

Introduction

The Model 2016-P Audio Analyzing Digital Multimeter combines audio band quality measurements and analysis with a full-function 6½ digit DMM. The Model 2016-P has twice the sine wave generator output of the Model 2015 for applications that require test signals greater than 8Vrms. The Model 2016-P offers additional processing capacity for frequency spectrum analysis.

Dual output source

The Model 2016-P includes an internal audio band sine wave source for generating stimulus signals. A second output, the inverse of the first output, is also available, simplifying the testing of differential input circuits for common mode or noise cancellation performance.

The Models 2015 and 2015-P have a 4Vrms single-ended output and an 8Vrms differential source output. For tests that require a higher stimulus signal, the Models 2016 and 2016-P provide a 9.5Vrms single-ended output and a 19Vrms differential output.

Spectrum analysis

The Model 2016-P has internal computational capabilities that allow it to characterize an acquired signal spectrum. This instrument can identify and report the frequency and amplitude for the highest value in a complete spectrum or within a specified frequency band. It can also identify additional peaks in descending order of magnitude. The Model 2016-P's on-board capabilities make it simple to obtain a thorough analysis of a frequency spectrum more quickly and with little or no need for external analysis software.

Operation

For frequency spectrum analysis operation refer to Model 2015/2015-P THD Multimeter User's Manual. For all other functions operation refer to Model 2016 THD Multimeter User's Manual. Both manuals are available as PDFs on the Product Information CD-ROM you received with your product.

Specifications

Refer to the attached specifications.

2016 Total Harmonic Distortion Specifications 2016-P Audio Analyzing Digital Multimeter

DISTORTION CHARACTERISTICS

VOLTAGE RANGE: 100mV, 1V, 10V, 100V, 750V (user selectable).
 INPUT IMPEDANCE: 1MΩ paralleled by <100pF.
 DISPLAY RANGE: 0–100% or 0–100.00dB.
 RESOLUTION: 0.0001% or 0.00001dB.
 FUNDAMENTAL FREQUENCY RANGE: 20Hz–20kHz.
 HARMONIC FREQUENCY RANGE: 40Hz–50kHz.
 FREQUENCY RESOLUTION: 0.008Hz.
 FREQUENCY ACCURACY: ±0.01% of reading.
 FREQUENCY TEMPERATURE COEFFICIENT: ≤100ppm over operating temperature range.

MEASUREMENT MODE	ACCURACY (1 Year, 23°C ±5°C)	RESIDUAL DISTORTION ¹
THD and individual harmonic magnitudes	±0.8dB, 20Hz to 20kHz ²	0.004% or –87dB 20Hz to 20kHz
THD + n	±1.5 dB, 100Hz to 20kHz ²	0.056% or –65dB 20Hz to 20kHz
SINAD	±1.5dB 100Hz to 20kHz ²	+65dB 20Hz to 20kHz
AC Level V rms	±(0.13% of reading + 0.009% of range) 20Hz to 20kHz	

Distortion Measurement Audio Filters

None C-Message
 CCITT Weighting CCIR/ARM
 CCIR "A" Weighting

NUMBER OF HARMONICS INCLUDED IN THD CALCULATION: 2 to 64 (user selectable).

HI AND LO CUTOFF FILTERS (bus settable): 20Hz–50kHz. Can be combined to form brickwall bandpass filter.

Distortion Measurement Reading Rate³

FUNDAMENTAL FREQUENCY ACQUISITION MODE	FUNDAMENTAL FREQUENCY RANGE	MINIMUM READINGS PER SECOND
Single acquisition or stored value	20 Hz to 100 Hz	14
	100 Hz to 1 kHz	24
	1 kHz to 20 kHz	28
Automatic	20 Hz to 30 Hz	5.5
	30 Hz to 400 Hz	6
	400 Hz to 20 kHz	6.6

Frequency Sweep Reading Rate

NUMBER OF FREQUENCIES	TIME (seconds) ⁴
5	0.2
30	1.1
100	3.5
200	6.9

Notes

- Input signal at full scale.
- V_{IN} ≥20% of range and harmonics >–65dB.
- Speeds are for default operating conditions (*RST), and display off, auto range off, binary data transfer, trig delay = 0.
- Typical times: frequencies in 400–4kHz range, binary data transfer, TRIG DELAY = 0, Display OFF, Auto Range OFF. Data returned is THD measurement plus AC voltage.

GENERATOR CHARACTERISTICS

FREQUENCY RANGE: 10–20kHz.
 FREQUENCY RESOLUTION: 0.007Hz.
 FREQUENCY ACCURACY: ±(0.015% of reading + 0.007Hz)¹.
 FREQUENCY TEMPERATURE COEFFICIENT: <100ppm over operating temperature range.

SOURCE OUTPUT:

Waveform: Sinewave.
 Amplitude Range: 4.75V rms (50Ω and 600Ω) or 9.5V rms (HI Z).
 Amplitude Resolution: 1.25mV rms (50Ω and 600Ω) or 2.5mV rms (HI Z).
 Amplitude Accuracy: ±(0.3% of setting + 5mV)^{1,4}.
 Amplitude Temperature Coefficient: Typically 0.015%/°C.
 Amplitude Flatness: ±0.1dB^{1,4,5}.
 Output Impedance: 50Ω ± 1Ω or 600Ω ± 10Ω, user selectable.
 THD: –64dB⁶.
 Noise: 250μV rms².
 DC Offset Voltage: ±3mV¹.

INV/PULSE OUTPUT (SINEWAVE MODE):

Frequency: Same as source output.
 Amplitude Range: 4.75V rms (50Ω and 600Ω) or 9.5V rms (HI Z).
 Amplitude Resolution: 1.25mV (50Ω and 600Ω) or 2.5mV rms (HI Z).
 Amplitude Accuracy: ±(2.0% of setting + 5mV)^{1,4}.
 Amplitude Flatness: ±0.1dB^{1,4,5}.
 Output Impedance: Same as Source Output setting.
 THD: –64dB⁶.
 Noise: 250μV rms².
 DC Offset Voltage: ±3mV typ., ±13mV max.¹

INV/PULSE OUTPUT (PULSE MODE):

Frequency: Same as source output.
 Duty Cycle: 45% ±3%.
 Output Impedance: Same output impedance as the source output.
 Amplitude: 0.0V ±0.07V to 4.9V ±0.12V pulse open circuit^{1,3}.
 0.0V ±0.05V to 3.3V ±0.08V pulse 100Ω load^{1,3}.
 Overshoot: 1.0V maximum pulse open circuit³.
 0.2V maximum with 100Ω load pulse open circuit³.
 Undershoot: 1.1V maximum pulse open circuit³.
 0.45V maximum with 100Ω load pulse open circuit³.

Notes

- 1 year, 23°C ±5°C.
- Measured at V_{OUT} = 0V with gain 100 amplifier and 2-pole 50kHz low pass filter, Inv/Pulse in sinewave mode, HI Z output impedance, and no load.
- With HI Z output impedance and 1m 50Ω coaxial cable.
- HI Z output impedance, no load.
- 4V output.
- THD measurement includes harmonics 2 through 5, 1V rms output, HI Z, no load.

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A	22893 Released	SZ	4/30/99	CKD.		DATE
B	24987 Revised	SZ	10/6/00	APP.	JK	DATE 4/30/99
C	27373 Revised	SZ	9/10/02	SPECIFICATIONS		
D	28238 Revised	SZ	9/5/03			
E	29327 Revised	SZ	11/1/03			

KEITHLEY Keithley Instruments, Inc.
Cleveland, Ohio 44139

PART NUMBER
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PURCHASED ITEM

2016 Total Harmonic Distortion Specifications 2016-P Audio Analyzing Digital Multimeter

DC CHARACTERISTICS

CONDITIONS: MED (1 PLC) OR SLOW (10 PLC) ACCURACY: ±(PPM OF READING + PPM OF RANGE)
OR MED (1 PLC) WITH FILTER OF 10(PPM = PARTS PER MILLION) (E.G., 10PPM = 0.001%)

FUNCTION	RANGE	RESOLUTION	TEST CURRENT OR BURDEN		INPUT RESISTANCE	24 HOUR ¹⁴ 23°C ± 1°	90 DAY 23°C ± 5°	1 YEAR 23°C ± 5°	TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C
			VOLTAGE (±5%)	VOLTAGE					
VOLTAGE	100.0000 mV	0.1 µV			> 10 GΩ	30 + 30	40 + 35	50 + 35	2 + 6
	1.000000 V	1.0 µV			> 10 GΩ	15 + 6	25 + 7	30 + 7	2 + 1
	10.00000 V	10 µV			> 10 GΩ	15 + 4	20 + 5	30 + 5	2 + 1
	100.0000 V	100 µV			10 MΩ ± 1%	15 + 6	30 + 6	45 + 6	5 + 1
	1000.000 V ⁹	1 mV			10 MΩ ± 1%	20 + 6	35 + 6	45 + 6	5 + 1
RESISTANCE ¹⁵	100.0000 Ω	100 µΩ	1 mA			30 + 30	80 + 40	100 + 40	8 + 6
	1.000000 kΩ	1 mΩ	1 mA			20 + 6	80 + 10	100 + 10	8 + 1
	10.00000 kΩ	10 mΩ	100 µA			20 + 6	80 + 10	100 + 10	8 + 1
	100.0000 kΩ	100 mΩ	10 µA			20 + 6	80 + 10	100 + 10	8 + 1
	1.000000 MΩ ¹⁶	1 Ω	10 µA			20 + 6	80 + 10	100 + 10	8 + 1
	10.00000 MΩ ^{11,16}	10 Ω	700 nA // 10MΩ			150 + 6	200 + 10	400 + 10	70 + 1
	100.0000 MΩ ^{11,16}	100 Ω	700 nA // 10MΩ			800 + 30	1500 + 30	1500 + 30	385 + 1
CURRENT	10.00000 mA	10 nA	< 0.15 V			60 + 30	300 + 80	500 + 80	50 + 5
	100.0000 mA	100 nA	< 0.03 V			100 + 300	300 + 800	500 + 800	50 + 50
	1.000000 A	1 µA	< 0.3 V			200 + 30	500 + 80	800 + 80	50 + 5
	3.00000 A	10 µA	< 1 V			1000 + 15	1200 + 40	1200 + 40	50 + 5
CONTINUITY 2W	1 kΩ	100 mΩ	1 mA			40 + 100	100 + 100	120 + 100	8 + 1
DIODE TEST	3.00000 V	10 µV	1 mA			20 + 6	30 + 7	40 + 7	8 + 1
	10.00000 V	10 µV	100 µA			20 + 6	30 + 7	40 + 7	8 + 1
	10.00000 V	10 µV	10 µA			20 + 6	30 + 7	40 + 7	8 + 1

DC OPERATING CHARACTERISTICS²

FUNCTION	DIGITS	READINGS/s	PLCs ⁸
DCV (all ranges),	6½ ^{3,4}	5	10
DCI (all ranges), and 2W Ohms (<10M range)	6½ ^{3,7}	30	1
	6½ ^{3,5}	50	1
	5½ ^{3,5}	270	0.1
	5½ ⁵	500	0.1
	5½ ⁵	1000	0.04
	4½ ⁵	2000	0.01

SPEED AND NOISE REJECTION

RATE	READINGS/S	DIGITS	RMS NOISE		
			10V RANGE	NMRR ¹²	CMRR ¹³
10 PLC	5	6½	< 1.5 µV	60 dB	140 dB
1 PLC	50	6½	< 4 µV	60 dB	140 dB
0.1 PLC	500	5½	< 22 µV	—	80 dB
0.01 PLC	2000	4½	< 150 µV	—	80 dB

DC SYSTEM SPEEDS^{2,6}

RANGE CHANGE³: 50 / s.
 FUNCTION CHANGE³: 45 / s.
 AUTORANGE TIME^{3,10}: <30 ms.
 ASCII READINGS TO RS-232 (19.2K BAUD): 55 / s.
 MAX. INTERNAL TRIGGER RATE: 2000 / s.
 MAX. EXTERNAL TRIGGER RATE: 400 / s.

DC GENERAL

LINEARITY OF 10VDC RANGE: ±(2ppm of reading + 1ppm of range).
 DCV, Ω, TEMPERATURE, CONTINUITY, DIODE TEST INPUT PROTECTION: 1000V, all ranges.
 MAXIMUM 4WQ LEAD RESISTANCE: 10% of range per lead for 100Ω and 1kΩ ranges; 1kΩ per lead for all other ranges.
 DC CURRENT INPUT PROTECTION: 3A, 250V fuse.
 SHUNT RESISTOR: 0.1Ω for 3A, 1A and 100mA ranges. 10Ω for 10mA range.
 CONTINUITY THRESHOLD: Adjustable 1Ω to 1000Ω.
 AUTOZERO OFF ERROR: Add ±(2ppm of range error + 5µV) for <10 minutes and ±1°C change.
 OVERRANGE: 120% of range except on 1000V, 3A and Diode.

DC Notes

- Add the following to ppm of range accuracy specification based on range: 1V and 100V, 2ppm; 100mV, 15ppm; 100Ω, 15ppm; <1MΩ, 2ppm; 10mA and 1A, 10ppm; 100mA, 40ppm.
- Speeds are for 60 Hz operation using factory default operating conditions (*RST). Autorange off, Display off, Trigger delay = 0.
- Speeds include measurement and binary data transfer out the GPIB.
- Auto zero off.
- Sample count = 1024, auto zero off.
- Auto zero off, NPLC = 0.01.
- Ohms = 24 readings/second.
- 1 PLC = 16.67ms @ 60Hz, 20ms @ 50Hz/400Hz. The frequency is automatically determined at power up.
- For signal levels >500V, add 0.02ppm/V uncertainty for the portion exceeding 500V.
- Add 120ms for ohms.
- Must have 10% matching of lead resistance in Input HI and LO.
- For line frequency ±0.1%.
- For 1kΩ unbalance in LO lead.
- Relative to calibration accuracy.
- Specifications are for 4-wire ohms. For 2-wire ohms, add 1Ω additional uncertainty.
- For rear inputs, add the following to Temperature Coefficient ppm of reading uncertainty: 10MΩ, 70ppm; 100MΩ, 385ppm. Operating environment specified for 0°C to 50°C and 50% RH at 35°C.

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KEITHLEY Keithley Instruments, Inc.
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SPECIFICATIONS

PART NUMBER SPEC-2016





PURCHASED ITEM

2016 Total Harmonic Distortion Specifications 2016-P Audio Analyzing Digital Multimeter

TRUE RMS AC VOLTAGE AND CURRENT CHARACTERISTICS

ACCURACY¹: ±(% of reading + % of range), 23°C ±5 °C

VOLTAGE RANGE	RESOLUTION	CALIBRATION CYCLE	3 Hz–10 Hz ¹⁰	10 Hz–20 kHz	20 kHz–50 kHz	50 kHz–100 kHz	100 kHz–300 kHz
100.0000 mV	0.1 µV	90 Days	0.35 + 0.03	0.05 + 0.03	0.11 + 0.05	0.60 + 0.08	4 + 0.5
1.000000 V	1.0 µV						
10.00000 V	10 µV						
100.0000 V	100 µV	1 Year	0.35 + 0.03	0.06 + 0.03	0.12 + 0.05	0.60 + 0.08	4 + 0.5
750.000 V	1 mV						

TEMPERATURE COEFFICIENT/°C ⁸	0.035 + 0.003	0.005 + 0.003	0.006 + 0.005	0.01 + 0.006	0.03 + 0.01
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CURRENT RANGE	RESOLUTION	CALIBRATION CYCLE	3 Hz–10 Hz	10 Hz–3 kHz	3 kHz–5 kHz
1.000000 A	1 µA	90 Day/1 Year	0.30 + 0.04	0.10 + 0.04	0.14 + 0.04
3.00000 A ⁹	10 µA	90 Day/1 Year	0.35 + 0.06	0.15 + 0.06	0.18 + 0.06

TEMPERATURE COEFFICIENT/°C ⁸	0.035 + 0.006	0.015 + 0.006	0.015 + 0.006
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HIGH CREST FACTOR ADDITIONAL ERROR ±(% of reading)⁷

CREST FACTOR:	1–2	2–3	3–4	4–5
ADDITIONAL ERROR:	0.05	0.15	0.30	0.40

AC OPERATING CHARACTERISTICS²

FUNCTION	DIGITS	READINGS/s	RATE	BANDWIDTH
ACV (all ranges), and	6½ ³	2s/reading	SLOW	3 Hz–300 kHz
ACI (all ranges)	6½ ³	1.4	MED	30 Hz–300 kHz
	6½ ⁴	4.8	MED	30 Hz–300 kHz
	6½ ³	2.2	FAST	300 Hz–300 kHz
	6½ ⁴	35	FAST	300 Hz–300 kHz

ADDITIONAL LOW FREQUENCY ERRORS ±(% of reading)

	SLOW	MED	FAST
20Hz – 30Hz	0	0.3	—
30Hz – 50Hz	0	0	—
50Hz – 100Hz	0	0	1.0
100Hz – 200Hz	0	0	0.18
200Hz – 300Hz	0	0	0.10
> 300Hz	0	0	0

AC SYSTEM SPEEDS^{2,5}

FUNCTION/RANGE CHANGE⁶: 4 / s.
 AUTORANGE TIME: <3 s.
 ASCII READINGS TO RS-232 (19.2K BAUD)⁴: 50 / s.
 MAX. INTERNAL TRIGGER RATE⁴: 300 / s.
 MAX. EXTERNAL TRIGGER RATE⁴: 260 / s.

AC GENERAL

INPUT IMPEDANCE: 1MΩ ±2% paralleled by <100pF.
 ACV INPUT PROTECTION: 1000Vp.
 MAXIMUM DCV: 400V on any ACV range.
 ACI INPUT PROTECTION: 3A, 250V fuse.
 BURDEN VOLTAGE: 1A Range: <0.3V rms. 3A Range: <1V rms.
 SHUNT RESISTOR: 0.1Ω on all ACI ranges.
 AC CMRR: >70dB with 1kΩ in LO lead.
 MAXIMUM CREST FACTOR: 5 at full scale.
 VOLT HERTZ PRODUCT: ≤8 × 10⁷ V·Hz.
 OVERRANGE: 120% of range except on 750V and 3A ranges.

AC Notes

- Specifications are for SLOW rate and sinewave inputs >5% of range.
- Speeds are for 60 Hz operation using factory default operating conditions (*RST). Auto zero off, Auto range off, Display off, includes measurement and binary data transfer out the GPIB.
- 0.01% of step settling error. Trigger delay = 400ms.
- Trigger delay = 0.
- DETECTOR: BANDwidth 300, NPLC = 0.01.
- Maximum useful limit with trigger delay = 175ms.
- Applies to non-sine waves >5Hz and <500Hz. (Guaranteed by design for Crest Factors >4.3)
- Applies to 0°–18°C and 28°–50°C.
- For signal levels > 2.2A, add additional 0.4% to 'of reading' uncertainty.
- Typical uncertainties. Typical represents two sigma or 95% of manufactured units measure < 0.35% of reading and three sigma or 99.7% < 1.06% of reading.

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