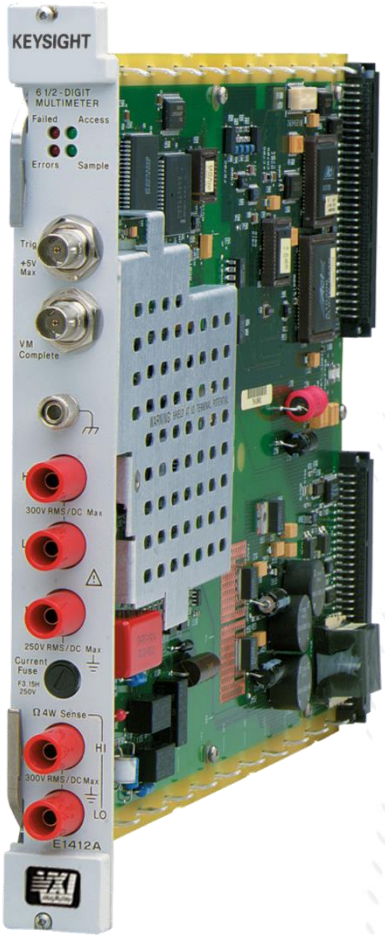
DATA SHEET

E1412A VXI High-Accuracy Multimeter

6.5 digit, C-Size



KEYSIGHT TECHNOLOGIES

Exceptional performance in a single-slot VXI module

The Keysight Technologies E1412A 6.5-Digit Multimeter is a C-size, 1-slot, message-based VXI module. This multimeter's wide product functionality includes volts, amps, ohms, and frequency with advanced tests including limit checks to drive a TTL output and DC voltage ratios. Standard measurements include ac/dc voltage, AC/DC current, 2- and 4-wire Ω, plus frequency/period. When measuring DCV, this multimeter can deliver 65 range changes per second and 30 function changes per second.

Key Features

- 1-Slot, C-size, message-based
- Integrating A/D
- DCV, ACV, DCI, ACI, 2/4-wire Ω, frequency, period
- NULL, MIN/MAX, LIMIT, dB, dBm
- 1000 reading/s into internal memory at 4.5 digits
- Fast range/function changes
- Reading storage with internal memory

Technical Specifications and Characteristics

DC Specifications and Characteristics

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

DC Summary	
DC Voltage and current	300 V and 3 A maximum
DC Voltage Accuracy	± 0.0019%

DC Voltage Accuracy ± (% of reading + % of range): Specifications for 1-hour warm-up at 6.5 digits

Range[1] DC Voltage	24 Hour[2] 23°C ± 1°C	90 Day 23°C ± 1°C	1 Year 23°C ± 1°C	Temperature Coefficient 0°C - 18°C and 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

DC Accuracy ± (% of reading + % of range)
Specifications for 1-hour warm-up at 6.5 digits

Range Resistance[3]	Test Current	24 Hour[2] 23°C ± 1°C	90 Day 23°C ± 1°C	1 Year 23°C ± 1°C	Temperature Coefficient 0°C - 18°C and 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
10.00000 kΩ	100 µA	0.0020 + 0.0005	0.008 + 0.001	0.010 + 0.001	0.0006 + 0.0001
100.0000 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
10.00000 MΩ	500 nA	0.015 + 0.001	0.035 + 0.001	0.054 + 0.001	0.0030 + 0.0004
100.0000 MΩ	500 nA || 10 MΩ	0.300 + 0.010	0.800 + 0.010	0.800 + 0.010	0.1500 + 0.0002
Range DC Current	**Burden Voltage**	**24 Hour 23°C ± 1°C**	**90 Day 23°C ± 1°C**	**1 Year 23°C ± 1°C**	**Temperature Coefficient 0°C - 18°C and 28°C - 55°C**
10.00000 mA	<0.1 V	0.005 + 0.010	0.050 + 0.020	0.070 + 0.020	0.005 + 0.0020
100.0000 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 Accuracy	
100 mV to 300 V Ranges[4]	(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] 20% overrange on all ranges, except 300 Vdc and 3 A range
[2] Relative to calibration standards.
[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
[4] 20% overrange on all ranges, except 300 Vdc

DC Specifications and Characteristics, cont.

DC Voltage Measurement Characteristics	
Measurement method	Continuously integrating, multi-slope III A/D converter
A/D linearity	0.0002% of reading + 0.0001% of range
2/4-wire Ω	100 MΩ
Input bias current	<30 pA at 25°C
Input terminals	Copper alloy
Input protection	300 V on all ranges
Input Resistance	
0.1 V, 1 V, 10 V ranges	Selectable 10 MΩ or 10 GΩ
100 V, 300 V ranges	10 MΩ ± 1%

Resistance Measurement Characteristics	
Measurement method	Continuously integrating, multi-slope III A/D converter
Max. lead resistance	0.0002% of reading + 0.0001% of range
Input protection	300 V on all ranges Externally accessible 3 A, 250 V fuse
Shunt Resistor	0.1 Ω for 1 A and 3 A, 5 Ω for 10 mA and 100 mA

DC:DC Ratio Measurement Characteristics	
Measurement method	Input HI-LO/Reference HI-LO *Apply "Reference HI-LO" signal to Ohms 4-Wire Sense terminals*
Input HI to Input LO	100 mV to 300 V
Reference HI to Input LO	<12 V on 100 mV to 10 V ranges (autoranged)
Reference LO to Input LO	<2 V

Measurement Noise Rejection 60 Hz (50 Hz) (For 1 kΩ unbalance in LO lead.)	
DC CMMR	140dB
Integration Time	**Normal mode rejection[1]**
100 PLC/1.67s (2s)	60 dB[2]
10 PLC/167 ms (200 ms)	60 dB[2]
1 PLC/16.7 ms (20 ms)	60 dB[2]
<1 PLC/3 ms (800 µs)	0 dB

[1] For power-line frequency ± 0.1%.
[2] For power-line frequency ± 1%, subtract 20 dB; for ± 3%, subtract 30 dB.

DC Specifications and Characteristics, cont.

Additional Error with Autozero OFF Following instrument warm-up at calibration temperature ± 1°C and <10 minutes	
100 mV-100 V ranges	add 0.0002% reading + 5 µV
300 V range	add 0.0006% reading

DC Operating Characteristics Reading speeds with Autozero off				
Function	**NPLC**	**Digits**	**Readings/s 60 Hz (50 Hz)**	**Additional Noise Error**
DCV, DCI, and Ω	100	6.5	0.6 (0.5)	None
DCV, DCI, and Ω	10	6.5	6 (5)	None
DCV, DCI, and Ω	1	5.5	60 (50)	0.001% of range[1]
DCV, DCI, and Ω	0.2	5.5	300	0.001% of range[1]
DCV, DCI, and Ω	0.02	4.5	1000	0.01% of range[1]

DC System Speeds Speeds are for 4.5 digits, Delay 0 and Autozero OFF. Includes measurement and data transfer over VXI backplane.	
Function change	30/s
Range change	65/s
Autorange time	<30 ms
Maximum internal trigger rate	1000/s
Maximum external trigger rate to memory	1000/s

Considerations	
Settling considerations	Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes.
Measurement considerations	Keysight recommends the use of PTFE (Polytetrafluoroethylene) or other high impedance, low-dielectric absorption wire insulation for these measurements

AC Specifications and Characteristics

AC Summary	
AC Voltage	300 V maximum
AC Voltage Accuracy	± 0.07
AC Current	3A maximum

[1] 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 µV for dc Volts, 4 µA for dc current, or 20 mΩ for resistance.

AC Specifications and Characteristics, cont.

True RMS AC Voltage[1] Accuracy ± (% of reading + % of range) Specifications for 1-hour warm-up at 6.5 digits. Slow ac filter, sinewave Input					
Range[2]	Frequency	24 Hour[3] 23°C ± 1°C	90 Day 23°C ± 1°C	1 Year 23°C ± 1°C	Temperature Coefficient 0°C - 18°C and 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[4]	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[4]	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[4]	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[4]	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[4]	50 kHz-100 kHz	0.55 + 0.08	0.60 + 0.08	0.06 + 0.08	0.060 + 0.008
1.000000 V to 300.000 V[4]	100 kHz-300 kHz[5]	5.00 + 0.50	5.00 + 0.50	5.00 + 0.50	0.200 + 0.020

True RMS AC Current[1] Accuracy ± (% of reading + % of range) Specifications for 1-hour warm-up at 6.5 digits. Slow ac filter, sinewave Input					
Range	Frequency	24 Hour 23°C ± 1°C	90 Day 23°C ± 1°C	1 Year 23°C ± 1°C	Temperature Coefficient 0°C - 18°C and 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] 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. of kHz, add 0.40% of range additional error.

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

[3] Relative to calibration standards.

[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 10^7 VHz.

AC Specifications and Characteristics, cont.

Low Frequency Errors (% of reading)				Crest Factor Errors (non-sinewave)[1]	
Frequency	AC Filter Slow	AC Filter Medium	AC Filter 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		

Noise Rejection For 1 kΩ unbalance in LO lead.	
AC CMMR	70 dB

True RMS AC Voltage Measurement Characteristics	
Measurement method	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.)
Crest Factor	Maximum 5:1 at full scale
AC filter bandwidth	Slow: 3 Hz-300 kHz Medium: 20 Hz-300 kHz Fast: 200 Hz-300 kHz
Input impedance	1 MΩ ±2%, in parallel with 100 pF
Input protection	300 Vrms all ranges

True RMS AC Current Measurement Characteristics	
Measurement method	Direct couple to the fuse and shunt. ac -coupled True RMS measurement (measures the ac component only).
Shunt resistor	Maximum 5:1 at full scale
Burden voltage	1 A range: <1 Vrms 3 A range: <2 Vrms
Input protection	Externally accessible 3 A, 250 V fuse

AC Operating Characteristics			
Function	Digits	Readings/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[2]	Fast
ACV and ACI	6.5	10	Fast
ACV and ACI	6.5	50[3]	Fast

[1] For frequencies below 100 Hz, slow ac filter specified for sinewave input only.
[2] For External Trigger or remote operation using default settling delay (Delay Auto).
[3] Maximum useful limit with default settling delays used.

AC Specifications and Characteristics, cont.

AC System Speeds Maximum useful limit with default settling delays used; Speeds are for 4.5 digits, Delay 0, and Fast ac filter.	
Function change	5/s
Autorange time	<0.8 s
ASCII reading to GPIB	50/s
Maximum internal trigger rate	50/s
Maximum external trigger rate to memory	50/s

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

Frequency and Period Specifications and Characteristics

Frequency and Period Accuracy ± (% of reading + % of range) Specifications for 1-hour warm-up at 6.5 digits					
Range	**Frequency[1]**	**24 Hour[2] 23°C ± 1°C**	**90 Day 23°C ± 1°C**	**1 Year 23°C ± 1°C**	**Temperature Coefficient 0°C - 18°C and 28°C - 55°C**
100 mV to 300 V	3 Hz-5 Hz	0.10	0.10	0.10	0.005
100 mV to 300 V	5 Hz-10 Hz	0.05	0.05	0.06	0.005
100 mV to 300 V	10 Hz-40 Hz	0.03	0.03	0.03	0.001
100 mV to 300 V	40 Hz-300 kHz	0.006	0.01	0.01	0.001

Frequency and Period Measurement Characteristics	
Maximum frequency	300 kHz (3.3 µs)
Measurement method	Reciprocal-counting technique. AC-coupled input using the ac voltage measurement function
Voltage ranges	100 mV rms full scale to 300 V rms. Auto or manual ranges.
Gate time	10 ms, 100 ms, or 1 s
Settling considerations	Errors will occur when attempting to measure the frequency or period of an input following a dc
Measurement considerations	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.
Max. reading rate	1K

[1] 20% overrange on all ranges, except 300 Vac range which has 1% overrange
[2] Relative to calibration standards

Frequency and Period Specifications and Characteristics, cont.

Frequency and Period Operating Characteristics		
Function	**Digits**	**Readings/s**
Frequency, Period	6.5	1
Frequency, Period	5.5	9.8
Frequency, Period	4.5	80

Frequency and Period System Speeds	
Configuration rates	14/s
Autorange time	<0.6 s
Maximum internal trigger rate	80/s
Maximum external trigger rate to memory	80/s

General Specifications and Characteristics

Module Characteristics	
Warmup time	1 hour
State storage memory	Power-off state automatically saved
Maximum internal trigger rate	80/s
Maximum external trigger rate to memory	80/s

VXI Characteristics	
VXI device type	Message-based
Data transfer bus	A16
Size	C
Slots	1
Connectors	P1/P2
Shared Memory	NA
VXI buses	NA

Module Cooling	
Watts/slot	9.40 watts
ΔP mm H^2O	0.05
Air Flow liter/s	0.80

Module Current Requirements		
Voltage rail	**I_{PM}**	**I_{DM}**
+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

Definitions and Conditions

Specification (spec)
The warranted performance of a calibrated instrument that has been stored for a minimum of 1 hour within the operating temperature range of 0 to 50 °C and after a 30-minute warm up period. All specifications account for the effects of measurement and calibration-source uncertainties and were created in compliance with ISO-17025 methods. In addition, a driver session must be opened to initialize the power supplies. This can be done programmatically or by opening SFP and connecting to the instrument. Data published in this document are specifications (spec) only where specifically indicated.
Typical (typ)
The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty or calibration-source, and is valid only at room temperature (approximately 25°C).
Nominal (nom)
The mean or average characteristic performance, or the value of an attribute that is determined by design such as a connector type, physical dimension, or operating speed. This data is not warranted and is measured at room temperature (approximately 25°C).
Measured (meas)
An attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 25°C).
Additional Information
All data are measured from multiple units at room temperature and are representative of product performance within the operating temperature range unless otherwise noted. The data contained in this document is subject to change.

Ordering Information

Model	Description
E1412A	6.5 Digit Hi-Accuracy Multimeter C-Size integrating A/D
E1412A-0B3	Service Manual
E1412A-A6J	ANSI Z540-1-1994 Calibration
E1412A-FRMK	Factory refurbished product
Related Products	
E8401A	13-slot, C-size, VXI Mainframe with 550W Power Supply and basic monitoring
E8403A	13-slot, C-size, VXI Mainframe with 1000W Power Supply and basic monitoring
E8404A	13-slot C-size VXI Mainframe, 1000W PS, Enhanced monitor, color graphic display
E1406A	VXI GPIB Command Module; C-size

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KEYSIGHT TECHNOLOGIES

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