



## Product Specifications

### dc Specifications

Specifications are for 1-hour warm-up at an integration time of 100 PLCs.

### dc Summary

**dc voltage:** 300 V max.  
**Voltage accuracy (dc):** ± 0.0019%

### dc Accuracy ± (% of reading + % of range):

Specifications are for 1-hour warm-up at 6.5 digits.

#### dc voltage:

Range <sup>(2)</sup>	Test Current or Burden Voltage	24 Hour <sup>(1)</sup> 23° C ± 1° C	90 Day 23° C ± 5° C	1 Year 23° C ± 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
100.0000 mV		0.0030 + 0.0030	0.0040 + 0.0035	0.0050 + 0.0035	0.0005 + 0.0005
1.000000 V		0.0020 + 0.0006	0.0030 + 0.0007	0.0040 + 0.0007	0.0005 + 0.0001
10.00000 V		0.0015 + 0.0004	0.0020 + 0.0005	0.0035 + 0.0005	0.0005 + 0.0001
100.0000 V		0.0020 + 0.0006	0.0035 + 0.0006	0.0045 + 0.0006	0.0005 + 0.0001
300.0000 V		0.0020 + 0.0018	0.0035 + 0.0030	0.0045 + 0.0030	0.0005 + 0.0003

#### Resistance:

Resistance: <sup>(3)</sup>	Test Current or Burden Voltage	24 Hour <sup>(1)</sup> 23° C ± 1° C	90 Day 23° C ± 5° C	1 Year 23° C ± 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
100.0000 Ω	1 mA	0.0030 + 0.0030	0.008 + 0.004	0.010 + 0.004	0.0006 + 0.0005
1.000000 kΩ	1 mA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
10.000000 kΩ	100 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
100.00000 kΩ	10 μA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
1.000000 MΩ	5 μA	0.002 + 0.001	0.008 + 0.001	0.010 + 0.001	0.0010 + 0.0002
10.000000 MΩ	500 nA	0.015 + 0.001	0.035 + 0.001	0.054 + 0.001	0.0030 + 0.0004
100.00000 MΩ	500 nA    10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002

#### dc current:

dc current:	Test Current or Burden Voltage	24 Hour <sup>(1)</sup> 23° C ± 1° C	90 Day 23° C ± 5° C	1 Year 23° C ± 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
10.000000 mA	<0.1 V	0.005 + 0.010	0.050 + 0.020	0.070 + 0.020	0.005 + 0.0020
100.00000 mA	<0.6 V	0.01 + 0.004	0.040 + 0.005	0.070 + 0.005	0.006 + 0.0005
1.000000 A	<1 V	0.10 + 0.006	0.130 + 0.010	0.150 + 0.010	0.005 + 0.0010
3.000000 A	<2 V	0.70 + 0.020	0.720 + 0.020	0.720 + 0.020	0.005 + 0.0020

#### dc:dc Ratio:

Range<sup>(2)</sup>

100 mV to 300 V:

(Input Accuracy) + (Reference Accuracy)

Input Accuracy = accuracy specification for the HI-LO input signal

Reference Accuracy = accuracy specification for HI-LO reference input signal

(1) Relative to calibration standards.

(2) 20% overrange on all ranges, except 300 Vdc and 3 A range.

(3) Specifications are for 4-wire Ω function, or 2-wire Ω using Math Null, Without Math Null, add 0.2 Ω additional error in 2-wire Ω function.

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**dc Voltage Characteristics**

<b>Measurement method:</b>	Continuously integrating, multi-slope III A/D converter
<b>A/D linearity:</b>	0.0002% of reading + 0.0001% of range
<b>2/4-wire <math>\Omega</math>:</b>	100 M $\Omega$
<b>Input resistance:</b>	
0.1 V, 1 V, 10 V ranges:	Selectable 10 M $\Omega$ or 10 G $\Omega$
100 V, 300 V ranges:	10 M $\Omega$ $\pm$ 1%
<b>Input bias current:</b>	<30 pA at 25° C
<b>Input terminals:</b>	Copper alloy
<b>Input protection:</b>	300 V on all ranges

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**Resistance**

<b>Measurement method:</b>	Selectable 4-wire or 2-wire $\Omega$ ( <i>Current source referenced to low input</i> )
<b>Max. lead resistance:</b>	(4-wire $\Omega$ ) 10% of range per lead for 100 $\Omega$ and 1 k $\Omega$ per lead on all other ranges
<b>dc Current</b>	
<b>Input protection:</b>	300 V on all ranges
<b>Shunt resistor:</b>	0.1 $\Omega$ for 1 A and 3 A, 5 $\Omega$ for 10 mA and 100 mA
<b>Input protection:</b>	Externally accessible 3 A, 250 V fuse

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**Measurement Noise Rejection**

60 Hz (50 Hz) (For 1 k $\Omega$  unbalance in LO lead.)

<b>dc CMMR:</b>	140 dB
<b>Integration Time</b>	<b>Normal mode rejection<sup>(1)</sup></b>
100 PLC/1.67s (2s)	60 dB <sup>(2)</sup>
10 PLC/167 ms (200 ms)	60 dB <sup>(2)</sup>
1 PLC/16.7 ms (20 ms)	60 dB <sup>(2)</sup>
<1 PLC/3 ms (800 $\mu$ s)	0 dB

(1) For power-line frequency  $\pm$  0.1%.

(2) For power-line frequency  $\pm$  1%, subtract 20 dB; for  $\pm$  3%, subtract 30 dB.

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**System Speed**

(Speeds are for 4.5 digits, Delay 0 and Autozero OFF. Includes measurement and data transfer over VXI backplane.)

<b>Function change:</b>	30/s
<b>Range change:</b>	65/s
<b>Autorange time:</b>	<30 ms
<b>Max. internal trigger rate:</b>	1000/s
<b>Max. external trigger rate to memory:</b>	1000/s

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**dc:dc Ratio**

<b>Measurement method:</b>	Input HI-LO/Reference HI-LO <i>Apply "Reference HI-LO" signal to Ohms 4-Wire Sense terminals."</i>
<b>Input HI to Input LO:</b>	100 mV to 300 V
<b>Reference HI to Input LO:</b>	<12 V on 100 mV to 10 V ranges (autoranged)
<b>Reference LO to Input LO:</b>	<2 V

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**Additional Error with Autozero OFF**

Following instrument warm-up at calibration temperature  $\pm$  1° C and <10 minutes.

<b>100mV-100V ranges:</b>	add 0.0002% reading + 5 $\mu$ V
<b>300 V range:</b>	add 0.0006% reading

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**dc Operating Characteristics**

Readings speeds for 60 Hz and (50 Hz) operation, Autozero OFF.

Function	NPLC	Digits	Reading/s	Additional Noise Error
DCV, DCI and $\Omega$	100	6.5	0.6 (0.5)	0% of range
DCV, DCI and $\Omega$	10	6.5	6 (5)	0% of range
DCV, DCI and $\Omega$	1	5.5	60 (50)	0.001% of range*
DCV, DCI and $\Omega$	.2	5.5	300	0.001% of range*
DCV, DCI and $\Omega$	.02	4.5	1,000	0.01% of range*

\*For 300 V range: use 0.003% of range for 5.5 digits and 0.030% of range for 4.5 digits. For all ranges: add 20  $\mu$ V for dc Volts, 4  $\mu$ A for dc current, or 20 m $\Omega$  for resistance.

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**Considerations**

**Settling considerations:** Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes.

**Measurement considerations:** Agilent recommends the use of Teflon or other high impedance, low-dielectric absorption wire insulation for these measurements.

## ac Specifications

### ac Summary

**ac voltage:** 300 V max.

**Voltage accuracy (ac):** ± 0.07%

### ac Accuracy ± (% of reading + % of range):

Specifications are for 1-hour warm-up at 6.5 digits.  
Slow ac filter, sinewave input.

### True RMS ac Voltage<sup>(3)</sup>:

Range <sup>(2)</sup>	Frequency	24 Hour <sup>(1)</sup> 23° C ± 1° C	90 Day 23° C ± 5° C	1 Year 23° C ± 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
100.0000 mV	3 Hz-5 Hz	1.00 + 0.03	1.00 + 0.04	1.00 + 0.04	0.100 + 0.004
100.0000 mV	5 Hz-10 Hz	0.35 + 0.03	0.35 + 0.04	0.35 + 0.04	0.035 + 0.004
100.0000 mV	10 Hz-20 kHz	0.04 + 0.03	0.05 + 0.04	0.06 + 0.04	0.005 + 0.004
100.0000 mV	20 kHz-50 kHz	0.10 + 0.05	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
100.0000 mV	50 kHz-100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
100.0000 mV	100 kHz-300 kHz	5.00 + 0.50	5.00 + 0.50	5.00 + 0.50	0.020 + 0.020
1.000000 V to 300.000 V <sup>(4)</sup>	3 Hz-5 Hz	1.00 + 0.02	1.00 + 0.03	1.00 + 0.03	0.100 + 0.003
1.000000 V to 300.000 V <sup>(4)</sup>	5 Hz-10 Hz	0.35 + 0.02	0.35 + 0.03	0.35 + 0.03	0.035 + 0.003
1.000000 V to 300.000 V <sup>(4)</sup>	10 Hz-20 kHz	0.04 + 0.02	0.05 + 0.03	0.06 + 0.03	0.005 + 0.003
1.000000 V to 300.000 V <sup>(4)</sup>	20 kHz-50 kHz	0.10 + 0.04	0.11 + 0.05	0.12 + 0.05	0.011 + 0.005
1.000000 V to 300.000 V <sup>(4)</sup>	50 kHz-100 kHz	0.55 + 0.08	0.60 + 0.08	0.60 + 0.08	0.060 + 0.008
1.000000 V to 300.000 V <sup>(4)</sup>	100 kHz-300 kHz <sup>(5)</sup>	5.00 + 0.50	5.00 + 0.50	5.00 + 0.50	0.200 + 0.020

### True RMS ac Current<sup>(3)</sup>:

Range	Frequency	24 Hour 23° C ± 1° C	90 Day 23° C ± 5° C	1 Year 23° C ± 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
1.000000 A	3 Hz-5 Hz	1.05 + 0.04	1.05 + 0.04	1.05 + 0.04	0.100 + 0.006
1.000000 A	5 Hz-10 Hz	0.35 + 0.04	0.35 + 0.04	0.35 + 0.04	0.035 + 0.006
1.000000 A	10 Hz-1 kHz	0.15 + 0.04	0.15 + 0.04	0.15 + 0.04	0.015 + 0.006
1.000000 A	1 kHz-50 kHz	0.40 + 0.04	0.40 + 0.04	0.40 + 0.04	0.015 + 0.006
3.000000 A	3 Hz-5 Hz	1.70 + 0.06	1.70 + 0.06	1.70 + 0.06	0.100 + 0.006
3.000000 A	5 Hz-10 Hz	0.95 + 0.06	0.95 + 0.06	0.95 + 0.06	0.035 + 0.006
3.000000 A	10 Hz-1 kHz	0.75 + 0.06	0.75 + 0.06	0.75 + 0.06	0.015 + 0.006
3.000000 A	1 kHz-50 kHz	1.00 + 0.06	1.00 + 0.06	1.00 + 0.06	0.15 + 0.06

(1) Relative to calibration standards.

(2) 20% overrange on all ranges, except 300 Vac and 3A ranges which have 1% overrange.

(3) 100 mV to 100 V range specifications are for sine wave input >5% of range. For inputs from 1% to 5% of range and <50 kHz, add 0.1% of range additional error. For 50 kHz to 100 kHz, add 0.13% additional error. 300 V range specifications are for sinewave input >15% of range. For inputs from 3% to 15% of range and >50 kHz, add 0.30% of kHz, add 0.40% of range additional error.

(4) For 300 V range, use (% reading) shown in table and multiply each (% range) x 3.

(5) 300 Vac range limited to 50 kHz. For frequencies >50 kHz, signals must be ≤1.5 x 10<sup>7</sup> VHz.

### Additional ac Specifications:

Frequency	Low Freq. Errors (% of reading)			Crest Factor Errors (non-sinewave)*	
	Slow	Medium	Fast	Crest Factor	Error (% of reading)
10 Hz-20 Hz	0	0.74	—	1-2	0.05%
20 Hz-40 Hz	0	0.22	—	2-3	0.15%
40 Hz-100 Hz	0	0.06	0.73	3-4	0.30%
100 Hz-200 Hz	0	0.01	0.22	4-5	0.40%
200 Hz-1 kHz	0	0	0.18		
>1 kHz	0	0	0		

\*For frequencies below 100 Hz, slow ac filter specified for sinewave input only.

### Noise Rejection

(For 1 kΩ unbalance in LO lead.)

ac CMMR: 70 dB

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**True RMS ac Voltage**

<b>Measurement method:</b>	ac-coupled True RMS — measures the ac component of the input with up to 300 Vdc of bias on any range. (Max ac+dc = 300 V rms.)
<b>Crest factor:</b>	Maximum 5:1 at full scale
<b>ac filter bandwidth:</b>	
Slow:	3 Hz-300 kHz
Medium:	20 Hz-300 kHz
Fast:	200 Hz-300 kHz
<b>Input impedance:</b>	1 M $\Omega$ $\pm$ 2%, in parallel with 100 pF
<b>Input protection:</b>	300 Vrms all ranges

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**True RMS ac Current**

<b>Measurement method:</b>	Direct couple to the fuse and shunt. ac-coupled True RMS measurement (measures the ac component only).
<b>Shunt resistor:</b>	0.1 $\Omega$ for 1 A and 3 A ranges
<b>Burden voltage:</b>	
1A range:	<1 Vrms
3A range:	<2 Vrms
<b>Input protection:</b>	Externally accessible 3 A, 250 V fuse

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**ac Operating Characteristics**

Maximum reading rates 0.01% of ac step additional error. Additional settling delay required when input dc level varies.

Function	Digits	Reading/s	ac Filter
ACV and ACI	6.5	7 s/reading	Slow
ACV and ACI	6.5	1	Medium
ACV and ACI	6.5	1.6 <sup>(1)</sup>	Fast
ACV and ACI	6.5	10	Fast
ACV and ACI	6.5	50 <sup>(2)</sup>	Fast

(1) For External Trigger or remote operation using default settling delay (Delay Auto).

(2) Maximum useful limit with default settling delays used.

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**Frequency and Period Specifications****Frequency and Period Accuracy (% of reading)**

Specifications are for 1-hour warm-up at 6.5 digits.

Function	Range <sup>(2)</sup>	Frequency	24 Hour <sup>(1)</sup> 23° C $\pm$ 1° C	90 Day 23° C $\pm$ 5° C	1 Year 23° C $\pm$ 5° C	Temperature Coefficient 0° C - 18° C 28° C - 55° C
Frequency, Period	100 mV to 300 V	3 Hz-5 Hz	0.10	0.10	0.10	0.005
Frequency, Period	100 mV to 300 V	5 Hz-10 Hz	0.05	0.05	0.06	0.005
Frequency, Period	100 mV to 300 V	10 Hz-40 Hz	0.03	0.03	0.03	0.001
Frequency, Period	100 mV to 300 V	40 Hz-300 kHz	0.006	0.01	0.01	0.001

(1) Relative to calibration standards.

(2) 20% overrange on all ranges, except 300 Vac range which has 1% overrange.

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**Systems Speeds**

Maximum useful limit with default settling delays used; Speeds are for 4.5 digits, Delay 0, and Fast ac filter.

<b>Function or range change:</b>	5/s
<b>Autorange time:</b>	<0.8 s
<b>ASCII reading to GPIB:</b>	50/sec
<b>Max. internal trigger rate:</b>	50/s
<b>Max. external trigger rate to memory:</b>	50/s

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**Additional Low-Frequency Errors (% of reading)**

Input >100 mV. For mV input, multiply % of reading error x 10.

Frequency	6.5 digits	5.5 digits	4.5 digits
3 Hz-5 Hz	0	0.12	0.12
5 Hz-10 Hz	0	0.17	0.17
10 Hz-40 Hz	0	0.2	0.2
40 Hz-100 Hz	0	0.06	0.21
100 Hz-300 Hz	0	0.03	0.21
300 Hz-1 kHz	0	0.01	0.07
>1 kHz	0	0	0.02

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## Measuring Characteristics

<b>Measurement method:</b>	Reciprocal-counting technique. ac-coupled input using the ac voltage measurement function.
<b>Voltage ranges:</b>	100 mV rms full scale to 300 V rms. Auto or manual ranges.
<b>Gate time:</b>	10 ms, 100 ms, or 1 s
<b>Settling considerations:</b>	Errors will occur when attempting to measure the frequency or period of an input following a dc offset voltage change. The input blocking RC time constant must be allowed to fully settle (up to 1 s) before the most accurate measurements are possible.
<b>Measurement considerations:</b>	All frequency counters are susceptible to error when measuring low-voltage, low-frequency signals. Shielding inputs from external noise pickup is critical for minimizing measurement errors.
<b>Max. reading rate:</b>	1K

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## Operating Characteristics

Speeds are for 4.5 digits, Delay 0, and Fast ac filter.

Function	Digits	Reading/s
Frequency, Period	6.5	1
Frequency, Period	5.5	9.8
Frequency, Period	4.5	80

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## Systems Speeds

<b>Configuration rates:</b>	14/s
<b>Autorange time:</b>	<0.6 s
<b>Max. internal trigger rate:</b>	80/s
<b>Max. external trigger rate to memory:</b>	80/s

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## Characteristics

<b>Warmup time:</b>	1 hour
<b>State storage memory:</b>	Power-off state automatically saved

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## Functions

<b>Idc:</b>	3 A
<b>Iac:</b>	3 A
<b>Frequency:</b>	300 kHz
<b>Period:</b>	3.3 $\mu$ s
<b>Temp.:</b>	Tm, Tc, RTD

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## General Specifications

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### VXI Characteristics

<b>VXI device type:</b>	Message based
<b>Data transfer bus:</b>	A16
<b>Size:</b>	C
<b>Slots:</b>	1
<b>Connectors:</b>	P1/2
<b>Shared memory:</b>	n/a
<b>VXI buses:</b>	n/a

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**Instrument Drivers** - See the Agilent Technologies Website ([http://www.agilent.com/find/inst\\_drivers](http://www.agilent.com/find/inst_drivers)) for driver availability and downloading.

<b>Command module firmware:</b>	n/a
<b>Command module firmware rev:</b>	n/a
<b>I-SCPI Win 3.1:</b>	n/a
<b>I-SCPI Series 700:</b>	n/a
<b>C-SCPI LynxOS:</b>	n/a
<b>C-SCPI Series 700:</b>	n/a
<b>Panel Drivers:</b>	No
<b>VXI plug&amp;play Win Framework:</b>	Yes
<b>VXI plug&amp;play Win 95/NT Framework:</b>	Yes
<b>VXI plug&amp;play HP-UX Framework:</b>	No

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### Module Current

	I <sub>PM</sub>	I <sub>DM</sub>
+5 V:	0.2	0.1
+12 V:	0.7	0.06
-12 V:	0	0
+24 V:	0	0
-24 V:	0	0
-5.2 V:	0	0
-2 V:	0	0

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### Cooling/Slot

<b>Watts/slot:</b>	9.40
$\Delta$ P mm H <sub>2</sub> O:	0.05
<b>Air Flow liter/s:</b>	0.80

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## Ordering Information

Description	Product No.
6.5-Digit Multimeter, High Accuracy	E1412A
ANSI Z540 Compliant Calibration	E1412A A6J

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