

2010 Low-Noise Multimeter

DC CHARACTERISTICS

CONDITIONS: MED (1 PLC)¹ 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 ¹³ 23°C±1°	90 Day 23°C±5°	1 Year 23°C±5°	2 Years 23°C±5°	
Voltage	100.00000 mV ¹⁷	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 ⁸	100 μV		10 MΩ ±1%	17 + 6	31 + 6	41 + 6	55 + 6	5 + 1
Resistance ¹⁴	10.000000 Ω ¹⁵	1 μΩ	10 mA		15 + 9	40 + 9	60 + 9	100 + 10	8 + 6
	100.00000 Ω ¹⁵	10 μΩ	1 mA		15 + 9	36 + 9	52 + 9	90 + 10	8 + 6
	1.0000000 kΩ ¹⁵	100 μΩ	1 mA		15 + 2	33 + 2	50 + 2	80 + 2	8 + 1
	10.000000 kΩ ¹⁵	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 ¹⁸	100 mΩ	10 μA		20 + 3	50 + 4	70 + 4	125 + 4	8 + 1
	10.000000 MΩ ^{10,18}	1 Ω	640 nA // 10MΩ		150 + 4	200 + 4	400 + 4	500 + 4	70 + 1
	100.00000 MΩ ^{10,18}	10 Ω	640 nA // 10MΩ		800 + 4	1500 + 4	1500 + 4	1800 + 4	385 + 1
Dry Circuit Resistance ¹⁵	10.00000 Ω	10 μΩ	1 mA	20 mV	25 + 90	50 + 90	70 + 90	120 + 90	8 + 60
	100.0000 Ω	100 μΩ	100 μA	20 mV	25 + 90	50 + 90	70 + 90	120 + 90	8 + 60
Current	10.000000 mA	1 nA	< 0.15 V		60 + 30	300 + 80	500 + 80	740 + 80	50 + 5
	100.00000 mA	10 nA	< 0.18 V		100 + 300	300 + 800	500 + 800	740 + 800	50 + 5
	1.0000000 A	100 nA	< 0.35 V		200 + 30	500 + 80	800 + 80	1200 + 80	50 + 5
	3.000000 A	1 μA	< 1 V		1000 + 15	1200 + 40	1200 + 40	1800 + 40	50 + 5
Continuity 2W	1 kΩ	100 mΩ	1 mA		40 + 100	100 + 100	120 + 100	190 + 10	8 + 1
Diode Test	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
DCV:DCV Ratio ¹⁶	100 mV to 1000 V				Ratio accuracy = accuracy of selected sense input range + accuracy of selected input range.				

DC OPERATING CHARACTERISTICS³

FUNCTION	DIGITS	READINGS/s	PLCs ⁷
DCV (all ranges),	7½ ²	4 (3)	5
DCI (all ranges), and	6½ ^{2,6}	30 (27)	1
Ohms (<10M range)	6½ ^{2,4}	50 (44)	1
	5½ ^{2,4}	260 (220)	0.1
	5½ ⁴	490 (440)	0.1
	5½ ⁴	1000 (1000)	0.04
	4½ ⁴	2000 (1800)	0.01

DC SYSTEM SPEEDS^{3,5}

RANGE CHANGE²: 50/s (42/s).

FUNCTION CHANGE²: 45/s (38/s).

AUTORANGE TIME^{2,9}: <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^{2,3}: 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 ¹¹	CMRR ¹²
		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.

HW 8/10/05
Rev. D

LTR	REVISIONS	APP.	DATE	DRN. CAB	DATE 1/9/96	KEITHLEY Keithley Instruments, Inc. Cleveland, Ohio 44139	
A	18127 Released	SZ	1/10/96	CKD. DMS	DATE 1/9/96		
B	27373 Revised	SZ	2/21/03	APP. DATE			
C	28238 Revised	SZ	9/5/03				
D	40994 Revised	SZ	8/10/05	SPECIFICATIONS			PART NUMBER
							SPEC-2010

2010 Low-Noise Multimeter

TRUE RMS AC VOLTAGE AND CURRENT CHARACTERISTICS

ACCURACY ¹ : ±(% 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

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

HIGH CREST FACTOR ADDITIONAL ERROR

±(% of reading) ⁷	1–2	2–3	3–4	4–5
Crest Factor:	1–2	2–3	3–4	4–5
Additional Uncertainty:	0.05	0.15	0.30	0.40

AC OPERATING CHARACTERISTICS ²

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

AC SYSTEM SPEEDS ^{2,5}

FUNCTION/RANGE CHANGE ⁶: 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: 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 × 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 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.
- 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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D	40994 Revised	SZ	8/10/05				

KEITHLEY Keithley Instruments, Inc.
Cleveland, Ohio 44139

PART NUMBER

SPEC-2010

BRUNING 40-21 62198-SBG

2010 Low-Noise Multimeter

FREQUENCY AND PERIOD CHARACTERISTICS ^{1,2}

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

FREQUENCY NOTES

- 1. Specifications are for square wave inputs only. Input signal must be >10% of ACV range. If input is <20mV on the 100mV range then the frequency must be >10Hz.
- 2. 20% overrange on all ranges except 750V range.

TEMPERATURE CHARACTERISTICS

THERMOCOUPLE ^{2,3,4}				
TYPE	RANGE	RESOLUTION	90 DAY/1 YEAR (23°C ± 5°C) RELATIVE TO SIMULATED REFERENCE JUNCTION	ACCURACY ¹ USING 2001-TCSCAN ⁵
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 ^{2,3,7,8}			90 DAY/1 YEAR (23°C ± 5°C) ACCURACY ⁶	2 YEAR (23°C ± 5°C) ACCURACY ⁶
RANGE		RESOLUTION		
-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

- 1. For temperatures <-100°C, add ±0.1°C and >900°C add ±0.3°C.
- 2. Temperature can be displayed in °C, K or °F.
- 3. Accuracy based on ITS-90.
- 4. Exclusive of thermocouple error.
- 5. Specifications apply to channels 2-6. Add 0.06°C/channel from channel 6.
- 6. Excluding probe errors.
- 7. 100Ω platinum, D100, F100, PT385, PT-3916 or user type.
- 8. Maximum lead resistance (each lead) to achieve rated accuracy is 5Ω.

INTERNAL SCANNER SPEED

MAXIMUM INTERNAL SCANNER RATES: RANGE: CHANNELS/s ¹
TRIGGER DELAY = 0

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

TRIGGER DELAY = AUTO

DCV ²	ACV ^{2,3}	2 WIRE OHMS ²	4 WIRE OHMS ²	T/C TEMPERATURE ²	RTD TEMPERATURE ²
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

- 1. Speeds are for 60Hz or 50Hz operation using factory default operating conditions (*RST). Auto Zero off, Auto Range off, Display off, sample count = 1024.
- 2. NPLC = 0.01.
- 3. 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.
LINE FREQUENCY: 50Hz to 60Hz and 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. Altitude up to 2000 meters.
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 × 10⁷V·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

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Specifications are subject to change without notice.

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