PRELIMINARY

INSTRUCTION MANUAL

FOR

REGULATED POWER SUPPLIES

LT860-GPIB SERIES

LAMBDA ELECTRONICS MELVILLE, L.I., N.Y.

MAIN PLANT TELEPHONE: (516) 694-4200

11/90

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SPECIFICATIONS AND FEATURES

Specifications Apply for all models

DC OUTPUT - Voltage and Current regulated for line load.

TABLE 1

VOLTAGE AND CURRENT RATINGS

MODEL	VOLTAGE RANGE	MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE		
		40°C	50°C	60°C
LT-861-GPIB	0 to 7.5	500A	450A	400A
LT-862-GPIB	0 to 18.0	225A	205A	180A
LT-863-GPIB	0 to 36.0	115A	104A	92A
LT-864-GPIB	0 to 60.0	70A	63A	56A

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

REGULATED VOLTAGE OUTPUT

Regulation (line) .... .05% of maximum output voltage for input variations from 187-265 or 265-187 volts AC.

Regulation (load) .... .05% of maximum output voltage for load variations from no load to full load or full load to no load.

Ripple and Noise .... 20 millivolts rms, with either positive or negative terminal grounded.

Temperature .... Change in output voltage (0.03% + 50 microvolts)/°C.

Remote Programming
External Resistor .... Nominal 200 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.

REGULATED CURRENT OUTPUT: AUTOMATIC CROSSOVER

Regulation (line)	0.3% of Io (max) for input variations from 187-265 or 265-187 volts AC.
Regulation (load)	0.3% of Io (max) for load voltage changes from 5% to rated DC voltage or rated DC voltage to 5%.
Current range	0.0% to full rated load current.
Voltage range	As shown in table 1.

POWER SUPPLY SPECIFICATIONS WITH IEEE-488

Regulated Voltage

Output Voltage Range	From a minimum of zero to a maximum of power supply rating +2%
Regulation	Line - As per power supply specifications. Load - As per power supply specifications.
Ripple and Noise	As per power supply specification.
Temperature Coefficient	Power supply specification +0.01%/^{o}C.
Programming Accuracy	0.1% of full scale.
Programming Resolution	0.1% of full scale.
Overshoot	0.25 volts max. at turn-on, turn-off or recovery.
Programming Range	0.00% to 102.38% of Vout.
Programming Time	Voltage up programming. 50 milli-seconds typical.

Current Limit Programming

Current Limit Programming	0.0% to 105% of rated current.
Regulation Line	Same as power supply specification.
Regulation Load	Same as power supply specification.
Programming Accuracy	2% of programmed value plus 1% of full scale.
Programming Resolution	1% of rated current.

CONFIDENCE CHECK SPECIFICATION (Rear Panel Auxiliary Connector)

Voltage .... +Vs pin 6 -Vs pin 7	±1% plus effect of 7.2K ohm ±5% source impedance on meter accuracy.
Current 861,862 .... +Is pin 8 -Is pin 9	.01 V/A ±1% plus effect of 360 ohm ±5% source impedance on meter accuracy.
864,863 .... +Is pin 8 -Is pin 9	.1 V/A ±1% plus effect of 360 ohm ±5% source impedance on meter accuracy.

AC INPUT - 187-265 VAC, 3 phase, ±10% max phase imbalance, 47-63 Hz standard input. Input power: 4800 watts. Input current: 17 Amps RMS per phase limited to 1000 amps interrupt capability - unit is not sensitive to phase rotation.

EFFICIENCY - >78% 861, >82% 862, 863, >90% 864

SOFT-START CIRCUIT - Limits inrush current at turn-on to less than 20A.

OVERLOAD PROTECTION

Thermal	Thermal sensor protects unit from excessive ambient temperature as well as inadequate air velocity. AC power must be momentarily removed from unit after thermal shutdown in order to restore operation.
Electrical External	Adjustable, automatic, electronic current-limiting circuit, settable to 105 percent of rated current, limits output current to preset limit for protection of load and power supply when external overloads and direct shorts occur.
Internal	Circuit breaker protects AC input circuit, limited to 1000 amps interrupt capability.

OVERVOLTAGE PROTECTION - All LT860-GPIB models include a built-in adjustable over voltage protection circuit which prevents damage to the load caused by excessive power supply output voltage. AC power must be momentarily removed from unit after overvoltage shutdown in order to restore operation.

INPUT CONNECTIONS - Terminal block on rear of chassis.

DIGITAL CONTROL INPUT - IEEE-488 Bus connector at rear of assembly.

OUTPUT CONNECTIONS - Buss Bars provided for DC output.
- Barrier strip provides sensing and remote turn off.

CONFIDENCE CHECK

MEASUREMENT TERMINALS - 9 pin auxiliary Amphenol 745183-1 connector on rear panel for confidence check.

OPERATING AMBIENT TEMPERATURE RANGE AND DUTY CYCLE - Continuous duty from 0 C to 60 C ambient with corresponding load current ratings for all modes of operation, and appropriate derating.

STORAGE TEMPERATURE (non-operating) -55 C to +85 C.

COOLING - Forced air cooling utilize ball bearing, long life fan (no lubrication needed). Leave adequate clearance at all air intake and exhaust openings.

METERING - Separate analog panel meters provided for simultaneous monitoring of output voltage and load current.

CONTROLS

Power	Front panel mounted circuit breaker for all units.
DC Output	Coarse and fine voltage and coarse current control permit adjustment of DC output; located on front panel of all models.
Overvoltage Control	Screwdriver adjust control located on front panel of all models.
Remote Shutdown	TB2 terminals +RT and -RT.
Primary Address Switch *	Allows user to select primary address for the system. (On rear panel).
Reset Switch *	Momentary contact switch (rear panel) allows users to reset system to initial status. All outputs are set to zero.
Mode Select Switch............................	Located on rear of panel, permits selection of programming mode - either by GPIB input in AUTO position or via front panel voltage adjust controls in MANUAL position.

* When changing the primary address to the LT860-GPIB either the reset switch must be depressed or the power must be momentarily removed from the power supply before it will respond to the new primary address.

INDICATORS

Overvoltage Overtemp, and low line (or phase loss) indicator lamps notify user of the occurrence of either an overvoltage, overtemperature, or AC line shutdown condition. AC power must be removed from the unit to reset the overvoltage and overtemp indicators. Auto/Manual LED indicates units is in MANUAL MODE when illuminated.

PHYSICAL DATA

Size .... 5 7/32" H x 17" W x 17 1/2" D

Weight .... 60 lbs. net, 72 lbs. shipping

Panel Finish .... Charcoal brown (standard)

MOUNTING

Standard 19" rack mounting

ACCESSORIES

Chassis Slides .... Lambda part number KHT-34-012.

CONTROLS AND INDICATORS

POWER ON-OFF CIRCUIT BREAKER. The power ON-OFF circuit breaker, located on the front panel, controls application of input power to the supply. When the circuit breaker is in the ON position, excessive input current will trip the circuit breaker, thereby removing power from the unit.

OUTPUT VOLTAGE CONTROL.* The OUTPUT VOLTAGE control is a dual control consisting of a course adjustment potentiometer, which varies the DC voltage over a range of 0-7.5, 0-18, 0-36, 0-60 volts as applicable, and a fine adjustment potentiometer, which varies the DC voltage by 2% of its rated output. Clockwise rotation results in increasing voltage. The total DC voltage output for voltage regulated operation is equal to the sum of each shaft setting; for current regulated operation the maximum voltage limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.

CURRENT LIMITER CONTROL.* The CURRENT LIMITER control is a single control consisting of a course adjustment potentiometer, which varies the DC current over 105% of the rated current range. Clockwise rotation results in increasing current. The control is located on the front panel of all units.

CONNECTION TERMINALS. Make all connections to the supply at the terminals on the rear of the supply. Apply input power to terminals A, B and C of barrier strip TB1 (phase rotation is immaterial.) Connect ground wire to safety ground terminal of TB1.

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 7. 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.

*Note front panel pots control unit when unit is set in Manual mode.

GROUND CONNECTIONS

This Lambda power supply can be operated either with negative or positive output terminal grounded or with no terminal grounded. Both positive and negative ground connections are shown in the diagrams for all suggested output connections illustrated in this manual.

NOTE: When operating the supply with neither terminal grounded high impedance leakage resistance and capacitance paths can exist between the power supply circuitry and chassis ground.

REMOTE SHUTDOWN

The remote shutdown is activated by driving 5 ma from +RT to -RT. (May be directly connected to TTL compatible signals.)

BASIC MODES OF OPERATION

This power supply is designed to operate as a constant voltage source or as a constant current source. Automatic crossover to either mode of operation occurs when load conditions change as follows:

CONSTANT VOLTAGE. The power supply will function as a constant voltage source while the load current does not equal the current value, I_{LIM}, set by the CURRENT LIMITER control. When load current exceeds current limit setting, the supply will crossover automatically and will operate as a constant current source. Further decrease in value of load Resistor R_L results in a decrease of voltage across the load while current remains regulated to I_{LIM}.

CONSTANT CURRENT (AUTOMATIC CROSSOVER). The power supply will function as a constant current source while the load voltage V_L does not equal the voltage value set by the OUTPUT VOLTAGE control. When load voltage V_L equals the value set by the OUTPUT VOLTAGE control, the supply will automatically crossover and operate as a constant voltage source.

SUPPLY - LOAD CONNECTIONS

NOTE: Refer to DETAILED OPERATING PROCEDURES for step-by-step instructions for operation of power supply.

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 load terminals as shown in figure 2.

LOCAL SENSING CONNECTION, Figure 3. Local sensing is the connection suitable for application with relatively constant load where extremely close load regulation over full-rated current excursion is not required at the load.

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.

PROGRAMMED VOLTAGE CONNECTIONS, USING EXTERNAL RESISTOR, Figure 5. Discrete voltage steps can be programmed with a resistance voltage divider valued at 200 ohms/volt output and a shorting-type switch as shown in figure 5. When continuous voltage variations are required, use variable resistor, with the same 200 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. Turn OUTPUT VOLTAGE ADJ controls to a position slightly below minimum value of required programmed voltage.

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

PROGRAMMED VOLTAGE CONNECTIONS USING PROGRAMMED VOLTAGE, Figure 6. The power supply voltage output can be programmed with an externally connected power supply. The output voltage of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply. Turn OUTPUT VOLTAGE ADJ controls to a position slightly below minimum value of required programmed voltage.

CONNECTIONS FOR OPERATION AS A CONSTANT CURRENT SOURCE

AUTOMATIC CROSSOVER CONSTANT CURRENT CONNECTIONS, Figure 3. Figure 3 shows the connections which are used when operating the power supply as a constant current source with automatic crossover.

In this mode of operation, when the load voltage increases, due to changing load resistance, to the limit of the OUTPUT VOLTAGE control setting, the power supply crossover circuit will cause the unit to operate as a constant voltage supply.

CONNECTIONS FOR SERIES OPERATION

The voltage capability of LT-860 series power supplies can be extended by series operation of two LT-860 power supplies of equal* voltage ratings. A maximum of 500 volts can be connected between either the +DC or -DC terminal and chassis ground.

*For applications using supplies of unequal ratings, consult factory for details of operation.

Two units are shown connected for series operation in figure 7. Figure 7 shows the series connection which would be suitable for use in all applications.

The series connection permits operation for either constant voltage or constant current with automatic crossover to either mode of operation whenever the respective limiting operating current or voltage is reached. Figure 7 shows connection for either local or remote sensing, when the series combination is operated for constant remote sensing, when the series combination is operated for constant voltage; figure 7A shows the connection required when the series combination is operated for constant current.

SAFETY NOTICE

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

CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Apply AC power to the supply but place power ON-OFF circuit breaker in OFF position.

   NOTE: When shipped from the factory, the supply is ready for use as a constant current source with automatic crossover or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in Figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply load connections. Refer to the appropriate connection diagram.

2. Determine load requirements, select wire size from figures 1 and 2, and choose desired type of supply-load connection from figures 3 and 4. Do not connect load.

3. Place power ON-OFF circuit breaker in ON position and check that all panel LEDs are not illuminated.

4. Set CURRENT LIMITER control fully CW, observe voltmeter, and adjust OUTPUT VOLTAGE control knobs to obtain desired voltage indication. When the current to the load must be limited to an intermediate value within the current rating of the supply, proceed as follows:

   (a) Place power ON-OFF circuit breaker in OFF position.

   (b) Connect jumper between +V and -V terminals. Jumper must be capable of handling maximum output current rating of unit.

   (c) Place power ON-OFF circuit breaker in ON position, observe ammeter, and adjust CURRENT LIMITER control to obtain the desired meter indication.

   (d) Place power ON-OFF circuit breaker in OFF position.

5. Connect supply to load as shown on selected connection diagram.

6. Place power ON-OFF circuit breaker on ON position and check that all panel LEDs are not illuminated.

7. Check that panel meters indicate desired values as required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control to obtain correct meter indications.

8. Power supply is now in proper operation.

PROGRAMMED CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Apply AC power to the supply, but place power ON-OFF circuit breaker in OFF position.

NOTE: When shipped from the factory, the supply is ready for use as a constant source with automatic crossover or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

2. Determine load requirements, select wire size and length from figures 1 and 2, and choose desired type of supply-load connections from figures 5 and 6. Refer to paragraph on Programmed Voltage Connections.

3. Connect supply terminals as shown on the selected connection diagram. As shown in figure 5, take care to use a shorting-type switch for the external programming control when several voltages are desired and the programming voltage method is not used. Do not connect load.

4. When current to the load must be limited to an intermediate value within the current rating of the supply, proceed as follows:

(a) Connect jumper between +V and -V terminals. Jumper must be capable of handling maximum output current rating of unit.

(b) Place power ON-OFF circuit breaker in ON position, observe ammeter, and adjust CURRENT LIMITER control to obtain the desired current limit meter indication.

(c) Place power ON-OFF circuit breaker in OFF position and remove jumper between +V and -V terminals.

5. Connect supply to load as shown on the selected connection diagram.

6. Place power ON-OFF circuit breaker on ON position and check that all panel LEDs do not illuminate.

7. Check that panel meters indicate desired values; as required, adjust CURRENT LIMITER knob and external programming voltage control to obtain correct meter indications.

8. Power supply is now operating properly.

CONSTANT CURRENT OPERATION WITH CROSSOVER, ADJUSTABLE VOLTAGE LIMIT

1. Apply AC power to the supply, but place power ON-OFF circuit breaker in OFF position.

NOTE: When shipped from factory, the supply is ready for use as a constant current source with automatic crossover or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

2. Determine load requirements, select wire size from figures 1 and 2, and connect supply terminals as shown in figure 3. Do not connect load.

3. Adjust CURRENT LIMITER control to the desired output current as follows:

(a) Connect jumper between +V and -V terminals. Jumper must be capable of handling maximum current rating of unit.

(b) Place power ON-OFF circuit breaker in ON position, observe ammeter, and adjust CURRENT LIMITER control to obtain the desired load current as indicated on current meter.

(c) Place power ON-OFF circuit breaker in OFF position and remove jumper between +V and -V terminals.

4. Place power ON-OFF circuit breaker in ON position, observe voltmeter, and adjust OUTPUT VOLTAGE control knobs to obtain the desired voltage limit point as indicated on voltage meter.

5. Place power ON-OFF circuit breaker in OFF position and connect load to the supply as shown in figure 3.

6. Place power ON-OFF circuit breaker in ON position and check that all LEDs do not illuminate.

7. Check that panel meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain correct indications.

8. Power supply is now in proper operation.

SERIES CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

Applies to units of equal voltage and current capacities. When units of unequal ratings are series connected, consult factory.

1. Apply AC power input to the (B) and (A) units, and place power ON-OFF circuit breaker in OFF position.

> NOTE: When shipped from factory, the supply is ready for use as a constant current source with automatic crossover or as a local-sensing constant voltage source. Jumpers are connected at the factory as shown in figure 3. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.

2. Determine load requirements, select wire size from figures 1 and 2, choose correct type of series supply-load connections from figure 7. Refer to paragraph on CONNECTIONS FOR SERIES OPERATION.

3. Connect power supply terminals as shown on the selected connection diagram. Do not connect load.

4. Place power ON-OFF circuit breakers in ON position, observe voltmeters, and adjust OUTPUT VOLTAGE control knots on the (A) and (B) units to obtain the desired total output voltage. Place power ON-OFF circuit breakers in OFF position.

5. When current to the load must be limited to an intermediate value within the current rating of each supply, proceed as follows:

(a) Connect jumpers between V+ and V- terminals on the (A) and (B) units. Jumpers must be capable of handling maximum current rating of unit.

(b) Place power ON-OFF circuit breakers in the ON position, observe ammeters, and adjust CURRENT LIMITER control on the (A) and (B) units to the desired current limit point, as indicated on the panel meter.

(c) Place power ON-OFF circuit breakers in OFF position and remove jumpers between +V and -V terminals.

6. Connect supplies to load as shown on the selected connection diagram.

7. Place power ON-OFF circuit breakers on ON position and check that panel LEDs do not illuminate.

8. Check that panel meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain current indications.

9. Power supplies are now in proper operation.

IEEE488 OPERATION

PROGRAMMING PANEL CONTROLS

AUTO/MANUAL (MODE) SWITCH - Although the LT-860 GPIB may be programmed via the GPIB bus with the mode switch in the manual position, the power supply output will continue to reflect the front panel adjustment settings until the mode switch is changed to the auto position, at which time the output of the power supply will change to the last programmed value (if any) since power up. Returning the switch to the manual position will cause the power supply to reflect the current front panel adjustment settings.

RESET - Causes the internal GPIB control microprocessor to reset. Power supply output will go to zero if the mode switch is in auto position or is changed to the auto position.

PRIMARY ADDRESS - GPIB primary address selection switches are arranged from most (top switch) to least significant (bottom switch) address bit positions. Depressing the "ON" side of the switch gives a logic one. Addresses settings from 0 to 30 (11110 Binary) inclusive are allowed.

INPUT DATA FORMAT

Communication is conducted in accordance with IEEE488 1978 standards. All data is transmitted in ASCII format.

The system is capable of the basic extended listener (LE2) interface function.

Input connector is wired per IEEE488 specifications. All communications, control and data entry is made through this connector.

The following control signals are recognized: ATN, IFC, NRFD, NDAC and DAV. REN and EOI are not recognized.

The following addressed commands are not recognized: GTL, PPC, GET, TCT. SDC is recognized. The following universal commands are not recognized LLO, PPU, SPE, SPD. DCL is recognized.

PROGRAMMING FORMAT AND PROCEDURE

COMMAND SEQUENCE TO ADJUST POWER SUPPLY VOLTAGE OR CURRENT

Definition of Terms

M - My listen address (switch selected primary address)

N - Secondary address number 1-6 (Hardwire set to 1)

P - Represents power supply program command

V1, V2, V3, V4 - Represents percent of full-scale voltage. These numbers are transmitted in ASCII format where 99.99% is transmitted by the controller as 39, 39, 39, 39 (hex).

I1, I2 - Represents percentage of full scale current. These numbers are transmitted in ASCII format where 50% is transmitted as 35, 30 (hex).

E - Represents data terminator command. Please note that a wrong terminator or an incorrect number of the data string digits will result in no change of actual power supply output. (EOI is optional)

UNL - Represents GPIB unlisten command.

Voltage and Current Limit Programming - This is best explained with the following example.

Character -		Description		Hex Code	ASCII	Mnemonic
M	-	Selected Primary Address (0-30)*		20-3E	-	MLA0-MLA30
N	-	Power Supply Address (1-6) Factory Hardwired to 1*		61	-	MSA1
P	-	Represents Power Supply Program Command		50	P	-
V1	-	7	Assume Power Supply is Programmed	37	7	-
V2	-	5	to 75.00% of rated full scale	35	5	-
V3	-	0	Voltage	30	0	-
V4	-	0		30	0	-
I1	-	9	Assume power supply is programmed	39	9	-
I2	-	9	For 99% of full scale current	39	9	-
E	-	E	Termination Character	45	E	(EOI Optional)
UNL	-	Unlist prevents data & commands intended for other devices from being interpreted as commands for power supply*		63	-	UNL

*Attention line held true during transmission of these bytes.

Termination of an Erroneous Command String - Inserting any character not recognized by the adapter, e.g., Q or Z etc., will terminate and abort a command string. Reset of all functions is automatic at power up or upon receiving the bus command of "DEVICE CLEAR." Manual reset, although provided is not required for this operation. In addition, reset in any form (DCL, SDC, Manual or Power Up Reset) will cause power supply output to go to zero only if the auto/manual switch is in the auto position.

OVER RANGE PROGRAMMING

Power supply output voltages and currents equal to or greater than 100% rated may be programmed in a similar manner within certain limits. Output voltage programmed values may not exceed 102.38% of rated V_o and output current programmed values may not exceed 105% of rated I_o. Furthermore, above range values are formatted somewhat differently - the V1 and/or I1 characters in the command string will be the ASCII character "A". For example, a power supply programmed to 101% voltage and 102% current limit would have the following V1 through I2 characters inserted in the previously shown command string.

ASCII		Hex
V1 - A	Above 100% Rated Voltage	41
V2 - 1	By 1.00%	31
V3 - 0		30
V4 - 0		30
I1 - A	Above 100% Rated Current	41
I2 - 2	By 2%	42

Attempting to send voltage or current values in excess of 102.38% or 105% respectively will cause the entire command string to be rejected, causing no change in the power supply output.

CAUTION

Operation of supply at voltage and current levels in excess of 100% simultaneously for extended periods of time (>5 minutes per hour) is not recommended unless inlet (front panel) ambient temperature is maintained below 30°C.

OPERATING PROCEDURE

AUTO MODE

1. Connect GPIB interface cable to mating connector on rear panel.

2. Set PRIMARY ADDRESS switch to appropriate address.

3. Set MODE SELECT switch to AUTO position.

4. Connect system DVM to CONFIDENCE CHECK pins on the amp connector on rear panel, if confidence check monitoring is desired.

5. Connect AC input to rear AC input terminal blocks.

6. Connect load and sensing connections.

The system is now ready for operation. To apply AC input, set front panel switch on ON position. All outputs will be set to zero. To program power supply, refer to programming procedure. For more information on programming, see section on the theory of operation.

MANUAL MODE

1. Set MODE SELECT Switch on programmer panel to MANUAL position. MANUAL MODE lamp on front panel will turn on.

2. Adjust output voltage by adjusting appropriate VOLTAGE ADJUST pot on front panel.

   NOTE: Output of a power supply can be measured via CONFIDENCE CHECK terminals on the Amp connector on rear of assembly, during both auto and manual mode operation.

CAUTION

Insure that all front panel VOLTAGE ADJUST controls are turned fully counter clockwise before switching operation from auto mode to manual mode. Failure to do so can cause damage to the load(s), if front panel controls are not correctly adjusted prior to switching modes.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermal Shutdown

Internal temperature sensing circuitry shuts down the unit when the temperature of the full-bridge inverter radiator exceeds a maximum safe value. After the unit has cooled sufficiently to reset the thermostat, AC power must be momentarily removed from the unit for approximately 5 seconds in order to restore operation.

Circuit Breaker

The circuit breaker will shut down the unit if input current exceeds a preset value. After determining the cause of input overload, manually reset the breaker.

Overvoltage Shutdown

When the power supply output voltage increases above the overvoltage limit, the overvoltage protector will remove inverter drive. After eliminating the cause(s) for overvoltage, resume operation of the supply by interrupting the AC input circuit for a period of 30 seconds (refer to TROUBLESHOOTING CHART).

Overvoltage/Overtemperature Indicator Lamp

Overvoltage and Overtemperature indicator lamps are provided to notify the user of the occurrence of either an overvoltage or overtemperature shutdown condition.

Low Line/Phase Loss Indicator Lamp

A line indicator lamp is provided to notify the user of the occurrence of either a low line condition or a phase loss. Reset is automatic when line recovers.

MAINTENANCE

GENERAL

This section describes trouble analysis routine, replacement procedures, 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.

PERIODIC MAINTENANCE

Unit should be disconnected from associated equipment and inspected for dust accumulation due to forced air cooling every six months (or more often if operated in extremely dusty environments). To inspect interior of unit, first remove AC input power. Then remove top cover by removing 12 screws along the top and sides of unit. If unit exhibits any dust accumulation it should be cleaned (vacuumed) in order to provide proper heat sink efficiency. (Failure to perform this maintenance may result in unwanted thermal shutdown.)

TROUBLE ANALYSIS

Whenever trouble occurs, systematically check 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 jumper and supply-load connections.

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 operation. Measure these voltages using the conditions for measurements 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 instrument 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.

For good transistors, the forward resistance for any junction is always greater than zero.

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 defective components could damage the replaced component.

When soldering semi-conductor devices, wherever possible, hold the lead being soldered with a pair of pliers placed between the components and the solder joint to provide an effective heatsink.

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 the measuring instrument.

3. Where ever possible, use a heatsink when soldering transistors.

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 insulated 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) Either positive or negative terminal is connected to chassis ground.

(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 EVEN IF FRONT PANEL ON-OFF SWITCH IS IN THE OFF POSITION.

TROUBLESHOOTING CHART

Symptom	Probable Cause	Remedy
1. Zero volts DC output (with CURRENT LIMITER and OUTPUT VOLTAGE panel controls set for maximum)	Short circuit across output of supply	Check load and load connections; correct as necessary
Additional Symptoms		
A. Voltage across C1 and C2 is less than 300V. Waveform not present at collector of Q305, Q306, Q311, Q312.	Missing phase	Check that all input phases are present
	Q301 thru 312	Check and replace components as necessary
B. Voltage across C1 and C2 does not regulate at 386V. Waveform present at collector of Q305, Q306, Q311, Q312.	IC301, IC302	Check and replace components as necessary
	Broken Wire	Repair as necessary.
C. Supply rails ±5V or ±15V not present at 300 board.	CR515, C520, CR506, C509, C521, CR516	Check and replace components as necessary.
	Broken Wire	Repair as necessary.
D. 386V present across C1, C2 but no waveform across T1 primary with waveform at pins 7 and 9 of T201 and T202.	Q209 thru Q216	Check and replace as necessary
E. Same as D with no waveform at pin 7 and 9 of T201 and T202. No 20 vdc present across C202	CR517, C522, CR520, CR521, R545, C523	Check and replace as necessary
	Broken Wire	Repair as necessary

TROUBLESHOOTING CHART (Continued)

	Symptom	Probable Cause	Remedy
F.	Same as E with 20vdc present across C202. Waveform present at J201-6, J201-8, J201-5, J201-3.	Q201 thru Q208 Q217 thru Q224	Check and replace as necessary
		Broken Wire	Repair as necessary
G.	Same as F with no waveform present at J201-6, J201-8, J201-5, J201-3 ±15V present at 100 board	IC107, IC108, IC111, IC110, IC112	Check and replace as necessary
H.	Same as G with ±15 not present at 100 board.	CR519, C524, CR518, CR517, C522	Check and replace as necessary
		Broken Wire	Repair as necessary
I.	No auxiliary Supply voltages present	Q501, IC502, IC504	Check and replace as necessary
2.	Output voltage too high, with no control of output.	Open sense lead	Refer to appropriate connection diagram and correct as required.
3.	No output voltage with overvoltage and over-current front panel LEDs on.	IC114, IC113	Check and replace as necessary
		Broken Wire	Repair as necessary

IEEE488 TROUBLESHOOTING CHART

	Symptom	Probable Cause	Remedy
A.	No output in Auto Mode	GPIB Subassembly	
		Broken Wire	Check and repair as necessary
B.	Same as A with no ±15V on connector J1001	Broken Wire	Check and repair as necessary
C.	Same as A with data & clock pulses on J901	IC901-911	Check and replace necessary
D.	Same as A with no data or clock pulses on J901, and no +5V on 800 board	CR518, C533	Change and replace as necessary

Symptom	Probable Cause	Remedy
D. (Cont'd)	Broken Wire	Check and repair as necessary
E. Same as D W/ +5V on 800 board	IC801-811	Check and replace as necessary
	Wrong primary address	Reset system and verify primary address.
	Controller error	Verify GPIB connection is good, and controller is functioning properly.

PERFORMANCE CHECK

Check With Constant Voltage Operation

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 voltage meter, (John Fluke Model 8840 or equivalent) to the selected power supply operating voltage. Check the power supply load regulation accuracy while switching from the load to no-load condition. Long load leads should be a twisted pair to minimize AC pick-up. A common mode choke in series with the measurement leads may be necessary.

Use a Variac to vary the line voltage from 187-265 or 265-187 volts AC and check the power-supply line regulation accuracy on the differential meter.

Use a true RMS voltmeter similar to John Fluke Model 8840 to measure rms ripple voltage of the power supply DC output. Use an oscilloscope to measure peak-to-peak ripple voltage of the power supply DC output.

Checks With Constant Current Operation

Check the regulation of the power supply using the test connection diagram shown in figure 10. Refer to SPECIFICATIONS AND FEATURES for minimum performance standards.

Check the power supply load regulation accuracy while switching from the short circuit to load condition. Measure the voltage across sensing resistor Rs. Use John Fluke Model 8840 or equivalent for the DVM connected across Rs. For Rs, use a 100 mv shunt rated for the same current as the unit being tested. To obtain regulation figure substitute values obtained into regulation formula:

$$\frac{\Delta E}{R_s} = \text{Regulation in milliamperes,}$$

Where E is the voltage change in millivolts and R_s is the resistance of the sensing resistor.

Use a Variac to vary the line voltage from 187-265 or 265-187 volts AC and check the power supply line regulation accuracy using the VTVM and the regulation formula:

$$\frac{\Delta E}{R_s}$$

COMPLETE POWER SUPPLY CALIBRATION PROCEDURE

When the power supply is to be completely calibrated, the controls listed below shall be calibrated in the order listed. See figure A for general location of these controls.

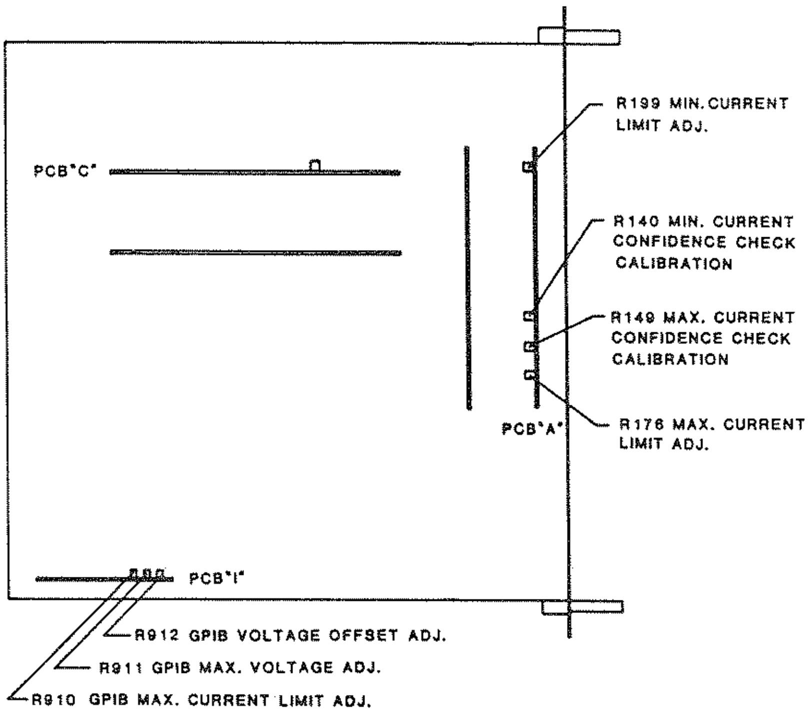


FIGURE A

A. Minimum current

   1. Minimum current limit

   2. Confidence check zero

B. Maximum current

   1. Manual mode current limit

   2. Auto mode current limit

   3. Confidence check max.

C. O.V. adjust pot.

D. Feed forward adjust pot.

E. GPIB voltage offset adjust.

F. GPIB max voltage adjust.

Preliminary Procedure

Before proceeding with the calibration, the power supply:

A. Must be removed from associated equipment,

B. Must be at ambient temperature of 25-30 C,

C. Must be disconnected from AC line input voltage,

D. Must be disconnected from the load,

E. ON-OFF circuit breaker must be in the OFF position.

INITIAL CONTROL ADJUSTMENT

To ensure predictable power supply response when input power is applied to the unit, and performing calibration procedures, adjust the following controls to the positions indicated in steps 1 through 4.

1. Turn OV adjustment on front panel to fully clockwise position.

2. Turn output voltage VDC control on front panel to fully C.C.W. position.

3. Turn current limiter IDC control on front panel to fully C.W. position.

4. Switch Auto/Manual switch on rear panel to Manual.

LT870 CALIBRATION

A. ADJUSTMENT OF MINIMUM CURRENT LIMIT I_o MIN

1. Perform steps (a) through (e) of preliminary procedure.

2. Break seal on the wiper of R199. Set R199 fully clockwise.

3. Connect DVM (John Fluke Model 8840 or equivalent) to output terminals of supply and current confidence check terminals on auxiliary connector. Place on/off circuit breaker in ON position and adjust variac to apply 187 VAC to the supply.

4. Turn output voltage VDC controls on front panel clockwise until DVM indicates maximum rated output voltage for the unit.

5. Turn current limiter IDC control on front panel to fully counterclockwise position.

6. Turn R199 counterclockwise until output voltage falls to zero.

7. Adjust R140 until the current confidence check meter measures zero volts out.

8. Seal wiper of R199 and R140 to resistor housing with pot sealant.

9. Place power ON-OFF circuit breaker in OFF position.

B. ADJUSTMENT OF MAXIMUM CURRENT LIMIT I_o MAX

This calibration procedure sets the max. current limit at 105% of the rated output of the set in manual mode, 100% in auto mode and calibrates the max confidence check output.

1. Perform steps (a) through (e) of preliminary procedure.

2. Break seal on wiper R176 and R910 set R190 fully CCW. Set R176 fully CW.

3. Connect load to unit, using local sensing connections, figure 3, and connect an ammeter in series with the load. Load must be adjustable to obtain 110% of unit output current rating at 40 C ambient temperature.

4. Connect DVM (John Fluke Model 8840 or equivalent) to sense terminals of supply and current confidence check terminals on auxiliary connector. Place ON-OFF circuit breaker in ON position and adjust variac to apply 187 VAC to the supply.

5. Turn output voltage VDC controls on front panel clockwise until DVM indicates maximum rated output voltage for the unit.

6. Turn CURRENT LIMITER IDC control on front panel to fully clockwise position.

7. Adjust load to obtain 110% of 40 C unit output current rating.

8. Turn R176 CCW until ammeter connected at load reads 105% of 40 C unit output current rating.

9. Seal R176 to resistor housing with pot sealant. Turn current limiter IDC control on front panel fully CCW. External ammeter should read zero. Turn current limiter IDC control fully CW. External ammeter should read 105% of 40 C unit output current rating.

10. Switch auto/manual mode select switch to auto mode.

11. Program output for 100.00% voltage and 100% current . (PAOOOAOE)

12. Adjust R910 clockwise until ammeter connected at load reads 100% of unit output current rating at 40 C.

13. Seal R910 to resistor housing with pot sealant.

14. Adjust R149 until current confidence check meter measures 100% of unit output current rating at 40 C. The scaling for the confidence check output is as shown on table *1 on page 25 seal pot.

C. ADJUSTMENT OF OV ADJ CONTROL R601

The adjustment procedure requires that the power supply is removed from the associated equipment, is at an ambient temperature of 25-30 C and is operated at nominal line voltage.

Adjust the voltage-protection point of overvoltage protector circuit as follows:

1. Turn OV ADJ control on front panel fully C.W.

2. The recommended voltage-protection point is 115% of normal power supply operation voltage plus one volt. Compute this value for the operating voltage being used.

3. Apply AC power to the supply and place power ON-OFF circuit breaker in ON position.

4. Monitor the output voltage using a DVM (John Fluke Model 8840 or equivalent).

5. Adjust OUTPUT VOLTAGE controls to the desired voltage-protection point; monitor the power supply output voltage to assure correct voltage. If the power supply does not have an adequate adjustment range, omit steps 6 and 7, and continue with step 8 below.

6. Slowly turn the OV ADJ control counterclockwise until the power supply output voltage drops, indicating that the voltage-protection point has been reached. Overvoltage indicator should be illuminated.

7. The voltage-protection point is now set. Place power ON-OFF circuit breaker in OFF position. Reduce power supply output voltage setting before turning power on.

8. If the power supply output voltage adjustment range does not extend to the voltage-protection point computed in step 2, proceed as follows:

(a) Turn on power supply and raise output voltage to the normal operating voltage; monitor the power supply output voltage.

(b) Slowly turn the OV ADJ control counterclockwise until the power supply output voltage drops.

(c) Refer to chart below, select appropriate volts/turn ratio, and turn OV ADJ control clockwise by the number of turns equivalent to 1 volt plus 15% of the operating voltage.

MODEL	VOLTS/TURN	OVERVOLTAGE ADJUSTMENT RANGE
LT 871	0.36	3.5-10 VDC
LT 872	0.93	6-24 VDC
LT 873	1.9	9-47 VDC
LT 874	3.2	12-75 VDC

For example:

When using power supply model LT 872 with output voltage setting of 18 volts, calculate as follows:

$$T = \frac{1+.15(OV)}{V/T}$$

where

T = turns of OV ADJ control
OV = operating voltage of power supply
V/T = volts per turn ratio from chart

$$T = \frac{1 + .15(18)}{.93} \cong 4.0$$

Rotate OV ADJ control 4.0 turns in clockwise direction to obtain a voltage setting 3.7 volts above the 18 volt power supply setting, or 21.7 volts.

D. ADJUSTMENT OF V_O MIN IN AUTO MODE.

1. Perform steps (a) through (e) of preliminary procedure.

2. Break seal on wiper of R912.

3. Connect DVM (John Fluke Model 8840) or equivalent to sense terminals of supply. Place ON-OFF circuit breaker in on position and adjust variac to apply 187 VAC to the supply.

4. Switch Auto/manual select switch to auto mode.

5. Program unit for 00.00% voltage and 100% current (POOOOAOE)

6. Adjust R912 for zero volts out on output.

7. Seal wiper of R912 to resistor housing with pot sealant.

E. ADJUSTMENT OF V_O MAX IN AUTO MODE

1. Perform steps (a) through (e) of preliminary procedure.

2. Break seal on wiper of R911. Set R911 fully counter clockwise.

3. Connect DVM (John Fluke Model 8840 or equivalent) to sense terminals of supply. Place ON-OFF circuit breaker in on position and adjust variac to apply 187 VAC to the supply.

4. Switch auto/manual select switch to auto mode.

5. Program unit for 100.00% voltage and 100% current. (PAOOOAOE)

6. Turn R911 clockwise until voltmeter connected at sense terminals reads 100% of the full voltage rating of the set.

7. Seal wiper of R911 to resistor housing with pot sealant.

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 repair 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 an electronic part, or is not listed, provide a description, function and location of the part.

FUNCTIONAL DESCRIPTION LT860-GPIB

The following is a brief summary of the general functions of the various circuits of the LT860-GPIB.

Boost Circuit

The input section of the LT860-GPIB consists of a three-phase rectifier (CR314, CR315, CR316) which feeds a boost regulator. The boost helps to limit peak input currents and to reduce input line ripple. The boost output is 400VDC (on C1, C2) and provides up to 34 db of input ripple rejection.

The power stage of the boost consists of two identical sections in quadrature, each switching at 30 kHz. Each section contains load-line correction circuitry to limit switching losses. The base drive to the boost switching Q's employs a baker clamp (CR311, CR303) to reduce storage switching time and reverse biases the base to -5V during turn-off for enhanced switching speeds.

The control circuitry is shared by both boost sections. Input ripple is reduced by both the feedback error amp and a voltage feedforward amp. Current sharing between each boost power stage is forced by feeding the collector current of switching Qs (Q305, Q306, Q311, Q312) back and summing it with the feedback and feedforward signal. Pulse by pulse current limit protects the switching Q's from over currents.

Inverter Circuit

The inverter section is fed by the output of the boost. It is a full-wave bridge inverter. Because the input to the inverter is dc, line regulation is not required by the inverter. The duty cycle of the inverter varies from 0% to approximately 85%.

The power stage of the inverter consist of paralleled switching transistors (Q209 thru Q216) with a current sharing xfmr (T203 thru T206) in series with the switching transistor emitters. The base drive employs baker clamps (CR208, CR213, CR226, CR231) with reverse bias at turn-off to enhance switching speeds.

The inverter control circuitry provides for regulating either output voltage or output current. The front panel potentiometers change the reference voltage to the corresponding error amplifier, varying the pulse width and output voltage/current. The control circuitry also provides a constant 5mA out of the -S terminal for resistive programming of 200 ohm/v. Voltage programming can be accomplished by applying a voltage from -V to -S. Pulse by pulse current limiting is used to prevent transformer saturation.

The shutdown circuitry on the control board disables the inverter under undesirable operating conditions. The actual monitoring of these conditions is done on the auxiliary/control board. The inverter will latch off under overtemperature conditions and/or overvoltage conditions. In the case of low line or phase loss condition, the control board will allow the inverter to turn back on again when the line has recovered to a proper level. Shutdown of the inverter can also be accomplished externally by the remote turn-off pins which correspond to J102 pins 3, 6, 1 and 4) of rear output connector J102.

Pulse width modulators (IC107, IC108) have four outputs, one for each pair of paralleled switching transistors. The outputs are A, A', B and B'. The pulse width is equal to the time during which both A and A' or B and B' are high. When A and A' overlap, main transformer T1 is energized in one direction and when B and B' overlap, T1 is energized in the opposite direction. Pulse width and pulse phase modulation control the output voltage. Primary/secondary isolation is accomplished by transformer isolating the base drive through T201 and T202.

Aux/Line Detector/Fan Driver Circuits

The auxiliary power supply provides all power to the LT870 circuits through multi-output, flyback, switching regulator (Q501, IC502, etc.) operating in the voltage mode. Its outputs are: ±5, and ±15 supplying the boost and the line detector; +20, +15 supply the inverter control circuitry and its base drive; +28V supplying the fan and its drive circuit; and +8 volts supplying the GPIB digital card. (This voltage is post-regulated to +5 volts by IC1001, on the interconnect board.)

Line detector (IC505, IC506) limits inrush current at turn-on and enables the boost, once the line reaches a sufficient voltage. It also detects loss of phase or a drop in the input line and disables the boost whenever this occurs. The line detector will also shutdown the inverter whenever the boost voltage drops below 360V.

Fan driver (IC501, Q502, etc.) takes the 28V from the auxiliary and regulates it to 26Vdc on the fan.

FUNCTIONAL DESCRIPTION OF LT860-GPIB IEEE488

The block diagram of the LT860-GPIB IEEE Control section is shown in figure B. All information sent in on the GPIB is buffered, decoded and sent out as a serial data string by the GPIB interface card to the serial-to-parallel digital-to-analog interface card. The digital-to-analog (DAC) card sends analog control signals to the power supply control card, controlling both voltage and current output. All confidence check information is continuously available at the rear panel auxiliary connector.

The LT870 accepts and interprets digital programming information from a remote controller on the IEEE 488 bus, which is also known as General Purpose Interface Bus or GPIB. The interface card converts programming information into the digital format which is used by the programmer card. When a programmer card receives this information, it sets up analog reference signals that control both voltage and current limit output of the power supply.

Programming of the system is simple. The programming format must be strictly observed or desired power supply programming will not occur. The system must receive its information in the following order: Primary address, Secondary address, P for power supply, ASCII programming data, and E for end. The Primary address is the GPIB primary address of the Lambda system (1 to 30). The secondary address is hardware preset to No. 1. For further details refer to the section on programming.

Interface Card Circuit

The interface card, a dedicated micro-computer system that can only listen to the IEEE 488 bus, allows the system to respond to GPIB protocol and ASCII programming information. It contains its own micro-processor and EPROM-based operating system, a single parallel-input channel that conforms to the IEEE 488-1978 standard, and one serial output channel (figure C.) A primary address switch on this card allows selection of the primary address to which the system will respond. The secondary address is hardware set to address No. 1.

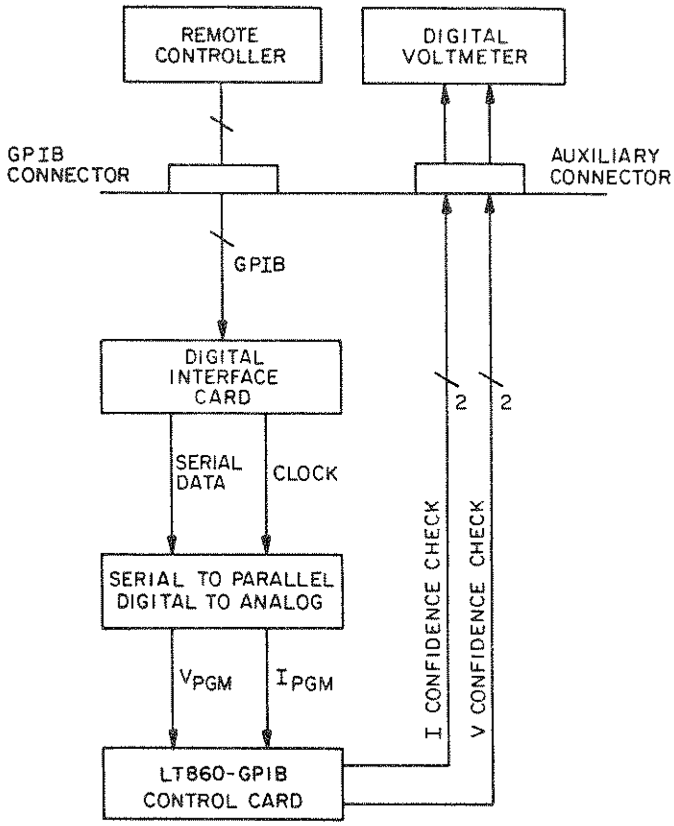


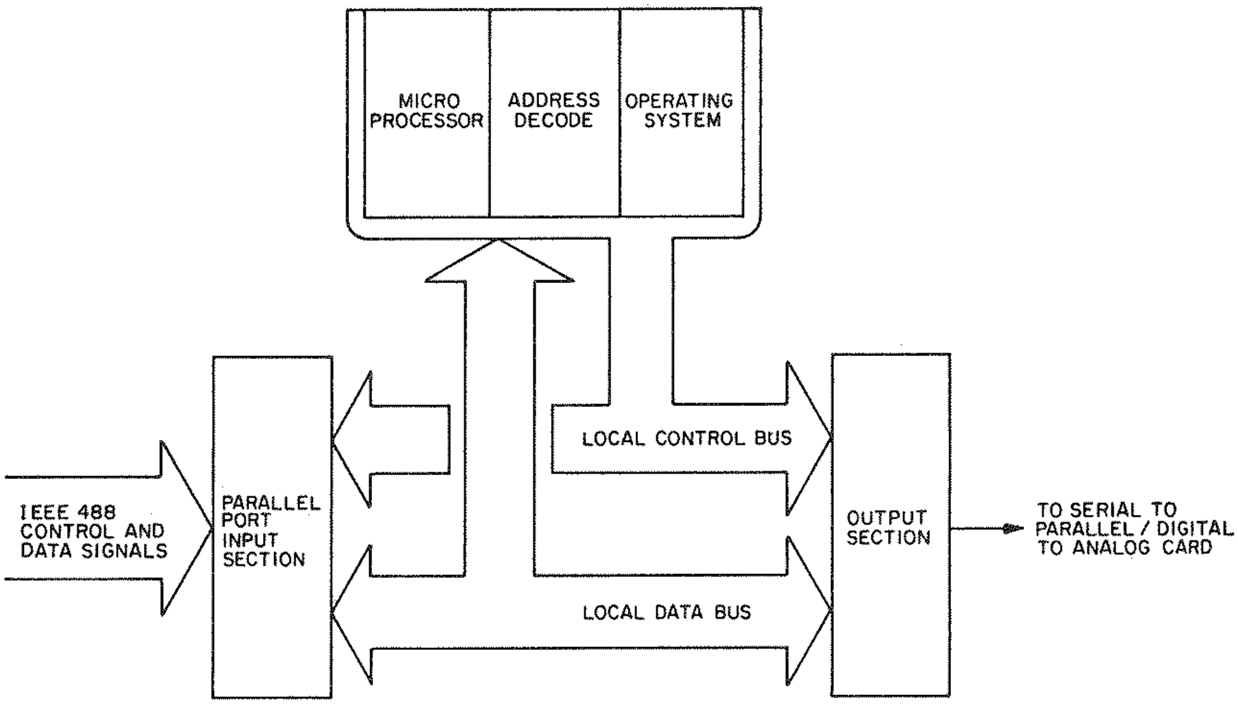
Figure B. GPIB Block Diagram

When the interface card receives its own primary address from the bus controller after a listen command, it puts the system into the primary-addressed state but it does not enter the listener-addressed state until it has received a secondary address. The interface card checks each block of programming information to verify the format. If the information is correct, and after receiving an E command, the interface card enters one of two conversion routines. These conversion routines convert the ASCII programming information to twenty bits of programming information for a programmer card. The conversion routine is selected by first transmitting the letter P in ASCII, which must precede the programming data. After data conversion the interface card transmits the information to the D to A card.

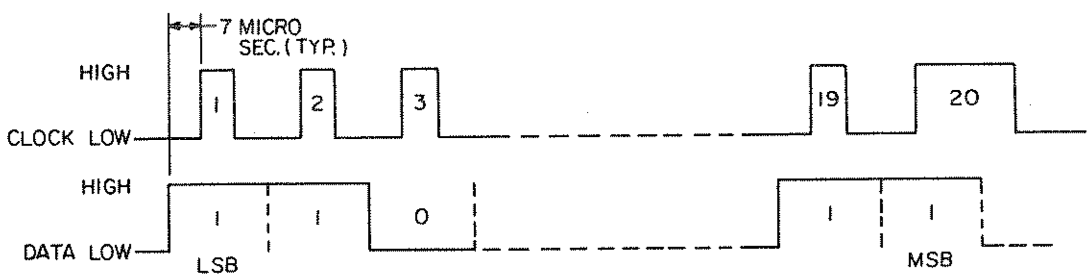
Programmer Card

(Serial to Parallel/Digital to Analog Programmer Card)

The programmer card is isolated from the interface card because of the different ground potential of the controller versus the LT860-GPIB output. Programming data enters the programmer card (figure D) serially on two transmission lines. The data signal is transmitted on the other line. The leading edge of each clock pulse shifts the programming data into a set of serial to parallel shift registers. A total of twenty clock pulses are used to enter the data into the shift registers. The final clock pulse is longer than all previous clock pulses by a factor of approximately three. This clock pulse passes through a pulse width discriminator and initiates the transfer of the programming data to two digital-to-analog converters or DAC's, figure 3. The output of these DAC's are used as references (programming voltages) for the output voltage and current limit of the power supply.



a. Interface Card Block Diagram



b. Timing Diagram of Data and Clock Pulses

Figure C. Interface Block Diagram and Timing Diagram

The Confidence Check

The LT860-GPIB confidence check allows monitoring of current and voltage by way of a digital voltmeter hookup to the auxiliary connector. The confidence check can be used in either AUTO-MODE or MANUAL MODE. The voltage confidence check is one to one. The current confidence check is as shown below.

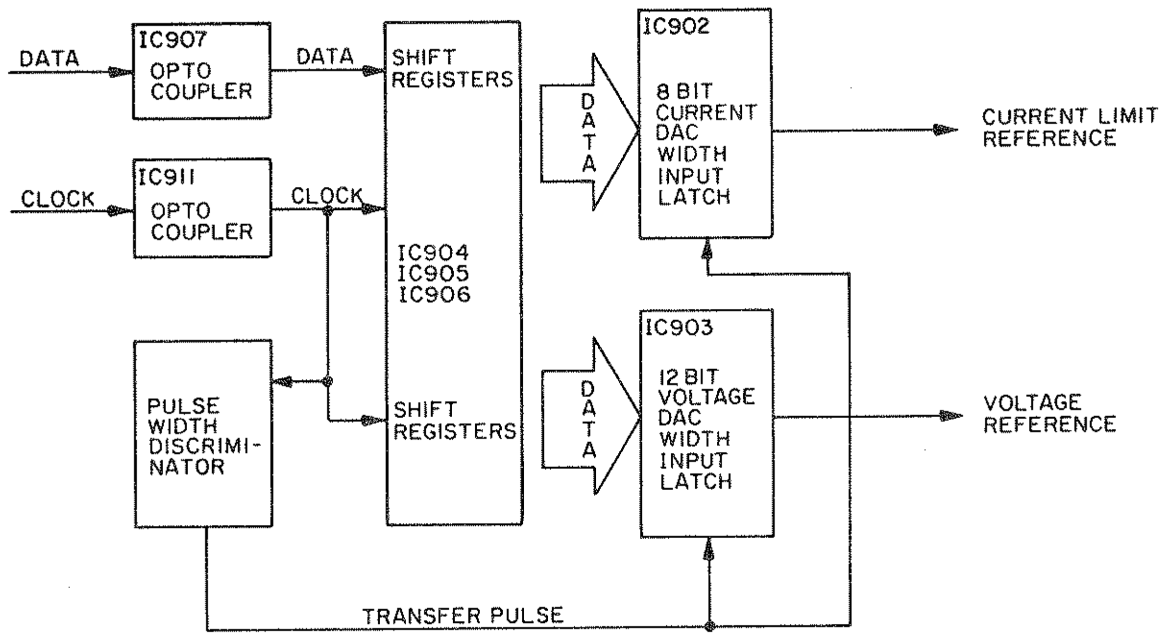


Figure D. Programmer Card, Block Diagram

TABLE 1. CURRENT CONFIDENCE CHECK

LT861-GPIB	LT862-GPIB	LT863-GPIB	LT864-GPIB
.01V/A	.01V/A	.1V/A	.1V/A

Programming Procedure

Hardware Hookup - Programming of a power supply in the system requires connection of the system to an IEE 488 bus and to a controller or a computer that can control the bus. Before connecting the system to the bus, make sure all instruments and controllers on the bus are de-energized. Connect one end of a standard GPIB cable to the GPIB port at the rear of the LT860-GPIB; connect the other end of the cable to the bus controller. Turn on the power supply system.

Setting the Primary Address Switch - When system power is first applied, the entire system undergoes a power-on reset. This power-on reset takes approximately 100 ms. During the reset process, the primary address switch is read and its bit pattern is stored in the appropriate register. The system also resets the output of the LT860-GPIB to zero. To change the primary address, set the address switch at the back of the rack adapter assembly to the desired address and press the reset button to complete the change. The primary address can only be changed by resetting the system or sequencing power-off and power-on again.

Secondary Address - The secondary address is hard-wired in the system at the factory and cannot be easily field changed. The secondary address is hard wired to No. 1 address on standard units.

Programming LT860-GPIB - The power supply is programmed by transmitting a series of decimal digits to the system that represents percentages of the supply's full-scale voltage and current limit. A total of six digits are transmitted to the system to program a supply. The first four digits represent a percentage of the power supply's full-scale output voltage and the last two digits represent a percentage of the supply's full-scale current limit. For example: the digit sequence 574599 represents a voltage setting of 57.45% of the maximum output voltage of the supply at 99% of the supply's maximum current limit. The normal range for voltage programming is 0000 to 9999, and is 0 to 99 for current limit. (See operating section for over range programming details)

To program a power supply the following format should be used.

TABLE 2. SEQUENCE FOR PROGRAMMING A POWER SUPPLY

	COMMAND	MEANING	ALLOWED VALUES
Primary Address Header	MLA	My listen address	(0 - 30)
	MSA	My secondary address	(1 - 6)
	P	Power Supply	(50) Hexadecimal ASCII
Program Information	1st Prog. Digit	MSD of % of full scale voltage	(30-39, 41) Hexadecimal ASCII
	2nd Prog. Digit		(30-39) Hexadecimal ASCII
	3rd Prog. Digit		(30-39) Hexadecimal ASCII
	4th Prog. Digit	LSD of % of full scale voltage	
	5th Prog. Digit	MSD of % of full scale current	(30-39, 41) Hexadecimal ASCII
	6th Prog. Digit	LSD of % of full scale current	(30-39) Hexadecimal ASCII
Terminator	E	End Command	(45)
	UNL	Unlisten (Allows bus to be used for other devices.)	

Only decimal values, 0 thru 9, are allowed as programming information for a power supply. (Except for over range values as shown in operating section.) The E command must be transmitted at the end of a programming sequence to complete the transfer of data and allow the adapter card to process the information. Any deviation from the programming format, before the E command is transmitted, will cause the programming information to be discarded, leaving all outputs to the system unchanged. Avoid the use of blanks, periods, carriage returns, line feeds and other delimiters between the characters of the programming information because this will be detected by the checking routine in the adapter causing it to reject the command.

Clearing A Power Supply - A power supply can be cleared using the commands listed in table 3.

TABLE 3. CLEARING A POWER SUPPLY

COMMAND	MEANING	ALLOWED VALUES
MLA	My listen address	0 30 (20-3E Hex)
MSA	My secondary address (of supply)	1 (61 Hex)
SDC	Selected device clear	04 Hex
UNL	Unlisten	63 Hex

TABLE 4. GPIB COMMANDS THAT THE LT860-GPIB RESPONDS TO

SINGLE LINE MESSAGES		
MESSAGES	MEANING	RESPONSE
ATN	Attention	Wait for message from controller.
IFC	Interface clear	Unlisten from the 488 Bus
DAV	Data Valid	Accept data and complete handshake
MULTILINE MESSAGES		
MLA	My listen address	Enters primary addressed state.
MSA	My secondary address	Enters listener addressed state.
UNL	Unlisten	Unlistens all devices from the bus.
DCL	Device Clear	Sets the output of all power supplies to zero regardless of address
SDC	Selected Device clear	The output of any listener addressed power supply is set to zero

TABLE 4. GPIB COMMANDS THAT THE LT860-GPIB RESPONDS TO (Cont'd)

LOCAL COMMANDS			
MESSAGE	FORMAT	MEANING	RESPONSE
P	ASCII Hex	Power supply Program command	Directs subsequent programming information to the addressed power supply.
E	ASCII Hex	End of programming string	Execute programmed command.

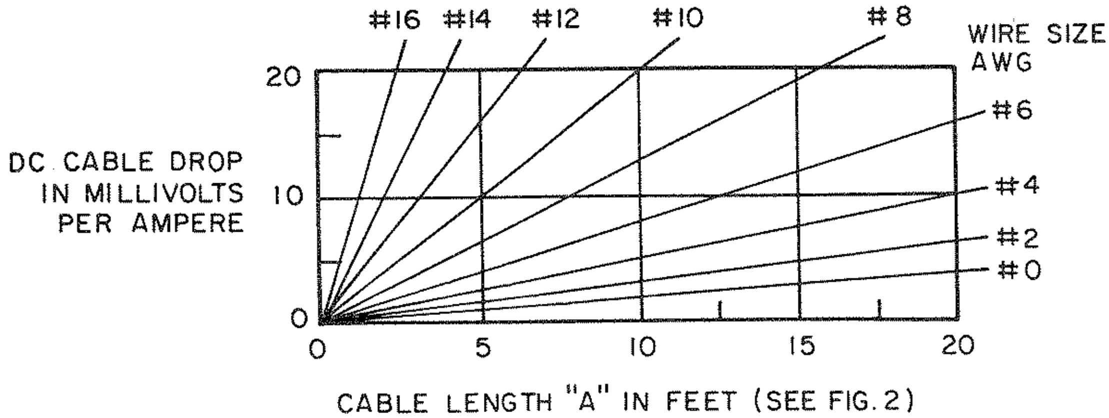


Figure 1. Cable Connection Chart

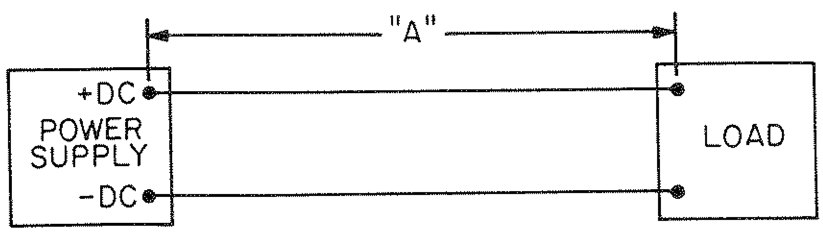
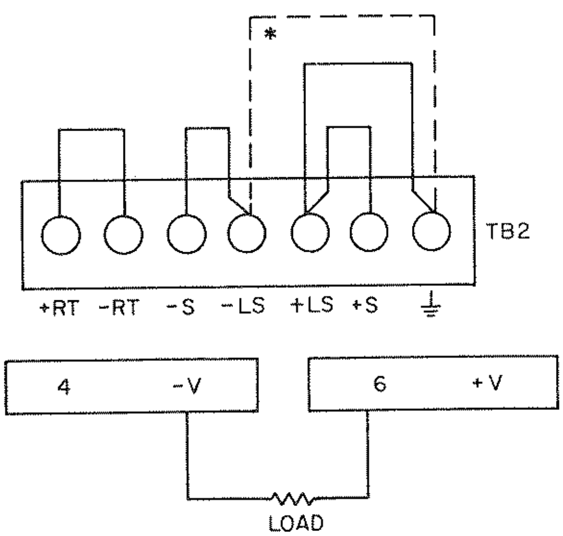
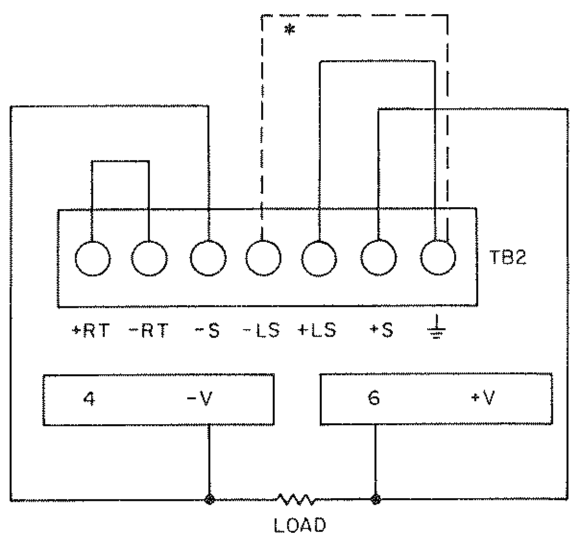


Figure 2. Cable Length "A" in Feet



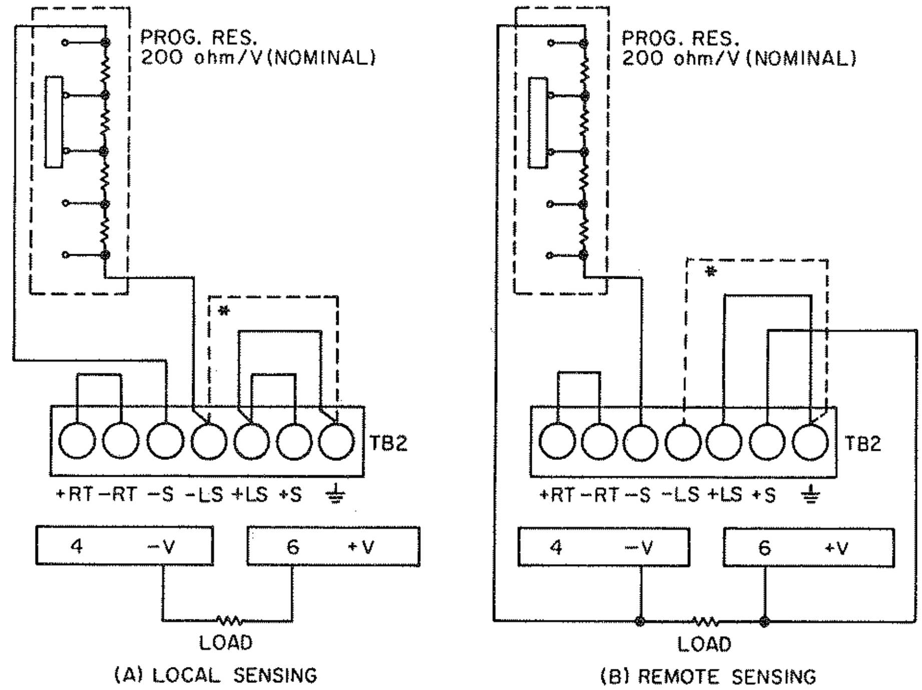
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS ⏚ AND +LS AND RECONNECT TO TERMINALS ⏚ AND -LS.

Figure 3. Local Sensing Connections



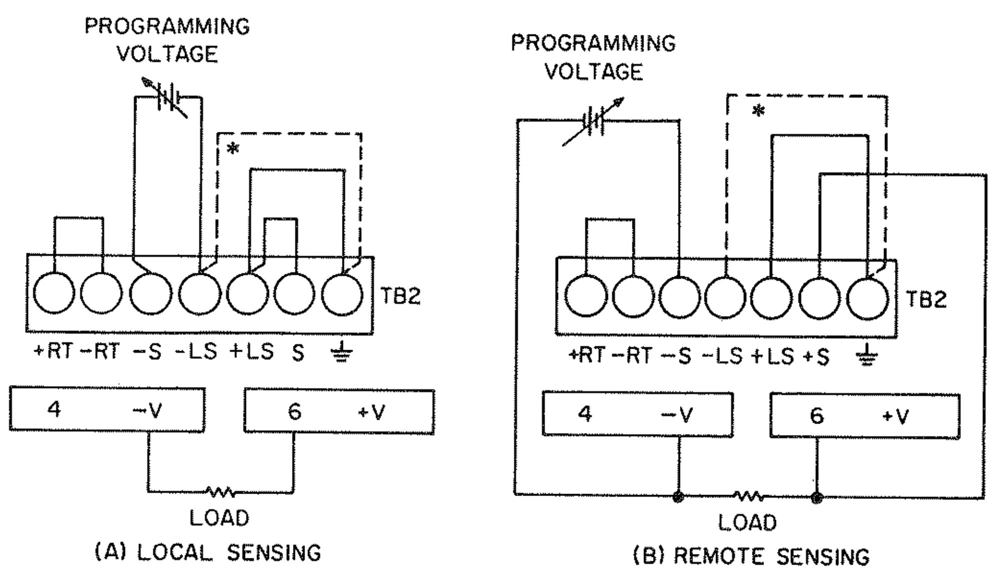
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS ⏚ AND +LS AND RECONNECT TO TERMINALS ⏚ AND -LS.

Figure 4. Remote Sensing Connections



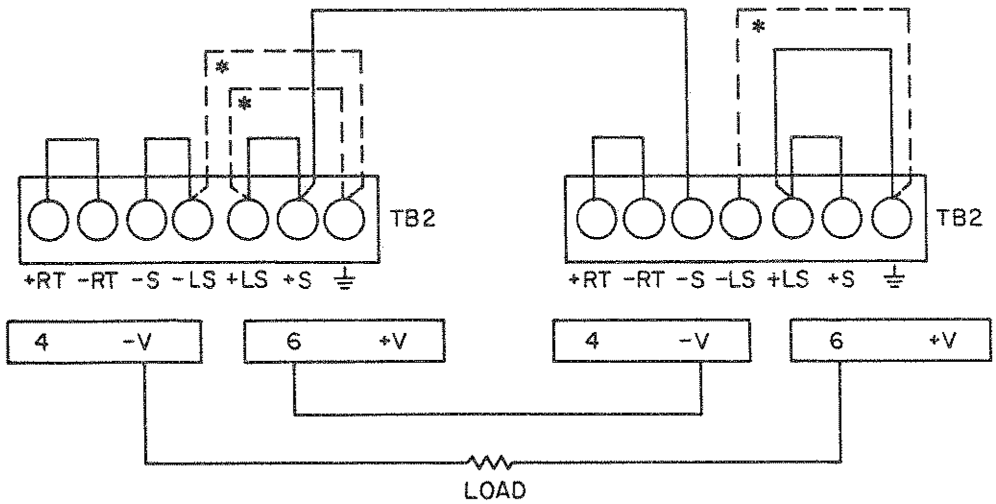
NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS ⏚ AND −LS AND RECONNECT TO TERMINALS ⏚ AND + LS.

Figure 5. Programmed Voltage, With External Resistor

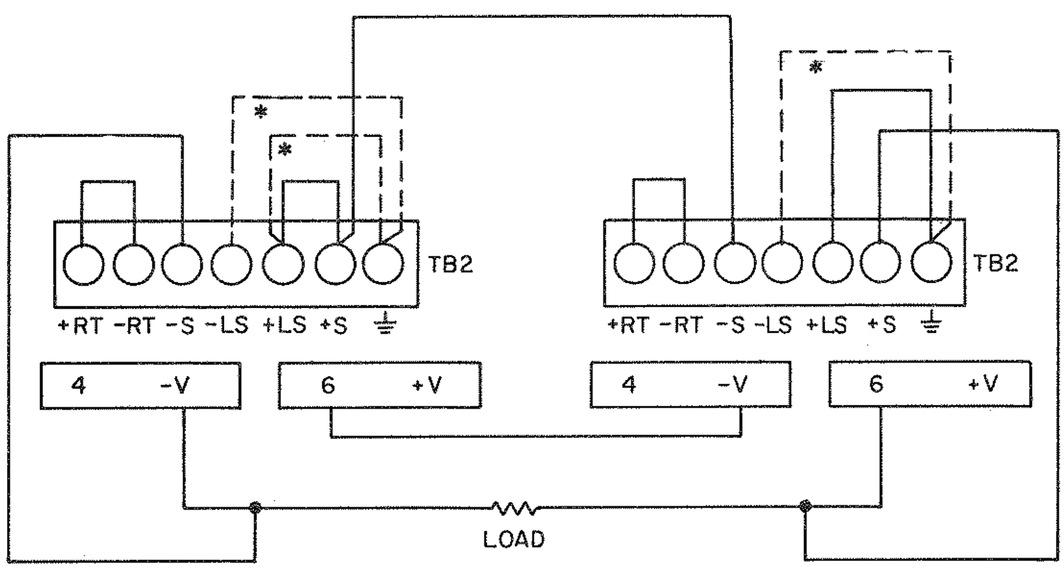


NOTE
* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS ⏚ AND + LS AND RECONNECT TO TERMINALS ⏚ AND −LS.

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 ⏚ AND +LS ON UNIT (A) AND CONNECT ANY ONE OF THE OTHER JUMPERS AS SHOWN IN DOTTED LINES.

Figure 7. Series Connection

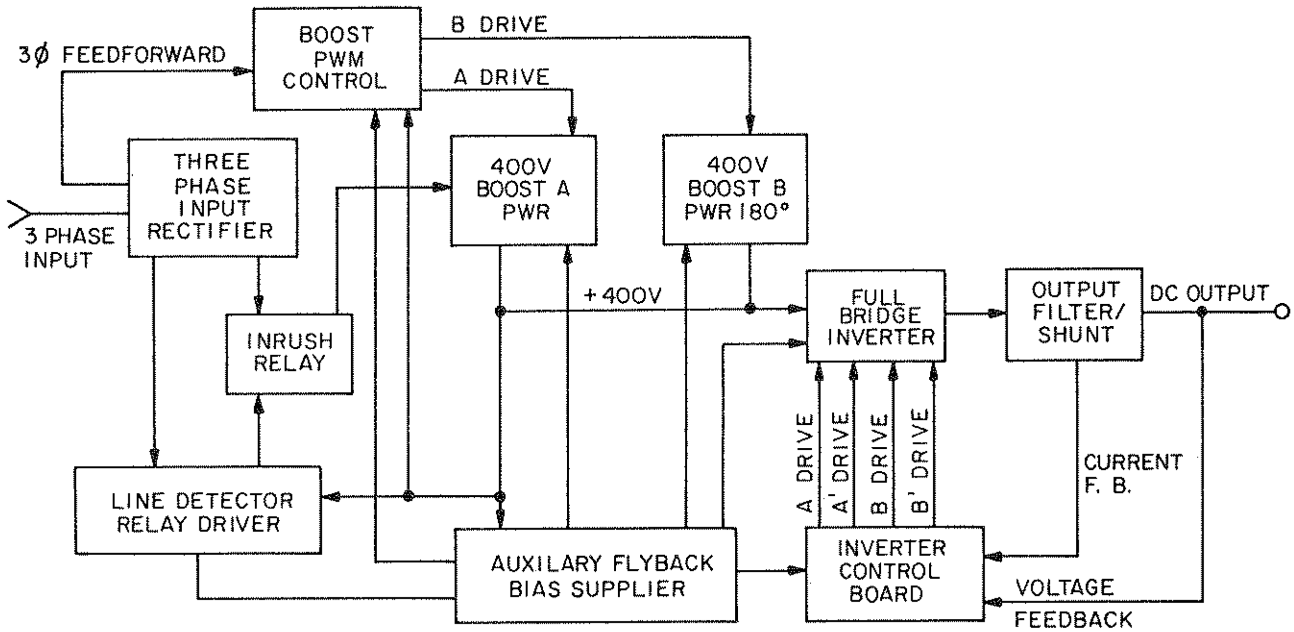


Figure 8. Block Diagram

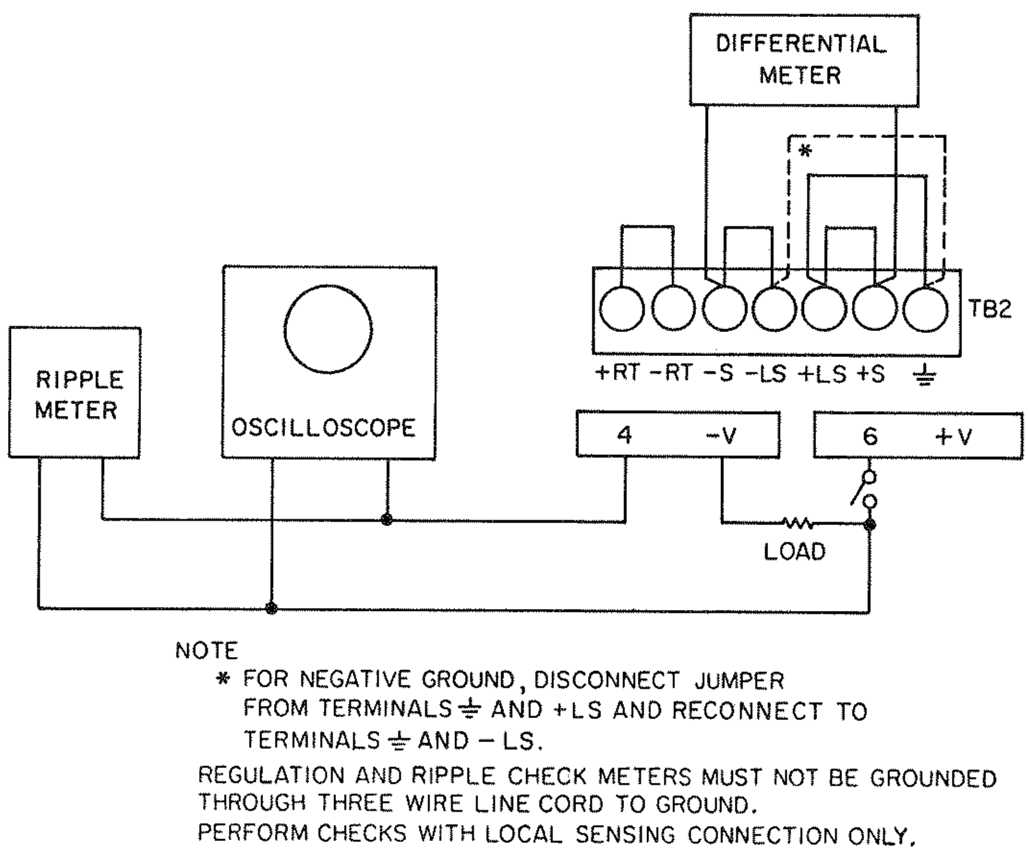
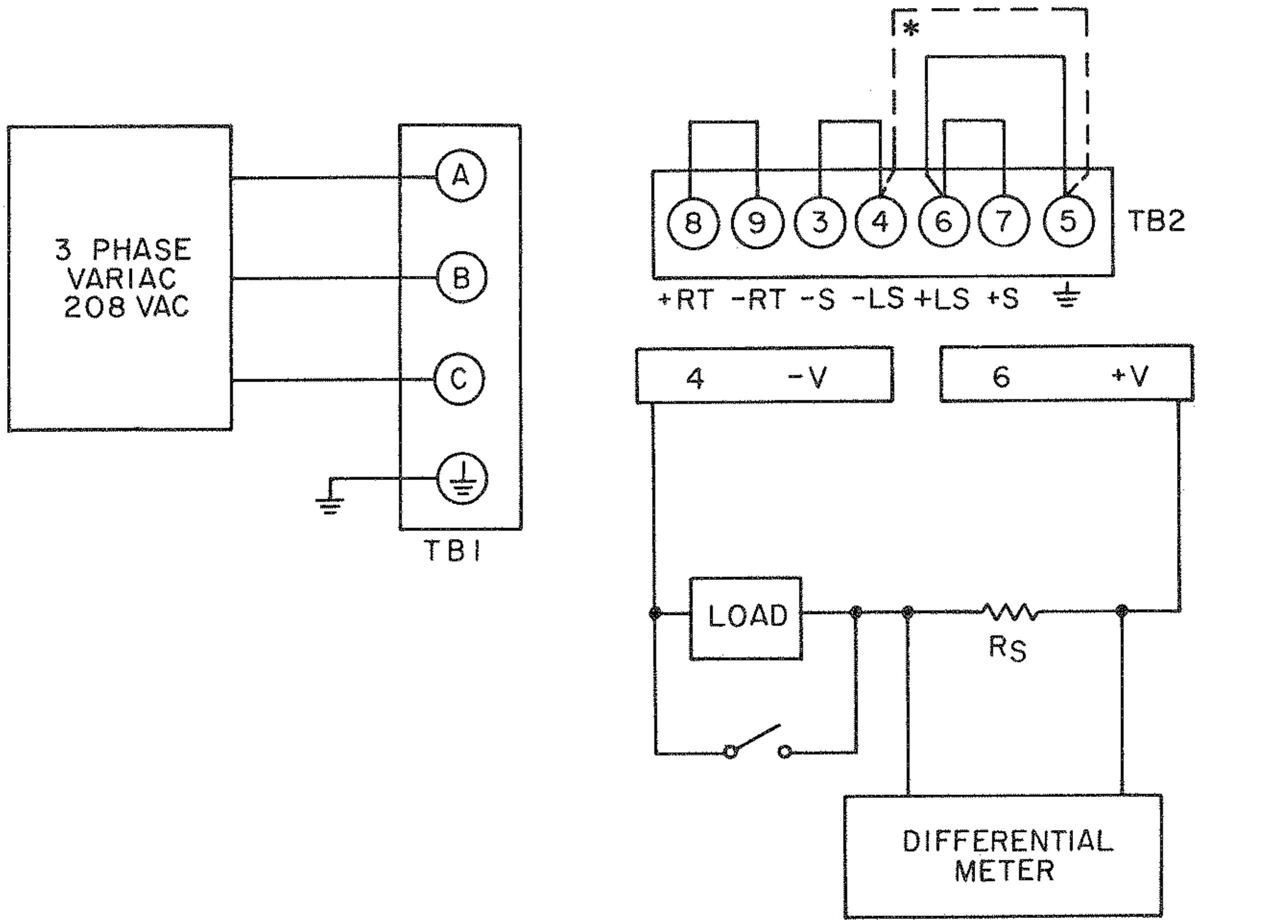


Figure 9. Test Connections For Constant Voltage Performance Checks



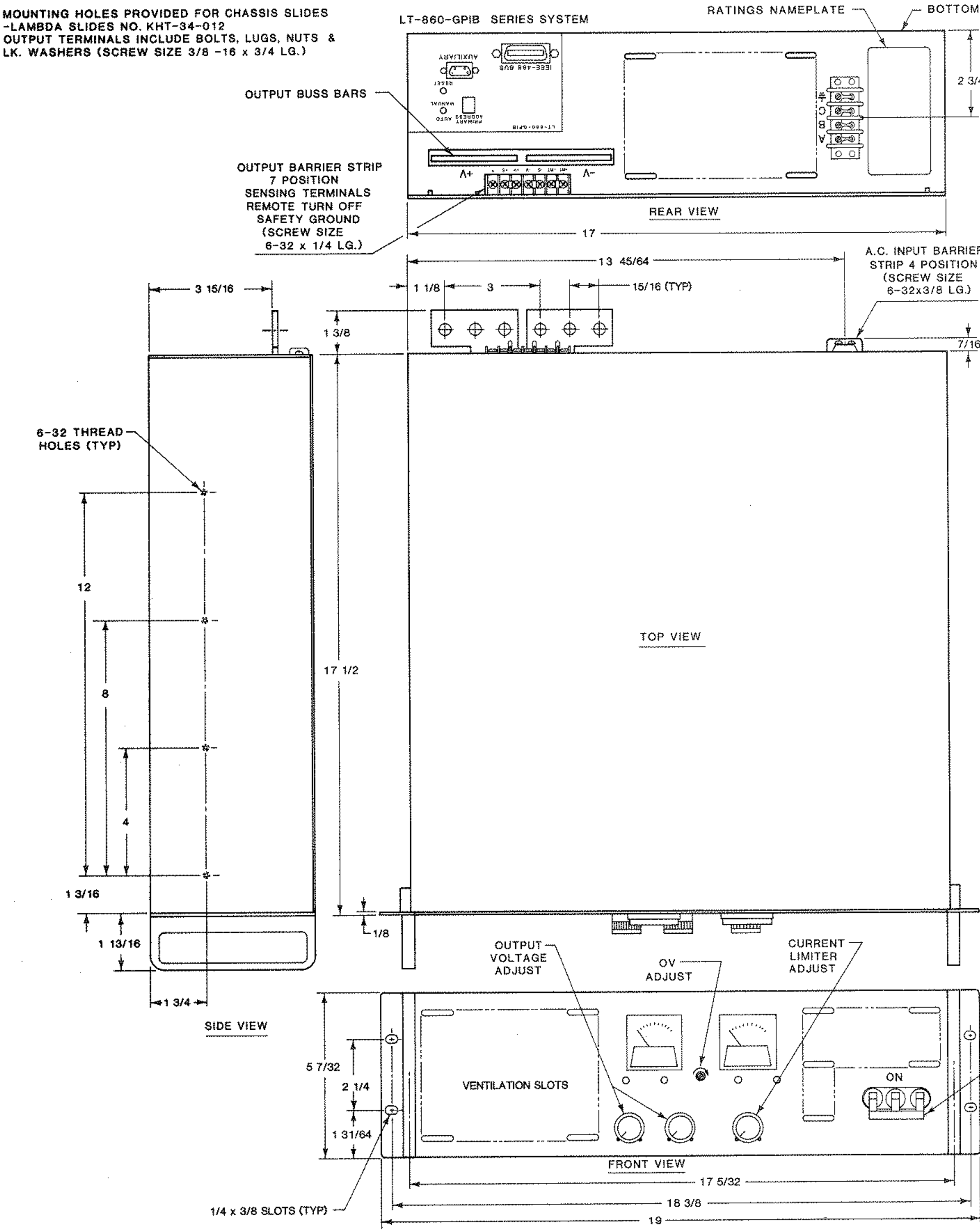
NOTES:

1. REGULATION METER MUST NOT BE GROUNDED THROUGH THREE-WIRE LINE CORD TO GROUND.
2. PERFORM CHECKS WITH LOCAL SENSING CONNECTIONS ONLY.

* FOR NEGATIVE GROUND, DISCONNECT JUMPER FROM TERMINALS ⏚ AND +LS AND RECONNECT TO TERMINALS ⏚ AND -LS.

Figure 10. Test Connections for Constant Current Performance Checks

MOUNTING HOLES PROVIDED FOR CHASSIS SLIDES -LAMBDA SLIDES NO. KHT-34-012
OUTPUT TERMINALS INCLUDE BOLTS, LUGS, NUTS & LK. WASHERS (SCREW SIZE 3/8 -16 x 3/4 LG.)



Outline Drawing