

Refer to the HP Website directory of addresses (URLs) for instrument driver availability and downloading instructions.

Specifications

DC Specifications

DC Summary

DC Voltage: 300 V max.
Voltage accuracy: $\pm 0.0019\%$

DC Accuracy $\pm(\% \text{ of reading} + \% \text{ of range})$:

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 $\pm$ 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
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: ⁽³⁾ Range ⁽²⁾	Test Current or Burden Voltage	24 Hour ⁽¹⁾ 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
100.0000 Ω	1 mA	0.0030+0.0030	0.008+0.004	0.010+0.004	0.0006+0.0005
1.000000 k Ω	1 mA	0.0020+0.0005	0.008+0.001	0.010+0.001	0.0006+0.0001
10.00000 k Ω	100 μ A	0.0020+0.0005	0.008+0.001	0.010+0.001	0.0006+0.0001
100.0000 k Ω	10 μ A	0.0020+0.0005	0.008+0.001	0.010+0.001	0.0006+0.0001
1.000000 M Ω	5 μ A	0.002+0.001	0.008+0.001	0.010+0.001	0.0010+0.0002
10.00000 M Ω	500 nA	0.015+0.001	0.035+0.001	0.054+0.001	0.0030+0.0004
100.0000 M Ω	500 nA 10 M Ω	0.300+0.010	0.800+0.010	0.800+0.010	0.1500+0.0002

DC current: Range ⁽²⁾	Test Current or Burden Voltage	24 Hour ⁽¹⁾ 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
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: 300 V
Voltage accuracy (DC): $\pm 0.0019\%$

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 M Ω
Input resistance:
0.1 V, 1 V, 10 V ranges: Selectable 10 M Ω or 10 G Ω
100 V, 300 V ranges: 10 M Ω $\pm$ 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 k Ω per lead on all other ranges
Input protection: 300 V on all ranges

DC Current

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 k Ω 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 μ 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.

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." 100 mV to 300 V
Input HI to Input LO:	
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 $\pm 1^\circ\text{C}$ and <10 minutes

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

AC Specifications

AC Accuracy $\pm$ (% of reading + % of range)

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

DC Operating Characteristics

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

Function	Digits	Reading/s	Additional Noise Error
DCV, DCI and Ohms	6.5	0.6 (0.5)	0% of range
DCV, DCI and Ohms	6.5	6 (5)	0% of range
DCV, DCI and Ohms	5.5	60 (50)	0.001% of range*
DCV, DCI and Ohms	5.5	300	0.001% of range*
DCV, DCI and Ohms	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, 20 μA for DC current, or 20 m Ω for resistance.

Settling Considerations	Reading settling times are affected by source impedance, cable dielectric characteristics, and input signal changes.
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Measurement Considerations	HP recommends the use of Teflon® or other high impedance, low-dielectric absorption wire insulation for these measurements.
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Teflon is a register trademark of E.I. duPont deNemours and Co.

AC Summary

AC Voltage	300 V max.
Voltage Accuracy	$\pm 0.07\%$

True RMS AC voltage

Range	Frequency	24 Hour 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
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	0.60+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

Range	Frequency	24 Hour 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
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) $\times$ 3.

(5) 300 VAC range limited to 50 kHz. For frequencies >50 kHz, signals must be $\leq 1.5 \times 10^7$ VHz.

Additional AC Specifications

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

AC voltage: 300 V
Voltage accuracy (AC): $\pm 0.07\%$

Noise Rejection

(For 1 k Ω 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 M Ω $\pm 2\%$, 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 HP-IB: 50/sec

Max. internal trigger rate: 50/s

Max. external trigger rate to memory: 50/s

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 $\pm$ 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 ⁽²⁵⁾	100 mV to 300 V	3 Hz-5 Hz	0.10	0.10	0.10	0.005
Frequency, Period ⁽²⁵⁾	100 mV to 300 V	5 Hz-10 Hz	0.05	0.05	0.06	0.005
Frequency, Period ⁽²⁵⁾	100 mV to 300 V	10 Hz-40 Hz	0.03	0.03	0.03	0.001
Frequency, Period ⁽²⁵⁾	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.

Additional Low-Frequency Errors (% of reading)

Input > 100 mV. For mV input, multiply % of reading error $\times$ 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

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

General Characteristics

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

General

Functions

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

VXI Characteristics

VXI device type:	Message-based
Data transfer bus:	A16
Size:	C
Slots:	1
Connectors:	P1/2
Shared memory:	n/a
VXI busses:	n/a
C-size compatibility:	Yes

Instrument Drivers

See the HP Website (http://www.hp.com/go/instrument_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
HP VEE Drivers:	n/a
VXIplug&play Win Framework:	Yes
VXIplug&play Win95/NT Framework:	Yes
VXIplug&play HP-UX Framework:	Yes

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 H₂O:	0.05
Air Flow liter/s:	0.80

Ordering Information

Description	Product No.
6 ½ Digit Multimeter; High Accuracy	HP E1412A
Mil std 45662A calibration w/ test data	HP E1412A 1BP
3 yr. retn. to HP to 1 yr. OnSite warr.	HP E1412A W01

Data Subject to Change
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Hewlett Packard Co.
HP Publication No.: 5965-5563E