

2015 Total Harmonic Distortion Specifications

DISTORTION CHARACTERISTICS

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

MEASUREMENT MODE	ACCURACY (1 Year, 23°C $\pm 5^\circ$ C)	RESIDUAL DISTORTION ¹
THD and individual harmonic magnitudes	± 0.8 dB 20Hz to 20kHz ²	0.004% or -87 dB 20Hz to 20kHz
THD + n	± 1.5 dB, 100Hz to 20kHz ²	0.056% or -65 dB 20Hz to 20kHz
SINAD	± 1.5 dB 100Hz to 20kHz ²	$+65$ dB 20Hz to 20kHz
AC Level V rms	$\pm(0.13\%$ 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.
- $V_{IN} \geq 20\%$ of range and harmonics > -65 dB.
- 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: $\pm(0.015\%$ of reading + 0.007Hz)¹.
FREQUENCY TEMPERATURE COEFFICIENT: < 100 ppm over operating temperature range.
SOURCE OUTPUT:
 Waveform: Sinewave.
 Amplitude Range: 2V rms (50 Ω and 600 Ω) or 4V rms (HI Z).
 Amplitude Resolution: 0.5mV rms (50 Ω and 600 Ω) or 1mV rms (HI Z).
 Amplitude Accuracy: $\pm(0.3\%$ of setting + 2mV)^{1, 4}.
 Amplitude Temperature Coefficient: Typically 0.015%/°C.
 Amplitude Flatness: ± 0.1 dB^{1, 4, 5}.
 Output Impedance: 50 $\Omega \pm 1\Omega$ or 600 $\Omega \pm 10\Omega$, user selectable.
 THD: -64 dB⁶.
 Noise: 100 μ V rms².
 DC Offset Voltage: ± 1.2 mV¹.

INV/PULSE OUTPUT (SINEWAVE MODE):

Frequency: Same as source output.
 Amplitude Range: 2V rms (50 Ω and 600 Ω) or 4V rms (HI Z).
 Amplitude Resolution: 0.5mV (50 Ω and 600 Ω) or 1mV rms (HI Z).
 Amplitude Accuracy: $\pm(2.0\%$ of setting + 2mV)^{1, 4}.
 Amplitude Flatness: ± 0.1 dB^{1, 4, 5}.
 Output Impedance: Same as Source Output setting.
 THD: -64 dB⁶.
 Noise: 100 μ V rms².
 DC Offset Voltage: ± 1.1 mV typ., ± 13 mV max.¹

INV/PULSE OUTPUT (PULSE MODE):

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

Notes

- 1 year, 23°C $\pm 5^\circ$ C.
- Measured at $V_{OUT} = 0$ V 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 50 Ω 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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DC CHARACTERISTICS

CONDITIONS: MED (1 PLC) OR SLOW (10 PLC) ACCURACY: \pm (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	INPUT	24 HOUR ¹⁴	90 DAY	1 YEAR	TEMPERATURE
			OR BURDEN					
			VOLTAGE (\pm 5%)					0°–18°C & 28°–50°C
VOLTAGE	100.0000 mV	0.1 μ V		> 10 G Ω	30 + 30	40 + 35	50 + 35	2 + 6
	1.000000 V	1.0 μ V		> 10 G Ω	15 + 6	25 + 7	30 + 7	2 + 1
	10.00000 V	10 μ V		> 10 G Ω	15 + 4	20 + 5	30 + 5	2 + 1
	100.0000 V	100 μ V		10 M Ω \pm 1%	15 + 6	30 + 6	45 + 6	5 + 1
	1000.000 V ⁹	1 mV		10 M Ω \pm 1%	20 + 6	35 + 6	45 + 6	5 + 1
RESISTANCE ¹⁵	100.0000 Ω	100 μ Ω	1 mA		30 + 30	80 + 40	100 + 40	8 + 6
	1.000000 k Ω	1 m Ω	1 mA		20 + 6	80 + 10	100 + 10	8 + 1
	10.00000 k Ω	10 m Ω	100 μ A		20 + 6	80 + 10	100 + 10	8 + 1
	100.00000 k Ω	100 m Ω	10 μ A		20 + 6	80 + 10	100 + 10	8 + 1
	1.000000 M Ω ¹⁶	1 Ω	10 μ A		20 + 6	80 + 10	100 + 10	8 + 1
	10.00000 M Ω ^{11,16}	10 Ω	700 nA // 10M Ω		150 + 6	200 + 10	400 + 10	70 + 1
	100.00000 M Ω ^{11,16}	100 Ω	700 nA // 10M Ω		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
	100.00000 mA	100 nA	< 0.03 V		100 + 300	300 + 800	500 + 800	50 + 50
	1.000000 A	1 μ A	< 0.3 V		200 + 30	500 + 80	800 + 80	50 + 5
	3.00000 A	10 μ A	< 1 V		1000 + 15	1200 + 40	1200 + 40	50 + 5
CONTINUITY 2W	1 k Ω	100 m Ω	1 mA		40 + 100	100 + 100	120 + 100	8 + 1
DIODE TEST	3.00000 V	10 μ V	1 mA		20 + 6	30 + 7	40 + 7	8 + 1
	10.00000 V	10 μ V	100 μ A		20 + 6	30 + 7	40 + 7	8 + 1
	10.00000 V	10 μ V	10 μ A		20 + 6	30 + 7	40 + 7	8 + 1

DC OPERATING CHARACTERISTICS²

FUNCTION	DIGITS	READINGS/s	PLCs ⁸
DCV (all ranges),	6 $\frac{1}{2}$ ^{3,4}	5	10
DCI (all ranges), and	6 $\frac{1}{2}$ ^{3,7}	30	1
2W Ohms (<10M range)	6 $\frac{1}{2}$ ^{3,5}	50	1
	5 $\frac{1}{2}$ ^{3,5}	270	0.1
	5 $\frac{1}{2}$ ⁵	500	0.1
	5 $\frac{1}{2}$ ⁵	1000	0.04
	4 $\frac{1}{2}$ ⁵	2000	0.01

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: \pm (2ppm of reading + 1ppm of range).

DCV, Ω , TEMPERATURE, CONTINUITY, DIODE TEST INPUT PROTECTION: 1000V, all ranges.

MAXIMUM 4W Ω LEAD RESISTANCE: 10% of range per lead for 100 Ω and 1k Ω ranges; 1k Ω per lead for all other ranges.

DC CURRENT INPUT PROTECTION: 3A, 250V fuse.

SHUNT RESISTOR: 0.1 Ω for 3A, 1A and 100mA ranges. 10 Ω for 10mA range.

CONTINUITY THRESHOLD: Adjustable 1 Ω to 1000 Ω .

AUTOZERO OFF ERROR: Add \pm (2ppm of range error + 5 μ V) for <10 minutes and \pm 1°C change.

OVERRANGE: 120% of range except on 1000V, 3A and Diode.

SPEED AND NOISE REJECTION

RATE	READINGS/S	DIGITS	RMS NOISE 10V RANGE	NMRR ¹²	CMRR ¹³
10 PLC	5	6 $\frac{1}{2}$	< 1.5 μ V	60 dB	140 dB
1 PLC	50	6 $\frac{1}{2}$	< 4 μ V	60 dB	140 dB
0.1 PLC	500	5 $\frac{1}{2}$	< 22 μ V	—	80 dB
0.01 PLC	2000	4 $\frac{1}{2}$	< 150 μ V	—	80 dB

DC Notes

- Add the following to ppm of range accuracy specification based on range: 1V and 100V, 2ppm; 100mV, 15ppm; 100 Ω , 15ppm; <1M Ω , 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 \pm 0.1%.
- For 1k Ω unbalance in LO lead.
- Relative to calibration accuracy.
- Specifications are for 4-wire ohms. For 2-wire ohms, add 1 Ω additional uncertainty.
- For rear inputs, add the following to Temperature Coefficient 'ppm of reading' uncertainty: 10M Ω 7ppm, 100M Ω 385ppm. Operating environment specified for 0°C to 50°C and 50% RH at 35°C.

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TRUE RMS AC VOLTAGE AND CURRENT CHARACTERISTICS

ACCURACY: \pm (% of reading + % of range), 23°C \pm 5 °C

VOLTAGE RANGE	RESOLUTION	CALIBRATION CYCLE	3 Hz–10 Hz	10 Hz–20 kHz	20 kHz–50 kHz	50 kHz–100 kHz	100 kHz–300 kHz
100.0000 mV	0.1 μ V	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 μ V						
10.00000 V	10 μ V	1 Year	0.35 + 0.03	0.06 + 0.03	0.12 + 0.05	0.60 + 0.08	4 + 0.5
100.0000 V	100 μ V						
750.000 V	1 mV						
TEMPERATURE COEFFICIENT / °C*			0.035 + 0.003	0.005 + 0.003	0.006 + 0.005	0.01 + 0.006	0.03 + 0.01

CURRENT RANGE	RESOLUTION	CALIBRATION CYCLE	3 Hz - 10 Hz	10 Hz - 5 kHz
1.000000 A	1 μ A	90 Day/1 Year	0.30 + 0.04	0.10 + 0.04
3.00000 ⁹ A	10 μ A	90 Day/1 Year	0.35 + 0.06	0.15 + 0.06
TEMPERATURE COEFFICIENT / °C*			0.035 + 0.006	0.015 + 0.006

HIGH CREST FACTOR ADDITIONAL ERROR \pm (% 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 CHARACTERISTICS ²

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 \pm (% 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 CHANGE: 4 / s.
 AUTORANGE TIME: <3 s.
 ASCII READINGS TO RS-232 (19.2K BAUD) ⁴: 50 / s.
 MAX. INTERNAL TRIGGER RATE ⁴: 300 / s.
 MAX. EXTERNAL TRIGGER RATE ⁴: 260 / s.

AC GENERAL

INPUT IMPEDANCE: 1M Ω \pm 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: 0.1 Ω on all ACI ranges.
 AC CMRR: >70dB with 1k Ω in LO lead.
 MAXIMUM CREST FACTOR: 5 at full scale.
 VOLT HERTZ PRODUCT: $\leq 8 \times 10^7$ 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.

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TRIGGERING AND MEMORY

READING HOLD SENSITIVITY: 0.01%, 0.1%, 0.1%, 1%, or 10% of reading.

TRIGGER DELAY: 0 to 99 hrs (1ms step size).

EXTERNAL TRIGGER LATENCY: 200 μ s + <300 μ s jitter with autozero off, trigger delay = 0.

MEMORY: 1024 readings.

MATH FUNCTIONS

Rel, Min/Max/Average/StdDev (of stored reading), dB, dBm, Limit Test, %, and mX+b with user defined units displayed.

dBm REFERENCE RESISTANCES: 1 to 9999 Ω in 1 Ω increments.

STANDARD PROGRAMMING LANGUAGES

SCPI (Standard Commands for Programmable Instruments)

REMOTE INTERFACE

GPIB (IEEE-488.1, IEEE-488.2) and RS-232C.

FREQUENCY AND PERIOD CHARACTERISTICS^{1,2}

ACV RANGE	FREQUENCY RANGE	PERIOD RANGE	GATE TIME	RESOLUTION \pm (ppm of reading)	ACCURACY 90 DAY/1 YEAR \pm (% of reading)
100 mV	3 Hz	333 ms	1 s (SLOW)	0.333	0.01
	to	to	0.1 s (MED)	3.33	0.01
750 V	500 kHz	2 μ s	10 ms (FAST)	33.3	0.01

Frequency Notes

- Specifications are for squarewave inputs >10% of ACV range, except 100mV range. On 100mV range frequency must be >10Hz if voltage is <20mV.
- 20% overrange on all ranges except 750V range.

TEMPERATURE CHARACTERISTICS

THERMOCOUPLE^{2,3,4} 90 DAY/1 YEAR (23°C \pm 5°C)
ACCURACY¹

TYPE	RANGE	RESOLUTION	Relative to Reference Junction
J	-200 to + 760°C	0.001°C	\pm 0.5°C
K	-200 to +1372°C	0.001°C	\pm 0.5°C
T	-200 to + 400°C	0.001°C	\pm 0.5°C

Temperature Notes

- For temperatures <-100°C, add \pm 0.1°C and >900°C add \pm 0.3°C.
- Temperature can be displayed in °C, K or °F.
- Accuracy based on ITS-90.
- Exclusive of thermocouple error.

GENERAL SPECIFICATIONS

POWER SUPPLY: 100V / 120V / 220V / 240V \pm 10%.

LINE FREQUENCY: 45Hz to 66Hz, automatically sensed at power-up.

POWER CONSUMPTION: 40 VA.

OPERATING ENVIRONMENT: Specified for 0°C to 50°C. Specified to 80% R.H. at 35°C.

STORAGE ENVIRONMENT: -40°C to 70°C.

WARRANTY: 3 years.

SAFETY: Conforms to European Union Directive 73/23/EEC EN61010-1, CAT II.

EMC: Complies with European Union Directive 89/336/EEC, EN61326-1.

VIBRATION: MIL-PRF-28800F Class 3 Random.

WARMUP: 1 hour to rated accuracy.

DIMENSIONS: Rack Mounting: 89mm high \times 213mm wide \times 370mm deep (3½ in \times 8½ in \times 14½ in).

Bench Configuration (with handle and feet): 104mm high \times 238mm wide \times 370mm deep (4¼ in \times 9¼ in \times 14¼ in).

NET WEIGHT: 4.2kg (8.8 lbs).

SHIPPING WEIGHT: 5kg (11 lbs).

VOLT HERTZ PRODUCT: \leq 8 \times 10⁶V·Hz.

ACCESSORIES SUPPLIED: Model 1751 Safety Test Leads, User Manual, Service Manual.

Specifications are subject to change without notice.