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Tektronix®

Series 2280S Precision Measurement, Low Noise, Programmable DC Power Supplies

DATASHEET



Key Features

- Monitor load currents from 100 nA to 6 A with high accuracy
- Measure voltage and current with 6½-digit resolution
- Capture dynamic load currents as short as 140 µs
- Output up to 192 W of low noise, linear regulated power
- Programmable rise and fall times eliminate voltage overshoot and undershoot transients
- Built-in graphing simplifies analyzing trends or displaying voltage or current waveforms
- High resolution TFT display and soft-key/icon-based user interface simplify power supply operation
- Programmable output sequences reduce test times
- Sink up to 0.45 A to discharge voltage quickly
- Digital I/O for direct communication with other devices and instruments
- GPIB, USB, and LAN interfaces
- Automate tests easily with KickStart start-up software

The Series 2280S Precision Measurement, Low Noise, Programmable DC Power Supplies are much more than just sources of clean power; they are also precision measurement instruments. They can source stable, low noise voltages as well as monitor load currents over a wide dynamic range from amps to nanoamps. The 2280S-32-6 can output up to 32 V at up to 6 A; the 2280S-60-3 can output up to 60 V at up to 3.2 A.

Both supplies use linear regulation to ensure low output noise and superior load current measurement sensitivity. A high resolution color Thin Film Transistor (TFT) screen displays a wide range of information on measurements. Soft-key buttons and a navigation wheel combine with the TFT display to provide an easy-to-navigate user interface that speeds instrument setup and operation. In addition, built-in plotting functions allow monitoring trends such as drift. These supplies provide the flexibility required for both benchtop and automated test system applications. For example, they provide a list mode, triggers, and other speed optimization functions to minimize test time in automated testing applications.

DMM-Quality Low Current Measurements with High Resolution

Unlike conventional power supplies, Series 2280S supplies can also make measurements with up to 6½ digits of resolution. Voltage output measurements can be resolved down to 100 µV. These supplies measure load currents from 100 nA to amps and can resolve down to 10 nA. Four load current measurement ranges (10 A, 1 A, 100 mA, and 10 mA) support measuring a device's full load current, standby mode current, and small sleep mode currents with DMM-quality accuracy. The high resolution allows characterizing small changes in load currents with confidence. It also makes it possible to make a broad range of measurements on a single range with excellent accuracy across both low and high current values.

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Measure Rapidly Changing Loads

To monitor fast-changing and pulse-like load currents properly, Series 2280S supplies offer the speed necessary to capture load changes that occur at intervals as short as 140 µs. This capability allows designers and manufacturers of portable, battery-operated devices to monitor load currents easily in all of a device's operating modes so they can determine the device's total power consumption.

This high speed measurement capability allows measuring each state of a power-up load sequence and a power-down sequence. Measurements can be made as fast as 2500 readings per second, making it possible to characterize and test the current draw at each of the start-up states.

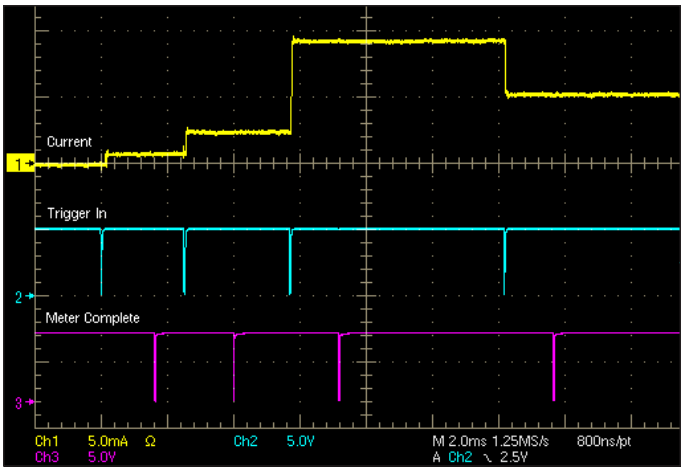


Figure 2. Measure the start-up load currents as a device powers up.

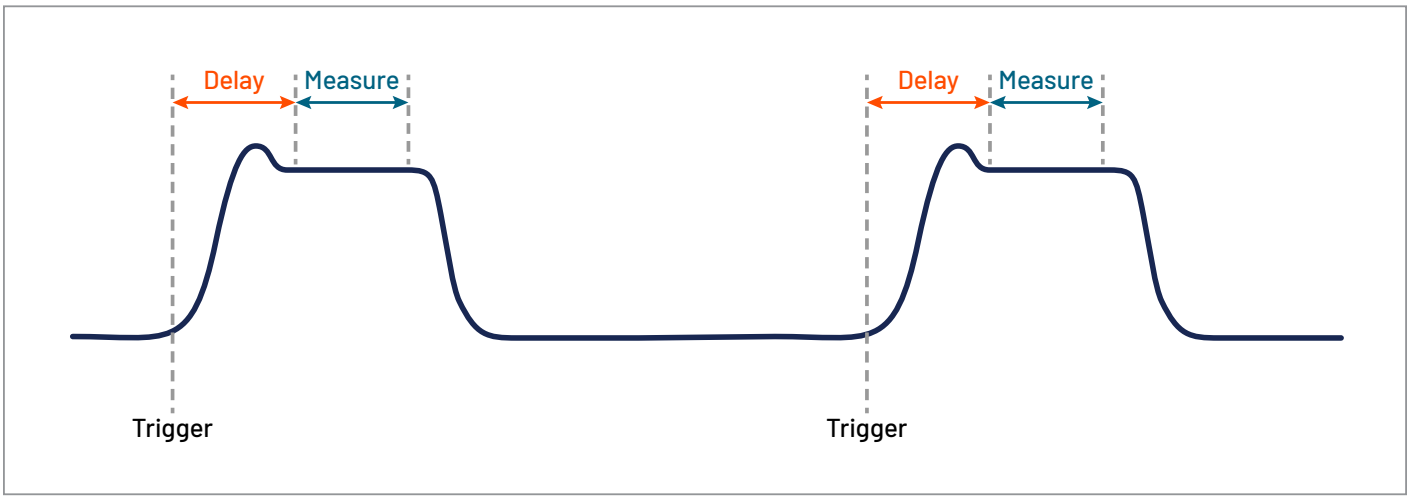


Figure 1. Make time-critical measurements on fast-changing or pulse-like loads. An external trigger initiates the acquisition. Programmable delay and measure times enable measurements at a specific time on the load current pulse. In addition to the digital trigger, a level threshold setting can be used to store up to 2500 measurements at a programmed reading rate.

View and Control Every Parameter of the Supply for Maximum Performance

The bright, 4.3-inch TFT display shows voltage and current readings, the source settings and many additional settings in large, easy-to-read characters. The icon-based main menu provides all the functions users can control and program for fast access to source setup, measurement setup, display formats, trigger options, and system settings. Menus are short, and the menu options you need are easy to find and clearly described, so that you can set up test parameters quickly by using the navigation wheel, keypad, or soft-keys. Many set-up parameters, such as for voltage and current settings, can be entered directly from the home screen; less complex tests don't even require accessing the main menu to make adjustments. Whether your test's requirements are uncomplicated or complex, the Series 2280S supplies provide a simple way to set up all the required parameters.



Figure 3. Adjust voltage, current, the current range, the measurement mode, protection levels, and other functions from the home screen.

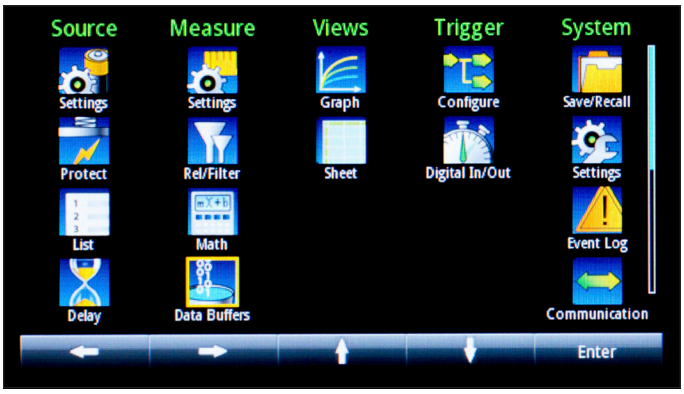


Figure 4. Access the full functionality of the Series 2280S supplies from the main menu.

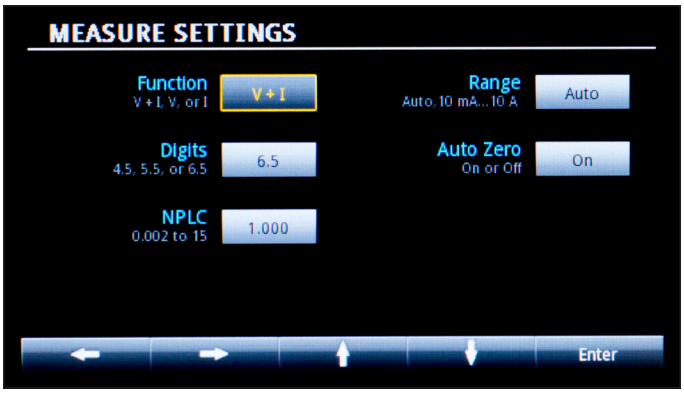


Figure 5. Configure the readback measurements exactly the way you need them using a Measure Sub-screen.

Controlled Rise and Fall Times Protect Devices Under Test

Are you working on a device or a system with a high in-rush current? Series 2280S supplies allow programming the voltage output's rise time to slow the voltage ramp and avoid voltage overshoot, which could potentially damage the DUT. The voltage fall time can also be controlled to prevent a fast ramp down of the output voltage. Voltage rise and fall times can be set as slow as 10 V/s or as fast as 100 V/s. Small voltage transitions can be programmed to rise and fall as fast as 1000 V/s.

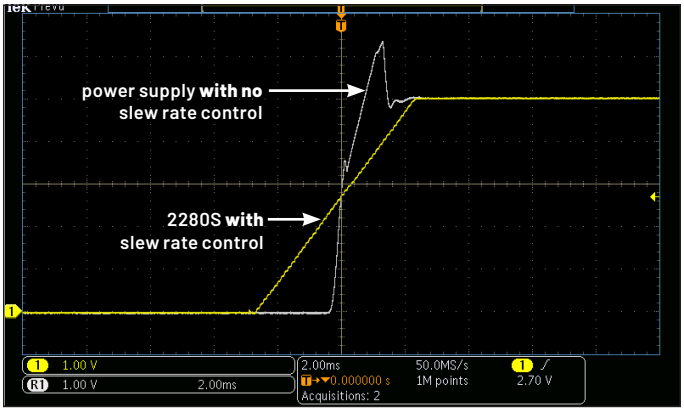


Figure 6. Programmable slew rates permit controlling voltage rise and fall rates, preventing undesirable transients during power up of capacitive loads.

Perform Semi-Automated Testing Right on Your Bench

Test your design over its operating voltage range automatically or study how it responds to DC output changes by using the Series 2280S supplies' built-in List Mode function. Create and save up to 10 lists of sequenced voltage levels with up to 99 distinct voltages in each list. The duration of each voltage level can be set as short as 1 ms or as long as 60 s. Create simple linear ramps or any custom configuration from either the front panel or an interface bus. A single trigger will automatically execute the list once or multiple times.

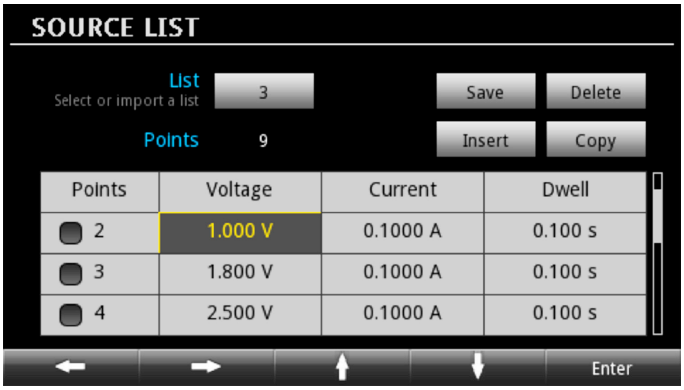


Figure 7A. Create an output sequence using the List setup screen.

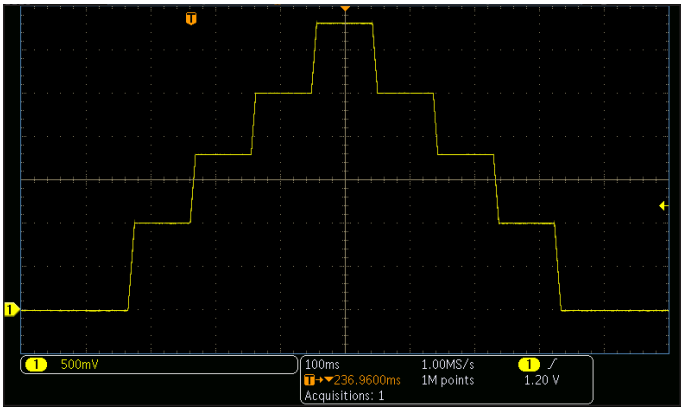


Figure 7B. Use the list mode to step the output voltage automatically through a series of levels. The voltages were created by the list shown in Fig. 7A.

Trend Analysis and Load Current Characterization

Use the built-in graphing function to monitor the stability of the load current or capture and display a dynamic load current. Or, use it to view a start-up or turn-off load current. Series 2280S supplies can take measurements quickly and store up to 2,500 measurement points. In addition to displaying a voltage or current waveform or both, they can compute statistics on the stored data. Statistical calculation options include average, maximum, minimum, peak-peak, and standard deviation. All the information you need is accessible through a few display menus.

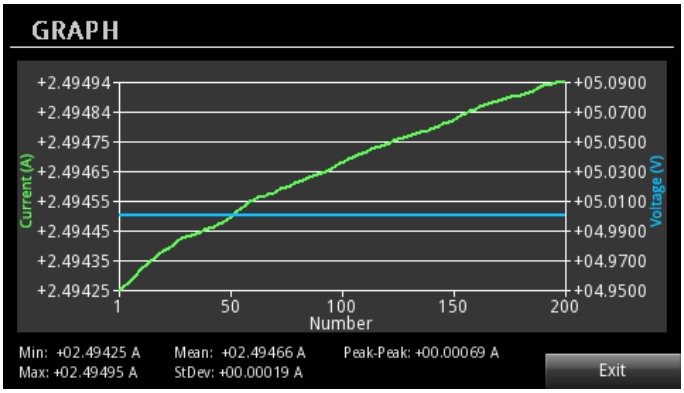


Figure 8. Monitor voltage, current, or both with the graphing function.

Automate a test quickly and easily with KickStart software

Set up an automated test for the Series 2280S supplies in four simple steps with the KickStart start-up software. Once the program is open, perform these steps: create a test file, select the 2280S power supply, select the power supply application, and enter the test parameters. Run the test, and get results without having to write a line of code. KickStart provides both graph and spreadsheet displays. Data is saved to the test file, and the data can be exported to data analysis programs. Or take a screen shot of the plot for reproduction in test reports. Up to 15,000 data points can be stored. KickStart may be all the software you ever need.

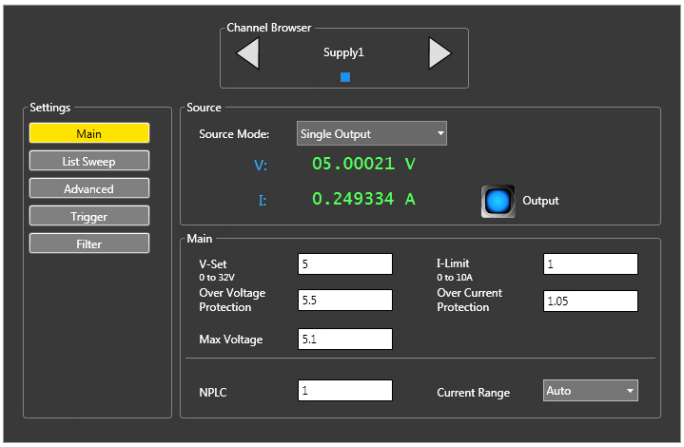


Figure 9. KickStart DC power main screen.

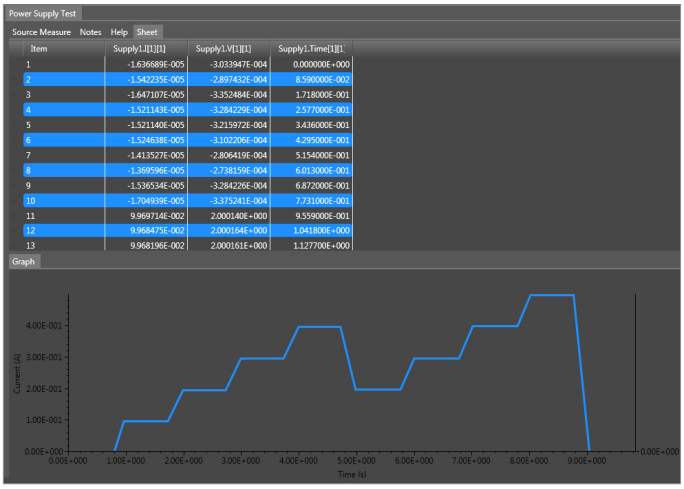


Figure 10. KickStart plot with measurement table.

Optimized Performance for Production Test

Series 2280S supplies are as powerful in a production test system as they are flexible on the R&D benchtop. In addition to their List Mode function, several other Series 2280S features help minimize test time in automated systems. For example, an external trigger input allows hardware synchronization and control by other instruments in the test system. To eliminate many system delays, Series 2280S supplies produce a "measurement complete output" to signal the test system when the supplies have completed their required actions. To reduce measurement time, the reading speed can be increased by reducing the acquisition time from power line cycle integration times, 16 ms at 60 Hz (20 ms at 50 Hz), to 33 µs (40 µs). Furthermore, the Series 2280S supplies can sink up to 0.45 A. Thus, these supplies can quickly discharge a voltage level and change to a different voltage.

A choice of front or rear panel terminals provides enhanced connection flexibility. For maximum voltage accuracy, 4-wire remote sensing ensures that the output voltage programmed is actually the level applied to the load. In addition, the sense lines are monitored in order to detect any breaks in them. These features ensure any production problems can be quickly identified and corrected. Four additional digital I/O pins can provide fault status outputs or control an external relay or status lamp. Series 2280S supplies can be controlled via their built-in GPIB, USB, or LAN interfaces. The USB interface is test and measurement system (TMC) compliant.

To facilitate production test software development, native National Instruments LabVIEW™ drivers, IVI-C and IVI-COM drivers are available at tek.com.



Figure 11. Series 2280S rear panel showing the rear output connector with remote sense inputs, digital I/O, and the three interfaces (GPIB, USB, and LAN).

Specifications

18°C to 28°C with 1-hour instrument warm-up.

DC Output Ratings

	2280S-32-6	2280S-60-3
Voltage	0 to 32 V	0 to 60 V
Current	0 to 6 A	0 to 3.2 A
Maximum Power	192 W	192 W

Voltage[1]

Source Setting

	2280S-32-6	2280S-60-3
Accuracy	±(0.02% + 3 mV)	±(0.02% + 6 mV)
Resolution	1 mV	1 mV

Measurement[2] (0.5 V overrange)

	2280S-32-6	2280S-60-3
Accuracy	±(0.02% + 2 mV)	±(0.02% + 4 mV)
Resolution	0.1 mV	0.1 mV

Additional Offset at Faster Measurement Settings

	2280S-32-6	2280S-60-3
5½ (0.1 PLC)	0.21 mV	0.40 mV
4½ (0.01 PLC)	1.44 mV	2.7 mV
3½ (0.002 PLC)	7.60 mV	14.25 mV

Regulation

	2280S-32-6	2280S-60-3
Load	±(0.01% + 2 mV)	±(0.01% + 2 mV)
Line	±(0.01% + 1 mV)	±(0.01% + 1 mV)

Output Ripple and Noise

	2280S-32-6	2280S-60-3
Bandwidth 20 Hz–20 MHz	< 1 mV_{RMS}	< 2 mV_{RMS}
	< 5 mV p-p	< 7 mV p-p

Load Transient Recovery Time **Resistive load change 50% load to 100% load or 100% load to 50% load:** <50 µs to within 15 mV of V-set.

Slew Rate: Rising Voltage and Falling Voltage
10 V/s to 100 V/s. Up to 1000 V/s under limited conditions[3]. 100 V/s (default).

Maximum Source Voltage Drop per Lead
To maintain specified voltage accuracy: 1 V.

Maximum Sense HI and Sense LO Lead Resistance
To maintain specified voltage accuracy: 2 Ω.

1 Specifications based on using remote sense connections. For 2-wire connections, add an offset of 0.5 mV/A (Front terminals).

2 6½-digit resolution, 1 PLC reading rate, filter on, autozero on.

3 100 V/s to 1000 V/s rise and fall slew rates:
2280S-32-6: limited to 5 V changes at a maximum of 3 A; between 0 V to 5 V, the load current can be up to full load, 6 A
2280S-60-3: limited to 10 V changes at a maximum of 2 A; between 0 V and 10 V, the load current can be up to full load, 3.2 A.

Current

Current Limit Setting

	2280S-32-6	2280S-60-3
Full-scale Amps	6 A	3.2 A
Accuracy	±(0.05% + 5 mA)	±(0.05% + 5 mA)
Resolution	0.1 mA	0.1 mA

Measurement[4] (120% over-range except 10 A)

Range	Resolution	2280S-32-6	2280S-60-3
10 mA	10 nA	±(0.05% + 10 µA)	±(0.05% + 10 µA)
100 mA	100 nA	±(0.05% + 10 µA)	±(0.05% + 10 µA)
1 A	1 µA	±(0.05% + 250 µA)	±(0.05% + 250 µA)
10 A	10 µA	±(0.05% + 250 µA)	±(0.05% + 250 µA)

Additional Offset at Faster Measurement Settings[5]

Measure Resolution and (NPLC)	Range	2280S-32-6	2280S-60-3
5½ (0.1 PLC)	10 mA	5.0 µA	5.0 µA
	100 mA	20 µA	20 µA
	1 A	80 µA	80 µA
	10 A	2.0 mA	2.0 mA
4½ (0.01 PLC)	10 mA	20 µA	20 µA
	100 mA	40 µA	40 µA
	1 A	500 µA	500 µA
	10 A	10 mA	10 mA
3½ (0.002 PLC)	10 mA	30 µA	30 µA
	100 mA	250 µA	250 µA
	1 A	25 mA	25 mA
	10 A	75 mA	75 mA

Current Pulse Measurement[6]

	2280S-32-6	2280S-60-3
Minimum Pulse Width (10 mA and 100 mA range)[7]	2.1 ms	2.1 ms
Minimum Pulse Width (1 A and 10 A range)[7]	140 µs	140 µs
Minimum time to capture two consecutive pulses	0.5 ms	0.5 ms

Regulation

	2280S-32-6	2280S-60-3
Load	±(0.01% + 0.25 mA)	±(0.01% + 0.25 mA)
Line	±(0.01% ± 0.25 mA)	±(0.01% ± 0.25 mA)

4 6½-digit resolution, 1 PLC integration time, Autozero on, Filter on. 10 mA and 100 mA ranges: Source Delay 2 ms. 1 A and 10 A ranges: Source Delay 1 ms.

5 Filter on, 10 mA and 100 mA ranges: Source Delay 2 ms. 1 A and 10 A ranges: Source Delay 1 ms.

6 Settings: Autozero off, 0.002 PLC, Arm Source: External, Trigger Source Immediate, Filter off. 10 mA and 100 mA ranges: Source Delay 2 ms. 1 A and 10 A ranges: Source Delay 0 ms or off.

7 Time includes trigger detection, jitter, and 0.002 PLC integration time.

Output Ripple and Noise

	2280S-32-6	2280S-60-3
Bandwidth 20 Hz–20 MHz	<3 mA RMS	<3 mA RMS

Maximum Continuous Average Sink Current

	2280S-32-6	2280S-60-3
Non-programmable	0.45 A ±15%	0.45 A ±15%

System Measurement Speeds

Readings/s	Settings	Concurrent (V + I)		Current or Voltage (I or V)	
	Measure Resolution and (NPLC)	Autozero On 60 Hz (50 Hz)	Autozero OFF 60 Hz (50 Hz)	Autozero On 60 Hz (50 Hz)	Autozero OFF 60 Hz (50 Hz)
'Read?' with BUS Transfer	6½ (5 PLC)	2.0 (1.5)	5.4 (4.5)	2.5 (2.3)	9.0 (8.5)
	6½ (1 PLC)	9.0 (8.0)	20 (18)	11.5 (9.5)	30.0 (28)
	5½ (0.1 PLC)	48 (38)	50 (48)	50.0 (48.0)	95.0 (85.0)
'*TRG' into Memory	4½ (0.01 PLC)[8]	440 (430)		1915 (1820)	
	3½ (0.002 PLC)[8]	510 (510)		2668 (2650)	

Protection

Overvoltage Protection (OVP)	2280S-32-6	2280S-60-3
Setting Accuracy	±(0.25% + 0.25 V)	±(0.25% + 0.5 V)
Resolution	125 mV	250 mV
Response Time	6 ms (typical)[9]	6 ms (typical)[9]
Overcurrent Protection (OCP)	2280S-32-6	2280S-60-3
Setting Accuracy	±(0.25% + 0.10 A)	±(0.25% + 0.10 A)
Resolution	25 mA	12.5 mA
Response Time	6 ms (typical)[9]	6 ms (typical)[9]
Overtemperature Protection (OTP)	2280S-32-6	2280S-60-3
Output Turn-off Temperature	>93 °C (typical)	>93 °C (typical)
Response Time	6 ms (typical)[9]	6 ms (typical)[9]

Other Timing Data

CV to CC Transition Time	**V-Set = 5 V, I-limit = 0.5 A, Resistive Load change 25 Ω to 2.5 Ω:** 2.4 ms.
CC to CV Transition Time	**V-Set = 5 V, I-limit = 0.5 A, Resistive Load change 2.5 Ω to 25 Ω:** 1.1 ms.
Function Change	**From detection of bus command to function change completed:** 10 ms (typical).
Output Off/On	**From detection of bus command to voltage beginning to decrease:** 5 ms (typical).
Reverse Leads Actuation	6 ms (typical)[9].

8 Settings: Autozero off, Output Delay off, Source Delay off, voltage output is constant, Measure Count 1000.

9 Time defined as from detection of condition to start of output turn-off.

General

Common Mode Current	< 6 µA peak-peak.
Chassis Isolation	±240 V, any terminal to chassis. >1 GΩ in parallel with <6.8 nF.
Temperature Coefficient	Add the following to all accuracy specifications when outside the range, 18°C to 28°C: (0.15 × specification)/°C for 0 ° to 18 °C and 28 ° to 40 °C.
Measurement Display Modes	Voltage and current, voltage only, current only.
Measurement Acquisition Control	Continuous, Manual, External digital input, PC bus.
List Mode	**Maximum number of stored lists:** 9. **Number of points in a list:** 2–99. **List Storage Location:** Internal memory or USB memory stick.
Math and Filter Functions	
REL	Removes offset from current reading display, Range: -1×10^6 to $+1\times10^6$.
Mx+b	Reading = x, M = -1×10^6 to $+1\times10^6$, b = -1×10^6 to $+1\times10^6$.
Filter	Moving average, Count 2–100, Window 0.01% to 100%.
Memory Buffer	2500 locations; each location contains voltage measurement, current measurement, CV/CC Mode, and time stamp, NVRAM.
Display	4.3 in. front-panel color display, resolution 480 pixels × 272 pixels. Soft button and navigation wheel control.
Display Modes	Real time voltage and current readings and settings. Plots of stored data: voltage vs. data point, current vs. data point, voltage and current vs. data point, 100 point resolution. Plots can also display statistics: mean, maximum, minimum, peak-peak, standard deviation. Table of stored data: time/date, voltage, current.
Communications	
GPIB	IEEE-488.2 compliant and status model topology.
LAN	RJ-45 connector, 10/100BT, Auto MDIX.
IP Configuration	Static or DHCP. LXI Core 2011, version 1.4.
USB	USB 2.0 device (rear panel, type B), USBTMC compliant. USB 2.0 host (front panel, type A), full speed, support USB flash drives.
Input Connections	**Front:** (2-wire). Adjustable supporting, safety shrouded banana, spade lug, or wire. **Rear:** (4-wire sense). 6-pin removal screw terminal, safety shrouded cover, removable local sense jumpers.
Real-Time Clock	Capacitive charged, 20 days between next power on cycle at 23 °C and ≤50%RH.

Digital I/O	9-pin female D-sub. 6 Input/Output pins.
Input Signal Levels	0.7 V (maximum logic low), 3.7 V (minimum logic high).
Input Voltage Limits	–0.25 V (Absolute minimum). +5.25 V (Absolute maximum).
Maximum Source Current	+2.0 mA@ >2.7 V (per pin).
Maximum Sink Current	–50 mA @ 0.7 V (per pin, solid-state fuse protected).
5 V power supply, limited to 0.5 A @ >4 V (solid-state fuse protected).	
Trig In minimum pulse ≥4 µs, Logic Low pulse.	
Meter Ready Pulse, 15–30 µs, Logic Low Pulse.	
EMC	Conforms to European Union EMC directive.
Safety	**U.S. NRTL Listing:** UL61010-1 3rd ed 2012 and UL61010-2-030:2012. **Canadian Certification:** CAN/CSA C22.2 No. 61010-1 3rd ed 2012. **European Union Compliance:** Low Voltage Directive .
Cooling	Forced air, side intake and rear exhaust.
Power Supply	100 V / 120 V / 220 V / 240 V ±10%.
Power Line Frequency	50/60 Hz ±3 Hz, automatically sensed at power-on.
Power Consumption	630 VA peak.
Operating Environment	For indoor, non-residential use only. 0 °C to 40 °C, ≤80% relative humidity up to 35 °C, non-condensing. Altitude: up to 2000 meters.
Storage Environment	–25 °C to 70 °C.
LXI Web Browser Compatible Operating System and Software	Windows 2000, Win 7 and XP compatible, supports Web browsers with Java plug-in (requires Java plug-in 1.7 or higher). Web page served by 2280S.
Rack Dimensions	**(W×H×D), without boot:** 213.8 mm × 88.4 mm × 383.3 mm (8.42 × 3.48 × 15.1 in.).
Bench Dimensions	**(W×H×D) with boot:** 255.3 mm × 107.2 mm × 415.0 mm (10.1 × 4.22 × 16.34 in.)
Shipping Weight	13.29 kg (29.3 lb).
Net Weight	10.85 kg (23.9 lb).
Warranty	3 years.

Ordering Information

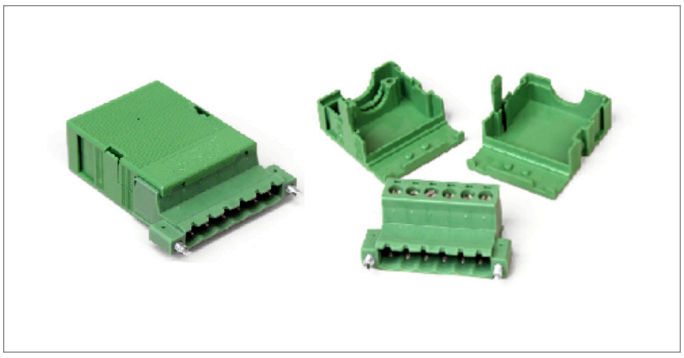
2280S-32-6	Precision Measurement DC Power Supply, 32 V, 6 A
2280S-60-3	Precision Measurement DC Power Supply, 60 V, 3.2 A

Supplied Accessories

Quick Start Guide
LAN Crossover Cable
Power Cord
Rear Panel Mating Connector with Cover

Available Accessories

2280-001	Rear Panel Mating Connector and Cover
174694600	LAN Crossover Cable, 3 m (9.8 ft)
4299-7	Universal Fixed Shelf Rack-Mount Kit
4299-8	Single Fixed Rack-Mount Kit
4299-9	Dual Fixed Rack-Mount Kit
KPCI-488LPA	IEEE-488.2 Interface Board for the PCI Bus
KUSB-488B	IEEE-488.2 USB-GPIB Interface Adapter for USB Port with 2 m (6.6 ft) cable
7007-1	Double Shielded Premium IEEE-488 Interface Cables, 1 m (3.2 ft)



2280-001: Rear Panel Mounting Connector and Cover (assembled view on the left, and connector and top and bottom cover shown separately on the right)

Available Services

2280S-32-6-EW	1 Additional Year of Factory Warranty (total of 4 years)
2280S-32-6-5Y-EW	2 additional years of factory warranty beyond the 3-Year factory warranty (total of 5 years)
C/2280S-32-6-3Y-STD	3 Calibrations Within 3 Years of Purchase
C/2280S-32-6-3Y-DATA	3 (ANSI-Z540-1 compliant) Calibrations Within 3 Years of Purchase
C/2280S-32-6-5Y-STD	5 Calibrations Within 5 Years of Purchase
C/2280S-32-6-5Y-DATA	5 (ANSI-Z540-1 compliant) Calibrations Within 5 Years of Purchase
2280S-60-3-EW	1 Additional Year of Factory Warranty (total of 4 years)
2280S-60-3-5Y-EW	2 additional years of factory warranty beyond the 3-Year factory warranty (total of 5 years)
C/2280S-60-3-3Y-STD	3 Calibrations Within 3 Years of Purchase
C/2280S-60-3-3Y-DATA	3 (ANSI-Z540-1 compliant) Calibrations Within 3 Years of Purchase
C/2280S-60-3-5Y-STD	5 Calibrations Within 5 Years of Purchase
C/2280S-60-3-5Y-DATA	5 (ANSI-Z540-1 compliant) Calibrations Within 5 Years of Purchase

Contact Information:

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