Data Sheet

Programmable DC Electronic Loads

8600 Series







The 8600 Series programmable DC electronic loads provide the performance of modular system DC electronic loads in a compact benchtop form factor. With fast transient operation speeds and high 16-bit measurement resolution, these standalone DC loads can be used for testing and evaluating a variety of DC sources such as DC power supplies, DC-DC converters, batteries, battery chargers, and photovoltaic arrays.

The DC loads can operate in constant current (CC), constant voltage (CV), constant resistance (CR), or constant power (CW) mode and be configured to provide a dynamically changing load to the DC source with fast load switching times. Versatile internal, external, and remote triggering options allow the dynamic load behavior to be synchronized with other events.

Increase productivity by saving your test parameters into any one of the I00 memory areas for quick system recall. All load parameters such as voltage, current, slew rate, and width can be set via the front panel or programmed remotely. The 8600 Series provides standard USB (USBTMC-compliant), GPIB, or RS-232 serial interfaces for remote communication.

To ensure the reliability of your testing, the 8600 Series provides a power-on system self-test and numerous protection features: overtemperature (OTP), overvoltage (OVP), overcurrent (OCP), overpower (OPP), and local/remote reverse voltage (LRV/RRV) protection.

Special applications

The 8600 Series provides a built-in battery test mode to measure the ampere-hour (Ah) characteristic of a battery and a unique CR-LED mode to simulate the loading behavior of a typical LED.

Features and Benefits

- Voltage range up to 500 V
- Current range up to 720 A
- CC/CV/CR/CW operating modes
- 16-bit voltage and current measurement system providing 1 mV / 0.1 mA resolution
- Transient mode up to 25 kHz in CC mode
- List mode function

Features and Benefits (cont.)

- Store and recall up to 100 setups
- Adjustable slew rate in CC mode
- Flexible triggering options via front panel, external input, timer, or bus
- Built-in battery test function with voltage level, capacity level, and timer stop conditions
- Test modes to validate the OCP/OPP protection functions of a power supply
- CR-LED mode to simulate the loading behavior of typical LEDs
- Remote sense
- Analog current control and monitoring
- Thermostatically controlled fan
- Standard USB (USBTMC-compliant), RS232, and GPIB interfaces supporting SCPI commands for remote control
- OVP/OCP/OPP/OTP including local and remote reverse voltage (LRV/RRV) protection

Model	8600	8601	8602	8610	8612	8614	8616	8620	8622	8624	8625
Power	150 W	250 W	200 W	750 W	750 W	1500 W	1200 W	3000 W	2500 W	4500 W	6000 W
Operating Voltage	0 – I20 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – I20 V
Rated Current	0 – 30 A	0 – 60 A	0 – I5 A	0 – I20 A	0 – 30 A	0 – 240 A	0 – 60 A	0 – 480 A	0 – 100 A	0 – 600 A	0 – 720 A
Form Factor	orm Factor 2U half-rack				3U					6	u

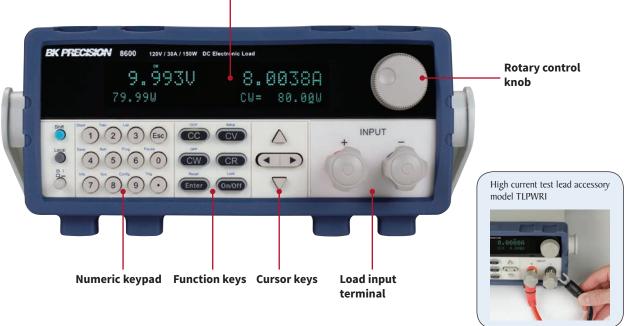


▶ Models 8600, 8601 & 8602

Front panel

Bright dual-line display

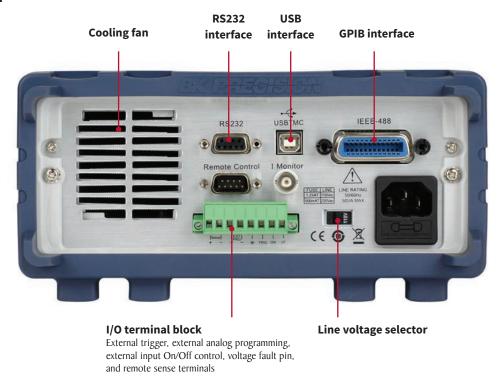
The 8600 Series display shows both measured input values and set parameters simultaneously.



Intuitive user interface

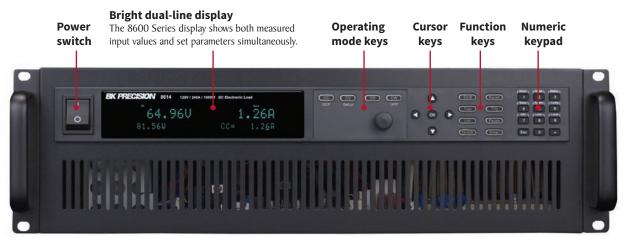
The numeric keys and rotary knob provide a convenient interface for setting the operating mode and desired current, voltage, and resistance levels quickly and precisely.

Rear panel

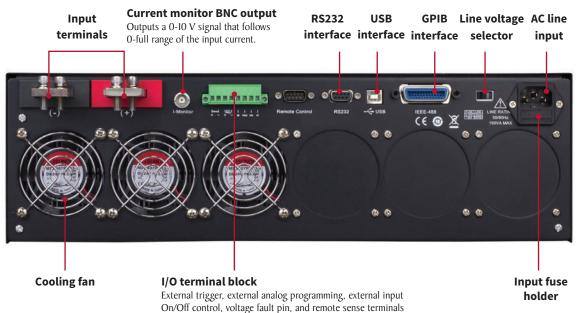


▶ Models 8610, 8612, 8614, 8616, 8620, 8622 (3U)

Front panel



Rear panel



▶ Models 8624 & 8625 (6U)



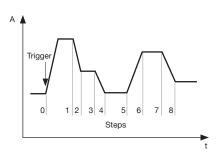
6U form factor models use the same front panel interface as the 3U models



The rear panel configurations of 6U and 3U models are identical, however the number of fans installed varies by model

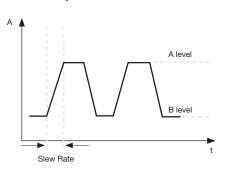
Flexible operation

List mode



List mode lets you generate more complex sequences of input changes with several different levels. Up to 7 groups of list files can be saved. Each list can contain up to 84 steps with a minimum width time of 20 μs per step.

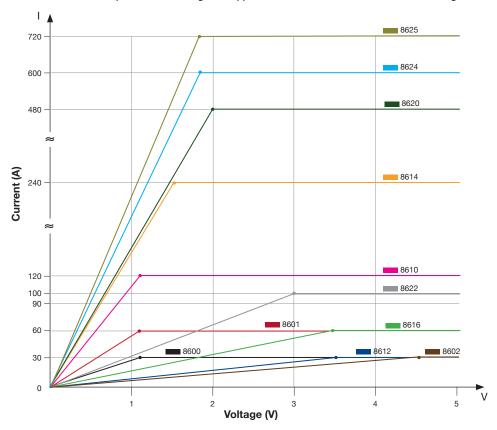
Transient operation



Transient operation enables the module to periodically switch between two load levels. A power supply's regulation and transient characteristic can be evaluated by monitoring the supply's output voltage under varying combinations of load levels, frequency, duty cycle, and slew rate. Transient operation can simulate these conditions.

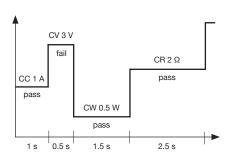
Low voltage operation

The 8600 Series can operate at low voltages for applications such as fuel cell and solar cell testing.



Typical minimum operating voltage at full scale current										
8600	8601	8602	8610	8612	8614	8616	8620	8622	8624	8625
1.1 V	1.1 V	4.5 V	1.2 V	3.6 V	1.5 V	3.6 V	2 V	3 V	1.8 V	1.8 V

Automatic test mode



The 8600 Series can execute multiple test sequences in automatic test mode. Up to 100 different sequences can be linked to run steps of various operating modes and loading conditions. Each sequence can also be programmed with upper and lower limit Pass/Fall criteria. When applied in production testing, you can easily judge whether the test parameters of your devices are within the specification limits and adjust your process according to the Pass/Fail verdict.

CR-LED mode

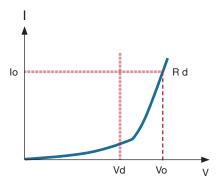


Figure - LED I-V Curve

Vd = Forward voltage of the LED

Rd = LED's operating resistance

Vo = Operating voltage across the LED

Io = Operating current across the LED

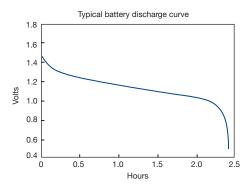
Use the load's unique CR-LED operating mode to test LED drivers. This function allows users to configure the LED's operating resistance and forward voltage along with the voltage range (same as CR operation) to simulate the loading behavior of typical LEDs.

Remote control and programming

Powerful communication interfaces

The 8600 Series provides standard GPIB, USB, and RS232 interfaces for remote communication. These interfaces offer SCPI and USBTMC standard communication protocols to control your electronic load from a PC.

Battery test function



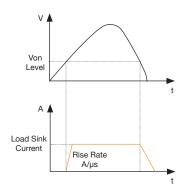
The built-in battery test function uses CC mode to calculate the battery capacity using a fixed current load discharge. Users can specify cut-off voltage level, capacity level, and time stop conditions.

Built-in rise and fall time measurement

External analog programming and monitoring interface

In addition to front panel and remote interface control, current values can also be programmed with an analog control signal. The electronic loads can be externally controlled from zero to full scale with a 0-10 V input signal. A BNC output is available on the rear for monitoring the current with a 0-10 V output signal.

Voltage-on (Von) latch operation

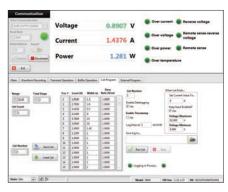


Control the input turn on state for the DC electronic load by configuring the Von latch function. This can be used to start and stop discharging of a battery or other power source at a specified voltage level.

20.001V 39.99W 0.0040S CC= 2.000A Oscilloscope display ΔT=4.00ms VΔT=250.0Hz X2 = 3.76ms X1 = -240.0 μs ΔV= 16.0V Y2 = 18.0V Y1 = 2.00V

The 8600 Series can measure the rise or fall time from a specified start and stop voltage level of the measured input without the need for an oscilloscope. This function can also be used as an internal timer to count how long the input has been enabled.

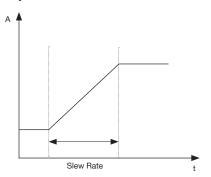
Application software



PC software is provided for front panel emulation, generating and executing test sequences, or logging measurement data without the need to write source code. Additionally, this application software integrates with NI Data Dashboard for LabVIEW apps, which allows users to create a custom dashboard on a tablet computer or smartphone to remotely monitor 8600 Series DC loads via this PC software.

- Remote monitoring on iOS, Android or Windows 8 compatible tablets or smartphones via NI Data Dashboard for LabVIEW apps
- Log voltage, current, and power values with timestamp
- Run transient operation and list mode programs remotely
- Create an unlimited number of external list files to be executed from PC memory

Adjustable slew rate



In CC mode, users can control the rate or slope of the change in current in a transient response test. Set the slew rate to as slow as 0.001 A/ms or as fast as 2.5 A/µs depending on the model and selected current range.

Specifications

Input ratingst In	Мо	del	8600	8601	8602			
Input current	Input ratings							
Input power High 0 - 30 A 0 - 60 A 0 - 15 A	Input v	oltage	0 – I20 V	0 – I20 V	0 – 500 V			
Input power ISO W 250 W 200 W	Input	Low	0 – 3 A	0 – 6 A	0 – 3 A			
Minimum operating voltage	current	High	0 – 30 A	0 – 60 A	0 – I5 A			
Operating voltage High 1.1 V at 30 A 1.1 V at 60 A 4.5 V at 15 A CV mode Range Low 0 − 18 V 0 − 50 V High 0 − 120 V 0 − 500 V High Low 0.1 mV 1 mV High Low 0.1 mV ± (0.025% + ± (0.025% + ± (0.05% + 0.025% + 5)) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.025% + 5) ± (0.05% + 0.05% + 5) ± (0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% + 0.05% + 0.05% + 5) ± (0.05% + 0.05% +	Input power		150 W	250 W	200 W			
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Range Low 0 − 18 V 0 − 50 V Resolution High 0 − 120 V 0 − 500 V High 0 − 1 mV 1 mV High 1 mV 10 mV Accuracy ± (0.05%+ 0.05%+ 0.05%+ 5) ± (0.05%+ 0.05%+ 5) ± (0.05%+ 0.05%+ 5) High ± (0.05%+ 0.05% FS) ± (0.05%+ 0.05% FS) ± (0.05%+ 0.05% FS) CC mode Low 0 − 3 A 0 − 6 A 0 − 3 A High 0 − 30 A 0 − 60 A 0 − 15 A Resolution High 1 mA Accuracy High ± (0.05%+0.05% FS) High ± (0.05%+0.05% FS) CR mode Range Low 0.05 Ω − 10 Ω 0.3 Ω − 10 Ω Resolution 16 bit 1 Accuracy High 0.01%+0.008 S CW mode 150 W 250 W 200 W Resolution 10 mW Accuracy 0.1% + 0.1% FS 0.2% + 0.2% FS 0.1% + 0.1% FS Transient mode (CC mode) T1 &		High	I.I V at 30 A	I.I V at 60 A	4.5 V at 15 A			
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Slew Rate (2) Low 0.001-2.5 A/ms 0.001-1 A/ms	TI & 7	T2 ^(I)	20 μs – 3600 s / Resolution: 10 μs					
Slew Rate (2)	Accu	racy	5 μs + 100 ppm					
High 0.001-2.5 A/μs 0.001-1 A/μs	Cl	Low	0.001-2	0.001-I A/ms				
	Slew Rate (2)	High	0.001-2	2.5 A∕µs				

 $^{^{(}I)}$ Fast pulse trains with large transitions may not be achievable.

⁽²⁾ The slew rate specifications are not warranted, but are descriptions of typical performance. The actual transition time is defined as the time for the input to change from 10% to 90%, or vice versa, of the programmed current values. In case of very large load changes, e.g. from no load to full load, the actual transition time will be larger than the expected time. The load will automatically adjust the slew rate to fit within the range (high or low) that is closest to the programmed value.

Readback volta	ge	I				
Range	Low	0 – 18 V	0 – 18 V	0 – 50 V		
8	High	0 – I20 V	0 – I20 V	0 – 500 V		
Resolution		0.	.I mV	I mV		
- resolution	High	I	mV	IO mV		
Accura	cy		±(0.05%+0.05% FS)		
Readback curre	nt					
Range	Low	0 – 3 A	0 – 6 A	0 – 3 A		
Kange	High	0 – 30 A	0 – 60 A	0 – I5 A		
Resolution	Low	0.01 mA	0.1 mA	0.01 mA		
Resolution	High	0.I mA	I mA	0.1 mA		
Accura	су	±(0.05%+ 0.05% FS)	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)		
Readback power	er					
Range	:	150 W	250 W	200 W		
Resoluti	on		IO mW			
Accura	cy	±(1%+0.1% FS)	±(0.2%+0.2% FS)	±(0.1%+0.1% FS)		
Protection rang	e (typical)		1			
OPP		150 W	250 W	200 W		
0.00	Low	3.3 A	6.6 A	3.3 A		
OCP	High	33 A	66 A	16.5 A		
OVP		120 V	120 V	500 V		
OTP			185 °F (85 °C)	1		
Short circuit (ty	pical)					
a (88)	Low	3.3 A	6.6 A	3.3 A		
Current (CC)	High	33 A	66 A	16.5 A		
Voltage (CV)		'			
Resistance	(CR)	35 mΩ	30 mΩ	300 mΩ		
General (typical)					
Input terminal i	mpedance	I50 kΩ	ΙΜΩ			
AC inp	ut	II0 V/220 V ±10%, 50/60 Hz				
Operating tem	perature	32 °F to 104 °F (0 °C to 40 °C)				
Storage temp	erature	14 °F to 140 °F (-10 °C to 60 °C)				
Humidi	ty	Indoor use, ≤ 95%				
Safety	,	EN61010-1:2001, EU Low Voltage Directive 2006/95/EC				
Electromag compatib		Meets EMC Directive 2004/108/EC, EN 61000-3- 2:2006, EN 61000-3-3:1995+A1:2001+A2:2005 EN 61000-4-2/-3/-4/-5/-6/-11, EN 61326-1:2006				
Dimensions (W	' x H x D)	8.5" x 3.5" x 15.2" (218 x 90 x 387 mm)				
Weigh	t	9.9 lbs (4.5 kg)				
			Three-Ye	ar Warranty		
Standard acco	essories	User manual, power cord, certificate of calibration & test report				
Optional acco	essories	TLPWRI high current test leads, IT-EI5I rackmount kit (models 8600, 8601, and 8602 only)				

Specifications (cont.)

Model		8610	8612	8614	8616	8620	8622	8624	8625		
Input ratings	;		•					'			
Input volt	age	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – I20 V		
Input	Low	0 – I2 A	0 – 3 A	0 – 24 A	0 –6 A	0 – 48 A	0 – 10 A	0 – 60 A	0 – 72 A		
current	High	0 – I20 A	0 – 30 A	0 – 240 A	0 –60 A	0 – 480 A	0 – 100 A	0 – 600 A	0 – 720 A		
Input pov	ver	750) W	I500 W	1200 W	3000 W	2500 W	4500 W	6000 W		
Minimum operating	Low	0.12 V at 12 A	0.36 V at 3 A	0.15 V at 24 A	0.36 V at 6 A	0.2 V at 48 A	0.3 V at I0 A	0.18 V at 60 A	0.18 V at 72 A		
voltage	High	I.2 V at I20 A	3.6 V at 30 A	I.5 V at 240 A	3.6 V at 60 A	2 V at 480 A	3 V at 100 A	18 V at 600 A	I.8 V at 720 A		
CV mode	ı										
D.	Low	0 – 18 V	0 – 50 V	0 – 18 V	0 – 50 V	0 – 18 V	0 – 50 V	0 – 18 V	0 – 18 V		
Range	High	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – I20 V		
D 1.0	Low	0.1 mV	I mV	0.1 mV	I mV	I mV	I mV	I mV	I mV		
Resolution	High	I mV	I0 mV	I mV	I0 mV	I0 mV	IO mV	IO mV	IO mV		
Accuracy	Low	±(0.025% -	+ 0.05% FS)	±(0.025%+ 0.025% FS)	±(0.025%+ 0.05% FS)		±(0.025% -	+ 0.05% FS)			
J	High	±(0.025% + 0.05% FS)									
CC mode											
	Low	0 – I2 A	0 – 3 A	0 – 24 A	0 – 6 A	0 – 48 A	0 – 10 A	0 – 60 A	0 – 72 A		
Range	High	0 – I20 A	0 – 30 A	0 – 240 A	0 – 60 A	0 – 480 A	0 – 100 A	0 – 600 A	0 – 720 A		
n l.:	Low	I mA	0.1 mA	I mA	0.1 mA	I mA	I mA	I mA	I mA		
Resolution	High	I0 mA	I mA	I0 mA	I mA	I0 mA	I0 mA	10 mA	I0 mA		
	Low	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)	±(0.025%+ 0.05% FS)					
Accuracy	High	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)		±(0.025%+	- 0.05% FS)			
CR mode	1										
D	Low	$0.02~\Omega - 10~\Omega$	$0.15~\Omega - 10~\Omega$	$0.01~\Omega - 10~\Omega$	0.01 Ω – 10 Ω	0.01 Ω – 10 Ω	$0.03~\Omega - 10~\Omega$	0.01 Ω – 10 Ω	$0.005~\Omega - 10~\Omega$		
Range	High				Ι0 Ω -	7.5 kΩ					
Resoluti	on			I6 bit							
Accuracy	Low	0.01%+0.08 S									
Accuracy	High				0.01%+0	0.0008 S					
CW mode											
Range		750) W	1500 W	1200 W	3000 W	2500 W	4500 W	6000 W		
Resoluti	on	10	mW			100	mW				
Accurac	у				0.2% +	0.2% FS					
Transient mo	ode (CC ı	mode)									
TI & T2	(1)				20 μs – 3600 s /	Resolution: 10 µs					
Accurac	су				5 μs + I	00 ppm					
Slew Rate (2)	Low	0.001-0.25 A/μs	0.000I-0.I A/μs	0.00I-0.25 A/μs	0.000I-0.I A/μs	0.00I-0.25 A/μs	0.00I-0.I A/μs	0.00I-0.25 A/μs	0.001-0.25 A/μs		
Siew Kate (=)	High	0.01-2.5 A/μs	0.00I-I A/μs	0.01-2.5 A/μs	0.00I-I A/μs	0.0I-2.5 A/μs	0.01-1 A/µs	0.01-2.5 A/μs	0.0I-2.5 A/μs		

 $^{^{\}mbox{\scriptsize (I)}}$ Fast pulse trains with large transitions may not be achievable.

⁽²⁾ The slew rate specifications are not warranted, but are descriptions of typical performance. The actual transition time is defined as the time for the input to change from 10% to 90%, or vice versa, of the programmed current values. In case of very large load changes, e.g. from no load to full load, the actual transition time will be larger than the expected time. The load will automatically adjust the slew rate to fit within the range (high or low) that is closest to the programmed value.

Specifications (cont.)

Mod	el	8610	8612	8614	8616	8620	8622	8624	8625				
Readback vol	ltage												
	Low	0 – 18 V	0 – 50 V	0 – 18 V	0 – 50 V	0 – 18 V	0 – 50 V	0 –	18 V				
Range	High	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – 500 V	0 – I20 V	0 – I20 V				
	Low	0.1 mV	I mV	0.1 mV		1	I mV	'					
Resolution High		1 mV 10 mV 1 mV 10 mV											
Accura	асу		±(0.05% +	- 0.05% FS)	1		±(0.025% +	% + 0.025% FS)					
Readback cur	rrent												
	Low	0 – I2 A	0 – 3 A	0 – 24 A	0 – 6 A	0 – 48 A	0 – I0 A	0 – 60 A	0 – 72 A				
Range	High	0 – I20 A	0 – 30 A	0 – 240 A	0 – 60 A	0 – 480 A	0 – 100 A	0 – 600 A	0 – 720 A				
	Low	I mA	0.1 mA	I mA	0.1 mA		11	mA					
Resolution	High	I0 mA	I mA	10 mA	I mA		10	mA					
Accura	асу	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)	±(0.05%+ 0.1% FS)	±(0.05%+ 0.05% FS)		05%+ 6 FS)				
Readback pov	wer												
Range	e	750) W	1500 W	1200 W	3000 W	2500 W	4500 W	6000 W				
Resolut	tion	10 :	nW		1	100	mW	1					
Accura	асу		±(0.2% + 0.2% FS)										
Protection rai	nge (typica	ıl)											
OPP)	760) W	1550 W	1250 W	3050 W	2550 W	4550 W	6050 W				
	Low	13.2 A	3.3 A	26.4 A	6.6 A	26.4 A	II A	66 A	79.2 A				
OCP	High	132 A	33 A	264 A	66 A	264 A	IIO A	660 A	792 A				
OVP)	130 V	530 V	130 V	530 V	130 V	530 V	130 V	130 V				
OTP)	185 °F (85 °C)											
Short circuit ((typical)												
Current (CC)	Low	13.2 A	3.3 A	26.4 A	6.6 A	52.8 A	II A	66 A	79.2 A				
Current (CC)	High	132 A	33 A	264 A	66 A	528 A	IIO A	660 A	793 A				
Voltage ((CV)				0	V							
Resistance	e (CR)	I0 mΩ	I20 mΩ	6 mΩ	60 mΩ	5 mΩ	30 mΩ	$3~\text{m}\Omega$	$2.5~\text{m}\Omega$				
General (typic	cal)			_									
Input terminal	impedance	300 kΩ	ΙΜΩ	300 kΩ	Ι ΜΩ	300 kΩ	Ι ΜΩ	300 kΩ	300 kΩ				
AC inp	out				110 V/220 V ±	10%, 50/60 Hz							
Operating ten	nperature	32 °F to I04 °F (0 °C to 40 °C)											
Storage temp	perature		14 °F to 140 °F (-10 °C to 60 °C)										
Humid	lity		Indoor use, ≤ 95%										
Safety	у			EN61010	0-1:2001, EU Low V	oltage Directive 200	6/95/EC						
Electroma compatib			Meets El	MC Directive 2004/ EN		3-2:2006, EN 61000 '-6/-II, EN 61326-1:2		+A2:2005					
Dimensions (V	V x H x D)		17.3" x 5.3" x 22.5" (439 x 133.3 x 580 mm) 17.3" x 10.5" x 23.2" (439 x 266 x 590 mm)										
Weigh	ht			54 lbs (24.6 kg)			142 lbs ((64.4 kg)				
								Three-Ye	ar Warrant				
Standard acc	cessories			User manua	l, power cord, certi	ficate of calibration	& test report						
Optional acc	cessories				TLPWRI high c	urrent test leads							

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