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 Corp. All information contained herein applies to all metered and non-metered LK half-rack models unless otherwise specified.
Standard 19" rack............ LK half-rack units; used with rack accommodation provided)
LRA-1 (slide)
LRA-2 (conventional mount) See figure 11.

MODEL OPTIONS

Suffix "OV" Overvoltage Protection Option. . . . .All LK power supplies are available with a built-in over-voltage protection circuit which prevents damage to the load that can be caused by excessive power supply output voltage.

Suffix "R" Fungus Proofing Option...Standard LK power supplies can be obtained with fungus proofing treatment with MIL V 173 varnish for all fungi nutrient components

Suffix "FM" Meter Option.. . . Standard LK power supplies can be obtained with voltmeter and ammeter

OPERATING INSTRUCTIONS

CONTROLS, INSTRUMENTS AND FUSES

ON-OFF Switch. The ON-OFF switch, located on the front panel, controls application of input power to the supply. When the switch is in the ON position, the red Indicator glows.

OUTPUT VOLTAGE Control. The OUTPUT VOLTAGE control is a dual control consisting of a coarse adjustment potentiometer, which varies the DC voltage over a range 0-19, 0-35 or 0-59 volts, as applicable, and a fine adjustment potentiometer, which varies the DC voltage over a one-volt range. 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 dual control consisting of a coarse adjustment potentiometer, which varies the DC current over 90% of the rated current range and a fine adjustment potentiometer, which varies the DC current over 10% of the rated current range. Clockwise rotation results in increasing current. The total DC current output for current regulated operation, is equal to the sum of each shaft setting; for voltage regulated operation the maximum current limit is equal to the sum of each shaft setting. The control is located on the front panel of all units.
Output Voltage Meter. A DC voltmeter monitors the Voltage at the output terminals of metered (FM) units for the rated voltage range.

Output Current-Meter. A DC ammeter monitors the load output current of metered (FM) units for the rated current range.

Fuses Fuse F1, Internally located, is a 3AG "SLO-BLO" fuse which functions in the AC Input circuit.

Fuse F2 Internally located, is a 3AG "SLO-BLO" fuse which protects the load from excessive output current that can be caused by Internal circuit failure.

NOTE: For fuse values see fuse chart in SPECIFICATIONS AND FEATURES

Connection Terminals. Make all connections to the supply at the terminal block on the rear of the supply. Apply Input power through the line cord or directly to terminals 1 and 2 if the line cord is removed. Always connect the ungrounded (hot.) power 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 8. 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.

OV ADJ Control. This potentiometer is only used on units with the OV Overvoltage Protector option. The OV ADJ control permits screwdriver setting of the overvoltage protection point through an access hole in the front panel.

GROUND CONNECTIONS

The 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.

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, $I_{\text{LIM}}$, set by the CURRENT LIMITER control. When load current $I_L = V / R_L$ the supply will cross over automatically and will operate as a constant current source. Further decrease in value of load resistance $R_L$ results in decrease of voltage across the load while current remains regulated to $I_{\text{LIM}}$.

**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 cross over 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 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 this characteristic, 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.

**Two-Wire Connection, Figure 3.** The two-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Compensation for lead drop is also valid for gradual changes of load current.

**Four-Wire Connection, Figure 4.** The four-wire connection with remote sensing, provides complete compensation for the DC voltage drops in the connecting cables. Compensation for lead drop is also valid for gradual changes of load current.

**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 a 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.

As shown in figure 5, voltages can be programmed utilizing either local or remote sensing connections, as desired.
The power supply output voltage can be programmed with an externally connected programming power supply. The output voltage of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

The programming supply must have a reverse current capability of 6 ma. minimum.

Alternatively, when supplies with less than 6 ma. reverse current capability are used, a resistor capable of drawing 6 ma. at the minimum programming voltage must be connected across the output terminals of the supply. This programming supply must be rated to handle all excess resistor current at the maximum programming 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, using local setting of current control.

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 LK power supplies can be extended by series operation of two LK power supplies of equal or unequal voltage ratings. A maximum of 200 volts can be connected between either the +DC or -DC terminal and chassis ground.

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

Diodes CRM and CRS, which protect the units against reverse voltage, must be capable of withstanding the maximum rated current.

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 voltage; figure 7a shows the connection required when the series combination is operated for constant current.

CONNECTIONS FOR PARALLEL OPERATION

The current capability of LK power supplies can be extended by parallel operation of two LK power supplies of equal+ voltage capacities. The two units are shown connected for parallel operation in figure 8. One power supply designated the (M) unit controls its own output as well as the output of the second power supply, designated the (S) unit.

*For applications using supplies of unequal voltage ratings, consult factory for details of operation.
Unit (S) operates to regulate its current in a ratio to that of the
(M) unit by comparing the current in its internal sampling resistor
with that current sampled by the master internal sampling resistor.
When power supplies of unequal current capacities are parallel con-
nected the division of current supplied will be approximately equal
to the ratio of the current ratings of the supplies.

Parallel connected units can be operated for constant voltage with
local sensing as well as for constant current with automatic cross-
over. When operating for constant voltage, the (M) unit can auto-
matically cross over into constant current operation.

DETAILED OPERATING PROCEDURES

SAFETY NOTICE

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT, OBSERVE
THE USUAL SAFETY PRECAUTIONS WHEN OPERATING OR SER-
VICING THE EQUIPMENT TO AVOID SHOCK OR INJURY.

CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Remove AC power input to supply and place ON-OFF switch in
OFF position before connecting load to the supply.

2. Determine load requirements, select wire size from fig-
ures 1 and 2 and choose desired type of supply-load connection from
figures 3 and 4.

3. Connect supply to load as shown on the selected connec-
tion diagram.

NOTE: When shipped from the factory, the supply is
ready for use as a constant current source with auto-
matic crossover or as a local-sensing constant vol-
tage 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.

4. Turn OUTPUT VOLTAGE control knobs to the desired voltage
setting.

5. When current to the load must be limited to an intermediate
value within the current rating of the supply, turn the CURRENT LIMIT
control knob to the desired current limit setting. If no Intermediate
current limit is required, turn the control knobs, CCW to the position
for full current rating for the maximum ambient temperature of operatic
Refer to section on specifications.

6. Apply AC power to supply

7. Place ON-OFF switch in ON position and check that red in-
dicator is lit.
8. Check that output current and output voltage meters indicate desired values; as required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs to obtain correct meter Indications. For non-metered models use externally connected meters and check that correct meter Indications exist at output terminals 6 and 4; for remote sensing connections, check at the load terminations of sensing leads on terminals 3 and 7.

9. Power supply is now In proper operation.

PROGRAMMED CONSTANT VOLTAGE OPERATION, ADJUSTABLE CURRENT LIMIT

1. Remove AC power Input to the supply and place ON-OFF switch In OFF position before connecting load to the supply.

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

3. Connect supply to load 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.

4. Turn OUTPUT VOLTAGE control knobs to the extreme CCW position. Adjust external programming voltage control to desired voltage setting.

5. When current to the load must be limited to an Intermediate value within the current rating of the supply, turn the CURRENT LIMITER control knobs to the desired current limit setting. If no Intermediate current limit Is desired, turn the control knobs CW to the position for full rated current for the ambient temperature of operation. Refer to section on specifications.

6. Apply AC power to the supply.

7. Place ON-OFF switch In ON position and check that red Indicator is lit.

8. Check that output current and output voltage meters Indicate desired values; as required, adjust CURRENT LIMITER knobs and external programming voltage control to obtain correct meter Indications. For non-metered models use externally connected meters and check that correct meter Indications exist at output terminals 4 and 6; for remote sensing connections check at the load terminations of sensing leads on terminals 3 and 7.

9. Power supply is now operating properly.

CONSTANT CURRENT OPERATION WITH CROSSOVER, ADJUSTABLE VOLTAGE LIMIT

1. Remove AC power Input to the supply and place ON-OFF switch In OFF position before connecting load to the supply.

2. Determine load requirements and connect load to the supply as shown In figure 3.
3. Turn the CURRENT LIMITER knobs to the desired current setting.

4. When load voltage must be limited to an intermediate value within the voltage rating of the supply, turn OUTPUT VOLTAGE control knobs to the desired voltage limit setting. If no Intermediate voltage limit, within rating of supply is desired, turn control knobs to the full CW position to obtain voltage limit at maximum voltage rating of the supply.

5. Apply AC power to the supply.

6. Place ON-OFF switch in ON position and check that red indicator is lit.

7. Check that output current and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs as required to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6.

8. Power supply is now in proper operation.

SERIES CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

1. Remove AC power input to the (B) and (A) units and place ON-OFF switches in OFF position before connecting load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 2 and choose correct type of series supply-load connections from figure 7. Refer to paragraph on Connections for Series Operation.

3. Connect supply to load as shown on the selected connection diagram. As required, select diodes CRs and CRM in accordance with Instructions contained in Connections for Series Operation.
4. Turn (A) and (B) unit OUTPUT VOLTAGE control knobs to the desired total voltage setting.

5. When current to the load must be limited to an intermediate value within current rating of the units, turn each CURRENT LIMITER control knob to the desired setting. If no intermediate current limit is required, turn the control knobs of each unit CW to the position for full current rating for the maximum ambient temperature of operation. Refer to section on specifications.

NOTE: When units of unequal current rating are series connected, the unit with the lower current rating must be capable of delivering the desired load current.

6. Apply AC power to the supplies.

7. Place ON-OFF switches of both units in ON position and check that red indicators are lit.

a. Check that output current and output voltage meters indicate desired values; total voltage is equal to sum of (A) and (B) units. As required, adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control knobs of both units to obtain correct indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals of both units; positive (+) terminal of (A) unit and minus (-) terminal of the (B) unit are the output terminals of the series combination.

For remote sensing connection, make checks at the load terminations of sensing leads from terminal 7 of (A) and from terminal 3 connection of (B) unit.

9. Power supplies are now in proper operation.

PARALLEL CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

1. Remove AC power input to each supply and place ON-OFF switch on both (M) and (S) units in OFF position before connection load to the supplies.

2. Determine load requirements, select wire size from figures 1 and 3 in the manual. Refer to paragraph on Connections for Parallel Operation.

3. Connect supplies to load as shown in connection diagram, figure a.

NOTE: When shipped from the factory, each supply is ready for use as a constant current source or as a local-sensing constant voltage source. Jumpers are connected at the factory. Take care to remove the appropriate jumpers for load requirements that need different supply-load connections. Refer to the appropriate connection diagram.
4. Turn OUTPUT VOLTAGE control knobs on the (M) unit to the desired voltage setting, and turn the OUTPUT VOLTAGE control knobs on the (S) unit to fully CCW position.

5. When current to the load must be limited to an intermediate point, turn the CURRENT LIMITER control knobs on both the (M) and (S) units to the desired current limit setting. Set current limit control on the (M) and (S) units to the position indicating the current value to be delivered by the respective unit. If no intermediate current limit is desired, turn the CURRENT LIMITER control knobs CW on both (M) and (S) units to the position for full rated current for the maximum ambient temperature of operation. Refer to section on specifications.

6. Apply AC power to each supply.

7. Place ON-OFF switches on (M) and (S) units in ON position and check that red indicators are lit.

8. Check that output current and output voltage meters on both (M) and (S) units indicate desired values; as required, adjust OUTPUT VOLTAGE control and CURRENT LIMITER control on (M) unit to obtain correct meter indications. For non-metered models use externally connected meters and check that correct meter indications exist at output terminals 4 and 6 of the (M) unit.

9. Power supplies are now in proper operation.

OPERATION AFTER PROTECTIVE DEVICE SHUTDOWN

Thermostat Shutdown

The thermostat opens the input circuit only when the temperature of the transistor heat radiator exceeds a maximum safe value. The thermostat will automatically reset when the temperature of the radiator decreases to safe operating value. After eliminating the cause(s) for overheating and allowing time for the power supply to cool to a proper temperature, resume operation of the supply. Refer to appropriate operation paragraph in DETAILED OPERATING PROCEDURES.

Fuse Shutdown

Internal component failure is prevented by fuses which protect the components from damage caused by excessive currents. Fuses 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.