

4600 Series Programmable AC Electronic Load

NHR
NH Research

Linear & Non-Linear AC Loading In Several Emulation Modes With Power & Crest Factor Control

Features

- 6 sizes – 3 to 36kW, 30 – 360A, 50 – 350V RMS (L-N)
- Sizable for single and 3-phase configurations
- CC, CR, CV, CP, SC, UPF & CNL emulation modes
- Programmable crest factor and power factor
- 12 high-accuracy internal measurements
- User-defined waveforms
- 100-step macro for per cycle loading changes
- PC softpanel GUI with current, voltage & power waveform display
- PC control using Lab VIEW & IVI drivers
- LAN & RS232 communication interfaces
- True short circuit operation



4600 Series front panel view

Applications

The 4600 Series AC Electronic Loads are designed for test applications that require linear and non-linear AC loading in several emulation modes with Power (*Fig. 1-4*) and Crest Factor control (*Fig. 1-4*). This programmable versatility allows testing with a wide variety of potential field operating conditions to assure unit-under-test (UUT) reliability. Products tested include uninterruptible power supplies (UPS), AC sources, inverters, switches, circuit breakers, fuses, and connectors.

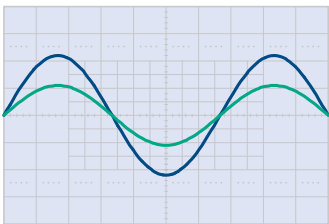


Fig. 1 - Unity Power Factor

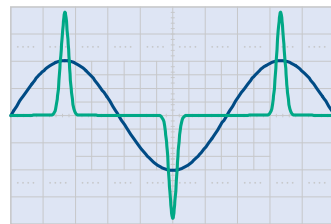


Fig. 2 - High Crest Factor

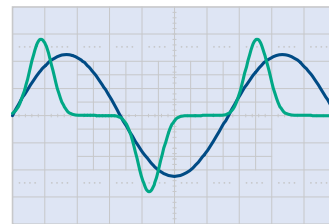


Fig. 3 - Leading Power Factor

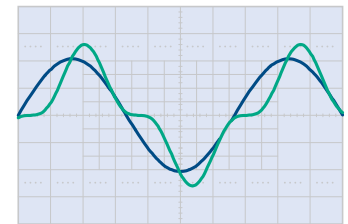


Fig. 4 - Lagging Power Factor

Waveforms: — Voltage & — Current

Emulation Modes

To provide testing under the broadest range of loading conditions, the 4600 Series AC Electronic Load offers 7 different emulation modes. Constant Current (CC) mode provides current to be drawn constantly, making it suitable for non-linear, linear, and regulation loading. Constant Resistance (CR) mode allows the electronic load to emulate a power resistor. Constant Voltage (CV) allows emulating a shunt regulator. Constant Power (CP) mode emulates a constant-power load such as a switching power supply. Short Circuit (SC) mode allows the electronic load to test the UUT's short circuit protection capability. Unity Power Factor (UPF) (*Fig. 1*) mode brings power factor to unity, useful when the input voltage is non-sinusoidal. The new Complex Non-Linear Waveform (CNL) mode allows the user to define the waveform to prevent UUT current over-stressing in the event of a voltage collapse. These comprehensive capabilities provide the user almost every conceivable AC loading condition possible.

High Accuracy Measurements

The 4600 Series AC Electronic Load provides high-accuracy frequency, voltage, peak voltage, current, peak current, crest factor, apparent power, true power, peak power, reactive power, power factor, and resistance measurements by combining high-resolution measurements with precision ranging. The ability to make measurements internally eliminates multiple external measurement instruments plus associated signal matrixing. In this manner, the 4600 Series AC Electronic Load provides for a more compact, less costly, and considerably faster test system.

The AC Electronic Load has the ability to control current through a user defined waveform.

User-Defined Waveforms

The 4600 Series AC Electronic Load has the ability to control current through a user defined waveform (Fig. 5). The waveform is created by a powerful graphical editor that facilitates starting with a straight line or modifying a generated waveform based on current, power, and crest factor. The graphical editor includes an auto-check feature to ensure the settings are compatible with each other and within the capabilities of the electronic load. It also supports waveform smoothing, symmetrical, and asymmetrical waveform creation.

With this editor, waveforms can be quickly created to duplicate complex transient conditions. This would include adding asymmetrical inflections, inserting transient anomalies such as spikes and dropouts, and any shape else that can be drawn as a single-cycle waveform.

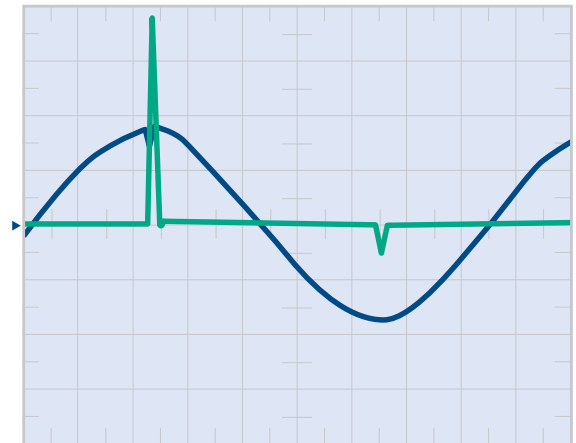
100-Step Multi-Mode Macros

Macros are queues of up to 100 steps that can be triggered locally, thereby providing very fast current, power, and crest factor changes, up to every cycle (Fig. 6). Further, a Macro can be executed as a single shot or looped.

emPower® LE adds a test sequencer, basic test routines, & reporting.

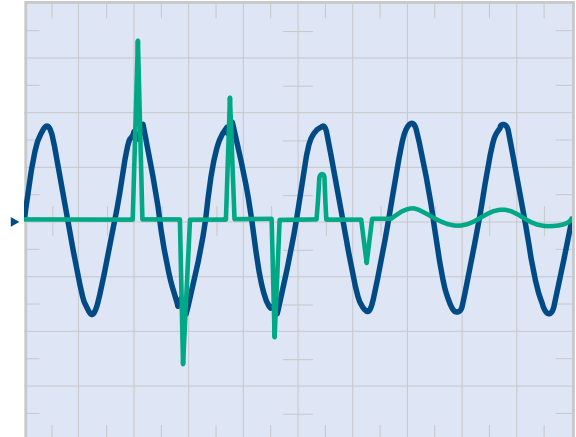
emPower® LE Test Executive Option

The 4600 Series AC Electronic Load is supplied with software for a PC softpanel that provides complete instrument control, measurement, and waveform display. Upgrading to a full test executive with drivers for all NH Research, Inc. (NHR) power instruments is also possible through emPower® LE (Fig. 7), which adds a test sequencer, basic test routines, and reporting.



2.000 mS/div Wf1, Chn 001, 100 V/div. Wf2, Chn 002, 20 A/div.

Fig. 5 - User-Defined Asymmetrical Current



10.000 mS/div Wf1, Chn 001, 100 V/div. Wf2, Chn 002, 20 A/div.

Fig. 6 - Start-Up Inrush Current Macro

Step	Name	Status	Signal	Test Routine	Stepover
1	Set Voltage	OK	V	Set Voltage	Auto
2	Set Current	OK	I	Set Current	Auto
3	Set Power	OK	P	Set Power	Auto
4	Set Frequency	OK	F	Set Frequency	Auto
5	Set Crest Factor	OK	CF	Set Crest Factor	Auto
6	Set Apparent Power	OK	AP	Set Apparent Power	Auto
7	Set True Power	OK	TP	Set True Power	Auto
8	Set Reactive Power	OK	RP	Set Reactive Power	Auto
9	Set Resistance	OK	R	Set Resistance	Auto
10	Set Impedance	OK	Z	Set Impedance	Auto
11	Set Phase Angle	OK	PA	Set Phase Angle	Auto
12	Set Power Factor	OK	PF	Set Power Factor	Auto
13	Set Crest Factor	OK	CF	Set Crest Factor	Auto
14	Set Apparent Power	OK	AP	Set Apparent Power	Auto
15	Set True Power	OK	TP	Set True Power	Auto
16	Set Reactive Power	OK	RP	Set Reactive Power	Auto
17	Set Resistance	OK	R	Set Resistance	Auto
18	Set Impedance	OK	Z	Set Impedance	Auto
19	Set Phase Angle	OK	PA	Set Phase Angle	Auto
20	Set Power Factor	OK	PF	Set Power Factor	Auto
21	Set Crest Factor	OK	CF	Set Crest Factor	Auto
22	Set Apparent Power	OK	AP	Set Apparent Power	Auto
23	Set True Power	OK	TP	Set True Power	Auto
24	Set Reactive Power	OK	RP	Set Reactive Power	Auto
25	Set Resistance	OK	R	Set Resistance	Auto
26	Set Impedance	OK	Z	Set Impedance	Auto
27	Set Phase Angle	OK	PA	Set Phase Angle	Auto
28	Set Power Factor	OK	PF	Set Power Factor	Auto
29	Set Crest Factor	OK	CF	Set Crest Factor	Auto
30	Set Apparent Power	OK	AP	Set Apparent Power	Auto
31	Set True Power	OK	TP	Set True Power	Auto
32	Set Reactive Power	OK	RP	Set Reactive Power	Auto
33	Set Resistance	OK	R	Set Resistance	Auto
34	Set Impedance	OK	Z	Set Impedance	Auto
35	Set Phase Angle	OK	PA	Set Phase Angle	Auto
36	Set Power Factor	OK	PF	Set Power Factor	Auto
37	Set Crest Factor	OK	CF	Set Crest Factor	Auto
38	Set Apparent Power	OK	AP	Set Apparent Power	Auto
39	Set True Power	OK	TP	Set True Power	Auto
40	Set Reactive Power	OK	RP	Set Reactive Power	Auto
41	Set Resistance	OK	R	Set Resistance	Auto
42	Set Impedance	OK	Z	Set Impedance	Auto
43	Set Phase Angle	OK	PA	Set Phase Angle	Auto
44	Set Power Factor	OK	PF	Set Power Factor	Auto
45	Set Crest Factor	OK	CF	Set Crest Factor	Auto
46	Set Apparent Power	OK	AP	Set Apparent Power	Auto
47	Set True Power	OK	TP	Set True Power	Auto
48	Set Reactive Power	OK	RP	Set Reactive Power	Auto
49	Set Resistance	OK	R	Set Resistance	Auto
50	Set Impedance	OK	Z	Set Impedance	Auto
51	Set Phase Angle	OK	PA	Set Phase Angle	Auto
52	Set Power Factor	OK	PF	Set Power Factor	Auto
53	Set Crest Factor	OK	CF	Set Crest Factor	Auto
54	Set Apparent Power	OK	AP	Set Apparent Power	Auto
55	Set True Power	OK	TP	Set True Power	Auto
56	Set Reactive Power	OK	RP	Set Reactive Power	Auto
57	Set Resistance	OK	R	Set Resistance	Auto
58	Set Impedance	OK	Z	Set Impedance	Auto
59	Set Phase Angle	OK	PA	Set Phase Angle	Auto
60	Set Power Factor	OK	PF	Set Power Factor	Auto
61	Set Crest Factor	OK	CF	Set Crest Factor	Auto
62	Set Apparent Power	OK	AP	Set Apparent Power	Auto
63	Set True Power	OK	TP	Set True Power	Auto
64	Set Reactive Power	OK	RP	Set Reactive Power	Auto
65	Set Resistance	OK	R	Set Resistance	Auto
66	Set Impedance	OK	Z	Set Impedance	Auto
67	Set Phase Angle	OK	PA	Set Phase Angle	Auto
68	Set Power Factor	OK	PF	Set Power Factor	Auto
69	Set Crest Factor	OK	CF	Set Crest Factor	Auto
70	Set Apparent Power	OK	AP	Set Apparent Power	Auto
71	Set True Power	OK	TP	Set True Power	Auto
72	Set Reactive Power	OK	RP	Set Reactive Power	Auto
73	Set Resistance	OK	R	Set Resistance	Auto
74	Set Impedance	OK	Z	Set Impedance	Auto
75	Set Phase Angle	OK	PA	Set Phase Angle	Auto
76	Set Power Factor	OK	PF	Set Power Factor	Auto
77	Set Crest Factor	OK	CF	Set Crest Factor	Auto
78	Set Apparent Power	OK	AP	Set Apparent Power	Auto
79	Set True Power	OK	TP	Set True Power	Auto
80	Set Reactive Power	OK	RP	Set Reactive Power	Auto
81	Set Resistance	OK	R	Set Resistance	Auto
82	Set Impedance	OK	Z	Set Impedance	Auto
83	Set Phase Angle	OK	PA	Set Phase Angle	Auto
84	Set Power Factor	OK	PF	Set Power Factor	Auto
85	Set Crest Factor	OK	CF	Set Crest Factor	Auto
86	Set Apparent Power	OK	AP	Set Apparent Power	Auto
87	Set True Power	OK	TP	Set True Power	Auto
88	Set Reactive Power	OK	RP	Set Reactive Power	Auto
89	Set Resistance	OK	R	Set Resistance	Auto
90	Set Impedance	OK	Z	Set Impedance	Auto
91	Set Phase Angle	OK	PA	Set Phase Angle	Auto
92	Set Power Factor	OK	PF	Set Power Factor	Auto
93	Set Crest Factor	OK	CF	Set Crest Factor	Auto
94	Set Apparent Power	OK	AP	Set Apparent Power	Auto
95	Set True Power	OK	TP	Set True Power	Auto
96	Set Reactive Power	OK	RP	Set Reactive Power	Auto
97	Set Resistance	OK	R	Set Resistance	Auto
98	Set Impedance	OK	Z	Set Impedance	Auto
99	Set Phase Angle	OK	PA	Set Phase Angle	Auto
100	Set Power Factor	OK	PF	Set Power Factor	Auto

Fig. 7 - emPower user interface

Any unit can be field expandable in 3kW increments to address future higher power needs.

Wide Range of Power Levels

The 4600 Series AC Electronic Load is now offered in 6 power levels between 3 and 36kW (Fig. 8). Any unit can be field expandable in 3kW increments to address future higher power needs. Contact NHR for any loads higher than 36kW.

Graphic User Interface

A PC-hosted graphic user interface eclipses the traditional front panel clutter of knobs, dials, keypads, and digital displays. This traditional clutter is a carry-over from a time in which test instrumentation had a far more limited set of features. In addition to a more comprehensive presentation of operation, measurement, and status information, softpanel advantages include the ability to program and recall Macros, editing user-defined waveforms, along with display of real-time current, voltage, and power waveforms without an oscilloscope.

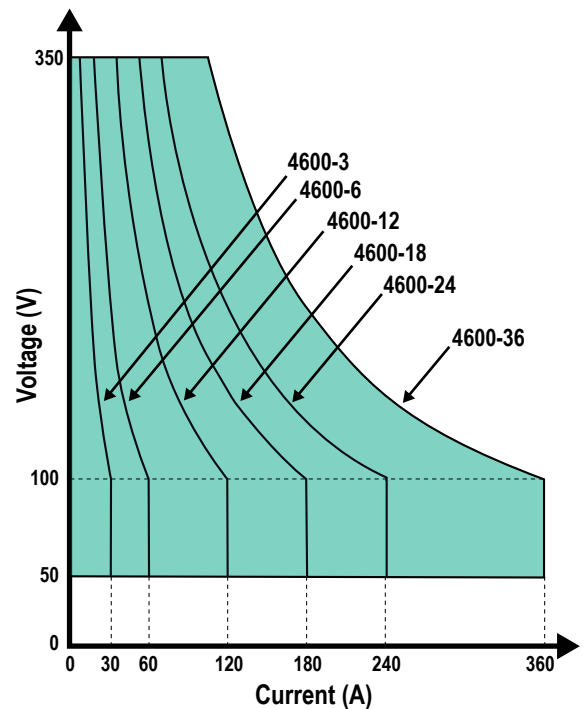


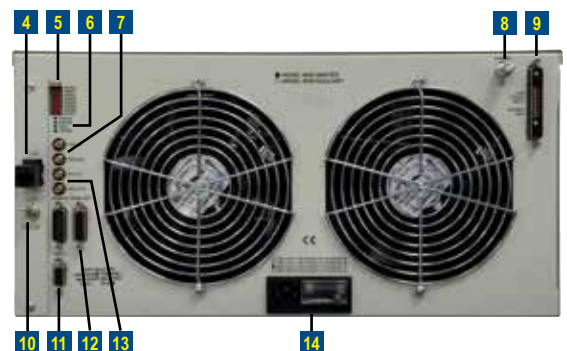
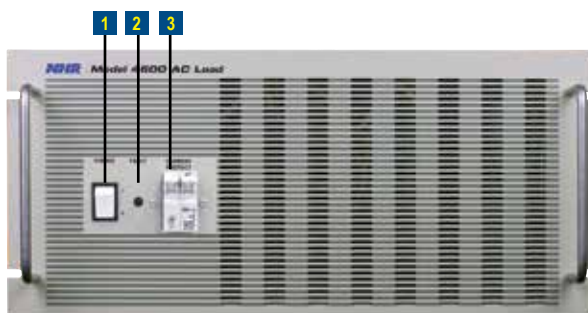
Fig. 8 - Operating Envelopes

PC softpanel provides complete instrument control, measurement and waveform display.

PC Softpanel



Panel Overview



- 1 Control Power switch
- 2 Fault indicator light
- 3 Circuit breaker
- 4 LAN port
- 5 Address switch

- 6 Status indicators
- 7 Trig In/Out connectors
- 8 Chassis GND stud
- 9 Load Power Input connector
- 10 LAN/RS 232 switch

- 11 RS 232 connector
- 12 COMM In/Out connectors
- 13 Hold In/Out connectors
- 14 AC input connector

4600 Series Programmable AC Electronic Load Specifications¹

4600 Ratings	4600-3	4600-6	4600-12	4600-18	4600-24	4600-36 ²	Control
Power	3kW	6kW	12kW	18kW	24kW	36kW	User Interface
Maximum Current ³	30A	60A	120A	180A	240A	360A	PC
Voltage Range ³	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	OS
Programmable Modes							Test Executive
Constant Current							Communications
Range (RMS)	0 - 30A	0 - 60A	0 - 120A	0 - 180A	0 - 240A	0 - 360A	Drivers
Accuracy	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	Additional Features
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	3-Phase Operation
Constant Voltage							Remote Voltage Sense
Range	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	Self Test
Accuracy	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	Performance Monitoring
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	Calibration
Constant Power							Protection
Range	300W - 3kW	600W - 6kW	1.2 - 12kW	1.8 - 18kW	2.4 - 24kW	3.6 - 36kW	Trigger Output
Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	Fan Noise Reduction
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	Load Connectors
Constant Resistance							Operating Temperature
Ranges	2.5-100, 100-1000Ω	1.25-50, 50-500Ω	0.63-25, 25-250Ω	0.42-17, 17-167Ω	0.31-12.5, 12.5-125Ω	0.2-8.3, 8.3-83Ω	Input Power
Accuracy	1, 5%	1, 5%	1, 5%	1, 5%	1, 5%	1, 5%	
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	
Short Circuit							
Max Surge Current	300A	600A	1200A	1800A	2400A	3600A	
Power Factor							
Range	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	
Accuracy	1%	1%	1%	1%	1%	1%	
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	
Crest Factor							
Range	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	
Accuracy	90A limit	180A limit	360A limit	540A limit	720A limit	1080A limit	
Resolution	1%	1%	1%	1%	1%	1%	
Resolution	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%	
Macros	Queues of up to 100 commands can be run manually or from a triggered event (phase angle, input voltage level, system trigger)						
Custom Waveforms	User-defined waveforms can be created through a full-screen graphical editor that provides control of current, voltage, resistance, power, crest factor and power factor						
Measurements							
Current							
Ranges (RMS)	0 - 30A	0 - 60A	0 - 120A	0 - 180A	0 - 240A	0 - 360A	
Accuracy	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Peak Current							
Ranges	0 - 90A	0 - 180A	0 - 360A	0 - 540A	0 - 720A	0 - 1080A	
Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Voltage							
Ranges	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	50 - 350V	
Accuracy	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Peak Voltage							
Ranges	50 - 500V	50 - 500V	50 - 500V	50 - 500V	50 - 500V	50 - 500V	
Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Frequency							
Range	45 - 440Hz	45 - 440Hz	45 - 440Hz	45 - 440Hz	45 - 440Hz	45 - 440Hz	
Accuracy	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
True Power							
Ranges	0 - 10.5kW	0 - 21kW	0 - 42kW	0 - 63kW	0 - 84kVA	0 - 126kVA	
Accuracy (R+FS) ⁴	0.2% + 0.03%	0.2% + 0.03%	0.2% + 0.03%	0.2% + 0.03%	0.2% + 0.03%	0.2% + 0.03%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Apparent Power							
Range	0 - 10.5kVA	0 - 21kVA	0 - 42kVA	0 - 63kVA	0 - 84kVA	0 - 126kVA	
Accuracy	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Reactive Power							
Range	0 - 10.5kVA	0 - 21kVA	0 - 42kVA	0 - 63kVA	0 - 84kVA	0 - 126kVA	
Accuracy	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Peak Power							
Range	0 - 45kW	0 - 90kW	0 - 180kW	0 - 270kW	0 - 360kW	0 - 540kW	
Accuracy	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	
Resolution	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	
Resistance							
Range	2.5-100, 100-1000Ω	1.25-50, 50-500Ω	0.63-25, 25-250Ω	0.42-17, 17-167Ω	0.31-12.5, 12.5-125Ω	0.2-8.3, 8.3-83Ω	
Accuracy	1%, 5%	1%, 5%	1%, 5%	1%, 5%	1%, 5%	1%, 5%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Crest Factor							
Range	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	1.414 - 4	
Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Power Factor							
Range	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	0 -1, lead/lag	
Accuracy	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	
Resolution	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	
Waveform Display	Continuously updated, graphical display of a full cycle of current, voltage and/or power waveforms						
Physical							
Enclosure	Chassis	Chassis (2)	Cabinet	Cabinet	Cabinet, 2-Bay	Cabinet, 2-Bay	
Dimensions (HxWxD)	8"x19x23"	17"x19x25"	57x23x30"	72x23x30"	57x46x30"	72x46x30"	
Weight	222x483x58mm	445x483x635mm	1448x584x762mm	1829x584x762mm	1448x1168x762mm	1829x1168x762mm	
	77lbs/35kg	154lbs/70kg	440lbs/200kg	650lbs/295kg	860lbs/390kg	1250 lbs/567 kg	

¹Specifications apply at 23* +/- 5* C after a 10 minute warm up and are subject to change without notice. All Accuracies and Resolutions are % of full scale

²Higher power and custom configurations available

³Accuracies apply when Settings and/or Measurements >10% of Range

⁴R+FS = Range + Full Scale



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