OPERATOR MANUAL FOR

ESS 2.5 KW-CE-IEEE

POWER SUPPLY

Document: 83-510-004 Rev C

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1. GENERAL INFORMATION

1.1 INTRODUCTION

The ESS 2.5 KW-CE-IEEE Power Supply, manufactured by Lambda EMI of Neptune, NJ, is a compact high performance device. It has numerous features that have been developed specifically for manufacturing, laboratory test and burn-in applications. It will drive a load with up to 2.5 Kilowatts of DC power and it is 3½ inches tall in a 19-inch rack. Standard features include:

- Output Voltage and Current Adjustable From Zero to Full Output
- Constant Voltage Regulation
- Constant Current Regulation
- Voltage Control Knob, 10 Turn
- Current Control Knob, 10 Turn
- Output Voltage LED, 3½ Digits
- Output Current LED, 3½ Digits
- Settable Over-Voltage Protection with Crowbar
- Isolated Power Outputs
- Series Supply Operation
- Parallel Supply Operation

- Remote Sensing of Voltage at Load
- Remote Programming of Voltage by External Voltage, Current or Resistance.
- Remote Programming of Current by External Voltage, Current or Resistance.
- Remote Programming is User Selectable for +5V or +10V Full Scale.

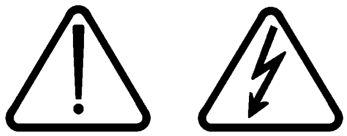
- Voltage Monitor
- Current Monitor
- Monitors are User Selectable +5V or +10V Full Scale.

- Low AC Input Shutdown
- High Temperature Shutdown
- Four Mode-Indicating LEDs
- Front Panel AC Circuit Breaker
- Open-Contact External Inhibit
- AC or DC External Enable
- Soft Start to Reduce AC Inrush
- Internal discharge resistors on AC Input and Output terminals
- "Zero Stacking" in mounting rack. Top and Bottom covers have no openings.
- Air Cooled, Fan Driven, in front, out rear.

- Optional IEEE-488 and RS-232 Digital Interface

NOTE: *This manual contains information, instructions and diagrams which apply to standard constructions. If special features or modifications have been installed, the instructions specific to that modification are contained in Addenda and take precedence if conflicts exist. Please take care to refer to the correct information for your unit.*

1.2 SAFETY PRECAUTIONS



All ESS power supplies are designed to minimize the risk of fire or shock hazard. This instrument received comprehensive mechanical and electrical inspection prior to shipment. Nevertheless, certain safety precautions must be observed. Only TECHNICALLY QUALIFIED SERVICE PERSONNEL familiar with the principles of electrical safety should operate this supply. The power supply SHOULD NOT BE EXPOSED TO WATER OR MOISTURE OR DUSTY ENVIRONMENTS. Electrical safety must be maintained at all times.

Lethal voltages are developed within the power supply's enclosure. Therefore, the cover may not be removed by the user (see Warrantee in preamble section for variance). Also, the large capacitors in the supply may store power even after the line power is removed. ALLOW AT LEAST 40 SECONDS DISCHARGE TIME between removing the line power and opening the cover. ALSO, ALLOW AT LEAST 40 SECONDS between switching the AC power off and switching it on again.

Dangers are inherent in high voltage equipment. However, power supplies with LOW VOLTAGE OUTPUTS ARE ALSO POTENTIALLY DANGEROUS. Beyond the steady state energy available, supply outputs have very large capacitors which can deliver huge surge currents capable of vaporizing metallic objects such as screwdrivers or jewelry. This could result in molten metal being sprayed. Proper care and judgment must always be observed.

1. Ensure all covers are in place and securely fastened before switching ON the AC power. Ensure the JI Programming Plug is attached.
2. Proper grounding from the input AC power is required to reduce the risk of electric shock. Ensure that the AC Protective Earth Ground (third prong) connection has at least the same gauge wire as the supply leads shown in Table 2.
3. Where high leakage exists and there is a warning label on the rear panel, the Protective Earth Ground must be connected. (Symbol for ⏚ protective earth ground).
4. Use extreme caution when connecting input AC power and never apply the incorrect input voltage, refer to ratings label.
5. Use extreme caution when connecting the high voltage output cables to the load.
6. Ensure all load capacitors are completely discharged prior to connection. Never handle the output cable when the power supply is operating.
7. Never attempt to operate the power supply in any manner not described in this manual.
8. Never remove DANGER and WARNING labels from the power supply. Replace lost or damaged labels immediately.
9. The power supply should only be serviced by Lambda EMI factory authorized personnel.

1.3 SCOPE OF THIS MANUAL

This manual is used for installing and operating the ESS 2.5 KW Power Supply.

Suggestions and requirements for connecting AC power, load cables and signal cables are given. Various operating modes and programming modes are described.

Although the Digital Programming (IEEE-488 and RS-232) option is mentioned here, for a complete description of the programming language, see Lambda EMI document, “User Manual For Embedded IEEE Option”, document number 83-468-007.

1.4 MODEL NUMBER FORMAT

The model numbering system for the ESS power supply includes symbols for features and options. They are separated by dashes.

Examples are: ESS 100-25-15-D-TC-CE and ESS 600-4-15-D-TC-CE-IEEE-0950.

Table 1 is a partial listing of the model number format for the ESS Power Supply family. For additional options, the customer may contact the Sales Department at Lambda EMI. Special options are typically shown as a four-digit suffix to the model number.

ESS (Voltage) - (Current) - (Input) - D - TC - CE - (Options)

DC Voltage Range

DC Current Range

AC INPUT VOLTAGE		
Output Power	Input	Suffix
2.5 KW	190-253 VAC, 50-60 Hz 1-Phase	-15

STANDARD	
Digital Meters	-D
Terminal Cover	-TC
Units Comply With CE Requirements	-CE

OPTIONS	
Lock Bushings	-LB
IEEE / RS232 Programming	-IEEE
Other Options	-xxxx

Table 1. Model Number Format

2. OUT-OF-BOX-INSPECTION

2.1 VISUAL INSPECTION

Prior to shipment, this instrument was inspected and found to be free of mechanical and electrical defects. As soon as the unit is unpacked, inspect for any damage that may have occurred in transit. Verify the following:

A. Check the operation of the front panel controls (knobs should rotate smoothly).

B. Verify that the circuit breaker latches in the ON and OFF positions.

C. Confirm that there are no dents or scratches on the panel surfaces.

D. Check front panel meters and LEDs for any broken or cracked lenses.

If any damage is found, follow the instructions in Section 2.3 and in the "Returning Equipment" instructions in the preamble section of this manual.

2.2 ELECTRICAL INSPECTION

Before the ESS is installed in a system, verify that no internal damage occurred during shipping. A simple preliminary electrical test should be performed. This test is described in Section 11. It takes only a few minutes and the only required equipment is a power cord and a piece of cable used to short-circuit the ESS output.

If any inconsistency from the above test procedure is noted, do not hesitate to call Lambda EMI Customer Service for assistance.

2.3 CONTACTING LAMBDA-EMI CUSTOMER SERVICE

Phone: (732) 922-9300 E-mail: service@lambda-emi.com

Fax: (732) 922-5403

Customer Service, or an approved Service Center, should be contacted if:

- The power supply is mechanically or electrically damaged.
- The power supply requires on-site calibration, routine internal cleaning, or replacement warning decals.
- The customer has questions about a special application which is not described in this manual.

Normally, the customer may *NOT* open any chassis covers which have a warranty seal. Breaking a seal will void the warranty.

At the discretion of Lambda EMI, the customer may be granted permission to break the warranty seal and open the chassis covers. Customer Service shall confirm the permission by sending a replacement seal. Once the unit has been serviced, the customer shall close the cover and apply the replacement seal adjacent to (not on top of) the broken seal.

2.4 RETURNING DEFECTIVE UNITS

The procedure for returning defective products is given in the preamble section of this manual.

3. INSTALLATION

3.1 19-INCH RACK MOUNTING

This power supply is intended for mounting in a conventional 19-inch rack. Its 3.47 inches height makes it a "2U" size instrument. The rack should enclose the sides, top and back to protect the operator from electrical shock and protect the supply from environmental contamination.

Never install the ESS so its weight is supported only by the front panel screws!

The ESS must never be installed so there is no support in the back. This arrangement can cause the front panel plate to be permanently distorted. Therefore, the ESS must be mounted on chassis slides or on a shelf inside the rack.

3.2 VENTILATION REQUIREMENTS

This instrument is fan cooled. Sufficient space must be allocated so that a free flow of cooling air can reach the front, back and sides of the instrument when it is in operation. Insure these clearances are met for adequate air flow:

- 4 inches (10 cm) front and rear, and
- 2 inches (5 cm) on each side.

Air enters through the front and side panels. It is forced out the rear panel. See the Outline Drawing at the end of this manual. This power supply should not be operated with its cover removed since the cover directs the flow from the internal fan.

3.3 AC POWER CONNECTION

The customer's AC line connects to the ESS through a terminal strip. It has four SAE #8 screws. Only use a power cable with the correct voltage and current ratings. The recommended wire gauge is listed in this table. The ground wire must be equal to or larger than the recommended gauge.

Output Power (Watt)	Phase	Frequency (Hz)	Input voltage (Vrms)	Max Input Current (Arms)	Recommended Wire AWG	mm^2
2.5 KW	1	47-63	190-253	24	10	5.3

Table 2. Input Power

The AC input rating is marked on the rear terminal of the power supply. The rating is also part of the unit's model number as shown in Table 1.

The Protective Earth Ground ⏚ must be connected before applying AC Line Power to the ESS.

3.4 CONNECTING THE LOAD

The load cables between the ESS outputs and the load must be robust. The terminal connections must be secured tightly. Failure to meet these requirements could cause substantial voltage losses, terminal over-heating, and insulation degradation

3.4.1 Low Voltage Models

For power supplies with *LESS* than 101 volts output rating, the POS and NEG bus bars have single holes for bolting the load cables.

- Hole Diameter: 0.41 Inches (10.3 mm)
- Bolt Size: 3/8 Inch OD (10 mm)

A clear Lexan terminal cover is provided. To attach it, loosen three chassis screws, slide the cover behind them, then tighten the screws. There are large holes are in the sides of the cover so the cable bolts may be accessed with a socket wrench.

3.4.2 High Voltage Models

For power supplies with *MORE* than 101 volts output rating, the POS and NEG outputs are threaded studs. A nut is used to attach the load cables.

- Stud Thread: SAE 1/4-20 NC
- Stud Length: 1 Inch Long (25 mm)
- Max Torque: 40 Inch-Pounds

A clear Lexan terminal cover is provided. To attach it, loosen three chassis screws, slide the cover behind them, then tighten the screws.

3.4.3 Load Connection Guidelines

General guidelines for connecting a load are as follows:

- Each pair of cables should be as short as possible.
- On high output current units, connections should be properly torqued. See the bolt manufacturer's specification.
- A chassis stud is located near the output terminals so a short jumper may be connected between an output bus bar and chassis ground. The system should *NOT* be grounded at more than one point.

  The stud size is SAE 10-32. The nut's maximum torque is 34 inch-pounds.
- If the load cables are long, they should be bundled together. In areas of high electrical noise, they may have to be twisted together.
- Maximize the separation between the AC power lines and the load cables to reduce the radiated and conducted electromagnetic emissions.

Typical cable sizes for load connections are shown below. Use cables that meet requirements for current, voltage, length, temperature and termination.

CURRENT (Amps)	RECOMMENDED COPPER WIRE SIZE	CURRENT (Amps)	RECOMMENDED COPPER WIRE SIZE
200	4/0	30	10
150	2/0	20	12
120	0	15	14
80	4	10	16
60	6	6	18
45	8	LESS	20

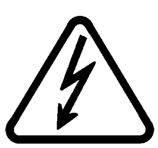
Table 3. Wire Sizes for Load Connection

3.5 INTRODUCING THE J1 PROGRAMMING PLUG

The J1 connector on the back panel is the key to the ESS's versatility. A programming plug must be installed on J1 to enable the power supply. This programming plug may be rewired to make the following features possible:

- Remote Voltage Sensing. See Section 9.
- Remote Programming via voltage, current or resistance. See Section 5.3
- Output Monitor signals for output voltage or current. See Section 6.2
- External Enable and Inhibit. See Section 7.3 and 7.4

The ESS is shipped with the "default" programming plug. It is made from a standard DB-25 connector with male pins, a backshell and four wires. Its wiring is configured for local programming and sensing (see Section 5.2). The connector and backshell are made of plastic to reduce the chance of arcing in high-voltage power supplies.



If a supply has more than 290 volts output, and if its POS bus bar is connected to Chassis Ground, then the J1 plug *backshell must NOT be conductive*.

Using a metallic backshell under these conditions may cause electrical arcing from the pins to the backshell.

Some guidelines on constructing a custom J1 Programming Plug:

- Recommended to use 26 AWG wire with 300 Volt insulation.
- There may be a need to "daisy-chain" two wires into one pin. One method is to crimp or solder wire stubs into the pins and then make a splice at the ends of the stubs. Insulate the splice!
- Passive components such as resistors, capacitors and diodes may be inserted into the backshell for the purpose of scaling, filtering and protecting.

Proper ESD precautions must be taken when taking off the cover and making connection to J1.

3.6 CONNECTING THE IEEE/RS232 INTERFACE

An embedded digital programming card is optional for the ESS. The IEEE-488, RS-232 and Address Switch are accessible through openings in the back panel. If this card is not installed, a blank panel covers the openings.

For details on connector location and pin orientation, see the Outline Drawing at the end of this manual.

For further details on the digital interface, see Lambda EMI document, “User Manual For Embedded IEEE Option”, document number 83-468-007.

Proper ESD precautions must be taken when taking off the cover and making connection to RS-232 and IEEE connectors when used J1.

4. CONTROLS, INDICATORS, CONNECTORS

4.1 FRONT PANEL LAYOUT

For more details, see the Outline Drawing at the end of this manual.

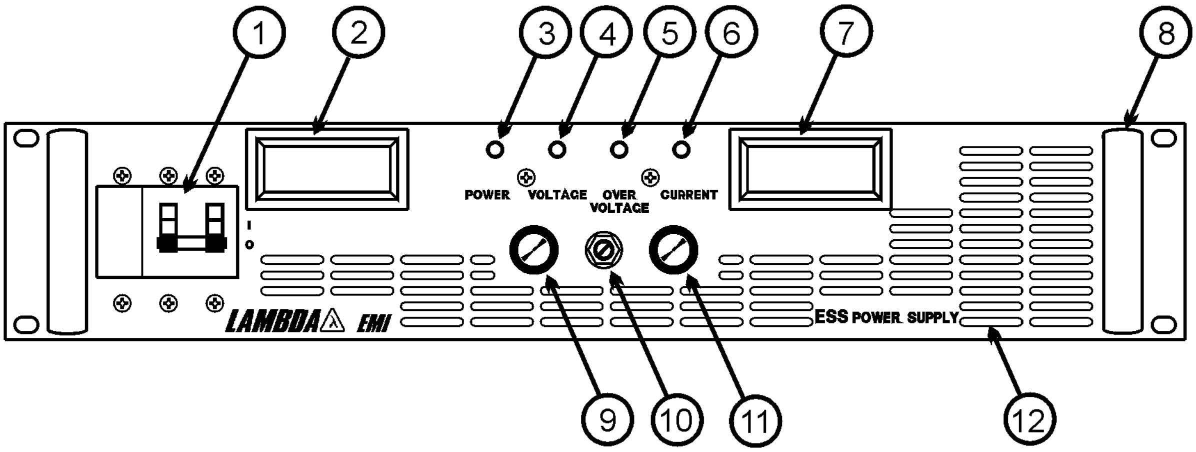


Figure 1. Front Panel Controls and Indicators

REF	DESCRIPTION	NOTE	SECTION
1	Power Switch	Power-On circuit breaker	
2	Voltmeter	Displays output voltage of power supply. 3.5 digits, fixed decimal point, LED display.	6.1
3	Power LED	Illuminates red when AC power switched ON	
4	Voltage Mode LED	Glows amber when supply is in the voltage mode (constant voltage operation).	5.1
5	Over Voltage LED	Glows red when shutdown has occurred because output exceeded the OV trip level.	7.2
6	Current Mode LED	Glows amber when supply is in the current mode (constant current operation).	5.1
7	Ammeter	Displays output current of power supply. 3.5 digits, fixed decimal point, LED display.	6.1
8	Handles	Protective, extends further than knobs	
9	Voltage Control	Adjusts the output voltage from zero to full. Ten turn potentiometer.	5.2
10	Over Volt Adjust	Sets Over-Voltage trip level. Single turn. Recessed slotted potentiometer shaft.	7.2
11	Current Control	Adjusts the output current from zero to full. Ten turn potentiometer.	5.2
12	Ventilation Holes	Located in front, back and sides.	3.2

Table 4. Front Panel Controls and Indicators

4.2 BACK PANEL LAYOUT

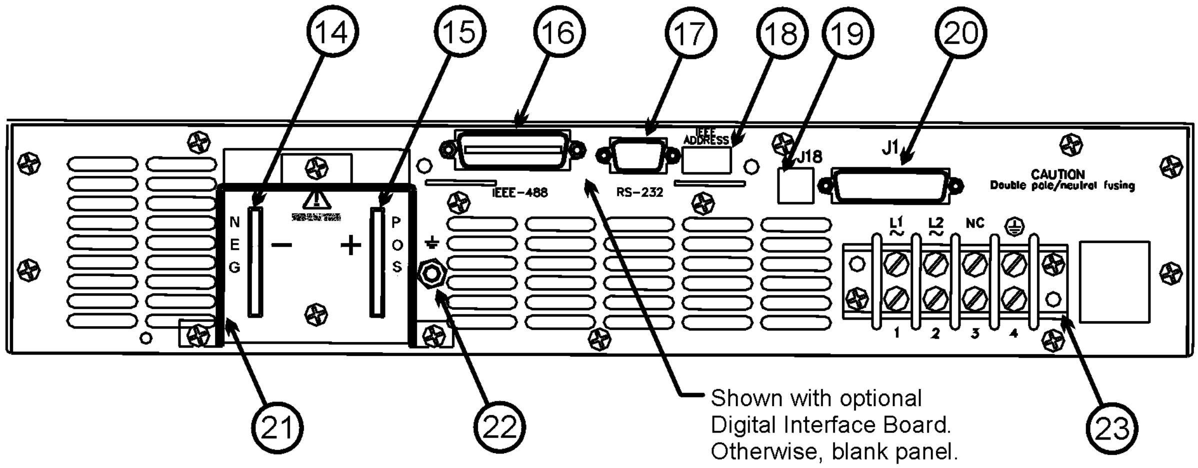
Refer to Figure 2 on Next Page.

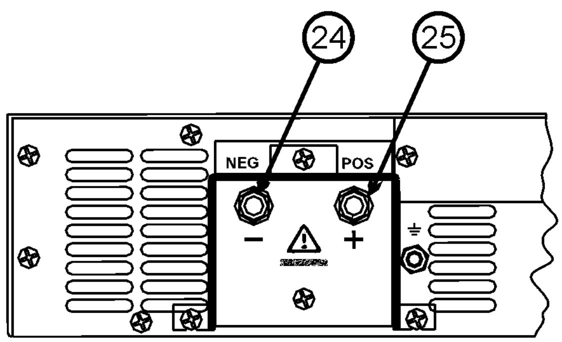
REF NO.	DESCRIPTION	NOTE	SEE SECTION
14	NEG Bus Bar	Negative output on lower voltage models. Is ground reference for J1 Prog Plug signals.	3.4.1
15	POS Bus Bar	Positive output on lower voltage models.	3.4.1
16	IEEE-488 Connector	Digital programming option. Standard 24 pin IEEE-488 connector.	5.4
17	RS-232 Connector	Digital programming option. Standard female DB-9 connector.	5.4
18	IEEE Address	Digital programming option. Six position DIP switch for IEEE programming.	5.4
19	J18 Connector	Positive output sense header, two terminals. Allows Local or Remote voltage sense.	9.1
20	J1 Connector	Analog programming connector. Standard female DB-25 connector.	3.5
21	Terminal Cover	Clear Lexan protective cover. Closed on top and sides.	
22	Chassis Stud	Ground connection for AC Line functional ground. Accepts SAE 10-32 nut.	3.4.3
23	AC Line Input	Terminal strip with safety barriers. Connects AC Power line. Two phases plus neutral.	3.3
24	NEG Output Stud	Negative output on higher voltage models. Is ground reference for J1 Prog Plug signals.	3.4.2
25	POS Output Stud	Positive output on higher voltage models.	3.4.2

Table 5. Back Panel Controls and Connectors

Low-Voltage Models

with outputs
***LESS* than 101 Volts**





High-Voltage Models

with outputs
***MORE* than 101 Volts**

Figure 2. Back Panel Controls and Connectors

4.3 J1 CONNECTOR PIN DIAGRAM

This is a summary of the signals at the J1 Analog Programming connector.

For connector assembly overview, see Section 3.5.

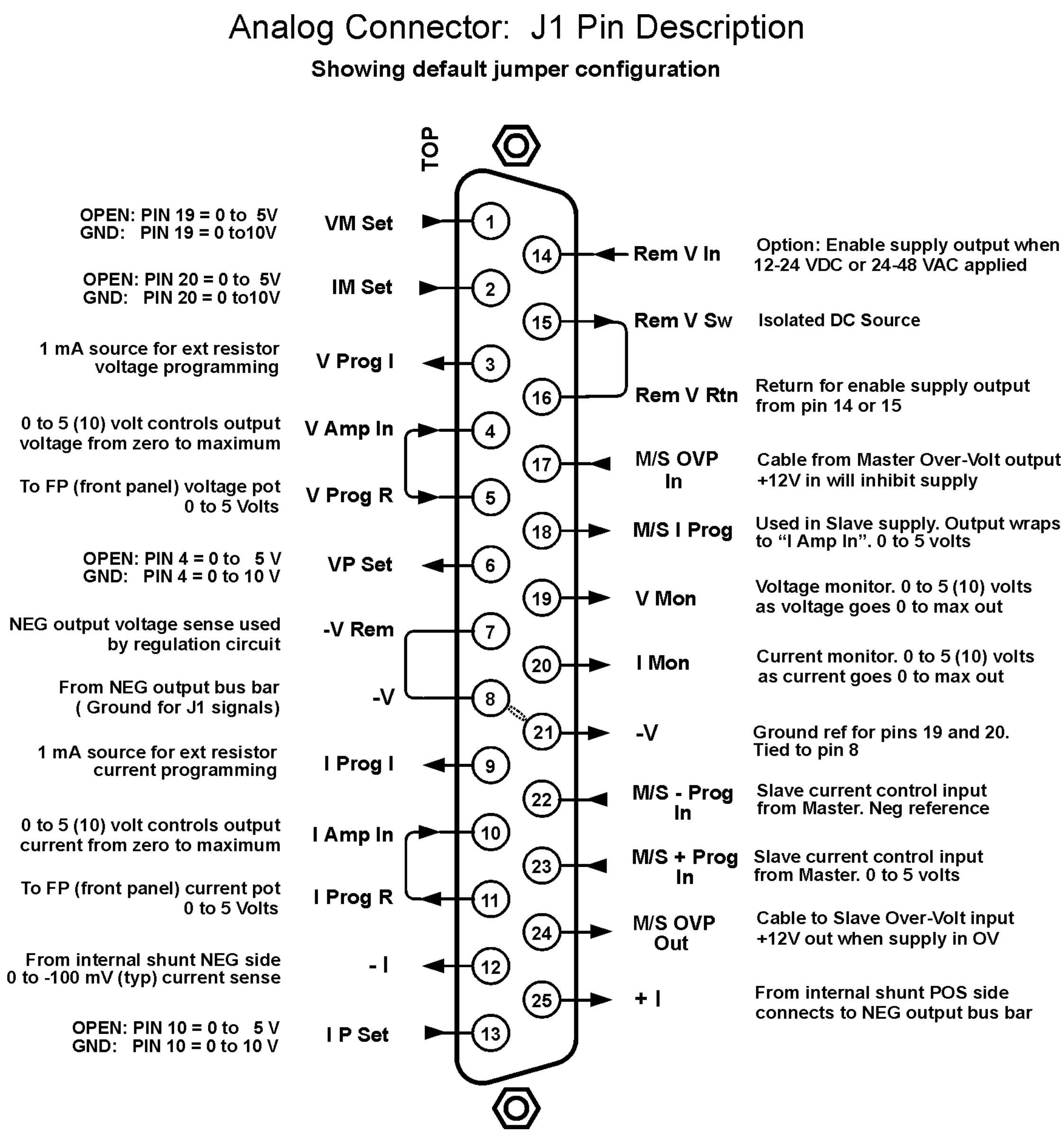


Figure 3. J1: Rear-Panel Programming Connector

5. PROGRAMMING THE OUTPUT

5.1 VOLTAGE MODE AND CURRENT MODE

The voltage and current controls set the boundary limits for the load voltage and current. The relationship between the control settings and the load resistance determines whether the power supply operates in *constant voltage* or *constant current* mode.

5.1.1 Constant Voltage Mode

When the load resistance is high enough, the power supply cannot produce more current without exceeding the supply's programmed voltage setting. Therefore, the supply will constantly adjust its output current so the voltage stays the same. This is the Constant Voltage Mode. It is also known as operating in the Voltage Mode.

The front panel VOLTAGE LED illuminates when the ESS is in this mode.

5.1.2 Constant Current Mode

When the load resistance is low enough, the power supply cannot produce more voltage without exceeding the supply's programmed current setting. Therefore, the supply will constantly adjust its output voltage so the current stays the same. This is the Constant Current Mode. It is also known as operating in the Current Mode.

The front panel CURRENT LED illuminates when the ESS is in this mode.

5.1.3 Crossover Point

The ESS will perform a programming mode *crossover* when there is a change in programmed voltage, programmed current or load resistance. The crossover point is determined by Ohm's law.

The power supply will exit constant voltage, and enter constant current, when the load resistance reduces sufficiently or when the programmed voltage increases sufficiently.

The power supply will exit constant current, and enter constant voltage, when the load resistance increases sufficiently or when the programmed voltage decreases sufficiently.

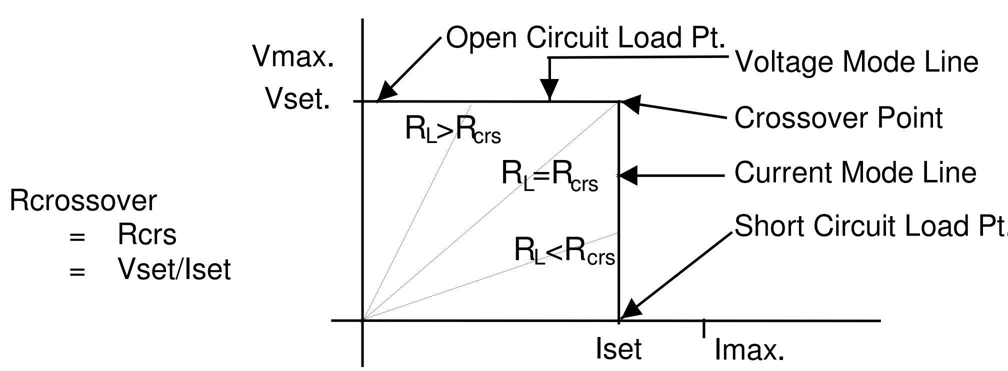


Figure 4. Voltage and Current Mode Crossover

5.2 LOCAL PROGRAMMING USING FRONT PANEL KNOBS

The ESS signals that control the output voltage and current enter at the backpanel J1 connector at pins 4 and 10. In LOCAL programming, the control voltages come directly from the front panel voltage and current potentiometers which are each 5 kilohms. The routing is shown in Figure 3. The potentiometers are each energized by a precision constant voltage source that is *not* accessible to the user.

5.3 ANALOG PROGRAMMING USING THE J1 CONNECTOR

The J1 Programming Plug can be modified by the user for remote Analog Programming. This configuration moves the programming from the front panel knobs to the user's remote programming source. The remote source may deliver any signal from 0 to 5 volts DC (10 volts selectable). This feature may be used along with Remote Voltage Sensing described in Section 9.

If an external Programming Plug is wired for remote voltage or current programming, the corresponding front panel knob will not operate. However, the front panel Over Voltage Potentiometer will always limit the output voltage. The VOLT and CURRENT LEDs will always show the operating mode of the power supply.

The remote source of the programming voltage can be generated in a variety of ways. Any 0 to 5 volt (10 volt selectable) source is acceptable. Some J1 Programming Plug wiring configurations are shown in detail. They are listed in this table.

Voltage Channel Programming	See Section	**Current Channel Programming**	See Section
Using Remote Resistance	8.2	Using Remote Resistance	8.5
Using Remote Voltage	8.3	Using Remote Voltage	8.6
Using Remote Current	8.4	Using Remote Current	8.7

If the J1 programming inputs are miswired, the ESS output may go out of CONTROL.
Damage to the ESS and the user load could occur!

If the programming source (such as a small power supply) has its negative terminal tied to chassis ground (the third prong in a power cord), then the ESS negative Bus Bar will also be tied to chassis ground!

5.3.1 Analog Programming Guidelines

There may be a small reduction in analog programming accuracy because the “programmer output impedance” will divide with the “ESS programming input impedance.” Make the programmer output impedance as low as possible.

The ESS programming input impedance (pins J1-4 and J1-10) is:

- 10 Kilohms for 0 to 5 Volt programming.
- 20 Kilohms for 0 to 10 Volt programming.

Care must be taken in analog programming. In power systems, problems in accuracy and stability can occur. These problems are typically caused by:

- Ground reference offsets between the programming source and the ESS J1 inputs. The source has to be tied closely to the negative Bus Bar of the supply.
- Ground loops generated in the programming lines. Do not make multiple connections between the negative Bus-Bar and the J1 Programming Ground.
- Common mode noise pickup in programming lines. Keep those wires twisted together. Twisted pair with a shield to chassis is better.

5.4 THE IEEE/RS232 PROGRAMMING OPTION

The IEEE-488 and RS-232 digital programming option includes commands for programming the output voltage and the current. There is also a command to set the ESS to Local mode so the front panel knobs may be used. When the digital port is being used, the front panel voltage and current knobs are disabled.

See Specifications Section 12.8.3 for digital programming accuracy. See the “User Manual For Embedded IEEE Option”, document number 83-468-007, for further details.

If the power supply has an IEEE/RS232 Interface card, the card will only work if the voltage and current programming are set to the +5 Volt range (J1-6 and J1-13 are not connected).

6. MEASURING THE OUTPUT

6.1 THE FRONT PANEL DISPLAYS

The ESS voltage and current outputs are continuously measured on two Light Emitting Diode (LED) displays. They have seven-segment red bars on a black background. Their resolution is three-and-a-half digits (000 to 1999). The decimal point is set at the factory and it does not change position.

The front panel voltmeter will always display the voltage between J18-2 and J1-8. In remote voltage sensing applications (see Section 9), the voltmeter shows the voltage at the point being sensed, not the bus bar voltage.

The front panel ammeter will always display the current flowing through the NEG bus bar output. Remote current sensing is not directly possible.

6.2 MEASURING OUTPUT USING THE J1 CONNECTOR

With the rear panel J1 connector, there are four ways to use an external voltmeter to measure the ESS output voltage and/or current.

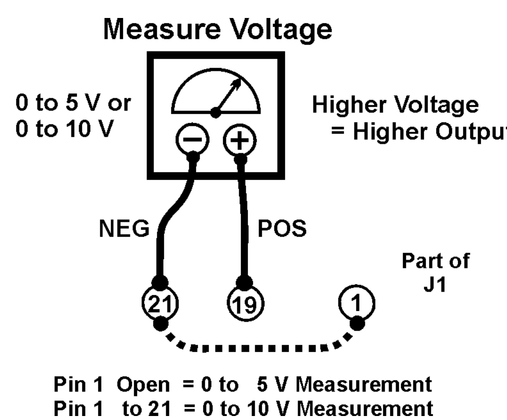
Measure What?	Signal Type	Source Pin	Signal Full Scale	See Section
Output Voltage	Monitor	J1-19	0 to 5 (10) VDC	6.2.1
Output Current	Monitor	J1-20	0 to 5 (10) VDC	6.2.2
Output Voltage	Measure	J18-1	0 to Max Output	6.2.3
Output Current	Measure	J1-12	0 to –0.100 VDC	6.2.4

There are important constrains. Read the "See Sections" carefully!

Table 6. Output Measurement Schemes Using J1

6.2.1 Monitor Output Voltage Using J1

The Voltage Monitor from J1-19 is a calibrated output signal which varies from 0 to 5 volts as the ESS output voltage varies from zero to full rating. The monitor output is useful because it scales high output voltages, reduces noise in the sense line, and because all monitors have the same full scale regardless of the ESS maximum output rating.



The full scale voltage from the Voltage Monitor is user selectable. If J1-1 is open (no wire), full scale is 5 VDC. This is the default setting. If J1-1 is connected to J1-21, full scale is 10 VDC. Monitor ground is at J1-21 or J1-8.

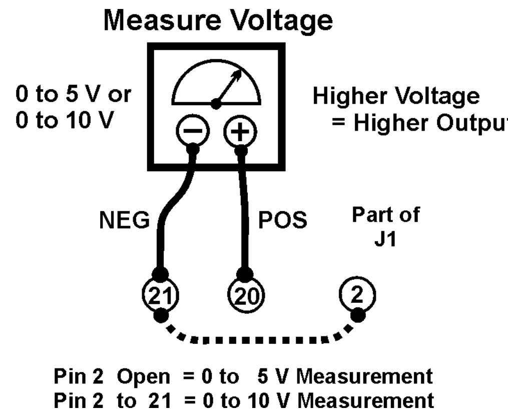
The J1-19 monitor output is *NOT* floating. It is always referenced to the NEG bus bar which is connected to J1-21 and J1-8.

6.2.2 Monitor Output Current Using J1

The Current Monitor from J1-20 is a calibrated output signal which varies from 0 to 5 volts as the ESS output current varies from zero to full rating. The monitor output is useful because it amplifies the small current sense signal, reduces noise in the sense line, and because all monitors have the same full scale regardless of the ESS maximum output rating.

The full scale voltage from the Current Monitor is user selectable. If J1-2 is open (no wire), full scale is 5 VDC. This is the default setting. If J1-2 is connected to J1-21, full scale is 10 VDC. Ground is at J1-21 or J1-8.

The J1-20 monitor output is *NOT* floating. It is always referenced to the NEG bus bar which is connected to J1-21 and J1-8.



6.2.3 Measuring Output Voltage Using J18

J18 is the two-pin connector on the ESS back panel. The voltage at the POS bus bar is passed directly to J18-1. Pin 1 is the one closest to the J1 connector. The output may be measured from this point if it is easier than connecting directly to the bus bar. The voltage is with respect to the NEG bus bar, J1-21 or J1-8.

6.2.4 Measuring Output Current Using J1

The ESS has an internal shunt resistor which is used to measure the actual output current through the NEG bus bar. The signal at both ends of the shunt are passed to the J1-25 and J1-12 terminals. J1-25 is connected to the NEG bus bar, J1-12 is always a lower (negative) voltage.

The signals from J1-12 and J1-25 should NOT be used in customer applications!

The outputs are for test purposes only. The internal shunt is located upstream of the ESS output capacitors. It has a large sawtooth waveform with a frequency of about 70 kilohertz and up to 400 millivolt peaks. Because of the wave shape and high common mode noise, external voltmeters tend to give incorrect readings.

To measure output current, the customer may choose to measure across an external shunt resistor or use the current monitor output (Section 6.2.2).

6.3 THE IEEE/RS232 MEASURING OPTION

The digital programming option includes commands to remotely measure the output voltage and the current. See Specification Section 11 for digital measuring accuracy. See the Lambda EMI document, “User Manual For Embedded IEEE Option”, document number 83-468-007, for further details.

7. PROTECTIVE SHUTDOWN

7.1 THE SHUTDOWN CONDITION

There are several events, either intentional or accidental, which will cause the ESS to “shut down” its output. During a shutdown, the output power FETs are turned off. After a shutdown, the output rectifier diode will prevent the charge from a capacitive load from flowing into the POS bus bar, but it will allow current from an inductive load to freewheel into the NEG bus bar.

Recovery from a shut down event varies with the cause of event.

7.2 FRONT PANEL OVER-VOLTAGE PROTECTION (OVP)

The ESS comes standard with a user settable Over-Voltage Protection (OVP) feature. It is used to protect the user’s load by shutting down the ESS if its output voltage goes too high. The ESS voltage could go too high if:

- An operator adjusts the ESS front panel knobs too high.
- There is a miswired or a damaged remote programming or sensing line.
- A current-regulated load opens up and the voltage shoots up.
- An ESS internal malfunction causes the output voltage to run away.

The OVP circuit is internally connected across the output bus bars. It is set by turning a front panel potentiometer. The potentiometer has a recessed slotted shaft. It is one turn from end to end.

When the OVP is rotated fully clockwise (maximum), the OVP trip point is approximately 120% of full output voltage. This is the factory default setting.

When the front panel OVP shaft is turned fully counter-clockwise (zero), an OVP shutdown will occur as soon as the ESS is switched on.

7.2.1 How to Adjust the OVP Trip Level

A. Turn off the ESS power. If load can be damaged by applying the maximum voltage, wait 20 seconds for safe power drain and then disconnect the load from the ESS output bus bars.

B. Rotate the front panel OVP full clockwise (upward).

C. Switch power ON. Rotate front panel volt and current knobs until the ESS output voltage equals the level where you want the OVP to trip.

D. Slowly rotate the front panel OVP counter-clockwise (downward).

E. When the OVP has been turned down far enough, the ESS will shut down. At this moment, the OVP trip level will be correctly set.

F. *TURN OFF* THE ESS POWER TO RESET the over-voltage condition.

7.2.2 Recovering From an OVP Shut Down

When a shut down event occurs, the ESS will inhibit is output. This is equivalent to programming the voltage and current to zero. A front panel “OVER VOLTAGE” red LED will illuminate.

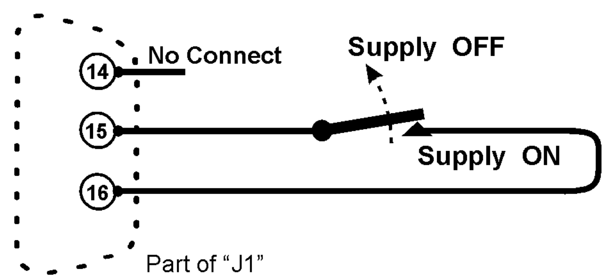
The only way to reset an OVP shut down is to switch the ESS power OFF. It is important to find the cause of this event and correct it before switching the power back ON.

7.2.3 Crowbar (Fast Discharge)

When an over-voltage shutdown occurs, an internal resistor will be switched between the output bus bars to discharge the ESS output and bring the output voltage to zero. The value of the resistor varies with the supply’s voltage rating, but they are rated at 10 Watts and they can be damaged if they have to discharge a large load during an over-voltage event.

7.3 REMOTE INHIBIT USING J1 (OPEN CONTACT)

By default, the ESS will remain shut down if the J1 Programming Plug is not attached. The plug is sensed via a jumper between J1-15 and J1-16. This arrangement is very useful in customer applications for safety and process synchronizing. Typically, a cable from J1-15 and J1-16 is run to a remote switch. The ESS will shut down if a door switch is opened, a product traverses a sensor, or an automation controller opens a switch.

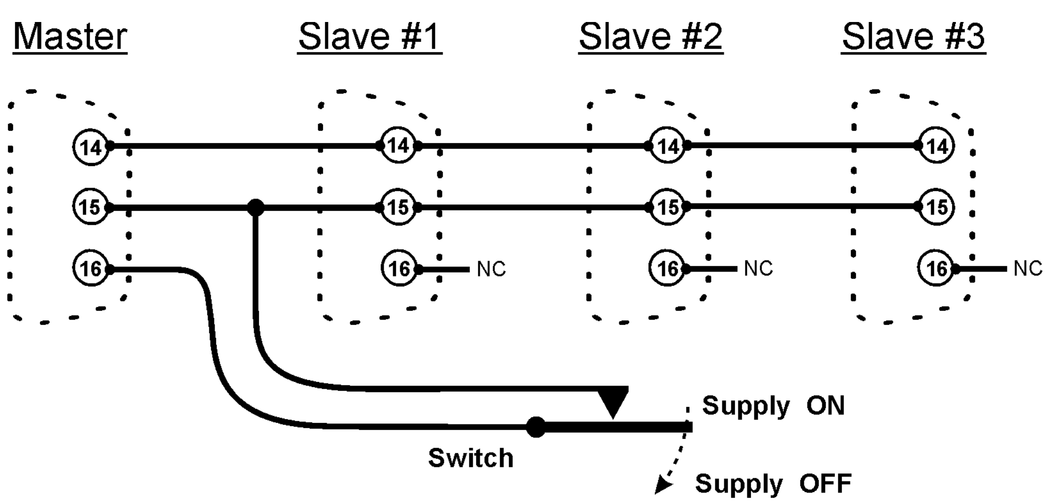


If an open contact inhibits the supply, its output will go to zero volts. The front panel will not indicate an error. When the contact closes again, the ESS will automatically return to its programmed output level.

When using J1-15 and J1-16, remote enable pin J1-14 must NOT *be used.*

J1-15 is a 15 volt, 1 amp isolated DC source. Neither it nor J1-16 needs to be grounded.

7.3.1 Remote Inhibit With Multiple Supplies



The interlock feature, described above for a single supply, may also be used with multiple supplies. The supplies may be connected in parallel, they may be programmed as Master and Slaves, or they may also be entirely independent. In any configuration, when the switch is opened, all supplies will shut down simultaneously.

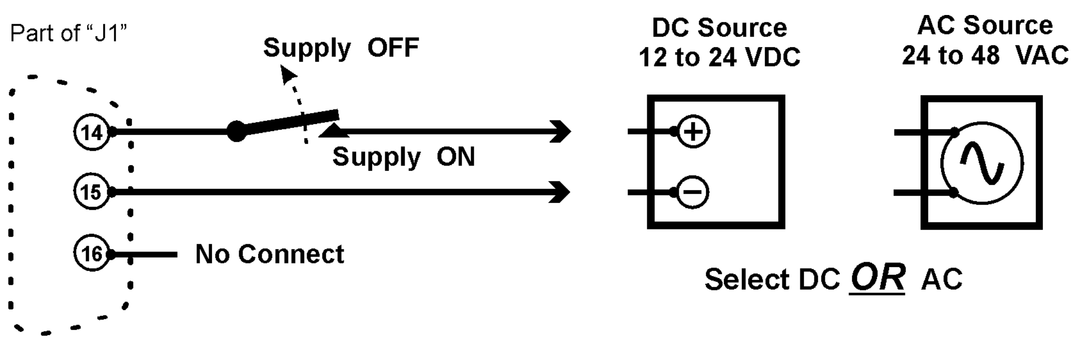
7.4 REMOTE ENABLE USING J1 (DC AND AC)

The ESS output may be turned ON and OFF by applying and removing and external voltage source between J1-14 and J1-15. The voltage source may be:

- 12 to 24 Volts DC or,
- 24 to 48 Volts AC, 60 Hz or faster.

See warning below.

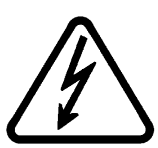
In the DC mode, pin J1-14 must be POS and J1-15 is NEG. The input impedance is 4.5 kilohms, so at 24 volts, the required current is 6 milliamps.



If the external voltage source is removed (OPENED or SHORTED), the ESS output will go to zero volts. The front panel will not indicate an error. When the source energizes again, the ESS will automatically return to its programmed output level.

When using J1-14 and J1-15, remote inhibit pin J1-16 must NOT *be used.*

J1-14 and J1-15 are isolated inputs. Neither pin needs to be grounded. For special applications, such as higher voltage enable signals, call Lambda EMI Customer Service.



On supplies with more than 290 volts output, if the positive output is tied to chassis ground, then the Enable signal to *J1-15 AND J1-16 MUST BE SUPPLIED* by a source that is isolated from the AC power mains.

7.5 OVER-TEMPERATURE SHUTDOWN

At higher power levels, the power switches inside the ESS will get hot. A thermal switch will cause an Over-Temperature Shutdown if they get hotter than 185°F (85°C).

If a over-temperature shutdown occurs, the ESS output will go to zero volts. The front panel will not indicate an error. The cooling fan will continue to blow. When the heatsink cools down sufficiently, the ESS will automatically return to its programmed output level.

If a shutdown due to over-temperature occurs, look for these corrective actions:

- Verify there is sufficient cool air circulating in the rack in which the ESS is installed.
- Check if the heatsink is clogged with dust. Gently blow air through the ESS vents.

7.6 LOW-LINE AC POWER SHUTDOWN

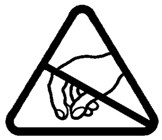
Problems with the AC power line include normal “brownout” conditions where the input drops below what is required by the ESS. When the power input gets too low, the ESS will perform a Low-Line Shutdown.

If a low-line shutdown occurs, the ESS output will go to zero volts. The front panel will not indicate an error. The cooling fan will continue to blow. When the AC input returns to normal, the ESS will automatically return to its programmed output level.

7.7 THE IEEE/RS232 PROTECTION OPTION

The digital programming option provides user settable over-voltage and over-current monitoring and shutdown. It also has settable programming limits and output inhibit commands. See the Lambda EMI document, “User Manual For Embedded IEEE Option”, document number 83-468-007, for further details.

8. PROGRAMMING WITH J1: WIRING DIAGRAMS



The J1 programming circuits may be damaged by Electrostatic Discharge (ESD). Follow proper ESD procedures before touching any wire connected to J1.

This section shows three voltage and three current programming methods. Any one voltage method may be combined with any one current method. In addition, the programming plug may be wired for voltage and current monitoring (Section 6.2). Also, these methods may be used in conjunction with remote voltage sensing (Section 9).

8.1 WIRING J1: LOCAL PROGRAMMING

When shipped from the factory, the J1 and J18 Programming Plugs are configured for:

- Local (front panel knob) programming of voltage and current.
- Local (internally from the bus bars) sensing of output voltage.
- Output monitoring set to 5 VDC full scale (Section 6.2)

The default J1 jumper configuration is:

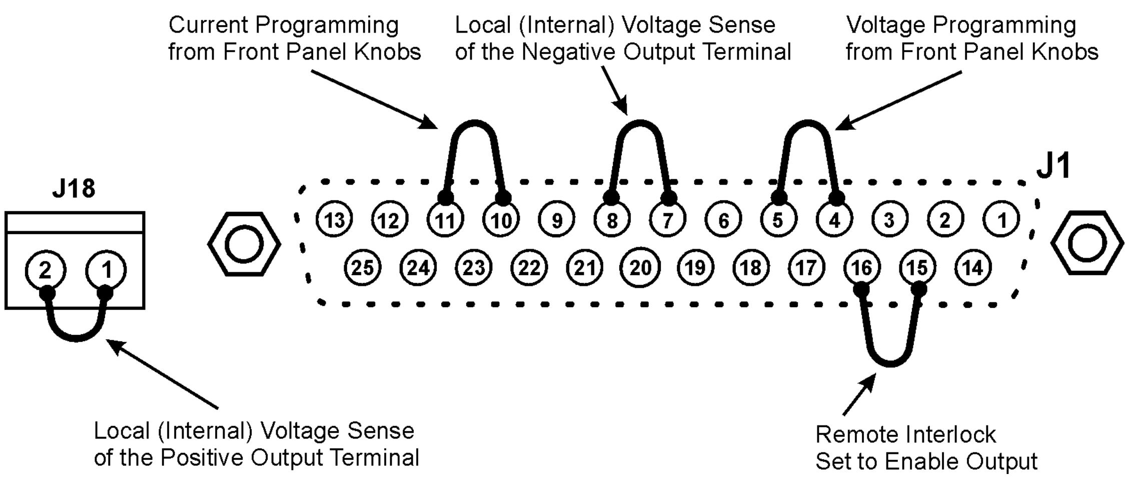


Figure 5. Wiring J1: Basic Programming Plug

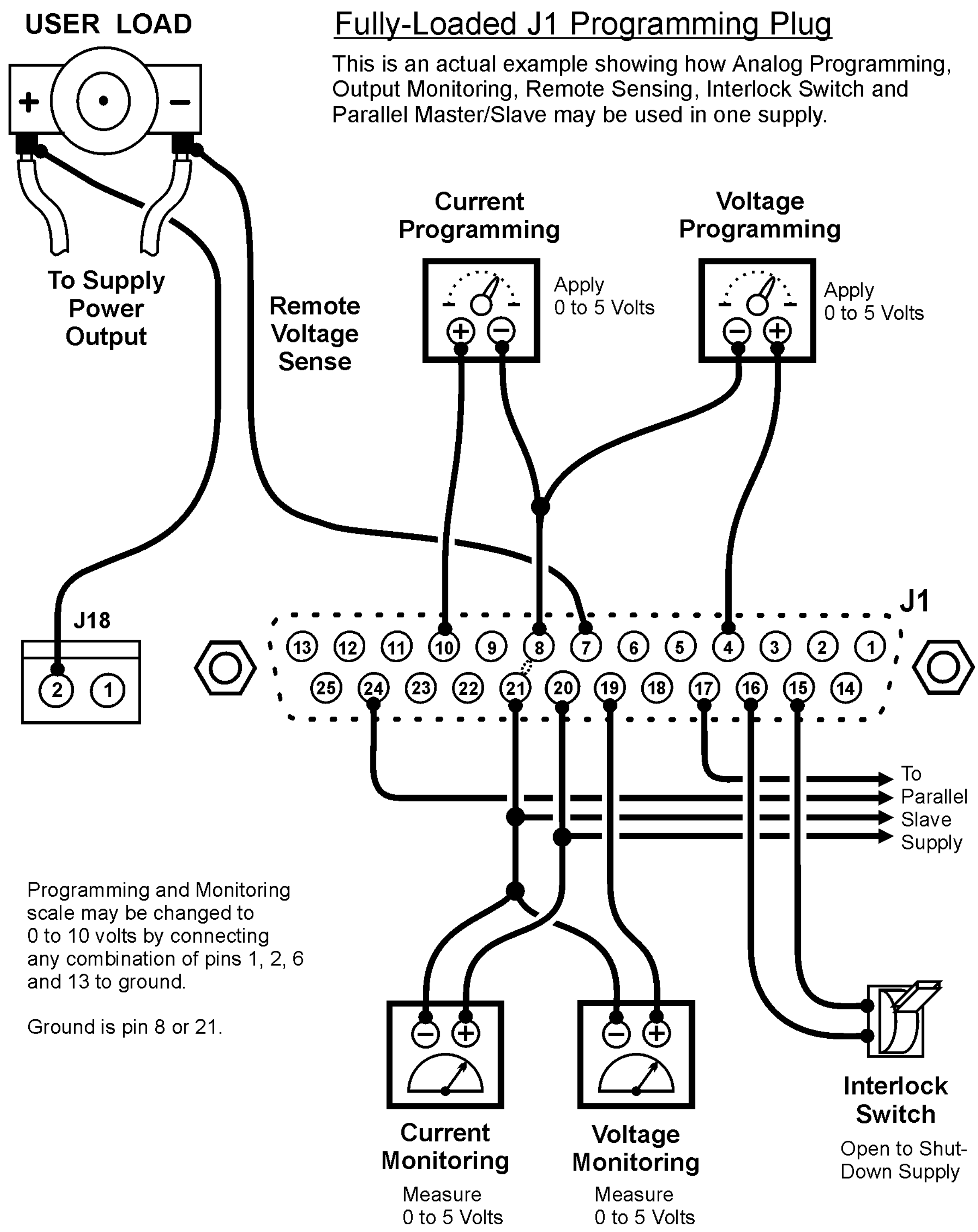
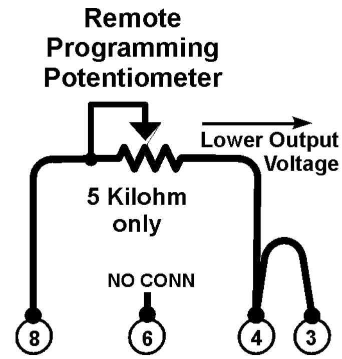


Figure 6. Wiring J1: Fully-Loaded Programming Plug

8.2 WIRING J1: PROGRAM VOLTAGE USING REMOTE RESISTANCE

A user-supplied resistance from 0 to 5 Kilohms can be used to program the ESS output from zero to maximum voltage. The programming is done by applying a 0 to 5 volt control signal to J1-4. The 1 milliamp constant-current source from J1-3 is routed to the remote potentiometer. The current source will work for 5 volt programming only, not 10 volt, so keep J1-6 disconnected.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-4 and J1-5 and add the circuit shown at right.



In this configuration, the front panel voltage knob is disabled. However, the current knob will still operate. Typically, the current knob is set fully clockwise to maximum to ensure the supply remains in voltage mode. The current knob may be turned down to protect the load.

There is an internal ten megohm pull-down resistor at the J1-4 input. If the J1-4 programming line is disconnected, the ESS output will slowly drop to zero volts.

The output of the supply may also be set to a fixed voltage by using a fixed resistor which is calculated from:

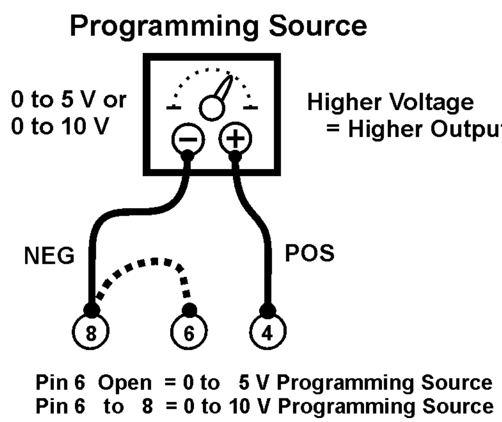
Resistance = (Desired Voltage ÷ Maximum Output Voltage) ***X*** *5 (kilohms)*

The current source from J1-3 is nominally 1 milliamp but may vary by $\pm$0.01 milliamp.

8.3 WIRING J1: PROGRAM VOLTAGE USING REMOTE VOLTAGE

The ESS output voltage can be remotely programmed by applying a 0 to 5 (or 10) volt control signal to J1-4. As the control voltage increases, the ESS output voltage will increase. The control NEG lead must always go to J1-8 which is internally tied to the negative bus bar output.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-4 and J1-5 and add the circuit shown.



The maximum voltage from the programming source is either 5 volts or 10 volts. If J1-6 is left open, the ESS is in the 5 volt programming mode. If J1-6 is grounded to J1-8 or to J1-21, it is in the 10 volt mode.

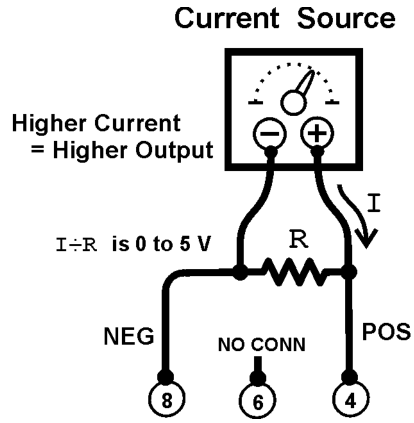
In the 5 volt programming mode, the J1-4 input impedance is ten megohms to the J1-8 return. In the 10 volt programming mode, the impedance is twenty kilohms. If the J1-4 input is disconnected, the ESS output will drop to zero volts.

In this configuration, the front panel voltage knob is disabled. However, the current knob will still operate. Typically, the current knob is set fully clockwise to maximum to ensure the supply remains in voltage mode. The current knob may be turned down to protect the load.

8.4 WIRING J1: PROGRAM VOLTAGE USING REMOTE CURRENT

A user supplied variable current may be used to control the ESS output voltage. The controlling current must be converted to a controlling voltage by applying an external resistance. The input at J1-4 has a ten megohm impedance. If the programming line is disconnected, the ESS output will drop to zero volts.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-4 and J1-5 and add the circuit shown at right.



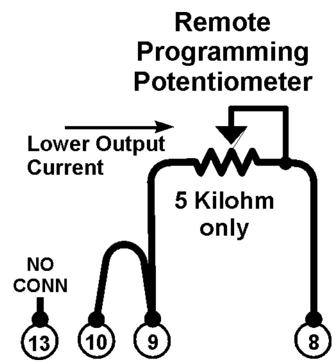
In this configuration, the front panel voltage knob is disabled. However, the current knob will still operate. Typically, the current knob is set fully clockwise to maximum to ensure the supply remains in voltage mode. The current knob may be turned down to protect the load.

The circuit may be modified for use with different currents and resistors. Select them so that at maximum programming current, the voltage across the resistor is 5 volts.

8.5 WIRING J1: PROGRAM CURRENT USING REMOTE RESISTANCE

A user supplied resistance from 0 to 5 Kilohms can be used to program the ESS output from zero to maximum current. The programming is done by applying a 0 to 5 volt control signal to J1-10. The 1 milliamp constant-current source from J1-9 is routed to the remote potentiometer. The current source will work for 5 volt programming only, not for 10 volt, so keep J1-13 disconnected.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-10 and J1-11 and add the circuit shown at right.



In this configuration, the front panel current knob is disabled. However, the voltage knob will still operate. Typically, the voltage knob is set fully clockwise to maximum to ensure the supply remains in current mode. The voltage knob may be turned down to protect the load.

There is an internal ten megohm pull-down resistor at the J1-10 input. If the J1-10 programming line is disconnected, the ESS output will drop to zero amps.

The output of the supply may also be set to a fixed current by using a fixed resistor which is calculated from:

Resistance = (Desired Current ÷ Maximum Output Current) ***X*** *5 (kilohms)*

The current source from J1-9 is nominally 1 milliamp but may vary by ±0.01 milliamp.

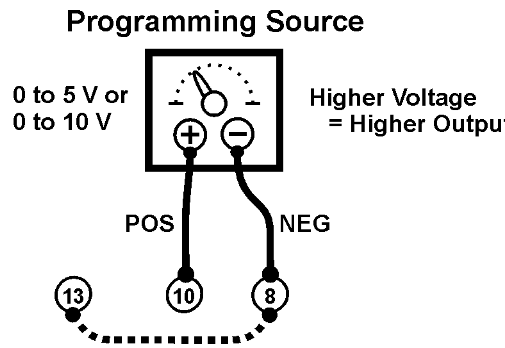
8.6 WIRING J1: PROGRAM CURRENT USING REMOTE VOLTAGE

The ESS output current can be remotely programmed by applying a 0 to 5 (or 10) volt control signal to J1-10. As the control voltage increases, the ESS output current will increase. The control NEG lead must always go to J1-8 which is internally tied to the negative bus bar output.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-10 and J1-11 and add the circuit shown.

The maximum voltage at J1-10 is either 5 volts or 10 volts. If J1-13 is left open, the ESS is in the 5 volt programming mode. If J1-13 is grounded to J1-8 or to J1-21, it is in the 10 volt mode.

In the 5 volt programming mode, the J1-10 input impedance is ten megohm to the J1-8 return. In the 10 Volt programming mode, the impedance is twenty kilohms. If the J1-10 input is disconnected, the ESS output will drop to zero amps.



In this configuration, the front panel current knob is disabled. However, the voltage knob will still operate. Typically, the voltage knob is set fully clockwise to maximum to ensure the supply remains in current mode. The voltage knob may be turned down to protect the load.

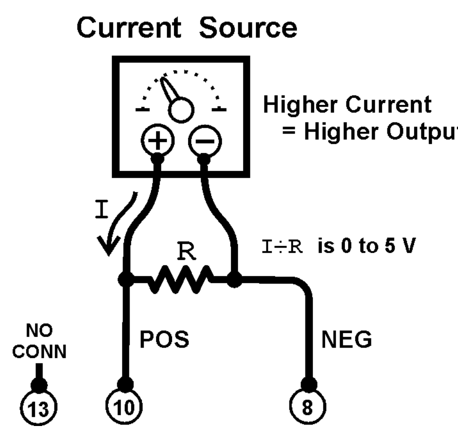
8.7 WIRING J1: PROGRAM CURRENT USING REMOTE CURRENT

A user supplied variable current may be used to control the ESS output current. The controlling current must be converted to a voltage by applying an external resistance. The input at J1-10 has a ten megohm impedance. If the programming line is disconnected, the ESS output will drop to zero amps.

To install this feature, start with the basic wiring shown in Figure 5. Remove the jumper between J1-10 and J1-11 and add the circuit shown at right.

In this configuration, the front panel current knob is disabled. However, the voltage knob will still operate. Typically, the voltage knob is set fully clockwise to maximum to ensure the supply remains in current mode. The voltage knob may be turned down to protect the load.

The circuit may be modified for use with different currents and resistors. Select them so that at maximum programming current, the voltage across the resistor is 5 volts.



9. REMOTE VOLTAGE SENSING

During normal operation, the ESS senses the output voltage at its POS bus bar. However, the voltage at the user's load will be somewhat less because the load cables and connections cause voltage drops. Where high accuracy is required, the ESS may be configured for remote sensing. In this mode, the voltage at the ESS bus bars will be higher than what the ESS is programmed to but the voltage at the load will be correct.

Since the front panel voltmeter is internally connected to the sensing terminals, it will display the voltage at the sense lines, not the power supply output bus bar voltage.

If the remote sensing lines are disconnected, the ESS will continue to operate normally. However, there will be a small loss of output accuracy. The ESS output voltage or current will increase by a few percent. However, the measurement circuits, including the front panel displays, will accurately show the change in output voltage and current.

If the sense inputs are miswired, the ESS output may immediately go above its maximum output rating with NO CONTROL! Damage to the ESS and user load is likely to occur!

9.1 CONNECTING THE REMOTE VOLTAGE SENSE LINES

9.1.1 Positive Sense Lead

The connector which mates to J18 is made by Amp, part 640429-2.

The output POS bus bar is internally connected to the backpanel J18-1 pin. An external jumper loop connects this to J18-2 where the ESS control reads the output voltage. Remote sensing is done by connecting a wire from the distant load to the J18-2 input. The loop from J18-1 to J18-2 must be removed. There is an internal 100 ohm resistor from J18-1 to J18-2 to maintain control if the sense wire is disconnected.

9.1.2 Negative Sense Lead

The output NEG bus bar is internally connected to the backpanel J1-8 pin. An external jumper loop connects this to J1-7 where the ESS control reads the output voltage. Remote sensing is done by connecting a wire from the distant load to the J1-7 input. The loop from J1-7 to J1-8 must be removed. There is an internal 100 ohm resistor from J1-8 to J1-7 to maintain control if the sense wire is disconnected.

9.2 ACCURACY AND REMOTE SENSING

The sense lines should reach as close to the load as possible. Supply output accuracy may be improved if the sense cables have equal length and gauge.

Noise picked up in the sense cable may reduce the output accuracy. For normal applications, use twisted-pair wire. For long cables in noisy environments, use a shielded cable. Terminate the shield, only on one end, to an ESS chassis screw or to the load chassis.

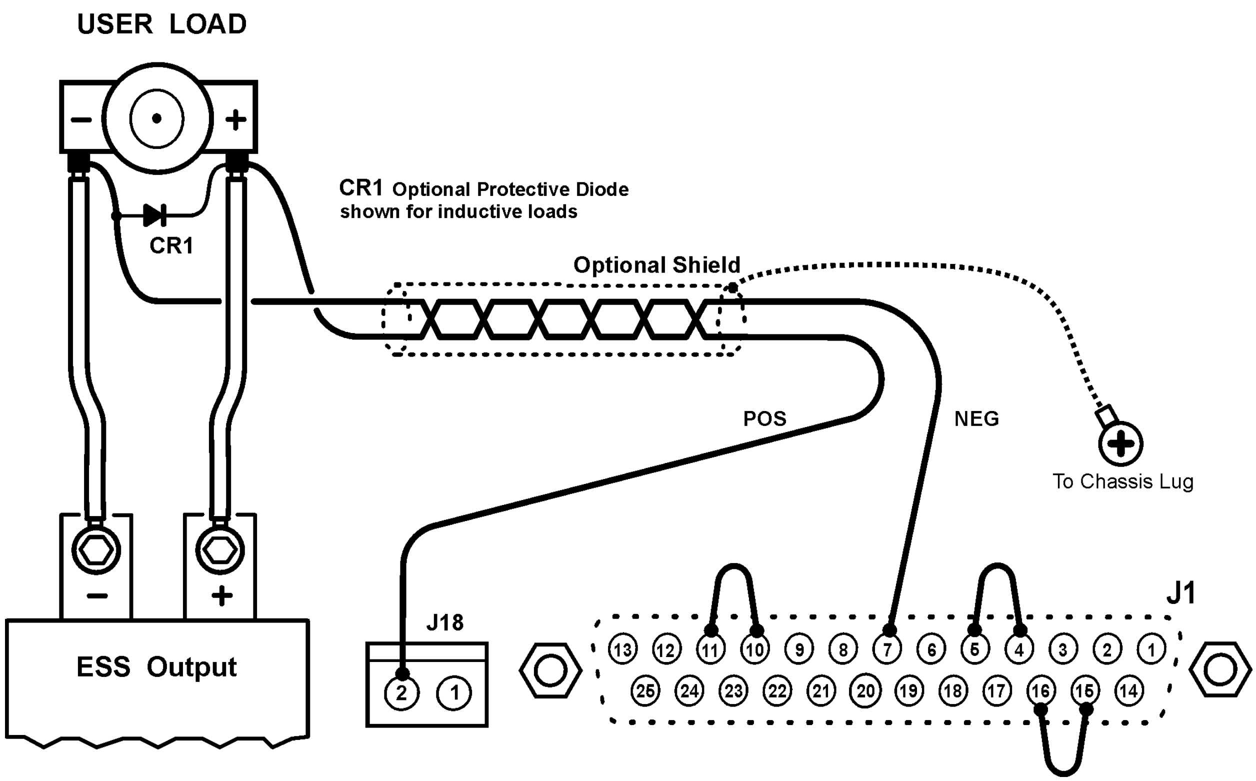


Figure 7. Remote Voltage Sensing Diagram

10. CONNECTING MULTIPLE SUPPLIES

10.1 PARALLEL OPERATION

When the customer requires more current than can be delivered by one power supply, up to four supplies may be paralleled. In this configuration, all the ESS positive outputs are connected to the load positive input, and all the ESS negative outputs are connected to the load negative input.

With parallel supplies, the voltage to the load is what is displayed by each supply, but the current into the load is the *sum* of the currents from each supply.

With parallel supplies, all supplies must have the same Maximum Voltage Rating.

If a low voltage supply is subjected to higher voltage from another supply, the lower voltage supply may be damaged!

10.1.1 Parallel Operation, Local Mode

In the Local configuration, each supply is separately adjusted by using its front panel voltage and current knobs. When first setting up parallel supplies, make sure all the knobs are turned counter-clockwise to zero. Slowly turn the knobs upward. You will see the supplies switching between voltage mode and current mode as each supply provides more or less current than its partners. Once they are adjusted, the supplies may be switched OFF and ON in any sequence.

In applications where it is difficult to adjust all the supplies, it is recommended that the Master/Slave configuration is used. This is described in the next section.

10.1.2 Fault Protection for Parallel Supplies

In parallel operation, the Over-Voltage Protection (OVP) must be DISABLED in the supplies *OR* the cable connections described here must be implemented.

In all ESS supplies, there is a Crowbar (Fast Discharge) resistor that connects between the output bus bars when an over-voltage shutdown occurs. This resistor is *NOT* rated for continuous operation. If a paralleled supply goes into OVP shutdown, the power from the still running supplies will burn out the resistor. Therefore, disable the OVP in every supply by turning their front panel OVP pots up fully clockwise.

Alternately, there is a Master/Slave Fault Detection feature that is available through the J1 programming plug. Construct a cable that connects:

- Daisy-chain all J1-17 pins from each supply together.
- And daisy-chain all J1-24 pins from each supply together.

If one supply shuts down because of over-voltage, over-temperature, or low-line then all the supplies will shut down simultaneously.

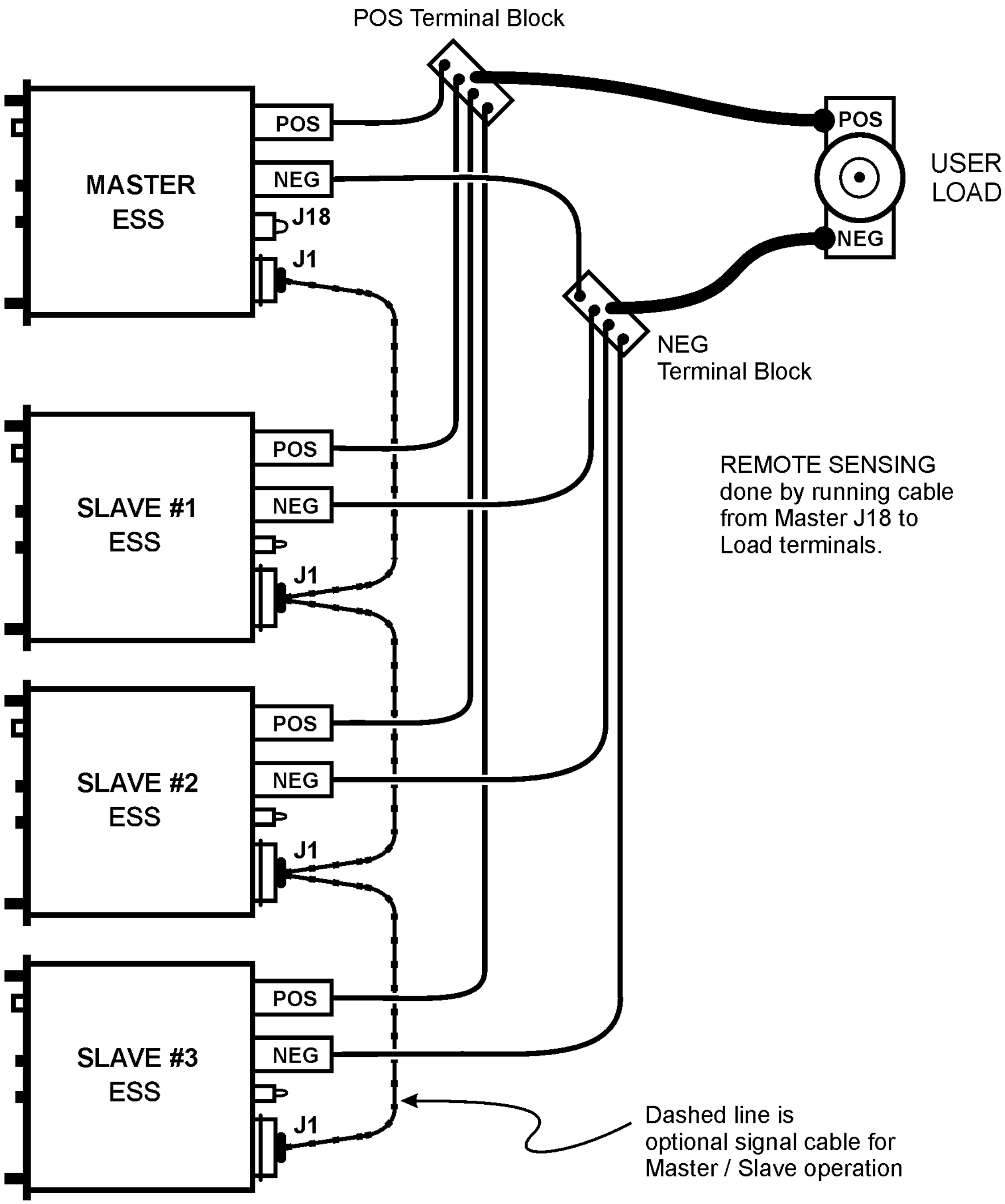


Figure 8. Connecting Parallel Supplies,

10.2 PARALLEL OPERATION, MASTER/SLAVE

The ESS has a special set of functions built into its programming plug so one Master Supply will accurately control up to three Slave supplies. All four supplies will always have the same current output. The interlock shut-down feature may also be used so if any one supply detects a fault, all the supplies will turn off together.

To use the Master/Slave function, all supplies must have the same maximum voltage and current rating.

In this configuration, the Master current-monitor output is cabled to a differential amplifier in each Slave. The amplifier output is then jumpered to the Slave's current programming input. The Master may be programmed in the voltage mode or the current mode. It may be programmed locally (front panel) or remotely (see Section 5.3). The Slaves will always follow equally.

When the Master/Slave setup is complete, the Slave's voltage knobs should be set clockwise to full voltage to ensure they stay in current mode. The Slave's current knobs will be disabled.

Each supply should display the same voltage as is the voltage seen by the load, but the current into the load is the *SUM* of all the currents. Once they are adjusted, the Master and Slaves may be switched OFF and ON in any sequence.

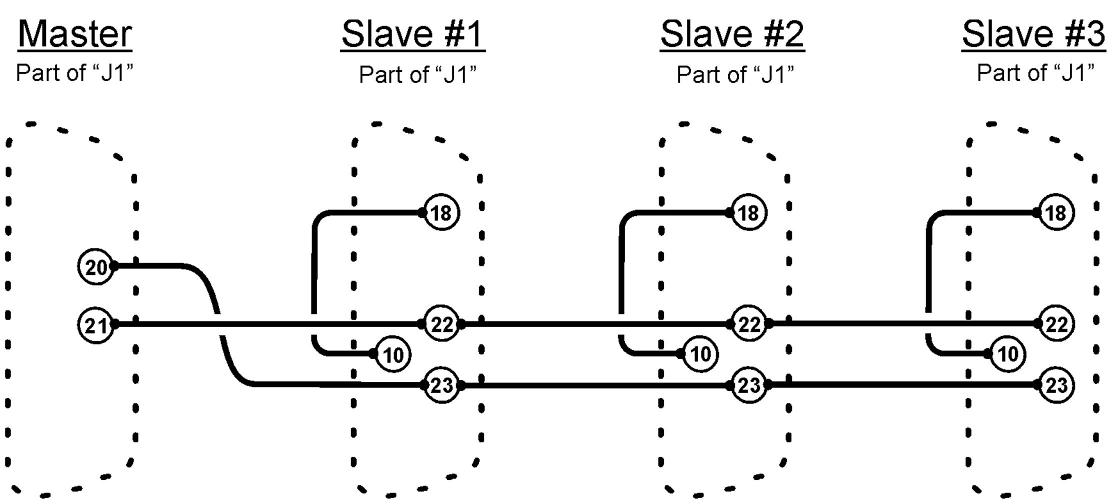


Figure 9. Parallel Master/Slave Control Cable

10.3 SERIES OPERATION

When the customer requires a regulated voltage that is higher than can be delivered from one power supply, two supplies may be connected in series. This configuration connects the negative output terminal of one to the positive output terminal of the other.

When supplies are connected in series, the current to the load is what is displayed by either supply, but the voltage to the load is the *sum* of the voltages from each supply.

With series supplies, all supplies must have the same Maximum Current Rating.

If a low current supply is subjected to higher current from another supply, the lower current supply may be damaged!

In the Local configuration, each supply is separately adjusted by using its front panel voltage and current knobs. When first setting up the supplies, make sure all the knobs are turned counter-clockwise to zero. Slowly turn the knobs upward. You will see the supplies switching between voltage mode and current mode as each supply provides more or less current than its partner.

For applications where it is difficult to adjust all the supplies, it is recommended that the Master/Slave configuration is used. This is described in the next Section.

The combined output may NOT exceed ± 600 volts with respect to chassis ground of either supply.

When a pair of supplies is connected in series, the top supply's J1 Programming connector, and all of its signals, are raised to a high offset voltage by the bottom supply. Connecting a ground or a ground-referenced voltage to the top J1 may damage the supply. In a series configuration, do *NOT* connect any J1 signals from one supply to the other.

The Over-Voltage Protection feature will not protect the load from an overvoltage, but no damage will be done to either power supply if one of them goes into a fault shutdown.

Once they are adjusted, the supplies may be switched OFF and ON in any sequence.

10.4 SERIES OPERATION, MASTER/SLAVE

The Local mode of series supplies, described above, may be sufficient for many applications. However, use the Master/Slave configuration to get easier control and equal voltage sharing. In this configuration, the resistor divided voltage from the Master POS bus bar output is connected to the Slave's voltage-programming input. When the voltage is set on the Master's front panel knob, the Slave's voltage output will automatically adjust equally. The Slave's front panel current knob is typically set clockwise to maximum so the Slave stays in voltage mode.

These are some guidelines for constructing a Series Master/Slave system:

1. Use the wiring diagram shown in Figure 10. The output from the Master J18-1 is divided by two user-supplied resistors. The divided voltage should be 5 volts with respect to the Slave ground when the Master and Slave are at their maximum voltages. This voltage is fed into the Slave voltage programming input at J1-4.

   A simple way to select the resistors is to set the TOP resistor to 5 kilohms and use this formula to calculate the BOTTOM resistor:

   R_{TOP} = 5 Kilohms

   R_{BOT} = ("Master Max Volt" **+** "Slave Max Volt" **-** 5) Kilohms

   For example, if a 100 volt Master is put in series with a 300 volt Slave, then use:
   R_{TOP} = 395 Kilohms and R_{BOT} = 5 Kilohms
2. The Master may be set up for remote voltage programming (Section 8.3) *only* if the programming source is differential (fully isolated from ground) and this source is capable of voltage offsets greater than the slave maximum voltage. The IEEE/RS232 programming option works with no restriction.
3. Remote voltage sensing *cannot* be done with series supplies.
4. If the voltage knob on the Slave is *not* fully up clockwise, the Slave will output less voltage as the Master voltage is adjusted.

When the Master/Slave setup is complete, the Slave voltage and current knobs should be set full clockwise. The voltage or current to the load can be regulated by adjusting the voltage and current knobs on the Master supply. When the Master voltage changes, the Slave voltage will follow.

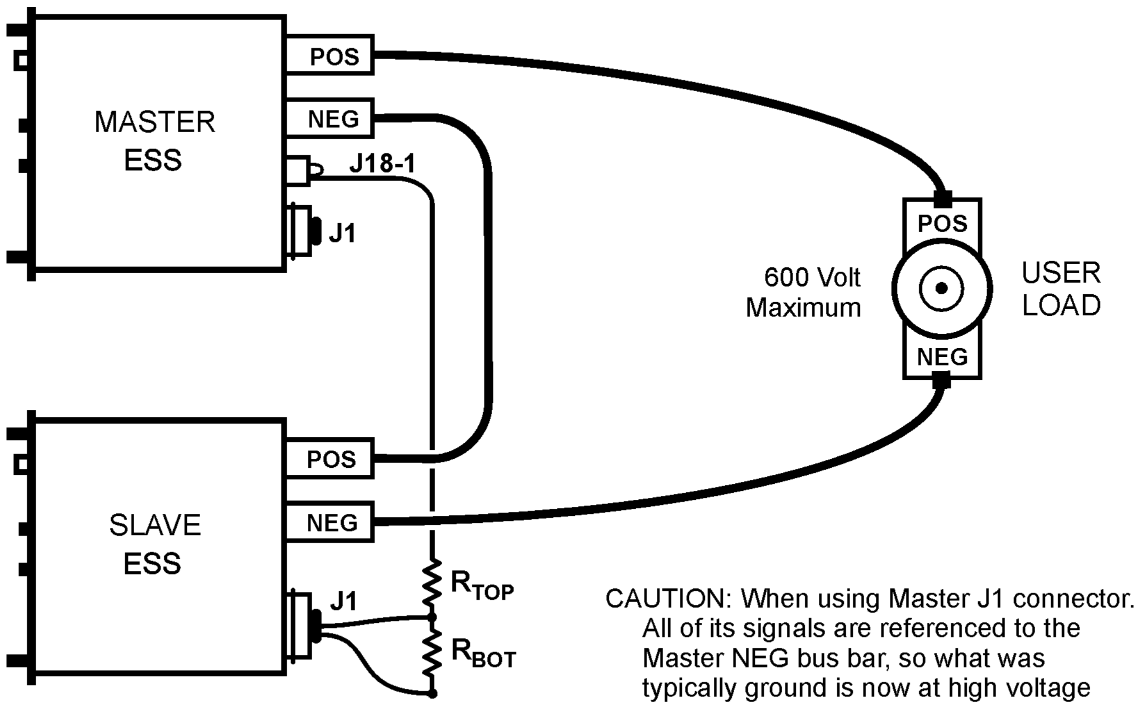


Figure 10. Series Master/Slave Supplies

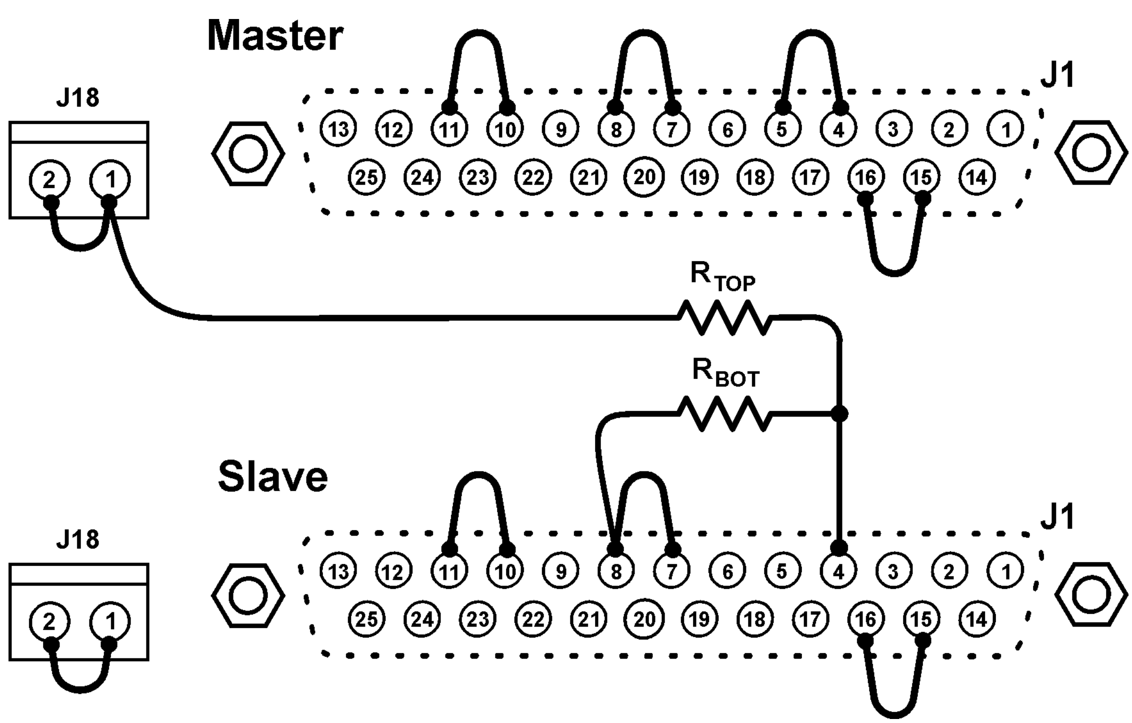


Figure 11. Series Master/Slave Control Cable

11. QUICK OPERATIONAL TEST

Before the ESS is installed in a system, verify that no internal damage occurred during shipping. A simple preliminary electrical test should be performed as follows:

Many operating errors are caused by a miswired J1 Programming Plug. For this test, verify the plug is wired and installed for the default Local mode. See Figure 3 for a diagram of the Local mode wiring.

A. Rotate Voltage and Current knobs completely counter-clockwise (downward). Rotate the Over-Voltage Pot fully clockwise (upward). Make sure the power switch is off (push down).

B. Apply the correct AC line power to the ESS. Refer to Section 3.3 for the power cord requirements.

C. With no load connected to the output terminals, flip ON the circuit breaker of the supply. The internal fans will start immediately. After a few seconds delay, the power supply will turn on.

D. Rotate the current knob up one turn clockwise. The output voltage and current will remain close to zero.

E. Rotate the voltage knob fully clockwise (upward). The front panel voltmeter will display the maximum output voltage of the supply. The VOLTAGE LED indicator will illuminate.

F. Rotate the Over-Voltage Potentiometer (OVP) down counter-clockwise. Within a quarter turn, the output voltage will drop to zero volts. The front panel OVER-VOLTAGE LED indicator will illuminate.

G. Switch the ESS power OFF. Rotate Voltage and Current knobs completely counter-clockwise (downward). Rotate the Over-Voltage Pot fully clockwise (upward).

H. Connect a shorting cable across the output bus bars of the supply. Make sure that the cable can sustain the maximum output current of the supply. Refer to Table 3 for recommended wire size.

I. Flip ON the ESS circuit breaker. The internal fans will start immediately. After a few seconds delay, the power supply will turn on.

J. Rotate the voltage knob up one turn clockwise. The output voltage and current will remain close to zero.

K. Rotate the current knob fully clockwise (upward). The front panel ammeter will display the maximum output current of the supply. The CURRENT LED indicator will illuminate.

L. Rotate current knob completely counter clockwise to zero. Turn OFF the ESS circuit breaker.

If any inconsistency from the above test procedure is noted, call Lambda EMI Customer Service for assistance.

12. ESS SPECIFICATIONS

All performance specifications, unless otherwise stated, are defined with the ESS operating in these conditions:

- Local programming mode.
- Unit operating at 90% power or greater.
- Ambient temperature is 72 °F (22 °C).
- Load is purely resistive.

Ripple, programming speed, transient response and stability are optimized with the power supply configured this way.

12.1 DECLARATION OF CONFORMITY

12.1.1 Compliance

Units with the IEEE/RS232 option *AND* whose output are greater than 401 volts
ARE NOT "CE" CERTIFIED

Safety	Meets IEC 950 / UL 1950, EN 60950, Hazardous Secondary for outputs up to 600 volts, single phase 230 VAC, 2.5 KW output (and for IEEE units up to 400 volts)
Input Disconnect Method	Circuit Breaker
Over-temperature Protection	Unit shall shut down when internal temperature exceeds safe operating levels.
CE: Leakage Current	3.5mA Standard (UL1950, EN60950)
CE: ESD Immunity	EN 61000-4-2 (IEC 801-2) Contact ±4KV Air ±8KV
CE: Radiated Immunity	EN 61000-4-3 (IEC 1000-4-3)
CE: Conducted Immunity	EN 61000-4-6 (IEC 1000-4-6)
CE: Power Freq. Mag Field	EN 61000-4-8
CE: EFT/Burst Immunity	EN 61000-4-4 (IEC 1000-4-4)
CE: Surge Immunity	EN 61000-4-5 (IEC 1000-4-5)
CE: Emissions (Conducted & Radiated)	EN 55011 Group 1 Class A (230VAC Input)

NOTE: CE = Applies to supplies with CE Certification.

12.1.2 EMC Requirements

Units with -CE suffix are tested to the EMC requirements of EN 50081-2 and EN 50082-2.

In the presence of high ambient electrical noise, shielding may be required on the load, the remote sensing cables and programming cables. To meet EMC specifications, it may be necessary to maximize the separation between the load cables and the AC power cables.

12.1.3 Electrical Safety

Meets UL-1950 Standards
Meets "Overvoltage Category II" per IEC-664.

12.2 PHYSICAL SPECIFICATIONS

12.2.1 Physical Size (See Outline Drawing)

Height:	3.34	Inches	(84.8 mm)
Width:	19.0	Inches	(483 mm)
Depth:	17.8	Inches	(452 mm)

12.2.2 Shipping Size

Packing Size:	Length:	27	Inches	(69 cm)
	Width:	25	Inches	(64 cm)
	Height::	11	Inches	(28 cm)
	Weight:	37	lbs	(17 kg)

12.3 ENVIRONMENTAL SPECIFICATIONS

12.3.1 Operating Environment

Operating Temperature:	0℃ to 50℃ without derating
	50℃ to 70℃ with derating (see 12.3.2)
Operating Humidity:	20% to 80% RH non-condensing
Altitude:	10,000 ft.

ESS meets UL-1950 “Pollution Degree 2” Standard.
Unit is *NOT* sealed. Conductive dust and moisture *WILL* cause damage.
Proper precautions and maintenance required.

12.3.2 Temperature Derating, 50℃ to 70℃

Output Current Coefficient: 4% per ℃ of the rated output voltage.
Derate linearly from 50℃ to 70℃

12.3.3 Storage Environment

Storage Temperature:	-40℃ to +85℃
Storage Humidity:	20% to 95% RH non-condensing.
Altitude:	10,000 ft.

12.3.4 Shock and Vibration

Vibration	Unpackaged	MIL-STD-810E, Method 514.4, Test Procedure 1, Test Condition 1.3.3.1
Shock	Unpackaged	25 Gpk half sine 11 msec
Audible Noise		65 dBA max at 3.5 feet from front panel

12.4 INPUT POWER

12.4.1 Required AC Power Input.

This table shows the maximum input current at a given output power, phase and input voltage.

Input Model	Supply Output Power	Nominal Line Input	Maximum Line Input	Maximum Input Current	Power Factor
-15	2.5 KWatt	1ϕ 220 - 230 VAC 50 – 60 Hz	1ϕ 190 - 253 VAC 47 – 63 Hz	24 Amp AC	0.6

12.4.2 AC Inrush Current.

Soft start is standard on all ESS models. Input line current during turn-on, turn-off, power interruption, or power reapplication is less than that at full load.

12.4.3 Overall Efficiency

Units with higher output voltages have higher efficiency. Efficiency is measured at nominal AC input line voltage and greater than 90% load (maximum current and maximum voltage).

Max Output MORE than 11 Volts: Efficiency greater than 85 %

Max Output LESS than 11 Volts: Efficiency greater than 77 %

12.5 PROGRAMMING: STATIC ACCURACY

12.5.1 Temperature Derating

Every programming accuracy is derated by:

± 0.02 % of full-scale (voltage or current) per degree Celsius above 25 °C

12.5.2 Analog Programming Accuracy

This refers to remotely programming the output voltage or current by means of an external DC voltage source to the J1 Programming connector.
For a given programming voltage, at 25 °C, the output accuracy is:

Output Mode	Programming Full Scale	Output Accuracy
Voltage Mode	0 to 5 Vdc	± 1 % of Full Output Voltage
Voltage Mode	0 to 10 Vdc	± 1 % of Full Output Voltage
Current Mode	0 to 5 Vdc	± 1 % of Full Output Current
Current Mode	0 to 10 Vdc	± 1 % of Full Output Current

12.5.3 Stability

After a 60 minute warm-up, maximum deviation in either voltage or current mode for an eight (8) hour period is 0.05% of maximum output under conditions of constant line, load and temperature.

12.5.4 Optional: Digital Programming Accuracy

When the IEEE/RS232 Interface option is installed, the accuracy of a “Program Voltage” or “Program Current” command is:

Output Mode	Output Accuracy
Voltage Mode	± 0.5 % of Full Output Voltage
Current Mode	± 0.5 % of Full Output Current

The digital to analog converters (DAC) are 12 bits resolution.

12.6 PROGRAMMING: DYNAMIC RESPONSE

12.6.1 Line Regulation

The supply output should not change as the input AC Line voltage varies.

Mode	Specification	Test Condition
Voltage	± 0.1 % of Full Output Voltage	Input (VAC_{RMS}) varies over its Required AC Power Input
Current	± 0.1 % of Full Output Current	Input (VAC_{RMS}) varies over its Required AC Power Input

12.6.2 Load Regulation

The supply output should not change as the load on its output varies.

Mode	Specification	Test Condition
Voltage	± 0.1 % of Full Output Voltage	Load changes from Full to Open
Current	± 0.1 % of Full Output Current	Load changes from Full to Short

12.6.3 Transient Load Response

A voltage transient occurs when the load is changed. The duration of the transient increases as the rated power supply output voltage increases.

Supply Vmax	Specification	Test Condition
Less than 20 V	Less than 650 µSec	Load changes 30% Supply in constant current mode
More than 21 V	Less than (650 × Vmax / 20) µSec	Load changes 30% Supply in constant current mode

12.6.4 Output Rise Time

Rise time is determined by applying a “zero to five volt step” to the analog voltage programming input. As the output rises from zero to full rated voltage, the time it takes the output to pass between the 10% to 90% Full Scale levels is measured. The load is set to draw full voltage and at least 90% of full current.

Output Voltage Range	10 % to 90 % Risetime	Risetime Levels
5 to 120 Volt	Less than 100 mSec	From 10 % to 90 % FS
121 to 400 Volt	Less than 200 mSec	From 10 % to 90 % FS
401 to 600 Volt	Less than 300 mSec	From 10 % to 90 % FS

12.6.5 Propagation Delay

When the analog programming input is stepped from 10 % to 100 % (from 0.5 volts to 5 volts), then the supply output voltage will begin to climb within 5 milliseconds. This applies to both voltage programming and current programming.

12.7 OUTPUT RIPPLE

The following specifications are for the 70 kHz (approx) carrier ripple that is the largest contributor to the ripple in the output voltage.

For models not shown in this table, use the next higher output.

Output Ripple, ESS 2.5 KW, 1-Phase				
Model	Max Voltage	Max Current	Max Ripple	(see Note 1 below)
ESS 7.5-300	7.5	300	75 mV	PARD
ESS 10-250	10	250	75 mV	PARD
ESS 12.5-200	12.5	200	75 mV	PARD
ESS 20-125	20	125	80 mV	PARD
ESS 25-100	25	100	85 mV	PARD
ESS 30-80	30	80	100 mV	PARD
ESS 40-60	40	60	100 mV	V_{P-P}
ESS 60-40	60	40	100 mV	V_{P-P}
ESS 80-30	80	30	100 mV	V_{P-P}
ESS 100-25	100	25	150 mV	V_{P-P}
ESS 125-20	125	20	150 mV	V_{P-P}
ESS 150-16	150	16	150 mV	V_{P-P}
ESS 160-15.6	160	15.5	150 mV	V_{P-P}
ESS 180-14	180	14	150 mV	V_{P-P}
ESS 200-12.5	200	12.5	170 mV	V_{P-P}
ESS 220-11	220	11	200 mV	V_{P-P}
ESS 250-10	250	10	200 mV	V_{P-P}
ESS 300-8	300	8	250 mV	V_{P-P}
ESS 400-6	400	6	300 mV	V_{P-P}
ESS 500-5	500	5	350 mV	V_{P-P}
ESS 600-4	600	4	400 mV	V_{P-P}

Note 1: PARD is "Periodic and Random Deviation" and includes all detectable noise peaks.
V_{P-P} is "Volts Peak-to-Peak" and high speed switching spikes at approximately 70 KHz are omitted.

Table 7. Output Ripple, ESS 2.5 KW, 1-Phase

12.8 MEASURING ACCURACY

12.8.1 Front Panel Meter Accuracy

Digital Voltmeter:	± 2% of full scale from Zero to Full Volt Rating
Digital Ammeter:	± 2% of full scale from Zero to Full Current Rating

12.8.2 Analog Measuring Accuracy

This refers to the accuracy of the monitor signals from the J1 Programming connector. The monitor signals vary from 0 to 5 volts (10 volts selectable) as the output voltage and current vary from zero to full rating. For a given output, the monitor accuracy is:

Monitor Mode	Monitor Full Scale	Monitor Accuracy
Voltage Monitor	0 to 5 Vdc	± 1 % (or ± 0.05 Volts)
Voltage Monitor	0 to 10 Vdc	± 1 % (or ± 0.10 Volts)
Current Monitor	0 to 5 Vdc	± 1 % (or ± 0.05 Volts)
Current Monitor	0 to 10 Vdc	± 1 % (or ± 0.10 Volts)

12.8.3 Optional: Digital Measurement Accuracy

When the IEEE/RS232 Interface option is installed, the accuracy of a “Measure Voltage” or “Measure Current” command is:

Measurement	Accuracy
Voltage	± 0.5 % of Full Output Voltage
Current	± 0.5 % of Full Output Current

The analog to digital converters (ADC) are 12 bits resolution.

Measurement filtering (AFV and AFC commands) set to default 20 readings.

12.9 OVER-VOLTAGE PROTECTION

12.9.1 Front Panel OV Potentiometer

Adjustment Range:	5 % to 110 % Max Output Voltage
Response Time:	Less than 3 mSec if output exceeds OVP setting by 1% of full scale

12.9.2 Optional: Digital Over-Voltage and Over-Current

Adjustment Range:	Zero to Max Output Voltage or Current
Response Time:	Output shut-down in less than 20 mSec if output exceeds voltage or current setting by 1% of full scale.

Sketch Your Own Programming Plug.

Dotted lines are the default LOCAL mode.