

Keysight N8900 Series Autoranging System DC Power Supply

Operating and
Service Guide

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Preliminary Information

Legal and Safety Information

Models and Options

Specifications and Characteristics

This document includes user, service, and programming information for the Keysight N8900 Series Autoranging System DC Power Supply.

Documentation and Firmware Revisions

You can download the latest version of this document at www.keysight.com/find/n8900-doc. The latest version is also available for mobile devices at www.keysight.com/find/n8900-mobilehelp. If you have feedback on this document, please contact Keysight at www.keysight.com/find/n8900-docfeedback.

For the latest firmware revision go to [Firmware Updates](#).

Contacting Keysight Technologies

Use www.keysight.com/find/assist for information on contacting Keysight worldwide, or contact your Keysight Technologies representative.

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Legal and Safety Information

Legal Notices

Safety Notices

Safety Symbols

Legal Notices

Copyright Notice

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Declaration of Conformity

Declarations of Conformity for this product and for other Keysight products may be downloaded from the Web. Go to <http://www.keysight.com/go/conformity> and click on “Declarations of Conformity.” You can then search by product number to find the latest Declaration of Conformity.

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This product complies with the WEEE Directive 2002/96/EC marketing requirement. The affixed product label (see below) indicates that you must not discard this electrical/electronic product in domestic household waste.

Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as “Monitoring and Control instrumentation” product.

Do not dispose in domestic household waste.

To return unwanted products, contact our local Keysight office, or see <http://www.keysight.com/environment/product> for more information.



Safety Notices

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

WARNING **HAZARDOUS VOLTAGES** All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

General

The equipment is for industrial use. **It is not applicable for IT mains supply systems.**

Equipment operators are subject to all applicable safety regulations. Along with the warning and safety notices in this manual, all relevant safety, accident prevention, and environmental regulations must also be followed. In particular, the operators of the equipment:

- Must be informed of the relevant safety requirements.
- Must have read and understood the operating manual before using the equipment.
- Must use the designated and recommended safety equipment.

Do not use this product in any manner not specified by the manufacturer. The protective features of this product may be impaired if it is used in a manner not specified in the operating instructions.

Environmental Conditions

Environmental condition are described under **Common Characteristics**.

Before Applying Power

Verify that all safety precautions are taken. All connections must be made with the unit turned off, and must be performed by qualified personnel who are aware of the hazards involved. Improper actions can cause fatal injury as well as equipment damage.

Note the instrument's external markings described under "Safety Symbols". Only operate the product at the rated mains voltage and phase as stipulated on the input label.

Ground the Instrument

This product is provided with protective earth terminals. To minimize shock hazard, the instrument must be connected to the AC mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the

protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in injury or death.

External Voltage Sources

Do not connect voltage sources to the output of the power supply with voltage ratings that are greater than the nominal voltage rating of the supply. Under no circumstances can you connect an external voltage with reversed polarity to the output terminal. Equipment damage will result.

Do Not Operate in an Explosive Atmosphere.

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

Do Not Remove the Instrument Cover

Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover.

Do Not Modify the Instrument

Do not install substitute parts or perform any unauthorized modification to the product. Return the product to a Keysight Sales and Service Office for service and repair to ensure that safety features are maintained.

Fuses

The instrument contains internal fuses, which are not customer accessible.

In Case of Damage

Instruments that are not functioning correctly, appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Cleaning

To prevent electric shock, unplug the unit before cleaning. Clean the outside of the instrument with a soft, lint-free, slightly damp cloth. Do not use detergent. Disassembly is not required or recommended for cleaning.

Safety Symbols

WARNING

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

1 Preliminary Information

CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.



Direct current



Alternating current



Frame or chassis terminal



Standby supply. Unit is not completely disconnected from AC mains when switch is off.



Caution, risk of electric shock



Caution, refer to accompanying documents



Earth ground terminal



The CE mark is a registered trademark of the European Community.



The TUV mark is a registered trademark of the European community.



The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australian EMC Framework regulations under the terms of the Radio Communications Act of 1992.



South Korean Class A EMC Declaration

This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.



Contains one or more of the 6 hazardous substances above the maximum concentration value (MCV), 40 Year EPUP.

ISM1-A

This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).

ICES/NMB-001

This text indicates product compliance with the Canadian Interference- Causing Equipment Standard (ICES-001).

Models and Options

Model Ratings

5 kW Models	Voltage	Current	AC mains
Keysight N8920A	80 V	170 A	208 VAC
Keysight N8921A	200 V	70 A	208 VAC
Keysight N8923A	500 V	30 A	208 VAC
Keysight N8924A	750 V	20 A	208 VAC
Keysight N8940A	80 V	170 A	400 VAC
Keysight N8941A	200 V	70 A	400 VAC
Keysight N8943A	500 V	30 A	400 VAC
Keysight N8944A	750 V	20 A	400 VAC

10 kW Models	Voltage	Current	AC mains
Keysight N8925A	80 V	340 A	208 VAC
Keysight N8926A	200 V	140 A	208 VAC
Keysight N8928A	500 V	60 A	208 VAC
Keysight N8929A	750 V	40 A	208 VAC
Keysight N8930A	1000 V	30 A	208 VAC
Keysight N8945A	80 V	340 A	400 VAC
Keysight N8946A	200 V	140 A	400 VAC
Keysight N8948A	500 V	60 A	400 VAC
Keysight N8949A	750 V	40 A	400 VAC
Keysight N8950A	1000 V	30 A	400 VAC

15 kW Models	Voltage	Current	AC mains
Keysight N8931A	80 V	510 A	208 VAC
Keysight N8932A	200 V	210 A	208 VAC
Keysight N8934A	500 V	90 A	208 VAC
Keysight N8935A	750 V	60 A	208 VAC
Keysight N8937A,	1500 V	30 A	208 VAC
Keysight N8937APV	1500 V	30 A	208 VAC
Keysight N8951A	80 V	510 A	400 VAC
Keysight N8952A	200 V	210 A	400 VAC
Keysight N8954A	500 V	90 A	400 VAC
Keysight N8955A	750 V	60 A	400 VAC
Keysight N8957A,	1500 V	30 A	400 VAC
Keysight N8957APV	1500 V	30 A	400 VAC

Accessories/Options

Accessory/Option Number	Description
Keysight N8958A	Rack Mount Kit for all models
SAS Curve Generator software	N8937APV/N8957APV only: www.keysight.com/find/N8900APVsoftware

Specifications and Characteristics

Specifications

Supplemental Characteristics

Common Characteristics

Autoranging Characteristics

Dimension Diagrams

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0°C to 45°C after a 30-minute warm-up period. Specifications apply from >2% to 100% of the rated voltage and from >1% to 100% of the rated current, measured at the output terminals with local sensing (sense terminals not connected).

Supplemental characteristics are not warranted but are descriptions of performance determined either by design or by type testing. All supplemental characteristics are typical unless otherwise noted.

Specifications and characteristics are subject to change without notice.

Specifications

Specification 5 kW	N8920A/ N8940A	N8921A/ N8941A	N8923A/ N8943A	N8924A/ N8944A
DC Ratings				
Voltage:	0 - 80 V	0 - 200 V	0 - 500 V	0 - 750 V
Current:	0 - 170 A	0 - 70 A	0 - 30 A	0 - 20 A
Power:	5 kW	5 kW	5 kW	5 kW
Output ripple & noise ¹				
CV rms:	16 mV	40 mV	70 mV	200 mV
CV peak-to-peak:	200 mV	375 mV/300 mV	350 mV	800 mV
Load regulation				
Voltage:	40 mV	100 mV	250 mV	375 mV
Current:	255 mA	105 mA	45 mA	30 mA
Voltage programming & measurement accuracy ²	≤ 80 mV	≤ 200 mV	≤ 500 mV	≤ 750 mV
Current programming & measurement accuracy ²	≤ 340 mA	≤ 140 mA	≤ 60 mA	≤ 40 mA
Transient response ³				
Recovery Time:	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms
Settling band:	0.8 V	2 V	5 V	7.5 V

¹From 20 Hz to 300 kHz for rms noise; from 20 Hz to 20 MHz for peak-to-peak noise

²Accuracy specifications are warranted at 23°C ±5°C

³Time to recover to within the settling band following a load change from 10% to 90% of full load

Specification 10 kW	N8925A/ N8945A	N8926A/ N8946A	N8928A/ N8948A	N8929A/ N8949A	N8930A/ N8950A
DC Ratings					
Voltage:	0 - 80 V	0 - 200 V	0 - 500 V	0 - 750 V	0 - 1000 V
Current:	0 - 340 A	0 - 140 A	0 - 60 A	0 - 40 A	0 - 30 A
Power:	10 kW	10 kW	10 kW	10 kW	10 kW
Output ripple & noise ¹					
CV rms:	25 mV	40 mV	70 mV	200 mV	350 mV
CV peak-to-peak:	320 mV	375 mV/300 mV	350 mV	800 mV	1600 mV
Load regulation					
Voltage:	40 mV	100 mV	250 mV	375 mV	500 mV
Current:	510 mA	210 mA	90 mA	60 mA	53 mA/45 mA
Voltage programming & measurement accuracy ²	≤ 80 mV	≤ 200 mV	≤ 500 mV	≤ 750 mV	≤ 1 V
Current programming & measurement accuracy ²	≤ 680 mA	≤ 280 mA	≤ 120 mA	≤ 80 mA	≤ 60 mA
Transient response ³					
Recovery Time:	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms
Settling band:	0.8 V	2 V	5 V	7.5 V	10 V

Specification 15 kW	N8931A/ N8951A	N8932A/ N8952A	N8934A/ N8954A	N8935A/ N8955A	N8937A/ N8937APV N8957A/ N8957APV
DC Ratings					
Voltage:	0 - 80 V	0 - 200 V	0 - 500 V	0 - 750 V	0 - 1500 V
Current:	0 - 510 A	0 - 210 A	0 - 90 A	0 - 60 A	0 - 30 A
Power:	15 kW	15 kW	15 kW	15 kW	15 kW
Output ripple & noise ¹					
CV rms:	25 mV	40 mV	70 mV	200 mV	400 mV
CV peak-to-peak:	320 mV	375 mV/300 mV	350 mV	800 mV	2400 mV
Load regulation					
Voltage:	40 mV	100 mV	250 mV	375 mV	750 mV
Current:	765 mA	315 mA	135 mA	90 mA	53 mA/45 mA
Voltage programming & measurement accuracy ²	≤ 80 mV	≤ 200 mV	≤ 500 mV	≤ 750 mV	≤ 1.5 V
Current programming & measurement accuracy ²	≤ 1.1 A	≤ 420 mA	≤ 180 mA	≤ 120 mA	≤ 60 mA
Transient response ³					
Recovery Time:	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms	≤ 1.5 ms
Settling band:	0.8 V	2 V	5 V	7.5 V	15 V

¹From 20 Hz to 300 kHz for rms noise; from 20 Hz to 20 MHz for peak-to-peak noise

²Accuracy specifications are warranted at 23°C ±5°C

³Time to recover to within the settling band following a load change from 10% to 90% of full load

1 Preliminary Information

Supplemental Characteristics 5 kW

Characteristic 5 kW	N8920A/ N8940A	N8921A/ N8941A	N8923A/ N8943A	N8924A/ N8944A
Voltage programming range	0 to 81.6 V	0 to 204 V	0 to 510 V	0 to 765 V
Current programming range	0 to 173.4 A	0 to 71.4 A	0 to 30.6 A	0 to 20.4 A
Programming and Measurement Resolution				
Voltage:	4 mV	9 mV	21 mV	31 mV
Current:	7 mA	3 mA	2 mA	1 mA
Temperature Coefficient ¹				
Voltage:	4 mV	10 mV	25 mV	37.5 mV
Current:	8.5 mA	3.5 mA	1.5 mA	1 mA
Output response time ²				
Up, full load:	≤ 30 ms	≤ 30 ms	≤ 30 ms	≤ 30 ms
Down, full load:	≤ 80 ms	≤ 80 ms	≤ 80 ms	≤ 80 ms
Down, no load:	≤ 30 s	≤ 10 s	≤ 10 s	≤ 10 s
Over-voltage protect range	0 to 88 V	0 to 220 V	0 to 550 V	0 to 825 V
Remote sense compensation per load lead	2 V	5 V	10 V	18 V
Source regulation ³				
Voltage:	16 mV	40 mV	100 mV	150 mV
Current:	85 mA	35 mA	15 mA	10 mA
CC rms ripple & noise	80 mA	22 mA	16 mA	16 mA
Output Terminal Isolation ⁴				
Positive Terminal:	+ 400 V	+ 600 V	+ 1000 V	+ 1000 V
Negative Terminal:	± 400 V	± 400 V	± 725 V	± 725 V
AC Input				
Nominal Rating:	208/220/230/240 VAC or 400 VAC			
Input Range:	± 10 % of nominal rating			
Frequency:	45 - 65 Hz			
Phase:	3-phase			
Input Current:	L2, L3 - 32 A / L2, L3 - 16 A			
Max. Inrush Current:	41 A / 28 A			
Power Factor:	> 0.99 at nominal input and rated power			
Efficiency:	87.5%/91.5%	90%/91.5%	91%/93.5%	88%/90%
Weight	≤18.5 kg (41 lbs) / ≤17 kg (38 lbs)			

¹Per °C, at rated voltage and current

²From 10% to 90% or from 90% to 10% of total voltage excursion

³+/-10% of nominal AC input rating

⁴Refer to [Manual Updates](#) for additional information

Supplemental Characteristics 10 kW

Characteristic 10 kW	N8925A/ N8945A	N8926A/ N8946A	N8928A/ N8948A	N8929A/ N8949A	N8930A/ N8950A
Voltage programming range	0 to 81.6 V	0 to 204 V	0 to 510 V	0 to 765 V	0 to 1020 V
Current programming range	0 to 346.8 A	0 to 142.8 A	0 to 61.2 A	0 to 40.8 A	0 to 30.6 A
Programming and Measurement Resolution					
Voltage:	4 mV	9 mV	21 mV	31 mV	41 mV
Current:	14 mA	6 mA	3 mA	2 mA	2 mA
Temperature Coefficient ¹					
Voltage:	4 mV	10 mV	25 mV	37.5 mV	50 mV
Current:	17 mA	7 mA	3 mA	2 mA	1.5 mA
Output response time ²					
Up, full load:	≤ 30 ms	≤ 30 ms	≤ 30 ms	≤ 30 ms	≤ 30 ms
Down, full load:	≤ 80 ms	≤ 80 ms	≤ 80 ms	≤ 80 ms	≤ 80 ms
Down, no load:	≤ 30 s / 40 s	≤ 10 s	≤ 10 s	≤ 10 s	≤ 10 s
Over-voltage protect range	0 to 88 V	0 to 220 V	0 to 550 V	0 to 825 V	0 - 1100 V
Remote sense compensation per load lead	2 V	5 V	10 V	18 V	22 V
Source regulation ³					
Voltage:	16 mV	40 mV	100 mV	150 mV	200 mV
Current:	170 mA	70 mA	30 mA	20 mA	15 mA
CC rms ripple & noise	160 mA	44 mA	32 mA	32 mA	22 mA
Output Terminal Isolation ⁴					
Positive Terminal:	+ 400 V	+ 600 V	+ 1000 V	+ 1000 V	+ 1000 V
Negative Terminal:	± 400 V	± 400 V	± 725 V	± 725 V	± 725 V
AC Input					
Nominal Rating:	208/220/230/240 VAC or 400 VAC				
Input Range:	± 10 % of nominal rating				
Frequency:	45 - 65 Hz				
Phase:	3-phase				
Input Current:	L1 - 56 A; L2, L3 - 32 A / L1 - 28 A; L2, L3 - 16 A				
Max. Inrush Current:	97 A / 49 A				
Power Factor:	> 0.99 at nominal input and rated power				
Efficiency:	87.5%/89.5%	89.5%/91.5%	91%/91%	88%/90%	91%/93.5%
Weight	≤ 27 kg (60 lbs) / ≤ 25.5 kg (55 lbs)				

¹Per °C, at rated voltage and current²From 10% to 90% or from 90% to 10% of total voltage excursion³+/-10% of nominal AC input rating⁴Refer to [Manual Updates](#) for additional information

1 Preliminary Information

Supplemental Characteristics 15 kW

Characteristic 15 kW	N8931A/ N8951A	N8932A/ N8952A	N8934A/ N8954A	N8935A/ N8955A	N8937A/ N8937APV N8957A/ N8957APV
Voltage programming range	0 to 81.6 V	0 to 204 V	0 to 510 V	0 to 765 V	0 to 1530 V
Current programming range	0 to 520.2 A	0 to 214.2 A	0 to 91.8 A	0 to 61.2 A	0 to 30.6 A
Programming and Measurement Resolution					
Voltage:	4 mV	9 mV	21 mV	31 mV	61 mV
Current:	21 mA	9 mA	4 mA	3 mA	2 mA
Temperature Coefficient ¹					
Voltage:	4 mV	10 mV	25 mV	37.5 mV	75 mV
Current:	25.5 mA	10.5 mA	4.5 mA	3 mA	1.5 mA
Output response time ²					
Up, full load:	≤ 30 ms	≤ 30 ms	≤ 30 ms	≤ 30 ms	≤ 30 ms
Down, full load:	≤ 80 ms	≤ 80 ms	≤ 80 ms	≤ 80 ms	≤ 80 ms
Down, no load:	≤ 30 s	≤ 10 s	≤ 10 s	≤ 10 s	≤ 10 s
Over-voltage protect range	0 to 88 V	0 to 220 V	0 to 550 V	0 to 825 V	0 - 1650 V
Remote sense compensation per load lead	2 V	5 V	10 V	18 V	30 V
Source regulation ³					
Voltage:	16 mV	40 mV	100 mV	150 mV	300 mV
Current:	255 mA	105 mA	45 mA	30 mA	15 mA
CC rms ripple & noise	240 mA	66 mA	48 mA	48 mA	26 mA
Output Terminal Isolation ⁴					
Positive Terminal:	Version 2 + 400 V	Version 2 + 600 V	Version 2 + 1000 V	Version 2 + 1000 V	Version 3 + 1500 V
Negative Terminal:	± 400 V	± 400 V	± 725 V	± 725 V	± 1000 V
AC Input					
Nominal Rating:	208/220/230/240 VAC or 400 VAC				
Input Range:	± 10 % of nominal rating				
Frequency:	45 - 65 Hz				
Phase:	3-phase				
Input Current:	L1, L2, L3 - 56 A / L1, L2, L3 - 28 A				
Max. Inrush Current:	97 A / 49 A				
Power Factor:	> 0.99 at nominal input and rated power				
Efficiency:	87.5%/89.5%	89.5%/91.5%	91%/93.5%	88%/90%	91%/93%
Weight	≤ 35.5 kg (78 lbs) / ≤ 32 kg (70 lbs)				

¹Per °C, at rated voltage and current

²From 10% to 90% or from 90% to 10% of total voltage excursion

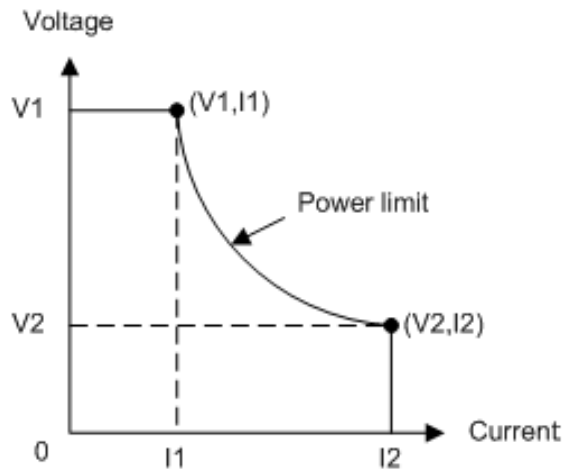
³+/-10% of nominal AC input rating

⁴Refer to [Manual Updates](#) for additional information

Common Characteristics

Characteristic	All Models
Command Response Time:	< 25 ms
Savable States:	10
Analog Programming	
Input range:	0 to 5 V or 0 to 10 V (selectable)
Accuracy:	Specified instrument accuracy $\pm 0.2\%$ of rating
Input impedance:	150 k Ω (referenced to ground)
Computer Interfaces	
LXI Core 2011:	10/100 Base-T Ethernet (Sockets, VXI-11 protocol, Web user interface)
USB:	USB 2.0 (USB-TMC488)
GPIB:	GPIB IEEE 488
Language:	SCPI - 1993, IEEE 488.2 compliant
Regulatory Compliance:	
EMC:	Complies with European EMC Directive for test and measurement products Complies with Australian standard and carries C-Tick mark This ISM device complies with Canadian ICES-001 Cet appareil ISM est conforme à la norme NMB-001 du Canada
Safety:	Complies with European Low Voltage Directive and carries the CE-marking. Conforms to US and Canadian safety regulations. Not applicable for IT mains supply systems
Environmental	
Operating environment:	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range:	0°C to 45°C
Relative humidity:	80% or less (non-condensing)
Altitude:	Up to 2000 meters
Storage temperature:	-20°C to 70°C
Acoustic Noise - 5 kW models	
At maximum fan speed:	76 dBA max. for 208 VAC input; 57 dBA max. for 400 VAC input
At idle:	55 dBA max. for 208 VAC input; 48 dBA max. for 400 VAC input
Acoustic Noise - 10 kW models	
At maximum fan speed:	77 dBA max. for 208 VAC input; 62 dBA max. for 400 VAC input
At idle:	55 dBA max. for 208 VAC input; 51 dBA max. for 400 VAC input
Acoustic Noise - 15 kW models	
At maximum fan speed:	79 dBA max. for 208 VAC input; 72.6 dBA max. for 400 VAC input
At idle:	56 dBA max. for 208 VAC input; 52 dBA max. for 400 VAC input

Autoranging Characteristics

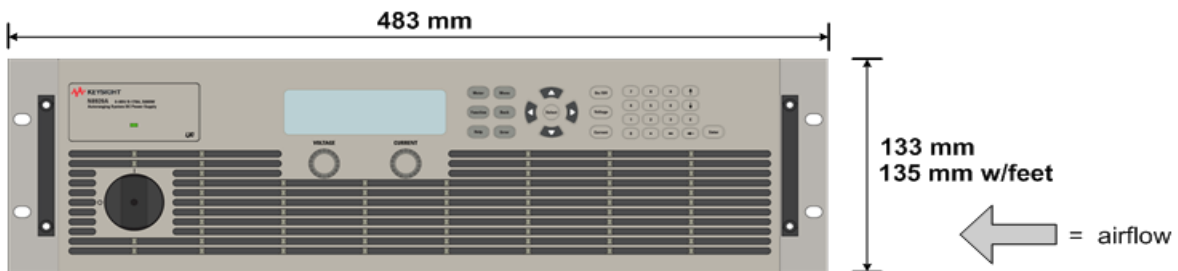
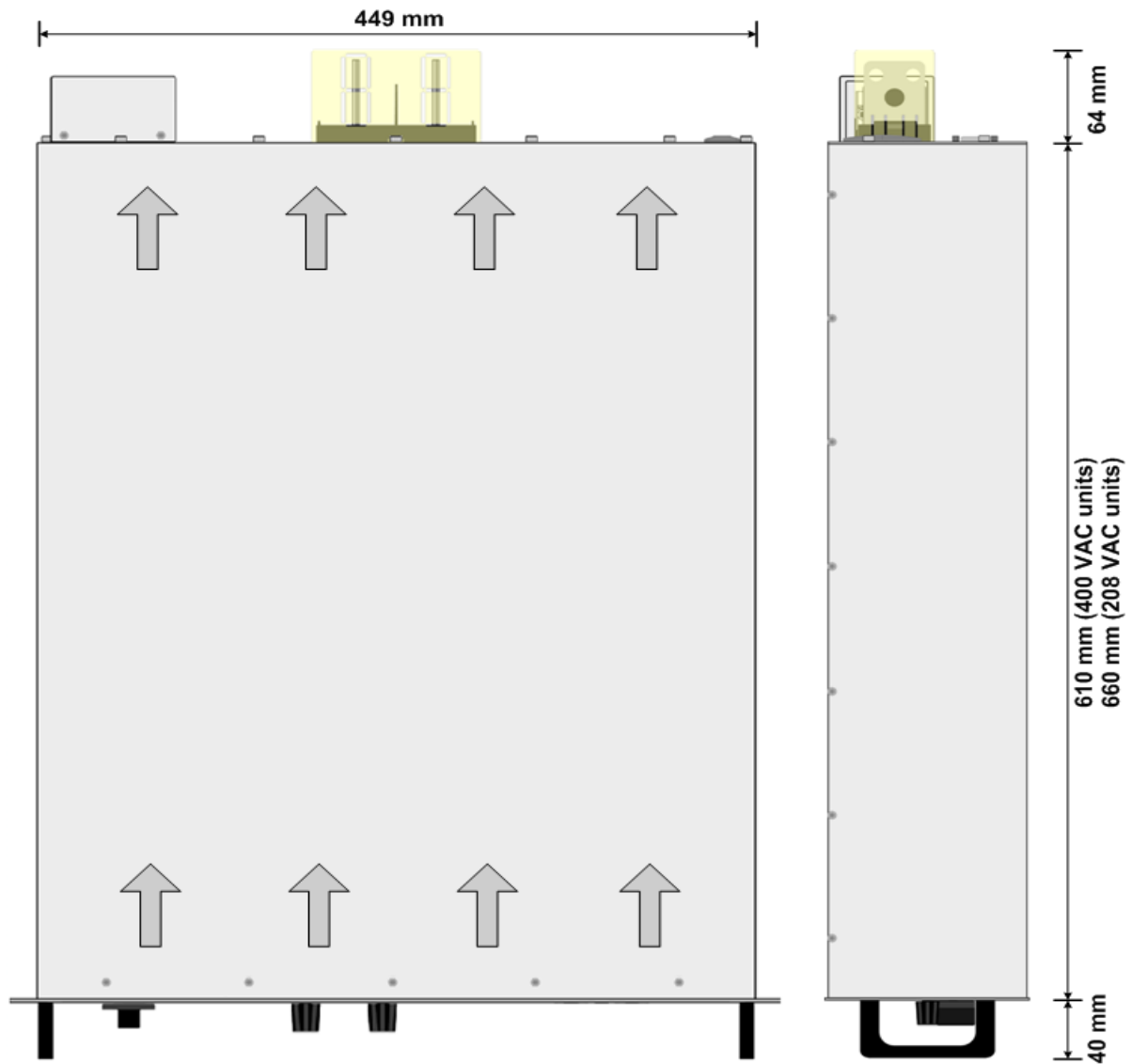


5 kW Models	N8920A N8940A	N8921A N8941A	N8923A N8943A	N8924A N8944A
V1	80 V	200 V	500 V	750 V
I1	62.5 A	25 A	10 A	6.667 A
V2	29.4 V	71.43 V	166.67 V	250 V
I2	170 A	70 A	30 A	20 A

10 kW Models	N8925A N8945A	N8926A N8946A	N8928A N8948A	N8929A N8949A	N8930A N8950A
V1	80 V	200 V	500 V	750 V	1000 V
I1	125 A	50 A	20 A	13.33 A	10 A
V2	29.4 V	71.43 V	166.67 V	250 V	333.33 V
I2	340 A	140 A	60 A	40 A	30 A

15 kW Models	N8931A N8951A	N8932A N8952A	N8934A N8954A	N8935A N8955A	N8937A N8937APV N8957A N8957APV
V1	80 V	200 V	500 V	750 V	1500 V
I1	187.5 A	75 A	30 A	20 A	10 A
V2	29.4 V	71.43 V	166.67 V	250 V	500 V
I2	510 A	210 A	90 A	60 A	30 A

Dimension Diagrams



2

Operating Information

Introduction to the Instrument

Front Panel Menu

Installing the Instrument

Getting Started

Remote Interface Configuration

Using the Power Supply

Introduction to the Instrument

Front Panel at a Glance

Front Panel Display at a Glance

Front Panel Keys at a Glance

Rear Panel at a Glance

The Keysight N8900 Series is a family of autoranging system DC power supplies with performance and features that are optimized for automated test systems. They are available in power levels of 5 kW, 10 kW, and 15 kW. Voltage levels range from 80 to 1500 V. Current levels range from 20 to 510 A.

Keysight N8937APV and N8957APV models simulate the output characteristics of a photovoltaic array. This capability lets you quickly and comprehensively test solar inverter maximum power point tracking (MPPT) algorithms and inverter efficiency. The SAS Curve Generator software is a free application that simplifies programming the photovoltaic (PV) models. It is available at www.keysight.com/find/N8900APVsoftware.

Output and system features that are common to all N8900 Series power supplies are described as follows. Refer to the **Models and Options** section for a description of the output ratings of the various models.

Output features

- Full programming capability is provided for the entire range of output voltage and current
- Paralleling capability for increased output power
- Protection capability includes over-voltage, over-current, over-temperature, and other protections
- Solar array simulator operation - only applies to N8937APV and N8957APV models

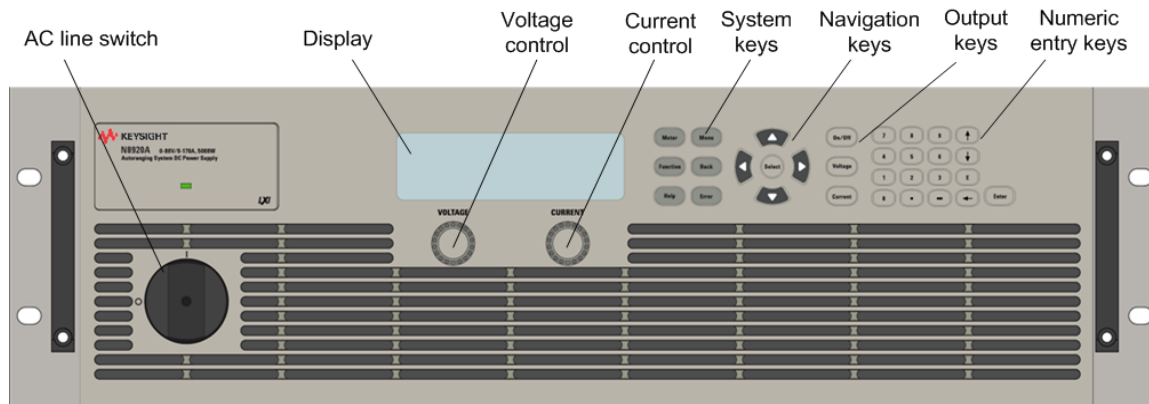
Measurement features

- Voltage, current, and power measurements
- Combined output current of paralleled units

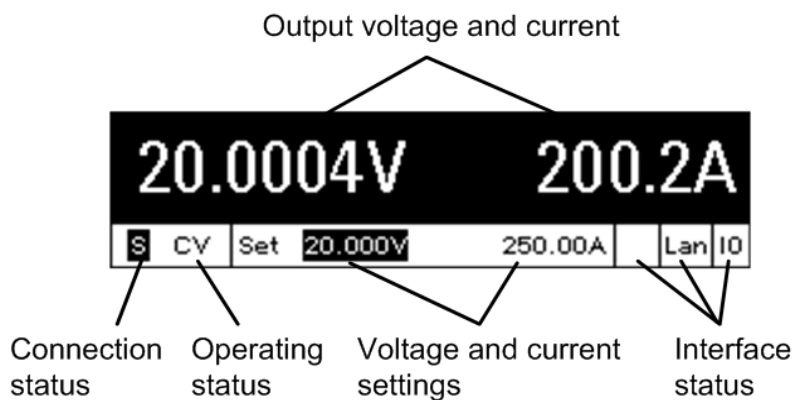
System features

- Save and recall up to 10 instrument states in non-volatile memory
- GPIB (IEEE-488), LAN, and USB remote programming interfaces are built in
- Front panel menu setup for GPIB and LAN parameters
- LXI Core 2011 compliant, including a built-in Web server
- SCPI (Standard Commands for Programmable Instruments) compatibility

Front Panel at a Glance



Front Panel Display at a Glance



Output voltage and current	Displays the actual output voltage and current.
Connection status	A = analog programming is enabled M = the paralleled unit is configured as the master S = the paralleled unit is configured as a slave
Operating status	Indicates one of the following: OFF = the output is off CV = the output is in constant voltage mode CC = the output is in constant current mode CP = the output is limited by the power limit boundary OV = the output is disabled by the over-voltage protection OC = the output is disabled by the over-current protection OT = the output is disabled by the over-temperature protection INH = the output is disabled by an external control signal PF = the output is disabled because of a low voltage on the AC mains MSP = the output is disabled by the master/slave protection UNR = the output is unregulated
Voltage and Current settings	Displays the programmed voltage and current settings.

2 Operating Information

Interface status	Indicates the following remote interface activity: Err = an error has occurred (press Error key to display error message) Lan = the LAN is connected and has been configured IO = there is activity on one of the remote interfaces
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Front Panel Keys at a Glance



The AC line switch turns the unit on or off (off = 0). The indicator above the On/Off switch shows the display status. **Green** indicates normal operation. **Amber** indicates that the display is in screen saver mode. It is also on during the boot-up process. Press any key to exit screen saver mode.



The system keys access the following front panel meter and command menus:

Meter returns the display to metering mode. Repeatedly press this key to cycle through the following measurement functions:
Voltage, Current
Voltage, Power
Voltage, Current, Power

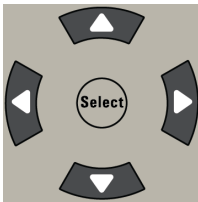
Menu accesses the command menu.

Function key is reserved for future use.

Back backs out of a menu without activating any changes.

Help accesses information about the displayed menu control.

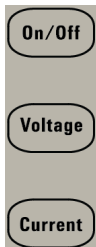
Error displays any error messages in the error queue.



The navigation keys do the following:

Arrows let you move around in the command menus.

Select lets you make a selection in the command menus. It also lets you enter edit mode for editing the numeric parameters.

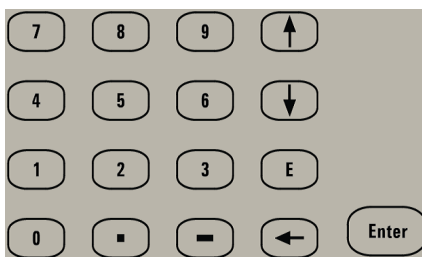


The output keys do the following:

On/Off enables or disables the output.

Voltage lets you change the voltage setting.

Current lets you change the current setting.



The numeric entry keys do the following:

The 0 through 9 keys enter numbers.

The (.) key is the decimal point.

The - key is used to enter a minus sign.

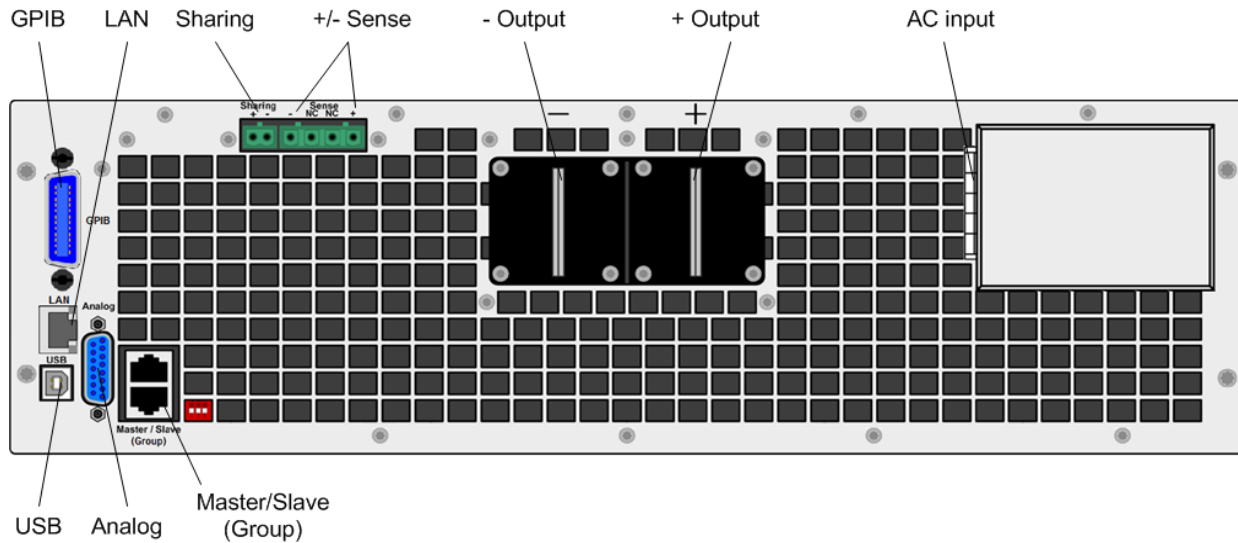
The up/down arrow keys increment or decrement voltage or current settings. They also select letters in alphabetic entry fields.

The E key enters an exponent. Add the value to the right of the E.

The back arrow key deletes digits as it backspaces over them.

The Enter key enters a value. If you exit a field without pressing the Enter key, the value is ignored.

Rear Panel at a Glance



GPIB	GPIB interface connector
LAN	LAN interface connector
Sharing	Current sharing connections - for parallel operation
+/-Sense	Remote sense connections (if not used, local sensing is internally connected)
-Output; +Output	Negative and positive output terminals
AC input	AC line input
USB	USB interface connector
Analog	External control signal connector
Master/Slave (Group)	Master/slave connectors - for grouping paralleled units

WARNING

For electrical shock protection, always connect the AC input earth ground terminal.

Front Panel Menu

This is an overview of the front-panel menus. For a brief tutorial, refer to [Use the front panel menu.](#)

Press the **Menu** key to access the front panel menus.

1st Menu Level	2nd Level	3rd & 4th Levels	Description
Output	Fixed ¹	Voltage	Programs the output voltage settings
		Current	Programs the output current settings
	SAS ¹	Curve ¹	Programs the SAS curve parameters: Imp, Isc, Vmp, and Voc
		Scale ¹	Selects a scale factor for the current and voltage curves
	Mode		Selects the operating mode: Fixed, Curve, or Table
Transient	Mode		Selects voltage and current transient modes
	Step		Programs the voltage and current step settings
Protect	OVP		Configures over-voltage protection settings
	OCP		Configures over-current protection settings
	Clear		Clears protection conditions and displays output status
States	Reset		Resets all instrument settings to the reset (*RST) state
	SaveRecall		Saves and recalls instrument settings
	PowerOn		Selects the power-on instrument state
System	IO	LAN	Displays LAN commands
		Settings	View the currently active network settings
		Modify	Modifies the network configuration
		Apply	Applies the configuration changes and restarts
		Cancel	Cancel the configuration changes
		Reset	Performs an LXI LCI reset of LAN settings and restarts
		Defaults	Resets the network to the as-shipped defaults and restarts
		USB	Displays USB identification string
		GPIB	Display or change the GPIB address
		Analog	Sets the analog interface amplitude (5 V or 10 V)

¹ Only applies to Models N8737APV and N8957APV.

1st Menu Level	2nd Level	3rd & 4th Levels	Description		
System	Group	Function	Defines the function of each unit in the paralleled group		
		Master	Displays the configured slave addresses		
		Slave	Specifies the slave address		
	Preferences	Display	Configures the screen saver and wake on IO timer		
	Admin	Cal	Login/Logout	Enter a password to access the Admin functions	
			Voltage	Displays calibration commands	
			Voltage	Calibrates voltage programming and measurement	
			Current	Calibrates current programming and measurement	
			Count	View the calibration count	
			Date	View and modify the calibration date	
			Save	Saves the calibration data	
			IO	Enables/disable the LAN, USB, and GPIB	
			Sanitize	Performs NISPOM secure erase of all user data	
			Update	Password protect firmware update	
			Password	Changes the admin password	
			About		Displays model, output ratings, serial number, and firm-ware

2 Operating Information

Installing the Instrument

Before Installation or Use

AC Mains Connections

Single Unit Connections

Multiple Unit Connections

External Control Signal Connections (Analog)

Interface Connections

Before Installation or Use

Inspect the Unit

When you receive your power supply, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier and nearest Keysight Sales and Support Office immediately. Refer to www.keysight.com/find/assist.

Until you have checked out the power supply, save the shipping carton and packing materials in case the unit has to be returned. Check the list below and verify that you have received these items with your unit. If anything is missing, please contact your nearest Keysight Sales and Support Office.

Check for Items Supplied

Before getting started, check the following list and verify that you have received these items with your unit. If anything is missing, please contact your nearest Keysight Sales and Support Office.

Item	Description	Part Number
DC covers	Safety covers for DC output terminals	5003-2051
Sense cover	Safety covers for sense terminals (≥ 750 V units)	5066-1913
2 position plug	Connector plug for Sharing terminals	5003-2038
4 position plug	Connector plug for Sense terminals (≤ 500 V units)	5003-2037
4 position plug	Connector plug for Sense terminals (≥ 750 V units)	0360-3120
AC plug	Connector plug for AC input	5003-2053 for 400 VAC inputs 5003-2091 for 208 VAC inputs
Hardware Kit	1-set mounting hardware for low current terminals 1-set mounting hardware for high current terminals	5003-2089 for ≥ 500 VAC outputs 5003-2090 for < 500 VAC outputs

Review Safety Information

This power supply is a Safety Class 1 instrument, which means it has a protective earth terminal. That terminal must be connected to earth ground through a power source equipped with an earth ground. Refer to the [Safety Notices](#) section at the beginning of this guide for general safety information. Before installation or operation, check the power supply and review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places throughout this guide.

Observe Environmental Conditions

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

2 Operating Information

The environmental conditions of the power supply are documented under **Specifications**. Basically, the unit should only be operated indoors in a controlled environment. Do not operate the unit in areas where the ambient temperature exceeds +45 degrees Celsius. This applies for rack-mounting as well as for bench use.

Use Caution when Transporting the Unit

CAUTION Two people are required when handling units. Because of the unit's weight, do not lift or move it alone. Moving by hand should be avoided where possible. If unavoidable, lift only the instrument's chassis; do not lift the unit using the exterior handles, knobs, or output terminals.

Provide Adequate Air Flow

CAUTION Do not block the air intake at the front, or the exhaust at the rear of the unit.

The dimensions of your power supply, an outline diagram, and airflow direction are given under **Dimension Diagrams**. Fans cool the power supply by drawing air through the front and exhausting it out the back. Allows at least 8 inches (20 cm) of space at the front and back of the unit for adequate air circulation.

AC Mains Connections

AC Mains Phase Distribution

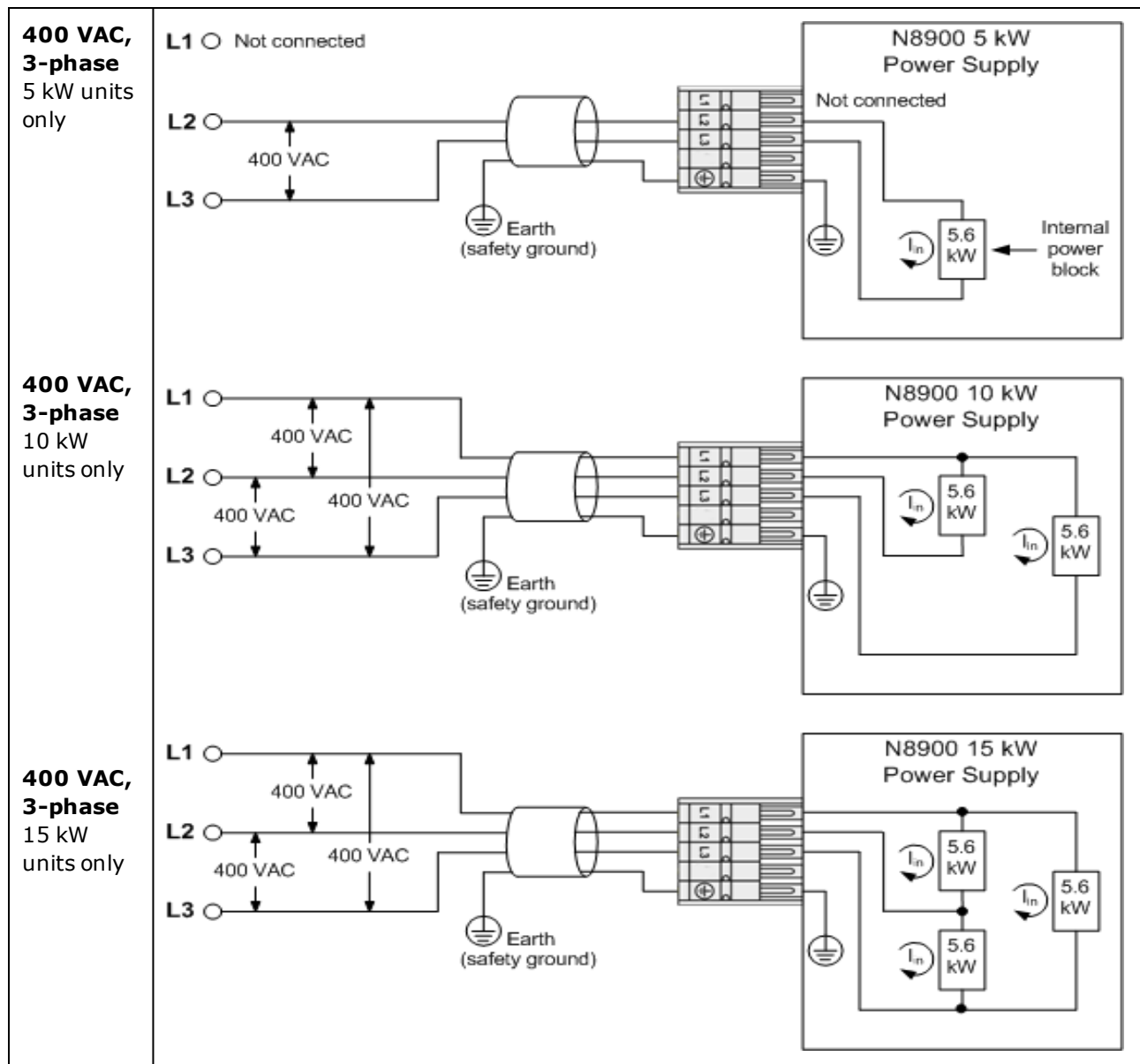
Phase Balancing with Multiple Units

Power Cables

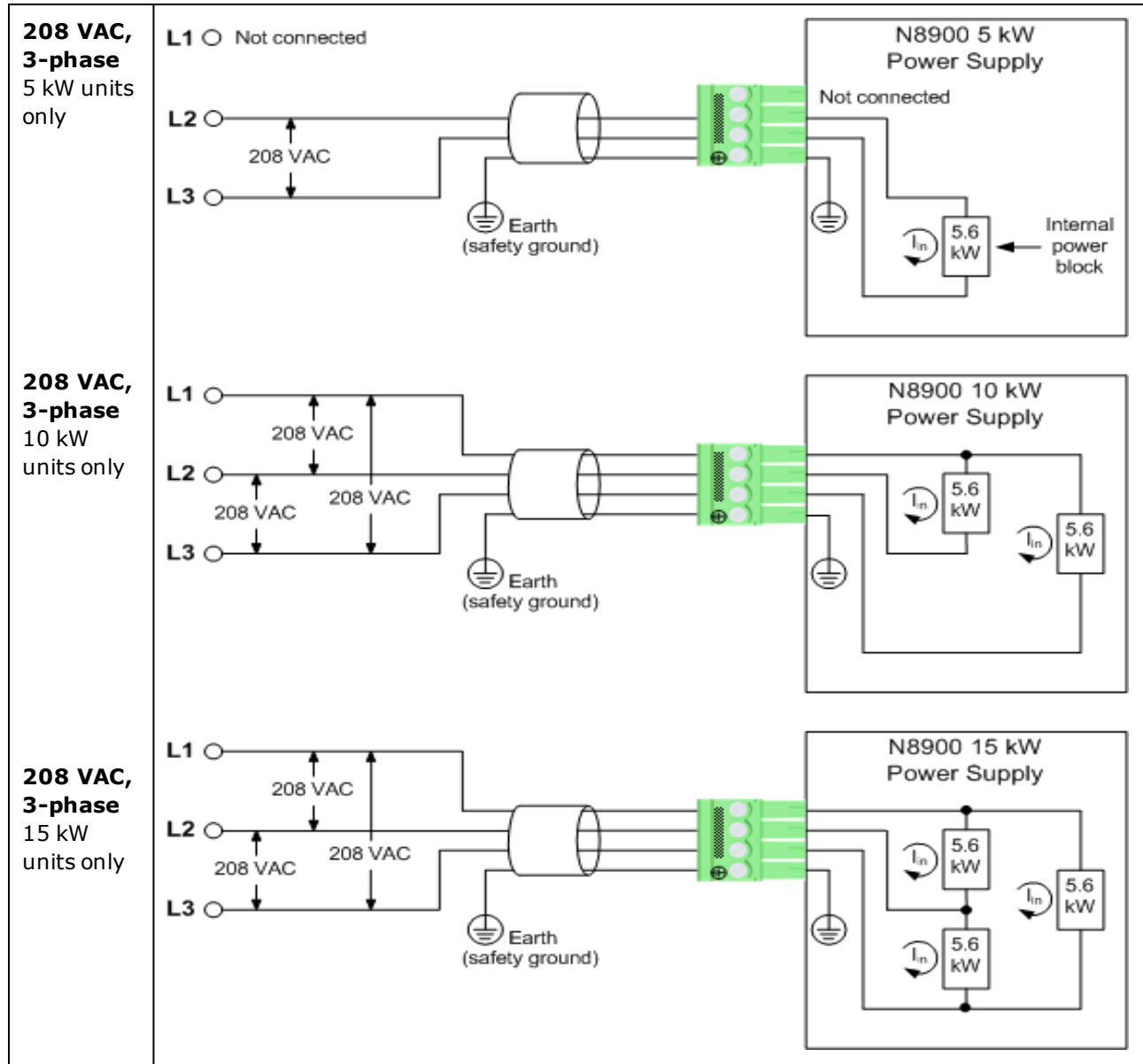
AC Mains Phase Distribution

WARNING **SHOCK HAZARD** The instrument requires a chassis ground connection through a separate conductor. The AC mains must include an earth ground connection.

AC mains connections must be made by a qualified electrician who knows about 3-phase mains circuits and all applicable safety standards and requirements.



2 Operating Information

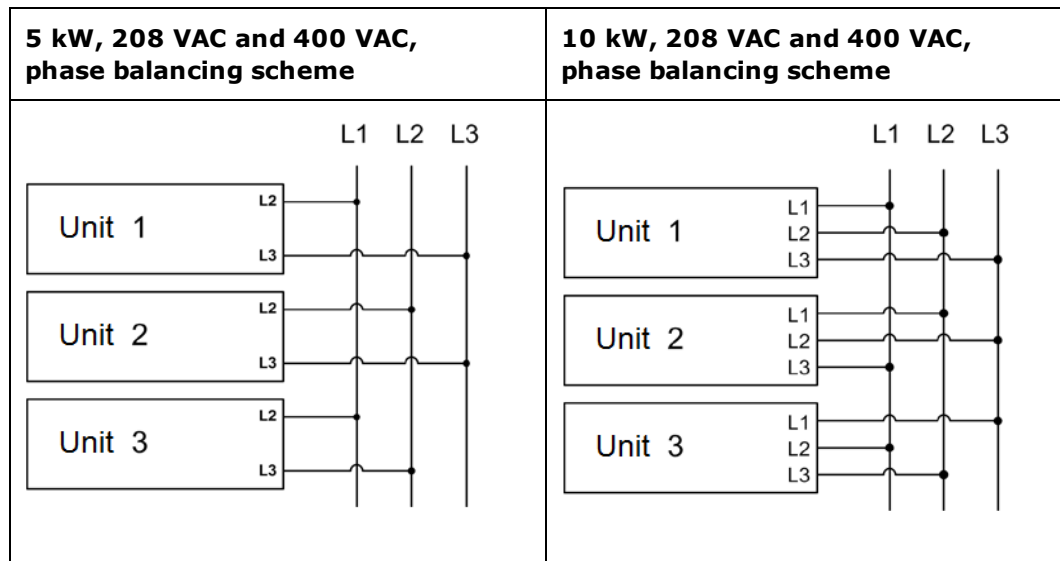


Note that either delta-type or Y-type AC mains distribution can be used, provided that the correct line-to-line voltage is applied.

Phase Balancing with Multiple Units

The previous figures illustrate the phase current distribution. The N8900 power supplies can have from one to three internal 5.6 kW power blocks, each of which is connected across a separate phase of the 3-phase AC mains. For 5 kW and 10 kW units this will result in a current imbalance when installing one or two units. Installing three units will result in a balanced current distribution. For 15 kW units, there is no current imbalance, as all phases draw approximately the same current.

The following figures illustrate how to install three 5 kW units or three 10 kW units in order to obtain a balanced current draw on the 3-phase AC mains.



Power Cables

An AC mains power cable is not provided with the unit. Refer to the following table for the maximum current capacity requirements for each cable conductor.

If required by local electrical codes, install a fuse or circuit breaker between the ac mains and the unit. Refer to the following table for current ratings.

Keep the AC mains cables as short as possible. The longer the cable, the greater the voltage loss due to cable resistance.

WARNING The cable cross-section must be suitable for the maximum input current of the instrument. The ground cable must have the same cross-section as the phase cable.

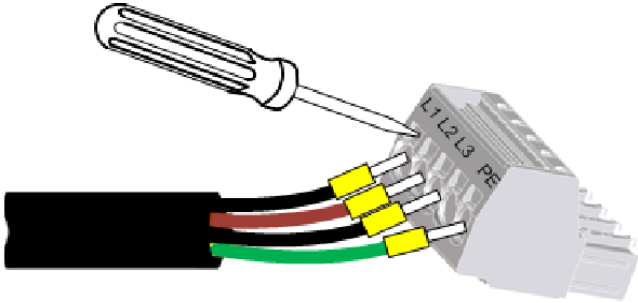
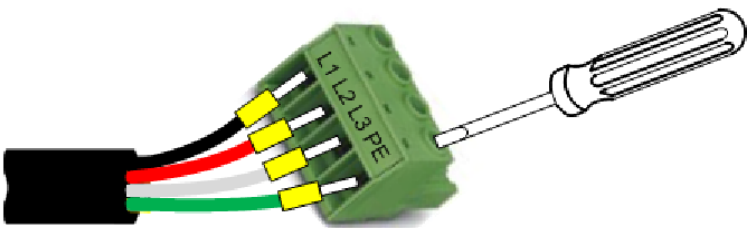
NOTE Safety agency requirements dictate that there must be a way to physically disconnect the AC mains cable from the unit. A disconnect device, either a switch or circuit breaker must be provided in the final installation. The disconnect device must be close to the equipment, must be easily accessible, and must be marked as the disconnect device for this equipment. It must meet the input ratings requirements listed in the following table.

Unit Rating	L1 I_{max}	L2 I_{max}	L3 I_{max}
5 kW - 208 Vac	NA	32 A	32 A
5 kW - 400 Vac	NA	16 A	16 A
10 kW - 208 Vac	56 A	32 A	32 A
10 kW - 400 Vac	28 A	16 A	16 A
15 kW - 208 Vac	56 A	56 A	56 A
15 kW - 400 Vac	28 A	28 A	28 A

2 Operating Information

Power Connector

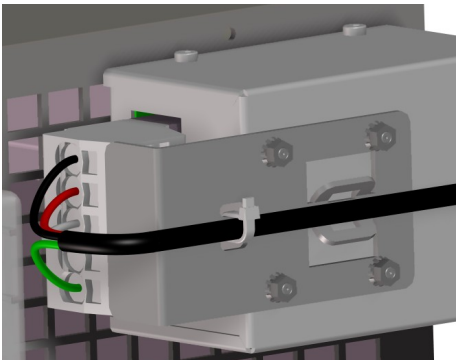
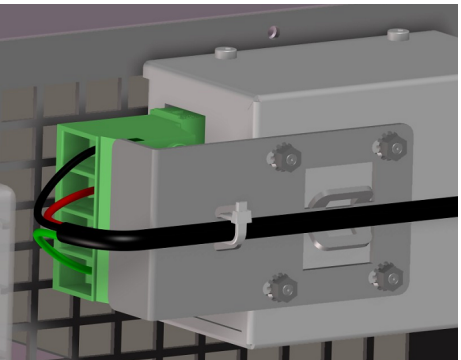
Remove the strain relief to access the connector plug. Connect the AC mains cable to the connector plug as shown in the following illustrations. Insert the cable wires into the connector plug. On 400 VAC connectors, insert a flat blade screwdriver to release the internal wire clamp. On 208 VAC connectors, turn the screw to open or close the clamp. Tighten all wires securely. The safety ground wire must be green. Other colors are for illustration purposes.

<p>400 VAC Connector</p> <p>Maximum wire size: 8 AWG or 10 mm²</p> <p>Maximum insulation diameter: 6.8 mm</p> <p>Wire stripping length: 13 - 15 mm</p> <p>Optional ferrule suggestion: For 8 AWG: WAGO 216-289 For 10 AWG: WAGO 216-288 For 12 AWG: WAGO 216-287 For 14 AWG: WAGO 216-286 (Refer to manufacturer for details.)</p>	
<p>208 VAC Connector</p> <p>Maximum wire size: 6 AWG or 16 mm²</p> <p>Maximum insulation diameter: 8.1 mm</p> <p>Wire stripping length: 12 mm</p>	

Strain Relief Bracket

You must install the strain relief bracket to ensure that the connector plug does not detach from the instrument during operation.

Fasten the power cable to the strain relief bracket as shown below, using the supplied tie wraps. This reduces weight and movement of the AC mains cable at the connector plug.

<p>Make sure the connector plug is fully inserted.</p> <p>Install the strain relief bracket as shown, using the four hex nuts.</p> <p>Fasten the AC mains cable to the strain relief using the supplied tie wraps.</p>		
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Single Unit Connections

Output Connections

Single Load Connections

Multiple Load Connections

Remote Sense Connections

Positive and Negative Voltages

Output Connections

WARNING **SHOCK HAZARD** Turn off AC power before making rear panel connections.

HAZARDOUS VOLTAGES All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

All output connections must be made with the unit turned off, and must be performed by qualified personnel who are aware of the hazards involved. Improper actions can cause fatal injury as well as equipment damage.

Never touch cables or connections immediately after turning off the unit. Depending on the model, lethal voltages can remain at the output terminals for 10 seconds or more after turn-off. Verify that there is no dangerous voltage on the output or sense terminals before touching them.

Positive output terminal isolation is up to +1,500 V from ground and varies by model. Negative output terminal isolation is up to $\pm 1,000$ V from ground and varies by model.

The following factors should be considered when wiring the load to the power supply:

- Load wire current carrying capacity
- Load wire insulation rating (must be equivalent to the maximum output voltage)
- Load wire voltage drop
- Load wire noise and impedance effect

Wire Sizes

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. With more than one load, any pair of load wires must be capable of safely carrying the full-rated current of the supply.

2 Operating Information

The following table lists the characteristics of AWG (American Wire Gauge) copper wire. Paralleled wires may be substituted for single wires. For example, two AWG 3/0 (95 mm²) cables may be paralleled for units rated at 510 A. Paralleled load wires may be required for larger-ampacity power supplies.

AWG	Nearest Metric size	Ampacity (Note1)	Resistance (Note2)
12	4 mm ²	up to 30 A	1.59
10	6 mm ²	up to 40 A	1.0
8	10 mm ²	up to 60 A	0.63
6	16 mm ²	up to 80 A	0.395
2	35 mm ²	up to 140 A	0.156
1/0	50 mm ²	up to 195 A	0.098
2/0	70 mm ²	up to 225 A	0.078
3/0	95 mm ²	up to 260 A	0.062
4/0	120 mm ²	up to 300 A	0.049

Note 1. Ampacity is based on a single conductor in free air, 26-30 °C ambient temperature, with the conductor rated at 60 °C. Ampacity ratings decrease when wires are bundled and at higher ambient temperatures.

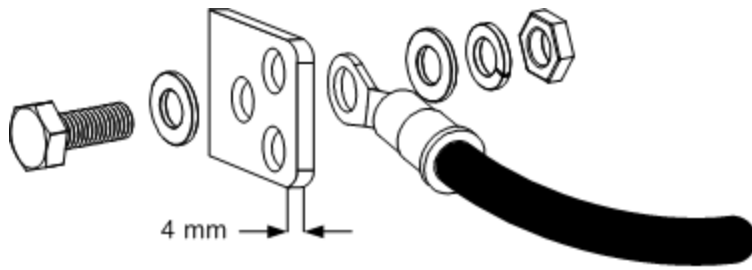
Note 2. Resistance is in ohms/1000 feet, at 20 °C wire temperature.

Along with conductor temperature, you must also consider voltage drop when selecting wire sizes. Although the power supply will compensate for the voltage in the load wires, it is recommended to minimize the voltage drop as much as possible to prevent excessive output power consumption from the power supply and poor dynamic response to load changes. Larger diameter wire sizes will help minimize load-wire voltage drops. Twisting or bundling load wires will help reduce transient voltage drops.

Single Load Connections

WARNING Ensure that the insulation rating of the load cables is greater than the voltage rating of the unit, which on some models is rated at up to 1500 VDC.

As shown in the following figure, terminate all load wires with the proper wire terminal lugs securely attached. **DO NOT** use unterminated wires when making connections at the power supply.



The following figures illustrates the recommended hardware sizes. A hardware kit is shipped with your unit. You must provide the cables and terminations. Ensure that the cable-mounting hardware does not short the output terminals.

<p>Use the M8 diameter bolts, nuts, ring lugs, and washers - for models rated under 500 V. Maximum torque: 12.4 Nm (9.2 lb-ft).</p>	<p>Use the M6 diameter bolts, nuts, ring lugs, and washers - for models rated 500 V and up. Maximum torque: 7.3 Nm (5.4 lb-ft).</p>

Route the load leads through the safety cover before attaching the safety cover to the rear panel. The following figures illustrate the two types of safety covers installed.

<p>Large safety cover - for all models.</p>	<p>Small safety cover - for models rated 500 V and up. Units units rated 500 V and up use both safety covers.</p>

Knockouts are provided on the large safety cover so that the load wires can be run in various directions. Note that heavy load cables must have some form of strain relief to prevent bending the safety cover or bus-bars.

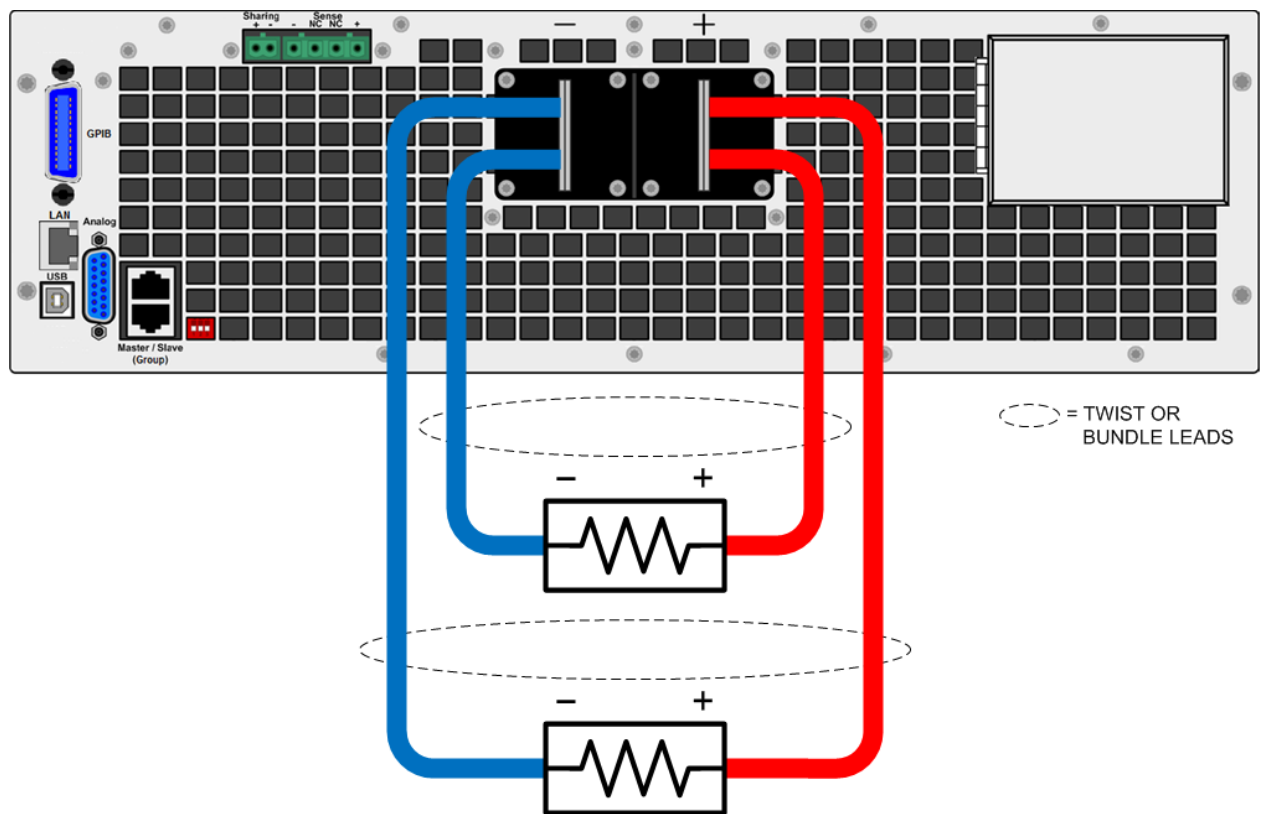
2 Operating Information

Always twist or bundle the load wires to reduce lead inductance and noise pickup. The goal is to always minimize the loop area or physical space between the + and - load wires from the power supply to the load.

Multiple Load Connections

If you are using local sensing and are connecting multiple loads to one output, connect each load to the output terminals using separate load wires as shown in the following figure. This minimizes mutual coupling effects and takes full advantage of the power supply's low output impedance. Keep each wire-pair as short as possible and twist or bundle the wires to reduce lead inductance and noise pickup. The goal is to always minimize the loop area or physical space between the + and - load wires from the power supply to the load.

If load considerations require the use of distribution terminals that are located away from the power supply, twist or bundle the wires from the output terminals to the remote distribution terminals. Connect each load to the distribution terminals separately. Remote voltage sensing is recommended under these circumstances. Sense either at the remote distribution terminals or, if one load is more sensitive than the others, directly at the critical load.



Remote Sense Connections

When the sense leads are not connected to the load, the power supply will internally sense the voltage at the output terminals (referred to as local sensing), which regulates the output voltage at the output terminals. This does not compensate for the load lead voltage drop.

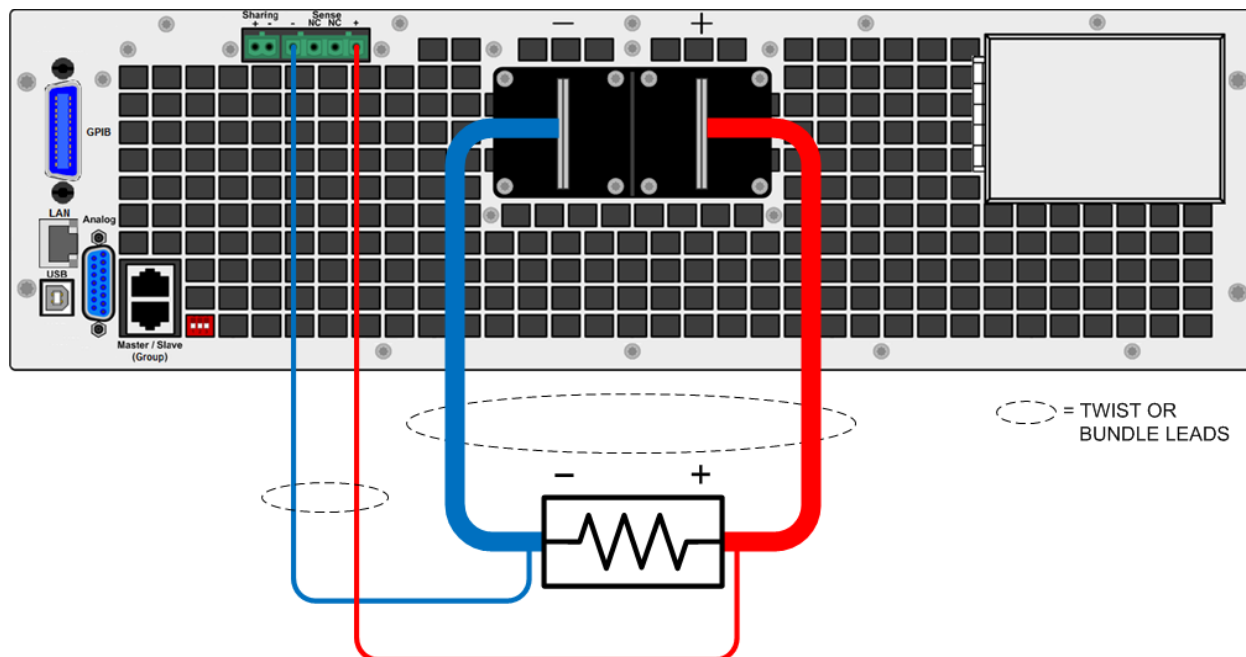
Remote sensing improves the voltage regulation at the load by monitoring the voltage at the load rather than at the output terminals. This lets the power supply compensate for the voltage drop in the load leads. Remote sensing is useful for CV operation with load impedances that vary or have significant lead resistance. It has no effect during CC operation. Because sensing is independent of other power supply functions, remote sensing can be used regardless of how the power supply is programmed.

CAUTION **Equipment Damage** Always connect the + sense lead to the + terminal of the load and the - sense lead to the - terminal of the load. If a sense lead opens during operation the output may momentarily overshoot. The two center sense terminals are not used.

Connect the unit for remote sensing by connecting the sense leads as close as possible to the load. The power supply will automatically detect that the remote sense terminals are being used and will compensate for the load lead voltage drop.

Do NOT bundle the sense wire-pair together with the load wires; keep the load wires and sense wires separate. Keep the sense wire-pair as short as possible and twist or bundle it to reduce lead inductance and noise pickup.

Note that the sense leads carry only a few milliamperes of current and can be a much lighter gauge than the load cables. However, note that any voltage drop in the sense leads can degrade the output voltage regulation. Try to keep the sense lead resistance less than about 0.5Ω per lead (this requires 20 AWG/ 1.0 mm^2 or heavier for a 50 foot length).



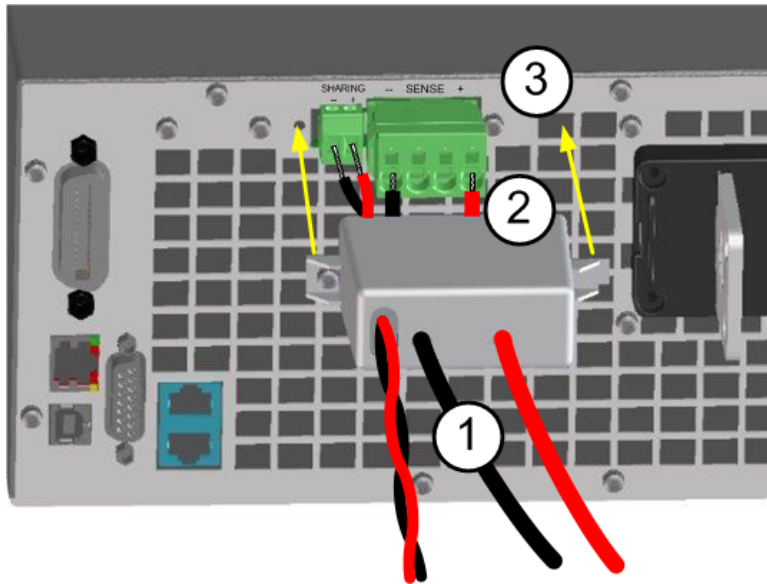
2 Operating Information

750 V to 1500 V Remote Sense Safety Cover

WARNING A remote-sense safety cover is provided and is required installation for all 750 V to 1500 V rated models. Always install the sense connector and safety cover even if you are not using the remote sense connections or the sharing connections.

Ensure that the insulation rating of the sense wires is greater than the voltage rating of the unit, which may be rated at up to 1500 VDC.

1. Route the sense wires (and the **sharing wires** if used) through the safety cover as shown in the figure.

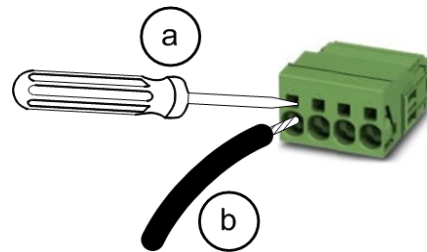


2. Push the wires straight into the connector. Keysight recommends that you use a ferrule at the end of stranded wires to facilitate insertion. If you do not have a ferrule, use solid wire, or open the connector clamp by inserting a small flat-bladed screwdriver (a) as shown below. Then insert the wire (b), and remove the screwdriver. If you are using the sharing connections, insert the sharing wires at this time.

Important: Because of the pressure required, do not try to open the connector clamp while the connector is installed in the unit.

Wire cross section: 0.2 - 10 mm² (24 - 8 AWG)

Wire stripping length 15 mm



3. Install the sense connector. Push on the connector until it clicks into place. Also install the **sharing connector**.

4. Install the safety cover on the rear panel as shown in the figure. First remove the screw next to the sharing connector. Hook the right side of the safety cover in the vent opening. Attach the left side of the cover using the captive Torx screw.

Over-voltage Protection

Remote over-voltage protection (OVP) provides a customer-configurable over-voltage protection. When combined with remote voltage sensing, this allows for more precise voltage protection directly at the load. The OVP circuit monitors the voltage at the + and – sense terminals if they are connected to the load, or at the output terminals if the sense terminals are not being used. Refer to [Programming Output Protection](#) for further information.

Output Noise

Any noise picked up on the sense leads will appear at the output terminals and may adversely affect CV load regulation. Twist the sense leads or use a ribbon cable to minimize the pickup of external noise. In extremely noisy environments it may be necessary to shield the sense leads. Ground the shield at the power supply end only; do not use the shield as one of the sensing conductors.

Positive and Negative Voltages

Either positive or negative voltages with respect to ground can be obtained from the output by grounding (or "commoning") one of the output terminals. Always use two wires to connect the load to the output regardless of where or how the system is grounded.

WARNING Positive output terminal isolation is up to +1,500 V from ground and varies by model. Negative output terminal isolation is up to $\pm 1,000$ V from ground and varies by model.

CAUTION **Equipment Damage** Before grounding any output terminal, check to see if the load is already grounded. Incorrect grounding could result in a short circuit.

Multiple Unit Connections

Parallel Connections

Share Connections

Group Connections

Series Connections

WARNING **SHOCK HAZARD** Turn off AC power before making rear panel connections.

HAZARDOUS VOLTAGES All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

All output connections must be made with the unit turned off, and must be performed by qualified personnel who are aware of the hazards involved. Improper actions can cause fatal injury as well as equipment damage.

Never touch cables or connections immediately after turning off the unit. Depending on the model, lethal voltages can remain at the output terminals for 10 seconds or more after turn-off. Verify that there is no dangerous voltage on the output or sense terminals before touching them.

Positive output terminal isolation is up to +1,500 V from ground and varies by model. Negative output terminal isolation is up to $\pm 1,000$ V from ground and varies by model.

Parallel Connections

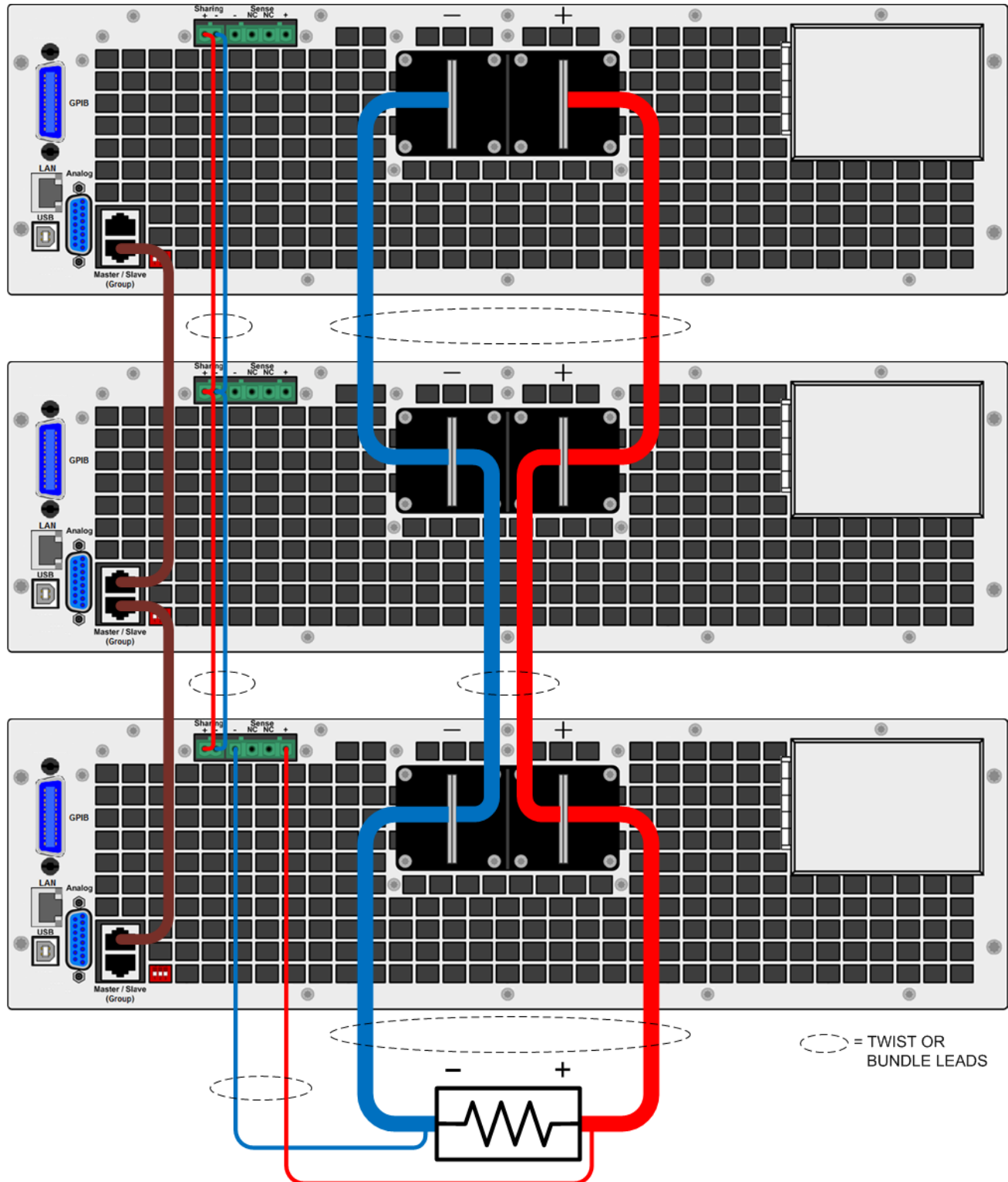
WARNING **SHOCK HAZARD** Using bus bars negates the safety function of the safety covers, as the exposed portion of the bus bar creates a shock hazard.

CAUTION **Equipment Damage** Only connect power supplies that have identical voltage and current ratings in parallel.

Connecting power supplies in parallel provides a greater current capability than can be obtained from a single unit. The figure below shows how to connect three units in parallel. If desired, up to 10 units may be connected in parallel.

If remote sensing is desired to compensate for the lead drops, connect the remote sense leads of the unit closest to the load directly to the load. Although the illustration shows remote sensing being used, it is recommended, but not required for parallel operation.

Bus bars can be used instead of cables to parallel the output terminals in a stacked configuration. Place the bus bars on the inside of the output terminals. Keep the wiring from the power supply to the load as short as possible and twist or bundle the leads to reduce lead inductance and noise pickup. The goal is to always minimize the loop area or physical space between the + and - output leads from the power supply to the load.

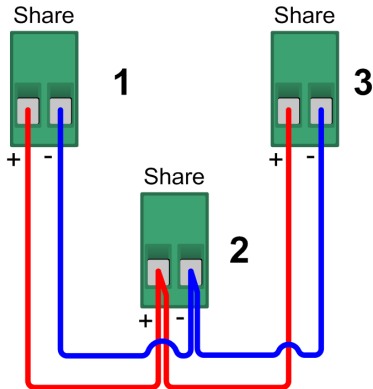


Share Connections

NOTE

Only N8900A units labeled Version 2b, 2c, 3b, or 3c on the rear label can current-share with other units similarly labeled. This limitation does not affect N8937APV or N8957APV models.

The **Share** terminals must be connected for parallel operation as shown in the previous figure. For further information about current sharing, refer to **Current Share Operation**. The following figure details the Share bus connections for multiple units.



Group Connections

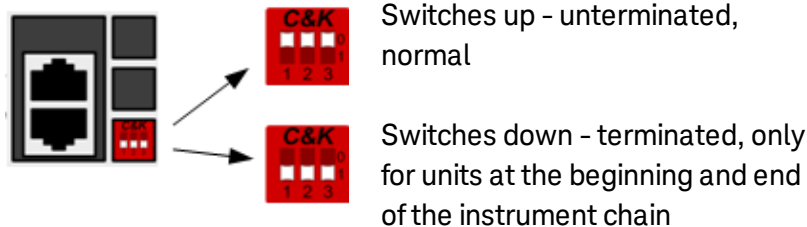
A **Group** or master/slave configuration can also be used when connecting units in parallel as shown in the figure. This allows one designated unit to be the master controller of all of the units connected in the group. Grouped connections use a digital RS485 bus. Connections are made using standard CAT5 or better cables. For further information about group configurations, refer to **Group Operation**.

CAUTION

Do not connect an Ethernet port to a Group connector.

The following figure details the termination switch settings for the grouped units. Only the first and last units in the connection chain need to have the switch set to the "terminated" position.

Group Connections



Series Connections

WARNING

SHOCK HAZARD Series connections are not allowed as floating voltages must not exceed the ratings given in the **specifications** table.

External Control Signal Connections (Analog)

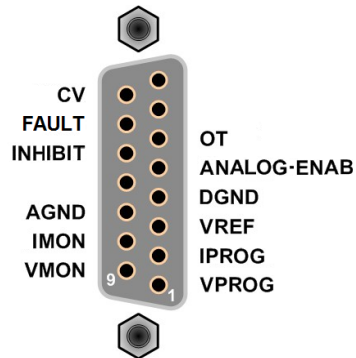
External control signal connections are made through the 15 pin "Analog" connector (Type: Sub-D, D-Sub) on the rear of the unit. Use a standard connector plug (customer-supplied) to make all connections. Remember to turn of the unit before making any rear panel connections.

CAUTION

Equipment Damage The external control interface is galvanically separated from DC output and referenced to earth ground. Therefore never connect a ground from the external control interface to the +DC or -DC outputs. Use an isolated, ungrounded, programming source to prevent ground loops when using the external control interface.

Pin Assignments

The following figure identifies the pins on the external control signal connector (labeled "Analog" on the rear panel).



You must provide the mating plug that for the external control signal connector. Use a 15-pin D-subminiature connector.

For information on using the external control functions refer to [External Control Signal Programming](#).

Interface Connections

GPIB Connections

USB Connections

LAN Connections - site and private

This section describes how to connect to the various communication interfaces on your power supply. For further information about configuring the remote interfaces, refer to [Remote Interface Configuration](#).

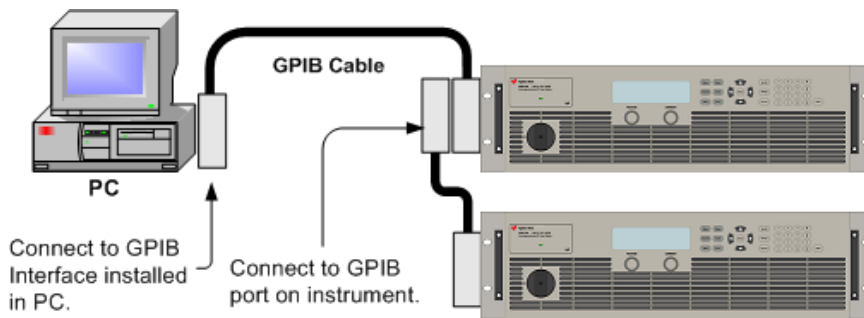
If you have not already done so, install the Keysight IO Libraries Suite, which can be found at www.keysight.com/find/iolib.

NOTE

For detailed information about interface connections, refer to the documentation included with the Keysight IO Libraries Suite.

GPIB Connections

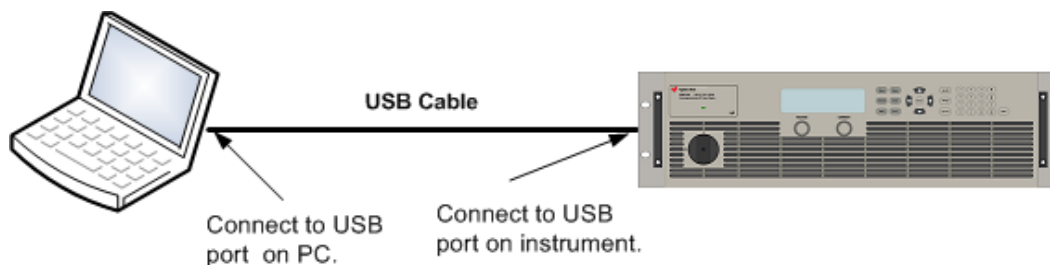
The following figure illustrates a typical GPIB interface system.



1. Connect your instrument to the GPIB interface card using a GPIB interface cable.
2. Use the Connection Expert utility of the Keysight IO Libraries Suite to configure the GPIB card's parameters.
3. You can now use Interactive IO within the Connection Expert to communicate with your instrument, or you can program your instrument using the various programming environments.

USB Connections

The following figure illustrates a typical USB interface system.

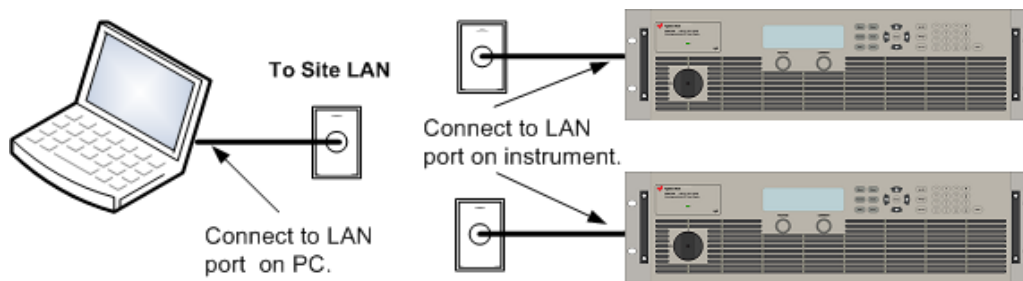


1. Connect your instrument to the USB port on your computer.
2. With the Connection Expert utility of the Keysight IO Libraries Suite running, the computer will automatically recognize the instrument. This may take several seconds. When the instrument is recognized, your computer will display the VISA alias, IDN string, and VISA address. This information is located in the USB folder.
3. You can now use Interactive IO within the Connection Expert to communicate with your instrument, or you can program your instrument using the various programming environments.

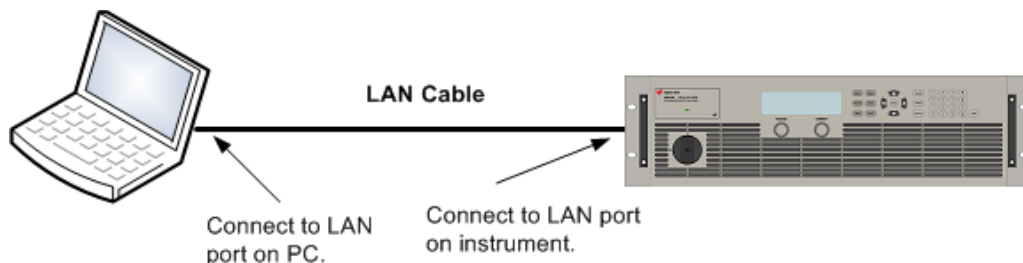
LAN Connections - site and private

CAUTION **Equipment Damage** Never insert a network cable which is connected to Ethernet or its components into the master- slave socket on the back side of the unit.

A site LAN is a local area network in which LAN-enabled instruments and computers are connected to the network through routers, hubs, and/or switches. They are typically large, centrally-managed networks with services such as DHCP and DNS servers. The following figure illustrates a typical site LAN system.



A private LAN is a network in which LAN-enabled instruments and computers are directly connected, and not connected to a site LAN. They are typically small, with no centrally-managed resources. The following figure illustrates a typical private LAN system.



1. Connect the instrument to the site LAN or to your computer using a LAN cable. The as-shipped instrument LAN settings are configured to automatically obtain an IP address from the network using a DHCP server (DHCP is set On). The DHCP server will register the instrument's hostname with the dynamic DNS server. The hostname as well as the IP address can then be used to communicate with the instrument. If you are using a private LAN, you can leave all LAN settings as they are. Most Keysight products and most computers will automatically choose an IP address using auto-IP if a DHCP server is not present. Each assigns itself an IP address from the block 169.254.nnn. The front panel Lan indicator will come on when the LAN port has been configured.

2 Operating Information

2. Use the Connection Expert utility of the Keysight IO Libraries Suite to add the Keysight N8900 models and verify a connection. To add the instrument, you can request the Connection Expert to discover the instrument. If the instrument cannot be found, add the instrument using the instrument's hostname or IP address.

3. You can now use Interactive IO within the Connection Expert to communicate with your instrument, or you can program your instrument using the various programming environments. You can also use the Web browser on your computer to communicate with the instrument as described under [Using the Web Interface](#).

Getting Started

Turn the Unit On

Set the Output Voltage

Set the Output Current

Set the Over-Voltage Protection

Enable the Output

Use the Built-in Help System

Turn the Unit On

Verify that the line cord is connected and plugged in to the correct AC line voltage.

Turn the unit on with the front panel power switch. Rotate the knob from 0 to 1. The front panel display will light up after a few seconds. A power-on self-test occurs automatically when you turn the unit on. This test assures you that the power supply is operational.



NOTE

It may take about 30 seconds or so for the power supply to initialize before it is ready for use.

If the instrument does not turn on, verify that the power cord is firmly connected. Also make sure that the instrument is connected to an energized power source.

If the power-on self test fails, the display shows **ERR** in the lower right corner. See [SCPI Error Messages](#) for information on error codes. See [Service and Repair - Introduction](#) for instructions on returning the instrument for service.

Set the Output Voltage

Method 1

Turn the Voltage knob to set the output voltage. The setting value appears in the Set field on the bottom of the display.



2 Operating Information

Method 2

Use the left and right navigation keys to navigate to the setting that you wish to change.



In the following display, the voltage setting is selected. Enter a value using the numeric keypad. Then press **Select**.



You can also use the numeric arrow keys to adjust the value up or down. Values become effective when the output is enabled.

Method 3

Use the **Voltage** key to select the voltage entry field. In the display below, the voltage setting is selected. Enter the desired setting using the numeric keypad. Then press **Enter**.

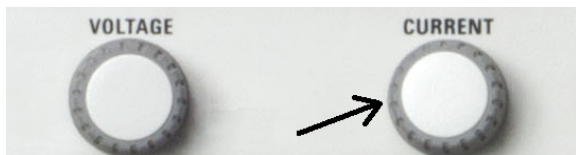


If you make a mistake, either use the backspace key to delete the number, press **Back** to back out of the menu, or press **Meter** to return to meter mode.

Set the Output Current

Method 1

Turn the Current knob to set the output current. The setting value appears in the Set field on the bottom of the display.



Method 2

Use the left and right navigation keys to navigate to the setting that you wish to change.



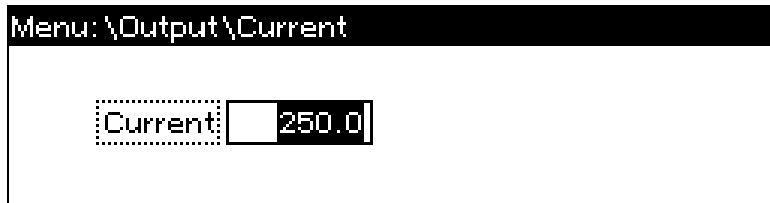
In the display below, the current setting is selected. Enter a value using the numeric keypad. Then press **Select**.



You can also use the numeric arrow keys to adjust the value up or down. Values become effective when the output is turned on.

Method 3

Use the **Current** key to select the current entry field. In the display below, the current setting is selected. Enter the desired setting using the numeric keypad. Then press **Select**.



If you make a mistake, either use the backspace key to delete the number, press Back to back out of the menu, or press Meter to return to meter mode.

Set the Over-Voltage Protection

Use the front panel menu.

The front panel command menu lets you access most of the power supply's functions. The actual function controls are located at the lowest menu level. Briefly:

- Press the **Menu** key to access the command menu.
- Press the left and right (<, >) navigation keys to move across the menu commands.
- Press the center **Select** key to select a command and move down to the next level in the menu.

2 Operating Information

- Press the **Help** key at the lowest menu level to display help information about the function controls.
- To exit the command menu press the **Meter** key to immediately return to meter mode, or press the **Menu** key to return to the top level.

For a map of the front panel menu commands, refer to [Front Panel Menu Reference](#).

Menu example - accessing over-voltage protection.

Press the **Menu** key to access the front panel command menu. The first line identifies the menu path. When the menu is first accessed, the menu is at the top or root, and the path is empty. The second line indicates the commands that are available at the present menu level. In this case, the top-level menu commands are shown, with the Output command highlighted. The third line indicates which commands are available under the Output command. If there are no lower level commands, a brief description of the highlighted command is displayed.

```
Menu: \  
Output Transient Protect States System  
Voltage, Current
```

Press the right arrow navigation key > to traverse the menu until the Protect command is highlighted. Press the **Select** key to access the Protect commands.

```
Menu: \  
Output Transient Protect States System  
OVP, OCP, Clear
```

Since the OVP command is already highlighted, press the Select key to access the OVP dialog.

```
Menu: \Protect  
OVP OCP Clear  
Overvoltage protection settings.
```

Note that the default OVP setting for all models is 120% of the rated output voltage. You can change the OVP setting using the numeric entry keys. Then press **Select**. Press the **Meter** key to return to meter view.

```
Menu: \Protect \OVP  
  
OVP Level: 24.00
```

Enable the Output

WARNING **HAZARDOUS VOLTAGES** All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Use the **On/Off** key to enable the output. If a load is connected to the output, the front panel display will indicate that it is drawing current. Otherwise, the current reading will be zero. The status indicator shows the output's status. In this case, "CV" indicates the output is in constant voltage mode.

NOTE If the output current is set to zero, the output voltage may remain as zero when the output is enabled, and a UNR status may appear in the display. You must program a minimum current value for the output voltage to rise to its programmed setting.



For a description of the status indicators, refer to [Front Panel Display at a Glance](#).

Use the Built-in Help System

View the list of help topics.

Press the **Help** key to view the context-sensitive help. Information about the present display is presented.

Press **Meter** or **Back** to exit Help.

View the help information for displayed messages.

Whenever a limit is exceeded or any other invalid configuration is found, the instrument will display a message, including Error code information.

Press **Meter** or **Back** to exit Help.

Remote Interface Configuration

USB Configuration

GPIB Configuration

LAN Configuration

Modifying the LAN Settings

Using the Web Interface

Using Telnet

Using Sockets

Interface Lockout

This instrument supports remote interface communication over three interfaces: GPIB, USB, and LAN. All three interfaces are "live" at power up. To use the interfaces, you must first install the Keysight IO Libraries software, found at www.keysight.com/find/iolib.

The front panel **IO** indicator comes on whenever there is activity on the remote interfaces. The front panel **Lan** indicator comes on when the LAN port is connected and configured.

This instrument provides Ethernet connection monitoring. With Ethernet connection monitoring, the instrument's LAN port is continually monitored, and automatically reconfigured when the instrument is unplugged for a minimum of 20 seconds and then reconnected to a network

USB Configuration

There are no configurable USB parameters. You can retrieve the USB connect string using the front panel menu:

Front Panel Menu	SCPI Command
Select System\IO\USB	Not available

The dialog displays the USB connect string.

GPIB Configuration

Each device on the GPIB (IEEE-488) interface must have a unique whole number address between 0 and 30. The instrument ships with the address set to 5. Your computer's GPIB interface card address must not conflict with any instrument on the interface bus. This setting is non-volatile; it will not be changed by power cycling or *RST. Use the front panel menu to change the GPIB address:

Front Panel Menu	SCPI Command
Select System\IO\GPIO Use the numeric keys to enter a new value from 0 to 30. Then press Enter .	Not available

LAN Configuration

The following sections describe the primary LAN configuration functions on the front-panel menus. Note that there are no SCPI commands to configure the LAN parameters. All LAN configuration must be done from the front panel.

NOTE

After changing the LAN settings, you must Save the changes. Select: **System\IO\LAN\Apply**. Selecting Apply activates the settings. LAN settings are non-volatile, they will not be changed by power cycling or *RST. If you do not want to save your changes select: **System\IO\LAN\Cancel**. Selecting Cancel cancels all changes.

When shipped, DHCP is on, which may enable communication over LAN. The letters DHCP stands for Dynamic Host Configuration Protocol, a protocol for assigning dynamic IP addresses to devices on a network. With dynamic addressing, a device can have a different IP address every time it connects to the network.

Viewing Active Settings

To view the currently active LAN settings:

Front Panel Menu	SCPI Command
Select System\IO\LAN\Settings Displays the active LAN settings. Use the up and down arrow key to scroll through the list.	Not available

The currently active settings for the IP Address, Subnet Mask, and Default Gateway may be different from the front panel configuration menu settings - depending on the configuration of the network. If the settings are different, it is because the network has automatically assigned its own settings

Resetting the LAN

You can perform an LXI LCI reset of the LAN settings. This resets DHCP, DNS server address configuration, mDNS state, and web password. These settings are optimized for connecting your instrument to a site network. They should also work well for other network configurations.

You can also reset the LAN to the as-shipped settings. This returns **ALL** LAN settings to the as-shipped values and restarts networking. All default LAN settings are listed under **Non-volatile Settings**.

2 Operating Information

Front Panel Menu	SCPI Command
Select System\IO\LAN\Reset Select System\IO\LAN\Defaults	Not available
Select Reset . This activates the selected LAN settings and restarts networking.	

Modifying the LAN Settings

IP Address

Select IP to configure the addressing of the instrument. Press the **Menu** key, then select **System\IO\LAN\Config\IP**. The configurable parameters include:

Front Panel Menu	SCPI Command
Select System\IO\LAN\Modify\IP	Not available
Select Auto or Manual. See below for a full description.	

- **Auto** - automatically configures the addressing of the instrument. When selected, the instrument will first try to obtain an IP address from a DHCP server. If a DHCP server is found, the DHCP server will assign an IP address, Subnet Mask, and Default Gateway to the instrument. If a DHCP server is unavailable, the instrument will try to obtain an IP address using AutoIP. AutoIP automatically assigns an IP address, Subnet Mask, and Default Gateway addresses on networks that do not have a DHCP server.
- **Manual** - allows you to manually configure the addressing of the instrument by entering values in the following three fields. These fields only appear when Manual is selected.
- **IP Address** - This value is the Internet Protocol (IP) address of the instrument. An IP address is required for all IP and TCP/IP communications with the instrument. An IP Address consists of 4 decimal numbers separated by periods. Each decimal number ranges from 0 through 255 with no leading zeros (for example, 169.254.2.20).
- **Subnet Mask** - This value is used to enable the instrument to determine if a client IP address is on the same local subnet. The same numbering notation applies as for the IP Address. When a client IP address is on a different subnet, all packets must be sent to the Default Gateway.
- **DEF Gateway** - This value is the IP Address of the default gateway that allows the instrument to communicate with systems that are not on the local subnet, as determined by the subnet mask setting. The same numbering notation applies as for the IP Address. A value of 0.0.0.0 indicates that no default gateway is defined.

Dot-notation addresses ("nnn.nnn.nnn.nnn" where "nnn" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

Host Name

A hostname is the host portion of the domain name, which is translated into an IP address. To configure the hostname of the instrument:

Front Panel Menu	SCPI Command
Select System\IO\LAN\Modify\Name	Not available
<p>You can enter any value from the numeric keypad. For additional characters, use the up/down navigation keys to enter an alpha character by scrolling through the selection list that appears when you press the keys. Use the backspace key to delete a value. Press Enter when you are finished.</p>	

Host Name - This field registers the supplied name with the selected naming service. If the field is left blank, no name is registered. A hostname may contain upper and lower case letters, numbers and dashes (-). The maximum length is 15 characters.

Each instrument is shipped with a default hostname with the format: A-modelnumber-serialnumber, where modelnumber is the unit's 6-character model number (e.g. N6950A), and serialnumber is the last five characters of the 10-character serial number located on the label on the top of the unit (e.g. 45678 if the serial number is MY12345678).

DNS Server and WINS Server

DNS is an internet service that translates domain names into IP addresses. It is also needed for the instrument to find and display its hostname assigned by the network. Normally, DHCP discovers the DNS address information; you only need to change this if DHCP is unused or not functional.

WINS configures the Windows service of the instrument. This is similar to the DNS service that translates domain names into IP addresses.

To manually configure the DNS and WINS services:

Front Panel Menu	SCPI Command
Select System\IO\LAN\Modify\DNS or Select System\IO\LAN\Modify\WINS	Not available
<p>Select Primary Address or Secondary Address. See below for a full description.</p>	

- **Primary Address** - This field enters the primary address of the server. Contact your LAN administrator for server details. The same numbering notation applies as for the IP Address. A value of 0.0.0.0 indicates that no default server is defined.
- **Secondary Address** - This field enters the secondary address of the server. Contact your LAN administrator for server details. The same numbering notation applies as for the IP Address. A value of 0.0.0.0 indicates that no default server is defined.

2 Operating Information

Dot-notation addresses ("nnn.nnn.nnn.nnn" where "nnn" is a byte value from 0 to 255) must be expressed with care, as most PC web software interprets byte values with leading zeros as octal (base 8) numbers. For example, "192.168.020.011" is actually equivalent to decimal "192.168.16.9" because ".020" is interpreted as "16" expressed in octal, and ".011" as "9". To avoid confusion, use only decimal values from 0 to 255, with no leading zeros.

mDNS Service Name

The mDNS service name is registered with the selected naming service. To configure the mDNS service name of the instrument:

Front Panel Menu	SCPI Command
Select System\IO\LAN\Modify\mDNS	Not available
You can enter any value from the numeric keypad. For additional characters, use the up/down navigation keys to enter an alpha character by scrolling through the selection list that appears when you press the keys. Use the backspace key to delete a value. Press Enter when you are finished.	

- **mDNS Service Name** - This field registers the service name with the selected naming service. If the field is left blank, no name is registered. A service name may contain upper and lower case letters, numbers and dashes(-).
- Each instrument is shipped with a default service name with the format: Keysight-modelnumber-description-serialnumber, where modelnumber is the unit's 6-character model number (e.g. N6950A), description is the description, and serialnumber is the 10-character serial number located on the label on the top of the unit (e.g. MY12345678).

Services

This selects the LAN services to enable or disable.

Front Panel Menu	SCPI Command
Select System\IO\LAN\Modify\Services	Not available
Check or uncheck the services that you wish to enable or disable.	

- The configurable services include: VXI-11, Telnet, Web control, Sockets, and mDNS.
- You must enable Web control if you wish to remotely control your instrument using its built-in Web interface.

Using the Web Interface

WARNING **HAZARDOUS VOLTAGES** All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Your power supply has a built-in Web interface that lets you control it directly from the Web browser on your computer. With the Web interface, you can access the front panel control functions including the LAN configuration parameters. Up to six simultaneous connections are allowed. With multiple connections, performance will be reduced.

NOTE The built-in Web interface only operates over the LAN. It requires Internet Explorer 7+. You also need the Java Plug-in version 7+. This is included in the Java Runtime Environment.

The Web interface is enabled when shipped. To launch the Web interface:

1. Open the Web browser on your computer.
2. Enter the instrument's hostname or IP address into the browser's Address field. The following home page will appear.
3. Click on the Browser Web Control button in the navigation bar on the left to begin controlling your instrument.
4. For additional help about any of the pages, click on the Help with this Page button.

The screenshot shows the web interface for a Keysight N8923A power supply. The header includes the Keysight Technologies logo and the title 'N8900 Autoranging System DC Power Supply'. A navigation bar on the left contains buttons for 'Welcome Page', 'Browser Web Control', 'View & Modify Configuration', and 'Help with this Page'. The main content area is titled 'Web-Enabled N8923A' and includes a table of instrument information, a product image, and a link to 'Turn On Front Panel Identification Indicator'.

Information about this Web-Enabled Autoranging System DC Power Supply:	
Instrument:	N8923A
Serial Number:	DE68420001
Description:	Keysight N8923A Power Supply - DE68420001
DNS Hostname:	A-N8923A-20001
NetBIOS Name:	A-N8923A-20001
mDNS Hostname:	A-N8923A-20001.local
IP Address:	141.121.202.215
Instrument Address String:	TCPIP::A-N8923A-20001::inst0::INSTR

[Turn On Front Panel Identification Indicator](#)

Advanced information about this Web-Enabled Autoranging System DC Power Supply

Use the navigation bar on the left to access your N8923A and related information.

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2 Operating Information

If desired, you can control access to the Web interface using password protection. As shipped, no password is set. To set a password, click on the View & Modify Configuration button. Refer to the on-line help for additional information about setting a password.

Using Telnet

In an MS-DOS Command Prompt box type: telnet hostname 5024 where hostname is the instrument's hostname or IP address, and 5024 is the instrument's telnet port.

You should get a Telnet session box with a title indicating that you are connected to the power supply. Type the SCPI commands at the prompt.

Using Sockets

NOTE

Power supplies allow any combination of up to six simultaneous data socket, control socket, and telnet connections to be made.

Keysight instruments have standardized on using port 5025 for SCPI socket services. A data socket on this port can be used to send and receive ASCII/SCPI commands, queries, and query responses. All commands must be terminated with a newline for the message to be parsed. All query responses will also be terminated with a newline.

The socket programming interface also allows a control socket connection. The control socket can be used by a client to send device clear and to receive service requests. Unlike the data socket, which uses a fixed port number, the port number for a control socket varies and must be obtained by sending the following SCPI query to the data socket: **SYSTem:COMMunicate:TCPIP:CONTRol?**

After the port number is obtained, a control socket connection can be opened. As with the data socket, all commands to the control socket must be terminated with a newline, and all query responses returned on the control socket will be terminated with a newline.

To send a device clear, send the string "DCL" to the control socket. When the power supply has finished performing the device clear it echoes the string "DCL" back to the control socket.

Service requests are enabled for control sockets using the Service Request Enable register. Once service requests have been enabled, the client program listens on the control connection. When SRQ goes true the instrument will send the string "SRQ +nn" to the client. The "nn" is the status byte value, which the client can use to determine the source of the service request.

Interface Lockout

The USB interface, LAN interface, and the Web server are enabled when shipped. To enable or disable the interfaces from the front panel:

Front Panel Menu	SCPI Command
Select System\Admin\IO Enable or disable the interfaces by checking or unchecking the following items: Enable LAN, Enable GPIB, and Enable USB. Then press Select .	Not available

If you cannot access the Admin menu, it may be password protected.

Using the Power Supply

This section contains details on using the instrument, including front panel and remote interface operation. You may want to read [Front-Panel Menu Reference](#) first. See [SCPI Programming Reference](#) for details on the SCPI commands to program the instrument. This section covers:

[Programming the Output](#)

[Programming Output Protection](#)

[Programming Output Steps](#)

[Making Measurements](#)

[Parallel Operation](#)

[External Control Signal Programming](#)

[System-Related Operations](#)

[Operating Mode Tutorial](#)

[SASimulator Operation](#) - applies to N8937APV and N8957APV models only

Programming the Output

NOTE

When the power supply is first turned on, it may take about 30 seconds or so to initialize the unit before it is ready for use.

Set the Output Voltage

Set the Output Current

Enable the Output

Set the Output Voltage

You can set the output voltage when the output is either disabled (OFF) or enabled (ON). When enabled, the output voltage will rise to the programmed setting. This assumes that a minimum output current has been programmed, that the output has not reached its current limit or power limit boundary.

Front Panel Menu	SCPI Command
Turn the Voltage knob while observing the voltage setting; or press the Voltage key and enter a value. Then press Select .	To set the output voltage to 90 volts: VOLT 90

When the unit is operating in constant voltage mode, CV status is displayed on the front panel.

Set the Output Current

You can set the output current when the output is either disabled (OFF) or enabled (ON). When enabled, the output current will be limited at its programmed setting.

Front Panel Menu	SCPI Command
Turn the Current knob while observing the current setting; or press the Current key and enter a Value. Then press Select .	To set the output current to 100 amps: CURR 100

When the unit is operating in constant current mode, CC status is displayed on the front panel.

Enable the Output

WARNING

HAZARDOUS VOLTAGES All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Front Panel Menu	SCPI Command
Press the On/Off key.	To turn the output on or off: OUTP ON OFF

Programming Output Protection

Set the Over-Voltage Protection

Set the Over-Current Protection

Clear Output Protection

The Keysight N8900 series power supplies have many protection functions. A front panel status indicator will turn on when a protection function has been set. Most protection functions are latching, which means that they must be cleared once they have been set. Of the following protection functions, only the OV and OC are user-programmable.

OV	Over-Voltage protection is a hardware OVP whose trip level is a user-programmable value. The OVP is always enabled.
OC	Over-Current protection is a user-programmable function that can be enabled or disabled. When enabled, the output will be disabled when the output current reaches the current limit setting.
OT	Over-Temperature protection monitors the internal temperature of the power supply and disables the output if the temperature exceeds the factory-defined limit. The OT protection is always enabled.
PF	Power-Fail indicates that a low voltage condition on the AC mains has occurred and has disabled the output. The PF protection is always enabled.
MSP	Master/Slave Protection indicates that a fault has occurred in the paralleled group. The outputs of all grouped units are disabled. MSP is always enabled.

Set the Over-Voltage Protection

The over-voltage protection will turn the output off if the output voltage reaches the programmed over-voltage limit. The OVP circuit monitors the voltage at the + and – sense terminals if they are connected to the load, or at the output terminals if the sense terminals are not being used.

Front Panel Menu	SCPI Command
Select Protect\OVP Enter the value in the OVP level box. Then press Select .	To set the OVP level to 55 volts: VOLT:PROT 55

Set the Over-Current Protection

When over-current protection is enabled, the power supply turns off the output if the output current reaches the current limit setting and transitions from CV to CC mode.

Front Panel Menu	SCPI Command
Select Protect\OCP Check Enable OCP . Then press Select .	To enable OCP: CURR:PROT:STAT ON

You can also specify an OCP delay to prevent momentary output settings, load, and status changes from tripping the over-current protection. In most cases these momentary conditions would not be considered an over-current protection fault, and having an OCP condition disable the output when they occur would be a nuisance. Specifying an OCP delay lets the OCP circuit ignore these momentary changes during the specified delay period. Once the OCP delay time has expired and the over-current condition persists, the output will shut down.

Front Panel Menu	SCPI Command
Select Protect\OCP Enter a delay value. Then press Select .	To specify a 10 millisecond delay: CURR:PROT:DEL 0.01

Factors that influence how long the settings change or output load change may last include: difference between old output value and new output value, the current limit setting, and the load capacitance in CV mode or load inductance in CC mode. The delay required must be determined empirically; the output programming-response time characteristics may be used as guidelines.

Note that the time it takes the output to go into CC mode varies - depending on the magnitude of the over-current condition compared to the current limit setting. For example, if the over-current is only slightly greater than the current limit setting, it may take several tens of milliseconds for the output to set the CC status bit. If the over-current is significantly greater than the current limit setting, it may only take a few hundred microseconds or less for the output to set the CC status bit. To determine when the output will shut down, you must add the time it takes for the CC status bit to the over-current protection delay time. If the over-current persists beyond the sum of these two time intervals, the output will shut down.

Clear Output Protection

If an over-voltage, over-current, over-temperature, power-fail condition, or master/slave protection occurs, the output is disabled. The appropriate operating status indicator on the front panel will be on. To clear the protection function and restore normal operation, first remove that condition that caused the protection fault. Then, clear the protection function as follows:

Front Panel Menu	SCPI Command
Select Protect\Clear Select Clear.	To clear a protection fault: OUTP:PROT:CLE

NOTE

MSP protection cannot be cleared using Protect\Clear. It can only be cleared by cycling power or re-discovering the slave units (see [Group Configuration](#)).

Programming Output Steps

The transient system of the Keysight N8900 HPS lets you generate output steps. An output step is a one-time event that steps the output voltage or current up or down in response to a trigger. The following steps are required to generate a triggered output step:

- Enable the output to respond to step triggers
- Program the voltage or current step levels
- Initiate the transient system
- Trigger the output step

Enable the output to respond to step triggers

First, you must enable the output to respond to Step triggers. Unless an output is enabled to respond to triggers, nothing will happen even if you have programmed a trigger level and generated a trigger for the output.

Front Panel Menu	SCPI Command
Select Transient\Mode . For voltage step triggering, set the transient mode to Step. For current step triggering, set the transient mode to Step. Then press Select .	To enable the transient function to respond to step triggers, use: VOLT:MODE STEP or CURR:MODE STEP

NOTE

In Step mode, the triggered value becomes the immediate value when the trigger is received. In Fixed mode, trigger signals are ignored; the immediate values remain in effect when a trigger is received.

Program the voltage or current step levels

Next, use the following commands to program a triggered level. The output will go to this level when the trigger is received.

Front Panel Menu	SCPI Command
Select Transient\Step . Select the Trig Voltage box to set the voltage. Select the Trig Current box to set the current. Enter a value and press Select .	To set a voltage step level to 55 V, and a current step level to 110 A, use: VOLT:TRIG 55 CURR:TRIG 110

Initiate the transient system

When the unit is turned on, the trigger system is in the idle state. In this state, the trigger system is disabled, ignoring all triggers. The INITiate commands enable the trigger system to receive triggers.

Front Panel Menu	SCPI Command
Not available	To initiate the transient trigger system: INIT:TRAN

It takes a few milliseconds for the instrument to be ready to receive a trigger signal after receiving the INITiate:TRANsient command. If a trigger occurs before the trigger system is ready for it, the trigger will be ignored. You can test the WTG_tran bit in the operation status register to know when the instrument is ready to receive a trigger.

Front Panel Menu	SCPI Command
Not available	To query the WTG_tran bit (bit 4): STAT:OPER:COND?

If a bit value of 16 is returned in the query, the WTG_tran bit is true, and the instrument is ready to receive the trigger signal. Refer to [Status Tutorial](#) for more information.

Trigger the output step

The trigger system is waiting for a trigger signal in the initiated state. Trigger the transient as follows:

Front Panel Menu	SCPI Command
Not available	To generate a transient trigger: TRIG:TRAN
	Alternatively, you can also program a *TRG or an IEEE-488 <get> command.

If the trigger does not occur, you must manually return the trigger system to the idle state. The following commands return the trigger system to the idle state:

Front Panel Menu	SCPI Command
Not available	ABOR:TRAN

When a trigger is received, the triggered functions are set to their programmed trigger levels. When the triggered actions are completed, the trigger system returns to the idle state.

You can test the TRAN_active bit in the Operation Status register to know when the transient trigger system has returned to the idle state.

2 Operating Information

Front Panel Menu	SCPI Command
Not available	To query the TRAN_active bit (bit 6): STAT:OPER:COND?

If a bit value of 64 is returned in the query, the TRAN_active bit is true, and the transient action is NOT complete. When the TRAN_active bit is false, the transient action is complete. Refer to [Status Tutorial](#) for more information.

Making Measurements

The Keysight N8900 series has fully integrated voltmeter and ammeter to measure the actual voltage and current that is being supplied to the load. Whenever the instrument is on, the front panel automatically measures output voltage and current.

Power measurements are derived from the voltage and current measurements.

Average (DC) Measurements

Use the following commands to make a measurement:

Front Panel Menu	SCPI Command
Select the Meter key. Repeatedly press this key to cycle through the following measurement functions: Voltage, Current Voltage, Power Voltage, Current, Power	To measure average (DC) output voltage, current, or power: MEAS:VOLT? MEAS:CURR? MEAS:POW?

Parallel Operation

Current Share Operation

Group Operation

Group Configuration

Group Protection

Parallel operation provides the possibility of connecting a number of devices together to create a system with higher total current and, hence, higher power. Refer to [Parallel Connections](#) for detailed information on how to connect the outputs, share cables, and master/slave cables.

Current Share Operation

NOTE

Only N8900A units labeled Version 2b, 2c, 3b, or 3c on the rear label can current-share with other units similarly labeled. This limitation does not affect N8937APV or N8957APV models.

The current SHARE cables must be connected on all paralleled units as previously described under Parallel Connections. The current share cables allow identical units to share current approximately equally in voltage priority mode. The current sharing operation works as follows:

- Program the output voltage of each paralleled unit to the same value.
- Set the current limit of each paralleled unit so as not to interfere with the expected current sharing level. When the current limit setting of any paralleled unit is reached, the output current of that unit will limit at its specified setting. If the current limit of the remaining units is set to a higher value, those units will continue to share current until their current limit is reached.
- Current sharing continues until the total current limit of the paralleled group is reached. This allows current to be shared among participating units without any additional external connections or programming considerations.

Group Operation (master/slave)

In addition to the current Share function, which must be used with paralleled units, you can also Group the paralleled units, with one unit configured as a master controlling up to 9 additional units. Grouping units provides the following benefits:

- Program the Output, Transient, Protect, and States functions on only one unit. The programmed settings will automatically be distributed to the connected units.
- The master unit displays, or makes available to be read by the remote controller, the sum of the actual current values of all the units. The output current of the slave units can be queried individually.

- The range for setting the values of the master unit is dependent on the number of paralleled units. For example, if 5 units each with a current rating of 90 A are connected to form a 450 A system, then the master can be programmed to provide current in the range from 0 to 450 A.
- The Group configuration is saved in non-volatile memory.

Group Configuration

NOTE

A maximum of 1 master and up to 9 slaves can be grouped. .

To configure the units in a paralleled group:

Configure the Unit as either a Master or Slave

The current SHARE cables must first be connected on all paralleled units as previously described under Paralleled Connections. The units at the end of the grouped connection chain must be terminated by setting the DIP switch located on the rear panel (see [Parallel Connections](#)).

Turn the outputs of all paralleled units off. If the output of any paralleled unit is on, and you try to configure any of the menu items, a status message will indicate "Output must be off to change configuration".

Front Panel Menu	SCPI Command
Select System\Group\Function	Not available
In the dialog box, select either Master or Slave. Only select None if the unit is not paralleled. Then press Select .	

When a unit has been configured as a slave, the following functions will be disabled, as these will be controlled by the master unit:

- Output On/Off.
- Voltage and Current setting controls.
- Output, Transient, Protect, and States menu functions.

The SCPI commands that correspond to the above functions are also disabled.

Specify the Address of Each Slave Unit

If the Slave selection is grayed out (unavailable) it means that the unit has not been configured as a slave in the Function menu.

Front Panel Menu	SCPI Command
Select System\Group\Slave	Not available
In the dialog box, select the address of the slave. Values can range from 1 - 15. Then press Select .	

2 Operating Information

View the Configured Slave Unit Addresses

If the Master selection is grayed out (unavailable) it means that the unit has not been configured as a master in the Function menu.

If the master had previously been configured, a list of slave unit addresses are displayed in the Configured box.

Front Panel Menu	SCPI Command
Select System\Group\Master	Not available
The Configured field displays the addresses of all connected and configured Slave units.	
If the Configured field is blank, press Discover Slaves to discover and display the addresses of the connected units.	

Group Protection

The following protection features are implemented in a grouped configuration:

Power On	At power-on, all grouped units will have their outputs off (unless they have been configured by the *RCL0 command to be programmed on).
Configuration check	At power on, the master unit will search for the slave units and compare the list of slaves found with the previously stored configuration. If the lists match, normal operation continues. If the lists do not match, a Master/Slave Protection (MSP) fault occurs and the outputs of all units remain off (see Programming Output Protection). A message is placed in the Error Queue that lists the slave units found and the slave units expected.
Communications check	If a master unit loses communication with any slave at any time, it will generate an MSP fault, which turns its own output off as well as the outputs of the slaves that it can still communicate with. If a slave loses communication with the master, the slave will also turn its output off.

External Control Signal Programming

The analog interface on the rear of the instrument provides the following capability:

[Analog Programming of Voltage and Current](#)

[Analog Monitoring of Voltage and Current](#)

[Monitoring Instrument Status](#)

[Output On/Off Control](#)

[Fault/Inhibit System Protection](#)

[Extending Fault/Inhibit Protection](#)

[Pin Descriptions and Characteristics](#)

NOTE

This section describes the programming capability of the analog interface with firmware version A.02.00 and up. For a brief description of the differences between this version and previous firmware versions, refer to [Manual Backdating](#).

CAUTION

Equipment Damage The digital and analog ground pins are internally connected to the USB and GPIB grounds. Only connect these pins to external circuitry that is either at earth ground potential or, to avoid ground loops, float the connections.

The OVP level and the OCP settings cannot be programmed using external control signals. They can still be programmed using the front panel or SCPI commands while the external control signal interface is enabled.

Analog Programming of Voltage and Current

NOTE

Analog programming of voltage and current as described in this section is not available in Master/Slave configurations.

Analog programming of voltage and current is NOT available on Models N8737APV and N8957APV

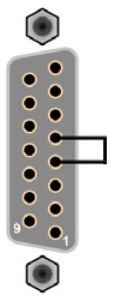
Specify the Analog Reference Voltage

You can specify either a 5 V or a 10 V reference voltage.

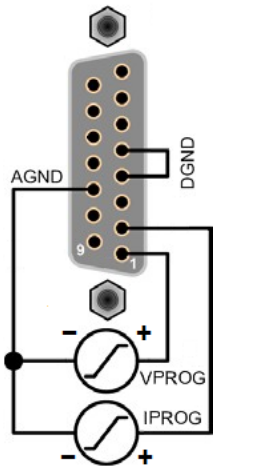
Front Panel Menu	SCPI Command
Select System\IO\Analog .	Not available
Select either the 5 V or 10 V reference voltage. Then press Select .	

2 Operating Information

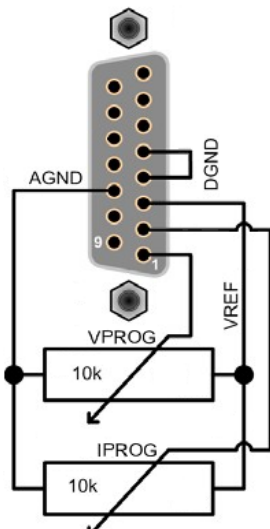
Enable the Voltage and Current Inputs

	<p>Enable analog programming of the output voltage and current by connecting the ANALOG-ENAB input (pin 5) to the Digital ground (pin 4).</p> <p>When analog programming is enabled, the front panel VOLTAGE and CURRENT controls are disconnected and have no effect on the output.</p> <p>You also cannot program the output using any other interface (i.e. GPIB, LAN, USB, web browser).</p>
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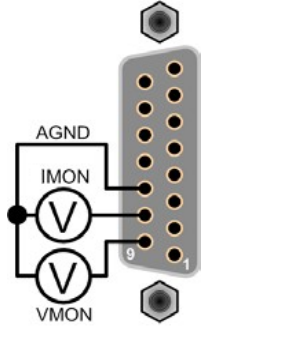
Control the Output Voltage and Current with Voltage Sources

	<p>Analog programming of the output voltage and current can be accomplished by connecting positive voltage sources to the VPROG and IPROG pins as shown.</p> <p>Depending on the reference voltage selection, a voltage source variable from 0 to + 5 V or 0 to + 10 V produces an output current or output voltage setting that is proportional to the zero to full-scale rating of the power supply.</p> <p>Note: Using a 0 to 5 V voltage source halves the effective resolution compared to using a 0 to 10 V voltage source.</p>
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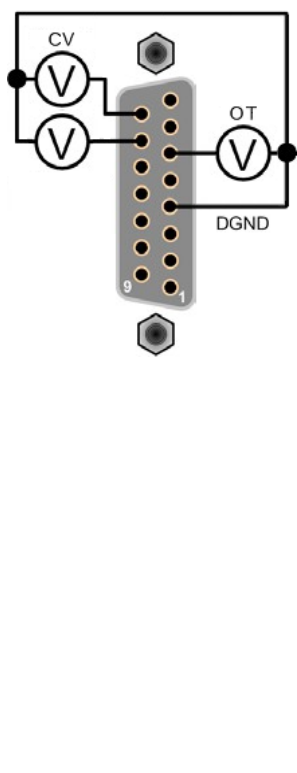
Control the Output Voltage and Current with Potentiometers

	<p>Analog programming of the output can be accomplished by connecting external potentiometers to the VPROG and IPROG pins as shown. This is similar to the function of the front panel voltage and current knobs.</p> <p>The potentiometers must be rated at 10 kΩ. Connect the VREF pin to one end of the potentiometers. Connect the wipers to the VPROG and IPROG pins.</p> <p>Note: Using a 5 V VREF halves the effective resolution of the potentiometers as compared to using a 10 V VREF.</p>
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Analog Monitoring of Voltage and Current

	<p>Output voltage and currents can be monitored and measured by connecting a standard multimeter to the VMON and IMON pins as shown.</p> <p>Depending on the reference voltage selection, a voltage reading from 0 to + 5 V or 0 to + 10 V corresponds to the zero to full-scale voltage or current output of the power supply.</p> <p>The output monitoring pins are always available. You do not need to enable analog programming to read the output voltage and current.</p>
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Monitoring Instrument Status

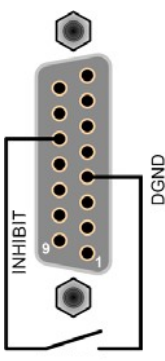
	<p>OT (over-temperature), CV (constant voltage), and Fault status can be monitored by connecting a standard multimeter to the appropriate status pins as shown.</p> <p>For OT, a reading >4 V indicates the status condition is true. A reading <1 V indicates the status is false. For CV, a reading >4 V indicates a CV status condition.</p> <p>For Fault, you can configure the polarity as positive or negative. For positive, a reading >4 V indicates the status condition is true. For negative, a reading <1 V indicates the status condition is true. When true, one of the following fault conditions has occurred:</p> <ul style="list-style-type: none"> over-voltage (OV) over-current (OC) over-temperature (OT) power-fail (PF) master-slave protect (MSP) inhibit signal (INH) <p>Query the Questionable status register to determine which fault condition occurred.</p> <p>The status monitoring pins are always available. You do not need to enable analog programming to monitor the output status.</p>
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Output On/Off Control

NOTE

In a master/slave configuration, only the master's Inhibit input and Fault output can be used. On the master unit these signals will control the entire master/slave system. Do not connect the Inhibit inputs and Fault outputs on any slave units.

2 Operating Information



The INHIBIT input (pin 13) can be used as a remote output control. This lets an external input signal control the output state of the instrument. This input is level triggered. Pin 4 is the common for pin 13. Use a low resistance contact such as a switch, relay, or transistor to connect the pin to digital ground (DGND).

You can configure the polarity of this pin as positive or negative. For the wiring shown, configuring negative polarity will cause the output to be inhibited when the switch is closed.

The following functions can be programmed:

LATChing - a true signal on the Inhibit input causes the output state to latch OFF. The output remains disabled until the Inhibit input is returned to logic-false and the latched INH status bit is cleared by sending the OUTPut:PROTEction:CLEar command or a protection clear command from the front panel.

LIVE - allows the enabled output to follow the state of the Inhibit input. When the Inhibit input is true, the output is disabled. When the Inhibit input is false, the output is re-enabled.

OFF - The Inhibit input is ignored.

The inhibit pin is always available. You do not need to enable analog programming to use the inhibit input.

To specify the fault function for pin 13:

Front Panel Menu	SCPI Command
Not available	OUTP:INH:MODE <LATC LIVE OFF>

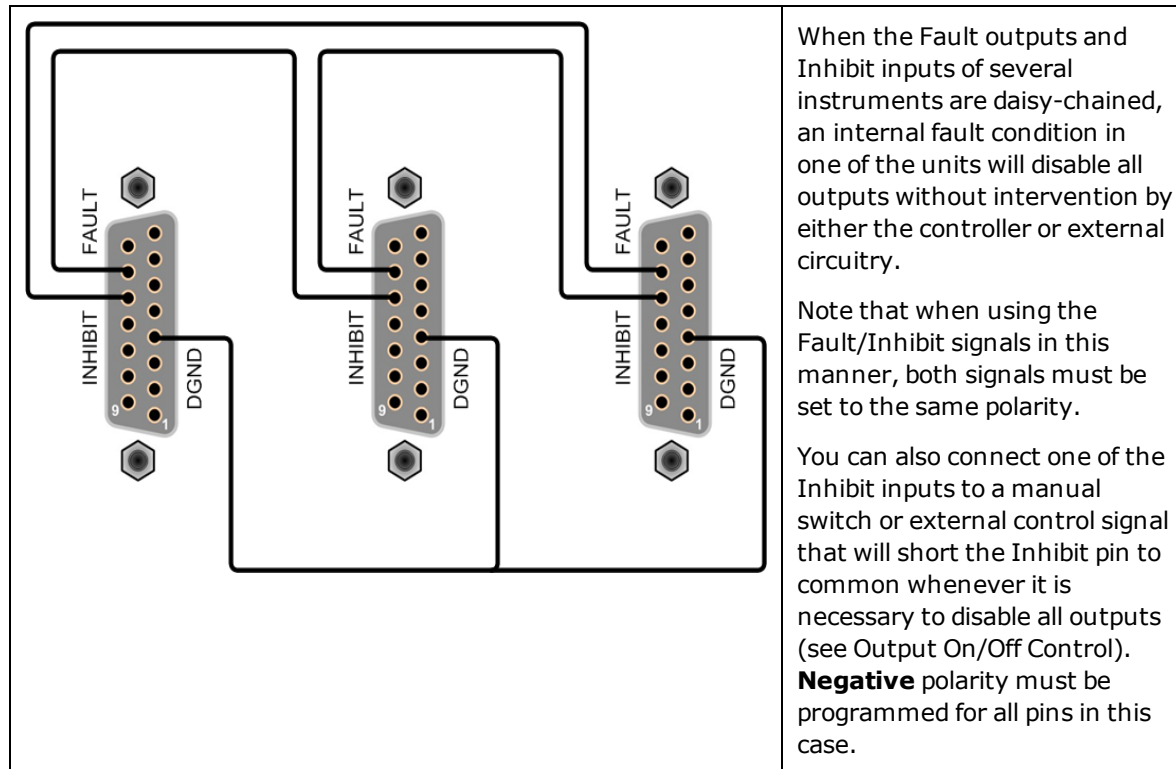
To specify Negative polarity for pin 13:

Front Panel Menu	SCPI Command
Not available	DIG:PIN13:POL NEG

Fault/Inhibit System Protection for Multiple Supplies

NOTE

Live mode is not recommended when programming Fault/inhibit system protection for multiple units. Live mode may result in unpredictable behavior of the units. Use Latching mode instead.



To specify either Positive or Negative polarity for pins 13 and 14:

Front Panel Menu	SCPI Command
Not available	To specify the polarity for pins 13 and 14: <code>DIG:PIN<13 14>:POL <POS NEG></code>

Clearing the Fault Condition for Multiple Supplies

To restore all instruments to a normal operating condition when a fault condition occurs in a daisy-chained system protection configuration, two fault conditions must be removed:

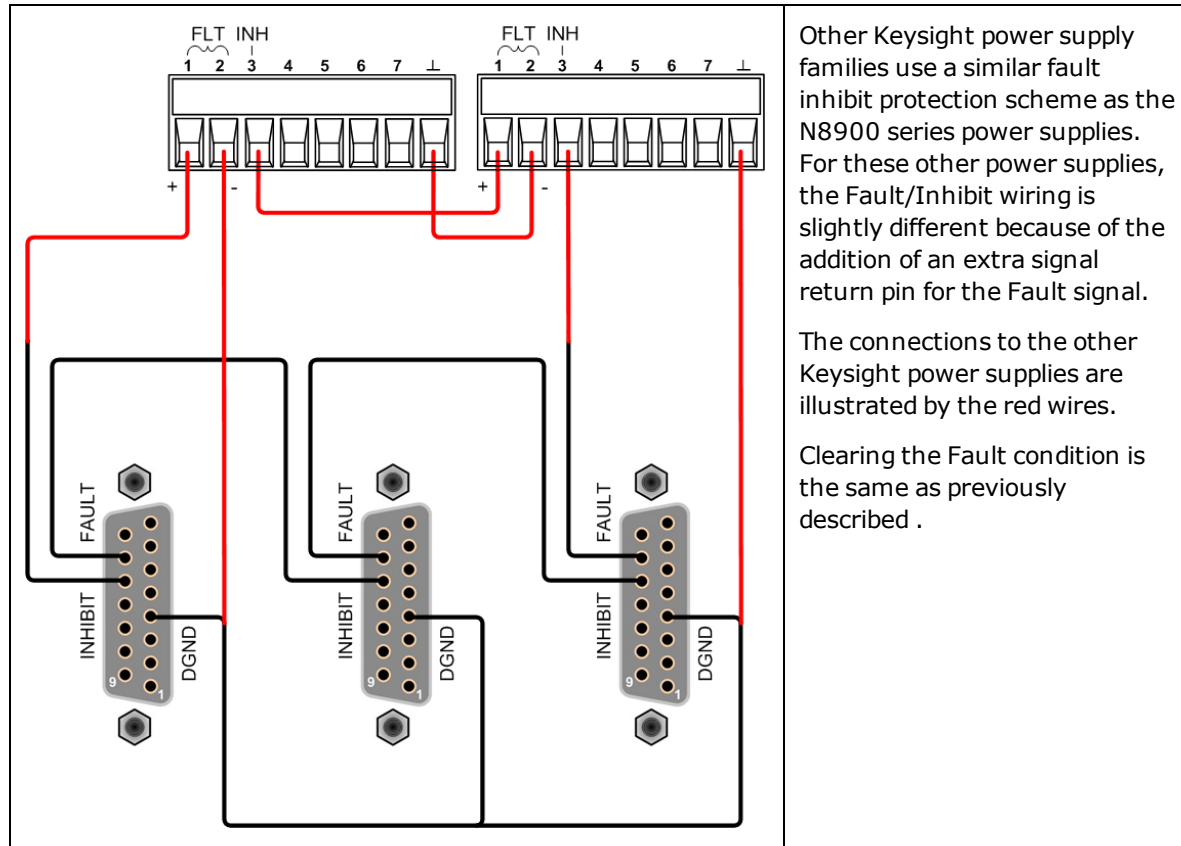
1. The initial protection fault or external Inhibit signal.
2. The subsequent daisy-chained fault signal (which is sourced by the Inhibit signal).

When the the operating mode of the Inhibit input is Latched, turn off the Inhibit input on ALL units individually. To re-enable the chain, re-program the Inhibit input on each unit to Latched mode.

Extending Fault/Inhibit Protection to Other Keysight Power Supplies

The following diagram illustrates how to connect other Keysight power supplies to the Fault/Inhibit scheme used in the Keysight N8900 series power supplies.

2 Operating Information



Other Keysight power supply families use a similar fault inhibit protection scheme as the N8900 series power supplies. For these other power supplies, the Fault/Inhibit wiring is slightly different because of the addition of an extra signal return pin for the Fault signal.

The connections to the other Keysight power supplies are illustrated by the red wires.

Clearing the Fault condition is the same as previously described .

Pin Descriptions and Characteristics

CAUTION **Equipment Damage** The digital and analog ground pins are internally connected to the USB and GPIB grounds. Only connect these pins to external circuitry that is either at earth ground potential or, to avoid ground loops, float the connections.

Pin Descriptions

Pin	Name	Type	Description
1	VPROG	Analog in	Programs output voltage. Only active when ANALOG-ENAB is low. This pin is not active on Models N8737APV and N8957APV.
2	IPROG	Analog in	Programs output current. Only active when ANALOG-ENAB is low. This pin is not active on Models N8737APV and N8957APV.
3	VREF	Analog out	Voltage reference. Can be connected to VPROG or IPROG directly to program full scale, or through potentiometers to adjust programmed values.
4	DGND	Ground	Ground for digital inputs and outputs.
5	ANALOG-ENAB	Digital in	Enables analog programming of the output when low.
6	OT	Digital out	Over-temperature status indicator. High when OT is tripped.
7, 8	Not used		

Pin	Name	Type	Description
9	VMON	Analog out	Voltage monitor signal.
10	IMON	Analog out	Current monitor signal.
11	AGND	Ground	Ground for analog inputs and outputs.
12	Not used		
13	INHIBIT	Digital in	Inhibits (turns off) the output. Can be configured as positive or negative polarity.
14	FAULT	Digital out	OV, OC, OT, PF, MSP, or INH status indicator. Can be configured as positive or negative polarity.
15	CV	Digital out	Constant voltage status indicator. High when in CV mode.

Pin Characteristics

Analog Input (pin 1, 2)	Full scale voltage: 5 V or 10 V, depending on the Menu:\System\IO\Analog setting. Input resistance: 150 k Ω . These pins are not active on Models N8737APV and N8957APV.
Analog Output (pin 3, 9, 10)	Full scale voltage: 5 V or 10 V, depending on the Menu:\System\IO\Analog setting.
Digital Inputs (pin 5, 13)	Drive with relay to ground or open-collector driver. Open-circuit voltage: approximately 6.5 V. Driver current sink requirement: < 0.4 V @ 3 mA
Digital Outputs (pin 6, 14, 15)	High state: 4.74 k Ω pull-up to approximately 10 V. Low state sink capability: < 0.4 V @ 5 mA
Voltage Reference	Voltage: Fixed 5 V or 10 V, depending on the Menu:\System\IO\Analog setting.

System-Related Operations

Instrument Identification

Instrument State Storage

Front Panel Display

Password Protection

Instrument Identification

You can query the model number, serial number, options, and firmware revision. SCPI commands let you return information with the *IDN? and *OPT? queries.

Front Panel Menu	SCPI Command
Select System \About \Frame .	To return model number, serial number, and firmware revision: *IDN? To return the installed options: *OPT?

Instrument State Storage

The power supply has ten storage locations in non-volatile memory to store instrument states. The locations are numbered 0 through 9. Any state previously stored in the same location will be overwritten.

Front Panel Menu	SCPI Command
Select States \SaveRecall .	To save a state in location 1: *SAV 1
In the SaveRecall field, enter a location from 0 to 9. Then press Select . Select Save to save the state or Recall to recall a state.	To recall a state from location 1: *RCL 1

Specifying a power-on state

When shipped from the factory, the power supply is configured to automatically recall the reset (*RST) settings at power-on. However, you can configure the power supply to recall the settings you have stored in memory location 0 (RCL0) at power-on.

Front Panel Menu	SCPI Command
Select States \PowerOn . Select Recall State 0. Then press Select .	OUTP:PON:STAT RCL0

WARNING

SHOCK HAZARD If the output is enabled when an instrument state is saved to location 0 (zero), the output will automatically be enabled at turn-on if the power-on state is set to recall location zero (RCL0).

Front Panel Display

The power supply has a front panel screen saver that significantly increases the life of the LCD display by turning it off during periods of inactivity. The delay can be set from 30 to 999 minutes in 1 minute increments. As shipped from the factory, the screen saver comes on one hour after activity on the front panel or interface has ceased.

When the screen saver is active, the front panel display turns off, and the LED next to the Line switch changes from green to amber. To restore the front panel display, simply press one of the front panel keys. The first action of the key turns the display on. Subsequently, the key will revert to its normal function.

If the Wake on I/O function is selected, the display is restored whenever there is activity on the remote interface. This also resets the timer on the screen saver. As shipped, Wake on I/O is active.

Front Panel Menu	SCPI Command
Select System\Preferences\Display	Not available
Enable or disable the screen saver by checking or unchecking the Screen Saver checkbox. Then press Select .	
Enter a value in minutes in the Saver Delay field to specify the time when the screen saver will activate.	
Check Wake on I/O to activate the display with I/O bus activity.	

Password Protection

You can password-protect all functions located in the Admin menu. These include: instrument calibration, interface access, non-volatile memory reset, firmware update, password updates.

As shipped from the factory, the Admin menu password is 0 (zero). This means that you do not have to enter a password to access the Admin menu. Simply select **System\Admin>Login** and press Enter. To password-protect the Admin menu:

Front Panel Menu	SCPI Command
Select System\Admin>Password	Enter calibration mode using the original password
The password must be numeric, and up to 15 digits long.	CAL:STAT ON, <password>
Press Select .	To change the password: CAL:PASS <password>
Log out of the Admin menu to activate the password. You can now only enter the Admin menu by providing the right password. Enter the password in the Password field.	To exit calibration mode and activate the password: CAL:STAT OFF

2 Operating Information

If the password is lost, access can be restored by setting an internal switch to reset the password to 0. If the message “Locked out by internal switch setting” or “Calibration is inhibited by switch setting” appears, the internal switch is set to prevent the password from being changed. Refer to [Calibration Switches](#) for more information.

Operating Mode Tutorial

Voltage Regulation

Current Regulation

Power Regulation

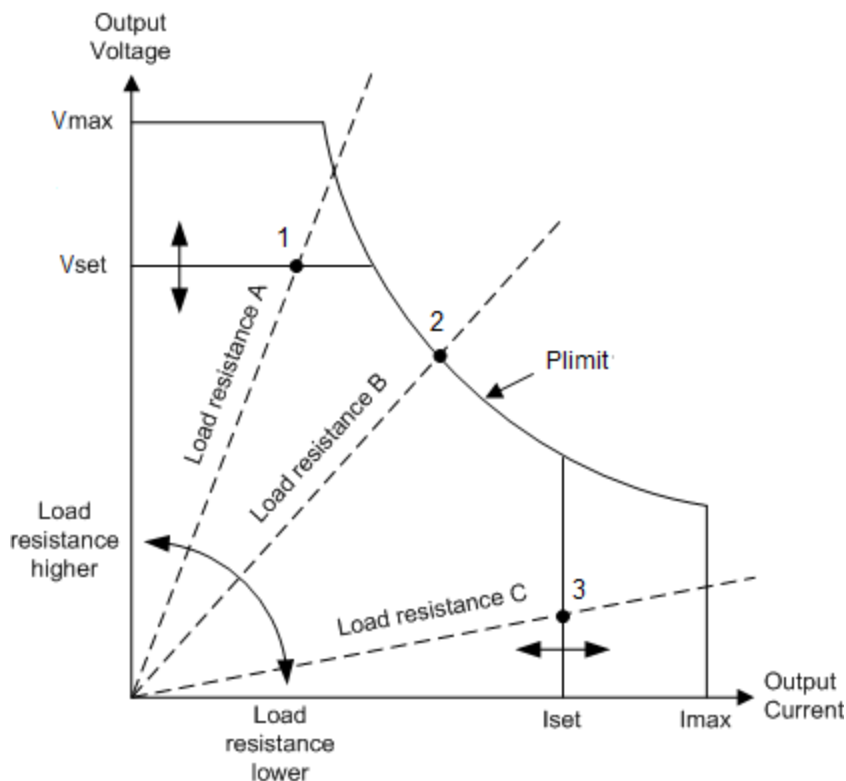
Voltage Regulation

Voltage regulation is also known as constant voltage mode (CV).

In CV mode, the DC output voltage of the power supply is held constant at its voltage setting, unless the output current or the output power reaches the current limit setting or the power limit. In both cases the device will automatically change to constant current (CC) or constant power (CP) operation. The output voltage is no longer held constant, and will sink to a value according to Ohm's law.

When the power supply is operating in constant voltage mode, the front panel CV status indicator is displayed. The CV status condition can also be read using SCPI commands and by monitoring the CV status pin on the Analog connector.

The figure below shows an operating locus that is defined by voltage setting, current setting, and power limit of the unit. The load resistance determines the point on that locus at which the power supply actually operates. The line representing Load resistance A, the highest load resistance shown on the figure, crosses the operating locus at point 1. Point 1 is on the part of the operating locus defined by the voltage setting, so the power supply operates in CV mode.



Current Regulation

Current regulation is also known as current limiting or constant current mode (CC).

In CC mode, the DC output current is held constant by the power supply when the output current reaches the current limit setting. The power supply then switches from CV to CC mode. If, however, the power consumption reaches the set maximum power value, the device will switch automatically to power limit (CP) where $V_{out} \times I_{out} = P_{limit}$.

When the power supply is operating in constant current mode, the front panel CC status indicator is displayed. The CC status condition can also be read by using SCPI commands.

In the figure above, the line representing load resistance C, the lowest load resistance shown on the graph, crosses the operating locus at point 3. Point 3 is on the part of the operating locus defined by the current setting, so the power supply operates in CC mode.

Power Regulation

Power regulation is also known as power limiting or constant power mode (CP).

In CP mode, the DC output power is limited at the unit's maximum rated power. Power limiting operates according to the auto-ranging principle such that at lower output voltages higher current flows, and at higher output voltages lower current flows. This maintains the output power within the power rating of the unit supply.

When the power supply is at the constant power limit, the front panel CP status indicator is displayed. The CP status condition can also be read by by using SCPI commands.

The power supply can operate at the power limit without being damaged. However, the power supply is not guaranteed to meet specifications when operating in power limit mode. Output ripple may increase and neither output voltage or current is regulated.

In the figure above, the line representing load resistance B crosses the operating locus at point 2. Point 2 is on the output power boundary of the unit, so the power supply operates in CP mode. Press the Meter key to display the power (W) being supplied to the output.

Refer to [Autoranging Characteristic](#) for the power limit indices of the various N8900A models.

SAS Operation

Introduction

Programming the Curve Parameters

Programming Table Parameters

Programming Scale Factors

Exponential Model Equations

NOTE

Solar Array Simulator operation only applies to Models N8737APV and N8957APV. These models have the capability to operate as a solar array simulator. All of the capabilities of the standard "A" models are also available in the "PV" models.

The SAS Curve Generator software is a free application that simplifies programming the PV models. It is available at www.keysight.com/find/N8900APVsoftware.

Introduction

The Models N8737APV and N8957APV operate as a solar array simulator only when the SAS:MODE command specifies either curve or table mode. In curve mode, an SAS characteristic is created from four input parameters:

I_{mp} – the current at the maximum power point

I_{sc} – the short-circuit current

V_{mp} – the voltage at the maximum power point

V_{oc} – the open-circuit voltage

When programming a new SAS curve, it is best to send all of the curve parameters on the same line. With this method, the curve parameters can be sent in any order, and the instrument will determine whether all four parameters are within acceptable limits. Any parameter not programmed will retain the value of the previously programmed curve.

If the curve parameters are sent individually, an error can occur if the parameter value is outside the allowable curve characteristic determined by the three remaining parameters.

In table mode, an SAS characteristic is created from up to 1024 points programmed by the user.

You can specify solar array simulator operation as follows:

Front Panel Menu	SCPI Command
Select Output\Mode .	To specify Curve mode: SAS:MODE CURV
Specify either Curve or Table mode. Then press Select .	To specify Table mode: SAS:MODE TABL

- The command is accepted only when the output is off, otherwise an error will be generated.

Programming the Curve Parameters

In Curve mode, the output has an I-V characteristic that follows an exponential model of a solar array. Refer to [SAS Equations](#), where the exponential model equations are listed. The exponential model is specified using the four parameters: Imp, Isc, Vmp, and Voc. These can be programmed individually, but when programming a new curve, it is best to send all of the curve parameters on the same line (see [SAS:CURV](#) commands).

Front Panel Menu	SCPI Command
Select Output\SAS\Curve	Specify the maximum power point current: SAS:CURV:IMP <value>
In the dialog, enter a value for each of the four I-V curve parameters. Then press Select .	Specify the short-circuit current: SAS:CURV:ISC <value>
	Specify the maximum power point voltage: SAS:CURV:VMP <value>
	Specify the open-circuit voltage: SAS:CURV:VOC <value>

Sending these commands with the output on causes the unit to cycle the output off, then on.

Programming the Table Parameters

In this mode, a table of I-V points specifies the curve. A table can be programmed with a maximum of 1024 I-V points per table. The table lists must satisfy the following requirements.

For both current and voltage lists:

- The number of points in each list can range from 3 to 1024.
- Both lists must contain the same number of points.

For the voltage list:

- The first value must be 0 (a range of ± 15 mV is allowed).
- The point values must be strictly monotonically increasing. Adjacent values are not permitted to be equal.

For the current list:

- The point values must be monotonically decreasing. Adjacent values are permitted to be equal.
- The last value must be 0 (a range of ± 0.3 mA is allowed).

Use the following commands to program the table parameters:

Front Panel Menu	SCPI Command
Not available	To program a current table list: <code>MEM:TABL:CURR <current>{,<current>}</code> To program a voltage table list: <code>MEM:TABL:VOLT <voltage>{,<voltage>}</code>

- Table values are **not** saved as part of the instrument state.

Use the following command to activate the tables and validate the table points.

Front Panel Menu	SCPI Command
Not available	To activate the current and voltage tables: <code>SAS:TABL:ACT</code>

- If the points do not represent a valid data set, an error will be generated.
- This command is accepted only when the output is off, otherwise an error will be generated.

Use the following commands to query the number of data points in the current and voltage tables.

Front Panel Menu	SCPI Command
Not available	To query the current and voltage table points: <code>MEM:TABL:CURR:POIN?</code> <code>MEM:TABL:VOLT:POIN?</code>

Programming Scale Factors

You can program scale factors for the current and voltage SAS curves.

Front Panel Menu	SCPI Command
Select Output\SAS\Scale . Enter a scale factor in percent for the current and/or voltage tables. Then press Select .	To program current and voltage scale factors: <code>SAS:SCAL:CURR <percent></code> <code>SAS:SCAL:VOLT <percent></code>

- This function is active in both Curve and Table modes. All of the voltages and currents on the SAS curve are multiplied by these scale factors.
- Unlike the commands that alter the programmed curve (SAS:CURV, SAS:TABL:ACT), these settings take effect immediately and without turning off the output.

NOTE

Solar Array Simulator operation only applies to Models N8737APV and N8957APV. These models have the capability to operate as a solar array simulator. All of the capabilities of the standard "A" models are also available in the "PV" models.

SAS Exponential Model Equations

The following equations describe the solar array simulator exponential model using the parameters R_s , N , and a , which are defined as functions of the four input parameters.¹

$$R_s = \frac{V_{oc} - V_{mp}}{I_{mp}}$$

$$N = \frac{\ln(2 - 2^a)}{\ln\left(\frac{I_{mp}}{I_{sc}}\right)}$$

$$a = \frac{V_{mp} \left(1 + \frac{R_s I_{sc}}{V_{oc}}\right) + R_s (I_{mp} - I_{sc})}{V_{oc}}$$

$$V = \frac{\frac{V_{oc} \ln\left(2 - \left(\frac{I}{I_{sc}}\right)^N\right)}{\ln(2)} - R_s (I - I_{sc})}{1 + \frac{R_s I_{sc}}{V_{oc}}}$$

Note that these equations tend to be most accurate for curves that are somewhat rectangular.²

Figure A indicates the potential range of Pmp error percent due to the modeling equation. The x-axis parameter is $(V_{oc}/V_{mp}) * (I_{sc}/I_{mp})$, which is a measure of the rectangularity of the simulator curve, with values near 1 being highly rectangular. The y-axis is a measure of the possible error of the curve algorithm equation at the peak power point as defined by the following equation:

$$\%Pmp_{error} = \left(\frac{Equation_{Pmp}}{(I_{mp})(V_{mp})} - 1 \right) * 100\%$$

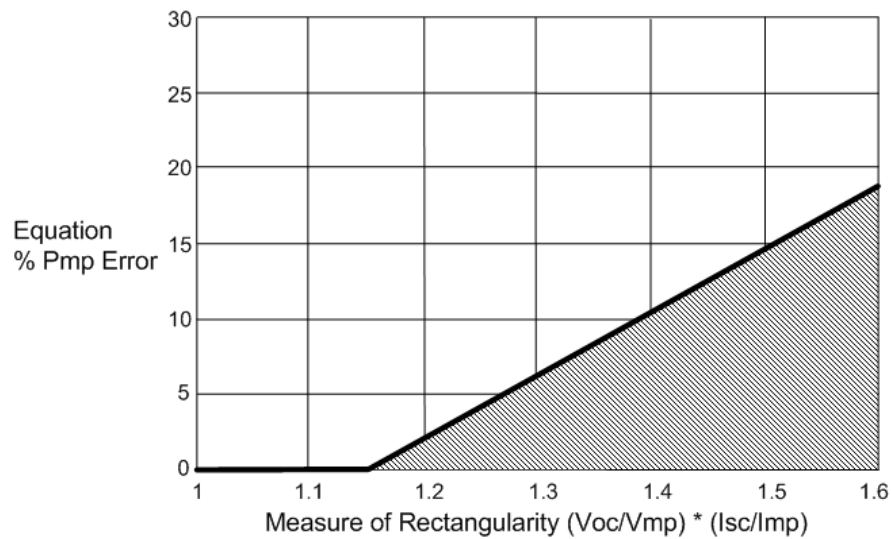


Figure A. Range of Pmp Error Due to Modeling Equation

¹The exponential model is described in the paper: Britton, Lunscher, and Tanju, "A 9 KW High-Performance Solar Array Simulator", Proceedings of the European Space Power Conference, August 1993 (ESA WPP-054, August 1993)

²The potential error between the equation's actual peak power and the expected peak power ($V_{mp} * I_{mp}$) will increase as the curves become less rectangular.

3

SCPI Programming Reference

Related Information

[Introduction to the SCPI Language](#)

[Commands by Subsystem](#)

[Command Quick Reference](#)

[Reset State \(*RST\)](#)

[SCPI Error Messages](#)

[Compatibility Commands](#)

Related Information

IO Libraries and Instrument Drivers

The Keysight IO Libraries Suite software is provided on the Keysight Automation Ready CD-ROM provided with your instrument. Installation instructions are provided on the CD-ROM.

For detailed information about interface connections, refer to the documentation included with the Keysight IO Libraries Suite. Or you can download the guide from the Web at www.keysight.com/find/connectivity.

You can also download the Keysight IO Libraries Suite software, along with IVI-COM and LabVIEW drivers from the Keysight Developer Network at www.keysight.com/find/adn.

N8900 Series Documentation

You can download the latest version of this document at www.keysight.com/find/n8900-doc.

Web Interface

The N8900 series provides a Web interface that is built into the instrument. You can use this interface over LAN for remote access and control of the instrument via a Web browser. See [Using the Web Interface](#) for details.

Introduction to the SCPI Language

Command Types

Keywords

Queries

Command Separators and Terminators

Syntax Conventions

Parameter Types

Device Clear

Command Types

This instrument complies with the rules and conventions of the present SCPI version (see [SYSTem:VERSion?](#)).

SCPI (Standard Commands for Programmable Instruments) is an ASCII-based instrument command language designed for test and measurement instruments. SCPI has two types of commands, common and subsystem.

Subsystem Commands

Subsystem commands perform specific instrument functions. They are comprised of alphabetically arranged commands that extend one or more levels below the root in a hierarchical structure, also known as a *tree system*. In this structure, associated commands are grouped together under a common node or root, thus forming *subsystems*. A portion of the OUTPut subsystem is shown below to illustrate the tree system. Note that some [optional] commands have been included for clarity.

```
OUTPut
  [:STATe] OFF|0|ON|1
  :PON
    :STATe RST|RCL0
  :PROTection
    :CLEAr
```

IEEE-488.2 Common Commands

The IEEE-488.2 standard defines a set of common commands that perform functions such as reset, self-test, and status operations. Common commands always begin with an asterisk (*), are three characters in length, and may include one or more parameters. The command keyword is separated from the first parameter by a blank space. Use a semicolon (;) to separate multiple commands as shown below:

Keywords

Keywords, also referred to as headers, are instructions recognized by the instrument. Common commands are also keywords.

OUTPut is the root keyword, PROTection is a second-level keyword, CLEar is a third-level keyword. Colons (:) separate the keyword levels.

The command syntax shows most commands (and some parameters) as a mixture of upper- and lower-case letters. The upper-case letters indicate the abbreviated spelling for the command. For shorter program lines, you can send the abbreviated form. For better program readability, you can send the long form.

In the above examples, OUTP and OUTPUT are both acceptable forms. You can use upper- or lower-case letters. Therefore, OUTPUT, outp, and Outp are all acceptable. Other forms such as OUT, are not valid and will generate an error.

Queries

Following a keyword with a question mark (?) turns it into a query (Example: VOLTage?, VOLTage:TRIGgered?). If a query contains parameters, place the query indicator at the end of the last keyword, before the parameters. Insert a space between the query indicator and the first parameter.

You can query the programmed value of most parameters. For example, you can query the voltage setting by sending:

```
VOLTage?
```

You can also query the minimum or maximum allowable voltage settings as follows:

```
VOLTage? MIN  
VOLTage? MAX
```

You must read back all the results of a query before sending another command to the instrument. Otherwise, a *Query Interrupted* error will occur and the unreturned data will be lost.

Command Separators and Terminators

Separators

Colons (:) separate keyword levels. Blank spaces must be used to separate command parameters from their corresponding keyword. Note the space between STATE and the *RST parameter.

```
OUTPut:PON:STATE RST
```

Semicolons (;) separate commands within the same subsystem. This lets you send several subsystem commands within the same message string. For example, sending the following command string:

```
OUTPut:STATe ON;PON:STATe RST
```

is the same as sending the following commands:

```
OUTPut ON
OUTPut:PON:STATe RST
```

Note that the semicolon follows the implied path of the hierarchical tree structure. In the above example, the optional :STATe keyword must follow the OUTput keyword to place the command parser at the second level in the hierarchy. This allows the use of the PON keyword after the semicolon, since PON is a second-level keyword.

You can also combine commands of different subsystems within the same message string. In this case, you must use a colon to return the command parser to the root level in order to access another subsystem. For example, you could clear the output protection and check the status of the Operation Condition register in one message by using a root specifier as follows:

```
OUTPut:PROTection:CLear;:STATus:OPERation:CONDition?
```

Note the use of the colon *after* the semicolon in order to return the command parser to the root.

Terminators

A command string sent to the instrument must terminate with a new line (<NL>) character. The IEEE-488 EOI (End-Or-Identify) message is interpreted as a <NL> character and can be used to terminate a command string in place of an <NL>. A carriage return followed by a new line (<CR><NL>) is also accepted. Command string termination will always reset the current SCPI command path to the root level.

Syntax Conventions

- Triangle brackets (< >) indicate that you must specify a value for the enclosed parameter. For example, in the VOLTage <value> command syntax, the <value> parameter is enclosed in triangle brackets. The brackets are not sent with the command string. You must specify a value for the parameter (Example: "VOLTage 50V") unless you select another option shown in the syntax (Example: "VOLTage MAX").
- A vertical bar (|) separates multiple parameter choices for a given command string. For example, RST|RCL0 in the OUTPut:PON:STATe command indicates that you can specify "RST" or "RCL0". The bar is not sent with the command string.
- Square brackets ([]) enclose some syntax elements - nodes and parameters for example. This indicates that the element is optional and can be omitted. The brackets are not sent with the command string. Any keyword enclosed in brackets is optional and can be omitted. However, if you are combining several commands within the same message string as previously described, you must include the optional commands to place the command parser at the correct level in the hierarchy.

Parameter Types

The SCPI language defines several data formats to be used in commands and queries.

Numeric Parameters

Commands that require numeric parameters will accept all commonly used decimal representations of numbers including optional signs, decimal points, and scientific notation. If a command accepts only certain specific values, the instrument will automatically round the input numeric parameters to the accepted values. The following command requires a numeric parameter for the voltage value:

```
[SOURce:]VOLTage 50V|MIN|MAX
```

Note that special values for numeric parameters such as MINimum and MAXimum are also accepted. Instead of selecting a specific value for the voltage parameter, you can substitute MIN to set the voltage to its minimum allowable value, MAX to set it to its maximum allowable value.

You can also send engineering unit suffixes with numeric parameters (e.g., V for volts, A for amperes, W for Watts). All parameters values are in base units.

Discrete Parameters

Discrete parameters are used to program settings that have a limited number of values (like IMMEDIATE, EXTERNAL, or BUS). They may have a short form and a long form just like command keywords. You can use upper- or lower-case letters. Query responses will always return the short form in all upper-case letters. The following command requires a discrete parameter for the display settings:

```
VOLTage:MODE FIXed|STEP
```

Boolean Parameters

Boolean parameters represent a single binary condition that is either true or false. For a false condition, the instrument will accept "OFF" or "0". For a true condition, the instrument will accept "ON" or "1". When you query a Boolean setting, the instrument will always return "0" or "1". The following command requires a Boolean parameter:

```
OUTput OFF|0|ON|1
```

ASCII String Parameters

String parameters can contain virtually any set of ASCII characters. A string must begin and end with matching quotes; either with a single quote or a double quote. You can include the quote delimiter as part of the string by typing it twice without any characters in between. The following command uses a string parameter:

```
CALibrate:DATE "12/12/12"
```


Device Clear

Device Clear is an IEEE-488 low-level bus message that you can use to return the instrument to a responsive state. Different programming languages and IEEE-488 interface cards provide access to this capability through their own unique commands. The status registers, the error queue, and all configuration states are left unchanged when a Device Clear message is received.

Device Clear performs the following actions:

- If a measurement is in progress, it is aborted.
- The instrument returns to the trigger idle state.
- The instrument's input and output buffers are cleared.
- The instrument is prepared to accept a new command string.

NOTE

The `ABORt` command is the recommended method to terminate an instrument operation.

Commands by Subsystem

Subsystem

Calibrate

Current

Digital

Display

Measure

Output

SASimulator - applies to N8937APV and N8957APV models only

Status

System

Trigger

Voltage

Common Commands

IEEE-488.2 common commands are included along with the Status, System, and Trigger subsystem commands.

Additional Commands

Compatibility

Calibrate Commands

Calibrate commands calibrate the instrument.

NOTE

Read [the calibration section](#) before calibrating. Improper calibration can reduce accuracy and reliability.

CALibrate:COUNT?

Returns the number of times the unit has been calibrated. The count is incremented whenever the calibration (including the date) is saved, the administration password is changed, the administration password is reset using the internal cal switch, or the instrument firmware is updated.

Parameter	Typical Return
(none)	The calibration count
Return the calibration count: <code>CAL:COUNT?</code>	

CALibrate:CURRENT[:LEVEL] [*<value>*]

Calibrates the current programming and measurement. The optional value parameter selects the range to calibrate. This is for compatibility with the N6700 series modular power system.

Parameter	Typical Return
Optional - the maximum value of the range.	(none)
Calibrates the current of the 100 A range: <code>CAL:CURR 100</code>	

CALibrate:DATA *<value>*

Enters the calibration value read by the external meter. You must first select a calibration level for the value being entered. Data values are expressed in base units - either volts or amperes, depending on which function is being calibrated.

Parameter	Typical Return
Numeric value	(none)
Specify calibration value 0.0237: <code>CAL:DATA 2.37E-2</code>	

CALibrate:DATE *<"date">*

CALibrate:DATE?

Enters the calibration date in nonvolatile memory. Enter any ASCII string up to 10 characters. The query returns the date.

Parameter	Typical Return
<"date">String program data. Enclose string parameters in single or double quotes.	Date of last calibration
Enters the calibration date: <code>CAL:DATE "12/12/12"</code>	

CALibrate:LEVel P1|P2|P3|P4 **CALibrate:LEVel?**

Advances to the next level in the calibration. P1 is the first level; P2 the second, P3 the third, and P4 the fourth.

Parameter	Typical Return
P1 P2 P3 P4	(none)
Selects the first calibration point: <code>CAL:LEV P1</code>	

- Some calibration sequences may require some settling time after sending CAL:LEV but before reading the data from the DVM and sending CAL:DATA.

CALibrate:PASSword <password>

Sets a numeric password to prevent unauthorized calibration.

Parameter	Typical Return
<password>a numeric value up to 15 digits	(none)
Set a new password to a value of 1234: <code>CAL:PASS 1234</code>	

- If the password is set to 0, password protection is removed and the ability to enter calibration mode is unrestricted. The factory setting is 0 (zero).
- To change the password: unsecure calibration memory with old code, then set the new code.
- If you forget your password, refer to [the calibration section](#).
- This setting is non-volatile; it will not be changed by power cycling or *RST.

CALibrate:SAVE

Saves the calibration constants in non-volatile memory. Do this at the end of the calibration to avoid losing changes.

Parameter	Typical Return
(none)	(none)
Store cal constants in non-volatile memory: <code>CAL:SAVE</code>	

CALibrate:STATe 0|OFF|1|ON [,<password>]**CALibrate:STATe?**

Enables or disables calibration mode. Calibration mode must be enabled for the instrument to accept any calibration commands. The first parameter specifies the state. The second optional parameter is the password.

Parameter	Typical Return
0 OFF 1 ON , default OFF	0 or 1
<password> a numeric value up to 15 digits	(none)
Disable calibration mode and unsecure calibration: CAL:STAT OFF,0 Enable calibration: CAL:STAT ON	

<password> is optional to secure the instrument, but must be correct if provided.

CALibrate:VOLTage[:LOCal][:LEVel] [<value>]

Calibrates the local voltage programming and measurement. The optional value parameter selects the range to calibrate. This is for compatibility with the N6700 series modular power system.

Parameter	Typical Return
Optional - the maximum value of the range.	(none)
Calibrates the voltage of the 80 V range: CAL:VOLT 80	

CALibrate:VOLTage:REMOte[:LEVel] [<value>]

Calibrates the remote voltage programming and measurement. The optional value parameter selects the range to calibrate. This is for compatibility with the N6700 series modular power system.

Parameter	Typical Return
Optional - the maximum value of the range.	(none)
Calibrates the voltage of the 80 V range: CAL:VOLT:REM 80	

Current Commands

Current commands program the output current and current protection functions. The **SOURCE** keyword is optional in the following commands.

```
[SOURCE:]CURRENT[:LEVEL][:IMMEDIATE][:AMPLITUDE] <value>|MIN|MAX
[SOURCE:]CURRENT[:LEVEL][:IMMEDIATE][:AMPLITUDE]? [MIN|MAX]
[SOURCE:]CURRENT[:LEVEL]:TRIGGERED[:AMPLITUDE] <value>|MIN|MAX
[SOURCE:]CURRENT[:LEVEL]:TRIGGERED[:AMPLITUDE]? [MIN|MAX]
```

Sets the immediate current level and the triggered current level when the output is operating in constant current mode. The triggered level is a stored value that is transferred to the output when an output Step is triggered. Units are in amperes. The maximum value depends on the current rating of the unit.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST 0	<current level>
Sets the output current level to 3 A: <code>CURR 3</code> Sets the triggered current level to 2 A: <code>CURR:TRIG 2</code>	

```
[SOURCE:]CURRENT:MODE FIXEd|STEP
[SOURCE:]CURRENT:MODE?
```

Sets the transient mode. This determines what happens to the output current when the transient system is initiated and triggered.

FIXed keeps the output current at its immediate value.

STEP steps the output to the triggered level when a trigger occurs.

Parameter	Typical Return
FIXed STEP, *RST FIXed	FIX or STEP
Sets the current mode to Step: <code>CURR:MODE STEP</code>	

```
[SOURCE:]CURRENT:PROTECTION:DELay <value>|MIN|MAX
[SOURCE:]CURRENT:PROTECTION:DELay? [MIN|MAX]
```

Sets the over-current protection delay. The over-current protection function will not be triggered during the delay time. After the delay time has expired, the over-current protection function will be active. This prevents momentary changes in output status from triggering the over-current protection function. Values up to 65.535 seconds can be programmed, with a resolution of 0.001 seconds.

Parameter	Typical Return
1 to 65.535, *RST 0.050 s	<delay value>
Sets the protection delay to 0.2 seconds: <code>CURR:PROT:DEL 0.2</code>	

[SOURce:]CURRent:PROTection:STATe 0|OFF|1|ON
[SOURce:]CURRent:PROTection:STATe?

Enables or disables the over-current protection. If the over-current protection function is enabled and the output goes into constant current operation, the output is disabled and the Questionable Condition status register OCP bit is set.

Parameter	Typical Return
0 OFF 1 ON, *RST OFF	0 or 1
Enable the current protection state: <code>CURR:PROT:STAT ON</code>	

- The current limit setting determines when the output goes into constant current operation.
- An over-current condition can be cleared with `OUTPut:PROTection:CLEar` after the cause of the condition is removed.

Digital Commands

Digital commands program the polarity of external control signal pins 13 and 14 on the Analog connector of the instrument. The SOURce keyword is optional.

[SOURce:]DIGital:PIN< 13|14 >:POLarity POSitive|NEGative
[SOURce:]DIGital:PIN< 13|14 >:POLarity?

Sets the polarity of the pins. **POSitive** means a logical true signal is a voltage high at the pin. **NEGative** means a logical true signal is a voltage low at the pin. The pin polarities are saved in non-volatile memory. Note that there is no space between the word PIN and the pin number.

Parameter	Typical Return
POSitive NEGative	POS or NEG
Sets pin 13 to POSitive polarity: DIG:PIN13:POL POS	

- For compatibility with software written to control other Keysight power supplies, PIN3 is accepted as an alias for PIN13, and PIN1 is accepted as an alias for PIN14.

Display/LXI Commands

DISPlay[:WINDow][:STATe] 0|OFF|1|ON

DISPlay[:WINDow][:STATe]?

Turns the front panel display on or off.

Parameter	Typical Return
0 OFF 1 ON, *RST ON	0 or 1
Turns the front panel display off: DISP OFF	

LXI:IDENTify[:STATe] 0|OFF|1|ON

LXI:IDENTify[:STATe]?

Turns the front panel LXI identify indicator on or off. When turned on, the "LAN" status indicator on the front panel blinks on and off to identify the instrument that is being addressed.

Parameter	Typical Return
0 OFF 1 ON, *RST OFF	0 or 1
To blink the front panel LXI indicator: LXI:IDENT ON	

Measure Commands

Measure commands measure the output voltage, current, or power. They trigger the acquisition of new data before returning the reading.

MEASure[:SCALar]:CURRent[:DC]?

MEASure[:SCALar]:POWer[:DC]?

MEASure[:SCALar]:VOLTage[:DC]?

Initiates and triggers a measurement. Returns the averaged output measurement. Values returned are either in amperes, volts, or watts.

Parameter	Typical Return
(none)	<DC value>
Returns the averaged current	MEAS:CURR?
Returns the averaged power	MEAS:POW?
Returns the averaged voltage	MEAS:VOLT?

Output Commands

Output commands control the output, power-on, and protection clear functions.

OUTPut[:STATe] 0|OFF|1|ON
OUTPut[:STATe]?

WARNING **HAZARDOUS VOLTAGES** All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Enables or disables the output. The state of a disabled output is a condition of zero output voltage and zero current.

Parameter	Typical Return
0 OFF 1 ON , *RST OFF	0 or 1
Turns the output off: <code>OUTP OFF</code>	

- When the output is enabled, the instrument status changes from **OFF** to the operating status (**CV**, **CC**, etc.).

OUTPut:INHibit:MODE LATChing|LIVE|OFF
OUTPut:INHibit:MODE?

Sets the operating mode of the remote inhibit digital pin. The inhibit function shuts down the output in response to an external signal on the Inhibit input pin. The Inhibit mode is stored in non-volatile memory. See [External Control Signal Programming](#).

LATChing - a logic-true signal on the Inhibit input causes the output state to latch OFF. The output remains disabled until the Inhibit input is returned to logic-false and the latched INH status bit is cleared by sending the `OUTPut:PROTection:CLEar` command or a protection clear command from the front panel.

LIVE - allows the enabled output to follow the state of the Inhibit input. When the Inhibit input is true, the output is disabled. When the Inhibit input is false, the output is re-enabled.

OFF - The Inhibit input is ignored.

NOTE In a master/slave configuration, only the master's Inhibit input can be used, and it will control the on/off state of the entire master/slave system. The inhibit mode of the master can be set to **LATChing**, **LIVE**, or **OFF** as appropriate. The inhibit mode of the slave units must be set to **OFF**.

Parameter	Typical Return
LATChing LIVE OFF	LATC, LIVE, or OFF
Sets the Inhibit Input to Live mode: <code>OUTP:INH:MODE LIVE</code>	

OUTPut:PON:STATe RST|RCL0 OUTPut:PON:STATe?

WARNING **SHOCK HAZARD** If the output is enabled when an instrument state is saved to location 0 (zero), the output will automatically be enabled at turn-on if the power-on state is set to recall location zero (RCL0).

This determines whether the power-on state is set to the *RST state (RST) or the state stored in memory location 0 (RCL0). Instrument states can be stored using the *SAV command. This parameter is saved in non-volatile memory.

Parameter	Typical Return
RST RCL0	RST or RCL0
Sets the power-on state to the *RST state: <code>OUTP:PON:STAT RST</code>	

OUTPut:PROTection:CLEar

This clears the latched protection status that disables the output when a protection condition occurs (see [Programming Output Protection](#)). The output is restored to the state it was in before the protection condition occurred.

Parameter	Typical Return
(none)	(none)
Clears the latched protection status: <code>OUTP:PROT:CLE</code>	

- All conditions that generate the fault must be removed before the latched status can be cleared.

Solar Array Simulator Commands

NOTE

SASimulator and MEMory commands only apply to Models N8737APV and N8957APV. These models have the capability to operate as a solar array simulator. Refer to [SAS Operation](#) for information on operating in Curve and Table modes.

SAS commands program the solar array simulator functions. Memory commands program the voltage and current data arrays. The SOURce keyword is optional in the SAS commands.

MEMory:TABLE[:SASimulator]:CURRent[:AMPlitude] <current>{,<current>}

MEMory:TABLE[:SASimulator]:CURRent[:AMPlitude]?

MEMory:TABLE[:SASimulator]:VOLTage[:AMPlitude] <voltage>{,<voltage>}

MEMory:TABLE[:SASimulator]:VOLTage[:AMPlitude]?

These commands set the voltage and current arrays that define the SAS characteristic when table mode is selected. Each of these commands must contain a list of voltage or current points, separated by commas (,). The table lists must satisfy the following requirements:

- For each table, the number of points can range from 3 to 1024; however, both tables must contain the same number of points.
- The current point values must be monotonically decreasing. Adjacent values are permitted to be equal. The last value must be zero (a range of ± 0.3 mA is allowed).
- The voltage point values must be strictly monotonically increasing. Adjacent values are NOT permitted to be equal. The first value must be zero (a range of ± 15 mV is allowed).

Parameter	Typical Return
Current: The last value must be 0. All previous values must range from 0 to 102% of the unit's current rating. *RST: 3 steps set to 0.3, 0.24, 0	<value 1>, < value 2>, <value 3>...
Voltage: The first value must be 0. All previous values must range from 0 to 102% of the unit's voltage rating. *RST: 3 steps set to 0, 12, 15	<value 1>, < value 2>, <value 3>...
Program a simple current table: MEM:TABL:CURR 20,15,0 Program a simple voltage table: MEM:TABL:VOLT 0,100,120	

- The points are validated when activating the table using SAS:TABL:ACT. If the points do not represent a valid set, an error will be generated.
- Table values are **not** saved as part of the instrument state with the *SAV command.

MEMory:TABLE[:SASimulator]:CURRent:POINTs?

MEMory:TABLE[:SASimulator]:VOLTage:POINTs?

This command returns the number of data points assigned to the voltage and current arrays that define the SAS characteristic when table mode is selected.

Parameter	Typical Return
(none)	1024
Return the points in a current table: <code>MEM:TABL:CURR:POIN?</code> Return the points in a voltage table: <code>MEM:TABL:VOLT:POIN?</code>	

[SOURce:]SASimulator:CURVe:IMP <current>|MIN|MAX
[SOURce:]SASimulator:CURVe:IMP? [MIN|MAX]

This command sets the current at the maximum power point of the SAS curve when operating in curve mode. The value is programmed in amperes.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST: 0.8% of rating	<Imp setting>
Sets the current of the maximum power point: <code>SAS:CURV:IMP 10</code> This sets all four parameters at once: <code>SAS:CURV:IMP 10; ISC 12; VMP 100; VOC 120</code>	

- Sending this command with the output on causes the unit to cycle the output off, then on.

[SOURce:]SASimulator:CURVe:ISC <current>|MIN|MAX
[SOURce:]SASimulator:CURVe:ISC? [MIN|MAX]

This command sets the short-circuit current when operating in curve mode. The value is programmed in amperes.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST: 1% of rating	<Isc setting>
Sets the short-circuit current: <code>SAS:CURV:ISC 12</code> This sets all four parameters at once: <code>SAS:CURV:IMP 10; ISC 12; VMP 100; VOC 120</code>	

- Sending this command with the output on causes the unit to cycle the output off, then on.

[SOURce:]SASimulator:CURVe:VMP <voltage>|MIN|MAX
[SOURce:]SASimulator:CURVe:VMP? [MIN|MAX]

This command sets the voltage at the maximum power point of the SAS curve when operating in curve mode. The value is programmed in volts.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST: 0.8% of rating	<Vmp setting>
Sets the voltage of the maximum power point: <code>SAS:CURV:VMP 100</code> This sets all four parameters at once: <code>SAS:CURV:IMP 10; ISC 12; VMP 100; VOC 120</code>	

- Sending this command with the output on causes the unit to cycle the output off, then on.

[SOURce:]SASimulator:CURVe:VOC <voltage>|MIN|MAX
[SOURce:]SASimulator:CURVe:VOC?

This command sets the open-circuit voltage when operating in curve mode. The value is programmed in volts.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST: 1% of rating	<Voc setting>
Sets the open-circuit voltage: SAS:CURV:VOC 120	
This sets all four parameters at once: SAS:CURV:IMP 10; ISC 12; VMP 100; VOC 120	

- Sending this command with the output on causes the unit to cycle the output off, then on.

[SOURce:]SASimulator:MODE <mode>
[SOURce:]SASimulator:MODE?

This command sets the unit to operate as either a standard power supply or a solar array simulator.

FIXed operates the unit as a standard CV/CC power supply.

CURVe operates the unit as a solar array simulator. The output characteristic is determined by the Isc, Imp, Voc, and Vmp parameters.

TABLE operates the unit as a solar array simulator. The output characteristic is determined by up to 1024 user-defined table points. The points are validated when the table is activated using the SAS:TABL:ACT command.

Parameter	Typical Return
FIXed CURVe TABLE, *RST: FIXed	FIX, CURV, or TABL
Sets the voltage mode to Step: VOLT:MODE STEP	

- This command is accepted only when the output is off.

[SOURce:]SASimulator:SCALE:CURRent <percent>|MIN|MAX
[SOURce:]SASimulator:SCALE:CURRent? [MIN|MAX]

This command sets a scale factor for the curve used in both curve and table modes. The output current will be equal to this percentage multiplied by the current computed from the SAS curve or table. This is often used to simulate variations in solar cell irradiance. Both V and I can be scaled at the same time.

Parameter	Typical Return
0 to 100 (%) *RST: 100	<% value>
Sets the scale factor for the current to 90%: SAS:SCAL:CURR 90	

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- This command may be sent at any time – with the output on or off, and when in fixed, curve, or table modes. In curve or table mode, the output will respond immediately to any change in this setting. There is no effect on the output when in fixed mode.

[SOURce:]SASimulator:SCALE:VOLTage <percent>|MIN|MAX
[SOURce:]SASimulator:SCALE:VOLTage? [MIN|MAX]

This command sets a scale factor for the curve used in both curve and table modes. The output voltage will be equal to this percentage multiplied by the voltage computed from the SAS curve or table. Both V and I can be scaled at the same time.

Parameter	Typical Return
0 to 100 (%) *RST: 100	<% value>
Sets the scale factor for the current to 90%: SAS:SCAL:VOLT 90	

- This command may be sent at any time – with the output on or off, and when in fixed, curve, or table modes. In curve or table mode, the output will respond immediately to any change in this setting. There is no effect on the output when in fixed mode.

[SOURce:]SASimulator:TABLE:ACTivate

This command activates the table points entered using the MEM:TABL:CURR and MEM:TABL:VOLT commands.

Parameter	Typical Return
(none)	(none)
Activate the table: SAS:TABL:ACT	

- This command may be sent when in fixed, curve, or table modes; however, the command only applies in table mode.
- The command is accepted only when the output is off. Sending this command with the output on will result in an error.
- If the MEM:SAS:TABLE:CURR and MEM:SAS:TABLE:VOLT commands are sent after the table is activated, the SAS:TABLE:ACT command must be sent again to activate the new table values.

Status Commands

Status commands let you determine the operating condition of the instrument at any time. The instrument has three groups of status registers; Operation, Questionable, and Standard Event. The Operation and Questionable status groups each consist of the Condition, Enable, and Event registers as well as NTR and PTR filters.

Instrument status is also programmed using the Common commands: *CLS, *ESE, *ESR?, *OPC, *OPC?, *SRE, *STB? and *WAI discussed at the end of this topic. Common commands control additional status functions such as the Service Request Enable and the Status Byte registers. Refer to [Status Tutorial](#) for more information.

STATus:OPERation[:EVENT]?

Queries the **event register** for the **Operation Status** group. This is a read-only register, which stores (latches) all events that are passed by the Operation NTR and PTR filter. Reading the Operation Status Event register clears it.

Parameter	Typical Return
(none)	<bit value>
Read the operation status event register: STAT:OPER?	

- *RST has no effect on this register.
- The value returned is the binary-weighted sum of all bits set in the register.

STATus:OPERation:CONDition?

Queries the **condition register** for the **Operation Status** group. This is a read-only register, which holds the live (unlatched) operational status of the instrument. Reading the Operation Status Condition register does not clear it.

Parameter	Typical Return
(none)	<bit value>
Read the operation status condition register: STAT:OPER:COND?	

- The condition register bits reflect the current condition. If a condition goes away, the corresponding bit is cleared.
- The value returned is the binary-weighted sum of all bits set in the register.

STATus:OPERation:ENABLE <value>**STATus:OPERation:ENABLE?**

Sets and queries bits in the **enable register** for the **Operation Status** group. The enable register is a mask for enabling specific bits from the Operation Event register to set the OPER (operation summary) bit of the Status Byte register. STATus:PRESet clears all bits in the enable register.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the enable register: STAT:OPER:ENAB 24	

- *CLS does not clear the enable register, but does clear the **event register**.

STATus:OPERation:NTRansition <value>**STATus:OPERation:NTRansition?****STATus:OPERation:PTRansition <value>****STATus:OPERation:PTRansition?**

Sets and queries the value of the **NTR** (Negative-Transition) and **PTR** (Positive-Transition) registers. These registers serve as a polarity filter between the Operation Condition and Operation Event registers.

When a bit in the NTR register is set to 1, then a 1-to-0 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.

When a bit in the PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Operation Condition register causes that bit in the Operation Event register to be set.

STATus:PRESet sets all bits in the PTR registers and clears all bits in the NTR registers.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the NTR register: STAT:OPER:NTR 24	
Enable bit 3 and 4 in the PTR register: STAT:OPER:PTR 24	

- If the same bits in both NTR and PTR registers are set to 1, then any transition of that bit at the Operation Condition register sets the corresponding bit in the Operation Event register.
- If the same bits in both NTR and PTR registers are set to 0, then no transition of that bit at the Operation Condition register can set the corresponding bit in the Operation Event register .
- The value returned is the binary-weighted sum of all bits set in the register.

STATus:PRESet

Presets all Enable, PTR, and NTR registers.

Operation register	Questionable register	Preset setting
STAT:OPER:ENAB	STAT:QUES:ENAB	all defined bits are disabled
STAT:OPER:NTR	STAT:QUES:NTR	all defined bits are disabled
STAT:OPER:PTR	STAT:QUES:PTR	all defined bits are enabled

Parameter	Typical Return
(none)	(none)

Preset the Operation and Questionable registers: STAT:PRES

STATus:QUESTIONable[:EVENT]?

Queries the **event register** for the **Questionable Status** group. This is a read-only register, which stores (latches) all events that are passed by the Operation NTR and PTR filter. Reading the Questionable Status Event register clears it.

Parameter	Typical Return
(none)	<bit value>

Read questionable status event register: STAT:QUES?

- *RST has no effect on this register.
- The value returned is the binary-weighted sum of all bits set in the register.

STATus:QUESTIONable:CONDition?

Queries the **condition register** for the **Questionable Status** group. This is a read-only register, which holds the live (unlatched) operational status of the instrument. Reading the Questionable Status Condition register does not clear it.

Parameter	Typical Return
(none)	<bit value>

Read questionable status condition register: STAT:QUES:COND?

- The condition register bits reflect the current condition. If a condition goes away, the corresponding bit is cleared.
- *RST clears this register, other than those bits where the condition still exists after *RST.
- The value returned is the binary-weighted sum of all bits set in the register.

STATus:QUESTionable:ENABle <value>**STATus:QUESTionable:ENABle?**

Sets and queries bits in the **enable register** for the **Questionable Status** group. The enable register is a mask for enabling specific bits from the Operation Event register to set the QUES (questionable summary) bit of the Status Byte register. STATus:PRESet clears all bits in the enable register.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 2 and 4 in the questionable enable register: STAT:QUES:ENAB 24	

- *CLS does not clear the enable register, but does clear the **event register**.

STATus:QUESTionable:NTRansition <value>**STATus:QUESTionable:NTRansition?****STATus:QUESTionable:PTRansition <value>****STATus:QUESTionable:PTRansition?**

Sets and queries the value of the **NTR** (Negative-Transition) and **PTR** (Positive-Transition) registers. These registers serve as a polarity filter between the Questionable Condition and Questionable Event registers.

When a bit in the NTR register is set to 1, then a 1-to-0 transition of the corresponding bit in the Questionable Condition register causes that bit in the Questionable Event register to be set.

When a bit in the PTR register is set to 1, then a 0-to-1 transition of the corresponding bit in the Questionable Condition register causes that bit in the Questionable Event register to be set.

STATus:PRESet sets all bits in the PTR registers and clears all bits in the NTR registers.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the questionable NTR register: STAT:QUES:NTR 24	
Enable bit 3 and 4 in the questionable PTR register: STAT:QUES:PTR 24	

- If the same bits in both NTR and PTR registers are set to 1, then any transition of that bit at the Questionable Condition register sets the corresponding bit in the Questionable Event register.
- If the same bits in both NTR and PTR registers are set to 0, then no transition of that bit at the Questionable Condition register can set the corresponding bit in the Questionable Event register .
- The value returned is the binary-weighted sum of all bits set in the register.

***CLS**

Clear Status Command. Clears the **event registers** in all register groups. Also clears the Status Byte and Error Queue. If *CLS immediately follows a program message terminator (<NL>), then the Output Queue and the MAV bit are also cleared. Refer to **Status Tutorial** for more information.

Parameter	Typical Return
(none)	(none)
Clear Event register bits, Status byte, and Error queue: *CLS	

ESE <value>**ESE?**

Event Status Enable Command and Query. Enables bits in the **enable register** for the **Standard Event Status** group. A 1 in the bit position enables the corresponding event. The selected bits are then reported to the ESB bit of the Status Byte Register. The query reads the enable register and returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register. Refer to **Status Tutorial** for more information.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the enable register: *ESE 24	

- Any or all conditions can be reported to the ESB bit through the enable register. To set the enable register mask, write a decimal value to the register using *ESE.
- *CLS does not clear the enable register, but does clear the **event register**.
- The value returned is the binary-weighted sum of all bits set in the register.

***ESR?**

Event Status Event Query. Queries the **event register** for the **Standard Event Status** group. The event register is a read-only register, which stores (latches) all standard events. Refer to **Status Tutorial** for more information.

Parameter	Typical Return
(none)	<bit value>
Read event status enable register: *ESR?	

- Any or all conditions can be reported to the ESB bit through the enable register. To set the enable register mask, write a decimal value to the register using *ESE.

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- Once a bit is set, it remains set until cleared by this query or *CLS.
- The value returned is the binary-weighted sum of all bits set in the register.

*OPC

Sets the OPC (operation complete) bit in the Standard Event register. This occurs at the completion of the current operation. Refer to [Status Tutorial](#) for more information.

Parameter	Typical Return
(none)	(none)
Set the Operation Complete bit: *OPC	

- The purpose of this command is to synchronize your application with the instrument.
- Used in conjunction with initiated acquisitions, initiated transients, output state changes, and output to settling time to provide a way to poll or interrupt the computer when these pending operations complete.
- Other commands may be executed before the operation complete bit is set.
- The difference between *OPC and *OPC? is that *OPC? returns "1" to the output buffer when the current operation completes.

*OPC?

Returns a 1 to the output buffer when all pending operations complete. The response is delayed until all pending operations complete. Other commands cannot be executed until this command completes.

Parameter	Typical Return
(none)	1
Return a 1 when commands complete: *OPC?	

- The purpose of this command is to synchronize your application with the instrument.

*SRE <value>

*SRE?

Service Request Enable Command and Query. Sets the value of the Service Request Enable register. This determines which bits from the [Status Byte Register](#) are summed to set the Master Status Summary (MSS) bit and the Request for Service (RQS) summary bit. A 1 in any Service Request Enable register bit position enables the corresponding Status Byte register bit. All such enabled bits are then logically OR-ed to cause the MSS bit of the Status Byte register to be set. Refer to [Status Tutorial](#) for more information.

The query reads the enable register and returns a decimal value which corresponds to the binary-weighted sum of all bits set in the register.

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the enable register: <code>*SRE 24</code>	

- When a serial poll is conducted in response to SRQ, the RQS bit is cleared, but the MSS bit is not.
- When `*SRE` is cleared (by programming it with 0), the power supply cannot generate an SRQ to the controller.

***STB?**

Status Byte Query. Reads the **Status Byte Register**, which contains the status summary bits and the Output Queue MAV bit. The Status Byte is a read-only register and the bits are not cleared when it is read. Refer to **Status Tutorial** for more information.

Parameter	Typical Return
(none)	<bit value>
Read status byte: <code>*STB?</code>	

***WAI**

Pauses additional command processing until all pending operations are complete. See **OPC** for more information.

Parameter	Typical Return
(none)	(none)
Wait until all pending operations complete. <code>*WAI</code>	

- `*WAI` can only be aborted by sending the instrument a Device Clear command.

System Commands

System commands control system functions that are not directly related to output control, measurement, or status functions.

System functions are also controlled using the Common commands: *IDN?, *LRN?, *OPT?, *RCL, *RST, *SAV, and *TST? discussed at the end of this topic.

SYSTem:COMMunicate:LAN:CONTrol?

SYSTem:COMMunicate:TCPIP:CONTrol?

Returns the initial socket control connection port number. This connection is used to send and receive commands and queries. Unlike the data socket, which uses a fixed port number, the control socket port number varies and must be obtained using these queries.

Parameter	Typical Return
(none)	5000 (0 if sockets are not supported)

Query the Control connection port number:
 SYST:COMM:LAN:CONT? or SYST:COMM:TCP:CONT?

SYSTem:COMMunicate:RLState LOCAL|REMOte|RWLock

SYSTem :COMMunicate:RLState?

Configures the remote/local state of the instrument. Remote and Local do the same thing and are included for compatibility with other products. Both allow front panel control.

RWLock disables the front panel keys. Then the instrument can only be controlled remotely.

Parameter	Typical Return
LOCAL REMOte RWLock, default LOCAL	LOC, REM, or RWL

Sets the remote/local state to remote: SYST:COMM:RLST REM

- The remote/local state is unaffected by *RST or any SCPI commands other than SYSTem:COMMunicate:RLState.
- The remote/local instrument state can also be set by other interface commands over the GPIB and some other I/O interface.

SYSTem:ERRor?

Reads and clears one error from the error queue.

Parameter	Typical Return
(none)	<+0,"No error">

Reads and clear first error in error queue: SYST:ERR?

- The front-panel ERR annunciator turns on when one or more errors are currently stored in the error queue. Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. When you have read all errors from the error queue, the ERR annunciator turns off.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350,"Error queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0,"No error".
- The error queue is cleared by the *CLS and when power is cycled. It is not cleared by a *RST.
- Errors have the following format (the error string may contain up to 255 characters).
<error code>,<error string> For a list of error codes and message strings, see [SCPI Error Messages](#).

SYSTem:SECurity:IMMediate

Clears all user memory and reboots the instrument. This command is typically used to prepare the instrument for removal from a secure area. It writes all zeros to flash memory and then performs a full chip erase as per the manufacturer's data sheet. Identification data such as instrument firmware, model number, serial number, MAC address, and calibration data is not erased. After the data is cleared, the instrument is rebooted.

This procedure is not recommended for use in routine applications because of the possibility of unintended loss of data.

Parameter	Typical Return
(none)	(none)
Sanitizes the instrument: SYST:SEC:IMM	

SYSTem:VERSion?

Returns the SCPI version that the instrument complies with. Cannot be determined from front panel.

Parameter	Typical Return
(none)	<"version">
Return the SCPI version: SYST:VERS?	

- The command returns a string in the form "YYYY.V", where YYYY represents the year of the version and V represents a version for that year.

*IDN?

Identification Query. Returns instrument's identification string, which contains four comma-separated fields. The first field is the manufacturer's name, the second field is the instrument model number, the third field is the serial number, and the fourth field is the firmware revision.

Parameter	Typical Return
(none)	Agilent Technologies,N8925A,MY00123456,A.01.01
Returns the instrument's identification string: <code>*IDN?</code>	

***LRN?**

Returns a sequence of SCPI commands that can later be used to put the instrument in the same state that it was in when the `*LRN?` query was sent. The scope of the returned settings is the same as for the `*SAV` and `*RCL` commands.

Parameter	Typical Return
(none)	ASCII string with semicolon-separated fields
Returns the sequence of SCPI commands: <code>*LRN?</code>	

- To read the string into your computer, first dimension a string variable with at least 2500 characters.

***OPT?**

Returns a string identifying any installed options. A 0 (zero) indicates no options are installed.

Parameter	Typical Return
(none)	OPT 760
Returns installed options: <code>*OPT?</code>	

***RCL <0-9>**

WARNING SHOCK HAZARD If the output is enabled when an instrument state is saved to location 0 (zero), the output will automatically be enabled at turn-on if the power-on state is set to recall location zero (RCL0).

Restores the instrument to a state that was previously stored in memory locations 0 through 9 with the `*SAV` command. All instrument states are recalled except: (1) the trigger system is set to the Idle state, (2) calibration is disabled, (3) trigger settings are set to their Idle state, and (4) non-volatile settings are not affected..

Parameter	Typical Return
0 - 9	(none)
Recall state from location 1: <code>*RCL 1</code>	

- Location 0 is automatically recalled at power turn-on when the Output Power-On state is set to RCL0.
- You cannot recall an instrument state from an empty or deleted storage location.
- Stored instrument states are affected by `*RST`.

***RST**

Resets the instrument to pre-defined values that are either typical or safe. These settings are described in [Factory Reset State](#).

Parameter	Typical Return
(none)	(none)
Reset the instrument: *RST	

- *RST forces the ABORt command. This cancels any trigger actions presently in process, and resets the WTG bit in the Status Operation Condition register.

***SAV <0-9>**

Saves the present state of the instrument to one of ten non-volatile memory locations.

Parameter	Typical Return
0 - 9	(none)
Save state to location 1: *SAV 1	

- If a particular state is desired at power-on, it should be stored in location 0. Location 0 is automatically recalled at power turn-on when the Output Power-On state is set to RCL 0.
- The calibration state is NOT saved as part of the *SAV operation.
- Data saved in non-volatile memory, described in the Non-volatile Settings, is not affected by the *SAV command.
- When shipped, locations 0 through 9 are empty.

***TST?**

Self-Test Query. Performs a instrument self-test. If test fails, one or more error messages will provide additional information. Use SYSTem:ERRor? to read error queue. See [SCPI Error Messages](#) for more information.

Parameter	Typical Return
(none)	Always returns 0
Perform self-test: *TST?	

- The *power-on* self-test is the same self-test performed by *TST.
- *TST? also forces an *RST command.

Trigger Commands

Trigger commands control the remote triggering of the instrument's output. Abort commands abort any pending triggers. Initiate commands initiate the transient trigger system.

ABORt:TRANsient

Cancels any triggered actions. It returns the trigger system back to the Idle state and resets the WTG-tran bit in the Operation Condition Status register.

Parameter	Typical Return
(none)	(none)
Aborts the triggered action: <code>ABOR:TRAN</code>	

- Note that this command does not turn off continuous triggers if `INITiate:CONTinuous:TRANsient ON` has been programmed. In this case, the trigger system will automatically re-initiate.
- `ABORt:TRANsient` is also executed at power-on and upon execution of the `*RST` command.

INITiate[:IMMediate]:TRANsient

Initiates the transient trigger system. This moves the trigger system from the "idle" state to the "wait-for-trigger" state; which enables the instrument to receive triggers.

Parameter	Typical Return
(none)	(none)
Initiates the trigger system: <code>INIT:TRAN</code>	

- It takes a few milliseconds for the instrument to be ready to receive a trigger signal after receiving the `INITiate` command.
- If a trigger occurs before the trigger system is ready for it, the trigger will be ignored. Check the `WTG_tran` bit in the operation status register to know when the instrument is ready.
- Use `ABORt:TRANsient` to return the instrument to idle.

INITiate:CONTinuous:TRANsient 0|OFF|1|ON

INITiate:CONTinuous:TRANsient?

Continuously initiates the transient trigger system. This allows multiple triggers to generate multiple output transients.

Parameter	Typical Return
0 OFF 1 ON, *RST ON	0 or 1
Continually initiates the trigger system: <code>INIT:CONT:TRAN ON</code>	

- With continuous triggering disabled, the trigger system must be initiated for each trigger using the INITiate:TRANSient command.
- ABORt:TRANSient does not abort continuous triggers if INITiate:CONTInuous:TRANSient ON has been programmed. In this case, the trigger system will automatically re-initiate.

TRIGger:TRANSient[:IMMEDIATE]

Generates an immediate trigger. This overrides any selected trigger source. Transient triggers affect the output voltage and output current.

Parameter	Typical Return
(none)	(none)
Generates a transient trigger: TRIG:TRAN	

- You must initiate the trigger system before you can send any trigger.
- When sent, the transient trigger will cause an output change as specified by the CURRent:TRIGgered or VOLTage:TRIGgered commands.
- When the trigger sequence completes, the WTG-tran bit in the Status Operation Condition register is cleared.

TRIGger:TRANSient:SOURce <source>

TRIGger:TRANSient:SOURce?

Selects the transient trigger source. BUS is the only trigger source that can be selected. This selects a remote trigger interface command as the trigger source.

Parameter	Typical Return
BUS	BUS
Example: TRIG:TRAN:SOUR BUS	

*TRG

Trigger Command. Generates a trigger when the trigger system has BUS selected as its source. The command has the same affect as the Group Execute Trigger (<GET>) command).

Parameter	Typical Return
(none)	(none)
Generates an immediate trigger: *TRG	

Voltage Commands

Voltage commands program the output voltage and voltage protection functions. The **SOURCE** keyword is optional in the following commands.

```
[SOURCE:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <value>|MIN|MAX
[SOURCE:]VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]
[SOURCE:]VOLTage[:LEVel]:TRIGgered[:AMPLitude] <value>|MIN|MAX
[SOURCE:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX]
```

Sets the immediate voltage level and the triggered voltage level when the output is in constant voltage mode. The triggered level is a stored value that is transferred to the output when an output Step is triggered. Units are in volts. The maximum value depends on the voltage rating of the unit.

Parameter	Typical Return
0 to 102% of rating MIN MAX, *RST 0	<voltage level>
Sets the output voltage level to 20 V: <code>VOLT 20</code> Sets the triggered voltage level to 25 V: <code>VOLT:TRIG 25</code>	

```
[SOURCE:]VOLTage:MODE FIXed|STEP
[SOURCE:]VOLTage:MODE?
```

Sets the transient mode. This determines what happens to the output voltage when the transient system is initiated and triggered. **FIXed** keeps the output voltage at its immediate value. **STEP** steps the output to the triggered level when a trigger occurs.

Parameter	Typical Return
FIXed STEP, *RST FIXed	FIX or STEP
Sets the voltage mode to Step: <code>VOLT:MODE STEP</code>	

```
[SOURCE:]VOLTage:PROTection[:LEVel] <value>|MIN|MAX
[SOURCE:]VOLTage:PROTection[:LEVel]? [MIN|MAX]
```

Sets the over-voltage protection level. Units are in volts. If the output voltage exceeds the OVP level, the output is disabled and the Questionable Condition status register OV bit is set.

Parameter	Typical Return
0 – 120% of voltage rating MIN MAX, *RST 120% of rating	<over-voltage level>
Sets the over-voltage protection to 60 V: <code>VOLT:PROT 60</code>	

- An over-voltage condition can be cleared with the `OUTput:PROTection:CLEar` command after the cause of the condition has been removed.

Status Tutorial

This section provides a detailed description of the individual registers and register groups. The status diagram at the end of this topic provides an graphical view of how the status registers and groups are interconnected.

Status Registers

Operation Status Group

Questionable Status Group

Standard Event Status Group

Status Byte Register

Error and Output Queues

Status Diagram

Status Registers

The Operation and Questionable status groups use four different type of registers to track qualify, flag, and enable instrument events.

- A Condition register continuously monitors the state of the instrument. The bits in the condition register are updated in real time and the bits are not latched or buffered
- An PTR/NTR register qualifies the signal that passes to the event register. When a PTR bit is set, signals with positive edge transition pass to the event register. When an NTR bit is set, signals with a negative edge transition pass to the event register. When both bits are set, all signal pass. When neither bits are set, no signals pass.
- An Event register latches the various events from the condition register. There is no buffering in this register; while an event bit is set, subsequent events corresponding to that bit are ignored. This is a read-only register
- An Enable register defines which bits in the event register will be reported to the Status Byte register group. You can write to or read from an enable register.

To program individual bits in any register group, you must send a value that corresponds to the binary-weighted value of all the bits that you wish to enable. For example, to enable bit 2 (decimal value = 4) and bit 4 (decimal value = 16), the corresponding decimal value would be 20 (4 + 16). Similarly, any register queries return the binary-weighted value of the bits that have been set. For example, with bit 3 (value 8) and bit 5 (value 32) being set, the query returns +40.

Operation Status Group

These registers record signals that occur during normal operation. The group consists of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Operation Status register group are logically-ORed into the OPERation summary bit (7) of the Status Byte register. Refer to [Status Registers](#) for a description of each register.

The following table describes the Operation Status register bit assignments.

Bit	Bit Name	Decimal Value	Definition
0	CV	1	Output is in constant voltage
1	CC	2	Output is in constant current
2	OFF	4	Output is programmed off
3	not used	not used	0 is returned
4	WTG-tran	16	Transient system is waiting or a trigger
5-15	not used	not used	0 is returned

Questionable Status Group

These register groups record signals that indicate abnormal operation. The group consists of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Questionable Status group are logically-ORed into the QUESTionable summary bit (3) of the Status Byte register. Refer to [Status Registers](#) for a description of each register.

The following table describes the Questionable Status register bit assignments.

Bit	Bit Name	Decimal Value	Definition
0	OV	1	Output is disabled by the over-voltage protection
1	OC	2	Output is disabled by the over-current protection
2	PF	4	Output is disabled by power-fail (low-line or brown-out on AC line)
3	CP	8	Output is limited by the power limit boundary
4	OT	16	Output is disabled by the over-temperature protection
5	MSP	32	Output is disabled by the master/slave protection
6-8	not used	not used	0 is returned
9	INH	512	Output is disabled by an external INHibit signal
10	UNR	1024	Output is unregulated
11-15	not used	not used	0 is returned

Standard Event Status Group

These registers are programmed by Common commands. The group consists of an Event and Enable register. The Standard Event event register latches events relating to communication status. It is a

read-only register that is cleared when read. The Standard Event enable register functions similarly to the enable registers of the Operation and Questionable status groups. Refer to [Status Registers](#) for a description of each register.

The following table describes the Standard Event Status register bit assignments.

Bit	Bit Name	Decimal Value	Definition
0	Operation Complete	1	All commands before and including *OPC have been executed.
1	not used	not used	0 is returned
2	Query Error	4	The instrument tried to read the output buffer but it was empty, a new command line was received before a previous query has been read, or both the input and output buffers are full.
3	Device-Specific Error	8	A device-specific error, including a self-test error, calibration error or other device-specific error occurred. Error Messages
4	Execution Error	16	An execution error occurred. Error Messages
5	Command	32	A command syntax error occurred. Error Messages
6	not used	not used	0 is returned
7	Power On	128	Power has been cycled since the last time the event register was read or cleared.

Status Byte Register

This register summarizes the information from all other status groups as defined in the IEEE 488.2 Standard Digital Interface for Programmable Instrumentation.

The following table describes the Status Byte Register register bit assignments.

Bit	Bit Name	Decimal Value	Definition
0	not used	not used	0 is returned
1	not used	not used	0 is returned
2	Error Queue	4	One or more errors in the Error Queue. Use <code>SYSTem:ERRor?</code> to read and delete errors.
3	Questionable Status Summary	8	One or more bits are set in the Questionable Data Register. Bits must be enabled, see <code>STATus:QUESTIONable:ENABLE</code> .
4	Message Available	16	Data is available in the instrument's output buffer.

Bit	Bit Name	Decimal Value	Definition
5	Event Status Summary	32	One or more bits are set in the Standard Event Register. Bits must be enabled, see *ESE .
6	Master Status Summary	64	One or more bits are set in the Status Byte Register and may generate a Service Request. Bits must be enabled, see *SRE .
7	Operation Status Summary	128	One or more bits are set in the Operation Status Register. Bits must be enabled, see STATus:OPERation:ENABle .

MSS and RQS Bits

MSS is a real-time (unlatched) summary of all Status Byte register bits that are enabled by the Service Request Enable register. MSS is set whenever the instrument has one or more reasons for requesting service. ***STB?** reads the MSS in bit position 6 of the response but does not clear any of the bits in the Status Byte register.

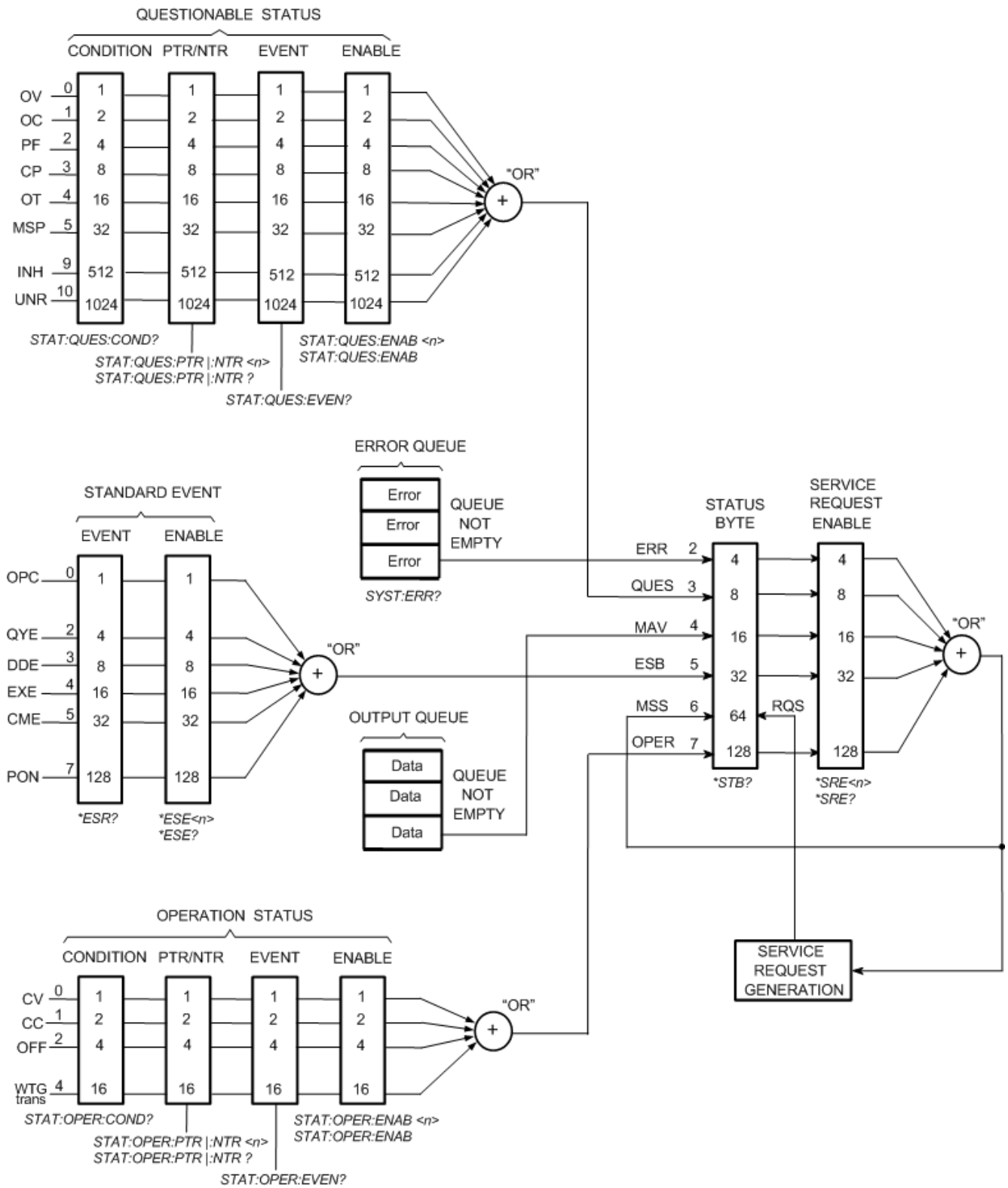
The RQS bit is a latched version of the MSS bit. Whenever the instrument requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller does a serial poll, RQS is cleared inside the register and returned in bit position 6 of the response. The remaining bits of the Status Byte register are not disturbed.

Error and Output Queues

The Error Queue is a first-in, first-out (FIFO) data register that stores numerical and textual description of an error or event. Error messages are stored until they are read with **SYSTem:ERRor?** If the queue overflows, the last error/event in the queue is replaced with error -350, "Queue overflow".

The Output Queue is a first-in, first-out (FIFO) data register that stores instrument-to-controller messages until the controller reads them. Whenever the queue holds messages, it sets the MAV bit (4) of the Status Byte register.

Status Diagram



Command Quick Reference

Some [optional] commands have been included for clarity. All settings commands have a corresponding query. See the [Syntax Conventions](#) for SCPI.

ABORt Command

ABORt
 :TRANsient Cancels any triggered actions.

CALibrate Commands

CALibrate
 :COUNT? Returns the number of times the unit has been calibrated.
 :CURRent
 [:LEVel] [<value>] Calibrates the current programming and measurement.
 :DATA <value> Enters the calibration value read by the external meter.
 :DATE <"date"> Enters the calibration date in nonvolatile memory.
 :LEVel P1|P2|P3|P4 Advances to the next level in the calibration.
 :PASSword <value> Sets a numeric password to prevent unauthorized calibration.
 :SAVE Saves the calibration constants in non-volatile memory.
 :STATe 0|OFF|1|ON Enables or disables calibration mode.
 :VOLTage
 [:LOCal]
 [:LEVel] [<value>] Calibrates the local voltage programming and measurement.
 :REMote
 [:LEVel] [<value>] Calibrates the remote voltage programming and measurement.

CURRent Commands

[SOURce:] Optional
 CURRent
 [:LEVel]
 [:IMMediate]
 [:AMPLitude] <value> Sets the output current.
 :TRIGgered
 [:AMPLitude] <value> Sets the triggered output current.
 :MODE FIXed|STEP Sets the transient mode.
 :PROTection
 :DELay <value> Sets the over-current protection delay.
 :STATe 0|OFF|1|ON Enables or disables the over-current protection.

DIGital Command

[SOURce:]	Optional
DIGital	
:PIN<pin>	
:POLarity POSitive NEGative	Sets the polarity of external control signal pins 13 and 14

DISPlay Command

DISPlay	
[:WINDow]	
[:STATe] 0 OFF 1 ON	Turns the front panel display on or off.

IEEE-488 Commands

*CLS	Clear status
*ESE <value>	Standard event status enable
*ESR?	Return event status register
*IDN?	Return instrument identification
*LRN?	Returns a sequence of SCPI commands
*OPC	Enable "operation complete" bit in ESR
*OPT?	Return option number
*RCL <value>	Recalls a saved instrument state
*RST	Reset
*SAV <value>	Saves an instrument state
*SRE <value>	Set service request enable register
*STB?	Return status byte
*TRG	Trigger
*TST?	Performs self-test, then returns result
*WAI	Pauses additional command processing until all device commands are done

INITiate Commands

INITiate	
[:IMMediate]	
:TRANsient	Initiates the transient trigger system.
:CONTInuous	
:TRANsient 0 OFF 1 ON	Continuously initiates the transient trigger system.

LXI Command

LXI

:IDENTify

:STATe 0|OFF|1|ON Turns the front panel LXI identify indicator on or off.

MEASure Commands

MEASure

[:SCALar]

:CURRent

[:DC]? Takes a measurement; returns the averaged current.

:POWer

[:DC]? Takes a measurement; returns the averaged power.

:VOLTage

[:DC]? Takes a measurement; returns the averaged voltage.

MEMory Commands

MEMory

:TABLe

[:SASimulator]

:CURRent

[:AMPLitude] <value>{,<value> Sets the output voltage.

:POINts? Sets the output voltage.

:VOLTage

[:AMPLitude] <value>{,<value> Sets the output voltage.

:POINts? Sets the output voltage.

OUTPut Commands

OUTPut

[:STATe] 0|OFF|1|ON Enables or disables the output.

:INHibit

:MODE LATChing|LIVE|OFF Sets the remote inhibit.

:PON

:STATe RST|RCL0 Sets the output power-on state.

:PROTection

:CLEar Resets the latched protection.

SASimulator Commands

[SOURce:]	Optional
SASimulator	
:CURve	
:IMP <value>	
:ISC <value>	Sets the output voltage.
:VMP <value>	
:VSC <value>	Sets the triggered output voltage.
:MODE FIXed SAS TABLE	Sets the SAS mode.
:SCALE	
:CURRent <value>	Sets the over-voltage protection level.
:VOLTage <value>	Sets the over-voltage protection level.
:TABLE	Sets the over-voltage protection level.
:ACTivate	Sets the over-voltage protection level.

STATus Commands

STATus	
:OPERation	
[:EVENT]?	Queries the operation event register.
:CONDition?	Queries the operation condition register.
:ENABle <value>	Sets the operation enable register.
:NTRansiton <value>	Sets the negative transition filter.
:PTRansiton <value>	Sets the positive transition filter.
:PRESet	Presets all Enable, PTR, and NTR registers.
:QUEStionable	
[:EVENT]?	Queries the questionable event register.
:CONDition?	Queries the questionable condition register.
:ENABle <value>	Sets the questionable enable register.
:NTRansiton <value>	Sets the negative transition filter.
:PTRansiton <value>	Sets the positive transition filter.

SYSTEM Commands

SYSTEM	
:COMMunicate	
:LAN TCPIP:CONTRol?	Returns the initial socket control connection port number.
:RLState LOCAL REMOte RWLOCK	Configures the remote/local state of the instrument.
:ERRor?	Reads and clears one error from the error queue.
:SECurity	
:IMMediate	Clears all user memory and reboots the instrument.
:VERSion?	Returns the SCPI version that the instrument complies with.

TRIGger Commands

TRIGger

:TRANSient

[:IMMEDIATE]

Generates an immediate trigger.

:SOURce <source>

Selects the transient trigger source.

VOLTage Commands

[SOURce:]

Optional

VOLTage

[:LEVel]

[:IMMEDIATE]

[:AMPLitude] <value>

Sets the output voltage.

:TRIGgerred

[:AMPLitude] <value>

Sets the triggered output voltage.

:MODE FIXed|STEP

Sets the transient mode.

:PROTection

[:LEVel] <value>

Sets the over-voltage protection level.

Reset State (*RST)

NOTE

The power-on/reset state may differ from that shown below if you have enabled power-on state recall mode from the **States** menu (see [Instrument State Storage](#)).

The following tables show the reset state. These parameters are set to the indicated values at power-on or after *RST.

Reset Settings

SCPI Command *RST Settings	
CALibrate:STATE	OFF
CURRent	0
CURRent:MODE	FIXed
CURRent:PROTection:DElay	50 ms
CURRent:PROTection:STATE	OFF
CURRent:TRIGgered	0
DISPlay	ON
MEMory:TABLE:CURRent	0.3, 0.24, 0
MEMory:TABLE:VOLTage	0, 12, 15
OUTPut	OFF
SASimulator:MODE	FIXed
SASimulator:CURve:IMP	0.24
SASimulator:CURve:ISC	0.3
SASimulator:CURve:VMP	12
SASimulator:CURve:VOC	15
SASimulator:SCALE:CURRent	100%
SASimulator:SCALE:VOLTage	100%
TRIGger:TRANSient:SOURce	BUS
VOLTage	0
VOLTage:MODE	FIXed
VOLTage:PROTection	120% of rating
VOLTage:TRIGgered	0

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The following table shows the as-shipped settings of the **non-volatile** parameters. These are not affected by power cycling or *RST.

Non-Volatile Settings

SCPI as-shipped settings	
CALibrate:DATE	empty string
CALibrate:PASSword	0
OUTPut:PON:STATe	RST
Front Panel as-shipped settings	
Firmware update password protected	Disabled
GPIB address	5
GPIB interface	Enabled
LAN interface	Enabled
USB interface	Enabled
Screen saver	Enabled
Screen saver delay	60 minutes
Wake on I/O	Enabled
Interface as-shipped settings	
Get IP Address	Automatic
IP Address	169.254.89.00
Subnet mask	255.255.0.0
Default gateway	0.0.0.0
Host name	A-N89xxx-xxxxx
mDNS service name	A-N89xxx-xxxxx.local.
LAN service - VXI-11	Enabled
LAN service - Telnet	Enabled
LAN service - mDNS	Enabled
LAN service - Web server	Enabled
LAN service - sockets	Enabled
Web password	Blank

SCPI Error Messages

The Keysight instrument returns error messages in accord with the SCPI standard.

- Up to 20 errors can be stored in each interface-specific error queue (one each for GPIB, USB, VXI-11, and Telnet/Sockets.) Errors appear in the error queue of the I/O session that caused the error.
- The instrument beeps once each time a command syntax or hardware error is generated. The front-panel ERROR annunciator turns on when one or more errors are in the error queue.
- A special global error queue holds all power-on and hardware-related errors (for example, over-temperature).
- Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. Once you have read all interface-specific errors, the errors in the global error queue are retrieved. When you have read all errors from the error queue, the ERR annunciator turns off.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350,"Error queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred when you read the error queue, the instrument responds with +0,"No error".
- The front panel reports errors from all I/O sessions and the global error queue. To read the error queue from the front panel, press the ERROR key.
- Error conditions are also summarized in the Status Byte Register. See [Status Subsystem Introduction](#) for details.
- The interface-specific error queues are cleared by power cycles and *CLS. The error queue is not cleared by *RST.
- **SCPI:**

`SYSTem:ERRor?` *Read and clear one error from the queue*

Errors have the following format (the error string may contain up to 255 characters):
-113,"Undefined header"

Error Device-dependent Errors (these errors set Standard Event Status register bit #3)

0 No error

This is the response to the ERR? query when there are no errors.

101 Calibration state is off

Calibration is not enabled. The instrument will not accept calibration commands.

102 Calibration password is incorrect

The calibration password is incorrect.

103 Calibration is inhibited by switch setting

Calibration mode is locked out by the calibration switch.

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104 Bad sequence of calibration commands

Calibration commands have not been entered in the proper sequence.

116 Locked out by internal switch setting

This function has been locked out by an internal switch.

200 Hardware error channel <1 >

A hardware error has occurred on the output.

202 Selftest Fail

A selftest failure has occurred. See selftest failure list for details.

209 Internal communication error

An internal communication error has occurred in the instrument.

210 Frame NVRAM error

A non-volatile RAM error has occurred in the instrument.

308 This setting cannot be changed while transient trigger is initiated

Setting cannot be changed while the instrument is waiting for or executing a trigger sequence.

309 Cannot initiate, voltage and current in fixed mode

Cannot initiate transient generator. Either the voltage or current function is set to Fixed mode.

315 Settings conflict error

A data element could not be programmed because of the present instrument state.

317 Invalid format

The saved state file is corrupted.

318 Configuration error

A master/slave configuration error has occurred.

320 Firmware update error

This may be due to the instrument hardware not being able to support the firmware version.

Command Errors (these errors set Standard Event Status register bit #5)

-100 Command error

Generic syntax error.

-101 Invalid character

An invalid character was found in the command string.

-102 Syntax error

Invalid syntax was found in the command string. Check for blank spaces.

-103 Invalid separator

An invalid separator was found in the command string. Check for proper use of , ; :

-104 Data type error

A different data type than the one allowed was found in the command string.

-105 GET not allowed

A group execute trigger is not allowed in a command string.

-108 Parameter not allowed

More parameters were received than were expected.

-109 Missing parameter

Fewer parameters were received than were expected.

-110 Command header error

An error was detected in the header.

-111 Header separator error

A character that was not a valid header separator was found in the command string.

-112 Program mnemonic too long

The header contains more than 12 characters.

-113 Undefined header

A command was received that was not valid for this instrument.

-114 Header suffix out of range

The value of the numeric suffix is not valid.

-120 Numeric data error

Generic numeric data error.

-121 Invalid character in number

An invalid character for the data type was found in the command string.

-123 Exponent too large

The magnitude of the exponent was larger than 32000.

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-124 Too many digits

The mantissa of a numeric parameter contained more than 255 digits, excluding leading zeros.

-128 Numeric data not allowed

A numeric parameter was received but a character string was expected.

-130 Suffix error

Generic suffix error

-131 Invalid suffix

A suffix was incorrectly specified for a numeric parameter.

-134 Suffix too long

The suffix contains more than 12 characters.

-138 Suffix not allowed

A suffix is not supported for this command.

-140 Character data error

Generic character data error

-141 Invalid character data

Either the character data element contains an invalid character, or the element is not valid.

-144 Character data too long

The character data element contains more than 12 characters.

-148 Character data not allowed

A discrete parameter was received, but a string or numeric parameter was expected.

-150 String data error

Generic string data error

-151 Invalid string data

An invalid character string was received. Check that the string is enclosed in quotation marks.

-158 String data not allowed

A character string was received, but is not allowed for this command.

Execution Errors (these errors set Standard Event Status register bit #4)

-200 Execution error

Generic syntax error

-220 Parameter error

A data element related error occurred.

-221 Settings conflict

A data element could not be executed because of the present instrument state.

-222 Data out of range

A data element could not be executed because the value was outside the valid range.

-223 Too much data

A data element was received that contains more data than the instrument can handle.

-224 Illegal parameter value

An exact value was expected but not received.

-225 Out of memory

The device has insufficient memory to perform the requested operation.

-230 Data corrupt or stale

Possible invalid data. A new reading was started but not completed.

-231 Data questionable

The measurement accuracy is suspect.

-232 Invalid format

The data format or structure is inappropriate.

-233 Invalid version

The version of the data format is incorrect to the instrument.

-240 Hardware error

The command could not be executed because of a hardware problem with the instrument.

-241 Hardware missing

The command could not be executed because of missing hardware, such as an option.

Query Errors (these errors set Standard Event Status register bit #2)**-400 Query Error**

Generic error query

-410 Query INTERRUPTED

A condition causing an interrupted query error occurred.

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-420 Query UNTERMINATED

A condition causing an unterminated query error occurred.

-430 Query DEADLOCKED

A condition causing a deadlocked query error occurred.

-440 Query UNTERMINATED after indefinite response

A query was received in the same program message after a query indicating an indefinite response was executed.

Compatibility Commands

The commands described in this section are provided for compatibility with the existing N6700 series modular power system (MPS). Note that the compatibility commands discussed in this section have no or little effect on the operation of the N8900 models, as they access functions that are either redundant or not available.

Channel Parameter

Since the N8900 models are single channel units, SCPI commands do not require a channel list parameter. However, for code compatibility with the N6700 MPS, the N8900 models will accept the channel list (, @1) for N6700 MPS commands that require this parameter. All channel-dependent commands sent to the N8900 models must be sent to channel 1 only.

Code Compatible Commands

These commands are not required for the N8900 models, but are provided for better compatibility with code written for the Keysight N6700 MPS. In most cases these commands either do nothing, or specify a pre-defined parameter that is compatible with the N8900 models.

N6700 MPS command	Action on N8900 models
SENSe:CURRent:RANGe Sets and gets the sense current range.	Returns the measurement current range.
SENSe:VOLTagE:RANGe Sets and gets the sense voltage range.	Returns the measurement voltage range.
[SOURce:]CURRent:RANGe Sets and gets the source current range.	Returns the output current range.
[SOURce:]VOLTagE:RANGe Sets and gets the source voltage range.	Returns the output voltage range.
[SOURce:]DIGital:PIN<pin>:FUNction Sets and gets the digital pin functions.	Returns the functions of external control signal pins 13 and 14, which are also aliased to N6700 MPS pins 1 and 3 respectively.
SYSTem:CHANnel[:COUNT]? Returns the number of output channels.	Always returns a "1".
SYSTem:CHANnel:MODEl? Returns the channel model number.	Returns the power supply model. Same as *IDN?
SYSTem:CHANnel:OPTion? Returns the channel options.	Returns the power supply options. Same as *OPT?
SYSTem:CHANnel:SERial? Returns the channel serial number.	Returns the power supply serial number. Same as *IDN?
SYSTem:GROUp:CATalog? Returns the number of grouped channels.	Returns a list of discovered slave addresses.

4

Service and Maintenance

Introduction

Verification and Calibration

Self-Test Procedure

Firmware Update

Instrument Sanitize

Calibration Switches

Disassembly

Manual Updates

Introduction

Types of Service Available

If your instrument fails during the warranty period, Keysight Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices.

Many Keysight products have optional service contracts that extend coverage after the standard warranty expires.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument, contact your nearest Keysight Technologies Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair-cost information where applicable. Ask the Keysight Technologies Service Center for shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for return shipments.

Before Returning the Unit

Before returning the unit, make sure the failure is in the instrument rather than any external connections. Also make sure that the instrument was accurately calibrated within the last year (see [Calibration Interval](#)).

If the unit is inoperative, verify that: the AC power cord is securely connected to the instrument; the AC power cord is plugged into a live outlet; and the front-panel power switch is turned on

If self-test failed, verify that: all connections (front and rear) are removed when self-test is performed. During self-test, errors may be induced by signals present on external wiring, such as long test leads that can act as antennae.

Repackaging for Shipment

To ship the unit to Keysight for service or repair:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material.
- Secure the container with strong tape or metal bands.
- If the original shipping container is unavailable, use a container that will ensure at least 10 cm (4 in.) of compressible packaging material around the entire instrument. Use static-free packaging materials.

Keysight suggests that you always insure shipments.

Verification and Calibration

Further Verification and Calibration topics:

Recommended Test Equipment and Setups

Performance Verification

Calibration Procedure

Test Record Forms

Verification

The verification procedures verify that the Keysight N8900 series power supply is operating normally and is within published specifications. If the instrument fails any of the tests or if abnormal test results are obtained, try calibrating the unit. If calibration is unsuccessful, return the unit to a Keysight Technologies Service Center.

Keysight Technologies Calibration Services - Your local Keysight Technologies Service Center offers low-cost recalibration. The service center uses automated calibration systems that allow Keysight to provide calibration at competitive prices.

Keysight Technologies recommends that complete verification should always be performed at the calibration interval. If the power supply passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated. This ensures that the instrument will remain within specifications for the next calibration interval and provides the best long-term stability. Performance data measured using this method can be used to extend future calibration intervals.

Calibration Interval

The instrument should be calibrated on a regular interval determined by the accuracy requirements of your application. A 1-year interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Accuracy specifications are not warranted beyond the 1-year calibration interval.

Test Considerations

For optimum performance, all verification and calibration procedures should comply with the following recommendations:

- Ambient temperature is stable, at $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$.
- Ambient relative humidity is less than 70%.
- 30 minute warm-up period before verification or adjustment.
- Cables as short as possible, twisted or shielded to reduce noise.

Measurement Techniques

Voltmeter

To ensure that the values read by the voltmeter during both the verification procedure and the calibration procedure are not affected by the instantaneous measurement of the AC peaks of the output current ripple, make several DC measurements and average them. You can set up the voltmeter to do this automatically by programming ≥ 10 power line cycles per measurement. If you are using a Keysight 3458A DMM also turn on auto-calibration (ACAL) and the autorange function (ARANGE).

Current Shunt

The 4-terminal current shunt is used to make accurate current measurements. It has two monitoring terminals as well as two load terminals. Connect the voltmeter directly to the monitoring terminals. Also allow sufficient airflow for cooling.

Electronic Load

Many of the test procedures require the use of a variable load capable of dissipating the required power. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors. Note that for proper operation, the electronic load requires a minimum of 3 V to be present at its input terminals. To avoid contact with any high voltages during operation, use switches to connect and disconnect the electronic load.

When paralleling loads for higher currents during transient response testing, use the external trigger input on the loads to synchronize the transition from low current to high current operation.

Note that you may use load resistors instead of an electronic load. To avoid contact with any high voltages during operation, use switches to connect, disconnect, or short the load resistors.

Program Control

You may choose to automate the calibration and verification procedures. If computer controlled test setups are used, the relatively slow settling times and slew rates of the power supply must be taken into account. "Wait" statements can be used in the test program to allow for the appropriate settling times for the power supply.

Recommended Test Equipment and Setups

Test Equipment

Verification and Calibration Setups

Test Equipment

The test equipment recommended for the performance verification and adjustment procedures is listed below. If the exact instrument is not available, substitute calibration standards of equivalent accuracy.

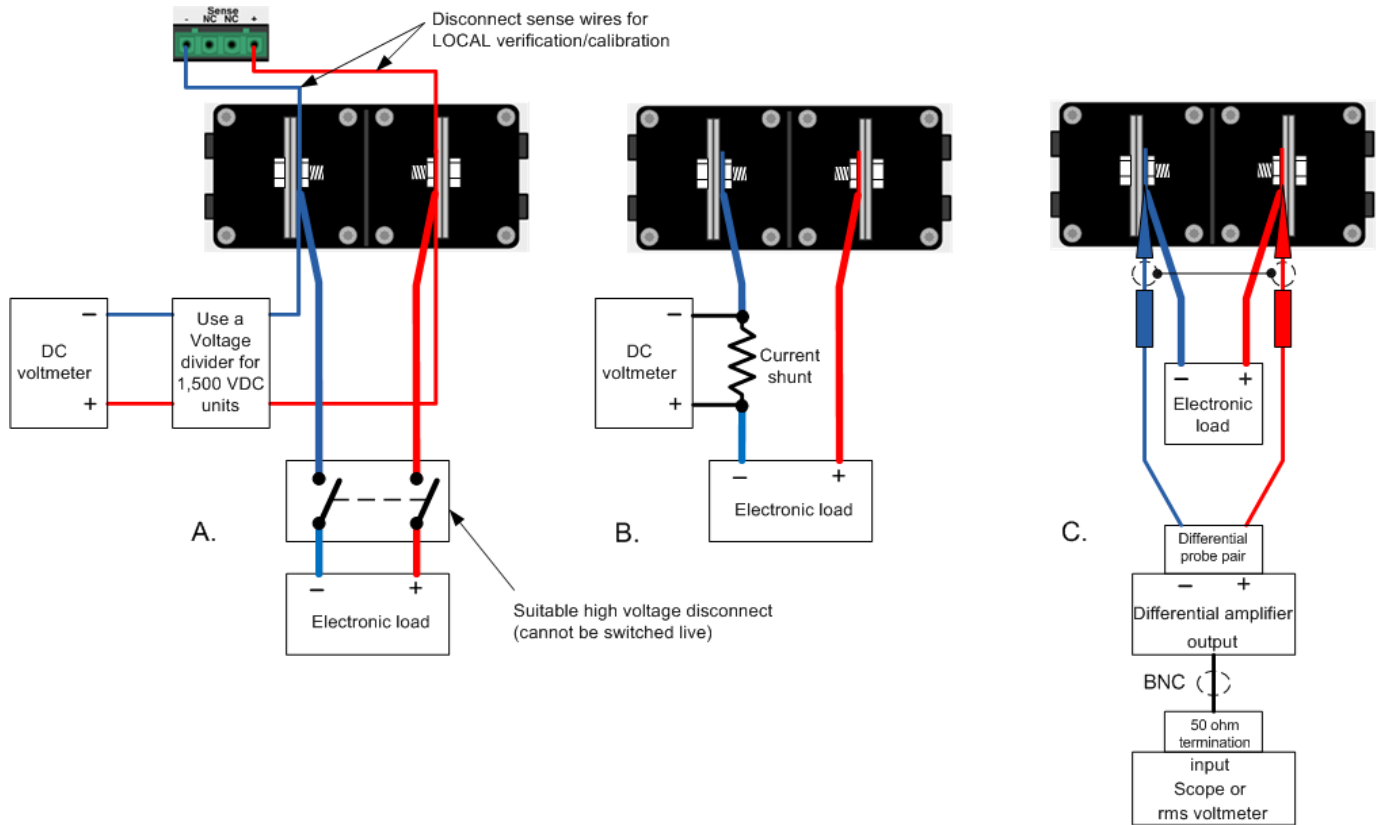
Instrument	Requirements	Recommended Model	Use ¹
Digital Multimeter	Resolution: 10 nV @ 1V; Readout: 8 1/2 digits Accuracy: 20 ppm	Keysight 3458A	V, C
Current Shunt ²	15 A (0.1Ω) 50 A (0.05Ω) 300 A (0.001Ω) 1000 A (0.0001Ω)	Guildline 9230-15R Guildline 9230-50, OPT 92310 Guildline 9230-300, OPT 92310 Guildline 9230A/1000, OPT 92310	V, C
Electronic load ²	160 V, 300 A 7.2 kW or equivalent 400 V, 150 A 7.2 kW or equivalent 750 V, 75 A 7.2 kW or equivalent	2 - EA-EL 9160-300 HP 2 - EA EL 9400-150 HP 2 - EA-EL 9750-75 HP	V, C
GPIB controller	Full GPIB capabilities	Keysight 82350B or equivalent	V, C
Oscilloscope	Sensitivity: 1 mV Bandwidth Limit: 20 MHz	Keysight DSO6054A or equivalent	V
RMS Voltmeter	True RMS Bandwidth: 300 kHz	Keysight 34410A or equivalent	V
Voltage divider	5 kV to 5 V (1000 to 1) Accuracy: 0.025%	Ohms-Lab KVVB-5-5 or equivalent	V, C
Disconnect switch	2 pole, 60 A	Square D QO200TR series G03 or equivalent	V, C
Differential Amplifier	Bandwidth: 20 MHz	LeCroy DA1855A, DA1850A, or equivalent	V
Differential Probe	100:1 / 10:1 selectable	LeCroy DXC100A or equivalent	V
Terminations	1 – 50Ω BNC termination		V

¹ V = Verification C = Calibration

² Dependent on rating of model being tested

Verification and Calibration Setups

WARNING HAZARDOUS VOLTAGES All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.



Performance Verification

Voltage Programming and Readback Accuracy

Constant Voltage Load Effect

Constant Voltage Ripple and Noise

Transient Recovery Time

Current Programming and Readback Accuracy

Constant Current Load Effect

WARNING **HAZARDOUS VOLTAGES** The output may be enabled at turn-on, depending on the ***PON setting**. Check this setting before attaching anything to the output terminals.

The following types of performance verification tests are available:

- **Self-Test** A self-test occurs whenever you turn on the instrument. This limited test assures that the instrument is operational. If a self test error occurs, do not perform the verification tests. For details, see [Self-Test Procedures](#).
- **Performance Verification Tests** Performance verification tests verify that the power supply is operating normally and meets its published specifications.

The performance verification tests are recommended as acceptance tests when you first receive the instrument. The acceptance test results should be compared against the instrument specifications. After acceptance, you should repeat the performance verification tests after every calibration interval.

Perform the verification tests before calibrating your power supply. If the power supply passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

If the instrument fails any of the tests or if abnormal test results are obtained, try calibrating the unit. If calibration is unsuccessful, return the unit to a Keysight Technologies Service Center.

Refer to [Recommended Test Equipment and Setups](#) for the equipment list and test setups required for verification. Refer to the [Measurement Techniques](#) section for information about setting up the voltmeter, connecting the current shunt, and connecting the electronic load.

WARNING **HAZARDOUS VOLTAGES** All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Always turn off the output when connecting or disconnecting any equipment on the sense or output terminals of the unit.

CAUTION

Equipment Damage It is recommended to set the overvoltage protection function of the instrument slightly higher than its operating point during the verification procedure. This will prevent damage to any external equipment (electronic load, differential amplifier) that may occur if the output voltage is accidentally programmed higher than the prescribed voltage setting.

NOTE

Turn the unit off or send a Reset command after completing the verification procedure to return all instrument settings to their default values.

Voltage Programming and Readback Accuracy

This test verifies that the voltage programming and measurement functions are within specifications.

Step 1. Turn off the power supply and connect a DMM and an electronic load to the output (see **Test Setup A**). Also connect the remote sense leads to the output.

Step 2. Turn on the power supply and program the instrument settings as described in the test record form under “Voltage Programming & Readback, Min Voltage”. Turn the output on.

Step 3. Turn on the electronic load and set it to CC mode. Program it to the current setting described in the test record under “Voltage Programming & Readback, Min Voltage”. The power supply's output status should be “CV”, and the output current should be close to the electronic load's current setting.

Step 4. Record the output voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, Minimum Voltage”.

WARNING

SHOCK HAZARD The next step applies the full output voltage of the power supply to the output terminals.

Before proceeding to step 5, turn off the output of the power supply and turn off the electronic load. If the electronic load is rated less than the voltage rating of the power supply, you must also physically disconnect the load from the power supply. Use a switch as shown in Test Setup A. Only open the switch when the output is turned off.

Step 5. Turn on the output and program the instrument settings as described in the test record form under “Voltage Programming & Readback, High Voltage”.

Step 6. Record the output voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, High Voltage”.

Step 7. Turn off the output. Disconnect the remote sense leads from the output and **repeat steps 1 through 6**. This verifies the voltage programming and readback accuracy with local sensing. In local sense mode the sense terminals are internally connected to the output terminals.

Constant Voltage Load Effect

This test measures the change in output voltage resulting from a large change in output current.

Step 1. Keep the connections as in Voltage Programming and Readback Accuracy (see [Test Setup A](#)). Connect the remote sense leads.

Step 2. Turn on the power supply and program the instrument settings as described in the test record form under “CV Load Effect”.

Step 3. Set the electronic load to the first current value as described in the test record form under “CV Load Effect”. The power supply's output status should be “CV”.

Step 4. Record the output voltage reading from the DMM.

Step 5. Set the electronic load to the second current value as described in the test record form under “CV Load Effect”. Record the voltage reading from the DMM again. The difference between the DMM readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Load Effect”.

Constant Voltage Ripple and Noise

Periodic and random deviations in the output combine to produce a residual AC voltage superimposed on the DC. This residual voltage is specified as the rms or peak-to-peak noise in the indicated frequency range (see [Specifications](#)).

Step 1. Turn off the power supply and connect an electronic load, differential amplifier, and an oscilloscope (ac coupled) to the output (see [Test Setup C](#)).

Step 2. As shown in the diagram, use the differential probe to connect the differential amplifier to the + and - output terminals. The shields of the two probes should be connected together. Connect the output of the differential amplifier to the oscilloscope with a 50 Ω termination at the input of the oscilloscope.

Step 3. Set the inputs of the differential amplifier to match the probes. Set the inputs to AC coupling. Set the input resistance to 1 M Ω . Set the oscilloscope's time base to 10 ms/div, and the vertical scale to the maximum sensitivity without clipping the waveform. Turn the bandwidth limit on (20 or 30 MHz), and set the sampling mode to peak detect.

Step 4. Program the power supply to the settings indicated in the test record form for the appropriate model under “CV Ripple and Noise” and enable the output. Let the oscilloscope run for a few seconds to generate enough measurement points. The result should not exceed the peak-to-peak limits in the test record form for the appropriate model under “CV Ripple and Noise, peak-to-peak”.

NOTE

If the measurement contains any question marks, clear the measurement and try again. This means that some of the scope data received was questionable.

Step 5. Use the oscilloscope to measure the rms noise if it has the ability to measure rms with a 300 kHz bandwidth. Otherwise, disconnect the oscilloscope and differential amplifier. Connect an rms

voltmeter directly to the output terminals (see [Test Setup A](#)). The result should not exceed the rms limits in the test record form for the appropriate model under “CV Ripple and Noise, rms”.

Transient Recovery Time

This test measures the time for the output voltage to recover to within the specified value following a 10% to 90% change in the load current.

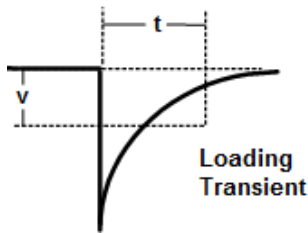
Step 1. Keep the connections as in Constant Voltage Ripple and Noise. If an rms meter was connected, disconnect it and reconnect the oscilloscope (see [Test Setup C](#)).

Step 2. Turn on the power supply and program the instrument settings as described in the test record form under “Transient Response”.

Step 3. Set the electronic load to operate in constant current mode. Program its transient generator to the values of output current as described in the test record form under “Transient Response”.

Step 4. Set the transient generator to 50 ms for both the first and second current values (this is the same as a 10 Hz frequency at 50% duty cycle).

Step 5. Adjust the oscilloscope for a waveform similar to that shown in the following figure.



Step 6. The output voltage should return to within the specified voltage at the specified time following the load change. Check the loading transient by triggering on the negative slope. Record the voltage at time “t” in the performance test record form under “Transient Response”.

Current Programming and Readback Accuracy

This test verifies that the current programming and measurement functions are within specifications.

Step 1. Turn off the power supply and connect an electronic load and a precision current shunt to the output terminals. The current shunt should be able to measure the power supply's rated current. Connect a DMM directly across the current shunt (see [Test Setup B](#)).

Step 2. Turn on the power supply and program the instrument settings as described in the test record form under “Current Programming & Readback, Min Current”. Turn the output on.

Step 3. Turn on the electronic load and set it to CV mode. Program it to the voltage setting described in the test record under “Current Programming & Readback, Min Current”. The power supply's output status should be “CC”, and the output voltage should be close to the electronic load's voltage setting.

Step 4. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value. Also, record the current measured over the interface. The

readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, Minimum Current”.

Step 5. Program the instrument settings as described in the test record form under “Current Programming & Readback, High Current”.

Step 6. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value. Also, record the current reading measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, High Current”.

Constant Current Load Effect

NOTE

For the 1000 V and 1500 V models, the CC load effect tests are performed up to 750 VDC, as this is the maximum input rating of the recommended electronic loads.

This test measures the change in output current following a large change in output voltage.

Step 1. Keep the connections as in Current Programming and Readback Accuracy (see [Test Setup B](#)).

Step 2. Turn on the power supply and program the instrument settings as described in the test record under “CC Load Effect”.

Step 3. Set the electronic load to the first voltage value as described in the test record form under “CC Load Effect”. The power supply's output status should be “CC”.

Step 4. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value.

Step 5. Set the electronic load to the second voltage value as described in the test record form under “CC Load Effect”. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value. The difference in the current readings in steps 4 and 5 is the load effect, which should not exceed the value listed in the test record for the appropriate model under “CC Load Effect”.

Calibration Procedure

[Enter Calibration Mode](#)

[Voltage Calibration - With Remote Sensing](#)

[Voltage Calibration - With Local Sensing](#)

[Current Calibration](#)

[Enter a Calibration Date and Log Out](#)

WARNING **HAZARDOUS VOLTAGES** The output may be enabled at turn-on, depending on the ***PON setting**. Check this setting before attaching anything to the output terminals.

The instrument features closed-case electronic calibration; no internal mechanical adjustments are required. The instrument calculates correction factors based on input reference values that you set and stores correction factors in non-volatile memory until the next calibration adjustment is performed. This EEPROM calibration memory is not changed by cycling power or *RST.

- Refer to [Recommended Test Equipment and Setups](#) for the equipment list and test setups required for calibration.
- Refer to the [Measurement Techniques](#) section for information about setting up the voltmeter, connecting the current shunt, and connecting the electronic load..
- The correct password is required to enter the Admin menu, which contains the calibration function. The password is factory-set to 0 (zero). You can change the password once calibration mode is entered to prevent unauthorized access to the calibration mode. Refer to [Password Protection](#) for more information.
- When calibrating the unit using SCPI commands, most steps involve sending a *OPC? query to synchronize with the instrument's command completion before proceeding. The response from the instrument must be read each time *OPC? is given. Additionally, the relatively slow settling times and slew rates of the power supply must be taken into account. Use "Wait" statements to allow for the appropriate settling times for the power supply.
- Any calibration section can be run and saved independently of the other sections. As each calibration section is completed, the instrument calculates new calibration constants and begins using them. However, these constants are not saved in nonvolatile memory until a SAVE command is explicitly given.
- Exit the calibration mode either by logging out of the Admin menu or by sending CAL:STAT OFF. Note that any calibration section that was calibrated but not saved will revert to its previous calibration constants.

WARNING HAZARDOUS VOLTAGES All models generate voltages in excess of 60 VDC, with some models rated at up to 1,500 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Always turn off the output when connecting or disconnecting any equipment on the sense or output terminals of the unit.

Enter Calibration Mode

Front Panel Menu	SCPI Command
Select System\Admin\Login .	CAL:STAT ON <password>
Enter your password. Then press Select .	

Voltage Calibration - With Remote Sensing

Voltage Programming and Measurement

NOTE To guarantee a clean signal for calibration points 1 through 3, program the electronic load to at least 5% of the rated output current of the model being calibrated.

Step 1. Turn off the output. Connect a DMM and an electronic load to the output as shown in **Test Setup A**. If the electronic load is rated less than the voltage rating of the power supply, install a disconnect switch as shown. For 1500 VDC models, connect a voltage divider as shown. Connect the remote sense leads to the output.

Step 2. Select the remote voltage programming and measurement calibration.

Front Panel Menu	SCPI Command
Select System\Admin\Cal\Volt\Vrem .	Specify remote sense voltage calibration:
Check that the voltmeter is connected and select Next.	CAL:VOLT:REM

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third voltage calibration point and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P3 *OPC? CAL:DATA <data>

WARNING **SHOCK HAZARD** The next step applies the full output voltage of the power supply to the output terminals.

Turn off the electronic load before proceeding. If the electronic load is rated less than the voltage rating of the power supply, you must also physically disconnect the load from the power supply. Use a switch as shown in **Test Setup A**.

Front Panel Menu	SCPI Command
A warning message about the full scale output voltage appears on the display. Select Next.	Not applicable

Step 6. Select the fourth voltage calibration point and enter the data. This is done at full scale voltage.

Front Panel Menu	SCPI Command
Display shows: "Enter P4 measured data" Enter the data from the external DMM. Press Enter when done. Press Back repeatedly to back out of the calibration menu.	CAL:LEV P3 *OPC? CAL:DATA <data>

Step 7. Save the calibration data.

Front Panel Menu	SCPI Command
Select System \Admin \Cal \Save . Select Save to save the calibration data.	To save calibration data: CAL:SAVE

Voltage Calibration - With Local Sensing

This procedure calibrates the instrument for Local sense operation (with the +/- sense leads not connected).

Step 1. Turn off the output. Keep all connections as before except **disconnect** the remote sense leads from the output (see **Test Setup A**). The unit will automatically revert to local sense mode when the remote sense leads are disconnected.

Step 2. Select the local voltage programming and measurement calibration.

Front Panel Menu	SCPI Command
Select System \Admin \Cal \Volt \Vloc . Check that the voltmeter is connected and select Next.	Specify local sense voltage calibration: CAL:VOLT

Repeat the remaining calibration procedure (steps 3 through 7) as described under Voltage Calibration - With Remote Sensing. Other than the first two steps, the remaining calibration steps are unchanged.

Current Calibration

Current Programming and Measurement

NOTE

To guarantee a clean signal for calibration points 1 through 4, program the electronic load to either 2% of the full-scale voltage rating of the power supply or 3 V - whichever is greater.

Step 1. Turn off the output. Connect an electronic load and a precision current shunt to the output terminals. The current shunt should be able to measure the rated output current of the power supply. Connect a DMM directly across the current shunt. (see [Test Setup B](#)).

Step 2. Select the current programming and measurement calibration.

Front Panel Menu	SCPI Command
Select System\Admin\CAL\Curr. Check that the shunt and voltmeter are connected and select Next.	Specify current calibration: CAL:CURRE

Step 3. Select the first current calibration point. Wait 15 seconds for the output to stabilize. Calculate the shunt current ($I=V/R$) and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point. Wait 15 seconds for the output to stabilize. Calculate the shunt current ($I=V/R$) and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third current calibration point. Wait 15 seconds for the output to stabilize. Calculate the shunt current ($I=V/R$) and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Enter when done.	CAL:LEV P3 *OPC? CAL:DATA <data>

4 Service and Maintenance

Front Panel Menu	SCPI Command
A warning message about the full scale output current appears on the display. Select Next.	Not applicable

Step 6. Select the fourth current calibration point. Wait 3 minutes for the internal shunt temperature to stabilize. Calculate the shunt current ($I=V/R$) and enter the data.

Front Panel Menu	SCPI Command
Display shows: "Enter P4 measured data" Enter the data from the external DMM. This should be the full-scale current rating. Press Enter when done. Press Back repeatedly to back out of the calibration menu.	<code>CAL:LEV P4</code> <code>*OPC?</code> <code>CAL:DATA <data></code>

Step 7. Save the calibration data.

Front Panel Menu	SCPI Command
Select System\Admin\CAL\Save . Select Save to save the calibration data.	To save calibration data: <code>CAL:SAVE</code>

Enter a Calibration Date and Log Out

Front Panel Menu	SCPI Command
Select System\Admin\CAL\DATE . Enter the calibration date in the Date field.	To enter a calibration date: <code>CAL:DATE "<date>"</code>
Select System\Admin\Logout to exit calibration mode.	To exit calibration mode: <code>CAL:STAT OFF</code>

Test Record Forms

N8920A/N8940A

N8920A/N8940A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
CV Load Effect:	Both	– 40 mV	_____	+ 40 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 200 mV
rms:	Both	N/A	_____	+ 16 mV
Transient response @ 1.5 ms:	Both	– 800 mV	_____	+ 800 mV
Current Programming & Readback				
Minimum current (Iout):	Both	8.15 A	_____	8.84 A
Current measured over interface:	Both	Idmm – 340 mA	_____	Idmm + 340 mA
High current (Iout):	Both	161.15 A	_____	161.84 A
Current measured over interface:	Both	Idmm – 340 mA	_____	Idmm + 340 mA
CC Load Effect:	Both	– 255 mA	_____	+ 255 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 17 A	4 V, 170 A
Voltage Programming & Readback High Voltage:	CC, 17 A	76 V, 170 A
CV Load Effect:	CC, 1.7 A to 161.5 A	20 V, 170 A
CV Ripple and Noise:	CC 161.5 A	20 V, 170 A
Transient Response:	CC, 17 A to 153 A	20 V, 170 A
Current Programming & Readback Min Current:	CV, 3 V	8 V, 8.5 A
Current Programming & Readback High Current:	CV, 3 V	8 V, 161.5 A
CC Load Effect:	CV, 3 V to 76 V	80 V, 17 A

N8921A/N8941A

N8921A/N8941A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
CV Load Effect:	Both	- 100 mV	_____	+ 100 mV
CV Ripple and Noise				
peak-to-peak:	N8921A	N/A	_____	+ 375 mV
	N8941A	N/A	_____	+ 300 mV
rms:	Both	N/A	_____	+ 40 mV
Transient response @ 1.5 ms:	Both	- 2 V	_____	+ 2 V
Current Programming & Readback				
Minimum current (Iout):	Both	3.36 A	_____	3.64 A
Current measured over interface:	Both	Idmm – 140 mA	_____	Idmm + 140 mA
High current (Iout):	Both	66.36 A	_____	66.64 A
Current measured over interface:	Both	Idmm – 140 mA	_____	Idmm + 140 mA
CC Load Effect:	Both	- 105 mA	_____	+ 105 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 7 A	10 V, 70 A
Voltage Programming & Readback High Voltage:	CC, 7 A	190 V, 70 A
CV Load Effect:	CC, 0.7 A to 66.5 A	50 V, 70 A
CV Ripple and Noise:	CC, 66.5 A	50 V, 70 A
Transient Response:	CC, 7 A to 63 A	50 V, 70 A
Current Programming & Readback Min Current:	CV, 4 V	9 V, 3.5 A
Current Programming & Readback High Current:	CV, 4 V	9 V, 66.5 A
CC Load Effect:	CV, 4 V to 190 V	200 V, 7 A

N8923A/N8943A

N8923A/N8943A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
CV Load Effect:	Both	- 250 mV	_____	+ 250 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 350 mV
rms:	Both	N/A	_____	+ 70 mV
Transient response @ 1.5 ms:	Both	- 5 V	_____	+ 5 V
Current Programming & Readback				
Minimum current (Iout):	Both	1.44 A	_____	1.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
High current (Iout):	Both	28.44 A	_____	28.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
CC Load Effect:	Both	- 45 mA	_____	+ 45 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 3 A	25 V, 30 A
Voltage Programming & Readback High Voltage:	CC, 3 A	475 V, 30 A
CV Load Effect:	CC, 0.3 A to 28.5 A	125 V, 30 A
CV Ripple and Noise:	CC, 28.5 A	125 V, 30 A
Transient Response:	CC, 3 A to 27 A	125 V, 30 A
Current Programming & Readback Min Current:	CV, 10 V	15 V, 1.5 A
Current Programming & Readback High Current:	CV, 10 V	15 V, 28.5 A
CC Load Effect:	CV, 10 V to 475 V	500 V, 3 A

N8924A/N8944A

N8924A/N8944A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
CV Load Effect:	Both	- 375 mV	_____	+ 375 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 800 mV
rms:	Both	N/A	_____	+ 200 mV
Transient response @ 1.5 ms:	Both	- 7.5 V	_____	+ 7.5 V
Current Programming & Readback				
Minimum current (Iout):	Both	0.96 A	_____	1.04 A
Current measured over interface:	Both	Idmm – 40 mA	_____	Idmm + 40 mA
High current (Iout):	Both	18.96 A	_____	19.04 A
Current measured over interface:	Both	Idmm – 40 mA	_____	Idmm + 40 mA
CC Load Effect:	Both	- 30 mA	_____	+ 30 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 2 A	37.5 V, 20 A
Voltage Programming & Readback High Voltage:	CC, 2 A	712.5 V, 20 A
CV Load Effect:	CC, 0.2 A to 19 A	187.5 V, 20 A
CV Ripple and Noise:	CC, 19 A	187.5 V, 20 A
Transient Response:	CC, 2 A to 18 A	187.5 V, 20 A
Current Programming & Readback Min Current:	CV, 15 V	20 V, 1 A
Current Programming & Readback High Current:	CV, 15 V	20 V, 19 A
CC Load Effect:	CV, 15 V to 712.5 V	750 V, 2 A

N8925A/N8945A

N8925A/N8945A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
CV Load Effect:	Both	– 40 mV	_____	+ 40 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 320 mV
rms:	Both	N/A	_____	+ 25 mV
Transient response @ 1.5 ms:	Both	– 800 mV	_____	+ 800 mV
Current Programming & Readback				
Minimum current (Iout):	Both	16.32 A	_____	17.68 A
Current measured over interface:	Both	Idmm – 680 mA	_____	Idmm + 680 mA
High current (Iout):	Both	322.32 A	_____	323.68 A
Current measured over interface:	Both	Idmm – 680 mA	_____	Idmm + 680 mA
CC Load Effect:	Both	– 510 mA	_____	+ 510 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 34 A	4 V, 340 A
Voltage Programming & Readback High Voltage:	CC, 34 A	76 V, 340 A
CV Load Effect:	CC, 3.4 A to 323 A	20 V, 340 A
CV Ripple and Noise:	CC, 323 A	20 V, 340 A
Transient Response:	CC, 34 A to 306 A	20 V, 340 A
Current Programming & Readback Min Current:	CV, 3 V	8 V, 17 A
Current Programming & Readback High Current:	CV, 3 V	8 V, 323 A
CC Load Effect:	CV, 3 V to 76 V	80 V, 34 A

N8926A/N8946A

N8926A/N8946A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
CV Load Effect:	Both	- 100 mV	_____	+ 100 mV
CV Ripple and Noise				
peak-to-peak:	N8926A	N/A	_____	+ 375 mV
	N8946A	N/A	_____	+ 300 mV
rms:	Both	N/A	_____	+ 40 mV
Transient response @ 1.5 ms:	Both	- 2 V	_____	+ 2 V
Current Programming & Readback				
Minimum current (Iout):	Both	6.72 A	_____	7.28 A
Current measured over interface:	Both	Idmm – 280 mA	_____	Idmm + 280 mA
High current (Iout):	Both	132.72 A	_____	133.28 A
Current measured over interface:	Both	Idmm – 280 mA	_____	Idmm + 280 mA
CC Load Effect:	Both	- 210 mA	_____	+ 210 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 14 A	10 V, 140 A
Voltage Programming & Readback High Voltage:	CC, 14 A	190 V, 140 A
CV Load Effect:	CC, 1.4 A to 133 A	50 V, 140 A
CV Ripple and Noise:	CC, 133 A	50 V, 140 A
Transient Response:	CC, 14 A to 126 A	50 V, 140 A
Current Programming & Readback Min Current:	CV, 4 V	9 V, 7 A
Current Programming & Readback High Current:	CV, 4 V	9 V, 133 A
CC Load Effect:	CV, 4 V to 190 V	200 V, 14 A

N8928A/N8948A

N8928A/N8948A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
CV Load Effect:	Both	- 250 mV	_____	+ 250 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 350 mV
rms:	Both	N/A	_____	+ 70 mV
Transient response @ 1.5 ms:	Both	- 5 V	_____	+ 5 V
Current Programming & Readback				
Minimum current (Iout):	Both	2.88 A	_____	3.12 A
Current measured over interface:	Both	Idmm – 120 mA	_____	Idmm + 120 mA
High current (Iout):	Both	56.88 A	_____	57.12 A
Current measured over interface:	Both	Idmm – 120 mA	_____	Idmm + 120 mA
CC Load Effect:	Both	- 90 mA	_____	+ 90 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 6 A	25 V, 60 A
Voltage Programming & Readback High Voltage:	CC, 6 A	475 V, 60 A
CV Load Effect:	CC, 0.6 A to 57 A	125 V, 60 A
CV Ripple and Noise:	CC, 57 A	125 V, 60 A
Transient Response:	CC, 6 A to 54 A	125 V, 60 A
Current Programming & Readback Min Current:	CV, 10 V	15 V, 3 A
Current Programming & Readback High Current:	CV, 10 V	15 V, 57 A
CC Load Effect:	CV, 10 V to 475 V	500 V, 6 A

N8929A/N8949A

N8929A/N8949A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
CV Load Effect:	Both	- 375 mV	_____	+ 375 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 800 mV
rms:	Both	N/A	_____	+ 200 mV
Transient response @ 1.5 ms:	Both	- 7.5 V	_____	+ 7.5 V
Current Programming & Readback				
Minimum current (Iout):	Both	1.92 A	_____	2.08 A
Current measured over interface:	Both	Idmm – 80 mA	_____	Idmm + 80 mA
High current (Iout):	Both	37.92 A	_____	38.08 A
Current measured over interface:	Both	Idmm – 80 mA	_____	Idmm + 80 mA
CC Load Effect:	Both	- 60 mA	_____	+ 60 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 4 A	37.5 V, 40 A
Voltage Programming & Readback High Voltage:	CC, 4 A	712.5 V, 40 A
CV Load Effect:	CC, 0.4 A to 38 A	187.5 V, 40 A
CV Ripple and Noise:	CC, 38 A	187.5 V, 40 A
Transient Response:	CC, 4 A to 36 A	187.5 V, 40 A
Current Programming & Readback Min Current:	CV, 15 V	20 V, 2 A
Current Programming & Readback High Current:	CV, 15 V	20 V, 38 A
CC Load Effect:	CV, 15 V to 712.5 V	750 V, 4 A

N8930A/N8950A

N8930A/N8950A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	49 V	_____	51 V
Voltage measured over interface:	Both	Vdmm - 1 V	_____	Vdmm + 1 V
High voltage (Vout):	Both	949 V	_____	951 V
Voltage measured over interface:	Both	Vdmm - 1 V	_____	Vdmm + 1 V
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	49 V	_____	51 V
Voltage measured over interface:	Both	Vdmm - 1 V	_____	Vdmm + 1 V
High voltage (Vout):	Both	949 V	_____	951 V
Voltage measured over interface:	Both	Vdmm - 1 V	_____	Vdmm + 1 V
CV Load Effect:	Both	- 500 mV	_____	+ 500 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 1600 mV
rms:	Both	N/A	_____	+ 350 mV
Transient response @ 1.5 ms:	Both	- 10 V	_____	+ 10 V
Current Programming & Readback				
Minimum current (Iout):	Both	1.44 A	_____	1.56 A
Current measured over interface:	Both	Idmm - 60 mA	_____	Idmm + 60 mA
High current (Iout):	Both	28.44 A	_____	28.56 A
Current measured over interface:	Both	Idmm - 60 mA	_____	Idmm + 60 mA
CC Load Effect:	N8930A	- 53 mA	_____	+ 53 mA
	N8950A	- 45 mA	_____	+ 45 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 3 A	50 V, 30 A
Voltage Programming & Readback High Voltage:	Disconnect load	950 V, 30 A
CV Load Effect:	CC, 0.3 to 28.5 A	250 V, 30 A
CV Ripple and Noise:	CC, 28.5 A	250 V, 30 A
Transient Response:	CC, 3 A to 27 A	250 V, 30 A
Current Programming & Readback Min Current:	CV, 20 V	25 V, 1.5 A
Current Programming & Readback High Current:	CV, 20 V	25 V, 28.5 A
CC Load Effect:	CV, 20 V to 750 V	760 V, 3 A

N8931A/N8951A

N8931A/N8951A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	3.92 V	_____	4.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
High voltage (Vout):	Both	75.92 V	_____	76.08 V
Voltage measured over interface:	Both	Vdmm – 80 mV	_____	Vdmm + 80 mV
CV Load Effect:	Both	– 40 mV	_____	+ 40 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 320 mV
rms:	Both	N/A	_____	+ 25 mV
Transient response @ 1.5 ms:	Both	– 800 mV	_____	+ 800 mV
Current Programming & Readback				
Minimum current (Iout):	Both	24.4 A	_____	26.6 A
Current measured over interface:	Both	Idmm – 1.1 A	_____	Idmm + 1.1 A
High current (Iout):	Both	483.4 A	_____	485.6 A
Current measured over interface:	Both	Idmm – 1.1 A	_____	Idmm + 1.1 A
CC Load Effect:	Both	– 765 mA	_____	+ 765 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 51 A	4 V, 510 A
Voltage Programming & Readback High Voltage:	CC, 51 A	76 V, 510 A
CV Load Effect:	CC, 5.1 A to 484.5 A	20 V, 510 A
CV Ripple and Noise:	CC, 484.5 A	20 V, 510 A
Transient Response:	CC, 51 A to 459 A	20 V, 510 A
Current Programming & Readback Min Current:	CV, 3 V	8 V, 25.5 A
Current Programming & Readback High Current:	CV, 3 V	8 V, 484.5 A
CC Load Effect:	CV, 3 V to 76 V	80 V, 51 A

N8932A/N8952A

N8932A/N8952A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	9.8 V	_____	10.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
High voltage (Vout):	Both	189.8 V	_____	190.2 V
Voltage measured over interface:	Both	Vdmm – 200 mV	_____	Vdmm + 200 mV
CV Load Effect:	Both	- 100 mV	_____	+ 100 mV
CV Ripple and Noise				
peak-to-peak:	N8932A	N/A	_____	+ 375 mV
	N8952A	N/A	_____	+ 300 mV
rms:	Both	N/A	_____	+ 40 mV
Transient response @ 1.5 ms:	Both	- 2 V	_____	+ 2 V
Current Programming & Readback				
Minimum current (Iout):	Both	10.08 A	_____	10.92 A
Current measured over interface:	Both	Idmm – 420 mA	_____	Idmm + 420 mA
High current (Iout):	Both	199.08 A	_____	199.92 A
Current measured over interface:	Both	Idmm – 420 mA	_____	Idmm + 420 mA
CC Load Effect:	Both	- 315 mA	_____	+ 315 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 21 A	10 V, 210 A
Voltage Programming & Readback High Voltage:	CC, 21 A	190 V, 210 A
CV Load Effect:	CC, 2.1 A to 199.5 A	50 V, 210 A
CV Ripple and Noise:	CC, 199.5 A	50 V, 210 A
Transient Response:	CC, 21 A to 189 A	50 V, 210 A
Current Programming & Readback Min Current:	CV, 4 V	9 V, 10.5 A
Current Programming & Readback High Current:	CV, 4 V	9 V, 199.5 A
CC Load Effect:	CV, 4 V to 190 V	200 V, 21 A

N8934A/N8954A

N8934A/N8954A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	24.5 V	_____	25.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
High voltage (Vout):	Both	474.5 V	_____	475.5 V
Voltage measured over interface:	Both	Vdmm – 500 mV	_____	Vdmm + 500 mV
CV Load Effect:	Both	- 250 mV	_____	+ 250 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 350 mV
rms:	Both	N/A	_____	+ 70 mV
Transient response @ 1.5 ms:	Both	- 5 V	_____	+ 5 V
Current Programming & Readback				
Minimum current (Iout):	Both	4.32 A	_____	4.68 A
Current measured over interface:	Both	Idmm – 180 mA	_____	Idmm + 180 mA
High current (Iout):	Both	85.32 A	_____	85.68 A
Current measured over interface:	Both	Idmm – 180 mA	_____	Idmm + 180 mA
CC Load Effect:	Both	- 135 mA	_____	+ 135 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 9 A	25 V, 90 A
Voltage Programming & Readback High Voltage:	CC, 9 A	475 V, 90 A
CV Load Effect:	CC, 0.9 A to 85.5 A	125 V, 90 A
CV Ripple and Noise:	CC, 85.5 A	125 V, 90 A
Transient Response:	CC, 9 A to 81 A	125 V, 90 A
Current Programming & Readback Min Current:	CV, 10 V	15 V, 4.5 A
Current Programming & Readback High Current:	CV, 10 V	15 V, 85.5 A
CC Load Effect:	CV, 10 V to 475 V	500 V, 9 A

N8935A/N8955A

N8935A/N8955A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	36.75 V	_____	38.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
High voltage (Vout):	Both	711.75 V	_____	713.25 V
Voltage measured over interface:	Both	Vdmm – 750 mV	_____	Vdmm + 750 mV
CV Load Effect:	Both	– 375 mV	_____	+ 375 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 800 mV
rms:	Both	N/A	_____	+ 200 mV
Transient response @ 1.5 ms:	Both	– 7.5 V	_____	+ 7.5 V
Current Programming & Readback				
Minimum current (Iout):	Both	2.88 A	_____	3.12 A
Current measured over interface:	Both	Idmm – 120 mA	_____	Idmm + 120 mA
High current (Iout):	Both	56.88 A	_____	57.12 A
Current measured over interface:	Both	Idmm – 120 mA	_____	Idmm + 120 mA
CC Load Effect:	Both	– 90 mA	_____	+ 90 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 6 A	37.5 V, 60 A
Voltage Programming & Readback High Voltage:	CC, 6 A	712.5 V, 60 A
CV Load Effect:	CC, 0.6 A to 57 A	187.5 V, 60 A
CV Ripple and Noise:	CC, 57 A	187.5 V, 60 A
Transient Response:	CC, 6 A to 54 A	187.5 V, 60 A
Current Programming & Readback Min Current:	CV, 15 V	20 V, 3 A
Current Programming & Readback High Current:	CV, 15 V	20 V, 57 A
CC Load Effect:	CV, 15 V to 712.5 V	750 V, 6 A

N8937A/N8957A

N8937A/N8957A Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	73.5 V	_____	76.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
High voltage (Vout):	Both	1498.5 V	_____	1501.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	73.5 V	_____	76.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
High voltage (Vout):	Both	1498.5 V	_____	1501.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
CV Load Effect:	Both	– 750 mV	_____	+ 750 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 2400 mV
rms:	Both	N/A	_____	+ 400 mV
Transient response @ 1.5 ms:	Both	– 15 V	_____	+ 15 V
Current Programming & Readback				
Minimum current (Iout):	Both	1.44 A	_____	1.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
High current (Iout):	Both	28.44 A	_____	28.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
CC Load Effect:	N8937A	– 53 mA	_____	+ 53 mA
	N8957A	– 45 mA	_____	+ 45 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 3 A	75 V, 30 A
Voltage Programming & Readback High Voltage:	Disconnect load	1500 V, 30 A
CV Load Effect:	CC, 0.3 A to 28.5 A	375 V, 30 A
CV Ripple and Noise:	CC, 28.5 A	375 V, 30 A
Transient Response:	CC, 3 A to 27 A	375 V, 30 A
Current Programming & Readback Min Current:	CV, 30 V	40 V, 1.5 A
Current Programming & Readback High Current:	CV, 30 V	40 V, 28.5 A
CC Load Effect:	CV, 30 V to 750 V	760 V, 3 A

N8937APV/N8957APV

N8937APV/N8957APV Test Record		Report Number _____	Date _____	
Test Description	Model	Min. Specs	Results	Max. Specs
With Remote Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	73.5 V	_____	76.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
High voltage (Vout):	Both	1498.5 V	_____	1501.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
With Local Sensing				
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	73.5 V	_____	76.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
High voltage (Vout):	Both	1498.5 V	_____	1501.5 V
Voltage measured over interface:	Both	Vdmm – 1.5 V	_____	Vdmm + 1.5 V
CV Load Effect:	Both	- 750 mV	_____	+ 750 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 2400 mV
rms:	Both	N/A	_____	+ 400 mV
Transient response @ 1.5 ms:	Both	- 15 V	_____	+ 15 V
Current Programming & Readback				
Minimum current (Iout):	Both	1.44 A	_____	1.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
High current (Iout):	Both	28.44 A	_____	28.56 A
Current measured over interface:	Both	Idmm – 60 mA	_____	Idmm + 60 mA
CC Load Effect:	N8937APV	- 53 mA	_____	+ 53 mA
	N8957APV	- 45 mA	_____	+ 45 mA

Test Description	Electronic Load Setting	Instrument Setting
Voltage Programming & Readback Min Voltage:	CC, 3 A	75 V, 30 A
Voltage Programming & Readback High Voltage:	Disconnect load	1500 V, 30 A
CV Load Effect:	CC, 0.3 A to 28.5 A	375 V, 30 A
CV Ripple and Noise:	CC, 28.5 A	375 V, 30 A
Transient Response:	CC, 3 A to 27 A	375 V, 30 A
Current Programming & Readback Min Current:	CV, 30 V	40 V, 1.5 A
Current Programming & Readback High Current:	CV, 30 V	40 V, 28.5 A
CC Load Effect:	CV, 30 V to 750 V	760 V, 3 A

Self-Test Procedure

Power-On Self-Test

Each time the instrument is powered on, a subset of self-tests are performed. This assures you that the instrument is operational.

Self-test checks that the minimum set of logic and power mesh systems are functioning properly. Self-test does not enable the output or place any voltages on the output. It leaves the instrument in the **reset state**.

User-Initiated Self-Test

The user-initiated self-test is the same as the power-on self-test.

Front Panel Menu	SCPI Command
Cycle ac power.	*TST?
If self-test fails, the front panel ERR indicator comes on. Press the Error key to display the list of errors.	If 0, self-test passed. If 1, self-test failed. If self test-fails, use SYSTem:ERRor? to view the self-test error.

For a list of errors, see **SCPI Error Messages**.

Firmware Update

NOTE

Refer to [Instrument Identification](#) to determine which firmware version is installed on your instrument.

Software Required

To update the firmware you need to download the following two items onto your computer from the firmware download page at www.keysight.com/find/N8900firmware. For models N8937APV and N8957APV, go to www.keysight.com/find/N8900APVfirmware.

- The latest firmware version
- The Universal Firmware Update Utility

Update Procedure

Once you have copied both items to your computer, proceed as follows:

1. Run the Universal Firmware Update Utility
2. Browse to the location of the firmware that you just downloaded. Press Next.
3. Select the interface that you are using to communicate with your instrument and enter the address or connections string. Press Next.
4. Verify that the information is correct for the instrument you are updating. Press Begin Update.

The update utility will now update the firmware and restart your instrument.

Restricting Access

Note that you can restrict access to the instrument by the firmware update utility. This prevents unauthorized users from updating the firmware.

Front Panel Menu	SCPI Command
Select System \Admin \Update	Not available
Check the Must log in as admin box.	
This requires a user to log into the Admin menu before the firmware update utility performs a firmware update.	

Instrument Sanitize

NOTE This procedure is not recommended for use in routine applications because of the possibility of unintended loss of data.

This procedure is typically used to prepare the instrument for removal from a secure area. It writes all zeros to flash memory and then performs a full chip erase as per the manufacturer's data sheet. Identification data such as instrument firmware, model number, serial number, MAC address, and calibration data is not erased. After the data is cleared, the instrument is rebooted.

If you cannot access the Admin menu, it may be password protected.

Front Panel Menu	SCPI Command
Select System \Admin \Sanitize	SYST:SEC:IMM
Select Sanitize.	
Selecting Sanitize removes all user-data from the instrument and cycles power.	

Calibration Switches

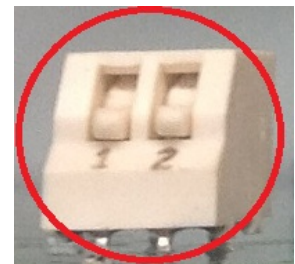
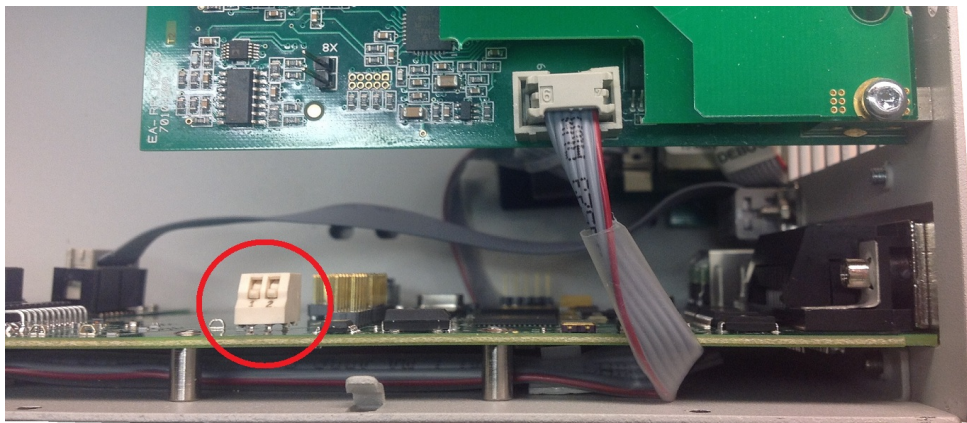
WARNING **SHOCK HAZARD** Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover. Some circuits are active and have power for a short time even when the power switch is turned off.

Two switches control the access to calibration commands. The switches are on the interface board located at the back of the unit and are accessible by removing the top cover. To access the calibration switches:

Accessing the Calibration Switch

1. Remove the instrument cover as described under **Disassembly**.
2. The calibration switch is on the top of the interface board. To change the calibration switch settings, use a small screwdriver to move the switches.
3. Replace the top cover when finished.

CAUTION Do not use a pencil to move the switches. Any graphite dust that gets on the switches will conduct electricity.



Switches shown in ON position

Switch Functions

Switches 1 and 2 set the calibration configuration as follows

	Switch 1	Switch 2	Description
Normal	ON	ON	This is the default or as-shipped switch setting. The calibration functions are accessible after entering a numeric password. The default password is 0 (zero).

4 Service and Maintenance

	Switch 1	Switch 2	Description
Clear Password	OFF	ON	The admin/calibration password is reset to 0 when the instrument is first powered on. Use this setting if you have forgotten the password.
Inhibit Calibration	OFF	OFF	All calibration commands are disabled. This is useful where calibration access is guarded by instrument seals.

Disassembly

WARNING **SHOCK HAZARD** Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover. Some circuits are active and have power for a short time even when the power switch is turned off.

Electrostatic Discharge (ESD) Precautions

Almost all electrical components can be damaged by electrostatic discharge (ESD) during handling. Component damage can occur at electrostatic discharge voltages as low as 50 V.

The following guidelines will help prevent ESD damage during service operations:

- Disassemble instruments only in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.

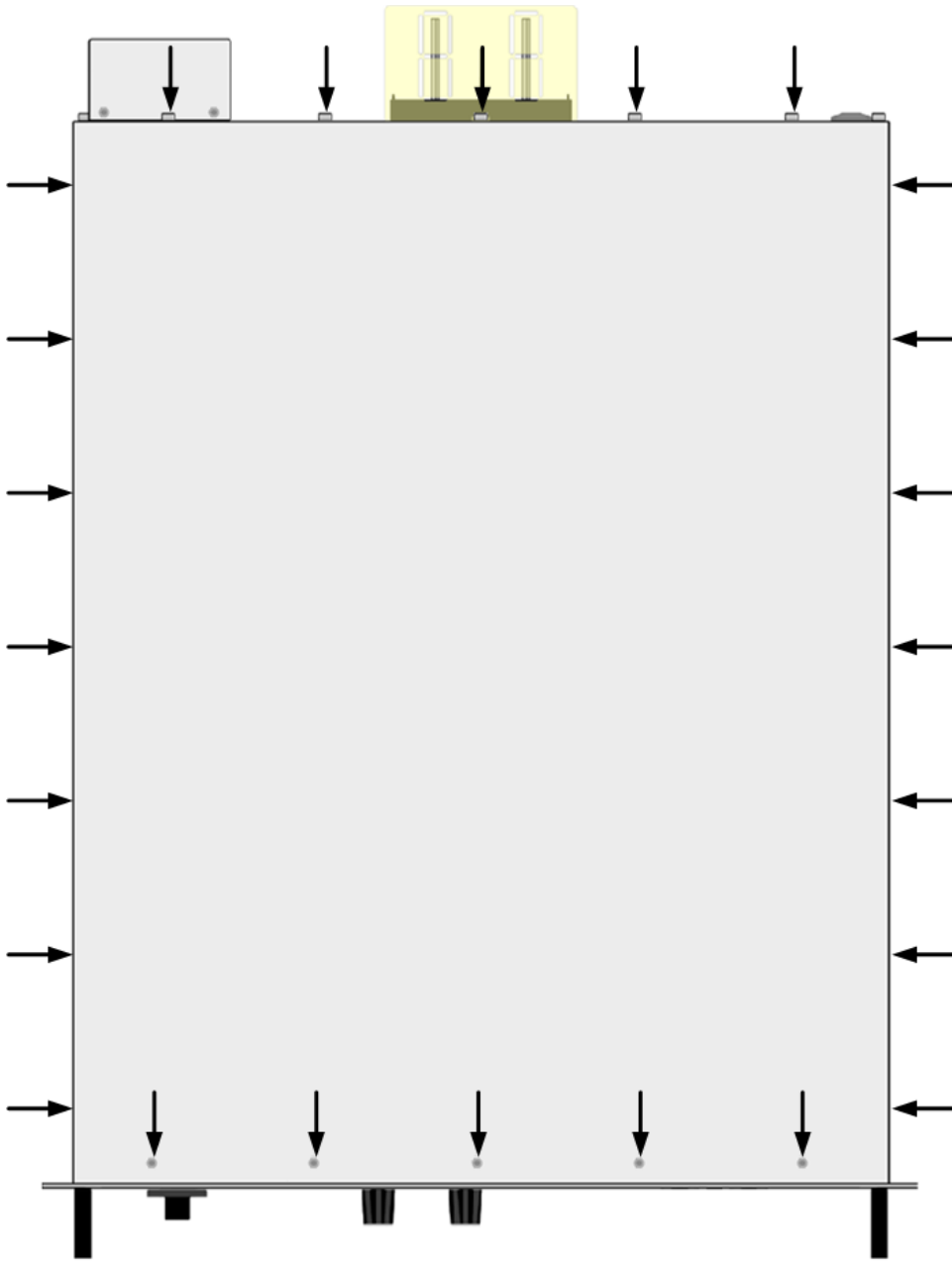
Cover Removal

Tools required:

- T10 Torx driver (cover disassembly)
- Small flat bladed screwdriver

Removal Procedure:

1. Turn off the power. Remove all cables from the instrument.
2. Remove the cover screws. Place them in a container so that you do not lose them.
3. Lift off the instrument cover.



Manual Backdating

Output Terminal Isolation

The **Supplemental Characteristics** section of this document describes the present output terminal isolation voltage limits for Version 2 and Version 3 instruments.

Version 2 and Version 3 instruments are clearly labeled as such on the rear label located on the AC input cover.

Previous instrument versions DO NOT have version number identification on their rear labels. If you have an instrument without a version number, then the following isolation voltage limits apply:

Instrument without a version number on the rear label		
Model voltage rating	Isolation from ground	
	Positive terminal	Negative terminal
80 V	+400 V	+/-400 V
200 V	+600 V	+/-400 V
500 V	+900 V	+/-400 V
750 V	+1000 V	+/-400 V
1000 V	+1000 V	+/-400 V
1500 V	+1500 V	+/-400 V

Analog Connector Operation

The **analog connector operation** has been changed with firmware revisions A.02.00 and up.

Previously, the function of the analog connector was as follows:

- Pin 13 – INHIBIT Inhibits (turns off) output when low. Only active when A-ENAB is low.
- Pin 14 – OVP Over-voltage status indicator. High when OVP is tripped.
- The polarity of Pins 13 and 14 is fixed at High true.
- The Fault Inhibit system protection cannot be extended to multiple supplies or to other Keysight supplies.

Keysight recommends that you update your instrument with the latest firmware revision.

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