PE II 10 kW Power Supply

March 2008 5706056E

User Manual

User Manual

PE II 10 kW Power Supply

5706056E

ADVANCED ENERGY®

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PRODUCT USAGE STATEMENT

⚠ WARNING:

Read this entire manual and all other publications pertaining to the work to be performed before you install, operate, or maintain this equipment. Practice all plant and product safety instructions and precautions. Failure to follow instructions can cause personal injury and/or property damage. If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired. All personnel who work with or who are exposed to this equipment must take precautions to protect themselves against serious or possibly fatal bodily injury.

Advanced Energy Industries, Inc., (AE) provides information on its products and associated hazards, but it assumes no responsibility for the after-sale operation of the equipment or the safety practices of the owner or user. This equipment produces or uses potentially lethal high-voltage, high-current, radio frequency (RF) energy. NEVER DEFEAT INTERLOCKS OR GROUNDS.

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Advanced Energy's technical writing staff has carefully developed this manual using research-based document design principles. However, improvement is ongoing, and the writing staff welcomes and appreciates customer feedback.

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Safety and Product Compliance Guidelines

IMPORTANT SAFETY INFORMATION

To ensure safe installation and operation of the Advanced Energy® PE II power supply, read and understand this manual before attempting to install and operate this unit. At a minimum, read and follow the safety instructions and practices documented under "Safety Guidelines" on page 1-2.

INTERPRETING THE MANUAL

The following sections explain the document type conventions and the danger, warning, and caution boxes that provide information about the specific levels of hazard seriousness.

Type Conventions

Please note the following type conventions:

- Pin and signal names appear in capitalized italics (*POWER_ON*).
- New terms appear in italicized text.
- Unit labels (switches, indicators, and so on) appear in boldface text (**MODIFY**).
- Commands (**162**) and command names (**set point**) appear in boldface, lowercase text.

Danger, Warning, and Caution Boxes

This symbol represents important notes concerning potential harm to people, this unit, or associated equipment. Advanced Energy® includes this symbol in Danger, Warning, and Caution boxes to identify specific levels of hazard seriousness.

DANGER:

DANGER indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury. DANGER is limited to the most extreme situations.

WARNING:

WARNING indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury, and/or property damage.

CAUTION:

CAUTION indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury, and/or damage to property. CAUTION is also used for property-damage-only accidents.

SAFETY GUIDELINES

Review the following information before attempting to install and operate the product.

Rules for Safe Installation and Operation

Please note the following rules:

- Do not attempt to install or operate this equipment without proper training.
- Ensure that this unit is properly grounded (see "Grounding the Unit" on page 5-2).
- Ensure that all cables are properly connected (see "Installing the Unit" on page 5-2).
- Verify that input line voltage and current capacity are within specifications before turning on the power supplies (see "Electrical Specifications" on page 3-8).
- Use proper electrostatic discharge (ESD) precautions.
- Always be careful around this equipment.

Interpreting Product Labels

The following labels may appear on your unit:

1332

Hazardous voltage

1069

Earth ground

1028

High voltage

1309

Hot surface

1030

Nonionizing radiation

1029

Protective Earth ground

1027

Refer to manual for more information

1024

Short circuit protected

1020

CE label

PRODUCT COMPLIANCE

The following sections include information about unit compliance and certification, including the conditions of use required to be in compliance with the standards and directives.

Note: Any unauthorized expansion, repair, modification, or misuse of this product violates any compliance or certification associated with the product. In this situation, you are responsible to guarantee the compliance of the product.

Product Certification

Certain options of this product are certified by:

- CE marking, self addressed by AE Compliance Engineering

For more information, refer to the letter of conformance (US) or declaration of conformity (EU) accompanying the product.

Safety and Compliance Directives and Standards

Certain options of this unit have been tested for and comply with the following electromagnetic compatibility (EMC) and safety directives and standards and industry guidelines.

Note: This device must be installed and used only in compliance with the directives and standards listed in addition to VDE 0113, EN 60204 (IEC 60204), and applicable requirements.

Note: This equipment must be installed and used in accordance with the Conditions of Use described in this manual. If this equipment is expanded, modified, or installed into a larger system, the user is responsible to guarantee the

compliance of the overall system. If this equipment is used with external components, the user must ensure that the Safety and EMC requirements are not violated.

ELECTROMAGNETIC COMPATIBILITY (EMC) DIRECTIVES AND STANDARDS

Table 1-1. *Electromagnetic compatibility (EMC) directives and standards*

Reference Number	Description
89/336/EEC	EC Council directive on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive)
EN 61000-6-2	Electromagnetic Compatibility (generic immunity standard—industrial)
EN 55011	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific, medical (ISM) radio frequency equipment (Class A, Group 2) (CISPR 11)
47 CFR Part 18	Code of Federal Regulations—Limits and methods of measurement of radio interference characteristics of industrial, scientific, and medical equipment

SAFETY DIRECTIVES AND STANDARDS

Table 1-2. *Safety directives and standards*

Reference Number	Description
73/23/EEC	EC Council directive on the harmonization of the laws of the Member States relating to electrical equipment designed for use within certain voltage limits (LVD - Low Voltage Directive)
EN 50178	Electronic equipment for use in electrical power installations

Installation Requirements

WARNING:
Operating and maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

CAUTION:
You must stop coolant flow when the PE II power supply is not operating or severe damage may occur from condensation. Condensation damage can result in a disqualification of the warranty if proper precautions are not taken to arrest cooling water flow during non-operating periods. Advanced Energy has a Water Shutoff Solenoid (AE part number: 3163028), with interface, designed for the PE II product line. Contact an Advanced Energy sales or service representative for more information. See "AE Global Customer Support" on page 6-17 for more information.

Conditions of Use

To comply with the stated directives and standards, you must meet the following conditions of use:

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

- Where the rated AC input voltage for this device is not directly available, a transformer meeting the applicable requirements must be installed at the AC input.
- Before making any other connection, connect the supplemental Protective Earth (ground) terminal to an earth (ground) terminal with a copper wire that is sized according to the applicable requirements.
- For delta-connected mains, primary and supplemental Protective Earth (ground) wires must be connected.
- Use only a shielded cable on the input power connector.
- Use only a shielded power cable on the output power connector.
- Install and operate this device only in a pollution degree 2 or better environment, which means an indoor location such as a computer room, office, or factory floor where only nonconductive pollution occurs during operation. Occasionally, a temporary conductivity caused by condensation occurs when the device is not operating.
- To prevent against condensation, install and operate this device with an external water solenoid valve so that water flow is interrupted when the device is not operating.

- Nonstandard connectors for input and/or output power must be inaccessible to the user.
- Advanced Energy Industries, Inc., may provide a supplementary protection circuit breaker in the power supply. You must provide a branch circuit backup fuse with a UL LISTED Type K5 or RK5 fuse or equivalent that is rated 15 A minimum and no more than four times full-load amps (not to exceed 125 A for 50 A or less rated breaker, and not to exceed 175 A for 51 through 100 A rated breaker).

INTERLOCKS

WARNING:
Advanced Energy Industries, Inc. products only include interlocks when required by product specification. Interlocks in Advanced Energy products are *not* intended to meet or satisfy safety requirements. Where interlocks exist, you must still meet and satisfy safety requirements. The presence of interlocks does *not* imply operator protection.

Table 1-3 lists the hardware interlocks associated with the PE II power supply. To recover from an interlock fault, see "User Port Pin Descriptions" on page 4-2.

Table 1-3. *Hardware interlocks and limiting conditions*

Mechanism	Detection Method	Equipment Condition When Interlock or Limit is Unsatisfied
The PE II power supply provides a single loop-through interlock string.	The current output of one pin must return to the other pin, and the loop must be isolated from ground.	Output remains off until you restablish the interlock and reset the unit by toggling off the *Output On* signal.

Figure 1-1 illustrates the interlock and limit circuit.

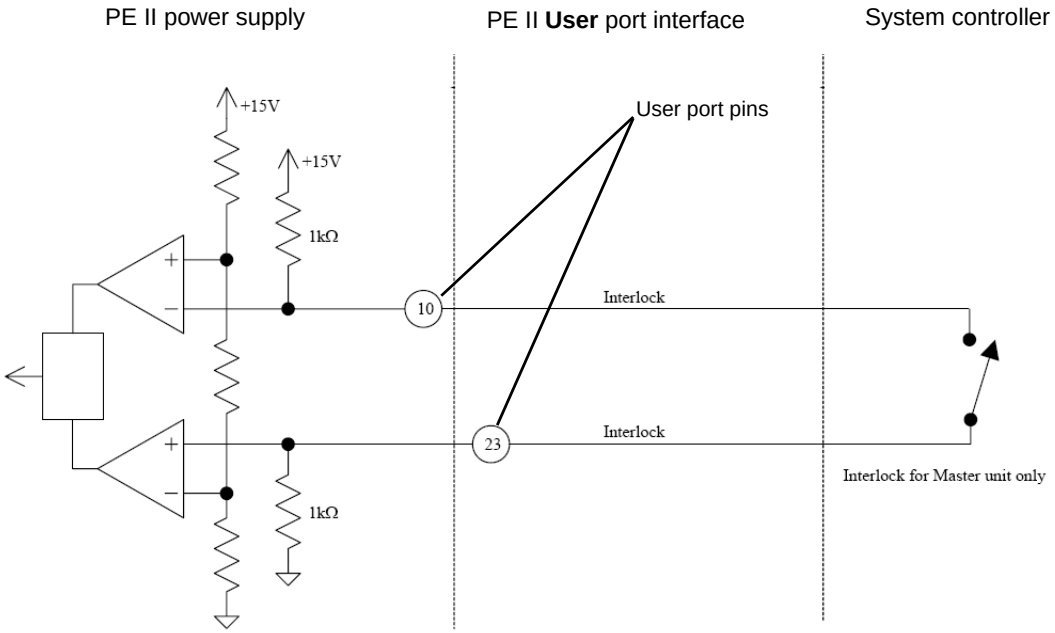

Figure 1-1. *Interlock circuit*

Product Overview

GENERAL DESCRIPTION

Product Overview

The PE II power supply provides a 40 kHz resonant switch-mode power output, featuring enhanced arc control and internal load matching with outputs of up to 60 kW when combining units—requiring no external hardware such as transformers. The power supply also offers two distinct arc-handling circuits and dual (floating) outputs that can be grounded on either side.

The PE II power supply features a water-cooled design and offers tight output regulation on power, voltage, or current with a measurement accuracy of 1% and with low harmonics. All PE II units are compatible with a programmable logic controller (PLC) and comply with CE specifications.

Product Benefits

The following information discusses the different product benefits of the PE II power supply.

HIGH POWER DENSITY

The PE II power supply features an output power factor of greater than 0.9, while featuring a compact design and wide tap range.

WIDE TAP RANGE

The voltage range of the PE II power supply allows you to operate continuously through nearly a 10:1 impedance range.

CONSTANT REGULATION

You can select to control your process by constant load power, load voltage, or load current.

ENHANCED ARC CONTROL

The PE II power supply features the following arc handling circuitry:

- Current arc (*I-Arc*) circuitry

The current arc circuitry handles major process arcs.

Note: See "I-Arc Settings (S1)" on page 5-33 for more information about the I-Arc settings available in the PE II power supply.

- Voltage arc (*V-Arc*) circuitry

  The voltage arc circuitry detects and reacts to micro arcs, which substantially reduces the occurrence of major process arcs by pulsing the power supply output off for a set amount of time. The V-Arc circuitry detects changes in the output waveform created by a micro arc within one half-cycle of the output. You can select how sensitive the V-Arc circuit is to the changes in the output waveform, and you can select the duration of the off pulse.

  Note: See "V-Arc Settings (S2)" on page 5-34 for more information about the V-Arc settings available in the PE II power supply.

AUTOMATIC PROCESS SAFEGUARD

In a master/slave configuration, if a slave unit experiences a fault the master unit automatically recognizes the fault occurrence and redistributes the power output to the working units. This process safeguard ensures maximum power output to the process and enables the power system to complete process runs even when a fault occurs on one unit.

FLEXIBLE MODULARITY

The PE II power supply is 177 mm (6.97") high. The PE II power supply is considerably smaller than competing power systems with comparable power configurations.

BUILT-IN PROTECTION

A PE II power supply features internal protection for overvoltage, overcurrent, overpower, and open and short circuit conditions. User connections let you add inputs such as vacuum, water, and system interlocks.

FUNCTIONAL DESCRIPTION

Figure 2-1 and the following paragraphs provide a high-level description of the PE II power supply operation.

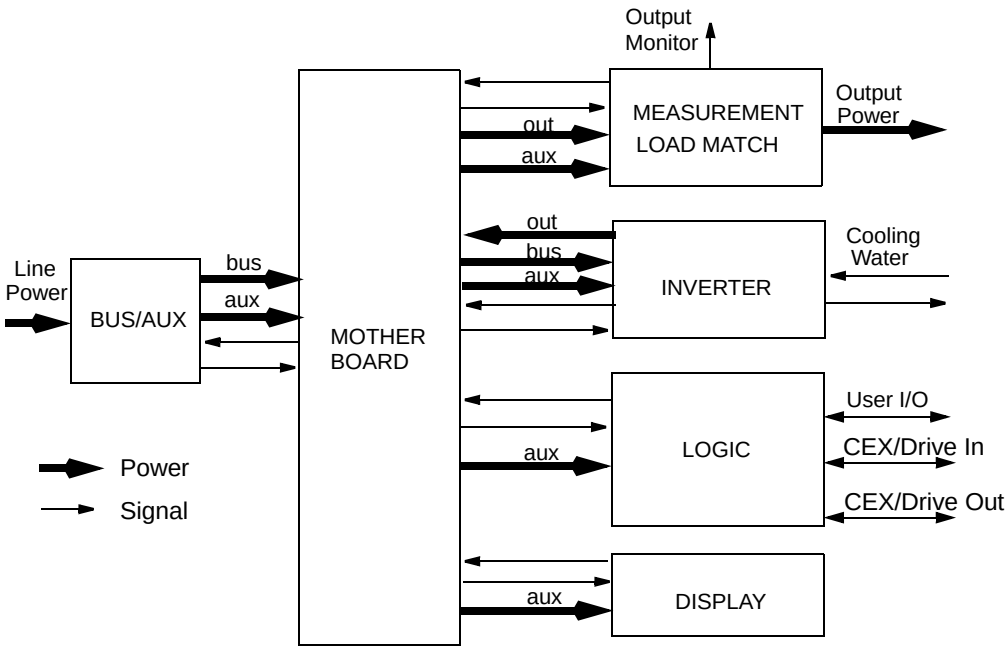

Figure 2-1. *System block diagram*

Bus/Aux

The Bus/Aux section contains the line filter, circuit breaker, bridge rectifier, a shock absorber, and the auxiliary power supply. The auxiliary power supply provides unregulated +24 V, regulated +15 V, regulated -15 V, and regulated +5 V to the mother board for distribution to the rest of the power supply.

Mother Board

The mother board provides the electrical connection for each of the sections, which includes the distribution of power from the Bus/Aux section and communication from the Logic section to the Measurement/Load Match, Inverter, and Display sections.

Measurement/Load Match

The Measurement section measures the power, voltage, and current output of the power supply. The mother board communicates the measurements to the other sections in the power supply. The Load Match section contains the relays that control the taps to match the input requirements of the load.

Note: See "Tap Operating Information" on page 3-11 for more information about the load matching capabilities of the PE II power supply.

Inverter

The Inverter section contains the drive board, main switching boards, the filter, and output transformer. The output transformer has multiple selectable taps. See "Tap Operating Information" on page 3-11 for more information about these taps.

Logic

The Logic section communicates through the **User** port and **CEX/Drive In** and **CEX/ Drive Out** ports.

Display (or Unit Front Panel)

The PE II power supply provides either a passive front panel or active front panel interface to display information about the unit operation. The passive front panel display features six status indicators, or LEDs. The active front panel features nine status LEDs, a digital display screen, and switches to control unit operation.

Note: See "Unit Front Panel" on page 4-12 for more information about the available features on a passive and active front panel interface.

WHAT'S NEW IN THE PE II POWER SUPPLY

The following sections describe the new features and differences of the PE II power supply compared to the PE power supply. Additionally, we offer some suggestions to facilitate the transition from a PE power supply to a PE II power supply in your system.

New Features of the PE II Power Supply

The PE II power supply has the following new features (compared to the PE power supply):

- seven selectable taps
- power, voltage, and current regulation modes
- pulsing capability (see "Pulsing Unit Output" on page 5-39 for more information)
- ability to set master or slave operation when combining units (through the **User** port). See "User Port" on page 4-1 for more information.

Differences Between PE and PE II Power Supplies

Following are the differences between the PE and PE II power supplies:

- Changed **User** port connector from a 15-pin subminiature D connector on the PE power supply to a 25-pin subminiature D on the PE II power supply.
- PE II power supply requires you to supply +24 V at 2.5 A maximum to operate the isolated digital I/O.

  Note: Be sure to ground the controller end of the user cable.

- On the PE II power supply, you can designate a unit as a master or stand-alone unit and as a slave unit.

  - Contact closure to the chassis ground (pin 21) with less than 800 Ω series resistance designates the unit as a master or standalone 10 kW power supply.
  - An open circuit designates the unit as a slave.

  Note: Be sure to place the jumper at the controller end of the user cable.

- On the PE II power supply, the interlock loop uses two pins to satisfy the interlock.

  The interlock loop requires the current output of one pin to return to another pin. This loop must be isolated from ground. If the loop is interrupted, the output remains off until the interlock is established and the unit reset by toggling off the *Output On* signal.

  Note: See "Interlocks" on page 1-7 for more information.

- Changed analog scaling from 0 V to 5 V on the PE power supply to 0 V to10 V on the PE II power supply.
- On the PE II power supply, the analog outputs are differential. You must ground the analog output's reference.

  Note: Be sure to ground the analog reference at the controller end.

- On the PE II power supply, the chassis ground must be connected at the controller end.

  Note: See "User Port Pin Descriptions" on page 4-2 for more information.

Using a PE II Power Supply

When replacing the PE power supply with a PE II power supply, do the following to facilitate the transition in your system:

- Leave the regulation signal open for power regulation on the PE II unit.
- Select the taps (see "Tap Operating Information" on page 3-11 for more information) on the PE II unit.

Specifications

FUNCTIONAL SPECIFICATIONS

Table 3-1 lists the functional specifications for the PE II power supply.

Table 3-1. *Functional specifications*

Description	Specification
Control signal sources	The unit is controlled from: • The analog/digital **User** port, or • The active front panel
Regulation mode	The unit regulates on load power, voltage, or current.
Automatic process safeguard	When set up for master/slave operation (to deliver 10 kW or greater), the power supply system automatically adjusts to the loss of a slave by redistributing the output power and limiting the maximum available power as a function of the number of slaves which have shut down. Power is removed for approximately 100 ms to reconfigure the remaining units.
Coolant and ambient temperature	The PE II power supply is designed to operate reliably with inlet cooling water temperatures between +5°C and +30°C and with an ambient air temperature of +40°C maximum. *Note:* To avoid excessive condensation and possible equipment damage, turn water flow off if the power supply output is turned off for more than 30 minutes. If the PE II power supply is enclosed in a cabinet, do not exceed the maximum ambient temperature.

Table 3-1. *Functional specifications (Continued)*

Protection	The PE II power supply is designed to protect itself from damage under the following conditions: • Any unmatched load condition at the unit output. Output power fold back occurs as required by the power supply protection circuits. • Ambient air temperatures, in excess of the specifications, resulting in internal temperatures exceeding preset limits. • Low cooling water flow rate and/or high cooling water temperature resulting in internal temperatures exceeding preset limits. • AC input low line or high line (up to ratings of regulatory agency approved input components).
Interlock	The PE II power supply provides a 25-pin, subminiature-D connector for a single loop-through interlock string. *Note:* The interlock loop uses two pins. The current output of one pin must return to the other pin, and the loop must be isolated from ground. See Table 4-2 on page 4-2 and refer to pins 10 and 23 for more information.

Table 3-1. *Functional specifications (Continued)*

Master/Slave capability	You can connect the PE II power supply with other PE II power supplies in a master/slave configuration, combining up to six units or 60 kW total. The power supplies must be the same power level. For example, you can combine up to six 5 kW units or up to six 10 kW units, but you cannot create a stack with both 5 kW and 10 kW units. The **User** port or active front panel (if applicable) of the master unit controls all the units combined in a master/slave configuration. See "Connecting for Multiple Unit Operation" on page 5-23 for more information.
Common Exciter (CEX) capability	You can connect multiple master/slave stacks or stand-alone PE II power supplies for common exciter (CEX) operation, combining up to 32 units. The master/slave stacks and stand-alone units can be the same or different power levels. See "Connecting for Multiple Unit Operation" on page 5-23 for more information.

PHYSICAL SPECIFICATIONS

Table 3-2 lists the physical specifications for the PE II power supply. Figure 3-1 on page 3-7 illustrates the unit dimensions.

Table 3-2. *Physical specifications*

Description	Specification
Size	177 mm (H) x 482.60 mm (W) x 596.90 mm (D) 6.97" (H) x 19" (W) x 23.50" (D) *Note:* An additional 2" at the back of the unit is required for clearance for cabling and water connections on the rear panel. See "Dimensional Drawing" on page 3-7 for more detailed information about the unit dimensions.
Weight	40.8 kg (90 lbs)
Mounting	Rack mounting ears are provided for standard 19" instrumentation rack. You must use support rails to support the unit. **ATTENTION:** **The PE II power supply face plate will *not* support the weight of the unit.**

Table 3-2. *Physical specifications (Continued)*

Connector/Cable	
RF output connectors	Dual output, through terminal block (with approved safety cover). See "Connecting Output Power" on page 5-4 for more information.
RF output cables	Advanced Energy Industries, Inc. supplies the output power cables for the unit. Use only a shielded cable on the output power connector. The output cover can accommodate cables from 0.35" (9 mm) to 0.71" (18 mm). Each output strain relief clamps around the cable shield to provide EMI shielding. *Note:* The maximum distance between any output cable in a combined set is 15.2 m (50´). See "Choosing the System Configuration" on page 5-22 for further information.
RF voltage monitor (*V-MON*)	BNC female (requiring 200 V/ V, ± 5%, 1 MHz bandwidth)
RF current monitor (*I-MON*)	BNC female (requiring 10 V/ V, ± 5%, 1 MHz bandwidth)
AC power input	Site-wired, 4-wire DIN rail (terminal block) with cover
AC line cord	The input requires a 4-conductor, 6 AWG, shielded wire terminated with ferrules. *Note:* Advanced Energy Industries, Inc. does not include the input cable with the PE II power supply. You are required to supply the cable for the input connection. See "Connecting Input Power" on page 5-17 for more information.
User port connector	25-pin, subminiature-D, female (with 4-40 jack post)
User port termination plug **Provided with Active Front Panel units only**	25-pin subminiature-D, male (with 4-40 jack screws). *Note:* A jumper for master operation and interlock are installed for first-time operation.
CEX/Drive In connector	50-pin, SCSI 2, female (with 2-56 jack post)
CEX/Drive Out connector	50-pin, SCSI 2, female (with spring clips)

Table 3-2. *Physical specifications (Continued)*

CEX/Drive ports cable	Advanced Energy Industries, Inc. supplies the 0.9 m (3´) cable with the PE II power supply. Secure the 50-pin, SCSI 2, male cable connectors with spring clips at one end and 2-56 jack screws at the other. The cable is shielded with 25 pairs of wire having a 100 Ω characteristic impedance. *Note:* The maximum distance between the first and last unit in a master/slave configuration is 15.2 m (50´). However, the maximum distance between two units configured for CEX operation is 15.2 m (50´).
CEX/Drive Out port termination plug	50-pin, SCSI 2, male with spring clips and custom termination. See “Verifying Continuity of the CEX Termination Plug” on page 6-16 for pin and signal descriptions.
Coolant connectors	3/8" female NPT See “Connecting Cooling Water” on page 5-3 for more information.

Dimensional Drawing

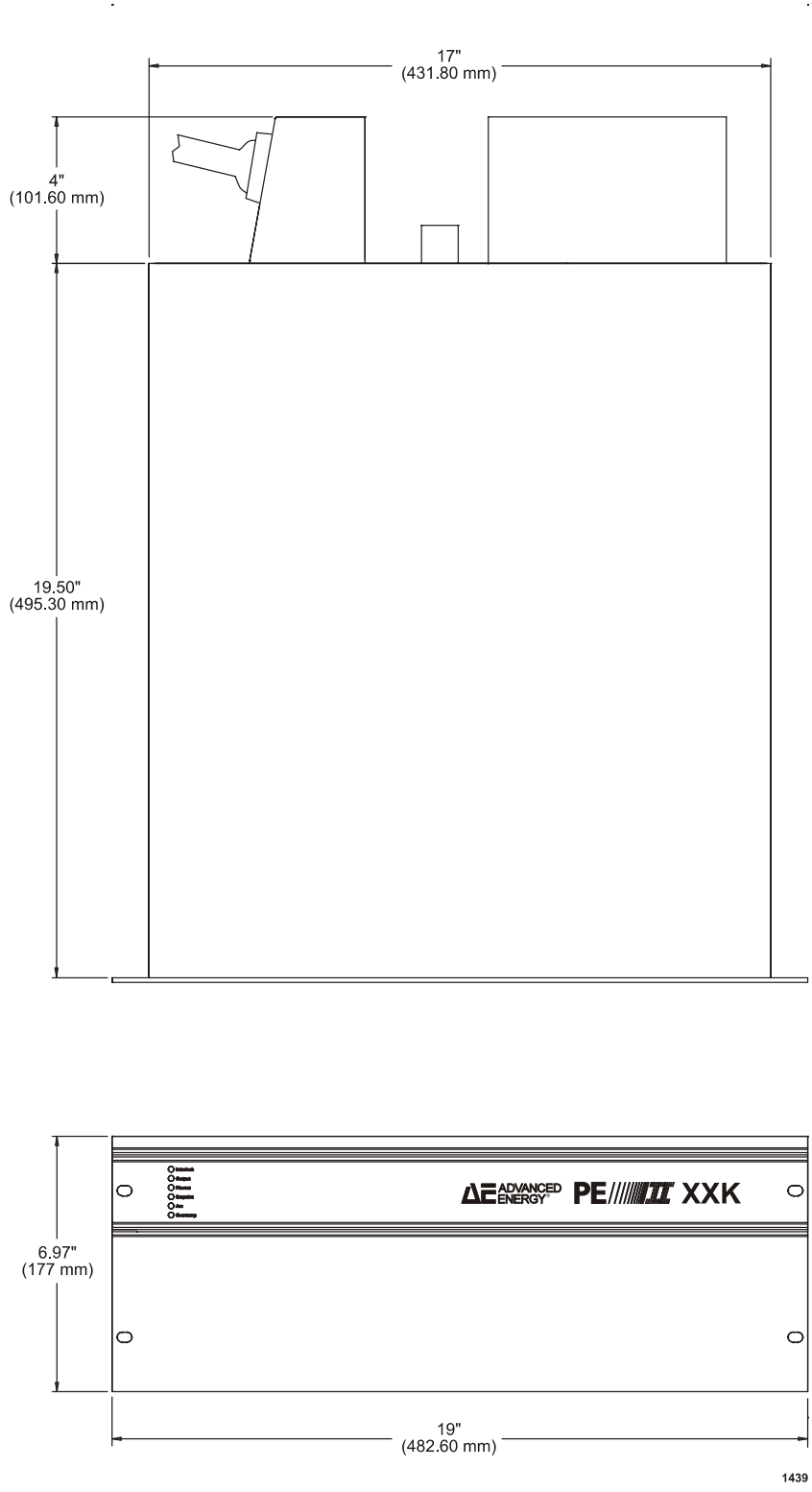

Figure 3-1. *Unit dimensions*

ELECTRICAL SPECIFICATIONS

Table 3-3 lists the electrical specifications for the PE II power supply.

Table 3-3. *Electrical specifications*

Description	Specification
208 VAC Input voltage (wye or delta connection)	180 to 230 VAC, 3-phase, 4-wire; 47 to 64 Hz; no neutral required. For wye connections, leakage current is less than 3.5 mA. Maximum phase to phase voltage: 208 V + 10% Maximum phase to ground/power supply chassis voltage: 250 V **DANGER:** **RISK OF DEATH OR BODILY INJURY: For delta connections, considerably more leakage current will exist. You must connect the primary and supplemental Protective Earth (ground) wires.**
208 VAC Input current	36 A nominal; 42 A maximum at low line; 50 A circuit breaker
Efficiency	85% at full-rated output (nominal)
Power factor	0.90 at full-rated output
Output frequency	40 kHz ± 0.01%
Output power	10 kW
Load match	7 taps at 10 kW *Note:* See "Tap Operating Information" on page 3-11 for tap ranges.
Limits	
Power	10.2 kW

Table 3-3. *Electrical specifications (Continued)*

Voltage	+20% above maximum voltage within a given tap range, as shown in table on load match output parameters. See "Tap Operating Information" on page 3-11 for tap ranges.
Impedance	Folds back current as a function of power at 10 kW. See "Tap Operating Information" on page 3-11 for tap impedance ranges.
Arc handling circuitry	
Current arc (*I-Arc*)	An I-Arc occurs when the output current exceeds the maximum current allowed in a given tap position by 20%. The unit responds by removing the output power for 10 ms and then re-applying power through a programmed ramp sequence. You can change the arc handling capabilites of your power supply by switching the settings on an eight-position DIP switch located on the logic board inside the unit. See "I-Arc Settings (S1)" on page 5-33 for more information.
Voltage arc (*V-Arc*)	A voltage arc (V-Arc) occurs when the output voltage loss in a half-cycle average is greater than the percentage of loss. The unit responds to a voltage arc by pulsing the output power off for a short time. You can change the arc handling capabilites of your power supply by switching the settings on an eight-position DIP switch located on the logic board inside the unit. The default arc handling settings are: the percentage of loss at 53%, the activation level at 15%, the pulse off time at 90 us, and the V-Arc function disabled. *Note:* See "V-Arc Settings (S2)" on page 5-34 for more information.
Regulation modes	
Power	1% to 100% of full-rated power; 20 dB dynamic range
Voltage	1% to 100% of full rated voltage; 40 dB dynamic range
Current	1% to 100% of full rated current; 40 dB dynamic range

Table 3-3. *Electrical specifications (Continued)*

Line regulation	-15% to +10% gives ≤ 0.1% for a single unit 0.15% combined change in power, voltage, or current (depending on the selected mode of regulation)
Control loop response	Typically 100 Hz for power, voltage, and current regulation
Output ramp	Preselected at 18 ms to 4.73 s in 18 ms steps. You can set the output ramp settings through an eight-position DIP switch located on the logic board inside the unit. See "Output Ramp Settings (S3)" on page 5-38 for more information.

Table 3-3. *Electrical specifications (Continued)*

Measurement accuracy of single unit or slaves	
Power	± 100 W for all impedances
Voltage	± 22 V for less than 25° phase ± 50 V for greater than 25° phase at all impedances
Current	± 3.5 A for all impedances
Measurement accuracy of master unit	
Power	(1.5) x (number of units in system)
Measurement accuracy of master/slave or CEX unit configuration	
Power	(100 W) x (1.5) x (number of units in system)
Current	(3.5 A) x (1.5) x (number of units in system)
Voltage	22 V x (number of units in system)
Output spectral purity	
Harmonics	-25 dBc at full power (at normal load)
Spurious noise	-35 dBc at full power (at normal load)
Line related	-30 dBc at full power (at normal load)
RF Monitor	
Voltage (*V-mon*)	200 V/ V, ± 5%, 1 MHz bandwidth
Current (*I-mon*)	10 A/ V, ± 5%, 1 MHz bandwidth

Tap Operating Information

You can change the tap setting at any time through the **User** port or by using the **Tap Select** knob on the active front panel (if applicable). If you change the tap setting while output is on, the unit does the following:

1. The output shuts off for 50 ms.
2. The unit resets to the new tap setting.
3. The output powers on again.

The following table lists the tap operating information. Figure 3-2 shows an example of a tap operating range. See "Tap Operating Ranges" on page 3-12 to view graphs illustrating the different tap operating ranges.

Note: All the tap specifications listed are for a single unit. To find the power or current of a master/slave or CEX configuration, you must multiply the tap value by the number of units in the system. To find the impedance, you must divide the tap value by the number of combined units.

Table 3-4. *Output load match parameters (for 10 kW units)*

Taps	Ratio	Min V/Max I (Z)	Normal V/I (Z)	Max V/Min I (Z)
1	0.67	307 V/32 A (9 Ω)	365 V/27 A (14 Ω)	433 V/23 A (19 Ω)
2	0.77	353 V/29 A (12 Ω)	419 V/23 A (18 Ω)	498 V/20 A (25 Ω)
3	0.87	399 V/25 A (16 Ω)	474 V/21 A (23 Ω)	563 V/17 A (33 Ω)
4	1.00	460 V/22 A (21 Ω)	547 V/18 A (30 Ω)	650 V/15 A (43 Ω)
5	1.13	521 V/19 A (27 Ω)	620 V/16 A (39 Ω)	737 V/13 A (56 Ω)
6	1.30	598 V/17 A (35 Ω)	711 V/14 A (51 Ω)	845 V/12 A (73 Ω)
7	1.47	675 V/14 A (45 Ω)	802 V/12 A (65 Ω)	953 V/10 A (93 Ω)

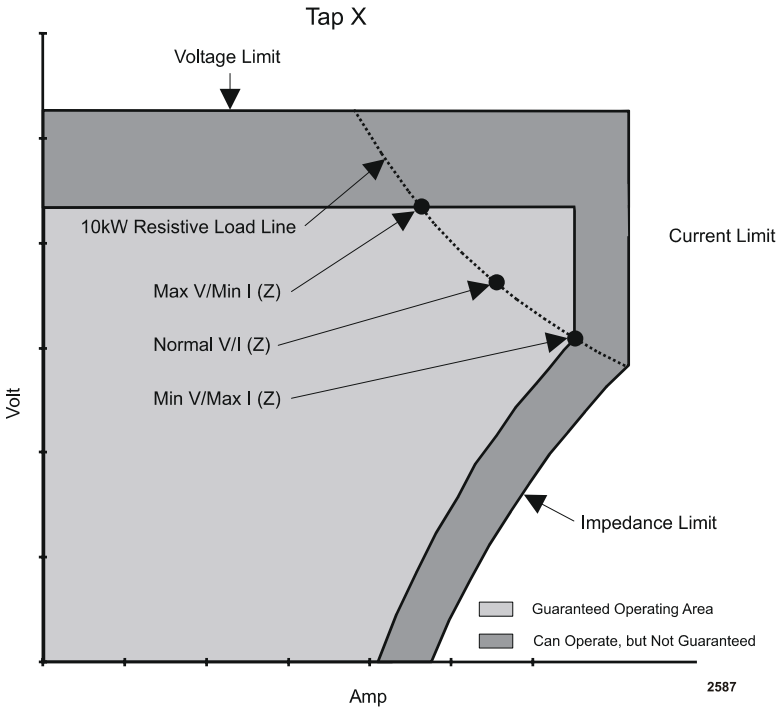

Figure 3-2. *Example of a tap operating range*

TAP OPERATING RANGES

The following figures illustrate the operating ranges for each tap setting. Figure 3-10 illustrates the overlap between the tap operating ranges.

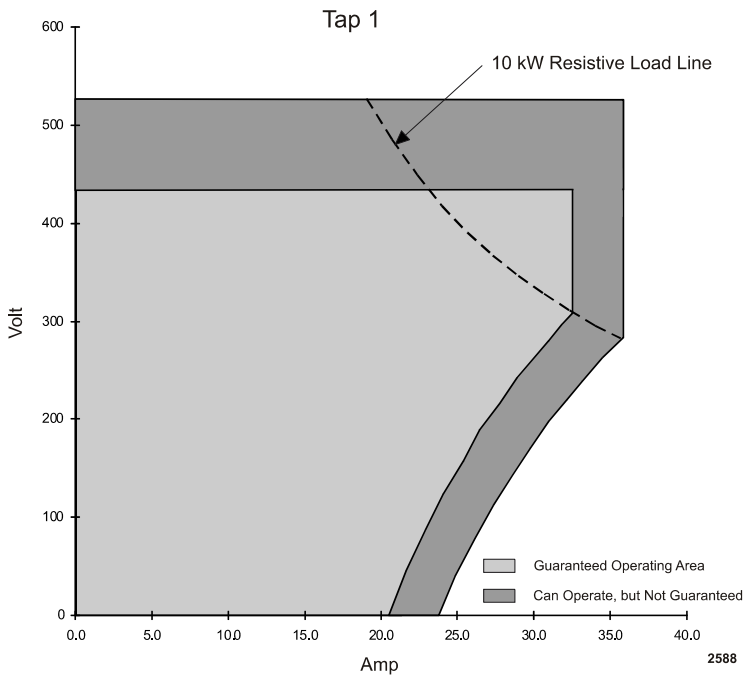

Figure 3-3. *Tap 1 operating range*

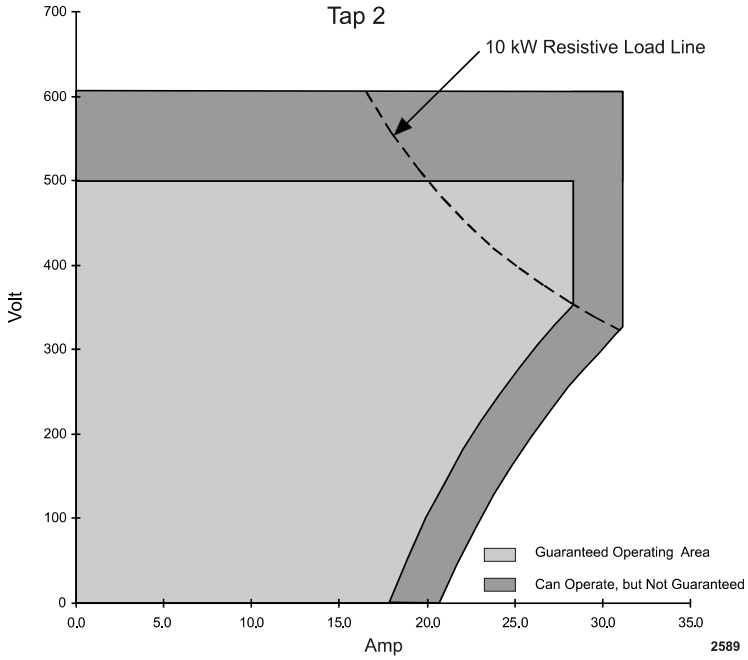

Figure 3-4. *Tap 2 operating range*

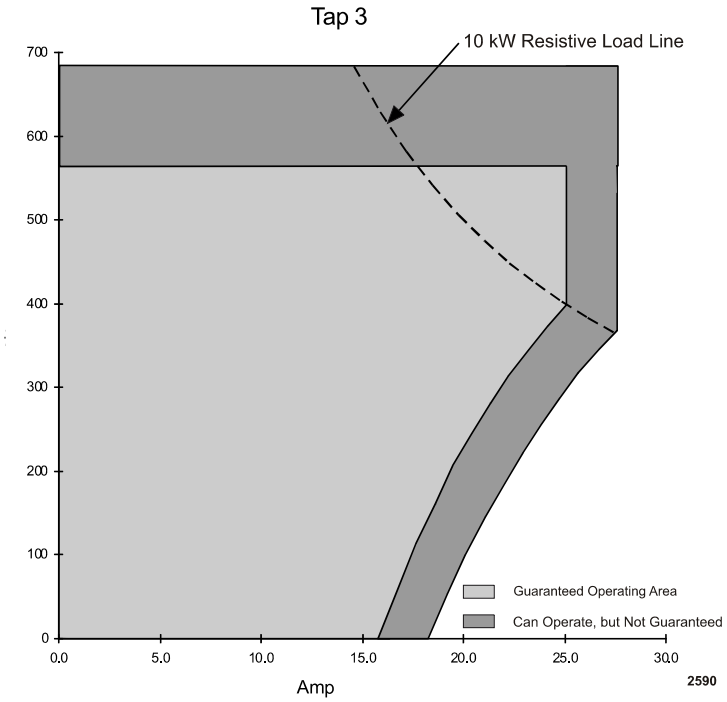

Figure 3-5. *Tap 3 operating range*

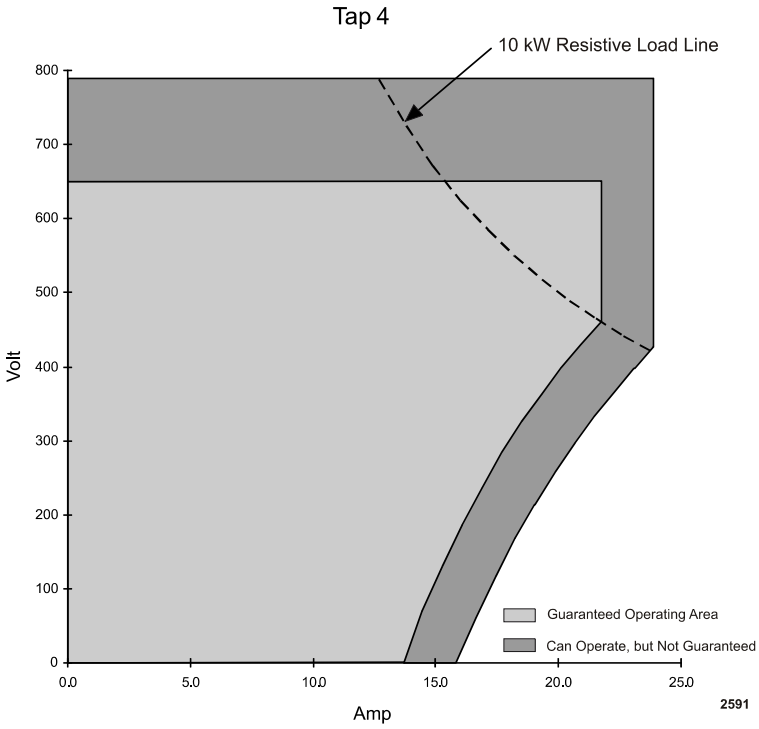

Figure 3-6. *Tap 4 operating range*

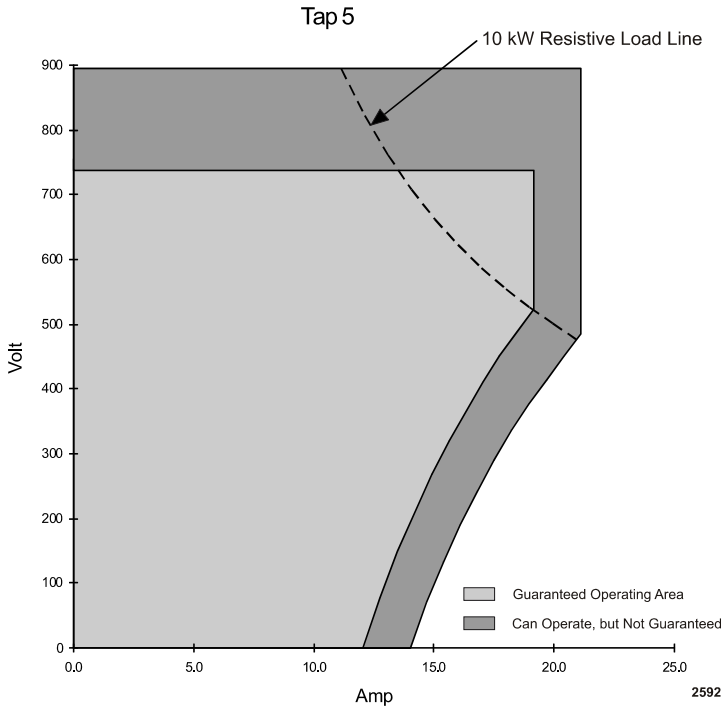

Figure 3-7. *Tap 5 operating range*

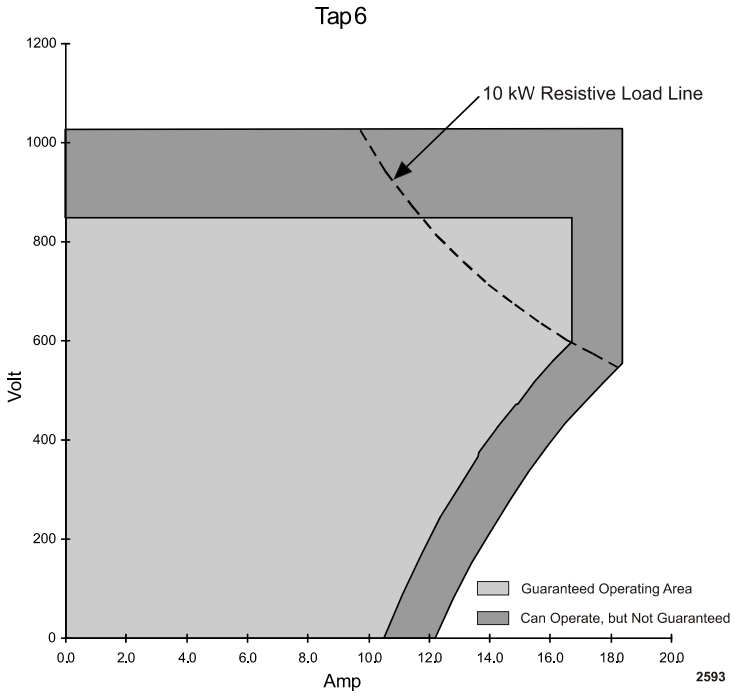

Figure 3-8. *Tap 6 operating range*

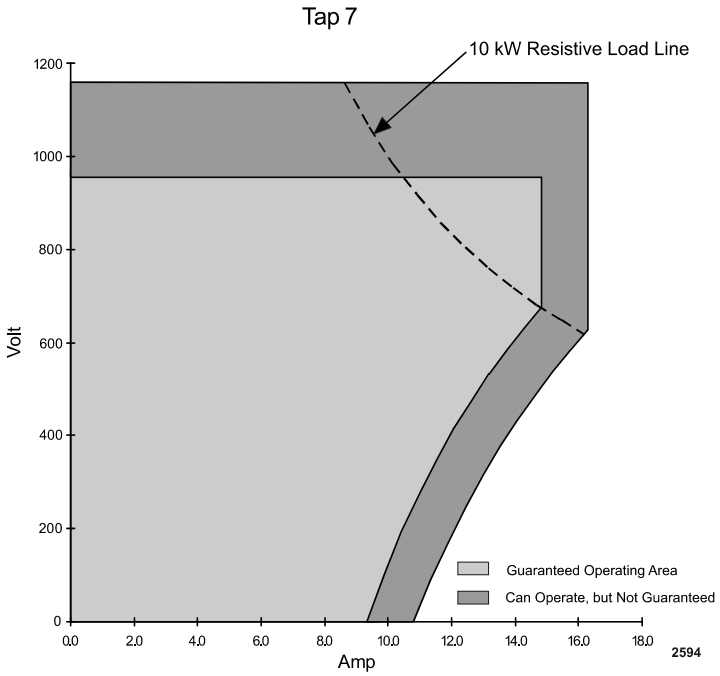

Figure 3-9. *Tap 7 operating range*

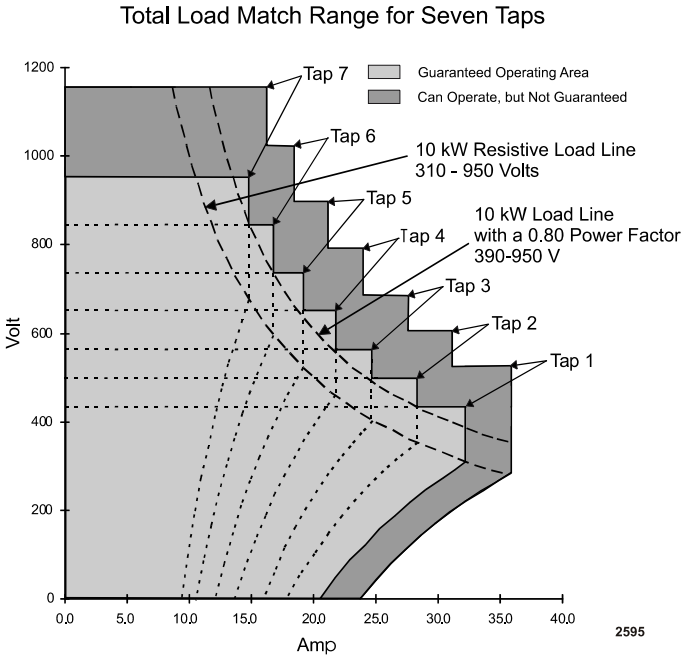

Figure 3-10. *Overlap of the tap operating ranges*

ENVIRONMENTAL SPECIFICATIONS

Table 3-5 lists the environmental specifications for the PE II power supply.

Table 3-5. *Environmental specifications*

	Temperature	Relative Humidity	Air Pressure
Operating	Class 3K3 O°C to +40°C +32°F to +104°F	Class 3K2 10% to 85% Note 1 +2 g/m^3 to +25 g/m^3	Class 3K3 80 kPa to 106 kPa 800 mbar to 1060 mbar (approximately 2000 m above sea level)
Storage	Class 1K4 -25°C to +55°C -13°F to +131°F	Class 1K3 35% to 95% +1 g/m^3 to 29 g/m^3	Class 1K4 80 kPa to 106 kPa 800 mbar to 1060 mbar (approximately 2000 m above sea level)
Transportation	Class 2K3 -25°C to +70°C -13°F to +158°F	Class 2K3 95% Note 2 +60 g/m^3 Note 3	Class 2K3 66 kPa to 106 kPa 660 mbar to 1060 mbar (approximately 3265 m above sea level)

Note 1 Non-condensing

Note 2 Maximum relative humidity when the unit temperature slowly increases, or when the unit temperature directly increases from -25°C to +30°C

Note 3 Maximum absolute humidity when the unit temperature directly decreases from +70°C to +15°C

COOLING SPECIFICATIONS

Table 3-6 lists the water coolant specifications for the PE II power supply.

CAUTION:
Do not use de-ionized water for cooling AE power supplies.

CAUTION:

You must stop coolant flow when the PE II power supply is not operating or severe damage may occur from condensation. Condensation damage can result in a disqualification of the warranty if proper precautions are not taken to arrest cooling water flow during non-operating periods. Advanced Energy has a Water Shutoff Solenoid (AE part number: 3163028), with interface, designed for the PE II product line. Contact an Advanced Energy sales or service representative for more information. See "AE Global Customer Support" on page 6-17 for more information.

Table 3-6. *Cooling specifications*

Description	Specification
Temperature	+5°C to +30°C inlet temperature
Flow rate	7.57 liters (2 gallons) per minute minimum
Pressure	100 psi (6.9 bars) maximum inlet pressure
Pressure drop	6 psi (0.41 bars) @ 2gpm, inlet to outlet (new)
Contaminants	The following specifications are recommended for the water used to cool the PE II power supply: • pH between 7 and 9 • total chlorine < 20 ppm • total nitrate < 10 ppm • total sulfate < 100 ppm • total dissolved solids < 250 ppm • total hardness expressed as calcium carbonate equivalent less than 250 ppm • specific resistivity of 2500 Ω/cm or higher at 25°C • total dissolved solids (TDS) as estimated by the following: $TDS \leq \frac{640{,}000}{\text{specific resistivity (in } \Omega\text{/cm)}}$

Communication Interfaces

USER PORT

The **User** port on the PE II power supply provides analog and digital signals for controlling and monitoring the unit. This section describes the **User** port connector, **User** port cabling requirements, and detailed information about the **User** port signals.

User Port Connector

As shown in Figure 4-1, the **User** port is a 25-pin, shielded, female, subminiature-D connector.

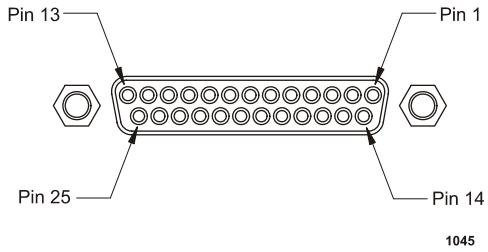

Figure 4-1. *User port connector*

User Port Interface Cabling Requirements

Connect the PE II power supply's 25-pin **User** port to the system controller with a shielded, 25-wire I/O cable. Shielded twisted-pair wiring may be used but is not mandatory.

Minimize signal losses by keeping the cable as short as possible. The maximum recommended cable length between the PE II power supply and the controller is 10 meters (33 feet). Minimize interference from adjacent electrical equipment by terminating the EMI shield in the cable to the metal shells of the cable's connectors. Additionally, you must tie the chassis of the PE II power supply to a local earth ground through an adequately sized copper grounding strap.

Note: Grounding the **User** port at the PE II power supply reduces noise interference. To avoid ground loop problems, you should typically ground only one end of the **User** port cable.

User Port Signal Type Descriptions

Table 4-1 provides information about the **User** port signal types.

Table 4-1. *User port signal type descriptions*

Description	Characteristics
Analog signal characteristics	An ".A" indicates an analog signal. All analog input/output signals are 0 V to 10 V pseudo-differential (non-ground referenced at the power supply). The analog reference lines should be tied to chassis or analog ground at the controller end. The maximum load on analog outputs is 5 mA.
Digital signal characteristics	A ".D" indicates a digital signal.
Digital outputs	Opto-isolated, referenced to digital common, standard 24 VDC PLC logic.

User Port Pin Descriptions

Table 4-2 provides the connector pin descriptions for the **User** port interface. For interface wiring diagrams for all active pins, see "User Port Wiring Diagrams" on page 4-7.

Table 4-2. *User port pin descriptions*

Signal Pin	Return Pin	Signal Name	Signal Type	Description
1	15	*CURRENT*	Analog output	Represents the value of the output current (in A_{RMS}). The signal is scaled as follows: • 0 V = 0 V • 10 V = *n* x 35 A *Note:* Where *n* is the number of combined units.
2	15	*VOLTAGE*	Analog output	Represents the value of the output voltage (in V_{RMS}). The signal is scaled as follows: • 0 V = 0 V • 10 V = 1100 V

Table 4-2. *User port pin descriptions (Continued)*

Signal Pin	Return Pin	Signal Name	Signal Type	Description
3	15	*POWER*	Analog output	Represents the average value of the output power. The signal is scaled as follows: • 0 V = 0 kW • 10 V = *n* x 10 kW *Note:* Where *n* is the number of combined units.
4	19	*OUTPUT ON*	Digital input	Turns the output on. Output is turned on when a digital high is applied to pin 4. See Table 4-4 on page 4-6 for digital signal requirements.
5	18	*SET POINT*	Analog input	Represents the desired output power, voltage, or current. Signal is scaled as follows: • 0 V = 0 (W, V, or A, depending on regulation mode selected) • 10 V = Full-rated output for unit Regulation mode is set through the active front panel or remotely using pins 11 and 24.
6	19	*+24V INPUT*	+24 VDC	Input voltage (user provided) for digital inputs and outputs. *Note:* See Table 4-4 on page 4-6 for the requirements for this voltage.
7	n/a	Unassigned	n/a	Reserved for future use.
8	19	*CURRENT ARC (I-ARC)*	Digital output	A high signal confirms that a current arc (I-Arc) has occurred; typical signal time is 20 ms ± 2 ms. See "I-Arc Settings (S1)" on page 5-33 for more information.

Table 4-2. *User port pin descriptions (Continued)*

Signal Pin	Return Pin	Signal Name	Signal Type	Description
9	19	*VOLTAGE ARC (V-ARC)*	Digital output	A high signal confirms that a voltage arc has occurred; typical signal time is 20 ms ± 2 ms. If a voltage arc recurs within 20 ms, the signal goes low for a minimum of 180 µs and then high again for the next 20 ms. *Note:* See "V-Arc Settings (S2)" on page 5-34 for more information.
10	23	*INTERLOCK*	Interlock loop	When this loop (pins 10 and 23) is interrupted, the output remains off until you reestablish the interlock and reset the unit by toggling off the *Output On* signal. *Note:* The interlock loop uses two pins. The current output of one pin must return to the other pin, and the loop must be isolated from ground. See "Interlocks" on page 1-7 for more information.
11	19	*REG 1*	Digital input	Used in conjunction with *REG 2* (pin 24) to set the regulation mode remotely. *Note:* See Table 4-3 on page 4-6 for further information.
12	19	*TAP 1*	Digital Input	Used in conjunction with *TAP 2* (pin 25) and *TAP 3* (pin 13) to select the taps remotely. *Note:* See Table 4-5 on page 4-7 for further information.
13	19	*TAP 3*	Digital input	Used in conjunction with *TAP 1* (pin 12) and *TAP 2* (pin 25) to select the taps remotely. *Note:* See Table 4-5 on page 4-7 for further information.

Table 4-2. *User port pin descriptions (Continued)*

Signal Pin	Return Pin	Signal Name	Signal Type	Description
14	19	*SET POINT*	Digital output	A high signal confirms that the power supply is delivering the requested set point (high). *Note:* Once the set point is confirmed, the signal transitions low and stays low for a minimum of 18 ms.
15	1, 2, 3	*ANALOG OUTPUT REFERENCE*	Analog output reference	Analog output reference for pins 1, 2, and 3. *Note:* The analog reference lines must be tied to chassis or analog ground at the controller end.
16	21	*MASTER*		Contact closure to the chassis ground (pin 21) with less than 800 Ω series resistance designates the unit as a master or standalone 10 kW power supply. An open circuit designates the unit as a slave.
17	19	*PULSE OFF*	Digital input	Pulses the power supply off. The pulsing signal is limited to the following: an off time from 1 ms to 500 ms and a repetition rate of 1 to 500 times per second. On time is limited to a minimum of 1 ms. See "Pulsing Unit Output" on page 5-39 for more information.
18	5	*SET POINT REFERENCE*	Analog input reference	Analog input reference for pin 5.
19	n/a	*DIGITAL COMMON*	Digital common reference	Dedicated reference for pins 4, 6, 8, 9, 11, 12, 13, 14, 16, 17, 20, 22, 24, and 25.
20	19	*OUTPUT*	Digital output	A high signal confirms that output is enabled.
21	n/a	*CHASSIS GND*	Ground	Chassis ground
22	19	*OVERTEMP*	Digital output	A high signal confirms that an internal temperature limit has been exceeded.
23	10	*INTERLOCK*	Interlock loop	See pin 10 for signal description.

Table 4-2. *User port pin descriptions (Continued)*

Signal Pin	Return Pin	Signal Name	Signal Type	Description
24	19	*REG 2*	Digital input	Sets the regulation mode remotely in conjunction with *REG 1* (pin 11) (Table 4-3 on page 4-6).
25	19	*TAP 2*	Digital input	Used with *TAP 1* (pin 12) and *TAP 3* (pin 13) to select the taps remotely.

REGULATION MODE CONTROL PINS

Table 4-3 provides further detail about setting the regulation mode via the **User** port.

Table 4-3. *Regulation mode control pins*

REG 2 (User port pin 24)	REG 1 (User port pin 11)	Mode
0	0	Power
0	1	Voltage
1	0	Current
1	1	Power

USER PORT +24 V SUPPLY REQUIREMENTS

Table 4-4 provides further detail about setting the +24 V supply requirements via the **User** port.

Table 4-4. *User-provided +24 V supply requirements*

Parameter	Setting
Voltage (nominal)	24 VDC
Permissible voltage range	20 V to 30 V
Current (load dependent)	2.5 A maximum

TAP SETTING CONTROL PINS

Table 4-5 provides further detail about making the tap selection via the **User** port.

Table 4-5. *Tap settings through the User port*

Tap Position	TAP 1 (Pin 12)	TAP 3 (Pin 13)	TAP 2 (Pin 25)
1	0	0	0
2	1	0	0
3	0	0	1
4	1	0	1
5	0	1	0
6	1	1	0
7	0	1	1
7	1	1	1

User Port Wiring Diagrams

The following schematics illustrate how to properly connect the PE II power supply **User** port. For detailed pin descriptions, see "User Port Pin Descriptions" on page 4-2.

ANALOG INPUT WIRING DIAGRAM

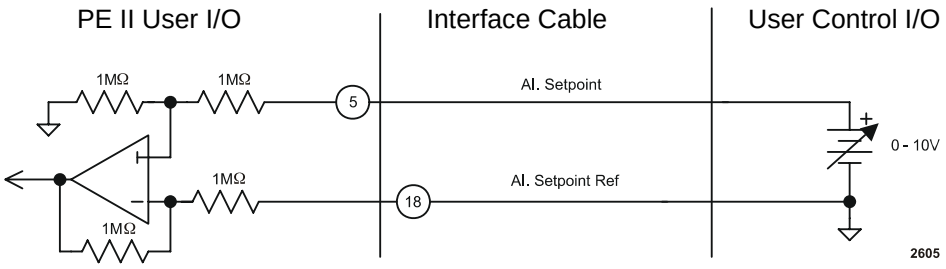

Figure 4-2. *Analog input schematic*

ANALOG OUTPUT WIRING DIAGRAM

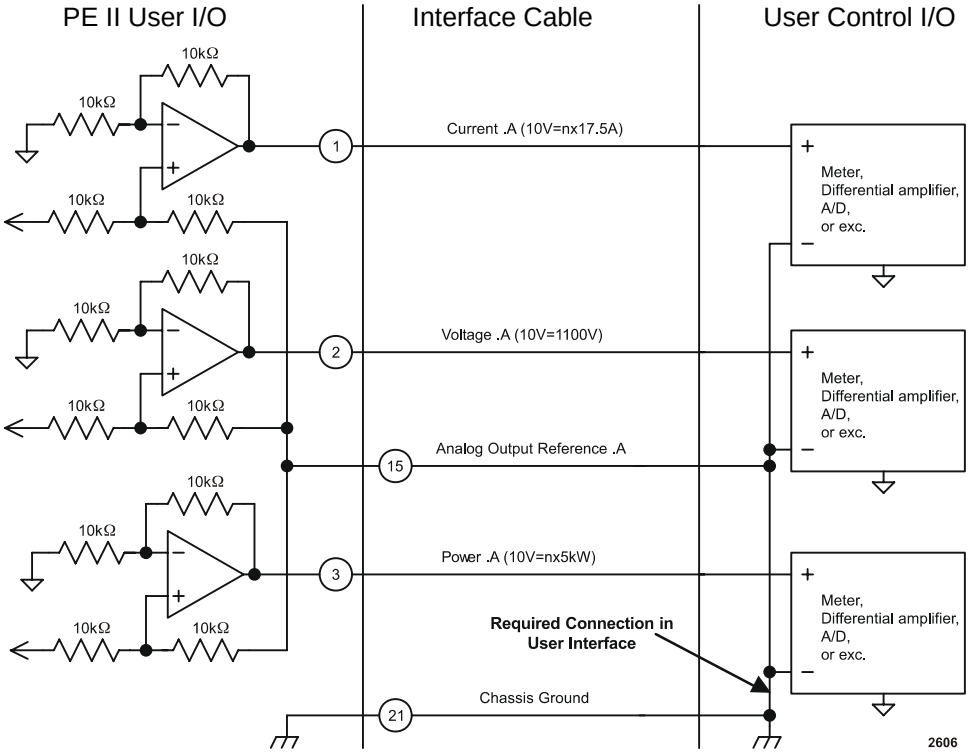

Figure 4-3. *Analog output schematic*

DIGITAL INPUT WIRING DIAGRAM (DIGITAL 0-24 V)

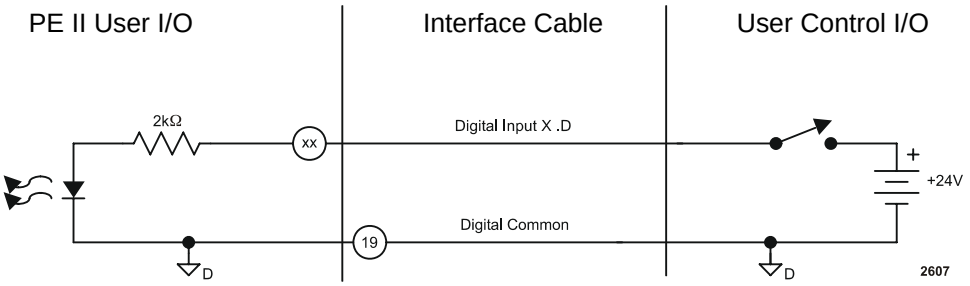

Figure 4-4. *Digital input (0 V to 24 V) schematic*

DIGITAL OUTPUT WIRING DIAGRAM

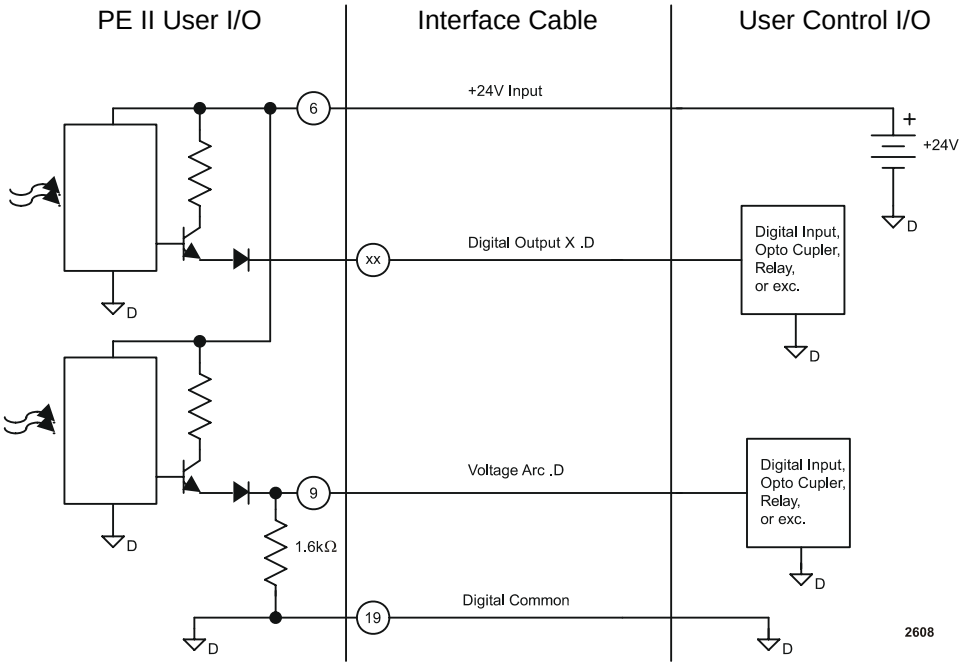

Figure 4-5. *Digital output schematic*

DIGITAL INPUT WIRING DIAGRAM (NON-24 V)

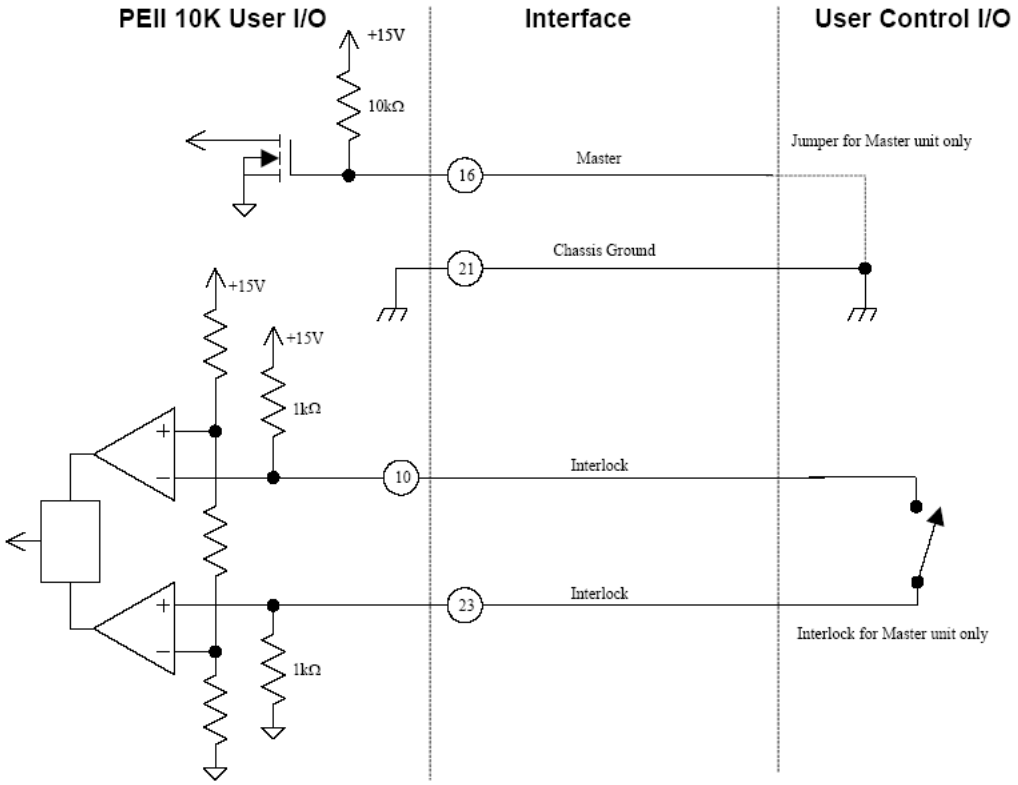

Figure 4-6. *Digital input (non-24 V) schematic*

OUTPUT ON WIRING DIAGRAM

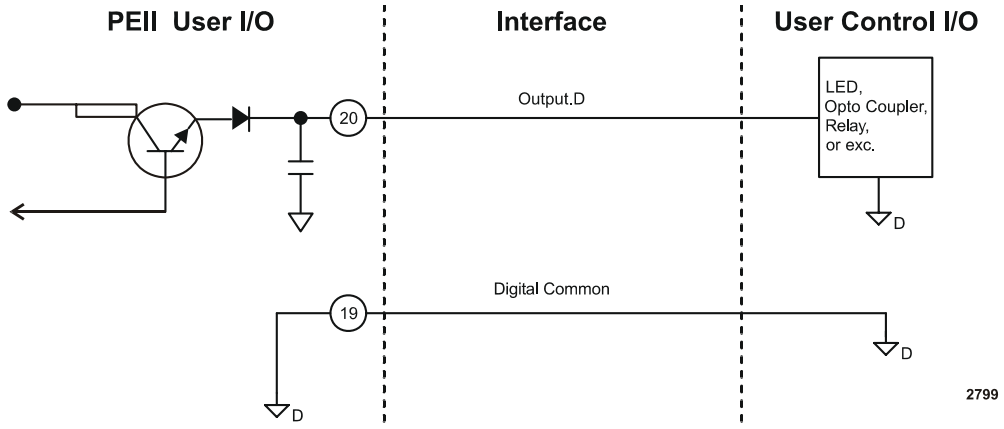

Figure 4-7. *Output on schematic*

CEX/DRIVE IN PORT CONNECTOR

The **CEX/Drive In** port is a 50-pin, SCSI 2, female connector with 2-56 jack posts located on the rear of the unit. This port serves as a communication interface for power supplies connected in a master/slave or CEX configuration. The signals on this connector are a mix of analog and digital signals.

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect all sources of input power before working on this unit or anything connected to it.

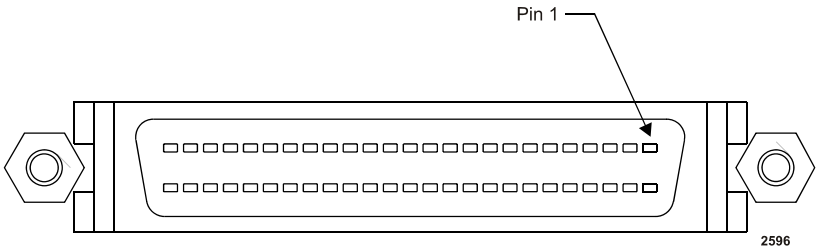

Figure 4-8. *CEX/DRIVE IN port connector*

CEX/DRIVE OUT PORT CONNECTOR

The **CEX/Drive Out** port connector is a 50-pin, SCSI 2, female, with spring clips, located on the rear of the unit. This port serves as a communication interface for power supplies connected in a master/slave or CEX configuration. The signals on this connector are a mix of analog and digital signals.

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect all sources of input power before working on this unit or anything connected to it.

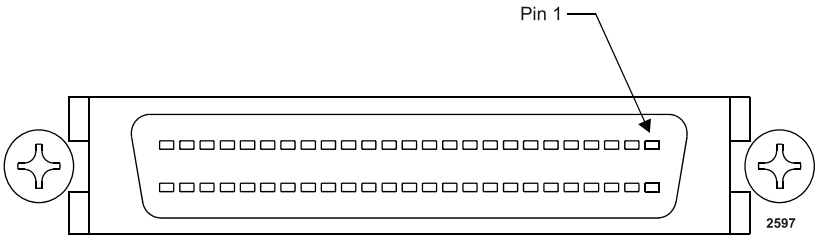

Figure 4-9. *CEX/DRIVE OUT port connector*

RF OUTPUT MONITORING PORTS

Use the *V-mon* and *I-mon* ports to view the voltage and current waveforms of the power supply outputs. The *V-mon* and *I-mon* port connectors are BNC female connectors located on the rear panel of the unit

Note: See "Electrical Specifications" on page 3-8 for more information about the *V-mon* and *I-mon* pin specifications.

UNIT FRONT PANEL

Depending on your unit configuration, you may have either a passive front panel interface or an active front panel interface. If you have a passive front panel interface, see "Passive Front Panel" for more information. If you have an active front panel interface, see "Active Front Panel" on page 4-14 for more information.

Passive Front Panel

The passive front panel features six status LEDs which show the PE II power supply status. To control and monitor the PE II power supply, use the **User** port communication interface.

Note: See Figure 5-27 on page 5-41 for an illustration of the passive front panel of the PE II power supply.

STATUS INDICATORS

Figure 4-10 shows the LEDs on a passive front panel interface. Table 4-6 provides a description of the passive front panel LEDs.

Note: For additional LED status information, see "Normal Operation" on page 5-29 and "Troubleshooting the Unit" on page 6-1.

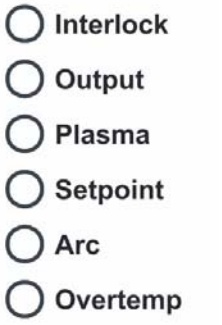

Figure 4-10. *Passive front panel LEDs*

Table 4-6. *Passive front panel LED status*

LED	Status Description
Interlock	When illuminated, this LED indicates that AC power is available to the unit, and indicates the status of the I/O interlock. The status of this LED works in conjunction with the **Output** LED to indicate problems in the setup of the unit or a combined system of power supplies.
Output	When illuminated, this LED indicates that the unit is ready to output power and the inverter section is functional. You can interpret the status of the LED according to the following: • The status of this LED works in conjunction with the **Interlock** LED to indicate problems in the setup of the unit or a combined system of power supplies. • The status of this LED works in conjunction with the **Overtemp** LED to indicate a relay failure in the tap select section.
Plasma	When illuminated, this LED indicates that the output current is greater than 1 to 5% of the maximum permissible current (see “Tap Operating Information” on page 3-11) for the selected tap. The status of this LED works in conjunction with the **Setpoint** LED to indicate that the unit is unable to balance its output with other units in a combined system of power supplies.

Table 4-6. *Passive front panel LED status (Continued)*

LED	Status Description
Setpoint	When illuminated, this LED indicates that the unit is able to satisfy the requested set point, power, voltage, or current. The status of this LED works in conjunction with the **Plasma** LED to indicate that the unit is unable to balance its output with the other units in a combined system of power supplies.
Arc	When illuminated, this LED indicates that the unit has experienced a current arc (I-Arc). To modify the arc handling capabilities of your unit, see "I-Arc Settings (S1)" on page 5-33 for more information.
Overtemp	When illuminated, this LED indicates that the unit has exceeded its maximum allowable internal temperature. The status of this LED works in conjunction with the **Output** LED to indicate a relay failure in the tap select section.

Active Front Panel

The following information describes the various features available on the active front panel interface.

STATUS INDICATORS

Figure 4-11 shows the LEDs on an active front panel interface. Table 4-7 provides a description of the active front panel LEDs.

Note: For additional LED status information, see "Normal Operation" on page 5-29 and "Troubleshooting the Unit" on page 6-1.

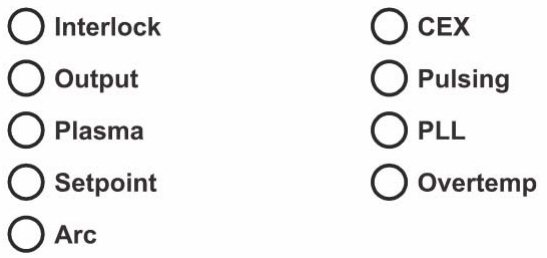

Figure 4-11. *Active front panel LEDs*

Table 4-7. *Active front panel LED status*

LED	Status Description
Interlock	When illuminated, this LED indicates that AC power is available to the unit, and indicates the status of the I/O interlock. The status of this LED works in conjunction with the **Output** LED to indicate problems in the setup of the unit or a combined system of power supplies.
Output	When illuminated, this LED indicates that the unit is ready to output power and the inverter section is functional. You can interpret the status of the LED according to the following: • The status of this LED works in conjunction with the **Interlock** LED to indicate problems in the setup of the unit or a combined system of power supplies. • The status of this LED works in conjunction with the **Overtemp** LED to indicate a relay failure in the tap select section.
Plasma	When illuminated, this LED indicates that the output current is greater than 1 to 5% of the maximum permissible current (see "Tap Operating Information" on page 3-11) for the selected tap. The status of this LED works in conjunction with the **Setpoint** LED to indicate that the unit is unable to balance its output with other units in a combined system of power supplies.
Setpoint	When illuminated, this LED indicates that the unit is able to satisfy the requested set point, power, voltage, or current. The status of this LED works in conjunction with the **Plasma** LED to indicate that the unit is unable to balance its output with the other units in a combined system of power supplies.
Arc	When illuminated, this LED indicates that the unit has experienced a current arc (I-Arc). To modify the arc handling capabilities of your unit, see "I-Arc Settings (S1)" on page 5-33 for more information.
CEX	When illuminated, this green LED indicates that the unit is receiving a CEX signal. *Note:* Only a master unit responds to the CEX input.

Table 4-7. *Active front panel LED status (Continued)*

LED	Status Description
Pulsing	When illuminated, this green LED indicates that the unit is receiving a pulsing signal. *Note:* Only a master unit responds to the pulsing input of a signal generator. See "Pulsing Unit Output" on page 5-39 for more information.
PLL	When illuminated, this yellow LED indicates that the phase lock loop of the PE II power supply is unable to lock on to the reference frequency. The reference frequency for a master unit is internal or from the CEX signal. For a slave unit, the master unit supplies the reference frequency.
Overtemp	When illuminated, this LED indicates that the unit has exceeded its maximum allowable internal temperature. The status of this LED works in conjunction with the **Output** LED to indicate a relay failure in the tap select section.

OUTPUT AND SET POINT READOUTS

The following output readouts are available on the active front panel's digital display screen (from left to right):

- power
- current
- voltage
- set point for power, voltage, or current (depending on the regulation mode).

The regulation mode LEDs to the right of the digitial display indicate the current regulation mode setting. For example, if you set power as the regulation mode, the **kW** LED is illuminated. See "Understanding Power Calculation for the Unit" on page 4-17 for more information about how to interpret the output readings on the PE II power supply.

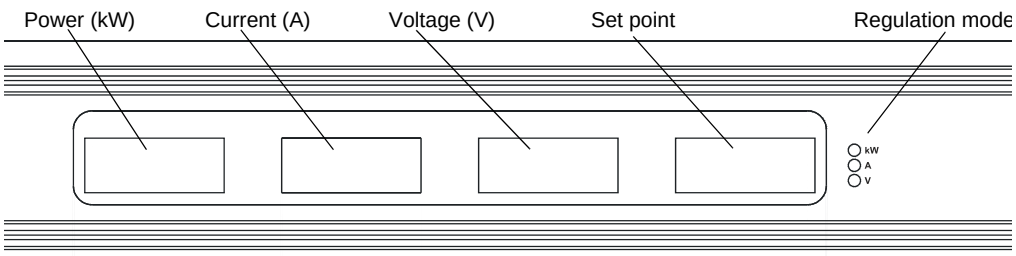

Figure 4-12. *Active front panel digital displays*

Understanding Power Calculation for the Unit

When viewing the output readings on the PE II power supply you may find some discrepancy in the displayed power reading and the actual power calculation based on the displayed voltage and current readings. The following information explains how the unit calculates power and why this discrepancy occurs.

The output readings are generated at the measurement/load match card of the PE II power supply (see "Measurement/Load Match" on page 2-4 for more information). This card converts voltage and current from an AC waveform to a DC_{RMS} representation. The I_{RMS} and V_{RMS} representations are derived from the peak values of the waveform. See Figure 4-13 for an illustration of the voltage and current waveforms. The current will lead or lag the voltage depending on if the power supply is sensing a primarily capacitive or primarily inductive load.

In contrast, the measurement/load match card measures power by reading the voltage and current waveforms and instantaneously calculating power. This calculation is then converted to a DC_{RMS} representation. In this situation, you must understand that the power reading displayed by the PE II power supply is not the result of the *peak voltage* multiplied by the *peak current,* and thus, does not represent *peak power*. The power reading displayed by the unit and used for power regulation is true power delivered to the chamber. When the PE II power supply calculates power it takes into account the *power factor (*or VA*)*. The power factor is calculated as:

VA = V x I x COS (phase angle).

Thus, the PE II power supply displays $voltage_{RMS}$, $current_{RMS}$, and power as:

KW = VA = V x I x COS (phase angle).

Figure 4-13 illustrates how the power supply calculates voltage, current and power. The circles in Figure 4-13 indicate the points on the waveform used to measure voltage and current and provide an example of how the unit measures power.

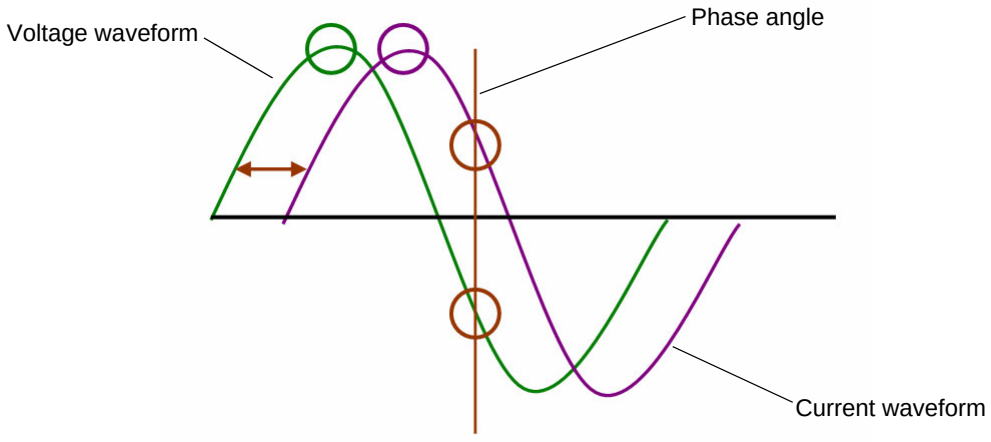

Figure 4-13. *Illustration of voltage and current waveforms*

If you use the voltage and current values displayed on the unit front panel to calculate power, you calculate a higher power value than the displayed power value. However, if you calculate power using the displayed voltage and current values multiplied by the cosine of the measured phase angle, you calculate an approximate power level close to the displayed power level. One method of measuring the phase angle is by using the **V-mon** and **I-mon** output monitoring ports.

Note: Because the phase angle can vary among chambers, the unit displays different power readings for different chambers. For example, a purely resistive load may give you a power factor of 1. In this situation, multiplying the displayed voltage value by the displayed current value would calculate a power level very close to the displayed power value.

The harmonic content of the AC waveforms may also cause a discrepancy in the displayed power reading and the actual power calculation based on the displayed voltage and current readings. A voltage waveform inherently has more harmonic content than a current waveform. In some situations, the 3rd and 5th harmonic can be very large and cause distortions in the calculations. The grounding of the chamber and power supply, cabling used, environment surrounding the power supply, incoming power quality, and so on can affect the waveform harmonics. The PE II power supply measurement has been designed to reduce the effect of this phenomenon, but it is virtually impossible to eliminate.

OUTPUT POWER SWITCHES

When in local control mode, the PE II power supply output power is controlled by the **Output Power Stop** and **Start** switches. These latch-type switches stay in the selected position: in for *on* (or closed), and out for *off* (or open) when pressed. These switches are disabled when the unit is operating in remote mode (monitoring and control functions are assigned to a controller through the **User** port). See "Remote Switches" on page 4-19 for more information about operating in remote mode.

Note: To view the status of the output, verify the status of the **Output** LED. For more information about the active front panel **Output** LED, see "Status Indicators" on page 4-14.

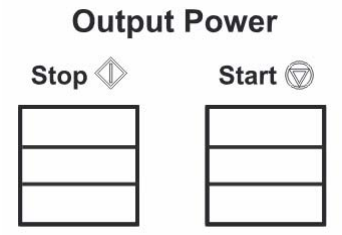

***Figure 4-14. Output Power Stop** and **Start** switches*

REGULATION SWITCHES

The regulation switches allow you to select voltage, current, or power regulation mode (when operating in local control mode). These latch-type switches stay in the selected position: in for *on* (or closed), and out for *off* (or open) when pressed. These switches are disabled when the unit is operating in remote mode (monitoring and control functions are assigned to a controller through the **User** port).

Note: See "Remote Switches" on page 4-19 for more information about operating in remote mode.

Figure 4-15 illustrates the regulation switches on an active front panel interface. Table 4-8 provides regulation mode and switch position information.

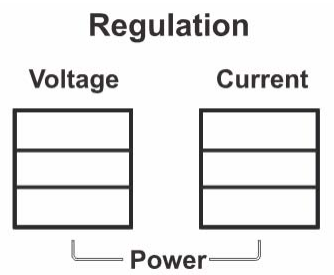

***Figure 4-15. Regulation** switches*

***Table 4-8.** Regulation mode and **Regulation** switch positions*

Regulation Mode	Voltage Switch	Current Switch
Voltage	In	Out
Current	Out	In
Power	In	In
Power	Out	Out

REMOTE SWITCHES

The **Remote** switches determine which functions of the PE II power supply you will control from the active front panel (local mode) and the **User** port (remote mode). These latch-type switches stay in the selected position: in for *on* (or closed), and out for *off* (or open) when pressed.

Note: When the LED on the switch is illuminated, the function is controlled through the **User** port.

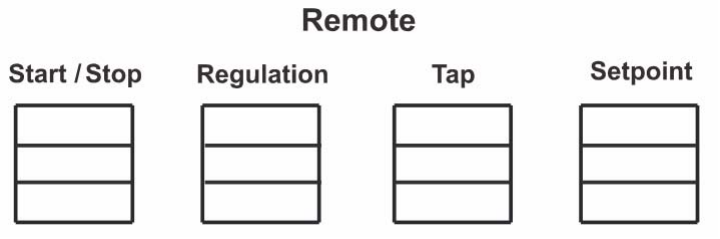

Figure 4-16. *Active front panel* ***Remote*** *switches*

The **Remote** switches function according to the following:

- **Start/Stop** switch

  Press this switch to assign the power stop/start function through the **User** port. When the LED on this switch is illuminated, the **Output Power** switches on the active front panel are disabled.

- **Regulation** switch

  Press this switch to assign the regulation mode selection through the **User** port. When the LED on this switch is illuminated, the **Regulation** switches on the active front panel are disabled.

- **Tap** switch

  Press this switch to assign the tap selection through the **User** port. When the LED on this switch is illuminated, the **Tap Select** knob on the active front panel is disabled.

- **Setpoint** switch

  Press this switch to select the regulation mode set point through the **User** port. When the LED on this switch is illuminated, the **Level** knob on the active front panel is disabled.

TAP SELECT KNOB

When in local control mode, use the **Tap Select** knob to select a tap to match an output load range. See "Tap Operating Information" on page 3-11 for tap settings and output load ranges.

Note: If the **Remote Tap** switch is depressed, you must use the **User** port interface to make the tap selection.

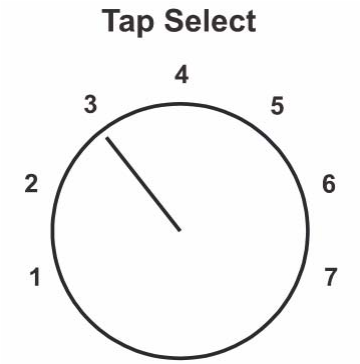

Figure 4-17. *Active front panel* ***Tap Select*** *knob*

LEVEL KNOB

When in local control mode, use the **Level** knob to select a set point level for the regulation mode (power, voltage, or current). As you set the set point, you can view the setting on the digital display readout screen. Once you have selected the desired set point level, twist the locking ring on the outside of the knob to secure the knob's position. The current set point level displays on the digital display screen of the active front panel. See "Output and Set Point Readouts" on page 4-16 for more information.

Note: If the **Remote Setpoint** switch is depressed, you must use the **User** port interface to select a set point level.

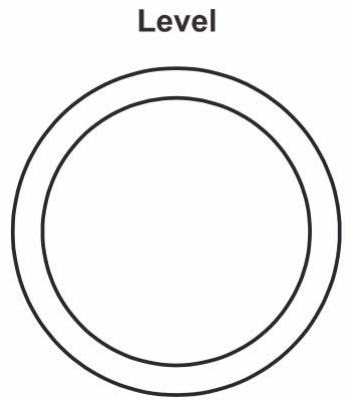

Figure 4-18. Level *knob*

Installation and Operation

PREPARING TO INSTALL THE UNIT

The following sections provide information that you need to understand before installing the PE II power supply.

Spacing Requirements

For the PE II power supply to be sufficiently cooled, you must mount the PE II power supply so that there is:

- A minimum of 25 mm (1") clearance on each side of the unit
- A minimum of 25 mm (1") clearance at the front panel
- A minimum of 50 mm (2") clearance at the rear panel
- A minimum of 13 mm (0.5") clearance above and below the unit.

Failure to observe these spacing requirements can cause overheating to occur which may result in damage to your unit.

See "Dimensional Drawing" on page 3-7 for an illustration of the unit dimensions.

Installation Requirements

Install this unit according to the following requirements.

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

WARNING:
Operating and maintenance personnel must receive proper training before installing, troubleshooting, or maintaining high-energy electrical equipment. Potentially lethal voltages are present and could cause death, serious personal injury, or damage to the equipment. Ensure that all appropriate safety precautions are taken.

CAUTION:
Where the rated AC input voltage for the power supply is not directly available, a transformer meeting the applicable requirements must be installed at the AC input.

Unpacking the Unit

Unpack your power supply carefully. Inspect the unit, looking for obvious physical damage. If no damage is apparent, proceed with the unit connections. If you do see signs of shipping damage, contact Advanced Energy Industries, Inc., and the carrier immediately. (See "AE Global Customer Support" on page 6-17 for contact information.) Save the shipping container for submitting necessary claims to the carrier.

INSTALLING THE UNIT

The following sections explain how to install the unit.

Mounting the Unit

Rack mounting ears are provided for standard 19" instrumentation rack. You must use support rails to support the unit.

ATTENTION:
The PE II power supply face plate will *not* support the weight of the unit.

Grounding the Unit

WARNING:
RISK OF DEATH OR BODILY INJURY. Do not attempt to turn on power until the PE II power supply is grounded.

The PE II power supply features an RFI ground stud. A suitable chassis ground connection made to this stud minimizes radio frequency interference. You must ground the power supply as specified by the conditions of use. See "Conditions of Use" on page 1-6 for more information.

Note: For more information about grounding and signal integrity, refer to the AE web site at www.advanced-energy.com.

Connecting Cooling Water

Following is information you need to make your cooling connections for the PE II power supply.

WARNING:
Do not use de-ionized water for cooling purposes. De-ionized water causes both corrosion and erosion of cooling manifolds.

CAUTION:
You must stop coolant flow when the PE II power supply is not operating or severe damage may occur from condensation. Condensation damage can result in a disqualification of the warranty if proper precautions are not taken to arrest cooling water flow during non-operating periods. Advanced Energy has a Water Shutoff Solenoid (AE part number: 3163028), with interface, designed for the PE II product line. Contact an Advanced Energy sales or service representative for more information. See "AE Global Customer Support" on page 6-17 for more information.

WARNING:
The PE II power supply is water cooled. Do not operate the unit until water is connected and the cooling requirements are met.

WARNING:
If you connect the cooling water on multiple units in series, be sure that input water temperature to all units is less than the maximum input water temperature.

To Make the Cooling Connections:

1. Connect the input and output water connections and tighten securely.

   Note: See "Rear Panel View" on page 5-43 for more information on the location of the input and output connections.

2. Turn on the water and ensure that no leaks exist.
3. Ensure the flow rate and temperature are within the minimum specifications required to operate your PE II power supply.

   Note: See "Cooling Specifications" on page 3-17 for more information.

Connecting Output Power

⚠ WARNING:
RISK OF DEATH OR BODILY INJURY. Once the connections are complete and power is turned on, lethal voltages are present at the output connector. Ensure this connector is terminated and follow normal safety precautions when the system is operating.

CABLE REQUIREMENTS

For a PE II power supply, you need an output cable with an operating voltage of 1100 V and current rating of 35 A. In addition, the insulation over the outside shield should be rated for 1100 V. The outside diameter of the cable must be between 9 mm (0.35") and 18 mm (0.71"). The maximum gauge wire that you can use for the terminal block connections is 8GA.

Note: Use only a shielded power cable on the output power connector.

OUTPUT CONFIGURATION OPTIONS

The following output configuration options are available on the PE II power supply:

- a single (grounded) output

  A single (grounded) output is a single output that has two terminals, of which one terminal is ground.

  Note: See "Connecting a Single (Grounded) Output Configuration" on page 5-5 for more information.

- a dual (floating) output

A dual (floating) output is a single output that has two terminals isolated from ground. Dual (floating) output *does not* have two separate terminals. The dual (floating) output can be converted to a single (grounded) output by grounding one of the output terminals.

Note: See "Connecting a Dual (Floating) Output Configuration" on page 5-12 for more information.

CONNECTING A SINGLE (GROUNDED) OUTPUT CONFIGURATION

When making a single (grounded) output connection, you can use the following types of cable:

- coax cable (see "Using Coax Cable in a Single (Grounded) Output Configuration" on page 5-5 for more information)
- multi-wire cable (see "Using Multi-Wire Cable on a Single (Grounded) Output" on page 5-9 for more information).

Using Coax Cable in a Single (Grounded) Output Configuration

The preparation and connection of your coax output cable in a single (grounded) output configuration is dependant upon the diameter of your output cable (braided) shield.

- If your output cable (braided) shield is less than 9 mm (0.35"), see "To Prepare a Cable with a Smaller Shield Diameter" on page 5-5.
- If your output cable (braided) shield is greater than 9 mm (0.35"), see "To Prepare an Output Cable with a Larger Shield" on page 5-7.

To Prepare a Cable with a Smaller Shield Diameter

The following procedure describes how to prepare the cable if the (braided) shield diameter is less than 9 mm (0.35").

1. Cut the coax cable to the desired length plus 8".
2. Strip the outer insulation of the cable back 6" (see Figure 5-1).
3. Separate the shield from the center conductor, leaving 2" of shield in place (see Figure 5-1).
4. Twist the remaining 4" of shield together (see Figure 5-1).

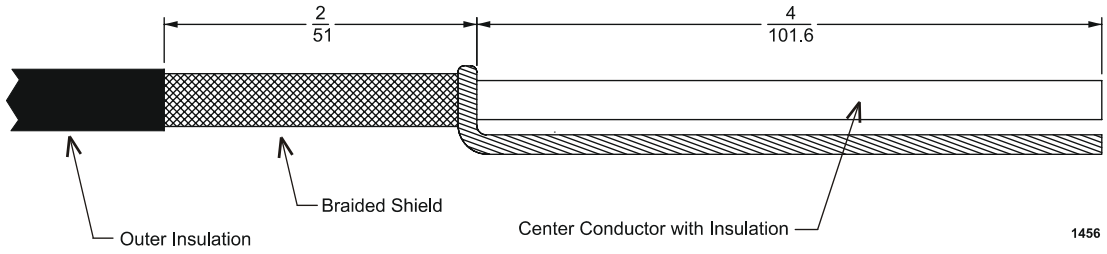

Figure 5-1. *Coax cable with 2" of braided shield in place (small shield)*

5. Fold or bend 2" of shield around the center conductor back 1" over the outside insulation (see Figure 5-2).

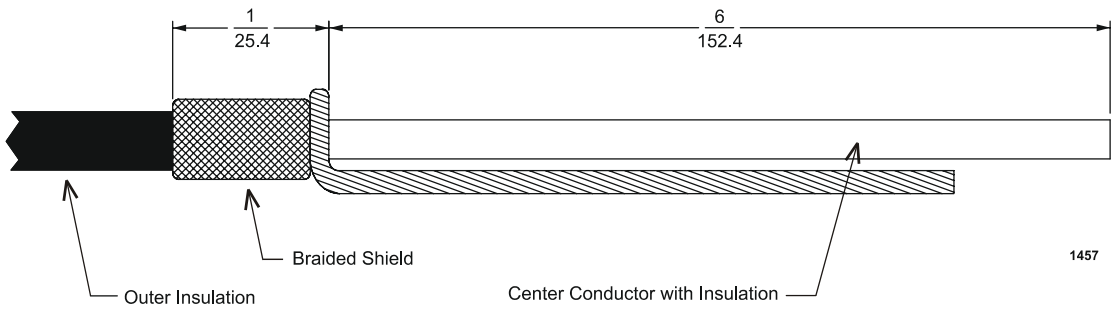

Figure 5-2. *Coax cable with braided shield folded back (small shield)*

6. Cut off 3" of the center conductor with 3" remaining.
7. Strip back 0.5" of the insulation from the center conductor. We suggest that you use a ferrule (brass sleeve) over the wire (optional). See Figure 5-3.
8. Cut a 3" piece of wire for the jumper, and strip back 0.5" of the insulation from both ends (see Figure 5-3).

   Note: The gauge of the jumper should be one to one-and-a-half times the gauge of the cable.

9. Attach the jumper to the shield with a ferrule (brass sleeve). We suggest that you use a ferrule (brass sleeve) over the other end of the wire (optional). See Figure 5-3.

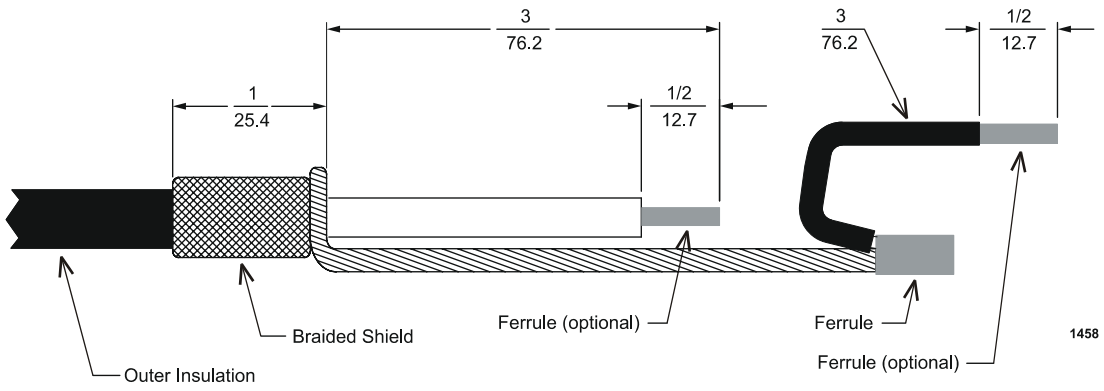

Figure 5-3. *Prepared coax cable for single output (small shield)*

10. See "To Install the Single (Grounded) Output Coax Cable" on page 5-8 to complete installation of the output cable.

To Prepare an Output Cable with a Larger Shield

The following procedure describes how to prepare the cable if the (braided) shield diameter is greater than 9 mm (0.35").

1. Cut the coax cable to the desired length plus 6".
2. Strip the outer insulation back 5" (see Figure 5-4).
3. Separate the shield from the center conductor, leaving 1" of shield in place (see Figure 5-4).
4. Twist the remaining 4" of shield together (see Figure 5-4).

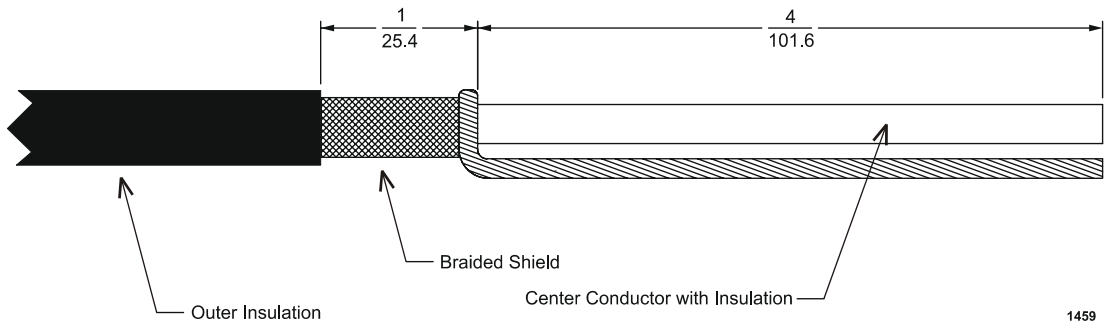

Figure 5-4. *Coax cable 2" of braided shield in place (large shield)*

5. Cut off 1" of the center conductor with 3" remaining.
6. Strip back 0.5" of insulation from the center conductor. We suggest that you use a ferrule (brass sleeve) over the wire (optional). See Figure 5-5.

7. Cut a 3" piece of wire for the jumper, and strip back 0.5" of insulation from both ends (see Figure 5-5).

   Note: The gauge of the jumper should be one to one-and-a-half times the gauge of the cable.

8. Attach the jumper to the shield with a ferrule (brass sleeve). We suggest that you use a ferrule (brass sleeve) over the other end of the wire (optional). See Figure 5-5.

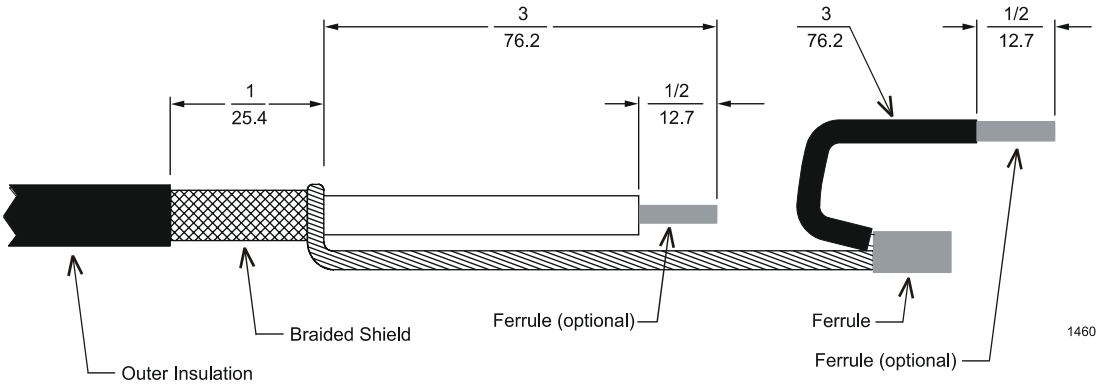

Figure 5-5. *Prepared coax cable single output (large shield)*

9. See "To Install the Single (Grounded) Output Coax Cable" on page 5-8 to complete installation of the output cable.

To Install the Single (Grounded) Output Coax Cable

The following procedure applies to single (grounded) output coax cable configurations with *both* a (braided) shield diameter less than 9 mm (0.35") and a (braided) shield diameter greater than 9 mm (0.35").

Note: If the outside diameter of the cable is less than 13 mm (0.5"), remove the black insert in the PE II strain relief and replace it with the grey insert to accommodate the smaller cable.

1. Remove the safety cover. Use a Phillips head screwdriver to remove the five cover screws.
2. Slide the coax cable through the right strain relief (labeled **Strain Relief #1** in Figure 5-6).
3. Connect the center conductor of the coax cable to the right position of the terminal strip (labeled **+** in Figure 5-6). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

4. Connect the jumper wire to the center position of the terminal strip (labeled with a ground symbol in Figure 5-6). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

5. Connect the shield and the other end of the jumper wire to the left position of the terminal strip (labeled **-** in Figure 5-6). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

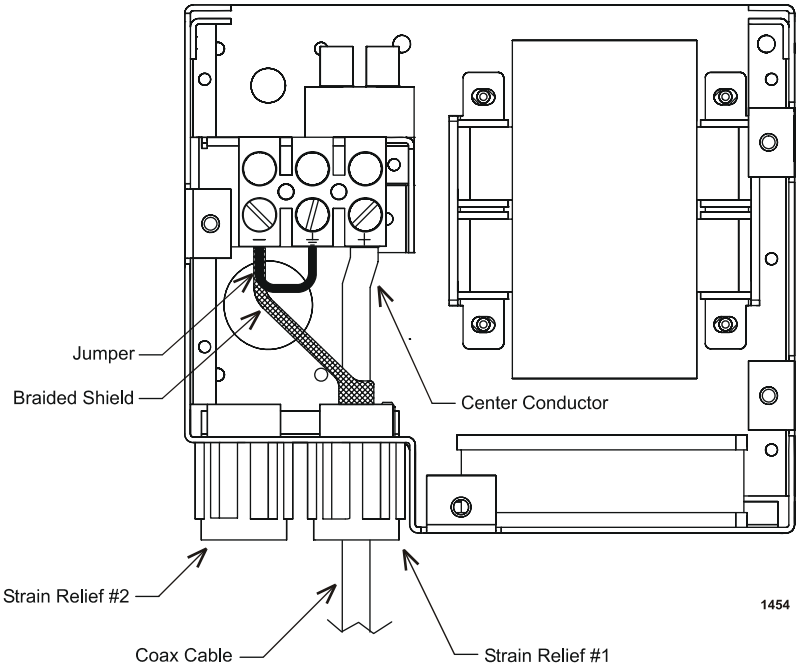

Figure 5-6. *Single (grounded) output power connection using coax cable*

6. Verify the wires have adequate slack inside the housing. Tighten the strain relief nut until it secures the cable into place.
7. Replace the cover on the output assembly. Replace and tighten the five cover screws.
8. See "Connecting Input Power" on page 5-17 to make the input power connection.

Using Multi-Wire Cable on a Single (Grounded) Output

Multi-wire cable is a shielded cable with two or more pairs of wires inside. The wires in each pair must be identified as either positive or negative conductors.

To Prepare a Multi-Wire Output Cable for a Single (Grounded) Output Configuration

The following procedure explains how to prepare a multi-wire output cable for a single (grounded) output configuration.

1. Cut the cable to the desired length plus 6".
2. Strip the outer insulation back 5" (see Figure 5-7).
3. Cut off 4" of shield from the center conductor. Leave 1" of shield in place (see Figure 5-7).
4. Strip back 1" of insulation from each wire (see Figure 5-7).
5. Bundle and twist the like wires together. Connect positive wires to positive wires and negative wires to negative wires. See Figure 5-7.
6. Cut a 3" piece of wire for the jumper. Strip back 0.5" of insulation on both ends (see Figure 5-7).

   Note: The gauge of the jumper should be one to one-and-a-half times the gauge of the wires in the bundle.

7. Attach the jumper to the negative bundle with a ferrule (brass sleeve). We suggest that you use a ferrule (brass sleeve) over the end of the jumper (optional). See Figure 5-7.

   Note: Place the ferrule against the insulation, and then crimp it and cut off any excess wire.

8. Put the ferrule over the end of the positive bundle (see Figure 5-7).
9. Cut off excess wire after the ferrules have been crimped.

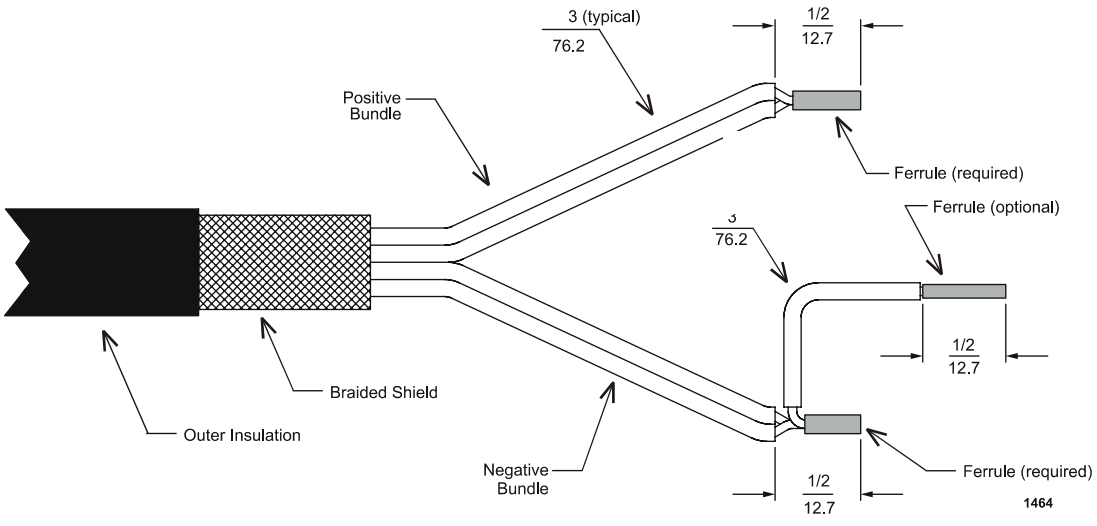

Figure 5-7. *Prepared multi-wire cable for single (grounded) output*

10. See "To Install Multi-Wire Cable in a Single (Grounded) Output Configuration" on page 5-11 to complete the cable connection.

To Install Multi-Wire Cable in a Single (Grounded) Output Configuration

The following procedure explains how to make the single (grounded) output cable connection using a multi-wire cable.

Note: If the outside diameter of the cable is less than 13 mm (0.5"), remove the black insert in the PE II strain relief and replace it with the grey insert to accommodate the smaller cable.

1. Remove the safety cover. Use a Phillips head screwdriver to remove the five cover screws.
2. Slide the coax cable through the right strain relief (labeled **Strain Relief #1** in Figure 5-8).
3. Connect the positive bundle to the right position of the terminal strip (labeled **+** in Figure 5-8). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

4. Connect the jumper wire to the center position of the terminal strip (labeled with a ground symbol in Figure 5-8). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

5. Connect the negative bundle to the left position of the terminal strip (labeled **-** in in Figure 5-8). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

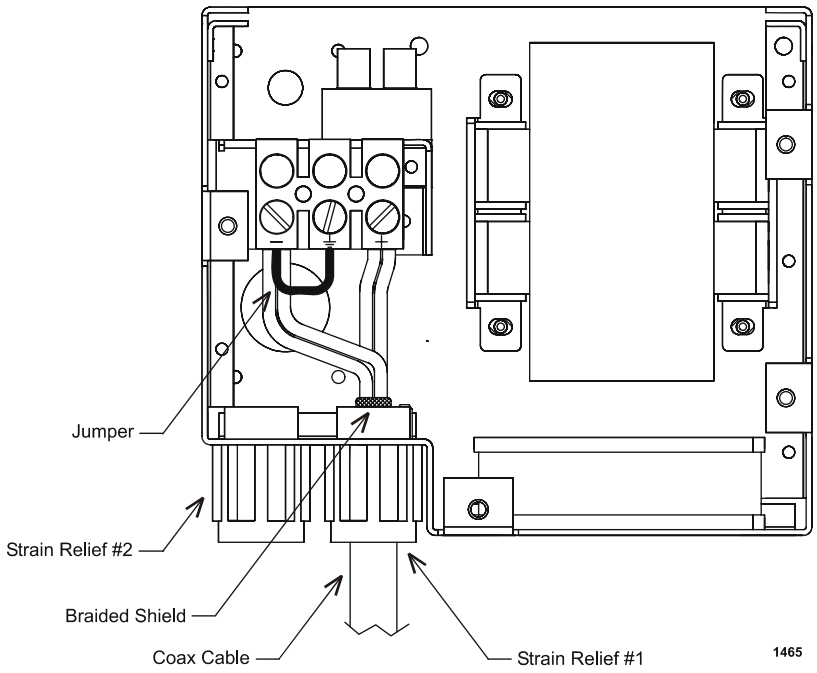

Figure 5-8. *Single (grounded) output power connection using multi-wire cable*

6. Verify the wires have adequate slack inside the housing. Tighten the strain relief nut until it secures the cable into place.
7. Replace the cover on the output assembly. Replace and tighten the five cover screws.
8. See "Connecting Input Power" on page 5-17 to make the input power connection.

CONNECTING A DUAL (FLOATING) OUTPUT CONFIGURATION

When making a dual (floating) output connection, you can use the following types of cable:

- coax cable (see "Using Coax Cable in a Dual (Floating) Output Configuration" on page 5-12 for more information)
- multi-wire cable (see "Using Multi-Wire Cable on a Dual (Floating) Output" on page 5-15 for more information).

Using Coax Cable in a Dual (Floating) Output Configuration

The preparation and connection of your coax output cable in a dual (floating) output configuration is dependant upon the diameter of your output cable (braided) shield.

- If your output cable braided shield is less than 9 mm (0.35"), go to "To Prepare an Output Cable with a Smaller Shield Diameter" on page 5-13.

- If your output cable braided shield is greater than 9 mm (0.35"), go to "To Prepare an Output Cable with a Larger Shield Diameter" on page 5-13.

To Prepare an Output Cable with a Smaller Shield Diameter

The following procedure explains how to prepare a cable with a (braided) shield diameter less than 9 mm (0.35").

1. Cut the cable to the required length plus 5".
2. Strip off 3" of the outside insulation (see Figure 5-9).
3. Cut off 2" of shield. Leave 1" of shield in place (see Figure 5-9).
4. Fold back the 1" of shield over the outside insulation (see Figure 5-9).
5. Strip 0.5" of the insulation from the center conductor. We suggest you use a ferrule (brass sleeve) to hold the wire strands together (optional). See Figure 5-9.

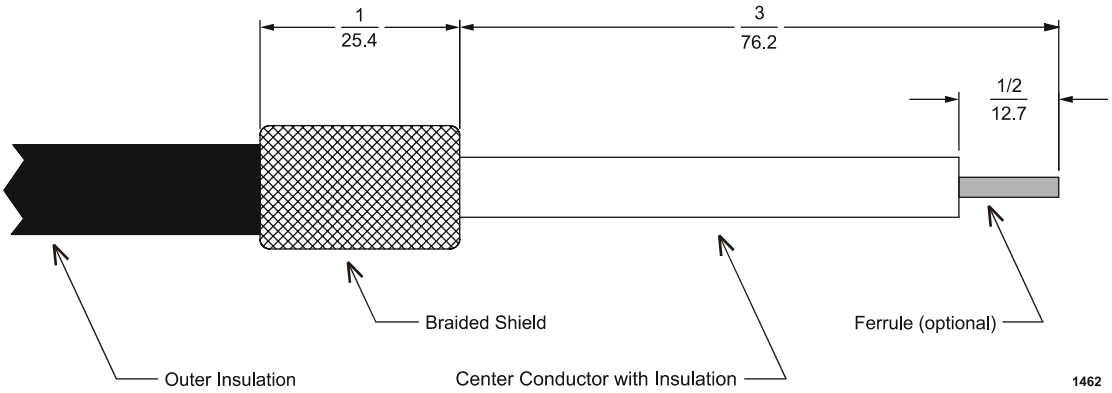

Figure 5-9. *Prepared coax cable single output (smaller shield)*

6. See "Installing the Cable Dual (Floating) Output Coax Cable" on page 5-14 to complete the output connection.

To Prepare an Output Cable with a Larger Shield Diameter

The following procedure explains how to prepare a cable with a (braided) shield diameter greater than 9 mm (0.35").

1. Cut the cable to the required length plus 5".
2. Strip off 4" of the outside insulation (see Figure 5-10).
3. Cut off 3" of shield. Leave 1" of shield in place (see Figure 5-10).
4. Strip back 0.5" of insulation from the center conductor. We suggest that you use a ferrule (brass sleeve) over the wire (optional). See Figure 5-10.

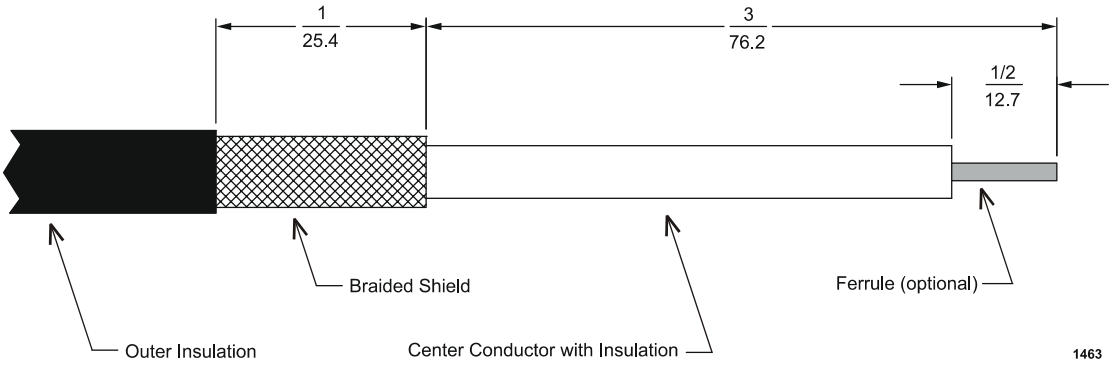

Figure 5-10. *Prepared coax cable single output (large shield)*

5. See "Installing the Cable Dual (Floating) Output Coax Cable" on page 5-14 to complete the output connection.

Installing the Cable Dual (Floating) Output Coax Cable

The following procedure applies to dual (floating) output coax cable configurations with *both* a (braided) shield diameter less than 9 mm (0.35") and a (braided) shield diameter greater than 9 mm (0.35").

Note: If the outside diameter of the cable is less than 13 mm (0.5"), remove the black insert in the PE II strain relief and replace it with the grey insert to accommodate the smaller cable.

1. Remove the safety cover. Use a Phillips head screwdriver to remove the five cover screws.
2. Mark (label) one cable positive and the other negative.
3. Slide the positive cable through the right strain relief (labeled **Strain Relief #1** in Figure 5-11).
4. Connect the positive wires of the cable to the right position of the terminal strip (labeled **+** in Figure 5-11). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

5. Slide the negative cable through strain relief #2 (labeled **Strain Relief #2** in Figure 5-11).
6. Connect the negative wires of the cable to the left position of the terminal strip (labeled **-** in Figure 5-11). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

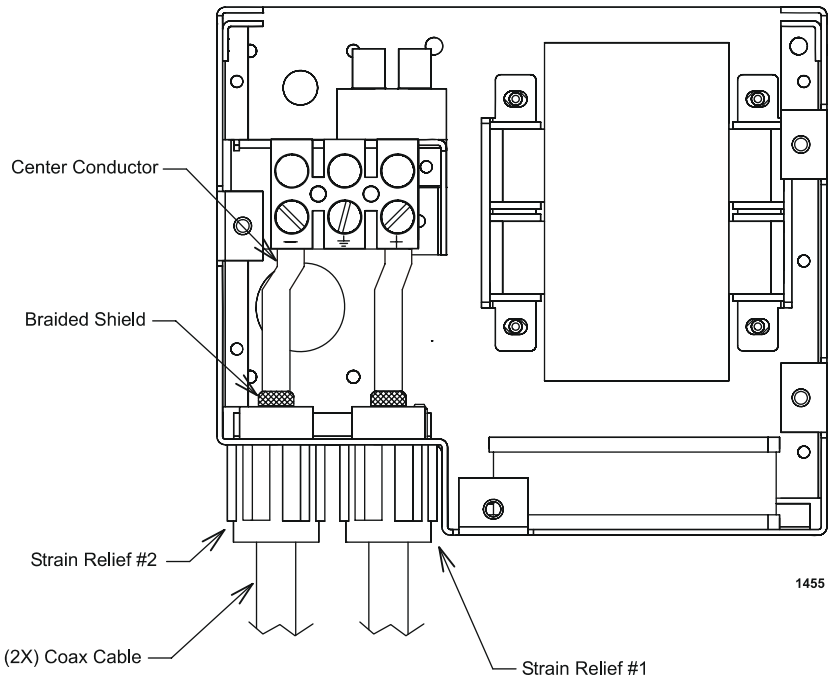

Figure 5-11. *Output power connections for dual (floating) output*

7. Verify the wires have adequate slack inside the housing. Tighten the strain relief nut until it secures the cable into place.
8. Replace the cover on the output assembly. Replace and tighten the five cover screws.
9. See "Connecting Input Power" on page 5-17 to make the input power connection.

Using Multi-Wire Cable on a Dual (Floating) Output

Multi-wire cable is a shielded cable with two or more pairs of wires inside. The wires in each pair need to be identified as either positive or negative conductors.

To Prepare a Multi-Wire Output Cable for a Dual (Floating) Output Configuration

The following procedure explains how to prepare the multi-wire output cable for a dual (floating) output configuration.

1. Cut the cable to the desired length plus 6".
2. Strip the outer insulation back 5" (see Figure 5-12).
3. Cut off 4" of shield from the center conductor. Leave 1" of shield in place (see Figure 5-12).
4. Strip back 1" of insulation from each wire (see Figure 5-12).

5. Put one ferrule (brass sleeve) over the end of the positive bundle and one over the end of the negative bundle (see Figure 5-12).
6. Place the ferrule against the insulation and crimp the ferrules (brass sleeves). Cut off any excess wire (see Figure 5-12).

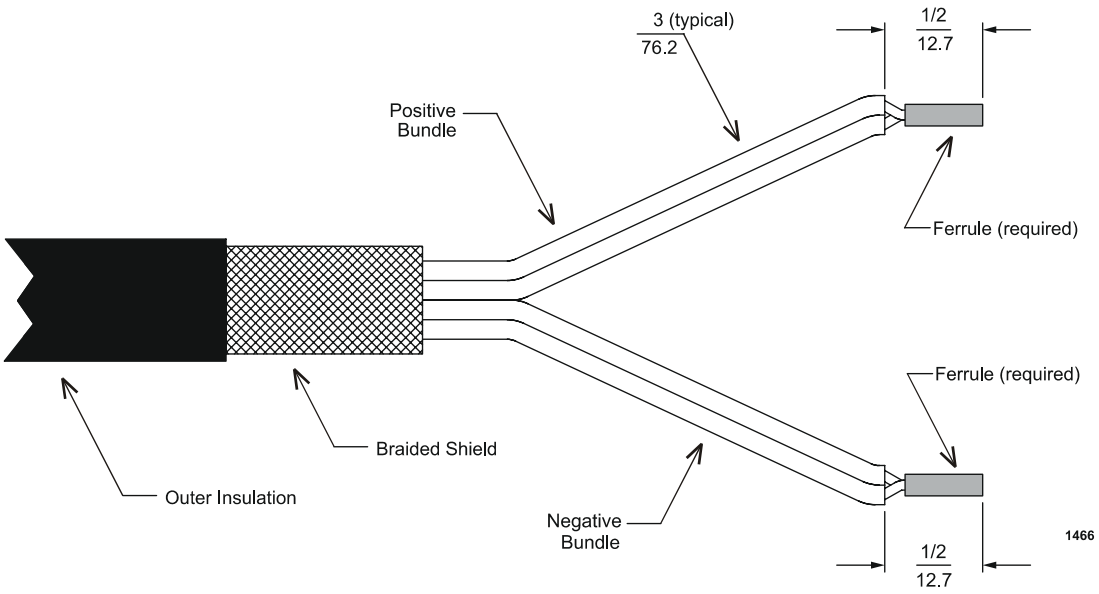

Figure 5-12. *Prepared multi-wire cable for dual (floating) output*

7. See "Installing the Multi-Wire Cable in a Dual (Floating) Output Configuration" on page 5-16 to complete the output connection.

Installing the Multi-Wire Cable in a Dual (Floating) Output Configuration

The following procedure explains how to make the dual (floating) output cable connection using a multi-wire cable.

Note: If the outside diameter of the cable is less than 13 mm (0.5"), remove the black insert in the PE II strain relief and replace it with the grey insert to accommodate the smaller cable.

1. Remove the safety cover. Use a Phillips head screwdriver to remove the five cover screws.
2. Slide the cable through strain relief #1 (labeled **Strain Relief #1** in Figure 5-13).
3. Connect the positive bundle to the right position of the terminal strip (labeled **+** in Figure 5-13). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

4. Connect the negative bundle to the left position of the terminal strip (labeled **-** in Figure 5-13). Tighten the terminal screw to secure the wire connection.

   Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

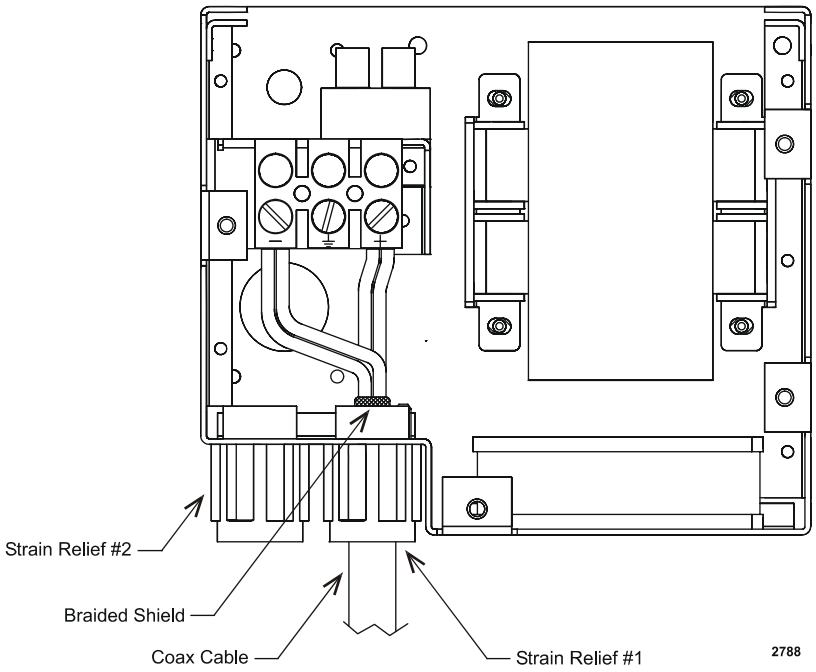

Figure 5-13. *Output power connections for dual (floating) output*

5. Verify the wires have adequate slack inside the housing. Tighten the strain relief nut until it secures the cable into place.
6. Replace the cover on the output assembly. Replace and tighten the five cover screws.
7. See "Connecting Input Power" on page 5-17 to make the input power connection.

Connecting Input Power

WARNING:
RISK OF DEATH OR BODILY INJURY. Before making any input line power connection, turn off building circuit breakers supplying input power to the power supply. Also, ensure that the circuit breakers on the rear panel are in the OFF position.

⚠ WARNING:
RISK OF DEATH OR BODILY INJURY. Operating and maintenance personnel must have the correct training before setting up and maintaining high-energy electrical equipment. This equipment must be installed according to applicable requirements.

⚠ WARNING:
RISK OF DEATH OR BODILY INJURY. Do not connect any power to this unit without first connecting cooling water and ensuring there are no leaks.

The PE II power supply requires a 208 VAC, three-phase, 47/64 Hz input voltage (for wye or delta connections). You connect the AC line input to the five terminal, DIN terminal block connector located on the rear panel of the unit. Labels on the input terminal shield identify the line (**L3**, **L2**, **L1**), neutral (**N**), and Protective Earth (ground) connections. No neutral connection is required.

CABLE REQUIREMENTS

The input connection requires a four-conductor, 6 AWG, shielded wire terminated with ferrules. Use only a shielded cable on the input power connector.

Note: Advanced Energy Industries, Inc., does not include the input cable with the PE II power supply. You are required to supply the cable for the input connection.

TO CONNECT INPUT POWER

To Connect the Input Power Line Cord:

1. Ensure all sources of input power are locked out/ tagged out.
2. Check your building supply power at the receptacle to ensure proper voltage and power (see "Electrical Specifications" on page 3-8 for more information).
3. Remove the three Phillips screws and star washers from the input terminal block cover.
4. Remove the input terminal block cover.
5. Prepare the input line cord. To prepare the input line cord (see Figure 5-14):
   a. Cut the line cord to the desired length plus 9".
   b. Strip back 9" of the outside insulation.
   c. Cut back 8.25" of the cable shield. Leave 0.75" of the shield in place.
   d. Cut off 3" from all wires *except* the ground wire (see Figure 5-14).

e. Strip off 0.5" insulation from the ends of the three wires and 0.5" off the ground. We suggest that you use a ferrule (brass sleeve) over each wire (optional). See Figure 5-14.

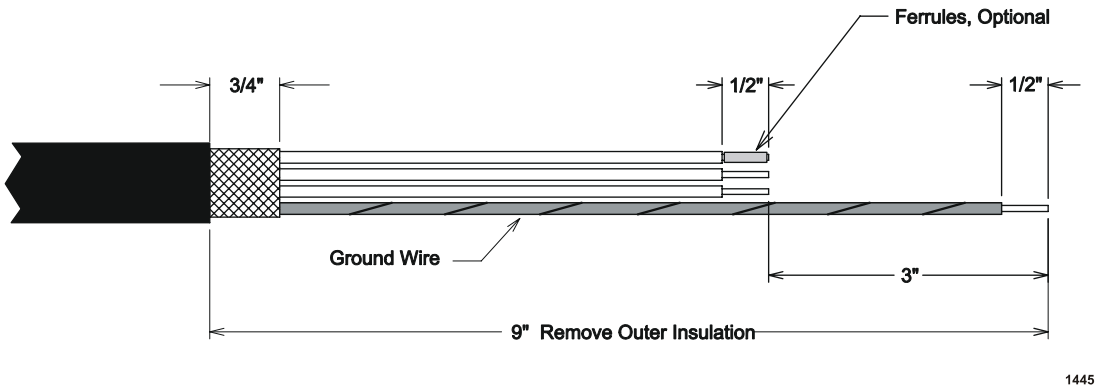

Figure 5-14. *Prepared line cord for AC input power connections*

6. Remove the strain relief nut and plastic insert from the strain relief body (see Figure 5-15).

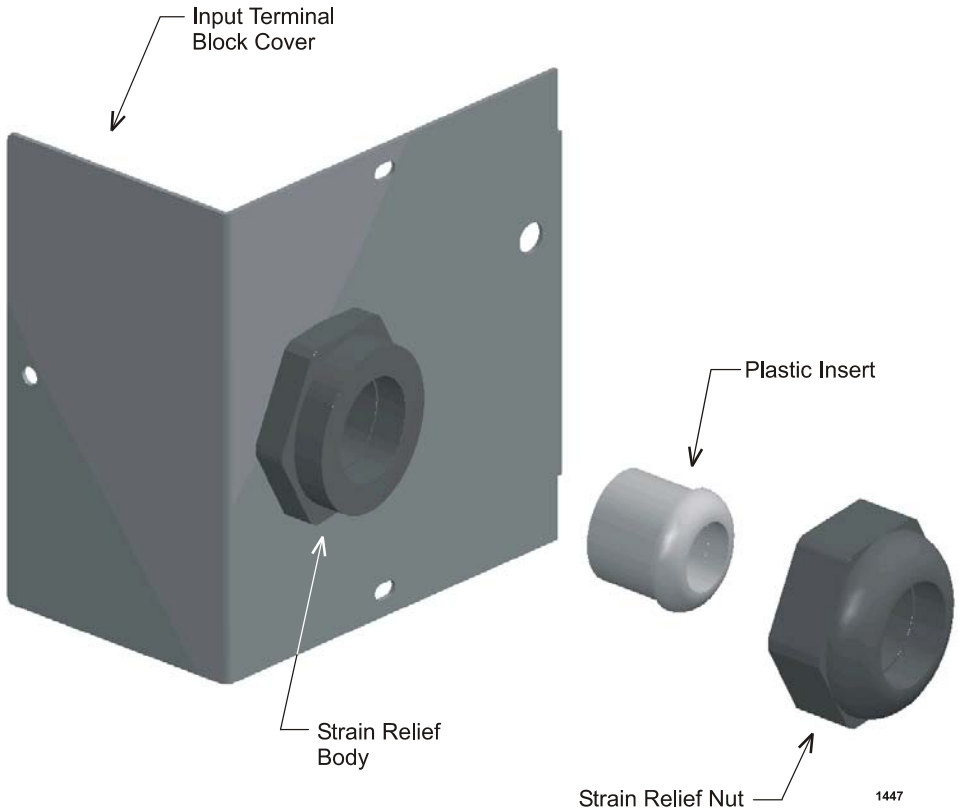

Figure 5-15. *Strain relief for input power connection*

7. Feed the prepared cable through the strain relief nut, plastic insert, and strain relief body, towards the inside of the removed input cover.

   Note: Feed enough cable through the strain relief to give yourself adequate slack to make the input terminal connections.

8. Insert the three wires (on the prepared cable) into the input terminal block slots labeled **L1**, **L2**, and **L3** (see Figure 5-16).

   Note: You *do not* need to make a neutral connection on the terminal block. Therefore, the N slot is not used. Additionally, phase rotation is not important for the input power connection.

9. Tighten the input terminal screws to secure the cable connections.

   Note: Torque the terminal screws 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

10. Insert the green/yellow ground wire into the ground slot (labeled with the ground symbol) of the terminal block (see Figure 5-16). Tighten the screw to secure the cable connection.

    Note: Torque the terminal screw 1.5 to 1.8 Nm (1.11 to 1.33 lb-ft).

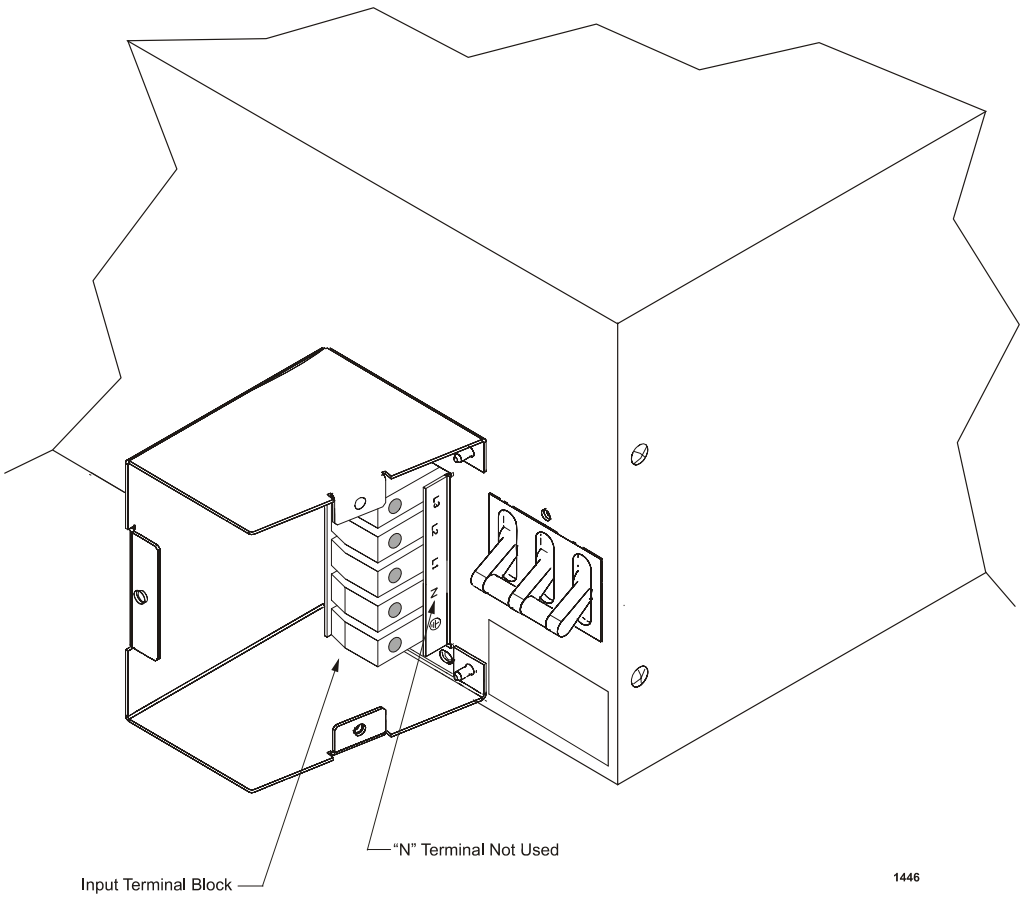

Figure 5-16. *Input terminal block (shown with cover removed)*

11. Slide the input cover past the end of the exposed shield on the input cable.
12. Slide the plastic insert to the edge of the outer insulation and fold the exposed shield over the outside of the plastic insert.
13. Slide the cover over the shield and plastic insert.
14. Slide the strain relief nut up to the cover and strain relief body. Tighten and secure the strain relief onto the cable.
15. Swing the cover and cable into position. Replace the cover screws and star washers to secure the input cover to the unit.
16. Verify the input strain relief is securely tightened.

Connecting I/O and Auxiliary Connectors

Following are the I/O and auxiliary connections for the PE II power supply:

- the **User** port connector (see "Connecting to the User Port" on page 5-21)
- **CEX/Drive In** connector (see "Connecting the CEX/Drive In and OUT Connectors" on page 5-22)
- **CEX/Drive Out** connector (see "Connecting the CEX/Drive In and OUT Connectors" on page 5-22).

Even if you do not intend to operate your unit remotely or use the unit in a CEX system, you must make the following connections for the unit to operate:

- Connect a system controller to the **User** port or insert the **User** port plug into the **User** port.
- Connect the unit to a CEX system, or insert the CEX termination plug into the **CEX/Drive Out** port.

See "Verifying Termination Plug Configuration" on page 6-16 for more information.

Note: Advanced Energy Industries, Inc., provides a termination plug for both the **User** port and **CEX/Drive Out** port with the product shipment.

CONNECTING TO THE USER PORT

To control and monitor the PE II power supply remotely from a system controller, you must connect the system controller to the power supply through the **User** port. See "User Port" on page 4-1 for more information about making the **User** port connection.

Note: Advanced Energy Industries, Inc. does not include the cables for the I/O and auxiliary connections for the PE II power supply. You are required to supply the cable for these connections.

To Connect to the User Port:

1. Ensure all sources of input power to the PE II power supply and system controller or other control signal source are off.
2. Connect the I/O cable to the **User** port on the PE II power supply. Verify the connection is secure.
3. Connect the I/O cable to the system controller or other control signal source. Verify the connection is secure.

CONNECTING THE CEX/DRIVE IN AND OUT CONNECTORS

If you plan to use the PE II power supply in a common exciter (CEX) system, you must make connections to the **CEX/Drive In** and **CEX/Drive Out** connections. See "Connections for Common Exciter (CEX) Operation" on page 5-25 for more information.

⚠ WARNING:
Turn off all units in a multiple unit configuration before you connect or disconnect the CEX/Drive cables or termination plug.

Note: Whether you configure your unit as a stand-alone unit or in a multiple unit configuration, you must have a CEX termination plug inserted in the **CEX/ Drive Out** connector on the last unit.

Choosing the System Configuration

You can operate the PE II power supply in the following configurations:

- Stand-alone unit operation

  The PE II power supply operates as a stand-alone unit (a master unit) with no slave units attached. See "Connecting for Stand-Alone Unit Operation" on page 5-23 for more information.

- Multiple unit configurations (see "Connecting for Multiple Unit Operation" on page 5-23 for more information)

  - Master/slave operation

    You connect multiple PE II power supplies in a master/slave configuration to increase the output power level. See "Connecting for Master/Slave Operation" on page 5-24 for more information.

  - Common exciter (CEX) operation

You connect multiple PE II power supplies so that the outputs of multiple units (combined blocks) are in sync with one another. See "Connections for Common Exciter (CEX) Operation" on page 5-25 for more information.

Whether you configure your system for stand-alone unit or multiple unit operation, you must have a CEX termination plug inserted in the **CEX/Drive Out** connector on the last unit in your system.

CONNECTING FOR STAND-ALONE UNIT OPERATION

Figure 5-17 illustrates the proper configuration for a stand-alone unit operation.

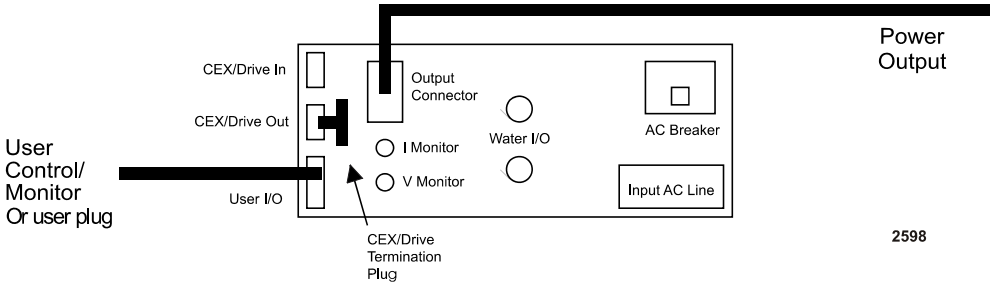

Figure 5-17. *Stand-alone unit configuration*

CONNECTING FOR MULTIPLE UNIT OPERATION

WARNING:
Turn off all units in a combined set before you connect or disconnect the CEX/Drive cables or the termination plug.

When connecting units in a multiple unit configuration (master/slave or CEX operation) keep the following in mind:

- You can only combine units of the same power level in a master/slave configuration.

  For example, you cannot place a PE II 5 kW unit with a PE II 10 kW unit in a master/slave configuration.

- You can combine as many as six units in a master/slave configuration.

  For example, you can combine six PE II 5 kW units for a total of 30 kW. Or, six PE II 10 kW units for a total of 60 kW.

- The maximum number of units you can configure in a single combined system (CEX and master/slave configuration) or CEX system is 32 units.

- Master units with active front panels must have a **User** port *termination* plug or **User** port cable connection installed.

For more information on configuring a power supply system that incorporates both master/slave and CEX stacks in a single system, see "Connecting for Master/Slave and CEX Operation" on page 5-26.

Connecting for Master/Slave Operation

Figure 5-18 illustrates the proper configuration for connecting your power supplies in a master/slave configuration. When combining units, be sure to connect the positive (+) terminals together and the negative (-) terminals together (see Figure 5-19).

Note: A total of six units can be combined. Within a combined block, you cannot mix PE II 5 kW units with PE II 10 kW units.

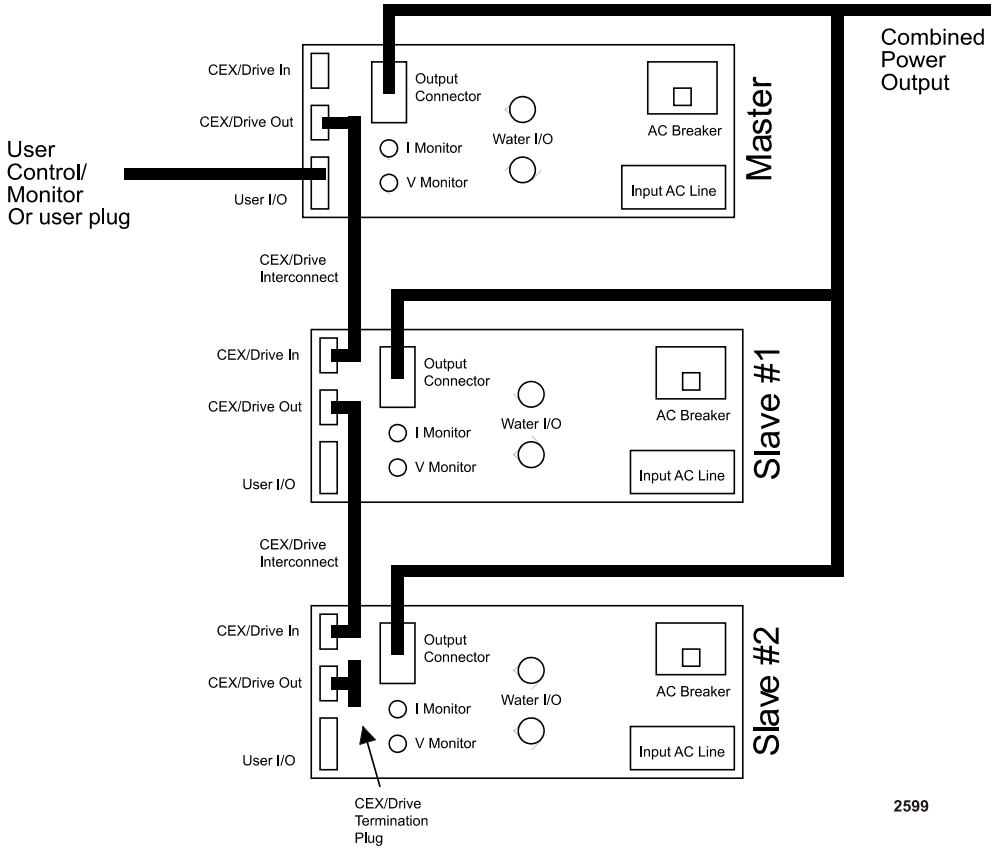

Figure 5-18. *Connections for a master/slave configuration*

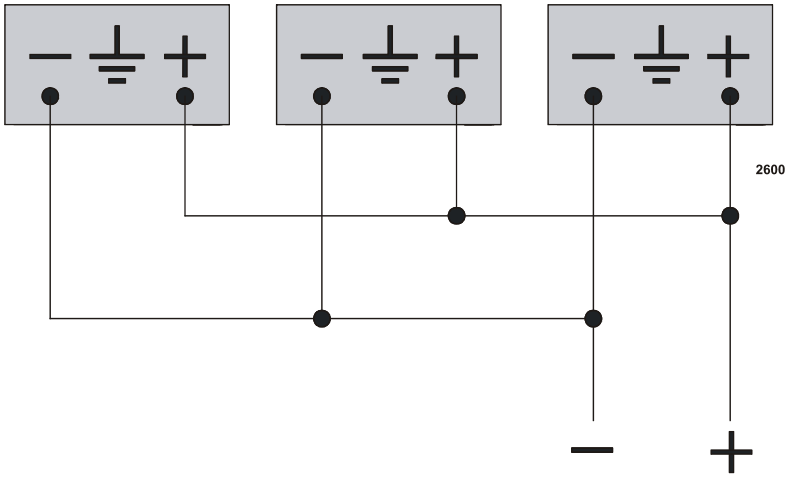

Figure 5-19. *Positive/negative output connections for multiple units*

Connections for Common Exciter (CEX) Operation

Figure 5-20 illustrates the proper configuration for connecting your power supplies for CEX operation.

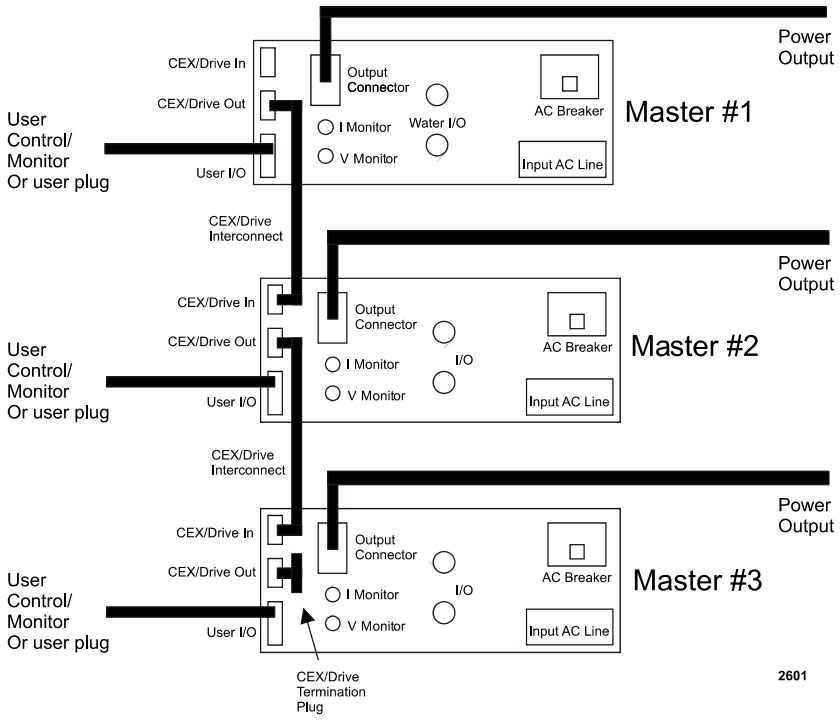

Figure 5-20. *Connections for CEX units*

Connecting for Master/Slave and CEX Operation

You may connect your power supplies in a configuration set up for master/slave and CEX operation. When connecting for both types of configurations, the individual stacks (or groups) of power supplies are made up of one to six units. You can connect a total of 32 power supplies in one system.

Figure 5-21 illustrates the following:

- the first two (top) units are configured for master/slave operation.
- the last (bottom) unit is a single unit configured for CEX operation to the master/slave block.

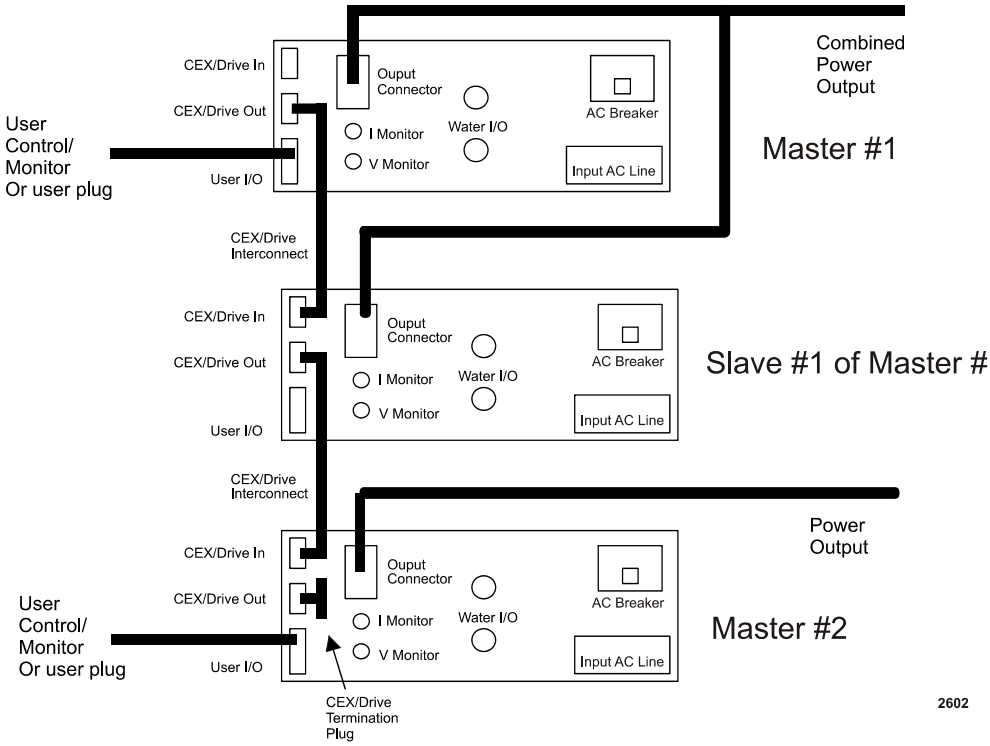

Figure 5-21. *Connections for both CEX and combined-unit configurations*

Note: For information on connecting 5 kW and 10 kW units in a combined CEX and master/slave configuration, see "Connecting for Master/Slave and CEX Operation (Advanced)" on page 5-26.

Connecting for Master/Slave and CEX Operation (Advanced)

When configuring units for both master/slave and CEX operation in one system, you can connect units with different power levels. However, you cannot mix units of differing power levels in a single master/slave configuration.

Figure 5-22 shows an example of a combined master/slave and CEX configuration with power supplies of varying power levels. Following is an explanation of this configuration.

- The single 10 kW block (unit 1) is configured for CEX operation to the 10 kW combined block (units 2 and 3).
- The 10 kW combined block is configured for CEX operation to the 25 kW combined block (units 4 through 8).
- The 25 kW combined block is configured for CEX operation to the 30 kW combined block (units 9 through 11).
- Unit 11 is the last unit and is, therefore, terminated with a CEX termination plug.

Note: Within a combined-unit block, you cannot mix PE II 5 kW units with PE II 10 kW units.

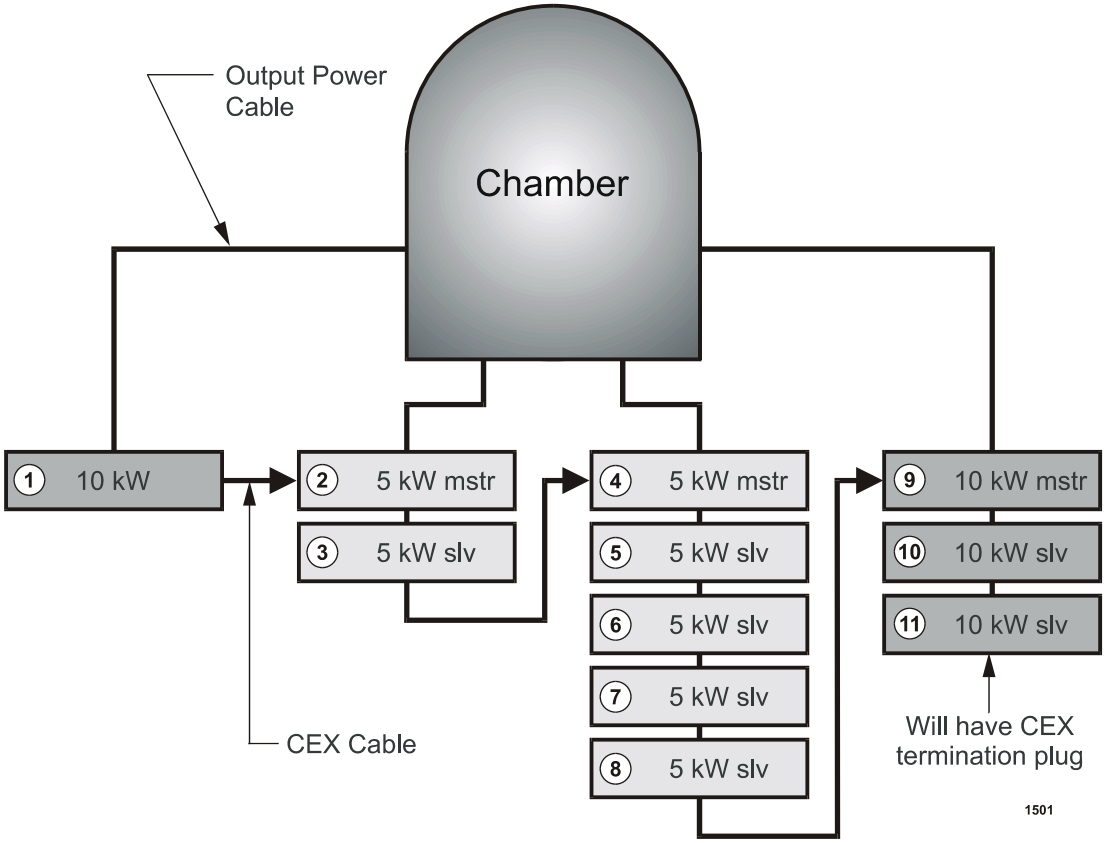

Figure 5-22. *Advanced combined unit and CEX system configuration*

FIRST-TIME OPERATION

Before You Operate the Unit

Before you operate the PE II power supply for the first time:

- Verify you properly installed and connected the power supply. See "Installing the Unit" on page 5-2 for more information.
- Verify you properly configured and installed any termination plugs required for operation. See "Verifying Termination Plug Configuration" on page 6-16 to verify plug configuration.
- Connect the PE II power supply output to *either*:
  - a dummy load using an appropriate cable and connector
  - the chamber using an appropriate cable and connector—satisfying all chamber conditions for operation.

⚠ WARNING:
RISK OF DEATH OR BODILY INJURY. The PE II power supply can operate without being hooked up to either a chamber or a dummy load. You are exposed to high voltage output from the unit if you do not hook the output to either a dummy load or a chamber.

First-Time Operation Instructions

To Operate the Power Supply for the First Time:

1. Verify you properly installed and connected the power supply. See "Installing the Unit" on page 5-2 for more information.
2. If you are operating a unit with an active front panel:
   - If you are operating in local mode, verify the **Remote** switches are *not* selected (the switch LEDs should *not* be illuminated).
   - If you are operating in remote mode (through the **User** port interface), verify the **Remote** switches are selected (the switch LEDs should be illuminated).
3. If you are operating a unit with a passive front panel:
   - Verify you have properly connected the system controller and the PE II power supply through the **User** port.

     Note: See "User Port Pin Descriptions" on page 4-2 for **User** port pin and signal information.

4. Select the proper load tap for the load you are connecting. See "Tap Operating Information" on page 3-11 for the tap information.

   Note: If you do not know what your load is or you are uncertain about what tap to select, begin with the lowest tap setting and progressively move up the taps until you achieve the desired operating results.

5. Turn on the circuit breaker that supplies input power to the PE II power supply.
6. Verify the **Interlock** LED is illuminated and steady.
7. Set the output set point level to 0 (minimum level).
8. Verify you have set the output set point to its minimum level.
9. Set the regulation mode to be power. You can select other modes, but the power mode is the easiest to begin operation with.
10. Turn on output power.

    Note: The **Interlock** and **Output** LEDs should be illuminated and steady.

11. Adjust the power supply output set point to be 10% of the desired output.

    Note: The **Setpoint** LED should be illuminated and steady.

12. Verify the output readback signals match the set point level.
13. If your unit appears to be functioning correctly, increase the set point to the desired power level.

If you encounter any difficulties during the start up procedure, see Chapter 6, "Troubleshooting the Unit" for error recovery and troubleshooting information.

NORMAL OPERATION

During normal operation of the PE II power supply, verify the unit is operating within the operating specifications set for the power supply (see Chapter 3, "Specifications" for more information). If the load or process changes, you must adjust the tap setting for the unit.

For quick-reference information on LED indications during normal operation, see:

- "LED Status for Normal Master Operation" on page 5-30
- "LED Status for Normal Slave Operation" on page 5-31

For information on enhancing the normal operation of your PE II power supply, see "Advanced Arc Handling Capabilities" on page 5-32.

LED Status for Normal Master Operation

Passive Front Panel							Active Front Panel		
States for Normal Master Unit Operation	**Interlock**	**Output**	**Plasma**	**Set point**	**Arc**	**Overtemp**	**PLL**	**CEX**	**Pulsing**
Breaker off									
Output off and interlock open	Flashing							On if CEX'd	On if Pulsed
Output off	On							On if CEX'd	On if Pulsed
Output on and ready to deliver power Set point below minimum or current less than 1%	On	On						On if CEX'd	On if Pulsed
Output on Out of set point due to limit	On	On	On	Flashing				On if CEX'd	On if Pulsed
Output on and unit is running properly	On	On	On	On				On if CEX'd	On if Pulsed
An I-Arc has occurred in the master or one of its slaves Factory-set response to I-Arcs	On	On	On	On	Flash for one second			On if CEX'd	On if Pulsed

LED Status for Normal Slave Operation

Passive Front Panel							Active Front Panel		
States of Normal Slave Unit Operation	**Interlock**	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**	**CE X**	**Pulsing**
Breaker off									
Output off Master unit breaker is off	Flashing	Flashing alternately with Interlock							
Output of slave is on and ready to deliver power Normal state for slave when master output is off; output is determined by master	On	On							
Output on Out of set point due to limit	On	On	On	Flashing					
Output on and unit is running properly	On	On	On	On					
An I-Arc has occurred in the slave Output response is determined by master Factory-set LED response to I-Arc	On	On	On (If not on check Master)	On (If not on, check Master)	Flash for one second				

ADVANCED ARC HANDLING CAPABILITIES

The following information explains how to enhance the arc handling capabilities of the PE II power supply by changing the switch settings on the internal DIP switches.

Overview

You can enhance the arc handling capabilities of your PE II power supply by changing the settings on the internal DIP switches. These DIP switches are located on the logic board inside your unit (see Figure 5-24). You can set the following features with the internal DIP switches:

- Set switch 1 (**S1**) to set the unit response to a sudden change in the plasma impedance (called *I-Arc*). See "I-Arc Settings (S1)" on page 5-33 for more information.
- Set switch **S2** to enable or disable V-Arc and set the V-Arc settings. See "V-Arc Settings (S2)" on page 5-34 for more information.
- Set switch **S3** to set the PE II power supply output ramp. "Output Ramp Settings (S3)" on page 5-38 for more information.

To access these switches you must remove the cover of the unit. The logic board is located on the right side of the unit as you face the front of the PE II power supply. Each DIP switch contains eight miniature switches (or min-switches) (see Figure 5-23). The position of the min-switch determines whether the function is enabled or disabled. To depress a switch towards the number enables a feature. To depress a switch away from the number, or towards "Open," disables the feature.

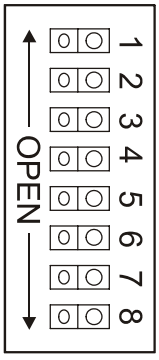

Figure 5-23. *Internal DIP switch*

WARNING:
Remove all input power before accessing the internal DIP switches.

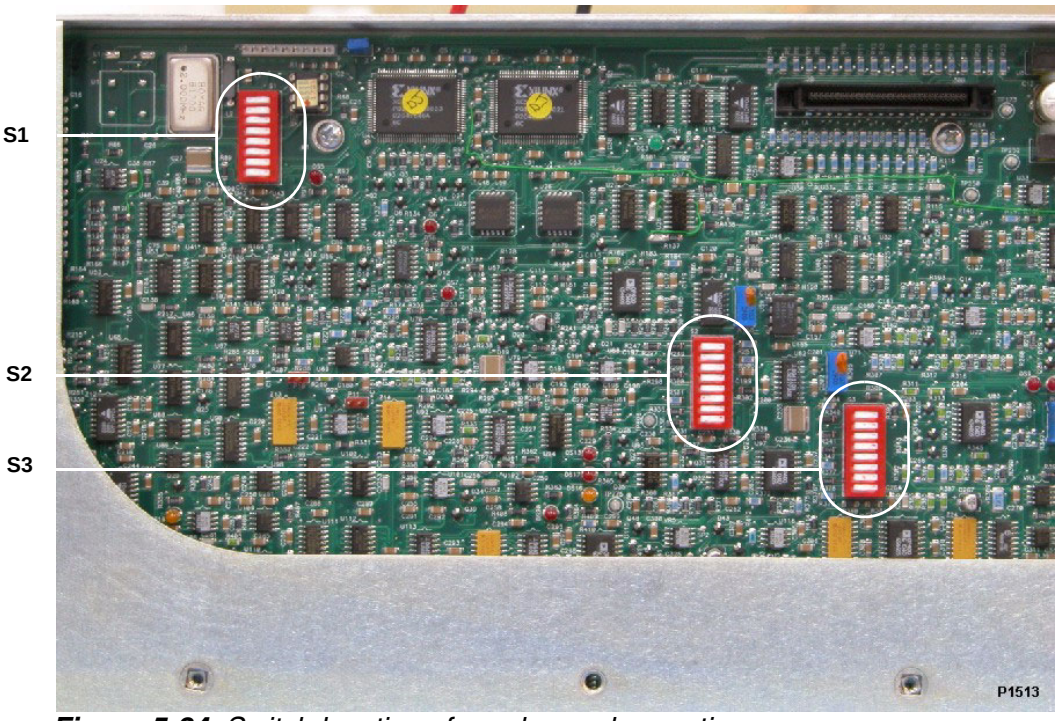

Figure 5-24. *Switch locations for enhanced operation*

I-Arc Settings (S1)

The purpose of the settings on switch 1 (**S1**) is to respond to a sudden change in the plasma impedance (called *I-Arc*) by shutting down the supply for 10 ms or until reset. You can modify the unit behavior to current arcs by changing the settings on **S1**.

Table 5-1 provides the information for setting switch **S1** for your application.

Table 5-1. *I-Arc settings (**S1**)*

Switch	Description
S1-1	When enabled (closed), one occurrence of an I-Arc causes the **Arc** LED to flash continuously until the output is shut off.
S1-2	When enabled (closed), one occurrence of an I-Arc shuts the power supply off.
S1-3 through **S1-8** are not used.	

FACTORY SETTINGS (S1)

Units are shipped with **S1-1** and **S1-2** disabled (open). With **S1-1** and **S1-2** disabled, when an I-Arc occurs the output shuts off for 10 ms and then power is reapplied. The **Arc** LED lights for 0.3 seconds to notify you an I-Arc has occurred.

V-Arc Settings (S2)

V-Arc is an arc handling feature that, in some cases, can prevent an arc shutdown from occurring. V-Arc checks for a loss of voltage during each half cycle. If V-Arc detects a drop in voltage, the unit pulses the output off for a short time (depending on the time out setting) to extinguish the arc. The percentage of loss is used to activate the V-Arc.

With switch **S2**, you can enable/disable V-Arc and set the V-Arc settings. Units are shipped with V-Arc response disabled (**S2-6** is open). Table 5-2 provides the information for setting switch **S2** for your application. See the following sections for more information about the V-Arc settings.

***Table 5-2.** V-Arc settings (**S2**)*

Switch	Setting	Example
S2-1	Activation level (V-Arc) (see Table 5-4)	To determine the time out setting, add the values for the open switches plus the default minimum setting. For example: Minimum = 90 µs **S2-3** open = 50 µs **S2-5** open = 200 µs Time out = 340 µs
S2-2	Activation level (V-Arc) (see Table 5-4)	
S2-3	Time out (V-Arc)—Open for 50 µs	
S2-4	Time out (V-Arc)—Open for 100 µs	
S2-5	Time out (V-Arc)—Open for 200 µs	
S2-6	V-Arc response enable/disable—Open to disable	
S2-7	% Loss (V-Arc) (see Table 5-3)	
S2-8	% Loss (V-Arc) (see Table 5-3)	

FACTORY SETTINGS (S2)

Advanced Energy Industries, Inc., ships units with **S2-2** and **S2-6** disabled (open) and all other **S2** switches enabled (closed). These settings set the activation level to 97 V, a time out function of 90 µs at 53% of loss of power, and V-Arc is disabled.

ENABLING AND DISABLING THE V-ARC RESPONSE

S2-6 enables and disables the V-Arc Response. We ship the unit with the V-Arc Response disabled.

SETTING THE PERCENTAGE OF LOSS

S2-7 and **S2-8** set the percentage of loss (sensitivity) (see Table 5-3 on page 5-35). The percentage of loss is the percentage of the AC wave, which is proportional to the AC output, that is lost when an arc occurs in a half-cycle period (see Figure 5-25).

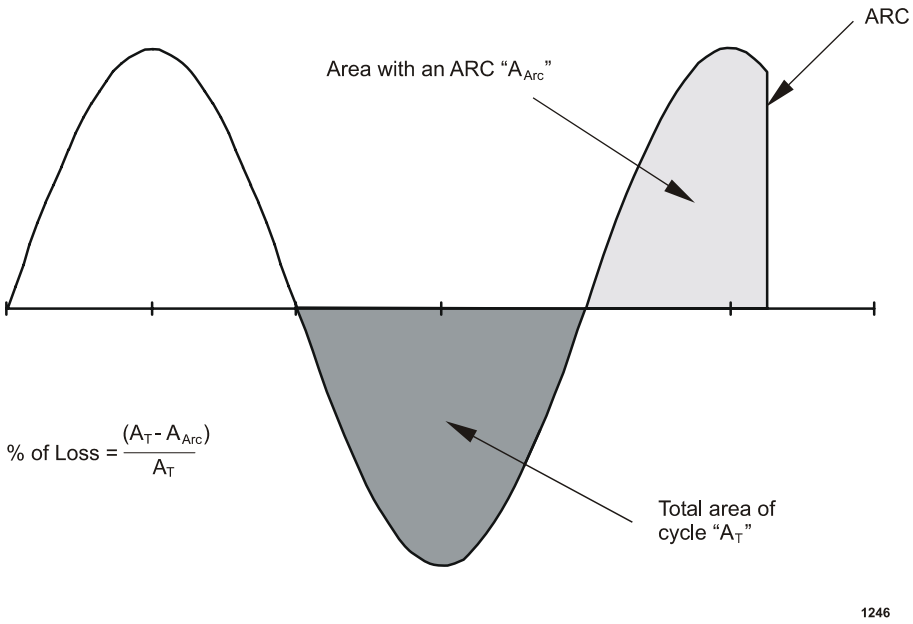

Figure 5-25. *V-Arc (% of loss)*

Table 5-3 provides the different percentage of loss settings for V-Arc.

Table 5-3. *Percentage of loss (V-Arc) settings*

% of Loss	S2-8	S2-7
15	Off (open)	Off (open)
27	Off (open)	On (closed)
40	On (closed)	Off (open)
53	On (closed)	On (closed)

SETTING THE TIME OUT

S2-3, **S2-4**, and **S2-5** set the *time out*. The time out is the time that the unit pulses off in response to a V-Arc to help inhibit I-Arcs.

SETTING THE ACTIVATION LEVEL

S2-1 and **S2-2** set the activation level. The activation level is the minimum voltage level at which the unit starts detecting V-Arcs. In other words, the activation level disables the detection of a V-Arc until the voltage reaches the defined level.

To find the correct activation level setting for your operation, multiply the maximum voltage (see "Tap Operating Information" on page 3-11 for the tap operating information) by the desired percentage of loss.

For example, Table 5-4 lists the settings for tap 4.

Table 5-4. *Activation level (V-Arc) settings for tap 4*

Tap 4	Percent of Max. V	S2-1	S2-2
388 V	60	Off (open)	On (closed)
281 V	43	Off (open)	Off (open)
184 V	28	On (closed)	On (closed)
97 V	15	On (closed)	Off (open)

DETERMINING THE OPTIMUM V-ARC SETTINGS

To determine the optimum V-Arc settings, you must monitor the **User** port to count the number of V-Arcs and I-Arcs per unit time and, then, calculate the ratio of rates and interrupt time. The optimum setting is between the largest I-Arc ratio and the lowest interrupt time, depending on how much the V-Arc interferes with the process.

See the procedure below for information on how to determine the optimum V-arc settings.

⚠ WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect all sources of input power before working on this unit or anything connected to it.

To Determine the Optimum V-Arc Settings:

1. Set the percentage of loss (**S2-8** and **S2-7**) to the least sensitive (53%). That is, set **S2-7** and **S2-8** to closed.
2. Disable V-Arc Response (**S2-6** open).
3. Record the rate (number of events/time) of V-Arc and I-Arc in Table 5-5 on page 5-37 (time can be in seconds or minutes).

   This is the rate of V-Arc and I-Arc when V-Arc is disabled.

4. Set the time out to the minimum (90 µs)—**S2-3**, **S2-4**, and **S2-5** are closed.
5. Enable V-Arc Response (**S2-6** closed).
6. Record the rate (number of events/time) of V-Arc and I-Arc in Table 5-5 on page 5-37. Time can be in seconds or minutes.

   This is the rate of V-Arc and I-Arc when V-Arc is enabled.
7. Repeat step 6 for time out settings: 140 µs, 190 µs, 240 µs, 290 µs, 340 µs, 390 µs, and 440 µs.

   See Table 5-2 on page 5-34 for more information regarding the switch positions for different time out settings.
8. Repeat steps 1 through 7 for all percentage of loss settings (40%, 27%, and 15%).

   See Table 5-3 on page 5-35 for more information regarding the percentage of loss settings.
9. Using the data you recorded in Table 5-5, calculate the ratio by dividing the disabled rate by the enabled rate.

   Record the value in Table 5-6.
10. Using the data you recorded in Table 5-5, calculate the interrupt time by multiplying the enabled rate by the time out.

    Record the value in Table 5-7.
11. Evaluate the results for optimum settings.

    The optimum setting is between the largest I-Arc ratio and the lowest interrupt time–depending on how much the V-Arc interferes with the process.

SAMPLE TABLES FOR DETERMINING V-ARC SETTINGS

Table 5-5. *Rate of activity*

% of Loss	Rates to Record	V-Arc Disabled	V-Arc Enabled (µs)							
			90	140	190	240	290	340	390	440
53	V-Arc									
	I-Arc									
40	V-Arc									
	I-Arc									
27	V-Arc									
	I-Arc									
15	V-Arc									
	I-Arc									

Table 5-6. *Ratio of rates*

% of Loss	Ratio	V-Arc Enabled (µs)							
		90	140	190	240	290	340	390	440
53	V-Arc								
	I-Arc								

Table 5-6. *Ratio of rates*

% of Loss	Ratio	V-Arc Enabled (µs)							
		90	140	190	240	290	340	390	440
40	V-Arc								
	I-Arc								
27	V-Arc								
15	V-Arc								
	I-Arc								

Table 5-7. *Interrupt times*

% of Loss	Interrupt Time	V-Arc Enabled (µs)							
		90	140	190	240	290	340	390	440
53	V-Arc								
	I-Arc								
40	V-Arc								
	I-Arc								
27	V-Arc								
	I-Arc								
15	V-Arc								
	I-Arc								

Output Ramp Settings (S3)

Switch **S3** allows you to set the PE II power supply output ramp. The output ramp is the amount of time the output takes to ramp from zero to set point—either after the output is turned on or after an I-Arc.

Table 5-8 provides the different settings for switch **S3**.

Table 5-8. *Output ramp settings (S3)*

Switch	Setting	Example
S3-1	18 ms when open	To determine the output ramp setting, add the values for the open switches plus the default minimum setting. For example: Minimum = 18 ms **S3-1** open = 18 ms **S3-2** open = 37 ms **S3-5** open = 300 ms Output ramp = 373 ms
S3-2	37 ms when open	
S3-3	73 ms when open	
S3-4	150 ms when open	
S3-5	300 ms when open	
S3-6	590 ms when open	
S3-7	1180 ms when open	
S3-8	2370 ms when open	

FACTORY SETTINGS (S3)

The PE II power supply is shipped with all **S3** switches enabled (closed), which results in an output ramp of 18 ms.

PULSING UNIT OUTPUT

When the unit pulses, the output is turned off and then on without the output ramp. The power supply regulates the output during the on time and controls the peak—not the overage—of the pulsed output with the set point. To pulse the output of the PE II power supply, you can use a signal generator (see Figure 5-26 on page 5-40).

The PE II power supply limits the pulsing signal in two ways:

- Off time is limited to a maximum of 500 ms.
- On time is limited to a minimum of 1 ms.

Other pulsing parameters of the unit are:

- Delay time is 25 µs
- Skew is 20 µs
- Rise time is 40 µs
- Fall time is 25 µs for resistive load.

Refer to pin 17 in "User Port Pin Descriptions" on page 4-2 for more information about setting the pulse for the unit. Figure 5-26 illustrates how to use a signal generator to control the PE II power supply with 0 V to 5 V pulses.

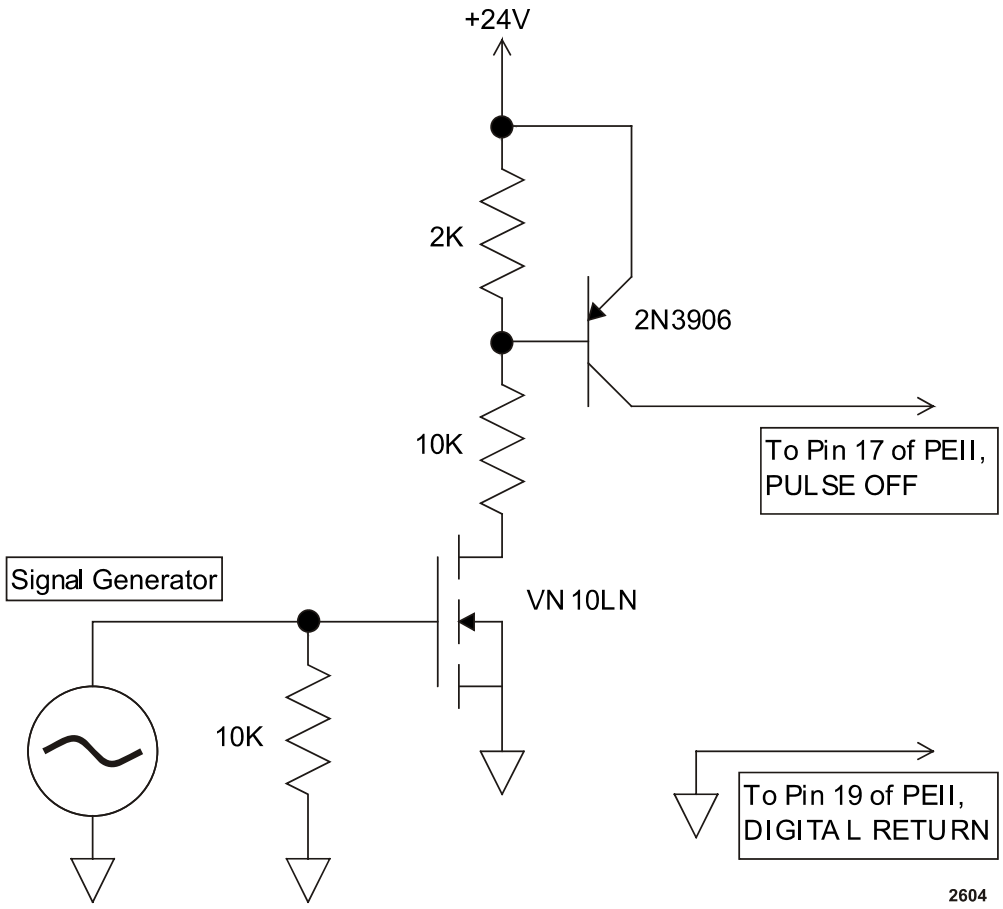

Figure 5-26. *Pulsing limits*

UNIT ILLUSTRATIONS

The following figures illustrate the front and rear panel views of the PE II power supply.

Passive Front Panel View

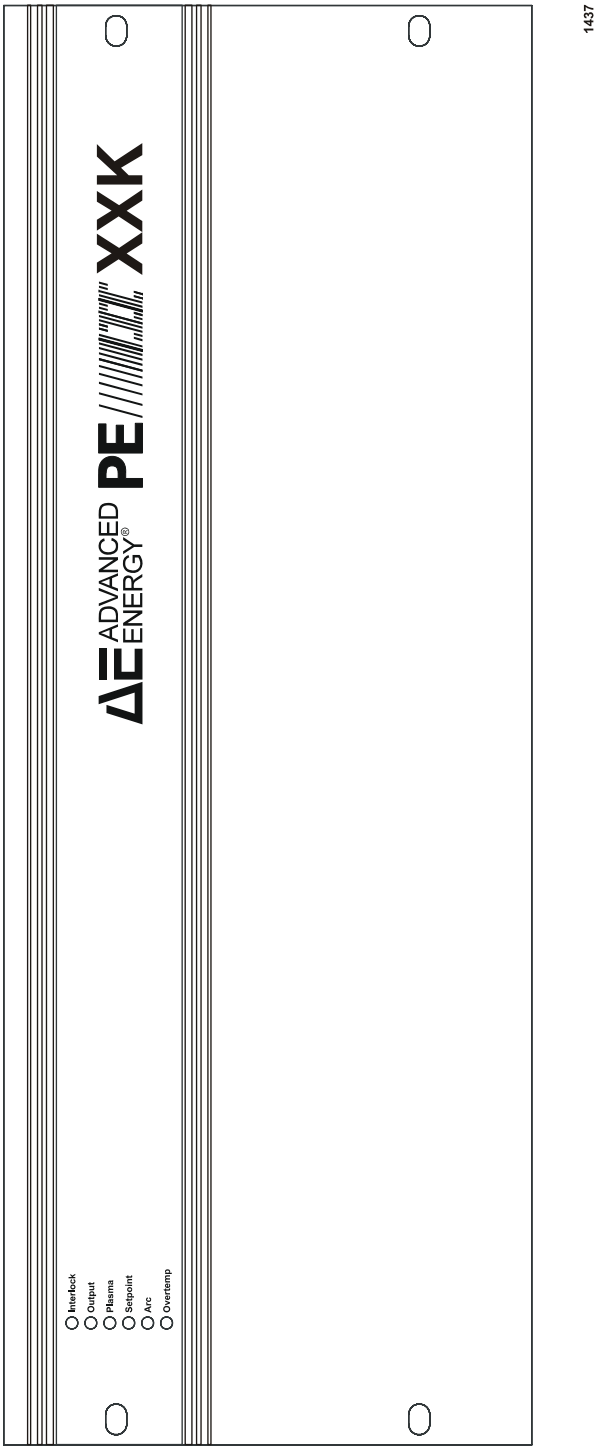

Figure 5-27. *Passive front panel view*

Active Front Panel View

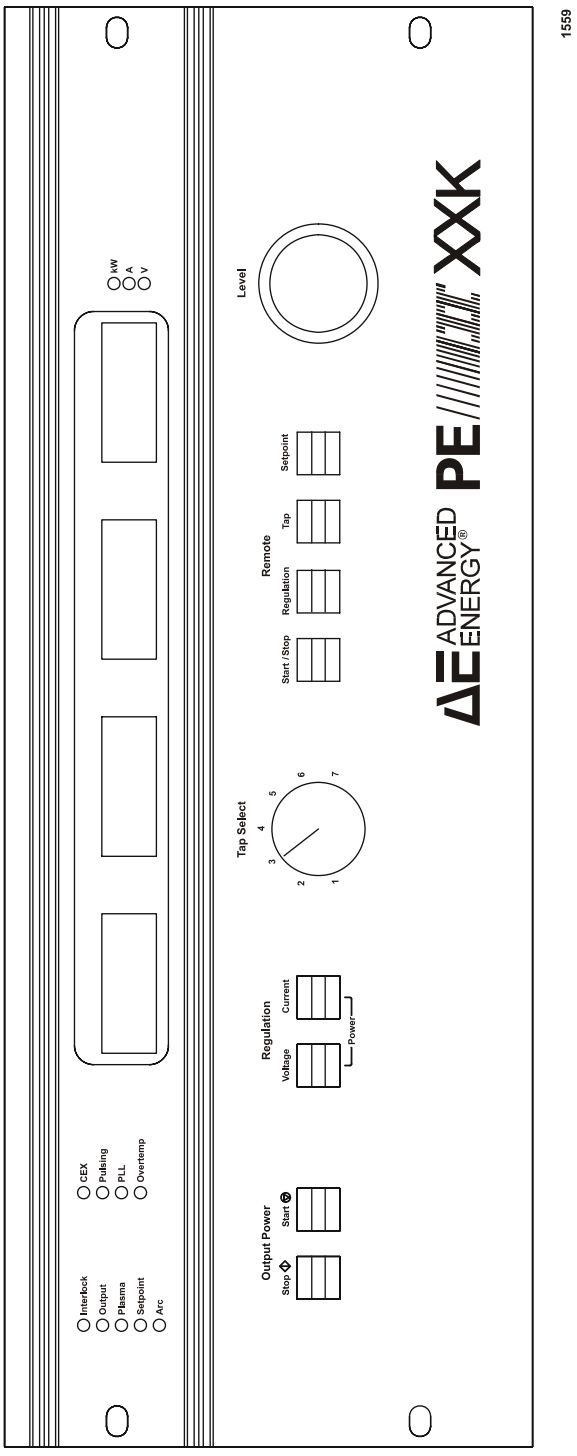

Figure 5-28. *Active front panel view*

Rear Panel View

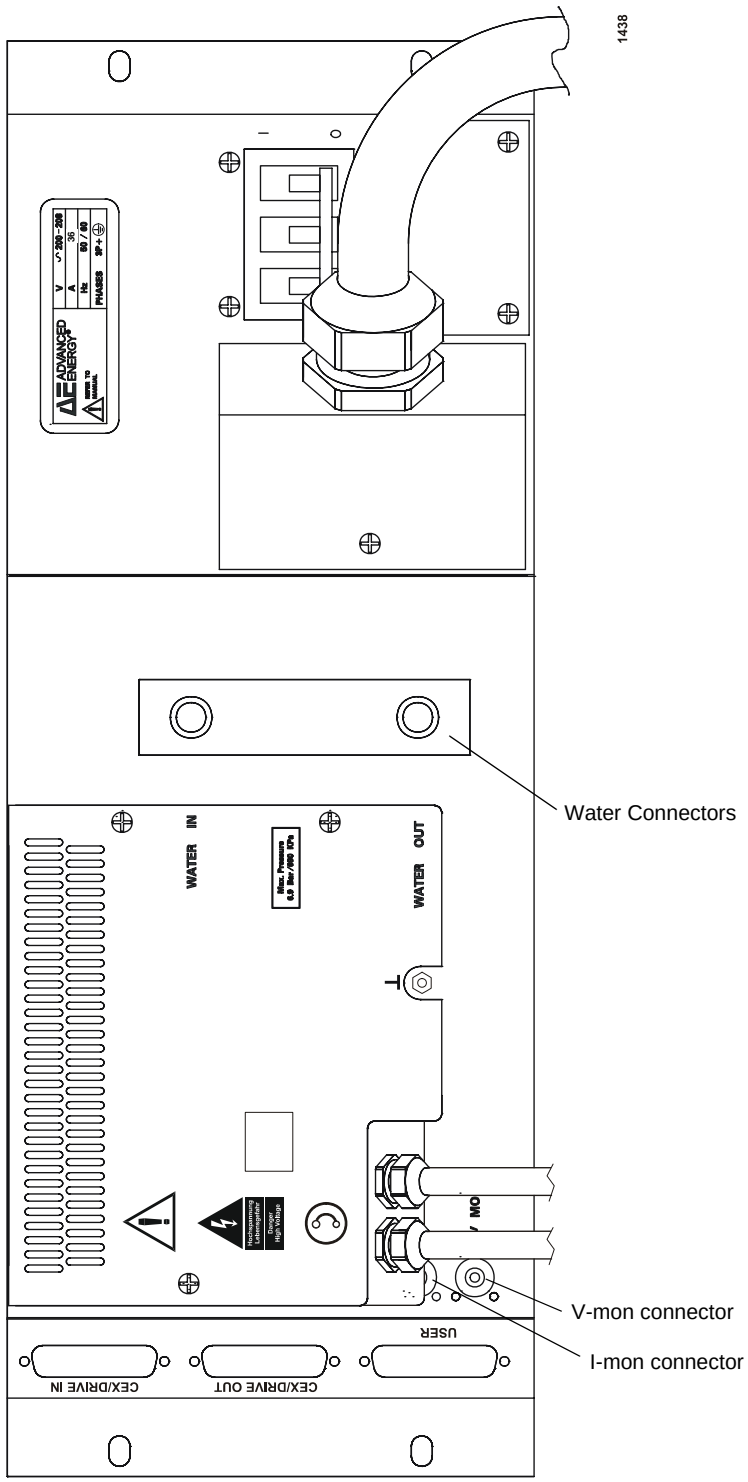

Figure 5-29. *Rear panel view*

Troubleshooting and Global Customer Support

This chapter contains basic troubleshooting information, as well as procedures for returning a unit for repair.

TROUBLESHOOTING THE UNIT

The following information helps you assess the condition of your unit and troubleshoot the fault occurrences. If any problems persist after performing the following procedures, contact AE Global Customer Support (see "AE Global Customer Support" on page 6-17).

WARNING:
RISK OF DEATH OR BODILY INJURY. Disconnect and lockout/tagout all sources of input power before working on this unit or anything connected to it.

Checks With Power Off

With Power Off, Complete the Following:

1. Ensure the power to the unit is off.
2. Check for visible damage to the unit, cables, and connectors.
3. Ensure all unit connectors are installed correctly and are fastened tightly.
4. Check to determine whether any system-related circuit breakers have been tripped.
5. Ensure there is input power to the unit, and ensure the input power meets specifications. See "Electrical Specifications" on page 3-8.
6. Ensure ground connections are adequate and secure. See "Grounding the Unit" on page 5-2.
7. Turn power to the unit on. See "First-Time Operation" on page 5-28.

Checks With Power On

With Power On, Complete the Following:

1. Follow the procedures in "First-Time Operation" on page 5-28. Is the unit functioning according to the first-time operation requirements?

   - If *yes*, your unit appears to be operating correctly, but if you suspect a malfunction, go to Step 2.
   - If *no*, go to Step 2.

2. Observe and record your unit's condition and operation *before* and *after* the fault occurrence. As you observe and record your unit's operation, keep the following in mind:

   - A slave unit will not respond to **User** port or front panel inputs, and the slave unit only reports on its activity.
   - A slave unit has its **Interlock** and **Output** LEDs illuminated constantly—even when the master unit output is off.
   - A master unit will respond to **User** port or active front panel inputs and report on the combined system activity.

   Record the following information *before* and *after* the fault occurrence.

   - Record the status of the following LEDs: **Interlock**, **Output**, **Plasma**, **Setpoint**, **Arc**, **Overtemp**, **PLL**, **CEX**, and **Pulsing**. Include whether the LED is on, off, or flashing.

     Note: The **PLL, CEX**, and **Pulsing** LEDs are only available on units with active front panels.

   - If your unit features an active front panel, record the read back displays of power, voltage, current and set point. Be sure to include all switch positions and indicators.
   - If you are monitoring the unit through the **User** port, measure and record the following I/O signals: *OUTPUT, SET POINT, I-ARC, V-ARC, OVERTEMPERATURE, POWER, CURRENT*, and *VOLTAGE*.
   - If your system controller features a system monitor, record the voltage and current readings on the system monitor.

3. See "Troubleshooting the Master Unit" on page 6-4 and "Troubleshooting a Slave Unit" on page 6-10 to help you decide what you should do for a particular problem.

   You may need the following equipment to continuing troubleshooting the problems:

   - Temperature probe
   - DVM for continuity or voltage measurements

- Oscilloscope with a camera or printer (for output monitor or waveforms)
- Chart recorder

If your problem persists after troubleshooting the unit, contact AE Global Customer Support (see "AE Global Customer Support" on page 6-17).

TROUBLESHOOTING THE MASTER UNIT

The status LEDs that are shown in bold type indicate the primary problem. This problem should be addressed first.

Table 6-1. *Master unit troubleshooting table*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output off and relay failure	On	**Flashing**				**On**	
• Output off and relay failure • Interlock open	Flashing	**Flashing**				**On**	
• Output off and relay failure • PLL not locked • CEX cable problems or frequency miss match	Flashing	**Flashing**				**On**	Flashing
Take these actions: 1. Turn breaker off and back on. 2. If state reoccurs immediately after output on, the LM board has failed. Call "AE Global Customer Support" on page 6-17.							
• Output off and low line or inverter failure	On	**Flashing**					
• Output off and low line or inverter failure • Interlock open	Flashing	**Flashing**					
• Output off and low line or inverter failure • Overtemperature condition	On	**Flashing**				Flashing	
• Output off and low line or inverter failure • Interlock open and overtemperature condition	Flashing	**Flashing**				Flashing	
Take these actions: 1. Check line voltage (see "Electrical Specifications" on page 3-8 for specifications). 2. Check that all phases of input power are present. 3. Cycle output off to clear master state; if you can not clear master state, the inverter has failed. Call "AE Global Customer Support" on page 6-17.							

Table 6-1. *Master unit troubleshooting table (Continued)*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output off • Missing CEX termination plug • CEX cable problems • Too many slaves combined • Missing the master jumper on the **User** port	**Flashing**	**Flashing alternately with Interlock**					
• Output off • Missing CEX termination plug • CEX cable problems • Too many slaves combined • Missing the master jumper on the **User** port • Overtemperature condition	**Flashing**	**Flashing alternately with Interlock**				Flashing	
Take these actions: Cycle output off (that is, stop and restart output) to clear master state after verifying the following: 1. Check CEX termination plug to ensure it is securely connected. 2. Check CEX termination continuity (see "Verifying Continuity of the CEX Termination Plug" on page 6-16 for procedures). 3. Check CEX cables to ensure that they are securely connected. 4. Replace CEX cables one at a time until the problem clears. 5. Check for too many slaves (see "Connecting for Master/Slave Operation" on page 5-24 for more information). 6. Check for master jumper on the **User** port (see Table 4-2 on page 4-2, and Figure 4-8 on page 4-11 for more information). 7. Check for master jumper on the **User** port on next master.							

Table 6-1. *Master unit troubleshooting table (Continued)*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output off and PLL not locked due to CEX cable problems or frequency miss match	**Flashing**	**Flashing alternately with Interlock**					**Flashing**
• Output off and PLL not locked due to CEX cable problems or frequency miss match • Overtemperature condition	**Flashing**	**Flashing alternately with Interlock**				Flashing	**Flashing**
Take these actions: Cycle output off (that is, start, stop, and restart output) to clear master state after verifying the following: 1. Check CEX termination plug to ensure it is securely connected. 2. Check CEX termination continuity (see "Verifying Continuity of the CEX Termination Plug" on page 6-16 for procedures). 3. Check CEX cables to ensure that they are securely connected. 4. Replace CEX cables one at a time until the problem clears. 5. Check that the frequencies of the units are all the same. 6. Allow the unit to cool and retry operation.							

Table 6-1. *Master unit troubleshooting table (Continued)*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output off and overtemperature condition	On					Flashing	
• Output off and overtemperature condition • Interlock open	Flashing					Flashing	
Take these actions: Allow the unit to cool, then cycle output off (that is, start, stop, and restart output) to clear master state after verifying the following: 1. Check coolant flow (see "Cooling Specifications" on page 3-17 for coolant flow requirements). 2. Check coolant temperature (see "Cooling Specifications" on page 3-17 for coolant temperature requirements). 3. Check ambient temperature of coolant (see "Cooling Specifications" on page 3-17 for coolant ambient temperature requirements). 4. Check spacing around units (see "Spacing Requirements" on page 5-1 for unit spacing requirements). 5. If the unit is an option 002 (use the next tap up).							
• No AC power or breaker off							
Take these actions: 1. Check unit circuit breaker. 2. Check main circuit breaker. 3. Check line voltage (see "Electrical Specifications" on page 3-8 for specification information). 4. Check that all phases of input power are present (see "Electrical Specifications" on page 3-8 for phase requirements).							
• Output off and interlock open	Flashing						
Take this action: Cycle output off (that is, start, stop, and restart output) to clear master state after verifying the following: 1. Check interlocks. 2. Check the **User** port connector; ensure it is connected and secure. 3. Check interlock continuity (see Table 4-2 on page 4-2 for pin information).							

Table 6-1. *Master unit troubleshooting table (Continued)*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output off	On						
Take these actions: 1. If you attempted to start output with an active front panel: ensure the **Remote Start/Stop** button is *not* in remote (*not* depressed). 2. If you attempted to start output through the **User** port, check *OUTPUT ON* signal (see Table 4-2 on page 4-2 for more information).							
• Output on and set point below minimum or current less than 1%	On	On					
Take these actions: 1. Ensure the set point level is greater than 1% of full scale output. 2. Ensure the current readback is less than 1% of I-Max for the selected tap.							
• Output on, current greater than 5%, and one unit (master or slave) not at set point due to limit	On	On	On	Flashing			
Take these actions: 1. If voltage is greater than the V-Max for the selected tap, switch to the next tap up. 2. If voltage is less than the V-Min for the selected tap, switch to the next tap down. 3. If you are at the highest tap, lowest tap, or less than the maximum available power, call Advanced Energy (see "AE Global Customer Support" on page 6-17 for contact information).							
• Output on, current greater than 5%, and unit at set point	On	On	On	On			
Take this action: • Check **User** port and ensure the analog reference is grounded on the user side.							

Table 6-1. *Master unit troubleshooting table (Continued)*

Master Unit State and Suggested Actions	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	**PLL**
• Output on, current greater than 5%, unit at set point, and a current arc has occurred • On the logic board **S1-1** and **S1-2** are open (factory switches settings)	On	On	On	On	Flashing for one second		
Take this action: • Check **S1** switches on the logic board (see "I-Arc Settings (S1)" on page 5-33 for more information).							
• Output on, current greater than 5%, unit at set point, and at least one current arc has occurred after turning output on • On the logic board **S1-1** closed and **S1-2** open	On	On	On	On	**Flashing**		
• Output off and at least one current arc has occurred after turning output on • On the logic board **S1-1** open and **S1-2** closed	On	On			**On**		
• Output off and at least one current arc has occurred after turning output on • On the logic **S1-1** closed and **S1-2** closed.	On	On			**Flashing**		
Take this action: 1. Cycle output off (that is turn output off, on, and off again) to clear master unit state after checking **S1.** 2. Check **S1** switches on the logic board (see "I-Arc Settings (S1)" on page 5-33 for more information).							

TROUBLESHOOTING A SLAVE UNIT

The status LEDs that are shown in bold type indicate the primary problem. This problem should be addressed first.

Table 6-2. *Slave unit troubleshooting table*

Slave Unit State (And Suggested Actions)	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
• Output off and relay failure	On	**Flashing**				**On**	
Output off and/or • Relay failure • PLL not locked • CEX cable problems • Frequency miss match	Flashing	**Flashing**				**On**	Flashing
Take these actions: 1. Turn unit breaker off and back on. 2. Turn output on. 3. If state reoccurs immediately after turning output on, the LM board has probably failed. Call Advanced Energy see "AE Global Customer Support" on page 6-17 for contact information.							
• Output off and low line or inverter failure	On	**Flashing**					
Output off and • Low line or inverter failure, and/or • Overtemperature condition	On	**Flashing**				Flashing	
Take these actions: Cycle master unit output on/off (that is, start and stop output) after performing each check below to clear the slave state: 1. Ensure AC line voltage is present and within specifications (see "Electrical Specifications" on page 3-8 for specification information). 2. Check that all phases of input power are present (see "Electrical Specifications" on page 3-8 for phase requirements information. 3. If you can not clear this state, the inverter has probably failed. Contact AE Global Customer Support (see "AE Global Customer Support" on page 6-17 for contact information.							

Table 6-2. *Slave unit troubleshooting table (Continued)*

Slave Unit State (And Suggested Actions)	**Status LEDs**						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
Output off and/or • CEX termination plug missing • CEX cable problems • Too many slaves combined • Problem with the master/slave connection	**Flashing**	**Flashing alternately with Interlock**					
Output off and • Missing CEX termination • CEX cable problems • Too many slaves combined • Problem with master unit • Overtemperature condition	**Flashing**	**Flashing alternately with Interlock**				Flashing	
Take these actions: Cycle master unit output on/off (that is, start and stop output) after performing each check below to clear the slave state: 1. Check the CEX termination plug to ensure it is present and securely connected. 2. Check CEX termination continuity ("Verifying Continuity of the CEX Termination Plug" on page 6-16 for further information). 3. Check CEX cable connections to ensure they are present and securely connected. 4. Replace CEX cables with a known-good cable one at a time in an attempt to isolate a faulty cable. 5. Ensure the master unit (the first unit in a combined set) is turned on; then make certain you do not have too many slaves combined (see. "Connecting for Multiple Unit Operation" on page 5-23 for master/slave combination information. 6. Check the Master breaker to ensure input power is available (see "Electrical Specifications" on page 3-8 for specification information. 7. Check for the master jumper on all master unit **User** port connectors (see Table 4-2 on page 4-2 for information related to this jumper).							

Table 6-2. *Slave unit troubleshooting table (Continued)*

Slave Unit State (And Suggested Actions)	**Status LEDs**						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
Output off and • PLL not locked due to CEX cable problems, and/or • PLL not locked due to frequency miss match	**Flashing**	**Flashing alternately with Interlock**					**Flashing**
Output off and • PLL not locked due to CEX cable problems, • PLL not locked due to frequency miss match, and/or • Overtemperature condition	**Flashing**	**Flashing alternately with Interlock**				Flashing	**Flashing**
Take these actions: Let the unit cool, then cycle the master unit output on/off (that is, start and stop output) after performing each check below to clear the slave state: 1. Check the CEX termination plug to ensure it is present and securely connected. 2. Check CEX termination continuity ("Verifying Continuity of the CEX Termination Plug" on page 6-16 for further information). 3. Check CEX cable connections to ensure they are present and securely connected. 4. Replace CEX cables with a known-good cable one at a time in an attempt to isolate a faulty cable. 5. Check that the frequencies of the units are all the same. 6. Allow the unit time to cool sufficiently.							
• Output off and overtemperature condition	On					Flashing	
Take these actions: Let unit cool, and then cycle the master unit output on/off (that is, start and stop output) after performing each check below to clear the slave state: 1. Check coolant flow (see "Cooling Specifications" on page 3-17 for flow rate specifications). 2. Check coolant temperature (see "Cooling Specifications" on page 3-17 for coolant temperature specifications). 3. Check ambient temperature (see "Environmental Specifications" on page 3-17 for ambient temperature specifications). 4. Check spacing around units to ensure proper airflow (see "Spacing Requirements" on page 5-1 for spacing specifications). 5. If the unit is an option 002 model (use the next tap up).							

Table 6-2. *Slave unit troubleshooting table (Continued)*

Slave Unit State (And Suggested Actions)	**Status LEDs**						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
• No AC power, and/or • Unit breaker off							
Take these actions: 1. Check unit circuit breaker to ensure it is on (closed). 2. Check master unit breaker to ensure it is on (closed). 3. Check input voltage (mains) breaker to ensure it is on (closed). 4. Check line voltage to ensure it is present and within specifications (see "Electrical Specifications" on page 3-8 for specification information). 5. Check that all phases of input power are present (see "Electrical Specifications" on page 3-8 for phase specifications).							
• Output off	On						
Take these actions: 1. If you are attempting to turn on output through an active front panel: ensure the **Remote Start/Stop** button is *not* in remote (that is, *not* depressed). 2. If you are attempting to turn on output through the User port: ensure the **Remote Start/Stop** button is in remote (that is, depressed) if your unit. is equipped with an active front panel, and then check the *OUTPUT ON* signal at the **User** port (see Table 4-2 on page 4-2 for **User** port pin and signal information).							
Normal state of a slave unit when master output is off, or master unit is at set point or below minimum or current less than 1% of I-Max for selected tap	On	On					
Take these actions: 1. Check set point level to ensure that it is greater than 1% of full-rated unit output. 2. Check current readback to ensure that it is less than 1% of I-Max for the selected tap (see "Output and Set Point Readouts" on page 4-16, and Table 4-2 on page 4-2 for more information.							

Table 6-2. *Slave unit troubleshooting table (Continued)*

Slave Unit State (And Suggested Actions)	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
• Output on, current greater than 5%, and slave not at set point due to some limit	On	On	On	Flashing			
Take these actions: 1. If the voltage is greater than the V-Max for the selected tap, then switch to the next tap up (see "Tap Operating Information" on page 3-11 for tap setting information). 2. If the voltage is less than the V-Min for the tap selected, then switch to the next tap down (see "Tap Operating Information" on page 3-11 for tap setting information). 3. If you are at the highest tap, lowest tap, or less than the maximum available power, call Advanced Energy (see "AE Global Customer Support" on page 6-17 for contact information).							
• Output on and the slave is out of balance with the combined system	On	On	Flashing	Flashing alternately with **Plasma** LED			
Take these actions: 1. Check output cables for opens, shorts, and proper connection to chamber. 2. Check CEX cable connections to ensure they are present and securely connected. 3. Replace CEX cables with a known-good cable one at a time in an attempt to isolate a faulty cable.							
• Output on, current greater than 5% and unit at set point	On	On	On	On			
Take this action: • Check that the **User** port analog reference is grounded on the user side.							

Table 6-2. *Slave unit troubleshooting table (Continued)*

Slave Unit State (And Suggested Actions)	Status LEDs						
	Interlock	**Output**	**Plasma**	**Setpoint**	**Arc**	**Overtemp**	PLL
• Output on, current greater than 5%, unit at set point, and a current arc has occurred • On the logic board, switches **S1-1** and **S1-2** are open (this is the factory switch settings)	On	On	On (if not on check master unit)	On (if not on check master unit)	Flashing for one second		
Take this action: • Check S1 switches on the logic board (see "I-Arc Settings (S1)" on page 5-33 for more information).							
• Output off and at least one current arc has occurred after turning the output on • On the logic board, switches **S1-1** is open and **S1-2** closed	On	On	**On (if not on check master unit)**	**On (if not on check master unit)**	**On**		
• Output off and at least one current arc has occurred after turning output on • On the logic board, switch **S1-1** is closed and **S1-2** open or closed	On	On	**On (if not on check master unit)**	**On (if not on check master unit)**	**Flashing**		
Take these actions: • Cycle master unit output off (that is, turn output on and then off again) to clear the slave state after performing each step below: • Check **S1** switches on the logic board (see "I-Arc Settings (S1)" on page 5-33 for more information).							

Verifying Termination Plug Configuration

Refer to the following information to verify the correct configuration of the termination plugs for the **CEX/Drive Out** port and **User** port.

VERIFYING CONTINUITY OF THE CEX TERMINATION PLUG

If a setup fault occurs and you suspect the CEX termination plug is at fault, perform the following check to verify the configuration of the termination plug.

To Verify Continuity of the CEX Termination Plug:

1. Using an ohm meter, verify:
   - 100 Ω exists between pins 1 and 26
   - 100 Ω exists between pins 2 and 27
   - 100 Ω exists between pins 3 and 28.
2. Verify that pins 10, 35, and 11 are all shorted together.
3. Verify that pins 15 and 40 are shorted together.
4. All other CEX termination plug pins should read open between any other pin.

VERIFYING CONTINUITY OF THE USER PORT TERMINATION PLUG

If a setup fault occurs and you suspect the **User** port termination plug is at fault, perform the following check to verify the configuration of the termination plug.

To Verify Continuity of the User Port Termination Plug:

1. Using an ohm meter, verify pins 16 and 21 are shorted together (master jumper).
2. Verify pins 10 and 23 are shorted together (interlock jumper).
3. All other **User** port plug pins should read open between any other pin.

AE WORLD WIDE WEB SITE

For additional product information, please visit Advanced Energy's World Wide Web site at:

- http://www.advanced-energy.com

AE GLOBAL CUSTOMER SUPPORT

Please contact one of the following offices if you have questions.

Note: When calling AE Global Customer Support, make sure to have the unit serial number and part number. These numbers are available on unit labels.

Table 6-3. *Global Customer Support locations*

Office	Contact
AE, World Headquarters 1625 Sharp Point Drive Fort Collins, CO 80525 USA *Note:* For returns and repairs, please call Global Customer Support to get the correct shipping address.	Phone (24 hrs/day, 7 days/week): 800.446.9167 or 970.221.0108 Fax (M–F, 7:00 am – 5:30 pm MST): 970.407.5981 Email: technical.support@aei.com (We will respond to email by the next business day.) *Note:* For customers outside the US, please contact your local AE office.
AE, GmbH Raiffeisenstrasse 32 70794 Filderstadt (Bonlanden) Germany	Phone: 49.711.779270 Fax: 49.711.7778700
AE, Japan KK TOWA Edogawabashi Bldg. 347 Yamabuki-cho Shinjuku-ku Tokyo 162-0801 Japan	Phone: 81.3.32351511 Fax: 81.3.32353580
AE, Korea Ltd. Gongduk Building, 4th floor 272-6 Seohyun-Dong, Bundang-Gu, Seongnam-Si Kyunggi, 463-050 Korea	Phone: 82.31.705.2100 Fax: 82.31.705.2766
AE, United Kingdom Unit 5, Minton Place, Market Court, Victoria Road Bicester, Oxon OX26 6QB UK	Phone: 44.1869.320022 Fax: 44.1869.325004

Table 6-3. *Global Customer Support locations (Continued)*

Office	Contact
AE, Taiwan, Ltd. 10F-6, No. 110, Chung Shan Rd. Sec. 3, Chungho City, Taipei Hsien Taiwan 235	Phone: 886.2.82215599 Fax: 886.2.82215050
AE China 469 Huaxia Dong Road Zhangjiang Town Shanghai, China 201203	Phone: 86.21.58579011 Fax: 86.21.58579003

RETURNING UNITS FOR REPAIR

Before returning any product for repair and/or adjustment, ***first follow all troubleshooting procedures***. If, after following these procedures, you still have a problem, or if the procedure instructs you to, contact AE Global Customer Support and discuss the problem with a representative. Be prepared to give the model number and serial number of the unit, as well as the reason for the proposed return. This consultation call allows Global Customer Support to determine whether the problem can be corrected in the field or if the unit needs to be returned. Such technical consultation is always free of charge.

If you return a unit without first getting authorization from Global Customer Support and that unit is found to be functional, you will be charged a re-test and calibration fee plus shipping charges.

To ensure years of dependable service, Advanced Energy® products are thoroughly tested and designed to be among the most reliable and highest quality systems available worldwide.

WARRANTY

Advanced Energy® (AE) products are warranted to be free from failures due to defects in material and workmanship for 12 months after they are shipped from the factory (please see warranty statement below, for details).

In order to claim shipping or handling damage, you must inspect the delivered goods and report such damage to AE within 30 days of your receipt of the goods. Please note that failing to report any damage within this period is the same as acknowledging that the goods were received undamaged.

For a warranty claim to be valid, it must:

- Be made within the applicable warranty period
- Include the product serial number and a full description of the circumstances giving rise to the claim
- Have been assigned a return material authorization number (see below) by AE Global Customer Support

All warranty work will be performed at an authorized AE service center (see list of contacts at the beginning of this chapter). You are responsible for obtaining authorization (see details below) to return any defective units, prepaying the freight costs, and ensuring that the units are returned to an authorized AE service center. AE will return the repaired unit (freight prepaid) to you by second-day air shipment (or ground carrier for local returns); repair parts and labor will be provided free of charge. Whoever ships the unit (either you or AE) is responsible for properly packaging and adequately insuring the unit.

Authorized Returns

Before returning any product for repair and/or adjustment, call AE Global Customer Support and discuss the problem with them. Be prepared to give them the model number and serial number of the unit as well as the reason for the proposed return. This consultation call will allow Global Customer Support to determine if the unit must actually be returned for the problem to be corrected. Such technical consultation is always available at no charge.

Units that are returned without authorization from AE Global Customer Support and that are found to be functional will not be covered under the warranty (see warranty statement, below). That is, you will have to pay a retest and calibration fee, and all shipping charges.

Warranty Statement

The seller makes no express or implied warranty that the goods are merchantable or fit for any particular purpose except as specifically stated in printed AE specifications. The sole responsibility of the Seller shall be that it will manufacture the goods in accordance with its published specifications and that the goods will be free from defects in material and workmanship. The seller's liability for breach of an expressed warranty shall exist only if the goods are installed, started in operation, and tested in conformity with the seller's published instructions. The seller expressly excludes any warranty whatsoever concerning goods that have been subject to misuse, negligence, or accident, or that have been altered or repaired by anyone other than the seller or the seller's duly authorized agent. This warranty is expressly made in lieu of any and all other warranties, express or implied, unless otherwise agreed to in writing. The warranty period is 12 months after the date the goods are shipped from AE. In

all cases, the seller has sole responsibility for determining the cause and nature of the failure, and the seller's determination with regard thereto shall be final. The AE Warranty Statement may be superseded by a service agreement entered into between AE and the buyer.

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