Model 2250

Phase Angle Voltmeter

Features:

- 700Vpk Reference and Signal Inputs
- Wide Frequency Response
- Isolated Reference and Signal Inputs
- Up to 86 dB Harmonic Rejection
- Ratio Measurement Capabilities
- Total Harmonic Distortion Capabilities
- DFT and Analysis Calculations
- IEEE-488, Recorder Output

Description:

The Model 2250 Phase Angle Voltmeter, also known as a Digital Analyzing Voltmeter is one of the most versatile AC measurement tools in the market. The instrument employs a microprocessor-based design that combines many of the capabilities of today's network/waveform analyzers in a digital voltmeter configuration.

One touch makes highly accurate ratio measurements in both phase-sensitive and voltage modes; measures percent, Total Harmonic Distortion and the magnitude and phase of selected harmonic; computes the percent deviation of a signal from a selected nominal value, plus more. The magnitude of the signal can be displayed in db (20 log 10) relative to either the reference input or a selected value.

Typical Applications:

- ATE
- Harmonic Analysis
- Amplifier Gain & Phase
- Attenuator Linearity Tests
- Accelerometer Testing
- Phase Angle Measurements
- Phase Sensitive Null Detection
- LVDT – RVDT Measurements
- Input – Output Impedance Testing
- Synchro, Resolver, & Transducer Testing
- Transformer Ratio & Phase Tests
- Network Transfer Function Analysis
- Filter Testing – Insertion Loss, Phase Shift measurements of Power and Complex Impedance Phasing of Servo Motors and Servo Systems

SPECIFICATIONS

Item	Specifications
Signal Voltage range	20 mV to 300Vrms* full scale in six ranges.
Maximum signal input	300Vrms, ±400 V dc, total to 700 V peak maximum.
Reference voltage range	2 mV to 300Vrms*, autoranging (no adjustment necessary); ±400 V dc, total of 700 V peak maximum.
Signal autoranging	Upranges at approximately 109% of range. Downranges at approximately 10% of range.
Ratio autoranging	Upranges at 160% of range. Downranges at 10% of range.
Display	0.56-inch LED main display.
Voltage	4-1/2 digits, 0.005% full range resolution.
Phase	+0.0° to +359.99° phase lead, 0.01° resolution or 0.0° ±180° 0.01° resolution.
Frequency range, all modes	10 Hz to 100 kHz.
Operating temperature range	10°C to 40°C ambient temperature.
Warm-up time	30 minutes, for rated accuracy. (Depress "CAL" switch after warm-up period.) Calibration for 10 operating frequencies plus TOTAL (AVG) may be stored in nonvolatile memory.
Voltage and ratio accuracy**	Specified at 23° ±5°C ambient temperature.

*300 V range is actually a 2000 V range with maximum signal limitations of 300 V. Use "2000 V full scale" figures to calculate accuracy specification. DO NOT apply voltages in excess of 300 V.

**Phase sensitive measurements are also affected by phase angle specifications. TOTAL mode voltage and ratio specifications apply within autorange limits only. 35µV TOTAL mode noise specification alters TOTAL mode voltage and ratio accuracy limits on signals measured on 20 mV range.

Item	Specifications
TOTAL (Sum) and Fund Modes	
200V Range and 300V Range (% Full Scale + % Reading)	
10 Hz to 30 Hz	±0.1% FSC + 0.1% rdng
>30 Hz to 1.5 kHz	±0.05% FSC + 0.1% rdng
>1.5 kHz to 5 kHz	±0.06% FSC + 0.12% rdng
>5 kHz to 20 kHz	±0.06% FSC + 0.21% rdng
>20 kHz to 32 kHz	±0.12% FSC + 0.34% rdng
>32 kHz to 54 kHz	±0.12% FSC + 0.8% rdng
>54 kHz to 100 kHz	±0.12% FSC + 1.2% rdng
20 mV (% Full Scale + % Reading)	
10 Hz to 30 Hz	±0.15% FSC + 0.05% rdng
>30 Hz to 1.5 kHz	±0.10% FSC + 0.05% rdng
>1.5 kHz to 5 kHz	±0.12% FSC + 0.06% rdng
>5 kHz to 20 kHz	±0.18% FSC + 0.12% rdng
>20 kHz to 32 kHz	±0.15% FSC + 0.19% rdng
>32 kHz to 54 kHz	±0.15% FSC + 0.5% rdng
>54 kHz to 100 kHz	±0.15% FSC + 0.75% rdng
All Other Ranges (% Full Scale + % Reading)	
10 Hz to 30 Hz	±0.1% FSC + 0.05% rdng
>30 Hz to 1.5 kHz	±0.05% FSC + 0.05% rdng
>1.5 kHz to 5 kHz	±0.06% FSC + 0.06% rdng
>5 kHz to 20 kHz	±0.06% FSC + 0.12% rdng
>20 kHz to 32 kHz	±0.12% FSC + 0.19% rdng
>32 kHz to 54 kHz	±0.12% FSC + 0.50% rdng
>54 kHz to 100 kHz	±0.12% FSC + 0.75% rdng
IN PHASE Mode	

Same as TOTAL (Sum) and FUND specifications above + FUND x $[\cos\theta \cos(\theta-\varphi)]$

e.g., ± 0.12% FSC + 1.2% rdng + FUND x $[\cos\theta \cos(\theta-\varphi)]$

where: θ=Phase angle of input signal
φ=Phase angle accuracy at input frequency

QUAD Mode	

Same as TOTAL (Sum) and FUND specifications above + FUND x $[\sin\theta-\sin(\theta-\varphi)]$

e.g., ± 0.12% FSC + 1.2% rdng + FUND x $[\sin\theta-\sin(\theta-\varphi)]$

where: θ=Phase angle of input signal
φ=Phase angle accuracy at input frequency

Item	Specifications
Total (AVG) Mode	

TOTAL (Avg)	0 to 1/2 Scale	>1/2 Scale to FSC
10 Hz to 26 Hz	0.25% FSC	0.5% reading
>26 Hz to 10 kHz	0.125% FSC	0.25% reading
>10 kHz to 30 kHz	0.25% FSC	0.5% reading
>30 kHz to 100 kHz	0.50% FSC	1.0% reading

Ratio modes

Reference input voltage:
2mVrms to 300Vrms continuous

Ratio range	Full Scale Ratio	Autorange Uprange Point	Maximum Display
.01 R	10.000 x 10^{-3}	16.000	99.999 x 10^{-3}
.1 R	100.00 x 10^{-3}	160.000	999.99 x 10^{-3}
1 R	1.0000	1.6000	9.9999
10 R	10.000	16.000	99.999
100 R	100.00	160.00	999.99
1000 R	1000.0		9999.99

Item	Specifications

NOTE

The Main Display SCALE prompt flags excessive ratio when not in autoranging mode.
Signal and reference voltage ranges always autorange when in ratio mode.

Ratio accuracy	@23± 5°C ambient temperature where: V ref = The actual voltage applied to the REF input. (This may be displayed by going out of Ratio mode and into TOTAL and READ REF.) V rng = The reference voltage range (in volts) being used. (This range is annunciated when the reference voltage is read as described above.) R rng = ratio range R = ratio tolerance

TOTAL (Sum) and FUND modes	200 V Range and 300 V Range	All Other Ranges
10 Hz to 30 Hz	$R = (0.0020\ R_{rng})\ \frac{Vrng}{Vref} + 0.0020 \times Reading$	$R = (0.0020\ R_{rng})\ \frac{Vrng}{Vref} + 0.0010 \times Reading$
>30 Hz to 1.5 kHz	$R = (0.0010\ R_{rng})\ \frac{Vrng}{Vref} + 0.0020 \times Reading$	$R = (0.0010\ R_{rng})\ \frac{Vrng}{Vref} + 0.0010 \times Reading$
>1.5 kHz to 5 kHz	$R = (0.0012\ R_{rng})\ \frac{Vrng}{Vref} + 0.0024 \times Reading$	$R = (0.0012\ R_{rng})\ \frac{Vrng}{Vref} + 0.0012 \times Reading$
>5 kHz to 20 kHz	$R = (0.0012\ R_{rng})\ \frac{Vrng}{Vref} + 0.0042 \times Reading$	$R = (0.0012\ R_{rng})\ \frac{Vrng}{Vref} + 0.0024 \times Reading$
>20 kHz to 32 kHz	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0068 \times Reading$	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0038 \times Reading$
>32 kHz to 54 kHz	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0160 \times Reading$	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0100 \times Reading$
>54 kHz to 100 kHz	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0240 \times Reading$	$R = (0.0024\ R_{rng})\ \frac{Vrng}{Vref} + 0.0150 \times Reading$

Item	Specifications
IN PHASE RATIO	
Add the following to specification (R) listed above:	$R + \frac{\text{SIG FUND}}{\text{REF FUND}} \times \lvert [\cos\theta - \cos(\theta - \varphi)] \rvert$
QUAD RATIO	
Add the following to specification (R) listed above:	$R + \frac{\text{SIG FUND}}{\text{REF FUND}} \times \lvert [\cos\theta - \cos(\theta - \varphi)] \rvert$

where: R = Total (SUM) and FUND mode ratio accuracy listed above
θ = Phase angle of input signal
φ = Phase angle accuracy at input signal

Orthogonality	
10 Hz to 30 Hz	± 0.10°
>30 Hz to 5.0 kHz	± 0.05°
>5.0 kHz to 100 kHz	$\frac{f \text{ (in kHz)}}{100}$ degrees
0 Volt input accuracy	Equal to full scale accuracy spec.
Total mode noise, 20 mV range	35μV maximum.
Nulling sensitivity	1μV
Phase angle accuracy	Accuracy specifications apply in "Autorange" only.
10 Hz to 30 Hz	±0.10°
>30 Hz to 5 kHz	±0.05°
>5 kHz to 100 kHz	$\frac{f \text{ (in kHz)}}{100}$ degrees
Harmonic rejection (Fundamental and phase sensitive modes)	2nd Harmonic: -60 dB 3rd Harmonic: -80 dB All high order harmonics at fundamental frequency of 400 Hz: -86 dB

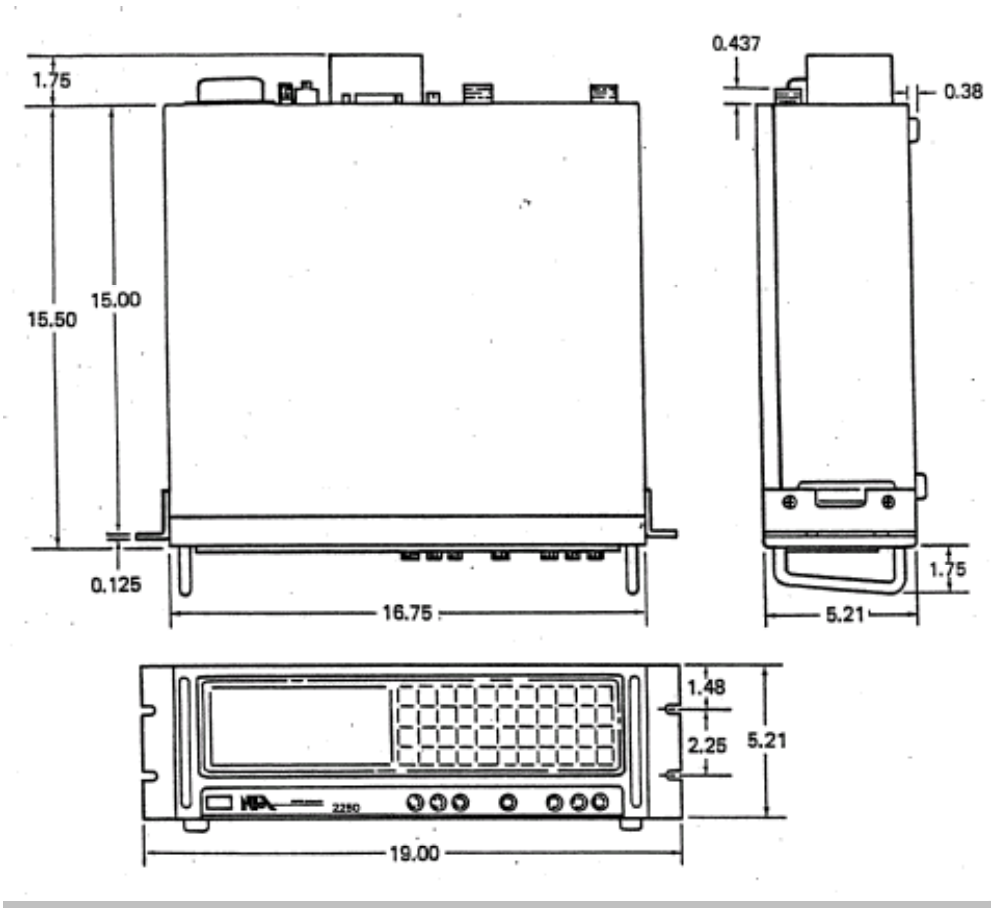
Item	Specifications
Total harmonic distortion Frequency of fundamental 10 Hz to 3.159 kHz 3.16 kHz to 10.599 kHz 10.6 kHz to 28.499 kHz 28.5 kHz to 100 kHz	Harmonics evaluated: 2nd to 30th 2nd to 10th 2nd and 3rd None
THD accuracy (For fundamental frequency of 10 Hz to 10 kHz)*	For THD readings $\geq$2%: ±0.015 x reading For THD readings <2%: $\pm[0.03 + (0.015 \times \frac{VSCALE}{ERMS})]$ where: VSCALE is the voltage scale annunciated ERMS is the signal voltage
THD range of evaluation	0.00% to 999.99%
THD method of evaluation	The 2250 DAV evaluates THD relative to the fundamental by using the harmonics evaluated at the frequency of interest in accordance with the table above and the following formula:
THD formula	$THD = \sqrt{\frac{(Ef2)^2 + (Ef3)^2 + \ldots(Efn)^2}{Ef1}}$ where: Ef1 = true rms voltage of fundamental. Ef2 = true rms voltage of the second harmonic. Efn = true rms voltage of the highest harmonic evaluated for that particular fundamental frequency, per table above.

* See "Harmonics Evaluated" above. Measurements of signals containing high amplitude harmonics of higher orders than those evaluated may incur additional error.

Item	Specifications
THD display	THD may be displayed as percent or in decibels relative to the fundamental.
Random noise measurement	Excluded, as it is not an element of Total Harmonic Distortion.
Harmonic phase:	
Method of measurement	The phase of the selected harmonic component is measured relative to the fundamental of that signal. In READ REF mode, phase angle of the selected harmonic component of the reference is measured relative to the fundamental component of the reference.
Accuracy	The phase accuracy (related to the phase of the fundamental) is n times the fundamental phase specification, where n equals the harmonic order.
Harmonic amplitude	Harmonic amplitude accuracy is equal to the fundamental accuracy specification times n, where n equals the harmonic order.
Filters	The signal and reference channel precision filters allow signals rich in harmonics (including square waves) to be evaluated for fundamental frequency phase-sensitive parameters.
Filters switched in	Filters are automatically switched in when in "FUND", "IN PHASE", "QUAD", and "PHASE ANGLE" modes.
Filters switched out	Filters are automatically switched out when in "TOTAL", or "THD" modes and during all harmonic measurements.
Frequency readout accuracy: 10 Hz to 100 Hz 100 Hz to 100 kHz	 ±2 % ±0.5%
Signal input impedance	2 Megohms shunted by 180 pf (typical).
Reference input impedance	2 Megohms shunted by 180 pf (typical).

Item	Specifications
Common mode rejection (20 mV range, zero source impedance)	
10 Hz to 999 Hz 1 kHz to 5 kHz >5 kHz to 32 kHz >32 kHz to 54 kHz	126 dB minimum 110 dB minimum 100 dB minimum 91 dB minimum
Trigger input	TTL compatible input, negative edge triggered. Minimum pulse width is 30nSec.
*Recorder output for DAV equipped with I/O board	Separate inphase and quadrature outputs are provided.
Range	Full scale equals ±2.00 V dc.
Accuracy	± .05% of full scale added to specification for mode, range, and frequency.
Resolution	1 mV nominal.
Power requirements	115/230Vrms ±15%, 47 to 67 Hz, 70 VA
Fuse	2 A for 115 V operations. 1 A for 230 V operations (included in separate bag marked "for 230V operation").
Connectors:	Type
Front SIG input Front REF input Rear SIG input Rear REF input Trigger input Recorder output Remote Interface Power input	5 way binding post 5 way binding post MS3102A14S-2P MS3102A14S-2P BNC female MS3102A14S-2S IEEE-488 standard connector IEC standard 115/230 V connector
Operating Position	Horizontal
Maximum tilt angle	±30°
Dimensions	5-1/4" x 16-3/4" x 19"D
Weight	35 pounds (15.9 kg)

PAV Outline and Dimension Drawing



Ordering Information

To order, select one of the part numbers shown below.

Part Number	Instrument Description
2250-F1	Version "F1" utilizes Native IEEE Interface (Standard Version)
2250-F2	Version "F2" utilizes MATE-CIIL and Native IEEE Interface
2250-F3	Version "F3" Emulates NAI Model 225 IEEE Interface