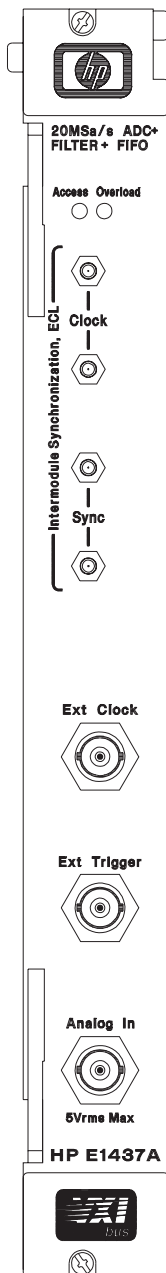


# HP E1437A

## Technical Specifications

### 20 MSample/second ADC with Filter and FIFO

Rev. June 1997



HP E1437A

Whether you analyze spectra or capture waveforms, the HP E1437A ADC will help you see signal features you may have never seen before.

#### A Remarkable Digitizer

At the heart of the HP E1437A is an exceptionally low distortion digitizer. Low distortion means high quality data will reveal even more about your signal when averaged, filtered or FFT processed.

#### Analog Signal Conditioning

You aren't restricted to operating the HP E1437A at a specific amplitude operating point thanks to built-in analog signal conditioning.

#### Digital Filtering and LO

Use the 24 real-time digital filters built-in to the HP E1437A to increase the precision of the output samples, or filter out extraneous signals.

#### FIFO Memory

The FIFO means you won't lose new samples while you are transferring a data block out.

#### VXIplug&play programming

The HP E1437A is VXIplug&play compatible and is shipped with software and documentation to support a broad set of controllers, and operating systems.

#### High Speed Data Transfers

VXI Local Bus capability means HP E1437A can output data at 40 MB/s continuously and as high as 60 MB/s when transferring blocks of data.

#### Specification Note

Specifications describe warranted performance over the temperature range of 0° to 55° C, after a 15-minute warm-up from ambient conditions and automatic calibrations enabled unless otherwise noted. Supplemental characteristics identified as "typical" or "characteristic," provide useful information by giving non-warranted performance parameters. Typical performance is applicable from 20° to 30° C.

#### Abbreviations

**dBm** = dB relative to 1 mW into 50Ω

**dBfs** = dB relative to full scale amplitude range.

**dBc** = dB relative to carrier amplitude.

Typical = typical, non-warranted, performance specification included to provide general product information.

## Input

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### Input Modes

DC coupled, AC coupled.  
Input grounded, input connected.  
Input BNC shell grounded, floating.

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### Full Scale Input Ranges

(ADC clipping levels, dBm values are approximate )

| Volts peak     | dBm, 50 $\Omega$ |
|----------------|------------------|
| <b>10.24 V</b> | 30               |
| <b>5.12 V</b>  | 24               |
| <b>2.56 V</b>  | 18               |
| <b>1.28 V</b>  | 12               |
| <b>640 mV</b>  | 6                |
| <b>320 mV</b>  | 0                |
| <b>160 mV</b>  | -6               |
| <b>80 mV</b>   | -12              |
| <b>40 mV</b>   | -18              |
| <b>20 mV</b>   | -24              |

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### Maximum Input Level

(for any time interval > 10 ms)

10 Vrms for 5.12 and 10.24 V ranges,  
5 Vrms for all other ranges

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### Return loss of 50 $\Omega$ Input Impedance

( $\pm$  1%, DC coupled, BNC shell grounded,  
frequency < 8MHz)

> 40 dB

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### AC Coupling Characteristics

(A 0.2  $\mu$ F capacitor is placed in series with the  
input signal)

0.2  $\mu$ F (typical)  
Maximum DC voltage is  $\pm$  50 V

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### Common Mode Characteristics

Shell floating impedance  
Shell grounded impedance  
Maximum Current (diode clamped to  
<  $\pm$  1 V peak)

50  $\Omega$  in parallel with 0.04  $\mu$ F (typical)  
< 0.1  $\Omega$  (typical)  
 $\pm$  1 amp peak

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### Common Mode Response

(Response to a sine wave voltage source of  
amplitude Vcom (in mV) applied through a 50  $\Omega$  series  
resistor; frequency < 8 MHz.)

| Range              | Response in dBfs               |
|--------------------|--------------------------------|
| 30 dBm to 0 dBm    | < (-90 +20 $\times$ LOG(Vcom)) |
| -6 dBm             | < (-80 +20 $\times$ LOG(Vcom)) |
| -12 dBm to -24 dBm | < (-65 +20 $\times$ LOG(Vcom)) |

## Accuracy

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### Resolution

|  |   |
|--|---|
| Raw ADC resolution                       | 23 bits, two's complement   |
| After digital zoom and filter operations | 32 bits, full resolution mode<br>16 bits, reduced resolution mode |

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### Amplitude Accuracy: (< 100 kHz, 25°C, analog alias filter on, digital decimation filters off, DC coupled)

|  |  |
|--|--|
| Absolute voltage measurement accuracy<br>12 dBm range          | ± 0.03 dB                                      |
| Range accuracy relative to 12 dBm range                        | ± 0.03 dB (for all ranges)                     |
| Alias filter off relative to alias filter on<br>mode at 12 kHz | ± 0.02 dB                                      |
| Temperature drift  | < 0.001 dB/°C (typical) of deviation from 25°C |

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### DC offset

|   |                         |
|---|-------------------------|
| Temperature drift                                     |                         |
| 30 dBm to – 6dBm ranges                               | < ± 0.01%/°C (typical)  |
| – 12 to – 24 dBm ranges                               | < ± 0.1 mV/°C (typical) |
| Input bias current (in parallel with 50 Ω input load) | < 64 μA                 |

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### Flatness (dB peak-to-peak, excluding digital filter response)

|                  |                  |
|------------------|------------------|
| Alias filter on  |                  |
| freq < 100 kHz   | < 0.03 dBpp      |
| freq < 5 MHz     | < 0.25 dBpp      |
| freq < 8 MHz     | < 0.80 dBpp      |
| Alias filter off |                  |
| freq < 8 MHz     | < 0.25 dBpp      |
| freq < 40 MHz    | 3 dBpp (typical) |

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|  |          |
|--|----------|
| <b>Anti-alias filter stopband rejection<br/>(12 MHz to 20 MHz)</b> | > 100 dB |
|--|----------|

## Dynamic Range

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**NOTE:** The performance specifications for the spurious response and discrete sidebands characteristics require that the mainframe containing the HP E1437A have Option 918 (connector shields E1400-80920) installed. In addition all modules in the mainframe must comply with the VXI 1.4 specification for ECL trigger lines; and the 10-MHz VXI system clock must be turned off. External clock input must be disconnected when not being used for ADC clock.

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### Signal to Noise Ratio

(The reference signal is a sine wave with peaks at the clipping voltage of the current range; typical values)

Alias filter on

|                         |       |
|-------------------------|-------|
| – 6 dBm to 30dBm ranges | 71 dB |
| – 12 dBm range          | 70 dB |
| – 18 dBm range          | 68 dB |
| – 24 dBm range          | 65 dB |

Alias filter off

|                         |       |
|-------------------------|-------|
| – 6 dBm to 30dBm ranges | 68 dB |
| – 12 dBm range          | 66 dB |
| – 18 dBm range          | 61 dB |
| – 24 dBm range          | 57 dB |

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### Input Noise Density (Alias filter on, Internal sample clock)

– 6 dBm to 30dBm ranges

|                   |                             |
|-------------------|-----------------------------|
| 1 MHz to 8 MHz    | – 140 dBfs/Hz               |
| 100 kHz to 1 MHz  | – 138 dBfs/Hz               |
| 10 kHz to 100 kHz | – 135 dBfs/Hz               |
| 1 kHz to 10 kHz   | – 131 dBfs/Hz               |
| 10 Hz to 1 kHz    | – 101 – 10* LOG (f) dBfs/Hz |

– 12 dBm range

|                   |                          |                          |
|-------------------|--------------------------|--------------------------|
| 1 MHz to 8 MHz    | – 139 dBfs/Hz            | – 151 dBm/Hz             |
| 100 kHz to 1 MHz  | – 137 dBfs/Hz            | – 149 dBm/Hz             |
| 10 kHz to 100 kHz | – 134 dBfs/Hz            | – 146 dBm/Hz             |
| 1 kHz to 10 kHz   | – 129 dBfs/Hz            | – 141 dBm/Hz             |
| 10 Hz to 1 kHz    | – 99 – 10*LOG(f) dBfs/Hz | – 111 – 10*LOG(f) dBm/Hz |

– 18 dBm range

|                   |                          |                          |
|-------------------|--------------------------|--------------------------|
| 1 MHz to 8 MHz    | – 137 dBfs/Hz            | – 155 dBm/Hz             |
| 100 kHz to 1 MHz  | – 135 dBfs/Hz            | – 153 dBm/Hz             |
| 10 kHz to 100 kHz | – 131 dBfs/Hz            | – 149 dBm/Hz             |
| 1 kHz to 10 kHz   | – 125 dBfs/Hz            | – 143 dBm/Hz             |
| 10 Hz to 1 kHz    | – 95 – 10*LOG(f) dBfs/Hz | – 113 – 10*LOG(f) dBm/Hz |

– 24 dBm range

|                   |                          |                          |
|-------------------|--------------------------|--------------------------|
| 1 MHz to 8 MHz    | – 134 dBfs/Hz            | – 158 dBm/Hz             |
| 100 kHz to 1 MHz  | – 132 dBfs/Hz            | – 156 dBm/Hz             |
| 10 kHz to 100 kHz | – 127 dBfs/Hz            | – 151 dBm/Hz             |
| 1 kHz to 10 kHz   | – 120 dBfs/Hz            | – 144 dBm/Hz             |
| 10 Hz to 1 kHz    | – 90 – 10*LOG(f) dBfs/Hz | – 114 – 10*LOG(f) dBm/Hz |

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**Spurious Response** (2 kHz to 8 MHz, terminated with 50 Ohm, input BNC shell grounded)

DSP clock = ADC clock, alias filter on < -110 dBfs  
DSP clock ≠ ADC clock, alias filter on < -95 dBfs  
DSP clock = ADC clock, alias filter off < -70 dBfs

---

**Phase Noise**

Phase noise density  
(Single sideband power density of a 5 MHz  
signal, vibration < 0.05G)

|                      | 20 MHz clock  | 20.48 MHz clock |
|----------------------|---------------|-----------------|
| $\Delta f = 100$ kHz | < -138 dBc/Hz | < -138 dBc/Hz   |
| $\Delta f = 1$ kHz   | < -130 dBc/Hz | < -130 dBc/Hz   |
| $\Delta f = 100$ Hz  | < -105 dBc/Hz | < -120 dBc/Hz   |

Discrete sidebands  
(100 Hz <  $\Delta f$  < 1 MHz, other modules must  
comply with VXI 1.4 specification for ECL  
trigger lines, External Clock disconnected)

Internal clock < -100 dBc

Internal clock < -80 dBc (typical)  
(distributed on backplane with CLK10  
backplane clock disabled)

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**Distortion**

Harmonic distortion products to 8 MHz < -75 dBc or < -110 dBfs  
(Includes aliased distortion components)

Intermodulation Distortion products to 8 MHz < -75 dBc or < -110 dBfs  
(two tones each at -6 dBc)

## Clock

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### Clock Input/Output Characteristics

External ADC clock input  
(AC coupled with small-signal input impedance of 100 k $\Omega$  above 10 kHz. Large signals are diode clamped through 100  $\Omega$ )

TTL, ECL, or > -6 dBm sine waves, BNC input

Intermodule Synchronization Clock/SYNC

ECL-10 K compatible, SMB

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### Clock Source Frequencies

Internal ADC clock

20 MHz or 20.48 MHz

External sample clock frequency range

DSP clock = ADC clock

2 MHz to 20.60 MHz

DSP clock  $\neq$  ADC clock

0 Hz to 20 MHz

DSP clock

Internal

20 MHz or 20.48 MHz

ADC

ADC clock must be > 2 MHz in this mode

---

### Internal Clock Characteristics

Frequency Accuracy (20 MHz or 20.48 MHz, 0°C to 40°C)

$\pm 100$  Hz

Jitter

< 5 ps rms (typical) (see phase noise specification for spectral content of jitter)

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### Sampling Skew (typical)

Within mainframe (rear clock distribution)

< 10 ns (typical)

Between mainframes (clock extended via a 1 m coaxial cable)

< 25 ns (typical)

## Trigger

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**Trigger sources** External TTL/ECL/sine wave, level, LOG(magnitude), software (via register write)

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**Slope** Positive/negative

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### Threshold

Level trigger  $V_{\text{range}} \times N/128, -128 \leq N \leq 128$ ; hysteresis is  $\frac{V_{\text{range}}}{256}$

LOG(magnitude) trigger  $V_{\text{range}} \text{ (dBm)} - N \times 0.3762574 \text{ dBm}, 0 \leq N \leq 255$ ; hysteresis is 1.5 dB

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**External trigger input** TTL/ECL/Sine wave, BNC

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### Trigger offset

Resolution (in output sample periods) 1 sample, 32-bit complex data  
2 samples, 16-bit complex or 32-bit real data  
4 samples, 16-bit real data

Maximum pre-trigger delay  $(132 - \frac{\text{dramsize}}{8}) \times \text{trigger offset resolution}$

Maximum post-trigger delay  $16,777,116 \times \text{trigger offset resolution}$

## Filtering

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$$H(f) = H_{\text{analog}}(f) \cdot H_{\text{digital}}\left(N, \frac{f - f_0}{f_s}\right)$$

where:

f = input signal frequency

f<sub>0</sub> = zoom center frequency (zero in baseband mode)

f<sub>s</sub> = ADC sampling frequency

N = Digital filter bandwidth selector; N = 0, 1, 2, 3, ..., 24

---

**Analog frequency response function** (typical), with alias filter off.

$$H_{\text{analog}} = \prod_{n=1}^5 \frac{1}{1 - jf / B_n}$$

| n | Poles, B <sub>n</sub> (MHz) |
|---|-----------------------------|
| 1 | -80.234 + j 0.0             |
| 2 | -103.94 + j 0.0             |
| 3 | -103.94 - j 0.0             |
| 4 | -72.9774 + j 49.94437       |
| 5 | -72.9774 - j 49.94437       |

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**Analog Frequency Response Function** (typical), with alias filter on.

$$H_{\text{analog}} = \prod_{n=1}^{11} \frac{1 - jf / A_n}{1 - jf / B_n}$$

| n  | Zeros, A <sub>n</sub> (MHz) | Poles, B <sub>n</sub> (MHz) |
|----|-----------------------------|-----------------------------|
| 1  | ∞                           | -3.423881 + j 0.0           |
| 2  | -0.278765 + j 37.0          | -3.122370 + j 3.010688      |
| 3  | -0.278765 - j 37.0          | -3.122370 - j 3.010688      |
| 4  | -0.085700 + j 19.5          | -2.397607 + j 5.453639      |
| 5  | -0.085700 - j 19.5          | -2.397607 - j 5.453639      |
| 6  | -0.053075 + j 14.6          | -1.579759 + j 7.117287      |
| 7  | -0.053075 - j 14.6          | -1.579759 - j 7.117287      |
| 8  | -0.042453 + j 12.6          | -0.864515 + j 8.088296      |
| 9  | -0.042453 + j 12.6          | -0.864515 + j 8.088296      |
| 10 | -0.038826 + j 11.84         | -0.271817 + j 8.524792      |
| 11 | -0.038826 - j 11.84         | -0.271817 - j 8.524792      |

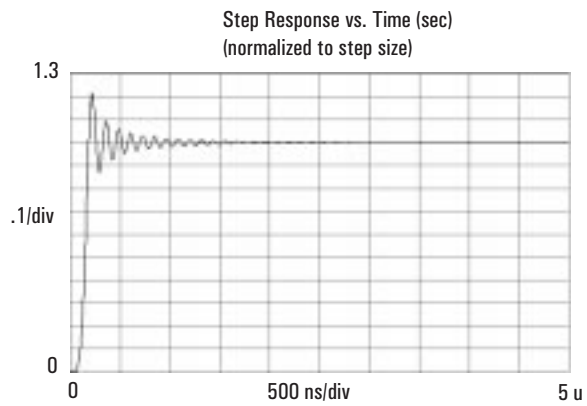
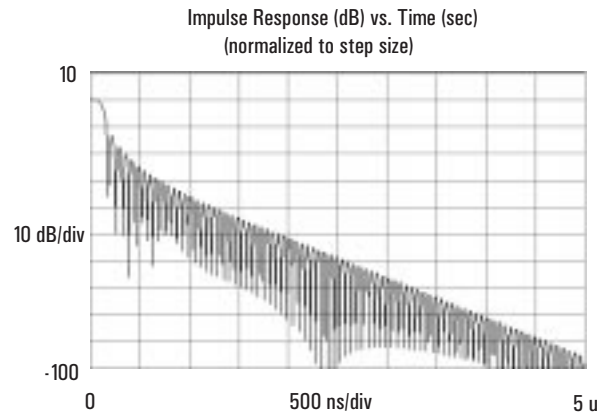
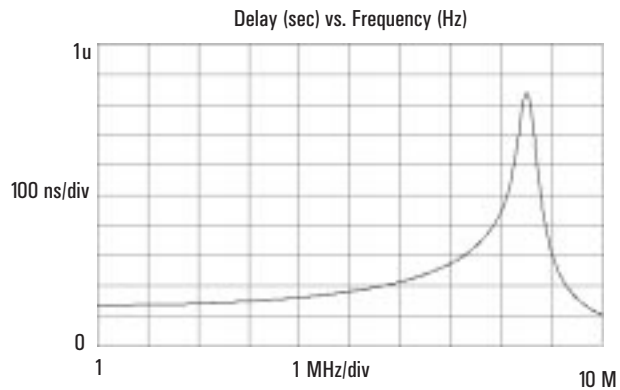
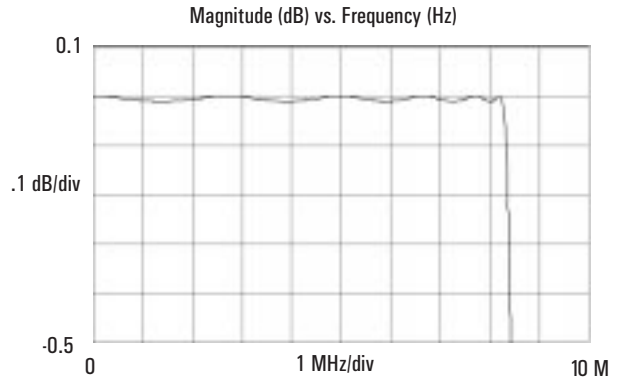
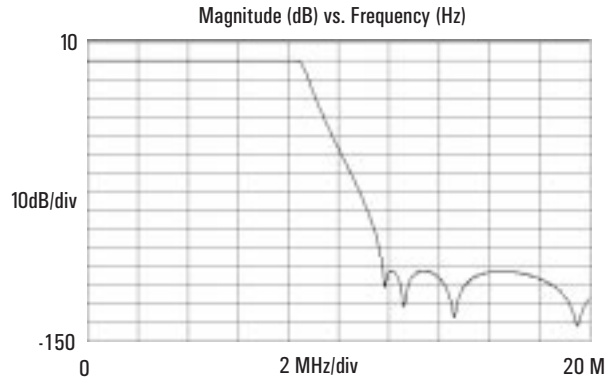


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Digital Frequency response function

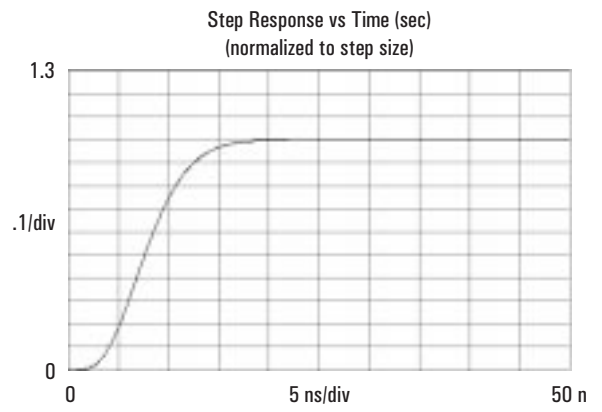
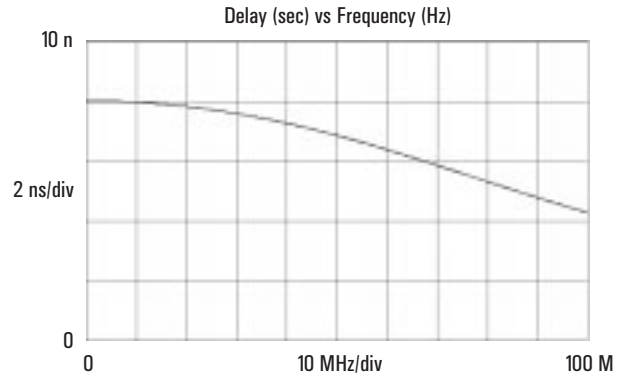
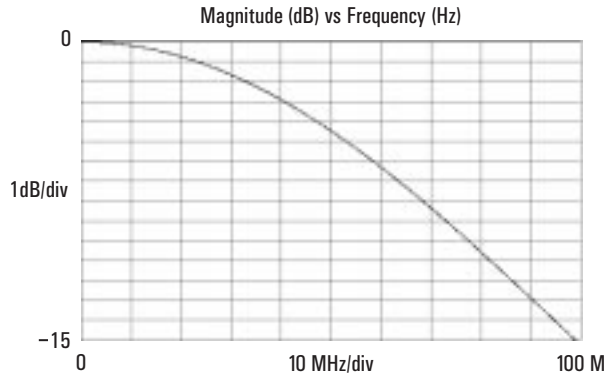
$$H_{digital}\left(N, \frac{f - f_0}{f_s}\right) = \begin{cases} 1, N = 0 \\ \prod_{n=1}^N \left( \frac{z^3 + 2z^2 + 2z + 1}{4z^3 + 2z} \right)^5 \Big|_{z = e^{j2\pi p(f-f_0)/f_s}}, N > 0 \end{cases}$$

Filter characteristics for nominal analog alias filter, N=0

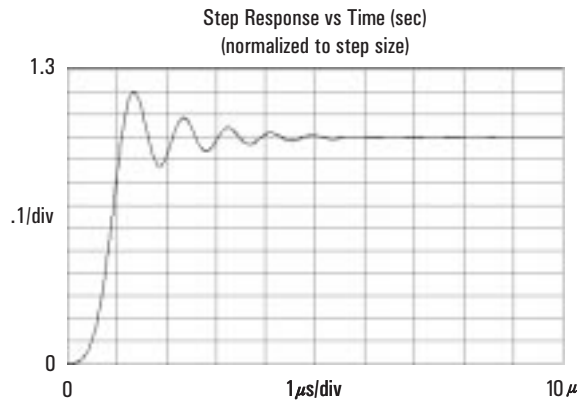
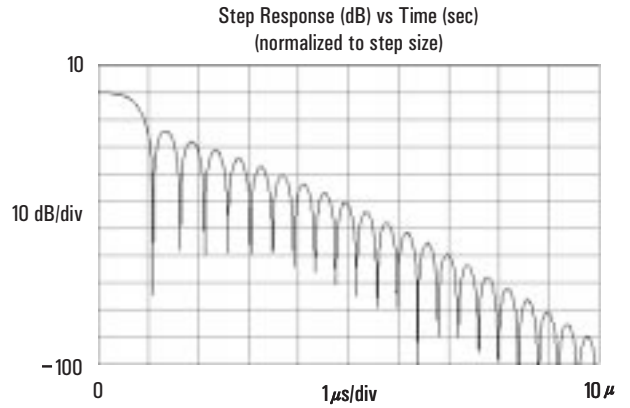
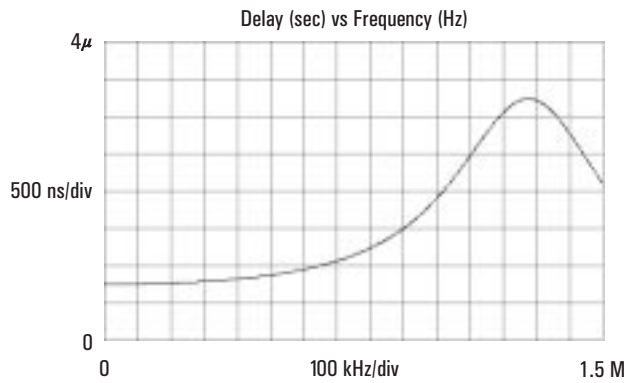
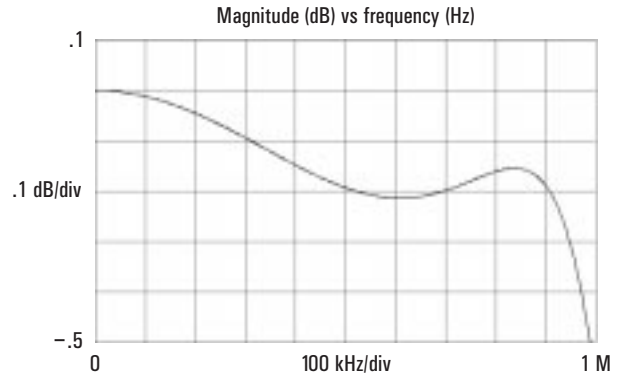
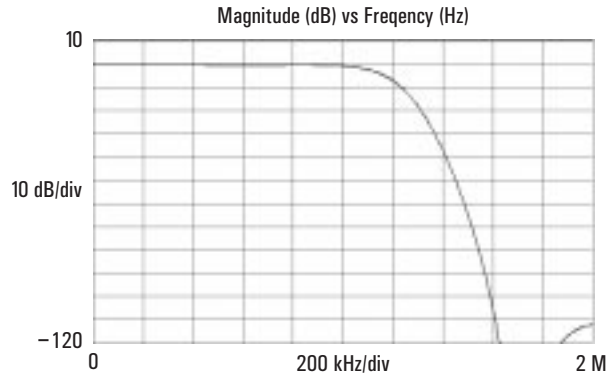


Filter characteristics with all alias filtering turned off, N=1

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Filter characteristics for 3rd pass digital filter + analog filter (dominated by digital), N=3





## VXI System Level Specifications

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### VXI Standard Information

Conforms to VXI Rev. 1.4  
C-size, single slot width  
Register/Message based programming  
"Slave" Data Transfer Bus functionality  
A16 address capability  
D16 data capability  
Local Bus capability  
Requires ECLTRG0 and ECLTRG1 lines for module synchronization

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### Size (single slot, C-size VXI module)

Dimensions 14 inches deep, 9.2 inches high, 1.2 inches wide  
(approx 36 cm deep, 23 cm high, 3 cm wide)  
Weight 3.9 pounds (approx 1.8 kg)

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### Software Drivers

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**Driver Type** C libraries with source code

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**Supported Operating Systems** Windows 3.1®, Windows95, WindowsNT™, HP-UX\*  
9.X

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**Supply Media** Disk, DAT

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\*HP-UX 9.X and 10.0 for HP 9000  
Series 700 and 800 computers are  
X/Open Company UNIX 93  
branded products

Windows NT is a U.S. trademark  
of Microsoft Corporation.

Windows and MS Windows are  
U.S. registered trademarks of  
Microsoft Corp.

## Regulatory Compliance

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|                         |   |
|-------------------------|---|
| <b>Safety Standards</b> | Designed for compliance to CSA C22.2, No. 231<br>Designed for compliance to UL 1244, 4th Edition<br>Designed for compliance to IEC 348, 2nd Edition, 1978 |
|-------------------------|---|

---

|                           |   |
|---------------------------|---|
| <b>Radiated Emissions</b> | CISPR 11 :1990 Group 1, Class A<br>(requires connector shields E1400-80920<br>in the mainframe) |
|---------------------------|---|

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## Environmental

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### Operating Restrictions

|                          |   |
|--------------------------|---|
| Ambient Temperature      | 0° to 55°C  |
| Humidity, Non-condensing | 10% to 90% at 40°C  |
| Maximum Altitude         | 4600 m (15,000 ft)<br>Above 2285 m (7500 ft), derate operating temperature<br>by – 3.6°C per 1000 m (– 1.1°C per 1000 ft) |

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### Storage and Transport Restrictions

|                          |                    |
|--------------------------|--------------------|
| Ambient Temperature      | – 40° to 70°C      |
| Humidity, Non-condensing | max 95% RH at 65°C |
| Maximum Altitude         | 4600 m (15,000 ft) |

**General Characteristics**

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**VXI Power Requirements**

| Range   | DC Current | Dynamic Current |
|---------|------------|-----------------|
| + 5 V   | 5.0 A      | 0.50 A          |
| - 5.2 V | 5.0 A      | 0.50 A          |
| - 2 V   | 0.3 A      | 0.10 A          |
| + 12 V  | 1.0 A      | 0.050 A         |
| - 12 V  | 1.2 A      | 0.050 A         |
| + 24 V  | 0 A        | 0 A             |
| - 24 V  | 0 A        | 0 A             |

**VXI Cooling Requirements**

|            |  |
|------------|--|
| 15° C rise | 4.0 liters/second<br>0.5 mm H <sub>2</sub> O |
|------------|--|

**Calibration interval**

1 year

**Warm-up time**

15 minutes

**For more information on Hewlett-Packard Test & Measurement products, applications or services please call your local Hewlett-Packard sales offices. A current listing is available via Web through Access HP at <http://www.hp.com>. If you do not have access to the internet please contact one of the HP centers listed below and they will direct you to your nearest HP representative.**

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Englewood, CO 80155-4026

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