Keysight N6705C
DC Power Analyzer

Operating and
Service Guide

KEYSIGHT
TECHNOLOGIES

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Legal and Safety Information

Legal Notices

Safety Notices

Safety Symbols

Legal Notices

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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.


Caution, risk of electric shock


Caution, refer to accompanying documents


Earth ground terminal


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



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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.

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

ISM1-A This text indicates that the instrument is an Industrial Scientific and Medical Group 1 Class A product (CISPER 11, Clause 4).

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

Safety Notices

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

WARNING 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.

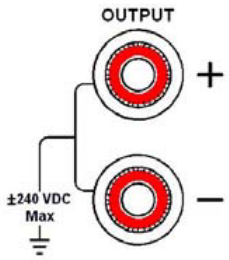
WARNING Ground the Instrument

This product is provided with protective earth terminals. To minimize shock hazard, the instrument must be connected to the AC mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in injury or death.

WARNING Load Connections

Power supplies can output high currents and high voltages. Make sure that the load or device under test can safely handle the output current and voltage. Also, make sure that the connection leads can safely withstand the expected currents and are insulated for the expected voltages.

Power supply outputs may be connected so as to float relative to earth ground. Isolation or floating voltage ratings are indicated on the instrument, near the output connectors (see below). Do not float the power supply output on the line-voltage mains. Observe all safety markings and protection limits.



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 Some power modules generate voltages exceeding 60 VDC

Ensure that instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

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 user accessible.

WARNING Cleaning

To prevent electric shock, always unplug the unit 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.

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1 Quick Reference

Legal and Safety Information

Introduction to the Instrument

Front Panel Menu Reference

Command Quick Reference

Model Descriptions, Differences, and Options

Specifications and Characteristics

This document includes user, service, and programming information for the Keysight N6705C DC Power Analyzer .

Documentation and Firmware Revisions

You can download the latest version of this document at www.keysight.com/find/n6705-doc. The latest version is also available for mobile devices at www.keysight.com/find/n6705-mobilehelp. If you have feedback on this document, please contact Keysight at www.keysight.com/find/n6705-docfeedback.

This document describes firmware revision E.02.01 and up. For the latest firmware revision go to Firmware Updates.

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KEYSIGHT TECHNOLOGIES

Introduction to the Instrument

Features at a Glance

Front Panel at a Glance

Rear Panel at a Glance

Meter View

Scope View

Data Logger View

Arbitrary Waveform Preview

Features at a Glance

The Keysight N6705 DC Power Analyzer is a multi-functional power system that combines the functions of a multiple-output DC voltage source with the waveform/data capturing capability of an oscilloscope and data logger.

As a multiple-output DC source, the Keysight N6705 provides up to four configurable outputs. Available power modules have power levels of 20 W through 500 W, have various voltage and current combinations, and provide a variety of performance features as described under Model Differences. Each output also has arbitrary (Arb) waveform generation capability, which lets you program predefined voltage and current waveforms – or define your own waveforms. Keysight N678xA Source/Measure Units (SMU) have a multiple-quadrant power mesh with separate voltage and current priority source modes. Keysight N679xA Electronic Load Modules are single-quadrant 100 W and 200 W loads having constant current, constant voltage, constant power, and constant resistance operating capabilities.

As a measurement system, the Keysight N6705 displays the average output voltage and current in Meter View. Waveforms are displayed in Scope View, which you can adjust using vertical and horizontal controls. The Data Logger View measures and charts average and peak voltage and current measurements over an extended period.

Output Features

- Color-coded display and output controls - The color-coded display and output controls let you easily identify which output is being controlled.
- Programmable voltage, current, power, or resistance - Full programming capability is provided for the entire range of output voltage and current for all power modules. Power and resistance programing is available on Keysight N679xA load modules.
- Low Output Noise - Available on Keysight N676xA and N675xA power modules. Output noise is <4.5 mV peak-to-peak, which is comparable to linear supplies.

- Arbitrary waveform generation - This allows the output to act as a DC bias transient generator or an arbitrary waveform generator.
- Fast up/down programming - Available on Keysight N675xA, N676xA, and N678xA SMU power modules. ≤1.5 millisecond response time from 10% to 90% of the output rating.
- Fast transient response - Available on Keysight N675xA, N676xA, and N678xA SMU power modules. Transient response is less than 100 µs.
- Output autoranging capability - Available on Keysight N676xA and N675xA power modules. Autoranging supplies the maximum rated power over a continuous range of voltage and current settings
- Output On/Off sequencing - A turn-on/turn-off delay capability for each output allows output on/off sequencing.
- Front panel binding posts + and – output and + and – sense terminals are provided for each output. Sense terminals provide 4-wire voltage measurements.
- Output protection - Each output has over-voltage, over-current, and over-temperature protection. Over-voltage and over-current protection are programmable.
- Emergency shut-off + and – output and + and – sense terminals are provided for each output. Sense terminals provide 4-wire voltage measurements.
- Multiple-Quadrant operation - Available on Keysight N678xA SMU and N6783A power modules. 2- quadrant operation provides source and sink output capability. Keysight model N6784A offers 4- quadrant output operation.
- Electronic Load operation - Available on Keysight N679xA load modules. 100 W and 200 W input ratings are available.

Measurement features

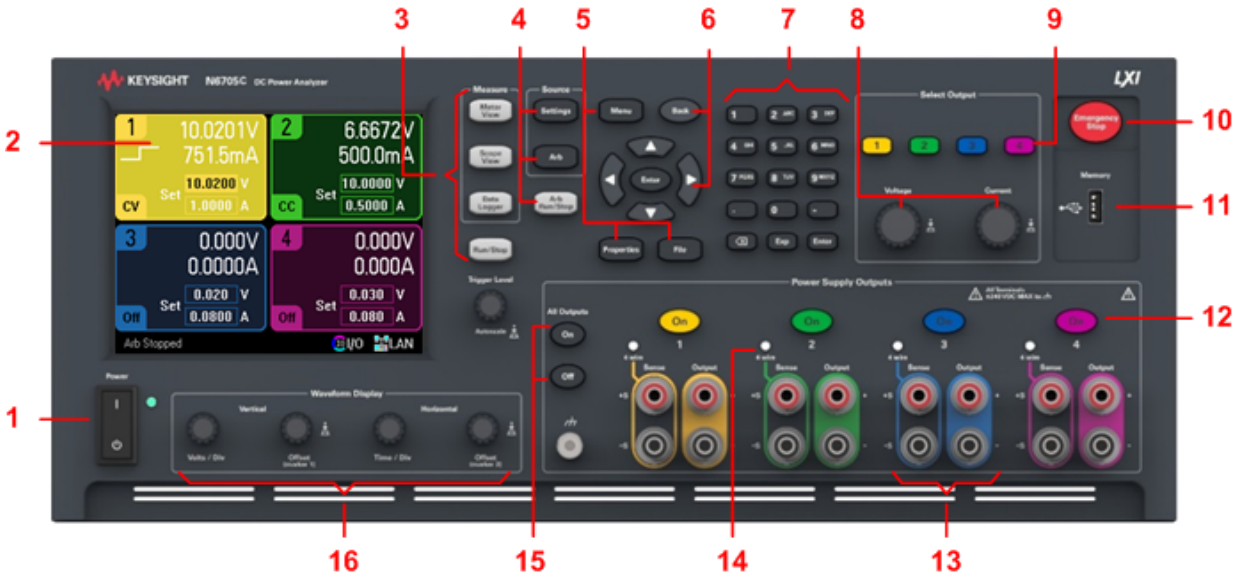
- Multiple-output/Single-output meter display - Switch between a 4-output summary view and a 1-output detailed view of power analyzer information. All power modules display real-time output voltage and current measurements as well as status information.
- Scope-like display - Voltage and/or current waveforms of all outputs can be simultaneously displayed. Adjustable markers provide calculated measurements.
- Data logging display - Average, minimum, and maximum voltage and current values can be logged over an extended time period to the display. Adjustable markers provide calculated measurements.
- Measurement functions - Average, minimum, and maximum values are provided for all voltage and current measurements. Output power (Watts) is calculated for all outputs in single-output meter view.
- Seamless measurement autoranging - Available on Keysight N678xA SMU power modules. Output measurements seamlessly autorange between ranges – however, the 10 µA current range must be selected manually.

- **Microampere current measurements** - Available on Keysight N6761A, N6762A, and N678xA SMU power modules. Current measurement can be made as low as 1 µA in the 10 µA range.
- **Fast Digitizing** Available on Keysight N678xA SMU power modules. 5.12 µs/sample for one parameter; 10.24 µs/sample for two parameters.
- **Histogram measurement** - Available on Keysight N6781A N6782A, N6785A, and N6786A SMU power modules. Provides a statistical measurement for profiling the measured current.

System features

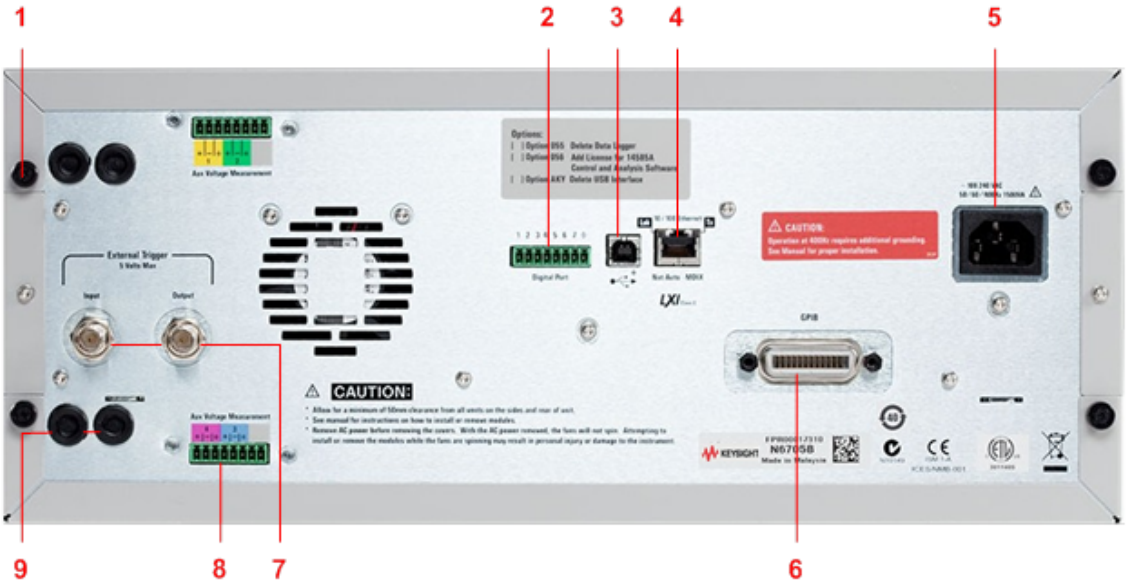
- **Choice of three interfaces** - GPIB (IEEE-488), LAN, and USB remote programming interfaces are built in.
- **Built-in Web server** - A built-in Web server lets you control the instrument directly from an internet browser on your computer.
- **SCPI language** - The instrument is compatible with the Standard Commands for Programmable Instruments (SCPI).
- **Savable instrument data** - A file management system saves display bitmaps, instrument states, scope results, arbitrary waveforms, and data log results.
- **Memory port** - Front USB port allows files to be saved to an external USB memory device.
- **Trigger connectors** - Rear panel trigger in/out BNC connectors.
- **Low acoustic noise** - Low acoustic noise for quiet bench operation.
- **Universal AC input** - Mainframes have universal input voltage capability with active power factor correction.

Front Panel at a Glance



1. Line switch - Turns the instrument On or Off.
2. Display - Displays all instrument functions - information changes based on selected function.
3. Measure keys - Selects the measurement function - Meter View, Scope View, or Data Logger. Run-/Stop key starts or stops the scope or data log measurement.
4. Source keys - Programs the source function – Source Settings or Arbitrary waveform. Arb Run-/Stop key starts or stops the arbitrary waveform function.
5. Menu, Properties, File keys - Menu key accesses all mode controls via a hierarchical command menu. Properties key displays information specific to the active view (this is a menu shortcut). File key lets you save the current display, instrument settings, and measurements.
6. Navigation keys - Navigate through the control dialog windows; press the Enter key to select a control. Back key cancels the values entered into the dialog and backs out of the control.
7. Numeric/Alpha Entry keys - Enters numeric and alpha values. Alpha keys automatically become active on fields that allow alpha character entry. Repeatedly pressing the key scrolls thorough the selections.
8. Voltage/Current knobs - Sets the voltage and current of the selected output.
9. Select Output keys - Selects an output to control. The lit key indicates the selected output.
10. Emergency Stop - Turns off all outputs without any delays; aborts any arbitrary waveforms.
11. Memory port - USB Memory device connector. Option AKY deletes the connector.
12. On Keys - Turns individual outputs On or Off; outputs are on when the key is lit.
13. Binding posts - The + and – output and sense binding post terminals for all outputs.
14. 4 Wire - Indicates that 4 Wire sensing is enabled on the output.
15. All Outputs On/Off keys - Turns all outputs On and Off according to the specified turn-on and turn-off delay.
16. Waveform Display controls - Controls the scope and data logging views.
    Vertical knobs control the vertical size and position. Press Offset to set marker 1. Horizontal knobs control the horizontal size and position. Press Offset to set marker 2. The Trigger knob moves the trigger level up or down. Press this knob to autoscale.

Rear Panel at a Glance



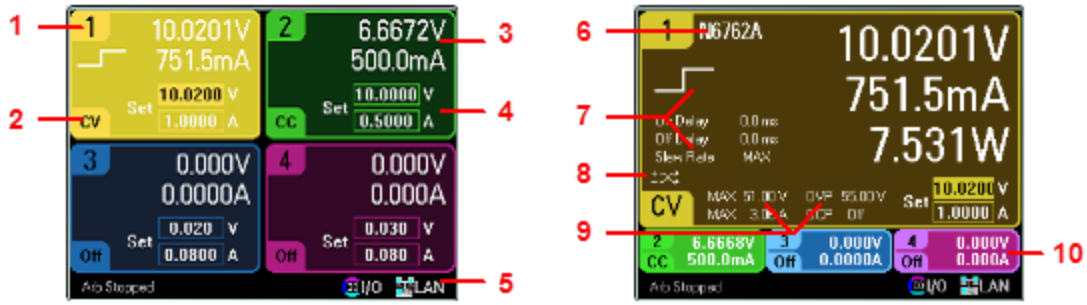
1. Cover screw - Facilitates top and bottom cover removal for power module installation.
2. Digital port connector - Connects to the 8-pin digital port. Port functions are user-configurable. Refer to Using the Digital Control Port for details.
3. USB connector - Connects to USB interface. May be disabled from front panel menu. Option AKY deletes the connector.
4. LAN connector - Connects to 10/100 Base-T interface. Left LED indicates activity. Right LED indicates link integrity. May be disabled from front panel menu.
5. IEC 320 connector - AC input connector. Power cord requires a ground conductor..
6. GPIB connector - GPIB interface connector. May be disabled from front panel menu.
7. Trigger connectors - BNC connectors for trigger in and trigger out signals. Refer to Trigger Commands for signal descriptions.
8. Auxiliary connectors - Auxiliary voltage measurement connectors. Only for use with Keysight N6781A and N6785A power modules.
9. Wiring access ports - Access for sense and output wire connections. Used for output connections on power modules rated >20 A. Also used for Keysight N678xA SMU power modules when extremely precise measurements or output guarding is required.

WARNING SHOCK HAZARD The power cord provides a chassis ground through a third conductor. Be certain that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

Meter View

Press **Meter View**

This key toggles between multiple and single output views.



Multiple Output View | Single Output View

1. Output Identifier	Identifies the output. When an output is selected, the background becomes highlighted. The selected output is displayed in an enlarged format in single output view.	
2. Output Status	Off: the output is off CV: the output is in constant voltage mode CC: the output is in constant current mode Unr: the output is unregulated CP+, CP–: a positive or negative power limit CL+, CL–: a positive or negative current limit VL+, VL–: a positive or negative voltage limit OV: over-voltage protection tripped	OV–: negative voltage protection tripped OC: over-current protection tripped OT: over-temperature protection tripped PF: a power-fail condition occurred Inh: an external inhibit signal is received Osc: the oscillation protection tripped Prot: a coupled output protect occurred SH: the load input is shorted (N679xA) UVI: an under-voltage inhibit occurred (N679xA)
3. Output Meter	Displays the actual output voltage and current. Displays power in single output view.	
4. Output Setting	Displays the present output voltage and current settings. Turn the front panel voltage or current knob to adjust these settings. Can also be changed using the numeric keypad.	
5. Remote Status	Error – an error has occurred (press the Menu key, select Utilities, then Error Log) LAN – the LAN is connected and has been configured IO – there is activity on one of the remote interfaces	
6. Model Number	Identifies the model number of the power module connected to this output.	
7. Arb, Delay, & Slew Rate	Displays the Arb waveform that is presently configured for this output. If no Arb is configured, no waveform will be displayed. Also displays the Output On and Output Off delay settings as well as the slew rate setting.	
8. Polarity Reverse	Indicates that the output and sense polarities are reversed.	
9. Ratings & Protection	Displays the maximum voltage and current ratings of the output. Also displays the present over-voltage protection setting and whether over-current protection is on or off.	
10. Other Outputs	Displays the actual voltage, current, and status of the other outputs.	

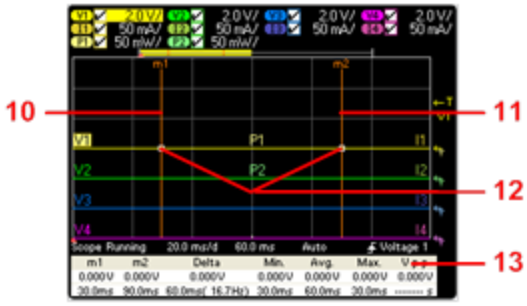
Scope View

Press **Scope View**

This key toggles between standard and marker views.



Standard View



Marker View

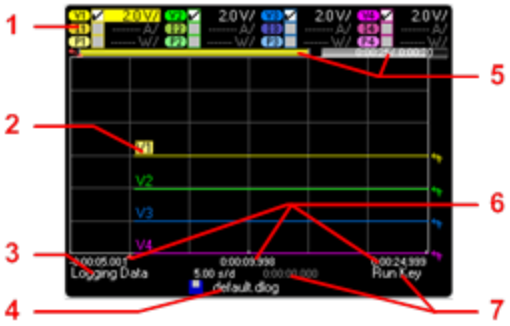
1. Trace Controls	Identifies the voltage or current trace that will be displayed. Dashes (----) indicate that the specified trace is turned off. Select the trace and press Enter to turn it on or off.
2. Output Traces	V1, V2, V3, and V4 indicate voltage traces. I1, I2, I3, and I4 indicate current traces. P1 and P2 indicate power traces. Press Trigger Level knob to autoscale all traces .
3. Horizontal Time-base	Identifies the horizontal time-base settings. These can be adjusted using the front panel Horizontal Time/Div and Offset knobs.
4. Scope Status	Indicates whether the scope is idle, running, or waiting for a trigger.
5. Data Bar	The highlighted area shows how much of the entire measurement is actually shown on the display. Use the Horizontal Time/Div knob and Offset knob to adjust the display
6. Trigger Level	Identifies the trigger level through which the waveform must pass before the scope will trigger. This can be adjusted using the Trigger Level knob.
7. Ground	Identifies the ground reference level for the trace. This can be adjusted using the Vertical Offset knob. The initial vertical offset of each trace is set to a different level to prevent the traces from overlapping.
8. Trigger Mode	Identifies the trigger mode setting. This can be selected by pressing the Properties key.
9. Trigger Source	Identifies the trigger source and trigger level. Voltage 1 indicates a voltage level on output 1 is the trigger source (see #6).
10. M1 Marker	Measurement Marker 1 enabled. Adjust using Marker 1 knob. Press knob to reset.
11. M2 Marker	Measurement Marker 2 enabled. Adjust using Marker 1 knob. Press knob to reset.
12. Intersect Point	Shows where the measurement markers intersect the waveform.
13. Meas-urements	Shows the calculations of the waveform data between Marker 1 and Marker 2.

Data Logger View

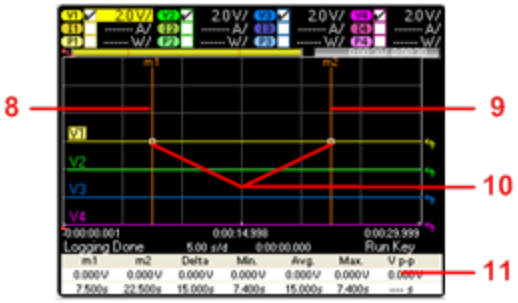
NOTE Option 055 deletes the Data Logger function on Model N6705

Press **Data Logger**

This key toggles between standard and marker views.



Standard View



Marker View

1. Trace Controls	Identifies the voltage or current trace that will be displayed. Dashes (----) indicate that the specified trace is turned off. Select the trace and press Enter to turn it on or off.
2. Output Traces	Voltage, current, or power traces. Voltage traces V1,V2, V3 and V4 shown. Press Trigger Level knob to autoscale all traces.
3. Status	Indicates whether the Data Logger is logging data, done logging, or is empty.
4. Filename	Indicate the file to which the data is being logged.
5. Data Bar & Time Elapsed	Displays the progress of the data logger. The yellow bar indicates the visible data. Numbers to the right indicate time elapsed/total duration.
6. Time base Information	Displays the time remaining before the trigger point; the time at the center line of the grid in relation to trigger point; and the time elapsed since the trigger
7. Trigger	Identifies the trigger source and trigger offset. The trigger offset is specified in % of the total duration, but shown in seconds on the display
8. M1 Marker	Measurement Marker 1 enabled. Adjust using Marker 1 knob. Press knob to reset.
9. M2 Marker	Measurement Marker 2 enabled. Adjust using Marker 1 knob. Press knob to reset.
10. Intersect Point	Shows where the measurement markers intersect the waveform.
11. Meas-urements	Shows the calculations of the waveform data between Marker 1 and Marker 2.

Arbitrary Waveform Preview

Press **Arb**

This dialog displays the arbitrary waveforms that have been configured.



Arb Preview

1. DC Value	This column indicates the present output voltage or current setting that appears at the output before the Arb is run. The output will return to this value after the Arb complete if the **Return to DC value** box has been checked. If the **Last Arb Value** box is checked, the output will remain at the last programmed Arb value.
2. Output	This column identifies the output channel on which the associated waveform will run. Use the navigation keys to select an output if you wish to select an Arb or edit the Arb on that output channel.
3. Wave shapes	This column illustrates the waveshapes that will run on each output when the arb(s) are started. Note that all Arbs will run simultaneously.
4. Trigger Source	This dropdown list selects the trigger source for all configured Arbs.
5. Repeat	This column indicates how many times the Arb will repeat if it has been configured to repeat. If the column is blank, the Arb will only run once.
6.	Indicates that the Arb on output 2 runs continuously.
7. 3	Indicates that the Arb on output 3 repeats three times.
8. Time	Indicates the time that the longest Arb will run. In this example, all Arbs run the same amount of time.
9. Close	Closes the Arb Preview and returns to the previous measurement view.

Front Panel Menu Reference

This is an overview of the front-panel menus. For a brief tutorial, refer to Use the Front Panel Menu. Press the **Menu** key to access the front panel menus.

Menu Heading	Description
Source Settings ►	
Voltage and Current Settings...	Configures voltage, current, power, and resistance settings, ranges, and emulation.
Protection...	Configures the over-voltage and over-current protection. Enables output coupling so ALL outputs are disabled when a fault occurs. Also clears output protection.
Advanced Protection...	Enables/disables the output inhibit function.
Output On/Off Delays...	Configures output on/off delays.
Output On/Off Coupling...	Couples specific outputs for the output on/off and delay function
Output Grouping...	Groups identical outputs for output paralleling function.
Advanced...	Configures advanced functions including slew rate, sensing, and power limit.
Ratings...	Displays power module ratings, serial number, firmware, and option information.
Arb ►	
Arb Preview	Displays the present status of the configured arbitrary waveforms.
Arb Selection...	Selects arbitrary waveforms for each output. Arb Properties configures the selected Arb.
Meter ►	
All Outputs Meter View	Displays the meter view of all outputs.
Single Output Meter View	Displays the meter view of the selected output.
Meter Properties...	Configures the meter view voltage and current measurement ranges.
Scope ►	
Standard View	Displays the standard scope view including vertical, horizontal, and trigger settings.
Marker View	Displays the measurement markers and measurement calculations area.
Scope Properties...	Configures the scope traces and voltage and current measurement ranges for individual outputs. Also configures the trigger source, mode, and horizontal offset.
Marker Properties...	Configures the measurements that appear on the bottom of the display in Marker view.
Horizontal Properties...	Configures the horizontal offset reference and sample points.
Datalogger ►	
Standard View	Displays the data log strip chart view including vertical, horizontal, and progress settings.

Menu Heading	Description
Marker View	Displays the measurement markers and measurement calculations area.
Datalogger Properties...	Configures the data log traces and voltage and current measurement ranges for individual outputs. Also configures the data log duration, sample period, and Min/Max values.
File Name Selection...	Specifies the filename for the next data logger acquisition.
Marker Properties...	Configures the measurements that appear on the bottom of the display in Marker view.
File ►	
Save...	Saves an instrument state or a scope measurement.
Load...	Loads an instrument state, scope data, or logged data.
Export...	Exports scope data, logged data, or a user-defined arbitrary waveform.
Import...	Imports s user-defined arbitrary waveform.
Screen Capture...	Captures the screen that was active when the File key was pressed.
File Management...	Accesses additional file functions: Show Details, Delete, Rename, Copy, New Folder.
Reset/Recall/Power-On State...	Resets the instrument to factory defaults; Saves/recalls instrument states; and specifies the power-on turn on state.
Utilities ►	
Error Log...	Lists all error messages.
IO Configuration ►	
Active LAN Status...	Displays the LAN status and active settings.
LAN Settings...	Configures the LAN interface. Enables/disables the LAN services, GPIB, and USB.
GPIB/USB...	Configures the GPIB and USB interface.
User Preferences ►	
Front Panel Preferences...	Configures screen saver, front panel key functions, and initial meter view.
Front Panel Lockout...	Password-protects the front panel keys.
Clock Setup...	Sets up the internal clock.
*IDN Setup...	Change manufacturer and model number for backward compatibility.
Administrative Tools ►	
Administrator LoginLogout	Accesses the password-protected administrative functions.
Calibration ►	Accesses the calibration functions: Turn On/Off, Voltage, Current, Miscellaneous, Date, Save, Count.
Sanitize...	Performs NISPOM secure erase of all user data.
Firmware Update...	Restricts unauthorized access by the Firmware Update Utility.

Menu Heading	Description
Install Options...	Installs additional firmware options. Requires Option key.
Change Admin Password...	Changes the administrator password.
Digital IO...	Configures the digital port. Pins can be individually configured.
Help ►	
Overview...	A brief overview.
Quick Start ►	How to quickly get started.
Using the Keysight N6705 ►	How to use the Keysight N6705.
Using the Utilities ►	How to use the utilities.
Front Panel Controls ►	How to use the front panel controls.
Front Panel Navigation...	How to navigate the front panel display.
Module Capabilities and Ratings	How to obtain module capabilities/ratings.
About	Identifies the mainframe and the installed modules.

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 (@chanlist)	Cancels any triggered measurements.
:DLOG	Stops internal data logging.
:ELOG (@chanlist)	Stops external data logging.
:HISTogram (@chanlist)	Stops the histogram current measurement. (N6781A/82A/85A/86A)
:TRANsient (@chanlist)	Cancels any triggered actions.

CALibrate

:COUNt?	Returns the number of times the unit has been calibrated.
:CURRent	
[:LEVel] <*value*>, (@channel)	Calibrates the current programming.
:LIMit	
:NEGative <*value*>, (@channel)	Calibrates negative current limit. (N678xA SMU, N6783A-BAT)
:POSitive <*value*>, (@channel)	Calibrates positive current limit. (N678xA SMU, N6783A, N679xA)
:MEASure <*value*>, (@channel)	Calibrates the current measurement.
:PEAK (@channel)	Calibrates peak current limit (N675xA, N676xA)
:DATA <*value*>	Enters the calibration value read by the external meter.
:DATE <*"date"*>, (@channel)	Stores the calibration date in nonvolatile memory.
:DPRog (@channel)	Calibrates the current downprogrammer.
:LEVel P1|P2|P3	Advances to the next level in the calibration.
:PASSword <*value*>	Sets a numeric password to prevent unauthorized calibration.
:RESistance 20 | 6, (@channel)	Calibrates the output resistance. (N6781A, N6785A)
:SAVE	Saves the calibration constants in non-volatile memory.
:STATe 0|OFF|1|ON	Enables or disables calibration mode.
:VOLTage	
[:LEVel] <*value*>, (@channel)	Calibrates the voltage programming.
:CMRR, (@channel)	Calibrates the voltage common mode rejection ratio. (N675xA, N676xA)
:LIMit	
:POSitive <*value*>, (@channel)	Calibrates positive current limit. (N678xA SMU)
:MEASure <*value*>, (@channel)	Calibrates the voltage measurement.
:AUXiliary, (@channel)	Calibrates the auxiliary voltage measurement. (N6781A, N6785A)

DISPlay

[:WINDow]	
[:STATe] 0|OFF|1|ON	Turns the front panel display on or off.
:VIEW METER1 | METER4	Selects 1-channel or 4-channel meter view.

FETCh

[:SCALar]	
:CURRent	
[:DC]? (@chanlist)	Returns the averaged measurement.
:ACDC? (@chanlist)	Returns the RMS measurement (AC + DC).
:HIGH? (@chanlist)	Returns the High level of a pulse waveform.
:LOW? (@chanlist)	Returns the Low level of a pulse waveform.
:MAXimum? (@chanlist)	Returns the maximum value.
:MINimum? (@chanlist)	Returns the minimum value.
:POWer	
[:DC]? (@chanlist)	Returns the averaged measurement. (N676xA/N678xA/N679xA)
:MAXimum? (@chanlist)	Returns the maximum value. (N676xA/N678xA/N679xA)
:MINimum? (@chanlist)	Returns the minimum value. (N676xA/N678xA/N679xA)
:VOLTage	
[:DC]? (@chanlist)	Returns the averaged measurement.
:ACDC? (@chanlist)	Returns the RMS measurement (AC + DC).
:HIGH? (@chanlist)	Returns the High level of a pulse waveform.
:LOW? (@chanlist)	Returns the Low level of a pulse waveform.
:MAXimum? (@chanlist)	Returns the maximum value.
:MINimum? (@chanlist)	Returns the minimum value.
:ARRAY	
:CURRent	
[:DC]? (@chanlist)	Returns an array with the instantaneous measurement.
:POWer	
[:DC]? (@chanlist)	Returns an array with the instantaneous measurement. (N676xA/N678xA/N679xA)
:VOLTage	
[:DC]? (@chanlist)	Returns an array with the instantaneous measurement.
:DLOG	
:AHOur? (@chanlist)	Returns the amp-hours between markers.
:CURRent	
[:DC]? (@chanlist)	Returns the average current between markers.
:MAXimum? (@chanlist)	Returns the maximum current between markers.
:MINimum? (@chanlist)	Returns the minimum current between markers.
:PTPeak? (@chanlist)	Returns the peak-to-peak current between markers
:VOLTage	
[:DC]? (@chanlist)	Returns the average voltage between markers.
:MAXimum? (@chanlist)	Returns the maximum voltage between markers.
:MINimum? (@chanlist)	Returns the minimum voltage between markers.
:PTPeak? (@chanlist)	Returns the peak-to-peak voltage between markers
:WHOur? (@chanlist)	Returns the watt-hours between markers.
:ELOG? <*value* (@chanlist)	Returns the most recent external datalog records.
:HISTogram	(HISTogram command only applies to models N6781A/82A/85A/86A)
:CURRent 8 | 0.0039, (@chanlist)	Returns the cumulative histogram current data

FORMat

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

HCOPy

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

IEEE 488.2 Common Commands

*CLS	Clears status.
*ESE <*value*>	Sets standard event status enable.
*ESR?	Returns event status register.
*IDN?	Returns instrument identification.
*OPC	Enables "operation complete" bit in ESR.
*OPC?	Returns a 1 when all pending operations complete.
*OPT?	Returns option number.
*RCL <*value*>	Recalls a saved instrument state.
*RDT?	Returns output channel descriptions.
*RST	Resets the instrument.
*SAV <*value*>	Saves an instrument state.
*SRE <*value*>	Sets service request enable register.
*STB?	Returns the status byte.
*TRG	Generates a trigger.
*TST?	Performs a selftest, then returns results.
*WAI	Pauses additional command processing until all device commands are done.

INITiate

[:IMMediate]	
:ACQuire (@chanlist)	Initiates the measurement trigger system.
:DLOG <"filename">	Initiates internal data logging.
:ELOG (@chanlist)	Initiates external data logging.
:HISTogram (@chanlist)	Initiates histogram measurements. (N6781A/82A/85A/86A)
:TRANsient (@chanlist)	Initiates the transient trigger system.
:CONTinuous	
:TRANsient 0|OFF|1|ON, (@chanlist)	Continuously initiates the transient trigger system.

LXI

:IDENtify	
[:STATe] 0|OFF|1|ON	Turns the front panel LXI identify indicator on or off.
:MDNS	
[:STATe] 0|OFF|1|ON	Controls the state of the mDNS server.

MEASure

[:SCALar]	
:CURRent	
[:DC]? (@chanlist)	Takes a measurement; returns the averaged current.
:ACDC? (@chanlist)	Takes a measurement; returns the RMS current (AC + DC).
:HIGH? (@chanlist)	Takes a measurement; returns the High level of a current pulse.
:LOW? (@chanlist)	Takes a measurement; returns the Low level of a current pulse.
:MAXimum? (@chanlist)	Takes a measurement; returns the maximum current.
:MINimum? (@chanlist)	Takes a measurement; returns the minimum current.
:POWer	
[:DC]? (@chanlist)	Takes a measurement; returns the averaged power. (N676xA/N678xA/N679xA)
:MAXimum? (@chanlist)	Takes a measurement; returns the maximum power. (N676xA/N678xA/N679xA)
:MINimum? (@chanlist)	Takes a measurement; returns the minimum power. (N676xA/N678xA/N679xA)
:VOLTage	
[:DC]? (@chanlist)	Takes a measurement; returns the averaged voltage.
:ACDC? (@chanlist)	Takes a measurement; returns the RMS voltage (AC + DC).
:HIGH? (@chanlist)	Takes a measurement; returns the High level of a voltage pulse.
:LOW? (@chanlist)	Takes a measurement; returns the Low level of a voltage pulse.
:MAXimum? (@chanlist)	Takes a measurement; returns the maximum voltage.
:MINimum? (@chanlist)	Takes a measurement; returns the minimum voltage.
:ARRAY	
:CURRent	
[:DC]? (@chanlist)	Takes a measurement; returns the instantaneous current.
:POWer	
[:DC]? (@chanlist)	Takes a measurement; returns the instantaneous power. (N676xA/N678xA/N679xA)
:VOLTage	
[:DC]? (@chanlist)	Takes a measurement; returns the instantaneous voltage.

MMEMory

:ATTRibute? <“object”>, <“attribute”>	Gets the attributes of a file system object.
:DATA [:DEFinite]? <“filename”>, <data>	Copies file contents; response is a definite length binary block.
:DELete <“filename”>	Deletes a file.
:EXPort	
:DLOG <“filename”>	Exports a data log from the display to a file.
:LOAD	
:ARB:SEQuence <“filename”>, (@chanlist)	Loads an Arb sequence.
:STORe	
:ARB:SEQuence <“filename”>, (@chanlist)	Stores an Arb sequence.

OUTPut

[:STATe] 0|OFF|1|ON [,NORelay], (@chanlist)	Enables or disables the output.
:COUPle	
:CHANnel [<*value*>, {<*value*>}]	Selects which channels are coupled.

:DOFFset <*value*>	Sets a delay offset to synchronize coupled output state changes.
:MODE AUTO|MANual	Specifies the output delay offset coupling mode.
:MAX	
:DOFFset?	Returns the delay offset required for this instrument.
:DELay	
:FALL <*value*>, (@chanlist)	Sets the output turn-off sequence delay.
:RISE <*value*>, (@chanlist)	Sets the output turn-on sequence delay.
:PMODE VOLTage|CURRent, (@chanlist)	Sets the mode for turn-on/off transitions. (N6761A, N6762A)
:TMODE HIGHz|LOWZ, (@chanlist)	Specifies the turn-on/turn-off impedance. (N678xA SMU)
:INHibit	
:MODE LATChing|LIVE|OFF	Sets the operating mode of the remote inhibit digital pin.
:PON	
:STATe RST|RCL0	Set the output power-on state.
:PROTection	
:CLEar (@chanlist)	Resets the latched protection.
:COUPle0|OFF|1|ON	Enables/disables channel coupling for protection faults.
:DELay <*value*>, (@chanlist)	Sets the over-current protection programming delay.
:OSCillation0|OFF|1|ON, (@chanlist)	Enables/disables output oscillation protection. (N678xA SMU)
:TEMPerature	
:MARGin? (@chanlist)	Returns the margin remaining before the over-temperature trips.
:WDOG	
[:STATe] 0|OFF|1|ON	Enables/disables the I/O watchdog timer.
:DELay <*value*>	Sets the watchdog delay time.
:RELay	
:POLarity NORMal|REVerse, (@chanlist)	Sets the polarity of the output relays. (Option 760)
:SHORt	
[:STATe] 0|OFF|1|ON	Simulates a short circuit on the input of the load. (N679xA)

SENSe

:CURRent	
:CCOMpensate 0|OFF|1|ON, (@chanlist)	Enables/disables capacitive current compensation. (not on N678xA SMU, N679xA)
[:DC]	
:RANGe	
[:UPPer] <*value*>, (@chanlist)	Selects a DC current measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:DLOG	
:CURRent	
[:DC]	
:RANGe	
[:UPPer] <*value*>, (@chanlist)	Selects the internal data log current measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:FUNCtion	
:CURRent 0|OFF|1|ON, (@chanlist)	Enables/disables current data logging.

:MINMax 0|OFF|1|ON	Enables/disables min/max internal data logging.
:VOLTage 0|OFF|1|ON, (@chanlist)	Enables/disables voltage data logging.
:MARKer<1|2>	
:POINt *<value>*	Positions the data log markers
:OFFSet *<value>*	Sets trigger offset as a percent from start of data log duration.
:PERiod *<value>*	Sets the interval between samples (replaces TINTerval).
:TIMe *<value>*	Sets the duration of the internal data log in seconds
:TINTerval *<value>*	Sets the interval between samples (for backward compatibility)
:VOLTage	
[:DC]	
:RANge	
[:UPPer] *<value>*, (@chanlist)	Selects the internal data log voltage measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:ELOG	
:CURRent	
[:DC]	
:RANge	
[:UPPer] *<value>*, (@chanlist)	Selects the external data log current measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:FUNCtion	
:CURRent 0|OFF|1|ON, (@chanlist)	Enables/disables current data logging.
:MINMax 0|OFF|1|ON, (@chanlist)	Enables/disables min/max current data logging.
:VOLTage 0|OFF|1|ON, (@chanlist)	Enables/disables voltage data logging.
:MINMax 0|OFF|1|ON, (@chanlist)	Enables/disables min/max voltage data logging.
:PERiod *<value>*, (@chanlist)	Sets the integration time of the external data log measurement.
:VOLTage	
[:DC]	
:RANge	
[:UPPer] *<value>*, (@chanlist)	Selects the external data log voltage measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:FUNCtion *<"function">*, (@chanlist)	Selects the measurement function (for backward compatibility)
:CURRent 0|OFF|1|ON, (@chanlist)	Enables/disables current measurements (replaces FUNCtion)
:VOLTage 0|OFF|1|ON, (@chanlist)	Enables/disables voltage measurements (replaces FUNCtion)
:INPut <MAIN|AUXiliary>, (@chanlist)	Selects the voltage measurement input. (N6781A, N6785A)
:HISTogram	
:CURRent	(HISTogram commands only apply to models N6781A/82A/85A/86A)
[:DC]	
:BIN	
:GAIN? 8|0.0039, (@chanlist)	Queries the LSB of the histogram in amperes per bin
:OFFSet? 8|0.0039, (@chanlist)	Queries the weight of the histogram in amperes
:RANGes? (@chanlist)	Queries the values of the bin ranges
:RANge	
[:UPPer] *<value>*, (@chanlist)	Selects the internal data log voltage measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless Elog measurement autoranging.

:FUNCtion	
:CURRent 0|OFF|1|ON, (@chanlist)	Enables/disables current histogram.
:SWEep	
:OFFSet	
:POINts <*value*>, (@chanlist)	Defines the offset in a data sweep for triggered measurements.
:POINts <*value*>, (@chanlist)	Defines the number of points in a measurement.
:TINTerval <*value*>, (@chanlist)	Defines the time period between measurement samples.
:RESolution RES20|RES40	Sets the measurement resolution.
:VOLTage	
[:DC]	
:RANGe	
[:UPPer] <*value*>, (@chanlist)	Selects a DC voltage measurement range.
:AUTO 0|OFF|1|ON, (@chanlist)	Enables/disables seamless measurement autoranging. (N678xA SMU)
:WINDow	
[:TYPE] HANNing|RECTangular, (@chanlist)	Selects the measurement window.

[SOURce:]

ARB

:COUNt?	Sets the ARB repeat count.
:CURRent | :VOLTage | :POWer | :RESISTANCE	Sets the Arb type (POWer and RESISTANCE only on N679xA)
:CDWell	
[:LEVel] <*value*>, {<*value*>}, (@chanlist)	Sets the list of the constant dwell Arb
:DWELl <*value*>, (@chanlist)	Sets the dwell time for the constant dwell Arb
:POINts? (@chanlist)	Returns the number of constant-dwell Arb points
:CONVert (@chanlist)	Converts the selected Arb to a user-defined list
:EXPonential	
:END	
[:LEVel] <*value*>, (@chanlist)	Sets the end level of the exponential Arb
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the exponential Arb
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
:TCONstant <*value*>, (@chanlist)	Sets the time constant of the exponential Arb
:TIMe <*value*>, (@chanlist)	Sets the time of the exponential Arb
:PULSe	
:END	
:TIMe <*value*>, (@chanlist)	Sets the length of the end time
:FREQuency <*value*>, (@chanlist)	Sets the frequency of the pulse
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the pulse
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
:TOP	
[:LEVel] <*value*>, (@chanlist)	Sets the top level of the pulse
:TIMe <*value*>, (@chanlist)	Sets the length of the pulse

:RAMP	
:END	
[:LEVel] <*value*>, (@chanlist)	Sets the end level of the ramp
:TIMe <*value*>, (@chanlist)	Sets the length of the end time
:RTIMe <*value*>, (@chanlist)	Sets the rise time of the ramp
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the ramp
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
:SINusoid	
:AMPLitude <*value*>, (@chanlist)	Sets the amplitude of the sine wave
:FREQuency <*value*>, (@chanlist)	Sets the frequency of the sine wave
:OFFSet <*value*>, (@chanlist)	Sets the DC offset of the sine wave
:STAIRcase	
:END	
[:LEVel] <*value*>, (@chanlist)	Sets the end level of the staircase
:TIMe <*value*>, (@chanlist)	Sets the length of the end time
:NSTeps <*value*>, (@chanlist)	Sets the number of steps in the staircase
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the staircase
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
:TIMe <*value*>, (@chanlist)	Sets the length of the staircase
:STEP	
:END	
:TIMe <*value*>, (@chanlist)	Sets the end level of the step
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the step
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
: TRAPezoid	
:END	
:TIMe <*value*>, (@chanlist)	Sets the length of the end time
:FTIMe <*value*>, (@chanlist)	Sets the length of the fall time
:RTIMe <*value*>, (@chanlist)	Sets the length of the rise time
:STARt	
[:LEVel] <*value*>, (@chanlist)	Sets the initial level of the trapezoid
:TIMe <*value*>, (@chanlist)	Sets the length of the start time or delay
:TOP	
[:LEVel] <*value*>, (@chanlist)	Sets the top level of the trapezoid
:TIMe <*value*>, (@chanlist)	Sets the length of the top of the trapezoid
:UDEFined	
:BOSTep	
[:DATA] <*Bool*>{,<*Bool*>}, (@chanlist)	Generate triggers at the Beginning Of STep
:POINts? (@chanlist)	Returns the number of BOST points
:DWELl <*value*>, {<*value*>}, (@chanlist)	Sets the user-defined dwell values
:POINts? (@chanlist)	Returns the number of dwell points

:LEVel <*value*>, {<*value*>}, (@chanlist)	Sets the user-defined level values
:POINts? (@chanlist)	Returns the number of points
:FUNCtion <function>, (@chanlist)	Selects the Arb function (for backward compatibility)
:SHAPe <function>, (@chanlist)	Selects the Arb function (replaces ARB:FUNCtion)
:TYPE CURRent|VOLTage|RESISTANCE, (@chanlist)	Selects the Arb type (replaces ARB:FUNCtion)
:SEQuence	
:COUNt <*value*>|INFinity, (@chanlist)	Sets the number of times the sequence is repeated
:LENGth? (@chanlist)	Returns the number of steps in the sequence
:QUALity? (@chanlist)	Returns the quality of the waveforms in the sequence
:RESet (@chanlist)	Resets the sequence to its power-on default setting
:STEP	
:COUNt <*value*>|INFinity, <step#> (@chanlist)	Sets the number of times the sequence step is repeated
:CURRent <function>, <step#> (@chanlist)	Programs the waveform steps in a current sequence
:FUNCtion	
:SHAPe <function>, <step#>, (@chanlist)	Creates a new sequence step
:PACing DWELl|TRIGger, <step#> (@chanlist)	Specifies the type of pacing for the step
:RESISTANCE <function>, <step#> (@chanlist)	Programs the steps in a resistance sequence
:VOLTage <function>, <step#> (@chanlist)	Programs the waveform steps in a voltage sequence
:TERMinate	
:LAST 0|OFF|1|ON, (@chanlist)	Sets the sequence termination mode
:TERMinate	
:LAST 0|OFF|1|ON, (@chanlist)	Sets the Arb termination mode

[SOURce:]

CURRent

[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the output current.
:TRIGgered	
[:AMPLitude] <*value*>, (@chanlist)	Sets the triggered output current
:LIMit	
[:POSitive]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the positive current limit. (N678xA SMU, N6783A, N679xA)
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the current limit tracking state. (N678xA SMU)
:NEGative	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the negative current limit. (N678xA SMU, N6783A-BAT)
:MODE FIXed|STEP|LIST|ARB, (@chanlist)	Sets the transient mode.
:PROTection	
:DELay	
[:TIME] <*value*>, (@chanlist)	Sets the over-current protection delay.
:STARt SCHange|CCTRans, (@chanlist)	Specifies what starts the over-current protection delay timer.

:STATe 0|OFF|1|ON, (@chanlist)	Enables/disables the over-current protection.
:RANGe <*value*>, (@chanlist)	Sets the output current range.
:SLEW	
[:POSitive]	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the current slew rate. (N678xA SMU, N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N678xA SMU, N679xA)
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the current slew tracking state. (N679xA)
:NEGative	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the negative current slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)

[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 function of the pins. DIO |DINPut |FAULt |INHibit |ONCouple |OFFCouple |TOUTput |TINPut
:POLarity POSitive|NEGative	Sets the polarity of the pins.
:TOUTput	
:BUS	
[:ENABle] 0|OFF|1|ON	Enables/disables BUS triggers on digital port pins.

[SOURce:]

EMULation <*type*>, (@chanlist) — Specifies the emulation mode on models N678xA SMU.
PS4Q \|PS2Q \|PS1Q \|BATTery \|CHARger \|CCLoad \|CVLoad \|VMETer \|AMETer.

[SOURce:]

FUNCtion CURRent\|VOLTage\|RESistance\|POWer, (@chanlist) — Sets the output priority mode. (N678xA SMU, N679xA)

[SOURce:]

LIST

:COUNt <*value*>|INFinity, (@chanlist)	Sets the list repeat count.
:CURRent	
[:LEVel] <*value*>{,<*value*>}, (@chanlist)	Specifies the setting for each list step.
:POINts? (@chanlist)	Returns the number of list points (same as steps).
:DWELl <*value*>{,<*value*>}, (@chanlist)	Specifies the dwell time for each list step.
:POINts? (@chanlist)	Returns the number of list points (same as steps).
:POWer	
[:LEVel] <*value*>{,<*value*>}, (@chanlist)	Specifies the setting for each list step. (N679xA)
:POINts? (@chanlist)	Returns the number of list points (same as steps). (N679xA)
:RESistance	

[:LEVel] <*value*>{,<*value*>}, (@chanlist)	Specifies the setting for each list step. (N679xA)
:POINts? (@chanlist)	Returns the number of list points (same as steps). (N679xA)
:STEP ONCE|AUTO, (@chanlist)	Specifies how the list responds to triggers.
:TERMinate	
:LAST 0|OFF|1|ON, (@chanlist)	Determines the output value when the list terminates.
:TOUTput	
:BOSTep	
[:DATA] <*Bool*>{,<*Bool*>}, (@chanlist)	Generates a trigger out at the Beginning Of STep
:POINts? (@chanlist)	Returns the number of list points (same as steps).
:EOSTep	
[:DATA] <*Bool*>{,<*Bool*>}, (@chanlist)	Generates a trigger out at the End Of STep
:POINts? (@chanlist)	Returns the number of list points (same as steps).
:VOLTage	
[:LEVel] <*value*>{,<*value*>}, (@chanlist)	Specifies the setting for each list step.
:POINts? (@chanlist)	Returns the number of list points (same as steps).

[SOURce:]

POWer

[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the input power level. (N679xA)
:TRIGgered	
[:AMPLitude] <*value*>, (@chanlist)	Sets the triggered input power. (N679xA)
:LIMit <*value*>, (@chanlist)	Sets the power limit on output channels. (not on N678xA)
:MODE FIXed|STEP|LIST|ARB, (@chanlist)	Sets the power transient mode. (N679xA)
:PROTection	
:DELay	
[:TIME] <*value*>, (@chanlist)	Sets the power protection delay. (N679xA)
:STATe 0|OFF|1|ON, (@chanlist)	Enables/disables the power protection. (N679xA)
:RANGe <*value*>, (@chanlist)	Sets the power range. (N679xA)
:SLEW	
[:POSitive]	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the power slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the power slew tracking state. (N679xA)
:NEGative	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the negative power slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)

[:SOURce]

RESistance

[:LEVel]	
[:IMMediate]	

[:AMPLitude] <*value*>, (@chanlist)	Sets the output resistance level. (N6781A, N6785A, N679xA)
:TRIGgered	
[:AMPLitude] <*value*>, (@chanlist)	Sets the triggered output resistance. (N679xA)
:MODE FIXed|STEP|LIST|ARB, (@chanlist)	Sets the transient mode. (N679xA)
:RANGe <*value*>, (@chanlist)	Sets the output resistance range. (N679xA)
:SLEW	
[:POSitive]	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the resistance slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the resistance slew tracking state. (N679xA)
:NEGative	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the negative resistance slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)
:STATe 0|OFF|1|ON, (@chanlist)	Enables/disables output resistance programming. (N6781A, N6785A)

[SOURce:]

STEP

:TOUTput 0|OFF|1|ON, (@chanlist)	Specifies whether a trigger out is generated when a transient step occurs.

[SOURce:]

VOLTage

[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the output voltage.
:TRIGgered	
[:AMPLitude] <*value*>, (@chanlist)	Sets the triggered output voltage.
:BWIDth	
[:RANGe] LOW|HIGH1|2|3, (@chanlist)	Sets the voltage bandwidth. (N678xA SMU)
:LEVel LOW|HIGH1|2|3, <frequency>, (@chanlist)	Sets the bandwidth frequency. (N678xA SMU)
:INHibit	
:VON	
[:LEVel] <*value*>, (@chanlist)	Current will sink if voltage is > voltage-on level. (N679xA)
:MODE LATChing|LIVE|OFF	Sets the under-voltage inhibit mode. (N679xA)
:LIMit	
[:POSitive]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the positive voltage limit. (N678xA SMU)
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the voltage limit tracking state. (N6784A)
:NEGative	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the negative voltage limit. (N6784A)
:MODE FIXed|STEP|LIST|ARB, (@chanlist)	Sets the transient mode.

:PROTection	
[:LOCal]	
[:LEVel] <*value*>, (@chanlist)	Sets the over-voltage protection level.
:DELay	
[:TIME] <*value*>, (@chanlist)	Sets the over-voltage protection delay. (N678xA SMU, N6783A)
:REMote	
[:POSitive]	
[:LEVel] <*value*>, (@chanlist)	Sets the positive remote OV protection. (N678xA SMU, N679xA)
:NEGative	
[:LEVel] <*value*>, (@chanlist)	Sets the negative remote OV protection. (N6784A)
:RANGe <*value*>, (@chanlist)	Sets the output voltage range.
:RESistance	
[:LEVel]	
[:IMMediate]	
[:AMPLitude] <*value*>, (@chanlist)	Sets the voltage priority resistance level. (N6781A, N6785A)
:STATe 0|OFF|1|ON, (@chanlist)	Enables/disables the voltage priority resistance. (N6781A, N6785A)
:SENSe	
:SOURce INTernal|EXTernal, (@chanlist)	Sets the state of the output remote sense relays.
:SLEW	
[:POSitive]	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the voltage slew rate.
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override.
:COUPle 0|OFF|1|ON, (@chanlist)	Sets the current slew tracking state. (N679xA)
:NEGative	
[:IMMediate] <*value*>|INFinity, (@chanlist)	Sets the negative current slew rate. (N679xA)
:MAXimum 0|OFF|1|ON, (@chanlist)	Enables/disables the maximum slew rate override. (N679xA)

STATus

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

SYSTem

:CHANnel	
[:COUNt]?	Returns the number of output channels in a mainframe.
:MODel? (@chanlist)	Returns the model number of the selected channel.
:OPTion? (@chanlist)	Returns the option installed in the selected channel.
:SERial? (@chanlist)	Returns the serial number of the selected channel.
: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.
:GROup	(GROup commands do NOT apply to models N678xA SMU)
:CATalog?	Returns the groups that have been defined.
:DEFine <chanlist>	Group multiple channels to create a single channel.
:DELete <channel>	Remove the specified channel from the group.
:ALL	Ungroups all channels.
:PASSword	
:FPANel	
:RESet	Resets the front panel lockout password to zero.
:PERSona	
:MANufacturer "<manufacturer>"	Changes the manufacturer identity.
:DEFault	Sets the manufacturer identity to the factory default.
:MODel "<model number>"	Changes the model number.
:DEFault	Sets the model number to the factory default.
:REBoot	Reboots the instrument to its power-on state.
:SECurity	
:IMMediate	Clears all user memory and reboots the instrument.
:SET <data>	Sets the instrument to the specified state.
:SET?	Retrieves the current 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] (@chanlist)	Triggers the measurement immediately.
:CURRent	
[:LEVel] <*value*>, (@chanlist)	Sets the current trigger level.
:SLOPe POSitive|NEGative, (@chanlist)	Sets the current trigger slope.
:SOURce <*source*>, (@chanlist)	Selects the trigger source for the acquisition system: BUS |CURRent<1-4> |EXTernal |PIN<1-7> |TRANsient<1-4> |VOLTage<1-4>
:TOUTput	
[:ENABle] 0|OFF|1|ON, (@chanlist)	Enables measurement triggers to be sent to a digital port pin.
:VOLTage	
[:LEVel] <*value*>, (@chanlist)	Sets the voltage trigger level.
:SLOPe POSitive|NEGative, (@chanlist)	Sets the voltage trigger slope.

:ARB	
:SOURce <*source*>	Selects the trigger source for the arbitrary waveform: BUS |EXTernal |IMMediate
:DLOG	
[:IMMediate]	Triggers the internal data logger immediately.
:CURRent	
[:LEVel] <*value*>, (@chanlist)	Sets the current trigger level of the data logger.
:SLOPe POSitive|NEGative, (@chanlist)	Sets the current trigger slope of the data logger.
:SOURce <*source*>	Selects the trigger source for internal data logging: BUS |CURRent<n> |EXTernal |IMMediate |VOLTage<n> |ARSK |OOOK
:VOLTage	
[:LEVel] <*value*>, (@chanlist)	Sets the voltage trigger level of the data logger.
:SLOPe POSitive|NEGative, (@chanlist)	Sets the voltage trigger slope of the data logger.
:ELOG	
[:IMMediate] (@chanlist)	Triggers the external data logger immediately.
:SOURce <*source*>, (@chanlist)	Selects the trigger source for external data logging: BUS |EXTernal |IMMediate| PIN<1-7>
:HISTogram	(HISTogram commands only apply to models N6781A/82A/85A/86A)
[:IMMediate] (@chanlist)	Triggers the current histogram immediately.
:SOURce <*source*>, (@chanlist)	Selects the trigger source for current histogram: BUS |EXTernal |IMMediate| PIN<1-7>
:MEASure	
:TALign	
:CORRection	
[:STATe] 0|OFF|1|ON	Improves the alignment of measurement triggers with measurement data.
:TRANsient	
[:IMMediate] (@chanlist)	Triggers the output immediately.
:SOURce <*source*>, (@chanlist)	Selects the trigger source for the transient system: BUS |EXTernal IMMediate |PIN<1-7> |TRANsient<1-4>

Model Descriptions, Differences, and Options

Model Descriptions

Model Differences

Options

Model Descriptions

Model	Description
N6705C	600 W DC Power Analyzer Mainframe - without power modules
N6715C	Build-to-order DC Power Analyzer Mainframe - with installed modules
N6731B / N6741B	50 W / 100 W 5 V DC Power Module
N6732B / N6742B	50 W / 100 W 8 V DC Power Module
N6733B / N6743B / N6773A	50 W / 100 W / 300 W 20 V DC Power Module
N6734B / N6744B / N6774A	50 W / 100 W / 300 W 35 V DC Power Module
N6735B / N6745B / N6775A	50 W / 100 W / 300 W 60 V DC Power Module
N6736B / N6746B / N6776A, N6777A	50 W / 100 W / 300 W 100 V DC Power Module
N6751A / N6752A	50 W / 100 W High-Performance Autoranging DC Power Module
N6753A, N6754A / N6755A, N6756A	300 W / 500 W High-Performance Autoranging DC Power Module
N6761A / N6762A	50 W / 100 W Precision DC Power Module
N6763A, N6764A / N6765A, N6766A	300 W / 500 W Precision DC Power Module
N6781A, N6782A, N6784A	20 W Source/Measure Unit (SMU)
N6785A, N6786A	80 W Source/Measure Unit (SMU)
N6783A-BAT / N6783A-MFG	18 W / 24 W Application-Specific DC Power Module
N6791A, N6792A	100 W/ 200 W Electronic Load Module

Power Model Differences

Feature	DC Power	High-Performance	Precision
(● = available)	N673xB, '4xB, '7xA	N675xA	N676xA
50 W output rating	N6731B – N6736B	N6751A	N6761A
100 W output rating	N6741B – N6746B	N6752A	N6762A
300 W output rating	N6773A – N6777A	N6753A,'54A	N6763A, '64A
500 W output rating		N6755A, '56A	N6765A, '66A
Output disconnect relays	Option 761	Option 761	Option 761
Output disconnect/polarity reversal relays [1]	Option 760	Option 760	Option 760
Arbitrary waveform generation	●	●	●
Autoranging output capability		●	●
Voltage/current turn-on preferred mode			N6761A, '62A
Precision voltage/current measurements			●
Low voltage/current output range			N6761A, '62A
Low voltage/current measurement range			●
200 microampere measurement range [2]			Option 2UA
Voltage/current scope traces	●	●	●
Simultaneous voltage/current scope traces			●
Simultaneous voltage/current data logging [3]			●
Interleaved voltage/current data logging [3]	●	●	
Dynamic current correction	●	N6751A, '52A	N6761A, '62A
SCPI command output list capability [4]	●	●	●
SCPI command array readback [4]	●	●	●
SCPI command programmable sample rate [4]	●	●	●
SCPI command external data logging [4]	●	●	●
Double-wide power modules (require 2 channel locations)		N6753A - N6756A	N6763A - N6766A

Note 1 Output current is limited to 10A max. on Models N6742B and N6773A with Option 760.
Option 760 is not available on Models N6741B, N6751A, N6752A, N6761A, and N6762A.
Note 2 Option 2UA.is only available on Models N6761A and N6762A. It includes Option 761.
Note 3 Option 055 deletes the Data Logger function on Model N6705C.
Note 4 Only available when using the remote interfaces; not from the front panel.

N678xA Power Model Differences

Feature	Source/Measure Units (SMU)					Application-Specific	
(● = available)	N6781A	N6782A	N6784A	N6785A	N6786A	N6783A -BAT	N6783A -MFG
Output rating	20 W	20 W	20 W	80 W	80 W	24 W	18 W
2-quadrant operation	●	●		●	●	●	●
4-quadrant operation			●				
Aux voltage measurement	●			●			
Output disconnect relays	●	●	●	●	●	Opt 761	Opt 761
Arbitrary waveforms [1]	●	●	●	●	●	●	●
Negative voltage protection	●	●	●	●	●	●	●
Voltage or current priority	●	●	●	●	●		
CC load or CV load	●	●	●	●	●		
Voltage/current measurement only	●	●	●	●	●		
Battery emulator or charger	●			●			
Programmable resistance	●			●			
Number of voltage output ranges	3	3	3	4	4	1	1
Number of current output ranges	3	3	4	4	4	1	1
Number of voltage measurement ranges	3	3	3	1	1	1	1
Number of current measurement ranges	4	4	4	3	3	2	2
Voltage/current scope traces	●	●	●	●	●	●	●
Simultaneous voltage/current measurements	●	●	●	●	●		
Simultaneous voltage/current data logging [2]	●	●	●	●	●		
Interleaved voltage/current data logging [2]						●	●
Seamless measurement autoranging	●	●	Opt SMR	●	●		
SCPI output list capability [1,3]	●	●	●	●	●	●	●
SCPI array readback [3]	●	●	●	●	●	●	●
SCPI programmable sample rate [3]	●	●	●	●	●	●	●
SCPI external data logging [3]	●	●	●	●	●	●	●
SCPI histogram measurements [3]	●	●		●	●		
Double-wide power modules				●	●		

Note 1 Arbitrary waveforms and List capability are not available on the negative current output on Model N6783A.
Note 2 Option 055 deletes the Data Logger function on Model N6705.
Note 3 Only available when using the remote interfaces; not the front panel.

N679xA Load Model Differences

Feature	Load Modules	
(● = available)	N6791A	N6792A
Input rating [1]	100 W	200 W
Input terminal short capability	●	●
Arbitrary waveform generation	●	●
Under-voltage inhibit	●	●
Voltage, current, resistance, and power priority	●	●
Number of resistance input ranges	3	3
Number of current input ranges [2]	2	2
Number of voltage input ranges [2]	1	1
Number of power input ranges	2	2
Simultaneous voltage and current measurements	●	●
SCPI command output list capability [3]	●	●
SCPI command array readback [3]	●	●
SCPI command programmable sample rate [3]	●	●
SCPI command external data logging [3]	●	●
Double-wide (occupies 2 channel locations)		●

Note 1 The load module's input is referred to by the term "Output" throughout this document.

Note 2 The input and measurement ranges re coupled.

Note 3 Only available when using the remote interfaces; not from the front panel.

Options

Options	Description
Mainframe options	
AKY	Deletes the front and rear panel USB connector
RBP	Recessed front panel binding posts
055	Deletes the Data Logger function
056	Keysight 14585A Control and Analysis Software
908	Rack Mount Kit. For mounting in a 19-inch EIA cabinet. Also available as Model N6709A.
909	Rack Mount Kit with handles. Also available as p/n 5063-9222.
Power Module options	
760 [1]	Output disconnect/polarity reversal. Disconnects the + and – output and sense terminals. Switches the + and – output and sense polarities. Not available on N6741B, N6751A, N6752A, N676xA, N678xA.SMU, or N679xA.
761 [1]	Output disconnect. Disconnects + and – output and sense terminals. Standard on N678xA SMU. Not available on N679xA.
LGA	Large gate array. Required on Models N6751A, N6752A
UK6	Commercial calibration with test results data
1A7	ISO 17025 calibration certificate
2UA	200 microampere measurement range. Only on Models N6761A, N6762A.
SMR	Seamless measurement autoranging for Model N6784A. Included with Models N6781A, N6782A, N6785A, and N6786A.

Note 1 A small AC network is always present across the output terminals.

Specifications

Supplemental Characteristics

Dimension Diagrams

This section lists the supplemental characteristics of the Keysight N6705C DC Power Analyzer. Supplemental characteristics are not warranted but are descriptions of performance determined either by design or by type testing. All supplemental characteristics are typical unless otherwise noted.

Specifications and characteristics are subject to change without notice.

NOTE Complete specifications and supplemental characteristics information for all power modules are included in the Keysight N6700 Modular Power System Family Specifications Guide.

Supplemental Characteristics

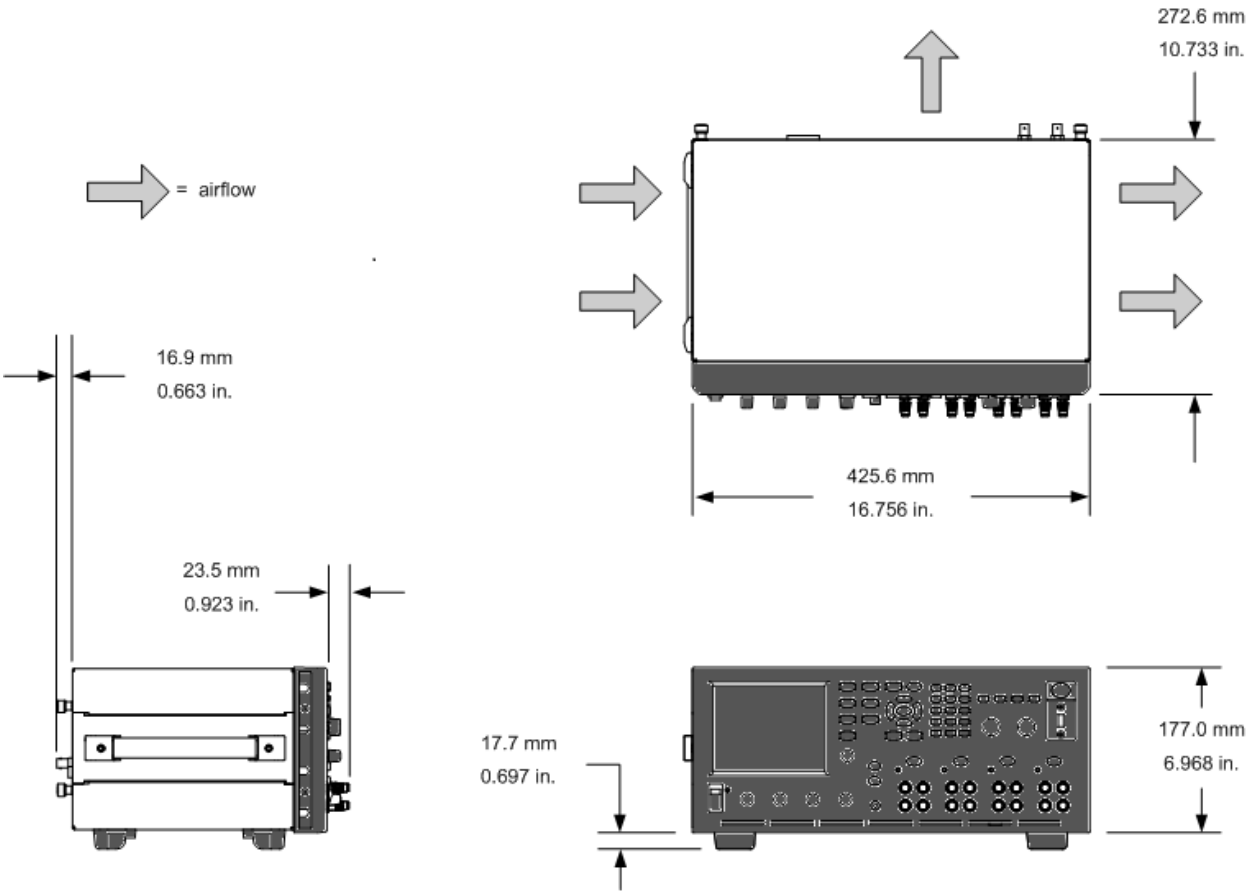
Characteristic	Keysight N6705C
Maximum total power available for power modules:	600 W
Front panel output terminals maximum current rating:	20 A
BNC trigger connectors	
IO:	Digital TTL level compatible
Maximum voltage:	5 V
Minimum input pulse:	> 6 ns, positive going; > 90 ns, negative going
Output pulse:	10 µs, negative-going
USB current ratings	
Front panel USB:	200 mA
Rear panel USB:	300 mA
Data storage of internal flash memory:	4 Gbytes
Protection Response	
INH Input:	5 µs from receipt of inhibit to start of shutdown
Fault on coupled output:	< 10 µs from receipt of fault to start of shutdown
Command Processing Time:	≤ 1 ms from receipt of command to start of output change

Characteristic	Keysight N6705C
Digital Control Characteristics	
Maximum voltage ratings	+16.5 VDC/-5 VDC between pins (pin 8 is internally connected to chassis ground).
Pins 1 and 2 as FLT output	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 digital/trigger outputs (pin 8 = common)	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 digital/trigger inputs and pin 3 as INH input (pin 8 = common)	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
Interface Capabilities	
LXI Core 2011:	10/100/1000 Base-T Ethernet (Sockets, VXI-11 protocol, Web interface)
USB 2.0 (USB-TMC488):	Requires Keysight IO Library version M.01.01 or 14.0 and up
10/100/1000 LAN:	Requires Keysight IO Library version L.01.01 or 14.0 and up
Built-in Web server:	Requires a Web browser
GPIB:	SCPI - 1993, IEEE 488.2 compliant interface
Regulatory Compliance:	
EMC:	Complies with European EMC Directive for test and measurement products: IEC/EN 61326-1; CISPR 11, Group 1, class A; AS/NZS CISPR 11; ICES/NMB-001 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.
Environmental	
Operating environment:	Indoor use, installation category II (for AC input), pollution degree 2
Temperature range:	0°C to 55°C (output current is derated 1% per °C above 40°C
Relative humidity:	Up to 95% (non-condensing)
Altitude:	Up to 2000 meters
Storage temperature:	-30°C to 70°C
Acoustic Noise Declaration This statement is provided to comply with the requirements of the German Sound Emission Directive, from 18 January 1991	Sound Pressure Lp <70 dB(A), At Operator Position, Normal Operation, According to EN 27779 (Type Test). Schalldruckpegel Lp <70 dB(A), Am Arbeitsplatz, Normaler Betrieb, Nach EN 27779 (Typ-prüfung).
Output Terminal Isolation:	No output terminal may be more than 240 VDC from any other terminal or chassis ground. N6781A/N6785A Note: When using the AUX measurement input terminals on Models N6781A and N6785A, no output or input terminal may be more than ±60 VDC from any other terminal or chassis ground.

Characteristic	Keysight N6705C
AC Input	
Input ratings:	~ 100 VAC – 240 VAC; 50/60/400Hz
Input range:	86–264 VAC; 47–63Hz; 380–420 Hz
Power Consumption:	1440 VA
Power Factor (Note 1):	0.99 @ nominal input and rated power
Fuse:	Internal fuse - not customer accessible
Net Weight	
N6705C with 4 modules:	16 kg / 35 lbs.
Single-wide module (typical):	1.23 kg / 2.71 lbs
Dimensions:	Refer to the dimension diagrams in the following section.

Note 1: Under full load at 400 Hz, power factor drops from 0.99 @ 120 VAC to as low as 0.76 @ 265 VAC. Power factor degrades further under no load conditions.

Dimension Diagrams



2 Installation

Preliminary Information

Installing the Power Analyzer

Connecting the Power Cord

Connecting the Outputs

Remote Sense Connections

Parallel and Series Connections

BNC Connections

Auxiliary Measurement Connections

Interface Connections

KEYSIGHT TECHNOLOGIES

Preliminary Information

Check for Items Supplied

Inspect the Unit

Review Safety Information

Observe Environmental Conditions

Check for Items Supplied

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

Mainframe Items	Description	Part Number
Power Cord	A power cord suitable for your location.	Call Keysight Sales & Support Office
Digital Connector plug	8-pin connector for connecting signal lines to the digital port.	Keysight 1253-6408 Phoenix Contact MC 1,5/8-ST-3,5
AUX Measurement Connector plug (2)	8-pin connector plug for the auxiliary measurement inputs. Only used with Models N6781A and N6785A.	Keysight 1253-6408 Phoenix Contact MC 1,5/8-ST-3,5
Spare grommets	Two spare grommets for rear panel sense and load wiring.	Keysight 0400-1009
Automation-Ready CD	Contains Keysight IO Libraries Suite.	Keysight E2094N
Quick Start Tutorial	A tutorial to help you quickly get started.	Keysight N6705-90005
T-10 Torx tool	Tool for installing or removing power modules.	Keysight 8710-2416
DC Power Module Items	**Description**	**Part Number**
8 A Output Connector plug	One 8 A, 8-pin connector plug for connecting power and sense leads. Only used in Models N678xA SMU.	Keysight 1253-6408 Phoenix Contact MC 1,5/8-ST-3,5
12 A Output Connector plug	One 12 A, 4-pin connector plug for connecting power and sense leads. Used in all except N6731B, N6741B, N6753A-N6756A, N6763A-N6766A, N6773A, N678xA SMU, N6791A, N6792A .	Keysight 1253-5826 Phoenix Contact MSTB 2,5/4-STF
20 A Output Connector plug	One 20 A, 4-pin connector plug for connecting power and sense leads. Only used in N6731B, N6741B, N6754A, N6756A, N6764A, N6766A, N6773A, N6791A .	Keysight 1253-6211 Phoenix Contact PC 4/4-ST-7,62
50 A Output Connector plug	One 50 A, 2-pin connector plug for connecting power leads. Only used in N6753A, N6755A, N6763A, N6765A, N6792A .	Keysight 1253-7187 Molex 39422-0002
AUX Measurement connector plug	A 2-pin connector plug for connecting the auxiliary measurement inputs. Only used in N6781A and N6785A.	Keysight 1253-8485 Phoenix Contact FMC 1,5/2-ST-3,5
Small Sense Jumpers	Two small jumpers for local sensing at the output connector. Used in all except N6731B, N6741B, N6753A-N6756A, N6763A-N6766A, N6773A, N678xA SMU, N6791A, N6792A .	Keysight 8120-8821 Phoenix Contact EPB 2-5(1733169)

DC Power Module Items	Description	Part Number
Large Sense Jumpers	Two large jumpers for local sensing at the output connector. Only used in N6731B, N6741B, N6754A, N6756A, N6764A, N6766A, N6773A, N6791A.	Keysight 0360-2935 Phoenix Contact 3118151
Sense Connector	A 4-pin connector for connecting sense leads. Wires (p/n 5185-8847) are used for local sensing. Only used in N6753A, N6755A, N6763A, N6765A.	Keysight 1253-5830 Phoenix Contact MC 1,5/4-ST-3,5
Module Cal. Certificate	A certificate of calibration referenced to the serial number.	N/A

Inspect the Unit

When you receive your power analyzer, 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 turned on and checked out the power analyzer, save the shipping carton and packing materials in case the unit has to be returned.

Review Safety Information

This Keysight N6705C DC Power Analyzer 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 a ground receptacle.

Refer to the Safety Summary page at the beginning of this guide for general safety information. Before installation or operation, review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places throughout this Guide

WARNING Some power modules generate voltages exceeding 60 VDC. Ensure that instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

Observe Environmental Conditions

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

The environmental conditions of the power analyzer are documented under Environmental Characteristics. Basically, the unit should only be operated indoors in a controlled environment.

The dimensions of your instrument as well as an outline diagram are also documented under Specifications. A fan cools the power analyzer by drawing air through the sides and exhausting it out the side and back. The instrument must be installed in a location that allows sufficient space at the sides and back of the unit for adequate air circulation.

Installing the Power Analyzer

Power Module Installation

High-Current Output Connections

Ferrite Core Installation - for Keysight N6792A only

Bench Installation

Rack Installation

Redundant Ground for 400 Hz Operation

Power Module Installation

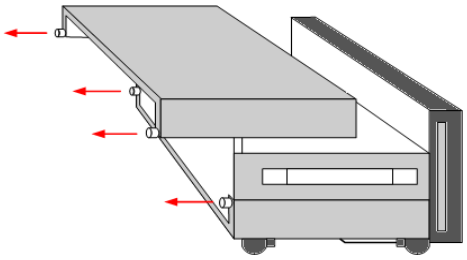
NOTE The information in this section applies if you have purchased an N6705 mainframe without the power modules installed, or if you are adding a power module to the mainframe.

CAUTION Equipment Damage Turn the mainframe off and disconnect the power cord before installing or removing power modules. Observe all standard electrostatic discharge precautions before handling electronic components.

Tools required: T10 Torx driver; Small flat-blade screwdriver; 5.5 mm hex wrench

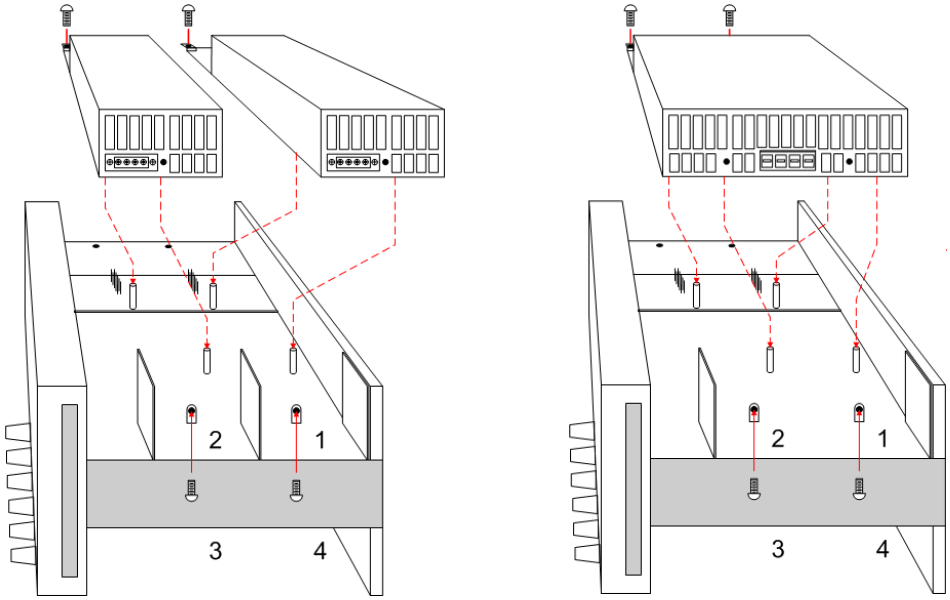
Step 1. Remove the top and bottom covers.

Loosen the thumb-screws to remove the covers. Slide the covers back. Turn the unit upside-down to remove the bottom cover.



Step 2. Place the power modules in the mainframe.

Align the power module over the pins and gently push it down onto the connector. Install the screws at each end of the power module. The torque specification for the screws is 9 inch-pounds.



The location of the power modules inside the mainframe determines their front panel output and programming channel assignments. For example, modules installed in channel 1 will be connected to the wire harness for output 1. Modules installed in channel 4 will be connected to the wire harness for output 4.

NOTE When installing a double-wide power module, you must first remove the center deflector. Use a T10 Torx to remove the top deflector; use a 5.5 mm hex to remove the bottom deflector. Install the deflector in the storage location on the opposite side. You can only connect the double-wide power module to output 1 or output 3.

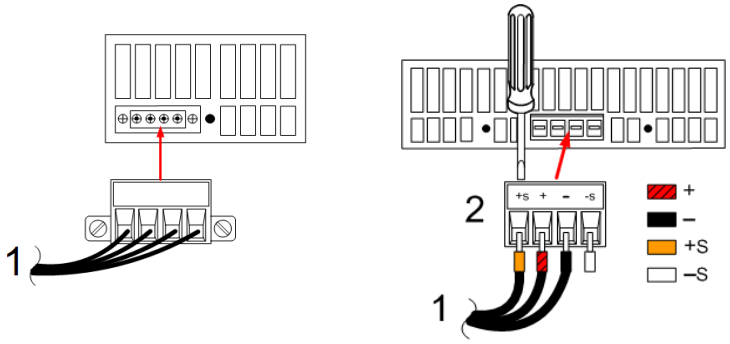
Step 3. Connect the front panel wire harness.

For power modules that use 12 A output connectors – Simply push the 12 A connector plug into the power module. Tighten the locking screws on the connector.

For power modules that use 20 A output connectors – Remove the 12 A connector plug from the harness and install the 20 A connector plug provided with the power module. Observe the output color code. Tighten all connector screws. Install the connector in the module.

For power and load modules that use 50 A output connectors – see High-Current Output Connections.

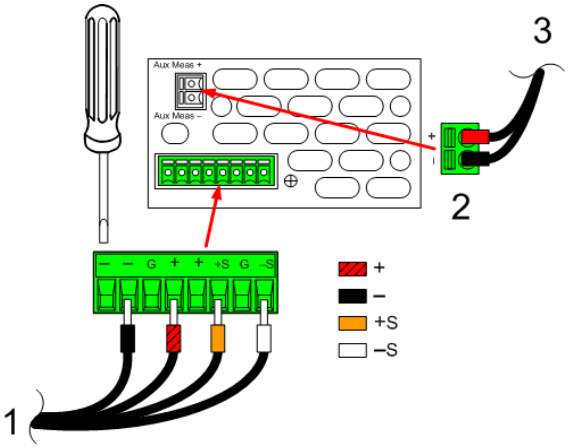
1. To front panel binding post
2. 20 A connector



For Keysight N678xA SMU power modules – Remove the 12A connector plug from the wire harness and install the 8-pin connector plug provided with the power module. Install the front panel cable wires in the output connector as shown. Observe the output color code. Tighten all connector screws.

For Keysight N6781A and N6785A power modules, also connect the auxiliary measurement cable. Remove the cable from its rear panel storage location and insert the connector into the power module. The cable's color code corresponds to the AUX voltage measurement label on the rear panel.

1. To front panel binding post
2. Aux Meas connector
3. To rear panel connector



Step 4. Finish the installation.

Place any unused cable harnesses in the clip ring located between the power modules and the front panel. Install the top and bottom covers. Push the covers into place and tighten the thumbscrews.

High-Current Output Connections

NOTE This information only applies to power modules with output current ratings of 50 A, and load modules with input current ratings of 40 A.

CAUTION **Do not connect the front panel cable assembly to the high-current output power modules.** Because the front panel binding posts have a maximum current rating of 20 A, they are not available for use with high-current power modules.

High-current (> 20 A) connections are made using the rear panel access ports of the mainframe. These access ports have a thin rubber membrane which can be pierced using the load wires.

User-supplied load and sense wires must be used to connect to the output and sense connector plugs on the high current power module. The sense connector is shipped with jumpers installed for local sensing.

Step 1. Route the load wires through the rear panel.

Push the high-current load wires through the rear panel access port. If you are using remote sensing, route the sense wires though the second access port. Twist each wire pair.

Step 2.Connect the wires to the power module.

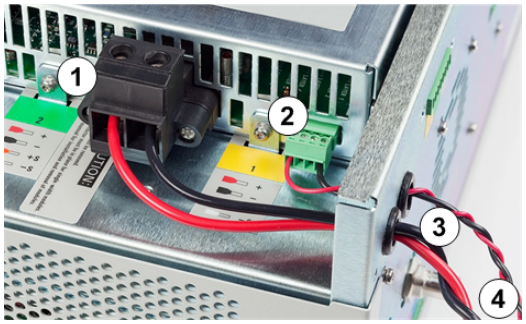
Connect the load wires to the output connector of the power module as shown. Connect the remote sense wires to the +S and -S terminals on the sense connector.

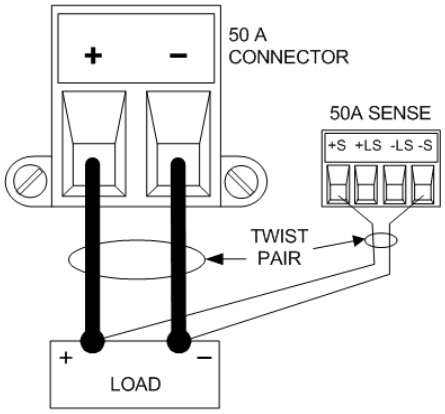
CAUTION The +LS and –LS terminals are ONLY used for local sense connections to the +S and - S terminals. Do not connect the +LS and –LS terminals in any other way.

Step 3. Finish the installation.

Place any unused cable harnesses in the clip ring located between the power modules and the front panel. Install the top and bottom covers. Push the covers into place and tighten the thumbscrews.

1. 50 A output connector
2. Sense connector
3. Twist leads
4. To load





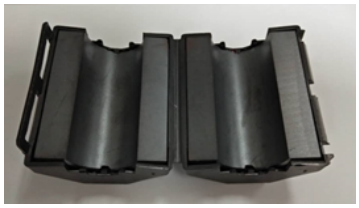
Ferrite Core Installation - for Keysight N6792A only

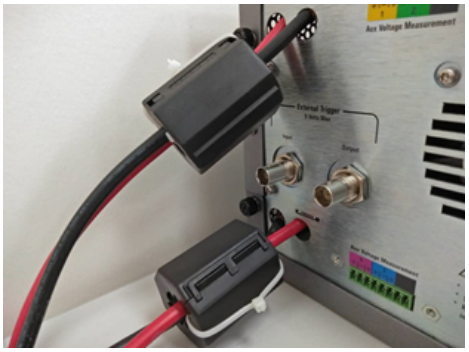
NOTE Compliance to radio frequency interference (RFI) standards requires a ferrite core to be installed on the load leads of the load module. The core is supplied with the module and does not affect the functionality of the module.

1. Locate the core along the length of the cables and pass the load cables through the core once

2. Clip the ferrite core onto the load cables as close as possible to the back of the unit. The recommended distance from the connector to the core is 4 cm.

3. Attach the tywrap to the load wires to prevent the core from sliding away from the back of the unit.

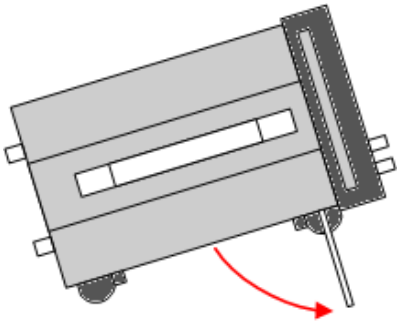




Bench Installation

CAUTION Do not block the air intake and exhaust at the sides, or the exhaust at the rear of the unit. Refer to the dimension diagram in the Specifications section.

Minimum clearances for bench operation are 2 inches (51 mm) along the sides and back. For easier display viewing and binding post access, you can tilt the front of the unit up by rotating the extension bar down.



Rack Installation

CAUTION Use Rack Mount kit (Option 908 or Option 909 with handles) to rack mount the instrument. Installation instructions are provided with the rack mount kit

Power analyzer mainframes can be mounted in a 19-inch EIA rack cabinet. They are designed to fit in four rack-units (4U) of space.

Remove the feet before rack mounting the unit. Do not block the air intake and exhausts at the sides and rear of the unit.

Redundant Ground for 400 Hz Operation

At 400 Hz AC input operation, the leakage current of the unit exceeds 3.5 mA. This requires the installation of a permanent, redundant ground from the instrument chassis to earth ground. This ensures that ground will always be connected and that any leakage current will be diverted to ground.

Refer to BNC Connectors later in this section for installation instructions.

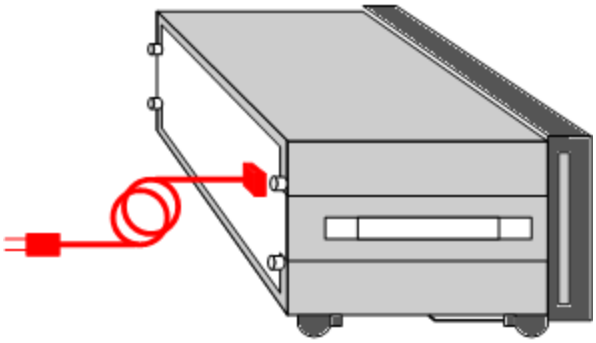
Refer to the Specifications section for power factor statistics at 400 Hz operation.

Connecting the Power Cord

WARNING FIRE HAZARD Use only the power cord that was supplied with your instrument. Using other types of power cords may cause overheating of the power cord, resulting in fire.

SHOCK HAZARD The power cord provides a chassis ground through a third conductor. Be certain that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

Connect the power cord to the IEC 320 connector on the rear of the unit. If the wrong power cord was shipped with your unit, contact your nearest Keysight Sales and Support Office.



The AC input on the back of your unit is a universal AC input. It accepts nominal line voltages in the range of 100 VAC to 240 VAC. The frequency can be 50 Hz, 60 Hz, or 400 Hz.

NOTE The detachable power cord may be used as an emergency disconnecting device. Removing the power cord will disconnect AC input power to the unit.

Connecting the Outputs

Binding Posts

Wire Sizing

Keysight N678xA SMU Wiring

Multiple Load Wiring

Positive and Negative Voltages

Protecting Sensitive Loads

Load Capacitor Response Times

NOTE Keysight N679xA Load Module input terminals are referred to as "Outputs" throughout this document. N679xA

Binding Posts

WARNING SHOCK HAZARD Turn off AC power before making rear panel connections. All wires and straps must be properly connected with the binding posts securely tightened.

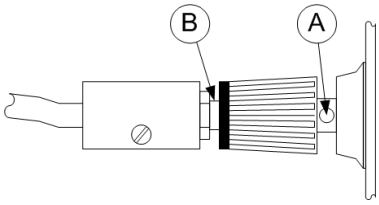
Some power modules generate voltages in excess of 60 VDC. Ensure that instrument connections, load wiring, and load connections are either insulated or covered so that no accidental contact with lethal output voltages can occur.

The binding posts accept wires sizes up to AWG 14 in location (A). Securely fasten all wires by hand-tightening the binding posts. You can insert standard banana plugs into the front of the connectors as shown in (B). A chassis ground binding post is located on the front panel for convenience.

Maximum current rating:

(A) = 20 A

(B) = 15 A



For power and load modules that have current ratings greater than 20 A – see High-Current Output Connections.

Wire Sizing

WARNING FIRE HAZARD Select a wire size large enough to carry short-circuit current without overheating (refer to the following table). To satisfy safety requirements, load wires must be heavy enough not to overheat while carrying the short-circuit output current of the unit. Keysight Model N678xA SMU wiring is described in the following section.

Along with conductor temperature, you must also consider voltage drop when selecting wire sizes. The following table lists the resistance for various wire sizes and the maximum lengths to limit the voltage drop to 1.0 V per lead for various currents.

Note that the minimum wire size required to prevent overheating may not be large enough to prevent over-voltage tripping or maintain good regulation. Under most conditions, the load wires should also be heavy enough to limit the voltage drop to no more than l.0 V per lead.

To help prevent nuisance tripping of the over-voltage circuit, select a wire size sufficient to handle the FULL output current of the unit no matter what the intended load current or current limit setting.

Load lead resistance is also an important factor relating to the CV stability of the instrument when remote sensing capacitive loads. If high capacitance loads are expected, you should not use wire gauges heavier than 12 to 14 AWG for long runs of load lead.

Wire Size	Metric size (Note1)		Resistance	Max length to limit voltage to 1 V/lead			
				for 5 A	for 10 A	for 20 A	for 50 A
AWG	2 wires bundled	4 wires bundled	Ω per foot	Wire length in feext			
20	7.8	6.9	0.0102	20	x	x	x
18	14.5	12.8	0.0064	30	15	x	x
16	18.2	16.1	0.0040	50	25	x	x
14	29.3	25.9	0.0025	80	40	20	x
12	37.6	33.2	0.0016	125	63	30	x
10	51.7	45.7	0.0010	200	100	50	20
8	70.5	62.3	0.0006	320	160	80	32
6	94	83	0.0004	504	252	126	50
Area in mm^2	2 wires bundled	4 wires bundled	Ω per meter	Wire length in meters			
0.5	7.8	6.9	0.0401	5	x	x	x
0.75	9.4	8.3	0.0267	7.4	x	x	x
1	12.7	11.2	0.0200	10	5	x	x
1.5	15.0	13.3	0.0137	14.6	7.2	x	x
2.5	23.5	20.8	0.0082	24.4	12.2	6.1	x
4	30.1	26.6	0.0051	39.2	19.6	9.8	3.9
6	37.6	33.2	0.0034	58	29	14.7	5.9
10	59.2	52.3	0.0020	102	51	25	10.3

Notes:
1. Capacity for AWG wires from MIL-W-5088B. Maximum ambient temperature: 55°C. Maximum wire temperature: 105°C
2. Capacity for metric wires from IE Publication 335-1.
3. Capacity of aluminum wire is approximately 84% of that listed for copper wire.
4. “x” indicates wire is not rated for the maximum output current of the power module.
5. Because of wire inductance considerations, it is also recommended that you keep your load leads twisted, tie wrapped, or bundled together and less than 50 feet (14.7 meters) in length per lead.

Keysight N678xA SMU Wiring

NOTE Because of the effect of wire inductance, the wire length information given in the previous table does not apply to Models N678xA SMU.

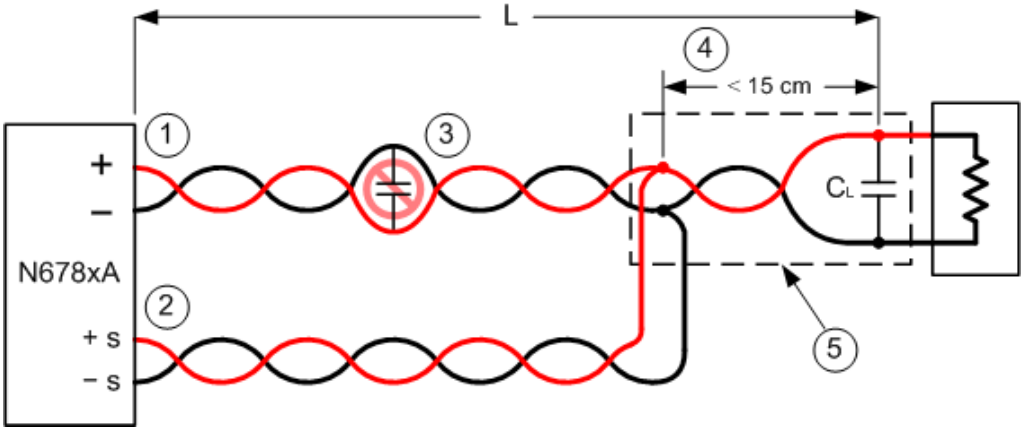
To minimize the effect of wire inductance, the following table describes the allowable load lead length for several common output wire types. Using longer (or shorter) wire lengths than those indicated in the table may cause output oscillation.

Cable Type	To module connector	
	Length in feet	Length in meters
Twisted pair (AWG 14 or smaller)	1 to 4.25 feet	0.3 to 1.3 meters
50 ohm coaxial (RG-58)	2 to 10 feet	0.6 to 3 meters
10 ohm coaxial (inductance per cable foot ≤ 32 nH)	8.5 to 33 feet	2 to 10 meters

High Bandwidth Modes with Remote Sensing

The following wiring requirements apply when using Keysight Models N678xA SMU in the High bandwidth modes with remote sensing.

Refer to Output Bandwidth for more information about the bandwidth settings.



1. Load wires must be twisted-pair or coax and must not be twisted along with the sense wires. Refer to the above table for length (L).

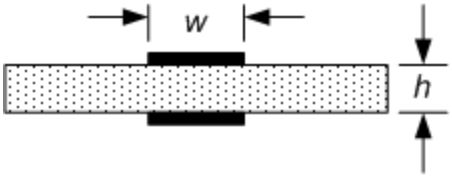
2. Sense wires must be twisted-pair or coax and must not be twisted with the load wires.

3. No capacitors are allowed within the sense-compensated load path.

4. If the load capacitor (CL) is not located at the sense point, the distance from the sense point to the load capacitor cannot exceed 15 cm and must be twisted-pair, coax, or pc traces.

5. If the test fixture consists of pc traces, the positive and negative traces should be directly facing on adjacent layers.

To minimize inductance, the width (w) of the traces should be at least as great as the thickness of the dielectric (h). It is better to make the traces much wider than this minimum requirement in order to minimize the DC resistance.



Low Bandwidth Mode with Remote or Local Sensing

All previously stated wiring requirements still apply in Low bandwidth mode except for the following.

The 15 cm maximum limit between the sense point and the load capacitor (see #4) does not apply when using Low bandwidth mode.

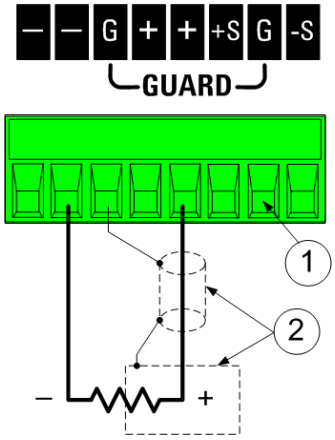
Guard Connections

The purpose of a cable guard is to eliminate the effects of leakage current that can exist in the current path of the external test circuit. The cable guard can be used when the test fixture requires guarding and the power analyzer is sourcing or measuring DC currents under 1 µA. Without a guard, leakage currents in the test circuit could affect the accuracy of the micro-amp measurements. Guarding is generally not required when measuring currents 1 µA and greater.

NOTE You cannot connect to the front panel binding posts when using the Guard. You must route ALL wires (guard, load, and sense) through the rear panel access ports of the mainframe. Refer to the diagram under High Current Output Connections for more information. These access ports can also be used when extremely precise output measurements are required.

As shown in the following figure, cable guards are available at the internal connector of Keysight Models N678xA SMU. The guard is typically used to drive the shields of cables and test fixtures. It provides a buffered voltage that is at the same potential as the + output terminals of the module connector. The guard current is limited to about 300 µA.

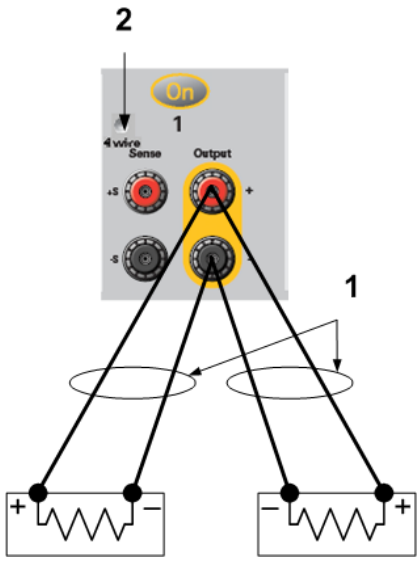
1. N678xA SMU connector
2. Guard shield (can be the shield of a coaxial cable)



Multiple Load Wiring

If you are using local sensing and are connecting multiple loads to one output, connect each load to the output terminals using separate load wires as shown.

1. Twist leads
2. 4-wire disabled (indicator is off)



This minimizes mutual coupling effects and takes full advantage of the power module's low output impedance. Keep each wire-pair as short as possible and twist or bundle the wires to reduce lead inductance and noise pickup. The goal is to always minimize the loop area or physical space between the + and - load wires from the power analyzer to the load. Keep the load leads under 14.7 meters (50 feet) per lead because of inductance effects

Note that Keysight Models N678xA SMU have additional wiring restrictions as previously discussed under Keysight N678xA SMU Wiring.

If load considerations require the use of distribution terminals that are located away from the instrument, connect the output terminals to the remote distribution terminals by a pair of twisted or bundled wires. 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.

Positive and Negative Voltages

Either positive or negative voltages with respect to ground can be obtained from the output by grounding (or "commoning") one of the output terminals. Always use two wires to connect the load to the output regardless of where or how the system is grounded. The instrument can be operated with any output terminal ± 240 VDC including output voltage from ground.

NOTE Keysight Models N678xA SMU 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.

Protecting Sensitive Loads from AC Power Switching Transients

NOTE This only applies if you are connecting loads that are highly sensitive to voltage or current transients to the output of the power analyzer. If your load is connected directly to the output of the power analyzer and is not connected to chassis ground in any way, you do not need to worry about AC power switching transients appearing at the output of the power analyzer.

Operating the AC line switch can inject common mode current spikes into the DC output leads, resulting in voltage spikes that may damage loads that are highly sensitive to voltage or current transients. Note that any electronic device meeting international standards for EMI compliance is likely to generate similar current spikes. This situation arises from the presence of EMI filters at both the AC input and the DC output. These filters typically include common mode capacitors connected to the chassis of the power analyzer. Since the AC input has an earth ground, any load that is also earth-grounded provides a possible return path for common mode currents.

To help mitigate common mode current spikes at the output when the unit is turned on or off:

1. Install a separate bonding wire from the load's common point, to the ground terminal of the power analyzer. This provides a lower impedance path that helps direct injected currents away from the DC output leads (and the sensitive load).

2. Disconnect the load from the output before turning the power analyzer on or off will always protect the load from common mode currents.

Load Capacitor Response Times

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

$$\text{Response Time} = \frac{(\text{Added Output Capacitor}) \times (\text{Change in Vout})}{(\text{Current Limit Setting}) - (\text{Load Current})}$$

Note that programming into an external output capacitor may cause the power analyzer to briefly enter constant current or constant power operating mode, which adds additional time.

4-Wire Sense Connections

Wiring

Open Sense Leads

Over-Voltage Protection Considerations

Output Noise Considerations

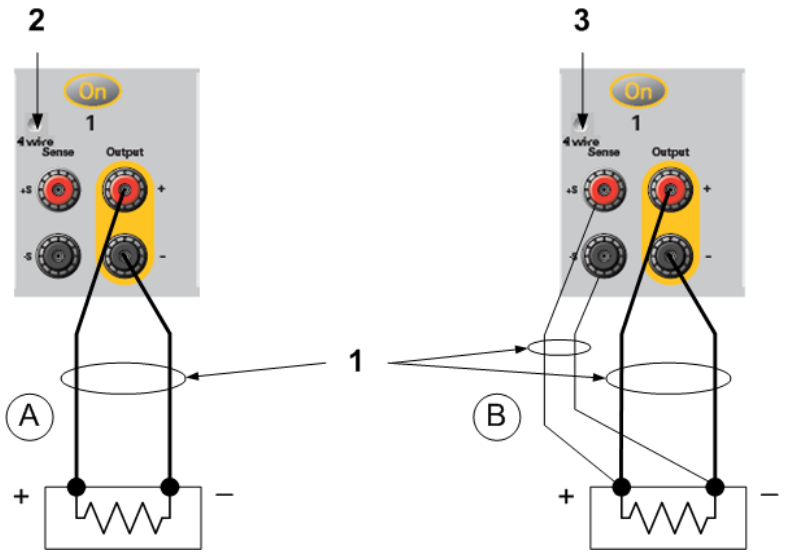
Wiring

The power analyzer includes built-in relays that connect or disconnect the ± sense terminals from their corresponding ± output terminals. As shipped, the sense terminals are internally connected to the output terminals. This is referred to as Local sensing.

4-wire, or remote sensing improves the voltage regulation at the load by monitoring the voltage at the load rather than at the output terminals. This automatically compensates for the voltage drop in the load leads, which is especially useful for CV operation with load impedances that vary or have significant lead resistance. Because remote sensing is independent of other power analyzer functions, it can be used regardless of how the instrument is programmed. Remote sensing has no effect during CC operation

The following figures illustrate load connections using local sensing (A), and 4-wire remote sensing (B). When the 4-wire indicator above the sense terminals is on, it indicates that the sense terminals must be connected to the load.

1. Twist leads
2. 4-wire disabled (indicator is off)
3. 4-wire enabled (indicator is on)



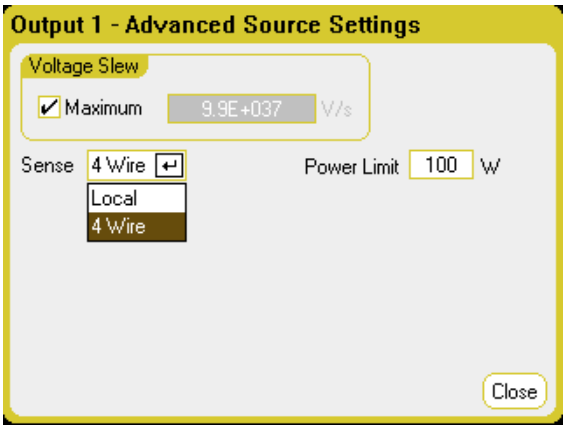
Connect the load to the output terminals using separate connecting wires. Keep the wire-pair as short as possible and twist or bundle it to reduce lead inductance and noise pickup. Keep the load leads under 14.7 meters (50 feet) per lead because of inductance effects.

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. The sense leads carry only a few

milliamperes of current and can be a lighter gauge than the load leads. However, any voltage drop in the sense leads can degrade the voltage regulation of the instrument. Try to keep the sense lead resistance less than about 0.5 Ω per lead (this requires 20 AWG or heavier for a 50 foot length).

Keysight Models N678xA SMU require remote sensing when using any of the High output bandwidth modes discussed under Output Bandwidth. Also, these models have additional wiring restrictions as discussed under Keysight N678xA SMU Wiring Requirements.

After turning the unit on, activate 4-wire remote voltage sensing by pressing the Settings key. Navigate to and select Advanced. In the Sense dropdown list select 4-Wire.



Open Sense Leads

The sense leads are part of the output's feedback path. Connect them in such a way so that they do not inadvertently become open circuited. The power analyzer includes protection resistors that reduce the effect of open sense leads during 4-wire-sensing. If the sense leads open during operation, the power analyzer returns to the local sensing mode, with the voltage at the output terminals approximately 1% higher than the programmed value.

Over-Voltage Protection Considerations

You must take into account any voltage drop in the load leads when setting the over-voltage trip point. This is because the OVP circuit senses at the output terminals and not at the sense terminals. Due to the voltage drop in the load leads, the voltage sensed by the OVP circuit could be higher than the voltage being regulated at the load.

OVP for Keysight N678xA SMU (local OVP)

For Keysight Models N678xA SMU only, the OVP circuit senses at the 4-wire sense terminals rather than at the output terminals. This allows for more precise overvoltage monitoring directly at the load. Since incorrect sense terminal wiring could defeat this feature, there is also a local OVP function.

The local OVP function tracks the programmed OVP setting and trips if the voltage at the + and - output terminals rises more than 1.5 V above the programmed OVP setting. The local OVP also trips if the voltage at the output terminals exceeds 7.5 V on the 6 V range and 21.5 V on the 20 V range.

Output Noise Considerations

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

The noise specifications documented in the Keysight N6700 Modular Power System Family Specifications Guide 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 µF per foot (30.5 cm) of load lead, right across the load.

Parallel and Series Connections

Parallel Connections

Series Connections

Parallel Connections

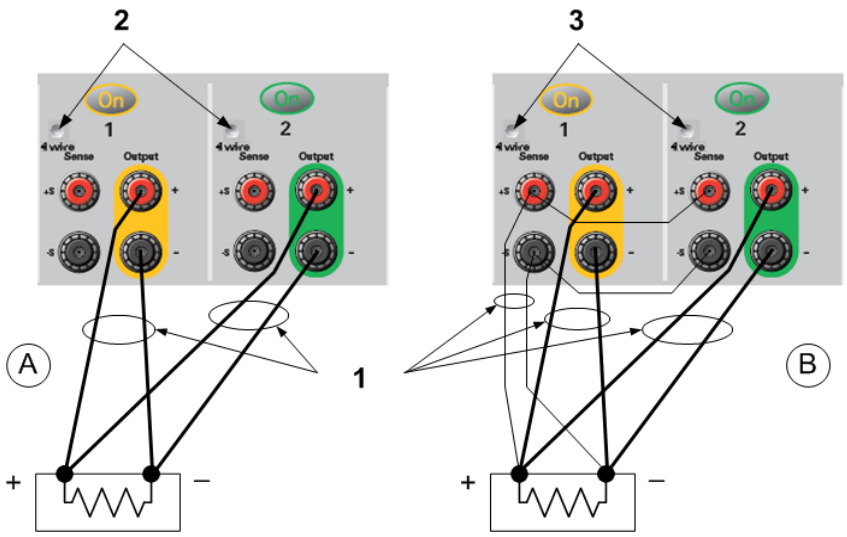
CAUTION **Equipment Damage** Only connect power supplies that have identical voltage and current ratings in parallel. Keysight Models N678xA SMU may be paralleled, but ONLY when operated in Current Priority mode. Voltage Priority operation is not allowed.

Connecting power supplies in parallel provides a greater current capability than can be obtained from a single unit.

The following figures show how to connect two outputs in parallel. The figure on the left illustrates local sensing. If voltage drop in the load leads is a concern, the figure on the right shows how to connect the sense leads directly at the load (4-wire sensing).

Once outputs have been connected in parallel, they can be configured or "grouped" to act as a single, higher-power output. This applies when programming via the front panel or using SCPI commands. How to group outputs that have been connected in parallel is discussed under Output Groups. The output grouping function is not available for N678xA SMU power modules.

1. Twist leads
2. 4-wire disabled (indicator is off)
3. 4-wire enabled (indicator is on)



Effect on Specifications

Specifications for outputs operating in parallel can be obtained from the specifications for single outputs. Most specifications are expressed as a constant or as a percentage (or ppm) plus a constant. For parallel operation, the percentage portion remains unchanged while constant portions or any constants are changed as indicated below. For current readback accuracy and temperature coefficient of current readback, use the minus current specifications:

Current: All parallel specifications referring to current are twice the single output specification except for programming resolution, which is the same for both single output and parallel output operation.

Voltage: All parallel specifications referring to voltage are the same as for a single output except for CV load effect, CV load cross regulation, CV source effect, and CV short term drift. These are all twice the voltage programming accuracy (including the percentage portion) at all operating points.

Load Transient Recovery Time: Load transient specifications are typically twice the single output.

Series Connections

WARNING SHOCK HAZARD Floating voltages must not exceed 240 VDC. No output terminal may be more than 240 VDC from chassis ground.

CAUTION Only connect outputs that have identical voltage and current ratings in series. Keysight Models N678xA SMU and N6783A cannot be connected in series.

To prevent currents from damaging the power analyzer when the load is connected, always turn series-connected outputs on and off together. Do not leave one output on while the other is off. Outputs connected together in series cannot be grouped.

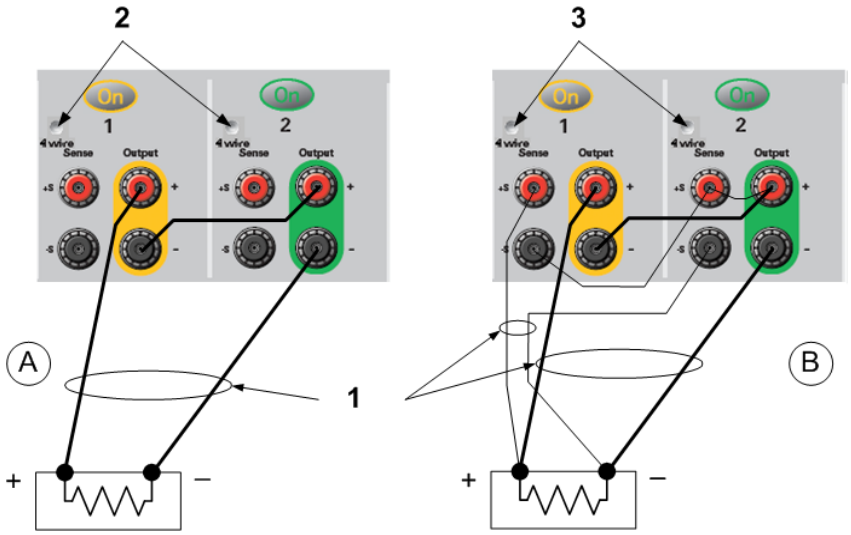
NOTE You can only use the series-connected outputs in “standard” power supply mode. You cannot generate arbitrary waveforms, make scope measurements or use data logging on outputs that are connected in series.

Connecting outputs in series provides a greater voltage capability than can be obtained from a single output. Because the current is the same through each element in a series circuit, outputs connected in series must have equivalent current ratings.

The following figures show how to connect two outputs in series to a single load. If voltage drop in the load leads is a concern, the figure on the right shows how to connect the sense leads directly at the load (4-wire sensing). . Connecting the +S terminal of output 2 to the -S terminal of output 1 and connecting a jumper between +S and + on output 2 compensates for the IR drop in the load lead from output 2 to output 1.

To program outputs connected in series, first program the current limit of each output to the total desired current limit point. Then program the voltage of each output so that the sum of both voltages equals the total desired operating voltage. The simplest way to accomplish this is to program each output to one half of the total desired operating voltage.

1. Twist leads
2. 4-wire disabled (indicator is off)
3. 4-wire enabled (indicator is on)



NOTE The operating mode of each output is determined by the output's programmed settings, operating point, and load condition. Because these conditions may change during series operation, the front panel status indicator will reflect these changes. This is normal. Momentary status changes are also normal.

Effect on Specifications

Specifications for outputs operating in series can be obtained from the specifications for single outputs. Most specifications are expressed as a constant or a percentage (or ppm) plus a constant. For series operation, the percentage portion remains unchanged while constant portions or any constants are changed as indicated.

Voltage: All series specifications referring to voltage are twice the single output specification except for programming resolution, which is the same as for a single output.

Current: All series specifications referring to current are the same as for a single output except for CC load effect, CC load cross regulation, CC source effect, and CC short term drift. These are twice the current programming accuracy (including the percentage portion) at all operating points.

Load Transient Recovery Time: Load transient specifications are typically twice the single output.

BNC Connections

The rear panel BNC connectors let you apply trigger signals to the instrument as well as generate trigger signals from the instrument. This also applies to the Digital Control Port.

Input - allows a positive- or negative-going external signal to trigger the instrument. The positive pulse must have a minimum pulse width of >6 nanoseconds. The negative pulse must have a minimum pulse width of >90 nanoseconds. Trigger input signals are used by the Arb, Scope, and Data Logger functions.

Output - generates a negative-going 10 microsecond pulse when a triggered event has occurred on the instrument.



Information on configuring external triggers is found under Trigger Commands. The electrical characteristics are described under Supplemental Characteristics.

Installing a Redundant Ground for 400 Hz Operation

Operation at 400 Hz requires the installation of a redundant ground from the instrument chassis to earth ground. The redundant ground must be permanently attached to the unit as well as to the earth ground point.

The following procedure describes how to make the permanent connection at the unit using one of the two rear panel BNC connectors. The user must ensure the integrity and permanence of the connection at the earth ground point.

The following customer-supplied hardware is required:

- Ground wire (14/16 AWG)
- Uninsulated ring terminal for attaching wire to unit (Tyco p/n 328976 or equivalent)
- Hardware for attaching wire to earth ground point

The following customer-supplied hardware is required:

- 5/8 inch nut driver

Step 1. Use the nut driver and remove the hex nut (1) from only one of the BNC connectors. Do not remove the lock washer located behind the hex nut.

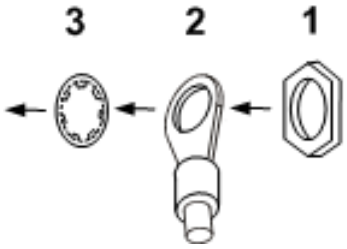
Step 2. Crimp the ring terminal (2) onto the end of the ground wire

Step 3. Place the ring terminal onto the threaded BNC connector. Make sure that the lock washer (3) is in place before installing the ring terminal.

Step 4. Tighten the hex nut onto the ring terminal.

Step 5. Attach the other end of the redundant ground wire to a convenient earth ground point.





Auxiliary Measurement Connections

NOTE This information only applies when Models N6781A and N6785A are installed in the mainframe.

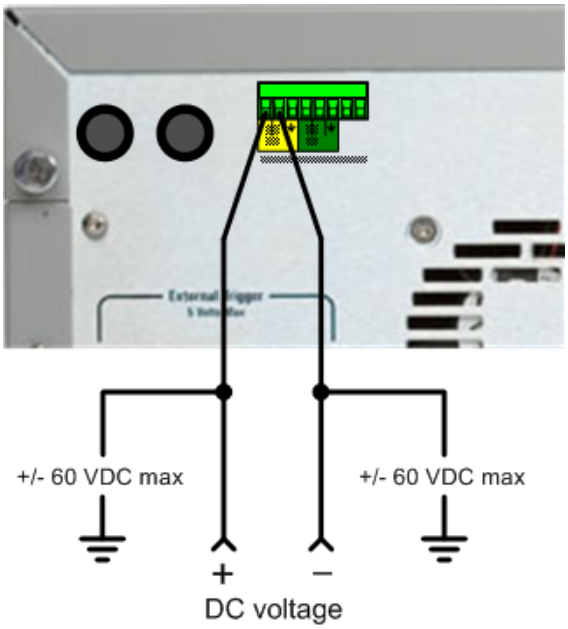
The auxiliary voltage measurement inputs are located on the rear panel of the Keysight N6705C. These are primarily used for battery voltage rundown measurements, but are also suitable for general purpose DC measurements.

The auxiliary voltage measurement inputs are isolated from other commons. They have a bandwidth of about 2 kHz. There is one input range: –20 to +20 VDC.

Two 8-pin connectors and quick-disconnect plugs are provided for accessing up to four potential auxiliary voltage measurement inputs. The connectors accept wires sizes from AWG 14 to AWG 30. Note that wire sizes smaller than AWG 24 are not recommended. Disconnect the connector plug to make your wire connections.

As shown in the following figure, auxiliary voltage measurements cannot be made on test points that are at a greater potential than ±60 VDC from ground. Refer to Auxiliary Voltage Measurements for more information.

CAUTION When using the auxiliary voltage measurement input, no front panel output terminal or rear panel input terminal may be more than ± 60 VDC from any other terminal and chassis ground.



Interface Connections

GPIB Connections

USB Connections

LAN Connections - site and private

Digital Port Connections

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

NOTE If you have not already done so, install the Keysight IO Libraries Suite, which can be found at www.keysight.com/find/iolib. 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. If you do not have a GPIB interface card installed on your computer, turn off your computer and install the GPIB card.

2. Connect your instrument to the GPIB interface card using a GPIB interface cable.

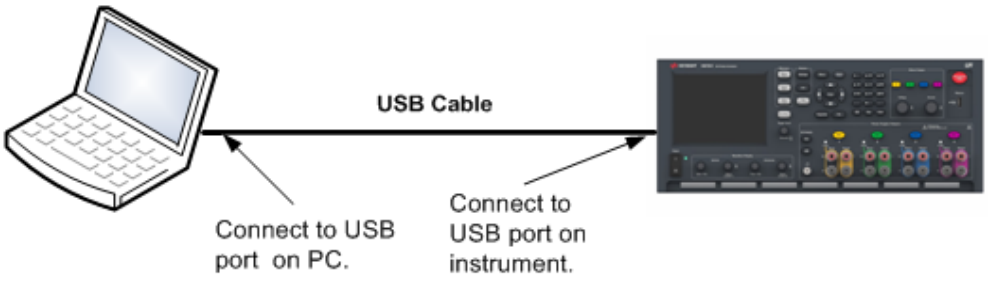
3. Use the Connection Expert utility of the Keysight IO Libraries Suite to configure the GPIB card's parameters.

4. The power analyzer is shipped with its GPIB address set to 5. Use the front panel menu if you need to change the GPIB address.

5. 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.



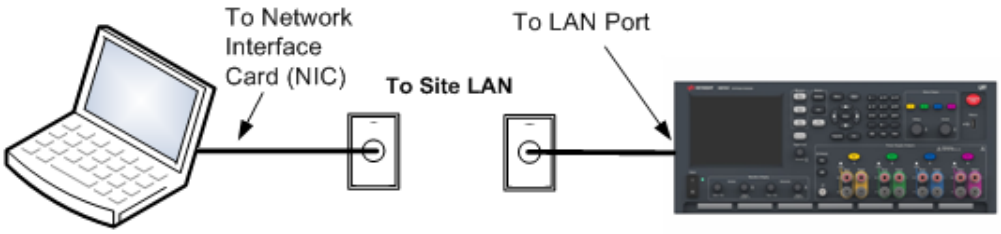
1. Connect your instrument to the USB port on your computer using a USB cable.

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. You can also view the instrument's VISA address from the front panel menu.

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.



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. The front panel Lan indicator will come on when the LAN port has been configured.

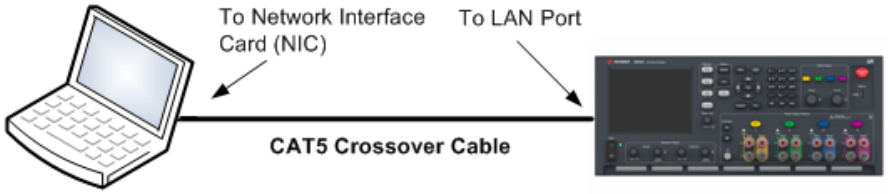
NOTE If you need to manually configure any instrument LAN settings, refer to Remote Interface Configuration for information about configuring the LAN settings from the front panel of the instrument.

2. Use the Connection Expert utility of the Keysight IO Libraries Suite to add the power analyzer 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 its hostname or IP address.

NOTE If this does not work, refer to "Troubleshooting Guidelines" in the Keysight Technologies USB/LAN/GPIB Interfaces Connectivity Guide included with the Keysight IO Libraries Suite.

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.

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 computer using a LAN crossover cable. Alternatively, connect the computer and the instrument to a standalone hub or switch using regular LAN cables.

NOTE Make sure your computer is configured to obtain its address from DHCP and that NetBIOS over TCP/IP is enabled. Note that if the computer had been connected to a site LAN, it may still retain previous network settings from the site LAN. Wait one minute after disconnecting it from the site LAN before connecting it to the private LAN. This allows Windows to sense that it is on a different network and restart the network configuration.

2. The factory-shipped instrument LAN settings are configured to automatically obtain an IP address from a site network using a DHCP server. You can leave these 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. Note that this may take up to one minute. The front panel Lan indicator will come on when the LAN port has been configured.

NOTE Turning off DHCP reduces the time required to fully configure a network connection when the power analyzer is turned on. To manually configure the instrument LAN settings, refer to Remote Interface Configuration for information about configuring the LAN settings from the front panel of the instrument.

3. Use the Connection Expert utility of the Keysight IO Libraries Suite to add the power analyzer 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 its hostname or IP address.

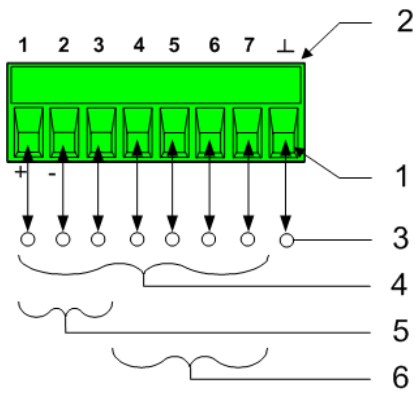
NOTE If this does not work, refer to "Troubleshooting Guidelines" in the Keysight Technologies USB/LAN/GPIB Interfaces Connectivity Guide included with the Keysight IO Libraries Suite.

4. 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

An 8-pin connector and a quick-disconnect connector plug are provided on each instrument for accessing the five digital control port functions. The digital control connector accepts wires sizes from AWG 14 to AWG 30. Note that wire sizes smaller than AWG 24 are not recommended. Disconnect the connector plug to make your wire connections.

1. Insert wires
2. Tighten screws
3. Signal common
4. Digital IO signals
5. FLT/INH signals
6. Output couple controls



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

Pin Functions

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

Pin Function	Available configurable pins
Digital I/O and Digital In	Pins 1 through 7
External Trigger In/Out	Pins 1 through 7
Fault Out	Pins 1 and 2
Inhibit In	Pin 3
Output State	Pins 4 through 7
Common	Pin 8

In addition to the configurable pin functions, the active signal polarity for each pin is also configurable. When Positive polarity is selected, a logical true signal is a voltage high at the pin. When Negative polarity is selected, a logical true signal is a voltage low at the pin.

For more information on configuring the digital port functions, refer to Using the Digital Control Port.

3 Using the Source/Load Functions

Turning the Unit On

Using the Power Analyzer

Generating Arbitrary Waveforms

Using the Protection Functions

This section contains instructions on how to operate your Keysight N6705C DC Power Analyzer. The specific functions described in this section are listed above.

Equivalent SCPI commands to program a specific function are included at the end of each topic. However some functions such as the front panel Scope View, Data Logger View, and some Administrative functions do not have equivalent SCPI commands. Command Quick Reference lists all of the SCPI commands that can be used to program the instrument

Turning the Unit On

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

Step 1. Turn the Unit On

After you have connected the line cord, turn the unit on using the Line switch. The front panel display lights up after a few seconds. The power analyzer's Meter View is shown in the following display.



A power-on selftest occurs automatically when you turn the unit on. This assures you that the instrument is operational. If selftest fails, or if other operating problems occur with your instrument, the front panel Error indicator comes on. See View the Error Log.

Step 2. Select an Output

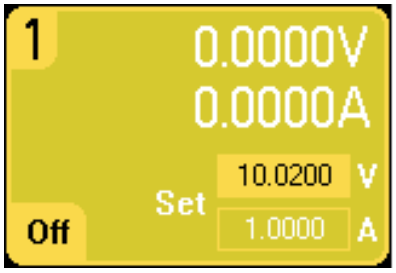
Press one of the four Select Output keys to select an output to control. The lit key identifies the selected output. All subsequent output-specific front panel commands are sent to the selected output.



NOTE Keysight N679xA Load Module input terminals are referred to as "Outputs" throughout this document. N679xA

Step 3. Set the Output Voltage and Current

Enter the voltage and current values directly in the numeric entry fields (the Set fields) while in Meter View. Use the navigation keys to select the field, then use the numeric entry keys to enter the value. The value becomes active when you press Enter.



Turn the Voltage and Current knobs. The output voltage or current setting changes when they are turned. The output also changes if it is enabled. These knobs are active in Meter View, Scope View, and Data Logger mode.



Push the voltage and current knobs to access a pop-up dialog that lets you:
1. Lock/Unlock the knobs.
2. Select limit parameters or select limit tracking on Keysight N678xA SMU and N6783A.

Step 4. Enable the Output

Press the color-coded On key to enable an individual output. When an output is on, the On key for that output is lit. When an output is off, the On key is not lit. The All Outputs On and Off keys turn all outputs on or off simultaneously.



The state of a disabled output (output off) is a condition of zero output voltage and zero source current

NOTE The red Emergency Stop key turns all outputs off immediately without any output off delays.

When an output is enabled, the power analyzer continuously measures and displays the output voltage and current of each output in Meter View.



From the remote interface:

A channel parameter is required with each SCPI command to select an output. For example, (@1) selects output 1, (@2,4) selects output 2 and 4, and (@1:4) selects outputs 1 through 4. The output list must be preceded with an @ symbol and be enclosed in parentheses ().

To set only output 1 to 10.02 V and 1 A:

```
VOLT 10.02,(@1)
CURR 1,(@1)
```

To set the output voltage of all outputs to 10 V:

```
VOLT 10.02,(@1:4)
```

To enable only output 1 and output 3:

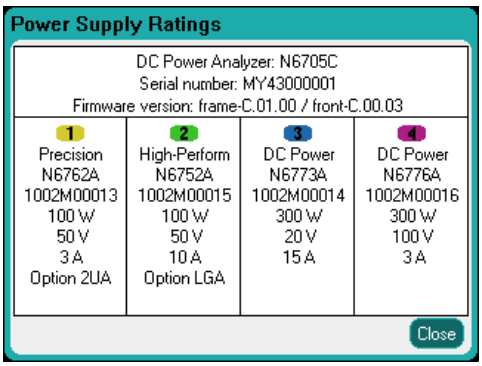
```
OUTP ON,(@1,3)
```

To measure the output voltage and current of output 1:

```
MEAS:VOLT? (@1)
MEAS:CURR? (@1)
```

View Instrument Identification

You can quickly view the output ratings, model numbers and options of all power modules installed in your instrument. You can also view the mainframe serial number and firmware revisions. Press the Settings key and then press the Properties key. The Power Supply Ratings window will appear.



The serial numbers of the power modules are located on their respective top covers. Press Meter View to return to the meter view.

From the remote interface:

For the power analyzer mainframe, you can programmatically query the model number, serial number, firmware revision, backup and active firmware. Send the following query:

```
*IDN?
```

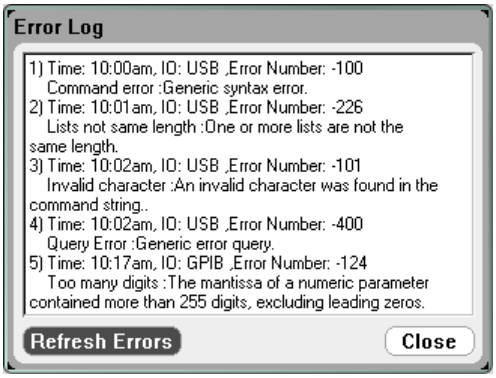
For power modules, you can programmatically query the model number, serial number, installed options, voltage, current and power rating. Send the following commands:

SYST:CHAN:MOD?(@1)
SYST:CHAN:OPT?(@1)
SYST:CHAN:SER?(@1)

NOTE You have the ability to change the identity of the mainframe. This functionality is only intended for compatibility with previous "A" and "B" version mainframes. To change the identity refer to *IDN Setup.

View the Error Log

To display the error log, press the Menu key, scroll and select Utilities, then Error Log.



- Errors are stored in the order they are received. The error at the end of the list is the most recent error.
- If there are more errors than can fit in the queue, the last error stored is replaced with -350,"Error queue overflow". No more errors are stored until you remove errors from the queue. If there are no errors, the instrument responds with +0,"No error".
- Except for selftest errors, errors are cleared when exiting the Error Log menu or when cycling power.

If you suspect that there is a problem with the power analyzer, refer to the Troubleshooting section. Press Meter View to return to the Meter View.

From the remote interface:

The following command reads and clears one error from the error queue:

SYST:ERR?

Using the Power Analyzer

Programming N673xB-N677xA Source Settings

Programming N678xA SMU Source Settings

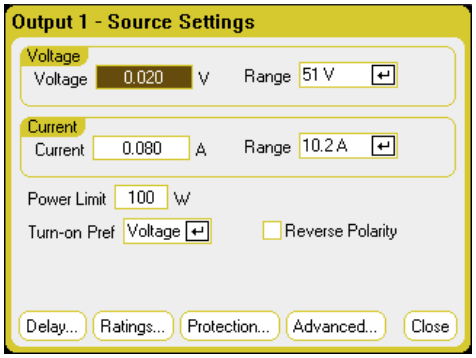
Programming N679xA Load Settings

Configuring an Output Turn-On/Turn-Off Sequence

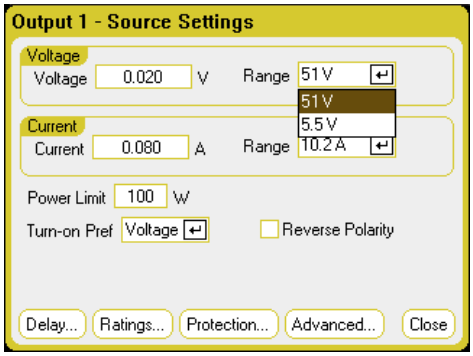
Programming N673xB-N677xA Source Settings

Output Voltage and Current

Press the Settings key to access the Source Settings window. Use the navigation keys to highlight the Voltage or Current fields. Then enter the voltage and current values with the numeric keys. As previously explained in Turning the Unit On, you can use the Voltage and Current knobs to fine tune the values in these fields. Press Enter to enter the value.



Voltage or Current Range - For outputs with multiple ranges, you can select a lower range if you need better output resolution. Use the navigation keys to highlight the Range field. Press the Enter key to access the dropdown range list. Use the navigation keys to select the desired output range.



Additional Source Settings

Along with setting the output voltage and current and ranges, you can program a number of additional source settings, which are module and option dependent.

Power Limit - For the majority of power analyzer configurations, full power is available from all installed power modules. However, it is possible to configure a mainframe in which the combined power module ratings exceed the 600 W power rating of the mainframe. The power limit field lets you reduce the power that can be sourced from an individual output, thereby preventing the combined power from exceeding the mainframe's power rating. To set a lower power limit, select the Power Limit Field and enter the power limit value in Watts. Refer to Power Limit Operation for more information.

Turn-on Pref - The turn-on preference function only applies to Keysight Models N6761A and N6762A. This specifies the preferred mode for output on/off transitions. It allows output state transitions to be optimized for either constant voltage or constant current operation. In the Turn-on Pref drop-down list, select either Voltage or Current. Selecting Voltage minimizes output on/off voltage overshoots in constant voltage operation. Selecting Current minimizes output on/off current overshoots in constant current operation.

Reverse Polarity – This control only applies if the power module has Option 760 installed. Check Reverse Polarity to reverse the polarity of the output and sense terminals. Uncheck to return the relay polarity to normal. The output is briefly turned off while the output and sense polarities are switched. Refer to Model Differences for Option 760 availability and current limitations. When the output and sense polarities are reversed, the following symbol appears on the front panel display: ±⤭

From the remote interface:

To set only output 1 to 10.02 V and 1 A:

```
VOLT 10.02,(@1)
CURR 1,(@1)
```

To select a lower voltage or current range on output 1, program a value that falls within the range:

```
VOLT:RANG 5,(@1)
CURR:RANG 1,(@1)
```

To set the power limit of outputs 1 and 2 to 50 W, and outputs 3 and 4 to their maximum settings:

```
POW:LIM 50,(@1,2)
POW:LIM MAX,(@3,4)
```

To set the Keysight N6761A turn-on preferred mode to constant current:

```
OUTP:PMOD CURR,(@1)
```

To reverse the relay polarity on units with Option 760:

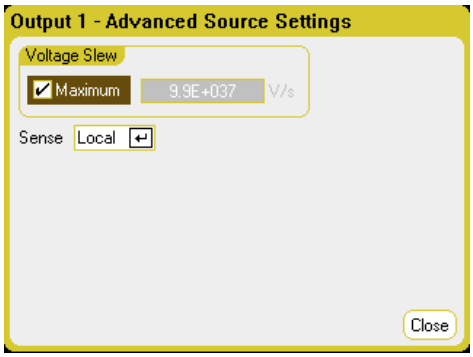
```
OUTP:REL:POL REV,(@1)
```

To return the relay polarity to normal:

```
OUTP:REL:POL NORM,(@1)
```

Advanced Source Settings

Advanced properties are configured in the Advanced Source Settings window. Press the Settings key to access the Source Settings window. Navigate to and select the Advanced button.



Voltage Slew - The voltage slew rate determines the rate at which the voltage changes to a new setting. To program a voltage slew rate, enter the rate (V/s) in the Voltage Slew field. Check Maximum to program the fastest rate. Note that the maximum slew rate is limited by the analog performance of the output circuit. The minimum slew rate is model-dependent and is a function of the full-scale voltage range.

Sense - The default sense setting is Local, where the sense terminals are connected directly to the output terminals. If you are using remote voltage sensing as explained under 4-Wire Sense, you must disconnect the sense terminals from the output terminals. Use the navigation keys and select the Sense dropdown list. Selecting the 4-Wire item disconnects the sense terminals from the output terminals. This lets you use remote voltage sensing.

From the remote interface:

To set the voltage slew rate to 5 Volt/second:

```
VOLT:SLEW 5,(@1)
```

To set the fastest voltage slew rate:

```
VOLT:SLEW INF,(@1)
```

To query the minimum voltage slew rate:

```
VOLT:SLEW? MIN,(@1)
```

To set the front panel sense terminals of output 1 to local sensing, and output 2 to remote sensing:

```
VOLT:SENS:SOUR INT,(@1)
VOLT:SENS:SOUR EXT,(@2)
```

To query the setting of the front panel sense terminals (INT=local sensing; EXT=remote sensing):

```
VOLT:SENS:SOUR? (@1)
```

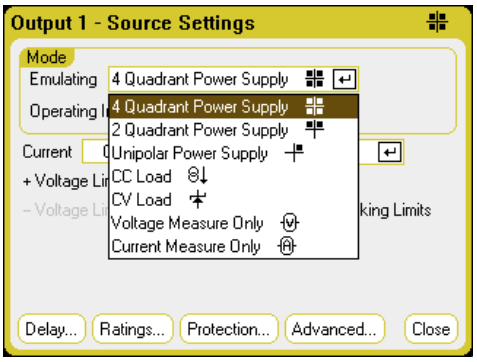
Programming N678xA SMU Source Settings

NOTE Use the Source Settings window to access the specialized operating modes of the Keysight N678xA SMU modules N678xA SMU.

Emulating Modes

The Emulating dropdown list lets you access the specialized operating modes of the Keysight N678xA SMU. Press the **Settings** key to access the Source Settings window. Use the navigation keys to select one of the emulating modes.

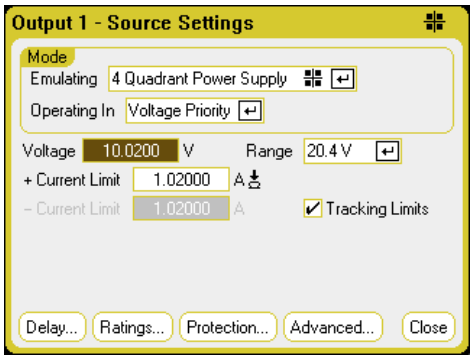
Information about the Voltage Measure Only and Current Measure Only modes is discussed under N678xA SMU Meter-Only Modes.



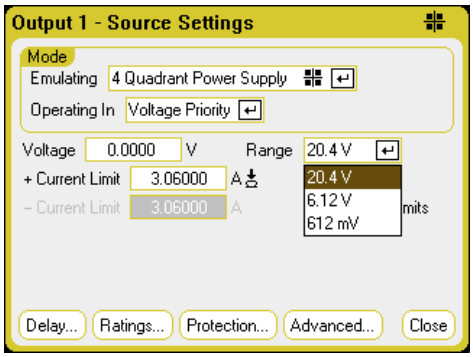
Output Voltage and Current

Use the navigation keys to highlight the Voltage or Current fields. Then enter the voltage and current values with the numeric keys. As previously explained in Turning the Unit On, you can use the Voltage and Current knobs to fine tune the values in these fields. Press **Enter** to enter the value.

As explained in subsequent sections, programming output voltage and current limit, or output current and voltage limit, is determined by the Voltage Priority or Current Priority selection.

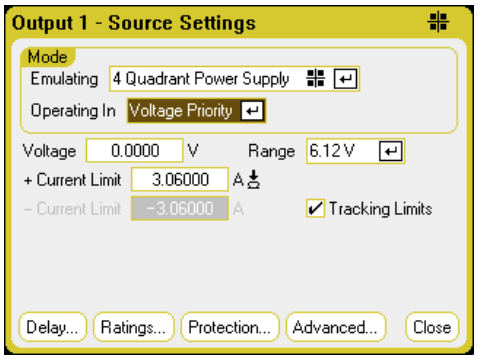


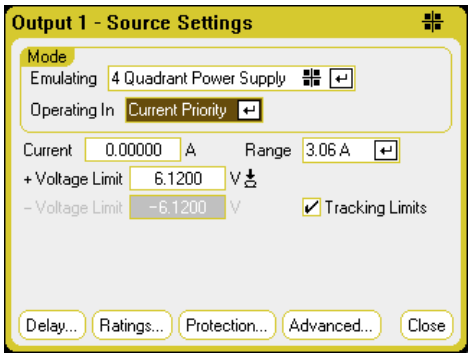
Voltage or Current Range - For outputs with multiple ranges, you can select a lower range if you need better output resolution. Use the navigation keys to highlight the Range field. Press the Enter key to access the dropdown range list. Use the navigation keys to select the desired output range.



4-Quadrant Power Supply

4-quadrant operation is only available on Keysight N6784A. Operation is allowed in all four output quadrants. The following figures show the 4-quadrant settings.





Operating in – selects either Voltage Priority or Current Priority. In voltage priority the output is controlled by a bi-polar constant voltage feedback loop, which maintains the output voltage at its positive or negative setting. In current priority the output is controlled by a bi-polar constant current feedback loop, which maintains the output source or sink current at its programmed setting. Refer to N678xA Multi-Quadrant Operation for a detailed description of voltage and current priority.

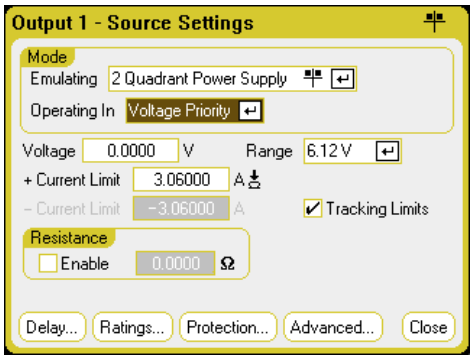
NOTE When switching between Voltage Priority and Current Priority, the output is turned off and the output settings revert to their Power-on or RST values.

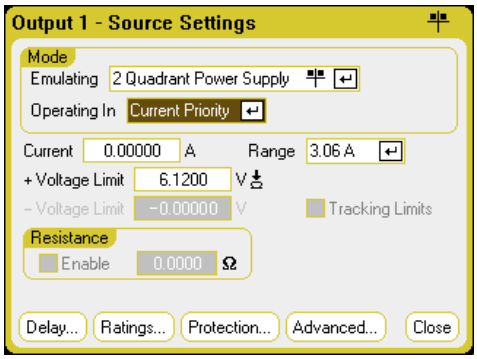
Depending on the priority mode, you can specify either the output Voltage or Current setting, as well as the appropriate output Range. You can also specify a Voltage Limit or Current Limit, which limits the selected parameter at the specified value. In voltage priority mode, the output voltage remains at its programmed setting as long as the load current is within the positive or negative limit. In current priority mode, the output current remains at its programmed setting as long as the output voltage is within its positive or negative limit setting.

Tracking Limits - lets the negative voltage or current limit track the positive voltage or current limit setting. By default, the negative limit will track the positive limit value. Un-check this box if you want to program asymmetrical positive and negative limits. If asymmetrical limits are programmed and tracking is turned on, the negative value is changed to track the positive limit.

2-Quadrant Power Supply

This operating mode is restricted to two quadrants (+V/+I and +V/-I). The following figures show the 2-quadrant settings.





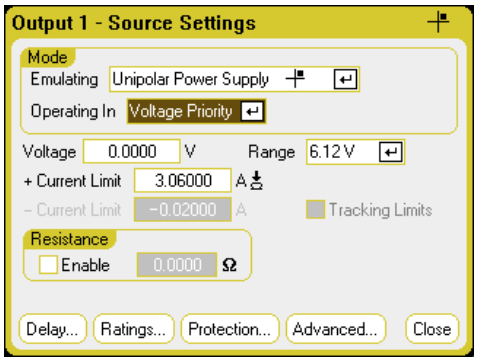
Operating in – selects either Voltage Priority or Current Priority. This selection determines which controls are displayed.

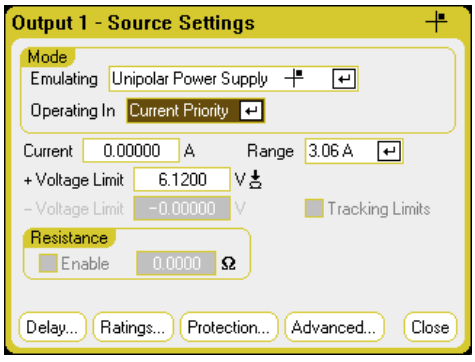
The other settings in 2-quadrant mode are the same as the settings in 4-quadrant mode except that you cannot program negative voltages or negative voltage limits. Because of this, voltage tracking is not available in Current Priority mode. Note that the negative voltage limit is fixed at –10 mV. Refer to N678xA Multi-Quadrant Operation for a detailed description of voltage and current priority.

Resistance - This is only available on Keysight Models N6781A and N6785A. Output resistance programming is primarily used in battery emulation applications, and only applies in Voltage Priority mode. Values are programmed in Ohms, from –40 mΩ to +1 Ω.

1-Quadrant Power Supply (unipolar)

This mode emulates a typical one quadrant or unipolar power supply with limited down-programming. The following figures show the 1-quadrant settings.





Operating in – selects either Voltage Priority or Current Priority. This selection determines which controls are displayed.

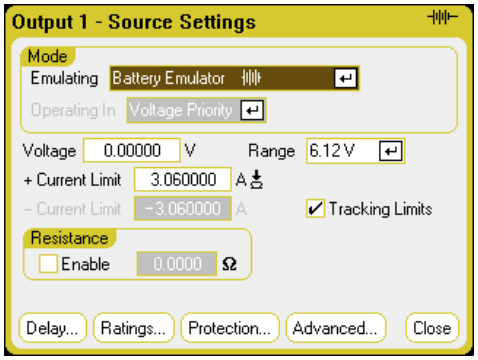
In 1-quadrant mode you cannot program negative voltages, negative currents, negative voltage limits, or negative current limits. Because of this, voltage tracking and current tracking are not available. Note that there is limited 2-quadrant operation with the negative current limit being fixed at 10% to 20% of the output current rating.

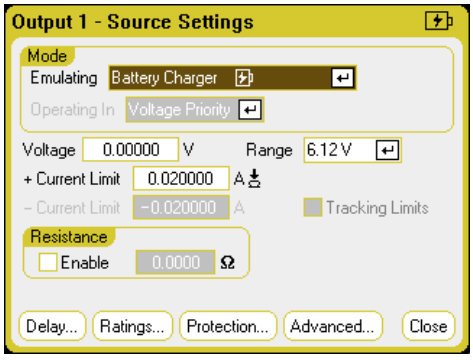
Resistance - This is only available on Keysight N6781A and N6785A. Output resistance programming is primarily used in battery emulation applications, and only applies in Voltage Priority mode. Values are programmed in Ohms, from – 40 mΩ to + 1 Ω.

Battery Emulator/Battery Charger

NOTE This information only applies to Models N6781A and N6785A. N6781A, N6785A

A battery emulator imitates a battery's charging and discharging functions. A battery charger imitates a battery charger; it cannot sink current like a battery. The following figures show the Battery emulator/Battery charger settings.



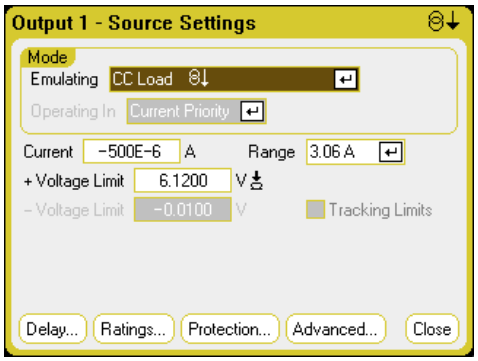


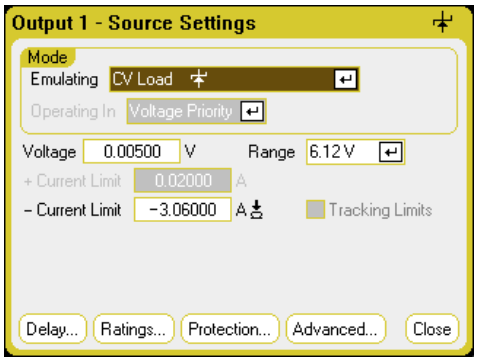
Battery Emulator - lets you specify the battery voltage and range as well as the + and – current limits. The output resistance is programmable, from – 40 mΩ to + 1 Ω. Voltage Priority mode is locked. The voltage setting is limited to positive values. The + and – current limits are set to their maximum values. The – current limit setting sets the current limit when the battery is being charged.

Battery Charger - lets you specify the charge voltage and range as well as the positive current limit. Voltage Priority mode is locked. Because the battery charger can only source current, the voltage and current settings are limited to positive values.

CC Load/CV Load

The CC Load emulates a constant-current load. The CV Load emulates a constant-voltage load. The figures below show the CC and CV load settings.





CC load - lets you specify the input Current and Range as well as the + Voltage Limit. Current Priority mode is locked. Remember to set the input current to a negative value. The + Voltage Limit should normally be set to its maximum value. The – Voltage limit is not programmable. In Meter mode, the measurement polarities and current settings are shown as negative values.

CV load - lets you specify the input Voltage and Range as well as the – Current Limit. Voltage Priority mode is locked. Set the input voltage to a positive value. The – Current Limit should normally be set to its maximum negative value. The + Current Limit is not programmable. In Meter mode, the measurement polarities and current settings are shown as negative values.

From the remote interface:

To specify the 4-quadrant, 2-quadrant, or 1-quadrant power supply emulation setting:

```
EMUL PS4Q,(@1)
EMUL PS2Q,(@1)
EMUL PS1Q,(@1)
```

To set the voltage priority mode:

```
FUNC VOLT,(@1)
```

To set the output voltage to 5 V in the high voltage range:

```
VOLT 5,(@1)
VOLT:RANG 20,(@1)
```

To set the positive current limit of output 1 to 1 A:

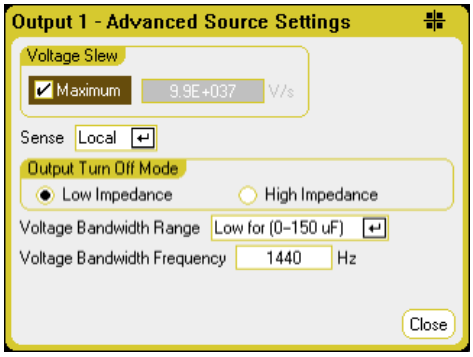
```
CURR:LIM 1,(@1)
```

To set the negative current limit, turn limit coupling (tracking) off. Then set the negative current limit:

```
CURR:LIM:COUP OFF,(@1)
CURR:LIM:NEG 0.5,(@1)
```

Advanced Source Settings

Advanced properties are configured in the Advanced Source Settings window. Press the Settings key to access the Source Settings window. Navigate to and select the Advanced button.



Voltage Slew - The voltage slew rate determines the rate at which the voltage changes to a new setting. The voltage slew control is only available in Voltage Priority mode. To program a voltage slew rate, enter the rate (V/s) in the Voltage Slew field. Check Maximum to program the fastest rate. Note that the maximum slew rate is limited by the analog performance of the output circuit. The minimum slew rate is model-dependent and is a function of the full-scale voltage range.

Current Slew – The current slew rate determines the rate at which the current changes to a new setting. The current slew control is only available in Current Priority mode. To program a current slew rate, enter the rate (A/s) in the Current Slew field. Check Maximum to program the fastest rate. Note that the maximum slew rate is limited by the analog performance of the output circuit. The minimum slew rate is model-dependent and is a function of the full-scale current range.

Sense - The default sense setting is Local, where the sense terminals are connected directly to the output terminals. If you are using remote voltage sensing as explained under 4-Wire Sense, you must disconnect the sense terminals from the output terminals. Use the navigation keys and select the Sense dropdown list. Selecting the 4-Wire item disconnects the sense terminals from the output terminals. This lets you use remote voltage sensing.

Output Turn-Off Mode – This is only available in Voltage Priority mode. It lets you specify high impedance or low impedance mode at output turn-on/turn-off.
Low impedance - at turn-on the output relays are closed after which the output is programmed to the set value. At turn-off the output is first programmed to zero, after which the output relays are opened.
High impedance – at turn-on the output is programmed to the set value after which the output relays are closed. At turn-off the output relays are opened while the output remains at its set value. This reduces current pulses that may be undesirable in some applications.

Voltage Bandwidth Range – This is only available in Voltage Priority mode. Voltage bandwidth range settings allow you to optimize output response time with capacitive loads. Refer to Output Bandwidth for more information.

Voltage Bandwidth Frequency – This is only available in Voltage Priority mode. The frequency field lets you enter a different frequency limit for the specified range. Refer to Output Bandwidth for more information.

From the remote interface:

To set the voltage slew rate to 5 Volt/second:

```
VOLT:SLEW 5,(@1)
```

To set the current slew rate to 1 Amp/second:

```
CURR:SLEW 1,(@1)
```

To query the minimum voltage or current slew rate:

```
VOLT:SLEW? MIN,(@1)
CURR:SLEW? MIN,(@1)
```

To set the front panel sense terminals to local sensing:

```
VOLT:SENS:SOUR INT,(@1)
```

To set the front panel sense terminals to remote sensing:

VOLT:SENS:SOUR EXT,(@1)

To query the setting of the front panel sense terminals (INT=local sensing; EXT=remote sensing):

VOLT:SENS:SOUR?,(@1)

To set the output turn-off mode to the high impedance setting:

OUTP:TMOD HIGHZ,(@1)

To set the output voltage bandwidth of output 1 to the default setting:

VOLT:BWID LOW,(@1)

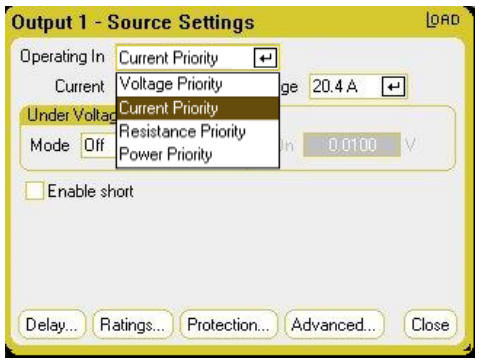
Programming N679xA Load Settings

NOTE Use the Source Settings window to access the specialized operating modes of the Keysight N679xA Load modules N679xA. Load module input terminals are referred to as "Outputs" throughout this document.

Priority Modes

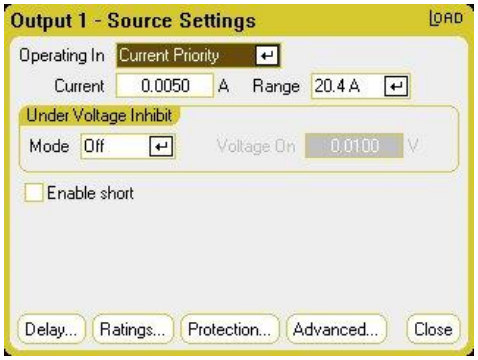
The Operating In dropdown list lets you select the priority mode of the Keysight N679xA Load module. Use the navigation keys to select one of the four priority modes. Then press Enter.

NOTE When switching between Priority modes, the load input is turned off and the Load settings revert to their Power-on or RST values.



Current Priority Mode

In this mode, the Load module will sink a current in accordance with the programmed value regardless of the input voltage. Note that a programmable voltage limit is not available. If the DUT imposes a voltage above the voltage rating of the module, the overvoltage protection will trip.



Current - Lets you enter a current value with the numeric keys. You can use the Current knob to adjust the value in this field. Press Enter to enter the value.

Range - Lets you select from two overlapping current ranges. The low range provides better resolution at low current settings.

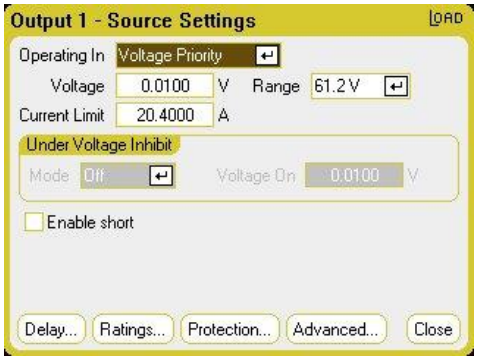
Under Voltage Inhibit - When the under-voltage inhibit function is enabled by selecting a mode, the load will not sink current until the input voltage rises above the voltage-on setting.
Off - turns the under-voltage inhibit function off.
Live - turns the input off whenever the voltage drops below the voltage-on setting. Turns the input back on when the voltage reaches the voltage-on setting.
Latched - lets the load sink current when the voltage subsequently drops below the voltage-on setting. An under-voltage inhibit condition is annunciated by the UVI status bit.

NOTE Under-voltage inhibit is not available when load modules are grouped or when the unit is operating in voltage priority mode.

Enable short - Lets you short the input terminals. This simulates a short circuit on the input of the load. It works in all priority modes and temporarily overrides input and slew settings. Note that the output on/off and the output protection functions take precedence over an input short. An input-short condition is annunciated by the SH status bit.

Voltage Priority Mode

In this mode, the load will sink enough current to control the DUT voltage to the programmed value. The module acts as a shunt voltage regulator when operating in voltage priority mode.



Voltage - Lets you enter a voltage value with the numeric keys. You can use the Voltage knob to adjust the value in this field. Press Enter to enter the value.

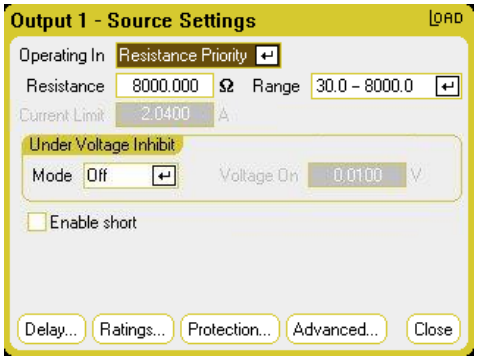
Range - There is only one voltage range.

Current Limit - You can specify a current limit that limits the input current when in voltage priority mode. It is programmable up to the rated current, with an over-range of 2%.

Refer to Current Priority Mode for descriptions of the Under Voltage Inhibit and Enable short controls.

Resistance Priority Mode

In this mode, the load will sink a current linearly proportional to the voltage in accordance with the programmed resistance value.



Resistance - Lets you enter a resistance value with the numeric keys. Press Enter to enter the value.

Range - Lets you select from three overlapping resistance ranges. The lower ranges provide better resolution at low resistance settings. The following ranges can be selected:

	N6791A	N6792A
High resistance range	from 30 Ω to 8 kΩ	from 15 Ω to 8 kΩ
Medium resistance range	from 2 Ω to 100 Ω	from 2 Ω to 100 Ω
Low resistance range	from 0.08 Ω to 3 Ω	from 0.04 Ω to 3 Ω

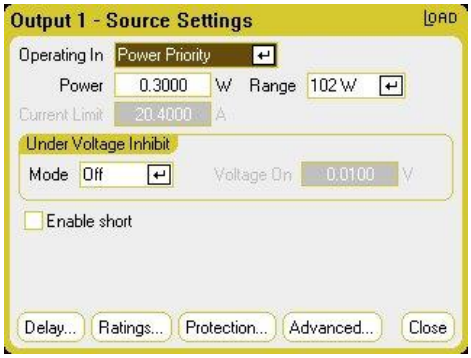
Current Limit - the current limit is fixed at the specified setting.

NOTE When changing ranges, the load input will be turned off, then back on again.

Refer to Current Priority Mode for descriptions of the Under Voltage Inhibit and Enable short controls.

Power Priority Mode

In this mode, the module will maintain the output power at the specified programmed power level. Note that the module has an independent power limit loop that regulates the output power at the limit setting - either 100 W or 200 W, with an over-range of 10%.



Power - Lets you enter a power value with the numeric keys. Press Enter to enter the value.

Range - Sets the power range. The value that you enter must be the highest value in Watts that you expect to source. The following ranges can be selected:

	N6791A	N6792A
High power range	from 0.3 W to 100 W	from 0.5 W to 200 W
Low power range	from 0.04 W to 10 W	from 0.1 W to 20 W

Refer to Current Priority Mode for descriptions of the Under Voltage Inhibit and Enable short controls.

From the remote interface:

To specify the load priority mode:

```
FUNC VOLT,(@1)
FUNC CURR,(@1)
FUNC RES,(@1)
FUNC POW,(@1)
```

To set the voltage to 10 V, the current to 5 A, the resistance to 100 Ω, and power to 50 W:

```
VOLT 10,(@1)
CURR 5,(@1)
RES 100,(@1)
POW 50,(@1)
```

Optionally, set a current limit value of 5 A while in voltage priority mode:

```
CURR:LIM 5,(@1)
```

To select a lower current, power, or resistance range, program a value that falls within the range:

```
CURR:RANG 5,(@1)
RES:RANG 50,(@1)
POW:RANG 5,(@1)
```

To short the input terminals:

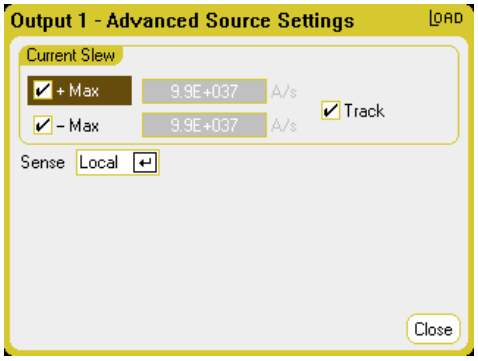
```
OUTP:SHOR ON,(@1:2)
```

To program a low-voltage limit (under-voltage inhibit) of 2 V, and enable the inhibit mode:

VOLT:INH:VON 2,(@1)
VOLT:INH:VON:MODE LIVE,(@1)

Advanced Source Settings

Advanced properties are configured in the Advanced Source Settings window. Press the **Settings** key to access the Source Settings window. Navigate to and select the Advanced button. The following dialog illustrates the advanced settings for Current Priority mode.



+Max and -Max - specifies the maximum or fastest allowable slew rate when checked. Unchecking these boxes lets you enter a slower slew rate in the appropriate fields. Separate slew settings can be programmed for Current Priority, Voltage Priority, Resistance Priority, and Power Priority modes

Track - lets the negative slew rate track the positive slew rate when checked. Un-check this box if you want to program asymmetrical positive and negative slew rates. If asymmetrical rates are programmed and tracking is turned on, the negative value is changed to track the positive value.

Sense - The default sense setting is Local, where the sense terminals are connected directly to the input terminals. If you are using remote voltage sensing as explained under 4-Wire Sense, you must disconnect the sense terminals from the input terminals. Selecting the 4-Wire item from the dropdown disconnects the sense terminals from the output terminals. This lets you use remote voltage sensing.

From the remote interface:

To set the current slew rate to 2 Amps/second:

CURR:SLEW 5,(@1)

To set the negative current slew, turn coupling (tracking) off. Then set the negative current slew:

CURR:SLEW:COUP OFF,(@1)
CURR:SLEW:NEG 3,(@1)

To set the front panel sense terminals to remote sensing:

VOLT:SENS:SOUR EXT,(@1)

To query the setting of the front panel sense terminals:

VOLT:SENS:SOUR? (@1)

Configuring an Output Turn-On/Turn-Off Sequence

Turn-on and turn-off delays control the turn-on/turn-off timing of the outputs in relation to each other.

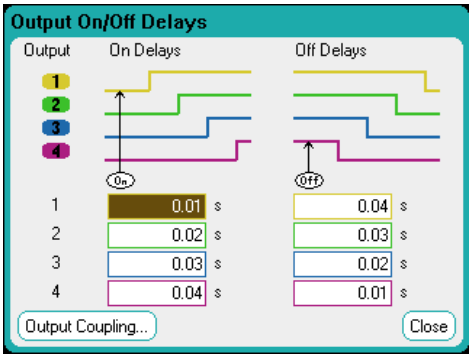
NOTE You can also synchronize Output On/Off delays across multiple mainframes. Refer to Output Couple Controls for further information.

Set the output voltage and current of the output channels

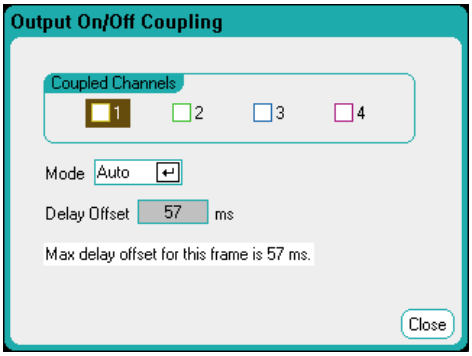
Refer to Turning the Unit On and set the output voltage and current values of all sequenced outputs.

Configure the turn-on turn-off delays

Press the Settings key twice to access the Output On/Off Delays window. Enter the On Delays and Off Delays for all outputs that will participate in the output on/off delay sequence. Values can range from 0 to 1023 seconds.



All power modules have an internal turn-on delay that applies from the time that the command to turn on the output is received until the output actually turns on. This turn-on delay is automatically added to the On Delays values. The turn-on delay does not apply when outputs turn off. To view the delay, select the Output Coupling button.

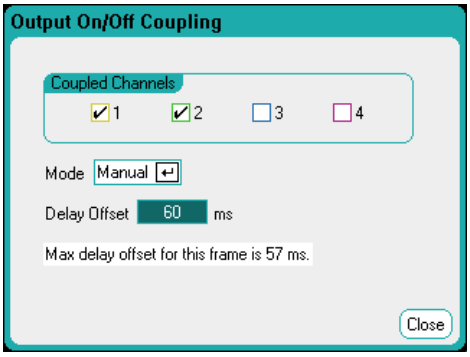


Normally, the firmware automatically calculates the delay offset based on the longest minimum turn-on delay of the installed power modules. However, if you will be excluding some outputs from participating in an output on/off delay sequence as described Step 3, the delay offset may be different based on the outputs that you will actually be sequencing. The minimum turn-on delays of the power modules are documented in the Keysight N6700 Modular Power System Family Specifications Guide.

Couple selected outputs

NOTE This step is only required if you will be excluding some outputs from participating in an output on/off delay sequence, or if you are coupling multiple mainframes, If all four outputs on a single mainframe are to be used in the sequence, you can skip this step.

In the Output On/Off Delays window, navigate to and select the Output Coupling Button.



Under Coupled Channels, select the outputs that will be coupled. Outputs excluded from an output on/off delay sequence can be put to other uses. Turning the output on or off on any coupled output will cause all coupled outputs to turn on or off according to their user-programmed delays.

Mode – If the Mode setting is set to Auto, the delay offset is automatically calculated by the firmware based on the outputs that are coupled. This is displayed in the Delay Offset field. To manually program a different delay offset, change the Mode setting to Manual.

Delay Offset – Manually specifying a delay offset lets you configure longer turn-on delays than the automatically calculated delay offset. This is useful if you are sequencing turn-on/turn-off delays across multiple mainframes as discussed under Output Couple Controls. Also, if you are using the scope to view the output sequence, you may choose longer turn-on delays to make the internal delay offset line up with the grid on the display. Note however, that if you program a shorter delay than the automatic delay offset, you may experience improper synchronization across all outputs.

Max delay offset for this frame - This field displays the maximum delay offset required for all the power modules that are installed in the power analyzer.

Use the All Outputs On and Off keys

Once output delays have been set, use the All Outputs On key to start the On delay sequence. Use the All Outputs Off key to start the Off delay sequence.

NOTE The All Outputs On/Off keys will turn ALL outputs on or off, whether they are configured to participate in an output on/off delay sequence or not.

From the remote interface:

To program turn-on and turn-off delays for channels 1 through 4:

```
OUTP:DEL:RISE 0.01,(@1)
OUTP:DEL:RISE 0.02,(@2)
OUTP:DEL:RISE 0.03,(@3)
OUTP:DEL:RISE 0.04,(@4)
OUTP:DEL:FALL 0.04,(@1)
OUTP:DEL:FALL 0.03,(@2)
OUTP:DEL:FALL 0.02,(@3)
OUTP:DEL:FALL 0.01,(@4)
```

To only include outputs 1 and 2 in a sequence and specify a different delay offset:

```
OUTP:COUP:CHAN 1,2
OUTP:COUP:DOFF:MODE MAN
OUTP:COUP:DOFF 0.050
```

To query the delay offset of the slowest power module in the mainframe (the maximum delay offset):

```
OUTP:COUP:MAX:DOFF?
```

To turn on two coupled outputs in a sequence:

```
OUTP ON,(@1:2)
```

Generating Arbitrary Waveforms

Arbitrary Waveform Description

Configuring Step Arbs

Configuring Ramp Arbs

Configuring Staircase Arbs

Configuring User-Defined Arbs

Configuring Sine Arbs

Configuring Pulse Arbs

Configuring Trapezoid Arbs

Configuring Exponential Arbs

Configuring Constant-Dwell Arbs

Configuring an Arb Sequence

Configuring Parameters Common to all Arbs

Running the Arbs

Importing and Exporting Arb Data

Arbitrary Waveform Description

Each output on the power analyzer can be modulated by the built-in arbitrary waveform generator function. This allows the output to act as a DC bias transient generator or an arbitrary waveform generator. The maximum bandwidth is based on the type of power module that is installed. This is documented in the Keysight N6700 Modular Power System Family Specifications Guide.

The arbitrary waveform generator has a variable dwell period, where each point in the waveform is defined by the current, voltage, power, or resistance setting along with the dwell time or duration to stay at that setting. Waveforms can be generated by specifying only a small number of points. For example, a pulse would only take three points to define it. However, sine, ramp, trapezoid, and exponential waveforms have 100 points assigned to the portion of their waveform that continuously changes. Constant-dwell waveforms can have up to 65,535 points assigned to them.

Each waveform can be repeated for a specific number of times, or continuously. For example, to generate a pulse train of 10 identical pulses, you can program one pulse and then repeat it 10 times.

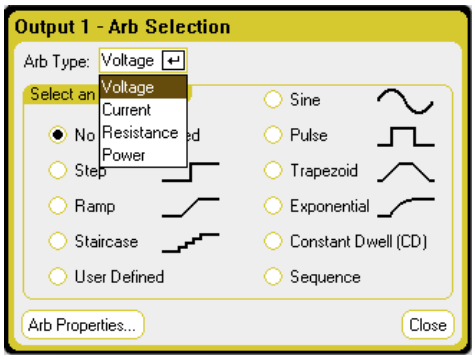
For the user-defined waveforms, you can specify up to 511 step-points for each waveform. You can specify a different dwell time for each of the step-points. The output will step through the user-defined values, staying at each point for the programmed dwell time, and then moving on to the next point.

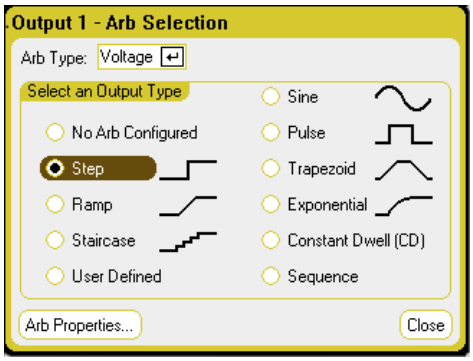
You can combine a number of individual arbitrary waveforms into an Arb sequence, as long as the total number of points of all waveforms does not exceed 511 points.

Configuring Step Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Step.



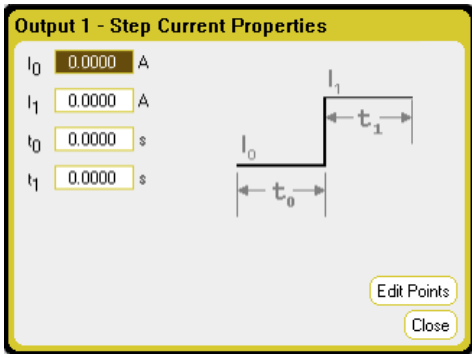


Step 2. Configure the Step Properties.

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before the step.
End Setting (I_1, V_1, P_1, or R_1)	The setting after the step.
Delay (T_0)	The delay after the trigger is received but before the step occurs.
End Time (T_1)	The time the output remains at the end setting after the step occurs.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP STEP,(@1)
```

Enter the values for the level before and after a voltage step:

```
ARB:VOLT:STEP:STAR 0,(@1)
ARB:VOLT:STEP:END 5,(@1)
```

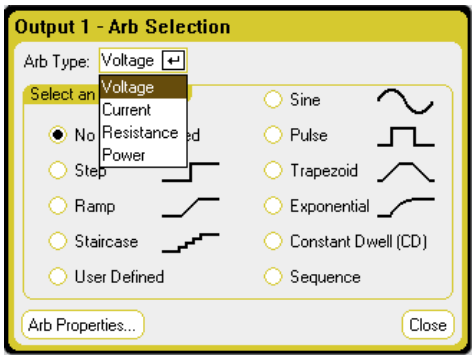
Enter the delay time before the step:

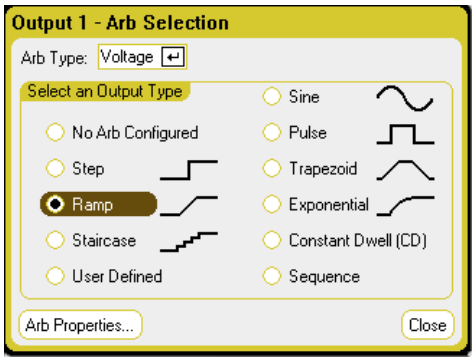
```
ARB:VOLT:STEP:STAR:TIM 0.01,(@1)
```

Configuring Ramp Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Ramp.



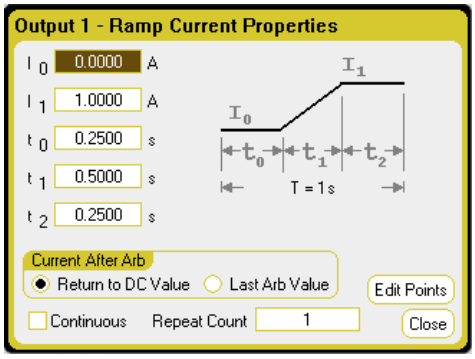


Step 2. Configure the Ramp Properties.

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before the ramp.
End Setting (I_1, V_1, P_1, or R_1)	The setting after the ramp.
Delay (T_0)	The delay after the trigger is received but before the ramp starts.
Ramp Time (T_1)	The time that the output ramps up.
End Time (T_2)	The time the output remains at the end setting after the ramp completes.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP RAMP,(@1)
```

Enter the values for the level before and after a voltage ramp:

```
ARB:VOLT:RAMP:STAR 0,(@1)
ARB:VOLT:RAMP:END 5,(@1)
```

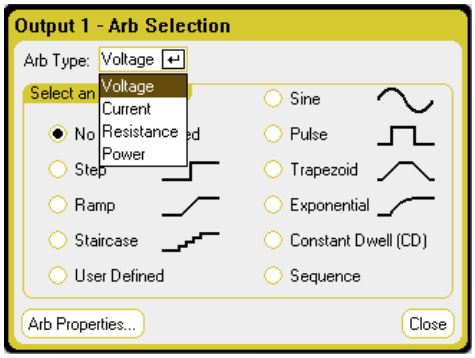
Enter the time before the pulse, the time of the pulse, and the time after the pulse:

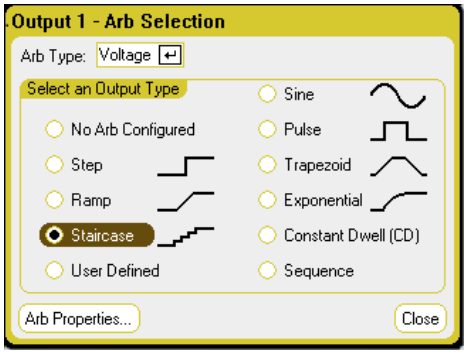
```
ARB:VOLT:RAMP:STAR:TIM 0.25,(@1)
ARB:VOLT:RAMP:RTIM 0.5,(@1)
ARB:VOLT:RAMP:END:TIM 0.01,(@1)
```

Configuring Staircase Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the Arb key twice or press the Arb key and then Properties to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Staircase.



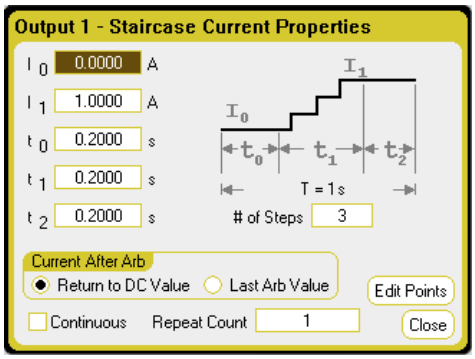


Step 2. Configure the Staircase Properties:

Press the Properties key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before the staircase.
End Setting (I_1, V_1, P_1, or R_1)	The setting after the final step. The difference between the start and end setting is divided equally between steps.
Delay (T_0)	The delay after the trigger is received but before the staircase starts.
Step Time (T_1)	The time to complete all staircase steps.
End Time (T_2)	The time the output remains at the end setting after the staircase completes.
# of Steps	The total number of staircase steps.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP STA,(@1)
```

Enter the values for the level before and after a voltage staircase:

```
ARB:VOLT:STA:STAR 0,(@1)
ARB:VOLT:STA:END 5,(@1)
```

Enter the time before the staircase, the stair-time of the ramp, and the time after the staircase:

```
ARB:VOLT:STA:STAR:TIM 0.2,(@1)
ARB:VOLT:STA:TIM 0.2,(@1)
ARB:VOLT:STA:END:TIM 0.2,(@1)
```

Enter the total number of staircase steps:

```
ARB:VOLT:STA:NST 3,(@1)
```

Configuring User-Defined Arbs

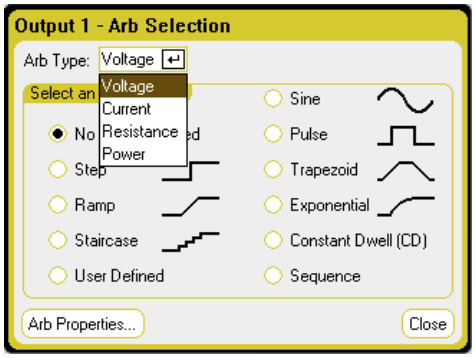
User-defined Arbs can contain up to 511 current, voltage, power, or resistance steps that are entered individually in the User-defined Properties window. Power and resistance steps apply to N679xA:

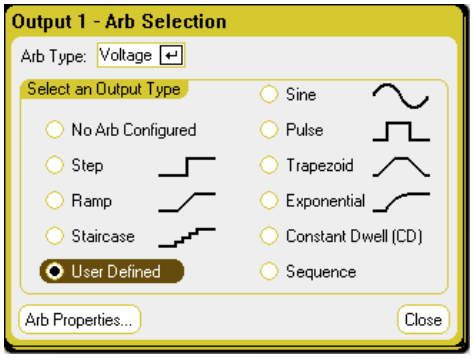
You can populate the User-defined Arb with values from a previously configured "standard" Arb and then edit the steps in the User-defined Properties window. To convert one of the standard Arbs to a user-defined Arb, refer to Configuring Parameters Common to all Arbs at the end of this section.

You can also import a User-defined Arb that was previously created using a spreadsheet as explained later in this section under Importing and Exporting Arb Data.

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

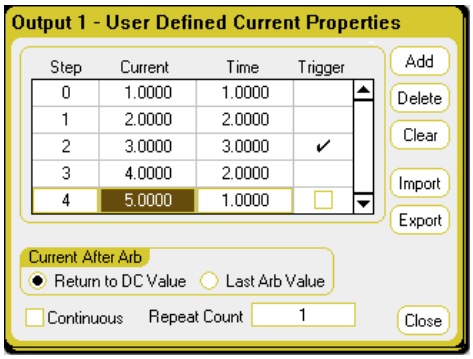
Press the Arb key twice or press the Arb key and then Properties to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select User-Defined.





Step 2. Configure the User-Defined Properties:

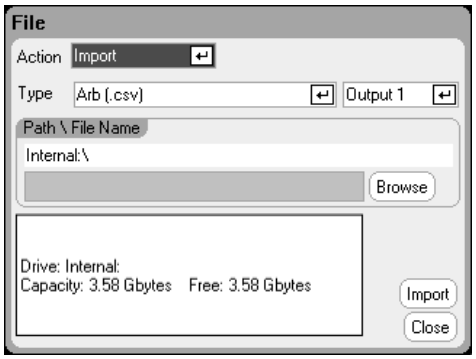
Press the Properties key or select the Arb Properties button. Then program the following parameters:

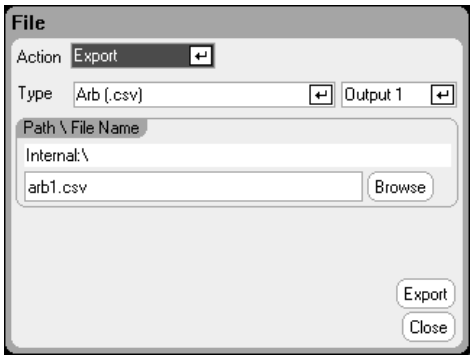


Parameter	Description
Step <n>	Each step of the waveform includes a current, voltage, power, or resistance parameter, dwell time, and trigger option. The total number of steps determines the length. Use the ▲ ▼ navigation keys to scroll through the steps.
Current, Voltage, Power, or Resistance	The current, voltage, power, or resistance value of the step.
Time	The time that the output stays at the step.
Trigger	Generate an external trigger signal at the start of the step when checked.
Add	Inserts a step below the selected step; values are copied from the previous step.
Delete	Deletes the presently selected step.
Clear	Clears values in all steps.
Import (.csv format)	Imports a current or voltage Arb list (see below).
Export (.csv format)	Exports a current or voltage Arb list (see below).

Step 3. Import or export User-Defined Arb data:

Select the Import button to import the file. Select the Export button to export the file. Then provide the following information:





Parameter	Description
Action	The Import or Export action.
Type	The Arb file type is .csv
Output1	When importing, the output on which the Constant-dwell Arb will run. When exporting, the output from which the Arb is exported.
Path/Filename	The path and filename of the Arb. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Specifies the location where the import file is located or where the export file will be placed.
Import	Imports the file.
Export	Exports the file.

Refer to under Importing and Exporting Arb Data later in this section for information on how to create .csv current or voltage data files.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP UDEF,(@1)
```

Enter the voltage values and dwell-times for five voltage steps:

```
ARB:VOLT:UDEF:LEV 1,2,3,4,5,(@1)
ARB:VOLT:UDEF:DWEL 1,2,3,2,1,(@1)
```

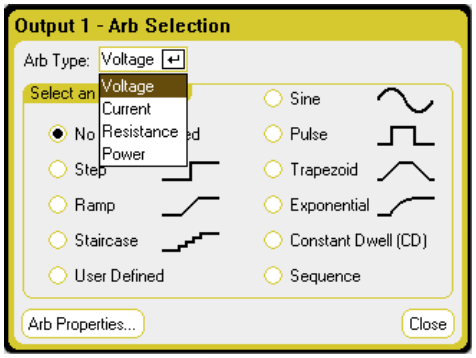
Generate an external trigger signal at the start of a voltage step (the trigger is generated at the start of step #3):

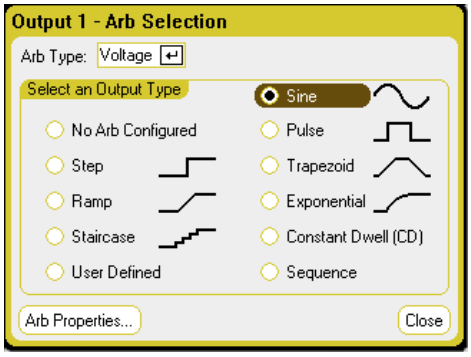
```
ARB:VOLT:UDEF:BOST 0,0,1,0,0,(@1)
```

Configuring Sine Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the Arb key twice or press the Arb key and then Properties to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Sine.



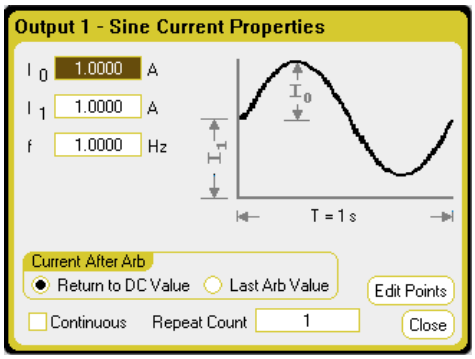


Step 2. Configure the Sine Properties:

Press the Properties key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Amplitude (I_0, V_0, P_0, or R_0)	The amplitude or peak value.
Offset (I_1, V_1, P_1, or R_1)	The offset from zero. For power modules that do not generate negative values, the offset must be ≥ Amplitude.
Frequency (f)	The frequency of the sine wave.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP SIN,(@1)
```

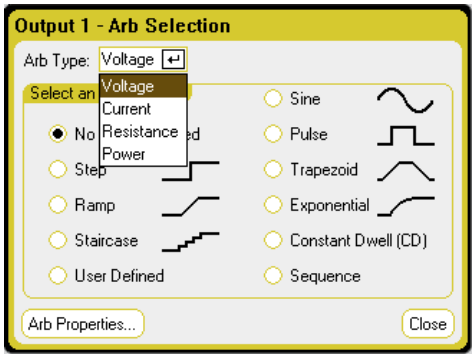
Enter the values for the voltage amplitude, offset from zero, and frequency:

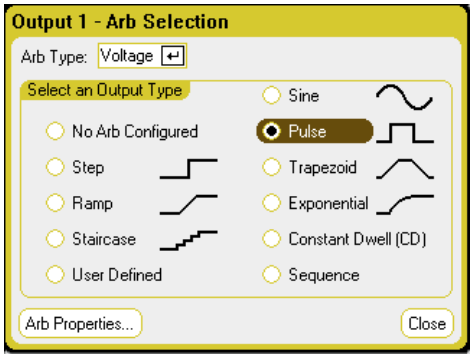
```
ARB:VOLT:SIN:AMPL 5,(@1)
ARB:VOLT:SIN:OFFS 5,(@1)
ARB:VOLT:SIN:FREQ 1,(@1)
```

Configuring Pulse Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Pulse.



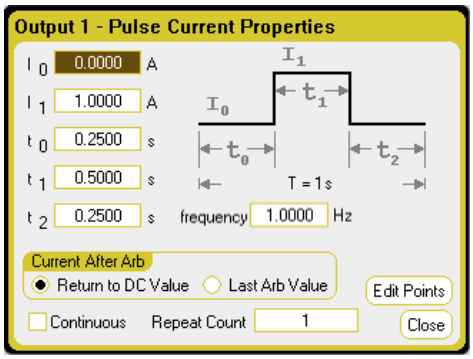


Step 2. Configure the Pulse Properties:

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before and after the pulse.
Pulse Setting (I_1, V_1, P_1, or R_1)	The amplitude of the pulse.
Delay (T_0)	The delay after the trigger is received but before the pulse starts.
Pulse Width (T_1)	The width of the pulse.
End Time (T_2)	The time the output remains at the end setting after the pulse completes.
Frequency	Enter a frequency value directly. this will change the (T_0), (T_1), (T_2) parameters

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP PULS,(@1)
```

Enter the values for the level before and the top of a voltage pulse:

```
ARB:VOLT:PULS:STAR 0,(@1)
ARB:VOLT:PULS:TOP 10,(@1)
```

Enter the time before the pulse, the time of the pulse, and the time after the pulse:

```
ARB:VOLT:PULS:STAR:TIM 0.25,(@1)
ARB:VOLT:PULS:TOP:TIM 0.5,(@1)
ARB:VOLT:PULS:END:TIM 0.25,(@1)
```

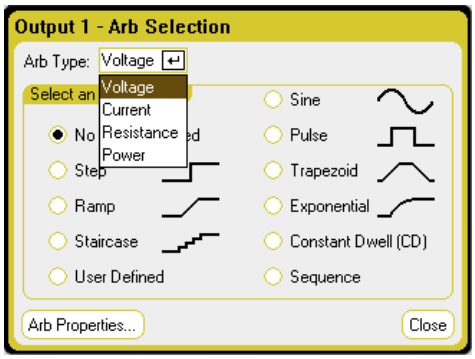
Enter the frequency of the pulse:

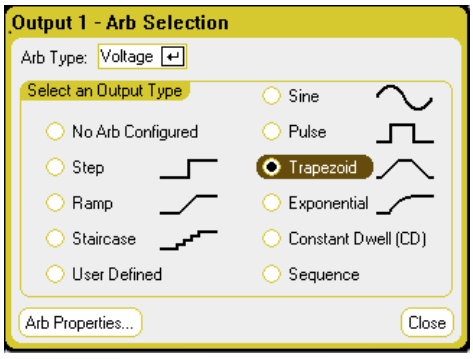
```
ARB:VOLT:PULS:FREQ 1,(@1)
```

Configuring Trapezoid Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Trapezoid.



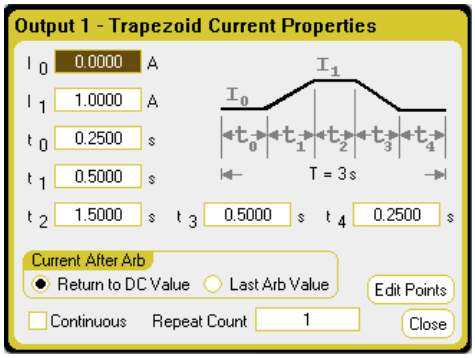


Step 2. Configure the Trapezoid Properties:

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before and after the trapezoid.
Peak Setting (I_1, V_1, P_1, or R_1)	The peak setting.
Delay (T_0)	The delay after the trigger is received but before the trapezoid starts.
Rise Time (T_1)	The time that the trapezoid ramps up.

Parameter	Description
Peak Width (T_2)	The width of the peak.
Fall Time (T_3)	The time that the trapezoid ramps down.
End Time (T_4	The time the output remains at the end setting after the trapezoid completes.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP TRAP,(@1)
```

Enter the values for the level before and during the top of a voltage trapezoid:

```
ARB:VOLT:TRAP:STAR 0,(@1)
ARB:VOLT:TRAP:TOP 5,(@1)
```

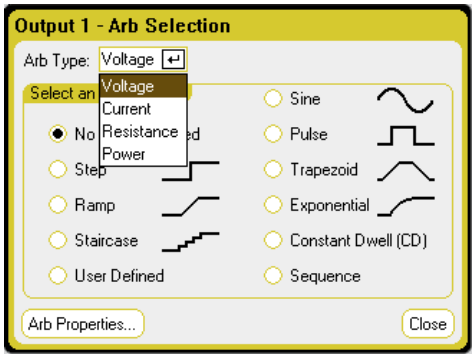
Enter the time before the trapezoid, the rise-time,fall-time, top-time, and the time after the trapezoid:

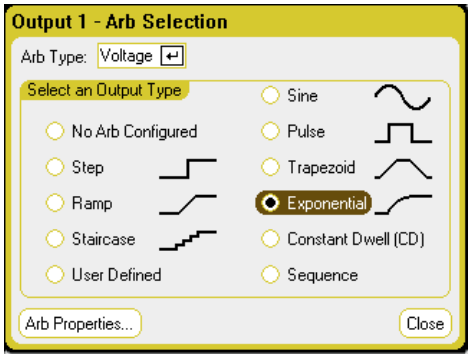
```
ARB:VOLT:TRAP:STAR:TIM 0.25,(@1)
ARB:VOLT:TRAP:RTIM 0.5,(@1)
ARB:VOLT:TRAP:FTIM 0.5,(@1)
ARB:VOLT:TRAP:TOP:TIM 1.5,(@1)
ARB:VOLT:TRAP:END:TIM 0.25,(@1)
```

Configuring Exponential Arbs

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Exponential.



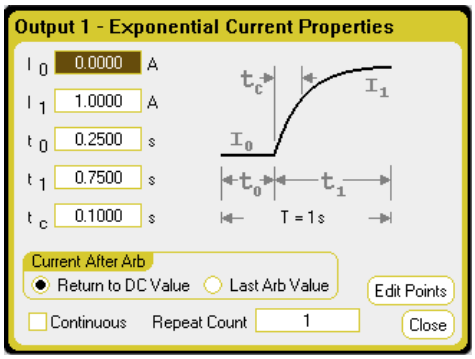


Step 2. Configure the Exponential Properties:

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

The I_0 and I_1 parameters shown apply to the Current Arb type.

The V_0, V_1, P_0, P_1, R_0, and R_1 parameters apply to the respective Voltage, Power and Resistance Arb types.



Parameter	Description
Start Setting (I_0, V_0, P_0, or R_0)	The setting before the waveform.
End Setting (I_1, V_1, P_1, or R_1)	The end setting of the waveform.
Delay (T_0)	The delay after the trigger is received but before the waveform starts.
Time (T_1)	Time for the amplitude to go from the start setting to the end setting.
Time Constant (T_C)	The time constant of the curve.

Step 3. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP EXP,(@1)
```

Enter the values for the level before and after a voltage exponential:

```
ARB:VOLT:EXP:STAR 0,(@1)
ARB:VOLT:EXP:END 5,(@1)
```

Enter the time before the exponential, the exponential time, and the time constant of the exponential:

```
ARB:VOLT:EXP:STAR:TIM 0.25,(@1)
ARB:VOLT:EXP:TIM 0.75,(@1)
ARB:VOLT:EXP:TCON 0.1,(@1)
```

Configuring Constant-Dwell Arbs

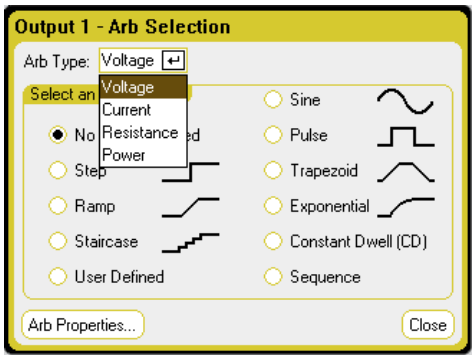
Constant-Dwell (CD) Arbs are a unique type that have some useful differences from other Arbs. CD Arbs are not limited to 511 points, they have up to 65,535 points. Unlike other Arbs, they do not have separate dwell values for each point - a single dwell value applies to ALL points. Also, the minimum dwell time of a CD Arb is 10 .24 microseconds, instead of the 1 microsecond resolution of other Arbs.

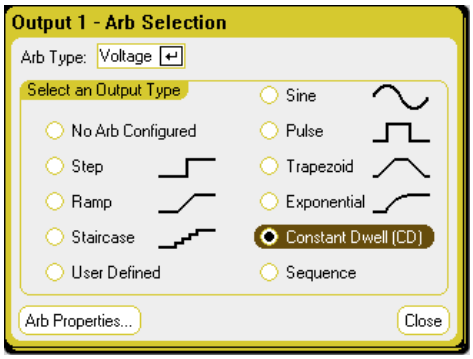
A CD Arb can run along with other Arbs on other outputs. If multiple outputs run a CD Arb, all CD Arbs must have the same dwell time. All CD Arbs must also have the same length and repeat count.

Because the CD Arbs can have such a large number of points, you cannot define individual values from the front panel. Instead, the data must be imported from a file. See Importing and Exporting Arb Data.

Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

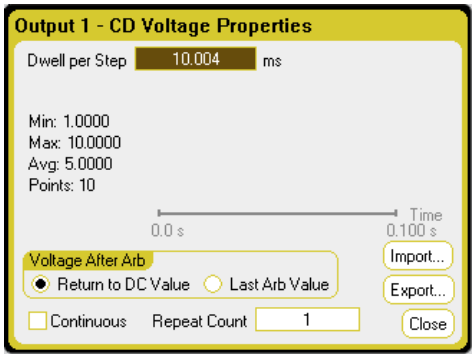
Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Constant-Dwell.





Step 2. Configure the Constant-Dwell Properties:

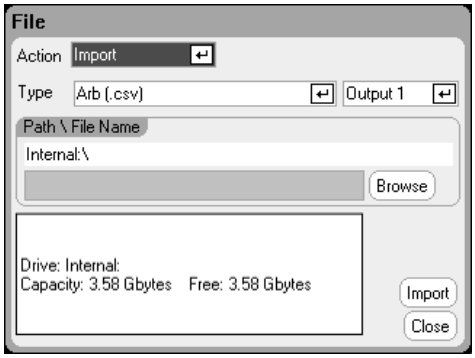
Press the **Properties** key or select the Arb Properties button. Then program the following parameters:

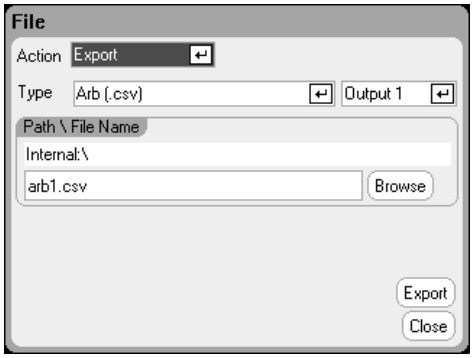


Parameter	Description
Dwell per Step	The dwell time for each step in seconds. Values range from 10.24 µs to 0.30 s.
Min	The minimum value of the imported Arb.
Max	The maximum value of the imported Arb.
Avg	The average value of the imported Arb.
Points	The number of points in the imported Arb.
Time	The total time of the imported Arb.
Import (.csv format)	Imports a current or voltage CD Arb list (see below).
Export (.csv format)	Exports a current or voltage CD Arb list. (see below).

Step 3. Import or export Constant-Dwell Arb data:

Select the Import button to import the file. Select the Export button to export the file. Then provide the following information:





Parameter	Description
Action	The Import or Export action.
Type	The Arb file type is .csv
Output1	When importing, the output on which the Constant-dwell Arb will run. When exporting, the output from which the Arb is exported.
Path/Filename	The path and filename of the Arb. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Specifies the location where the import file is located or where the export file will be placed.
Import	Imports the file.
Export	Exports the file.

Refer to under Importing and Exporting Arb Data later in this section for information on how to create .csv current or voltage data files.

Step 4. Configure the final steps common to all Arbs.

Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Select the Arb Type and Shape:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP CDW,(@1)
```

Program the dwell time and the number of points in a voltage CD Arb:

```
ARB:VOLT:CDW:DWEL 0.01,(@1)
ARB:VOLT:CDW 1,2,3,4,5,6,7,8,9,10,(@1)
```

The list of constant-dwell steps can be a list of comma-separated ASCII values (the default setting), or for better performance, it can be sent as a definite length binary block as described in IEEE 488.2.

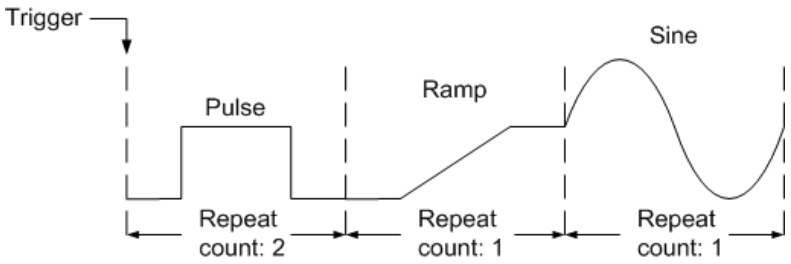
NOTE If you are sending data as a definite length binary block, the instrument will recognize the data format; however, you must specify the byte order. Refer to Measurement Data Formats for more information.

Configuring an Arb Sequence

The Arb Sequence allows multiple and different Arbs to run one after another is succession. Any of the standard Arb types, except for constant-dwell Arbs, can be included in the Arb sequence. All Arbs in the sequence must be of the same type; either voltage, current, resistance, or power.

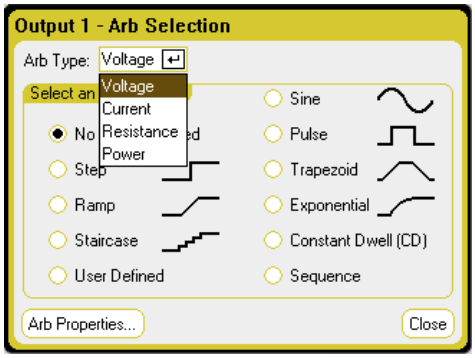
As with single Arbs, each Arb in the sequence has its own repeat count, can be set for dwell or trigger pacing, and can be set to repeat continuously. Note also that a repeat count can be set for the entire sequence, and it can also be set to repeat continuously.

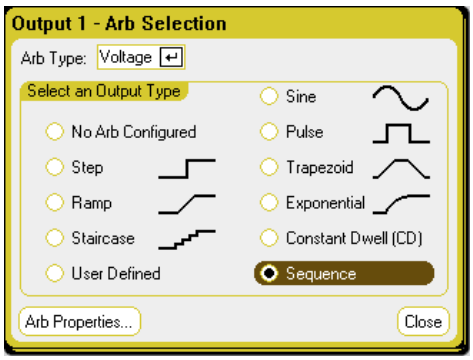
The following figure illustrates a sequence comprised of a pulse Arb, a ramp Arb, and a sine Arb. The repeat count value indicates how many times each Arb repeats before moving to the next type.



Step 1. Select the Arb Type and Shape. Power and resistance types apply to N679xA:

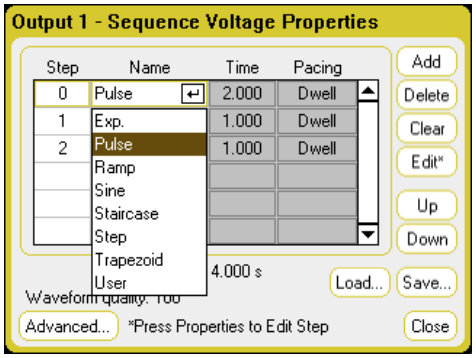
Press the **Arb** key twice or press the **Arb** key and then **Properties** to access the Arb Selection window. In the Arb Type dropdown, select the Arb type. Then select Sequence.

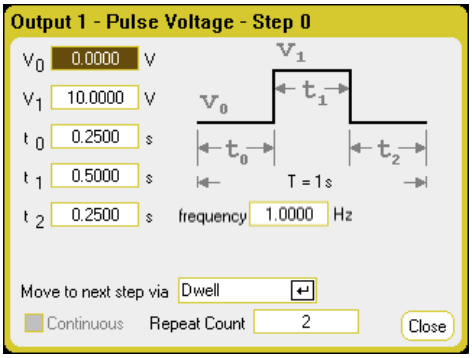




Step 2. Configure the Sequence Properties:

Press the **Properties** key or select the Arb Properties button. Then program the following parameters:



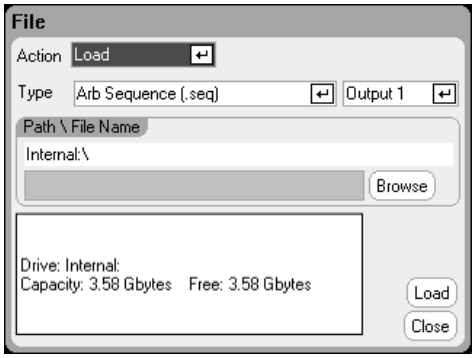


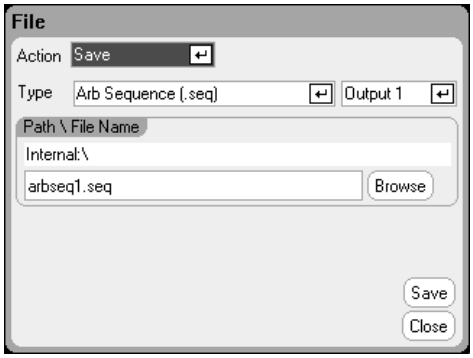
Parameter	Description
Step <n>	Each step of the sequence includes a step number, an arbitrary waveform, step time, and pacing option. The total number of steps determines the length. Use the ▲ ▼ navigation keys to scroll through the steps.
Name	The name of the Arb. Select an Arb from the dropdown list. Select Edit or Properties to edit the waveform. The Pulse waveform edit fields are shown above.
Time	Displays the total time that is allocated to the step in the Edit function. This time does not include the number of repeat counts
Pacing	Displays the pacing of the step. Dwell-paced transitions to the next step when the dwell time has elapsed. Trigger-paced transitions to the next step when an external trigger is received. If the step time completes before the trigger occurs, the step remains at the last Arb value while waiting for the trigger.
Add	Inserts a step below the selected step; values are copied from the previous step. Continue to Add steps until your sequence is complete.
Delete	Deletes the presently selected step.
Clear	Clears the presently selected step.
Edit	Edits the selected Arb. The Pulse waveform edit fields are shown above. Move to the next step specifies the step pacing, either dwell or trigger-paced. Repeat Count specifies how many times the Arb repeats. Continuous can only be selected if the Arb is trigger-paced.
Up	Move up through the steps.
Down	Move down through the steps.
Load (.seq format)	Loads a previously created sequence file (see below).
Save (.seq format)	Saves the present voltage or current sequence (see below).
Total time	Indicates the total run-time of the sequence.
Waveform Quality	Indicates the number of points allocated to the continuously changing portion of the following waveforms: sine, trapezoid, ramp, and exponential. Normally, each continuous section is approximated using 100 points, but in an Arb sequence this could result in exceeding the 511-point limit as more waveforms are added. The more of these waveforms that are added to the sequence, the fewer points will be allocated, down to a minimum of 16 points.
Advanced	Lets you edit the common properties that apply to the entire sequence. Refer to Configuring Parameters Common to all Arbs at the end of this section.

Step 3. Save or load Arb Sequences:

Arb sequences are saved and recalled in instrument state files, but you can also save and load them in files that are separate from other instrument settings.

Select the Load button to load the file. Select the Save button to save the file. Then provide the following information:

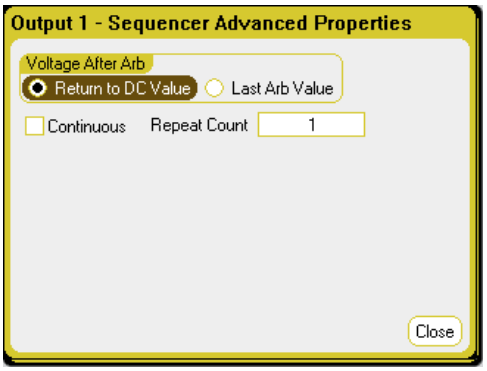




Parameter	Description
Action	The Load or Save action.
Type	The Sequence file type is .seq
Output1	When loading, the output on which the sequence will run. When saving, the output from which the sequence is saved.
Path/Filename	The path and filename of the sequence. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Specifies where the sequence file is located or where the sequence file will be placed.
Load	Loads the file.
Save	Saves the file.

Step 4. Configure the final steps common to all Arbs.

Press the Advanced button to specify what happens when the Arb sequence completes.



Refer to Configuring Parameters Common to all Arbs at the end of this section.

From the remote interface:

Observe the following when creating or editing an Arb sequence:

- The Arb function type must match the Arb type specified in each sequence step.
- Sequence steps must be specified sequentially. The last value in the parameter list is the sequence step number.
- When a step is added, all Arb parameters must be entered.

The following commands program a voltage sequence comprised of a pulse, a ramp, and a sine Arb with the pulse Arb repeated twice.

To set up output 1 to program a sequence of voltage waveforms:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP SEQ,(@1)
ARB:SEQ:RESet (@1)
```

To program step 0 as a voltage pulse:

```
ARB:SEQ:STEP:FUNC:SHAP PULS,0,(@1)
ARB:SEQ:STEP:VOLT:PULS:STAR:TIM 0.25,0,(@1)
ARB:SEQ:STEP:VOLT:PULS:TOP 10.0,0,(@1)
ARB:SEQ:STEP:VOLT:PULS:TOP:TIM 0.5,0,(@1)
ARB:SEQ:STEP:VOLT:PULS:END:TIM 0.25,0,(@1)
```

To program step 1 as a voltage ramp:

```
ARB:SEQ:STEP:FUNC:SHAP RAMP,1,(@1)
ARB:SEQ:STEP:VOLT:RAMP:STAR:TIM 0.25,1,(@1)
ARB:SEQ:STEP:VOLT:RAMP:END 10.0,1,(@1)
ARB:SEQ:STEP:VOLT:RAMP:RTIM 0.5,1,(@1)
ARB:SEQ:STEP:VOLT:RAMP:END:TIM 0.25,1,(@1)
```

To program step 2 as a voltage sine wave:

```
ARB:SEQ:STEP:FUNC:SHAP SIN,2,(@1)
ARB:SEQ:STEP:VOLT:SIN:FREQ 0.0167,2,(@1)
ARB:SEQ:STEP:VOLT:SIN:OFFS 10.0,2,(@1)
ARB:SEQ:STEP:VOLT:SIN:AMPL 20.0,2,(@1)
```

To repeat step 0 twice:

```
ARB:SEQ:STEP:COUN 2,0,(@1)
```

Configuring Parameters Common to all Arbs

From the front panel: The following properties are common to most Arb functions:



Parameter	Description
Return to DC Value	The parameter setting returns to the DC value that was in effect prior to the Arb.
Last Arb Value	The parameter setting remains at the last Arb value after the Arb completes.
Edit Points	Create a user-defined Arb from the present Arb property values. This lets you edit specific points in the standard arbitrary waveform. This function (button) is not available on User_Defined, Constant-Dwell or Sequence Arbs.
Continuous	Check to repeat the Arb continuously.
Repeat Count	The number of times the Arb repeats. Except for CD Arbs, the maximum repeat count is about 16 million. The maximum repeat count for voltage and current CD Arbs is 256.
Close	Saves and closes the Properties window.

From the remote interface:

The parameter setting returns to the DC value that was in effect prior to the Arb.

ARB:TERM:LAST OFF,(@1)

The parameter setting remains at the last Arb value after the Arb completes.

ARB:TERM:LAST ON,(@1)

Create a user-defined Arb from the present Arb property values (same as Edit Points button):

ARB:CURR:CONV (@1)
ARB:VOLT:CONV (@1)

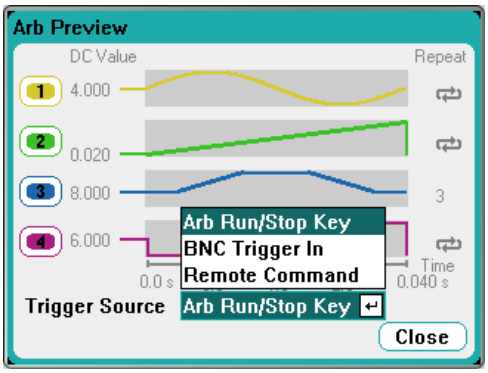
Specify the repeat count of the Arb, or specify continuous repetition (INF):

ARB:COUN 10,(@1)
ARB:COUN INF,(@1)

Running the Arbs

Step 1. Select the Arb trigger source:

From the front panel: Press the Arb key, then select the Trigger Source field. The same trigger source will be used to trigger all of the arbitrary waveforms. Note that the Arb Preview dialog provides a preview of the Arb waveform that will be run.



Trigger Source	Description
Arb Run/Stop Key	The front panel Run/Stop key will trigger the Arb when pressed.
BNC Trigger In	A signal on the rear panel BNC input connector will trigger the Arb
Remote Command	A remote interface command will trigger the Arb.

From the remote interface:

Select from one of the following SCPI trigger sources:

Trigger Source	Description
Bus	Selects a GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).
IMMediate	Selects the immediate trigger source. This triggers the Arb immediately when the INITiate command is sent.
EXTernal	Selects the trigger input BNC connector on the rear panel. You must provide a low-true signal to the connector.

Enable the specified Arb function to respond to output triggers:

```
CURR:MODE ARB,(@1)
VOLT:MODE ARB,(@1)
POW:MODE ARB,(@1)
RES:MODE ARB,(@1)
```

Specify one of the following three trigger sources:

```
TRIG:ARB:SOUR BUS
TRIG:ARB:SOUR IMM
TRIG:ARB:SOUR EXT
```

Step 2. Initiate and Trigger the Arb:

NOTE When the arbitrary waveform runs, front panel voltage and current controls as well as any remote voltage and current commands are ignored until after the Arb completes.

From the front panel: Press the Output On key to enable the output. Select Meter View or Scope View to display the Arb. Depending upon the selected trigger source, trigger the arbitrary waveforms as follows:

Trigger Source	Description
Arb Run/Stop Key	Press the **Arb Run/Stop** key to initiate and start the Arbs. All Arbs are triggered simultaneously. Press the **Arb Run/Stop** key again to stop the Arbs.
Rear Trigger Input	Provide a low-true signal to the Trigger In BNC connector. Refer to Supplemental Characteristics for minimum pulse width. All Arbs are triggered simultaneously.

Once configured, the instrument will wait indefinitely for the trigger signal. If the trigger does not occur, and you wish to cancel the arbitrary waveform, press the Arb Run/Stop key to stop the Arb.

From the remote interface:

To enable output 1:

```
OUTP ON,(@1)
```

To initiate the transient trigger system:

```
INIT:TRAN (@1)
```

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. Refer to Status Tutorial for more information.

To query the WTG_tran bit (bit 4):

```
STAT:OPER:COND? (@1)
```

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.

NOTE Unless INITiate:CONTinuous:TRANsient is programmed, it will be necessary to initiate the transient trigger system each time a triggered action is desired.

To trigger the Arb if the trigger source is BUS:

```
*TRG
```

As previously discussed, a trigger can also be generated by a trigger signal applied to the rear panel BNC input connector. If this 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.

If the trigger does not occur, and you wish to cancel the arbitrary waveform, send

ABOR:TRAN,(@1)

When a trigger is received, the Arb runs. When the Arb completes, 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.

To query the TRAN_active bit (bit 6):

STAT:OPER:COND? (@1)

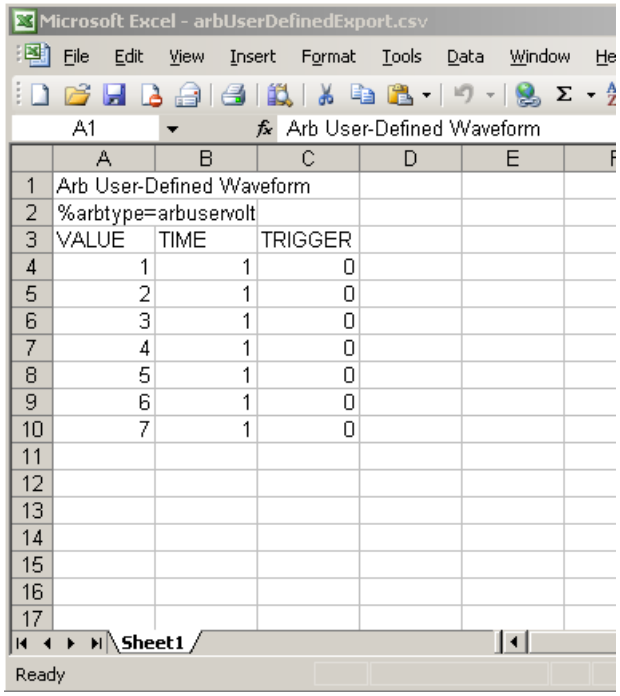
If a bit value of 64 is returned in the query, the TRAN_active bit is true, and the Arb has NOT completed. When the TRAN_active bit is false, the Arb has completed.

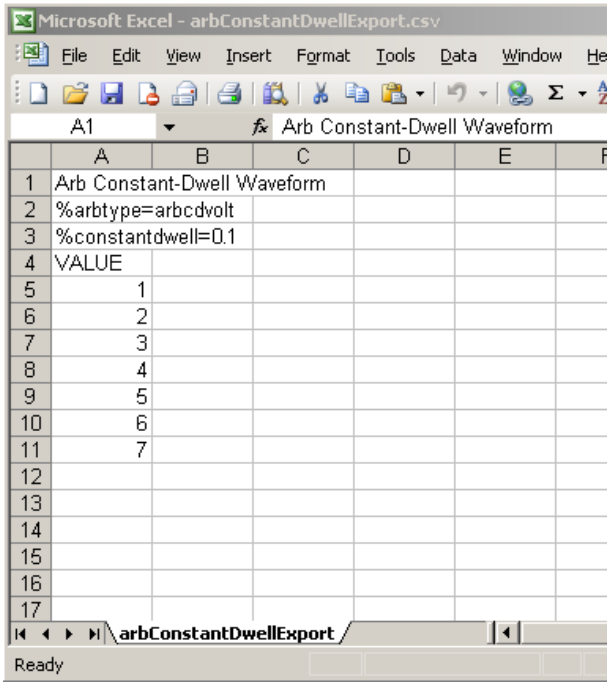
Importing and Exporting Arb Data

NOTE You can only import and export User-Defined and Constant-Dwell Arb data.

You can create an arbitrary waveform in a Microsoft Excel spreadsheet and import it into the instrument using the Import function as previously explained in this section under Configuring User-Defined Arbs and Configuring Constant-Dwell Arbs. Likewise, you can also Export an arbitrary waveform from the instrument to a spreadsheet.

In the following spreadsheet examples, the file format for User-Defined Arbs and Constant-Dwell Arbs is shown. The format includes a notes section, tag header, and the appropriate number of data header and data row columns.





Notes section - This section contains text to describe the file. It can also contain empty rows. Notes rows are generally one column wide.

Tag header - This row must contain one of the following tags:

%arbtype=arbuservolt
%arbtype=arbusercurr
%arbtype=arbuserpow
%arbtype=arbuserres
%arbtype=arbcdvolt
%arbtype=arbcdcurr
%arbtype=arbcdpow
%arbtype=arbcdres

For constant-dwell Arbs, a second tag row must specify the dwell:
%constantdwell=<float>

Data header - For user-defined Arbs, the data header row must have 3 columns with the following headings: VALUE, TIME, and TRIGGER. For constant-dwell Arbs, the header row has one column with the heading: VALUE. All rows following the header are the data rows.

Data rows - For user-defined Arbs, the data in the VALUE column must match the Arb type; either voltage or current values. The TIME column specifies the dwell time of the step in seconds. The TRIGGER column requires a value of zero as the default. If you want the Arb to generate an external trigger signal at the start of the step, replace the zero with a one. For constant-dwell Arbs, the data in the VALUE column must match the Arb type; either voltage or current values.

Using the Protection Functions

Protection Functions

Configuring Protection

Advanced Protection

Protection Functions

Each output has independent protection functions. A front panel status indicator will turn on when a protection function has been set. Protection functions are latching, which means that they must be cleared once they have been set.

Additionally, as explained under Output Coupling, you can configure the instrument so that when a protection fault occurs on one output, ALL outputs will be turned off.

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

OV - Over-voltage protection is a hardware protection whose trip level is a programmable value. The OV protection is always enabled.

OV– - Negative voltage protection is a hardware OVP. Only applies to Keysight N6784A and N6783A.

OC - Over-current protection is a programmable function that can be enabled or disabled. When enabled, the output will be disabled when the output current teaches the current limit setting.

OT - Over-temperature protection monitors the temperature of each output and shuts down the output if any temperature exceeds the maximum factory-defined limits (see OUTPut:PROTection:TEMPerature:MARGin?).

OSC - Oscillation protection shuts down the output if an oscillation is detected on the output. Only applies to Keysight N678xA SMU.

PF - PF indicates that a power fail condition on the AC mains has disabled the output.

CP+ - CP+ indicates that a positive power limit condition has disabled the output. This protection function does not apply to all power modules. Refer to Power Limit Operation for further information.

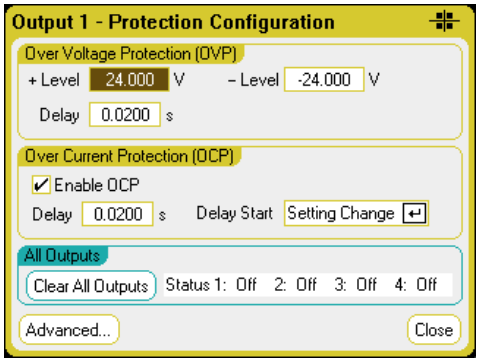
CP– - CP– indicates that a negative power limit condition has disabled the output. This protection function does not apply to all power modules. Refer to Power Limit Operation for further information.

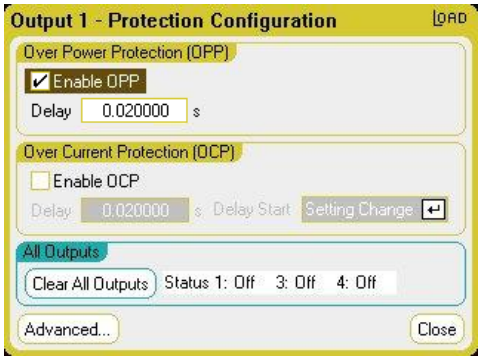
PROT - Prot indicates that the output is disabled, either because of a coupled protection signal from another output, or because the programmed watchdog time has expired.

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 further information.

Configuring Protection

Protection functions are configured in the Protection Configuration window. Press the Settings key to access the Source Settings window. Navigate to and select Protection. Then press Enter.





Over-Voltage Protection - Over-voltage protection disables the output if the output voltage reaches the OVP level. The OVP circuit monitors the voltage at the + and – output terminals. To set the over-voltage protection, enter an over-voltage value in the +Level field.

For models N678xA SMU N678xA SMU, the OVP circuit senses at the 4-wire sense terminals rather than at the output terminals. This allows for more precise over-voltage monitoring directly at the load. Refer to Over-Voltage Protection Considerations for details. These models also have a back-up local OVP function. Refer to Local OVP for a description of the feature. Additionally, for model N6784A, you can program a negative over-voltage value. Enter the value in the -Level field.

For models N678xA SMU and N6783A N678xA SMU N6783A, you can specify a delay to prevent momentary voltage excursions from tripping the over-voltage protection. Enter the value in the over-voltage Delay field. These models also have negative voltage protection, which disables the output if negative voltages are detected. Negative voltage protection is indicated by the OV- annunciator.

For models N679xA N679xA the over-voltage protection level is not programmable and is fixed at 110% of the rated input voltage.

Over-Current Protection - With over-current protection enabled, the power analyzer disables the output if the output current reaches the current limit setting, which causes a transition from CV to CC mode. To enable over-current protection, check the Enable OCP box.

Note that you can also specify a Delay to prevent momentary CV-to-CC status changes from tripping the over-current protection. The delay can be programmed from 0 to 0.255 seconds. You can specify if the Start of the delay is initiated by any transition into CC mode, or only at the end of a settings change in voltage, current, or output state. Refer to CC Mode Delay for more information.

Models N679xA N679xA have an additional fixed over-current protection that is always enabled. This protection will turn the output off whenever the input current exceeds 105% of the high ranges and approximately 110% of the low current ranges.

Over-Power Protection - For models N679xA N679xA only, the over-power protection will turn the output off if the input power exceeds 110% of the module's power rating. You can program an

over-power protection delay to prevent the over-power protection function from being triggered during the delay time. This prevents momentary input power spikes from triggering the over-power protection. A status bit (CP+) indicates that the output has been turned off by a power limit condition.

All Outputs Status – The Status field shows the status of all outputs. This indicator also appears in the lower left corner of each output in Meter View. When a protection function trips the power analyzer disables the affected output and the status indicator shows which protection function was activated.

Clear All Outputs - To clear the protection function, first remove that condition that caused the protection fault. Then select Clear All Outputs. This clears the protection function and returns the output to its previous operating state.

Advanced button – Advanced protection properties are configured in the Advanced Protection window. Navigate to and select Advanced.

From the remote interface:

To program the OVP level for outputs 1 and 2 to 10 V:

VOLT:PROT 10,(@1,2)

To enable OCP for outputs 1 and 2 and specify a 10 millisecond delay for the OCP:

CURR:PROT:STAT 1,(@1,2)
CURR:PROT:DEL.01,(@1,2)

To start the delay timer by ANY output transition into CC mode:

CURR:PROT:DEL:STAR CCTR, (@1,2)

To start the timer by a settings change in voltage current or output:

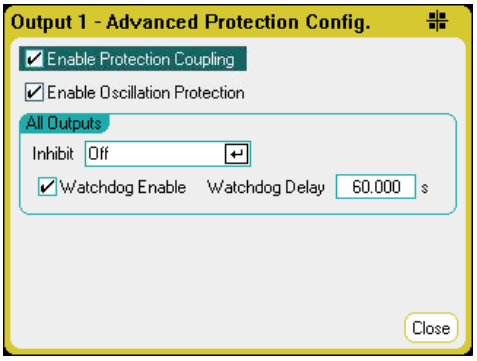
CURR:PROT:DEL:STAR SCH, (@1,2)

To clear an output protection fault on output 1:

OUTP:PROT:CLE (@1)

Advanced Protection

Press the Settings key to access the Source Settings window. Navigate to and select Protection. Navigate to and select Advanced.



Enable Protection Coupling – Checking this box lets you couple the outputs so that when a protection fault occurs on one output, ALL outputs will be turned off.

Enable Oscillation Protection - This is only available on models N678xA SMU N678xA SMU. If open sense leads or capacitive loads outside the allowable range cause the output to oscillate, the oscillation protection function detects the oscillation and latches the output off. The condition is annunciated on the front panel by the Osc status.

All Outputs – For all outputs you can program the Inhibit input (digital pin 3) on the rear panel to act as an external protection shutdown signal. The behavior of this signal can be set to either Latched or Live (non-latched). Off disables the remote inhibit. Refer to Inhibit Input for further information.

Watchdog – For all outputs you can program a watchdog timer function. The output watchdog timer causes all outputs 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 or when using the Web server – the outputs will still shut down after the time period has elapsed.

After the time period has expired, the outputs will be disabled, but the programmed output state is not changed. This condition is annunciated on the front panel by the Prot status. The delay is programmable from 1 to 3600 seconds in 1 second increments.

From the remote interface:

To program the INH signal to act as an external shutdown:

```
DIG:PIN3:FUNC INH
```

To configure the pin polarity for pin 3:

```
DIG:PIN3:POL POS
```

To enable output protection coupling:

```
OUTP:PROT:COUP ON
```

To enable output oscillation protection:

```
OUTP:PROT:OSC ON, (@1)
```

To enable the watchdog timer function and set the delay to 15 minutes (900 seconds):

```
OUTP:PROT:WDOG ON
OUTP:PROT:WDOG:DEL 900
```

4 Using the Measurement Functions

Using the Meter Functions

Using the Scope Functions

Using the Data Logger Functions

External Data Logging

Equivalent SCPI commands to program a specific function are included at the end of each topic. However some functions such as the front panel Scope View, Data Logger View, and some Administrative functions do not have equivalent SCPI commands

Using the Meter Functions

Meter View

Meter Ranges and Measurement Times

Seamless Measurements

N678xA SMU Meter-Only Modes

N679xA Load Measurements

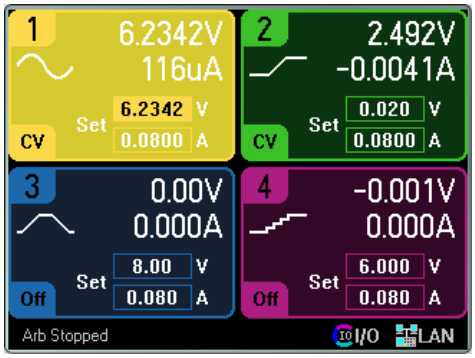
Auxiliary Voltage Measurements

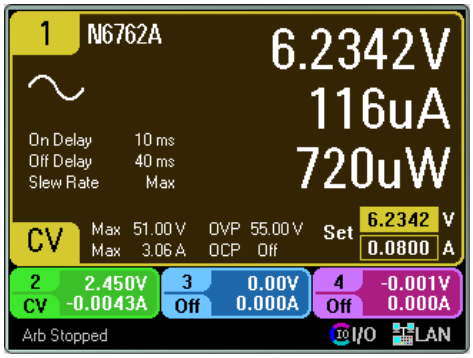
Each power module has a fully integrated voltmeter and ammeter to measure the actual voltage and current being sourced from the output to the device under test. The accuracy of the voltage and current measurements is based on the type of power modules that are installed, as documented in the Keysight N6700 Modular Power System Family Specifications Guide .

Meter View

Each output has its own measurement capability. When the Meter view is displayed, the measurement system continuously measures the output voltage and current. The measurement system acquires as many points as needed based on the number of power line cycles (NPLC) and the time interval, and averages the samples.

As shown below, the default view on the left displays all four outputs. The single-output view on the right displays more information about the selected output. Press the Meter View key to toggle between the two views.





From the remote interface:

To trigger and return DC current or voltage measurements:

```
MEAS:CURR? (@1)
MEAS:VOLT? (@1)
```

To return a previously triggered DC current or voltage:

```
FETC:CURR? (@1)
FETC:VOLT? (@1)
```

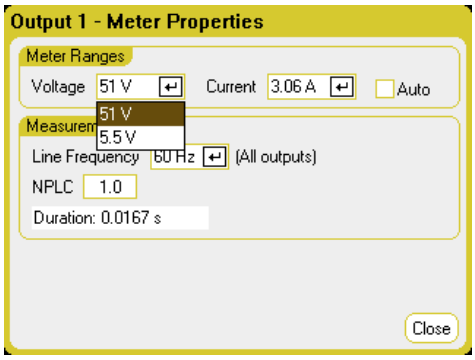
Meter Ranges and Measurement Times

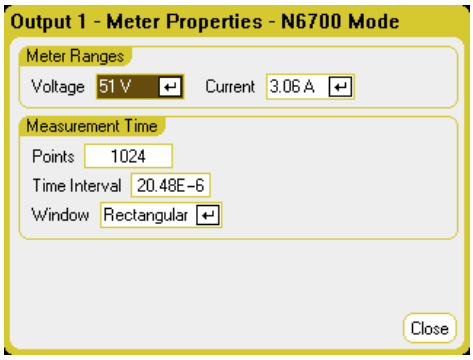
Some power modules have multiple voltage and current meter ranges (see Model Differences). Selecting a lower measurement range provides greater measurement accuracy, provided that the measurement does not exceed the range. If the measurement exceeds the range, an "Overload" error will occur.

Measurement Time parameters can be configured for all power modules.

From the front panel:

To specify a measurement range, press the Meter View key, then press Properties.





NOTE

How the Meter View measurement system behaves depends on whether the standard controls, or the N6700 Mode controls are selected. N6700 mode controls are selected in the Front Panel Preferences dialog, located in the Utilities menu.

The standard measurement controls are shown in the Meter Properties dialog on the left. These controls are completely independent from the measurement controls for Scope View, Data Logger View, Elog, Histogram, and the SCPI commands.

The N6700 Mode controls are shown in the Meter Properties dialog on the right. In N6700 mode, the Meter View measurement system uses the same measurement control settings as set by their corresponding SCPI commands.

Meter Ranges - In the Voltage or Current dropdown menu, select the desired lower measurement range. Check the Auto box to enable measurement autoranging. The instrument automatically selects the best measurement range for the amplitude of the measurement. Note that this functionality is not the same as seamless measurements.

Line Frequency – Specify the ac mains frequency (50 Hz or 60 Hz).

NPLC - Specify the number of power line cycles (NPLC) that the measurement will span. Increase the NPLC for improved accuracy and noise reduction on low current and voltage measurements.

Duration – Indicates the duration of the measurement based on the Frequency and NPLC settings.

N6700 Mode

Meter Ranges – These selections match the SCPI range commands. The Auto selection is not available, as SCPI commands do not support automatic measurement range selection based on amplitude.

Points - Specify the number of sample points in each measurement.

Time Interval - Indicates the integration time of each measurement.

Window – Specify a Hanning or Rectangular measurement window.

From the remote interface:

In N6700 mode, the Meter View measurement system uses the same measurement settings as the following SCPI commands. To specify a voltage or current measurement range:

SENS:CURR:RANG <current>,(@1)
SENS:VOLT:RANG <voltage>,(@1)

The range value that you send should be the maximum value that you expect to measure. The instrument selects the range with the best resolution for the value entered.

You can also specify the points, time interval, and window function:

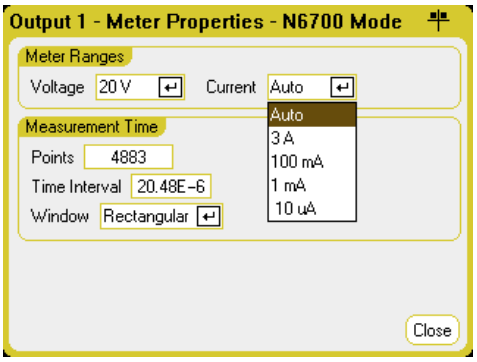
SENS:SWE:POIN <points>,(@1)
SENS:SWE:TINT <interval>,(@1)
SENS:WIND RECT|HANN,(@1)

Seamless Measurements

Seamless measurement autoranging for both voltage and current is available on models N678xA SMU and with Option SMR. N678xA SMU Option SMR This enables a wide dynamic measurement range with no data lost across ranges.

NOTE Seamless autoranging does not include the 10 µA range, which must be selected manually. Seamless autoranging is only available in Meter View when N6700 Mode is selected in the Front Panel Preferences dialog, located in the Utilities menu.

To enable seamless voltage or current autoranging, press the Meter View key, then press Properties. In the Voltage or Current dropdown menu, select Auto.



From the remote interface:

Use the following SCPI commands to enable seamless measurements:

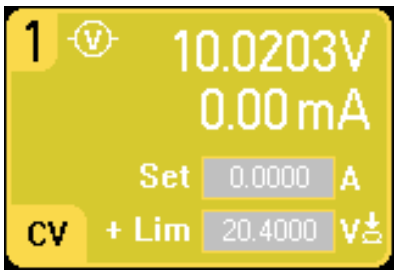
```
SENS:CURR:RANG:AUTO ON,(@1)
SENS:VOLT:RANG:AUTO ON,(@1)
```

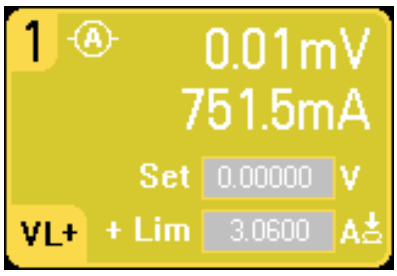
N678xA SMU Meter-Only Modes N678xA SMU

Models N678xA SMU can measure voltage or current at the output terminals without involving the source function of the instrument.

Make all measurement connections before selecting the Measure Only functions. This is necessary because when the Measure Only functions are selected, the instrument goes through an initialization sequence that minimizes the amount of disturbances imposed on the DUT.

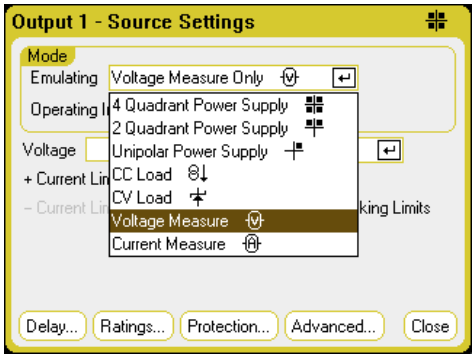
When the Measure Only modes are selected, the output is enabled to allow the meters to measure correctly. The voltage or current measurement is continuously displayed on the Meter View. Both voltage and current meters are active in either mode.

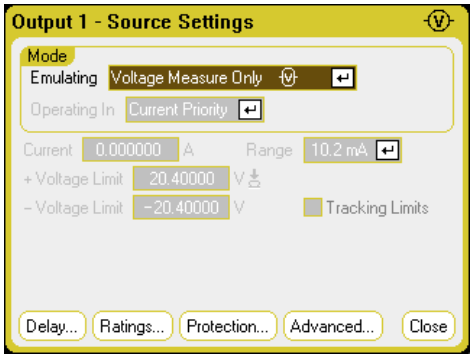




From the front panel:

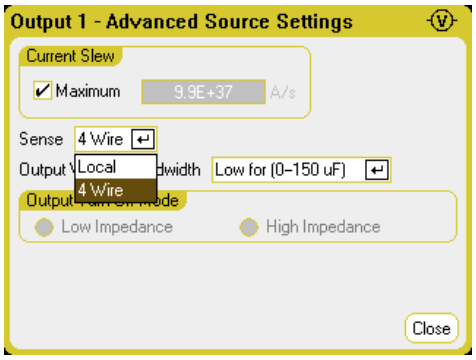
In the Source Settings window, the Voltage Measure selection emulates a voltmeter. Current priority mode is set by default. The +/- Voltage Limits are set to their maximum values. The voltage measurement cannot exceed the voltage ratings of the unit as indicated in the +/- Voltage Limit fields.

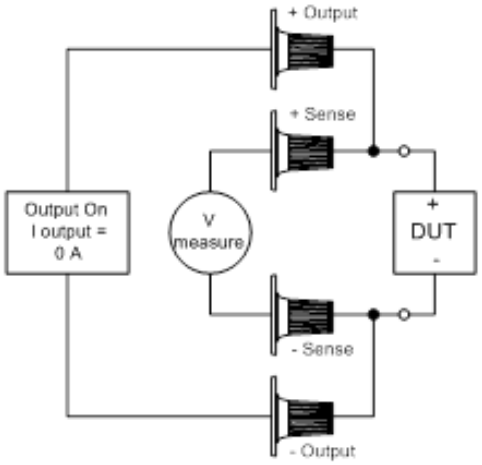




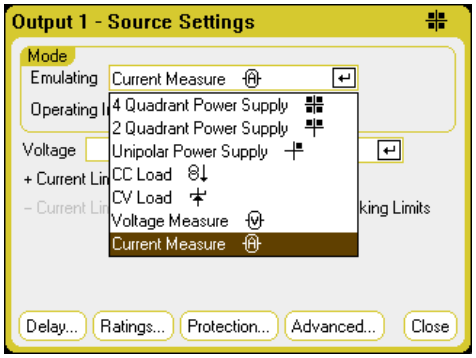
Voltage Measure - the Voltage Measure mode works best when the sense terminals are connected to the output terminals. You can use 4 Wire sensing and connect the sense and output leads directly to the DUT as shown below, or you can use Local sensing and connect only the output leads to the DUT.

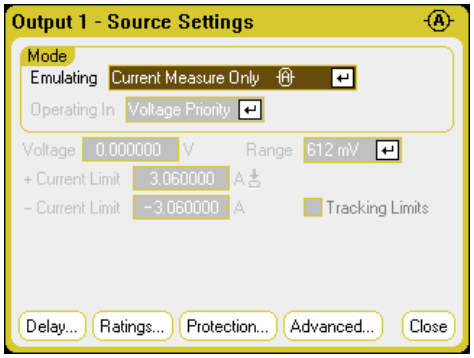
NOTE The input impedance in Voltage Measure mode will be somewhere around 2000 pF depending on the grounding of the DUT. This may draw up to a few microamperes of current from the nodes that are being measured.





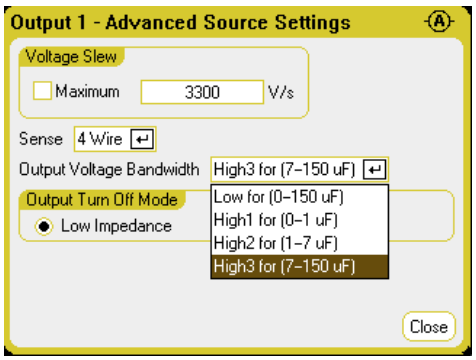
Current Measure - the Current Measure selection emulates a zero-burden ammeter. Voltage priority mode is set by default. The +/- Current Limits are set to their maximum values. The current measurement cannot exceed the current ratings of the unit as indicated in the +/- Current Limit fields.

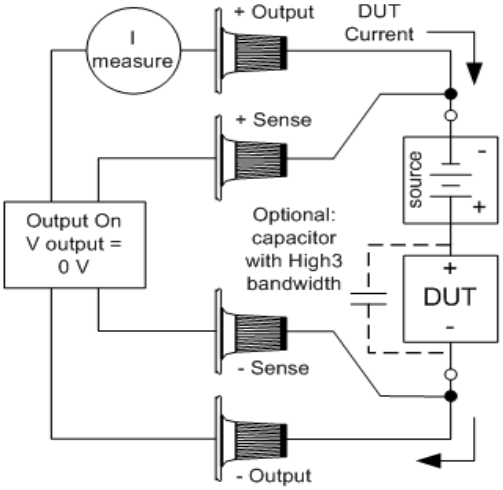




The following additional settings are also required. Remote sensing (4 Wire) is always required. For applications with transient voltage drops, use the High3 setting with a compensation capacitor across

the DUT. Capacitors can be film or ceramic with values from 7 µF to 150 µF. Refer to Keysight N678xA SMU Wiring for additional wiring information.





From the remote interface:

To specify current measure and measure the current:

```
EMUL AMET,(@1)
MEAS:CURR?(@1)
```

To specify voltage measure and measure the voltage:

```
EMUL VMET,(@1)
MEAS:VOLT?(@1)
```

N679xA Load Measurements

NOTE This information only applies to Models N679xA. N679xA

No matter which priority mode you are operating in, the front panel display returns the Voltage and Current measurements from either the output or sense terminals. Power measurements are displayed along with voltage and current in single-channel view.

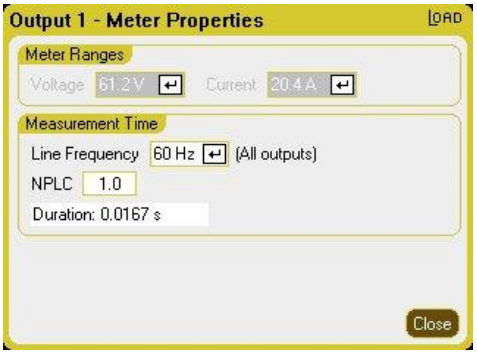
The following meter view applies to Voltage priority mode. Current, power, and resistance views are similar. All measurements have an over-range capability of 20% above the maximum range limit. If the measurement exceeds this limit, an “Overload” error will occur.



From the front panel:

To view the meter properties, press the Meter View key, then press Properties.

Note that the Meter Properties dialog only displays the voltage or current ranges that have been set in the Source Settings dialogs. Also, Load modules have a High and a Low current meter ranges; however, these cannot be selected in the Meter properties window. The reason for this is because measurement ranges are coupled with the priority mode range settings.



The voltage measurement range is set to 61.2 V for all priority modes.
For the Voltage priority mode, the current measurement range is set to High.
For the Power priority low range, the current measurement range is set to Low.
For the Power priority high range, the current measurement range is set to High.
For the Resistance priority high range, the current range is set to Low.
For the Resistance priority medium and low ranges, the current range is set to High.

When changing priority modes, all ranges will be reset to the default (*RST) settings. Measurement ranges are not auto-ranging.

Line Frequency – Specify the ac mains frequency (50 Hz or 60 Hz).

NPLC - Specify the number of power line cycles (NPLC) that the measurement will span. Increase the NPLC for improved accuracy and noise reduction on low current and voltage measurements.

Duration – Indicates the duration of the measurement based on the Frequency and NPLC settings.

From the remote interface:

To trigger and return a measurement:

```
MEAS:CURR? (@1)
MEAS:VOLT? (@1)
```

To return a previous measurement:

```
FETC:CURR? (@1)
FETC:VOLT? (@1)
```

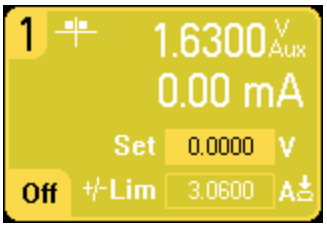
Auxiliary Voltage Measurements

NOTE This information only applies to Models N6781A and N6785A. N6781A, N6785A

Models N6781A and N6785A have an auxiliary voltage measurement input, whose primary use is for battery voltage rundown measurements. It may also be suitable for other applications including general purpose DC voltage measurements between +/-20 VDC.

Auxiliary voltage measurements cannot be made along with output voltage measurements. When the auxiliary voltage measurement input is selected, all voltage measurement functions receive their input from this source instead of the normal + and – sense terminals. These functions include the front panel, SCPI measurements, Scope View, Data Logger View, Elog, and histogram measurements.

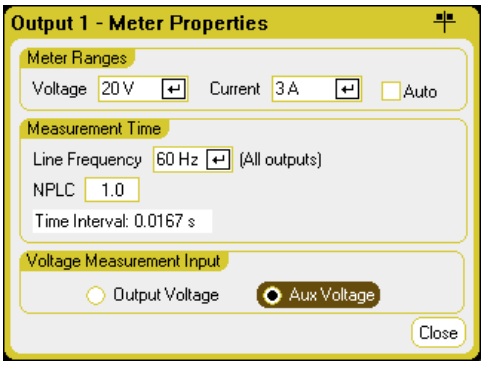
The instrument will continuously display the auxiliary voltage measurement on the Meter View.



NOTE When the auxiliary voltage measurement terminals are left unconnected, the front panel meter will indicate a voltage reading of approximately 1.6V. This is a normal indication which does not affect the external voltage measurement once the measurement terminals are connected.

From the front panel:

To enable auxiliary voltage measurements, select **Meter View**, then **Properties**, then select Aux Voltage.



From the remote interface:

To specify the auxiliary voltage measurement input:

```
SENS:FUNC:VOLT:INP AUX,(@1)
```

Using the Scope Functions

Making a Measurement

Scope View

Scope Properties

Scope Ranges

Scope Markers

Horizontal Properties

Scope Presets

The power analyzer's scope function is similar to a bench oscilloscope, displaying output voltage and current signals as a function of time. It has controls that select which outputs and functions to display, front panel knobs that adjust gain and offset, and configurable triggers and markers.

You can configure the Scope View to display voltage or current waveforms for all outputs. Power waveforms can only be displayed on Keysight Models N676xA and N678xA SMU, as these have simultaneous voltage and current measurement capability (see Model Differences). As explained under Horizontal Properties, the maximum sampling rate of the scope varies, depending on the number of waveforms that are displayed. Note that in the Scope View there is only one time-base and trigger configuration for all outputs.

Making a Measurement

In the following measurement example, an output turn-on sequence is displayed using the oscilloscope. The oscilloscope measures the actual voltages as the outputs turn on.

Step 1 – Program the output voltage and current values:

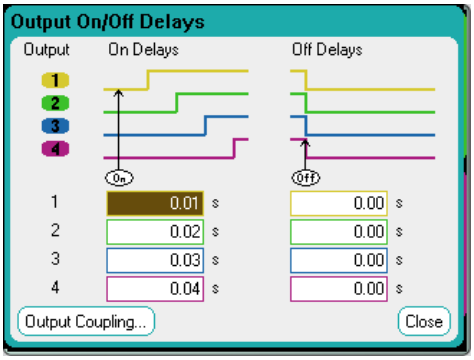
In Meter View, set the output voltage and currents of all four outputs of the power analyzer to 10 volts and 1 ampere. This is described under Turning the Unit On.



Step 2 – Configure the output turn-on sequence:

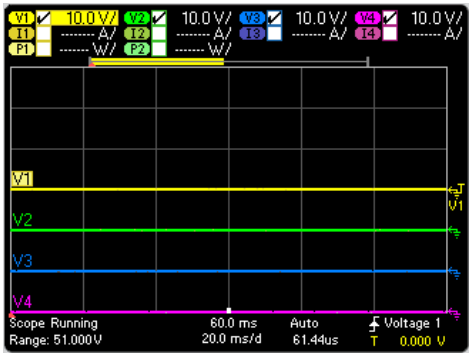
Configure the output turn-on sequence as described under Configuring a Turn-On/Turn-Off Sequence. Note that you will only need to configure the Turn-on delays, not the turn off delays. The turn on delays for the output channels are as follows:

- Output 1: 10 ms
- Output 2: 20 ms
- Output 3: 30 ms
- Output 4: 40 ms



Step 3 – Configure the Scope View traces:

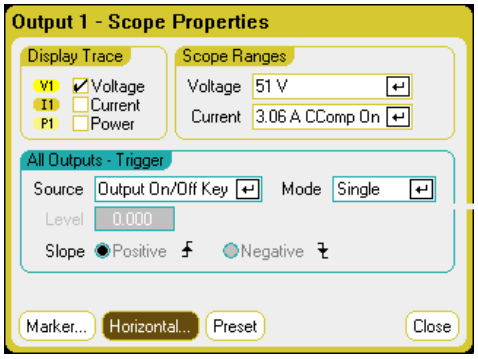
- Check V1 through V4
- Uncheck I1 through I4
- Use the Vertical Volts/Div. knob to set V1 through V4 to 10 V/Div.
- Use the Offset knob to move the four traces so that they are separated by at least one space on the vertical grid.
- Use the Horizontal Time/Div. knob to set the timebase to 20 ms.

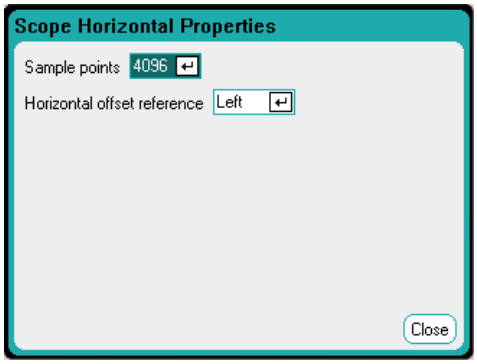


Step 4 – Configure the Scope properties:

Press the Properties key to configure the scope properties as follows:

- In the Trigger Source dropdown list, select Output On/Off Key.
- In the Mode dropdown list, select Single.
- Select the Horizontal button and make sure that the Horizontal Offset Reference is set to Left.



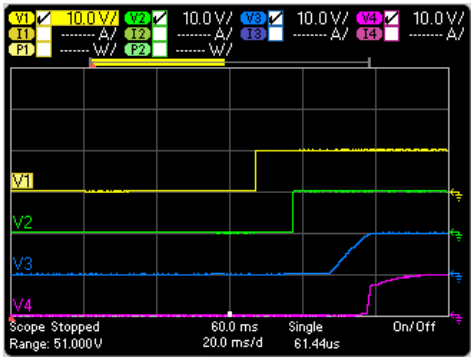


Step 5 – Turn on the outputs and measure the voltage:

Press the Scope View key to return the display the scope view:

- Press the Run/Stop key to run the scope. When this key is lit, it indicates that the scope is running.
- Press the All Outputs On key to start the output sequence and trigger the scope.

You should see the output waveforms displayed as follows:



Note that the delay for output 1 does not start until 57 milliseconds have elapsed. This is because the internal delay for the mainframe used in this example is 57 milliseconds. This built in delay precedes any user-defined delays that have been programmed.

Also note that outputs 3 and 4 start at the specified delay time but do not ramp up as fast as outputs 1 and 2. This is because Outputs 1 and 2 are “Precision” and “High Performance” modules, while outputs 3 and 4 are “DC Power” modules, which have a slower turn-on ramp. Refer to Model Differences.

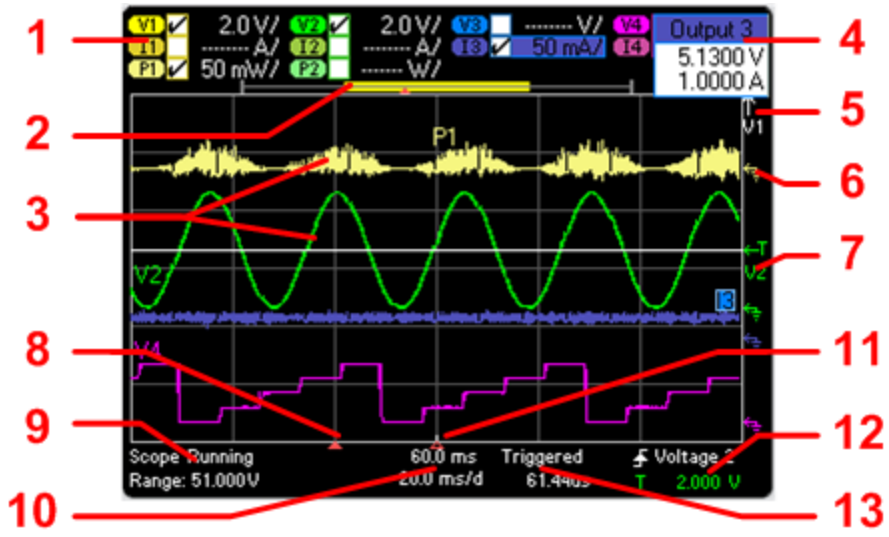
From the remote interface:

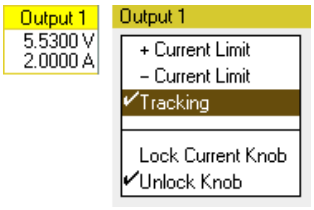
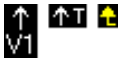
You cannot program the scope from the remote interface.

Scope View

Press the Scope View key to view the scope. This key toggles between the Standard view shown below, and Marker view, which enables markers and marker calculations.

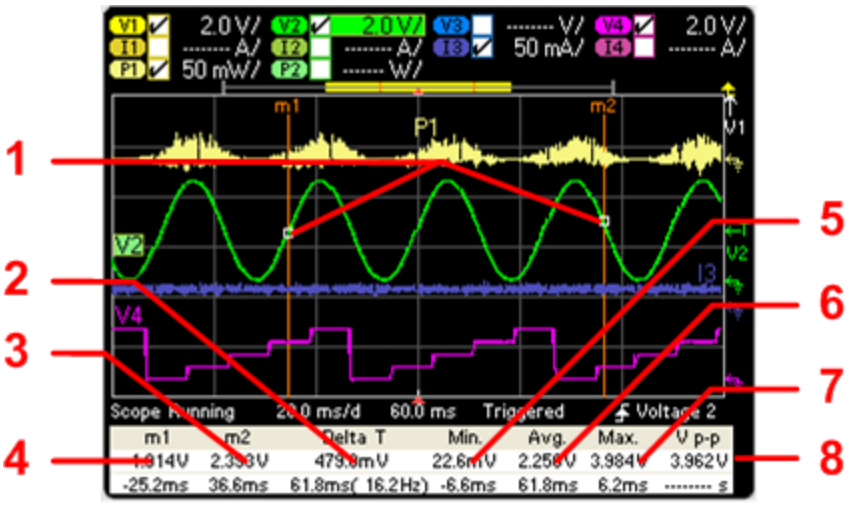
Standard View



Symbol/Field	Description
1 Trace Controls	Identifies the volt/div. or curr/div. setting. √ indicates the trace is on. Dashes (----) indicate the trace is off. Select the trace and press Enter to turn it on or off.
2 Data Bar 	The data bar represents all of the waveform data that has been collected. The yellow part indicates the portion of the data that is visible on the display. The black part represents the data that is not visible.
3 Scope Traces	Voltage trace labels appear on the left side of the grid (V1 V2, V3, V4). Current trace labels appear on the right side of the grid (I1, I2, I3, I4). Power trace labels appear on the center of the grid (P1, P2, P3, P4). If a portion of a trace is red, it means that portion of the trace is out of range. Push the Trigger Level knob to autoscale the traces. This will trigger a new measurement. Only Models N676xA and N678xA SMU can display power traces.
4 Output Pop-ups 	Turning the voltage and current knobs displays a pop-up dialog showing the present output settings. Pushing the voltage and current knobs displays a pop-up dialog allowing the following actions: • Lock/Unlock the voltage or current knobs. • On Models N678xA, select a limit parameter to control or select limit tracking.
5 Out of View Arrows 	Indicate that the trace, V1 in the figure, is out of view. Use the Vertical Volt/Div knob or the Vertical Offset knob to bring the trace into view. Push the Trigger Level knob to autoscale the traces. This will trigger a new measurement.
6 Ground Reference 	The ground reference of the trace. Ground references are offset so that they do not overlap. The ground reference offset value is referenced to the horizontal center line of the grid.

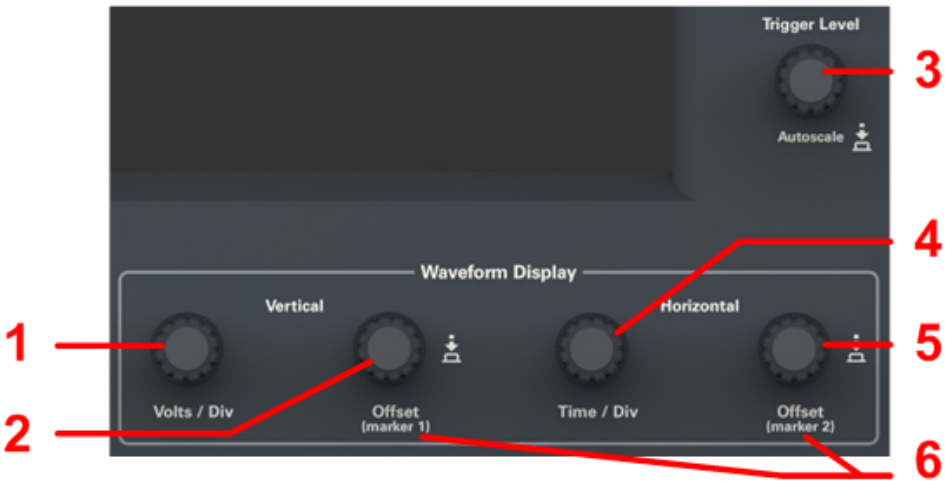
Symbol/Field	Description
7 Trigger Level 	Shows the location of the voltage or current trigger level and output. In this example, the voltage trigger level of output 2 is shown. The trigger source and amplitude are shown at the bottom right of the display.
8 Trigger Indicator 	Shows the position of the trigger with respect to the waveform. In the figure, the trigger is offset to the left of the original point. The trigger point corresponds to the offset reference when the offset is zero.
9 Scope Status	Indicates whether the scope is Running, Stopped, or Waiting for a trigger.
Range	Range indicates the measurement range setting of the selected trace. If the range field is red, it means that portions of the selected trace are out of range.
10 Time	Indicates the time from the trigger point indicator to the vertical center line of the grid. Negative values indicate the center line is to the left of the trigger point. Positive values indicate the center line is to the right of the trigger point. Use the front panel Horizontal Offset knob to adjust the trigger point.
Time/Div.	Time/Div. identifies the horizontal time-base setting. This can be adjusted using the front panel Horizontal Time/Div knob.
11 Horizontal Reference 	Indicates the horizontal reference. In the figure, the reference is centered. Change the reference justification in the Scope Horizontal Properties window.
12 Trigger Source	In the figure, the trigger source is a voltage level on output 2.
	Up trigger indicates the measurement will be triggered on the up-slope (positive).
	Down trigger indicates the measurement will be triggered on the down-slope (negative).
Amplitude	If the trigger source is set to a voltage or current level, the amplitude of the trigger level is indicated below the trigger source. In the figure, the voltage trigger level is set to 4.5 V.
13 Trigger Mode	Indicates the trigger mode (Auto, Single, or Triggered).
Sample Rate	The indicated scope sample rate is based on the horizontal time/div. setting. When the time/div. setting is less than 20 ms/division, the scope will sample at its fastest rate, depending on the number of traces selected: 1 trace (Model N678xA SMU only): 5.12 microseconds 1 to 2 traces (all modules): 10.24 microseconds 3 to 4 traces (all modules): 20.48 microseconds

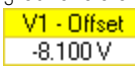
Marker View

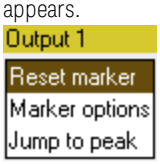


Symbol/Field	Description
1 m1/m2 points	Shows where the measurement markers intersect the selected waveform. Data values at the bottom of the display are referenced to the intersect locations of the markers. Calculations are based on the data points in between the intersect locations.
2 Delta	Indicates the delta or absolute difference between the markers in units (volts, amps, or watts) and in time (seconds). The value in parenthesis is the frequency, which is the reciprocal of the time (1/time).
3 m2	Indicates the m2 marker value in volts, amps, or watts at the intersection point. Also indicates the distance in time that the m2 marker is in relation to the present trigger position.
4 m1	Indicates the m1 marker value in volts, amps, or watts at the intersection point. Also indicates the distance in time of the m1 marker in relation to the present trigger position.
5 Min	Indicates the minimum data value (in volts, amps, or watts) between the marker locations of the selected waveform. Also indicates the distance in time of the minimum value in relation to the present trigger position.
6 Avg	Calculates the average data value (in volts, amps, or watts) between the marker locations of the selected waveform. Time indicates the time between markers over which the average value is calculated.
7 V p-p	Indicates the maximum data value (in volts, amps, or watts) between the marker locations of the selected waveform. Also indicates the distance in time of the maximum value in relation to the present trigger position.
8 Trigger Mode	Calculates the difference between the maximum and minimum values. Time information is not valid for calculated p-p values.
RMS (if selected)	Calculates the rms value between the marker locations. To view the rms values, you may need to unselect one of the other measurements in the Scope Marker Properties window. Only 5 measurements may be displayed at a time.

Using the Waveform Display Knobs



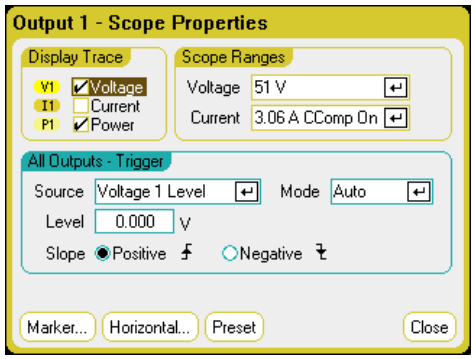
Symbol/Field	Description
1 Vertical Volts/Div.	Makes the waveform bigger or smaller vertically in relation to its ground reference. Specified in volts/division or amps/division on the y axis. On outputs with multiple ranges, when Knob Control is selected in the Scope Range Property window, adjusting the vertical gain will automatically select lower measurement ranges for better resolution. If the vertical gain causes the trace to be out of view, arrow symbols will indicate the direction of the trace .  
2 Vertical Offset	Moves the ground reference of the trace up or down in relation to the horizontal center line of the grid. The offset popup that appears in the upper right corner of the display shows how far the ground reference of the selected trace is above or below the horizontal center line of the grid.  Positive values indicate that the center line is above the ground reference. Negative values indicate that the center line is below the ground reference.
3 Trigger Level	Moves the trigger level up and down when a voltage or current level is the trigger source. The trigger level is identified by the  symbol. If the trigger level is out of view, an arrow  indicates the direction of the trigger level. Push the Trigger Level knob to auto-scale the traces on the display. This will trigger a new measurement.
4 Horizontal Time/Div	Stretches or shrinks the waveform horizontally around the horizontal offset reference. Specified in time/division on the x axis. Applies to ALL traces.
5 Horizontal Offset	Moves the waveform to the right or left of the horizontal offset reference. The trigger point is indicated by the solid arrow. 

Symbol/Field	Description
6 Marker 1/Marker 2	Moves the measurement markers right or left. Press **Scope View** to display the markers. Markers are displayed on the selected trace. Values at the bottom of the display are referenced to the intersection of the markers. If a marker is out of view, an arrow indicates the direction of the marker  . Push the Marker 1 or Marker 2 knobs to reset the markers. When pushed, the following menu appears.  Push the Enter key to Reset the marker. Push Enter again to undo the reset action. Scroll down and select Marker options to access the Scope Marker Properties window. Scroll down and select Jump to peak to move the marker to the peak measurement point of the trace.

Scope Properties

NOTE There are no remote interface commands that correspond directly to the front panel Scope functions. Refer to Digitizing Measurements for information on programming digitized measurements from the remote interface.

With the Scope View displayed, press the **Properties** key to access the Scope Properties window.



Display Trace lets you select which traces to display for the output. If no box is checked, no traces will be displayed for that output. Voltage, current, and power traces can be displayed simultaneously only on Models N676xA and N678xA SMU, as these models have simultaneous voltage and current measurement capability (see Model Differences). All other power modules can display either voltage or current traces, but not simultaneously.

Source dropdown lets you select a trigger source. This trigger source will trigger the scope measurements on all output channels. Depending upon the selected trigger source, you can trigger the scope as follows:

Trigger Source	Description
Voltage <1-4> level Current <1-4> level	Triggers the measurement when the voltage or current of the corresponding output passes through the specified level.
Arb Run/Stop key	Triggers the measurement when the Arb Run/Stop key is pressed.
Output On/Off key	Triggers the measurement when any of the Output On/Off keys are pressed. Also applies to the All Outputs On/Off key.
BNC Trigger In	Provide a low-true signal to the BNC trigger input connector. Refer to Supplemental Characteristics for minimum pulse width. Selecting BNC Trigger In also enables any digital I/O pins configured as Trigger Outputs.
Remote Command	Send a trigger command over one of the three interfaces (i.e. *TRG).

If a trigger source is grayed out, it is unavailable. This can happen on power modules that cannot simultaneously display voltage and current. For these power modules, if one of the traces has been turned on, you cannot use the other trace as the trigger source. Also, current levels are not available as trigger sources on outputs that have been grouped (paralleled).

Level lets you specify a trigger level if you selected a Voltage level or Current level as the trigger source.

Slope specifies if the measurement will be triggered on the positive (up-slope) or negative (down-slope) portion of the waveform.

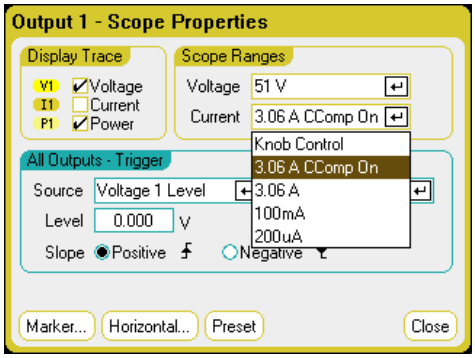
Mode dropdown lets you select a trigger mode.

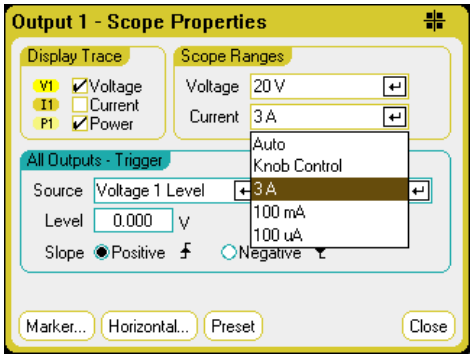
Trigger Mode	Description
Auto	Configures the scope to display a single-sweep measurement when a trigger is received, or automatically if a trigger is not received. The scope continues running and waits for another trigger when the measurement completes.
Single	Configures the scope to display a single-sweep measurement when a trigger is received. The scope stops running when the measurement completes.
Triggered	Configures the scope to display a single-sweep measurement when a trigger is received. The scope continues running and waits for the next trigger when the measurement completes.

Scope Ranges

For outputs that have multiple measurement ranges, you can select a lower range for better measurement resolution. Scope range settings are independent of the Meter View and Data Logger range settings.

In the Scope Ranges area, select the desired lower measurement range from the Voltage or Current dropdown menus.





Selecting Knob Control allows the Vertical Volts/Div knob on the front panel to automatically select lower measurement ranges at higher measurement resolutions. For lower measurement resolution a higher range is automatically selected. The present range is displayed on the lower left corner of the Scope View window.

Some models have a high measurement range labeled CComp On, which is selected by default. The CComp On range compensates output current measurements during voltage transients. For more information, see Dynamic Current Measurement Control.

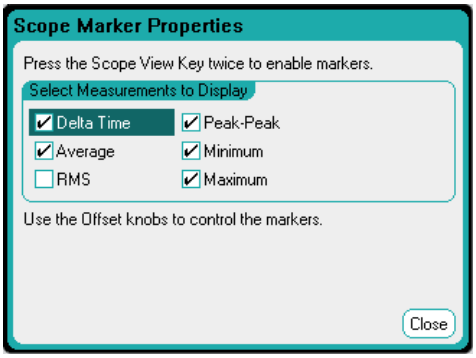
NOTE On Keysight N679xA Load modules N679xA, the source and measurement ranges are coupled. Therefore the scope measurement ranges are not settable (grayed out) in the Scope Properties window.

Seamless Measurements

For Models N6781A, N6782A, N6785A, and N6786A, you can select seamless voltage and current measurements, which results in a wide dynamic range with no data being lost across ranges. Select Auto to enable seamless measurement ranging. Seamless ranging does not include the 10 µA range, which must be selected manually.

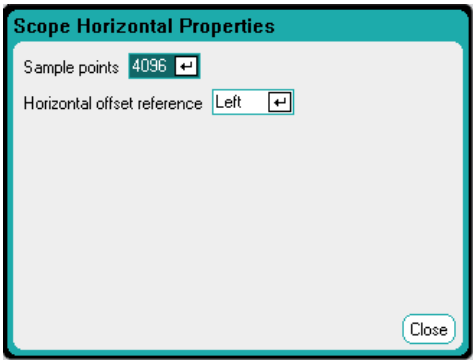
Scope Markers

Select the Markers button to configure the measurements that appear on the bottom of the display in Marker view. Measurements apply to the portion of the waveform between the two markers. You can only select a maximum of five measurements to be displayed.



Horizontal Properties

Select the Horizontal button to configure the horizontal properties.



Sample Points - lets you specify the number of points in a scope trace. The maximum number of points that can be specified depends on the number of scope traces that have been enabled. The minimum number of points that can be specified is 1024.

1 trace enabled: 256 K points
2 traces enabled: 128 K points
4 traces enabled: 64 K points
8 traces enabled: 32 K points (maximum points = 256 K/# of traces)

The Power trace counts as 2 traces, since voltage and current must be measured to calculate power. If the voltage and current traces have already been selected, the Power trace is not counted

Horizontal Offset Reference - places the reference point on the left, right, or center of the display. This is the position of the trigger if no offset has been set. Left lets you see the waveform after the trigger event. Center lets you see the waveform before and after the trigger event. Right lets you see the waveform up to the trigger event.

Scope Presets

Select the Preset button to return the Scope View to the power-on display settings. The vertical offset of each trace will be set to a different value. This is to prevent the traces from overlapping. The offset is referenced to the horizontal center line of the grid.

Using the Data Logger Functions

Logging Data

Data Logger View

Data Logger Properties

Data Logger Ranges

Data Logger Trigger

Data Logger Filename

Data Logger Markers

Data Logger Presets

Data Logger Sampling Modes

Data Logger and Scope Display Differences

NOTE The Data Logger function is not available if Option 055 has been ordered.

The Data Logger is similar to the Scope View function except that it lets you view and log output voltage and current data for up to 99,999 hours.

As in Scope View, you can configure the Data Logger View to display voltage or current waveforms for all outputs. Power waveforms can be displayed for all outputs because of the interleaved data logging capability. Refer to Data Logger Sampling Modes for more information.

The display functions like a strip chart recorder. Use the Waveform Display knobs to scroll through the data. Unless specified otherwise, data is automatically stored to a file named *default.dlog*.

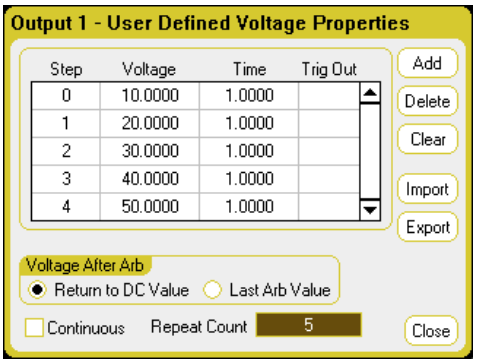
Logging Data

In the following data log example, a user-defined arbitrary waveform is captured on the data logger. The data logger records the actual output voltage of the arbitrary waveform.

Step 1 – Program the arbitrary waveform:

Configure the user-defined arbitrary waveform as described under Configuring User-Defined Arbs. Program the voltage and time values as follows:

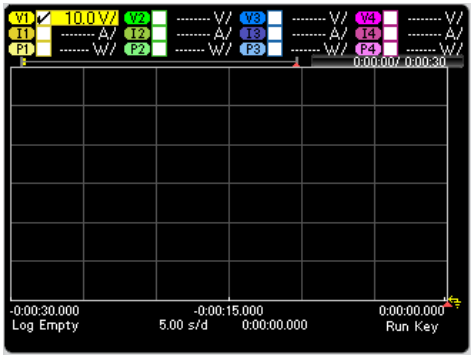
Step 0: 10 V; 1 s
Step 1: 20 V; 1 s
Step 2: 30 V; 1 s
Step 3: 40 V; 1 s
Step 4: 50 V; 1 s
Repeat Count: 5



Step 2 – Configure the data logger traces:

- Check V1
- Uncheck V2 through V4 as well as the current and power traces
- Use the Vertical Volts/Div. knob to set V1 10 V/Div.
- Use the Offset knob to move the V1 trace to the bottom of the grid.

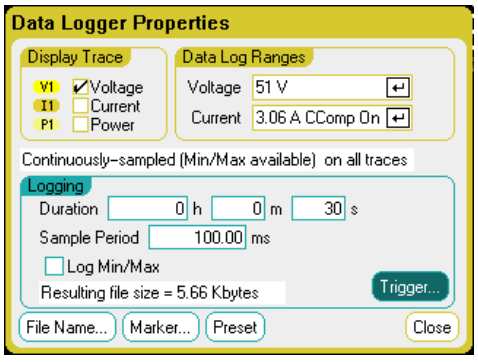
Traces are color coded according to output. The ground symbol on the right side of the display indicates the ground reference of the trace.

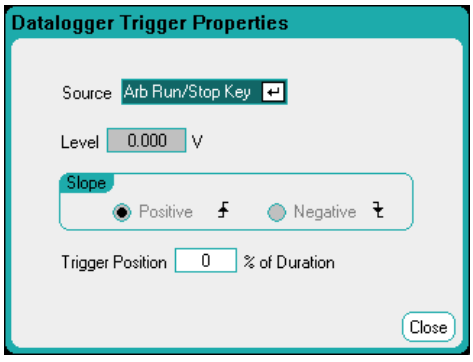


Step 3 – Configure the data logger properties:

Press the **Properties** key to configure the data logger properties.

- Leave the default Duration and Sample Period at 30 seconds and 100 milliseconds respectively.
- Select the Trigger button and set the trigger source to Arb Run/Stop Key.



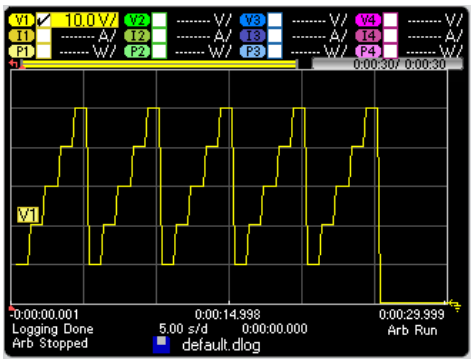


Step 4 – Turn on output 1, start the Arb, and log the data:

Press the Data Logger key to return the display to the data logger view:

- Press the Output 1 On key to turn on output 1.
- Press the Run/Stop key to run the data logger. When this key is lit, the data logger is initiated and the output 1 trace is displayed on the screen.
- Press the Arb Run/Stop key to start the user-defined Arb and trigger the data logger.

The data logger will run for 30 seconds and log the voltage data from output 1. When the data log completes, you should see the output waveform displayed as follows:

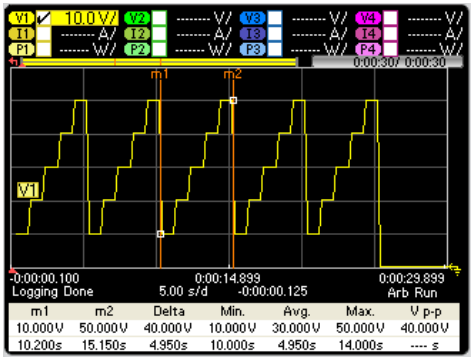


A message will indicate that the logged data has been saved in a file named default.dlog. If you wish to save the data under a different filename, you must specify the filename before the data logger runs. Select the Filename button located in the Datalogger Properties dialog to specify a filename.

Step 5 – Use the marker controls to measure the logged data:

Press the Data Logger key to display the marker controls.

- Use the marker 1 and Marker 2 knobs to move the markers along the voltage trace. Measurements between the markers are displayed on the bottom of the display.
- You can also use the Vertical Volts/Div knob and the Horizontal Time/Div knob to zoom in on any portion of the logged data.



From the remote interface:

To program a User-defined voltage waveform of five steps on output 1:

```
ARB:FUNC:TYPE VOLT,(@1)
ARB:FUNC:SHAP UDEF,(@1)
ARB:VOLT:UDEF:LEV 10,20,30,40,50,(@1)
ARB:VOLT:UDEF:DWEL 1,(@1)
ARB:VOLT:UDEF:BOST 0,(@1)
ARB:TERM:LAST OFF,(@1)
```

To initiate the transient trigger system:

```
VOLT:MODE ARB,(@1)
TRIG:ARB:SOUR BUS
INIT:TRAN (@1)
```

To set up the data log for output 1:

```
SENS:DLOG:FUNC:VOLT ON,(@1)
SENS:DLOG:TIME 30
SENS:DLOG:PER .1
```

To initiate that data logger and specify the filename in which to save the data:

```
TRIG:DLOG:SOUR BUS
INIT:DLOG “internal:\data1.dlog”
```

To turn on output 1 and trigger the Arb and the data logger:

```
OUTP ON, (@1)
*TRG
```

Once the data log completes, you can position the data log markers and return data from between the marker locations. To position the two data log markers at 10 seconds and at 15 seconds from the start trigger of the data log:

```
SENS:DLOG:MARK1:POIN 10
SENS:DLOG:MARK2:POIN 15
```

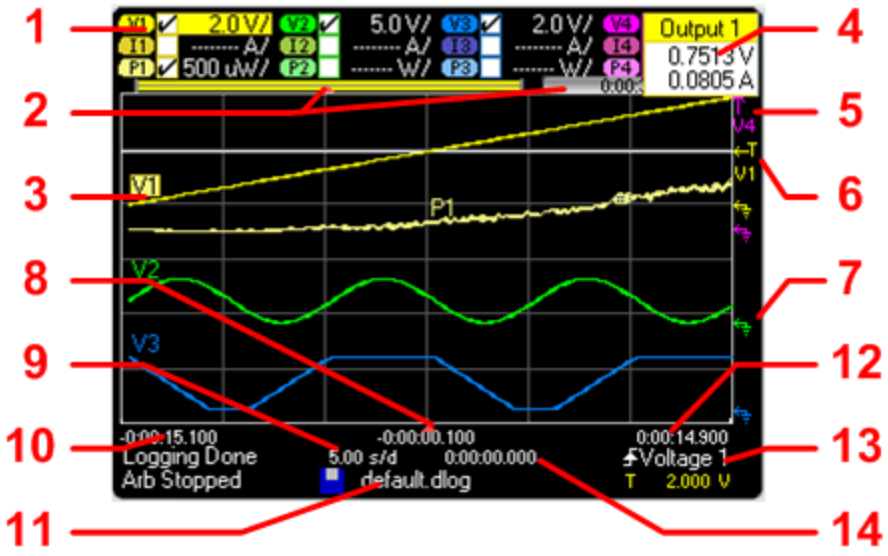
The following commands return either the average, minimum, or maximum values between the marker positions:

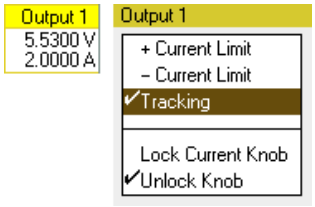
```
FETC:DLOG:VOLT? (@1)
FETC:DLOG:VOLT:MIN? (@1)
FETC:DLOG:VOLT:MAX? (@1)
```

Data Logger View

Press the Data Logger key to access the data logger. This key toggles between the Standard view shown below, and Marker view, which enables markers and marker calculations.

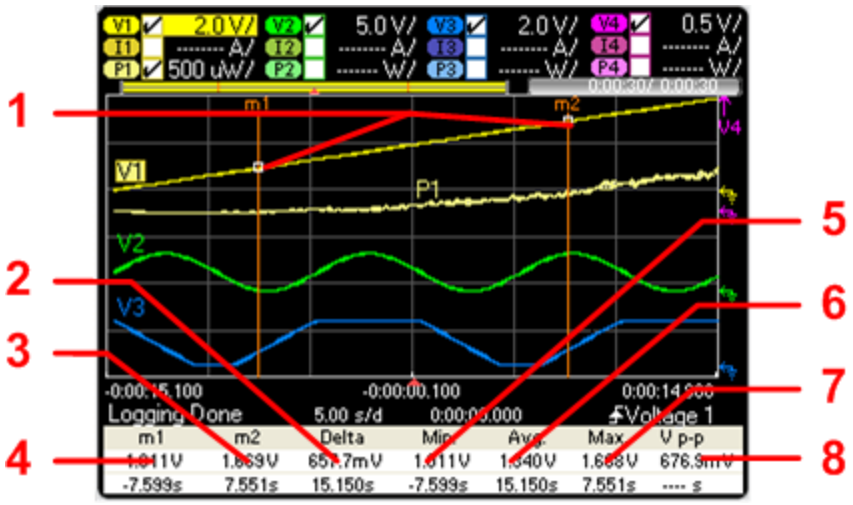
Standard View



Symbol/Field	Description
1 Trace Controls	Identifies the volt/div. or curr/div. setting. √ indicates the trace is on. Dashes (----) indicate the trace is off. Select the trace and press Enter to turn it on or off.
2 Data Bar	The data bar represents all of the logged data. The yellow part indicates the portion of the data that is visible on the display. The black part represents the data that is not visible.
Time Elapsed	Indicates the time elapsed during the data log and the total duration. The values match when data logging finishes.
3 Data Traces	Voltage trace labels appear on the left side of the grid (V1 V2, V3, V4). Current trace labels appear on the right side of the grid (I1, I2, I3, I4). Power trace labels appear on the center of the grid (P1, P2, P3, P4). If a portion of a trace is red, it means that portion of the trace is out of range. Push the Trigger Level knob to auto-scale the data traces.
4 Output Pop-ups 	Turning the voltage and current knobs displays a pop-up dialog showing the present output settings. Pushing the voltage and current knobs displays a pop-up dialog allowing the following actions: • Lock/Unlock the voltage or current knobs. • On Models N678xA, select a limit parameter to control or select limit tracking.
5 Out of View Arrows 	Indicate that the trace, V4 in the figure, is out of view. Use the Vertical Volt/Div knob or the Vertical Offset knob to bring the trace into view. Push the Trigger Level knob to autoscale the data traces.
7 Trigger Level 	Shows the location of the voltage or current trigger level and output. In this example, the voltage trigger level of output 1 is shown. The trigger source and amplitude are shown at the bottom right of the display.

Symbol/Field	Description
6 Ground Reference 	The ground reference of the trace. Ground references are offset so that they do not overlap. The ground reference offset value is referenced to the horizontal center line of the grid.
8 Trigger Point Indicator 	Indicates the trigger position in the data log. In this example the trigger point was offset by 50%, and the pre trigger data and the post trigger data was logged. The time at the trigger point is always zero. Change the trigger offset in the Datalogger Trigger Properties window.
9 Time/Div.	Identifies the horizontal time-base setting. This can be adjusted using the front panel Horizontal Time/Div knob.
10 Left-Grid Time	Identifies the time at the left gridline in relation to the trigger point. If the trigger is at the left of the grid, the time will be zero.
11 Filename	Indicates the filename of the data that is being displayed.
12 Right-Grid Time	Identifies the time at the right gridline in relation to the trigger point. If the trigger point is at the start of the data log, the time will equal the total duration of the data log.
13 Trigger Source	In the figure, the trigger source is a voltage level on output 1. The Data Logger starts logging data when the indicated level is reached.
	Up trigger indicates the data logger will be triggered on the up-slope (positive).
	Down trigger indicates the data logger will be triggered on the down-slope (negative).
Amplitude	If the trigger source is set to a voltage or current level, the amplitude of the trigger level is indicated below the trigger source. In the figure, the voltage trigger level is set to 2 V.
14 Offset Time 	Indicates the time that the right gridline is offset or away from the end of the data log. When this value is zero, it means that the right gridline is positioned at the end of the data log. Turning the offset knob will move the grid away from the end of the data log, as indicated by the Offset Time. The yellow part of the bar represents the data that is visible on the display. The black part represents the offset time.

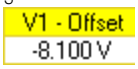
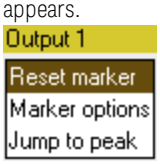
Marker View



Symbol/Field	Description
1 m1/m2 points	Shows where the measurement markers intersect the selected waveform. Data values at the bottom of the display are referenced to the intersect locations of the markers. Calculations are based on the data points in between the intersect locations.
2 Delta	Indicates the delta or absolute difference between the markers in units (volts, amps, or watts) and in time (seconds).
3 m2	Indicates the m2 marker value in volts, amps, or watts at the intersection point. Also indicates the distance in time that the m2 marker is in relation to the present trigger position.
4 m1	Indicates the m1 marker value in volts, amps, or watts at the intersection point. Also indicates the distance in time of the m1 marker in relation to the present trigger position.
5 Min	Indicates the minimum data value (in volts, amps, or watts) between the marker locations of the selected waveform. Also indicates the distance in time of the minimum value in relation to the present trigger position.
6 Avg	Calculates the average data value (in volts, amps, or watts) between the marker locations of the selected waveform. Time indicates the time between markers over which the average value is calculated.
7 V p-p	Indicates the maximum data value (in volts, amps, or watts) between the marker locations of the selected waveform. Also indicates the distance in time of the maximum value in relation to the present trigger position.
8 Trigger Mode	Calculates the difference between the maximum and minimum values. Time information is not valid for calculated p-p values.
Ah (if selected)	Calculates the Amp-hours between the marker locations. To view the Amp hours, you may need to unselect one of the other measurements in the Datalogger Marker Properties window. Only 5 measurements may be displayed at a time.
Wh (if selected)	Calculates the Watt-hours between the marker locations. To view the Watt hours, you may need to unselect one of the other measurements in the Datalogger Marker Properties window. Only 5 measurements may be displayed at a time.

Using the Waveform Display Knobs

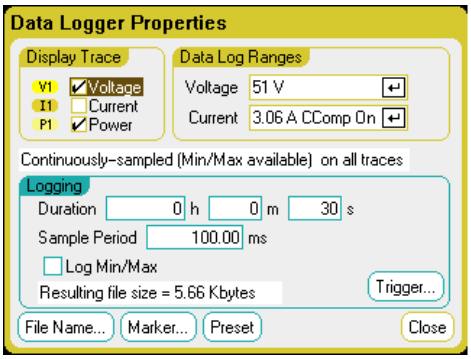


Symbol/Field	Description
1 Vertical Volts/Div.	Makes the waveform bigger or smaller vertically in relation to its ground reference. Specified in volts/division or amps/division on the y axis. On outputs with multiple ranges, when Knob Control is selected in the Scope Range Property window, adjusting the vertical gain will automatically select lower measurement ranges for better resolution. If the vertical gain causes the trace to be out of view, arrow symbols will indicate the direction of the trace . 
2 Vertical Offset	Moves the ground reference of the trace up or down in relation to the horizontal center line of the grid. The offset popup that appears in the upper right corner of the display shows how far the ground reference of the selected trace is above or below the horizontal center line of the grid.  Positive values indicate that the center line is above the ground reference. Negative values indicate that the center line is below the ground reference.
3 Trigger Level	Moves the trigger level up and down when a voltage or current level is the trigger source. The trigger level is identified by the  symbol. If the trigger level is out of view, an arrow  indicates the direction of the trigger level. Push the Trigger Level knob to auto-scale the traces on the display.
4 Horizontal Time/Div	Zooms in or out of the data so that you can view waveform details. The numbers on the bottom of the display indicate the location of the data that is being viewed relative to the entire data log.
5 Horizontal Offset	Moves the grid area to the right or left along the logged data.
6 Marker 1/Marker 2	Moves the measurement markers right or left. Press **Data Logger** to display the markers. Markers are displayed on the selected trace. Values at the bottom of the display are referenced to the intersection of the markers. If a marker is out of view, an arrow indicates the direction of the marker  . Push the Marker 1 or Marker 2 knobs to reset the markers. When pushed, the following menu appears.  Push the Enter key to Reset the marker. Push Enter again to undo the reset action. Scroll down and select Marker options to access the Datalogger Marker Properties window. Scroll down and select Jump to peak to move the marker to the peak measurement point of the trace.

Data Logger Properties

From the front panel:

With the Data Logger View displayed, press the **Properties** key to access the Scope Properties window.



Display Trace - lets you select which traces to display for the output. If no box is checked, no data logging will occur on the output.

The text line under the traces identifies the data logging mode. Continuously-sampled mode continuously samples the voltage or current data and stores one averaged value per sample period. Selecting Log Min/Max also stores the minimum and maximum values per sample period. Standard (interleaved) mode alternates voltage and current measurements. One voltage and one current value is returned per sample period.

NOTE Depending on which traces are enabled on specific power modules, the Data Logger selects between Continuously-sampled mode and Normal (interleaved) mode. Refer to Data Logger Sampling Modes for more information.

Duration lets you specify the duration of the data log in hours, minutes, and seconds. The maximum duration is 99,999 hours. The logging information applies to data logger measurements on all output channels.

Sample Period specifies the interval between data samples in milliseconds, which can be set from 20 microseconds to 60 seconds.

Log Min/Max when checked, lets you log the minimum and maximum values to the data log file when in Continuously-sampled mode. With Log Min/Max checked, the resulting file size will triple.

Resulting file size text box indicates the file size when the data log completes. The maximum file size is 2E9 bytes (1.87 Gbytes in Microsoft Windows units). If settings exceed this limit, the logging interval will automatically increase to keep the size within the limit. If the file size exceeds the available space on the drive to which it will be written, an error is generated and the Data Logger will not run.

From the remote interface:

To enable current or voltage data logging on outputs 1 and 2:

```
SENS:DLOG:FUNC:CURR ON,(@1,2)
SENS:DLOG:FUNC:VOLT ON,(@1,2)
```

You cannot data log output power from the remote interface. To obtain power data, you need to data log both voltage and current and then calculate the power from the resulting voltage and current data.

To log the minimum and maximum values to the data log file for all enabled outputs:

SENS:DLOG:FUNC:MINM ON

To specify a data log of 1000 seconds on all enabled outputs:

SENS:DLOG:TIME 1000

To specify a sample period of 50 milliseconds between data samples on all enabled outputs:

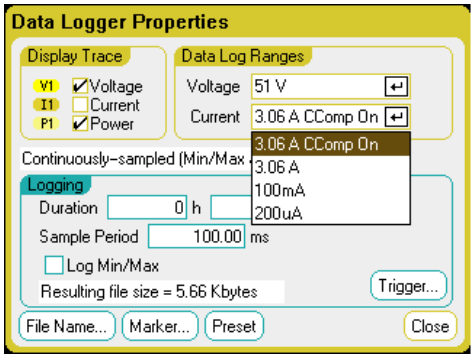
SENS:DLOG:PER .05

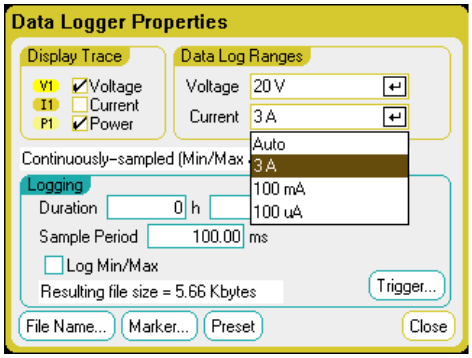
Data Logger Ranges

For outputs that have multiple measurement ranges, you can select a lower range for better measurement resolution. Data Logger range settings are independent of the Meter View and Scope range settings.

From the front panel:

In the Data Log Ranges area, select the desired lower measurement range from the Voltage or Current dropdown menus.





Some models have a high measurement range labeled CComp On, which is selected by default. The CComp On range compensates output current measurements during voltage transients. For more information, see Dynamic Current Measurement Control.

NOTE On Keysight N679xA Load modules (N679xA), the source and measurement ranges are coupled. Therefore the data logger measurement ranges are not settable (grayed out) in the Data Logger Properties window.

Seamless Measurements

Seamless measurement autoranging for both voltage and current is available on models N678xA SMU and with Option SMR. (N678xA SMU) (Option SMR) This enables a wide dynamic measurement range with no data lost across ranges.

Seamless ranging does not include the 10 µA range, which must be selected manually. Select Auto to enable seamless measurement ranging.

From the remote interface:

To enable seamless measurement autoranging:

```
SENS:DLOG:CURR:RANG:AUTO ON,(@1)
SENS:DLOG:VOLT:RANG:AUTO ON,(@1)
```

To select a lower current or voltage measurement range:

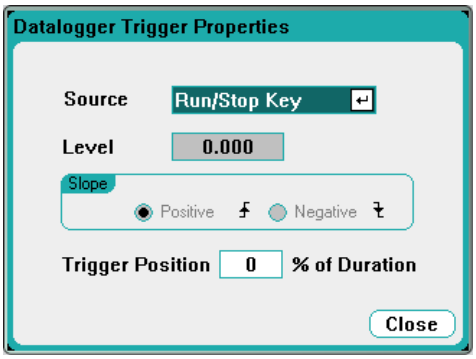
```
SENS:DLOG:CURR:RANG 0.1, (@1)
SENS:DLOG:VOLT:RANG 5, (@1)
```

Data Logger Trigger

NOTE Once the Data Logger has been triggered, do not change the display to Scope View or Meter View; otherwise Data Logger will stop.

From the front panel:

Select the **Trigger** button to configure the trigger properties. The Data Logger uses triggers to synchronize itself with an external event.



The Source dropdown list lets you select a trigger source. The same trigger source will be used to trigger all of the outputs that have been configured for data logging. Depending upon the selected trigger source, you can trigger the Data Logger as follows:

Trigger Source	Description
Voltage <1-4> level Current <1-4> level	Triggers the Data Logger when the voltage or current of the corresponding output passes through the specified level.
Run/Stop key	Triggers the Data Logger when the Run/Stop key is pressed. This is the default trigger source.
Arb Run/Stop key	Triggers the Data Logger when the Arb Run/Stop key is pressed.
Output On/Off key	Triggers the Data Logger when any of the Output On/Off keys are pressed. Also applies to the All Outputs On/Off key.

Trigger Source	Description
BNC Trigger In	Provide a low-true signal to the BNC trigger input connector. Refer to Supplemental Characteristics for minimum pulse width. Selecting BNC Trigger In also enables any digital I/O pins configured as Trigger Outputs.
Remote Command	Send a trigger command over one of the three interfaces (i.e. *TRG).

If a trigger source is grayed out, it is unavailable. For example, current levels are not available as trigger sources on outputs that have been grouped (paralleled). Note also that a trace must be turned on for it to be used as a trigger source.

Level - specifies a trigger level if you selected a Voltage level or Current level as the trigger source. Along with the level, you must also specify a slope.

Slope - specifies if the measurement will be triggered on the positive (up-slope) or negative (down-slope) portion of the waveform.

Trigger Position % of Duration - specifies a trigger offset. This allows the specified percent of pre-trigger data to be logged to the file. The trigger position is expressed as a percentage of the data log duration. For example, if you specified a data log duration of 30 minutes and a trigger position of 50%, the Data Logger will log 15 minutes of pre-trigger data to the file before the trigger occurs. Subsequently, 15 minutes of post-trigger data will then be logged to the data file.

From the remote interface:

To select the immediate trigger source (triggers the Data Logger immediately when initiated):

TRIG:DLOG:SOUR IMM

To select the rear panel trigger input BNC connector:

TRIG:DLOG:SOUR EXT

To select a BUS trigger source:

TRIG:DLOG:SOUR BUS

To select a voltage level of another output as the trigger (output 3 will generate the voltage level trigger):

TRIG:DLOG:SOUR VOLT3

To select a current level of another output as the trigger (output 4 will generate the current level trigger):

TRIG:DLOG:SOUR CURR4

To select the Arb Run/Stop key as the trigger source:

TRIG:DLOG:SOUR ARSK

To select the Output On/Off key as the trigger source for output 1:

TRIG:DLOG:SOUR OOOK

To select a voltage trigger level and slope on output 3 for the datalog:

TRIG:DLOG:VOLT 10,(@3)
TRIG:DLOG:VOLT:SLOP POS,(@3)

To select a current trigger level and slope on output 4 for the datalog:

TRIG:DLOG:CURR 1,(@4)
TRIG:DLOG:CURR:SLOP POS,(@4)

To specify a trigger offset at 25 percent of the duration of the datalog:

SENS:DLOG:OFFS 25

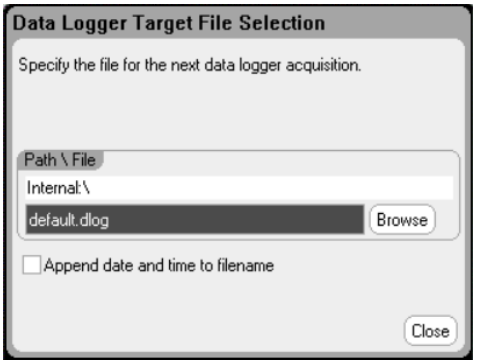
To trigger the datalog measurement: (If the trigger source is BUS, you can also send *TRG or <GET>.)

TRIG:DLOG (@1)

Data Logger Filename

From the front panel:

Select the Filename button to specify a filename in which to save the datalog. Data will be logged to this filename the *next* time the Data Logger runs. If you do not specify a filename, the data will be logged to default.dlog, which is overwritten each time the Data Logger runs.



Enter the filename in the Path\File field. Check Append date and time to filename to include time-stamp information in the filename.

From the remote interface:

To specify the internal filename in which to save the datalog:

INIT:DLOG “datalog1.dlog”

You can also export the datalog that is presently displayed in the data logger view. To export the datalog to the specified filename, send:

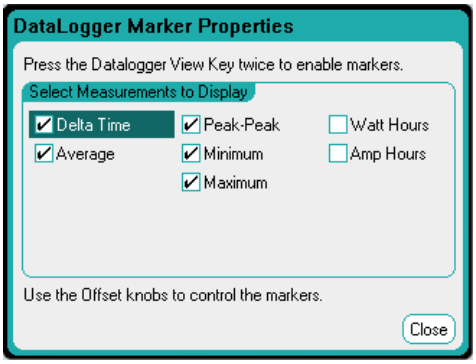
MMEM:EXP:DLOG “datalog1.csv”

NOTE To export a datalog that has been saved in the instrument, you must first load the saved file into the data logger view.

Data Logger Markers

From the front panel:

Select the Markers button to configure the measurements that appear on the bottom of the display in Marker view. Measurements apply to the portion of the trace between the two markers. You can only select a maximum of five measurements to be displayed.



From the remote interface:

The following commands position the markers. To position the two data log markers at 100 seconds and at 200 seconds from the start trigger on the data log:

SENS:DLOG:MARK1:POIN 100
SENS:DLOG:MARK2:POIN 200

The following commands return data between the two markers. To return the average current or voltage between the markers:

FETC:DLOG:CURR? (@1)
FETC:DLOG:VOLT? (@1)

To return the minimum current or voltage between the markers:

FETC:DLOG:CURR:MIN? (@1)
FETC:DLOG:VOLT:MIN? (@1)

To return the maximum current or voltage between the markers:

FETC:DLOG:CURR:MAX? (@1)
FETC:DLOG:VOLT:MAX? (@1)

To return the peak-to-peak current or voltage between the markers:

FETC:DLOG:CURR:PTP? (@1)
FETC:DLOG:VOLT:PTP? (@1)

Data Logger Presets

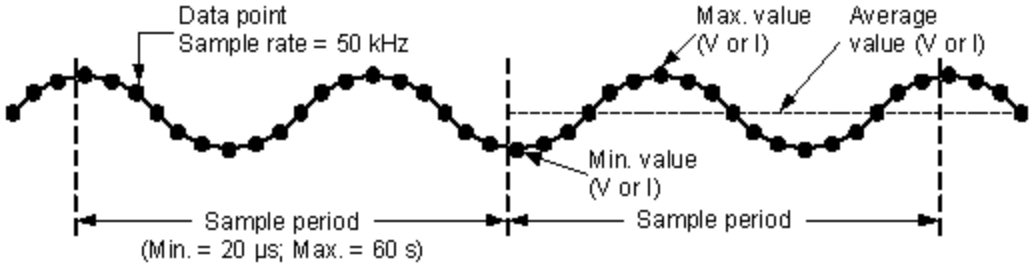
Select the Preset button to return the Data Logger View to the power-on display settings. The vertical offset of each trace will be set to a different value. This is to prevent the traces from overlapping. The offset is referenced to the horizontal center line of the grid.

Data Logger Sampling Modes

The power analyzer provides two modes of data logging: Continuously-sampled mode (the default), and Standard (or interleaved) mode. The mode is automatically selected based on the installed power module types and the selected measurements, and applies to all outputs. A text message in the Display Trace area of the Data Logger Properties window indicates which mode is in effect.

Continuously-sampled mode

Continuously-sampled mode continuously samples the voltage or current data at 200 kHz for Models N678xA SMU, and at 50 kHz for all other power modules. Both voltage and current can be sampled continuously on Models N676xA and N678xA SMU. Power is calculated from the instantaneous voltage and current values. Either voltage or current can be sampled continuously on all other power modules. Only the averaged value (and optionally, a minimum and maximum value) is returned for each sample period.



Continuous data sampling is available for the following power modules with the indicated display trace selections:

Power Module	Display Trace selection
N676xA, N678xA	Voltage, Current, & Power (24 parameters maximum)
N673xB, N674xB	Voltage or Current only (12 parameters maximum)
N675xA, N677xA	Voltage or Current only (12 parameters maximum)
N6783A-BAT/MFG	Voltage or Current only (12 parameters maximum)
Available capabilities for ALL outputs	
• Sample period: 20.48 microseconds to 60 seconds •Trigger source: all trigger sources available •Trigger offset: 0 to 100% •Values logged: average, minimum, maximum (minimum/maximum values must be selected)	

The fastest sample period that can be programmed for continuously-sampled measurements is 20.48 microseconds. However, this speed is only possible if one parameter is being measured. Note that you can measure up to 24 parameters (average voltage+min+max X 4 outputs, and average current+min+max X 4 outputs) with a corresponding decrease in measurement sample rate. The following typical sample periods are based on the number of parameters selected:

1 parameter (voltage or current)	20 microseconds (rounded)
3 parameters (voltage+min+max)	60 microseconds (rounded)
6 parameters (voltage+min+max X 2 outputs)	120 microseconds (rounded)
12 parameters (voltage+min+max X 4 outputs)	240 microseconds (rounded)
24 parameters (voltage+min+max X 4 outputs & current+min+max X 4 outputs)	480 microseconds (rounded)

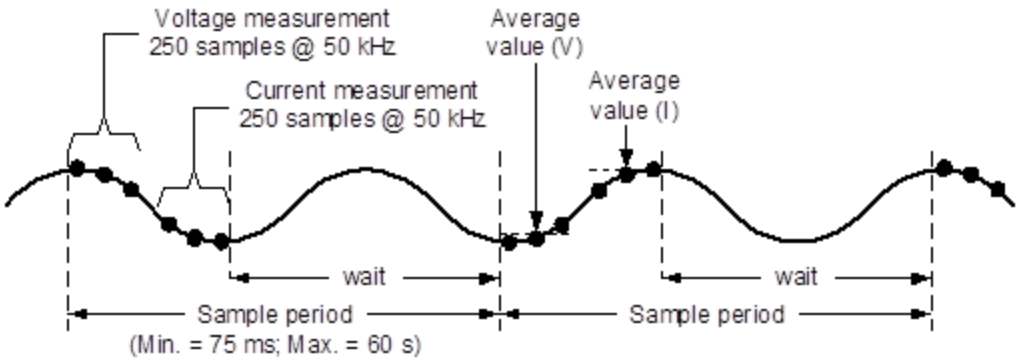
NOTE When the Power trace is selected, it counts as 2 parameters, since voltage and current must be measured to calculate power. If voltage and current traces have already been selected, the Power trace is not counted as a parameter

Standard mode (interleaved)

Standard (interleaved) mode only applies when both voltage and current measurement traces are selected on power modules other than Models N676xA and N678xA SMU. These other power modules cannot measure voltage and current simultaneously; hence, the voltage and current measurements must be interleaved for all power modules in the mainframe. Each measurement is sampled for about 5 milliseconds at the beginning of every sample period. Power is calculated from the interleaved measurements.

Standard data sampling is used with the following Power Module and Display Trace selections:

Power Module	Display Trace selection
N673xB, N674xB	Voltage, Current, and Power
N675xA, N677xA	Voltage, Current, and Power
N6783A-BAT/MFG	Voltage, Current, and Power
Available capabilities for ALL outputs	
• Sample period: 20.48 microseconds to 60 seconds • Trigger source: all trigger sources available • Trigger offset: 0 to 100% • Values logged: average, minimum, maximum (minimum/maximum values must be selected)	



Data Logger and Scope Display Differences

The Scope View and Data Logger displays are similar in many respects, such as the way traces are displayed, how traces are selected, and the marker controls - to name a few. This similarity makes it easier to program each function.

However, there are important differences in the Scope and Data Logger displays that may not be obvious at first glance. To help eliminate confusion when using both Scope and Data Logger, the following table lists the major differences in the display functions.

Function	Scope View	Data Logger
Graph	Waveform capture	Strip chart
Trace selection	Voltage, current, and power traces - for N676xA and N678xA SMU power modules Voltage or current trace - for all other power modules	*Continuous mode* Voltage, current, and power traces - for N676xA and N678xA SMU power modules Voltage or current trace - for all other power modules *Interleaved mode* Voltage and current, or power
Trigger level selection	Note that current levels cannot be selected as triggers on outputs that have been grouped.	*Continuous mode* Voltage or current level of selected trace - for all power modules *Interleaved mode* Run Stop key only - for all power modules Note that current levels cannot be selected as triggers on outputs that have been grouped.
Trigger mode	Auto, single, or triggered	Does not apply
Trigger position	Turn the horizontal offset knob	Press Properties, select Trigger. Trigger position is specified as a % of the data log duration.
Horizontal trigger offset reference	Left, center, or right	Does not apply to strip chart
Trace save	Press File, select Save.	Automatically saved to default.dlog file. A different file name can be specified prior to running the datalog.

External Data Logging

Data Logging Functions

Select the Measurement Function and Range

Specify the Integration Period

Select the Elog Trigger Source

Initiate and Trigger the Elog

Periodically Retrieve the Data

Terminate the Elog

Data Logging Functions

NOTE The external Data Logger function is not available if Option 055 has been ordered.

In addition to the built-in data logger, the power analyzer has an external data logger (Elog) function that lets you log voltage and current measurements from all four outputs directly to an internal FIFO (first-in, first-out) buffer. Note that this buffer is only large enough to hold about 20 seconds of accumulated measurements. The following table lists the major differences between the built-in and external data loggers

The following table details the various data logging functions.

Function	Built-in Data Logger	External Data Logger
Data viewing	Optimized for viewing the measurements on the power analyzer's display.	No front panel view or front panel control.
Data Storage	Stores the measurements to an internal file. Can be left unattended for an extended time and results can be viewed afterward.	Buffers measurements for about 20 seconds and requires that the computer periodically reads measurements to prevent the power analyzer's buffer from overflowing. The computer needs to provide the data storage function.
Measurement Resources	Allocates all the measurement resources of ALL outputs, even if data logging is only enabled on some of the outputs.	Runs independently on each output. Some outputs can be running an external data log, while the remaining outputs can be used in front panel control or used for other SCPI functions.
Interleaved Mode	Interleaved mode allows the data logger to log both voltage and current on power modules that have only one measurement converter.	Interleaved mode is not available. If a power module has only one measurement converter, then either voltage or current can be logged, but not both.
Logging Rate	Can log data at up to 20.48 microseconds for one parameter.	Can log data at up to 102.4 microseconds for one parameter with data format = real.

Programming the external data logger consists of:

- Selecting the measurement functions and ranges.
- Specifying the measurement integration period.
- Selecting the trigger source.
- Triggering the data logger.
- Retrieving the data log measurement.

The external data logger function cannot be programmed from the front panel. When an external data log measurement is initiated on an output channel, the front panel changes to Meter View. Any channel that is performing an external data log measurement displays a message to this effect. Switching to Scope or Data Logger view will terminate the external data log measurement

Select the Measurement Function and Range

The following commands select a measurement function. To enable voltage measurements and min/max measurements on channel 1:

SENS:ELOG:FUNC:VOLT ON,(@1)
SENS:ELOG:FUNC:VOLT:MINM ON,(@1)

To enable current measurements and min/max measurements on channel 1:

SENS:ELOG:FUNC:CURR ON,(@1)
SENS:ELOG:FUNC:CURR:MINM ON,(@1)

The following commands select the range. To select the 5 V voltage range on channel 1:

SENS:ELOG:VOLT:RANG 5,(@1)

To set the 1 A current range on channel 1:

SENS:ELOG:CURR:RANG 1,(@1)

In order to log both voltage and current on an output channel, that channel must have simultaneous measurement capability (see Model Differences), Models that do not have simultaneous measurement capability cannot externally log both voltage and current. There is no interleaved voltage/current mode as there is with the instrument's internal data logger

Seamless Measurements

Seamless measurement autoranging for both voltage and current is available on models N678xA SMU and with Option SMR. N678xA SMU Option SMR This enables a wide dynamic measurement range with no data lost across ranges

Seamless ranging does not include the 10 µA range, which must be selected manually. To enable seamless elog autoranging on channel 1:

SENS:ELOG:VOLT:RANG:AUTO ON,(@1)
SENS:ELOG:CURR:RANG:AUTO ON,(@1)

Specify the Integration Period

The integration period can be set from a minimum of 102.4 microseconds to a maximum of 60 seconds. The following specifies an integration period of 600 microseconds:

SENS:ELOG:PER 0.0006, (@1)

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. You can specify up to six measurement parameters per channel: Voltage+Vmax+Vmin, and Current+Imax+Imin.

Although the absolute minimum integration period is 102.4 microseconds, the actual minimum depends on the number of measurement parameters that are being logged. The actual minimum is 102.4 microseconds times the number of parameters being logged at each interval. Note that you can measure up to 4 parameters with the time interval resolution set to 20 microseconds, and up to 24 parameters with the resolution set to 40 microseconds. When the instrument sets an integration period, the value sent is rounded to the nearest integer multiple of the chosen resolution, either 20.48 microseconds or 40.96 microseconds.

1 parameter (Voltage or Current), with 20 µs resolution	102.4 µs
2 parameters (Voltage and Current), with 20 µs resolution	204.8 µs
4 parameters (Voltage+Vmin+Vmax+Current), with 20 µs resolution	409.6 µs
8 parameters with 40 µs resolution	819.2 µs
16 parameters with 40 µs resolution	1638.4 µs
24 parameters with 40 µs resolution	2457.6 µs

You can change the time interval resolution as follows:

SENS:SWE:TINT:RES RES20|RES40

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. Refer to Measurement Data Formats for more information. To set the data format to REAL, use:

FORM 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:

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 port.
IMMediate	Selects the immediate trigger source. This triggers the data logger immediately when initiated.

PIN<1-7>	Selects a specific pin that is configured as a Trigger Input on the digital port. The selected pin must be configured as a Trigger Input in order to be used as a trigger source (see Using the Digital Port).

Use the following commands to select a trigger source. To select Bus triggers:

TRIG:TRAN:SOUR BUS, (@1)

To select any digital pin as the trigger source:

TRIG:TRAN:SOUR EXT,(@1)

To select the immediate trigger source:

TRIG:TRAN:SOUR IMM,(@1)

To select digital pin 5 as the trigger source:

TRIG:ACQ:SOUR PIN5,(@1)

Initiate and Trigger the Elog

When the power analyzer 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, use:

INIT:ELOG (@1)
TRIG:ELOG (@1)

Alternatively, if the trigger source is BUS, you can 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. To retrieve a maximum of 1000 records:

FETC:ELOG? 1000, (@1)

ASCII data (the default) is returned as comma-separated ASCII numeric data sets of average, min, or max values terminated by a newline. ASCII queries can only fetch data from one channel at a time.

Binary data is returned as a comma-separated list of data for each channel requested. The data is a definite length binary block, with the byte order specified by the FORMat:BORDer command.

Terminate the Elog

ABOR:ELOG (@1)

5 Using the System Functions

Using the File Functions

Specifying User Preferences

Using the Administrative Tools

Configuring the Remote Interfaces

NOTE Most of the system functions can only be programmed using the front panel menus.

Using the File Functions

Save

Load

Export

Import

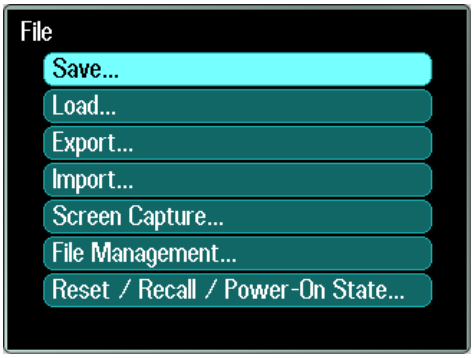
Screen Capture

File Management

Reset/Recall/Power-On State

Using an External USB Memory Device

Press the File key to access the file functions, then scroll to and select from the following:



Save Function

To save the instrument state, scope data, or an Arb sequence, press the File key, then scroll to and select Save.



Parameter	Description
Type	Specifies the data type: instrument state or scope data or Arb sequence.
Path\File Name	Specifies a file name in which to save the data. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel. Enter a name in the text field. See Enter the File Name.
Browse	Lets you browse another directory or USB memory device.
Save	Saves the data to the file name in binary format.

Enter the File Name

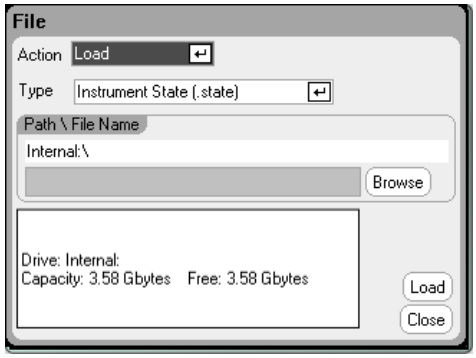
Use the navigation keys to scroll to and select the File Name field. Use the alpha/numeric keys to enter a file name. Alpha keys automatically become active on data entry fields that allow alpha as well as numeric characters. Repeatedly pressing a key cycles through the choices. This is similar to the way cell phones work. For example, repeatedly pressing 2 ABC cycles as follows:

a, b, c, A, B, C, 2

After a brief pause, the cursor will accept the displayed character and move one position to the right. Use Backspace to back up and delete an entry. Use ▶ to enter a space. Press Enter when finished.

Load Function

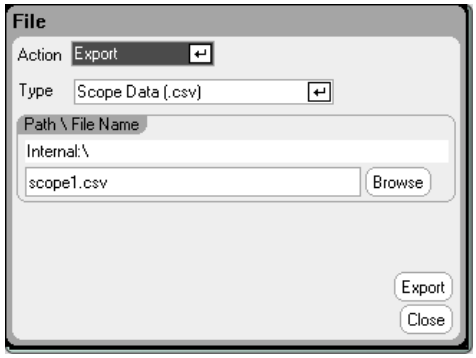
To load an instrument state, scope data, logged data, or an Arb sequence, press the File key, then scroll to and select Load. You can only load binary files. You cannot load data files in .csv format.



Parameter	Description
Type	Data type: instrument state, scope data, or logged data, or Arb sequence.
Path\File Name	Displays the file where the data is located. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
Save	Loads the data from the binary file into the instrument.

Export Function

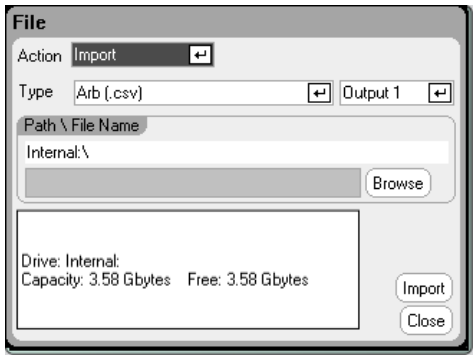
To export (and convert) scope data, logged data, or Arb data (user-defined or CD), press the **File** key, then scroll to and select Export.



Parameter	Description
Type	Data type: scope data, logged data, or Arb (User or CD). All data is exported in .csv format (comma separated values).
Path\File Name	Specifies a file name in which to export the data. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel. Enter a name in the text field. See Enter the File Name.
Browse	Lets you browse another directory or USB memory device.
Export	Exports the data to the file name in .csv format.

Import Function

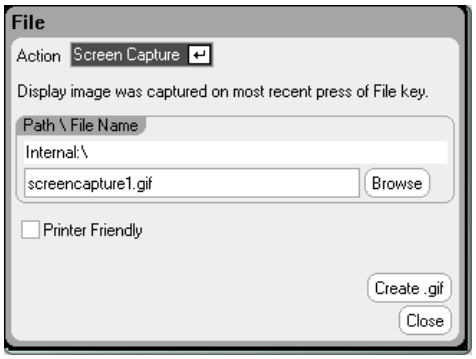
To import (and convert) Arb data (user-defined or CD), press the **File** key, then scroll to and select Import.



Parameter	Description
Type	Data type: Arb data (user-defined or CD). Data is converted from .csv format to an internal file format.
Output <1-4>	Specifies the output that will receive the Arb data.
Path\File Name	Specifies a file where the data is located. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
Export	Imports the .csv data to the file name in .csv format.

Screen Capture

To capture a screen, press the **File** key, then scroll and select Screen Capture. This saves the screen that was active when you pressed File



A copy of the current screen is saved whenever the **File** key is pressed.

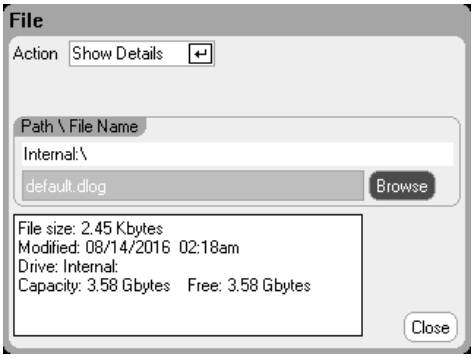
Parameter	Description
Path\File Name	Specifies a file name in which to save the image. Screens are saved in .gif format (graphics interchange format). Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel. Enter a name in the text field. See Enter the File Name.
Browse	Lets you browse another directory or USB memory device.
Print Friendly	Check this box to save Scope View and Data Logger screens with a white instead of a dark background.
Create .gif	Saves the image to the specified .gif file.

NOTE The time of step 0 is the sum of the Start Time, Top Time and End Time. The default pacing for sequence steps is Dwell-pacing.

File Management

Show Details

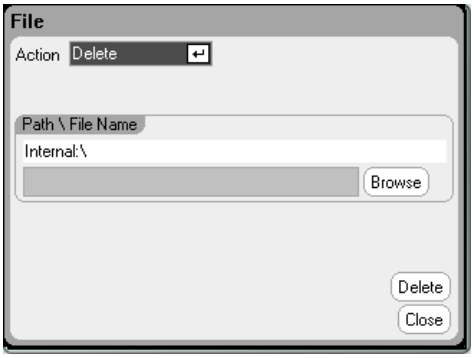
To view the details of a specific file, press the File key, then scroll to and select File Management. In the Action dropdown box, select Show Details.



Parameter	Description
Path\File Name	Specifies the file. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
Details	File details are displayed in the text box.

Delete Function

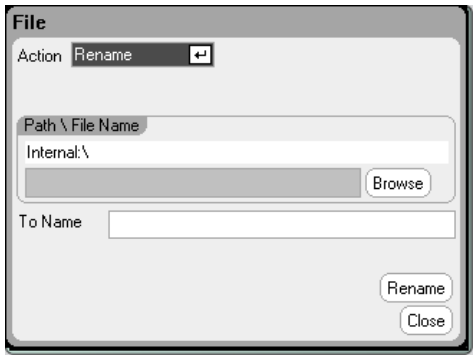
To delete a file, press the File key, then scroll to and select File Management. In the Action dropdown box, select Delete.



Parameter	Description
Path\File Name	Specifies a file or directory to be deleted. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
Delete	Deletes the selected file.

Rename Function

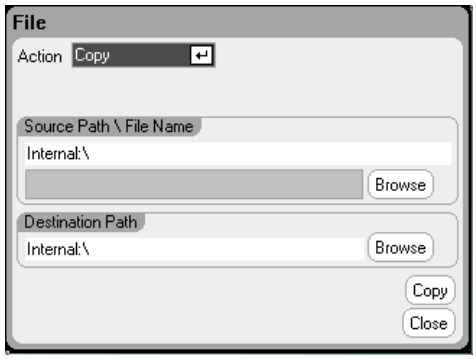
To rename a file, press the **File** key, then scroll to and select File Management. In the Action dropdown box, select Rename.



Parameter	Description
Path\File Name	Specifies a file or directory to be renamed. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
To Name	Enter the name that you wish to rename the file to in this text field. See Enter the File Name.
Rename	Renames the selected file.

Copy Function

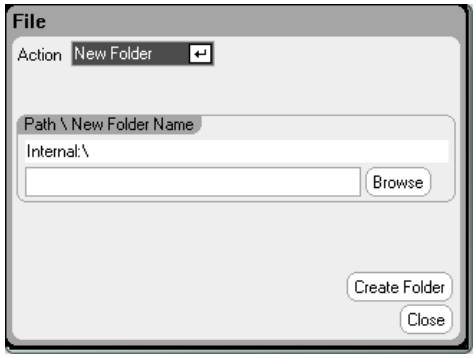
To copy the selected file to another directory or an external USB memory device, press the **File** key, then scroll to and select File Management. In the Action dropdown box, select Copy.



Parameter	Description
Path\File Name	Specifies the file to be copied. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.

Parameter	Description
Destination Path	Specifies a destination directory. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel.
Browse	Lets you browse another directory or USB memory device.
Copy	Copies the selected file to the specified destination.

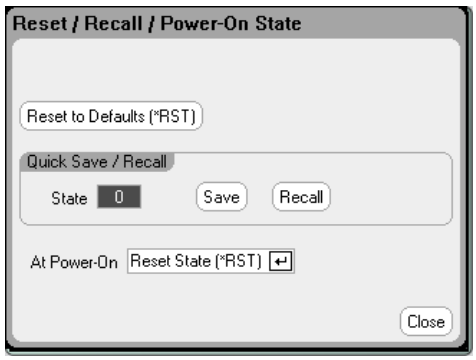
New Folder



Parameter	Description
Path\New Folder Name	Specifies a name for the folder. Internal:\ specifies the instrument's internal memory. External:\ specifies the Memory port on the front panel. Enter the name in the text field. See Enter the File Name.
Browse	Lets you browse another directory or USB memory device.
Create Folder	Creates the new folder in the specified location.

Reset/Recall/Power-On State

As shipped, the power analyzer is configured to automatically recall the Reset State (*RST) settings at power-on. However, you can configure the reset, recall, and power-on state of the instrument. Press the **File** key, then scroll and select Reset/Recall/Power-On State.



Selecting Reset to Defaults lets you immediately return the instrument to its factory default settings as described under Reset State.

Quick Save/Recall - lets you save and subsequently recall an instrument state in memory locations 0 through 9. This is the same as saving an instrument state to a file name, but quicker. These functions can also be accessed using the SCPI *SAV and *RCL commands.

At Power-On - lets you recall the Reset State (*RST), or recall the instrument state in location 0.

From the remote interface:

To save a state in location 1:

*SAV 1

To recall a state in location 1:

*RCL 1

To to recall the settings you have stored in memory location 0 (RCL0) at power-on:

OUTP:PON:STAT RCL0

Using an External USB Memory Device

You can use an external USB memory device (commonly referred to as a flash drive) to transfer files to and from the power analyzer. Connect the memory device to the front panel Memory port, which is specifically designed for this purpose. The rear panel USB connector should only be used for connecting to a PC.

When using an external USB memory device, be aware of the following cautions:

- While the power analyzer supports the majority of USB memory devices, there may be differences in manufacturing standards of some devices that will prevent them from working in the power analyzer.
- It is recommended that you test your USB device by importing and exporting a file before you actually use it to save data directly from the test you will be running. If the USB memory device does not work in the power analyzer, try a device from a different manufacturer.

Exporting Data to a Spreadsheet

You can export scope data and logged data to a spreadsheet such as Microsoft Excel on your PC as follows:

1. Collect the scope or logged data using the power analyzer.
2. Insert a USB memory device into the Memory port on the front of the power analyzer.

3. Export the scope data or logged data to the memory device using the Export file function as previously discussed. Note that the export file format is .csv (comma separated values).

4. Inset the memory device into the USB port on your computer.

5. Run Microsoft Excel and select File, then Open. Navigate to the USB memory device. Under Files of type:, select Text Files (*.csv). Open the scope data or data log file.

Logging Data Directly to the Memory Device

You can save logged data directly to the USB memory device rather than to the instrument's internal memory as follows:

1. Insert a USB memory device into the Memory port on the front of the power analyzer.

2. In the Datalogger Target File Selection window (located under Datalogger Properties/File Name), use the Browse button and select External:\. Enter a filename in the text field. The data will now be placed on the USB memory device.

NOTE Data is saved in binary format. To export in .csv format you must Load the data from the USB memory device back into the instrument and Export the data in .csv format as previously described under "Exporting Data to a Spreadsheet".

Specifying User Preferences

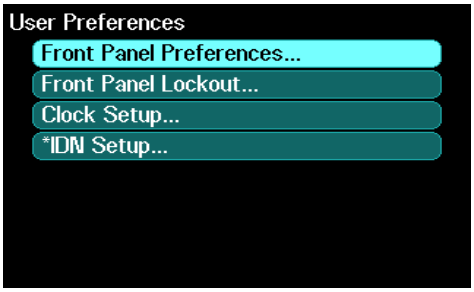
Front Panel Preferences

Front Panel Lockout

Clock Setup

***IDN Setup**

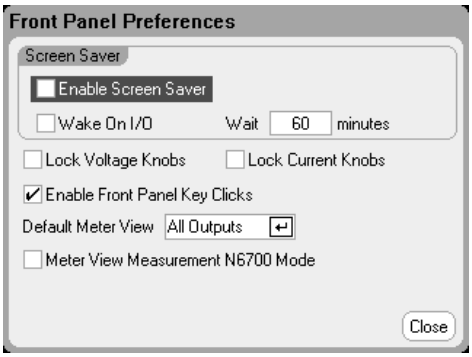
To configure the User Preferences, press the Menu key, scroll down and select the Utilities item, then select User Preferences. Then scroll to and select one of the following User Preferences:



Front Panel Preferences

The power analyzer has a front panel screen saver that increases the life of the LCD display by turning it off during periods of inactivity. As shipped from the factory, the screen saver comes on one hour after activity on the front panel or interface has ceased.

When the screen saver is active, the front panel display turns off, and the LED next to the Line switch changes from green to amber. To restore the front panel display, simply press one of the front panel keys.



Enable Screen Saver - check to enable the screen saver. Uncheck to disable the screen saver.

Wait - when Screen saver is enabled, enter a value in minutes in this field to specify the time when the screen saver will activate. The wait can be set from 30 to 999 minutes in 1 minute increments.

Wake on I/O - check to activate the display with I/O bus activity. If Wake on I/O is enabled, the display is restored whenever there is activity on the remote interface. This also resets the Wait timer.

Lock Voltage Knobs / Lock Current Knobs - check these to disable the front panel voltage or current knobs. This is useful if you wish to prevent someone from changing the voltage or current settings if a test is in progress. Uncheck to enable the voltage or current knobs.

Enable Front Panel Key Clicks check to enable key clicks. Uncheck to disable key clicks.

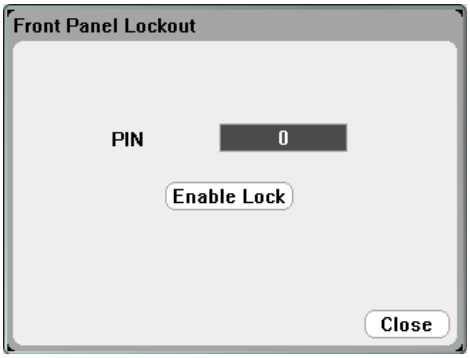
Default Meter View - in the dropdown, specify if the instrument turns on in single-output view or all-outputs view.

Meter View Measurement N6700 Mode - check to synchronize the corresponding SCPI SENSe measurement settings to the Meter View properties and vice versa. Refer to Meter Ranges and Measurement Times for details.

Front Panel Lockout

You can password-protect the front panel keys to prevent unwanted control of the instrument from the front panel. The lock setting and password is saved in non-volatile memory so that the front panel remains locked even when AC power is cycled.

To access the front panel lockout function press the Menu key, scroll down and select Utilities, then User Preferences, then Front Panel Lockout.



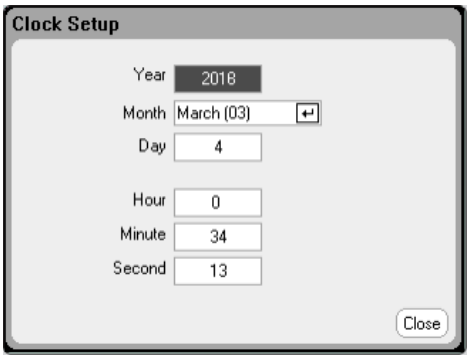
In the PIN text box, enter the numeric password that you wish to use to unlock the front panel. Then click Enable Lock to lock the front panel keys. A dialog prompting the user to unlock the front panel appears every time a key is pressed. Enter the password to unlock the front panel.

NOTE If the password is lost, the SYSTem:PASSword:FPANel:RESet command can reset the front panel lockout password.

Clock Setup

When shipped from the factory, the power analyzer's clock is set to Greenwich mean time.

To access the clock function press the Menu key, scroll down and select Utilities, then User Preferences, then Clock Setup.



Select a Month from the dropdown list. Enter the Day, then Year.

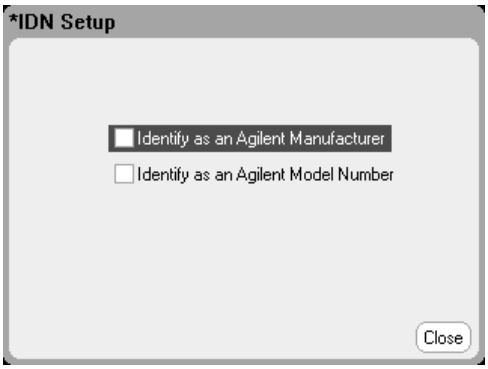
Enter the Hour (0 - 23), Minute, and Second. The time becomes active when the values are entered.

*IDN Setup

You have the ability to change the identity of the mainframe, as reported in the *IDN? query. This functionality is only intended for compatibility with previous "A" and "B" version mainframes.

To access the *IDN function press the Menu key, scroll down and select Utilities, then User Preferences, then *IDN Setup.

Check the appropriate box to identify the instrument as an Agilent product.



From the remote interface, program:

SYST:PERS:MAN "<manufacturer>"
SYST:PERS:MOD "<model number>"

The *IDN setup change and PERSona commands affects the following identification items:

- *IDN? command for vendor and model
- VISA programmatic access APIs for vendor and model
- LXI instrument web pages
- LXI XML
- LXI mDNS announcements

Using the Administrative Tools

Administrator Login/Logout

Calibration

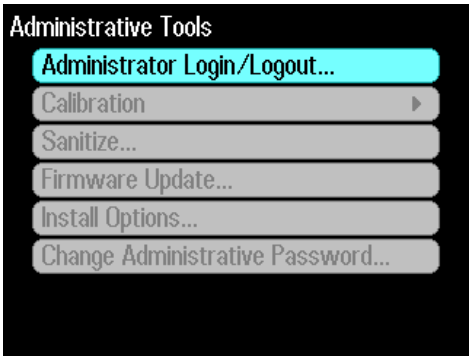
Sanitize

Firmware Update

Install Options

Change Administrative Password

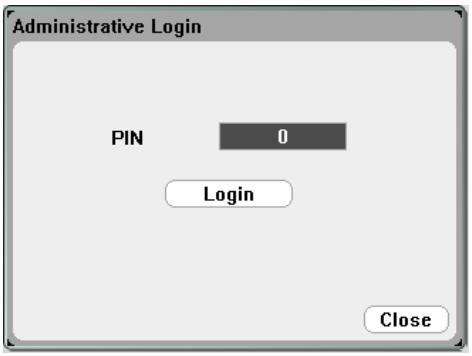
To enter the Administrative Utilities menu, press the Menu key, scroll down and select Utilities, then select Administrative Tools. Access to the Administrative Tools menu is password protected. Select Administrator Logout/Login to enter the password:



Administrator Login/Logout

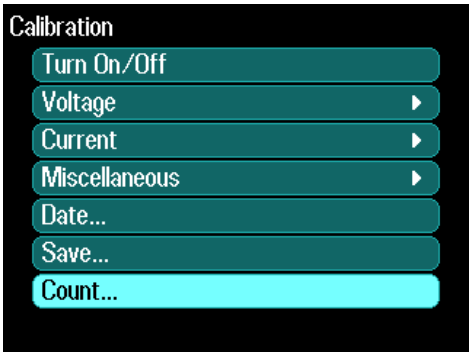
If a password is required, enter it in to the PIN field, select the Login button and press [Enter].

As shipped from the factory, the password is 0 (zero). If the PIN field shows 0; simply select the Login button and press [Enter].



Calibration

The calibration functions are located in the Administration Tools menu and are password-protected from unauthorized use. For complete information about calibrating the instrument, refer to the calibration section.



Sanitize

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

To erase all user-data from the instrument and restore the factory-shipped settings, log into the Administrative Tools menu. Then select Sanitize and press the Sanitize button. Refer to Instrument Sanitize for more information.



Firmware Update

You must use the Firmware Update Utility to update the firmware in your instrument. Refer to Firmware Update for more information.

You can restrict access to the instrument by the Firmware Update Utility. This prevents unauthorized users from updating the firmware. Check Login as administrator to allow firmware update.

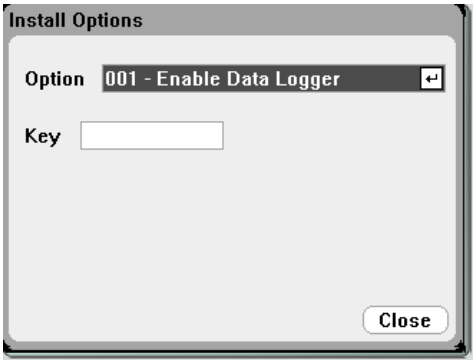


Install Options

The Install Options function lets you install firmware options into the power analyzer.

Option 001	Data Logger Software This option is only available on instruments that have been purchased with Option 055 – Delete Data Logger.
Option 056	Keysight 14585A Control and Analysis Software

To access the disk management utilities, log into the Administrative Tools menu. Select Install Options. From the dropdown menu, select the option you wish to install. Enter the Access Key number from your software license documentation.



Obtaining the License

To obtain the license, you must first purchase the option. After you have purchased the option, you will receive a Software Entitlement Certificate. When this is received, you can obtain the license.

To get the license key, log onto the website https://software.business.keysight.com/asm and follow the on-screen directions. These include:

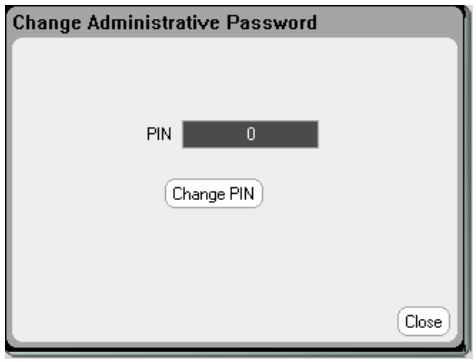
1. Creating a user account (if not already set up).
2. Entering your Order and Certificate number (these appear in your Software Entitlement Certificate).
3. Entering the Host instrument's 10-character serial number (this is located on the rear panel of the instrument).
4. Selecting the software license for the instrument.

When you have completed the license request, a license key will be sent to your email. Enter the Access Key into the Key field of the Install Options window shown above.

Change Password

To password-protect or change the password for the Administrative Tools menu, log into the Administrative Tools menu as previously described. Select Change Password. Select a password that is numeric and up to 15 digits long. Enter it into the PIN field and then select Change Pin.

When done, select Administrator Login/Logout to log out of the Administrative Tools menu and activate the password. You can now only enter the Administrative Tools menu by providing the new password.



If the password is lost or forgotten, access to the Administrative Tools menu 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 the calibration switches section).

Configuring the Remote Interfaces

GPIB Configuration

USB Configuration

LAN Configuration

Modifying the LAN Settings

Using the Web Interface

Using Sockets

Using Telnet

Securing the LAN

This Keysight N6705C DC Power Analyzer supports remote interface communication over three interfaces: GPIB, USB, and LAN. All three interfaces are live at power on. For information on connecting the interfaces, refer to Interface Connections.

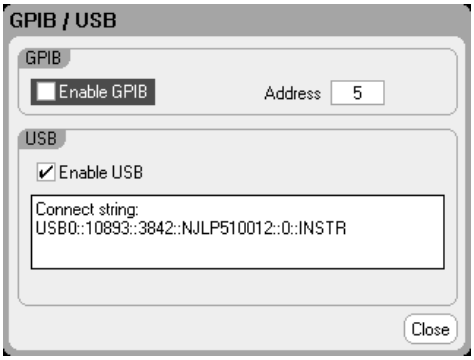
The front panel IO indicator comes on whenever there is activity on the remote interfaces. The front panel Lan indicator comes on when the LAN port is connected and configured.

Ethernet connection monitoring is also provided. 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

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.

To access the GPIB parameters from the front panel, press the Menu key, select Utilities, then I/O Configuration, then GPIB/USB. Check or uncheck Enable GPIB to enable or disable the GPIB. Use the numeric keys to enter a value in the Address field. Press Enter to enter the value.



USB Configuration

Use the front panel menu to access the GPIB/USB window as described above. You can view the USB connect string in the GPIB/USB dialog. Check or uncheck Enable USB to enable or disable the USB.

LAN Configuration

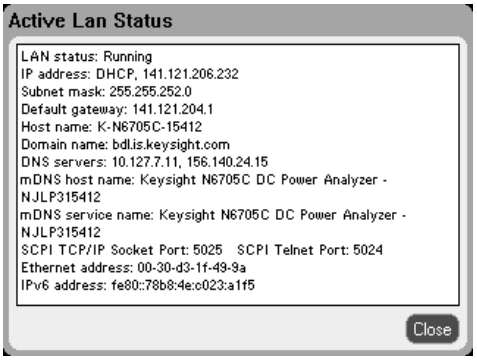
The following sections describe the primary LAN configuration functions on the front-panel menus. Note that there are no SCPI commands to configure the LAN parameters. All LAN configuration must be done from the front panel.

NOTE After changing the LAN settings, you must Save the changes. Select: System\IO\LAN\Apply. Selecting Apply cycles power to the instrument and activates the settings. LAN settings are nonvolatile, 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, press the Menu key, scroll down and select the Utilities, then select I/O Configuration, then Active LAN Status.

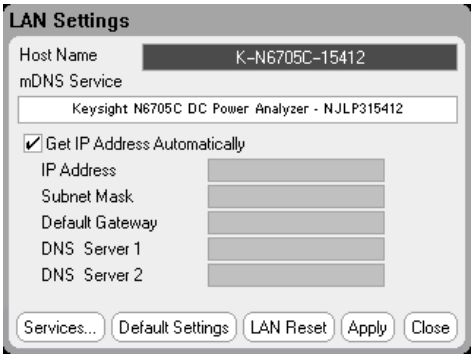


The currently active settings may be different from the front panel configuration menu settings - depending on the configuration of the network. If the settings are different, it is because the network has automatically assigned its own settings.

Modifying the LAN Settings

As shipped from the factory, the power analyzer's pre-configured settings should work in most LAN environments. If you need to manually configure these settings, press the Menu key, scroll down and select the Utilities, then select I/O Configuration, then LAN Settings.

Refer to Non-Volatile Settings for information on the factory-shipped LAN settings.



Host Name

A hostname is the host portion of the domain name, which is translated into an IP address. Use the numeric/alpha keys to enter letters or numbers. Repeatedly pressing a key cycles through the list of choices. After a short delay the cursor automatically moves to the right.

- 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 power analyzer is shipped with a default hostname with the format: Keysight-modelnumber-serialnumber, where modelnumber is the mainframe's 6-character model number (e.g. N6705C), and serialnumber is the last five characters of the 10-character mainframe serial number located on the label on the top of the unit (e.g. 45678 if the serial number is MY12345678).

mDNS Service

The mDNS service name is registered with the selected naming service.Use the numeric/alpha keys to enter letters or numbers. Repeatedly pressing a key cycles through the list of choices. After a short delay the cursor automatically moves to the right.

- 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 power analyzer is shipped with a default service name with the format: Keysight-modelnumber-serialnumber, where modelnumber is the mainframe's 6-character model number (e.g. N6705C), and serialnumber is the last five characters of the 10-character mainframe serial number located on the label on the top of the unit (e.g. 45678 if the serial number is MY12345678).

Get IP Address Automatically - checked

- Checking this box - 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. (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.)

Get IP Address Automatically - unchecked

- Unchecking this box - allows you to manually configure the addressing of the instrument by entering values in the following fields. These fields only appear when Manual is selected. Select Apply to apply the manually-entered settings.
- 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. Note that the Internet Engineering Task Force reserved the IP address range of 169.254.1.0 to 169.254.254.255 for link-local addressing (auto-IP). Do not assign a manual IP address within this range.
- 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.
- Default 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.
- DNS server 1 - This field enters the primary address of the DNS 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.
- DNS server 2 - This field enters the secondary address of the DNS 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.

Resetting the LAN

You can reset the LAN to the as-shipped settings by selecting 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.

You can also perform an LXI LCI reset by selecting LAN Reset. This resets the DHCP, DNS server address configuration, mDNS state, mDNS service name and the web password. These settings are

optimized for connecting your instrument to a site network. They should also work well for other network configurations.

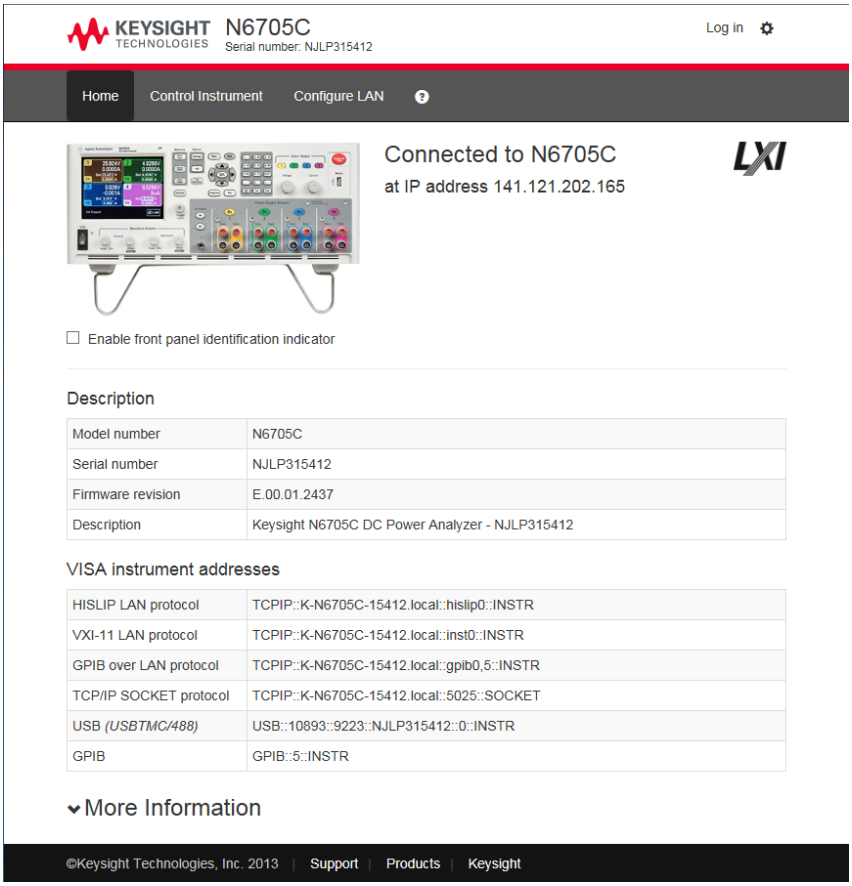
Using the Web Interface

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

NOTE The built-in Web interface only operates over the LAN. It requires a web browser.

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



If desired, you can control access to the Web interface by enabling or disabling Web control under LAN Services (see Securing the LAN).

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 analyzer 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.

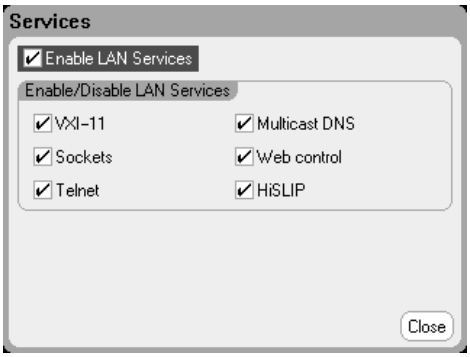
Using Telnet

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

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

Securing the LAN

You can enable or disable a number of LAN services. All LAN services are enabled when shipped. To enable or disable selected LAN services from the front panel, select Utilities, then select I/O Configuration, LAN Settings, then Services...



Check or uncheck Enable LAN Services.

Under Enable/Disable LAN services, configure the services that you wish to enable.

NOTE LAN services must be enabled in order to enable the Web interface control.

6
Advanced Source, Measurement, and Control

Advanced Source Operation

Advanced Measurements

Using the Digital Control Port

This section discusses the difference between constant voltage and constant current operating modes, multiple output quadrant operation, and other advanced source functions.

Advanced measurement functions such as digitizing measurements, external data logging, histogram measurements, and other measurement functions are described.

A Digital Control Port consisting of seven I/O pins located on the rear panel, can be programmed to provide various external control functions.

Advanced Source Operation

Single-Quadrant Operation

Autoranging

CC Mode Delay

Power Limit Operation

Output Grouping

N678xA Multi-Quadrant Operation

N678xA Output Bandwidth

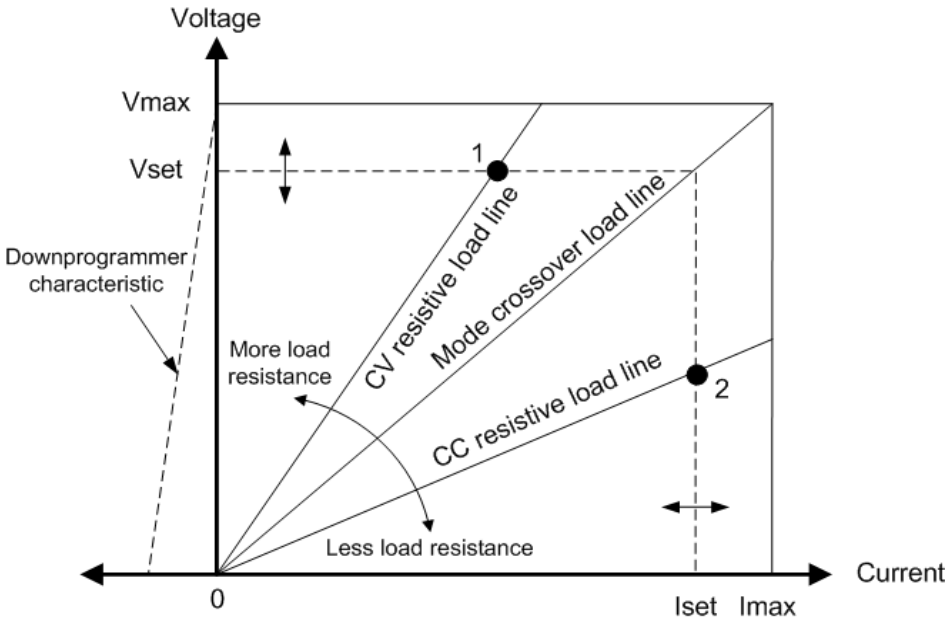
N679xA Load Module Operation

Single-Quadrant Operation

The Keysight N6705C DC Power Analyzer can operate in either constant voltage (CV) or constant current (CC) over the rated output voltage and current. Constant voltage mode is defined as an operating mode in which the dc source maintains its output voltage at the programmed voltage setting in spite of changes in load, line, or temperature. Thus, when the load resistance changes, the output voltage remains constant while the output current changes to accommodate the change in load.

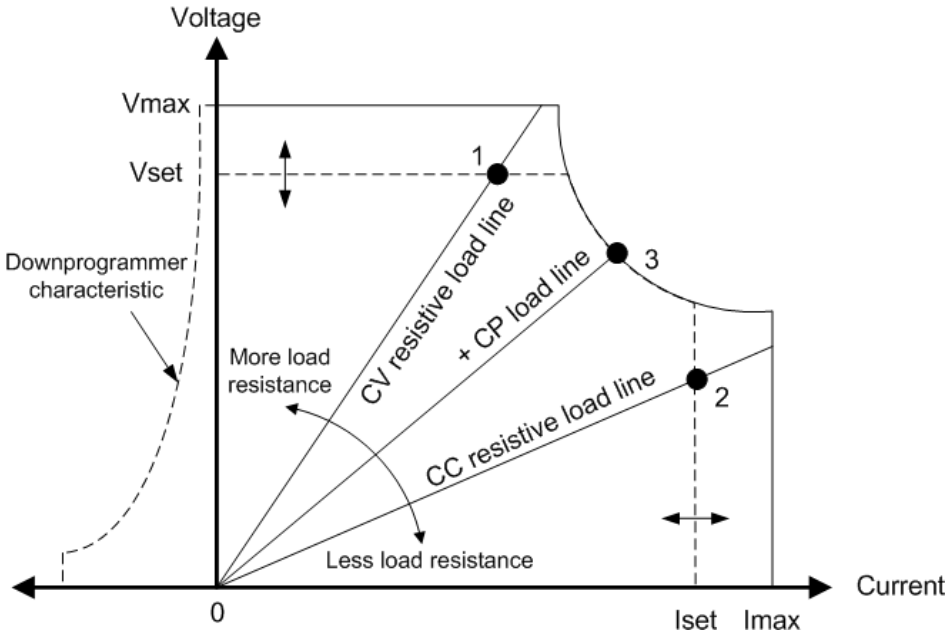
Constant current mode is defined as an operating mode in which the dc source maintains its output current at the programmed current limit in spite of changes in load, line, or temperature. Thus, when the load resistance changes, the output current remains constant while the output voltage changes to accommodate the change in load.

All DC power modules, except for Keysight Models N678xA SMU not N678xA SMU, are designed as constant voltage sources. This means that the specifications and operating characteristics are optimized for constant voltage mode operation. Note that these power modules cannot be programmed to operate in a specific mode. At turn-on, the operating mode will be determined by the voltage setting, current setting, and the load resistance. In the following figure, operating point 1 is defined by a fixed load line traversing the positive operating quadrant in the constant voltage region. Operating point 2 is defined by a fixed load line traversing the positive operating quadrant in the constant current region.



Autoranging

The following figure illustrates the autoranging output characteristic of the Keysight N675xA and N676xA power modules N675xA, N676xA. Point 3 shows a situation in which the voltage and current settings are such that the operating locus is limited by the maximum output power boundary of the output. Depending on the power module, this may be greater than the output power rating of the module. In this situation, the output is not guaranteed to meet its operating specifications because it is operating in an area that is outside its specified power rating.



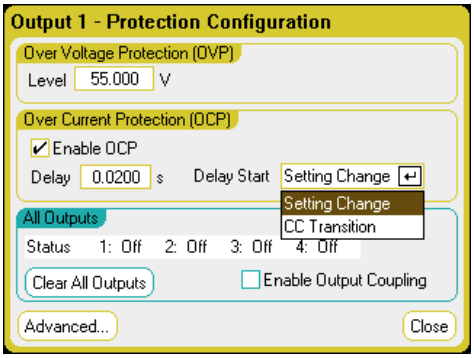
Downprogrammming

As shown by the dashed line on the left in the figures, the power analyzer is capable of sinking current over the output voltage range from zero volts to the rated voltage. This negative current sinking capability provides fast downprogramming of the output. The negative current is not programmable.

CC Mode Delay

The power supply may momentarily cross into constant-current (CC) mode when it is turned on, when an output value is programmed, or when the output load is connected. In most cases these temporary conditions would not be considered an over-current protection fault, and having an OCP condition disable the output when the CC status bit is set would be a nuisance. Specifying an OCP delay will ignore the CC status bit during the specified delay period. For example, if the OCP delay is 100 ms, and the output goes into CC mode for 80 ms and then back to CV mode, the output will not shut down, If the CC mode persists for more than 100 ms, the output will shut down.

To program a delay time, press the Settings key to access the Source Settings. Navigate to and select Protection. Then press Enter.



You can specify if the delay timer is started by any transition of the output into CC mode (select CC Transition), or if the delay timer is started at the end of a settings change in voltage, current, or output state (select Settings Change).

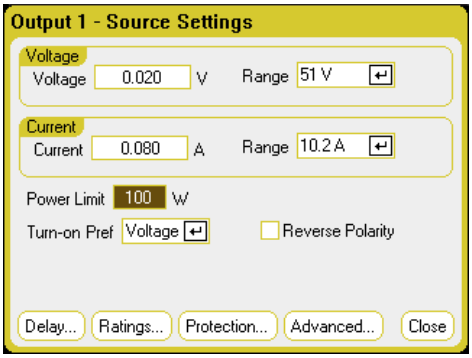
Factors that influence how long the settings or load change lasts may include: the difference between the old and new output value, the current limit setting, load capacitance in CV mode, load inductance in CC mode, the slew rate, and bandwidth setting. The delay required must be determined empirically;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

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

Power Limit Operation

For Keysight N6705 mainframes, the instrument will operate normally as long as the combined output power of the modules is within the power rating of the mainframe. If the combined power drawn from all of the outputs exceeds the mainframe's power rating of 600 W, a power fault protection event will occur. This causes ALL outputs to turn off and remain off until a protection clear command is given. A status bit (PF) will indicate that a power fault protection event has occurred.

To specify a module output power limit, press the Settings key to access the Source Settings window.



For Keysight N675xA, and N676xA power modules, the power limit function limits the output power at its programmed setting. A status bit (CP+) will indicate that the output is in power limit mode. When the power drawn by the load is reduced below the power limit setting, the output returns to normal operation. Note that these power modules contain an active down-programmer circuit, which is limited to about 7 W continuous power. A status bit (CP-) will indicate that the output has reached the negative limit.

For Keysight N673xB, N674xB, and N677xA power modules, the power limit function turns the output off after a power limit persists for about 1 millisecond. A status bit (CP+) will indicate that the output has been turned off by a power limit condition. To restore the output, you must first adjust the load so that it draws less power. Then clear the protection function as previously explained. For these power modules, it may be preferable to use the current or voltage setting to limit the output power so as to avoid turning the output off.

NOTE If the mainframe power limit is left at the maximum rating, the above power modules will not enable the power limit protection. The power limit protection will only activate when the power limit is set to a value less than the maximum rating of the power module and the output power subsequently exceeds this limit setting.

For Keysight N678xA SMU, N6783A-BAT/MFG, and N679xA loads, the mainframe power limit function does not affect the operation of the module. Note that Keysight N679xA load modules have a separate over-power protection function that limits the input power of the module.

Output Grouping

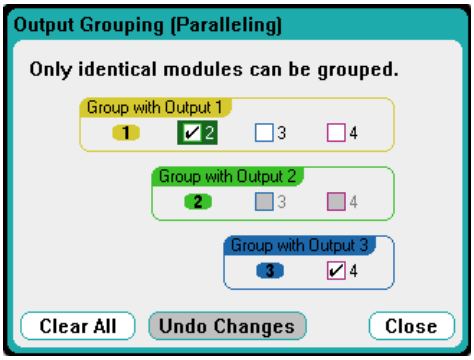
NOTE Output grouping does not apply to Keysight Models N678xA SMU .

Up to four identical outputs can be configured or “grouped” to create a single output with higher current and power capability. The following conditions apply for grouped outputs:

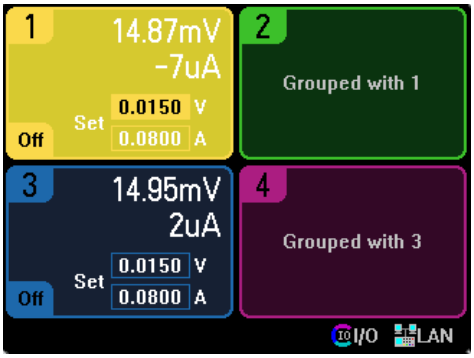
- Only identical outputs can be grouped. Outputs without identical model numbers and options will be unavailable for grouping.
- Grouped outputs must be connected in parallel as described under Parallel Connections.
- On Keysight N676xA power modules, low current measurement ranges are unavailable. Low current output ranges, are available.
- Current-level triggering is unavailable for grouped outputs.
- Over-current protection delay has a slightly slower response time (~10 ms) and slightly less resolution than an ungrouped output.
- The power limit setting for Keysight N673xB, N674xB, N677xA, and N6783A power modules must be set to its maximum value.

From the front panel:

To group outputs, press the Menu key. Select Source Settings, then Output Grouping. Check the outputs that you wish to group.



Grouped outputs are controlled using the output number of the lowest output in the group. As shown in the following figure, output 1 is grouped with output 2 and output 3 is grouped with output 4.



To return grouped outputs back to an ungrouped state, turn the output off and remove the parallel connections between the outputs. Then uncheck the check boxes. Then cycle AC power to the unit for the grouping or ungrouping changes to take effect. Grouped settings are saved in non-volatile memory.

From the remote interface:

Send the following command to group channels 2 through 4. To address this group, use channel 2.

SYST:GRO:DEF 2,3,4

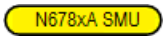
To ungroup all channels:

SYST:GRO:DEL:ALL

To reboot the instrument for the grouping changes to take effect either cycle AC power, or sent the following command:

SYST:REB

N678xA Multi-Quadrant Operation

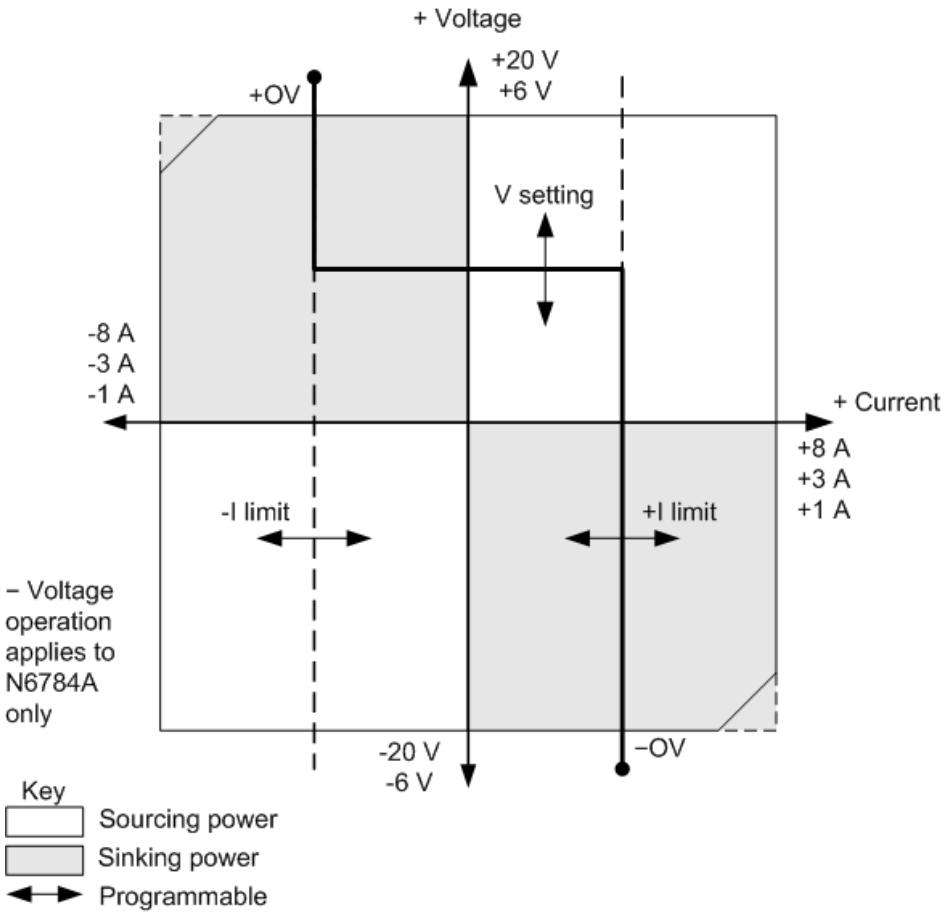
Keysight Models N678xA SMU 

can be operated in either voltage or current priority mode. They can source as well as sink output power. Note that Keysight Models N6781A, N6782A, N6785A, and N6786A operate only in the + Voltage quadrants.

Voltage Priority Mode

In voltage priority mode, the output voltage should be programmed to the desired positive or negative value. A positive current limit value should also be set. The current limit should always be set higher than the actual output current requirement of the external load. With tracking enabled, the negative current limit tracks the positive current limit setting. With tracking disabled, you can set different values for the positive and negative current limits.

The following figure shows the voltage priority operating locus of the power modules. 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 current is within the limit settings.

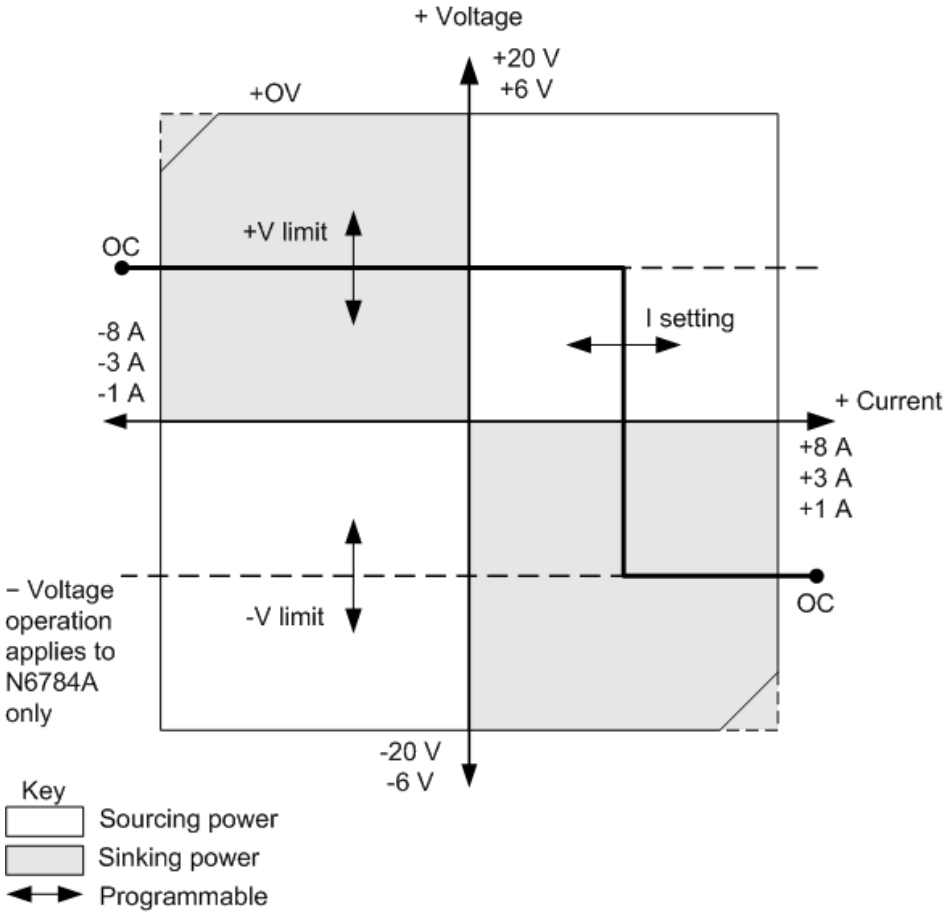
When the output current reaches either the positive or negative current limit, the unit no longer operates in constant voltage mode and the output voltage is no longer held constant. Instead, the power analyzer will now regulate the output current at its current limit setting. Either a LIM+ (positive current limit), or LIM- (negative current limit) status flag is set to indicate that a current limit has been reached.

As shown by the vertical portions of the load line, when the unit is sinking power, the output voltage may continue to increase in the positive or negative direction as more current is forced into the unit. When the output voltage exceeds either the positive or negative over-voltage setting, the output will shut down, the output relays will open, and either the OV or OV- and the PROT status bits will be set. Either the user-defined over-voltage setting or the local over-voltage function can trip the over-voltage protection.

Current Priority Mode

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 higher than the actual output voltage requirement of the external load. With tracking enabled, the negative voltage limit tracks the positive voltage limit setting. With tracking disabled, you can set different values for the positive and negative voltage limits.

The following figure shows the current priority operating locus of the power modules. 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 the positive or negative voltage limit setting. A CC (constant current) status flag indicates when the output voltage is within the limit settings.

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

voltage limit) or LIM- (negative voltage limit) status flag is set to indicate that either the positive or negative voltage limit has been reached.

As shown by the horizontal portions of the load line, when the unit is sinking power, the output current may continue to increase in the positive or negative direction as more current is forced into the unit. Once the current is exceeds 112% of the rated current of the range, the output will shut down, the output relays will open, and the OC and PROT status bits will be set.

N678xA Output Bandwidth

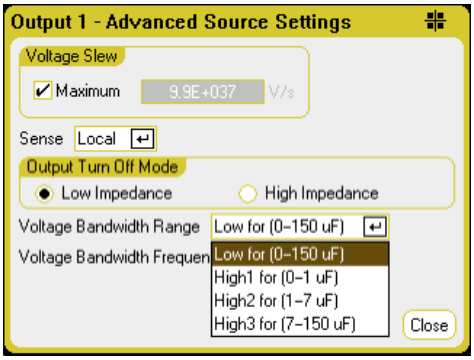
Keysight Models N678xA SMU N678xA SMU have several voltage bandwidth settings that let you optimize output response time with capacitive loads.

The Low bandwidth setting provides stability with a wide range of capacitive loads. Additional settings provide faster output response when the load capacitance is restricted to smaller values.

If capacitive loads cause the output to oscillate on the Low bandwidth or any other bandwidth setting, a protection function will detect the oscillation and latch the output off. This condition is annunciated by the OSC status bit. Oscillation usually occurs with load capacitances that fall outside the indicated ranges. At power-on the oscillation protection function is enabled.

From the front panel:

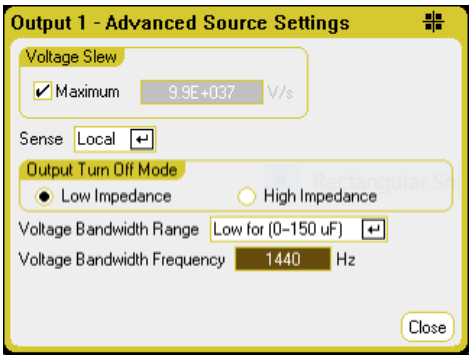
Press the Settings key to access the Source Settings window. Navigate to and select Advanced.



Select a bandwidth according to the following load capacitances and load lead lengths:

Setting	Load Capacitance	Sensing	Maximum distance from sense point to capacitor	ESR @100 kHz	Minimum frequency
Low	0–150 µF	Local or Remote	Full lead length [1]	50 to 200 mΩ	1440 Hz
High1	0–1 µF	Remote only	6 inches (155 mm)	50 to 200 mΩ	33,000 Hz
High2	0–7 µF	Remote only	6 inches (155 mm)	50 to 200 mΩ	20,500 Hz
High3	7–150 µF	Remote only	6 inches (155 mm)	50 to 200 mΩ	8300 Hz

Note 1 Refer to Keysight N678xA SMU Wiring for information on allowable full lead lengths.



The frequency parameter sets the pole frequency associated with a voltage bandwidth range. The power-on default for each range is the minimum frequency. This is optimized for no overshoot with the worst-case load capacitance for that range. If the load capacitance is not worst-case, or if some output overshoot is acceptable, the output voltage transition times can be reduced by increasing the frequency limit.

From the remote interface:

The bandwidth is selected using the following SCPI command:

VOLT:BWID <LOW|HIGH1|HIGH2|HIGH3>, (@1)

When queried, the bandwidth that was selected is returned.

To select a different frequency limit, use the following SCPI command:

VOLT:BWID:LEV <LOW|HIGH1|HIGH2|HIGH3>, <frequency>, (@1)

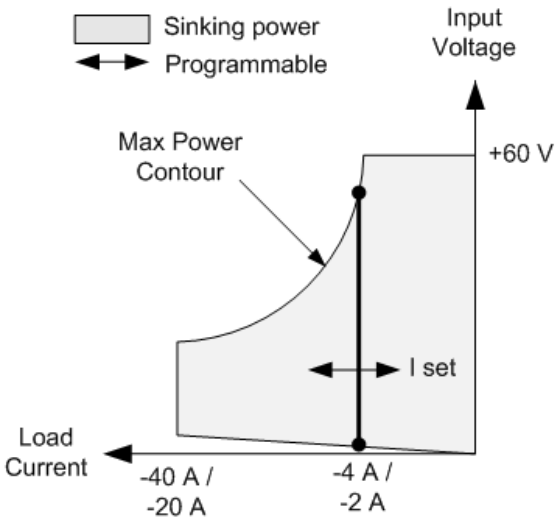
When queried, the selected frequency is returned.

Keysight N679xA Load Module Operation

The operating modes of operation for Keysight N679xA Load modules N679xA are: current priority, voltage priority, power priority, and resistance priority. When programmed to a mode, a module remains in that mode until the mode is changed or until a fault condition, such as an over-power or over-temperature occurs.

Current Priority Mode

In this mode, the load module will sink a current in accordance with the programmed value regardless of the input voltage.

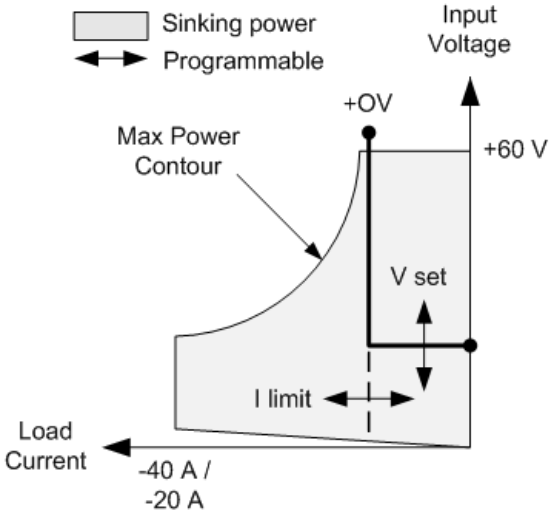


The heavy solid vertical line illustrates the locus of possible operating points as a function of the load current. A CC (constant current) status flag indicates that the load current is at the specified setting. A voltage limit is not programmable in current priority mode. Also, if the DUT imposes a voltage that is above 110% of the rated input voltage, the overvoltage protection will trip and the output will turn off.

Current may be programmed in one of two overlapping ranges, a Low range and a High range. The low range provides better programming and measurement resolution at low current settings.

Voltage Priority Mode

In this mode, the load module will attempt to sink enough current to maintain the input voltage at its programmed value.



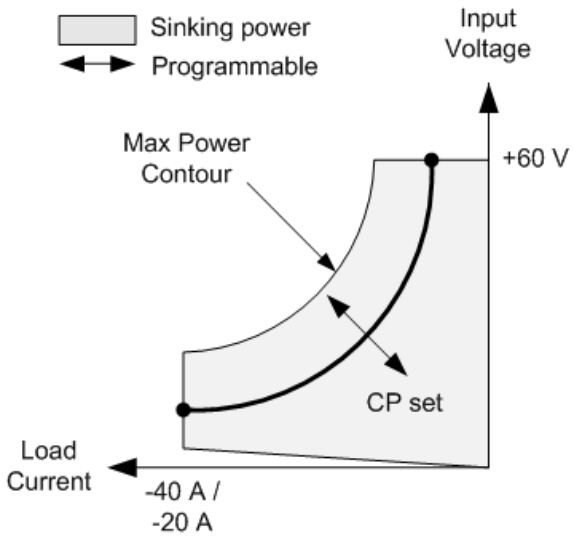
The heavy solid line illustrates the locus of possible operating points as a function of the load voltage.

Note that in voltage priority mode, a current limit can be imposed. As shown by the horizontal portion of the line, the input voltage remains regulated at its programmed setting as long as the input current remains within the current limit setting. A CV (constant voltage) status flag indicates that the input current is within the limit settings.

When the input current reaches the current limit, the unit is no longer in constant voltage operation and the input voltage is no longer held constant. Instead, the load module will now regulate the input current at its current limit setting. A CL (current limit) status flag is set to indicate that a current limit has been reached. If the input voltage increases until it exceeds 110% of the rated input voltage, the overvoltage protection will trip and the output will turn off.

Power Priority Mode

In this mode, the load module will regulate the power being drawn from the DUT according to the programmed constant-power value.



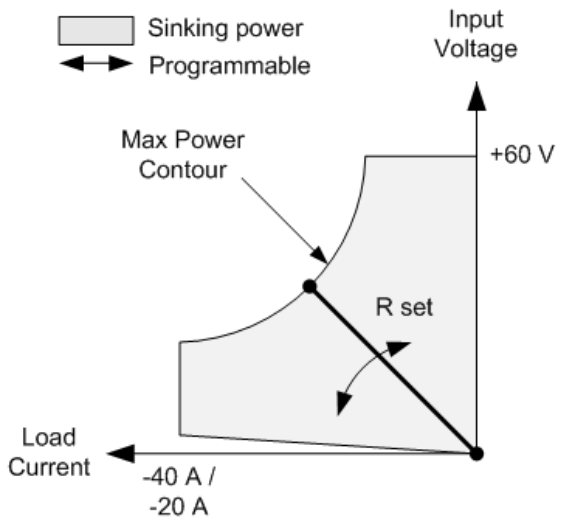
The load module regulates the input power by measuring the input voltage and current and adjusting the input power based on data streamed from the measurement ADCs.

Power may be programmed in one of two overlapping ranges, a Low range and a High range. The low range provides better programming and measurement resolution at low power settings.

The load modules have a built-in over-power protection function that will not let you exceed 110% of the power rating of the load module (the Max Power Contour).

Resistance Priority Mode

In this mode, the load module will sink current proportional to the input voltage in accordance with the programmed resistance.



The heavy solid line illustrates the locus of possible operating points as a function of the resistance.

Resistance may be programmed in one of three overlapping ranges - a Low, Medium, and a High resistance range. The lower ranges provide better programming and measurement resolution at lower resistance settings. The load module automatically selects the resistance range that best corresponds to the resistance value that you program. If the resistance value falls in a region where ranges overlap, the load selects the range with the highest resolution for the resistance value.

Advanced Measurements

Digitizing Measurements

Measurement System Bandwidth

Averaged Measurements

Current Histogram Measurements

Measurement Data Formats

Dynamic Current Measurement Control

Digitizing Measurements

The digitizing measurements discussed in this section allow you to perform most but not all of the scope measurement function available on the front panel. One example of functionality not available over the remote interface is the ability to program markers and make calculated measurements between markers.

With the digitizing measurement functions you can:

- Specify a measurement function and range.
- Adjust the measurement sample rate.
- Adjust the measurement to capture pre-trigger data.
- Select a measurement window that can attenuate AC noise.
- Select the measurement trigger source.
- Initiate the trigger system and generate a trigger.
- Retrieve the digitized measurements.

NOTE When a measurement is in progress over the remote interface, the front panel display may indicate "-- -- -- -- --". Front panel measurements resume when the remote measurement completes.

Select a Measurement Function and Range

The following commands select a measurement function. To enable voltage measurements on channels 1-4, use:

SENS:FUNC:VOLT ON,(@1:4)

To enable voltage measurements on channels 1-4, use:

SENS:FUNC:CURR ON,(@2)

If a power module has simultaneous measurements (refer to Model Differences), you can enable BOTH voltage and current measurements on the same output channel.

Some power modules also have multiple measurement ranges. Selecting a lower measurement range provides greater measurement accuracy, provided that the measurement does not exceed the range. To select the low measurement range on channel 1, use:

SENS:VOLT:RANG 5,(@1)

To select the 1 A current range on channel 1:

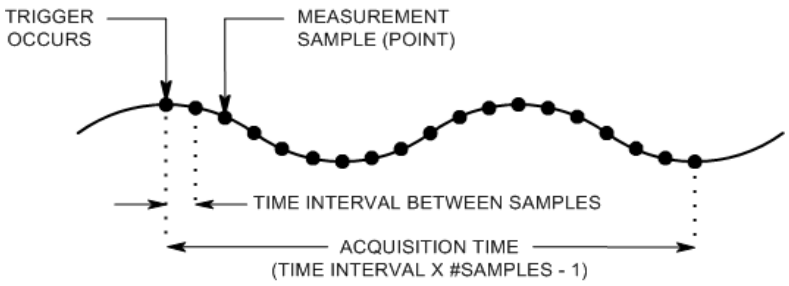
SENS:CURR:RANG 1,(@1)

Seamless Measurements - For Keysight Models N678xA SMU and with Option SMR N678xA SMU Option SMR, you can select seamless measurement autoranging, which enables a wide dynamic measurement range with no data lost when transitioning across ranges. Seamless autoranging does not include the 10 µA range, which must be selected manually. To enable seamless voltage or current autoranging on channel 1:

SENS:VOLT:RANG:AUTO ON,(@1)
SENS:CURR:RANG:AUTO ON,(@1)

Adjust the Measurement Sample Rate

The following figure illustrates the relationship between measurement samples (or points), and the time interval between samples in a typical measurement.



You can vary the measurement data sampling rate using the following commands. For example, to set the time interval to 60µs with 4096 samples, use:

SENS:SWE:TINT 60E-6,(@1)
SENS:SWE:POIN 4096,(@1)

The maximum number of sample points that are available for all measurements is 512 K points (K = 1024). If you specify a voltage measurement with 500 K points on channel 1 for example, you will only have 12 K points available for all other measurements.

Time interval values can range from 5.12 microseconds (for one parameter on Models N678xA SMU) to 40,000 seconds. Note that the shortest time interval (fastest speed) that can be specified depends on the number of parameters that are being measured, the model that is doing the measuring, and the time interval resolution. You can only measure up to 4 parameters with the time interval resolution set to 20 microseconds.

1 parameter (models N678xA SMU only)	5.12 µs
1 or 2 parameters (all models)	10.24 µs
3 or 4 parameters (all models), with 20 µs programmed resolution	20.48 µs
5 to 8 parameters (all models), with 40 µs programmed resolution	40.96 µs

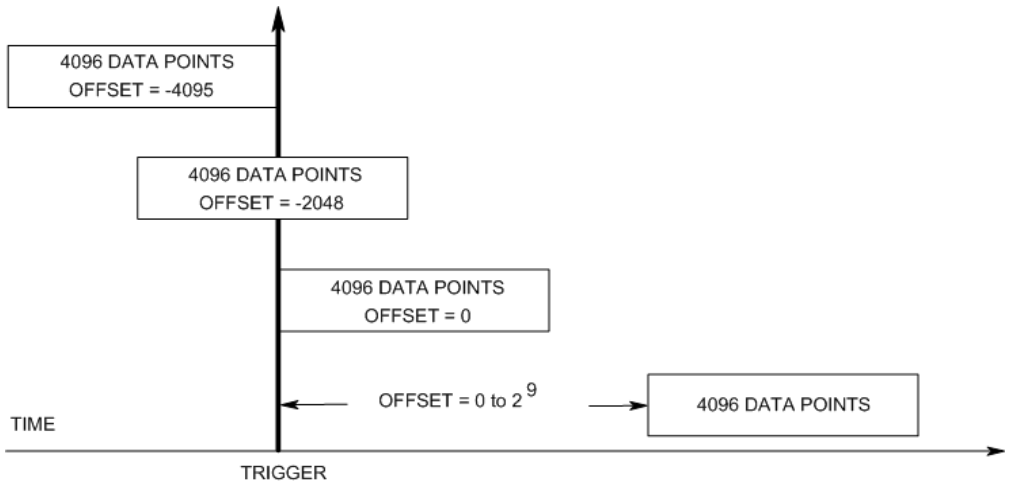
Time interval values from 10.24 up to 20.48 microseconds are rounded to the nearest 10.24-microsecond increment. Values above 20.48 microseconds are rounded to the nearest 20.48-microsecond increment when the resolution is set to RES20. Values above 40.96 microseconds are rounded to the nearest 40.96-microsecond increment when the resolution is set to RES40.

You can change the time interval resolution as follows:

SENS:SWE:TINT:RES RES20
SENS:SWE:TINT:RES RES40

Capture Pre-Trigger Data (optional)

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.



The following command offsets the beginning of the acquisition buffer relative to the trigger by 100 points on channel 1:

SENS:SWE:OFFS:POIN 100,(@1)

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.

NOTE If, during a pre-trigger data acquisition, a trigger occurs before the pre-trigger data count is completed, the measurement system ignores this trigger. This will prevent the completion of the measurement if another trigger is not generated.

Specify a Window Function

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.

To select the Hanning window function, use:

SENS:WIND HANN,(@1)

Select the Measurement 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 a TRIGger:ACQuire command to trigger the measurement, select a trigger source from the following:

BUS	Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger)
CURRent<1-4>	Triggers the measurement when the current of the corresponding output passes through the specified level.
EXTernal	Selects the trigger input BNC connector. Requires a low-true trigger signal.
PIN<1-7>	Selects a specific pin that is configured as a Trigger Input on the digital port. The selected pin must be configured as a Trigger Input in order to be used as a trigger source (see Using the Digital Port).
TRANsient<1-4>	Selects the specified output channel's transient system as the trigger source.
VOLTage<1-4>	Triggers the measurement when the voltage of the corresponding output passes through the specified level.

Use the following commands to select a trigger source. To select Bus triggers for output 1:

TRIG:ACQ:SOUR BUS,(@1)

To select Digital pin triggers, where n is the pin number that will generate the trigger:

TRIG:ACQ:SOUR PIN<n>,(@1)

To select a Transient output as trigger, where n is the output channel that will generate the trigger signal:

TRIG:ACQ:SOUR TRAN<n>,(@1)

To enable trigger signals for output Steps or Lists: (Specify if the list trigger occurs at the Beginning Of the Step, or End Of the Step.)

```
STEP:TOUT ON,(@3)
LIST:TOUT:BOST 1, (@3)
LIST:TOUT:EOST 1, (@3)
```

To select a voltage or current level of another output as the trigger for output 1: (Output 3 will generate the voltage or current level to trigger output 1.)

```
TRIG:ACQ:SOUR VOLT3,(@1)
TRIG:ACQ:SOUR CURR3,(@1)
```

To specify the voltage or current trigger level and slope of output 3:

```
TRIG:ACQ:CURR 10,(@3)
TRIG:ACQ:CURR:SLOP POS,(@3)
TRIG:ACQ:VOLT 10,(@3)
TRIG:ACQ:VOLT:SLOP POS,(@3)
```

NOTE A non-programmable hysteresis for level triggers reduces false triggering on slow signals. The hysteresis is set to 0.0005 X maximum range value. For example, on the 50 V range, the hysteresis is approximately 25 mV.

Initiate the Measurement

When the power analyzer 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 the trigger system for all four outputs:

```
INIT:ACQ (@1:4)
```

It takes a few milliseconds for the instrument to be ready to receive a trigger signal after receiving the INITiate:ACQuire command, and it can take longer for Keysight Models N678xA SMU.

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.

```
STAT:OPER:COND?(@1)
```

If a bit value of 8 is returned in the query, the WTG_meas bit is true, and the instrument is ready to receive the trigger signal. Refer to Status Tutorial for more information.

NOTE It will be necessary to initiate the measurement 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:

TRIG:ACQ (@1)

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 another output channel or an input pin on the digital port connector. If any of these systems are configured as the trigger source, the instrument will wait indefinitely for the trigger signal. If the trigger does not occur, you must abort the measurement.

To abort the measurement and return the trigger system to the Idle state:

ABOR:ACQ (@1)

Retrieve the Measurement Data

After a trigger is received and the measurement completes, the trigger system will return to the idle state. When this occurs, you can use FETCh queries to return specific voltage or current data from a previously triggered measurement. FETCh queries do not alter the data in the measurement buffer.

To return average voltage & current:
FETC:VOLT?(@1)
FETC:CURR?(@1)

To return RMS voltage & current:
FETC:VOLT:ACDC?(@1)
FETC:CURR:ACDC?(@1)

To return the high level of a pulse:
FETC:VOLT:HIGH?(@1)
FETC:CURR:HIGH?(@1)

To return the low level of a pulse:
FETC:VOLT:LOW?(@1)
FETC:CURR:LOW?(@1)

To return the maximum value:
FETC:VOLT:MAX?(@1)
FETC:CURR:MAX?(@1)

To return the minimum value:
FETC:VOLT:MIN?(@1)
FETC:CURR:MIN?(@1)

To return power:
FETC:POW?(@1)

Power can only be measured on power modules with simultaneous measurement capability (refer to Model Differences).

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. To query the MEAS_active bit (bit 5):

STAT:OPER:COND?(@1)

If a bit value of 32 is returned in the query, 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.

Use Array queries to return all data from the measurement buffer.

FETC:ARR:CURR?(@1)
FETC:ARR:VOLT?(@1)
FETC:ARR:POW?(@1)

NOTE You can specify the format of the array data. Refer to Measurement Data Formats for more information

ASCII data (the default format) is returned as comma-separated ASCII numeric voltage or current data terminated by a newline. An ASCII query can only fetch data from one channel at a time.

Binary data is returned as a comma-separated list of data for each channel requested. The data for each channel is a definite length binary block, with the byte order specified by the BORDer command.

Each FETCh command also has a corresponding MEASure command. Measure commands initiate, trigger, and return the data all in one step. Each measurement command overwrites previous data. Refer to Measure commands for more information.

Measurement System Bandwidth

NOTE The following applies when making dynamic current measurements; not when making static (or DC) measurements. This information does not apply to models N678xA SMU. For N678xA bandwidth information, refer to the Keysight N6700 Modular Power System Family Specifications Guide.

The measurement bandwidth of the power analyzer is dependent on the following factors:

- Whether voltage or current is being measured.
- Whether dynamic current correction has been turned on or off.
- The analog bandwidth of the power module.

The following table documents the bandwidth for the above-mentioned factors.

Power Module	Dynamic Current Correction	
	On	Off
	Voltage measurements	
N6751A/52A, N6761A/62A	10 kHz BW (– 3dB)	10 kHz BW (– 3dB)
N6753A–56A, N6763A–66A	N/A	10 kHz BW (– 3dB)
N673xB, N674xB, N677xA	10 kHz BW (– 3dB)	25 kHz *
	Current Measurements	
N6751A, N6752A	2 kHz BW (– 3dB)	*10 kHz BW (– 3dB)*
N6753A–N6756A	N/A	*10 kHz BW (– 3dB)*
N6761A–N6762A	2 kHz BW (– 3dB)	*2 kHz BW (– 3dB)*
N6763A–N6766A	N/A	*2 kHz BW (– 3dB)*
N673xB, N674xB, N677xA	2 kHz BW (– 3dB)	*25 kHz* *

* Note Nyquist-limited to 25 kHz due to 50 kHz digitization rate.

Note that when dynamic current correction is turned off, you will see additional current in the output current measurement as the output capacitor charges and discharges when changing from one voltage value to another voltage value.

The values in *italics* in the table will change based on the resistance of the output load. The values specified in the table only apply when the output load resistance is at or close to zero ohms. At larger resistance values, errors are introduced into the measurement due to the interaction of the output load and the power module's output capacitor. Use the following formula to calculate the largest frequency that can be measured without errors.

$$f = \frac{1}{2\pi C_O R_L}$$

f = maximum measurable frequency without measurement errors
Co = the output capacitor value (from the following table)
RL = the load resistance

Power Module	Co Value	Power Module	Co Value
N6751A, N6752A, N6761A, N6762A	25.4 µF	N6731B, N6741B	30 µF
N6753A, N6755A, N6763A, N6765A	4.7 µF	N6732B, N6742B	23.5 µF
N6754A, N6756A, N6764A, N6766A	2.2 µF	N6733B, N6743B	13.4 µF
N6773A	13.2 µF	N6734B, N6744B	9.8 µF
N6774A	11.2 µF	N6735B, N6745B	12.8 µF
N6775A	4.02 µF	N6736B, N6746B	3.52 µF
N6776A, N6777A	3.54 µF		

For example, if you are measuring the output current on a Keysight N6731B with a 10 ohm load connected to the output, and with dynamic current correction turned off, the largest frequency that can be measured without introducing measurement errors is 530 Hz. If a 1 ohm load were connected to the output, the largest frequency that could be measured without errors would be 5.3 kHz.

For frequencies above the maximum measurable frequency, the current flowing in the output capacitor causes the measured current to be greater than the actual output current by a factor of +20 dB per decade increase of frequency.

Averaged Measurements

Measurement values returned in Meter View, Scope View, and by the Data Logger are averaged. Each measurement value is an arithmetic average of all the data points in the specified sample period. The average is calculated as follows:

$$A = \frac{\sum_{i=1}^{N} x_i}{N}$$

A = the average
N = the number of data points
xi = the ith data point

The Meter View sample period depends on the number of power line cycles (NPLC) specified for each measurement sample. The sample period of the Scope View can be adjusted indirectly by using the Horizontal Time/Div knob to adjust the horizontal time base. The Data Logger sample period can be adjusted by pressing Data Logger, then Properties, and entering a value in the Sample Period field.

Note that in the Scope Marker View, you can view the average value as well as the minimum and maximum value of the sample period that is located between the two markers.

Current Histogram Measurements

NOTE The following information only applies to Keysight Models N6781A, N6782A, N6785A, and N6786A. Histogram measurements are not available if option 055 (delete data logger) has been ordered.

A current histogram measurement provides a statistical measurement for profiling the measured current. The acquisition generates an array of frequency of occurrence vs. current amplitude data that can be analyzed using a CCDF function. The value of each element represents the number of times an amplitude within the range of that element has been detected.

There are two ranges of histogram bins, a low range and a high range for each model. Each range has 4096 bins with a minimum and maximum amplitude, and a bin size (see below).

	Models N6781A/N6782A		Models N6785A/N6786A	
	Low Range	High Range	Low Range	High Range
Amplitude	–7.8 mA to +7.8 mA	–8 A to + 8 A	–15.6 mA to +15.6 mA	–16 A to + 16 A
Bin size	3.8 µA	3.9 mA	7.6 µA	7.8 µA

Both ranges are filled when the histogram runs. Measurement magnitudes that fall within the low range are automatically placed in the low-range histogram. The values for both histogram ranges can be queried as follows:

SENS:HIST:CURR:BIN:RANG? (@1)

This query returns the amplitudes of the high and low range. These amplitude limits are subsequently used by other SCPI commands when returning the histogram counts for the specified range. Programming a current histogram measurement consists of:

- Selecting the histogram function and range.
- Specifying the trigger source.
- Initiating and triggering the histogram.
- Retrieving the histogram measurement.
- Querying the histogram bin and offset to calculate amperes.

Histograms cannot be programmed from the front panel and cannot run simultaneously with any other measurement. When a histogram measurement is initiated on an output channel, the front panel changes to Meter view. Any channel that is performing a histogram measurement displays a message to this effect. Switching to Scope or Data Logger view will terminate the histogram measurement.

Select the Histogram Function and Range

The following command selects a measurement function. To enable current histogram measurements on channel 1:

SENS:HIST:FUNC:CURR ON,(@1)

Each output channel uses its own current measurement range, which includes autoranging. To select the 3 A current range on channel 1:

SENS:HIST:CURR:RANG 3,(@1)

Seamless Measurements - For Keysight Models N6781A, N6782A, N6785A, and N6786A, you can select seamless current autoranging, which results in a wide dynamic range with no data lost across ranges. Seamless ranging does not include the 10 µA range, which must be selected manually. To enable seamless current autoranging on channel 1:

SENS:HIST:CURR:RANG:AUTO ON,(@1)

Select the Histogram Trigger Source

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

BUS	Selects GPIB device trigger, *TRG, or <GET> (Group Execute Trigger).
EXTernal	Selects the trigger input BNC connector. Requires a low-true trigger signal.
IMMediate	Selects the immediate trigger source. This triggers the histogram immediately when initiated.
Pin<1-7>	Selects a specific pin that is configured as a Trigger Input on the digital port. The selected pin must be configured as a Trigger Input in order to be used as a trigger source (see Using the Digital Port).

Use the following commands to select a trigger source. To select Bus triggers for output 1:

TRIG:HIST:SOUR BUS,(@1)

To select the IMMediate trigger source for output 1:

TRIG:HIST:SOUR IMM,(@1)

To select the EXTernal trigger source for output 1:

TRIG:HIST:SOUR EXT,(@1)

To select Digital pin triggers on pin 3 for output 1:

TRIG:HIST:SOUR PIN3,(@1)

Initiate and Trigger the Histogram

When the power analyzer 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 then trigger histogram measurements on output 1:

INIT:HIST (@1)
TRIG:HIST (@1)

If the trigger source is BUS, you can also program *TRG or <GET> to trigger the histogram.

When a histogram measurement is initiated and triggered, the current is continuously sampled. Histograms sample at the rate of 20.48 microseconds per sample. Each sampled value is compared to the amplitude range of each bin of the histogram and the value of the bin that the sampled value falls within is incremented by 1. There is some overlap between the lowest bins of the high range and the highest bins of the low range; values that overlap both ranges are placed in the low range buckets. Each Fetch returns the latest cumulative histogram data. The measurement continues until it is aborted. The count bins are 64-bits wide, which eliminates any concern for overflow.

Terminate the Measurement

Measurements continue until the histogram is aborted. To abort the histogram measurement:

ABOR:HIST (@1)

Retrieve the Histogram Measurement

The following command returns the histogram counts for the 7.8 mA histogram range from output 1:

FETC:HIST:CURR? 0.0078,(@1)

The following command returns the histogram counts for the 8 A histogram range from output 1:

FETC:HIST:CURR? 8,(@1)

Histogram data is returned as 4096 comma-separated ASCI values terminated by a newline. A histogram query can only fetch data from one histogram range at a time.

Query the Histogram Bin and Offset to Calculate Amperes

The gain and offset are needed to convert a bin number to amperes. Therefore, the bin gain and offset can be queried for each histogram range. For example, to query the gain and offset value for the 3.9 mA histogram range, use:

SENS:HIST:CURR:BIN:GAIN? 0.0078,(@1)
SENS:HIST:CURR:BIN:OFFS? 0.0078,(@1)

To query the gain and offset value for the 8 A histogram range, use:

SENS:HIST:CURR:BIN:GAIN? 8,(@1)
SENS:HIST:CURR:BIN:OFFS? 8,(@1)

The median current in amperes of a bin can then be calculated using:

current = (bin number) x gain + offset

where (bin number) is an integer between 0 and 4095 corresponding to the 4096 counts returned by FETC:HIST:CURR? Because the current measurements can be positive or negative, bin 0 represents the most negative current, bin 2048 represents 0, and bin 4095 is the most positive current.

Measurement Data Formats

The default data format for measurement queries is ASCII. You can also specify Real data format when returning SCPI array and external datalog measurements as well as for setting and querying constant-dwell Arb levels.

ASCII - Numeric data is transferred as ASCII bytes in <NR1>, <NR2>, or <NR3> format as appropriate. The numbers are separated by commas.

Real - Data is returned in binary IEEE single precision floating point. In this case the four bytes of each value can be returned in either big-endian or little-endian byte order, determined by the FORMat:BORDer setting.

The following command specifies the data format:

FORM ASCII | REAL

You can also specify how binary data is transferred. This only applies when the FORMat:DATA is set to REAL

Normal - Binary data is transferred in normal order. The most significant byte is returned first, and the least significant byte is returned last (big-endian).

Swapped - Binary data is transferred in swapped-byte order. The least significant byte is returned first, and the most significant byte is returned last (little-endian).

The following command specifies the byte order of the data:

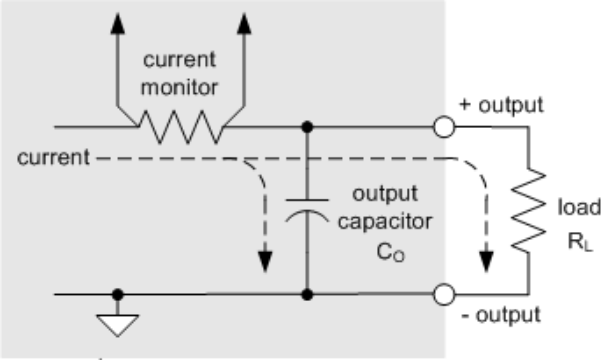
FORM:BORD NORM | SWAP

Use swapped format if you are using a little-endian data processor.

Dynamic Current Measurement Control

NOTE This control is used when making dynamic current measurements; it is not required for static (or dc) measurements. On Models N678xA SMU, N6753A - N6756A, and N6763A - N6766A, the designs are such that dynamic current correction is not needed and the control is therefore unavailable.

The power analyzer measures the output current across an internal current monitor. For most power modules this current monitor is located on the inboard side of the output capacitor.



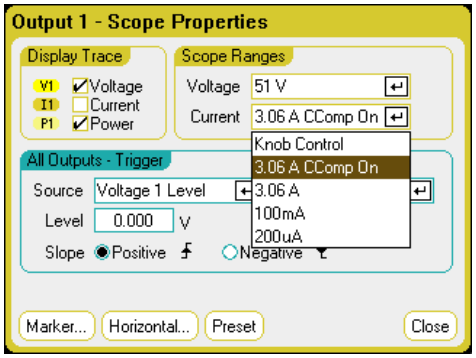
For static (or dc) measurement applications this measurement method yields accurate measurements. However, due to the output capacitor C0, when there is a significant and rapid change in output voltage, the additional output current does not all flow into load RL; some of it flows through the output capacitor. In this momentary situation the measurement circuit is not only measuring the output current going into the load, but also the output current flowing through the output capacitor. Since the load never sees the additional current, this results in an inaccurate output current measurement.

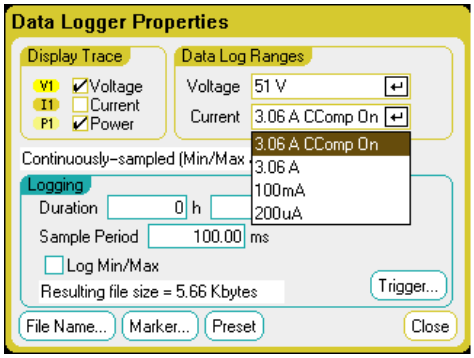
When the output current is measured and averaged over a number of samples as in the case of static measurements, the inaccuracy is insignificant. However, with the power analyzer's scope and data logging functions, which capture thousands of measurement samples per second, this inaccuracy becomes evident.

Dynamic current correction compensates for the current flowing into the output capacitor. The power analyzer calculates what the additional current is and subtracts it from the current measurement, thus providing accurate output current measurements. This feature is turned on by default and only applies to the high current range.

NOTE Dynamic current correction increases the peak to peak noise in current measurements on some power modules. It may also limit the measurement bandwidth as explained in the next section. If either condition is a significant factor in your application, you should turn dynamic current correction off.

To turn dynamic current correction on or off, press Scope View or Data Logger, then press Properties. In the current range dropdown box, select the range labeled "CComp On" to turn current correction on. Un-select the "CComp On" range to turn current correction off.


Output 1 - Scope Properties
Display Trace
V1 Voltage
I1 Current
P1 Power
Scope Ranges
Voltage 51 V
Current 3.06 A CComp On
Knob Control
3.06 A CComp On
3.06 A
100mA
200uA
All Outputs - Trigger
Source Voltage 1 Level
Level 0.000 V
Slope Positive Negative
Marker...
Horizontal...
Preset
Close


Data Logger Properties
Display Trace
V1 Voltage
I1 Current
P1 Power
Data Log Ranges
Voltage 51 V
Current 3.06 A CComp On
3.06 A CComp On
3.06 A
100mA
200uA
Continuously-sampled (Min/Max
Logging
Duration 0 h
Sample Period 100.00 ms
Log Min/Max
Resulting file size = 5.66 Kbytes
Trigger...
File Name...
Marker...
Preset
Close

Using the Digital Control Port

Bi-directional Digital IO

Digital Input

Fault Output

Inhibit Input

Fault/Inhibit System Protection

Trigger Input

Trigger Output

Output Couple Controls

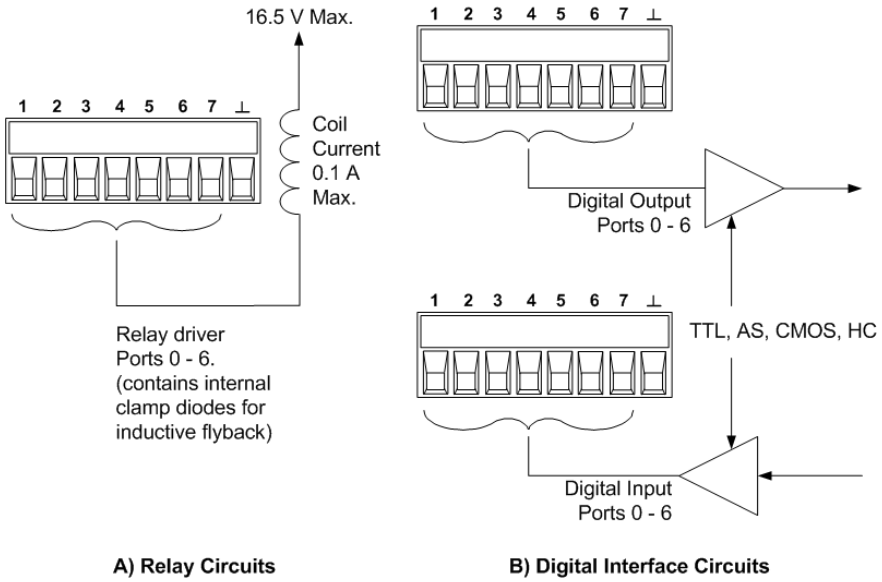
A Digital Control Port consisting of seven I/O pins is provided to access various control functions. Each pin is user-configurable. The following control functions are available for the I/O pins:

Bi-directional Digital IO

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:

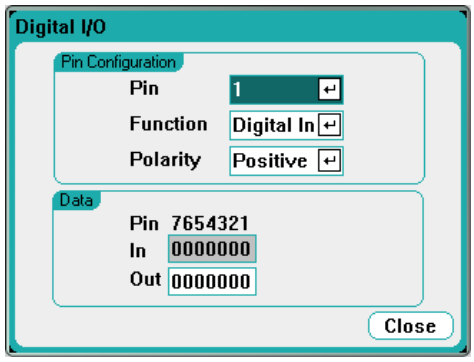
Pins	7	6	5	4	3	2	1
Bit weight	6 (msb)	5	4	3	2	1	0 (lsb)

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.



From the front panel:

To configure the bi-directional digital I/O, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter.



Select the pin you wish to configure from the Pin dropdown list.

Select the Digital I/O function from the Function dropdown list. Select and program the remaining pins in the same manner.

Configure the polarity for each pin by selecting the Polarity dropdown menu. Select either Positive or Negative. Select and program the remaining pins in the same manner.

The Data fields only apply to the Digital I/O and Digital In functions. Enter the binary word into the Out field of the Digital I/O window. The In field reflects the condition of the external signal that is applied to the pins.

From the remote interface:

To configure the digital I/O function for pins 1 through 4:

```
DIG:PIN1:FUNC POS
DIG:PIN2:FUNC POS
```

DIG:PIN3:FUNC POS
DIG:PIN4:FUNC POS

To configure the pin polarity to positive for pins 1 through 4:

DIG:PIN1:POL POS
DIG:PIN2:POL POS
DIG:PIN3:POL POS
DIG:PIN4:POL POS

To send a binary weighted value 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 ground reference for the input pins is Signal Common on pin 8.

From the front panel;

To configure the digital input function, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter. The Digital I/O window will appear as previously shown under Bi-directional Digital I/O.

Select the pin you wish to configure from the Pin dropdown list.

Select the Digital In function from the Function dropdown list. Select and program the remaining pins in the same manner.

Configure the polarity for each pin by selecting the Polarity dropdown menu. Select either Positive or Negative. Select and program the remaining pins in the same manner.

The Data fields only apply to the Digital I/O and Digital In functions. The In field reflects the condition of the external signal that is applied to the pins. The pin state is not affected by the value of the binary output word.

From the remote interface:

To configure the pin function:

DIG:PIN1:FUNC DINP

To select the pin polarity:

DIG:PIN1:POL POS
DIG:PIN1:POL NEG

To read the pin data:

DIG:INP:DATA?

Fault Output

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

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. Note that the Fault output signal remains latched until the fault condition is removed and the protection circuit is cleared. as explained under under Clearing Protection Functions.

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

From the front panel:

To configure the digital input function, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter. The Digital I/O window will appear as previously shown under Bi-directional Digital I/O.

Select pin 1 from the Pin dropdown list.

Select the Fault Out function for the pin the from the Function dropdown list.

Configure the polarity for the pin by selecting the Polarity dropdown menu. Select either Positive or Negative.

From the remote interface:

To configure the pin function:

DIG:PIN1:FUNC FAUL

To select the pin polarity:

DIG:PIN1:POL POS
DIG:PIN1:POL NEG

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 all the output channels in the mainframe. The polarity of pin 3 can also be configured. 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.

From the front panel:

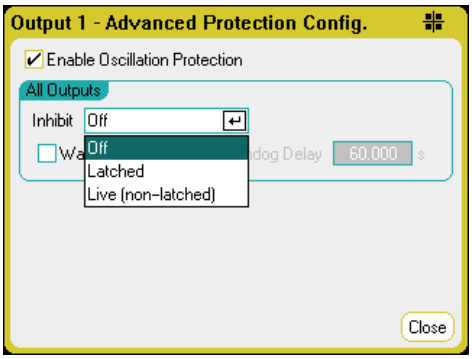
To configure the digital input function, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter. The Digital I/O window will appear as previously shown under Bi-directional Digital I/O.

Select pin 3 from the Pin dropdown list.

Select the Inhibit In function for the pin the from the Function dropdown list.

Configure the polarity for the pin by selecting the Polarity dropdown menu. Select either Positive or Negative

Next, you must configure the Inhibit Input mode. Press the Settings key to access the Source Settings window. Navigate to and select Protection, then Advanced. Then press Enter.



From the remote interface:

To select the Inhibit function:

DIG:PIN1:FUNC INH

To select the pin polarity:

DIG:PIN1:POL POS
DIG:PIN1:POL NEG

To set Inhibit mode to Latching:

OUTP:INH:MODE LATC

To set Inhibit mode to Live:

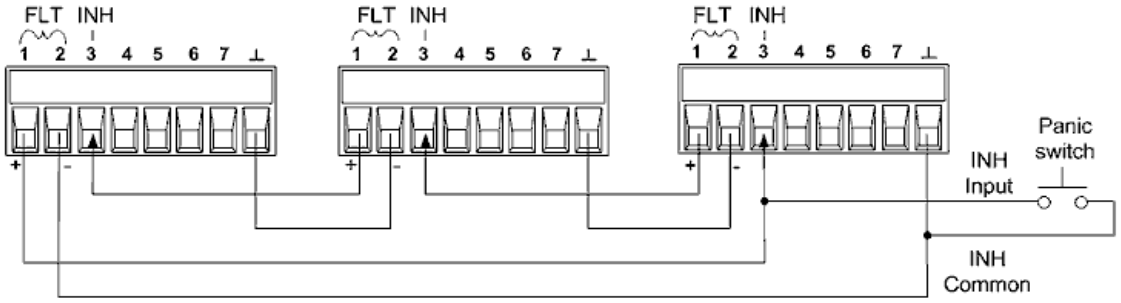
OUTP:INH:MODE LIVE

To disable the Inhibit signal:

OUTP:INH:MODE OFF

Fault/Inhibit System Protection

The following figure illustrates some ways that you can connect the Fault/Inhibit pins of the connector.



As shown in the 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.

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 user-definable 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.

Trigger Input

Any of the Digital Control pins can be programmed to function as a trigger input. All pins are referenced to the Signal Common pin.

To input an external trigger signal, 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 2

microseconds. The pin's polarity setting determines which edge generates a trigger-in event. Positive means a rising edge and Negative means a falling edge.

You can configure the scope, the data logger, and the arbitrary waveform generator to be triggered by external trigger signals. Simply select BNC Trigger In as the trigger source when configuring the scope, data logger, or arbitrary waveform generator. This will enable input trigger signals on the configured digital pins as well as on the BNC trigger input connector. A trigger is generated when an external signal that meets the signal criteria is applied to any configured trigger input pin or to the BNC connector.

From the front panel:

To configure the trigger input function, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter. The Digital I/O window will appear as previously shown under Bi-directional Digital I/O.

Select the pin you wish to configure from the Pin dropdown list.

Select the Trigger In function for the pin the from the Function dropdown list.

Configure the polarity for the pin by selecting the Polarity dropdown menu. Select either Positive or Negative.

From the remote interface:

To select the trigger input function:

DIG:PIN1:FUNC TOUT

To select the pin polarity:

DIG:PIN1:POL POS
DIG:PIN1:POL NEG

Trigger Output

Any of the Digital Control pins can be programmed to function as a trigger output. All pins are referenced to the Signal Common pin.

When configured as a trigger output, the designated trigger pin will generate a 10-microsecond trigger pulse in response to a trigger event. The polarity setting can be either positive-going (rising edge) or negative-going (falling edge) when referenced to common.

Trigger out signals can be generated when configuring User-defined voltage or current arbitrary waveforms. If you check the Trigger box when configuring the User-defined arbitrary waveform, an output trigger signal will be generated on the configured digital pin as well as on the BNC trigger output connector at the start of the voltage or current step.

From the remote interface:

To select the trigger input function:

DIG:PIN1:FUNC TINP

To select the pin polarity:

DIG:PIN1:POL POS
DIG:PIN1:POL NEG

Output Couple Controls

This function lets you connect multiple Keysight N6705 mainframes together and synchronize the output on/off sequence across mainframes. Each mainframe that will be synchronized must have at least one coupled output.

1. Configure the outputs on each mainframe as described under Configuring an Output Turn-On/Turn-Off Sequence. Set the output coupling Mode to Manual.
2. Set the delay offset of each individual mainframe to match the longest delay offset of the main-frame group.
3. Connect and configure the digital connector pins of the synchronized mainframes as described in this section.

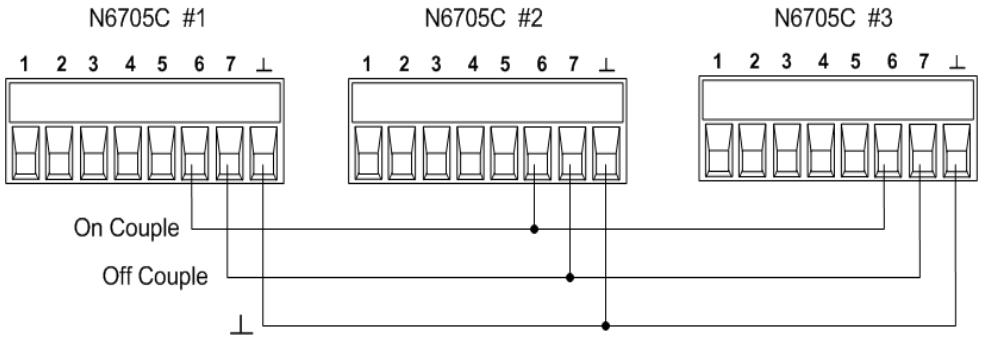
NOTE

All synchronized N6705 mainframes must have the same firmware revision. Only pins 4 through 7 can be configured as synchronization pins. You cannot configure more than one On Couple and one Off Couple pin per mainframe.

The polarity of the pins is not programmable; it is set to Negative

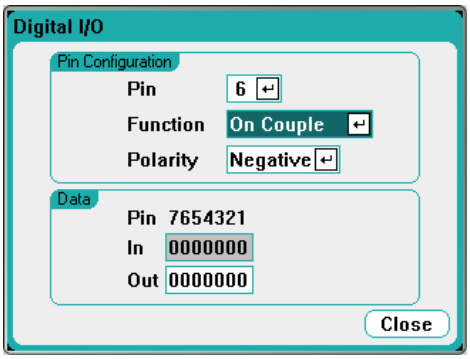
The digital connector pins of the synchronized mainframes that contain coupled outputs must be connected together as shown in the following figure. In this example, pin 6 will be configured as the output On control. Pin 7 will be configured as the output Off control. The ground or Common pins also need to be connected together.

Only two of the digital connector pins on each mainframe can be configured as “On Couple” and “Off Couple” on each synchronized mainframe. The designated pins will function as both an input and an output, with a negative transition on one pin providing the synchronization signal to the other pins.



From the front panel:

To configure the trigger input function, press the Menu key, scroll down and select the Utilities item, then select Digital I/O. Then press Enter.



Select pin 6 from the Pin dropdown list. Then select the On Couple function for the pin the from the Function dropdown list.

Select pin 7 from the Pin dropdown list. Then select the Off Couple function for the pin the from the Function dropdown list.

Repeat these steps for mainframes #2 and #3.

From the remote interface:

To configure pin 6 of mainframe #1 as the ON control:

```
DIG:PIN6:FUNC ONC
```

To configure pin 7 of mainframe #1 as the OFF control:

```
DIG:PIN7:FUNC OFFC
```

Repeat these commands for mainframes #2 and #3.

Operation

Once configured and enabled, turning the output on or off on any coupled output will cause all coupled outputs on all configured mainframes to turn on or off according to their user-programmed delays. This applies to the front panel On and Off keys, the Web server, and to SCPI commands.

Turning the outputs on or off using the front panel All Outputs On and Off keys will cause all coupled outputs as well as non-coupled outputs on that mainframe to turn on or off.

7 SCPI Programming Reference

Related Information

Introduction to the SCPI Language

Commands by Subsystem

Status Tutorial

Reset and Non-volatile Settings

SCPI Error Messages

Compatibility with N6705A and N6705B

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.

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.

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.

N6705C Documentation

You can download the latest version of this document at www.keysight.com/find/n6705c.

Web Interface

The N6705C provides a Web interface that is built into the instrument. You can use this interface over LAN for remote access and control of the instrument via a Web browser. See Using the Web Interface for details.

Introduction to the SCPI Language

Command Types

Keywords

Queries

Coupled Commands

Command Separators and Terminators

Syntax Conventions

Parameter Types

Device Clear

Command Types

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

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

IEEE 488.2 Common commands are defined by the IEEE 488.2 standard to perform common interface functions such as reset, status, and synchronization. All common commands consist of a three-letter mnemonic preceded by an asterisk: *RST *IDN? *SRE 8.

Subsystem commands perform specific instrument functions. They can be a single command or a group of commands. The groups are comprised of commands that extend one or more levels below the root. Subsystem commands are arranged alphabetically according to the function they perform. The following figure shows a portion of a subsystem command tree, from which you access the commands located along the various paths. Some [optional] commands have been included for clarity

```
OUTPut
      [:STATe] OFF|0|ON|1,(@1)
      :INHibit
            :MODE OFF
      :PROTection
            :CLEar (@1)
```

Keywords

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

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

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

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

Queries

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

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

```
VOLTage? (@1)
```

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

```
VOLTage? MIN,(@1)
VOLTage? MAX,(@1)
```

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.

Coupled Commands

When commands are coupled it means that the value sent by one command is affected by the settings of another command. The following commands are coupled:

[SOURce:]CURRent and [SOURce:]CURRent:RANGe.

[SOURce:]VOLTage and [SOURce:]VOLTage:RANGe.

If a range command is sent that places an output on a range with a lower maximum setting than the present level, an error is generated. This also occurs if a level is programmed with a value too large for the present range.

These types of errors can be avoided by sending the both level and range commands as a set, in the same SCPI message. For example,

```
CURRent 10,(@1);CURRent:RANGe 10,(@1)<NL>
```

will always be correct because the commands are not executed until the message terminator is received. Because the range and setting information is received as a set, no range/setting conflict occurs.

Command Separators and Terminators

Separators

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

```
FETCh:CURRent? [<start_index>, <points>,] (@1)
```

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,(@1);PON:STATe RST
```

is the same as sending the following commands:

```
OUTPut ON,(@1)
OUTPut:PON:STATe RST
```

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

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

```
OUTPut:PROTection:CLEar (@1);:STATus:OPERation:CONDition? (@1)
```

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

Terminators

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

Syntax Conventions

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

Channel Parameter

The channel parameter <chanlist> is required to address one or more channels. It has the following syntax:

(@<channel> [,<channel>][,<channel>][,<channel>])

You can also specify a range of sequential channels as follows:

(@<start_channel>:<end_channel>)

For example, (@2) specifies channel 2 and (@1:3) specifies channels 1 through 3. The channel list, shown as <chanlist> throughout this document, must be preceded with the @ symbol and must be enclosed in parentheses (). A maximum of 4 channels may be specified through a combination of single channels and ranges. Query results are channel list order-sensitive. Results are returned in the order they are specified in the list.

NOTE When adding a channel list parameter to a query, you must include a space character between the query indicator (?) and the channel list parameter. Otherwise error –103, Invalid separator will occur.

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,(@1)
```

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

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

Discrete Parameters

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

```
VOLTage:MODE FIXed|STEP,(@1)
```

Boolean Parameters

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

```
OUTput OFF|0|ON|1,(@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",(@1)
```

Device Clear

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

Device Clear performs the following actions:

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

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

Commands by Subsystem

Abort

ARB

Calibrate

Current

Digital

Display

Fetch

Format

Function

Hcopy

IEEE 488.2 Common

Initiate

List

LXI

Measure

Memory

Output

Power

Resistance

Sense

Status

Step

System

Trigger

Voltage

Abort Commands

Abort commands cancel any pending triggered actions. They return the specified trigger system back to the Idle state.

ABORt:ACQuire (@<chanlist>)
ABORt:DLOG
ABORt:ELOG (@<chanlist>)
ABORt:HISTogram (@<chanlist>) N6781A, N6782A N6785A, N6786A
ABORt:TRANsient (@<chanlist>)

ABORt:ACQuire - Cancels any triggered measurements. It also resets the WTG-meas bit in the Condition Status register.

ABORt:DLOG - Stops internal data logging.

ABORt:ELOG - Stops external data logging.

ABORt:HISTogram - Stops the histogram current measurement.

ABORt:TRANsient - Cancels any triggered actions. It also resets the WTG-tran bit in the Operation Condition Status register.

Parameter	Typical Return
(none)	(none)
Cancel the measurement: ABOR:ACQ (@1) Stop the internal data log: ABOR:DLOG Stop the external data log: ABOR:ELOG (@1) Cancel the histogram measurement: ABOR:HIST (@1) Cancel the triggered action: ABOR:TRAN (@1)	

- ABORt:ACQuire and ABORt:TRANsient are also executed at power-on and upon execution of the *RST 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.

ARB Commands

ARB commands program the arbitrary waveform generator. They program pre-defined, user-defined, and sequenced waveforms.

Constant-Dwell

Exponential

Pulse

Ramp

Sinusoid

Staircase

Step

Trapezoid

User-Defined

ARB Sequence

[SOURce:]ARB:COUNt <*value*>, (@<chanlist>)
[SOURce:]ARB:COUNt? [MIN|MAX,] (@<chanlist>)

Sets the number of times that the arbitrary waveform is repeated. The repeat count range is 1 through >16 million. For constant-dwell Arbs only, the maximum count is limited to 256.

Parameter	Typical Return
1 – 16,777,216 |MIN|MAX|INFinity, *RST 1	<Arb count>
Sets the Arb count to 10: ARB:COUN 10, (@1)	

- Use the INFinity parameter to repeat the arbitrary waveform continuously. If MAX, or a value greater than 16,777,216 is programmed, the Arb will also repeat continuously.
- Use ABORt:TRANsient to stop the Arb at any time. When the Arb is aborted, the output returns to the settings that were in effect before the Arb started.
- If a count of 9.9E37 is returned, it means that the Arb is set to repeat continuously.

[SOURce:]ARB:CURRent:CONVert (@<chanlist>)
[SOURce:]ARB:VOLTage:CONVert (@<chanlist>)
[SOURce:]ARB:POWer:CONVert (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:CONVert (@<chanlist>) N679xA

Converts the specified arbitrary waveform to a list of points in the user-defined current, voltage, power, or resistance Arb types. This makes it possible to modify/edit one of the "standard" arbitrary

waveforms. The command performs the same function as the "Edit Points" button on the front panel ARB Properties dialog windows.

To use this command you must first specify an Arb shape and type using the ARB:FUNCtion:SHAPe and the ARB:FUNCtion:TYPE commands.

Parameter	Typical Return
(none)	(none)
The following commands convert the ARB previously specified on channel 1: ARB:CURR:CONV (@1) ARB:VOLT:CONV (@1) ARB:POW:CONV (@1) ARB:RESISTANCE:CONV (@1)	

- If the Arb function is set to User-Defined or None, the command is ignored.

[SOURce:]ARB:FUNCtion:SHAPe <function>, (@<chanlist>)
[SOURce:]ARB:FUNCtion:SHAPe? (@<chanlist>)

NOTE This command replaces the previous ARB:FUNCtion command and should be used in new applications. ARB:FUNCtion is used for backward compatibility.

Sets the function of the arbitrary waveform generator as follows:

STEP	Specifies a step
RAMP	Specifies a ramp
STAircase	Specifies a staircase
SINusoid	Specifies a sine wave
PULSe	Specifies a pulse
TRAPezoid	Specifies a trapezoid
EXPonential	Specifies a exponential waveform
UDEFined	Specifies a user-defined waveform
CDWell	Specifies a constant-dwell waveform
SEQuence	Specifies a sequence of arbitrary waveforms
NONE	Specifies no arbitrary waveform

Parameter	Typical Return
STEP | RAMP | STAircase | SINusoid | PULSe | TRAPezoid | EXPonential | UDEFined | CDWell | SEQuence |NONE, *RST NONE	STEP, RAMP, STA, SIN, PULS, TRAP, EXP, or UDEF.
Specify a step on channel 1: ARB:FUNC:SHAP STEP, (@1)	

- Select the VOLTage:MODE Arb parameter to enable the instrument to generate arbitrary voltage waveforms when the transient system is initiated and triggered.
- Select the CURRent:MODE Arb parameter to enable the instrument to generate arbitrary current waveforms when the transient system is initiated and triggered.
- Select the POWer:MODE Arb parameter to enable the instrument to generate arbitrary power waveforms when the transient system is initiated and triggered.
- Select the RESISTANCE:MODE Arb parameter to enable the instrument to generate arbitrary resistance waveforms when the transient system is initiated and triggered.

[SOURce:]ARB:FUNCtion:TYPE <type>, (@<chanlist>)
[SOURce:]ARB:FUNCtion:TYPE? (@<chanlist>)

NOTE This command replaces the previous ARB:FUNCtion command and should be used in new applications. ARB:FUNCtion is still available for backward compatibility.

Selects either a current, voltage, power, or resistance Arb. Only one type of Arb may be output at a time.

Parameter	Typical Return
CURRent|VOLTage|POWer|RESISTANCE, *RST VOLTage	<type>
Specify an Arb type on channel 1: ARB:FUNC:TYPE CURR, (@1)	

- Power and resistance Arb types only apply to load modules N679xA.

[SOURce:]ARB:TERMinate:LAST <Bool>, (@<chanlist>)
[SOURce:]ARB:TERMinate:LAST? (@<chanlist>)

Determines the output value when the ARB terminates. The state is either ON (1) or OFF (0).

When ON	The output remains at the last Arb sequence value. The last voltage resistance, or current Arb value becomes the IMMediate value when the Arb completes.
When OFF	The output returns to the settings in effect before the Arb started. This also applies when the Arb is aborted,

Parameter	Typical Return
0|OFF|1|ON, *RST Off	0 or 1
Sets the ARB to terminate with the voltage, resistance, or current set at the last Arb value: ARB:TERM:LAST ON,(@1)	

- The query returns 0 if the output returns to the settings that were in effect before the Arb started, and 1 if the output remains at the last Arb value.

Constant-Dwell (CD)

Back to ARB Commands

[SOURce:]ARB:CURRent:CDWell[:LEVel] <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:CURRent:CDWell[:LEVel]? (@<chanlist>)
[SOURce:]ARB:VOLTage:CDWell[:LEVel] <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:VOLTage:CDWell[:LEVel]? (@<chanlist>)
[SOURce:]ARB:POWer:CDWell[:LEVel] <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:POWer:CDWell[:LEVel]? (@<chanlist>)
[SOURce:]ARB:RESISTANCE:CDWell[:LEVel] <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:CDWell[:LEVel]? (@<chanlist>)

Specifies the level of each current, voltage, or resistance point in a constant-dwell Arb.

You can only program one constant-dwell Arb type at a time, so setting the current CD Arb resets the voltage, power, and resistance Arbs to 1 point at the minimum value. A comma-delimited list of up to 65,535 points may be programmed.

Parameter	Typical Return
Current: 0 - maximum Voltage: 0 - maximum Power: 0 - maximum Resistance: 0 - maximum Values are range and module-rating dependent. *RST 1 point set to the minimum value.	<value> [,<value>] or <block> [,<block>]
Program five current points: ARB:CURR:CDW 5,4,3,2,1,(@1) Program five voltage points: ARB:VOLT:CDW 20,21,22,23,24,(@1) Program five power points: ARB:POW:CDW 10,20,30,40,50,(@1) Program five resistance points: ARB:RESISTANCE:CDW 50,100,500,100,50,(@1)	

- For better performance, the list of points can be sent as a definite length binary block instead of an ASCII list.
- 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. Only one channel can be queried when the format is ASCII. When the data format is set to REAL, data is returned as single precision floating point numbers in definite length arbitrary block response format. Each block contains all the records for one of the channels given in the <chanlist> parameter. If multiple channels are given, then each definite length arbitrary block of data is separated by a comma.

[SOURce:]ARB:CURRent:CDWell:DWELl <*value*>,(@<chanlist>)
[SOURce:]ARB:CURRent:CDWell:DWELl? (@<chanlist>)
[SOURce:]ARB:VOLTage:CDWell:DWELl <*value*>,(@<chanlist>)
[SOURce:]ARB:VOLTage:CDWell:DWELl? (@<chanlist>)
[SOURce:]ARB:POWer:CDWell:DWELl <*value*>,(@<chanlist>) N679xA
[SOURce:]ARB:POWer:CDWell:DWELl? (@<chanlist>)
[SOURce:]ARB:RESISTANCE:CDWell:DWELl <*value*>,(@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:CDWell:DWELl? (@<chanlist>)

Specifies the dwell time in seconds for each current, voltage, power, or resistance point in a constant-dwell Arb

You can only program one constant-dwell Arb type at a time, so setting the current CD Arb resets the voltage, power, and resistance Arbs to 1 point at the minimum value. Programmed values can range from 10.24 microseconds to 0.30 seconds. Values are rounded to the nearest 10.24-microsecond increment.

Parameter	Typical Return
0.00001024 - 0.30, *RST 0.001	<dwell value>
Program a constant-dwell current time: ARB:CURR:CDW:DWEL 0.2,(@1) Program a constant-dwell voltage time: ARB:VOLT:CDW:DWEL 0.5,(@1) Program a constant-dwell power time: ARB:POW:CDW:DWEL 5,(@1) Program a constant-dwell resistance time: ARB:RESISTANCE:CDW:DWEL 2,(@1)	

- The maximum repeat count for CD Arbs is 256. See [SOURce:]ARB:COUNt.

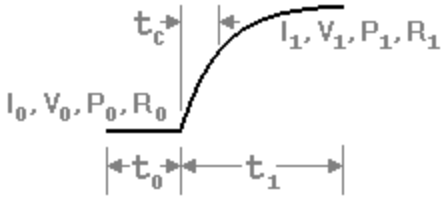
[SOURce:]ARB:CURRent:CDWell:POINts? (@<chanlist>)
[SOURce:]ARB:VOLTage:CDWell:POINts? (@<chanlist>)
[SOURce:]ARB:POWer:CDWell:POINts? (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:CDWell:POINts? (@<chanlist>) N679xA

Returns the number of current, voltage, or resistance points in a constant-dwell Arb in the form +n.nnnnnnE+nn.

Parameter	Typical Return
(none)	<number of points>
Program a constant-dwell time of 0.2 seconds: ARB:CURR:CDW:DWEL 0.2,(@1) ARB:VOLT:CDW:DWEL 0.2,(@1) ARB:POW:CDW:DWEL 0.2,(@1) ARB:RESISTANCE:CDW:DWEL 0.2,(@1)	

Exponential

Back to ARB Commands

Arb Type	
Exponential	

[SOURce:]ARB:CURRent:EXPonential:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:EXPonential:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:EXPonential:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:EXPonential:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:EXPonential:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:EXPonential:END[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level after the exponential waveform ends. Referenced to I1, V1, P1, and R1 in the Exponential diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level after the exponential waveform ends for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<end value>
Step 0 - 99, *RST 0	(none)

Parameter	Typical Return
Programs an end level current: ARB:CURR:EXP:END 1,(@1) Programs an end level voltage: ARB:VOLT:EXP:END 20,(@1) Programs an end levelpower: ARB:POW:EXP:END 50,(@1) Programs an end level resistance: ARB:RESISTANCE:EXP:END 100,(@1) Programs an end current for step 0: ARB:SEQ:STEP:CURR:EXP:END 1, 0,(@1)	

[SOURce:]ARB:CURRent:EXPonential:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:EXPonential:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:EXPonential:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:EXPonential:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:EXPonential:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:EXPonential:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level when the exponential waveform starts. Referenced to I0, V0, P0, and R0 in the Exponential diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level after the exponential waveform ends for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start level current: ARB:CURR:EXP:STAR 0,(@1) Programs a start level voltage: ARB:VOLT:EXP:STAR 0,(@1) Programs a start level power: ARB:POW:EXP:STAR 0,(@1) Programs a start level resistance: ARB:RESISTANCE:EXP:END 50,(@1) Programs a start current for step 0: ARB:SEQ:STEP:CURR:EXP:STAR 0, 0,(@1)	

[SOURce:]ARB:CURRent:EXPonential:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:EXPonential:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:EXPonential:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:EXPonential:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:EXPonential:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:EXPonential:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the exponential waveform occurs. Referenced to t0 in the Exponential diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the exponential waveform occurs for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current Arb: ARB:CURR:EXP:STAR:TIM 1,(@1) Programs a start time for the voltage Arb: ARB:VOLT:EXP:STAR:TIM 1,(@1) Programs a start time for the power Arb: ARB:POW:EXP:STAR:TIM 1,(@1) Programs a start time for the resistance Arb: ARB:RESISTANCE:EXP:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEQ:STEP:CURR:EXP:STAR:TIM 1, 0,(@1)	

[SOURce:]ARB:CURRent:EXPonential:TCONstant <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:EXPonential:TCONstant? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:TCONstant <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:TCONstant? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:EXPonential:TCONstant <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:EXPonential:TCONstant? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:EXPonential:TCONstant <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:EXPonential:TCONstant? [MIN|MAX,] (@<chanlist>)

Specifies the time constant of the exponential curve. Referenced to tc in the Exponential diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:TCONstant <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:TCONstant ? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:TCONstant <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:TCONstant ? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:TCONstant <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:TCONstant ? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:TCONstant <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:TCONstant ? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time constant of the exponential curve for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 1	<time constant>
Step 0 - 99, *RST 0	(none)
Programs a time constant for the current Arb: ARB:CURR:EXP:TCON 5,(@1) Programs a time constant for the voltage Arb: ARB:VOLT:EXP:TCON 5,(@1) Programs a time constant for the power Arb: ARB:POW:EXP:TCON 5,(@1) Programs a time constant for the resistance Arb: ARB:RESISTANCE:EXP:TCON 5,(@1) Programs a time constant for step 0: ARB:SEQ:STEP:CURR:EXP:TCON 5, 0,(@1)	

[SOURce:]ARB:CURRent:EXPonential:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:EXPonential:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:EXPonential:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:EXPonential:TIMe <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:EXPonential:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:EXPonential:TIMe <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:EXPonential:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the total time for the current, voltage, power, or resistance to go from the starting level to the ending level in seconds. Referenced to t1 in the Exponential diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:EXPonential:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:TIMe<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:EXPonential:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:EXPonential:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:EXPonential:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

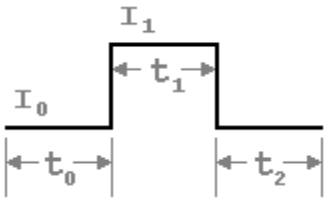
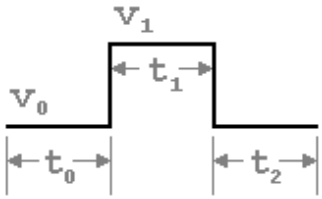
Specifies the total time for the current, voltage, power, or resistance to go from the starting level to the ending level in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<total time>

Parameter	Typical Return
Step 0 - 99, *RST 0	(none)
Programs the total time for the current Arb: ARB:CURR:EXP:TIM 10,(@1) Programs the total time for the voltage Arb: ARB:VOLT:EXP:TIM 10,(@1) Programs the total time for the power Arb: ARB:POW:EXP:TIM 10,(@1) Programs the total time for the resistance Arb: ARB:RESISTANCE:EXP:TIM 10,(@1) Programs the total time for step 0: ARB:SEQ:STEP:CURR:EXP:TIM 10, 0,(@1)	

Pulse

Back to ARB Commands

Arb Type	Current	Voltage
Pulse		

[SOURce:]ARB:CURRent:PULSe:END:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:END:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:END:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time in seconds, after the pulse completes, that the starting current, voltage, power, or resistance level persists. Referenced to t2 in the Pulse diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:END:TIMe<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:END:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:END:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time in seconds, after the pulse completes, that the starting current, voltage, power, or resistance level persists for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<end time>
Step 0 - 99, *RST 0	(none)
Programs an end time for the current pulse: ARB:CURR:PULS:END:TIM 2,(@1) Programs an end time for the voltage pulse:ARB:VOLT:PULS:END:TIM 2,(@1) Programs an end time for the power pulse:ARB:POW:PULS:END:TIM 2,(@1) Programs an end time for the resistance pulse:ARB:RESISTANCE:PULS:END:TIM 2,(@1) Programs an end time for step 0: ARB:SEQ:STEP:CURR:PULS:END:TIM 2, 0,(@1)	

[SOURce:]ARB:CURRent:PULSe:FREQuency<*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:FREQuency <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:FREQuency <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:FREQuency <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:FREQuency? [MIN|MAX,] (@<chanlist>)

Specifies the frequency of the current, voltage, power, or resistance pulse in Hertz.

[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:FREQuency<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:FREQuency <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:FREQuency <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:FREQuency <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the frequency of the current, voltage, power, or resistance pulse in Hertz for Arb sequence steps.

Parameter	Typical Return
3.8147E-5 - 1.0E4 | MIN | MAX, *RST 1	<frequency>
Step 0 - 99, *RST 0	(none)
Programs a current frequency: ARB:CURR:PULS:FREQ 10,(@1) Programs a voltage frequency: ARB:VOLT:PULS:FREQ 10,(@1) Programs a power frequency: ARB:POW:PULS:FREQ 10,(@1) Programs a resistance frequency: ARB:RESISTANCE:PULS:FREQ 10,(@1) Programs a current frequency for step 0: ARB:SEQ:STEP:CURR:PULS:FREQ 10, 0,(@1)	

[SOURce:]ARB:CURRent:PULSe:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the current, voltage, power, or resistance before and after the pulse occurs. Referenced to I0, V0, P0, and R0 in the Pulse diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the current, voltage, power, or resistance before and after the pulse occurs for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start- and end-level current: ARB:CURR:PULS:STAR 1,(@1) Programs a start- and end-level voltage: ARB:VOLT:PULS:STAR 1,(@1) Programs a start- and end-level power: ARB:POW:PULS:STAR 1,(@1) Programs a start- and end-level resistance: ARB:RESISTANCE:PULS:STAR 1,(@1) Programs a start- and end-level for step 0: ARB:SEQ:STEP:CURR:PULS:STAR 1, 0,(@1)	

[SOURce:]ARB:CURRent:PULSe:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the pulse occurs. Referenced to t0 in the Pulse diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the pulse occurs for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current pulse: ARB:CURR:PULS:STAR:TIM 1,(@1) Programs a start time for the voltage pulse: ARB:VOLT:PULS:STAR:TIM 1,(@1) Programs a start time for the power pulse: ARB:POW:PULS:STAR:TIM 1,(@1) Programs a start time for the resistance pulse: ARB:RESISTANCE:PULS:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEQ:STEP:CURR:PULS:STAR:TIM 1, 0,(@1)	

[SOURce:]ARB:CURRent:PULSe:TOP[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:TOP[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:TOP[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:TOP[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the top current, voltage, power, or resistance level of the pulse. Referenced to I1, V1, P1, and R1 in the Pulse diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the top current, voltage, power, or resistance level of the pulse for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<top value>
Step 0 - 99, *RST 0	(none)
Programs the top level current: ARB:CURR:PULS:TOP 2,(@1) Programs the top level voltage: ARB:VOLT:PULS:TOP 20,(@1) Programs the top level voltage: ARB:POW:PULS:TOP 50,(@1) Programs the top level resistance: ARB:RESISTANCE:PULS:TOP 20,(@1) Programs the top level for step 0: ARB:SEQ:STEP:CURR:PULS:TOP 2, 0,(@1)	

[SOURce:]ARB:CURRent:PULSe:TOP:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:PULSe:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:TOP:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:PULSe:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:PULSe:TOP:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:PULSe:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:PULSe:TOP:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:PULSe:TOP:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time of the pulse in seconds. Referenced to t1 in the Pulse diagrams.

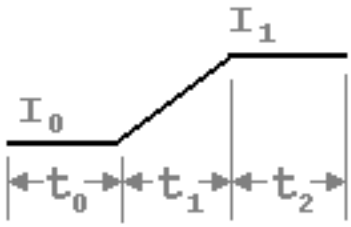
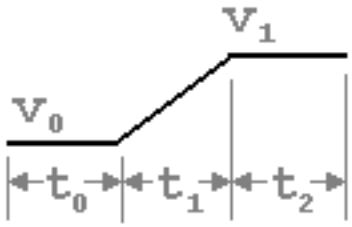
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:PULSe:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:PULSe:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:PULSe:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:PULSe:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time of the pulse in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<end time>
Step 0 - 99, *RST 0	(none)
Programs a top time for the current pulse: ARB:CURR:PULS:TOP:TIM 2,(@1) Programs a top time for the voltage pulse: ARB:VOLT:PULS:TOP:TIM 2,(@1) Programs a top time for the power pulse: ARB:POW:PULS:TOP:TIM 2,(@1) Programs a top time for the resistance pulse: ARB:RESISTANCE:PULS:TOP:TIM 2,(@1) Programs a top time for step 0: ARB:SEQ:STEP:CURR:PULS:TOP:TIM 2, 0,(@1)	

Ramp

Back to ARB Commands

Arb Type	Current	Voltage
Ramp		

[SOURce:]ARB:CURRent:RAMP:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:RAMP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:RAMP:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:RAMP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:RAMP:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:RAMP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level level after the ramp occurs. Referenced to I1, V1, P1, and R1 in the Ramp diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level level after the ramp occurs for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<end value>
Step 0 - 99, *RST 0	(none)

Parameter	Typical Return
Programs an end level current: ARB:CURR:RAMP:END 2,(@1) Programs an end level voltage: ARB:VOLT:RAMP:END 20,(@1) Programs an end level power: ARB:POW:RAMP:END 20,(@1) Programs an end level resistance: ARB:RESISTANCE:RAMP:END 50,(@1) Programs an end level current for step 0: ARB:SEQ:STEP:CURR:RAMP:END 2, 0,(@1)	

[SOURce:]ARB:CURRent:RAMP:END:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:RAMP:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:END:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:RAMP:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:RAMP:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:RAMP:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:RAMP:END:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time in seconds, after the ramp completes, that the ending current, voltage, power, or resistance level level persists. Referenced to t2 in the Ramp diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:END:TIMe<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:END:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:END:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time in seconds, after the ramp completes, that the ending current, voltage, power, or resistance level level persists for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<end time>
Step 0 - 99, *RST 0	(none)
Programs an end time for the current ramp: ARB:CURR:RAMP:END:TIM 2,(@1) Programs an end time for the voltage ramp:ARB:VOLT:RAMP:END:TIM 2,(@1) Programs an end time for the power ramp:ARB:POW:RAMP:END:TIM 2,(@1) Programs an end time for the resistance ramp: ARB:RESISTANCE:RAMP:END:TIM 2,(@1) Programs an end time for step 0: ARB:SEQ:STEP:CURR:RAMP:END:TIM 2, 0,(@1)	

[SOURce:]ARB:CURRent:RAMP:RTIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:RAMP:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:RTIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:RAMP:RTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:RAMP:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:RAMP:RTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:RAMP:RTIMe? [MIN|MAX,] (@<chanlist>)

Specifies the rise time of the ramp in seconds. Referenced to t1 in the Ramp diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:RTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:RTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:RTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:RTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the rise time of the ramp in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 1	<rise time>
Step 0 - 99, *RST 0	(none)
Programs a rise time for the current ramp: ARB:CURR:RAMP:RTIM 10,(@1) Programs a rise time for the voltage ramp: ARB:VOLT:RAMP:RTIM 10,(@1) Programs a rise time for the power ramp: ARB:POW:RAMP:RTIM 10,(@1) Programs a rise time for the resistance ramp: ARB:RESISTANCE:RAMP:RTIM 10,(@1) Programs a rise time for step 0: ARB:SEQ:STEP:CURR:RAMP:RTIM 10, 0,(@1)	

[SOURce:]ARB:CURRent:RAMP:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:RAMP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:RAMP:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:RAMP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:RAMP:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:RAMP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level before the ramp occurs. Referenced to I0, V0, P0, and R0 in the Ramp diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
SOURce:]ARB:SEQuence:STEP:POWer:RAMP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level before the ramp occurs for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start level current: ARB:CURR:RAMP:STAR 1,(@1) Programs a start level voltage: ARB:VOLT:RAMP:STAR 1,(@1) Programs a start level power: ARB:POW:RAMP:STAR 1,(@1) Programs a start level for the resistance: ARB:RESISTANCE:RAMP:STAR 1,(@1) Programs a start level for step 0: ARB:SEQ:STEP:CURR:RAMP:STAR 1, 0,(@1)	

[SOURce:]ARB:CURRent:RAMP:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:RAMP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:RAMP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:RAMP:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:RAMP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:RAMP:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:RAMP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the ramp occurs. Referenced to t0 in the Ramp diagrams.

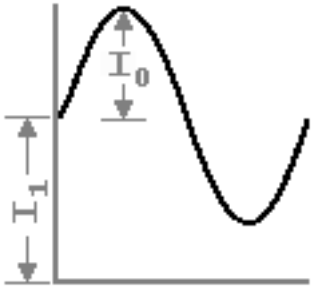
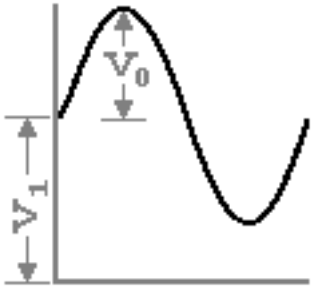
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:RAMP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:RAMP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:RAMP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:STARt:TIMe<*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:RAMP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current ramp: ARB:CURR:RAMP:STAR:TIM 1,(@1) Programs a start time for the voltage ramp: ARB:VOLT:RAMP:STAR:TIM 1,(@1) Programs a start time for the power ramp: ARB:POW:RAMP:STAR:TIM 1,(@1) Programs a start time for the resistance ramp: ARB:RESISTANCE:RAMP:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEQ:STEP:CURR:RAMP:STAR:TIM 1, 0,(@1)	

Sinusoid

Back to ARB Commands

Arb Type	Current	Voltage
Sinusoid		

[SOURce:]ARB:CURRent:SINusoid:AMPLitude<*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:SINusoid:AMPLitude? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:AMPLitude <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:AMPLitude? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:SINusoid:AMPLitude <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:SINusoid:AMPLitude? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:SINusoid:AMPLitude <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:SINusoid:AMPLitude? [MIN|MAX,] (@<chanlist>)

Specifies the amplitude or peak value of the current, voltage, power, or resistance sine wave. Referenced to I0, V0, P0, and R0 in the Sinusoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:AMPLitude<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:AMPLitude? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:AMPLitude <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:AMPLitude? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:AMPLitude <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:AMPLitude? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:AMPLitude <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:AMPLitude? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the amplitude or peak value of the current, voltage, power, or resistance sine wave for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<amplitude>
Step 0 - 99, *RST 0	(none)

Parameter	Typical Return
Programs a current amplitude: ARB:CURR:SIN:AMPL 5,(@1) Programs a voltage amplitude: ARB:VOLT:SIN:AMPL 10,(@1) Programs a power amplitude: ARB:POW:SIN:AMPL 30,(@1) Programs a resistance amplitude: ARB:RESISTANCE:SIN:AMPL 50,(@1) Programs a current amplitude for step 0: ARB:SEQ:STEP:CURR:SIN:AMPL 5, 0,(@1)	

[SOURce:]ARB:CURRent:SINusoid:FREQuency<*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:SINusoid:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:FREQuency <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:SINusoid:FREQuency <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:SINusoid:FREQuency? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:SINusoid:FREQuency <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:SINusoid:FREQuency? [MIN|MAX,] (@<chanlist>)

Specifies the frequency of the current, voltage, power, or resistance sine wave in Hertz.

[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:FREQuency<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:FREQuency <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:FREQuency <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:FREQuency <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:FREQuency? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the frequency of the current, voltage, power, or resistance sine wave in Hertz for Arb sequence steps.

Parameter	Typical Return
3.8147E-5 - 1.0E4 | MIN | MAX, *RST 1	<frequency>
Step 0 - 99, *RST 0	(none)
Programs a current frequency: ARB:CURR:SIN:FREQ 10,(@1) Programs a voltage frequency: ARB:VOLT:SIN:FREQ 10,(@1) Programs a power frequency: ARB:POW:SIN:FREQ 10,(@1) Programs a resistance frequency: ARB:RESISTANCE:SIN:FREQ 10,(@1) Programs a current frequency for step 0: ARB:SEQ:STEP:CURR:SIN:FREQ 10, 0,(@1)	

[SOURce:]ARB:CURRent:SINusoid:OFFSet<*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:SINusoid:OFFSet? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:OFFSet <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:SINusoid:OFFSet? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:SINusoid:OFFSet <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:SINusoid:OFFSet? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:SINusoid:OFFSet <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:SINusoid:OFFSet? [MIN|MAX,] (@<chanlist>)

Specifies the offset of the current, voltage, power, or resistance sine wave from zero. Referenced to I1, V1, P1, and R1 in the Sinusoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:OFFSet<*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:SINusoid:OFFSet? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:OFFSet <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:SINusoid:OFFSet? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:OFFSet <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:SINusoid:OFFSet? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:OFFSet <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:SINusoid:OFFSet? [MIN|MAX,] <*step#*>, (@<chanlist>)

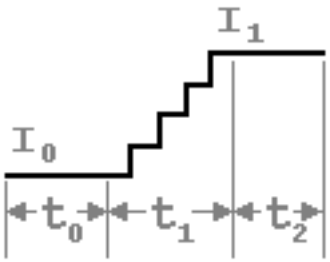
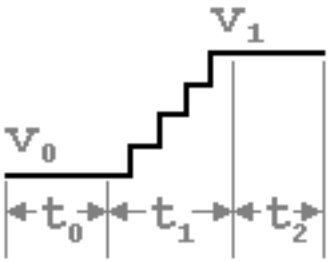
Specifies the offset of the current, voltage, power, or resistance sine wave from zero for Arb sequence steps.

NOTE Except for models N678xA SMU, the output cannot generate negative amplitudes. Therefore, the offset value cannot be less than the peak value of the sine wave.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST 0 Voltage: 0 - maximum|MIN|MAX, *RST 0 Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<offset value>
Step 0 - 99, *RST 0	(none)
Programs a current offset: ARB:CURR:SIN:OFFS 5,(@1) Programs a voltage offset: ARB:VOLT:SIN:OFFS 10,(@1) Programs a power offset: ARB:POW:SIN:OFFS 30,(@1) Programs a resistance offset: ARB:RESISTANCE:SIN:OFFS 50,(@1) Programs a current offset for step 0: ARB:SEQ:STEP:CURR:SIN:OFFS 5, 0,(@1)	

Staircase

Back to ARB Commands

Arb Type	Current	Voltage
Staircase		

[SOURce:]ARB:CURRent:STAircase:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:END[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level after the staircase occurs. Referenced to I1, V1, P1, and R1 in the Staircase diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the ending current, voltage, power, or resistance level after the staircase occurs for Arb sequence steps.

NOTE The difference between the start level and the end level is divided equally among the number of steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<end value>

Parameter	Typical Return
Step 0 - 99, *RST 0	(none)
Programs an end level current: ARB:CURR:STA:END 2,(@1) Programs an end level voltage: ARB:VOLT:STA:END 20,(@1) Programs an end level power: ARB:POW:STA:END 20,(@1) Programs an end level resistance: ARB:RESISTANCE:STA:END 50,(@1) Programs an end level current for step 0: ARB:SEQ:STEP:CURR:STA:END 2, 0,(@1)	

[SOURce:]ARB:CURRent:STAircase:END:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:END:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:END:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time in seconds, after the staircase completes, that the ending current, voltage, power, or resistance level persists. Referenced to t2 in the Staircase diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:END:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:END:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time in seconds, after the staircase completes, that the ending current, voltage, power, or resistance level persists for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<end time>
Step 0 - 99, *RST 0	(none)
Programs an end time after the current staircase:ARB:CURR:STA:END:TIM 2,(@1) Programs an end time after the voltage staircase:ARB:VOLT:STA:END:TIM 2,(@1) Programs an end time after the power staircase:ARB:POW:STA:END:TIM 2,(@1) Programs an end time after the resistance staircase: ARB:RESISTANCE:STA:END:TIM 2,(@1) Programs an end time for step 0:ARB:SEQ:STEP:CURR:STA:END:TIM 2, 0,(@1)	

[SOURce:]ARB:CURRent:STAircase:NSTeps <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:NSTeps? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:NSTeps<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:NSTeps? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:NSTeps<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:NSTeps? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:NSTeps<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:NSTeps? [MIN|MAX,] (@<chanlist>)

Specifies the number of steps in the staircase.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:NSTeps <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:NSTeps? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:NSTeps <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:NSTeps? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:NSTeps <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:NSTeps? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:NSTeps <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:NSTeps? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the number of steps in the staircase for Arb sequence steps.

Parameter	Typical Return
0 – 500 | MIN | MAX, *RST 10	<number of steps>
Step 0 - 99, *RST 0	(none)
Programs five steps for the current staircase: ARB:CURR:STA:NST 5,(@1) Programs five steps for the voltage staircase: ARB:VOLT:STA:NST 5,(@1) Programs five steps for the power staircase: ARB:POW:STA:NST 5,(@1) Programs five steps for the resistance staircase: ARB:RESISTANCE:STA:NST 5,(@1) Programs five steps for sequence step 0: ARB:SEQ:STEP::CURR:STA:NST 5, 0(@1)	

[SOURce:]ARB:CURRent:STAircase:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the initial current, voltage, power, or resistance before the staircase occurs. Referenced to I0, V0, P0, and R0 in the Staircase diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the initial current, voltage, power, or resistance before the staircase occurs for Arb sequence steps.

NOTE The difference between the start level and the end level is divided equally among the number of steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start level current: ARB:CURR:STA:STAR 1,(@1) Programs a start level voltage: ARB:VOLT:STA:STAR 10,(@1) Programs a start level power: ARB:POW:STA:STAR 10,(@1) Programs a start level resistance: ARB:RESISTANCE:STA:STAR 100,(@1) Programs an start level for step 0:ARB:SEQ:STEP:CURR:STA:STAR 1, 0,(@1)	

[SOURce:]ARB:CURRent:STAircase:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the staircase occurs. Referenced to t0 in the Staircase diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the staircase occurs for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current staircase: ARB:CURR:STA:STAR:TIM 1,(@1) Programs a start time for the voltage staircase: ARB:VOLT:STA:STAR:TIM 1,(@1) Programs a start time for the power staircase: ARB:POW:STA:STAR:TIM 1,(@1) Programs a start time for the resistance staircase: ARB:RESISTANCE:STA:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEG:STEP:CURR:STA:STAR:TIM 1, 0,(@1)	

[SOURce:]ARB:CURRent:STAircase:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STAircase:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STAircase:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STAircase:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STAircase:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STAircase:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STAircase:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the total time to complete all of the staircase steps in seconds. Referenced to t1 in the Staircase diagrams. Each step is of equal time.

[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STAircase:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STAircase:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STAircase:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STAircase:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

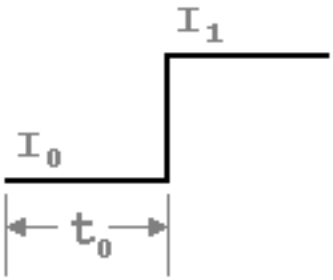
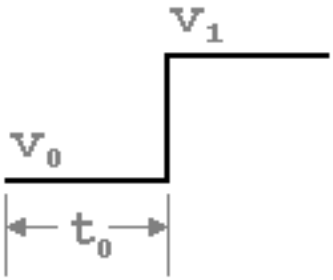
Specifies the total time to complete all of the staircase steps in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 1	<staircase time>

Parameter	Typical Return
Step 0 - 99, *RST 0	(none)
Programs a time for the current staircase: ARB:CURR:STA:TIM 10,(@1) Programs a time for the voltage staircase: ARB:VOLT:STA:TIM 10,(@1) Programs a time for the power staircase: ARB:POW:STA:TIM 10,(@1) Programs a time for the resistance staircase: ARB:RESISTANCE:STA:TIM 10,(@1) Programs a time for step 0:ARB:SEG:STEP:CURR:STA:TIM 10, 0,(@1)	

Step

Back to ARB Commands

Arb Type	Current	Voltage
Step		

[SOURce:]ARB:CURRent:STEP:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STEP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:END[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STEP:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STEP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STEP:END[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STEP:END[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the step current, voltage, power, or resistance level. Referenced to I1, V1, P1, and R1 in the Step diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:END[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:END[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the step current, voltage, power, or resistance level for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<end value>
Step 0 - 99, *RST 0	(none)

Parameter	Typical Return
Programs the step level current: ARB:CURR:STEP:END 2,(@1) Programs the step level voltage: ARB:VOLT:STEP:END 20,(@1) Programs the step level power: ARB:POW:STEP:END 50,(@1) Programs the step level resistance: ARB:RESISTANCE:STEP:END 100,(@1) Programs a step level for step 0: ARB:SEQ:STEP:CURR:STEP:END 2, 0,(@1)	

[SOURce:]ARB:CURRent:STEP:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STEP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STEP:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STEP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STEP:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STEP:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level. Referenced to I0, V0, P0, and R0 in the Step diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the initial current, voltage, power, or resistance level for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start level current: ARB:CURR:STEP:STAR 1,(@1) Programs a start level voltage: ARB:VOLT:STEP:STAR 1,(@1) Programs a start level power: ARB:POW:STEP:STAR 1,(@1) Programs a start level resistance: ARB:RESISTANCE:STEP:STAR 50,(@1) Programs a start level for step 0: ARB:SEQ:STEP:CURR:STEP:STAR 1, 0,(@1)	

[SOURce:]ARB:CURRent:STEP:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:STEP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:STEP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:STEP:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:STEP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:STEP:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:STEP:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the step occurs. Referenced to t0 in the Step diagrams.

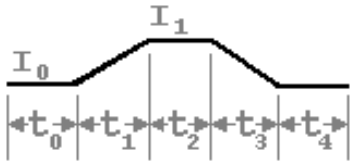
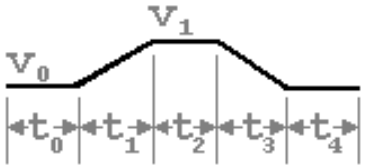
[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:STEP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:STEP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:STEP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:STEP:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the step occurs for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current step: ARB:CURR:STEP:STAR:TIM 1,(@1) Programs a start time for the voltage step: ARB:VOLT:STEP:STAR:TIM 1,(@1) Programs a start time for the power step: ARB:POW:STEP:STAR:TIM 1,(@1) Programs a start time for the resistance step: ARB:RESISTANCE:STEP:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEQ:STEP:CURR:STEP:STAR:TIM 1, 0,(@1)	

Trapezoid

Back to ARB Commands

Arb Type	Current	Voltage
Trapezoid		

[SOURce:]ARB:CURRent:TRAPezoid:END:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:END:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:END:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:END:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:END:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time in seconds, after the trapezoid, that the starting current, voltage, power, or resistance level persists. Referenced to t4 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:END:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:END:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:END:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:END:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time in seconds, after the trapezoid, that the starting current, voltage, power, or resistance level persists for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<end time>
Step 0 - 99, *RST 0	(none)
Programs an end time after the current trapezoid: ARB:CURR:TRAP:END:TIM 2,(@1) Programs an end time after the voltage trapezoid: ARB:VOLT:TRAP:END:TIM 2,(@1) Programs an end time after the power trapezoid: ARB:POW:TRAP:END:TIM 2,(@1) Programs an end time after the resistance trapezoid: ARB:RESISTANCE:TRAP:END:TIM 2,(@1) Programs an end time for step 0:ARB:SEQ:STEP:CURR:TRAP:END:TIM 2, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:FTIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:FTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:FTIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:FTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:FTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:FTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:FTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:FTIMe? [MIN|MAX,] (@<chanlist>)

Specifies the fall time of the trapezoid in seconds. Referenced to t3 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:FTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:FTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:FTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:FTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:FTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:FTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:FTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:FTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the fall time of the trapezoid in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 1	<fall time>
Step 0 - 99, *RST 0	(none)
Programs a fall time for the current trapezoid: ARB:CURR:TRAP:FTIM 10,(@1) Programs a fall time for the voltage trapezoid: ARB:VOLT:TRAP:FTIM 10,(@1) Programs a fall time for the power trapezoid: ARB:POW:TRAP:FTIM 10,(@1) Programs a fall time for the resistance trapezoid: ARB:RESISTANCE:TRAP:FTIM 10,(@1) Programs a fall time for step 0:ARB:SEQ:STEP:CURR:TRAP:FTIM 10, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:RTIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:RTIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:RTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:RTIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:RTIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:RTIMe? [MIN|MAX,] (@<chanlist>)

Specifies the rise time of the trapezoid in seconds. Referenced to t1 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:RTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:RTIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:RTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:RTIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:RTIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the rise time of the trapezoid in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 1	<rise time>
Step 0 - 99, *RST 0	(none)
Programs a rise time for the current trapezoid: ARB:CURR:TRAP:RTIM 10,(@1) Programs a rise time for the voltage trapezoid: ARB:VOLT:TRAP:RTIM 10,(@1) Programs a rise time for the power trapezoid: ARB:POW:TRAP:RTIM 10,(@1) Programs a rise time for the resistance trapezoid: ARB:RESISTANCE:TRAP:RTIM 10,(@1) Programs a rise time for step 0:ARB:SEQ:STEP:CURR:TRAP:RTIM 10, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:STARt[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:STARt[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the initial and final current, voltage, power, or resistance level of the trapezoid. Referenced to I0, V0, P0, and R0 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:STARt[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:STARt[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the initial and final current, voltage, power, or resistance level of the trapezoid for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<start value>
Step 0 - 99, *RST 0	(none)
Programs a start- and end-level current: ARB:CURR:TRAP:STAR 1,(@1) Programs a start- and end- level voltage: ARB:VOLT:TRAP:STAR 1,(@1) Programs a start- and end- level power: ARB:POW:TRAP:STAR 1,(@1) Programs a start- and end-level resistance: ARB:RESISTANCE:TRAP:STAR 10,(@1) Programs a start- and end-level for step 0: ARB:SEQ:STEP:CURR:TRAP:STAR 1, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:STARt:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:STARt:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:STARt:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:STARt:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:STARt:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the rising ramp occurs. Referenced to t0 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:STARt:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:STARt:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the delay in seconds after the trigger is received, but before the rising ramp occurs for Arb Sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<start time>
Step 0 - 99, *RST 0	(none)
Programs a start time for the current trapezoid: ARB:CURR:TRAP:STAR:TIM 1,(@1) Programs a start time for the voltage trapezoid: ARB:VOLT:TRAP:STAR:TIM 1,(@1) Programs a start time for the power trapezoid: ARB:POW:TRAP:STAR:TIM 1,(@1) Programs a start time for the resistance trapezoid: ARB:RESISTANCE:TRAP:STAR:TIM 1,(@1) Programs a start time for step 0: ARB:SEQ:STEP:CURR:TRAP:STAR:TIM 1, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:TOP[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:TOP[:LEVel] <*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:TOP[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:TOP[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] (@<chanlist>)

Specifies the top current, voltage, power, or resistance level of the trapezoid. Referenced to I1, V1, P1, and R1 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:TOP[:LEVel] <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:TOP[:LEVel]? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the top current, voltage, power, or resistance level of the trapezoid for Arb sequence steps.

Parameter	Typical Return
Current: 0 - maximum|MIN|MAX, *RST MIN Voltage: 0 - maximum|MIN|MAX, *RST MIN Power: 0 - maximum|MIN|MAX, *RST MIN Resistance: 0 - maximum|MIN|MAX, *RST MIN Values are range and module-rating dependent.	<top value>
Step 0 - 99, *RST 0	(none)
Programs the top level current: ARB:CURR:TRAP:TOP 2,(@1) Programs the top level voltage: ARB:VOLT:TRAP:TOP 20,(@1) Programs the top level power: ARB:POW:TRAP:TOP 50,(@1) Programs the top level resistance: ARB:RESISTANCE:TRAP:TOP 100,(@1) Programs a top level for step 0: ARB:SEQ:STEP:CURR:TRAP:TOP 2, 0,(@1)	

[SOURce:]ARB:CURRent:TRAPezoid:TOP:TIMe <*value*>, (@<chanlist>)
[SOURce:]ARB:CURRent:TRAPezoid:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:TOP:TIMe<*value*>, (@<chanlist>)
[SOURce:]ARB:VOLTage:TRAPezoid:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:POWer:TRAPezoid:TOP:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:POWer:TRAPezoid:TOP:TIMe? [MIN|MAX,] (@<chanlist>)
[SOURce:]ARB:RESISTANCE:TRAPezoid:TOP:TIMe<*value*>, (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:TRAPezoid:TOP:TIMe? [MIN|MAX,] (@<chanlist>)

Specifies the time of the top level of the trapezoid in seconds. Referenced to t2 in the Trapezoid diagrams.

[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:TRAPezoid:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:TRAPezoid:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:TRAPezoid:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:TOP:TIMe <*value*>, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:TRAPezoid:TOP:TIMe? [MIN|MAX,] <*step#*>, (@<chanlist>)

Specifies the time of the top level of the trapezoid in seconds for Arb sequence steps.

Parameter	Typical Return
0 – 262.144 | MIN | MAX, *RST 0	<top time>
Step 0 - 99, *RST 0	(none)
Programs a top time for the current trapezoid: ARB:CURR:TRAP:TOP:TIM 2,(@1) Programs a top time for the voltage trapezoid: ARB:VOLT:TRAP:TOP:TIM 2,(@1) Programs a top time for the power trapezoid: ARB:POW:TRAP:TOP:TIM 2,(@1) Programs a top time for the resistance trapezoid: ARB:RESISTANCE:TRAP:TOP:TIM 2,(@1) Programs a top time for step 0: ARB:SEQ:STEP:CURR:TRAP:TOP:TIM 2, 0,(@1)	

User-Defined

Back to ARB Commands

[SOURce:]ARB:CURRent:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} (@<chanlist>)
[SOURce:]ARB:CURRent:UDEFined:BOSTep[:DATA]? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:BOSTep[:DATA]? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} (@<chanlist>) N679xA
[SOURce:]ARB:POWer:UDEFined:BOSTep[:DATA]? (@<chanlist>)
[SOURce:]ARB:RESISTANCE:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:BOSTep[:DATA]? (@<chanlist>)

Specifies which user-defined Arb points or steps will generate a trigger-out signal at the beginning of the step (BOSTep). A comma-delimited list of up to 511 steps may be programmed. The state is either ON (1) or OFF (0). A trigger is only generated when the state is set to ON.

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:BOSTep[:DATA]? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:BOSTep[:DATA]? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} <*step#*>, (@<chanlist>)
N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:BOSTep[:DATA]? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:BOSTep[:DATA] 0|OFF|1|ON {,0 or 1} <*step#*>, (@<chanlist>)
N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:BOSTep[:DATA]? <*step#*>, (@<chanlist>)

Specifies which user-defined Arb points or steps will generate a trigger-out signal at the beginning of the step (BOSTep) for Arb sequence steps. The last value in the sequence is the step number.

Parameter	Typical Return
0|OFF|1|ON, *RST 1 point with a value of Off	0 or 1 [,0 or 1]
Step 0 - 99, *RST 0	(none)
Output a trigger at the start of the current steps: ARB:CURR:UDEF:BOST ON,ON,ON,ON,ON,(@1) Output a trigger at the start of the voltage steps: ARB:VOLT:UDEF:BOST ON,ON,ON,ON,ON,(@1) Output a trigger at the start of the power steps: ARB:POW:UDEF:BOST ON,ON,ON,ON,ON,(@1) Output a trigger at the start of the resistance steps: ARB:RESISTANCE:UDEF:BOST ON,ON,ON,ON,ON,(@1) Output triggers at the start of the steps during sequence step 0:ARB:SEQ:STEP:CURR:UDEF:BOST ON,ON,ON,ON,ON, 0,(@1)	

- At the end of the user-defined Arb, the output state of the unit depends upon the ARB:TERMinate:LAST program settings.
- The order in which the values are entered determines the sequence of execution.
- To create a valid user-defined Arb, the current level, voltage level, power level, resistance level, BOST, and dwell lists must either all be the same length, or have a length of 1, which is interpolated as having the same length as the maximum length list.

[SOURce:]ARB:CURRent:UDEFined:BOSTep:POINts? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:BOSTep:POINts? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:BOSTep:POINts? (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:BOSTep:POINts? (@<chanlist>) N679xA

Returns the number of beginning-of-step points in the user-defined Arb, not the point values.

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:BOSTep:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:BOSTep:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:BOSTep:POINts? <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:BOSTep:POINts? <*step#*>, (@<chanlist>) N679xA

Returns the number of beginning-of-step points in the user-defined Arb for Arb sequence steps.

Parameter	Typical Return
(none)	<number of points>
Step 0 - 99, *RST 0	(none)
Returns the number of current BOST points: ARB:CURR:UDEF:BOST:POIN? (@1) Returns the number of voltage BOST points: ARB:VOLT:UDEF:BOST:POIN? (@1) Returns the number of power BOST points: ARB:POW:UDEF:BOST:POIN? (@1) Returns the number of resistance BOST points: ARB:RESISTANCE:UDEF:BOST:POIN? (@1) Returns the number of BOST points for step 0: ARB:SEQ:STEP:CURR:UDEF:BOST:POIN? 0,(@1)	

[SOURce:]ARB:CURRent:UDEFined:DWELl <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:CURRent:UDEFined:DWELl? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:DWELl <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:DWELl? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:DWELl <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:POWer:UDEFined:DWELl? (@<chanlist>)
[SOURce:]ARB:RESISTANCE:UDEFined:DWELl <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:DWELl? (@<chanlist>)

Specifies the dwell time for each user-defined current Arb point. A comma-delimited list of up to 511 points may be programmed. Dwell time is the time that the output will remain at a specific point. Dwell times can be programmed from 0 through 262.144 seconds with the resolution shown in the table below:

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:DWELl <*value*>{<,*value*>}, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:DWELl? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:DWELl <*value*>{<,*value*>}, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:DWELl? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:DWELl <*value*>{<,*value*>}, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:DWELl? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:DWELl <*value*>{<,*value*>}, <*step#*>, (@<chanlist>)
N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:DWELl? <*step#*>, (@<chanlist>)

Specifies the dwell time for each user-defined current Arb point for Arb Sequence steps. The last value in the sequence is the step number.

Range in seconds	Dwell resolution	Range in seconds	Dwell resolution
All Models except N678xA		Models N678xA only	
0 - 0.262144	1 microsecond	0 - 0.268435	1.024 microsecond
0 - 2.62144	10 microseconds	0 - 2.68435	10.24 microsecond
0 - 26.2144	100 microseconds	0 - 26.8435	102.4 microsecond
0 - 262.144	1 millisecond	0 - 268.435	1.024 millisecond

Parameter	Typical Return
0 - 262.144 (all except N678xA SMU) 0 - 268.435 (N678xA SMU only *RST 1 point with a value of 0.001	<dwell time>
Step 0 - 99, *RST 0	(none)
Program a current dwell list: ARB:CURR:UDEF:DWEL 0.1,0.2,0.3,0.4,0.5,(@1) Program a voltage dwell list: ARB:VOLT:UDEF:DWEL 0.1,0.2,0.3,0.4,0.5,(@1) Program a power dwell list: ARB:POW:UDEF:DWEL 0.1,0.2,0.3,0.4,0.5,(@1) Program a resistance dwell list: ARB:RESISTANCE:UDEF:DWEL 0.1,0.2,0.3,0.4,0.5,(@1) Program a dwell list for step 0: ARB:SEQ:STEP:CURR:UDEF:DWEL 0.1,0.2,0.3,0.4,0.5, 0,(@1)	

- At the end of the user-defined Arb, the output state of the unit depends upon the ARB:TERMinate:LAST program settings.
- The order in which the values are entered determines the sequence of execution.
- To create a valid user-defined Arb, the current level, voltage level, power level, resistance level, BOST, and dwell lists must either all be the same length, or have a length of 1, which is interpolated as having the same length as the maximum length list.

[SOURce:]ARB:CURRent:UDEFined:DWELl:POINts? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:DWELl:POINts? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:DWELl:POINts? (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:DWELl:POINts? (@<chanlist>) N679xA

Returns the number of dwell points in the user-defined Arb, not the point values.

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:DWELl:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:DWELl:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:DWELl:POINts? <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:DWELl:POINts? <*step#*>, (@<chanlist>) N679xA

Returns the number of dwell points in the user-defined Arb for Arb sequence steps.

Parameter	Typical Return
(none)	<number of points>
Step 0 - 99, *RST 0	(none)
Returns the number of current dwell points: ARB:CURR:UDEF:DWEL:POIN? (@1) Returns the number of voltage dwell points: ARB:VOLT:UDEF:DWEL:POIN? (@1) Returns the number of power dwell points: ARB:POW:UDEF:DWEL:POIN? (@1) Returns the number of resistance dwell points: ARB:RESISTANCE:UDEF:DWEL:POIN? (@1) Returns the number of dwell points for step 0: ARB:SEQ:STEP:CURR:UDEF:DWEL:POIN? 0,(@1)	

[SOURce:]ARB:CURRent:UDEFined:LEVel <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:CURRent:UDEFined:LEVel? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:LEVel <*value*>{<,*value*>},(@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:LEVel? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:LEVel <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:POWer:UDEFined:LEVel? (@<chanlist>)
[SOURce:]ARB:RESISTANCE:UDEFined:LEVel <*value*>{<,*value*>},(@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:LEVel? (@<chanlist>)

Specifies the level of each current or voltage point in a user-defined Arb. A comma-delimited list of up to 511 points may be programmed.

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:LEVel <*value*>{<,*value*>}, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:LEVel? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:LEVel <*value*>{<,*value*>}, <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:LEVel? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:LEVel <*value*>{<,*value*>}, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:LEVel? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:LEVel <*value*>{<,*value*>}, <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:LEVel? <*step#*>, (@<chanlist>)

Specifies the level of each current or voltage point in a user-defined Arb for Arb sequence steps. The last value in the sequence is the step number.

Parameter	Typical Return
Current: 0 - maximum Voltage: 0 - maximum Power: 0 - maximum Resistance: 0 - maximum Values are range and module-rating dependent. *RST 1 point set to the minimum value.	<value> [,<value>]
Step 0 - 99, *RST 0	(none)
Program the current points: ARB:CURR:UDEF 5,4,3,2,1,(@1) Program the voltage points: ARB:VOLT:UDEF 20,21,22,23,24,(@1) Program the power points: ARB:POW:UDEF 20,30,40,50,60,(@1) Program the resistance points: ARB:RESISTANCE:UDEF 60,70,80,90,100,(@1) Program the points for step 0: ARB:SEQ:STEP:CURR:UDEF 5,4,3,2,1,0,(@1)	

- At the end of the user-defined Arb, the output state of the unit depends upon the ARB:TERMinate:LAST program settings.
- The order in which the values are entered determines the sequence of execution.
- To create a valid user-defined Arb, the current level, voltage level, power level, resistance level, BOST, and dwell lists must either all be the same length, or have a length of 1, which is interpolated as having the same length as the maximum length list.

[SOURce:]ARB:CURRent:UDEFined:LEVel:POINts? (@<chanlist>)
[SOURce:]ARB:VOLTage:UDEFined:LEVel:POINts? (@<chanlist>)
[SOURce:]ARB:POWer:UDEFined:LEVel:POINts? (@<chanlist>) N679xA
[SOURce:]ARB:RESISTANCE:UDEFined:LEVel:POINts? (@<chanlist>) N679xA

Returns the number of current or voltage points in the user-defined Arb, not the point values.

[SOURce:]ARB:SEQuence:STEP:CURRent:UDEFined:LEVel:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:VOLTage:UDEFined:LEVel:POINts? <*step#*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:POWer:UDEFined:LEVel:POINts? <*step#*>, (@<chanlist>) N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE:UDEFined:LEVel:POINts? <*step#*>, (@<chanlist>) N679xA

Returns the number of current or voltage points in the user-defined Arb for Arb sequence steps.

Parameter	Typical Return
(none)	<number of points>
Step 0 - 99, *RST 0	(none)
Returns the number of current points: ARB:CURR:UDEF:LEV:POIN? (@1) Returns the number of voltage points: ARB:VOLT:UDEF:LEV:POIN? (@1) Returns the number of power points: ARB:POW:UDEF:LEV:POIN? (@1) Returns the number of resistance points: ARB:RESISTANCE:UDEF:LEV:POIN? (@1) Returns the number of points for step 0: ARB:SEQ:STEP:CURR:UDEF:LEV:POIN? 0,(@1)	

Arb Sequence

Back to ARB Commands

[SOURce:]ARB:SEQuence:COUNt <*value*>, (@<chanlist>)
[SOURce:]ARB:SEQuence:COUNt? [MIN|MAX,] (@<chanlist>)

Sets the number of times that the Arb sequence is repeated. The repeat count range is 1 through 4096.

Parameter	Typical Return
1 - 4096 | MIN | MAX | INFinity, *RST 1	<sequence count>
Sets the sequence count to 10: ARB:SEQ:COUN 10, (@1)	

- Use the INFinity parameter to repeat the sequence continuously. If MAX, or a value greater than 4096 is programmed, the sequence will also repeat continuously.
- Use ABORt:TRANsient to stop the sequence at any time. When the sequence is aborted, the output returns to the settings that were in effect before the sequence started.
- If a count of 9.9E37 is returned, it means that the sequence is set to repeat continuously.

[SOURce:]ARB:SEQuence:LENGth? (@<chanlist>)

Returns the total number of steps in the Arb sequence.

Parameter	Typical Return
(none)	<number of steps>
Returns the number of steps in the Arb sequence: ARB:SEQ:LENG? (@1)	

[SOURce:]ARB:SEQuence:QUALity? (@<chanlist>)

Returns the quality of the waveforms in the Arb sequence. This is a number between 16 and 100 that is an indication of how well waveforms are represented. It is the number of points used to represent ARBs that are smooth curves (ramp, trapezoid, exponential, and sine). 16 is the minimum number of points that defines the curve (worst quality). 100 is the maximum number of points that defines the curve (best quality).

Note that the quality of a given waveform is determined by the total number and type of waveforms that comprise the sequence. The maximum number of points allowed in a sequence is 511. As more waveforms are added to the sequence, the quality of the waveforms is reduced to accommodated the 511-point limit.

Parameter	Typical Return
(none)	a value between 16 and 100
Returns the quality of the Arb sequence : ARB:SEQ:QUAL? (@1)	

[SOURce:]ARB:SEQuence:RESet (@<chanlist>)

Resets the Arb sequence to its power-on default setting: Step = 0; Shape = PULSe

Parameter	Typical Return
(none)	(none)
Returns the number of steps in the Arb sequence: ARB:SEQ:LENG? (@1)	

[SOURce:]ARB:SEQuence:STEP:COUNt <value>, <step#>, (@<chanlist>)
[SOURce:]ARB:SEQuence:STEP:COUNt? [MIN|MAX,] <step#>, (@<chanlist>)

Sets the number of times that the sequence step is repeated. The repeat count range is 1 through >16 million. The maximum number of steps that can be programmed is 100. This setting is only valid if the ARB:SEQuence:STEP:PACing is TRIGgered.

Parameter	Typical Return
Count: 1 - 16,777,216 | MIN | MAX | INFinity, *RST 1	<step count>
Step: 0 - 99, *RST 0	(none)
Sets the a repeat count of 10 for step 1: ARB:SEQ:STEP:COUN 10, 1, (@1)	

- Use the INFinity parameter to repeat the sequence step continuously. If MAX, or a value greater than 16,777,216 is programmed, the step will also repeat continuously.
- Use ABORt:TRANsient to stop the sequence at any time. When the sequence is aborted, the output returns to the settings that were in effect before the sequence started.
- If a count of 9.9E37 is returned, it means that the sequence step is set to repeat continuously.

[SOURce:]ARB:SEQuence:STEP:CURRent
[SOURce:]ARB:SEQuence:STEP:VOLTage
[SOURce:]ARB:SEQuence:STEP:POWer N679xA
[SOURce:]ARB:SEQuence:STEP:RESISTANCE N679xA

Program waveform steps within an Arb sequence.

All of the ARB:CURRent, ARB:VOLTage, ARB:POWer, and ARB:RESISTANCE commands that set waveform parameters have corresponding commands that set those same parameters for waveform steps within an Arb sequence. They follow the pattern:

[SOURce:]ARB:CURRent:EXPonential:END <level>, (@<chanlist>)
[SOURce:]ARB:**SEQuence:STEP**:CURRent:EXPonential:END <level>, **<step#>**, (@<chanlist>)

where items in bold are added to the sequence step version of the single Arb command. The <step#> parameter indicates the step number within the Arb sequence. The following Arb functions use the ARB:SEQuence <step#> format:

Exponential, Pulse, Ramp, Sinusoid, Staircase, Step, Trapezoid, and User-defined.

[SOURce:]ARB:SEQuence:STEP:FUNCtion:SHAPe <function>, <step#>, (@<chanlist>)
[SOURce:]ARB::SEQuence:STEP:FUNCtion:SHAPe? <step#>, (@<chanlist>)

Creates a new Arb sequence step or changes the waveform of an existing sequence step. The maximum number of steps that can be programmed is 100. The following waveforms may be assigned to a sequence step:

STEP	Specifies a step
RAMP	Specifies a ramp
STAircase	Specifies a staircase
SINusoid	Specifies a sine wave
PULSe	Specifies a pulse
TRAPezoid	Specifies a trapezoid
EXPonential	Specifies a exponential waveform
UDEFined	Specifies a user-defined waveform
CDWell	Specifies a constant-dwell waveform
SEQuence	Specifies a sequence of arbitrary waveforms
NONE	Specifies no arbitrary waveform

Parameter	Typical Return
STEP | RAMP | STAircase | SINusoid | PULSe | TRAPezoid | EXPonential | UDE:Fined | CDWell | SEQuence |NONE, *RST NONE	STEP, RAMP, STA, SIN, PULS, TRAP, EXP, or UDEF.
Step 0 - 99, *RST 0	(none)
Specify a shape for sequence step 1: ARB:SEQ:STEP:FUNC:SHAP SIN, 1, (@1)	

- If the <step#> specified is an existing sequence step, that step will be changed to the specified waveshape with all parameters reset to default values.
- New sequence steps must be specified sequentially. To create a new sequence step, <step#> should be specified to be the current length of the sequence (see ARB:SEQuence:LENGth?). When a step is added, all parameters of the step waveform are reset to their default values.

[SOURce:]ARB:SEQuence:STEP:PACing <pacing>, <step#>, (@<chanlist>)
[SOURce:]ARB::SEQuence:STEP:PACing? <step#>, (@<chanlist>)

Specifies the type of pacing for the specified step number as follows:

DWELl	When dwell paced, the step moves to the next step when the dwell time is finished.
TRIGgered	When trigger paced, the step waits at the last value of the step until a trigger is received. The next step is started upon receipt of the trigger.

Parameter	Typical Return
DWELl | TRIGgered, *RST DWELl	DWEL or TRIG
Step 0 - 99, *RST 0	(none)
Specify trigger pacing for sequence step 1: ARB:SEQ:STEP:PAC TRIG, 1, (@1)	

- If the <step#> specified is an existing sequence step, that step will be changed to the specified waveshape with all parameters reset to default values.
- New sequence steps must be specified sequentially. To create a new sequence step, <step#> should be specified to be the current length of the sequence (see ARB:SEQuence:LENGth?). When a step is added, all parameters of the step waveform are reset to their default values.

[SOURce:]ARB:SEQuence:TERMinate:LAST <Bool>, (@<chanlist>)
[SOURce:]ARB:SEQuence:TERMinate:LAST? (@<chanlist>)

Determines the output value when the Arb sequence terminates. The state is either ON (1) or OFF (0).

When ON	The output remains at the last Arb sequence value. The last current, voltage, power, or resistance Arb value becomes the IMMediate value when the sequence completes.
When OFF	The output returns to the settings in effect before the sequence started. This also applies when the sequence is aborted,

Parameter	Typical Return
0|OFF|1|ON, *RST Off	0 or 1
Sets the sequence to terminate with the voltage, resistance, or current set at the last sequence value: ARB:SEQ:TERM:LAST ON,(@1)	

- The query returns 0 if the output returns to the settings that were in effect before the sequence started, and 1 if the output remains at the last sequence value.

Calibrate Commands

Calibrate commands calibrate the instrument. only one channel can be calibrated at a time.

If calibration mode has not been enabled with CALibrate:STATe, the calibration commands will generate an error. Use CALibrate:SAVE to save any changes, otherwise all changes will be lost when you exit calibration mode.

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

CALibrate:COUNt?

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

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

CALibrate:CURRent[:LEVel] <*value*>, (@<channel>)

Calibrates the output current. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum current of the range.	(none)
Calibrates the output current of the 10 A range: CAL:CURR 10.2, (@1)	

CALibrate:CURRent:LIMit:NEGative <*value*], (@<channel>) N678xA SMU N6783A-BAT

Calibrates the negative current limit. The value must be specified as negative. There is only one negative current range.

Parameter	Typical Return
The maximum current of the range.	(none)
Calibrates the negative current limit: CAL:CURR:LIM:NEG -2, (@1)	

CALibrate:CURRent:LIMit:POSitive <*value*>, (@<channel>) N678xA SMU N6783A N679xA

Calibrates the positive current limit. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum current of the range.	(none)
Calibrates the positive current limit: CAL:CURR:LIM:POS 2, (@1)	

CALibrate:CURRent:MEASure <*value*>, (@<channel>)

Calibrates the current measurement. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum current of the range.	(none)
Calibrates the current measurement range: CAL:CURR:MEAS 10.2, (@1)	

CALibrate:CURRent:PEAK (@<channel>) N675xA, N676xA

Calibrates the peak current limit.

Parameter	Typical Return
(none)	(none)
Calibrates the peak current limit: CAL:CURR:PEAK (@1)	

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
The measured voltage or current value.	(none)
Specifies the measured value 10.01: CAL:DATA 10.01	

CALibrate:DATE <*"date"*>, (@<channel>)
CALibrate:DATE?

Stores the calibration date in nonvolatile memory. Enter any ASCII string up to 16 characters. The query returns the date. If no date is stored, an empty quoted string ("") is returned.

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

- The firmware does not interpret the string format. The command only stores the calibration date.

CALibrate:DPRog (@<channel>)

Calibrates the current downprogrammer.

Parameter	Typical Return
(none)	(none)
Calibrates the current downprogrammer: CAL:DPR (@1)	

CALibrate:LEVel P1|P2|P3

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 level: CAL:LEV P1	

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

CALibrate:PASSword <*password*>

Sets a numeric password to prevent unauthorized calibration. The new password is automatically stored in nonvolatile memory and does not have to be stored with CALibrate:SAVE.

Parameter	Typical Return
<*password*>a numeric value 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 factory setting is 0 (zero).
- To change the password: unsecure calibration with the old password, then set the new password.
- If you forget your password, refer to the calibration section.

CALibrate:RESistance 20|6, (@<channel>) N6781A, N6785A

Calibrates the output resistance. The parameter selects the voltage range. Note that the 6 V range only applies to Model N6781A.

Parameter	Typical Return
20|6	(none)
Calibrates the output resistance of the 20 V range: CAL:RES 20, (@1)	

CALibrate:SAVE

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

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

- If calibration mode is exited by programming CALibration:STATe OFF without first saving the new constants, the previous calibration constants are restored.

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 optional parameter is the password. This is required if the existing password is not 0 (zero). If the password is not entered or is incorrect, an error is generated and the calibration mode remains disabled.

Parameter	Typical Return
0|OFF|1|ON , default OFF	0 or 1
<*password*> a numeric value up to 15 digits	(none)
Disable calibration mode and unsecure calibration: CAL:STAT OFF, 0 Enable calibration using a numeric password: CAL:STAT ON, 1234	

- If calibration mode is exited by programming CALibration:STATe OFF without first saving the new constants, the previous calibration constants are restored.

CALibrate:VOLTage[:LEVel] <*value*>, (@<channel>)

Calibrates the output voltage. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum voltage of the range.	(none)
Calibrates the voltage of the 50 V range: CAL:VOLT 51, (@1)	

CALibrate:VOLTage:CMRR (@<channel>) N675xA, N676xA

Calibrates the voltage common mode rejection ratio.

Parameter	Typical Return
(none)	(none)
Calibrates the voltage common mode rejection ratio: CAL:VOLT:CMRR (@1)	

CALibrate:VOLTage:LIMit:POSitive <*value*>, (@<channel>) N678xA SMU

Calibrates the positive voltage limit. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum voltage of the range.	(none)
Calibrates the positive voltage limit: CAL:VOLT:LIM:POS 20.4, (@1)	

CALibrate:VOLTage:MEASure <*value*>, (@<channel>)

Calibrates the voltage measurement range. The value entered selects the range that is being calibrated.

Parameter	Typical Return
The maximum voltage of the range.	(none)
Calibrates the voltage measurement range: CAL:VOLT:MEAS 51, (@1)	

CALibrate:VOLTage:MEASure:AUXiliary (@<channel>) N6781A, N6785A

Calibrates the auxiliary voltage measurement input.

Parameter	Typical Return
(none)	(none)
Calibrates the auxiliary voltage measurement input: CAL:VOLT:MEAS:AUX (@1)	

Current Commands

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

[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)
[SOURce:]CURRent[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude] <*value*>, (@<chanlist>)
[SOURce:]CURRent[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX,] (@<chanlist>)

Sets the immediate current level and the triggered current level when the output is in constant current mode. The triggered level is a stored value that will be programmed when a Step transient is triggered. Units are in amperes. The maximum value depends on the current rating of the unit.

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST 0 The maximum value is 102% of the current rating of the module.	<current level>
Sets the output current level to 3 A: CURR 3, (@1) Sets the triggered current level to 2 A: CURR:TRIG 2, (@1)	

- The query returns the programmed current level in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)

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[SOURce:]CURRent:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)
[SOURce:]CURRent:LIMit:NEGative[:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)

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[SOURce:]CURRent:LIMit:NEGative[:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)

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|MIN|MAX, *RST 102% Negative: -102% of rating to 0|MIN|MAX, *RST -102%	<+ current limit> <- current limit>
Sets the positive current limit to 2 A: CURR:LIM 2 (@1) Sets the negative current limit to -2 A: CURR:LIM:NEG -2 (@1)	

- MIN is the most negative value of the range. MAX is the least negative value of the range.
- The query returns the programmed current limit in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.
- The negative current limit of Model N6783A-MFG is not programmable, but is fixed at -2A.

[SOURce:]CURRent:LIMit:COUPle 0|OFF|1|ON, (@<chanlist>) N678xA SMU
[SOURce:]CURRent:LIMit:COUPle? (@<chanlist>)

Sets the current limit tracking state.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the current limit tracking state: `CURR:LIM:COUP ON, (@1)`	

[SOURce:]CURRent:MODE FIXed|STEP|LIST|ARB, (@<chanlist>)
[SOURce:]CURRent:MODE? (@<chanlist>)

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, (@1)`	

[SOURce:]CURRent:PROTection:DELay[:TIME] <*value*>, (@<chanlist>)
[SOURce:]CURRent:PROTection:DELay[:TIME]? [MIN|MAX,] (@<chanlist>)

NOTE This command is the same as OUTPut:PROTection:DELay.

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 miilisecond.

Parameter	Typical Return
0 – 0.255|MIN|MAX, *RST 0.020	<delay value>
Sets the protection delay to 0.2 seconds: `CURR:PROT:DEL 0.2, (@1)`	

- 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, (@<chanlist>)
[SOURce:]CURRent:PROTection:DELay:STARt? (@<chanlist>)

Specifies what starts the over-current protection delay timer.

SCHange starts the over-current delay timer at the END of a settings change in voltage, current, or output state; allowing for additional protection delay time. Transitions into constant current mode are ignored DURING a programmed settings change in voltage, current, or output state.

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 as the current protection delay mode: `CURR:PROT:DEL:STAR CCTR, (@1)`	

[SOURce:]CURRent:PROTection:STATe 0|OFF|1|ON, (@<chanlist>)
[SOURce:]CURRent:PROTection:STATe? (@<chanlist>)

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

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the current protection state: `CURR:PROT:STAT ON, (@1)`	

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

[SOURce:]CURRent:RANGe <*value*>, (@<chanlist>)
[SOURce:]CURRent:RANGe? [MIN|MAX,] (@<chanlist>)

Sets the output current range on models that have multiple ranges. The value that you enter must be the highest value in amperes that you expect to source. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST MAX The maximum value is 102% of the current rating of the power module.	<current range>
Sets the output current range to 3 A: `CURR:RANG 3, (@1)`	

- This command is coupled with [SOURce:]CURRent. This means that if a range command places an output on a range with a lower maximum current than the present current level, an out of range error occurs. This also occurs if a current is programmed that is too large for the present range. Errors can be avoided by sending both level and range commands in the same SCPI message. When the range and level information is received as a set, no range/setting conflict occurs.
- If a programmed range change occurs while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.
- The query returns the maximum current that can be programmed on the range that is presently set. The current is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]CURRent:SLEW[:POSitive][:IMMediate] <*value*>, (@<chanlist>) N678xA SMU N679xA

[SOURce:]CURRent:SLEW[:POSitive][:IMMediate]? [MIN|MAX,] (@<chanlist>)

[SOURce:]CURRent:SLEW:NEGative[:IMMediate] <*value*>, (@<chanlist>) N679xA

[SOURce:]CURRent:SLEW:NEGative[:IMMediate]? [MIN|MAX,] (@<chanlist>)

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 analog performance of the output circuit. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37|MIN|MAX|INFinity, *RST MAX	<slew rate>
Sets the positive output slew rate to 1 A per second: `CURR:SLEW 1, (@1)` Sets the negative output slew rate to 1 A per second: `CURR:SLEW:NEG 1, (@1)`	

- The query returns the value that was sent. If the value is less than the minimum slew rate, only the minimum value is returned. The resolution of the slew setting is also the minimum value, which can be queried using CURRent:SLEW? MIN. The exact value varies slightly based on calibration.
- The query returns the programmed slew rate in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas. If a slew rate of 9.9E37 is returned, it means that the maximum or fastest slew rate has been set.

[SOURce:]CURRent:SLEW:COUPle 0|OFF|1|ON, (@<chanlist>) N679xA

[SOURce:]CURRent:SLEW:COUPle? (@<chanlist>)

Sets the current slew tracking state.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the current slew tracking state: `CURR:SLEW:COUP ON, (@1)`	

[SOURce:]CURRent:SLEW[:POSitive]:MAXimum 0|OFF|1|ON, (@<chanlist>) N678xA SMU N679xA

[SOURce:]CURRent:SLEW[:POSitive]:MAXimum? (@<chanlist>)

[SOURce:]CURRent:SLEW:NEGative:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA

[SOURce:]CURRent:SLEW:NEGative:MAXimum? (@<chanlist>)

Enables/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.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Disable the positive maximum slew rate: CURR:SLEW:MAX OFF, (@1) Disable the negative maximum slew rate: CURR:SLEW:NEG:MAX OFF, (@1)	

- The CURRent:SLEW:MAX command is coupled to the CURRent:SLEW command. If the CURRent:SLEW command sets the slew 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 Commands

Digital commands program the digital control port on the rear panel of the instrument. Refer to Using the Digital Port for more information.

[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 function of the pins. 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|EXPRession<1-8>|FAULt|INHibit|ONCouple|OFFCouple TINPut|TOUTput	DIO, DINP, EXPR<n>, 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 polarity of the pins.

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/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 Command

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 , default OFF	0 or 1
Turns the front panel display off: DISP OFF	

DISPlay[:WINDow]:VIEW METER1|METER4
DISPlay[:WINDow]:VIEW?

Selects the output channel view of the front panel display. METER1 displays one output channel. METER4 displays all output channels up to a maximum of four.

Parameter	Typical Return
METER1 | METER4, *RST METER1	METER1 or METER4
Sets the front panel to display up to four channels: DISP VIEW METER4	

Emulation Command

[SOURce:]EMULation <type>, (@<chanlist>) N678xA SMU
[SOURce:]EMULation? (@<chanlist>)

Specifies the emulation type for models N678xA. Refer to Emulation Mode Settings for information on the default parameter settings for each of the following emulation modes:

PS4Q	Four-quadrant bipolar power supply (model N6784A only). Power supply operation is available in all four output quadrants with no restrictions.
PS2Q	Two-quadrant bipolar power supply. In this mode operation is restricted to two quadrants (+V/+I and +V/- I).
PS1Q	Unipolar, one-quadrant power supply. This mode emulates a typical one quadrant or unipolar power supply with limited down-programming.
BATTery	Two-quadrant battery emulator. A battery emulator imitates a battery's charging and discharging functions. N6781A, N6785A
CHARger	One-quadrant battery charger. A battery charger imitates a battery charger; it cannot sink current like a battery. N6781A, N6785A
CCLoad	One-quadrant load. This mode emulates a constant-current load.
CVLoad	One-quadrant load. This mode emulates a constant-voltage load.
VMETer	Voltage measurement. The voltage measurement emulates a voltmeter.
AMETer	Current measurement. The current measurement emulates a zero-burden ammeter.

Parameter	Typical Return
<type>: PS4Q | PS2Q | PS1Q | BATTery | CHARger | CCLoad | CVLoad | VMETer | AMETer, *RST PS4Q for N6784A; PS2Q for N6781A, N6782A, N6785A, N6786A	PS4Q, PS2Q, PS1Q, BATT, CHAR, CCL, CVL, VMET, AMET
Selects CC load as the emulation type for channel 1: EMUL CCL, (@1)	

Fetch Commands

Fetch commands return measurement data that has been previously acquired by a MEASurement command or triggered acquisition. FETCh queries do not generate a new measurement, 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]? (@<chanlist>)
FETCh[:SCALar]:VOLTage[:DC]? (@<chanlist>)
FETCh[:SCALar]:POWer[:DC]? (@<chanlist>) N676xA N678xA SMU N679xA

Returns the averaged measurement. Values are either in amperes, volts, or watts. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<DC value>
Returns the averaged current FETC:CURR? (@1) Returns the averaged voltage FETC:VOLT? (@1) Returns the averaged power FETC:POW? (@1)	

FETCh[:SCALar]:CURRent:ACDC? (@<chanlist>)
FETCh[:SCALar]:VOLTage:ACDC? (@<chanlist>)

Returns the RMS measurement (AC + DC). Values returned are either in amperes, or volts. See Measurement Data Formats.The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<ACDC value>
Returns the measured RMS current FETC:CURR:ACDC? (@1) Returns the measured RMS voltage FETC:VOLT:ACDC? (@1)	

FETCh[:SCALar]:CURRent:HIGH? (@<chanlist>)
FETCh[:SCALar]:VOLTage:HIGH? (@<chanlist>)

Returns the High level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Data Formats. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<HIGH value>
Returns the measured high level current FETC:CURR:HIGH? (@1) Returns the measured high level voltage FETC:VOLT:HIGH? (@1)	

FETCh[:SCALar]:CURRent:LOW? (@<chanlist>)
FETCh[:SCALar]:VOLTage:LOW? (@<chanlist>)

Returns the Low level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Data Formats. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<LOW value>
Returns the measured low level current FETC:CURR:LOW? (@1) Returns the measured low level voltage FETC:VOLT:LOW? (@1)	

FETCh[:SCALar]:CURRent:MAXimum? (@<chanlist>)
FETCh[:SCALar]:VOLTage:MAXimum? (@<chanlist>)
FETCh[:SCALar]:POWer:MAXimum? (@<chanlist>) N676xA N678xA SMU N679xA
FETCh[:SCALar]:CURRent:MINimum? (@<chanlist>)
FETCh[:SCALar]:VOLTage:MINimum? (@<chanlist>)
FETCh[:SCALar]:POWer:MINimum? (@<chanlist>) N676xA N678xA SMU N679xA

Returns the maximum or minimum value. Values returned are either in amperes, volts, or Watts. See Measurement Data Formats. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<MIN value> <MAX value>
Returns the measured minimum current FETC:CURR:MIN? (@1) Returns the measured minimum voltage FETC:VOLT:MIN? (@1) Returns the measured minimum power FETC:POW:MIN? (@1) Returns the measured maximum current FETC:CURR:MAX? (@1) Returns the measured maximum voltage FETC:VOLT:MAX? (@1) Returns the measured maximum power FETC:POW:MAX? (@1)	

FETCh:ARRay:CURRent[:DC]? (@<chanlist>)
FETCh:ARRay:VOLTage[:DC]? (@<chanlist>)
FETCh:ARRay:POWer[:DC]? (@<chanlist>) N676xA N678xA SMU N679xA

Returns an array with the instantaneous measurement. Values 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 FETC:ARR:CURR? (@1) Returns the measured voltage array FETC:ARR:VOLT? (@1) Returns the measured power array FETC:ARR:POW? (@1)	

FETCh:DLOG:AHOur? (@<chanlist>)
FETCh:DLOG:WHOur? (@<chanlist>)

Returns the amp-hours or watt-hours delineated by the front panel markers on the selected data log traces that appears in the instrument's Data Logger view. These values corresponds to the Ah (amp-hours) or Wh (watt-hour) value shown on the bottom of the instrument's Data Logger view when markers are displayed. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<amp-hour value> <watt-hour value>
Returns the amp-hours delineated by the markers FETC:DLOG:AHO? (@1) Returns the watt-hours delineated by the markers FETC:DLOG:WHO? (@1)	

FETCh:DLOG:CURRent[:DC]? (@<chanlist>)
FETCh:DLOG:VOLTage[:DC]? (@<chanlist>)

Returns the averaged measurement. Values returned are either in amperes or volts. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<datalog value>
Returns the averaged current FETC:DLOG:CURR? (@1) Returns the averaged voltage FETC:DLOG:VOLT? (@1)	

FETCh:DLOG:CURRent:MAXimum? (@<chanlist>)
FETCh:DLOG:VOLTage:MAXimum? (@<chanlist>)
FETCh:DLOG:CURRent:MINimum? (@<chanlist>)
FETCh:DLOG:VOLTage:MINimum? (@<chanlist>)

Returns the maximum or minimum value. Values returned are either in amperes, or volts. See Measurement Data Formats.The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<MIN value> <MAX value>
Returns the measured minimum current FETC:DLOG:CURR:MIN? (@1) Returns the measured minimum voltage FETC:DLOG:VOLT:MIN? (@1) Returns the measured maximum current FETC:DLOG:CURR:MAX? (@1) Returns the measured maximum voltage FETC:DLOG:VOLT:MAX? (@1)	

FETCh:DLOG:CURRent:PTPeak? (@<chanlist>)
FETCh:DLOG:VOLTage:PTPeak? (@<chanlist>)

Returns the peak-to-peak output current or voltage that is delineated by the front panel markers on the selected data log trace that appears in the instrument's Data Logger view. These values corresponds to the Vp-p Ip-p valuec shown on the bottom of the instrument's Data Logger view when markers are displayed. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<peak-to-peak value>
Returns the p-to-p current delineated by the markers FETC:DLOG:CURR:PTP? (@1) Returns the p-to-p voltage delineated by the markers FETC:DLOG:VOLT:PTP? (@1)	

FETCh:ELOG? <*maxrecords*>, (@<chanlist>)

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 specifies the maximum number of records of datalog data that the controller will return for each channel. A 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 external datalog sensing. If ALL datalog sense functions are enabled, one record will contain:
Current average, Current minimum, Current maximum, Voltage average, Voltage minimum, and Voltage maximum, in that order. If any of these sense functions are not enabled, that data is not part of the returned record.

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, (@1)	

FETCh:HISTogram:CURRent? <range>, (@<chanlist>) N6781A, N6782A N6785A, N6786A

Returns the current histogram bin data. There are two bin ranges, with 4096 bins in each range.

	Models N6781A/N6782A		Models N6785A/N6786A	
Range	Low	High	Low	High
Value	7.8 mA	8 A	15.6 mA	16 A

The reading is in the form +n.nnnnnnE+nn. Values are separated by commas.

Parameter	Typical Return
8 | 0.0078 (for N6781A/N6782A) 16 | 0.0156 (for N6785A/N6786A)	<bin data> [,<bin data>] or <Block>
Returns low range current data FETC:HIST:CURR? 0.0078, (@1)	

Format Commands

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 subset of SCPI queries that can return large quantities of data. These include: FETC:ARR:CURR? and FETC:ARR:VOLT?.

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. These include: FETC:ARR:CURR? and FETC:ARR:VOLT?.

Function Command

[SOURce:]FUNCtion CURRent|VOLTage|POWer|RESistance, (@<chanlist>) N678xA SMU N679xA

[SOURce:]FUNCtion? (@<chanlist>)

Sets the output priority mode. Power and Resistance priority modes only apply to models N679xA.

In voltage priority mode the output is controlled by a bi-polar constant voltage feedback loop, which maintains the output voltage at its positive or negative programmed setting. In current priority mode the output is controlled by a bi-polar constant current feedback loop, which maintains the output sourcing or sinking current at its programmed setting.

For N679xA load modules in power or resistance priority modes, the constant current along with the constant voltage feedback loops maintain the input power and resistance at their programmed settings.

Refer to Operating Mode Tutorial for more information.

Parameter	Typical Return
CURRent|VOLTage|POWer|RESistance, *RST CURRent for N679xA *RST VOLTage for N678xA SMU	CURR, VOLT, POW, or RES
Selects current priority regulation mode: FUNC CURR, (@1)	

Hcopy Commands

HCOPy commands return the front panel 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 488.2 Common Commands

*CLS

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

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

*ESE <*value*>
*ESE?

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

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

- Any or all of the enabled events of the Standard Event Status Event Register are logically ORed to cause the Event Summary Bit (ESB) of the Status Byte Register to be set.
- *CLS does not clear the enable register, but does clear the event register.
- The value returned is the binary-weighted sum of all bits set in the register.

*ESR?

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

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

- To be reported to the Standard Event Register, the corresponding bits in the event register must be enabled using *ESE.
- Once a bit is set, it remains set until cleared by this query or *CLS.
- The value returned is the binary-weighted sum of all bits set in the register.

*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)	<ASCII string with comma-separated fields>
Return the instrument's identification string: *IDN?	

- Example response: Keysight Technologies,N6705C,MY55123456,E.00.02.2266

*OPC
*OPC?

Operation Complete Command and Query. *OPC sets the OPC (Operation Complete) status bit in the *Standard Event register* when the instrument has completed all pending operations sent before *OPC. This occurs at the completion of the current operation. Refer to Status Tutorial for more information.

*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
Sets the Operation Complete bit: *OPC Returns a 1 when commands complete: *OPC?	

- These commands are primarily used for program synchronization.
- Used in conjunction with initiated acquisitions, initiated 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.

*OPT?

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

Parameter	Typical Return
(none)	<option number>
Returns installed options: *OPT?	

*RCL <0-9>

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

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

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

*RDT?

Returns the output channel descriptions. The description is an arbitrary ASCII string with up to four semicolon-separated fields. To read the string into your computer, be sure to dimension a string variable with at least 50 characters.

Parameter	Typical Return
(none)	<ASCII string with semicolon-separated fields>
Identify the mainframe's installed power modules: *RDT?	

- Example 4-channel response: CHAN1,N6751A;CHAN2,N6752A;CHAN3,N6761A;CHAN4,N6762A

*RST

Reset Command Resets the instrument to pre-defined values that are either typical or safe. These settings are described in Factory Reset State.

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

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

*SAV <0-9>

Save State Saves the present state of the instrument to one of ten non-volatile memory locations. Any state previously stored in the same location will be overwritten. Refer to Reset State for a list of instrument settings that can be saved. Settings

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

- If a particular state is desired at power-on, it should be stored in location 0. Location 0 is automatically recalled at power turn-on when the Output Power-On state is set to RCL 0.
- The calibration state is NOT saved as part of the *SAV operation.
- Data saved in non-volatile memory is not affected by the *SAV command.
- A reset (*RST) command does not affect the instrument states stored in memory. Once a state is stored, it remains until it is overwritten or specifically deleted.

*SRE <*value*>
*SRE?

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

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

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

- When a serial poll is conducted in response to a service request, RQS is cleared but MSS is not.
- When *SRE is cleared (by programming it with 0), the power analyzer cannot generate a service request.

*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?	

- The status summary bits are cleared when the appropriate event registers are read. The MAV bit is cleared at power-on, by *CLS, or when there is no more response data available.
- When a serial poll is conducted in response to a service request, RQS is cleared, but MSS is not.

*TRG

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

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

*TST?

SelfTest Query. Performs an instrument selftest. A 0 (zero) indicates the instrument passed selftest. If selftest fails, one or more error messages will provide additional information. Use SYSTem:ERRor? to read the error queue. See SCPI Error Messages for more information.

Parameter	Typical Return
(none)	0 or 1
Perform selftest: *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 Commands

Initiate commands initialize the trigger system. This enables the trigger system to receive triggers.

INITiate[:IMMediate]:ACQuire (@<chanlist>)
INITiate[:IMMediate]:DLOG <"filename">
INITiate[:IMMediate]:ELOG (@<chanlist>)
INITiate[:IMMediate]:HISTogram (@<chanlist>) N6781A, N6782A N6785A, N6786A
INITiate[:IMMediate]:TRANsient (@<chanlist>)

INITiate:ACQuire - Initiates the measurement trigger system. When a measurement trigger is initiated, an event on a selected trigger source causes the specified triggering action to occur.

INITiate:DLOG - Initiates internal data logging. When the internal data log is initiated, an event on a selected data log trigger source starts a data log. The filename in which to save the data should be the full path and filename. All data log files must have the extension .dlog.

INITiate:ELOG - Initiates external data logging. When the external data log is initiated, an event on a selected external data log trigger source starts the data log.

INITiate:HISTogram - Initiates a histogram current measurement. A histogram measurement provides a statistical measurement for profiling the signal levels of a sense function.

INITiate:TRANsent - Initiates the transient trigger system. When initiated, an event on the selected trigger source causes the specified triggered action to occur on the output.

Parameter	Typical Return
INIT:DLOG: <*"filename"*>String program data. Enclose string parameters in single or double quotes.	(none)
Initiates the measurement trigger system: INIT:ACQ (@1) Initiates an internal data log: INIT:DLOG "Daltalog1.dlog" Initiates an external data log: INIT:ELOG (@1) Initiates a histogram current measurement: INIT:HIST (@1) Initiates the transient trigger system: INIT:TRAN (@1)	

- It takes a few milliseconds for the instrument to be ready to receive a trigger signal after receiving the INITiate command, and it can take longer if the value of SENSe:SWEep:OFFSet:POINts is negative.
- If a trigger occurs before the trigger system is ready for it, the trigger will be ignored. Check the WTG_meas and the WTG_tran bits in the operation status register to know when the instrument is ready.
- Use the appropriate ABORt command to return the instrument to the Idle state.

INITiate:CONTinuous:TRANsient 0|OFF|1|ON, (@<chanlist>)
INITiate:CONTinuous:TRANsient? (@<chanlist>)

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

Parameter	Typical Return
0|OFF|1|ON , *RST ON	0 or 1
Continually initiates the trigger system: INIT:CONT:TRAN ON, (@1)	

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

List Commands

List commands program an output sequence of multiple current, voltage, power, or resistance settings. A comma-delimited list of up to 512 steps may be programmed. Note that for Models N678xA SMU N678xA SMU, only the parameters associated with **one** of the priority modes (either voltage priority or current priority) may be list controlled.

[SOURce:]LIST:COUNt <*value*>, (@<chanlist>)
[SOURce:]LIST:COUNt? [MIN|MAX,] (@<chanlist>)

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. Use the Infinity parameter to run the list continuously.

Parameter	Typical Return
1 – 4096|MIN|MAX|INFinity, *RST 1	<list count>
Sets the list count to 10: LIST:COUN 10, (@1)	

- Use ABORt:TRANsient to stop the list at any time. When the list is aborted, the output returns to the settings that were in effect before the list started.
- The query returns the list count for each channel specified. If a repeat count of 9.9E37 is returned, it means the list is set to repeat continuously.

[SOURce:]LIST:CURRent[:LEVel] <*value*>{,<*value*>}, (@<chanlist>)
[SOURce:]LIST:CURRent[:LEVel]? (@<chanlist>)
[SOURce:]LIST:VOLTage[:LEVel] <*value*>,{<*value*>}, (@<chanlist>)
[SOURce:]LIST:VOLTage[:LEVel]? (@<chanlist>)
[SOURce:]LIST:POWer[:LEVel] <*value*>,{<*value*>}, (@<chanlist>) N679xA
[SOURce:]LIST:POWer[:LEVel]? (@<chanlist>)
[SOURce:]LIST:RESistance[:LEVel] <*value*>,{<*value*>}, (@<chanlist>) N679xA
[SOURce:]LIST:RESistance[:LEVel]? (@<chanlist>)

Specifies the setting for each list step. Values are specified in amperes, volts, watts or ohms. A comma-delimited list of up to 512 steps may be programmed.

Parameter	Typical Return
0 to maximum. Values are range and module-rating dependent.. *RST 1 step set to the minimum programmable value.	<list value 1>, <list value 2>, <list value 3>...
Programs a current list of 3 steps. LIST:CURR 3,2,1, (@1) Programs a voltage list of 3 steps. LIST:VOLT 20,10,5, (@1) Programs a power list of 3 steps. LIST:POW 20,10,5, (@1) Programs a resistance list of 3 steps. LIST:RES 20,50,100, (@1)	

- The order in which the list values are entered determines the sequence when the list executes.
- To create a valid list, the current, voltage, power, resistance, BOST, EOST, and Dwell lists must all be the same length or have a length of 1, which is interpreted as having the same length as the longest list.
- This command overwrites any present list in active memory; it does not append to the present list.

[SOURce:]LIST:DWELl <*value*>{,<*value*>}, (@<chanlist>)
[SOURce:]LIST:DWELl? (@<chanlist>)

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 or 0 through 268.435 seconds with the following resolution:

All models except N678xA SMU and N679xA		Models N678xA SMU and N679xA only	
Range in seconds	Resolution	Range in seconds	Resolution
0 - 0.262144	1 microsecond	0 - 0.268435	1.024 microsecond
0.262144 - 2.62144	10 microseconds	0.268435 - 2.68435	10.24 microseconds
2.62144 - 26.2144	100 microseconds	2.68435 - 26.8435	102.4 microseconds
26.2144 - 262.144	1 millisecond	26.8435 - 268.435	1.024 millisecond

A comma-delimited list of up to 512 steps may be programmed. At the end of the dwell time, the output state of the unit depends upon the [SOURce:]LIST:STEP program settings.

Parameter	Typical Return
0 – 262.144 (all except N678xA and N679xA) 0 - 268.435 (N678xA SMU and N679xA only) *RST 1 step with a value of 0.001	<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, (@1)	

- The order in which the list values are entered determines the sequence when the list executes.
- To create a valid list, the current, voltage, power, resistance, BOST, EOST, and Dwell lists must all be the same length or have a length of 1, which is interpreted as having the same length as the longest list.
- This command overwrites any present list in active memory; it does not append to the present list.

[SOURce:]LIST:CURRent:POINts? (@<chanlist>)
[SOURce:]LIST:DWELl:POINts? (@<chanlist>)
[SOURce:]LIST:VOLTage:POINts? (@<chanlist>)
[SOURce:]LIST:POWer:POINts? (@<chanlist>) N679xA
[SOURce:]LIST:RESistance:POINts? (@<chanlist>) N679xA
[SOURce:]LIST:TOUTput:BOSTep:POINts? (@<chanlist>)
[SOURce:]LIST:TOUTput:EOSTep:POINts? (@<chanlist>)

Returns the number of list points (same as steps). The queries do not return the point values.

Parameter	Typical Return
(none)	<points>
Returns the number of points in the current list: LIST:CURR:POIN? (@1) Returns the number of points in the dwell list: LIST:DWEL:POIN? (@1) Returns the number of points in the voltage list: LIST:VOLT:POIN? (@1) Returns the number of points in the power list: LIST:POW:POIN? (@1) Returns the number of points in the resistance list: LIST:RES:POIN? (@1) Returns the number of points in the BOST list: LIST:TOUT:BOST:POIN? (@1) Returns the number of points in the EOST list: LIST:TOUT:EOST:POIN? (@1)	

[SOURce:]LIST:STEP ONCE|AUTO, (@<chanlist>)
[SOURce:]LIST:STEP? (@<chanlist>)

Specifies how the list responds to triggers.

ONCE - the output remains at the present step until a trigger advances it to the next step. Triggers that arrive during the dwell time are ignored.

AUTO - the output automatically advances 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, (@1)	

[SOURce:]LIST:TERMinate:LAST 0|OFF|1|ON, (@<chanlist>)
[SOURce:]LIST:TERMinate:LAST? (@<chanlist>)

Determines the output value when the list terminates. When ON (1), the output remains at the last list step. The value of the last list step becomes the IMMediate value. 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, (@1)	

- The query command returns 0 if the output returns to the settings that were in effect before the list started, and 1 if the output voltage or current remains at the value of the last list step.

[SOURce:]LIST:TOUTput:BOSTep[:DATA] 0|OFF|1|ON {,0|OFF|1|ON}, (@<chanlist>)
[SOURce:]LIST:TOUTput:BOSTep[:DATA]? (@<chanlist>)
[SOURce:]LIST:TOUTput:EOSTep[:DATA] 0|OFF|1|ON {,0|OFF|1|ON}, (@<chanlist>)
[SOURce:]LIST:TOUTput:EOSTep[:DATA]? (@<chanlist>)

Specifies which list steps generate a trigger signal at the beginning of step (BOSTep) or end of step (EOSTep). A comma-delimited list of up to 512 steps may be programmed.

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 , *RST 1 step with a value of OFF	<list value 1>, <list value 2>, <list value 3>...
To generate triggers at the beginning of the second step of a 3-step list: LIST:TOUT:BOST OFF,ON,OFF, (@1)	

- The order in which the list values are entered determines the sequence when the list executes.
- To create a valid list, the current, voltage, power, resistance, BOST, EOST, and Dwell lists must all be the same length or have a length of 1, which is interpreted as having the same length as the longest list.
- This command overwrites any present list in active memory; it does not append to the present list.

LXI Commands

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:IDEN ON	

LXI:MDNS[:STATe] 0|OFF|1|ON
LXI:MDNS[:STATe]?

Controls the state of the mDNS server. Enables or disables multitasking DNS service on a private LAN

Parameter	Typical Return
0|OFF|1|ON , *RST OFF	0 or 1
To enable mDNS: LXI:MDNS ON	

Measure Commands

Measure commands measure the output voltage, current, or power. The MEASure queries start a new measurement immediately. They are not synchronized to any trigger event.

Use the INITiate, TRIGger, and FETCh commands if a synchronized measurement is necessary.

The default time interval and number of points settings yield a measurement time of 21 milliseconds per reading (1024 data points at 20.48 microsecond intervals). The default windowing function is Rectangular.

MEASure[:SCALar]:CURRent[:DC]? (@<chanlist>)
MEASure[:SCALar]:VOLTage[:DC]? (@<chanlist>)
MEASure[:SCALar]:POWer[:DC]? (@<chanlist>) N676xA N678xA SMU N679xA

Initiates and triggers a measurement. Returns the averaged output measurement. Values are either in amperes, volts, or watts. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<DC value>
Returns the averaged current MEAS:CURR? (@1) Returns the averaged power MEAS:POW? (@1) Returns the averaged voltage MEAS:VOLT? (@1)	

MEASure[:SCALar]:CURRent:ACDC? (@<chanlist>)
MEASure[:SCALar]:VOLTage:ACDC? (@<chanlist>)

Initiates, triggers, and returns the total RMS measurement (AC + DC). Values returned are either in amperes, or volts. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<ACDC value>
Returns the measured RMS current MEAS:CURR:ACDC? (@1) Returns the measured RMS voltage MEAS:VOLT:ACDC? (@1)	

MEASure[:SCALar]:CURRent:HIGH? (@<chanlist>)
MEASure[:SCALar]:VOLTage:HIGH? (@<chanlist>)

Initiates, triggers, and returns the High level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Data Formats. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<HIGH value>
Returns the measured high level current MEAS:CURR:HIGH? (@1) Returns the measured high level voltage MEAS:VOLT:HIGH? (@1)	

MEASure[:SCALar]:CURRent:LOW? (@<chanlist>)
MEASure[:SCALar]:VOLTage:LOW? (@<chanlist>)

Initiates, triggers, and returns the Low level of a pulse waveform. Values returned are either in amperes, or volts. See Measurement Data Formats. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<LOW value>
Returns the measured low level current MEAS:CURR:LOW? (@1) Returns the measured low level voltage MEAS:VOLT:LOW? (@1)	

MEASure[:SCALar]:CURRent:MAXimum? (@<chanlist>)
MEASure[:SCALar]:VOLTage:MAXimum? (@<chanlist>)
MEASure[:SCALar]:POWer:MAXimum? (@<chanlist>) N676xA N678xA SMU N679xA
MEASure[:SCALar]:CURRent:MINimum? (@<chanlist>)
MEASure[:SCALar]:VOLTage:MINimum? (@<chanlist>)
MEASure[:SCALar]:POWer:MINimum? (@<chanlist>) N676xA N678xA SMU N679xA

Initiates, triggers, and returns the maximum or minimum values of a measurement. Values returned are either in amperes, volts, or Watts. The reading is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

Parameter	Typical Return
(none)	<MIN value> <MAX value>
Returns the measured minimum current MEAS:CURR:MIN? (@1) Returns the measured minimum voltage MEAS:VOLT:MIN? (@1) Returns the measured minimum power MEAS:POW:MIN? (@1) Returns the measured maximum current MEAS:CURR:MAX? (@1) Returns the measured maximum voltage MEAS:VOLT:MAX? (@1) Returns the measured maximum power MEAS:POW:MAX? (@1)	

MEASure:ARRay:CURRent[:DC]? (@<chanlist>)
MEASure:ARRay:VOLTage[:DC]? (@<chanlist>)
MEASure:ARRay:POWer[:DC]? (@<chanlist>) N676xA N678xA SMU N679xA

Initiates and triggers a measurement; returns a list of the digitized output measurement samples. Values are either in amperes, volts, or watts.

The sampling rate is set by SENSe:SWEep:TINTerval. The position of the trigger relative to the beginning of the data buffer is determined by SENSe:SWEep:OFFSet:POINts. The number of points returned is set by SENSe:SWEep: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
(none)	<value> [,<value>] or <Block>
Returns the measured current array MEAS:ARR:CURR? (@1) Returns the measured power array MEAS:ARR:POW? (@1) Returns the measured voltage array MEAS:ARR:VOLT? (@1)	

Memory Commands

MMEMory commands provide mass storage capability for output measurement data. The mass storage may be either internal or external to the instrument. The mass storage device is selected using the full path embedded within the filename. The filename parameter is a string.

MMEMory:ATTribute? <"object">, <"attribute">

Returns the objects and attributes of a file system drive or of an individual file.

Object	Description
"INTernal"	Specifies the instrument's internal drive.
"EXTernal"	Specifies the instrument's USB drive
"filename"	Specifies the full path and filename.

Attribute	Description
"DriveCapacity"	Specifies the capacity of the internal or external drive in bytes. Only applies when the object is INTernal or EXTernal.
"DriveFreeSpace"	Specifies the number of free bytes on the internal or external drive. Only applies when the object is INTernal or EXTernal.
"FileSize"	Specifies the size of the file or folder. Only applies when the object is <filename>.

Parameter	Typical Return
<object>: "INTernal:"|"EXTernal:"|"<"filename"> <attribute>: "DriveCapacity"|"DriveFreeSpace" |"FileSize" Enclose string parameters in single or double quotes.	<ASCII string>
Queries the internal drive description: MMEM:ATTR? "INT:","DriveFreeSpace" Queries the attributes of a data log file: MMEM:ATTR? "INT:\datalog\data1.dlog","FileSize"	

- The query returns an ASCII string enclosed in double quotes containing the value of the specified attribute, or a blank string if the name of the attribute is not valid or an error has occurred.

MMEMory:DATA[:DEFinite] <"filename">, <data>
MMEMory:DATA[:DEFinite]? <"filename">

Copies a file to the file system of the instrument. <"filename"> should be the full path and filename. <data> is a definite length arbitrary binary block of the form #<D><DD...D><data-bytes>, where **#<D>** indicates the response is definite length with <D> indicating the number of digits in the length. **<DD...D>** indicates the length of the binary block containing the actual file. **<data-bytes>** are the contents of the file.

Parameter	Typical Return
<*"filename"*>: String program data. Enclose string parameters in single or double quotes. <data>: #<D><DD...D><data-bytes>	<Block>
Copies a file and its contents to the file system: MMEM:DATA "internal:\example.bin", <insert definite length binary block here>	

- The query returns the contents of the specified file.

MMEMory:DELete <"filename">

Deletes the specified file. The filename should be the full path and filename.

Parameter	Typical Return
<*"filename"*>: String program data. Enclose string parameters in single or double quotes.	(none)
Deletes the file named data1.dlog: MMEM:DEL "internal:\datalog\data1.dlog"	

MMEMory:EXPort:DLOG <"filename">

Exports the data that is currently loaded in the instrument's datalog viewer to a file. The export filename should be the full path and filename. The exported data is in .csv (comma separated values) format .

Parameter	Typical Return
<*"filename"*>: String program data. Enclose string parameters in single or double quotes.	(none)
Exports a data log file to the USB drive: MMEM:EXP:DLOG "external:\data1.csv"	

MMEMory:LOAD:ARB:SEQuence <"filename">, (@<chanlist>)

Loads an arbitrary wavefoprm sequence from a file. The filename should be the full path and filename. All Arb sequence data is saved in a proprietary format (.seq) which is not editable.

Parameter	Typical Return
<*"filename"*>: String program data. Enclose string parameters in single or double quotes.	(none)
Loads a sequence file from the USB drive to channel 1: MMEM:LOAD:ARB:SEQ "external:\data1.seq",(@1)	

MMEMory:STORe:ARB:SEQuence <"filename">, (@<chanlist>)

Stores an arbitrary wavefoprm sequence to a file. The filename should be the full path and filename. All Arb sequence data is saved in a proprietary format (.seq) which is not editable.

Parameter	Typical Return
<*"filename"*>: String program data. Enclose string parameters in single or double quotes.	(none)
Stores a sequence file from channel 1 to the USB drive: `MMEM:STOR:ARB:SEQ "external:\data1.seq",(@1)`	

- An ARB sequence can only be saved from one channel at a time.

Output Commands

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

NOTE Keysight N679xA Load Module inputs are referred to as "Outputs" throughout this document N679xA.

OUTPut[:STATe] 0|OFF|1|ON [,NORelay], (@<chanlist>)
OUTPut[:STATe]? (@<chanlist>)

Enables or disables the output. The state of a disabled output is a condition of zero output voltage and zero current. If output and sense relays are installed (Option 761), the relays will open when the output is disabled and close when the output is enabled.

NORelay - If you require shorter output turn-on delay times, and do not need the galvanic relay disconnect feature, the optional NORelay parameter lets you turn the output state on or off and leave the state of the relays unchanged. When not specified, the relays open and close as the output is turned off and on. Relays only open and close when the output is at zero voltage; zero current.

Parameter	Typical Return
0|OFF|1|ON , *RST OFF	0 or 1
Turns the output off: OUTP OFF, (@1)	

- Because of internal circuit start-up procedures and any installed relay options, the OUTPut ON command may take between 35 and 50 milliseconds to complete. The OUTPut OFF command may take between 20 and 25 milliseconds to complete. To mitigate this built-in delay, you can program the output to zero volts rather than using the output on/off command.
- To use the optional NORelay parameter, you must first set the relays to the closed state by programming OUTPut ON without the NORelay parameter. The relays will be set closed. For the output relays to remain closed from then on, you must subsequently include the NORelay parameter each time you program the output on or off.

OUTPut[:STATe]:COUPle:CHANnel [<channel> {,<channel>}]
OUTPut[:STATe]:COUPle:CHANnel?

Specifies which output channels in the mainframe are controlled by the output synchronization function. The output channels that have been synchronized or coupled will turn on and off together when any one of them is turned on or off, or when a signal is received from a digital connector pin that has been configured as an On couple or an Off couple pin as described described under Output Couple Control. This parameter is saved in non-volatile memory.

Parameter	Typical Return
1|2|3|4, *RST 0	<coupled channels>
Couples channel 1,2,and 4: OUTP:COUP:CHAN 1,2,4	

- There can be only one set of coupled channels in a mainframe. If another coupled set is programmed, the existing set is deleted and the new set applies. If you do not specify an output channel, this command will uncouple all output channels on the mainframe.
- When this command is sent, all channels in the unit will go to the output off state.

OUTPut[:STATe]:COUPle:DOFFset <*value*>
OUTPut[:STATe]:COUPle:DOFFset? [MIN|MAX,]

Sets a delay offset to synchronize coupled output state changes. Delay times can be programmed from 0 to 1.023 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 delay only applies to coupled channels, provided OUTput:COUPle is enabled. 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	

- When this command is sent, all channels in the unit will go to the output off state.

OUTPut[:STATe]:COUPle:DOFFset:MODE AUTO|MANual
OUTPut[:STATe]:COUPle:DOFFset:MODE?

Specifies the mode that determines where the output coupling delay value comes from when outputs are synchronized. This parameter is saved in non-volatile memory.

AUTO - The power analyzer automatically calculates the maximum delay offset value for all output channels in the mainframe.
MANual - The power analyzer uses the delay offset value set by OUTPut:COUPle:DOFFSet.

Parameter	Typical Return
AUTO|MANual, *RST AUTO	AUTO or MAN
Sets the delay offset mode to manual: OUTP:COUP:DOFF:MODE MAN	

- When this command is sent, all channels in the unit will go to the output off state.

OUTPut[:STATe]:COUPle:MAX:DOFFset?

Returns the largest delay offset that is required for the output channels installed in this mainframe. 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*>, (@<chanlist>)
OUTPut[:STATe]:DELay:FALL? [MIN|MAX,] (@<chanlist>)
OUTPut[:STATe]:DELay:RISE <*value*>, (@<chanlist>)
OUTPut[:STATe]:DELay:RISE? [MIN|MAX,] (@<chanlist>)

Specifies the delay in seconds that the instrument waits before turning the output on (rise) or off (fall). This allows multiple channels 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 from 0 to 1023 seconds 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, (@1) Sets a delay of 0.2 s before turning the output off: OUTP:DEL:FALL 0.2, (@1)	

- Each power module 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]:PMODe VOLTage|CURRent, (@<chanlist>) N6761A, N6762A
OUTPut[:STATe]:PMODe? (@<chanlist>)

Selects the preferred mode for output on or output off transitions. It allows output state transitions to be optimized for either constant voltage or constant current operation. Turn-on and turn-off overshoots are minimized for the preferred mode of operation.

Voltage - minimizes output on/off voltage overshoots in constant voltage operation.
Current - minimizes output on/off current overshoots in constant current operation.

Parameter	Typical Return
VOLTage|CURRent, *RST VOLTage	VOLT or CURR
Sets the preferred mode to CURRent: OUTP:PMODE CURR, (@1)	

OUTPut[:STATe]:TMODe HIGHz|LOWz, (@<chanlist>) N678xA SMU
OUTPut[:STATe]:TMODe? (@<chanlist>)

Specifies the output impedance mode at turn-off.

HIGHz - sets the output to a high impedance mode at turn-off. In high impedance mode, the output relays are opened while the output remains at its set value.
LOWZ - sets the output to a low impedance mode at turn-off. In low impedance mode, the output is first down-programmed to zero, after which the output relays are opened.

Parameter	Typical Return
HIGHz|LOWZ, *RST HIGHz	HIGH or LOWZ
Sets the turn-off mode to high impedance: OUTP:TMODE HIGH, (@1)	

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

Sets the operating mode of the Inhibit Input digital pin. The inhibit function shuts down the output in response to an external signal on the Inhibit input pin. The parameter is saved in non-volatile memory.

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 OUTPut:PROTection:CLEar or a protection clear 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 latching mode: OUTP:INH:MODE LATC	

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

OUTPut:PROTection:CLEar (@<chanlist>)

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

Parameter	Typical Return
(none)	(none)
Clears the latched protection status: OUTP:PROT:CLE (@1)	

- 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:COUPle 0|OFF|1|ON

Enables or disables channel coupling for protection faults. When enabled, ALL output channels are disabled when a protection fault occurs on any output channel. When disabled, only the affected output channel is disabled when a protection fault is triggered

Parameter	Typical Return
0|OFF|1|ON , *RST OFF	0 or 1
Turns the output coupling protection on: OUTP:PROT:COUP ON	

OUTPut:PROTection:DELay <*value*>, (@<chanlist>)
OUTPut:PROTection:DELay? [MIN|MAX,] (@<chanlist>)

NOTE This command is the same as [SOURce:]CURRent:PROTection:DELay.

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|MIN|MAX, *RST 0.020	<delay value>
Sets a delay protection of 0.2 seconds: OUTP:PROT:DEL 0.2, (@1)	

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

OUTPut:PROTection:OSCillation 0|OFF|1|ON, (@<chanlist>) N678xA SMU
OUTPut:PROTection:OSCillation? (@<chanlist>)

Enables/Disables oscillation protection. If capacitive loads cause the output to oscillate on any of the bandwidth settings, this protection function will detect the oscillation and latch the output off.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables oscillation protection: OUTP:PROT:OSC ON, (@1)	

OUTPut:PROTection:TEMPerature:MARGin? (@<chanlist>)

Returns the margin remaining before the over-temperature trips. The temperature margin is 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? (@1)	

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

Enables/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 OUTput:PROTection:WDOG:DELay. 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*>
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|MIN|MAX, *RST 60	<delay value>
Sets a watchdog delay of 600 seconds: OUTP:PROT:WDOG:DEL 600	

OUTPut:RELay:POLarity NORMal|REVerse, (@<chanlist>)
OUTPut:RELay:POLarity? (@<chanlist>)

NOTE This command only applies to models N673xA. N674xA, N675xA, N676xA, and N677xA with Option 760.

Sets the polarity of the output relays on power modules with polarity reversal relays installed (Option 760). Polarity reversal affects both the output and the sense terminals.

Normal causes the output polarity to be the same as the output connector labeling.
Reverse causes the output polarity to be the reverse of the output connector labeling. This briefly turns the output off while the output and sense terminal polarities are switched.

NOTE When installed on models N6742B and N6773A, Option 760 (Polarity Reversal) will limit the output current of these models to a maximum of 10 A. Option 760 is **not** available on models N6741B, N6751A, N6752A, N676xA, or N678xA SMU.

Parameter	Typical Return
NORMal|REVerse, *RST NORMal	NORM or REV
Sets the output polarity to Reverse: `OUTP:REL:POL REV (@1)`	

OUTPut:SHORt[:STATe] 0|OFF|1|ON N679xA
OUTPut:SHORt[:STATe]?

Simulates a short circuit on the input of the load. It works in all priority modes and temporarily overrides input and slew settings. Note that the Output on/off and the output protection functions take precedence over an input short. The actual value of the short depends on the mode and range that are active when the short is programmed.

In CV mode, a short is equivalent to programming zero volts.
In CC mode, a short is equivalent to programming full-scale current for the present current range.
In CR mode, a short is equivalent to programming the minimum resistance for the present resistance range.

Turning the short circuit on does not affect the programmed settings, and the load input will return to the previously programmed values when the short is turned off.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Simulate a short on the load input terminals: `OUTP:SHOR ON`	

Power Commands

[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)
[SOURce:]POWer[:LEVel]:TRIGgered[:AMPLitude] <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX,] (@<chanlist>)

Sets the immediate input power level and the triggered input power level. Values can range from zero to the maximum input power rating of the load module. The triggered level is a stored value that will be programmed when a Step transient is triggered. Units are in Watts.

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST MIN	0 (zero)
Specifies a power level of 50 Watts: POW 50, (@1) Specifies a triggered power level of 75 Watts: POW:TRIG 75, (@1)	

- The query returns the programmed power in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]POWer:LIMit <*value*>, (<@chanlist>)
[SOURce:]POWer:LIMit? [MIN|MAX,] (<@chanlist>)

Sets the power limit on output channels. Units are in Watts.

For the majority of Keysight N6705C configurations, full power is available from all installed power modules. However, it is possible to configure a mainframe in which the combined ratings of the power modules exceed the power rating of the mainframe

For these instrument configurations, the power allocation lets you programmatically limit the output power of some of the power modules so that the combined output power does not exceed the power rating of the mainframe. Refer to Power Limit Operation for more information.

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST MAX	<power limit>
Sets the power limit to 75 W on channels 1 and 2: POW:LIM 75, (@1,2)	

- Setting a power limit of MAX on an output channel sets the output channel to its maximum rated power limit. If the power limit is left at the maximum rating, then the power module will not enable its power limit function.
- The query returns the programmed power level in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas. Querying MAX on an output channel returns the maximum rated power limit.
- For models N679xA, the query returns the input power level setting.

[SOURce:]POWer:MODE FIXed|STEP|LIST|ARB, (@<chanlist>) N679xA
[SOURce:]POWer:MODE? (@<chanlist>)

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

FIXed – keeps the input power at its immediate value.
STEP – steps the input power to the triggered level when a trigger occurs.
LIST – causes the input power to follow the list values when a trigger occurs.
ARB causes the input power 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 input power mode to Step: POW:MODE STEP, (@1)	

[SOURce:]POWer:PROTection:DELay[:TIME] <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer:PROTection:DELay[:TIME]? [MIN|MAX,] (@<chanlist>)

NOTE This command is the same as OUTPut:PROTection:DELay.

Sets the over-power protection delay. The over-power protection function will not be triggered during the delay time. This prevents momentary changes in output status from triggering the over-power protection function. If the input is regulating in power limit longer than the programmable delay time, the OPP will trip, and the input will be turned off. Programmed values can range from 0 to 0.255 seconds with a resolution of 1 millisecond.

Parameter	Typical Return
0 - 0.255|MIN|MAX, *RST 0.020	<delay value>
Sets the protection delay to 0.2 seconds: VOLT:PROT:DEL 0.2, (@1)	

[SOURce:]POWer:PROtection:STATe 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]POWer:PROtection:STATe?[MIN|MAX,] (@<chanlist>)

Enables/disables the over-power protection. When the input power exceeds the power rating of the module by 10%, the output is disabled and the Questionable Condition status register CP+ bit is set.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the power protection state: POW:PRO:STAT ON, (@1)	

[SOURce:]POWer:RANGe <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer:RANGe? [MIN|MAX,] (@<chanlist>)

Sets the power range. The value that you enter must be the highest value in Watts that you expect to source. The instrument selects the range with the best resolution for the value entered. The following ranges are available for the N679xA load modules.

	N6791A	N6792A
High power range	from 0.3 W to 100 W	from 0.5 W to 200 W
Low power range	from 0.04 W to 10 W	from 0.1 W to 20 W

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST 100|200	100 or 200
Sets the low power range (from 0.04 W to 10 W): POW:RANG 5, (@1)	

- This command is coupled with [SOURce:]POWer. This means that if a range command places an output on a range with a lower maximum power than the present power level, an out of range error occurs. This also occurs if a power level is programmed that is too large for the present range. Errors can be avoided by sending both level and range commands in the same SCPI message. When the range and level information is received as a set, no range/setting conflict occurs.
- If a programmed range change occurs while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.
- The query returns the maximum power that can be programmed on the range that is presently set. The power is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]POWer:SLEW[:POSitive][:IMMediate] <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer:SLEW[:POSitive][:IMMediate]? [MIN|MAX,] (@<chanlist>)
[SOURce:]POWer:SLEW:NEGative[:IMMediate] <*value*>, (@<chanlist>) N679xA
[SOURce:]POWer:SLEW:NEGative[:IMMediate]? [MIN|MAX,] (@<chanlist>)

Sets the input power slew rate. The slew rate is set in watts per second and affects all programmed power 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 analog performance of the input circuit. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37|MIN|MAX|INFinity, *RST MAX	<slew rate>
Sets the input power slew rate to 10 watts per second: POW:SLEW 10, (@1) Sets the negative input power slew rate to 10 watts per second: POW:SLEW:NEG 10, (@1)	

- The query returns the value that was sent. If the value is less than the minimum slew rate, only the minimum value is returned. The resolution of the slew setting is also the minimum value, which can be queried using POWer:SLEW? MIN. The exact value varies slightly based on calibration.
- The query returns the programmed slew rate in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas. If a slew rate of 9.9E37 is returned, it means that the maximum or fastest slew rate has been set.

[SOURce:]POWer:SLEW:COUPle 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]POWer:SLEW:COUPle? (@<chanlist>)

Sets the input power slew tracking state.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the input power slew tracking state: POW:SLEW:COUP ON, (@1)	

[SOURce:]POWer:SLEW[:POSitive]:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]POWer:SLEW[:POSitive]:MAXimum? (@<chanlist>)
[SOURce:]POWer:SLEW:NEGative:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]POWer:SLEW:NEGative:MAXimum? (@<chanlist>)

Enables/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 POWer:SLEW. Use POWer:SLEW? MAX to query the maximum slew rate.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the maximum slew rate override: POW:SLEW:MAX ON, (@1) Enable the negative maximum slew rate: POW:SLEW:NEG:MAX ON, (@1)	

- The POWer:SLEW:MAX command is coupled to the POWer:SLEW command. If the POWer:SLEW command sets the slew rate to MAX or INFinity, POWer:SLEW:MAX is enabled. If the slew rate is set to any other value, POWer:SLEW:MAX is disabled.

Resistance Commands

Resistance commands program the output resistance.

[SOURce:]RESistance[:LEVel][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)
N6781A, N6785A N679xA
[SOURce:]RESistance[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)
[SOURce:]RESistance[:LEVel]:TRIGgered[:AMPLitude] <*value*>, (@<chanlist>) N679xA
[SOURce:]RESistance[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX,] (@<chanlist>)

Sets the immediate resistance level and the triggered resistance level. The triggered level is a stored value that will be programmed when a Step transient is triggered. Units are in ohms.

Parameter	Typical Return
- 40 mΩ to +1 Ω|MIN|MAX, *RST 0 (N6781A/85A) 80 mΩ to +8 kΩ|MIN|MAX, *RST 8 kΩ (N679xA)	0 (zero)
Specifies a resistance of 0.5 ohms: RES 0.5, (@1) Specifies a triggered resistance of 1 ohms: RES:TRIG 0.5, (@1)	

- The query returns the programmed resistance in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.
- For models N6781A, N6785A this command has been superceded by the VOLTage:RESistance <value> command, which should be used in new applications. RESistance <value> is still available for backward compatibility, but will generate an error if an N6781A/N6785A module is programmed together with an N679xA load module.

[SOURce:]RESistance:MODE FIXed|STEP|LIST|ARB, (@<chanlist>) N679xA
[SOURce:]VOLTage:MODE? (@<chanlist>)

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

FIXed – keeps the resistance at its immediate value.
STEP – steps the resistance to the triggered level when a trigger occurs.
LIST – causes the resistance to follow the list values when a trigger occurs.
ARB – causes the resistance 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 resistance mode to Step: RES:MODE STEP, (@1)	

[SOURce:]RESistance:RANGe <*value*>, (@<chanlist>) N679xA
[SOURce:]RESistance:RANGe? [MIN|MAX,] (@<chanlist>)

Sets the resistance range. The value that you enter must be the highest value in ohms that you expect to source. The instrument selects the range with the best resolution for the value entered. The following overlapping resistance ranges are available for the N679xA load modules.

	N6791A	N6792A
High resistance range	from 30 Ω to 8 kΩ	from 15 Ω to 8 kΩ
Medium resistance range	from 2 Ω to 100 Ω	from 2 Ω to 100 Ω
Low resistance range	from 0.08 Ω to 3 Ω	from 0.04 Ω to 3 Ω

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST 8000	8000
Sets the medium resistance range (from 2 to 100 ohms): RES:RANG 100, (@1)	

- This command is coupled with [SOURce:]RESistance. This means that if a resistance value is programmed that does not fall within the presently selected range, the range command automatically selects the correct range for the new resistance value. An out of range error occurs if a resistance value is less than the low-range minimum, or greater than the high-range maximum.
- The resistance level value always takes precedence over the resistance range value. Therefore, an out of range error occurs if a resistance range is changed when the presently selected resistance value does not fall within the new range. Errors can be avoided by sending both level and range commands in the same SCPI message. When the range and level information is received as a set, no range/setting conflict occurs.
- If a programmed range change occurs while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.
- The query returns the maximum resistance that can be programmed on the range that is presently set. The resistance is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]RESistance:SLEW[:POSitive][:IMMediate] <*value*>, (@<chanlist>) N679xA
[SOURce:]RESistance:SLEW[:POSitive][:IMMediate]? [MIN|MAX,] (@<chanlist>)
[SOURce:]RESistance:SLEW:NEGative[:IMMediate] <*value*>, (@<chanlist>) N679xA
[SOURce:]RESistance:SLEW:NEGative[:IMMediate]? [MIN|MAX,] (@<chanlist>)

Sets the resistance slew rate. The slew rate is set in ohms per second and affects all programmed resistance 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 analog performance of the output circuit. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37|MIN|MAX|INFinity, *RST MAX	<slew rate>
Sets the slew rate to 50 ohms per second: RES:SLEW 50, (@1) Sets the negative slew rate to 25 ohms per second: RES:SLEW:NEG 25, (@1)	

- The query returns the value that was sent. If the value is less than the minimum slew rate, only the minimum value is returned. The resolution of the slew setting is also the minimum value, which can be queried using RESistance:SLEW? MIN. The exact value varies slightly based on calibration.
- The query returns the programmed slew rate in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas. If a slew rate of 9.9E37 is returned, it means that the maximum or fastest slew rate has been set.

[SOURce:]RESistance:SLEW:COUPle 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]RESistance:SLEW:COUPle? (@<chanlist>)

Sets the resistance slew tracking state.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the resistance slew tracking state: RES:SLEW:COUP ON, (@1)	

[SOURce:]RESistance:SLEW[:POSitive]:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]RESistance:SLEW[:POSitive]:MAXimum? (@<chanlist>)
[SOURce:]RESistance:SLEW:NEGative:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]RESistance:SLEW:NEGative:MAXimum? (@<chanlist>)

Enables/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 RESistance:SLEW. Use RESistance:SLEW? MAX to query the maximum slew rate.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the maximum slew rate override: RES:SLEW:MAX ON, (@1) Enable the negative maximum slew rate: RES:SLEW:NEG:MAX ON, (@1)	

- The RESistance:SLEW:MAX command is coupled to the RESistance:SLEW command. If the RESistance:SLEW command sets the slew rate to MAX or INFinity, RESistance:SLEW:MAX is enabled. If the slew rate is set to any other value, RESistance:SLEW:MAX is disabled.

[SOURce:]RESistance:STATe 0|OFF|1|ON, (@<chanlist>) N6781A, N6785A
[SOURce:]RESistance:STATe? (@<chanlist>)

Enables/disables output resistance programming.

Parameter	Typical Return
0|OFF|1|ON , *RST OFF	0 or 1
Turns resistance programming on: RES:STAT ON, (@1)	

- This command has been superceded by the VOLTage:RESistance:STAte command, which should be used in new applications. RESistance:STATe is still available for backward compatibility.

Sense Commands

Sense commands control the measurement ranges, datalog, Elog, histogram, sweep, and window functions.

SENSe:CURRent:CCOMpensate 0|OFF|1|ON, (@<chanlist>)
SENSe:CURRent:CCOMpensate? (@<chanlist>)

NOTE This command does **NOT** apply to models N678xA SMU or N679xA loads not N678xA SMU not N679xA.

On models N676xA this command only applies in the High current range.

Enables or disables the capacitive current compensation.

When turned ON, this function corrects the output current measurement for the current that flows into the output capacitor. This current is only significant when high dv/dt occurs, and because this current does not flow into the output load, it represents an error when not corrected. Note that turning on the current measurement compensation increases the peak to peak noise in current measurements.

Parameter	Typical Return
0|OFF|1|ON, *RST ON	0 or 1
Disable sense current compensation: `CURR:CCOM OFF, (@1)`	

SENSe:CURRent[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:CURRent[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)

Selects a DC current measurement range. The value that you enter must be the highest value that you expect to measure. Units are in amperes. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX	<max current>
Selects the 2 A range: `SENS:CURR:RANG 2, (@1)`	

- When queried, the returned value is the maximum DC current that can be measured on the range that is presently set.

SENSe:CURRent[:DC]:RANGe:AUTO 0|OFF|1|ON, (@<chanlist>) N678xA SMU Option SMR
SENSe:CURRent[:DC]:RANGe:AUTO? (@<chanlist>)

Enables or disables seamless measurement autoranging.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable current measurement autoranging: SENS:CURR:RANG:AUTO ON, (@1)	

- Autoranging does not include the 10 µA range, which must be selected individually.

SENSe:DLOG:CURRent[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:DLOG:CURRent[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)
SENSe:DLOG:VOLTage[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:DLOG:VOLTage[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)

Selects the internal datalog current or voltage measurement range. The value that you enter must be the highest value that you expect to measure. Units are in amperes or volts. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX	<maximum value of range>
Selects the 1 A range: SENS:DLOG:CURR:RANG 1, (@1) Selects the 2 V range: SENS:DLOG:VOLT:RANG 2, (@1)	

- When queried, the returned value is the maximum current or voltage that can be measured on the range that is presently set.

SENSe:DLOG:CURRent[:DC]:RANGe:AUTO 0|OFF|1|ON, (@<chanlist>) N678xA SMU Option SMR
SENSe:DLOG:CURRent[:DC]:RANGe:AUTO? (@<chanlist>)
SENSe:DLOG:VOLTage[:DC]:RANGe:AUTO 0|OFF|1|ON , (@<chanlist>) N6781A, N6782A
SENSe:DLOG:VOLTage[:DC]:RANGe:AUTO? (@<chanlist>)

Enables or disables seamless datalog measurement autoranging.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable seamless internal datalog measurement autoranging: SENS:DLOG:CURR:RANG:AUTO ON, (@1) SENS:DLOG:VOLT:RANG:AUTO ON, (@1)	

- Autoranging does not include the 10 µA range, which must be selected individually.

SENSe:DLOG:FUNCtion:CURRent 0|OFF|1|ON, (@<chanlist>)
SENSe:DLOG:FUNCtion:CURRent? (@<chanlist>)
SENSe:DLOG:FUNCtion:VOLTage 0|OFF|1|ON, (@<chanlist>)
SENSe:DLOG:FUNCtion:VOLTage? (@<chanlist>)

Enables or disables the internal datalog current or voltage measurement function.

Parameter	Typical Return
0|OFF|1|ON, *RST current OFF; voltage ON	0 or 1
Enables internal datalog measurements: SENS:DLOG:FUNC:CURR ON, (@1) SENS:DLOG:FUNC:VOLT ON, (@1)	

SENSe:DLOG:FUNCtion:MINMax 0|OFF|1|ON
SENSe:DLOG:FUNCtion:MINMax?

Enables or disables logging of the minimum and maximum current or voltage values. Applies to all channels.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables MIN/MAX datalog values: SENS:DLOG:FUNC:MINM ON	

- Although data is logged to the data file at the logging interval, it is sampled at a rate of 20.48 microseconds. When the data is logged, the minimum, maximum, and average values are computed from all of the samples taken during the logging interval. With MINMax disabled, only the average values are entered into the datalog file. With MINMax enabled, all three values are entered into the datalog file - thus tripling its size.

SENSe:DLOG:MARKer1:POINt <value>
SENSe:DLOG:MARKer1:POINt?
SENSe:DLOG:MARKer2:POINt <value>
SENSe:DLOG:MARKer2:POINt?

Sets the position of the data logger markers in seconds relative to the trigger position. A negative time gives positions before the trigger. The marker positions are adjusted to the closest actual sample point. Querying the marker positions after a FETCh:DLOG:CURRent? or FETCh:DLOG:VOLTage? query will return the exact time point that corresponds to the returned measurement data.

Parameter	Typical Return
- 359,996,400 to +359,996,400 *RST 7.5 for marker 1; 27.5 for marker 2	<marker point>
Sets the marker 1 position in seconds: SENS:DLOG:MARK1:POIN 50 Sets the marker 2 position in seconds: SENS:DLOG:MARK2:POIN 150	

SENSe:DLOG:OFFSet <value>
SENSe:DLOG:OFFSet?

Specifies the datalog trigger offset as a percent of the total datalog duration. This lets you specify the percent of pre-trigger data that will be logged to the datalog file.

A percent of 0 means the trigger occurs at the beginning of the running datalog, while 100 means that the trigger occurs at the end of the running datalog. Any value between 0 and 100 can be set.

Parameter	Typical Return
0 - 100, *RST 0	<offset percent>
Specifies a trigger offset of 50%: SENS:DLOG:OFFS 50	

- The offset must be set to zero when interleaved data logging is in effect.

SENSe:DLOG:PERiod <*value*>
SENSe:DLOG:PERiod? [MIN|MAX,]

Sets the integration time of the datalog 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).

NOTE This command replaces the previous SENSe:DLOG:TINTerval command and should be used in new applications. SENSe:DLOG:TINTerval is still available for backward compatibility.

Parameter	Typical Return
0.0002048 to 60|MIN|MAX, *RST 0.1	<datalog period>
Specifies a datalog period of 0.01 seconds: SENS:DLOG:PER 0.01	

- This function cannot be set to values less than 75 milliseconds when interleaved data logging is in effect.

SENSe:DLOG:TIME <*value*>
SENSe:DLOG:TIME? [MIN|MAX,]

Specifies the duration of the datalog in seconds. Values from 1 second up to the equivalent of 99,999 hours can be specified.

The resulting datalog file cannot exceed 2E9 bytes (1.87 Gbytes in Microsoft Windows units). If the duration value causes the file to exceeds this size, the time interval will automatically be adjusted to a longer interval to reduce the file size

Parameter	Typical Return
1 to 359,996,400|MIN|MAX, *RST 30	<datalog time>
Specifies a datalog duration of 5000 seconds: SENS:DLOG:TIME 5000	

SENSe:DLOG:TINTerval <*value*>
SENSe:DLOG:TINTerval? [MIN|MAX,]

Sets the integration time of the datalog measurement. Values from 1 millisecond to 60 seconds can be specified

NOTE This command has been superseded by SENSe:DLOG:PERiod, but is still available for backward compatibility.

Parameter	Typical Return
0.0002048 to 60|MIN|MAX, *RST 0.1	<datalog period>
Specifies a datalog time interval of 0.01 seconds: SENS:DLOG:TINT 0.01	

- This function cannot be set to values less than 75 milliseconds when interleaved data logging is in effect.

SENSe:ELOG:CURRent[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:ELOG:CURRent[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)
SENSe:ELOG:VOLTage[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:ELOG:VOLTage[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)

Selects the external datalog (Elog) current or voltage measurement range. The value that you enter must be the highest value that you expect to measure. Units are in amperes or volts. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX	<maximum value of range>
Selects the 1 A range: SENS:ELOG:CURR:RANG 1, (@1) Selects the 2 V range: SENS:ELOG:VOLT:RANG 2, (@1)	

- When queried, the returned value is the maximum current or voltage that can be measured on the range that is presently set.

SENSe:ELOG:CURRent[:DC]:RANGe:AUTO 0|OFF|1|ON, (@<chanlist>) N678xA SMU Option SMR

SENSe:ELOG:CURRent[:DC]:RANGe:AUTO? (@<chanlist>)

SENSe:ELOG:VOLTage[:DC]:RANGe:AUTO 0|OFF|1|ON , (@<chanlist>) N6781A, N6782A
SENSe:ELOG:VOLTage[:DC]:RANGe:AUTO? (@<chanlist>)

Enables or disables seamless Elog measurement autoranging.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable seamless Elog measurement autoranging: SENS:ELOG:CURR:RANG:AUTO ON, (@1) SENS:ELOG:VOLT:RANG:AUTO ON, (@1)	

- Autoranging does not include the 10 µA range, which must be selected individually.

SENSe:ELOG:FUNCtion:CURRent 0|OFF|1|ON, (@<chanlist>)
SENSe:ELOG:FUNCtion:CURRent? (@<chanlist>)
SENSe:ELOG:FUNCtion:VOLTage 0|OFF|1|ON, (@<chanlist>)
SENSe:ELOG:FUNCtion:VOLTage? (@<chanlist>)

Enables or disables the Elog current or voltage measurement function.

Parameter	Typical Return
0|OFF|1|ON, *RST current OFF; voltage ON	0 or 1
Enables Elog current measurements: SENS:ELOG:FUNC:CURR ON, (@1) Enables Elog voltage measurements:SENS:ELOG:FUNC:VOLT ON, (@1)	

SENSe:ELOG:FUNCtion:CURRent:MINMax 0|OFF|1|ON, (@<chanlist>)
SENSe:ELOG:FUNCtion:CURRent:MINMax? (@<chanlist>)
SENSe:ELOG:FUNCtion:VOLTage:MINMax 0|OFF|1|ON, (@<chanlist>)
SENSe:ELOG:FUNCtion:VOLTage:MINMax? (@<chanlist>)

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 Elog current values: SENS:ELOG:FUNC:CURR:MINM ON, (@1) Enables MIN/MAX Elog voltage values:SENS:ELOG:FUNC:VOLT:MINM ON, (@1)	

SENSe:ELOG:PERiod <*value*>, (@<chanlist>)
SENSe:ELOG:PERiod? [MIN|MAX,] (@<chanlist>)

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|MIN|MAX, *RST 0.1	<period>
Specifies an Elog period of 0.01 seconds: SENS:ELOG:PER 0.01, (@1)	

SENSe:FUNCtion "CURRent"|"VOLTage"|"NONe", (@<chanlist>)
SENSe:FUNCtion? (@<chanlist>)

Selects a measurement function on models that do not have simultaneous voltage and current measurement capability. This command is required so that the acquisition system knows which function to acquire when a measurement is triggered. Selecting NONE disables the measurement function.

Parameter	Typical Return
"CURRent"|"VOLTage"|"NONE", *RST VOLTage	CURR, VOLT, or NONE
Selects the current measurement function: SENS:FUNC "CURR", (@1)	

- This command has been superceded by the SENSe:FUNCtion:CURRent and SENSe:FUNCtion:VOLTage commands, which should be used in new applications. SENSe:FUNCtion is still available for backward compatibility.

SENSe:FUNCtion:CURRent 0|OFF|1|ON, (@<chanlist>)
SENSe:FUNCtion:CURRent? (@<chanlist>)
SENSe:FUNCtion:VOLTage 0|OFF|1|ON, (@<chanlist>)
SENSe:FUNCtion:VOLTage? (@<chanlist>)

Enables or disables the current or voltage measurement function.

Parameter	Typical Return
0|OFF|1|ON, *RST current OFF; voltage ON	0 or 1
Enables current measurements: SENS:FUNC:CURR ON, (@1) Enables voltage measurements: SENS:FUNC:VOLT ON, (@1)	

- These commands replace the previous SENSe:FUNCtion command and should be used in new applications. SENSe:FUNCtion is still available for backward compatibility.

SENSe:FUNCtion:VOLTage:INPut MAIN|AUXiliary, (@<chanlist>) N6781A, N6785A
SENSe:FUNCtion:VOLTage:INPut? (@<chanlist>)

Selects the voltage measurement input.

MAIN – selects the front panel binding posts as the measurement inputs.
AUXiliary – selects the rear panel auxiliary voltage inputs as the measurement inputs.

Parameter	Typical Return
MAIN|AUXiliary, *RST MAIN	MAIN or AUX
Selects the auxiliary voltage input: SENS:FUNC:VOLT:INP AUX, (@1)	

SENSe:HISTogram:CURRent[:DC]:BIN:GAIN? <binrange>, (@<chanlist>) N6781A, N6782A N6785A, N6786A

SENSe:HISTogram:CURRent[:DC]:BIN:OFFset? <binrange>, (@<chanlist>) N6781A, N6782A N6785A, N6786A

Queries the gains and offsets of a histogram in amperes per bin number. Histogram bins are numbered 0 through 4095, and the mean current value of a bin is:

Current = (bin number x gain) + offset

where gain is the value returned by this command, and offset is the value returned by SENS:HIST:CURR:BIN:OFFS. The gains and offsets vary slightly between units of the same model because of software calibration.

Binrange specifies one of the two histogram ranges. Each range has 4096 bins with a minimum and maximum amplitude and a bin size as follows:

	Models N6781A/N6782A		Models N6785A/N6786A	
Range:	Low	High	Low	High
Amplitude:	- 7.8 mA to +7.8 mA	- 8 A to +8 A	- 15.6 mA to +15.6 mA	- 16 A to +16 A
Bin size:	3.8 µA	3.9 µA	7.6 µA	7.8 mA

Parameter	Typical Return
8 | 0.0078 (for N6781A/N6782A) 16 | 0.0156 (for N6785A/N6786A)	<current bin gain>
Returns the histogram current bin gain of the 8 A range: SENS:HIST:CURR:BIN:GAIN? (@1) Returns the histogram current bin offset of the 8 A range: SENS:HIST:CURR:BIN:OFFS? (@1)	

SENSe:HISTogram:CURRent[:DC]:BIN:RANGes? (@<chanlist>) N6781A, N6782A N6785A, N6786A

Queries the values of the current bin ranges. The following values are returned:

	Models N6781A/N6782A		Models N6785A/N6786A	
Range:	Low	High	Low	High
Value:	7.8 mA	8 A	15.6 mA	16 A

Parameter	Typical Return
(none)	<current range>
Returns a current bin range: SENS:HIST:CURR:BIN:RANG? (@1)	

SENSe:HISTogram:CURRent[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>) N6781A, N6782A N6785A, N6786A

SENSe:HISTogram:CURRent[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)

Selects the current histogram measurement range. The value that you enter must be the highest value that you expect to measure. Units are in amperes. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX	<maximum value of range>
Selects the 1 A range: SENS:HIST:CURR:RANG 1, (@1)	

- When queried, the returned value is the maximum current that can be measured on the range that is presently set.

SENSe:HISTogram:CURRent[:DC]:RANGe:AUTO 0|OFF|1|ON, (@<chanlist>) N6781A, N6782A N6785A, N6786A

SENSe:HISTogram:CURRent[:DC]:RANGe:AUTO? (@<chanlist>)

Enables or disables seamless histogram current measurement autoranging.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable seamless histogram measurement autoranging: SENS:HIST:CURR:RANG:AUTO ON, (@1)	

- Autoranging does not include the 10 µA range, which must be selected individually.

SENSe:HISTogram:FUNCtion:CURRent <Bool>, (@<chanlist>) N6781A, N6782A N6785A, N6786A
SENSe:HISTogram:FUNCtion:CURRent? (@<chanlist>)

Enables or disables the current histogram function.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables current histogram measurements: SENS:HIST:FUNC:CURR ON, (@1)	

SENSe:SWEep:OFFSet:POINts <*value*>, (@<chanlist>)
SENSe:SWEep:OFFSet:POINts? [MIN|MAX,] (@<chanlist>)

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|MIN|MAX, *RST 0	<offset points>
Specifies -2048 offset points: SENS:SWE:OFFS:POIN -2048, (@1)	

SENSe:SWEep:POINts <*value*>, (@<chanlist>)
SENSe:SWEep:POINts? [MIN|MAX,] (@<chanlist>)

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, (@1)	

SENSe:SWEep:TINTerval <*value*>, (@<chanlist>)
SENSe:SWEep:TINTerval? [MIN|MAX,] (@<chanlist>)

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|MIN|MAX, *RST 0.00000512	<time interval>
Specifies an interval of 1 ms between points: SENS:SWE:TINT 0.001, (@1)	

SENSe:SWEep:TINTerval:RESolution RES20|RES40
SENSe:SWEep:TINTerval:RESolution?

Sets the resolution used in setting the time interval between digitized measurements. Applies for time intervals above 20.48 microseconds. External data log measurements also use this setting.

RES20 -- rounds all values above 20.48 microseconds to the nearest 20.48 µs multiple.
RES40 -- rounds all values above 20.48 microseconds to the nearest 40.96 µs multiple.

Parameter	Typical Return
RES20|RES40, *RST 20.48 µs	RES20 or RES40
Specifies a 40 µs resolution: SENS:SWE TINT:RES RES40	

SENSe:VOLTage[:DC]:RANGe[:UPPer] <*value*>, (@<chanlist>)
SENSe:VOLTage[:DC]:RANGe[:UPPer]? [MIN|MAX,] (@<chanlist>)

Selects a DC voltage measurement range. The value that you enter must be the highest value that you expect to measure. Units are in volts. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX	<max voltage>
Selects the 2 V range: SENS:VOLT:RANG 2, (@1)	

- When queried, the returned value is the maximum DC voltage that can be measured on the range that is presently set.

SENSe:VOLTage[:DC]:RANGe:AUTO 0|OFF|1|ON, (@<chanlist>) N6781A, N6782A
SENSe:VOLTage[:DC]:RANGe:AUTO? (@<chanlist>)

Enables or disables seamless measurement autoranging.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable voltage measurement autoranging: SENS:VOLT:RANG:AUTO ON, (@1)	

- Autoranging does not include the 10 µA range, which must be selected individually.

SENSe:WINDow[:TYPE] HANNing|RECTangular, (@<chanlist>)
SENSe:WINDow[:TYPE]? (@<chanlist>)

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, (@1)	

Status Commands

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

Instrument status is also programmed using the IEEE 488.2 Common commands: *CLS, *ESE, *ESR?, *OPC, *OPC?, *SRE, *STB? and *WAI discussed under IEEE 488.2 Common Commands.

STATus:OPERation[:EVENt]? (<@chanlist>)

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

Parameter	Typical Return
(none)	<bit value>
Read the operation status event register: `STAT:OPER? (@1)`	

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

STATus:OPERation:CONDition? (<@chanlist>)

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? (@1)`	

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

STATus:OPERation:ENABle <*value*>, (<@chanlist>)
STATus:OPERation:ENABle? (<@chanlist>)

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

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the enable register: STAT:OPER:ENAB 24, (@1)	

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

STATus:OPERation:NTRansition <*value*>, (<@chanlist>)
STATus:OPERation:NTRansition? (<@chanlist>)
STATus:OPERation:PTRansition <*value*>, (<@chanlist>)
STATus:OPERation:PTRansition? (<@chanlist>)

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

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

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

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

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the NTR register: STAT:OPER:NTR 24, (@1) Enable bit 3 and 4 in the PTR register: STAT:OPER:PTR 24, (@1)	

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

STATus:PRESet

Presets all Enable, PTR, and NTR registers.

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

Parameter	Typical Return
(none)	(none)
Preset the Operation and Questionable registers: STAT:PRES	

STATus:QUEStionable[:EVENt]? (<@chanlist>)

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

Parameter	Typical Return
(none)	<bit value>
Read questionable status event register: STAT:QUES? (@1)	

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

STATus:QUEStionable:CONDition? (<@chanlist>)

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

Parameter	Typical Return
(none)	<bit value>
Read questionable status condition register: STAT:QUES:COND? (@1)	

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

STATus:QUEStionable:ENABle <*value*>, (<@chanlist>)
STATus:QUEStionable:ENABle? (<@chanlist>)

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

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 2 and 4 in the questionable enable register: STAT:QUES:ENAB 24, (@1)	

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

STATus:QUEStionable:NTRansition <*value*>, (<@chanlist>)
STATus:QUEStionable:NTRansition? (<@chanlist>)
STATus:QUEStionable:PTRansition <*value*>, (<@chanlist>)
STATus:QUEStionable:PTRansition? (<@chanlist>)

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

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

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

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

Parameter	Typical Return
A decimal value that corresponds to the binary-weighted sum of the bits in the register.	<bit value>
Enable bit 3 and 4 in the questionable NTR register: STAT:QUES:NTR 24, (@1) Enable bit 3 and 4 in the questionable PTR register: STAT:QUES:PTR 24, (@1)	

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

Step Command

[SOURce:]STEP:TOUTput 0|OFF|1|ON, (<@chanlist>)
[SOURce:]STEP:TOUTput? [MIN|MAX,] (<@chanlist>)

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	

- The query command returns 0 if the trigger signal will NOT be generated (OFF) when a step occurs, and 1 if a trigger signal will be generated (ON) when a step occurs.

System Commands

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

IEEE 488.2 Common Commands also control system functions such as selftest, saving and recalling states, and others.

SYSTem:CHANnel[:COUNt]?

Returns the number of output channels in a mainframe.

Parameter	Typical Return
(none)	4
Returns the number of channels: SYST:COUN?	

SYSTem:CHANnel:MODel? (@<chanlist>)

Returns the model numbers of the selected channels. Multiple responses are separated by commas.

Parameter	Typical Return
<channel list>	N6751A, N6761A
Returns the model numbers in channels 2 and 3: SYST:MOD? (@2,3)	

SYSTem:CHANnel:OPTion? (@<chanlist>)

Returns the options installed in the selected channels. The query returns an ASCII string enclosed in double quotes. If no option is installed, an empty quoted string ("") is returned. Multiple responses are separated by commas.

Parameter	Typical Return
<channel list>	"Opt 760","Opt 760",""
Returns the options in channels 1 through 3: SYST:OPT? (@1:3)	

SYSTem:CHANnel:SERial? (@<chanlist>)

Returns the serial numbers of the selected channels. Multiple responses are separated by semicolons.

Parameter	Typical Return
<channel list>	MY00123456; MY00234567
Returns the serial numbers in channels 2 and 3: SYST:SER? (@2,3)	

SYSTem:COMMunicate:RLSTate LOCal|REMote|RWLock
SYSTem :COMMunicate:RLSTate?

Configures the remote/local state of the instrument.
Remote and Local do the same thing and are included for compatibility with other products. Both allow front panel control.
RWLock disables the front panel keys. Then the instrument can only be controlled remotely.

Parameter	Typical Return
LOCal|REMote|RWLock, default LOCal	LOC, REM, or RWL
Sets the remote/local state to remote: SYST:COMM:RLST REM	

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

Returns the initial socket control connection port number. After the control port number is obtained, a control socket connection can be opened.

Parameter	Typical Return
(none)	5000 (0 if sockets are not supported)
Query the Control connection port number: SYST:COMM:TCP:CONT?	

- The control socket connection can only be used by a client to send a Device Clear to the instrument or to detect Service Request (SRQ) events.
- Refer to Using Sockets for more information.

SYSTem:DATE <yyyy>, <mm>, <dd>
SYSTem:DATE?

Sets the date of the real time clock in year (yyyy), month (mm), and day (dd). The query returns comma-separated values that correspond to the year, month, and day.

Parameter	Typical Return
<yyyy>: A 4-digit integer representing the year <mm>: An integer from 1 to 12 <dd>: An integer from 1 to 31	<year, month, day>
Set the date January 1, 2016: SYST:DATE 2016,1,1	

SYSTem:ERRor?

Reads and clears one error from the error queue.

Parameter	Typical Return
(none)	<+0,"No error">
Reads and clears the 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 have accumulated than the queue can hold, 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 80 characters). <*error code*>,<*error string*> For a list of error codes and message strings, see SCPI Error Messages.

SYSTem:GROup:CATalog?

NOTE This command does NOT apply to models N678xA SMU not N678xA SMU.

Returns the groups that have been defined. The defined groups are enclosed in quotes.

Parameter	Typical Return
(none)	<grouped channels>
returns the channels that are grouped: SYST:GRO:CAT?	

- Example response with 4 channels; no channels grouped: "1","2","3","4"
- Example response with channels 1 and 2 grouped; 3 and 4 grouped: "1,2","3,4"
- Example response channels 1 - 3 grouped; channel 4 not grouped: "1,2,3","4"

SYSTem:GROup:DEFine <chanlist>

NOTE This command does NOT apply to models N678xA SMU not N678xA SMU.

Groups multiple channels to create a single channel. This effectively creates a single output with higher current and power capability. You can group up to four channels per mainframe.

Parameter	Typical Return
<channel list>	(none)
Define channels 1 , 2, and 3 as a group: SYST:GRO:DEF 1:3 Define channels 1 and 4 as a group: SYST:GRO:DEF 1,4	

- All channels in a group must have identical model numbers and have identical options installed. Refer to Output Groups for more information.
- For the group definitions to take effect, reboot the unit by cycling AC power or sending the SYSTem:REBoot command.
- Group channel definitions are stored in non-volatile memory and are unaffected by *RST or *RCL. Group channel *settings* (voltage, current, etc.) are set and saved by *RST or *RCL

SYSTem:GROup:DELete <channel>

NOTE This command does NOT apply to models N678xA SMU not N678xA SMU.

Removes the specified channel from the group. Other channels in the group are left intact.

When ungrouping a channel, you must also remove the parallel connections between the output and sense terminals of that channel.

Parameter	Typical Return
<channel>	(none)
Delete channel 3 from the group: SYST:GRO:DEL 3	

- For the group definitions to take effect, reboot the unit by cycling AC power or sending the SYSTem:REBoot command.

SYSTem:GROup:DELete:ALL

NOTE This command does NOT apply to models N678xA SMU not N678xA SMU.

Deletes all groups. Returns any channels that have been grouped back to an ungrouped state.

When ungrouping a channel, you must also remove the parallel connections between the output and sense terminals of that channel.

Parameter	Typical Return
(none)	(none)
Delete all groups: SYST:GRO:DEL:ALL	

- For the group definitions to take effect, reboot the unit by cycling AC power or sending the SYSTem:REBoot command.

SYSTem:PASSword:FPANel:RESet

Resets the front panel lockout password to zero. This command does not reset the calibration password.

The front panel password can also be reset to 0 by setting an internal switch on the unit. Refer to Calibration Switches for more information.

Parameter	Typical Return
(none)	(none)
To reset the front panel password: SYST:PASS:FPAN:RES	

SYSTem:PERSona:MANufacturer "Agilent"|"Keysight"
SYSTem:PERSona:MANufacturer?
SYSTem:PERSona:MANufacturer:DEFault

Changes the manufacturer identity. This command is used to change the manufacturer's ID string for backward compatibility. This affects the following identity items:

- *IDN? contains "Agilent" instead of "Keysight"
- Default LAN hostname has the prefix A instead of K
- The LXI XML file fields include "Agilent" instead of "Keysight"
- The mDNS service name contains "Agilent" instead of "Keysight"

The DEFault command returns the manufacturer's ID back to Keysight.

Parameter	Typical Return
"Agilent"|"Keysight"	Keysight
Changes the manufacturer's ID to Agilent: SYST:PERS:MAN "Agilent"	

SYSTem:PERSona:MODel "<model number>"
SYSTem:PERSona:MODel?
SYSTem:PERSona:MODel:DEFault

Changes the model number. This command is used to change the mainframe model ID string for backward compatibility.

Compatibility	Factory setting
N6705A|N6705B	N6705C

The DEFault command returns the model's ID to the factory setting.

Parameter	Typical Return
"<model number>"	N6705C
Changes the model number ID to N6705B: SYST:PERS:MOD "N6705B"	

SYSTem:REBoot

Reboots the instrument to its power-on state. Refer to Reset State for more information.

Parameter	Typical Return
(none)	(none)
To reboot the instrument: SYST:REB	

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 by writing all zeros to flash memory and then performing 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 <data>
SYSTem:SET?

Sets the instrument to the specified state. Used to get an instrument state and later restore the instrument back to that state. <data> is a definite length arbitrary binary block of the form #<D><DD...D><data-bytes>, where

#<D> indicates the response is definite length with <D> indicating the number of digits in the length field.
<DD...D> indicates the length of the binary block containing the actual file.
<data-bytes> are the contents of the file.

The query returns a definite length binary block that contains the present instrument state.

Parameter	Typical Return
<data>: #<D><DD...D><data-bytes>	<Block>
Sets an instrument state: SYST:SET <insert definite length binary block here> Gets an instrument state: SYST:SET?	

SYSTem:TIME <hh>, <mm>, <ss>
SYSTem:TIME?

Sets the time of the real time clock in hours (hh), minutes (mm), and seconds (ss). The query returns comma-separated values that correspond to the hour, minute, and second.

Parameter	Typical Return
<hh>: An integer from 0 to 23 <mm>: An integer from 0 to 59 <ss>: An integer from 0 to 59	<hour, minute, second>
Set the time to 8:10 PM: SYST:TIME 20,10,0	

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 Commands

Trigger commands control the transient and acquisition subsystems.

TRIGger:ACQuire[:IMMediate] (@<chanlist>)
TRIGger:DLOG[:IMMediate]
TRIGger:ELOG[:IMMediate] (@<chanlist>)
TRIGger:HISTogram[:IMMediate] (@<chanlist>) N6781A, N6782A N6785A, N6786A
TRIGger:TRANsient[:IMMediate] (@<chanlist>)

These commands override any selected trigger source and generate immediate triggers.

TRIGger:ACQuire - Triggers the measurement immediately.
TRIGger:DLOG - Triggers the internal data logger immediately.
TRIGger:ELOG - Triggers the external data logger immediately.
TRIGger:HISTogram - Triggers the current histogram immediately.
TRIGger:TRANsient - Triggers the output immediately.

Parameter	Typical Return
(none)	(none)
Generates an acquisition trigger: TRIG:ACQ (@1)	

- You must initiate the applicable trigger system before you can send any trigger.
- At acquire trigger completion, the WTG-meas bit in the Status Operation Condition register is cleared.
- At transient trigger completion, the WTG-tran bit in the Status Operation Condition register is cleared.

TRIGger:ACQuire:CURRent[:LEVel] <*value*>, (@<chanlist>)
TRIGger:ACQuire:CURRent[:LEVel]? [MIN|MAX,] (@<chanlist>)
TRIGger:ACQuire:VOLTage[:LEVel] <*value*>, (@<chanlist>)
TRIGger:ACQuire:VOLTage[:LEVel]? [MIN|MAX,] (@<chanlist>)

Sets the current or voltage 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
Current: 0 - maximum|MIN|MAX, *RST 0 Voltage: 0 - maximum|MIN|MAX, *RST 0 The maximum values are 102% of the rating of the power module.	<triggered level>
Set the triggered current level to 3 A: TRIG:ACQ:CURR 3, (@1) Set the triggered voltage level to 50 V: TRIG:ACQ:VOLT 50, (@1)	

TRIGger:ACQuire:CURRent:SLOPe POSitive|NEGative, (@<chanlist>)
TRIGger:ACQuire:CURRent:SLOPe? (@<chanlist>)
TRIGger:ACQuire:VOLTage:SLOPe POSitive|NEGative, (@<chanlist>)
TRIGger:ACQuire:VOLTage:SLOPe? (@<chanlist>)

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
Sets the current slope to falling edge: TRIG:ACQ:CURR:SLOP NEG, (@1) Sets the voltage slope to falling edge: TRIG:ACQ:VOLT:SLOP NEG, (@1)	

TRIGger:ACQuire:TOUTput[:ENABle] 0|OFF|1|ON, (@<chanlist>)
TRIGger:ACQuire:TOUTput[:ENABle]? (@<chanlist>)

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 Trigger Output).

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable sending measurement triggers to digital pins: TRIG:ACQ:TOUT ON, (@1)	

TRIGger:ACQuire:SOURce <*source*>, (@<chanlist>)
TRIGger:ACQuire:SOURce? (@<chanlist>)
TRIGger:ARB:SOURce <*source*>
TRIGger:ARB:SOURce?
TRIGger:DLOG:SOURce <*source*>
TRIGger:DLOG:SOURce?
TRIGger:ELOG:SOURce <*source*>, (@<chanlist>)
TRIGger:ELOG:SOURce? (@<chanlist>)
TRIGger:HISTogram:SOURce <*source*>, (@<chanlist>) N6781A, N6782A N6785A, N6786A
TRIGger:HISTogram:SOURce? (@<chanlist>)
TRIGger:TRANsient:SOURce <*source*>, (@<chanlist>)
TRIGger:TRANsient:SOURce? (@<chanlist>)

TRIGger:ACQuire:SOURce - selects the trigger source for the acquisition system.
TRIGger:ARB:SOURce - selects the trigger source for the arbitrary waveform generator.
TRIGger:DLOG:SOURce - selects the trigger source for internal data logging.
TRIGger:ELOG:SOURce - selects the trigger source for external data logging.
TRIGger:HISTogram:SOURce - selects the trigger source for the current histogram.
TRIGger:TRANsient:SOURce - selects the trigger source for the transient system.

The following trigger sources can be selected for the specified trigger system:

Trigger Source	Description	Trigger System
BUS	Selects a remote interface trigger command.	All trigger systems
CURRent<1-4>	Selects the output current level of a channel.	Acquire and DLOG triggers only
EXTernal	Selects the rear panel Trigger In BNC connector and any connector pins configured as trigger sources.	All trigger systems
IMMediate	Generates a trigger as soon as the trigger system is INITiated.	All trigger systems
PIN<1-7>	Selects a digital port pin configured as a trigger input.	All trigger systems except ARB and DLOG
TRANsient<1-4>	Selects the transient system as the trigger source.	Acquire and Transient triggers only
VOLTage<1-4>	Selects the output voltage level of a channel.	Acquire and DLOG triggers only
ARSK	Selects the Arb Run/Stop key.	DLOG triggers only
OOOK	Selects the Output On/Off key.	DLOG triggers only

Parameter	Typical Return
BUS|CURRent<1-4>|EXTernal|PIN<1-7>| TRANsient<1-4>|VOLTage<1-4>, ARSK, OOOK, *RST BUS	BUS, CURR<n>, EXT, PIN<n>, TRAN<n>, VOLT<n>, ARSK, OOOK
Selects a current level on channel 1 as the acquire trigger: TRIG:ACQ:SOUR CURR1, (@1) Selects the Trigger In BNC connector as the Arb trigger source: TRIG:ARB:SOUR EXT Selects the Arb Run/Stop key as the DLOG trigger source: TRIG:DLOG:SOUR ARSK) Selects a digital port pin 1 as the Elog trigger source: TRIG:ELOG:SOUR PIN1, (@1) Selects the transient system of channel 4 as the trigger source: TRIG:TRAN:SOUR TRAN4, (@1) Selects the voltage level of channel 3 as the acquisition trigger: TRIG:ACQ:SOUR VOLT3, (@1)	

TRIGger:DLOG:CURRent[:LEVel] <*value*>, (@<chanlist>)
TRIGger:DLOG:CURRent[:LEVel]? [MIN|MAX,] (@<chanlist>)
TRIGger:DLOG:VOLTage[:LEVel] <*value*>, (@<chanlist>)
TRIGger:DLOG:VOLTage[:LEVel]? [MIN|MAX,] (@<chanlist>)

Sets the current or voltage triggered level of the data logger. Applies when the data logger 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
Current: 0 - maximum|MIN|MAX, *RST 0 Voltage: 0 - maximum|MIN|MAX, *RST 0 The maximum values are 102% of the rating of the power module.	<triggered level>
Set the triggered current level to 3 A: TRIG:DLOG:CURR 3, (@1) Set the triggered voltage level to 50 V: TRIG:DLOG:VOLT 50, (@1)	

TRIGger:DLOG:CURRent:SLOPe POSitive|NEGative, (@<chanlist>)
TRIGger:DLOG:CURRent:SLOPe? (@<chanlist>)
TRIGger:DLOG:VOLTage:SLOPe POSitive|NEGative, (@<chanlist>)
TRIGger:DLOG:VOLTage:SLOPe? (@<chanlist>)

Sets the slope of the signal. Applies when the data logger 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
Sets the current slope to falling edge: TRIG:DLOG:CURR:SLOP NEG, (@1) Sets the voltage slope to falling edge: TRIG:DLOG:VOLT:SLOP NEG, (@1)	

TRIGger:MEASure:TALign:CORRection[:STATe] 0|OFF|1|ON, (@chanlist) N678xA SMU
TRIGger:MEASure:TALign:CORRection[:STATe]? (@chanlist)

Improves the time alignment of measurement triggers with measurement data when enabled. The power-on state is OFF for backwards compatibility.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
To improve the measurement trigger alignment: TRIG:MEAS:TAL:CORR ON, (@1)	

Voltage Commands

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

[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)
[SOURce:]VOLTage[:LEVel][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude] <*value*>, (@<chanlist>)
[SOURce:]VOLTage[:LEVel]:TRIGgered[:AMPLitude]? [MIN|MAX,] (@<chanlist>)

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

Parameter	Typical Return
0 - maximum|MIN|MAX, *RST 0 The maximum value is 102% of the voltage rating of the power module	<voltage level>
Sets the output voltage level to 20 V: VOLT 20, (@1) Sets the triggered voltage level to 25 V: VOLT:TRIG 25, (@1)	

The query returns the programmed voltage level in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]VOLTage:BWIDth[:RANGe] LOW|HIGH1|HIGH2|HIGH3, (@<chanlist>) N678xA SMU
[SOURce:]VOLTage:BWIDth[:RANGe]? (@<chanlist>)
[SOURce:]VOLTage:BWIDth:LEVel LOW|HIGH1|HIGH2|HIGH3, <frequency>, (@<chanlist>) N678xA SMU
[SOURce:]VOLTage:BWIDth:LEVel? (@<chanlist>)

Sets the voltage bandwidth. This lets you optimize output response time with capacitive loads. Refer to Output Bandwidth for additional information. These compensation modes only apply when the unit is operating in voltage priority mode.

LOW -	optimized for stability with a wide range of load capacitance from 0 to 150 µF
HIGH1 -	provides faster up-programming speed and faster response time with load capacitance from 0–1 µF
HIGH2 -	provides faster up-programming speed and faster response time with load capacitance from 0–7 µF
HIGH3 -	provides faster up-programming speed and faster response time with load capacitance from 7–150 µF
<frequency>	specifies the bandwidth range frequency. This setting is optional, for faster output response time above the default frequency. The minimum frequencies are also the *RST settings.

Parameter	Typical Return
LOW|HIGH1|HIGH2|HIGH3, *RST LOW	LOW, HIGH1, HIGH2, or HIGH3
1,440 to 1,000,000 Hz (LOW) 33,000 to 1,000,000 (HIGH1) 20,500 to 1,000,000 (HIGH2) 8,300 to 1,000,000 (HIGH3)	<range frequency>
Sets the voltage bandwidth to HIGH3: VOLT:BWID HIGH3, (@1) Sets the bandwidth frequency to 25 kHz: VOLT:BWID:LEV HIGH3, 25,000, (@1)	

[SOURce:]VOLTage:INHibit:VON[:LEVel] <*value*>, (@<chanlist>) N679xA
[SOURce:]VOLTage:INHibit:VON[:LEVel]? (@<chanlist>)

When enabled, as specified by VOLTage:INHibit:VON:MODE, the load module will not sink current until the input voltage rises above the voltage-on setting. Units are in volts.

Parameter	Typical Return
0 to 60 V | MIN | MAX, *RST 0.01	<voltage-on value>
Specifies a voltage-on of 4 volts: VOLT:INH:VON 4, (@1)	

[SOURce:]VOLTage:INHibit:VON:MODE LATChing|LIVE|OFF N679xA
[SOURce:]VOLTage:INHibit:VON:MODE?

Specifies the behavior of the under-voltage inhibit function. When enabled (not OFF), the load module will not sink current until the input voltage rises above the voltage-on setting specified by VOLTage:INHibit:VON <value>.

LIVE - turns the input off whenever the voltage drops below the voltage-on setting. Turns the input back on when the voltage reaches the voltage-on setting.
LATChing - allows the load to sink current even if the voltage subsequently drops below the voltage-on setting.
OFF - turns the under-voltage inhibit function off.

Parameter	Typical Return
LIVE|LATChing|OFF, *RST OFF	LIVE, LATC, or OFF
Sets the inhibit mode to latching: VOLT:INH:VON:MODE LATC	

- The under-voltage inhibit function will ignore any programmed on/off delays.
- The under-voltage inhibit function function is not available when load modules are grouped.
- The under-voltage inhibit function is not available in CV operating mode.

[SOURce:]VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude] <*value*> , (@<chanlist>)

N678xA SMU

[SOURce:]VOLTage:LIMit[:POSitive][:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)

[SOURce:]VOLTage:LIMit:NEGative[:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)

N6784A

[SOURce:]VOLTage:LIMit:NEGative[:IMMediate][:AMPLitude]? [MIN|MAX,] (@<chanlist>)

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

Parameter	Typical Return
Positive: 0 to 102% of rating|MIN|MAX, *RST 102% Negative: -102% of rating to 0|MIN|MAX, *RST -102%	<+ voltage limit> <- voltage limit>
Sets the positive voltage limit to 20.4 V: VOLT:LIM 20, (@1) Sets the negative voltage limit to -20.4 V: VOLT:LIM:NEG -20, (@1)	

- MIN is the most negative value of the range. MAX is the least negative value of the range.
- The query returns the programmed voltage limit in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]VOLTage:LIMit:COUPle 0|OFF|1|ON, (@<chanlist>)

N6784A

[SOURce:]VOLTage:LIMit:COUPle? (@<chanlist>)

Sets the voltage limit tracking state. The negative voltage limit tracks the positive voltage limit setting.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the voltage limit tracking state: VOLT:LIM:COUP ON, (@1)	

[SOURce:]VOLTage:MODE FIXed|STEP|LIST|ARB, (@<chanlist>)

[SOURce:]VOLTage:MODE? (@<chanlist>)

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, (@1)	

[SOURce:]VOLTage:PROTection[:LOCal][:LEVel] <*value*>, (@<chanlist>)
[SOURce:]VOLTage:PROTection[:LOCal][:LEVel]? [MIN|MAX,] (@<chanlist>)

NOTE This command does NOT apply to models N678xA SMU (not N678xA SMU). For models N678xA SMU, refer to VOLTage:PROTection:REMote.

Only the query applies to models N679xA (N679xA). Load models have a fixed over-voltage protection level.

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 – maximum|MIN|MAX, *RST MAX The maximum value is 120% of the voltage rating of the power module.	<over-voltage level>
Sets the over-voltage protection to 60 V: VOLT:PROT 60, (@1)	

- An over-voltage condition can be cleared with the OUTput:PROTection:CLEar command after the cause of the condition has been removed.
- The query returns the programmed voltage protection level in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]VOLTage:PROTection:DELay[:TIME] <*value*>, (@<chanlist>) (N678xA SMU) (N6783A)
[SOURce:]VOLTage:PROTection:DELay[:TIME]? [MIN|MAX,] (@<chanlist>)

Sets the over-voltage protection delay. The over-voltage protection function will not be triggered during the delay time. After the delay time has expired, the over-voltage protection function will be active. This prevents momentary changes in output status from triggering the over-voltage protection function. Programmed values can range from 60 microseconds to 5 milliseconds with a resolution of 20.48 microseconds.

Parameter	Typical Return
60 µs - 5 ms | MIN | MAX, *RST 0	<delay value>
Sets the protection delay to 1 millisecond: VOLT:PROT:DEL 0.001, (@1)	

[SOURce:]VOLTage:PROTection:REMote[:POSitive][:LEVel] <*value*> , (@<chanlist>) (N678xA SMU)
[SOURce:]VOLTage:PROTection:REMote[:POSitive][:LEVel]? [MIN|MAX,] (@<chanlist>)
[SOURce:]VOLTage:PROTection:REMote:NEGative[:LEVel] <*value*>, (@<chanlist>) (N6784A)
[SOURce:]VOLTage:PROTection:REMote:NEGative[:LEVel]? [MIN|MAX,] (@<chanlist>)

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

Parameter	Typical Return
Positive: 0 – 22|MIN|MAX, *RST MAX Negative: -22 to 0|MIN|MAX, *RST MAX	<remote over-voltage level>
Sets the over-voltage protection to 15 V: VOLT:PROT:REM 15, (@1) Sets the over-voltage protection to -15 V: VOLT:PROT:REM:NEG -15, (@1)	

- The remote OVP trips if the output terminal voltage is >1.5 V over the sense terminal voltage.
- MIN is the most negative value of the range. MAX is the least negative value of the range.
- The query returns the programmed voltage protection level in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]VOLTage:RANGe <*value*>, (@<chanlist>)
[SOURce:]VOLTage:RANGe? [MIN|MAX,] (@<chanlist>)

Sets the output voltage range on models that have multiple ranges. The value that you enter must be the highest value in volts that you expect to source. The instrument selects the range with the best resolution for the value entered.

Parameter	Typical Return
0 to maximum|MIN|MAX, *RST MAX The maximum value is 102% of the voltage rating of the power module.	<voltage range>
Sets the output voltage range to 5 V: VOLT:RANG 5, (@1)	

- This command is coupled with [SOURce:]VOLTage. This means that if a range command places an output on a range with a lower maximum voltage than the present voltage level, an out of range error occurs. This also occurs if a voltage is programmed that is too large for the present range. Errors can be avoided by sending both level and range commands in the same SCPI message. When the range and level information is received as a set, no range/setting conflict occurs.
- If a programmed range change occurs while the output is enabled, the output will be temporarily disabled while the range switch occurs. The transition from on-to-off and then from off-to-on will also be delayed by the settings of OUTPut:DELay:FALL and OUTPut:DELay:RISE.
- The query returns the maximum voltage that can be output on the range that is presently set. The voltage is in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas.

[SOURce:]VOLTage:RESistance[:LEVel][:IMMediate][:AMPLitude] <*value*>, (@<chanlist>)
N6781A, N6785A

[SOURce:]VOLTage:RESistance[:LEVel][:IMMediate][:AMPLitude]?

Sets the output resistance level when in voltage priority mode. Units are in volts.

Parameter	Typical Return
0 to 60 V | MIN | MAX, *RST MAX	<resistance level>
Specifies the voltage priority resistance level: VOLT:RES 30, (@1)	

- This command replaces the previous RESistance <value> command and should be used in new applications. RESistance <value> is still available for backward compatibility.

[SOURce:]VOLTage:RESistance:STATe 0|OFF|1|ON, (@<chanlist>) N6781A, N6785A
[SOURce:]VOLTage:RESistance:STATe? (@<chanlist>)

Enables or disables output resistance in voltage priority mode.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable resistance in voltage priority mode: VOLT:RES:STAT ON, (@1)	

- This command replaces the previous RESistance:STATe command and should be used in new applications. RESistance:STATe is still available for backward compatibility.

[SOURce:]VOLTage:SENSe:SOURce INTernal|EXTernal
[SOURce:]VOLTage:SENSe:SOURce?

Sets the state of the output remote sense relays.

INTernal – sets the remote sense relays to local sense (4-wire sense off).
EXTernal – sets the remote sense relays to remote sense (4-wire sense on).

Parameter	Typical Return
INTernal|EXTernal, *RST INTernal	INT or EXT
Sets the sense mode to external (4-wire): VOLT:SENS:SOUR EXT, (@1)	

[SOURce:]VOLTage:SLEW[:POSitive][:IMMediate] <*value*>, (@<chanlist>)
[SOURce:]VOLTage:SLEW[:POSitive][:IMMediate]? [MIN|MAX,] (@<chanlist>)
[SOURce:]VOLTage:SLEW:NEGative[:IMMediate] <*value*>, (@<chanlist>) N679xA
[SOURce:]VOLTage:SLEW:NEGative[:IMMediate]? [MIN|MAX,] (@<chanlist>)

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 analog performance of the output circuit. The keywords MAX or INFinity set the slew rate to maximum.

Parameter	Typical Return
0 – 9.9E+37|MIN|MAX|INFinity, *RST MAX	<slew rate>

Parameter	Typical Return
Sets the output slew rate to 5 V per second: VOLT:SLEW 5, (@1) Sets the negative output slew rate to 5 V per second: VOLT:SLEW:NEG 5, (@1)	

- The query returns the value that was sent. If the value is less than the minimum slew rate, only the minimum value is returned. The resolution of the slew setting is also the minimum value, which can be queried using VOLTage:SLEW? MIN. The exact value varies slightly based on calibration.
- The query returns the programmed slew rate in the form +n.nnnnnnE+nn for each channel specified. Multiple responses are separated by commas. If a slew rate of 9.9E37 is returned, it means that the maximum or fastest slew rate has been set.

[SOURce:]VOLTage:SLEW:COUPle 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]VOLTage:SLEW:COUPle? (@<chanlist>)

Sets the voltage slew tracking state.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enables the voltage slew tracking state: VOLT:SLEW:COUP ON, (@1)	

[SOURce:]VOLTage:SLEW[:POSitive]:MAXimum 0|OFF|1|ON, (@<chanlist>)
[SOURce:]VOLTage:SLEW[:POSitive]:MAXimum? (@<chanlist>)
[SOURce:]VOLTage:SLEW:NEGative:MAXimum 0|OFF|1|ON, (@<chanlist>) N679xA
[SOURce:]VOLTage:SLEW:NEGative:MAXimum? (@<chanlist>)

Enables/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.

Parameter	Typical Return
0|OFF|1|ON, *RST OFF	0 or 1
Enable the maximum slew rate override: VOLT:SLEW:MAX ON, (@1) Enable the negative maximum slew rate: VOLT:SLEW:NEG:MAX ON, (@1)	

- 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 at the end of this topic shows how the status registers and groups are interconnected.

Status Registers

Operation Status Group

Questionable Status Group

Standard Event Status Group

Status Byte Register

Error and Output Queues

Status Diagram

Status Registers

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

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

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

Operation Status Group

These registers record signals that occur during normal operation. The group consists of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Operation Status register group are logically-

ORed into the OPERation summary bit (7) of the Status Byte register. Refer to Status Registers for a description of each register. The following table describes the 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
6	TRAN-active	64	Transient system is initiated
7-8	not used	not used	0 is returned
9	CR	256	Output is in constant resistance mode
10	CP	512	Output is in constant power mode
11	SH	1024	Load Input terminals are shorted
12-15	not used	not used	0 is returned

Questionable Status Group

These register groups record signals that indicate abnormal operation. The group consists of a Condition, PTR/NTR, Event, and Enable register. The outputs of the Questionable Status group are logically-ORed into the QUEStionable summary bit (3) of the Status Byte register. Refer to Status Registers for a description of each register. The following table describes the 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 an AC power-fail (low-line or brownout)
3	CP+	8	Output is limited (or disabled) by the positive power limit
4	OT	16	Over-temperature protection has tripped
5	CP–	32	Output is limited by the negative power limit
6	OV–	64	Negative over-voltage protection has tripped
7	LIM+	128	In voltage priority mode, the output is in positive current limit In current priority mode, the output is in positive voltage limit In power and resistance priority modes, the output is in positive current limit
8	LIM–	256	In voltage priority mode, the output is in negative current limit In current priority mode, the output is in negative voltage limit
9	INH	512	Output is inhibited by an external INHibit signal
10	UNR	1024	Output is unregulated

Bit	Bit Name	Decimal Value	Definition
11	PROT	2048	Output has been disabled because it is coupled to a protection condition that occurred on another channel
12	OSC	4096	Oscillation detector has tripped
13	not used	not used	0 is returned
14	UVI	16,384	Ouptut is disabled by the under-voltage inhibit protection
15	not used	not used	0 is returned

Standard Event Status Group

These registers are programmed by Common commands. The group consists of an Event and Enable register.The Standard Event event register latches events relating to communication status. It is a read-only register that is cleared when read. The Standard Event enable register functions similarly to the enable registers of the Operation and Questionable status groups. Refer to Status Registers for a description of each register. The following table describes the 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 input and output buffers are full.
3	Device-Specific Error	8	A device-specific error, including a selftest error, calibration error or other device-specific error occurred. Error Messages
4	Execution Error	16	An execution error occurred. Error Messages
5	Command	32	A command syntax error occurred. Error Messages
6	not used	not used	0 is returned
7	Power On	128	Power has been cycled since the last time the event register was read or cleared.

Status Byte Register

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

Bit	Bit Name	Decimal Value	Definition
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 Service Request. Bits must be enabled, see *SRE.
7	Operation Status Summary	128	One or more bits are set in the Operation Status Register. Bits must be enabled, see STATus:OPERation:ENABle.

MSS and RQS Bits

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

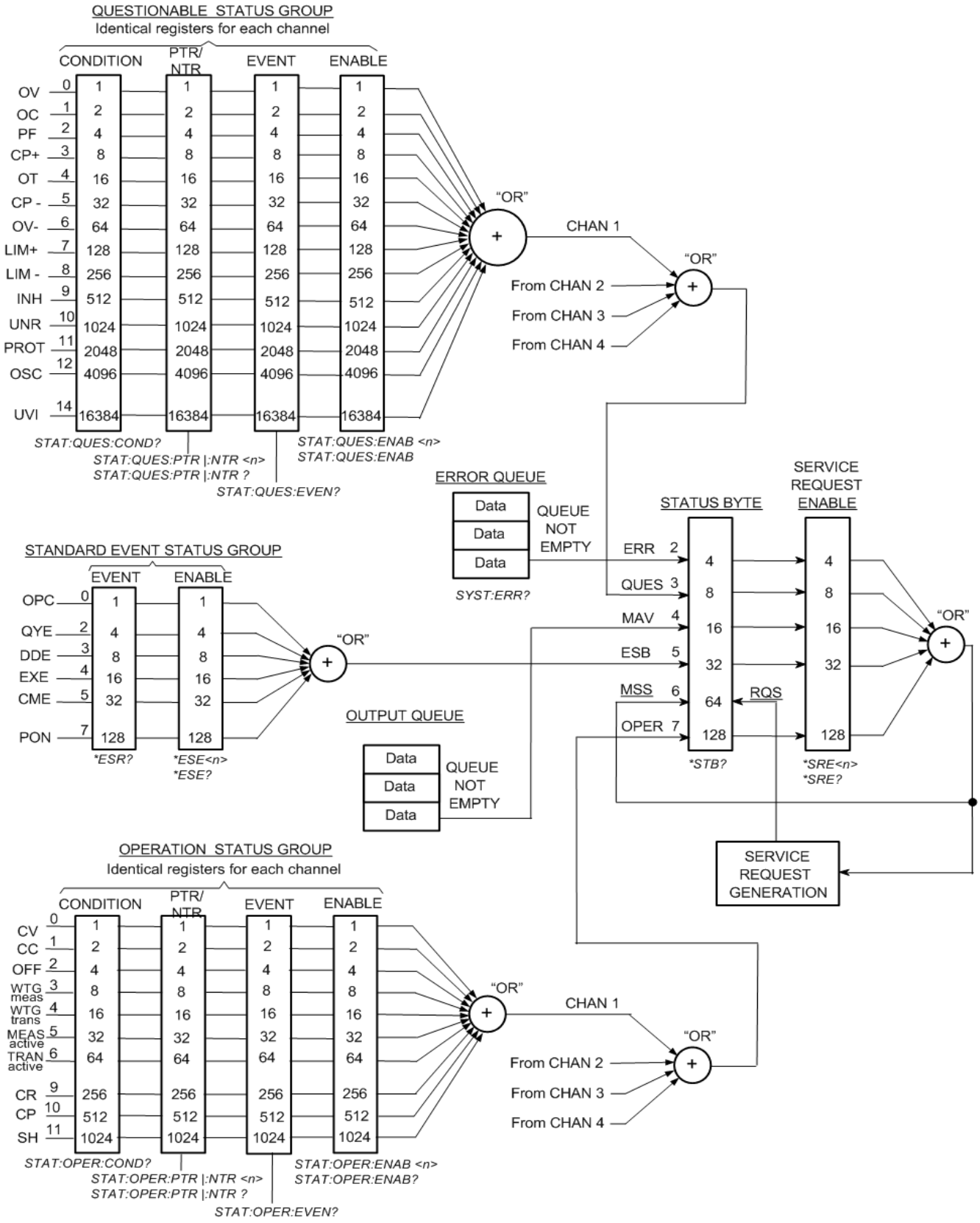
The RQS bit is a latched version of the MSS bit. Whenever the instrument requests service, it sets the SRQ interrupt line true and latches RQS into bit 6 of the Status Byte register. When the controller does a serial poll, RQS is cleared inside the register and returned in bit position 6 of the response.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

Error and Output Queues

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

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

Status Diagram



Reset (*RST) and Non-volatile Settings

Reset State

Non-volatile Settings

Initial N678xA SMU Emulation Mode Settings

Reset and Non-volatile Settings

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

CPI Command *RST Settings			
ARB:COUNt	1	POWer	MIN
ARB:CURRent|VOLTage:CDWell:DWELl	0.001	POWer:LIMit	MAX
ARB:CURRent|VOLTage:CDWell:LEVel	MIN	POWer:MODE	FIX
ARB:CURRent|VOLTage:EXPonential:END	MIN	POWer:PROTection:DELay	0.02
ARB:CURRent|VOLTage:EXPonential:STARt	MIN	POWer:PROTection:STATe	OFF
ARB:CURRent|VOLTage:EXPonential:STARt:TIMe	0	POWer:RANGe	MAX
ARB:CURRent|VOLTage:EXPonential:TCONstant	1	POWer:SLEW	MAX
ARB:CURRent|VOLTage:EXPonential:TIMe	1	POWer:SLEW:COUPle	ON
ARB:CURRent|VOLTage:PULSe:END:TIMe	0	POWer:SLEW:MAX	ON
ARB:CURRent|VOLTage:PULSe:STARt	MIN	POWer:SLEW:NEGative	MAX
ARB:CURRent|VOLTage:PULSe:STARt:TIMe	0	POWer:SLEW:NEGative:MAX	ON
ARB:CURRent|VOLTage:PULSe:TOP	MIN	POWer:TRIGgered	MIN
ARB:CURRent|VOLTage:PULSe:TOP:TIMe	1	RESistance	0 or 8,000
ARB:CURRent|VOLTage:RAMP:END	MIN	RESistance:MODE	FIX
ARB:CURRent|VOLTage:RAMP:END:TIMe	0	RESistance:RANGe	MAX
ARB:CURRent|VOLTage:RAMP:RTIMe	1	RESistance:SLEW	MAX
ARB:CURRent|VOLTage:RAMP:STARt	MIN	RESistance:SLEW:COUPle	ON

CPI Command *RST Settings			
ARB:CURRent|VOLTage:RAMP:STARt:TIMe	0	RESistance:SLEW:MAX	ON
ARB:CURRent|VOLTage:SINusoid:AMPLitude	MIN	RESistance:SLEW:NEGative	MAX
ARB:CURRent|VOLTage:SINusoid:FREQuency	1	RESistance:SLEW:NEGative:MAX	ON
ARB:CURRent|VOLTage:SINusoid:OFFSet	0	RESistance:STATe	OFF
ARB:CURRent|VOLTage:STAircase:END	MIN	RESistance:TRIGgered	8000
ARB:CURRent|VOLTage:STAircase:END:TIMe	0	SENSe:CURRent:CCOMmunicate	ON
ARB:CURRent|VOLTage:STAircase:NSTeps	10	SENSe:CURRent:RANGe	MAX
ARB:CURRent|VOLTage:STAircase:STARt	MIN	SENSe:CURRent:RANGe:AUTO	OFF
ARB:CURRent|VOLTage:STAircase:STAR:TIMe	0	SENSe:DLOG:CURRent:RANGe:AUTO	OFF
ARB:CURRent|VOLTage:STAircase:TIMe	1	SENSe:DLOG:FUNCtion:CURRent	OFF
ARB:CURRent|VOLTage:STEP:END	MIN	SENSe:DLOG:FUNCtion:MINMax	OFF
ARB:CURRent|VOLTage:STEP:STARt	MIN	SENSe:DLOG:FUNCtion:VOLTage	ON
ARB:CURRent|VOLTage:STEP:STARt:TIMe	0	SENSe:DLOG:OFFset	0
ARB:CURRent|VOLTage:TRAPezoid:END:TIMe	0	SENSe:DLOG:TINTerval	0.1
ARB:CURRent|VOLTage:TRAPezoid:FTIMe	1	SENSe:DLOG:TIME	30
ARB:CURRent|VOLTage:TRAPezoid:RTIMe	1	SENSe:DLOG:VOLTage:RANGe:AUTO	OFF
ARB:CURRent|VOLTage:TRAPezoid:STARt	MIN	SENSe:ELOG:CURRent:RANGe:AUTO	OFF
ARB:CURRent|VOLTage:TRAPezoid:STARt:TIMe	0	SENSe:ELOG:FUNCtion:CURRent	ON
ARB:CURRent|VOLTage:TRAPezoid:TOP	MIN	SENSe:ELOG:FUNCtion:CURRent:MINMax	OFF
ARB:CURRent|VOLTage:TRAPezoid:TOP:TIMe	1	SENSe:ELOG:FUNCtion:VOLTage	OFF
ARB:CURRent|VOLTage:UDEFined:BOSTep	OFF	SENSe:ELOG:FUNCtion:VOLTage:MINMax	OFF
ARB:CURRent|VOLTage:UDEFined:DWELl	0.001	SENSe:ELOG:PERiod	0.1
ARB:CURRent|VOLTage:UDEFined:LEVel	MIN	SENSe:ELOG:VOLTage:RANGe:AUTO	OFF
ARB:FUNCtion:SHAPe	NONE	SENSe:FUNCtion	"VOLT"
ARB:FUNCtion:TYPE	VOLT	SENSe:FUNCtion:CURRent	OFF
ARB:SEQuence:COUNt	1	SENSe:FUNCtion:VOLTage	ON
ARB:SEQuence:STEP:COUNt	1	SENSe:FUNCtion:VOLTage:INPut	MAIN
ARB:SEQuence:STEP:FUNCtion:SHAPe	PULS	SENSe:HISTogram:CURRent:RANGe	MAX
ARB:SEQuence:STEP:PACing	DWEL	SENSe:HISTogram:CURRent:RANGe:AUTO	OFF

CPI Command *RST Settings			
ARB:SEQuence:TERMinate:LAST	ON	SENSe:HISTogram:FUNCtion:CURRent	ON
ARB:TERMinate:LAST	OFF	SENSe:SWEep:POINts	1024 or 4883
CALibrate:STATe	OFF	SENSe:SWEep:OFFset:POINts	0
CURRent	MIN	SENSe:SWEep:TINTerval	20.48E–6
CURRent:LIMit	MAX	SENSe:SWEep:TINTerval:RESolution	RES20
CURRent:LIMit:COUPle	ON	SENSe:VOLTage:RANGe	MAX
CURRent:LIMit:NEGative	MIN	SENSe:VOLTage:RANGe:AUTO	OFF
CURRent:MODE	FIX	SENSe:WINDow	RECT
CURRent:PROTection:DELay	0.02	STEP:TOUTput	FALSE
CURRent:PROTection:DELay:STARt	SCH	TRIGger:ACQuire:CURRent	MIN
CURRent:PROTection:STATe	OFF	TRIGger:ACQuire:CURRent:SLOPe	POS
CURRent:RANGe	MAX	TRIGger:ACQuire:SOURce	BUS
CURRent:SLEW	MAX	TRIGger:ACQuire:TOUTput	OFF
CURRent:SLEW:COUPle	ON	TRIGger:ACQuire:VOLTage	MIN
CURRent:SLEW:MAX	ON	TRIGger:ACQuire:VOLTage:SLOPe	POS
CURRent:SLEW:NEGative	MAX	TRIGger:ARB:SOURce	IMM
CURRent:SLEW:NEGative:MAX	ON	TRIGger:DLOG:CURRent	MIN
CURRent:TRIGgered	MIN	TRIGger:DLOG:CURRent:SLOPe	POS
DIGital:OUTPut:DATA	0	TRIGger:DLOG:SOURce	IMM
DISPlay:VIEW	METER1	TRIGger:DLOG:VOLTage	MIN
EMULation	PS4Q or PS2Q	TRIGger:DLOG:VOLTage:SLOPe	POS
FUNCtion	VOLT or CURR	TRIGger:ELOG:SOURce	BUS
FORMat:DATA	ASCII	TRIGger:HISTogram:SOURce	BUS
FORMat:BORDer	NORM	TRIGger:TRANsient:SOURce	BUS
INITiate:CONTinuous:TRANsient	OFF	VOLTage	MIN
LIST:COUNt	1	VOLTage:BWIDth	LOW
LIST:CURRent	MIN	VOLTage:INHibit:VON	0.01
LIST:DWELl	0.001	VOLTage:INHibit:VON:MODE	OFF
LIST:STEP	AUTO	VOLTage:LIMit	MAX

CPI Command *RST Settings			
LIST:TERMinate:LAST	OFF	VOLTage:LIMit:COUPle	ON
LIST:TOUTput:BOSTep	OFF	VOLTage:LIMit:NEGative	MIN
LIST:TOUTput:EOSTep	OFF	VOLTage:MODE	FIX
LIST:VOLTage	MIN	VOLTage:PROTection	MAX
OUTPut	OFF	VOLTage:PROTection:DELay	0
OUTPut:DELay:FALL	0	VOLTage:PROTection:REMote	MAX
OUTPut:DELay:RISE	0	VOLTage:PROTection:REMote:NEGative	MIN
OUTPut:PMODe	VOLT	VOLTage:RANGe	MAX
OUTPut:PROTect:COUPle	OFF	VOLTage:SLEW	MAX
OUTPut:PROTect:DELay	0.02	VOLTage:SLEW:COUPle	ON
OUTPut:PROTect:OSCillation	ON	VOLTage:SLEW:MAX	ON
OUTPut:PROTect:WDOG	OFF	VOLTage:SLEW:NEGative	MAX
OUTPut:RELay:POLarity	NORM	VOLTage:SLEW:NEGative:MAX	ON
OUTPut:SHORt	OFF	VOLTage:TRIGgered	MIN
OUTPut:TMODe	LOWZ		

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.

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).

Factory as-shipped settings	
Admin/Calibration password	0 (zero)
Calibraton date	March 6, 2016
Channel grouping	No groups
Digital port function (all pins)	Digital In
Digital port polarity (all pins)	Positive
Firmware update password protected	Disabled
Front panel lockout	Disabled
Front panel meter view	4-channel
GPIB address	5
GPIB interface	Enabled
Key clicks	Enabled
LAN interface	Enabled
On/Off key affects all channels	Disabled
Output inhibit mode	Off
Saved states	*RST command
Screen saver	Enabled
Screen saver delay	60 minutes
USB interface	Enabled
Wake on I/O	Enabled
Web server	Enabled

LAN Interface as-shipped settings These settings are optimized for connecting your power analyzer to a site network. They should also work well for other network configurations. The LAN as-shipped settings can be restored by selecting the **System\IO\LAN\Defaults** menu.	
Get IP Address	Automatic
Subnet mask	255.255.0.0
Default gateway	0.0.0.0
Host name	Keysight-<serial number>
mDNS service name	Keysight N67xxx DC Power Analyzer <serial number>
LAN service - VXI-11	Enabled
LAN service - Telnet	Enabled
LAN service - mDNS	Enabled
LAN service - Web server	Enabled
LAN service - sockets	Enabled
Web password	Blank

Initial N678xA SMU Emulation Mode Settings

The following tables document the emulation mode settings that are applied when the emulation mode is selected. Emulation mode settings are not saved. N/A means not applicable.

	4 Quadrant Power Supply[1]		2 Quadrant Power Supply		1 Quadrant Power Supply	
Priority mode	voltage	current	voltage	current	voltage	current
Quadrants	4	4	2	2	1	1
Voltage range	6.12 V	N/A	6.12 V	N/A	6.12 V	N/A
Voltage	0 V	N/A	0 V	N/A	0 V	N/A
I limit range	3.06 A	N/A	3.06 A[3]	N/A	3.06 A[3]	N/A
+ I limit	3.06 A	N/A	3.06 A[3]	N/A	min.	N/A
– I limit	– 3.06 A	N/A	– 3.06 A[3]	N/A	– 0.612 A	N/A
Current range	N/A	3.06 A	N/A	3.06 A[3]	N/A	3.06 A[3]
Current	N/A	0 A	N/A	0 A	N/A	0 A
V limit range	N/A	6.12 V	N/A	6.12 V	N/A	6.12 V

	4 Quadrant Power Supply[1]		2 Quadrant Power Supply		1 Quadrant Power Supply	
+ V limit	N/A	6.12 V	N/A	6.12 V	N/A	6.12 V
– V limit [1]	N/A	– 6.12 V	N/A	min.	N/A	min.
Output resistance [2]	0 Ω/off	N/A	0 Ω/off	N/A	0 Ω/off	N/A
Output state	off	off	off	off	off	off
I limit tracking	on	on	on	off	off	off
V limit tracking [1]	on	on	off	off	off	off

Note 1: N6784A only
Note 2: N6781A and N6785a only
Note 3: 8.16 A for Models N6785A and N6786A

	Battery Emulator [2]	Battery Charger 2	CC Load	CV Load	Voltmeter	Ammeter
Priority mode	voltage	voltage	current	voltage	current	voltage
Quadrants	2	1	1	1	4	4
Voltage range	6.12 V	6.12 V	N/A	6.12 V	N/A	lowest
Voltage	0 V	0 V	N/A	5 mV	0 V	0 V
I limit range	3.06 A [3]	3.06 A [3]	N/A	3.06 A [3]	3.06 A [3]	3.06 A [3]
+ I limit	3.06 A [3]	min.	N/A	min.	N/A	3.06 A [3]
– I limit	– 3.06 A [3]	min.	N/A	max.	N/A	– 3.06 A [3]
Current range	N/A	N/A	3.06 A [3]	N/A	lowest	N/A
Current	N/A	N/A	– 0.5 A	N/A	0 A	N/A
V limit range	N/A	N/A	6.12 V	N/A	20.4 V	N/A
+ V limit	N/A	N/A	6.12 V	N/A	20.4 V	N/A
– V limit [1]	N/A	N/A	min.	N/A	– 20.4 V	N/A
Output resistance [2]	0 Ω/off	0 Ω/off	N/A	0 Ω/off	N/A	0 Ω/off
Output state	off	off	off	off	on	on
I limit tracking	off	off	off	off	off	off
V limit tracking [1]	off	off	off	off	off	off

Note 1: N6784A only
Note 2: N6781A and N6785a only
Note 3: 8.16 A for Models N6785A and N6786A

SCPI Error Messages

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

- Up to 20 errors can be stored in each interface-specific error queue (one each for GPIB, USB, VXI-11, and Telnet/Sockets.) Errors appear in the error queue of the I/O session that caused the error.
- The instrument beeps each time a command syntax or hardware error is generated. The front-panel ERROR annunciator turns on when one or more errors are in the error queue.
- A special global error queue holds all power-on and hardware-related errors (for example, over-temperature).
- Error retrieval is first-in-first-out (FIFO), and errors are cleared as you read them. Once you have read all interface-specific errors, the errors in the global error queue are retrieved. When you have read all errors from the error queue, the ERR annunciator turns off.
- If more than 20 errors have occurred, the last error stored in the queue (the most recent error) is replaced with -350,"Error queue overflow". No additional errors are stored until you remove errors from the queue. If no errors have occurred, 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.
- The interface-specific error queues are cleared by power cycles and *CLS. The error queue is not cleared by *RST.
- The SYSTem:ERRor? query reads and clears one error from the error queue. Errors have the following format -113,"Undefined header". The error string may contain up to 255 characters.

Error List

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.

100 Too many channels

You have specified more channels than are installed in the mainframe

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.

111 Aux vloc cal constants out of range

Calibration constants on the internal auxiliary local ADC are outside the acceptable range.

112 Aux vrem cal constants out of range

Calibration constants on the internal auxiliary remote ADC are outside the acceptable range.

113 Aux imon cal constants out of range

Calibration constants on the internal auxiliary imon ADC are outside the acceptable range.

114 Wrong status

An incorrect status function has been reported.

115 Output track resistance out of range

The output track resistance is out of range. Re-calibrate the output module.

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, empty slots

There is an empty slot between modules. This 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.

209 Internal communication error

An internal communication error has occurred in the instrument.

210 Frame NVRAM error

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

211 Output state couple modules do not match

One or more modules in the group does not match the non-volatile configurations settings.

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 power modules either does not have the hardware capability or the options required to support this command.

311 This group of channel has non-identical features

One or more modules in this group does not match the ratings or options of the other modules.

312 The command is disabled when the channel is grouped

This command is disabled when the output channel is grouped.

313 Datalog time interval is out of range

The data log time interval is outside the programmable range.

314 Time of day clock has stopped

The time of day clock has stopped. Replace the internal battery. See Service Guide.

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.

318 Datalog error

An error has occurred in the data returned by the datalogger.

319 Measurement is not allowed while datalogger is running

You cannot make measurements in Meter View or Scope View while the datalogger is running.

320 Firmware update error

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

321 Modules do not match data format

One or more power modules does not match the data format of the file that is being loaded

322 User defined arb error

An error has occurred in the format or the data of the user–defined arb.

323 Meas TINTerval too small on too many channels

The measurement time interval is too small to be supported by the number of channels.

324 Inconsistent arb settings

The arb settings are inconsistent; most likely a mismatch in the arb lengths.

325 Arb sequence error

An error has occurred with the arb sequence.

326 Not supported by emulation mode

The function/parameter is not supported by the specified emulation mode.

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.

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.

–170 Expression error

Generic expression error.

–171 Invalid expression data

The expression data element was invalid.

–178 Expression data not allowed

Expression data element was sent 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.

–260 Expression error

An expression program data element related error occurred.

–261 Math error in expression

An expression program data element could not be executed due to a math error.

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.

Selftest Errors (these errors set Standard Event Status register bit #3)

202 Selftest Fail Aux Adc 0 expected <n1> to <n2>, measured <n3>, chan <n4>

Auxiliary ADC failed. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

202 Selftest Fail DACs 0 expected <n1> to <n2>, measured <n3>, chan <n4>

Both voltage and current DACs are at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

202 Selftest Fail DACs 1 expected <n1> to <n2>, measured <n3>, chan <n4>

Voltage DAC is at zero; current DAC is at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

202 Selftest Fail DACs 2 expected <n1> to <n2>, measured <n3>, chan <n4>

Voltage DAC is at full scale; current DAC is at zero. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

202 Selftest Fail DACs 3 expected <n1> to <n2>, measured <n3>, chan <n4>

Both voltage and current DACs are at full scale. n1 and n2 are the expected limits. n3 is the measured value. n4 is the channel location of the failed module.

Compatibility with A and B Version Power Analyzers

Persona Commands

New Feature Comparison With A and B Power Analyzers

The Persona commands described in this section are provided for compatibility with the existing N6705A and N6705B DC Power Analyzers. This section also compares the new N6705C features to the previous N6705A and N6705B power analyzers.

Persona Commands

Persona commands are provided to allow users to change the programmatic identity of the N6705C mainframes back to the "A" or "B" version mainframes for code compatibility. The manufacturer string can also be changed for code compatibility. The persona commands are non-volatile.

Model Number

To change the model number ID of an N6705C to N6705B:
SYST:PERS:MOD "N6705B"

To return the model number to the factory shipped setting:
SYST:PERS:MOD:DEF

Manufacturer ID

To change the manufacturer ID to Agilent Technologies:
SYST:PERS:MAN "Agilent"

To return the manufacturer to the factory shipped setting:
SYST:PERS:MAN:DEF

New Feature Comparison With A and B Power Analyzers

Feature	N6705C Implementation	N6705A/B Implementation
Color	Phantom gray	Quartz gray
Start-up time	Approximately 30 seconds	Approximately 15 seconds
Compliance	LXI 1.4 Core, HiSLIP, IPv6	LXI 1.1 Class C
Ethernet connectivity	Up to 1000 Mbps	Up to 100 Mbps
Auto-MDIX	Supported	Not available
*IDN response	Keysight Technologies N6705C	Agilent Technologies N6705A, N6705B
Firmware update method	Firmware Update Utility only	Firmware Update Utility or front panel USB port
Firmware update lockout from front panel	Requires Admin password to update firmware	Not available
ID strings - LAN, USB, GPIB, and Web page	Keysight, K-<hostname>	Agilent, A-<hostname>
Low battery detect at start-up	Supported	Not available
Saved state locations	10	2
Web control	No Java plug-in required	Java plug-in required
Calibration count	CALibrate:COUNt	Returns -100 Command error
Display image capture commands	HCOPy:SDUMp:DATA? HCOPy:SDUMp:DATA:FORMat	Returns -100 Command error
Front panel display enable/disable	DISPlay[:WINDow][:STAte]	Returns -100 Command error
LXI identify and MDNS commands	LXI:IDENtify[:STATe] LXI:MDNS[:STATe]	Returns -100 Command error
Difference between the internal temperature and the OT trip point	OUTPut:PROTection:TEMPerature:MARgin	Returns -100 Command error
PERSona commands switch manufacturer and model number for backward compatibility	SYSTem:PERSona:MANufacturer SYSTem:PERSona:MANufacturer:DEFault SYSTem:PERSona:MODel SYSTem:PERSona:MODel:DEFault	Returns -100 Command error
Memory sanitization NISPOM compatible	SYSTem:SECurity:IMMediate	Returns -100 Command error
Set the instrument state in binary format	SYSTem:SET	Returns -100 Command error

8
Verification and Calibration

Test Equipment and Setups

Performance Verification

Module Calibration

Test Record Forms

The verification procedures described in this section verify that the Keysight N6705C DC Power Analyzer is operating normally and is within published specifications.

Perform the verification tests before calibrating your power analyzer. If the power analyzer passes the verification tests, the power modules are operating within their calibration limits and do not need to be re-calibrated.

NOTE Keysight N6705C mainframes do not require calibration.

Test Equipment and Setups

Equipment Required

Measurement Setups

Equipment Required

The test equipment recommended for the verification and calibration 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 or equivalent	V, C
Current Shunt[2]	15 A (0.1Ω) 30 A (0.1Ω) 50 A (0.05Ω)	Guildline 9230A-15R Guildline 9230A-30 Guildline 9230A-50	V, C
Load Resistors	25 Ω, 250 W, 1% (N6751A/52A/61A/62A) 4 Ω, 250 W, 1% (N6751A/52A/61A/62A) 20 kΩ, 1%, 1/8W (for option 1UA/2UA) 10 Ω, 1%, 1/8W (N678xA SMU) 10 kΩ, 1%, 1/8W (N678xA SMU) 1 MΩ, 1%, 1/8W (N678xA SMU)	Vishay NH-250-25Ω-1% Vishay NH-250-4Ω-1%	C C V, C V, C V, C V, C
Electronic load[2]	150 V, 50 A minimum, with transient capability and a slew rate of 833 kA/s or better	Keysight N3300A mainframe, with N330xA modules	V, C
Keysight N6784A	Load for N678xA SMU and N6783A (set to CC load mode)	Keysight N6784A	V
GPIB controller	Full GPIB capabilities	Keysight 82350B or equivalent	V, C
Oscilloscope	Sensitivity: 1 mV Bandwidth Limit: 20 MHz Probe: 1:1 with RF tip	Keysight DSO6054A or equivalent	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 DA1855A, DA1850A, or equivalent	V
Terminations	1 – 50Ω BNC termination 2 – 50Ω 1/8 W termination resistors		V
Power supply	80 V, 50 A, 300 W minimum (for N679xA load modules)	Keysight N6763A, N6764A, and N6776A or equivalent	V, C
Variable voltage transformer or AC source	Adjustable to highest rated input voltage Power: 500 VA	Keysight 6813B or equivalent	V
RC – for N678xA transient test	Capacitor: 150 µF fixed film Resistor 50 mΩ	EPCOS B32526R0157K Vishay LVR01R0500FE70	V

[1] V = Verification C = Calibration
[2] Dependent on rating of model being tested

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. You can set up the voltmeter to do this automatically by programming 100 power line cycles per measurement.

If you are using a Keysight 3458A DMM, turn on auto-calibration (ACAL) and autorange (ARANGE). Perform auto-calibration every 24 hours when verifying or calibrating models N678xA SMU.

Current Monitoring Shunt

The 4-terminal current shunt is used to make accurate current measurements. It has two monitoring terminals as well as two load terminals. Connect the voltmeter directly to the monitoring terminals. Also allow sufficient airflow for cooling.

Electronic Load

Many of the test procedures require the use of a variable load capable of dissipating the required power. If a variable resistor is used, switches should be used to connect, disconnect, or short the load resistor. For most tests, an electronic load can be used. The electronic load is considerably easier to use than load resistors, but it may not be fast enough to test transient recovery time and may be too noisy for the noise (PARD) tests. Fixed load resistors may be used in place of a variable load, with minor changes to the test procedures.

Note that an N6784A SMU power module should be used as the load when testing transient response on models N678xA SMU and N6783A.

Program Control

You may chose to automate the calibration and verification procedures. If computer controlled test setups are used, the relatively slow settling times and slew rates of the power analyzer must be taken into account. Use "Wait" statements to allow for the appropriate settling times for the power analyzer.

Performance Verification

Verification Description

Verification Test Setups

Constant Voltage Tests

Transient Recovery Time

Auxiliary Voltage Measurement Accuracy - Models N6781A and N6785A

Constant Current Tests

Resistance Programming Accuracy - Models N6781A and N6785A

Negative Current Output - Models N6783A-BAT and N6783A-MFG

Load Module Verification Tests

Verification Description

The verification procedures described in this section verify that the Keysight N6705C DC Power Analyzer is operating normally and is within published specifications. The following types of performance verification tests are available:

Performance Tests - These tests verify that the power analyzer is operating normally and meets the specifications published in the Keysight N6700 Modular Power System Family Specifications Guide.

Calibration Tests - These tests verify that the power analyzer is operating within its calibration limits.

Keysight Technologies recommends that complete verification should always be performed at the calibration interval. If the power analyzer passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated. This ensures that the instrument will remain within specifications for the next calibration interval and provides the best long-term stability. Performance data measured using this method may be used to extend future calibration intervals.

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.

Verification Test Setups

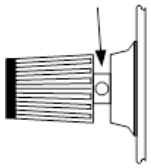
NOTE Refer to Test Equipment for the equipment required for verification. Refer to the Measurement Setups section for information about setting up the voltmeter, connecting the current shunt, and connecting the electronic load.

Test each output channel individually. Refer to the appropriate test record form for the instrument settings of the power module you are checking. For optimum performance, all verification and calibration procedures should comply with the following recommendations:

- Ambient temperature is stable, at 23°C ±5°C.
- Ambient relative humidity is less than 70%.
- 30 minute warm-up period before verification or adjustment.
- Cables as short as possible, twisted or shielded to reduce noise and inductance.
- Load lead lengths for models N678xA SMU must be between 1 and 4 feet.

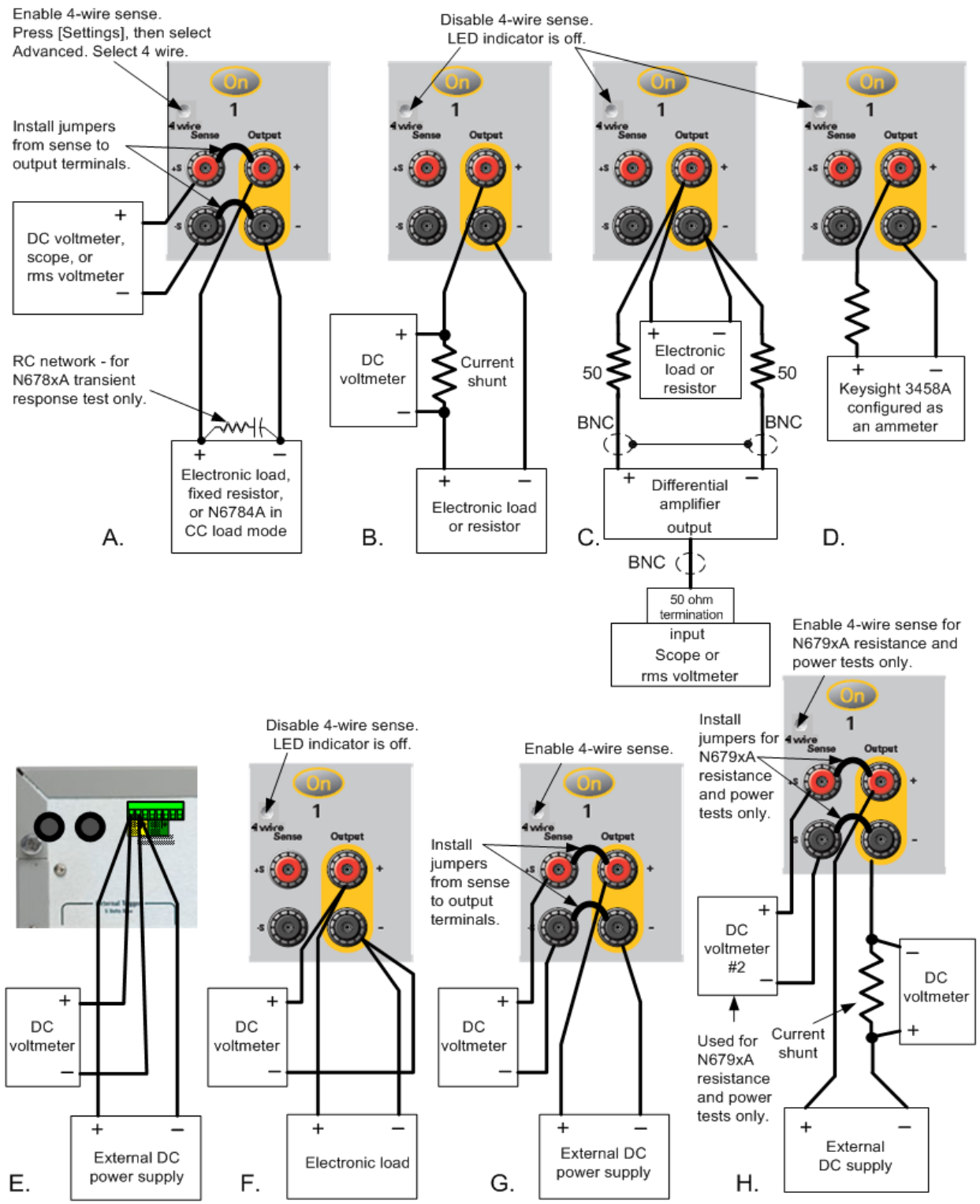
Front Panel Connections

Except for Setup A (and G and H for N679xA modules) do not connect anything to the Sense terminals. Check the front panel 4 wire LED to see whether 4 wire sensing is enabled (LED is lit) or disabled (LED not lit). To change the 4 wire sense settings, press [Settings], then navigate to and select Advanced. Under Sense, select Local or 4 Wire sensing. Connect all leads to the output terminals as shown in the following figure.



The following figures show the verification test set-ups. Connect all leads to the output terminals as shown in the figure.

High-current load and sense connections for models N6753A, N6755A, N6763A, N6765A and N6792A must be made directly at the modules, and not at the front panel, as shown under High-Current Output Connections.


Enable 4-wire sense.
Press [Settings], then select
Advanced. Select 4 wire.
Install jumpers
from sense to
output terminals.
DC voltmeter,
scope, or
rms voltmeter
RC network - for
N678xA transient
response test only.
Electronic load,
fixed resistor,
or N6784A in
CC load mode
A.
Disable 4-wire sense.
LED indicator is off.
DC
voltmeter
Current
shunt
Electronic load
or resistor
B.
Electronic
load or
resistor
50
50
BNC
BNC
Differential
amplifier
output
BNC
50 ohm
termination
input
Scope or
rms voltmeter
C.
Keysight 3458A
configured as
an ammeter
D.
Enable 4-wire sense for
N679xA resistance and
power tests only.
Install
jumpers for
N679xA
resistance
and power
tests only.
DC
voltmeter
#2
Used for
N679xA
resistance
and power
tests only.
Current
shunt
DC
voltmeter
External
DC supply
H.
DC
voltmeter
External DC
power supply
E.
Disable 4-wire sense.
LED indicator is off.
DC
voltmeter
Electronic load
F.
Enable 4-wire sense.
Install
jumpers
from sense
to output
terminals.
DC
voltmeter
External DC
power supply
G.

Constant Voltage Tests

Voltage Programming and Readback Accuracy (all except N679xA not N679xA)

Test category = performance, calibration

This test verifies that the voltage programming and measurement functions are within specifications.

Step 1. Turn off the power analyzer and connect a DMM across the sense terminals (see Test Setup A). Do not connect the load.

Step 2. Turn on the power analyzer 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" and the output current should be close to zero.

Step 3. Record the output voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under "Voltage Programming & Readback, Minimum Voltage".

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 and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under "Voltage Programming & Readback, High Voltage".

Step 6. *For models N6761A, N6762A, N6781A, N6782A, and N6784A only.* Set both the voltage programming and the voltage measurement to the low range (5.5 V for models N676xA; 6 V programming and 1 V measurement for models N678xA). Set the instrument as described under "Voltage Programming & Readback, Low Voltage". Repeat step 5 for the low voltage range. The readings should be within the limits specified under "Voltage Programming & Readback Low Voltage".

Step 7. *For models N6781A, N6782A, and N6784A only.* Set the voltage programming to the 600 mV range and the voltage measurement to the 100 mV range. Set the instrument as described under "600 mV Programming & 100 mV Readback". Repeat step 5. The readings should be within the limits specified under "600 mV Programming & 100 mV Readback".

Step 8. *For models N6763A – N6766A only.* Set the instrument as described under "Voltage Readback, Low Voltage". Record the voltage measured over the interface. The reading should be within the limits specified under "Voltage Readback Low Range".

Constant Voltage Load Effect (all except N679xA not N679xA)

Test category = performance

This test measures the change in output voltage resulting from a large change in output current from full load to no load.

Step 1. Turn off the power analyzer and connect a DMM and an electronic load (see Test Setup A).

Step 2. Turn on the power analyzer and program the instrument settings as described in the test record form under “CV Load Effect”.

Step 3. Set the electronic load for the output channel’s current as described in the test record form under “CV Load Effect”. The output status 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. Open the 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”.

Step 6. *For models N6781A, N6782A, and N6784A only.* Repeat steps 2 through 5 for the 6 V range.

Constant Voltage Source Effect (all except N678xA SMU, N679xA not N678xA SMU not N679xA)

Test category = performance

This test measures the change in output voltage that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

Step 1. Turn off the power analyzer and connect the ac power line through a variable voltage transformer or an AC source.

Step 2. Connect a DMM and an electronic load (see Test Setup A). Set the transformer or AC source to nominal line voltage.

Step 3. Turn on the power analyzer and program the instrument settings as described in the test record form under “CV Source Effect”.

Step 4. Set the electronic load for the output channel’s current as described in the test record form under “CV Source Effect”. The output status should be “CV”. If it isn’t, adjust the load so that the output current drops slightly.

Step 5. Adjust the AC input to the lowest rated line voltage (86 VAC).

Step 6. Record the output voltage reading from the DMM.

Step 7. Adjust the AC input to the highest rated line voltage (264 VAC).

Step 8. Record the output voltage reading on the DMM. The difference between the DMM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record form for the appropriate model under “CV Source Effect”.

Constant Voltage Ripple and Noise (all except N679xA not N679xA)

Test category = performance

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 frequency range specified in the Keysight N6700 Modular Power System Family Specifications Guide.

Step 1. Turn off the power analyzer and connect a load resistor or electronic load, differential amplifier, and an oscilloscope (ac coupled) to the output (see Test Setup C).

Step 2. *For models N6751A/52A, N6761A/62A, and N678xA SMU* - use an appropriate load resistor to keep the power analyzer at the instrument setting specified in the test record form under "CV Ripple and Noise". For all other power modules - use an electronic load to keep the power analyzer at the instrument setting specified in the test record form under "CV Ripple and Noise".

Step 3. As shown in the diagram, use two BNC cables to connect the differential amplifier to the + and – output terminals. Each cable should be terminated by a 50 Ω resistor. The shields of the two BNC cables 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 4. Set the differential amplifier to multiply by ten, divide by one, and 1 MΩ input resistance. The positive and negative inputs of the differential amplifier should be set to AC coupling. Set the oscilloscope's time base to 5 ms/div, and the vertical scale to 10 mV/div. Turn the bandwidth limit on (usually 20 or 30 MHz), and set the sampling mode to peak detect.

Step 5. Program the power analyzer to the settings indicated in the in the test record form for the appropriate model under "CV Ripple and Noise" and enable the output. Let the oscilloscope run for a few seconds to generate enough measurement points. On the Keysight Infiniium scope, the maximum peak-to-peak voltage measurement is indicated at the bottom of the screen on the right side. Divide this value by 10 to get the CV peak-to-peak noise measurement. The result should not exceed the peak-to-peak limits in the test record form for the appropriate model under "CV Ripple and Noise, peak-to-peak".

NOTE If the measurement contains any question marks, clear the measurement and try again. This means that some of the scope data received was questionable.

Step 6. 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 by 10. The result should not exceed the rms limits in the test record form for the appropriate model under "CV Ripple and Noise, rms".

Step 7. *For models N6781A, N6782A, and N6784A only.* Repeat steps 2 through 6 for the 6 V range.

Transient Recovery Time

For all except N678xA SMU, N6783A, N679xA

not N678xA SMU | not N6783A | not N679xA

Test category = performance

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current.

Step 1. Turn off the power analyzer and connect an oscilloscope across the sense terminals (see Test Setup A). Connect an electronic load to the output terminals.

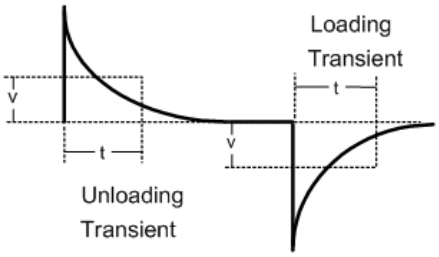
Step 2. Turn on the power analyzer and program the instrument settings as described in the test record form under “Transient Response”.

Step 3. Set the electronic load to operate in constant current mode. Program its load current to the lower current value indicated in the test record form under “Transient Response”.

Step 4. Set the electronic load's transient generator frequency to 100 Hz and its duty cycle to 50%.

Step 5. Program the load's transient current level to the higher current value indicated in the test record form under “Transient Response”, and turn the transient generator on.

Step 6. Adjust the oscilloscope for a waveform similar to that shown in the following figure.



Step 7. The output voltage should return to within the specified voltage at the specified time following the 50% load change. Check both loading and unloading transient by triggering on the positive and negative slope. Record the voltage at time “t” in the performance test record form under “Transient Response”.

For N678xA SMU and N6783A

N678xA SMU | N6783A

Test category = performance

This test measures the time for the output voltage to recover to within the specified value following a 50% change in the load current of the specified range for models N678xA SMU and N6783A.

Step 1. Turn off the power analyzer and connect an oscilloscope across the sense terminals (see Test Setup A). Connect an N6784A as a load to the output terminals. For models N678xA SMU only, observe the following additional connection requirements:
a. Twist the load leads, length must be between 1 and 4 ft.
b. Connect a 150 µF capacitor and 50 mΩ resistor across the load.
c. Disconnect the sense jumpers. Keep 4-wire sensing enabled.

d. Connect a 22 AWG twisted-pair from the +/- sense terminal to the output terminals of the N6784A load.

Step 2. Turn on the power analyzer and program the instrument settings as described in the test record form under "Transient Response 6V".

Step 3. Set the N6784A that is being used as the load as follows:
a. Emulation Mode = CC Load (in current priority mode)
b. + Voltage limit = 6.12 V
c. Current Slew setting:
N678xA: Maximum (the default)
N6783A: 67500 A/s (for a pulse rise/fall time of 20 µs)
d. Arb = Current Pulse
e. Load pulse properties:
N678xA: I0= –0.1 A; I1= –1.5A; T0= 1ms; T1= 1ms; T2= 1ms
N6783A: I0= –0.15A; I1= –1.5A; T0= 0.5ms; T1= 0.5ms; T2= 0.5ms
f. Continuous = ON
g. Press Arb run..

Step 4. Adjust the oscilloscope for a waveform similar to that shown in the previous figure.

Step 5. The output voltage should return to within the specified voltage at the specified time following the 50% load change. Check both loading and unloading transient by triggering on the positive and negative slope. Record the voltage at time "t" in the performance test record form under "Transient Response".

Step 6. *For models N6781A, N6782A, and N6784A only.* Repeat steps 3 through 5 for the 20 V range. Program the instrument settings as described on the test record form under "Transient Response 20 V". Change the settings of the N6784A that is being used as the load as follows:
b. + Voltage limit = 20.4 V
e. Load pulse properties:
N678xA: I0= –0.1 A; I1= –0.9A; T0= 1ms; T1= 1ms; T2= 1ms

Auxiliary Voltage Measurement Accuracy - Models N6781A and N6785A N6781A, N6785A

Test category = performance

Step 1. Turn off the power analyzer and connect the external DMM and an external power supply to the auxiliary voltage inputs (see Test Setup E).

Step 2. Turn on the external power supply and set the output to 20 volts. Turn on the power analyzer. In the front panel menu, select Measure\Input and then select Auxiliary.

Step 3. Record the external DMM reading and the auxiliary DVM readings. The auxiliary voltage reading should be within the designated voltage limit indicated in the test record form under "Auxiliary Voltage Readback".

Step 4. Reverse the leads of the external power supply and repeat step 3.

Constant Current Tests

Current Programming and Readback Accuracy (all except N679xA not N679xA)

Test category = performance, calibration

This test verifies that the current programming and measurement functions are within specifications.

Step 1. Turn off the power analyzer and connect the current shunt directly across the output terminals. Connect the DMM directly across the current shunt (see Test Setup B). Note that the electronic load is not used in this portion of the test.

Step 2. Turn on the power analyzer and program the instrument settings as described in the test record form under "Current Programming & Readback, Min Current". The output status should be "CC", and the output voltage should be close to zero.

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 over the interface. The readings should be within the limits specified in the test record form for the appropriate model under "Current Programming & Readback, Minimum Current".

Step 4. Program the instrument settings as described in the test record form under "Current Programming & Readback, High Current".

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 over the interface. The readings should be within the limits specified in the test record form for the appropriate model under "Current Programming & Readback, High Current".

Step 6. *For models N6761A and N6762A only.* Connect the Keysight 3458A directly across the output (see Test Setup D without the resistor). Set the Keysight 3458A to the 100 mA range (no autoranging). Set both the current programming and the current measurement functions to the low range. Set the instrument as described under "Current Programming & Readback, Low Current". Record the current reading of the 3458A. Also, record the current reading measured over the interface. The readings should be within the limits specified under "Current Programming & Readback, Low Range".

Step 7. *For models N6761A and N6762A with option 2UA only.* Connect the Keysight 3458A and a 20k resistor to the output (see Test Setup D). Set the Keysight 3458A to measure current using the 1 mA range. Set the current measurement to the 200 µA range. Set the instrument as described in the test record form under "Current Readback, 200 µA Current". Record the current reading of the Keysight 3458A and the current measured over the interface. Readings should be within limits specified for the appropriate model under "Current Readback, 200µA Range".

Step 8. *For models N6763A–N6766A, and N6783A only.* Set the current measurement to the low range. Set the instrument as described under "Current Readback, Low Current". Repeat step 5. Record the current measured over the interface. The readings should be within the limits specified under "Low Current Readback Low Range".

Step 9. *Steps 9 and 10 for models N6781A, N6782A, N6784A only.* Connect the Keysight 3458A directly across the output (see Test Setup D without the resistor). Set the Keysight 3458A to the 100 mA range (no autoranging). Set the current programming to the low ranges - 300 mA for N6781A and N6782A; 100 mA for the N6784A. Set the instrument as described under "Current Programming 300 mA & 100 mA ranges". Record the current readings of the 3458A. The readings should be within the limits specified under "300 mA and 100 mA range Current Iout".

Step 10. Set the current programming to the 10 mA range for the N6784A. Set the instrument as described under "Current Programming 10 mA range". Record the current reading of the 3458A. The reading should be within the limits specified under "10 mA range Current Iout".

Step 11. *Steps 11 and 12 for models N6781A, N6782A, N6784A, N6785A, and N6786A only.* Connect the Keysight 3458A in series with a 10 Ω resistor to the output (see Test Setup D). Set the Keysight 3458A to measure current using the 100 mA range. Set the current measurement to the 100 mA range. Set the instrument as described under "Current Readback 100 mA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "100 mA Range Readback".

Step 12. Connect the Keysight 3458A in series with a 10 kΩ resistor to the output (see Test Setup D). Set the Keysight 3458A to measure current using the 10 mA range. Set the current measurement to the 1 mA range. Set the instrument as described under "Current Readback 1 mA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "1 mA Range Readback".

Step 13. *For models N6781A, N6782A, and N6784A only.* Connect the Keysight 3458A in series with a 1 MΩ resistor to the output (see Test Setup D). Set the Keysight 3458A to measure current using the 100 µA range. The remote command is "DCI 100e-6". Set the current measurement to the 10 µA range. Set the instrument as described under "Current Readback, 10 µA Range". Record the current reading of the 3458A and the current measured over the interface. The readings should be within the limits specified under "10 µA Range Readback".

Constant Current Load Effect (all except N679xA not N679xA)

Test category = performance

This test measures the change in output current resulting from a change in output voltage from full scale to short circuit.

Step 1. Turn off the power analyzer and connect the current shunt, DMM, and electronic load (see Test Setup B). Connect the DMM directly across the current shunt.

Step 2. Turn on the power analyzer and program the instrument settings as described in the test record under "CC Load Effect".

Step 3. Set the electronic load for CV mode and program it to the output channel's 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 4. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout).

Step 5. Short the electronic load. For models N6751A and N6752A, wait 10 seconds for the output to stabilize. For models N6761A and N6762A, wait 60 seconds for the output to stabilize. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). 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".

Step 6. *For models N6781A and N6782A only.* Repeat steps 2 through 5 for the 1 A range and the 300 mA range.

Step 7. *For model N6784A only.* Repeat steps 2 through 5 for the 1 A range, the 100 mA range, and the 10 mA range.

Constant Current Source Effect (all except N678xA SMU, N679xA not N678xA SMU not N679xA)

Test category = performance

This test measures the change in output current that results from a change in AC line voltage from the minimum to maximum value within the line voltage specifications.

Step 1. Turn off the power analyzer and connect the ac power line through a variable voltage transformer or an AC source.

Step 2. Connect the current shunt, DMM, and electronic load (see Test Setup B). Connect the DMM directly across the current shunt. Set the transformer or AC source to nominal line voltage.

Step 3. Turn on the power analyzer and program the instrument settings as described in the test record form under "CC Source Effect".

Step 4. Set the electronic load for the output channel's voltage as described in the test record form under "CC Source Effect". The output status should be "CC". If it isn't, adjust the load so that the output voltage drops slightly.

Step 5. Adjust the AC input to the lowest rated line voltage (86 VAC).

Step 6. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout).

Step 7. Adjust the AC input to the highest rated line voltage (264 VAC).

Step 8. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iout). The difference between the DMM reading in steps 6 and 8 is the source effect, which should not exceed the value listed in the test record form for the appropriate model under "CC Source Effect".

Resistance Programming Accuracy

For N6781A and N6785A N6781A, N6785A

Test category = performance, calibration

NOTE Current readback accuracy must be verified prior to this test.

Step 1. Turn off the power analyzer and connect an external DMM and an electronic load directly to the output (see Test Setup F).

Step 2. Turn on the power analyzer and set the 20 V range, and program the output to 10 V. Turn the output on and record the voltage reading on the DMM. This is the voltage with no load (Vnl).

Step 3. Program the output resistance to 1 ohm. Turn on the electronic load. Select CC mode, current: 1 A, Input On.

Step 4. Record the voltage reading on the DMM. This is the voltage with a load (Vwl). Record the current reading on the front panel of the power analyzer. This is the current with a load (Iwl).

Step 5. Calculate the resistance value as follows: R = (Vnl–Vwl)/Iwl This is the output resistance, which should not exceed value listed in the test record under “Resistance Programming”.

Step 6. For Model N6781A, repeat steps 2 through 5 for the 6 V range. Set the output voltage to 6 V and the load current to 3 A.

Negative Current Output - Models N6783A-BAT and N6783A-MFG N6783A

Test category = performance, calibration

Step 1. Turn off the power analyzer and connect the DMM, current shunt, and a power supply to the output (see Test Setup H). Connect plus to plus, minus to minus. Set the external power supply to 3V, 3A. DMM #2 is not used.

Step 2. Turn on the power analyzer and set the N6783A power module to the values indicted in the test record under “Negative Current Output”. The display should read approximately -2 A.

Step 3. Divide the voltage drop (DMM reading) across the current shunt by its resistance to convert to amperes and record this value. The reading should be within the limits specified on the test record under Constant Current Tests, “Negative Current Output”.

Load Module Verification Tests - Models N6791A and N6792A N679xA)

Voltage Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the voltage programming and measurement functions are within specifications.

Step 1. Turn off the power analyzer and connect a DMM across the sense terminals and an external power supply across the input terminals (see Test Setup G).

Step 2. Turn on the power analyzer and program the N679xA load settings as described in the test record form for “Voltage Programming & Readback, Minimum voltage”. Turn on the power supply and program it to the power supply settings described in the test record form.

Step 3. Turn the load input on. The load status should be “CV” and the input current should be close to zero.

Step 4. Record the voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, Minimum voltage”.

Step 5. Program the N679xA load settings as described in the test record form for “Voltage Programming & Readback, High voltage”.

Step 6. Record the voltage reading from the DMM and the voltage measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Voltage Programming & Readback, High voltage”.

Current Programming and Readback Accuracy

Test category = performance, calibration

This test verifies that the current programming and measurement functions are within specifications.

High Range

Step 1. Turn off the power analyzer and connect the DMM, current shunt, and an external power supply across the input terminals (see Test Setup H). Connect the DMM directly across the current shunt. DMM #2 is not used.

Step 2. Turn on the power analyzer and program the N679xA load settings as described in the test record form under “Current Programming & Readback - High range, Minimum current”. Turn on the power supply and program it to the power supply settings described in the test record form.

Step 3. Turn the load input on. The load status should be “CC”, and the input voltage should be close to zero.

Step 4.Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback - High range, Minimum current”.

Step 5. Program the N679xA load settings as described in the test record form under “Current Programming & Readback, High current”.

Step 6. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current reading measured over the

interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, High current”.

Low Range

Step 7. Program the N679xA load settings as described in the test record form under “Current Programming & Readback - Low range, Minimum current”.

Step 8. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current reading measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, Low range, Minimum current”.

Step 9. Program the N679xA load settings as described in the test record form under “Current Programming & Readback - Low range, Low current”.

Step 10. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current reading measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Current Programming & Readback, Low range, Low current”.

Resistance Programming Accuracy

Test category = performance

This test verifies that the resistance programming is within specification. The programmed resistance values are checked by recording the voltage across the current monitor resistor and the input voltage (voltage at the modules + and – sense terminals), then calculating the resistance as follows;

Resistance = Input Voltage / (voltage across current monitor / monitor resistor value)

The Resistance value must then be converted to Siemens by inverting the value: S = 1/R

High Range

Step 1. Turn off the power analyzer and connect the current shunt, DMM, and an external power supply (see Test Setup H). Connect the DMM directly across the current shunt. Connect DMM #2 across the sense terminals.

Step 2. Turn on the power analyzer and program the N679xA load settings as described in the test record form for “Resistance Programming - High range, Minimum resistance”. Turn on the power supply and program it to the power supply settings described in the test record form.

Step 3. Turn the load input on. The load status should be “CR”

Step 4. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 5. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under “Resistance Programming - High range, Minimum resistance”.

Step 6. Program the N679xA load settings as described in the test record form under “Resistance Programming - High range, High resistance”. Program the power supply to the power supply settings described in the test record form.

Step 7. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 8. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under “Resistance Programming - High range, High resistance”.

Medium Range

Step 9. Program the N679xA load settings as described in the test record form for “Resistance Programming - Medium range, Minimum resistance”. Program the power supply to the power supply settings described in the test record form.

Step 10. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 11. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under “Resistance Programming - Medium range, Minimum resistance”.

Step 12. Program the N679xA load settings as described in the test record form under “Resistance Programming - Medium range, High resistance”. Program the power supply to the power supply settings described in the test record form.

Step 13. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 14. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under “Resistance Programming - Medium range, High resistance”.

Low Range

Step 15. Program the N679xA load settings as described in the test record form for “Resistance Programming - Low range, Minimum resistance”. Program the power supply to the power supply settings described in the test record form.

Step 16. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 17. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under “Resistance Programming - Low range, Minimum resistance”.

Step 18. Program the N679xA load settings as described in the test record form under "Resistance Programming - Low range, High resistance". Program the power supply to the power supply settings described in the test record form.

Step 19. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin).

Step 20. Calculate the resistance value as follows: R = Vin/Iin. Vin is the voltage measured by the second DMM. Convert the input resistance (R) to Siemens by inverting the value: S = 1/R. The value in Siemens should not exceed value listed in the test record under "Resistance Programming - Low range, High resistance".

Power Programming and Readback Accuracy

Test category = performance

This test verifies that the power programming and measurement functions are within specifications.

High Range

Step 1. Turn off the power analyzer and connect the current shunt, DMM, and an external power supply (see Test Setup H). Connect the DMM directly across the current shunt. Connect DMM #2 across the sense terminals.

Step 2. Turn on the power analyzer and program the N679xA load settings as described in the test record form under "Power Programming & Readback - High range, Minimum power". Turn on the power supply and program it to the power supply settings described in the test record form.

Step 3.Turn the load input on. The load status should be "CP".

Step 4. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current measured over the interface. Calculate the power as follows: P = Iin x Vin. Vin is the voltage measured by the second DMM. The readings should be within the limits specified in the test record form for the appropriate model under "Power Programming & Readback - High range, Minimum power".

Step 5. Program the N679xA load settings as described in the test record form under "Power Programming & Readback High range, High power".

Step 6. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also record the current reading measured over the interface. Calculate the power as follows: P = Iin x Vin. Vin is the voltage measured by the second DMM. The readings should be within the limits specified in the test record form for the appropriate model under "Power Programming & Readback - High range, High power".

Low Range

Step 7. Program the N679xA load settings as described in the test record form under "Power Programming & Readback - Low range, Minimum power".

Step 8. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also, record the current reading measured over the interface. Calculate the power as follows: P = Iin x Vin. Vin is the voltage measured by the second DMM. The readings should be within the limits specified in the test record form for the appropriate model under “Power Programming & Readback, Low range, Minimum power”.

Step 9. Program the N679xA load settings as described in the test record form under “Power Programming & Readback - Low range, Low power”.

Step 10. Divide the voltage drop (DMM reading) across the current shunt by the shunt resistance to convert to amps and record this value (Iin). Also, record the current reading measured over the interface. The readings should be within the limits specified in the test record form for the appropriate model under “Power Programming & Readback, Low range, Low power”.

Power Module Calibration

Calibration Description

Calibration Setups

Calibration Procedure – Models N673xB, N674xB, N677xA

Calibration Procedure – Models N675xA and N676xA

Calibration Procedure – Models N678xA SMU

Calibration Procedure – Models N6783A-BAT and N6783A-MFG

Calibration Procedure – Models N6791A and N6792A

Calibration Description

NOTE Perform the verification tests before calibrating your power analyzer. If the power analyzer passes the verification tests, the unit is operating within its calibration limits and does not need to be re-calibrated.

The Keysight N6705C DC Power Analyzer 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.

- The correct password is required to enter the Admin menu, which contains the calibration function. The password is factory-set to 0 (zero). You can change the password once calibration mode is entered to prevent unauthorized access to the calibration function. Refer to Password Protection for more information.
- Calibrate only ONE channel at a time. The calibration commands accept only a single channel number for the channel parameter. Calibration cannot be performed on channels that have been grouped. If any channels are grouped, they must be ungrouped before they can be calibrated.
- When calibrating the unit using SCPI commands, most steps involve sending a *OPC? query to synchronize with the power analyzer'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.
- When calibrating the unit using SCPI commands, most steps involve sending a *OPC? query to synchronize with the instrument's command completion before proceeding. The response from the instrument must be read each time *OPC? is given. Additionally, the relatively slow settling times and slew rates of the power analyzer must be taken into account. Use "Wait" statements to allow for the appropriate settling times for the power analyzer.

- **Once started, you must perform the complete voltage or current calibration procedure 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 channels that were calibrated but not saved will revert to their previous calibration constants.

Calibration Interval

The power modules should be calibrated on a regular interval determined by the accuracy requirements of your application. The recommended calibration interval for Keysight N6700-series power modules is one year. Keysight N6705C mainframes do not require calibration.

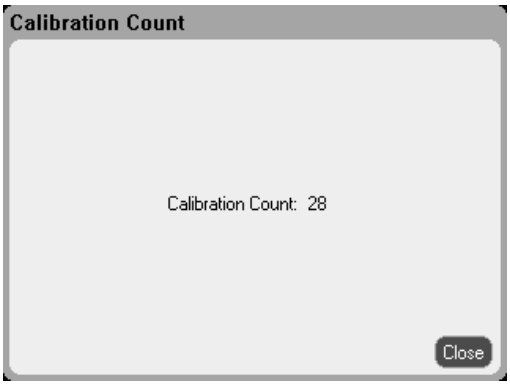
Calibration Switches

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.

Calibration Count

The N6705C records the number of times the unit is calibrated. The calibration count is incremented whenever the calibration (or date) is saved, the administration password is changed (or reset using the internal switches), or the firmware is updated.

From the Calibration menu, select Count.



From the remote interface, program:

CAL:COUN?

Calibration Setups

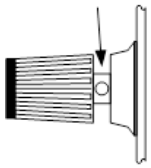
NOTE Refer to Test Equipment for the equipment required for calibration. Refer to the Measurement Setups section for information about setting up the voltmeter, connecting the current shunt, and connecting the electronic load.

For optimum performance, all verification and calibration procedures should comply with the following recommendations:

- Ambient temperature is stable, at 23°C ±5°C.
- Ambient relative humidity is less than 70%.
- 30 minute warm-up period before verification or adjustment.
- Cables as short as possible, twisted or shielded to reduce noise and inductance.
- Load lead lengths for Models N678xA SMU must be between 1 and 4 feet. This is also recommended for other power modules.

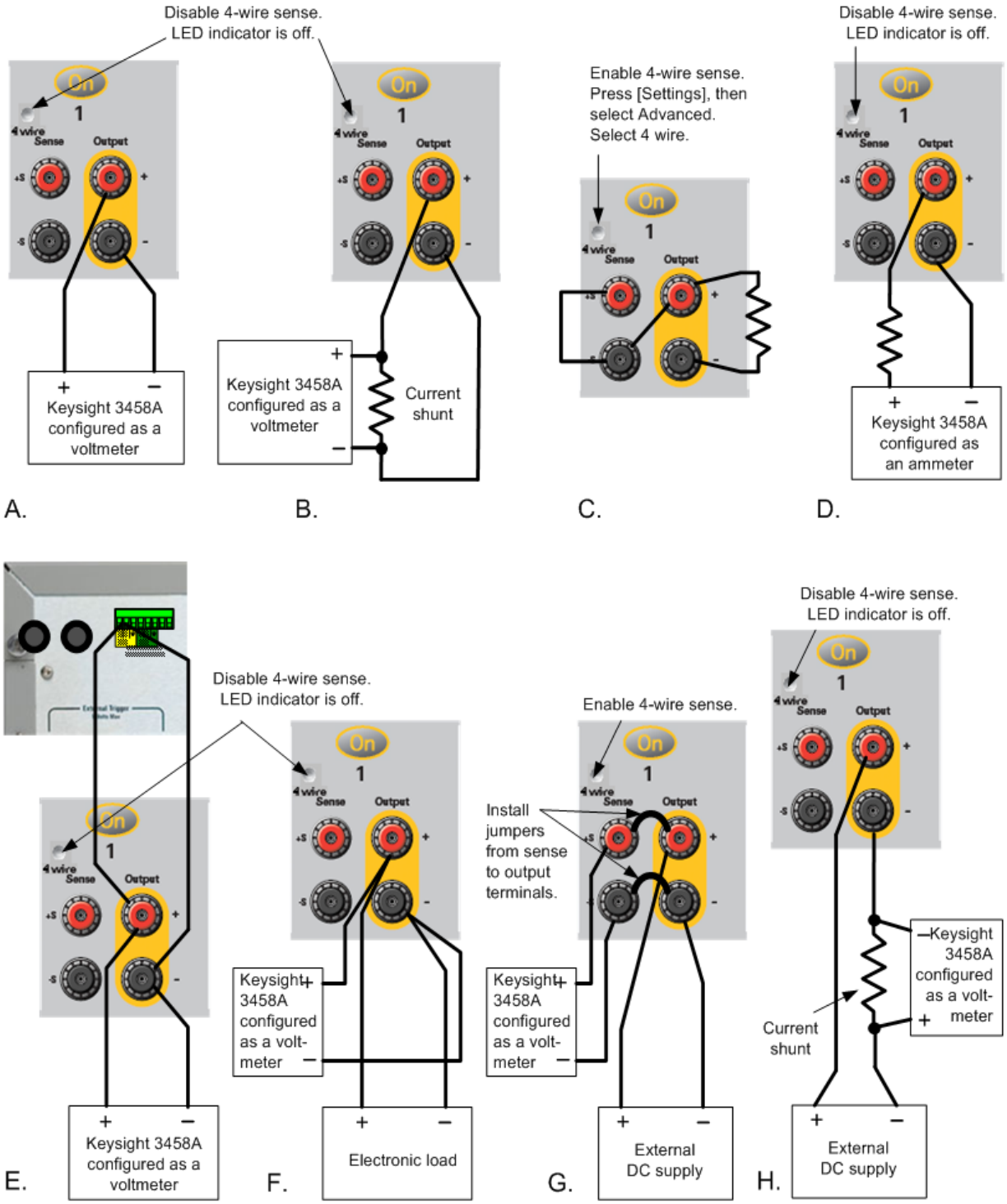
Front Panel Connections

Except for Cal Setup C and G, do not connect anything to the Sense terminals. Check the front panel 4 wire LED to see whether 4 wire sensing is enabled (LED is lit) or disabled (LED not lit). To change the 4 wire sense settings, press [Settings], then navigate to and select Advanced. Under Sense, select Local or 4 Wire sensing. Connect all leads to the output terminals as shown in the following figure.



The following figures show the calibration test set-ups. Connect all leads to the output terminals as shown in the figure.

High-current load and sense connections for models N6753A, N6755A, N6763A, N6765A and N6792A must be made directly at the modules, and not at the front panel, as shown under High-Current Output Connections.


Disable 4-wire sense.
LED indicator is off.
Keysight 3458A configured as a voltmeter
A.
Disable 4-wire sense.
LED indicator is off.
Keysight 3458A configured as a voltmeter
Current shunt
B.
Enable 4-wire sense.
Press [Settings], then select Advanced.
Select 4 wire.
C.
Disable 4-wire sense.
LED indicator is off.
Keysight 3458A configured as an ammeter
D.
Disable 4-wire sense.
LED indicator is off.
Keysight 3458A configured as a voltmeter
E.
Disable 4-wire sense.
LED indicator is off.
Keysight 3458A configured as a volt-meter
Electronic load
F.
Enable 4-wire sense.
Install jumpers from sense to output terminals.
Keysight 3458A configured as a volt-meter
External DC supply
G.
Disable 4-wire sense.
LED indicator is off.
Current shunt
Keysight 3458A configured as a volt-meter
External DC supply
H.

Calibration Procedure – Models N673xB, N674xB, N677xA

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Press **Menu** then select Utilities, Administrative Tools, Administrator Login/Logout. Enter the password in the PIN field and select Login. Select the Calibration menu. Select Turn On/Off to access the menu items.	CAL:STAT ON <password>

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Keysight 3458A DMM to an output channel as shown in Cal Setup A.

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 60 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, High Range Prog and Meas. Then select Start.	CAL:VOLT 60, (@1)

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Calibration

High Range Programming and Measurement

NOTE The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 5 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, High Range Prog and Meas. Then select Start.	CAL:CURR 5, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Enter a Calibration Date, Save, and Log Out

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Date. Enter the date, then select Insert Date. Then select Close.	To enter a calibration date: CAL:DATE "<date>"
From the Calibration menu, select Save. Select Save Calibration for all Outputs. Then select Close.	To save the calibration data: CAL:SAVE
From the Administrative Tools menu, select Administrator Login/Logout to log out of the Admin menu.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N675xA and N676xA

NOTE Models N6761A and N6762A require a 30-minute warm-up period in the reset (*RST) state before starting calibration.

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Press **Menu** then select Utilities, Administrative Tools, Administrator Login/Logout. Enter the password in the PIN field and select Login. Select the Calibration menu. Select Turn On/Off to access the menu items.	CAL:STAT ON <password>

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Keysight 3458A DMM to an output channel as shown in Cal Setup A.

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 50 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, High Range Prog and Meas. Then select Start.	CAL:VOLT 50, (@1)

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Low Range Voltage Programming - Models N6761A through N6766A

Step 1. Select the low-voltage programming range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 5 V range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Low Range Programming. Then select Start.	CAL:VOLT 5, (@1)

Step 2. Select the first voltage calibration point and enter the data. This value may be positive or negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 3. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM.Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Low Range Voltage Measurement - Models N6761A through N6766A

Step 1. Select the low-voltage measurement range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 5 V range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Low Range Measurement. Then select Start.	CAL:VOLT:MEAS 5, (@1)

Step 2. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 3. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Voltage Common Mode Rejection Ratio Calibration

Step 1. For this step, make the connections as shown in Cal Setup C. Connect an external jumper between the +sense and the –sense terminals. Connect a second jumper from the +output to the

–sense terminal.

For models N6751A, N6752A, N6761A, and N6762A only, connect a 25 Ω load resistor across the +output and –output terminals.

This procedure is automatic and only takes a few seconds.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Miscellaneous, Common Mode Rejection Ratio, then Start. Then select Close.	CAL:VOLT:CMRR (@1) *OPC?

After calibration completes, disconnect all jumpers and resistors.

Current Calibration

High Range Programming and Measurement

NOTE The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 5 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, High Range Prog and Meas. Then select Start.	CAL:CURR 5, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Low Range Current Programming - Models N6761A through N6766A

Step 1. Connect only the current measurement terminals of the Keysight 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low-current programming range. The value to program a range must be the maximum current of the range. This example selects the 100 mA range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Low Range Prog and Meas. Then select Start.	CAL:CURR 0.1, (@1)

Step 3. Select the first current calibration point and enter the data. For models N6761A and N6762A only, wait a minimum of 5 minutes for the output current to stabilize. before entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data. Wait a minimum of 30 seconds for the output current to stabilize

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Low Range Current Measurement - Models N6761A through N6766A

Step 1. Connect only the current measurement terminals of the Keysight 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low-current measurement range. The value to program a range must be the maximum current of the range. This example selects the 100 mA range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Low Range Measurement. Then select Start.	CAL:CURR:MEAS 0.1, (@1)

Step 3. Select the first current calibration point and enter the data. For models N6761A and N6762A only, wait a minimum of 5 minutes for the output current to stabilize before entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Steps 4 and 5 apply only to models N6761A and N6762A

Step 4. Disconnect the Keysight 3458A from the output terminals. Then select the second current calibration point.

Front Panel Menu Reference	SCPI Command
The second calibration point is automatically selected. "Disconnect Meter" should be displayed. Press Enter when done.	CAL:LEV P2

Step 5. Wait a minimum of 5 minutes for the internal temperature to stabilize. Then select the third current calibration point.

Front Panel Menu Reference	SCPI Command
The third calibration point is automatically selected. "Wait 5 minutes, press Next" should be displayed. Wait 5 minutes and press Next.	CAL:LEV P3 *OPC?

100 uA/200 uA Range Measurement - Models N6761A/N6762A with Option 1UA or 2UA

Step 1. Remove all loads from the output. Leave the sense terminals connected to the output terminals.

Step 2. Select either the 100 µA measurement range or the 200 µA measurement range. Then wait 10 seconds.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, 1UA/2UA Option Range Meas. Then select Start.	CAL:CURR:MEAS 0.0001, (@1) or CAL:CURR:MEAS 0.0002, (@1) *OPC?

Step 3. Select the first current calibration point.

Front Panel Menu Reference	SCPI Command
The first calibration point is automatically selected. "Waiting 10 seconds" should be displayed.	CAL:LEV P1 *OPC?

Step 4. Connect the Keysight 3458A and a 20 k Ω resistor to the output (see Cal Setup D).

Front Panel Menu Reference	SCPI Command
Measure the output current with the Keysight 3458A and enter the value. Press Select when done. Press Next to finish calibration.	CAL:DATA <data>

Peak Current Limit Calibration

NOTE For models N6753A through N6756A and N6763A through N6766A, the peak current limit calibration is valid for five years.

Step 1. Connect only the electronic load or equivalent resistor (up to 500 W rating) across the output terminals for the first calibration point.

Model	1st calibration point	2nd calibration point
N6751A/N6752A N6761A/N6762A	25 Ω resistor (do not use electronic load)	4 Ω resistor (do not use electronic load)
N6753A/N6763A	Electronic load set to 26.25A, CC mode (0.6 Ω equivalent, including lead resistance)	Electronic load set to 13.12A, CC mode (1.2 Ω equivalent, including lead resistance)
N6754A/N6764A	Electronic load set to 10.5A, CC mode (3.8 Ω equivalent, including lead resistance)	Electronic load set to 5.25A, CC mode (7.6 Ω equivalent, including lead resistance)
N6755A/N6765A	Electronic load set to 43.75A, CC mode (0.37 Ω equivalent, including lead resistance)	Electronic load set to 21.88A, CC mode (0.73Ω equivalent, including lead resistance)
N6756A/N6766A	Electronic load set to 17.5A, CC mode (2.3 Ω equivalent, including lead resistance)	Electronic load set to 8.75A, CC mode (8.75Ω equivalent, including lead resistance)

Step 2. Select peak current limit calibration.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Miscellaneous, Peak Current Limit. Then select Start.	CAL:CURR:PEAK (@1)

Step 3. Select the first current calibration point.

Front Panel Menu Reference	SCPI Command
Select Next. The calibration is automatic.	CAL:LEV P1 *OPC?

Step 4. Set the electronic load or connect the appropriate resistor for the second calibration point.

Step 5. Select the second current calibration point.

Front Panel Menu Reference	SCPI Command
Select Next. The calibration is automatic.	CAL:LEV P2 *OPC?

Downprogrammer Calibration

Step 1. Remove all loads from the output. This procedure is automatic and takes a few seconds.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Miscellaneous, Downprogrammer. Select Start. Then select Close.	CAL:DPRog (@1)

Enter a Calibration Date, Save, and Log Out

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Date. Enter the date, then select Insert Date. Then select Close.	To enter a calibration date: CAL:DATE "<date>"
From the Calibration menu, select Save. Select Save Calibration for all Outputs. Then select Close.	To save the calibration data: CAL:SAVE
From the Administrative Tools menu, select Administrator Login/Logout to log out of the Admin menu.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N678xA SMU

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Press **Menu** then select Utilities, Administrative Tools, Administrator Login/Logout. Enter the password in the PIN field and select Login. Select the Calibration menu. Select Turn On/Off to access the menu items.	CAL:STAT ON <password>

Voltage Calibration

High Range Programming and Measurement – All Models

Step 1. Connect the voltage input of the Keysight 3458A DMM to an output channel as shown in Cal Setup A.

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 20 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, High Range Prog and Meas. Then select Start.	CAL:VOLT 20, (@1)

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5 applies only to model N6784A

Step 5. Select the third voltage calibration point for the negative range and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Low Range Voltage Programming - Models N6781A, N6782A, N6784A

Step 1. Select the low-voltage programming range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 6 V range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Low Range Programming. Then select Start.	CAL:VOLT 6, (@1)

Step 2. Select the first voltage calibration point and enter the data. This value may be positive or negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 3. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 4 applies only to models N6781A and N6782A

Step 4. Repeat steps 1 through 3 for the 600 mV range. This time, select the Low2 range.

Steps 5 and 6 apply only to model N6784A

Step 5. Select the third voltage calibration point for the negative range and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Step 6. Repeat steps 1 through 3, and 5 for the 600 mV range. This time, select the Low2 range.

Low Range Voltage Measurement - Models N6781A, N6782A, N6784A

Step 1. Select the low-voltage measurement range. The value entered must be the maximum voltage of the range to be calibrated. This example selects the 1 V range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Low Range Measurement. Then select Start.	CAL:VOLT:MEAS 1, (@1)

Step 2. Select the first voltage calibration point and enter the data. This value may be positive or negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 3. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM.Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 4 applies only to models N6781A and N6782A

Step 4. Repeat steps 1 through 3 for the 100 mV range. This time, select the Low2 range.

Steps 5 and 6 apply only to model N6784A

Step 5. Select the third voltage calibration point for the negative range and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Step 6. Repeat steps 1 through 3, and 5 for the 100 mV range. This time, select the Low2 range.

Positive Voltage Limit - Models N6781A, N6782A, N6784A

Step 1. Select the positive voltage limit range. The value to program a range must be the maximum voltage of the range to be calibrated. This example selects the 20 V positive limit range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Positive Voltage Limit. Then select Start. Select the 20 V range.	CAL:VOLT:LIM:POS 20, (@1)

Step 2. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 3. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 4. Repeat steps 1 through 3 for the 6 V positive limit range. This time, select the Low range.

Auxiliary Voltage Measurement - Models N6781A, N6785A

Step 1. Connect the auxiliary input terminals to the output terminals of model N6781A. Also connect the voltage input of the Keysight 3458A to the output terminals of model N6781A (see Cal Setup E).

Step 2. Select the auxiliary voltage measurement input of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, Aux Measurement. Then select Start.	CAL:VOLT:MEAS:AUX (@1)

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third voltage calibration point for the negative range and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Current Calibration

High Range Programming and Measurement- All Models

NOTE Do not connect anything to the Sense terminals

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the full-scale range of output 1. For models N6781A, N6782A, and N6784A, the full-scale 3 A range calibrates both the 3 A and 1 A ranges.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, High Range Prog and Meas. Then select Start.	For N6785A, N6786A: CAL:CURR 8, (@1) For N6781A, N6782A, N6784A: CAL:CURR 3, (@1)

Step 3. Select the first current calibration point and enter the data. This value may be positive or negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data. Wait a minimum of 1 minute for the output current to stabilize before entering the data.

Front Panel Menu Reference	SCPI Command
Wait 1 minute and select Next. Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third current calibration point for the negative range and enter the data. The value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Low Range Current Programming - Models N6781A, N6782A, N6784A

Step 1. Connect only the current measurement terminals of the Keysight 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low-current programming range. The value to program a range must be the maximum current of the range. Models N6781A and N6782A have 300 mA range. Model N6784A has a 100 mA and a 10 mA range. This example selects the 300 mA programming range of output 1. For model N6784A, select the 100 mA programming range.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Low Range Programmming. Then select Start.	CAL:CURR 0.3, (@1)

Step 3. Select the first current calibration point and enter the data. This value may be positive or negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Wait 5 minutes and select Next. Display shows: "Enter P2 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third current calibration point for the negative range and enter the data. The value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Step 6. Repeat steps 1 through for the 10 mA programming range of Model N6784A. This time, select the Low2 range.

100 mA Measurement Range - All Models

Step 1. Connect only the current measurement terminals of the Keysight 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the 100 mA measurement range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, 100 mA Measurement Range. Then select Start.	CAL:CURR:MEAS 0.1, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point for the negative range and enter the data. The value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

1 mA Measurement Range – All Models

Step 1. Connect the Keysight 3458A in series with a 10 kΩ resistor to the output (see Equipment Required and Cal Setup D).

Step 2. Select the 1 mA measurement range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, 1 mA Measurement Range. Then select Start.	CAL:CURR:MEAS 0.001, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4 applies only to models N6781A, N6782A, and N6784A

Step 4. Select the second current calibration point for the negative range and enter the data. The value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

10 µA Measurement Range - Models N6781A, N6782A, N6784A

Step 1. Connect the Keysight 3458A in series with a 1 MΩ resistor to the output (see Equipment Required and Cal Setup D). Set the Keysight 3458A to measure current using the 100 µA range (no autoranging). The remote command to do this is "DCI 100e-6".

Step 2. Select the 10 µA measurement range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, 10 µA Measurement Range. Then select Start.	CAL:CURR:MEAS 0.00001, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point for the negative range and enter the data. The value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Limit - All Models

CAUTION This procedure calibrates the POSITVE current limit for Models N6781A, N6782A, and N6784A. It calibrates the NEGATIVE current limit for Models N6785A and N6786A.

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's rated full-scale current (see Cal Setup B). Connect the Keysight 3458A across the shunt resistor.

Step 2. Select the 3 A current limit of output 1 for models N6781A, N6782A, and N6784A. Select the -8A current limit of output 1 for models N6785A and N6786A.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Current Limit. Then select Start.	For N6781A, N6782A, N6784A: CAL:CURR:LIM:POS 3, (@1) For N6785A, N6786A: CAL:CURR:LIM:NEG -8, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data. Wait a minimum of 1 minute for the output current to stabilize before entering the data.

Front Panel Menu Reference	SCPI Command
Wait1 minute and select Next. Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Resistance Calibration - Models N6781A, N6785A

Step 1. Connect an electronic load directly to the output terminals. Also connect the voltage input of the Keysight 3458A to the output terminals (see Cal Setup F). Set the load to constant current mode, current to 0.95A.

Step 2. Select the 20 V resistance range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Miscellaneous Resistance, 20 V Range. Then select Start.	CAL:RES 20 (@1)

Step 3. Select the first resistance calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second resistance calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the third resistance calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: “Enter P3 measured data” Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Step 6. For Model N6781A repeat steps 1 through 5 for the 6 V resistance range. This time, select the Low range.

Enter a Calibration Date, Save, and Log Out

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Date. Enter the date, then select Insert Date. Then select Close.	To enter a calibration date: CAL:DATE "<date>"
From the Calibration menu, select Save. Select Save Calibration for all Outputs. Then select Close.	To save the calibration data: CAL:SAVE
From the Administrative Tools menu, select Administrator Login/Logout to log out of the Admin menu.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N6783A-BAT and N6783A-MFG

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Press **Menu** then select Utilities, Administrative Tools, Administrator Login/Logout. Enter the password in the PIN field and select Login. Select the Calibration menu. Select Turn On/Off to access the menu items.	CAL:STAT ON <password>

Voltage Calibration

High Range Programming and Measurement

Step 1. Connect the voltage input of the Keysight 3458A DMM to an output channel as shown in Cal Setup A.

Step 2. Select the full-scale voltage programming and measurement range. The value entered must be the maximum voltage of the range that you are calibrating. The following example selects the 6 V full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Voltage, High Range Prog and Meas. Then select Start..	CAL:VOLT 6, (@1)

Step 3. Select the first voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Enter the data from the external DMM. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Enter the data from the external DMM. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Calibration

High Range Programming and Measurement

NOTE The output voltage may go negative at some point during this procedure on units that have polarity reversal relays (Option 760).

Step 1. Connect a precision shunt resistor to the output. The shunt resistor should be able to measure at least 120% of the output's full-scale current (see Cal Setup B). Connect the Keysight 3458A DMM across the shunt resistor.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 3 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, High Range Prog and Meas. Then select Start.	CAL:CURR 3, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Low Range Current Measurement

Step 1. Connect only the current measurement terminals of the Keysight 3458A to the output terminals (see Cal Setup D without the resistor).

Step 2. Select the low-current measurement range. The value to program a range must be the maximum current of the range. This example selects the 100 mA range of output 1.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Low Range Measurement. Then select Start.	CAL:CURR:MEAS 0.15, (@1)

Step 3. Select the first current calibration point and enter the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter measured data" Measure the current with the Keysight 3458A and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Negative Current Limit Calibration

Step 1. Connect the Keysight 3458A, current shunt, and a power supply to the output (see Cal Setup H). Connect plus to plus, minus to minus. Set the external power supply to 3V, 3A.

Step 2. Select the negative-current range. The value to select the range must be negative and the maximum current of the range.

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Current, Current Limit. Then select Start.	CAL:CURR:LIM:NEG -2, (@1)

Step 3. Select the first current calibration point and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point and enter the data. This value should be negative.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Enter a Calibration Date, Save, and Log Out

Front Panel Menu Reference	SCPI Command
From the Calibration menu, select Date. Enter the date, then select Insert Date. Then select Close.	To enter a calibration date: CAL:DATE "<date>"
From the Calibration menu, select Save. Select Save Calibration for all Outputs. Then select Close.	To save the calibration data: CAL:SAVE
From the Administrative Tools menu, select Administrator Login/Logout to log out of the Admin menu.	To exit calibration mode: CAL:STAT OFF

Calibration Procedure – Models N6791A and N6792A

Enter Calibration Mode

Front Panel Menu Reference	SCPI Command
Press **Menu** then select Utilities, Administrative Tools, Administrator Login/Logout. Enter the password in the PIN field and select Login. Select the Calibration menu. Select Turn On/Off to access the menu items.	CAL:STAT ON <password>

Voltage Calibration

High Range Measurement

Step 1. · Connect an external power supply to the load module's input terminals. Set the power supply to 60 V with a current limit of 0.5 A. Connect a DVM capable of handling 60 V in parallel with the unit's input (see Cal Setup G). Turn on the output of the power supply.

Step 2. Select the full-scale voltage range.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Volt\Vprog**. Select the High range. Then press Next.	CAL:VOLT 60, (@1)

Step 3. Select the first voltage calibration point and enter the data. Wait a minimum of 1 minute for the current to stabilize before entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data"Enter the data from the external DMM.Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second voltage calibration point and enter the data. Wait a minimum of 1 minute for the current to stabilize before entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Enter the data from the external DMM.Press Select when done. Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Calibration

NOTE Voltage calibration must be completed prior to calibrating current.

High Range Programming and Measurement

Step 1. · Connect an external power supply to the module's input terminals configured to source 3 V with a current limit of 21 A (42 A for N6792A). Connect a precision current shunt resistor in series with the unit's input and a precision voltmeter to measure the voltage across the shunt. The shunt resistor should be suitable for measuring current corresponding to 120% of the rated current of the load module's high current programming range. (see Cal Setup H). Turn on the output of the power supply.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 20 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Curr\Iprog** Select the High range. Then press Next.	CAL:CURR 20, (@1)

Step 3. Select the first current calibration point. Wait a minimum of 10 seconds for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data.Press Select when done.	CAL:LEV P2 *OPC? CAL:DATA <data>

Step 5. Select the second current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P3 measured data" Calculate the shunt current (I=V/R) and enter the data.Press Select when done.Press Next to finish calibration.	CAL:LEV P3 *OPC? CAL:DATA <data>

Low Range Current Programming and Measurement

Step 1. Keep the power supply, shunt resistor, and precision voltmeter as described under "High Range Programming and Measurement" connected to the load module. Turn on the output of the power supply.

Step 2. Select the low-current programming range. The value to program a range must be the maximum current of the range. This example selects the 2 A programming range of output 1. Low ranges vary according to model.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Curr\Iprog|** Select the Low range. Then press Next.	CAL:CURR: 2, (@1)

Step 3. Select the first current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data"Calculate the shunt current (I=V/R) and enter the data. Press Select when done.Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Current Limit Programming

Step 1. · Connect an external power supply to the module's input terminals configured to source 3 V with a current limit of 21 A (42 A for N6792A). Connect a precision current shunt resistor in series with the unit's input and a precision voltmeter to measure the voltage across the shunt. The shunt resistor should be suitable for measuring current corresponding to 120% of the rated current of the load module's high current programming range. (see Cal Setup H). Turn on the output of the power supply.

Step 2. Select the full-scale current programming range. The value to program a range must be the maximum current of the range. The following example selects the 20 A full-scale range of output 1. Full-scale ranges vary according to model.

Front Panel Menu Reference	SCPI Command
Select **System\Admin\Cal\Curr\Ilim** Select the High range. Then press Next.	CAL:CURR:LIM:POS 20, (@1)

Step 3. Select the first current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P1 measured data" Calculate the shunt current (I=V/R) and enter the data. Press Select when done.	CAL:LEV P1 *OPC? CAL:DATA <data>

Step 4. Select the second current calibration point. Wait a minimum of 5 minutes for the temperature to stabilize before measuring the input current and entering the data.

Front Panel Menu Reference	SCPI Command
Display shows: "Enter P2 measured data" Calculate the shunt current (I=V/R) and enter the data.Press Select when done.Press Next to finish calibration.	CAL:LEV P2 *OPC? CAL:DATA <data>

Test Record Forms

Test Record Form - Keysight N6731B and N6741B

Test Record Form - Keysight N6732B and N6742B

Test Record Form - Keysight N6733B and N6743B

Test Record Form - Keysight N6734B and N6744B

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Test Record Form - Keysight N6751A and N6752A

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Test Record Form - Keysight N6775A

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Test Record Form - Keysight N6777A

Test Record Form - Keysight N6781A, N6782A, and N6784A

Test Record Form - Keysight N6785A and N6786A

Test Record Form - Keysight N6783A-BAT and N6783A-MFG

Test Record Form - Keysight N6791A

Test Record Form - Keysight N6792A

Test Record Form - Keysight N6731B and N6741B

N6731B and N6741B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 4 mV	_____	+ 34 mV
Voltage measured over interface:	Both	Vout – 20 mV	_____	Vout + 20 mV
High voltage (Vout):	Both	4.976 V	_____	5.024 V
Voltage measured over interface:	Both	Vout – 25 mV	_____	Vout + 25 mV
CV Load Effect:	Both	– 5 mV	_____	+ 5 mV
CV Source Effect:	Both	– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak:	N6731B	N/A	_____	+ 10 mV
	N6741BBoth	N/A	_____	+20 mV
rms:		N/A	_____	+ 2 mV
Transient response				
Voltage @ 200 µs:	N6731B	– 80 mV	_____	+ 80 mV
	N6741B	– 100 mV	_____	+ 100 mV
Voltage @ 200 µs with Option 760/761:	N6731B	– 100 mV	_____	+ 100 mV
	N6741B	– 125 mV	_____	+ 125 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 40 mA	_____	+ 80 mA
Current measured over interface:	Both	Iout – 20 mA	_____	Iout + 20 mA
High current (Iout):	N6731B	9.965 A	_____	10.035 A
	N6741B	19.95 A	_____	20.05 A
Current measured over interface:	N6731B	Iout – 35 mA	_____	Iout + 35 mA
	N6741B	Iout – 50 mA	_____	Iout + 50 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6731B Setting	N6741B Setting
Voltage Programming & Readback Min Voltage:	15 mV, 10 A	15 mV, 20 A
Voltage Programming & Readback High Voltage:	5 V, 10 A	5 V, 20 A
CV Load Effect, Source Effect, Ripple and Noise:	5 V, 10 A	5 V, 20 A
Transient Response:	5 V, from 5 A to 10 A	5 V, from 10 A to 20 A
Current Programming & Readback Min Current:	60 mA, 5 V	60 mA, 5 V
Current Programming & Readback High Current:	10 A, 5 V	20 A, 5 V
CC Load Effect, Source Effect:	10 A, 5 V	20 A, 5 V

Test Record Form - Keysight N6732B and N6742B

N6732B and N6742B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 4 mV	_____	+ 34 mV
Voltage measured over interface:	Both	Vout – 20 mV	_____	Vout + 20 mV
High voltage (Vout):	Both	7.973 V	_____	8.027 V
Voltage measured over interface:	Both	Vout – 28 mV	_____	Vout + 28 mV
CV Load Effect:	Both	– 6 mV	_____	+ 6 mV
CV Source Effect:	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 12 mV
rms:	Both	N/A	_____	+ 2 mV
Transient response				
Voltage @ 200 µs:	N6732B	– 80 mV	_____	+ 80 mV
	N6742B	– 100 mV	_____	+ 100 mV
Voltage @ 200 µs with Option 760/761:	N6732B	– 100 mV	_____	+ 100 mV
	N6742B	– 125 mV	_____	+ 125 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 20 mA	_____	+ 60 mA
Current measured over interface:	Both	Iout – 10 mA	_____	Iout + 10 mA
High current (Iout):	N6732B	6.2206 A	_____	6.2794 A
	N6742B	12.46 A	_____	12.54 A
Current measured over interface:	N6732B	Iout – 19.37 mA	_____	Iout + 19.37 mA
	N6742B	Iout – 29 mA	_____	Iout + 29 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6732B Setting	N6742B Setting
Voltage Programming & Readback Min Voltage:	15 mV, 6.25 A	15 mV, 12.5 A
Voltage Programming & Readback High Voltage:	8 V, 6.25 A	8 V, 12.5 A
CV Load Effect, Source Effect, Ripple and Noise:	8 V, 6.25 A	8 V, 12.5 A
Transient Response:	8 V, from 3.125 A to 6.25 A	8V, from 6.25A to 12.5A
Current Programming & Readback Min Current:	40 mA, 8 V	40 mA, 8 V
Current Programming & Readback High Current:	6.25 A, 8 V	12.5 A, 8 V
CC Load Effect, Source Effect:	6.25 A, 8 V	12.5 A, 8 V

Test Record Form - Keysight N6733B and N6743B

N6733B and N6743B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 10 mV	_____	+ 50 mV
Voltage measured over interface:	Both	Vout – 20 mV	_____	Vout + 20 mV
High voltage (Vout):	Both	19.96 V	_____	20.04 V
Voltage measured over interface:	Both	Vout – 40 mV	_____	Vout + 40 mV
CV Load Effect:	Both	– 9 mV	_____	+ 9 mV
CV Source Effect:	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 14 mV
rms:	Both	N/A	_____	+ 3 mV
Transient response				
Voltage @ 200 µs:	N6733B	– 200 mV	_____	+ 200 mV
	N6743B	– 300 mV	_____	+ 300 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 10 mA	_____	+ 30 mA
Current measured over interface:	Both	Iout – 5 mA	_____	Iout + 5 mA
High current (Iout):	N6733B	2.4762 A	_____	2.5237 A
	N6743B	4.9725 A	_____	5.0275 A
Current measured over interface:	N6733B	Iout – 8.75 mA	_____	Iout + 8.75 mA
	N6743B	Iout – 12.5 mA	_____	Iout + 12.5 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6733B Setting	N6743B Setting
Voltage Programming & Readback Min Voltage:	30 mV, 2.5 A	30 mV, 5 A
Voltage Programming & Readback High Voltage:	20 V, 2.5 A	20 V, 5 A
CV Load Effect, Source Effect, Ripple and Noise:	20 V, 2.5 A	20 V, 5 A
Transient Response:	20 V, from 1.25 A to 2.5 A	5 V, from 2.5 A to 5 A
Current Programming & Readback Min Current:	10 mA, 20V	10 mA, 20 V
Current Programming & Readback High Current:	2.5 A, 20 V	5 A, 20 V
CC Load Effect, Source Effect:	2.5 A, 20 V	5 A, 20 V

Test Record Form - Keysight N6734B and N6744B

N6734B and N6744B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+ 5 mV	_____	+ 75 mV
Voltage measured over interface:	Both	Vout – 35 mV	_____	Vout + 35 mV
High voltage (Vout):	Both	34.93 V	_____	35.07 V
Voltage measured over interface:	Both	Vout – 70 mV	_____	Vout + 70 mV
CV Load Effect:	Both	– 11 mV	_____	+ 11 mV
CV Source Effect:	Both	– 4 mV	_____	+ 4 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 15 mV
rms:	Both	N/A	_____	+ 5 mV
Transient response				
Voltage @ 200 µs:	N6734B	– 200 mV	_____	+ 200 mV
	N6744B	– 300 mV	_____	+ 300 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 15 mA	_____	+ 25 mA
Current measured over interface:	Both	Iout – 4 mA	_____	Iout + 4 mA
High current (Iout):	N6734B	1.47775 A	_____	1.52225 A
	N6744B	2.9755 A	_____	3.0245 A
Current measured over interface:	N6734B	Iout – 6.25 mA	_____	Iout + 6.25 mA
	N6744B	Iout – 8.5 mA	_____	Iout + 8.5 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6734B Setting	N6744B Setting
Voltage Programming & Readback Min Voltage:	40 mV, 1.5 A	40 mV, 3 A
Voltage Programming & Readback High Voltage:	35 V, 1.5 A	35 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise:	35 V, 1.5 A	35 V, 3 A
Transient Response:	35 V, from 0.75 A to 1.5 A	35 V, from 1.5 A to 3 A
Current Programming & Readback Min Current:	5 mA, 35 V	5 mA, 35 V
Current Programming & Readback High Current:	1.5 A, 35 V	3 A, 35 V
CC Load Effect, Source Effect:	1.5 A, 35 V	3 A, 35 V

Test Record Form - Keysight N6735B and N6745B

N6735B and N6745B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+ 10 mV	_____	+ 130 mV
Voltage measured over interface:	Both	Vout – 60 mV	_____	Vout + 60 mV
High voltage (Vout):	Both	59.88 V	_____	60.12 V
Voltage measured over interface:	Both	Vout – 120 mV	_____	Vout + 120 mV
CV Load Effect:	N6735B	– 13 mV	_____	+ 13 mV
	N6745B	– 16 mV	_____	+ 16 mV
CV Source Effect:	Both	– 6 mV	_____	+ 6 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 25 mV
rms:	Both	N/A	_____	+ 9 mV
Transient response				
Voltage @ 200 µs:	N6735B	– 400 mV	_____	+ 400 mV
	N6745B	– 500 mV	_____	+ 500 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 17.5 mA	_____	+ 22.5 mA
Current measured over interface:	Both	Iout – 4 mA	_____	Iout + 4 mA
High current (Iout):	N6735B	0.7788 A	_____	0.8212 A
	N6745B	1.5776 A	_____	1.6224 A
Current measured over interface:	N6735B	Iout – 5.2 mA	_____	Iout + 5.2 mA
	N6745B	Iout – 6.4 mA	_____	Iout + 6.4 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6735B Setting	N6745B Setting
Voltage Programming & Readback Min Voltage:	70 mV, 0.8 A	70 mV, 1.6 A
Voltage Programming & Readback High Voltage:	60 V, 0.8 A	60 V, 1.6 A
CV Load Effect, Source Effect, Ripple and Noise:	60 V, 0.8 A	60 V, 1.6 A
Transient Response:	60 V, from 0.4 A to 0.8 A	60 V, from 0.8 A to 1.6 A
Current Programming & Readback Min Current:	2.5 mA, 60 V	2.5 mA, 60 V
Current Programming & Readback High Current:	0.8 A, 60 V	1.6 A, 60 V
CC Load Effect, Source Effect:	0.8 A, 60 V	1.6 A, 60 V

Test Record Form - Keysight N6736B and N6746B

N6736B and N6746B	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+ 0 mV	_____	+ 200 mV
Voltage measured over interface:	Both	Vout – 100 mV	_____	Vout + 100 mV
High voltage (Vout):	Both	99.8 V	_____	100.2 V
Voltage measured over interface:	Both	Vout – 200 mV	_____	Vout + 200 mV
CV Load Effect:	N6736B	– 20 mV	_____	+ 20 mV
	N6746B	– 30 mV	_____	+ 30 mV
CV Source Effect:	Both	– 10 mV	_____	+ 10 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 30 mV
rms:	Both	N/A	_____	+ 18 mV
Transient response				
Voltage @ 200 µs:	N6736B	– 500 mV	_____	+ 500 mV
	N6746B	– 1000 mV	_____	+ 1000 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 8.5 mA	_____	+ 11.5 mA
Current measured over interface:	Both	Iout – 2 mA	_____	Iout + 2 mA
High current (Iout):	N6736B	0.4893 A	_____	0.5107 A
	N6746B	0.9885 A	_____	1.0115 A
Current measured over interface:	N6736B	Iout – 2.75 mA	_____	Iout + 2.75 mA
	N6746B	Iout – 3.5 mA	_____	Iout + 3.5 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6736B Setting	N6746B Setting
Voltage Programming & Readback Min Voltage:	100 mV, 0.5 A	100 mV, 1 A
Voltage Programming & Readback High Voltage:	100 V, 0.5 A	100 V, 1 A
CV Load Effect, Source Effect, Ripple and Noise:	100 V, 0.5 A	100 V, 1 A
Transient Response:	100 V, from 0.25 A to 0.5 A	100 V, from 0.5 A to 1 A
Current Programming & Readback Min Current:	1.5 mA, 100 V	1.5 mA, 100 V
Current Programming & Readback High Current:	0.5 A, 100 V	1 A, 100 V
CC Load Effect, Source Effect:	0.5 A, 100 V	1 A, 100 V

Test Record Form - Keysight N6751A and N6752A

N6751A and N6752A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 1 mV	_____	+ 39 mV
Voltage measured over interface:	Both	Vout – 20 mV	_____	Vout + 20 mV
High voltage (Vout):	Both	49.951 V	_____	50.049 V
Voltage measured over interface:	Both	Vout – 45 mV	_____	Vout + 45 mV
CV Load Effect:	Both	– 2 mV	_____	+ 2 mV
CV Source Effect:	Both	– 1 mV	_____	+ 1 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 4.5 mV
rms:	Both	N/A	_____	+ 0.35 mV
Transient response				
Voltage @ 100 µs:	Both	– 75 mV	_____	+ 75 mV
Voltage @ 100 µs with Option 761:	N6752A	– 125 mV	_____	+ 125 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 10 mA	_____	+ 30 mA
Current measured over interface:	Both	Iout – 4 mA	_____	Iout + 4 mA
High current (Iout):	N6751A	4.975 A	_____	5.025 A
	N6752A	9.970 A	_____	10.030 A
Current measured over interface:	N6751A	Iout – 9 mA	_____	Iout + 9 mA
	N6752A	Iout – 14 mA	_____	Iout + 14 mA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA

Test Description	N6751A Setting	N6752A Setting
Voltage Programming & Readback Min Voltage:	20 mV, 1 A	20 mV, 2 A
Voltage Programming & Readback High Voltage:	50 V, 1 A	50 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise:	50 V, 1 A	50 V, 2 A
Transient Response:	10 V, from 3 A to 5 A	8.5 V, from 5 A to 10 A
Current Programming & Readback Min Current:	10 mA, 10 V	10 mA, 8.5 V
Current Programming & Readback High Current:	5 A, 10 V	10 A, 8.5 V
CC Load Effect, Source Effect:	5 A, 10 V	10 A, 8.5 V

Test Record Form - Keysight N6753A and N6755A

N6753A and N6755A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0 mV	_____	+ 20 mV
Voltage measured over interface:	Both	Vout – 10 mV	_____	Vout + 10 mV
High voltage (Vout):	Both	19.978 V	_____	20.022 V
Voltage measured over interface:	Both	Vout – 20 mV	_____	Vout + 20 mV
CV Load Effect:	Both	– 2 mV	_____	+ 2 mV
CV Source Effect:	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 5 mV
rms:	Both	N/A	_____	+ 1 mV
Transient response				
Voltage @ 100 µs:	Both	– 30 mV	_____	+ 30 mV
Voltage @ 100 µs with Option 760/761:	Both	– 200 mV	_____	+ 200 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 20 mA	_____	+ 80 mA
Current measured over interface:	Both	Iout – 30 mA	_____	Iout + 30 mA
High current (Iout):	Both	49.920 A	_____	50.080 A
Current measured over interface:	Both	Iout – 80 mA	_____	Iout + 80 mA
CC Load Effect:	Both	– 12 mA	_____	+ 12 mA
CC Source Effect:	Both	– 5 mA	_____	+ 5 mA

Test Description	N6753A Setting	N6755A Setting
Voltage Programming & Readback Min Voltage:	10 mV, 15 A	10 mV, 25 A
Voltage Programming & Readback High Voltage:	20 V, 15 A	20 V, 25 A
CV Load Effect, Source Effect, Ripple and Noise:	20 V, 15 A	20 V, 25 A
Transient Response:	6 V, from 25 A to 50 A	10 V, from 25 A to 50 A
Current Programming & Readback Min Current:	50 mA, 6V	50 mA, 10 V
Current Programming & Readback High Current:	50 A, 6 V	50 A, 10 V
CC Load Effect, Source Effect:	50 A, 6 V	50 A, 10 V

Test Record Form - Keysight N6754A and N6756A

N6754A and N6756A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	0 mV	_____	+ 50 mV
Voltage measured over interface:	Both	Vout – 25 mV	_____	Vout + 25 mV
High voltage (Vout):	Both	59.939 V	_____	60.061 V
Voltage measured over interface:	Both	Vout – 55 mV	_____	Vout + 55 mV
CV Load Effect:	Both	– 2 mV	_____	+ 2 mV
CV Source Effect:	Both	– 1.2 mV	_____	+ 1.2 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 6 mV
rms:	Both	N/A	_____	+ 1 mV
Transient response				
Voltage @ 100 µs:	Both	– 90 mV	_____	+ 90 mV
Voltage @ 100 µs with Option 760/761:	Both	– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 8 mA	_____	+ 32 mA
Current measured over interface:	Both	Iout – 8 mA	_____	Iout + 8 mA
High current (Iout):	N6754A	19.968 A	_____	20.032 A
	N6756A	16.071 A	_____	17.029 A
Current measured over interface:	N6754A	Iout – 28 mA	_____	Iout + 28 mA
	N6756A	Iout – 25 mA	_____	Iout + 25 mA
CC Load Effect:	Both	– 5 mA	_____	+ 5 mA
CC Source Effect:	Both	– 2 mA	_____	+ 2 mA

Test Description	N6754A Setting	N6756A Setting
Voltage Programming & Readback Min Voltage:	25 mV, 5 A	25 mV, 8.33 A
Voltage Programming & Readback High Voltage:	60 V, 5 A	60 V, 8.33 A
CV Load Effect, Source Effect, Ripple and Noise:	60 V, 5 A	60 V, 8.33 A
Transient Response:	15 V, from 10 A to 20 A	29 V, from 8.5 A to 17 A
Current Programming & Readback Min Current:	20 mA, 15 V	20 mA, 29 V
Current Programming & Readback High Current:	20 A, 15 V	17 A, 29 V
CC Load Effect, Source Effect:	20 A, 15 V	17 A, 29 V

Test Record Form - Keysight N6761A and N6762A

N6761A and N6762A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+ 9 mV	_____	+ 21 mV
Voltage measured over interface:	Both	Vout – 6 mV	_____	Vout + 6 mV
High voltage (Vout):	Both	49.986 V	_____	50.014 V
Voltage measured over interface:	Both	Vout – 14 mV	_____	Vout + 14 mV
Low Range Voltage Prog. & Readback				
Low Voltage Vout:	Both	5.4976 V	_____	5.5024 V
Voltage measured over interface:	Both	Vout – 2.4 mV	_____	Vout + 2.4 mV
CV Load Effect:	Both	– 0.5 mV	_____	+ 0.5 mV
CV Source Effect:	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 4.5 mV
rms:	Both	N/A	_____	+ 0.35 mV
Transient response				
Voltage @ 150 µs:	Both	– 75 mV	_____	+ 75 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 0.8 mA	_____	+ 1.2 mA
Current measured over interface:	Both	Iout – 160 µA	_____	Iout + 160 µA
High current (Iout):	N6761A	1.4992 A	_____	1.5008 A
	N6762A	2.9986 A	_____	3.0014 A
Current measured over interface:	N6761A	Iout – 0.76 mA	_____	Iout + 0.76 mA
	N6762A	Iout – 1.36 mA	_____	Iout + 1.36 mA
Low Range Current Prog. & Readback				
Low Current (full-scale) Iout:	Both	0.099930 A	_____	0.100070 A
Current measured over interface:	Both	Iout – 45 µA	_____	Iout + 45 µA
CC Load Effect:	Both	– 65 µA	_____	+ 65 µA
CC Source Effect:	Both	– 30 µA	_____	+ 30 µA

Test Description	N6761A Setting	N6762A Setting
Voltage Programming & Readback Min Voltage:	15 mV, 1 A	15 mV, 2 A
Voltage Programming & Readback High Voltage:	50 V, 1 A	50 V, 2 A
Voltage Programming & Readback Low Voltage:	5.5 V 1 A	5,5 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise:	50 V, 1 A	50 V, 2 A
Transient Response:	33 V, from 0.9 A to 1.5 A	33 V, from 1.5 A to 3 A
Current Programming & Readback Min Current:	1 mA, 33 V	1 mA, 33 V
Current Programming & Readback High Current:	1.5 A, 33 V	3 A, 33 V
Current Programming & Readback Low Current:	0.1 A, 33 V	0.1 A, 33 V
Current Readback 100 µA Current:	1 mA, 1.9 V	1 mA, 1.9 V
Current Readback 200 µA Current:	1 mA, 3.9 V	1 mA, 3.9 V
CC Load Effect, Source Effect:	1.5 A, 33 V	3 A, 33 V

Test Record Form - Keysight N6763A and N6765A

N6763A and N6765A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+5 mV	_____	+ 20 mV
Voltage measured over interface:	Both	Vout – 10 mV	_____	Vout + 10 mV
High voltage (Vout):	Both	19.989 V	_____	20.011 V
Voltage measured over interface:	Both	Vout – 16 mV	_____	Vout + 16 mV
Low Voltage measured over interface:	Both	Vout – 2.1 mV	_____	Vout + 2.1 mV
CV Load Effect:	Both	– 2 mV	_____	+ 2 mV
CV Source Effect:	Both	– 0.5 mV	_____	+ 0.5 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 5 mV
rms:	Both	N/A	_____	+ 1 mV
Transient response				
Voltage @ 100 µs:	Both	– 30 mV	_____	+ 30 mV
Voltage @ 100 µs with Option 760/761:	Both	– 200 mV	_____	+ 200 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 35 mA	_____	+ 65 mA
Current measured over interface:	Both	Iout – 60 mA	_____	Iout + 60 mA
High current (Iout):	Both	49.935 A	_____	50.065 A
Current measured over interface:	Both	Iout – 60 mA	_____	Iout + 60 mA
Low Current measured over interface:	Both	Iout – 1.85 mA	_____	Iout + 1.85 mA
CC Load Effect:	Both	– 12 mA	_____	+ 12 mA
CC Source Effect:	Both	– 5 mA	_____	+ 5 mA

Test Description	N6763A Setting	N6765A Setting
Voltage Programming & Readback Min Voltage:	10 mV, 15 A	10 mV, 25 A
Voltage Programming & Readback High Voltage:	20 V, 15 A	20 V, 25 A
Voltage Readback Low:	2 V 15 A	2 V, 25 A
CV Load Effect, Source Effect, Ripple and Noise:	20 V, 15 A	20 V, 25 A
Transient Response:	6 V, from 25 A to 50 A	10 V, from 25 A to 50 A
Current Programming & Readback Min Current:	50 mA, 6V	50 mA, 10 V
Current Programming & Readback High Current:	50 A, 6 V	50 A, 10 V
Current Readback Low:	1.5 A, 6 V	1.5 A, 10 V
CC Load Effect, Source Effect:	50 A, 6 V	50 A, 10 V

Test Record Form - Keysight N6764A and N6766A

N6764A and N6766A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	+13 mV	_____	+ 37 mV
Voltage measured over interface:	Both	Vout – 25 mV	_____	Vout + 25 mV
High voltage (Vout):	Both	59.970 V	_____	60.030 V
Voltage measured over interface:	Both	Vout – 43 mV	_____	Vout + 43 mV
Low Voltage measured over interface:	Both	Vout – 6.8 mV	_____	Vout + 6.8 mV
CV Load Effect:	Both	– 2 mV	_____	+ 2 mV
CV Source Effect:	Both	– 1.2 mV	_____	+ 1.2 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 6 mV
rms:	Both	N/A	_____	+ 1 mV
Transient response				
Voltage @ 100 µs:	Both	– 90 mV	_____	+ 90 mV
Voltage @ 100 µs with Option 760/761:	Both	– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 16 mA	_____	+ 24 mA
Current measured over interface:	Both	Iout – 5 mA	_____	Iout + 5 mA
High current (Iout):	N6764A	19.981 A	_____	20.019 A
	N6766A	16.9833 A	_____	17.0167 A
Current measured over interface:	N6764A	Iout – 25 mA	_____	Iout + 25 mA
Low Current measured over interface:	N6766A	Iout – 22 mA	_____	Iout + 22 mA
	Bpth	Iout – 1 mA	_____	Iout + 1 mA
CC Load Effect:		– 5 mA	_____	+ 5 mA
CC Source Effect:		– 2 mA	_____	+ 2 mA

Test Description	N6764A Setting	N6766A Setting
Voltage Programming & Readback Min Voltage:	25 mV, 5 A	25 mV, 8.33 A
Voltage Programming & Readback High Voltage:	60 V, 5 A	60 V, 8.33 A
Voltage Readback Low:	6 V 5 A	6 V, 8.33 A
CV Load Effect, Source Effect, Ripple and Noise:	60 V, 5 A	60 V, 8.33 A
Transient Response:	15 V, from 10 A to 20 A	29 V, from 8.5 A to 17 A
Current Programming & Readback Min Current:	20 mA, 15 V	20 mA, 29 V
Current Programming & Readback High Current:	20 A, 15 V	17 A, 29 V
Current Readback Low:	0.5 A, 15 V	0.5 A, 29 V
CC Load Effect, Source Effect:	20 A, 15 V	17 A, 29 V

Test Record Form - Keysight N6773A

Keysight N6773A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):		+ 10 mV	_____	+ 50 mV
Voltage measured over interface:		Vout – 20 mV	_____	Vout + 20 mV
High voltage (Vout):		19.96 V	_____	20.04 V
Voltage measured over interface:		Vout – 40 mV	_____	Vout + 40 mV
CV Load Effect:		– 13 mV	_____	+ 13 mV
CV Source Effect:		– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak:		N/A	_____	+ 20 mV
rms:		N/A	_____	+ 3 mV
Transient response				
Voltage @ 250 µs:		– 300 mV	_____	+ 300 mV
Voltage @ 250 µs with Option 760/761:		– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):		– 30 mA	_____	+ 90 mA
Current measured over interface:		Iout – 15 mA	_____	Iout + 15 mA
High current (Iout):		14.9175 A	_____	15.0825 A
Current measured over interface:		Iout – 37.5 mA	_____	Iout + 37.5 mA
CC Load Effect:		– 6 mA	_____	+ 6 mA
CC Source Effect:		– 1 mA	_____	+ 1 mA

Test Description	N6773A Setting
Voltage Programming & Readback Min Voltage:	30 mV, 15 A
Voltage Programming & Readback High Voltage:	20 V, 15 A
CV Load Effect, Source Effect, Ripple and Noise:	20 V, 15 A
Transient Response:	20 V, from 7.5 A to 15 A
Current Programming & Readback Min Current:	30 mA, 20V
Current Programming & Readback High Current:	15 A, 20 V
CC Load Effect, Source Effect:	15 A, 20 V

Test Record Form - Keysight N6774A

Keysight N6774A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):		+ 5 mV	_____	+ 75 mV
Voltage measured over interface:		Vout – 35 mV	_____	Vout + 35 mV
High voltage (Vout):		34.93 V	_____	35.07 V
Voltage measured over interface:		Vout – 70 mV	_____	Vout + 70 mV
CV Load Effect:		– 16 mV	_____	+ 16 mV
CV Source Effect:		– 4 mV	_____	+ 4 mV
CV Ripple and Noise				
peak-to-peak:		N/A	_____	+ 22 mV
rms:		N/A	_____	+ 5 mV
Transient response				
Voltage @ 250 µs:		– 300 mV	_____	+ 300 mV
Voltage @ 250 µs with Option 760/761:		– 350 mV	_____	+ 350 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):		– 45 mA	_____	+ 75 mA
Current measured over interface:		Iout – 12 mA	_____	Iout + 12 mA
High current (Iout):		8.42725 A	_____	8.57275 A
Current measured over interface:		Iout – 24.75 mA	_____	Iout + 24.75 mA
CC Load Effect:		– 6 mA	_____	+ 6 mA
CC Source Effect:		– 1 mA	_____	+ 1 mA

Test Description	N6774A Setting
Voltage Programming & Readback Min Voltage:	40 mV, 8.5 A
Voltage Programming & Readback High Voltage:	35 V, 8.5 A
CV Load Effect, Source Effect, Ripple and Noise:	35 V, 8.5 A
Transient Response:	35 V, from 4.25 A to 8.5 A
Current Programming & Readback Min Current:	15 mA, 35 V
Current Programming & Readback High Current:	8.5 A, 35 V
CC Load Effect, Source Effect:	8.5 A, 35 V

Test Record Form - Keysight N6775A

Keysight N6775A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):		+ 10 mV	_____	+ 130 mV
Voltage measured over interface:		Vout – 60 mV	_____	Vout + 60 mV
High voltage (Vout):		59.88 V	_____	60.12 V
Voltage measured over interface:		Vout – 120 mV	_____	Vout + 120 mV
CV Load Effect:		– 24 mV	_____	+ 24 mV
CV Source Effect:		– 6 mV	_____	+ 6 mV
CV Ripple and Noise				
peak-to-peak:		N/A	_____	+ 35 mV
rms:		N/A	_____	+ 9 mV
Transient response				
Voltage @ 250 µs:		– 500 mV	_____	+ 500 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):		– 52.5 mA	_____	+ 67.5 mA
Current measured over interface:		Iout – 12 mA	_____	Iout + 12 mA
High current (Iout):		4.9325 A	_____	5.0675 A
Current measured over interface:		Iout – 19.5 mA	_____	Iout + 19.5 mA
CC Load Effect:		– 6 mA	_____	+ 6 mA
CC Source Effect:		– 1 mA	_____	+ 1 mA

Test Description	N6774A Setting
Voltage Programming & Readback Min Voltage:	70 mV, 5 A
Voltage Programming & Readback High Voltage:	60 V, 5 A
CV Load Effect, Source Effect, Ripple and Noise:	60 V, 5 A
Transient Response:	60 V, from 2.5 A to 5 A
Current Programming & Readback Min Current:	7.5 mA, 60 V
Current Programming & Readback High Current:	5 A, 60 V
CC Load Effect, Source Effect:	5 A, 60 V

Test Record Form - Keysight N6776A

Keysight N6776A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):		+ 0 mV	_____	+ 200 mV
Voltage measured over interface:		Vout – 100 mV	_____	Vout + 100 mV
High voltage (Vout):		99.8 V	_____	100.2 V
Voltage measured over interface:		Vout – 200 mV	_____	Vout + 200 mV
CV Load Effect:		– 45 mV	_____	+ 45 mV
CV Source Effect:		– 10 mV	_____	+ 10 mV
CV Ripple and Noise				
peak-to-peak:		N/A	_____	+ 45 mV
rms:		N/A	_____	+ 18 mV
Transient response				
Voltage @ 250 µs:		– 1000 mV	_____	+ 1000 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):		– 25.5 mA	_____	+ 34.5 mA
Current measured over interface:		Iout – 6 mA	_____	Iout + 6 mA
High current (Iout):		2.9655 A	_____	3.0345 A
Current measured over interface:		Iout – 10.5 mA	_____	Iout + 10.5 mA
CC Load Effect:		– 6 mA	_____	+ 6 mA
CC Source Effect:		– 1 mA	_____	+ 1 mA

Test Description	N6776A Setting
Voltage Programming & Readback Min Voltage:	100 mV, 3 A
Voltage Programming & Readback High Voltage:	100 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise:	100 V, 3 A
Transient Response:	100 V, from 1.5 A to 3 A
Current Programming & Readback Min Current:	4.5 mA, 100 V
Current Programming & Readback High Current:	3 A, 100 V
CC Load Effect, Source Effect:	3 A, 100 V

Test Record Form - Keysight N6777A

Keysight N6777A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):		+ 0 mV	_____	+ 300 mV
Voltage measured over interface:		Vout – 150 mV	_____	Vout + 150 mV
High voltage (Vout):		149.7 V	_____	150.3 V
Voltage measured over interface:		Vout – 300 mV	_____	Vout + 300 mV
CV Load Effect:		– 68 mV	_____	+ 68 mV
CV Source Effect:		– 15 mV	_____	+ 15 mV
CV Ripple and Noise				
peak-to-peak:		N/A	_____	+ 68 mV
rms:		N/A	_____	+ 27 mV
Transient response				
Voltage @ 250 µs:		– 2.0 V	_____	+ 2.0 V
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):		– 27 mA	_____	+ 33 mA
Current measured over interface:		Iout – 6 mA	_____	Iout + 6 mA
High current (Iout):		1.967 A	_____	2.033 A
Current measured over interface:		Iout – 9 mA	_____	Iout + 9 mA
CC Load Effect:		– 6 mA	_____	+ 6 mA
CC Source Effect:		– 1 mA	_____	+ 1 mA

Test Description	N6777A Setting
Voltage Programming & Readback Min Voltage:	150 mV, 2 A
Voltage Programming & Readback High Voltage:	150 V, 2 A
CV Load Effect, Source Effect, Ripple and Noise:	150 V, 2 A
Transient Response:	150 V, from 1 A to 2 A
Current Programming & Readback Min Current:	3 mA, 150 V
Current Programming & Readback High Current:	2 A, 150 V
CC Load Effect, Source Effect:	2 A, 150 V

Test Record Form - Keysight N6781A, N6782A, and N6784A

N6781A, '82A, and '84A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	All	– 1.8 mV	_____	+ 1.8 mV
Voltage measured over interface:	All	Vout – 1.2 mV	_____	Vout + 1.2 mV
High voltage (Vout):	All	19.9932 V	_____	20.0068 V
Voltage measured over interface:	All	Vout – 6.2 mV	_____	Vout + 6.2 mV
Voltage Prog. & Readback Low Range				
1 V Voltage Vout:	All	0.99915 V	_____	1.00085 V
Voltage measured over interface:	All	Vout – 325 µV	_____	Vout + 325 µV
600 mV Prog. & 100 mV Readback				
100 mV Voltage Vout:	All	99.775 mV	_____	100.225 mV
Voltage measured over interface:	All	Vout – 75 µV	_____	Vout + 75 µV
CV Load Effect				
20 V output range:	All	– 700 µV	_____	+ 700 µV
6 V output range:	All	– 400 µV	_____	+ 400 µV
CV Ripple and Noise				
peak-to-peak 20 V output range:	All	N/A	_____	+ 12 mV
rms 20V output range:	All	N/A	_____	+ 1.2 mV
peak-to-peak 6 V output range:	All	N/A	_____	+ 12 mV
rms 6V output range:	All	N/A	_____	+ 1.2 mV
Transient response				
6 V output range @ 35 µs:	All	– 20 mV	_____	+ 20 mV
20 V output range @ 35 µs:	All	– 10 mV	_____	+ 10 mV
Auxiliary voltage readback:	N6781A	Vout – 10 mV	_____	Vout + 10 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	All	– 300 µA	_____	+ 300 µA
Current measured over interface:	All	Iout – 250 µA	_____	Iout + 250 µA
High current (Iout):	All	2.9985 A	_____	3.0015 A
Current measured over interface:	All	Iout – 1.15 mA	_____	Iout + 1.15 mA
300mA, 100mA, 10mA Programming				
300 mA range Current Iout:	N6781A/N6782A	99.82 mA	_____	100.18 mA
100 mA range Current Iout:	N6784A	99.958 mA	_____	100.042 mA
10 mA range Current Iout:	N6784A	9.9925 mA	_____	10.0075 mA
100 mA, 1 mA, 10 µA Readback				
100mA rng measured over interface:	All	Iout – 35 µA	_____	Iout + 35 µA
1 mA range measured over interface:	All	Iout – 350 µA	_____	Iout + 350 µA
(when installed in N6705 analyzer):		(Iout – 360 µA)	(_____)	(Iout + 360 µA)
10µA range measured over interface:	All	Iout – 10.5 nA	_____	Iout + 10.5 nA
(when installed in N6705 analyzer):		(Iout – 22.5 nA)	(_____)	(Iout + 22.5 nA)

N6781A, '82A, and '84A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
CC Load Effect				
3 A output range:	All	– 100 µA	_____	+ 100 µA
1 A output range:	All	– 50 µA	_____	+ 50 µA
300 mA output range:	N6781A/N6782A	– 50 µA	_____	+ 50 µA
100 mA & 10 mA output ranges:	N6784A	– 1 µA	_____	+ 1 µA
	N6781A Resistance Tests			
Resistance Programming				
20 V output range:	N6781A	0.996 Ω	_____	1.004 Ω
6 V output range:	N6781A	0.9975 Ω	_____	1.0025 Ω

Test Description	N6781A, '82A, and '84A Settings
Voltage Programming & Readback Min Voltage:	Voltage Priority; 0 V, 1 A
Voltage Programming & Readback High Voltage:	Voltage Priority; 20 V, 1 A
Voltage Programming & Readback Low Voltage:	Voltage Priority; 1 V, 1 A
600 mV Programming & 100 mV Readback	Voltage Priority; 0.1 V, 1 A
CV Load Effect, 20 V range	Voltage Priority; 20 V, 1 A
CV Load Effect, 6 V range	Voltage Priority; 6 V, 3 A
CV Load Effect, 600 mV range	Voltage Priority; 100 mV, 3 A
CV Ripple and Noise, 20 V range	Voltage Priority; 20 V, 1 A
CV Ripple and Noise, 6 V range	Voltage Priority; 6 V, 3 A
Transient Response, 6 V range	Voltage Priority; Comp.= HIGH3; 6V, from 0.1 to 1.5 A
Transient Response, 20 V range	Voltage Priority; Comp.= HIGH3; 20V, from 0.1 to 0.9 A
Current Programming & Readback, Min Current	Current Priority; 0 A, 6 V
Current Programming & Readback, High Current	Current Priority; 3 A, 6 V
Current Programming 300 mA & 100 mA ranges	Current Priority; 100 mA, 20 V
Current Programming 10 mA range	Current Priority; 10 mA, 20 V
Current Readback 100 mA range	Voltage Priority; 100 mA, 1 V
Current Readback 1 mA Range	Voltage Priority; 1 mA, 10 V
Current Readback 10 µA Range	Voltage Priority; 10 µA, 10 V
CC Load Effect, 3 A range	Current Priority; 3 A, 6 V
CC Load Effect, 1 A range	Current Priority; 1 A, 6 V
CC Load Effect, 300 mA range	Current Priority; 100 mA, 6 V
CC Load Effect, 100 mA range	Current Priority; 100 mA, 6 V
CC Load Effect, 10 mA range	Current Priority; 10 mA, 6 V
N6781A Resistance Programming, 20 V range	Voltage Priority; 10 V, 1 Ω (Elect. load: CC mode, 20 V, 1A)
N6781A Resistance Programming, 6 V range	Voltage Priority; 6 V, 1 Ω (Elect. load: CC mode, 20 V, 3A)

Test Record Form - Keysight N6785A and N6786A

N6785A and N6786A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 1.8 mV	_____	+ 1.8 mV
Voltage measured over interface:	Both	Vout – 1.8 mV	_____	Vout + 1.8 mV
High voltage (Vout):	Both	19.9932 V	_____	20.0068 V
Voltage measured over interface:	Both	Vout – 6.8 mV	_____	Vout + 6.8 mV
CV Load Effect	Both	– 700 µV	_____	+ 700 µV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 15 mV
rms:	Both	N/A	_____	+ 1.5 mV
Transient response				
6 V output range @ 35 µs:	Both	– 20 mV	_____	+ 20 mV
Auxiliary voltage readback:	N6785A	Vout – 10 mV	_____	Vout + 10 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	– 1.5 mA	_____	+ 1.5 mA
Current measured over interface:	Both	Iout – 1.5 mA	_____	Iout + 1.5 mA
High current (Iout):	Both	7.9953 A	_____	8.0047 A
Current measured over interface:	Both	Iout – 4.7 mA	_____	Iout + 4.7 mA
100 mA and 1 mA Readback				
100mA rng measured over interface:	Both	Iout – 35 µA	_____	Iout + 35 µA
1 mA range measured over interface:	Both	Iout – 350 µA	_____	Iout + 350 µA
(when installed in N6705 analyzer):		(Iout – 360 µA)	(_____)	(Iout + 360 µA)
CC Load Effect:	Both	– 400 µA	_____	+ 400 µA
		N6781A Resistance Tests		
Resistance Programming	N6785A	0.998 Ω	_____	1.002 Ω

Test Description	N6781A, '82A, and '84A Settings
Voltage Programming & Readback Min Voltage:	Voltage Priority; 0 V, 4 A
Voltage Programming & Readback High Voltage:	Voltage Priority; 20 V, 4 A
CV Load Effect	Voltage Priority; 20 V, 4 A
CV Ripple and Noise	Voltage Priority; 20 V, 4 A
Transient Response	Voltage Priority; Comp.= HIGH3; 6V, from 0.1 to 1.5 A
Current Programming & Readback, Min Current	Current Priority; 0 A, 6 V
Current Programming & Readback, High Current	Current Priority; 8 A, 6 V
Current Readback 100 mA range	Current Priority; 100 mA, 1 V
Current Readback 1 mA Range	Voltage Priority; 1 mA, 10 V
CC Load Effect	Current Priority; 8 A, 6 V
N6781A Resistance Programming	Voltage Priority; 10 V, 1 Ω (Elect. load: CC mode, 20 V, 1A)

Test Record Form - Keysight N6783A-BAT and N6783A-MFG

N6783A-BAT, '83A-MFG	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
		Constant Voltage Tests		
Voltage Programming & Readback				
Minimum voltage (Vout):	Both	– 5 mV	_____	+ 25 mV
Voltage measured over interface:	Both	Vout – 5 mV	_____	Vout + 5 mV
High voltage (Vout):	N6783A-BAT	7.982 V	_____	8.018 V
	N6783A-MFG	5.984 V	_____	6.016 V
Voltage measured over interface:	N6783A-BAT	Vout – 9 mV	_____	Vout + 9 mV
	N6783A-MFG	Vout – 8 mV	_____	Vout +8 mV
CV Load Effect:	Both	– 6 mV	_____	+ 6 mV
CV Source Effect:	Both	– 2 mV	_____	+ 2 mV
CV Ripple and Noise				
peak-to-peak:	Both	N/A	_____	+ 8 mV
rms:	Both	N/A	_____	+ 1.5 mV
Transient response 6 V				
Voltage @ 45 µs:	N6732B	– 75 mV	_____	+ 75 mV
Voltage @ 75 µs with Option 761:	N6742B	– 90 mV	_____	+ 90 mV
		Constant Current Tests		
Current Programming & Readback				
Minimum current (Iout):	Both	+ 3.2 mA	_____	+ 6.8 mA
Current measured over interface:	Both	Iout – 0.6 mA	_____	Iout + 0.6 mA
High current (Iout):	Both	2.9952 A	_____	3.0048 A
Current measured over interface:	Both	Iout – 3.6 mA	_____	Iout + 3.6 mA
Low current measured over interface:	Both	Iout – 225 µA	_____	Iout + 225 µA
CC Load Effect:	Both	– 2 mA	_____	+ 2 mA
CC Source Effect:	Both	– 1 mA	_____	+ 1 mA
Negative Current Output:	Both	– 1.9942 A	_____	+ 2.0058 A

Test Description	N6783A-BAT Setting	N6783A-MFG Setting
Voltage Programming & Readback Min Voltage:	15 mV, 3 A	15 mV, 3 A
Voltage Programming & Readback High Voltage:	8 V, 3 A	6 V, 3 A
CV Load Effect, Source Effect, Ripple and Noise:	8 V, 3 A	6 V, 3 A
Transient Response:	6 V, from 0.15 A to 1.5 A	6 V, from 0.15 A to 1.5 A
Current Programming & Readback Min Current:	5 mA, 8 V	40 mA, 6 V
Current Programming & Readback High Current:	3 A, 8 V	3, 6 V
Current Readback Low Current:	150 mA, 8 V	150 mA, 6 V
CC Load Effect, Source Effect:	3 A, 8 V	3 A, 6 V
Negative current output:	0 V, – 2 A	0 V, – 2 A

Test Record Form - Keysight N6791A

Keysight N6791A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Priority Tests				
Voltage Programming & Readback				
Minimum voltage:		2.9919 V	_____	3.0081 V
Voltage measured over interface:		Vin – 8.1 mV	_____	Vin + 8.1 mV
High voltage:		59.9748 V	_____	60.0252 V
Voltage measured over interface:		Vin – 25.2 mV	_____	Vin + 25.2 mV
Current Priority Tests				
Current Programming & Readback - High range				
Minimum current:		2.398 mA	_____	7.602 mA
Current measured over interface:		Iin – 2.402 mA	_____	Iin + 2.402 mA
High current:		19.9894 A	_____	20.0106 A
Current measured over interface:		Iin – 10.4 mA	_____	Iin + 10.4 mA
Current Programming & Readback - Low range				
Minimum current:		0.5396 mA	_____	1.4604 mA
Current measured over interface:		Iin – 0.4004 mA	_____	Iin + 0.4004 mA
Low current:		1.99874 A	_____	2.00126 A
Current measured over interface:		Iin – 1.2 mA	_____	Iin + 1.2 mA
Resistance Priority Tests				
Resistance Programming - High range				
Minimum resistance:		1.0975 mS	_____	3.9025 mS
High resistance:		0 S	_____	1.5251 mS
Resistance Programming - Medium range				
Minimum resistance:		0.318999 S	_____	0.347666 S
High resistance:		0 S	_____	0.02401 S
Resistance Programming - Low range				
Minimum resistance:		12.1075 S	_____	12.8925 S
High resistance:		2.1175 S	_____	2.8825 S
Power Priority Tests				
Power Programming & Readback - High range				
Minimum power:		49.79 W	_____	50.21 W
Power measured over interface:		Win – 190 mW	_____	Win + 190 mW
High power:		99.76 W	_____	100.24 W
Power measured over interface:		Win – 220 mW	_____	Win + 220 mW
Power Programming & Readback - Low range				
Minimum power:		4.967 W	_____	5.033 W
Power measured over interface:		Win – 28 mW	_____	Win + 28 mW
Low power:		9.964 W	_____	10.036 W
Power measured over interface:		Win – 31 mW	_____	Win + 31 mW

Test Description	N6791A Settings	Power Supply Settings
Voltage Programming & Readback Minimum voltage:	Voltage priority; 3 V	65 V; 1.5 A
Voltage Programming & Readback High voltage:	Voltage priority; 60 V	65 V; 1.5 A
Current Programming & Readback - High Range, Minimum current	Current priority; 0.005 A	5 V; 25 A
Current Programming & Readback - High Range, High current	Current priority; 20 A	5 V; 25 A
Current Programming & Readback - Low Range, Minimum current	Current priority; 0.001 A	5 V; 25 A
Current Programming & Readback - Low Range, Low current	Current priority; 2 A	5 V; 25 A
Resistance Programming - High range, Minimum resistance	Resistance priority; 400 Ω	40 V; 1 A
Resistance Programming - High range, High resistance	Resistance priority; 8000 Ω	60 V; 1 A
Resistance Programming - Medium range, Minimum resistance	Resistance priority; 3.0 Ω	5 V; 3 A
Resistance Programming - Medium range, High resistance	Resistance priority; 100 Ω	5 V; 1 A
Resistance Programming - Low range, Minimum resistance	Resistance priority; 0.08 Ω	1 V; 15 A
Resistance Programming - Low range, High resistance	Resistance priority; 0.40 Ω	0.5 V; 3 A
Power Programming & Readback - High Range, Minimum power	Power priority; 50 W	25 V; 3 A
Power Programming & Readback - High Range, High power	Power priority; 100 W	25 V; 5 A
Power Programming & Readback - Low Range, Minimum power	Power priority; 5 W	25 V; 0.5 A
Power Programming & Readback - Low Range, Low power	Power priority; 10 W	25 V; 0.5 A

Test Record Form - Keysight N6792A

Keysight N6792A	Report Number _____		Date_____	
Test Description	**Model**	**Min. Specs**	**Results**	**Max. Specs**
Voltage Priority Tests				
Voltage Programming & Readback				
Minimum voltage:		2.9919 V	_____	3.0081 V
Voltage measured over interface:		Vin – 8.1 mV	_____	Vin + 8.1 mV
High voltage:		59.9748 V	_____	60.0252 V
Voltage measured over interface:		Vin – 25.2 mV	_____	Vin + 25.2 mV
Current Priority Tests				
Current Programming & Readback - High range				
Minimum current:		4.796 mA	_____	15.204 mA
Current measured over interface:		Iin – 4.604 mA	_____	Iin + 4.604 mA
High current:		39.9788 A	_____	40.0212 A
Current measured over interface:		Iin – 20.6 mA	_____	Iin + 20.6 mA
Current Programming & Readback - Low range				
Minimum current:		1.0792 mA	_____	2.9208 mA
Current measured over interface:		Iin – 0.8208 mA	_____	Iin + 0.8208 mA
Low current:		3.99748 A	_____	4.00252 A
Current measured over interface:		Iin – 2.42 mA	_____	Iin + 2.42 mA
Resistance Priority Tests				
Resistance Programming - High range				
Minimum resistance:		0 S	_____	5.3025 mS
High resistance:		0 S	_____	2.9251 mS
Resistance Programming - Medium range				
Minimum resistance:		0.313999 S	_____	0.352666 S
High resistance:		0 S	_____	0.02901 S
Resistance Programming - Low range				
Minimum resistance:		11.9375 S	_____	13.0625 S
High resistance:		1.9475 S	_____	3.0525 S
Power Priority Tests				
Power Programming & Readback - High range				
Minimum power:		99.58 W	_____	100.42 W
Power measured over interface:		Win – 380 mW	_____	Win + 380 mW
High power:		199.52 W	_____	200.48 W
Power measured over interface:		Win – 440 mW	_____	Win + 440 mW
Power Programming & Readback - Low range				
Minimum power:		9.929 W	_____	10.071 W
Power measured over interface:		Win – 56 mW	_____	Win + 56 mW
Low power:		19.923 W	_____	20.077 W
Power measured over interface:		Win – 62 mW	_____	Win + 62 mW

Test Description	N6792A Settings	Power Supply Settings
Voltage Programming & Readback Minimum voltage:	Voltage priority; 3 V	65 V; 1.5 A
Voltage Programming & Readback High voltage:	Voltage priority; 60 V	65 V; 1.5 A
Current Programming & Readback - High Range, Minimum current	Current priority; 0.01 A	5 V; 45 A
Current Programming & Readback - High Range, High current	Current priority; 40 A	5 V; 45 A
Current Programming & Readback - Low Range, Minimum current	Current priority; 0.002 A	5 V; 45 A
Current Programming & Readback - Low Range, Low current	Current priority; 4 A	5 V; 45 A
Resistance Programming - High range, Minimum resistance	Resistance priority; 400 Ω	40 V; 1 A
Resistance Programming - High range, High resistance	Resistance priority; 8000 Ω	60 V; 1 A
Resistance Programming - Medium range, Minimum resistance	Resistance priority; 3.0 Ω	5 V; 3 A
Resistance Programming - Medium range, High resistance	Resistance priority; 100 Ω	5 V; 1 A
Resistance Programming - Low range, Minimum resistance	Resistance priority; 0.08 Ω	1 V; 15 A
Resistance Programming - Low range, High resistance	Resistance priority; 0.40 Ω	0.5 V; 3 A
Power Programming & Readback - High Range, Minimum power	Power priority; 100 W	25 V; 5 A
Power Programming & Readback - High Range, High power	Power priority; 200 W	6 V; 40 A
Power Programming & Readback - Low Range, Minimum power	Power priority; 10 W	25 V; 0.5 A
Power Programming & Readback - Low Range, Low power	Power priority; 20 W	25 V; 1.0 A

9
Service and Maintenance

Introduction

Firmware Update

Instrument Sanitize

Calibration Switches

Disassembly

Troubleshooting

Replaceable Parts

KEYSIGHT TECHNOLOGIES

Introduction

Types of Service Available

If your instrument fails during the warranty period, Keysight Technologies will repair or replace it under the terms of your warranty. After your warranty expires, Keysight offers repair services at competitive prices.

Many Keysight products have optional service contracts that extend coverage after the standard warranty expires.

Obtaining Repair Service (Worldwide)

To obtain service for your instrument, contact your nearest Keysight Technologies Service Center. They will arrange to have your unit repaired or replaced, and can provide warranty or repair–cost information where applicable. Ask the Keysight Technologies Service Center for shipping instructions, including what components to ship. Keysight recommends that you retain the original shipping carton for return shipments.

Before Returning the Unit

Before returning the unit,

- Make sure the failure is in the instrument rather than any external connections.
- Make sure that the instrument was accurately calibrated within the last year.
- Perform the Preliminary Checkout procedures in the troubleshooting section.

Repackaging for Shipment

To ship the unit to Keysight for service or repair:

- Attach a tag to the unit identifying the owner and indicating the required service or repair. Include the model number and full serial number.
- Place the unit in its original container with appropriate packaging material.
- Secure the container with strong tape or metal bands.
- If the original shipping container is unavailable, use a container that will ensure at least 10 cm (4 in.) of compressible packaging material around the entire instrument. Use static-free packaging materials.

Keysight suggests that you always insure shipments.

Firmware Update

NOTE Refer to Instrument Identification to determine which firmware version is installed on your instrument.

To update your instrument with the latest firmware, go to www.keysight.com/find/N6705firmware. The upgrade procedure consists of the following steps:

- Download and unzip the Keysight N6705 Firmware Update file located under "Documents & Downloads" at the bottom of the Web page. Make a note of where you saved the unzipped file.
- Download and install the Keysight N6705 Firmware Update Utility located under "Documents & Downloads" at the bottom of the Web page. You can skip this step if the utility is already installed on your computer.
- Run the Keysight N6705 Firmware Update Utility and update the firmware on your instrument. Select Start > Programs > Keysight > Firmware Update Utility. If prompted for a password, enter the Administrative Tools password to allow the firmware update to proceed.
- Cycle power to the mainframe. The updated firmware will be running when power is reapplied.

Restricting Access

NOTE You can restrict access to the instrument by the firmware update utility. This prevents unauthorized users from updating the firmware.

Press the Menu key, scroll down and select Utilities, then select Administrative Tools. Enter the password, then select Firmware Update. Check the "Log in as administrator to allow firmware update" box.



When checked, this allows only those who know the administrative password to use the Firmware Update utility to update the firmware. When the Firmware Update Utility is run, a dialog will be displayed asking the user to enter the Administrative Tools password to allow the firmware update to proceed.


Unsecure Instrument
The instrument is in a secured state and cannot be updated. Please enter the calibration password/security code* below and press OK to unlock the instrument and proceed with the firmware update.
*The calibration password/security code protects the instrument from unauthorized firmware updates.
Calibration Password/Security Code
OK
Cancel

Instrument Sanitize

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

Sanitize removes all user-data from the instrument and restores the factory-shipped settings. Refer to Non-Volatile Settings for a list of the factory settings.

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

From the Front Panel

Log into the Administrative Tools menu. If you cannot access the Admin menu, it may be password protected. Then select Sanitize and press the Sanitize button.



From the Remote Interface

SYST:SEC:IMM

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.

Calibration Switches

Accessing the Calibration Switches

Switch Functions

WARNING 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.

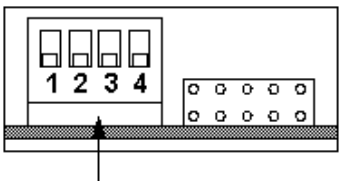
Two switches control access to the admin menu and calibration functions. The switches are on the interface board located behind the right side cover.

Accessing the Calibration Switch

Step 1. Remove the right side cover (the side with the handle). Remove the handle screws with a Philips pozidrive. Then remove the screw at the back using a T10 driver. Remove the panel.

Step 2. The calibration switches are visible through the cutout. To change the calibration switch settings, use a small screwdriver to move the switches.

Switches shown in ON position



CAUTION Do not use a pencil to move the switches. Any graphite dust that gets on the switches will conduct electricity.

Step 3. Replace the side cover when finished.

Switch Functions

Switches 1 and 2 set the calibration configuration as shown. Switches 3 and 4 are not used.

	Sw 1	Sw 2	Description
Normal	ON	ON	This is the default or as-shipped switch setting. The calibration functions are accessible after entering a numeric password. The default password is 0 (zero).
Clear Password	OFF	ON	The admin/calibration password is reset to 0 when the instrument is first powered on. Use this setting if you have forgotten the password.
Inhibit Calibration	OFF	OFF	All calibration commands are disabled. This is useful where calibration access is guarded by instrument seals.

Battery Replacement

The internal battery powers the real-time clock. The primary function of the clock it to provide a time stamp for the internal file system. If the battery fails, the clock and time stamp function will not be available. No other instrument functions are affected.

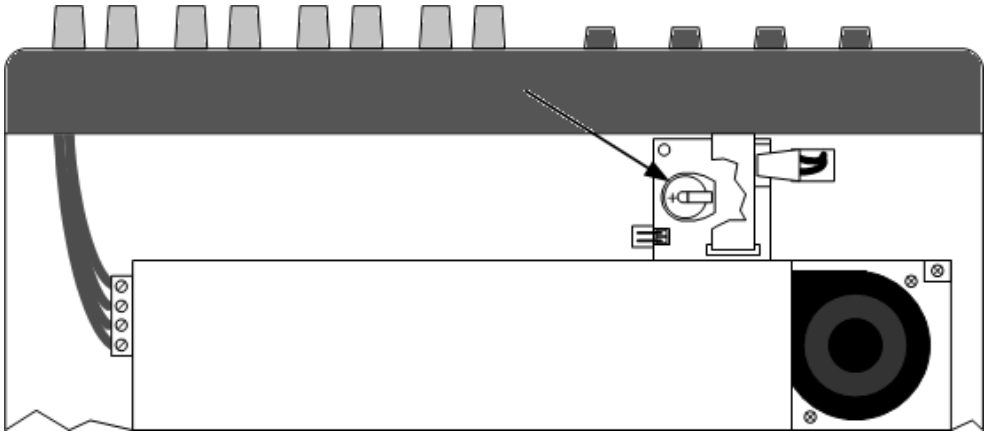
Under normal use at room temperature, the lithium battery has a life expectancy between seven and ten years. Note that battery life will be reduced if the instrument is stored for a prolonged period at temperatures above 40 degrees C.

The part number of the battery is Panasonic CR 2032.

Step 1. Remove the top cover. Loosen the thumbscrews to remove the top cover. The battery is located right behind the front panel assembly.

Step 2. Lift the clip and remove the old battery. Use a small flat-blade screwdriver and carefully lift the clip. Remove the battery.

Step 3. Install the new battery. Insert the new battery. Make sure that the positive side (+) is facing up. Release the clip.



Step 4. Reassemble the unit and turn it on. Then reset the date and time. Refer to Clock Setup.

CAUTION Properly dispose of the old battery in accordance with local laws and regulations.



Disassembly

Electrostatic Discharge

Disassembly Tools

Removing/Installing Flat Flexible Cables

Removing/Installing Power Modules

Removing/Installing the Top Chassis

Removing/Installing the Bias Board

Removing/Installing the Processor Carrier Board

Removing/Installing the P600 Processor

Removing/Installing the AC Module

Removing/Installing the Bulk Supply

Removing/Installing the BNC Board

Removing/Installing the Top Backplane Board

Removing/Installing the Bottom Backplane Board

Removing/Installing the Sub Panel

Removing/Installing the Display

Removing/Installing the Binding Post Board

Removing/Installing the Front Panel Board

This section discusses the disassembly procedures for troubleshooting and repairing Keysight N6705C Power Analyzer mainframes.

WARNING SHOCK HAZARD. FAN 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.

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 work area.

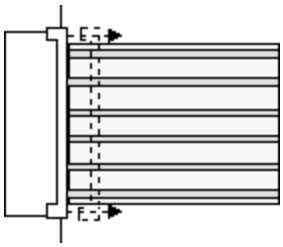
Disassembly Tools

Tool	Use
N6705CT10 Torx driver	All Disassemblies
T20 Torx driver	Removing Top Chassis, AC Module, Bulk Supply and Calibration
7/32 in. nut driver	Removing Ground Nut
1/4 in. nut driver	Removing Binding Post Assembly
11/32 in. nut driver	Removing Bulk Supply Cable
5/8 in. nut driver	Removing Trigger Assembly
Flat Blade driver	Replacing Battery and Calibration
Diagonal cutters	Removing top and bottom backplanes
Philips pozidrive	Removing side cover without handle

Disassembly Procedures

Removing/Installing Flat Flexible Cables (FFC)

- Note the position of the conductive side of the cable for re-installation. (The blue tab is on the non-conductive side.)
- To remove the FFC cable, gently lift up on the tabs located on the short ends of the plastic connector until the cable is released. Remove the cable.



- To install the FFC cable, insert the cable into the slot in the connector. Using a small screwdriver or your fingers, apply gentle, even pressure to the tabs until the connector clicks and locks the cable into place. After installation, check the cable to ensure the cable is straight and securely aligned within the connector

Removing/Installing Power Modules

Refer to Power Module Installation for details.

Step 1. Remove the top (or bottom) covers. Loosen the thumbscrews to remove the covers. Turn the unit upside-down to remove the bottom cover.

Step 2. To remove a power module, first remove the connector from the end of the module. Then remove the two fastening screws at either end of the module. Grasp the module at the ends (near the fan and the output connector), and lift it straight up out of the mainframe.

CAUTION Equipment Damage Backplane connector pins are exposed in empty module slots. Ensure that the pins are protected from damage whenever the covers are removed.

Step 3. To install a module, align the module over the alignment pins, and push it down onto the backplane connector.

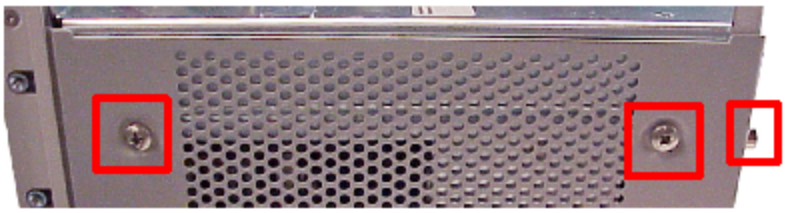
Step 4. Fasten the module to the mainframe. Install the two fastening screws to either end of the module. Install the connector plug into the module.

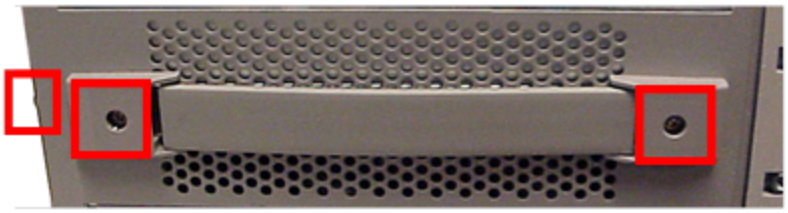
Step 5. Install the top (or bottom) covers when finished.

Removing/Installing the Top Chassis (5002-2850)

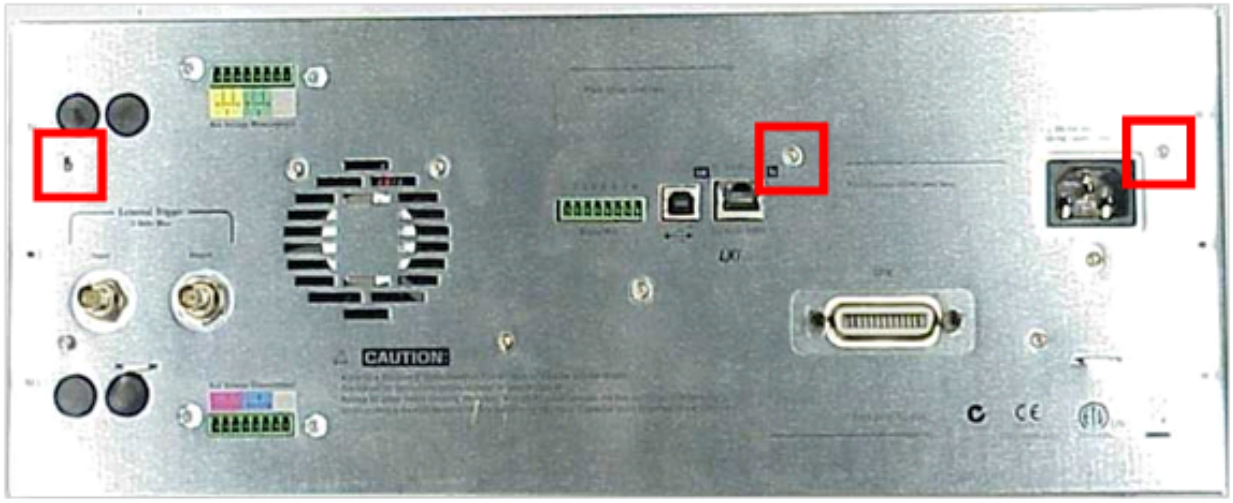
Step 1. Remove the top cover and any modules as previously described.

Step 2. Remove the side panels. The handle side requires a T20 driver (see Figure 4-7). The other side panel requires a Philips pozidrive head (see Figure 4-8). There is also a screw (T10) that needs to be removed from the rear of each side panel.





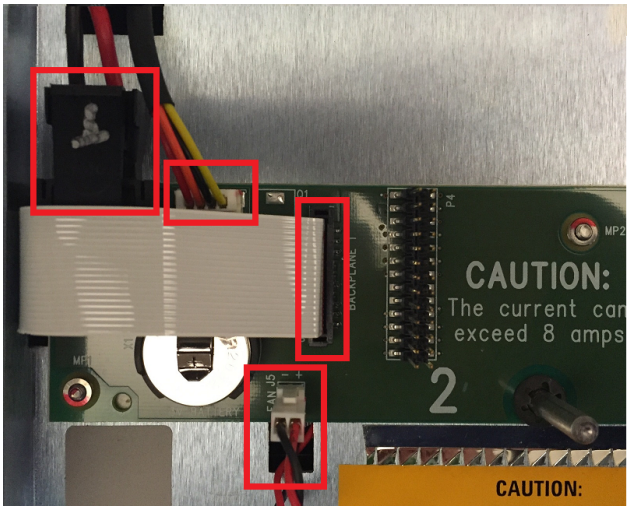
Step 3. Remove three screws using a T10 driver from the rear panel.



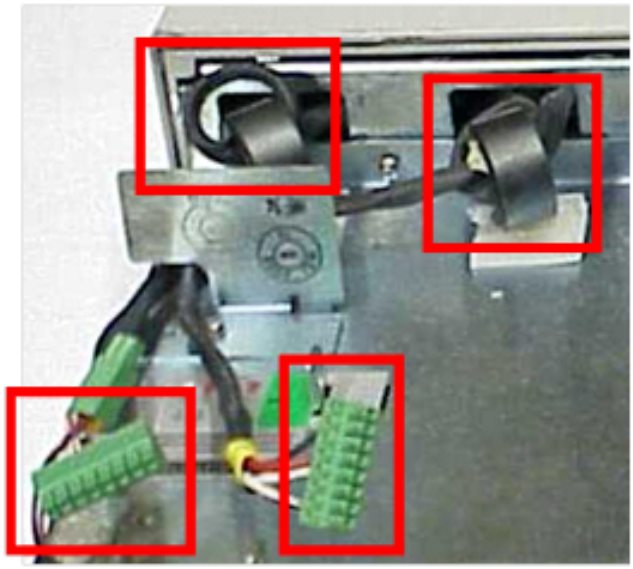
Step 4. Remove three screws using a T10 driver from the front panel sub assembly.



Step 5. Disconnect the four cables from the backplane assembly.



Step 6. Remove the top chassis. Angle the top chassis so you can maneuver around the fin attached to the rear panel. To completely disconnect the top chassis, unwrap the front panel cable harnesses from the ferrite cores.

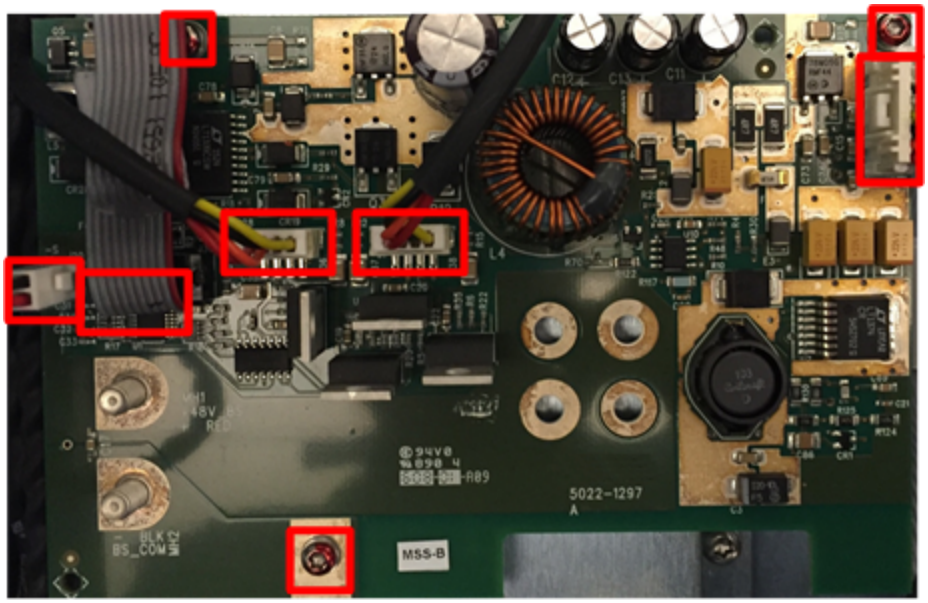


Step 7. To install the top chassis, perform steps 1-6 in reverse order. Be sure to tuck all cables in before replacing the top chassis

Removing/Installing the Bias Board (5067-5202)

Step 1. Remove the top chassis as previously described.

Step 2. Remove three screws using a T10 driver and disconnect five cables.



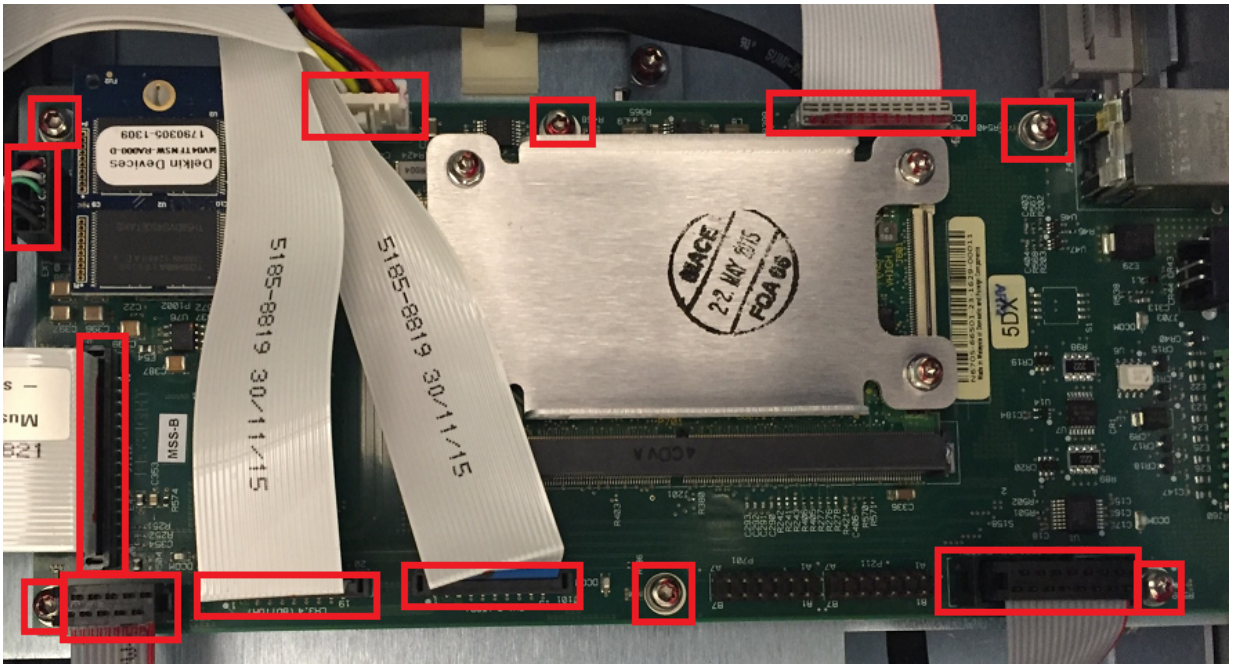
Step 3. Remove the bias board.

Step 4. To install the bias board, perform the above steps in reverse order.

Removing/Installing the Processor Carrier Board (N6705-66501)

Step 1. Remove the top chassis as previously described.

Step 2. Disconnect the eight cables and remove six screws using a T10 driver.



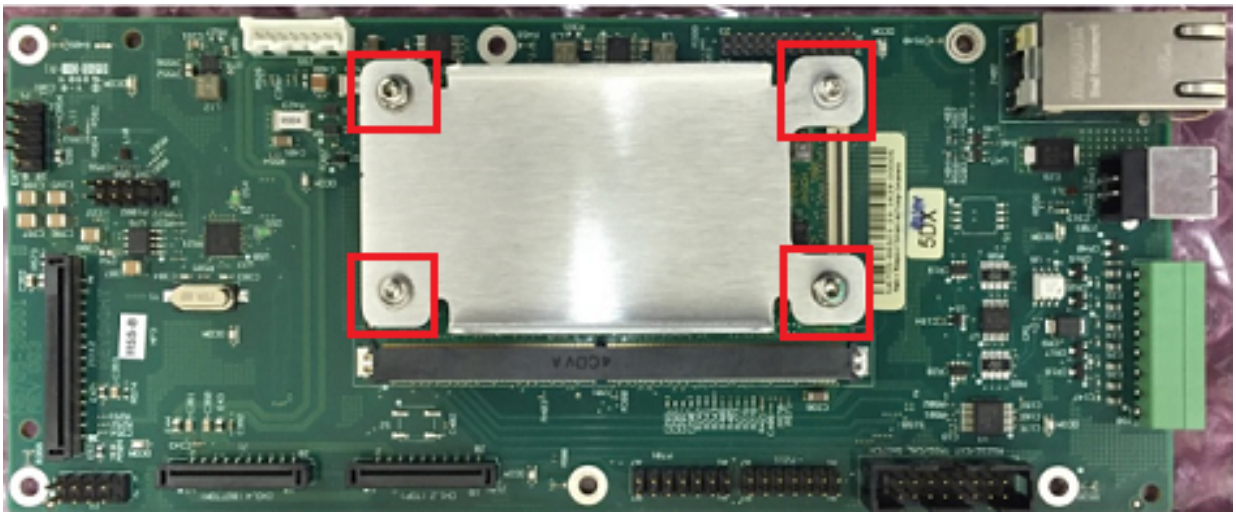
Step 3. Remove the Processor Carrier by sliding forward and lifting.

Step 4. To install the Processor Carrier board, perform the above steps in reverse order.

Removing/Installing the P600 Processor (P0600-63002)

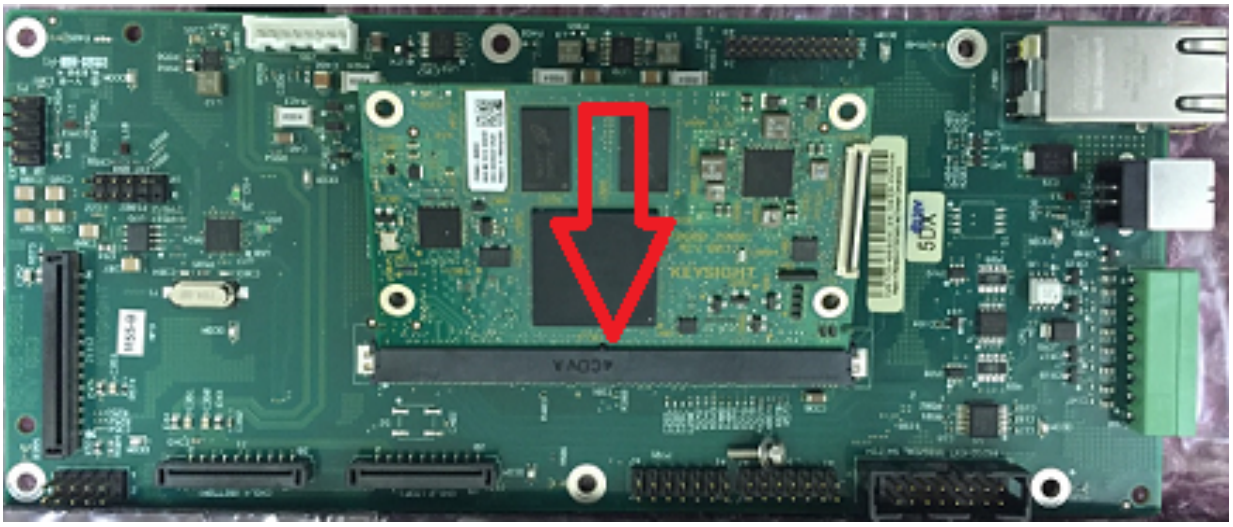
Step 1. Remove the top chassis as previously described.

Step 2. Remove the four screws that attach the heat spreader to the board using a T10 driver.



Step 3. Slide the board out of the connector.

Step 4. When installing the P600 board, insert the board on an angle into the connector.



Step 5. Then position the heat spreader over the board and gently push the heat spreader down. Install the four screws.

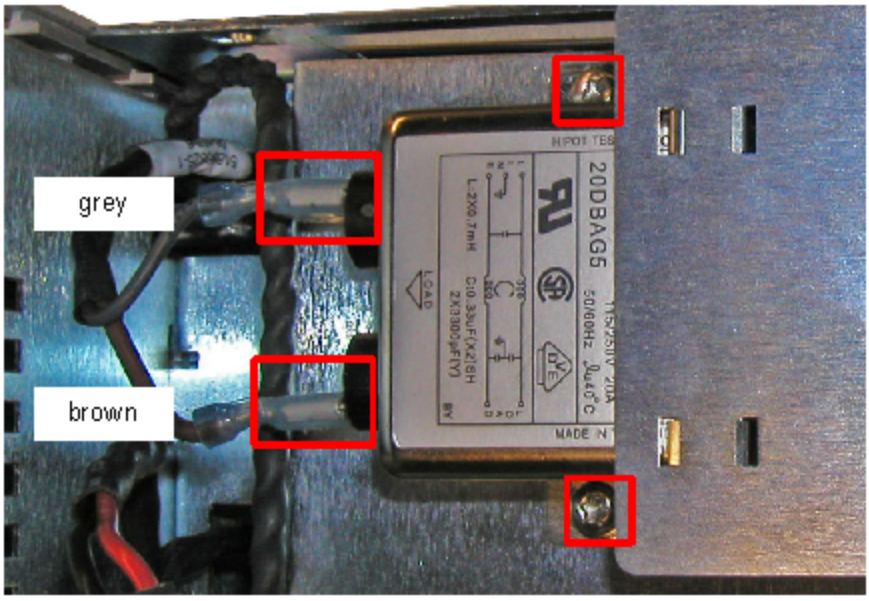
Removing/Installing the AC Filter Module (5188-4226)

Step 1. Remove the top chassis as previously described.

Step 2. Remove the screw using a T10 driver from the rear panel located beneath the AC receptacle.



Step 3. Disconnect the two connections and remove two screws using a T20 driver from the AC Module.



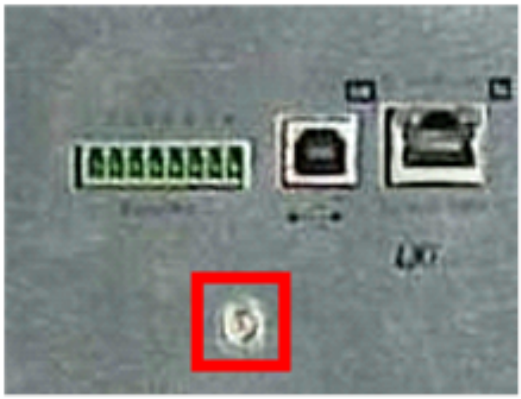
Step 4. Remove the AC Module

Step 5. To install the AC module, perform the above steps in reverse order.

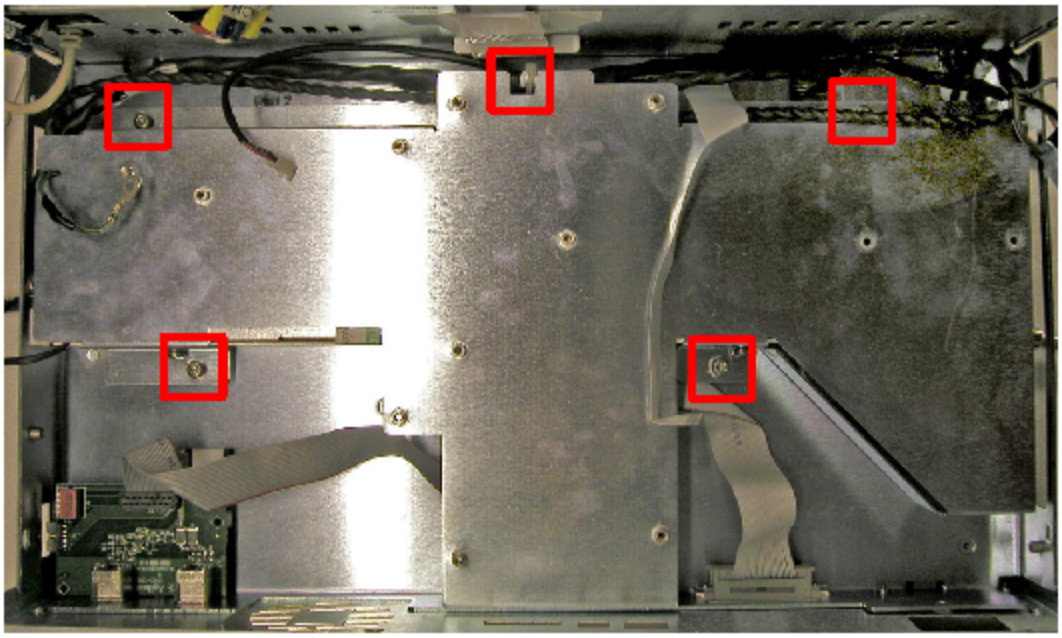
Removing/Installing the Bulk Supply (0950-5355)

Step 1. Remove the top chassis, Processor Carrier PCA, Bias PCA, and AC Module as previously described.

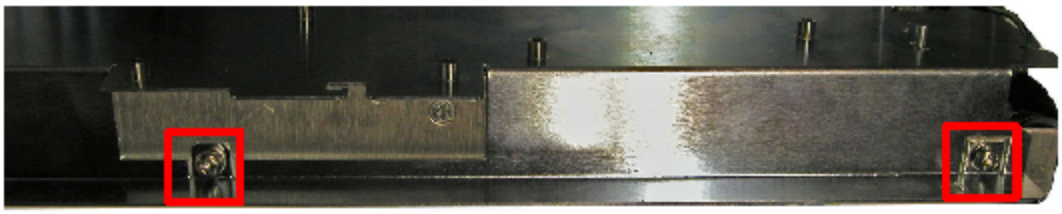
Step 2. Remove one screw using a T10 driver from the rear panel.

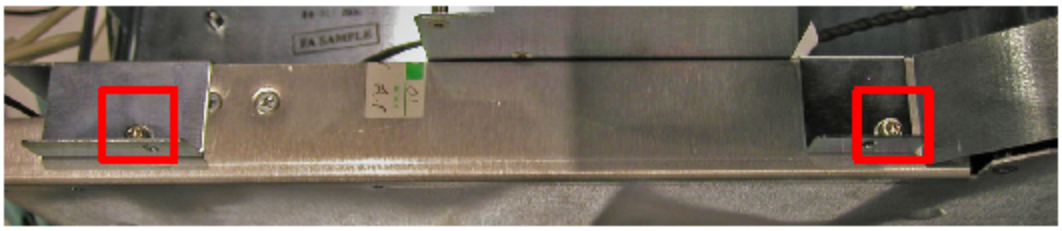


Step 3. Unhook the cable tie and remove four screws using a T20 driver.

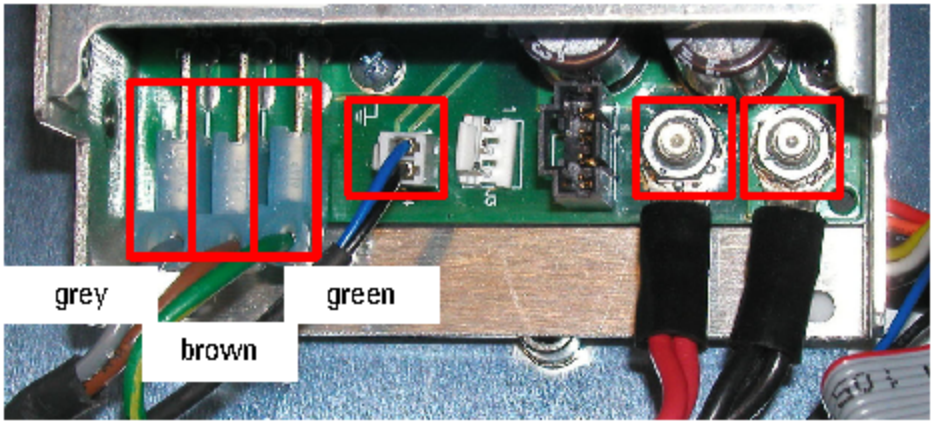


Step 4. Remove four screws using a T20 driver from the sides of the bulk shroud and remove the bulk shroud.





Step 5. Disconnect four connections and remove two 11/32 in. nuts from the bulk supply.



Step 6. Remove the bulk supply.

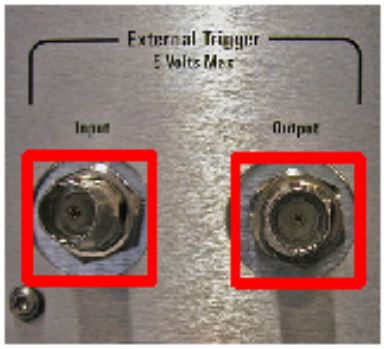
Step 7. To install the bulk supply, perform the above steps in reverse order.

NOTE For reassembly, make a note of the color-coding of all the wires as well as the pins to which the wires are connected (see table below).

Removing/Installing the BNC Trigger Board (N6705-66502)

Step 1. Remove the top chassis as previously described.

Step 2. Remove the two 5/8 in. nuts from the binding posts.



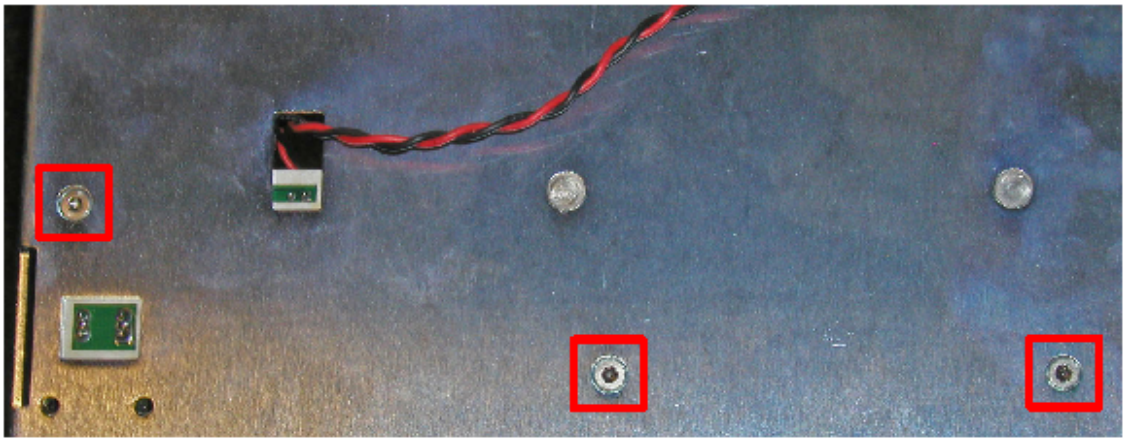
Step 3. Remove the BNC board

Step 4. To install the BNC board, perform steps 1-3 in reverse order.

Removing/Installing the Top Backplane Board (5067-5100)

Step 1. Remove the top chassis as previously described.

Step 2. Remove three screws using a T10 driver from the chassis on the side opposite to the backplane board.



Step 3. Disconnect any remaining cables if required, and either cut or carefully slide the two push-on retainers off of the retaining pins.



Step 4. Remove the top backplane board.

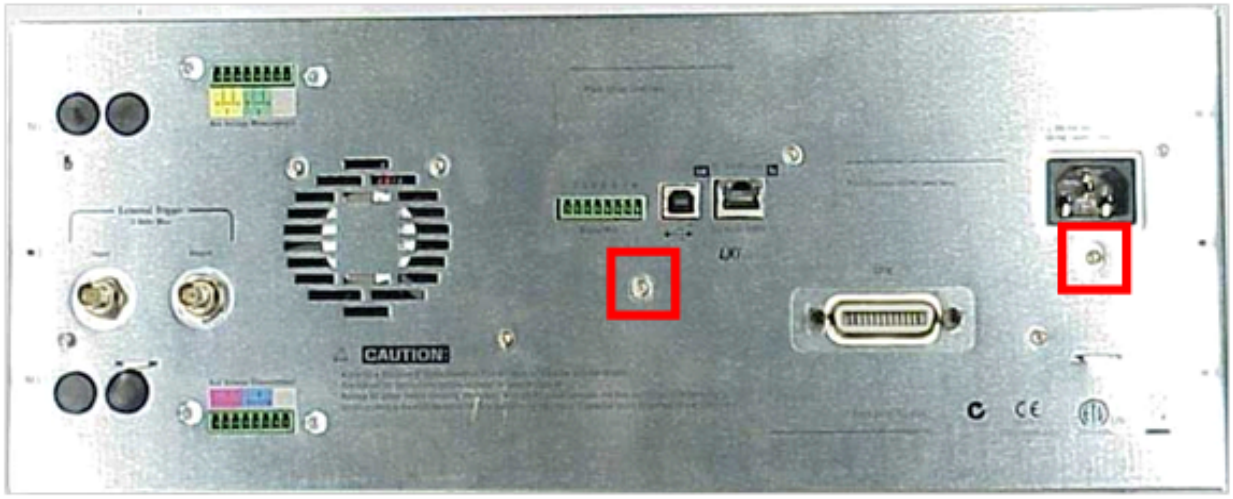
Step 5. To install the top backplane board, perform the above steps reverse order. New push-on retainers can be purchased separately.

Removing/Installing the Bottom Backplane Board (5067-5201)

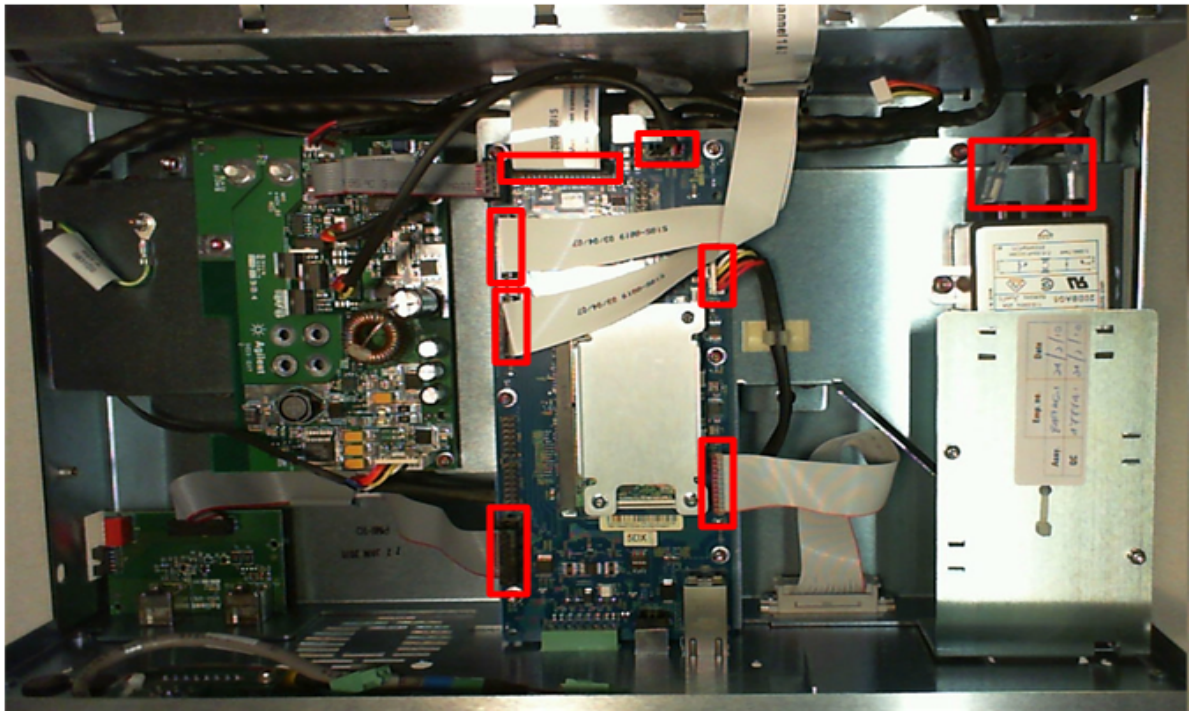
Step 1. Remove the top chassis as previously described.

Step 2. Remove the bottom cover as previously described.

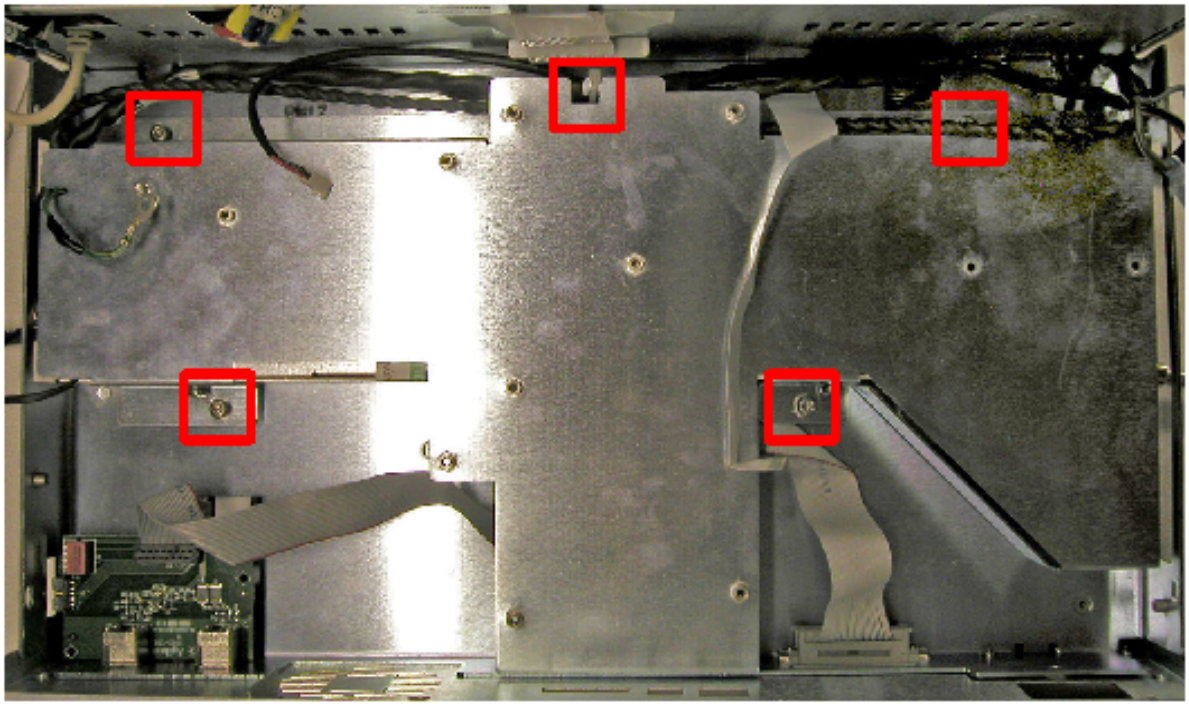
Step 3. Remove two screws using a T10 driver from the back panel. (one to the AC module and the other to the bulk shroud).



Step 4. Disconnect seven cables from the Processor Carrier PCA and the two contacts to the AC module.

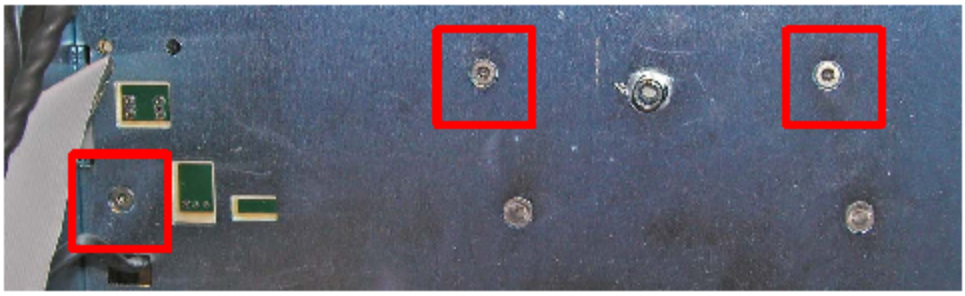


Step 5. Unhook the cable tie from the bulk shroud and remove four screws using a T20 driver. (Figure shows PCA boards removed for clarity)

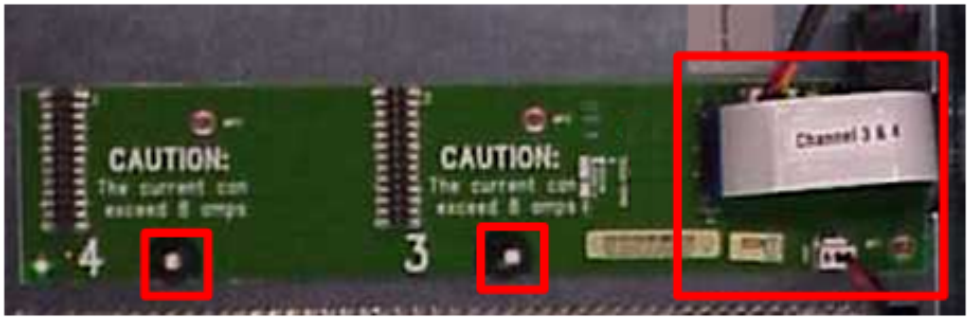


Step 6. Gently lift bulk shroud out of mainframe and place on right side of mainframe (non-handle side - right side when viewed from front).

Step 7. Carefully stand mainframe on its right end and remove three screws using a T10 driver from the side opposite to the backplane board.



Step 8. Disconnect any remaining cables if required, and either cut or carefully slide the two push-on retainers off of the retaining pins.



Step 9. Remove the backplane board.

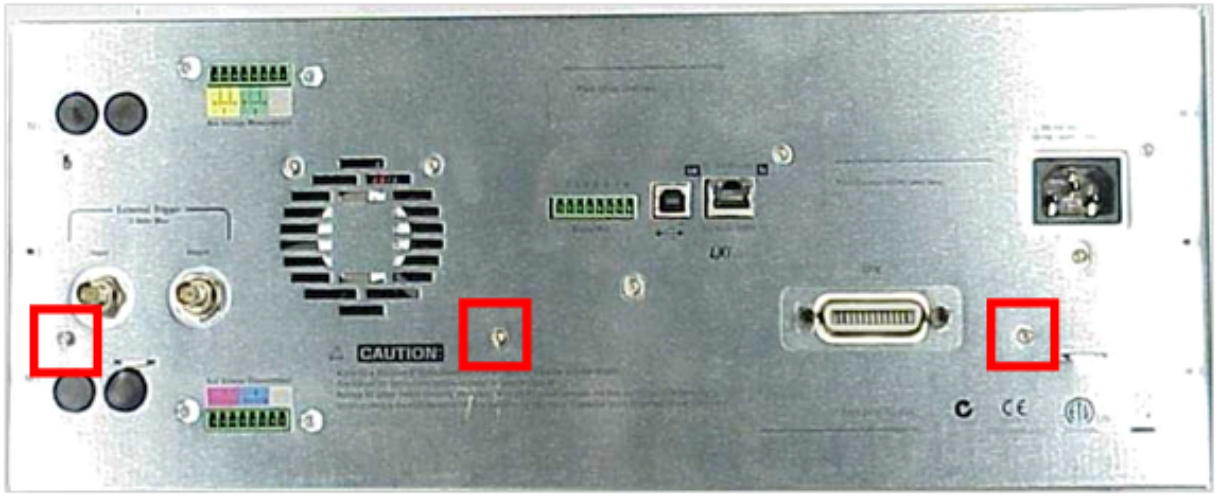
Step 10. To install the bottom backplane board, perform the above steps in reverse order. New push-on retainers can be purchases separately.

Removing/Installing the Sub Panel (5002-2852)

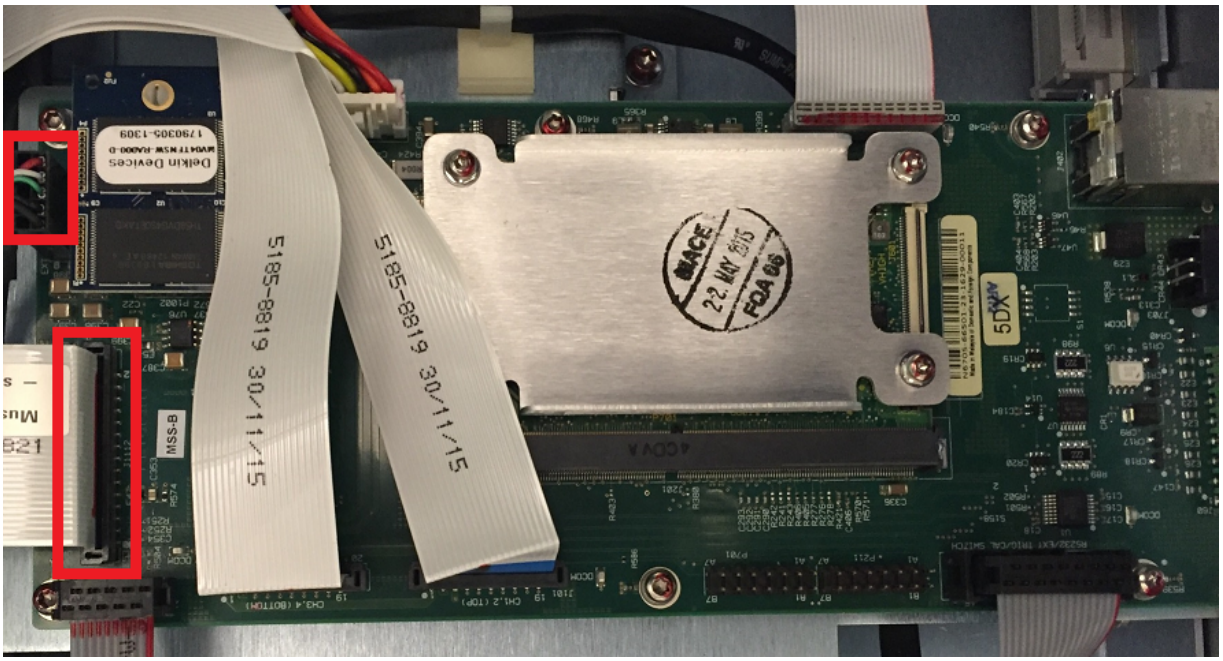
Step 1. Remove the top chassis as previously described.

Step 2. Remove the bottom cover as previously described.

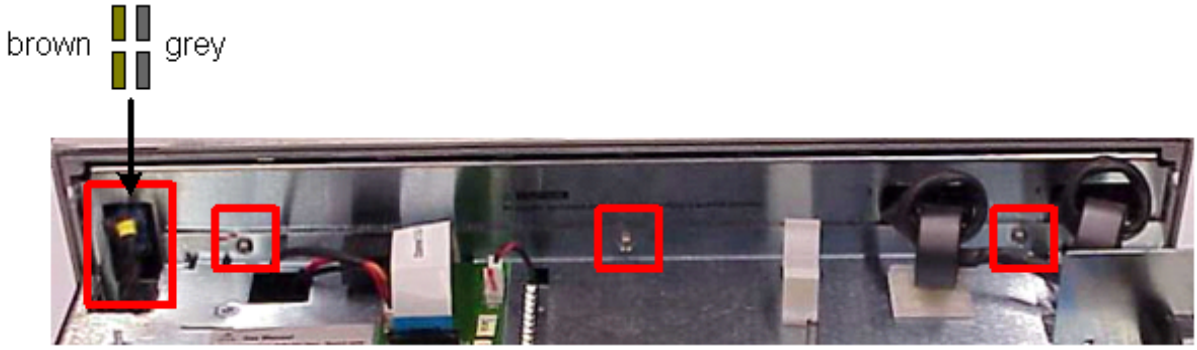
Step 3. Remove three screws using a T10 driver from the rear panel and remove the rear panel.



Step 4. Disconnect the USB cable and front panel to Processor Carrier FFC cable.



Step 5. Disconnect all cables to the AC switch on the rear bottom chassis, remove three screws using a T10 driver, and separate mainframe from front panel.



Step 6. Remove two screws using a T10 from each side of the front panel.



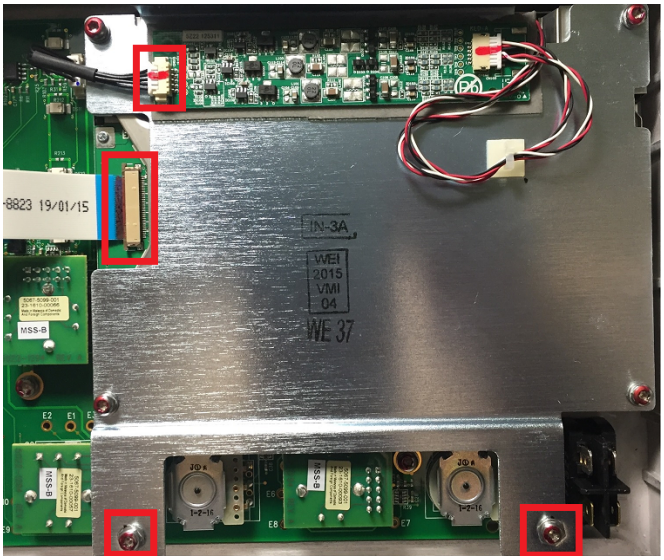
Step 7. Remove the sub panel.

Step 8. To install the sub panel, perform the above steps in reverse order.

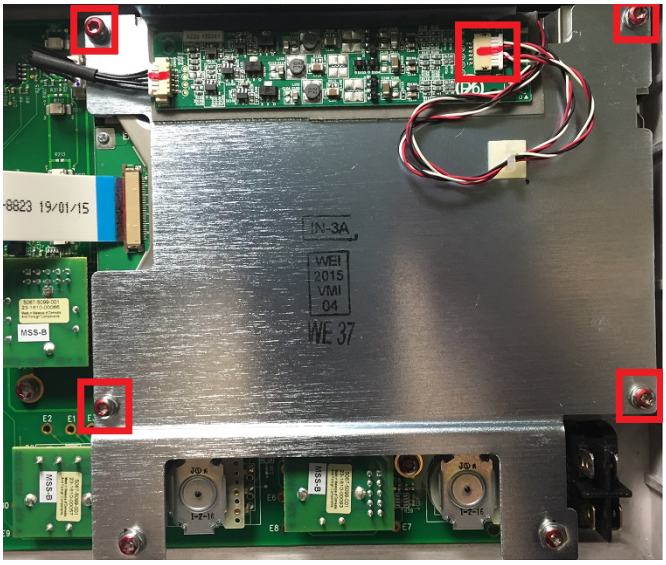
Removing/Installing the Display (2090-1096)

Step 1. Remove the sub panel as previously described.

Step 2. Disconnect two cables and remove two screws using a T10 driver.



Step 3. Disconnect one cable and remove four screws using a T10 driver to remove display from bracket.

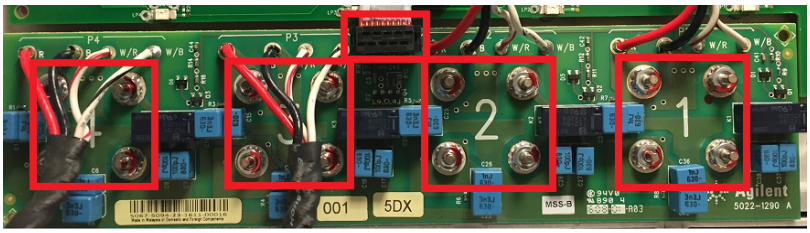


Step 4. To install the display, perform the above steps in reverse order.

Removing/Installing the Binding Post Board (5067-5094)

Step 1. Remove the sub panel as previously described.

Step 2. Disconnect the binding post board to front panel board ribbon cable and remove sixteen 1/4 in. nuts from the assembly.



Step 3. Remove the binding post board.

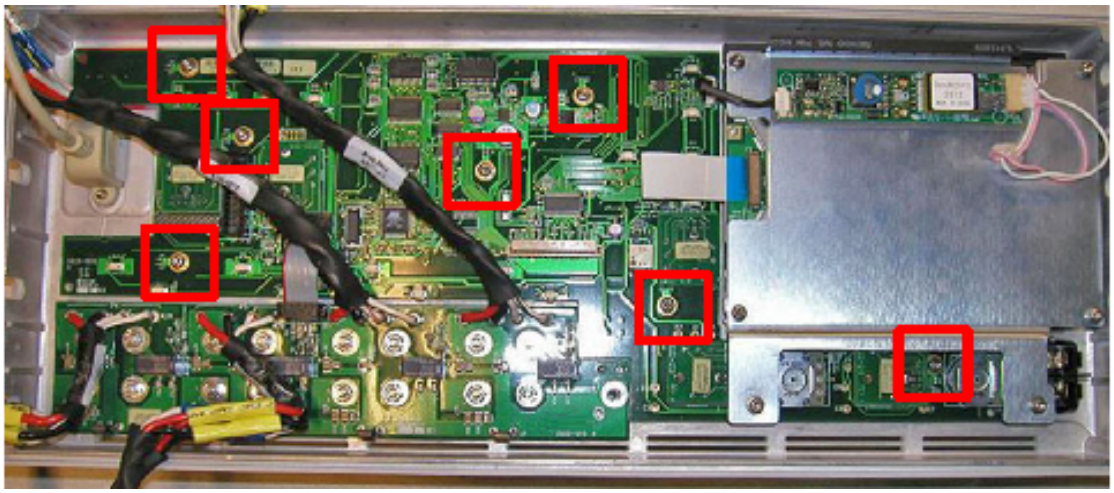
Step 4. To install the binding post board, perform the above steps in reverse order.

Removing/Installing the Front Panel Board (5067-5096)

Step 1. Remove the sub panel as previously described.

Step 2. Remove the display as previously described.

Step 3. Remove seven screws using a T10 driver.



Step 4. Remove the seven knobs from the front panel.



Step 5. Remove the front panel board.

Step 6. To reinstall the front panel board, perform the above steps in reverse order.

Troubleshooting

Preliminary Checkout

Overall Troubleshooting

Bias Board Troubleshooting

Backplane Board Troubleshooting

Calibration and Passwords

Before performing the Overall Troubleshooting procedures, perform the Preliminary Checkout procedure below.

If the power analyzer passes selftest and there are no obvious faults, perform the Verification Procedures to determine if any power modules are not calibrated, or are not operating properly. This will help isolate a problem to a specific power module.

The following test equipment is required for troubleshooting Keysight N6700 MPS mainframes:

- Keysight 34401A or equivalent - Digital multimeter for measuring voltage and resistance.

WARNING SHOCK HAZARD. FAN HAZARD. Only qualified, service-trained personnel who are aware of the hazards involved should perform the troubleshooting procedures described here.

Preliminary Checkout

Is the instrument inoperative?

- Verify that the AC power cord is connected to the instrument.
- Verify that the front-panel Line switch has been pushed.

Does the instrument fail selftest?

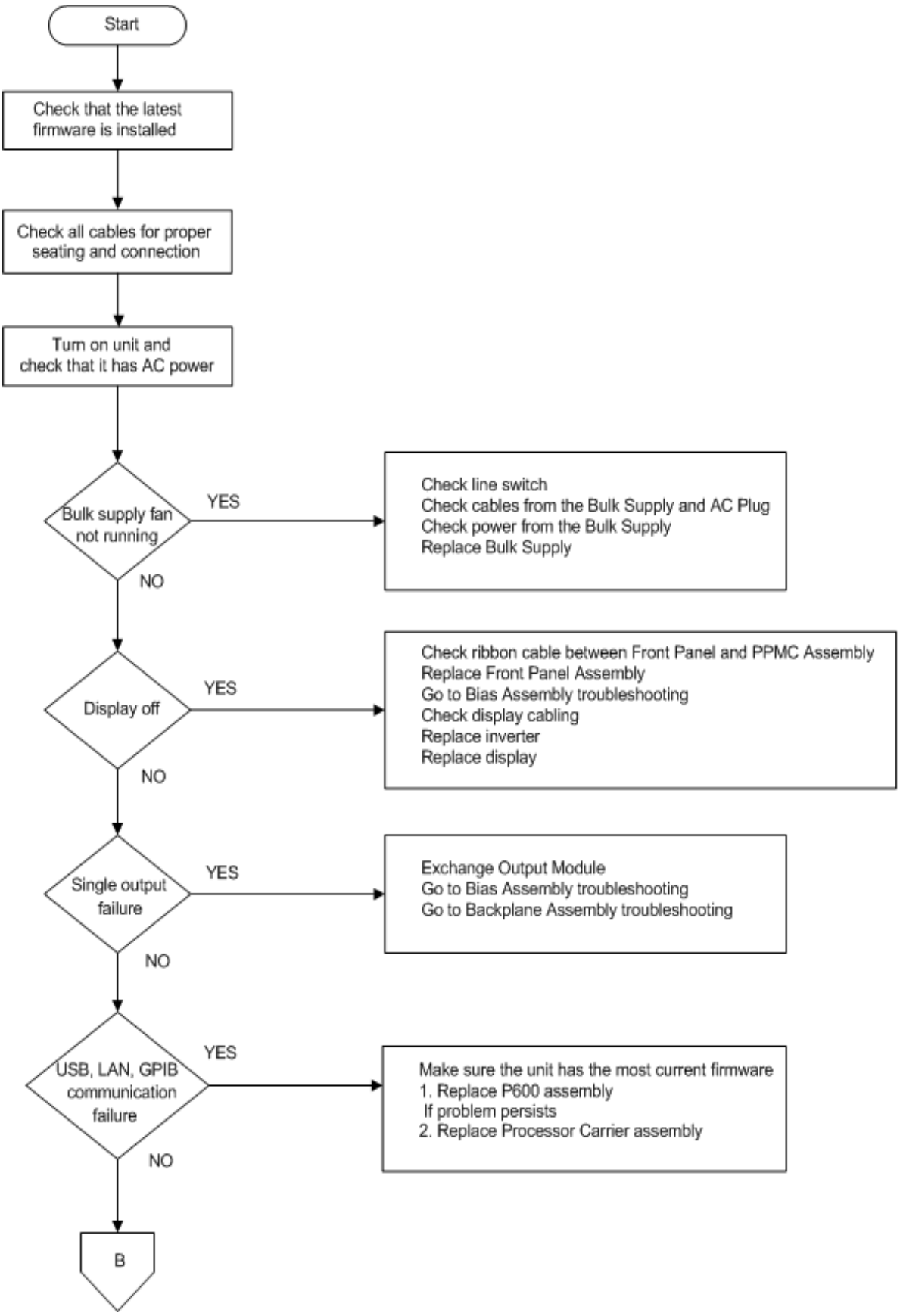
A power-on selftest occurs automatically when you turn the unit on. You can also initiate a selftest by sending the *TST? query.

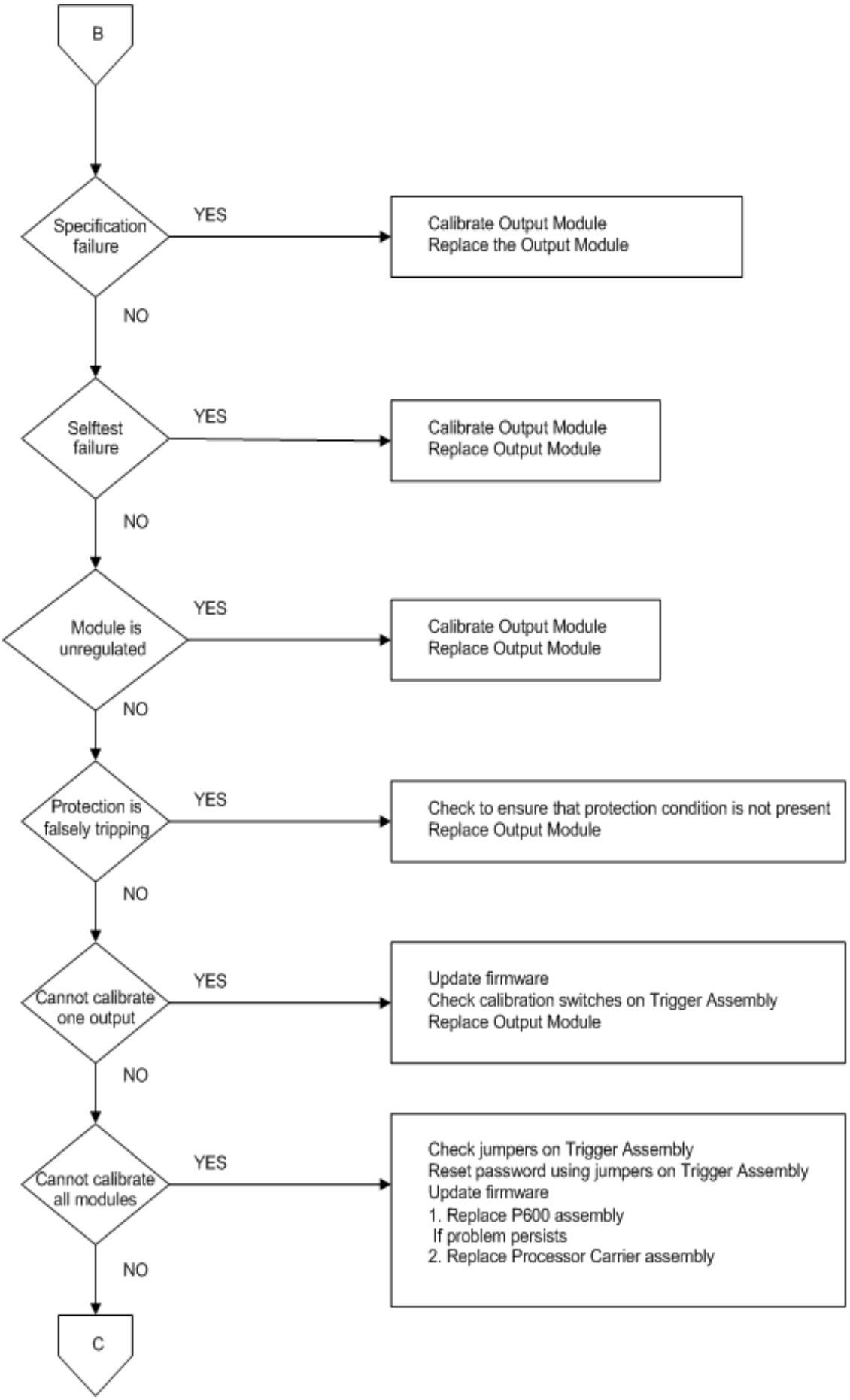
If selftest fails, the front panel ERR indicator comes on. Go to the Utilities menu to view the Error Log. Refer to Selftest Errors for a list of selftest error codes.

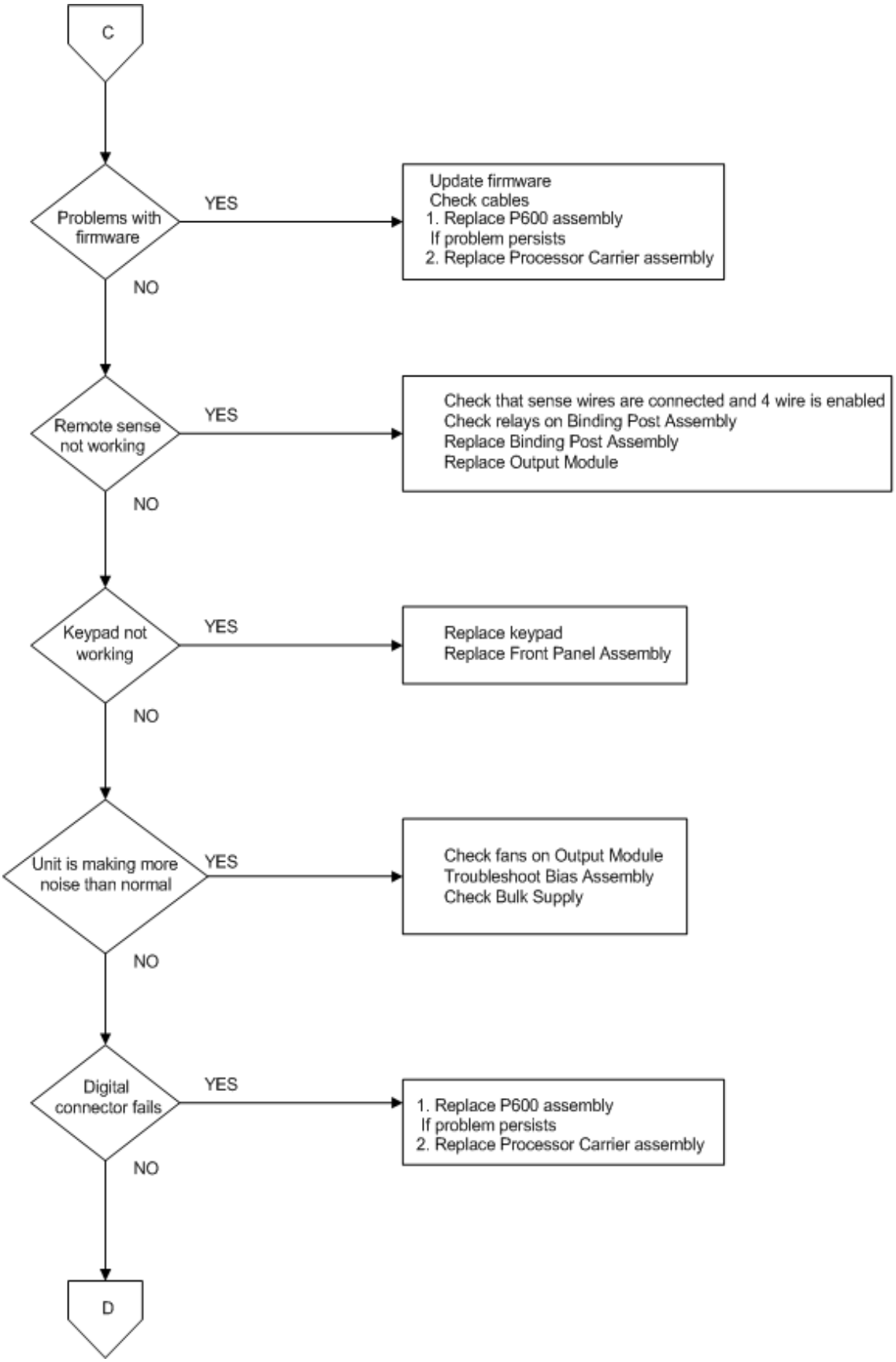
- Remove all external connections to the instrument.
- If the selftest indicates that a power module is defective, remove the module to see if selftest passes.
- Check that the mainframe has the latest firmware installed.
- Turn off the unit and cycle power to run selftest again.

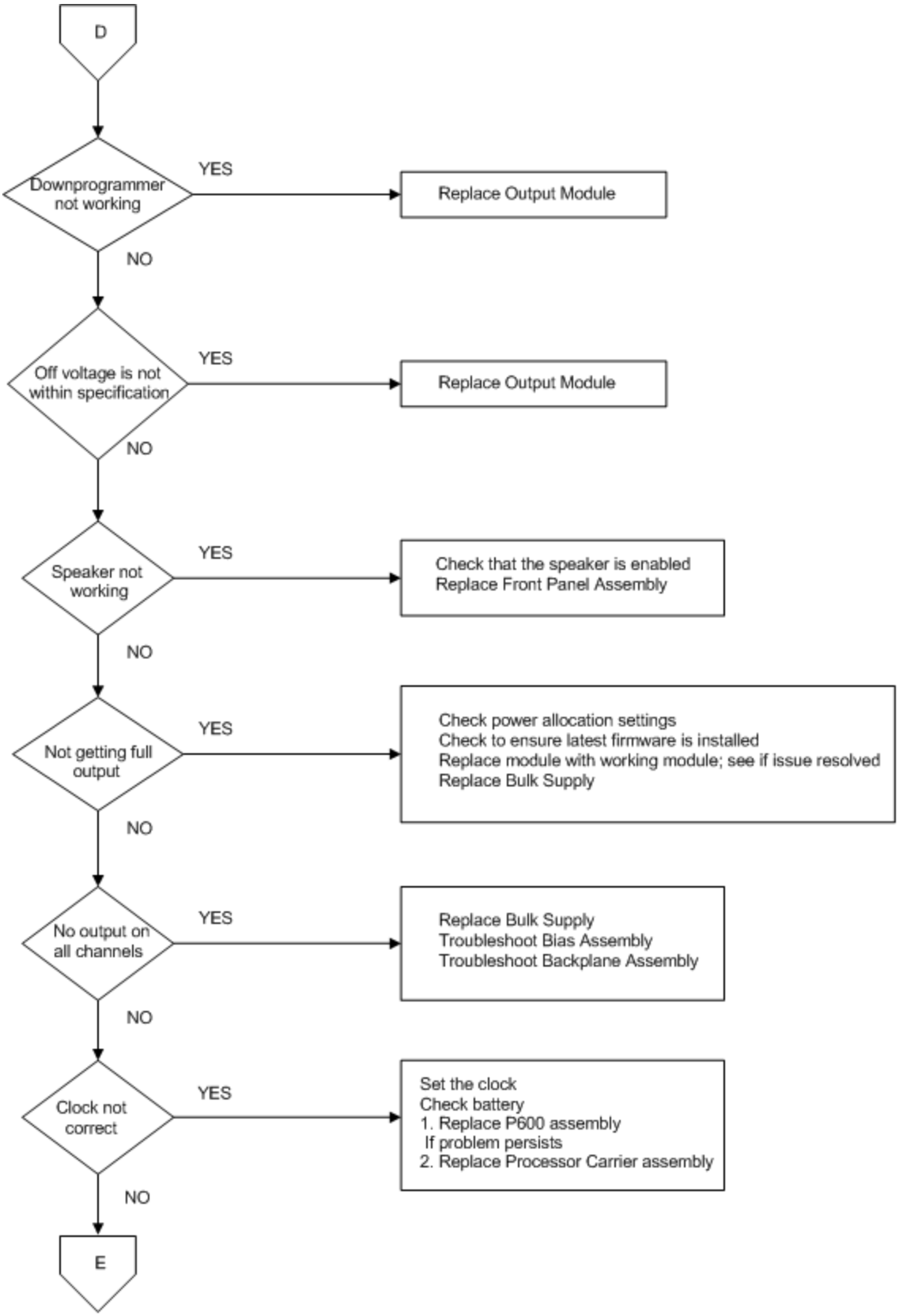
If the supply passes selftest and there are no obvious faults, perform the Verification Procedures to determine if any functions are not calibrated, or are not operating properly.

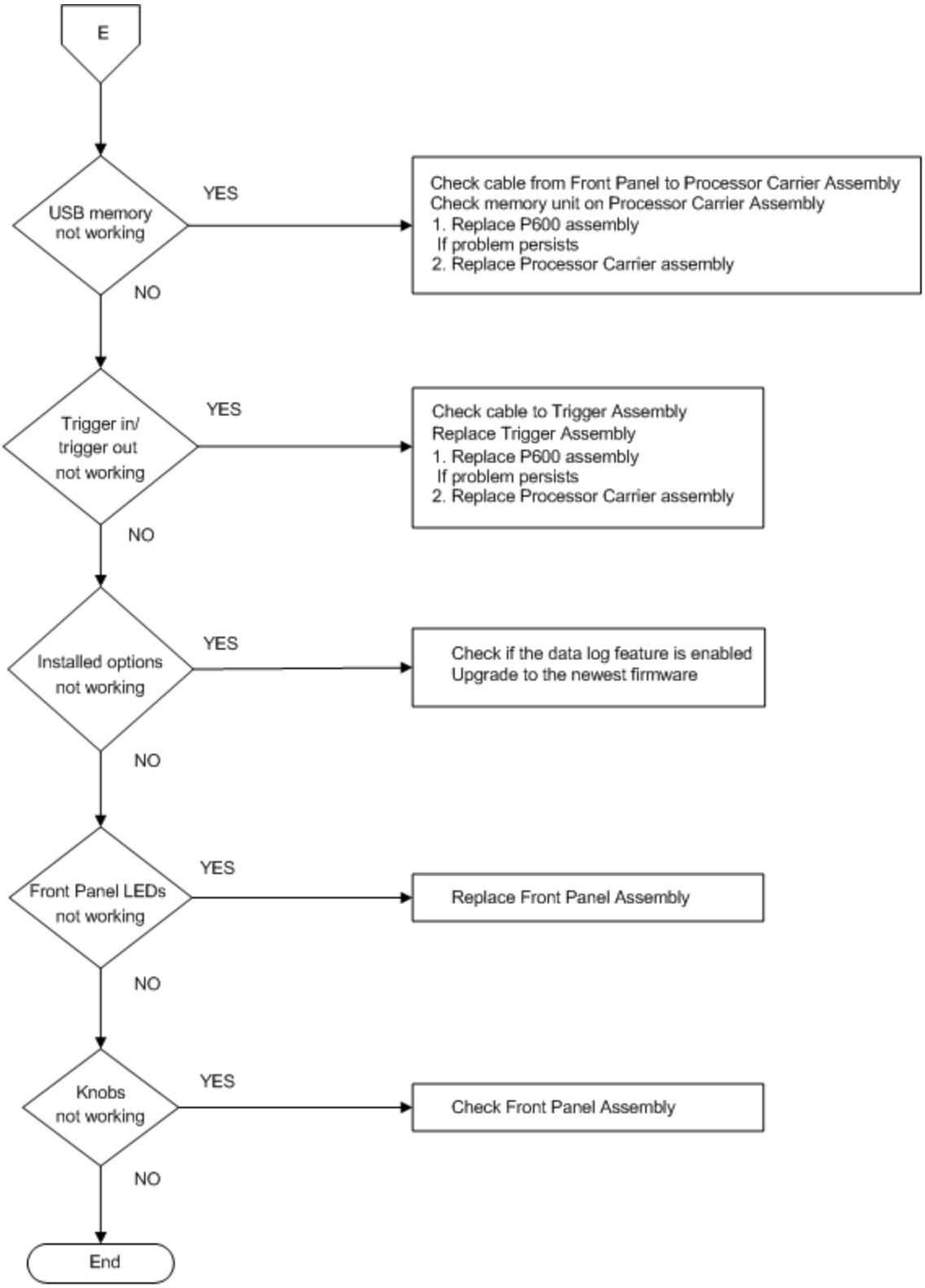
Overall Troubleshooting




B
Specification failure
YES
Calibrate Output Module
Replace the Output Module
NO
Selftest failure
YES
Calibrate Output Module
Replace Output Module
NO
Module is unregulated
YES
Calibrate Output Module
Replace Output Module
NO
Protection is falsely tripping
YES
Check to ensure that protection condition is not present
Replace Output Module
NO
Cannot calibrate one output
YES
Update firmware
Check calibration switches on Trigger Assembly
Replace Output Module
NO
Cannot calibrate all modules
YES
Check jumpers on Trigger Assembly
Reset password using jumpers on Trigger Assembly
Update firmware
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
C


C
Problems with firmware
YES
Update firmware
Check cables
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
Remote sense not working
YES
Check that sense wires are connected and 4 wire is enabled
Check relays on Binding Post Assembly
Replace Binding Post Assembly
Replace Output Module
NO
Keypad not working
YES
Replace keypad
Replace Front Panel Assembly
NO
Unit is making more noise than normal
YES
Check fans on Output Module
Troubleshoot Bias Assembly
Check Bulk Supply
NO
Digital connector fails
YES
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
D


D
Downprogrammer not working
YES
Replace Output Module
NO
Off voltage is not within specification
YES
Replace Output Module
NO
Speaker not working
YES
Check that the speaker is enabled
Replace Front Panel Assembly
NO
Not getting full output
YES
Check power allocation settings
Check to ensure latest firmware is installed
Replace module with working module; see if issue resolved
Replace Bulk Supply
NO
No output on all channels
YES
Replace Bulk Supply
Troubleshoot Bias Assembly
Troubleshoot Backplane Assembly
NO
Clock not correct
YES
Set the clock
Check battery
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
E

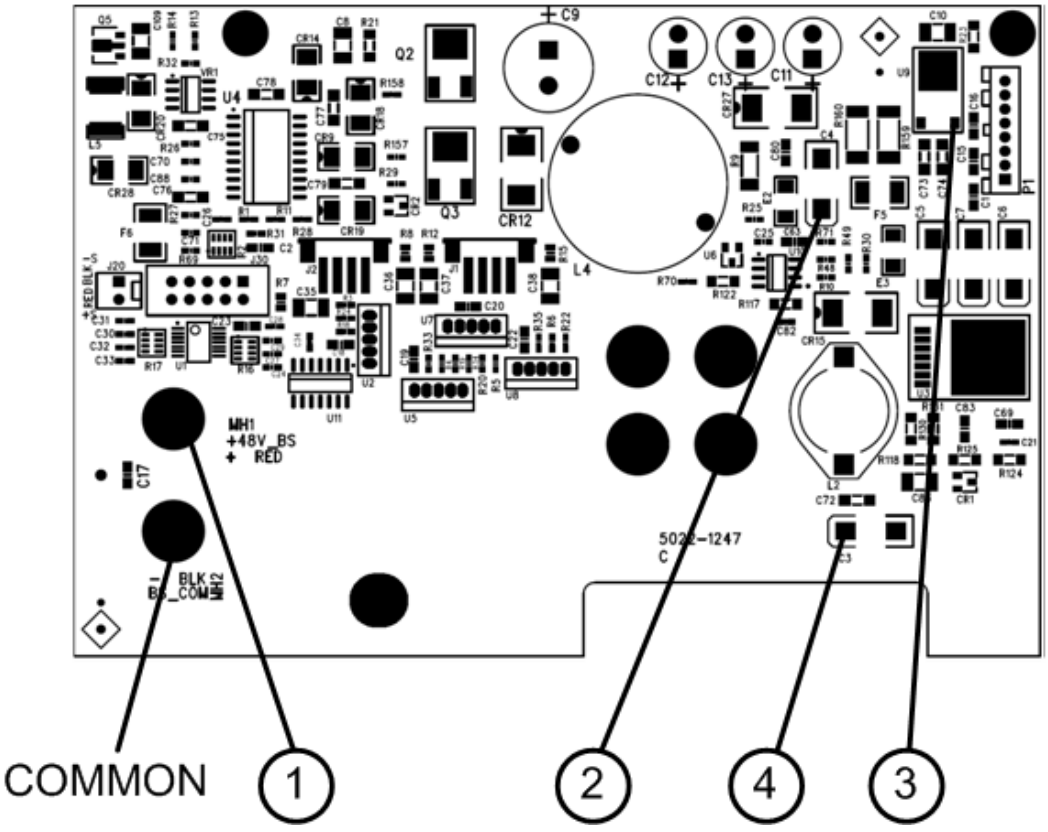

E
USB memory not working
YES
Check cable from Front Panel to Processor Carrier Assembly
Check memory unit on Processor Carrier Assembly
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
Trigger in/ trigger out not working
YES
Check cable to Trigger Assembly
Replace Trigger Assembly
1. Replace P600 assembly
If problem persists
2. Replace Processor Carrier assembly
NO
Installed options not working
YES
Check if the data log feature is enabled
Upgrade to the newest firmware
NO
Front Panel LEDs not working
YES
Replace Front Panel Assembly
NO
Knobs not working
YES
Check Front Panel Assembly
NO
End

Bias Board Troubleshooting

Troubleshooting the bias board involves checking for the presence of the correct bias voltages on the board. Refer to the following table and figures.

Note that if the bias voltages at test points 2 - 4 in the following table are not present, it could be caused by a defect in the power module or interface board that is pulling the bias voltage low.

Test Point	Location	Voltage	Description
TP 1	+ RED	+ 48 V	Output of bulk supply. If not present, replace the bulk supply.
TP 2	+ C4	+ 12 V	If biases at TP 2, TP 3, or TP 4 are not present, disconnect the backplane and interface board cable assemblies and recheck. If biases are still not present, replace the bias board.
TP 3	U9 - 2	+ 5 V	Same as above.
TP 4	+ C3	+ 3.3 V	Same as above.
Common	– BLK	common	



Backplane Board Troubleshooting

Troubleshooting the backplane board consists of visually inspecting the pins and pin connections.

If there are missing or broken pins, replace the board.

If there are bent pins, carefully try to straighten the pin. If you are unsuccessful, replace the board.

Closely examine the solder connections at the pins. If there are cracks in the solder, carefully re-solder the connector. If unsuccessful, replace the board.

Calibration and Passwords

Calibration is not required after the mainframe has been repaired. All calibration information is module-specific and resides in each power module.

However, if the A5 board that contains the calibration switches has been replaced, any calibration password that has been set will be lost. Passwords that are used to prevent access to the front panel Admin menu will also be lost.

The calibration password will automatically be reset to the factory default, which is zero (0). Front panel access to the Admin menu will be unrestricted unless a password is set.

Refer to Password Protection for information on setting the calibration password as well as the Admin menu password.

Replaceable Parts

Parts List

Location Diagrams

Parts List

The following table lists the available replaceable parts. The location diagrams below the table show the location of these parts.

Reference Designator	N6705C Part number	Description
		Electrical Assemblies
A1	N6705-66501 N6705-66511	Processor carrier PCA Processor carrier without USB connector - Option AKY
A2	5067-5202	Bias PCA
A3	5067-5096	Front panel PCA
A4	5067-5094 5067-6629	Standard binding post PCA Option RBP binding post PCA
A5	0950-5355	Bulk supply (1200W single-output)
A6	Contact Keysight Service and Support	P600 processor (installs on Processor Carrier board)
		Individual Parts
1	5003-2223	Side cover (qty 2)
2	5003-2222	Bottom cover
3	5003-2221	Top cover
4	5040-1741	Window
5	5043-1310	Keypad
6	5043-1305	12 mm knob (qty 5)
7	5043-1306	18 mm knob (qty 2)
8	5067-6094 1254-2328	Standard red biding post (qty 8) Recessed red biding post - Option RBP (qty 8)
9	5067-6095 1254-2330	Standard black binding post (qty 8) Recessed black binding post - Option RBP (qty 8)
10	3101-4076	AC switch

Reference Designator	N6705C Part number	Description
11	54810-03702	Tilt stand
12	5043-1309	Foot assembly (qty 4)
13	5003-2353	Rear panel
14	5002-2852	Sub panel
15	1253-7050	AC plug
16	5002-2850	Chassis top
17	5002-2857	Deflector (qty 4)
18	5040-1742	Insulator backplane (qty 2)
19	5067-5100	Backplane 1 PCA (top)
20	5067-5201	Backplane 2 PCA (bottom)
21	5067-4312	Fan assembly
22	5003-2352	Bulk supply cover
23	5040-1744	Top AC filter cover
24	5185-8830	AC filter cover
25	5002-2849	Chassis bottom
26	N6705-66502	BNC trigger PCA
27	5067-2562	Inverter PCA and bracket assembly
28	2090-1096	Display
29	5043-1304 N6705-60011	Standard front frame Option RPB front frame
30	0510-1350	Push-on retainer
		Cables
31	5185-8809	AC in to filter cable
32	E5810-61605	GPIB connector and Cable
33	5185-8811	48 V rail to backplane 1 & 2 cable
34	5185-8812	Sense cable
35	5185-8813	Bias to Processor carrier cable
36	5185-8819 (2)	Processor carrier to backplane 1; Processor carrier to backplane 2
37	5185-8821	Display to front panel cable
38	5185-8810	Bulk supply to line switch cable
39	5185-8823	Processor carrier to front panel cable

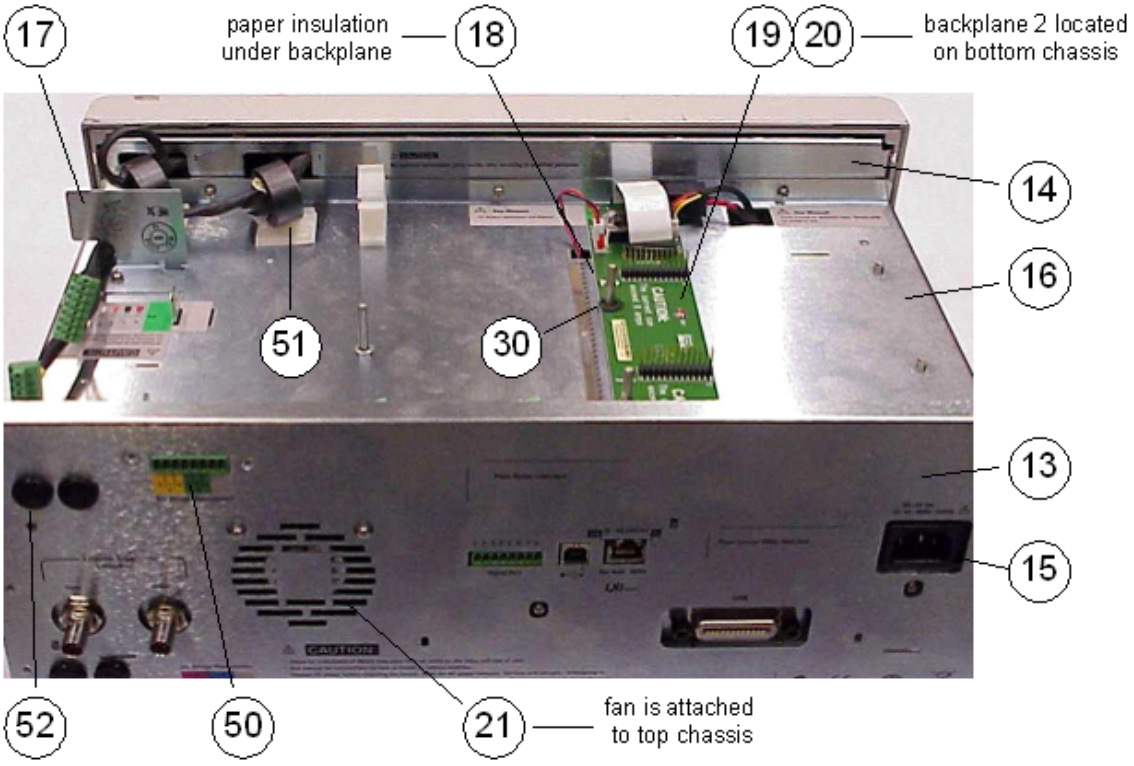
Reference Designator	N6705C Part number	Description
40	N1912-61002	Backlight cable assembly
41	5185-8824	Bulk supply ground wire
47	5067-4311 (2)	Bias to backplane 1; Bias to backplane 2
48	5185-8825	Filter to line switch cable
49	D8104-61602	Front panel USB cable
50	5067-5095 (2)	Auxiliary voltage PCA
51	9170-2264 (4)	Front panel cable inductor
52	0510-1350 (4)	Rear panel cable grommet
53	1510-0038	Ground binding post
54	5188-4226	AC filter module (with 1M ohm resistor)
55	5003-1139	Heat spreader for P600 processor
		Handle parts and label
	5041- 7902	End cap
	E6601-21033	Round handle retainer
	5063-1581	Strap handle with insert
	N6705-80011	Rear mainframe label

Part Location Diagrams

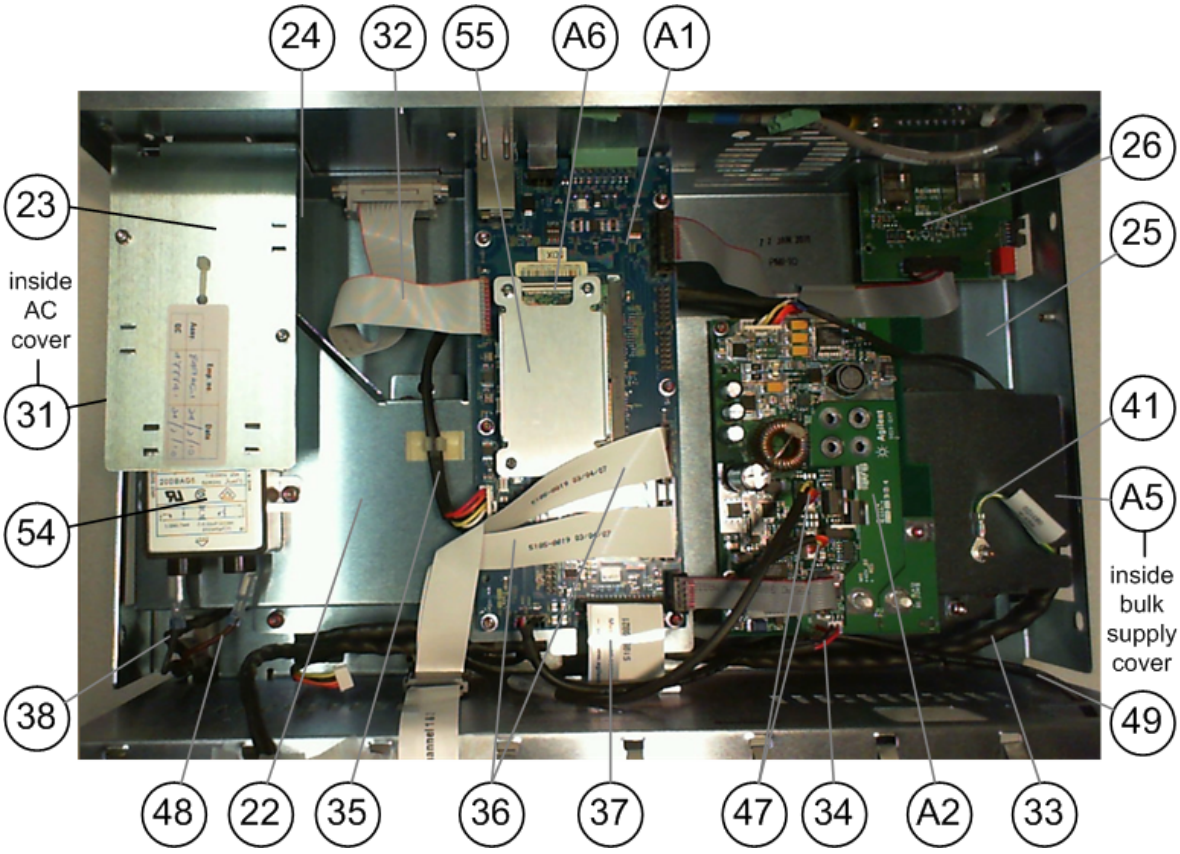
Front and Side Parts



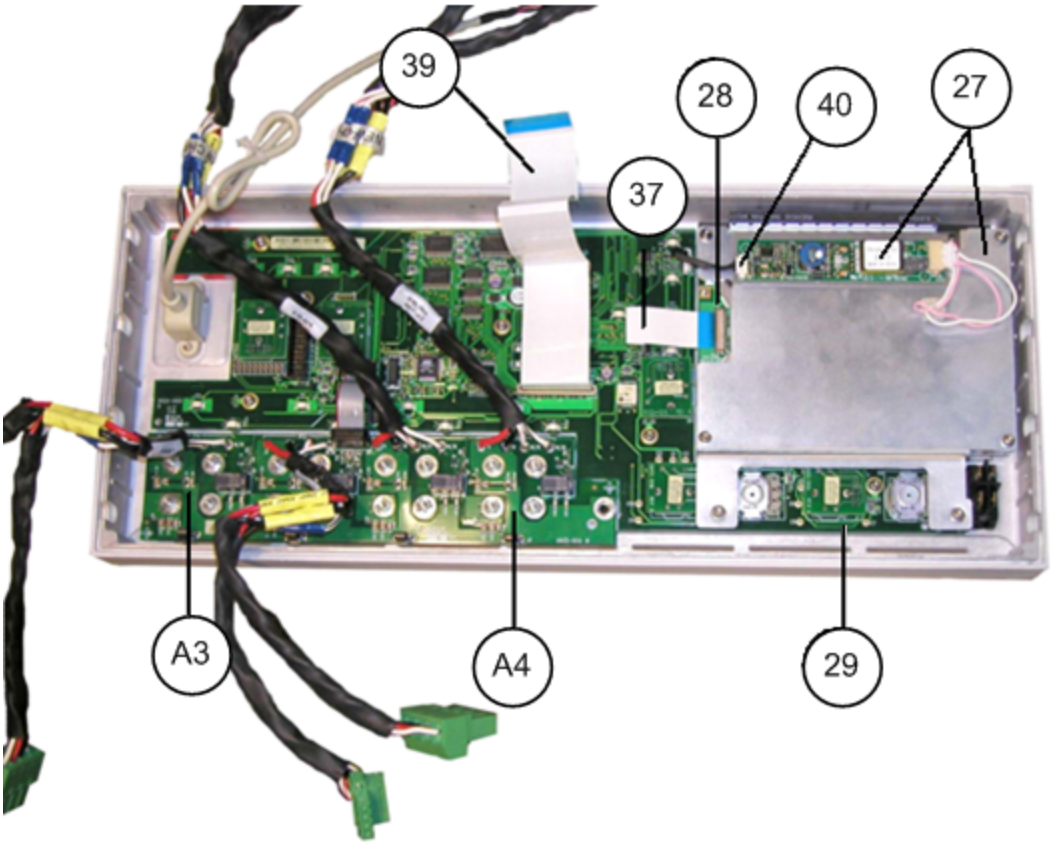
Back and Top Chassis Parts



Mezzanine Parts



Front Panel Parts



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*ESR? 314

*IDN? 315

*OPC 315

*OPT? 315

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*RST 316

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*SRE 317

*STB? 317

*TRG 318

*TST? 318

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