OPERATION MANUAL

Date: 08/07/09
Revision: 8

This manual covers:
PD Series Programmable DC Linear Power Supplies
All PD Models Covered

AMERICAN RELIANCE, INC.
3445 Fletcher Ave., El Monte, CA 91731
Ph: (626) 443-6818 E-mail:ariinfo@amrel.com
Website: www.amrel.com

WARRANTY INFORMATION

CERTIFICATION

American Reliance certifies that this product met its published specifications at time of shipment from the factory.

THREE-YEAR LIMITED WARRANTY

American Reliance warrants to the original user or purchaser that your unit is free from any defects in material or workmanship for a period of three years from the date of purchase. If any defect is discovered within the warranty period, American Reliance will repair or replace the unit, subject to verification of the defect or malfunction, upon delivery or prepaid shipment to American Reliance.

IMPORTANT:

(1) Unless a problem is discovered upon initial inspection after purchase of the unit, please do not return the product to the distributor where it was purchased. American Reliance Inc. accepts the responsibility of keeping you a satisfied customer.

(2) If your product requires troubleshooting, warranty service or need a RMA number for return, contact your merchant. Or if you are unable to contact your merchant, or the merchant is unable to provide service, contact American Reliance Inc. directly at:

Phone:	**626-443-6818**
Toll Free #:	**1-800-654-9838**
Fax:	**626-443-8600**
Email:	**ariinfo@amrel.com**

This warranty does not apply to defects or to physical damage resulting from abuse, neglect, accident, improper repair, alteration, or unreasonable use of the unit, resulting in (but not limited to) cracked or broken cases or parts, or to units damaged by excessive heat. Except upon initial purchase, this warranty does not cover finish or appearance items nor does it cover items damaged in shipment to American Reliance for repair or calibration. American Reliance assumes no responsibility for shipping and handling. However, repaired units will be shipped back to the customer with return shipping charges paid by American Reliance.

To receive service under this warranty, you must include proof of purchase; including date and place of purchase (a copy of your purchase receipt) or American Reliance will not be responsible for repairs or replacement of the unit under warranty.

Any applicable implied warranties, including warranties of merchantable and fitness for a particular use, are hereby limited to three years from the date of purchase. Consequential or incidental damages resulting from loss of use or from a breach of any applicable express or implied warranties are hereby excluded.

This warranty is in lieu of all other agreements and warranties, general or specific, express or implied. No representative or person is authorized to assume for American Reliance any other liability in connection with the sale or use of this American Reliance product.

Some states do not allow limitations on how long implied warranties last and do not allow exclusion of incidental or consequential damages, so the above limitations and exclusions may not apply. This warranty gives the customer specific legal rights, which may vary from state to state.

NON-WARRANTY SERVICE
Any American Reliance out-of-warranty instrument that is thought to be defective, but is considered repairable, should be sent in for non-warranty service. Please contact our service department at (800) 654-9838 for current repair charges.

The instrument should be returned to American Reliance, by following the directions under the heading "Shipping Instructions" in this section.

EXCLUSIVE REMEDIES
This remedies provided herein are the customer's sole and exclusive remedies. American Reliance Inc. shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any legal theory.

RMA RETURNS
Product returned for warranty and non-warranty service to American Reliance must be shipped, freight prepaid (will not accept COD shipments).

American Reliance Inc.
3445 Fletcher Ave.
El Monte, CA 91731
Attn: RMA # _____

- ***Please call our service department at 1-800-654-9838 to obtain a return authorization (RMA #) from AMREL before returning any product.***

The instrument must be carefully packed, preferably in its original carton, and should be accompanied by a letter or note containing the following information:

User's Name	Proof of Purchase
User's Address	Description of problem
Model number	Serial number

If service is desired, such as calibration, it must be stated in the enclosed letter. For non-warranty repairs, and for calibration, the correct service charge must accompany the unit in the form of a check or money order payable to American Reliance Inc. Please do not send cash. Contact our service department at (800) 654-9838.

American Reliance will return the serviced instrument, with freight paid by American Reliance, via UPS ground service unless otherwise requested.

***NOTE: ALL INSTRUMENTS, WHICH ARE RETURNED FOR REPAIR OR CALIBRATION MUST <u>HAVE AN ASSIGNED R.M.A. NUMBER WRITTEN ON THE FRONT OF THE PACKAGE</u>. THIS NUMBER MAY BE OBTAINED BY OUR SERVICE DEPARTMENT. ANY INSTRUMENT DELIVERED WITHOUT THIS NUMBER WILL BE REFUSED AND RETURNED.**

SAFETY SUMMARY

<NOTE>: The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. American Reliance Inc. assumes no liability for the customer's failure to comply with these requirements.

WARNING
Servicing instructions are for use by service-trained personnel. To avoid dangerous electrical shock, do not perform any servicing unless you are qualified to do so. Some procedures described in this manual are performed with power supplied to the instrument while its protective covers are removed. If contacted, the energy available at many points may result in personal injury.

ENVIRONMENTAL CONDITIONS
This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at maximum relative humility of 95% and at altitudes of up to 2000 meters. Refer to the specifications for the ac mains voltage requirements and ambient operating temperature range.

BEFORE APPLYING POWER
Verify that the product is set to the appropriate line voltage, the correct line fuse is installed, and all safety precautions are taken.

GROUND THE INSTRUMENT
Before switching on the instrument, the protective earth terminal of the instrument must be connected to the protective conductor of the main power cord. The mains plug shall be inserted only in an outlet socket that is provided with a protective earth contact. This protective action must not be negated by the use of an extension cord that does not have a protective conductor. Any interruption of the protective grounding or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

FUSES
Only fuses with the required rated current, voltage, and specified type should be used. Do not use repaired fuses or defective fuse holder. To do so, could cause a shock or fire hazard.

AVOID ACCESS TO LIVE CIRCUITS
Operating personnel must not remove the instrument cover. Component replacement and internal adjustments must only be made by qualified service personnel. Do not replace components with the power cable connected. Under certain conditions, dangerous voltage may exits even with the power cable removed, to avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

AVOID TROUBLESHOOTING ALONE
Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present. Any adjustment, maintenance, and repair of this instrument while it is opened and under voltage should be avoided as much as possible. If this is unavoidable, only qualified personnel who are aware of the hazard involved should carry out the adjustment, maintenance, and repair.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT
Because of the danger of introducing additional hazards, do not install substitute parts or perform an unauthorized modification to the instrument. Return the instrument to an American Reliance Service Department for service and repair to ensure that safety features are maintained.

SAFETY SYMBOLS

WARNING The WARNING symbol denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a WARNING symbol until the indicated conditions are fully understood and met.

CAUTION The CAUTION symbol denotes a hazard. It calls attention to an operating procedure, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of parts or all of the products. Do not proceed beyond a CAUTION symbol until the indicated conditions are fully understood and met.

SAFETY SYMBOL DEFINITIONS

Symbol	Description
	Direct current.
	Alternating current.
	Earth (ground) terminal.
	Protective earth (ground) terminal.
	Terminal for Neutral conductor on permanently installed equipment.
	Terminal for Line conductor on permanently installed equipment.
	In position of a bi-stable push button control.
	Out position of a bi-stable push button control.
	Caution, risk of electric shock.
	Caution (refer to accompanying documents).

TABLE OF CONTENTS

ONE: FEATURES AND SPECIFICATION **1-1**
INTRODUCTION 1-1
FEATURES AND OPTIONS 1-1
CONTROL PANEL & DESCRIPTION 1-2
LCD STATUS ENUNCIATOR 1-3
LCD DESCRIPTION 1-3
FRONT PANEL KEYPAD DEFINITION 1-4
FRONT PANEL KEYPAD FEATURES 1-4
REAR CONTROL PANEL & DESCRIPTION 1-6
REAR PANEL DC OUTPUT CONNECTORS 1-8
REMOTE SENSE 1-9
REMOTE SENSE CHARACTERISTICS 1-9
TTL INTERLOCK SHUTDOWN 1-10
OUTPUT TERMINALS AND WIRES 1-10
OPERATING CHARACTERISTIC AND CONFIGURATIONS 1-11

TWO: INSTALLATION **2-1**
INTRODUCTION 2-1
BASIC SET UP PROCEDURE 2-1
INSPECTION, CLEANNING, AND PACKAGING 2-2
RETURNING POWERSUPPLIES TO THE MANUFACTURE 2-2
PACKAGING FOR SHIPPING OR STORAGE 2-3
LOCATION, MOUNTING, AND VENTILATION 2-3
FUSE REPLACEMENT 2-4
AC INPUT 2-4
AC INPUT POWER CONNECTION 2-4
AC INPUT CORD 2-5
LOAD WIRING 2-5
LOAD WIRING LENGTH FOR OPERATION WITH SENSE LINES 2-6
NOISE AND IMPEDANCE EFFECTS 2-6
REVERSE POLARITY 2-6
INDUCTIVE LOADS 2-7
CONNECTING SINGLE LOADS 2-7
REMOTE SENSE CONFIGURATION 2-8
PARALLEL POWER SUPPLY OPERATION 2-8
CONNECTING MULTIPLE LOADS 2-9
PARALLEL POWER DISTRIBUTION 2-9
RADIAL POWER DISTRIBUTION METHOD 2-9
MULTIPLE LOADS WITH LOCAL SENSING 2-9
MULTIPLE LOADS WITH REMOTE SENSING 2-10

THREE: LOCAL OPERATION
(MODELS PDXX-XXE WITH ETHERNET INTERFACE & ENCODER KNOB OPTION) **3-1**
INTRODUCTION 3-1
STANDARD OPERATION 3-1
GENERAL INFORMATION 3-1
SETTING VOLTAGE 3-2
SETTING CURRENT 3-2
OVER VOLTAGE PROTECTION 3-2
SETTING THE OVER VOLTAGE THRESHOLD 3-2
TUNE MODE 3-3
ROTARY KNOB OPERATION 3-3
ENABLING/DISABLING OVER VOLTAGE PROTECTION 3-4

OVER CURRENT PROTECTION 3-4
ENABLING/DISABLING OVER CURRENT PROTECTION 3-5
ENABLING/DISABLING OUTPUTS 3-5
ISOLATION RELAY FUNCTION (OPTIONAL) 3-5
UTILITY MENU 3-7
TRACKING SELECTION MODE 3-9
FRONT PANEL LOCK OPERATION 3-10
PROFILE SAVE AND LOAD 3-10
STEPPING MODE 3-11
LIST CYCLE 3-11
CONSTANT CURRENT RANGE SELECTION 3-12
STEPS TO VIEW "*IDN?" INFORMATION
FROM THE FRONT PANEL 3-12
STEP TO SET THE EOS MODE FROM THE FRONT PANEL 3-12
STEP TO VIEW SELF-TEST RESULT 3-12
EXTERNAL ANALOG PROGRAMMING 3-13

FOUR: LOCAL OPERATION
(MODELS PDXX-XXA WITH GPIB IEEE4888.2 & RS232 INTERFACE ONLY) **4-1**
INTRODUCTION 4-1
STANDARD OPERATION 4-1
GENERAL INFORMATION 4-1
SETTING VOLTAGE 4-2
SETTING CURRENT 4-2
OVER VOLTAGE PROTECTION 4-2
SETTING THE OVER VOLTAGE THRESHOLD 4-2
ENABLING/DISABLING OVER VOLTAGE PROTECTION 4-3
OVER CURRENT PROTECTION 4-3
ENABLING/DISABLING OVER CURRENT PROTECTION 4-4
ENABLING/DISABLING OUTPUTS 4-4
ISOLATION RELAY FUNCTION (OPTIONAL) 4-5
UTILITY MENU 4-6
CONSTANT CURRENT RANGE SELECTION 4-7
STEPS TO VIEW "*IDN?" INFORMATION
FROM THE FRONT PANEL 4-7
STEP TO SET THE EOS MODE FROM THE FRONT PANEL 4-7
EXTERNAL ANALOG PROGRAMMING (OPTIONAL) 4-8

FIVE: LOCAL OPERATION FOR SINGLE OUTPUT MODELS RATED ABOVE 600W **5-1**
INTRODUCTION 5-1
FEATURES AND OPTIONS 5-1
FRONT AND REAR PANEL DESCRIPTION (PD-E > 600W MODELS) 5-2
FRONT PANEL KEYPAD DEFINITION (PD-E > 600W MODELS) 5-3
LCD STATUS ANNUNCIATOR (PD-E > 600W MODELS) 5-5
REAR PANEL CONNECTORS (PD-E > 600W MODELS) 5-6
REAR PANEL CONNECTORS (> 30 ADC OUTPUT CURRENT) 5-7
LOCAL OPERATION (PD-E > 600W MODELS) 5-8
SETTING CURRENT 5-8
OVER VOLTAGE PROTECTION 5-8
SETTING THE OVER VOLTAGE THRESHOLD 5-8
ENABLING / DISABLING OVER VOLTAGE PROTECTION 5-9
OVER CURRENT PROTECTION 5-9
ENABLING / DISABLING OVER CURRENT PROTECTION 5-10
ENABLING / DISABLING OUTPUTS 5-10
UTILITY MENU 5-11

TRACKING SELECTION MODE 5-13
FRONT PANEL LOCK OPERATION 5-14
PROFILE SAVE AND LOAD 5-14
STEPPING MODE 5-15
LIST CYCLE 5-15
FRONT & REAR PANEL DESCRIPTION (PD-A > 600W MODELS) 5-16
FRONT PANEL KEYPAD DEFINITION (PD-A >600W MODELS) 5-17
VFD STATUS ENUNCIATOR (PD-A > 600W MODELS) 5-19
REAR PANEL FEATURES 5-20
LOCAL OPERATION (PD-A > 600W MODELS) 5-21
SETTING VOLTAGE 5-22
SETTING CURRENT 5-22
OVER VOLTAGE PROTECTION 5-22
SETTING THE OVER VOLTAGE THRESHOLD 5-22
ENABLING / DISABLING OVER VOLTAGE PROTECTION 5-23
OVER CURRENT PROTECTION 5-23
ENABLING / DISABLING OVER CURRENT PROTECTION 5-19
ENABLING / DISABLING OUTPUTS 5-19
UTILITY MENU 5-20
CONSTANT CURRENT RANGE SELECTION (IF APPLICABLE) 5-21
STEPS TO VIEW "*IDN?" INFORMATION FROM THE FRONT PANEL 5-21
STEPS TO SET THE EOS MODE FROM THE FRONT PANEL 5-21
STEP TO VIEW SELF-TEST RESULT 5-21
REMOTE SENSE 5-22
REMOTE SENSE CONFIGURATION 5-22
REMOTE SENSE CHARACTERISTICS 5-23
ISOLATION RELAY FUNCTION 5-24
TTL SHUTDOWN 5-30

SIX: REMOTE OPERATION 6-1
INTRODUCTION 6-1
REMOTE INTERFACE FUNCTIONS 6-1
ADDRESS SETTING FOR THE REMOTE INTERFACE 6-1
GPIB CAPABILITIES OF THE POWER SUPPLY 6-2
RS-232 CAPABILITIES OF THE POWER SUPPLY 6-2
ETHERNET CAPABILITIES OF THE POWER SUPPLY *(E & AK OPTION ONLY)* 6-3
ETHERNET RETURNED DATA STRING FORMAT (*E & AK OPTION ONLY)* 6-8
COMMANDS LIST 6-8
SUBSYSTEM COMMANDS SYNTAX 6-9
NON-SCPI COMMANDS 6-11
IEEE 488.1 COMMANDS 6-11
DESCRIPTION OF COMMON COMMANDS 6-12
DESCRIPTION OF SUBSYSTEM COMMANDS 6-17
CALIBRATION SUBSYSTEM 6-17
CHANNEL SUBSYSTEM 6-21
CURRENT SUBSYSTEM 6-22
LIST SUBSYSTEM 6-24
MEASUREMENT SUBSYSTEM 6-27
OUTPUT SUBSYSTEM 6-28
STATUS SUBSYSTEM 6-29
SYSTEM SUBSYSTEM 6-31
TRIGGER SUBSYSTEM 6-36
VOLTAGE SUBSYSTEM 6-37
NON-SCPI COMMANDS AND THEIR EQUIVALENT SCPI COMMANDS 6-38
IEEE 488.1 COMMANDS AND THEIR EQUIVALENT SCPI COMMANDS 6-40
STATUS REPORTING 6-41
SCPI GPIB COMMAND STATUS MODEL 6-42

COMMAND INDEX AND ERROR CODE FOR “SYST:ERR?” QUERY 6-44

SIX: CALIBRATION 7-1
INTRODUCTION 7-1
CALIBRATION SERVICE ENVIRONMENT AND PRECAUTIONS 7-1
CALIBRATION CONFIGURATION 7-2
LOCAL CALIBRATION (ETHERNET & ENCODER OPTION ONLY) 7-3
LOCAL CALIBRATION (IEEE-488.2 OPTION) 7-4
REMOTE CALIBRATION 7-6

APPENDIX A: EXTERNAL ANALOG PROGRAMMING A-1

ONE: FEATURES AND SPECIFICATION

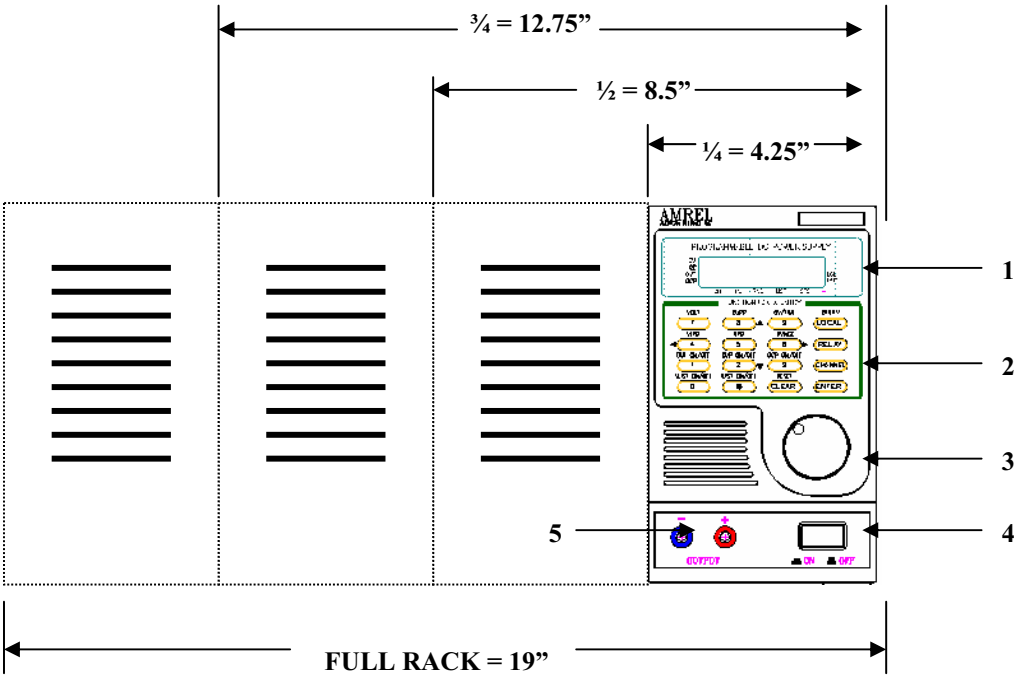
INTRODUCTION

This PD Series Programmable DC Linear Power Supply from American Reliance Inc. offers a complete solution to power supply system requirements. This instrument was designed to assist in the development and testing of new products, as well as is being a standard instrument for automatic test systems. This instrument provides low-noise, precisely regulated variable DC output of power. Over Voltage Protection (OVP) and Over Current Protection (OCP) are standard. Front panel controls and indicators are extensive. Units come with Standard Commands for Programmable Instrument (SCPI) commands, remote monitoring of output voltage and currents is a standard features. This power supply can be used either on a bench or in a standard 19 in. (483 mm) rack: The power supply occupies 6.968 in. (4 U) of vertical rack space. Designed for continuous use in standalone or systems applications, this power supply is typically used to power DC equipment, control circuits, or burn-in component applications.

FEATURES AND OPTIONS

- Simultaneous digital display of both voltage and current.
- Front panel keypad or rotary knob (Tune mode) for accurate setting of the output voltage and current from zero to the rated output.
- Automatic crossover of Constant Current or Constant Voltage mode.
- GPIB, RS-232, and Ethernet (Optional) control for remote digital programming and readback.
- Front panel push-button control of output standby mode and preview of voltage, current, or OVP and OCP set points. Front panel Liquid Crystal Display (LCD) indicators for voltage and current mode operation, OVP, remote programming mode, and shutdown.
- Front panel lock mode.
- Tracking Selection Mode for multiple channels setting.
- VLIST and ILIST in stepping mode, PD Series generate customized sequence of different output level up to maximum of 20 steps (points), with dwell times from 10ms to 1 minute. This sequence can be cycled once or to a user-defined number of cycles.
- (Optional) Local/Remote voltage and current limit programming with selectable programming ranges.
- (Optional) TTL function to enable/disable the power supply output.
- (Optional) CHANNEL to select multiple channels output operation.
- (Optional) External analog voltage (0 to $+10V_{DC}$) input for the programming voltage/current output.
- (Optional) LCD backlight setting.

CONTROL PANEL & DESCRIPTION



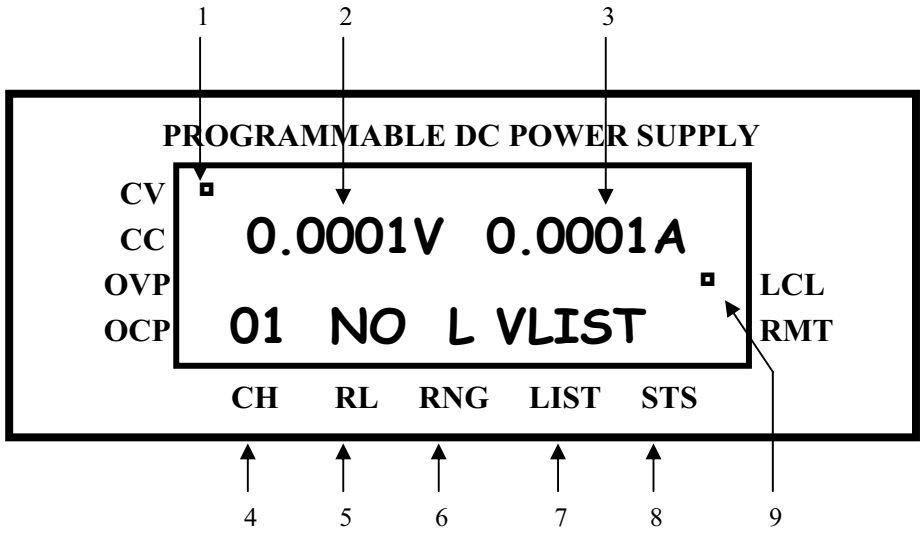
NOTE: *The size of the PD series power supply will depend on the maximum power.*

DESCRIPTION

1. Liquid Crystal Display (LCD).
2. Front Panel Keypad Control.
3. Front Panel Rotary Knob (ENCODER & ETHERNET OPTION ONLY).
4. Power ON/OFF switch.
5. Front Panel DC Output Terminal.

LCD STATUS ENUNCIATOR

LIQUID CRYSTAL DISPLAY:



<NOTE:>The LCD displays real time output Voltage/Current & mode status. These messages are viewed in either local or remote mode.

LCD DESCRIPTION

1. Indicator for Constant Voltage (CV), Constant Current (CC), Over Voltage Protection (OVP), and Over Current Protection (OCP).

2. Voltage reading indicator.

3. Current reading indicator.

4. **CH** operating channel indicator: 01 – 31 channel. (OPTIONAL)

5. **RL** operating output isolation relay indicator: Open (OP), Normal (NO), and Reverse (RE). (OPTIONAL)

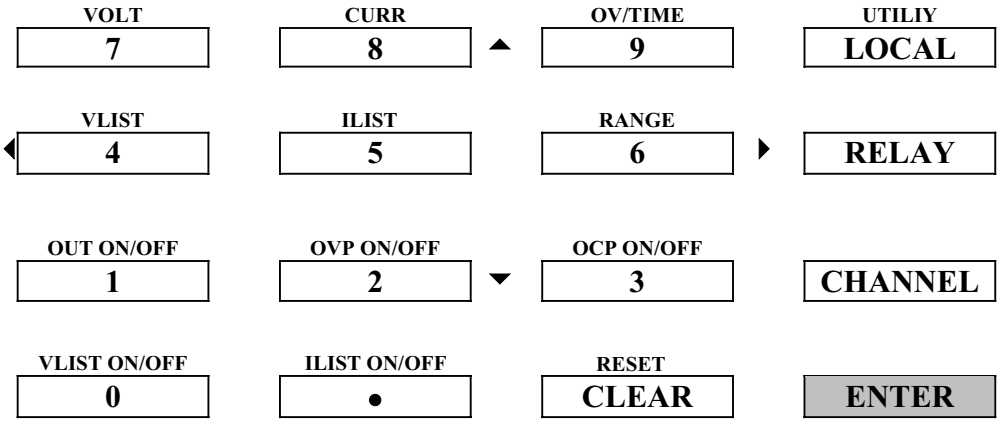
6. **RNG** operating range indicator: Low range (L), Middle range (M), and High range (H). (OPTIONAL)

7. **LIST** operating list indicator: V_{LIST} ON/V_{LIST} & I_{LIST} ON/I_{LIST}. (OPTIONAL)

8. **STS** operating status indicator: (Not implemented).

9. Local mode (LCL) / Remote mode (RMT) indicator.

FRONT PANEL KEYPAD DEFINITION



Most soft keys have dual functions. The first function is mode entry as described by VOLT, CURR right above the key. Once in a mode entry, use these keys as numeric keypad to enter the desired number. Press ENTER key to accept the number keyed or CLEAR key to clear the number.

FRONT PANEL KEYPAD FEATURES

1. VOLT 7

Press this key to enter a new voltage setting in flashing bracket or to display the present voltage setting. Numeric key for 7. And also select voltage calibration key in calibration mode.

2. CURR 8

Press this key to enter new current setting in flashing bracket or to display the present current setting. Numeric key for 8. And also select current calibration key in calibration mode.

3. OV/TIME 9

Press this key to enter new over voltage protection value in flashing bracket or to display the present over voltage protection value. This key can also be used after pressing #4 key or #5 key to alter time interval in millisecond for STEP programming. Numeric key for 9. And also select over-voltage calibration key in calibration mode.

4. RESET CLEAR

Reset is similar to a warm boot-up for the computer. If in entry mode, pressing this key will clear the number entered or return to the previous mode. This key can also be used to disable an over-voltage condition.

5. UTILITY LOCAL

Press this key to enter utility menu to change GPIB address, RS-232 speed, and RS-232 response speed or loop count of step. (These functions will be explained in details in the display section). Use #8 key and #2 key to scroll to the desired sub-menu to be change and use #4 key and #6 key to alter the setting in the sub-menu.

6. ILIST 5

Press this key to do current step programming. Use #8 key and #2 key to scroll up to 20 current stepping value. Use #7 key to change current stepping value at that step. Use #9 key to change stepping time interval at that step. Numeric key for 5.

7. RANGE 6 ▶ — (Optional) High/Middle/Low range selection for constant current mode. This key also scrolls menu options. Numeric key for 6.

8. OUT ON/OFF 1 — Press this key to turn the output on or off. When the output is disabled, the LCD displays "--OUTPUT OFF--".

9. VLIST ON/OFF 0 — Press this key to start and stop voltage stepping. Numeric key for 0.

10. OVP ON/OFF 2 — Press this key to enable and disable over voltage protection. If over voltage protection is enabled, a ■ is indicated by OVP. Numeric entry key for 2.

11. OCP ON/OFF 3 — Press this key to enable or disable over current protection. If over current protection is enabled, a ■ is indicated by OCP. Numeric key for 3.

12. ILIST ON/OFF • — Press this key to start and stop current stepping. Numeric enter for decimal point.

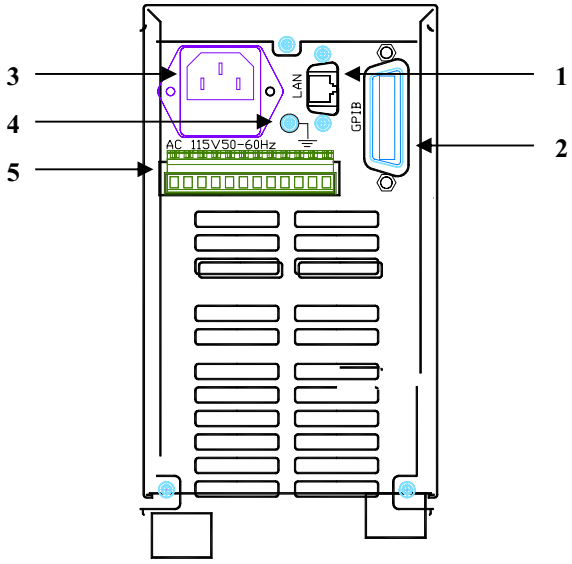
13. **RELAY** — (Optional) Press this key to activate the isolation relay menu.

14. VLIST 4 — Press this key to do voltage step programming. Use #8 key and #2 key to scroll up to 20 voltage step. Use #7 key to change voltage value at that step. Use #9 key to alter time stepping interval at that step.

15. CHANNEL — (Optional) Channel function is to select multiple channels (including the master unit to be programmed.

16. ENTER — Enters the number keyed.

REAR CONTROL PANEL & DESCRIPTION
(MODELS PDXX-XXE WITH ETHERNET INTERFACE & ENCODER KNOB OPTION)

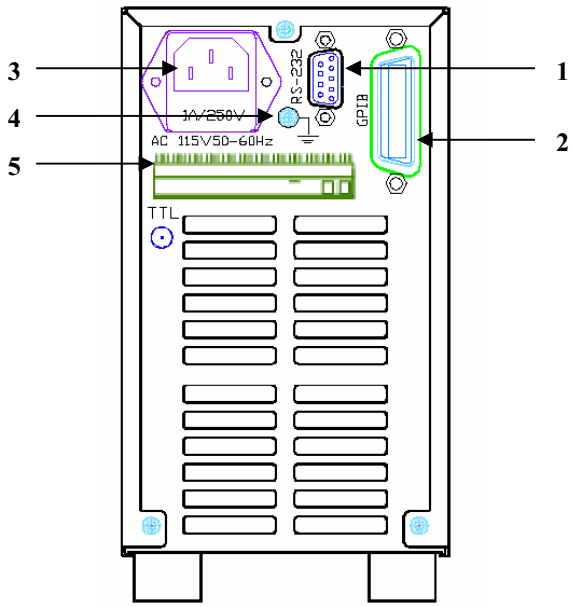


NOTE: *The size of the PD series power supply will depend on the maximum power.*

DESCRIPTION

1. Ethernet (LAN) RJ45 connector for Ethernet Interface Only.
2. GPIB Standard IEEE 488 GPIB Interface Connector.
3. AC Input AC input terminal
4. Chassis GND Chassis/line Ground lug screw.
5. DC Output Connectors (Connectors vary by unit size, channel, current rating and voltage rating)

REAR CONTROL PANEL & DESCRIPTION *(MODELS PDXX-XXA WITH GPIB IEEE4888.2 & RS232 INTERFACE ONLY)*



NOTE: *The size of the PD series power supply will depend on the maximum power.*

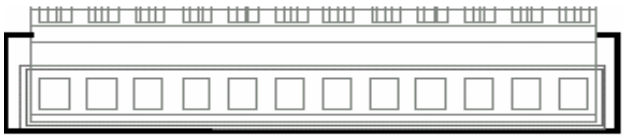
DESCRIPTION

1. RS-232 RS-232 connector for RS-232 Interface Only.
2. GPIB Standard IEEE 488 GPIB Interface Connector.
3. AC Input AC input terminal
4. Chassis GND Chassis/line Ground lug screw.
5. DC Output Connectors (Connectors vary by unit size, channel, current rating and voltage rating)

REAR PANEL DC OUTPUT CONNECTORS

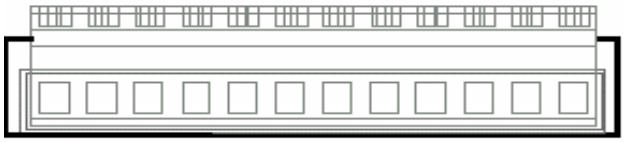
TYPE A: Single channel output with output rating less than 8amps.

1	2	3	4	5	6	7	8	9	10	11	12
GND	GND	-S	-OUT	-OUT	+OUT	+OUT	+S	+S	EXTV	EXTI	EXTG



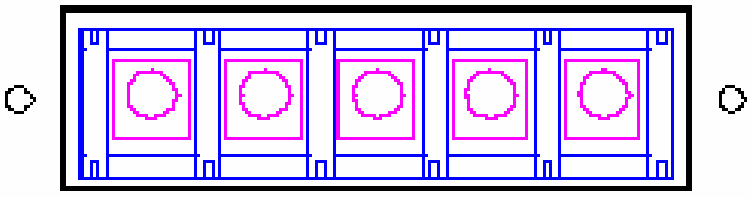
TYPE B: Dual channel output with output rating less than 8 amps.

		CHANNEL 1					**CHANNEL 2**				
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
GND1	GND1	-S1	-OUT1	+OUT1	+S1	+S2	+OUT2	-OUT2	-S2	GND2	GND2



TYPE C: Single and multiple channel output with output rating greater than 8 amps.

– S	– OUT	+ OUT	+ S	GND



REMOTE SENSE

In constant voltage mode (CV), the output is locally strapped for local sensing (normal operation); an unavoidable voltage drop is incurred in the load leads, which adds to its voltage regulation. By connecting the supply for remote sensing, voltage is sensed at the load rather than at the output terminals. This allows the supply to automatically compensate for voltage drops in the load leads and improve regulation. In remote sensing, the MES:VOLT? Query and the front panel meter monitor load voltage at the sensing points.

In remote sensing, the OVP circuit makes measurements at the load sense points. The voltage sensed by the OVP circuit could be significantly higher than the voltage being regulated at the load. Therefore, set OVP threshold voltage accordingly.

REMOTE SENSE CHARACTERISTICS

OUTPUT NOISE: Noise picked up on the sense leads will appear at the supply's output and may adversely affect CV load regulation. Twist the sense leads to minimize external noise pickup and run them parallel and close to the load leads. In noisy environments, it may be necessary to shield the sense leads. If a shield is used, ground the shield at the power supply end only and do not use the shield as one of the sensing conductors

STABILITY: When the supply is connected for remote sensing, it is possible for the impedance of the load wires and the capacitance of the load to form a filter, which will become part of the supply's CV feedback loop. The extra phase shift created by this filter can degrade the supply's stability and can result in poor transient response performance. In extreme cases, it can cause oscillation.

It is difficult to state simple rules defining the conditions under which this can occur, and which corrective action to take. A certain amount of trial and error may be called for. Three guidelines that are almost always valid are:

a. Keep the leads as short as possible
b. Twist the load leads together to minimize inductance.
c. Shield he sense lead and ground shield at supply.

In most circumstances, once these three guidelines are followed, problems associated with the load lead inductance will be eliminated. This leaves the load lead resistance and load capacitance as the major cause of the reduced stability. In this case, you may obtain further improvement to the stability by:

a. Keeping the load capacitance as small as possible.
b. Increasing the diameter of the load leads to reduce resistance.

If heavier gauge leads (# 10 or greater) are used, circumstances may arise when the load lead inductance and the load capacitance can form an under damped filter. This filter occasionally has the effect of destabilizing phase response. In this case, the above steps can worsen stability since they will reduce damping in the system.

TTL INTERLOCK SHUTDOWN (OPTIONAL)

The PD Series comes with an optional TTL enable/disable function. This is accomplished using a BNC connector on the rear of the power supply.

A **'Low Signal'** less than 2.8Vdc signal into the TTL input will enable the TTL Shutdown function; it will disable the power supply output. The display will indicate the unit been shutdown and the unit will continuously beep. By inputting a "**High Signal**" into the unit, the signal will disable the TTL Shutdown function and allow further operation.

A **'High Signal'** greater +2.4Vdc signal input into the TTL input port allows the power supply to operate normally.

OUTPUT TERMINALS AND WIRES

All models have terminal connectors on the rear panel; a positive terminal, a negative terminal, a positive remote sense terminal, a negative remote sense terminal, and an earth ground terminal.

NOTE: *The power supply is set at the factory for local sense operation (i.e. the +S and –S terminals are connected to the "+" and "-" terminals by a jumper wire at the rear connector). When operating in remote sense mode, remove the jumpers and refer to the section on remote sense.*

Additionally, some models have positive and negative terminals in the front of the unit. Brief definition of remote sense is "a measurement of voltage at the load rather than at the output terminals". Local connections are made to the **"+"** and **"-"** terminals of the power supply and wrap and bundle wires to reduce coupling effect.

In order to safely and sufficiently handle electric current, the proper wire size must be used. Select a wire size with sufficient rating to carry the current without overheating. Other factors to be taken into consideration are voltage drop and conductor temperature.

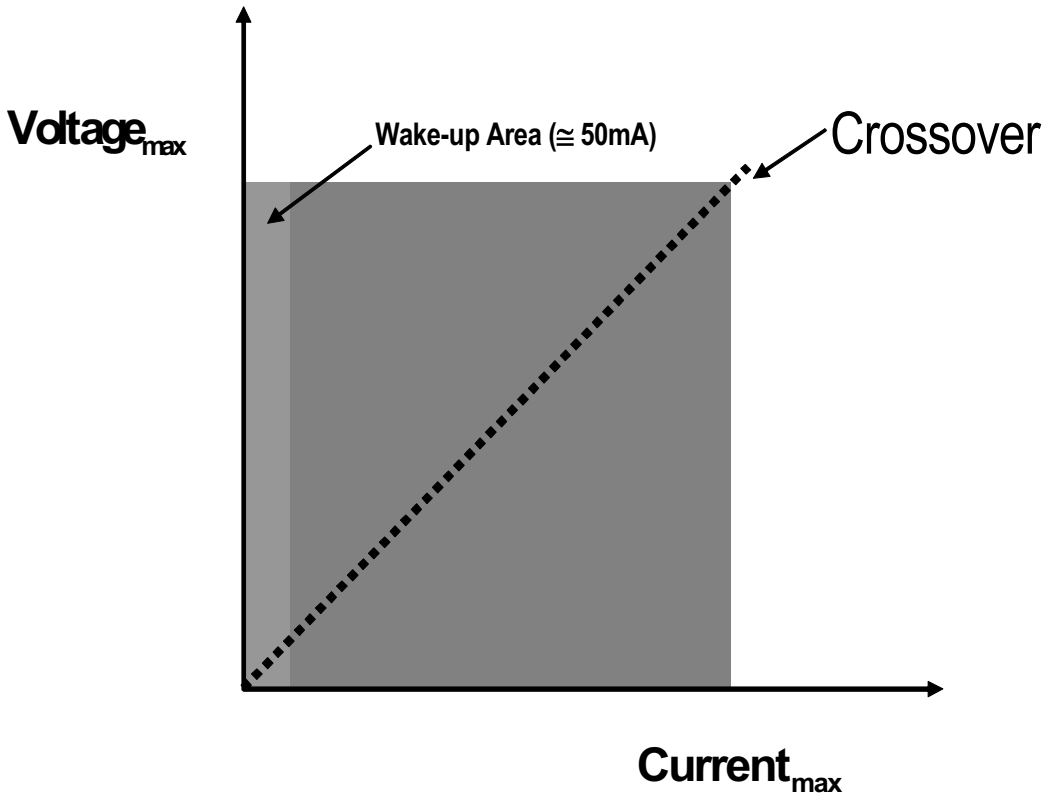
OPERATING CHARACTERISTICS AND CONFIGURATIONS

These sections contain information on operating characteristics and how to configure the PD Series.

All power supplies operate in either constant voltage (CV) or constant current (CC) mode over the rated output. Their respective voltage and current operating locus are found in operating quadrants for all models. The power supply acts as a constant voltage source for comparatively large values of load resistance and as a constant current source for comparatively small values of load resistance. The automatic crossover or transition between these two modes of operations occurs at a critical stage or "crossover" value of load resistance; $R_C = E_S/I_S$, where E_S is the front panel voltage setting and I_S the front panel current setting.

The wake-up area (≈ 50mA) is the minimum current (factory) setting to excite any output voltage setting within the power supply range.

OPERATING QUADRANT



TWO: INSTALLATION

INTRODUCTION

This section provides recommendations and procedures for inspecting, installing, and testing the power supply.

BASIC SETUP PROCEDURE

To summarize the basic setup procedure and an overall view of the subsections. Use the procedure as a quick reference if you are familiar with the installation requirements for the power supply. If you want more information, each step in the procedure refers to subsequent sections, which contain more details. Execute each step in the sequence provided.

BASIC SETUP PROCEDURE

Step#	Description	Action	Reference
1	Inspection	Perform an initial physical inspection of the supply.	Inspection, cleaning, and packaging.
2	Installation	Install the instrument on bench or rack mount, ensuring adequate ventilation.	Location, mounting, and ventilation.
3	Input power	Connect AC input power	AC input power connection.
4	Test	Perform functional tests for CV mode, CC mode, and front panel controls.	Functional test.
5	Load	Connect the load.	Load connection.
6	Sense	Connect sensing lines.	Local and Remote sense.

* See Local Operation for instructions for front panel operation, OVP

INSPECTION, CLEANING, AND PACKAGING

- INITIAL INSPECTION: When you first receive your unit, perform a quick physical check.

1. Inspect the instrument for cracks, scratches, broken switches, connectors, and display.
2. Make sure there is not damage on the AC power cord, the AC in put cover is installed properly and with the strain relief.
3. Make sure there in no loose component in the unit that may cause by the long distance shipping.

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

- MAINTENANCE: No routine servicing of the power supply is required except for periodic cleaning. Whenever the instrument is removed from operation, first use a low pressure air to blow dust from in and around components on the printed circuit board, clean the front panel with dry cloths or with a weak solution of soap and water, clean the metal surfaces with naphtha or an equivalent solvent when used in high humility. Then use the low-pressure air to blow it again.

RETURNING POWER SUPPLIES TO THE MANUFACTURER

Return Material Authorization Policy for warranty and non-warranty service:
Before returning a product directly to American Reliance Inc. you must obtain a Return Material Authorization (RMA) number and the correct manufactory Ship To: address. Products must also be shipped prepaid. Product shipments will be refused and returned at sender expense if they are unauthorized shipped without RMA # clearly marked on the outside of the shipping box, shipped "COD", or if they are shipped to the wrong location.

Please have the following information when contacting American Reliance for RMA #:

1- The model number of your product.
2- The serial number of your product.
3- Information about the failure and/or reason for the return.
4- A copy of your dated proof of purchase.
5- Firmware Version

When returning the product to American Reliance Inc.:

1- Package the unit safely, 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 information:

   - The RMA# supplied by American Reliance 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 person, telephone, email where sender can be reached during work hours.
   - A brief description of the problem.

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

If you are returning a product from outside of the United States:

In addition to the above, you must include return freight funds if you instrument is out of warranty and are fully responsible for all documents, duties, tariff, and deposits.

PACKAGING FOR SHIPPING OR STORAGE

Instructions to prepare the instrument 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 at the front panel label) and its serial number (available at 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 or shipping, repack the power supply in its original box. If the original box is not available, seal the instrument in a plastic bag and pack it in a 200 lb. (90Kg) test corrugated cardboard carton large enough allow 3 inches (76.2mm) of cushioning material to surround the unit or use a material such as foam slabs or chips or an appropriate wooden crate. Please consult with AMREL shipping department for proper packing material and handling.

3- Mark the address of the service center and your return address carton.

4- For storing, no more than two cartons high. The storage temperature should be between -40°C to 70°C.

LOCATION, MOUNTING, AND VENTILATION

Power supply is designed for rack-mounted or bench top applications.

RACK MOUNTING INTALLATION:

1- Use the integral rack-mount ears at both sides of the front panel to install the power supply in a rack mount application.

2- Provide adequate support for the rear of the instrument without obstructing the ventilation inlets on the sides of the unit. Use a support bar at the bottom or rear of the unit. Follow the rack-mount manufacturer's instructions to install the support bar. (NOT INCLUDED)

VENTILATION:

Whether you place the power supply in a rack or on a bench, allow cooling air to reach the ventilation inlets on the sides of the instrument and allow 4 in. (101.6mm) of unrestricted air space at the rear of the unit for the fan exhaust. Any ventilation space at the top and bottom of the supply will further lower internal operating temperatures.

FUSE REPLACEMENT

If the fuse is suspected to be defective, it should be inspected and, if necessary, replaced. To inspect or replace the fuse, please contact to American Reliance service department before perform the following steps:

(1) Disconnect the AC line cord from the unit to reduce electrical shock hazard.
(2) Remove the fuse by sliding out the fuse holder. The fuse holder is beneath the AC receptacle. Test the fuse for electrical continuity with an ohmmeter.
(3) If the fuse is found to be defective, replace it with a replacement fuse with same time of rating.
(4) Replace the fuse and re-install the fuse holder.
(5) Re-install the cover and connect the AC power cord.

CAUTION

USE OF ANY FUSE OTHER THAN THE ONE SPECIFIED MAY CAUSE DAMAGE TO THE UNIT, POSE A SEVERE FIRE HAZARD, AND WILL VOID THE WARRANTY.

AC INPUT POWER CONNECTION

WARNING

Disconnect AC power from the instrument before removing the cover. Even with the front panel power switch in the OFF position, live line voltages are exposed when the cover is removed and the AC cord is attached. Repairs must be made by experienced service technicians only.

NOTE: *You must obtain an authorization from Amrel first before removing the cover of the instrument. Otherwise the warranty will be a void.*

WARNING

There is a potential shock hazard if the power supply chassis and cover are not connected to an electrical ground via the safety ground in the AC input connector. Ensure that the power supply is connected to a grounded AC outlet with the recommended AC input connector configured for the available line voltage.

CAUTION

When power switch is turned ON, output voltage or current previously set will be applied to loads.

AC INPUT

CAUTION

Check the AC input voltage label above the AC input at the rear panel of the unit before plug in AC source. PD Series has fixed AC input voltage.

AC INPUT CORD

⚠ WARNING

The AC input cord is the disconnect device for the power supply. The plug must be readily identifiable to the operator. The input cord must be no longer than 3 m (9.84 feet). The AC cord size wire will depend on the maximum power of the power supply.

The AC input cord we recommend is specified below, "AC Cord Specification".
If you require a special cord, call our sales representative.

AC CORD SPECIFICATION

WIRE SIZE DIMENSIONS AWG	TYPE OF CONDUCTOR	RATINGS	LENGTH (feet)
16/3	SJT	75°C	6
18/3	SJT	75°C	6

LOAD WIRING

To select wiring for connecting the load to the power supply, consider the following factors:

- Insulation rating of the wire
- Current carrying capacity of the wire
- Maximum load wiring length for operation with sense lines
- Noise and impedance effects of the load lines
- Length, impedance and gauge size of the load lines

CURRENT CARRYING CAPACITY: As a minimum, load wiring must have a current 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 2.1 shows the maximum current rating, based on 450 A/cm², for various gauges of wire rate for 105°C operations. Operate at the maximum current rating results in an approximately 30°C temperature rise 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 wiring rated for higher temperature.

TABLE 2.1 CURRENT CARRYING CAPACITY FOR LOAD WIRING

WIRE SIZE (AWG)	MAXIMUM CURRENT (A)
2/0	303
1/0	247
1	192
2	155
4	97
6	61
8	36
10	21

LOAD WIRING LENGTH FOR OPERATION WITH SENSE LINES

For applications using remote sensing, you must limit the voltage drop across each load line. We recommend that you use the larger load wiring or ensure a smaller voltage drop (1V typical max.), although the unit will compensate for up to 5V drop in each line

NOISE AND IMPEDANCE EFFECTS

To minimize noise pickup or radiation, use shielded pair wiring or shortest possible length for load wires. Connect the shield to the chassis via a rear panel mounting screw. Where shielding is impossible or impractical, simply twisting the wires together will offer 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.

Note: *Use shorter, low impedance and wider gauge load cables*

LOAD CONNECTIONS

WARNING

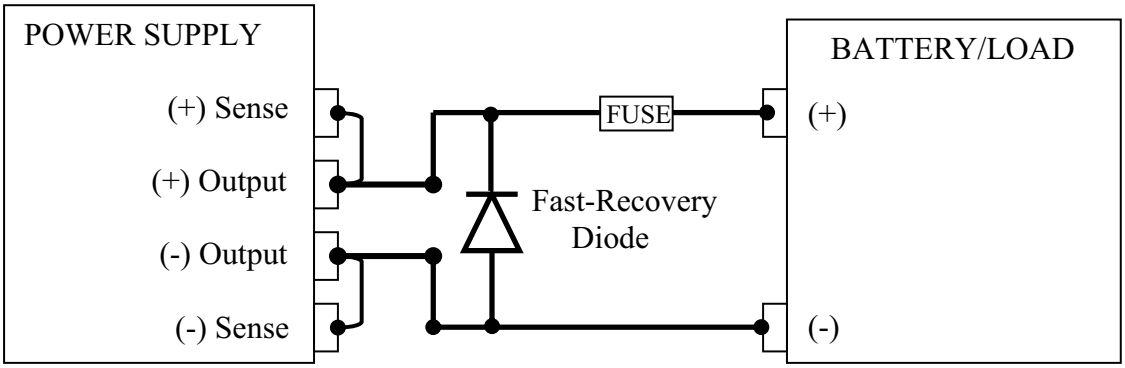
There is a potential shock hazard at the load when using a power supply with a rated output greater than 40V. To protect personnel against accidental contact with hazardous voltages, ensure that the load, including connections, have no live parts, which are accessible. Also ensure that the insulation rating of the load wiring and circuitry is greater than or equal to the maximum output voltage of the power supply.

CAUTION

When making connections to the output terminal, ensure that each terminal's mounting hardware and wiring assembly are placed to avoid touching the other terminal and shorting the power supply output. Heavy connecting cables must have some form of strain relief to avoid loosening the connections.

REVERSE POLARITY

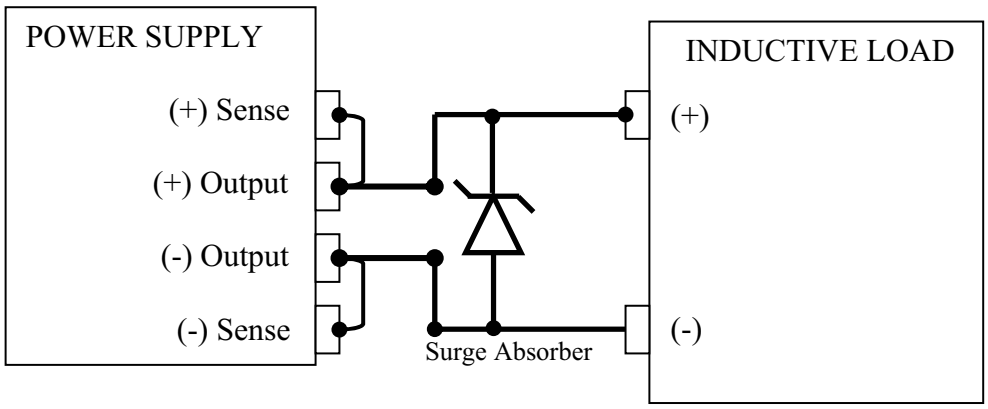
To prevent from damages caused by reverse polarity, a fast recovery diode and a fuse should be connected to the test system. Both the fuse and the diode should be rated for two times the maximum rated voltage and current of the unit. Please connect the components according to the following diagram.



REVERSE POLARITY PROTECION

INDUCTIVE LOADS

To prevent damage to the power supply from inductive kickback or back EMF from a motor, connect a surge absorber diode across the output (parallel). The diode should be rated at greater than two times the supply's output voltage and have a current surge rating two times greater than the supply's output rating. Connect the cathode to the positive output and the anode to the negative output/return.

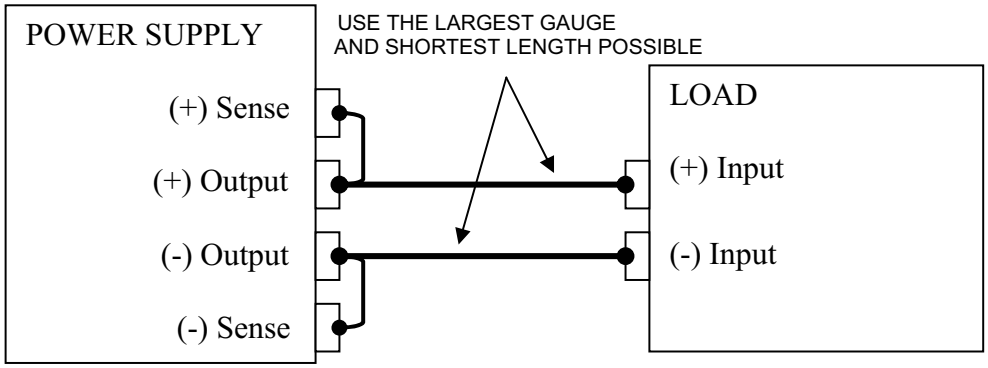


INDUCTIVE LOAD WITH SURGE ABSORBER PROTECTION

CONNECTING SINGLE LOADS

The single loads connection. Local sense lines shown below are the factory default connections for the rear DC output terminal or using the internal isolation relay terminal.

You do not need remote sensing for basic operation of your supply. However, if you wish to correct any small drops in your load lines, the remote sensing feature.



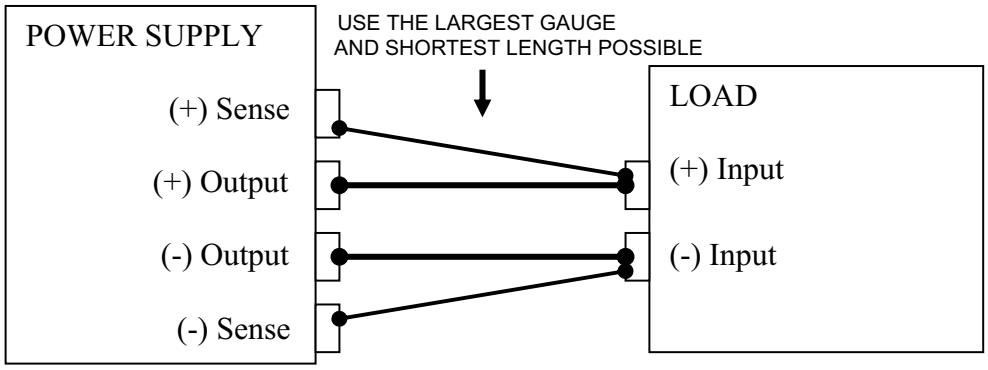
SINGLE LOAD WITH LOCAL SENSING (DEFAULT)

REMOTE SENSE CONFIGURATION

CAUTION

Turn off the power supply before making any connections on the rear panel terminal block.

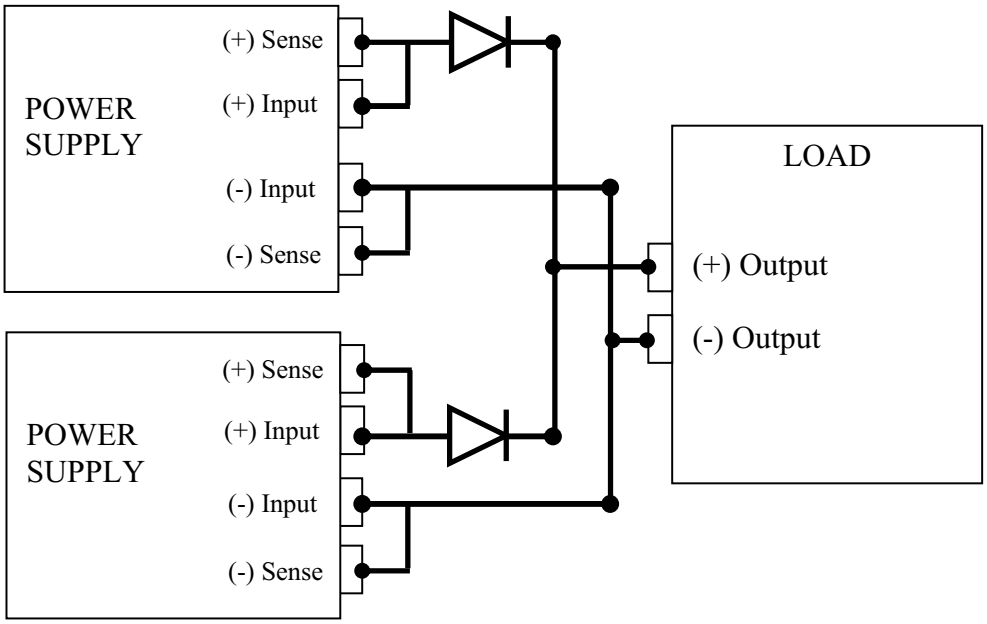
Configure the unit for remote sensing by first disconnecting the jumper wires between the sense and load terminals. Keep in mind that sense and load leads should be as short as possible. Additionally, the sense leads resistance should be no greater than 0.5 ohm/lead, and the voltage drop over the load leads should be no greater than 2.0V/lead.



SINGLE LOAD WITH REMOTE SENSING

PARALLEL POWER SUPPLY OPERATION

When operating power supplies in parallel, a situation can occur where a power supply in the configuration shuts down and the voltage from the other paralleled regulators will feed back into it. To prevent damages to the power supply, connect a high voltage rated, blocking diode in series with the Load. The break down voltage and current rating for the blocking diode should be at least two times the maximum rated values of the power supply. Please see the diagram below.



CONNECTING MULTIPLE LOADS

Proper connection of distributed loads is an important aspect of power supply use. Two common methods of connection are the parallel power distribution method and the radical power distribution method.

PARALLEL POWER DISTRIBUTION

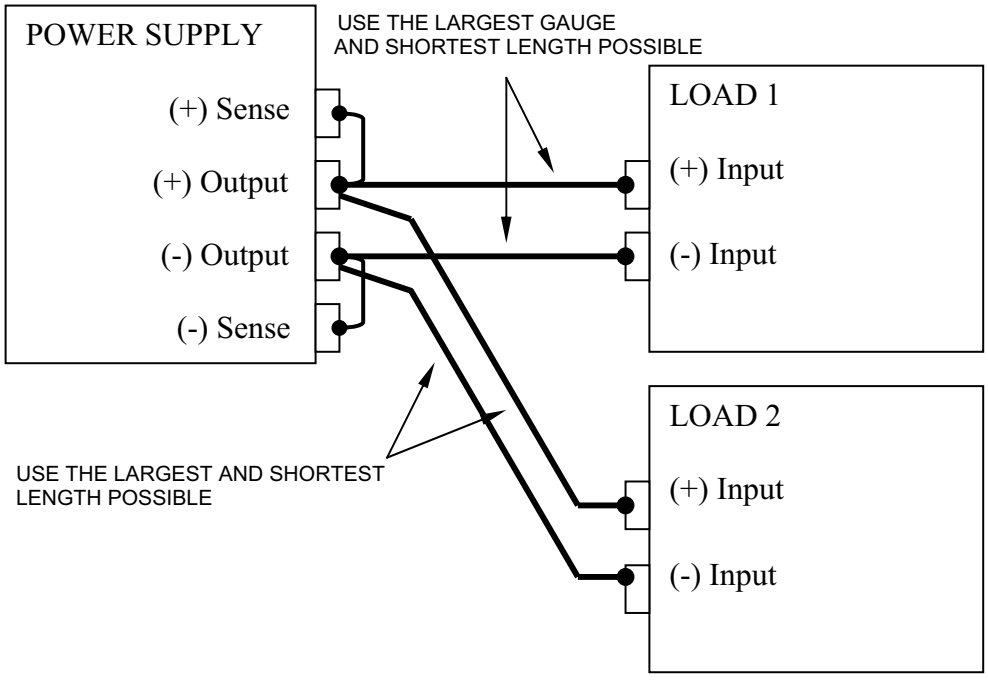
This distribution method involves connecting leads from the power supply to one load, from that load to the next load, and so on for each load in the system. This method results in the voltage at each load depending on the current drawn by the other loads and allows DC ground loops to develop. Except for low current application, we do not recommend using this method.

RADIAL POWER DISTRIBUTION METHOD

To connect distributed loads, we recommend that you use radial power distribution. With this method, you connect power to each load individually from a single pair of terminals designated as the positive and negative distribution terminals. These terminals may be the power supply output terminals, the terminals of one of the loads, or a distinct set of terminals especially established for distribution use. Connect the sense leads to these to these terminals to compensate for losses and minimize the effect of one load upon another.

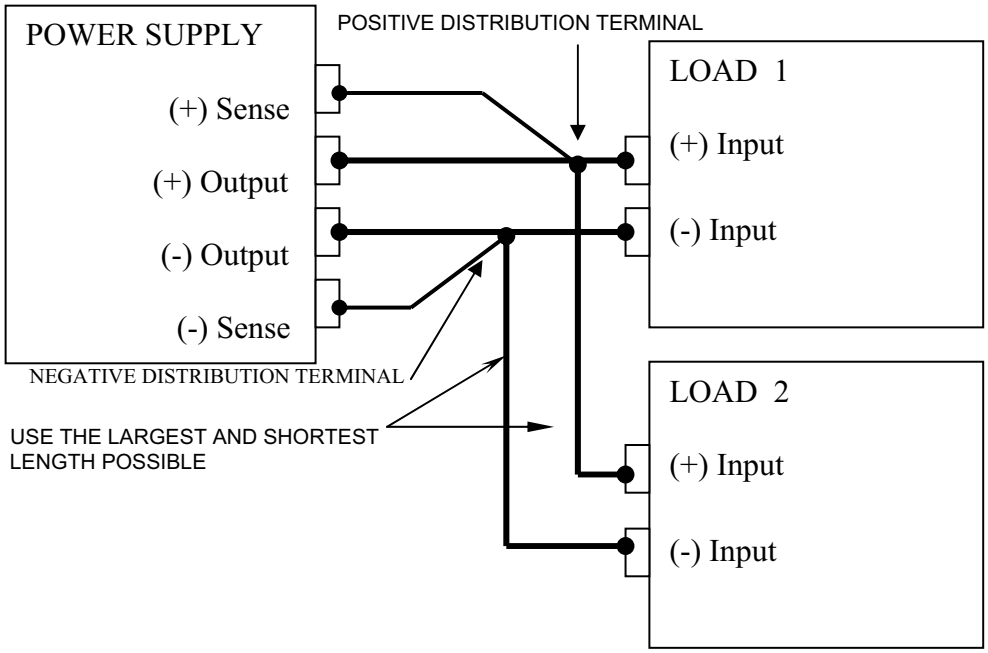
The recommended load and sensing connections for multiple loads:

MULTIPLE LOADS WITH LOCAL SENSING



RADIAL POWER DISTRIBUTION METHOD WITH LOCAL SENSE

MULTIPLE LOADS WITH REMOTE SENSING



RADIAL POWER DISTRIBUTION METHOD WITH REMOTE SENSE

THREE: LOCAL OPERATION
(MODELS PDXX-XXE WITH ETHERNET INTERFACE & ENCODER KNOB OPTION)

INTRODUCTION

These sections contain information on how to locally program the PD Series. Upon powering up, the power supplies default to local mode operation. All front panel keys may be used to control the power supply.

All operations performed in local mode, may also be performed in remote mode. The unit indicates remote operation when the RMT's indicator is shows on the display.

STANDARD OPERATION

This power supply has two basic operating modes: Constant Voltage Mode (CV) and Constant Current Mode (CC), and two control modes: Local Control Mode (default setting) and Remote Programming Mode. Both operating modes are available regardless of which control mode is used.

GENERAL INFORMATION

1. The power supplies are able to directly accept programming values of voltage, current and over voltage. ***"When a valid input is made, the unit will round off the value to the nearest multiple of the resolution". If a non-valid input is made, the unit will display "--- OVERFLOW---" and return to previous values.***

2. The actual programming of voltage and current values via front panel keypad is straightforward. Simply, press any of the functional keys and the LCD shows the current value in use. ***To change this value, simply use the numeric keys to enter a value. If an error is made, press the "CLEAR" key and then reenter the correct value. Once the final value is set, press the "ENTER" key.*** After pressing the **"ENTER"** key, the LCD module returns to the metering mode. If a user wishes to recall a setting, press the function key pertaining to the operation.

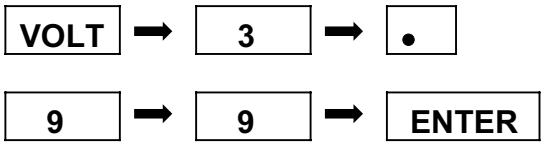
   For example, to recall a set voltage, press **"VOLT"** and then press **"ENTER"** or **"CLEAR"** key to return unit to metering mode.

3. To change any of the output parameters (i.e. VOLT, CURR, OVSET, and VLIST) simply press the desired function keys, enter the new value and press **"ENTER"**.

(INPUT MODE)

SETTING VOLTAGE

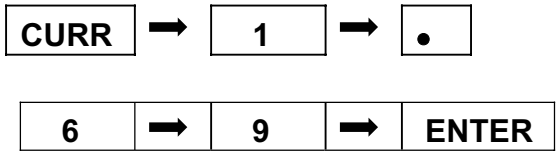
To locally program the voltage (VSET), press **"VOLT"**, enter the value and press **"ENTER"**. For example, if one wished to set a voltage of 3.99, press:



The LCD displays 3.99 V and the unit returns to metering mode.

SETTING CURRENT

To locally program the current (ISET), press **"CURR"** and enter the value and then press **"ENTER"**. For example, if one wishes to set a current of 1.69 amps, press:



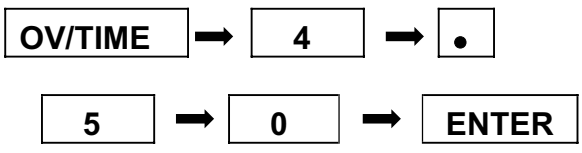
The LCD display 1.69 and the unit returns to metering mode.

OVER VOLTAGE PROTECTION

The power supply has an over voltage protection **(OVP)** feature to guard against abnormal operating conditions such as voltage overshoot. When the supply's output voltage exceeds a threshold voltage, the OVP is activated, and the unit disables the output. The LCD will indicate the condition.

SETTING THE OVER VOLTAGE THRESHOLD

To locally program the threshold voltage press **"OV/TIME"**, enter the value and press **"ENTER"**. For example, to program an over voltage value of 4.50V, press:



When output voltage exceeds 4.50V, OVP is triggered, OVP enunciator is blinking, and the output is disabled.

TUNE MODE

The Tune Mode provides a simple and accurate method to adjust the output voltage and current. Using the rotary knob, each digit can be fine tuned to obtain precise entries.

When the PD series power supply's output is ON, you may press or hold the rotary knob to enter into the Tune Mode. This function allows you to edit voltage and current and select the right digit for increment or decrement the value.

In Tune Mode, the default cursor positioned at the lowest digit of voltage and current value. To turn right, it increment the digit value and carries to next digit. And to turn left, it decrement the digit and borrows to next digit. The output voltage and current values also refresh according to the new values setting.

ROTARY KNOB OPERATION

The AMREL PD Series comes with a standard rotary knob at front control panel. See definition below.

Definition for knob "Turn":

Turn right:

1. At "Menu Mode", it is similar to " ▸ " keys.
2. At "Input Mode" or "Tune Mode", it increments the digit value of the cursor location.

Turn left:

1. At "Menu Mode", it is similar to " ◂ " keys.
2. At "Input Mode" or "Tune Mode", it decrements the digit value of the cursor location.

Definition for knob "Press/Hold"

Press: (Press and release)

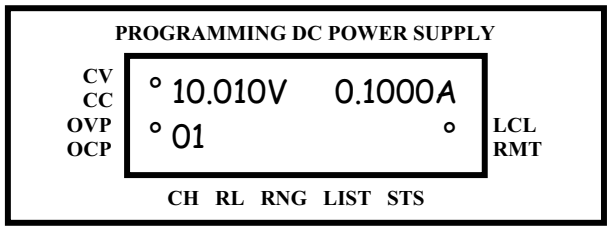
1. At "Menu Mode", it is similar to "CLEAR" keys.
2. At "Input Mode" or "Tune Mode", it moves the cursor to left.

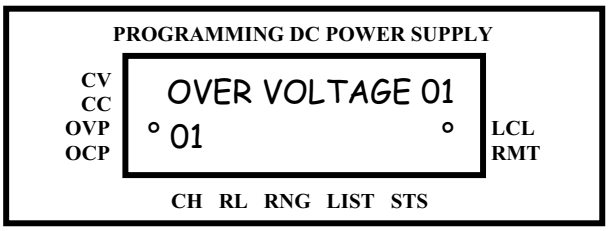
Hold: (Press and Hold for 2 seconds)

1. At "Menu Mode", it is similar to "ENTER" key.
2. At "Metering Mode", it is similar to "UTILITY" key.

ENABLING / DISABLING OVER VOLTAGE PROTECTION

The user can enable or disable the OVP circuit by pressing the **"OVP ON/OFF (2)"** key. When it is enabled the OVP enunciator is on.





When the LCD displays “OVER VOLTAGE”, the over voltage protection circuit has been activated and the output is disabled. To reset, press the **"CLEAR (RESET)"** key. To turn the output on again, press the **"OUT ON/OFF (1)”** key.

Important Notes:

1. ***Remote sensing, take into consideration the voltage drop across the load leads since the threshold measurement is taken at the output.***

2. ***In inductive load applications, a high-surge voltage would enable the OVP circuit and disable the output.***

3. ***Also note the programming resolution and programming accuracy specifications***

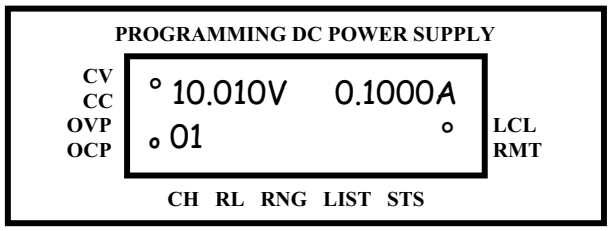
4. ***When the OVP circuit is disabled, the threshold voltage becomes invalid.***

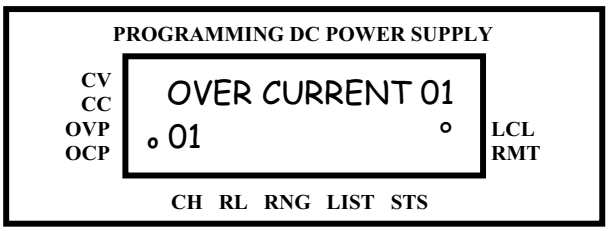
OVER CURRENT PROTECTION

The power supply has an over current protection (OCP) feature to guard the supply against current overdraw. If the OCP feature is enabled and the supply switches to CC mode, the OCP protection will trigger when the current level exceeds the OCP level and then disable the output. The OCP threshold is fixed at the value of the current limit.

ENABLING / DISABLING OVER CURRENT PROTECTION

To enable the over current protection circuit, press the **"OCP ON/OFF (3)"** key and the OCP enunciator is turned on. To disable the over current protection, press the **"OCP ON/OFF (3)"** key one more time and the enunciator is turned off. When the LCD displays "OVER CURRENT", the over current protection circuit has been activated and the output is disabled. To reset, press the **"OCP ON/OFF (3)"** key and the enunciator will stop blinking. To turn the output on again, press the **"OCP ON/OFF (3)"** key.





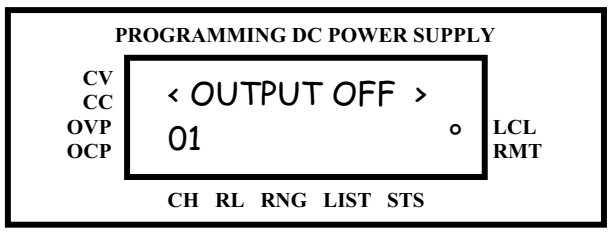
Important Notes:

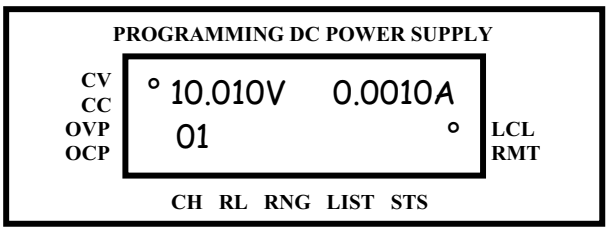
1. ***OCP is set by the value of the current limit.***

2. ***If OCP is enabled and the constant current Mode (CC) is activated, the power supply output is disabled.***

ENABLING / DISABLING OUTPUTS

All models of the PD Series have the capability of disabling their outputs by entering a new operating parameters or connecting / disconnecting the load. Once the modification has been completed, one can enable the power supply to operate at the new values. The output is enabled or disabled by pressing the **"OUT ON/OFF (1)"** key. To return the supply to normal operation, press the **"OUT ON/OFF 1)"** key again to toggle the output on.





The PD Series output is enabled or disabled by selecting the channel/s and pressing the **"OUT (ON/OFF) (1)"** key. If this is a multi-channel power supply, the channels can be selected by pressing the "ENTER" or "CLEAR" keys.

ISOLATION RELAY FUNCTION (OPTIONAL)

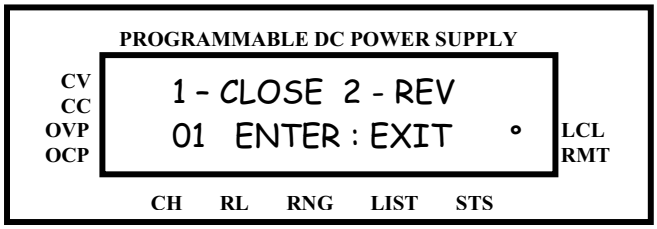
The AMREL PD Series has an internal output isolation relay function. The relay allows the user to reverse or disconnect the electronic load from the UUT either via the front panel keypad or the GPIB Interface Bus.

Pressing the (RELAY) key will activate the relay menu. Enter "1" to close the Relay, "2" to reverse the output. Press Enter key to continue selection or clear to exit.

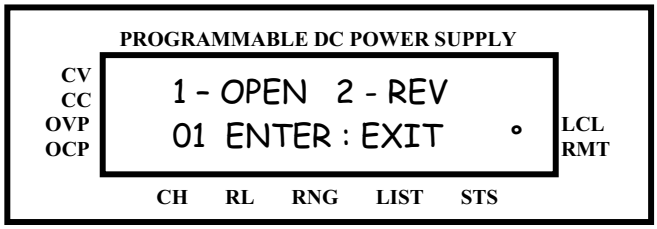
Note: *It is recommended that the output be turned off before closing or reversing the relay.*

DISPLAYS CLOSE/OPEN FOR ISOLATION RELAY OUTPUT

1 – Press RELAY key:
2 – Press #1 key to close the isolation relay output.

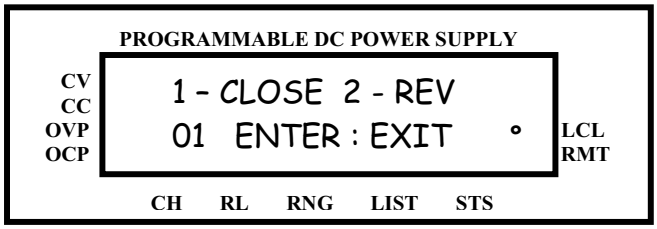


1 – Press RELAY key:
2 – Press #1 key to open the isolation relay output.

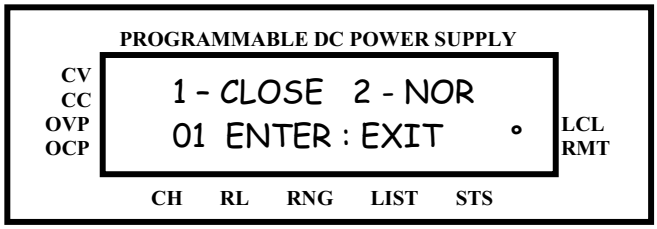


DISPLAYS REVERSE/NORMAL ISOLATION RELAY OUTPUT

1 – Press RELAY key:
2 – Press #2 key to reverse the isolation relay output.

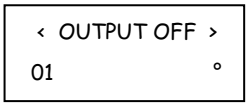


1 – Press RELAY key:
2 – Press #2 key to normal the isolation relay output.

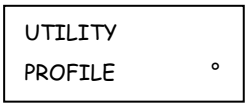


UTILITY MENU

Follow simply step below for Utility function.

1. Metering menu 

as shown, when turned the power switch "ON".

2. Pressed **UTILITY** to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select (LOAD or SAVE). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

a- Load Mode: Press ENTER then use key #6 as (▸) and #4 as (◂) to select profile location (0-3). Press **ENTER** key to accept the profile number then press **CLEAR** key to back to metering menu).
b- Save Mode Press ENTER then use key #6 as (▸) and #4 as (◂) to select profile location (0-3). Press **ENTER** key to accept the profile number then press **CLEAR** key to back to metering menu).

3. Press once #6 key after pressed **UTILITY** to advance to

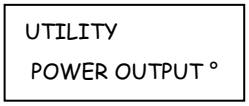
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set times of loops. Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

4. Press twice #6 key after pressed **UTILITY** to advance to

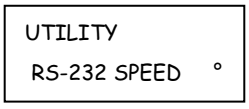
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set the GPIB address (0 – 31). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

5. Press three times #6 key after pressed **UTILITY** to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set the maximum channel address (0 – 31). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

6. Press four times #6 key after press **UTILITY** to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select output On / Off as default when power up. Press **ENTER** key to accept the setting then press **CLEAR** key to back to metering menu.

7. Press five times #6 key after pressed UTILITY to advance to 

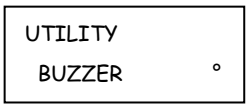
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set baud rate. (2400 / 4800 / 9600 / 19200 / 38400 / 57600 / 115200 bps). Press **ENTER** key to accept the value and press **CLEAR** key to back to metering menu.

8. Press six times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set EOS Code. (NONE / CR / LF / CR+LF). Press **ENTER** key to accept the EOS Code then press **CLEAR** key to back to metering menu.

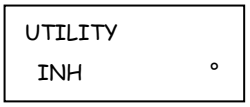
9. Press seven times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set LCD backlight. (Always / 5 min / Off). Press **ENTER** key to accept the LCD setting then press **CLEAR** key to back to metering menu.

10. Press eight times #6 key after pressed UTILITY to advance to 

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired buzzer operating mode: **On, Off, or Alarm**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

Note: *In ALARM mode, the buzzer sounds only during protection alarm trip events*

11. Press nine times #6 key after pressed UTILITY to advance to 

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired Remote Inhibit operating mode: **Off, Live, or Latched**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

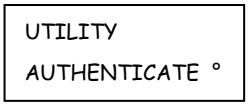
OFF	Remote Inhibit Off
LIVE	Self-recoverable Remote Inhibit
LATCH	Latched Remote Inhibit

Remote Inhibit function is Low-active: *Short – INH Enabled and Open – INH Disabled*

12. Press ten times #6 key after pressed UTILITY to advance to

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired computer programming command protocol: **SCPI or IEEE488.1**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

Note: *The IEEE488.1 protocol is for legacy PDS & PD models, default protocol is SCPI*

13. Press eleven times #6 key after pressed UTILITY to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select and configure AUTHENTICATE menu options:

a- **SERIAL NO.:** Press **ENTER** to see the MAC ID address for the specific channel being controlled. Press **CLEAR** key to back to metering menu.
b- **INTERFACE:** Press **ENTER** check which interfaces are available on the unit. Press **CLEAR** key to back to metering menu.

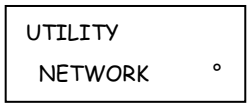
c- **CODE:** Optional interfaces, such as Ethernet, can be enabled in the field using a code. Please contact an AMREL representative today.

14. Press twelve times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select Panel Enable Mode or Panel Password Mode):

a- **Panel Enable Mode:** Press ENTER then use key #6 as (▸) and #4 as (◂) to enable/disable (On/Off). Press **ENTER** key to accept the password then press **CLEAR** key to back to metering menu).

b- **Panel Password Mode:** Press ENTER then press **CLEAR** key to back to metering menu).

15. Press ten times #6 key after pressed UTILITY to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select ADDRESS, NETMASK, or GATEWAY):

a- **ADDRESS:** Press ENTER to input the IP address. Press **ENTER** key to accept the address then press **CLEAR** key twice to back to metering menu.

b- **NETMASK:** Press **ENTER** to input the NETMASK. Press **ENTER** key to accept the password then press **CLEAR** key to back to metering menu.

c- **GATEWAY:** Press ENTER then input the GATEWAY address. Press **ENTER** key to accept the address then press **CLEAR** key twice to back to metering menu.

16. Press nine times #6 key after pressed UTILITY will back to step 1 (System Status). Also you may press #4 key to back to previous function.

TRACKING SELECTION MODE

The dual channel PDS series has the ability of tracking since it has two outputs. You can set channel 1 as the master channel then channel 2 will be slave channel or channel 2 as master channel then channel 1 as slave channel. The slave channel output is identical (synchronized with) to master channel and is controlled by the master channel. For example: If the voltage changes by amount “x” in the master channel, the slave channel will also change by amount “x".

Tracking setting procedure:

i. At Metering Mode. Press “ENTER” and “7” key simultaneously to enter to Tracking Selection Mode.

ii. Press “CHANNEL” key or “ ◂ ▸ ” key to select channel.
iii. Press “ENTER” key to set the tracking option (1 = Master (T) and 2 = Slave (t)) for each channel.
iv. Press “CLEAR” to back to Metering Mode.
v. Now set the voltage or current at the master channel and the slave channel will be identical to master channel.

This setting can also be set with the rotary knob. Turning the knob will select the channel and pressing the knob will select the tracking option, and holding the knob will go back to Metering Mode.

FRONT PANEL LOCK OPERATION

This PD series power supply has the ability to lock the front panel when the power is turned OFF and turn back ON. See the front panel lock setting below:

1. Presses UTILITY then use the " ▸ " key to scroll till "PANEL LOCK" and then press ENTER key.
2. Use the " ▸ " key to select PANEL ENABLE or PANEL PASSWORD.

Panel Enable:

1. Select PANEL ENABLE and press ENTER key.
2. Use the " ▸ " key to enable or disable (ON/OFF) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

Panel Password:

2. Select PANEL PASSWD and press ENTER key.
3. Enter the password and press ENTER key to accept your password. (1 to 6 digit password)
4. Press CLEAR key twice to back to metering mode.

PROFILE SAVE AND LOAD

This function allow you to select saved and reload the profiles (Default setting) to a specified location in memory, and the profile settings. See the front panel profile setting below and the remote section:

1. Presses UTILITY then it will show "PROFILE" and then press ENTER key.
2. Use the " ▸ " key to select LOAD or SAVE.

LOAD:

1. Select LOAD and then press ENTER key.
2. Use the " ▸ " key to select the profile number (0-3) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

SAVE:

1. Select SAVE and then press ENTER key.
2. Use the " ▸ " key to select the profile number (0-3) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

Example for Local Mode setting:

1. Set the voltage and current (Set Default).
2. Select save profile by pressing UTILITY, press ENTER when see PROFILE. Use " ▸ " key to select SAVE and then press ENTER. Use " ▸ " key to select profile save location (0-3), and then press ENTER.
3. Press CLEAR three times will back to metering mode.

Next operation when you turn the load's power ON. You can select the profile location and reload the previous setting. This operation is very useful for stepping mode.

Note: *See the REMOTE OPERATION SECTION for the remote interface operation.*

STEPPING MODE

Voltage/Current List Edit Mode.
Voltage/Current step programming permits the user to program a sequence of different voltage outputs with its applied duration via front panel keypad.

VLIST setting:

1. At metering menu; Press key# 4 (VLIST) to enter into the voltage list edit mode.
2. Press "CHANNEL" key to select operation channel, if applicable.
3. Use " ◂ " or " ▸ " to select list step.
4. Press key# 7 (VOLT) to set the list voltage value at this step.
5. Press key# 9 (OV/TIME) to set list dwelling time in millisecond.
6. Repeat step 3 to 5 if need to edit more list steps.
7. Press CLEAR key to go back to metering menu.

ILIST setting:

1. At metering menu; Press key# 5 (ILIST) to enter into the current list edit mode.
2. Press "CHANNEL" key to select operation channel, if applicable.
3. Use " ◂ " or " ▸ " to select list step.
4. Press key# 8 (CURR) to set the list voltage value for the selected step.
5. Press key# 9 (OV/TIME) to set the list dwelling time in milliseconds.
6. Repeat step 3 to 5 if need to edit more list steps.
7. Press CLEAR key to go back to metering menu.

Voltage/Current list operation:

1. At metering menu; Press key# 0 (VLIST ON/OFF) or decimal key (.) to enable / disable the voltage/current list operation.
2. When list operation is ON, the display shows "VLIST ON" OR "ILIST ON".

Note: *List operation can only be enabling when output status is ON.*

LIST CYCLE

List Cycle is the cycle of loops the step program will be repeated. The stepping function provides loop control with list cycle function, which instructs the power supply to repeat the stepping function, based on the list cycle. For example: List cycle is set to 10 and the power supply will cycle the desired steps 10 times.

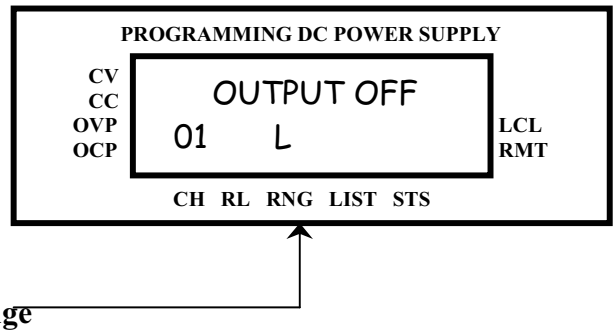
Set List Cycle:

1. Press UTILITY.
2. Use " ▸ " key to select LIST CYCLE, and then press ENTER.
3. Use " ◂ " or " ▸ " to set the cycle time, and then press ENTER.
4. Press CLEAR twice to back to metering menu.

CONSTANT CURRENT RANGE SELECTION (OPTIONAL)

The PD features a three range of output operating for Constant Current Mode (CC). The user must select the PD output range corresponding to the output source value, by pressing the key #6 locates at the front panel keypad, and then the LCD module will display the operating range L / M / H.

Example:
(H) = 0 – 1 Amp / 30 Volt
(M) = 0 – 15 Amp / 2 Volt
(L) = 0 – 30 Amp / 1 Volt



(L/M/H) Range

*STEPS TO VIEW "*IDN?" INFORMATION FROM THE FRONT PANEL*

Turn on AC Power or push "Clear" button; the front panel display should contain the following three fields:

1) AMREL – Manufacturer;
2) PD###### – Model Number;
3) Version number.

STEPS TO SET THE EOS MODE FROM THE FRONT PANEL

1) After front panel display is stable, push "Utility";
2) Then choose "EOS Mode" by pushing key number 6 " ▸ " button;
3) Choose "LF+CR" by pushing key number 2 " ▾ " button;
4) Push "Enter" button;
5) Push "Clear" button.

Note: *If this is not set to "LF+CR" the output will be ASCII verses a Hex number.*

STEP TO VIEW SELF-TEST RESULT

The only way to view the self-test result from front panel is to view the channels from the display. If there is a "∧" symbol on top of channel number, it means that self-test for this channel is passed.

EXTERNAL ANALOG PROGRAMMING (OPTIONAL)

Inputting an external analog voltage can control the voltage and current outputs of the PD series. The outputs are linearly proportioned to an ***external input voltage ranging from 0 to 10Vdc***. Setting the current and voltage parameters via the front panel or GPIB bus, to either 1) VSET to 0V, ISET to a proper value for CV operation, or 2) setting ISET to 0A and VSET to a proper value for CC operation, the external analog-programming mode will be activated**.**

To control the output voltage with the analog programming mode requires the following procedures; apply the ***external 0 to 10Vdc source*** (Xv) between **Pin-10 (positive)** and **Pin-12 (negative)**. These pins are located at the rear I/O connector.

The output voltage is derived by the following equation:

$$\mathbf{Vout} = x_v \left(\frac{V\max}{10} \right)$$

The output current is derived by the following equation:

$$\mathrm{Iout} = x_v \left(\frac{\mathrm{Im}ax}{10} \right)$$

Variable	***Definition***
Iout	Current requirement
Xv	External analog voltage
Imax	Rated maximum output current

To control both voltage and current simultaneously in the external programming method **requires that the user apply two separately isolated 0 to 10Vdc supplies.**

Variable	***Definition***
Vout	Voltage requirement
Xv	External analog voltage
Vmax	Rated maximum output voltage

To control the output current with the analog-programming mode requires the following procedure; apply the ***external 0 to 10Vdc source*** **(Xv)** between **Pin-11 (positive)** and **Pin-12 (negative).** These pins are located at the rear I/O connector.

FOUR: LOCAL OPERATION
(MODELS PDXX-XXA WITH GPIB IEEE4888.2 & RS232 INTERFACE ONLY)

INTRODUCTION

These sections contain information on how to locally program the PD Series. Upon powering up, the power supplies default to local mode operation. All front panel keys may be used to control the power supply.

All operations performed in local mode, may also be performed in remote mode. The unit indicates remote operation when the RMT's indicator is shows on the display.

STANDARD OPERATION

This power supply has two basic operating modes: Constant Voltage Mode (CV) and Constant Current Mode (CC), and two control modes: Local Control Mode (default setting) and Remote Programming Mode. Both operating modes are available regardless of which control mode is used.

GENERAL INFORMATION

1. The power supplies are able to directly accept programming values of voltage, current and over voltage. ***"When a valid input is made, the unit will round off the value to the nearest multiple of the resolution". If a non-valid input is made, the unit will display " --- OVER --- " and return to previous values.***

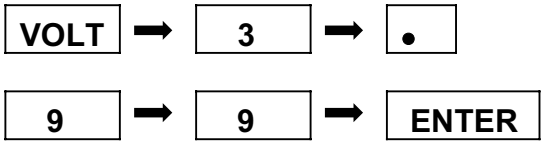
2. The actual programming voltage and current values via front panel keypad is straightforward. ***To change this value, simply use the numeric keys to enter a value. If an error is made, press the "CLEAR" key and then reenter the correct value. Once the final value is set, press the "ENTER" key.*** After pressing the **"ENTER"** key, the LCD module returns to the metering mode. If a user wishes to recall a setting, press the function key pertaining to the operation.

   For example, to recall a set voltage, press **"VOLT"** and then press **"ENTER"** or **"CLEAR"** key to return unit to metering mode.

3. To reset any of the output parameters (i.e. VOLT, CURR, OVSET, and VLIST) simply press the desired function keys, enter the new value and press **"ENTER"**.

SETTING VOLTAGE

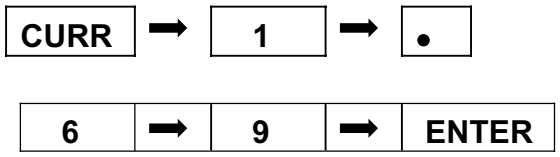
To locally program the voltage (VSET), press **"VOLT"**, enter the value and press **"ENTER"**. For example, if one wished to set a voltage of 3.99, press:



The LCD displays 3.99 V and the unit returns to metering mode.

SETTING CURRENT

To locally program the current (ISET), press **"CURR"** and enter the value and then press **"ENTER"**. For example, if one wishes to set a current of 1.69 amps, press:



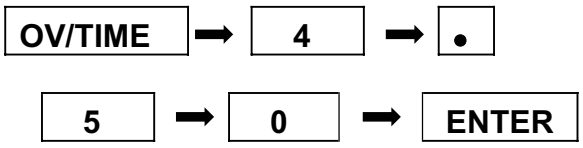
The LCD display 1.69 and the unit returns to metering mode.

OVER VOLTAGE PROTECTION

The power supply has an over voltage protection **(OVP)** feature to guard against abnormal operating conditions such as voltage overshoot. When the supply's output voltage exceeds a threshold voltage, the OVP is activated, and the unit disables the output. The LCD will indicate the condition.

SETTING THE OVER VOLTAGE THRESHOLD

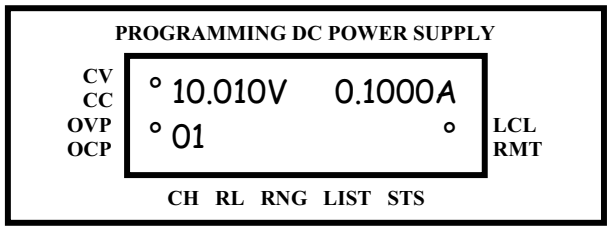
To locally program the threshold voltage press **"OV/TIME"**, enter the value and press **"ENTER"**. For example, to program an over voltage value of 4.50V, press:

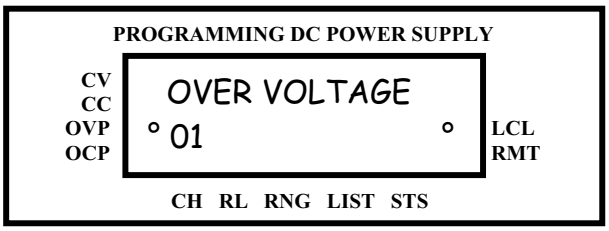


When output voltage exceeds 4.50V, OVP is triggered, OVP enunciator is blinking, and the output is disabled.

ENABLING / DISABLING OVER VOLTAGE PROTECTION

The user can enable or disable the OVP circuit by pressing the **"OVP ON/OFF (2)"** key. When it is enabled the OVP enunciator is on.





When the LCD displays “OVER VOLTAGE”, the over voltage protection circuit has been activated and the output is disabled. To reset, press the **"CLEAR (RESET)"** key. To turn the output on again, press the **"OUT ON/OFF (1)”** key.

<NOTES:>

1. ***Remote sensing, take into consideration the voltage drop across the load leads since the threshold measurement is taken at the output.***

2. ***In inductive load applications, a high-surge voltage would enable the OVP circuit and disable the output.***

3. ***Also note the programming resolution and programming accuracy specifications***

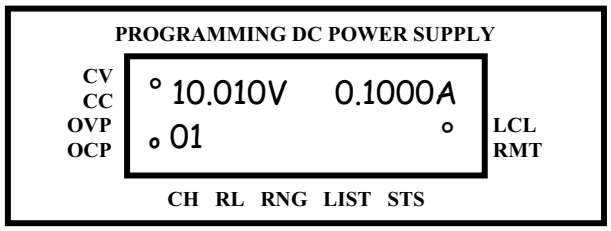
4. ***When the OVP circuit is disabled, the threshold voltage becomes invalid.***

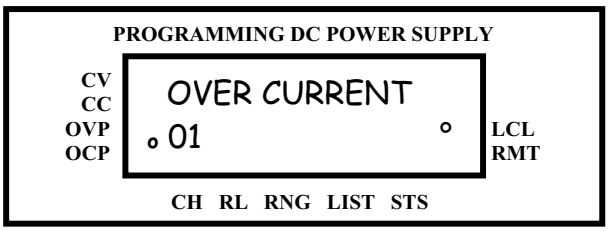
OVER CURRENT PROTECTION

The power supply has an over current protection (OCP) feature to guard the supply against current overdrawn. If the OCP feature is enabled and the supply switches to CC mode, the OCP circuit is triggered and the output is disabled. The OCP threshold is set by the value of the current limit.

ENABLING / DISABLING OVER CURRENT PROTECTION

To enable the over current protection circuit, press the **"OCP ON/OFF (3)"** key and the OCP enunciator is turned on. To disable the over current protection, press the **"OCP ON/OFF (3)"** key one more time and the enunciator is turned off. When the LCD displays "OVER CURRENT", the over current protection circuit has been activated and the output is disabled. To reset, press the **"OCP ON/OFF (3)"** key and the enunciator will stop blinking. To turn the output on again, press the **"OCP ON/OFF (3)"** key.





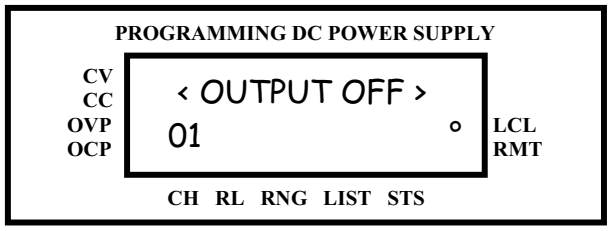
<NOTES:>

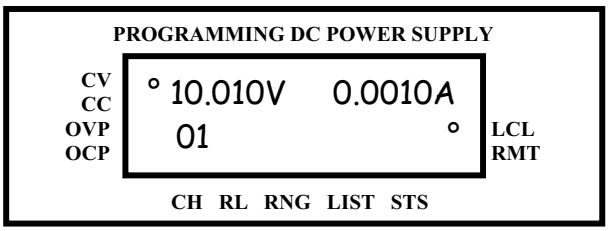
1. ***OCP is set by the value of the current limit.***

2. ***If OCP is enabled and the constant current Mode (CC) is activated, the power supply output is disabled.***

ENABLING / DISABLING OUTPUTS

All models of the PD Series have the capability of disabling their outputs by entering a new operating parameters or connecting / disconnecting the load. Once the modification has been completed, one can enable the power supply to operate at the new values. The output is enabled or disabled by pressing the **"OUT ON/OFF (1)"** key. To return the supply to normal operation, press the **"OUT ON/OFF 1)"** key again to toggle the output on.





The PD Series output is enabled or disabled by selecting the channel/s and pressing the **"OUT (ON/OFF) (1)"** key.

ISOLATION RELAY FUNCTION (OPTIONAL)

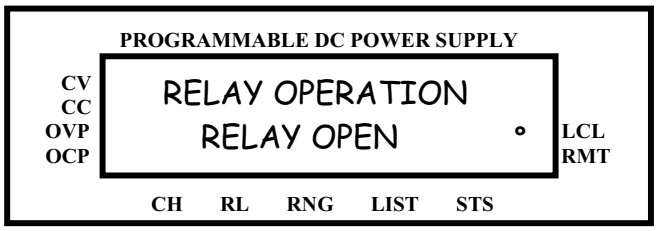
The AMREL PD Series has an internal output isolation/reverse relay. The relay allows the user to reverse or disconnect the electronic load from the UUT either via the front panel keypad or the GPIB Interface Bus.

Pressing the (RELAY) key will activate the relay menu. Use "4" or "6" to select between RELAY OPEN, NORMAL CLOSE or REVERSE CLOSE options. Press Enter key to continue selection or clear to exit.

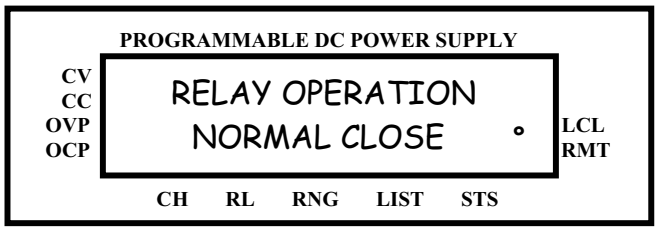
* **NOTE:** It is recommended that the output be turned off before closing or reversing the relay.

DISPLAYS CLOSE/OPEN FOR ISOLATION RELAY OUTPUT

1 – Press RELAY key:
2 – Press #4/6 key to select open/close relay state.

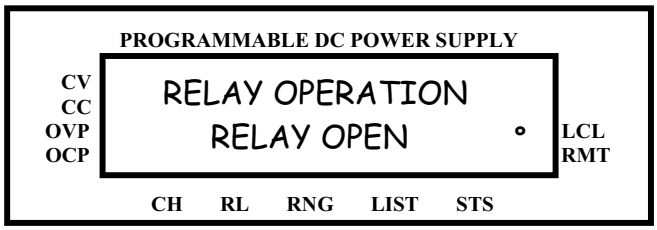


1 – Press RELAY key:
2 – Press #4/6 key to select open/close relay state.

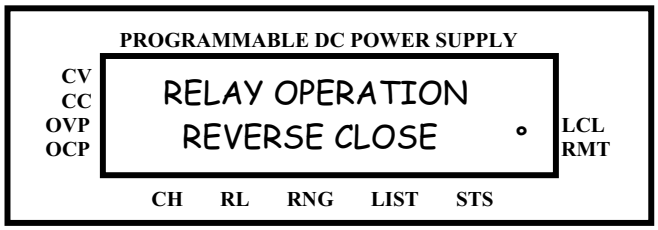


DISPLAYS REVERSE/NORMAL ISOLATION RELAY OUTPUT

1 – Press RELAY key:
2 – Press #4/6 key to select normal/reverse relay state.

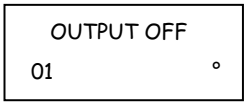


1 – Press RELAY key:
2 – Press #4/6 key to select normal/reverse relay state.

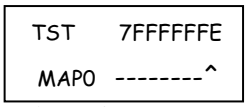


UTILITY MENU

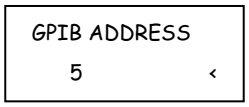
Follow simply step below for Utility function.

1. Main menu 

as show when turned the power switch "ON".

2. Press **UTILITY** key to advance to 

use key #8 as up and #2 as down to change MAP group from 0 – 3 to view the status of the unit. Press **CLEAR** key to back to main menu.

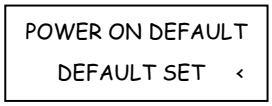
3. Press #6 key once after pressed **UTILITY** key to advance to 

use key #8 as up and #2 as down to change the GPIB address from 0 – 31 address. Press **ENTER** key to accept the value then press **CLEAR** key to back to main menu.

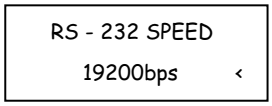
4. Press twice #6 key after pressed **UTILITY** to advance to

use key

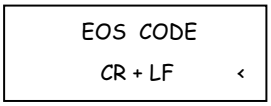
#8 as up and #2 as down to select (0-31 channel). Press **ENTER** key to accept the value then press **CLEAR** key to back to main menu.

5. Press three times #6 key after press **UTILITY** to advance to 

use key #8 and #2 to select (Output On, Output Off, or Default Set by manufacture). Press **ENTER** key to accept the setting then press **CLEAR** key to back to main menu. **(OPTIONAL)**

6. Press four times #6 key after pressed UTILITY to advance to 

use key #8 as up and #2 as down to select (9600 bps / 2400 bps / 19200 bps). Press **ENTER** key to accept the value and press **CLEAR** key to back to main menu.

7. Press five times #6 key after pressed UTILITY to advance to 

use key #8 as up and #2 as down to select (NONE / CR / LF / CR+LF). Press **ENTER** key to accept the EOS Code then press **CLEAR** key to back to main menu.

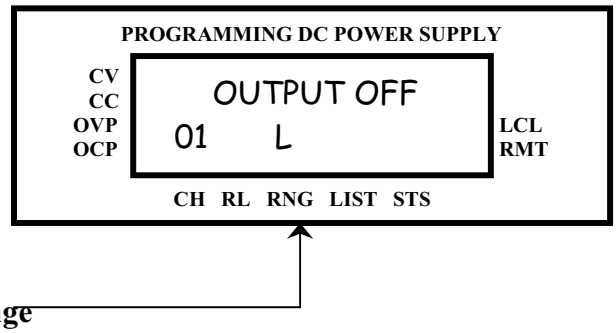
8. Press six times #6 key after pressed UTILITY will back to step 1 (System Status). Also you may press #4 key to back to previous function.

*** Note: Power on default function is an optional feature.**

CONSTANT CURRENT RANGE SELECTION (OPTIONAL)

The PD features a two range of output operating for Constant Current Mode (CC). The user must select the PD output range corresponding to the output source value, by pressing the key #6 locates at the front panel keypad, and then the LCD module will display the operating range L / M / H.

Example:
(H) = 0 – 1 Amp / 30 Volt
(M) = 0 – 15 Amp / 2 Volt
(L) = 0 – 30 Amp / 1 Volt



*STEPS TO VIEW "*IDN?" INFORMATION FROM THE FRONT PANEL*

Turn on AC Power or push "Clear" button; the front panel display should contain the following three fields:

4) AMREL – Manufacturer;
5) PD###### – Model Number;
6) Version number.

STEPS TO SET THE EOS MODE FROM THE FRONT PANEL

6) After front panel display is stable, push "Utility";
7) Then choose "EOS Mode" by pushing "6→" button;
8) Choose "LF+CR" by pushing "2↓" button;
9) Push "Enter" button;
10) Push "Clear" button.

<NOTE>: If this is not set to "LF+CR" the output will be ASCII verses a Hex number.

EXTERNAL ANALOG PROGRAMMING (OPTIONAL)

The external analog voltage can program the voltage and current outputs of the PD series. The outputs are linearly proportioned to an ***external input voltage from 0 to 10Vdc***. Setting these parameters via the front panel or GPIB bus, VSET to 0V, ISET to a proper value for CV operation, or setting ISET to 0A and VSET to a proper value for CC operation activates the external analog-programming mode**.**

To control the output voltage with the analog programming mode requires the following procedures; apply the ***external 0 to 10Vdc source*** (Xv) between **Pin-10 (positive)** and **Pin-12 (negative)**. These pins are located at the rear I/O connector.

The output voltage is derived by the following equation:

$$\mathbf{Vout} = x_v \left(\frac{V\max}{10} \right)$$

The output current is derived by the following equation:

$$\mathrm{Iout} = x_v \left(\frac{\mathrm{Im}ax}{10} \right)$$

Variable	***Definition***
Iout	Current requirement
Xv	External voltage
Imax	Rated maximum output current

To control both voltage and current simultaneously in the external programming method **requires that the user apply two separately isolated 0 to 10Vdc supplies.**

Variable	***Definition***
Vout	Voltage requirement
Xv	External voltage
Vmax	Rated maximum output voltage

To control the output current with the analog-programming mode requires the following procedure; apply the ***external 0 to 10Vdc source*** **(Xv)** between **Pin-11 (positive)** and **Pin-12 (negative).** These pins are located at the rear I/O connector.

FIVE: LOCAL OPERATION FOR SINGLE OUTPUT MODELS RATED ABOVE 600W

INTRODUCTION

This PD Series Programmable DC Power Supply from American Reliance Inc. offers a complete solution to power supply system requirements. This instrument was designed to assist in the development and testing of new products, as well as is being a standard instrument for automatic test systems. This instrument provides low-noise, precisely regulated variable DC output at 600 to 2K Watts of power. Over Voltage Protection (OVP) and Over Current Protection (OCP) are standard. Front panel controls and indicators are extensive. Units come with Standard Commands for Programmable Instrument (SCPI) commands, remote monitoring of output voltage and currents is a standard features. This power supply can be used either on a bench or in a standard 19 in. (483 mm) rack: The power supply occupies 6.968 in. (4 U) of vertical rack space. Designed for continuous use in standalone or systems applications, this power supply is typically used to power DC equipment, control circuits, or burn-in component applications.

FEATURES AND OPTIONS

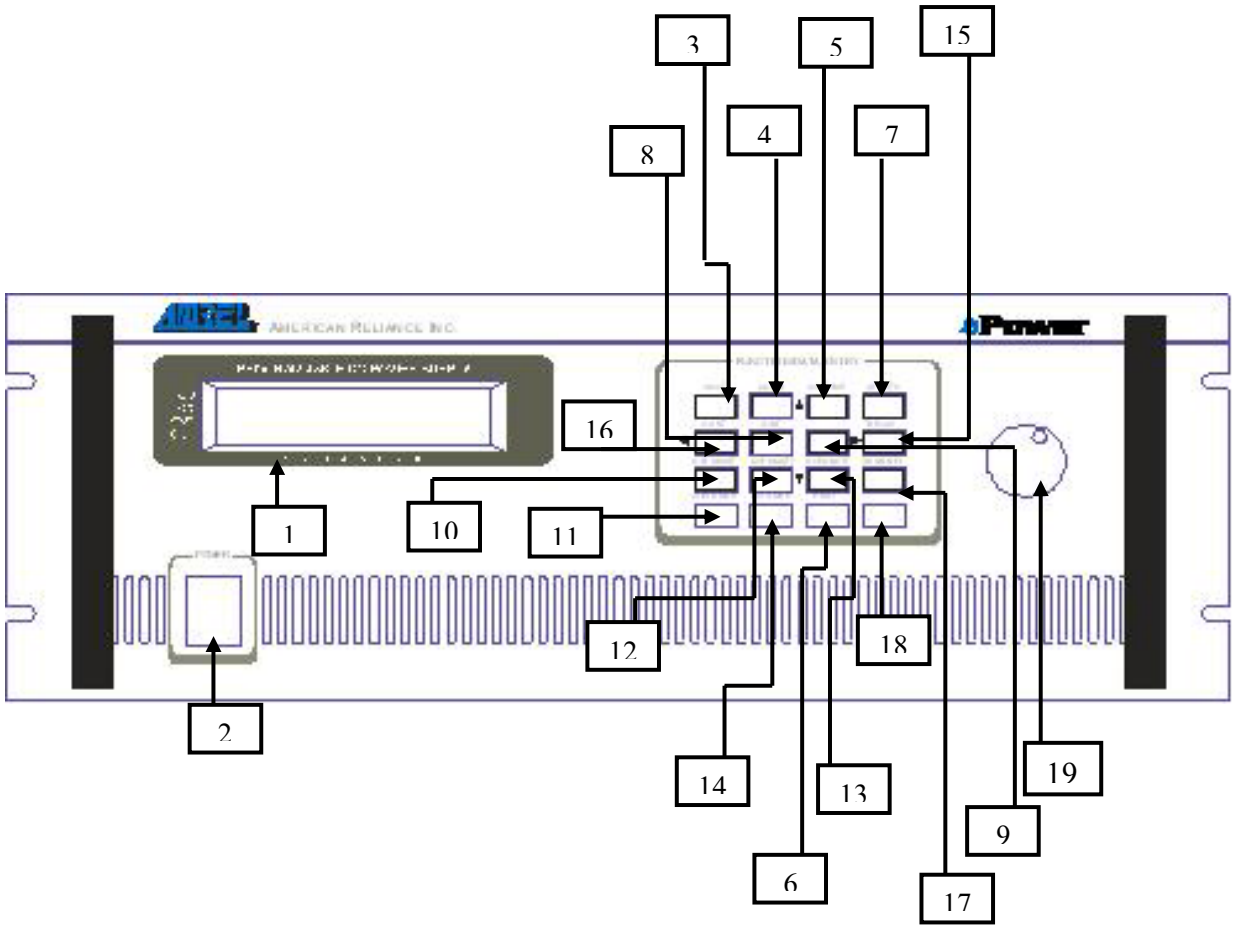
- Fast Transient Response – 50us
- Low Ripple and Noise (PARD)
- 16 bit digital design displays both voltage and current measurements, OVP, OCP, V_{LIST}, I_{LIST}, and other system indicators on an VFD display without the need for external DMM
- Front panel keypad & encoder for precise and easy-to-operate setting of the output voltage, current and other system functions
- Automatic crossover of Constant Current or Constant Voltage mode.
- GPIB/RS-232/ Ethernet interfaces for flexible remote digital programming and read back
- VLIST and ILIST in stepping mode, PD Series generate customized sequence of different output level up to maximum of 20 steps (points), with dwell times from 10ms to 1 minute stored in 4 profiles. This sequence can be cycled once or to a user-defined number of cycles
- Programmable OVP (Over-voltage Protection) & OCP (Over-current Protection), redundant OTP (Over-temperature Protection), UVP (Under-voltage Protection), Remote Lockout (for I_{LIST}, V_{LIST} and ATE), Fan-speed control
- Remote Sensing to compensate for measurement errors due to large line drops
- Electronic Remote/Local Closed-cased calibration
- Polarity Reversal & Isolation Relays Available
- LabView/LabWindows Drivers Available
- (Optional) Local/Remote voltage and current limit programming with selectable programming ranges.
- (Optional) TTL function to enable/disable the power supply output.
- (Optional) CHANNEL to select multiple channels output operation.
- (Optional) External analog voltage (0 to +10V_{DC}) input for the programming voltage/current output.
- (Optional) LCD backlight setting.
- Modified & Customized Solutions

FRONT & REAR PANEL DESCRIPTION (PD-E > 600W Models)

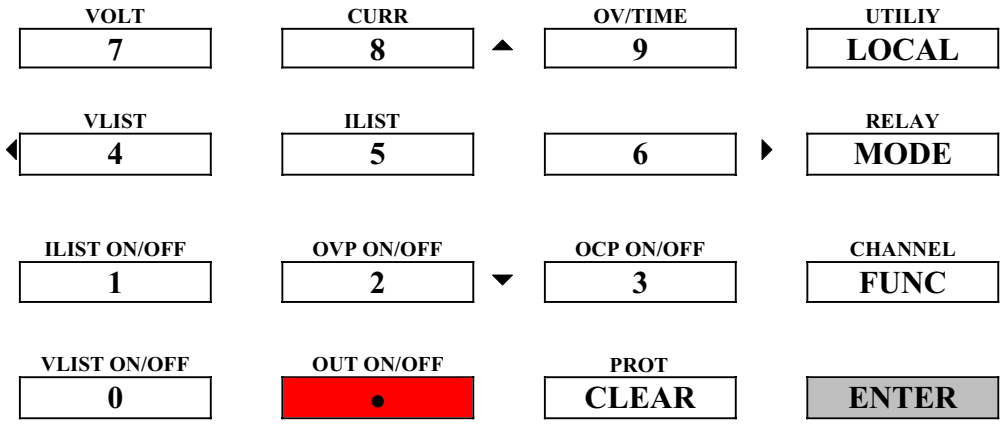
FRONT PANEL CONTROLS (PD-E > 600W Models)

Use this Figure 5.1 to familiarize your self with this instrument.
See next page for keypad definition.
(1 in. = 25.4mm)

Figure 5.1 Power Supply Front Panel



FRONT PANEL KEYPAD DEFINITION (PD-E > 600W Models)



Most soft keys have dual functions. The first function is mode entry as described by VOLT, CURR right above the key. Once in a mode entry, use these keys as numeric keypad to enter the desired number. Press ENTER key to accept the number keyed or CLEAR key to clear the number.

FRONT PANEL FEATURES

1. LCD Display — Displays alphanumeric information with status annunciators. A detailed listing of descriptions is presented in section LCD **STAUS ANNUNCIATORS**

2. Power On/Off — Powers on the unit.

3. VOLT [7] — Press this key to enter a new voltage setting in flashing bracket or to display the present voltage setting.
Numeric key for 7.

4. CURR [8] — Press this key to enter new current setting in flashing bracket or to display the present current setting.
Numeric key for 8.

5. OV/TIME [9] — Press this key to enter new over voltage protection value in flashing bracket or to display the present over voltage protection value.
This key can also be used after pressing #4 key or #5 key to alter time interval in millisecond for STEP programming.
Numeric key for 9.

6. PROT [CLEAR] — Restarts the PD similar to a warm boot for computer. If in entry mode, pressing this key will clear the number entered or return to the previous mode. This key can also be used to disable an over-voltage condition.

7. UTILITY [LOCAL] — Press this key to enter utility menu to change GPIB address, RS-232 speed, and RS-232 response speed or loop count of step. (These functions will be explained in details in the display section).
Use #8 key and #2 key to scroll to the desired sub-menu t be change and use #4 key and #6 key to alter the setting in that sub-menu.

8. ILIST [5] — Press this key to do ILIST or Current Step. Use #8 key and #2 key to scroll up to 100 current stepping value. Use #7 key to change current stepping value at that step. Use #9 key to change stepping time interval at that step. Numeric key for 5.

9. [6 ▶] — This key scrolls menu. Numeric key for 6.

10. ILIST ON/OFF [1] — Press this key to turn the ILIST on or off. When the output is disabled, the LCD displays "--OUTPUT OFF--".

11. VLIST ON/OFF [0] — Press this key to start and stop voltage stepping (VLIST). Numeric key for 0.

12. OVP ON/OFF [2] — Press this key to enable and disable over voltage protection. If over voltage protection is enabled, a ■ is indicated by OVP. Numeric entry key for two.

13. OCP ON/OFF [3] — Press this key to enable or disable over current protection. If over current protection is enabled, a ■ is indicated by OCP. Numeric key for 3.

14. OUT ON/OFF [•] — Press this key to enable/disable supply output. Numeric enters for decimal point.

15. RELAY [MODE] — Press this key to set the number of loop times for the voltage and/or current stepping.

16. VLIST [4] — Press this key to do voltage step programming. Use #8 key and #2 key to scroll up to 100 voltage step. Use #7 key to change voltage value at that step. Use #9 key to alter time stepping interval at that step.

17. CHANNEL [FUNC] — For Multi-channel PDS use to select channels

18. [ENTER] — Enters the number keyed.

19. Encoder — Digital Encoder to provide real-time programmatic control

LCD STATUS ANNUNCIATOR (PD-E > 600W Models)

LIQUID CRYSTAL DISPLAY:

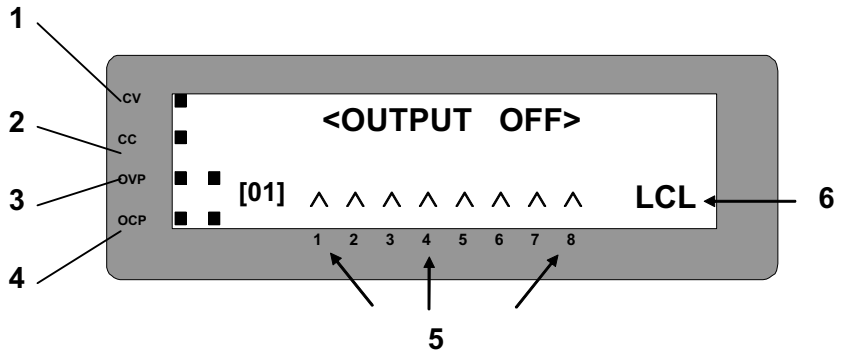


FIGURE 5.2 PD SERIES

<NOTE :> ***The LCD displays real time output Voltage/Current & mode status. These messages are viewed in either local or remote mode.***

LCD DESCRIPTION REFERS TO FIGURE 5.2

1. **CV:** When this indicator is on, the unit is operating in a constant voltage mode.

2. **CC**: When this indicator is on, the unit is operating in a constant current mode.

3. **OVP**: When this indicator is on, the unit is operating with over voltage protection enabled. This prevents the output voltage from exceeding a preset voltage level.

4. **OCP**: When this indicator is on, the unit is operating with over current protection enabled. This prevents the output current from exceeding a preset current level.

5. **Channel indicator**: The power supply indicates which channel it is currently displaying by having ^ instead of _ on top of the number. (Not available for this PDS40-30AR).

6. **Mode indicator**: This status annuciator indicate if the PD is in **LCL** (local) mode or in **RMT** (remote) mode.

REAR PANEL CONNECTORS (PD-E > 600W Models)

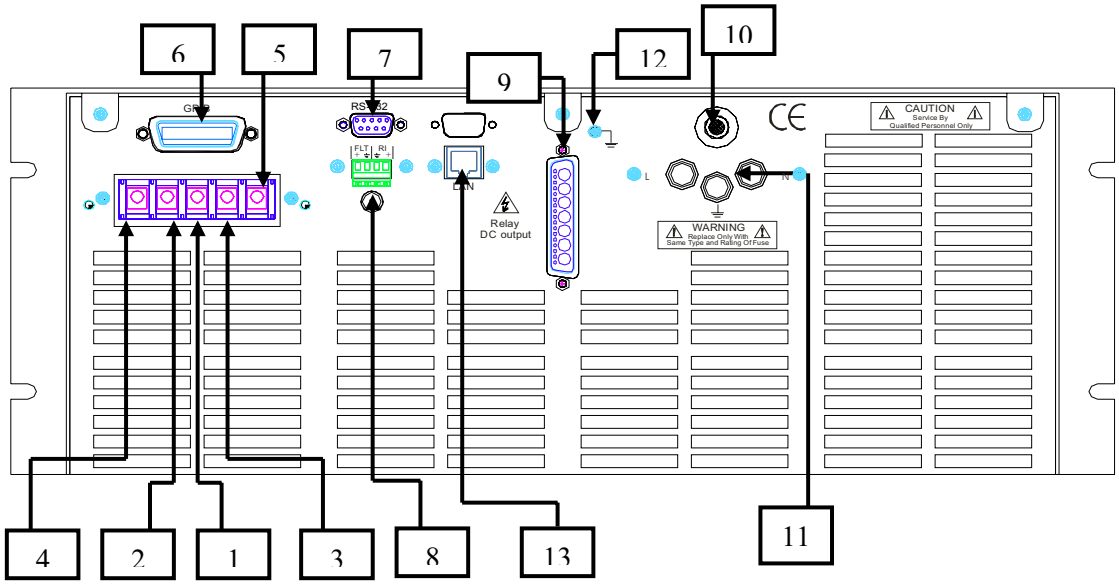


FIGURE A.2 POWER SUPPLY REAR PANEL (**NOTE:** Terminal Block for units up to 30Adc only)

REAR PANEL FEATURES

1.	Positive DC Output	Positive DC Output Connector.
2.	Negative DC Output	Negative DC output connector.
3.	Positive Sense	Positive sense connector.
4.	Negative Sense	Negative sense connector.
5.	Sense Ground	Sense ground connector.
6.	GPIB	Standard GPIB Interface Connector.
7.	RS232	9-pin D-sub male connector for RS232 Interface.
8.	Remote Inhibit (RI) Fault (FLT)	Short to shutdown the normal DC output. TTL Low output to signal a failure
9.	Relay DC Output	Relay output connector with isolation relay and reverse output.
10.	Circuit Breaker	Circuit breaker to protect AC input.
11.	AC Input	AC input terminal strip.
12.	Chassis GND	Chassis/line ground lug screw.
13.	Ethernet	Ethernet Interface Port.

REAR PANEL CONNECTORS (> 30Adc Output Current)

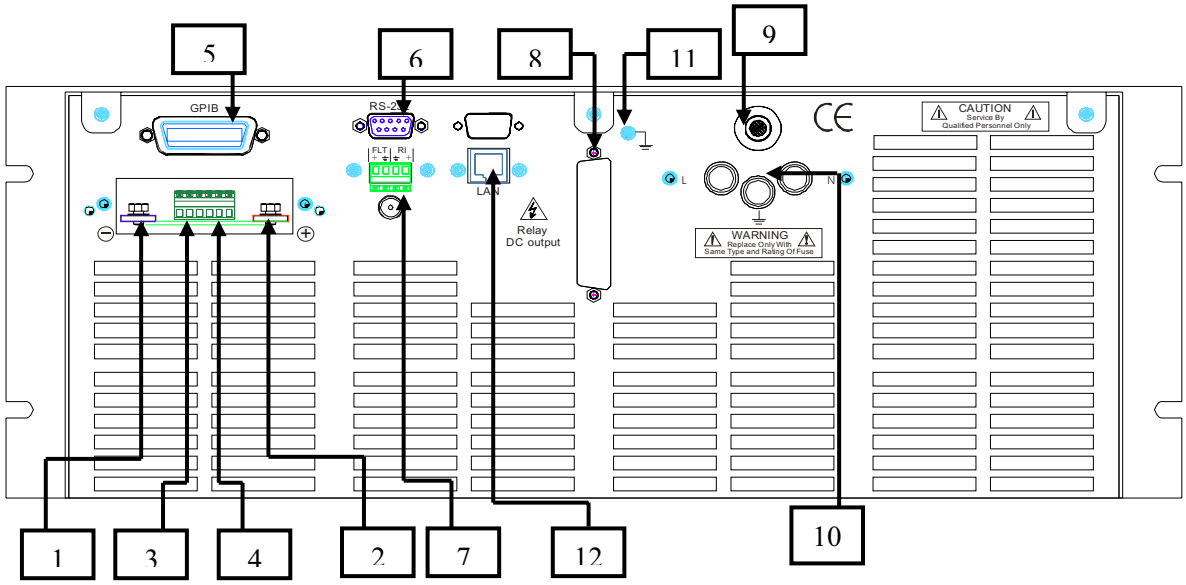


FIGURE 5.3 POWER SUPPLY REAR PANEL

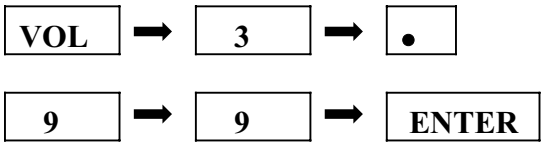
REAR PANEL FEATURES

1.	Positive DC Output	Positive DC Output Connector.
2.	Negative DC Output	Negative DC output connector.
3.	Positive Sense	Positive sense connector.
4.	Negative Sense	Negative sense connector.
5.	GPIB	Standard GPIB Interface Connector.
6.	RS232	9-pin D-sub male connector for RS232 Interface.
7.	Remote Inhibit (RI) Fault (FLT)	Short to shutdown the normal DC output. TTL Low output to signal a failure
8.	Relay DC Output	Relay output connector with isolation relay and reverse output.
9.	Circuit Breaker	Circuit breaker to protect AC input.
10.	AC Input	AC input terminal strip.
11.	Chassis GND	Chassis/line ground lug screw.
12.	Ethernet	Ethernet Interface Port.

LOCAL OPERATION (PD-E > 600W Models)

SETTING VOLTAGE

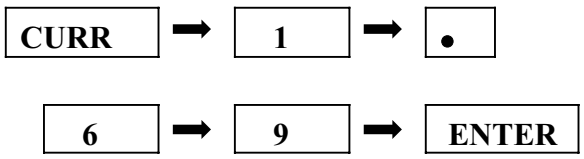
To locally program the voltage (VSET), press **"VOLT"**, enter the value and press **"ENTER"**. For example, if one wished to set a voltage of 3.99, press:



The VFD displays 3.99 V and the unit returns to metering mode.

SETTING CURRENT

To locally program the current (ISET), press **"CURR"** and enter the value and then press **"ENTER"**. For example, if one wishes to set a current of 1.69 amps, press:



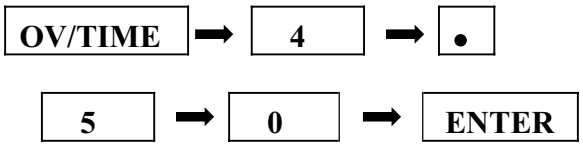
The VFD display 1.69 and the unit returns to metering mode.

OVER VOLTAGE PROTECTION

The power supply has an over voltage protection **(OVP)** feature to guard against abnormal operating conditions such as voltage overshoot. When the supply's output voltage exceeds a threshold voltage, the OVP is activated, and the unit disables the output. The VFD will indicate the condition.

SETTING THE OVER VOLTAGE THRESHOLD

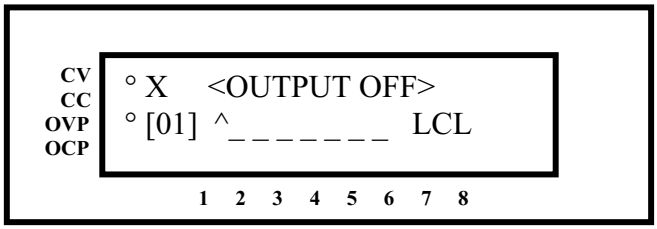
To locally program the threshold voltage press **"OV/TIME"**, enter the value and press **"ENTER"**. For example, to program an over voltage value of 4.50V, press:

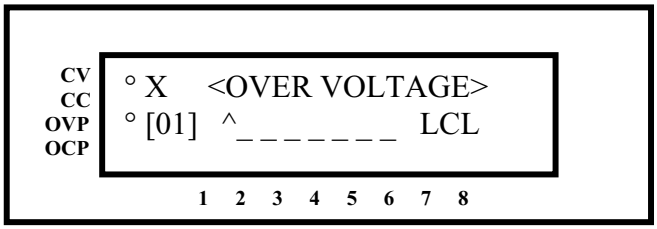


When output voltage exceeds 4.50V, OVP is triggered, OVP enunciator is blinking, and the output is disabled.

ENABLING / DISABLING OVER VOLTAGE PROTECTION

The user can enable or disable the OVP circuit by pressing the **"OVP ON/OFF (2)"** key. When it is enabled the OVP enunciator is on.





When the VFD displays “OVER VOLTAGE”, the over voltage protection circuit has been activated and the output is disabled. To reset, press the **"CLEAR (RESET)"** key. To turn the output on again, press the **"OUT ON/OFF (1)”** key.

<NOTES:>

1. ***Remote sensing, take into consideration the voltage drop across the load leads since the threshold measurement is taken at the output.***

2. ***In inductive load applications, a high-surge voltage would enable the OVP circuit and disable the output.***

3. ***Also note the programming resolution and programming accuracy specifications***

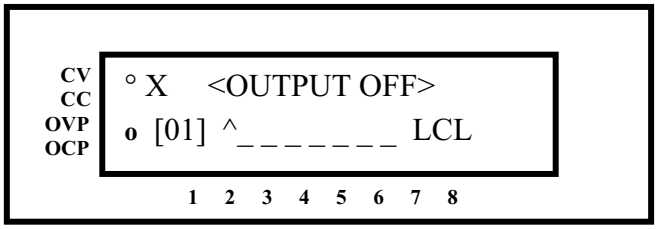
4. ***When the OVP circuit is disabled, the threshold voltage becomes invalid.***

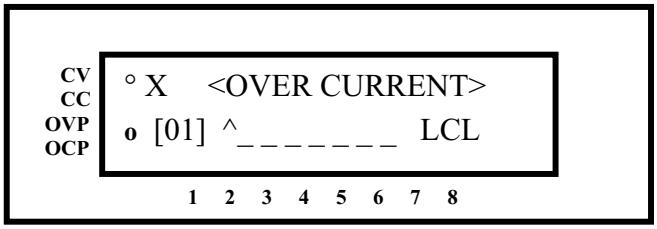
OVER CURRENT PROTECTION

The power supply has an over current protection (OCP) feature to guard the supply against current overdrawn. If the OCP feature is enabled and the supply switches to CC mode, the OCP circuit is triggered and the output is disabled. The OCP threshold is set by the value of the current limit.

ENABLING / DISABLING OVER CURRENT PROTECTION

To enable the over current protection circuit, press the **"OCP ON/OFF (3)"** key and the OCP enunciator is turned on. To disable the over current protection, press the **"OCP ON/OFF (3)"** key one more time and the enunciator is turned off. When the VFD displays "OVER CURRENT", the over current protection circuit has been activated and the output is disabled. To reset, press the **"OCP ON/OFF (3)"** key and the enunciator will stop blinking. To turn the output on again, press the **"OCP ON/OFF (3)"** key.



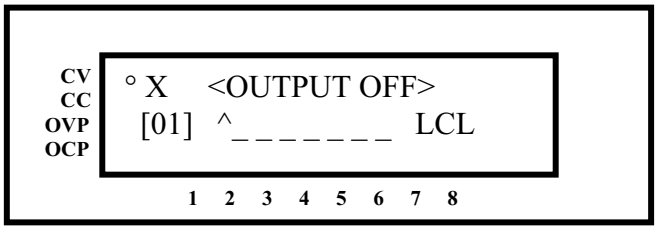


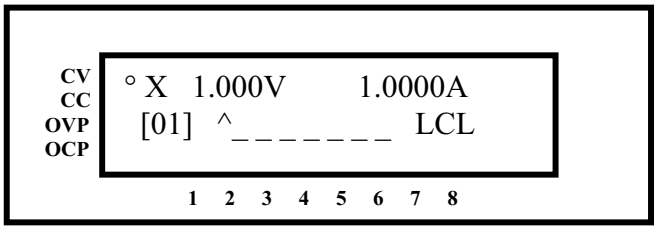
<NOTES:>

1. ***OCP IS SET BY THE VALUE OF THE CURRENT LIMIT.***
2. ***If OCP is enabled and the constant current Mode (CC) is activated; the power supply output is disabled.***

ENABLING / DISABLING OUTPUTS

All models of the PDS series have the capability of disabling their outputs by entering a new operating parameters or connecting / disconnecting the load. Once the modification has been completed, one can enable the power supply to operate at the new values. The output is enabled or disabled by pressing the **"OUT ON/OFF (1)"** key. To return the supply to normal operation, press the **"OUT ON/OFF 1)"** key again to toggle the output on.

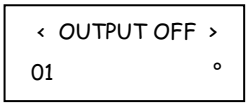




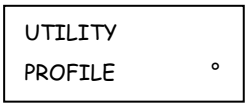
The PDS series output is enabled or disabled by selecting the channel/s and pressing the **"OUT (ON/OFF) (1)"** key. If this is a multi-channel power supply, the channels can be selected by pressing the "ENTER" or "CLEAR"

UTILITY MENU

Follow simply step below for Utility function.

1. Metering menu 

as shown, when turned the power switch "ON".

2. Pressed **UTILITY** to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select (LOAD or SAVE). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

a- Load Mode: Press ENTER then use key #6 as (▸) and #4 as (◂) to select profile location (0-3). Press **ENTER** key to accept the profile number then press **CLEAR** key to back to metering menu).
b- Save Mode Press ENTER then use key #6 as (▸) and #4 as (◂) to select profile location (0-3). Press **ENTER** key to accept the profile number then press **CLEAR** key to back to metering menu).

3. Press once #6 key after pressed **UTILITY** to advance to

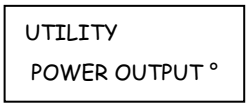
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set times of loops. Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

4. Press twice #6 key after pressed **UTILITY** to advance to

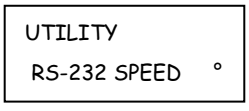
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set the GPIB address (0 – 31). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

5. Press three times #6 key after pressed **UTILITY** to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set the maximum channel address (0 – 31). Press **ENTER** key to accept the value then press **CLEAR** key to back to metering menu.

6. Press four times #6 key after press **UTILITY** to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select output On / Off as default when power up. Press **ENTER** key to accept the setting then press **CLEAR** key to back to metering menu.

7. Press five times #6 key after pressed UTILITY to advance to 

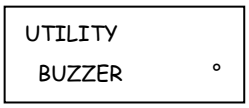
then press ENTER. Use key #6 as (▸) and #4 as (◂) to set baud rate. (2400 / 4800 / 9600 / 19200 / 38400 / 57600 / 115200 bps). Press **ENTER** key to accept the value and press **CLEAR** key to back to metering menu.

8. Press six times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set EOS Code. (NONE / CR / LF / CR+LF). Press **ENTER** key to accept the EOS Code then press **CLEAR** key to back to metering menu.

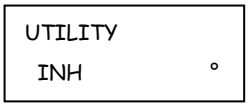
9. Press seven times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to set LCD backlight. (Always / 5 min / Off). Press **ENTER** key to accept the LCD setting then press **CLEAR** key to back to metering menu.

10. Press eight times #6 key after pressed UTILITY to advance to 

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired buzzer operating mode: **On, Off, or Alarm**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

Note: *In ALARM mode, the buzzer sounds only during protection alarm trip events*

11. Press nine times #6 key after pressed UTILITY to advance to 

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired Remote Inhibit operating mode: **Off, Live, or Latched**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

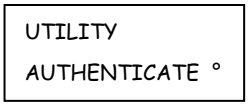
OFF	Remote Inhibit Off
LIVE	Self-recoverable Remote Inhibit
LATCH	Latched Remote Inhibit

Remote Inhibit function is Low-active: *Short – INH Enabled and Open – INH Disabled*

12. Press ten times #6 key after pressed UTILITY to advance to

then press **ENTER** key. Use key #6 as (▸) and #4 as (◂) to select the desired computer programming command protocol: **SCPI or IEEE488.1**. Press **ENTER** key to accept the buzzer setting then press **CLEAR** key to back to metering menu.

Note: *The IEEE488.1 protocol is for legacy PDS & PD models, default protocol is SCPI*

13. Press eleven times #6 key after pressed UTILITY to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select and configure AUTHENTICATE menu options:

a- **SERIAL NO.:** Press **ENTER** to see the MAC ID address for the specific channel being controlled. Press **CLEAR** key to back to metering menu.
b- **INTERFACE:** Press **ENTER** check which interfaces are available on the unit. Press **CLEAR** key to back to metering menu.

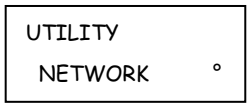
c- **CODE:** Optional interfaces, such as Ethernet, can be enabled in the field using a code. Please contact an AMREL representative today.

14. Press twelve times #6 key after pressed UTILITY to advance to

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select Panel Enable Mode or Panel Password Mode):

a- **Panel Enable Mode:** Press ENTER then use key #6 as (▸) and #4 as (◂) to enable/disable (On/Off). Press **ENTER** key to accept the password then press **CLEAR** key to back to metering menu).

b- **Panel Password Mode:** Press ENTER then press **CLEAR** key to back to metering menu).

15. Press ten times #6 key after pressed UTILITY to advance to 

then press ENTER. Use key #6 as (▸) and #4 as (◂) to select ADDRESS, NETMASK, or GATEWAY):

a- **ADDRESS:** Press ENTER to input the IP address. Press **ENTER** key to accept the address then press **CLEAR** key twice to back to metering menu.

b- **NETMASK:** Press **ENTER** to input the NETMASK. Press **ENTER** key to accept the password then press **CLEAR** key to back to metering menu.

c- **GATEWAY:** Press ENTER then input the GATEWAY address. Press **ENTER** key to accept the address then press **CLEAR** key twice to back to metering menu.

16. Press nine times #6 key after pressed UTILITY will back to step 1 (System Status). Also you may press #4 key to back to previous function.

TRACKING SELECTION MODE

The dual channel PDS series has the ability of tracking since it has two outputs. You can set channel 1 as the master channel then channel 2 will be slave channel or channel 2 as master channel then channel 1 as slave channel. The slave channel output is identical (synchronized with) to master channel and is controlled by the master channel. For example: If the voltage changes by amount “x” in the master channel, the slave channel will also change by amount “x".

Tracking setting procedure:

i. At Metering Mode. Press “ENTER” and “7” key simultaneously to enter to Tracking Selection Mode.

ii. Press “CHANNEL” key or “ ◂ ▸ ” key to select channel.
iii. Press “ENTER” key to set the tracking option (1 = Master (T) and 2 = Slave (t)) for each channel.
iv. Press “CLEAR” to back to Metering Mode.
v. Now set the voltage or current at the master channel and the slave channel will be identical to master channel.

This setting can also be set with the rotary knob. Turning the knob will select the channel and pressing the knob will select the tracking option, and holding the knob will go back to Metering Mode.

FRONT PANEL LOCK OPERATION

This PD series power supply has the ability to lock the front panel when the power is turned OFF and turn back ON. See the front panel lock setting below:

1. Presses UTILITY then use the " ▸ " key to scroll till "PANEL LOCK" and then press ENTER key.
2. Use the " ▸ " key to select PANEL ENABLE or PANEL PASSWORD.

Panel Enable:

1. Select PANEL ENABLE and press ENTER key.
2. Use the " ▸ " key to enable or disable (ON/OFF) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

Panel Password:

2. Select PANEL PASSWD and press ENTER key.
3. Enter the password and press ENTER key to accept your password. (1 to 6 digit password)
4. Press CLEAR key twice to back to metering mode.

PROFILE SAVE AND LOAD

This function allow you to select saved and reload the profiles (Default setting) to a specified location in memory, and the profile settings. See the front panel profile setting below and the remote section:

1. Presses UTILITY then it will show "PROFILE" and then press ENTER key.
2. Use the " ▸ " key to select LOAD or SAVE.

LOAD:

1. Select LOAD and then press ENTER key.
2. Use the " ▸ " key to select the profile number (0-3) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

SAVE:

1. Select SAVE and then press ENTER key.
2. Use the " ▸ " key to select the profile number (0-3) the front panel keys.
3. Press ENTER key to accept your setting.
4. Press CLEAR key three times to back to metering mode.

Example for Local Mode setting:

1. Set the voltage and current (Set Default).
2. Select save profile by pressing UTILITY, press ENTER when see PROFILE. Use " ▸ " key to select SAVE and then press ENTER. Use " ▸ " key to select profile save location (0-3), and then press ENTER.
3. Press CLEAR three times will back to metering mode.

Next operation when you turn the load's power ON. You can select the profile location and reload the previous setting. This operation is very useful for stepping mode.

Note: *See the REMOTE OPERATION SECTION for the remote interface operation.*

STEPPING MODE

Voltage/Current List Edit Mode.
Voltage/Current step programming permits the user to program a sequence of different voltage outputs with its applied duration via front panel keypad.

VLIST setting:

1. At metering menu; Press key# 4 (VLIST) to enter into the voltage list edit mode.
2. Press "CHANNEL" key to select operation channel, if applicable.
3. Use " ◂ " or " ▸ " to select list step.
4. Press key# 7 (VOLT) to set the list voltage value at this step.
5. Press key# 9 (OV/TIME) to set list dwelling time in millisecond.
6. Repeat step 3 to 5 if need to edit more list steps.
7. Press CLEAR key to go back to metering menu.

ILIST setting:

1. At metering menu; Press key# 5 (ILIST) to enter into the current list edit mode.
2. Press "CHANNEL" key to select operation channel, if applicable.
3. Use " ◂ " or " ▸ " to select list step.
4. Press key# 8 (CURR) to set the list voltage value for the selected step.
5. Press key# 9 (OV/TIME) to set the list dwelling time in milliseconds.
6. Repeat step 3 to 5 if need to edit more list steps.
7. Press CLEAR key to go back to metering menu.

Voltage/Current list operation:

1. At metering menu; Press key# 0 (VLIST ON/OFF) or decimal key (.) to enable / disable the voltage/current list operation.
2. When list operation is ON, the display shows "VLIST ON" OR "ILIST ON".

Note: *List operation can only be enabling when output status is ON.*

LIST CYCLE

List Cycle is the cycle of loops the step program will be repeated. The stepping function provides loop control with list cycle function, which instructs the power supply to repeat the stepping function, based on the list cycle. For example: List cycle is set to 10 and the power supply will cycle the desired steps 10 times.

Set List Cycle:

1. Press UTILITY.
2. Use " ▸ " key to select LIST CYCLE, and then press ENTER.
3. Use " ◂ " or " ▸ " to set the cycle time, and then press ENTER.
4. Press CLEAR twice to back to metering menu.

FRONT & REAR PANEL DESCRIPTION (PD-A > 600W Models)

FRONT PANEL CONTROLS (PD-A > 600W Models)

Use this Figure 5.4 to familiarize your self with this instrument.
See next page for keypad definition.
(1 in. = 25.4mm)

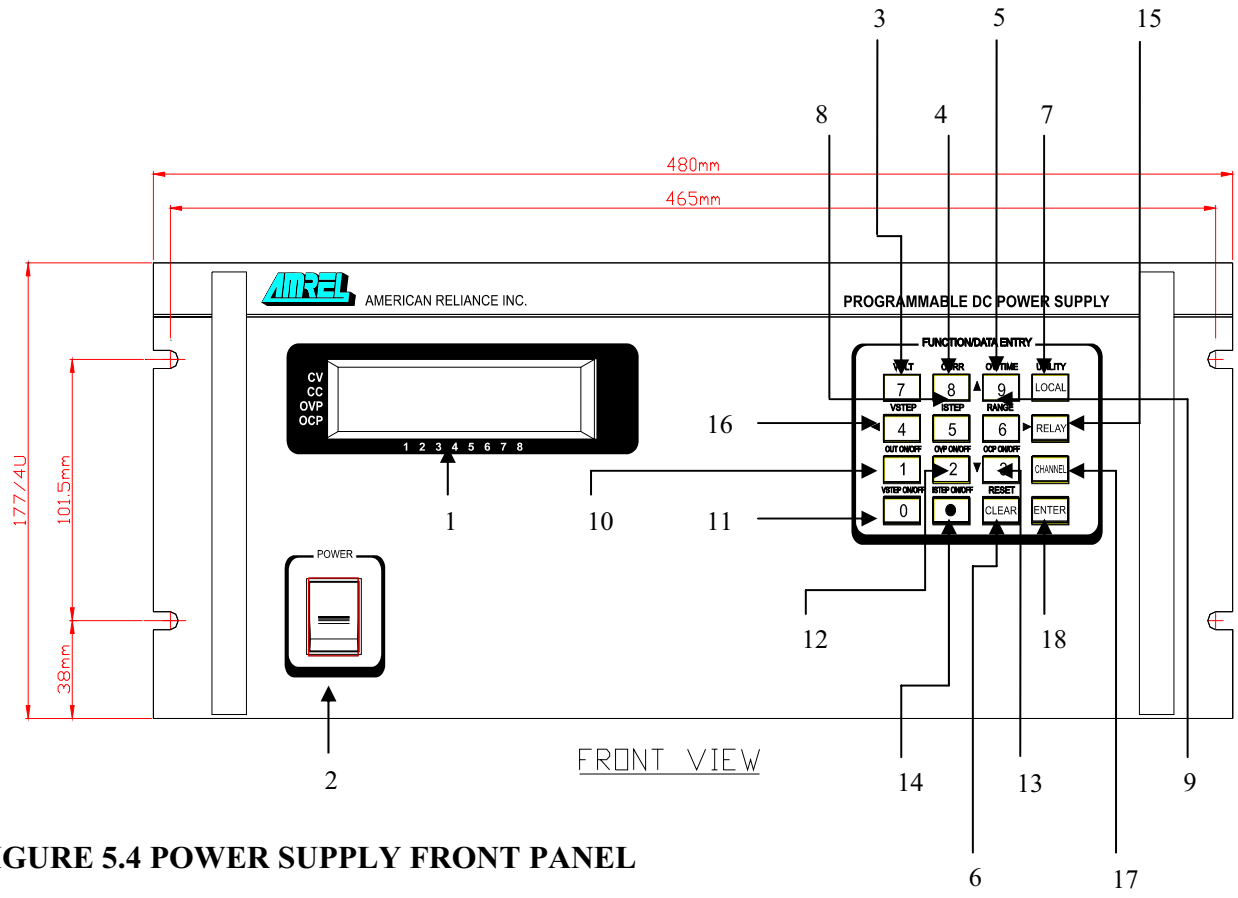
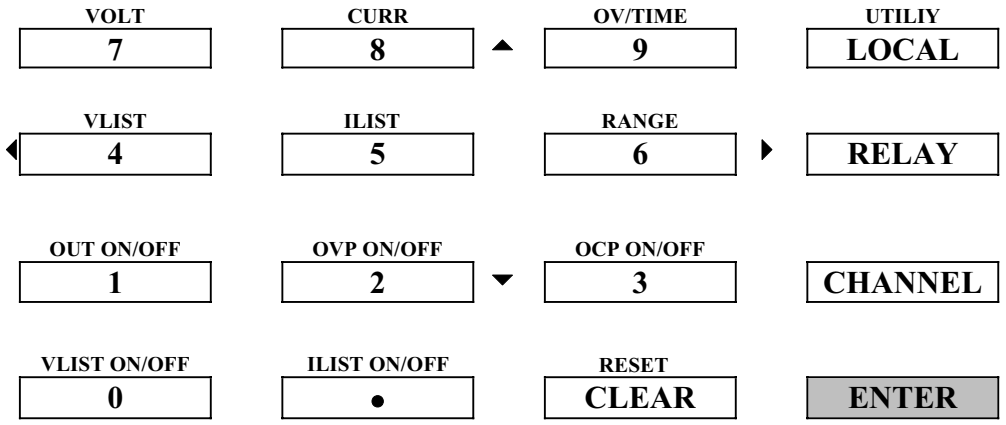


FIGURE 5.4 POWER SUPPLY FRONT PANEL

FRONT PANEL KEYPAD DEFINITION (PD-A > 600W Models)



Most soft keys have dual functions. The first function is mode entry as described by VOLT, CURR right above the key. Once in a mode entry, use these keys as numeric keypad to enter the desired number. Press ENTER key to accept the number keyed or CLEAR key to clear the number.

FRONT PANEL FEATURES

1. VFD Display — Displays alphanumeric information with status enunciators. A detailed listing of descriptions is presented in section VFD **STAUS ENUNCIATORS**

2. Power On/Off — Powers on the unit.

3. VOLT / 7 — Press this key to enter a new voltage setting in flashing bracket or to display the present voltage setting. Numeric key for 7.

4. CURR / 8 — Press this key to enter new current setting in flashing bracket or to display the present current setting. Numeric key for 8.

7. OV/TIME / 9 — Press this key to enter new over voltage protection value in flashing bracket or to display the present over voltage protection value. This key can also be used after pressing #4 key or #5 key to alter time interval in millisecond for STEP programming. Numeric key for 9.

8. RESET / CLEAR — Restarts the PDS similar to a warm boot for computer. If in entry mode, pressing this key will clear the number entered or return to the previous mode. This key can also be used to disable an over-voltage condition.

7. UTILITY / LOCAL — Press this key to enter utility menu to change GPIB address, RS-232 speed, and RS-232 response speed or loop count of step. (These functions will be explained in details in the display section). Use #8 key and #2 key to scroll to the desired sub-menu t be change and use #4 key and #6 key to alter the setting in the sub-menu.

8. ISTEP / 5 — Press this key to do current step programming. Use #8 key and #2 key

to scroll up to 100 current stepping value. Use #7 key to change current stepping value at that step. Use #9 key to change stepping time interval at that step. Numeric key for 5.

10. RANGE 6 ▶ — High/Low range selection for constant current mode. This key also to scrolls menu. Numeric key for 6.

10. OUT ON/OFF 1 — Press this key to turn the output on or off. When the output is disabled, the LCD displays "--OUTPUT OFF--".

11. VSTEP ON/OFF 0 — Press this key to start and stop voltage stepping. Numeric key for 0.

14. OVP ON/OFF 2 — Press this key to enable and disable over voltage protection. If over voltage protection is enabled, a ■ is indicated by OVP. Numeric entry key for 2.

15. OCP ON/OFF 3 — Press this key to enable or disable over current protection. If over current protection is enabled, a ■ is indicated by OCP. Numeric key for 3.

16. ISTEP ON/OFF ● — Press this key to start and stop current stepping. Numeric enter for decimal point.

15. **RELAY** — Press this key will activate the relay menu.

16. VSTEP 4 — Press this key to do voltage step programming. Use #8 key and #2 key to scroll up to 100 voltage step. Use #7 key to change voltage value at that step. Use #9 key to alter time stepping interval at that step.

17. CHANNEL — PDS40-30AR only has a single channel. (Key disabled).

18. ENTER — Enters the number keyed.

VFD STATUS ENUNCIATOR (PD-A > 600W Models)

VACUUM FLUORESCENT DISPLAY:

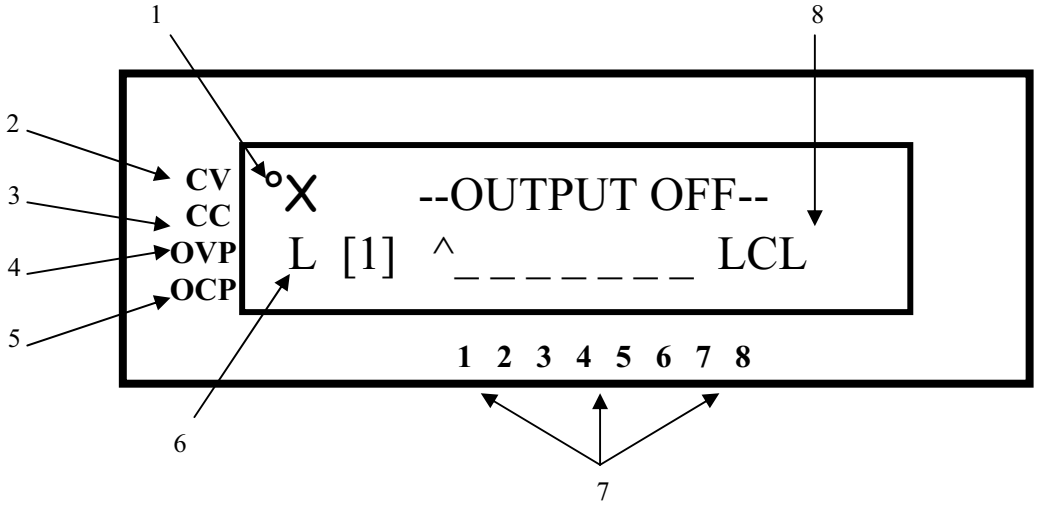


FIGURE 5.5 PDS (SCPI) SERIES

<NOTE>: ***The VFD displays real time output Voltage/Current & mode status. These messages are viewed in either local or remote mode.***

VFD DESCRIPTION REFERS TO FIGURE 5.5

1. Indicator for (CV, CC, OVP, OCP).

2. **CV** : When this indicator is on, the unit is operating in a constant voltage mode.

3. **CC** : When this indicator is on, the unit is operating in a constant current mode.

4. **OVP** : When this indicator is on, the unit is operating with over voltage protection enabled. This prevents the output voltage from exceeding a preset voltage level.

5. **OCP** : When this indicator is on, the unit is operating with over current protection enabled. This prevents the output current from exceeding a preset current level.

6. **Range indicator** : This status enunciator indicate that Constant Current mode is in the **L** (Low Range) mode or in **H** (High Range) mode.

7. **Channel indicator** : The power supply indicates which channel it is currently displaying by having ^ instead of _ on top of the number. (Not available for this PDS40-30AR).

8. **Mode indicator** : This status enunciator indicate if the PDS is in **LCL** (local) mode or in **RMT** (remote) mode.

REAR PANEL CONNECTORS (PD-A > 600W Models)

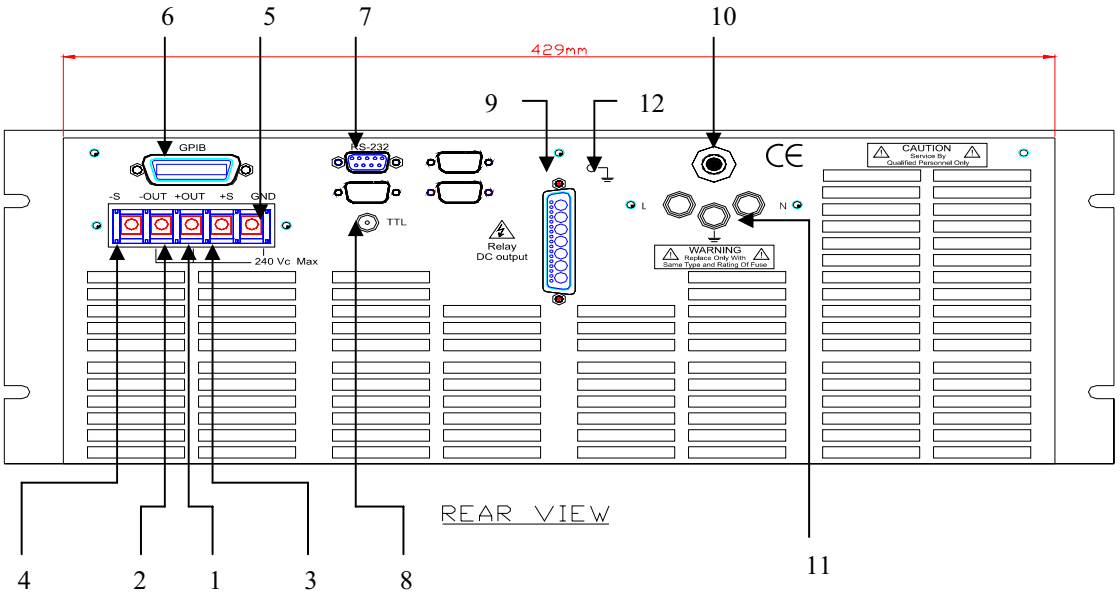


FIGURE 5.6 POWER SUPPLY REAR PANEL

REAR PANEL FEATURES

10. Positive DC Output	Positive DC Output Connector. (Without relay control).
11. Negative DC Output	Negative DC output connector. (Without relay control).
12. Positive Sense	Positive sense connector.
13. Negative Sense	Negative sense connector.
14. Sense Ground	Sense ground connector.
15. GPIB	Standard GPIB Interface Connector.
16. RS232	9-pin D-sub male connector for RS232 Interface.
17. TTL	TTL signal to shutdown the normal DC output.
18. Relay DC Output	Relay output connector with internal output isolation relay and reverse polarity function.
10. Circuit Breaker	Circuit breaker to protect AC input.
11. AC Input	AC input terminal strip.
12. Chassis GND	Chassis/line ground lug screw.

LOCAL OPERATION (PD-A > 600W Models)

INTRODUCTION

These sections contain information on how to locally program the (PD-A <600W) Series. Upon powering up, the power supplies is in local mode operation. All front panel keys may be used to control the power supply.

All operations performed in local mode, may also be performed in remote mode. The unit indicates remote operation when the **"RMT"** enunciator is on the display.

STANDARD OPERATION

This power supply has two basic operating modes: Constant Voltage Mode (CV) and Constant Current Mode (CC), and two control modes: Local Control Mode (default setting) and Remote Programming Mode. Both operating modes are available regardless of which control mode is used.

GENERAL INFORMATION

1. The power supplies are able to directly accept programming values of voltage, current and over voltage. ***"When a valid input is made, the unit will round off the value to the nearest multiple of the resolution". If a non-valid input is made, the unit will display " --- OVER --- " and return to previous values.***

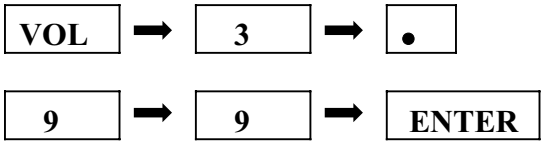
2. The actual programming of voltage and current values via front panel keypad is straightforward. Simply, press any of the functional keys and the VFD shows the current value in use. ***To change this value, simply use the numeric keys to enter a value. If an error is made, press the "CLEAR" key and then reenter the correct value. Once the final value is set, press the "ENTER" key.*** After pressing the **"ENTER"** key, the VFD module returns to the metering mode. If a user wishes to recall a setting, press the function key pertaining to the operation.

For example, to recall a set voltage, press **"VOLT"** and then press **"ENTER"** or **"CLEAR"** key to return unit to metering mode.

3. To reset any of the output parameters (i.e. VOLT, CURR, OVSET, and VSTEP) simply press the desired function keys, enter the new value and press **"ENTER"**.

SETTING VOLTAGE

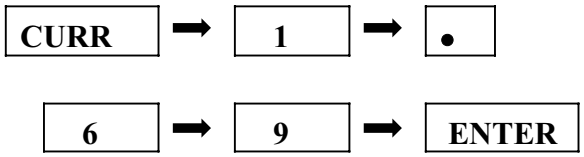
To locally program the voltage (VSET), press **"VOLT"**, enter the value and press **"ENTER"**. For example, if one wished to set a voltage of 3.99, press:



The VFD displays 3.99 V and the unit returns to metering mode.

SETTING CURRENT

To locally program the current (ISET), press **"CURR"** and enter the value and then press **"ENTER"**. For example, if one wishes to set a current of 1.69 amps, press:



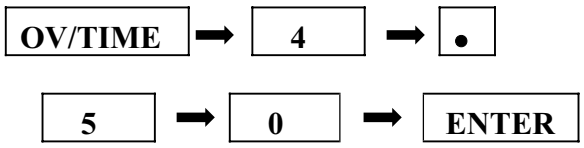
The VFD display 1.69 and the unit returns to metering mode.

OVER VOLTAGE PROTECTION

The power supply has an over voltage protection **(OVP)** feature to guard against abnormal operating conditions such as voltage overshoot. When the supply's output voltage exceeds a threshold voltage, the OVP is activated, and the unit disables the output. The VFD will indicate the condition.

SETTING THE OVER VOLTAGE THRESHOLD

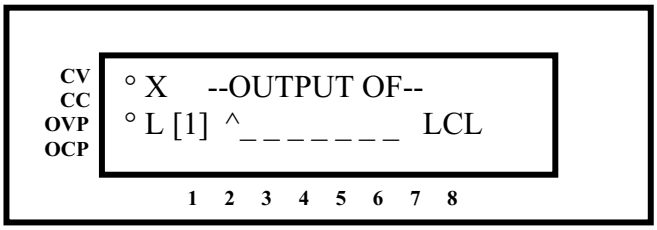
To locally program the threshold voltage press **"OV/TIME"**, enter the value and press **"ENTER"**. For example, to program an over voltage value of 4.50V, press:

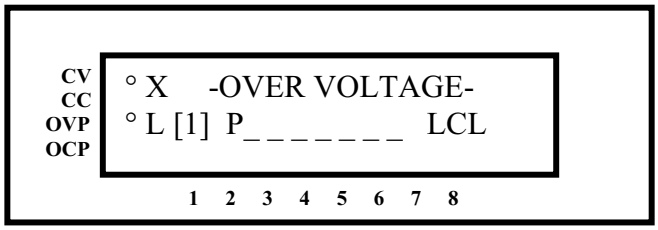


When output voltage exceeds 4.50V, OVP is triggered, OVP enunciator is blinking, and the output is disabled.

ENABLING / DISABLING OVER VOLTAGE PROTECTION

The user can enable or disable the OVP circuit by pressing the **"OVP ON/OFF (2)"** key. When it is enabled the OVP enunciator is on.





When the VFD displays “OVER VOLTAGE”, the over voltage protection circuit has been activated and the output is disabled. To reset, press the **"CLEAR (RESET)"** key. To turn the output on again, press the **"OUT ON/OFF (1)”** key.

<NOTES:>

1. ***Remote sensing, take into consideration the voltage drop across the load leads since the threshold measurement is taken at the output.***

3. ***In inductive load applications, a high-surge voltage would enable the OVP circuit and disable the output.***

3. ***Also note the programming resolution and programming accuracy specifications***

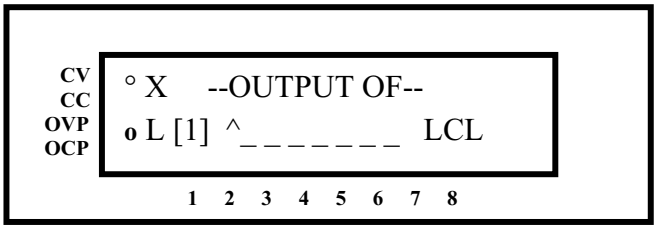
4. ***When the OVP circuit is disabled, the threshold voltage becomes invalid.***

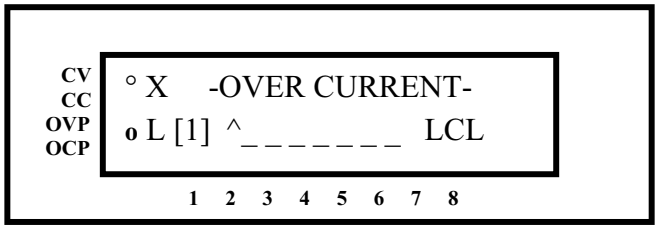
OVER CURRENT PROTECTION

The power supply has an over current protection (OCP) feature to guard the supply against current overdrawn. If the OCP feature is enabled and the supply switches to CC mode, the OCP circuit is triggered and the output is disabled. The OCP threshold is set by the value of the current limit.

ENABLING / DISABLING OVER CURRENT PROTECTION

To enable the over current protection circuit, press the **"OCP ON/OFF (3)"** key and the OCP enunciator is turned on. To disable the over current protection, press the **"OCP ON/OFF (3)"** key one more time and the enunciator is turned off. When the VFD displays "OVER CURRENT", the over current protection circuit has been activated and the output is disabled. To reset, press the **"OCP ON/OFF (3)"** key and the enunciator will stop blinking. To turn the output on again, press the **"OCP ON/OFF (3)"** key.





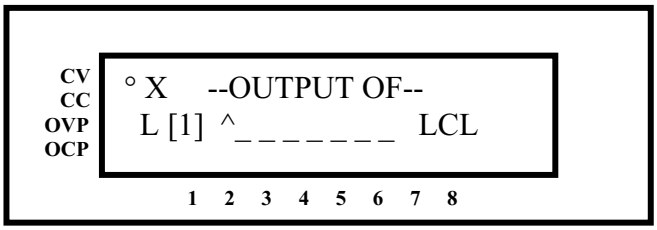
<NOTES:>

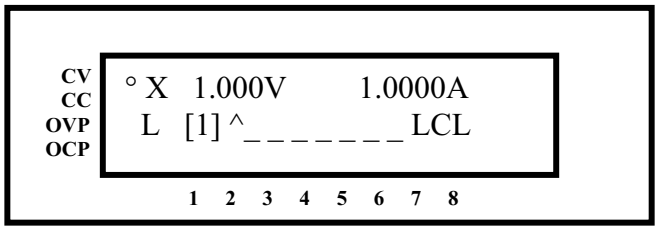
3. OCP IS SET BY THE VALUE OF THE CURRENT LIMIT.

4. If OCP is enabled and the constant current Mode (CC) is activated; the power supply output is disabled.

ENABLING / DISABLING OUTPUTS

All models of the PDS series have the capability of disabling their outputs by entering a new operating parameters or connecting / disconnecting the load. Once the modification has been completed, one can enable the power supply to operate at the new values. The output is enabled or disabled by pressing the **"OUT ON/OFF (1)"** key. To return the supply to normal operation, press the **"OUT ON/OFF 1)"** key again to toggle the output on.

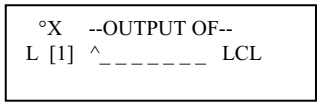




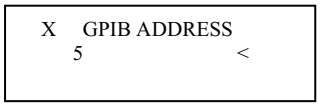
The PDS series output is enabled or disabled by selecting the channel/s and pressing the **"OUT (ON/OFF) (1)"** key. If this is a multi-channel power supply, the channels can be selected by pressing the "ENTER" or "CLEAR" keys.

UTILITY MENU

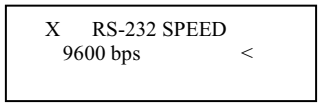
Follow simply step below for Utility function.

1. Main menu 

as show when turned the power switch "ON".

2. Press **UTILITY** key to advance to 

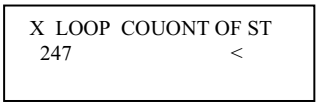
use key #8 as up and #2 as down to
change the GPIB address from 0 – 31 address. Press **ENTER** key to accept the value and press **CLEAR** key to back to main menu.

3. Press #6 key after pressed UTILITY to advance to 

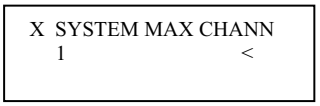
use key #8 as up and #2 as down to select (1200 bps or 2400 bps or 9600 bps). Press **ENTER** key to accept the value and press **CLEAR** key to back to main menu.

4. Press twice #6 key after pressed UTILITY to advance to

use key #8 as up and #2 as down to select (NONE or CR or LF or CR+LF). Press **ENTER** key to accept the value and press **CLEAR** key to back to main menu.

5. Press three times #6 key after pressed UTILITY to advance to 

use key #8 as up and #2 as down to select (0-255 count). Press **ENTER** key to accept the value and press **CLEAR** key to back to main menu.



6. Press four times #6 key after pressed UTILITY to advance to
use key #8 as up and #2 as down to select (0-30 channel). Press **ENTER** key to accept the value and pres **CLEAR** key to back to main menu.

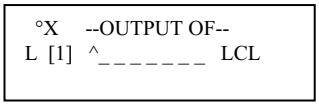
7. Press five times #6 key will back to GPIB ADDRESS menu. Also you may press #4 key to back to previous function.

CONSTANT CURRENT RANGE SELECTION (IF APPLICABLE)

The PDS features a two range of output operating for Constant Current Mode (CC). The user must select the PDS output range corresponding to the output source value, by pressing the key #6 locate at the front panel keypad, then the VFD module will display the operating range L / H.

L = 0 – 1 Amp
H = 0 – 30 Amp

(L/H) Range ⟶



*STEPS TO VIEW "*IDN?" INFORMATION FROM THE FRONT PANEL*

Turn on AC Power or push "Clear" button; the front panel display should contain the following three fields:

1) AMREL – Manufacturer;
2) PDS40-30AR – Model Number;
3) Version number.

STEPS TO SET THE EOS MODE FROM THE FRONT PANEL

1) After front panel display is stable, push "Utility";
2) Then choose "EOS Mode" by pushing "6→" button;
3) Choose "LF+CR" by pushing "2↓" button;
4) Push "Enter" button;
5) Push "Clear" button.

<NOTE>: If this is not set to "LF+CR" the output will be ASCII verses a Hex number.

STEP TO VIEW SELF-TEST RESULT

The only way to view the self-test result from front panel is to view the channels from the display. If there is a "∧" symbol on top of channel number, it means that self-test for this channel is passed.

REMOTE SENSE (PD-A & PD-E MODELS > 600W)

In constant voltage mode (CV), the output is locally strapped for local sensing (normal operation); an unavoidable voltage drop is incurred in the load leads, which adds to its voltage regulation. By connecting the supply for remote sensing, as shown in **Figure 5.7**, voltage is sensed at the load rather than at the output terminals. This allows the supply to automatically compensate for voltage drops in the load leads and improve regulation. In remote sensing, the VOUT? Query and the front panel meter monitor load voltage at the sensing points.
In remote sensing, the OVP circuit makes measurements at the load sense points. The voltage sensed by the OVP circuit could be significantly higher than the voltage being regulated at the load. Therefore, set OVP threshold voltage accordingly.

REMOTE SENSE CONFIGURATION (PD-A & PD-E MODELS > 600W)

CAUTION

Turn off the power supply before making any connections on the rear panel terminal block. Configure the unit for remote sensing by first disconnecting the jumper wires between the sense and load terminals. Connect the load and sense leads to the load as in **Figure 5.73.** Keep in mind that sense and load leads should be as short as possible. Additionally, the sense leads resistance should be no greater than 0.5 ohm/lead, and the voltage drop over the load leads should be no greater than 2.0V/lead.

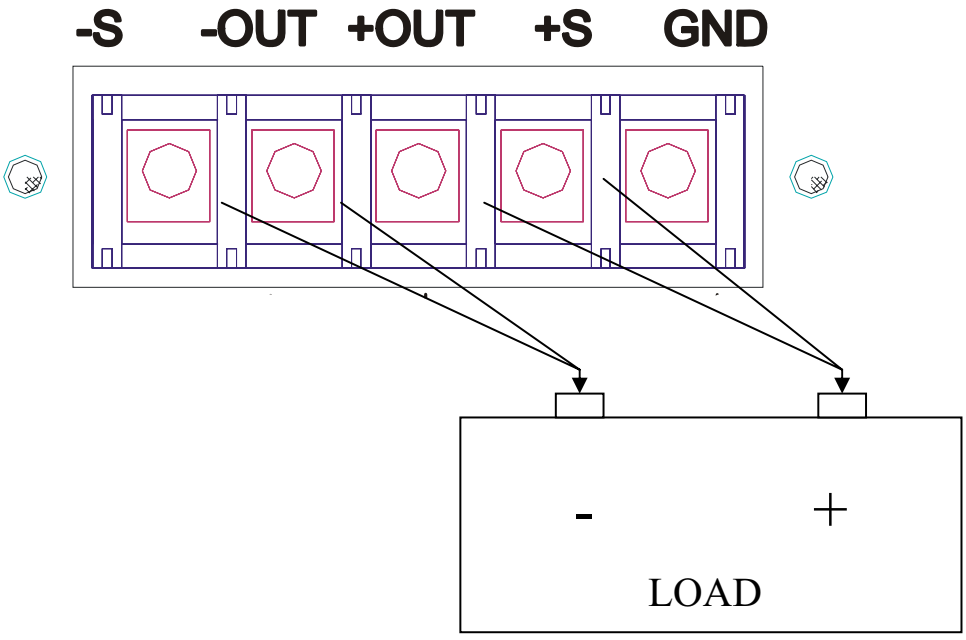
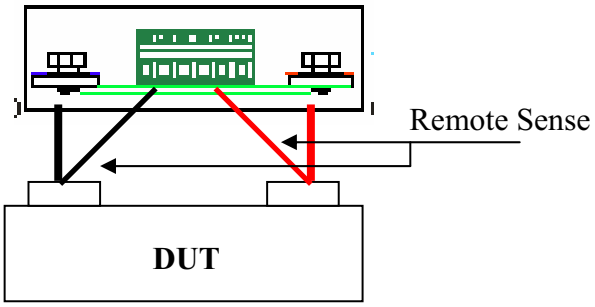


FIGURE 5.7 REMOTE SENSE CONFIGURATION (Single Channel Supply)

FIGURE 5.8: REMOTE SENSE CONFIGURATION FOR OUTPUT CURRENT > 30ADC

1	2	3	4	5	6
+OUT	+S	X	X	-S	-OUT



Note: Pin 1 & 2 and 5 & 6 are shorted when not using remote sense operation

REMOTE SENSE CHARACTERISTICS (PD-A & PD-E MODELS > 600W)

OUTPUT NOISE: Any noise picked up on the sense leads will appear at the supply's output and may adversely affect CV load regulation. Twist the sense leads to minimize External noise pickup and run them parallel and close to the load leads. In noisy environments, it may be necessary to shield the sense leads. Ground the shield at the power supply end only. Do not use the shield as one of the sensing conductors

STABILITY: When the supply is connected for remote sensing, it is possible for the impedance of the load wires and the capacitance of the load to form a filter, which will become part of the supply's CV feedback loop. The extra phase shift created by this filter can degrade the supply's stability and can result in poor transient response performance. In extreme cases, it can cause oscillation.

It is difficult to state simple rules defining the conditions under which this can occur, and which corrective action to take. A certain amount of trial and error may be called for. Three guidelines that are almost always valid are:

a. *Keep the leads as short as possible*
b. *Twist the load leads together to minimize Inductance.*
c. *Shield he sense lead and ground shield at Supply.*

In most circumstances, once these two guidelines are followed, problems associated with the load lead inductance are eliminated. This leaves the load lead resistance and load capacitance as the major cause of the reduced stability. In this case, you may obtain further improvement to the stability by:

a. ***Keeping the load capacitance as small as possible.***
b. ***Increasing the diameter of the load lea to reduce resistance.***

If heavier gauge load leads (# 10 or greater) are used, circumstances may arise when the load lead inductance and the load capacitance can form an under damped filter. This filter occasionally has the effect of destabilizing phase response. In this case, the above steps can worsen stability since they will reduce damping in the system.

ISOLATION RELAY FUNCTION

The AMREL PD-R has an internal output isolation relay function. The relay allows the user to reverse or disconnect the electronic load from the UUT either via the front panel keypad or the GPIB Interface Bus.

Pressing the (RELAY) key will activate the relay menu. Enter "1" to close the Relay, "2" to reverse the output. Press Enter key to continue selection or clear to exit.

* **NOTE:** It is recommended that the output be turned off before closing or reversing the relay.

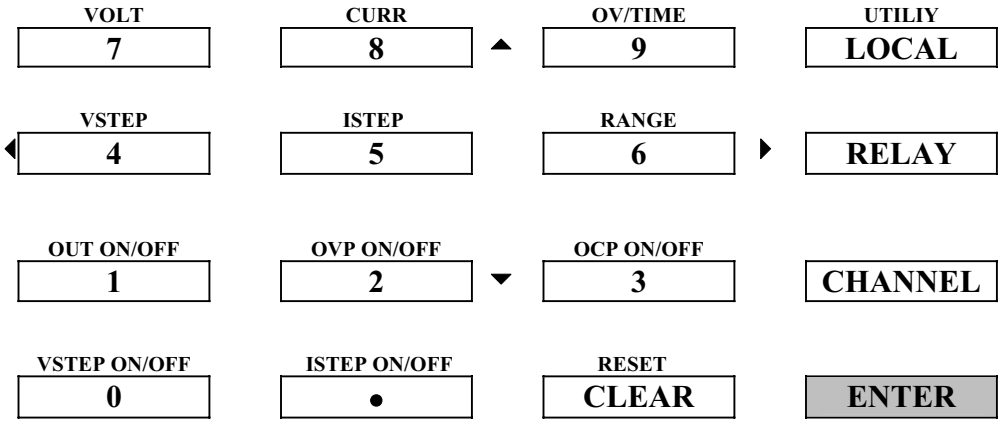
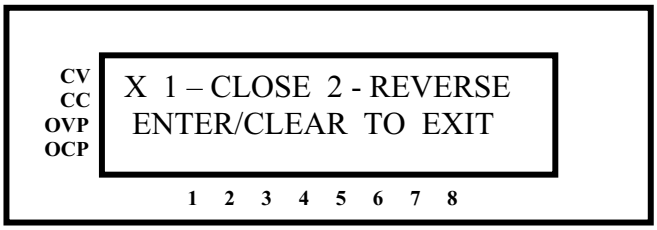


FIGURE 1.5 FRONT PANEL KEYPAD

1 – Press RELAY key:
2 – Press #1 key to close the isolation relay output.



1 – Press RELAY key:
2 – Press #1 key to open the isolation relay output.

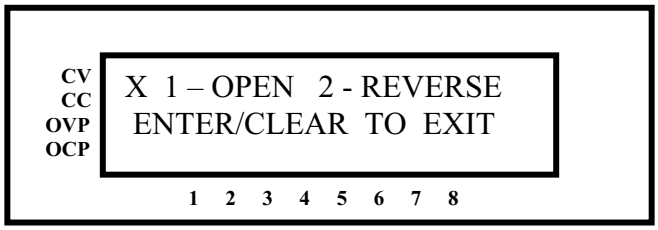
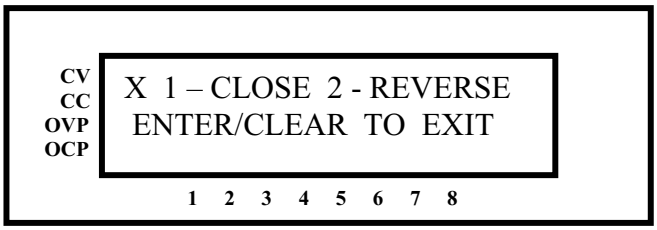


FIGURE 1.6 DISPLAYS CLOSE/OPEN FOR ISOLATION RELAY OUTPUT

1 – Press RELAY key:
2 – Press #2 key to reverse the isolation relay output.



1 – Press RELAY key:
2 – Press #2 key to normal the isolation relay output.

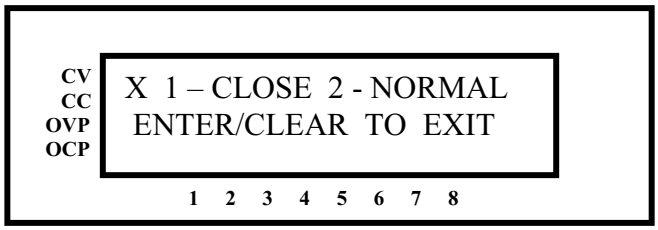


FIGURE 1.7 DISPLAYS REVERSE/NORMAL ISOLATION RELAY OUTPUT

*** Follow the GPIB output subsystem command to operate relay and relay reversal. Pg. #.**
(RELAY DC OUTPUT):

NORMAL:
Pin A7 ---------- (+) Output
Pin A6 ---------- (-) Output
Pin 17 ---------- (+) Sense
Pin 16 ---------- (-) Sense

REVERSE:
Pin A7 ---------- (-) Output
Pin A6 ---------- (+) Output
Pin 17 ---------- (-) Sense
Pin 16 ---------- (+) Sense

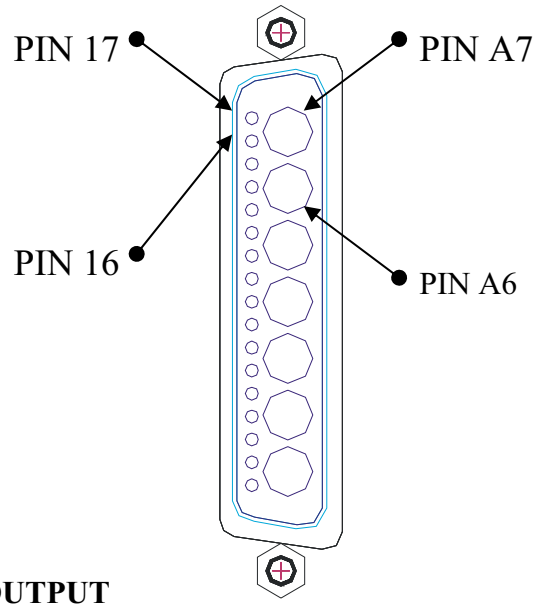


FIGURE 5.9 ISOLATION RELAY DC OUTPUT

TTL SHUTDOWN

The PDS 40-30AR comes with an optional TTL enable/disable function. This is accomplished using a BNC connector on the rear of the power supply.

FIGURE 5.10 TTL INPUT CONNECTER

A **'short'** signal to the TTL input will **disable the power supply output**. The display will indicate the unit been shutdown and the unit will continuously beep. **This signal must be cleared and the power supply must be reset in order to allow operation.**

An **'open'** signal allows for **normal operation** of the power supply

SIX: REMOTE OPERATION

INTRODUCTION

AMREL PD series Power Supplies have GPIB, RS-232 and Ethernet (E-Option Only) interfaces for users to remotely operate.

REMOTE INTERFACE FUNCTIONS

The SCPI interface operations allow for constant talk and listen between systems. The PD-MC1 is able to act as both talker and listener. The computer is able to act as a talker, listener, and controller.

LISTENER:	A device capable of accepting data over an interface.
TALKER:	A device capable of transmitting data over an interface.
CONTROLLER:	A device capable of specifying the talker and listener for an information transfer.

Even though the GPIB/RS-232 control is implemented in the power supply, instructions are only enabled when a computer is equipped with a GPIB/RS-232 interface controller card. A controller manages the operation of the bus systems by designating which devices to send and receive data. The controller also provides command specifications within other devices.

The PD Series supports the following IEEE-488 interface functions:

L4	- Basic Listener, Un-addressable if MTA
T6	- Basic Talker, Serial Poll, Un-addressed if MTA
SH1	- Full Source Handshake
AH1	- Full Acceptor Handshake
RL1	- Remote & Local Lockout
DC1	- Device Clear
E1	- Open Collector Driver Electronics (250kb/s max)
C0	- Non-system controller
SR1	- Service Request Function
TE0	- Omitted extended talker function
LE0	- Omitted extended listener function
PP0	- Omitted parallel poll function
DT0	- Omitted device trigger

ADDRESS SETTING FOR THE REMOTE INTERFACE

The main purpose of address setting is for specifying unit identification between the instruments and controller in a GPIB or RS-232 connection system. The Master Controller has 32 addresses (0-31) available and is set through front panel of the controller unit. If a number higher than 31 is selected, the GPIB or the RS-232 communication will not function. The default GPIB address value is set to 5.

GPIB CAPABILITIES OF THE POWER SUPPLY

All Power Supply functions except for setting the GPIB address are programmable over the GPIB.

GPIB Address

The power supply operates from a GPIB address that is set from the front panel. To set the GPIB address, press the **UTILITY (LOCAL)** key on the front panel, choose "**GPIB ADDRESS**" and press **ENTER** key. Choose an address and press **ENTER** key. Press **CLEAR** key to go back to the previous option. The GPIB address is stored in non-volatile memory.

RS-232 CAPABILITIES OF THE POWER SUPPLY

The power supply provides an RS-232 programming interface. All SCPI commands are available through RS-232 programming. When the RS-232 interface is selected, the GPIB interface and Ethernet interface should not be operated. The EIA RS-232 Standard defines the interconnections between Data Terminal Equipment (DTE) and Data Communications Equipment (DCE). The power supply is designed to be a DTE. It can be connected to another DTE such as a PC COM port through a null modem cable.

NOTE: The RS-232 baud rate settings in your program must match the settings specified in the front panel. If you need to change the baud rate setting, press the front panel **UTILITY (LOCAL)** key, select "**RS-232 SPEED**" and press **ENTER**. Select the baud rate and press **ENTER** key. Press **CLEAR** key to go back to the previous option. The baud rate is stored in non-volatile memory.

RS-232 Flow Control

The RS-232 interface flow control options are default set (fixed) for the power supply as following:

- Parity: NONE
- Data bit: 8
- Stop bit: 1
- Start bit: 1
- XON-XOFF: OFF
- RTS-CTS: OFF

RS-232 serial connection **D-SUB CONNECTOR (DB-9 FEMALE)**

PIN 1 ---NO CONNECTION
PIN 2 ----------RXD
PIN 3 ----------TXD
PIN 4 ----------DTR
PIN 5 ----------GND
PIN 6 ---NO CONNECTION
PIN 7 ----------RTS
PIN 8 ---NO CONNECTION
PIN 9 ---NO CONNECTION

<NOTE:> The D-SUB Female Connector TXD and RXD pins are internally swapped. Therefore, interface cable between power supply and computer (controller) should not swap pins, such as a Null Modem cable.

Baud Rate

You can select one of the following baud rates from the front panel, which is stored in non-volatile memory:

2400 4800 9600 19200 38400 57600 115200

The default baud rate is set to 9600.

RS-232 Returned String Format

For non-query commands: OK + LF + CR;
For queries: OK + LF + CR + returned value + LF + CR + OK + LF + CR.

Note: Using RS-232 interface to get the voltage or current read back value, a minimum 50 milliseconds delay must be added to the application program.

RS-232 Troubleshooting

If you are having trouble communicating over the RS-232 interface, check the following:

- The computer and the PD unit must be configured for the same baud rate, parity, number of data bits, and flow control options. Note that the PD unit is configured for 1 start bit and 1 stop bit (these values are fixed).
- The correct interface cables or adaptors must be used.
- The interface cable must be connected to the correct serial port on your computer (COM1, COM2, etc.).

ETHERNET CAPABILITIES OF THE POWER SUPPLY (ETHERNET OPTION ONLY)

The power supply provides an Ethernet programming interface as optional. All SCPI commands are also available through Ethernet programming. When the Ethernet interface is selected, the GPIB interface and RS-232 interface should not be operated.

Obtain Network Information

To connect the power supply to the network, you only need a network cable with RJ-45 connector. No transceiver is necessary. However, you need to obtain the following information from the power supply unit and your network administrator:

1. Power supply Ethernet MAC Address:

It's a twelve digits string that unequally identifies the power supply unit. It can be obtained from the control board.

2. Network information:

1) DHCP server enabled? Yes or no.
2) Power supply IP address: _____._____._____._____
3) Gateway IP address: _____._____._____._____
4) Subnet mask: _____._____._____._____

Setting the Power Supply Ethernet Parameters

You need to set the power supply Ethernet IP address first. The power supply IP address uniquely identifies the power supply to other devices on the network, and is required for the power supply to communicate over the network.

1. **Ethernet Network settings: DHCP supported.** The purpose of a DHCP (Dynamic Host Configuration Protocol) server is to issue an IP address to a network device that requests an address. The IP address enables the device to communicate with the network. This is similar to personal computer Plug & Play concept.

   The following procedure presumes that your power supply has the Ethernet option and you have connected the power supply to your network.

   If your network supports DHCP server, do the following:

   1) Power on the power supply.
   2) Press **UTILITY (LOCAL)** key at the front panel, then choose "**NETWORK"**, press **ENTER** key.
   3) Choose "**ADDRESS"** and Press **ENTER** key. Enter the IP address as "0.0.0.0" if it is not and Press **ENTER** key.
   4) Choose "**NETMASK**" by Press **RANGE (6)** key once and Press **ENTER** key. Enter the value as "0.0.0.0" if it is not. Press **ENTER** key.
   5) Choose "**GATEWAY**" by Press **RANGE (6)** key once and Press **ENTER** key. Enter the default gateway IP address as "0.0.0.0" if it is not. Press **ENTER** key.
   6) Press RESET (CLEAR) key twice to go back to normal mode.

   Note: If the DHCP server assign a dynamic IP address, then the value of the power supply IP address maybe different each time you power on the power supply. However, if you intend to remotely control the power supply, a static IP address is more convenient, as the power supply IP address does not change, making it easier for remote devices to access power supply.

2. **Ethernet Network settings: DHCP not supported.** If your network does not support DHCP server, you must enter the Ethernet settings manually which you obtained from your network administrator.

   The following procedure presumes that your power supply has the Ethernet option and you have connected the power supply to your network.

   If your network does not support DHCP server, do the following:

   1) Power on the power supply.
   2) Press **UTILITY (LOCAL)** key at the front panel, then choose "**NETWORK"**, press **ENTER** key.
   3) Choose "**ADDRESS"** and Press **ENTER** key. Enter the IP address obtained from your network administrator and Press **ENTER** key.
   4) Choose "**NETMASK**" by Press **RANGE (6)** key once and Press **ENTER** key. Enter the value obtained from your network administrator. Press **ENTER** key.
   5) Choose "**GATEWAY**" by Press **RANGE (6)** key once and Press **ENTER** key. Enter the default gateway IP address obtained from your network administrator. Press **ENTER** key.
   6) Press RESET (CLEAR) key twice to go back to normal mode.

Using AMREL software tools to communicate with your power supply via Ethernet interface.

American Reliance, Inc. provides free software tools for you to configure and communicate with your power supply. Please contact AMREL customer support for details.

One of the most convenient tools for you to choose is AMREL eTool4-ConfigTool. This software tool automatically checks all connected power supply units on Ethernet when both PC and the power supply units are connected to Ethernet, along with basic information of the power supply units, such as model number, maximum voltage and current, and so on. Also automatically set Ethernet configurations for all connected power supply units if your network is DHCP enabled. This software tools comes with your purchase of the unit, or you can download it from AMREL ftp site. Please contact AMREL customer support for details or refer to the following.

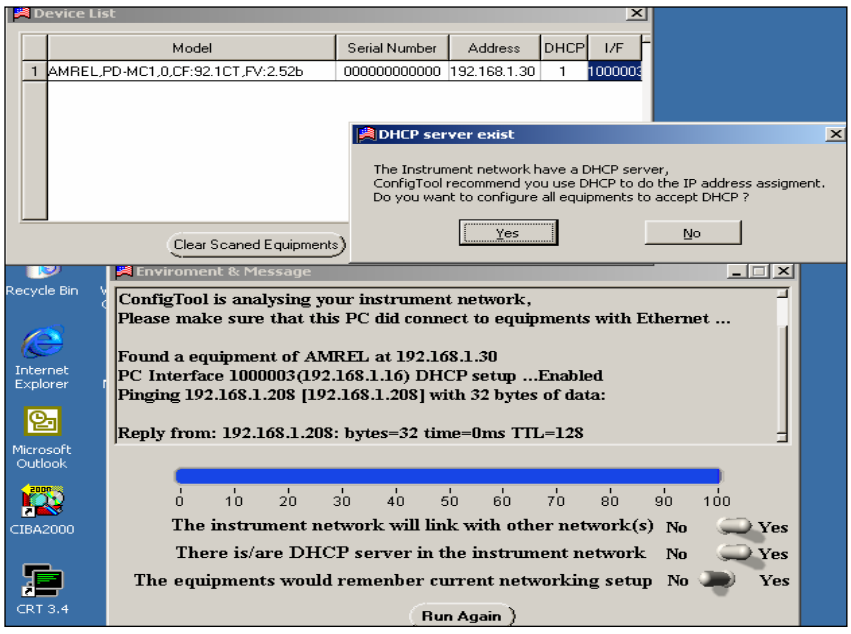
Please do the following steps to download, install and use eTool4-ConfigTool:

1. Installation:

    1) Copy all the needed files to a local computer from E-Power folder at AMREL ftp site: ftp://66.121.66.205 (need a user name and password from AMREL authorization.
    2) Run setup.exe file and follow the on screen instructions.
    3) Choose “Start | Programs (or All Programs for Windows XP) | Config Tool” to run the program.

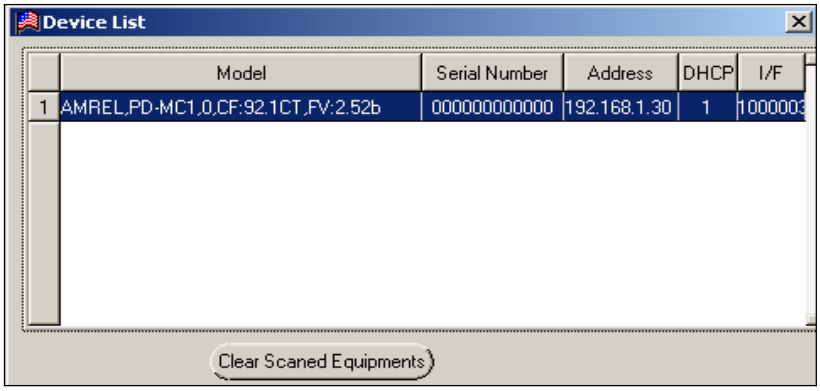
2. Configure Instrument:

    1) When the program first runs, the software automatically search the connected instruments and the following three panel show up:

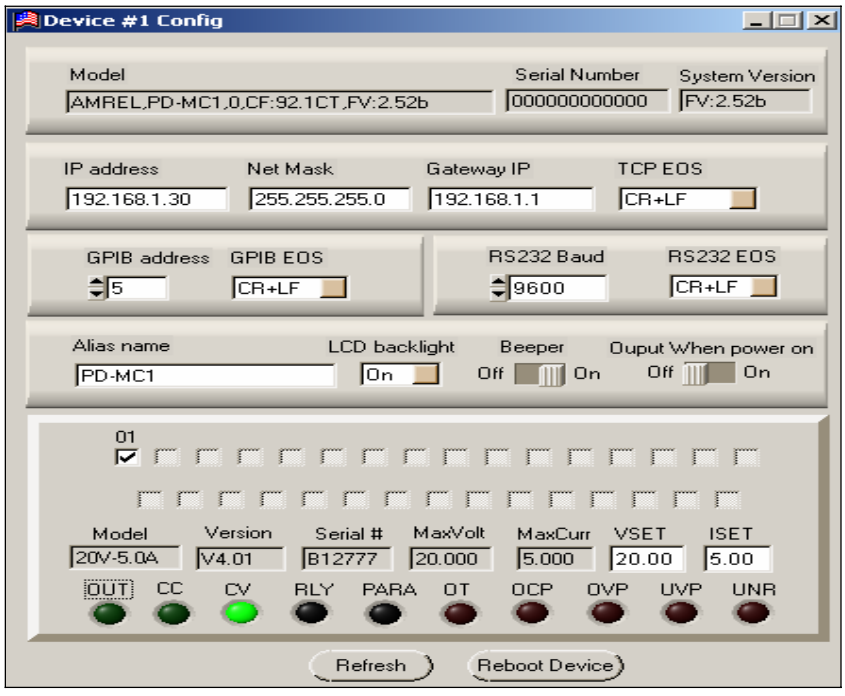


2) If Users' local network supports DHCP server, users can just click "Yes" to configure all equipments to accept DHCP. Otherwise, just click "No" to ignore it.

3) The following panel then shows up for users to choose a unit to run. Users can select a unit from the instrument list and double click the row. The unit configuration panel then shows up for users to simply configure the unit.



4) Most of the information in the following device configuration panel is read from the instrument and displayed to users. It's not for users to make changes. However, users still can operate on the following settings: Beep on/off, Output when power on, VSET, ISET and OUT state by just configuring the corresponding areas showing in the following panel.



3. Close the Program.

    1) Click “Close IO”.
    2) Click close program icon “ ” to exit the program.

ETHERNET RETURNED DATA STRING FORMAT (ETHERNET OPTION ONLY)

For non-query commands: OK + <EOI character>;
For queries: OK + <EOI character> + returned value + <EOI character> + OK + <EOI character>.

PROGRAMMING COMMAND SET FOR AMREL PD SERIES POWER SUPPLY

Introduction
This manual gives the syntax and parameters for all the programming commands used by AMREL PD series power supply, including the terms, symbols, and syntactical structures used here and gives an introduction to programming. You should also be familiar with front panel operation in order to understand how the power supply functions.

The programming examples are simple applications of SCPI commands. Because the SCPI syntax remains the same for all programming languages, the examples given for each command are generic.

Syntax Forms Syntax definitions use the long form, but only short form headers (or "keywords") appear in the examples. Use the long form to help make your program self-documenting.

Parameters	Most commands require a parameter and all queries will return a parameter. The range for a parameter may vary according to the model of power supply. When this is the case, refer to the Specifications table.
Models	If a command only applies to specific models, those models are listed in the <Model> Only entry. If there is no <Model> Only entry, the command applies to all models.
Related Commands	Where appropriate, related commands or queries are included. These are listed because they are either directly related by function, or because reading about them will clarify or enhance your understanding of the original command or query.
Order of Presentation	The manual is organized according to the following categories: common commands, subsystem commands, Non-SCPI commands, and IEEE 488.1 commands. Each category commands that follow are arranged in alphabetical order. Section 1, command list includes all the commands.

COMMANDS LIST

*CLS	Clears status
*ESE <n>	Enables standard event status
*ESE?	Returns standard event status
*ESR?	Returns event status register
*IDN?	Returns instrument identification
*OPC	Enables “operation complete” bit in ESR
*OPC?	Returns a “1” when operation completes
*RCL	Recalls profile settings
*RST [<channel>]	Resets
*SAV [<channel>] [n]	Saves instrument state and profile
*SAV? <channel>	Returns saving status
*SRE <n>	Sets service request enable register
*SRE?	Returns service request enable register
*STB?	Returns status byte
*TRG	Trigger

*TST?	Performs self-test and returns test result

SUBSYSTEM COMMANDS SYNTAX

ABORt	Resets the trigger system to idle state
CALibrate	
:CURRent	
[:DATA] <channel> <value>	Enters the current calibration value
:LEVel <channel> <n>	Sets the current calibration point
:SAVe <channel> <n>	Resaves current calibration data
:OFFSet <channel> <n> <value>	Sets / Queries calibration offset value
:PASSword <channel> [<password>]	Sets calibration password
:SAVe <channel>	Saves new calibration constants
:SLOPe <channel> <n> <value>	Sets / Queries calibration slope value
:STATe <channel> <bool> [<password>]	Sets / Queries calibration state
:VOLTage	
[:DATA] <channel> <value>	Enters the voltage calibration value
:LEVel <channel> <n>	Sets the voltage calibration point
:SAVe <channel> <n>	Resaves voltage calibration data
CHANnel	
:MODel? <channel>	Returns model number
:SERial <channel> <serial-number>	Sets / Queries serial number
:VERSion? <channel>	Returns channel version
CURRent	
[:LEVel]	
[IMMediate] <channel> <value>	Sets / Queries the output current level
:TRIGgered <channel> <value>	Sets / Queries the current triggered level
:PROTection	
:CLEar <channel>	Resets latched current protection
:STATe <channel> <bool>	Sets / Queries current protection state
LIST	
:COUNt <channel> <count>	Sets / Queries the number of times for a list
:CURRent <channel> <point> <value>	Sets / Queries current value for a list point
:STATe <channel> <bool>	Sets / Queries current list state
:STEP <channel> <n>	Sets / Queries list step
:TIMe <channel> <point> <value>	Sets / Queries current dwelling time for a list point
:VOLTage <channel> <point> <value>	Sets / Queries voltage value for a list point
:STATe <channel> <bool>	Sets / Queries voltage list state
:STEP <channel> <n>	Sets / Queries voltage list step
:TIMe <channel> <point> <value>	Set / Queries voltage dwelling time for a list point
MEASure	
:CURRent? <channel>	Returns current measured value
:DELay <n>	Sets / Queries delay time for measuring
:VCOUT? <channel>	Returns both voltage and current measured value
:VOLTage? <channel>	Returns voltage measured value

OUTPut	
[:STATe] <channel> <bool>	Sets / Queries output status
:PROTection	
:CLEar <channel>	Resets latched protection
:RELay	
[:STATe] <channel> <bool>	Sets / Queries output relay state
:POLarity <channel> <polarity>	Sets / Queries output relay polarity
STATus	
:OPERation	
[:EVENt]? <channel>	Returns the value of operation event register
:QUEStionable	
[:EVENt]? <channel>	Returns the value of questionable event register
:ENABle <channel>	Enables / Queries the specific bit in the questionable enable register
SYSTem	
:BACK <NR1>	Sets / Queries system LCD backlight mode
:BUZZer <bool>	Sets / Queries system buzzer mode
:CHANnel:MAXimum <NR1>	Sets / Queries max # of channels in a system
:CONSol	
:BAUD <baudrate>	Sets / Queries RS-232 baud rate value
:EOS <NR1>	Sets / Queries RS-232 EOS mode
:DEFault:OUTPut <NR1>	Sets / Queries default power on output status
:EOS <NR1>	Sets / Queries current interface EOS mode
:ERRor?	Returns error number and string
:GPIB:EOS	Sets / Queries GPIB EOS mode
:NET	
:ADDRess	Sets / Queries Ethernet IP address
:DHCP?	Queries if the DHCP is enabled
:EOS	Sets / Queries Ethernet EOS mode
:GATE	Sets / Queries Ethernet default gateway IP address
:STATe?	Queries Ethernet configuration state
SUBNet	Sets / Queries Ethernet Subnet value
:PROT	Returns value of Protect Event Status register
:VERSion?	Returns the firmware version number
:INH:STAT <NR1>	Sets / Queries Remote Inhibit (RI) shutdown mode
TRIGger	
[:STARt]	
[:IMMediate]	Enables output trigger immediately
:DELay <channel> <value>	Sets / Queries delay time for output trigger
VOLTage	
[:LEVel]	
[:IMMediate] <channel> <value>	Sets / Queries the output voltage level
:TRIGgered <channel> <value>	Sets / Queries the voltage triggered level
:PROTection	
:CLEar <channel>	Resets latched voltage protection
[:LEVel] <channel> <value>	Sets / Queries over voltage protection level
:STATe <channel> <bool>	Sets / Queries over voltage protection state

NON-SCPI COMMANDS

CURR:CAL:SAVE <channel> <n>	Resaves current calibration data
MOD? <channel>	Returns model number
PROT:CHAN?	Returns protected channel number
SERI <channel> <serial-number>	Sets / Queries serial number
SYST:CHAN <channel>	
SYST:OFFSet <channel> <n> <value>	Sets / Queries calibration offset value
SYST:SLOPe <channel> <n> <value>	Sets / Queries calibration slope value
SYST:STATUS	
TRAC	
TRAC:CLE	
VOLT:CAL:SAVE <channel> <n>	Resaves voltage calibration data

IEEE 488.1 COMMANDS

IOUT? <channel>	Returns output current
IOUT1?	Returns output current for channel 1
IOUT2?	Returns output current for channel 2
ISET <channel> <value>	Sets current limit
ISET1 <value>	Sets current limit for channel 1
ISET2 <value>	Sets current limit for channel 2
ISET? <channel>	Returns setting current value
ISET1?	Returns setting current value for channel 1
ISET2?	Returns setting current value for channel 2
OCP <channel> <bool>	Sets over current protection state
OCP1 <bool>	Sets over current protection for channel 1
OCP2 <bool>	Sets over current protection for channel 2
OUT <channel> <bool>	Sets output state
OUT1 <bool>	Sets output state for channel 1
OUT2 <bool>	Sets output state for channel 2
OVP <channel> <bool>	Sets over voltage protection state
OVP1 <bool>	Sets over voltage protection state for channel1
OVP2 <bool>	Sets over voltage protection state for channel2
OVSET <channel>	Sets over voltage protection level
OVSET1	Sets over voltage protection level for channel1
OVSET2	Sets over voltage protection level for channel2
OVSET? <channel>	Returns over voltage protection level
OVSET1?	Returns over voltage protection level for channel 1
OVSET2?	Returns over voltage protection level for channel 2
STATUS?	Returns status for both channel 1 and 2
VOUT? <channel>	Returns output voltage value
VOUT1?	Returns output voltage value for channel 1
VOUT2?	Returns output voltage value for channel 2
VSET <channel> <value>	Sets voltage level
VSET1 <value>	Sets voltage level for channel 1
VSET2 <value>	Sets voltage level for channel 2
VSET? <channel>	Returns setting voltage value
VSET1?	Returns setting voltage value for channel 1
VSET2?	Returns setting voltage value for channel 2

DESCRIPTION OF COMMON COMMANDS

Common commands begin with an * and consist of three letters (command) or three letters and a "?" (query). They are defined by the IEEE 488.2 standard to perform common interface functions. The PD series power supply responds to the following commands:

***CLS**
Meaning and Type
Clear Status Device Status

Description
This command causes the following actions (see "Status Reporting" for descriptions of all registers):

- Clears the following registers:
  - Standard Event Status ("*ESR?" returned value)
  - Status Byte ("*STB?" returned value)
- Clears the Error Queue ("SYST:ERR?" returned value)
- Also clears over-voltage protection status (to comply with AMREL old 488.1 unit).

Command Syntax	*CLS
Parameters	(None)
Query Syntax	(None)
Related Commands	*ESR? *STB? SYST:ERR?

***ESE**
Meaning and Type
Event Status Enable Device Status

Description
This command programs the Standard Event Status Enable register bits. The programming value determines which events of the Standard Event Status Event register (see ***ESR?**) are allowed to set the Event Summary Bit of the Status Byte register. A "1" in the bit position enables the corresponding event. All of the enabled events of the Standard Event Status Event register are logically ORed to cause the Event Summary Bit of the Status Byte register to be set.

Bit Configuration of Standard Event Status Enable Register Table:

Bit Position	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Bit Name	**PON**	**0**	**CME**	**NU**	**NU**	**QYE**	**0**	**OPC**
Bit Weight	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
CME = Command error; OPC = Operation complete; PON = Power-on; QYE = Query error; NU = Not used.								

Command Syntax	*ESE <NR1>
Parameters	*0 to 255*
Power On Value	128
Suffix	(None)
Example	*ESE 32
Query Syntax	*ESE?
Returned Parameters	<NR1> (Register decimal value)
Related Commands	*ESR? *STB? *OPC*

<Note> *: The OPC bit at the register cannot be set through ****ESE*** command. It must use ****OPC*** command. But the OPC bit can only be cleared by executing ****ESE*** command.

***ESR?**
Meaning and Type
Event Status Register Device Status

Description
This query reads the Standard Event Status Event register. Reads the register and clears it. The bit configuration of this register is the same as the Standard Event Status Enable register (***ESE**).

Query Syntax	*ESR?
Parameters	(None)
Returned Parameters	<NR1> (Register decimal value)
Related Commands	*CLS *ESE *ESE? *OPC

***IDN?**
Identification Query
Meaning and Type
Identification System Interface

Description
This query requests the power supply to identify itself. It returns a string composed of five fields separated by commas.

Query Syntax	*IDN?	
Returned Parameters	<CRD>	
	Field	Information
	AMREL,	Manufacturer
	xxxxx-xx,	Model number
	0,	
	CF:92.CT,	
	FV:x.xx	Revision levels of firmware
Example	AMREL,PD-MC1,0,CF:92.1CT,FV2.47	
Related Commands	(None)	

***OPC**
Meaning and Type
Operation Complete Device Status

Description
This command causes the interface to set the OPC bit (bit 0) of the Standard Event Status register when the power supply has completed all pending operations. (See ***ESE** for the bit configuration of the Standard Event Status register.) Pending operations are complete when:

- All commands sent before ***OPC** have been executed. This includes overlapped commands. Most commands are sequential and are completed before the next command is executed. Overlapped commands are executed in parallel with other commands. Commands that affect output voltage, current or state, relays, and trigger actions are overlapped with subsequent commands sent to the power supply. The ***OPC** command provides notification that all overlapped commands have been completed.
- Any change in the output level caused by previous commands has been completed (completion of settling time, relay bounce, etc.)
- All triggered actions are completed.

***OPC** does not prevent processing of subsequent commands but Bit 0 will not be set until all pending operations are completed.

Command Syntax	*OPC
Parameters	(None)
Related Commands	*OPC? *ESE?

***OPC?**
Meaning and Type
Operation Complete Device Status

Description
This query causes the interface to place an ASCII "1" in the Output Queue when all pending operations are completed. *Pending operations* are as defined for the ***OPC** command. Unlike ***OPC, *OPC?** prevents processing of all subsequent commands. ***OPC?** Is intended to be used at the end of a command line so that the application program can then monitor the bus for data until it receives the "1" from the power supply Output Queue.

CAUTION: Do not follow ***OPC?** with ***TRG** or GPIB bus triggers. Such triggers sent after ***OPC?** will be prevented from executing and will prevent the power supply from accepting further commands.

***RCL**
Meaning and Type
Recall Device State

Description
This command recalls the power supply profile settings, which is saved by *SAV command.

Command Syntax	*RCL [<channel>] [n]
Parameters	<channel>: 1 – 31, channel number n: 0 – 3, profile number.
Query Syntax	(None)
Related Commands	*SAV

***RST**
Meaning and Type
Reset Device State

Description
This command resets the power supply to a factory-defined state as defined below. ***RST** also forces an **ABORt** command.

COMMAND	STATE	COMMAND	STATE	COMMAND	STATE
CAL:STAT	OFF	LIST:VOLT:STAT	OFF	TRIG:DEL	0
CURR[:LEV][:IMM]	1.0	LIST:VOLT:STEP	NONE	UNDER:PROT:STAT	OFF
CURR:PROT:STAT	OFF	OUTP:REL:POL	NORM	VOLT[:LEV][:IMM]	5.0
LIST:COUN	0	OUTP:REL[:STAT]	OPEN	VOLT:PROT:LEV	MAX
LIST:CURR:STAT	OFF	OUTP[:STAT]	OFF	VOLT:PROT:STAT	OFF
LIST:CURR:STEP	NONE	PARA:STAT	OFF		

Command Syntax	*RST [<channel>] *
Parameters	None or 1 – 31
Query Syntax	(None)
Related Commands	*SAV

<Note> *: If this command is sent without a channel number, it resets all channels connected to the master controller.

***SAV**
Meaning and Type
Save Device State

Description
This command stores the present state of the power supply to a specified location in memory, and the profile settings. If a particular state is desired at power on, it should be stored in a profile number 0. It then will be recalled at power on if the power supply configuration switch is set for this mode of operation.

The following power supply states are stored by ***SAV:**

CURR[:LEV][:IMM] VOLT[:LEV][IMM] VOLT:PROT[:LEV], LIST:COUN, LIST:CURR, LIST:CURR:TIM, LIST:VOLT, LIST:VOLT:TIM

Command Syntax	*SAV <channel> [n]
Parameters	channel: 1 to 31 n: 0 to 3, profile number
Query Syntax	*SAV? <channel>
Returned Parameter	<NR1> 0 | 1 0 Indicates saving successfully 1 Indicates saving in processing
Related Commands	*RST, *RCL

***SRE**
Meaning and Type
Service Request Enable Device Interface

Description
This command sets the condition of the Service Request Enable register. This register determines which bits from the Status Byte register (see ***STB** for its bit configuration) are allowed to generate an SRQ. A *1* in any Service Request Enable register bit position enables the corresponding Status Byte register bit and all such enabled bits then are logically ORed to cause Bit 6 of the Status Byte register to be set.

When ***SRE** is cleared (by programming it with 0), the power supply cannot generate an SRQ to the controller.

Command Syntax	*SRE <NR1>
Parameters	0 to 255
Default Value	0
Example	*SRE 32
Query Syntax	*SRE?
Returned Parameters	<NR1> Register decimal value
Related Commands	*ESE *ESR

***STB?**
Meaning and Type
Status Byte Device Status

Description
This query reads the Status Byte register, which contains the status summary bits. Reading the Status Byte register does not clear it. It is cleared at power on or by ***CLS**.

Bit Configuration of Status Byte Register Table:

Bit Position	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Bit Name	**NU**	**SRQ**	**SE**	**MSA**	**QD**	**NU**	**NU**	**NU**
Bit Weight	**128**	**64**	**32**	**16**	**8**	**4**	**2**	**1**
MSA = Message available; NU = Not used; QD = Questionable date enable register; SE = Standard event enable register; SRQ = Service request.								

Query Syntax	*STB?
Returned Parameters	<NR1> Register decimal value
Related Commands	(None)

***TRG**
Meaning and Type
Trigger Device Trigger

Description
This command generates a trigger to power supply.

Command Syntax	*TRG
Parameters	(None)
Query Syntax	(None)
Related Commands	ABOR; CURR:TRIG TRIG[:IMM]; VOLT:TRIG

***TST?**
Meaning and Type
Test Device Test

Description
This query causes the power supply to do a self-test and report any errors.

Query Syntax	*TST?
Returned Parameters	<CRD> A string representing a 4-byte Hexadecimal value with a "&H" header. Each bit represents self-test result for the corresponding channel: 0 Indicates power supply passed self-test. 1 Nonzero, indicates an error.
Related Commands	*VRF

Bit configuration of *TST? query returned value corresponding to channel number table:

Bit Position	7	6	5	4	3	2	1	0
Channel	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Bit Position	15	14	13	12	11	10	9	8
Channel	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**
Bit Position	23	22	21	20	19	18	17	16
Channel	**24**	**23**	**22**	**21**	**20**	**19**	**18**	**17**

Bit Position	31	30	29	28	27	26	25	24
Channel	**NU**	**31**	**30**	**29**	**28**	**27**	**26**	**25**

<Note> 1) Example: If the returned string is "&H7FFFFFE", it means only channel 1 was connected and passed the self-test by converting the Hexadecimal value "7FFFFFE" to binary value which is "0111 1111 1111 1111 1111 1111 1111 1110" and comparing the bit configuration with the above table to get the channel number.

<Note> 2) Example: If the returned value is a series of numbers, such as "26 48 37 46 46 46 46 46 46 45", it represents ASCII code in Hexadecimal format, same as "&H7FFFFFFE ". It means only channel 1 was connected and passed the self-test.

DESCRIPTION OF SUBSYSTEM COMMANDS

ABOR

This command cancels any trigger actions presently in process. Pending trigger levels are reset equal to their corresponding immediate values. **ABOR** also cancels any programmed lists that may be in process. **ABOR** also resets the WTG bit in the Operation Condition Status register. **ABOR** is executed at power turn on and upon execution of ***RST**.

Command Syntax	ABORt
Parameters	(None)
Examples	ABOR
Query Syntax	(None)
Related Commands	*RST *TRG TRIG

CALIBRATION SUBSYSTEM

The commands in this subsystem allow users to do the following:

- Enable and disable the calibration mode.
- Calibrate the current and voltage output levels, and store new calibration constants in nonvolatile memory.
- Reload calibration data and store it in nonvolatile memory.

CAL:CURR

This command can only be used in the calibration mode. It enters a current value that users obtain by reading an external meter. Users must first select a calibration level **(CAL:CURR:LEV)** for the value being entered. Two successive values (one for each end of the calibration range) must be selected and entered. The power supply then computes new current calibration constants. These constants are **not** stored in nonvolatile memory until saved with the ***SAV <channel>** commands.

Command Syntax	CALibrate:CURRent[:DATA] <channel> <NRf>
Parameters	<channel>: 1 – 31 (channel number) <NRf>: External reading in Amps
Examples	CAL:CURR 1 3.2223 CAL:CURR:DATA 1 5.000
Query Syntax	*(None)*
Related Commands	CAL:SAV CAL:STAT CAL:CURR:LEV\

CAL:CURR:LEV

This command can only be used in the calibration mode. It sets the power supply to a current calibration point that is then entered with **CAL:CURR[:DATA].** During calibration, three points must be entered and the low-end point (**MIN**) must be selected and entered first.

Command Syntax	CALibrate:CURRent:LEVel <channel > <CRD>
Parameters	<channel >: 1 – 31, channel number <CRD>: MIN | MID | MAX
Examples	CAL:CURR:LEV 1 MIN; CAL:CURR:LEV 1 MAX
Query Syntax	(None)
Related Commands	CAL:CURR[:DATA] CAL:STAT

CAL:CURR:SAV

This commands reloads the current calibration constants to power supply. These constants are **not** stored in nonvolatile memory until saved with the ***SAV <channel>** commands.

Command Syntax	CALirate:CURRent:SAVe <channel> <NR1> CURRent:CALibrate:SAVe <channel> <NR1>
Parameters	<channel>: 1 – 31, channel number <NR1>: 1 – 12, Calibration mode 1 Voltage output 2 Current output 3 Voltage read back 4 Current read back
Examples	CAL:CURR:SAV 1 2; CURR:CAL:SAV 1 4
Query Syntax	(None)
Related Commands	*SAV

CAL:OFFS

This command resets or queries the power supply's calibration offset constant value. These constants are **not** stored in nonvolatile memory until saved with the **CAL:CURR:SAV or CAL:VOLT:SAV and *SAV** commands.

Command Syntax	CALibrate:OFFSet <channel> <NR1> <NRf>
Parameters	SYSTem:OFFSet <channel> <NR1> <NRf> channel: 1-31, channel number <NR1>: 1 – 12, calibration mode 1 Voltage output 2 Current output 3 Voltage read back 4 Current read back <NRf>: offset value
Example	SYST:OFFS 1 1 -0.0665278 CAL:OFFS 1 1 –0.0665278
Query Syntax	SYSTem:OFFSet? <channel> <NR1> CALibrate:OFFSet? <channel> <NR1>
Return Parameter	<NRf>: calibration offset constant value
Related Commands	CAL:CURR:SAV; CAL:VOLT:SAV; *SAV

CAL:PASS
This command sets calibration password.

Command Syntax	CALibrate:PASSword <channel> [<CRD1>] [<CRD2>]
Parameters	<channel>: 1 – 31, channel number <CRD1>: character string for old calibration password. <CRD2>: character string for new password.
Example	CAL:PASS 1 12345 – sets calibration password as "12345". CAL:PASS 1 12345 54321 – sets new calibration password as "54321"
Query syntax	(None)
Related commands	CAL:STAT

Note: The power supply unit default password is empty (no password). If this command has only one character string field, it is used to set the first password (the old password is empty – no old password). If the old password exists, the first character string field must match the old password. Otherwise, an error message is generated.

CAL:SAV
This command can only be used in the calibration mode. It saves any new calibration constants (after a current or voltage calibration procedure has been completed) in nonvolatile memory.

Command Syntax	CALibrate:SAVe <channel >
Parameters	<channel >: 1 – 31, channel number
Examples	CAL:SAV 1
Query Syntax	(None)
Related Commands	CAL:CURR CAL:VOLT CAL:STAT

CAL:SLOP
This command resets or queries the power supply's calibration slope constant value. These constants are **not** stored in nonvolatile memory until saved with the **CAL:CURR:SAV or CAL:VOLT:SAV and *SAV** commands.

Command Syntax	CALibrate:SLOPe <channel> <NR1> <NRf> SYSTem:SLOPe <channel> <NR1> <NRf>
Parameters	<channel>: 1-31, channel number <NR1>: 1 – 12, calibration mode 1 Voltage output 2 Current output 3 Voltage read back 4 Current read back <NRf>: slope value, obtained from the query
Examples	SYST:SLOPE 1 1 -0.0665278 CAL:SLOP 1 1 –0.0665278
Query Syntax	SYST:SLOPE? <channel> <NR1> CAL:SLOP? <channel> <NR1>
Return Parameter	<NRf>: calibration slope constant value
Related Commands	CAL:CURR:SAV; CAL:VOLT:SAV; *SAV

CAL:STAT
This command enables and disables the calibration mode. The calibration mode must be enabled before the power supply will accept any other calibration commands.

Whenever the calibration mode is changed from enabled to disabled, any new calibration constants are lost unless they have been stored with **CAL:SAVE**.

Command Syntax	CALibrate:STATe <channel> <bool> [<password>]
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | OFF | 1 | ON <password>: Calibration password.
*RST Value	OFF
Examples	CAL:STAT 1 ON; CAL:STAT 1 OFF
Query Syntax	CALibrate:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	CAL:SAV

Note: If the calibration password is set, the password string must match the existing password. Otherwise, gives an error message.

CAL:VOLT
This command can only be used in the calibration mode. It enters a voltage value that is obtained from an external meter. Users must first select a calibration level **(CAL:VOLT:LEV)** for the value being entered. Two successive values (one for each end of the calibration range) must be selected and entered. The power supply then computes new voltage calibration constants. These constants are **not** stored in nonvolatile memory until saved with the **CAL:SAVE** command.

Command Syntax	CALibrate:VOLTage[:DATA] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: External meter value in Volts
Examples	CAL:VOLT 1 3.1024; CAL:VOLT 1 5.000
Query Syntax	(None)
Related Commands	CAL:SAV; CAL:STAT; CAL:VOLT:LEV

CAL:VOLT:LEV
This command can only be used in the calibration mode. It sets the power supply to a voltage calibration point that is then entered with **CAL:VOLT[:DATA].** During calibration, two points must be entered and the low-end point (**MIN**) must be selected and entered first.

Command Syntax	CALibrate:VOLTage:LEVel <channel> <CRD>
Parameters	<channel>: 1 – 31, channel number <CRD>: MINimum |MAXimum
Examples	CAL:VOLT:LEV 1 MIN; CAL:VOLT:LEV 1 MAX
Query Syntax	(None)
Related Commands	CAL:VOLT[:DATA]; CAL:STAT

CAL:VOLT:SAV
This command reloads the voltage calibration constants to power supply. These constants are **not** stored in nonvolatile memory until saved with the ***SAV <channel>** commands.

Command Syntax	CALirate:VOLTage:SAVe <channel> <NR1> VOLTage:CALibrate:SAVe <channel> <NR1>
Parameters	<channel>: 1 – 31, channel number <NR1>: 1 – 4, Calibration mode 1 Voltage output 2 Current output 3 Voltage read back 4 Current read back
Examples	CAL:VOLT:SAV 1 2; VOLT:CAL:SAV 1 4
Query Syntax	(None)
Related Commands	*SAV

CHANNEL SUBSYSTEM

The commands in this subsystem only exist in Master – Slave power supply system. They allow users to do the following:

- Query individual channel's model information.
- Set or query output shut down time.

CHAN:MOD?
This query returns the model number of a specified channel.

Query Syntax	CHANnel:MODel? <channel> MODel? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<CRD> represents model number
Examples	CHAN:MOD? 1 MOD? 1
Related Commands	(None)

CHAN:SER
This command sets or queries the power supply's serial number for a specified channel.

Command Syntax	CHANnel:SERial <channel> <CRD> SERI <channel> <CRD>
Parameters	<channel>: 1 –31, channel number <CRD>: 6 characters long
Examples	CHAN:SER 1 B12345; SERI 1 B12543
Query Syntax	CHAN:SER? <NR1> SERI? <NR1>
Returned parameters	<CRD> represents serial number
Related Commands	(None)

CHAN:VERS?
This query returns the power supply's firmware version number for a specified channel.

Query Syntax	CHAN:VERS? <channel>
Parameters	<channel>: 1 –31, channel number
Examples	CHAN:VERS? 1
Returned parameters	<CRD> represents firmware version number
Related Commands	SYST:VERS?

CURRENT SUBSYSTEM

This subsystem programs the output current of the power supply.

CURR
This command directly programs the immediate current level of the power supply. The immediate level is the current applied at the output terminals.

Command Syntax	CURRent[:LEVel][:IMMediate] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: minimum to maximum current value of the channel
Default Suffix	*A*
*RST Value	1.0
Examples	CURR 1 0.500; CURR:LEV 1 30.0
Query Syntax	CURRent[:LEVel] [:IMMediate]? <channel> CURRent[:LEVel] [:IMMediate]? <channel> MAX CURRent[:LEVel] [:IMMediate]? <channel> MIN
Returned Parameters	<NRf>: CURR? returns the present programmed current level. CURR? MAX and CURR? MIN return the maximum and minimum programmable current levels.
Related Commands	*SAV *RST

CURR:TRIG

This command programs the pending current trigger level of the power supply. The pending current trigger level is a stored value that is transferred to the output terminals when a trigger occurs. A pending triggered level is unaffected by subsequent **CURR** commands and remains in effect until the trigger subsystem receives a trigger or an **ABORt** command is given. If there is no pending trigger level, then the query form returns the immediate current limit level.

Command Syntax	CURRent[:LEVel]:TRIGgered <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: minimum to maximum current value of the channel
Default Suffix	*A*
*RST Value	*1.0*
Examples	CURR:TRIG 1 12.000; CURR:LEV:TRIG 1 1.2 CURRent[:LEVel]:TRIGgered? <channel>
Query Syntax	CURRent[:LEVel]:TRIGgered? <channel> MAX
Returned Parameters	CURRent[:LEVel]:TRIGgered? <channel> MIN <NRf> CURR:TRIG? returns the presently programmed triggered level. If no triggered level is programmed, the CURR level is returned. CURR:TRIG? MAX and CURR:TRIG? MIN return the maximum and minimum programmable triggered current levels.
Related Commands	ABOR; CURR; *RST

CURR:PROT:CLE

This command clears the over-current protection status, and it dose not clear the over-current protection setting (**CURR:PROT:STAT**). After this command, output remains in OFF state.

Command Syntax	CURRent:PROTection:CLEar <channel>
Parameter	<channel>: 1-31, channel number
Example	CURR:PROT:CLE 1
Query Syntax	(None)
Related Commands	CURR:PROT:STAT

CURR:PROT:STAT

This command enables or disables the power supply over-current (OC) protection function. If the over-current protection function is enabled and the power supply goes into constant current (CC) mode, then the output is disabled and the Questionable Condition status register OC bit is set (**STAT:QUES?**). An over-current status can be cleared with the **OUTP:PROT:CLE** command.

Command Syntax	CURRent:PROTection:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
*RST Value	OFF
Examples	CURR:PROT:STAT 1 0; CURR:PROT:STAT 1 ON
Query Syntax	CURRent:PROTection:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP:PROT:CLE; *RST

LIST SUBSYSTEM

This subsystem controls the generation of parameter lists that sequence the power supply output through values of voltage and current. Two subsystem commands specify lists of output voltages (**LIST:VOLT**), and currents (**LIST:CURR**), the time interval that each value (point) of a list is to remain in effect (**LIST:VOLT:TIME and LIST:CURR:TIME**), and the list step(**LIST:VOLT:STEP and LIST:CURR:STEP**). A count command (**LIST:COUN**) determines how many times the power supply sequences through a list before that list is completed. Each list can have from 1 to 20 points.

LIST:COUN
This command sets the number of times that the list is executed before it is completed. The command accepts parameters in the range 1 through 60000, but any number greater than 65534.

Command Syntax	LIST:COUNt <channel> <NR1>
Parameters	<Channel>: 1 – 31, channel number
	<NR1>: 1 – 60000, number of times
*RST Value	1
Examples	LIST:COUN 1 3
Query Syntax	LIST:COUNt? <channel>
Returned Parameters	<NR1> number of times
Related Commands	LIST:CURR; LIST:VOLT

LIST:CURR
This command specifies the output current points in a list. The current points are given in the command parameters, which are separated by commas. Up to 20 points may be entered and the output current values specified by the points will be generated in the same order as they were entered.

Command Syntax	LIST:CURRent <channel> <point> <NRf>
Parameters	<channel>: 1 – 31, channel number
	<point>: 1 – 20, point number
	<NRf>: minimum to maximum current value of the channel
Default Suffix	*A*
Examples	LIST:CURR 1 1 2.5
Query Syntax	LIST:CURRent? <channel> <NR1>
Returned Parameters	<NRf>: current level at the point specified by the point number
Related Commands	LIST:CURR:STAT

LIST:CURR:STAT
This command enables or disables the output current list operation state.

Command Syntax	LIST:CURRent:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number
	<bool>: 0 | 1 | OFF | ON
Examples	LIST:CURR:STAT 1 ON; LIST:CURR:STATE 2 OFF
Query Syntax	LIST:CURR:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	LIST:CURR:STEP

LIST:CURR:STEP

This command specifies how current list sequencing occurs in response to enabling current list state (**LIST:CURR:STAT**). If default step (**NONE**) or **AUTO** is sent, enabling list operation state causes the current list to sequence through all its points. The time that a list remains at each point is as specified in the dwell list. As soon as the dwell interval expires, the list moves to the next point. If **ONCE** is sent, after enabling list operation state, a single trigger advances a list only one point. After the specified dwell interval, the list remains at that point until the next trigger occurs.

In either mode, triggers that occur during a dwell interval are ignored.

Command Syntax	LIST:CURRent:STEP <channel> <CRD>
Parameters	<channel>: 1 – 31, channel number
	<CRD>: NONE | AUTO | ONCE, list step
*RST Value	NONE
Examples	LIST:CURR:STEP 1 ONCE; LIST:CURR:STEP 2 AUTO
Query Syntax	LIST:CURRent:STEP? <channel>
Returned Parameters	<CRD>: NONE | AUTO | ONCE, list step
Related Commands	LIST:CURR; LIST:CURR:STAT; LIST:CURR:TIME

LIST:CURR:TIM

This command sets the dwelling time for the output current list of the specified point. Each point specifies the time, in milliseconds, that the output of the power supply is to remain at the level specified by the corresponding point in the current list if the **CURR:LIST:STEP** is set to **NONE** or **AUTO**. At the end of the dwell time, the output of the power supply is set to OFF.

Command Syntax	LIST:CURRent:TIMe <channel> <point> <NR1>
Parameters	<channel>: 1 – 31, channel number
	<point>: list point number
	<NR1>: 1 – 99990, dwelling time
Default Suffix	*ms*
Examples	LIST:CURR:TIM 1 10 1000
Query Syntax	LIST:CURRent:TIMe? <channel> <point>
Returned Parameters	<NR1> dwelling time
Related Commands	LIST:CURR:STAT

LIST:VOLT

This command specifies the output voltage points in a list. The voltage points are given in the command parameters, which are separated by commas. Up to 20 points may be entered and the output voltage values specified by the points will be generated in the same order as they were entered.

Command Syntax	LIST:VOLTage <channel> <point> <NRf>
Parameters	<channel>: 1 – 31, channel number
	<point>: 1 – 20, point number
	<NRf>: minimum to maximum voltage value of the channel
Default Suffix	*V*
Examples	LIST:VOLT 1 1 2.5
Query Syntax	LIST:VOLTage? <channel> <NR1>
Returned Parameters	<NRf>: voltage level at the point specified by the point number
Related Commands	LIST:VOLT:STA

LIST:VOLT:STAT
This command enables or disables the output voltage list operation state.

Command Syntax	LIST:VOLTage:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number
	<bool>: 0 | 1 | OFF | ON
Examples	LIST:VOLT:STAT 1 ON; LIST:VOLT:STATE 2 OFF
Query Syntax	LIST:VOLTage:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	LIST:VOLT:STEP

LIST:VOLT:STEP
This command specifies how voltage list sequencing occurs in response to enabling voltage list state (**LIST:VOLT:STAT**). If default step (**NONE**) or **AUTO** is sent, enabling list operation state causes the voltage list to sequence through all its points. The time that a list remains at each point is as specified in the dwell list. As soon as the dwell interval expires, the list moves to the next point. If **ONCE** is sent, after enabling list operation state, a single trigger advances a list only one point. After the specified dwell interval, the list remains at that point until the next trigger occurs.

In either mode, triggers that occur during a dwell interval are ignored.

Command Syntax	LIST:VOLTage:STEP <channel> <CRD>
Parameters	<channel>: 1 – 31, channel number
	<CRD>: NONE | AUTO | ONCE, list step
*RST Value	NONE
Examples	LIST:VOLT:STEP 1 ONCE; LIST:VOLT:STEP 2 AUTO
Query Syntax	LIST:VOLTage:STEP? <channel>
Returned Parameters	<CRD>: NONE | AUTO | ONCE, list step
Related Commands	LIST:VOLT; LIST:VOLT:STAT; LIST:VOLT:TIME

LIST:VOLT:TIM
This command sets the dwelling time for the output voltage list of the specified point. Each point specifies the time, in milliseconds, that the output of the power supply is to remain at the level specified by the corresponding point in the voltage list if the **VOLT:LIST:STEP** is set to **NONE** or **AUTO**. At the end of the dwell time, the output of the power supply is set to OFF.

Command Syntax	LIST:VOLTage:TIMe <channel> <point> <NR1>
Parameters	<channel>: 1 – 31, channel number
	<point>: list point numner
	<NR1>: 1 – 99990, dwelling time
Default Suffix	*ms*
Examples	LIST:VOLT:TIM 1 10 1000
Query Syntax	LIST:VOLTage:TIMe? <channel> <point>
Returned Parameters	<NR1> dwelling time
Related Commands	LIST:VOLTage:STAT

MEASUREMENT SUBSYSTEM

The commands / queries in this subsystem wither return the current measured at the power supply output terminals or the voltage measured at the sense terminals, or set or query the measurement delay time.

MEAS:CURR?
This query returns the current measured at the power supply output terminals.

Query Syntax	MEASure:CURRent? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*A*
Examples	MEAS:CURR? 1
Returned Parameters	<NRf> measured current value
Related Commands	CURR

MEAS:DEL
This command sets the delay time to obtain read back value for "MEAS:VOLT?" and "MEAS:CURR?" queries.

Command Syntax	MEASure:DELay <NR1>
Parameters	<NR1>: 1 – 5000, delay time
Default Suffix	*ms*
Default value	0 ms
Examples	MEAD:DEL 800
Query Syntax	MEASure:DELay?
Returned Parameters	<NR1> delay time
Related Commands	MEAR:VOLT? MEAS:CURR?

MEAS:VCOUT?
This query returns the voltage and current measured at the power supply sense terminals.

Query Syntax	MEASure:VCOUT? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*None*
Examples	MEAS:VCOUT? 1
Returned Parameters	<NRf> measured voltage and current value
Related Commands	VOLT, CURR

MEAS:VOLT?
This query returns the voltage measured at the power supply sense terminals.

Query Syntax	MEASure:VOLTage? <channel>
Parameters	<channel>: 1 – 31, channel number
Default Suffix	*V*
Examples	MEAS:VOLT? 1
Returned Parameters	<NRf> measured voltage value
Related Commands	VOLT

OUTPUT SUBSYSTEM

This subsystem controls the power supply voltage and current outputs and the optional output relay.

OUTP
This command enables or disables the power supply output. The state of a disabled output is a condition of zero output voltage.

Command Syntax	OUTPut[:STATe] <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | OFF | 1 | ON
*RST Value	0
Examples	OUTP 1 ON OUTP:STAT 1 OFF
Query Syntax	OUTPut[:STATe]? <channel>
Returned Parameters	0 | 1
Related Commands	*RST

OUTP:PROT:CLE
This command clears any over-voltage (OV), over-current (OC), or under-voltage (UV) protection features. The corresponding status bit in STAT:QUES? is also cleared. After this command, the output is remained OFF.

Command Syntax	OUTPut:PROTection:CLEar <channel>
Parameters	<Channel>: 1 – 31, channel number
Examples	OUTP:PROT:CLE 1
Query Syntax	(None)
Related Commands	OUTP:STAT? STAT:QUES?

OUTP:REL
This command is valid only if the power supply is configured for the optional relay connector. Programming **ON** opens the relay contacts; programming **OFF** closes them. The relay is controlled independently of the output state. If the power supply is supplying power to a load, that power will appear at the relay contacts during switching. If the power supply is not configured for the relay connector, sending either relay command has no affect, but the corresponding relay bit **STAT:QUES?** changes accordingly .

Command Syntax	OUTPut:RELay[:STATe] <channel> <bool>
Parameters	<channel>: 1 – 31, channel number <bool>: 0 | 1 | OFF | ON
*RST Value	1
Examples	OUTP:REL 1 1 OUTP:REL 1 OFF
Query Syntax	OUTPut:RELay? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP[:STAT]; *RST

OUTP:REL:POL
This command is valid only if the power supply is configured for the optional relay connector. Programming **NORM**al causes the relay output polarity to be the same as the power supply output. Programming **REV**erse causes the relay output polarity to be opposite to that of the power supply output. If **OUTP[:STAT] = ON** when either relay command is sent, the power supply output voltage is set to 0 during the time that the relays are changing polarity. If the power supply is not configured for the relay connector, sending either relay command has no affect, but the corresponding relay bit **STAT:QUES?** changes accordingly.

Command Syntax	OUTPut:RELay:POLarity <channel> <CRD> | <bool>
Parameters	<channel>: 1 – 31, channel number
	<CRD> | <bool>: NORMal | 0 | REVerse | 1
*RST Value	0 | NORMal
Examples	OUTP:REL:POL 1 NORM
Query Syntax	OUTPut:RELay:POLarity? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP[:STAT] *RST

STATUS SUBSYSTEM

This subsystem programs the power supply status registers. The power supply has three groups of status registers: **Operation, Questionable**, and **Standard Event**. The Standard Event group is programmed with Common commands.

Status Operation Registers

The bit configuration of Status Operation register is shown in the following table:

Bit Configuration of Operation Register Table:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**AUTO**	**ONCE**	**WTG**	**REL**	**POL**	**OV**	**OC**	**CAL**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**NU**	**NU**	**NU**	**PARA**	**LSV**	**LSC**	**TTL**	**OUT**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256

CAL = Interface is computing new calibration constants. OC = The over-current protection operation is ON. OV = The over-voltage protection operation is ON. POL = The relay is in negative position (set to REVerse). REL = The relay operation is connect (set to CLOSE). WTG = Interface waiting for a trigger. ONCE = Stepping on dependant upon the ONCE trigger function. AUTO = Stepping on is depend upon AUTO trigger function. OUT = Output is configured to ON. TTL = TTL shut down. LSC = The current stepping operation is ON. LSV = The voltage stepping operation is ON. PARA = Power supply is in parallel operation mode. NU = Not used.

STAT:OPER?
This query returns the value of the Status Operation Event register. The Event register is a read-only register, which holds (latches) all operation events that are set by users. Reading the Operation Event register does not clear it.

Query Syntax	STATus:OPERation[:EVENt]? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<NR1> Register Decimal Value
Examples	STAT:OPER? 1
Related Commands	*RST

Bit Configuration of Questionable Registers:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**LSC**	**LSV**	**OUT**	**OT**	**CC**	**CV**	**OC**	**OV**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**NU**	**NU**	**TRAC**	**UV**	**ORO**	**UNR**	**TTL**	**POL**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256

OV = Over-voltage protection circuit has tripped. OC = Over-current protection circuit has tripped. CV = The power supply is in constant voltage mode. CC = The power supply is in constant current mode. OT = Over-temperature status condition exists. OUT = Power supply output states. LSV = The voltage list operation. LSC = The current list operation. POL = The relay operation is on negative operation**.** TTL = TTL shut down is occurred. UNR = Power supply output is unregulated. ORO: Output Relay Open = 1, Output Relay Close = 0. UV: Under Voltage Protection: protection was triggered. TRAC: Tracking operation enabled=1. NU = Not used.

STAT:QUES?
This command returns the value of the Questionable Event register. The Event register is a read-only register, which holds (latches) all events that occurred. Reading the Questionable Event register does not clear it.

Query Syntax	STATus:QUEStionable[:EVENt]? <channel>
Parameters	<channel>: 1 – 31, channel number
Returned Parameters	<NR1> Register Decimal Value
Examples	STAT:QUES:EVEN? 1
Related Commands	*RST

STAT:QUES:ENAB
This command sets or reads the value of the Questionable Enable register. This register is a mask for enabling specific bits from the Questionable Event register to set the questionable summary bit of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event Register bits that are enabled by the Questionable Status Enable Register.

Command Syntax	STATus:QUEStionable:ENABle <NRf>
Parameters	0 to 32727
Suffix	(None)
Default Value	0
Example	STAT:QUES:ENAB 18
Query Syntax	STATus:QUEStionable:ENABle?
Returned Parameters	<NR1> Register Decimal Value
Related Commands	STAT:QUES?

SYSTEM SUBSYSTEM

The commands / queries in this subsystem include some millenniums system information, such as setting or querying the maximum number of channels for a controller, EOS mode, error code, and system version.

SYST:BACK
This command sets and queries the power supply LCD backlight mode.

Command Syntax	SYSTem:BACKlight <NR1>
Parameter	<NR1>: 0 – LCD backlight OFF 1 – LCD backlight always ON 2 – LCD backlight OFF 5 minutes after latest key / wheel access.
Default Value	0
Example	SYST:BACKLIGHT 1
Query Syntax	SYSTem:BACKlight?
Returned Parameter	<NR1> represents LCD backlight mode
Related Commands	None

SYST:BUZZ
This command sets and queries the power supply buzzer mode.

Command Syntax	SYSTem:BUZZer <NR1l>
Parameter	<NR1>: 0 | OFF – Buzzer sound OFF 1 | ON – Buzzer sound ON 2 | ALARM – Buzzer sounds during Protection Modes
Default Value	1
Example	SYST:BUZZER 0
Query Syntax	SYSTem:BUZZer?
Returned Parameter	<NR1> represents Buzzer mode.
Related Commands	None

SYST:CHAN:MAX
This command sets and queries the maximum number of the slave channels permitted to connect to the master controller.

Command Syntax	SYSTem:CHANnel:MAXimum <NR1>
Parameter	<NR1>: 1 – 31, maximum channel numbers*
Default Value	1
Example	SYST:CHAN:MAX 8
Query Syntax	SYSTem:CHANnel:MAXimum?
Returned Parameter	<NR1> represented maximum channel numbers
Related Commands	*TST?

<Note> *: After setting a new value for this command, user must power cycle the power supply. Otherwise, the new value does not affect the maximum number of slave channels permitted to connect to the master controller.

SYST:CONS:BAUD
This command sets and queries the RS-232 interface baud rate setting.

Command Syntax	SYSTem:CONSol:BAUD <baudrate>
Parameters	<baudrate>: RS-232 baud rate value
Example	SYST:CONS:BAUD 115200
Query syntax	SYSTem:CONSol:BAUD?
Returned Parameters	<NR1>: Represented the baud rate value
Related Commands	None

SYST:CONS:EOS
This command sets and queries the RS-232 interface EOS mode.

Command Syntax	SYSTem:CONSol:EOS <NR1>
Parameters	<NR1>: 0 – None 1 – CR 2 – LF 3 – CR + LF
Example	SYST:CONS:EOS 1
Query syntax	SYSTem:CONSol:EOS?
Returned Parameters	<NR1>: Represents EOS mode
Related Commands	SYST:EOS

SYST:DEF:OUTP
This command sets and queries the power on output status.

Command Syntax	SYSTem:DEFault:OUTPut <NR1>
Parameters	<NR1>: 0 | 1 0 -- Power ON output status always OFF 1 -- Power ON output status same as the Power OFF status
Example	SYST:DEF:OUTP 1 SYST:DEF:OUTP 0
Query syntax	SYSTem:DEFault:OUTPut?
Returned Parameters	<NR1>: Represented the default power on output status
Related Commands	None

SYST:EOS
This command sets and queries the end of string (EOS) mode for read back of current interface.

Command Syntax	SYSTem:EOS <NR1>
Parameter	<NR1>: 0 – 3, end of string (EOS) mode 0 NONE * 1 CR 2 LF 3 CR + LF (For RS-232 interface only)
Default Value	3
Example	SYST:EOS 1
Query Syntax	SYSTem:EOS?
Returned Parameter	<NR1> represented EOS mode
Related Commands	NONE

<Note> *: If the end of string mode is set to 0 using this command, the returned value is in binary format if users communicate the power supply using National Instrument's Measurement and Automation software.

SYST:ERR?
This query returns the next error message response string from the remote programming error queue. The queue is a FIFO (first-in, first-out) buffer that stores maximum 9 errors as they occur. As it is read, each error is removed from the queue. When all errors have been read, the query returns **255-255-0**.

The error response string format CH-CMD-ERR, containing three fields, where CH indicates the channel number where the error occurs (if error is not related to channel, or no error occurs, this field is 255), CMD indicates the command index (if error is not related to a command or no error occurs, this field is 255. The ERR indicates the actual error code (if no error occurs, this field is 0. Please refer to Appendix A for error code).

Query Syntax	SYSTem:ERRor?
Parameters	(None)
Returned Parameters	<CRD> CH-CMD-ERR
Example	SYST:ERR?

SYST:GPIB:EOS
This command sets and queries the GPIB interface EOS mode.

Command Syntax	SYSTem:GPIB:EOS <NR1>
Parameters	<NR1>: 0 – None 1 – CR 2 – LF 3 – CR + LF
Example	SYST:GPIB:EOS 1
Query syntax	SYSTem:GPIB:EOS?
Returned Parameters	<NR1>: Represents EOS mode
Related Commands	SYST:EOS

SYST:NET:ADDR
This command sets and queries the Ethernet IP address.

Command Syntax	SYSTem:NET:ADDRess [<CRD1>] <CRD2>
Parameters	<CRD>: <CRD1>: serial number <CRD2>: IP address in decimal dot notation
Example	SYST:NET:ADDR 192.168.1.3
Query syntax	SYSTem:NET:ADDRess? [<Serial Number>]
Returned Parameters	<CRD>: Represents IP address
Related Commands	SYST:NET:GATE, SYST:NET:SUBNET

SYST:NET:DHCP
This query reads if the power supply Ethernet configuration is from DHCP server.

Query syntax	SYST:NET:DHCP?
Returned Parameters	<NR1>: 0 – Ethernet configuration is from set up 1 – Ethernet configuration is from DHCP server
Related Commands	SYST:NET:ADDR

SYST:NET:EOS
This command sets and queries the Ethernet interface EOS mode.

Command Syntax	SYSTem:NET:EOS <NR1>
Parameters	<NR1>: 0 – None 1 – CR 2 – LF 3 – CR + LF
Example	SYST:NET:EOS 1
Query syntax	SYSTem:NET:EOS?
Returned Parameters	<NR1>: Represents EOS mode
Related Commands	SYST:EOS

SYST:NET:GATE
This command sets and queries the Ethernet default gateway IP address.

Command Syntax	SYSTem:NET:GATE <CRD>
Parameters	<CRD>: Gateway IP address in decimal dot notation
Example	SYST:NET:GATE 192.168.1.0
Query syntax	SYSTem:NET:GATE?
Returned Parameters	<CRD>: Represents gateway IP address
Related Commands	SYST:NET:ADDR, SYST:NET:SUBNET

SYST:NET:STAT
This query reads Ethernet configuration state.

Query syntax	SYST:NET:STATe?
Returned Parameters	<CRD>: Represents the net configuration state containing the following fields: <serial number>: power supply serial number <DHCP flag>: if net setting is from DHCP or not <ip address>: power supply unit IP address <idn string>: same as "*IDN?" query string
Related Commands	CHAN:SER, SYST:NET:DHCP, SYST:NET:IP, *IDN?

SYST:NET:SUBN
This command sets and queries the Ethernet subnet value.

Command Syntax	SYSTem:NET:SUBNet <CRD>
Parameters	<CRD>: Subnet value in decimal dot notation
Example	SYST:NET:SUBNET 255.255.255.0
Query syntax	SYSTem:NET:SUBNet?
Returned Parameters	<CRD>: Represents subnet value
Related Commands	SYST:NET:ADDR, SYST:NET:GATE

SYST:PROT?

This query can only be used after SRQ is properly set. It reads the Protect Event Status register, which contains channel number where protection has occurred. A 1 in any Protect Event Status register bit position indicates that the protected channel number is the bit position plus 1**.**

Query Syntax	SYST:PROT? PROT:CHAN?
Parameters	(None)
Returned Parameters	Hexadecimal string (with &H) representing protect register value
Examples	"&H00000020" indicates protection occurred at channel 6
Related Commands	(None)

BIT CONFIGURATION OF PROTECT REGISTER IS SHOWN IN THE FOLLOWING TABLE:

Bit Position	7	6	5	4	3	2	1	0
Channel	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
Bit Weight(hex)	80	40	20	10	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Channel	**16**	**15**	**14**	**13**	**12**	**11**	**10**	**9**
Bit Weight(hex)	8000	4000	2000	1000	800	400	200	100
Bit Position	23	22	21	20	19	18	17	16
Channel	**24**	**23**	**22**	**21**	**20**	**19**	**18**	**17**
Bit Weight(hex)	800000	400000	200000	100000	80000	40000	20000	10000
Bit Position	31	30	29	28	27	26	25	24
Channel	**32**	**31**	**30**	**29**	**28**	**27**	**26**	**25**
Bit Weight(hex)	80000000	40000000	20000000	10000000	8000000	4000000	2000000	1000000

SYST:VERS?

This query returns the power supply's controller firmware version. The returned value is of the form "FV:x.xx" where x.xx is the firmware revision number.

Query Syntax	SYSTem:VERSion?
Parameters	(None)
Returned Parameters	<CRD>
Example	SYST:VERS?
Related Commands	*IDN?

SYST:INH:STAT

This command sets and queries the Remote Inhibit (RI) Shutdown Mode

Command Syntax	SYST:INH:STAT <NR1>
Parameters	<NR1>: 0 – **LATCH:** Output off & protection mode latches system 1 – **LIVE:** Output auto-recovers once protection is cleared 2 – **OFF**: Remote Inhibit (RI) Shutdown function disabled
Example	SYST:INH:STAT 1
Query syntax	SYST:INH:STAT?
Returned Parameters	<NR1>: Represents RI Shutdown mode
Related Commands	NONE

TRIGGER SUBSYSTEM

This subsystem controls the triggering of the power supply.

TRIG
This command initiates a pending level change as specified by **CURR[:LEV]:TRIG** or **VOLT[:LEV]:TRIG** and clears the WTG bit in the Status Operation Condition register.

Command Syntax	TRIGger[:STARt][:IMMediate]
Parameters	(None)
Examples	TRIG TRIG: IMM
Query Syntax	(None)
Related Commands	ABOR; CURR:TRIG; *TRG; VOLT:TRIG

Note: The function of **TRIG** is similar to ***TRG** command except that the trigger is enabled by software in this command, and it is enabled through hardware method in ***TRG** command. Most of the time, they can be used interchangeably. But there is one exception: In parallel operation mode, due to some speed constraints, it's better for users to choose **"TRIG"** command to enable trigger instead of "***TRG**" command.

TRIG:DEL
This command sets the time delay between the detection of an event on a trigger source and the start of any corresponding trigger action on the power supply's output.

Command Syntax	TRIGger[:STARt]:DELay <channel> <NR1>
Parameters	<channel>: 1 – 31, channel number <NR1>: 0 – 32000, delay time in millisecond
Default Suffix	*ms*
*RST Value	0
Examples	TRIG:DEL 1 1000
Query Syntax	TRIGger[:STARt]:DELay? <channel>
Returned Parameters	<NR1> delay time in millisecond
Related Commands	ABOR CURR:TRIG *TRG TRIG VOLT:TRIG

VOLT SUBSYSTEM

This subsystem programs the output voltage of the power supply.

VOLT

This command directly programs the immediate voltage level of the power supply. The immediate level is the voltage applied at the output terminals.

Command Syntax	VOLTage[:LEVel] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: minimum to maximum voltage value of the channel
Default Suffix	*V*
*RST Value	5.0
Examples	VOLT 1 0.500; VOLT:LEV 1 30.0
Query Syntax	VOLTage[:LEVel]? <NR1> VOLTage[:LEVel]? <NR1> MAX VOLTage[:LEVel]? <NR1> MIN
Returned Parameters	<NRf>: VOLT? returns the present programmed volatge level. VOLT? MAX and VOLT? MIN return the maximum and minimum programmable voltage levels.
Related Commands	*SAV *RST

VOLT:PROT

This command sets the over-voltage protection (OVP) level of the power supply. If the output voltage exceeds the OVP level, and the **VOLT:PROT:STAT** is set to ON, then the power supply output is disabled and the Questionable status register (**STAT:QUES?**) OV bit is set . An over-voltage condition can be cleared with the **OUTP:PROT:CLE or VOLT:PROT:CLE or *RST** command after the condition that caused the OVP trip is removed.

Command Syntax	VOLTage:PROTection[:LEVel] <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number <NRf>: 5.0% to 110% of maximum voltage level
Default Suffix	*V*
*RST Value	110% of maximum voltage level
Examples	VOLT:PROT 1 25.0; VOLT:PROT:LEV 1 33.0
Query Syntax	VOLTage:PROTection[:LEVel]? <channel>
Returned Parameters	<NRf> represents presently programmed OVP level
Related Commands	OUTP:PROT:CLE; VOLT:PROT:CLE; *RST; *SAV

VOLT:PROT:CLE

This command clears the over-voltage protection status, and it dose not clear the over-voltage protection setting (**VOLT:PROT:STAT**). After this command, output remains in OFF state.

Command Syntax	VOLTage:PROTection:CLEar <channel>
Parameter	<channel>: 1-31, channel number
Example	VOLT:PROT:CLE 1
Query Syntax	(None)
Related Commands	VOLT:PROT:STAT

VOLT:PROT:STAT
This command enables or disables the power supply over-voltage (OV) protection function. If the over-voltage protection function is enabled and the output voltage exceeds the OVP level, then the output is disabled and the Questionable Condition status register (**STAT:QUES?**) OV bit is set. An over-voltage status can be cleared with the **OUTP:PROT:CLE, VOLT:PROT:CLE or *RST** command.

Command Syntax	VOLTage:PROTection:STATe <channel> <bool>
Parameters	<channel>: 1 – 31, channel number
	<bool>: 0 | 1 | OFF | ON
*RST Value	OFF
Examples	VOLT:PROT:STAT 1 0; VOLT:PROT:STAT 1 ON
Query Syntax	VOLTage:PROTection:STATe? <channel>
Returned Parameters	0 | 1
Related Commands	OUTP:PROT:CLE; VOLT:PROT:CLE; *RST

VOLT:TRIG
This command programs the pending triggered voltage level of the power supply. The pending triggered voltage level is a stored value that is transferred to the output terminals when a trigger occurs. A pending triggered level is unaffected by subsequent **VOLT:LEV[:IMM]** commands and remains in effect until the trigger subsystem receives a trigger or an **ABORt** command is given

Command Syntax	VOLTage[:LEVel]:TRIGgered <channel> <NRf>
Parameters	<channel>: 1 – 31, channel number
	<NRf>: minimum to maximum voltage level
Default Suffix	*V*
*RST Value	*5.0*
Examples	VOLT:TRIG 1 25; VOLT:LEV:TRIG 1 22.0
Query Syntax	VOLTage[:LEVel]:TRIGgered? <channel>
Returned Parameters	<NRf> the presently programmed voltage level.
	If the TRIG level is not programmed, the VOLT level is returned.
Related Commands	ABOR; VOLT; *RST

NON-SCPI COMMANDS AND THEIR EQUIVALENT SCPI COMMANDS

In order to comply with AMREL old PD firmware version, some Non-SCPI commands are still supported in this version. However, most of the Non-SCPI commands have an equivalent SCPI commands, and some of them don't. Table below shows the corresponding SCPI command for each Non-SCPI command. Others without mapping SCPI commands are also displayed in the following section.

Non-SCPI Command and Equivalent SCPI Command Table:

Non-SCPI Command	Equivalent SCPI Command
CURR:CAL:SAV	CAL:CURR:SAVE
MOD?	CHAN:MOD?
PROT:CHAN?	SYST:PROT?
SERI	CHAN:SER
SYST:OFFS	CAL:OFFS
SYST:SLOPE	CAL:SLOP
VOLT:CAL:SAV	CAL:VOLT:SAVE

SYST:CHAN
This command sets the current active channel.

Command Syntax	SYST:CHAN <channel>
Parameters	Channel number: 1 – 31
Example	SYST:CHAN 2 (sets channel 2 as current active channel)
Query Syntax	SYST:CHAN?
Returned Parameters	<NR1>: Representing current active channel.

SYST:STATUS?
This query reads the value from status register.

Query Syntax	SYST:STATUS? <channel>
Parameters	Channel numbers: 1 – 31
Returned parameters	Decimal value representing status register

Bit configurations for status register table:

Bit Position	7	6	5	4	3	2	1	0
Bit Weight	128	64	32	16	8	4	2	1
Definition	CC/CV	NU	NU	OC Set	OV Set	OUT	OV	OC

OC: Over-current protection circuit has tripped; OV = Over-voltage protection circuit has tripped; OUT: Output is set to ON; OV Set: OVP is set to ON; OC Set: OCP is set to ON; NU: not used; CC/CV: 0 means PD unit is in CC mode, 1 means PD unit is in CV mode.

TRAC
This command sets the synchronous behavior for each channel.

Command Syntax	TRACk <Master channel> <Slave channel>
Parameters	Master channel number: 0 –31 (if this parameter is 0, this command affects all channels connected to one controller). Slave Channel number: 0 –31 (except the master channel number. If this parameter is 0, this command affects all channels connected to one controller).
Example	TRAC 1 2; TRACK 1 3 – Sets three channels (1, 2, 3) in a tracking group.
Query Syntax	TRAC? <CHAN>
Returned Parameters	<CRD> -- represents track state. MTR: Master channel TR: Slave channel NONE: Not in track group

TRAC:CLE
This command clears all channels inside the track group.

Command Syntax	TRAC:CLE <Master channel>
Parameters	Master channel: channel number, 1 – 31
Example	TRAC:CLE 1
Query Syntax	TRAC:CLE <Master channel>

IEEE 488.1 COMMANDS AND THEIR EQUIVALENT SCPI COMMANDS

In order to comply with AMREL old PD IEEE 488.1 firmware option, some IEEE 488.1 commands are still supported in this version. However, each IEEE 488.1 command has an equivalent SCPI command. The following table shows the corresponding SCPI command for each IEEE 488.1 command.

IEEE 488.1 Commands and Equivalent SCPI Command:

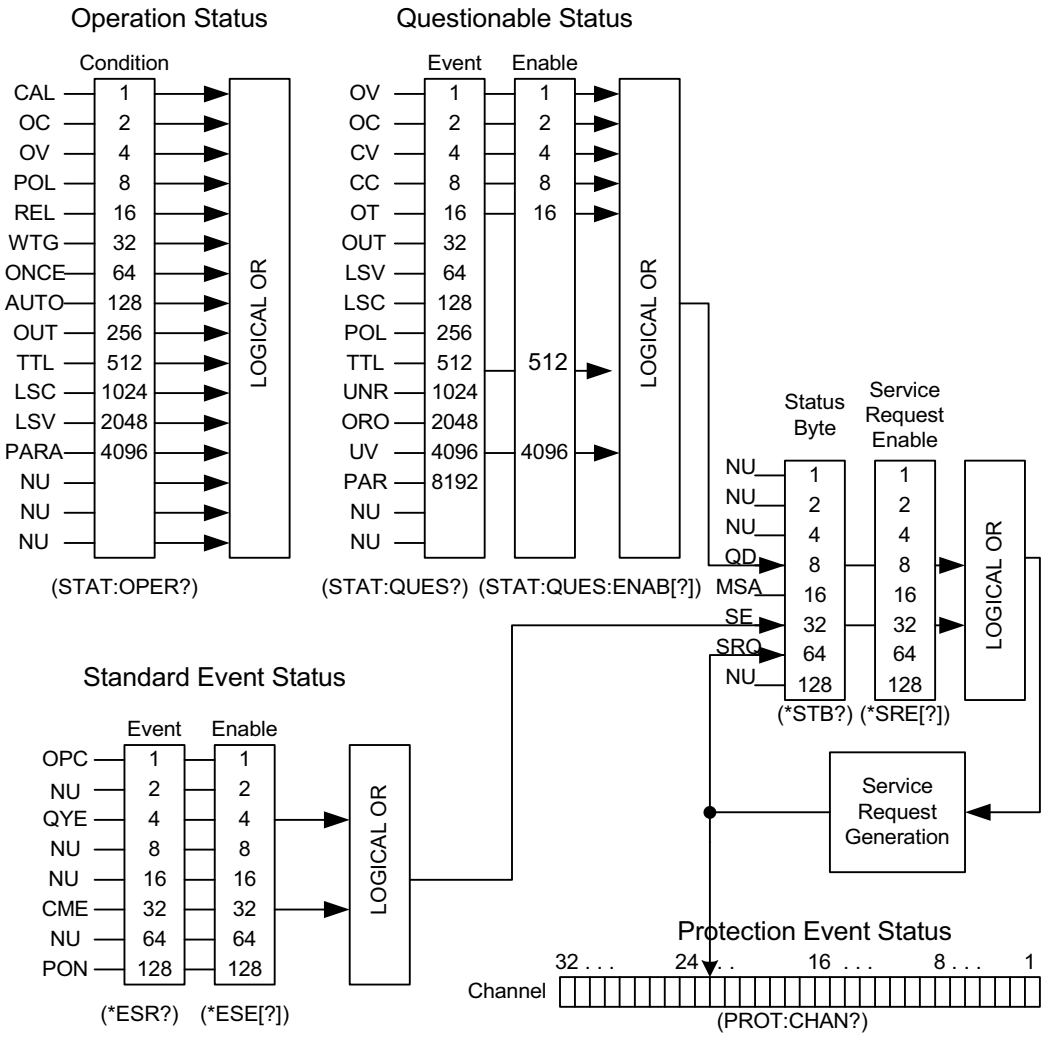
Command	Equivalent SCPI command
IOUT? <channel>	MEAS:CURR? <channel>
IOUT1?	MEAS:CURR? 1
IOUT2?	MEAS:CURR? 2
ISET <channel> <value>	CURR <channel> <value>
ISET1 <value>	CURR 1 <value>
ISET2 <value>	CURR 2 <value>
ISET? <channel>	CURR? <channel>
ISET1?	CURR? 1
ISET2?	CURR? 2
OCP <channel> <bool>	CURR:PROT:STAT <channel> <bool>
OCP1 <bool>	CURR:PROT:STAT 1 <bool>
OCP2 <bool>	CURR:PROT:STAT 2 <bool>
OUT <channel> <bool>	OUTP <channel> <bool>
OUT1 <bool>	OUTP 1 <bool>
OUT2 <bool>	OUTP 2 <bool>
OVP <channel> <bool>	VOLT:PROT:STAT <channel> <bool>
OVP1 <bool>	VOLT:PROT:STAT 1 <bool>
OVP2 <bool>	VOLT:PROT:STAT <bool>
OVSET <channel> <value>	VOLT:PROT <channel> <value>
OVSET1 <value>	VOLT:PROT 1 <value>
OVSET2 <value>	VOLT:PROT 2 <value>
OVSET? <channel>	VOLT:PROT? <channel>
OVSET1?	VOLT:PROT? 1
OVSET2?	VOLT:PROT? 2
STATUS?	N / A *
VOUT? <channel>	MEAS:VOLT? <channel>
VOUT1?	MEAS:VOLT? 1
VOUT2?	MEAS:VOLT? 2
VSET <channel> <value>	VOLT <channel> <value>
VSET1 <value>	VOLT 1 <value>
VEST2 <value>	VOLT 2 <value>
VSET? <channel>	VOLT? <channel>
VSET1?	VOLT? 1
VSET2?	VOLT? 2

<Note> *: For IEEE 488.1 option status reporting, please refer to 6.2 Status reporting – Non-SCPI command status reporting part of this manual.

STATUS REPORTING

SCPI GPIB Command Status Reporting

The following figure shows the SCPI GPIB command status model of the power supply.



The above figure shows the status register structure of the power supply. The Standard Event, Status Byte, and Service Request Enable registers perform standard GPIB functions. The Operation Status, Questionable Status, and Protection Event Status registers implement status functions specific to the power supplies. Bit configuration for each register is also shown in the above figure.

Operation status register

The Operation Status Condition register latches any operation condition that is passed to the power supply by users. It is a read-only register. Use "STAT:OPER?" query to read the register, but not clear it.

Questionable Status group

The Questionable Status group consists of two registers. The Questionable Status Event register holds real-time status of the power supply. It is a read-only register. Use "STAT:QUES?" query to read it, but not clear it. The Questionable Status Enable register is a mask for enabling specific bits from the Questionable Event register to set the Questionable Data (QD) bit of the Status Byte register. This bit (bit 3) is the logical OR of all the Questionable Event register bits that are enabled by the Questionable Status Enable register. Use "STAT:QUES:ENAB" command to set or read this register.

Standard Event Status group

Standard Event Status group consists of an Event register and an Enable register that are programmed by COMMON commands. The Standard Event register latches events relating to interface communication status. It is a read-only register. The Standard Event Enable register functions similarly to the enable registers of the Questionable Status Enable register. The common "***ESE"** command programs specific bits in the Standard Event Status Enable register. "***ESR?"** reads the Standard Event Status Event register. Reading the register clears it.

Status byte and Service Request Enable registers

Status Byte register summarizes the information from all other status groups. The register can be read by "***STB?".** Whenever the power supply requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller services the interrupt, RQS is cleared inside the register and returned in bit position 6 of the response. The remaining bits of the Status Byte register are not disturbed. No bits of the Status Byte register are cleared by reading it.

Service Request Enable register determines which bits from the Status Byte register are allowed to generate SRQ using "***SRE**" common command.

Users can determine the reason for an SRQ by the following actions:

- Use the "***STB?"** query to determine which summary bits are active.
- Read the corresponding Event register for each summary bit to determine which events caused the summary bit to be set. If it is caused by Questionable Data (QD) bit of the Status Byte register, users must read the Protection Event Status register to determine the actual channel number where the SRQ is generated.
- The interrupt will recur until the specific condition that caused the event is removed.

Protection Event Status register

Protection Event Status register stores the channel number where a service request is occurred if it is caused by the Questionable Data (QD) bit of the Status Byte register. Use **"SYST:PROT?"** query to read it but not clear it. It is cleared only after the specific condition that caused the event is removed.

Non-SCPI Command Status Reporting *

A status register is used for Non-SCPI command status reporting. This register also monitoring the real-time status condition of the power supply. Each output channel has an 8 bit register which signifies a true condition as "1" and a false condition as "0". These bit conditions stay true as long as the condition is true. **The status word received is in decimal format, and needs to be converted to binary format.** Each bit is assigned a particular condition. Use **"STATUS?"** query to read the register.

<Note> *: This status reporting model only applies to maximum two slave units connected to a master controller and the channel numbers are set to 1 or 2. Byte 1 is for channel 1 and Byte 2 is for channel 2.

Bit configuration of Status register:

Bit Position	7	6	5	4	3	2	1	0
Bit Name	**BEEP**	**NU**	**CC/CV**	**OV**	**OC**	**OCP**	**OUT**	**ERR**
Bit Weight	128	64	32	16	8	4	2	1
Bit Position	15	14	13	12	11	10	9	8
Bit Name	**NU**	**TRACK**	**CC2/CV2**	**OV2**	**OC2**	**OCP2**	**OUT2**	**CHAN**
Bit Weight	32768	16384	8192	4096	2048	1024	512	256
ERR = Error message. 0 – no error; 1 – error. OUT = output status. 0 – Output ON; 1 – Output OFF. OCP = OCP setting. 0 – OCP disabled; 1 – OCP enabled. OC = Over-current protection circuit has tripped. 0 – Normal; 1 – OC tripped. OV = Over-voltage protection circuit has tripped. 0 – Normal; 1 – Tripped. CV = CC or CV mode. 0 – CV mode; 1 – CC mode. NU = Not used. BEEP = Audible indicator setting. 0 – OFF; 1 – ON. CHAN = Active channel. 0 – channel 1; 1 – channel 2. OCP2 = OCP setting in channel 2. 0 – OCP disabled; 1 – OCP enabled. OC2 = Over-current protection circuit has tripped in channel 2. 0 – Normal; 1 – OC tripped. OV2 = Over-voltage protection circuit has tripped in channel 2. 0 – Normal; 1 – Tripped. CV2 = CC or CV mode in channel 2. 0 – CV mode; 1 – CC mode. TRACK = Tracking mode setting for dual channel model. 0 – OFF; 1 – ON.								

COMMAND INDEX AND ERROR CODE FOR "SYST:ERR?" QUERY

Command index for SYST:ERR? query:

*RST	0		SERI	32		SYST:CHAN	118
*CLR	1		*VRF	34		CAL:CURR:LEV	119
VOLT:PROT:CLE	2		LIST:CURR	40		CAL:VOLT:LEV	120
CURR:PROT:CLE	3		LIST:CURR:TIME	41		SYST:SLOPE	121
OUTP:PROT:CLE	4		LIST:VOLT	42		SYST:OFFSET	122
CAL:STAT	5		LIS:VOLT:TIME	43		CHAN:VERS	123
VOLT:PROT:STAT	6		CAL:SAVE	50		PROT:CHAN	125
CURR:PROT:STAT	7		CURR:CAL:SAVE	58		TRAC	126
OUTP	8		VOLT:CAL:SAVE	59		TRAC:CLE	127
OUTP:REL	9		UND:PROT:CLE	70		PARA:CLE	171
OUTP:REL:POL	10		MEAS:VOLT(VOUT)	97		PARA:CURR	172
LIST:VOLT:STEP	11		MEAS:CURR(IOUT)	98		PARA :GROU	173
LIST:CURR:STEP	12		ABOR	101		PARA:OUTP:TRIG	174
LIST:VOLT:STAT	13		*OPC	102		PARA:OUTP:REL	175
LIST:CURR:STAT	14		CAL:VOLT	103		PARA:STAT	176
*SAV	16		*IDN	105		PARA:VOLT	177
UND:PROT:STAT	17		*TST	109		PARA:OUTP:REL:POL	178
SHUT:DOWN	19		*ESR	110		*ESE	180
VOLT(VSET)	20		*TRG (TRIG)	111		SYST:CHAN:MAX	181
VOLT:TRIG	21		SYST:ERR	112		MEAS:DEL	182
CURR(ISET)	22		SYST:VERS	113		SYST:EOS	183
CURR:TRIG	23		STAT:OPER	114		*SRE	184
VOLT:PROT(:LEV)	24		STAT:QUES	115		*STB	185
TRIG:DEL	25		CAL:CURR	116		STAT:QUES:ENAB	186
LIST:COUN	31		MODEL	117		SYST:DEF:OUTP	187

Error code for SYST:ERR? Query:

01: RS485 busy, the master controller is communicating with power supply.
02: RS485 error, power supply receives command error.
03: RS485 error, SPLR-MC1 controller time out error. Controller sends data to power
supply but no response.
04: RS485 error, output voltage and current measurement errors.
20: GPIB error, GPIB command parameter error.
30: GPIB error, power supply command is not selected or missed.
50: GPIB error, GPIB command not in the list.
60: GPIB error, try to send a command to a channel already in a parallel group.
70: GPIB error, command error during parallel operation.

SEVEN: CALIBRATION

INTRODUCTION

WARNING

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 40V. Filter capacitors store potentially dangerous energy for some time after power is removed.

This procedure describes calibration for the AMREL Programmable DC Power Supply. The supply is calibrated either through local or remote control. The following information provides calibration procedures in local and remote mode.

NO hardware adjustment is necessary since all calibration is accomplished by software. The software sends calibration constants to the supply via the front panel keys. To maintain power supply's precision output. It is recommended that the power supply should calibrate on an annually basis.

The four parameters that need be calibrated are output voltage, output current, readback voltage and readback current. After all the power supply parameters are calibrated, the supply returns to normal operating condition. If there are any errors in the calibration, cycle the power and recalibrate. All constants are saved in a non-volatile EEPROM.

CALIBRATION SERVICE ENVIRONMENT AND PRECAUTIONS

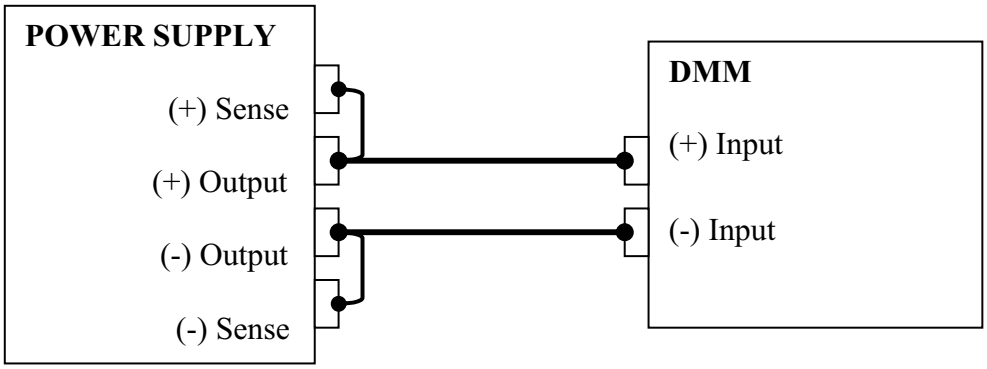
- Follow established antistatic procedures.
- Work at a bench with adequate room and support for the test unit and for all equipment required.
- To reduce shock hazard, use only an insulated, straight-bladed screwdriver when calibrating.
- NEVER calibrate these units alone. Ensure that someone is present who can help should an accident occur.

CALIBRATION CONFIGURATION

You will need the following equipment when calibrating your power supply:

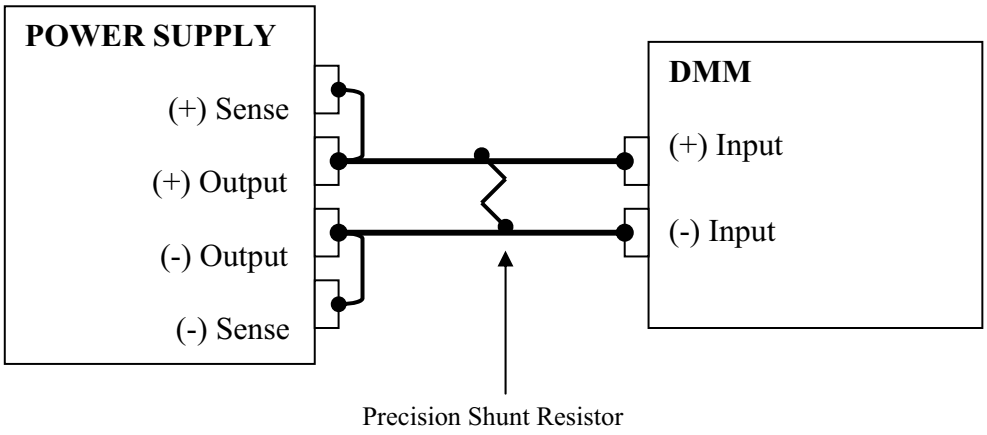
- 5 ½ digit true RMS voltmeter (DMM) (±0.05% accuracy) with test leads
- Current shunt 0.01 or 0.001 ohm and connecting wire.

If your product requires calibration and need calibration kit, please contact our sales department at 1-800-654-9838 for more detail information.



<NOTE>: JUMPER MUST SET BETWEEN +S AND +OUTPUT, –S AND –OUTPUT.

FIGURE 5.1 VOLTAGE CALIBRATION CONFIGURATION



<NOTE>: JUMPER MUST SET BETWEEN +S AND +OUTPUT, –S AND –OUTPUT.

FIGURE 5.2 CURRENT CALIBRATION CONFIGURATION

LOCAL CALIBRATION (ENCODER & ETHERNET OPTION ONLY)

The following steps describe the calibration procedure of the supply via front panel keypads in local mode.

CAUTION

In these procedures, voltages and currents may exceed full-scale value. Take all necessary precautions.

STEPS:

1. Disconnect all loads from the supply.
2. Strap the supply for local sensing.
3. Connect the DMM to the +S and -S rear terminals as in figure 5.1 for CV calibration and figure 5.2 for CC calibration.
4. Turn on the power supply.
5. Press RELAY key first (locate at the front panel keypad) and will show:
   (ONLY APPLY TO UNITS WITH ISOLATION RELAY FUNCTION)

   1-CLOSE 2-REVERSE
   ENTER/CLEAR TO EXIT

   (Press 1 to select "Close" parameter, and then press ENTER key to accept the command)

1. Press **0** and **ENTER** keys simultaneously to get into Calibration mode.
2. Press "CHANNEL" key to select the active channel to be calibrate.
3. Press "VOLT" key to select voltage calibration. Wait till the second row of the LCD displays "LO=", enter the measured value from the DMM and press ENTER key.
4. Repeat for "MI=" (middle) and "HI=" (high) level calibration.
5. When "SUCCESS" is displayed, the voltage calibration is finish.
6. Press "CURR" key to select current calibration. Similar to voltage calibration steps.
7. Press "CHANNEL" key to select next channel for calibration if necessary and follow from step 8.
8. Press "OV/TIME" key to select Over-voltage calibration. Wait until "SUCCESS" is displayed. This procedure is automatically done by the unit itself.
   Note: Over voltage calibration can only be performed after voltage calibration is done.
9. Press "UTILITY" (LOCAL) key to save calibration data. Wait until "SUCCESS" is displayed and the calibration is finished.
10. Press "CLEAR" key to go back to metering mode.

LOCAL CALIBRATION IS NOW COMPLETE.

LOCAL CALIBRATION (IEEE-488.2 OPTION ONLY)

The following steps describe the calibration procedure of the supply via front panel keypads in local mode.

CAUTION

In these procedures, voltages and currents may exceed full-scale value. Take all necessary precautions.

STEPS:

1. Disconnect all loads from the supply.
2. Strap the supply for local sensing.
3. Connect the DMM to the +S and -S rear terminals as in figure 5.1 for CV calibration and figure 5.2 for CC calibration.
4. Turn on the power supply.
5. Press RELAY key first (locate at the front panel keypad) and will show:
   (ONLY APPLY TO UNITS WITH ISOLATION RELAY FUNCTION)

   1-CLOSE 2-REVERSE
   ENTER/CLEAR TO EXIT

   Press 1 to select "Close" parameter, then press ENTER key to accept the command.

6. **FOLLOW CV MODE CALIBRATION STEP BELOW:**
   (Due to adjusting Calibration to test Low, Mid, High Count Functions)
   Press **0** and **ENTER** keys simultaneously to get into Calibration mode.

CALIBRATION VOLTAGE	Then press key number 8.
CV LOW: 6374 VOLT [XXX] V	Reading the voltage on voltmeter and enter value on the XXX section and press ENTER key. Then press key number 8. (The value V: 6374 is varied by difference model unit)
CV MID: 17842 VOLT [XXX] V	Reading the voltage on the voltmeter and enter value on the XXX section and press ENTER key. Then press key number 8. (The value V: 17842 is varied by difference model unit)
CV HIGH: 47891 VOLT [XXX] V	Reading the voltage on the voltmeter and enter value on the XXX section and press ENTER key. Then press key number 8. (The value V: 47891 is varied by difference model unit)
CV CALIBRATION CALCULATION ?	Press the ENTER key.
CV CALIBRATION CALCULATION OK	Press the ENTER key to save the CV calibration. If the CV values are unsure, press key number 2, will back to CALIBRATION VOLTAGE.
CALIBRATION VOLTAGE	After pressed ENTER, the display will show , press key number 6 will show the follow step for Constant Current Calibration procedure.

CALIBRATION CURRENT	Disconnect the voltmeter, Connect Current Shunt (0.01ohm) and Current meter or DMM direct to the power supply as shown in Figure 5.2. Then press key number 8.

<NOTE>: Reading the Current meter value at Low point and calculate the current value by applying the formula: **(I = V/R)**.

Example: DMM meter value reads V = 18.091mV and the Current Shunt used 0.01ohm = R.
R is varied by different current shunt's value used.

I = 18.091mV / 0.01ohm = 1809.1mA
I = 1.8091A

Enter the Calculated current value "I" = 1.8091A on the CALIBRTE LOW cnt section mode and press ENTER key.

FOLLOW CC MODE CALIBRATION STEP BELOW:

CALIBRATION CURRENT	Press key number 8.
CC LOW: 5617 CURR [XXX] A	Reading the voltage on voltmeter divide "R" and enter "I" value in to the XXX section and press ENTER key. Then press key number 8. (The value 5617 is varied by difference model unit)
CC MID: 17078 CURR [XXX] A	Reading the voltage on the voltmeter divide "R" and enter "I" value in to the XXX section and press ENTER key. Then press key number 8. (The value 17078 is varied by difference model unit)
CC HIGH: 47085 CURR [XXX] V	Reading the voltage on the voltmeter divide "R" and enter "I" value on the XXX section and press ENTER key. Then press key number 8. (The value 47085 is varied by difference model unit)
CC CALIBRATION CALCULATION ?	Press the ENTER key.
CC CALIBRATION CALCULATION OK	Press the ENTER key to save the CC calibration. If the CC values are unsure, press key number 2, will back to CALIBRATION CURRENT.

Press clear key to back to main menu.
Press "6" & "ENTER" key simultaneously to save all new calibration data into the power supply's memory.

LOCAL CALIBRATION IS NOW COMPLETE.

REMOTE CALIBRATION

The PD Series can be calibrated via computer commands. Therefore, it is not necessary to remove the power supply from the system. Please follow the following procedures to do calibration remotely.

CV MODE calibration:

1. CAL:STAT <channel> ON – enables the calibration mode
2. CAL:VOLT:LEV <channel> MIN – power supply sends a low voltage to output.
3. Read voltage value from DMM and send this value to the power supply.
4. CAL:VOLT <channel> value – sends read voltage value to power supply.
5. CAL:VOLT:LEV <channel> MID – power supply sends a middle voltage to output.
6. Read voltage value from DMM and send this value to the power supply.
7. CAL:VOLT <channel> value –sends read voltage value to power supply
8. CAL:VOLT:LEV <channel> MAX – power supply sends a high voltage to output.
9. Read voltage value from DMM and send this value to the power supply.
10. CAL:VOLT <channel> value –sends read voltage value to power supply
11. CAL:SAVE <channel>- calculates new voltage calibration data.
12. CAL:STAT<channel. OFF – disables the calibration mode
13. *SAV <channel>– saves all calibration data to internal flash memory
14. Wait about 2-3 minutes

CC MODE Calibration:

15. CAL:STAT <channel> ON – enables the calibration mode
16. CAL:CURR:LEV <channel> MIN – power supply sends a low voltage to output.
17. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
18. CAL:CURR <channel> value – sends calculated current value to power supply.
19. CAL:CURR:LEV <channel> MID – power supply sends a middle voltage to output.
20. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
21. CAL:CURR <channel> value – sends calculated current value to power supply.
22. CAL:CURR:LEV <channel> MAX – power supply sends a high voltage to output.
23. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
24. CAL:CURR <channel> value –sends calculated current value to power supply
25. CAL:SAVE <channel> – saves new current calibration data.
26. CAL:STAT<channel. OFF – disables the calibration mode
27. *SAV <channel> – saves all calibration data to internal flash memory save calibration data to channel's Flash Rom.
28. Wait about 2-3 minute

CC MODE LOW RANGE Calibration (OPTIONAL)

29. CURR <channel> 0.5 - set current less than low range max value (1 Amp)
30. CURR:RANGE <channel> 0 – change to low range current function.
31. CAL:STAT <channel> 2 – enables the calibration mode
32. CAL:CURR:LEV <channel> MIN – power supply sends a low voltage to output.
33. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
34. CAL:CURR <channel> value – sends calculated current value to power supply.
35. CAL:CURR:LEV <channel> MID – power supply sends a middle voltage to output.
36. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
37. CAL:CURR <channel> value – sends calculated current value to power supply.
38. CAL:CURR:LEV <channel> MAX – power supply sends a high voltage to output.
39. Read voltage value from DMM. Divide value (volts) by the current shunt resistance (ohms) to obtain calculated current value. Send this value to the power supply.
40. CAL:CURR<channel> value –sends calculated current value to power supply
41. CAL:SAVE <channel> – saves new current calibration data.
42. CAL:STAT<channel. OFF – disables the calibration mode
43. *SAV <channel> – saves all calibration data to internal flash memory
44. Wait about 2-3 minute

Remote Calibration is now complete.

APPENDIX A: EXTERNAL ANALOG PROGRAMMING

The voltage and current outputs of the PD series can be programmed by an external analog voltage. The outputs are linearly proportioned to an ***external input voltage from 0 to 10 volts***. The external analog programming mode is activated by setting these parameters via the front panel or GPIB bus, ***VSET to 0V, ISET to a proper value for CV operation***, or setting ***ISET to 0A and VSET to a proper value for CC operation***.

To control the output voltage with the analog programming mode requires the following procedure: apply the ***external 0 to 10V source*** (Xv) between **Pin-2 (positive)** and **Pin-1 (common)**. These input terminals are located at the rear of the power supply.

The output voltage is derived by the following equation:

$$\mathbf{Vout} = x_v \left(\frac{V\max}{10} \right)$$

Variable	*Definition*
Vout	Voltage requirement
Xv	External voltage
Vmax	Rated maximum output voltage

To control the output current with the analog programming mode requires the following procedure, apply the ***external 0 to 10V source*** (Xv) between **Pin-4 (positive)** and **Pin-1(common)**.

The output current is derived by the following equation:

$$\mathbf{Iout} = x_v \left(\frac{\mathrm{Im}\,ax}{10} \right)$$

Variable	*Definition*
Iout	Current requirement
Xv	External voltage
Imax	Rated maximum output current

To control both voltage and current simultaneously in the external programming method **requires that the user apply two separately isolated 0 to 10V supplies.**

NOTES: *The V and I terminals are at a negative sense potential; with this in mind do not connect them to any other terminal on the rear panel. This precaution will prevent permanent damage to the power supply!*

External analog programming port

Pin-#	assignment	I/O	function
1	Return (-)	output	Ext. V/I Prog. (-)
2	Voltage Prog.	output	Ext. Vprog. (+)
3	N/A	N/A	N/A
4	Current Prog.	output	Ext. Iprog. (+)
5	N/A	N/A	N/A
6	N/A	N/A	N/A
7	N/A	N/A	N/A
8	N/A	N/A	N/A
9	N/A	N/A	N/A