

INSTRUCTION MANUAL
FOR
REGULATED POWER SUPPLIES

MODEL
LPT-7202-FM

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 model LPT-7202-FM.

LAMBDA ELECTRONICS

MAIN PLANT TELEPHONE: 516 MYrtle 4-4200

MELVILLE, L.I., N.Y.

IM – LPT

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

| VOLTAGE RANGE (VOLTS) | MAXIMUM CURRENT (AMPS) AT AMBIENT TEMPERATURE | | | |
|-----------------------|---|------|------|------|
| | 30°C | 40°C | 50°C | 60°C |
| O-7 (Unit A) | 5.0 | 4.5 | 4.0 | 3.5 |
| O-20 (Unit B) | 1.5 | 1.35 | 1.20 | 1.0 |
| O-20 (Unit C) | 1.5 | 1.35 | 1.20 | 1.0 |

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

REGULATED VOLTAGE OUTPUT

| | | |
|-------------------------|--------------|--|
| Regulation | (line) | 0.01 per cent plus 1.0 millivolt for input variations from 105-432 or 132-105 volts AC. |
| Regulation | (load) | 0.01 percent plus 1.0 millivolt for load variations from no load to full load or full load to no load. |
| Remote Programming | | |
| External Resistor | | Nominal 200 ohms/volt output. |
| Programming Voltage | | One-to-one voltage change. |
| Ripple and Noise | | 500 microvolts rms; 1.5 millivolts peak-to-peak with either positive or negative terminal grounded. |
| Temperature Coefficient | | Output change in voltage less than (0.015% + 0.3 mv)/°C |

DC OUTPUT – Current regulated for line and load; automatic crossover with voltage limit.

Multi-Current Ranges Current range must be chosen to suit the appropriate maximum ambient temperature. Current ratings apply for entire voltage range. For maximum current range, see Table I. Minimum current rating: 45 ma or 1% of max. current rating whichever is greater.

Voltage Range. For voltage range see Table I: voltage ratings apply for entire current range.

REGULATED CURRENT OUTPUT: AUTOMATIC CROSSOVER

Regulation (line) Less than 0.2% or 5 milliamperes, whichever is greater, variations from 105-132 or 132-105 volts AC.

Regulation (load)..... Less than 0.2% or 5 milliamperes for load voltage changes from 0 to max. or max. to 0 volts DC.

AC INPUT – 105-132 volts AC at 47-440 Hz. Input power*: 235 Watts. For 47-53 Hz operation, derate current 10% for each ambient temperature given in table I. For 63-440 Hz operation, consult factory.

*With output loaded to full 30°C rating and input voltage 132 volts AC, 60 Hz.

OVERLOAD PROTECTION

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

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..... “SLO-BLO”, 5 A fuse F1 protects the AC input circuit. Overload of the supply does not cause fuse failure.

Fuse F2 provides protection against internal circuit failure in conjunction with overvoltage protector option (Unit A only).

INPUT AND OUTPUT CONNECTIONS – Heavy duty terminal blocks on rear of chassis with 5-foot; 3 wire detachable line cord; five-way binding posts provide for additional positive (+), ground, and negative (-) DC output connection on front panel.

OVERSHOOT – No overshoot of output voltage under conditions of power turn-on, power turn-off or **power** failure.

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.

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

METERS – Voltmeters and ammeters.

CONTROLS

- DC Output Controls Coarse and fine voltage controls and coarse current control permit adjustment of DC output; located on front panel.
- Binding Posts (+) (-) (GND) Five-way binding posts.
- Remote Sensing. Provision is made for remote sensing to eliminate effect of power output lead resistance on DC regulation.
- Power Panel mounted switch and indicator light.

PHYSICAL DATA

Size..... 5-3/16” H x 12-1/2” W x 11” D

Weight..... 24 lbs. net, 29 lbs. shipping wt.

MOUNTING

Laboratory bench table top Secure the four bumper feet to the bottom of the unit using four 6 x 32 screws and lockwashers supplied with the power supply. Bumpers must be used to permit proper circulation of air through the unit. Removal of bumpers will restrict free flow of air, avoid removing bumpers. See figure 13 for outline drawing.

MODEL OPTIONS

- Suffix “R” Fungus. LPT-7202-FM power **supplies can be obtained with fungus proofing treatment with MIL V 173 varnish for all fungi nutrient components.**
- Proofing Option
- Suffix “V” option. **LPT-72021FM power supplies can be obtained for 205-265 VAC, 47-440 Hz input or 187-242 VAC, 47-440 Hz input. See nameplate for AC input rating. See schematic for rewiring of AC input. For 47-53 Hz operation, derate current 10% for each ambient temperature given in table I. For 63-440 Hz operation, consult factory.**

ACCESSORIES

Overvoltage Protector Externally mounted, Overvoltage Protector LHOV-4 is available for use with LPT-7202-FM supplies.

THEORY OF OPERATION

GENERAL

The text in this section refers to circuit designations of unit **A** of the LPT-7202 model power supply, however the discussion is equally applicable to units Band C which have similar components.

The Lambda power supply consists of an **AC** input circuit and transformer; a bias supply consisting of an auxiliary rectifier, filter, and preregulator*; a main regulator circuit consisting of the main rectifier, filter, a series regulator, emitter follower drivers, a current comparator*, a voltage comparator*, a voltage amplifier*, current and voltage sensing networks, a voltage reference*, and a current amplifier*.

*This circuit element is part of integrated circuit IC101.

The circuit arrangement is shown in block diagram form, figure 10. The circuitry is discussed with reference to the block diagram and the schematic diagram.

FUNCTIONAL DESCRIPTION

Single phase input power is applied to transformer T1 through the input circuit containing a thermostat and fuse **F1**, which protect the supply against overheating and internal faults.

The main rectifier, a full wave rectifier, provides the power which is filtered by capacitor C1 and then regulated via a series regulator and delivered to the output. Half-wave auxiliary rectifier CR101 provides voltage filtered by capacitor **C101** for the preregulator located in IC101.

Constant Voltage Circuit Operation

Constant voltage developed by IC101 across R101, R102 produces a constant current of 5 milliamperes through R108, R106, and Q103B. This current is fed through dividers R1 A, B which, in turn, develop a constant reference voltage for one input to the voltage comparator. A second input, the load voltage, is compared to the reference voltage by the comparator. A change in output voltage produces an error signal at the output of the comparator. If the output voltage tends to rise, the comparator conducts, less current flows through CR104 and current to driver Q53 is reduced. This action increases the voltage across the series regulator thus reducing the output voltage.

Constant Current Operation

Constant current developed by IC101 flows through resistor R3. A reference voltage, developed at the wiper of R3 is applied at one input to the current comparator. A second input to the comparator is the voltage developed across R52. If the current to the load tends to increase, the voltage across R52 increases causing the comparator to conduct. This action reduces current to driver Q53 and increases the series regulator impedance, thus limiting the output current. The current limit value is determined by the setting of resistor R3.

OPERATING INSTRUCTIONS

CONTROLS, INSTRUMENTS, AND FUSES

Power ON-OFF Switch. The power 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 power on indicator glows.

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 0-6, 0-19, 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 controls are located on the front panel.

CURRENT LIMITER Control. The CURRENT LIMITER control varies the DC current over the rated current range*. Clockwise rotation results in increasing current. The controls are located on the front panel.

*Operation for output current below rated limits can result in no output or no regulation.

Output Voltage Meter. A DC voltmeter monitors the voltage at the output terminals over the rated voltage range.

Output Current Meter. A DC ammeter monitors the load output current over the rated current range.

Fuses. **Fuse F1**, internally located, is a 5 ampere, 3AG “SLO-BLO” fuse which functions in the AC input circuit.

Fuse F2 internally located is a 10 ampere, 3AG “NORM-BLO” fuse which provides protection against internal circuit failure in unit A.

Connection Terminals. Make all connections to the supply at the terminal blocks on the rear of the supply. DC output connections can also be made at the five-way binding posts located on the front panel. 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 terminals are brought out to terminal 6 (0-7 volt, unit A); terminal 14 (0-20 volt, unit B); terminal 26 (0-20 volt, unit C). The supply negative terminals are brought out to terminal 4 (0-7 volt, unit A); terminal 12(0-20 volt, unit B); terminal 24 (0-20 volt, unit C). 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 sense terminals or use the shortest leads possible.

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_{LIM} , set by the CURRENT LIMITER control. When load current $I_L = V/R_L = I_{LIM}$, 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 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 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 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 and/or where short power output leads are used.

Remote Sensing Connection, Figure 4. Remote sensing provides complete compensation for the DC voltage drops in the connecting cables. A 2MF, 35V capacitor may be required to reduce noise, between terminals 3-4, 6-7, **11-12**, **14-15**, **23-24**, and 26-27 whenever remote sensing is used. +S and -S sensing leads must be twisted together.

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.

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 of the programmed supply will maintain a one-to-one ratio with the voltage of the programming supply.

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. *

*Setting control for output currents below rated limits can result in no output or no regulation.

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 the LPT-7202-FM power supply can be extended by series operation of two LPT-7202-FM power supply outputs of equal* voltage ratings. A maximum of 300 volts can be connected between either the +DC or -DC terminal and chassis ground.

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

The two units are shown connected for series operation in figures 7 and 8. Figure 7 shows the series connection diagram which would be suitable for use in all applications where exact one-to-one voltage tracking of the "master" (M) unit by the "slave" (S) unit is not required. The slight offset in tracking is easily compensated for by adjusting the OUTPUT VOLTAGE controls on the (S) unit.

Figure 8 shows the series connection diagram suitable for applications where exact one-to-one voltage tracking is required. In this series configuration, resistor RBAL permits the (S) unit to track the (M) unit on an exact one-to-one basis, thereby eliminating the possibility of an offset voltage existing between the two units.

Resistor R BAL should be a two-watt, 10 ohm/volt output, resistor. This value would permit wide-range compensation for manufacturing differences inherent in the components used in each unit. Resistors RS and RM function in the voltage sensing circuits of both units, enabling the (S) unit to reference its output voltage to that of the (M) unit. In figure 7, R_M performs a similar function. Capacitor C_S , used to eliminate stray AC pickup, is rated at 2.5 mfd, 200 V.

For either series mode of operation, select R_S and R_M on the basis of 200 ohms per volt of (M) unit output voltage. R_S must equal R_M . Choose R_S and R_M to be low temperature coefficient resistors,

Diodes CR_M and CR_S , which protect the units against reverse voltage must be capable of withstanding the maximum rated current of the (M) unit, and must have a reverse blocking voltage equal to 2.5 times the maximum rated output voltage. These diodes not required for series operation of B and C units.

Both methods permit 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. As shown in figures 7 and 8, each method permits connection for either local or remote sensing.

CONNECTIONS FOR PARALLEL OPERATION

The current capability of LPT-7202 power supply can be extended by parallel operation of two LPT-7202 power supply outputs of equal* voltage capacities. The two units are shown connected for parallel operation in figure 9. One unit designated the "master" or (M) unit controls its own output as well as the output of the second unit designated the "slave" or (S) unit.

*For applications using supply outputs of unequal voltage ratings, consult factory for details of operation.

Unit (S) operates to regulate its current to be equal 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.

Parallel connected units can be operated for constant voltage with local sensing, figure 9A, or remote sensing, figure 9B, as well as for constant current with automatic crossover, figure 9A. When operating for constant voltage, the (M) unit can automatically 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 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 switch 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. When five way binding posts are used, do not remove barrier strip jumpers.

2. Determine load requirements, select wire size from figure 1 and 2, and choose desired type of supply-load connection from figure 3 and 4. Do not connect load.
3. Place power ON-OFF switch in ON position and check that red indicator is lit.
4. Set CURRENT LIMITER control fully CW 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 switch in OFF position, b) connect jumper between +V and -V terminals, c) place power ON-OFF switch in ON position and adjust CURRENT LIMITER control to obtain the desired meter indication, d) place power ON-OFF switch in OFF position and remove jumper.
5. Connect supply to load as shown on selected connection diagram.
6. Place power 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; 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 switch 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. When the five way binding posts are used, do not remove barrier strip jumpers.

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 or 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
 - b) Place power ON-OFF switch in ON position and adjust CURRENT LIMITER control to obtain the desired current limit meter indication.
 - c) Place power ON-OFF switch 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** switch in ON position and check that red power-on indicator is lit.
7. Check that output current and output voltage 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 switch 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. When the five way binding posts are used, do not remove barrier strip jumpers.

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 LIMIT control to the desired output current as follows:
 - a) Connect jumper between +V and -V terminals.
 - b) Place power ON-OFF switch in ON position and adjust CURRENT LIMITER control to obtain the desired load current as indicated on current meter.
 - c) Place power ON-OFF switch in OFF position and remove jumper between +V and -V terminals.
4. Place power ON-OFF switch in ON position and adjust OUTPUT VOLTAGE control knobs to obtain the desired voltage limit point as indicated on voltage meter.
5. Place power ON-OFF switch in OFF position and connect load to the supply as shown in figure 3.
6. Place power ON-OFF switch in ON position and check that red power-on indicator is lit.
7. Check that output current and output voltage 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 CONNECTIONS CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT**

1. Apply AC power input to the supply, but place power ON-OFF switch 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. When the five way binding posts are used, do not remove barrier strip jumpers.

2. Determine load requirements, select wire size from figures 1 and 2 choose correct type of series supply-load connections from figures 7 and 8. Refer to paragraph on CONNECTIONS FOR SERIES OPERATION.
3. Connect power supply terminals as shown on the selected connection diagram. As required, select resistors R_{BAL} , R_S , and R_M and diodes CR_S and CR_M in accordance with instructions contained in CONNECTIONS FOR SERIES OPERATION. Do not connect load.
4. ******Place power ON-OFF switch in ON position and adjust OUTPUT VOLTAGE control knobs on the (M) unit to obtain the desired meter indication. Adjust (S) unit OUTPUT VOLTAGE controls until (S) unit voltage meter indication equals (M) unit voltage meter indication. This setting will be approximately one-half of the combined (M) and (S) unit output voltage. The (S) unit will track any change in (M) unit output voltage made with the (M) unit OUTPUT VOLTAGE control. Place power ON-OFF switch 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 (M) unit.
 - b) Place power ON-OFF switch in ON position and adjust CURRENT LIMITER control on the (M) unit to the desired current limit point, as indicated on current meter.

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

**This step does not apply to figure 8.

- c) Set CURRENT LIMITER control on (S) unit slightly above CURRENT LIMITER control setting on (M) unit.
- d) Place power ON-OFF switch in OFF position and remove jumpers between +V and -V terminals.

6. Connect supply to load as shown on the selected connection diagram.
7. Place power ON-OFF switch in ON Position and check that red power-on indicator is lit.
8. Check that output current and output voltage meters indicate desired values: adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain correct indications.
9. Power supplies are now in proper operation.

SERIES CONNECTION CONSTANT CURRENT OPERATION, WITH VOLTAGE LIMIT

1. Apply AC power input to the supply, but place power ON-OFF switch 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. When the five way binding posts are used, do not remove barrier, strip jumpers.

2. Determine load requirements, select wire size from figures **1** and **2** and choose correct type of series supply-load connections from figures 7A and 8A. Refer to paragraph on CONNECTIONS FOR SERIES OPERATION.
3. Connect power supply terminals as shown on the selected connection diagram. As required, select resistors R_{BAL} , R_S , and R_M and diodes CR, and CR_M as instructed in CONNECTIONS FOR SERIES OPERATION. Do not connect load.
4. Place power ON-OFF switch in ON position.
5. Adjust (S) unit OUTPUT VOLTAGE controls until (S) unit voltage meter indication equals (M) unit voltage meter indication. The (S) unit will track any change in (M) unit output voltage made with the (M) unit OUTPUT VOLTAGE control.
6. When the voltage to the load must be limited to an intermediate value within the voltage rating of the series combination, proceed as follows:
 - a) Place power ON-OFF switch in ON position.
 - b) Turn the (M) unit OUTPUT VOLTAGE control knobs until voltage meter indicates approximately one-half the total rating desired for the series combination.
 - c) Place power ON-OFF switch in OFF position.
7. Adjust CURRENT LIMITER control for the desired load current as follows:
 - a) Connect jumpers between +V and -V terminals or: (M) unit.
 - b) Place power ON-OFF switch in ON position and adjust CURRENT LIMITER control to the desired load current as indicated on (M) unit current meter.
 - c) Set CURRENT LIMITER control on (S) unit slightly above CURRENT LIMITER control setting on (M) unit.
 - d) Place power ON-OFF switch in OFF position and remove jumpers between +V and -V terminals.
8. Connect supplies to load as shown on the selected connection diagram.
9. Place power ON-OFF switch in ON position and check that red power-on indicator is lit.
10. Check that output current and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain correct indications.
11. Power supplies are now in proper operation.

PARALLEL CONNECTION CONSTANT VOLTAGE OPERATION, WITH CURRENT LIMIT

1. Apply AC power input to the supply, but place power ON-OFF switch 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.. When the five way binding posts are used, do not remove barrier strip jumpers.

2. Determine load requirements, select wire size from figures 1 and 2 and choose correct type of parallel supply-load connections from figures 9A and 9B Connect supply terminals as shown on the selected connection diagram, but do not connect load.
3. Place power ON-OFF switch in ON position.
4. Turn (M) and (S) unit CURRENT LIMITER controls fully CW.
5. Adjust (M) unit OUTPUT VOLTAGE control for the desired voltage as read on (M) unit voltage meter.
6. Place power ON-OFF switch in OFF position.
7. When current to the load must be limited to an intermediate value within the current rating of each unit, proceed as follows :
 - a) Connect supply to the load and place a jumper across load terminals.
 - b) Place power ON-OFF switch in ON position and adjust (M) unit CURRENT LIMITER control for desired meter reading. The short circuit current will be the sum of (M) & (S) unit current meter readings.
 - c) Place power ON-OFF switch in OFF position and remove jumper across load.
8. Place power ON-OFF switch in ON position and check that red power-on indicator is lit.
9. Check that output current and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain correction indications.
10. Power supplies are now in proper operation.

PARALLEL CONNECTION CONSTANT CURRENT OPERATION, WITH VOLTAGE LIMIT

1. Apply AC power input to the supply, but place power ON-OFF switch 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. When the five way binding posts are used, do not remove barrier strip jumpers.

2. Determine load requirements,, select wire size from figures 1 and 2, and choose correct type of parallel supply-load connections from figure 9A. Connect supply terminals as shown on the selected connection diagram, but do not connect load.
3. Place power ON-OFF switch in ON position.
4. Turn (S) unit current limiter control fully CW.

5. Adjust (M) unit OUTPUT VOLTAGE **control for the desired voltage limit point as read on (M) unit** voltage meter.
6. Place power ON-OFF switch in OFF position.
7. Set the desired load current as follows:
 - a) Connect supply to the load and place a jumper across load terminals.
 - b) Place power ON-OFF switch in ON position and adjust (M) unit CURRENT LIMITER control for desired meter reading. The regulated current will be the sum of (M) and (S) unit current meter readings.
 - c) Place power ON-OFF switch in OFF position and remove jumper across load.
8. Place power ON-OFF switch in ON position and check that red power-on indicator is lit.
9. Check that output current and output voltage meters indicate desired values; adjust OUTPUT VOLTAGE control knobs and CURRENT LIMITER control as required to obtain correct indications.
10. 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 operation 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.