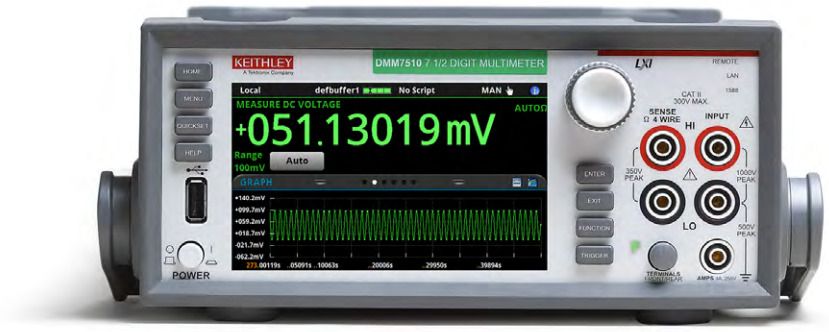
Datasheet

DMM7510 7½–Digit Graphical Sampling Multimeter



KEITHLEY
A Tektronix Company

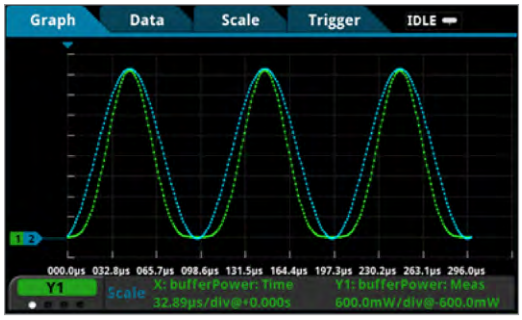
The DMM7510 combines all the advantages of a precision digital multimeter, a graphical touchscreen display, and a high speed, high resolution digitizer to create an industry first: a graphical sampling multimeter. The digitizer gives the DMM7510 unprecedented signal analysis flexibility; the five-inch capacitive touchscreen display makes it easy to observe, interact with, and explore measurements with "pinch and zoom" simplicity. This combination of high performance and high ease of use offers unparalleled insight into your test results.

Key Features

- Precision multimeter with 3½- to 7½-digit resolution
- Capture and display waveforms or transients with 1 MS/sec digitizer
- Large internal memory buffer; store over 11 million readings in standard mode or 27.5 million in compact mode
- 14 PPM basic one-year DCV accuracy
- 100 mV, 1 Ω, and 10 µA ranges offer the sensitivity needed for measuring low level signals such as portable device sleep mode currents
- Make accurate low resistance measurements with offset compensated ohms, four-wire, and dry circuit functions
- Auto-calibration feature improves accuracy and stability by minimizing temperature and time drift
- Display more with five-inch, high resolution touchscreen interface
- Readings and screen images can be saved quickly via the front panel USB memory port
- Multiple connectivity options: GPIB, USB, and LXI-compliant LAN interfaces
- Two-year specifications enable longer calibration cycles

Capture Waveforms with the Built-in 1 MS/sec Digitizer

Capturing and displaying waveforms and transient events just got easier with the DMM7510's voltage or current digitizing function. The built-in 1 MS/sec, 18-bit digitizer makes it possible to acquire waveforms without the need to use a separate instrument. The digitizing functions employ the same ranges that the DC voltage and current functions use to deliver exceptional dynamic measurement range. In addition, the voltage digitizing function uses the same DC voltage input impedance (10 GΩ or 10 MΩ) levels to reduce loading significantly on the DUT.



The built-in graphing utility supports displaying and comparing measurements or waveforms from up to four reading buffers at once.

Advanced triggering options make it possible to capture a signal at precisely the right point.

Tektronix®

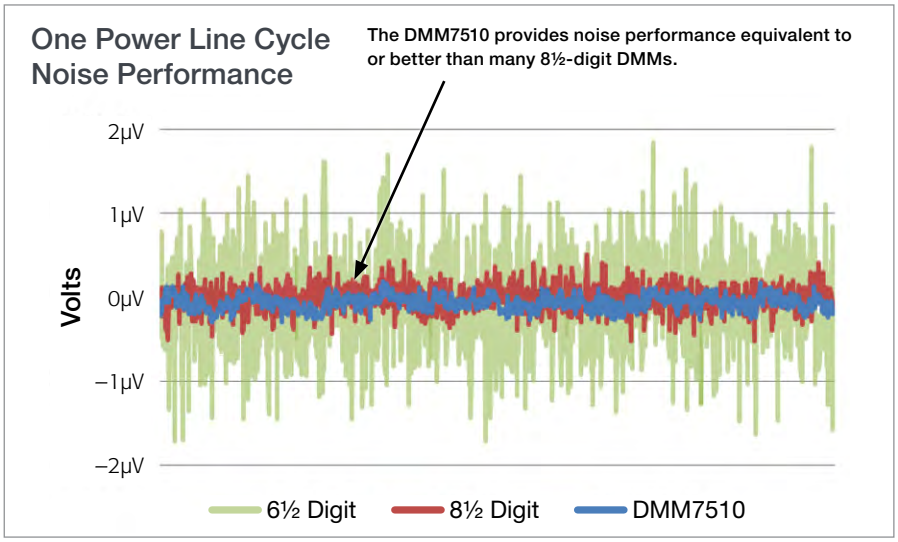
Accurately Measure and Visualize Ultra-Low Current Drain Levels

Determine the current drain of the components such as the microcontroller (MCU) in your low-power, battery-operated product as well as the product's total current draw. In addition, profile the current drain in all of the product's operating states from its sleep mode to its transmit mode. Using the enhanced accuracy DC current function, the DMM7510 can measure a 1 µA sleep mode current with 1 pA resolution and with 0.375 nA tolerance. Furthermore, using the digitizing current function, the DMM7510 can capture the current wave shapes as the product transitions from sleep mode to transmit mode.

Capture the current drain from all the operating states – sleep mode to active transmit mode – of a component or a product with the DMM7510's digitizing function. Focus in on characteristics of the wave shapes with the touchscreen pinch and zoom features.

Make Demanding Measurements with Confidence

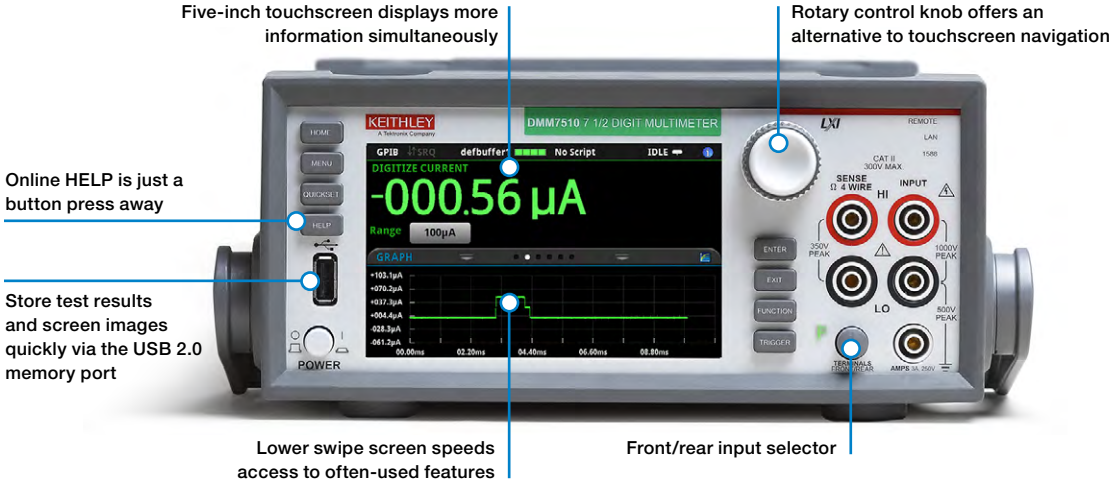
The DMM7510's design makes the most of Keithley's low level measurement expertise. Features like the low noise input stage and the 32-bit A-to-D converter allow this instrument to deliver DC accuracies typically only found in metrology-grade instrumentation—but at about half the price of those solutions. The DMM7510's 100 mV, 10 Ω, and 10 µA ranges deliver the sensitivity needed to measure low signals with confidence when characterizing today's demanding electronic designs. In addition to one- and two-year accuracy specifications, an auto-calibration function ensures greater accuracy between calibration cycles.



Comparison of the DMM7510's 1 VDC noise performance with that of typical 6½- and 8½-digit multimeters. All data was taken at 1 NPLC with a low thermal short applied to the input.

15 Measurement Functions

The DMM7510 provides 15 basic measurement functions. In addition to the digitizing voltage and current functions, it includes capacitance, ACV and ACI, temperature (RTD, thermistor, and thermocouple), 2- and 4-wire resistance, dry circuit ohms, period, frequency, diode test, and DC voltage ratio. The instrument's flat menu structure allows for fast configuration and improves usability. Its intuitive design lets you to learn how to operate the instrument and begin making device measurements faster and with greater confidence.

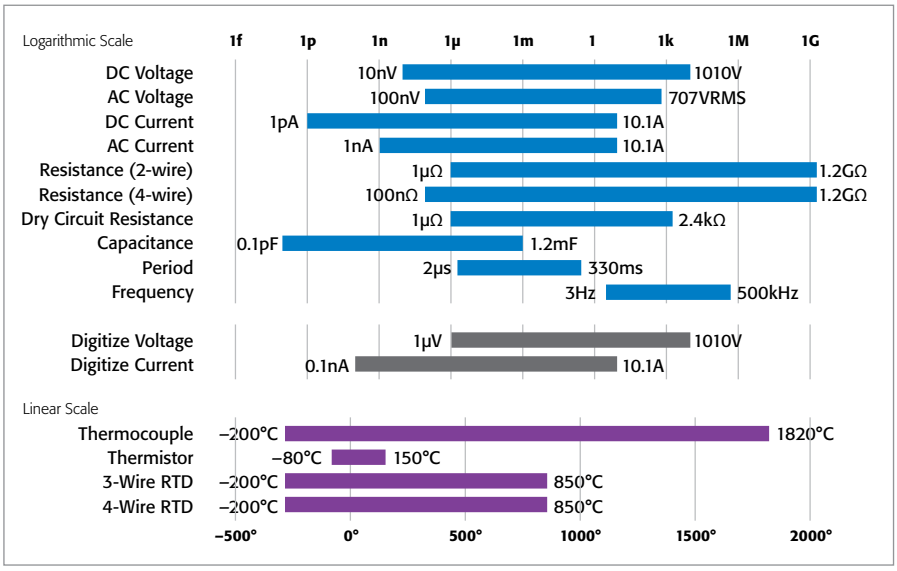


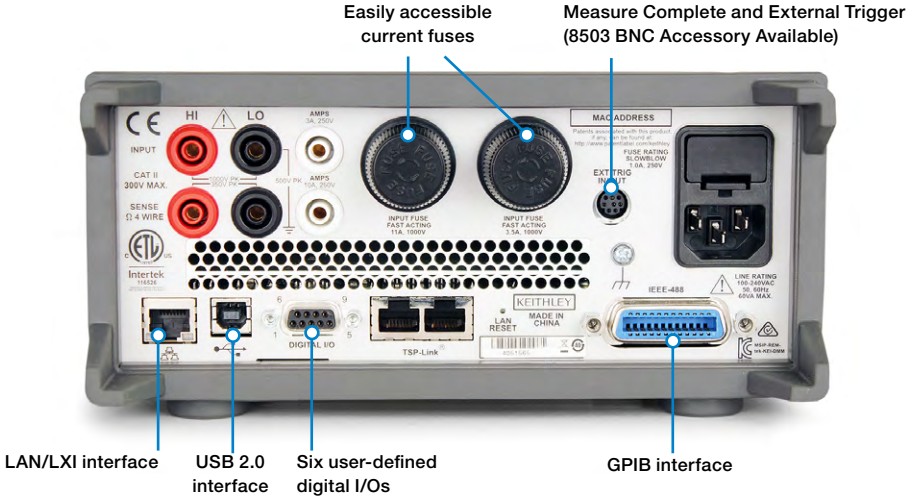
Designed for Higher Testing Productivity

In addition to its advanced touchscreen, the DMM7510's front panel offers a variety of features that enhance its speed, user-friendliness, and learnability, including a USB 2.0 memory I/O port, a HELP key, a rotary navigation/control knob, and front/rear input selector button. All front-panel buttons are backlit to enhance visibility.

The rear panel of the DMM7510 provides connections and controls that simplify configuring multi-instrument test solutions, including input connectors, remote control interfaces (GPIB, USB 2.0 and LXI/Ethernet), a D-sub 9-pin digital I/O port (for internal/external trigger signals and handler control), and TSP-Link® jacks for connecting to other TSP-enabled instruments.

DMM7510 Measurement Capabilities





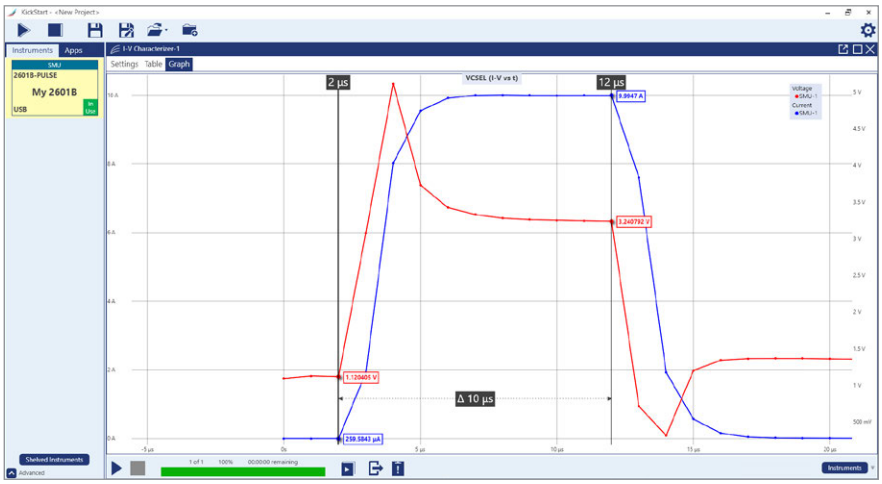
Flexible System Integration and Programming

To offer users maximum programming flexibility and simplify configuring multi-instrument test systems, the DMM7510 includes Keithley's powerful Test Script Processor (TSP®) system and SCPI programming mode. The embedded scripting capability allows running powerful test scripts directly on the instrument, without the need for an external PC controller. These test scripts are complete test programs based on an easy-to-use yet highly efficient and compact scripting language, Lua (www.lua.org). Scripts are a collection of instrument control commands and/or program statements. Program statements control script execution and provide facilities such as variables, functions, branching, and loop control. This allows you to create powerful measurement applications with significantly reduced development times. Test scripts can contain any sequence of routines that are executable by conventional programming languages (including decision-making algorithms), so the instrument can manage every facet of the test without the need to communicate with a PC for decision-making. This eliminates delays due to GPIB, Ethernet or USB traffic congestion and greatly improves overall test times.

TSP technology also offers "mainframe-less channel expansion." The TSP-Link® channel expansion bus and a 100 Base T Ethernet cable allow connecting multiple DMM7510s with other TSP-enabled instruments in a master-slave configuration so they operate as a single integrated system. These instruments include the 2450 and 2460 Graphical SourceMeter® SMU instruments, Series 2600B SourceMeter SMU instruments, and the Series 3700A Switch/Multimeter systems. TSP-Link supports up to 32 units per GPIB or IP address, so it's easy to scale a system to fit the requirements of an application.

A standard SCPI programming mode supports taking advantage of all of the DMM7510's new features when programming remotely. In addition, the instrument is code-compatible with the SCPI language, which many other DMMs use. This code compatibility avoids the need to rewrite code that is normally associated with upgrading to a new instrument with new capabilities.

Instrument Control Software



Keithley's KickStart instrument control software lets you begin taking measurements in minutes.

KickStart combines a wide range of functions to enhance testing productivity:

- Instrument-specific UI panel
- Manual instrument configuration
- Basic reading display and tabular viewing of data
- Datalogging
- Native X-Y data graphing
- Panning and zooming
- Basic statistics (native to instrument, mX+b)
- Saving/exporting data
- Connect using any remote interface (GPIB, USB, LAN)
- Saving instrument setups
- Screenshot capture
- Command line dialog box

Ready-to-use Instrument Drivers Simplify Programming

Need to create your own customized application software? Native National Instruments LabVIEW®, IVI-C, and IVI-COM drivers are available for downloading at www.tek.com to simplify the programming process.

Specification Conditions

This document contains specifications and supplemental information for the DMM7510 7½-Digit Graphical Sampling Multimeter instrument. Specifications are the standards against which the DMM7510 is tested. Upon leaving the factory, the Model DMM7510 meets these specifications. Supplemental and typical values are nonwarranted, apply at 23°C (73°F), and are provided solely as useful information. Measurement accuracies are specified at the DMM7510 terminals under these conditions:

- Temperature 23° ±5°C, 5% to 80% relative humidity, noncondensing.
- After a 90-minute warmup period.
- 1 PLC or 5 PLC; for NPLC settings less than 1 PLC, add appropriate ppm of range for peak noise uncertainty from the RMS noise table.
- Autozero enabled unless otherwise noted.
- Remote sense operation or properly zeroed local operation.
- Calibration period: One year or two years (calibration period may vary depending on customer requirements).
- T_{ACAL} = Ambient temperature of last automatic calibration.
- T_{CAL} = Ambient temperature of last external calibration; factory calibration performed at 23° ±1°C.

DC Voltage

Accuracy (Input impedance AUTO)

Range [1]	Resolution	Input Impedance [2]	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [2]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [3]
100.00000 mV [4]	10 nV	>10 GΩ or 10 MΩ ±1 %	6 + 9	12 + 9	18 + 9	29 + 9	0.1 + 2.5
1.0000000 V [4]	100 nV	>10 GΩ or 10 MΩ ±1 %	4 + 1	9 + 2	15+ 2	26 + 2	0.1 + 0.5
10.000000 V [4]	1 µV	>10 GΩ or 10 MΩ ±1 %	2 + 0.7	9 + 1.2	14 + 1.2	22 + 1.2	0.1 + 0.05
100.00000 V [4]	10 µV	10 MΩ ±1 %	8 + 3	(18 + 5) [5]	(22 + 5) [5]	(30 + 5) [5]	(0.15 + 0.05) [5]
				35 + 5	40 + 5	45 + 5	2.0 + 0.5
1000.0000 V [4, 6]	100 µV	10 MΩ ±1 %	8 + 3	(19 + 5) [5]	(23 + 5) [5]	(31 + 5) [5]	(0.15 + 0.05) [5]
				35 + 5	40 + 5	45 + 4	2.0 + 0.5

RMS Noise **(additional peak noise uncertainty)** [7]

Applies to ±ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Input impedance set to Auto.

NOTES

1. 20% overrange on all ranges except 1% for 1000 V range.
2. Relative to calibration accuracy.
3. Add per degree from T_{CAL} ±5°C.
4. When properly zeroed using the Rel function with external cables.
5. Specified within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL}.
6. For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.
7. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. V_{RMS} noise is typical. Additional peak noise is guaranteed.

Examples:

10 V at 0.006 PLC: 1.2 (from Accuracy table) + 11 (additional peak noise uncertainty) = 12.2 ppm of range.

10 V at 1 PLC: 1.2 + 0 = 1.2 ppm of range.

NPLC	Digits	100 mV	1 V	10 V	100 V	1000 V
5	7½	0.5	0.08	0.06	0.3	0.06
1	7½	0.5	0.09	0.07	0.4	0.07
0.2 [8]	6½	2 (10)	0.2 (1.6)	0.1 (1.1)	1.1 (9.4)	0.1 (1)
0.2	6½	2 (12)	0.2 (1.6)	0.1 (1)	1.1 (8.9)	0.2 (1.1)
0.06	5½	3 (17)	0.4 (2.7)	0.3 (2.1)	3 (17)	0.3 (2.4)
0.006	4½	6 (42)	3 (18)	1 (11)	20 (100)	3 (18)
0.0005	3½	30 (220)	20 (150)	20 (130)	120 (690)	20 (150)

DC Voltage Sense Accuracy

	Accuracy ±(ppm of reading + ppm of range)				
Range	24 Hour T_{CAL} ±1°C	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [9]
100.00000 mV	6 + 14	12 + 14	18 + 14	29 + 14	0.1 + 2.5
1.0000000 V	4 + 1.5	9 + 3	15 + 3	26 + 3	0.1 + 0.5
10.00000 V	2 + 1.0	9 + 1.8	14 + 1.8	22 + 1.8	0.1 + 0.05

DC Voltage Ratio

For input signals ≥1% of the range, ratio accuracy = ±[[V_{INPUT} ppm of reading + V_{INPUT} ppm of range * (V_{INPUT} range/V_{INPUT} input)] + [V_{SENSE} ppm of reading + V_{SENSE} ppm of range * (V_{SENSE} range/V_{SENSE} input)]].

DC Voltage Characteristics

ADC Linearity	1.0 ppm of reading + 1.0 ppm of range.
Input Impedance	100 mV to 10 V Ranges: Selectable >10 GΩ ‖ <400 pF (auto) or 10 MΩ ±1% (10 MΩ).
	100 V to 1000 V Ranges: 10 MΩ ±1%.
Input Bias Current	<50 pA at 23°C under the following conditions: Autozero off or input impedance 10 MΩ.
Common Mode Current	<2.1 µA peak-peak in 1 MHz bandwidth. <100 nA peak-peak in 1 kHz bandwidth.
Common Mode Voltage	500 V_{peak} LO terminal to chassis maximum.
DC Voltage Autozero Off Error	For ±1°C and ≤10 minutes, add ±(8 ppm of reading + 15 µV).

Normal Mode Rejection

For DC voltage, line frequency ±0.1%.

	5 PLC	1 PLC	≤0.2 PLC	≤0.01 PLC
Line Sync On	110 dB	90 dB	45 dB	—
Line Sync Off	60 dB	60 dB	—	—

NOTES

8. With line sync on.
9. Add per degree from T_{CAL} ±5°C.

Common Mode Rejection

For DC voltage and 1kΩ unbalanced in LO terminal; AC CMRR is 70 dB.

NPLC	5	1	0.2	≤ 0.2
Line Sync	On	On	On	Off
CMRR	140 dB	140 dB	120 dB	80 dB

Resistance

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL}) [10]

Range [11]	Resolution	Test Current [12] (±5%)	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [13]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [14]
1.0000000 Ω	0.1 µΩ	10 mA	15 + 50	30 + 50	30 + 50	30 + 50	0.15 + 0.1
10.000000 Ω	1 µΩ	10 mA	15 + 5	30 + 5	30 + 5	30 + 5	0.15 + 0.1
100.00000 Ω	10 µΩ	1 mA	12 + 4	27 + 4	27 + 4	27 + 4	0.15 + 0.1
1.0000000 kΩ	100 µΩ	1 mA	12 + 3	24 + 3	24 + 3	24 + 3	0.15 + 0.1
10.000000 kΩ [15]	1 mΩ	100 µA	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
100.00000 kΩ [15, 16]	10 mΩ	10 µA	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
1.0000000 MΩ [15, 17]	100 mΩ	10 µA	14 + 3	30 + 4	30 + 4	30 + 4	0.15 + 0.1
10.000000 MΩ [18]	1 Ω	0.69 µA I10 MΩ	150 + 6	200 + 10	200 + 10	200 + 10	70 + 1
100.00000 MΩ [18]	10 Ω	0.69 µA I10 MΩ	800 + 30	2000 + 30	2000 + 30	2000 + 30	385 + 1
1.0000000 GΩ [18]	100 Ω	0.69 µA I10 MΩ	9000 + 100	9000 + 100	9000 + 100	9000 + 100	3000 + 1

Accuracy [19]

Range [20]	Resolution	Test Current [21] (±5%)	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [22]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [23]
1 Ω	0.1 µΩ	10 mA	15 + 50	40 + 50	50 + 50	70 + 50	2.5 + 5
10 Ω	1 µΩ	10 mA	15 + 5	40 + 5	50 + 5	70 + 5	2.5 + 0.5
100 Ω	10 µΩ	1 mA	12 + 4	35 + 4	47 + 4	65 + 4	5 + 0.25
1 kΩ	100 µΩ	1 mA	12 + 3	30 + 3	41 + 3	65 + 3	5 + 0.25
10 kΩ [24]	1 mΩ	100 µA	10 + 3	30 + 3	42 + 3	65 + 3	2.5 + 0.25
100 kΩ [24, 25]	10 mΩ	10 µA	13 + 3	38 + 3	50 + 3	65 + 3	5 + 1
1 MΩ [24, 26]	100 mΩ	10 µA	14 + 3	38 + 5	50 + 5	65 + 5	5 + 1
10 MΩ [27]	1 Ω	0.69 µA I10 MΩ	150 + 6	200 + 10	400 + 10	600 + 12	70 + 1
100 MΩ [27]	10 Ω	0.69 µA I10 MΩ	800 + 30	2000 + 30	2000 + 30	2600 + 30	385 + 1
1 GΩ [27]	100 Ω	0.69 µA I10 MΩ	9000 + 200	9000 + 200	13000 + 200	14000 + 200	3000 + 1

NOTES

10. Specifications are for 4-wire resistance, offset compensation on for ≤10 kΩ measurements, and offset compensation off for ≥10 kΩ measurements. 1 Ω range is 4-wire only. For 2-wire, with Rel, add 50 mΩ to ppm of range uncertainty. Without Rel and with 1756 test leads, add 100 mΩ to ppm of range uncertainty.
11. 20% overrange on all ranges.
12. Test current with offset compensation off, ±5%.
13. Relative to calibration accuracy.
14. Add per degree from T_{CAL} ±5°C.
15. Specifications are for external cable and load capacitance <1nF.
16. For offset compensation on, add 10ppm uncertainty to ppm of reading.
17. For 4-wire 1 MΩ, open lead detector on, add 10 ppm uncertainty to ppm of reading.
18. Specified for <10% lead resistance mismatch in HI and LO.
19. Specifications are for 4-wire resistance, offset compensation on for ≤10 kΩ measurements, and offset compensation off for ≥10 kΩ measurements. 1Ω range is 4-wire only. For 2-wire, with Rel, add 50 mΩ to ppm of range uncertainty. Without Rel and with 1756 test leads, add 100 mΩ to ppm of range uncertainty.
20. 20% overrange on all ranges.
21. Test current with offset compensation off.
22. Relative to calibration accuracy.
23. Add per degree from T_{CAL} ±5°C.
24. Specifications are for external cable and load capacitance <1 nF.
25. For offset compensation on, add 10ppm of uncertainty to ppm of reading.
26. For 4-wire, 1 MΩ, open lead detection on, add 10ppm uncertainty to ppm of reading.
27. Specified for <10% lead resistance mismatch in HI and LO.

Resistance Open Circuit DC Voltage [28]

Range [20]	2-wire	Offset Compensation Off	Offset Compensation On
		4-wire	4-wire
1 Ω	–	9.2 V	9.5 V
10 Ω	9.2 V	9.2 V	9.5 V
100 Ω, 1 kΩ	14.0 V	14.2 V	14.3 V
10 kΩ	9.5 V	9.5 V	0.0 V
100 kΩ, 1 MΩ	12.7 V	14.3 V	0.0 V (100 kΩ range only)
10 MΩ to 1 GΩ	6.9 V	6.9 V	–

4-Wire Ohms (≤10kΩ) Offset Compensation On

RMS Noise (additional peak noise uncertainty) [29]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Examples

1 kΩ at 0.006 PLC: 3 (from Accuracy table) + 26 (additional peak noise uncertainty) = 29 ppm of range.

1 kΩ at 1 PLC: 3 + 0 = 3 ppm of range.

NPLC	Digits	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	2.8	0.3	0.3	0.07	0.3
1	7½	4.2	0.4	0.4	0.12	0.5
0.2 [30]	6½	30 (160)	3 (13)	3 (13)	0.4 (2.6)	1.2 (8.2)
0.2	6½	50 (250)	5 (22)	5 (22)	0.6 (3.2)	1.2 (8.3)
0.06	5½	110 (490)	11 (47)	11 (46)	1.1 (6.6)	2 (16)
0.006	4½	110 (710)	10 (70)	10 (70)	4 (26)	10 (60)
0.0005	3½	520 (3420)	50 (340)	50 (340)	40 (220)	50 (300)

2-Wire Ohms

RMS Noise (additional peak noise uncertainty) [29]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements for <1 PLC.

Examples

10 kΩ at 0.006 PLC: 3 (from Accuracy table) + 5 (50 mΩ with Rel) + 43 (additional peak noise uncertainty) = 51 ppm of range.

10 kΩ at 1 PLC: 3 + 5 + 0 = 8 ppm of range.

NPLC	Digits	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	1.1	0.8	0.1	0.2
1	7½	0.6	0.6	0.09	0.4
0.2 [30]	6½	2 (17)	2 (10)	0.2 (1.5)	0.8 (6.3)
0.2	6½	2 (17)	2 (14)	0.3 (1.6)	0.8 (6.4)
0.06	5½	3 (22)	3 (19)	0.4 (3.7)	2 (12)
0.006	4½	6 (50)	6 (50)	3 (21)	6 (43)
0.0005	3½	30 (300)	30 (230)	20 (150)	30 (210)

NOTES

28. Open circuit voltage is typical, measured from input HI to LO, SHI and SLO open. For 1 Ω to 1 MΩ ranges using an external digital multimeter (DMM) set to 10 MΩ input impedance; for 10 MΩ to 1 GΩ ranges, set external DMM to >10 GΩ input impedance.
29. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. RMS noise is typical. Additional peak noise is guaranteed.
30. With line sync on.

Resistance Characteristics

Maximum 4-Wire Ohms Lead Resistance	5 Ω per lead for 1Ω range, 10% of range per lead for 10 Ω to 1 kΩ ranges; 1 kΩ per lead for all other ranges.
Offset Compensation	Selectable on 4-wire, 1 Ω to 100 kΩ ranges.
Open Lead Detector	Default is off.
Autozero Off Error	For 2-wire ohms, ±1°C and ≤10 minutes, add ±(8ppm of reading) + 1.5 mΩ for 10 Ω, 15 mΩ for 100 Ω and 1 kΩ ranges, 150 mΩ for 10 kΩ range, 1.5 Ω for 100 kΩ range, and 15 Ω for all other ranges. For 4-wire ohms, ±1°C and ≤10 minutes, add ±(8 ppm of reading).
Input Current Limit	For signals with a magnitude of +12 V to +40 V or –12 V to –40 V: ±13 mA source or sink, typical. For signals with a magnitude of greater than +40 V or –40 V: ±130 µA source or sink, typical.

Dry Circuit Resistance

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5ºC from T_{ACAL})

Range[31]	Resolution	Test Current[35] (±5%)	Open Circuit DUT Voltage[32]	Accuracy ±(ppm of reading + ppm of range)				
				24 Hour T_{CAL} ±1°C[33]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 years T_{CAL} ±5°C	Temperature Coefficient[34]
1.000000 Ω	1 µΩ	10 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
10.00000 Ω	10 µΩ	1 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
100.0000 Ω	100 µΩ	100 µA	25 mV	25 + 80	90 + 80	90 + 80	90 + 80	1.5 + 0.1
1.000000 kΩ	1 mΩ	10 µA	25 mV	25 + 80	180 + 80	180 + 80	180 + 80	1.5 + 0.1
10.00000 kΩ	10 mΩ	5 µA	25 mV	25 + 80	320 + 80	320 + 80	320 + 80	1.5 + 0.1

Accuracy

Range[31]	Resolution	Test Current[35] (±5%)	Open Circuit DUT Voltage[32]	Accuracy ±(ppm of reading + ppm of range)				
				24 Hour T_{CAL} ±1°C[33]	90 Day T_{CAL} ±°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient[34]
1.000000 Ω	1 µΩ	10 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	2.5 + 1
10.00000 Ω	10 µΩ	1 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	5 + 1
100.0000 Ω	100 µΩ	100 µA	25 mV	25 + 80	90 + 80	140 + 80	200 + 80	2.5 + 1
1.000000 kΩ	1 mΩ	10 µA	25 mV	25 + 80	180 + 80	400 + 80	600 + 80	5 + 1
10.00000 kΩ	10 mΩ	5 µA	25 mV	25 + 80	320 + 80	800 + 80	1300 + 80	8 + 1

RMS Noise (additional peak noise uncertainty)[36]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements when < 1 PLC.

NOTES

31. 20% overrange on all ranges, except 2.4 kΩ for the 10 kΩ range.
32. Maximum clamp voltages are DC, typical accuracy is ±20%. Add 20% for offset compensation on.
33. Relative to calibration accuracy.
34. Add per degree from T_{CAL} ±5°C.
35. Test current with offset compensation off.
36. Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. $_{RMS}$ noise is typical. Additional peak noise is guaranteed.

Examples: 10 Ω at 0.2 PLC: 80 (from Accuracy table) + 230 (additional peak noise uncertainty) = 310 ppm of range.

10 Ω at 1 PLC: 80 + 0 = 80 ppm of range.

NPLC	Digits	1 Ω	10 Ω	100 Ω	1 kΩ	10 kΩ
5	7½	10	11	6	5	0.9
1	7½	9	9	7	7	0.8
0.2 [37]	6½	30 (130)	30 (120)	30 (120)	30 (120)	3 (16)
0.2	6½	60 (220)	60 (230)	50 (190)	50 (190)	9 (35)
0.06	5½	70 (350)	70 (350)	50 (290)	50 (280)	20 (90)
0.006	4½	130 (750)	120 (830)	110 (700)	100 (690)	20 (110)
0.0005	3½	520 (3550)	530 (3520)	530 (3380)	500 (3370)	100 (670)

Dry Circuit Resistance Characteristics

Maximum 4-Wire Ohms Lead Resistance

0.5 Ω per lead for 1 Ω range.
10% of range per lead for 10 Ω to 100 Ω ranges.
50 Ω per lead for 1 kΩ to 10 kΩ ranges.

Input Current Limit For signals greater than ±20 mV, current limited, ±13 mA typical.

Offset Compensation Selectable on 1 Ω to 10 kΩ ranges.

Autozero Off Error For ±1°C and ≤10 minutes, add ±8 ppm of reading.

DC Current

Enhanced Accuracy (within 30 days of autocalibration, T_{OPER} ±5°C from T_{ACAL})

Range [38]	Resolution	Maximum Burden Voltage	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [39]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [40]
10.000000 µA	1 pA	15 mV	30 + 30	75 + 30	75 + 30	75 + 30	0.15 + 0.1
100.00000 µA	10 pA	15 mV	20 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
1.0000000 mA	100 pA	15 mV	30 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
10.000000 mA	1 nA	20 mV	40 + 5	60 + 9	60 + 9	60 + 9	0.15 + 0.1
100.00000 mA	10 nA	200 mV	50 + 18	150 + 30	150 + 30	150 + 30	0.15 + 0.1
1.0000000 A	100 nA	400 mV	150 + 50	400 + 50	400 + 50	400 + 50	0.15 + 0.1
3.000000 A	1 µA	1300 mV	200 + 40	400 + 40	400 + 40	400 + 40	0.15 + 0.1
10.000000A [41]	1 µA	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

NOTES

37. With line sync on.
38. 20% overrange supported for all ranges except for 3 A and 10 A, which are 1% supported.
39. Relative to calibration accuracy.
40. Add per degree from T_{CAL} ±5°C.
41. Rear input terminals only.

Accuracy

Range [38]	Resolution	Maximum Burden Voltage	Accuracy ±(ppm of reading + ppm of range)				
			24 Hour T_{CAL} ±1°C [39]	90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [40]
10.000000 µA	1 pA	15 mV	30 + 30	100 + 30	125 + 40	175 + 50	10 + 8
100.00000 µA	10 pA	15 mV	20 + 5	75 + 12	100 + 15	150 + 20	10 + 3
1.0000000 mA	100 pA	15 mV	30 + 5	75 + 12	100 + 15	150 + 20	10 + 3
10.000000 mA	1 nA	20 mV	40 + 5	75 + 12	100 + 15	150 + 20	10 + 3
100.00000 mA	10 nA	200 mV	50 + 18	300 + 30	400 + 30	500 + 30	50 + 5
1.0000000 A	100 nA	400 mV	150 + 50	400 + 50	450 + 50	500 + 50	10 + 10
3.000000 A	1 µA	1300 mV	200 + 40	400 + 40	450 + 40	500 + 40	10 + 10
10.000000 A [41]	1 µA	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

RMS Noise (additional peak noise uncertainty) [42]

Applies to ± ppm of range.

Peak noise uncertainty is included in DC specifications for ≥1 PLC.

Add peak noise uncertainty to measurements when <1 PLC.

Examples

1 mA at 0.006 PLC: 9 (from Accuracy table) + 20 (additional peak noise uncertainty) = 29 ppm of range.

1 mA at 1 PLC: 9 +0 = 9 ppm of range.

NPLC	Digits	10 µA	100 µA	1 mA	10 mA	100 mA	1A	3A	10A [43]
5	7½	0.15	0.14	0.09	0.1	0.3	0.3	0.2	0.8
1	7½	0.4	0.13	0.1	0.1	0.5	0.5	0.3	1.2
0.2	6½	0 (220)	0 (23)	0.2 (3.4)	0.2 (1.6)	2 (10)	2 (11)	0.7 (4.6)	4 (32)
0.2 [44]	6½	120 (260)	12 (26)	1.2 (3.8)	0.3 (1.8)	1.9 (9.8)	2 (10)	0.8 (5)	8 (37)
0.06	5½	130 (280)	12 (29)	1.3 (5.6)	0.4 (3.9)	2 (14)	2 (14)	1.2 (7.7)	10 (59)
0.006	4½	130 (350)	14 (42)	3 (20)	2 (20)	4 (30)	4 (31)	7 (51)	20 (110)
0.0005	3½	260 (2110)	30 (300)	20 (150)	20 (160)	30 (190)	30 (190)	70 (510)	60 (420)

DC Current Characteristics

Range	10 µA	100 µA	1 mA	10 mA	100 mA	1 A	3 A	10 A [43]
Effective Internal Shunt Value [45]	1 kΩ	100 Ω	10 Ω	1 Ω	0.1 Ω	0.1 Ω	0.1 Ω	0.005 Ω
Autozero Off Error: For ±1°C and ≤10 minutes add ±(8 ppm of reading + range error)	150 pA	1.5 nA	15 nA	150 nA	15 µA	150 µA	150 µA	3 mA
Overload Recovery: For each additional sustained amp beyond ±1.5 A, add the following initial ppm of range error until thermally settled after overload recovery	15500	1800	150	150	6500	200	—	—

NOTES

42. Noise values are based on 1000 readings with autozero on and AMPS terminal open. RMS noise is typical. Additional peak noise is guaranteed.
43. Rear input terminals only.
44. With line sync on.
45. Values are typical and guaranteed by design.

Temperature

4-Wire RTD or 3-Wire RTD

Types: 100 Ω platinum PT100, D100, F100, PT385, PT3916; or user-configurable 0 Ω to 10 kΩ.

Type	Range	Resolution	Accuracy ±°C	
			2 Year, T_{CAL} ±5°C	Temperature Coefficient [46]
4-Wire RTD	–200 to 850 °C	0.01 °C	0.06 °C	0.003 °C/°C
3-Wire RTD [47]	–200 to 850 °C	0.01 °C	0.75 °C	0.003 °C/°C

Thermistor

Types: 2.252 kΩ, 5 kΩ, and 10 kΩ.

Type	Range	Resolution	Accuracy ±°C	
			2 Year, T_{CAL} ±5°C	Temperature Coefficient [46]
Thermistor	–80 to +150 °C	0.01 °C	0.08 °C	0.002 °C/°C

Thermocouple

Types: B, E, J, K, N, R, S, T

			Accuracy ±°C	
Type	Range	Resolution	2 Year, T_{CAL} ±5°C [48] Simulated Reference Junction	Temperature Coefficient [46]
B	350 to +1820 °C	0.1 °C	0.6 °C	0.03 °C/°C
E	–200 to +1000 °C	0.001 °C	0.2 °C	0.03 °C/°C
J	–200 to +760 °C	0.001 °C	0.2 °C	0.03 °C/°C
K	–200 to +1372 °C	0.001 °C	0.2 °C	0.03 °C/°C
N	–200 to +1300 °C	0.001 °C	0.2 °C	0.03 °C/°C
R	0 to +1768 °C	0.1 °C	0.6 °C	0.03 °C/°C
S	0 to +1768 °C	0.1 °C	0.6 °C	0.03 °C/°C
T	–100 to +400 °C	0.001 °C	0.2 °C	0.03 °C/°C

Continuity

Range [49]	Resolution	Test Current	Open Circuit Voltage	Accuracy ±(ppm of reading + ppm of range)	
				2 Year, T_{CAL} ±5°C	Temperature Coefficient [50]
1.0000 kΩ	100 mΩ	1 mA	14.0 V	100 + 100	2.5 + 1

Continuity Characteristics

Continuity High Limit User-selectable; default 10 Ω.

NOTES

46. Add per degree from T_{CAL} ±5°C; specifications without autocalibration.
47. For 3-wire RTD, accuracy is for <0.1 Ω lead resistance mismatch for input HI and LO. Add 0.25°C/0.1 Ω of HI-LO lead resistance mismatch.
48. Exclusive of cold-junction errors.
49. Specifications exclude lead resistance.
50. Add per degree from T_{CAL} ±5°C; specifications without autocalibration.

Capacitance

Accuracies specified for additional cable and stray capacitance properly zeroed with the Rel function.

Accuracy

Range [51]	Resolution	Charge Current [52, 53]	Maximum Circuit Voltage	Accuracy ±(% of reading + % of range)	
				2 years T_{CAL} ±5°C	Temperature Coefficient [50]
1.0000 nF	0.1 pF	1.1 µA	2.8 V	1 + 0.2	0.15 + 0.05
10.000 nF	1 pF	1.1 µA	2.8 V	1 + 0.1	0.15 + 0.01
100.00 nF	10 pF	10 µA	3 V	0.4 + 0.1	0.01 + 0.01
1.0000 µF	0.1 nF	100 µA	3 V	0.4 + 0.1	0.01 + 0.01
10.000 µF	1 nF	100 µA	3 V	0.4 + 0.1	0.01 + 0.01
100.00 µF	10 nF	1 mA	3 V	0.4 + 0.1	0.01 + 0.01
1000.0 µF	0.1 µF	10 mA	3 V	0.5 + 0.1	0.01 + 0.01

Diode

Voltage Measure Range [51]	Resolution	Bias Level (Selectable)	Accuracy ±(ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [50]
10.000000 V	1 µV	10 µA / 100 µA / 1 mA	20 + 5	30 + 5	45 + 5	2.5 + 1

Digitize Voltage

Accuracy (Input Impedance AUTO)

Range [54, 55]	Resolution [56]	Input Impedance [57]	Accuracy ±(ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [58]
100.000 mV	1 µV	>10 GΩ or 10 MΩ ±1%	210 + 100	220 + 100	230 + 100	15 + 20
1.00000 V	10 µV	>10 GΩ or 10 MΩ ±1%	110 + 75	120 + 75	130 + 75	15 + 20
10.0000 V	0.1 mV	>10 GΩ or 10 MΩ ±1%	110 + 75	120 + 75	130 + 75	10 + 20
100.000 V [59]	1 mV	10 MΩ ±1%	110 + 75	120 + 75	130 + 75	15 + 20
1000.00 V [60]	10 mV	10 MΩ ±1%	110 + 75	120 + 75	130 + 75	10 + 20

NOTES

51. 20% overrange on all ranges.
52. Charging current values are typical, guaranteed by design.
53. Discharge current limited to <13 mA.
54. For DC coupling, 20% overrange for 100 mV to 100 V. For AC coupling, 500% overrange 100 mV to 100 V. 1% for 1000 V range DC and AC coupling.
55. Accuracy with sample rate 1k per second, aperture auto, and 100 reading buffer average.
56. Power up default is 4½ digits.
57. User-selectable.
58. Add per degree from T_{CAL} ±5%.
59. For 100 V range, input impedance auto and without ACAL, add 100ppm of range additional uncertainty and 15 ppm/°C additional uncertainty for "of range" temperature coefficient for operation outside of T_{CAL} ±5°C.
60. For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.

Signal Characteristics [61, 62, 63]

Typical AC and DC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 20 kHz [64]	THD 20 kHz Signal (–1dB FS) [65]	DC-coupled Settling Time (0.5%)	AC-coupled Filter FAST Settling Time (0.5%)	AC-coupled Filter SLOW Settling Time (0.5%)	AC Coupling Low Frequency (–3dB) point [66]
100.000 mV	600 kHz	0.015 dB	0.04 %	5 µs	80 ms	2.3 s	1 Hz
1.00000 V	600 kHz	0.01 dB	0.03 %	6 µs	80 ms	2.5 s	1 Hz
10.0000 V	600 kHz	0.01 dB	0.01 %	4 µs	80 ms	2.5 s	1 Hz

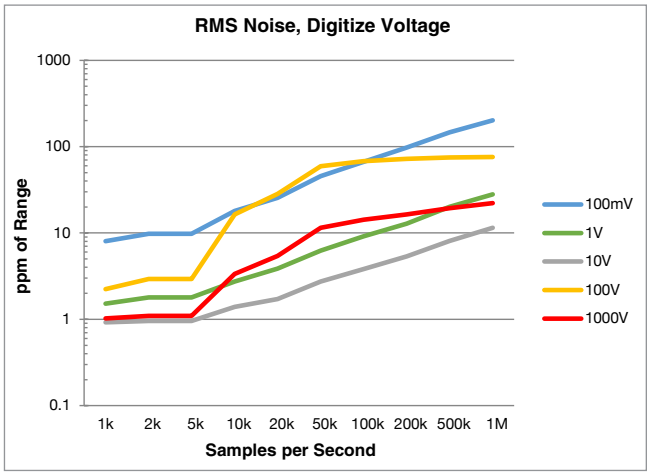
Typical DC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 1 kHz [64]	Total Harmonic Distortion (THD) 1 kHz Signal (–1dB FS) [65]	Settling Time (0.5%)
100.000 V	20 kHz [67]	0.1 dB	1.3 %	160 µs
1000.00 V	20 kHz	0.1 dB	1.8 %	80 µs

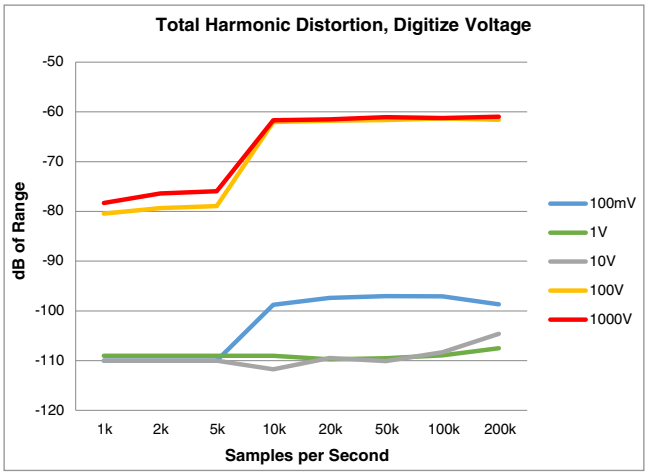
Typical AC Coupled

Range	Analog Bandwidth (–3dB)	Maximum Flatness Error 3 Hz to 20 kHz	Filter FAST Settling Time (0.5%)	Filter SLOW Settling Time (0.5%)	Low Frequency Coupling Point [66] (–3dB)
100.000 V	600 kHz	0.1 dB	80 ms	2.3 s	1 Hz
1000.00 V	600 kHz	0.1 dB	80 ms	2.3 s	1 Hz

DC-Coupled Additional Noise Uncertainty, Typical [68]



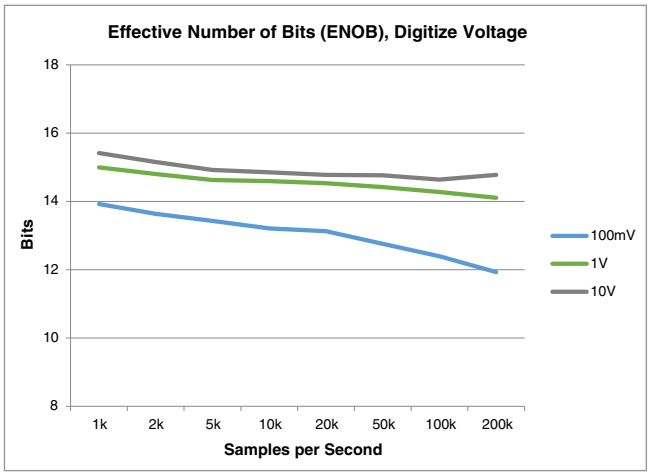
DC-coupled Total Harmonic Distortion (THD), Typical [69]



NOTES

61. Accuracy with sample rate 1M per second and aperture 1 µs.
62. Verified with sine wave input and DC content ≤3% of range.
63. For AC coupling, maximum crest factor of 5.
64. For DC coupled, 0dB reference frequency is 3 Hz. For AC coupled, 0dB reference frequency is 1 kHz. For AC coupled operation below 1 kHz, add 0.1 dB.
65. Exclusive of source input noise.
66. With AC coupling frequency = 3 Hz and AC coupling filter = Slow.
67. For input impedance auto, bandwidth is 6 kHz.
68. Specified with aperture auto and 4-wire short on input terminals. For 100 V range, input impedance 10 MΩ, multiply by 2.5. For all ranges and sample rate >1 k, add an additional 3× RMS noise uncertainty to ppm of range.
69. Specified with aperture auto and 1 kHz sine wave input. Distortion is calculated using first five harmonics.

DC-Coupled Effective Number Of Bits (ENOB), Typical [70]



Digitize Current

DC Accuracy [71]

Range [72]	Resolution [73]	Burden Voltage	Accuracy ± (ppm of reading + ppm of range)			
			90 Day T_{CAL} ±5°C	1 Year T_{CAL} ±5°C	2 Year T_{CAL} ±5°C	Temperature Coefficient [74]
10.0000 µA	0.1 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
100.000 µA	1 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
1.00000 mA	10 nA	15 mV	150 + 75	160 + 75	170 + 75	30 + 15
10.0000 mA	100 nA	20 mV	150 + 75	160 + 75	170 + 75	30 + 15
100.000 mA	1 µA	200 mV	340 + 100	450 + 100	560 + 100	50 + 20
1.00000 A	10 µA	400 mV	400 + 110	500 + 110	600 + 110	50 + 25
3.00000 A	100 µA	1300 mV	650 + 150	900 + 150	900 + 150	50 + 25
10.0000 A [75]	100 µA	650 mV	950 + 350	1500 + 350	2000 + 350	50 + 25

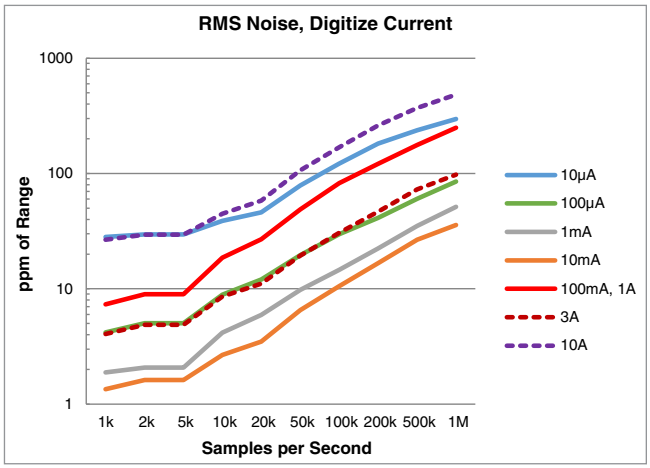
NOTES

70. Specified with aperture Auto, 100Hz sine wave for sample rate ≤5k, and 1kHz sine wave for sample rate ≥10k. For the 100V and 1000V ranges, use the 1V and 10V range ENOB, respectively; guaranteed by design.
71. Accuracy with sample rate 1k per second, aperture auto, and 100 reading buffer average.
72. 20% overrange on all ranges except 3.3% for 3A and 10A ranges.
73. Power up default is 4½ digits.
74. Add per degree from T_{CAL} ±5°C.
75. Rear input terminals only.

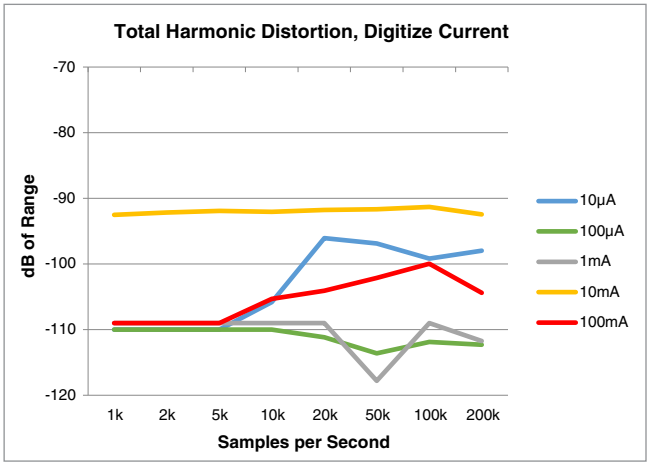
Signal Characteristics, Typical [76]

Range [72]	Maximum Flatness Error 3 Hz to 20 kHz	Analog Bandwidth (–3dB)	Total Harmonic Distortion (THD) 20 kHz Signal (–1dB FS)	DC-coupled Settling Time (0.5%)
10.0000 µA	0.15 dB	100 kHz	0.02 %	8 µs
100.000 µA	0.15 dB	100 kHz	0.01 %	7 µs
1.00000 mA	0.1 dB	100 kHz	0.01 %	3 µs
10.0000 mA	0.1 dB	100 kHz	0.01 %	8 µs
100.000 mA	0.1 dB	100 kHz	0.02 %	5 µs
1.00000 A [77]	0.1 dB	100 kHz	0.02 %	6 µs
3.0000 A [77]	0.1 dB	100 kHz	0.02 %	6 µs
10.0000 A [75, 77, 78]	0.1 dB	100 kHz	0.02 %	6 µs

Additional Noise Uncertainty, Typical [79]



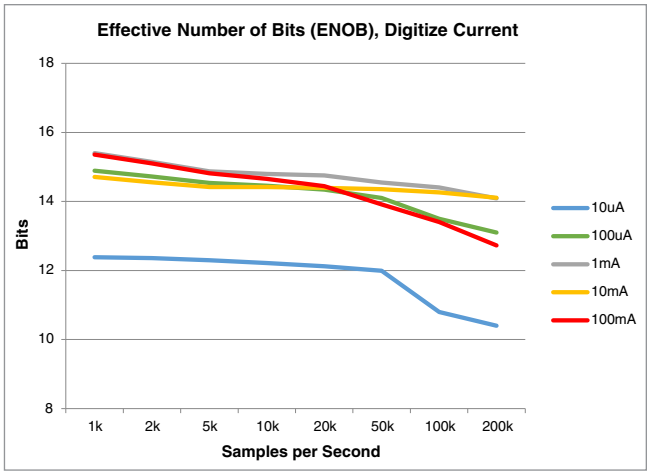
Total Harmonic Distortion (THD), Typical [80]



NOTES

76. Verified with sine wave input and DC content ≤3% of range.
77. 10A range is available only on the rear input terminals.
78. 10A flatness verified to 10kHz; 100kHz guaranteed by design.
79. Specified with aperture Auto and open input terminals. For all ranges and for ≥1k sample rate, add an additional 3× $_{RMS}$ noise uncertainty to ppm of range.
80. Specified with aperture Auto and 1kHz sine wave input. Distortion is calculated using first five harmonics. For the 1A, 3A, and 10A ranges, use the 100mA range accuracy; guaranteed by design.

Effective Number Of Bits (ENOB), Typical [81]



Digitizer Characteristics

Maximum Resolution	18 bits.
Measurement Input Coupling	DC or AC (voltage only).
Sampling Rate [82]	Programmable 1 k through 1 million.
Volatile Sample Memory with Timestamp	27.5 million.
Minimum Record Time	1 µs.
Timestamp Resolution	1 ns with standard or full buffer style. 1 µs with compact buffer style.
Timestamp Accuracy	With standard or full buffer style, 20 ns between adjacent readings, with total buffer time <2 s. With compact buffer style, 2 µs adjacent readings, with total buffer buffer time <2 s.
Maximum Record Length	8 million.

NOTES

81. Specified with aperture Auto, 100 Hz sine wave for sample rate ≤5 k, and 1 kHz sine wave for sample rate ≥10 k. For the 1 A, 3 A, and 10 A ranges, use the 100 mA ENOB; guaranteed by design.
82. Sample rate is not continuously adjustable. For valid discrete settings, see the DMM7510 Reference Manual.

True RMS AC Voltage and AC Current

Function	Range [83]	Resolution	1-Year Accuracy: ±(% of reading + % of range) T_{CAL} ±5°C					
			3 Hz to 5 Hz	5 Hz to 10 Hz	10 Hz to 20 kHz	20 kHz to 50 kHz	50 kHz to 100 kHz	100 kHz to 300 kHz
Voltage [84]	100.0000 mV	0.1 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	1.000000 V	1 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	10.00000 V	10 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	100.0000 V	100 µV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
	700.000 V	1 mV	1.0 + 0.03	0.30 + 0.03	0.06 + 0.03	0.14 + 0.05	0.6 + 0.08	4.0 + 0.5
Temperature Coefficient/°C (all ranges)	–	–	0.01 + 0.003	0.03 + 0.003	0.005 + 0.003	0.006 + 0.005	0.01 + 0.006	0.03 + 0.01

Function	Range [83]	Resolution	1-Year Accuracy: ±(% of reading + % of range) T_{CAL} ± 5°C				
			3 Hz to 5 Hz	5 Hz to 10 Hz	10 Hz to 2 kHz	2 kHz to 5 kHz	5 kHz to 10 kHz
Current [84]	1.000000 mA	1 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.09 + 0.03
	10.00000 mA	10 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.09 + 0.03
	100.0000 mA	100 nA	1.0 + 0.04	0.30 + 0.04	0.08 + 0.03	0.09 + 0.03	0.01 + 0.006
	1.000000 A	1 µA	1.0 + 0.04	0.30 + 0.04	0.20 + 0.04	0.88 + 0.04	0.01 + 0.006
	3.000000 A	1 µA	1.0 + 0.05	0.30 + 0.05	0.20 + 0.05	0. 88 + 0.05	2.0 + 0.04
	10.00000 A [85]	10 µA	1.0 + 0.05	0.40 + 0.05	0.40 + 0.05	0. 88 + 0.05	2.0 + 0.05
Temperature Coefficient/°C (all ranges)	–	–	0.10 + 0.004	0.030 + 0.004	0.005 + 0.003	0.006 + 0.005	0.006 + 0.005

Additional AC Uncertainties – Low Frequency Uncertainty

Additional Uncertainty ±(% of reading), Lower Frequency Uncertainty	Detector Bandwidth (BW)		
	3 BW (3 Hz to 300 kHz)	30 BW (30 Hz to 300 kHz)	300 BW (300 Hz to 300 kHz)
20 Hz to 30 Hz	0	0.3	—
30 Hz to 50 Hz	0	0	—
50 Hz to 100 Hz	0	0	4.0
100 Hz to 200 Hz	0	0	0.72
200 Hz to 300 Hz	0	0	0.18
300 Hz to 500 Hz	0	0	0.07
> 500 Hz	0	0	0

NOTES

83. 20% overrange on AC functions except 1% on 700 V, 3.33% on 3 A, and 1% on 10 A. Default resolution is 6½ digits.
84. Specifications are for detector bandwidth of 3Hz and sine wave inputs >5% of range. Detector bandwidth of 3 Hz and 30 Hz are multisample A/D conversions. Detector bandwidth of 300 Hz is a single A/D conversion, programmable from 0.0005 PLC to 15 PLC (60 Hz), 12 PLC (50 Hz). Default condition set to 1 PLC.
85. Rear terminals only.

Additional AC Voltage Crest Factor Uncertainties [86]

Additional Uncertainty ±(% of reading)

Input Signal Frequency	Detector Bandwidth	Maximum Crest Factor: 5 at Range Full Scale			
		1 to 2	2 to 3	3 to 4	4 to 5
3 Hz to 5 Hz	3 Hz	1.00	4.00	4.80	5.00
5 Hz to 10 Hz	3 Hz	0.50	1.20	1.30	1.40
10 Hz to 30 Hz	3 Hz	0.20	0.30	0.60	0.90
5 Hz to 100 Hz	30 Hz	0.20	0.30	0.60	0.90
100 Hz to 300 Hz	30 Hz	0.05	0.15	0.30	0.40
100 Hz to 300 Hz	300 Hz	0.50	1.20	1.30	1.50
500 Hz to 10 kHz	300 Hz	0.05	0.15	0.30	1.20

AC Voltage Characteristics

Measurement Method AC-coupled, true RMS.

Input Impedance 1 MΩ ± 2% || <150 pF.

Volt*Hertz Product <2.1 × 10^7 V*Hz verified; input frequency verified for <300 kHz.

AC Current Characteristics

Measurement Method AC-coupled, true RMS.

Range	1 mA	10 mA	100 mA	1 A	3 A	10 A [87]
Burden Voltage (RMS)	<16 mV	<20 mV	<0.2 V	<0.4 V	<1.3 V	<0.65 V
Overload Recovery: For each additional sustained ampere beyond ±1.5 A, add the following initial % of range error until thermally settled after overload recovery	0.006	0.006	0.12	0.05	—	—

Frequency and Period

Measurement Accuracy [88]

Aperture	Measurement Resolution	Accuracy, ±(ppm of reading + ppm of aperture time) Frequency: 3 Hz to 500 kHz Period: 333 ms to 2 µs	
		1 Year, T_{CAL} ±5°C	2 Year, T_{CAL} ±5°C
250 ms	0.1 ppm	80 + 0.333	160 + 0.333
100 ms	0.1 ppm	80 + 3.33	160 + 3.33
10 ms	0.1 ppm	80 + 33.3	160 + 33.3

Threshold Level Accuracy [89]

Threshold Range	Threshold Resolution	Accuracy ±(% of reading) 2 Year, T_{CAL} ±5°C
100 mV to 700 V	0.05%	1.0%

NOTES

86. Applies for non-sine wave inputs, DC content ≤3% of range, maximum crest factor ≤5.0. For bandwidth 30Hz, autozero off, 6½ digits at 1 PLC, 3½ digits at 0.0005 PLC.
87. Rear input terminals only.
88. Specified for square wave inputs. Input signal must be >10% of ACV range. If input is <20 mV on the 100 mV range, then the frequency must be >10 Hz. For sine wave inputs, frequency must be >100 Hz. For frequencies ≤100 Hz, threshold level ≤50% of input signal and ≤7 Hz, threshold level ≤3% of range.

Frequency and Period Characteristics

Measurement Method	Reciprocal counting technique.
Aperture	10 ms to 273 ms; default is 10 ms.

Typical Reading Rates, 60 Hz (50 Hz) Operation [90, 91, 92, 93]

NPLC	Digits	Functions: DC Voltage (10 V), 2-wire Ohms (≤10 kΩ), DC Current (1 mA)		Functions: 4-wire ohms (≤1 kΩ), 4-wire/3-wire RTD		Functions: Thermistor		Functions: Dry Circuit (≤1 kΩ)	
		Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer	Measurements Into Buffer	Measurements Into Computer
1	7½	59.8 (49.8)	58 (48)	29 (24)	28 (24)	57 (48)	57 (48)	27 (23)	26 (22)
0.2	6½	295 (240)	250 (210)	128 (109)	119 (100)	230 (200)	230 (200)	100 (89)	96 (85)
0.06	5½	965 (810)	950 (800)	310 (280)	315 (280)	900 (750)	900 (750)	190 (180)	190 (180)
0.006	4½	7500 (6700)	7300 (6500)	750 (730)	740 (720)	6800 (6000)	6800 (6000)	295 (290)	295 (290)
0.0005	3½	26000 (26000)	24000 (24000)	860 (860)	860 (860)	18000 (18000)	18000 (18000)	310 (310)	310 (310)

Detector Bandwidth (Hz)	Digits	Functions: ACV, ACI	
		Measurements Into Buffer	Measurements Into Computer
3	6½	0.5 (0.5)	0.5 (0.5)
30	6½	3.3 (3.3)	3.3 (3.3)
300 [94]	6½	59.8 (49.8)	55 (46)
300 [94]	3½	26200 (26200)	24500 (24500)

Digitize, Typical

Sampling Rate	Digits	Resolution	Measurements Into Computer [93]
10 kS/s	5½	18	9700
20 kS/s	4½	16	19000
50 kS/s	4½	16	44400
100 kS/s	4½	15	80000
1 MS/s	3½	12	108000

System Performance, Typical

Mode	3½-digit, autozero off, 0.0005 PLC, excludes measurement time.
	Time includes function change from DC voltage or 2-wire ohms to listed function.

NOTES

89. Threshold range is voltage $_{RMS}$ and threshold level voltage peak. Specified with 1kHz square wave. 100V and 700V threshold ranges guaranteed by design.
90. Reading speeds for autozero off, fixed range, autodelay off. Offset compensation off and open lead detector off where applicable.
91. Buffer measurements: For <0.2 PLC, multisample, single buffer transfer binary reading only.
92. PC measurements: For 1 and 0.2 PLC single reading and single transfer to computer (USB).
93. Reading rates using factory default operating conditions and autorange off, autodelay off. Speeds include measurement and data transfer out of the USB. ≥1000 readings with binary transfer over USB.
94. For bandwidth 300Hz, autozero off, 6½ digits at 1 PLC, 3½ digits at 0.0005 PLC.

Function	Function Change (ms)	Range Change (ms)
DC Voltage or 2-wire ohms (<10 kΩ)	6	1.3
4-wire ohms (<10 kΩ)	7	1.3
DC Current	7	1.3
Frequency or Period [95]	7	1.3
AC Voltage or AC Current	7	1.3
Digitize Voltage or Current	7	1.3

Ranges for Function Change Times

Function change times apply to the ranges listed in the table below.

Function	Range
DC Voltage	10 V
2-wire or 4-wire Ohms	1 kΩ
DC Current	1 mA
Dry-circuit Ohms	10 Ω
Thermocouple	Use DC Voltage rates
Thermistor	Use 2-wire Ohms rates
AC Current	1 mA
AC Voltage	1 V

Buffer Transfer Speed (Binary)	Measurements into Computer (per second)		
	USB	LAN	GPIB
Average for 1000 readings	280000	270000	190000
Average for 1000 readings with timestamp	170000	140000	100000

Triggering

Time Base Accuracy	25ppm.
Trigger Source	Analog DCV, DCI, or any system trigger.
Trigger Coupling	DC or AC (DCV function only).
Input Trigger Latency [96, 97, 98]	<225 ns.
Input Trigger Jitter [96, 97]	<50 ns.
Sample period Jitter [96, 97]	<1 ns.

DMM Rear-Panel Triggers

EXT TRIG IN and OUT	0 V to 5 V logic signal input and output, TTL compatible.
EXT trigger latency (IN and OUT)	<400 ns.
EXT trigger latency (IN or OUT)	<200 ns (guaranteed by design).

NOTES

95. For DC voltage or 2-wire ohms to frequency or period, 10ms aperture. For AC current or AC voltage, detector bandwidth is 300 Hz.
96. Guaranteed by design; for digital I/O only.
97. Stimulus command required to meet specifications.
98. If using trigger model, add 200 ns uncertainty.

Analog Triggering [99]

Analog Level, Edge, Or Window Trigger Types [100]

Trigger Characteristics	Voltage Input	Current Input
Input	100 mV to 1000 V	10 µA to 10 A
Resolution	0.05%	0.05%
Basic Accuracy (T_{ACAL} ±5°C) [101, 102]	1%	1%

Analog Trigger Latencies

	Digital I/O	External
Positive Logic	800 ns + 40 ns jitter	930 ns + 40 ns jitter
Negative Logic	800 ns + 40 ns jitter	840 ns + 40 ns jitter

Window Filter and Memory (buffer)

Window Filter Size	0 to 10% of reading, where 0 averages all readings.
Memory	Up to 27.5 million timestamped readings with the compact buffer style, with additional memory available using an external USB flash drive.
Maximum Internal Memory (Buffer)	27.5 million readings with the compact buffer style (6½-digit without formatting), 11 million readings with the standard or full buffer style.

NOTES

99. For DC or AC coupled, the trigger level can be set up to 100% of measure range.
100. Rising or falling edge triggering supported. Window trigger requires setting two independent levels.
101. Trigger event occurs after the threshold crossing at a time determined by total trigger latencies.
102. Accuracy specifications require user $_{ACAL}$ and are verified with level trigger amplitude set to 50% of range with a 100 Hz sine wave at 100% full scale of range. High frequency rejection is off. NPLC 0.0005 (DC voltage/DC current) or aperture 1 µs for digitize voltage or digitize current. Specified for fixed range, autozero off. For digitized DC voltage AC coupled, add 0.5%. For DC current and digitized DC current 3 A or 10 A ranges, add an additional 2%.

General Instrument Specifications

Specification Conditions	This document contains specifications and supplemental information for the DMM7510 Precision Sampling Digital Multimeter instrument. Specifications are the standards against which the DMM7510 is tested. Upon leaving the factory, the DMM7510 meets these specifications. Supplemental, typical, and characteristic values are non-warranted, apply at 23°C, and are provided solely as useful information. All specifications apply to front or rear terminal inputs, except 10 A specifications (rear terminals only).
Input Protection	1010 V DC (715 V_{RMS} V AC) all ranges and functions on HI and LO terminals; 350 V all ranges and functions on sense HI, sense LO terminals; 250 V rated current input terminal; fused 3 A and 10 A ranges; current input terminals protected to 1 kV.
3 A Input Fuse Protection	3.5 A, 1 kV fast blow type.
10 A Input Fuse Protection	11 A, 1 kV fast blow type.
AC Voltage input	**Maximum DCV:** 1000V on any AC voltage range.
Common Mode Isolation	500 VDC or ACVpeak LO to chassis. All terminals >10 GΩ, <350 pF any terminal to chassis.
Power Line	Universal input, 100 V to 240 V.
Line Frequency	50 Hz or 60 Hz, automatically sensed at power-up.
Power Consumption	60 VA.
Operating Environment	Specified for 0° to 50°C, ≤80% relative humidity at 35°C, altitude up to 2000 meters.
Storage Environment	–30° to 70°C.
Real Time Clock	Lithium battery backup (3+ years battery life).
EMC	Conforms to European Union EMC Directive.

Safety	NRTL listed to UL61010-1, and CSA C22.2 No 61010-1; conforms with European Union Low Voltage Directive.
Vibration	MIL-PRF-28800F Class 3, Random.
Warm-up	90 minutes to rated accuracy.
Input Signal Connections	Front and rear safety banana jacks.
Cooling	Forced air, fixed speed.
Dimensions	**Without handle and bumpers:** 88 mm high × 213 mm wide × 410 mm deep (3.46 in. × 8.39 in. × 16.13 in.).
	With handle and bumpers (bench configuration): 106 mm high × 255 mm wide × 425 mm deep (4.18 in. × 10.05 in. × 16.75 in.).
Shipping weight (with bumpers and handle)	4.08 kg (9.0 lb.).
Shipping weight (without bumpers and handle)	3.63 kg (8.0 lb.).
Digital I/O:	
Connector	9-pin female D.
5V Power Supply Pin	Limited to 500 mA at > 4 V (solidstate fuse protected).
Lines	Six input/output, user-defined, for digital I/O or triggering.
Input Signal Levels:	0.7 V (maximum logic low) 3.7 V (minimum logic high).
Input Voltage Limits:	–0.25 V (absolute minimum) +5.25 V (absolute maximum).
Maximum Source Current	+2.0 mA at >2.7 V (per pin).
Maximum Sink Current	–50 mA at 0.7 V (per pin, solid-state fuse protected).
Handler	User-defined start of test, end of test, four category bits
Math Functions	Rel, dB, Limit Test, Percentage, 1/x, and mX + b.
Remote Interface:	
LAN	RJ-45 connector, 10/100BT; Virtual Front Panel.
IP Configuration	Static or DHCP.
GPIB	IEEE-488.1 compliant. Supports IEEE-488.2 common commands and status model topology.
USB Device (rear panel, type B)	2.0 full speed, USBTMC compliant.
USB Host (front panel, type A)	USB 2.0, support for flash drives, FAT 32.
LXI Compliance	LXI version 1.4 Core 2011.
Language	Embedded Test Script Processor (TSP) accessible from any host interface; responds to high-speed test scripts comprised of remote commands and statements (for example, branching, looping, math); able to execute high-speed test scripts stored in memory without host intervention; also SCPI (default command set).
Accessories Supplied	Product Information CD-ROM, DMM7510 Quick Start Guide, power cord, 1 m USB cable (type A to type B), and 3 m LAN cable.
Accessories Available	(Calibration / Data / ISO 17025), software IVI/VISA drivers for Microsoft® Visual Basic®, Visual C/C++®, National Instruments (NI™) LabVIEW™, Keithley Test Script Builder, Keithley KickStart Instrument Control Software, and NI LabWindows™/CVI.
Display	Five-inch capacitive touch, color thin-film-transistor (TFT) WVGA (800×480) with LED backlight.
Password Protection	30 characters.
Expansion Interface	The TSP-Link® expansion interface allows TSP-enabled instruments to trigger and communicate with each other.
IP configuration	Static or DHCP (manual or automatic).

Ordering Information

DMM7510	7½-Digit Graphical Sampling Multimeter
DMM7510-RACK	7½-Digit Graphical Sampling Multimeter, with No Handle

Supplied Accessories

	DMM7510 QuickStart Guide
	Test Script Builder Software (available at www.keithley.com)
	LabVIEW and IVI Drivers (available at www.keithley.com)

Available Accessories

Test Leads and Probes

1754	2-Wire Universal 10-Piece Test Lead Kit
5804	Safety Universal Test Lead Kit
5805	Kelvin (4-Wire) Spring-Loaded Probes
5806	Kelvin Clip Lead Set
5808	Low Cost Single-pin Kelvin Probe Set

Cables, Connectors, Adapters

CA-18-1	Shielded Dual Banana Cable, 1.2 m (4 ft.)

Communication Interfaces & Cables

KPCI-488LPA	IEEE-488 Interface for PCI Bus
KUSB-488B	IEEE-488 USB-to-GPIB Interface Adapter
7007-1	Shielded GPIB Cable, 1 m (3.2 ft)

Triggering and Control

8501-1	Trigger Link Cable, DIN-to-DIN, 1 m (3.2 ft.)
8503	DIN-to-BNC Trigger Cable

Rack Mount Kits

4299-8	Single Fixed Rack Mount Kit
4299-9	Dual Fixed Rack Mount Kit

Available Services

Extended Warranties

DMM7510-EW	1 Year Factory Warranty Extended to 2 Years from Date of Shipment
DMM7510-3Y-EW	1 Year Factory Warranty Extended to 3 Years from Date of Shipment
DMM7510-5Y-EW	1 Year Factory Warranty Extended to 5 Years from Date of Shipment

Calibration Contracts

C/DMM7510-3Y-17025	KeithleyCare 3 Year ISO-17025 Calibration Plan
C/DMM7510-3Y-DATA	KeithleyCare 3 Year Calibration w/Data Plan
C/DMM7510-3Y-STD	KeithleyCare 3 Year Std Calibration Plan
C/DMM7510-5Y-17025	KeithleyCare 5 Year ISO-17025 Calibration Plan
C/DMM7510-5Y-DATA	KeithleyCare 5 Year Calibration w/Data Plan
C/DMM7510-5Y-STD	KeithleyCare 5 Year Std Calibration Plan
C/NEW DATA	Calibration Data for New Units
C/NEW DATA ISO	ISO-17025 Calibration Data for New Units

Warranty Information

Warranty Summary	This section summarizes the warranties of the DMM7510. For complete warranty information, refer to the DMM7510 Reference Manual. Any portion of the product that is not manufactured by Keithley is not covered by this warranty and Keithley will have no duty to enforce any other manufacturer's warranties.
Hardware Warranty	Keithley Instruments, Inc. warrants the Keithley manufactured portion of the hardware for a period of one year from defects in materials or workmanship; provided that such defect has not been caused by use of the Keithley hardware which is not in accordance with the hardware instructions. The warranty does not apply upon any modification of Keithley hardware made by the customer or operation of the hardware outside the environmental specifications.
Software Warranty	Keithley warrants for the Keithley produced portion of the software or firmware will conform in all material respects with the published specifications for a period of ninety (90) days; provided the software is used on the product for which it is intended in accordance with the software instructions. Keithley does not warrant that operation of the software will be uninterrupted or error-free, or that the software will be adequate for the customer's intended application. The warranty does not apply upon any modification of the software made by the customer.

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