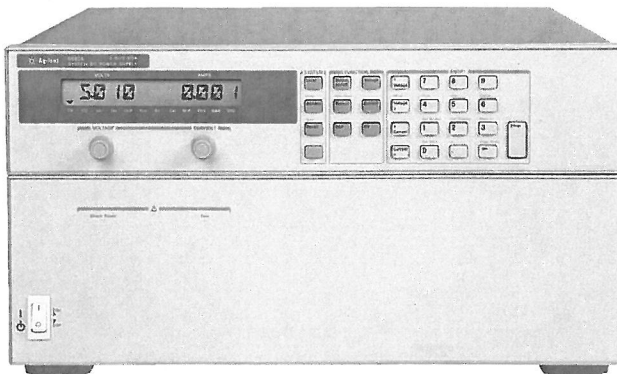


Agilent 6680A Series Single-Output, 5000 W DC Power Supplies, GPIB

Data Sheet

Reliable DC power for manufacturing test and
long-term burn-in



- Low output ripple and noise
- Selectable compensation for inductive loads
- Analog control of output voltage and current
- Fan-speed control to minimize acoustic noise
- Built-in measurements and advanced programmable features
- Protection features to ensure DUT safety

This series of 5000 watt DC power supplies has the exceptional, proven reliability that test system engineers look for. It also has the features needed for easy test system integration.

Programming of the DC output and the extensive protection features can be done either from the front panel or using industry standard SCPI commands via the GPIB. Using the serial link, up to 16 power supplies can be connected through one GPIB address. Test system integration can be further simplified by using the *VXIplug&play* drivers.

The output voltage and current can also be controlled with analog signals. This is helpful for certain types of noisy environments, and also immediate reactions to process changes.

The 6680A series has extremely low ripple and noise for a 5000 watt DC power supply. This helps the built-in measurement system make extremely accurate current and voltage measurements.

Selectable compensation is provided for problem-free powering of inductive loads.



Agilent Technologies

Specifications

Specifications (at 0 ° to 55 °C unless otherwise specified)	6680A	6681A	6682A	6683A	6684A	6680A-J04 Special order option
Number of outputs	1	1	1	1	1	1
GPIO	Yes	Yes	Yes	Yes	Yes	Yes
Output ratings						
Voltage	0 to 5 V	0 to 8 V	0 to 21 V	0 to 32 V	0 to 40 V	0 to 3.3 V
Current (40 °C then derate linearly 1%/°C from 40 °C to 55 °C)	0 to 875 A	0 to 580 A	0 to 240 A	0 to 160 A	0 to 128 A	0 to 1000 A
Programming accuracy at 25 °C ± 5 °C						
Voltage 0.04% +	5 mV	8 mV	21 mV	32 mV	40 mV	5 mV
Current 0.1% +	450 mA	300 mA	125 mA	85 mA	65 mA	450 mA
Ripple and noise constant voltage mode from 20 Hz to 20 MHz						
Voltage rms	1.5 mV	1.5 mV	1.5 mV	1.0 mV	1.0 mV	3.4 mV
peak-to-peak	10 mV	10 mV	10 mV	10 mV	10 mV	15 mV
Readback accuracy at 25 °C ± 5 °C (percent of reading plus fixed)						
Voltage 0.05% +	7.5 mV	12 mV	32 mV	48 mV	60 mV	7.5 mV
Current 0.1% +	600 mA	400 mA	165 mA	110 mA	90 mA	600 mA
Load and line regulation						
Voltage 0.002% +	0.19 mV	0.3 mV	0.65 mV	1.1 mV	1.5 mV	0.19 mV
Current 0.005% +	65 mA	40 mA	17 mA	12 mA	9 mA	77 mA
Transient response time	Less than 900 µs for the output voltage to recover to within 150 mV following a change in load from 100% to 50% or 50% to 100% of the output current rating of the supply					

Supplemental characteristics (Non-warranted characteristics determined by design and useful in applying the product)	6680A	6681A	6682A	6683A	6684A	6680A-J04 Special order option
Ripple and noise constant current mode from 20 Hz to 20 MHz						
Current rms	290 mA	190 mA	40 mA	28 mA	23 mA	—
Average programming resolution						
Voltage	1.35 mV	2.15 mV	5.7 mV	8.6 mV	10.8 mV	12 mV
Current	235 mA	155 mA	64 mA	43 mA	34 mA	260 mV
OVP	30 mV	45 mV	120 mV	180 mV	225 mV	25 mV
Output voltage programming response time* (excluding command processing time)	9 ms	12 ms	45 ms	60 ms	60 ms	9 ms
Output common-mode noise current (to signal-ground binding post)						
rms	1.5 mA	1.5 mA	3 mA	3 mA	3 mA	2.0 mA
peak-to-peak	10 mA	10 mA	20 mA	20 mA	20 mA	12.5 mA

* Full load programming rise/fall time (10% to 90% or 90% to 10%) with full resistive load equal to rated output voltage/rated output current.

Supplemental characteristics for all model numbers

DC floating voltage: Output terminals can be floated up to ± 60 VDC from chassis ground

Remote sensing: Up to half the rated output voltage can be dropped in each load lead. The drop in the load leads subtracts from the voltage available for the load.

Command processing time: Average time required for the output voltage to begin to change following receipt of digital data is 20 ms for power supplies connected directly to the GPIB.

Modulation: (Analog programming of output voltage and current):

Input signal: 0 to -5 V for voltage, 0 to $+5$ V for current

Input impedance: 30 k Ω or greater

AC input (47 to 63 Hz):

180 to 235 VAC (line-to-line, 3 phase), 27.7 A rms maximum worst case, 21.4 A rms nominal; 360 to 440 VAC, 14.3 A rms maximum worst case, 10.7 A rms nominal (maximum line current includes 5% unbalanced phase voltage condition.) Output voltage derated 5% at 50 Hz and below 200 VAC

Input power: 7350 VA and 6000 W maximum; 160 W at no load

GPIB interface capabilities:

SH1, AH1, T6, L4, SR1, RL1, PP0, DC1, DT1, E1, and C0. IEEE-488.2 and SCPI command set.

Software driver:

- IVI-COM
- VXIplug&play

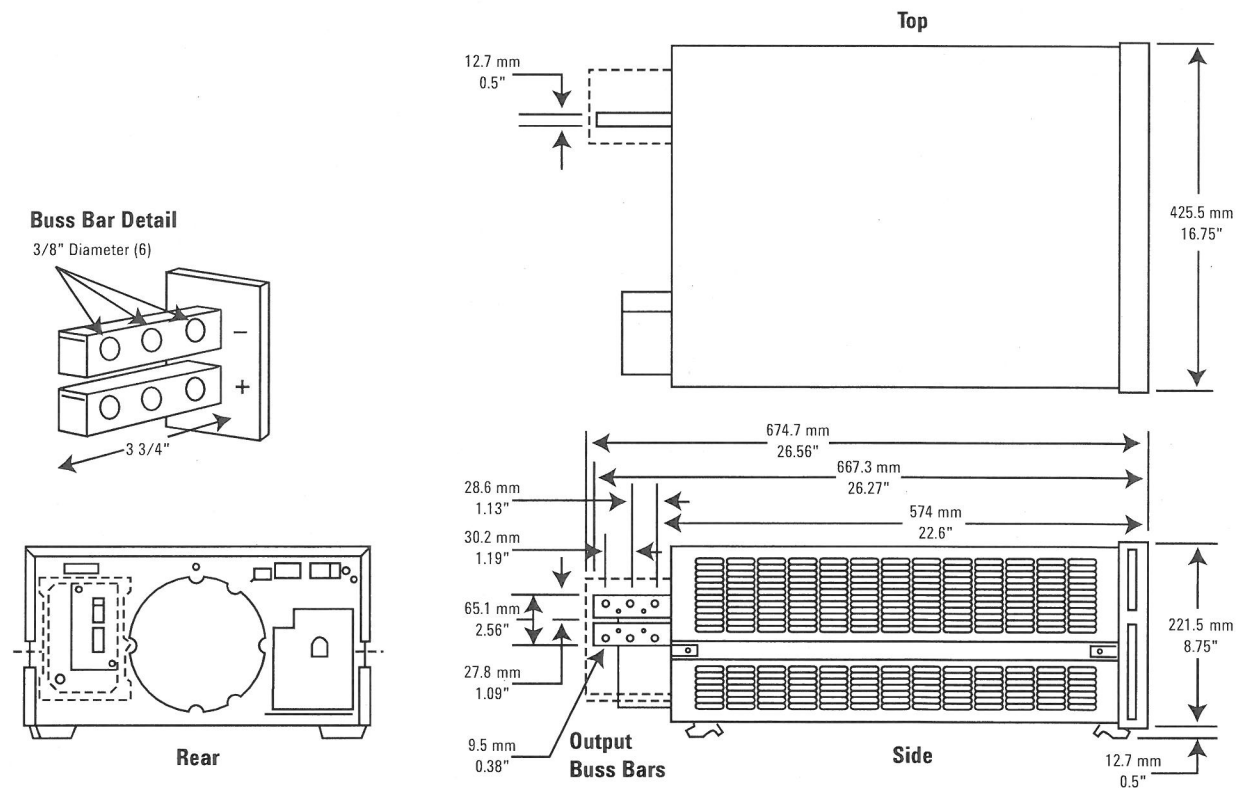
Size:

425.5 mm W x 221.5 mm H x 674.7 mm D (16.75 in x 8.75 in x 25.56 in)

Weight: Net, 51.3 kg (113 lbs); shipping, 63.6 kg (140 lbs)

Warranty: One year

Agilent models: 6680A, 6681A, 6682A, 6683A, 6684A



Ordering information

The 6680A power supplies come with full documentation on CD-ROM. The CD-ROM includes user's guide, programming guide, service manual, quick start guide, and application notes.

Opt 208 180 to 235 VAC, 3 phase, 47 to 63 Hz

Opt 400 360 to 440 VAC, 3 phase, 47 to 63 Hz

Opt 602 Two bus bar spacers for paralleling power supplies (p/n 5060-3514)

Opt 0L1 Printed user's and programming guides

Opt 0B3 Printed service manual

Accessories

1CM028A* Rack mount flange kit 88.1 mm H (3U) and 132.6 mm H (2U) – 4 brackets (5U total)

1CP014A* Double rack mount flange and handle kit 88.1 mm H (2U) and 132.6 mm H (3U)

E3663AC Support rails for Agilent rack cabinets

p/n 5080-2148 Serial link cable 2 m (6.6 ft.)

p/n 5060-3513 Three 30 A replacement fuses for 180 to 235 VAC line

p/n 5060-3512 Three 16 A replacement fuses for 360 to 440 VAC line

Application notes

6671A/72A/81A/82A/90A System DC Power Supplies Product Overview
5988-3050EN

Agilent DC Power Supplies for Base Station Testing, 5988-2386EN

10 Practical Tips You Need to Know About Your Power Products,
5965-8239E

* Support rails required



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United States	(800) 829 4444

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Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 375 8100

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Denmark	45 45 80 12 15
Finland	358 (0) 10 855 2100
France	0825 010 700*
	*0.125 €/minute
Germany	49 (0) 7031 464 6333
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
United Kingdom	44 (0) 118 927 6201

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Revised: January 6, 2012

Product specifications and descriptions in this document subject to change without notice.

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Published in USA, March 14, 2012
5990-9307EN



Agilent Technologies

**OPERATING GUIDE
GPIB DC POWER SUPPLIES
Agilent Technologies Models
664xA, 665xA, 667xA, 668xA, and 669xA**



Agilent Technologies

**Agilent Part No. 5964-8267
Microfiche Part No. 5964-8268**

**Printed in Malaysia
September, 2009**

Certification

Agilent Technologies certifies that this product met its published specifications at time of shipment from the factory. Agilent Technologies further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology, to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies hardware product is warranted against defects in material and workmanship for a period of one year from date of delivery. Agilent Technologies software and firmware products, which are designated by Agilent Technologies for use with a hardware product and when properly installed on that hardware product, are warranted not to fail to execute their programming instructions due to defects in material and workmanship for a period of 90 days from date of delivery. During the warranty period Agilent Technologies will, at its option, either repair or replace products which prove to be defective. Agilent Technologies does not warrant that the operation of the software, firmware, or hardware shall be uninterrupted or error free.

For warranty service, with the exception of warranty options, this product must be returned to a service facility designated by Agilent Technologies. Customer shall prepay shipping charges by (and shall pay all duty and taxes) for products returned to Agilent Technologies for warranty service. Except for products returned to Customer from another country, Agilent Technologies shall pay for return of products to Customer.

Warranty services outside the country of initial purchase are included in Agilent Technologies' product price, only if Customer pays Agilent Technologies international prices (defined as destination local currency price, or U.S. or Geneva Export price).

If Agilent Technologies is unable, within a reasonable time to repair or replace any product to condition as warranted, the Customer shall be entitled to a refund of the purchase price upon return of the product to Agilent Technologies.

Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Customer, Customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation and maintenance. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. Agilent Technologies SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Exclusive Remedies

THE REMEDIES PROVIDED HEREIN ARE THE CUSTOMER'S SOLE AND EXCLUSIVE REMEDIES. AGILENT TECHNOLOGIES SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Assistance

The above statements apply only to the standard product warranty. Warranty options, extended support contracts, product maintenance agreements and customer assistance agreements are also available. Contact your nearest Agilent Technologies Sales and Service offices for further information on Agilent Technologies' full line of Support Programs.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair 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. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

GENERAL

Any LEDs used in this product are Class 1 LEDs as per IEC 825-1.

This ISM device complies with Canadian ICES-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada.

ENVIRONMENTAL CONDITIONS

With the exceptions noted, all instruments are intended for indoor use in an installation category II¹, pollution degree 2 environment. They are designed to operate at a maximum relative humidity of 95% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

Exceptions: Agilent Technologies Models 6680A, 6681A, 6682A, 6683A, 6684A, 6690A, 6691A and 6692A are intended for use in an installation category III² environment.

¹Category II - Local level for connection to household outlets for 120 V, 230 V, etc.

²Category III - Distribution level or cases where the reliability and availability of the equipment are subject to special requirements.

BEFORE APPLYING POWER

Verify that the product is set to match the available line voltage and the correct fuse is installed.

GROUND THE INSTRUMENT.

This product is a Safety Class 1 instrument (provided with a protective earth terminal). To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument must be connected to the ac mains through a three-conductor power cable, with the third wire firmly connected to an electrical ground (safety ground) at the power outlet. For instruments designed to be hard-wired to the ac power lines (supply mains), connect the protective earth terminal to a protective conductor before any other connection is made. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury. If the instrument is to be energized via an external autotransformer for voltage reduction, be certain that the autotransformer common terminal is connected to the neutral (earthed pole) of the ac power lines (supply mains).

FUSES

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short circuited fuseholders. To do so could cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified service personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power, discharge circuits and remove external voltage sources before touching components.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT EXCEED INPUT RATINGS



















This instrument may be equipped with a line filter to reduce electromagnetic interference and must be connected to a properly grounded receptacle to minimize electric shock hazard. Operation at line voltages or frequencies in excess of those stated on the data plate may cause leakage currents in excess of 5.0 mA peak.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to an Agilent Technologies Sales and Service Offices for service and repair to ensure that safety features are maintained.

Instruments which appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Safety Symbol Definitions

Symbol	Description	Symbol	Description
	Direct current		Terminal for Line conductor on permanently installed equipment
	Alternating current		Caution, risk of electric shock
	Both direct and alternating current		Caution, hot surface
	Three-phase alternating current		Caution (refer to accompanying documents)
	Earth (ground) terminal		In position of a bi-stable push control
	Protective earth (ground) terminal		Out position of a bi-stable push control
	Frame or chassis terminal		On (supply)
	Terminal for Neutral conductor on permanently installed equipment		Off (supply)
	Terminal is at earth potential (Used for measurement and control circuits designed to be operated with one terminal at earth potential.)		Standby (supply). Units with this symbol are not completely disconnected from ac mains when this switch is off. To completely disconnect the unit from ac mains, either disconnect the power cord or have a qualified electrician install an external switch.
<p>WARNING The WARNING sign 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 sign until the indicated conditions are fully understood and met.</p>		<p>CAUTION The CAUTION sign 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 part or all of the product. Do not proceed beyond a CAUTION sign until the indicated conditions are fully understood and met.</p>	

Printing History

The edition and current revision of this manual are indicated below. Reprints of this manual containing minor corrections and updates may have the same printing date. Revised editions are identified by a new printing date. A revised edition incorporates all new or corrected material since the previous printing date. Changes to the manual occurring between revisions are covered by change sheets shipped with the manual. In some cases, the manual change applies only to specific instruments. Instructions provided on the change sheet will indicate if a particular change applies only to certain instruments.

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Edition 1 - July, 2001

Update1 - March, 2002

Update2 - January, 2005

Update3 - September, 2009

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Herstellerbescheinigung

Diese Information steht im Zusammenhang mit den Anforderungen der Maschinenläminformationsverordnung vom 18 Januar 1991. * Schalldruckpegel Lp <70 dB(A) * Am Arbeitsplatz * Normaler Betrieb * Nach EN 27779 (Typprüfung).

Manufacturer's Declaration

This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991. * Sound Pressure Lp <70 dB(A) * At Operator Position * Normal Operation * According to EN 27779 (Type Test).



Agilent Technologies

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014



Manufacturer's Name and Address

Responsible Party

Agilent Technologies, Inc.
550 Clark Drive, Suite 101
Budd Lake, New Jersey 07828
USA

Alternate Manufacturing Site

Agilent Technologies (Malaysia) Sdn. Bhd
Malaysia Manufacturing
Bayan Lepas Free Industrial Zone, PH III
11900 Penang, Malaysia

Declares under sole responsibility that the product as originally delivered

- Product Names** a) Single Output 2,000 Watt System dc Power Supplies
b) Single Output 2,000 Watt Manually Controlled dc Power Supplies
c) Single Output 5,000 Watt System dc Power Supplies
d) Single Output 6,500 Watt System dc Power Supplies
- Model Numbers** a) 6671A, 6672A 6673A, 6674A, 6675A
b) 6571A, 6572A 6573A, 6574A, 6575A
c) 6680A, 6681A, 6682A, 6683A, 6684A
d) 6690A, 6691A, 6692A
e) E4356A
- Product Options** This declaration covers all options and customized products based on the above products.

Complies with the essential requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

EMC Information ISM Group 1 Class A Emissions

As detailed in Electromagnetic Compatibility (EMC), Certificate of Conformance Number CC/TCF/02/020 based on Technical Construction File (TCF) HPNJ2, dated June 4, 2002

Assessed by: Celestica Ltd, Appointed Competent Body
Westfields House, West Avenue
Kidsgrove, Stoke-on-Trent
Straffordshire, ST7 1TL
United Kingdom

Safety Information and Conforms to the following safety standards.

IEC 61010-1:2001 / EN 61010-1:2001
Canada: CSA C22.2 No. 1010.1:1992
UL 61010B-1: 2003

This DoC applies to above-listed products placed on the EU market after:

January 1, 2004

Date

Bill Darcy/ Regulations Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor, or *Agilent Technologies Deutschland GmbH, Herrenberger Straße 130, D71034 Böblingen, Germany*

Revision: B.00.00

Issue Date: Created on 11/24/2003 3:23 PM

Document No. 6x7y668xA.11.24.doc

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Agilent Technologies

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014



Manufacturer's Name and Address

Responsible Party

Agilent Technologies, Inc.
550 Clark Drive, Suite 101
Budd Lake, New Jersey 07828
USA

Alternate Manufacturing Site

Agilent Technologies (Malaysia) Sdn. Bhd
Malaysia Manufacturing
Bayan Lepas Free Industrial Zone, PH III
11900 Penang, Malaysia

Declares under sole responsibility that the product as originally delivered

- Product Names**
- a) Single Output 500 Watt System dc Power Supplies
 - b) Single Output 500 Watt Manually Controlled dc Power Supplies
 - c) Single Output 500 Watt System Solar Array Simulator

- Model Numbers**
- a) 6651A, 6652A 6653A, 6654A, 6655A
 - b) 6551A, 6552A 6553A, 6554A, 6555A
 - c) E4350B, E4351B

Product Options This declaration covers all options and customized products based on the above products.

Complies with the essential requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

EMC Information ISM Group 1 Class A Emissions

As detailed in Electromagnetic Compatibility (EMC), Certificate of Conformance Number CC/TCF/00/074 based on Technical Construction File (TCF) HPNJ1, dated Oct. 27, 1997

Assessed by: Celestica Ltd, Appointed Competent Body
Westfields House, West Avenue
Kidsgrove, Stoke-on-Trent
Staffordshire, ST7 1TL
United Kingdom

Safety Information and Conforms to the following safety standards.

IEC 61010-1:2001 / EN 61010-1:2001
Canada: CSA C22.2 No. 1010.1:1992
UL 61010B-1: 2003

This DoC applies to above-listed products placed on the EU market after:

January 1, 2004

Date

Bill Darcy/ Regulations Manager

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Agilent Technologies

DECLARATION OF CONFORMITY

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014



Manufacturer's Name and Address

Responsible Party

Agilent Technologies, Inc.
550 Clark Drive, Suite 101
Budd Lake, New Jersey 07828
USA

Alternate Manufacturing Site

Agilent Technologies (Malaysia) Sdn. Bhd
Malaysia Manufacturing
Bayan Lepas Free Industrial Zone, PH III
11900 Penang, Malaysia

Declares under sole responsibility that the product as originally delivered

Product Names a) Single Output 200 Watt System dc Power Supplies
b) Single Output 200 Watt Manually Controlled dc Power Supplies

Model Numbers a) 6641A, 6642A 6643A, 6644A, 6645A
b) 6541A, 6552A 6543A, 6544A, 6545A

Product Options This declaration covers all options and customized products based on the above products.

Complies with the essential requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC (including 93/68/EEC) and carries the CE Marking accordingly.

EMC Information ISM Group 1 Class A Emissions

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Assessed by: Celestica Ltd, Appointed Competent Body
Westfields House, West Avenue
Kidsgrove, Stoke-on-Trent
Straffordshire, ST7 1TL
United Kingdom

Safety Information and Conforms to the following safety standards.

IEC 61010-1:2001 / EN 61010-1:2001
Canada: CSA C22.2 No. 1010.1:1992
UL 61010B-1: 2003

This DoC applies to above-listed products placed on the EU market after:

January 1, 2004

Date

Bill Darcy/ Regulations Manager

For further information, please contact your local Agilent Technologies sales office, agent or distributor, or *Agilent Technologies Deutschland GmbH, Herrenberger Straße 130, D71034 Böblingen, Germany*

Revision: B.00.00

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Each power supply is programmable locally from the front panel or remotely via a rear-panel analog control port. Operational features include:

- Constant voltage (CV) or constant current (CC) output over the rated output range.
- Built-in overvoltage (OV), overcurrent (OC), and overtemperature (OT) protection.
- Automatic turn-on selftest.
- Pushbutton nonvolatile storage and recall of up to 5 operating states (4 in Series 668xA/669xA supplies).
- Local or remote sensing of output voltage.
- Auto-parallel operation for increased total current.
- Series operation for increased total voltage.
- Analog input for remote programming of voltage and current.
- Voltage output for external monitoring of output current.
- User calibration from the front panel.

Front Panel Programming

The front panel has both rotary (RPG) and keypad controls for setting the output voltage and current. The panel display provides digital readouts of the output voltage and current. Other front panel controls permit:

- Enabling or disabling the output.
- Setting the overvoltage protection (OVP) trip voltage.
- Enabling or disabling the overcurrent protection (OCP) feature.
- Saving and recalling operating states.
- Setting the GPIB address.
- Reading GPIB error message codes.
- Calibrating the power supply, including changing the calibration protection password.

Remote Programming

The power supply may be remotely programmed via the GPIB bus and/or from an analog input port. GPIB programming is with SCPI (Standard Commands for Programmable Instruments) commands that make the power supply programs compatible with those of other GPIB instruments. (A software-controlled Compatibility Mode also permits programming in the command set of the Agilent 6030xA Autoranging Series.) In addition to control functions, SCPI programming permits writing to the front panel LCD and complete calibration functions. Power supply status registers permit remote monitoring of the following conditions:

- Overvoltage, overcurrent, overtemperature, and unregulated states.
- Operating mode (constant voltage or constant current).
- State of the RI (remote inhibit) input signal.
- Power-on status (PON).
- Status of the output queue (QYE).
- Pending triggers (WTG).
- GPIB interface programming errors (CME, DDE, and EXE).
- Calibration state (enabled or disabled).

The status registers can be programmed to generate an output fault signal (FLT) upon the occurrence of one or more selected status events.

Analog Programming

The power supply has an analog port for remote programming. The output voltage and/or current of the power supply may be controlled by individual dc programming voltages applied to this port. The port also provides a monitor output that supplies a dc voltage proportional to the output current.

Table 1-4b. Supplemental Characteristics for Series 668xA (continued)¹

Parameter	All Models																		
Command Processing Time (Average time for output voltage to change after receipt of digital data when the supply is connected directly to the GPIB Bus): 20 ms																			
Monotonicity:	Output is monotonic over entire rated voltage, current, and temperature range.																		
Auto-Parallel Configuration:	Up to 3 identical models																		
Nonvolatile Storage State storage & recall locations: Prestored turn-on state: Maximum memory write cycles:	4 Location 0 40,000, typical																		
Digital Port Characteristics	(see Table 1-5)																		
GPIB Interface Capabilities	(see Table 1-5)																		
Serial Link Capabilities	(see Table 1-5)																		
Recommended Calibration Interval:	1 year																		
Safety Compliance Complies with: Designed to comply with:	CSA 22.2 No.231, IEC 1010 (carries CE mark) UL 1244																		
RFI Suppression (complies with):	CISPR-II, Group 1, Class B																		
Dimensions Width: Height including removable feet excluding removable feet Depth (without output safety cover):	425.5 mm (16.75 in) 234.2 mm (9.25 in) 221.5 mm (8.75 in) 674.7 mm (25.56 in)																		
Weight Net: Shipping:	51.3 kg (113 lb) 63.6 kg (140 lb)																		
Output Characteristic Curve:	<table border="1" style="margin-left: auto; margin-right: auto;"> <caption>Maximum Rated Output</caption> <thead> <tr> <th>Agilent Model</th> <th>Vout</th> <th>Iout</th> </tr> </thead> <tbody> <tr> <td>6680A</td> <td>5 V</td> <td>875 A</td> </tr> <tr> <td>6681A</td> <td>8 V</td> <td>580 A</td> </tr> <tr> <td>6682A</td> <td>21 V</td> <td>240 A</td> </tr> <tr> <td>6683A</td> <td>32 V</td> <td>160 A</td> </tr> <tr> <td>6684A</td> <td>40 V</td> <td>128 A</td> </tr> </tbody> </table>	Agilent Model	Vout	Iout	6680A	5 V	875 A	6681A	8 V	580 A	6682A	21 V	240 A	6683A	32 V	160 A	6684A	40 V	128 A
Agilent Model	Vout	Iout																	
6680A	5 V	875 A																	
6681A	8 V	580 A																	
6682A	21 V	240 A																	
6683A	32 V	160 A																	
6684A	40 V	128 A																	
Notes: ¹ For Performance Specifications, see Table 1-4a.																			

The power cord supplied with power supply may or may not include a power plug (see "Options" in Chapter 1) at one end of the cord. Terminating connections and a ground lug are attached to the other end of the cord.

See Figure 2-2 and proceed as follows:

1. If they are not already in place, position the strain relief connector (11), safety cover (5), rubber boot (9), and connector nut (8) on the power cord (7).
2. Secure the ground wire (2) to the chassis earth ground stud.
3. For single-phase operation, connect the neutral wire (1) to the N input terminal and the line wire (3) to the L input terminal (this line is fused inside the supply).
4. For line-to-line operation from a three-phase source as shown in Figure 2-3, connect one phase to the N input terminal and another phase to the L input terminal (this line is fused inside the supply).

Note The N terminal is not internally grounded.

5. Position the safety cover over the power input terminals and tighten the cover screws (10) and strain relief connector screws (6). Torque the cover screws using 10 to 12 inch-pounds (1.13 to 1.36 Newton meters). Torque the strain relief screws using 2 to 4 inch-pounds (0.23 to 0.45 Newton meters).

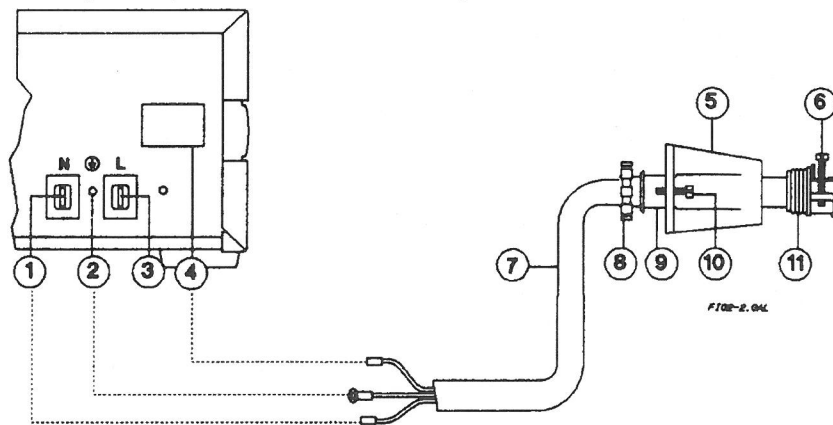


Figure 2-2. Connecting the Series 667xA Power Cord

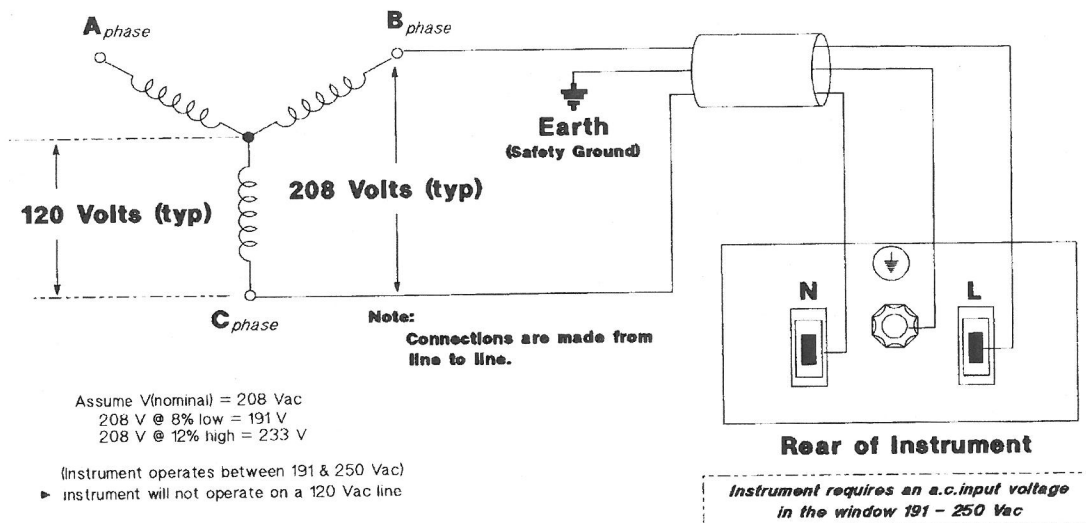


Figure 2-3. 667xA Connection to a 3-Phase Line

Installing the Series 668xA Power Cord

The Series 668xA power supply requires a 3-phase power source that provides 7350 VA (6000 W) maximum. The supply has a delta input (no neutral connection) and will accept power from either delta (triangle) or wye (star) sources. Two voltage ranges are available (see "AC Input Ratings" in Table 1-4a). *In order to maintain phase current balancing, the power source should be a dedicated line with only Agilent Technologies Series 668xA/669xA supplies drawing current from it.* A disconnect box located near the power supply (see Figure 2-4) is recommended for all installations and is mandatory for direct-wired installations.

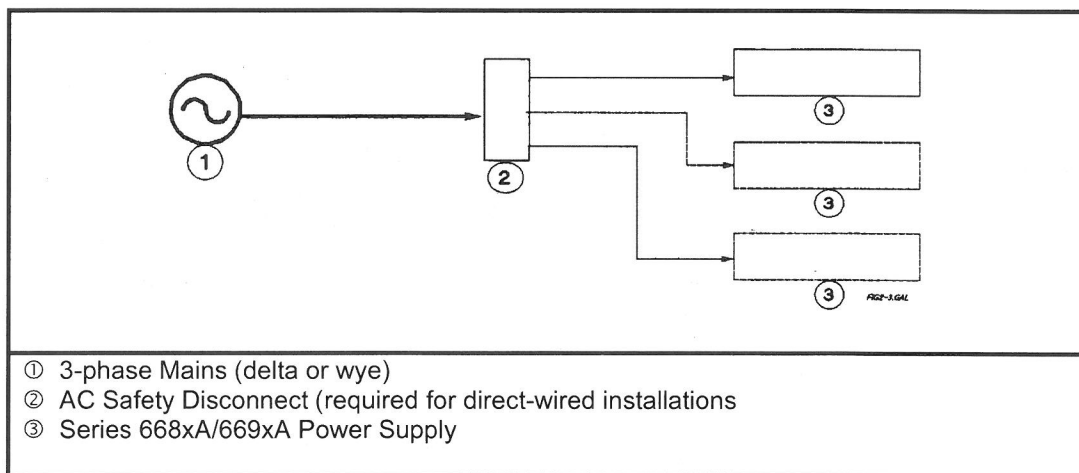


Figure 2-4. Series 668xA/669xA Overall Wiring Diagram.

WARNING

Installation of the power cord must be done by a qualified electrician and in accordance with local electrical code.

The power cords supplied with the power supply do not include a power plug (see "Options" in Chapter 1) at one end of the cord. Terminating connectors and a ground lug are attached to the other end of the cord.

See Figure 2-5 and proceed as follows:

1. Check the line fuses (2), Figure 2-5) as follows:
 - a. Examine the **LINE RATING** label (1) on the rear panel.
 - b. Unscrew the line fuse caps (2) from the rear panel and verify that all fuses are as specified on the label. Replace the fuses.
2. Open the line clamp (7) and insert the line cord (10) through the opening.
3. Position the line cord so that the clamp is near the end of the outside insulating sheath. Tighten the screws (8) securing the clamp. Torque the screws using 2 to 4 inch-pounds (0.23 to 0.45 Newton meters).
4. Secure the three ac lines to the ac power strip as follows:
* Phase 1 (3) to L1. Phase 2 (4) to L2. Phase 3 (6) to L3.
5. Secure the ground wire (5) to the chassis earth ground stud.

CAUTION

Do not connect anything to the terminal marked "DO NOT USE".

6. Slip the safety cover (9) over the fuses and terminal strip and secure the cover with the four cap screws. Torque the screws using 10 to 12 inch-pounds (1.13 to 1.36 Newton meters).
7. If required, wire the appropriate power plug to the other end of the power cord.

Note

For user-made cable (10), strip back sheath 100 mm (3.9 in).

Turn-On Checkout

Note This chapter provides a preliminary introduction to the power supply front panel. See "Chapter 5 - Front Panel" for more details.

Introduction

Successful tests in this chapter provide a high degree of confidence that the power supply is operating properly. For verification tests, see "Appendix B - Operation Verification". Complete performance tests are given in the service manual (see Table 1-5 in Chapter 1). **Do not apply ac power to the power supply until told to do so.**

Preliminary Checkout (All Models)

1. Make certain that the front panel switch is off.
2. Examine the Line Voltage Rating or Line And Fuse Rating label (see "Chapter 2 - Installation")
 - a. Verify that the line voltage rating agrees with your power source. If it does not, see "Appendix C - Line Voltage Conversion".
 - b. **Series 664xA/665xA** - Use a screwdriver to remove the line fuse from the fuseholder (3, Figure 2-1). Verify that the fuse is as specified on the label. Replace the fuse.
 - c. **Series 668xA** - Unscrew the fuse caps from the rear panel (2, Figure 2-4). Verify that the fuse is as specified on the label. Replace the fuse.
 - d. **Series 669xA** - Flip open the fuseholder located under the ac line safety cover on the rear panel. Verify that the fuse is as specified on the label. Replace the fuse.
3. Check the sense wiring as follows:
 - a. **Series 664xA/665xA** - The SENSE switch (4, Figure 4-3a) is set to **Local**.
 - b. **Series 667xA** - Remove the output safety cover (1, Figure 4-4a) and examine the output sense terminals (4 and 5). They should be wired for local sensing as follows:
 1. The +LS sense terminal wired to the +S terminal of the analog connector (2).
 2. The -LS sense terminal wired to the -S terminal of the analog connector.
 3. If the power supply is not wired for local sensing, make the above connections, using small-capacity wire (#22 is sufficient).
 - c. **Series 668xA/669xA** - Examine the output bus bars (Figure 4-5a) and make sure they are connected for local sensing as follows:
 1. The + bar is wired to the +S terminal of the analog connector.
 2. The - bar is wired to the -S terminal of the analog connector.
 3. If the power supply is not wired for local sensing, make the above connections, using small-capacity wire (#22 is sufficient).
4. Make sure that there is no load connected to the output terminals or bus bars.

Power-On Checkout (All Models)

1. Connect the power cord to the power source (for **Series 668xA & 669xA**, turn on the safety disconnect switch).
2. Turn the front panel power switch to ON (1).
3. The power supply undergoes a self-test when you turn it on. If the test is normal, the following sequence appears on the LCD:
 - a. **Series 664xA/665xA** - The GPIB address (factory default is 5).
 - b. **Series 667xA/668xA/669xA** - The GPIB address (factory default is 5). This is then followed by **PWR ON INIT** for approximately 10 seconds.
4. The display then goes into the meter mode with the **Dis** annunciator on and all others off. “Meter mode” means that the **VOLTS** digits indicate the output voltage and the **AMPS** digits indicate the output current. These values will be at or near zero.
5. Verify that the power supply fan is on by placing your hand near the rear grill to feel the air flow. You may also be able to hear the fan operating.
6. Press **Output on/off** once. The **Dis** annunciator will go off and the CV annunciator will go on .

Note If the power supply detects an error during self-test, the display will show an error message. Go to “In Case of Trouble” at the end of this chapter.

Using the Keypad (All Models)

Shifted Keys

Some of the front panel keys perform two functions, one labeled in black and the other in blue. You access the blue function by first pressing the blue **Shift** key, which is not labeled. When the **Shift** annunciator is on, you will know you have access to the key's shifted (blue) function.

Backspace Key

The **←** key is an erase key. If you make a mistake entering a number and have not yet entered it (have not pressed **Enter**), you can delete the number by pressing **←**. You may delete as many numbers as you wish by repeatedly pressing this key.

Output Checkout (All Models)

Important When the power supply is turned on, it asserts the state stored in EEPROM memory location 0. For a new supply, this is the factory default (*RST) state. The following procedures assume that the factory default state is still in location 0 (Turn-On Conditions in “Chapter 5 - Front Panel” for details).

Checking the Voltage Function

The tests in Table 3-1 check the basic voltage functions with no load connected to the power supply. The VOLTS display will show various readings. Ignore the AMPS display.

Table 3-1. Checking the Voltage Functions (Output Terminals Open)

Procedure	Display	Explanation
Output Terminals Open or Connected to a Voltmeter		
If Dis is on, turn it off by pressing Output on/off		
Press Voltage key	VOLT 0.000	Default voltage setting. CV annunciator should be on. (If CC annunciator is on, increase the current by pressing Current one or more times until CC turns off and CV turns on.)
Press 4	VOLT 4	Program output to 4 volts.
Press Enter	4.000	Enter the voltage. Meter mode displays output voltage. During these tests, there may be a small (relative to full output) AMPS reading that will be ignored.
Press ↓Voltage several times		Voltage decreases several millivolts each time you press the key.*
Press ↑Voltage the same number of times		Voltage increases several millivolts each time you press the key.*
* The number of millivolts change is determined by the voltage programming resolution of your power supply (see "Supplemental Characteristics" in Chapter 1).		
Rotate Voltage control first counterclockwise and then clockwise		Control operates similarly to ↓Voltage and ↑Voltage keys. The control is rate sensitive. Turning it more quickly causes a more rapid change in voltage.
Press Voltage 4 Enter	4.000	Program output to 4 volts.
Press OV		Display shows default OVP (overvoltage protection) trip voltage for your supply (see "Supplemental Characteristics" in Chapter 1).
Press 3	OV 3	Program the OVP to 3 volts, which is less than the output voltage.
Press Enter	0.000	OVP voltage entered is less than the output voltage. This causes the OVP circuit to trip. The output drops to zero, CV turns off, and Prot turns on.
Press Protect	OV - - - -	Shows that the power supply shuts down because the OVP circuit has tripped.
Press ←		Return display to meter mode (optional step).
Press OV 4.5 Enter	0.000	Program the OVP to 4.5 volts, which is greater than the output voltage. Note: You cannot clear an OVP trip until you have first removed the cause of the condition.
Press Prot Clear (Shift Protect)*	4.000	The OVP circuit is cleared, restoring the output. Prot turns off and CV turns on.
* Shift is the unlabeled blue key.		

Checking the Current Function

WARNING

ENERGY HAZARD. Some supplies (Series 668xA/669xA) can provide more than 240 VA at more than 2 V. If the output connections touch, severe arcing may occur resulting in burns, ignition or welding of parts. Do not attempt to make connections while the output is live.

The tests in Table 3-2 check the basic current functions with a short connected across the power supply output. **Do not program maximum output currents unless the shorting wire is capable of handling the current** (see "Supplemental Characteristics" and Table 4-2). The AMPS display will show various readings. Ignore the VOLTS display.

Table 3-2. Checking the Current Functions (Output Terminals Shorted)

Action	Display	Explanation
<p>Turn off the power supply and connect a #14 AWG or larger wire across the output (+) and (-) terminals. If you intend to test at full-rated output current, use a wire or wires of sufficient size to carry the maximum current of the supply (see "Supplemental Characteristics" in Chapter 1 and Table 4-2 in Chapter 4).</p>		
<p>Turn on the supply. Set the voltage to its maximum value. This example assumes that you have an 8-volt supply (see "Performance Specifications" in Chapter 1 for the value for your specific supply).</p> <p>Press Voltage 8 Enter</p> <p>Press Current 1 Enter</p> <p>Press Output on/off</p> <p>Press ↓Current several times</p> <p>Press ↑Current the same number of times</p> <p>Rotate the Current control first counterclockwise and then clockwise</p> <p>Press OCP</p>	<p>Meter mode</p> <p>VOLT 8.000</p> <p>AMPS 1.000</p> <p>AMPS 1.000</p>	<p>Essentially zero outputs with Dis annunciator on.</p> <p>Program output to 8 volts.</p> <p>Program output to 1 ampere.</p> <p>CAUTION: Be certain to observe this step with Series 668xA/669xA supplies. Start at 1 ampere before going to greater output currents.</p> <p>Dis annunciator turns off, CC annunciator turns on, and AMPS display shows the programmed current.</p> <p>*Current decreases several milliamperes each time you press the key.:</p> <p>*Current increases several milliamperes each time you press the key.</p> <p>*The number of milliamperes is determined by the current programming resolution of the power supply (see "Supplemental Characteristics" in Chapter 1).</p> <p>Control operates similarly to the ↓Current and ↑Current keys. The control is rate sensitive. Turning it more quickly causes a more rapid change in current.</p> <p>You have enabled the overcurrent protection circuit. The circuit then tripped because of the output short. The CC annunciator turns off and the OCP and Prot annunciators come on. The output current is near zero.</p>

Table 3-2. Checking the Current Functions (Output Terminals Shorted) (continued)

Action	Display	Explanation
Press Output on/off	AMPS 0.000	Dis annunciator turns on.
Press OCP		You have disabled the overcurrent protection circuit. The OCP annunciator turns off.
Press Prot Clear (Shift) Protect **		You have cleared the overcurrent protection circuit. The Prot annunciator turns off.
Press Output on/off	AMPS 1.000	Dis turns off and CC turns on. The output current is restored.
<p>If you have a shorting wire of sufficient capacity, you may continue testing up to the maximum rated current of the power supply (see "Performance Specifications"). When finished, go to the next step.</p>		
Press Output on/off	AMPS 0.000	Dis turns on and output current drops to zero.
<p>Turn off the power supply and remove the short from the output terminals.</p>		
<p>** Shift is the unlabeled blue key.</p>		

Checking the Save and Recall Functions (All Models)

The Series 668xA/669xA supplies have four nonvolatile memory storage locations (0 through 3). The supplies of all other series have five (locations 0 through 4). Proceed as follows:

- Make certain that the output is on (**Dis** annunciator is off).
- Set the voltage output to 5 by pressing **Voltage 5 Enter**.
- Save this value to location 1 by pressing **Shift Save 1 Enter**.
- Return the output voltage to 0 by pressing **Recall 0 Enter** (This step is based on the fact that a newly shipped power supply has the *RST parameters stored in location 0 (see "Chapter 5 - Front Panel" for more information).
- Press **Recall 1 Enter** and notice that the output voltage returns to the value stored in location 1.

Determining the GPIB Address (All Models)

When the power supply is turned on, the display shows ADDR n, where n is the power supply GPIB address. Any time you want to see the address, press **Address**.

The display will indicate **ADDR 5**, which is the factory default. If the address has been changed, then a different number will appear (see "Setting the GPIB Address" in "Chapter 5 - Front Panel").

In Case of Trouble

Line Fuse

If the power supply appears "dead" with a blank display and the fan not running, first check your power source to be certain line voltage is being supplied to the power supply. If the source is normal, the power supply line fuse may be defective. **On**

Series 669xA supplies, if the **Red indicator** appears in the fuse window on the rear panel, then one or more of the line fuses are open. If the supply has a defective fuse, replace it only once. If it fails again, investigate the reason for the failure. Proceed as follows:

Series 664xA and 665xA Supplies

The line fuse is located on the rear panel (3, Figure 2-1). Proceed as follows:

1. Turn off the front panel power switch.
2. Using a screwdriver, remove the fuse from the fuseholder. Replace it with one of the same type (see Table 1-5 in Chapter 1). **Do not use a time-delay** type fuse.
3. Turn on the power supply and check the operation.

Series 667xA Supplies

WARNING

Hazardous voltage can remain inside the power supply even after it has been turned off. Fuse replacement should be done only by qualified electronics personnel.



The line fuse is located inside the power supply. To change it, proceed as follows:

1. Turn off the front panel power switch and unplug the line cord from the power source.
2. Remove the power supply dustcover as follows:
 - a. Remove the four screws securing the carrying straps and dustcover.
 - b. Spread the bottom rear of the dustcover and pull it back to disengage it from the front panel.
 - c. Slide the dustcover back far enough to expose the line fuse (1, Figure 3-1).
3. Observe the input rail LED under the RFI shield (4, Figure C-3 in "Appendix C - Line Voltage Conversion"). **If the LED is on, there is still hazardous voltage inside the supply.** Wait until the LED goes out (this may take several minutes) before proceeding.
4. Connect a dc voltmeter across test points TP1 and TP2 (Figure C-3). It may be necessary to remove the RFI shield in order to reach these test points. (The shield is secured by four screws on each side.) When the voltmeter indicates 60 volts or less, it is safe to work inside the power supply.
5. Replace the fuse with one of the same type (see Table 1-5 in Chapter 1). **Do not use a time-delay** type fuse.
6. If you removed it in step b, be sure to replace the RFI shield.
7. Replace the dustcover.
8. Connect the line cord to the power source.
9. Turn on the front panel power switch and check the operation.

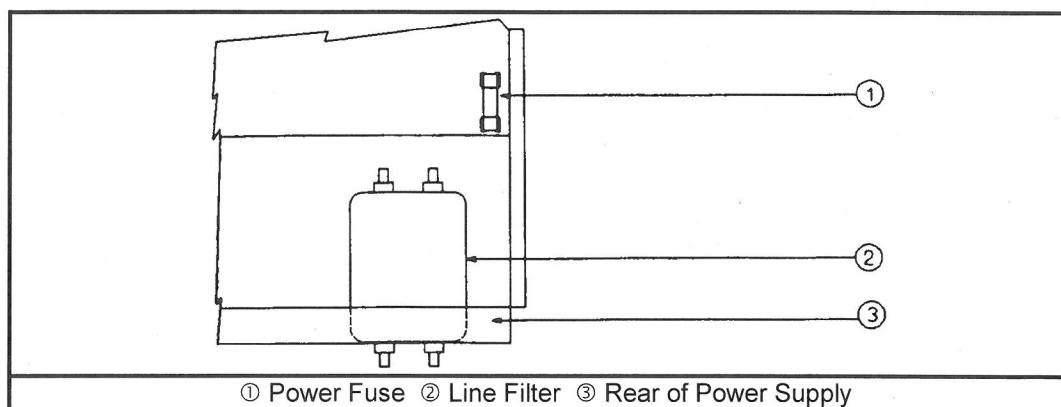


Figure 3-1. Series 667xA Line Fuse

Series 668xA Supplies

The line fuses are located on the rear panel (see Figure 2-5). Proceed as follows:

1. Turn off the front panel power switch and remove the input power (unplug the power cord or open the safety disconnect).
2. Remove the ac input safety cover from the rear panel.
3. Unscrew the fuse caps and remove the fuses.
4. If one or two fuses are defective, replace **all three** with fuses of the same type (see Table 1-5 in Chapter 1).
5. Turn on the power supply and check the operation. If it is normal, replace the ac input safety cover.

Series 669xA Supplies

The line fuses are located on the rear panel (see Figure 2-6). Check the fuse indicator window on the rear of the ac input safety cover. If the RED indicator is visible in the window, proceed as follows:

1. Turn off the front panel power switch and remove the input power (unplug the power cord or open the safety disconnect).
2. Remove the ac input safety cover from the rear panel.
3. Flip the fuseholder levers down and check the fuses. If a fuse has blown, the indicator pin will extend out of the center of the fuse body (see Figure 2-5)
4. If one or two fuses are defective, replace **all three** with fuses of the same type (see Table 1-5 in Chapter 1). If all three fuses are blown, the power supply probably has a defect that requires service.

Note: When installing the fuses, make sure that the fuse indicator pin located in the center of the fuse is facing OUT, not IN.

5. Replace the ac input safety cover.
6. Turn on the power supply and check the operation.

Maintenance Note It is recommended that new line fuses be installed every four years.

Error Messages (All Models)

Power supply failure may occur during power-on selftest or during operation. In either case, the display may show an error message that indicates the reason for the failure.

Selftest Errors

When a selftest error occurs, it prevents all front panel operation. The display may show either a power-on error message or a checksum error message.

Power-On Error Messages

Power-on messages appear as:

En- - - - -

Where "n" is a number listed in Table 3-3. If this occurs, turn the power off and then back on to see if the error persists. It is possible to recover from the EE CHKSUM error (see "Checksum Errors"). If any other message persists, the power supply requires service.

Table 3-3. Power-On Selftest Errors

Error No.	Display	Failed Test	Error No.	Display	Failed Test
E1	FP RAM	Front Panel RAM	E8	SEC RAM	Secondary RAM
E2	FP ROM	Front Panel ROM checksum	E9	SEC ROM	Secondary ROM checksum
E3	EE CHKSUM	EEPROM	E10	SEC 5V	Secondary 5 V ADC reading
E4	PRI XRAM	Primary external RAM	E11	TEMP	Secondary ambient thermistor reading
E5	PRI IRAM	Primary internal RAM	E12	DACS	Secondary VDAC/IDAC readback
E6	PRI ROM	Primary ROM checksum			
E7	GPIB	GPIB R/W to serial poll			

Checksum Errors.

If the display shows **EE CHKSUM**, the power supply has detected an EEPROM checksum error. A checksum error can occur due to the following conditions:

- Excessive number of write cycles to an EEPROM (see "Nonvolatile Memory Write Cycles" in "Supplemental Characteristics" tables). This condition, which would appear only after extended use, is not recoverable and requires service.
- Loss of ac input power during a checksum calculation. This condition, which is very unlikely, is recoverable.

You may be able to recover from a checksum error by writing to the EEPROM while the power supply is in the calibration mode. To do this, proceed as follows:

1. Enable the calibration mode by pressing **Shift Cal Enable 1 Enter**.
2. **PASWD** will appear on the display.
3. Press the number keys corresponding to the password, followed by **Enter**. The **Cal** annunciator will go on.

Note On new equipment, the calibration password corresponds to the four-digit model number (such as **6 6 5 1**). See "Appendix A - Calibration" for more information about the calibration password.

4. Save any operating state (for example, press **Shift Save 0 Enter**).
5. Turn the power off and then back on.

A normal display free of error messages should appear. If not, the power supply requires service.

Runtime Error Messages

Under unusual operating conditions, the **VOLT** or **AMPS** display may show **+OL** or **-OL**. This indicates that the output voltage or current is beyond the range of the meter readback circuit. Table 3-4 shows other error messages that may appear at runtime.

Table 3-4. Runtime Errors

Display	Meaning	Display	Meaning
EE WRITE ERR	EEPROM status timeout	UART FRAMING	UART byte framing error
SBUB FULL	Message too long for buffer	UART OVERRUN	Overfilled UART receive buffer
SERIAL DOWN	Failed communication with front panel	UART PARITY	UART byte parity error panel
STK OVERFLOW	Front panel stack overflow		

User Connections

Rear Panel Connections (All Models)

Make application load connections to the output terminals or bus bars, analog connector, and digital connector as shown on the rear-panel drawing for your model power supply. These connections are organized by series as follows:

- Series 664xA and 665xA
- Series 667xA
- Series 668xA and 669xA

Make controller connections (GPIB and serial link) as shown in Figure 4-6 at the end of this chapter.

Load Wire Selection (All Models)

WARNING

Fire Hazard To satisfy safety requirements, load wires must be large enough not to overheat when carrying the maximum short-circuit current of the power supply. If there is more than one load, then any pair of load wires must be capable of safely carrying the full-rated current of the supply. With the larger-capacity supplies (such as Series 668xA), use of two or more load wires in parallel may be required.

Table 4-1 lists the characteristics of AWG (American Wire Gauge) copper wire.

Table 4-1. Stranded Copper Wire Capacity and Resistance

AWG No.	Ampacity ¹	Resistance ² (Ω/m)	AWG No.	Ampacity ¹	Resistance ² (Ω/m)
14	25	0.0103	2	140	0.00064
12	30	0.0065	1/0	195	0.00040
10	40	0.0041	2/0	225	0.00032
8	60	0.0025	3/0	260	0.00025
6	80	0.0016	4/0	300	0.00020
4	105	0.0010			

NOTES:

1. Ampacity is based on 30 °C ambient temperature with conductor rated at 60 °C. For ambient temperature other than 30 °C, multiply the above ampacities by the following constants:

Temp (°C)	Constant	Temp (°C)	Constant
21-25	1.08	41-45	0.71
26-30	1.00	46-50	0.58
31-35	0.91	51-55	0.41
36-40	0.82		
2. Resistance is nominal at 75 °C wire temperature.

Analog Connector (All Models)

This connector, which is on the rear panel, is for connecting remote sense leads, external current monitors, and external programming sources. The connector accepts wires sizes from AWG 22 to AWG 12.

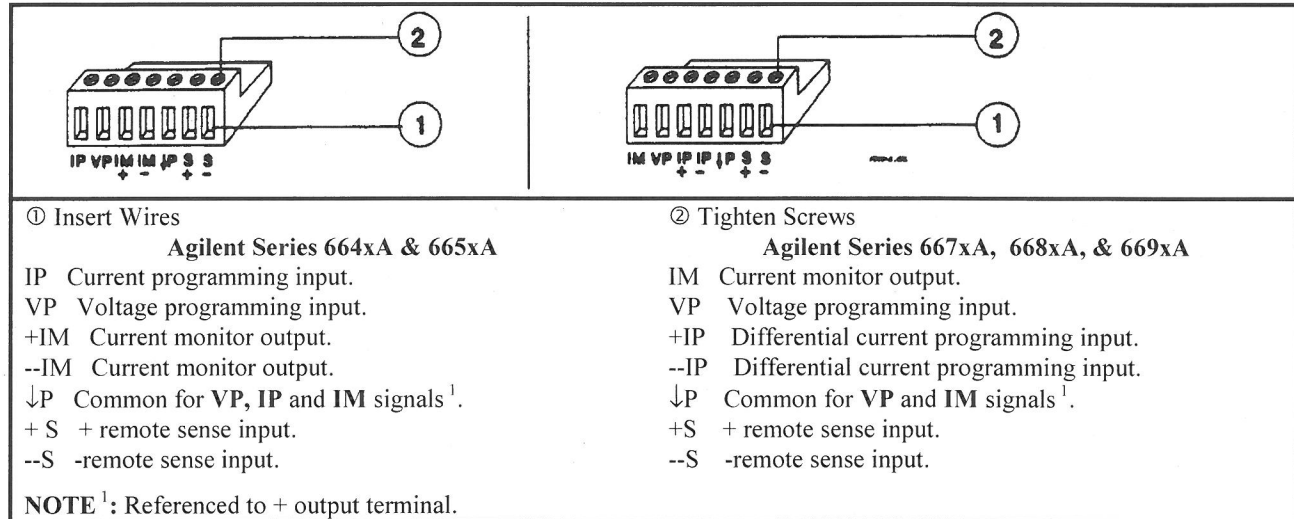


Figure 4-1. Rear Panel Analog Connector

Note It is good engineering practice to twist and shield all signal wires to and from the analog and digital connectors.

Digital Connector (All Models)

This connector, which is on the rear panel, is for connecting fault/inhibit, digital I/O, or relay link signals. The connector accepts wires sizes from AWG 22 to AWG 12. Refer to Appendix D for more information about using this connector.

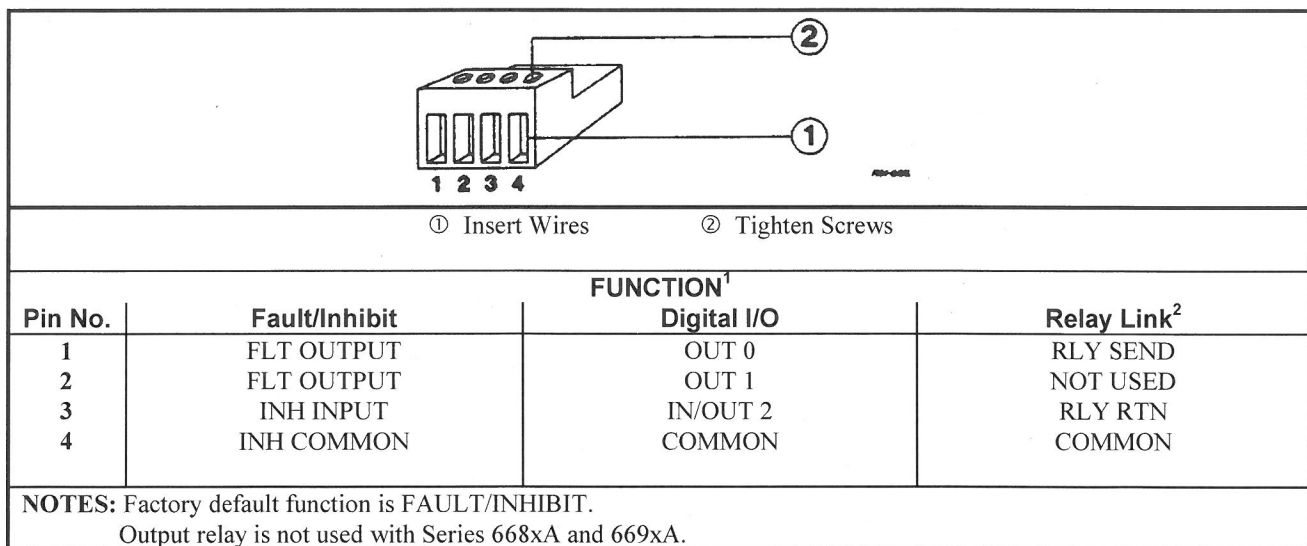


Figure 4-2. Rear Panel Digital Connector

Connecting Series 668xA and 669xA Power Supplies to the Load

WARNING

ENERGY HAZARD. These power supplies can provide more than 240 VA at more than 2 V. If the output connections touch, severe arcing may occur resulting in burns, ignition or welding of parts. Do not attempt to make connections to live output circuits.

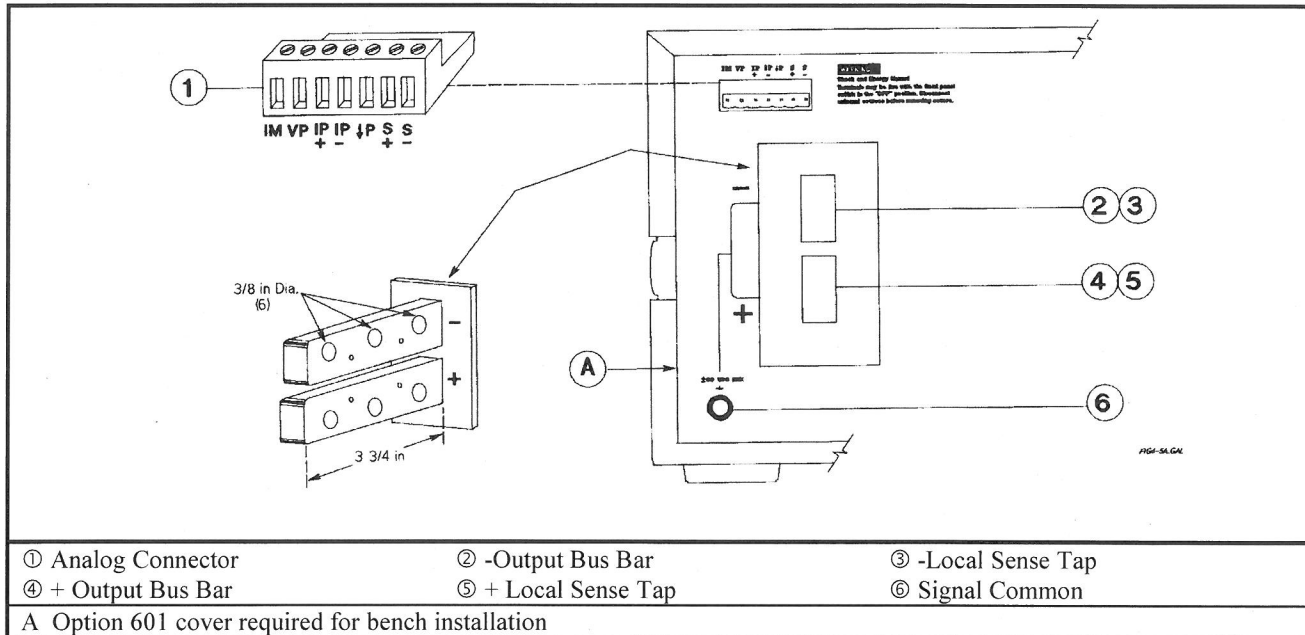


Figure 4-5a. Series 668xA and 669xA Rear Panel Output Connections

Output Isolation

Except for a high value ($>1 \text{ M}\Omega$) internal bleeder resistor, the output of the power supply is isolated from earth ground. Either output terminal may be grounded or an external dc voltage source may be connected between either output and ground. However, both output terminals must be kept within $\pm 60 \text{ Vdc}$ of ground.

WARNING

The earth ground terminal located near the output bus bars is a low-noise signal ground for convenience only. It is not designed to function as a safety ground.

Load Considerations

Capacitive Loads

In most cases, the power supply will maintain stability with external load capacitors. However, large load capacitors may cause ringing in the supply's transient response. It's possible that certain combinations of load capacitance, equivalent series resistance, and load-lead inductance will result in instability (see also "Stability" under "Remote Sensing"). If you need help solving a stability problem, contact an Agilent Service Engineer through your local Agilent Sales and Support Offices.

If the output is rapidly programmed into capacitive loads, the power supply may momentarily cross into CC operation, thereby extending the CV programming time. When it crosses into CC mode, the supply's maximum slew rate is limited by the CC loop and is a function of the loop current compensation. This may be optimized for particular compensation. These momentary crossover situations, which are communicated via the status register, may increase programming times, but will not damage the power supply.

Inductive Loads

Inductive loads present no loop stability problems in CV mode. In CC mode, inductive loads will form a parallel resonance with the power supply's output capacitor, possibly causing current ringing in the load. For a given inductance, the power supply's CC control loop can be made to stabilize the current. However, stabilizing the current for a very large load inductance creates a much slower mode crossover (CV to CC or vice versa) time. Thus, there is a tradeoff between mode crossover speed and inductive compensation. To allow an optimal solution for each load, a CC loop compensation switch is provided so the CC control loop can be optimized for a specific load inductance. See "Appendix E - Current Loop Compensation" for details.

Battery Charging

The power supply's OVP circuit has a downprogrammer FET that discharges the power supply output whenever OVP trips. If a battery (or other external voltage source) is connected across the output and the OVP is inadvertently triggered or the output is programmed below the battery voltage, the power supply will sink current from the battery. To avoid this, insert a reverse blocking diode in series with the \oplus output of the supply. Connect the diode **cathode** to the + battery terminal and the diode **anode** to the supply \oplus output terminal. The diode will require a heat sink.

Local Voltage Sensing

For local sensing the +S and--S analog connector pins must be connected to the + and - bus bars (see Figure 4-5b). This is the default configuration as wired at the factory. Each sense lead is connected to the small, tapped hole nearest the corresponding output lead. Since local sensing does not compensate for voltage drops in the screw connections or load leads, local sensing should only be used in applications that require low output currents or where load regulation is not critical.

Note	If the sense terminals are left open, the voltage at the output bus bars will increase approximately 3 to 5% over the programmed value. The readback voltage will not reflect this increase because readback is measured at the sense terminals.
-------------	--

Remote Voltage Sensing

The dashed lines in the wiring diagrams illustrate remote voltage sensing. The remote sense terminals of the power supply are connected directly to the load rather than to the output bus bars. This allows the supply to automatically increase the voltage at the output bus bars to compensate for any voltage drop in the load leads, as well as to accurately read back the voltage directly from the load.

Setting Up Remote Sense Operation

You must connect the positive side of the load to the +S analog connector pin and the negative side of the load to the -S analog connector pin (see Figure 4-1). Connect the sense leads carefully so that they do not become open-circuited. If sense leads are left open during operation, the supply will regulate at the output bus bars instead of at the load. Remember to bundle or tie wrap the load leads to minimize inductance and reduce noise pickup.

The sense leads are part of the supply's feedback path and must be kept at a low resistance in order to maintain optimal performance. Connect the sense leads carefully so that they do not become open-circuited. If the sense leads are left unconnected or become open during operation, the supply will regulate at the output bus bars, resulting in a 3 to 5% increase in output over the programmed value.

CV Regulation

The maximum output voltage under remote sensing is reduced by the voltage drop in the load leads. See "Remote Sensing Capability" in Table 1-3b for further characteristics and a general formula for determining the extra degradation in the output due to voltage drop in the output leads.

OVP Considerations

The power supply OVP circuit senses voltage near the output bus bars, not at the load. Therefore the signal sensed by the OVP circuit can be significantly higher than the actual voltage at the load. When using remote sensing, you must program the OVP trip voltage high enough to compensate for the voltage drop between the output bus bars and the load.

Output Rating

In remote sense applications, the voltage drop in the load leads subtracts from the available load voltage. As the power supply increases its output to overcome this voltage drop, the sum of the programmed voltage and the load-lead drop may exceed the power supply's maximum voltage rating. This will not damage the supply, but may trip the OV protection circuit, which senses the voltage at the output bus bars. When the supply is operated beyond its rated output the performance specifications are not guaranteed, although typical performance may be good.

Output Noise

Any noise picked up on the sense leads may appear at the output of the supply and can adversely affect the voltage load regulation. Use shielded twisted pairs for the sense leads and route them parallel and close to the load leads. Ground the shields only at the power-supply end, utilizing the signal ground binding post. *Do not use a shield as one of the sense conductors.* Bundle or tie-wrap the load leads to minimize inductance and reduce noise pickup.

Stability

Using sensing under unusual combinations of load lead lengths and large load capacitances may cause your application to form a low-pass filter, which becomes part of the voltage feedback loop. The extra phase shift created by this filter can degrade the supply's stability, resulting in poor transient response. In severe cases, it may cause oscillation. To minimize this possibility, keep the load leads as short as possible and tie wrap them together.

In most cases, following these guidelines will eliminate problems associated with load lead inductance. However, if a large bypass capacitor is required at the load and load-lead length cannot be reduced, then a sense-lead bypass network may be needed to ensure stability (see Figure 4-5b).

The voltage rating of the 33 μF capacitors should be about 50% greater than the anticipated load-lead drop. Addition of the 20 Ω resistors will cause a slight voltage rise at the remote sensing points. For utmost voltage programming accuracy, the supply should be recalibrated with the DVM at the remote sensing points (see "Appendix A - Calibration"). In addition, the sense protect resistors inside the power supply may have to be removed. (If you need help with a stability problem, contact an Support Engineer through your local Agilent Sales and Support offices.)

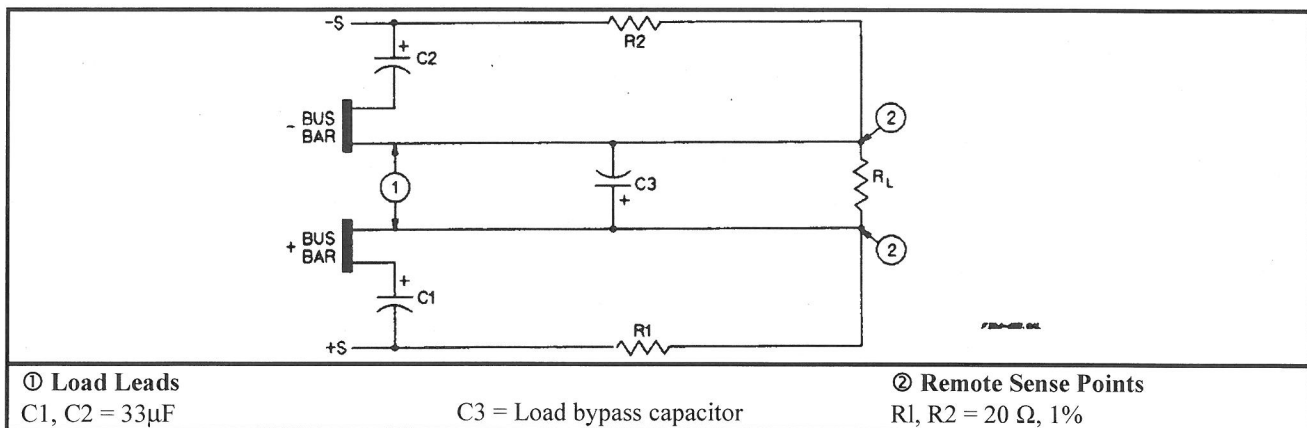


Figure 4-5b. Series 668xA and 669xA Sense Lead Bypass Network

Connecting One Power Supply to a Single Load

Figure 4-5c shows how to connect a single power supply to one load. Keep output load leads close together (small loop area) to obtain a low inductance and low impedance connection to the load. If you wish to use remote sensing, connect the sense leads at the load as shown in the figures.

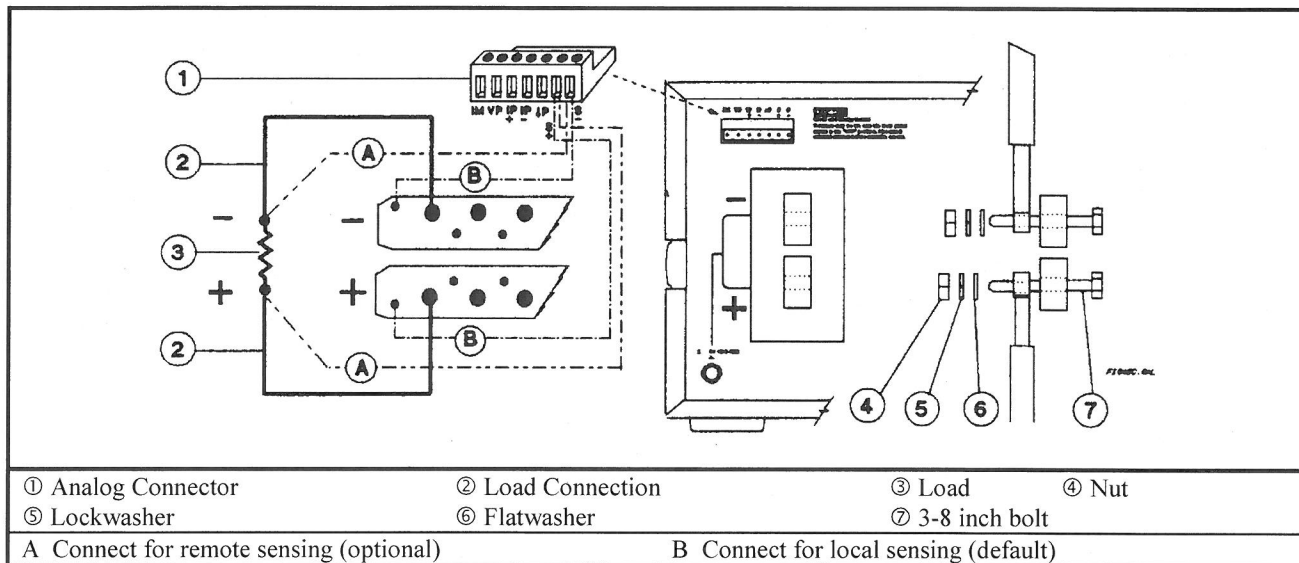


Figure 4-5c. Series 668xA and 669xA Single Load Connection (Remote Sensing Optional)

Note

If you are using a bench application requiring the Option 601 Output Connector Kit, be sure to consult the instructions supplied with the kit.

Connecting One Power Supply to Multiple Loads

Figure 4-5d shows how to connect a single power supply to more than one load. When connecting multiple loads to the power supply with local sensing, connect each load to the output bus bars with separate connecting wires. This minimizes mutual coupling effects and takes full advantage of the supply's low output impedance. Keep each pair of load wires as short as possible and twist or bundle them to reduce lead inductance and noise pickup.

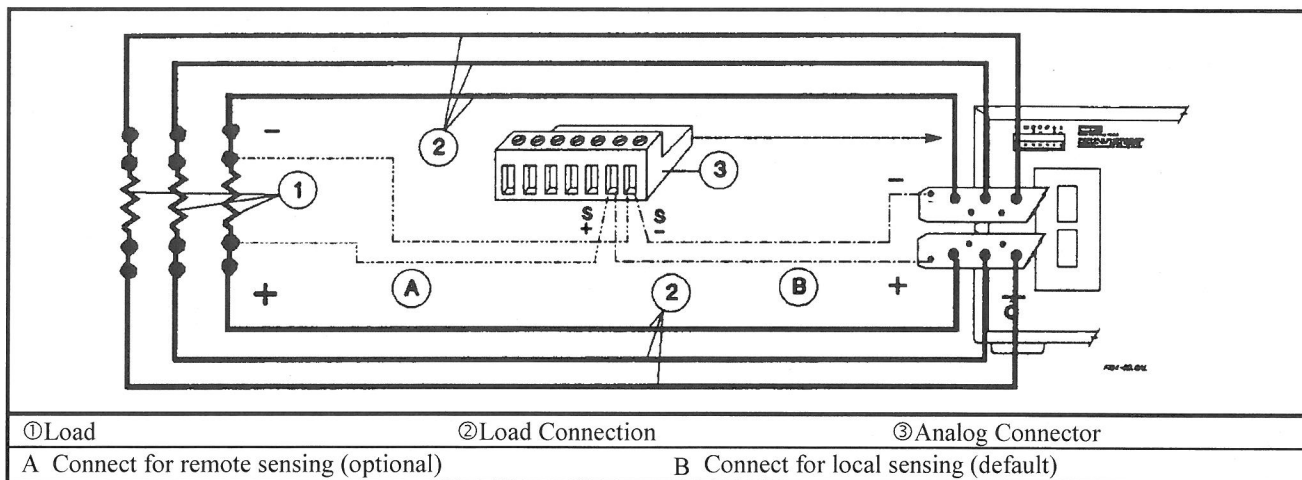


Figure 4-5d. Series 668xA and 669xA Multiple Load Connection (Remote Sensing Optional)

Connecting Supplies in Auto-Parallel

Note Refer to Appendix F for more information about auto-parallel operation.

Auto-Parallel Wiring (Figure 4-5e). Figure 4-5e shows how power supplies can be auto-parallelled for increased current output. Up to three supplies can be connected for auto-parallel operation. Use heavy enough load leads so that the absolute voltage difference between the \oplus output terminals of the "master" supply and the \oplus output terminal of the first "slave" supply is kept under 2 V at rated current. This also applies to the voltage difference between the \oplus output terminals of the first and second "slave" supplies. If remote sensing is necessary, connect the remote sense terminals of the "master" supply as shown by the dashed lines in Figure 4-5e. See "Remote Voltage Sensing" for more information.

Auto-Parallel Programming. Program only the output current of the first ("master") supply in the series; the "slave" supplies automatically track the master's output. Program the output current of the slave supplies to zero. However, the voltage and OVP settings of the slave supplies must be set higher than the operating voltage of the master supply. This ensures that the slave supplies will operate in CC mode when tracking the output of the master supply. Be sure to set the output current of the slave supplies to zero, because all current programming inputs (GPIB, front panel, and external voltage) are additive. Functions such as status, voltage readback, and current readback can still be read back individually for each supply.

If a "slave" supply experiences a desired shutdown condition (such as caused by overtemperature or overcurrent), it does not automatically shut down all other supplies. You must first enable remote inhibit (RI) and discrete fault indicator (DFI) operation. It is recommended that you use the RI and DFI functions to automatically shut down all supplies whenever one supply experiences a shutdown condition. See "Fault/Inhibit Operation" in "Appendix D - Digital Port Functions" for wiring information and "Questionable Status Group" in the "Programming Guide" for programming information.

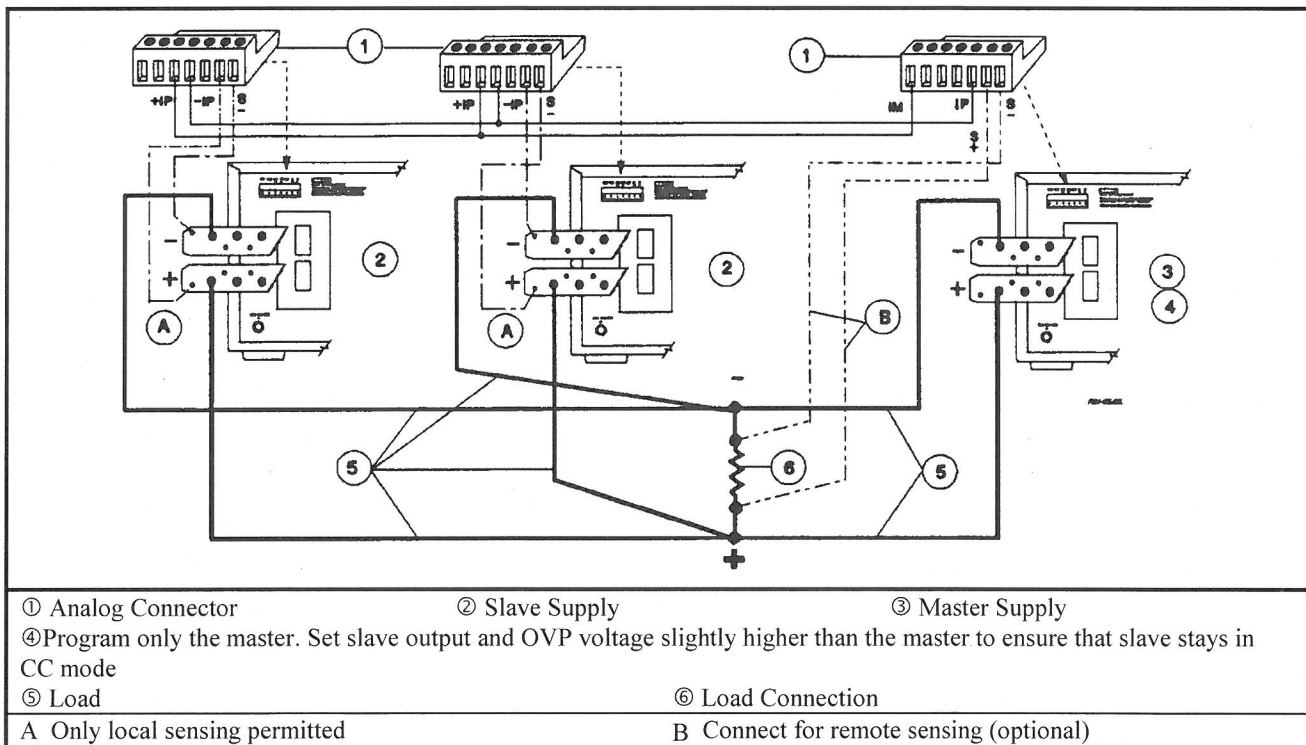


Figure 4-5e. Series 668xA and 669xA Auto-Parallel Connection (Remote Sensing Optional)

Connecting Supplies in Series

CAUTION

Floating voltages must not exceed ± 60 Vdc. No output terminal may be more than 60 V from chassis ground.

Figure 4-5f illustrates how power supplies can be connected in series for increased voltage capability. Series connections are straightforward in this case.

Program each power supply as an independent supply. If two supplies are used in series operation, each supply can be programmed to deliver 50% of the total output voltage. Set the current limit of each power supply to the maximum that the load can handle without damage.

If one supply experiences a desired shutdown condition (such as caused by overtemperature or overcurrent), it does not automatically shut down the other supply. You must first enable remote inhibit (RI) and discrete fault indicator (DFI) operation. It is recommended that you use the RI and DFI functions to automatically shut down both supplies whenever one supply experiences a shutdown condition. See "Fault/Inhibit operation" in "Appendix D - Digital Port Functions" for wiring information and "Questionable Status Group" in the "Programming Guide" for programming information.

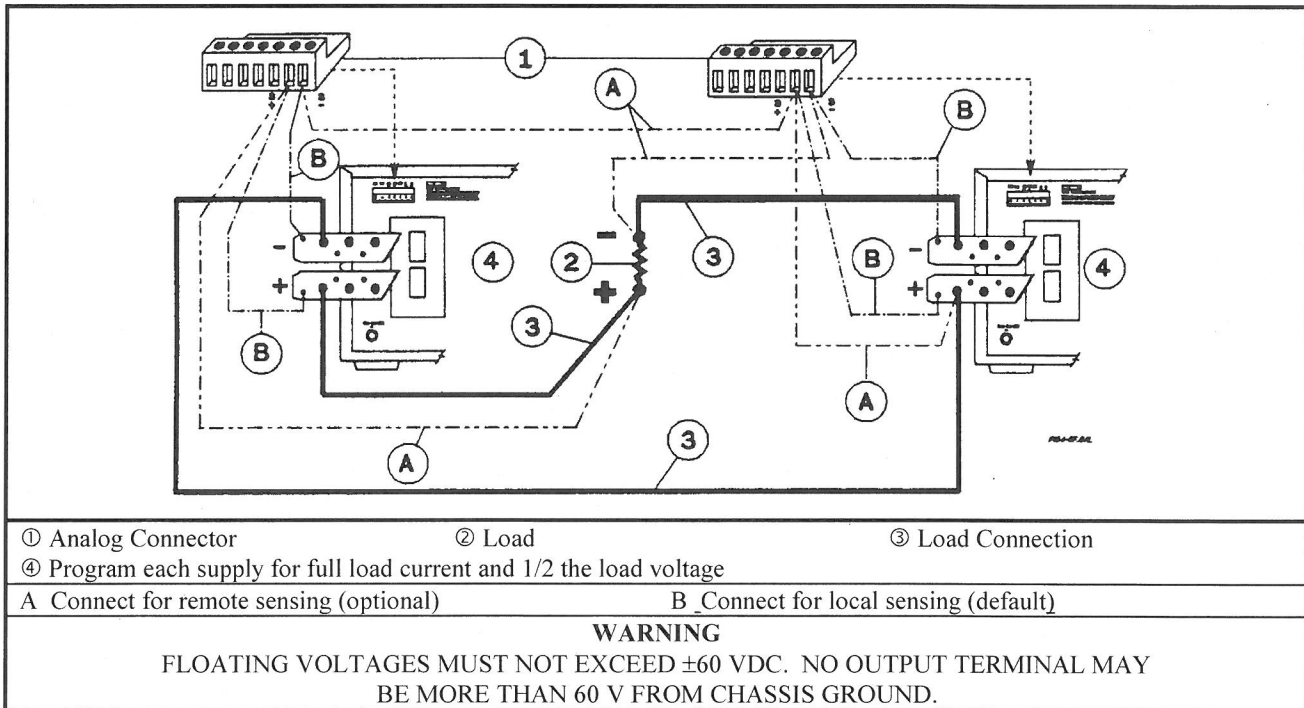


Figure 4-5f. Series 668xA and 669xA Series Connection (Remote Sensing Optional)

WARNING

Each power supply has a reverse voltage protection diode across its output. If the fan in one of the series power supplies shuts down for any reason (such as a fan circuit defect or loss of ac power), the supply may severely overheat due to current forced through its reverse current diode by the functioning supply. This possibility can be eliminated by use of the RI/DFI functions previously noted. Also, if a reverse voltage is applied across a functioning supply, it has no control over the current conducted through this diode. To avoid damaging the supply, never connect it in such a way that a reverse voltage can force it to conduct current in excess of the supply's maximum rated current. (see Table 1-4b)

External Voltage Control

The setup shown in Figure 4-5g allows an external dc voltage to program the power supply output. A zero-to-full scale voltage applied to the voltage programming input produces a proportional zero-to-full scale output voltage. The voltage programming source is referenced to the programming **Common P** ($\downarrow P$) terminal. A zero-to-full scale voltage applied to one of the current programming inputs produces a proportional zero-to-full scale output current. See Figure 4-1 for an explanation of these programming input connections.

Wiring Considerations

The input impedance of the analog input is over 30 k Ω . If the output impedance of your programming source is not negligible with this, programming errors will result. Larger output impedances result in proportionally greater errors.

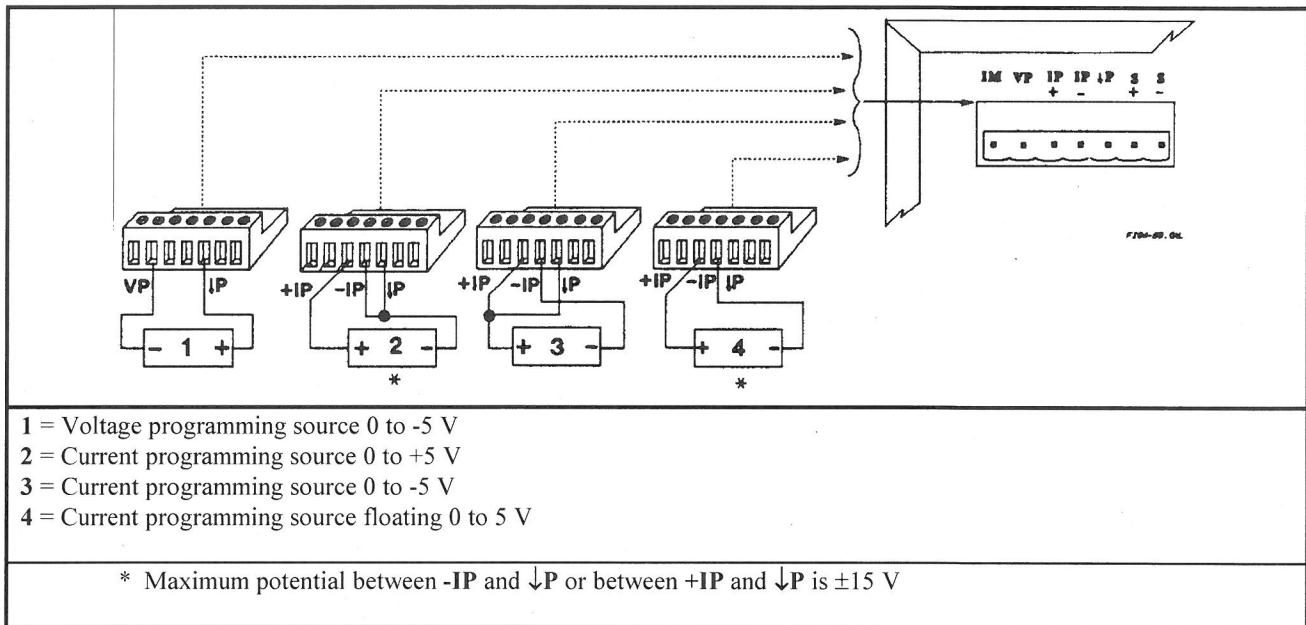


Figure 4-5g. Series 668xA and 669xA Analog Programming Connections

Programming

Note from Figure 4-1 that you have three options for programming the current. You can use a voltage source that is positive, negative, or floating with respect to **Common P**. Do not exceed +15 V with respect to **Common P**.

CAUTION

Make certain that the common connection for your voltage programming source is isolated from the load. Failure to do this may cause damage to the power supply.

The effect of the analog programming source is always summed with the values programmed over the GPIB or from the front panel. The voltage source can act alone only if you set the other program sources to zero. Keep the total programmed setting of the supply (the analog input summed with the GPIB or front panel settings) at or under the output ratings specified in Table 1-3a. Exceeding the output ratings will not damage the supply, but it may not be able to regulate its output the higher levels. If this happens, the **Unr** annunciator will light to warn you that the output is unregulated.

Controller Connections

Figure 4-6 shows two basic ways of connecting your power supply to a controller. They are "linked" and "stand-alone" configurations.

Stand-Alone Connections

See Figure 4-6A. Each stand-alone power supply has its own GPIB bus address. Stand-alone power supplies may be connected to the bus in series configuration, star configuration, or a combination of the two. You may connect from 1 to 15 stand-alone power supplies to a controller GPIB interface.

Linked Connections

See Figure 4-6B. Up to 16 power supplies may be used at a single GPIB primary bus address by making linked connections. (You cannot use linked connections if you intend to program power supplies with the Compatibility Language - see the power supply "Programming Guide".)

- The first power supply in a linked connection is a "direct supply" connected to the controller via a GPIB cable. The direct supply is the only supply connected directly to the bus and has a unique primary bus address.
- The remaining power supplies are "linked supplies" connected to the direct supply via a serial-link cable. Each linked supply has a unique secondary GPIB address and derives its primary address from the direct supply. You may connect from 1 to 15 linked supplies to each direct supply.

Note

The power supply is shipped from the factory with its GPIB address set to 5. The power supply primary and secondary addresses can be changed from the front panel as described in "Chapter 2 - Remote Programming" of the "Programming Guide". For power supply GPIB interface capabilities, see Table 1-5 in Chapter 1 of this guide.

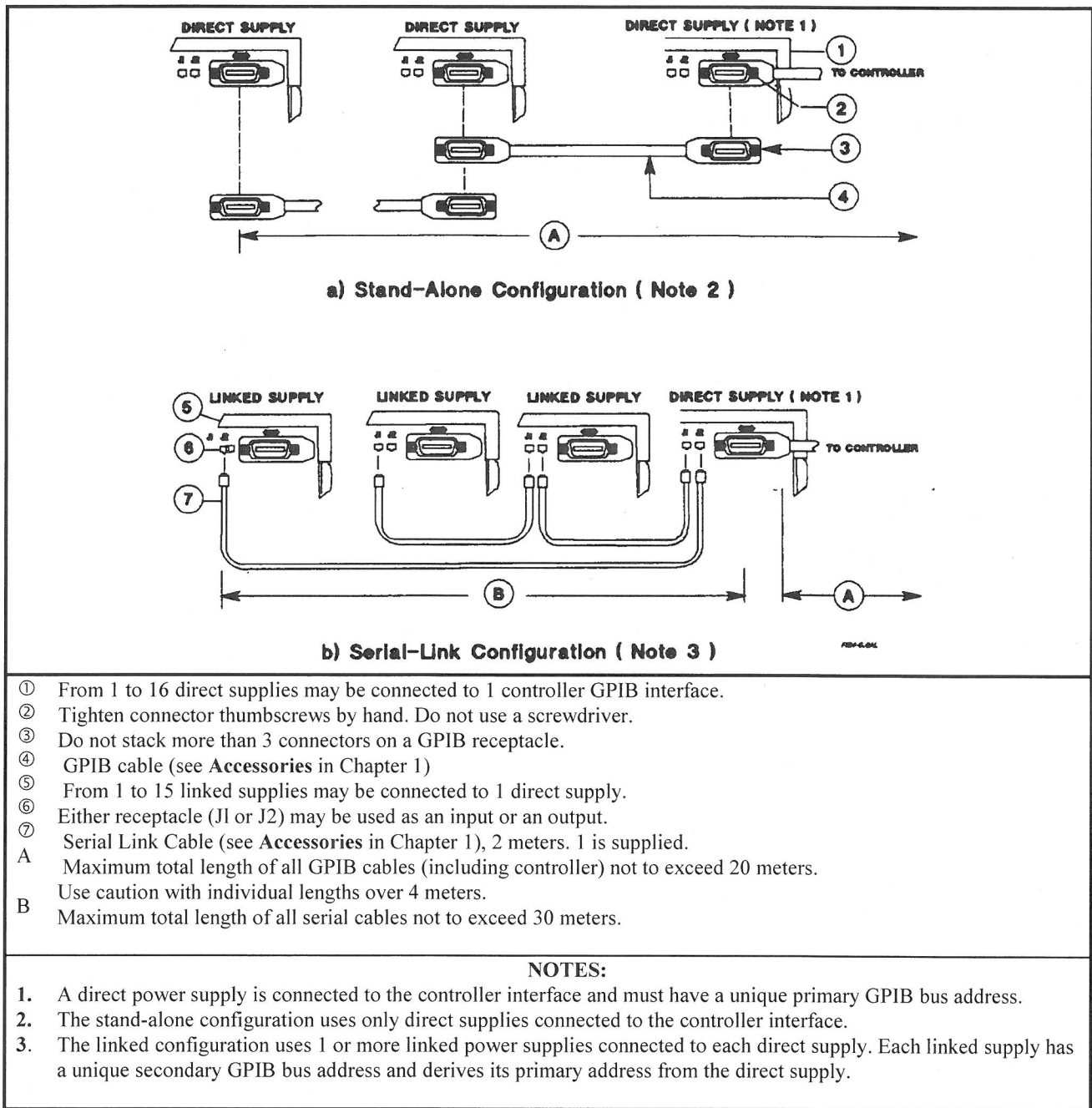


Figure 4-6. Controller Connections

Front Panel Operation

Introduction

This chapter shows you how to operate the front panel. It is assumed that you are familiar with the turn-on checkout procedure in Chapter 3. That chapter describes how to perform basic power supply functions from the control panel. operations that you can perform are:

- Enabling or disabling the power supply output.
- Setting the output voltage and current.
- Monitoring the output voltage and current.
- Setting the overvoltage protection (OVP) trip point.
- Enabling the overcurrent protection (OCP) circuit.
- Saving operating states in nonvolatile memory.
- Recalling operating states from nonvolatile memory.
- Setting the power supply GPIB bus address.
- Displaying error codes created during remote operation.
- Enabling local (front panel) operation.

Note You also can calibrate the power supply from the front panel (see Appendix A).

Getting Acquainted

The front panel is summarized in Figure 5-1 and Table 5-1. Note that the panel is organized as follows:

- ① LCD display (including annunciators)
- ② Output VOLTAGE and CURRENT rotary (RPG) knobs
- ③ SYSTEM keypad
- ④ FUNCTION keypad
- ⑤ ENTRY keypad
- ⑥ Power (LINE) switch

Some keys have two functions. For example, the System **Recall** key (3, Figure 5-1) can be used either to recall a stored operating state or to **Save** (store) an operating state. The first operation is shown **on** the key and the second (shifted) operation is shown in blue **above** the key. In order to do a shifted operation, first press the solid blue key, which is unlabeled but shown throughout this manual as **Shift**.

For example, for a recall operation, press the recall key **Recall**. For a save operation, press the save key, which is **Shift Recall**. When you do this, the **Shift** annunciator will light to remind you that the **Recall** key is now functioning as the **Save** key. In this chapter, such a shifted operation may be shown simply as **Save**.

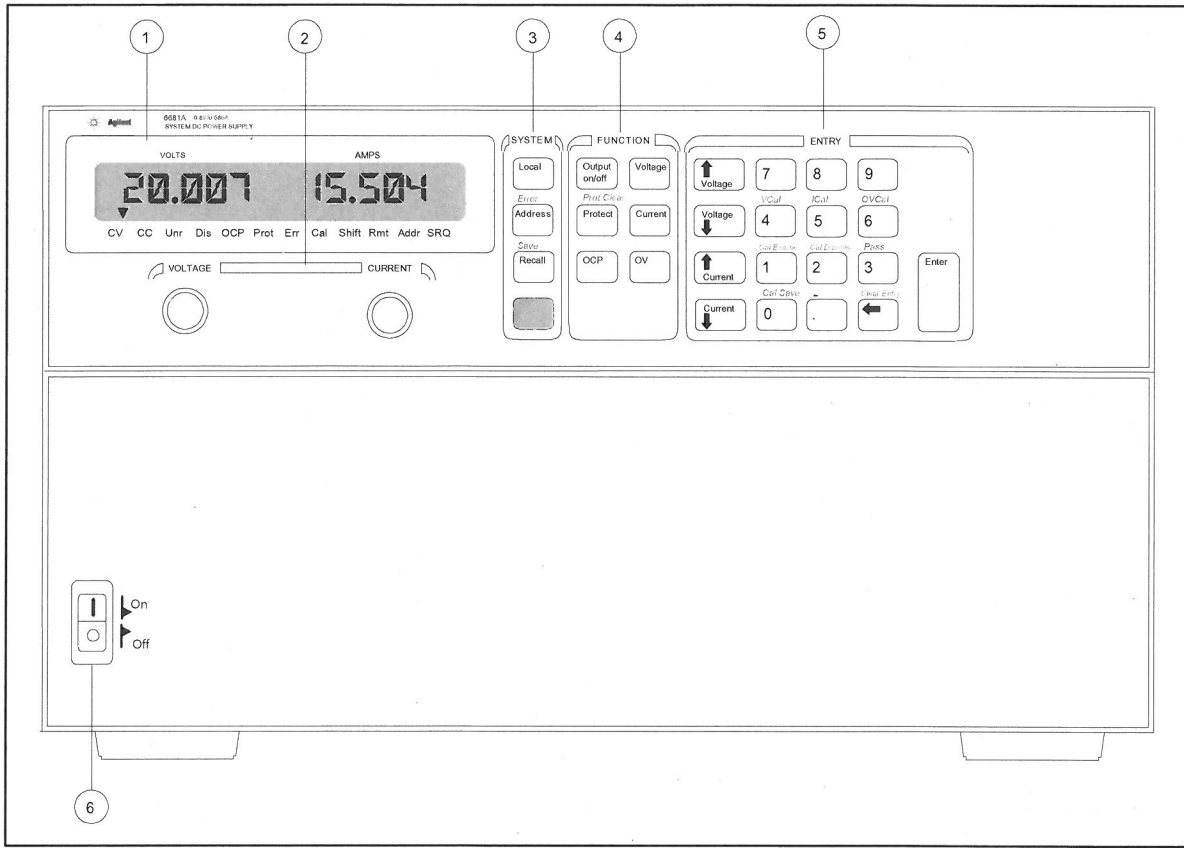


Figure 5-1. Front Panel Controls and Indicators

Table 5-1. Front Panel Controls and Indicators (see Figure 5-1)

Control or Indicator	Function or Indication
① Display	
VOLTS	Shows present output voltage of the power supply.
AMPS	Shows present output current of the power supply.
Status Annunciators	
CV	The power supply is in constant-voltage mode.
CC	The power supply is in constant-current mode.
Unr	The power supply output is unregulated (output is neither CV or CC).
Dis	The power supply output is disabled.
OCP	The overcurrent protection function is enabled.
Prot	A protection circuit has caused the power supply to shut down. (Press Protect to determine the reason.)
Err	An error has been generated as a result of remote operation. (Press Error to display the error code).
Cal	The power supply is in calibration mode.
Shift	The shift key Shift has been pressed.
Rmt	The power supply is in the remote mode (controlled over the GPIB).
Addr	The power supply is addressed to listen or talk.
SRQ	The power supply is requesting service from the controller.

Table 5-1. Front Panel Controls and Indicators (continued)


② Output Rotary Controls	
Voltage	Rotate clockwise to increase output voltage or program setting. Use to rapidly set an approximate output value (see ↑Voltage and ↓Voltage keys).
Current	Rotate clockwise to increase output current or program setting. Use to rapidly set an approximate current value (see ↑Current and ↓Current keys).
③ SYSTEM Keys	
Local	When the power supply is under remote control, press to enable local operation. <i>This control can be defeated by a lock-out command over the GPIB</i>
Address	Press to display the power supply's GPIB address. You can change the address with the ENTRY keys
Error	Use to display error codes generated during remote operation. (Select by pressing Shift Address .)
Recall	Use to restore a previously saved power supply state. Use ENTRY keys 0 through 4 (0 through 3 on the Series 668xA) to specify which location to recall. (Select by pressing Shift Recall .) Note: Location 0 may contain the power supply turn-on state. See "Turn-on operation" in this chapter.
Save	Use to save the power supply's present state to nonvolatile memory. (Select by pressing Shift Recall .) Use ENTRY keys to specify the location where you want to store the state. You may use locations 0 through 4 (0 through 3 on the Series 668xA).
	This unlabeled blue key is the Shift key. Press to access the shifted (alternate) key functions.
④ Function Keys	
Output on/off	Press to enable or disable the power supply output. This key toggles between the two states. The disabled state programs the output to the *RST voltage and current settings (see the Programming Guide).
Voltage	Press to display the output voltage setting. After pressing Voltage , you may use the ENTRY keys to change the value.
Current	Press to display the output current setting. After pressing Current , you may use the ENTRY keys to change the value.
OV	Press to display the OV trip voltage setting. After pressing OV , you may use the ENTRY keys to change the value.
Protect	When the Prot annunciator is on, press Protect to see which protection circuit caused the power supply to shut down. Response can be OC (overcurrent), OT (overtemperature), or OV (overvoltage). If no protection circuit has tripped, the display will show dashes (- - -).
Prot Clear	Press this key to reset the protection circuit. <i>If the condition that caused the circuit to trip has been removed</i> , the Prot annunciator will go off.
OCP	Press to enable or disable the power supply OCP trip circuit. This key toggles between the two states, which are indicated by the OCP annunciator.
⑤ ENTRY Keys	
↑Voltage	Press to increment the output voltage in the CV mode, or to increase the voltage setting after you have pressed the Voltage key. ³
↓Voltage	Press to decrement the output voltage in the CV mode, or to decrease the voltage setting after you have pressed the Voltage key. ³
↑Current	Press to increment the output current in the CC mode, or to increase the current setting after you have pressed the Current key. ³
↓Current	Press to decrement the output current in the CC mode, or to decrease the current setting after you have pressed the Current key. ³

Table 5-1. Front Panel Controls and Indicators (continued)

⑤ ENTRY Keys (continued)	
0 thru 9	Press to select numerical values .
-	Press to enter a minus sign.
←	Press to delete the last keypad entry. Use this key to remove one or more incorrect digits before they are entered.
³ These four entry keys operate in two modes. Press and release for a single minimal change as determined by the programming resolution (see Table 1-2 in Chapter 1). Press and hold for an increasingly rapid output change.	
Clear Entry	Press to delete an entire keypad entry and return to the meter mode. Use this key to exit from a value before it is entered.
Enter	Press to enter a value or to accept an existing value and return the display to the meter mode. The remaining shifted keys are for calibration (see "Appendix A - Calibration").
⑥ Line Switch	
On / Off	Turns the ac line on or off.

Programming the Output

Important These instructions show how to program a single power supply. There are special considerations when you have two or more supplies connected in series or in autoparallel. See "Chapter 4 - User Connections and Considerations".

The power supply accepts values directly in volts and amperes. Values will be rounded off to the nearest multiple of the output resolution (see "Average Resolution" in Table 1-2 of Chapter 1). If you attempt to enter a value not in a valid range, the entry will be ignored and **OUT OF RANGE** appears on the display.

Figure 5-2 shows the general response of a typical power supply. Unless directed otherwise, always keep the output voltage and current within the boundaries of its operating line for the specified mode of operation (CV or CC).

Establishing Initial Conditions

Set the power supply to its *RST state by pressing **Recall** **0** **Enter**. This state was stored in location 0 at the factory. If it has since been changed, you can restore it as directed under "Turn-on Conditions", later in this chapter. *RST results in the following operating conditions:

- Zero voltage output.
- Minimal current output.
- Output disabled (**Dis** annunciator on).
- Overcurrent protection off (**OCP** annunciator off).
- Protection circuits cleared (**Prot** annunciator off).

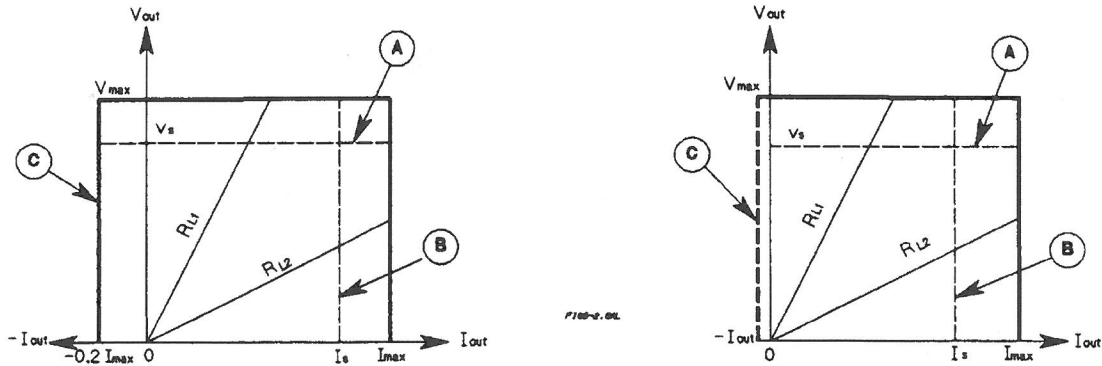


Figure 5-2. Typical Power Supply Operating Curve

Programming Voltage

To program the output for 4.5 volts, proceed as follows:

- Press **Voltage**. The display will change from meter mode to indicate VOLTS.
- Press **4 . 5 Enter**. If you discover a mistake before pressing **Enter**, erase the incorrect value with the backspace key **←**.
- The display will return to the meter mode and indicate 0.000 volts.
- Press **Output on/off** to enable the output (**Dis** annunciator turns off). The VOLTS display will indicate 4.500 volts.

Note

The power supply must be programmed for a minimal current in order to increase the output voltage beyond zero. Normally, there is sufficient idle current to do this. If the power supply does not respond or the **CC** annunciator turns on, go to "Programming Current" and set the current to a small value.

- Now raise the voltage by pressing **↑Voltage**. Note that the voltage increases by a specific increment (depending on the voltage programming resolution) each time you press the key and increases rapidly as you hold down the key. To lower the voltage, press **↓Voltage**.
- Try raising and lowering the voltage by rotating the **Voltage** control clockwise and then counterclockwise. Note how the output responds as compared to using the **Entry** keys.

Try to program a voltage greater than the V_{MAX} for your supply (see "Supplemental Characteristics" for your particular model in Chapter 1). Note that the display shows **OUT OF RANGE**.

Programming Overvoltage Protection

Overvoltage protection guards the load against voltages that reach a specified value above the programmed output voltage.

Setting the OVP Level

Assuming that you have programmed the power supply for 4.5 volts, you can set the OVP level to 4.8 volts as follows:

- Press **OV**. The display will change from meter mode to indicate 0V, followed by the present OVP value.
- Press **4 . 8 Enter**.
- The display will return to the meter mode and indicate the output (4.500 volts).
- Press **OV** again. The display will now indicate **0V 4 . 800**.
- Press **Enter** to return to the meter mode.

Checking OVP Operation

Assuming the above operating conditions (voltage programmed to 4.5 V and OVP programmed to 4.8 V), trip the OVP circuit as follows:

- Gradually increase the output voltage by pressing **[Voltage]** until the OVP circuit trips. This will cause the output voltage to drop to zero and the **Prot** annunciator to go on.
- There now is no power supply output due to an overvoltage condition.
- To verify this, press **[Protect]** and observe that the display indicates **0V**. This shows that the protection circuit tripped due to an overvoltage condition.

Clearing The OVP Condition

With the OVP tripped, return to the meter mode and try to clear the condition by pressing **[Prot Clear]**. Nothing will appear to happen because the OV trip voltage is still below the programmed output voltage. Thus, as soon as the circuit is cleared, it trips again. You can clear the OV condition by:

- Lowering the output voltage below 4.8 (the OV setting), or
- By raising the OV trip voltage above the output voltage setting.

Try either of these methods. Now when you press **[Prot Clear]**, the **Prot** annunciator will turn off and the output voltage will return to normal.

Programming Current

WARNING

ENERGY HAZARD. Some power supplies (Series 668xA) can provide more than 240 VA at more than 2 V. If the output connections touch, severe arcing may occur resulting in burns, ignition or welding of parts.

You may program the power supply current without a load, but must have a load in order to draw output current. These tests assume you have the load connected in accordance with the information in “Chapter 4 - User Connections and Considerations”. If you do not have a load on the power supply, you may connect a short across the output terminals as described in “Chapter 3 - Turn-on Checkout”.

The example will program a low current. (You may later increase the output current to the levels you will expect to use.) To program the output current to 1.3 amperes, proceed as follows:

- Disable the output by pressing **[Output on/off]**. The **Dis** annunciator will turn on.
- Program the voltage by pressing **[Voltage]** **[5]** **[Enter]**.
- Press **[Current]**. The display will change from meter mode to indicate **AMPS**.
- Press **[1]** **[.]** **[3]** **[Enter]**. If you discover a mistake before pressing **[Enter]** erase the incorrect value with the backspace key **[←]**.
- The display will return to the meter mode and indicate up to 0 . 000.
- Press **[Output on/off]** to enable the output. **Dis** will turn off and the display will indicate **VOLTS 5 . 000 AMPS 1. 300**.
- Now increase the current by pressing **[Current]**. Note that the current increases by a specific increment (depending on the current programming resolution) each time you press the key and increases rapidly as you hold down the key. To decrease the current, press **[Current]**.
- Try increasing and decreasing the current by rotating the **Current** knob clockwise and counterclockwise. Note how the output responds as compared to using the **Entry** keys.

Disable the output by pressing **[Output on/off]**. The **Dis** annunciator will turn on. Now try to program a current greater than the I_{MAX} for your supply. Note that the display shows **OUT OF RANGE**.

Programming Overcurrent Protection

When enabled, overcurrent protection removes the power supply output whenever it goes into CC operation. This prevents the supply from indefinitely supplying the full programmed current to the load.

Setting The OCP Protection

To activate overcurrent protection, press **OCP**. The **OCP** annunciator will light and power supply will continue to operate normally until it is forced into CC operation. If that occurs, the OCP circuit will trip and the power supply will remove its output.

Checking OCP Operation

The easiest way to check this operation at any specified current is to increase the load current beyond the programmed current value and, if necessary, decrease the programmed voltage. This will force the power supply into the CC mode (see Figure 5-2). When OCP trips, the **Prot** annunciator will light and the power supply output will drop to zero.

There is now no power supply output due to an overcurrent condition. To verify this, press **Protect** and observe that the display indicates **OC**.

Clearing The OCP Condition

With the OCP tripped, return to the meter mode and try to clear the condition by pressing **Prot Clear**. Nothing will appear to happen because the reason for the condition has not been removed. Thus, as soon as the circuit is cleared, it trips again. You can clear the OC condition by:

- Increasing the load resistance to lower the output current below the programmed current value, or
- By raising the programmed current to a value above that required by the load.

Clear the fault by either of the above methods. Then clear the OCP circuit by pressing **Prot Clear**. The **Prot** annunciator will go off and the power supply output will be restored to normal.

If desired, you can also restore the output by disabling the OCP function (press **OCP** to turn off the **OCP** annunciator). This restores the output but does not clear any condition that may have caused OCP to trip.

Note Under certain conditions, the OCP circuit may fail to clear because load demand occurs before the power supply has time to build up the required output current capacity. In such cases, disable the output (press **Output on/off**) before clearing the OCP circuit). After OCP is cleared, enable the power supply output.

CV Mode vs. CC Mode

Once you program a voltage (V_S) and a current (I_S) in Figure 5-2, the power supply will try to maintain itself in either CV or CC mode, depending on the impedance of the load (R_L). If the load demands less current than I_S , operation will be in CV mode with the voltage maintained at V_S . The output current will be at some value below I_S as determined by $V_S \div R_L$.

If the current increases beyond I_S (see R_{L2}), the supply will switch to CC mode by varying its output voltage to maintain a constant current value of I_S . As more current is demanded, the voltage decreases to maintain the increased current level. If the load current increases to the maximum output of the power supply, the output voltage will be maintained at a near-zero level.

Unregulated Operation

If the power supply goes into a mode of operation that is neither CV nor CC, the **Unr** annunciator will light. An unregulated condition limits the output current to a value that is safe for the power supply. Some unregulated states occur so briefly that they do not turn on the **Unr** annunciator, but they may set the **UNR** status bit during remote operation (see the power supply “Programming Guide”). One condition that can cause a noticeable unregulated state is low ac line voltage.

Saving and Recalling Operating States

You can save programming time by storing up to 5 (up to 4 with Series 668xA supplies) operating states in nonvolatile memory. The front panel programming parameters that are saved are:

- Output voltage, Output current, OVP voltage.
- OCP state (on or off), Output state (enabled or disabled).

Note More power supply parameters are saved in remote operation. See the power supply “Programming Guide”.

As an example, set up the following state:

- Voltage = 4 V Current = 5 A OVP voltage = 4.5 V.
- OCP = on (**OCP** annunciator on) Output = off (**Dis** annunciator on).

Save the above state to location 1 by pressing **Save** **1** **Enter**. Now set up the following state:

- Voltage = 4.5 V Current = 2.5 A OVP voltage = 5 V.
- OCP = off (**OCP** annunciator off) Output = on (**Dis** annunciator off).

Save the above state to location 2 by pressing **Save** **2** **Enter**.

Restore the first state by pressing **Recall** **1** **Enter** and verify the parameters. Restore the second state by pressing **Recall** **2** **Enter**. Note how the power supply is automatically programmed each time.

Turn-On Conditions

Whenever you apply power to a new power supply it automatically turns on in a safe reset state with the following parameters:

Output on/off off **Voltage** 0 **Current** minimum* **OV** maximum **OCP** off

*Minimum is the *RST value specified in Table 3-1 in the Programming Guide.

It is recommended that you leave the turn-on conditions as programmed. However, you may change them if you wish. To do this, proceed as follows:

1. Set up the power supply to the state you want when it is turned on.
2. Store that state to location 0.
3. Turn off the power supply.
4. Hold in the **0** key and turn the power supply back on. The display indicates **RCL 0 PWR-ON** to verify that the power supply has configured its turn-on state to that stored in location 0.
5. From now on the supply will always turn on to the state defined in location 0.