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## 7-1/2 Digit Graphical Sampling Multimeter Specifications

### SPECIFICATION CONDITIONS

This document contains specifications and supplemental information for the Model DMM7510 7-1/2 Digit Graphical Sampling Multimeter instrument. Specifications are the standards against which the DMM7510 is tested. Upon leaving the factory, the 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 °C ±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 °C ±1 °C

### DC VOLTAGE

#### ACCURACY (INPUT IMPEDANCE AUTO)

Range <sup>1</sup>	Resolution	Input impedance	Accuracy ±[ppm of reading + ppm of range]				
			24 hour $T_{CAL} \pm 1 \text{ } ^\circ\text{C}^2$	90 day $T_{CAL} \pm 5 \text{ } ^\circ\text{C}$	1 year $T_{CAL} \pm 5 \text{ } ^\circ\text{C}$	2 year $T_{CAL} \pm 5 \text{ } ^\circ\text{C}$	Temperature coefficient <sup>3</sup>
100.00000 mV <sup>4</sup>	10 nV	> 10 GΩ or 10 MΩ ±1 %	6 + 9	12 + 9	18 + 9	29 + 9	0.1 + 2.5
1.0000000 V <sup>4</sup>	100 nV	> 10 GΩ or 10 MΩ ±1 %	4 + 1	9 + 2	15 + 2	26 + 2	0.1 + 0.5
10.000000 V <sup>4</sup>	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 <sup>4</sup>	10 μV	10 MΩ ±1 %	8 + 3	[18 + 5] <sup>5</sup>	[22 + 5] <sup>5</sup>	[30 + 5] <sup>5</sup>	[0.15 + 0.05] <sup>5</sup>
				35 + 5	40 + 5	45 + 5	2.0 + 0.5
1000.0000 V <sup>4,6</sup>	100 μV	10 MΩ ±1 %	8 + 3	[19 + 5] <sup>5</sup>	[23 + 5] <sup>5</sup>	[31 + 5] <sup>5</sup>	[0.15 + 0.05] <sup>5</sup>
				35 + 5	40 + 5	45 + 4	2.0 + 0.5

<sup>1</sup> 20 % overrange on all ranges except 1 % for 1000 V range.

<sup>2</sup> Relative to calibration accuracy.

<sup>3</sup> Add per degree from  $T_{CAL} \pm 5 \text{ } ^\circ\text{C}$ .

<sup>4</sup> When properly zeroed using the Rel function with external cables.

<sup>5</sup> Specified within 30 days of autocalibration,  $T_{OPER} \pm 5 \text{ } ^\circ\text{C}$  from  $T_{ACAL}$ .

<sup>6</sup> For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.

Specifications are subject to change without notice.

**RMS NOISE (ADDITIONAL PEAK NOISE UNCERTAINTY)<sup>7</sup>**

- 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

**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 <sup>8</sup>	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**

Range	Accuracy ±[ppm of reading + ppm of range]				
	24 hour T <sub>CAL</sub> ±1 °C	90 day T <sub>CAL</sub> ±5 °C	1 year T <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>9</sup>
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
10.000000 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 <sub>INPUT</sub> ppm of reading + V <sub>INPUT</sub> ppm of range * (V <sub>INPUT</sub> range/V <sub>INPUT</sub> input)] + [V <sub>SENSE</sub> ppm of reading + V <sub>SENSE</sub> ppm of range * (V <sub>SENSE</sub> range/V <sub>SENSE</sub> input)]]
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**DC VOLTAGE CHARACTERISTICS**

<b>ADC linearity</b>	1.0 ppm of reading + 1.0 ppm of range
<b>Input impedance</b>	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 %
<b>Input bias current</b>	< 50 pA at 23 °C under the following conditions: Autozero off or input impedance 10 MΩ
<b>Common mode current</b>	< 2.1 µA peak-peak in 1 MHz bandwidth < 100 nA peak-peak in 1 kHz bandwidth
<b>Common mode voltage</b>	500 V <sub>peak</sub> LO terminal to chassis maximum
<b>DC voltage autozero off error</b>	For ±1 °C and ≤ 10 minutes, add ± (8 ppm of reading + 15 µV)

<sup>7</sup> Noise values are based on 1000 readings with autozero on and using low thermal 4-wire short. V<sub>RMS</sub> noise is typical. Additional peak noise is guaranteed.

<sup>8</sup> With line sync on.

<sup>9</sup> Add per degree from T<sub>CAL</sub> ± 5 °C.

Specifications and characteristics are subject to change without notice.

**NORMAL MODE REJECTION**

For DC voltage, line frequency  $\pm 0.1\%$

	5 PLC	1 PLC	$\leq 0.2$ PLC	$\leq 0.01$ PLC
Line sync on	110 dB	90 dB	45 dB	—
Line sync off	60 dB	60 dB	—	—

**COMMON MODE REJECTION**

For DC voltage and 1 k $\Omega$  unbalanced in LO terminal; AC CMRR is 70 dB

NPLC	5	1	0.2	$\leq 0.2$
Line sync	On	On	On	Off
CMRR	140 dB	140 dB	120 dB	80 dB

**RESISTANCE**

**ENHANCED ACCURACY (WITHIN 30 DAYS OF AUTOCALIBRATION,  $T_{OPER} \pm 5^\circ\text{C}$  FROM  $T_{ACAL}$ )<sup>10</sup>**

Range <sup>11</sup>	Resolution	Test current <sup>12</sup> ( $\pm 5\%$ )	Accuracy $\pm$ [ppm of reading + ppm of range]				
			24 hour $T_{CAL} \pm 1^\circ\text{C}$ <sup>13</sup>	90 day $T_{CAL} \pm 5^\circ\text{C}$	1 year $T_{CAL} \pm 5^\circ\text{C}$	2 year $T_{CAL} \pm 5^\circ\text{C}$	Temperature coefficient <sup>14</sup>
1.0000000 $\Omega$	0.1 $\mu\Omega$	10 mA	15 + 50	30 + 50	30 + 50	30 + 50	0.15 + 0.1
10.000000 $\Omega$	1 $\mu\Omega$	10 mA	15 + 5	30 + 5	30 + 5	30 + 5	0.15 + 0.1
100.00000 $\Omega$	10 $\mu\Omega$	1 mA	12 + 4	27 + 4	27 + 4	27 + 4	0.15 + 0.1
1.0000000 k $\Omega$	100 $\mu\Omega$	1 mA	12 + 3	24 + 3	24 + 3	24 + 3	0.15 + 0.1
10.000000 k $\Omega$ <sup>15</sup>	1 m $\Omega$	100 $\mu\text{A}$	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
100.00000 k $\Omega$ <sup>15,16</sup>	10 m $\Omega$	10 $\mu\text{A}$	13 + 3	30 + 3	30 + 3	30 + 3	0.15 + 0.1
1.0000000 M $\Omega$ <sup>15,17</sup>	100 m $\Omega$	10 $\mu\text{A}$	14 + 3	30 + 4	30 + 4	30 + 4	0.15 + 0.1
10.000000 M $\Omega$ <sup>18</sup>	1 $\Omega$	0.69 $\mu\text{A}$    10 M $\Omega$	150 + 6	200 + 10	200 + 10	200 + 10	70 + 1
100.00000 M $\Omega$ <sup>18</sup>	10 $\Omega$	0.69 $\mu\text{A}$    10 M $\Omega$	800 + 30	2000 + 30	2000 + 30	2000 + 30	385 + 1
1.0000000 G $\Omega$ <sup>18</sup>	100 $\Omega$	0.69 $\mu\text{A}$    10 M $\Omega$	9000 + 100	9000 + 100	9000 + 100	9000 + 100	3000 + 1

<sup>10</sup> Specifications are for 4-wire resistance, offset compensation on for  $\leq 10$  k $\Omega$  measurements, and offset compensation off for  $\geq 10$  k $\Omega$  measurements. 1  $\Omega$  range is 4-wire only. For 2-wire, with Rel, add 50 m $\Omega$  to ppm of range uncertainty. Without Rel and with Model 1756 test leads, add 100 m $\Omega$  to ppm of range uncertainty.

<sup>11</sup> 20 % overrange on all ranges.

<sup>12</sup> Test current with offset compensation off.

<sup>13</sup> Relative to calibration accuracy.

<sup>14</sup> Add per degree from  $T_{CAL} \pm 5^\circ\text{C}$ .

<sup>15</sup> Specifications are for external cable and load capacitance < 1 nF.

<sup>16</sup> For offset compensation on, add 10 ppm uncertainty to ppm of reading.

<sup>17</sup> For 4-wire 1 M $\Omega$ , open lead detector on, add 10 ppm uncertainty to ppm of reading.

<sup>18</sup> Specified for < 10 % lead resistance mismatch in HI and LO.

Specifications are subject to change without notice.

**ACCURACY<sup>19</sup>**

Range <sup>20</sup>	Resolution	Test current <sup>21</sup> (±5 %)	Accuracy ±[ppm of reading + ppm of range]				
			24 hour T <sub>CAL</sub> ±1 °C <sup>22</sup>	90 day T <sub>CAL</sub> ±5 °C	1 year T <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>23</sup>
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 <sup>24</sup>	1 mΩ	100 μA	10 + 3	30 + 3	42 + 3	65 + 3	2.5 + 0.25
100 kΩ <sup>24,25</sup>	10 mΩ	10 μA	13 + 3	38 + 3	50 + 3	65 + 3	5 + 1
1 MΩ <sup>24,26</sup>	100 mΩ	10 μA	14 + 3	38 + 5	50 + 5	65 + 5	5 + 1
10 MΩ <sup>27</sup>	1 Ω	0.69 μA    10 MΩ	150 + 6	200 + 10	400 + 10	600 + 12	70 + 1
100 MΩ <sup>27</sup>	10 Ω	0.69 μA    10 MΩ	800 + 30	2000 + 30	2000 + 30	2600 + 30	385 + 1
1 GΩ <sup>27</sup>	100 Ω	0.69 μA    10 MΩ	9000 + 200	9000 + 200	13000 + 200	14000 + 200	3000 + 1

**RESISTANCE OPEN CIRCUIT DC VOLTAGE<sup>28</sup>**

Range <sup>20</sup>	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	–

<sup>19</sup> 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 Model 1756 test leads, add 100 mΩ to ppm of range uncertainty.

<sup>20</sup> 20 % overrange on all ranges.

<sup>21</sup> Test current with offset compensation off.

<sup>22</sup> Relative to calibration accuracy.

<sup>23</sup> Add per degree from T<sub>CAL</sub> ±5 °C.

<sup>24</sup> Specifications are for external cable and load capacitance < 1 nF.

<sup>25</sup> For offset compensation on, add 10 ppm of uncertainty to ppm of reading.

<sup>26</sup> For 4-wire, 1 MΩ, open lead detection on, add 10 ppm uncertainty to ppm of reading.

<sup>27</sup> Specified for < 10 % lead resistance mismatch in HI and LO.

<sup>28</sup> 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.

Specifications and characteristics are subject to change without notice.

**4-WIRE OHMS ( $\leq 10\text{ k}\Omega$ ) OFFSET COMPENSATION ON**
**RMS NOISE (ADDITIONAL PEAK NOISE UNCERTAINTY)<sup>29</sup>**

- Applies to  $\pm$  ppm of range
- Peak noise uncertainty is included in DC specifications for  $\geq 1$  PLC
- Add peak noise uncertainty to measurements for  $< 1$  PLC

**Examples**

- 1 k $\Omega$  at 0.006 PLC: 3 (from Accuracy table) + 26 (additional peak noise uncertainty) = 29 ppm of range
- 1 k $\Omega$  at 1 PLC: 3 + 0 = 3 ppm of range

NPLC	Digits	1 $\Omega$	10 $\Omega$	100 $\Omega$	1 k $\Omega$	10 k $\Omega$
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 <sup>30</sup>	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)<sup>29</sup>**

- Applies to  $\pm$  ppm of range
- Peak noise uncertainty is included in DC specifications for  $\geq 1$  PLC
- Add peak noise uncertainty to measurements for  $< 1$  PLC

**Examples:**

- 10 k $\Omega$  at 0.006 PLC: 3 (from Accuracy table) + 5 (50 m $\Omega$  with Rel ) + 43 (additional peak noise uncertainty) = 51 ppm of range
- 10 k $\Omega$  at 1 PLC: 3 + 5 + 0 = 8 ppm of range

NPLC	Digits	10 $\Omega$	100 $\Omega$	1 k $\Omega$	10 k $\Omega$
5	7½	1.1	0.8	0.1	0.2
1	7½	0.6	0.6	0.09	0.4
0.2 <sup>30</sup>	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)

<sup>29</sup> 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.

<sup>30</sup> With line sync on.

## RESISTANCE CHARACTERISTICS

<b>Maximum 4-wire ohms lead resistance</b>	5 $\Omega$ per lead for 1 $\Omega$ range, 10 % of range per lead for 10 $\Omega$ to 1 k $\Omega$ ranges; 1 k $\Omega$ per lead for all other ranges
<b>Offset compensation</b>	Selectable on 4-wire, 1 $\Omega$ to 100 k $\Omega$ ranges
<b>Open lead detector</b>	Default is off
<b>Autozero off error</b>	For 2-wire ohms, $\pm 1$ $^{\circ}\text{C}$ and $\leq 10$ minutes, add $\pm(8$ ppm of reading) and 1.5 m $\Omega$ for 10 $\Omega$ range, 15 m $\Omega$ for 100 $\Omega$ and 1 k $\Omega$ ranges, 150 m $\Omega$ for 10 k $\Omega$ range, 1.5 $\Omega$ for 100 k $\Omega$ range, and 15 $\Omega$ for all other ranges  For 4-wire ohms, $\pm 1$ $^{\circ}\text{C}$ and $\leq 10$ minutes, add $\pm(8$ ppm of reading)
<b>Input current limit</b>	For signals with a magnitude of +12 V to +40 V or -12 V to -40 V: $\pm 13$ mA source or sink, typical For signals with a magnitude of greater than +40 V or -40 V: $\pm 130$ $\mu\text{A}$ source or sink, typical

## DRY CIRCUIT RESISTANCE

### ENHANCED ACCURACY (WITHIN 30 DAYS OF AUTOCALIBRATION, $T_{\text{OPER}} \pm 5$ $^{\circ}\text{C}$ FROM $T_{\text{CAL}}$ )

Range <sup>31</sup>	Resolution	Test current <sup>35</sup> ( $\pm 5$ %)	Open circuit DUT voltage <sup>32</sup>	Accuracy $\pm$ [ppm of reading + ppm of range]				
				24 hour $T_{\text{CAL}} \pm 1$ $^{\circ}\text{C}$ <sup>33</sup>	90 day $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	1 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	2 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	Temperature coefficient <sup>34</sup>
1.000000 $\Omega$	1 $\mu\Omega$	10 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
10.00000 $\Omega$	10 $\mu\Omega$	1 mA	25 mV	25 + 80	50 + 80	50 + 80	50 + 80	1.5 + 0.1
100.0000 $\Omega$	100 $\mu\Omega$	100 $\mu\text{A}$	25 mV	25 + 80	90 + 80	90 + 80	90 + 80	1.5 + 0.1
1.000000 k $\Omega$	1 m $\Omega$	10 $\mu\text{A}$	25 mV	25 + 80	180 + 80	180 + 80	180 + 80	1.5 + 0.1
10.00000 k $\Omega$	10 m $\Omega$	5 $\mu\text{A}$	25 mV	25 + 80	320 + 80	320 + 80	320 + 80	1.5 + 0.1

## ACCURACY

Range <sup>31</sup>	Resolution	Test current <sup>35</sup> ( $\pm 5$ %)	Open circuit DUT voltage <sup>32</sup>	Accuracy $\pm$ [ppm of reading + ppm of range]				
				24 hour $T_{\text{CAL}} \pm 1$ $^{\circ}\text{C}$ <sup>33</sup>	90 day $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	1 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	2 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	Temperature coefficient <sup>34</sup>
1.000000 $\Omega$	1 $\mu\Omega$	10 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	2.5 + 1
10.00000 $\Omega$	10 $\mu\Omega$	1 mA	25 mV	25 + 80	50 + 80	70 + 80	90 + 80	5 + 1
100.0000 $\Omega$	100 $\mu\Omega$	100 $\mu\text{A}$	25 mV	25 + 80	90 + 80	140 + 80	200 + 80	2.5 + 1
1.000000 k $\Omega$	1 m $\Omega$	10 $\mu\text{A}$	25 mV	25 + 80	180 + 80	400 + 80	600 + 80	5 + 1
10.00000 k $\Omega$	10 m $\Omega$	5 $\mu\text{A}$	25 mV	25 + 80	320 + 80	800 + 80	1300 + 80	8 + 1

<sup>31</sup> 20 % overrange on all ranges, except 2.4 k $\Omega$  for the 10 K range.

<sup>32</sup> Maximum clamp voltages are DC, typical accuracy is  $\pm 20$  %. Add 20 % for offset compensation on.

<sup>33</sup> Relative to calibration accuracy.

<sup>34</sup> Add per degree from  $T_{\text{CAL}} \pm 5$   $^{\circ}\text{C}$ .

<sup>35</sup> Test current with offset compensation off.

Specifications and characteristics are subject to change without notice.

**RMS NOISE (ADDITIONAL PEAK NOISE UNCERTAINTY)<sup>36</sup>**

- 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:

- 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 <sup>37</sup>	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**

<b>Maximum 4-wire ohm lead resistance</b>	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
<b>Input current limit</b>	For signals > [±20 mV], current limited, ±13 mA, typical
<b>Offset compensation</b>	Selectable on 1 Ω to 10 kΩ ranges
<b>Autozero off error</b>	For ±1 °C and ≤ 10 minutes, add ± 8 ppm of reading

<sup>36</sup> 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.

<sup>37</sup> With line sync on.

## DC CURRENT

### ENHANCED ACCURACY (WITHIN 30 DAYS OF AUTOCALIBRATION, $T_{OPER} \pm 5 \text{ }^\circ\text{C}$ FROM $T_{ACAL}$ )

Range <sup>38</sup>	Resolution	Maximum burden voltage	Accuracy $\pm$ [ppm of reading + ppm of range]				
			24 hour $T_{CAL} \pm 1 \text{ }^\circ\text{C}$ <sup>39</sup>	90 day $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	1 year $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	2 year $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	Temperature coefficient <sup>40</sup>
10.000000 $\mu\text{A}$	1 pA	15 mV	30 + 30	75 + 30	75 + 30	75 + 30	0.15 + 0.1
100.00000 $\mu\text{A}$	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 $\mu\text{A}$	1300 mV	200 + 40	400 + 40	400 + 40	400 + 40	0.15 + 0.1
10.000000 A <sup>41</sup>	1 $\mu\text{A}$	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

### ACCURACY

Range <sup>38</sup>	Resolution	Maximum burden voltage	Accuracy $\pm$ [ppm of reading + ppm of range]				
			24 hour $T_{CAL} \pm 1 \text{ }^\circ\text{C}$ <sup>39</sup>	90 day $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	1 year $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	2 year $T_{CAL} \pm 5 \text{ }^\circ\text{C}$	Temperature coefficient <sup>40</sup>
10.000000 $\mu\text{A}$	1 pA	15 mV	30 + 30	100 + 30	125 + 40	175 + 50	10 + 8
100.00000 $\mu\text{A}$	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 $\mu\text{A}$	1300 mV	200 + 40	400 + 40	450 + 40	500 + 40	10 + 10
10.000000 A <sup>41</sup>	1 $\mu\text{A}$	650 mV	700 + 275	800 + 275	1500 + 275	2000 + 275	50 + 10

<sup>38</sup> 20 % overrange supported for all ranges except for 3 A and 10 A, which are 1 % supported.

<sup>39</sup> Relative to calibration accuracy.

<sup>40</sup> Add per degree from  $T_{CAL} \pm 5 \text{ }^\circ\text{C}$ .

<sup>41</sup> Rear input terminals only.

Specifications and characteristics are subject to change without notice.



**RMS NOISE (ADDITIONAL PEAK NOISE UNCERTAINTY)<sup>42</sup>**

- Applies to  $\pm$  ppm of range
- Peak noise uncertainty is included in DC Specifications for PLC  $\geq 1$
- Add peak noise uncertainty to measurements for PLC  $< 1$

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 $\mu$ A	100 $\mu$ A	1 mA	10 mA	100 mA	1 A	3 A	10 A <sup>43</sup>
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 <sup>44</sup>	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	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 $\mu$ A	100 $\mu$ A	1 mA	10 mA	100 mA	1 A	3 A	10 A <sup>43</sup>
<b>Effective internal shunt value<sup>45</sup></b>	1 k $\Omega$	100 $\Omega$	10 $\Omega$	1 $\Omega$	0.1 $\Omega$	0.1 $\Omega$	0.1 $\Omega$	0.005 $\Omega$
<b>Autozero off error:</b> For $\pm 1$ °C and $\leq 10$ minutes add $\pm(8$ ppm of reading + range error)	150 pA	1.5 nA	15 nA	150 nA	15 $\mu$ A	150 $\mu$ A	150 $\mu$ A	3 mA
<b>Overload recovery:</b> For each additional sustained amp beyond $\pm 1.5$ A, add the following initial ppm of range error until thermally settled after overload recovery	15500	1800	150	150	6500	200	—	—

<sup>42</sup> Noise values are based on 1000 readings with autozero on and AMPS terminal open. RMS noise is typical. Additional peak noise is guaranteed.

<sup>43</sup> Rear input terminals only.

<sup>44</sup> With line sync on.

<sup>45</sup> Values are typical and guaranteed by design.

Specifications are subject to change without notice.

## TEMPERATURE

### 4-WIRE RTD OR 3-WIRE RTD

**Types:** 100  $\Omega$  platinum PT100, D100, F100, PT385, PT3916; or user-configurable 0  $\Omega$  to 10 k $\Omega$

Type	Range	Resolution	Accuracy $\pm$ $^{\circ}\text{C}$	
			2 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	Temperature coefficient <sup>46</sup>
4-Wire RTD	-200 $^{\circ}\text{C}$ to 850 $^{\circ}\text{C}$	0.01 $^{\circ}\text{C}$	0.06 $^{\circ}\text{C}$	0.003 $^{\circ}\text{C}/^{\circ}\text{C}$
3-Wire RTD <sup>47</sup>	-200 $^{\circ}\text{C}$ to 850 $^{\circ}\text{C}$	0.01 $^{\circ}\text{C}$	0.75 $^{\circ}\text{C}$	0.003 $^{\circ}\text{C}/^{\circ}\text{C}$

### THERMISTOR

**Types:** 2.252 k $\Omega$ , 5 k $\Omega$ , and 10 k $\Omega$

Type	Range	Resolution	Accuracy $\pm$ $^{\circ}\text{C}$	
			2 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$	Temperature coefficient <sup>46</sup>
Thermistor	-80 $^{\circ}\text{C}$ to +150 $^{\circ}\text{C}$	0.01 $^{\circ}\text{C}$	0.08 $^{\circ}\text{C}$	0.002 $^{\circ}\text{C}/^{\circ}\text{C}$

### THERMOCOUPLE

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

Type	Range	Resolution	Accuracy $\pm$ $^{\circ}\text{C}$	
			2 year $T_{\text{CAL}} \pm 5$ $^{\circ}\text{C}$ <sup>48</sup> Simulated reference junction	Temperature coefficient <sup>46</sup>
B	350 $^{\circ}\text{C}$ to +1820 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.6 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
E	-200 $^{\circ}\text{C}$ to +1000 $^{\circ}\text{C}$	0.001 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
J	-200 $^{\circ}\text{C}$ to +760 $^{\circ}\text{C}$	0.001 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
K	-200 $^{\circ}\text{C}$ to +1372 $^{\circ}\text{C}$	0.001 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
N	-200 $^{\circ}\text{C}$ to +1300 $^{\circ}\text{C}$	0.001 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
R	0 $^{\circ}\text{C}$ to +1768 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.6 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
S	0 $^{\circ}\text{C}$ to +1768 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$	0.6 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$
T	-100 $^{\circ}\text{C}$ to +400 $^{\circ}\text{C}$	0.001 $^{\circ}\text{C}$	0.2 $^{\circ}\text{C}$	0.03 $^{\circ}\text{C}/^{\circ}\text{C}$

<sup>46</sup> Add per degree from  $T_{\text{CAL}} \pm 5$   $^{\circ}\text{C}$ ; specifications without autocalibration.

<sup>47</sup> For 3-wire RTD, accuracy is for < 0.1  $\Omega$  lead resistance mismatch for input HI and LO. Add 0.25  $^{\circ}\text{C}/0.1$   $\Omega$  of HI-LO lead resistance mismatch.

<sup>48</sup> Exclusive of cold-junction errors.

Specifications and characteristics are subject to change without notice.

## CONTINUITY

Range <sup>49</sup>	Resolution	Test current	Open circuit voltage	Accuracy ±[ppm of reading + ppm of range]	
				2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>50</sup>
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
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## CAPACITANCE

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

## ACCURACY

Range <sup>51</sup>	Resolution	Charge current <sup>52, 53</sup>	Maximum circuit voltage	Accuracy ±[% of reading + % of range]	
				2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>50</sup>
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 <sup>51</sup>	Resolution	Bias level (selectable)	Accuracy ±[ppm of reading + ppm of range]			
			90 day T <sub>CAL</sub> ±5 °C	1 year T <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>50</sup>
10.000000 V	1 μV	10 μA / 100 μA / 1 mA	20 + 5	30 + 5	45 + 5	2.5 + 1

<sup>49</sup> Specifications exclude lead resistance.

<sup>50</sup> Add per degree from T<sub>CAL</sub> ±5 °C; specifications without autocalibration.

<sup>51</sup> 20 % overrange on all ranges.

<sup>52</sup> Charging current values are typical, guaranteed by design.

<sup>53</sup> Discharge current limited to < 13 mA.

Specifications are subject to change without notice.

## DIGITIZE VOLTAGE

### ACCURACY (INPUT IMPEDANCE AUTO)

Range <sup>54,55</sup>	Resolution <sup>56</sup>	Input impedance <sup>57</sup>	Accuracy ±[ppm of reading + ppm of range]			
			90 day T <sub>CAL</sub> ±5 °C	1 year T <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>58</sup>
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 <sup>59</sup>	1 mV	10 MΩ ±1 %	110 + 75	120 + 75	130 + 75	15 + 20
1000.00 V <sup>60</sup>	10 mV	10 MΩ ±1 %	110 + 75	120 + 75	130 + 75	10 + 20

### SIGNAL CHARACTERISTICS<sup>61,62,63</sup>

#### TYPICAL AC AND DC COUPLED

Range	Analog bandwidth (-3 dB)	Maximum flatness error 3 Hz to 20 kHz <sup>64</sup>	THD 20 kHz signal (-1 dB FS) <sup>65</sup>	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 (-3 dB) point <sup>66</sup>
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 (-3 dB)	Maximum flatness error 3 Hz to 1 kHz <sup>64</sup>	Total harmonic distortion (THD) 1 kHz signal (-1 dB FS) <sup>65</sup>	Settling time (0.5 %)
100.000 V	20 kHz <sup>67</sup>	0.1 dB	1.3 %	160 µs
1000.00 V	20 kHz	0.1 dB	1.8 %	80 µs

<sup>54</sup> 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.

<sup>55</sup> Accuracy with sample rate 1 k per second, aperture auto, and 100 reading buffer average.

<sup>56</sup> Power up default is 4½ digits.

<sup>57</sup> User-selectable.

<sup>58</sup> Add per degree from T<sub>CAL</sub> ± 5 %.

<sup>59</sup> For 100 V range, input impedance auto and without A<sub>CAL</sub>, add 100 ppm of range additional uncertainty and 15 ppm/°C additional uncertainty for "of range" temperature coefficient for operation outside of T<sub>CAL</sub> ±5 °C.

<sup>60</sup> For signal levels greater than 500 V, add 0.02 ppm/V to the ppm of the readings specification for measurements exceeding 500 V.

<sup>61</sup> Accuracy with sample rate 1 M per second and aperture 1 µs.

<sup>62</sup> Verified with sine wave input and DC content ≤ 3 % of range.

<sup>63</sup> For AC coupling, maximum crest factor of 5.

<sup>64</sup> For DC coupled, 0 dB reference frequency is 3 Hz. For AC coupled, 0 dB reference frequency is 1 kHz. For AC coupled operation below 1 kHz, add 0.1 dB.

<sup>65</sup> Exclusive of source input noise.

<sup>66</sup> With AC coupling frequency = 3 Hz and AC coupling filter = Slow.

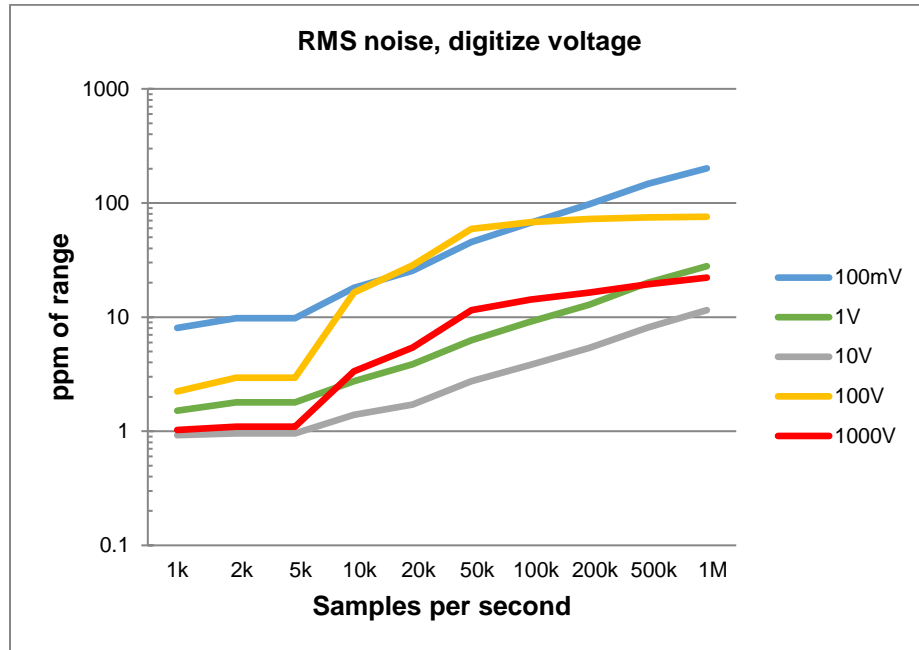
<sup>67</sup> For input impedance auto, bandwidth is 6 kHz.

Specifications and characteristics are subject to change without notice.

**TYPICAL AC COUPLED**

Range	Analog bandwidth (-3 dB)	Maximum flatness error 3 Hz to 20 kHz <sup>64</sup>	Filter Fast settling time (0.5 %)	Filter Slow settling time (0.5 %)	Low frequency coupling point <sup>66</sup> (-3 dB)
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

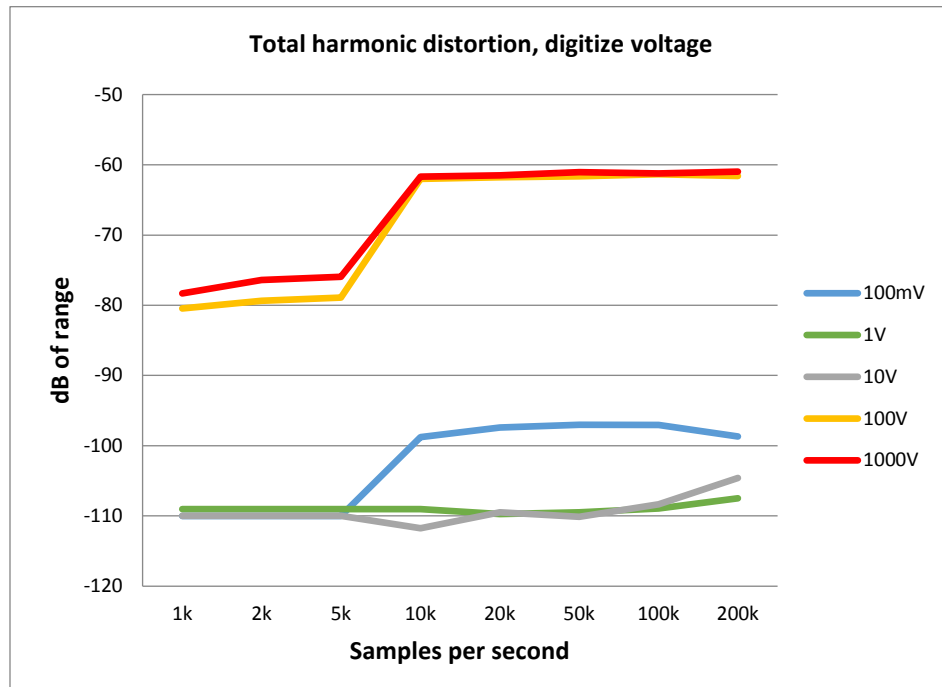
**DC-COUPLED ADDITIONAL NOISE UNCERTAINTY, TYPICAL <sup>68</sup>**



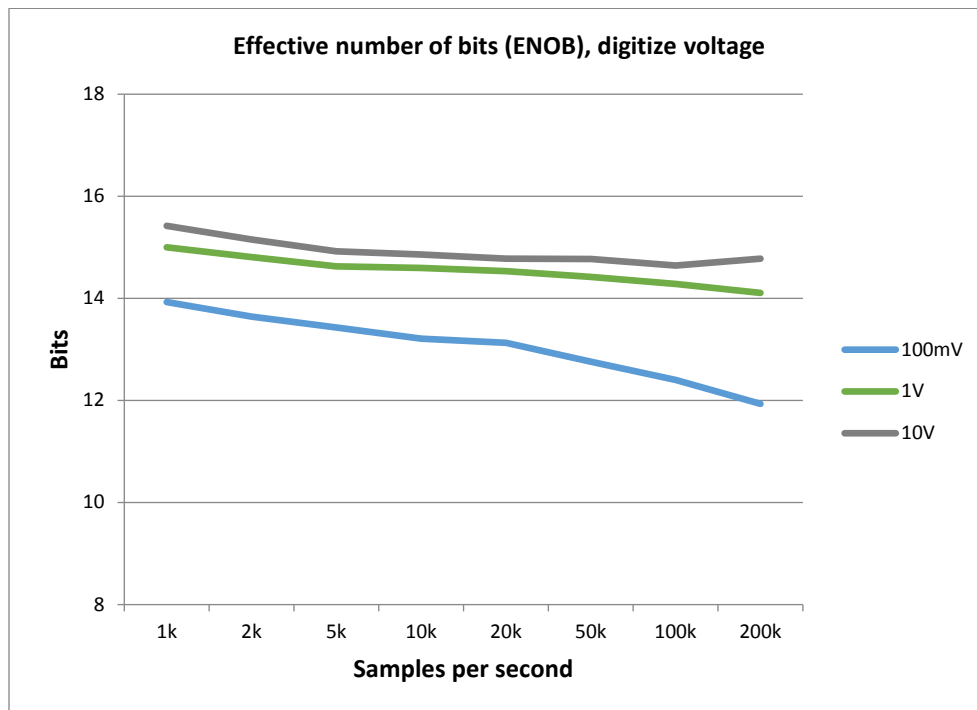
<sup>68</sup> Specified with aperture Auto and 4-wire short on input terminals. For 100 V range, input impedance 10 MΩ, multiply by 2.5. For all ranges and sample rate > 1 k, add an additional 3× RMS noise uncertainty to ppm of range.

Specifications are subject to change without notice.

**DC-COUPLED TOTAL HARMONIC DISTORTION (THD), TYPICAL<sup>69</sup>**



**DC-COUPLED EFFECTIVE NUMBER OF BITS (ENOB), TYPICAL<sup>70</sup>**



<sup>69</sup> Specified with aperture Auto, 100 Hz sine wave for sample rate  $\leq 5$  k, and 1 kHz sine wave for sample rate  $\geq 10$  k. Distortion is calculated using first five harmonics.

<sup>70</sup> Specified with aperture Auto, 100 Hz sine wave for sample rate  $\leq 5$  k, and 1 kHz sine wave for sample rate  $\geq 10$  k. For the 100 V and 1000 V ranges, use the 1 V and 10 V range ENOB, respectively; guaranteed by design.

Specifications and characteristics are subject to change without notice.

## DIGITIZE CURRENT

### DC ACCURACY<sup>71</sup>

Range <sup>72</sup>	Resolution <sup>73</sup>	Burden voltage	Accuracy ± [ppm of reading + ppm of range]			
			90 day T <sub>CAL</sub> ±5 °C	1 year T <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±5 °C	Temperature coefficient <sup>74</sup>
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 <sup>75</sup>	100 µA	650 mV	950 + 350	1500 + 350	2000 + 350	50 + 25

### SIGNAL CHARACTERISTICS, TYPICAL<sup>76</sup>

Range <sup>72</sup>	Maximum flatness error 3 Hz to 20 kHz	Analog bandwidth (-3 dB)	Total harmonic distortion (THD) 20 kHz signal (-1 dB 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 <sup>77</sup>	0.1 dB	100 kHz	0.02 %	6 µs
3.0000 A <sup>77</sup>	0.1 dB	100 kHz	0.02 %	6 µs
10.0000 A <sup>75,77,78</sup>	0.1 dB	100 kHz	0.02 %	6 µs

<sup>71</sup> Accuracy with sample rate 1 k per second, aperture auto, and 100 reading buffer average.

<sup>72</sup> 20 % overrange on all ranges except 3.3 % for 3 A and 10 A ranges.

<sup>73</sup> Power up default is 4½ digits.

<sup>74</sup> Add per degree from T<sub>CAL</sub> ±5 °C.

<sup>75</sup> Rear input terminals only.

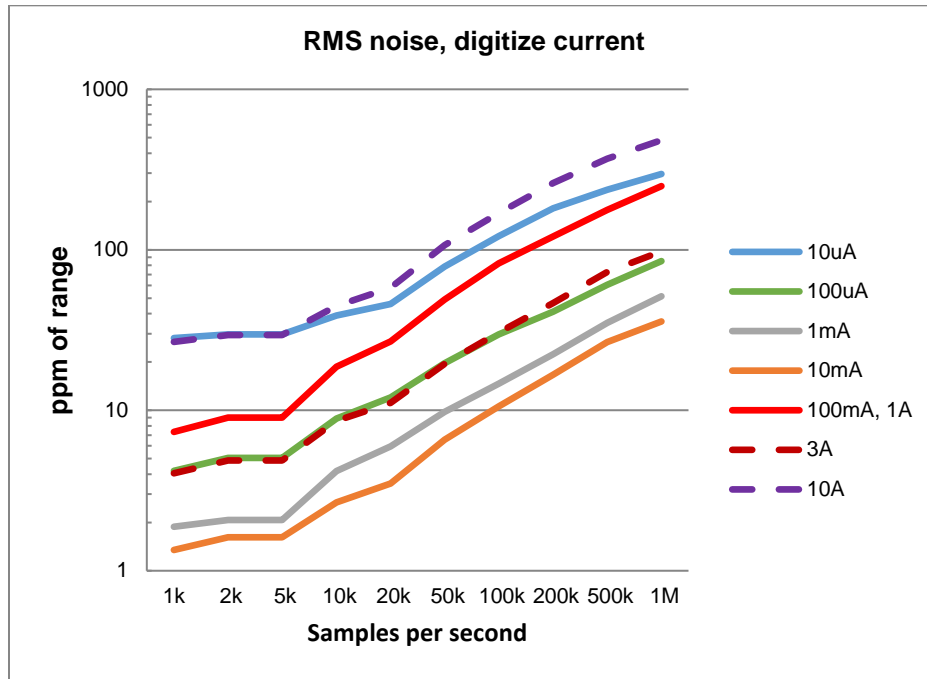
<sup>76</sup> Verified with sine wave input and DC content ≤ 3 % of range. For flatness error, 0 dB reference frequency is 3 Hz.

<sup>77</sup> For the 1 A, 3 A, and 10 A ranges, use the 100 mA range accuracy; guaranteed by design.

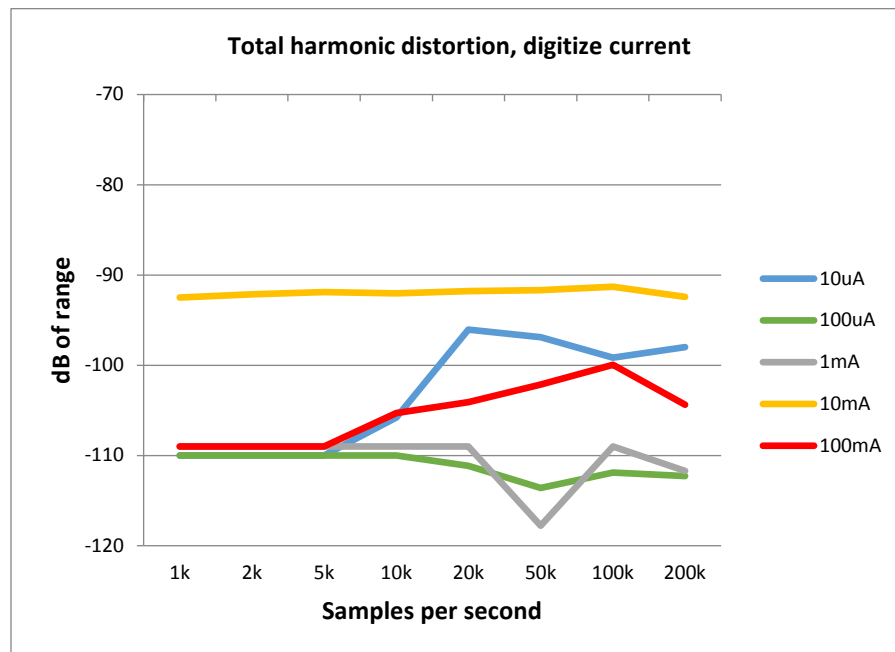
<sup>78</sup> 10 A flatness verified to 10 kHz; 100 kHz guaranteed by design.

Specifications are subject to change without notice.

**ADDITIONAL NOISE UNCERTAINTY, TYPICAL<sup>79</sup>**



**TOTAL HARMONIC DISTORTION (THD), TYPICAL<sup>80</sup>**



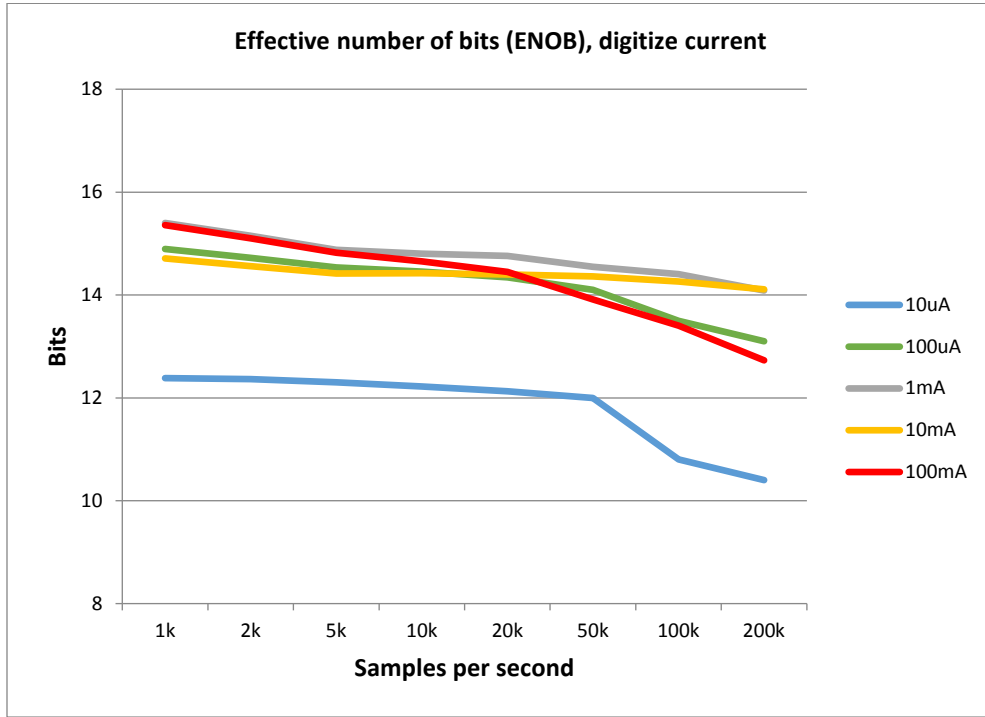
<sup>79</sup> Specified with aperture Auto and open input terminals. For all ranges and for  $\geq 1$  k sample rate, add an additional  $3 \times$  RMS noise uncertainty to ppm of range.

<sup>80</sup> Specified with aperture Auto, 100 Hz sine wave for sample rate  $\leq 5$  k, and 1 kHz sine wave for sample rate  $\geq 10$  k. Distortion is calculated using first five harmonics. For the 1 A, 3 A, and 10 A ranges, use the 100 mA range accuracy; guaranteed by design.

Specifications and characteristics are subject to change without notice.



**EFFECTIVE NUMBER OF BITS (ENOB), TYPICAL<sup>81</sup>**



**DIGITIZER CHARACTERISTICS**

Maximum resolution	18 bits
Measurement input coupling	DC or AC (voltage only)
Sampling rate <sup>82</sup>	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 time < 2 s
Maximum record length	8 million

<sup>81</sup> 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.

<sup>82</sup> Sample rate is not continuously adjustable. For valid discrete settings, see the *Model DMM7510 Reference Manual*.

Specifications are subject to change without notice.

## TRUE RMS AC VOLTAGE AND AC CURRENT

Function	Range <sup>83</sup>	Resolution	1 year accuracy: ± (% of reading + % of range) T <sub>CAL</sub> ± 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 <sup>84</sup>	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 <sup>83</sup>	Resolution	1 year accuracy: ± (% of reading + % of range) T <sub>CAL</sub> ± 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 <sup>84</sup>	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	0.09 + 0.03
	1.000000 A	1 μA	1.0 + 0.04	0.30 + 0.04	0.20 + 0.04	0.88 + 0.04	2.0 + 0.04
	3.000000 A	1 μA	1.0 + 0.05	0.30 + 0.05	0.20 + 0.05	0.88 + 0.05	2.0 + 0.05
	10.00000 A <sup>85</sup>	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

<sup>83</sup> 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.

<sup>84</sup> Specifications are for detector bandwidth of 3 Hz 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.

<sup>85</sup> Rear input terminals only.

Specifications and characteristics are subject to change without notice.

**ADDITIONAL AC VOLTAGE CREST FACTOR UNCERTAINTIES<sup>86</sup>**

Additional uncertainty ± (% of reading)

Input signal frequency	Detector bandwidth	Crest factor 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 x 10 <sup>7</sup> V*Hz verified; input frequency verified for < 300 kHz

**AC CURRENT CHARACTERISTICS**

Measurement method	AC-coupled, true RMS
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Range	1 mA	10 mA	100 mA	1 A	3 A	10 A <sup>87</sup>
Burden voltage (RMS)	< 16 mV	< 20 mV	< 0.2 V	< 0.4 V	< 1.3 V	< 0.65 V
<b>Overload recovery:</b> 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	—	—

<sup>86</sup> Applies for non-sine wave inputs, DC content ≤ 3 % of range, maximum crest factor ≤ 5.0.

<sup>87</sup> Rear input terminals only.

Specifications are subject to change without notice.

## FREQUENCY AND PERIOD

### MEASUREMENT ACCURACY<sup>88</sup>

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 <sub>CAL</sub> ±5 °C	2 year T <sub>CAL</sub> ±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<sup>89</sup>

Threshold range	Threshold resolution	Accuracy ±[% of reading]
		2 year T <sub>CAL</sub> ±5 °C
100 mV to 700 V	0.05 %	1.0 %

### FREQUENCY AND PERIOD CHARACTERISTICS

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

<sup>88</sup> 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.

<sup>89</sup> Threshold range is voltage RMS and threshold level voltage peak. Specified with 1 KHz square wave. 100 V and 700 V threshold ranges guaranteed by design.

**TYPICAL READING RATES, 60 Hz (50 Hz) OPERATION<sup>90,91,92,93</sup>**

		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)	
NPLC	Digits	Measure- ments into buffer	Measure- ments into computer	Measure- ments into buffer	Measure- ments into computer	Measure- ments into buffer	Measure- ments into computer	Measure- ments into buffer	Measure- ments 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)

		Functions: AC voltage, AC current	
Detector bandwidth (Hz)	Digits	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 <sup>94</sup>	6½	59.8 (49.8)	55 (46)
300 <sup>94</sup>	3½	26200 (26200)	24500 (24500)

**DIGITIZE, TYPICAL**

Sampling rate	Digits	Resolution	Measurements into computer <sup>93</sup>
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

<sup>90</sup> Reading speeds for autozero off, fixed range, autodelay off. Offset compensation off and open lead detector off where applicable.

<sup>91</sup> Buffer measurements: For < 0.2 PLC, multisample, single buffer transfer binary reading only.

<sup>92</sup> PC measurements: For 1 and 0.2 PLC single reading and single transfer to computer (USB).

<sup>93</sup> 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.

<sup>94</sup> For bandwidth 300 Hz, autozero off, 6½ digits at 1 PLC, 3½ digits at 0.0005 PLC.

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## 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

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 <sup>95</sup>	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

<sup>95</sup> For DC voltage or 2-wire ohms to frequency or period, 10 ms aperture. For AC current or AC voltage, detector bandwidth is 300 Hz.

## TRIGGERING

Time base accuracy	25 ppm
Trigger source	Analog DC voltage, DC current, or any system trigger
Trigger coupling	DC or AC (DC voltage function only)
Input trigger latency <sup>96,97,98</sup>	< 225 ns
Input trigger jitter <sup>96,97</sup>	< 50 ns
Sample period jitter <sup>96,97</sup>	< 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)

## ANALOG TRIGGERING<sup>99</sup>

### ANALOG LEVEL, EDGE, OR WINDOW TRIGGER TYPES<sup>100</sup>

Trigger characteristics	Voltage input	Current input
Input range	100 mV to 1000 V	10 $\mu$ A to 10 A
Resolution	0.05 %	0.05 %
Basic accuracy ( $T_{ACAL} \pm 5^\circ C$ ) <sup>101,102</sup>	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 styles

<sup>96</sup> Guaranteed by design; for digital I/O only.

<sup>97</sup> Stimulus command required to meet specifications.

<sup>98</sup> If using trigger model, add 200 ns uncertainty.

<sup>99</sup> For DC or AC coupled, the trigger level can be set up to 100 % of measure range.

<sup>100</sup> Rising or falling edge triggering supported. Window trigger requires setting two independent levels.

<sup>101</sup> Trigger event occurs after the threshold crossing at a time determined by total trigger latencies.

<sup>102</sup> Accuracy specifications require user  $A_{CAL}$  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  $\mu$ s 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 %.

Specifications are subject to change without notice.

## 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).

<b>Input protection</b>	1010 V DC (715 V <sub>RMS</sub> 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
<b>3 A input fuse protection</b>	3.5 A, 1 kV fast blow type; Keithley part number DMM7510-FUSE-3A
<b>10 A input fuse protection</b>	11 A, 1 kV fast blow type; Keithley part number DMM7510-FUSE-10A
<b>AC voltage input</b>	Maximum DC voltage: 1000 V on any AC voltage range
<b>Common mode isolation</b>	500 V DC or AC V <sub>peak</sub> LO to chassis All terminals > 10 GΩ, < 350 pF any terminal to chassis
<b>Power line</b>	Universal input, 100 V to 240 V
<b>Line frequency</b>	50 Hz or 60 Hz, automatically sensed at power-up
<b>Power consumption</b>	60 VA
<b>Operating environment</b>	Specified for 0 °C to 50 °C, ≤ 80 % relative humidity at 35 °C, altitude up to 2000 meters
<b>Storage environment</b>	-30 °C to 70 °C
<b>Real time clock</b>	Lithium battery backup (3+ years battery life)
<b>EMC</b>	Conforms to European Union EMC Directive
<b>Safety</b>	NRTL listed to UL61010-1, and CSA C22.2 No 61010-1; conforms with European Union Low Voltage Directive
<b>Vibration</b>	MIL-PRF-28800F Class 3, Random
<b>Warm-up</b>	90 minutes to rated accuracy
<b>Input signal connections</b>	Front and rear safety banana jacks
<b>Cooling</b>	Forced air, fixed speed
<b>Dimensions</b>	<b>Without handle and bumpers:</b> 88 mm high × 213 mm wide × 410 mm deep (3.46 in. × 8.39 in. × 16.13 in.) <b>With handle and bumpers (bench configuration):</b> 106 mm high × 255 mm wide × 425 mm deep (4.18 in. × 10.05 in. × 16.75 in.)
<b>Shipping weight (with bumpers and handle)</b>	4.08 kg (9.0 lb)
<b>Shipping weight (without bumpers and handle)</b>	3.63 kg (8.0 lb)



<b>Digital I/O</b>	<b>Connector</b>	9-pin female D
	<b>5 V power supply pin</b>	Limited to 500 mA at > 4 V (solid-state fuse protected)
	<b>Lines</b>	Six input/output, user-defined, for digital I/O or triggering
	<b>Input signal levels</b>	0.7 V (maximum logic low) 3.7 V (minimum logic high)
	<b>Input voltage limits</b>	-0.25 V (absolute minimum) +5.25 V (absolute maximum)
	<b>Maximum source current</b>	+2.0 mA at > 2.7 V (per pin)
	<b>Maximum sink current</b>	-50 mA at 0.7 V (per pin, solid-state fuse protected)
	<b>Handler</b>	User-defined start of test, end of test, four category bits
<b>Math functions</b>	Rel, dB, Limit Test, Percentage, 1/x, and mX + b	
<b>Remote interface</b>	LAN: RJ-45 connector, 10/100BT; Virtual Front Panel 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	
<b>LXI compliance</b>	LXI version 1.4 Core 2011	
<b>Language</b>	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)	
<b>Accessories supplied</b>	Product Information CD-ROM, <i>Model DMM7510 Quick Start Guide</i> , <i>Kickstart Software Quick Start Guide</i> , power cord, 1 m USB cable (type A to type B), 3 m LAN cable, and Model 1756 Standard Test Lead Kit	
<b>Accessories available</b>	(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, and NI LabWindows™/CVI	
<b>Display</b>	Five-inch capacitive touch, color thin-film-transistor (TFT) WVGA (800 x 480) with LED backlight	
<b>Password protection</b>	30 characters	
<b>Expansion interface</b>	The TSP-Link® expansion interface allows TSP-enabled instruments to trigger and communicate with each other	
<b>IP configuration</b>	Static or DHCP (manual or automatic)	