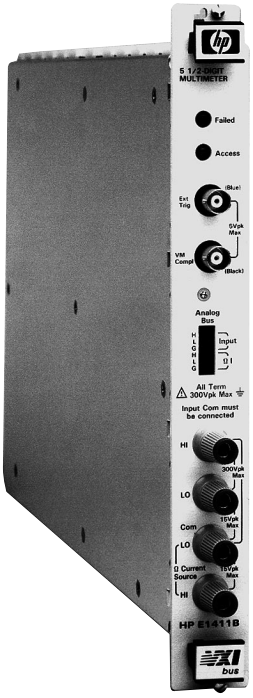
5.5 Digit Multimeter Hi-Accuracy, C-Size
HP E1411B

Technical Specifications

- **DCV, ACV, 2- & 4-Wire Ohm, Temperature**
- **5.5-digit low-noise integrating A/D**
- **13 kHz High-speed sampling A/D**
- **Balanced differential isolated inputs**
- **Software calibration**



Description

The HP E1411B 5.5-Digit Multimeter is a **C-size, 1-slot, register-based VXI module.** It is identical in electrical design to the HP E1326B, differing only in size. You can use the integrating A/D to make 5.5-digit, low-noise measurements, or switch to the sampling A/D to make 14-bit readings at rates up to 13 kHz.

When combined with any HP VXI relay or FET multiplexer, you can create a multichannel scanning multimeter. For example, by sending just one SCPI command to the HP E1406A, you can program the multimeter and the channels of your multiplexers all at one time. The HP E1411B provides flexible triggering with built-in timer pacer, also.

Product functions for this DMM include Vdc/ac, 2- & 4-Wire Ohm, offset-compensated Ohm, thermocouples, thermistors, and RTDs. This autoranging DMM is especially well suited for data acquisition and computer-aided test applications.

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

Specifications

Max. reading rate: 13 K

Reading Rate

Auto zero off, fixed range, default trigger delay, offset comp off, Sample Source "TIMER" for rates >15 readings/s.

Typical Reading Rates (rdgs/s)

	Aperture						
	320 ms	**267 ms**	**20 ms**	**16.7 ms**	**2.5 ms**	**100 µs**	**10 µs**
DC voltage:	3	3.5	49	59	365	3125	13000
Four-wire resistance:	3	3.5	49	59	365	3125	13000
AC voltage:	1.3	1.4	1.9	1.9	1.9	1.9	1.9

Resolution (bits/digits)

	Aperture						
	320 ms	**267 ms**	**20 ms**	**16.7 ms**	**2.5 ms**	**100 µs**	**10 µs**
Binary bits:	± 22	± 22	± 20	± 20	± 18	± 15	± 14
Decimal digits:	6.5	6.5	6	6	5.5	4.5	4

Noise Rejection (dB)

Noise Rejection Conditions: CMR measured with 1 kΩ in both HIGH and LOW leads with a 10% imbalance, LOW connected to COMMON at source, measured with respect to earth ground. NMR is for specified frequencies ±0.1%.

DC Voltage & Resistance

		Aperture						
		320 ms	**267 ms**	**20 ms**	**16.7 ms**	**2.5 ms**	**100 µs**	**10 µs**
DC	Common mode rejection	150 dB	150 dB	150 dB	150 dB	150 dB	150 dB	150 dB
50 Hz	Power line cycles (NPLCs)	16	—	1	—	—	—	—
	Normal mode (50 Hz) rejection	84 dB	0 dB	60 dB	0 dB	0 dB	0 dB	0 dB
60 Hz	Power line cycles (NPLCs)	—	16	—	1	—	—	—
	Normal mode (60 Hz) rejection	0 dB	84 dB	0 dB	60 dB	0 dB	0 dB	0 dB
400 Hz	Power line cycles (NPLCs)	128	—	8	—	1	—	—
	Normal mode (400 Hz) rejection	84 dB	0 dB	84 dB	0 dB	60 dB	0 dB	0 dB
AC Voltage								
DC to 400 Hz	Common mode rejection	110 dB	110 dB	110 dB	110 dB	110 dB	110 dB	110 dB

DC Voltage

Accuracy Conditions: Auto zero on, one hour warmup. Temperature within ±5 °C of calibration temperature (module calibrated at 18-28 °C).

Range	**Input Resistance**	**Resolution vs Aperture (Volts)**		**90-Day Accuracy vs Aperture ± (% of Reading Volts)**	
		20/16.7 ms	**10 µs**	**20/16.7 ms**	**10 µs**
125 mV	>100 MΩ	120 nV	7.6 µV	0.023% + 5 µV	0.115% +60 µV
1 V	>100 MΩ	1.0 µV	61 µV	0.013% + 15 µV	0.1% + 200 µV
8 V	>100 MΩ	7.6 µV	488 µV	0.01% + 50 µV	0.1% + 1.5 mV
64 V	10 MΩ ± 5%	61 µV	3.9 mV	0.015% + 1 mV	0.1% + 20 mV
300 V	10 MΩ ± 5%	488 µV	31 mV	0.015% + 5 mV	0.1% + 80 mV

DC voltage: 300 V
Voltage accuracy (DC): 0.0145%

Four Wire Resistance

Accuracy Conditions: Auto zero on, one hour warmup. Temperature within ± 5 °C of calibration temperature (module calibrated at 18-28 °C).

Range	**Source Current**	**Maximum Open Circuit Voltage**	**Resolution vs Aperture (µ)**		**90-Day Accuracy vs Aperture ± (% of Reading W)**	
			20/16.7 ms	**10 µs**	**20/16.7 ms**	**10 µs**
256 Ω	488 µA	11.5 V	250 µΩ	15 mΩ	0.035% + 10 mΩ	0.12% + 50 mΩ
2 kΩ	488 µA	11.5 V	2 mΩ	125 mΩ	0.025% + 20 mΩ	0.1% + 200 mΩ
16 kΩ	61 µA	11.5 V	15 mΩ	1 Ω	0.025% + 200 mΩ	0.1% + 2 Ω
131 kΩ	61 µA	11.5 V	125 mΩ	8 Ω	0.025% + 1 Ω	0.1% + 16 Ω
1 MΩ	7.6 µA	11.5 V	1 Ω	64 Ω	0.015% + 10 Ω	0.1% + 120 Ω

2/4-wire Ω: 1 MΩ

True RMS AC Voltage (AC coupled)

Crest Factor: 7 at 10% full scale; 1.5 at full scale.Accuracy Conditions: Sine wave inputs >10% of full scale. DC component <10% of AC component. Auto-zero on, 1 hour warmup. Temperature within ± 5 °C of calibration temperature (module calibrated at 18-28 °C).

Range (RMS)	Input Impedance	Frequency	Resolution vs Aperture (Volts)		90-Day Accuracy vs Aperture ± (% of Reading + Volts)	
			320/267 ms	10 μs	320/267 ms	All other apertures
87.5 mV	>100 MΩ, <100 pF	20-50 Hz	30 nV	7.6 μV	2.175% + 200 μV	2.175% + 1 mV
		50 Hz-1 kHz			0.675% + 200 μV	0.675% + 200 μV
		1-5 kHz			0.675% + 200 μV	0.675% + 200 μV
		5-10 kHz			3.175% + 200 μV	3.175% + 200 μV
700 mV	>100 MΩ, <100 pF	20-50 Hz	0.24 μV	61 μV	2.125% + 1.5 mV	2.125% + 8 mV
		50 Hz-1 kHz			0.625% + 1.5 mV	0.625% + 1.5 mV
		1-5 kHz			0.625% + 1.5 mV	0.625% + 1.5 mV
		5-10 kHz			3.125% + 1.5 mV	3.125% + 1.5 mV
5.6 V	>100 MΩ, <100 pF	20-50 Hz	2.0 μV	488 μV	2.125% + 15 mV	2.125% + 80 mV
		50 Hz-1 kHz			0.625% + 15 mV	0.625% + 15 mV
		1-5 kHz			1.125% + 15 mV	1.125% + 15 mV
		5-10 kHz			10.125% + 15 mV	10.125% + 15 mV
44.8 V	10 MΩ ± 5%, <100 pF	20-50 Hz	15 μV	3.9 mV	2.125% + 100 mV	2.125% + 500 mV
		50 Hz-1 kHz			0.625% + 100 mV	0.625% + 100 mV
		1-5 kHz			1.125% + 100 mV	1.125% + 100 mV
		5-10 kHz			10.125% + 100 mV	10.125% + 100 mV
300 V	10 MΩ ± 5%, <100 pF	20-50 Hz	122 μV	31 mV	2.125% + 500 mV	2.125% + 2.5 V
		50 Hz-1 kHz			0.625% + 500 mV	0.625% + 500 mV
		1-5 kHz			1.125% + 500 mV	1.125% + 500 mV
		5-10 kHz			10.125% + 500 mV	10.125% + 500 mV

AC voltage: 300 V
Voltage accuracy (AC): 0.84%

Timing/Synchronization

Timer/pacer:
- **Timer range:** 76 μs to 65.5 ms
- **Resolution:** 2 μs

Programmable delay:
- **Delay range:** 40 μs to 16 s
- **Resolution:** 2 μs

External trigger:
- **Minimum pulse width:** 100 ns
- **Maximum trigger rate:** 5 kHz *(Trigger Condition, negative edge; Fixed range, 10 μs aperture)*

Isolation 450 Vpk between any terminal and chassis.

DC Voltage Accuracy with Relay Multiplexers

Range	20/16.7 ms	10 μs	20/16.7 ms	10 μs
125 mV	0.023% + 9 μV	0.115% + 64 μV	0.023% + 55 μV	0.115% + 110 μV
1 V	0.013% + 19 μV	0.1% + 204 μV	0.013% + 65 μV	0.1% + 250 μV
8 V	0.01% +54 μV	0.1% + 1.5 mV	0.01% + 100 μV	0.1% + 1.55 mV
64 V	0.015% + 1 mV	0.1% + 20 mV	0.015% + 1.05 mV	0.1% + 20 mV
300 V	0.015% + 5 mV	0.1% + 80 mV	0.015% + 5.05 mV	0.1% + 80 mV

Accuracy Conditions: Auto zero on, one hour warmup. Temperature within ± 5 °C of calibration temperature (module calibrated at 18-28 °C).

True RMS AC Voltage (AC coupled) with Relay Multiplexers

1-5 kHz and 5-10 kHz frequencies (all apertures) when using Relay Multiplexers (HP E1343A, E1345A, E1346A, or E1347A). Add 0.2% to the AC Voltage specifications.

Strain Measurements with Strain Relay Multiplexers

With the HP E1355A, E1356A, E1357A, and E1358A, relay and FET strain multiplexer cards. All measurements are made using the MEAS command. Note: The HP E1406A command module and embedded controllers provide units conversion; if the E1411B is register programmed, your program must make the units conversion.

Vs = 5 V Power Supply / Gage Factor = 2

		18-20 °C		Temp. Coefficient	
		με	%e	με	%e
Relays	Quarter	20.8	.023	1.96	0.006
	Half	2.92	.023	0.23	0.006
	Full	0.834	.023	0.053	0.006
Fets	Quarter	26.3	.023	3.98	0.006
	Half	5.63	.023	1.24	0.006
	Full	2.19	.023	0.557	0.006

Vs = 1 V Power Supply / Gage Factor = 2

		18-20 °C		Temp. Coefficient	
		με	%e	με	%e
Relays	Quarter	25.8	0.023	1.96	0.006
	Half	5.39	0.023	0.23	0.006
	Full	2.07	0.023	0.053	0.006
Relays	Quarter	52.9	0.023	12.0	0.006
	Half	18.9	0.023	5.27	0.006
	Full	8.85	0.023	2.57	0.006

Vs = 0.1 V Power Supply / Gage Factor = 2

		18-20 °C		Temp. Coefficient	
		με	%e	με	%e
Relays	Quarter	81.3	0.023	1.96	0.006
	Half	33.2	0.023	0.23	0.006
	Full	16	0.023	0.053	0.006
Relays	Quarter	353	0.023	103	0.006
	Half	169	0.023	50.7	0.006
	Full	83.8	0.023	25.3	0.006

Temperature

The temperature accuracy graphs (below) include instrument and firmware linearization errors. The linearization algorithm used is based on the IPTS-68(78) standard transducer curves. Add your transducer accuracy to determine total measurement error.

Note: *The HP E1406A command modules and HP Embedded VXI controllers provide units conversion; if the HP E1411B is register-programmed, your program must make the neccessary units conversion.*

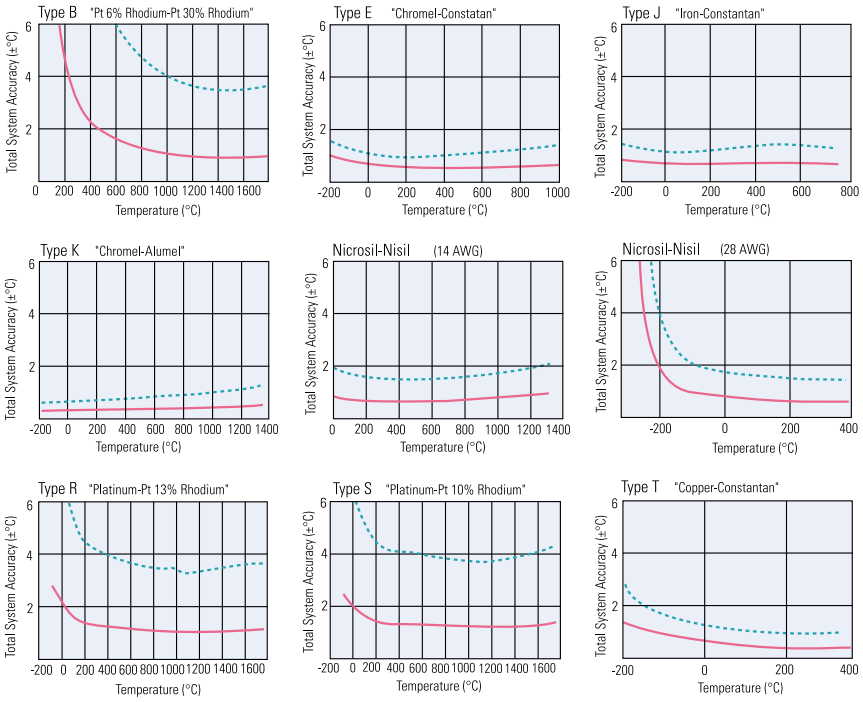
Four Wire Resistance with Relay Multiplexers

Accuracy Conditions: Auto zero on, one hour warmup, temperature within ±5 °C of calibration temperature (module calibrated at 18-28 °C).

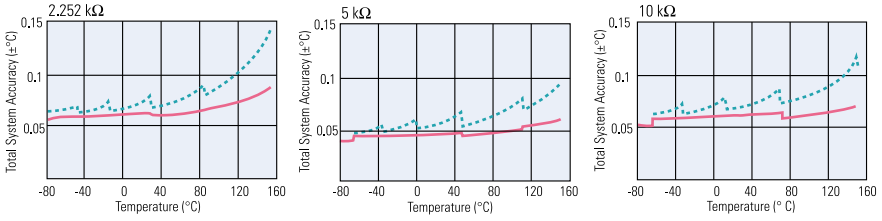
Note: *With offset compensation on, accuracy is the same as for the voltmeter above.*

Range	20/16.7 ms	10 μs
256 Ω	0.035% + 18.2 mΩ	0.12% + 58.2 mΩ
2 kΩ	0.025% + 28.2 mΩ	0.1% + 208 mΩ
16 kΩ	0.025% + 266 mΩ	0.1% + 2.1 Ω
131 kΩ	0.025% + 1.1 Ω	0.1% + 16.1 Ω
1 MΩ	0.025% + 10.5 Ω	0.1% + 121 Ω

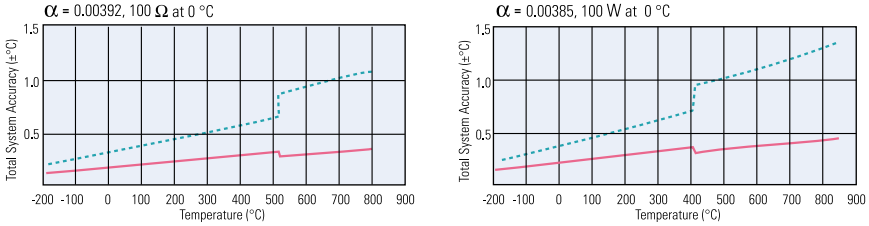
Thermocouple
(E1411B Multimeters and
HP E1345A/E1347A/E1476A TC MUX):
16 ms aperture (1 PLC):
---
100 us aperture:
.....



Thermistors
(HP E1411 B Multimeters
and HP E1345A/E1347A/E1476 A MUXs)
4-wire Ω:
16 ms aperture (1 PLC):
---
100 us aperture:
.....



RTDs
(HP E1411 B Multimeters
and HP E1345A/E1476 A MUXs)
4-wire Ω:
16 ms aperture (1 PLC):
---
100 us aperture:
.....



General Functions

Idc:	—
Iac:	—
Frequency:	—
Period:	—
Temp.:	Tm Tc RTD

VXI Characteristics

VXI device type:	Message-based
Data transfer bus:	Not Specified
Size:	C
Slots:	1
Connectors:	P1/2
Shared memory:	Yes, Shared memory available with HP E1406A/ E1306A/E1300A/01A SCPI driver
VXI busses:	TTL Trigger Bus
C-size compatibility:	Yes

Instrument Drivers

See the HP Website (http://www.hp.com/go/inst__ drivers) for driver availability and downloading.

Command module firmware:	ROM
Command module firmware rev:	A.02
I-SCPI Win 3.1:	Yes
I-SCPI Series 700:	Yes
C-SCPI LynxOS:	Yes
C-SCPI Series 700:	Yes
HP VEE Drivers:	Yes
VXI*plug&play* Win Framework:	Yes
VXI*plug&play* Win95/NT Framework:	Yes
VXI*plug&play* HP-UX Framework:	No (not available at time of publication)

Module Current

	I_{PM}	I_{DM}
+5 V:	0.2	0.01
+12 V:	0.55	0.01
−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:	8.50
ΔP mm H_2O:	0.14
Air Flow liter/s:	0.71

Ordering Information

Description	Product No.
5 ½ Digit Multimeter, High Accuracy	HP E1411B
Service manual	HP E1411B 0B3
Mil std 45662A calibration w/ test data	HP E1411B 1BP
Japan - Japanese localization	HP E1411B ABJ
3 yr. retn. to HP to 1 yr. OnSite warr.	HP E1411B W01

HP Publication No.: 5965-5562E