

Powertek

PA901

Precision Single-Channel Harmonic Power Analyzer



World Class Accuracy and Bandwidth
Easy-to-Use Touchscreen Operation
All the Data You Need at a Price You Can Afford

Introducing the new PA901 Precision Harmonic Power Analyzer, a refreshingly easy-to-use high performance power analyzer that won't break your budget. The PA901 delivers Single-channel, high-accuracy, wideband performance—to tackle the toughest energy measurement applications. Trust Powertek to deliver world class power measurement capability at a price that is surprisingly affordable.

The PA901

Harmonic Power Analyzer:

Precision + Ease of Use = Affordability

The new PA901 boasts an impressive array of precision power measurement capabilities, yet its color touchscreen user interface is refreshingly easy to use. The accuracy of the PA901 is truly world class—surpassing rival instruments costing triple the price. And when it comes to speed and bandwidth—the PA901 tops the charts with 100 full precision readings per second and measurement bandwidths sufficient to handle 5 MHz waveforms. For tackling tough power factor, low phase angle and high crest factor loads—the PA901 is unbeatable. Offering full performance for crest factors as high as 30:1 - the PA901 places the advantage of superior power measurement capability squarely in the palm of your hands or if you prefer—at the tip of your finger.

The Best Solution for the Toughest Power Measurement Applications

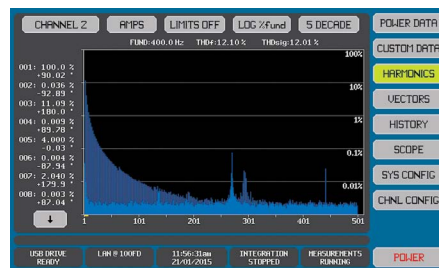
Energy is one of our most precious resources. Design engineers are under constant pressure to increase efficiency and reduce excess product power consumption down to the last mW. Challenging programs like LED and HID lighting, solar panel energy output, efficiency testing on inverters and PWM motor drive systems on electric vehicles—all require fast, precise, reliable power measurement. The un-equalled performance of the PA901 gives you the competitive advantage—the ability to accurately capture



the waveforms and power data you need to squeeze the last drop of extra energy out of your project.

Harmonics Screen

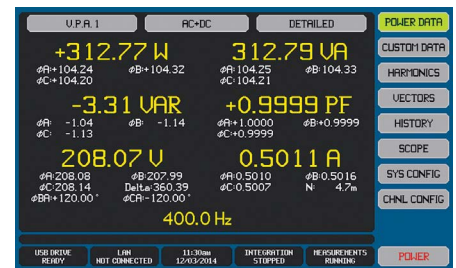
To meet advanced power harmonics requirements, the PA901 displays up to 500 harmonics even at aviation power frequencies. The chart can be set to show linear, relative linear, logarithmic or relative logarithmic amplitudes



Additionally, eight harmonics can be selected for numeric display of amplitude and phase by touching the harmonic bar of interest. The user may also import harmonic limits, which when enabled will show out of tolerance harmonics in red above the limit line.

Power Data Screen

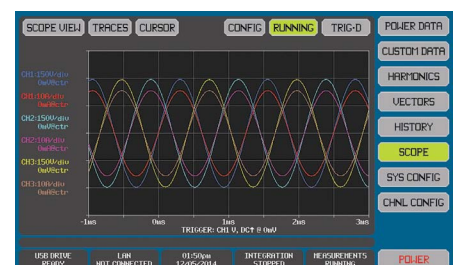
The power data screen, available with one touch, displays V, A, W, VA, VAR and PF data for any selected channel or group of channels known as a Virtual Power Analyzer™ (VPA). Up to three different VPAs can exist in a single PA901. In addition to the primary data, peak readings, phase, CF and other parameters are also available. Integrated



data results (WHr) can also be controlled and viewed from the power data screen. For users with unique data requirements, custom data screens can be built with a spreadsheet application and downloaded to the PA901 via interface or USB drive.

Scope Screen

Scope view offers waveform acquisition and analysis similar to a digital scope. Up to six signals can be displayed, each having



user selectable scaling, offset and color. Timebase, trigger and trigger position are all user selectable. However, with amplitude accuracies as high as 0.03% - you are unlikely to find any other scope with this high level of precision.

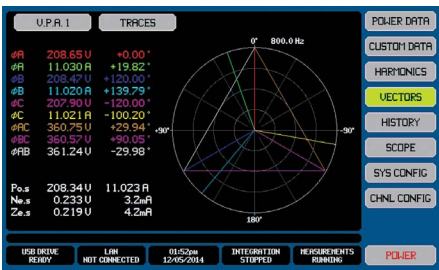
Cycle View



The cycle view represents a single cycle of the voltage and or current periodic waveforms. The above waveforms represent a full 10V square wave in blue and a 50:1 zoomed in view in red. Since the user sets amplitude and scaling - the result is an almost unlimited ability to amplitude zoom to expose fine detail. The sampling is forced to be asynchronous to higher order harmonics which leads to an effective sampling rate of 384MSPS.

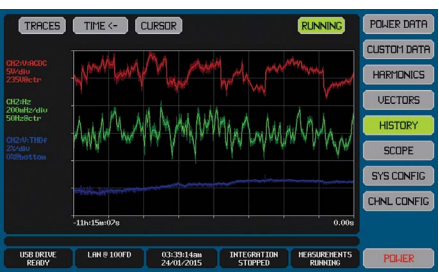
Vector Screen

A polar chart graphically displays the fundamental voltage and current vectors for the selected channel or VPA. For multi-phase VPAs, the inter-phase voltages and



non-measured neutral phase vectors are displayed. The user may enable the display of and select the color of each vector up to a maximum of 10.

History Screen



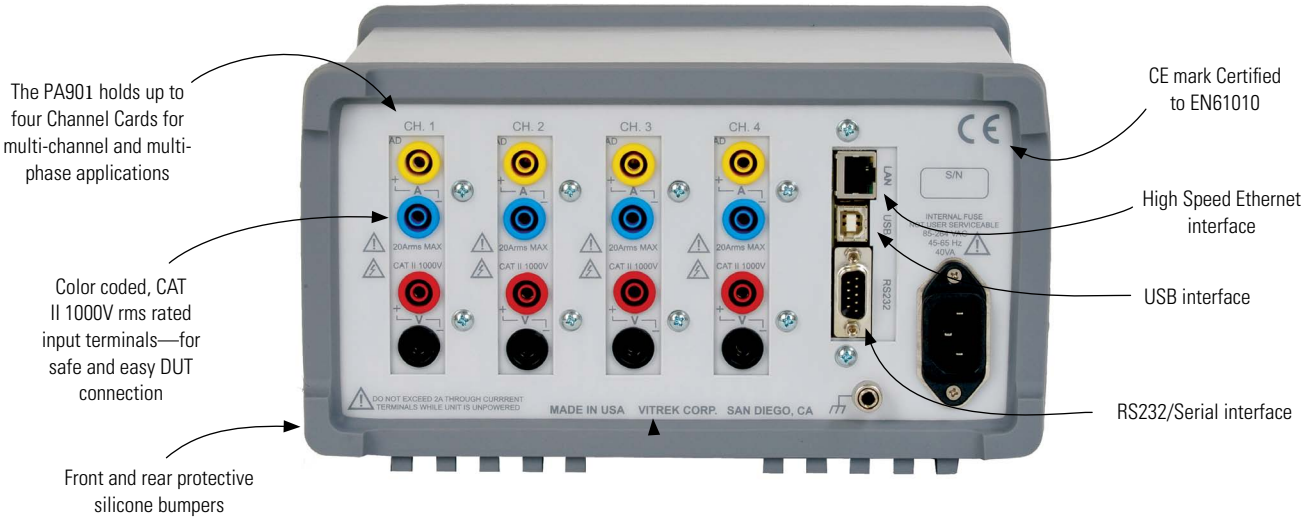
The PA901 automatically maintains a continuous historical record of all non-harmonic measurement results and selected harmonics. Up to four user selectable parameters can be graphically displayed using the HISTORY screen. The user can display the entire recorded period up to 397 days or zoom in as far as 1/64th of the total span. This provides an almost unlimited ability to amplitude zoom and includes a cursor which may be moved throughout the period with a touch of the screen.

Modular Design means Flexibility

The PA901 uses a modular design approach to provide the performance you need at a price that meets your budget. A single PA901 mainframe holds up to 3 Channels of power measurement in any combination of three different Channel types.

- The S type Channel card provides economical, high performance power measurement with a basic 0.1% accuracy and enough bandwidth to handle waveforms up to 1 MHz.
- The A type ultra-precision Channel card offers a two year accuracy rating of 0.03% of reading and bandwidth up to 1 MHz.
- The W type Wideband Channel card performs precision power measurements on the toughest real world waveforms, with sampling speed fast enough to tame waveforms up to 5Mhz

And speaking of flexibility, each of the above Channel cards is available with your choice of three different current input options. The D current input option uses an auto-ranging Dual Shunt system to deliver precision current measurement from as low as 0.1micro-amp resolution on the 1 amp range up to 20 amps rms on the high range. For higher current measurements, the H current input option operates from 10 micro-amp resolution up to 30 amps rms. The X input current option is designed to provide optimum compatibility with a wide range of external shunts and current transducers. Powertek makes it easy for you to configure a harmonic power analyzer that is perfect for your application.



PA901

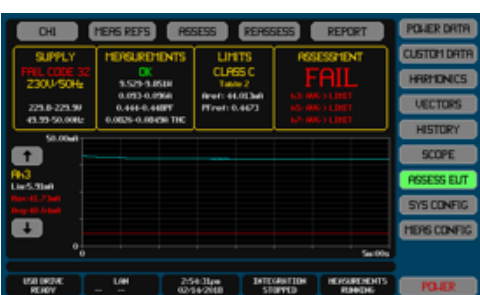
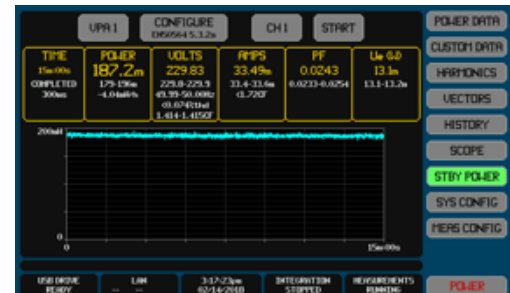
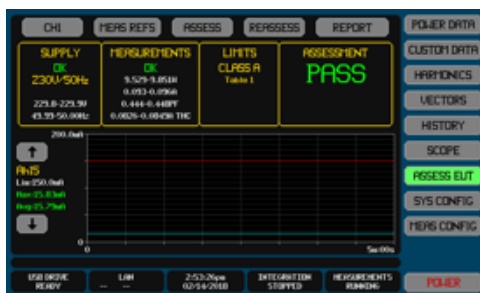
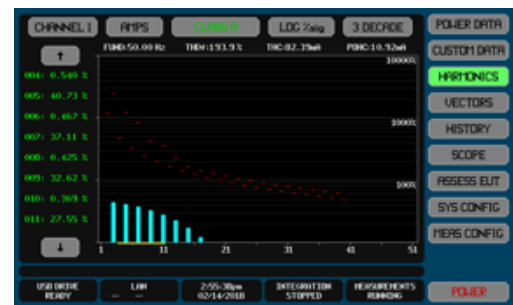
Built-in standards compliance testing

One of the PA901 newest features is the built-in compliance test for various industry leading environmental performance standards. These compliance tests are integrated into the PA901 and are selectable from the touch-screen. The test results can also be displayed on the touch-screen with no requirement for PC-based software.

This on-display feature significantly improves the user interface and efficiency when performing these critical tests. Engineers and technicians enjoy the flexibility of using the touch-screen at the test station with software available if required.

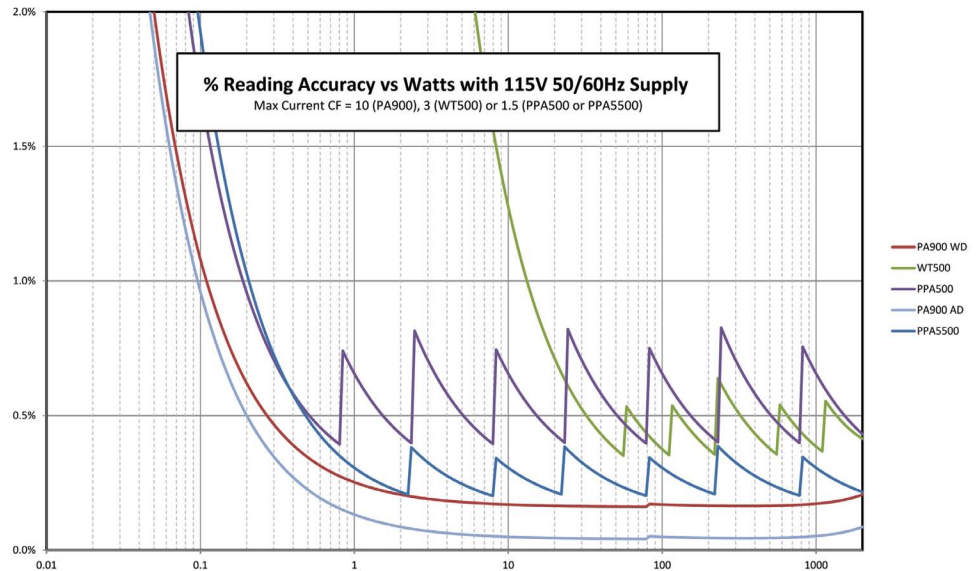
The PA901's built-in compliance testing support environmental/performance standards including:

- EN60034-2-1:2014 (motor drives)
- EN50564:2011 (standby power)
- EN61000-3-2 and 3-12 and 4-7 (harmonics emissions)
- RTCA DO-160E/F/G (avionics)
- Boeing 787B3-0147
- Airbus ABD0100.1.8 (A380) and ABD0100.1.8.1 (A350)



Features

- Most advanced Power Measurement Platform with an unprecedented range of capabilities
- Highest Precision with Industry leading noise floor—as low as 1ppm vs 300ppm or more on competitive units
- Up to 500 Harmonics at 400Hz, meets Airbus avionics power measurement criteria. Bar graph also features fingertip selectable numeric amplitude and phase data
- Large, Hi-Resolution Color Display shows all the data you want with an easy-to-use touchscreen user interface to get you up and testing in no time
- Modular design lets you choose up to 3 Power Measurement Channel Cards in any combination of three different Channel Card types
- The S type Channel Card provides 0.1% basic Accuracy with 1 MHz class bandwidth for an extremely economical price
- The A type Channel Card offers world class 0.03% Accuracy with 1MHz class bandwidth at a very reasonable cost
- The W type Channel Card delivers 5 MHz class bandwidth and a 0.1% basic accuracy
- All Channel Cards types are available with one of 3 current input options: D - Dual Shunt, H - High Current and X - External Current Transducer Input
- Built-in Data Logger—Logs up to 16 selectable data results to USB thumbdrive. Intervals from 10mS to 100 hours with optional time/date stamps
- Power Data Screen - displays V, A, W, VA, VAR and PF data for any selected channel or group of channels
- Custom Power Data Screens - lets you choose the color, font size, location and data you want displayed
- With selectable time base and triggering—Scope View, acts as a digital scope to capture events such as in-rush current
- Cycle View - Represents a single cycle of the voltage and current periodic waveforms sampled over many cycles within a measurement period
- Vector Screen—Displays up to 10 fundamental voltage and current vectors
- History Screen—Like a DVR, the PA901 automatically maintains a continuous historical recording of measurement data. Any data from this record may be viewed or downloaded. Pause, clear and restart functionality is available from the HISTORY screen or via interface
- Effective Sampling Rate - for analysis of periodic signals within a measurement period is 384MSPS
- Measurement Resolution—22 bit for S & W type Channel Cards, 24 bit for A type
- Up to 3 Different Virtual Power Analyzers™ (VPAs) may be



configured for three phase measurements or input/output efficiency tests—so there is no need to interconnect separate units in order to make synchronous or non-synchronous group power measurements

- VPA Efficiency Grouping—Available data includes: Power totals for IN, MIDDLE and OUT efficiency groups, the power loss between any pair of groups, and the percentage efficiency between any pair of groups
- VPA Multi-Channel Wiring—Each VPA may be configured as 2Ø3w (2 ch), 3Ø3w (2 ch), 3Ø3w (3 ch), 3Ø4w (3 ch)
- Connectivity - Ethernet, High Speed Serial and USB (client) control interfaces
- Front Panel USB Drive Interface—Permits data logging to a file, 'screen shot' capture, easy import and export of: display and measurement configurations and custom data screen definitions
- Available MT type Channel Card for motor torque and speed inputs
- CE mark certified to EN61010
- Two year parts and labor warranty, two year accuracy specs and calibration cycle
- Made in the USA

PA901 Performance Specifications

Voltage Input Specifications

		S or A Channel	W Channel
Specified Input Range	DC	0 to ±1000V	0 to ±700V
	AC	0.1 to 1000Vrms	0.1 to 700Vrms
	Peak	<1800V	<1800V
Safe Input Range	<1ms	2500Vrms (<3000Vpk)	2000Vrms (<3000Vpk)
	<100ms	2000Vrms (<3000Vpk)	1500Vrms (<3000Vpk)
	<5s	1500Vrms (<2500Vpk)	1000Vrms (<2500Vpk)
	Cont	1000Vrms (<1800Vpk)	700Vrms (<1800Vpk)
Impedance		1.2MΩ ± 1%	400KΩ ± 1%

Voltage Accuracy Specifications

The voltage input has a single dynamic range which covers the entire specified input range.

	S Channel	A Channel	W Channel
Resolution	0.001V	0.1mV	0.001V
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.005*(F))%rdg 10-40KHz: (0.05+(0.012*(F-10)))%rdg 40-100KHz: (0.41+(0.025*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.002*(F))%rdg 40-100KHz: (0.08+(0.004*(F-40)))%rdg 100-1000KHz: (0.32+(0.013*(F-100)))%rdg
Bandwidth (-3dB)	>700KHz		>2.5MHz
Floor Adder	DC: 0.002V AC<100Hz: 0.003V AC>100Hz: 0.005V	DC: 0.001V AC<100Hz: 0.002V AC>100Hz: 0.005V	DC: 0.003V AC<100Hz: 0.004V AC>100Hz: 0.007V
Self-Heating Adder	0.0005ppm rdg per Vrms ²		0.0015ppm rdg per Vrms ²
Single Harmonic Adder	<10KHz: 0.01%fund + 0.001V <85KHz: 0.05%fund + 0.005V	<10KHz: 0.005%fund + 0.0005V <85KHz: 0.05%fund + 0.005V	<10KHz: 0.015%fund + 0.0015V <100KHz: 0.03%fund + 0.005V <310KHz: 0.08%fund + 0.01V
ΣHarmonic Adder	<10KHz: 0.02%fund + 0.002V <85KHz: 0.1%fund + 0.01V	<10KHz: 0.015%fund + 0.001V <85KHz: 0.15%fund + 0.01V	<10KHz: 0.03%fund + 0.003V <100KHz: 0.06%fund + 0.007V <310KHz: 0.15%fund + 0.015V
CMRR	1uV per V.Hz		0.7uV per V.Hz
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

Current Input Specifications

		H option	D option			X option	
			AUTO range	HI range	LO range	HI range	LO range
Specified Input Range	DC	0 to ±30A	0 to ±20A	0 to ±20A	0 to ±1A	0 to ±15V	0 to ±0.5V
	<100Hz	3mA to 30Arms	10uA to 20Arms	2mA to 20Arms	10uA to 1Arms	800uV to 15Vrms	20uV to 0.5Vrms
	>100Hz	20mA to 30Arms	150uA to 20Arms	15mA to 20Arms	150uA to 1Arms	2mV to 15Vrms	80uV to 0.5Vrms
	Peak	<200A	<50A	<150A	<1A	<18V	<0.5V
Safe Input Range	<1ms	200Arms (<300Apk)	30Arms (<50Apk)	150Arms (<250Apk)	30Arms (<50Apk)	200Vrms (300Vpk)	20Vrms (300Vpk)
	<20ms	75Arms (<300Apk)	20Arms (<50Apk)	50Arms (<200Apk)	20Arms (<50Apk)	50Vrms (300Vpk)	10Vrms (200Vpk)
	<1s	50Arms (<200Apk)	20Arms (<50Apk)	30Arms (<150Apk)	5Arms (<25Apk)	30Vrms (300Vpk)	5Vrms (100Vpk)
	Cont	30Arms	20Arms (<50Apk)	20Arms (<150Apk)	2Arms (<5Apk)	20Vrms (300Vpk)	2Vrms (50Vpk)
	Power Off	As Above	As LO Range			As Above	As HI Range
Impedance		<10mΩ	As HI/LO range	<20mΩ	0.57Ω ± 10%	20.5KΩ ± 1%	10.25KΩ ± 1%

H Option Current Measurement Accuracy Specifications

The H option current input has a single range which covers the entire specified input range.

	S Channel	A Channel	W Channel
Resolution	100uA	10uA	100uA
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.003*(F))%rdg 10-40KHz: (0.03+(0.007*(F-10)))%rdg 40-100KHz: (0.24+(0.02*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.0015*(F))%rdg 40-100KHz: (0.06+(0.003*(F-40)))%rdg 100-1000KHz: (0.24+(0.012*(F-100)))%rdg
Bandwidth (-3dB)	>1.25MHz		>5MHz
Floor Adder	DC: 200uA AC<100Hz: 800uA AC>100Hz: 3mA	DC: 100uA AC<100Hz: 500uA AC>100Hz: 2mA	DC: 300uA AC<100Hz: 1mA AC>100Hz: 4mA
Self-Heating Adder	1.5ppm reading per Arms ²		
Single Harmonic Adder	<10KHz: 0.01%fund + 100uA <85KHz: 0.05%fund + 5mA	<10KHz: 0.005%fund + 80uA <85KHz: 0.03%fund + 5mA	<10KHz: 0.015%fund + 150uA <100KHz: 0.03%fund + 5mA <310KHz: 0.08%fund + 5mA
ΣHarmonic Adder	<10KHz: 0.02%fund + 200uA <85KHz: 0.1%fund + 7mA	<10KHz: 0.015%fund + 150uA <85KHz: 0.15%fund + 7mA	<10KHz: 0.03%fund + 300uA <100KHz: 0.06%fund + 7mA <310KHz: 0.15%fund + 10mA
CMRR	500pA per V.Hz		
V:A Phase	(0.01° + 0.015°*F)		(0.01° + 0.007°*F)
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

D Option HI Range Current Measurement Accuracy Specifications

The D option current input has two ranges, this section covers the HI range which covers the entire specified HI input range.

	S Channel	A Channel	W Channel
Resolution	100uA	10uA	100uA
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.003*F)%rdg 10-40KHz: (0.03+(0.007*(F-10)))%rdg 40-100KHz: (0.24+(0.02*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.0015*F)%rdg 40-100KHz: (0.06+(0.003*(F-40)))%rdg 100-1000KHz: (0.24+(0.012*(F-100)))%rdg
Bandwidth (-3dB)	>1.25MHz		>5MHz
Floor Adder	DC: 200uA AC<100Hz: 500uA AC>100Hz: 2mA	DC: 100uA AC<100Hz: 300uA AC>100Hz: 1.5mA	DC: 300uA AC<100Hz: 700uA AC>100Hz: 3mA
Self-Heating Adder	2ppm reading per Arms ²		
Single Harmonic Adder	<10KHz: 0.01%fund + 70uA <85KHz: 0.05%fund + 3.5mA	<10KHz: 0.005%fund + 50uA <85KHz: 0.03%fund + 3.5mA	<10KHz: 0.015%fund + 100uA <100KHz: 0.03%fund + 3.5mA <310KHz: 0.08%fund + 4mA
ΣHarmonic Adder	<10KHz: 0.02%fund + 150uA <85KHz: 0.1%fund + 5mA	<10KHz: 0.015%fund + 120uA <85KHz: 0.15%fund + 5mA	<10KHz: 0.03%fund + 200uA <100KHz: 0.06%fund + 5mA <310KHz: 0.15%fund + 7mA
CMRR	400pA per V.Hz		
V:A Phase	(0.01° + 0.015°*F)		(0.01° + 0.007°*F)
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

D Option LO Range Current Measurement Accuracy Specifications

The D option current input has two ranges, this section covers the LO range which covers the entire specified LO input range.

	S Channel	A Channel	W Channel
Resolution	1uA	0.1uA	1uA
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.003*F)%rdg 10-40KHz: (0.03+(0.007*(F-10)))%rdg 40-100KHz: (0.24+(0.02*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.0015*F)%rdg 40-100KHz: (0.06+(0.003*(F-40)))%rdg 100-1000KHz: (0.24+(0.012*(F-100)))%rdg
Bandwidth (-3dB)	>1.25MHz		>6MHz
Floor Adder	DC: 2uA AC<100Hz: 3uA AC>100Hz: 10uA	DC: 1uA AC<100Hz: 1.5uA AC>100Hz: 8uA	DC: 3uA AC<100Hz: 4uA AC>100Hz: 15uA
Single Harmonic Adder	<10KHz: 0.01%fund + 0.4uA <85KHz: 0.05%fund + 20uA	<10KHz: 0.005%fund + 0.3uA <85KHz: 0.03%fund + 20uA	<10KHz: 0.015%fund + 0.5uA <100KHz: 0.03%fund + 20uA <310KHz: 0.08%fund + 30uA
ΣHarmonic Adder	<10KHz: 0.02%fund + 1uA <85KHz: 0.1%fund + 30uA	<10KHz: 0.015%fund + 0.7uA <85KHz: 0.15%fund + 30uA	<10KHz: 0.03%fund + 1uA <100KHz: 0.06%fund + 30uA <310KHz: 0.15%fund + 40uA
CMRR	20pA per V.Hz		
V:A Phase	(0.01° + 0.015°*F)		(0.01° + 0.007°*F)
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

X Option HI Range Current Measurement Accuracy Specifications

The X option current input has two ranges, this section covers the HI range which covers the entire specified HI input range.

	S Channel	A Channel	W Channel
Resolution	1uV	0.1uV	1uV
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.003*F)%rdg 10-40KHz: (0.03+(0.007*(F-10)))%rdg 40-100KHz: (0.24+(0.02*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.0015*F)%rdg 40-100KHz: (0.068+(0.004*(F-40)))%rdg 100-1000KHz: (0.308+(0.015*(F-100)))%rdg
Bandwidth (-3dB)	>1.25MHz		>3MHz
Floor Adder	DC: 2uV AC<100Hz: 2uV AC>100Hz: 8uV	DC: 1uV AC<100Hz: 1.5uV AC>100Hz: 5uV	DC: 2uV AC<100Hz: 3uV AC>100Hz: 10uV
Single Harmonic Adder	<10KHz: 0.01%fund + 0.3uV <85KHz: 0.05%fund + 10uV	<10KHz: 0.005%fund + 0.1uV <85KHz: 0.03%fund + 10uV	<10KHz: 0.015%fund + 0.3uV <100KHz: 0.03%fund + 10uV <310KHz: 0.08%fund + 15uV
ΣHarmonic Adder	<10KHz: 0.02%fund + 0.5uV <85KHz: 0.1%fund + 15uV	<10KHz: 0.015%fund + 0.3uV <85KHz: 0.15%fund + 15uV	<10KHz: 0.03%fund + 0.5uV <100KHz: 0.06%fund + 15uV <310KHz: 0.15%fund + 20uV
CMRR	1nV per V.Hz		
V:A Phase	(0.01° + 0.015°*F)		(0.01° + 0.007°*F)
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

X Option LO Range Current Measurement Accuracy Specifications

The X option current input has two ranges, this section covers the LO range which covers the entire specified LO input range.

	S Channel	A Channel	W Channel
Resolution	1uV	0.1uV	1uV
Base Accuracy	0.1%rdg	0.03%rdg	0.1%rdg
Frequency Adder	0.01-1Hz: 0.05%rdg <10KHz: (0.003*F)%rdg 10-40KHz: (0.03+(0.007*(F-10)))%rdg 40-100KHz: (0.24+(0.02*(F-40)))%rdg		0.01-1Hz: 0.1%rdg <40KHz: (0.0015*F)%rdg 40-100KHz: (0.068+(0.004*(F-40)))%rdg 100-1000KHz: (0.308+(0.015*(F-100)))%rdg
Bandwidth (-3dB)	>1.25MHz		>3MHz
Floor Adder	DC: 2uV AC<100Hz: 2uV AC>100Hz: 8uV	DC: 1uV AC<100Hz: 1.5uV AC>100Hz: 5uV	DC: 2uV AC<100Hz: 3uV AC>100Hz: 10uV
Single Harmonic Adder	<10KHz: 0.01%fund + 0.3uV <85KHz: 0.05%fund + 10uV	<10KHz: 0.005%fund + 0.1uV <85KHz: 0.03%fund + 10uV	<10KHz: 0.015%fund + 0.3uV <100KHz: 0.03%fund + 10uV <310KHz: 0.08%fund + 15uV
ΣHarmonic Adder	<10KHz: 0.02%fund + 0.5uV <85KHz: 0.1%fund + 15uV	<10KHz: 0.015%fund + 0.3uV <85KHz: 0.15%fund + 15uV	<10KHz: 0.03%fund + 0.5uV <100KHz: 0.06%fund + 15uV <310KHz: 0.15%fund + 20uV
CMRR	1nV per V.Hz		
V:A Phase	(0.01° + 0.015°*F)		(0.01° + 0.007°*F)
Inter-Channel Phase	(0.02° + 0.15°*F)		(0.02° + 0.07°*F)

Common Input Specifications

Specifications apply to the inputs of all channel types and current options.

- Isolation From any V or A terminal to PA901 chassis ground
- Impedance : >1GΩ||<30pF
- 4500Vpk max without damage
- 2500Vrms max for <1s without damage
- 1000Vrms max continuous rated working voltage (CAT I/II)
- 600Vrms max continuous rated working voltage (CAT III)
- 300Vrms max continuous rated working voltage (CAT IV)

Crest Factor Specifications valid for crest factors <30:1 unless otherwise limited by the specified input range

Watts, VAR and VA Measurement Accuracy Specifications

Fundamental Phase Adder (for W or VAR only, typically can be ignored for active loading where the PF is reduced by distortion rather than phase shift. K is 0.3 for Watts, harmonic VAR and harmonic VA otherwise 1.0.

	S Channels	A Channels	W Channels
Base Accuracy	0.17%rdg	0.05%rdg	0.17%
Frequency Adder	Add Frequency Adders for voltage and current		
Floor Adder	DC: Vdc*(DC Current Floor Adder) + Adc*(DC Voltage Floor Adder) + (DC Voltage Floor Adder)*(DC Current Floor Adder) AC: Vac*K*(AC Current Floor Adder) + Aac*K*(AC Voltage Floor Adder)		
Fundamental Phase Adder	Watts: Vfund*(PFfund - cos(cos ⁻¹ (PFfund) + V:A phase for current input)) VAR: Vfund*((1-PFfund) - cos(cos ⁻¹ (1-PFfund) + V:A phase for current input))		
Self-Heating Adder	Add Self-Heating Adders for voltage and current		
Single Harmonic Adder	Add Single Harmonic Adders for voltage and current		
ΣHarmonic Adder	Add ΣHarmonic Adders for voltage and current		

Power Factor Measurement Accuracy Specifications

For a non-unity power factor due to non-linearity in the load. Max. Error = $PF - ((W + \text{the AC Floor Adder portion with } K = 0.3) / (VA + \text{the AC Floor Adder portion with } K = 1.0))$

Voltage and Current Signal Sampling

Rate	245KSPS nominal (900KSPS nominal for W channels)
Resolution	22 bits (S and W channels) or 24 bits (A channels)
Measurement Gaps	No inter-measurement gaps (100% signal coverage), for all non-harmonic measurements
Synchronization Accuracy	Both measurement period and rate are adjusted such that there is synchronization to within $\leq \pm 5\text{ppm}$ of an integer number of fundamental cycles
Asynchronization	Both measurement period and rate are adjusted such that there is no synchronization to $> 500\text{Hz}$ periodic signal content other than the fundamental frequency
Sampling Jitter	Sampling is deliberately jittered such that the relative time of any given sample in a measurement period varies by up to $\pm \frac{1}{2}$ a sample period but the net effect is zero when averaged over the entire measurement period. The jitter is quasi-random such that there are no sub-measurement period periodic elements within the actual sampling rate.
Inter-Input Difference	The V and A inputs of each channel are sampled to ensure that the signals at the terminals are sampled nominally within $\leq \pm 5\text{ns}$ of each other (equivalent of $\pm 0.0018^\circ$ per KHz phase)
Inter-Channel Difference	All channels within each Virtual Power Analyzer are sampled to ensure that the signals at the terminals are sampled nominally within $\leq \pm 20\text{ns}$ of each other (equivalent of $\pm 0.0072^\circ$ per KHz phase)
Effective Sampling Rate	Including the effects of jittered sampling, the overall effective sampling rate for analysis of periodic signals within a measurement period is 384MSPS.

Phase and Frequency Compensation

No phase or frequency compensation of samples is performed after sampling. Each signal is independently sampled to produce synchronous sampling at the terminals of the PA901.

Virtual Power Analyzers™

The PA901 is actually three power analyzers in a single mainframe with a single user interface. These are called Virtual Power Analyzers or VPAs. Channels may be configured in any one (or none) of the 3 VPAs. Each VPA may be configured for up to all channels installed. Each VPA is independently configured for multi-channel wiring configuration, signal filtering, default measurement coupling, display results smoothing and significant digits, VA/VAR combine method, and efficiency grouping.

Each virtual power analyzer may be configured as having one of the following synchronizations to the other virtual power analyzers—

- Totally asynchronous to the other virtual power analyzers in all aspects.
- Fully synchronous to another virtual power analyzer (identical sampling, measurement period and fundamental frequency).
- Totally asynchronous to the other virtual power analyzers but using the fundamental frequency established in another virtual power analyzer.

Virtual Power Analyzer Wiring

Each virtual power analyzer may be configured for the following multi-channel wiring configuration (depending on the number of channels assigned to the virtual power analyzer).

- General (1 to 4 channels), 2ø3w (2 channels), 3ø3w (2 channels), 3ø3w (3 channels) and 3ø4w (3 channels). Total power (W, VA, VAR, and PF) and mean voltage and current results are available in addition to the results for each individual channel. Also, measurements of the inter-phase voltages (A-B, A-C and B-C) and the Efficiency Grouping (IN, MIDDLE and OUT)

Non-Harmonic Analysis

The voltage and current samples are used to perform mathematical analysis of the signals to produce the various non-harmonic measurement results. The precision of the calculations within each measurement period is at least 32 bits for non-accumulated data (e.g. peak measurements) and at least 64 bits for accumulated data (e.g. DC and average rectified measurements) and at least 96 bits for accumulated squared or cross-multiplied data (e.g. RMS and power measurements). Post-measurement calculations are performed using 32 bit precision, except for integrated data which is performed using 64 bit precision.

Non-harmonic measurement results include (for every channel and in most cases totals for every virtual power analyzer)—

DC	Volts, Amps, Watts
AC (RMS)	Volts, Amps, Watts, VA, VAR, Power Factor, Effective Phase
AC+DC (RMS)	Volts, Amps, Watts, VA, VAR, Power Factor, Effective Phase
AC+DC (Rectified)	Volts, Amps
AC+DC (peak)	Volts (peak, hipk and lopk), Amps (peak, hipk and lopk)
AC+DC Crest Factor	Volts, Amps
AC+DC Form Factor	Volts, Amps
Inter-phase	Volts
Neutral	Amps
Load	Impedance (DC, AC and AC+DC), AC series resistance and inductance, AC parallel resistance and capacitance

Inrush Analysis (Maximum Hold)

Applicable non-harmonic measurement results for every channel and for virtual power analyzers have a maximum hold function which accommodates detection and measurement of inrush and similar transient events.

Harmonic Analysis

Harmonic Analysis is performed on each input of each channel configured to do so. There is no restriction on the number of channels configured for harmonic analysis, nor on the number of harmonics analysed (up to the maximum of 100 per channel input standard and 500 per channel input with H500 option).

The voltage and current samples are analysed by means of DFT analysis performed with 48 bit precision and 64 bit accumulation. The DFT is modified from a standard sine/cosine transform by the use of modified sine and cosine tables to account for the jittered samples. The voltage and current samples are sub-sampled and anti-alias filtered as needed. All harmonics of all inputs of all channels within a Virtual Power Analyser are simultaneously analysed to produce consistent multi-channel results.

Harmonic Bandwidth	LF and VLF measurement periods : the smallest of (F/2) or 1Hz Other measurement periods : the smallest of (F/2) or 100Hz Where F is the fundamental frequency
Maximum Harmonic	The smallest of 500th; a frequency of 80KHz (S and A channels) or 305KHz (W channels); or a user configured lower limit (harmonics over the 100th requires option H500)

Harmonics Results	Amplitude and phase for each harmonic for every configured signal. Combined as needed to produce measurement results which includes Volts, Amps, Watts, VAR, PF, Load (fundamental), Inter-phase Phase (fundamental), Inter-phase Volts (fundamental), Neutral Amps (fundamental), THD (relative to fundamental) and THD (relative to AC RMS)
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Integrated Results

Integration may be configured to be manually or automatically timed, from front panel or interface commands, with programmable delay. Historical Data Collection: The PA901 always maintains a record of all non-harmonic results and a selection of the harmonic results internally in volatile memory. This record automatically extends up to 397 days.

Data Logging

The user may select up to 16 measurement results to data log at configured intervals of time to a drive attached to the front panel USB port.

Cycle View

The actual single cycle voltage and current periodic waveforms are provided for frequencies up to the maximum harmonic fundamental frequency.

Scope View

The actual voltage and current waveforms can be captured in a manner similar to that in a digital sampling oscilloscope. Signals can be viewed and configured in the SCOPE screen or interrogated and configured via an interface. Time base, trigger and trigger position, scale and offset are all selectable.

Front Panel Results Screens

The following results screens are available at the front panel of the PA901 using a single 'button' on the screen to select which is being displayed—POWER DATA Screen: This displays V, A, W, VA, VAR and PF data for any selected channel or the totals for any VPA.

CUSTOM DATA Screen

The user may build a custom data screen showing any of the available results from any of the channels and/or analyzers.

HARMONICS Screen

This displays a bar chart showing all available harmonics for any selected signal (V or A) and also a listing of any 8 harmonics numerical amplitudes and phases (scrollable within the available harmonics). If a set of limits is available and has been enabled for the selected signal, the bar chart displays a limit line and also displays any failing harmonics as a red color above the limit.

VECTORS Screen

This displays a polar chart graphically showing the fundamental voltage and current vectors for a selected channel or analyzer

Front Panel USB Drive Interface

The PA901 can interface to an external drive (e.g. a ‘thumb’ or ‘flash’ drive) via the front panel USB port of the PA901. This provides the following capabilities – the ability to import or export a configuration of the PA901, the ability to import or export a custom data screen definition, the ability to data log to a file, the ability to export a ‘screen shot’ from the PA901 and the ability to import or export a set of harmonics limits.

Interfaces

LAN (Ethernet), Serial (RS232), USB (Client) and USB (Host – Front Panel) for mass data storage

Display

7” 800x480pixel (approx. 0.0075” resolution) 18bpp color LCD with a high resolution pressure sensing touch panel.

Channels

Up to four channels, in any combination of types (S, A or W) with any current input options (D, H or X).

Line Power

Installation Category II; 85-264Vrms, 45 to 65Hz, 40VA max.

Safety

Measurement Category EN61010-1 CAT I 1000V; CAT II 1000V; CAT III 600V; CAT IV 300V

Environment

Storage -20 to 75C (non-condensing), Operating 0 to 40C, <85% RH (non-condensing); Pollution Degree 2
Operating Altitude 0 to 2000m (6560ft) ASL

Physical

5.25" (133mm) H x 9.5" (240mm) W x 11" (280mm) D. 7 lbs/ 3.2kg net, 11lbs/5kG shipping.

Accuracy Specification Conditions

Accuracy specifications apply following a 10 minute warm-up period after turning power ON in the PA901 Accuracy specifications are valid for ambient temperatures +/-5C from calibration temperature. Add 0.005% reading/C outside of +/-5C from the calibration temperature. Accuracy specifications are valid for a period of two years after calibration in normal use. Accuracy is given by Base Accuracy + relevant Frequency Adder (if applicable) + relevant

Floor Adder (use both DC and relevant AC floor adders for AC+DC measurements) + Self-Heating Adder + relevant Harmonic Adder (if applicable). For all listed peak voltage and current measurements, accuracy is same but using 10* relevant Floor Adder. In all specifications F is frequency in KHz.

Accessories

A PA901 comes standard with operator manual CD, power cord and a NIST cal cert with no data including all channels. An ISO 17025 accredited cal cert with data and uncertainties is available. Each channels cards include four color coded, heavy duty 1.5 meter alligator to sheathed banana test leads.

Warranty

Two year parts and labor.

Product Configuration Guide

To build a product configuration code for your PA901 add the 2 digit Channel Card codes (comma separated) in the order desired, for up to a maximum of 3 channel cards. The MT type card is available in slot 4 only.

For example a PA903AD,AD,WX,WX configures a PA901 with an AD type card in slots 1 & 2 and a WX type card in slots 3 & 4.

To add advanced computational options, add one or both codes after the last channel card.

Advanced Computational Options

Code	Option
5	H500 500 Harmonics Capability
E	EN61000 Compliance Computations

For example a PA901SH,AX,MT5E configures a PA901 with an SH type card in slot 1, an AX type card in slot 2, an MT type card in slot 4 (MT fits in slot 4 only, so slot 3 is left blank) and the H500 and EN61000 advanced computational options.

For units with all identical cards a product configuration code is not required. However, orders for units with different type channel cards require a configuration code to establish the desired location of each channel card. For orders placed online, please include the configuration code in the comment field.

Ordering Information

Item	Description
PA901	Power Analyzer Mainframe – 4 Channel Capacity
SD	Standard Dual Current Channel Card
SH	Standard High Current Channel Card
SX	Standard External Current Channel Card
AD	Hi Accuracy Dual Shunt Channel Card
AH	Hi Accuracy High Current Channel Card
AX	Hi Accuracy External Current Channel Card
WD	Wideband Dual Current Channel Card
WH	Wideband High Current Channel Card
WX	Wideband External Current Channel Card
MT	Motor Transducer Channel Card
H500	Increases Capability up to 500 Harmonics
EN	Adds Built-in EN61000 Compliance Computations
LPA-1	Universal Load Power Adaptor
HC-7	Hard Carrying/Shipping Case with Die Cut Foam
RM-7	4U (7"H) 19" W Rack Mount Kit
ISO-CALN-C1	Channel Card ISO 17025 Cal with Data (with purchase)

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