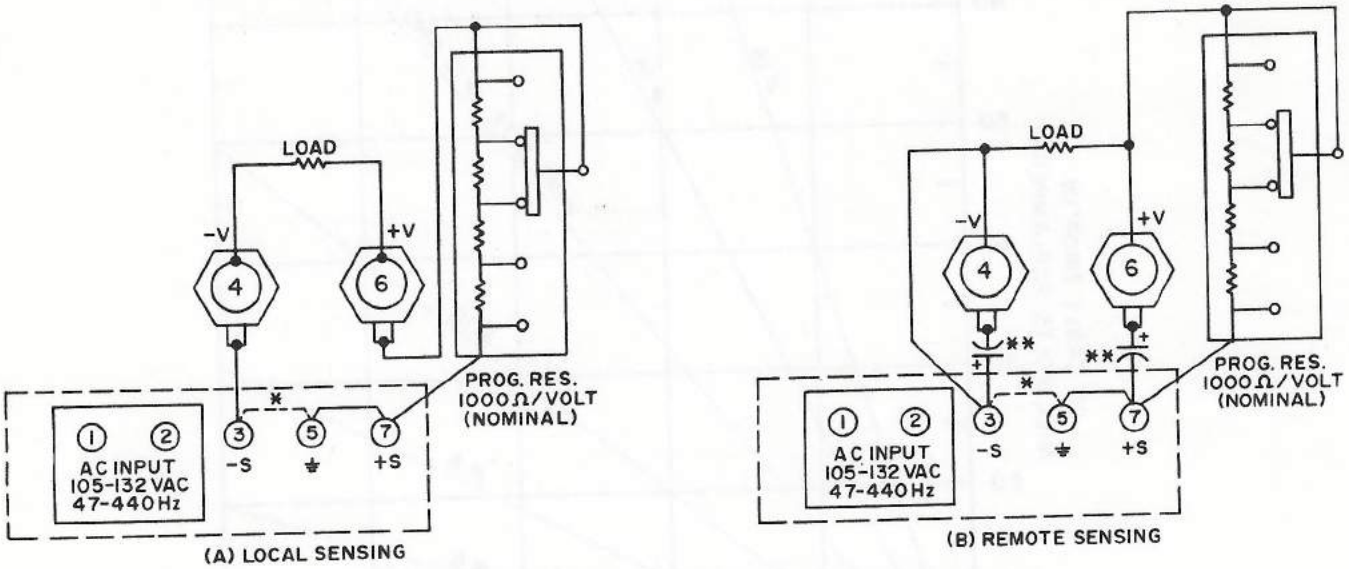
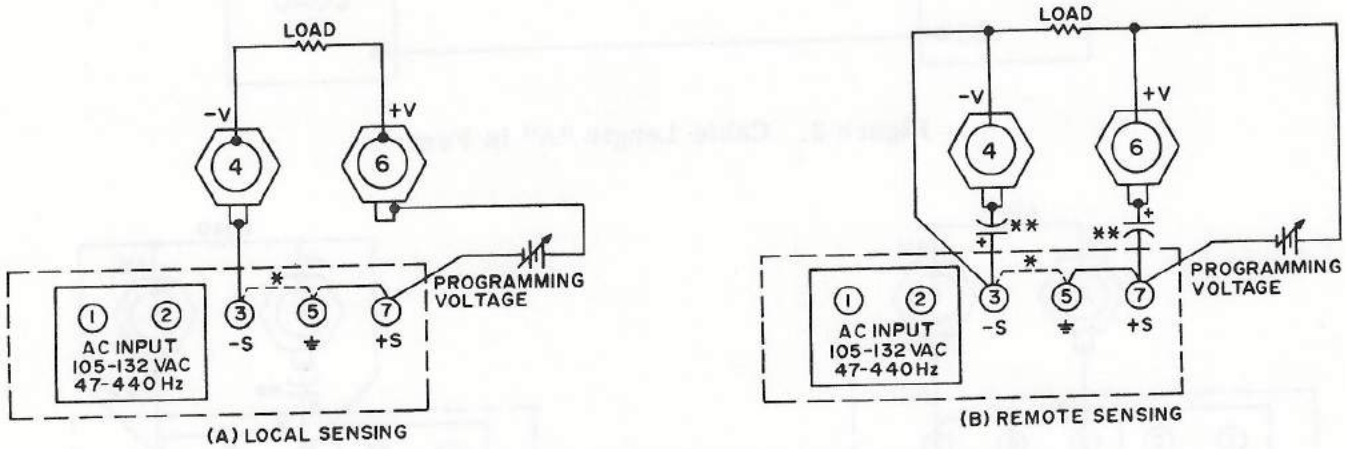



Figure 4. Remote Sensing Connections



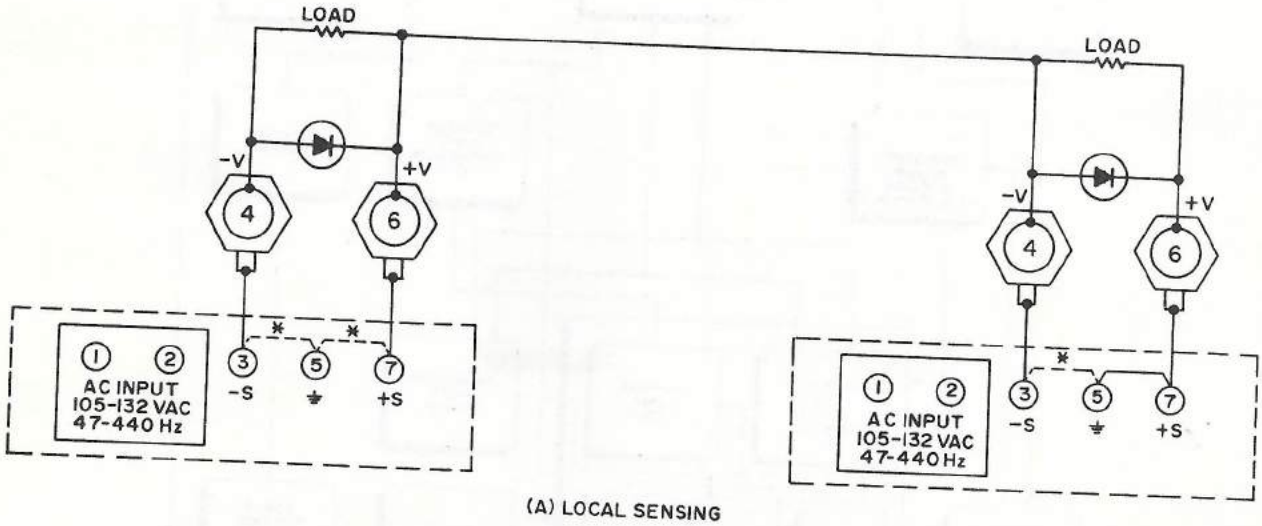

NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 7 AND RECONNECT TO TERMINALS 3 AND 5.
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 5. Programmed Voltage, with External Resistor.

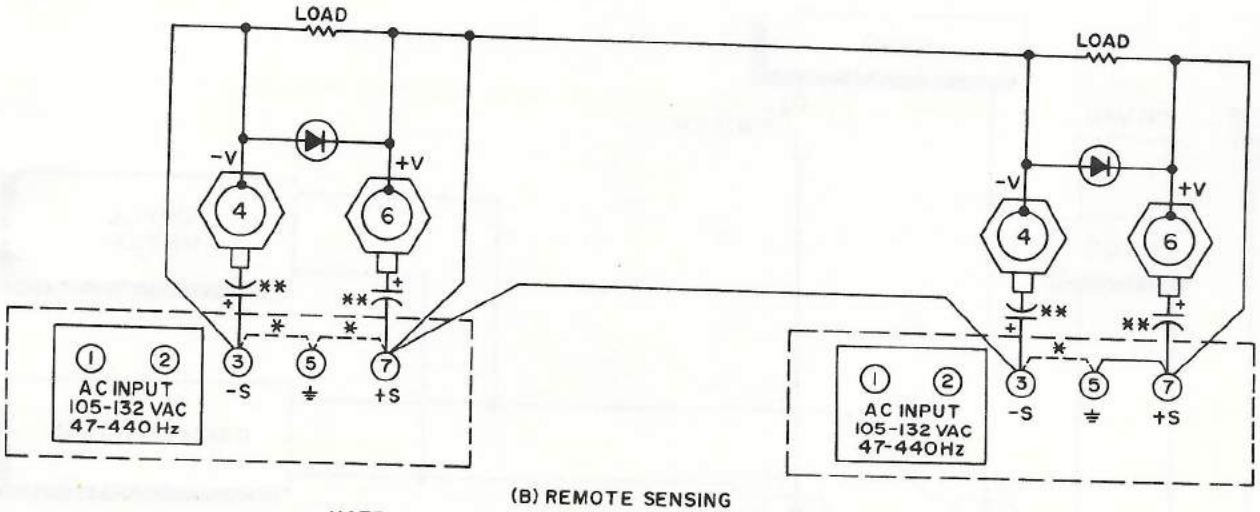



NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS 5 AND 7 AND RECONNECT TO TERMINALS 3 AND 5.
** A 2.5 MF, ELECT., CAP. MAY BE REQUIRED.

Figure 6. Programmed Voltage, with External Programming Voltage Source




(A) LOCAL SENSING




(B) REMOTE SENSING

NOTE:

* MAKE ONLY ONE GROUND CONNECTION FOR SERIES COMBINATION. TO CHANGE GROUND AS SHOWN, REMOVE JUMPER FROM TERMINALS 5 AND 7 ON RIGHT UNIT AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINE.

** A 2.5MF, ELECT., CAP. MAY BE REQUIRED.

Figure 7. Series Connection

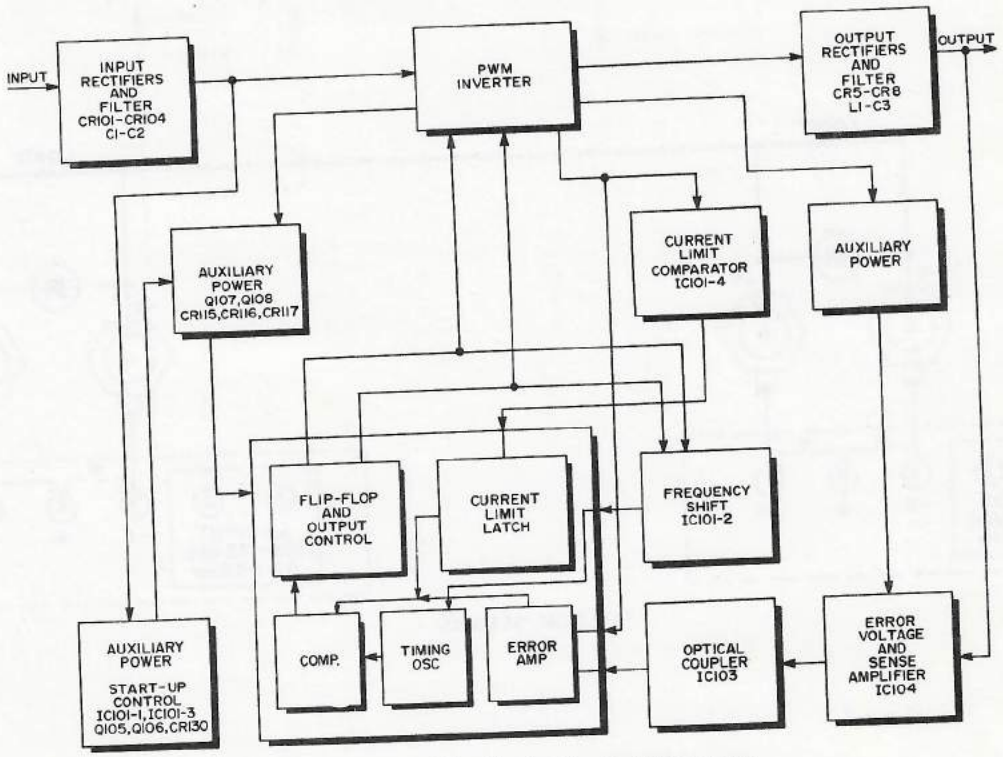
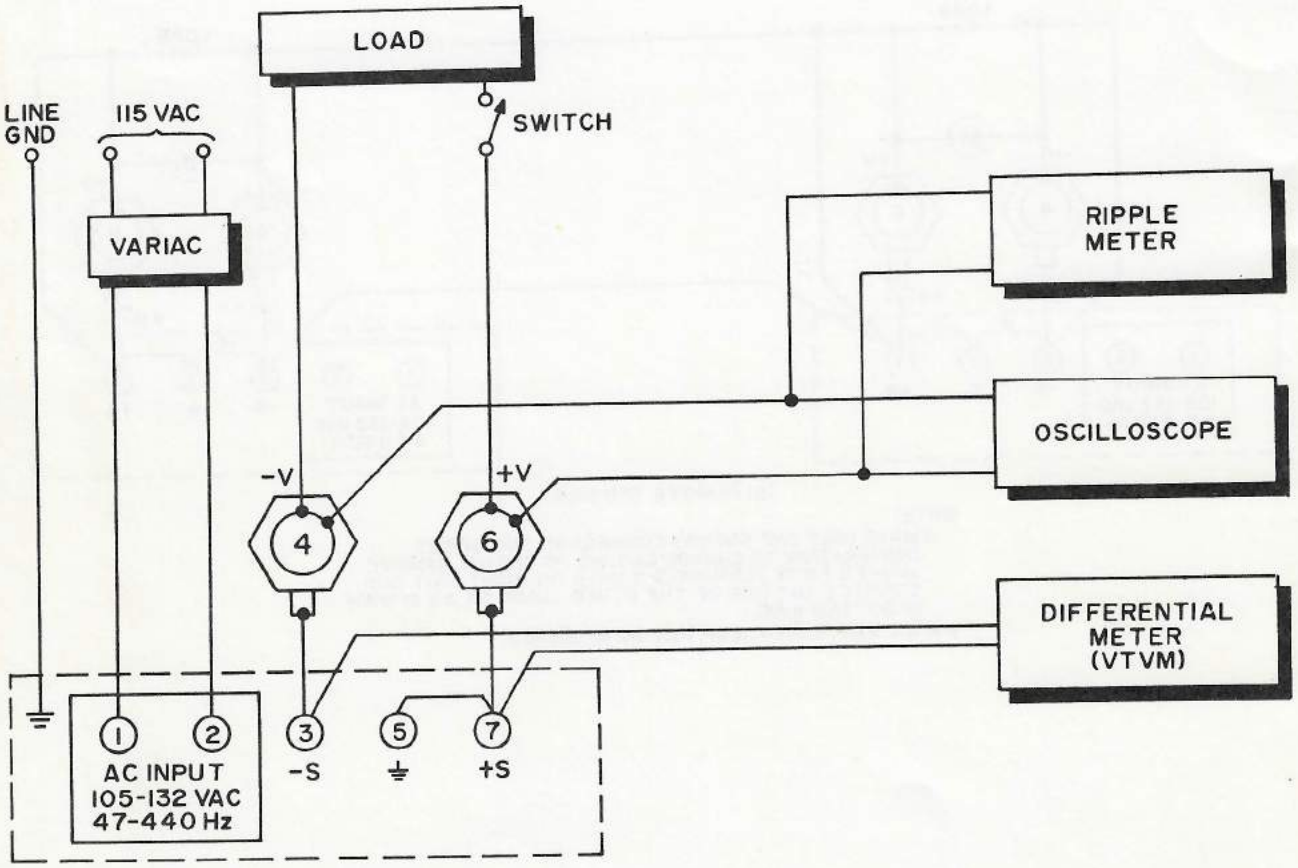



Figure 8. Typical Block Diagram




NOTES

1. REGULATION AND RIPPLE CHECK METERS MUST NOT BE GROUNDED THROUGH THREE WIRE LINE CORD TO GROUND.
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTION ONLY

Figure 9. Test Connections for Performance Checks

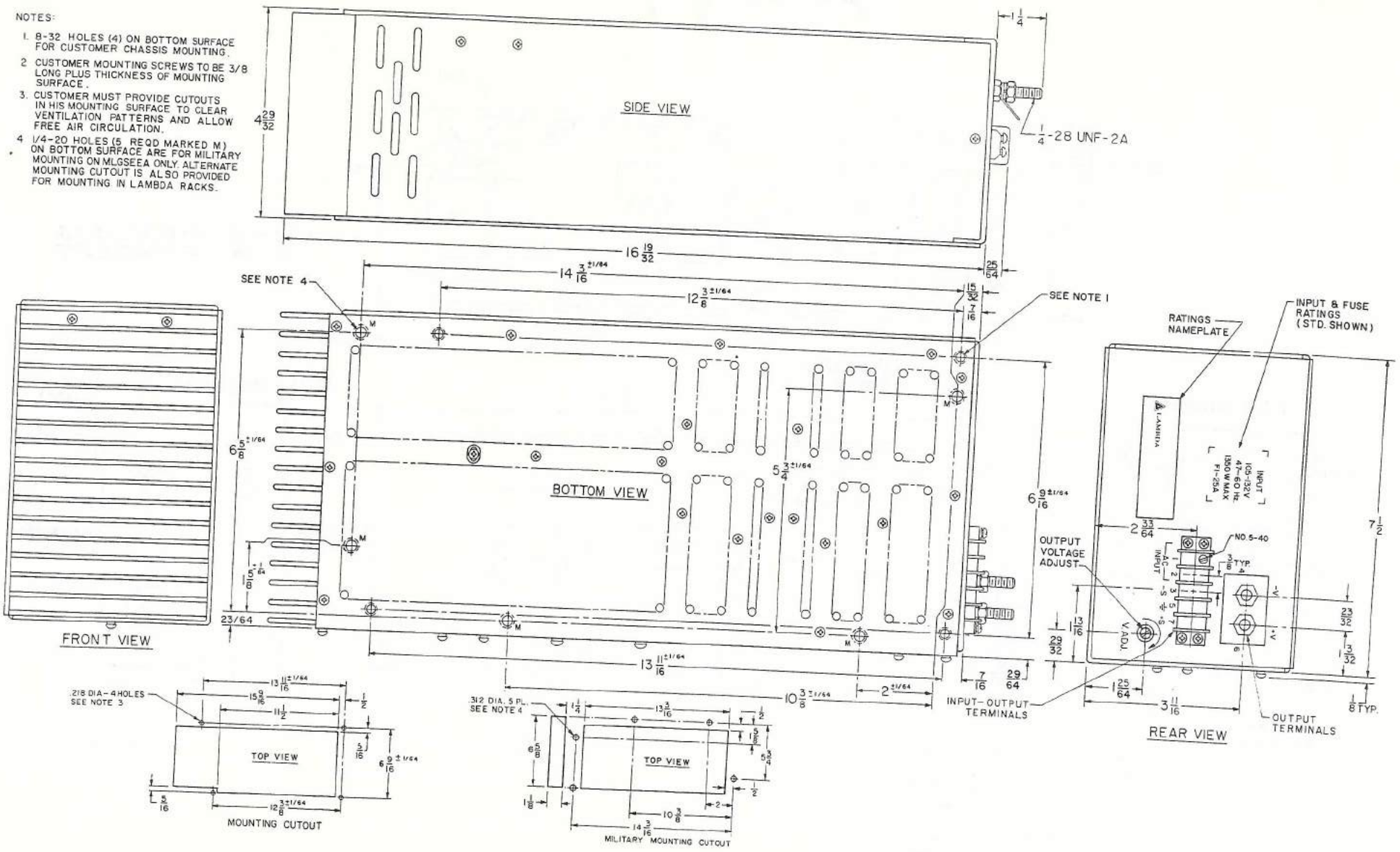



Figure 10. Outline Drawing

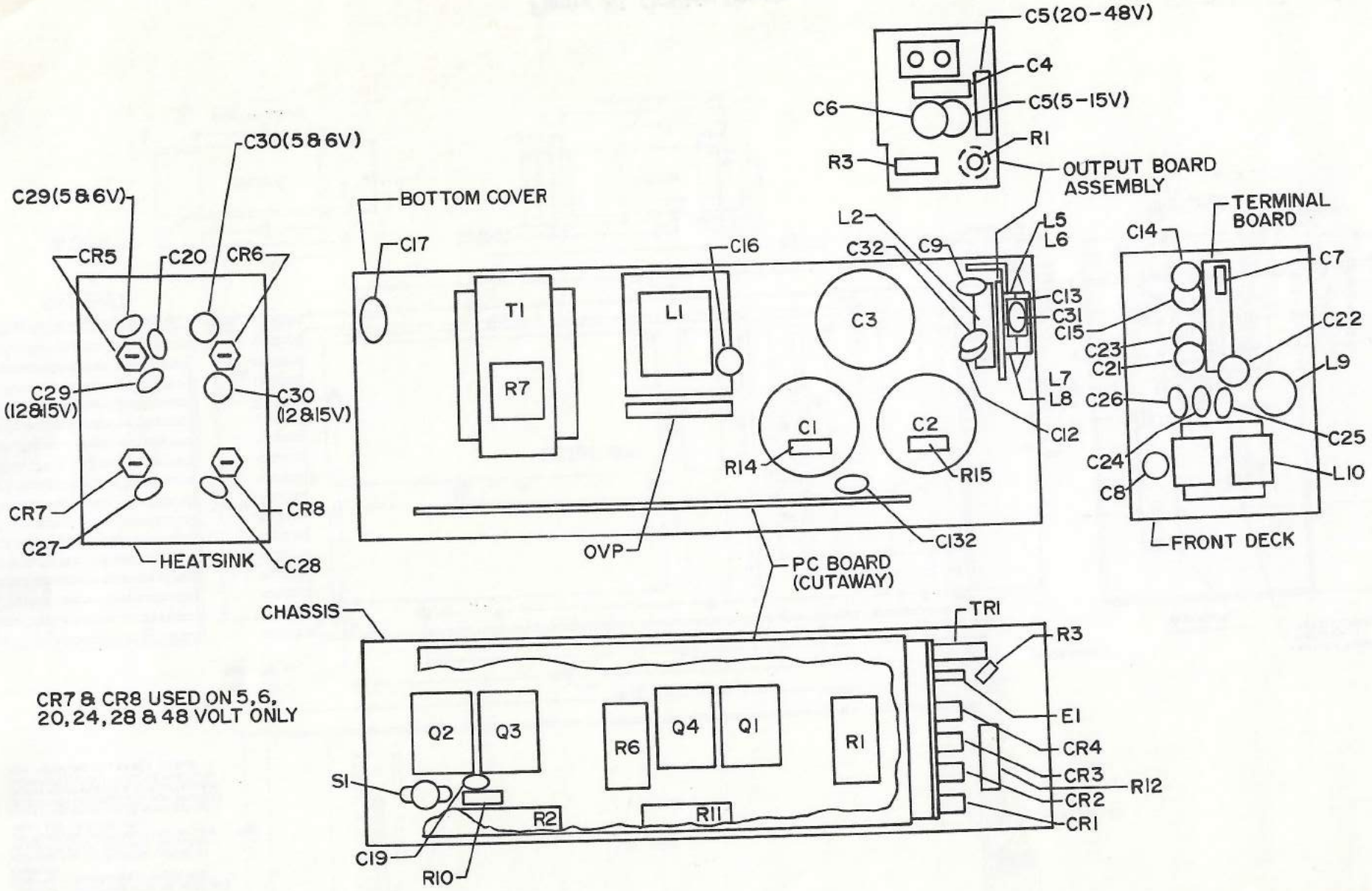
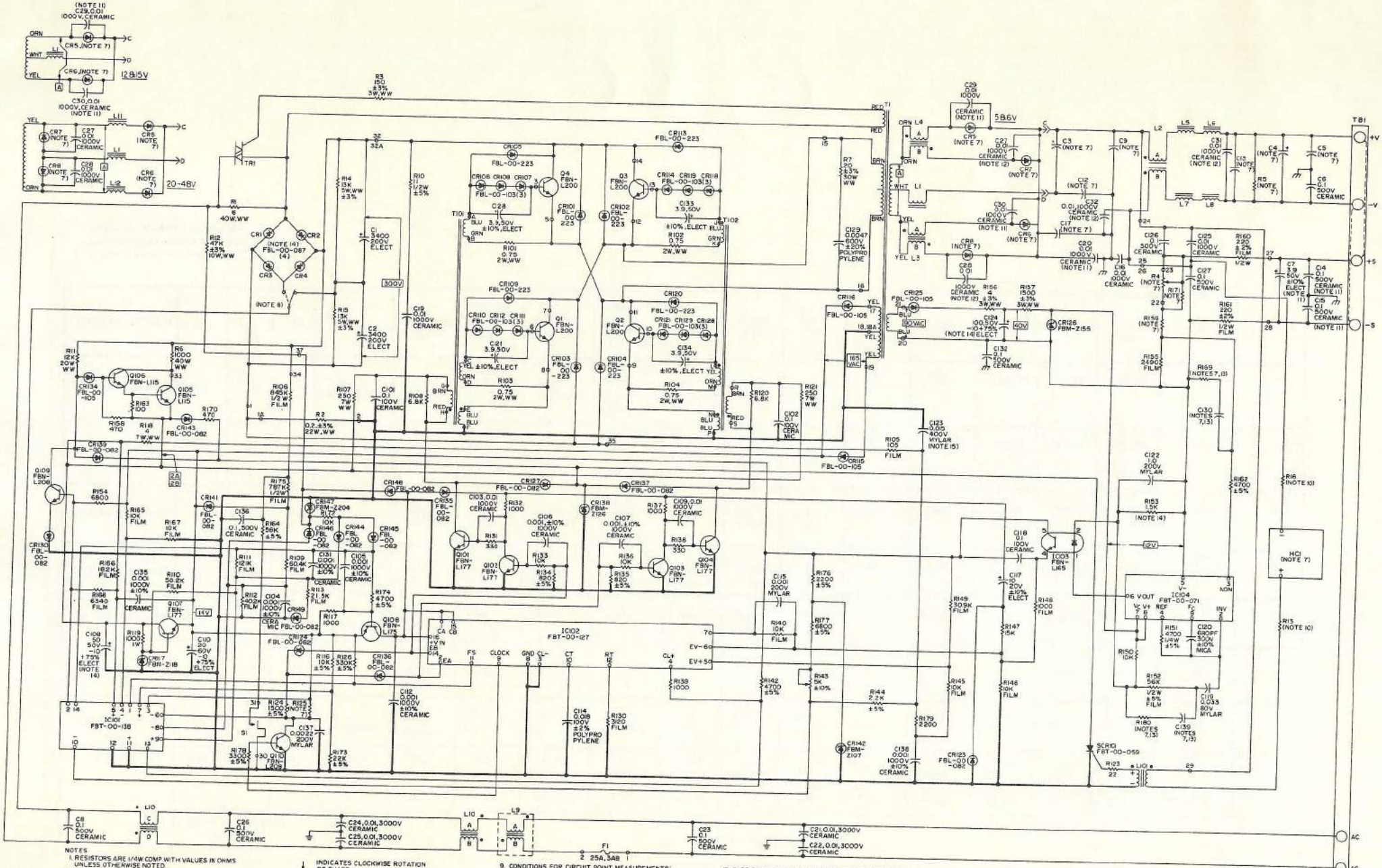



Figure 11. Component Location Diagram



NOTES

1. RESISTORS ARE 1/4W COMP WITH VALUES IN OHMS UNLESS OTHERWISE NOTED.
2. CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
3. CAPACITOR TOLERANCES: ELECTROLYTIC -10+50%, CERAMIC ±20%, MYLAR ±10% UNLESS OTHERWISE NOTED.
4. RESISTOR TOLERANCES: COMP ±10%, WIREWOUND ±5%, FILM ±1%.
5. SYMBOLS
   - ▭ INDICATES ACTUAL UNIT MARKING
   - ↓ INDICATES CLOCKWISE ROTATION OF SHAFT
   - * SEE INSTRUCTION MANUAL
   - —o— INDICATES TERMINAL ON PRINTED WIRING BOARD OR TERMINAL BOARD.
   - ⊘ INDICATES ADJUSTMENT OR CALIBRATION CONTROL
6. DESIGNATIONS ARE LAMBDA PART NUMBERS.
7. SEE TABLE 1 FOR COMPONENT VALUES.
8. ON UNITS WITH "V" OPTION, CR3 AND CR4 ARE ADDED AND CONNECTION C8 — R15 CHANGES TO C8 — CR3, CR4.
9. CONDITIONS FOR CIRCUIT POINT MEASUREMENTS: INPUT-115 VAC, 57-63 Hz. NOMINAL VOLTAGE, NO LOAD, +5 AND +V SHORTED, -5 AND -V SHORTED. INDICATED VALUES ARE TYPICAL VALUES AND ARE DC UNLESS OTHERWISE NOTED. DC MEASUREMENTS TAKEN WITH 2000 OHMS/VOLT METER. VOLTAGES IN PARENTHESIS ARE TAKEN BETWEEN INDICATED POINTS 5 AND TERM 8 OF IC102 UNLESS OTHERWISE INDICATED. OTHER VOLTAGES ARE TAKEN BETWEEN INDICATED POINTS. POINT 2A TAKEN WHEN MAIN SWITCHER IS NOT FUNCTIONING. POINT 2B TAKEN WHEN MAIN SWITCHER IS FUNCTIONING
10. IN 5&6V MODELS R13 IS 3 TURNS 15° OF 20AWG WIRE THRU L101; IN 12-48V MODELS R13 IS 1 TURN 11 1/2° OF 18 AWG RESISTANCE WIRE THRU L101; R16 IS 12 1/2° OF 18AWG RESISTANCE WIRE.
11. C7, C14, C15, C20, C29 AND C30 ONLY USED ON 5-15 VOLT UNITS.
12. C27, C28, C31, C32 NOT USED ON 12 AND 15 VOLT UNITS.
13. R109, C130 ONLY USED ON AND R180, C139 NOT USED ON UNITS WITH SERIAL NO. PREFIX C.
14. ON UNITS WITH SERIAL NO. PREFIXES C&D: R153 WAS 2.2K, C124 WAS 100MF 35V, C108 WAS 50MF 40V AND CR1-CR4 WAS FBL-00-052
15. C123 IS 0.022MF 60V ON LGS-EEA-48-0V-R.

FOR WIRING OF POWER SUPPLY TO LOAD REFER TO SUPPLY-TO-LOAD WIRING DIAGRAMS.

DOTTED CONNECTIONS SHOWN ON TB1 INDICATE JUMPERS IN PLACE FOR LOCAL SENSING CONNECTION

THIS SCHEMATIC APPLIES TO UNITS BEARING SERIAL NO. PREFIXES C-E

SCHEMATIC DIAGRAM
REGULATED POWER SUPPLY

| MODELS | |
|---|---|
| LGS-EEA-5-0V-R | LGS-EEA-20-0V-R |
| LGS-EEA-6-0V-R | LGS-EEA-24-0V-R |
| LGS-EEA-12-0V-R | LGS-EEA-28-0V-R |
| LGS-EEA-15-0V-R | LGS-EEA-48-0V-R |

LAMBDA
ELECTRONICS
MELVILLE, NEW YORK
DIVISION OF Veeco INSTRUMENTS INC.

TABLE I

SCHEMATIC DATA REFERENCES

MODELS LGS-EEA-5-OV-R — LGS-EEA-48-OV-R

| MODEL | SCHEMATIC VOLTAGE MEASUREMENTS | | | SCHEMATIC COMPONENTS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A PK-PK VAC | 2A VDC | 2B VDC | C3 | C4 | C5, C13 | C9, C12 | C17 | *C130 | C139 | R4 | R5 | R125 | R159 | R171 | R180 | CR5, 6, 7, 8 | HC1 |
| | | | | ELECT +50-10% | ELECT ±20% | CERAMIC ±20% | CERAMIC ±20% | CERAMIC ±20% | MYLAR ±10% | MYLAR ±10% | CERMET ±10% | ±5%, 10W | COMP ±5%, ¼W | FILM ±1%, ¼W | FILM 1%, ¼W | FILM ±1%, ¼W | *FBL-00- | *L-20-OV- |
| LGS-EEA5-OV-R | 63 | 25 | 33 | 100,000 mf 7.5V | 39 mf ±10% 10V | 0.1 mf 500V | 0.1 mf 500V | 0.01 mf 1,000V | 0.47 50V | 0.01 80V | 2.5K 2W | 5.0 | 62K | 1.5K ½W | 2.32K | 10.5K | 184 | 5 |
| LGS-EEA6-OV-R | 63 | 25 | 33 | 100,000 mf 7.5V | 39 mf ±10% 10V | 0.1 mf 500V | 0.1 mf 500V | 0.01 mf 1,000V | 0.39 100V | 0.01 80V | 2.5K 2W | 5.0 | 62K | 2.37K | 3.65K | 10.5K | 184 | 6 |
| LGS-EEA12-OV-R | 126 | 25 | 33 | 65,000 mf 15V | 22 mf 35V | 0.1 mf 500V | 0.1 mf 500V | 0.01 mf 1,000V | 0.18 100V | 0.0047 200V | 5.0K 2W | 37 | 62K | 7.68K | 7.68K | 18.2K | CR7, 8 NOT USED 197 | 12 |
| LGS-EEA15-OV-R | 157 | 25 | 33 | 55,000 mf 17.5V | 22 mf 35V | 0.1 mf 500V | 0.1 mf 500V | 0.01 mf 1,000V | 0.15 80V | 0.0047 200V | 5.0K 2W | 75 | 62K | 10.2K | 19.6K | 22.6K | CR7, 8 NOT USED 197 | 15 |
| LGS-EEA20-OV-R | 41 | 25 | 33 | 45,000 mf 25V | 22 mf 35V | 0.47 mf ±10% 400V MYLAR | 0.01 mf 1,000V | 0.47 mf ±10% 400V MYLAR | 0.1 80V | 0.0033 200V | 10K 2W | 100 | 120K | 14.7K | 10.5K | 30.9K | 197 | 20 |
| LGS-EEA24-OV-R | 48 | 25 | 33 | 32,000 mf 30V | 22 mf 35V | 0.47 mf ±10% 400V MYLAR | 0.01 mf 1,000V | 0.47 mf ±10% 400V MYLAR | 0.047 80V | 0.0015 200V | 10K 2W | 150 | 120K | 18.2K | 16.2K | 56.2K | 197 | 24 |
| LGS-EEA-28-OV-R | 62 | 25 | 31 | 32,000 mf 30V | 22 mf 35V | 0.47 mf ±10% 400V MYLAR | 0.01 mf 1,000V | 0.47 mf ±10% 400V MYLAR | 0.047 80V | 0.0015 200V | 10K 2W | 250 | 120K | 21.5K | 30.9K | 56.2K | 197 | 28 |
| LGS-EEA-48-OV-R | 90 | 25 | 31 | 16,000 mf 55V | 20 mf +75-10% 60V | 0.47 mf ±10% 400V MYLAR | 0.01 mf 1,000V | 0.47 mf ±10% 400V MYLAR | NOT USED | NOT USED | 25K 2W | 750 | 120K | 39.2K | 24.9K | NOT USED | 207 | *LH-OV-6 |

*Only used on units with serial no. prefix c.
**Not used on units with serial no. prefix c.
+This no. is a Lambda Part No.

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