

# 2010 Low-Noise Multimeter

## DC CHARACTERISTICS

CONDITIONS: MED (1 PLC) <sup>1</sup> or SLOW (5 PLC)

FUNCTION	RANGE	RESOLUTION	TEST CURRENT ±5% OR BURDEN VOLTAGE	INPUT RESISTANCE OR CLAMP VOLTAGE	ACCURACY: ±(ppm of reading + ppm of range) (ppm = parts per million) (e.g., 10ppm = 0.001%)				TEMPERATURE COEFFICIENT 0°-18°C & 28°-50°C
					24 Hour <sup>13</sup> 23°C±1°	90 Day 23°C±5°	1 Year 23°C±5°	2 Years 23°C±5°	
<b>Voltage</b>	100.00000 mV <sup>17</sup>	10 nV		> 10 GΩ	10 + 9	25 + 9	37 + 9	50 + 10	2 + 6
	1.0000000 V	100 nV		> 10 GΩ	7 + 2	18 + 2	25 + 2	32 + 2	2 + 1
	10.000000 V	1 μV		> 10 GΩ	7 + 4	18 + 4	24 + 4	32 + 4	2 + 1
	100.00000 V	10 μV		10 MΩ ±1%	10 + 4	25 + 5	35 + 5	52 + 5	5 + 1
	1000.0000 V <sup>8</sup>	100 μV		10 MΩ ±1%	17 + 6	31 + 6	41 + 6	55 + 6	5 + 1
<b>Resistance <sup>14</sup></b>	10.000000 Ω <sup>15</sup>	1 μΩ	10 mA		15 + 9	40 + 9	60 + 9	100 + 10	8 + 6
	100.00000 Ω <sup>15</sup>	10 μΩ	1 mA		15 + 9	36 + 9	52 + 9	90 + 10	8 + 6
	1.0000000 kΩ <sup>15</sup>	100 μΩ	1 mA		15 + 2	33 + 2	50 + 2	80 + 2	8 + 1
	10.000000 kΩ <sup>15</sup>	1 mΩ	100 μA		15 + 2	32 + 2	50 + 2	80 + 2	8 + 1
	100.00000 kΩ	10 mΩ	10 μA		15 + 4	40 + 4	70 + 4	120 + 4	8 + 1
	1.0000000 MΩ <sup>18</sup>	100 mΩ	10 μA		20 + 3	50 + 4	70 + 4	125 + 4	8 + 1
	10.000000 MΩ <sup>10,18</sup>	1 Ω	640 nA // 10MΩ		150 + 4	200 + 4	400 + 4	500 + 4	70 + 1
	100.00000 MΩ <sup>10,18</sup>	10 Ω	640 nA // 10MΩ		800 + 4	1500 + 4	1500 + 4	1800 + 4	385 + 1
	<b>Dry Circuit Resistance <sup>15</sup></b>	10.00000 Ω	10 μΩ	1 mA	20 mV	25 + 90	50 + 90	70 + 90	120 + 90
<b>Current</b>	100.00000 Ω	100 μΩ	100 μA	20 mV	25 + 90	50 + 90	70 + 90	120 + 90	8 + 60
<b>Current</b>	10.000000 mA	10 nA	< 0.15 V		60 + 30	300 + 80	500 + 80	740 + 80	50 + 5
	100.00000 mA	100 nA	< 0.18 V		100 + 30	300 + 80	500 + 80	740 + 80	50 + 5
	1.0000000 A	1 μA	< 0.35 V		200 + 30	500 + 80	800 + 80	1200 + 80	50 + 5
	3.000000 A	10 μA	< 1 V		1000 + 15	1200 + 40	1200 + 40	1800 + 40	50 + 5
<b>Continuity 2W</b>	1 kΩ	100 mΩ	1 mA		40 + 100	100 + 100	120 + 100	190 + 10	8 + 1
<b>Diode Test</b>	10.000000 V	1 μV	1 mA		20 + 6	30 + 7	40 + 7	55 + 7	8 + 1
	4.400000 V	1 μV	100 μA		20 + 6	30 + 7	40 + 7	55 + 7	8 + 1
	10.000000 V	1 μV	10 μA		20 + 6	30 + 7	40 + 7	55 + 7	8 + 1
<b>DCV:DCV Ratio <sup>16</sup></b>	100 mV to 1000 V				Ratio accuracy = accuracy of selected sense input range + accuracy of selected input range.				

## DC OPERATING CHARACTERISTICS <sup>3</sup>

FUNCTION	DIGITS	READINGS/s	PLCs <sup>7</sup>
DCV (all ranges), DCI (all ranges), and Ohms (<10M range)	7½ <sup>2</sup>	4 (3)	5
	6½ <sup>2,6</sup>	30 (27)	1
	5½ <sup>2,4</sup>	260 (220)	0.1
	5½ <sup>4</sup>	490 (440)	0.1
	5½ <sup>4</sup>	1000 (1000)	0.04
	4½ <sup>4</sup>	2000 (1800)	0.01

## DC SYSTEM SPEEDS <sup>3,5</sup>

RANGE CHANGE <sup>2</sup>: 50/s (42/s).

FUNCTION CHANGE <sup>2</sup>: 45/s (38/s).

AUTORANGE TIME <sup>2,9</sup>: <30ms (<35ms).

ASCII READINGS TO RS-232 (19.2K BAUD): 55/s (55/s).

MAX. INTERNAL TRIGGER RATE: 2000/s (2000/s).

MAX. EXTERNAL TRIGGER RATE: 480/s (480/s).

RATIO SPEED <sup>2,3</sup>: 10/s (8/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 4WΩ LEAD RESISTANCE: 5% of range per lead for 10Ω, 100Ω and 1kΩ ranges; 1kΩ per lead for all other ranges.

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

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

CONTINUITY THRESHOLD: Adjustable 1Ω to 1000Ω.

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

OFFSET COMPENSATION: Available for 10kΩ and lower ranges only.

## DC NOISE PERFORMANCE

RATE	DIGITS	RMS NOISE 100mV RANGE		RMS NOISE 10V RANGE		NMRR <sup>11</sup>	CMRR <sup>12</sup>
		10 sec.	2 min.	10 sec.	2 min.		
5 PLC	7½	100 nV	110 nV	1.1 μV	1.2 μV	60 dB	140 dB
1 PLC	6½	120 nV	125 nV	1.3 μV	1.4 μV	60 dB	140 dB
0.1 PLC	5½	1.9 μV	1.9 μV	11 μV	11.5 μV	—	80 dB
0.01 PLC	4½	3.0 μV	2.9 μV	135 μV	139 μV	—	80 dB

## DC NOTES

- For the following ranges, add 4ppm to the range accuracy specification: 100mV, 10Ω, 100Ω, 10mA, 100mA, and 1A. Dry Circuit function add 40ppm.
- Speeds include measurement and binary data transfer out the GPIB.
- Speeds are for 60Hz (50Hz) operation using factory default operating conditions (\*RST). Autorange off, Display off, Trigger delay = 0.
- Sample count = 1024, auto zero off.
- Auto zero off, NPLC = 0.01.
- Ohms, 17 (15) 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 to "ppm of range" uncertainty. 10Ω range is for 4-wire only.
- Offset compensation on.
- Sense LO input must be referenced to Input LO. Sense HI input must not exceed 125% (referenced to Input LO) of range selected. Sense input has 100mV, 1V and 10V ranges.
- When properly zeroed using REL function.
- For rear inputs, add the following to Temperature Coefficient "ppm of reading" uncertainty: 1MΩ 25ppm, 10MΩ 250ppm, 100MΩ 2500ppm. 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

VOLTAGE RANGE	RESOLUTION	CALIBRATION CYCLE	ACCURACY 1: ±(% of reading + % of range), 23°C ±5 °C				
			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 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	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 µV						
750.000 V	1 mV						
Temperature Coefficient/°C <sup>8</sup>			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 µA	90 Day/1 Year	0.30 + 0.04	0.10 + 0.04
3.00000 A <sup>9</sup>	10 µA	90 Day/1 Year	0.35 + 0.06	0.15 + 0.06
Temperature Coefficient/°C <sup>8</sup>			0.035 + 0.006	0.015 + 0.006

## HIGH CREST FACTOR ADDITIONAL ERROR

±(% of reading)<sup>7</sup>

Crest Factor:	1–2	2–3	3–4	4–5
Additional Uncertainty:	0.05	0.15	0.30	0.40

## AC OPERATING CHARACTERISTICS<sup>2</sup>

FUNCTION	DIGITS	RDGS./s	RATE	BANDWIDTH
ACV (all ranges)	6½ <sup>3</sup>	0.5 (0.4)	SLOW	3 Hz–300 kHz
and	6½ <sup>3</sup>	1.4 (1.5)	MED	30 Hz–300 kHz
ACI (all ranges)	6½ <sup>4</sup>	4.0 (4.3)	MED	30 Hz–300 kHz
	6½ <sup>3</sup>	2.2 (2.3)	FAST	300 Hz–300 kHz
	6½ <sup>4</sup>	35 (30)	FAST	300 Hz–300 kHz

## AC SYSTEM SPEEDS<sup>2,5</sup>

FUNCTION/RANGE CHANGE<sup>6</sup>: 4/s.

AUTORANGE TIME: <3 s.

ASCII READINGS TO RS-232 (19.2K BAUD)<sup>4</sup>: 50/s.

MAX. INTERNAL TRIGGER RATE<sup>4</sup>: 300/s.

MAX. EXTERNAL TRIGGER RATE<sup>4</sup>: 300/s.

## ADDITIONAL LOW FREQUENCY ERRORS

±(% of reading)

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

## AC GENERAL

INPUT IMPEDANCE: 1MΩ ±2% paralleled by <100pF.

ACV INPUT PROTECTION: 1000V.

MAXIMUM DCV: 400V on any ACV range.

ACI INPUT PROTECTION: 3A, 250V fuse.

BURDEN VOLTAGE: 1A Range: <0.35V 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 × 10<sup>7</sup> 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 60Hz (50Hz) 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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## FREQUENCY AND PERIOD CHARACTERISTICS<sup>1,2</sup>

ACV RANGE	FREQUENCY RANGE	PERIOD RANGE	GATE TIME	RESOLUTION ±(ppm of reading)	ACCURACY 90 Day/1 Year ±(% of reading)
100 mV	3 Hz	333 ms			
	to	to	1 s	0.3	0.01
750 V	500 kHz	2 μs			

## FREQUENCY NOTES

- Specifications are for sinewave 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<sup>2,3,4</sup>

TYPE	RANGE	RESOLUTION	ACCURACY <sup>1</sup>	
			90 DAY/1 YEAR (23°C ± 5°C) RELATIVE TO SIMULATED REFERENCE JUNCTION	2001-TCSCAN <sup>5</sup> USING
J	-200 to + 760°C	0.001°C	±0.5°C	±0.65°C
K	-200 to +1372°C	0.001°C	±0.5°C	±0.70°C
N	-200 to +1300°C	0.001°C	±0.5°C	±0.70°C
T	-200 to + 400°C	0.001°C	±0.5°C	±0.68°C

### 4-WIRE RTD<sup>2,3,7,8</sup>

RANGE	RESOLUTION	ACCURACY	
		90 DAY/1 YEAR (23°C ± 5°C) ACCURACY <sup>6</sup>	2 YEAR (23°C ± 5°C) ACCURACY <sup>6</sup>
-100° to +100°C	0.001°C	±0.08°C	±0.12°C
-200° to +630°C	0.001°C	±0.14°C	±0.18°C

## Temperature Notes

- For temperatures <-100°C, add ±0.1°C and >900°C add ±0.3°C.
- Temperature can be displayed in °C, K or °F.
- Accuracy based on ITS-90.
- Exclusive of thermocouple error.
- Specifications apply to channels 2-6. Add 0.06°C/channel from channel 6.
- Excluding probe errors.
- 100Ω platinum, D100, F100, PT385, PT-3916 or user type.
- Maximum lead resistance (each lead) to achieve rated accuracy is 5Ω.

## INTERNAL SCANNER SPEED

MAXIMUM INTERNAL SCANNER RATES: RANGE: CHANNELS/s<sup>1</sup>

TRIGGER DELAY = 0

DCV <sup>2</sup>	ACV <sup>2,3</sup>	2 WIRE OHMS <sup>2</sup>	4 WIRE OHMS <sup>2</sup>	T/C TEMPERATURE <sup>2</sup>	RTD TEMPERATURE <sup>2</sup>
All : 105	All : 96	All : 102	<10MΩ : 55	All : 70	All : 2

TRIGGER DELAY = AUTO

DCV <sup>2</sup>	ACV <sup>2,3</sup>	2 WIRE OHMS <sup>2</sup>	4 WIRE OHMS <sup>2</sup>	T/C TEMPERATURE <sup>2</sup>	RTD TEMPERATURE <sup>2</sup>
0.1 V : 100	All : 1.8	100 Ω : 82	100 Ω : 42	All : 70	All : 2
1 V : 100		1 kΩ : 85	1 kΩ : 42		
10 V : 100		10 kΩ : 42	10 kΩ : 25		
100 V : 70		100 kΩ : 28	100 kΩ : 21		
1000 V : 70		1 MΩ : 8	1 MΩ : 7		
		10 MΩ : 5	10 MΩ : 5		
		100 MΩ : 3	100 MΩ : 3		

## Internal Scanner Speed Notes

- Speeds are for 60Hz or 50Hz operation using factory default operating conditions (\*RST). Auto Zero off, Auto Range off, Display off, sample count = 1024.
- NPLC = 0.01.
- DETECTOR BANDWIDTH: 300.

## Triggering and Memory

READING HOLD SENSITIVITY: 0.01%, 0.1%, 1%, or 10% of reading.  
 TRIGGER DELAY: 0 to 99 hrs (1ms step size).  
 EXTERNAL TRIGGER DELAY: <1ms.  
 EXTERNAL TRIGGER JITTER: <500μs.  
 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 9999Ω in 1Ω increments.

## REMOTE INTERFACE

Keithley 199/196 Emulation

GPIB (IEEE-488.2) and RS-232C

SCPI (Standard Commands for Programmable Instruments)

## GENERAL

**POWER SUPPLY:** 100V / 120V / 220V / 240V ±10%.

**LINE FREQUENCY:** 45Hz to 66Hz and 360Hz to 440Hz, automatically sensed at power-up.

**POWER CONSUMPTION:** 22VA.

**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:** 2 hours to rated accuracy.

**DIMENSIONS:**

**Rack Mounting:** 89mm high × 213mm wide × 370mm deep (3½ in × 8½ in × 14½ in).

**Bench Configuration (with handle and feet):** 104mm high × 238mm wide × 370mm deep (4½ in × 9½ in × 14½ in).

**SHIPPING WEIGHT:** 5kg (11 lbs).

**VOLT HERTZ PRODUCT:** ≤8 × 10<sup>7</sup>V-Hz.

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

## ACCESSORIES AVAILABLE

1050	Padded Carrying Case with handle and should strap
1754	Universal Test Lead Kit
2000-SCAN	10-Channel Scanner
2001-TCSCAN	9-Channel Thermocouple Scanner (includes 1-channel reference junction)
2010-EW	1-Year Warranty Extension
4288-1	Single Fixed Rack Mount Kit
4288-2	Dual Fixed Rack Mount Kit
5804	4 Terminal Test Lead Set
5805	Kelvin Probes
5806	Kelvin Clip Lead Set
5807-7	Helical Spring Point Test Leads
7007-1	Shielded GPIB Cable, 1m (3.2 ft)
7007-2	Shielded GPIB Cable, 2m (6.5 ft)
7009-5	Shielded RS-232 Cable 1.5m (5 ft)
8502	Trigger Link Adapter to 6 female BNC connector
8503	Trigger Link Cable to 2 Male BNCs, 1m (3.2 ft.)
8605	High Performance Modular Test Leads
8606	High Performance Probe Tip Kit