Keysight Regenerative Power System RP7900 Series

Operating and Service Guide

Legal and Safety Information

Legal Notices

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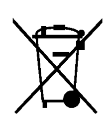
Product Category: With reference to the equipment types in the WEEE directive Annex 1, this product is classified as “Monitoring and Control instrumentation” product.

Do not dispose in domestic household waste.

To return unwanted products, contact your local Keysight office.



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.

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.
	WARNING risk of electric shock
	WARNING refer to accompanying documents
	Earth ground terminal
	The CE mark is a registered trademark of the European Community.
ISM1-A	This indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4)
ICES/NMB-001	This indicates product compliance with the Canadian Interference- Causing Equipment Standard.
Intertek	The ETL mark is a registered trademark of Intertek. The text indicates product compliance with the Canadian Interference- Causing Equipment Standard (ICES-001).
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
40	Contains one or more of the 6 hazardous substances above the maximum concentration value (MCV), 40 Year EPUP.
	South Korean Class A EMC Declaration. This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference. This EMC statement applies to the equipment only for use in business environments.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

※ 사용자 안내문은 "업무용 방송통신기자재"에만 적용한다.

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.

The equipment is for industrial use. 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.

WARNING General
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.

WARNING Environmental Conditions
Never use the instrument outside of the specified environmental conditions described in the Environmental Characteristics of the specifications.

WARNING Heavy Weight
Danger to hands and feet. To avoid personal injury and damage to the instrument, always use a sturdy cart or other suitable device to move the instrument. Do not lift the instrument alone; always use two people to lift the instrument.

WARNING SHOCK HAZARD Ground the Instrument
This product is provided with a protective earth terminal. 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.

WARNING 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".

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

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

WARNING SHOCK HAZARD from external energy sources.
Because the instrument can be used as a load to sink current, hazardous voltages from an external energy source such as a battery may be present on the output terminals even with the unit turned off. Provision must be made to disconnect the external energy source before touching the output or sense terminals.

WARNING Do Not Operate in an Explosive Atmosphere
Do not operate the instrument in the presence of flammable gases or fumes.

WARNING 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.

WARNING 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.

WARNING Fuses
The instrument contains an internal fuse, which is not customer accessible.

WARNING Cleaning
To prevent electric shock, always disconnect the AC mains before cleaning. Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not use detergent or chemical solvents. Do not attempt to clean internally.

WARNING

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.

1
Quick Reference

This document includes user, service, and programming information for the Keysight Regenerative Power System (RPS) Family.

Documentation, Firmware, and Technical Support

You can download the latest version of this document at www.keysight.com. Type in your model number in the Search field. Manuals are available under the Document Library tab. The latest version is also available for mobile devices at www.keysight.com/find/RPS-mobilehelp.

For the latest firmware revision go to Firmware Updates.

If you have questions about your shipment, or if you need information about warranty, service, or technical support, contact Keysight Technologies.

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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KEYSIGHT TECHNOLOGIES

Introduction to the Instrument

Regenerative Power System at a Glance

The Keysight Regenerative Power System (RPS) Family includes 3U rack-mountable DC power supplies with performance and features that are optimized for automated test systems. The output and system features are described as follows. The Models and Options section describes the features that apply to specific models.

Output features

- Full programming capability for the entire range of output voltage and current
- Output autoranging for greater flexibility
- Output can operate in voltage priority or current priority mode
- High-speed up and down output programming
- Output resistance programming
- Turn-on/turn-off delays allow output on/off sequencing across multiple units
- Current sharing capability for paralleled outputs
- Protection capability includes over-voltage, over-current, and over-temperature
- Two-quadrant operation provides current sourcing and sinking capability
- 100% rated current-sink capability
- 5 kW and 10 kW rated models

Measurement features

- 5.12 microsecond sample rate
- Real-time power measurements
- A-hour & W-hour measurement
- Digitized measurement capability

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
- Master-Slave function allows for composite output control and display from one unit

Regenerative Operation

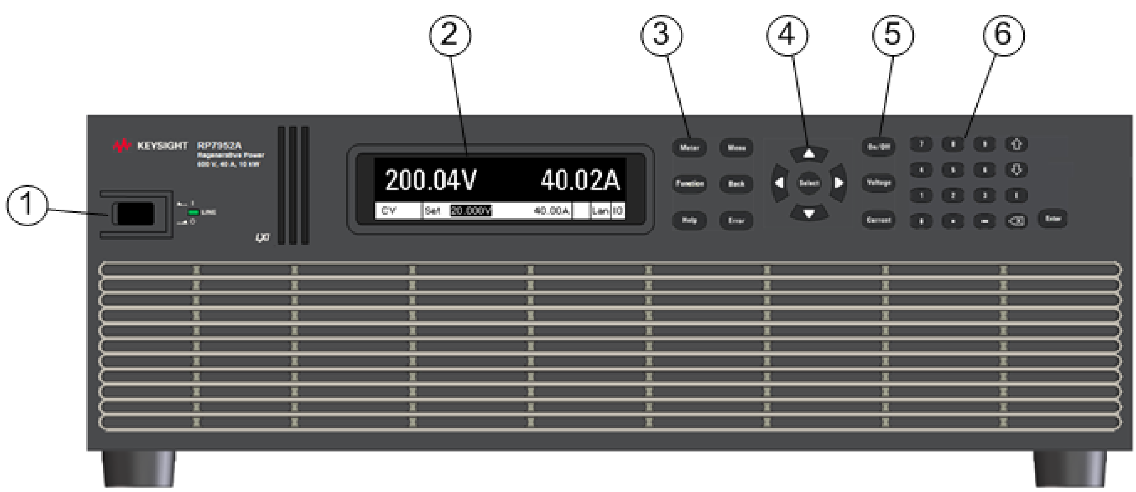
Regenerative operation is automatic and requires no programming on the part of the user. Whenever the RPS is sinking current, either by rapidly downprogramming the output, or by discharging an energy source such as a battery, the unit will direct the excess power back to the AC mains. You cannot disable the regenerative operation.

During regenerative operation, the power factor of 0.99 is maintained. Sinewave current distortion is less than 2% at full load. This ensures the quality of the AC signal that is returned to the AC mains.

When an AC mains dropout is sensed, galvanic relays disconnect the AC mains and the unit shuts down. To safeguard your device under test, the RPS provides “anti-islanding” that senses that the grid is live before regenerating power back to the grid.

Refer to Common Characteristics for additional information about unit shutdown and restart.

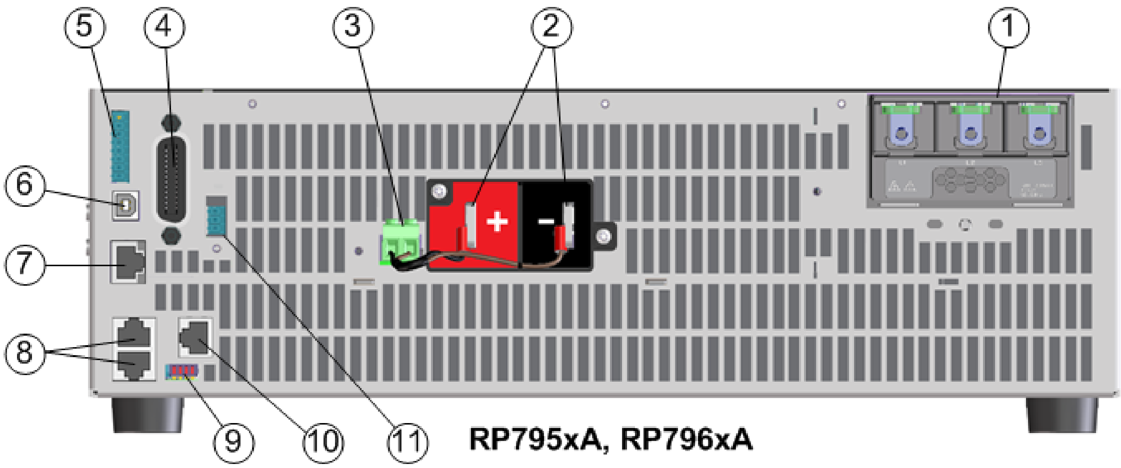
Front Panel at a Glance

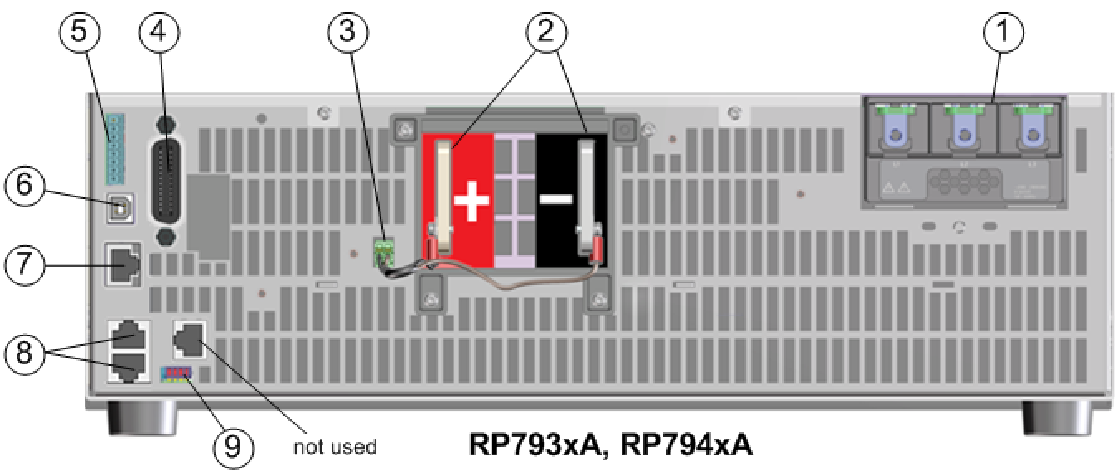


1. **On/Off switch and LED** - LED indicates power is on. Green indicates normal operation. Amber indicates display is in screen-saver mode.
2. **Display** - Turns off after 1 hour of inactivity. Press any key to restore the display.
3. **System keys** - Select metering function. Access front panel command, help, and error menus.
4. **Navigation keys** - Move the cursor to a menu item. Select the highlighted menu item.

5. **Output keys** - Turn the outputs on or off. Enter voltage or current.
6. **Numeric Entry keys** - Enter values. Arrow keys increment or decrement numeric settings.

Rear Panel at a Glance

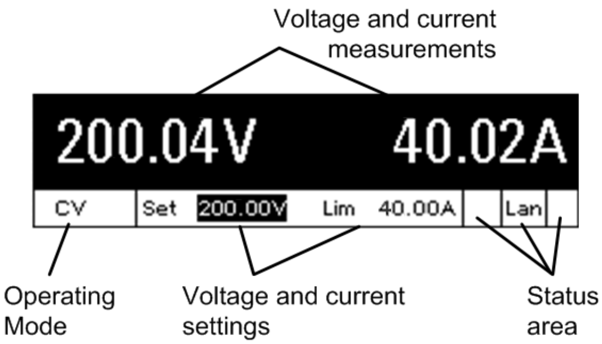




1. **AC input** - 3-phase AC input (L1, L2, L3) with chassis ground. The AC input is bi-directional.
2. **DC outputs** - Positive and negative output terminals.
3. **Sensing** - Remote sense terminals - connected for local sensing.
4. **GPIB** - GPIB interface connector.
5. **Digital IO** - Digital IO connector. Pins are user-configurable.
6. **USB** - USB interface connector.
7. **LAN** - 10/100/1000 Base-T Left LED indicates activity. Right LED indicates link integrity.
8. **Master/slave** - Master/slave connectors - for grouping paralleled units.
9. **Termination switches** - Specifies master/slave termination types.

10. **SDS connector** – Keysight SD1000A system connector – for models RP795xA, RP796xA only.
11. **Sharing** – Current sharing connector – for models RP795xA, RP796xA only.

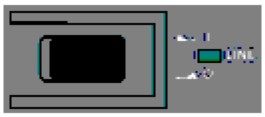
Front Panel Display at a Glance



Voltage and current measurements	Displays the actual output voltage and current
Operating mode	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 disabled by the positive power limit CP– = the output is disabled by the negative power limit VL+ = the output is in positive voltage limit mode CL+/– = the output is in positive or negative current limit mode OV = the output is disabled by the over-voltage protection OV– = the output is disabled by the negative over-voltage protection OC = the output is disabled by the over-current protection OT = the over-temperature protection has tripped PF = the output is disabled by a power-fail condition P = the instrument has been paralleled with another instrument Inh = the output is disabled by an external inhibit signal Unr = the output is unregulated Prot = the output is disabled by a protection condition on another unit EDP = the output is disabled by excessive output dynamics protection IPK+/– = the output is in positive or negative peak current limit CSF = a current sharing fault has occurred MSP = A master/slave protection has occurred SDP = A safety disconnect system fault has occurred UV = the output is disabled by the under-voltage protection T-on = the output is turning on T-off = the output is turning off
Voltage and current settings	Displays the programmed voltage and current. These settings may not match the measured output voltage or current. For example, in constant voltage operation, the output current setting (limit) may be set to 1 A, but the actual (measured) output current must be less than 1 A for the output to remain in constant voltage mode. If the Current limit is reached, the output will no longer be operating in constant voltage mode, but will be in current limit mode. In this case, the actual output voltage will now be less than the output voltage setting.

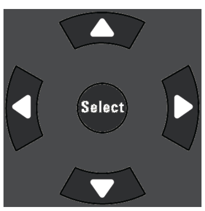
Status area	Indicates the following remote interface activity: Err = an error has occurred (press Error key to display error message) Lan = the LAN is connected and has been configured IO = there is activity on one of the remote interfaces

Front Panel Keys at a Glance

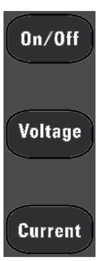


The On/Off switch turns the unit on or off. The LED indicates power is on. **Green** indicates normal operation. **Yellow** indicates that the display is in screen saver mode. The LED is also yellow during the boot-up process . Press any key to exit screen saver mode.

The System keys access the following front panel meter and command menus:
Meter returns the display to metering mode. Also toggles between current and power measurements.
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:
The Arrow keys move around in the command menus. They also select alpha characters in alpha-numeric entry fields.
The Select key 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 controls 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 Backspace 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.

NOTE Press the Help key to get context sensitive help.

Front Panel Menu Reference

Press the **Menu** key to access the front panel menus. For a brief tutorial, refer to Use the front panel menu. If a menu item is grayed-out, it is not available for the model that is being programmed.

1st Menu Level	2nd Level	3rd & 4th Levels		Description
Output	Voltage			Programs output voltage settings
	Current			Programs output current settings
	Mode			Programs output priority mode
	Sequence	Delay		Programs output on/off delay
		Couple		Configures output state coupling
	Advanced	Slew		Programs output current or voltage slew rates
		Resistance		Programs output resistance
		Bandwidth	Current	Programs current bandwidth
			Voltage	Programs voltage bandwidth
		Tmode		Programs output turn-on/turn-off mode
		CurrSharing		Enables/disables output current sharing
Measure	Sweep			Configures measurement sampling
	Window			Select measurement window
	Control			Initiates, triggers, and aborts acquisitions; displays trig state
	AhWh			Measures or resets amp-hours and watt hours
Transient	Mode			Selects voltage and current transient modes
	Step			Configures voltage or current steps and trigger signals
	List	Pace		Specifies Dwell or Trigger paced list
		Repeat		Specifies number of list repetitions, or continuous list
		Terminate		Specifies list termination conditions
		Config		Configures individual list step settings
		Reset		Aborts the list and resets all list settings
	Arb	Repeat		Specifies number of Arb repetitions, or continuous Arb
		Terminate		Specifies Arb termination conditions
		Config		Configures individual Arb settings

1st Menu Level	2nd Level	3rd & 4th Levels		Description
	TrigSource			Specifies the transient and CD Arb trigger source
	Control			Initiates, triggers, and aborts transients; displays trig state
Protect	OVP			Configures over-voltage protection settings
	OCP			Configures over-current protection settings
	Inhibit			Configures inhibit input mode settings
	WDog			Configures output watchdog protections 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	Settings	View the currently active network settings
			Modify	Modify the network configuration (IP, Name, DNS, mDNS, Services)
			Apply	Applies the configuration changes and restarts unit
			Cancel	Cancels 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
		DigPort	Pins	Configures the individual digital port pins
			Data	Reads/writes data to the digital port
	Groups	Function		Specifies the master or slave function
		Master		Discovers and connects the master to the slave units
		Slave		Specifies the slave address
	SDS	Status		Returns the connection status of the SD1000A Safety Disconnect System
		Config		Configures the connection to the SDS unit
		Data	Input	Reads status data from the digital port of the SDS unit
			Output	Sets the state of the external output signals of the SDS unit
	Preferences	Clock		Sets the real-time clock
		Display		Configures the screen saver and start-up meter view

1st Menu Level	2nd Level	3rd & 4th Levels		Description
		LineFreq		Specifies automatic or manual line frequency detection.
		Lock		Locks the front panel keys with a password
	Admin	Login		Enter a password to access the Admin functions
		Cal	Vprog	Calibrates voltage programming
			Curr	Calibrates current programming and measurement
			Misc	Calibrates CurrSharing, ResBout, and CurrTC
			Count	View the calibration count
			Date	Saves the calibration date
			Save	Saves the calibration data
		IO		Enables/disables USB, GPIB, and LAN services
		Sanitize		Performs NISPOM secure erase of all user data
		Update		Password protected firmware update
		Password		Changes the admin password
	About			Displays model, options, serial number, and firmware

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

:ACQuire	Cancels any triggered measurements.
:ELOG	Stops external data logging.
:TRANsient	Cancels any triggered actions.

CALibrate

:COUNt?	Returns the number of times the unit has been calibrated.
:CURRent	
[:LEVel] *<value>*	Calibrates the current programming and measurement.
:SHARing	Calibrates the Imon signal for paralleled units. (N675xA, N676xA)
:TC	Calibrates the temperature coefficient. (N673xA, N674xA)
:DATA *<value>*	Enters the calibration value read by the external meter.
:DATE *<"date">*	Enters the calibration date in nonvolatile memory.
:LEVel P1|P2|P3	Advances to the next level in the calibration.
:PASSword *<value>*	Sets a numeric password to prevent unauthorized calibration.
:RESistance	
:BOUT	Calibrates the bottom out resistance. (N675xA, N676xA)
:SAVE	Saves the calibration constants in non-volatile memory.
:STATe 0|OFF|1|ON	Enables or disables calibration mode.
:VOLTage	
[:LEVel] *<value>*	Calibrates the local voltage programming and measurement.

DISPlay

[:WINDow]	
[:STATe] 0|OFF|1|ON	Turns the front panel display on or off.
:VIEW METER_VI|METER_VP|METER_VIP	Selects the parameters to display on the front panel.
:SAVer	
[:STATe] 0|OFF|1|ON	Turns the front panel screen saver on or off.

FETCh

[:SCALar]	
:CURRent	
[:DC]? [*<start_index>*, *<points>*]	Returns the averaged measurement.
:ACDC?	Returns the RMS measurement (AC + DC).
:HIGH?	Returns the High level of a pulse waveform.
:LOW?	Returns the Low level of a pulse waveform.
:MAXimum?	Returns the maximum or minimum value.
:MINimum?	
:POWer	
[:DC]? [*<start_index>*, *<points>*]	Returns the averaged measurement.

:MAXimum?	Returns the maximum or minimum value.
:MINimum?	
:VOLTage	
[:DC]? [<*start_index*>, <*points*>]	Returns the averaged measurement.
:ACDC?	Returns the RMS measurement (AC + DC).
:HIGH?	Returns the High level of a pulse waveform.
:LOW?	Returns the Low level of a pulse waveform.
:MAXimum?	Returns the maximum or minimum value.
:MINimum?	
:AHOur? [IGNORE_OVLD]	Returns the accumulated amp-hours.
:ARRAY	
:CURRent	
[:DC]? [<*start_index*>, <*points*>]	Returns the instantaneous measurement.
:POWer	
[:DC]?	Returns the instantaneous measurement.
:VOLTage	
[:DC]? [<*start_index*>, <*points*>]	Returns the instantaneous measurement.
:ELOG <*maxrecords*>	Returns the most recent external datalog records.
:WHOur? [IGNORE_OVLD]	Returns the accumulated watt-hours.

FORMat

[:DATA] ASCII | REAL	Specifies the format of the returned data.
:BORDer NORMal | SWAPped	Specifies how binary data is transferred.

HCOPy

:SDUMp	
:DATA? [BMP|GIF|PNG]	Returns an image of the front panel display.
:DATA	
:FORMat BMP|GIF|PNG	Specifies the format for front panel images returned.

IEEE-488 Common Commands

*CLS	Clear status command.
*ESE <*value*>	Event status enable command and query.
*ESR?	Event status event query.
*IDN?	Identification Query.
*OPC	Sets the OPC (operation complete) bit in the standard event register.
*OPC?	Returns a 1 to the output buffer when all pending operations complete.
*OPT?	Returns a string identifying any installed options.
*RCL <*value*>	Recalls a saved instrument state.
*RST	Resets the instrument to pre-defined values that are either typical or safe.
*SAV <*value*>	Saves the instrument state to one of ten non-volatile memory locations.
*SRE <*value*>	Service request enable command and query.
*STB?	Status byte query.
*TRG	Trigger command.

- *TST? Self-test query.
- *WAI Pauses additional command processing until all pending operations are complete.

INITiate

- [:IMMediate]
  - :ACQuire Initiates the measurement trigger system.
  - :ELOG Initiates external data logging.
  - :TRANsient Initiates the transient trigger system.
- :CONTinuous
  - :TRANsient 0|OFF|1|ON Continuously initiates the transient trigger system.

INSTrument

- :GROup
  - :FUNCtion MASTer|NONE|SLAVe Set the master/slave function
  - :MASTer
    - :CONNect
      - [:STATe] 0|OFF|1|ON Connects the master to previously discovered slave units
      - :DELay <delay> Specifies an auto-connect delay after power-on
      - :MODE AUTO|MANual Automatic connect at power-on or by command
    - :DISCover Discovers bus or LAN connected slave units
    - :RESet Reset the master configuration
  - :SLAVe
    - :ADDRess <bus address> Sets the slave bus address

LXI

- :IDENtify
  - [:STATe] 0|OFF|1|ON Turns the front panel LXI identify indicator on or off.
- :MDNS
  - [:STATe] 0|OFF|1|ON Sets the MDNS state

MEASure

- [:SCALar]
  - :CURRent
    - [:DC]? Takes a measurement; returns the averaged current.
    - :ACDC? Takes a measurement; returns the RMS current (AC + DC).
    - :HIGH? Takes a measurement; returns the High level of a current pulse.
    - :LOW? Takes a measurement; returns the Low level of a current pulse.
    - :MAXimum? Takes a measurement; returns the maximum current.
    - :MINimum? Takes a measurement; returns the minimum current.
  - :POWer
    - [:DC]? Takes a measurement; returns the averaged power.
    - :MAXimum? Takes a measurement; returns the maximum power.
    - :MINimum? Takes a measurement; returns the minimum power.
  - :VOLTage

[:DC]?	Takes a measurement; returns the averaged voltage.
:ACDC?	Takes a measurement; returns the RMS voltage (AC + DC).
:HIGH?	Takes a measurement; returns the High level of a voltage pulse.
:LOW?	Takes a measurement; returns the Low level of a voltage pulse.
:MAXimum?	Takes a measurement; returns the maximum voltage.
:MINimum?	Takes a measurement; returns the minimum voltage.
:ARRAY	
:CURRent[:DC]?	Takes a measurement; returns the instantaneous current.
:POWer[:DC]?	Takes a measurement; returns the instantaneous power.
:VOLTage[:DC]?	Takes a measurement; returns the instantaneous voltage.

OUTPut

[:STATe] 0|OFF|1|ON	Enables or disables the output.
:COUPle	
[:STATe] 0|OFF|1|ON	Enables or disables output coupling.
:DOFFset <*value*>	Sets a delay offset to synchronize coupled output state changes.
:MAX	
:DOFFset?	Returns the delay offset required for this instrument.
:DELay	
:FALL <*value*>	Sets the output turn-off sequence delay.
:RISE <*value*>	Sets the output turn-on sequence delay.
:TMODE	
:COUPle 0|OFF|1|ON	Couples the turn-on and turn-off settings (N673xA, N674xA)
[:OFF] LOWZ|HIGHZ	Selects the output turn-off mode (N673xA, N674xA)
:ON LOWZ|HIGHZ	Selects the output turn-on mode (N673xA, N674xA)
:INHibit	
:MODE LATChing|LIVE|OFF	Sets the operating mode of the remote inhibit digital pin.
:PON	
:STATe RST|RCL0	Sets the output power-on state.
:PROTection	
:CLEar	Resets the latched protection.
:TEMPerature	
:MARGin?	Returns the margin remaining before the over-temperature trips.
:WDOG	
[:STATe] 0|OFF|1|ON	Enables or disables the I/O watchdog timer.
:DELay <*value*>	Sets the watchdog delay time.
:RELay	
:LOCK	
[:STATe] 0|OFF|1|ON	Enables or disables the locked relay state of the SD1000A unit.

SENSe

:AHOur	
:RESet	Resets the amp-hour or watt-hour measurement to zero.
:ELOG	

:FUNCtion	
:CURRent 0|OFF|1|ON	Enables/disables external current logging.
:MINMax 0|OFF|1|ON	Enables/disables external min/max current logging.
:VOLTage 0|OFF|1|ON	Enables/disables external voltage logging.
:MINMax 0|OFF|1|ON	Enables/disables external min/max voltage logging.
:PERiod <*value*>	Sets the external datalog integration time.
:FUNCtion	
:CURRent 0|OFF|1|ON	Enables/disables current measurements.
:VOLTage 0|OFF|1|ON	Enables/disables voltage measurements.
:SWEep	
:NPLCycles <*value*>	Sets the measurement time in number of power line cycles.
:OFFSet	
:POINts <*value*>	Defines the offset in a data sweep for triggered measurements.
:POINts <*value*>	Defines the number of points in a measurement.
:TINTerval <*value*>	Defines the time period between measurement samples.
:WHOur	
:RESet	Resets the accumulated watt-hour measurement.
:WINDow	
[:TYPE] HANNing|RECTangular	Selects the measurement window.

[SOURce:]

ARB

:COUNt <*value*>|INFinity	Specifies the number of times the Arb repeats.
:CURRent	
:CDWell	
[:LEVel] <*value*>{,<*value*>}|<*Block*>	Specifies the level of each point in the Arb.
:DWELl <*value*>	Specifies the dwell time of each point in the Arb.
:POINts?	Returns the number of points in the Arb.
:FUNCtion	
:TYPE CURRent|VOLTage	Specifies either a voltage or current Arb.
:TERMinate	
:LAST 0|OFF|1|ON	Selects the output setting after the Arb ends.

[SOURce:]

CURRent

[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>	Sets the output current when in current priority mode
:TRIGgered	
[:AMPLitude] <*value*>	Sets the triggered output current
:BWIDth	
:RANGe 0 | 1	Sets the current compensation. (N673xA, N674xA)
:LEVel 0 | 1, <*value*>	Sets the compensation frequency. (N673xA, N674xA)
:LIMit	

[:POSitive]	
[:IMMediate]	
[:AMPLitude] <*value*>	Sets the current limit when in voltage priority mode.
:NEGative	
[:IMMediate]	
[:AMPLitude] <*value*>	Sets the current limit when in voltage priority mode.
:MODE FIXed|STEP|LIST|ARB	Sets the transient mode.
:PROTection	
:DELay	
[:TIME] <*value*>	Sets the over-current protection delay.
:STARt SCHange|CCTRans	Specifies what starts the over-current protection delay timer.
:STATe 0|OFF|1|ON	Enables or disables the over-current protection.
:SHARing	
[:STATe] 0|OFF|1|ON	Enables or disables current sharing on paralleled units. (N675xA, N676xA)
:SLEW	
[:IMMediate] <*value*>|INFinity	Sets the current slew rate.
:MAXimum 0|OFF|1|ON	Enables or disables the maximum slew rate override.

[SOURce:]

DIGital

:INPut	
:DATA?	Reads the state of the digital control port.
:OUTPut	
:DATA <*value*>	Sets the state of the digital control port.
:PIN<1-7>	
:FUNCtion <*function*>	Sets the pin function. DIO |DINPut |FAULt |INHibit |ONCouple |OFFCouple |TOUTput |TINPut
:POLarity POSitive|NEGative	Sets the pin polarity.
:TOUTput	
:BUS	
[:ENABle] 0|OFF|1|ON	Enables or disables BUS triggers on digital port pins.

[SOURce:]

FUNCtion CURRent|VOLTage	Sets the output regulation - voltage priority or current priority.

[SOURce:]

LIST

:COUNt <*value*>|INFinity	Sets the list repeat count.
:CURRent	
[:LEVel] <*value*>{,<*value*>}	Specifies the setting for each list step.
:POINts?	Returns the number of list points.
:DWELl <*value*>{,<*value*>}	Specifies the dwell time for each list step.
:POINts?	Returns the number of list points.
:STEP ONCE|AUTO	Specifies how the list responds to triggers.

:TERMinate	
:LAST 0|OFF|1|ON	Determines the output value when the list terminates.
:TOUTput	
:BOSTep	
[:DATA] <*Bool*>{,<*Bool*>}	Generates a trigger out at the Beginning Of STep
:POINts?	Returns the number of list points.
:EOSTep	
[:DATA] <*Bool*>{,<*Bool*>}	Generates a trigger out at the End Of STep
:POINts?	Returns the number of list points.
:VOLTage	
[:LEVel] <*value*>{,<*value*>}	Specifies the setting for each list step.
:POINts?	Returns the number of list points.

[SOURce:]

POWer

:LIMit?	Returns the output power limit of the instrument

[SOURce:]

STEP

:TOUTput0|OFF|1|ON	Specifies whether a trigger out is generated when a transient step occurs.

[SOURce:]

VOLTage

[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>	Sets the output voltage when in voltage priority mode.
:TRIGgered	
[:AMPLitude] <*value*>	Sets the triggered output voltage.
:BWIDth LOW|HIGH1	Sets the voltage compensation (N675xA, N676xA)
:RANGe 0 | 1 | 2	Sets the voltage compensation. (N673xA, N674xA)
:LEVel 0 | 1 | 2, <*value*>	Sets the compensation frequency. (N673xA, N674xA)
:LIMit	
[:POSitive]	
[:IMMediate]	
[:AMPLitude] <*value*>	Sets the voltage limit when in current priority mode.
:LOW <*value*>	Sets the low-voltage limit. (N673xA, N674xA)
:MODE FIXed|STEP|LIST|ARB	Sets the transient mode.
:PROTection	
[:LEVel] <*value*>	Sets the over-voltage protection level.
:LOW	
[:LEVel] <*value*>	Sets the low-voltage protection level. (N673xA, N674xA)
:DELay <*value*>	Sets the low-voltage protection delay. (N673xA, N674xA)
:STATe 0|OFF|1|ON	Enables or disables low-voltage protection. (N673xA, N674xA)
:RESistance	
[:LEVel]	

[:IMMediate]	
[:AMPLitude] <*value*>	Sets the output resistance level.
:STATe 0|OFF|1|ON	Enables or disables output resistance programming.
:SLEW	
[:IMMediate] <*value*>|INFinity	Sets the voltage slew rate.
:MAXimum 0|OFF|1|ON	Enables or disables the maximum slew rate override.

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<1|2>	
[: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

:COMMunicate	
:LAN|TCPip:CONTrol?	Returns the initial socket control connection port number.
:RLSTate LOCal|REMote|RWLock	Configures the remote/local state of the instrument.
:DATE <*yyyy*>, <*mm*>, <*dd*>	Sets the date of the system clock.
:ERRor?	Reads and clears one error from the error queue.
:LFRequency?	Returns the power-line reference frequency.
:LFRequency	
:MODE AUTO|MAN50|MAN60	Specifies automatic or manual line frequency detection.
:PASSword	
:FPANel	
:RESet	Resets the front panel lockout password to zero.
:REBoot	Reboots the instrument to its power-on state.
:SDS	(SDS commands apply to N795xA, N796xA only)
:CONNect	Connect to the SDS unit.
:MODE AUTO|MANual	Selects the connection mode at power-on.
:DIGital	
:DATA	
:INPut?	Reads the SDS digital port signals.
:OUTPut <*value*>	Sets the SDS digital output signals.
:ENABle 0|OFF|1|ON	Enables or disables the SDS unit.
:STATus?	Returns the SDS status.

:SECurity	
:IMMediate	Clears all user memory and reboots the instrument.
:SET <block data>	Get and set the instrument state
:TIME <*hh*>, <*mm*>, <*ss*>	Sets the time of the system clock.
:VERSion?	Returns the SCPI version that the instrument complies with.

TRIGger

:ACQuire	
[:IMMediate]	Generates an immediate trigger.
:CURRent	
[:LEVel] <*value*>	Sets the triggered level of the output.
:SLOPe POSitive|NEGative	Sets the slope of the signal.
:INDices	
[:DATA]?	Returns the indices where triggers were captured.
:COUNt?	Returns the number of triggers captured during the acquisition.
:SOURce <*source*>	Selects the trigger source for the acquisition system: BUS |CURRent1 |EXTernal |PIN<1-7> |TRANsient1 |VOLTage1
:TOUTput	
[:ENABle] 0|OFF|1|ON	Enables measurement triggers to be sent to a digital port pin.
:VOLTage	
[:LEVel] <*value*>	Sets the triggered level of the output.
:SLOPe POSitive|NEGative	Sets the slope of the signal.
:ARB	
:SOURce <*source*>	Selects the trigger source for arbitrary waveforms: BUS |EXTernal |IMMediate |PIN<1-7>
:ELOG	
[:IMMediate]	Generates an immediate trigger.
:SOURce <*source*>	Selects the trigger source for external data logging: BUS |EXTernal |IMMediate |PIN<1-7>
:TRANsient	
[:IMMediate]	Generates an immediate trigger.
:SOURce <*source*>	Selects the trigger source for the transient system: BUS |EXTernal |IMMediate |PIN<1-7>

Model Features and Options

Model Features

5 kW Models - 10 kW Models -	RP7931A/RP7941A RP7933A/RP7943A	RP7932A/RP7942A RP7935A/RP7945A	RP7936A/RP7946A	RP7951A/RP7961A RP7952A/RP7962A	RP7953A/RP7963A
Voltage, Current, & Power Ratings	0 to 20 V 0 to ±400 A (5 kW) 0 to ±800 A (10 kW)	0 to 80 V 0 to ±125 A (5 kW) 0 to ±250 A (10 kW)	0 to 160 V 0 to ±125 A (10 kW)	0 to 500 V 0 to ±20 A (5 kW) 0 to ±40 A (10 kW)	0 to 950 V 0 to ±20 A (10 kW)
3-phase, 200/208 VAC nominal	RP7931A/RP7933A	RP7932A/RP7935A	RP7936A	RP7951A/RP7952A	RP7953A
3-phase, 400/480 VAC nominal	RP7941A/RP7943A	RP7942A/RP7945A	RP7946A	RP7961A/RP7962A	RP7963A
2-quadrant source-sink operation	Yes	Yes	Yes	Yes	Yes
Output autoranging	1.6-to-1	2-to-1	2-to-1	2-to-1	2-to-1
Output lists	Yes	Yes	Yes	Yes	Yes
Arbitrary waveforms	Yes	Yes	Yes	Yes	Yes
Adjustable bandwidth	Voltage & Current	Voltage & Current	Voltage & Current	Voltage only	Voltage only
Parallel operation	Yes	Yes	Yes	Yes	Yes
Master-slave mode	Yes	Yes	Yes	Yes	Yes
Voltage & current programming	Yes	Yes	Yes	Yes	Yes
Output resistance programming	Yes*	Yes*	Yes	Yes	Yes
Voltage & current measurement	Yes	Yes	Yes	Yes	Yes
Amp-hour, Watt-hour, & power measurement	Yes	Yes	Yes	Yes	Yes
Array readback	Yes	Yes	Yes	Yes	Yes
Adjustable sampling	Yes	Yes	Yes	Yes	Yes
External data logging	Yes	Yes	Yes	Yes	Yes
Under-voltage protection	Yes	Yes	Yes	No	No
SDS unit available	No	No	No	Yes	Yes

*Requires firmware version B.03.02.1232 and up.

Options/Accessories

Option/Accessory	Description
Option UK6	Commercial calibration with test results data
Option 056	Add license for Keysight 14585A Control and Analysis Software
Keysight SD1000A Option 500 Keysight SD1000A Option 950	Safety Disconnect System - includes redundant power and sense disconnect relays. This accessory requires Option 500 to be used on the 500 V models, and Option 950 to be used on the 950 V models. This accessory cannot be used on the RP793xA and RP794xA models.
Keysight RP7909A	Rack mount and slide kit - for mounting units in 19-inch EIA cabinets

Specifications and Characteristics - RP793xA, RP794xA

Specifications - RP793xA, RP794xA

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40°C after a 30-minute warm-up period. Specifications apply at the output terminals, with the sense terminals connected to the output terminals (local sensing).

Specification	RP7931A, RP7941A	RP7932A, RP7942A	RP7933A, RP7943A	RP7935A, RP7945A	RP7936A, RP7946A
DC Ratings					
Voltage source:	0 to 20 V	0 to 80 V	0 to 20 V	0 to 80 V	0 to 160 V
Current source and sink:	0 to ±400 A	0 to ±125 A	0 to ±800 A	0 to ±250 A	0 to ±125 A
Power:	0 to ±5 kW	0 to ±5 kW	0 to ±10 kW	0 to ±10 kW	0 to ±10 kW
Output ripple & noise					
CV peak-to-peak:[1]	30 mV	80 mV	30 mV	80 mV	200 mV
CV rms:[2]	3 mV	8 mV	3 mV	8 mV	20 mV
Load regulation					
Voltage:	1 mV	3 mV	1 mV	3 mV	6 mV
Current:	25 mA	13 mA	50 mA	25 mA	13 mA
Voltage programming & measurement accuracy[3]	0.02% + 2 mV	0.02% + 8 mV	0.02% + 2 mV	0.02% + 8 mV	0.02% + 16 mV
Current programming & measurement accuracy:[3]	0.04% + 45 mA	0.03% + 13 mA	0.04% + 90 mA	0.03% + 25 mA	0.03% + 13 mA
Transient response[4]					
Recovery Time:	300 µs	300 µs	300 µs	300 µs	300 µs
Settling band:	0.2 V	0.8 V	0.2 V	0.8 V	1.6 V

[1] From 20 Hz to 20 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
[2] From 20 Hz to 10 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
[3] Percent of value + offset; at 25°C ±5°C after a 30 minute warm-up; measurement NPLC=1; valid for 1 year, see Calibration Interval; with a sense lead voltage drop of up to 1V
[4] Time to recover to within the settling band following a step change from 40% to 90% of full load with a 35 µs current rise time

Supplemental Characteristics - RP793xA, RP794xA

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

Characteristic	RP7931A, RP7941A	RP7932A, RP7942A	RP7933A, RP7943A	RP7935A, RP7945A	RP7936A, RP7946A
Minimum compliance limits					
Voltage priority:	±400 mA	±125 mA	±800 mA	±250 mA	±125 mA
Current priority[1]:	0 and 20 mV	0 and 80 mV	0 and 20 mV	0 and 80 mV	0 and 160 mV
Voltage programming					
Range:	0.02 to 20.4 V	0.08 to 81.6 V	0.02 to 20.4 V	0.08 to 81.6 V	0.16V to 163.2V
Resolution:	191 µV	800 µV	191 µV	800 µV	1.6 mV
Current programming					
Range:	-408 A to 408 A	-127.5 A to 127.5 A	-816 A to 816 A	-255 A to 255 A	-127.5A to 127.5A
Resolution:	7.7 mA	2.5 mA	15.5 mA	5 mA	2.5 mA
Resistance programming					
Range:	0 to 0.098 Ω	0 to 1.25 Ω	0 to 0.049 Ω	0 to 0.625 Ω	0 to 2.5 Ω
Resolution:	0.8 µΩ	9.8 µΩ	0.4 µΩ	4.8 µΩ	19.6 µΩ
Accuracy:	0.05% + 4 µΩ	0.05% + 32 µΩ	0.05% + 2 µΩ	0.05% + 16 µΩ	0.05% + 50 µΩ
Additional V-programming offset/ Ohm:	50 mV	15 mV	100 mV	30 mV	15 mV
Measurement range					
Voltage:	-25 V to 25 V	-100 V to 100 V	-25 V to 25 V	-100 V to 100 V	-200 V to 200 V
Current:	-1014 A to 1014 A	-315 A to 315 A	-2028 A to 2028 A	-630 A to 630 A	-315 A to 315 A
Measurement digitization noise[2]					
Voltage:	4 mV	20 mV	4 mV	20 mV	40 mV
Current:	400 mA	200 mA	800 mA	400 mA	200 mA
Programming & measurement tempCo[3]					
Voltage:	0.0015% +80 µV/°C	0.0015% +300µV/°C	0.0015% +80 µV/°C	0.0015% +300µV/°C	0.0015%+600µV/°C
Current:	0.0075% +1.2mA/°C	0.0025% +400µA/°C	0.0075% +2.3mA/°C	0.0025% +800µA/°C	0.0025%+400µA/°C
Output current ripple & noise (CC rms):	200 mA	70 mA	200 mA	70 mA	50 mA
Common mode current					
CC rms:	2 mA	2.5 mA	2 mA	2.5 mA	3.5 mA
CC peak-to-peak:	20 mA	24 mA	20 mA	24 mA	30 mA
Overvoltage protection[4]					
Maximum setting:	24 V	96 V	24 V	96 V	192 V
Response time:	< 30 µs	< 30 µs	< 30 µs	< 30 µs	< 30 µs
Accuracy:	0.02% + 2 mV	0.02% + 8 mV	0.02% + 2 mV	0.02% + 8 mV	0.02% + 16 mV
Voltage Programming Speed, no load[5]					
Rise/fall time 10% to 90% of step:	80 µs	75 µs	80 µs	75 µs	75 µs
Settling time to 0.1% of step:	810 µs	480 µs	810 µs	480 µs	550 µs
Voltage Programming Speed, full load[6]					
Rise/fall time 10% to 90% of step:	140 µs	130 µs	140 µs	130 µs	170 µs
Settling time to 0.1% of step:	4.2 ms	1.35 ms	4.2 ms	1.35 ms	1.35 ms
Current Up/down Programming Speed[7]					
Rise/fall time 10% to 90% of step:	300 µs	180 µs	300 µs	180 µs	190 µs
Settling time to 0.1% of step::	960 µs	500 µs	960 µs	500 µs	550 µs

Characteristic	RP7931A, RP7941A	RP7932A, RP7942A	RP7933A, RP7943A	RP7935A, RP7945A	RP7936A, RP7946A
Output on delay time[8]					
Voltage priority - high impedance:	8.1 ms	8.1 ms	8.1 ms	8.1 ms	8.1 ms
Voltage priority - low impedance:	8.1 ms	8.1 ms	8.1 ms	8.1 ms	8.1 ms
Current priority:	7.1 ms	7.1 ms	7.1 ms	7.1 ms	7.1 ms
Maximum load inductance:[9]	20 µH	200 µH	10 µH	100 µH	400 µH
Line regulation					
Voltage:	< 10 µV	< 10 µV	< 10 µV	< 10 µV	< 10 µV
Current:	< 20 µA	< 10 µA	< 40 µA	< 10 µA	< 10 µA
Typical leakage current					
Output disabled - instantaneous:[10]:	2 µA	800 µA	4 µA	800 µA	800 µA
Output disabled - long term[11]:	0.4 µA	800 µA	0.8 µA	800 µA	800 µA
Unit unplugged from AC mains:	2 µA	800 µA	4 µA	800 µA	800 µA

1 For lower and upper voltage compliance, respectively
2 For digitization at 5.12 µs sampling rate
3 Applies for ambient temperatures above 30°C or below 20°C
4 From occurrence of over-voltage to start of shutdown
5 In the CV Comp 0 range, Frequency = 100 kHz, under no load, and a step change from 10% to 100% of output rating
6 In the CV Comp 0 range, Frequency = 2.3 kHz, with full constant current load, and a step change from .1% to 100% of output rating
7 In the CC Comp 0 range, Frequency = 100 kHz, and a step change from 10% to 100% of current rating, into low impedance DC source
8 Time from when the Output On command is received to the initiation of turning the output on
9 CAUTION Unit is susceptible to internal damage if Maximum Load Inductance limits are exceeded at the rated current
10 Unit powered on with the output disabled for >1 second after full load operation
11 Unit powered on with the output disabled for >10 seconds after full load operation

Common Characteristics

Common Characteristic	All Models
Command Processing Time	≤ 1 ms from receipt of command to start of output change. Applies to simple settings commands over the GPIB interface (see Typical Command Processing Times)
Constant Dwell ARBs	
Number of points:	Up to 65,535
Dwell range:	One dwell setting applies for the entire ARB, from 10.24 µs to 0.30 seconds
Dwell resolution:	Values are rounded to the nearest 10.24-microsecond increment
Computer Interfaces	
LXI:	LXI 1.4 Core, HiSLIP, IPv6
LAN:	10 Mb, 100 Mb, 1 Gb LAN
USB:	USB 2.0 (USB-TMC488 protocol)
GPIB:	SCPI - 1993, IEEE 488.2 compliant interface
Environmental	
Operating environment:	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range:	0°C to 55°C (Maximum continuous power available is derated at 1% of rating per degree C from 40°C to 55°C)
Relative humidity:	95% or less (non-condensing)
Altitude:	Up to 2000 meters
Storage temperature:	-30°C to 70°C

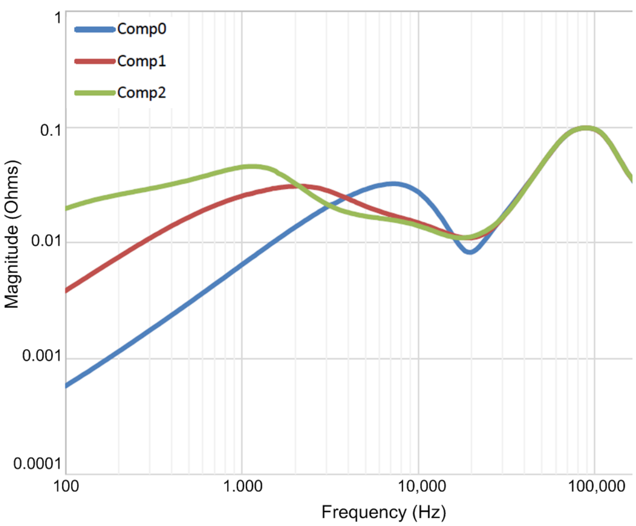
Common Characteristic	All Models
Acoustic statement (European Machinery Directive)	Acoustic noise emission LpA 79 dB at Operator position LpA 73 dB at Bystander position LpA 61.4 at Idle fan speed Normal operation mode per ISO 7779
Digital Port	
Max voltage rating:	+16.5 VDC/- 5 VDC between pins
Pins 1 & 2 as FLT:	Maximum low-level output voltage = 0.5 V @ 4 mA Maximum low-level sink current = 4 mA Typical high-level leakage current = 1 mA @ 16.5 VDC
Pins 1-7 as outputs:	Maximum low-level output voltage = 0.5 V @ 4 mA; 1 V @ 50 mA; 1.75 V @ 100 mA Maximum low-level sink current = 100 mA Typical high-level leakage current = 0.8 mA @ 16.5 VDC
Pins 1-7 as inputs:	Maximum low-level input voltage = 0.8 V Minimum high-level input voltage = 2 V Typical low-level current = 2 mA @ 0 V (internal 2.2k pull-up) Typical high-level leakage current = 0.12 mA @ 16.5 VDC
Pin 8:	Pin 8 is common (internally connected to chassis ground)
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 mark. Conforms to US and Canadian safety regulations.
	Declarations of Conformity for this product may be downloaded from the Web. Go to http://www.keysight.com/go/conformity and click on “Declarations of Conformity.”
AC Input	
Phase and range:	3 phase; 200 VAC nominal ±10%, and 208 VAC nominal ±10% 3 phase; 400 VAC nominal ±15%, and 480 VAC nominal ±10%
Frequency:	50/60 Hz
Input VA:	RP7931A, RP7932A, RP7941A, RP7942A, RP7936A: 6.5 kVA RP7933A, RP7935A, RP7936A, RP7943A, RP7945A, RP7946A: 11.5 kVA
Input current per phase	
200 VAC input:	RP7931A, RP7932A: 17.3 A; RP7933A, RP7935A, RP7936A; 35 A
400 VAC input:	RP7941A, RP7942A: 8.66 A; RP7943A, RP7945A, RP7946A: 17.3 A
Efficiency at full power:	RP7931A, RP7932A, RP7941A, RP7942A: 84% RP7933A, RP7935A, RP7936A, RP7943A, RP7945A, RP7946A: 85%
Power Factor:	0.99 @ nominal input and rated power
Fuse:	Internal fuse - not user accessible
NOTE	During a 1-cycle line dropout the unit may reboot. The output will remain off after reboot until the operator reinstates the previous settings, either by the front panel controls or using a computer program. This behavior is consistent with safe operating procedures.
Output Terminal Isolation:	
For 20 VDC models:	No output terminal may be more than ±60 VDC from any other terminal or chassis ground.
For 80 & 160 VDC models:	No output terminal may be more than ±240 VDC from any other terminal or chassis ground.

Common Characteristic	All Models
Typical Weight	RP7931A, RP7932A, RP7941A, RP7942A: 60 lbs. (27.3 kg) RP7933A, RP7935A, RP7936A, RP7943A, RP7945A, RP7946A: 70 lbs. (31.8 kg)

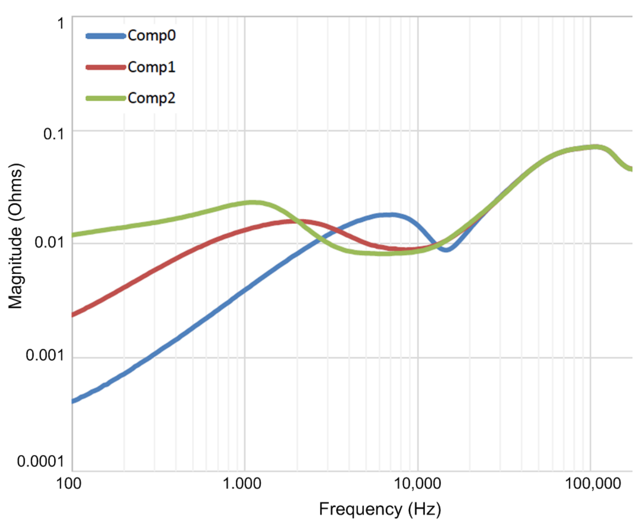
Output Impedance Graphs

The following graphs show the small signal output impedance of the compensation modes for voltage priority and current priority modes. Impedances are captured when measuring at the load leads 6 inches away from the bus bars.

Voltage Priority Mode (20 V units)

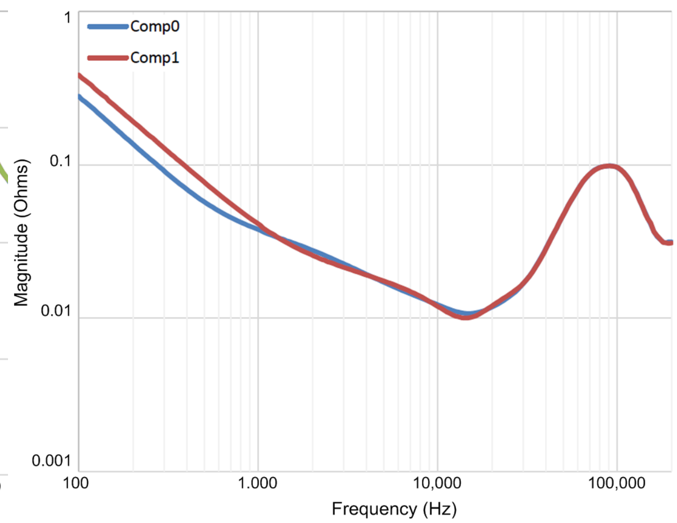


20 V, 5 kW unit (@ 10 V, 200 A 6" leads, local sense)

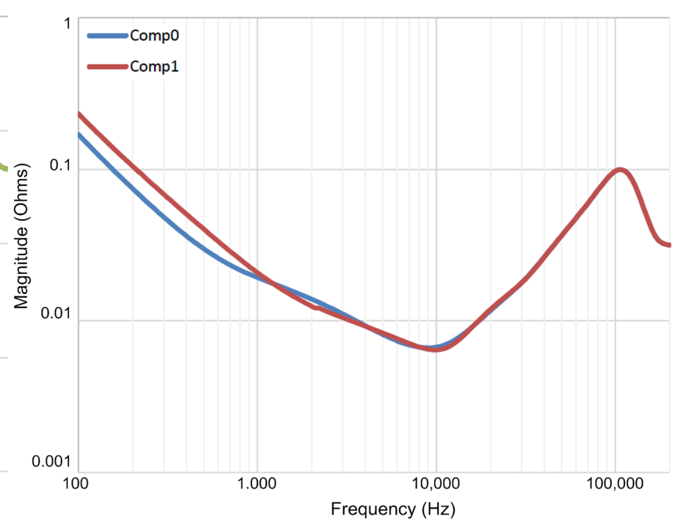


20 V, 10 kW unit (@ 10 V, 400 A, 6" leads, local sense)

Current Priority Mode (20 V units)

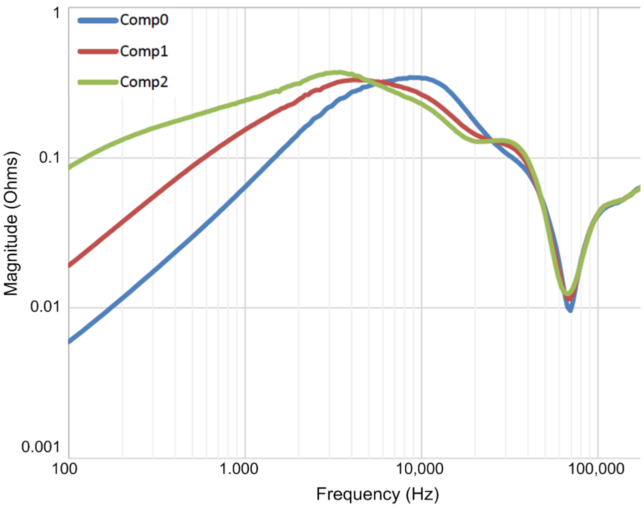


20 V, 5 kW unit (@ 10 V, 200 A, 6" leads)

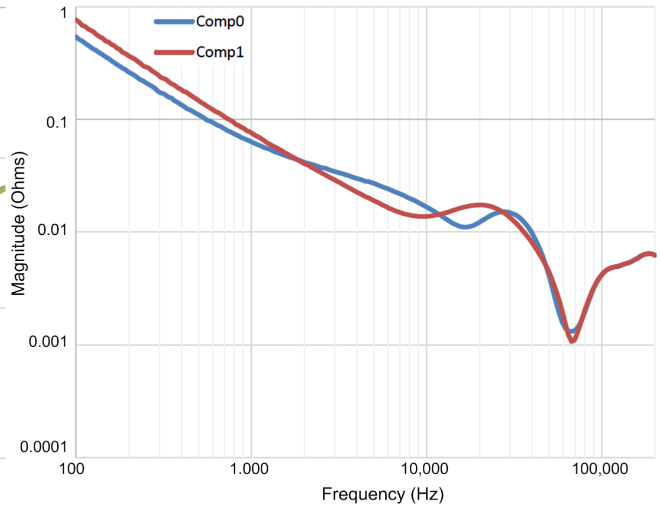


20 V, 10 kW unit (@ 10 V, 400 A, 6" leads)

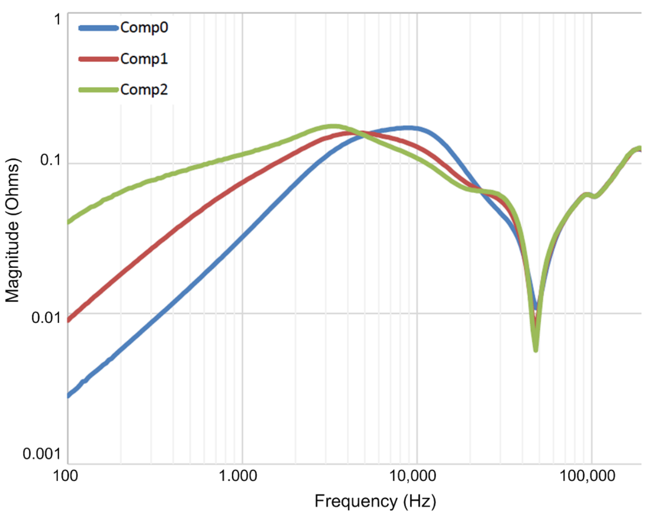
Voltage Priority Mode (80 V units)	Current Priority Mode (80 V units)



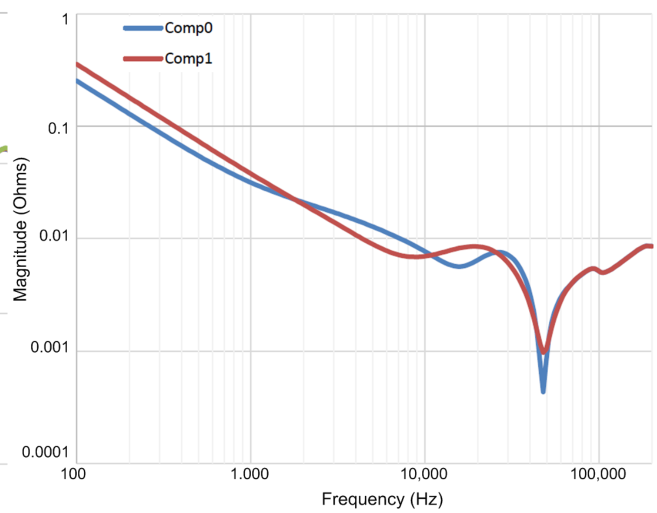
80 V, 5 kW unit (@ 40 V, 125 A 6" leads, local sense)



80 V, 5 kW unit (@ 40 V, 125 A, 6" leads)

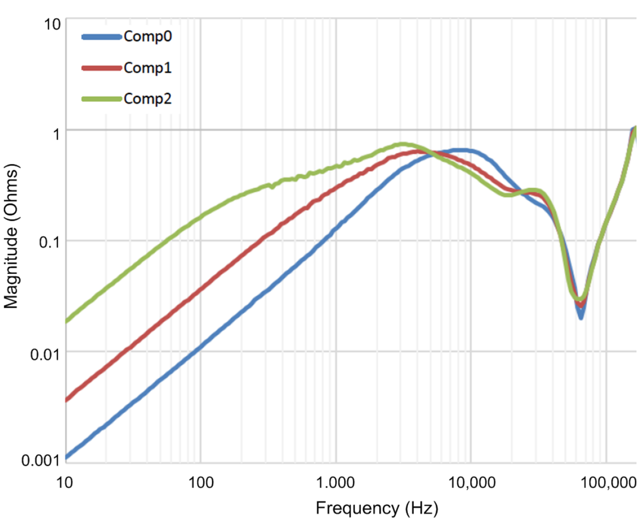


80 V, 10 kW unit (@ 40 V, 250 A, 6" leads, local sense)

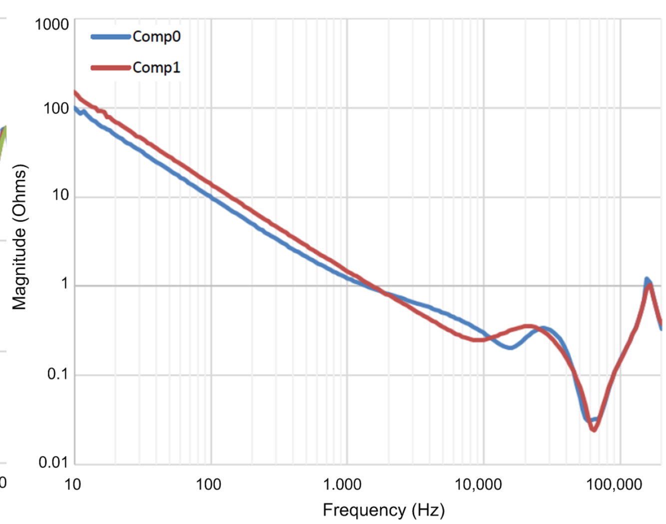


80 V, 10 kW unit (@ 40 V, 250 A, 6" leads)

Voltage Priority Mode (160 V units)	Current Priority Mode (160 V units)



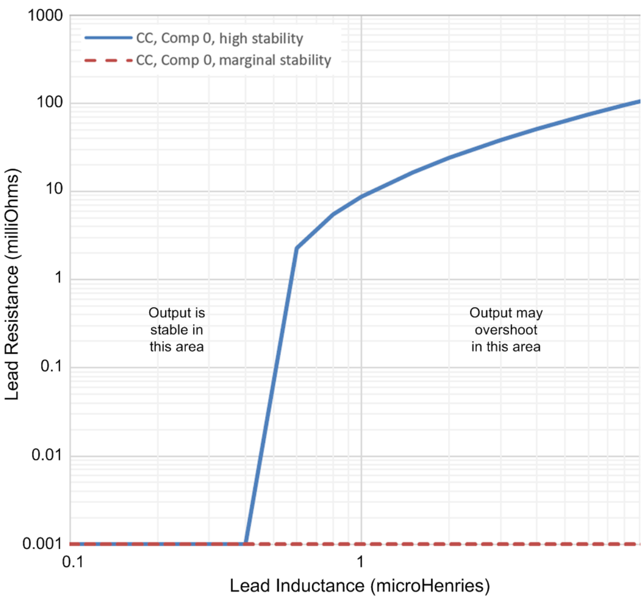
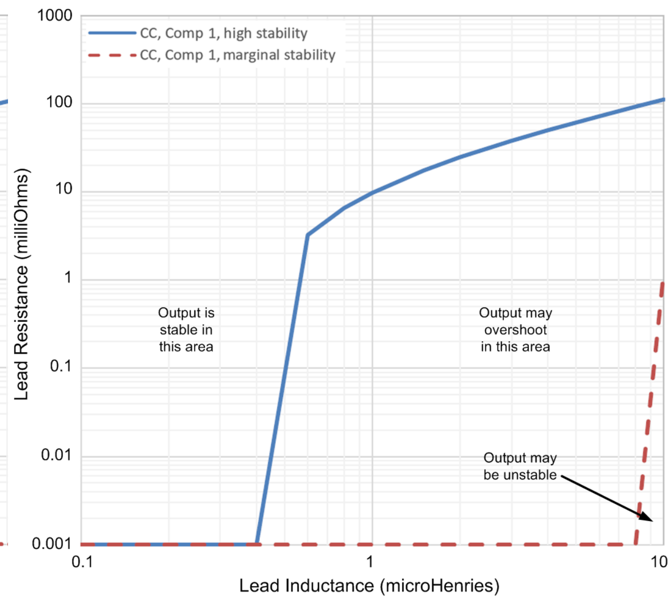
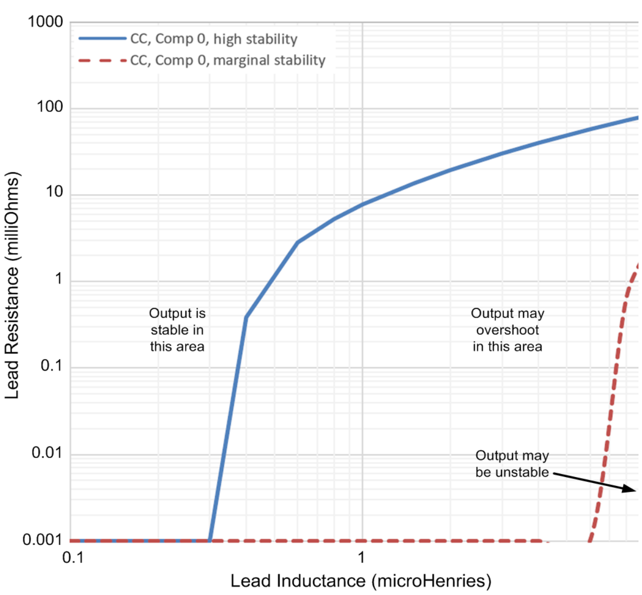
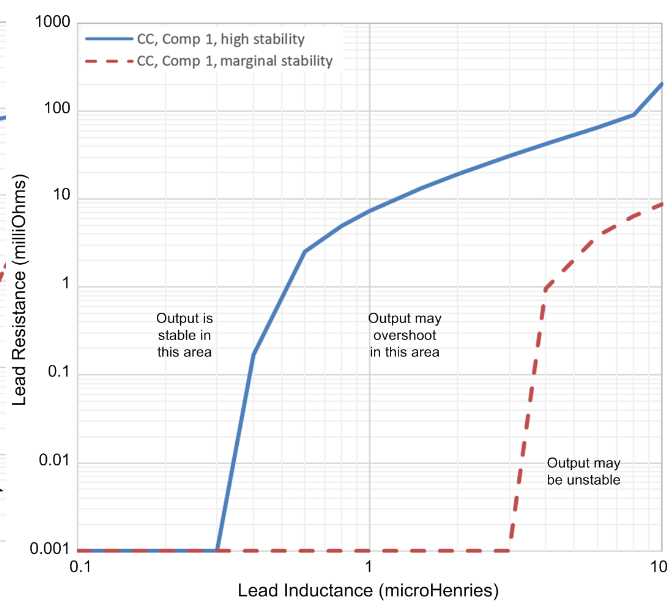
160 V, 10 kW unit (@ 80 V, 125 A 6" leads, local sense)



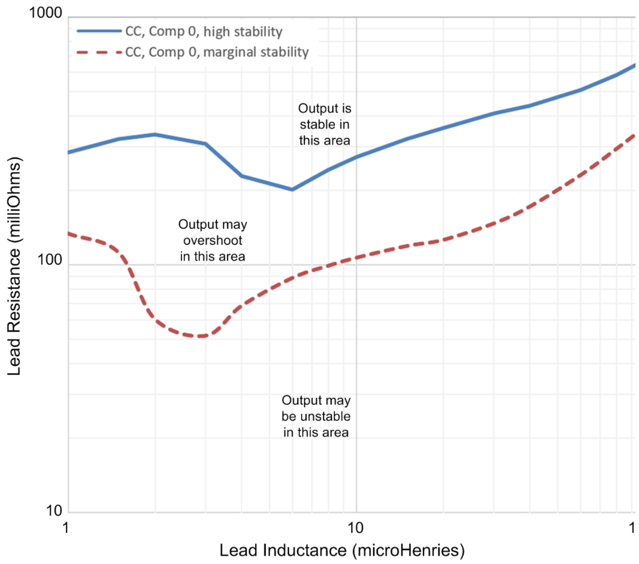
160 V, 10 kW unit (@ 80 V, 125 A, 6" leads)

Inductive Load Boundary for Current Priority Mode

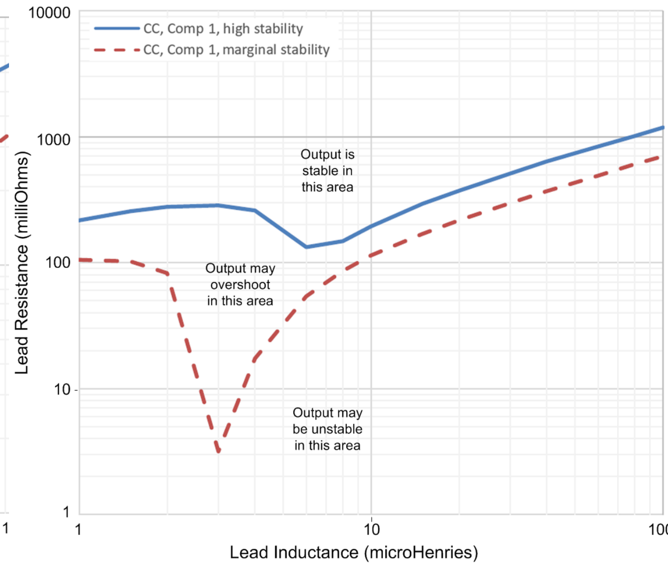
The following figures show the boundary limitations for inductive loads with series resistance for current priority mode. Operation below the marginal stability lines with either Comp 0 or Comp 1 bandwidth settings may result in output instability. Note that lead and DUT resistance are indistinguishable in this context. It is also important to consider the voltage drop and power dissipation in the leads from increased lead resistance. Refer to Inductance Considerations for details.

Compensation for Current Priority Mode 0 (20 V units)	Compensation for Current Priority Mode 1 (20 V units)
 20 V, 5 kW unit	 20 V, 5 kW unit
 20 V, 10 kW unit	 20 V, 10 kW unit

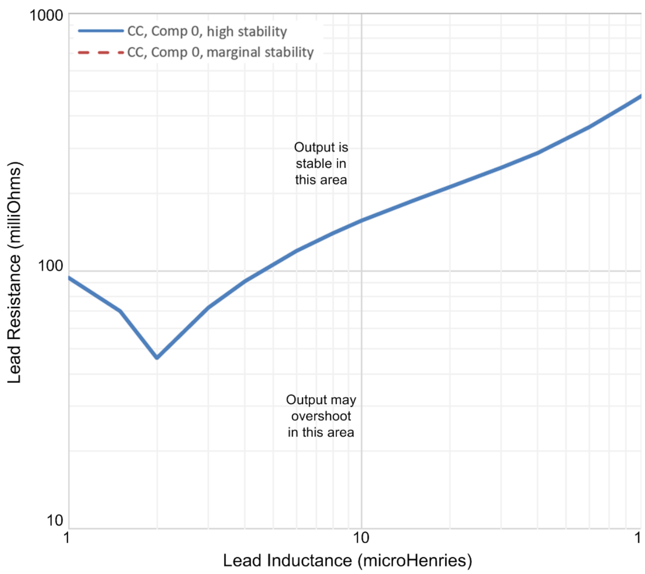
Compensation for Current Priority Mode 0 (80 V units)	Compensation for Current Priority Mode 1 (80 V units)



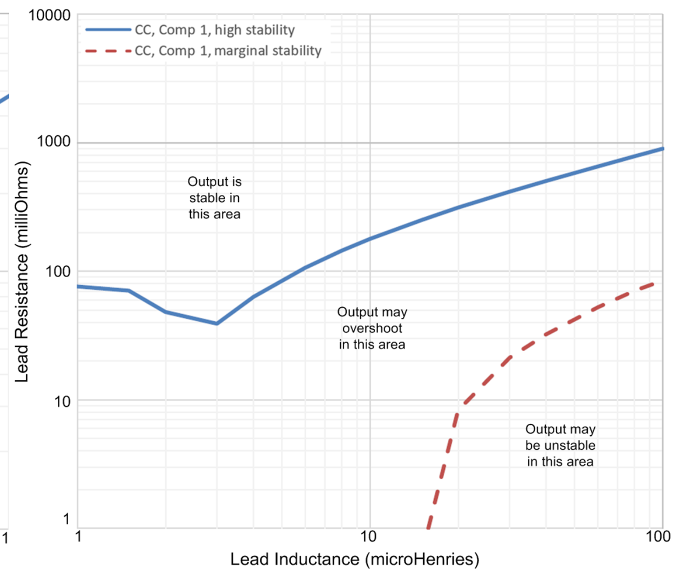
80 V, 5 kW unit



80 V, 5 kW unit

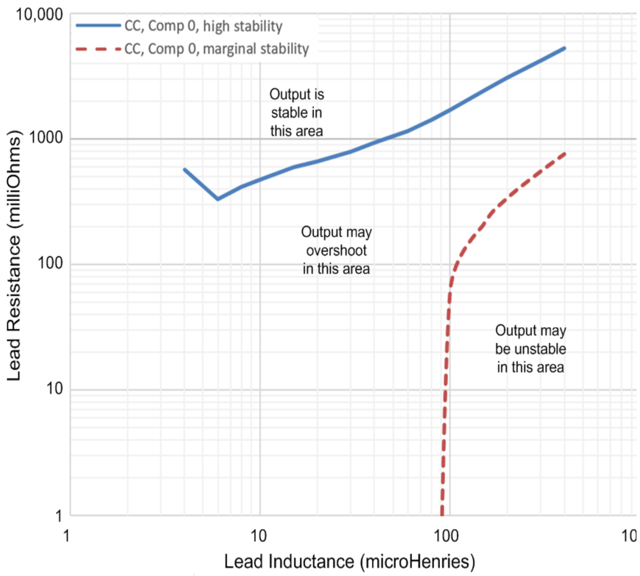


80 V, 10 kW unit



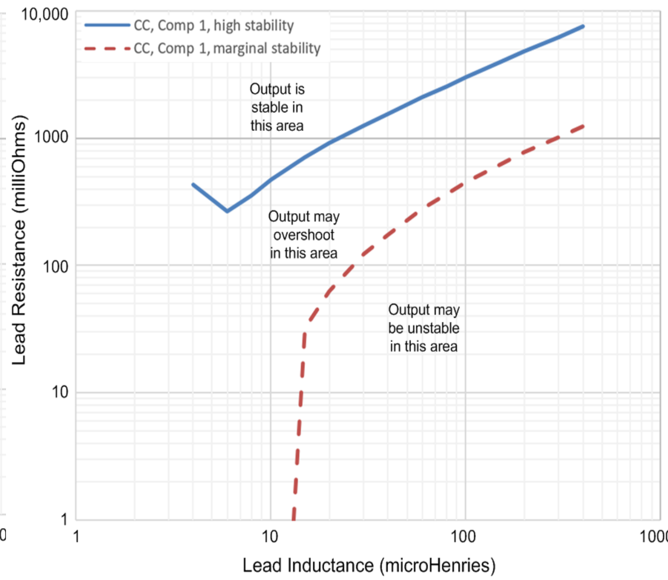
80 V, 10 kW unit

Compensation for Current Priority Mode 0 (160 V units)



160 V, 10 kW unit

Compensation for Current Priority Mode 1 (160 V units)



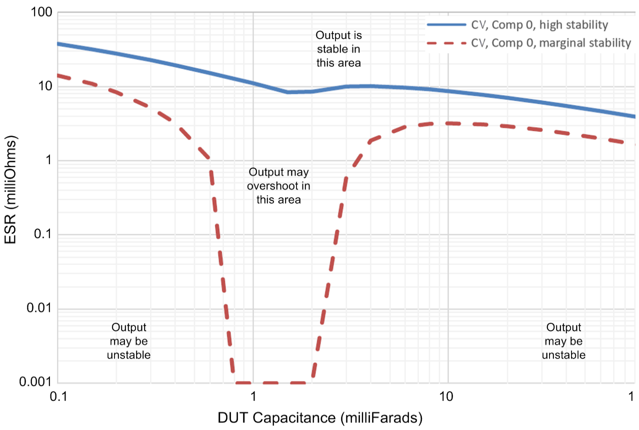
160 V, 10 kW unit

Capacitive Load Boundary for Voltage Priority Mode

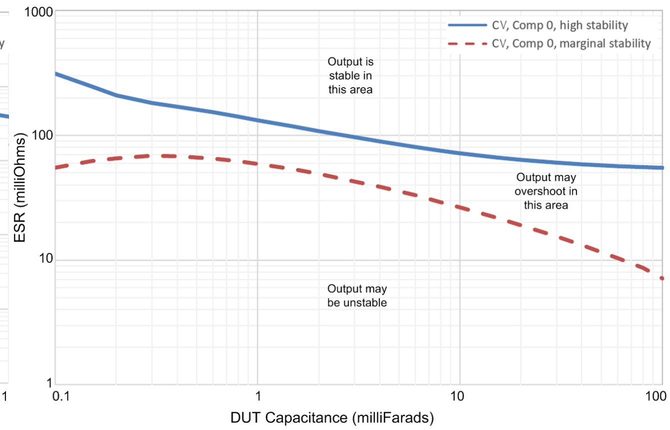
The following figures show the boundary limitations for capacitive loads with equivalent series resistance for voltage priority mode. Operation below the marginal stability lines with the Compensation bandwidth settings may result in output instability. Conditions with and without load leads illustrate the additional effects of inductance on CV mode stability. There are no absolute limits for DUT capacitance, as the stability is also a function of ESR. Refer to Load Capacitance and Lead Inductance Considerations for details.

Minimum ESR vs. DUT Capacitance for 20 V, 5 kW units

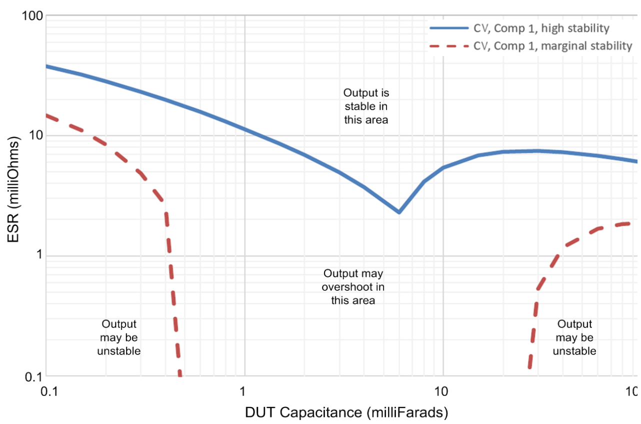
With local sensing and DUT directly connected to bus bars	With remote sensing and load leads around 6 µH/2 mΩ



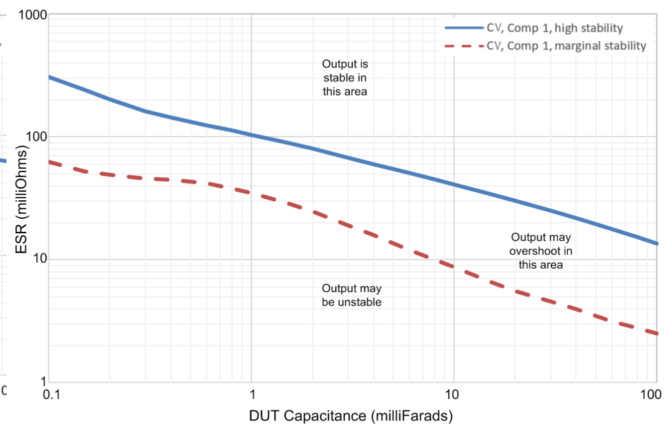
20 V, 5 kW unit; comp 0



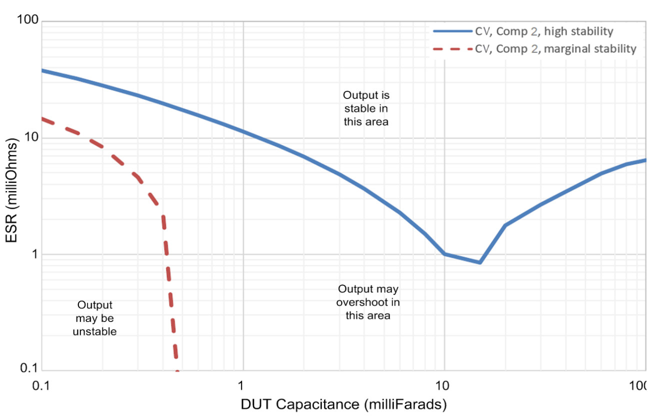
20 V, 5 kW unit; comp 0



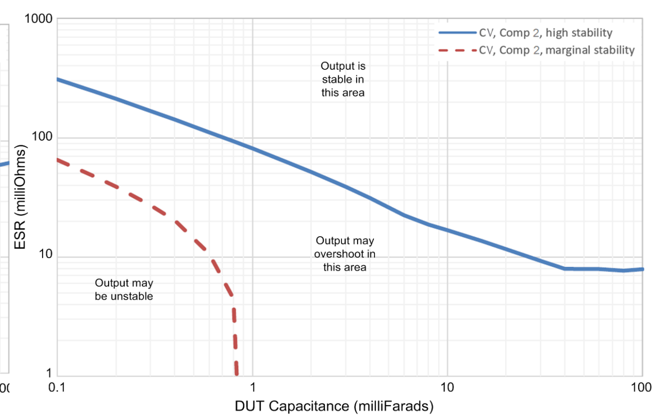
20 V, 5 kW unit; comp 1



20 V, 5 kW unit; comp 1



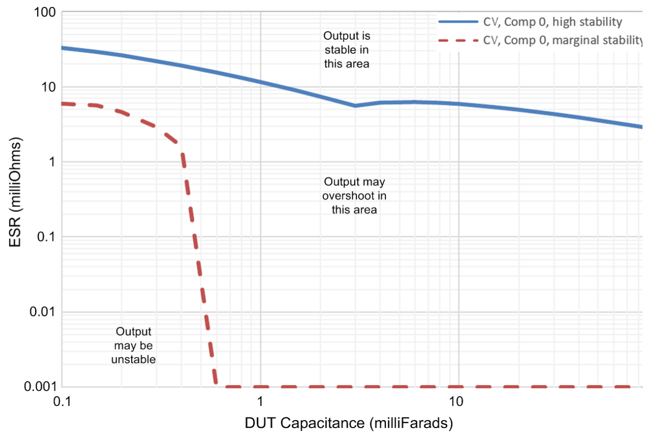
20 V, 5 kW unit; comp 2



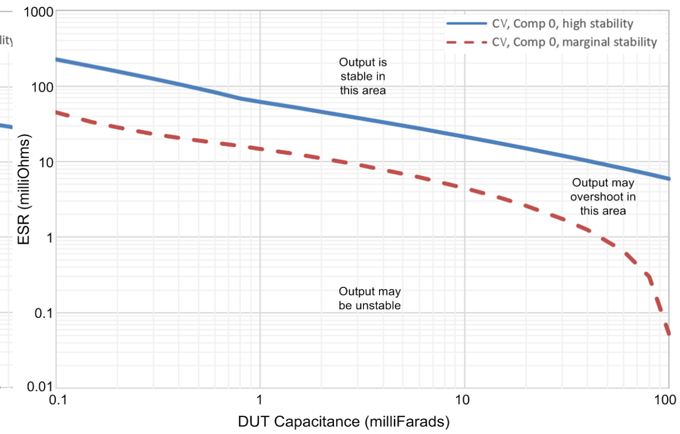
20 V, 5 kW unit; comp 2

Minimum ESR vs. DUT Capacitance for 20 V, 10 kW units

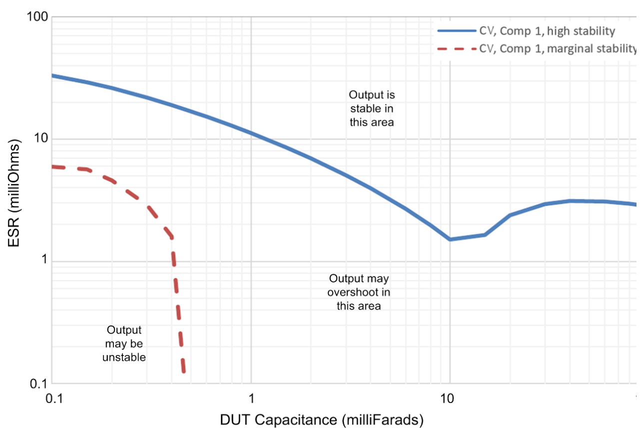
With local sensing and DUT directly connected to bus bars	With remote sensing and load leads around 3 µH/1 mΩ



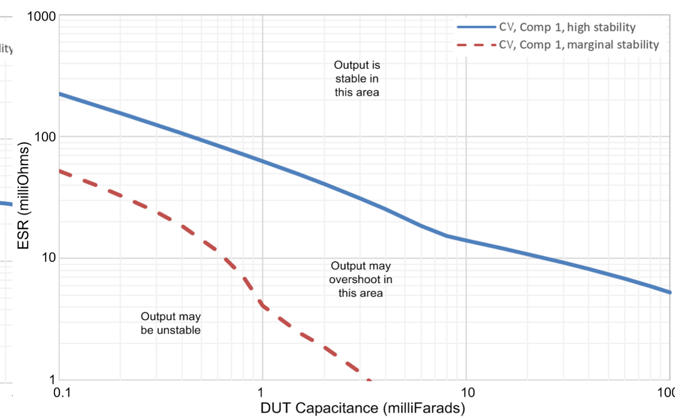
20 V, 10 kW unit; comp 0



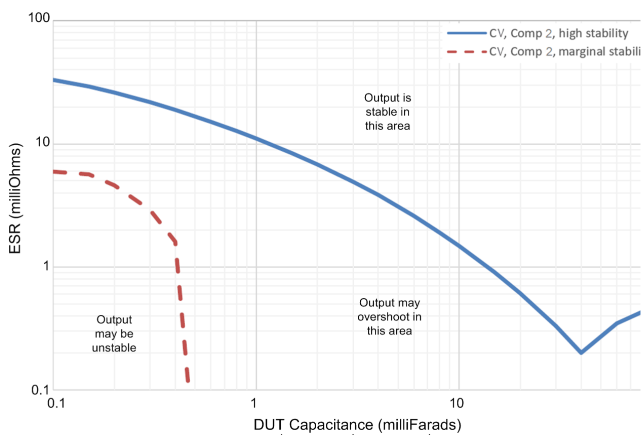
20 V, 10 kW unit; comp 0



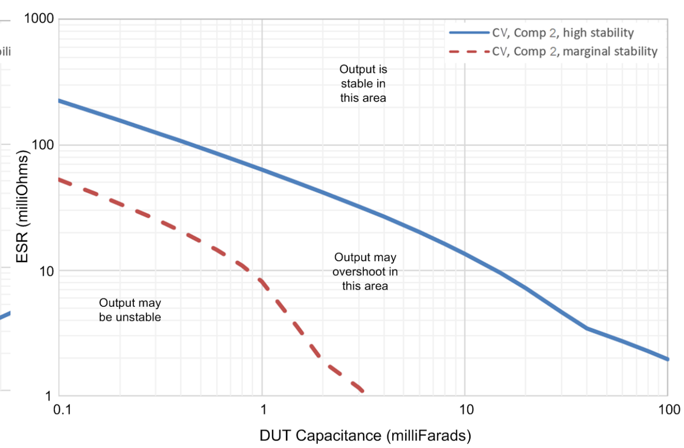
20 V, 10 kW unit; comp 1



20 V, 10 kW unit; comp 1



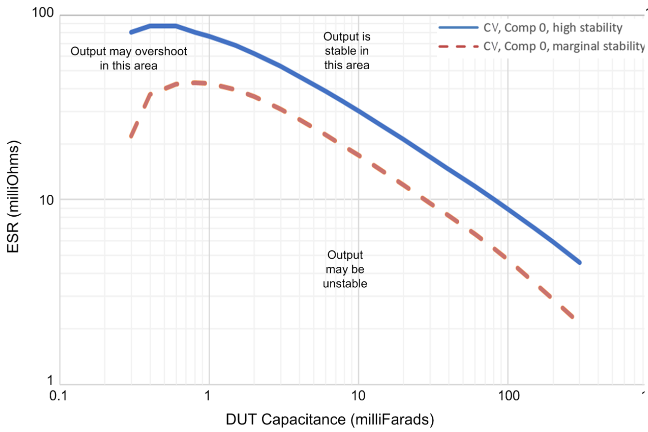
20 V, 10 kW unit; comp 2



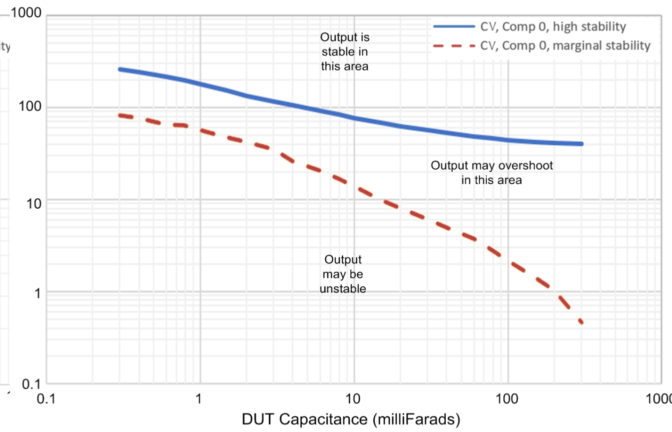
20 V, 10 kW unit; comp 2

Minimum ESR vs. DUT Capacitance for 80 V, 5 kW units

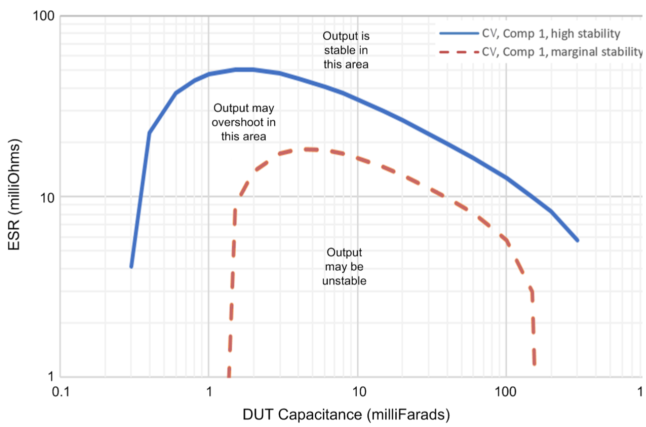
With local sensing and DUT directly connected to bus bars	With remote sensing and load leads around 6 µH/2 mΩ



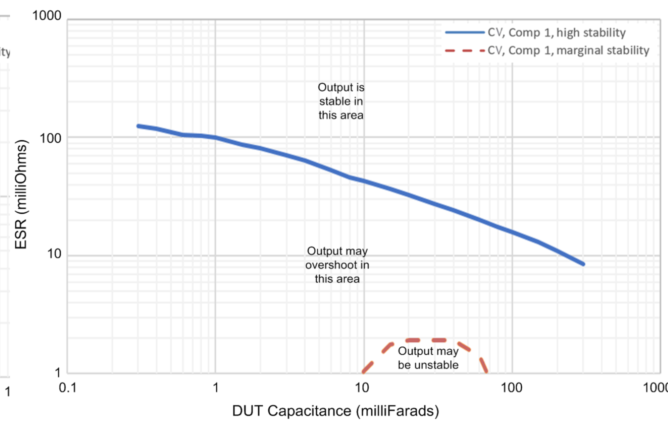
80 V, 5 kW unit; comp 0



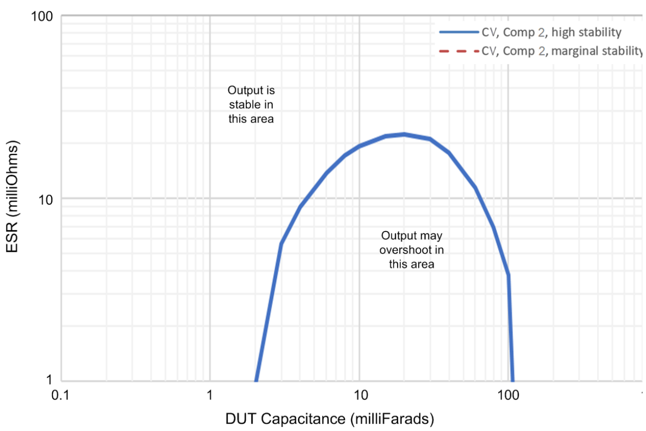
80 V, 5 kW unit; comp 0



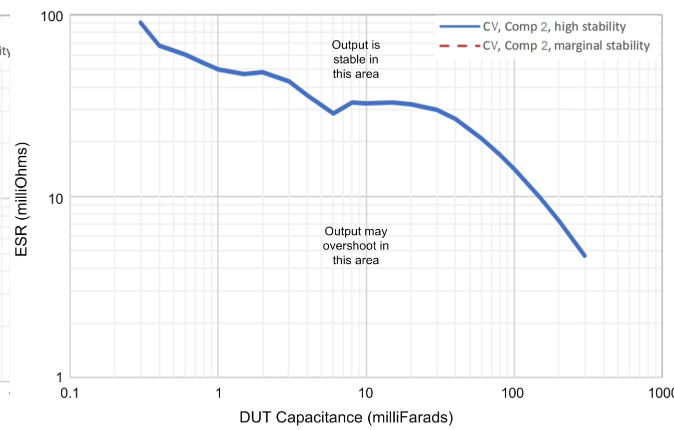
80 V, 5 kW unit; comp 1



80 V, 5 kW unit; comp 1



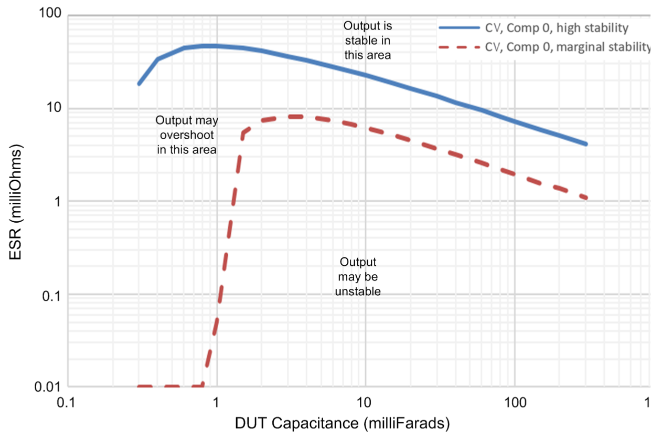
80 V, 5 kW unit; comp 2



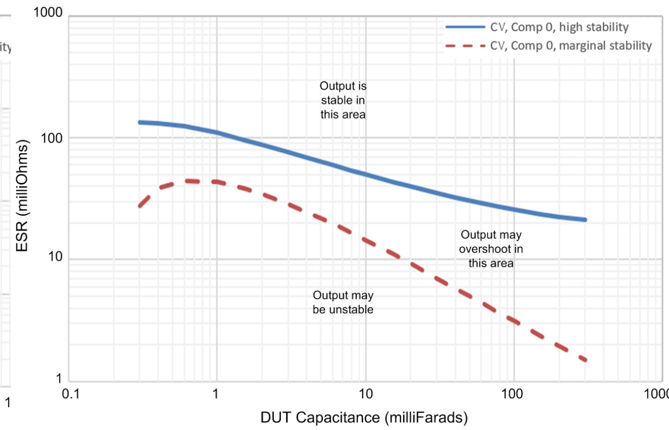
80 V, 5 kW unit; comp 2

Minimum ESR vs. DUT Capacitance for 80 V, 10 kW units

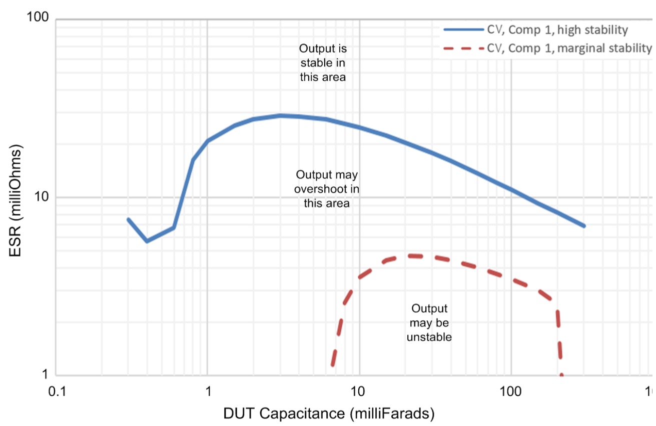
With local sensing and DUT directly connected to bus bars	With remote sensing and load leads around 3 µH/1 mΩ



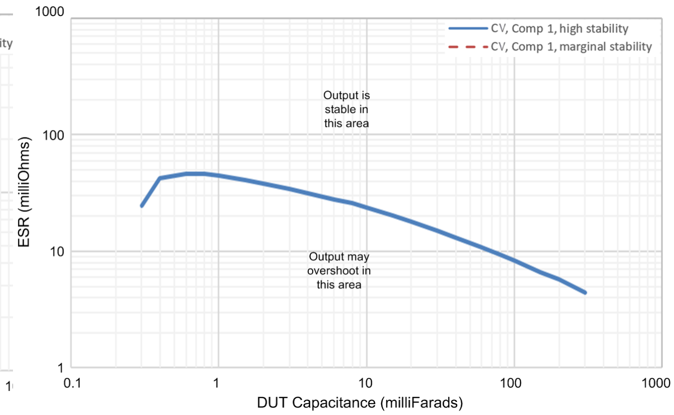
80 V, 10 kW unit; comp 0



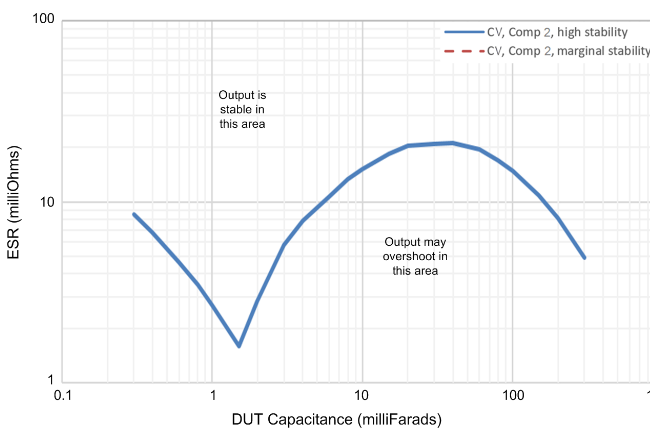
80 V, 10 kW unit; comp 0



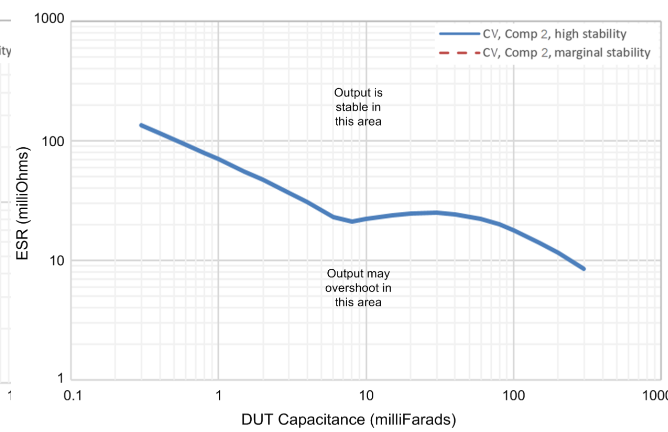
80 V, 10 kW unit; comp 1



80 V, 10 kW unit; comp 1



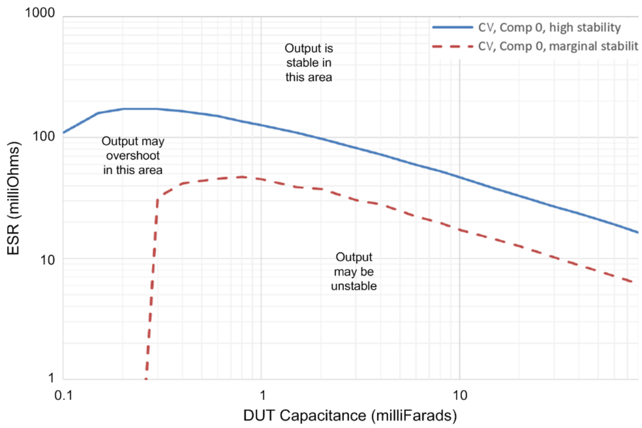
80 V, 10 kW unit; comp 2



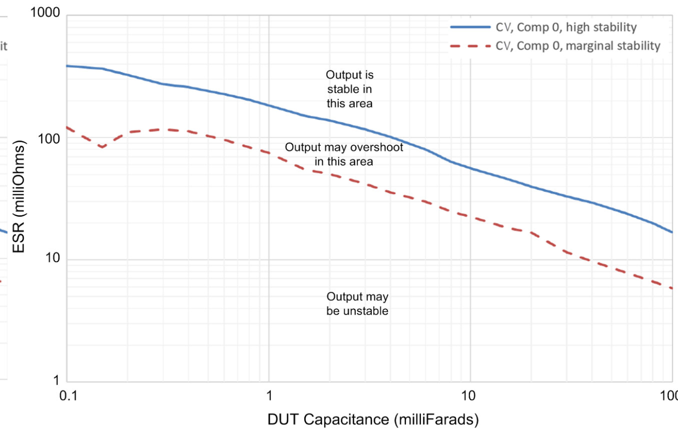
80 V, 10 kW unit; comp 2

Minimum ESR vs. DUT Capacitance for 160 V, 10 kW units

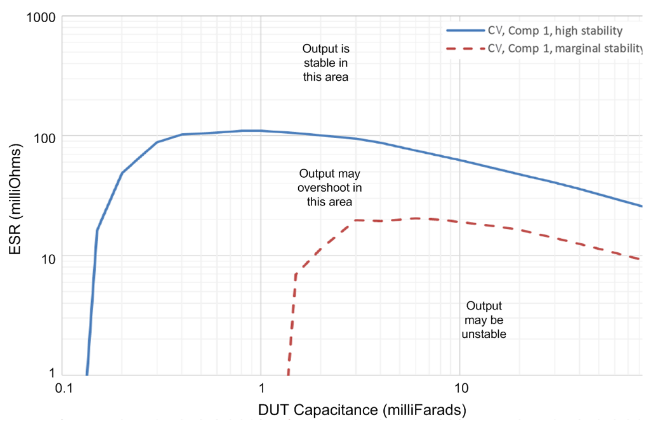
With local sensing and DUT directly connected to bus bars	With remote sensing and load leads around 6 µH/2 mΩ



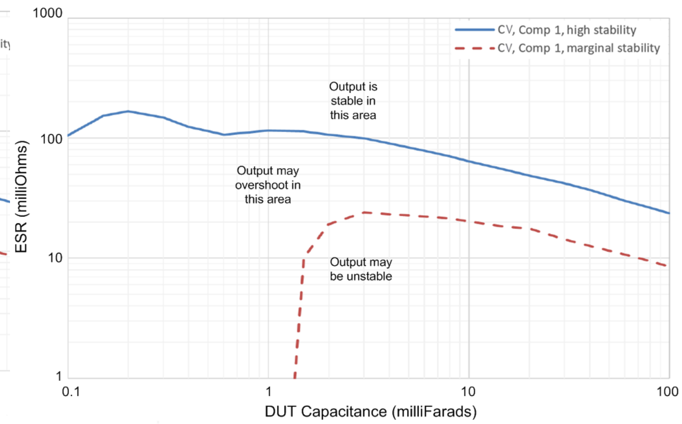
160 V, 10 kW unit; comp 0



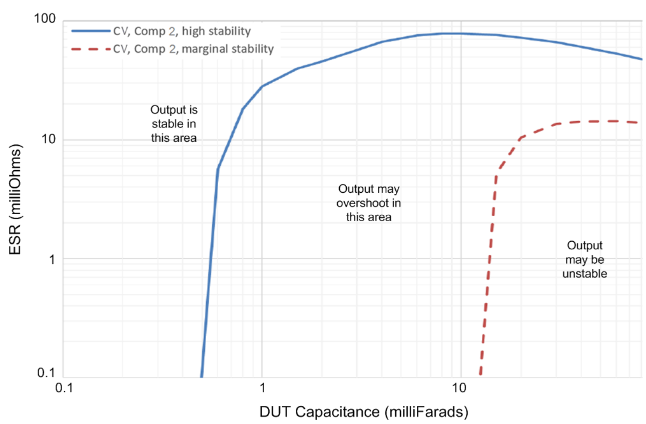
160 V, 10 kW unit; comp 0



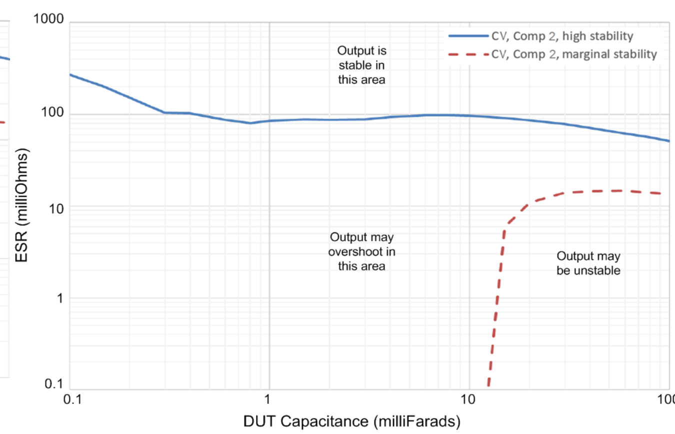
160 V, 10 kW unit; comp 1



160 V, 10 kW unit; comp 1



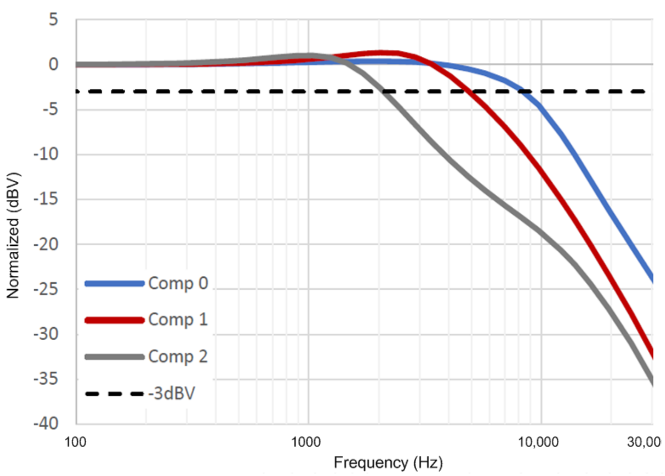
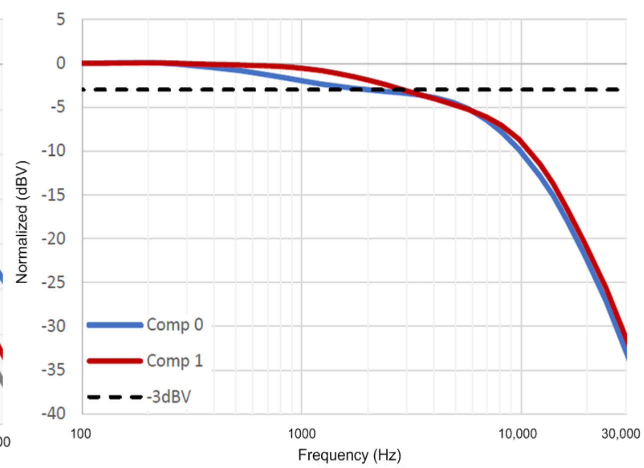
160 V, 10 kW unit; comp 2



160 V, 10 kW unit; comp 2

Small Signal Programming Response (All Models)

The following graphs show the output voltage and current programming response characteristic. The voltage response applies with no load conditions. The current response applies with AC short-circuit conditions where the DUT is a low impedance operating above 10% of the rated output of the RPS, with less than 1 foot of load leads. The table provides additional bandwidth details.

Voltage Priority Programming Response - open circuit	Current Priority Programming Response - AC short circuit
	

	Priority	Comp 0 (-1dB)	Comp 0 (-3dB)	Comp 1 (-1dB)	Comp 1 (-3dB)	Comp 2 (-1dB)	Comp 2 (-3dB)
20 V models	Voltage	5.6 kHz	8.3 kHz	3.8 kHz	4.7 kHz	1.6 kHz	2.0 kHz
	Current	550 Hz	2.0 kHz	1.3 kHz	2.7 kHz	N/A	N/A
80 V models	Voltage	5.7 kHz	7.5 kHz	5.3 kHz	6.6 kHz	4.9 kHz	5.9 kHz
	Current	1.9 kHz	2.7 kHz	3.1 kHz	3.5 kHz	N/A	N/A
160 V models	Voltage	5.5 kHz	7.0 kHz	5.1 kHz	6.2 kHz	4.8 kHz	5.6 kHz
	Current	1.9 kHz	2.5 kHz	3.0 kHz	3.5 kHz	N/A	N/A

Measurement Accuracy and Resolution - with shorter measurement intervals

The following table shows changes to the short-term measurement accuracy and resolution with various number of power line cycle (NPLC) measurement settings. Changes are due to the A-to-D converter's noise performance. The table's baseline is 1 NPLC with no added noise. To determine the measurement accuracy at shorter averaging intervals, simply calculate the percent of range to add, then add it to the fixed accuracy value in the specification table.

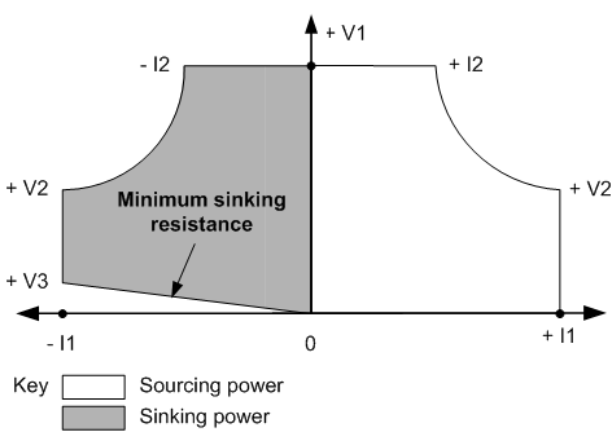
For example, to determine the percent of range to add to the accuracy specification of the voltage measurement when making measurements at 0.003 NPLC, simply multiply the full voltage rating by the "% of range added to spec value" as follows: 20 V x 0.006% = 1.2 mV. Add this number to the offset part of the measurement accuracy specification: 2 mV + 1.2 mV. The new voltage measurement accuracy is 0.02% + 3.2 mV at 0.003 NPLC.

NPLC @60Hz	Number of averaged points	Voltage Measurement % of range added to spec.	Current Measurement % of range added to spec.
1	3255	0	0
0.6	1953	0.00013%	0.0005%
0.1	325	0.0005%	0.004%
0.06	195	0.0009%	0.005%
0.031	100	0.0015%	0.008%
0.010	33	0.0025%	0.0015%
0.006	20	0.004%	0.020%
0.003	10	0.006%	0.03%
0.0003	1	0.02%	0.10%

Excessive Dynamic Protection

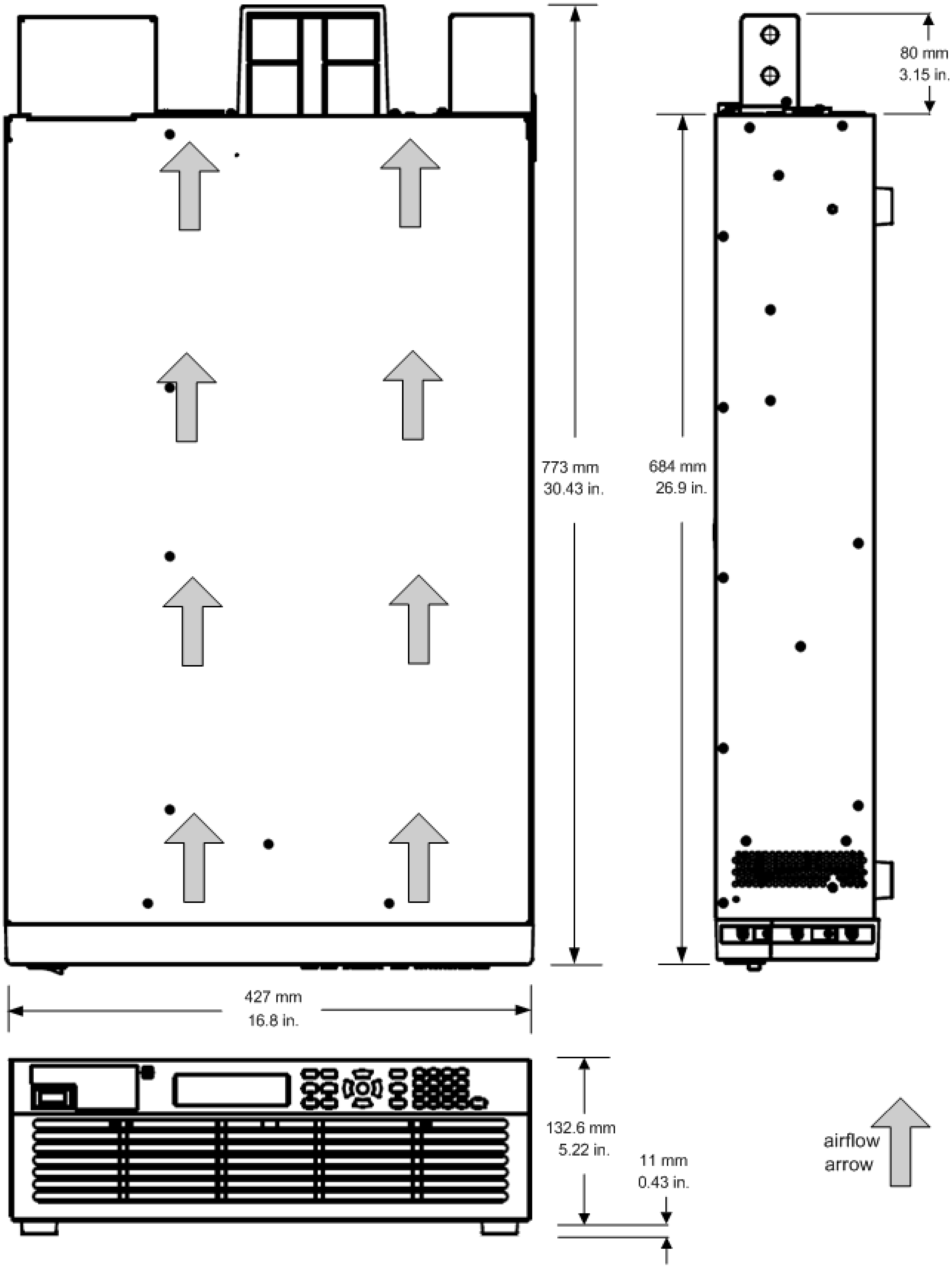
For the high current models, EDP does not limit the allowable programmable waveform amplitude or frequency. You can program a full scale square wave at a maximum frequency of 97.6 kHz indefinitely.

Output Quadrants



Model	+ V1	+ V2	+ V3	+/- I1	+/- I2	Minimum sink resistance
RP7931A/RP7941A	20 V	12.5 V	0.5 V	400 A	250 A	1.25 mΩ
RP7933A/RP7943A	20 V	12.5 V	0.5 V	800 A	500 A	625 µΩ
RP7932A/RP7942A	80 V	40 V	0.75 V	125 A	62.5 A	6 mΩ
RP7935A/RP7945A	80 V	40 V	0.75 V	250 A	125 A	3 mΩ
RP7936A/RP7946A	160 V	80 V	1.5 V	125 A	62.5 A	12 mΩ

Dimensions - RP793xA and RP794xA



Specifications and Characteristics - RP795xA, RP796xA

Specifications - RP795xA, RP796xA

Unless otherwise noted, specifications are warranted over the ambient temperature range of 0 to 40°C after a 30-minute warm-up period. Specifications apply at the output terminals, with the sense terminals connected to the output terminals (local sensing).

Specification	RP7951A, RP7961A	RP7952A, RP7962A	RP7953A, RP7963A
DC Ratings			
Voltage source:	0 to 500 V	0 to 500 V	0 to 950 V
Current source and sink:	0 to ±20 A	0 to ±40 A	0 to ±20 A
Power:	0 to ±5 kW	0 to ±10 kW	0 to ±10 kW
Output ripple & noise			
CV peak-to-peak:[1]	500 mV	500 mV	1000 mV
CV rms:[2]	100 mV	100 mV	200 mV
Load regulation			
Voltage:	30 mV	30 mV	60 mV
Current:	9 mA	17 mA	9 mA
Voltage programming accuracy:[3]	0.03% + 60 mV	0.03% + 60 mV	0.03% + 120 mV
Voltage measurement accuracy:[3]	0.03% + 80 mV	0.03% + 80 mV	0.03% + 160 mV
Current programming & measurement accuracy:[3]	0.1% + 12 mA	0.1% + 24 mA	0.1% + 12 mA
Transient response[4]			
Recovery Time:	500 µs	500 µs	500 µs
Settling band:	1.25 V	1.25 V	2.375 V

1 From 20 Hz to 20 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
2 From 20 Hz to 10 MHz (-3dB bandwidth) with resistive load, terminals ungrounded, or either terminal grounded
3 Percent of value + offset; at 25°C ±5°C after a 30 minute warm-up; measurement NPLC=1; valid for 1 year, see Calibration Interval
4 Time to recover to within the settling band following a step change from 50% to 100% of full load at the maximum slew rate

Supplemental Characteristics - RP795xA, RP796xA

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

Characteristic	RP7951A, RP7961A	RP7952A, RP7962A	RP7953A, RP7963A
Output ripple and noise			
CC rms:	100 mA	200 mA	100 mA
Voltage programming			
Range:	0.5 to 510 V	0.5 to 510 V	1.0 to 969 V
Resolution:	10.5 mV	10.5 mV	21 mV
Current programming			
Range:	-20.5 A to 20.5 A	-41 A to 41 A	-20.5 A to 20.5 A
Resolution:	190 µA	380 µA	190 µA
Resistance programming			
Range:	0 to 25 Ω	0 to 12.5 Ω	0 to 50 Ω
Resolution:	140 µΩ	70 µΩ	280 µΩ
Accuracy:	0.08% + 200 µΩ	0.08% + 110 µΩ	0.08% + 280 µΩ
Additional V-programming offset with resistance programming enabled:	+157mV +(0.36Ω x A)	+157mV +(0.36Ω x A)	+313mV +(0.72Ω x A)
Additional V-programming offset/ Ohm:	175 mV	175 mV	350 mV
Voltage Programming Speed (Comp 0)[1,2]			
Rise/fall time 10% to 90% of step:	1 ms	1 ms	1 ms
Settling time to 0.1% of step:	6 ms	6 ms	6 ms
Voltage Programming Speed (Comp 1)[1,2]			
Rise/fall time 10% to 90% of step:	15 ms	15 ms	15 ms
Settling time to 0.1% of step:	50 ms	50 ms	50 ms
Current Programming Speed[1]			
Rise time 10% to 90% of step:	2 ms	2 ms	2 ms
Maximum slew rate			
Voltage:	200 kV/s	200 kV/s	400 kV/s
Current:	1.6 kA/s	3.2 kA/s	1.6 kA/s
Small signal programming bandwidth			
Voltage @ 3dB with no load:	500 Hz	500 Hz	500 Hz
Current with output shorted:	40 Hz	40 Hz	40 Hz
Line regulation			
Voltage:	< 10 mV	< 10 mV	< 20 mV
Current:	< 290 uA	< 580 uA	< 290 uA
Reactive loads			
Capacitance default/low:	80 µF/800 µF	160 µF/1600 µF	40 µF/400 µF
Inductance:[3]	5 µH	5 µH	5 µH

1 Up programming with full resistive load and a step change from 0.1% to 100% of rated output
2 Down programming with no load and a step change from 100% to 0.1% of rated output
3 Equivalent to 10 feet of load leads

Common Characteristics

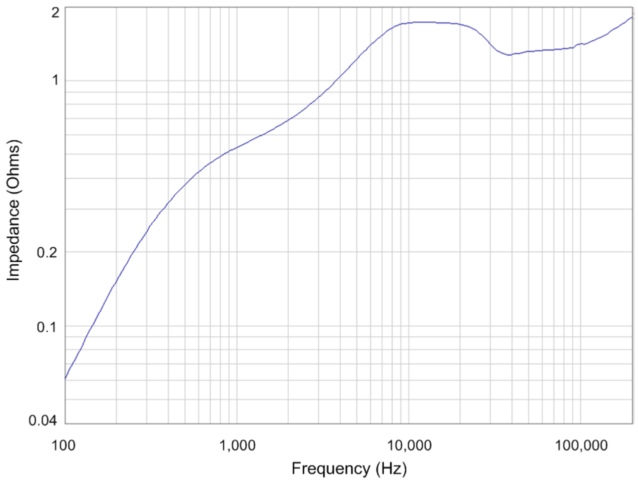
Common Characteristic	All Models
Command Processing Time	≤ 1 ms from receipt of command to start of output change. Applies to simple settings commands over the GPIB interface (see Typical Command Processing Times)
Constant Dwell ARBs	
Number of points:	Up to 65,535
Dwell range:	One dwell setting applies for the entire ARB, from 10.24 µs to 0.30 seconds
Dwell resolution:	Values are rounded to the nearest 10.24-microsecond increment
Computer Interfaces	
LXI:	LXI 1.4 Core, HiSLIP, IPv6
LAN:	10 Mb, 100 Mb, 1 Gb LAN
USB:	USB 2.0 (USB-TMC488 protocol)
GPIB:	SCPI - 1993, IEEE 488.2 compliant interface
Environmental	
Operating environment:	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range:	0°C to 55°C (Maximum continuous power available is derated at 1% of rating per degree C from 40°C to 55°C)
Relative humidity:	95% or less (non-condensing)
Altitude:	Up to 2000 meters
Storage temperature:	-30°C to 70°C
Acoustic statement (European Machinery Directive)	Acoustic noise emission LpA 79 dB at Operator position LpA 73 dB at Bystander position LpA 61.4 at Idle fan speed Normal operation mode per ISO 7779
Digital Port	
Max voltage rating:	+16.5 VDC/- 5 VDC between pins
Pins 1 & 2 as FLT:	Maximum low-level output voltage = 0.5 V @ 4 mA Maximum low-level sink current = 4 mA Typical high-level leakage current = 1 mA @ 16.5 VDC
Pins 1-7 as outputs:	Maximum low-level output voltage = 0.5 V @ 4 mA; 1 V @ 50 mA; 1.75 V @ 100 mA Maximum low-level sink current = 100 mA Typical high-level leakage current = 0.8 mA @ 16.5 VDC
Pins 1-7 as inputs:	Maximum low-level input voltage = 0.8 V Minimum high-level input voltage = 2 V Typical low-level current = 2 mA @ 0 V (internal 2.2k pull-up) Typical high-level leakage current = 0.12 mA @ 16.5 VDC
Pin 8:	Pin 8 is common (internally connected to chassis ground)

Common Characteristic	All Models
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 mark. Conforms to US and Canadian safety regulations.
	Declarations of Conformity for this product may be downloaded from the Web. Go to http://www.keysight.com/go/conformity and click on “Declarations of Conformity.”
AC Input	
Phase and range:	3 phase; 200 VAC nominal ±10%, and 208 VAC nominal ±10% 3 phase; 400 VAC nominal ±15%, and 480 VAC nominal ±10%
Frequency:	50/60 Hz
Input VA:	RP7951A, RP7961A: 6.5 kVA RP7952A, RP7962A, RP7953A, RP7963A: 11.5 kVA
Input current per phase	
200 VAC input:	RP7951A: 17.3 A; RP7952A, RP7953A: 35 A
400 VAC input:	RP7961A: 8.66 A; RP7962A, RP7963A: 17.3 A
Efficiency at full power:	RP7951A, RP7952A, RP7953A: 86.3% RP7961A , RP7962A, RP7963A: 91.5%
Power Factor:	0.99 @ nominal input and rated power
Fuse:	Internal fuse - not user accessible
NOTE	During a 1-cycle line dropout the unit may reboot. The output will remain off after reboot until the operator reinstates the previous settings, either by the front panel controls or using a computer program. This behavior is consistent with safe operating procedures.
Output Terminal Isolation:	No output terminal may be more than ±950 VDC from any other terminal or chassis ground.
Typical Weight	RP7951A, RP7961A: 60 lbs. (27.3 kg) RP7952A, RP7962A, RP7953A, RP7963A: 70 lbs. (31.8 kg)

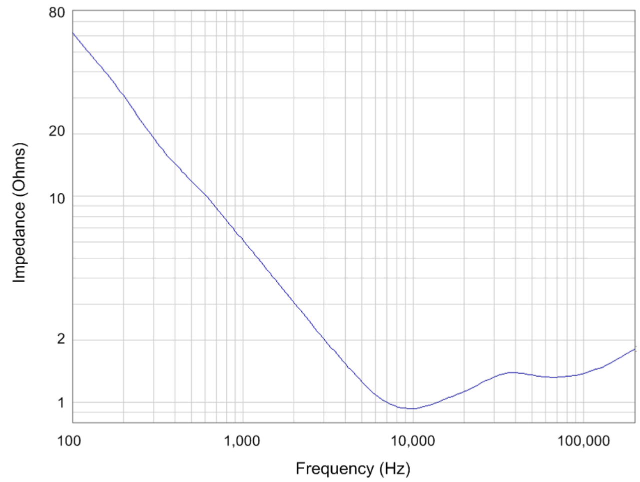
Output Impedance Graphs

All the voltage priority impedance graphs are in High bandwidth setting. There are only very minor differences at low frequencies on the graphs in Low bandwidth setting. The bandwidth setting has no effect in current priority mode.

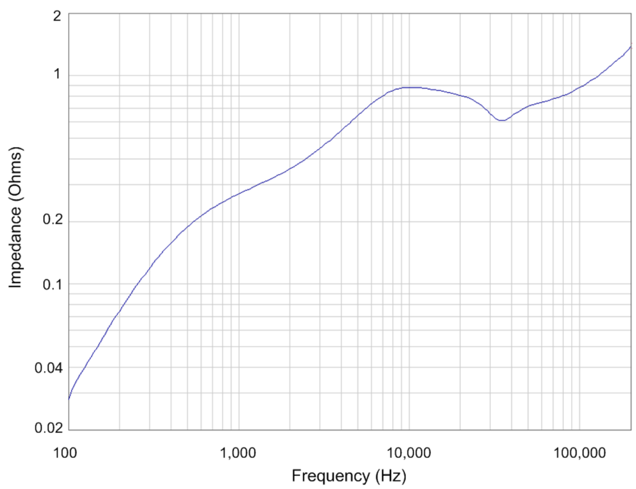
Voltage Priority Mode	Current Priority Mode



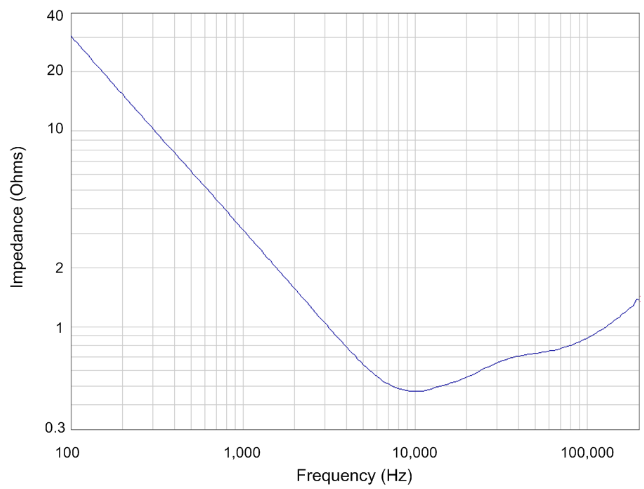
500 V, 5 kW unit (@ 250 V, 10 A)



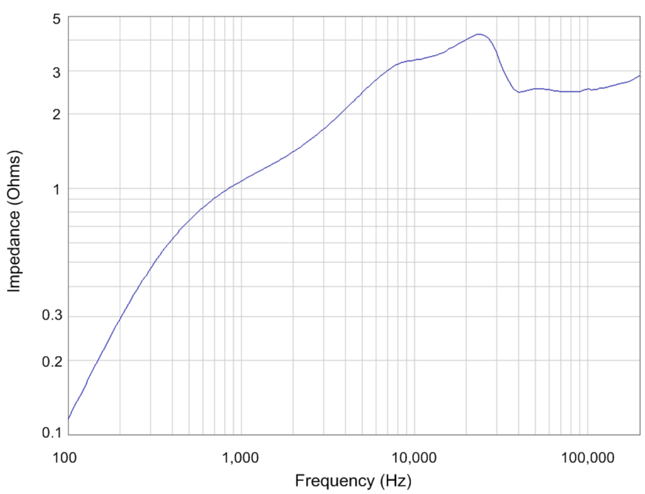
500 V, 5 kW unit (@ 100 V, 15 A)



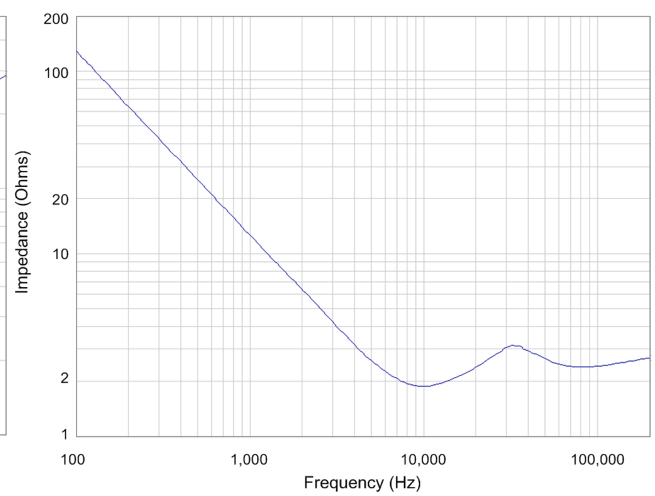
500 V, 10 kW unit (@ 250 V, 20 A)



500 V, 10 kW unit (@ 100 V, 15 A)



950 V, 10 kW unit (@ 500 V, 5 A)

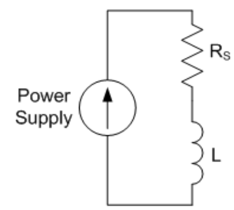


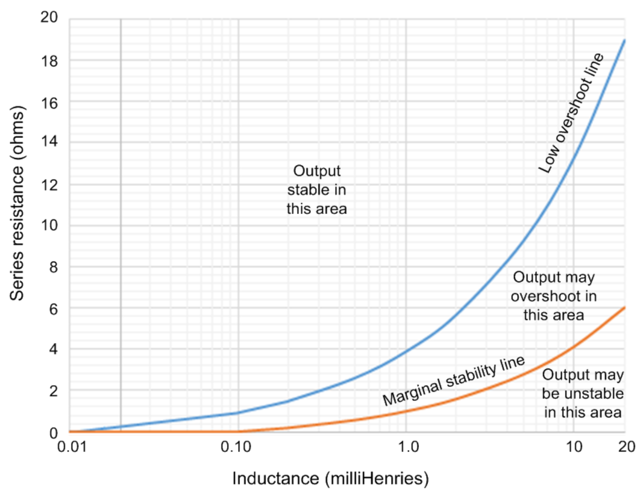
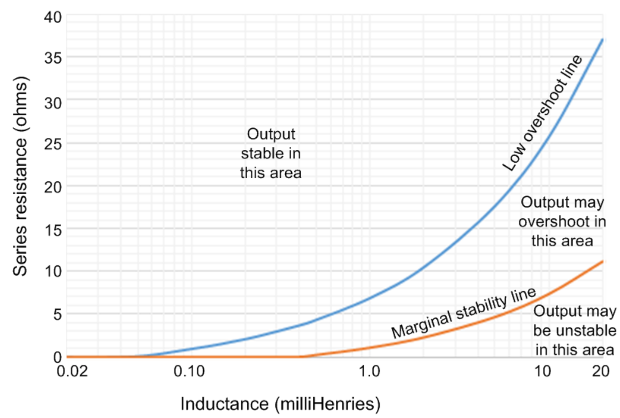
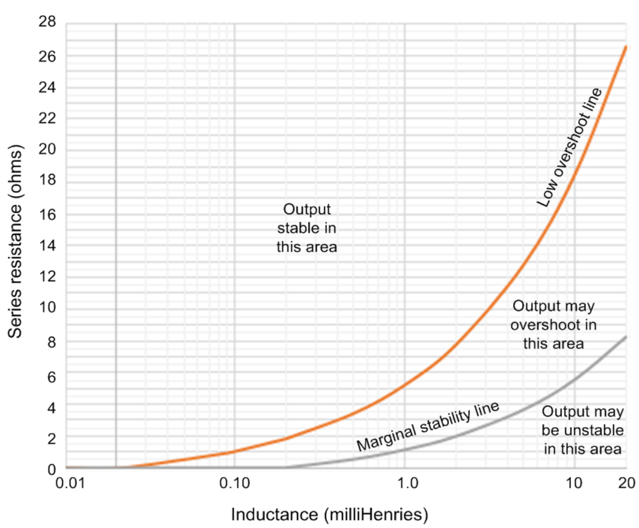
950 V, 10 kW unit (@ 100 V, 15 A)

Inductive Load Boundary for Current Priority Mode

CAUTION EQUIPMENT DAMAGE You must protect the solid-state output relays from damage with load inductance greater than 12.5 µH or twisted load leads longer than 15 meters (each wire). You can increase this length by paralleling additional twisted load leads. To minimize the di/dt and resulting voltage across the relays, make sure that the output current has been downprogrammed to zero before turning the output off.

The following figures show the boundary limitations for inductive loads (L) with series resistance (Rs) when operating in current priority mode. Operation below the marginal stability line may result in output instability. Note that increased load resistance allows increased output inductance.

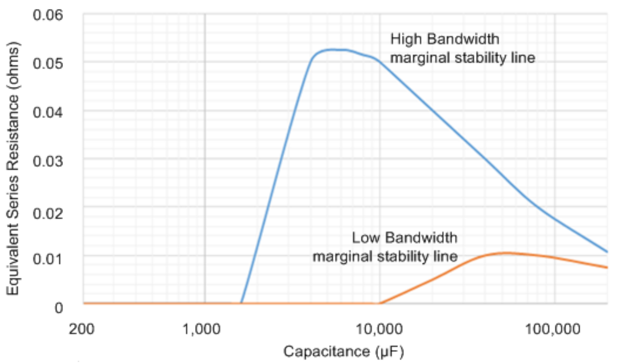


500 V units	950 V units
 500 V, 10 kW unit	 950 V, 10 kW unit
 500 V, 5 kW unit	

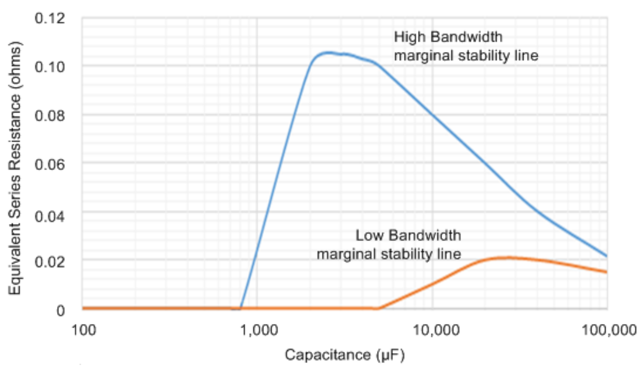
Capacitive Load Boundary for Voltage Priority Mode

The following figures show the boundary limitations for capacitive loads with equivalent series resistance. Operation *below* the two marginal stability lines when operating with either the High or Low bandwidth setting may result in output instability.

500 V units

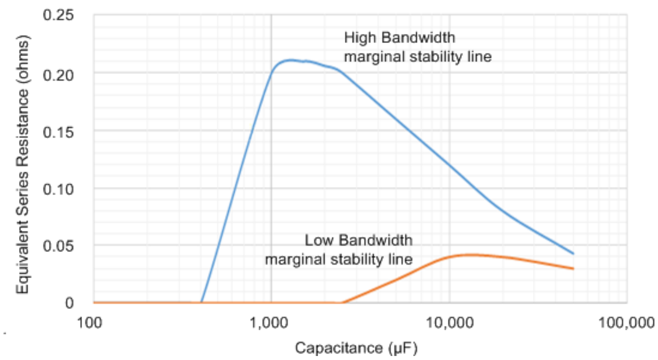


500 V, 10 kW unit



500 V, 5 kW unit

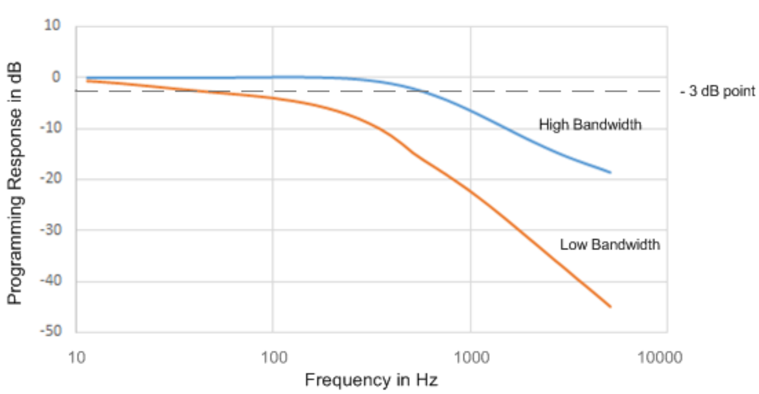
950 V units



950 V, 10 kW unit

Voltage Programming Response (All Models)

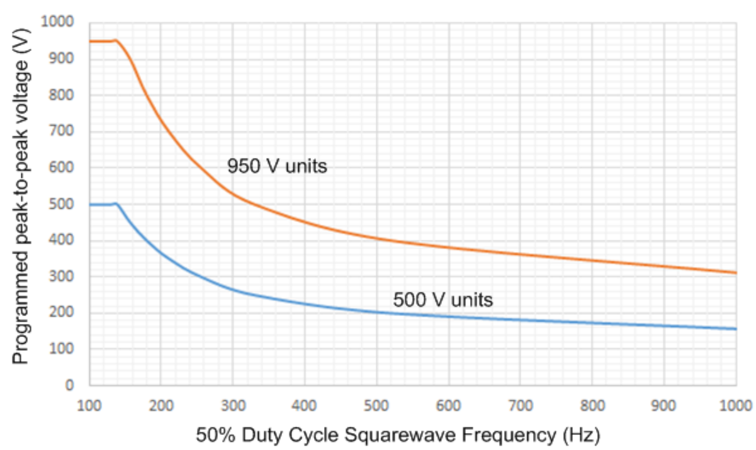
The following graph shows the output voltage programming response characteristic. This applies for small signals only, under no load conditions.



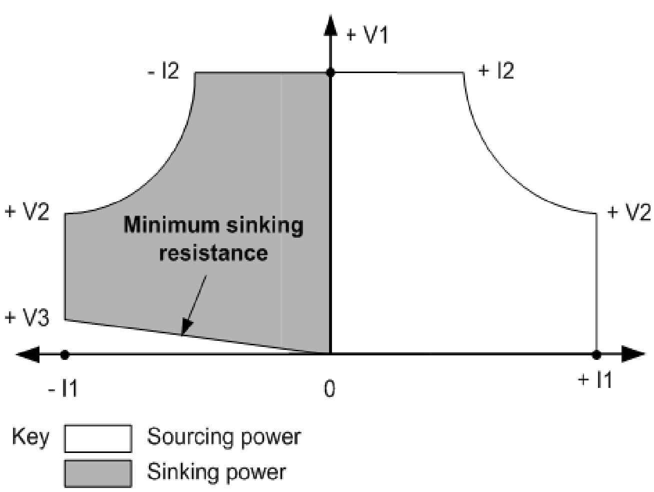
Excessive Dynamic Protection

The following graph shows the square wave amplitude thresholds versus frequency with no load. In the area *above* the indicated amplitude threshold, sustained generation of a square wave may engage the excessive dynamic protection (EDP) function, which disables the output. EDP protection may be engaged by programmed voltage changes, lists, Arbs, or load-induced voltage swings.

Maximum Peak-to-Peak Programmable Voltage
versus Square Wave Frequency

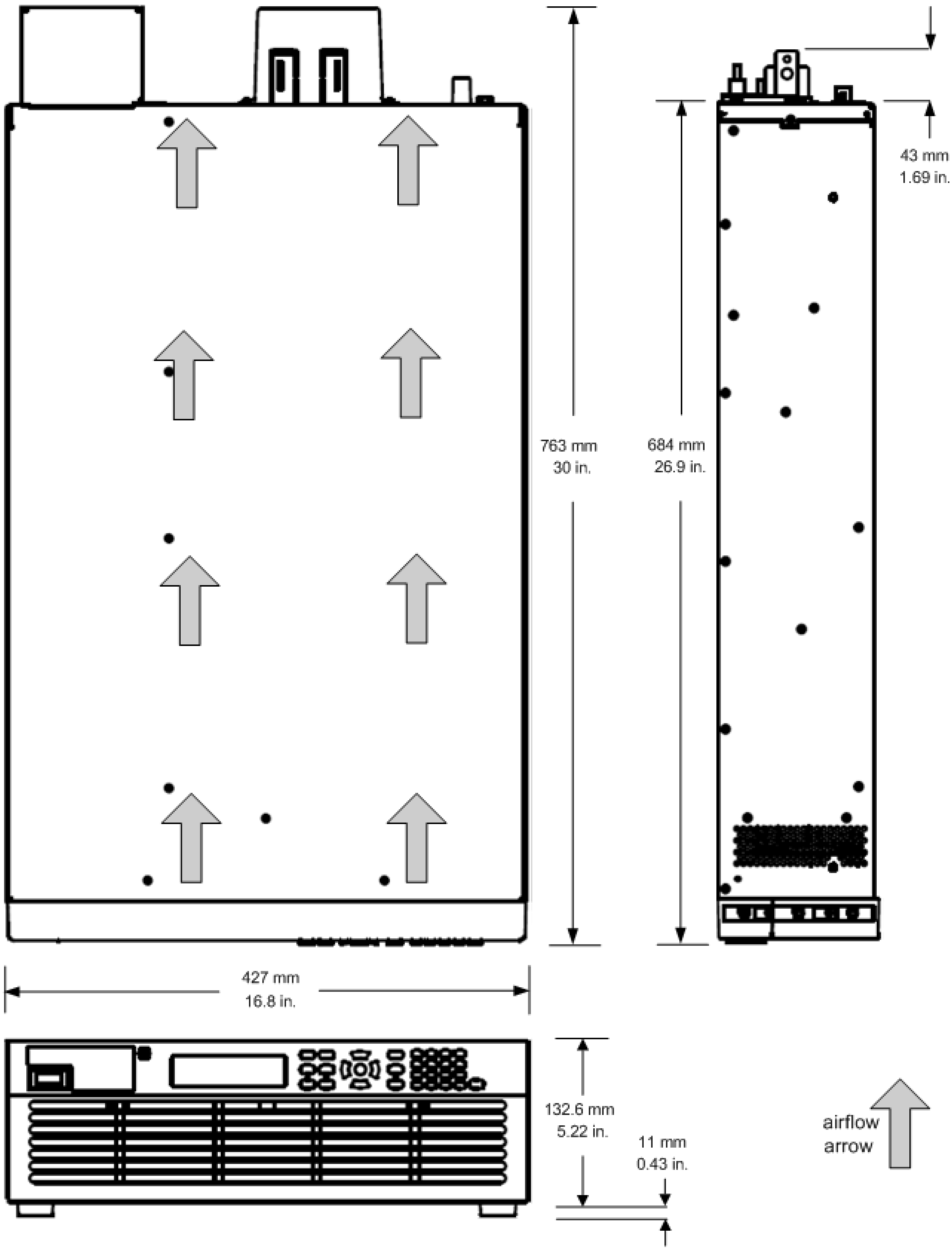


Output Quadrants



Model	+ V1	+ V2	+ V3	+/- I1	+/- I2	Minimum sink resistance
RP7951A/RP7961A	500 V	250 V	8 V	20 A	10 A	0.4 Ω
RP7952A/RP7962A	500 V	250 V	8 V	40 A	20 A	0.2 Ω
RP7953A/RP7963A	950 V	500 V	16 V	20 A	10.5 A	0.8 Ω

Dimensions - RP795xA and RP796xA



2
Installing the Instrument

WARNING Heavy Weight
Danger to hands and feet. To avoid personal injury and damage to the instrument, always use a sturdy cart or other suitable device to move the instrument. Do not lift the instrument alone; always use two people to lift the instrument.

Before Installation or Use

Inspect the Unit

When you receive your RPS unit, 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 unit, save the shipping carton and packing materials in case the unit has to be returned.

Check for Items Supplied

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

RP7900A Items	Description	Part Number
Remote sense cable for RP795xA. RP796xA (installed)	High voltage cable with 2-pin connector for + and - sense	Keysight 5188-9516 Plug only: Phoenix Contact 1714278
Remote sense cable for RP793xA. RP794xA (installed)	Sense cable with 2-pin connector for + and - sense	Keysight 5190-4501 Plug only: Phoenix Contact 1952267
Digital connector plug*	8-pin connector for the digital port	Keysight 1253-6408; Phoenix Contact 1840421
Master/slave cable*	1 m cable (CAT6A) for master/slave communication	Keysight 8121-2314
Input safety cover with bushing*	Safety cover for AC input with strain relief bushing	Cover only: Keysight 5066-1925 Bushing only: Keysight 1410-1901
Output safety cover*	Safety cover for high voltage output bus bars Safety cover for high current output bus bars	Keysight 5066-1927 Keysight 5188-9544
Sharing connector cable* RP795xA. RP796xA only	High-voltage cable with 3-pin connectors for the sharing port	Keysight 5188-9517 Plug only: Keysight 0360-3038; Phoenix Contact 1840379
Control safety cover* RP795xA. RP796xA only	Safety cover for current-sharing cable	Keysight 5066-1926
Ferrite core* RP795xA. RP796xA only	Ferrite core installs on the current sharing cable	Keysight 9170-2573
ESD cover with flange*	ESD cover for remote interface connections	Keysight 5003-2364 - cover Keysight 0515-1946 - screws
Hardware Kits RP795xA. RP796xA RP793xA. RP794xA	 Nuts and bolts for + and - high voltage bus bars Nuts and bolts for + and - high current bus bars	 Keysight 5067-6031 Keysight 5066-1936
Ferrite core for power cord	For earlier models RP7961A, RP7962A, RP7963A	Keysight 9170-2578
Calibration certificate	Calibration certificate referenced to serial number	None

* Parts marked with an asterisk are included in Cover KIt, p/n 5066-1930.

SD1000A Items	Description	Part Number
Output power cable	Cable to connect the RP7900A output to the SD1000A input	Keysight 5188-2407
Hardware kit	Nuts and bolts for + and - bus bar connections	Keysight 5067-6031
Interface cable	1 m cable (CAT6A) for interfacing with RP7900A units	Keysight 8121-2314

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 Summary page 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.

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

Observe Environmental Conditions

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

The environmental conditions for the power supply are documented under RP793xA-RP794xA and RP795xA-RP796xA common characteristics. Basically, the unit should only be operated indoors in a controlled environment. Do not operate the unit in areas where the ambient temperature exceeds +55 degrees Celsius. This applies for rack-mounting as well as for bench use.

Provide Adequate Air Flow

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

The dimensions of your power supply as well as an outline diagram are given under RP793xA-RP794xA and RP795xA-RP796xA dimensions. Fans cool the power supply by drawing air through the front and exhausting it out the back. The unit must be installed in a location that allows sufficient space of at least 12 inches (30.5 cm) at the front and back of the unit for adequate air circulation.

Stacking Instruments

CAUTION Never stack more than three instruments on top of one another in a free-standing installation.

Rack Mounting

This section contains information for installing an RP7909A Rack Mount Kit. The rack mount kit allows the RPS units to be mounted in a 19-inch EIA rack cabinet.

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

Rack Mount Kit Contents	Keysight Part number
Slide rails, 2 pair (includes mounting hardware)	5003-1128
Rack Flange kit without handles (do not use handles):	5067-6705
Flange mount, qty 2	5022-9638
Flange attachment screws, qty 6 (M4x0.7 10mm)	0515-1114
Front dress screws, qty 4 (10-32 x 0.625)	3030-1768
Metal clip-nuts, qty 4 (10-32 x 0.5)	0590-0804

Installing the Instrument

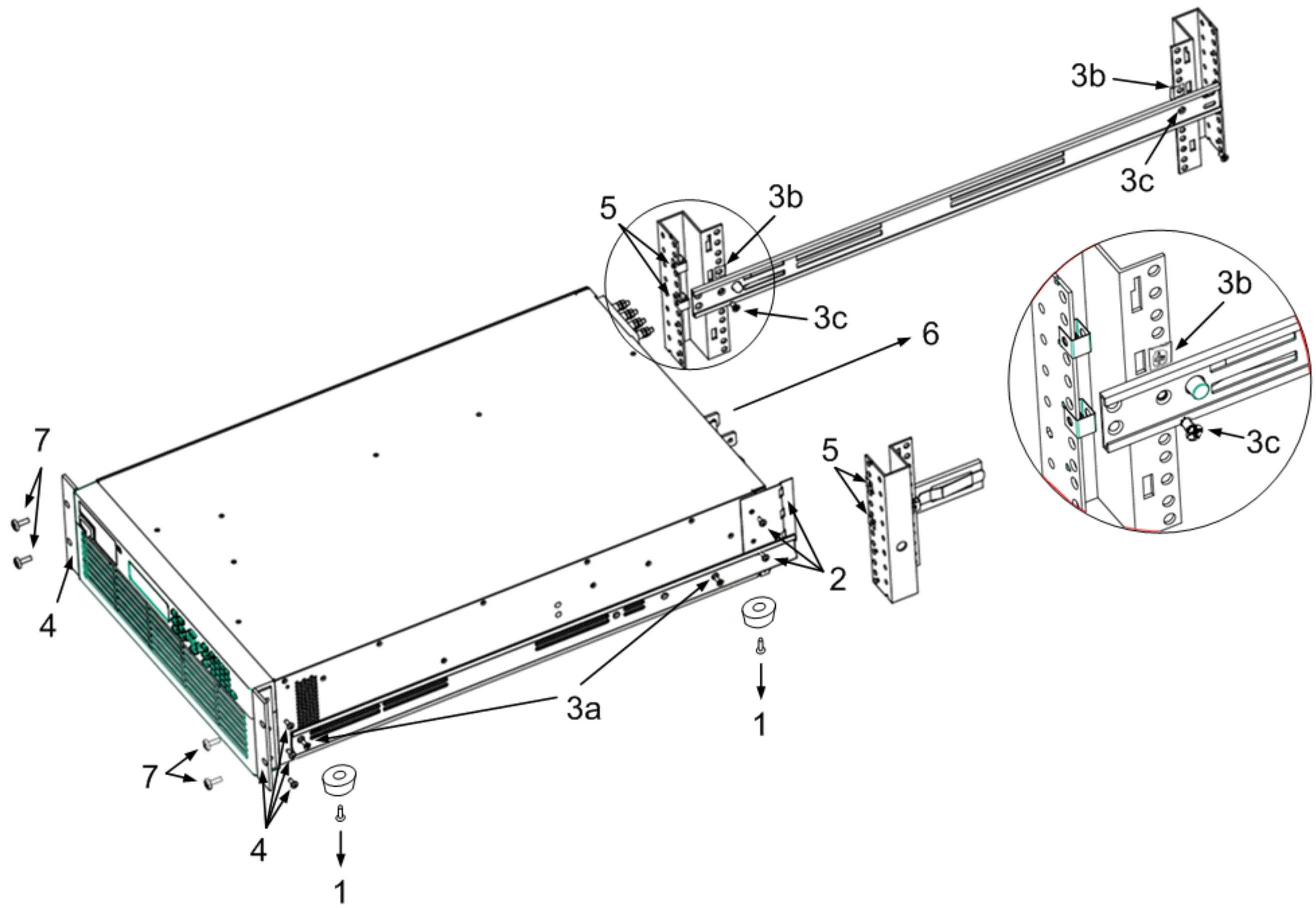
CAUTION Keysight RP7900A series power supplies weigh as much as 70 lbs. (31.8 kg). Two people are required for installation. Do not lift or move the unit alone. Avoid moving the unit by hand. If unavoidable, lift only the unit's chassis; do not lift the unit using the output terminals.

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

Tools required: Phillips driver, T22 Torx driver, T10 Torx driver.

1. Remove the four feet from the bottom of the instrument.
2. Install the ESD cover flange to the side of the instrument using the two screws provided. The flange and the screws (0515-1946) are provided in the Cover Kit (5066-1930) that is shipped with the instrument.
3. Install the slide rails 5003-1128. Refer to the slide rail instructions.
   a. Install the movable part of each slide rail to the sides of the instrument using the four screws provided (0515-1013).
   b. Install four clip-nuts on the rack frame where your instrument will be located. Install one clip nut on each corner (0590-0804).
   c. Install the stationary part of each slide rail to the sides of the rack frame using the four screws provided (2680-0104).
4. Install the two flange mounts to the front panel corners of the instrument using the six screws provided (0515-1114).

5. Install four clip nuts on the front of the rack frame for attaching the front panel (0590-0804).
6. Slide the instrument into the rack.
7. Attach the front panel to the instrument to the rack using the four dress screws provided (3030-1768).



Single Unit Connections

Power Cable Connections

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.

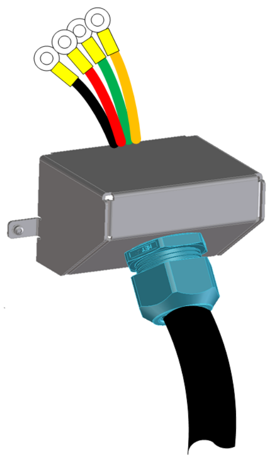
NOTE Safety agency requirements dictate that there must be a way to physically disconnect the AC mains cable from the unit. A disconnect device, either a switch or circuit breaker must be provided in the final installation. The disconnect device must be close to the equipment, be easily accessible, and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

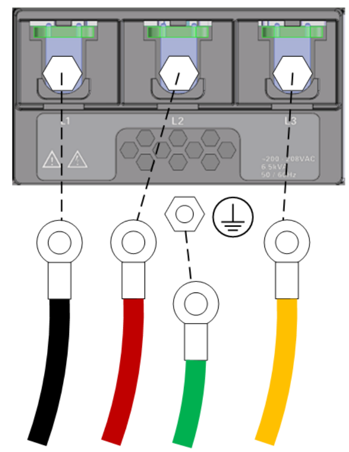
Model	Unit Rating	L1 I_{max}	L2 I_{max}	L3 I_{max}
RP7931A, RP7932A, RP7951A	5 kW - 200/208 VAC	19.5 A	19.5 A	19.5 A
RP7941A, RP7942A, RP7961A	5 kW - 400/480 VAC	9.5 A	9.5 A	9.5 A
RP7933A, RP7935A, RP7936A, RP7952A, RP7953A	10 kW - 200/208 VAC	39 A	39 A	39 A
RP7943A, RP7945A, , RP7946A, RP7962A, RP7963A	10 kW - 400/480 VAC	19 A	19 A	19 A

Either a delta-type or a Y-type AC mains distribution can be used, provided that the correct line-to-line voltage is applied (see above). Do not connect the neutral wire on Y-type AC mains distribution. An earth-ground to chassis-ground connection through a separate conductor must always be provided.

Power Cord Installation

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.





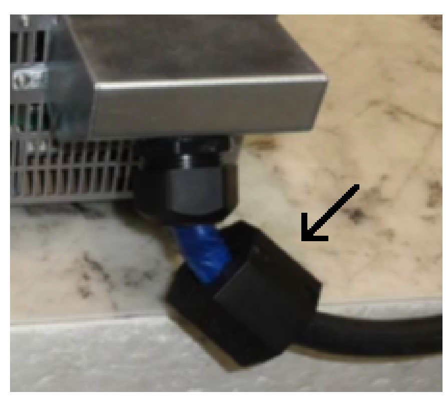
- If attached, remove the safety cover from the unit.
- Insert the terminated ends of the power cord through the strain relief of the safety cover. The safety cover strain relief is designed to accommodate both a wire cable, or individual wires.
- Do not tighten the strain relief until all wire connections are complete.
- Attach the safety cove to the unit.
- Attach the ring-terminated line wires to the AC mains terminals (U.S. color code shown). The bolt diameter is M5.
  Place the ring terminals between the star washers. Connect the ground wire to the chassis stud *below* the AC line filter assembly.
  If provided, do not connect the neutral wire.
- Tighten the terminal bolts to 23 in-lb (2.6 Nm).
- Note that on earlier units, the AC mains terminals have hex-nut terminal connections.

Ferrite Core Installation - for earlier RP7961A, RP7962A, RP7963A models

For 400/480 VAC input units that have hex-nut terminal connections (not bolts), install a ferrite core (p/n 9170-2578) to reduce RFI interference.

Place the core as close as possible to the input cover as shown.

Place a tie-wrap behind the core to prevent it from sliding down the power cord.



Regenerative Operation

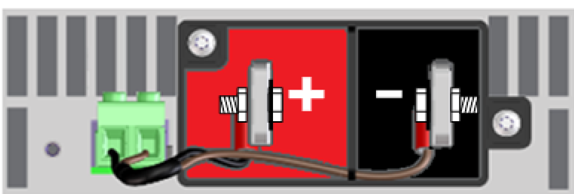
NOTE Compliance to all regulations for the operation of and connection to the public grid of energy back-feeding equipment is required. Connections must be made by a qualified electrician who knows about energy back-feeding equipment to ensure that all applicable safety requirements have been applied and all necessary conditions have been met.

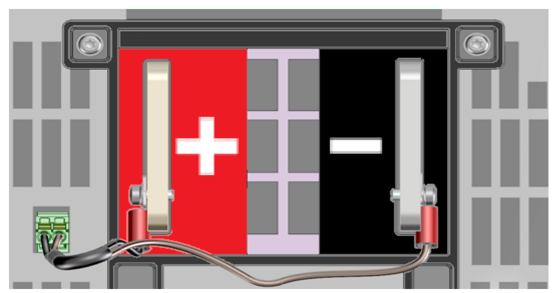
Whenever the unit is sinking current, either from rapid downprogramming of the output, or from discharging an energy source such as a battery, the unit will direct the excess power back to the AC mains through the power cord. In case of an AC mains power failure, the unit will automatically disconnect from the AC mains. This occurs even when the unit is directing power back to the AC mains.

Output Connections

Sense Connections

Ensure that the sense cable is installed on the back of the instrument as shown. The only time the sense cable should be disconnected from the output bus bars is when remote sensing.





If the sense cable is not installed prior to instrument turn-on or becomes disconnected, the unit will continue to operate. The open-circuit voltage at the output terminals will be anywhere from 0% to 0.54% higher than the programmed value because the regulation point is now maintained through internal sense-protect resistors. The following table gives the change in voltage **at the output terminals** as a percent of the voltage setting when the sense leads are not connected. The readback voltage will still appear to be at the programmed value.

Model	Δ Gain percent
RP7931A, RP7941A, RP7933A, RP7943A *	0 %
RP7932A, RP7942A, RP7935A, RP7945A	+ 0.54 %
RP7936A, RP7946A	+ 0.27 %
RP7951A, RP7952A, RP7961A, RP7962A	+ 0.13 %
RP7953A, RP7963A	+ 0.06 %

* For the 20 V RPS units only, the sense leads are buffered so that there is virtually no change in the open-circuit output voltage if the sense cable is not installed or becomes disconnected.

Bus Bar Connections

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

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 Size

WARNING FIRE HAZARD To satisfy safety requirements, load wires must be large enough not to overheat when carrying the maximum short-circuit output current. If there is more than one load, then any pair of load wires must be capable of safely carrying the full-rated current of the unit. Paralleled load wires may be required for larger-ampacity models.

The following table lists the characteristics of AWG (American Wire Gauge) copper wire.

AWG	Equivalent mm^2	Nearest Metric size	Ampacity (Note 1)	Resistance (Note 2)
18	0.82	1.0 mm^2	up to 14 A	6.385 Ω
16	1.31	1.5 mm^2	up to 18 A	4.016 Ω
14	2.1	2.5 mm^2	up to 25 A	2.525 Ω
12	3.3	4 mm^2	up to 30 A	1.588 Ω
10	5.3	6 mm^2	up to 40 A	0.999 Ω
8	8.4	10 mm^2	up to 60 A	0.628 Ω
6	13.3	16 mm^2	up to 80 A	0.395 Ω
4	21.2	25 mm^2	up to 105 A	0.248 Ω
2	33.6	35 mm^2	up to 140 A	0.156 Ω
1/0	53.5	50 mm^2	up to 195 A	0.098 Ω
2/0	67.4	70 mm^2	up to 225 A	0.078 Ω
3/0	85	95 mm^2	up to 260 A	0.062 Ω
4/0	107	120 mm^2	up to 300 A	0.049 Ω
6.2/0 (350 MCM)	177	185 mm^2	up to 420 A	N/A

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

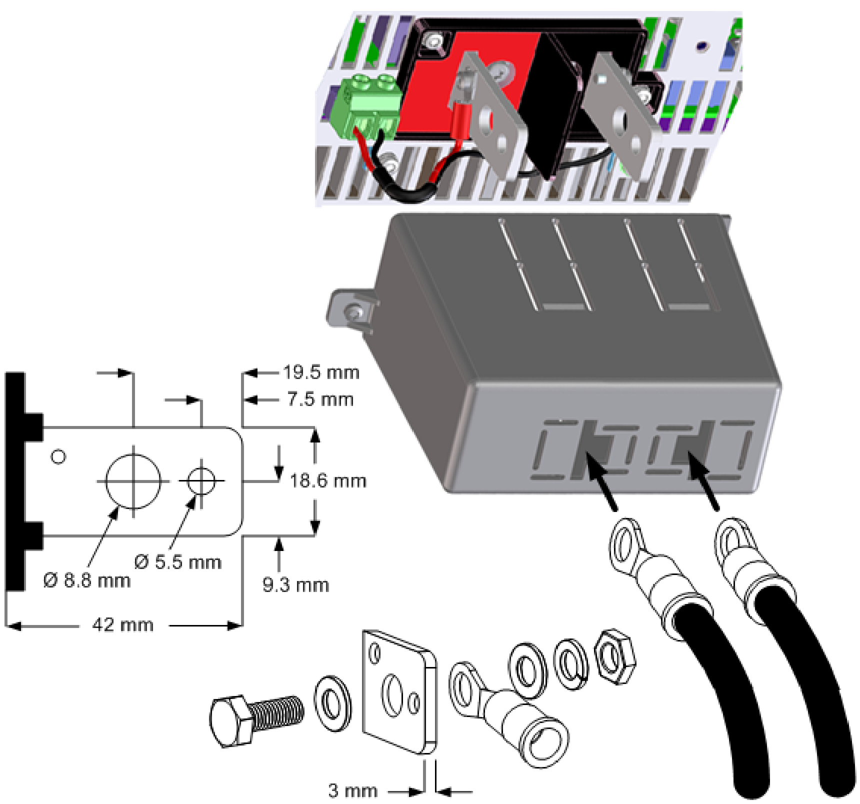
Along with temperature, you must also consider voltage drop when selecting wire sizes. The RPS will tolerate a voltage drop of 1 V per lead while maintaining the specified programming and measurement accuracy (see specifications). Voltage drops of up to 25% of the rated output voltage per lead will be tolerated with only slightly reduced programming and measurement accuracy. Of course, any voltage drop in the load leads reduces the maximum voltage available at the load. Subtract the load lead drop from the rated voltage of the unit to determine the maximum voltage available at the load.

Single Load Connections

1. As shown in the following figure, terminate all load wires with wire terminal lugs securely attached. DO NOT use unterminated wires for load connections at the power supply.
2. Route the wires through the safety cover before attaching them to the bus bars. Knockouts are provided on for larger diameter wires. The figure illustrates the recommended hardware for connecting wires to the bus bars. You must provide all cabling. Ensure that the wire-mounting hardware does not short the output terminals.
3. When attaching terminal lugs to the bus bars, ensure there is enough room for the safety cover. Twist or bundle the load wires to reduce lead inductance and noise pickup. The goal is to minimize the loop area or physical space between the + and - output leads from the bus bars to the load.
4. Attach the safety cover to the rear panel. Note that heavy wiring cables must have some form of strain relief to prevent bending the safety cover or bus bars.

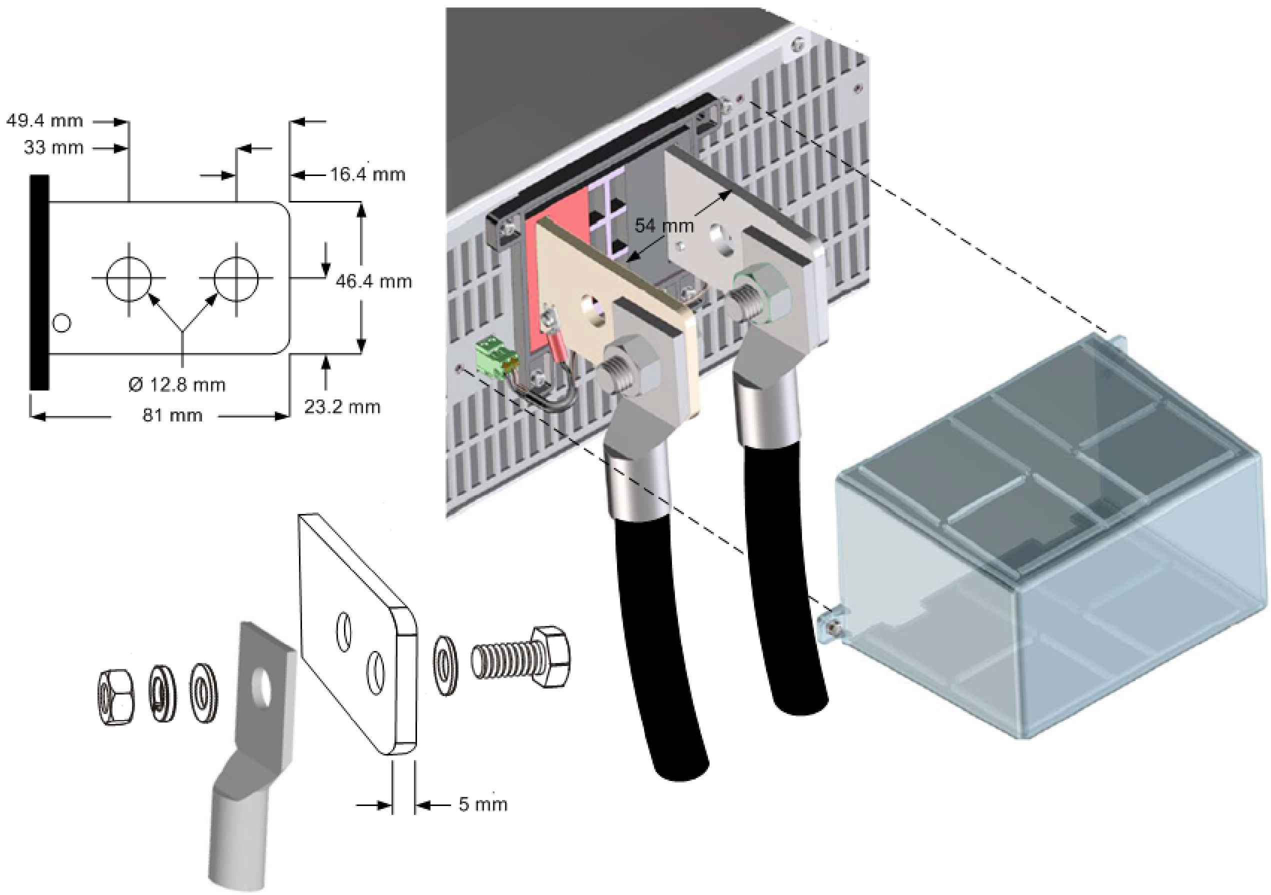
High Voltage Models - RP795xA and RP796xA RP795xA, RP796xA

CAUTION Tightening torque of the output bolts cannot exceed 10.8 Nm (8 lb-ft).



High Current Models - RP793xA and RP794xA RP793xA, RP794xA

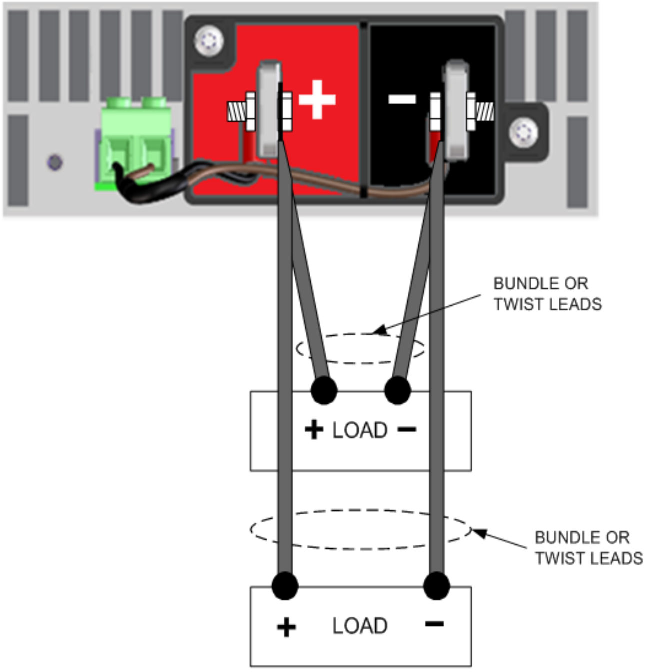
CAUTION Tightening torque of the output bolts cannot exceed 20.3 Nm (15 lb-ft).



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 connecting 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 pair of wires as short as possible and twist or bundle them to reduce lead inductance and noise pickup. The goal is to minimize the loop area or physical space between the + and - output leads from the bus bars to the load.

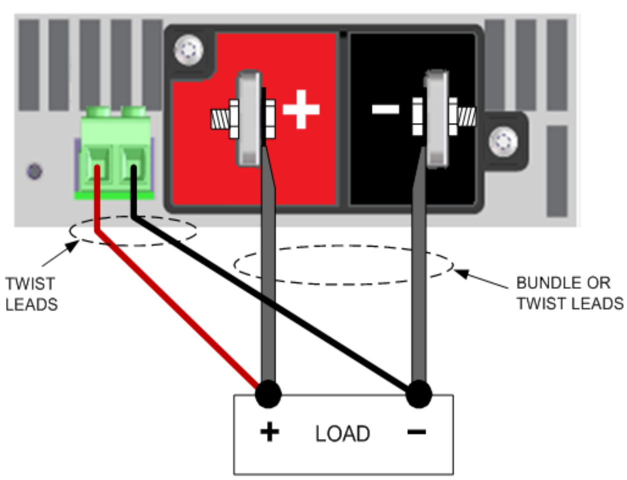
If load considerations require the use of distribution terminals that are located away from the power supply, twist or bundle the wires from the output terminals to the remote distribution terminals. Connect each load to the distribution terminals separately. Remote voltage sensing is recommended under 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

Remote sensing improves the voltage regulation at the load by monitoring the voltage there instead of at the output terminals. This allows the power supply to automatically compensate for the voltage drop in the load leads. Remote sensing is especially 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.

Connect the unit for remote sensing by first removing the local sense cable between the sense and load terminals. Then make your connections as shown in the following figure.



Connect the output terminals to the load using separate connecting wires. Keep the wire-pair as short as possible and twist or bundle it to reduce lead inductance and noise pickup.

Sense connectors accept wire sizes between AWG 16 (1.5 mm^2) maximum and AWG 24 (0.2 mm^2) minimum. Strip the wire insulation back 10 mm. Tighten the screws securely.

Connect the sense leads as close to the load as possible. Do NOT bundle the sense wire-pair together with the load leads; keep the load wires and sense wires separate. Sense wiring can be of a lighter gauge than the load wiring. The sense leads can carry up to 1 mA of current without degrading the current measurement.

NOTE Keep the sense lead resistance less than about 0.5 Ω per lead (this requires 20 AWG or heavier for a 50 foot length).

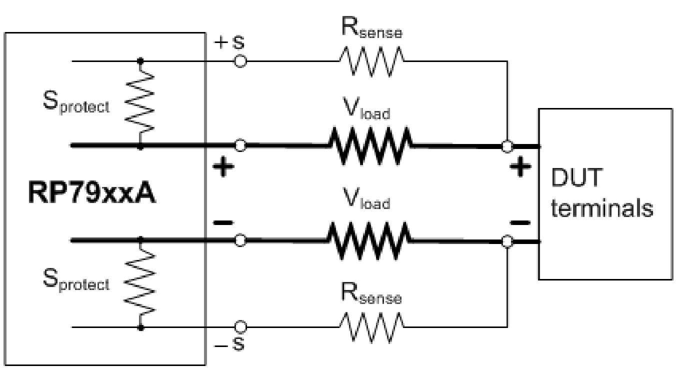
Note however, that any voltage drop in the sense leads can degrade the output voltage regulation. As the voltage drop in the load leads increases, the load voltage regulation error due to sense-lead resistance increases according to the following formula:

$\Delta V_{regulation} = 2(V_{load}(R_{sense}/S_{protect}))$

R_{sense} is the resistance in ohms of each sense lead. V_{load} is the voltage drop in each load lead. $S_{protect}$ is the internal sense protect resistor (see table).

The formula assumes that the voltage drop in the + and - sense leads and in the + and - load leads are equal.

Model	$S_{protect}$ resistor
RP7931A, RP7941A, RP7933A, RP7943A	1.96 kΩ
RP7932A, RP7942A, RP7935A, RP7945A	524 Ω
RP7936A, RP7946A	524 Ω
RP7951A, RP7952A, RP7961A, RP7962A	1.6 kΩ
RP7953A, RP7963A	1.5 kΩ



If the remote sense wires open during normal operation (with output current present), the change in output voltage **at the load** will depend on the load current and the wire resistances involved. When the sense leads open, the unit automatically reverts to local sensing. The voltage at the previous remote sense point (usually at the load) will drop by an amount given by the following equation:

$\Delta V = I_{out} \times$ (total resistance of load wiring)

Conversely, if the unit were sinking current, the voltage at the previous remote sense point would rise by the same amount.

Shorted sense leads are detected by the over-voltage protection function. This function results in the output being disabled due to an over-voltage fault (OV).

Reversed sense leads are detected by the negative over-voltage protection function. This results in the output being disabled due to a negative over-voltage fault (OV).

Refer to Additional Load Considerations - RP793xA, RP794xA for information about lead inductance when using remote sensing with

Over-voltage Protection

Over-voltage protection (OVP) provides a configurable over-voltage protection based on sense lead voltage. Having the OVP circuit monitor the sense lead voltage rather than the output terminal voltage allows for more precise voltage monitoring directly at the load.

Note that due to the voltage drop in the load leads, the voltage at the output of the power supply could be higher than the voltage being regulated at the load. The voltage at the output terminals of the power supply can never exceed the unit's voltage rating.

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 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.

The noise specifications documented in the specification tables apply at the output terminals when using local sensing. However, voltage transients may be produced at the load by noise induced in the leads or by load current transients acting on the inductance and resistance of the load lead. If it is desirable to keep voltage transient levels to a minimum, place an aluminum or tantalum capacitor, with an approximate value of 10 microfarad per foot (30.5 cm) of load lead, right across the load.

Additional Load Considerations - all Models

Response Time with External Capacitor

When programming with an external capacitor, voltage response time may be longer than with purely resistive loads. Use the following formula to estimate the additional up-programming response time:

$$\text{Response Time} = \frac{\text{(added output capacitor)X(change in Vout)}}{\text{(current limit setting)}-\text{(load current)}}$$

Note that programming into an external output capacitor may cause the RPS to briefly enter constant current operating mode, which adds additional response time. By setting the proper voltage slew rate when using an external capacitor, it may be possible to prevent mode crossover into constant current.

Positive, Negative, and Floating 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.

- 20 V models can operate with any output terminal ± 60 VDC including output voltage from ground.
- 80 V and 160 V models can operate with any output terminal ± 240 VDC including output voltage from ground.
- 500 V and 950 V models can operate with any output terminal ± 950 VDC including output voltage from ground.

NOTE The RPS models are optimized for grounding the negative output terminal. Grounding the positive terminal may result in increased current measurement noise and a reduction in current measurement accuracy.

Additional Load Considerations - RP793xA, RP794xA

NOTE This information applies to models RP793xA and RP794xA only. RP793xA, RP794xA

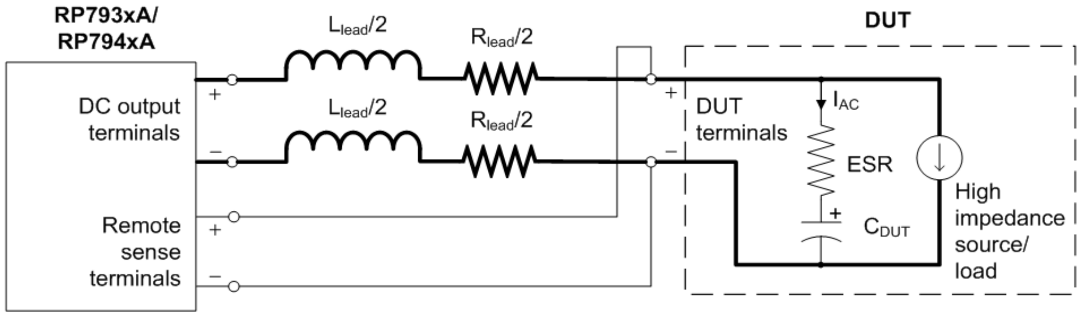
Load Inductance Limitations

CAUTION EQUIPMENT DAMAGE The instrument's internal voltage clamps are susceptible to thermal damage when the output is abruptly turned off at full load current if the lead inductance exceeds the model-dependent Maximum Load Inductance characteristic.

As a wire inductance reference point, a single pair of load leads typically yields between 500 nH to 1 µH per meter of paired length (round trip), depending on the gauge of wire, thickness of insulation, and mechanical coupling of the leads. To attain greater lead lengths, wire inductance can be minimized by paralleling additional bundled sets of load leads or using specialized low inductance wiring.

Load Capacitance and Lead Inductance Considerations in Voltage Priority Mode

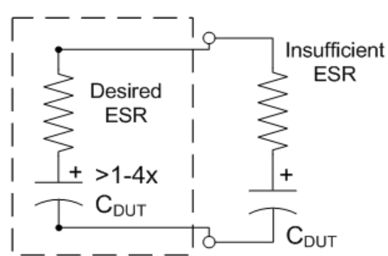
For operation of the RPS units in voltage priority mode, the setup typically resembles that in the following figure where the DUT is of a resistive or high impedance nature and may have some local bypass capacitance near its own terminals. Remote sensing at the DUT terminals is recommended if accurate DC voltage regulation is required.



In voltage priority mode, large capacitive loads and high inductance leads have the potential to create ringing and dynamically unstable voltage at the DUT when undergoing sudden load or voltage changes. ESR tends to mitigate this by dampening the resonance that occurs between the load capacitance and lead inductance. Lead resistance contributes to the damping effects of ESR but also increases voltage drop and power dissipation in the load leads. The Capacitive Load Boundary graphs in the Characteristics section have guidelines for minimum required ESR as a function of DUT capacitance under two sets of load lead conditions. This is a function of the voltage compensation mode.

For a DUT which has internal capacitance with insufficient ESR as shown in the Capacitive Load Boundary graphs, such as film capacitor or ceramic capacitors, additional capacitance and series resistance can be added in parallel to dampen the effects of ringing, as shown in the following figure. The additional capacitance should be at least 1 to 4 times the value of C_{DUT} and the desired ESR should be chosen based on the Capacitive Load Boundary plots for C_{DUT}. This can be implemented through either the addition of an explicit capacitor and resistor or an electrolytic capacitor with the appropriate value of rated ESR. The parallel capacitance and ESR must be able to handle DUT-specific requirements such as current or voltage ripple. In addition, parallel capacitance will limit the ability of the RPS to measure fast current edges sourced directly from the DUT, as well as slow down the voltage programming speed and bandwidth.

Typical external damping network

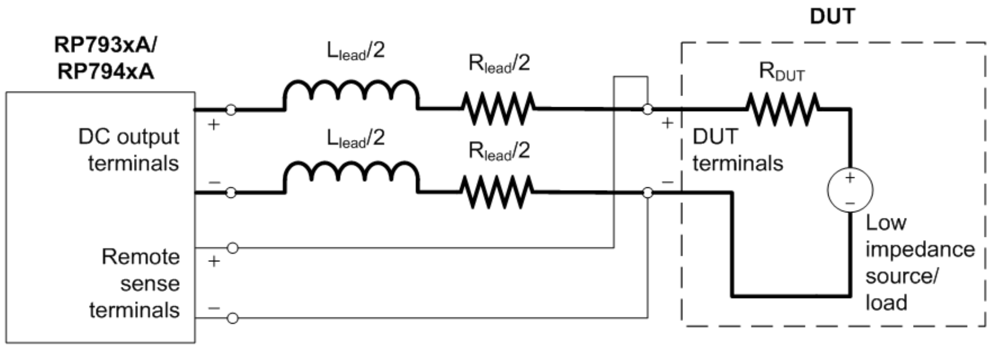


Transient Voltage Deviation

The specified voltage transient response to a load current step for the RPS may become degraded when remote sensing with long load leads, especially with low bypass capacitance at the DUT. This can be manifested as a poorly dampened ringing or even as a well dampened response with very large peak deviation. This issue is exaggerated in the case of lower voltage, higher current RPS units. To mitigate this, parallel capacitance can be added at the terminals of interest to reduce the amplitude of voltage deviation. It is likely an external parallel damping network, as previously illustrated, would be needed in place of or in addition to a pure capacitor. Generally, a capacitor with low ESR in parallel with a capacitor with high ESR allows for good stability, minimized transient response voltage deviation, as well as good voltage noise filtering.

Lead Inductance Considerations in Current Priority Mode

For operation of the RPS units in current priority mode, the setup typically resembles that in the following figure where the DUT is of a low impedance or voltage source nature. Sense lead measurements are still utilized to detect over/under voltage protection events and when cross-over into CV operation occurs.



In current priority mode, large inductive leads have the potential to create ringing in the output current when undergoing current programming steps or load voltage changes. This effect increases as inductance increases and lead resistance decreases. The Inductive Load Boundary graph in the Characteristics section shows the minimum amount of lead resistance to mitigate programming overshoot and unstable programming response under two sets of load lead conditions. This is a function of the current compensation mode. Note that lead and DUT resistance are indistinguishable in this context, so any resistance in the DUT is added to the effective lead resistance as specified in the graphs.

Dynamic Current Programming with Large Inductive Loads

Additional constraints may be required when programming current steps with high inductance DUTs or leads. Programming speed decreases with inductive loads greater than 1 µH. When programming large current steps, further speed degradation and overshoots may occur due to inherent voltage limitations of the RPS. Without lowering the inductance, the speed degradation cannot be improved. However, the overshoot aspect can be mitigated or removed by gradually decreasing the programming pole or slew rate setting until the desired level of performance is achieved.

Excessive Current in Current Priority Mode

CAUTION Excessive output current may damage the device under test under certain conditions. This can occur, for example, if the DUT shorts the output of the instrument when the lower voltage limit is set substantially above zero.

When operating in current priority mode, if the voltage of a low-impedance DUT, such as a battery or short circuit, rises above the upper voltage limit setting or falls below the lower voltage limit setting, current flow exceeding the RPS unit's steady state rating can occur, potentially damaging the DUT. After a short delay, the excessive current flow will cause over-current protection to engage - disabling the output of the RPS.

Multiple Unit Connections

Parallel Connections

Connecting power supplies in parallel provides a greater current capability than can be obtained from a single unit. The use of a master/slave configuration is required for models RP793xA, RP794xA, and recommended for models RP795xA, RP796xA (refer to Parallel Operation).

Models RP795xA, RP796xA may be operated in parallel without using a master/slave configuration, but the Current Sharing function must be explicitly enabled (refer to Independent Parallel Operation).

WARNING SHOCK HAZARD All paralleled units must be connected to qround through a grounded power cord at all times. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal on any unit will cause a potential shock hazard that could result in injury or death.

CAUTION **To Prevent Possible Equipment Damage:**

- Connect no more than twenty units of identical voltage ratings. All units must have the same voltage rating but current ratings can be different. All units must have the same version firmware installed. Refer to Instrument Identification for details.
- Always turn the AC power on and off together. Never leave any units powered on while the others are turned off.
- For models RP795xA and RP796xA, always connect the negative output terminals of all paralleled units together to prevent damaging the Sharing bus.

Load and Sense Connections

The following figures illustrate three units connected in parallel. Note the following recommendations:

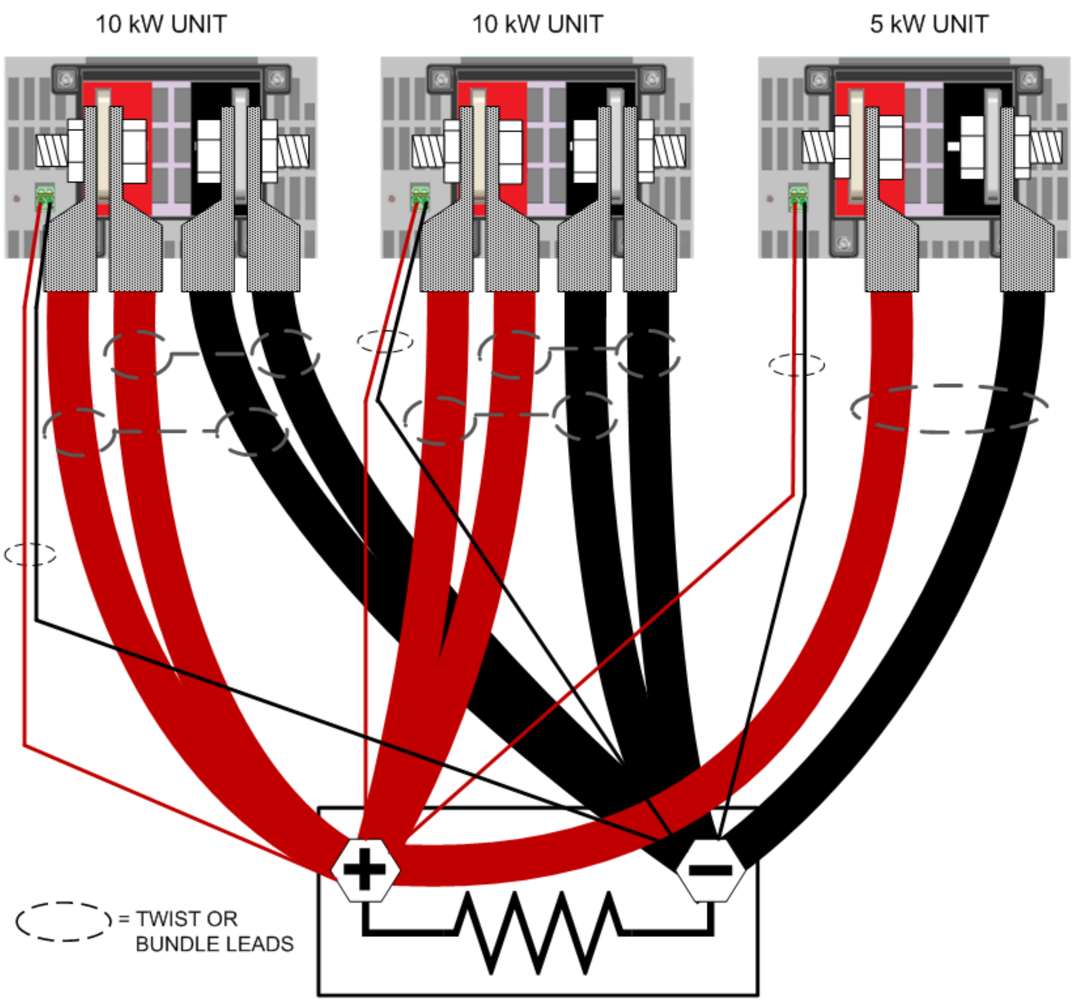
- Always install the paralleled units relatively close to each other.
- Keep the cables from the power supplies to the load as short as possible and twist or bundle the leads to reduce lead inductance and noise pickup. The goal is to minimize the loop area or physical space between the + and - output leads from the bus bars to the load.
- A symmetrical arrangement of separate load-wire pairs of equal length connecting to a common load point is highly recommended. This provides the best possible dynamic response.

- Bus bars can be used to parallel the output terminals in a stacked configuration. Ensure that the cross-section area of the bus bars will accommodate the total output current of the stack. Bus bars can be placed either on the inside or outside of the output terminals. Exposed bus bar surfaces must either be enclosed in a cabinet or insulated so that no accidental contact with lethal voltages can occur.
- To maintain the specified load regulation with paralleled units, connect all sense wires directly to the load. Twist each sense wire pair. Do not use remote sensing together with local sensing.

Although the following figures show the recommended use of remote sensing, local sensing may be used if absolutely necessary. With local sensing however, the sharing circuits will work properly only if the voltage drop measured *between* the local sense points of any unit to the local sense points of any other paralleled unit is less than 0.5% of the maximum voltage rating of the units.

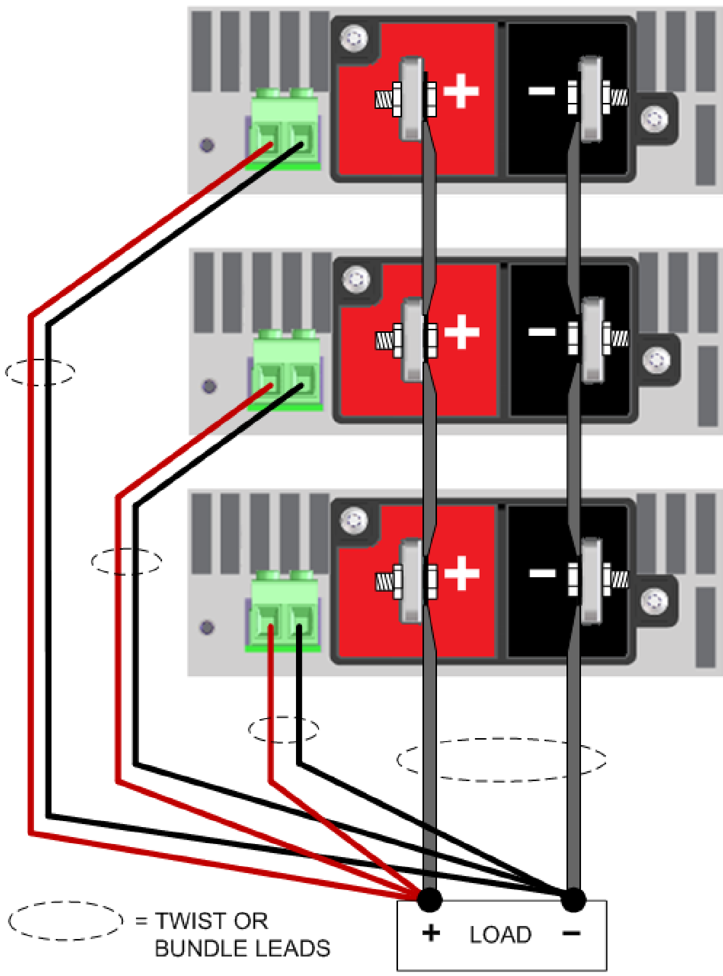
Parallel connection example - RP793xA, RP794xA

The cable lengths shown are not to scale. All load cables pairs must be symmetrical and of equal length for best performance. Size the load cables according to the current rating of the unit. Double the cables on the 10 kW units so that cable inductance scales with the 5 kW units. Plus cables should be bundled with minus cables.



Parallel connection example - RP795xA, RP796xA

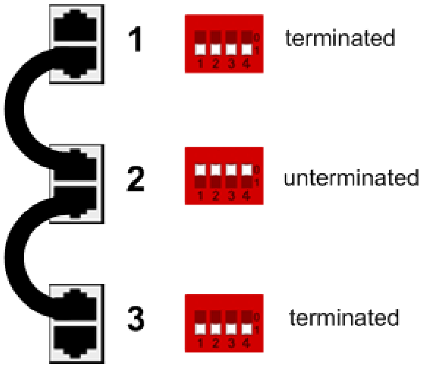
WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.



Master/Slave Connections - for all models

A master/slave configuration can be used when connecting units in parallel as shown in the following figure. This allows one designated unit to be the master controller of all of the units in the paralleled stack. Master/slave connections use a digital RS485 bus. Connections are made using standard CAT5 or better cables as shown in the figure to the left. Any unit may be designated as the "master" unit. For further information about master/slave configurations, refer to Parallel Operation.

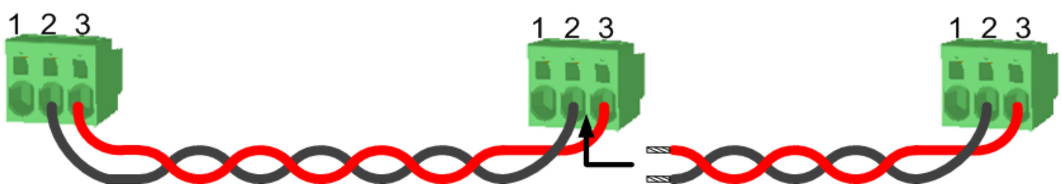
The figure also shows the termination switch settings for the paralleled units. Only the first and last units in the stack must have the switch set to the "terminated" position. The switches of the in-between units must be set to "unterminated". If only two units are connected in a master/slave configuration, both units must have their switches set to "terminated". A current-sharing fault (CSF) may occur if the switches are not set incorrectly.



Current Sharing Connections - RP795xA, RP796xA

NOTE Current sharing between paralleled models RP795xA and RP796xA (RP795xA, RP796xA) requires a separate sharing cable connecting the units. This cable provides the analog signal that allows units of the same voltage rating to share current. The current sharing function must be enabled by the user. For further information about current sharing, refer to Enable Current Sharing.

Connect the **Sharing** terminals for current sharing operation as shown in the following figure. Connection plugs are attached to each end of the sharing cable as shown. When connecting multiple cables, remove a connector plugs from one of the cables and attach the wire ends to the previous cable. Parallel pins 2 together and parallel pins 3 together. Pin 1 is not used.



NOTE If the Sharing cable is disconnected, the paralleled units will still operate, but will not share current or maintain constant voltage mode operation. When the output is disabled, the sharing relay opens and disconnects the unit from the Sharing bus.

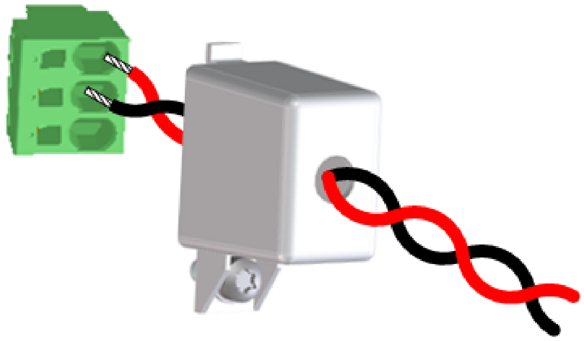
Sharing Cable and Cover Installation

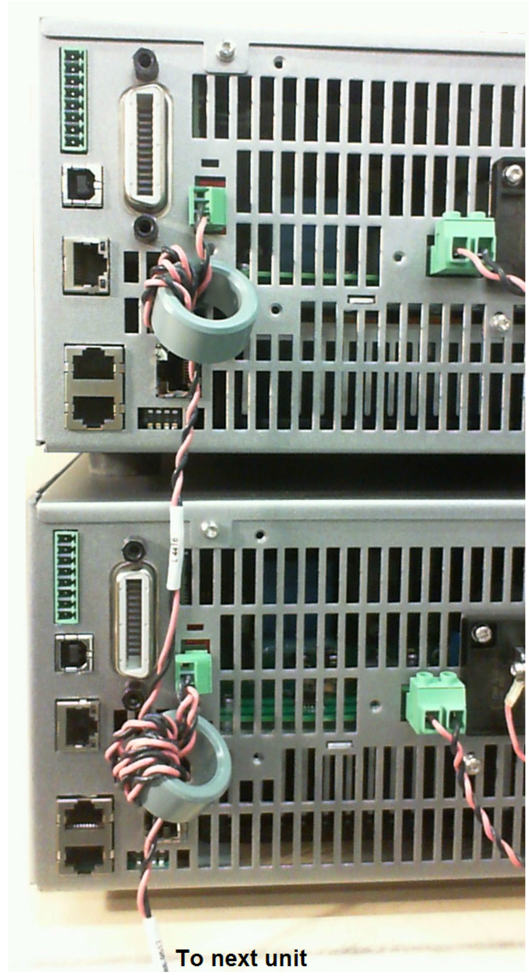
WARNING SHOCK HAZARD Install the safety cover over the current sharing connectors when floating the output terminals. The sharing terminals will be at the float potential, which cannot exceed the isolation ratings given in the **characteristics** tables.

Because of the danger of electric shock when touching the sharing connection plugs, you must install the safety cover along with the cable. To install the cable through the cover, you must disconnect one of the connectors to fit the wires through the safety cover.

A ferrite core is also provided to comply with the EMC IEC61326-1 standard. The ferrite core does not affect the functionality of this product.

The following figures detail the sharing cable incorporated with the safety cover and the ferrite core.





Cables are shown without covers for clarity.

- Disconnect one of the 3-pin connector plugs.
- For EMI reduction, loop the sharing cable through the ferrite 4 times (referenced from the *inside* of the core). Each end of the sharing cable must have a core installed.
- When using multiple sharing cables, both sharing cables must loop through the core. Refer to the second core in the figure.
- Install the safety covers over the sharing cable as shown above.
- Re-connect the connector plug that you removed.
- Plug the sharing cable connector into the back of the unit.
- Connect the safety cover to the unit.

Refer to Interface Connections for information about connecting the ESD cover.

Series Connections

Series connections are not permitted under any circumstances.

WARNING SHOCK HAZARD/LETHAL VOLTAGES Series connections are not permitted for many reasons. One of the primary reasons for models RP795xA and RP796xA, for example, is that floating voltages cannot exceed the isolation ratings given in the **RP795xA, RP796xA** characteristics tables.

Interface Connections

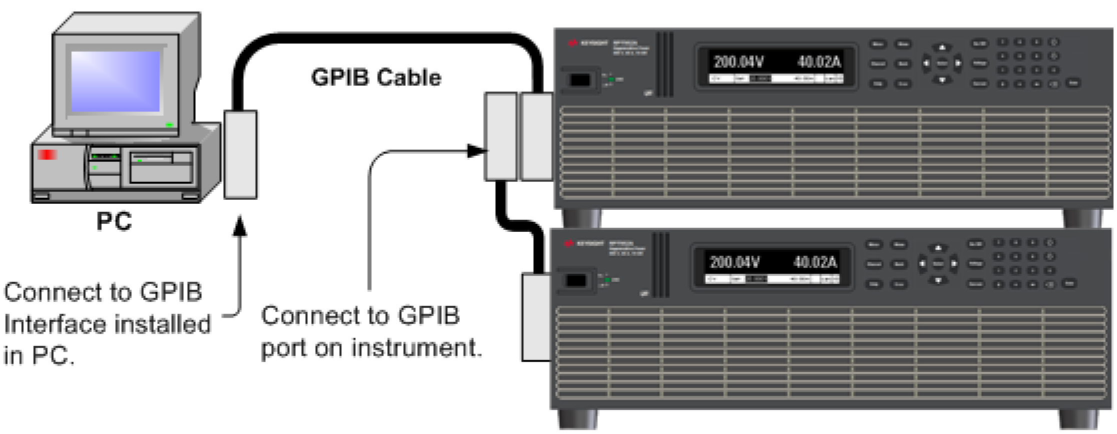
This section describes how to connect to the various communication interfaces on your RPS. For further information about configuring the remote interfaces, refer to Remote Interface Configuration.

If you have not already done so, install the latest Keysight IO Libraries Suite from www.keysight.com.

NOTE For detailed information about interface connections, refer to the Keysight Technologies USB/LAN/GPIB Interfaces Connectivity Guide, included with the Keysight IO Libraries Suite.

GPIB Connections

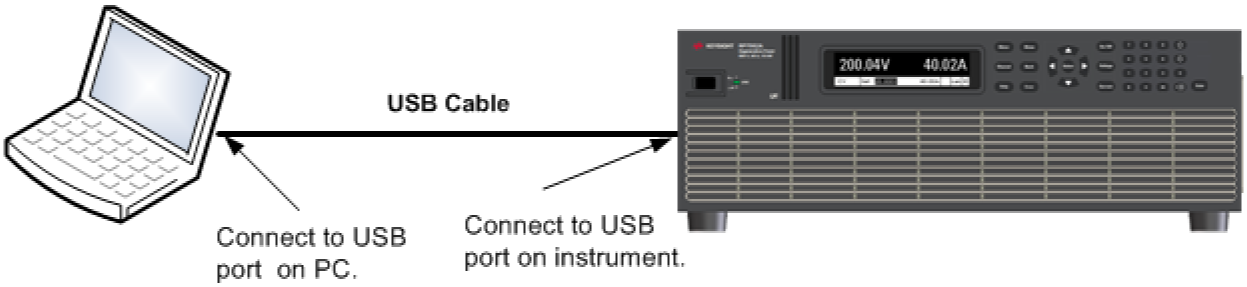
The following figure illustrates a typical GPIB interface system.



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

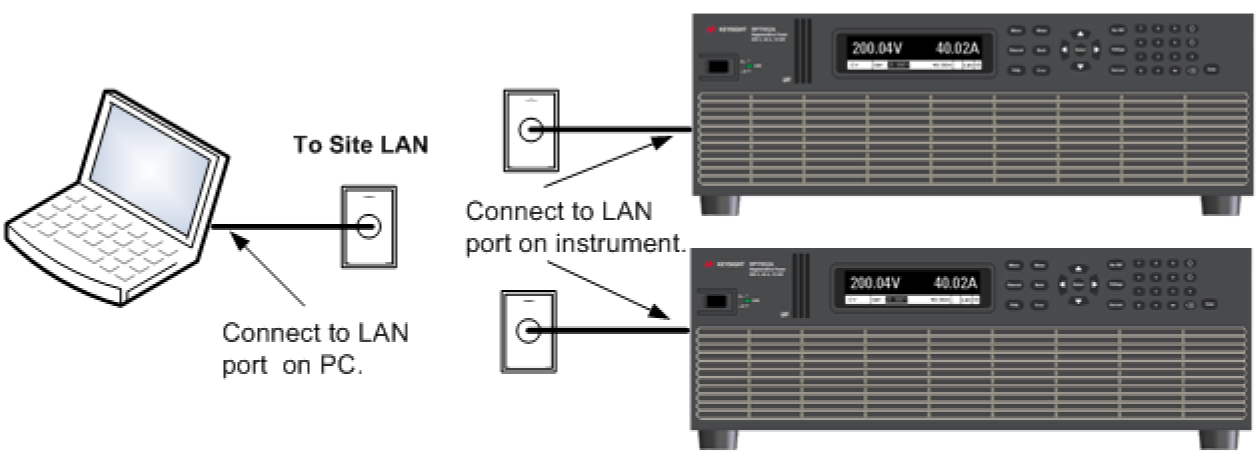
The following figure illustrates a typical USB interface system.



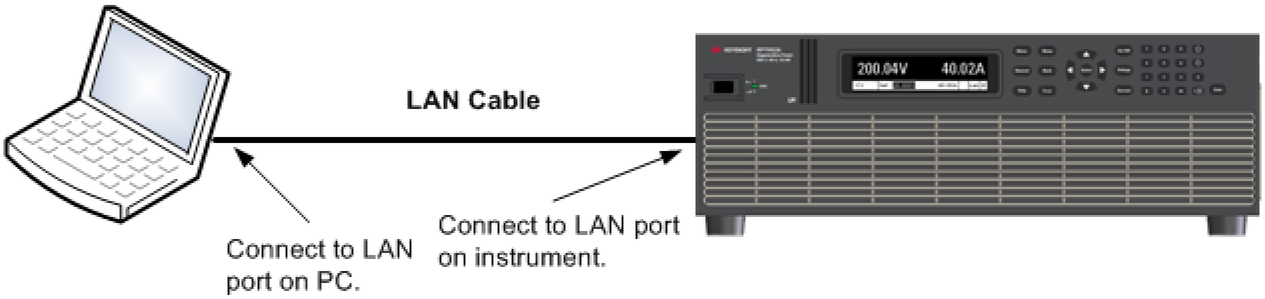
1. Connect your instrument to the USB port on your computer.
2. With the Connection Expert utility of the Keysight IO Libraries Suite running, the computer will automatically recognize the instrument. This may take several seconds. When the instrument is recognized, your computer will display the VISA 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

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.



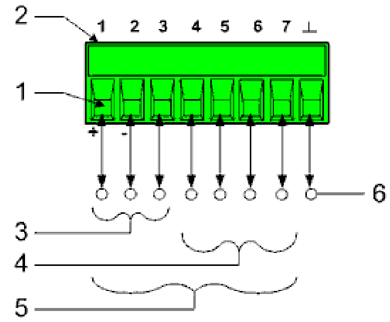
1. Connect the instrument to the site LAN or to your computer using a LAN cable. The as-shipped instrument LAN settings are configured to automatically obtain an IP address from the network using a DHCP server (DHCP is set On). The DHCP server will register the instrument's hostname with the dynamic 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. Use the Connection Expert utility of the Keysight IO Libraries Suite to add the RPS 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.

Digital Port Connections

NOTE It is good engineering practice to twist and shield all signal wires to and from the digital connector. If shielded wire is used, connect only one end of the shield to chassis ground to prevent ground loops.

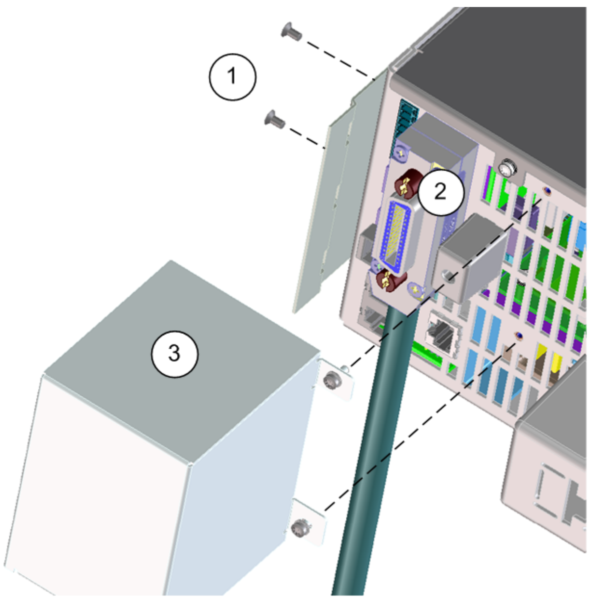
An 8-pin connector and a quick-disconnect connector plug are provided for accessing the digital port functions. Disconnect the connector plug to make your wire connections. The connector plug accepts wires sizes from AWG 14 (1.5 mm^2) to AWG 28 (0.14 mm^2). Wire sizes smaller than AWG 24 (0.25 mm^2) are not recommended. Strip wire insulation back 7 mm.

1. Insert wires
2. Tighten screws
3. Fault/Inhibit configurable pins (observe INH polarity)
4. Output Couple configurable pins
5. Digital IO-configurable pins
6. Signal common



Information on using the digital port is found under Programming the Digital Port. The electrical characteristics are described in the RP793xA, RP794xA and RP795xA, RP796xA common characteristics tables.

Interface Cover Installation



The ESD cover and hardware are shipped with the unit (see Items Supplied).

1. Connect the cover flange to the side of the instrument using the two screws provided. IMPORTANT - This must be done *before* rack mounting the unit.
2. Connect the LAN, USB, GPIB cable, and digital IO wires (GPIB shown) to the appropriate rear panel connector.
3. Install the ESD cover to the back of the unit using the two screws. Make sure the cover is inserted into the flange.

3
Getting Started

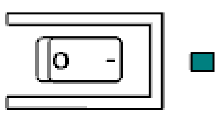
Using the Front Panel

Turn the Unit On

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

Verify that the line cord is connected and plugged in.

Turn the unit on with the front panel power switch. 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.

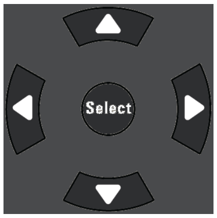
If the instrument does not turn on, verify that the power cord is firmly connected (power-line voltage is automatically sensed at power-on). Also make sure that the instrument is connected to an energized power source. If the LED next to the power switch is off, there is no AC power connected. If the LED is amber, the instrument is in standby mode with AC power connected, and if it is green, the instrument is on.

NOTE If a self-test error occurs, a message is displayed on the front panel. For other self-test errors, see Service and Maintenance for instructions on returning the instrument for service.

Set the Output Voltage

Method 1

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 turned on.

In voltage priority mode, the unit will maintain the output voltage at its programmed setting. In current priority mode, the unit will limit the output voltage when it reaches the specified voltage limit value. Refer to Set the Output Mode for more information.

Method 2

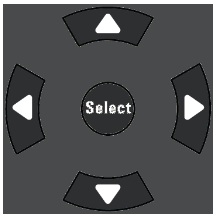
Use the **Voltage** key to select the voltage entry field. In the display below, the voltage setting is selected. Enter the desired setting using the numeric keypad. Then press **Enter**.

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

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



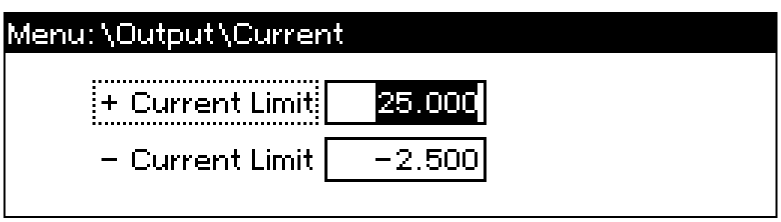
In the display below, the current setting is selected. Use the up and down navigation keys to toggle between the + and - limit entries. Enter a value using the numeric keypad. Then press **Select**.

You can also use the numeric arrow keys to adjust the value up or down. You can set both positive and negative current values. Values become effective when the output is turned on.

In current priority mode, the unit will maintain the output current at its programmed setting. In voltage priority mode, the unit will limit the output current when it reaches the specified current limit value. Refer to Set the Output Mode for more information.

Method 2

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 **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 Over-voltage Protection

Use the front panel menu.

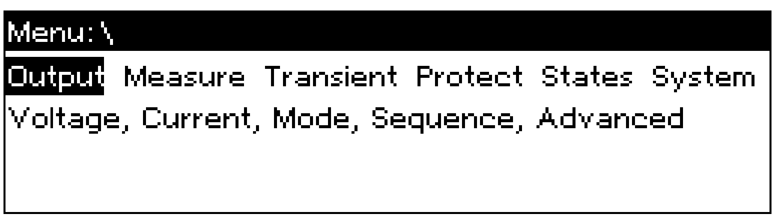
The front panel command menu lets you access most of the instrument's functions. The actual function controls are located at the lowest menu level. Briefly:

- 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.
- 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.

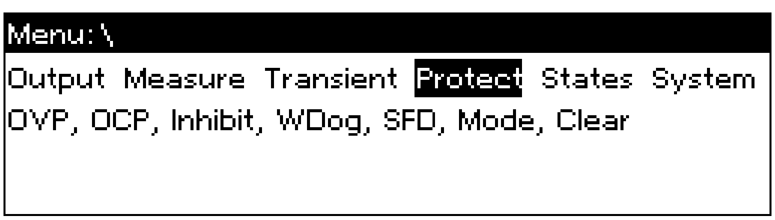
For a map of the front panel menu commands, refer to Front Panel Menu Reference.

Menu example - setting 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.

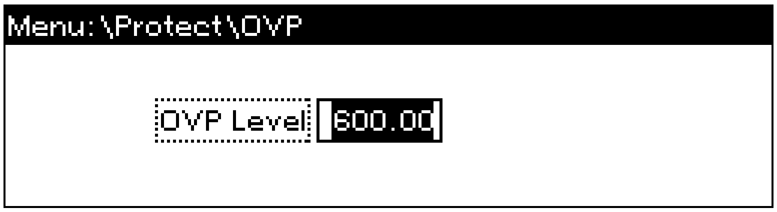


Press the right arrow navigation key > to traverse the menu until the Protect command is highlighted. Press the **Select** key to access the Protect commands.



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

The default OVP setting for this model is 600 V. You can change the OVP setting using the numeric entry keys and pressing **Enter** and **Select**. Press the **Meter** key to return to meter view.



Enable the Output

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.

For a description of the status indicators, refer to Front Panel Display at a Glance.

Use Built-in Help System

Press the **Help** key at the lowest menu level to display help information about the menu function controls.

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

Introduction

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 latest Keysight IO Libraries Suite from www.keysight.com. Then connect your instrument to your PC.

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 Reference	SCPI Command
Select **System\IO\USB** The dialog displays the USB connect string.	Not available

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 Reference	SCPI Command
Select **System\IO\GPIB**. 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 Reference	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

Resetting the LAN performs a LAN Configuration Initialize (LCI) reset of the instrument which enables DHCP, DNS and ping. It also resets the web site password to the factory default password. This does not reset the hostname or the mDNS service name.

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

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

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

- 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 Reference	SCPI Command
Select **System\IO\LAN\Modify\Name** 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 left/right navigation keys to traverse the text field. Use the backspace key to delete a value. Press Enter when you are finished.	Not available

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: K-modelnumber-serialnumber, where modelnumber is the unit’s 7-character model number (e.g. RP7951A), 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

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.

To manually configure the DNS services:

Front Panel Menu Reference	SCPI Command
Select **System\IO\LAN\Modify\DNS** Select Primary Address or Secondary Address. See below for a full description.	Not available

- 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.

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 Reference	SCPI Command
Select **System\IO\LAN\Modify\mDNS** 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 left/right navigation keys to traverse the text field. Use the backspace key to delete a value. Press Enter when you are finished.	Not available

- 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 7-character model number (e.g. RP7951A), 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 Reference	SCPI Command
Select **System\IO\LAN\Modify\Services** Check or uncheck the services that you wish to enable or disable.	Not available

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

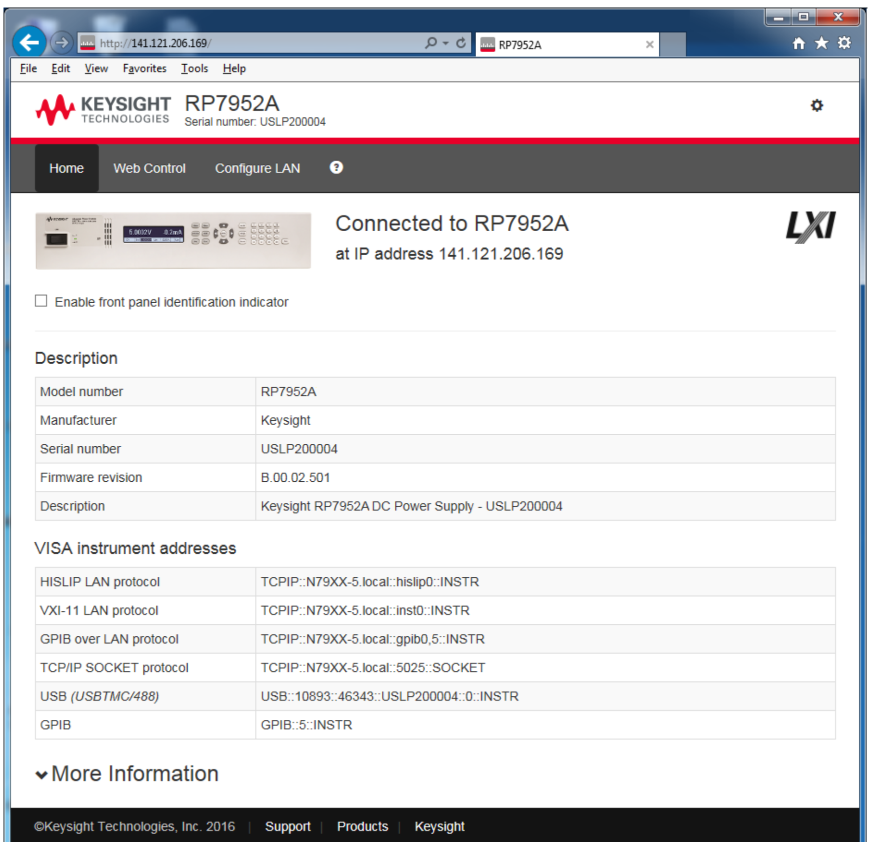
Using the Web Interface

Your RPS 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 additional connections, performance will be reduced.

NOTE The built-in Web interface only operates over the LAN. A Web browser is required to use the Web Interface.

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 Web Control tab on the top of the page to begin controlling your instrument.
4. For additional help about any of the pages, click on the ?.



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 "gear" icon. 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 RPS 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 Reference	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	Not available

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

4
Using the Regenerative Power System

Programming the Output

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

NOTE When the RPS is first turned on, it may take about 30 seconds or so to initialize the instrument before it is ready for use.

Set the Output Priority Mode

Select either voltage or current priority mode. Refer to Priority Mode Operation for more information.

Voltage priority mode keeps the output voltage constant. The output voltage remains at its programmed setting, provided the load current remains within the + or - current limit setting.

Current priority mode keeps the output current constant. The output current remains at its programmed setting, provided the load voltage remains within the voltage limit setting.

Front Panel Menu Reference	SCPI Command
Select **Output\Mode**. Select either Voltage priority or Current priority. Then press **Select**.	To specify current or voltage priority mode: FUNC CURR|VOLT

NOTE When switching between voltage priority and current priority mode, the output is turned off and the output settings revert to their Power-on or RST values.

Set the Output Voltage

When the unit is in voltage priority mode, the output voltage remains at its programmed setting as long as the load current remains within its programmed positive or negative limit.

Front Panel Menu Reference	SCPI Command
Press the **Voltage** key. Enter a value and press Select.	To set the output voltage to 400 volts: VOLT 400

When the unit is in current priority mode, you can specify a voltage limit which limits the output voltage at the specified value. The output current remains at its programmed setting, provided the load voltage remains within the voltage limit setting.

Front Panel Menu Reference	SCPI Command
Press the **Voltage** key. Specify a + Voltage limit. Then press **Select**.	To set the voltage limit: VOLT:LIM 420

Set the Low Voltage Limit

NOTE This information applies to models RP793xA and RP794xA only. RP793xA, RP794xA

Sets the low voltage limit when in current priority mode. This prevents the voltage from dropping below the low voltage limit when discharging a battery. When the low voltage limit is reached, the unit transitions from current priority mode to voltage priority mode operation, which stops discharging the battery. The low voltage limit is annunciated by the UV status bit.

Note that the low voltage limit also prevents the output from turning on when the output voltage is below the programmed low voltage limit. If you need to turn the output on, you must first set the low voltage limit to zero.

Front Panel Menu Reference	SCPI Command
Press the **Voltage** key. The Low Voltage Limit field only appears when the unit is set to operate in Current Priority mode. Specify the low voltage limit. Then press **Select**.	To set the low voltage limit: VOLT:LIM:LOW 4

Set the Output Current

When the unit is in voltage priority mode, you can specify a positive and negative current limit, which limits the output current at the specified value.

Front Panel Menu Reference	SCPI Command
Press the **Current** key.	To set the positive current limit: CURR:LIM 12
Specify a positive or negative Current limit. Then press **Select**.	To set the negative current limit: CURR:LIM:NEG -3

When the unit is in current priority mode, you can specify a positive or negative output current level, which will be maintained as long as the output voltage remains within its programmed limit.

Front Panel Menu Reference	SCPI Command
Press the **Current** key.	To set the current to +5 amperes: CURR 5
Enter a positive or negative value. Then press **Select**.	To set the current to –5 amperes: CURR –5

Set the Slew Rate

The voltage slew rate determines the rate at which the voltage changes to a new setting. This applies to both voltage settings in voltage priority mode, and voltage limit settings in current priority mode. When set to MAXimum, INFinity, or to a very large value, the slew rate will be limited by the unit's listed programming speed and bandwidth. This setting can be used to prevent crossover into current limit while up- and down-programming capacitive loads, or to limit programming response to a controlled rate. Use the following equation to calculate the maximum slew rate limit to ensure smooth and linear up- and down-programming performance.

Max slew rate (V/s) = (Current limit setting (A) – Load current (A))/(Load capacitance (F))

The current slew rate determines the rate at which the current changes to a new programmed setting. This applies to both current settings in current priority mode, and current limit settings in voltage priority mode. When set to MAXimum, INFinity, or to a very large value, the slew rate will be limited by the unit's listed programming speed and bandwidth.

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\Slew**	To set the voltage slew rate to 5 V/s VOLT:SLEW 5
Then select Voltage or Current	
Enter the voltage or current slew rate in the Slew Rate field.	To set the current slew rate to 1 A/s CURR:SLEW 1
Check Max slew rate to program the fastest slew rate.	To set the fastest slew rate: VOLT:SLEW MAX

Set the Output Resistance

NOTE Requires firmware version B.03.02.1232 and up.for models RP793xA and RP794xA.

Output resistance programming is mainly used in battery testing applications and only applies in voltage priority mode. It is used to emulate the internal resistance of a non-ideal voltage source such as a battery. Values are programmed in ohms.

Refer to the RP793xA, RP794xA and RP795xA, RP796xA characteristics tables for the model-specific resistance programming ranges.

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\Resistance**. Specify an Output Resistance value. Then check the **Enable** box. Then press **Select**.	To select a resistance of 0.5 ohms: VOLT:RES 0.5 To enable output resistance: VOLT:RES:STAT ON

NOTE When units are paralleledd, the programmable output resistance is reduced. The programmable output resistance for a single unit must be divided by the total number of paralleled units.

Set the Output Bandwidth - RP795xA, RP796xA

NOTE This information applies to models RP795xA and RP796xA only. RP795xA, RP796xA

Voltage compensation modes let you optimize output response time with capacitive loads.

High1 compensation setting provides maximum up-programming speed as well as the fastest transient response settling time. This mode is optimized for use with resistive loads; however capacitive loads up to the limits outlined in the table below can be used when using load leads shorter than 3 meters (10 feet). Exceeding these limits can lead to voltage programming overshoots and transient response instability.

Low compensation setting is optimized for use with large capacitive loads up to the limits shown in the table below, along with load leads longer than 3 meters (10 feet). In this mode, the up- and down-programming speed and voltage control-loop bandwidth are limited to prevent voltage programming overshoots and improve transient response stability. Low mode provides the best stability and overshoot minimization over all load configurations.

<frequency> specifies the low-pass corner frequency of a filter applied to the programming signal. Refer to the frequency description in the next section

NOTE Connecting very low ESR capacitors larger than the High mode limit with load leads shorter than 3 m (10 ft.) is not recommended in either bandwidth range. This load configuration can lead to voltage programming overshoots.

Setting	5 kW Models	10 kW Models	950 V Models
High1	0 to 80 µF	0 to 80 µF	0 to 40 µF
Low	0 to 100,000 µF	0 to 100,000 µF	0 to 50,000 µF

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\Bandwidth\Voltage**. Select either Low or High 1. If desired, enter the pole frequency in the Frequency field. Then press **Select**.	To set the bandwidth for RP795xA and RP796xA: VOLT:BWID LOW | High1 To specify the pole frequency: VOLT:BWID:LEV 0 | 1, <frequency>

Set the Output Bandwidth - RP793xA, RP794xA

NOTE This information applies to models RP793xA and RP794xA only. RP793xA, RP794xA

Voltage compensation modes let you optimize output response time with capacitive loads.

The Capacitive Load Boundary graphs in the Characteristics section illustrate the minimum ESR as a function of DUT capacitance to allow for stable operation.

Comp 0 (High speed/Small capacitive load) – provides the fastest programming speed and transient response time. Best suited for resistive DUTs with low capacitance. Default frequency = 1.4 kHz.

Comp 1 (Medium speed/Medium capacitive load) – provides intermediate programming speed and transient response time. Best suited for DUTs with higher capacitance with some trade-off in programming speed and transient response. Default frequency = 460 Hz.

Comp 2 (Slow speed/Large capacitive load) – best suited for DUTs with high capacitance/low ESR with the trade-off of a slower programming speed and transient response. Default frequency = 55 Hz .

<frequency> specifies the low-pass corner frequency of a filter applied to the programming signal. The programmed voltage is a digitized signal which passes through a single-pole low pass filter where the pole is specified in Hertz. This filter has the effect of slowing down the output with respect to changes in the programmed voltage or current. This, in combination with the configurable slew setting, allows for a trade-off between programming speed and output voltage or current overshoot. For example, increasing the filter frequency may result in more overshoot and decreasing the frequency will lower the overshoot, depending on the compensation setting and the load impedance. This frequency setting does not affect the unit’s transient response to a load change.

The following table summarizes the effect that the compensation settings have on the CV Programming Speed Characteristics.

Setting	Step Conditions	Frequency	20 V Models	80 V Models
Comp 0	no load, 10-100% of rating full CC load, 0-100% of rating	100 kHz 2.3 kHz	80 µs/810 µs 140 µs/4.2 ms	71 µs/480 µs 145 µs/1.35 ms
Comp 1	full CC load, 0-100% of rating	1.4 kHz	190 µs/2.3 ms	205 µs/1.5 ms
Comp 2	full CC load, 0-100% of rating	900 Hz	350 µs/3.8 ms	360 µs/1.25 ms

The following table describes the CV small signal bandwidth characteristics

CV programming small signal bandwidth (-3dB) at no load		
Setting	20 V Models	80 V Models
Comp 0	8.3 kHz	7.5 kHz
Comp 1	4.7 kHz	6.6 kHz
Comp 2	2 kHz	5.9 kHz

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\Bandwidth\Voltage**. Select either Comp 0, 1, or 2. If desired, enter the pole frequency in the Frequency field. Then press **Select**.	To set the voltage compensation bandwidth: VOLT:BWID:RANG 0 | 1 | 2 To specify the pole frequency: VOLT:BWID:LEV 0 | 1 | 2, <frequency>

Current compensation modes allow you to optimize output response time with inductive loads.

Comp 0 Best suited for longer load leads (higher inductance) with relatively fast programming response (see Inductance Load Boundary graph).

Comp 1 Optimizes programming speed for DUTs with limited lead inductance. This setting may require paralleling additional sets of leads to achieve the desired overall lead length.

<frequency> specifies the low-pass corner frequency of a filter applied to the programming signal. Refer to the previous description under Voltage Compensation modes.

The following table summarizes the effect that the compensation settings have on the CC Programming Speed Characteristics.

Setting	Step Conditions	Frequency	20 V Models	80 V Models
Comp 0	0-100% of current step at Vout	100 kHz	300 µs/960 µs	180 µs/500 µs
Comp 1	> 10% of voltage rating	100 kHz	150 µs/350 µs	60 µs/300 µs

The following table describes the CC small signal bandwidth characteristics

CC programming small signal bandwidth (-3dB) at no load		
Setting	20 V Models	80 V Models
Comp 0	2 kHz	2.7 kHz
Comp 1	2.7 kHz	3.5 kHz

Front Panel Menu Reference	SCPI Command

Select **Output\Advanced\Bandwidth\Current**. Select either Comp 0 or Comp 1. If desired, enter the pole frequency in the Frequency field. Then press **Select**.	To set the current compensation bandwidth: CURR:BWID:RANG 0 | 1 | 2 To specify the pole frequency: CURR:BWID:LEV 0 | 1 | 2, <frequency>

Set the Output Turn-On/Turn-Off Mode - RP793xA, RP794xA

NOTE This information applies to models RP793xA and RP794xA only. RP793xA, RP794xA

The turn-on/turn-off setting only applies when the RPS is operating in voltage priority mode. In current priority mode, the turn-on/turn-off behavior is always impedance.

The voltage priority turn-on and turn-off behavior can be set to either low impedance or high impedance mode.

Low impedance mode is for devices like power converters. During output transitions, current is sourced or discharged for fast output voltage response.

High impedance mode is for devices like batteries, where output transitions are controlled to minimize output current.

When coupling is enabled, changing the turn-on setting also changes the turn-off setting and vice-versa.

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\Tmode**. Select either High impedance or Low impedance for turn-on an turn-off modes. Check Coupled to couple the turn-on and turn-off modes. Then press **Select**.	To select high impedance turn-on: OUTP:TMOD:ON HIGHZ To select low impedance turn-off: OUTP:TMOD:OFF LOWZ To couple the turn-on and turn-off modes: OUTP:TMOD:COUP ON

Enable the Output

Because of internal circuit start-up procedures and any installed relay options, OUTPut ON may take tens of milliseconds to complete its function. OUTPut OFF delays may also be in effect. For more information regarding output turn-on and turn-off delays, refer to Turn-On/Turn-Off Delays.

Front Panel Menu Reference	SCPI Command
Press the **On/Off** key.	OUTP ON|OFF

In addition to the front panel and SCPI Output On and Output Off commands, you can also use OnCouple and OffCouple signals to enable and disable the output. Refer to Output Couple Control for more information. When coupling is enabled, changing the turn-on setting also changes the turn-off setting and vice-versa.

NOTE During a 1-cycle AC line dropout the unit may reboot. The output will remain off after reboot until the operator reinstates the previous settings, either by the front panel controls or using a computer program. This behavior is consistent with safe operating procedures.

Parallel Operation

Introduction

WARNING SHOCK HAZARD All paralleled units must be connected to qround through a grounded power cord at all times. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal on any unit will cause a potential shock hazard that could result in injury or death.

CAUTION To Prevent Possible Equipment Damage:

- Connect no more than twenty units **of identical voltage ratings**. All units must have the same voltage rating but current ratings can be different. All units must have the same version firmware installed. Refer to Instrument Identification for details.
- Always turn the **AC power** on and off together. Never leave any units powered on while the others are turned off.
- For models RP795xA and RP796xA, always connect the **negative** output terminals of all paralleled units together to prevent damaging the Sharing bus.

Parallel operation lets you connect multiple power supplies together to create a system with higher total current and power. This applies for current sourcing as well as current sinking operation. Refer to Multiple Unit Connections for detailed information on how to connect the outputs and the master/slave cables. Remember to also set the termination switches.

Units of dissimilar power ratings may be paralleled, provided they have identical voltage ratings. In this case, the units will share current proportionally according to their current rating. For example, a 10 kW unit rated at 40 A and a 5 kW unit rated at 20 A will share their output current in a 2-to-1 ratio.

NOTE Models RP795xA, RP796xA (RP795xA, RP796xA) also require connecting the Sharing cable as described under Sharing Connections.

Two modes of parallel operation are available:

Master/Slave operation - In this mode, the paralleled group is controlled through the master unit, and appears as a single higher-power supply. The master unit provides the aggregate of most source and measurement functions. The **current sharing** function is automatically enabled during master/slave operation. This is the recommended method of paralleling units.

Independent parallel operation for Models RP795xA, RP796xA (RP795xA, RP796xA) - In this mode all paralleled units are programmed independently. Connect and program the output On Couple and output Off Couple digital port signals to provide synchronized instrument turn-on and turn-off capability. You must explicitly enable the current sharing function on each paralleled unit.

Master/Slave Operation

Up to twenty paralleled instruments can be connected in a master/slave configuration. All units must have the same voltage rating but current ratings can be different. All units must have the same version firmware installed. Refer to Instrument Identification to view the firmware version. The configuration procedure for master/slave operation is as follows:

- Configure one unit as the master
- Configure the other units as slaves with unique bus addresses
- Select the connection mode and auto-connect delay time
- Perform a one-time discovery on the master - it saves the master/slave configuration
- At power-on, the master connects automatically or manually
- If the master/slave configuration is subsequently changed, it needs to be re-discovered

Master/Slave Configuration

Configure each paralleled instrument as either a Master or Slave.

Front Panel Menu Reference	SCPI Command
Select **System\Group\Function** In the dialog box, select either Master, Slave, or None. Then press Select.	To configure the paralleled unit: INST:GRO:FUNC MAST|SLAV|NON

If the unit is the master, a delay may be programmed to allow the slave units enough time to boot up before the master auto-connects to the slave. If there is a delay in powering up the slave units, the master auto-connect may fail.

Front Panel Menu Reference	SCPI Command
Select **System\Group\Delay** In the dialog box, set the auto-connect delay. Then press Select.	To set the auto-connect delay to 10: INST:GRO:MAST:DEL 10

If the unit is a slave, each slave unit must be assigned a unique bus address (from 1 - 19).

Front Panel Menu Reference	SCPI Command
Select **System\Group\Slave** In the dialog box, select the address of the slave unit. Values can range from 1 - 14. Then press Select.	To set the slave address to 1: INST:GRO:SLAV:ADDR 1

Specify the master unit's connection mode.

AUTO - the master unit will automatically connect to the previously discovered slaves at power-on.
MANual - the master will connect to the previously discovered slaves when it receives a connection command from the front panel or from INST:GRO:MAST:CONN:MODE.

Front Panel Menu Reference	SCPI Command
Select **System\Group\Mode** In the dialog box, select the connection mode. Then press Select.	Set the master's connection mode: INST:GRO:MAST:CONN:MODE AUTO

Discover all the slave units. Slave units must always be discovered the first time. Once all slaves have been discovered they do not need to be discovered again - unless the master/slave configuration changes.

Front Panel Menu Reference	SCPI Command
Select **System\Group\Discover** In the dialog box select Discover to discover all slave units. Then press Select.	To discover the slave units: INST:GRO:MAST:DISC

Connect the master unit to all previously discovered slave units.

Front Panel Menu Reference	SCPI Command
Select **System\Group\Connect** In the dialog box select Connect to connect all slave units to the master. Then press Select.	To connect the master unit to all discovered slave units: INST:GRO:MAST:CONN

Master/Slave Programming Considerations

Program the output voltage and current settings of the master unit the same as you would an individual unit. Refer to Set the Output Voltage and Set the Output Current for details. Slave units are locked; you cannot program the settings of the slave units.

Set both positive and negative current limits high to allow for up/down programming transient dynamics. Transient dynamics are mainly a result of DUT capacitance charging currents. Note that the master unit's current limit and current setting are automatically proportioned among the paralleled group according to the current rating of each unit.

Reduce the slew rates to mitigate imperfect voltage programming synchronization. By default, the slew rates are set to their maximum values.

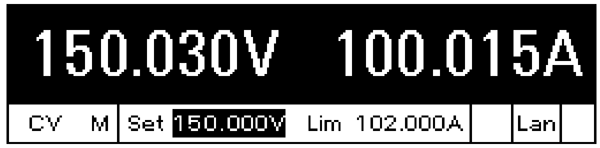
Master/Slave Front Panel Display

The current value read from the front panel of the master unit is the aggregate of the values of the master and the slave units. The slave units return their individual current values.

This example illustrates how the front panel display operates during master/slave operation. In this example, three RPS units are paralleled in a master/slave configuration. The units are operating in voltage priority mode. Two of the units are rated at 10 kW, one unit is rated at 5 kW.

This is the 10 kW master unit.

- The "M" indicates master unit.
- The current displayed (100 A) is the total output current of all paralleled units. The unit is only contributing 40 A to the total.



This is the 10 kW slave unit.

- The "S" indicates slave unit.
- The current displayed (40 A) is the current that this unit is contributing to the total.

This is the 5 kW slave unit.

- The "S" indicates slave unit.
- The current displayed (20 A) is the current that this unit is contributing to the total. This is half of the current of the 10 kW units.

NOTE In current priority mode, set the output current of the master unit to the desired value. Set the voltage limit to a higher value than the expected operating voltage of the unit.

Master/Slave Communication

While connected, the master unit periodically polls the slave units for status. If communication with a slave fails, the master goes into master/slave protection (MSP). The master sends a command to the slaves that do respond to also go into MSP. A current-sharing fault (CSF) will likely occur If the termination switches are not set incorrectly.

Slave units use the periodic master status poll as a timer to trip MSP. If the slave does not receive a status poll every 10 seconds or less, it goes into MSP.

Slaves units may go into MSP 10 seconds after power-on. Once the slave units are discovered, the master unit will establish communication with the slave units, thereby clearing the MSP.

Master/Slave Protection

If the master unit goes into protection, it sends a protection command to the slave units. The master unit indicates the type of protection event that has occurred. The slave units indicate PROT. Once the protection condition is corrected, clearing protection on the master unit will clear protection on all units (see Clearing Protection).

If any slave unit goes into protection, the master unit and the slave unit on which the protection event occurred indicate the type of protection event. All other slaves indicate PROT. Once the protection condition is corrected, clearing protection on the master unit will clear protection on all units.

When using the Fault or Inhibit functions on the rear panel digital connector, connect the Fault/Inhibit pins only on the master unit. You do not need to connect the Fault/Inhibit pins of the slave units.

Master/Slave Command Details

Once connected, the group of units are controlled through the master and appear as a single higher power unit. All programming commands should be sent to the master unit.

The following SCPI commands are not supported in master/slave mode:

<table>
<tr><td>ARB</td><td>all ARB commands</td></tr>
<tr><td>ELOG</td><td>all ELOG commands</td></tr>
<tr><td>CURRent:SHARing</td><td>Current sharing is automatically enabled</td></tr>
<tr><td>FETCh:CURRent<:HIGH|:LOW|:MAX|:MIN></td><td>all :HIGH :LOW :MAX and :MIN commands</td></tr>
<tr><td>FETCh:POWer<:MAX|:MIN></td><td>all :MAX and :MIN commands</td></tr>
<tr><td>FETCh:VOLTage<:HIGH|:LOW|:MAX|:MIN></td><td>all :HIGH :LOW :MAX and :MIN commands</td></tr>
<tr><td>MEASure:CURRent<:HIGH|:LOW|:MAX|:MIN></td><td>all :HIGH :LOW :MAX and :MIN commands</td></tr>
<tr><td>MEASure:POWer<:MAX|:MIN></td><td>all :MAX and :MIN commands</td></tr>
<tr><td>MEASure:VOLTage<:HIGH|:LOW|:MAX|:MIN></td><td>all :HIGH :LOW :MAX and :MIN commands</td></tr>
<tr><td>LIST</td><td>all LIST commands</td></tr>
<tr><td>SYSTem:REBoot</td><td>Reboot command</td></tr>
<tr><td>TRIGger:ARB:SOURce</td><td>ARB source command</td></tr>
<tr><td>TRIGger:ACQ<:CURR:LEV|:VOLT:LEV></td><td>Level triggered acquisitions</td></tr>
<tr><td>POWer:LIMit?</td><td>Power limit query</td></tr>
</table>

The following SCPI commands can be sent to the slave unit in master/slave mode.

<table>
<tr><td>FETCh<:VOLTage|:CURRent|:POWer></td><td>only :VOLT :CURR :POW commands</td></tr>
<tr><td>MEASure<:VOLTage|:CURRent|:POWer></td><td>only :VOLT :CURR :POW commands</td></tr>
<tr><td>All front panel SYSTEM\IO commands</td><td>only available on front panel menu</td></tr>
</table>

Parallel Operation at Maximum Current - RP793xA, RP794xA

Due to individual circuit tolerances between the paralleled units in a Master/Slave configuration, the current contributed by each unit may differ slightly from the “ideal amount”, which assumes that all units share current exactly equally. When operating at the maximum current rating of the paralleled group, these individual circuit tolerances could cause one or more of the units to depart from CV operation and enter into CC operation. The maximum current rating of the group will still be available, but the dynamic transient response may change due to the transition of one of the units into CC.

If strict CV operation is required under all operating conditions, especially at the maximum current rating of the paralleled group, it is recommended to set the CC limit to the maximum programmable value on the Master unit. If this is not sufficient, reduce the total requested load current, or consider adding an extra unit to provide additional headroom for the group to maintain CV operation under maximum load conditions.

Master/Slave Troubleshooting

If the following status indicators appear on the front panel:

MSP

There has been a communication loss between the master and slave units. Check that the master/slave CAT5 cables are installed correctly. They should not be installed in the LAN or SDS connector.

CSF

There has been a current sharing fault due to the master/slave loop being out of regulation. This can occur if the termination switches are set incorrectly. It can also occur temporarily if there has been a mode crossover from a load transient or due to rapid up/down programming. If this is the case, set the current limit to a higher value. CSF can also occur if the loop can no longer regulate the current imbalance between units. CSF can also be an initial indication of communication loss with the master unit; which will transition to MSP.

If the following error messages occur:

No slaves discovered or **1 slave discovered** (if expecting multiple slave units)

Check that there are no duplicate slave addresses.

Error 332, Master/Slave Error

This most often indicates that the master unit has lost communication with a slave, and is usually accompanied by MSP. Check that the master/slave CAT5 cables are installed correctly. This can also occur when changing the master slave configuration. Always set the master unit to None when changing master/slave configurations.

Independent Parallel Operation - RP795xA, RP796xA

CAUTION Never leave any units powered on while the others are off. If AC power is turned on or off on a single unit, the outputs of the units that are on will be enabled and will transition to their programmed settings. To prevent this, program the outputs of all units to zero before powering them off, and always power all units on and off together.

Enable Current Sharing

NOTE The current sharing function is automatically enabled for models RP795xA, RP796xA (RP795xA, RP796xA) in **master/slave** operation.
Units can be operated in parallel without current sharing, but the output current will not be shared equally, and constant voltage mode may not be maintained on all units.

Current sharing is an analog control function that fine-tunes the output voltage up to about 0.5% of the unit's voltage rating. This improves the current readback accuracy among paralleled units. This applies whether units are connected for master/slave operation or whether they are connected for independent parallel operation.

Units of equivalent current ratings will share current equally. Units of dissimilar current ratings will share current according the ratio of their current rating. For example, a unit rated at 40 A and a unit rated at 20 A will share their output current in a 2-to-1 ratio.

In Independent Parallel operation only, the front panel status displays a "P", indicating that current sharing is enabled and the sharing relay has closed to connect the unit to the sharing bus. When the output is disabled, the sharing relay opens and disconnects the unit from the sharing bus.

Front Panel Menu Reference	SCPI Command
Select **Output\Advanced\CurrSharing** Check Enable current sharing to enable.	To enable current sharing: CURR:SHAR ON

Current Sharing Operation

In voltage priority mode:

- Program the initial output voltage setting of each paralleled unit to the same value.
- Set the current limit of each unit according to the following equations. This lets all units share current until the *total* current limit point is reached, which is the sum of the individual current limits.

For each 5 kW unit: $I_{CL\_5kW} = I_{CL\_TOTAL} / (N_T + N_{10kW})$*
For each 10 kW unit: $I_{CL\_10kW} = 2(I_{CL\_TOTAL}) / (N_T + N_{10kW})$

where:
I_{CL_5kW} is the current limit setting of the 5 kW unit
I_{CL_10kW} is the current limit setting of the 10 kW unit
I_{CL_TOTAL} is the sum total of all individual current limits
N_T is the total number of paralleled units of any rating
N_{10kW} is the total number of paralleled 10 kW units
*If there are no 10 kW units used, then $N_{10kW} = 0$.

Note that in a mixed power configuration, you must set the current limit of the 10 kW units to twice the value of the 5 kW units. This is because in a mixed power configuration, each 10 kW unit will contribute twice as much current as each 5 kW unit.

When the current limit setting of any paralleled unit is reached, the output current of that unit will limit at its specified setting.

In current priority mode:

- Set the voltage limit of each paralleled unit to the same value.
- Program the current setting of each paralleled unit according to the equations above if current sharing is desired. The total output current will be the sum of all the individual current settings.

Note that in current priority mode, the sharing configuration will balance the currents only if all of the units are operating in voltage limit mode, with the VL+ status annunciator on.

Parallel Effects on Load Regulation

The design of the RPS has been optimized for parallel operation. Therefore, the effect of paralleled units on the specifications has been kept to a minimum. When units are paralleled, there is no degradation of any specification other than the load regulation specification. All other specifications, including output noise, programming accuracy, readback accuracy, and transient response are unaffected by paralleled operation.

With two or more units are paralleled with current sharing enabled, there will be a small additional voltage regulation effect. The worst case additional voltage regulation effect is as follows:

$\Delta V_{OUT(WORST\_CASE)} = 0.003\%(V_{RATING})$

To determine the total output voltage regulation effect for a specific unit, you must add the worst-case value from the following table to the CV load regulation specification for each paralleled unit. These are the worst-case values for each unit based on its voltage rating.

V_{RATED}	$\Delta V_{OUT(WORST\_CASE)}$	V_{RATED}	$\Delta V_{OUT(WORST\_CASE)}$
500 V	15 mV	950 V	28.5 mV

Example: You have two 500 V units connected in parallel. The load regulation effect due to current sharing is 15 mV from the table above. The CV load regulation specification is 30 mV. Therefore, the total output voltage regulation effect is 30 mV + 15 mV, or 45 mV.

Current Sinking Operation

Current Sinking

Regenerative Operation

Current Sinking

Current sinking, also referred to as downprogramming, is the ability to pull current into the positive terminal of the DC power supply. For example, the power supply pulls or sinks current into the positive terminal whenever a lower output voltage is programmed. This is necessary because stored energy from the power supply's output capacitor and external capacitance from the load including the wiring must be discharged to lower the voltage at the output terminals.

The ability to rapidly transition from a higher to a lower constant voltage level greatly improves the power supply’s output response time. This is the most commonly used application of the regenerative function of the RPS, which is automatic and completely transparent to the user.

The DC power supply can continuously sink up to 100% of its rated current for an indefinite time. This two-quadrant sourcing and sinking capability of the DC power supply allows for seamless transitions between sourcing and sinking current without changing the power supply’s output characteristics or introducing any disruptive behavior. The following controls are provided to fully utilize the two-quadrant output capability of the supply.

Current Limit control in voltage priority mode

When operating in voltage priority mode, you can program a negative and positive current limit. This will limit any current overshoots that may occur during rapid up- or down-programming.

Current setting control in current priority mode

When operating in current priority mode, you can program the output current to seamlessly cross the zero point when transitioning from positive to negative or negative to positive. Additionally, when operating in the negative current quadrant, you can program a negative current setting that will hold the sink current at the specified value. This is useful, for example, for discharging a battery at a constant current rate.

If your application requires precise control of the source and sink currents, current slew controls are available to specify a current slew rate when sourcing and sinking current.

Regenerative Operation

Regenerative operation is automatic and requires no programming on the part of the user. Whenever the unit is sinking current, either by rapidly downprogramming the output, or by discharging an energy source such as a battery, the unit will direct the excess power back into the AC mains.

Programming Output Protection

Set the Over-Voltage Protection

Set the Over-Current Protection

Output Watchdog Timer

Set the Under-Voltage Protection

Clear Output Protection

Introduction

The RPS models have many protection functions. These functions disable the output to protect the device under test (DUT), as well as the power supply. 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.

CAUTION All protections cause a high impedance output disconnect. The output is disconnected without actively sinking current, so the DUT's voltage discharge depends on its characteristics. The DUT and load lead inductance must be within the specified hardware limits to safely absorb any stored energy. Refer to the Maximum Load Inductance limits under RP793xA, RP794xA characteristics.

Of the following protection functions, the OV, OC, PROT, INH, and UV are user-programmable.

OV Over-voltage protection is a hardware protection whose trip level is user-programmable. OV protection occurs automatically if the remote sense leads are shorted. OV protection is always enabled.

OV- Negative over-voltage protection trips if the remote sense leads are reversed. At turn-on, it also trips if voltages more negative than -5V for models RP795xA, RP796xA, or -1% of the rated output for models RP793xA, RP794xA are present at the output terminals. After turn-on the level increases to -20% for models RP793xA and RP794xA. OV- protection is not programmable and 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 reaches the current limit setting. An OCP also occurs if internal current limitations are exceeded regardless of the OCP setting.

CP+ Positive over-power compares the output power against a built-in threshold. A CP+ protection occurs when the threshold is exceeded. CP+ protection is always enabled.

CP- Negative over-power compares the internally dissipated power against a built-in threshold. A CP- protection occurs when the threshold is exceeded. CP- protection is always enabled.

OT Over-temperature protection monitors the internal temperature of the power supply and disables the output if the temperature exceeds the pre-defined limit (see OUTPut:PROTection:TEMPerature:MARGin?). OT protection is always enabled.

PF Power-fail indicates that a power fail condition on the AC mains has occurred and has disabled the output. PF protection is always enabled.

EDP excessive dynamic protection
For models RP795xA, RP796xA, EDP disables the output in the event of excessive large repetitive voltage swings caused by programmed voltage changes, lists, Arbs, or load-induced voltage swings (see Output Dynamic Response). If unchecked, these voltage swings could result in premature failure of components in the unit. EDP protection is always enabled.
For models RP793xA, RP794xA, EDP disables the output in the event of large dynamic power transfers that could damage the unit. This could happen, for example, if unintended and sustained oscillations cause large power transfers - from full power sourcing to full power sinking. Assuming that the unit is operating within the suggested operating conditions, EDP should not engage under normal conditions. EDP protection is always enabled.

Prot Protection indicates the output is disabled because the programmed output watchdog timer expired. It also indicates that an MSP fault has occurred on a slave unit.

INH The Inhibit input (pin 3) on the rear panel digital connector can be programmed to act as an external shutdown signal. Refer to Inhibit Input for details.

UV For models RP793xA, RP794xA, under-voltage protection prevents the voltage from dropping below the low-voltage limit setting when discharging a battery. It also prevents the output from turning on if the output voltage is below the programmed low-voltage level.

MSP A Master/Slave Protection fault has occurred in the paralleled group. The outputs of all paralleled units are disabled. MSP is always enabled. Refer to Parallel Protection for details.

SDP A Safety Disconnect Protection fault has occurred due to a Keysight SD1000A SDS hardware or communication failure. The unit must be rebooted to clear this protection condition. Refer to SDP protection for details.

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. An OVP shutdown will automatically occur if the + and – sense leads are accidentally shorted to each other.

Front Panel Menu Reference	SCPI Command
Select **Protect\OVP** Enter a value in the OVP level box. Then press **Select**.	To set the OVP level to 400 volts: VOLT:PROT 400

Set the Over-Current Protection

Enable OCP

With over-current protection enabled, the output turns off when the output current reaches the current limit setting and transitions from constant voltage (CV) to current limit (CL+ or CL-).

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

Delay OCP

You can 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.

The following selections are available to start the over-current delay timer:

Settings Change this starts the over-current delay whenever a command changes the output settings. It includes changes made by the transient system so that the timer is started at each list step and at each Arb output change. It also includes voltage and current slew changes, so that the timer is restarted throughout the entire slew time.

Current Limit starts the over-current delay timer by any transition of the output into current limit.

The delay can be programmed from 0 to 0.255 seconds. You can specify if the OCP delay timer is started by any transition of the output into current limit, or only at the end of a settings change in voltage, current, or output state.

Front Panel Menu Reference	SCPI Command
Select **Protect\OCP** Enter a delay value. Then press **Select**. By default, the delay timer will be started by an output "Settings Change". Check "CC Transition" to start the delay timer by ANY output transition into CL mode.	To specify a 10 millisecond delay: CURR:PROT:DEL 0.01 To start the delay timer by an output settings change: CURR:PROT:DEL:STAR SCH To start the delay timer by ANY output transition into CL mode: CURR:PROT:DEL:STAR CCTR

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

Also note that the time it takes the output to go into current limit (CL) 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 CL status bit. To determine when the output will shut down, you must add the time it takes for the CL status bit to the over-current protection delay time. If the over-current persists beyond the sum of both time intervals, the output will shut down.

Output Watchdog Timer

When enabled, the output watchdog timer causes the output to go into protection mode if there is no SCPI I/O activity on the remote interfaces (USB, LAN, GPIB) within the user-specified time period. Note that the watchdog timer function is NOT reset by activity on the front panel – the output will still shut down after the time period has elapsed.

After the time period has expired, the output will be disabled, but the programmed output state is not changed. The Prot bit in the status questionable register as well as the Prot indicator on the front panel will be set. A watchdog protect can be cleared as described under Clear Output Protection Functions.

The watchdog delay can be programmed from 1 to 3600 seconds in 1-second increments. To enable the watchdog timer and specify a delay value, proceed as follows:

Front Panel Menu Reference	SCPI Command
Select **Protect\WDog** Check Enable Watchdog to enable the watchdog timer. Enter a value in the Watchdog Delay box. Then press **Select**.	To enable the output watchdog timer: OUTP:PROT:WDOG ON To set the output watchdog timer to 120 seconds: OUTP:PROT:WDOG:DEL 120

Set the Under-Voltage Protection

NOTE This information applies to models RP793xA and RP794xA only. RP793xA, RP794xA

The under-voltage protection will turn the output off if the output voltage falls below the programmed low voltage setting. The voltage circuit monitors the voltage at the + and – sense terminals.

This feature is used when discharging batteries to prevent the battery voltage from dropping below the low voltage setting.

In voltage priority mode, the output voltage must be at the target value before the under-voltage protection is enabled to prevent the unit from tripping during output up-programming. A delay can be set that is longer than the output up-programming time to prevent the protection from tripping during the voltage transition.

In current priority mode, if the output is turned on with the voltage limit set to a value below the low-voltage setting, the under-voltage protection will also trip.

The under-voltage protection delay can be programmed from 20.48 microseconds to 2611 seconds in 20.48 microsecond increments. To enable the under-voltage protection and specify a delay value, proceed as follows:

Front Panel Menu Reference	SCPI Command
Select **Protect\UVP** Enter a value in the UVP level box. Then check **Enable UVP** Enter a value in the UVP Delay box. Then press **Select**.	To set the UVP level to 2 volts: VOLT:PROT:LOW 2 To enable low-voltage protection: VOLT:PROT:LOW:STAT ON To specify a protection delay of 5 seconds: VOLT:PROT:LOW:DEL 5

Clear Output Protection

If an over-voltage, over-current, over-temperature, power-fail condition, power-limit condition, protection condition, or inhibit signal 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 Reference	SCPI Command
Select **Protect\Clear** Select Clear.	To clear a protection fault: OUTP:PROT:CLE

NOTE The output is re-enabled once the ouptut protection function is cleared.

Programming Output Transients

Common Actions for All Transients

Programming a Step Transient

Programming a List Transient

Programming an Arbitrary Waveform

Output Transients

An output transient is defined as a triggered action that causes a change in output voltage or current. The three available transient types are: step, list, and arbitrary waveforms.

Step - a one-time event that steps the output voltage or current up or down in response to a trigger.

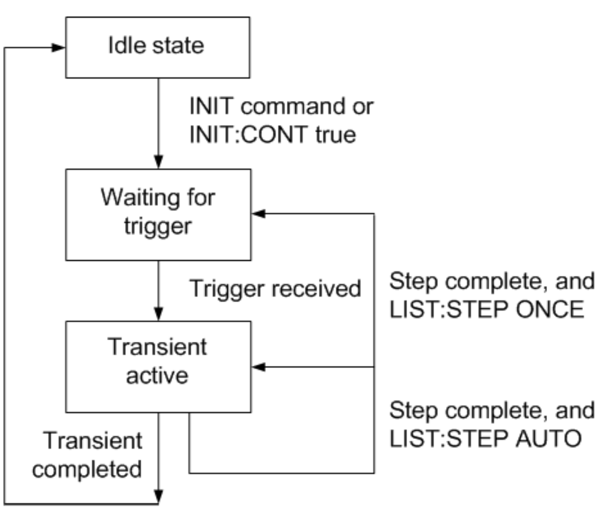
List - describes a precisely timed, complex sequence of output steps or changes.

Arbitrary Waveform - allows the output to generate complex user-defined voltage or current waveforms of up to 65,535 data points.

Common Actions for All Transients

- Enable the output transient function
- Program the transient parameters
- Select the trigger source
- Initiate the transient system
- Trigger the transient

The transient trigger process is illustrated below. This applies to all transient types. The arrows on the right are specific to List transients. For an overview of the trigger system, refer to Trigger Overview.



Enable the output transient function

First, you must enable the output to respond to transient triggers. Unless an output transient function enabled, nothing will happen even if you have programmed the transient parameters and generated a transient trigger.

Front Panel Menu Reference	SCPI Command
Select **Transient\Mode**. If you are operating in voltage priority mode select Voltage mode. If you are operating in current priority mode select Current mode. In the dropdown list, select Step, List or Arb transients. Then press **Select**.	To enable the transient function, use: VOLT:MODE STEP VOLT:MODE LIST VOLT:MODE:ARB or CURR:MODE STEP CURR:MODE:LIST CURR:MODE:ARB

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 transient parameters

For example, set the triggered voltage level if you are programming a voltage step:

Front Panel Menu Reference	SCPI Command
Select **Transient\Step**. Select the Trig Voltage box to set the voltage. Enter a value and press Select.	To set a voltage step level of 15 V use: VOLT:TRIG 15

Select the trigger source

NOTE A TRIGger:TRANsient[:IMMediate] command over the bus will always generate an immediate transient trigger, regardless of the selected trigger source.

Unless you are using the front panel menu or a TRIGger:TRANsient[:IMMediate] command to trigger the transient, select a trigger source from the following:

Trigger Source	Description
Bus	Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).
External	Selects ANY pin that has been configured as a Trigger Input on the digital control port.
Immediate	Triggers the transient as soon as it is INITiated.
Pin<1-7>	Selects a specific pin<n> that is configured as a Trigger Input on the digital control port.

Use the following commands to select a trigger source:

Front Panel Menu Reference	SCPI Command
Select **Transient\TrigSource**. To select immediate triggers, select Imm. To select Bus triggers, select Bus. To select digital pin 5 as the trigger, select Pin 5, or EXT.	To select Bus triggers: TRIG:TRAN:SOUR BUS To select digital pin 5 as the trigger: TRIG:TRAN:SOUR PIN5

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 Reference	SCPI Command
Select **Transient\Control**. Scroll to Initiate. Then press **Select**.	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 after being initiated.

Front Panel Menu Reference	SCPI Command
Select **Transient\Control**. The Trig state field indicates "Initiated".	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.

NOTE Unless INITiate:CONTinuous:TRANsient is programmed, the instrument executes one transient each time a trigger signal is received. Thus, it will be necessary to initiate the trigger system each time another triggered transient is desired.

Trigger the transient

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

Front Panel Menu Reference	SCPI Command
Select **Transient\Control**. Select Trigger to generate an immediate trigger signal regardless of the trigger source setting.	To generate a transient trigger: TRIG:TRAN Alternatively, if the trigger source is BUS, you can also program a *TRG or an IEEE-488 <get> command.

If a digital pin is configured as the trigger source, the instrument will wait indefinitely for the trigger signal. 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 Reference	SCPI Command
Select **Transient\Control**. Then select the Abort control.	ABOR:TRAN

When a trigger is received, the triggered functions are set to their programmed transient values. 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.

Front Panel Menu Reference	SCPI Command
Select **Transient\Control**. The Trig state field indicates "Idle".	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.

Programming a Step Transient

Program the Step Levels

Use the following commands to program the triggered output step level. The output will go to this level when the trigger is received. In the front panel menu, you can only program the step level based on the priority mode that you are operating in - voltage or current priority.

Front Panel Menu Reference	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 of 15 V use: VOLT:TRIG 15 To set a current step level of 1 A use: CURR:TRIG 1

Generate a Trigger Out Signal

The output step can generate a trigger signal that can be routed to a pin on the digital port that has been configured as a trigger output (TOUT). Use the following commands to generate a trigger signal when the step occurs:

Front Panel Menu Reference	SCPI Command
Select **Transient\Step**. Check Enable Trigger Output. Then press **Select**.	To program a Step trigger signal, use: STEP:TOUT ON

Programming a List Transient

- Program the list levels
- Program the dwell times
- Specify the list pacing
- Specify any trigger signals that the list should generate
- Specify how many times you want the list to repeat
- Specify how you want the list to end

Lists let you generate complex sequences of output changes with rapid, precise timing, which may be synchronized with internal or external signals. In contrast to an output step, which is a one-time output change, an output list is a sequence of output changes. Lists can contain up to 512 individually programmed steps, and can be programmed to repeat themselves. Only the parameters associated with one of the priority modes, either voltage or current priority, may be list controlled.

The voltage and current lists are paced by a separate dwell list that defines the duration or dwell of each step. Each of the up to 512 steps can have a unique dwell time associated with it, which specifies the time in seconds that the list will remain at that step before moving on to the next step. Refer to LIST:DWEL for information about the dwell range and resolution.

Lists can also be trigger-paced, in which the list advances one step for each trigger received. This is useful if you need an output list to closely follow triggered events. With a trigger-paced list, triggers that are received during the dwell period are ignored. You can set the list dwell time to zero ensure that no triggers are lost.

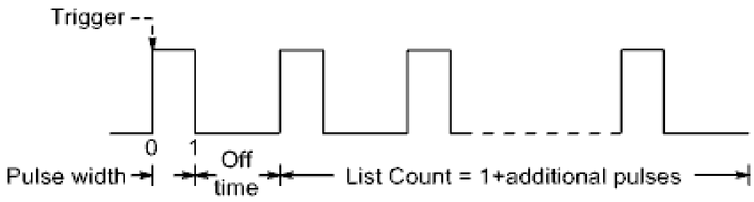
Lists can also generate trigger signals at specified steps. This is accomplished by two additional lists: a beginning-of-step (BOST) and an end-of-step (EOST) list. These lists define which steps will generate a trigger signal and if the trigger occurs at the beginning or end of the step. These trigger signals can be used to synchronize other events with the list.

All lists (voltage, current, dwell, BOST, EOST) must be set to the same number of steps, otherwise an error occurs when the list is run. For convenience, a list may be programmed with only one step or value. In this case, a single-step list is treated as if it had the same number of steps as the other lists, with all values being equal to the one value.

NOTE List data is not saved as part of a saved instrument state.

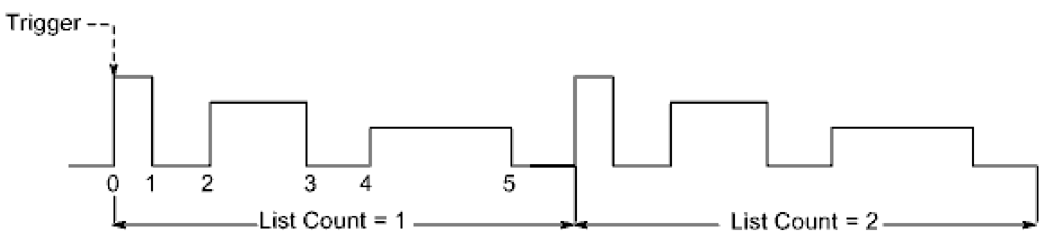
Program the list levels

Example 1 If you are programming a voltage pulse or pulse train, set the amplitude of the pulse. For example, to generate a pulse with an amplitude of 15 V, program the amplitude for the pulse (step 0), and the amplitude for the off time (step 1).



Front Panel Menu Reference	SCPI Command
Select **Transient\List\Config**. Select List Step 0 (the pulse) and enter a voltage value of 15. Press Select. Select List Step 1 (the off time) and enter a voltage value of 0. Press Select. Use the up/down arrows to select the next step.	To program the amplitude for step 0 (the pulse) and step 1 (the off time): LIST:VOLT 15,0

Example 2 If you are programming an arbitrary voltage list, specify the amplitudes for the list. The order in which the values are entered determines the order in which the values will be output. To generate the voltage list shown in the figure, a list may include the following values: 9, 0, 6, 0, 3, 0:



Front Panel Menu Reference	SCPI Command
Select **Transient\List\Config**. Select the List Step number and enter a voltage value. Press Select. Repeat this for each step. Use the up/down arrows to select the next step.	To program a voltage list of 5 steps: LIST:VOLT 9,0,6,0,3,0

Program the dwell times

Example 1 If you are programming a voltage pulse, set the dwell time of the pulse width. Also specify the dwell of the off time. This is necessary if you are generating a pulse train, since the off time determines the time between pulses. To generate a pulse with a pulse width of 1 second and an off time of 2 seconds, use:

Front Panel Menu Reference	SCPI Command
Select **Transient\List\Config**. Select List Step 0 (the pulse) and enter a dwell value of 1. Press Select. Select List Step 1 (the off time) and enter a dwell value of 2. Press Select. Use the up/down arrows to select the next step.	To program the dwell for step 0 (the pulse) and step 1 (the off time): LIST:DWEL 1,2

You have now configured a single pulse. If you wish to generate a pulse train, simply specify the number of pulse repetitions as described under "Specify How Many Times the List Repeats".

Example 2 If you are programming an arbitrary voltage list, specify the amplitudes for the list. The dwell values determine the time interval, in seconds, that the output remains at each step in the list before it advances to the next step. To specify the six dwell intervals in the figure, a list may include the following values: 2, 3, 5, 3, 7, 3:

Front Panel Menu Reference	SCPI Command
Select **Transient\List\Config**. Select the List Step number and enter a dwell value. Press Select. Repeat this for each step. Use the up/down arrows to select the next step.	To program a dwell of 5 values, use: LIST:DWEL 2,3,5,3,7,3

NOTE The number of dwell steps must equal the number of voltage steps. If a dwell list has only one value, that value will be applied to all steps in the list.

Specify the list pacing

You can specify if the list will be dwell or trigger-paced. The default selection is dwell-paced.

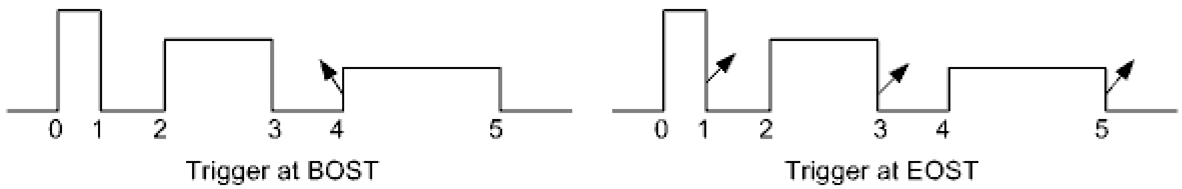
In a dwell paced list, each step is assigned a dwell time. The dwell time determines the time that the output remains at the step. As each dwell time elapses, the next step is immediately output.

In a trigger-paced list, the list advances one step for each trigger received. You can also a dwell period if you want to ignore triggers during the dwell time, or guarantee a minimum dwell time between triggered list steps.

Front Panel Menu Reference	SCPI Command
Select **Transient\List\Pace**. Select either Dwell paced or Trigger paced. Then press **Select**.	To set the list pacing to dwell-paced: LIST:STEP AUTO To set the list pacing to trigger-paced: LIST:STEP ONCE

Specify any trigger signals that the list should generate

You can generate trigger signals that can be routed to other destinations. For example, you can use trigger signals to trigger actions on any external equipment connected to the digital port. The following figure gives an example of generating four trigger signals on the arbitrary list of Example 2.



Front Panel Menu Reference	SCPI Command
Select **Transient\List\Config**. Select the List Step number 4. To generate a trigger, enter a 1 in the Tout Begin Step field. Select the List Step numbers 0, 2, and 4. To generate a trigger, enter a 1 in the Tout End Step field. If zeroes are entered in the fields, no trigger is generated for the step.	To program a trigger at the beginning of step 4: LIST:TOUT:BOST 0,0,0,0,1,0 To program a trigger at the end of step 0, 2, and 4: LIST:TOUT:EOST 1,0,1,0,1,0

Specify how many times you want the list to repeat

You can specify how many times you want the list (or pulse) to repeat. At reset, the list count is set to 1 repetition. Sending the INFinity parameter in the SCPI command makes the list repeat indefinitely.

Front Panel Menu Reference	SCPI Command
Select **Transient\List\Repeat**. Enter the number of list repetitions (2) and press Select.	To program the list to repeat twice: LIST:COUN 2

Specify how you want the list to end

Specify the output state after the list has completed. There are two choices: the output returns to the value that was in effect before the list started, or the output remains at the value of the last list step.

Front Panel Menu Reference	SCPI Command
Select **Transient\List\Terminate**. Select either Return to Start, or Stop at Last Step and press Select.	To return the output to the pre-list state: LIST:TERM:LAST OFF To keep the output at the end list state: LIST:TERM:LAST ON

Programming an Arbitrary Waveform

- Specify the Arb type and dwell
- Configure the Arb
- Specify how many times you want the Arb to repeat
- Specify how you want the Arb to end

NOTE Certain output amplitude and frequency combinations can exceed the instrument's dynamic response capability and cause the output to shut down, especially under no-load conditions. Refer to Output Dynamic Response for more information.

The output of the Keysight RPS models can be modulated by the instrument's built-in arbitrary waveform generator. This allows the output to generate complex user-defined voltage or current waveforms. The following are key features of the constant-dwell arbitrary waveform generator:

- Generate voltage or current arbitrary waveforms.
- Arbs can contain up to 65,535 data points.
- A single dwell value applies to every point in the constant-dwell arbitrary waveform (see ARB:VOLT:CDW:DWEL for dwell information).
- Only the Arb that corresponds to the active priority mode, either voltage or current priority, may be generated.

Specify the Arb type and dwell

To specify the Arb type and dwell:

Front Panel Menu Reference	SCPI Command
Select **Transient\Arb\Config**. In the dropdown list, pick either a voltage or a current Arb. Then press **Select**. Enter a dwell value in the Dwell field. Then press **Select**.	To specify a voltage or current Arb: ARB:FUNC:TYPE VOLT ARB:FUNC:TYPE CURR To specify a dwell time of 1 millisecond: ARB:VOLT:CDW:DWEL 0.001 ARB:CURR:CDW:DWEL 0.001

Configure the Arb

Note that you can only *view* Arb point data from the front panel. You cannot *program* Arb data from the front panel. You must use the SCPI ARB:CURRent:CDWell or ARB:VOLTage:CDWell commands to program the Arb data.

Front Panel Menu Reference	SCPI Command
Select **Transient\Arb\Config**. If Arb points have been imported or programmed using the SCPI command, the Points field displays the number of points in the Arb. View the amplitude of any Arb point by entering the point number in the Point # field. The Level field displays the amplitude.	To program 10 points in a current Arb: ARB:CURR:CDW 1,2,2,3,4,4,3,2,2,1 To query the number of Arb points: ARB:CURR:CDW:POIN? To query the Arb point values: ARB:CURR:CDW?

Specify how many times you want the Arb to repeat

Depending on your application, specify how many times you want the Arb to repeat. Sending the INFinity parameter in the SCPI command makes the Arb repeat indefinitely. At reset, the Arb count is set to 1.

Front Panel Menu Reference	SCPI Command
Select **Transient\Arb\Repeat**. Enter the number of list repetitions (2) and press Select.	To program the Arb to repeat twice: ARB:COUN 2

Specify how you want the Arb to end

Specify the output state after the Arb has completed. There are two choices: the output returns to the state it was in before the Arb started, or the output remains at the values of the last Arb point.

Front Panel Menu Reference	SCPI Command
Select **Transient\Arb\Terminate**. Select either Return to Start, or Stop at Last Step and press Select.	To return the output to the pre-Arb state: ARB:TERM:LAST OFF To keep the output at the Arb end point: ARB:TERM:LAST ON

Sequencing the Output

This section describes how you can synchronize output turn-on and turn-off sequences on single and multiple units.

Turn-On/Turn-Off Delays

All power supplies exhibit an internal delay offset that applies from the time that a command to turn on the output is received until the output actually turns on. Specifying a common delay offset will serves as a reference point for any user-programmed turn-on delays. This user-defined offset also makes it possible to connect multiple power supplies together and program accurate turn-on sequences across multiple outputs. The user-programmed turn-on delay will then be added to the common user-defined reference point.

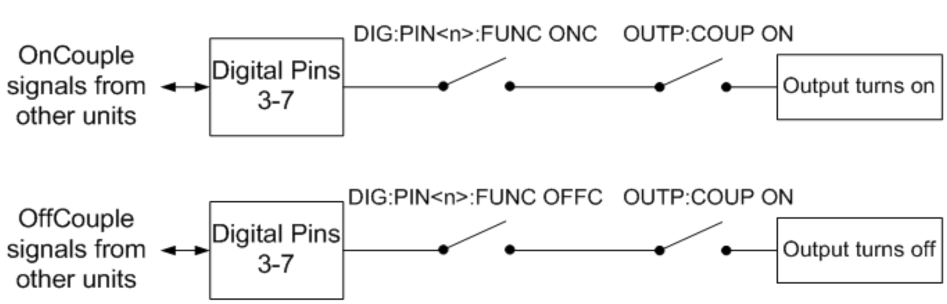
There is no need to specify a common delay offset when outputs turn off. Outputs start executing their turn-off delays as soon as an Output Off command is received. The internal delay offset is shown in the following table.

	Voltage Priority	Current Priority
Without SD1000A safety disconnect unit	≤ 12 milliseconds	≤ 14 milliseconds
With SD1000A safety disconnect unit	≤ 158 milliseconds	≤ 167 milliseconds

Coupling the Output

In addition to the front panel and SCPI Output On and Output Off commands, you can also use OnCouple and OffCouple signals to enable and disable the output. These signals provide an additional level of control when sequencing the output on individual and multiple units.

The following figure illustrates the programming path when using the OnCouple and OffCouple signals to control the output.



As shown in the figure, you can configure digital ports pins 3 through 7 to provide the OnCouple and OffCouple signals that enable or disable the output. The output is enabled or disabled when the corresponding signal is true. Refer to Output Couple Control for more information on configuring the digital port pins.

Lastly, you must enable output sequencing to use OnCouple and OffCouple signals to enable or disable the output. Refer to Enable Output Sequencing below.

Sequencing Multiple Units

To sequence the output turn-on for multiple units:

1. Connect and configure the digital connector pins of all units.

2. Enable the sequence function on each unit.

3. Specify the user-programmed turn-on delay for each unit.

4. This step is required if you have power supplies with **different** minimum delay offsets (see below). Specify a common delay offset for all of the sequenced units. The common delay offset must be larger or equal to the largest maximum delay offset. When the common delay offset completes, the user-programmed turn-on delays will start.

Connect and Configure the Digital Connector Pins

The digital connector pins of the sequenced units must be connected together and configured. Refer to Output Couple Control for more information.

Enable Output Sequencing

Output turn-on sequencing must be enabled on each unit that will participate in output turn-on synchronization.

Front Panel Menu Reference	SCPI Command
Select **Output\Sequence\Couple**. Check Enable to enable sequencing. Uncheck to disable.	To enable, send: OUTP:COUP ON To disable, send: OUTP:COUP OFF

Specify the Turn-On and Turn-Off Delays for each Unit

Turn-on delays can be specified for all coupled units. Any delay sequence can be implemented. There are no restrictions on what the sequence is or what unit comes up first.

Front Panel Menu Reference	SCPI Command
Select **Output\Sequence\Couple**. Specify the Turn-on delay in seconds. Repeat for each additional unit.	Program a turn-on delay: OUTP:DEL:RISE .02 Repeat for each instrument.

Turn-off delays can also be specified for all coupled units. Any delay sequence can be implemented. There are no restrictions on what the sequence is or what unit turns off first.

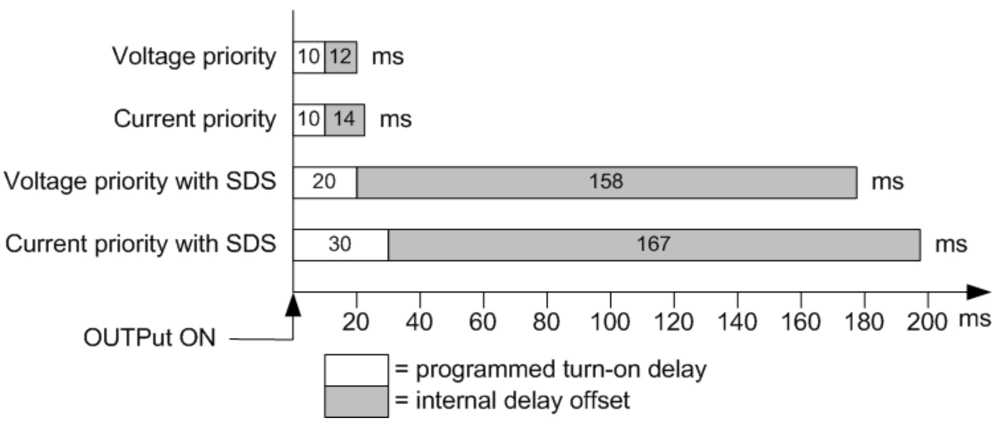
Front Panel Menu Reference	SCPI Command
Select **Output\Sequence\Delay**. Specify the Turn-off delay in seconds. Repeat for each additional unit.	Program a turn-off delay: OUTP:DEL:FALL .01 Repeat for each instrument.

Specify the Common Delay Offset

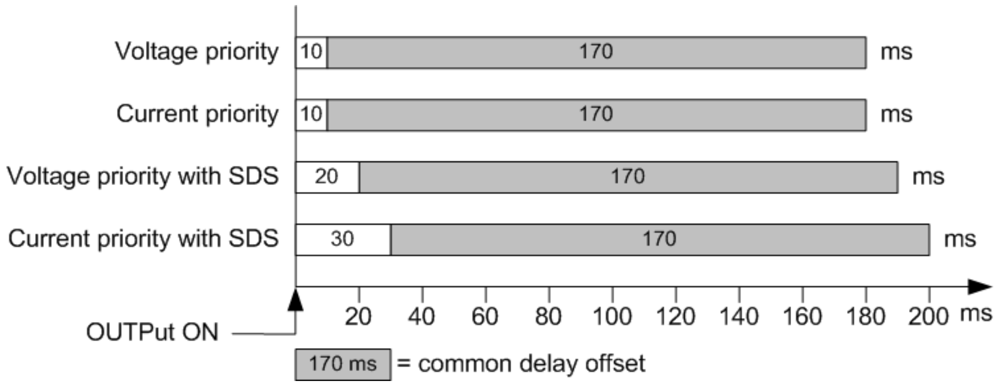
NOTE There is no need to specify a common delay offset when outputs turn off. Outputs start executing their turn-off delays as soon as an Output Off command is received (and any user-programmed turn-off delay has expired).

Specifying a common delay offset lets you accurately synchronize the user-programmed turn-on delays when sequencing power supplies with different internal delay offsets.

In the following figure, you can see how the internal delay offsets are appended to the user-programmed delay times. The internal delay offsets vary based on priority mode, and whether an SD1000A unit is connected to the power supply.



Although you cannot eliminate the internal delay offset times, you can specify a common delay offset to accurately synchronize the user-programmed turn on delays with each other. If in the above example you were to program a common delay offset of 170 ms, that common delay offset would then supersede the different internal delay times of the coupled units. The 170 ms common offset would in effect synchronize the internal delay of the coupled units.



The common delay offset assures that the user-programmed turn-on delays will be synchronized to start at the completion of the common delay offset. Query the delay offset of each unit and use the slowest delay as the common delay offset.

Front Panel Menu Reference	SCPI Command
Select **Output\Sequence\Couple**. The Max delay offset for this frame field displays the delay offset of the unit. Enter the delay offset value of the slowest unit in the Delay offset field in milliseconds. Then press **Select**.	To query the delay offset of the slowest unit: OUTP:COUP:MAX:DOFF? Use the delay offset of the slowest unit to specify the common delay offset OUTP:COUP:DOFF 0.170

NOTE To circumvent the additional relay turn-on times of the SD1000A, a non-volatile OUTPut:RELay:LOCK command can be sent, after which the internal delay offset will match those of models without connected SD1000A units.

Output Turn-On Turn-Off Behavior

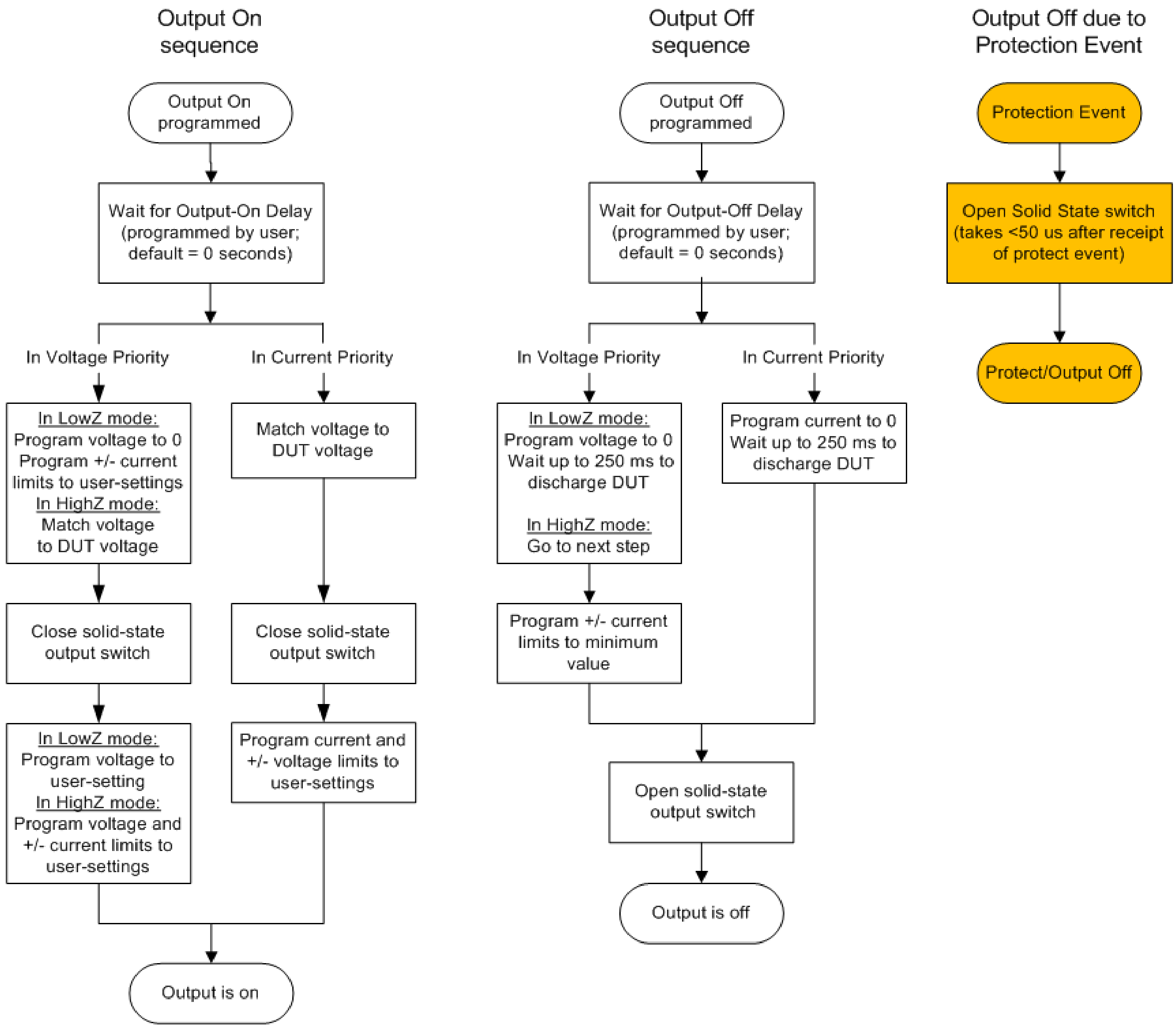
The turn-on and turn-off sequences are primarily controlled by three factors: the user-programmed turn-on/turn-off delays, the voltage and current priority mode settings, and the operation of the Keysight SD1000A unit (if installed).

The following table documents the output impedance setting for the turn-on and turn-off sequences. For models RP793xA and RP794xA only, you can specify either Low or High output impedance when operating in Voltage priority mode.

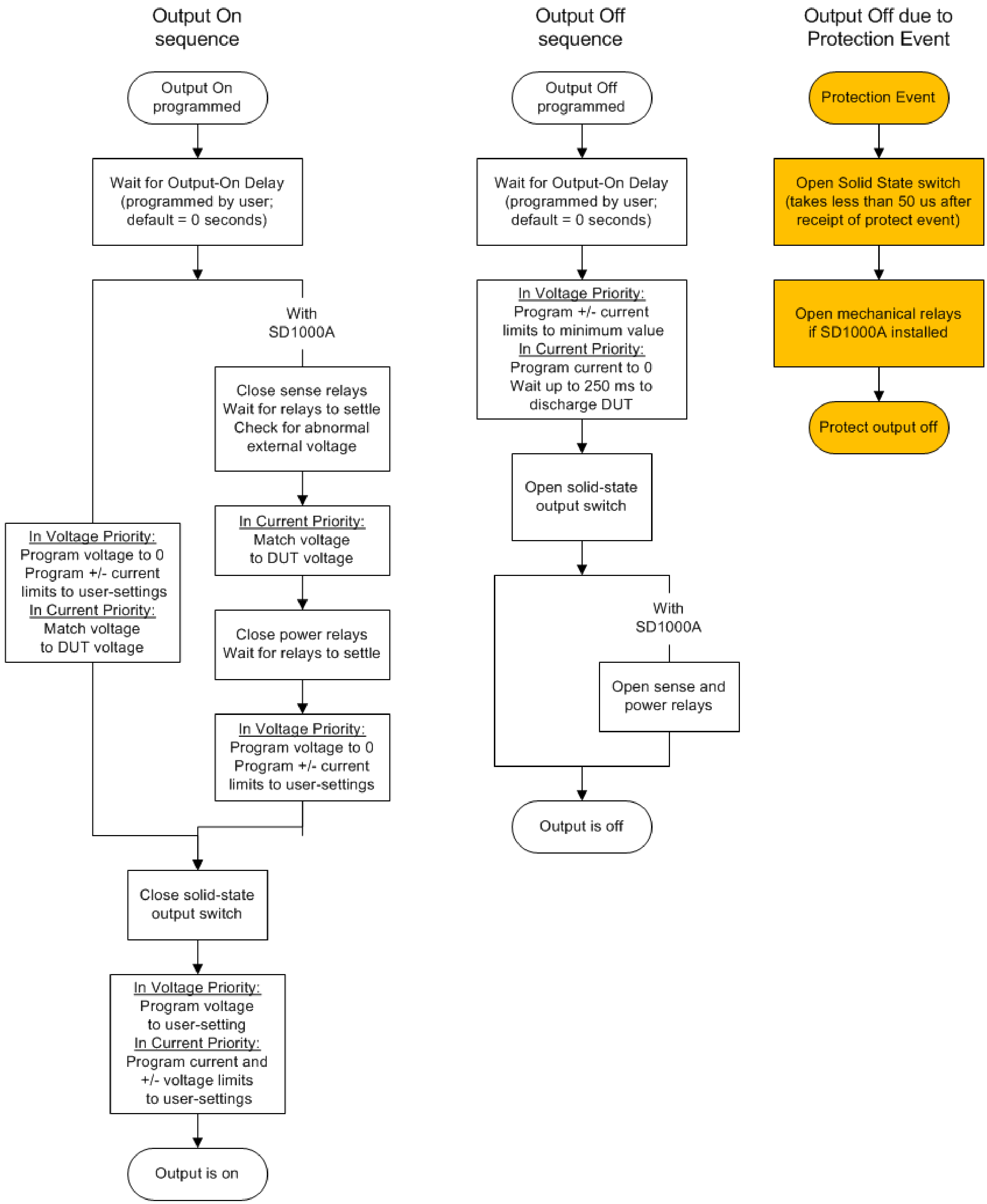
Output turn-on/turn-off impedance for	Voltage Priority	Current Priority
Models RP793xA; RP794xA	Impedance is user-selectable via OUTPut:TMODe command	High impedance turn-on High impedance turn-off
Models RP795xA; RP796xA	Low impedance turn-on High impedance turn-off	High impedance turn-on High impedance turn-off

The following flowcharts illustrate the output turn-on and output turn-off sequences followed by a description of the individual actions. Note that the sections under "With SD1000A" only apply when the Keysight SD1000A unit is installed.

Turn-On/Turn-Off - RP793xA and RP794xA



Turn-On/Turn-Off - RP795xA and RP796xA



Output-On Sequence

Upon the receipt of an Output On command, the power supply waits for the duration of the user-programmed turn-on delay.

In voltage priority with LowZ, the power supply programs its internal circuits to a voltage of zero and sets the current limits to their user-programmed values. In voltage priority with HighZ, the power supply matches its voltage to the DUT voltage.

In current priority, the power supply also matches its voltage to the DUT voltage. This ensures that when a source such as a battery is connected to the output, that there is no current surge into the power supply from the DUT when the output is turned on.

If an SD1000A unit is connected, the unit's internal delay offset is significantly longer. This is due to the closure and settling times of the sense and power relays of the SDS. If an abnormal voltage is detected, the relays remain open and a error is generated.

The power supply's solid-state output switch is then closed, connecting the output to the internal power circuits. The output voltage and current are programmed to their user-settings. The output follows the slew rate setting.

Output-Off Sequence

Upon the receipt of an Output Off command, the power supply waits for the duration of the user-programmed turn-off delay.

In voltage priority with LowZ, the power supply programs the voltage to zero. It then waits up to 250 ms to discharge any current from the DUT. It then programs the current limits to their minimum settings. In voltage priority with HighZ, the power supply only programs the current limits to their minimum settings.

In current priority, the power supply programs the current to zero. It then waits up to 250 ms to discharge any current from the DUT.

The power supply's solid-state output switch is then opened, disconnecting the output from the internal power circuits. If an SD1000A unit is connected, its sense and power relays are also opened.

NOTE If you wish to program a voltage turn-off slew rate, you must set the slew rate and program the output voltage to zero *before* you send the output off command.

Also, Models RP795xA and RP796xA use a 1 MΩ resistance, and the SD1000A uses a 25 kΩ resistance for Option 500 and a 97.5 kΩ resistance for Option 950 to downprogram any voltage from the DUT.

Output-Off Protection Sequence

The turn-off protection sequence differs from the normal turn-off sequence in that it turns off the output as fast as possible. When a protection event is detected, the power supply immediately opens the solid-state output switch. This typically takes less than 50 µs following the initial detection.

If an SD1000A unit is connected, its output and sense relays are hot-switched open.

External Data Logging

External Data Logging

NOTE The external data logging function can only be programmed using SCPI commands.

The Keysight RPS models have an "external" data logging function (Elog) that lets you continuously log voltage and current measurements. Data logging is external to the instrument because it can only be implemented using SCPI commands. Voltage and current measurement data is temporarily stored in a FIFO (first-in, first-out) buffer located in the instrument. However, this buffer is only large enough to hold about 20 seconds of accumulated measurements. This means that you must periodically empty the internal buffer to an external storage device; otherwise the data in the buffer will be overwritten.

The following table details the various data logging functions.

Function	Description
Data Storage	Buffers measurements for about 20 seconds and requires that the computer periodically reads measurements to prevent the internal buffer from overflowing. The computer needs to provide the external data storage.
Measurement Functions	Both output voltage and output current can be logged.
Integration Period	parameter with data format set to REAL. During the specified integration period, the samples are averaged, and min and max values are tracked.
Data viewing	No front panel view or control. Data is collected and viewed externally.

Note that the Elog function uses the acquire trigger process to make the measurements.

Select the Measurement Function and Range

The following commands select a measurement function:

Front Panel Menu Reference	SCPI Command
Not available	To enable voltage or current measurements: SENS:ELOG:FUNC:VOLT ONSENS:ELOG:FUNC:CURR ON To enable min/max measurements: SENS:ELOG:FUNC:VOLT:MINM ON SENS:ELOG:FUNC:CURR:MINM ON

Specify the Integration Period

The integration period can be set from a minimum of 102.4 microseconds to a maximum of 60 seconds.

Front Panel Menu Reference	SCPI Command
Not available	To set an integration period of 600 microseconds: SENS:ELOG:PER 0.0006

During the integration period, Elog samples are averaged, and the minimum and maximum values are tracked. At the end of each integration period the average, minimum, and maximum values are added to the internal FIFO buffer.

Although the absolute minimum integration period is 102.4 microseconds, the actual minimum depends on the number of measurements that are being logged. The formula is 102.4_microseconds X #_of_measurements. For example:

102.4 microseconds: 1 measurement (voltage or current)
204.8 microseconds: 2 measurements (voltage and current)
409.6 microseconds: 4 measurements (voltage+min+max+current)

If the specified integration period is at or near the minimum logging intervals, the data format must be specified as binary. If the REAL format is not specified, the data will be in ASCII format and the minimum logging intervals will typically be up to five times longer than what can be achieved with binary format.

Front Panel Menu Reference	SCPI Command
Not available	To set the data format to REAL: FORM[:DATA] REAL

Select the Elog Trigger Source

The TRIGger:ELOG command generates an immediate trigger regardless of the trigger source. Unless you are using this command, select a trigger source from the following:

Trigger Source	Description
Bus	Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).
External	Selects ANY pin that has been configured as a Trigger Input on the digital control port.
Immediate	Triggers the transient as soon as it is INITiated.
Pin<1-7>	Selects a specific pin<n> that is configured as a Trigger Input on the digital control port.

Use the following commands to select one of the available trigger sources:

Front Panel Menu Reference	SCPI Command
Not available	To select Bus triggers: TRIG:TRAN:SOUR BUS To select digital pin 5 as the trigger: TRIG:ACQ:SOUR PIN5 To select expression1 as the trigger: TRIG:ACQ:SOUR EXPR1

Initiate and Trigger the Elog

When the power supply is turned on, the trigger system is in the Idle state. In this state, the trigger system is disabled, ignoring all triggers. The INITiate command enables the measurement system to receive triggers. To initiate and trigger the Elog:

Front Panel Menu Reference	SCPI Command
Not available	To initiate the Elog: INIT:ELOG To trigger the Elog: TRIG:ELOG Alternatively, if the trigger source is BUS, you can also program a *TRG or an IEEE-488 <get> command.

When triggered, the Elog starts placing data in the internal measurement buffer. Because the buffer is only large enough to hold 20 seconds of accumulated measurement your PC application must periodically retrieve (or fetch) the data from this buffer.

Periodically Retrieve the Data

Each FETCh command returns number of requested records of the data in the buffer and removes them, making room available for more data. The Elog continues until it is aborted.

An Elog record is one set of voltage and current readings for one time interval. The exact format of a record depends on which functions have been enabled for Elog sensing. If all functions are enabled,

then one record will contain the following data in the specified order:
Current average
Current minimum
Current maximum
Voltage average
Voltage minimum
Voltage maximum

Front Panel Menu Reference	SCPI Command
Not available	To retrieve a maximum of 1000 records: FETC:ELOG? 1000

ASCII data (the default format) is returned as comma-separated ASCII numeric data sets of average/min/max values terminated by a newline. REAL data is returned as a definite length block, with the byte order specified by the FORMat:BORDer command.

Terminate the Elog

Front Panel Menu Reference	SCPI Command
Not available	To abort the Elog: ABOR:ELOG

Making Measurements

Average Measurements

The Keysight RPS models have a fully integrated voltmeter and ammeter to measure the actual voltage and current that is being supplied to the load.

Whenever the power supply is on, the front panel automatically measures output voltage and current by acquiring a number of measurements over the specified number of power line cycles, and averaging the samples. The default number of power line cycles is 1 cycle. At 1 cycle, the number of samples (or points) is 3255 @60 Hz and 3906 @50 Hz. The default sample interval is 5.12 microseconds.

Use the following commands to make a measurement:

Front Panel Menu Reference	SCPI Command
Select the **Meter** key. Repeatedly press the key to cycle through the following measurement functions: Voltage, Current Voltage, Power Voltage, Current, Power If dashes are displayed, the front panel measurement is interrupted because a remote interface measurement is taking place.	To measure average (DC) output voltage, current, or power: MEAS:VOLT? MEAS:CURR? MEAS:POW? To return measurement data from the previously acquired array: FETC:VOLT? FETC:CURR? FETC:POW?

Measurement Sweep

You can set the measurement time in number of power line cycles (NPLC). Using an integer number of power line cycles can reduce measurement noise from line frequency sources.

Front Panel Menu Reference	SCPI Command
Select **Measure\Sweep** Enter the number of power line cycles in the NPLC field. Then press **Select**.	To set the number of power line cycles to 10: SENS:SWE:NPLC 10

NOTE The AC line frequency is detected automatically for the SENSe:SWEep:NPLC command.

Measurement Windowing

Windowing is a signal conditioning process that reduces the error in average measurements made in the presence of periodic signals and noise. Two window functions are available: Rectangular and Hanning. At power-on, the measurement window is Rectangular.

The Rectangular window calculates average measurements without any signal conditioning. However, in the presence of periodic signals such AC line ripple, a Rectangular window can introduce errors when calculating average measurements. This can occur when a non-integral number of cycles of data has been acquired due to the last partial cycle of acquired data.

One way of dealing with AC line ripple is to use a Hanning window. The Hanning window applies a cos4 weighting function to the data when calculating average measurements. This attenuates the AC noise in the measurement window. The best attenuation is achieved when at least three or more waveform cycles are in the measurement.

Front Panel Menu Reference	SCPI Command
Select **Measure\Window**. Select either Rectangular or Hanning. Then press **Select**.	To set the sense window to Hanning: SENS:WIND HANN

A-hour & W-hour measurement

Amp-hour and watt-hour measurements are available on all RPS models. These measurements are made independently of other measurements.

The amp-hour and watt-hour measurements are created by accumulating full range current and power measurements at approximately 200k samples/second. The accumulators can hold enough data for at least 100,000 hours.

The approximate limit of accumulated charge is $\pm(900{,}000{,}000 \cdot I_{RATING})$ in Coulombs or $\pm(250{,}000 \cdot I_{RATING})$ in Amp-hours.

The approximate limit of accumulated energy is $\pm(1{,}100{,}000{,}000 \cdot P_{RATING})$ in Joules or $\pm(310{,}000 \cdot P_{RATING})$ in Watt-hours.

I_{RATING} is the current rating of the unit. P_{RATING} is the power rating of the unit.

To return Amp-hours and Watt-hours measurements:

Front Panel Menu Reference	SCPI Command
Select **Measure\AHWH**. Displays the accumulated Amp-hours and Watt-hours.	To return the Amp-hours and Watt hours: FETC:AHO? FETC:WHO?

To reset the Amp-hours and Watt-hours measurements:

Front Panel Menu Reference	SCPI Command
Select **Measure\AHWH**. Select Reset to return the measurements to zero.	To reset Amp-hours and Watt-hours: SENS:AHO:RES SENS:WHO:RES

Digitized Measurements

In addition to the average voltage, current, and power measurements, which are available from both the front panel and via SCPI commands, digitized measurements can also be returned. Digitized measurements differ from average measurements because you can select the type of measurement returned and fine tune the measurement quality.

Measurement Types

The following digitized measurements are available. These can only be measured using the corresponding SCPI command.

ACDC is a calculation that returns the total RMS measurement (AC + DC).

HIGH level is a calculation that generates a histogram of the waveform using 16 bins between the maximum and minimum data points. The bin containing the most data points above the 50% point is the high bin. The average of all the data points in the high bin is returned as the High level. If no high bin contains more than 1.25% of the total number of acquired points, then the maximum data point is returned.

LOW level is a calculation that generates a histogram of the waveform using 16 bins between the maximum and minimum data points. The bin containing the most data points below the 50% point is the low bin. The average of all the data points in the low bin is returned as the Low level. If no low bin contains more than 1.25% of the total number of acquired points, then the minimum data point is returned.

MAX is the maximum value of the digitized measurement.

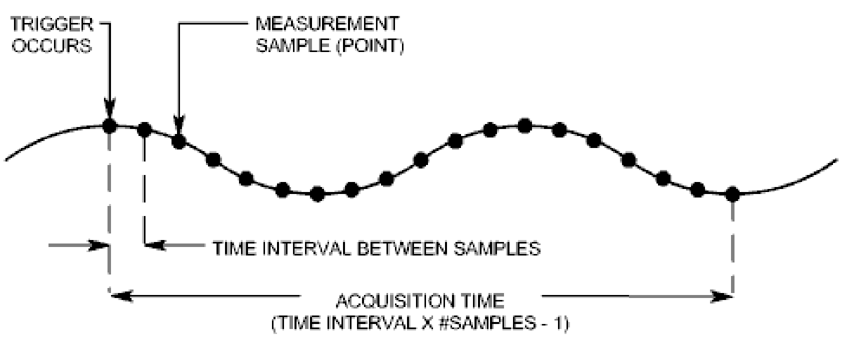
MIN is the minimum value of the digitized measurement.

Array queries are also available to return ALL values in the voltage and current measurement buffer. No averaging is applied, only raw data is returned from the buffer.

Front Panel Menu Reference	SCPI Command
Not available	To measure RMS voltage & current: MEAS:VOLT:ACDC? MEAS:CURR:ACDC? To measure the high level of a pulse: MEAS:VOLT:HIGH? MEAS:CURR:HIGH? To measure the low level of a pulse: MEAS:VOLT:LOW? MEAS:CURR:LOW? To measure the maximum value: MEAS:VOLT:MAX? MEAS:CURR:MAX? To measure the minimum value: MEAS:VOLT:MIN? MEAS:CURR:MIN? To take a measurement and return array data: MEAS:ARR:VOLT? MEAS:ARR:CURR? MEAS:ARR:POW?

Measurement Quality

The following figure illustrates the relationship between measurement samples (or points), and the time interval between samples in a typical measurement. You can fine tune the measurement by specifying the number of points in the measurement acquisition as well as the time interval between points.



You can configure the measurement acquisition as follows:

Front Panel Menu Reference	SCPI Command
Select **Measure\Sweep**. Enter the number of points. Then press **Select**. Enter the time interval. Then press **Select**.	To set the time interval to 60µs with 4096 samples: SENS:SWE:TINT 60E-6 SENS:SWE:POIN 4096

The maximum number of sample points that are available for all measurements is 512 K points (K = 1024).

Time interval values can range from 5.12 microseconds to 40,000 seconds for both voltage and current measurements. Values above 5.12 microseconds are rounded to the nearest 5.12 microsecond increment. Values above 10.24 microseconds are rounded to the nearest 10.24 microsecond increment. Values above 20.48 microseconds are rounded to the nearest 20.48 microsecond increment.

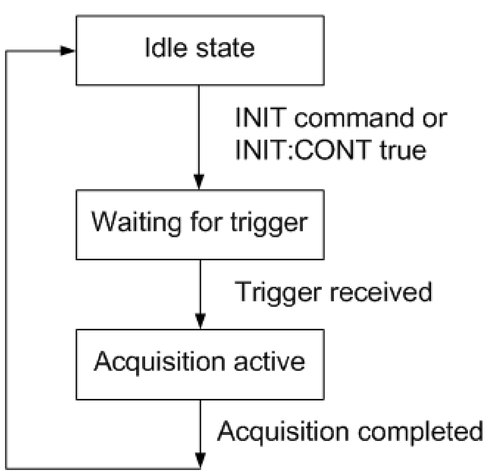
Note that Keysight RP7900 models also support the NPLC (number of power line cycles) command to configure measurement tint and points as previously discussed. The NPLC command automatically increases the number of points to maintain the shortest possible time interval. If the maximum number of points for that time interval is reached, it increases the time interval.

Measurement Triggering

- Capture pre-trigger data, if desired
- Select the trigger source
- Initiate the acquisition system
- Trigger the measurement
- Fetch the measurement
- Multiple trigger events per measurement

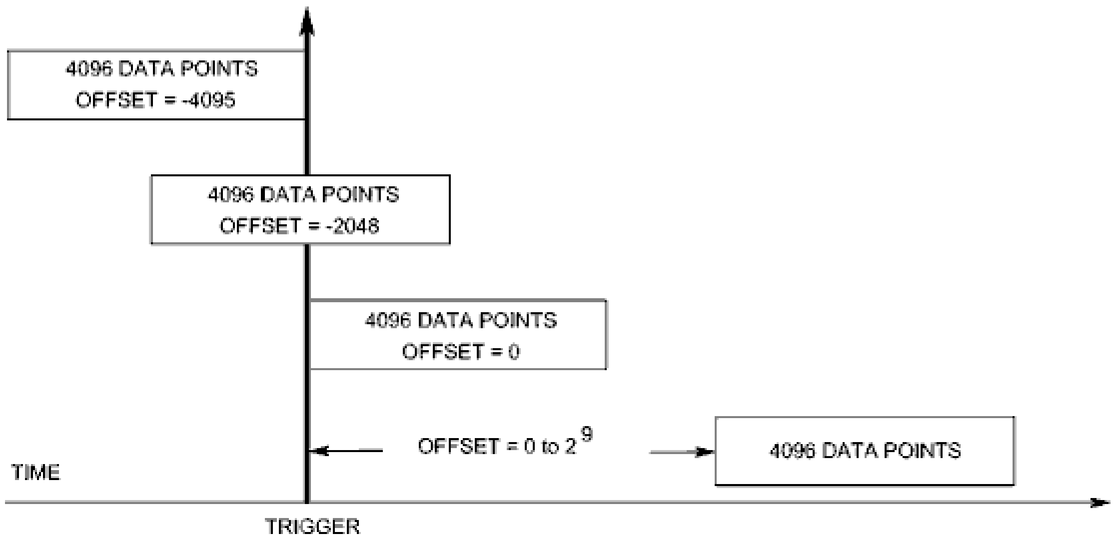
Use the acquisition trigger system to synchronize the digitized measurements with a trigger signal from a number of trigger sources. Then use FETCh commands to return voltage or current information from the acquired data.

The following figure illustrates the measurement acquisition process. This process applies to both measurement triggers and external data logging. For an overview of the trigger system, refer to Trigger Overview.



Capture pre-trigger data, if desired

The measurement system lets you capture data before, after, or at the trigger signal. As shown in the following figure, you can move the block of data being read into the acquisition buffer with reference to the trigger. This allows pre- or post-trigger data sampling.



To offset the beginning of the acquisition buffer relative to the acquisition trigger:

Front Panel Menu Reference	SCPI Command
Select **Measure\Sweep**. Enter an Offset value. Then press **Select**.	To offset the measurement by 100 points: SENS:SWE:OFFS:POIN 100

When the value is 0, all measurement samples are taken after the trigger. Positive values represent the delay after the trigger occurs but before the samples are acquired. This can be used to exclude measurement samples that occur during the delay time. (Delay time = offset x sample period). Negative values represent data samples taken prior to the trigger. This lets you acquire measurement samples prior to the trigger.

Select the trigger source

NOTE A TRIGger:ACQuire[:IMMediate] command over the bus will always generate an immediate measurement trigger, regardless of the selected trigger source.

Unless you are using TRIGger:ACQuire[:IMMediate], select a trigger source from the following:

Trigger Source	Description
Bus	Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).
Current	Selects an output current level.
External	Selects ANY pin that has been configured as a Trigger Input on the digital control port.
Pin<1-7>	Selects a specific pin<n> that is configured as a Trigger Input on the digital control port.
Transient	Selects the unit's transient system. You must also set up the transient system to generate a trigger out signal. See Programming Output Transients.
Voltage	Selects an output voltage level.

Use the following commands to select a trigger source:

Front Panel Menu Reference	SCPI Command
Not available	To select Bus triggers: TRIG:TRAN:SOUR BUS To select digital pin 5 as the trigger: TRIG:ACQ:SOUR PIN5 To select a voltage or current level: TRIG:ACQ:SOUR VOLT TRIG:ACQ:SOUR CURR To select an output transient as trigger: TRIG:ACQ:SOUR TRAN

Initiate the acquisition 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 Reference	SCPI Command
Not available	To initiate the measurement trigger system: INIT:ACQ

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

Front Panel Menu Reference	SCPI Command
Select **Measure\Control**. The Trig state field indicates "Initiated".	To query the WTG_meas bit (bit 3): STAT:OPER:COND?

If bit 3 is set in the query response, the WTG_meas bit is true, and the instrument is ready to receive the trigger signal. Refer to Status Tutorial for more information.

NOTE The instrument executes one measurement acquisition each time a bus, pin, transient, or level trigger command is received. Thus, it will be necessary to initiate the trigger system each time a triggered measurement is desired.

Trigger the Measurement

The trigger system is waiting for a trigger signal in the initiated state. You can immediately trigger the measurement as follows:

Front Panel Menu Reference	SCPI Command
Not available	To generate a measurement trigger: TRIG:ACQ Alternatively, if the trigger source is BUS, you can also program a *TRG or an IEEE-488 <get> command.

As previously discussed, a trigger can also be generated by a digital pin, an output transient, and an output voltage or current level. If a digital pin is configured as the trigger source, the instrument will wait indefinitely for the trigger signal. 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 Reference	SCPI Command
Select **Measure\Control**. Then select the Abort control.	ABOR:ACQ

Fetch the measurement

After a trigger is received and the measurement completes, the trigger system will return to the idle state.

Once the measurement completes, FETCh queries can retrieve the most recent measurement data without initiating a new measurement or altering the data in the measurement buffer.

Front Panel Menu Reference	SCPI Command
Not available	To return RMS voltage & current: FETC:VOLT:ACDC? FETC:CURR:ACDC? To return the high level of a pulse: FETC:VOLT:HIGH? FETC:CURR:HIGH? To return the low level of a pulse: FETC:VOLT:LOW? FETC:CURR:LOW? To return the maximum value: FETC:VOLT:MAX? FETC:CURR:MAX? To return the minimum value: FETC:VOLT:MIN? FETC:CURR:MIN? To return array data: FETC:ARR:VOLT? FETC:ARR:CURR? FETC:ARR:POW?

If a FETCh query is sent before the measurement is finished, the response will be delayed until the measurement trigger occurs and the acquisition completes. You can test the MEAS_active bit in the operation status register to know when the measurement trigger system has returned to the idle state.

Front Panel Menu Reference	SCPI Command
Select **Measure\Control**. The Trig state field indicates "Idle".	To query the MEAS_active bit (bit 5): STAT:OPER:COND?

If bit 5 is set in the query response, the MEAS_active bit is true, and the measurement is NOT complete. When the MEAS_active bit is false, you can retrieve the measurement. Refer to Status Tutorial for more information.

Multiple trigger events per measurement

The Keysight RPS models can capture other triggers that occur during the acquisition, return the number and position of those triggers, and calculate DC values based on a subset of the data surrounding those triggers. The basic concept is that a single long acquisition may contain several events of interest, and that these events are marked by locations where additional triggers occurred. The locations of these events are described as an index into the acquisition's store of acquired data. Indices range from 0 to 1 less than the number of acquired readings (see SENse:SWEep:POINts).

You can query and return the indices where additional triggers occurred during the measurement. The number of indices returned matches the number of triggers that occurred.

Front Panel Menu Reference	SCPI Command
Not available	To query how many (if any) additional triggers occurred: TRIG:ACQ:IND:COUN? To return the indices where the triggers occurred: TRIG:ACQ:IND?

You can also return the actual measurement data that was captured after any of the aforementioned trigger indices.

Front Panel Menu Reference	SCPI Command
Not available	To return DC voltage or current calculated after the trigger indcies: FETC:VOLT? [<*start_index*>, <*points*>] FETC:CURR? [<*start_index*>, <*points*>] To return instantaneous voltage or current data after the trigger indices: FETC:ARR:VOLT? [<*start_index*>, <*points*>] FETC:ARR:CURR? [<*start_index*>, <*points*>]

Programming the Digital Port

Digital Control Port

A Digital Control Port consisting of seven I/O pins is provided to access various control functions. Each pin is user-configurable. The following control functions are available for the I/O pins. See SCPI Programming Reference for details on the SCPI commands to program the Digital Port.

The following table describes the possible pin configuration for the digital port functions. For a complete description of the electrical characteristics of the digital control port, refer to the Specifications section.

Function	Description
DIO	General-purpose ground-referenced digital input/output function. The output can be set with [SOURce:]DIGit-al:OUTPut:DATA.
DINPut	Digital input-only mode. The digital output data of the pin is ignored.
FAULt	Applies only to pin 1. Pin 1 functions as an isolated fault output. The fault signal is true when any output is in a protected state. Pin 2 serves as the isolated common for pin 1. When pin 1 is set to the FAULt function, the instrument ignores any commands to program pin 2. Queries of pin 2 will return FAULt. If pin 1 is changed from FAULt to another function, pin 2 is set to DINPut.
INHibit	Applies only to pin 3. When pin 3 is configured as an inhibit input; a true signal at the pin will disable the output.
ONCouple	Applies only to pins 4-7. The ONCouple pin synchronizes the output On state between instruments. Only one pin can be configured as an ONCouple. The pin functions as both an input and an output.
OFFCouple	Applies only to pins 4-7. The OFFCouple pin synchronizes the output Off state between instruments. Only one pin can be configured as an OFFCouple. The pin functions as both an input and an output.
TINPut	A trigger input pin can be selected as the source for measurement and transient trigger signals. See TRIGger-:ACQuire:SOURce and TRIGger:TRANsient:SOURce
TOUTput	A trigger output pin will generate output triggers from any subsystem that has been configured to output trigger signals.
Common	Applies only to pin 8. Connected to ground.

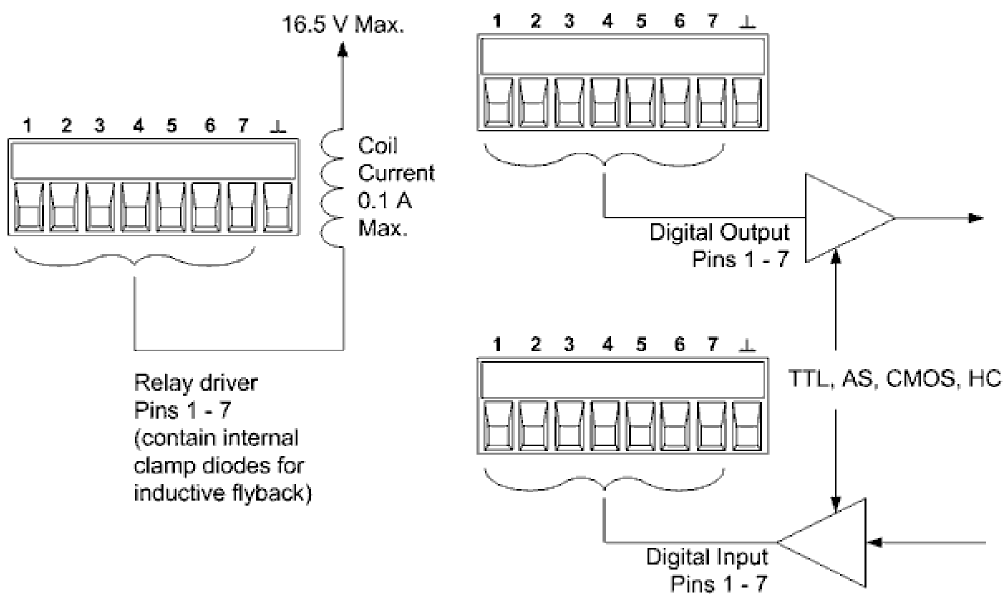
In addition to the configurable pin functions, the signal polarity (Positive or Negative) for each pin is also configurable. For level signals, POSitive indicates a voltage high at the pin. NEGative indicates a voltage low at the pin. For edge signals, POSitive means a rising edge and NEGative means a falling edge.

Bi-Directional Digital I/O

Each of the seven pins can be configured as general purpose bi-directional digital inputs and outputs. The polarity of the pins can also be configured. Pin 8 is the signal common for the digital I/O pins. Data is programmed according to the following bit assignments:

Pin	7	6	5	4	3	2	1
Bit Weight	6 (MSB)	5	4	3	2	1	0 (LSB)

The digital I/O pin can be used to control both relay circuits as well as digital interface circuits. The following figure illustrates typical relay circuits as well as digital interface circuit connections using the digital I/O functions



To configure the pins for digital I/O:

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select a pin in the Pin field. In the Function field, select Dig IO. In the Polarity field, select either Positive or Negative. To send data to the pins, select **System\IO\DigPort\Data**. Select the Data Out field and enter the binary word.	To select the pin function: DIG:PIN<1-7>:FUNC DIO To select the pin polarity: DIG:PIN<1-7>:POL POS To configure pins 1 through 7 as “0000111”: DIG:OUTP:DATA 7

Digital Input

Each of the seven pins can be configured as digital input only. The polarity of the pins can also be configured. Pin 8 is the signal common for the digital input pins. The pin status reflects the true condition of the external signal that is applied to the pin. The pin state is not affected by the setting of DIGital:OUTPut:DATA. To configure the pins for digital input only:

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select a pin in the Pin field. In the Function field, select **Dig In**. In the Polarity field, select either Positive or Negative. To read the data from the pins, select **System\IO\DigPort\Data**. The input data is displayed as a binary number in the Data In field.	To select the pin function: DIG:PIN<1-7>:FUNC DINP To select the pin polarity: DIG:PIN<1-7>:POL POS To read the data on the pins: DIG:INP:DATA?

External Trigger I/O

Each of the seven pins can be configured as trigger inputs or trigger outputs. The polarity of the pins can also be configured. When you program trigger polarity, POSitive means a rising edge and NEGative means a falling edge. Pin 8 is the signal common for the trigger pins. For an overview of the trigger system, refer to Trigger Overview.

When configured as a trigger input, you can apply either a negative-going or a positive-going pulse to the designated trigger input pin. The trigger latency is 5 microseconds. The minimum pulse width is 4 microseconds for positive-going signals, and 10 microseconds for negative-going signals. The pin's polarity setting determines which edge generates a trigger-in event.

When configured as a trigger output, the designated trigger pin will generate a 10 microsecond-wide pulse when a Trigger Out occurs. Depending on the polarity setting, it can be either positive-going (rising edge) or negative-going (falling-edge) when referenced to common.

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select a pin in the Pin field. In the Function field, select either the Trig In or Trig Out function. In the Polarity field, select either Positive or Negative.	To select the trigger output function for pin 1: DIG:PIN1:FUNC TOUT To select the trigger input function for pin 2: DIG:PIN2:FUNC TINP To select the pin polarity: DIG:PIN1:POL POS DIG:PIN2:POL POS

Fault Output

Pins 1 and 2 can be configured as a fault-output pair. The Fault Output function enables a fault condition to generate a protection fault signal on the digital port. Refer to Programming Output Protection for a list of protection signals.

Both pins 1 and 2 are dedicated to this function. Pin 1 is the Fault output; pin 2 is the common for pin 1. This provides for an optically-isolated output. The polarity of pin 1 can also be configured. When the pin polarity is POSitive, a fault condition causes the isolated output to conduct. Note that the Fault output signal remains latched until the fault condition is removed and the protection circuit is cleared. as explained under Clear Output Protection.

NOTE Pin 2's selected function is ignored. Pin 2 should be connected to the ground of the external circuit.

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select pin 1, then Function, then Fault Out. In the Polarity field, select either Positive or Negative.	To configure the Fault function: DIG:PIN1:FUNC FAUL To select the pin polarity: DIG:PIN1:POL POS

Inhibit Input

Pin 3 can be configured as a remote inhibit input. The Inhibit Input function lets an external input signal control the output state of instrument. The input is level triggered. The signal latency is 5 microseconds. Pin 8 is the common for pin 3. The following non-volatile inhibit input modes can be programmed:

LATChing - causes a logic-true transition on the Inhibit input to disable the output. The output will remain disabled after the inhibit signal is received.

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.

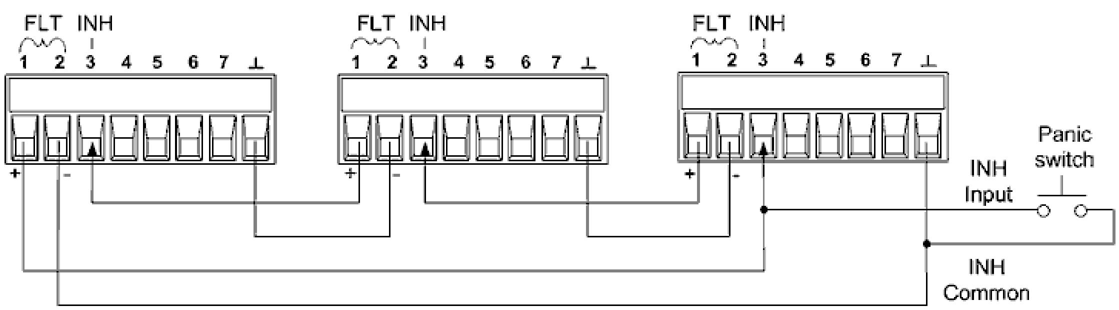
To configure the Inhibit Input function:

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select pin 3, then Function, then Inhibit In. In the Polarity field, select either Positive or Negative. Select **Protect\Inhibit**. Select either Latching or Live. To disable the Inhibit signal, select Off.	To select the Inhibit function: DIG:PIN3:FUNC INH To select the pin polarity: DIG:PIN3:POL POS To specify the Inhibit mode: OUTP:INH:MODE LATC OUTP:INH:MODE LIVE OUTP:INH:MODE OFF

Fault/Inhibit System Protection

As shown in the following figure, when the Fault outputs and Inhibit inputs of several instruments are daisy-chained, an internal fault condition in one of the units will disable all outputs without intervention by either the controller or external circuitry. Note that when using the Fault/Inhibit signals in this manner, both signals must be set to the same polarity.

Also, as shown in the figure, you can also connect the Inhibit input to a manual switch or external control signal that will short the Inhibit pin to common whenever it is necessary to disable all outputs. Negative polarity must be programmed for all pins in this case. You can also use the Fault output to drive an external relay circuit or signal other devices whenever a protection fault occurs.



Clearing a System Protection Fault

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).

NOTE Even when the initial fault condition or external signal is removed, the fault signal is still active and will continue to shut down the outputs of all the units.

To clear the daisy-chained fault signal if the operating mode of the Inhibit input is Live, simply clear the output protection on any ONE unit as explained under Clearing Protection Functions. If 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.

Output Couple Control

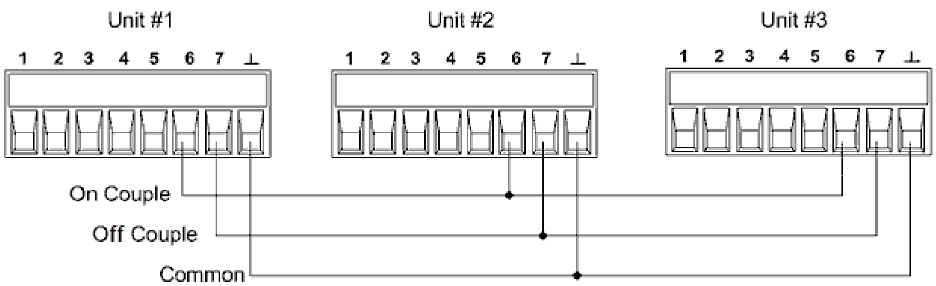
This function lets you connect multiple instruments together and synchronize the output on/off sequence across all units. Each unit that will be sequenced must also be "coupled" to the other units.

1. Couple the output on each unit as described under Sequencing the Output.

2. Set the delay offset of each individual unit to match the longest delay offset of the group.

3. Connect and configure the digital connector pins of the sequenced units as shown below.

Only pins 4 through 7 can be configured as "coupled" pins. The designated pins will function as both an input and an output, with a negative transition on one pin providing the sequence signal to the other pins. The polarity of the pins is not programmable; it is set to NEGative.



In this example, pin 6 is configured as the output On control. Pin 7 is configured as the output Off control. The ground or Common pins are connected together.

Front Panel Menu Reference	SCPI Command
Select **System\IO\DigPort\Pins**. Select pin 6, then Function, then On Couple. Select **Pins.**, select pin7, then Function, then Off Couple. Repeat these steps for units #2 and #3	To set pin 6 of unit 1 as the ON control: DIG:PIN6:FUNC ONC To configure pin 7 of unit 1 as the OFF control: DIG:PIN7:FUNC OFFC Repeat commands for units 2 and 3.

Once configured and enabled, turning the output on or off on any coupled unit will cause all coupled units to turn on or off according to their user-programmed delays.

System-Related Operations

Though not directly related to output programming, the following functions also control instrument operation.

Instrument Identification

Instrument State Storage

Front Panel Display

Front Panel Lock-Out

Password Protection

Instrument Identification

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

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

Specifying a power-on state

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

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

Front Panel Display

The power supply has a front panel screen saver that significantly increases the life of the LCD display by dimming it during periods of inactivity. The delay can be set from 30 to 999 minutes in 1 minute increments. As shipped, 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 dims, and the LED next to the Line switch turns 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 brightness up. 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 Reference	SCPI Command
Select **System\Preferences\Display\Saver** 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.	To turn the front panel screen saver on or off: DISP:SAV ON|OFF

Specifying the power-on view

Note that you can specify which measurement functions are displayed at turn-on.

Front Panel Menu Reference	SCPI Command
Select **System\Preferences\Display\View**. From the dropdown menu select: Voltage,Current; Voltage,Power; or Volt,Curr,Power. Then press **Select**.	To select a turn-on meter view: DISP:VIEW METER_VI DISP:VIEW METER_VP DISP:VIEW METER_VIP

Front Panel Lock-Out

You can lock the front panel keys to prevent unwanted control of the instrument from the front panel. This is the most secure way of locking the front panel keys because you need a password to unlock the front panel. This parameter is saved in non-volatile memory. Therefore, the front panel remains locked even after AC power is cycled.

Front Panel Menu Reference	SCPI Command
Select **System\Preferences\Lock** In the dialog box, enter the password to unlock the front panel. Then select Lock.	Not available

The menu to unlock the front panel appears every time a key is pressed. Enter the password to unlock the front panel.

NOTE If the password is lost, the SYSTem:PASSword:FPANel:RESet command can reset the front panel lockout password. Refer to Calibration Switches for more information.

The SYSTem:COMMunicate:RLSTate RWLock command can also lock and unlock the front panel. This command is completely independent of the front panel lockout function. If you use this command to lock the front panel, the front panel will be unlocked when AC power is cycled.

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, 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 Reference	SCPI Command
Select **System\Admin\Password** Enter a numeric password, up to 15 digits long. Then press Select. Log out of the Admin menu to activate the password. You can now only enter the Admin menu by providing the correct password in the Password field.	Enter calibration mode using the original password CAL:STAT ON, <password> To change the password: CAL:PASS <password> To exit calibration mode and activate the password: CAL:STAT OFF

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.

Clock Setup

The real-time clock is used to provide time stamp information for the Keysight 14585A Control and Analysis Software, which is its only function. When shipped, the real-time clock is set to Greenwich mean time. To set the clock:

Front Panel Menu Reference	SCPI Command
Select **System\Preferences\Display\Clock**. Enter the date in the Month, Day and Year fields. Enter the time in the Hour, Minute, and Second fields. Press Select to set the date and time.	To set the date: SYSTem:DATE 2018,06,30 To set the time: SYSTem:TIME 20,30,0

Priority Mode Tutorial

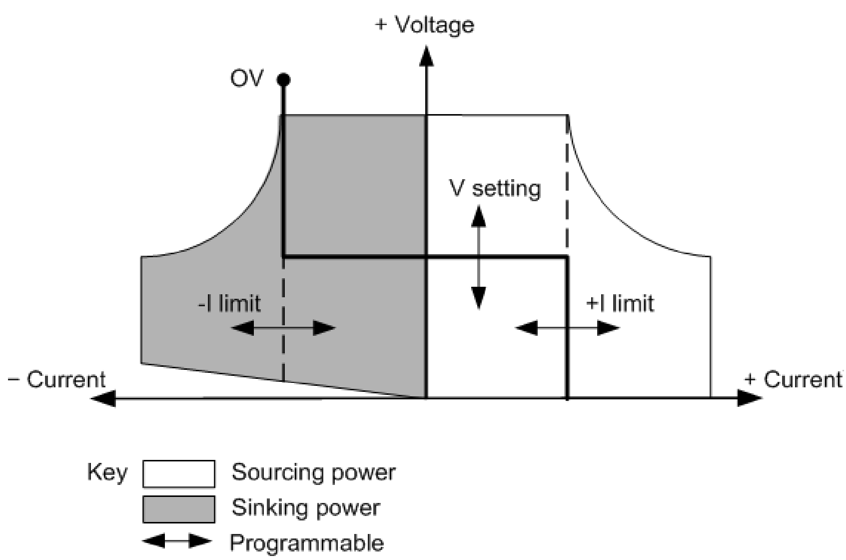
Voltage Priority

Current Priority

Voltage Priority

In voltage priority mode, the output is controlled by a constant-voltage feedback loop, which maintains the output voltage at its programmed setting as long as the load current remains within the positive or negative current limit settings. Voltage priority mode is best suited for use with resistive or high impedance loads, and loads that are sensitive to voltage overshoots. Do not use voltage priority mode with low-impedance sources such as batteries, power supplies, or large charged capacitors.

In voltage priority mode, the output voltage should be programmed to the desired value. A positive and negative current limit value should also be set. The current limit should always be set to a value that is greater than the actual output current requirement of the external load. The following figure shows the voltage priority operating locus of the output. The area in the white quadrants shows the output as a source (sourcing power). The area in the shaded quadrants shows the output as a load (sinking power).



The heavy solid line illustrates the locus of possible operating points as a function of the output load. As shown by the horizontal portion of the line, the output voltage remains regulated at its programmed setting as long as the load current remains within the positive or negative current limit setting. A CV (constant voltage) status flag indicates that the output voltage is being regulated and the output current is within its limit settings.

Note that when the output current reaches either the positive or negative current limit, the unit no longer operates in constant voltage mode and the output voltage is no longer held constant. Instead, the power supply will now regulate the output current at its current limit setting. Either a LIM+

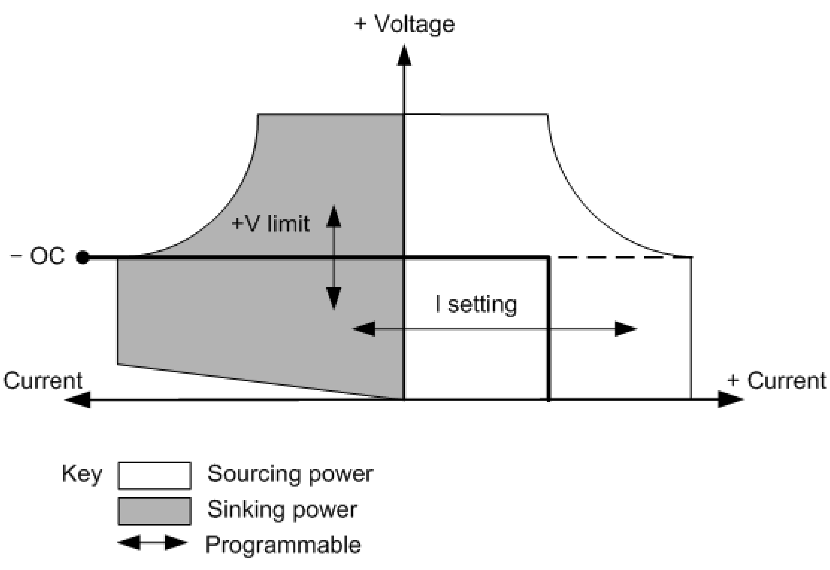
(positive current limit), or LIM– (negative current limit) status flag is set to indicate that a current limit has been reached. These conditions are annunciated by CL+ or CL- on the front panel.

As shown by the vertical portions of the load line, the output voltage may continue to increase in the positive direction or decrease in the negative direction as current is forced into or pulled out of the unit. When the output voltage exceeds the over-voltage protection setting, the output will shut down, the output relays will open, and the OV status bit will be set.

Current Priority

In current priority mode, the output is controlled by a bi-polar constant current feedback loop, which maintains the output source or sink current at its programmed setting. The output current remains at its programmed setting, provided the load voltage remains within the voltage limit setting. Current priority mode is best suited for use with batteries, power supplies, large charged capacitors, and loads that are sensitive to current overshoots. It minimizes current overshoots during programming, turn-on, and turn-off transitions and seamlessly transitions between positive and negative currents.

In current priority mode, the output current should be programmed to the desired positive or negative value. A positive voltage limit value should also be set. The voltage limit should always be set to a value that is greater than the actual output voltage requirement of the external load. The following figure shows the current priority operating locus of the output. The area in the white quadrants shows the output as a source (sourcing power). The area in the shaded quadrants shows the output as a load (sinking power).



The heavy solid line illustrates the locus of possible operating points as a function of the output load. As shown by the vertical portion of the line, the output current remains regulated at its programmed setting as long as the output voltage remains within its limit setting. A CC (constant current) status flag indicates that the output current is being regulated and the output voltage is within its limit settings.

Note that when the output voltage reaches the voltage limit, the unit no longer operates in constant current mode and the output current is no longer held constant. Instead, the power supply will now regulate the output voltage at its voltage limit setting. A LIM+ (positive voltage limit) status flag is set to indicate that the voltage limit has been reached. This condition is annunciated by VL+ on the front panel.

As shown by the horizontal portion of the load line, when the unit is sinking power, the output current may continue to increase in the negative direction as more current is forced into the unit. This can happen when the load is a power source such as a battery, and its output voltage is higher than the voltage limit setting of the power supply. Once the current exceeds the built-in negative over-current limit, the output will shut down, the output relays will open, and the OC status bits will be set. In such a case, it is important to set the voltage limit properly in order prevent this protection shutdown.

NOTE For additional information on priority mode operation during output turn-on/turn-off, refer to Turn-On Turn-Off Behavior.

5
SCPI Programming Reference

KEYSIGHT TECHNOLOGIES

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.

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.

Regenerative Power System Documentation

The latest version of this document can be downloaded at www.keysight.com/find/RPS-doc.

For detailed information about interface connections, refer to the Keysight Technologies USB/LAN/GPIB Interfaces Connectivity Guide, included with the Keysight IO Libraries Suite. Or you can download the guide from the Web at www.keysight.com/find/connectivity.

Web Interface

The RPS 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.

Example Programs

There are several example programs on the product page Web site at www.keysight.com/find/RPS. These are application-focused programs that demonstrate different programming environments.

SCPI Introduction

Introduction

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.

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:

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
      :DELay
            :FALL <value>|MIN|MAX
            :RISE <value>|MIN|MAX
      :INHibit
            :MODE LATChing|LIVE|OFF
```

Keywords

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

OUTPut is the root keyword, DELay is a second-level keyword, FALL and RISE are third-level keywords. 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 previously set OUTPut:DELay:FALL time by sending:

```
OUTPut:DELay:FALL?
```

You can also query the minimum or maximum allowable fall time as follows:

```
OUTPut:DELay:FALL? MIN
OUTPut:DELay:FALL? 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. If a command requires more than one parameter, use a comma to separate adjacent parameters. In the following example, the optional *startindex* and *points* parameters must be separated with a comma. Note the space between CURRent? and the first parameter.

```
FETCh:CURRent? [<start_index>, <points>]
```

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;DELay:RISE 1;FALL 2
```

is the same as sending the following commands:

```
OUTPut ON
OUTPut:DELay:RISE 1
OUTPut:DELay;FALL 2
```

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 DELay keyword after the semicolon, since DELay is a second-level keyword. Next, the command parser is placed at the third level in the hierarchy by the :RISE keyword. This allows the use of the FALL keyword after the second semicolon, since FALL is a third-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 OUTPut:DELay syntax statements shown above, 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: "OUTP:DEL:FALL 0.1") unless you select another option shown in the syntax (Example: "OUTP:DEL:FALL MIN").
- A vertical bar (|) separates multiple parameter choices for a given command string. For example, LATChing|LIVE|OFF in the OUTPut:INHibit command indicates that you can specify "LATChing", "LIVE", or "OFF". 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. In the case of an optional parameter, if you do not specify a value for an optional parameter the instrument will ignore the parameter. In the FETCh:CURRent? example above, the optional <startindex> and <points> parameters let you return array data starting at startindex and containing the specified number of data points. If these parameters are not specified, the query returns all of the array data.
- Braces ({ }) indicate parameters that may be repeated zero or more times. It is used especially for showing lists. The notation <value>{,<value>} shows that the first value must be entered, while additional values may be omitted or may be entered one or more times.

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, MAXimum, and INFinity 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:

```
DISPlay:VIEW METER_VI|METER_VP|METER VIP
```

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:

```
DISPlay 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"
```

Arbitrary Block Program or Response Data

Definite-length block data <Block> allows any type of device-dependent data to be programmed or returned as a series of 8-bit binary data bytes. This is particularly useful for transferring large quantities of data or 8-bit extended ASCII codes.

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.

Typical Command Processing Times

The following table documents some typical, average command processing times for several types of setting commands and response queries. This can help you determine the impact of some commonly used SCPI commands on total test time. All times are in milliseconds.

Setting commands like VOLT <n> only account for the IO latency + command processing, not the time for the action to complete (like the output voltage to finish changing or output state completing turn on).

Query command times apply from when the command was sent to the instrument until the response is received.

Commands	GPIB	VXI-11
Set the output voltage: VOLT <n>	0.24 ms	0.65 ms
Return the output setting: OUTP?	0.30 ms	1.35 ms
Set the unit to the reset state: *RST	5.01 ms	5.26 ms
10 point measurement		
Return 10 point measurement: MEAS:VOLT?	3.00 ms	3.30 ms
Return 10 point fetch: FETC:VOLT?	0.49	1.49 ms
1 NPLC measurement		
Return 1 NPLC measurement: MEAS:VOLT?	21.03 ms	20.96 ms
Return 1 NPLC fetch: FETC:VOLT?	0.63 ms	1.41 ms
25 k point measurement		
Return 25 k point measurement: MEAS:VOLT?	521.0 ms	521.1 ms
Return 25 k point fetch: FETC:VOLT?	5.07 ms	7.01 ms
Return 25 k point ASCII array fetch: FETC:ARR:VOLT?	4009.5 ms	1010.8 ms
Return 25 k point binary array fetch: FETC:ARR:VOLT?	694.25 ms	30.39

Commands by Subsystem

ABORt Subsystem

Abort commands cancel any triggered actions and returns the trigger system back to the Idle state. Abort commands are also executed with the *RST command.

ABORt:ACQuire
ABORt:ELOG
ABORt:TRANsient

ABORt:ACQuire - Cancels any triggered measurements. It also resets the WTG-meas and MEAS-active bits in the Operation Status registers.

ABORt:ELOG - Stops external data logging. It also resets the WTG-meas and MEAS-active bits in the Operation Status registers.

ABORt:TRAN - Cancels any triggered actions. It also resets the WTG-tran and TRAN-active bits in the Operation Status registers. 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.

Parameter	Typical Return
(none)	(none)
Aborts the triggered measurement: ABOR:ACQ	

ARB Subsystem

ARB commands program the constant-dwell arbitrary waveforms. Constant-dwell waveforms can have up to 65,535 points assigned to them, with the same dwell time for each point.

[SOURce:]ARB:COUNt <*value*>|MIN|MAX|INFinity
[SOURce:]ARB:COUNt? [MIN|MAX]

Specifies the number of times the Arb repeats. Use the INFinity parameter to repeat the Arb continuously.

Parameter	Typical Return
1 – 256, *RST 1	<count>
Programs a repeat count of 10: ARB:COUN 10	

[SOURce:]ARB:CURRent:CDWell[:LEVel] <*value*>{,<*value*>}|<*Block*>
[SOURce:]ARB:CURRent:CDWell[:LEVel]?
[SOURce:]ARB:VOLTage:CDWell[:LEVel] <*value*>{,<*value*>}|<*Block*>
[SOURce:]ARB:VOLTage:CDWell[:LEVel]?

Specifies the level of each point in the Arb. Values are specified in either amperes or volts. The minimum and maximum values depend on the ratings of the unit.

Current and voltage Arbs share settings, so setting the current Arb resets the voltage Arb level to its default value and vice versa. For better performance, the list can be sent as single precision floating point values in definite length arbitrary block format instead of an ASCII list. The response format is dependent on the return format ASCII or REAL.

Parameter	Typical Return
-102% to 102% of current rating or 0 to 102% of voltage rating	<value> [,<value>] or <Block>
Programs a constant dwell Arb of 5 voltage points:ARB:VOLT:CDW 5,4,3,2,1	

[SOURce:]ARB:CURRent:CDWell:DWELl <*value*>
[SOURce:]ARB:CURRent:CDWell:DWELl?
[SOURce:]ARB:VOLTage:CDWell:DWELl <*value*>
[SOURce:]ARB:VOLTage:CDWell:DWELl?

Specifies the dwell time of each point in the Arb. Values are in seconds and are rounded to the nearest 10.24-microsecond increment.

Current and voltage Arbs share settings, so setting this parameter for a current Arb changes the voltage dwell value and vice versa.

Parameter	Typical Return
0.00001024 – 0.30, *RST 0.001	<dwell value>
Programs a constant dwell time of 0.2 seconds: ARB:CURR:CDW:DWEL 0.2	

- You can program dwell times that are much faster than the response time of the instrument. The "extra" points and dwell times can serve the purpose of smoothing the resultant waveshape.

[SOURce:]ARB:CURRent:CDWell:POINts?
[SOURce:]ARB:VOLTage:CDWell:POINts?

Returns the number of points in the Arb.

Parameter	Typical Return
(none)	<points>
Returns the number of current points in the Arb: ARB:CURR:CDW:POIN?	

[SOURce:]ARB:FUNCtion:TYPE CURRent|VOLTage
[SOURce:]ARB:FUNCtion:TYPE?

Specifies either a voltage or current Arb. Only one type of Arb may be output at a time. The selection must match the priority mode.

Parameter	Typical Return
CURRent|VOLTage, *RST VOLTage	VOLT or CURR
Specifies a voltage Arb: ARB:FUNC:TYPE VOLT	

[SOURce:]ARB:TERMinate:LAST 0|OFF|1|ON
[SOURce:]ARB:TERMinate:LAST?

Selects the output setting after the Arb ends. When ON (1), the output voltage or current remains at the last Arb value. The last Arb voltage or current value becomes the IMMediate value when the ARB completes. When OFF (0), and also when the Arb is aborted, the output returns to the settings that were in effect before the Arb started.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Terminate with the output at the last Arb value: ARB:TERM:LAST ON	

CALibrate Subsystem

Calibrate commands calibrate the instrument.

NOTE Read the calibration section before calibrating. Improper calibration reduces accuracy and reliability.

CALibrate:COUNt?

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

Parameter	Typical Return
(none)	<count>
Return the calibration count: CAL:COUN?	

CALibrate:CURRent[:LEVel] <*value*>

Calibrates the current programming and measurement. The value selects the range to calibrate.

Parameter	Typical Return
The maximum current of the output range.	(none)
Calibrates the current of the 10 A range: CAL:CURR 10	

CALibrate:CURRent:SHARing RP795xA, RP796xA

Calibrates the Imon signal for paralleled units.

Parameter	Typical Return
(none)	(none)
Calibrates the current sharing: CAL:CURR:SHAR	

CALibrate:CURRent:TC RP793xA, RP794xA

Calibrates the temperature coefficient.

Parameter	Typical Return
(none)	(none)
Calibrates the temperature coefficient: CAL:CURR:TC	

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: CAL:DATA 2.37E-2	

CALibrate:DATE <*"date"*>
CALibrate:DATE?

Enters the calibration date in nonvolatile memory. Enter any ASCII string up to 15 characters. The query returns the date.

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

CALibrate:LEVel P1\|P2\|P3
CALibrate:LEVel?

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

Parameter	Typical Return
P1|P2|P3	(none)
Selects the first calibration point: CAL:LEV P1	

- 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. This is the same as the Admin password.

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

- If the password is set to 0, password protection is removed and the ability to enter calibration mode is unrestricted. The as-shipped 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 Calibration Switches.
- This setting is non-volatile; it will not be changed by power cycling or *RST.

CALibrate:RESistance:BOUT RP795xA, RP796xA

Calibrates the bottom out resistance.

Parameter	Typical Return
(none)	(none)
Calibrates the bottom out resistance: CAL:RES:BOUT	

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 calibration constants into non-volatile memory: CAL:SAVE	

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, *RST OFF	0 or 1
<*password*> a numeric value up to 15 digits	(none)
Disable calibration: CAL:STAT OFF Enable calibration: CAL:STAT ON [,value]	

A password is required if <*password*> has been set to a non-zero value.

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

Calibrates the local voltage programming and measurement. The value selects the range to calibrate.

Parameter	Typical Return
The maximum voltage of the output range.	(none)
Calibrates the voltage of the 20 V range: CAL:VOLT 20	

CURRent Subsystem

Current commands program the output current of the instrument.

[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 or triggered current level when the output is operating in current priority 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. The minimum value is the most negative value.

Parameter	Typical Return
-102% to 102% of rating, *RST 0	<current level>
Sets the positive current limit to 2 A: `CURR:LIM 2`	

[SOURce:]CURRent:BWIDth:LEVel 0 | 1, <*value*>|MIN|MAX (RP793xA, RP794xA)
[SOURce:]CURRent:BWIDth:LEVel? [MIN|MAX]

Specifies the low-pass filter corner frequency applied to the programming setpoint signal with the indicated range of user-configurable setpoints. The value is in Hertz. The default frequency is optimized for maximum up-programming speed as well as the fastest transient response time. It can be reduced to compensate for output overshoots.

Parameter	Typical Return
0 | 1	0 or 1
10 to 5,000 all ranges	<pole frequency>
Sets the current bandwidth to 1, frequency 60 Hz: `CURR:BWID:LEV 1, 60`	

[SOURce:]CURRent:BWIDth:RANGe 0 | 1 (RP793xA, RP794xA)
[SOURce:]CURRent:BWIDth[:RANGe]?

Sets the current compensation. This lets you optimize output response time with inductive loads. These compensation modes only apply when the unit is operating in current priority mode.

0 - provides maximum up-programming speed and the fastest transient response time when the output inductance is restricted to small values.

1 - best suited for stability with a wide range of output inductances. Refer to Set the Output Bandwidth for specific inductive load limits.

Parameter	Typical Return
0 | 1, *RST 0	0 or 1
Sets the current bandwidth to 1: CURR:BWID 1	

[SOURce:]CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude] <*value*>|MIN|MAX [SOURce:]CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MIN|MAX] [SOURce:]CURRent:LIMit:NEGative[:IMMediate][:AMPLitude] <*value*>|MIN|MAX [SOURce:]CURRent:LIMit:NEGative[:IMMediate][:AMPLitude]? [MIN|MAX]

Sets the current limit when in voltage priority mode. Units are in amperes. The maximum value depends on the current rating of the unit. The minimum value is the most negative value.

Parameter	Typical Return
Positive: 0 to 102% of rating, *RST 1.02% of rating Negative: -102% of rating to 0, *RST -102% of rating	<+current limit> <–current limit>
Sets the positive current limit to 2 A: CURR:LIM 2 Sets the negative current limit to -2 A: CURR:LIM:NEG -2	

[SOURce:]CURRent:MODE FIXed|STEP|LIST|ARB [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.

LIST causes the output to follow the list values when a trigger occurs.

ARB causes the output to follow the arbitrary waveform values when a trigger occurs.

Parameter	Typical Return
FIXed|STEP|LIST|ARB, *RST FIXed	FIX, STEP, LIST, or ARB
Sets the current mode to Step: CURR:MODE STEP	

[SOURce:]CURRent:PROTection:DELay[:TIME] <*value*>|MIN|MAX [SOURce:]CURRent:PROTection:DELay[:TIME]? [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 255 milliseconds can be programmed, with a resolution of 1 millisecond.

Parameter	Typical Return
0 – 0.255, *RST 0.020 s	<delay value>
Sets the protection delay to 0.2 seconds: CURR:PROT:DEL 0.2	

- The operation of over-current protection is affected by the setting of the current protection delay start event, which is specified by CURRent:PROTection:DELay:STARt.

[SOURce:]CURRent:PROTection:DELay:STARt SCHange|CCTRans
[SOURce:]CURRent:PROTection:DELay:STARt?

Specifies what starts the over-current protection delay timer. **SCHange** starts the over-current delay whenever a command changes the output settings. **CCTRans** starts the over-current delay timer by any transition of the output into current limit mode.

Parameter	Typical Return
SCHange|CCTRans, *RST SCHange	SCH or CCTR
Selects the CCTRans delay mode: CURR:PROT:DEL:STAR CCTR	

[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 current limit, 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: CURR:PROT:STAT ON	

- An over-current condition can be cleared with OUTPut:PROTection:CLEar after the cause of the condition is removed.

[SOURce:]CURRent:SHARing[:STATe] 0|OFF|1|ON RP795xA, RP796xA
[SOURce:]CURRent:SHARing[:STATe]?

Enables or disables current sharing on paralleled units. This command must be sent to each unit that is paralleled. When enabled, the load current is shared equally among the paralleled outputs. The rear panel **Share** terminals must be connected; otherwise an error will occur.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
To enable current sharing: CURR:SHAR ON	

[SOURce:]CURRent:SLEW[:IMMediate] <*value*>|MIN|MAX|INFinity
[SOURce:]CURRent:SLEW[:IMMediate]? [MIN|MAX]

Sets the current slew rate. The slew rate is set in amps per second and affects all programmed current changes, including those due to the output state turning on or off. The slew rate can be set to any value between 0 and 9.9E+37. For very large values, the slew rate will be limited by the unit's listed programming speed and bandwidth. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37, *RST MAX	<max value>
Sets the output slew rate to 1 A per second: CURR:SLEW 1	

- The query returns the value that was sent. If the value is less than the minimum slew rate, the minimum value is returned. The resolution of the slew setting is the same as the minimum value, which can be queried using CURRent:SLEW? MIN. The exact value varies slightly according to calibration.

[SOURce:]CURRent:SLEW:MAXimum 0|OFF|1|ON
[SOURce:]CURRent:SLEW:MAXimum?

Enables or disables the maximum slew rate override. When enabled, the slew rate is set to its maximum value. When disabled, the slew rate is set to the immediate value set by the CURRent:SLEW command. Use CURRent:SLEW? MAX to query the maximum slew rate that was set.

Parameter	Typical Return
0|OFF|1|ON, *RST ON	0 or 1
Enable the maximum slew rate: CURR:SLEW:MAX ON	

- The CURRent:SLEW:MAX command is coupled to the CURRent:SLEW command. If CURRent:SLEW sets the rate to MAX or INFinity, CURRent:SLEW:MAX is enabled. If the slew rate is set to any other value, CURRent:SLEW:MAX is disabled.

DIGital Subsystem

Digital commands program the digital control port on the rear panel of the instrument.

[SOURce:]DIGital:INPut:DATA?

Reads the state of the digital control port. Returns the binary-weighted value of the state of pins 1 through 7 in bits 0 through 6 respectively.

Parameter	Typical Return
(none)	<bit value>
Reads the state of the digital control port: DIG:INP:DATA?	

[SOURce:]DIGital:OUTPut:DATA <*value*>
[SOURce:]DIGital:OUTPut:DATA?

Sets the state of the digital control port. This only affects the pins whose function has been set to Digital IO operation. The port has seven signal pins and a digital ground pin. In the binary-weighted value that is written to the port, the pins are controlled according to the following bit assignments:

Pin	1	2	3	4	5	6	7
Bit number	0	1	2	3	4	5	6
Decimal value	1	2	4	8	16	32	64

Bit values corresponding to digital port pins that are not configured as DIO are ignored.

Parameter	Typical Return
0 – 127, *RST 0	<bit value>
Programs pins 1, 3, and 5 on: DIG:OUTP:DATA?	

[SOURce:]DIGital:PIN<1-7>:FUNCtion <*function*>
[SOURce:]DIGital:PIN<1-7>:FUNCtion?

Sets the pin function. The functions are saved in non-volatile memory.

DIO	General-purpose ground-referenced digital input/output function.
DINPut	Digital input-only mode.
FAULt	Pin 1 functions as an isolated fault output. Pin 2 is common for pin 1
INHibit	Pin 3 functions as an inhibit input.
ONCouple	Pins 4 -7 synchronize the output On state.
OFFCouple	Pins 4 -7 synchronize the output Off state.
TINPut	A trigger input function.
TOUTput	A trigger output function

Parameter	Typical Return
DIO|DINPut|FAULt|INHibit|ONCouple|OFFCouple TINPut|TOUTput	DIO, DINP, FAUL, INH, ONC, OFFC, TINP, or TOUT
Sets pin 1 to FAULt mode: DIG:PIN1:FUNC FAUL	

[SOURce:]DIGital:PIN<1-7>:POLarity POSitive|NEGative [SOURce:]DIGital:PIN<1-7>:POLarity?

Sets the pin polarity. **POSitive** means a logical true signal is a voltage high at the pin. For trigger inputs and outputs, POSitive means a rising edge. **NEGative** means a logical true signal is a voltage low at the pin. For trigger inputs and outputs, NEGative means a falling edge. The pin polarities are saved in non-volatile memory.

Parameter	Typical Return
POSitive|NEGative	POS or NEG
Sets pin 1 to POSitive polarity: DIG:PIN1:POL POS	

[SOURce:]DIGital:TOUTput:BUS[:ENABle] 0|OFF|1|ON [SOURce:]DIGital:TOUTput:BUS[:ENABle]?

Enables or disables BUS triggers on digital port pins. This allows a BUS trigger to be sent to any digital port pin that has been configured as a trigger output. A trigger out pulse is generated when the state is on and a bus trigger is received. A BUS trigger is generated using the *TRG command.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable BUS triggered signals on the digital pins: CURR:TOUT:BUS ON	

- The query returns 0 (OFF) if the trigger signal will NOT be generated with a BUS trigger command, and 1(ON) if a trigger signal will be generated with a BUS trigger command.

DISPlay Subsystem

Display commands control the front panel display.

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	

DISPlay[:WINDow]:VIEW METER_VI|METER_VP|METER_VIP
DISPlay[:WINDow]:VIEW?

Selects the parameters to display on the front panel. METER_VI displays output voltage and current. METER_VP displays output voltage and power. METER_VIP displays output voltage, current, and power.

Parameter	Typical Return
METER_VI|METER_VP|METER_VIP, *RST METER_VI	METER_VI, METER_VP, or METER_VIP
To display voltage and power: DISP:VIEW METER_VP	

DISPlay:SAVer[:STATe] 0|OFF|1|ON
DISPlay:SAVer[:STATe]?

Turns the front panel screen saver on or off.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Turns the front panel screen saver on: DISP:SAV ON	

FETCh Subsystem

Fetch commands return measurement data that has been previously acquired. FETCh queries do not generate new measurements, but allow additional measurement calculations from the same acquired data. The data is valid until the next MEASure or INITiate command occurs.

FETCh[:SCALar]:CURRent[:DC]? [<*start_index*>, <*points*>]
FETCh[:SCALar]:VOLTage[:DC]? [<*start_index*>, <*points*>]
FETCh[:SCALar]:POWer[:DC]? [<*start_index*>, <*points*>]

Returns the averaged measurement. Values returned are either in amperes, volts, or watts.

Optional parameters specify a subset starting at <startindex> and of length <points>.

Parameter	Typical Return
[<startindex>] the start index [<points>] the number of points	<DC value>
Returns the measured DC current FETC:CURR?	

FETCh[:SCALar]:CURRent:ACDC?
FETCh[:SCALar]:VOLTage:ACDC?

Returns the RMS measurement (AC + DC). Values returned are either in amperes, or volts.

Parameter	Typical Return
(none)	<ACDC value>
Returns the measured RMS voltage FETC:VOLT:ACDC?	

FETCh[:SCALar]:CURRent:HIGH?
FETCh[:SCALar]:VOLTage:HIGH?

Returns the High level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Types.

Parameter	Typical Return
(none)	<HIGH value>
Returns the measured high level current FETC:CURR:HIGH?	

FETCh[:SCALar]:CURRent:LOW?
FETCh[:SCALar]:VOLTage:LOW?

Returns the Low level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Types.

Parameter	Typical Return
(none)	<LOW value>
Returns the measured low level voltage FETC:VOLT:LOW?	

FETCh[:SCALar]:CURRent:MAXimum?
FETCh[:SCALar]:VOLTage:MAXimum?
FETCh[:SCALar]:POWer:MAXimum]?
FETCh[:SCALar]:CURRent:MINimum?
FETCh[:SCALar]:VOLTage:MINimum?
FETCh[:SCALar]:POWer:MINimum]?

Returns the maximum or minimum value. Values returned are either in amperes, volts, or watts.

Parameter	Typical Return
(none)	<MIN value> <MAX value>
Returns the measured maximum current FETC:CURR:MAX? Returns the measured minimum voltage FETC:VOLT:MIN? Returns the measured maximum power FETC:POW:MAX?	

FETCh:AHOur? [IGNORE_OVLD]
FETCh:WHOur? [IGNORE_OVLD]

FETCh:AHOur? - Returns the accumulated amp-hours.

FETCh:WHOur? - Returns the accumulated watt-hours.

See Amp-Hour and Watt-Hour Measurements for details.

If any measurement sample was overrange, the query returns SCPI Not a Number (9.91E37). If the optional IGNORE_OVLD parameter is sent, the accumulated measurement will be returned even if some samples were outside of the measurement range.

Parameter	Typical Return
IGNORE_OVLD ignore overload measurements	<amp-hours> <watt-hours>
Returns the amp-hour measurement FETC:AHO? Returns the watt-hour measurement FETC:WHO?	

FETCh:ARRay:CURRent[:DC]? [<*start_index*>, <*points*>]
FETCh:ARRay:VOLTage[:DC]? [<*start_index*>, <*points*>]
FETCh:ARRay:POWer[:DC]? [<*start_index*>, <*points*>]

Returns the instantaneous measurement. Values returned are either in amperes, volts, or watts.

Optional parameters specify a subset starting at <startindex> and of length <points>.

The return format depends on the settings of the FORMat:BORDer and FORMat[:DATA] commands. When the data format is set to ASCII, returned values are comma separated. When the data format is set to REAL, data is returned as single precision floating point values in definite length arbitrary block response format.

Parameter	Typical Return
[<startindex>] the start index [<points>] the number of points	<value> [,<value>] or <Block>
Returns the measured current array FETC:ARR:CURR?	

FETCh:ELOG? <*maxrecords*>

Returns the most recent external datalog records. Data must be read from the buffer periodically to avoid the buffer overflowing. Whenever data is read using FETCh:ELOG? then that buffer space is made available in the instrument for storing more acquired data.

Maxrecords is the maximum number of records of datalog data that the controller will return.

The return format depends on the settings of the FORMat:BORDer and FORMat[:DATA] commands. When the data format is set to ASCII, returned values are comma separated. When the data format is set to REAL, data is returned as single precision floating point values in definite length arbitrary block response format.

Parameter	Typical Return
[<maxrecords>] the number of records returned (1 to 16,384)	<value> [,<value>] or <Block>
Returns 100 data records FETC:ELOG? 100	

FORMat Subsystem

FORMat commands specify the format for transferring measurement data.

FORMat[:DATA] ASCII|REAL
FORMat[:DATA]?

Specifies the format of the returned data. This is used by queries that can return a block of data. ASCII returns data as ASCII bytes in numeric format as appropriate. The numbers are separated by commas. REAL returns data in a definite length block as IEEE single precision floating point values. In this case the 4 bytes of each value can be returned in either big-endian or little-endian byte order, determined by the FORMat:BORDer setting.

Parameter	Typical Return
ASCII|REAL, *RST ASCII	ASCII or REAL
Sets the data format to ASCII: FORMat ASCII	

- The data format is used by a small sub set of queries that can return large quantities of data.

FORMat:BORDer NORMal|SWAPped
FORMat:BORDer?

Specifies how binary data is transferred. This only applies when the FORMat:DATA is set to REAL. NORMal transfers data in normal order. The most significant byte is returned first, and the least significant byte is returned last (big-endian). SWAPped transfers data in swapped-byte order. The least significant byte is returned first, and the most significant byte is returned last (little-endian).

Parameter	Typical Return
NORMal|SWAPped, *RST NORMal	NORM or SWAP
Sets the data transfer to Swapped: FORM:BORD SWAP	

- The byte order is used when fetching real data from SCPI measurements.

FUNCtion Command

[SOURce:]FUNCtion CURRent|VOLTage
[SOURce:]FUNCtion?

Sets the output regulation - voltage priority or current priority. In voltage priority mode, the output is controlled by a constant voltage feedback loop, which maintains the output voltage at its programmed setting. In current priority mode, the output is controlled by a constant current feedback loop, which maintains the output current at its positive or negative programmed setting.

Refer to Priority Mode Tutorial for more information.

Parameter	Typical Return
CURRent|VOLTage, *RST VOLTage	CURR or VOLT
Sets the output regulation to current priority: FUNC CURR	

HCOPy Subsystem

HCOPy commands return the display image.

HCOPy:SDUMp:DATA? [BMP|GIF|PNG]

Returns an image of the front panel display. The format may be specified by the optional parameter. If no format is specified, the format is determined by HCOPy:SDUMp:DATA:FORMat.

The response is a SCPI 488.2 definite length binary block of the form: #<nonzero digit><digits><8 bit data-bytes> where:
<nonzero digit> specifies the number of digits to follow,
<digits> specify the number of 8 bit data bytes to follow, and
<8 bit data bytes> contain the data to be transferred.

Parameter	Typical Return
[BMP|GIF|PNG]	<Block>
Returns the image in GIF format: HCOP:SDUM:DATA? GIF	

HCOPy:SDUMp:DATA:FORMat BMP|GIF|PNG
HCOPy:SDUMp:DATA:FORMat?

Specifies the format for front panel images returned.

Parameter	Typical Return
BMP|GIF|PNG, *RST PNG	BMP, GIF, or PNG
Specify GIF as the image format: HCOP:SDUM:DATA:FORM GIF	

IEEE-488 Common Commands

IEEE-488 Common commands generally control overall instrument functions, such as reset, status, and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk: *RST *IDN? *SRE 8.

*CLS

Clear status command. 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 registers, status byte, and error queue: *CLS	

*ESE <*value*>
*ESE?

Event status enable command and query. Sets the value in the enable register for the Standard Event Status group. Each set bit of the register enables a corresponding event. All enabled events are logically ORed into the ESB bit of the status byte. The query reads the enable register. Refer to Status Tutorial for more information.

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

- The value returned is the binary-weighted sum of all enabled bits in the register. For example, with bit 2 (value 4) and bit 4 (value 16) set, the query returns +20.
- 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.

*ESR?

Event status event query. Reads and clears the event register for the Standard Event Status group. The event register is a read-only register, which latches all standard events. Refer to Status Tutorial for more information.

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

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

*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)	Keysight Technologies,RP7951A,MY12345678,A.01.01
Return the instrument's identification string: *IDN?	

*OPC

Sets the OPC (operation complete) bit in the standard event register. This occurs at the completion of the pending 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, transients, output state changes, and output 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.

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.
- Other commands cannot be executed until this command completes.

*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 *OPT?	

*RCL <0-9>

Recalls a saved instrument state. This restores the instrument to a state that was previously stored in locations 0 through 9 with the *SAV command. All instrument states are recalled except: (1) the output state is set to OFF, (2) the trigger systems are set to the Idle state, (3) calibration is disabled, (4) all lists are set to their *RST values, and (5) the non-volatile settings are not affected.

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

- Location 0 is automatically recalled at power turn-on when the Output Power-On state is set to RCL 0.
- Stored instrument states are not affected by *RST.

*RST

Resets the instrument to pre-defined values that are either typical or safe. These settings are described in Reset State.

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

- *RST forces the ABORt commands. This cancels any measurement or transient actions presently in process. It resets the WTG-meas, MEAS-active, WTG-tran, and TRAN-active bits in the Operation Status registers.

*SAV <0-9>

Saves the instrument state to one of ten non-volatile memory locations. For safety reasons, when a saved state is recalled, the output state will be set to OFF.

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.
- Output state, List data, and the calibration state is NOT saved as part of the *SAV operation.
- Data saved in non-volatile memory, described under Non-Volatile Settings, is not affected by the *SAV command.
- When shipped, locations 0 through 9 are empty.

*SRE <*value*>
*SRE?

Service request enable command and query. This 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.

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

- 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.

*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: *STB?	

*TRG

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

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

*TST?

Self-test query. Performs a instrument self-test. If self-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)	0 (pass) or +1 (failed)
Perform self-test: *TST?	

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

*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. *WAI	

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

INITiate Subsystem

Initiate commands initialize the trigger system. This moves the trigger system from the "idle" state to the "wait-for- trigger" state; which enables the instrument to receive triggers. An event on the selected trigger source causes the trigger to occur.

INITiate[:IMMediate]:ACQuire
INITiate[:IMMediate]:ELOG
INITiate[:IMMediate]:TRANsient

INITiate:ACQuire - Initiates the measurement trigger system.

INITiate:ELOG - Initiates external data logging.

INITiate:TRANsient - Initiates the transient trigger system.

Parameter	Typical Return
(none)	(none)
Initiate the measurement-trigger system: INIT:ACQ	

- 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_meas bit in the operation status register to know when the instrument is ready.
- Use ABORt commands 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 output trigger system: INIT:CONT:TRAN ON	

- With initiate continuous disabled, the output trigger system must be initiated for each trigger using the INITiate:TRANsient command.
- ABORt:TRANsient does not turn off continuous triggers if INITiate:CONTinuous:TRANsient ON has been programmed. In this case, the trigger system will automatically re-initiate.

INSTrument Subsystem

Instrument commands program he Master/Slave function of the instrument. Master Slave operation is used when connecting a number of instruments in parallel to create a system with higher total current and, hence, higher power.

INSTrument:GROup:FUNCtion MASTer|SLAVe|NONe
INSTrument:GROup:FUNCtion?

Set the function of a unit in a master/slave configuration. This setting is saved in non-volatile memory.

MASTer – Configures the instrument as the master unit in a master/slave group.

SLAVe – Configures the instrument as a slave unit in a master/slave group.

NONE – disables the master/slave function. The unit operates independently.

Parameter	Typical Return
MASTer | SLAVe | NONE	MAST, SLAV, or NONE
Configures the instrument as the master INST:GRO:FUNC MAST	

INSTrument:GROup:MASTer:CONNect[:STATe] [,0|OFF|1|ON]

Instructs the master unit to connect to the previously discovered slave units. If the slave configuration on the bus matches the discovered one, the master will start normal operation. Otherwise the command will fail with an error, and all units will operate independently.

Parameter	Typical Return
optional 0|OFF|1|ON	0 or 1
Connect the master to the slave units INST:GRO:MAST:CONN	

INSTrument:GROup:MASTer:CONNect:DELay <*value*>|MIN|MAX
INSTrument:GROup:MASTer:CONNect:DELay? [MIN|MAX]

Set the delay after power-on before the master units attempts to connect to slave units. This only applies if the connect mode is set to AUTO. This setting is saved in-volatile memory.

Parameter	Typical Return
0 to 120 seconds	0
Configures the connection delay for 10 seconds INST:GRO:MAST:CONN:DEL 10	

INSTrument:GROup:MASTer:CONNect:MODE AUTO|MANual
INSTrument:GROup:MASTer:CONNect:MODE?

Specifies the connection mode of the master unit. This setting is saved in non-volatile memory.

AUTO – the master unit will try to connect to the previously discovered slaves at power-on.

MANual – the master will connect to the previously discovered slaves when it receives a connection command from the front panel or from INST:GROUP:MAST:CONN.

Parameter	Typical Return
AUTO | MANual	AUTO or MAN
Specifies automatic connection mode INST:GRO:MAST:CONN:MODE AUTO	

INSTrument:GROup:MASTer:DISCover

Instructs the master unit to discover all slave units connected to the master/slave bus.

Parameter	Typical Return
(none)	(none)
Discover all slave units INST:GRO:MAST:DISC	

INSTrument:GROup:MASTer:RESet

Resets the master-discovered slave configuration. It disconnects any slave-connected units and returns them to independent operation.

Parameter	Typical Return
(none)	(none)
Resets all slave units INST:GRO:MAST:RES	

INSTrument:GROup:SLAVe:ADDRess <*value*>

Sets the slave unit's bus address. Each slave unit in a master/slave group must have a unique bus address or bus communication will fail. This setting is saved in non-volatile memory.

Parameter	Typical Return
1 - 9	1
Set the slave unit's address to 1 INST:GRO:SLAV:ADDR 1	

LIST Subsystem

List commands program an output sequence of multiple voltage or current settings. A comma-delimited list of up to 512 steps may be programmed. Note that these commands only apply in the presently active priority mode, either voltage priority or current priority.

[SOURce:]LIST:COUNt <*value*>|MIN|MAX|INFinity
[SOURce:]LIST:COUNt? [MIN|MAX]

Sets the list repeat count. This sets the number of times that a list is executed before it completes. The count range is 1 through 4096. Infinity runs the list continuously.

Parameter	Typical Return
1 – 4096, *RST 1	<count>
Sets the list count to 10: LIST:COUN 10	

[SOURce:]LIST:CURRent[:LEVel] <*value*>{,<*value*>}
[SOURce:]LIST:CURRent[:LEVel]?
[SOURce:]LIST:VOLTage[:LEVel] <*value*>,{<*value*
[SOURce:]LIST:VOLTage[:LEVel]?

Specifies the setting for each list step. Values are specified in either amperes or volts.

Parameter	Typical Return
Voltage: 0 to 102% of rating Current: -102% to 102% of rating	<list value 1>,<list value 2>,<list value 3>
Programs a current list. The list contains 3 steps: LIST:CURR 3,2,1 Programs a voltage list. The list contains 3 steps: LIST:VOLT 20,10,5	

[SOURce:]LIST:DWELl <*value*>{,<*value*>}
[SOURce:]LIST:DWELl?

Specifies the dwell time for each list step. Dwell time is the time that the output will remain at a specific step. Dwell times can be programmed from 0 through 262.144 seconds with the following resolution:

Range in seconds	Resolution
0 - 0.262144	1 microsecond
0.262144 - 2.62144	10 microseconds
2.62144 - 26.2144	100 microseconds
26.2144 - 262.144	1 millisecond

Parameter	Typical Return
0 – 262.144, *RST 1 ms	<list value 1>, <list value 2>, <list value 3>
Programs a dwell list. The list contains 3 steps: LIST:DWEL 0.2,0.8,1.6	

[SOURce:]LIST:CURRent:POINts?
[SOURce:]LIST:DWELl:POINts?
[SOURce:]LIST:VOLTage:POINts?
[SOURce:]LIST:TOUTput:BOSTep:POINts?
[SOURce:]LIST:TOUTput:EOSTep:POINts?

Returns the number of list points. Points are the same as steps. The queries do not return the point values.

Parameter	Typical Return
(none)	<points>
Returns the number of points in the dwell list: LIST:DWEL:POIN?	

[SOURce:]LIST:STEP ONCE|AUTO
[SOURce:]LIST:STEP?

Specifies how the list responds to triggers. ONCE causes the output to remain at the present step until a trigger advances it to the next step. Triggers that arrive during the dwell time are ignored. AUTO causes the output to automatically advance to each step, after the receipt of an initial starting trigger. Steps are paced by the dwell list. As each dwell time elapses, the next step is immediately output.

Parameter	Typical Return
ONCE|AUTO, *RST AUTO	ONCE or AUTO
Specifies the list steps to be paced by trigger signals: LIST:STEP ONCE	

[SOURce:]LIST:TERMinate:LAST 0|OFF|1|ON
[SOURce:]LIST:TERMinate:LAST?

Determines the output value when the list terminates. When ON (1), the output voltage or current remains at the last list step. The value of the last voltage or current list step becomes the IMMediate value when the list completes. When OFF (0), and also when the list is aborted, the output returns to the settings that were in effect before the list started.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Terminate with the output at the last step value: LIST:TERM:LAST ON	

[SOURce:]LIST:TOUTput:BOSTep[:DATA] 0|OFF|1|ON {,0|OFF|1|ON}
[SOURce:]LIST:TOUTput:BOSTep[:DATA]?
[SOURce:]LIST:TOUTput:EOSTep[:DATA] 0|OFF|1|ON {,0|OFF|1|ON}
[SOURce:]LIST:TOUTput:EOSTep[:DATA]?

Specifies which list steps generate a trigger signal at the beginning of step (BOSTep) or end of step (EOSTep). A trigger is only generated when the state is set to ON. The trigger signal can be used as a trigger source for measurements and transients of other units, and for digital port pins configured as trigger outputs.

Parameter	Typical Return
0|OFF|1|ON	0 or 1
To generate triggers at the beginning of the second step of a 3-step list: LIST:TOUT:BOST OFF,ON,OFF	

LXI Subsystem

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	

LXI:MDNS[:STATe] 0|OFF|1|ON
LXI:MDNS[:STATe]?

Sets the MDNS state on or off.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
To set the MDNS state on: LXI:MDNS ON	

MEASure Subsystem

Measure commands measure the output voltage or current. They trigger the acquisition of new data before returning the reading. Measurements are performed by digitizing the instantaneous output voltage or current for a specified measurement time, storing the results in a buffer, and calculating the value for the specified measurement type.

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

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

Parameter	Typical Return
(none)	<DC value>
Returns the measured DC current MEAS:CURR?	

MEASure[:SCALar]:CURRent:ACDC?
MEASure[:SCALar]:VOLTage:ACDC?

Initiates, triggers, and returns the total RMS measurement (AC + DC). Values returned are either in amperes, or volts.

Parameter	Typical Return
(none)	<ACDC value>
Returns the measured RMS voltage MEAS:VOLT:ACDC?	

MEASure[:SCALar]:CURRent:HIGH?
MEASure[:SCALar]:VOLTage:HIGH?

Initiates, triggers, and returns the High level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Types.

Parameter	Typical Return
(none)	<HIGH value>
Returns the measured high level current MEAS:CURR:HIGH?	

MEASure[:SCALar]:CURRent:LOW?
MEASure[:SCALar]:VOLTage:LOW?

Initiates, triggers, and returns the Low level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Types.

Parameter	Typical Return
(none)	<LOW value>
Returns the measured low level voltage MEAS:VOLT:LOW?	

MEASure[:SCALar]:CURRent:MAXimum?
MEASure[:SCALar]:VOLTage:MAXimum?
MEASure[:SCALar]:POWer:MAXimum?
MEASure[:SCALar]:CURRent:MINimum?
MEASure[:SCALar]:VOLTage:MINimum?
MEASure[:SCALar]:POWer:MINimum?

Initiates, triggers, and returns the maximum or minimum values of a measurement. Values returned are either in amperes, volts, or watts.

Parameter	Typical Return
(none)	<MIN value>, <MAX value>
Returns the measured maximum current MEAS:CURR:MAX? Returns the measured minimum voltage MEAS:VOLT:MIN? Returns the measured maximum power MEAS:POW:MAX?	

MEASure:ARRay:CURRent[:DC]?
MEASure:ARRay:VOLTage[:DC]?
MEASure:ARRay:POWer[:DC]?

Initiates and triggers a measurement; returns a list of the digitized output measurement samples. Values returned are either in amperes, volts, or watts.

The return format depends on the settings of the FORMat:BORDer and FORMat[:DATA] commands. When the data format is set to ASCII, returned values are comma separated. When the data format is set to REAL, data is returned as single precision floating point values in definite length arbitrary block response format.

Parameter	Typical Return
(none)	<value> [,<value>] or <Block>
Returns the measured current array MEAS:ARR:CURR?	

OUTPut Subsystem

The Output subsystem controls the output state, power-on, protection, and relay functions.

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

Enables or disables the output. The state of a disabled output is a condition of zero output voltage and zero source current. If a Keysight SD1000A SDS is connected, the SDS relays will open when the output is disabled and close when the output is enabled.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Turns the output off: OUTP OFF	

- When output is enabled, the front-panel status indicator changes from **OFF** to indicate the operating status of the instrument (**CV**, **CC**, etc.).
- Separate delays can be programmed for the off-to-on and the on-to-off transition using OUTPut:DELay:RISE and OUTput:DELay:FALL.
- Because of internal circuit start-up procedures, OUTPut ON may take 12 milliseconds to complete its function in voltage priority mode, and 14 milliseconds in current priority mode. If a Keysight SD1000A SDS is connected, the start-up will take longer (see Turn-On/Turn-Off Delays).

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

Enables or disables output coupling. Output coupling allows the outputs of multiple instruments to turn on and off sequentially according to their specified OUTPut:DELay:RISE and OUTput:DELay:FALL programming delays. This parameter is saved in non-volatile memory.

Parameter	Typical Return
0|OFF|1|ON	0 or 1
Turns the output coupling state on: OUTP:COUP ON	

- You must connect and configure the ONCouple and OFFCouple digital connector pins of all synchronized instruments as described in the Output Couple Control section.
- Because some power supplies have different minimum delay offsets, you must also specify a common delay offset for all of the synchronized units. This value must be the largest delay offset of the synchronized group. Use OUTPut:COUPle:MAX:DOFFset? to query the delay offset for each unit. The largest value returned must be specified as the common delay offset for each unit.

OUTPut[:STATe]:COUPle:DOFFset <*value*>|MIN|MAX
OUTPut[:STATe]:COUPle:DOFFset? [MIN|MAX]

Sets a delay offset to synchronize coupled output state changes. Units are in seconds. Setting this time to the maximum delay offset specified for any instrument that is being coupled will cause all coupled outputs to synchronize to the turn-on times specified by OUTPut:DELay:RISE. This parameter is saved in non-volatile memory.

Parameter	Typical Return
0 to 1.023	<delay value>
Specifies a delay of 60 milliseconds: OUTP:COUP:DOFF 0.06	

OUTPut[:STATe]:COUPle:MAX:DOFFset?

Returns the delay offset required for this instrument. As a minimum, the OUTPut:COUPle:DELay:OFFSet value must be set to the maximum delay offset returned for any coupled output.

Parameter	Typical Return
(none)	<offset value>
Returns the maximum delay offset: OUTP:COUP:MAX:DOFF?	

OUTPut[:STATe]:DELay:FALL <*value*>|MIN|MAX
OUTPut[:STATe]:DELay:FALL? [MIN|MAX]
OUTPut[:STATe]:DELay:RISE <*value*>|MIN|MAX
OUTPut[:STATe]:DELay:RISE? [MIN|MAX]

Specifies the delay in seconds that the instrument waits before turning the output on (rise) or off (fall). This allows multiple instruments to turn on or off in sequence. The output will not turn on or off until its delay time has elapsed. This command affects on-to-off state transitions. It does NOT affect transitions to off caused by protection functions. Delay times can be programmed with the following resolution:

Range in seconds	Resolution	Range in seconds	Resolution
0 to 1.023E−4	100 nanoseconds	1.03E−1 to 1.023E+0	1 millisecond
1.03E−4 to 1.023E−3	1 microsecond	1.03E+0 to 1.023E+1	10 milliseconds
1.03E−3 to 1.023E−2	10 microseconds	1.03E+1 to 1.023E+2	100 milliseconds
1.03E−2 to 1.023E−1	100 microseconds	1.03E+2 to 1.023E+3	1 second

Note that both Rise and Fall commands use the same resolution; which is determined by whichever delay time (fall or rise) is the longest.

Parameter	Typical Return
0 - 1023, *RST 0	<delay value>
Sets a delay of 0.5 s before turning the output on: OUTP:DEL:RISE 0.5	

- Each RPS model exhibits a minimum delay offset that applies from the time that a command to turn on the output is received until the output actually turns on. If you specify a turn-on delay, this delay will be added to the minimum delay offset, resulting in a turn-on delay that is actually longer than the one you programmed.
- Use OUTput:COUPle:MAX:DOFFset? to query the delay offset that is required for each instrument.

OUTPut[:STATe]:TMODE:COUPle 0|OFF|1|ON (RP793xA, RP794xA)
OUTPut:[:STATe]TMODE:COUPle?

When coupling is enabled, changing the turn-on setting also changes the turn-off setting and vice-versa. If the turn-on and turn-off settings are not the same and coupling is enabled, the turn-off setting will be changed to agree with the turn-on setting.

Parameter	Typical Return
0|OFF|1|ON	0 or 1
Couples the Turn-on/turn/off modes: OUTP:REL:LOCK ON	

OUTPut[:STATe]:TMODe[:OFF] HIGHZ | LOWZ (RP793xA, RP794xA)
OUTPut:TMODe:OFF?
OUTPut[:STATe]:TMODe:ON HIGHZ | LOWZ (RP793xA, RP794xA)
OUTPut:TMODe:ON?

These commands set the output turn-on and turn-off behavior to Low impedance or High impedance.

Low Impedance - programs the output voltage to zero, then disconnects the output. Maximum negative current sinking occurs for up to 250 ms during the turn-off transition.

High Impedance - disconnects the output without actively sinking current.

Parameter	Typical Return
HIGHZ|LOWZ	HIGHZ or LOWZ
Sets the turn-on state to high impedance: OUTP:TMOD:ON HIGHZ Sets the turn-off state to low impedance: OUTP:TMOD:OFF LOWZ	

- The turn-on/turn-off setting only applies when the RPS is operating in voltage priority mode. In current priority mode, the turn-on/turn-off behavior is always high impedance.

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 Programming the Digital Port.

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.

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

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

Sets the output power-on state. 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: OUTP:PON:STAT RST	

- If the power-on state is set to 0 with no state stored, a self-test error "file not found; 0 state" is generated and the instrument is set to the *RST state.
- If a master auto-connect command fails, the power-on state is set to *RST.

OUTPut:PROTection:CLEar

Resets the latched protection. This clears the latched protection status that disables the output when a protection condition occurs (see Programming Output Protection).

Parameter	Typical Return
(none)	(none)
Clears the latched protection status: OUTP:PROT:CLE	

- All conditions that generate the fault must be removed before the latched status can be cleared. The output is restored to the state it was in before the fault condition occurred.
- If a protection shutdown occurs during an output list, the list continues running even though the output is disabled. When the protection status is cleared and the output becomes enabled again, the output will be set to the values of the step that the list is presently at.

OUTPut:PROTection:TEMPerature:MARGin?

Returns the minimum difference between the internal temperature sensors and the over-temperature trip level. The margin is returned in degrees Celsius.

Parameter	Typical Return
(none)	<margin value>
Returns the temperature margin: OUTP:PROT:TEMP:MARG?	

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

Enables or disables the I/O watchdog timer. When enabled, the output will be disabled if there is no I/O activity on any remote interface within the time period specified by the OUTPut:PROTection:WDOG:DELay command. The output is latched off but the programmed output state is not changed.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the watchdog timer protection: OUTP:PROT:WDOG ON	

OUTPut:PROTection:WDOG:DELay <*value*>|MIN|MAX
OUTPut:PROTection:WDOG:DELay? [MIN|MAX]

Sets the watchdog delay time. When the watchdog timer is enabled, the output is disabled if there is no SCPI I/O activity on any remote interface (USB, LAN, GPIB) within the delay time. The watchdog timer function is NOT reset by activity on the front panel – the output will still shut down after the time period has elapsed. Programmed values can range from 1 to 3600 seconds in 1 second increments.

Parameter	Typical Return
0 - 3600, *RST 60 seconds	<delay value>
Sets a watchdog delay for 600 seconds: OUTP:PROT:WDOG:DEL 600	

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

Enables or disables the locked relay-state of the Keysight SD1000A Safety Disconnect System. When locked, the output relays of the SDS remain closed and do not change along with the output state of the power supply. This improves the output response time for applications that do not require a physical output disconnect during normal output on/off operation. This parameter is saved in non-volatile memory.

Parameter	Typical Return
0|OFF|1|ON	0 or 1
Locks the SDS relays closed: OUTP:REL:LOCK ON	

POWer Query

[SOURce:]POWer:LIMit?

Returns the power limit of the instrument in Watts, either 5 kW or 10 kW.

Parameter	Typical Return
None	5,000 or 10,000
Return the power limit: POWer:LIMit?	

SENSe Subsystem

Sense commands control the current measurement ranges and window as well as the data acquisition sequence.

SENSe:AHOur:RESet
SENSe:WHOur:RESet

Resets the amp-hour or watt-hour measurement to zero.

Parameter	Typical Return
(none)	(none)
Resets the amp-hour measurement: SENS:AHO:RES Resets the watt-hour measurement: SENS:WHO:RES	

SENSe:ELOG:FUNCtion:CURRent 0|OFF|1|ON
SENSe:ELOG:FUNCtion:CURRent?
SENSe:ELOG:FUNCtion:VOLTage 0|OFF|1|ON
SENSe:ELOG:FUNCtion:VOLTage?

Enables or disables the Elog current or voltage measurement function.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables datalog current measurements: SENS:ELOG:FUNC:CURR ON	

SENSe:ELOG:FUNCtion:CURRent:MINMax 0|OFF|1|ON
SENSe:ELOG:FUNCtion:CURRent:MINMax?
SENSe:ELOG:FUNCtion:VOLTage:MINMax 0|OFF|1|ON
SENSe:ELOG:FUNCtion:VOLTage:MINMax?

Enables or disables logging of the minimum and maximum current or voltage values.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables MIN/MAX logging values: SENS:ELOG:FUNC:VOLT:MINM ON	

SENSe:ELOG:PERiod <*value*>|MIN|MAX
SENSe:ELOG:PERiod? [MIN|MAX]

Sets the integration time of an Elog measurement.

Although the absolute minimum logging period is 102.4 microseconds, the actual minimum varies as a function of the number of readings that are being logged (see Integration Period).

Parameter	Typical Return
0.0001024 to 60, *RST MAX	<period>
Specifies a datalog period of 0.01 seconds: SENS:ELOG:PER 0.01	

SENSe:FUNCtion:CURRent 0|OFF|1|ON
SENSe:FUNCtion:CURRent?
SENSe:FUNCtion:VOLTage 0|OFF|1|ON
SENSe:FUNCtion:VOLTage?

Enables or disables current or voltage measurements.

Parameter	Typical Return
0|OFF|1|ON, *RST ON	0 or 1
Enables current measurements: SENS:FUNC:CURR ON Disables voltage measurements: SENS:FUNC:VOLT OFF	

SENSe:SWEep:NPLCycles <*value*>|MIN|MAX
SENSe:SWEep:NPLCycles? [MIN|MAX]

Sets the measurement time in number of power line cycles. Increasing the number of power line cycles reduces the measurement noise on current and voltage measurements. Changing the NPLC changes the number of points and time interval setting. The number of points in 1 NPLC depends on the line frequency setting (see SYSTem:LFR:MODE).

Parameter	Typical Return
0.0003072 to 1,258,290,000,000, *RST 1	<NPLC value>
Specifies 100 power line cycles: SENS:SWE:NPLC 100	

SENSe:SWEep:OFFSet:POINts <*value*>|MIN|MAX
SENSe:SWEep:OFFSet:POINts? [MIN|MAX]

Defines the offset in a data sweep for triggered measurements. Positive values represent the delay after the trigger occurs but before the samples are acquired. Negative values represent data samples taken prior to the trigger.

Parameter	Typical Return
–524,287 to 2,000,000,000, *RST 0	<offset points>
Specifies -2048 offset points: SENS:SWE:OFFS:POIN -2048	

SENSe:SWEep:POINts <*value*>|MIN|MAX
SENSe:SWEep:POINts? [MIN|MAX]

Defines the number of points in a measurement. The number of points depends on the line frequency (50 Hz or 60 Hz). The default number of points result in a measurement of 1 NPLC.

Parameter	Typical Return
1 to 524,288 MIN|MAX, *RST 3255 (60 Hz); 3906 (50 Hz)	<points>
Specifies 2048 points: SENS:SWE:POIN 2048	

SENSe:SWEep:TINTerval <*value*>|MIN|MAX
SENSe:SWEep:TINTerval? [MIN|MAX]

Defines the time period between measurement samples. Units are in seconds. Values are rounded to the nearest 20.48 microsecond increment. Below 20.48 microseconds, values are rounded to the nearest 10.24 or 5.12 microsecond increment respectively.

Parameter	Typical Return
0.00000512 to 40,000, *RST 0.00000512	<time interval>
Specifies an interval of 1 ms between points: SENS:SWE:TINT 0.001	

SENSe:WINDow[:TYPE] HANNing|RECTangular
SENSe:WINDow[:TYPE]?

Selects the measurement window. This sets a signal conditioning function used in scalar DC measurement calculations. Neither window function alters the instantaneous voltage or current data returned in the measurement array.

Hanning window is a "raised cosine" function. It is a signal conditioning function that reduces errors in DC measurement calculations in the presence of periodic signals such as AC line ripple. This window only works up to 4883 measurement points. The instrument will revert to a rectangular window when the points exceed 4883.

Rectangular window returns measurement calculations with no signal conditioning.

Parameter	Typical Return
HANNing|RECTangular, *RST RECTangular	RECT or HANN
Specifies a Hanning window function: SENS:WIND HANN	

[SOURce] Subsystem

The SOURce keyword is optional in many commands that set parameters for a source or output, such as [SOURce:]CURRent <value>.

Because SOURce subsystem commands are often used without the optional SOURce keyword, these commands are listed by their individual subsystems, below:

Subsystems and Commands Using the Optional [SOURce:] Keyword

ARB

CURRent

DIGital

FUNCtion

LIST

POWer:LIMit

STEP:TOUTput

VOLTage

STATus Subsystem

Status register programming lets 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.

The Status subsystem is also programmed using Common commands. 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/or PTR filter. Reading the Operation Status Event register clears it.

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

- The value returned is the binary-weighted sum of all enabled bits in the register. For example, with bit 3 (value 8) and bit 5 (value 32) set and enabled, the query returns +40.
- *RST has no effect on this 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 value returned is the binary-weighted sum of all enabled bits in the register. For example, with bit 3 (value 8) and bit 5 (value 32) set and enabled, the query returns +40.
- 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.

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

Sets the value of 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 corresponding to the binary-weighted sum of the register's bits.	<bit value>
Enable bit 3 and 4 in the enable register: STAT:OPER:ENAB 24	

- For example, with bit 3 (value 8) and bit 5 (value 32) set and enabled, the query returns +40.
- *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 corresponding to the binary-weighted sum of the register's bits.	<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 enabled bits in the register.

STATus:PRESet

Presets all Enable, PTR, and NTR registers.

Operation register	Questionable register	Preset setting
STAT:OPER:ENAB	STAT:QUES<1|2>:ENAB	all defined bits are disabled
STAT:OPER:NTR	STAT:QUES<1|2>:NTR	all defined bits are disabled
STAT:OPER:PTR	**STAT:QUES<1|2>:PTR**	all defined bits are enabled

Parameter	Typical Return
(none)	(none)
Preset the Operation and Questionable registers: STAT:PRES	

STATus:QUEStionable<1|2>[: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/or PTR filter. Reading the Questionable Status Event register clears it.

Parameter	Typical Return
(none)	<bit value>
Read questionable status event register #1: STAT:QUES1?	

- The value returned is the binary-weighted sum of all enabled bits in the register. For example, with bit 2 (value 4) and bit 4 (value 16) set, the query returns +20.
- *RST has no effect on this register.

STATus:QUEStionable<1|2>: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 #1: STAT:QUES1:COND?	

- The value returned is the binary-weighted sum of all enabled bits in the register. For example, with bit 2 (value 4) and bit 4 (value 16) set, the query returns +20.
- 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.

STATus:QUEStionable<1|2>:ENABle <*value*>
STATus:QUEStionable<1|2>:ENABle?

Sets the value of 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 corresponding to the binary-weighted sum of the register's bits.	<bit value>
Enable bit 2 and 4 in the questionable enable register #1: STAT:QUES1:ENAB 24	

- For example, with bit 2 (value 4) and bit 4 (value 16) set, the query returns +20.
- *CLS does not clear the enable register, but does clear the event register.

STATus:QUEStionable<1|2>:NTRansition <*value*>
STATus:QUEStionable<1|2>:NTRansition?
STATus:QUEStionable<1|2>:PTRansition <*value*>
STATus:QUEStionable<1|2>: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 corresponding to the binary-weighted sum of the register's bits.	<bit value>
Enable bit 3 and 4 in the questionable NTR register #1: STAT:QUES:NTR 24 Enable bit 3 and 4 in the questionable PTR register #1: 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 enabled bits in the register.

STEP Command

[SOURce:]STEP:TOUTput 0|OFF|1|ON
[SOURce:]STEP:TOUTput?

Specifies whether a trigger out is generated when a transient step occurs. A trigger is generated when the state is on (true).

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Sets the step trigger signal to ON: STEP:TOUT ON	

SYSTem Subsystem

System commands control system functions that are not directly related to output control, measurement, or status functions. Note that IEEE-488 Common commands also control system functions such as self-test, saving and recalling states, and others. SYSTem:SDS commands program the Keysight SD1000A Safety Disconnect System.

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)	<port #> (0 if sockets 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. **LOCal** sets instrument to front panel control. **REMote** sets the instrument to front panel control. **RWLock** disables the front panel keys. The instrument can only be controlled via the remote interface. This programmable setting is completely independent from the front panel lock/unlock function.

Parameter	Typical Return
LOCal|REMote|RWLock , *RST 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.
- When multiple remote programming interfaces are active, the interface with the most recently changed remote/local state determines the instrument's remote/local state.

SYSTem:DATE <*yyyy*>, <*mm*>, <*dd*>
SYSTem:DATE?

Sets the date of the system clock. Specify the year (2000 to 2099), month (1 to 12), and day (1 to 31). The real time clock is only used in conjunction with the Keysight 14585A Control and Analysis software.

Parameter	Typical Return
<yyyy,<mm>,<dd>	+2018,+04,+30
Set the date to June 30, 2018: SYST:DATE 2018,06,30	

- The real-time clock does not adjust itself for time zone changes or daylight savings time.

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:LFRequency?

Returns the power-line reference frequency. This determines the integration time used by SENSe:SWEep:NPLC command.

At power-on, if the line frequency mode is set to Auto, the power supply automatically detects the power-line frequency (50 Hz or 60 Hz) and uses this value to determine the integration time used.

If the auto line detect fails because the line is noisy or out of tolerance, it uses a setting of 60 Hz.

Parameter	Typical Return
(none)	50 or 60
Query the power line frequency: SYST:LFR?	

SYSTem:LFRequency:MODE AUTO|MAN50|MAN60
SYSTem:LFRequency:MODE?

Specifies automatic or manual line frequency detection.
AUTO specifies automatic detection.
MAN50 specifies a setting of 50 Hz.
MAN60 specifies a setting of 60 Hz.
This parameter is saved in non-volatile memory.

Parameter	Typical Return
AUTO|MAN50|MAN60	AUTO, MAN50, or MAN60
Sets the line frequency mode to 60 Hz: SYST:LFR:MODE MAN60	

SYSTem:PASSword:FPANel:RESet

Resets the front panel lockout password to zero. This command does not reset the calibration password.

Parameter	Typical Return
(none)	<+0,"No error">
Resets the front panel password: SYST:PASS:FPAN:RES	

SYSTem:REBoot

Reboots the instrument to its power-on state.

Parameter	Typical Return
(none)	(none)
Reboots the instrument: SYST:REB	

SYSTem:SDS:CONNect RP795xA, RP796xA

Connects the power supply to the Keysight SD1000A SDS unit. This command is used when the SDS connect mode is set to MANual.

Parameter	Typical Return
(none)	(none)
Connect the SDS unit: SYST:SDS:CONN	

SYSTem:SDS:CONNect:MODE AUTO|MANual RP795xA, RP796xA
SYSTem:SDS:CONNect:MODE?

Specifies the connection method to the SDS unit at turn-on. This setting is non-volatile.

AUTO - automatically connect the SDS unit to the power supply at turn-on.
MANual - wait for a front panel or SCPI command to connect the SDS to the power supply.

Parameter	Typical Return
AUTO|MANual	AUTO or MAN
Sets the connect mode to manual: SYST:SDS:CONN:MODE MAN	

SYSTem:SDS:DIGital:DATA:INPut? RP795xA, RP796xA

Returns the SDS input state. The bits indicate the state of the SDS external input signals.

Bit	Description	Bit	Description
0	Estop is activated, the power supply is inhibited	2	The remote start is active
1	The cover is open, the power supply is inhibited	3	The relay control mode is set to external

Parameter	Typical Return
(none)	<integer>
Return the state of the SDS inputs: SYST:SDS:DIG:DATA:INP?	

SYSTem:SDS:DIGital:DATA:OUTPut 0|1 RP795xA, RP796xA
SYSTem:SDS:DIGital:DATA:OUTPut?

Send an integer whose bits set the state of the SDS external output signals - either on or off. At present there is only one digital output signal available - on the DI/DO connector. This setting is volatile and is not part of the instrument saved state.

Parameter	Typical Return
0 | 1 , *RST 0	0 or 1
Sets the state of the external signals on: SYST:SDS:DIG:DATA:OUTP 1	

SYSTem:SDS:ENABle 0|OFF|1|ON RP795xA, RP796xA
SYSTem:SDS:ENABle?

The SDS must be enabled to allow the power supply to communicate with it. This is a non-volatile setting.

Parameter	Typical Return
0|OFF|1|ON	0 or 1
Enables the SDS unit: SYST:SDS:ENAB ON	

SYSTem:SDS:STATus? RP795xA, RP796xA

Returns the protection status of the SDS unit. The integer bits indicate the reason for the SDS protection.

Bit	Description
0	A power supply-to-SDS communication failure
1	AC contact fault - the AC contact input is not active
2	An Internal SDS hardware failure

These faults can only be cleared by turning off the power supply, correcting the problem and rebooting the power supply.

Parameter	Typical Return
(none)	<integer>
Return the status of the SDS unit: SYST:SDS:STAT?	

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 sanitizes all user data. It writes all zeros to flash memory and then performs a chip erase as per manufacturer's data sheet. Identification data (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:SET <block data>
SYSTem:SET?

Get and set the instrument state. The query form of the command returns a definite length block that contains the instrument state. This block data can be sent back to the instrument to restore it to the state in the block.

Parameter	Typical Return
<block data>	<block data>
Sends the block tate back to the instruemnt: SYST:SET <block data>	

SYSTem:TIME <hh>, <mm>, <ss>
SYSTem:TIME?

Sets the time of the system clock. Specify hours (0 to 23), minutes (0 to 59), and seconds (0 to 59). The real time clock is only used in conjunction with the Keysight 14585A Control and Analysis software.

Parameter	Typical Return
<hh>,<mm>,<ss>	<hh,mm,ss>
Set the clock to 8:30 PM: SYST:TIME2018,06,30	

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.

TRIGger Subsystem

Trigger commands control the transient and acquisition subsystems. Refer to Trigger Overview for more information.

TRIGger:ACQuire[:IMMediate]
TRIGger:ELOG[:IMMediate]
TRIGger:TRANsient[:IMMediate]

Generates an immediate trigger. This overrides any selected trigger source.

TRIGger:ACQuire triggers the acquisition system.

TRIGger:ELOG triggers the external datalogger.

TRIGger:TRANsient triggers the transient system.

Parameter	Typical Return
(none)	(none)
Generate a measurement trigger: TRIG:ACQ	

TRIGger:ACQuire:CURRent[:LEVel] <*value*>|MIN|MAX
TRIGger:ACQuire:CURRent[:LEVel]? [MIN|MAX]
TRIGger:ACQuire:VOLTage[:LEVel] <*value*>|MIN|MAX
TRIGger:ACQuire:VOLTage[:LEVel]? [MIN|MAX]

Sets the triggered level of the output. Applies when the measurement trigger source is set to a level. Values are specified in either amperes or volts. The minimum and maximum values depend on the ratings of the unit.

Parameter	Typical Return
Voltage: 0 to 102% of rating, *RST 0 Current: -102% to 102% of rating	<level value>
Set the triggered current level to 3 A: TRIG:ACQ:CURR 3 Set the triggered voltage level to 50 V: TRIG:ACQ:VOLT 50	

TRIGger:ACQuire:CURRent:SLOPe POSitive|NEGative
TRIGger:ACQuire:CURRent:SLOPe?
TRIGger:ACQuire:VOLTage:SLOPe POSitive|NEGative
TRIGger:ACQuire:VOLTage:SLOPe?

Sets the slope of the signal. Applies when the measurement trigger source is set to a level. POSitive specifies a rising slope of the output signal. NEGative specifies a falling slope of the output signal.

Parameter	Typical Return
POSitive|NEGative, *RST POSitive	POS or NEG
Set current slope to negative (falling edge): TRIG:ACQ:CURR:SLOP NEG Set voltage slope to negative (falling edge): TRIG:ACQ:VOLT:SLOP NEG	

TRIGger:ACQuire:INDices[:DATA]?

Returns the indices into the acquired data where triggers were captured during the acquisition. The number of indices returned is the same as the value returned by TRIGger:ACQuire:INDices:COUNt?

Parameter	Typical Return
(none)	<time>
Returns the number of indices: TRIG:ACQ:IND?	

TRIGger:ACQuire:INDices:COUNt?

Returns the number of triggers captured during the acquisition.

Parameter	Typical Return
(none)	<time>
Return the number of triggers: TRIG:ACQ:IND:COUN?	

TRIGger:ACQuire:TOUTput[:ENABle] 0|OFF|1|ON
TRIGger:ACQuire:TOUTput[:ENABle]?

Enables measurement triggers to be sent to a digital port pin. The digital port pin must be configured as trigger output before it can be used as a trigger source (see External Trigger I/O).

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable sending measurement triggers to digital pins: TRIG:ACQ:TOUT ON	

TRIGger:ACQuire:SOURce *<source>*
TRIGger:ACQuire:SOURce?

Selects the trigger source for the acquisition system:

BUS	Selects a remote interface trigger command.
CURRent1	Selects an output current level.
EXTernal	Selects ALL digital port pins that have been configured as trigger sources.
PIN<1-7>	Selects a digital port pin configured as a trigger input.
TRANsient1	Selects the transient system as the trigger source.
VOLTage1	Selects an output voltage level.

Parameter	Typical Return
BUS|CURRent1 | EXTernal | PIN<1-7> | TRANsient1 | VOLTage1, *RST BUS	BUS, CURR1, EXT, PIN<n>, TRAN1, or VOLT1
Select digital port pin 1 as the measurement trigger source: TRIG:ACQ:SOUR PIN1	

TRIGger:ARB:SOURce <*source*>
TRIGger:ARB:SOURce?
TRIGger:ELOG:SOURce <*source*>
TRIGger:ARB:SOURce?
TRIGger:TRANsient:SOURce <*source*>
TRIGger:TRANsient:SOURce?

TRIG:ARB:SOURce – Selects the trigger source for arbitrary waveforms:

TRIG:ELOG:SOURce – Selects the trigger source for external data logging:

TRIG:TRANsient:SOURce – Selects the trigger source for the transient system:

BUS	Selects a remote interface trigger command.
EXTernal	Selects ALL digital port pins that have been configured as trigger sources.
IMMediate	Triggers the transient as soon as it is INITiated.
PIN<1-7>	Selects a digital port pin configured as a trigger input.

Parameter	Typical Return
BUS | EXTernal | IMMediate | PIN<1-7> *RST BUS	BUS, EXT, IMM, PIN<n>
Select digital port pin 1 as the Arb trigger source: TRIG:ARB:SOUR PIN1 Select digital port pin 1 as the transient trigger source: TRIG:TRAN:SOUR PIN1	

VOLTage Subsystem

Voltage commands program the output voltage of the instrument.

[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 or triggered voltage level when the output is operating in voltage priority mode. The triggered level is the 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
0.1% to 102% of rating, *RST 0.1% of rating	<voltage level>
Sets the output voltage to 20 V: VOLT 20 Sets the triggered voltage to 10 V: VOLT:TRIG 10	

[SOURce:]VOLTage:BWIDth LOW|HIGH1 RP795xA, RP796xA
[SOURce:]VOLTage:BWIDth?

NOTE This command is provided for backward compatibility with previous RP795xA and RP796xA units. Newer units should use the VOLT:BWID:RANG command.

Sets the voltage compensation. This lets you optimize output response time with capacitive loads. These compensation modes only apply when the unit is operating in voltage priority mode.

LOW (0) is optimized for stability with a wide range of output capacitors.

HIGH1 (1) provides maximum up-programming speed as well as the fastest transient response time when the output capacitance is restricted to small values. Refer to Set the Output Bandwidth for specific capacitive load limits.

Parameter	Typical Return
LOW|HIGH1, *RST HIGH1	LOW or HIGH1
Sets the voltage bandwidth to Low: VOLT:BWID LOW	

[SOURce:]VOLTage:BWIDth:LEVel 0 | 1 | 2, <*value*>|MIN|MAX
[SOURce:]VOLTage:BWIDth:LEVel? 0 | 1 | 2, [MIN|MAX]

Sets the programming pole frequency associated with each voltage priority compensation range. The value is in Hertz. The default frequency is optimized for maximum up-programming speed as well as the fastest transient response time. It can be reduced to compensate for output overshoots.

For RP795xA and RP796xA units, you can only specify two compensation ranges 0 (Low) or 1 (High1).

Parameter	Typical Return
0 | 1 | 2	0, 1, or 2
10 to 100,000 for RP793xA and RP794xA all ranges 200 to 500,000 for RP795xA and RP796xA range 0 (Low) 17,000 to 500,000 for RP795xA and RP796xA range 1 (High1)	<pole frequency>
Sets the voltage bandwidth to 1, frequency 10 kHz: VOLT:BWID:LEV 1, 10,000	

[SOURce:]VOLTage:BWIDth:RANGe 0 | 1 | 2 RP793xA, RP794xA
[SOURce:]VOLTage:BWIDth:RANGe?

Sets the voltage compensation. This lets you optimize output response time with capacitive loads. These compensation modes only apply when the unit is operating in voltage priority mode. Refer to Set the Output Bandwidth for information about the effect that the compensation settings have on the Programming Speed Characteristics.

0 (High speed/Small capacitive load) – provides the fastest programming speed and transient response time.

1 (Medium speed/Medium capacitive load) – provides intermediate programming speed and transient response time. setting is optimized for stability with a wide range of output capacitors.

2 (Slow speed/Large capacitive load) – best suited for DUTs with high capacitance/low ESR with the trade-off of a slower programming speed and transient response.

Parameter	Typical Return
0 | 1 | 2, *RST 0	0, 1, or 2
Sets the voltage bandwidth to comp 1: VOLT:BWID:RANG 1	

[SOURce:]VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude] <*value*>|MIN|MAX
[SOURce:]VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MIN|MAX]

Sets the voltage limit when in current priority mode. Units are in volts.

Parameter	Typical Return
0.1% to 102% of rating, *RST 1% of rating	<voltage limit>
Sets the voltage limit to 20 V: VOLT:LIM 20	

[SOURce:]VOLTage:LIMit:LOW <*value*>|MIN|MAX
[SOURce:]VOLTage:LIMit:LOW? [MIN|MAX]

Sets the low voltage limit when in current priority mode. This prevents the voltage from dropping below the low voltage limit when discharging a battery. When the voltage drops to the specified low limit value, the output transitions from current priority to negative voltage limit and the discharging stops. This sets the LIM- bit in the Questionable Status Register.

Parameter	Typical Return
0 to 102% of rating, *RST 0	<low voltage limit>
Sets the low voltage limit to 2 V: VOLT:LIM:LOW 2	

- This command is coupled to the VOLTage:LIMit command. The voltage limit must always be programmed to a higher value than low voltage limit.
- The low voltage limit also prevents the output from turning on when the output voltage is below the programmed low voltage limit.

[SOURce:]VOLTage:MODE FIXed|STEP|LIST|ARB
[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.
LIST causes the output to follow the list values when a trigger occurs.
ARB causes the output to follow the arbitrary waveform values when a trigger occurs.

Parameter	Typical Return
FIXed|STEP|LIST|ARB, *RST FIXed	FIX, STEP, LIST, or ARB
Sets the voltage mode to Step: VOLT:MODE STEP	

[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 to 120% of rating, *RST 120% of rating	<protect level>
Sets the over-voltage protection to 24 V: VOLT:PROT 24	

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

[SOURce:]VOLTage:PROTection:LOW[:LEVel] <*value*>|MIN|MAX RP793xA, RP794xA
[SOURce:]VOLTage:PROTection:LOW[:LEVel] ? [MIN|MAX]

Prevents the output from turning on if the output voltage is below the low-voltage protection level. When the low-voltage condition is true, the Questionable Status Register UV bit is set.

Parameter	Typical Return
0 to 102% of rating, *RST 0	<low-voltage protect setting>
Sets the protection level to 2 V: VOLT:PROT:LOW 2	

[SOURce:]VOLTage:PROTection:LOW:DELay <*value*>|MIN|MAX RP793xA, RP794xA
[SOURce:]VOLTage:PROTection:LOW:DELay? [MIN|MAX]

Sets the low-voltage protection delay in seconds. The low-voltage protection function will not be triggered during the delay time. After the delay time has expired, the low-voltage protection function will be active. This can be used to prevent false tripping when protection is enabled, as well as momentary changes in output state from triggering the over-current protection function. The minimum delay is 20.48 microseconds, and a maximum delay of 2611 seconds.

Parameter	Typical Return
0.00002048 – 2611 seconds *RST 20.48 µs	<delay value>
Sets the protection delay to 0.2 seconds: VOLT:PROT:LOW:DEL 0.2	

[SOURce:]VOLTage:PROTection:LOW:STATe 0|OFF|1|ON RP793xA, RP794xA
[SOURce:]VOLTage:PROTection:LOW:STATe?

Enables or disables low-voltage protection.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the under-voltage protection state: VOLT:PROT:LOW:STAT ON	

- A low-voltage condition can be cleared with OUTPut:PROTection:CLEar after the cause of the condition is removed.

[SOURce:]VOLTage:RESistance[:LEVel][:IMMediate][:AMPLitude] <*value*>|MIN|MAX
[SOURce:]VOLTage:RESistance[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX]

Sets the output resistance level. Only applies in voltage priority mode. Units are in ohms. Refer to the RP793xA, RP794xA and RP795xA, RP796xA characteristics for the resistance programming ranges.

Parameter	Typical Return
0 to maximum (model dependent) | MIN | MAX, *RST 0	0
Specifies an output resistance of 0.5 ohms: VOLT:RES 0.5	

- Requires firmware version B.03.02.1232 and up for models RP793xA and RP794xA.
- When units are paralleledd, the programmable output resistance is reduced. The programmable output resistance for a single unit must be divided by the total number of paralleled units.

[SOURce:]VOLTage:RESistance:STATe 0|OFF|1|ON
[SOURce:]VOLTage:RESistance:STATe?

Enables or disables output resistance programming. Only applies in voltage priority mode.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Turns resistance programming on: VOLT:RES:STAT ON	

- Requires firmware version B.03.02.1232 and up for models RP793xA and RP794xA.

[SOURce:]VOLTage:SLEW[:IMMediate] <*value*>|MIN|MAX|INFinity
[SOURce:]VOLTage:SLEW[:IMMediate]? [MIN|MAX]

Sets the voltage slew rate. The slew rate is set in volts per second and affects all programmed voltage changes, including those due to the output state turning on or off. The slew rate can be set to any value between 0 and 9.9E+37. For very large values, the slew rate will be limited by the unit's listed programming speed and bandwidth. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37, *RST MAX	<max value>
Sets the output slew rate to 5 V per second: VOLT:SLEW 5	

- The query returns the value that was sent. If the value is less than the minimum slew rate, the minimum value is returned. The resolution of the slew setting is the same as the minimum value, which can be queried using VOLTage:SLEW? MIN. The exact value varies slightly according to calibration.

[SOURce:]VOLTage:SLEW:MAXimum 0|OFF|1|ON
[SOURce:]VOLTage:SLEW:MAXimum?

Enables or disables the maximum slew rate override. When enabled, the slew rate is set to its maximum value. When disabled, the slew rate is set to the immediate value set by the VOLTage:SLEW command. Use VOLTage:SLEW? MAX to query the maximum slew rate that was set.

Parameter	Typical Return
0|OFF|1|ON, *RST ON	0 or 1
Enable the maximum slew rate override: VOLT:SLEW:MAX ON	

- The VOLTage:SLEW:MAX command is coupled to the VOLTage:SLEW command. If VOLTage:SLEW sets the rate to MAX or INFinity, VOLTage:SLEW:MAX is enabled. If the slew rate is set to any other value, VOLTage:SLEW:MAX is disabled.

Status Tutorial

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

Status Registers

The Operation and Questionable status groups use four different types of registers to track qualify, flag, and enable instrument events. The Standard Event group only uses Event and Enable registers.

- 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.

- 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 transitions that pass through the PTR and NTR registers. When an event bit is set, it remains set until the Event register is read. Reading the Event register clears it.

- An Enable register defines which bits in the event register will be reported to the Status Byte register. You can write to or read from an enable register.

Operation Status Group

These registers record signals that occur during normal operation. The groups consist 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 Diagram.

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	WTG-meas	8	Measurement system is waiting for a trigger
4	WTG-tran	16	Transient system is waiting for a trigger
5	MEAS-active	32	Measurement system is initiated or in progress
6	TRAN-active	64	Transient system is initiated or in progress
7-15	not used	not used	0 is returned

Questionable Status Groups

These registers record signals that indicate abnormal operation. The groups consist of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Questionable Status groups are logically-ORed into the QUEStionable summary bit (3) of the Status Byte register. Refer to Status Diagram.

The following table describes the Questionable1 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 brownout on AC line)
3	CP+	8	Output is disabled by the positive over-power limit
4	OT	16	Output is disabled by the over-temperature protection
5	CP-	32	Output is disabled by the negative over-power limit
6	OV-	64	Output is disabled by a negative OV due to reversed sense leads
7	LIM+	128	Output is in positive voltage or current limit
8	LIM-	256	Output is in positive voltage or negative current limit
9	INH	512	Output is disabled by an external INHibit signal
10	UNR	1024	Output is unregulated
11	PROT	2048	Output is disabled by a watchdog timer protection
12	EDP	4096	Output is disabled by excessive output dynamic protection
13-15	not used	not used	0 is returned

The following table describes the Questionable2 assignments.

Bit	Bit Name	Decimal Value	Definition
0	not used	not used	0 is returned
1	IPK+	2	Output is in positive peak current limit
2	IPK-	4	Output is in negative peak current limit
3	CSF	8	A current sharing fault has occurred
4	MSP	16	Output is disabled by a master/slave protection
5	SDP	32	Output is disabled by a Safety Disconnect System protection
6	UV	64	An under-voltage protection has occurred.
7-15	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 Diagram.

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. Refer to Status Diagram.

The following table describes the Status Byte 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 SYSTem:ERRor? 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 STATus:QUEStionable:ENABle.
4	Message Available	16	Data is available in the instrument's output buffer.
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 Request for Service. 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.

Master Status Summary and Request for Service 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.

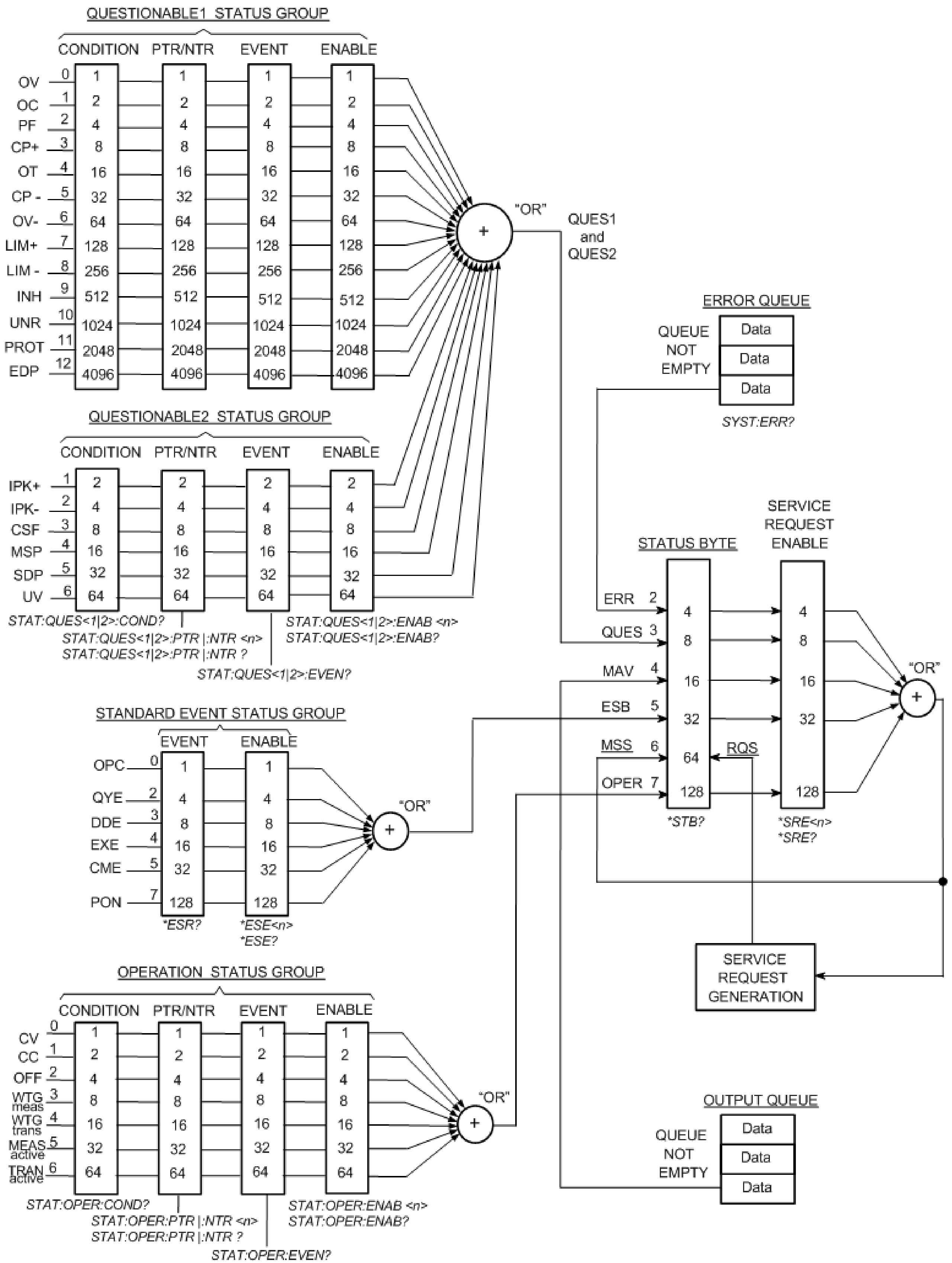
The RQS bit is a latched version of the MSS bit. Whenever the instrument requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller does a serial poll, RQS is cleared inside the register and returned in bit position 6 of the response. 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 messages until the controller reads them. Whenever the queue holds messages, it sets the MAV bit (4) of the Status Byte register.

Status Diagram



Trigger Tutorial

The RPS trigger system is a flexible, multi-purpose system that controls the operation of the instrument to suit a variety of user-defined applications. The trigger diagram below provides a graphical view of how the trigger sources and destinations are interconnected.

Trigger Sources

Trigger Destinations

Trigger Diagram

Trigger Sources

The following table describes the available trigger sources, which are shown on the left of the trigger diagram. Not all trigger sources can be applied to every trigger subsystem.

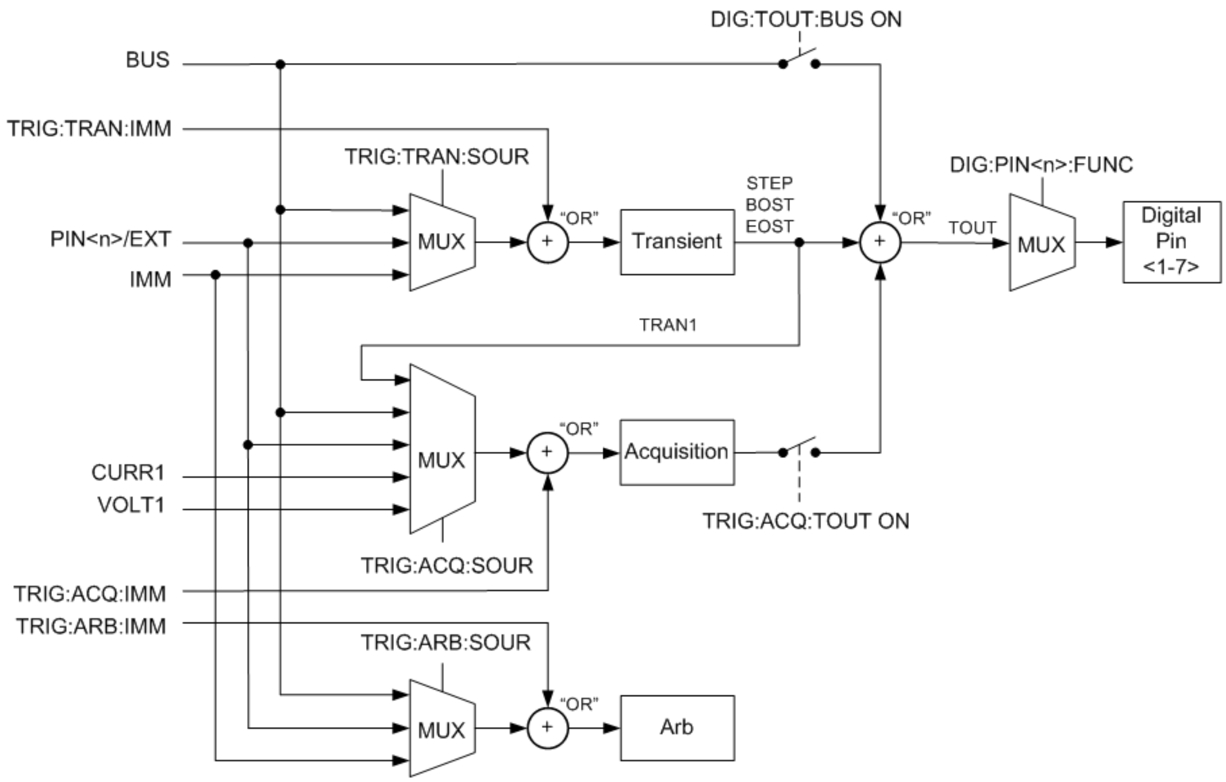
Source	Description
BUS	Enables GPIB device triggers, *TRG, or <GET> (Group Execute Trigger).
CURR1	Selects an output current level.
IMMediate	Triggers the transient as soon as it is INITiated.
PIN<n>|EXTernal	Selects a digital port pin configured as a trigger input. <n> specifies the pin number. EXTernal selects ALL connector pins that have been configured as trigger inputs.
TRAN1	Selects the transient system as the trigger source.
TRIG:ACQ:IMM	Triggers the acquisition immediately.
TRIG:TRAN:IMM	Triggers the transient immediately.
VOLT1	Selects an output voltage level.

Trigger Destinations

The following table describes the trigger system destinations.

Destination	Description
Digital pin	Sends the trigger to the designated digital pin. See Programming the Digital Port.
Transient system	Sends the trigger to the designated transient (STEP, BOST, EOST)
Acquisition system	Sends the trigger to the acquisition system (TOUT)
Arb	Starts the arbitrary waveform. Note that the waveform must first be enabled and initiated. See Programming Output Transients.

Trigger Diagram



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)..

Reset Settings

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

SCPI Command *RST Settings	
ARB:COUNt	1
ARB:CURRent:CDWell:DWELl	0.001
ARB:FUNCtion:SHAPe	CDW
ARB:FUNCtion:TYPE	VOLTage
ARB:TERMinate:LAST	OFF
ARB:VOLTage:CDWell:DWELl	0.001
CALibrate:STATe	OFF
CURRent	0
CURRent:LIMit	1.02% of rating
CURRent:LIMit:NEGative	-10.2% of rating
CURRent:MODE	FIXed
CURRent:PROTection:DELay	20 ms
CURRent:PROTection:DELay:STARt	SCHange
CURRent:PROTection:STATe	OFF
CURRent:SHARing	OFF
CURRent:SLEW	MAX
CURRent:SLEW:MAXimum	ON
CURRent:TRIGgered	0
DIGital:OUTPut:DATA	0
DIGital:TOUTput:BUS	OFF
DISPlay	ON

SCPI Command *RST Settings	
DIGital:OUTPut:DATA	0
DIGital:TOUTPut:BUS	OFF
FORMat:DATA	ASCII
FORMat:BORDer	NORMal
FUNCtion	VOLTage
INITialize:CONTinuous:TRANsient	OFF
LIST:COUNt	1
LIST:CURRent	1 step set to 0
LIST:DWELl	1 step set to 0.001
LIST:STEP	AUTO
LIST:TERMinate:LAST	OFF
LIST:TOUTput:BOSTep	1 step set to OFF
LIST:TOUTput:EOSTep	1 step set to OFF
LIST:VOLTage	1 step set to 0.1% of rating
LXI:IDENtify	OFF
LXI:MDNS	OFF
OUTPut	OFF
OUTPut:DELay:FALL	0
OUTPut:DELay:RISE	0
OUTPut:PROTection:WDOG	OFF
OUTPut:PROTection:WDOG:DELay	60
RESistance	0
RESistance:STATe	0
SENSe:CURRent:RANGe:AUTO	102.5% of rating
SENSe:FUNCtion:CURRent	1
SENSe:FUNCtion:VOLTage	1
SENSe:SWEep:NPLCycles	1
SENSe:SWEep:OFFSet:POINts	0
SENSe:SWEep:POINts	3255 (60 Hz); 3906 (50 Hz)

SCPI Command *RST Settings	
SENSe:SWEep:TINTerval	5.12E–6
SENSe:WINDow	RECTangular
STEP:TOUTput	OFF
TRIGger:ACQuire:CURRent	0
TRIGger:ACQuire:CURRent:SLOPe	POSitive
TRIGger:ACQuire:SOURce	BUS
TRIGger:ACQuire:TOUTput	OFF
TRIGger:ACQuire:VOLTage	0
TRIGger:ACQuire:VOLTage:SLOPe	POSitive
TRIGger:ARB:SOURce	BUS
TRIGger:TRANsient:SOURce	BUS
VOLTage	0.1% of rating
VOLTage:LIMit	1% of rating
VOLTage:MODE	FIXed
VOLTage:PROTection	120% of rating
VOLTage:RESistance	0
VOLTage:RESistance:STATe	OFF
VOLTage:SLEW	MAX
VOLTage:SLEW:MAXimum	ON
VOLTage:TRIGgered	0.1% of rating

Non-Volatile Settings

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

SCPI as-shipped settings	
CALibrate:DATE	empty string
CALibrate:PASSword	0
DIGital:PIN<all>:FUNCtion	DINput
DIGital:PIN<all>:POLarity	POSitive

SCPI as-shipped settings	
DISPlay:VIEW	METER_VI
INSTrument:GROup:FUNCtion	NONE
INSTrument:GROup:SLAVe:ADDRess	1
OUTPut:COUPle	OFF
OUTPut:COUPle:DOFFset	0
OUTPut:INHibit:MODE	OFF
OUTPut:PON:STATe	RST
OUTPut:RELay:LOCK	OFF
SYSTem:LFRequency:MODE	AUTO
SYSTem:SDS:DIGital:DATA:OUTPut	0
SYSTem:SDS:ENABle	OFF
Front Panel as-shipped settings	
Front panel lockout password	Disabled
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 GPIB Address	Automatic
Subnet mask	255.255.0.0
Default gateway	0.0.0.0
Host name	K-<serial number>
mDNS service name	Keysight RP79xxx Regenerative Power System <serial number>
LAN service - VXI-11	Enabled
LAN service - Telnet	Enabled

SCPI as-shipped settings	
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 front-panel ERR annunciator turns on when there are 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):

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.

104 Bad sequence of calibration commands

Calibration commands have not been entered in the proper sequence.

105 Unexpected output current

The measured output current is outside the acceptable range.

106 Zero measurement out of range error

The “zero” measurement value is outside the acceptable range.

107 Programming cal constants out of range

The programmed calibration constant is outside the acceptable range.

108 Measurement cal constants out of range

The measurement calibration constant is outside the acceptable range.

109 Over voltage cal constants out of range

The over voltage calibration constant is outside the acceptable range.

110 Wrong V+I

The instrument was unable to set the correct voltage or current value.

114 Wrong status

An incorrect status function has been reported.

116 Locked out by internal switch setting

This function has been locked out by an internal switch.

117 Calibration error

A calibration error has occurred. Do not save calibration constants. Try re-calibrating the unit.

200 Hardware error channel <1>

A hardware error has occurred on the output.

201 Invalid configuration

An invalid parallel or SDS configuration is not allowed.

202 Selftest Fail

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

203 Compatibility function not implemented

The requested compatibility function is not available.

204 NVRAM checksum error

A checksum error has occurred in the instrument's nonvolatile random access memory.

205 NVRAM full

The nonvolatile random access memory of the instrument is full.

206 File not found

The internal calibration file or the internal channel attribute file was not found in NVRAM.

207 Cal file version error

The calibration file was written or read using old firmware. Firmware must be updated.

208 Running backup firmware

The instrument is presently running the backup (previous) version of the firmware.

210 Frame NVRAM error

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

212 State file not loaded

A previously saved output state file has failed to load.

214 Line frequency error

A discrepancy has occurred between the line frequency and the line frequency setting.

215 Hardware failure

A hardware failure has occurred on the power supply

302 Option not installed

The option that is programmed by this command is not installed.

303 There is not a valid acquisition to fetch from

There is no valid data in the measurement buffer.

304 Volt and curr in incompatible transient modes

Voltage and current cannot be in Step and List mode at the same time.

305 A triggered value is on a different range

A triggered value is on a different range than the one that is presently set.

306 Too many list points

Too many list points have been specified.

307 List lengths are not equivalent

One or more lists are not the same length.

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.

310 The command is not supported by this model

This instrument either does not have the hardware capability or the options required to support this command.

315 Settings conflict error

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

316 Mass storage error

The mass storage memory has been exceeded.

317 Invalid format

An invalid data format was found in the command string.

320 Firmware update error

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

324 Inconsistent arb settings

The arb settings are inconsistent; most likely a mismatch in the arb lengths.

327 Initiated with no sense function enabled

A measurement has been initiated without specifying the measurement (sense) function.

328 Too many measurement points

Too many measurement points have been specified.

331 Illegal parameter value

The parameter value is out of range or does not exist.

332 Master/slave error

An error has occurred in the master/slave configuration

333 Safety Disconnect error

An error has occurred in the SDS unit.

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.

-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.

-160 Block data error

Generic block data error

-161 Invalid block data

The number of data bytes sent does not match the number of bytes specified in the header.

-168 Block data not allowed

Data was sent in arbitrary block format 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.

-226 Lists not same length

One or more lists are not the same length.

-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.

-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

This section describes the compatibility of the Keysight RPS7900-series with existing Keysight N7900-series Advanced Power Systems (APS). Because of their feature sets, only programs written for the N7900 Advanced Power Systems are compatible with the Regenerative Power System (RPS) models. Note that not all features are common to both families.

APS code-compatible commands with RPS models

These Keysight N7900 APS commands are compatible with the RPS models.

N7900-series APS commands	Action or equivalence on RPS models
[SOURce] :RESistance <value> :STATe <Bool>	[SOURce] :VOLTage :RESistance <value> :STATe <Bool>

APS feature set comparison with RPS models

The following table compares the feature set of the Keysight N7900 APS models with the feature set of the RPS models

Feature	In N7900 APS models?
Two quadrant operation	Yes
Voltage and current priority operation	Yes
Voltage and current slew rates	Yes
Resistance programming (in voltage priority mode)	Yes
Output bandwidth selection (in voltage priority mode)	Yes
Output triggering	
Single step output change	Yes
Output list of up to 512 points	Yes
Constant-dwell arbitrary waveform – up to 64k points	Yes
Scalar measurements	
DC, RMS, High/Low, Min/Max current scalar measurements	Yes
DC, RMS, High/Low, Min/Max voltage scalar measurements	Yes
Average Power	Yes
Amp hours and Watt hours	Yes
Digitized measurements	
Simultaneous voltage and current measurements	Yes
Current, voltage, and power array data	Yes
External data logging	Yes

Feature	In N7900 APS models?
Trigger systems	
Measurements	Yes
Transients	Yes
Digital port pins	Yes
Output state	Yes
User defined protection	Yes
Black box events	Yes
Trigger routing	Yes
Protection functions	
Remote and local over-voltage	Yes
Over-current	Yes
Over-temperature	Yes
Excessive output dynamics	Yes
High Z/Low Z	Yes
User protection	Yes
Available auxiliary safety disconnect system	No
System features	
Digital port pins	Yes
Remote Inhibit/Fault output	Yes
Fan speed control	Yes
Coupled output On/Off	Yes
Two wire current sharing	Yes
Output Relay	Yes
Black Box recorders	Yes
Sense fault detection	Yes
Master/slave capability	No

6
Verification and Calibration

KEYSIGHT
TECHNOLOGIES

Test Equipment and Setups

Test Equipment

Measurement 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]	100 A (0.01Ω) 0.01%, TC=4ppm/ΩC 300 A (0.001Ω) 0.01%, TC=4ppm/ΩC 1000A, 0.1mΩ 0.02%, TC=25ppm/ΩC	Guildline 9230A/100 Guildline 9230A/300 Guildline 9230A/1000 or equivalent	V, C
Electronic load and source[2]	20 V, 800 A, 10 kW 80 V, 250 A, 10 kW 160 V, 125 A, 10 kW 500 V, 40 A, 10 kW 950 V, 20 A, 10 kW	Keysight RP7933A or RP7943A[3] Keysight RP7935A or RP7945A[3] Keysight RP7936A or RP7946A[3] Keysight RP7952A or RP7962A[3] Keysight RP7953A or RP7963A[3]	V
DC power supply[4]	80 V, 40 A	Keysight RP7935A/RP7945A[3] or equivalent	C
GPIB controller	Full GPIB capabilities	Keysight 82350B or equivalent	V, C
Oscilloscope	Sensitivity: 1 mV Bandwidth: 20 MHz Probe: 10:1 with RF tip Probe: 100:1 with RF tip	Keysight DSO6054A or equivalent Keysight 10073D Keysight 10076C	V
RMS Voltmeter	True RMS Bandwidth: 20 MHz Sensitivity: 100 µV	Rhode and Schwartz Model URE3 or equivalent	V
Differential Amplifier	Bandwidth: 20 MHz	LeCroy 1855A, DA1850A, or equivalent	V
Differential Probe	10:1/100:1 selectable	LeCroy DXC100A, or equivalent	V
Terminations	50Ω BNC termination		V

[1]V=Verification; C=Calibration
[2]Dependent on output voltage rating of the model being tested
[3]Dependent on the AC mains available at the test facility (either 208 VAC 3ø or 480 VAC 3ø)
[4]Required for calibration on models RP795xA/RP796xA only

Measurement Setups

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.

If you are using a Keysight 3458A DMM, you can set up the voltmeter to do this automatically. From the instrument's front panel, program 100 power line cycles per measurement. Press NPLC 100 ENTER. Additionally, turn on auto-calibration (ACAL) and the autorange function (ARANGE).

Current Shunt

The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

Electronic Load

Many of the test procedures require the use of a variable load capable of dissipating the required power. For all tests, a Keysight RP79xxA unit can be used as a load, provided that its voltage rating is equivalent to the unit under test. The RP79xxA load unit is considerably easier to use than load resistors.

Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures. To avoid contact with any high voltages during operation, use switches to connect, disconnect, or short the load resistors.

Also, if computer controlled test setups are used, the relatively slow (compared to computers and system voltmeters) settling times and slew rates of the RPS may have to be taken into account. "Wait" statements can be used in the test program if the test system is faster than the RPS.

Performance Verification

Introduction

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

Use the performance verification tests to verify that the unit under test (UUT) is operating normally and meets its published specifications. You can perform two different levels of performance verification tests:

- Performance Verification Tests An extensive set of tests that are recommended as an acceptance test when you first receive the instrument or after performing adjustments.
- Calibration-Tests These tests verify that the instrument is operating within its calibration limits.

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.

Keysight Technologies recommends that you repeat the performance verification tests at every calibration interval. 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 may be used to extend future calibration intervals.

Perform the verification tests before calibrating your power supply. If the instrument 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 the Recommended Test Equipment and Setups section for a list of the equipment and test setups required for verification. Also refer to the Measurement Setups section for information about connecting the voltmeter, current shunt, and load.

WARNING

SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

Always turn off the output when connecting or disconnecting any equipment on the sense or output terminals of the unit.

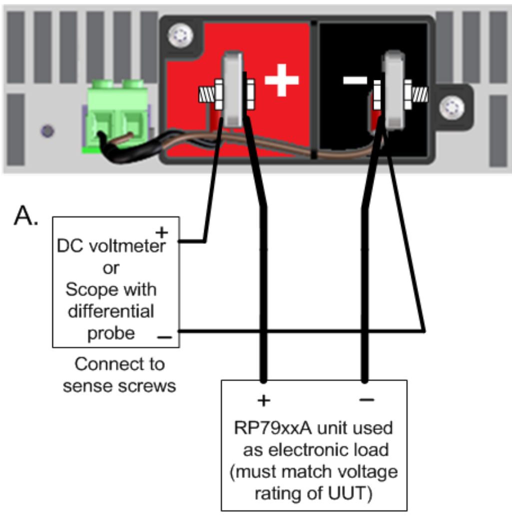
CAUTION

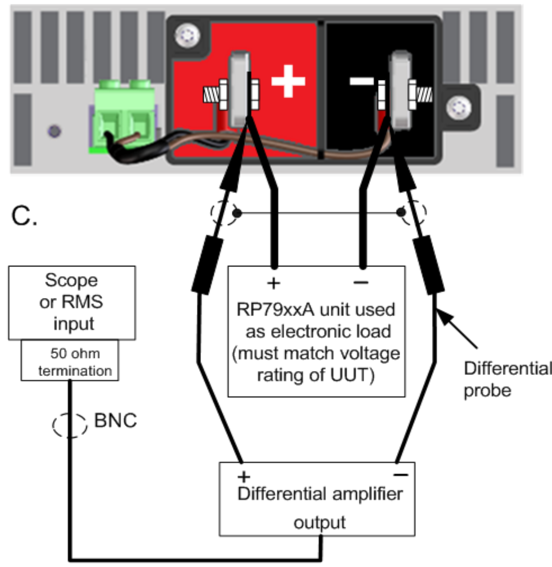
Equipment Damage It is recommended to set the overvoltage protection function of the instrument slightly higher than its operating point during the verification procedure. This will prevent damage to any external equipment (electronic load, differential amplifier) that may occur if the output voltage is accidentally programmed higher than the prescribed voltage setting.

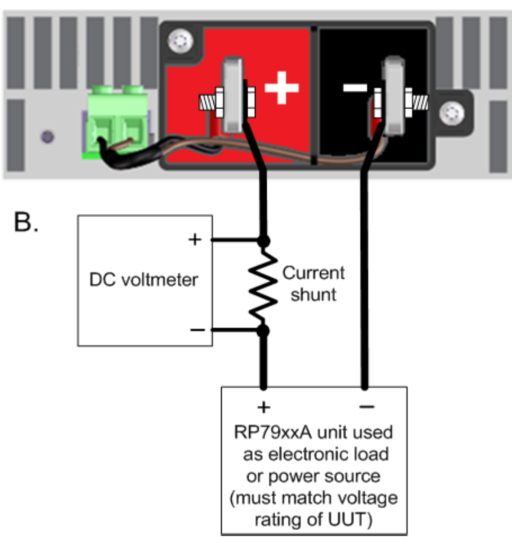
NOTE

Turn the unit off or send a Reset command after completing the verification procedure to return all instrument settings to their default values.

Verification Setups







RP79xxA unit under test	RP79xxA load unit
RP7931A/RP7941A	RP7933A/RP7943A
RP7932A/RP7942A	RP7935A/RP7945A
RP7933A/RP7943A	RP7933A/RP7943A
RP7935A/RP7945A	RP7935A/RP7945A
RP7936A/RP7946A	RP7936A/RP7946A
RP7951A/RP7961A	RP7952A/RP7962A
RP7952A/RP7962A	RP7952A/RP7962A
RP7953A/RP7963A	RP7953A/RP7963A

Test Considerations

For optimum performance, all verification and calibration procedures should comply with the following:

- Ambient temperature is stable, between 18 and 28 °C.
- Ambient relative humidity is less than 80%.
- 30 minute warm-up period before verification or adjustment.
- Cables as short as possible, twisted or shielded to reduce noise.

Verification Procedure

Voltage Programming and Readback Accuracy

This test verifies that the voltage programming and measurement functions are within specifications.

Step 1. Turn off the unit under test. Only connect the DMM to the sense screws (see Test Setup A). Do NOT connect the RP79xxA load unit.

Step 2. Turn on the unit under test and program the instrument settings as described in the test record form under “Voltage Programming & Readback, Min Voltage”. Turn the output on. The output status should be “CV”, with the output current close to zero.

Step 3. Record the output voltage reading from the DMM (Vout) and the voltage measured by the instrument 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 The next step applies the full output voltage of the unit under test to the output.

Step 4. Program the instrument settings as described in the test record form under “Voltage Programming & Readback, High Voltage”.

Step 5. Record the output voltage reading from the DMM (Vout) and the voltage measured by the instrument 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”.

Constant Voltage Load Effect

This test measures the change in voltage resulting from a change in current from full load to no load.

Step 1. Turn off the unit under test. Connect the DMM to the sense screws and connect the RP79xxA load unit. Make sure that the voltage rating of the RP79xxA load matches the voltage rating of the unit under test. (see Test Setup A).

Step 2. Turn on the unit under test and program the instrument settings as described in the test record form under “CV Load Effect”. Turn the output on.

Step 3. Set the RP79xxA load for the output current as described in the test record form under “CV Load Effect”. Turn the output on. The output status of the unit under test should be “CV”. If it isn’t, adjust the load so that the output current drops slightly.

Step 4. Record the output voltage reading from the DMM.

Step 5. Turn off the output of the RP79xxA load. 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 output voltage. This residual voltage is specified as the rms or peak-to-peak noise in the indicated frequency range (see RP793xA, RP794xA and RP795xA, RP796xA specifications).

Step 1. Turn off the unit under test. Connect the RP79xxA load unit, differential amplifier, and an oscilloscope (ac coupled) to the output (see Test Setup C). Make sure that the voltage rating of the RP79xxA load matches the voltage rating of the unit under test.

Step 2. As shown in the diagram, use the differential probes 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. For models RP795xA, RP796xA, set the probe to 1:100 and set the inputs of the differential amplifier to match the probe setting. For models RP794xA, RP795xA, set the probe to 1:10 and set the inputs of the differential amplifier to match the probe setting. Set the inputs to AC coupling. Set the input resistance to 1 MΩ. Set the oscilloscope’s time base to 5 ms/div, and set the vertical scale to the maximum sensitivity without clipping the waveform. Turn the bandwidth limit on (usually 20 MHz), and set the sampling mode to peak detect.

Step 4. Turn on the unit under test and program the instrument settings as described in the in the test record form under “CV Ripple and Noise”. Turn the output on. Program the RP79xxA load as shown in the test record card and turn the output on. Let the oscilloscope run for a few seconds to generate enough measurement points. On the Keysight Infiniium scope, the maximum peak-to-peak voltage measurement is indicated at the bottom of the screen on the right side. The result should not exceed the peak-to-peak limits in the test record form 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. Disconnect the oscilloscope and connect an rms voltmeter in its place. Do not disconnect the 50 ohm termination. Divide the reading of the rms voltmeter according to the differential amplifier setting. 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 50% change in the instrument's rated load current.

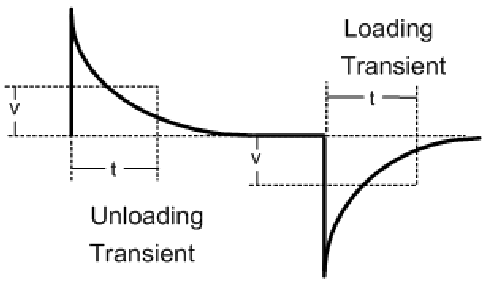
Step 1. Turn off the unit under test. Connect an oscilloscope with the specified probe across the sense terminals (see Test Setup A). Connect the RP79xxA load unit to the output terminals. Make sure that the voltage rating of the RP79xxA load matches the voltage rating of the unit under test.

Step 2. Turn on the unit under test and program the instrument settings as described in the test record form under “Transient Response”.

Step 3. Set the RP79xxA loads's list generator to generate a 100 Hz current waveform with a duty cycle of 50%. Use the following commands to program the list:

FUNC:CURR - specifies current priority
VOLT:LIM MAX - specifies the voltage limit
CURR:MODE LIST - specifies current priority
LIST:CURR <low_value>,<high_value> - refer to test record card for low and high current values
LIST:DWEL 0.005, 0.005 - specifies a 100 Hz current waveform with a 50% duty cycle
LIST:COUN INF - sets the list count to infinity
INIT:TRAN - initiates the transient system
TRIG:TRAN - triggers the transient system
OUTP:ON - turns on the load

Step 4. Adjust the oscilloscope for a waveform similar to that shown in the following figure.



Step 5. The output voltage should return to within the specified voltage at the specified time after the load change. Check both loading and unloading transients by triggering on the positive and 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 unit under test. Connect the current shunt directly across the output terminals. Connect the DMM directly across the current shunt (see Test Setup B). Note that the RP79xxA load is not used in this portion of the test.

Step 2. Turn on the unit under test and program the instrument settings as described in the test record form under “Current Programming & Readback, Min Current”. The output status should be “CC”, with the output voltage close to zero. Wait 5 minutes for the temperature to settle.

Step 3. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value. (Iout). Also, record the current measured by the instrument over the interface. The readings should be within the limits specified in the test record form under “Current Programming & Readback, Minimum Current”.

Step 4. Program the instrument settings as described in the test record form under “Current Programming & Readback, High Current”. Wait 5 minutes for the temperature to settle.

Step 5. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value.(Iout). Also, record the current reading measured by the instrument over the interface. The readings should be within the limits specified in the test record form under “Current Programming & Readback, High Current”.

Constant Current Load Effect

This test measures the change in current resulting from a change in voltage from a short to full scale.

Step 1. Turn off the unit under test. Connect the current shunt directly across the output terminals. Connect the DMM directly across the current shunt (see Test Setup B).

Step 2. Turn on the unit under test and program the instrument settings as described in the test record under “CC Load Effect”. The output status should be “CC”, with the output voltage be close to zero. Wait 5 minutes for the temperature to settle.

Step 3. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value.

Step 4. Turn off the unit under test and connect the RP79xxA load unit between the current shunt and the output terminals (see Test Setup B). Make sure that the voltage rating of the RP79xxA load matches the voltage rating of the unit under test.

WARNING The next step applies the full output voltage of the unit under test to the output.

Step 5. Turn on the unit under test and program the instrument settings as described in the test record under “CC Load Effect”. The output status should be “CC”, with the output voltage close to zero.

Step 6. Set the RP79xxA load for voltage priority mode and program it to the voltage as described in the test record under “CC Load Effect”. The output status should be “CC”. If it isn’t, adjust the load so that the output voltage drops slightly.

Step 7. Short the electronic load. 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”.

Current Sink Capability Verification

This test checks the ability of the power supply to sink up to 100% of its rated output current.

Step 1. Turn off the unit under test and connect the RP79xxA as an external source to the + and – output terminals (see Test Setup C). Make sure that the voltage rating of the RP79xxA source matches the voltage rating of the unit under test.

Step 2. Set the RP79xxA external source as follows: Voltage setting = 50 % of the rated output voltage of the unit under test. Current limit setting = 110% of the rated output current of the unit under test.

Step 3. Turn on the unit under test. Set the operating mode to current priority. Program the instrument settings as described in the test record under “Current Sink Verification”.

Step 4. Check the front panel display of the RP79xxA source and verify that the supply is sinking 100% of its rated current. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value. The readings should be within the limits specified in the test record form under “Current Sink Tests”.

Instrument Calibration

Introduction

WARNING SHOCK HAZARD, LETHAL VOLTAGES Many models generate voltages greater than 60 VDC, with some models rated at 950 VDC! Ensure that all instrument connections, load wiring, and load connections are either insulated or covered using the safety covers provided, so that no accidental contact with lethal voltages can occur.

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 the Recommended Test Equipment and Setups section for a list of the equipment and test setups required for calibration. Also refer to the Measurement Setups section for information about connecting the voltmeter, current shunt, and load. Additional information about calibration follows.

- The correct password is required to enter the Admin menu, which contains the calibration function. The password is pre-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 power supply's command completion before proceeding. The response from the instrument must be read each time *OPC? is given. In some steps, it may take up to 30 seconds for *OPC? to respond.

- Once started, you must complete each calibration section in its entirety. 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.

Calibration Interval

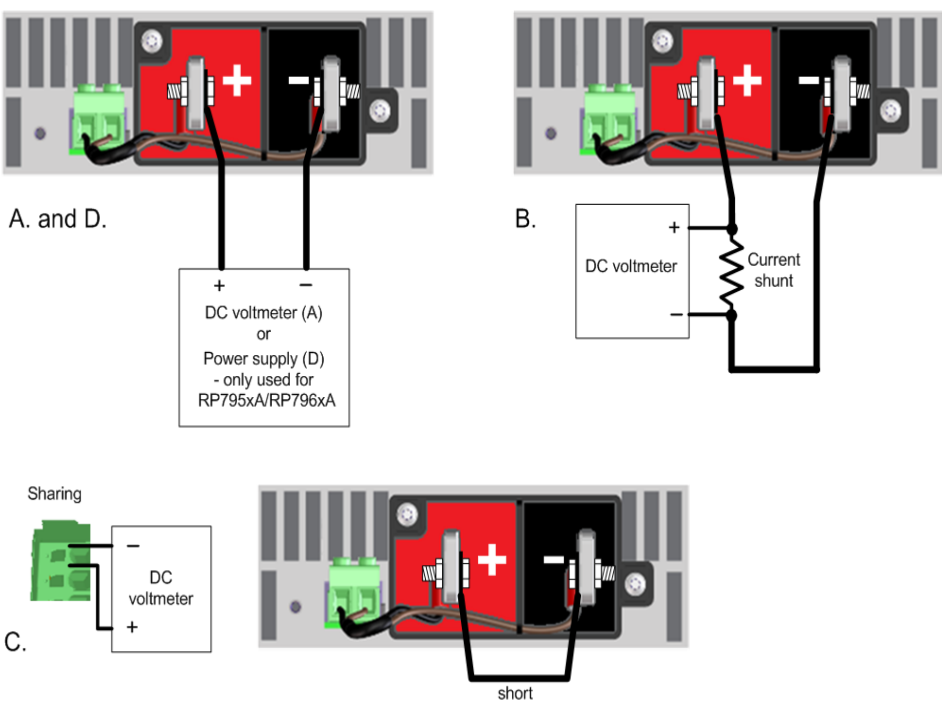
One Year Calibration Interval

The instrument should be calibrated on a regular interval determined by the accuracy requirements of your application. A **one-year** interval is adequate for most applications. Accuracy specifications are warranted only if adjustment is made at regular calibration intervals. Published accuracy specifications are not warranted beyond the one-year calibration interval.

Three Year Calibration Interval

Voltage and current programming and measurement accuracy specifications can be extended to a three-year period calibration interval by multiplying (or increasing) the one-year calibration accuracy specifications shown in the verification Test Record Forms by a factor of three.

Calibration Setups



Test Considerations

For optimum performance, all verification and calibration procedures should comply with the following:

- Ambient temperature is stable, between 18 and 28 °C.
- Ambient relative humidity is less than 80%.
- 30 minute warm-up period before verification or adjustment.
- Cables as short as possible, twisted or shielded to reduce noise.

Calibration Procedure

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Login**. Enter your password in the Password field. Then press **Select**.	CAL:STAT ON <password>

Voltage Calibration

Voltage Programming and Measurement

Step 1. Connect the voltage input of the Keysight 3458A DMM to the output (see Cal Setup A).

Step 2. Select the voltage programing and measurement calibration.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Vprog**. Check that the voltmeter is connected and select Next.	Specify the full-scale voltage range. Full scale ranges vary by model. This selects the 500 V range: CAL:VOLT 500

Step 3. Select the first voltage calibration point. Measure the output voltage with the DMM and enter the data.

Front Panel Menu Reference	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>

WARNING The next step applies the full output voltage of the unit under test to the output.

Step 4. Select the second voltage calibration point. Measure the output voltage with the DMM and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P2 measured data”. Enter the data from the external DMM. Press Enter when done. Press Back to finish.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Temperature Coefficient Calibration RP793xA, RP794xA

NOTE The temperature coefficient calibration procedure must be performed **Before** any other current calibration procedures.

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure the output's **full-scale** current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Step 2. Select the temperature coefficient calibration.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Misc\CurrTC**. Check that the shunt is connected and select Next.	CAL:CURR:TC

Step 3.Select the first current calibration point. Wait 5 minutes for the temperature to settle. Calculate the shunt current (I=V/R) and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P1 measured data”. This should be about 50% of the full-scale current rating. Press Enter when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point. Wait 5 minutes for the temperature to settle. Calculate the shunt current (I=V/R) and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P2 measured data”. Enter the data from the external DMM. This should be about 80% of the full-scale current rating. Press Enter when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third current calibration point.Wait 5 minutes for the temperature to settle.Calculate the shunt current (I=V/R) and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P3 measured data”. Enter the data from the external DMM. This should be about 100% of the full-scale current rating. Press Enter when done. Press Back to finish.	CAL:LEV P3 *OPC? CAL:DATA <data>

Current Calibration

Current Programming and Measurement

Step 1. Disconnect all equipment form the output terminals.

Step 2. Select the current programing and measurement calibration.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Curr\Iprog**. Check that nothing is connected to the output and select Next.	Specify the full-scale current range. Full scale ranges vary by model. This selects the 20 A range: CAL:CURR 20

Step 3. Select the first current calibration point. Wait 5 minutes for the temperature to settle.

Front Panel Menu Reference	SCPI Command
Wait 5 minutes, then select Next again.	CAL:LEV P1 *OPC?

Step 4. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 70% of the output's full-scale current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Front Panel Menu Reference	SCPI Command
Check that the shunt is connected and select Next.	Not applicable

Step 5. Select the second current calibration point. Wait 5 minutes for the temperature to settle. Calculate the shunt current (I=V/R) and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data". Enter the data from the external DMM. This should be about 70% of the full-scale current rating. Press Enter when done. Press Back to finish.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Sharing Calibration RP795xA, RP796xA

This procedure calibrates the Imon signal that is used when units are connected in parallel.

Step 1. Connect a short across the + and - output terminals. Connect the Keysight 3458A DMM across pins 2 and 3 of the Sharing connector (see Cal Setup C).

Step 2. Select the current sharing calibration.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Misc\CurrShar**. Check that the short is connected and select Next.	CAL:CURR:SHAR

Step 3. Select the first calibration point. Measure the voltage across the sharing connector and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P1 measured data”. Enter the data from the external DVM. This should be about 1 volt. Press Enter when done. Press Back to finish.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. After the calibration completes, disconnect the voltmeter and short.

Resistance Bottom-Out Calibration RP795xA, RP796xA

This procedure calibrates the minimum voltage that can be achieved while sinking current.

Step 1. Connect an external power supply to the + and - output terminals (see Cal Setup D).

Step 2. Set the external supply as follows: Voltage setting = (0.9 V + 0.08 * maximum output voltage of the unit under test). The voltage must be within 10% of this value. Current limit = (0.95 * rated output current of the unit under test). The current limit must be within 2% of this value.

Step 3. Select the resistance bottom-out calibration. Calibration takes approximately 5 seconds.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Misc\ResBout**. Check that the power supply is connected and select Next.	CAL:RES:BOUT *OPC?

Step 4. After the calibration completes, disconnect the power supply.

Enter a Calibration Date

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Date**. Enter the calibration date in the Date field. If desired, you can enter alphanumeric data in this field.	CAL:DATE "<date>"

Save Calibration and Log Out

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Save**. Select Save to save all calibration data.	To save calibration data: CAL:SAVE
Select **System\Admin\Logout** to exit calibration mode.	To exit calibration mode: CAL:STAT OFF

Test Record Forms

Keysight RP7951A/RP7961A

RP7951A/RP7961A Test Record	Report Number ______		Date__________	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.43985	______	0.56015
Voltage measured over interface:	Both	Vout - 0.08015	______	Vout + 0.08015
High voltage (Vout):	Both	499.79	______	500.21
Voltage measured over interface:	Both	Vout - 0.230	______	Vout + 0.230
CV Load Effect:				
	Both	- 0.030	______	+ 0.030
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	0.500
rms:	Both	N/A	______	0.100
Transient response @ 500 µs:				
	Both	- 1.25	______	+ 1.25
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.012	______	0.012
Current measured over interface:	Both	Iout - 0.012	______	Iout + 0.012
High current (Iout):	Both	19.968	______	20.032
Current measured over interface:	Both	Iout - 0.032	______	Iout + 0.032
CC Load Effect:				
	Both	- 0.009	______	+ 0.009
Current Sink Tests				
100% of current rating:	Both	- 20.032	______	- 19.968

	RP7951A/RP7961A UUT Settings	RP7952A/RP7962A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.5 V, 10.25 A	not used
Voltage Programming & Readback High:	Voltage priority: 500 V, 10.25 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 250 V, 20.5 A	Current priority: 255 V, 20 A
Transient Response:	Voltage priority: 250 V, 20.5 A	Current priority: 255 V, 10 A to 20 A, slew=max
Current Programming & Readback Min:	Current priority: 255 V, 0 A	Voltage priority: 250 V, 0 A
Current Programming & Readback High:	Current priority: 255 V, 20 A	Voltage priority: 250 V, 20.5 A
CC Load Effect:	Current priority: 510 V, 10 A	Voltage priority: 500 V, 10.25 A
100% of current rating (Isink):	Current priority: 255 V, - 20 A	Voltage priority: 250 V, 20.5 A

Keysight RP7952A/RP7962A

RP7952A/RP7962A Test Record		Report Number ______		Date__________
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.43985	______	0.56015
Voltage measured over interface:	Both	Vout - 0.08015	______	Vout + 0.08015
High voltage (Vout):	Both	499.78	______	500.21
Voltage measured over interface:	Both	Vout - 0.230	______	Vout + 0.230
CV Load Effect:				
	Both	- 0.030	______	+ 0.030
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	0.500
rms:	Both	N/A	______	0.100
Transient response @ 500 µs:				
	Both	- 1.25	______	+ 1.25
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.024	______	0.024
Current measured over interface:	Both	Iout - 0.024	______	Iout + 0.024
High current (Iout):	Both	39.936	______	40.064
Current measured over interface:	Both	Iout - 0.064	______	Iout + 0.064
CC Load Effect:				
	Both	- 0.017	______	+ 0.017
Current Sink Tests				
100% of current rating:	Both	- 40.064	______	- 39.936

	RP7952A/RP7962A UUT Settings	RP7952A/RP7962A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.5 V, 20.5 A	not used
Voltage Programming & Readback High:	Voltage priority: 500 V, 20.5 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 250 V, 41 A	Current priority: 255 V, 40 A
Transient Response:	Voltage priority: 250 V, 41 A	Current priority: 255 V, 20 A to 40 A, slew=max
Current Programming & Readback Min:	Current priority: 255 V, 0 A	Voltage priority: 250 V, 0 A
Current Programming & Readback High:	Current priority: 255 V, 40 A	Voltage priority: 250 V, 41 A
CC Load Effect:	Current priority: 510 V, 20 A	Voltage priority: 500 V, 20.5 A
100% of current rating (Isink):	Current priority: 255 V, - 40 A	Voltage priority: 250 V, 41 A

Keysight RP7953A/RP7963A

RP7953A/RP7963A Test Record	Report Number ______		Date__________	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.8797	______	1.1203
Voltage measured over interface:	Both	Vout - 0.1603	______	Vout + 0.1603
High voltage (Vout): *	Both	949.595	______	950.405
Voltage measured over interface:	Both	Vout - 0.445	______	Vout + 0.445
CV Load Effect:				
	Both	- 0.060	______	+ 0.060
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	1.000
rms:	Both	N/A	______	0.200
Transient response @ 500 µs:				
	Both	- 2.375	______	+ 2.375
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.012	______	0.012
Current measured over interface:	Both	Iout - 0.012	______	Iout + 0.012
High current (Iout):	Both	19.968	______	20.032
Current measured over interface:	Both	Iout - 0.032	______	Iout + 0.032
CC Load Effect:				
	Both	- 0.009	______	+ 0.009
Current Sink Tests				
100% of current rating:	Both	- 20.032	______	- 19.968

	RP7953A/RP7963A UUT Settings	RP7953A/RP7963A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 1.0 V, 10.75 A	not used
Voltage Programming & Readback High:	Voltage priority: 950 V, 10.75 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 500 V, 20.5 A	Current priority: 510 V, 20 A
Transient Response:	Voltage priority: 500 V, 20.5 A	Current priority: 510 V, 10 A to 20 A, slew=max
Current Programming & Readback Min:	Current priority: 510 V, 0 A	Voltage priority: 500 V, 0 A
Current Programming & Readback High:	Current priority: 510 V, 20 A	Voltage priority: 500 V, 20.5 A
CC Load Effect:	Current priority: 969 V, 10 A	Voltage priority: 950 V, 10.75 A
100% of current rating (Isink):	Current priority: 510 V, - 20 A	Voltage priority: 500 V, 20.5 A

Keysight RP7931A/RP7941A

RP7931A/RP7941A Test Record	Report Number _____		Date_________	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.017996	_____	0.022004
Voltage measured over interface:	Both	Vout - 0.002004	_____	Vout + 0.002004
High voltage (Vout):	Both	19.994	_____	20.006
Voltage measured over interface:	Both	Vout - 0.006	_____	Vout + 0.006
CV Load Effect:				
	Both	- 0.001	_____	+ 0.001
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	0.030
rms:	Both	N/A	_____	0.003
Transient response @ 300 µs:				
	Both	- 0.20	_____	+ 0.20
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.045	_____	0.045
Current measured over interface:	Both	Iout - 0.045	_____	Iout + 0.045
High current (Iout):	Both	399.795	_____	400.205
Current measured over interface:	Both	Iout - 0.205	_____	Iout + 0.205
CC Load Effect:				
	Both	- 0.025	_____	+ 0.025
Current Sink Tests				
100% of current rating:	Both	- 399.795	_____	- 400.205

	RP7931A/RP7941A UUT Settings	RP7933A/RP7943A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.02 V, 204 A	not used
Voltage Programming & Readback High:	Voltage priority: 20 V, 204 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 10 V, 408 A	Current priority: 10.2 V, 400 A
Transient Response:	Voltage priority: 10 V, 408 A	Current priority: 10.2 V, 200 A to 400 A, slew=5 A/µs
Current Programming & Readback Min:	Current priority: 10.2 V, 0 A	Voltage priority: 10 V, 0 A
Current Programming & Readback High:	Current priority: 10.2 V, 400 A	Voltage priority: 10 V, 408 A
CC Load Effect:	Current priority: 20.4 V, 200 A	Voltage priority: 20 V, 204 A
100% of current rating (Isink):	Current priority: 10.2 V, - 400 A	Voltage priority: 10 V, 408 A

Keysight RP7932A/RP7942A

RP7932A/RP7942A Test Record		Report Number ______		Date__________
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.071984	______	0.088016
Voltage measured over interface:	Both	Vout - 0.008016	______	Vout + 0.008016
High voltage (Vout):	Both	79.976	______	80.024
Voltage measured over interface:	Both	Vout - 0.024	______	Vout + 0.024
CV Load Effect:				
	Both	- 0.003	______	+ 0.003
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	0.080
rms:	Both	N/A	______	0.008
Transient response @ 300 µs:				
	Both	- 0.80	______	+ 0.80
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.013	______	0.013
Current measured over interface:	Both	Iout - 0.013	______	Iout + 0.013
High current (Iout):	Both	124.9495	______	125.0505
Current measured over interface:	Both	Iout - 0.0505	______	Iout + 0.0505
CC Load Effect:				
	Both	- 0.013	______	+ 0.013
Current Sink Tests				
100% of current rating:	Both	- 124.9495	______	- 125.0505

	RP7932A/RP7942A UUT Settings	RP7935A/RP7945A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.08 V, 63.75 A	not used
Voltage Programming & Readback High:	Voltage priority: 80 V, 63.75 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 40 V, 127.5 A	Current priority: 40.4 V, 125 A
Transient Response:	Voltage priority: 40 V, 127.5 A	Current priority: 40.4 V, 62.5 A to 125 A, slew=2 A/µs
Current Programming & Readback Min:	Current priority: 40.4 V, 0 A	Voltage priority: 40 V, 0 A
Current Programming & Readback High:	Current priority: 40.4 V, 125 A	Voltage priority: 40 V, 127.5 A
CC Load Effect:	Current priority: 80.8 V, 62.5 A	Voltage priority: 80 V, 63.75 A
100% of current rating (Isink):	Current priority: 40.4 V, - 125 A	Voltage priority: 40 V, 127.5 A

Keysight RP7933A/RP7943A

RP7933A/RP7943A Test Record	Report Number _____		Date_________	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.017996	_____	0.022004
Voltage measured over interface:	Both	Vout - 0.002004	_____	Vout + 0.002004
High voltage (Vout):	Both	19.994	_____	20.006
Voltage measured over interface:	Both	Vout - 0.006	_____	Vout + 0.006
CV Load Effect:				
	Both	- 0.001	_____	+ 0.001
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	0.030
rms:	Both	N/A	_____	0.003
Transient response @ 300 µs:				
	Both	- 0.8	_____	+ 0.8
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.090	_____	0.090
Current measured over interface:	Both	Iout - 0.090	_____	Iout + 0.090
High current (Iout):	Both	799.59	_____	800.41
Current measured over interface:	Both	Iout - 0.41	_____	Iout + 0.41
CC Load Effect:				
	Both	- 0.050	_____	+ 0.050
Current Sink Tests				
100% of current rating:	Both	- 799.59	_____	- 800.41

	RP7933A/RP7943A UUT Settings	RP7933A/RP7943A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.02 V, 408 A	not used
Voltage Programming & Readback High:	Voltage priority: 20 V, 408 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 10 V, 816 A	Current priority: 10.2 V, 800 A
Transient Response:	Voltage priority: 10 V, 816 A	Current priority: 10.2 V, 400 A to 800 A, slew=10 A/µs
Current Programming & Readback Min:	Current priority: 10.2 V, 0 A	Voltage priority: 10 V, 0 A
Current Programming & Readback High:	Current priority: 10.2 V, 800 A	Voltage priority: 10 V, 816 A
CC Load Effect:	Current priority: 20.4 V, 400 A	Voltage priority: 20 V, 408 A
100% of current rating (Isink):	Current priority: 10.2 V, - 800 A	Voltage priority: 10 V, 816 A

Keysight RP7935A/RP7945A

RP7935A/RP7945A Test Record		Report Number ______		Date__________
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.071984	______	0.088016
Voltage measured over interface:	Both	Vout - 0.008016	______	Vout + 0.008016
High voltage (Vout):	Both	79.976	______	80.024
Voltage measured over interface:	Both	Vout - 0.024	______	Vout + 0.024
CV Load Effect:				
	Both	- 0.003	______	+ 0.003
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	0.080
rms:	Both	N/A	______	0.008
Transient response @ 300 µs:				
	Both	- 0.80	______	+ 0.80
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.025	______	0.025
Current measured over interface:	Both	Iout - 0.025	______	Iout + 0.025
High current (Iout):	Both	249.9	______	250.1
Current measured over interface:	Both	Iout - 0.1	______	Iout + 0.1
CC Load Effect:				
	Both	- 0.025	______	+ 0.025
Current Sink Tests				
100% of current rating:	Both	- 249.9	______	- 250.1

	RP7935A/RP7945A UUT Settings	RP7935A/RP7945A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.08 V, 127.5 A	not used
Voltage Programming & Readback High:	Voltage priority: 80 V, 127.5 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 40 V, 255 A	Current priority: 40.4 V, 250 A
Transient Response:	Voltage priority: 40 V, 255 A	Current priority: 40.4 V, 125 A to 250 A, slew=4 A/µs
Current Programming & Readback Min:	Current priority: 40.4 V, 0 A	Voltage priority: 40 V, 0 A
Current Programming & Readback High:	Current priority: 40.4 V, 250 A	Voltage priority: 40 V, 255 A
CC Load Effect:	Current priority: 80.8 V, 125 A	Voltage priority: 80 V, 127.5 A
100% of current rating (Isink):	Current priority: 40.4 V, - 250 A	Voltage priority: 40 V, 255 A

Keysight RP7936A/RP7946A

RP7936A/RP7946A Test Record		Report Number ______		Date__________
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0.143968	______	0.176032
Voltage measured over interface:	Both	Vout - 0.016032	______	Vout + 0.016032
High voltage (Vout):	Both	159.952	______	160.048
Voltage measured over interface:	Both	Vout - 0.048	______	Vout + 0.048
CV Load Effect:				
	Both	- 0.006	______	+ 0.006
CV Ripple and Noise				
peak-to-peak:	Both	N/A	______	0.200
rms:	Both	N/A	______	0.020
Transient response @ 300 µs:				
	Both	- 0.80	______	+ 0.80
Current Programming & Readback				
Minimum current (Iout):	Both	- 0.013	______	0.013
Current measured over interface:	Both	Iout - 0.013	______	Iout + 0.013
High current (Iout):	Both	124.9495	______	125.0505
Current measured over interface:	Both	Iout - 0.0505	______	Iout + 0.0505
CC Load Effect:				
	Both	- 0.013	______	+ 0.013
Current Sink Tests				
100% of current rating:	Both	- 124.9495	______	- 125.0505

	RP7936A/RP7946A UUT Settings	RP7936A/RP7946A Load Settings
Voltage Programming & Readback Min:	Voltage priority: 0.16 V, 63.75 A	not used
Voltage Programming & Readback High:	Voltage priority: 160 V, 63.75 A	not used
CV Load Effect, CV Ripple and Noise:	Voltage priority: 80 V, 125 A	Current priority: 80.8 V, 125 A
Transient Response:	Voltage priority: 80 V, 62.5 A	Current priority: 80.8 V, 62.5 A to 125 A, slew=2 A/µs
Current Programming & Readback Min:	Current priority: 80.8 V, 0 A	Voltage priority: 80 V, 0 A
Current Programming & Readback High:	Current priority: 80.8 V, 125 A	Voltage priority: 80 V, 127.5 A
CC Load Effect:	Current priority: 161.6 V, 62.5 A	Voltage priority: 160 V, 63.75 A
100% of current rating (Isink):	Current priority: 80.8 V, - 125 A	Voltage priority: 80 V, 127.5 A

7
Service and Maintenance

Introduction

Repair 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
- the front-panel Power On/Standby switch has been pushed

If self-test failed, verify that:

Ensure 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, Keysight strongly recommends obtaining one of the following packaging kits to ensure that the unit is not damaged in shipment:
  P/N 5188-9520 - Packaging kit for models RP795xA/RP796xA
  P/N 5188-9614 - Packaging kit for models RP793xA/RP794xA.

Keysight suggests that you always insure shipments.

Cleaning

WARNING SHOCK HAZARD To prevent electric shock, disconnect the AC mains 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.

Self-Test Procedure

Power-On Self-Test

Each time the instrument is powered on, a self-test is performed. This test 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 Reference	SCPI Command
Cycle ac power. If self-test fails, the front panel ERR indicator comes on. Press the Error key to display the list of errors.	*TST? 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. To obtain the latest firmware for the RP793xA and RP794xA series, go to www.keysight.com/find/RPSfirmware. To obtain the latest firmware for the RP795xA and RP796xA series, go to www.keysight.com/find/RPS2firmware.

Software Required

To update the firmware you need to download the following two items onto your computer from the RPS product page at the RPS firmware link referenced above.

- The Universal Firmware Update Utility
- The latest firmware version

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 Reference	SCPI Command
Select **System\Admin\Update** 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.	Not available

Instrument Sanitize

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

This procedure sanitizes all user data. 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 Reference	SCPI Command
Select **System\Admin\Sznitize** Select Sanitize. Selecting Sanitize removes all user-data from the instrument and cycles power.	SYST:SEC:IMM

Refer to http://rfmw.em.keysight.com/aerospace/index.aspx for detailed information.

Turn-on after Sanitization

The first time the unit is turned on after it has been sanitized, several NVRAM checksum errors will be generated. These errors annunciate the fact that two files were missing, which have been recreated with default values. The next time the unit tuns on, there should be no errors.

Sanitizing an Inoperative Instrument

If the instrument is no longer functioning and you are unable to use the sanitization procedure described above, you must physically remove the P600 board from the instrument and destroy it. Refer to Disassembly.

Calibration Switches

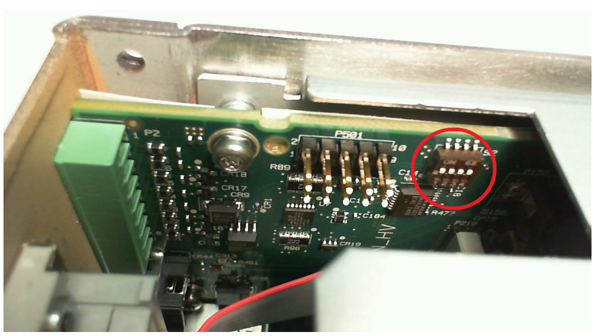
WARNING **SHOCK HAZARD Only qualified, service-trained personnel who are aware of the hazards involved should remove instrument covers. Always disconnect the power cable and any external circuits before removing the instrument cover. Some circuits are active and have power for a short time even when the power switch is turned off.**

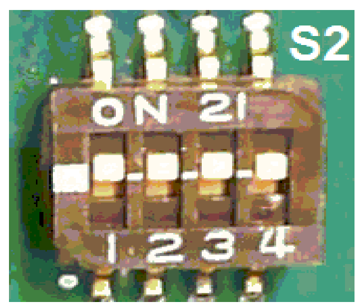
Two switches control the access to calibration commands. The switches are on the interface board and are accessible by removing the top cover.

Accessing the Calibration Switch

1. Remove the instrument cover as described under Disassembly.
2. The calibration switch is on the interface board at the rear corner of the unit. To change the calibration switch settings, use a small screwdriver to move the switches. As shipped, all switches are set toward the ON position (see below).
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.





Switch Functions

Switches 1 and 2 set the calibration configuration as follows. Switches 3 and 4 are not used.

	Switch 1	Switch 2	Description
Normal	ON	ON	This is the as-shipped switch setting. The calibration functions are accessible after entering a numeric password. The default password is 0 (zero).
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	ON	OFF	All calibration commands are disabled. This is useful where access is guarded by instrument seals.

Battery Replacement

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.

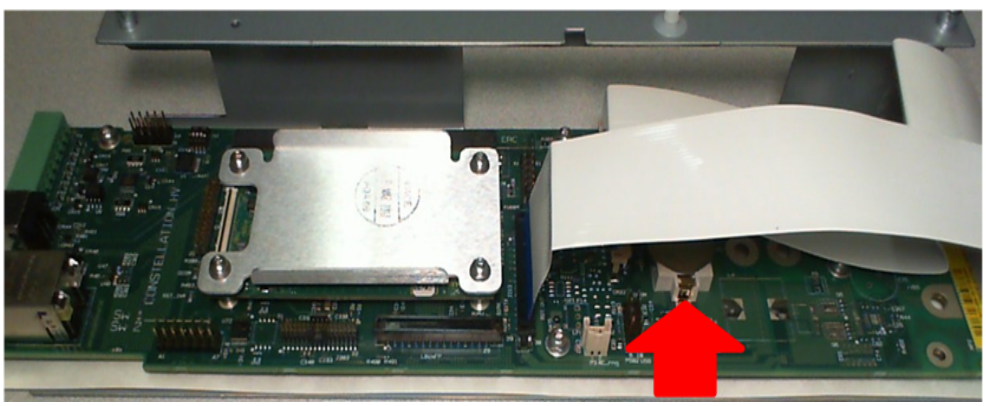
The internal battery powers the real-time clock. The primary function of the clock it to provide time stamp information for the Keysight 14585A Control and Analysis Software. If the battery fails, the time will not be available for the software. No other instrument functions are affected.

Under normal use at room temperature, the lithium battery has a life expectancy between seven and ten years. Note that battery life will be reduced if the instrument is stored for a prolonged period at temperatures above 40 degrees C.

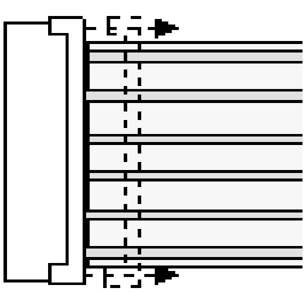
The part number of the battery is Panasonic CR 2032.

Replacement Procedure

1. Remove the instrument cover as described under Disassembly.
2. Remove the Control board as described under Disassembly.
3. The battery is located on the Constellation board under the ribbon cable.



4. To access the battery, release the ribbon cables by pulling up on the locking tab.



5. Use a flat-bladed screwdriver and carefully pry up on the side of the battery indicated by the arrow.

6. Install the new battery. Make sure that the positive side (+) is facing up. Place the battery *under* the small spring clips indicated by the circle, then push down on the opposite end of the battery indicated by the red arrow. The top of the small spring clips should be visible after the battery is seated (see red circle).
7. Replace the ribbon cables by fully inserting the cables into the connector; then pushing down on the locking tab to secure the cables.
8. Replace the Control board and top cover when finished.
9. Reset the date and time (see Clock Setup).

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:

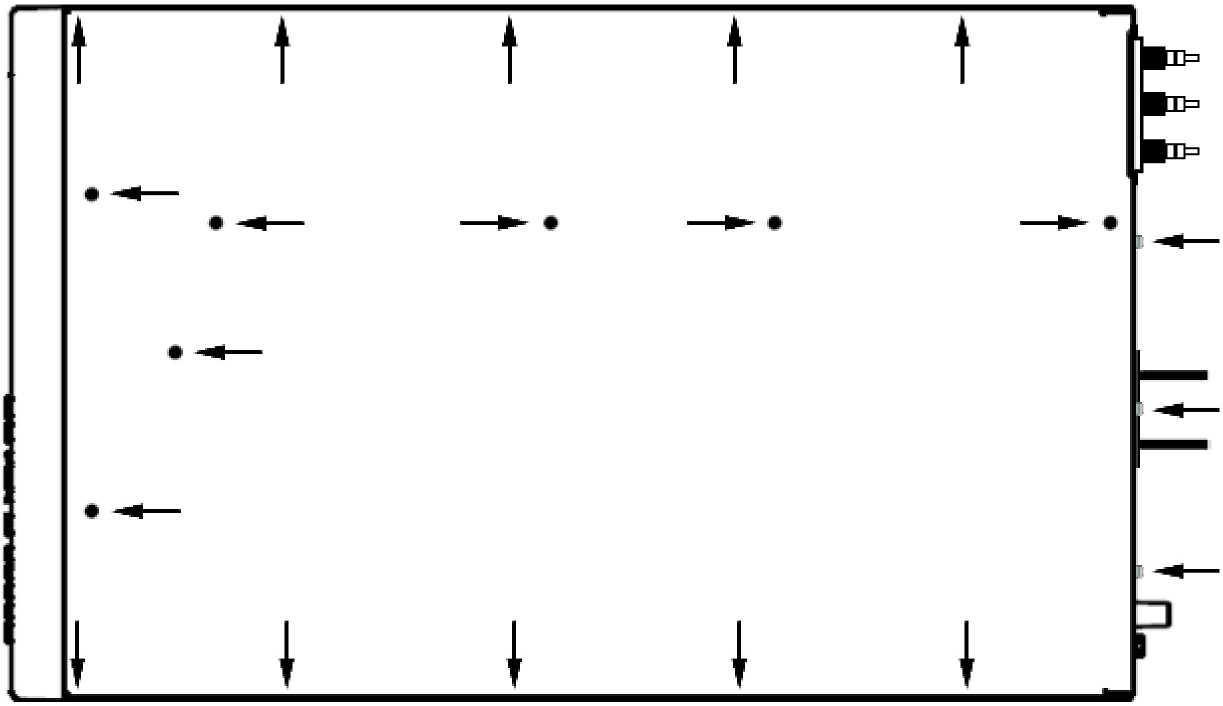
- Disassemble instruments only in a static-free work area.
- Use a conductive work area to reduce static charges.
- Use a conductive wrist strap to reduce static charge accumulation.
- Minimize handling.
- Keep replacement parts in original static-free packaging.
- Remove all plastic, foam, vinyl, paper, and other static-generating materials from the immediate work area.

Tools Required

- T10 Torx driver for cover and board disassembly
- T8 Torx driver for P600 disassembly
- Small flat bladed screwdriver for battery removal

Cover Disassembly

1. Turn off the power. Remove all cables from the instrument.
2. Remove the 7 flat-head screws located on the top, the 10 flat-head screws along the sides, and the 3 pan-head screws on the back (see figure below). Place the screws in a container so that you do not lose them.
3. Remove the instrument cover.

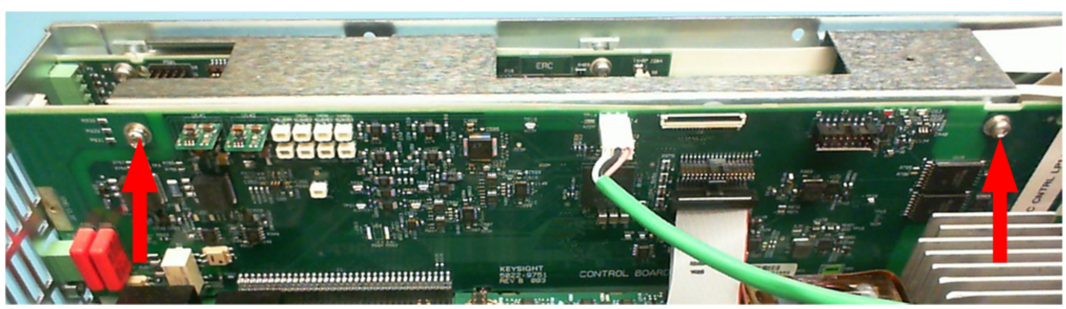


Control Board Disassembly

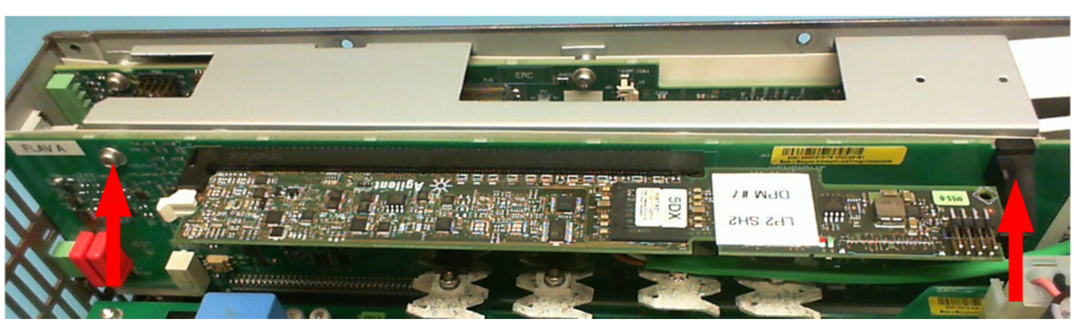
The Control board is located on the outside of the Constellation board. It must be removed to provide access to the battery and the P600 board, which are both locate on the Constellation board.

1. As indicate below, first remove the two screws along the top of the Control board. Place the screws in a container so that you do not lose them.

RP793xA
RP794xA



RP795xA
RP796xA



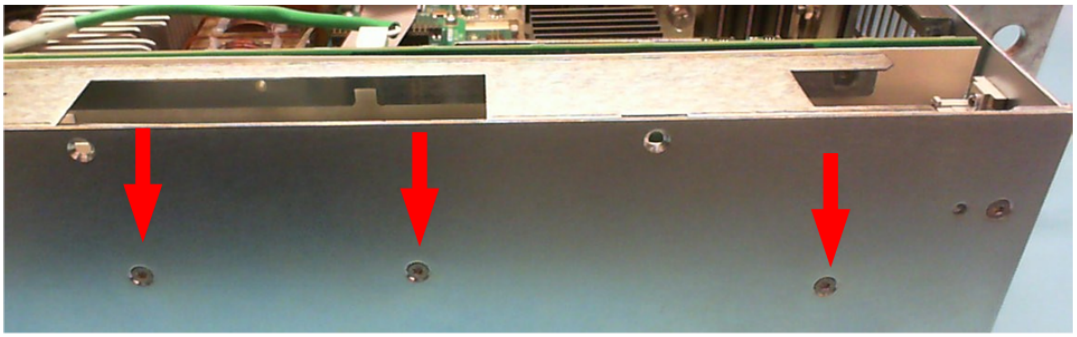
2. You can now lift the board out of its socket and move it to the side.
(When reassembling the Control board, don't forget to replace the insulator behind the board.

Constellation Board Disassembly

If you have trouble accessing the Constellation board after you have moved the Control board out of the way, you can remove the Constellation board assembly.

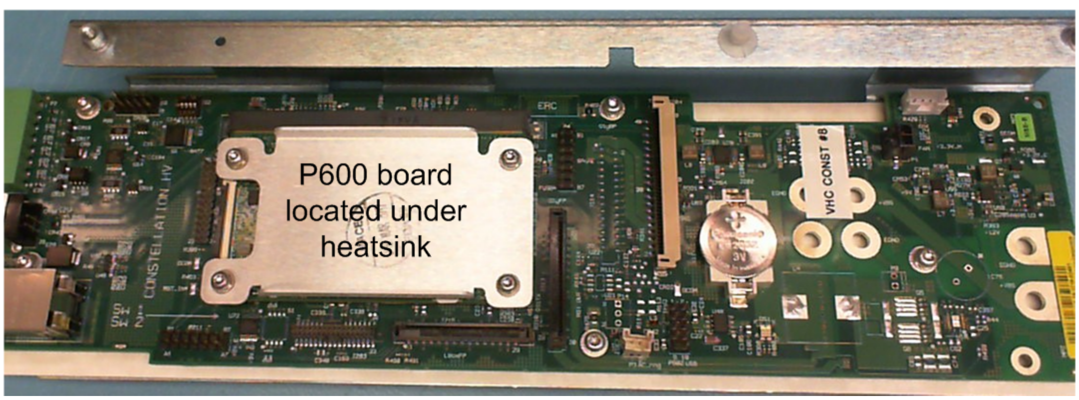
1. Remove the three screws along the side of the chassis that attach the Constellation board. Place the screws in a container so that you do not lose them.

Remove screws



2. You can now lift the Constellation assembly out of the unit to access the P600 board and battery.
3. To access the P600 board, use a T8 Torx driver to remove the four heatsink screws. You can now remove the P600 board from its socket.

Remove 4 heatsink screws to remove the P600 board



Appendix A
Keysight SD1000A Safety Disconnect System

Description

Installation

Operation

Keysight SD1000A Safety Disconnect System

CAUTION The Keysight SD1000A SDS with option 500 can only be used with Keysight Models RP7951A, RP7952A, RP7961A, and RP7962A.

The Keysight SD1000A SDS with option 950 can only be used with Keysight Models RP7953A and RP7963A.

Introduction

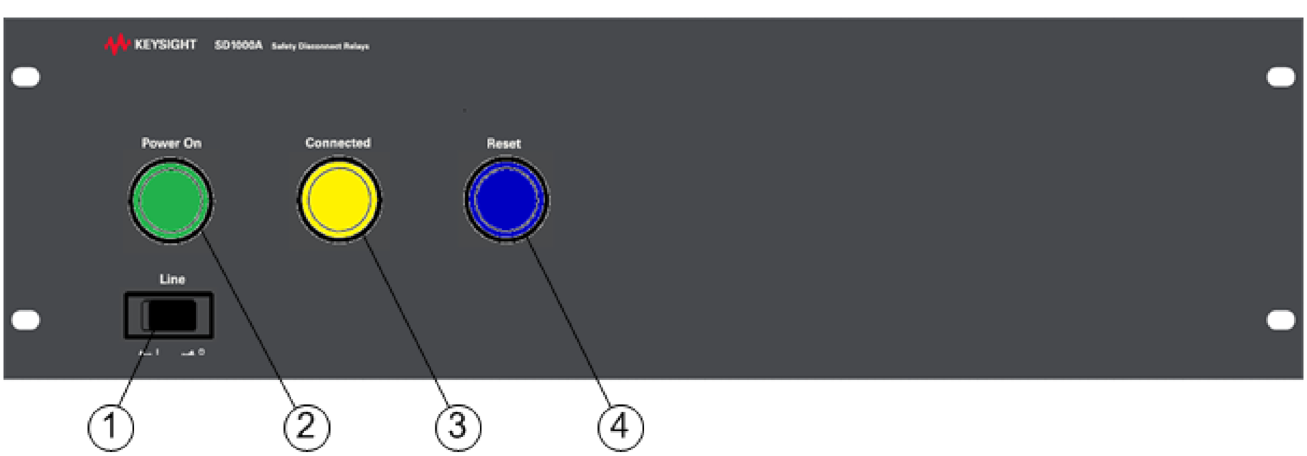
NOTE All legal and safety information for the Keysight RP7900 series also applies to the Keysight SD1000A unit.

The Keysight SD1000A Safety Disconnect System (SDS) is an automated switching interface between the Keysight RP7900 series power supply and the unit under test (UUT). It is intended to ensure operator safety when the RP7900 power supply is used in a production environment. The SDS provides the interface between safety inputs such as an emergency stop switch or fixture cover switch and UUT, so that the operator is never exposed to harmful voltages when operating the test system.

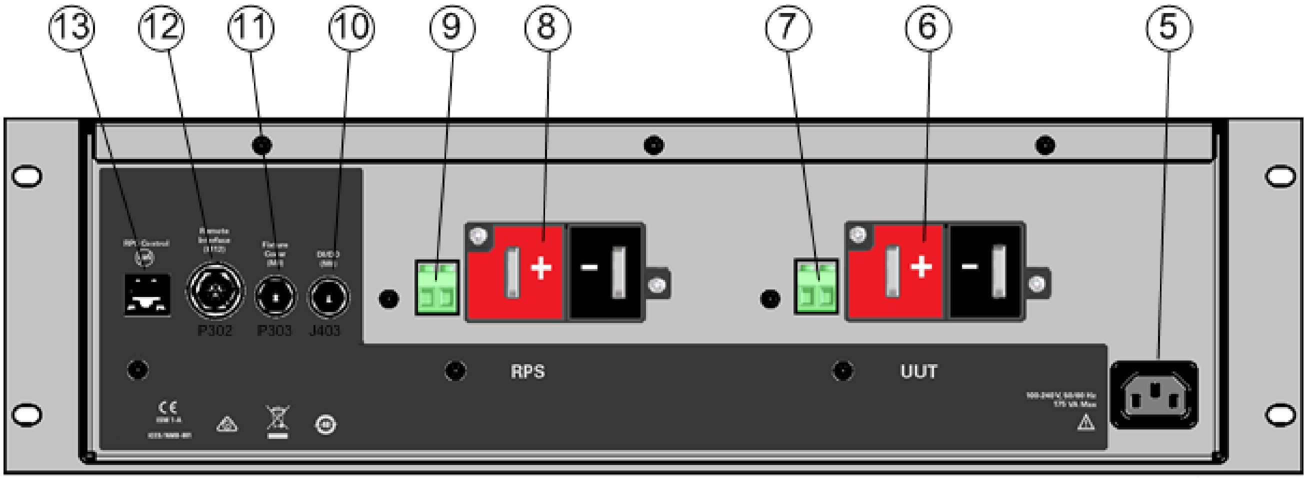
The SDS contains redundant series-connected relays (two power and two sense relays) which provide an additional level of safety when disconnecting high voltage from the UUT. The SDS is connected to the Keysight RP7900 series power supply with a dedicated interface cable. Operation of the SDS is integrated into the Keysight RP7900 series to make it work as though the relays are internal to the power supply.

Keysight SD1000A Safety Disconnect System at a Glance

Front View



Rear View



1. **Line switch** Turns the unit on or off.
2. **Green Power On light** Indicates that the SDS unit has been turned on when illuminated
3. **Yellow Connected light** Indicates that one or more relays are closed when illuminated
4. **Blue Reset light** Indicates that the SDS must be reset when illuminated
5. **AC input** Universal AC input (100-240 VAC)
6. **UUT output terminals** + and - output connections for powering the UUT
7. **UUT sense terminals** [1] + and - connections for local or remote sensing
8. **RPS input terminals** + and - input connections from the RP7900 unit
9. **RPS sense terminals** [1] + and - connections for local or remote sensing
10. **DI/DO connector** Female connector for digital IO control
11. **Fixture Cover connector** Male connector for fixture cover (refer to Cover switch)
12. **Remote Interface connector** Male connector for status and control interface (refer to ESTOP switch)
13. **RPS Control interface** Interface connector for the RP7900 series power supplies

Note 1 As shipped, sense terminals are connected for local sensing.

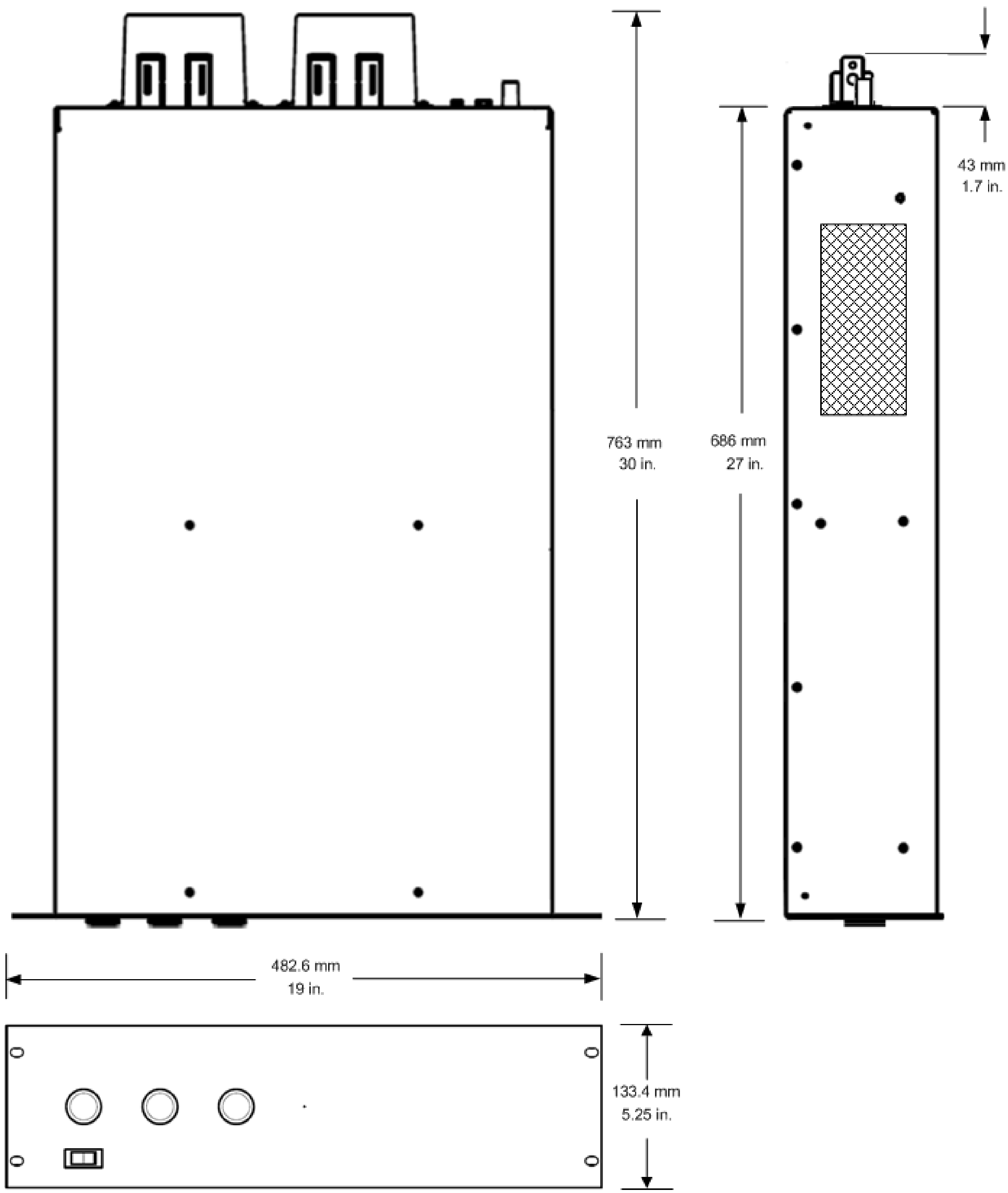
Supplemental Characteristics

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.

Characteristic	Keysight SD1000A
Power relay ratings	
Option 500:	500 VDC; 60 ADC
Option 950:	950 VDC; 60 ADC
Power relay, mechanical life:	1,000,000 cycles
Power relay, hot-switched life:	10,000 cycles
Sense relay life:	1,000,000 cycles
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.
	Declarations of Conformity for this product may be downloaded from the Web. Go to http://regulations.corporate.keysight.com and click on “Declarations of Conformity.”
Environmental	
Operating environment:	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range:[1]	0°C to 55°C
Relative humidity:	95% or less (non-condensing)
Altitude:	Up to 2000 meters
Storage temperature:	-30°C to 70°C
Output Terminal Isolation:	No output terminal may be more than ±950 VDC from any other terminal or chassis ground.
AC Input	
Nominal Rating:	Single phase; 100–240 VAC input, 50-60 Hz
Input Range:	86–264 VAC; 47–63 Hz
Power consumption:	150 W
Typical Weight	33 lbs (15 kg)

[1] Maximum continuous power available is derated at 1% of rating per degree C from 40°C to 55°C

Dimensions



NOTE The SDS is passive-cooled and does not require a fan or other cooling considerations - provided that the venting holes on the sides of the unit are not blocked.

Installing the Keysight SD1000A Safety Disconnect System

Keysight SD1000A-to-RP7900 Connections

External Control Connections

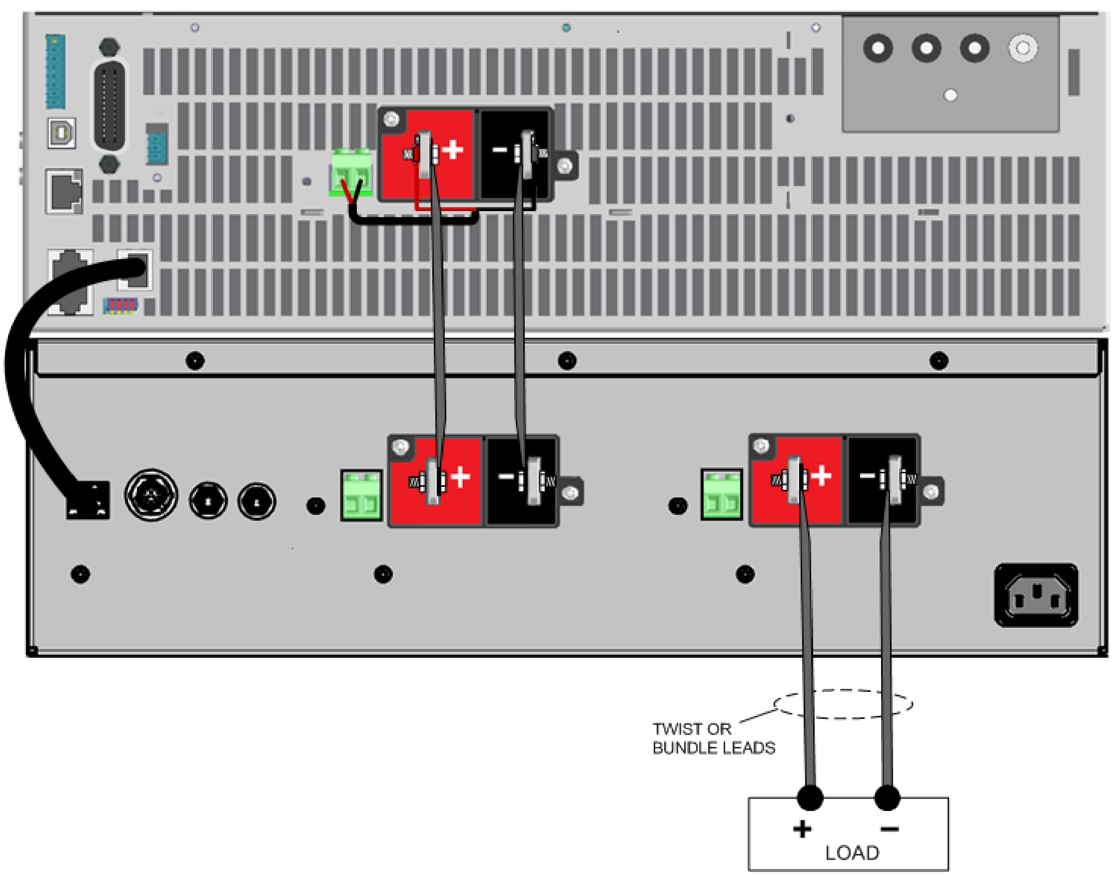
For items supplied, refer to Items Supplied. For detailed connection information and wire sizes, refer to Single Unit Connections.

Keysight SD1000A-to-RP7900 Connections

As shown in the following figures, Install the SDS unit as close as possible to the RP7900 series unit. Both units are designed to fit into a standard System II racks. Rack ears are built into the SDS unit.

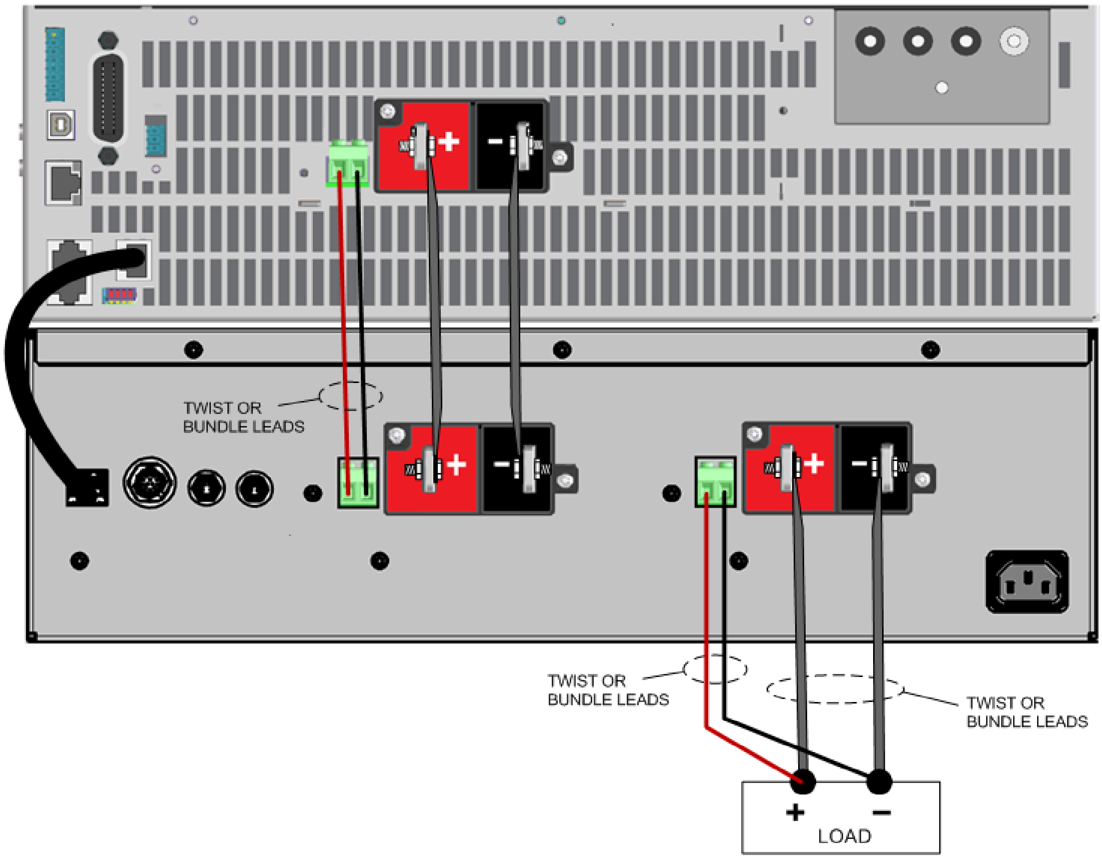
If you are using a master/slave power supply configuration, the master power supply must be connected to the SDS unit.

Connections with Local Sensing



CAUTION Tightening torque of the output bolts cannot exceed 10.8 Nm (8 lb-ft).

Connections with Remote Sensing



1. Connect the interface cable from the RP7900 unit to the SDS unit.
2. Connect the output of the RP7900 series to the input of the SDS unit.
3. Connect the output of the SDS unit to the device under test (the load).
4. If remote sensing is used, do NOT bundle the sense wire-pair together with the load leads; keep the load wires and sense wires separate.
5. Install the bus bar safety covers. Depending on how the units are wired, you may need to remove the bus bar cut-outs from the safety covers.

Connections with Paralleled Units

The limiting factor as to how many Keysight RP7900 units you can connect to one SDS unit is the current rating of the SDS relays, which is 60 A. For example, you can connect one 500 V, 10 kW unit and one 500 V, 5 kw unit to one SDS unit and still be within the maximum current rating of 60 A.

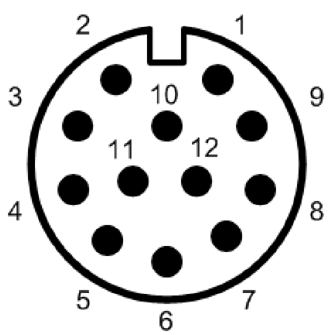
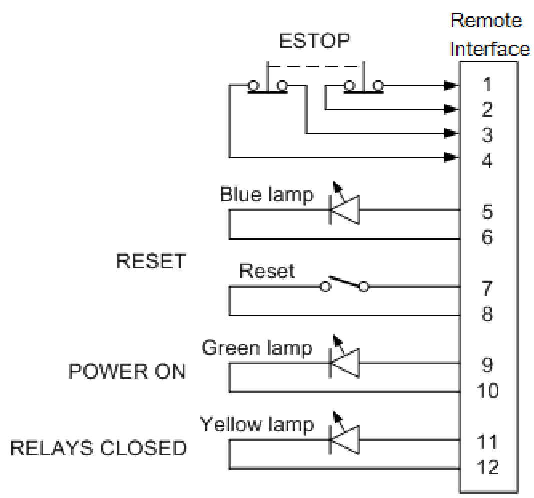
- In a master/slave configuration, connect the SDS interface cable to the *master* RP7900 unit.
- For detailed connection information for paralleled units, refer to Multiple Unit Connections.
- If remote sensing is being used, connect the sense leads of both RP7900 units to the RPS sense terminals on the SDS unit.

- If multiple RPS units are used in a paralleled group, each 60 A group will require its own dedicated SDS unit.

External Control Connections

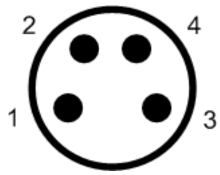
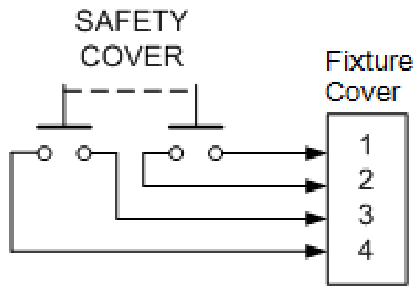
Several customer-configurable functions are available on the rear panel of the SDS (see Controlling the SDS Using Externally Wired Controls). The connectors and pin-out functions are described as follows:

Remote Interface (M12) Connector

Rear panel pinout view	Typical connections
	

Pin	Description
1	ESTOP switch, pins 1-2 switch contact normally-closed
2	ESTOP switch, pins 1-2 switch contact normally-closed
3	ESTOP switch, pins 3-4 switch contact normally-closed
4	ESTOP switch, pins 3-4 switch contact normally-closed
5	RESET lamp (blue) +24V
6	RESET lamp (blue) 24V return
7	RESET switch, contact normally-open
8	RESET switch, contact normally-open
9	Power On lamp (green) +24V
10	Power On lamp (green) 24V return
11	Relays Closed lamp (yellow) +24V
12	Relays Closed lamp (yellow) 24V return

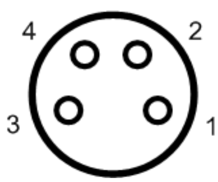
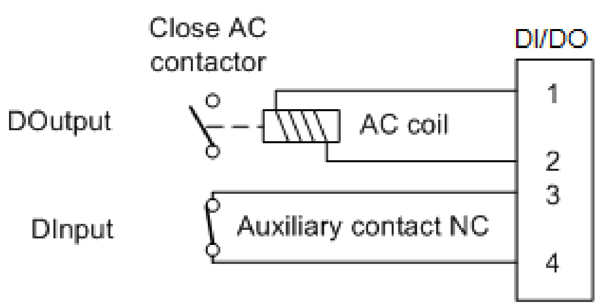
Fixture Cover (M8) Connector

<table>
<tr><th>Rear panel pinout view</th><th>Typical connections</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Pin	Description
1	Safety cover switch, pins 1-2 switch contact normally-open
2	Safety cover switch, pins 1-2 switch contact normally-open
3	Safety cover switch, pins 3-4 switch contact normally-open
4	Safety cover switch, pins 3-4 switch contact normally-open

DI/DO (M8) Connector

In Safety Disconnect mode the DI/DO inputs and outputs are intended to control an auxiliary AC contactor.

<table>
<tr><th>Rear panel pinout view</th><th>Typical connections</th></tr>
<tr><td>
</td><td>
</td></tr>
</table>

Pin	Description
1	DOutput, +24V drive signal for AC contactor (drive current ≤500 mA)
2	DOutput, 24V drive signal return
3	DInput, AC contactor OK when shorted to pin 4
4	DInput, AC contactor OK when shorted to pin 3

Mating Connector Part Numbers

Connector	Mates with	Phoenix Contact part number
M12 female	Remote Interface (M12)	1404420 (Wire gauge 24-28 AWG)
M8 female	Fixture Cover (M8)	1681185 (Wire gauge 22-28 AWG)
M8 male	DI/DO (M8)	1681169 (Wire gauge 22-28 AWG)

Typical Customer-supplied Components

Component	Description	Part number
ESTOP switch	2-pole NC, latching, compatible with 24V	Eaton C22-PVT45P-K02
RESET lamp/switch	Blue LED 24V with momentary contact NO switch	Eaton C22S-DL-B-K10-24
POWER ON lamp	Green LED 24V	Eaton C22-L-G-24
RELAYS CLOSED lamp	Yellow LED 24V	Eaton C22-L-Y-24
Safety cover switch	Mates directly with a magnetic relay	Pilz magnetic relay 504222
AC contactor	3-phase AC contactor with NC auxiliary contacts	Omron J7KNA-09-01

Operating the Keysight SD1000A Safety Disconnect System

Controlling the SDS Using the RP7900 Power Supply

Controlling the SDS Using Externally Wired Controls

Controlling the SDS Using the RP7900 series Power Supply

When connected to the RP7900 series power supply, the relays of the SDS automatically open and close along with the output state of the power supply.

Connecting to the SDS

Step 1. Make sure that the interface cable to the SDS has been installed (see Installation).

Step 2. Turn on the SDS first. The green Power On light on the SDS indicates that AC power is applied. The blue Reset light is also on because the SDS is not communicating with the RP7900 yet.

Step 3. Turn on the RP7900.

Step 4. Enable the SDS using the front panel of the RP7900 or the SCPI command.

Front Panel Menu Reference	SCPI Command
Select **System\SDS** Check ☑ hardware present	SYST:SDS:ENAB ON

Step 5. Connect the SDS unit to the RP7900 power supply. If the attempt to connect to the SDS fails, the RP7900 unit will go into an SDP protection.

Front Panel Menu Reference	SCPI Command
Select **System\SDS\Config** Click the Connect button to connect the SDS.	SYST:SDS:CONN

Step 6. (optional) You can program the RP7900 to automatically connect to the SDS at power-on.

Front Panel Menu Reference	SCPI Command
Select **System\SDS\Config** Select Auto in the Connect dropdown menu. Then press Select.	SYST:SDS:CONN:MODE AUTO

Step 7. Check the connection status of the SDS as follows:

Front Panel Menu Reference	SCPI Command
Select **System\SDS\Status** The State dialog will indicate the connection status of the SDS.	SYST:SDS:STAT?

Normal Relay Open/Close Sequence

In normal operation, the RP7900 power supply directly controls the state of the SDS relays to prevent hot-switching the DC relays. The following is the normal closing sequence of the SDS and the power supply:

1. Close the power relays
2. Enable the power supply output
3. Up-program the power supply output
4. Close the sense relays

The following is the normal opening sequence of the SDS and power supply:

1. Disable the power supply output
2. Open the sense and power relays

You may choose to Lock the output relays of the SDS closed to improve the output response time for applications that do not require a physical output disconnect during normal output on/off operation of the RP7900 power supply (see OUTput:RELay:LOCK).

The following is the latched "safe" state of the SDS after a safety disconnect event has occurred:

1. Power relays are open
2. Sense relays are open
3. "Connected" light is off
4. Power supply output is disabled
5. Discharge relays are closed and are discharging the DUT
6. Auxiliary output is disabled
7. General purpose output is disabled

As part of the safety-disconnect sequence, the SDS will discharge the UUT terminals to a level under 40V within three seconds. This provides for an additional level of safety at the UUT. This is accomplished by switching a 25 kΩ resistance for Option 500 and a 97.5 kΩ resistance for Option 950 across the output terminals of the SDS. In the unlikely event that UUT does not stop sourcing power, the SDS resistors are sized to tolerate the power draw continuously.

System Disconnect Protection

The RP7900 power supply periodically checks the status of the SDS. If at power-on or at any other time the SDS does not respond, the RP7900 will go into a latched System Disconnect Protection (SDP). If the SDS status indicates a fault condition, the RP7900 will also go into a latched SDP protection. Finally, latched protection will also occur if an external AC contactor is connected, but not active when the SDS relays are instructed to close.

A SYST:SDS:STAT? query can be used to determine the cause of an SDP.

An SDP protection can only be cleared by turning off the RP7900 unit, correcting the problem, and rebooting the RP7900 unit.

NOTE The SDS has a watchdog timer that will also put it into a safe state if communication with the RP7900 unit is lost.

Controlling the SDS Using Externally Wired Controls

NOTE The SDS must still be connected to the RP7900 when being controlled externally.

The external control lines described in this section must be wired to the appropriate connectors on the back of the SDS unit (see installation section). These external control lines provide an extra layer of operator safety, as they allow the SDS to be programmed externally of the RP7900 power supply.

Customer-supplied Emergency Stop (ESTOP) Switch

NOTE If an Emergency Stop safety switch is not being used, you must short Remote Interface pin 1 to pin 2 and pin 3 to pin 4. If the pins are not shorted, there will be a SDP protection event - requiring power cycling.

The ESTOP safety switch must be a dual-channel normally-closed switch that when pressed, puts the SDS in a latched, safe state that includes opening the main and sense relays and discharging the unit under test. Pressing ESTOP is a latched safety state requiring the operator to reset the SDS to exit the safe state. The ESTOP signals are located on the Remote Interface connector on the SDS rear panel.

The opening sequence in response to an ESTOP event is as follows:

1. Open the power relays
2. Open the sense relays
3. Disable the power supply output
4. Discharge the UUT
5. Remain in this latched safety state until the ESTOP event is removed and the RESET switch is pressed

When the SDS is in ESTOP mode, the power supply indicates a status of Inhibit (INH). A SCPI query can be used to determine the cause of the power supply inhibit.

It is recommended to provide a reset switch for the operator to clear the SDS condition and turn the output back on (see Reset Switch).

Customer-supplied Reset Switch

RESET is a momentary-contact, operator input switch used to manually reset the SDS and exit the latched safety state. Once the ESTOP switches are closed or any other error condition is rectified, the operator must press the RESET switch to use the system again. The RESET switch must be an illuminated blue switch that is located remotely, which indicates a reset is required when lit. An additional blue RESET lamp is also located on the SDS front panel. The RESET signals are located on the Remote Interface connector on the SDS rear panel.

The operation of the Reset lamps is defined as follows:

- Turns on when an ESTOP switch closes
- Turns on when an error condition occurs (loss of power, loss of communication, etc.)
- Turns off when ESTOP button is released and SDS and power supply are reset

Customer-supplied Fixture Cover Switches

NOTE If a fixture cover is not being used, you must short Fixture Cover pin 1 to pin 2 and pin 3 to pin 4. If the pins are not shorted, there will be a SDP protection event - requiring power cycling.

Fixture cover switches must be dual-channel, normally-open switches that are mechanically interlocked to a safety cover. This safety cover must limit access to the UUT during normal operation. The fixture cover input is a non-resetting input. When the fixture cover is opened allowing access to the UUT, the fixture cover switches open - initiating a disconnect sequence. When the fixture cover is closed all switches close, returning the SDS to the previous state. The fixture cover signals are located on the Fixture Cover connector on the SDS rear panel.

The operating sequence of the SDS in response to an open fixture cover input is as follows:

1. Opens the power relays
2. Opens the sense relays
3. Disables the power supply output
4. Discharges the UUT
5. Returns the SDS and power supply to the prior state when the cover is closed

The SDS remains in the safe state as long as the fixture cover input is true (open). When the fixture cover is open, the power supply indicates a status of Inhibit (INH). A SCPI query can be used to determine the cause of the power supply inhibit.

Customer-supplied AC Contactor

NOTE If an AC contactor is not being used, you must short DI/DO pin 3 to pin 4. If the pins are not shorted, there will be a SDP protection event - requiring power cycling.

A programmable general purpose output, +24V (DOutput-1) with a return (DOutput-2), is available on the DI/DO connector on the SDS rear panel to control the relay coil of an external AC contactor. Normally-closed auxiliary contacts from the AC contactor should also be wired to DInput-3 and DInput-4 to sense the state of the AC contactor. The DInput-DOutput combination form a safety handshake with the AC contactor.

Select the general purpose output as follows:

Front Panel Menu Reference	SCPI Command
Select **System\SDS\Output** Specify a 1 to enable the general purpose output. Then press Select.	SYST:SDS:DIG:DATA:OUTP 1

The operating mode of the SDS when an external AC contactor is installed is as follows:

- When either the SDS relays or the AC contactor is enabled (programmed to close), the SDS checks to see if the AC contactor is presently open (DInput-3 and DInput-4 shorted).
- If the digital input is shorted, the SDS relays and the contactor can be enabled and disabled.
- If the digital input is open without the contactor being enabled, the SDS goes into SDP protection.
- If the digital input opens after the contactor is enabled via the front panel or a SCPI command, the SDS relays can be enabled or disabled.
- The SDS contactor-check will reset when both the SDS relays and the contactor are disabled.

NOTE The command processing time is much faster than the time it takes to change the relay state of the contactor. If you quickly send an AC contactor enable command, then an off command, and then another on command, the digital input could read an open causing the unit to go into protect.

External Control Status Information

You can return the status of the external control functions via the front panel of the power supply.

Front Panel Menu Reference	SCPI Command
Select **System\SDS\Data\Input** Safety Cover - closed or open EStop signal - off or on Relay Control - internal or external Remote start - off or on	not available

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