FLUKE

The Fluke 6100A
Electrical Power Standard

The most accurate, comprehensive and flexible source of electrical power signals

Measurement validation for electrical power applications

The importance of accurate measurement of power and energy has increased dramatically over a relatively short period of time. Deregulation and the increasingly distributed nature of the power supply network mean that measurements are made more frequently, and a higher degree of accuracy is required as previously acceptable levels of error begin to compound.

At the same time, the environment in which these measurements are being made is becoming increasingly hostile to good measurement practice. Harmonic distortion, voltage fluctuations, phase imbalances and other extraneous, re-injected signal components provide an alien environment for measurement devices designed to operate primarily on sinusoidal signals.

Additionally, many new measurement and instrument types have arisen in an attempt to fully characterize network performance, and the nature of the product delivered – electricity. Flicker and harmonic measurements are becoming as commonplace as power factor measurements were a few years ago, and even more complex measurements such as inter-harmonics are now relatively routine.

Against this turbulent change, little progress has been made in the verification of these measurements. Instruments to be used to measure and report precise parameters on power lines carrying significantly distorted, noisy and fluctuating voltages are verified and calibrated under laboratory conditions. Pure, noise free, leveled sinusoidal voltages and currents are still routinely applied as reference signals.

In the field of new measurements and new instrument types, the situation is even worse. Some of the more complex measurements have few standards or protocols which define precisely how they should be made, and there are no real solutions to the problems of how to verify the measurement, or how to calibrate the instrument making it. Perhaps it's unsurprising that different measurement techniques and different instruments yield different results on what is ostensibly the same measurement, or that measurement traceability often stops at the manufacturer.

Predictably, concern is increasing globally about the acceptability of this situation.

Against this background, Fluke has developed the 6100A Electrical Power Standard.

Comprehensive functionality

Who needs a 6100A?

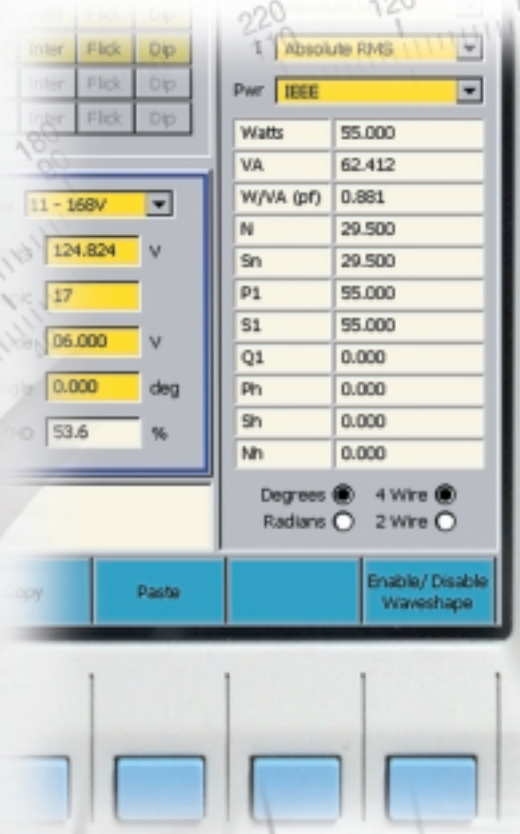
Validation of electrical power measurements and the equipment that make them is required in many disciplines:

- In design engineering to guarantee that measurements are being made correctly and accurately
- In manufacturing test to make certain that measurements are correct and repeatable on every unit manufactured
- In service and calibration to ensure that instruments continue to perform to specification throughout their lifetime
- In standards laboratories to ensure measurement techniques and equipment meet appropriate standards.

The 6100A provides the signals to allow this process to be completed effectively, quickly and easily. More importantly, it ensures that the process of validation is completed thoroughly, accurately and with all measurements being traceable to national standards. The 6100A was designed to produce a comprehensive array of electrical power signal types to a very high degree of accuracy. This can be achieved over 1, 2, 3 or 4 phases independently and simultaneously depending on system configuration.

Phantom power

The 6100A will supply pure sinusoidal voltage to 1000 V and current to 20 Amps. Up to 50 VA's of power is available from the voltage terminals to support instruments which draw power from the line on which they are measuring. Up to 14 V of compliance is available from the current output to ensure current is delivered in setups involving long cable runs, connectors and switches, or where multiple instruments are connected in series. The current output is also able to produce an auxiliary voltage in order to simulate signals that may be produced by transducers or current probes.



In addition to the values of V, I and phase angle set by the user, the on-screen display shows calculated values of real power (W), apparent power (VA), reactive power (VAR). and power factor (PF). Reactive power for non-sinusoidal signals is calculated by the 6100A using any of seven user selectable methods.

In this mode of operation the 6100A can be used to calibrate or verify measurement of power, VA, VAR, phase angle, power factor, voltage and current on single or multi-phase instruments.

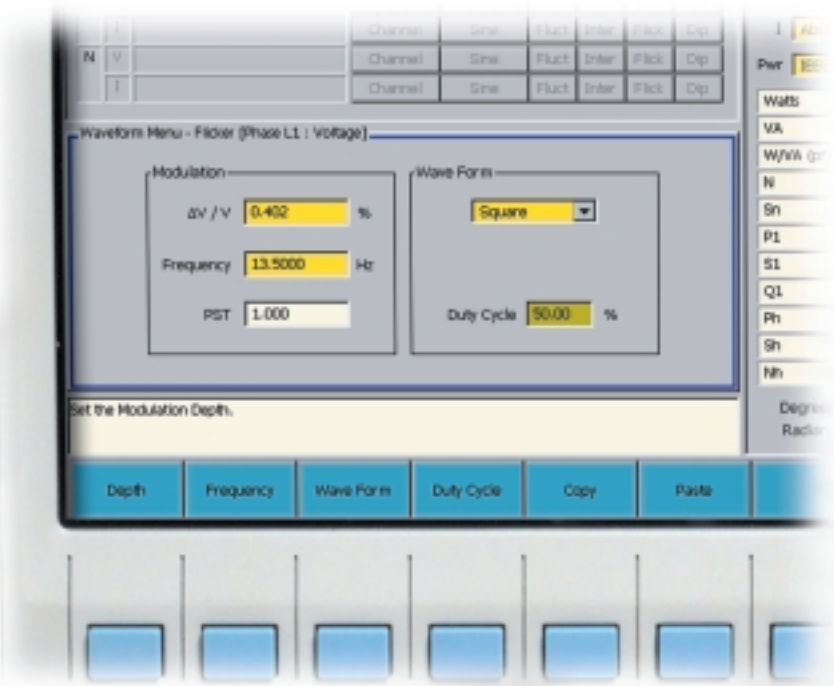
Resolution and accuracy

The Fluke 6100A sets a new benchmark for accuracy in power standards. Voltage and current are generated with up to 6 digits resolution and accuracies approaching 100 ppm (0.01 %). Phase adjustment provides for 1 milli-degree or 10 micro-radian resolution. Phase performance is exceptional, with accuracy to 3 milli-degrees and short term stability to 200 micro-degrees. In multi-phase systems phase accuracy between phases is down to 5 milli-degrees, again with short term stability to 200 micro-degrees. This outstanding level of phase performance equals or exceeds a number of commercially available phase standards.

Complex measurements

Flicker

Flicker is a complex measurement which sets out to measure the "annoyance factor" of a flickering light caused by modulation on its supply voltage, which is in turn caused by events such as large loads switching. The measurement is defined by IEC standard IEC-61000-3-3. In simple terms, the measurement of flicker is a combination of two variables, amplitude and frequency of modulation over a period of time, (ten minutes to produce the so called Pst or short term flicker severity value). The 6100A simulates flicker by modulating voltage amplitude at a depth and frequency set by the user. The Pst value of this combination is calculated and displayed on screen.

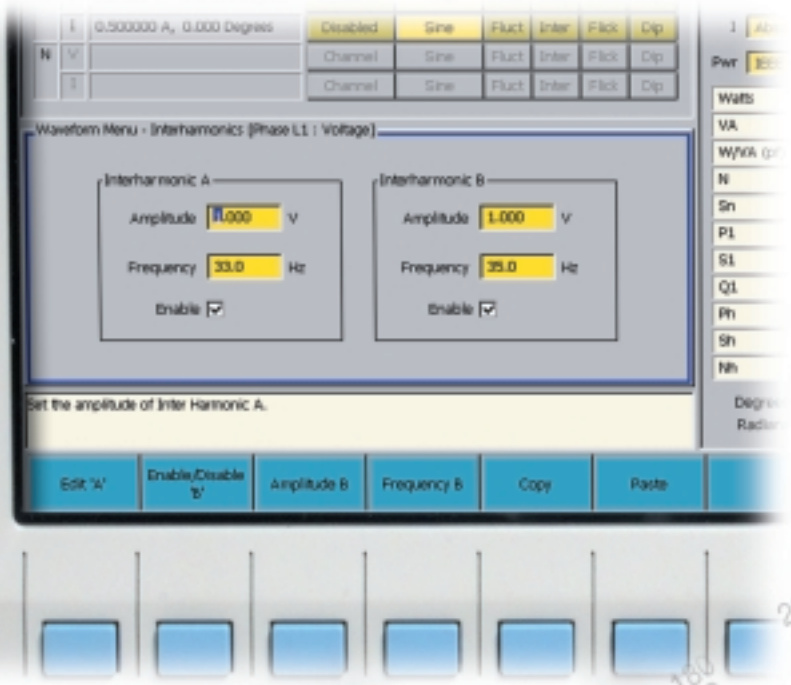


Harmonics

In addition to sinusoidal voltages and currents, the 6100A can supply accurate amounts of harmonic distortion independently on the voltage and current outputs. All of the first 100 harmonics can be set individually by the user, with levels of up to 30 % of the fundamental value. Addition of harmonics does not significantly impair accuracy or compromise traceability of the measurement.

This mode of operation can be used to calibrate or verify measurements made by devices such as harmonic analyzers, power loggers, disturbance analyzers, etc. It is also valuable in ensuring that simpler measurements such as voltage, power or power factor are performed correctly and accurately under non-sinusoidal conditions.

Complex measurements



Interharmonics

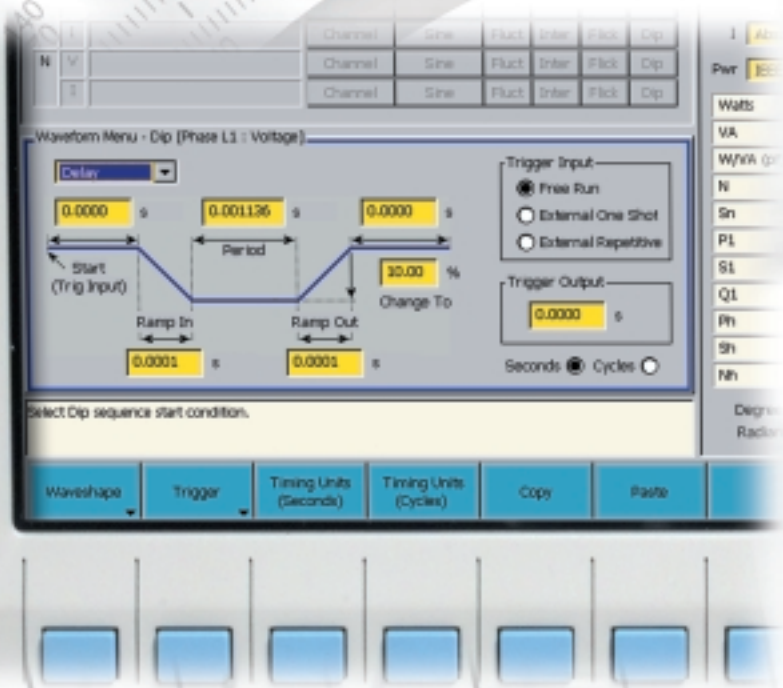
Interharmonics are continuous signal elements unrelated to the fundamental frequency. For example, in a 60 Hz supply system, 180 Hz is a harmonic (the 3rd) but 190 Hz is an interharmonic. The 6100A can generate two independent interharmonics at a user-definable level and frequency on both the current and voltage outputs. With this function, the 6100A can simulate interharmonics caused by imperfect loads, or deliberately induced signals such as power line carrier signals.

Fluctuating harmonics

Fluctuating harmonics are individual harmonics which are amplitude modulated. The 6100A is able to individually modulate from one to all of the currently defined harmonics at up to 30 % of its nominal amplitude with a frequency of up to 30 Hz, and with a sinusoidal, square or rectangular waveshape.

Dips and swells

Output voltage or current can be caused to dip to a level below nominal or swell to a level above nominal for a period of between half a cycle and one minute. Ramp in and ramp out times, period, repetition delay and dip/swell level are all independently controllable. The dip or swell can be triggered internally to be synchronous with a preset value of phase of the fundamental, or triggered externally from another device.



Complex measurements

Simultaneous application

Full verification of complex measurement devices requires that complex combinations of signals are handled correctly. This fact has been recognized within the power measurement industry, and is being incorporated in IEC 61000-4-30 (Testing and measurement techniques – Power quality measurement methods). This standard requires, amongst other things, that measurement instruments are tested with compound signal types (for example flicker, imbalance and harmonics all present) to ensure that performance is maintained under real world conditions. The 6100A supports this need by making most signal types available simultaneously.

Multi-phase operation

The 6100A Master unit offers self-contained single phase operation, with one voltage and one current output. For multi-phase applications, the addition of one or more 6101A Auxiliary units provides additional phases, with identical performance but without the overhead of controls or display. Additional phases can be added individually until a maximum of four phases is reached. In multiphase systems, each phase remains totally independent and totally electrically isolated, yet synchronized with, and under the control of the master unit. This means applications where phase imbalance or sequence errors are required are simple and easy to arrange.

User interface

The user interface of the 6100A is critical to allow users to exploit its extensive capabilities. To ensure simplicity of operation, a Windows® user interface has been adopted. The interface can be accessed through a combination of front panel knobs and buttons, or by connecting the user's own mouse and keyboard. Actions are then viewed on the 6100A's high resolution, 9-inch TFT display. Status information of all four phases is displayed, alongside more detailed information on current parameters being set or adjusted. Frequency domain and time domain representation of current signal types can be displayed on the screen so that the user is able evaluate the effect of control settings before applying the signal to the output terminals of the 6100A. At the bottom of the screen a context sensitive help window further guides the operator through instrument setup by providing additional control information and error messages.

Instrument setups can be saved and recalled within the instrument or on floppy disk.

6100A and 6101A specifications

Primary specifications

Voltage/Current amplitude setting resolution	6 digits
Range of fundamental frequency	16 Hz to 450 Hz
Frequency accuracy	50 ppm
Frequency setting resolution	0.1 Hz
Time to full accuracy	1 hour
Settling time	< 1.4 second
Nominal angle between voltage phases	120 °
Nominal angle between voltage and current of a phase	0 °
Phase angle setting	± 180 °, ± π radians
Phase angle setting resolution	0.001 °, 0.00001 radians

Voltage output

Range	Band	Frequency	1 year accuracy, TCal ± 5 °C ± (ppm of output + µV)		Stability ± (ppm of output + µV) per hour		Maximum burden
1.1 V - 16 V	6.4 V – 16 V	16 Hz – 450 Hz	112	1.5	40	0.4	800 mA
	0 V – 6.4 V	16 Hz – 450 Hz	122	2.0	40	0.8	800 mA
	0 V – 4.8 V	450 Hz – 6 kHz	512	2.0	60	0.8	800 mA
2.3 V - 33 V	13.2 V – 33 V	16 Hz – 450 Hz	112	1.5	40	0.6	800 mA
	0 V – 13.2 V	16 Hz – 450 Hz	122	2.0	40	0.8	800 mA
	0 V – 9.9 V	450 Hz – 6 kHz	512	2.0	60	0.8	800 mA
5.6 V - 78 V	31 V – 78 V	16 Hz – 450 Hz	112	2.0	40	0.8	500 mA
	0 V – 31 V	16 Hz – 450 Hz	122	2.0	40	0.8	500 mA
	0 V – 23 V	450 Hz – 6 kHz	512	2.0	60	0.8	500 mA
11 V - 168 V	67 V – 168 V	16 Hz – 450 Hz	112	4.4	40	1.5	220 mA
	0 V – 67 V	16 Hz – 450 Hz	122	4.4	40	1.5	220 mA
	0 V – 50 V	450 Hz – 6 kHz	512	4.4	60	1.5	220 mA
23 V - 336 V	134 V – 336 V	16 Hz – 450 Hz	112	8.8	40	3.0	100 mA
	0 V – 134 V	16 Hz – 450 Hz	122	12.0	40	3.0	100 mA
	0 V – 100 V	450 Hz – 6 kHz	512	12.0	60	3.0	100 mA
70V - 1008 V	330 V – 1008 V	16 Hz – 450 Hz	158	26	100	10	50 mA
	0 V – 330 V	16 Hz – 450 Hz	166	33	100	10	50 mA
	0 V – 302 V	450 Hz – 6 kHz	524	33	150	10	50 mA

Voltage from current terminals

Range (source Z)	Band	Frequency	1 year accuracy, TCal ± 5 °C ± (ppm of output + µV)		Stability ± (ppm of output + µV) per hour		Minimum load Z for specification
0.05 V - 0.25 V	0.1 V – 0.25 V	16 Hz – 450 Hz	200	30	50	15	22 kΩ
(1 Ω)	0 V – 0.1 V	16 Hz – 450 Hz	200	30	50	15	25 kΩ
	0 V – 0.075 V	450 Hz – 6 kHz	1000	30	100	15	25 kΩ
0.15 V - 1.5 V	0.6 V – 1.5 V	16 Hz – 450 Hz	200	40	50	20	170 kΩ
(6.67 Ω)	0 V – 0.6 V	16 Hz – 450 Hz	200	50	50	25	170 kΩ
	0 V – 1.5 V	450 Hz – 6 kHz	1000	50	100	25	170 kΩ
1 V -10 V	4 V – 10 V	16 Hz – 450 Hz	200	240	50	120	1 MΩ
(40.2 Ω)	0 V – 4 V	16 Hz – 450 Hz	200	300	50	150	1 MΩ
	0 V – 10 V	450 Hz – 6 kHz	1000	300	100	150	1 MΩ

6100A and 6101A specifications

Current output

Range	Band	Frequency	1 year accuracy, TCal ± 5 °C ± (ppm of output + µV)		Stability ± (ppm of output + µV) per hour		Maximum compliance voltage (Vpk)
0.05 A - 0.25 A	0.1 A – 0.25 A	16 Hz – 450 Hz	130	6	50	3	14 V
	0 A – 0.1 A	16 Hz – 450 Hz	139	6	50	3	14 V
	0 A – 0.075 A	450 Hz – 6 kHz	505	6	100	3	14 V
0.05 A - 0.5 A	0.2 A – 0.5 A	16 Hz – 450 Hz	130	12	50	5	14 V
	0 A – 0.2 A	16 Hz – 450 Hz	139	12	50	5	14 V
	0 A – 0.5 A	450 Hz – 6 kHz	505	12	100	5	14 V
0.1 A - 1 A	0.4 A – 1 A	16 Hz – 450 Hz	130	24	50	10	14 V
	0 A – 0.4 A	16 Hz – 450 Hz	139	24	50	10	14 V
	0 A – 1 A	450 Hz – 6 kHz	505	24	100	10	14 V
0.2 A - 2 A	0.8 A – 2 A	16 Hz – 450 Hz	130	48	50	20	14 V
	0 A – 0.8 A	16 Hz – 450 Hz	139	48	50	20	14 V
	0 A – 2 A	450 Hz – 6 kHz	505	48	100	20	14 V
0.5 A - 5 A	2 A – 5 A	16 Hz – 450 Hz	130	120	50	50	14 V
	0 A – 2 A	16 Hz – 450 Hz	139	120	50	50	14 V
	0 A – 5 A	450 Hz – 6 kHz	505	120	100	50	14 V
1 A - 10 A	4 A – 10 A	16 Hz – 450 Hz	164	240	70	100	14 V
	0 A – 4 A	16 Hz – 450 Hz	191	240	70	100	14 V
	0 A – 10 A	450 Hz – 6 kHz	519	240	110	100	14 V
2A - 20 A	8 A – 20 A	16 Hz – 450 Hz	189	720	90	300	13 V
	0 A – 8 A	16 Hz – 450 Hz	213	720	90	300	13 V
	0 A – 20 A	450 Hz – 6 kHz	665	720	120	300	13 V

Phase Angle - Current to Voltage

Voltage Range	16 V to 1008 V Frequency	40 % to 100 % of range		<40 % of range	
		1 year accuracy TCal ± 5 °C	Stability per hour	1 year accuracy TCal ± 5 °C	Stability per hour
0.25 A – 5 A	16 Hz – 69 Hz	0.003 °	0.0002 °	0.010 °	0.001 °
	69 Hz – 180 Hz	0.005 °	0.0002 °	0.017 °	0.002 °
	180 Hz – 450 Hz	0.015 °	0.0002 °	0.050 °	0.005 °
	450 Hz – 3 kHz	0.150 °	0.0010 °	0.200 °	0.100 °
	3 kHz – 6 kHz	0.300 °	0.0010 °	0.450 °	0.100 °
5 A – 20 A	16 Hz – 69 Hz	0.004 °	0.0003 °	0.013 °	0.002 °
	69 Hz – 180 Hz	0.007 °	0.0003 °	0.023 °	0.004 °
	180 Hz – 450 Hz	0.020 °	0.0003 °	0.065 °	0.010 °
	450 Hz – 3 kHz	0.200 °	0.0010 °	0.250 °	0.100 °
	3 kHz – 6 kHz	0.400 °	0.0010 °	0.600 °	0.150 °

Phase Angle - Voltage to Voltage (Multiphase systems)

Voltage Range	16 V to 1008 V Frequency	40 % to 100 % of range		<40 % of range	
		1 year accuracy TCal ± 5 °C	Stability per hour	1 year accuracy TCal ± 5 °C	Stability per hour
16 V – 1008 V	16 Hz – 69 Hz	0.005 °	0.0002 °	0.010 °	0.001 °
	69 Hz – 180 Hz	0.007 °	0.0005 °	0.020 °	0.002 °
	180 Hz – 450 Hz	0.020 °	0.0010 °	0.050 °	0.005 °

6100A and 6101A specifications

Current output DC offset

Full Range	Maximum offset
0.25 A	25 µA
0.5 A	50 µA
1 A	100 µA
2 A	200 µA
5 A	500 µA
10 A	2 mA
20 A	4 mA
0.25 V	50 µV
1.5 V	150 µV
10 V	1 mV

Voltage output DC offset

Full Range	Maximum offset
16 V	2 mV
33 V	2 mV
78 V	5 mV
168 V	10 mV
336 V	20 mV
1008 V	60 mV

Power

The following tables show in parts per million the minimum to maximum power accuracy for specific voltage and current bands under sinusoidal conditions.

Sinusoidal VA

I Range	V Range	16 (6.4 to 16 V)	33 (13.2 to 33 V)	78 (31 to 78 V)	168 (67 to 168 V)	336 (134 to 336 V)	1000 (330 to 1000 V)
<5 A	(0.1 to 5 A)	257 to 395	220 to 295	206 to 259	207 to 260	207 to 260	240 to 304
10	(4 to 10 A)	279 to 412	245 to 318	233 to 285	233 to 286	233 to 286	263 to 326
20	(8 to 20 A)	305 to 444	274 to 358	263 to 330	264 to 330	264 to 330	290 to 366

Sinusoidal power 16 Hz to 69 Hz, 1.0 > Power Factor > 0.75

I Range	V Range	16 (6.4 to 16 V)	33 (13.2 to 33 V)	78 (31 to 78 V)	168 (67 to 168 V)	336 (134 to 336 V)	1000 (330 to 1000 V)
<2 A	(0.1 to 2 A)	261 to 298	225 to 298	212 to 263	212 to 264	212 to 264	244 to 307
5 A	(2 to 5 A)	254 to 400	229 to 301	215 to 266	216 to 267	216 to 267	248 to 310
10	(4 to 10 A)	285 to 417	253 to 324	241 to 292	241 to 292	241 to 292	270 to 332
20	(8 to 20 A)	311 to 449	281 to 364	270 to 335	271 to 336	271 to 336	297 to 371

Sinusoidal power 16 Hz to 69 Hz, 0.75 > Power Factor > 0.5

I Range	V Range	16 (6.4 to 16 V)	33 (13.2 to 33 V)	78 (31 to 78 V)	168 (67 to 168 V)	336 (134 to 336 V)	1000 (330 to 1000 V)
<2 A	(0.1 to 2 A)	272 to 405	238 to 308	225 to 275	226 to 275	226 to 275	257 to 317
5	(2 to 5 A)	284 to 413	251 to 319	239 to 286	240 to 287	240 to 287	269 to 327
10	(4 to 10 A)	304 to 430	273 to 340	262 to 310	363 to 310	263 to 3109	290 to 348
20	(8 to 20 A)	328 to 461	300 to 378	290 to 351	290 to 352	290 to 352	315 to 385

(Valid for RMS values > 40 % of range for voltage and current, not valid when Flicker, Fluctuating Harmonics, Dips/Swells or Interharmonics are applied)

6100A and 6101A specifications

Harmonics

Number of harmonics available	100 (simultaneously if required)
Maximum harmonic frequency available	6 kHz (100th Harmonic of 60 Hz)
Maximum level of individual harmonic	30 % of fundamental level
Setting Method (user selectable)	% RMS, % fundamental, dB down from fundamental, absolute value

Flicker

Setting range	±30 % of set voltage or current within range values (60 % ΔV/V)
Flicker modulation depth accuracy	0.025 %
Modulation depth setting resolution	0.001 %
Shape	Rectangular or Sinusoidal
Duty cycle (shape = rectangular)	0.1 % to 99.9 % ±31 µs
Modulating Frequency range	0.0008 Hz to 40 Hz
Pst Indication accuracy	0.25 % Valid for Voltage only between 220 V and 240 V

Although Flicker is voltage phenomena the 6100A will provide Flicker on its current output. Flicker is not available if Fluctuating Harmonics are already enabled on that channel.

Fluctuating Harmonics

Number of harmonics to fluctuate	Any number from 0 to all set harmonics can fluctuate
Setting range	±30 % of nominal harmonic voltage
fluctuation accuracy	0.025 %
Modulation depth setting resolution	0.001 %
Shape	Rectangular or Sinusoidal
Duty cycle (shape = rectangular)	0.1 % to 99.9 % ±31 µs
Modulating Frequency range	0.008 Hz to 30 Hz

Not available on voltage or current channels if Flicker is already enabled on that channel

Interharmonics

Frequency accuracy	500 ppm
Amplitude accuracy 16 Hz to < 6 kHz	1 %
Amplitude accuracy > 6 kHz	4 %
Maximum value of a single interharmonic	Maximum value for an interharmonic < 2850 Hz is 30 % of range. See Extended specifications for frequencies>2850 Hz
Frequency range of interharmonics	16 Hz to 9 kHz

Dips and swells

Dip/Swell Min duration	0.5 cycles
Dip/Swell Max duration	1 minute
Dip Min amplitude	10 % of the nominal output
Swell Max amplitude	The lesser of full range value or 140 % of the nominal output
Ramp up/down period	Settable 100 µs to 30 seconds
Optional repeat with delay	0 to 60 seconds ±31 µs
Starting level amplitude accuracy	±0.25 % of level
Dip/Swell level amplitude accuracy	±0.25 % of level
Trigger out	TTL falling edge coincident with start of Dip/Swell event remaining low for 10 µs to 31 µs

6100A and 6101A specifications

General specifications

Power	
Voltage	100 V to 240 V with up to 10 % fluctuations
Transient overvoltages	Impulse withstand (overvoltage) category II of IEC 60364-4-443
Frequency	47 Hz to 63 Hz
Max. consumption	1000 VA 100 V – 130 V, 1250 VA 130 V – 240 V

Dimensions	
Height	233 mm (9.17 inches)
Width	432 mm (17 inches)
Depth	630 mm (24.8 inches)
Weight	23 kg (51 lbs)

Environment	
Operating temperature	5 °C to 40 °C
Calibration temperature	16 °C to 30 °C
Storage temperature	0 °C to 50 °C
Transit temperature	-20 °C to 60 °C < 100 hours
Warm up time	1 hour
Safe Operating Max. Relative Humidity (non-condensing)	< 80 % 5 °C to 31 °C ramping linearly to 50 % at 40 °C
Storage Max Relative Humidity (non-condensing)	<95 % 0 °C to 50 °C
Operating altitude	0 m to 2,000 m
Non operating altitude	0 to 12,000 m
Shock	MIL-PRF-28800 class 3
Vibration	MIL-PRF-28800 class 3
Enclosure	MIL-PRF-28800 class 3

Safety

Designed to EN61010-1:2001, CAN/CSA 22.2 No 1010.1-92, UL61010A-1 Indoor use only, pollution degree 2; installation category II
CE marked and ETL listed

EMC

EN61326 : 2002, class A [1], EN61000-3-2:2000, FCC rules part 15, sub-part J, class A

[1] Class A equipment is suitable for use in establishments other than domestic, and those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes.

FLUKE

6100A Electrical Power Standard

Ordering information

6100A Electrical Power Standard Master comprises:

- One phase, (one voltage channel to 1000 V, one current channel to 20 A)
- User controls and display system
- Interfacing via GPIB
- Interfacing to Auxiliary Unit

6101A Auxiliary Power Standard comprises:

- One phase, (one voltage channel to 1000 V, one current channel to 20 A)
- Cable and interfacing to connect to Master

6120A Complete 2-phase system comprises:

- One 6100A
- One 6101A

6130A Complete 3-phase system comprises:

- One 6100A
- Two 6101As

6140A Complete 4-phase system comprises:

- One 6100A
- Three 6101As

Fully configured 4-phase Electrical Power Standard system

Fluke. *Keeping your world up and running.*

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