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Operating Manual

XPR 6000 Watt Series Programmable DC Power Supply

www.xantrex.com



Operating Manual for
XPR 6000 Watt Series
Programmable DC
Power Supply

Limited Warranty

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This Limited Warranty is provided by Xantrex Technology, Inc. (“Xantrex”) and covers defects in workmanship and materials in your **XPR 6000 Watt Series DC Power Supply**. This warranty lasts for a Warranty Period of **5 years** from the date of purchase at point of sale to you, the original end user customer.

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- The dated purchase receipt from the original purchase of the product at point of sale to the end user, or
- The dated dealer invoice or purchase receipt showing original equipment manufacturer (OEM) status, or
- The dated invoice or purchase receipt showing the product exchanged under warranty

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- b. the product if it has been subjected to fire, water, generalized corrosion, biological infestations, and high input voltage from lightning strikes;
- c. the product if repairs have been done to it other than by Xantrex or its authorized service centers (hereafter "ASCs");
- d. the product if it is used as a component part of a product expressly warranted by another manufacturer;
- e. the product if its original identification (trade-mark, serial number) markings have been defaced, altered, or removed.

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THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK.

WARNING: Please refer to your product user manual for limitations on uses of the product.
Limitations on Use Specifically, please note that this power supply is not intended for use in connection with life support systems and Xantrex makes no warranty or representation in connection with any use of the product for such purposes.

Xantrex Technology, Inc.
8999 Nelson Way
Burnaby, British Columbia
Canada V5A 4B5

Information About Your Power Supply Please record the following information when you first open your Power Supply package:

Model Number	_____
Serial Number	_____
Purchased From	_____
Purchase Date	_____

Release Release 1.1 (2003-04)

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Warnings, Cautions, and Notes

Warnings, cautions, and notes are defined and formatted in this manual as shown below.



WARNING

Describes a potential hazard which could result in injury or death, or, a procedure which, if not performed correctly, could result in injury or death.



CAUTION

Describes a procedure which, if not performed correctly, could result in damage to data, equipment, or systems.

Note

Describes additional operating information which may affect the performance of the equipment.

Power Supply Safety



WARNING—High Energy and High Voltage

Exercise caution when using and calibrating a power supply. High energy levels can be stored at the output voltage terminals on a power supply in normal operation. In addition, potentially lethal voltages exist in the power circuit and on the output and sense connectors of a power supply with a rated output greater than 40 V. Filter capacitors store potentially dangerous energy for some time after power is removed.



CAUTION

Operate the power supply in an environment free of flammable gases or fumes. To ensure that the power supply's safety features are not compromised, use the power supply as specified in this manual and do not substitute parts or make any unauthorized modifications. Contact the service technician for service and repair help. Repairs must be made by experienced service technicians only.

About This Manual

Who Should Use This Manual

This manual is designed for users who understand basic electrical theory, especially as applied to the operation of power supplies. This implies a recognition of constant voltage and constant current operating modes and the control of input and output power, as well as the observance of safe techniques while making connections to the supply and any changes in settings.

Navigation

To help you locate information easily, this manual has the following:

- A Table of Contents
- A List of Figures
- A List of Tables

Sections

Section 1 About the XPR Power Supply describes the power supply features, front panel controls, front panel display, and rear panel connectors. It also gives an overview of operation.

Section 2 Installation describes how to mount the power supply, how to connect it, and how to run initial tests.

Section 3 Operation describes basic operation and functions carried out from the front panel.

Section 4 Remote Operation explains how to hook up the remote analog interface.

Appendix A Specifications and Characteristics provides electrical and mechanical specifications.

Revisions

The current release of this manual is listed below. Updates may be issued as an addendum.

Release 1.1 (2003-04)

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Section 1. About The XPR Power Supply

Overview

The XPR Series of programmable DC power supplies is designed for use in OEM, ATE, burn-in, magnet charging, and other high power systems for a broad range of applications. The XPR uses “Soft Switching” technology which provides superior performance combined with a high level of user control through both front panel and remote interfaces.

Features and Options

- Zero voltage (soft) switching for low noise output, improved efficiency and higher reliability
- Active Power Factor Correction (PFC) for lower input current draw and lower current harmonic generation
- Remote voltage sense with 5V line drop compensation
- Automatic Voltage/Current mode crossover
- Remote interlock
- Simultaneous digital display of both voltage and current.
- Ten-turn front panel voltage and current controls for high resolution setting of the output voltage and current from zero to the rated output.
- Front panel push-button control of output standby mode and preview of voltage, current, or OVP setpoints. Front panel light emitting diode (LED) indicators for voltage and current mode operation, OVP, remote programming mode, and shutdown. Front panel control of OVP.
- Multiple units can be connected in parallel or in series to provide increased current or voltage.
- Over Temperature shutdown, latching or auto reset.
- Remote analog voltage and current limit programming with selectable programming ranges.
- External monitor signals for output voltage and current.
- Isolated analog remote programming control of the output voltage or current and isolated readback of output voltage and current with the optional ISOL Interface.
- CSA Certified to UL 3111-1, CSA 1010.1; CE Mark; FCC Class A

Front Panel

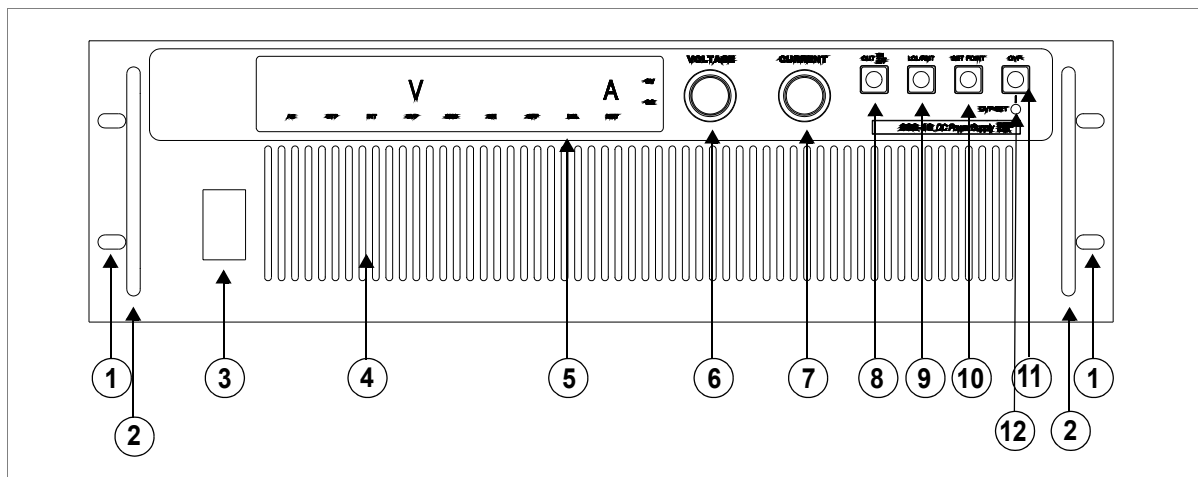


Figure 1.1 Front Panel

1. Rack mount brackets
2. Handles
3. On/Off switch
4. Air intake vents
5. Front panel display. See [Figure 1.2, on page 19](#) for details.
6. Voltage knob: Turn knob to increase or decrease output voltage.
7. Current knob: Turn knob to increase or decrease output current limit.
8. OUT ON/OFF button: Toggle between Output ON and Output OFF.
9. LCL/RMT button: Toggle between local mode and remote mode.
10. SET POINT button: View and set operating setpoints for output voltage and current (Local Mode only).
11. OVP button: View and set Over Voltage Protection setpoint with OVP Adjust Potentiometer.
12. OVP SET: Front panel screw, Over Voltage Protection Adjust Potentiometer.

Status Annunciators

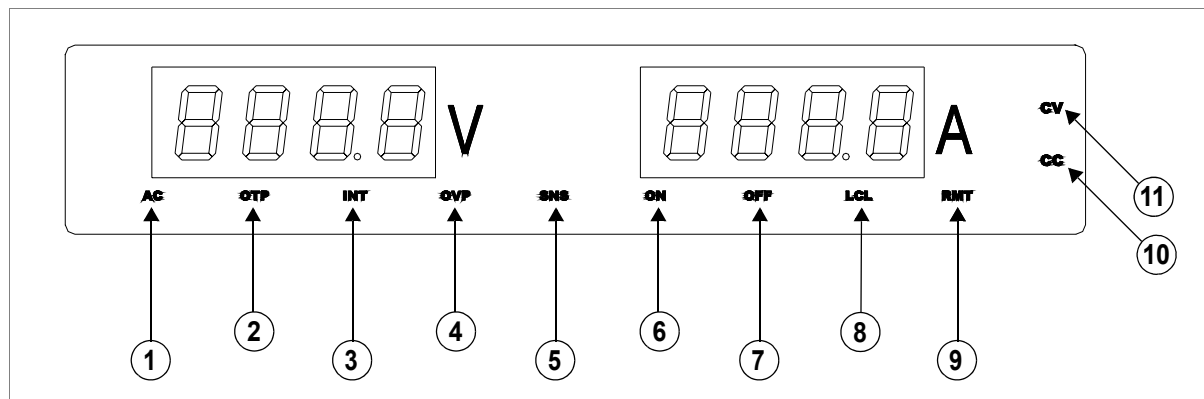


Figure 1.2 Front Panel Display, Status Annunciators

1. AC: The AC input is out of range and has caused the output of the supply to be shut down (red)
2. OTP: The internal Over Temperature Protection threshold has been exceeded, disabling the supply output until the sensors cool to within the normal operating temperature range (red)
3. INT: The external shutdown line has been asserted, disabling the output of the supply (green)
4. OVP: The output Over Voltage Protection threshold have been exceeded, latching the supply output off (red)
5. SNS: The remote sense line protection circuit has been activated, latching the supply output off (red)
6. ON: The supply output is enabled (green)
7. OFF: The supply output has been disabled (green)
8. LCL: The supply is in Local control mode (green)
9. RMT: The supply is in Remote program mode (green)
10. CV: The supply is operating in Constant Voltage mode (green)
11. CC: The supply is operating in Constant Current mode (green)

Rear Panel Connectors and Switch

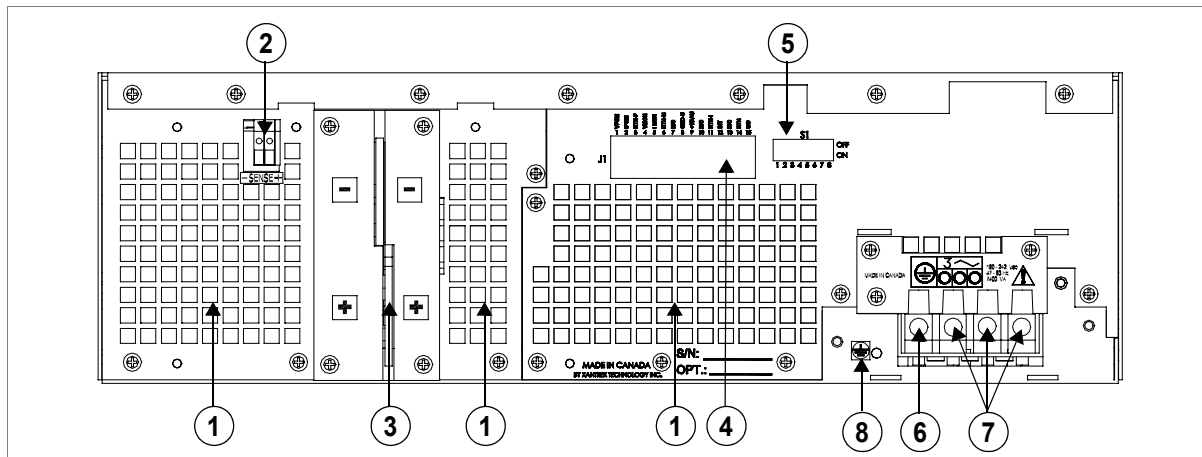


Figure 1.3 Rear panel

1. Fan Exhaust Vents: Do Not Obstruct.
2. Remote Sensing Ports: From the rear panel point of view, left is negative; right is positive.
3. DC Output: Bus bars are shown. Terminal blocks are used for higher voltages (150 Vdc and higher).
4. Programming, Monitoring and User Line Connector (J1).
5. Programming, Monitoring and Shutdown Select Switch (S1).
6. Protective Conductor Ground Screw.
7. Ac Input.
8. Chassis ground stud.

Rear Panel S1 Switch

The S1 Programming, Monitoring, and Interlock select switch is an 8-position piano DIP switch located on the power supply's rear panel. See [Figure 1.4](#). The S1 switch enables you to choose:

- Resistive programming of output voltage or current limit
- Output voltage and current limit programming scales
- Output voltage and current monitor scales
- Remote shutdown circuit logic
- Over temperature shutdown mode

- 1 Resistive Programming of Output Voltage
- 2 Resistive Programming of Output Current Limit
- 3 Selects Output Voltage Programming and Monitor Range select
- 4 Selects Output Current Limit Programming and Monitor Range select
- 5 Selects Output Voltage Control: Local or Remote
- 6 Selects Output Current Control: Local or Remote
- 7 Selects Remote Interlock Logic
- 8 Selects Over Temperature Shutdown Reset Mode

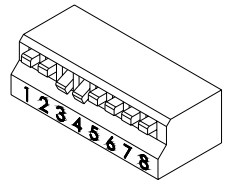


Figure 1.4 Programming and Monitoring S1 Switch
(Switch is shown in factory default configuration.)

The rear panel at the switch is labeled with OFF at the top and ON at the bottom. Any of the eight switches on S1 is OFF when it has been flipped up to break contact, ON when flipped down to close contact.

[Table 1.1](#) shows the functions assigned to each S1 switch. Factory defaults are underlined.

Table 1.1 Rear Panel S1 Switch Assignments

Switch	Function	OFF	ON
S1-1	1 mA current source for resistive programming of output voltage	<u>Voltage source programming</u>	Resistive programming (0-5 k, 0-10 k)
S1-2	1 mA current source for resistive programming of output current limit	<u>Voltage source programming</u>	Resistive programming (0-5 k, 0-10 k)
S1-3	Output voltage programming and monitor range select	0-5 V (0-5 k)	<u>0-10 V</u> (0-10 k)
S1-4	Output current limit programming and monitor range select	0-5 V (0-5 k)	<u>0-10 V</u> (0-10 k)
S1-5	Output voltage control mode select	<u>Local Control</u>	Remote Control
S1-6	Output current control mode select	<u>Local Control</u>	Remote Control
S1-7	Remote Interlock logic signal select	<u>Active High=OFF</u>	Active Low=OFF
S1-8	Over temperature shutdown reset mode select	<u>Auto reset</u>	Latch OFF

Resetting the Switches

Before making any changes to the switch settings, either turn off the AC power switch or disable the power supply output by pushing the front panel OUT ON/OFF switch to its IN position. This temporarily shuts down the power supply. The front panel OFF LED turns on. Then use any small, flat-bladed screwdriver to change the switch settings.

About The XPR Power Supply

Rear Panel Connectors and Switch

Rear Panel J1 Connector

The J1 Programming and Monitoring connector is a 15-terminal wire clamp connector located on the power supply's rear panel. See [Figure 1.5](#). The J1 connector provides access to the following functions:

- Remote programming of output voltage AND/OR current limit
- Remote monitoring of calibrated readback signals for output voltage and output current
- Remote control of the shutdown function using TTL-compatible signals (Interlock module)
- 15 V user supply to allow for contract closure control of the remote on/off line, current limited

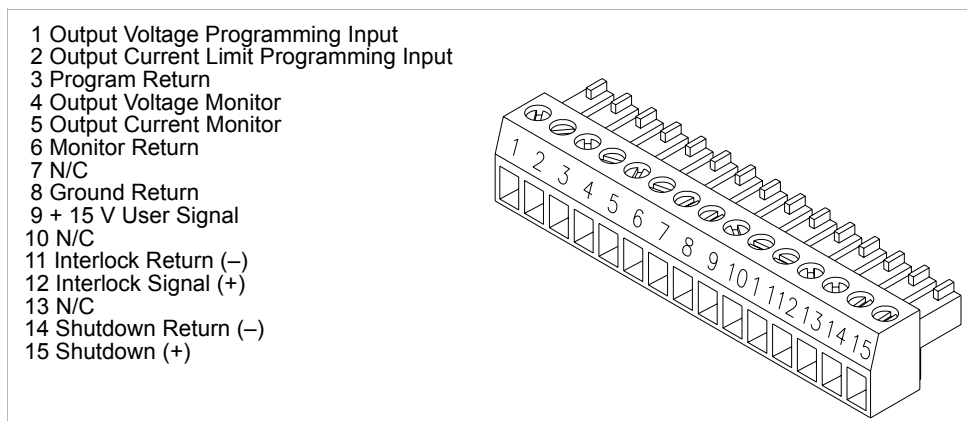


Figure 1.5 Programming and Monitoring J1 Connector

See [Table 1.2, on page 23](#) for the list of the J1 connector terminal numbers, their references, and corresponding functions.

Table 1.2 Rear Panel J1 Connector Terminals and Functions

Pin	Reference	Name	Function	In/Output
J1-1	VPGM	Output Voltage Programming Input	Input for voltage programming signals from a voltage source (select S1-5 = ON and: S1-3 = OFF for 0-5 V range S1-3 = ON for 0-10 V range (see Table 4.3, on page 63 for details)	Input
J1-2	IPGM	Output Current Limit Programming Input	Input for current limit programming signals from a voltage source (select S1-6 = ON and: S1-4 = OFF for 0-5 V range S1-4 = ON for 0-10 V range (see Table 4.3, on page 63 for details)	Input
J1-3	RTN-P ¹	Program Return	Return for voltage and current programming signals	Input
J1-4	VMON	Output Voltage Monitor	Output for output voltage monitor signal	Output
J1-5	IMON	Output Current Monitor	Output for output current monitor signal	Output
J1-6	RTN-M ¹	Monitor Return	Return for voltage and current monitoring signals	Output
J1-7	N/C	No connection	None.	N/C
J1-8	GND-U ²	Return of 15 V User Signal	Return for 15 V isolated ³ supply voltage.	Output
J1-9	+15V-U	+ 15 V User Signal	+ 15 V isolated voltage supply	Output
J1-10	N/C	No connection	None.	N/C
J1-11	RTN-I ⁴	Return Interlock	Return safety interlock (shutdown)	Input
J1-12	INT	Interlock Signal (4-15 V)	Safety interlock (shutdown) 4-15 V	Input
J1-13	N/C	No connection	None.	N/C
J1-14	RTN	Return Shutdown	Return master/slave S/D signal	Input
J1-15	S/D	Shutdown	Shutdown master/slave signal (5-15 V)	Input

1. Both RTN-PGM and RTN-MON are connected at the same potential.
2. An isolated (see footnote below) supply voltage is available for external usage (e.g. remote on/off line). Its internal impedance is approximately 100 Ω .
3. User supply is isolated to 600 V from the power supply output and chassis.
4. Safety Interlock circuit is isolated to 600 V from the power supply output and chassis.

About The XPR Power Supply

Rear Panel Connectors and Switch

Section 2. Installation

Overview

[Section 2](#) provides recommendations and procedures for inspecting, installing, and testing the power supply. For more information about controls and connectors, refer to the front panel diagram ([Figure 1.1](#)) as well as the rear panel diagram ([Figure 1.3](#)) in [Section 1](#).

Basic Setup Procedure

[Table 2.1](#) provides a summary of the setup procedure and an overview of the subsections in this chapter. Use this table as a quick reference if you are familiar with the installation requirements for the power supply. If you require more information, each step in the table refers to a subsequent section which contains more details. Complete each step in the sequence given.

Table 2.1 Basic Setup Procedure

Step #	Description	Action	Reference
1	Inspection	Visually inspect the power supply.	“Inspection, Cleaning, and Packaging” on page 26
2	Installation	Install the power supply, ensuring adequate ventilation.	“Location, Mounting, and Ventilation” on page 29
3	Input Power	Connect AC input power.	“AC Input Power” on page 32
4	Test	Perform functional tests for voltage mode operation, current mode operation, and front panel controls.	“Basic Tests” on page 35
5	Select Wires	Select wires that can tolerate the DC current output.	“Load Wiring” on page 39
6	Connect Load	Connect the load wires to the DC output.	“Load Connections” on page 41
7	Connect Remote Sensing (if required)	Connect remote sensing connectors on power supply to load.	“Remote Sensing” on page 45

Installation

Inspection, Cleaning, and Packaging

Inspection, Cleaning, and Packaging

Initial Inspection

When you receive your power supply, do a quick visual check.

1. Ensure that the box contains the power supply, the operating manual, the AC input cover and strain relief, and the output cover.
2. Inspect the unit for scratches and cracks as well as broken switches, connectors, or displays.

If the unit is damaged, save all packaging materials and notify the carrier immediately.

Maintenance

Routine servicing of the power supply is not required except for periodic cleaning. Whenever a unit is removed from operation, clean the metal surfaces with naphtha or an equivalent mild solvent, and clean the front panel with a damp cloth using a weak solution of soap and water. Use low-pressure compressed air to blow dust from in and around vent openings and components on the printed circuit boards.

Returning Power Supplies to the Manufacturer

Return Material Authorization Policy

Before returning a product directly to Xantrex you must obtain a Return Material Authorization (RMA) number and the correct factory “Ship To” address. Products must also be shipped prepaid. Product shipments will be refused and returned at your expense if they are unauthorized, returned without an RMA number clearly marked on the outside of the shipping box, if they are shipped collect, or if they are shipped to the wrong location.

When you contact Xantrex to obtain service, please have your operating manual ready for reference and be prepared to supply:

- The serial number of your product
- Information about the installation and use of the unit
- Information about the failure and/or reason for the return
- A copy of your dated proof of purchase

When you ship:

1. Package the unit safely following the procedures on [page 28](#), preferably using the original box and packing materials. Please ensure that your product is shipped fully insured in the original packaging or equivalent. This warranty will not apply where the product is damaged due to improper packaging.
2. Include the following:
 - The RMA number supplied by Xantrex Technology Inc clearly marked on the outside of the box.
 - A return address where the unit can be shipped. Post office boxes are not acceptable.
 - A contact telephone number where you can be reached during work hours
 - A brief description of the problem

Ship the unit prepaid to the address provided by your Xantrex customer service representative.

If you are returning a product from outside of the USA or Canada:

In addition to the above, you **MUST** include return freight funds and are fully responsible for all documents, duties, tariffs, and deposits.

If you are returning a product to a Xantrex Authorized Service Center (ASC):

A Xantrex return material authorization (RMA) number is not required. However, you must contact the ASC prior to returning the product or presenting the unit to verify any return procedures that may apply to that particular facility.

Installation

Returning Power Supplies to the Manufacturer

Packaging for Shipping or Storage

Follow these instructions to prepare the unit for shipping or storage.

1. When returning the unit or sending it to the service center, attach a tag to the unit stating its model number (available from the front panel label) and its serial number (available from the rear panel label). Give the date of purchase and an invoice number, if you have it, as well as a brief description of the problem.
2. For storage and shipping, repack the power supply in its original container. If the original container is not available, seal the unit in a plastic bag and then pack it into a wooden or sturdy cardboard box large enough to allow 2 in. (5cm) of cushioning material to surround the unit. For cushioning, use material such as foam slabs that are capable of supporting the unit.
3. Label the box as shown below in [Figure 2.1](#).
4. If shipping, mark the service center address and your return address on the carton.
5. If storing, stack no more than 5 boxes high. Check the storage temperature range and storage altitude specification in [“Environmental Specification” on page 75](#).

POWER SUPPLY
Model Number: _____
Serial Number: _____
FRAGILE — ELECTRONIC EQUIPMENT

Figure 2.1 Shipping or Storage Carton Label

Location, Mounting, and Ventilation

Use the power supply in rack-mounted applications only. The power supply is designed to fit in a standard 19 in. (483mm) equipment rack.

Rack Mounting



WARNING- High Energy and High Voltage

Ensure that the 8-32 rack mounting screws do not extend more than 1/8 in. (3.0mm) into the sides of the power supply.

To install the power supply in an equipment rack:

1. Open the box containing the unit. See [Figure 2.2](#).
2. With the help of at least one other person, lift the unit out of its package and slide it into an empty space in a mounting rack equipped with rails that are rated to support the unit's weight. See [Figure 2.3](#).



CAUTION

The power supply is too heavy for one person to safely lift and mount. To avoid injury, ask a co-worker for assistance.

3. While your assistant(s) holds the unit steady, fasten it to the rack by inserting bolts through the mounting brackets on either side of the front panel and securing them with a washer and nut.
4. The front panel mounting brackets are designed to prevent the unit from sliding out of the rack, not to support its full weight. Provide adequate support for the rear of the unit without obstructing the ventilation inlets. Use slide rails as illustrated in [Figure 2.3](#) or slide brackets attached to the 8-32 mounting holes on each side of the unit. Follow the manufacturer's instructions to install rails or slides.

Installation

Location, Mounting, and Ventilation

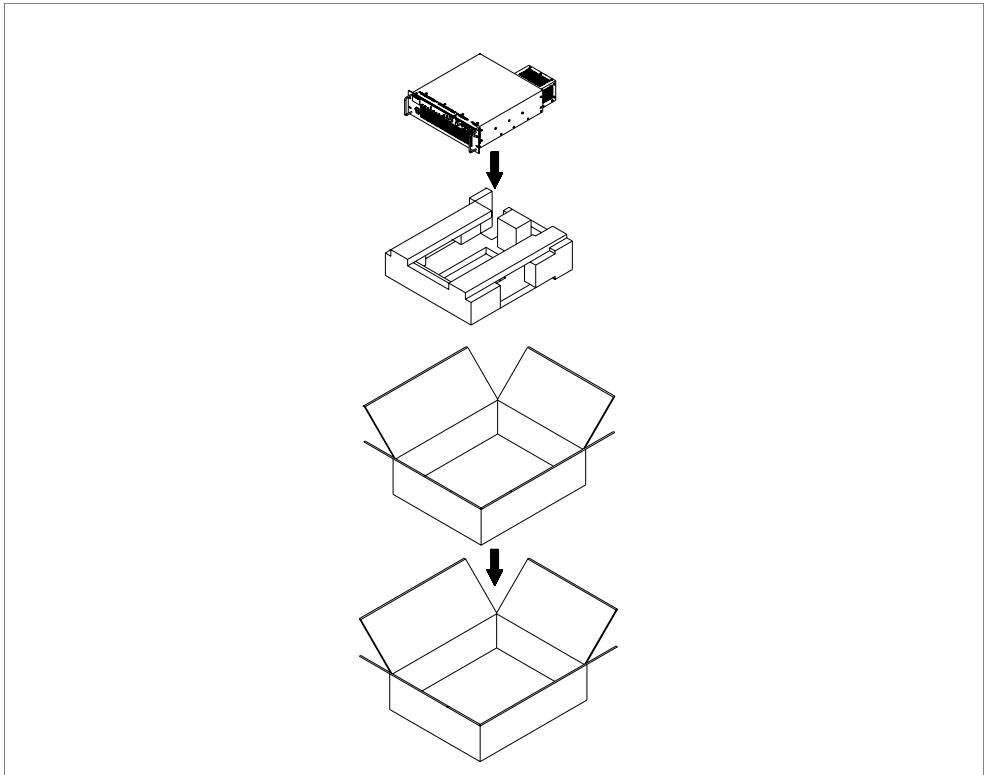


Figure 2.2 Unpacking the Power Supply

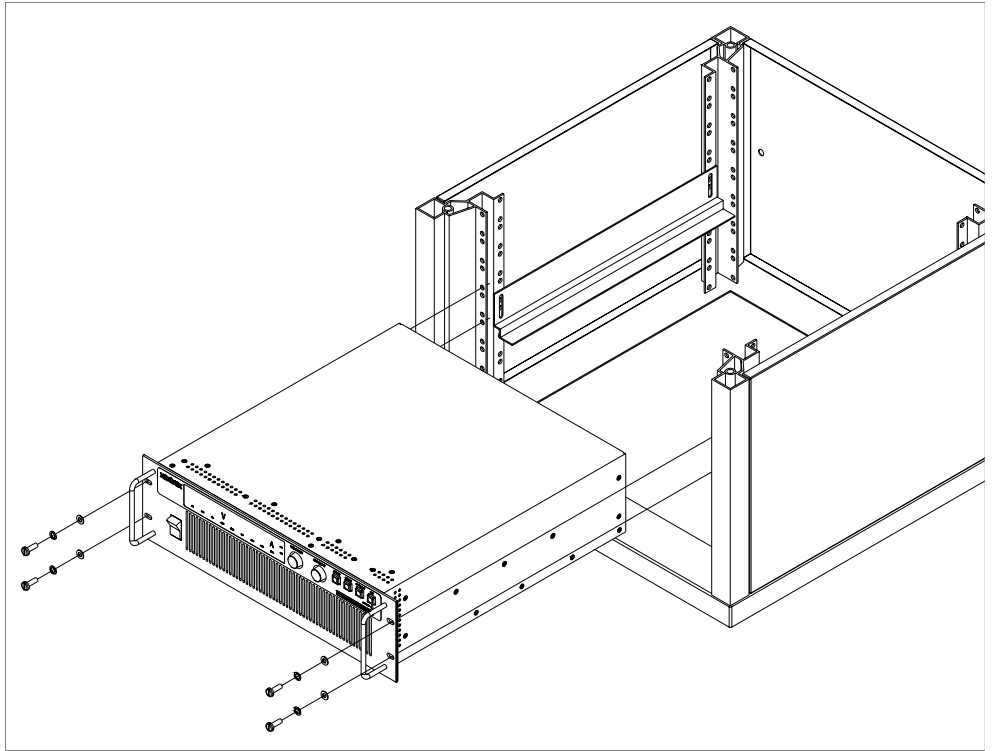


Figure 2.3 Mounting the Power Supply in the Rack With Support Rails¹

Ventilation Allow cooling air to reach the ventilation inlets on the front of the unit and allow 4 in. (10 cm) of unrestricted air space at the rear of the unit for the fan exhaust. Ventilation inlets are located on the top and sides; they are not required, however, and may be blocked, if required.

See [“Specifications and Characteristics” on page 65](#) for the operating ambient temperature range.

1. Available from rack or cabinet vendors (e.g. Schroff, part number 30150-094).

AC Input Power



WARNING

Disconnect AC power from the unit before removing the connector cover. Live line voltages may be exposed when the cover is removed.



WARNING

A safety ground wire must be connected to the unit as shown in [Figure 2.4](#) to ensure operator safety.



CAUTION

When the power switch is turned on, output voltage or current previously set may be applied to loads, depending on the supply configuration.

AC Input Connector

The AC input connector is a standard wire clamp terminal block with 3-phase connectors and a chassis ground connector. The safety ground wire, alternatively, may be connected to the chassis using a ring tongue on the ground stud as shown in [Figure 2.4](#).

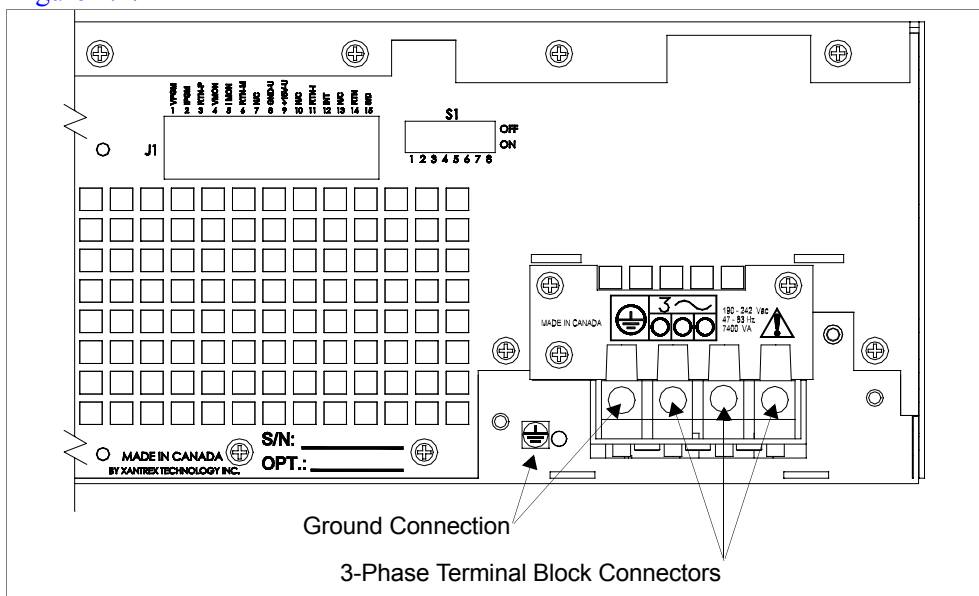


Figure 2.4 AC Input Connector

AC Input Wire The manufacturer recommends the AC input wire specified in [Table 2.2](#). This must be permanently connected to an approved AC distribution box with suitably rated over-current protection. If you require a special cord, contact the manufacturer.

Table 2.2 AC Wire Specification for 6000 Watt units

AC Input Voltage Range	Wire
190–242Vac, 47–63Hz, 3-phase, 4 wire (standard)	4 x 10 AWG (3 wire plus safety ground), stranded copper, 60°C minimum, 300V, 0.800 in. maximum cable diameter, rated for 25A.
342–500Vac, 47–63Hz, 3-phase, 4 wire (HV-Input)	4 x 14 AWG (3 wire plus safety ground), stranded copper, 60°C minimum, 600V, 0.800 in. maximum cable diameter, rated for 13A.

AC Wire Input Connection See [Figure 2.5, on page 34](#).

To connect the AC input wires:

1. Ensure that the AC input cord is de-energized, and that the power switch on the front of the power supply is OFF.
2. Strip approximately 4 in. (10 cm) from the jacket of the AC wire. Strip 0.55 in. (14 mm) at the end of each wire.
3. Undo the 2 screws for the AC wiring strain relief/cover on the rear panel. Remove the cover.
4. Undo the strain relief screws. Insert the AC input cable through the strain relief until the outer cable jacket is flush with the inside of the strain relief. Tighten the strain relief cable clamp screws.
5. Insert the ground wire (green) 0.55 in. (14 mm) into the left-most terminal location, and tighten securely. (The safety ground wire may alternatively be connected to the chassis ground stud next to the terminal block, using a suitably sized ring terminal).
6. Route the AC wires to the input terminal block by connecting the red, black, and white wires to the remaining 3 cable clamp connectors. There is no set order for connecting the wires. Any of the 3-phase wires can be connected to any of the 3 line input connectors. To connect each wire, loosen the terminal screw, insert the stripped wire 0.55 in. (14mm) into the terminal, and tighten the screw securely.
7. Reinstall the AC input strain relief/cover, routing wires inside the cover to prevent pinching.
8. Connect the free end of the cable to the AC source, checking that the voltage is within the approved input range for the supply.
9. Energize the AC input.

Installation

AC Input Power

It is now safe to turn the power supply on.

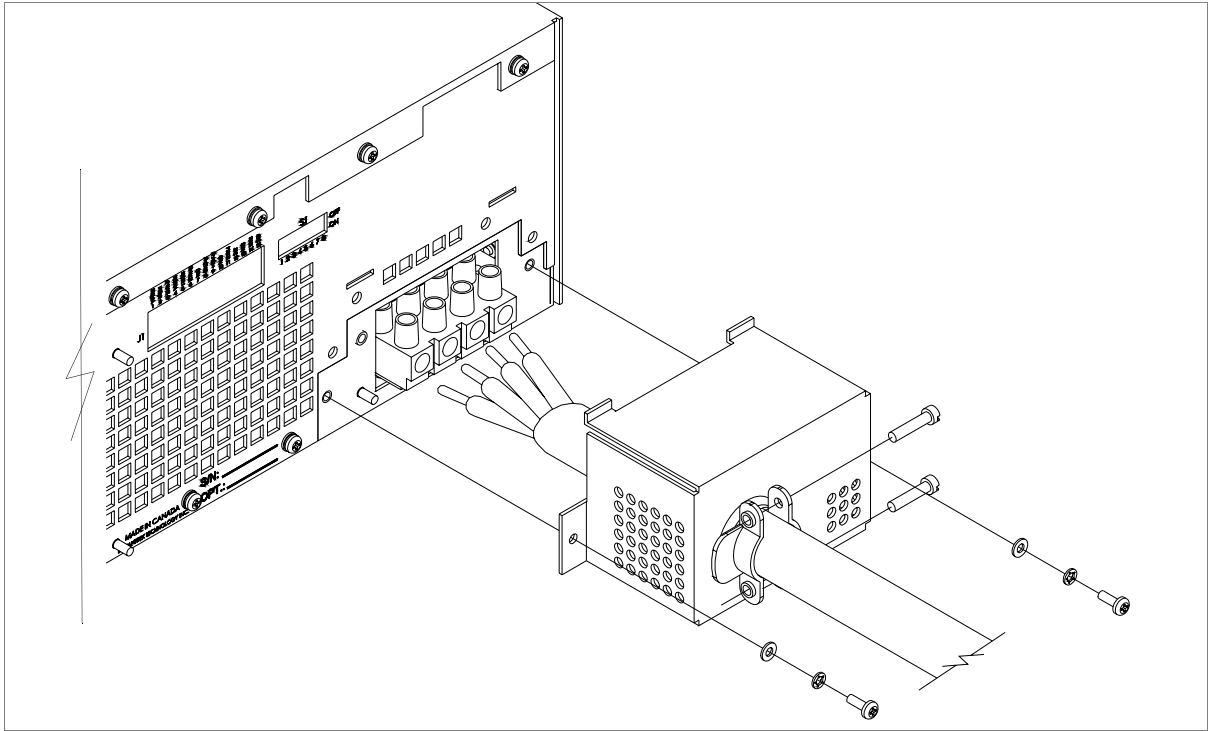


Figure 2.5 Attaching the AC Input Wires

Basic Tests



WARNING

The factory setting for Power ON is 0V and 0A. These settings can be changed by end users. If you suspect that the power supply has been used by someone else since it was received from the factory, be prepared for the unit to power ON with a live DC output.

The functional test procedures described in this section include power-on and front panel function checks as well as voltage and current mode operation checks.

Equipment Required

- Digital Voltmeter (DVM) rated better than 0.05% accuracy.
- DC shunt 1mV/A ($\pm 0.25\%$) with connecting wire. The recommended current ratings for the DC shunt and the wire must be at least 10% more than the output current of the power supply.

Power ON Check

To complete the power on check:

1. Ensure that the AC power switch is OFF.
2. Connect the unit to an AC outlet.
3. Turn the front panel AC power switch to ON.

After a short power-on delay, the front panel meters and the CV annunciator illuminate. Both voltmeter and ammeter displays should read zero.

Check the front panel annunciators. If the ON LED is illuminated, press **OUT ON/OFF** button to disable the output. The OFF LED should now be illuminated. If the LCL LED is illuminated, the power supply control is in Local Mode. If the RMT LED is illuminated, the power supply control is in Remote Mode. For an illustration of the annunciators and their locations, see [“Status Annunciators” on page 19](#).

AC Protection will disable the output if the AC line drops or is over the acceptable range. The AC LED turns off when the input voltage is within the range.

If you observe or suspect that one or more of the display LEDs is malfunctioning, contact the manufacturer.



WARNING

On units rated higher than 40V, ensure that the electrical connections are protected to prevent accidental contact.



CAUTION

When making connections to the bus bars, ensure that each terminal's mounting hardware and wiring assembly are placed so they don't touch the other terminal and short the power supply outlet. Heavy connecting cables must have some form of strain relief so the connections aren't loosened and the bus bars aren't bent.

**Voltage Mode
Operation
Check**

1. Ensure the voltage and current controls on the front panel are turned fully counter-clockwise.
2. Connect a DVM to the output terminals on the rear panel, observing correct polarity.
3. Turn the current control a 1/2-turn clockwise. Slowly turn the voltage control clockwise and observe both the front panel voltmeter and the DVM.
4. Compare the DVM reading with the front panel voltmeter reading to verify the accuracy of the internal voltmeter. Both readings should be within the error specification for the display. The minimum control range is from zero to the maximum rated output for the power supply model. The voltage mode CV LED turns on.
5. Press OUT ON/OFF button to turn the DC output OFF.
6. Turn the front panel AC power switch to OFF.

**Current Mode
Operation
Check**

1. Ensure that the front panel power switch is set to OFF.
2. Turn the voltage and current controls on the front panel fully counter-clockwise.
3. Connect the DC shunt across the output terminals on the rear panel.
4. Connect the DVM across the DC shunt.
5. Turn the AC power switch to ON.
6. Turn the voltage control one (1) or two (2) turns clockwise.
7. Turn the current control slowly clockwise.
8. Compare the DVM reading with the front panel ammeter reading using $I=V/R$ where I is the current, V is the DVM reading, and R is the DC shunt resistance. The minimum control range is from zero to the maximum rated output for the power supply model. The current mode CC LED turns on.
9. Press OUT ON/OFF button to turn the DC output OFF.
10. Turn the front panel power switch to OFF.
11. Disconnect the DVM and the shunt.

Front Panel Function Checks

1. Turn the front panel power switch to ON.
2. Set voltage and current controls fully clockwise. Push the OUT ON/OFF switch to its IN position and check that the voltmeter reading falls to zero and the OFF (OUTPUT OFF) LED turns on. Push the OUT ON/OFF switch once again to reset it to its OUT position. The OFF LED turns off and the voltmeter reading returns to its previous value.
3. Press the OUT ON/OFF switch to its IN position.
4. Press the OVP CHECK switch and check that the voltmeter displays approximately the model-rated output voltage plus 10%.
5. Turn the OVP SET potentiometer counter-clockwise and check that the voltmeter reading decreases. Continued turning (up to 20 turns) will see the reading decrease to approximately 5% of the model-rated voltage output. Turn the OVP SET potentiometer clockwise until the voltmeter once again displays approximately the model-rated output voltage plus 10%.
6. Press the OUT ON/OFF switch to its OUT position.
7. Press the SET POINT switch and check that the voltmeter and ammeter display approximately the power supply output ratings.
8. Turn the front panel power switch to OFF.

Load Wiring

When connecting load wiring to the power supply, consider the following factors:

- Current carrying capacity of the wire
- Maximum load wiring length for operation with sense lines
- Noise and impedance effects of the load lines

Current Carrying Capacity

As a minimum, load wiring must have a constant capacity greater than the output current rating of the power supply. This ensures that the wiring will not be damaged even if the load is shorted. [Table 2.3](#) shows the maximum current rating, based on 450A per square centimeter, for various gauges of wire rated for 105°C operation. Operating at the maximum current rating results in a temperature rise of approximately 30°C for a wire operating in free air. Where load wiring must operate in areas with elevated ambient temperatures or bundled with other wiring, use larger gauges or higher temperature-rated wiring. For high current applications, custom-designed bus bars are typically used. To increase the current carrying capability, use parallel cables.

Table 2.3 Current Carrying Capacity for Load Wiring¹

Wire Size (AWG)	Maximum Current (A)	Wire Size (AWG)	Maximum Current (A)
20	2.5	4	97
18	4	2	155
16	6	1	192
14	10	1/0	247
12	16	2/0	303
10	21	3/0	350
8	36	4/0	405
6	61	250MCM	455

1. Single insulated conductors in free air, 30°C

Installation

Load Wiring

Load Wiring Length for Operation with Sense Lines

For applications using remote sensing, or for improved voltage regulation at the load, you must limit the voltage drop across each load line. We recommend that you use larger load wiring to ensure a smaller voltage drop (1V maximum under full load conditions), although units will compensate for up to 5V drop in each line with the remote sense lines connected. The combined voltage drop across the load lines and load cannot exceed the rated output of the supply.

Noise and Impedance Effects

To minimize noise pickup or radiation, use the shortest possible length of shielded-twisted pair wiring for load lines. Connect the shield to the chassis via a rear panel mounting screw. Where shielding is not possible or is impractical, twisting the wires together offers some noise immunity. When using local sense connections, use the largest practical wire size to minimize the effects of load line impedance on the regulation of the supply.

Load Connections



WARNING

Exercise caution when operating the power supply. High energy levels can be stored at the output terminals on a power supply in normal operation. In addition, potentially lethal voltages exist in the power circuit and on the output and sense connectors of a power supply with a rated output greater than 40V. Filter capacitors store potentially dangerous energy for some time after power is removed.



CAUTION

When making connections to the bus bars, ensure that each terminal's mounting hardware and wiring assembly are placed to avoid touching the other terminal and shorting the power supply outlet. Heavy connecting cables must have some form of strain relief so they don't loosen the connections or bend the bus bars.

Make load connections at the rear of the power supply at the positive and negative output bus bars or to the 4-terminal wire clamp connector, depending on the model. (See Figure 2.6.)

Wire Size The wire should be one size larger than necessary to accommodate the required output current. Normally, the next largest commonly used gauge is used. For example, use 10AWG for 20A, and 8AWG for 30A.

Isolation The wire must have a suitable insulating coating that will prevent arcing between the positive and negative output lines, and must be rated for 105°C operation.

Installation

Load Connections

Single Load To connect a single load to the DC output bus bars (5–80V outputs):

1. Ensure that the power supply is powered OFF.
2. Place a 5/16 in. (M8) bolt in the connecting hole of the negative bus bar, and fasten the negative wire or bus bar, a flatwasher, lockwasher, and a nut to the bolt.
3. Using a wrench, turn the bolt until it is secure at approximately 25 foot-pounds (34Nm).
4. Fasten the positive wire or bus bar to the positive bus, using a bolt, flatwasher, lockwasher, and nut.
5. Tighten the bolt to approximately 25 foot-pounds (34Nm).
6. Ensure that the positive and negative wires are arranged so bare wires do not come into contact with each other or the chassis.

To connect the DC output wire clamp connectors (100–600V outputs):

- Connect appropriately sized wires as described in steps 1 to 6 above, except strip 0.5 in. (13 mm) of insulation off each load wire, and clamp in the output connector by securely tightening the vertical clamp screw for each output.

Multiple Loads To connect multiple loads in parallel:

- Follow the “Single Load” procedure with the following exception:
- To minimize interaction between loads, bring the wiring for each load directly back to the supply output. When each load to the power supply is wired separately, the loads will see only the precisely regulated output from the supply. If 2 loads share a single cable, the fluctuation in current to one load will cause the voltage to vary on the others. This is due to wire impedance drops.

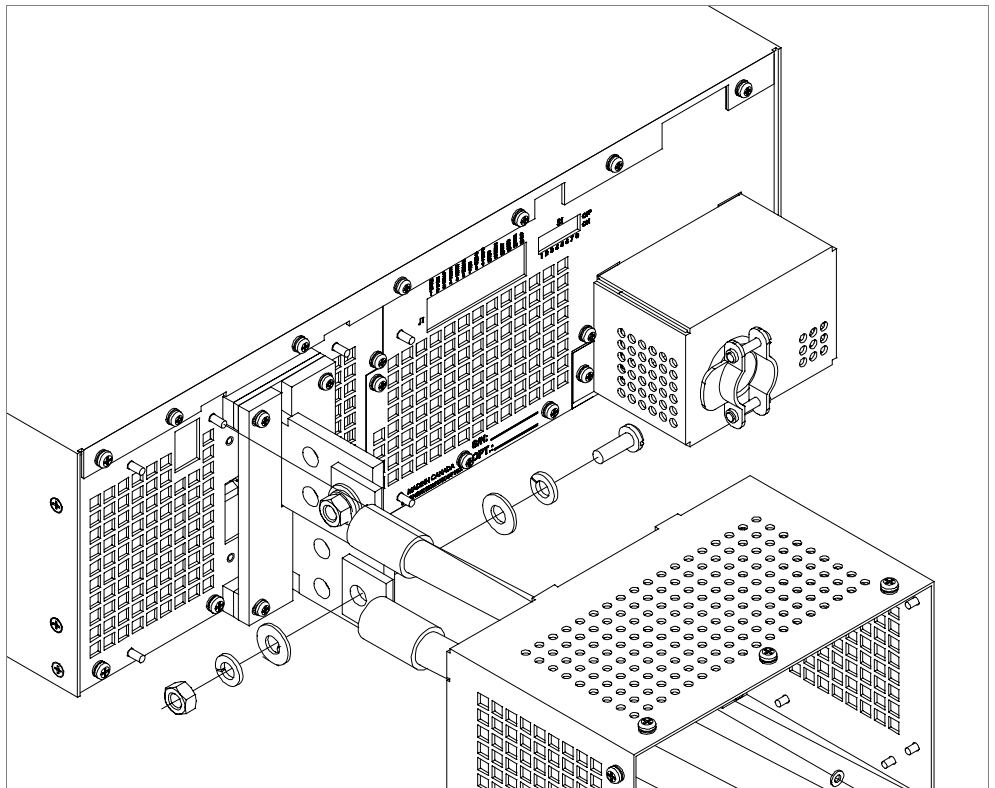


Figure 2.6 Fastening the Output Wires
(Low and Medium Voltage)

Installation

Load Connections

Output Strain Relief/Cover

See [Figure 2.7](#) for installation of the output cover. Use this cover to protect users from accidental contact with the bus bars and to clamp output cables in place.

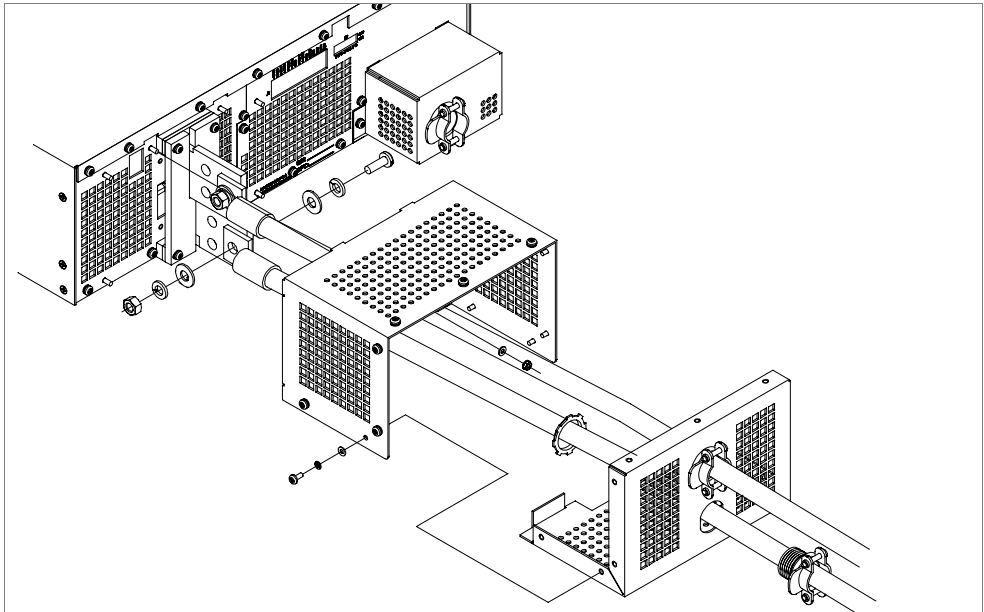


Figure 2.7 Output Bus Bar Cover
(Low and Medium Voltage)

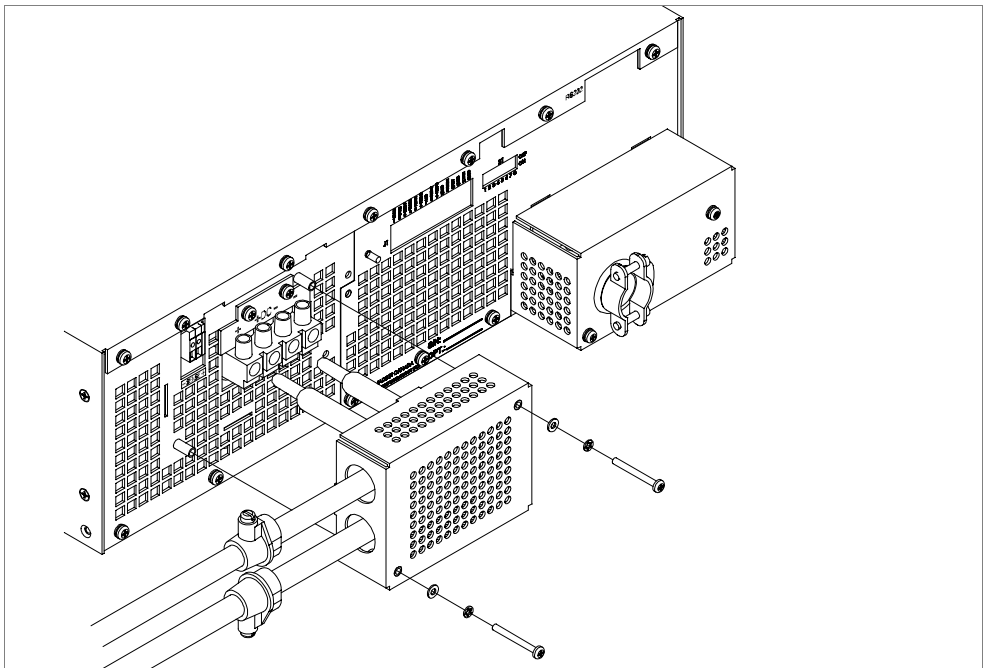


Figure 2.8 Output Cover with Strain Relief
(High Voltage 100–600V)

Remote Sensing

The power supply regulates the output voltage at the output connectors in its normal configuration without remote sense lines connected.

Remote sensing lets the power supply track and regulate the output voltage at the load, and thereby compensate for the voltage drop in the load lines. The power supply will only compensate within the limitations of its voltage rating, to a maximum of 5V per load line. Remote sensing is normally only required for critical loads which cannot tolerate the slight voltage drop in the load lines caused by their resistance. Remote sensing has no effect when the power supply is operating in Constant Current mode.

Two remote sensing connectors are located on the rear panel of the power supply. See [Figure 1.3, on page 20](#) for location and polarity. Connect 2 wires from these ports to the load, where the power supply cables terminate for your connection. Carefully observe the correct polarity when making the connection.

The remote sensing input is sensitive to electrical noise, so always use a shielded twisted pair, 22AWG or greater for the sense line cable. Terminate the shield to the supply chassis or the negative output of the power supply for best results.

Installation

Remote Sensing

Section 3. Operation

Overview

Once you have installed the power supply and connected both the AC input power and the load as explained in [Section 2](#), the power supply is in its default configuration and is ready to operate in local control mode.

[Section 3](#) begins by explaining how to power on and power off the power supply. It then provides information about configuring the power supply, and also gives procedures for operating the supply via the front panel controls.

In addition, brief descriptions are provided of Constant Voltage and Constant Current modes. See [page 49](#).

Powering ON the Power Supply



WARNING- Shock Hazard

The factory setting for Power ON is 0V and 0A. These settings can be changed by end users. If you suspect that the power supply has been used by someone else since it was received from the factory, be prepared for the unit to power ON with a live DC output.

To power on the power supply:

1. Ensure that the AC power switch is OFF.
2. Connect the unit to an AC source.
3. Turn on the front panel AC power switch.

After a short power-on delay, the digital meters on the front panel and the CV annunciator illuminate. The voltmeter and ammeter displays should read zero.

Check the front panel annunciators. If ON is illuminated, press the **OUT ON/OFF** button to disable it. The OFF annunciator should now be illuminated. For an illustration of the annunciators and their locations, see Figure 1.2.

Operation

Power Supply Operating States

Power Supply Operating States

The power supply has 4 operating states:

- Power-On
- Output Shutdown
- Soft Start
- Normal Operation

Power-On This is the period between the time that AC power is applied to the supply (AC breaker turned on) and the time that the power supply is ready for operation. During this period, the internal circuits are powering up.

Output Shutdown In this state, the output is disabled and there is no output regardless of power settings. The power supply can be placed in the Output Shutdown state by the ON/OFF button, via the Interlock signal, or from a protection mechanism. This is also called the Standby mode.

Soft Start In this state, the output power is ramping up gradually towards its target load. This reduces equipment stress. This state occurs whenever the supply output is set to ON or a protection state is re-set, and is approximately 2 seconds in duration.

Normal Operation This is the normal operating state for the power supply. The power supply is ready to accept settings.

Power Supply Regulation Modes

The power supply has 2 regulation modes while in the Normal Operation State:

- Constant Voltage (CV)
- Constant Current (CC)

The CV and CC annunciators indicate the regulation mode.

Constant Voltage (CV)	In this mode, the supply's output voltage is constant while the current and power vary with the load. The power supply will operate in constant voltage mode whenever the load current I_L is less than the current limit setting I_{SET} , or: $I_L < I_{SET}$ ($I_L = V_{SET}/R_L$). In constant voltage mode, the power supply maintains the output voltage at the selected value (V_{SET}) while the load current I_L varies with the load requirements.
Constant Current (CC)	In this mode, the supply's output current is constant while the voltage and power vary with the load. The power supply will operate in constant current mode whenever the load resistance is low enough that the load current I_L is equal to the current limit setting I_{SET} ($V_L = I_{SET}R_L$). In constant current mode, the power supply maintains the output current at the selected value (I_{SET}) while the load voltage V_L varies with the load requirements.
Automatic Mode Crossover	This feature allows the power supply to automatically switch operating modes in response to changing load requirements. If, for example, the power supply was operating in Constant Voltage (CV) Mode ($I_L < I_{SET}$), and the load changed so the load current (I_L) became EQUAL TO the current limit setting (I_{SET}), the power supply would automatically switch into Constant Current (CC) Mode and the output voltage would vary in response to changes in load current. If the additional load was subsequently removed so the load current was again LESS THAN the current limit setting, the supply would automatically return to Constant Voltage (CV) Mode.

Remote Control Modes

Two analog control interfaces are available. You can control the power supply remotely using 0–5V or 0–10V signals via the remote analog programming interface or via remote resistive programming interface using 0-5k Ω or 0-10k Ω adjustable resistors.

Front Panel Controls

The power supply is shipped ready to operate in local mode using the front panel knobs and function buttons.

This section describes the function buttons and control knobs that you use to operate the power supply. (Additional details about the front panel keys, control knobs, and display annunciators are provided in [Section 1, “About The XPR Power Supply”](#).)

The next section provides details about configuring and operating the power supply.

Function Buttons Four function buttons are located on the front panel. Each is described below. For the purposes of simple front panel control, you should understand the function of the **LCL/RMT**, **OUT ON/OFF**, **SET POINT**, and **OVP** buttons.

1. **SET POINT VOLTAGE:** Lets you pre-set a setpoint before the output is enabled. To pre-set a voltage setpoint, press **SET POINT**, use the Voltage knob to set a value (Local Mode). The value must be between 0 V and 103% of the units rated voltage. (See [page 49](#).)

This output can be changed while the output is OFF.

2. **SET POINT CURRENT:** Lets you pre-set a setpoint before enabling it. To pre-set a current setpoint, press **SET POINT**, use the Current knob to set a value (Local Mode). The value must be between 0 A and 103% of the units rated current. (See [page 49](#).)

This output can be changed while the output is OFF.

3. **OUT ON/OFF:** This is a latch ON/OFF button that enables (OUT position) and disables (ON position) the power supply output. Normally, you should leave the power supply in its Output Off state when no load is attached or there is no need for DC output. (See [“Controlling Output ON/OFF via Front Panel” on page 53](#).)

When the ON annunciator is illuminated, the output is enabled. When the OFF annunciator is illuminated, the output is disabled.

4. **LCL/RMT:** This button lets you toggle between local and remote control. If the RMT annunciator is illuminated, both voltage and current output can only be controlled via a remote voltage source or resistive programming.
5. **OVP:** Lets you pre-set an OVP setpoint before output is enabled. To pre-set Over Voltage Protection setpoint limit, press OVP button and turn the front panel screw until the desired OVP limit is achieved.

Using Over Voltage Protection (OVP)

The OVP circuit protects the load in the event of a remote programming error, an incorrect voltage control adjustment, or a power supply failure. The protection circuit monitors the output voltage at the output of the power supply and will shut down the main power converter whenever a preset voltage limit is exceeded. Set the preset voltage limit (also called the set point or trip level) using the screwdriver-adjustable, front panel OVP potentiometer (OVP set).

Note The default preset limit is approximately 110% of the rated output voltage. When using OVP with remote sensing lines connected, compensate for the voltage line drop across the output return line by measuring or calculating the line drop, then adding this value to the desired OVP setpoint.

Front Panel OVP Operation

In local control mode, check the OVP set point at any time by pressing the OVP CHECK switch. The OVP set point is the value displayed on the digital voltmeter.

To set the trip level from the front panel:

1. Disconnect any loads. Turn the power supply ON.
2. Adjust the power supply output voltage to any voltage lower than the desired trip level.
3. Press the front panel OUT ON/OFF (output shutdown) switch to its IN position. The OFF LED turns on.
4. Press the OVP switch to see the OVP set point on the voltmeter display.
5. Holding down the OVP switch, turn the OVP SET potentiometer until the desired set point is reached. Release the OVP switch.
6. Press the OUT ON/OFF switch to its OUT position. The ON LED turns on.

To check that the power supply shuts off at the desired set point, slowly increase the output voltage while monitoring the front panel voltmeter. The OVP LED on the front panel turns on when the OVP circuit activates, and the output voltage will quickly fall to zero.

Operation

Using Over Voltage Protection (OVP)

Resetting the OVP Circuit

To reset the OVP circuit after it activates:

1. Reduce the power supply's output voltage setting to below the OVP set point.
2. Press the OUT ON/OFF switch IN. The OFF LED on the front panel turns on. The OVP LED turns off.
3. Press the OUT ON/OFF switch again to return power to the load and resume normal operation.

OR

1. Reduce the power supply's output voltage setting to below the OVP set point.
2. Turn the power supply OFF using the AC power switch, wait until the front panel displays go out, then turn the power supply back ON again.

Using the Shutdown Function (Output ON/OFF)

Use the shutdown function to disable or enable the supply's output so that you can make adjustments to either the load or the power supply without shutting off the power supply. Activate this function from the front panel at any time by using the OUT ON/OFF switch. You can also activate it via remote control through the rear panel J1 Programming and Monitoring connector, using a 4 V to 15 V signal or a transistor-transistor logic (TTL) compatible signal. The input lines for the Interlock circuit are optically isolated.

Controlling Output ON/OFF via Front Panel

The OUT ON/OFF switch is a press ON/press OFF switch located on the power supply's front panel. Push the switch to its IN position to disable the output. The output voltage and current fall to zero and the OFF LED turns on. Push the switch once more to reset it to its OUT position and resume normal power supply operation. (ON LED turns on.)

Controlling the Interlock Function via the J1 Connector

The Interlock (TTL Shutdown) circuit accepts a 4 V to 15 V signal to disable or enable the power supply output. Make connections for signals at connector J1, located on the unit's rear panel. Set rear panel switch S1-7 to select signal logic. (See [Table 3.1, on page 53.](#))

To activate the Interlock (TTL Shutdown) function:

1. Turn OFF the power supply.
2. Connect the signal source to J1 connector terminal 12 (Interlock Input/positive) and terminal 11 (Interlock Return).
3. Set switch S1-7 to select the desired circuit logic as set out in [Table 3.1](#).
4. Turn on the power supply. The power supply will operate as described in the Supply Output column in [Table 3.1](#), according to the logic that you select and the level of the input signal. The INT (Interlock) LED on the front panel turns on when the Interlock circuit is activated.

Table 3.1 Switch Settings for Interlock Circuit Logic

Switch S1-7 Setting	Source Signal	Signal Level	Supply Output	INT LED
OFF (Active low, default)	4-15 V	HIGH	OFF	ON
	0-0.4 V	LOW	ON	OFF
ON (Active high)	4-15 V	HIGH	ON	OFF
	0-0.4 V	LOW	OFF	ON

Operation

Over Temperature Protection (OTP)

Note If switch S1-7 is ON but there is no signal applied, the INT LED turns on and the power supply will not provide an output until the HIGH signal level is applied. Any of the eight switches on S1 is OFF when it has been flipped up to break contact, ON when flipped down to close contact.

Over Temperature Protection (OTP)

The OTP function allows you to select how the power supply recovers from an over temperature shutdown using the rear panel switch S1-8. See [Table 3.2](#) for the switch settings and selections. The OTP shutdown circuit activates before the internal components can exceed their safe internal operating temperatures. When an OTP shutdown occurs, the front panel OTP LED turns on. An Over temperature condition will disable the output.

Table 3.2 Switch Settings for Over Temperature Recovery Options

Switch S1-8	OTP Shutdown Selection	Description
OFF	Auto Reset (Default)	The supply recovers to normal operation when the over temperature condition no longer exists.
ON	Latch OFF	After an over temperature shutdown, the supply stays off until you turn the AC power switch OFF, then you turn the power supply ON to continue use.

User Diagnostics

If your power supply is not performing as described in this manual, run through the procedures and checks in this section before calling your service technician. These procedures are confined to operator level functions only and do not require cover-off servicing.

Emergency Shutdown

In an emergency, carry out both of these steps:

1. Shut the power supply OFF immediately.
2. Disconnect the power supply from the load.

Unusual or Erratic Operation

If the power supply displays any unusual or erratic operation, follow these steps:

1. Shut the power supply OFF immediately.
2. Disconnect the power supply from the load.
3. Test the power supply with no load, running the tests in [“Basic Tests” on page 35](#).
4. If the tests show that the power supply is functioning normally, check all load, programming, and monitoring connections and circuits.
5. Check the AC input for correct voltage and frequency.

If the problem is not solved after following this procedure, or if the unit fails to operate correctly upon retesting, call your service technician.

Turn to the next page for more information about troubleshooting for operators.

Troubleshooting for Operators

Use the checks in [Table 3.3](#) to ensure that the power supply is configured and connected for normal operation. If you need any further troubleshooting, call your service technician.

Abbreviated References Used in Table

AC	AC Fail	LCL	Local Mode
OTP	Over Temperature Protection	ON	Output is enabled
OVP	Over Voltage Protection	OFF	Output is disabled
INT	Interlock	CV	Constant Voltage Mode
RMT	Remote Mode	CC	Constant Current Mode

Operation

User Diagnostics

Table 3.3 User Diagnostics

Symptom	Check	Further Checks and Corrections
No output and the display is blank.	Is input voltage within specified range?	Connect to appropriate voltage source. See page 32 .
	Power switch ON?	Turn on power.
	Internal circuit?	See your service technician.
No output but the display turns on.	OVP LED turned on?	See page 51 .
	Front panel INT LED turned on?	See page 53 .
	OTP LED turned on?	See page 54 .
	Current limit set to zero?	See page 49 .
	Voltage control set to zero?	See page 49 .
	LCL/RMT LED turned on?	If using remote analog control, check your analog programming source (Section 4).
	Is front panel AC LED turned on?	Connect unit to AC supply in specified range. See page 33 .
Output not adjustable.	Internal circuit.	See your service technician.
	Is unit in current limit mode? (CC LED turned on.)	Turn current knob clockwise to increase current limit. Reduce load if current is at maximum. See page 49 .
	Is unit in remote mode? (RMT LED turned on.)	If using remote analog control, check your analog programming source (Section 4).
Output voltage fluctuating or regulation poor.	Is unit at maximum voltage or current limit?	Reduce load for lower voltage or current requirement.
	Is unit at current limit?	Increase current limit setting or reduce load. See page 49 .
	Is input voltage within specified range?	Connect to appropriate AC voltage source. See page 33 .
	Is unit under remote analog control?	Ensure program source is stable.
Output oscillating.	Internal circuit.	See your service technician.
	Internal circuit.	See your service technician.

Alarms



WARNING- Fire Hazard

If an over-voltage, over-current, or over-power protection error persists without apparent cause, press **OUT ON/OFF** button to disable the output, and turn the AC switch OFF. Inspect the load and power supply for evidence of an electrical fault. The power supply should not be brought back into operation if there is any evidence of an electrical fire or other safety hazards.

The possible alarms are:

- AC - AC Input is out of range, non-latching shutdown
- OTP - Internal over temperature condition, latching or non-latching, S1 selects
- INT - External interlock is active (see Interlock [page 53](#))
- OVP - Output over voltage condition, latching shutdown
- SNS - Output remote sense line fault, latching shutdown

These conditions have corresponding indicator LEDs on the front panel (see [Figure 1.1, on page 18](#) and [Figure 1.2, on page 19.](#))

Operation

Alarms

Section 4. Remote Operation

Introduction

The rear panel switches and connector on the power supply allow you to program the supply with an analog device or to output readback signals. This section covers the following topics:

- See [“Remote Analog Programming of Output Voltage and Current Limit” on page 61](#) for procedures covering remote analog programming of output voltage and current limit with 0-5 V and 0-10 V voltage sources and 0-5 k and 0-10 k resistances.
- See [“Remote Programming Options” on page 61](#) for more about the connector and switch settings for using calibrated readback signals for output voltage and output current with selectable 0-5 V or 0-10 V scales.

Isolated Programming

The 4-channel Isolated (ISOL) Programming Interface is an internal card which can be ordered as an option. It allows remote programming and readback of the power supply's output voltage and current limit with 0-5 V and 0-10 V analog signals at a different voltage potential relative to the power supply's output. Contact the manufacturer to order the ISOL Interface.

Making Connections for Remote Control

See [Figure 4.1](#) for the locations of the user and programming lines J1 and S1.

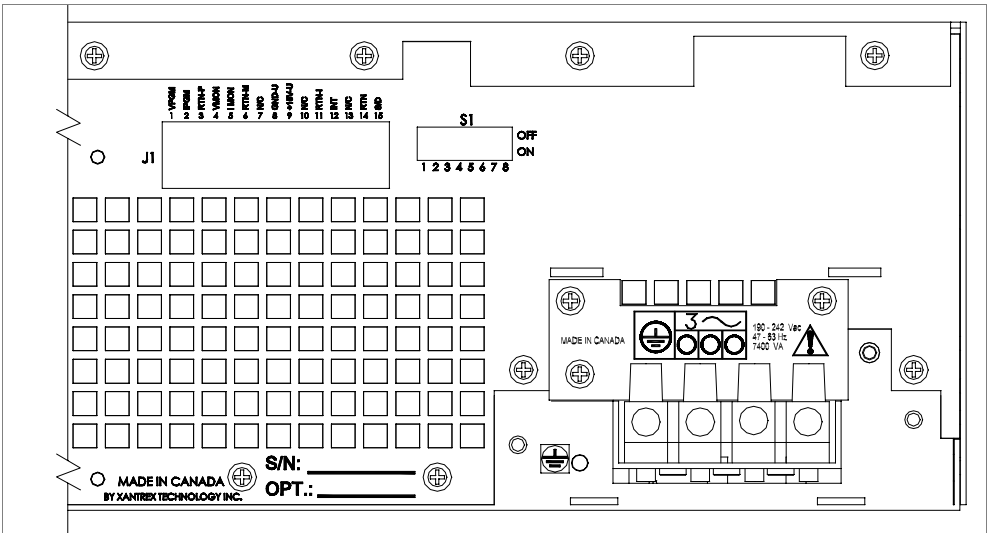


Figure 4.1 Location of J1 and S1

Remote Shutdown
Using a Contact Closure

The interlock input may be configured for use with an external voltage free contact. Connect pins as shown:

Table 4.1 Analog Pin Connections with a Contact Closure

Programming Line Pin #		User Line Pin #
J1-9	to	J1-12
J1-8	to	J1-11

Closing an external contact across the interlock pins A4/A5 will then enable the unit. Opening the contact will disable the supply output.

Remote Analog Programming of Output Voltage and Current Limit

Remote analog programming allows control of the power supply's output voltage and/or current limit to shift from local operation at the front panel voltage and current controls to external analog sources. As you vary the external programming source, the power supply's output varies proportionally over its output range.

Using remote analog programming requires that you reset switch S1 and make connections to the J1 connector on the power supply's rear panel.

Remote Programming Options

See [Table 4.2](#) for a summary of the options available to you for programming output voltage and current limit using an analog source.

Table 4.2 Remote Programming Options

Control of...	Programming Scales ¹
Output Voltage and/or	0-5 V and 0-10 V voltage sources
Current Limit	0-5 k and 0-10 k resistances

1. These scales may be used in any combination.

Select Remote Control Function

The **REMOTE CONTROL** options allow you to select an interface for remote control. Before selecting a remote control source, be sure to set up each input using the appropriate S1 settings.

Remote control functions are listed here along with their respective programming interfaces:

- Analog V & I: Voltage and current programmed via the analog interface (LCL/RMT button is ON or S1-5 and S1-6 are ON at rear panel)
- Analog V: Voltage programmed via the analog interface; current programmed via front panel (LCL/RMT button is OFF and S1-5 is ON at rear panel)
- Analog I: Current programmed via the analog interface; voltage programmed via front panel (LCL/RMT button is OFF and S1-6 is ON at rear panel)

Voltage source programming is selected at rear panel switch S1: S1-5 and/or S1-6 are ON and S1-1 and S1-2 are OFF.

Remote Operation

Select Remote Control Function

Resistive programming is selected at rear panel switch S1: S1-1 and S1-2 are ON.



CAUTION

Before turning on the power supply in resistive programming mode, make sure that the resistors are connected at J1-1 to J1-3 and J1-2 to J1-3.

Remote Analog Programming Procedure



CAUTION

To maintain the isolation of the power supply output and prevent ground loops, use an isolated (ungrounded) programming source when operating the power supply via remote analog control at the J1 connector.



CAUTION

The remote programming inputs are internally referenced to the supply's negative output. Do not connect control ground (J1 terminals 3 or 6) to the supply's positive output.

1. Turn the power supply OFF.
2. Set switches S1-1, S1-2, S1-3, and S1-4 according to the programming sources that you are using, as indicated in [Figure 1.5, on page 22](#) and [Table 1.2, on page 23](#). See [Table 4.3, on page 63](#) for more information about switch settings.
3. Connect the programming source(s) to the mating J1 connector as indicated in [Figure 1.5, on page 22](#) and connect the correct polarity for voltage sources. Ensure that the mating connector is plugged securely into the rear panel connector.
4. Set the programming sources to the desired levels and turn the power supply ON. The LCL LED turns off and the RMT LED turns on. Adjust the external programming source to change the power supply's output.

Table 4.3 Power Supply Settings for Different Programming Sources

Power Supply Output Voltage: Programming Source	Power Supply Output Current Limit: Programming Source					
		0-5 Vdc	0-10 Vdc	0-5 k Resistor	0-10 k Resistor	None (Front Panel Control: Local Mode)
	0-5 Vdc	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF
		S1-2= OFF	S1-2= OFF	S1-2=ON	S1-2=ON	S1-2= OFF
		S1-3= OFF	S1-3= OFF	S1-3= OFF	S1-3= OFF	S1-3= OFF
		S1-4= OFF	S1-4=ON	S1-4= OFF	S1-4=ON	S1-4= OFF
		S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON
		S1-6=ON	S1-6=ON	S1-6=ON	S1-6=ON	S1-6= OFF
	0-10 Vdc	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF
		S1-2= OFF	S1-2= OFF	S1-2=ON	S1-2=ON	S1-2= OFF
		S1-3=ON	S1-3=ON	S1-3=ON	S1-3=ON	S1-3=ON
		S1-4= OFF	S1-4=ON	S1-4= OFF	S1-4=ON	S1-4=ON
		S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON
		S1-6=ON	S1-6=ON	S1-6=ON	S1-6=ON	S1-6= OFF
	0-5 k Resistor	S1-1=ON	S1-1=ON	S1-1=ON	S1-1=ON	S1-1=ON
		S1-2= OFF	S1-2= OFF	S1-2=ON	S1-2=ON	S1-2= OFF
		S1-3= OFF	S1-3= OFF	S1-3= OFF	S1-3= OFF	S1-3= OFF
		S1-4= OFF	S1-4=ON	S1-4= OFF	S1-4=ON	S1-4= OFF
		S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON
		S1-6=ON	S1-6=ON	S1-6=ON	S1-6=ON	S1-6= OFF
	0-10 k Resistor	S1-1=ON	S1-1=ON	S1-1=ON	S1-1=ON	S1-1=ON
		S1-2= OFF	S1-2= OFF	S1-2=ON	S1-2=ON	S1-2= OFF
		S1-3=ON	S1-3=ON	S1-3=ON	S1-3=ON	S1-3=ON
		S1-4= OFF	S1-4=ON	S1-4= OFF	S1-4=ON	S1-4=ON
		S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON	S1-5=ON
		S1-6=ON	S1-6=ON	S1-6=ON	S1-6=ON	S1-6= OFF
	None (Front Panel Control: Local Mode)	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF	S1-1= OFF
		S1-2= OFF	S1-2= OFF	S1-2=ON	S1-2=ON	S1-2= OFF
		S1-3= OFF	S1-3=ON	S1-3= OFF	S1-3=ON	S1-3=ON
		S1-4= OFF	S1-4=ON	S1-4= OFF	S1-4=ON	S1-4=ON
		S1-5= OFF	S1-5= OFF	S1-5= OFF	S1-5= OFF	S1-5= OFF
		S1-6=ON	S1-6=ON	S1-6=ON	S1-6=ON	S1-6= OFF

Default settings



CAUTION

To prevent possible damage, the power supply settings for different sources must be strictly used as shown in Table 4.3, "Power Supply Settings for Different Programming Sources," on page 63.

Note: The front panel RMT/LCL switch may be pressed at any time, to force both the voltage and current setpoints to be remotely controlled via the J1 inputs.

Remote Operation

Remote Monitoring of Output Voltage and Current

Remote Monitoring of Output Voltage and Current

Readback Signals The J1 connector on the rear panel provides access to calibrated readback signals for remote monitoring of the output voltage and current. Rear panel switches S1-3 and S1-4 allow you to select either a 0-5 Vdc or a 0-10 Vdc range for the output. The readback signal represents 0 to 100% of the power supply's output.

See [Table 4.4](#) for the required J1 connections and switch settings for remote monitoring of readback signals with 0-5 Vdc or 0-10 Vdc outputs. Use shielded pair wiring (20 to 24 AWG) and ground the shield to the chassis.

Table 4.4 Power Supply Settings for Remote Monitoring of Readback Signals

Readback Signal	J1 Connection Signal (+)	J1 Connection Return (-)	Switch S1 Setting	
Output Voltage (0-5 Vdc)	J1-4	J1-6	S1-3=	OFF
Output Voltage (0-10 Vdc)	J1-4	J1-6	S1-3=ON	
Output Current (0-5 Vdc)	J1-5	J1-6	S1-4=	OFF
Output Current (0-10 Vdc)	J1-5	J1-6	S1-4=ON	

Appendix A. Specifications and Characteristics

Notes

- These specifications are represented over the full operating temperature range.
 - Nominal line input voltage assumed unless otherwise stated.
 - All sense lines are configured for default local operation.
 - All specifications are subject to change without notice.
-

Specifications and Characteristics

Electrical Specifications—Summary

Electrical Specifications—Summary

Table A.1 Specifications for 6000 Watt units (10V to 60V Models)

Models	10-600	20-300	30-200	40-150	60-100
Output Ratings:					
Output Voltage ¹	0–10 V	0–20 V	0–30 V	0–40 V	0–60 V
Output Current ²	0–600 A	0–300 A	0–200 A	0–150 A	0–100 A
Output Power	6000 W	6000 W	6000 W	6000 W	6000 W
Line Regulation: ³					
Voltage (0.01% of Vmax)	1 mV	2 mV	3 mV	4 mV	6 mV
Current (0.05% of Imax)	300 mA	150 mA	100 mA	75 mA	50 mA
Load Regulation: ⁴					
Voltage (0.05% of Vmax + 5 mV)	10 mV	15 mV	20 mV	25 mV	35 mV
Current (0.1% of Imax + 20 mA)	620 mA	320 mA	220 mA	170 mA	120 mA
Meter Accuracy:					
Voltage (0.5% of Vmax + 1 count)	0.06 V	0.2 V	0.25 V	0.3 V	0.4 V
Current (0.5% of Imax + 1 count)	4 A	2.5 A	2.0 A	1.75 A	0.6 A
Output Noise (0–20 MHz):					
Voltage (p–p)	100 mV	75 mV	75 mV	75 mV	100 mV
Output Ripple (rms):					
Voltage	10 mV	10 mV	12 mV	15 mV	15 mV
Current ⁵	3100 mA	1600 mA	1000 mA	750 mA	450 mA
OVP Adjustment Range: (0% to 103% of Vmax)	0–10.3 V	0–20.6 V	0–30.9 V	0–41.2 V	0–61.8 V
Efficiency: ⁶	0.85	0.87	0.87	0.87	0.89

1. Minimum output voltage is <0.3% of rated voltage at zero output setting.

2. Minimum output current is <0.2% of rated current at zero output setting when measured with rated load resistance.

3. For input voltage variation over the AC input voltage range, with constant rated load.

4. For 0–100% load variation, with constant nominal line voltage.

5. Current mode noise is measured from 10% to 100% of rated output voltage, full current, unit in CC mode.

6. Typical efficiency at nominal input voltage and full output power.

Table A.2 Drift Specifications for 6000 Watt units (10V to 60V Models)

Models	10–600	20–300	30–200	40–150	60–100
Drift (30 minutes): ¹					
Voltage (0.04% of Vmax)	4 mV	8 mV	12 mV	16 mV	24 mV
Current (0.6% of Imax)	3600 mA	1800 mA	1200 mA	900 mA	600 mA
Drift (8 hours): ²					
Voltage (0.02% of Vmax)	2 mV	4 mV	6 mV	8 mV	12 mV
Current (0.04% of Imax)	240 mA	120 mA	80 mA	60 mA	40 mA
Temperature Coefficient: ³					
Voltage (0.04% of Vmax/°C)	4 mV	8 mV	12 mV	16 mV	24 mV
Current (0.06% of Imax/°C)	360 mA	180 mA	120 mA	90 mA	60 mA

1. Maximum drift over 30 minutes with constant line, load, and temperature, after power on.
2. Maximum drift over 8 hours with constant line, load, and temperature, after 30 minute warm-up.
3. Change in output per °C change in ambient temperature, with constant line and load.

Specifications and Characteristics

Electrical Specifications—Summary

Table A.3 Specifications for 6000 Watt units (80V to 600V Models)

Models	80–75	100–60	150–40	300–20	600–10
Output Ratings:					
Output Voltage ¹	0–80 V	0–100 V	0–150 V	0–300 V	0–600 V
Output Current ²	0–75 A	0–60 A	0–40 A	0–20 A	0–10 A
Output Power	6000 W	6000 W	6000 W	6000 W	6000 W
Line Regulation: ³					
Voltage (0.01% of Vmax)	8 mV	10 mV	15 mV	30 mV	60 mV
Current (0.05% of Imax)	37.5 mA	30 mA	20 mA	10 mA	5 mA
Load Regulation: ⁴					
Voltage (0.05% of Vmax + 5 mV)	45 mV	55 mV	80 mV	155 mV	305 mV
Current (0.1% of Imax + 20 mA)	95 mA	80 mA	60 mA	40 mA	30 mA
Meter Accuracy:					
Voltage (0.5% of Vmax + 1 count)	0.5 V	0.6 V	1.75 V	2.5 V	4.0 V
Current (0.5% of Imax + 1 count)	0.48 A	0.4 A	0.3 A	0.2 A	0.06 A
Output Noise (0–20 MHz):					
Voltage (p–p)	100 mV	100 mV	150 mV	250 mV	350 mV
Output Ripple (rms):					
Voltage	15 mV	20 mV	20 mV	30 mV	80 mV
Current ⁵	320 mA	230 mA	120 mA	50 mA	25 mA
OVP Adjustment Range: (0% to 103% of Vmax)	0–88 V	0–110 V	0–165 V	0–330 V	0–660 V
Efficiency: ⁶	0.89	0.90	0.90	0.91	0.91

1. Minimum output voltage is <0.3% of rated voltage at zero output setting.

2. Minimum output current is <0.2% of rated current at zero output setting when measured with rated load resistance.

3. For input voltage variation over the AC input voltage range, with constant rated load.

4. For 0–100% load variation, with constant nominal line voltage.

5. Current mode noise is measured from 10% to 100% of rated output voltage, full current, unit in CC mode.

6. Typical efficiency at nominal input voltage and full output power.

Table A.4 Drift Specifications for 6000 Watt units (80V to 600V Models)

Models	80–75	100–60	150–40	300–20	600–10
Drift (30 minutes): ¹					
Voltage (0.04% of Vmax)	32 mV	40 mV	60 mV	120 mV	240 mV
Current (0.6% of Imax)	450 mA	360 mA	240 mA	120 mA	60 mA
Drift (8 hours): ²					
Voltage (0.02% of Vmax)	16 mV	20 mV	30 mV	60 mV	120 mV
Current (0.04% of Imax)	30 mA	24 mA	16 mA	8 mA	4 mA
Temperature Coefficient: ³					
Voltage (0.04% of Vmax/°C)	32 mV	40 mV	60 mV	120 mV	240 mV
Current (0.06% of Imax/°C)	45 mA	36 mA	24 mA	12 mA	6 mA

1. Maximum drift over 30 minutes with constant line, load, and temperature, after power on.

2. Maximum drift over 8 hours with constant line, load, and temperature, after 30 minute warm-up.

3. Change in output per °C change in ambient temperature, with constant line and load.

Specifications and Characteristics

AC Line Input Specifications

AC Line Input Specifications

The input to the power supply requires the following specifications.

AC Line Input Voltage Operating Ranges

Table A.5 AC Line Input Specifications

Operating Range	
nominal 208V _{rms} (Standard)	190 to 242 V _{ac} 3 ϕ (3 wire + safety ground)
nominal 400V _{rms} (with HV-Input option)	342 to 500 V _{ac} 3 ϕ (3 wire + safety ground)
Frequency Range	
47 to 63 Hz	
Maximum Peak In-rush Current at turn on	
35 A _{rms}	
Minimum Power Factor ¹	
nominal 208V _{rms} (Standard)	0.95
nominal 400V _{rms} (with HV-Input option)	0.9
Operating Current	
nominal 208V _{rms} (Standard)	
Maximum ²	24 A
Typical ³	20 A
Operating Current	
nominal 400V _{rms} (with HV-Input option)	
Maximum ⁴	13 A
Typical ⁵	11 A

1. At nominal input voltage and maximum power
2. At 190V_{ac} input voltage, 55°C ambient temperature and maximum power
3. At 208V_{ac} input voltage, 25°C ambient temperature and maximum power
4. At 342 V_{ac} input voltage, 55°C ambient temperature and maximum power
5. At 400V_{ac} input voltage, 25°C ambient temperature and maximum power.

Output Performance Specifications

These specifications define the electrical performance specifications of the power supply output. These specifications apply to both local and remote sense configurations, except where noted. These specifications apply to all programming sources, except where noted.

Rated Output Range

Voltage	0–100%
Current	0–100%

Efficiency

- Typical 89% efficiency at nominal line voltage and ambient temperature.
- Minimum 82% efficiency. Specific minimum efficiency limits are model dependent.

Load Regulation

Voltage	5 mV + 0.05% of Vmax
Current	20 mA + 0.1% of Imax

Line Regulation

Voltage	0.01% of Vmax
Current	0.05% of Imax

Programming Range for Voltage and Current

Voltage and Current	From 0–103% of the rated maximum output
---------------------	---

OVP Programming Range

- 0–103% of maximum rated voltage

Typical Programming Resolution

Front Panel or Control Resolution	
Voltage	0.02% of Vmax
Current	0.02% of Imax

Front Panel Voltage and Current Meters

3.5-digit green numeric LED displays. For accuracy see [Table A.1, on page 66](#) and [Table A.3, on page 68](#).

Specifications and Characteristics

Output Performance Specifications

Programming Accuracy¹

Remote Analog Programming Interface	
Voltage Programming	1% of V or I _{max}
Resistive Programming	2% of V or I _{max}

Readback Accuracy

Front Panel or Remote Analog Programming Interface	
Voltage Readback	1% of V _{max}
Current Readback	1% of I _{max}

30 Minute Drift²

Voltage	0.04% of V _{max}
Current	0.6% of I _{max}

8 Hour Drift Temperature Stability³

Voltage	0.02% of V _{max}
Current	0.04% of I _{max}

Temperature Coefficients

Front Panel or Analog Programming Interface	
Voltage Programming	0.04% of V _{max} /°C
Current Programming	0.06% of I _{max} /°C
Voltage Readback	0.04% of V _{max} /°C
Current Readback	0.06% of I _{max} /°C

1. Accuracy specifications apply for settings in range of 1% to 100% of rated output
2. At 25°C ±5°C, with full power load
3. At 25°C ±5°C after 30 minutes full load operation

Analog Programming Interface

Programming Lines, Impedance	
0-5 V _{dc} range	Approximately 3 MOhm
0-10 V _{dc} range	Approximately 3 MOhm
Readback Lines, Impedance	
0-5 V _{dc} range	Approximately 400 Ohm
0-10 V _{dc} range	Approximately 400 Ohm
Isolation, all program and readback lines	
<ul style="list-style-type: none"> • non-isolated for standard configuration, referenced to supply “negative” output. • 600 Vdc with respect to chassis potential or negative output with Isolated Programming (ISOL) Internal Interface card (available as an optional configuration) 	

Interlock - Remote Shutdown

4-15 V signal or TTL-compatible output, selectable logic.

TTL input impedance	2kOhm (in series with one diode drop)
Maximum Supply Voltage	15 V _{dc}
Minimum Supply Voltage	4 V _{dc}

User Supply Voltage

+ 15 V supply voltage source with approximately 100Ω impedance¹.

Maximum Supply Voltage	17.5 V
Minimum Supply Voltage	14 V

Switching Frequency

Typical 31 kHz; 62 kHz output ripple

Rise Time

5 to 95% step in output voltage.

Load Condition	Time (Max)
No Load	100 ms
Full Load	100 ms

1. Isolated from power supply output and chassis to 600 V.

Specifications and Characteristics

Output Performance Specifications

Fall Time

For a programmed 95% to 5% step in output voltage.

Load Condition	Time (Max)
No Load	3 s
Full Load	50 ms

Time Delay From Power On Until Output Stable

5 s maximum

(Within regulation envelope)

Time Delay From Output Enable Until Output Stable

2 s maximum

(Within regulation envelope)

Output Hold-Up Time – Power Off

Minimum 4 ms (at full load)

Output Hold-Up Time – Source Interruption

Minimum 4 ms with output deviation less than 5% of maximum output voltage after source interruption.

Transient Response Time¹

Time to recover within 0.75% of rated output of previous level after step change in load current between 50% and 100%.

Mode	Time
Voltage Mode	3 ms

Mode Crossover

Maximum deviation as a percentage of rated output voltage.

CV – CC Overshoot	1%
-------------------	----

Peak–Peak and RMS Noise Bandwidth Limits

The frequency range for Peak to Peak measurements is 10 Hz–20 MHz.

The frequency range for RMS measurements is 10 Hz–100 kHz.

1. Time for the output voltage to recover within 0.75% of rated output of its previous level after a step change in load current of up to 50% - 100% and 100% to 50% of rated output

Maximum Remote Sense Line Drop Compensation

Minimum 3.8 V for each line, 5 V typical

Isolation

AC Input to Output	1350 V _{ac}
AC Input to Chassis	1350 V _{ac}
Output to Chassis	600 V _{ac}

Environmental Specification

Thermal Specification

Operating Temperature Range	0°C–50°C ¹
Storage Temperature Range	– 40°C–+ 85°C

1. Consult the factory for operation below 0°C and above 50°C.

Humidity Specification

Operating Humidity Range	< 95% RH, Non-condensing
Storage Humidity Range	< 95% RH, Non-condensing

Approvals CSA certified to UL 3111-1, and CSA C22.2 No. 1010.1

FCC Part 15B and Industry Canada Class A

CE Marked for Low Voltage Directive and EMC Directive (Class A emissions)

Specifications and Characteristics

Mechanical Specification

Mechanical Specification

Weight 6000 W: approx. 75 lb. (34 kg) for 10 V-600 A unit, without packaging

Size

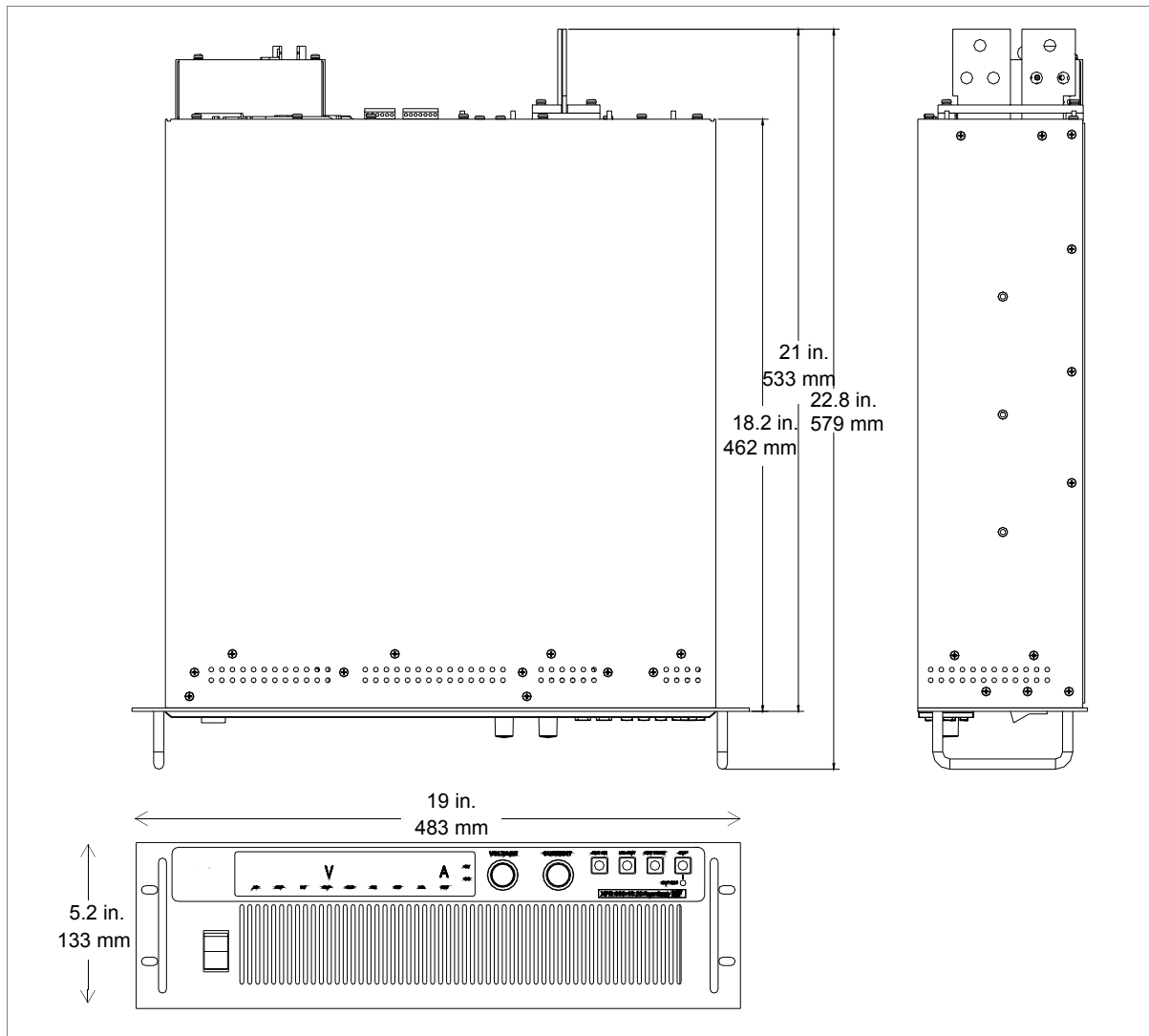


Figure A.1 Power Supply Dimensions

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