

SPECIFICATION CONDITIONS

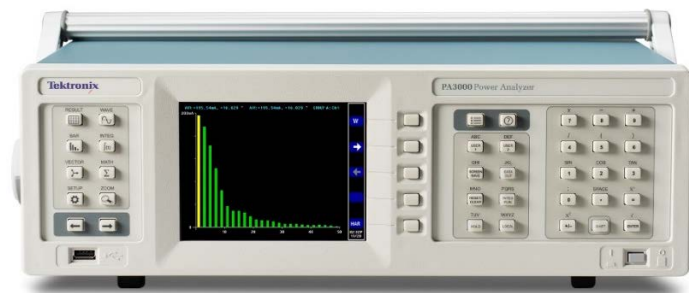
This document contains specifications and supplemental information for the Model PA3000 Power Analyzer. Specifications are the standards against which the Model PA3000 is tested. Upon leaving the factory, the Model PA3000 meets these specifications. Supplemental and typical values are nonwarranted, apply at 23 °C, and are provided solely as useful information.

Source and measurement accuracies are specified at the Model PA3000 terminals under these conditions:

1. 23 °C ± 5 °C, < 70 percent relative humidity
2. After a one-hour warm-up period
3. A/D autozero enabled
4. Averaging set to 10
5. Calibration period: One year

MEASUREMENT CHANNELS

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| Voltage connections | <ul style="list-style-type: none"> ▪ Measurements to 600 V_{rms}, DC to 1 MHz, continuous ▪ Measurements to 2000 V_{pk}, maximum crest factor of 10 |
| 30 A current connection¹ | <ul style="list-style-type: none"> ▪ 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 | <ul style="list-style-type: none"> ▪ 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 | <ul style="list-style-type: none"> ▪ Measurements to 20 V_{pk}, DC to 1 MHz, continuous ▪ Measurements to 50 V_{pk} for 1 s |
| Analog card power supply outputs | <ul style="list-style-type: none"> ▪ ± 15 V supply ▪ ± 15 V ± 5%, 250 mA max (protected) per analog card output |



¹ 30 A DC for 30 minutes maximum. 20 A DC indefinitely

ACCURACY SPECIFICATIONS^{2,3,4}

| | |
|--------------------------------|---|
| <p>Current accuracy</p> | <p>Accuracy A_{rms} (45 Hz – 850 Hz):^{5,6,7}</p> <ul style="list-style-type: none"> ▪ 1 A shunt: $\pm 0.04\%$ reading $\pm 0.04\%$ range ▪ 30 A shunt: $\pm 0.04\%$ reading $\pm 0.04\%$ range ▪ External shunt: $\pm 0.1\%$ reading $\pm 0.04\%$ range <p>Accuracy A_{rms} (10 Hz – 45 Hz, 850 Hz – 1 MHz):^{8,9,10}</p> <ul style="list-style-type: none"> ▪ 1 A shunt: $\pm (0.05 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.05\%$ range $\pm 40 \mu A$ ▪ 30 A shunt: $\pm (0.05 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.05\%$ range $\pm 4 \text{ mA}$ ▪ External shunt: $\pm (0.1 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.05\%$ range $\pm 1.1 \text{ mV}$^{11,12} <p>Accuracy A_{dc}:</p> <ul style="list-style-type: none"> ▪ 1 A shunt: $\pm 0.05\%$ reading $\pm 0.1\%$ range $\pm 100 \mu A$ ▪ 30 A shunt: $\pm 0.05\%$ reading $\pm 0.1\%$ range $\pm 10 \text{ mA}$ ▪ External A shunt: $\pm 0.1\%$ reading $\pm 0.1\%$ range $\pm 1.1 \text{ mV}$ <p>Ranges (peak):</p> <ul style="list-style-type: none"> ▪ 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 |
| <p>Voltage accuracy</p> | <p>Accuracy V_{rms} (45 Hz – 850 Hz):^{5,7,13}</p> <ul style="list-style-type: none"> ▪ $\pm 0.04\%$ reading $\pm 0.04\%$ range <p>Accuracy V_{rms} (10 Hz – 45 Hz, 850 Hz – 1 MHz):^{8,9,10}</p> <ul style="list-style-type: none"> ▪ $\pm (0.05 + 1 \times 10^{-5} \times f)\%$ reading $\pm 0.05\%$ range $\pm 20 \text{ mV}$ <p>Accuracy V_{dc}:</p> <ul style="list-style-type: none"> ▪ $\pm 0.05\%$ reading $\pm 0.1\%$ Range $\pm 50 \text{ mV}$ <p>Ranges (peak):</p> <ul style="list-style-type: none"> ▪ 5 V, 10 V, 20 V, 50 V, 100 V, 200 V, 500 V, 1000 V, 2000 V |

² Temperature coefficient: $\pm 0.02\%$ of reading per $^{\circ}\text{C}$, 0°C to 18°C and 28°C to 40°C

³ To meet specifications in Integration Mode, the unit must be in a fixed range with autozero off

⁴ External shunt impedance is $\leq 10 \Omega$

⁵ Low Bandwidth is on for accuracy specifications $< 850 \text{ Hz}$, if High Bandwidth is on then add 0.1% of range to the specification

⁶ If autozero is off, then add $85 \mu A$ of offset for the 1 A Shunt, 8.5 mA for the 30 A Shunt, or $360 \mu V/Z_{ext}$ for the external shunt

⁷ Specifications are valid only when applicable voltage and current inputs are $> 1\%$ of range

⁸ Typical performance

⁹ Signal level of the frequency source over 50 kHz must be $> 25\%$ of range, otherwise results will show as zero

¹⁰ High Bandwidth is on for accuracy specifications $> 850 \text{ Hz}$

¹¹ External shunt limited to $\leq 100 \text{ kHz}$

¹² Typical Spec. Measurement should be $> 75\%$ of full scale. To optimize performance on the 50 mV range for external shunt, turn the filter on

¹³ If autozero is off, then add 20 mV of offset

Specifications are subject to change without notice

SUPPLEMENTAL CHARACTERISTICS

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

MEASUREMENT CHARACTERISTICS

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| Voltage harmonics accuracy ^{14,15} | $\pm (0.08 + 2 \times 10^{-5} \times f_{nn})\%$ reading $\pm 0.08\%$ range $\pm 0.02V$ |
| Voltage harmonics phase ^{15,16} | <p>With current as phase reference:</p> <ul style="list-style-type: none"> $\pm 0.05^\circ \pm (0.014 \times V_{range}/V_{reading_{nn}})^\circ \pm (7.4 \times 10^{-4} \times f_{nn})^\circ$ <p>With voltage as phase reference:</p> <ul style="list-style-type: none"> $\pm 0.05^\circ \pm (0.014 \times V_{range}/V_{reading_{nn}})^\circ \pm (3.7 \times 10^{-4} \times f_{nn})^\circ$ |
| Current harmonics accuracy ^{14,15} | <p>1 A shunt:</p> <ul style="list-style-type: none"> $\pm (0.08 + 2 \times 10^{-5} \times f_{nn})\%$ reading $\pm 0.08\%$ range $\pm 40 \mu A$ <p>30 A shunt:</p> <ul style="list-style-type: none"> $\pm (0.08 + 2 \times 10^{-5} \times f_{nn})\%$ reading $\pm 0.08\%$ range $\pm 4 \text{ mA}$ <p>External shunt:</p> <ul style="list-style-type: none"> $\pm (0.08 + 2 \times 10^{-5} \times f_{nn})\%$ reading $\pm 0.08\%$ range $\pm 1.1 \text{ mV}$ |
| Current harmonics phase ^{15,16} | <p>With voltage as phase reference:</p> <ul style="list-style-type: none"> $\pm 0.05^\circ \pm (0.014 \times A_{range}/A_{reading_{nn}})^\circ \pm (7.4 \times 10^{-4} \times f_{nn})^\circ$ <p>With current as phase reference:</p> <ul style="list-style-type: none"> $\pm 0.05^\circ \pm (0.014 \times A_{range}/A_{reading_{nn}})^\circ \pm (3.7 \times 10^{-4} \times f_{nn})^\circ$ |
| Voltage peak accuracy | $\pm (0.1 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.15\%$ range $\pm 80 \text{ mV}$ |
| Current peak accuracy | <ul style="list-style-type: none"> 1 A shunt: $\pm (0.1 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.2\%$ range $\pm 400 \mu A$ 30 A shunt: $\pm (0.1 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.2\%$ range $\pm 30 \text{ mA}$ External shunt: $\pm (0.15 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.2\%$ range $\pm 3 \text{ mV}$ |
| Voltage accuracy $V_{r_{mn}}$ | $\pm (0.2 + 2.5 \times 10^{-5} \times f)\%$ reading $\pm 0.1\%$ range $\pm 0.1 \text{ V}$ |
| Current accuracy $I_{r_{mn}}$ | <ul style="list-style-type: none"> 1 A shunt: $\pm (0.2 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.1\%$ range $\pm 200 \mu A$ 30 A shunt: $\pm (0.2 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.1\%$ range $\pm 20 \text{ mA}$ External A shunt: $\pm (0.2 + 2 \times 10^{-5} \times f)\%$ reading $\pm 0.1\%$ range $\pm 100 \mu V/Z_{ext}$ |
| Hour accuracy ¹⁷ | $\pm 0.0125\%$ |
| Watts accuracy (45 Hz – 850 Hz) ¹⁸ | $\pm (V_{rmsaCC} \times A_{rms}) \pm (A_{rmsaCC} \times V_{rms})$ |
| Watt hour accuracy | $\pm (Wattacc + Houracc)$ |
| VA accuracy (45 Hz – 850 Hz) | $\pm (V_{rmsaCC} \times A_{rms}) \pm (A_{rmsaCC} \times V_{rms})$ |
| PF accuracy | $Wacc / VA$ |

¹⁴ High Bandwidth is on for harmonic measurements > 1 kHz

¹⁵ Harmonics are valid when the magnitude of the harmonic is > 2 % of range

¹⁶ Specification is with High Bandwidth on. If Low Bandwidth is on add $0.0002^\circ \times f_{nn}$ to the phase error

¹⁷ To meet specifications in Integration Mode, the unit must be in a fixed range with autozero off

¹⁸ Accuracy specification is for PF = 1. For PF $\neq 1$, see the W Accuracy equation under *Accuracy equations* in the user manual

Specifications are subject to change without notice

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| Frequency accuracy¹⁹ | 0.1 Hz – 10 Hz: <ul style="list-style-type: none"> ▪ 0.1 % of reading 10 Hz – 1 MHz: <ul style="list-style-type: none"> ▪ 0.05 % of reading |
| Effect of common mode | Voltage: <ul style="list-style-type: none"> ▪ 600 V, 60 Hz < 10 mV ▪ 100 V, 100 kHz < 65 mV Current: <ul style="list-style-type: none"> ▪ 600 V, 60 Hz, 30 A shunt < 1 mA ▪ 100 V, 100 kHz, 30 A shunt < 25 mA ▪ 600 V, 60 Hz, 1 A shunt < 25 μA ▪ 100 V, 100 kHz, 1 A shunt < 500 μA ▪ 600 V, 60 Hz, external shunt < 1 mV ▪ 100 V, 100 kHz, external shunt < 20 mV |
| Input impedance | Voltage: <ul style="list-style-type: none"> ▪ Differential input impedance: 1 MΩ 13 pF ▪ High and low impedance to ground: 30 pF 30 A current connections: <ul style="list-style-type: none"> ▪ Shunt Impedance: 5 mΩ ▪ High and low impedance to ground: 45 pF 1 A current connections: <ul style="list-style-type: none"> ▪ Shunt Impedance: 500 mΩ ▪ High and low impedance to ground: 45 pF External current connections: <ul style="list-style-type: none"> ▪ High and low impedance to ground: 45 pF ▪ External Shunt Impedance (Z_{ext}): $\leq 10 \Omega$ |
| Analog inputs | Ranges: <ul style="list-style-type: none"> ▪ 10 Vdc range: ± 1 V to ± 10 V ▪ 1 Vdc range: ± 0.1 V to ± 1 V Accuracy: <ul style="list-style-type: none"> ▪ $\pm 0.2\%$ of reading $\pm 0.2\%$ of range ± 0.005 V Sample rate: <ul style="list-style-type: none"> ▪ 1000 samples per second |

¹⁹ For steady state frequency. If frequency has changed, then allow 3x the update rate for an accurate frequency measurement. See *Update rate* in the user manual

AVAILABLE MEASUREMENTS²⁰

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| V _{rms} – Volts RMS | V _{cf} – Volts crest factor ²¹ | PF _{av} – Average power factor |
| A _{rms} – Amps RMS | A _{cf} – Amps crest factor ²¹ | CVA _r – Correction VAR |
| Watt – Watts ²¹ | V _{thd} – Volts total harmonic distortion ²¹ | VAH _f – Fundamental VA hours |
| VA – Volt-Amps ²¹ | V _{df} – Volts distortion factor ²¹ | VA _{rHf} – Fundamental VAR hours |
| VA _r – Reactive power ²¹ | V _{tif} – Volts telephone influence factor ²¹ | V _f – Fundamental volts rms |
| Freq – Frequency | A _{thd} – Amps total harmonic distortion ²¹ | A _f – Fundamental amps rms |
| PF – Power factor ²¹ | A _{df} – Amps distortion factor ²¹ | W _f – Fundamental power ²¹ |
| V _{pk+} – Volts peak (positive) | A _{tif} – Amps telephone influence factor ²¹ | VA _r – Fundamental apparent power ²¹ |
| V _{pk-} – Volts peak (negative) | Z – Impedance ²¹ | VA _{rf} – Fundamental reactive power ²¹ |
| A _{pk+} – Amps peak (positive) | R – Resistance ²¹ | PF _f – Fundamental power ²¹ |
| A _{pk-} – Amps peak (negative) | X – Reactance ²¹ | V _{rng} – Voltage range |
| V _{dc} – DC Volts | Hr – Hour | A _{rng} – Amps range |
| A _{dc} – DC Amps | WHr – Watt hours | V _{ll} – Voltage Line-to-Line |
| V _{rmn} – Volts rectified mean | VAHr – VA hours | V _{ln} – Voltage Line-to-Neutral |
| A _{rmn} – Amps rectified mean | VA _{rHr} – VAR hours | A _n – Neural amps |
| V _{cmn} – Volts corrected rectified mean | AHr – Amp hours | V Harmonics – Voltage harmonic n |
| A _{cmn} – Amps corrected rectified mean | W _{av} – Average watts | A Harmonics – Current harmonic n |
| | | W Harmonics – Watts harmonic n |

GENERAL SPECIFICATIONS

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|----------------------------|--|
| IEEE-488 (optional) | IEEE Std 488.1 compliant. |
| RS-232 | <ul style="list-style-type: none"> ▪ 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 | <ul style="list-style-type: none"> ▪ IEEE 802.3 compatible, 10Base-T ▪ RJ-45 connector with Link and Activity indicators ▪ TCP/IP connection on port 5025 |
| USB device | <ul style="list-style-type: none"> ▪ USB 2.0 compatible ▪ Full speed (12 Mbits/sec) |

²⁰ Definitional equations available in the user manual

²¹ Accuracy equations available in the user manual

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| USB host | <ul style="list-style-type: none"> ▪ USB flash drive must be formatted with FAT12, FAT16 or FAT32 file ▪ Rear panel USB does not support USB flash drives ▪ Sector size must be 512 bytes. Cluster size up to 32 kB ▪ Only Bulk Only Mass Storage (BOMS) devices which support the SCSI or AT command sets are supported ▪ 250 mA, +5 V supply per port |
| Auxiliary inputs/outputs | <p>Analog inputs: +10 V to -10 V signal on each analog input</p> <ul style="list-style-type: none"> ▪ Pin 1 – Pin 4 : Analog input 1 through Analog input 4 <p>Digital outputs: Each digital output is +5 V TTL with 10 kΩ output impedance</p> <ul style="list-style-type: none"> ▪ Pin 5 – Pin 8 : Digital output 1 through digital output 4 <p>Counter inputs: +10 V to -10V signal on each counter input</p> <ul style="list-style-type: none"> ▪ Pin 9 – Pin 10: Counter input 1 through counter input 2 ▪ Signal must be less than 0.5 V to be a zero ▪ Signal must be greater than 1.5 V to be a one ▪ Duty cycle must be between 20 % and 80 % <p>Ground:</p> <ul style="list-style-type: none"> ▪ Pin 11 – Pin 22: Connected to ground ▪ Pin 23 – Pin 25: Have no connection |
| Transducer power supply | ± 15 V, Max current 250 mA per analog card |
| Power supply | 100 V to 240 V AC, 50 Hz or 60 Hz, 120 VA maximum |
| Warranty | 3 years |
| EMC | Conforms to European Union EMC Directive |
| Safety | NRTL listed to UL61010-1 and UL61010-2-30 Conforms to European Union Low Voltage Directive |
| Environment | <p>Altitude: Maximum 2000 m (6562 ft) above sea level</p> <p>Operating: 0 °C to 40 °C, 70 % relative humidity up to 31 °C, Decreasing linearly to 50 % relative humidity at 40 °C</p> <p>Storage: -25 °C to 65 °C</p> |
| Dielectric strength | <ul style="list-style-type: none"> ▪ 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 | <p>With handle and feet: 14.6 cm high × 45 cm wide × 33.5 cm deep (5.75" × 17.75" × 13.2")</p> <p>Without handle and feet: 13.2 cm high × 42 cm wide × 33.5 cm deep (5.2" × 16.5" × 13.2")</p> |
| Weight | 9.5 kg (20.9 lb.) – 4 channel instrument with GPIB option installed |

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