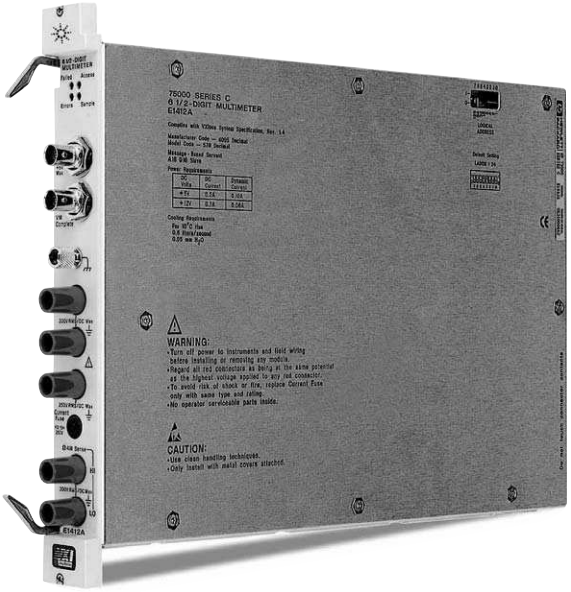
Agilent E1412A

6.5-Digit High-Accuracy Multimeter, C-Size

Data Sheet

- **1-Slot, C-size, message based**
- **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**



Agilent E1412A

Description

The Agilent Technologies E1412A 6.5-Digit Multimeter is a **C-size, 1-slot, message-based VXI module.** It is identical in electrical design to the E1312A, differing only in size. It delivers the widest functionality in Agilent's DMM line. It also delivers high performance and Agilent high quality at prices you'd expect to pay for a 5.5-digit DMM.

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.

Refer to the Agilent Technologies Website for instrument driver availability and downloading instructions, as well as for recent product updates, if applicable.

Agilent Technologies

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[2]	Test Current or Burden Voltage	24 Hour[1] 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

Range

Resistance:[3]	Test Current or Burden Voltage	24 Hour[1] 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
10.00000 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:	Test Current or Burden Voltage	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
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:

Range[2]	
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.

dc Voltage 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 resistance:	
0.1 V, 1 V, 10 V ranges:	Selectable 10 MΩ or 10 GΩ
100 V, 300 V ranges:	10 MΩ ± 1%
Input bias current:	<30 pA at 25° C
Input terminals:	Copper alloy
Input protection:	300 V on all ranges

Resistance

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

Measurement Noise Rejection

60 Hz (50 Hz) (For 1 kΩ unbalance in LO lead.)

dc CMMR:	140 dB
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.

System Speed

(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
Max. internal trigger rate:	1000/s
Max. external trigger rate to memory:	1000/s

dc:dc Ratio

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

Additional Error with Autozero OFF

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

100mV-100V ranges:	add 0.0002% reading + 5 µV
300 V range:	add 0.0006% reading

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 Ω	100	6.5	0.6 (0.5)	0% of range
DCV, DCI and Ω	10	6.5	6 (5)	0% of range
DCV, DCI and Ω	1	5.5	60 (50)	0.001% of range*
DCV, DCI and Ω	.2	5.5	300	0.001% of range*
DCV, DCI and Ω	.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 µV for dc Volts, 4 µA for dc current, or 20 mΩ for resistance.

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[3]:

Range[2]	Frequency	24 Hour[1] 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[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	0.60 + 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[3]:

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 10^7 VHz.

Additional ac Specifications:

Low Freq. Errors (% of reading) Frequency	ac Filter Slow	Medium	Fast	Crest Factor Errors (non-sinewave)* 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

True RMS ac Voltage

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

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(1)	Fast
ACV and ACI	6.5	10	Fast
ACV and ACI	6.5	50(2)	Fast

(1) For External Trigger or remote operation using default settling delay (Delay Auto).
(2)Maximum useful limit with default settling delays used.

Systems Speeds

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

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

Frequency and Period Accuracy (% of reading)
Specifications are for 1-hour warm-up at 6.5 digits.

Function	Range(2)	Frequency	24 Hour(1) 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
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.

Measuring Characteristics

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 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.
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

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

Systems Speeds

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

Characteristics

Warmup time:	1 hour
State storage memory:	Power-off state automatically saved

Functions

Idc:	3 A
Iac:	3 A
Frequency:	300 kHz
Period:	3.3 µs
Temp.:	Tm, Tc, RTD

General Specifications

VXI Characteristics

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

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

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

Module Current

	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

Cooling/Slot

Watts/slot:	9.40
ΔP mm H_2O:	0.05
Air Flow liter/s:	0.80

Ordering Information

Description	Product No.
6.5-Digit Multimeter, High Accuracy	E1412A
ANSI Z540 Compliant Calibration	E1412A A6J
Service Manual	E1412A 0B3

Agilent Technologies' Test and Measurement Support, Services, and Assistance

Agilent Technologies aims to maximize the value you receive, while minimizing your risk and problems. We strive to ensure that you get the test and measurement capabilities you paid for and obtain the support you need. Our extensive support resources and services can help you choose the right Agilent products for your applications and apply them successfully. Every instrument and system we sell has a global warranty. Two concepts underlie Agilent's overall support policy: "Our Promise" and "Your Advantage."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you receive your new Agilent equipment, we can help verify that it works properly, and help with initial product operation.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and onsite education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

Agilent Email Updates

www.agilent.com/find/emailupdates

Get the latest information on the products and applications you select.

Agilent T&M Software and Connectivity

Agilent's Test and Measurement software and connectivity products, solutions and developer network allows you to take time out of connecting your instruments to your computer with tools based on PC standards, so you can focus on your tasks, not on your connections.

Visit **www.agilent.com/find/connectivity** for more information.

For more assistance with all your test and measurement needs or to find your local Agilent office go to **www.agilent.com/find/assist**

Product specifications and descriptions in this document subject to change without notice.

Printed in the USA May 1, 2005
5965-5563E

Agilent Technologies