Scanning A/D Converter HP E1413C

Technical Specifications

- **Multi-function measurement capability**
- **Sample/Hold, Transient Strain**
- **On-board averaging and hi/lo limit checking**
- **Auto-sequenced scan lists—easier multi-rate scanning**
- **Engineering units conversion at full speed**

Description

The HP E1413C 64-Channel Scanning A/D is a **C-size, 1-slot register-based VXI module.** It is designed for high-performance data-acquisition and computer-aided test applications. The key requirements of these applications are high-speed scanning, 16-bit resolution, high accuracy (0.01% of reading), 4 mV to 16 V full-scale input (60V with E1513A attenuator SCP), 64 kSa dual-ported FIFO buffer for fast data transfers, current value buffer for on-line monitoring, and automatic self-calibration. A functionally identical B-size version of the E1413C is available, the 32-Channel, 3-slot HP E1313A (not adaptable to C-size). It can be upgraded to 64 channels with an option adding another VXI slot.

The unique design of the analog sub-system provides a new level of density by combining a 16-bit A/D with a 64-channel differential FET multiplexer. Up to eight Signal Conditioning Plug-ons (SCPs)—most with eight channels each—can be added to the HP E1413B/C to provide additional capabilities (i.e., direct input (>100 kHz BW), 10 Hz low-pass filtering, fixed gain/filter per channel, etc.).

A C-size configuration using MXIbus allows you to link together multiple mainframes on a single backplane for larger scanning A/D systems. Twelve HP E1413C modules may be used in an HP E1401A 13-slot, C-size mainframe for a total of 768 channels.This module provides multi-function measurement capability within individual scans without any configuration re-programming. These include DC voltage, temperature, resistance, and strain.

Refer to the HP Website for instrument driver availability and downloading instructions.

Compact Packaging with Signal Conditioning

More specifically the capabilities of the HP E1413C with SCPs are:

- HP E1501A direct input (>100 kHz BW)
- HP E1502A 10 Hz low-pass filtering
- HP E1503A programmable gain/filter per channel
- HP E1504A breadboard
- HP E1505A current sources for resistance and temperature
- HP E1506A, E1507A, E1510A, E1511A bridge completion and excitation for strain, sample and hold (E1510A/11A)
- HP E1508A, E1509A fixed gain and filter per channel
- HP E1512A 25 Hz low-pass filtering
- HP E1513A attenuator input for signals up to 60 VDC
- HP E1514A, E1515A isolated x1 low-pass filter
- HP E1516A, E1517A isolated gain/filter inputs

The on-board calibration reference is automatically routed to the input of the signal conditioning during the calibration cycle, thus eliminating the need to remove the module for calibration.

Flexible Scanning

Channel scans can be made in any order using any function on any channel—all at full speed, including autoranging. Up to four unique scan lists, each with up to 1,024 channel entries, can be stored in RAM and selected on the fly with a single software command. In addition, these scan lists can be automatically sequenced with a unique auto sequencing scan list. Lists can be sequenced so as to simplify the scanning of channels at different rates.

High-Speed Data Transfers and Memory

Data transfer speed has been greatly improved because multiple HP E1413Cs can scan in parallel at full speed and then sequentially transfer data over the VXI backplane in D16 or D32 format at rates that match even the fastest embedded VXI computer. And the data is transferred in computer-ready, IEEE-754, 32-bit floating-point real Engineering Unit format. Two on-board RAMs facilitate overall performance. The FIFO RAM is a dual-ported high-speed buffer that stores up to 64,000 samples until the controller is ready for efficient fast data transfer. For on-line monitoring, the Current Value Table RAM contains the most recently measured values for each channel in use. The CVT and FIFO RAMs can be accessed asynchronously.

Data Averaging

Averaging can be enabled on a scan basis to provide averaging for each channel over 2 to 256 samples in binary steps. The averaged data goes to both the CVT and the FIFO buffer. The maximum sample rate is >1 kSa/s per channel for 64 channels, although higher rates are possible with fewer channels. When averaging multiple channels in a scan list, scan list switching and autoranging are not allowed, this would distort the average.

Per Channel Limits with Interrupt

Individual high and low limits per channel can be downloaded to the E1413C in engineering units format. If a limit is exceeded, an interrupt or trigger line can be pulled and the limit register can be read to determine the out-of-limit channel. A cumulative mode can be selected that holds the channel number of any out-of-limit reading since the last INIT command. The FIFO buffer can then be read to determine the actual out-of-limit readings.

Signal Digitizing

The HP E1413C is suitable for digitizing of multi-channel transient signals up to a 1 KHz sampling rate when used with the HP E1510A Sample/Hold SCP anti-aliasing filters. Digitizing higher frequency signals using the HP E1501A Direct Input SCP will require the use of external anti-aliasing filters. The scan trigger, either internally or externally generated, is used to initiate the channel samples controlled by the internal sample timer. The typical scan trigger jitter time is ±100 ps.

Comparison to HP E1413B

The HP E1413C uses the new HP QUIC terminal blocks for more choice of input connection methods. Although there is a mechanical difference, in all other respects the HP E1413C is functionally identical to the HP E1413B which will continue to be available for installations where mechanical consistency is necessary. Contact HP for information about an upgrade kit to convert to the new mechanical style.

Summary Specifications

The following specifications include the SCP and scanning A/D performance together as a unit. Accuracy is stated for a single sample, averaging multiple samples will improve accuracy by reducing noise of the signal. The basic E1413C scanning A/D has a full scale range of ±16 V and five autoranging gains of X1, X4, X16, X64, and X256. An SCP must be used with each eight channel input block to provide input protection and signal conditioning.

Measurement resolution: 16 bits (including sign)

Maximum reading rate: 100K samples/sec divided by the number of channels in the scan-for example: 100K/64 = 1.56K samples/sec/ch 100K/16 = 6.25K samples/sec/ch

Memory: 64 kSa

Maximum input voltage: Normal mode plus common mode

Operating: <±16 V peak

Damage level: >±42 V peak

Maximum common mode voltage:

Operating: ±16 V peak

Damamge level: >±42 V peak

SCP input impedance: >100 MOhm differential
Maximum tare cal offset:
62.5 mV range ±75% of full scale
other ranges ±25% of full scale

Jitter:

Phase jitter scan-to-scan: 80 pS RMS

Phase jitter card-to-card: 41 nS peak 12 nS RMS

Measurement accuracy: 90 days, 23 +/1 deg C (with *CAL done after 1 hr warm-up and CALZERO done within 5 min).

Note: *Beyond the 5 min. limitation and CALZERO not done, apply the following drift error:*
Drift = 10 μV/°C ÷ SCP gain, per °C change from CALZERO temperature

Using accuracy data: Below are listed data needed to calculate accuracy. Many definitions of accuracy are possible. Here we use two: 1) Single-shot, 3 sigma and 2) Worst Case. To calculate accuracy assuming temperature is held constant within ± 1 degree C of the temperature at calibration, the following formulas apply:

$$\text{Single Shot, } 3\sigma = \pm\sqrt{(GainError{-}\mu V)^2 + (OffsetError{-}\mu V)^2 + (Noise{-}3\sigma)^2}\ \mu V$$

Correcting for temperature: To calculate accuracy over temperature range outside the ±1 °C range, results after *CAL are given by replacing each of the above error terms as follows:

Replace $(GainError{-}\mu V)^2$
with $(GainError{-}\mu V)^2 + (GainTempco{-}\mu V)^2$.
Replace $(OffsetError{-}\mu V)^2$
with $(OffsetError{-}\mu V)^2 + (OffsetTempco{-}\mu V)^2$.

Specifications

Timing Signals

Timing: scan-to-scan timing and sample-to-sample timing can be set independently.

Scan triggers: can be derived from a software command or a TTL level from other VXI modules, internal timer, or external hardware. Typical latency 17.5 μs.

Synchronization: multiple HP E1413C modules can be synchronized at the same rate using the TTL trigger output from one HP E1413C module to trigger the others.

Alternate synchronization: multiple HP E1413C module can be synchronized at different integer-related rates using the scan timer/N mode and the TTL trigger output from one HP E1413C module to trigger the others.

Scan triggers:

Internal	Resolution	Trigger count
100 μsec to 6.5536 sec	100 μsec	1 to 65,535 or infinite

Sample timer:

Range	Resolution
10 μsec to 32768 msec	0.5 μsec

Note: *For detailed information on noise characteristics and reduction techniques for the HP E1413B/C, refer to the product note: HP E1413A/B/C, E1313A, and E1415A Recommended Wiring and Noise Reduction Techniques, pub. no. 5965-1653E.*

Voltage Measurements

(For autorange, add .05% of reading for input voltages > ±4 V.)

HP E1501A Direct Input SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset error	Noise 3σ	Noise* 3σ
62.5 mV	0.01%	5.3 μV	18 μV	8 μV
256 mV	0.01%	10.3 μV	45 μV	24 μV
1.0 V	0.01%	31 μV	110 μV	90 μV
4.0 V	0.01%	122 μV	450 μV	366 μV
16.0 V	0.01%	488 μV	1.8 mV	1.5 mV

****A/D filter ON (min sample period ≤ 100 Hz scanrate 64 CH)***

Normal mode rejection	Common mode rejection	Input Capacitance
0 dB	>105 dB (0 to 60 Hz)	80 pF typical

Temperature coefficients:

Gain	Offset	
10ppm/°C	(0-40°C) 0.14 μV/°C	(40-55°C) 0.38 μV/°C+ .8 μV

HP E1502A Low Pass Filter SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset error	Noise 3σ	Noise* 3σ
62.5 mV	0.01%	7.2 μV	34 μV	15 μV
256 mV	0.01%	12.2 μV	60 μV	28 μV
1.0 V	0.01%	33 μV	110 μV	92 μV
4.0 V	0.01%	122 μV	450 μV	366 μV
16.0 V	0.01%	488 μV	1.8 mV	1.5 mV

***A/D filter ON (min sample period ≤ 100 Hz scanrate 64 CH)**

Normal Mode Rejection			Common Mode Rejection	Typical	Mininum
10 Hz LP filter	10 Hz:	−6 dB	0 to 60 Hz	<108 dB	>100 dB
	50 Hz:	>23 dB			
	60 Hz:	>25 dB			

Temperature coefficients:

	Temp Range	Tempco
Gain:		10 ppm/°C
Offset:	(0-30 °C) (30-40 °C) (40-55 °C)	No additional error 0.1 μV/°C 0.27 μV/°C+2.4μV

HP E1512A Low Pass Filter SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset error	Noise 3σ	Noise* 3σ
62.5 mV	0.01%	7.2 μV	34 μV	15 μV
256 mV	0.01%	12.2 μV	60 μV	28 μV
1.0 V	0.01%	33 μV	110 μV	92 μV
4.0 V	0.01%	122 μV	450 μV	366 μV
16.0 V	0.01%	488 μV	1.8 mV	1.5 mV

***A/D filter ON (min sample period ≤ 100 Hz scanrate 64 CH)**

HP E1508A Fixed Filter/Amplifier SCP

Accuracy:
Fixed gain x16:

Range ±FS	Gain % of rdg	Offset error	Noise 3σ	Noise* 3σ
3.906 mV	0.01%	3.8 μV	3.4 μV	2.9 μV
15.63 mV	0.01%	4.2 μV	4.1 μV	3.5 μV
(at ≥ 40C)			4.4 μV	3.8 μV
62.5 mV	0.01%	4.9 μV	7.5 μV	6.3 μV
256 mV	0.01%	8.0 μV	28 μV	23 μV
1.0 V	0.01%	31 μV	113 μV	94 μV

***A/D filter ON (min sample period ≥145 μS: ≤100 Hz scanrate 64 Ch)**

HP E1509A Fixed Filter/Amplifier SCP

Accuracy:
Fixed gain x64:

Range ±FS	Gain % of rdg	Offset error	Noise 3σ	Noise* 3σ
3.906 mV	0.01%	2.3 μV	1.7 μV	1.4 μV
15.63 mV	0.01%	2.4 μV	2.2 μV	1.9 μV
(≥40 °C)			2.5 μV	2.2 μV
62.5 mV	0.01%	3.0 μV	7.0 μV	5.7 μV
256 mV	0.01%	8.0 μV	28 μV	23 μV

***A/D filter ON (min sample period ≤ 100 Hz scanrate 64 CH)**

HP E1503A Programmable Filter/Gain SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset 2 Hz	Offset 10 Hz	Offset 100 Hz
62.5 mV	0.01%	12 μV	8.8 μV	6.8 μV
256 mV	0.01%	15 μV	12.5 μV	11.2 μV
1.0 V	0.01%	33 μV	31.8 μV	31.3 μV
4.0 V	0.01%	123 μV	122 μV	122 μV
16.0 V	0.01%	488 μV	488 μV	488 μV

Range ±FS	Filt Off	Noise 3σ	Noise* 3σ
62.5 mV	6.3 μV	45 μV	26 μV
256 mV	10.8 μV	63 μV	31 μV
1.0 mV	31.2 μV	112 μV	93 μV
4.0 mV	122 μV	450 μV	366 μV
16.0 V	488 μV	1.8 mV	1.5 mV

***A/D filter ON (min sample period ≥145 μS: ≤100 Hz scanrate 64 Ch)**

Temperature coefficients:

Gain: 15ppm / °C (after *CAL)
Offset: Add tempco error plus fixed offset to above table

Temp.	Tempco	2 Hz	10 Hz	100 Hz	Filt Off
(0-30)	.16 μV/° C	0 μV	0 μV	0 μV	0 μV
(30-40)	.18 μV/° C	13 μV	9 μV	1.1 μV	0.2 μV
(40-55)	.39 μV/° C	31 μV	22 μV	6.4 μV	1.1 μV

Accuracy:
Gain of x8:

Range ±FS	Gain % of rdg	Offset 2 Hz	Offset 10 Hz	Offset 100 Hz
7.8 mV	0.01%	4.6 μV	3.6 μV	3.2 μV
31.3mV	0.01%	4.7 μV	3.8 μV	3.3 μV
125 mV	0.01%	6.0 μV	5.3 μV	5.0 μV
0.50 V	0.01%	16 μV	16 μV	16 μV
2.0 V	0.01%	61 μV	61 μV	61 μV

Range ±FS	Filt Off	Noise 3σ	Noise* 3σ
3.9 mV	3.6 μV	5.3 μV	4.5 μV
15 mV	5 μV	6.9 μV**	5.9 μV**
62 mV	14 μV	14 μV	12 μV

***A/D filter ON (min sample period ≥145 μS: ≤100 Hz scanrate 64 Ch)**
****7.4 μV and 6.3 μV when temp≥ 40 °C**

Temperature coefficients:

Gain: 15ppm/ °C (after *CAL)
Offset: add tempco error plus fixed offset to above table

Temp.	Tempco	2 Hz	10 Hz	100 Hz	Filt Off
(0-30)	.16 μV/° C	0 μV	0 μV	0 μV	0 μV
(30-40)	.18 μV/° C	13 μV	9 μV	1.1 μV	0.2 μV
(40-55)	.39 μV/° C	31 μV	22 μV	6.4 μV	1.1 μV

Accuracy:
Gain of x64:

Range ±FS	Gain % of rdg	Offset 2 Hz	Offset 10 Hz	Offset 100 Hz
3.9 mV	0.01%	2.9	2.3 μV	2.1
15 mV	0.01%	3.0	2.4 μV	2.2
62 mV	0.01%	3.5	3.0 μV	2.9
156 mV	0.01%	8.2 μ V	8.0 μV	8.0 μV

Range ±FS	Filt Off	Noise 3σ	Noise* 3σ
3.9 mV	2.1 μV	1.6 μV**	1.3 μV*
15 mV	2.2 μV	2.2 μV***	1.9 μV***
62 mV	2.9 μV	7.0 μV	5.7 μV
256 mV	8.0 μV	28 μV	23 μV

***A/D filter ON (min sample period≥145uS: ≤100 Hz scanrate 64 Ch)**
****1.9 uV and 1.7 uV for 100 Hz filter**
*****2.5 uV and 1.9 uV when temp >= 40 °C**

Temperature coefficients:

Gain: 15ppm/ (after *CAL)
Offset: Add tempco error plus fixed offset to above table

Temp.	Tempco	2 Hz	10 Hz	100 Hz	Filt Off
(0-30)	.16 μV/° C	0 μV	0 μV	0 μV	0 μV
(30-40)	.18 μV/° C	1.1 μV	0.2 μV	0.1 μV	0.1 μV
(40-55)	.39 μV/° C	6 μV	1.4 μV	0.6 μV	0.6 μV

HP E1513A Divide by 16 Attenuator SCP

Accuracy:

Range ±FS	Linearity % of rdg	Offset error	Noise 3σ	Noise* 3σ
62.5 mV**	0.02%	100 μV	700 μV	288 μV
256 mV**	0.02%	175 μV	860 μV	430 μV
1.0 (16 V)	0.02%	500 μV	1.8 mV	1.4 mV
4.0 (60 V)	0.02%	1.95 mV	7.0 mV	5.8 mV

***A/D filter ON (min sample period ≥145 μS: ≤100 Hz scanrate 64 Ch)**
****These ranges are not recommended.**

HP E1514A Isolated Fixed/Filter Amplifier SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset error	Noise mV 3σ	Noise mV*σ
16	0.015	976 μV	2.1	1.7

***Max. scan rate - 100 rdgs/s/channel**

General:

Max. input voltage	Max. common mode voltage	Input Impedance	Max. tare call offset	Measurement range
<±60VDC, 42V pAC	<±60VDC, 42V pAC	1 MΩ ± 2%	3.2213 V	0-±16V FS (DC volts)

Normal mode rejection	Common mode rejection
10 Hz: −6dB 60 Hz: > −25dB	DC @ 60 V: −105dB DC-1KHz @ 42 Vp: −100dB DC-10KHz @ 10 Vp: −80dB DC-100KHz @ 2 Vp: −65dB

HP E1515A Isolated Fixed/Filter Amplifier SCP

Accuracy:

Range ±FS	Gain % of rdg	Offset error	Noise mV 3σ	Noise mV*σ
16	0.015	976 μV	2.1	1.7

***Max. scan rate - 100 rdgs/s/channel**

General:

Max. input voltage	Max. common mode voltage	Input Impedance	Max. tare call offset	Measurement range
<±60 VDC, 42V pAC	<±60 VDC, 42V pAC	1 MΩ ± 2%	3.2213 V	0-16 V FS (DC volts)

Normal mode rejection	Common mode rejection
10 Hz: −6 dB 60 Hz: > −15 dB	DC @ 60 V: −105dB DC-1 KHz @ 42 Vp: −100dB DC-10 KHz @ 10 Vp: −80dB DC-100 KHz @ 2 Vp: −65dB

HP E1516A Isolated Fixed/Filter Amplifier SCP

Accuracy:
Gain x64:

Range ±FS	Gain % of rdg	Offset error	Noise mV 3σ	Noise mV*3σ
0.0625	0.015	3.8 μV	10	8

***Max. scan rate - 100 rdgs/s/channel**

General:
Measurement range:
DC volts: 0-±0.0625 V FS
Temperature: −200 to +1700 °C

Max. input voltage	Max. common mode voltage	Input Impedance	Max. tare call offset
<±60 VDC, 42 V peak AC	<±60 VDC, 42 V peak AC	1 MΩ±2%	0.0122 V

Normal mode rejection	Common mode rejection
10 Hz: −6 dB 60 Hz: >−25 dB	DC @ 60 V: −145 dB DC-1KHz @ 42Vp: −120dB DC-10KHz @ 10 Vp: −120 dB DC-100 KHz @ 2 Vp: −110 dB

HP E1517A Isolated Fixed/Filter Amplifier SCP

Accuracy:
Gain x64:

Range ±FS	Gain % of rdg	Offset error	Noise mV 3σ	Noise mV*3σ
0.0625	0.015	3.8 μV	1.5	10

***Max. scan rate - 100 rdgs/s/channel**

General:
Measurement range:
DC volts: 0−±0.0625 V FS
Temperature: −200 to +1700 °C

Max. input voltage	Max. common mode voltage	Input Impedance	Max. tare call offset
<±60 VDC, 42 V peak AC	<±60 VDC, 42 V peak AC	1 MΩ±2%	0.0122 V

Normal mode rejection	Common mode rejection
100 Hz: −6 dB 200 Hz: >−15 dB	DC @ 60 V: −145 dB DC -1 KHz @ 42 Vp: −105 dB DC -10 KHz @ 10 Vp: −105 dB DC -100 KHz @ 2 Vp: −105 dB

Bandwidth:
Filter Off Mode (2 pole)
The maximum bandwidth is limited to the lesser of 250 kHz or the following: X1 gain (1600/input voltage) HzX8 gain (200/input voltage) HzX64 gain (25/input voltage) Hz

Temperature Measurements

Any of the input SCPs can be used to make temperature measurements with thermocouples, thermistors, or RTDs, but the HP E1503A/E1508A/E1509A SCPs provide higher accuracy with thermocouples. One internal current source is supplied to bias the thermistor located on the terminal block and is used to establish the temperature reference. Jumpers are supplied for connecting the current source to external thermistors or RTDs. Please note, the reference thermistor cannot be read through the HP E1509A SCP. Thermistors and RTD's require an input SCP and a Current Source SCP for excitation. Engineering units conversion to degrees C are made on-card at full speed.

Temperature accuracy: (all specifications for the following were measured with the A/D Filter off.)

The thermocouple graphs following this description include the errors due to measuring the voltage output of the thermocouple, and the algorithm errors due to converting the thermocouple voltage to temperature or the Measurement/Conversion Error (MCE). To this error the Reference Junction Measurement error (RJME) must be added due to measuring the reference junction temperature with an RTD or a 5K thermistor. See the following graphs for the RTD or the 5K thermistor to determine this additional error. Also, the Isothermal Reference Gradient errors (IRGE) must be added due to gradients across the isothermal reference. If an external isothermal reference panel is used, consult the manufacturer's specifications. If HP termination blocks are used as the isothermal reference, see the notes on next page.

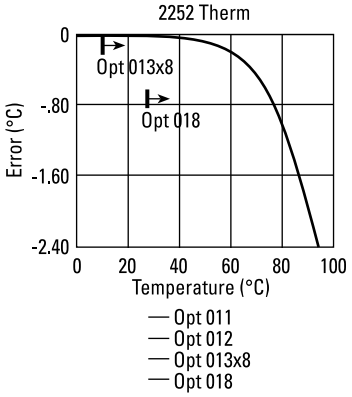
$$\textit{Total Temperature Error} = [(MCE)^2 + (RJME)^2 + (IRGE)^2]^{1/2}$$

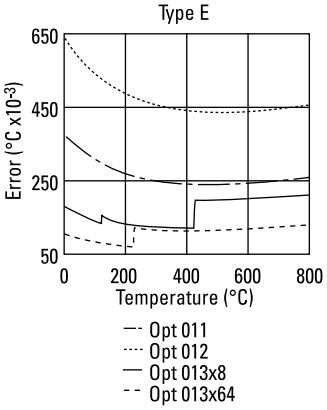
Note:

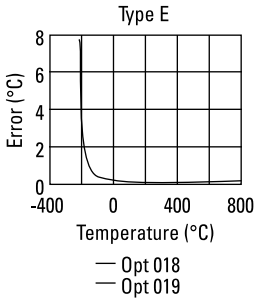
1) When using the Terminal Module as the isothermal reference, add ±0.6 °C to the thermocouple accuracy specs to account for temperature gradients across the Terminal Module. The ambient temperature of the air surrounding the Terminal Module must be within ±2 °C of the temperature of the inlet cooling air to the VXI mainframe.

2) When using the E1586A Rack Mount Terminal Panel as the isothermal reference, add ±0.2 °C to the thermocouple accuracy specs to account for temperature gradients across the E1586A. The E1586A should be mounted in the bottom part of the rack, below and away from other heat sources for best performance.

The following temperature accuracy graphs 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.

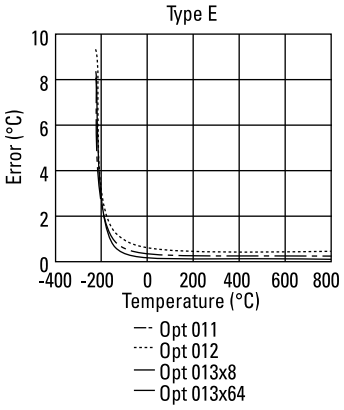


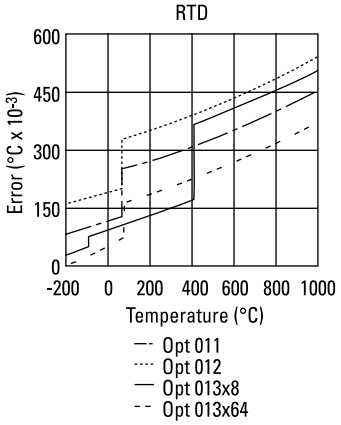


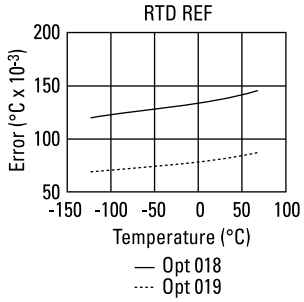


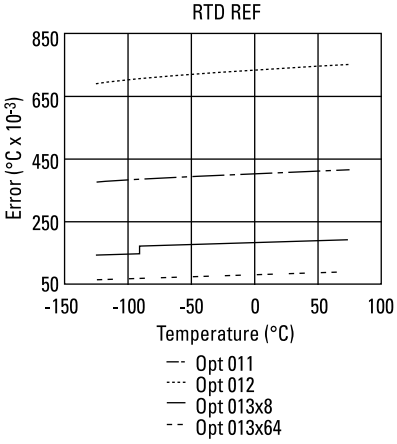
Conversion Chart

Opt 011	=	E1501A
Opt 012	=	E1502A
Opt 013	=	E1503A
Opt 014	=	E1504A
Opt 015	=	E1505A
Opt 016	=	E1506A
Opt 017	=	E1507A
Opt 018	=	E1508A
Opt 019	=	E1509A
Opt 020	=	E1510A
Opt 021	=	E1511A

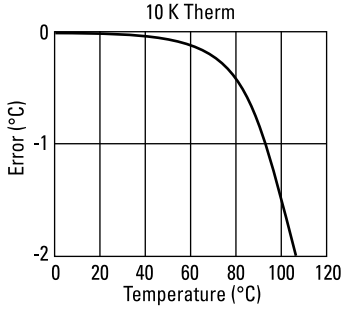






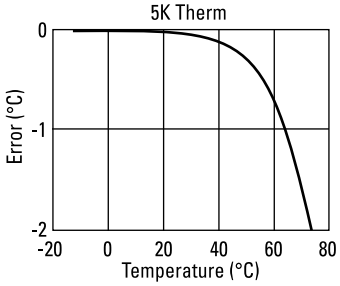


10 K Therm



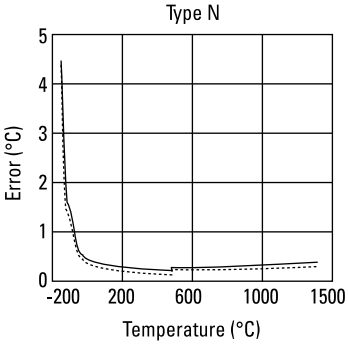
— Opt 011
— Opt 012
— Opt 013x8
— Opt 018

5K Therm



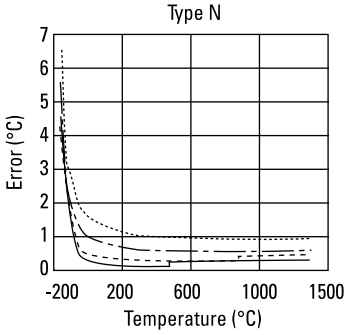
— Opt 011
— Opt 012
— Opt 013x8
— Opt 018

Type N



— Opt 018
···· Opt 019

Type N

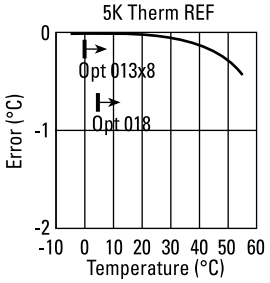


— Opt 011
···· Opt 012
— Opt 013x8
- - Opt 013x64

Conversion Chart

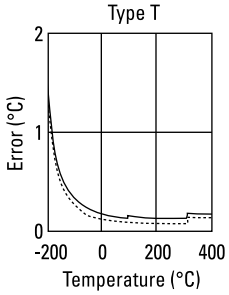
Opt 011	=	E1501A
Opt 012	=	E1502A
Opt 013	=	E1503A
Opt 014	=	E1504A
Opt 015	=	E1505A
Opt 016	=	E1506A
Opt 017	=	E1507A
Opt 018	=	E1508A
Opt 019	=	E1509A
Opt 020	=	E1510A
Opt 021	=	E1511A

5K Therm REF



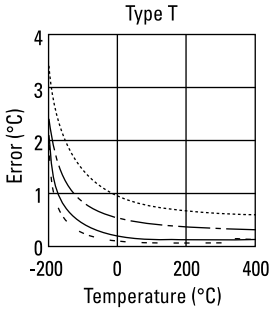
— Opt 011
— Opt 012
— Opt 013x8
— Opt 018

Type T



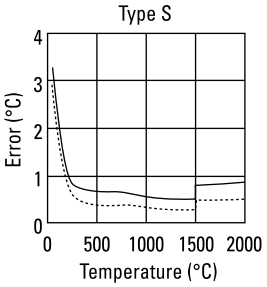
— Opt 018
···· Opt 019

Type T



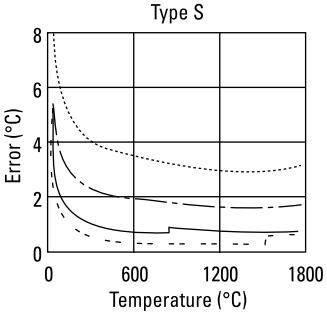
— Opt 011
···· Opt 012
— Opt 013x8
- - Opt 013x64

Type S



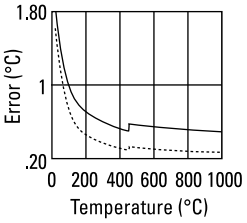
— Opt 018
···· Opt 019

Type S



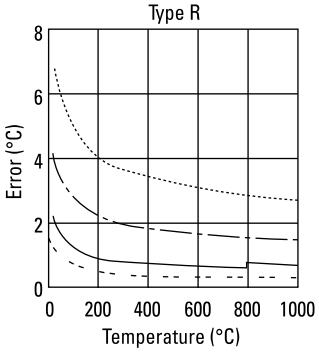
— Opt 011
···· Opt 012
— Opt 013x8
- - Opt 013x64

Type R



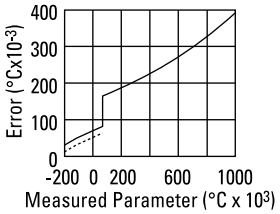
— Opt 018
···· Opt 019

Type R



— Opt 011
···· Opt 012
— Opt 013x8
- - Opt 013x64

RTD

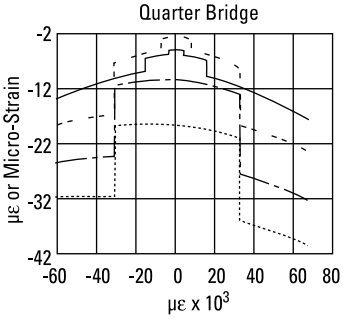


— Opt 018
···· Opt 019

Conversion Chart

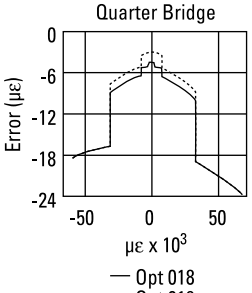
Opt 011	=	E1501A
Opt 012	=	E1502A
Opt 013	=	E1503A
Opt 014	=	E1504A
Opt 015	=	E1505A
Opt 016	=	E1506A
Opt 017	=	E1507A
Opt 018	=	E1508A
Opt 019	=	E1509A
Opt 020	=	E1510A
Opt 021	=	E1511A

Quarter Bridge



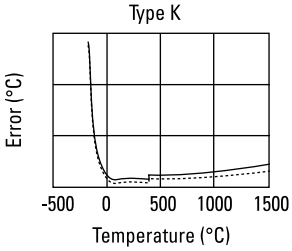
— Opt 011
···· Opt 012
— Opt 013x8
- - Opt 013x64

Quarter Bridge



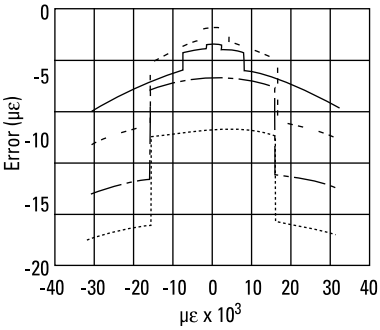
— Opt 018
···· Opt 019

Type K

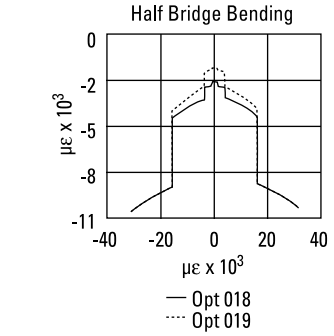


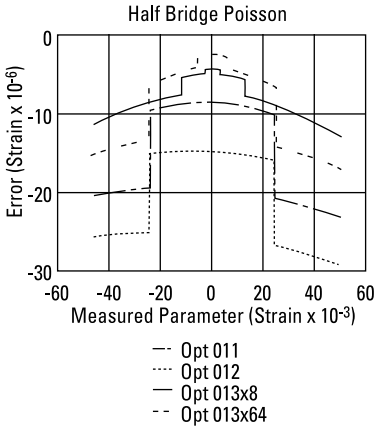
— Opt 018
···· Opt 019

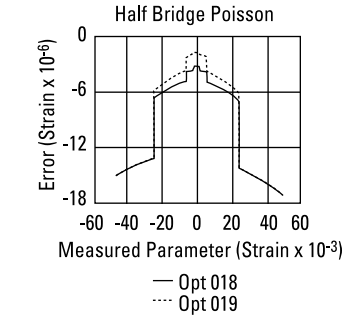
Half Bridge Bending

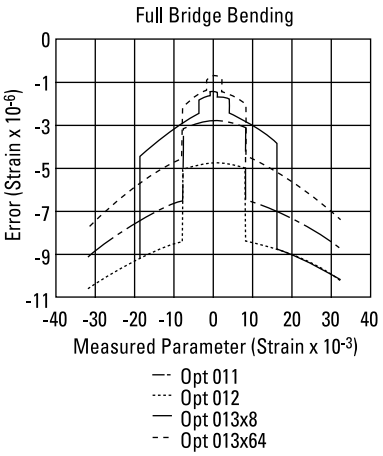


— Opt 01
···· Opt 012
— Opt 013x8
- - Opt 013x64









Reference

One of the 64 channels can be used to measure the reference, or a known reference temperature can be downloaded to the HP E1413C

Thermistors and RTDs: all require an input SCP and the HP E1505A Current Souce SCP for excitation.

Engineering units: conversion to degrees C are made on-card at full speed.

Transducer types:

Thermocouples	Thermistors	RTD's
E, E ext, J, K, N, R, S, T (linearized to ITS90 per NIST Monograph 175)	2250, 5 kΩ, 10 KΩ	100 Ω type 85 and 92

Measurement range: −200 to +1700 °C (depending on transducer type)

Accuracy: 0.003 °C to 3 °C total error (not including transducer error)

Resistance Measurements

Resistance is measured using the HP E1505A Current Source SCP. Measurements are made by applying a DC current to the unknown and measuring the voltage drop across the unknown. The current source is provided through the HP E1505A. The recommended application is as shown here using 4-wire Ω connections. Two-wire Ω measurement is possible but not recommended since two 150 Ω series resistors protecting the input FET multiplexer are included in the measurement. The HP E1505A provides eight independently programmable current sources.

HP E1505A Current Source SCP

Resistance Measurements

MIN current source	MAX current source
30.5 μA ± 9 nA	488.3 μA ± 60 nA

Range Ωs FS	Current Amplitude (μA)	A/D Range (Vdc)	Max. Resolution (Ω)
131.1 K	30.518	4	4
32.77 K	30.518	1	1
8.192 K	30.518	.25	.25
8.192 K	488.28	4	.25
2.048 K	488.28	1	.0625
512	488.28	.25	.015
128	488.28	.0625	.0039

Conversion Chart

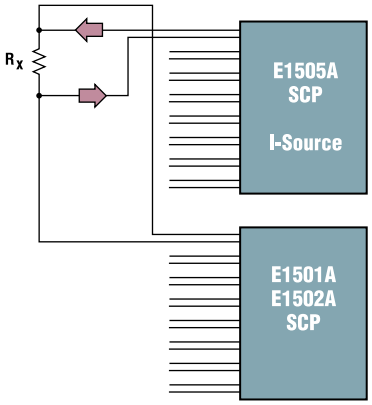
Opt 011 = E1501A
Opt 012 = E1502A
Opt 013 = E1503A
Opt 014 = E1504A
Opt 015 = E1505A
Opt 016 = E1506A
Opt 017 = E1507A
Opt 018 = E1508A
Opt 019 = E1509A
Opt 020 = E1510A
Opt 021 = E1511A

Measurment Accuracy

Accuracy:

Any input SCP/Most sensitive range: 90 days, 23 ±/1 °C (with *CAL done after 1 hr warm-up and CALZERO done within 5 min)

Accuracy with MIN Current Source=±[0.035% of rdg +0.015% of FS +(rdg/10^6)]
Accuracy with MAX Current Source=±[0.02% of rdg +0.015% of FS +(rdg/10^6)]



Resistance Measurement

Static Strain Measurements

Note: *SCPs are available for making both static (the HP E1506A and E1507A) and dynamic strain (the HP E1510A and E1511A) measurements.*

Two SCPs are required to make static strain measurements. The HP E1506A and E1507A provide excitation and bridge completion for 120 and 350 Ω gages, respectively. The second SCP makes the measurement connection, e.g., the HP E1503A, E1508A, and E1509A. The HP E1506A and E1507A provide strain excitation and completion for a total of 8 channels. Excitation can be external or internal. Excitations and completions are configured by jumpers.

HP E1506A Strain Completion/Excitation SCP

Accuracy:

Gain + offset error: 40 με
Noise error: 27 με (A/D filter off)
20 με (A/D filter off)

HP E1507A Strain Completion/Excitation SCP

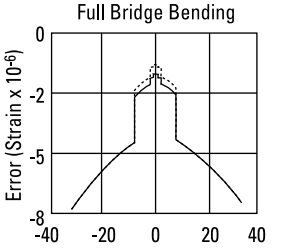
Accuracy:

Gain + offset error: 40 με
Noise error: 27 με (A/D filter off)
20 με (A/D filter off)

HP E1506A/E1507A Strain Bridge SCP: Internal excitation voltage source: 3.9 V ±512 μV. Externally supplied voltages are supported.

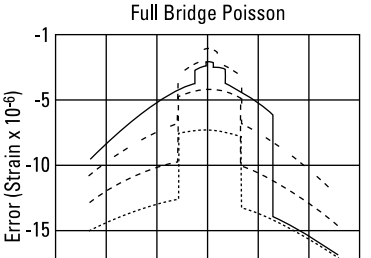
Completion resistors: HP E1506A, 120 Ω ± 0.05%. HP E1507A, 350 Ω ± 0.05%

Full Bridge Bending



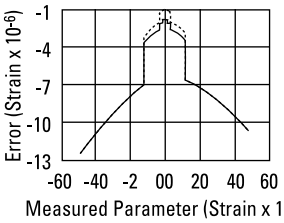
— Opt 018
···· Opt 019

Full Bridge Poisson



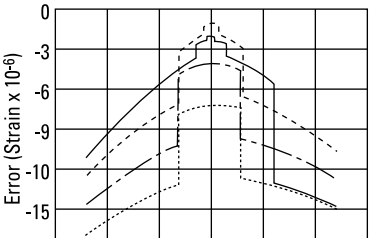
—·· Opt 011
···· Opt 012
— Opt 013x8
-- Opt 013x64

Full Bridge Bending Poisson



— Opt 018
···· Opt 019

Full Bridge Bending Poisson

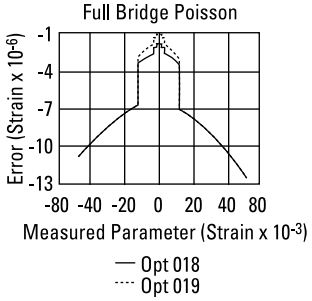


—·· Opt 011
···· Opt 012
— Opt 013x8
-- Opt 013x64

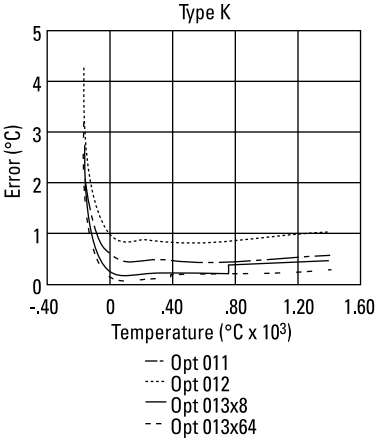
Conversion Chart

Opt 011	=	E1501A
Opt 012	=	E1502A
Opt 013	=	E1503A
Opt 014	=	E1504A
Opt 015	=	E1505A
Opt 016	=	E1506A
Opt 017	=	E1507A
Opt 018	=	E1508A
Opt 019	=	E1509A
Opt 020	=	E1510A
Opt 021	=	E1511A

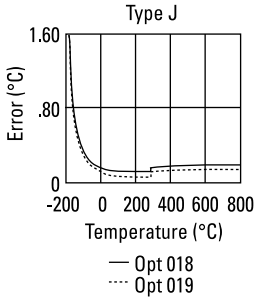
Full Bridge Poisson



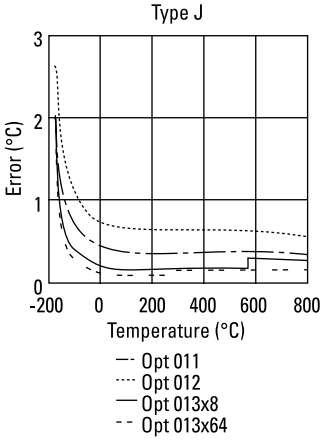
Type K



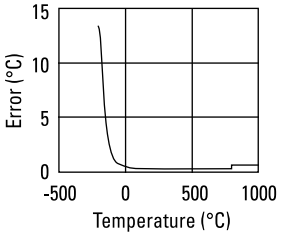
Type J



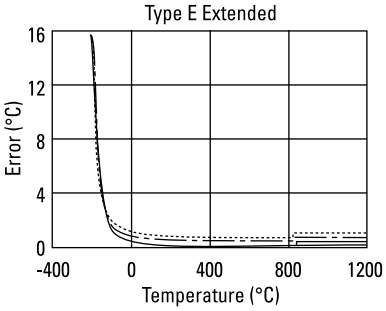
Type J



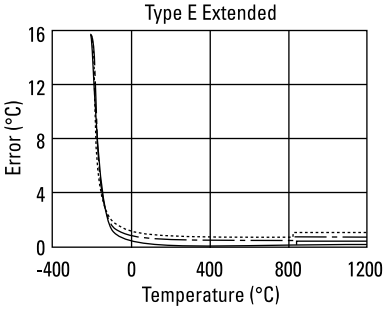
Type E Extended



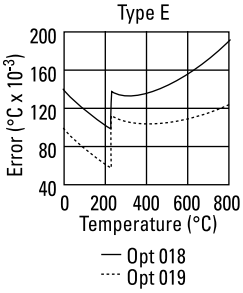
Type E Extended



Type E Extended



Type E



Conversion Chart

Opt 011	=	E1501A
Opt 012	=	E1502A
Opt 013	=	E1503A
Opt 014	=	E1504A
Opt 015	=	E1505A
Opt 016	=	E1506A
Opt 017	=	E1507A
Opt 018	=	E1508A
Opt 019	=	E1509A
Opt 020	=	E1510A
Opt 021	=	E1511A

Transient Measurements

When making higher speed measurements, a vital issue often is the time skew between channels. Ideally, in many applications, the sampled data is needed at essentially the same instant in time. While the intrinsic design of the E1413C provides scanning of 64 channels, with maximum skew of 640 μS between them, far less than most sampled data systems, this still may not be small enough skew for some applications.

Transient Voltage Measurements

The HP E1510A provides basic sample and hold capability on four channels; the other four are standard direct input connections as in the HP E1501A. 6-pole Bessel filters provide alias and alias-based noise reduction while giving excellent transient response without overshoot or ringing. The HP E1510 can be used in strain applications primarily where the bridge is external.

HP E1510A Sample/Hold SCP

Inputs: four simultaneous sample-and-hold channels with programmable gain and Bessel filters and four direct input channels per SCP. Thirty-two (32) channels of each per HP E1413C module

Range: full scale input ranges for each channel are: ±8 V; ±500 mV, ±62.5 mV; and ±7.8 mV

Gain: programmable to 0.5, 8, 16

Filters: 6-pole Bessel filters for alias and alias-based noise rejection, independently programmable 3 dB bandwidths of 1 kHz, 500 Hz, 250 Hz, 100 Hz, or 15 Hz

Usage per HP E1413C module: eight HP E1510A single wide SCPs provide up to 32 channels of signal conditioning for general sample-and-hold or strain measurements using external bridges

Usage with static strain SCPs: the HP E1510A may also be used with the existing HP E1506A and E1507A strain completion SCPs to achieve 20 channels of strain input with excitation and completion in a single HP E1413C module.

Accuracy:

Gain x0.5:

Range ±FS	% Gain error	Offset error	Noise 3σ
125 mV	0.02	488 μV	1.5 mV
0.5 V	0.02	488 μV	1.5 mV
2.0 V	0.02	488 μV	1.5 mV
8.0 V	0.02	488 μV	1.5 mV

Gain of x8:

Range ±FS	% Gain error	Offset error	Noise 3σ
7.8 mV	0.02	30.5 μV	95 μV
31.25 mV	0.02	30.5 μV	95 μV
125 mV	0.02	30.5 μV	95 μV
0.5 V	0.02	30.5 μV	95 μV

Gain of x64:

Range ±FS	% Gain error	Offset error	Noise 3σ
3.9 mV	0.02	15.0 μV	12 μV
15.6 mV	0.02	15.0 μV	12 μV
62.5 mV	0.02	15.0 μV	12 μV

Transient Strain Measurements

Strain Measurements:

The HP E1511A, a double-wide SCP, has all the capabilities of the HP E1510A but adds on-board bridge excitation and completion functions. The four direct input channels are used for monitoring the bridge excitation. A maximum of four SCP's (16 channels) can be installed on an HP E1413C. *Note:* For field wiring, the use of shielded twisted pair wiring is highly recommended.

HP E1511A Transient Strain SCP

Bridge completion: jumper selectable 120/350 Ω resistors for ¼ configuration

Programmable excitation: 10 V, 5 V, 2 V, 1 V and Off

Shunt cal: programmable: 29.4 kΩ

Accuracy:

Gain x0.5:

Range ±FS	% Gain error	Offset error	Noise 3σ
125 mV	0.02	488 μV	1.5 mV
0.5 V	0.02	488 μV	1.5 mV
2.0 V	0.02	488 μV	1.5 mV
8.0 V	0.02	488 μV	1.5 mV

Gain of x8:

Range ±FS	% Gain error	Offset error	Noise 3σ
7.8 mV	0.02	30.5 μV	95 μV
31.25 mV	0.02	30.5 μV	95 μV
125 mV	0.02	30.5 μV	95 μV
0.5 V	0.02	30.5 μV	95 μV

Gain of x64:

Range ±FS	% Gain error	Offset error	Noise 3σ
3.9 mV	0.02	15.0 μV	12 μV
15.6 mV	0.02	15.0 μV	12 μV
62.5 mV	0.02	15.0 μV	12 μV

Breadboard SCP

The HP E1504A Breadboard SCP provides six square inches of board space for user-supplied custom circuitry. Up to eight FET mux channels can be accessed. Includes +5 V and ±19 V supplies and overvoltage protection.

Additional Information:

HP pub. no.: 5962-8638

VXI Characteristics

VXI device type: Register-based

Size: C

Slots: 1

Connectors: P1/2

Shared memory: n/a

VXI busses: TTL Trigger Bus (T)

C-size compatibility: Yes

Instrument Drivers

Refer to HP's Website (http://www.hp.com/go/inst_drivers) for driver availability and downloading.

Command module firmware:	Downloadable
Command module firmware rev:	A.08
I-SCPI Win 3.1:	No
I-SCPI Series 700:	No
C-SCPI LynxOS:	Yes
C-SCPI Series 700:	Yes
HP VEE Drivers:	No
VXI*plug&play* Win Framework:	No
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:	4.6	0.02
+12 V:	1	0
−12 V:	1	0
+24 V:	0.07	0.01
−24 V:	0.1	0
−5.2 V:	0.06	0
−2 V:	0	0

Cooling/Slot

Watts/slot:	15.00
ΔP mm H_2O:	0.08
Air Flow liter/s:	0.08

Ordering Information

Description	Product No.
64-channels muxed to 16-bit 100 kHz A/D	HP E1413C
Service manual	HP E1413C 0B3
Interface to rack mount terminal panel	HP E1413C A3F
3 yr. retn. to HP to 1 yr. OnSite warr.	HP E1413C W01

HP Publication No.: 5965-5583E