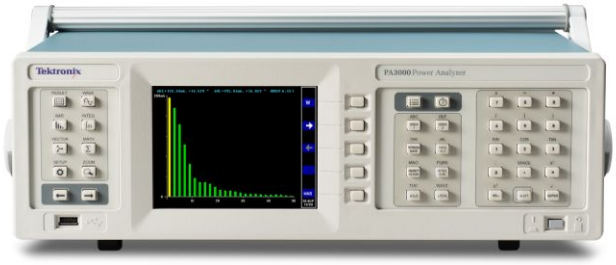
Tektronix®

PA3000

Four-channel, Multi-phase AC/DC Power Analyzer



The Tektronix PA3000 is a one to four channel power analyzer that is optimized for testing today's single and multi-phase, high efficiency power conversion products and designs. Use it to quickly visualize, analyze, and document power efficiency, energy consumption, and electrical performance to the latest regional and international standards, including Level VI, EnergyStar, CEC, IEC 62301, CQC-3146, and more.

Key features and specifications

- One to four channels support single and three phase applications
- 10 mW standby power measurement
- 1 MHz bandwidth
- 1 MS/s sampling rate
- 16 bit A/D
- Harmonic analysis to 100th order
- ±0.04% basic voltage and current accuracy
- Measurements to 30 A_{rms} and 600 V_{rms} Cat II (2000 V_{pk})
- USB and LAN interfaces standard (GPIB option)
- Free PWRVIEW software
- Full color graphical display for intuitive readouts of measured values, waveforms, harmonics, and energy integration plots

The essential power measurement tool for R&D and validation

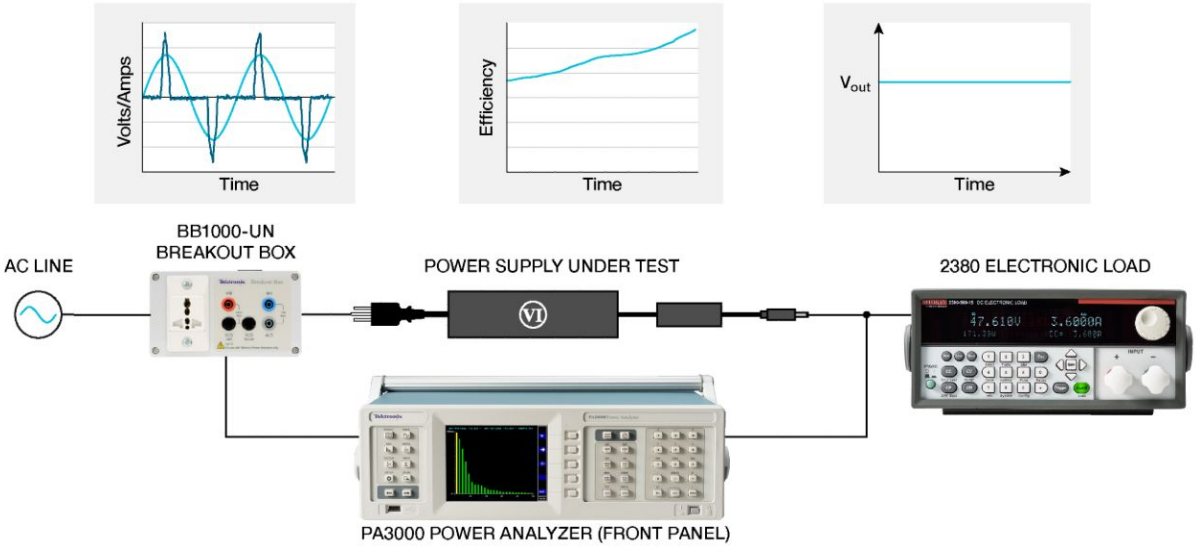
- High accuracy supports testing to Level VI efficiency standards for external AC/DC power supplies
- Dedicated energy consumption testing in integration mode for standards like Energy star and CEC
- Complete solution for full compliance testing to IEC 62301 standby power requirements
- High 1 MHz bandwidth supports the LED module energy certification requirements of CQC-3146 as well as harmonic analysis of designs with higher fundamental frequencies
- More than 50 standard measurement functions, including harmonics, frequency, and star-delta computation
- Multiple analog and digital inputs for sensor data such as thermocouples, speeds sensors, and torques sensors
- Built-in ±15 V supplies for external transducers to support high current applications

Applications

- AC/DC power supplies and LED drivers
- Appliances and consumer electronics
- UPS systems, inverters, and DC/AC conversion systems
- Wireless battery charging
- Three phase motors and drives

AC/DC power supplies and LED drivers

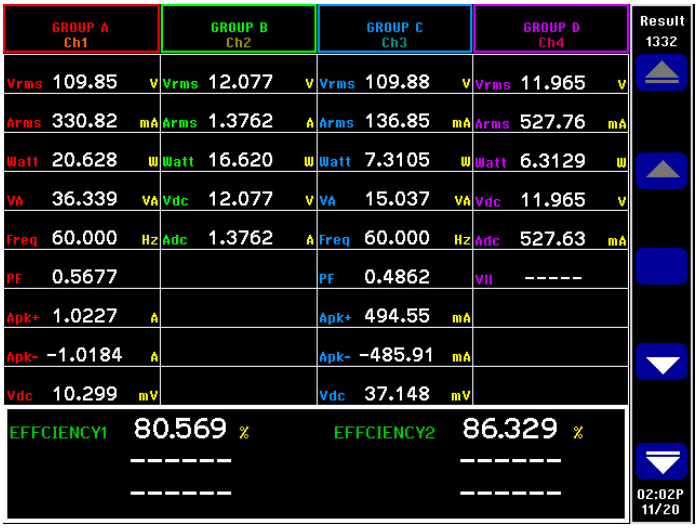
Key tests include efficiency, standby power, harmonics, inrush current, and input power parameters such as power factor. The PA3000's graphical color display and PWRVIEW software boost productivity when performing these tests.



Example test configuration and measurement results for testing AC/DC power supplies and LED drivers

Efficiency Testing

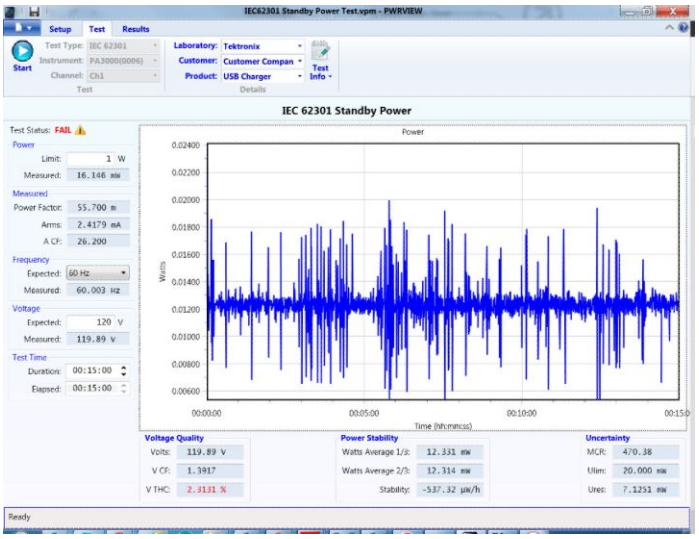
- 0.04% basic accuracy for voltage and current enables high efficiency testing and incremental design changes for various regulatory standards
- 1 to 4 channels for comparative testing on two power supplies simultaneously
- Wide dynamic range from 90 µA to 30 A enables testing no load through full load.



Comparative efficiency testing on two AC-DC power supplies simultaneously

Standby Power testing

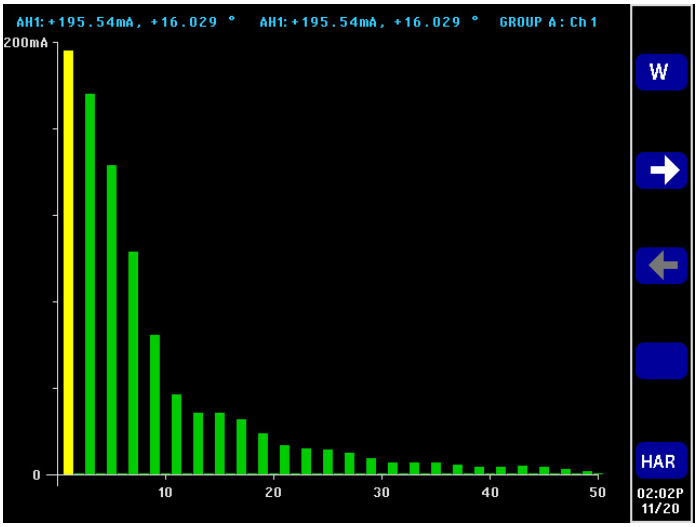
- 90 µA current measuring capability for standby power testing as low as 10 mW to support demanding low power designs
- Full compliance IEC 62301 ED 2.0 standby power standard test with device uncertainty calculations as required by the standard
- Long averaging enables stable standby power results
- Auto-up ranging mode enables gap-less measurement



Full compliance IEC 62301 ED 2.0 Standby Power testing with PWRVIEW

Harmonic analysis

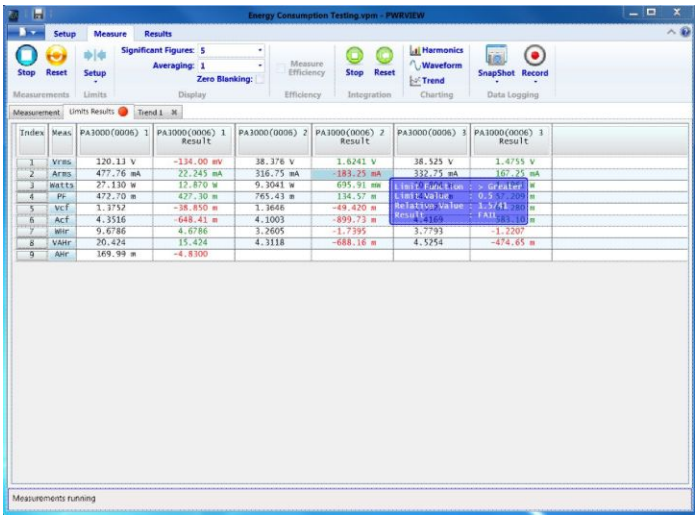
- Voltage and current harmonic analysis up to 100th order
- Easy THD and distortion factor measurements



Harmonics testing up to 100th order

Limits and Specification testing

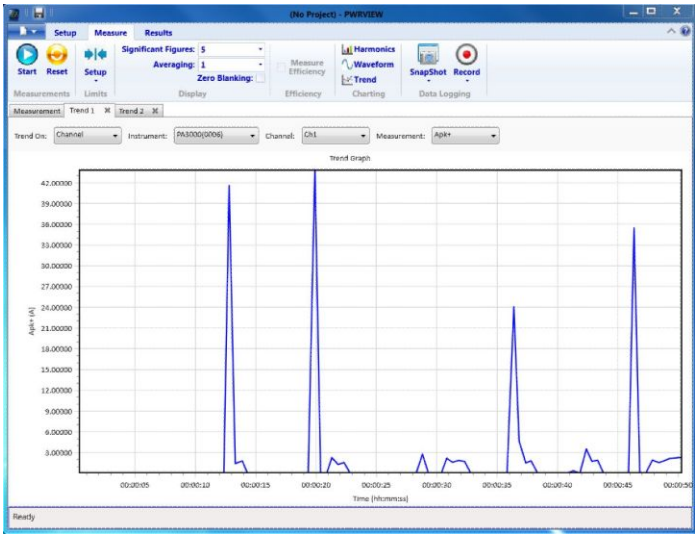
- Custom limits setup with free PWRVIEW software enables standards and specification testing to set limits



Custom limits setup for personalized limit checks on all measured parameters

Inrush Current testing

- Min Max hold feature with 1 MS/s sampling rate allows testing for inrush events



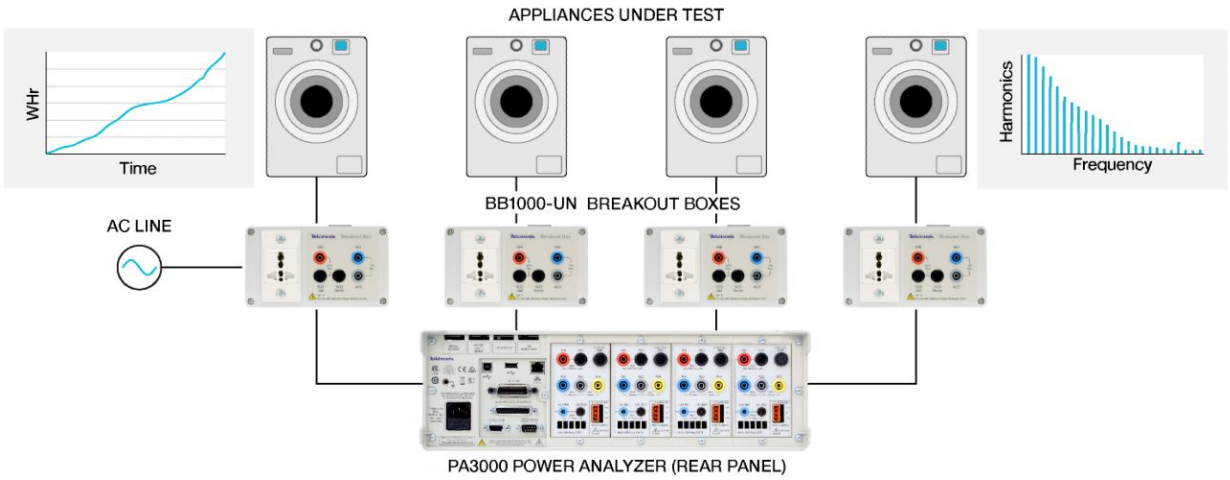
Inrush event testing with Trend chart and Min Max hold feature

Input Power analysis

- More than 50 measurement parameters including Power factor, crest factor, THD
- Continuous 1 MS/s sampling rate enables accurate and gap-less input power analysis on non-sinusoidal signals

Appliances and consumer electronics

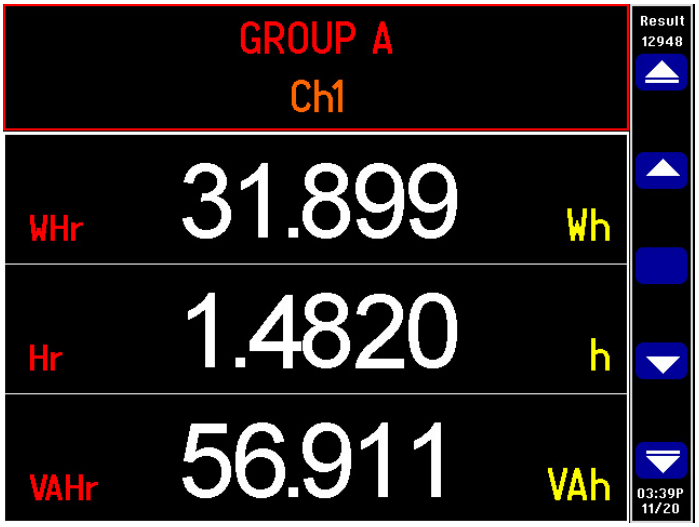
Key tests include energy consumption and standby power. The PA3000's built-in test modes simplify test setup.



Example test configuration and measurement results for testing appliances and consumer electronics

Energy Consumption testing

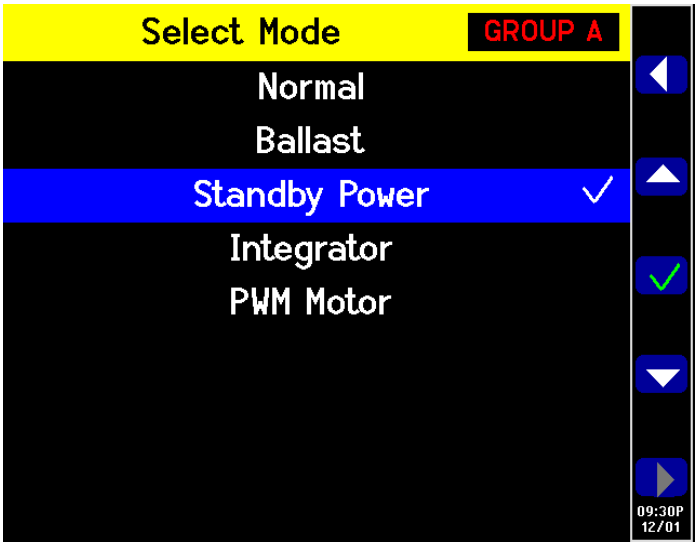
- Dedicated Energy Consumption (Integrator) mode enables easy setup and testing for home and office appliances
- Auto-up-only ranging feature with PWRVIEW enables gapless energy consumption testing
- Integration and trend charts for long term monitoring
- 1 to 4 channels enable simultaneous testing of multiple products



Energy Consumption testing

Standby Power testing

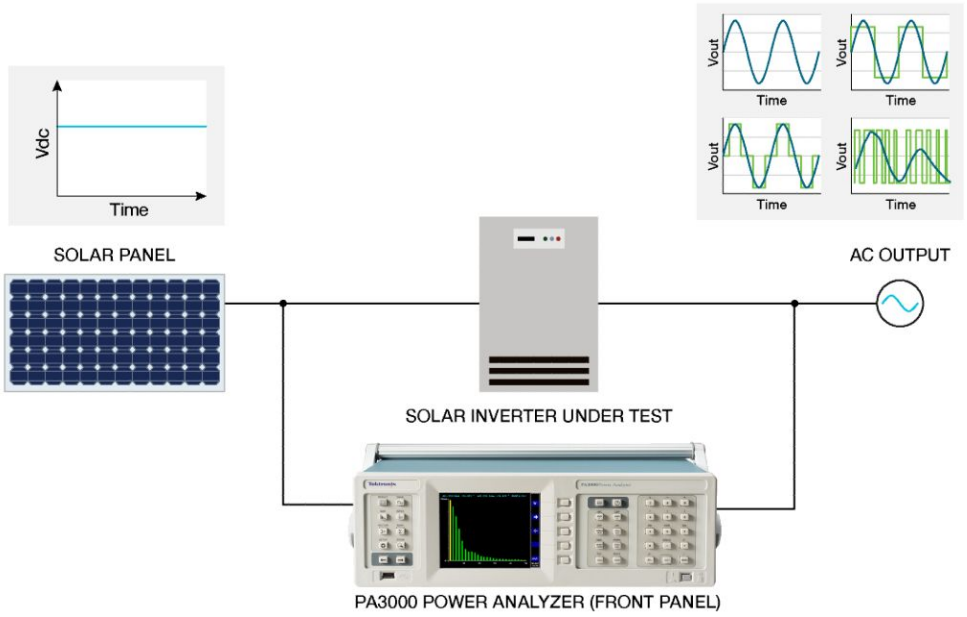
- 90 µA current measuring capability and various ranging features for standby power testing on modern appliances
- Full compliance IEC 62301 standby power standard test with device uncertainty calculations as required by the standard
- Long averaging enables stable standby power results
- Auto-up ranging mode enables gap-less measurement



Dedicated Standby Power testing mode and Integrator mode

Solar inverters and UPS systems

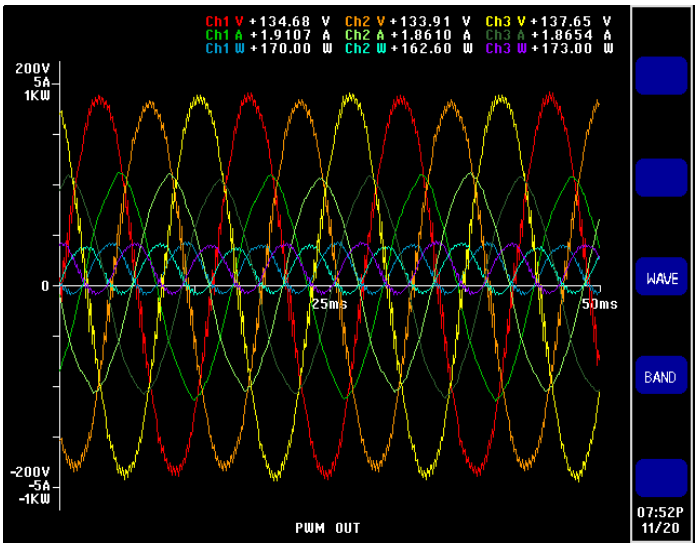
Key requirements include system efficiency testing and single or three-phase output waveform analysis. The PA3000 enables long-term datalogging in PWRVIEW software or to a USB memory stick.



Example test configuration and measurement results for testing solar inverters and UPS systems

System Efficiency testing

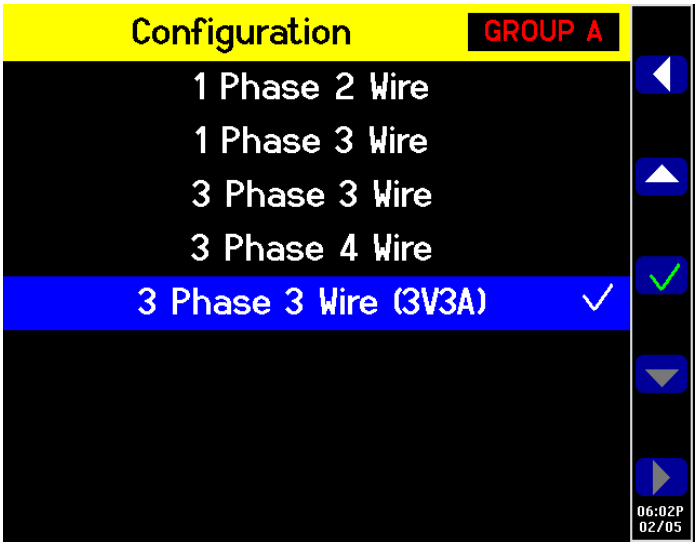
- Up to four channels for simultaneously measuring all the stages of a UPS system or solar inverters
- High AC (0.04%) and DC (0.05%) basic accuracy for accurate measurements on all conversion stages
- 90 µA-30 A direct current measurement enables testing on wide range of loads
- Available high accuracy current transducers enable high power testing in kilowatt range
- Waveform view enables monitoring all phases simultaneously on single and three phase systems



Three phase waveform view

Output Voltage and Power Analysis (1θ & 3θ)

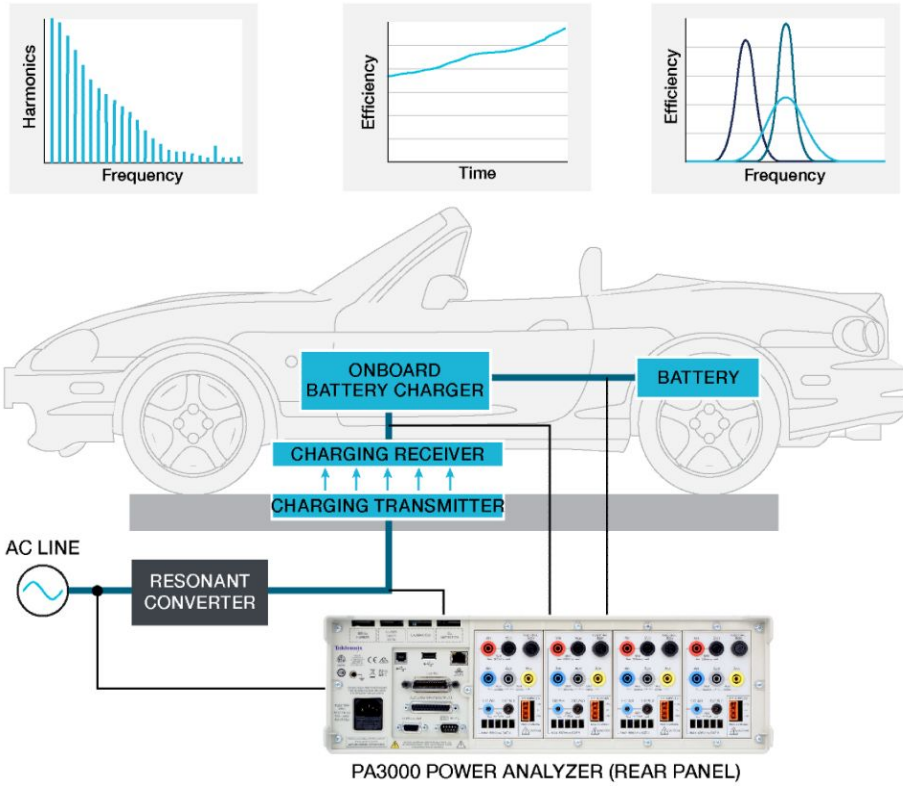
- Default wiring configurations for single and three phase systems make it easy to setup and test complex voltage and power parameters
- 3 Phase 3 Wire (3V3A) configuration allows star delta conversion for line to line voltage, line to neutral voltage and phase or neutral current measurement.
- Voltage crest factor, VTHD and harmonics up to 100th order enable analyzing output voltage for various load conditions
- Trend charts in PWRVIEW software for long term monitoring
- Data logging via USB flash drive or PWRVIEW software for logging tracking data over a long period.



Default wiring configuration choices

Wired and wireless automotive battery chargers

Key tests include efficiency and harmonic analysis. The 4-channel PA3000 enables testing power at each stage of the wireless charging system, including transmitter and receiver.



Example test configuration and measurement results for testing wireless automotive battery chargers

Efficiency testing

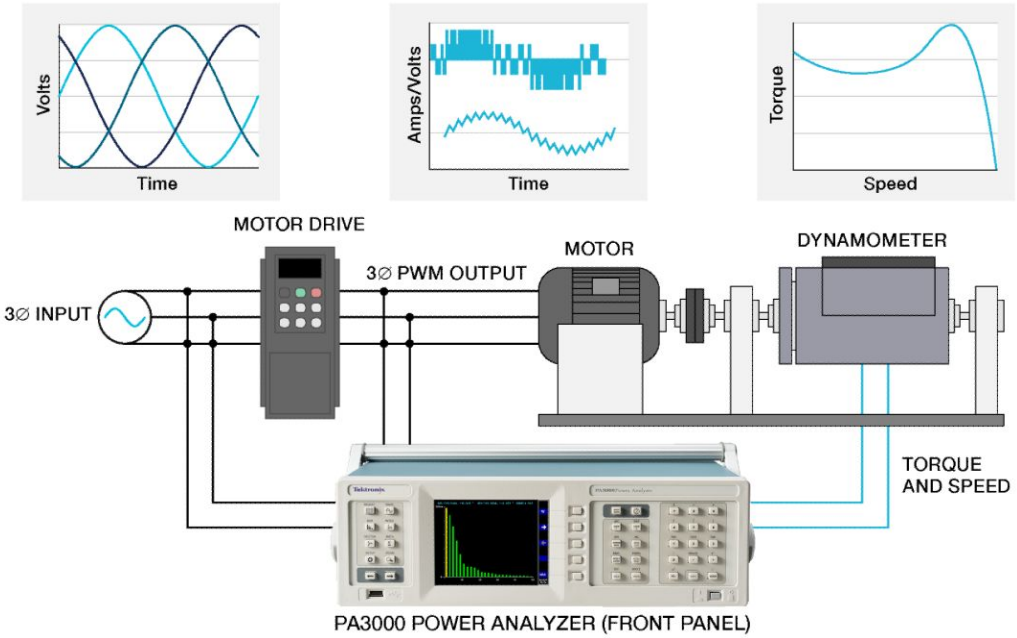
- High AC (0.04%) and DC (0.05%) basic accuracy for accurate measurements on all battery charger stages
- 30 A internal shunt and available high accuracy current transducers for high power testing in kilowatt range
- Standard ±15 V power supply on the back panel to power external current transducers
- Up to four channels enable testing power on each stage of wireless charger including the transmitter and the receiver
- Dedicated efficiency measurement on PWRIVEW software and Math function on PA3000 enable easy setup
- 1 MHz bandwidth enables accurate RMS and efficiency measurements for high frequency transmitter and receiver power signals

Harmonic analysis

- 1 MHz bandwidth enables harmonic analysis on wireless chargers with KHz fundamental frequency on transmitter and receiver
- Voltage, current and power harmonics to 100th order with THD and distortion factor to analyze distorted input and output signals

Three phase motor drives

Key tests include output power, efficiency, and harmonic analysis. The PA3000's PWRVIEW software offers wizard-driven setups to simplify 3-phase 3-wire and 3-phase 4-wire test configurations.



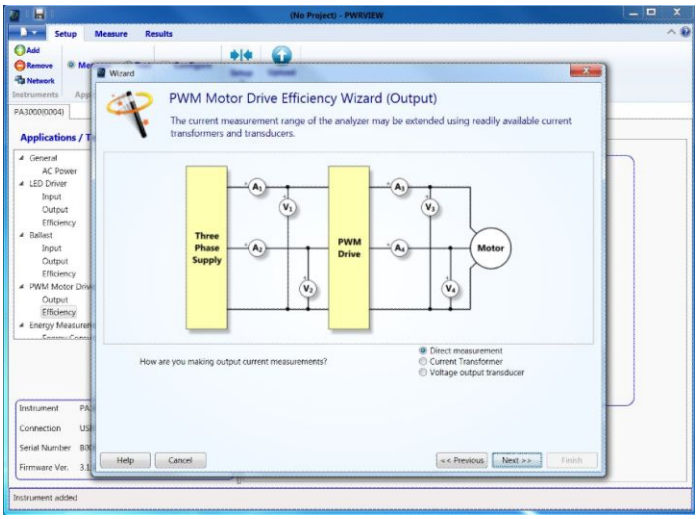
Example test configuration and measurement results for testing three-phase motor drives

Output power

- Dedicated PWM Motor drive mode to test output voltage waveforms
- High frequency sampling with digital filtering in PWM mode, to reject the carrier frequency and detect the motor frequency while still using pre-filtered data for all measurements
- Optimized for steady-state three phase power measurements on the output.

Efficiency testing

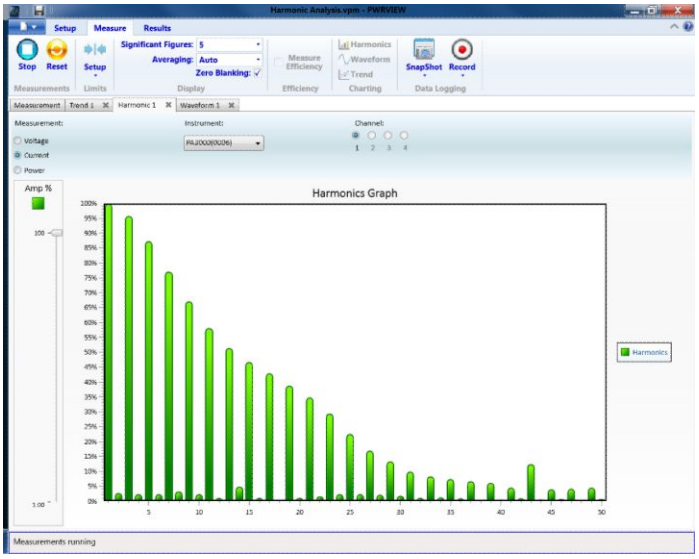
- Dedicated application wizard on PWRIVEW software and Math function on PA3000 enable easy setup for motor drive efficiency
- Available 3 Phase 3 Wire configuration makes it easy to measure three phase inputs and outputs with four channels for system efficiency
- Four analog inputs rated at ±10 V and two counter inputs with 1 MHz bandwidth for torque and speed measurements enable measuring complete mechanical system efficiency
- 30 A internal shunt and available high accuracy current transducers for high power testing in kilowatt range
- Standard ±15 V power supply on the back panel to power external current transducers



PWM Motor Efficiency Wizard in the PWRVIEW software

Harmonic analysis

- Accurate frequency detection from 0.1 Hz – 1 MHz enables accurate frequency and harmonic measurements from low to high motor speeds
- Voltage, current and power harmonics to 100th order with THD and distortion factor to analyze distorted input and output signals and understand the heating effects of the signal

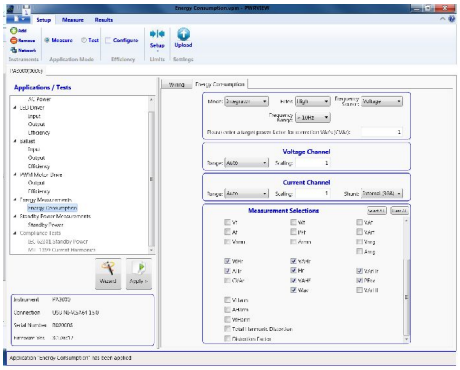


PWRVIEW Harmonic analysis

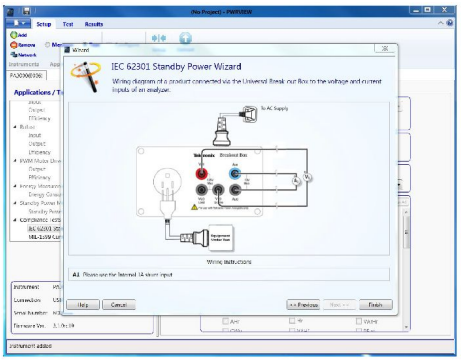
PWRVIEW PC software

PWRVIEW is a supporting software application for Windows PCs that compliments and extends the functionality of the PA3000. PWRVIEW enables you to do the following:

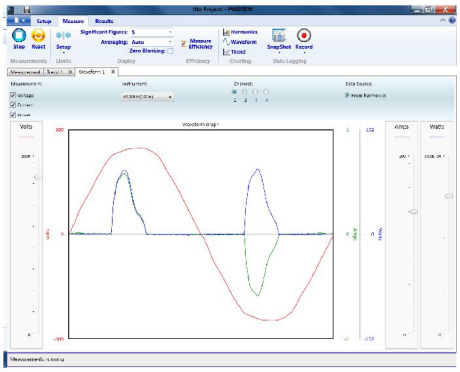
- Communicate with the PA3000 over any of the instrument's comm ports (USB, LAN, GPIB, RS-232)
- Change instrument settings remotely
- Transfer, view, and save measurement data in real-time from the instrument, including user-defined hi/lo limit waveforms, harmonic bar charts, and plots
- Log measurement data over a period of time or with manual trigger
- Communicate with and download data from multiple PA3000 instruments simultaneously
- Create formulas for the calculation of power conversion efficiency and other values
- Export measurement data to .csv format for importing into other applications
- Automate instrument setup, data collection, and report generation for key applications with just a few clicks, using wizard-driven interfaces
- Perform automated full compliance testing for Low Power Standby per IEC62301 ED 2.0 and MIL-STD-1399-Section 300B
- Additional information for using PWRVIEW is available in the built-in online help or can be downloaded as a PDF file from the Tektronix Web site. Go to www.tek.com/manual/downloads and search for PWRVIEW Online Help (Tektronix part number 077-1165-00).



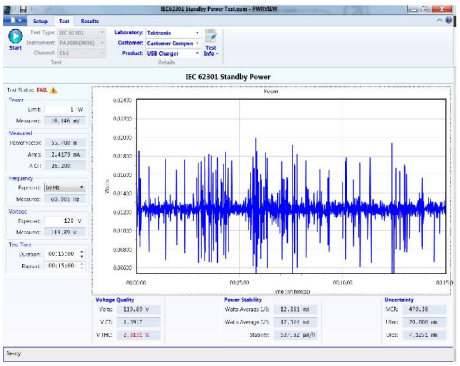
PWRVIEW setup page with variety of default applications and tests



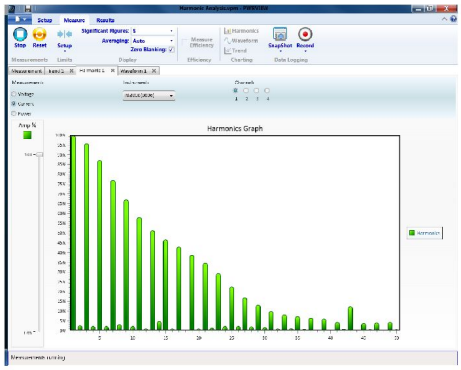
Application wizards for easy and accurate test setup



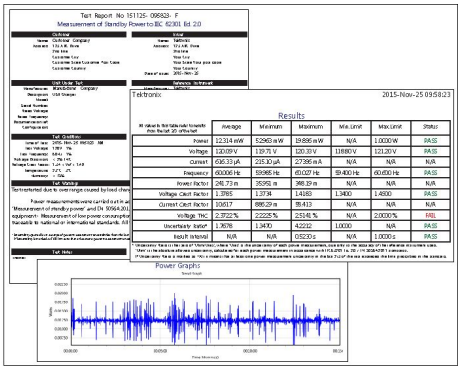
Waveform view for graphical analysis



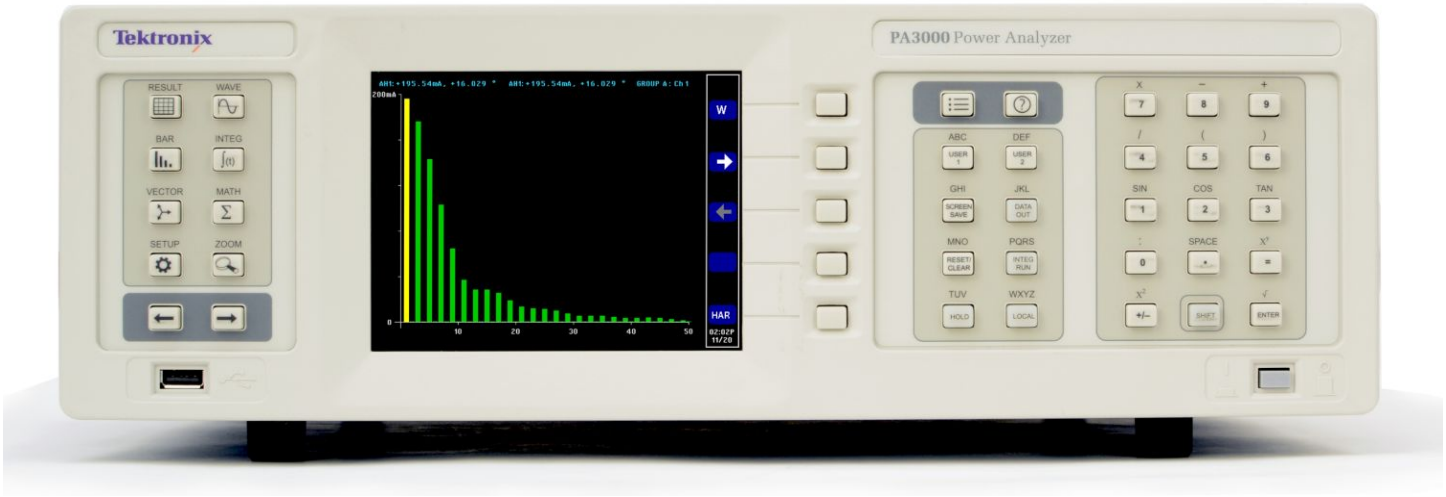
IEC62301 Standby power testing with real-time uncertainty and stability measurements



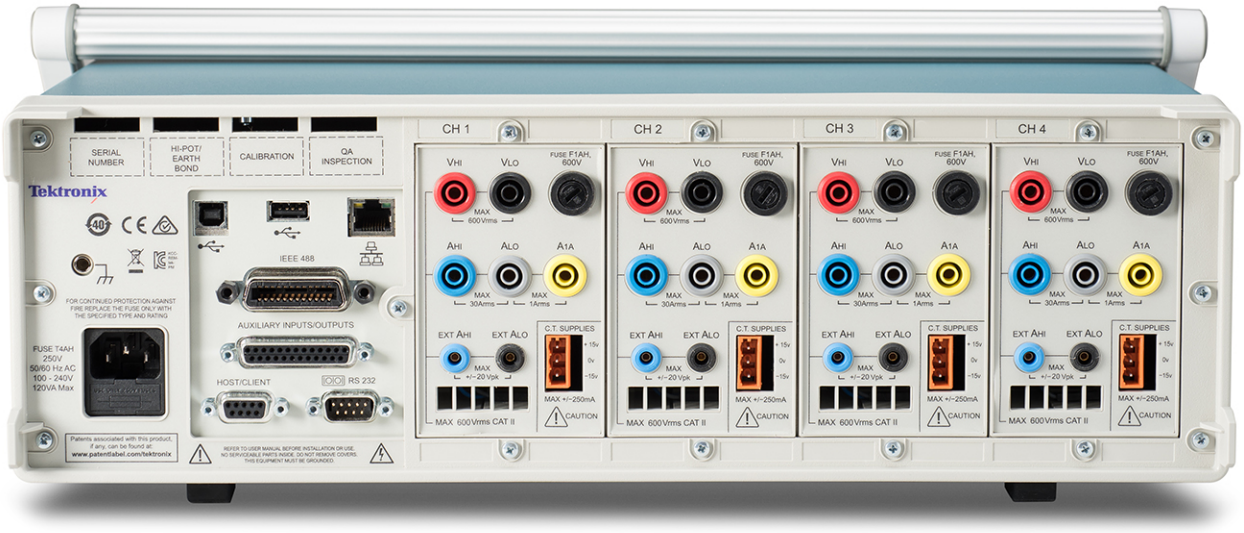
Harmonic analysis to the 100th order with user-definable limits



Formatted test reports to prove design performance



PA3000 front panel



PA3000 rear panel with four input channels and optional GPIB interface

Available measurements

V_{rms} – Volts RMS	A_{cf} – Amps crest factor	VAH_f – Fundamental VA hours
A_{rms} – Amps RMS	V_{thd} – Volts total harmonic distortion	VA_rH_f – Fundamental VAr hours
Watt – Watts	V_{df} – Volts distortion factor	V_f – Fundamental volts rms
VA – Volts-Amps	V_{tif} – Volts telephone influence factor	A_f – Fundamental amps rms
VA_r – Volts-Amps reactive power	A_{thd} – Amps total harmonic distortion	W_f – Fundamental power
Freq – Frequency	A_{df} – Amps distortion factor	VA_f – Fundamental apparent power
PF – Power factor	A_{tif} – Amps telephone influence factor	VA_{rf} – Fundamental reactive power
V_{pk+} – Volts peak (positive)	Z – Impedance	PF_f – Fundamental power factor
V_{pk-} – Volts peak (negative)	R – Resistance	V_{rng} – Voltage range
A_{pk+} – Amps peak (positive)	X – Reactance	A_{rng} – Amps range
A_{pk-} – Amps peak (negative)	Hr - Hour	V_{ll} – Voltage Line-to-Line
V_{dc} – DC Volts	WHr – Watt hours	V_{ln} – Voltage Line-to-Neutral
A_{dc} – DC Amps	VAHr – VA hours	A_n -- Neutral current (or phase 3 current for 3p3w)
V_{rmn} – Volts rectified mean	VA_rHr – VAr hours	V Harmonics – Voltage harmonics
A_{rmn} – Amps rectified mean	AHr – Amp hours	A Harmonics – Amps harmonics
V_{cmn} – Volts corrected rectified mean	W_{av} – Average watts	W Harmonics – Watts harmonics
A_{cmn} – Amps corrected rectified mean	PF_{av} – Average power factor	
V_{cf} – Volts crest factor	CVA_r – Correction VAr	

Measurement channels

One to four channels, factory configurable

Voltage connections (4 mm safety banana jack inputs)	Measurements to 600 V_{rms}, DC to 1 MHz, continuous Measurements to 2000 V_{pk}, maximum crest factor of 10
30 A current connection (4 mm safety banana jack inputs)	Measurements to 30 A_{rms}, DC to 1 MHz, continuous Measurements to 200 A_{pk}, maximum crest factor of 10 Measurements to 75 A_{rms} for 1 s non-repetitive
1 A current connection (4 mm safety banana jack inputs)	Measurements to 1 A_{rms}, DC to 1 MHz, continuous Measurements to 5 A_{pk}, maximum crest factor of 10 Measurements to 2 A_{rms} for 1 s non-repetitive
External current connection (2 mm safety banana jack inputs)	Measurements to 20 V_{pk}, DC to 1 MHz, continuous Measurements to 50 V_{pk} for 1 s
Analog card power supply outputs	±15 V supply ±15 V ±5%, 250 mA max (protected) per analog card output
Each measurement channel includes a set of 4 mm stackable banana safety test leads and 2 mm stackable banana safety test leads.	

Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise. Specifications are subject to change without notice.

For detailed information on the PA3000 Power Analyzer product specifications refer to the Model PA3000 Power Analyzer Instrument Specifications document, Tektronix part number 077-1252-00 downloadable from www.tek.com/manual/downloads.

Current accuracy

Accuracy A_{rms}	(45 Hz to 850 Hz)
1 A shunt	±0.04% reading ±0.04% range
30 A shunt	±0.04% reading ±0.04% range
External shunt	±0.1% reading ±0.04% range
Accuracy A_{rms}, typical	(10 Hz to 45 Hz, 850 Hz to 1 MHz)
1 A shunt	$\pm(0.05 + 2\times10^{-5} \times f)$% reading ±0.05% range ±40 µA
30 A shunt	$\pm(0.05 + 2\times10^{-5} \times f)$% reading ±0.05% range ±4 mA
External shunt	$\pm(0.1 + 2\times10^{-5} \times f)$% reading ±0.05% range ±1.1 mV
Accuracy A_{dc}	
1 A shunt	±0.05% reading ±0.1% range ±100 µA
30 A shunt	±0.05% reading ±0.1% range ± 10mA
External A shunt	±0.1% reading ±0.1% range ±1.1 mV
Ranges	(peak)
1 A shunt	12.5 mA, 25 mA, 50 mA, 125 mA, 250 mA, 500 mA, 1.25 A, 2.5 A, 5 A
30 A shunt	500 mA, 1 A, 2 A, 5 A, 10 A, 20 A, 50 A, 100 A, 200 A
External A shunt	50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, 10 V, 20 V

Voltage accuracy

Accuracy V_{rms} (45 Hz to 850 Hz)	±0.04% reading ±0.04% range
Accuracy V_{rms} (10 Hz to 45 Hz, 850 Hz to 1 MHz), typical	$\pm(0.05 + 1\times10^{-5} \times f)$% reading ±0.05% range ±20 mV
Accuracy V_{dc}	±0.05% reading ±0.1% Range ±50 mV
Ranges (peak)	5 V, 10 V, 20 V, 50 V, 100 V, 200 V, 500 V, 1000 V, 2000 V

Supplemental characteristics

The following specifications are supplemental characteristics that provide additional information about instrument functions and performance. These characteristics are non-warranted specifications; they describe the typical performance of the PA3000.

For detailed information on the PA3000 Power Analyzer product specifications refer to the Model PA3000 Power Analyzer Instrument Specifications document, Tektronix part number 077-1252-00 downloadable from www.tek.com/manual/downloads.

Hours accuracy	±0.0125%
Watts accuracy (45 Hz to 850 Hz)	$\pm(V_{rms}acc \times A_{rms}) \pm(A_{rms}acc \times V_{rms})$
Watt hour accuracy	±(Wattacc + Houracc)
VA accuracy (45 Hz to 850 Hz)	$\pm(V_{rms}acc \times A_{rms}) \pm(A_{rms}acc \times V_{rms})$
PF accuracy	Wacc / VA
Frequency accuracy	
0.1 Hz to 10 Hz	0.1% of reading
10 Hz to 1 MHz	0.5% of reading
Analog inputs	
Ranges	10 V_{dc} range: ±1 V to ±10 V
	V_{dc} range: ±0.1 V to ±1 V
Accuracy	±0.2% of reading ±0.2% of range ±0.005 V
Sample rate	1000 samples per second

Communications

IEEE-488 (Option)	IEEE Std 488.1 compliant
RS-232	Baud rates from 9600 bps, 19200 bps (default), and 38400 bps
	8 bit, No parity, 1 stop bit, hardware flow control
	9 pin male D-type connector
Ethernet	IEEE 802.3 compatible, 10Base-T
	RJ-45 connector with Link and Activity indicators
	TCP/IP connection on port 5025
USB device	USB 2.0 compatible, Full speed (12 Mb/sec)

General specifications

EMC	Conforms to European Union EMC directive
Safety	Conforms to European Union Low Voltage directive
Temperature	
Operating	0 °C to 40 °C (32 °F to 104 °F), 70% relative humidity up to 31 °C (87.8 °F)
Storage	-25 °C to 65 °C (-13 °F to 149 °F)
Altitude	Up to 2000 m (6562 ft) above sea level
Warm up time	One hour
Calibration period	One year
Power supply	100 V to 240 VAC, 50 Hz or 60 Hz, 120 VA maximum
Transducer power supply	±15 V, Maximum current 250 mA per analog card
Dielectric strength	Mains supply inlet (Live + Neutral to earth): 1.5 kVAC Voltage measurement inputs : 2 kV_{pk} to earth Current measurement inputs : 2 kV_{pk} to earth
Dimensions	
With handle and feet	14.6 cm high × 45 cm wide × 33.5 cm deep (5.75 in × 17.75 in × 13.2 in)
Without handle and feet	13.2 cm high × 42 cm wide × 33.5 cm deep (5.2 in × 16.5 in × 13.2 in)
Weight	9.5 kg (20.9 lb) – 4 channel instrument with GPIB option installed
Warranty	Three years

Ordering information

PA3000 models

A PA3000 must be ordered with one of the following options:

Opt. 1CH	One input module installed
Opt. 2CH	Two input modules installed
Opt. 3CH	Three input modules installed
Opt. 4CH	Four input modules installed

Standard accessories

- Lead Set (one per input module)
- Country-specific power cord
- Power output for external current transducers
- USB Host - to - Device interface cable
- Certificate of calibration documenting traceability to National Metrology Institute(s) and ISO9001 Quality System Registration
- Three year product warranty

Options

Opt. GPIB	GPIB Interface

Language options

No language options. Translated manuals can be downloaded from the Tektronix Web Site for the following languages:

- French (Tektronix part number, 077115300)
- German (Tektronix part number, 077115400)
- Japanese (Tektronix part number, 077115500)
- Korean (Tektronix part number, 07711600)
- Simplified Chinese (Tektronix part number, 077115700)
- Spanish (Tektronix part number, 077116000)
- Portuguese (Tektronix part number, 077116100)

Power cord options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A4	North America power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 50/60 Hz)
Opt. A10	China power plug (50 Hz)

Opt. A11	India power plug (50 Hz)
Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. G3	Complete Care 3 Years (includes loaner, scheduled calibration, and more)
Opt. G5	Complete Care 5 Years (includes loaner, scheduled calibration, and more)

Recommended accessories

BB1000-UN	Universal breakout box (120 V/240 V)
CT-60-S	Fixed-core current transducer, AC/DC, high accuracy, up to 60 A
CT-200-S	Fixed-core current transducer, AC/DC, high accuracy, up to 200 A
CT-1000-S	Fixed-core current transducer, AC/DC, high accuracy, up to 1000 A
CT-100-M	Fixed-core current transducer, AC/DC, Hall effect, up to 100 A
CT-200-M	Fixed-core current transducer, AC/DC, Hall effect, up to 200 A
CT-1000-M	Fixed-core current transducer, AC/DC, Hall effect, up to 1000 A
CL200	Current clamp, 1 A - 200 A, for Tektronix Power Analyzers, AC only
CL1200	Current clamp, 0.1 A - 1200 A, for Tektronix Power Analyzers, AC only
PA-LEADSET	Replacement lead set for Tektronix Power Analyzers (One channel lead set)

See Accessories datasheet # 55W-30309-0 for more detailed descriptions.

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

GPIB IEEE-488

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Product Area Assessed: The planning, design/development and manufacture of electronic Test and Measurement instruments.

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For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit www.tek.com.

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