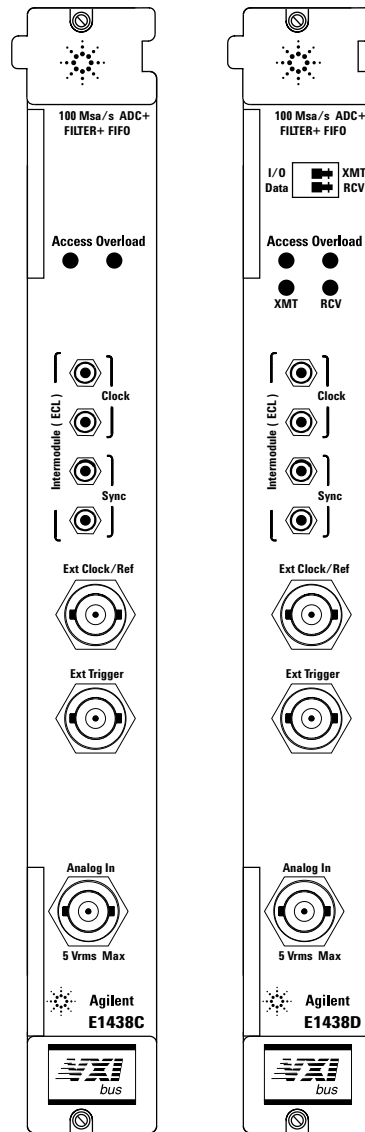


# Agilent E1438C/D 100 MSa/s Digitizer with DSP and Memory

## Data Sheet



The Agilent E1438C/D is ideal for application in signal acquisition and analysis, high resolution ATE and radar testing. This single-channel 100 MSa/s digitizer combines exceptional spurious-free dynamic range with alias-protected signal conditioning, center frequency tunable digital filtering, and a large signal capture memory, in a single-wide C-size VXI module. The only difference between the C and D versions is the E1438D includes a 2.5 Gbit/sec optical front panel data port and support for the VXI local bus.



# Specifications

## Input Specification

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|                       |   |
|-----------------------|---|
| Input characteristics | BNC connector, shell grounded to chassis.<br>50 $\Omega$ impedance.<br>dc coupled or ac coupled through 0.2 $\mu$ F capacitor.<br>Input signal can be switched to ground.<br>40 MHz anti-alias filter with bypass switch. |
|-----------------------|---|

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|                 |                              |
|-----------------|------------------------------|
| Input ranges    | +30 to -21 dBm in 3 dB steps |
| dBm 50 $\Omega$ | Volts peak                   |
| 30 dBm          | 10.0 Vp                      |
| 27 dBm          | 7.08 Vp                      |
| 24 dBm          | 5.01 Vp                      |
| 21 dBm          | 3.55 Vp                      |
| 18 dBm          | 2.51 Vp                      |
| 15 dBm          | 1.78 Vp                      |
| 12 dBm          | 1.26 Vp                      |
| 9 dBm           | 891 mVp                      |
| 6 dBm           | 631 mVp                      |
| 3 dBm           | 447 mVp                      |
| 0 dBm           | 316 mVp                      |
| -3 dBm          | 224 mVp                      |
| -6 dBm          | 158 mVp                      |
| -9 dBm          | 112 mVp                      |
| -12 dBm         | 79.4 mVp                     |
| -15 dBm         | 56.2 mVp                     |
| -18 dBm         | 39.8 mVp                     |
| -21 dBm         | 28.2 mVp                     |

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|                    |                  |
|--------------------|------------------|
| ADC overload level | 0 dBfs (typical) |
|--------------------|------------------|

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|  |                    |
|--|--------------------|
| Return loss of 50 $\Omega$ input impedance<br>0.1—40 MHz | > 18 dB (1.3 VSWR) |
|--|--------------------|

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|   |              |
|---|--------------|
| Amplitude accuracy (power measurement,<br>at 10 MHz, 0—40 dBfs) |              |
| Alias filter on   | $\pm 0.7$ dB |

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|  |                  |
|--|------------------|
| Flatness (dB relative to 10 MHz, excluding<br>digital filter response) |                  |
| Alias filter on, freq < 40 MHz   | $\pm 1.0$ dB     |
| Alias filter off, freq < 40 MHz  | $\pm 2.0$ dB     |
| Alias filter off, at 100 MHz   | -18 dB (typical) |

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|                    |  |
|--------------------|--|
| DC offset          |  |
| Auto-zero accuracy | $\pm 2\%$ fs (typical)                 |
| Temperature drift  | < $\pm 0.1$ mV/ $^{\circ}$ C (typical) |

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|                    |                        |
|--------------------|------------------------|
| Input bias current | < 50 $\mu$ A (typical) |
|--------------------|------------------------|

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|   |         |
|---|---------|
| Anti alias filter stopband rejection<br>(60—200 MHz, typical value for +27 and<br>+30 dBm ranges) | > 90 dB |
|---|---------|

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# Specifications (continued)

## Input Specification (continued)

Signal-to-noise ratio (full scale input, full bandwidth, excluding distortion. See noise, distortion and spur specs.)

|                  |                   |
|------------------|-------------------|
| Alias filter on  | > 60 dB (typical) |
| Alias filter off | > 55 dB (typical) |

Input noise density (alias filter on, internal sample clock)

|                   |                            |
|-------------------|----------------------------|
| 100 kHz to 40 MHz | < -133 dBfs/Hz             |
| 10 kHz to 100 kHz | < -130 dBfs/Hz             |
| 1 kHz to 10 kHz   | < -122 dBfs/Hz             |
| 100 Hz to 1 kHz   | < (-92 -10 LOG(f)) dBfs/Hz |
| Sensitivity       | < -155 dBm/Hz (typical)    |

Residual responses (with 50  $\Omega$  termination at input connector, 2 kHz to 40 MHz)

< -90 dBfs

Harmonic distortion, aliased harmonic distortion, and spurious responses

|                               |                         |
|-------------------------------|-------------------------|
| Input signals > -10 dBfs      | < -65 dBc               |
| Input signals -10 to -20 dBfs | < -70 dBc               |
| Input signals < -20 dBfs      | < -70 dBc or < -90 dBfs |

Intermodulation distortion (two in-band signals 1 MHz apart. Measured in dBc, relative to one signal.)

|                                |                         |
|--------------------------------|-------------------------|
| 0—30 MHz input signals         |                         |
| each signal -6 to -14 dBfs     | < -65 dBc               |
| each signal -14 to -20 dBfs    | < -70 dBc               |
| each signal < -20 dBfs         | < -70 dBc or < -90 dBfs |
| 30—40 MHz input signals        |                         |
| each signal -6 to -14 dBfs     | < -62 dBc               |
| each signal -14 to -23 dBfs    | < -67 dBc               |
| each signal < -23 dBfs         | < -67 dBc or < -90 dBfs |
| 3 <sup>rd</sup> order products |                         |
| each input -16 dBfs            | -85 dBc (typical)       |

Phase noise density (single sideband power density of 10 MHz signal, < 0.05G vibration, absolute or residual. Block data transfer mode, see Note 1.)

|                                    |                         |
|------------------------------------|-------------------------|
| $\Delta f = 10$ kHz                | < -128 dBc/Hz (typical) |
| $\Delta f = 1$ kHz                 | < -120 dBc/Hz (typical) |
| $\Delta f = 100$ Hz, residual only | < -110 dBc/Hz (typical) |

Discrete sidebands (5 Hz to 100 kHz  $\Delta f$ , see Notes 1 and 2)

|                                  |                             |
|----------------------------------|-----------------------------|
| $\Delta f > 20$ kHz              | < -90 dBc                   |
| $\Delta f < 20$ kHz              | < -90 dBc (typical, Note 1) |
| Inter-module clock via VXI lines | < -80 dBc (typical)         |

Note 1. Phase noise and sidebands performance at frequency offsets of less than 20 kHz may be degraded by noise and ripple on the VXI power supplies.

Note 2. Specifications for Dynamic Range, Spurious Responses and Sidebands require the mainframe containing the E1438C/D to 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, the 10 MHz VXI system clock must be turned off, and the E1438C/D External Clock input must be disconnected when not being used. Dynamic range specifications require 24-bit data resolution.

# Specifications (continued)

## Sample Clock and DSP Specifications

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|                                       |   |
|---------------------------------------|---|
| Clock sources                         |   |
| Internal sample clock frequency       | 100 MSa/s or 102.4 MSa/s (program control)      |
| External reference for internal clock | 10 MHz for 100 MSa/s, 10.24 MHz for 102.4 MSa/s |
| External sample clock frequency range | 10—102.4 MHz                                    |

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|                               |                  |
|-------------------------------|------------------|
| Internal clock specifications |                  |
| Frequency accuracy, 0—40° C   | ±7 ppm           |
| Frequency accuracy, 40—55° C  | ±10 ppm          |
| External reference lock range | ±6 ppm (typical) |

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|                                       |  |
|---------------------------------------|--|
| Clock input/output characteristics    |  |
| External sample clock/reference input | BNC connector. ac-coupled comparator with 1 K $\Omega$ impedance. Accepts TTL, ECL, or > -6 dBm sine waves   |
| External trigger input                | For ECL, the input is ac coupled, 1 k $\Omega$ , edge sensitive. For TTL, the input is dc coupled, 1 k $\Omega$ , TTL levels. (TTL trigger is currently only available on the E1438D.) |
| Inter-module front panel clock/sync   | SMB connector, ECL-10K compatible  |
| Inter-module VXI backplane clock/sync | VXI backplane ECLTRG lines   |
| 10 MHz reference output               | SMB connector +8 dBm   |

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|  |                   |
|--|-------------------|
| Multi-module sampling skew                     |                   |
| Within mainframe, uncorrected                  | < 10 ns (typical) |
| Between mainframes, 1 meter cable, uncorrected | < 25 ns (typical) |
| Resolution of correction                       | 5 ps (nominal)    |

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|                            |   |
|----------------------------|---|
| Digital decimation filters | 17 octave steps (40 MHz to 305 Hz), < 0.215 dB ripple, software correctable |
|----------------------------|---|

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|                          |                             |
|--------------------------|-----------------------------|
| Digital local oscillator | < 0.01 Hz tuning resolution |
|--------------------------|-----------------------------|

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## Regulatory Compliance

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|                                 |   |
|---------------------------------|---|
| Safety standards                | Designed for compliance to EN 61010-1(1993) |
| Radiated emissions and immunity | EN 61326-1 (see Note 2, page 3)             |

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## Environmental

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|                        |  |
|------------------------|--|
| Operating restrictions |  |
| Maximum altitude       | 4600 meters, above 2285 meters derate operating temperature by -3.6° C per 1000 meters |
| Ambient Temperature    | 0—55° C  |
| Humidity               | 10—90% at 40° C, non-condensing  |

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## Optical serial front panel data port (E1438D only)

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|                  |   |
|------------------|---|
| Standard support | Draft standard VITA 17.1, 1 Gbit/sec and 2.5 Gbit/sec |
| Connector        | Dual LC receptacle                                    |
| Optical type     | Multi-mode fiber, 850 nm wavelength                   |
| Maximum length   | 100 meters  |

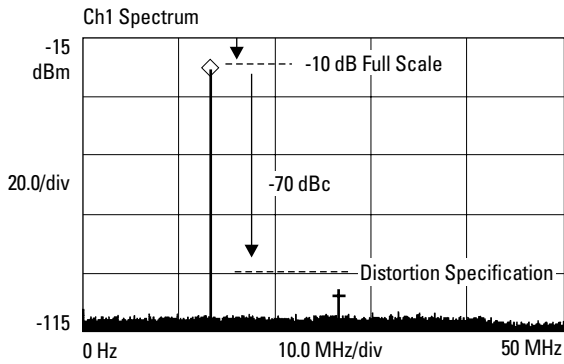
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# Typical Performance Charts

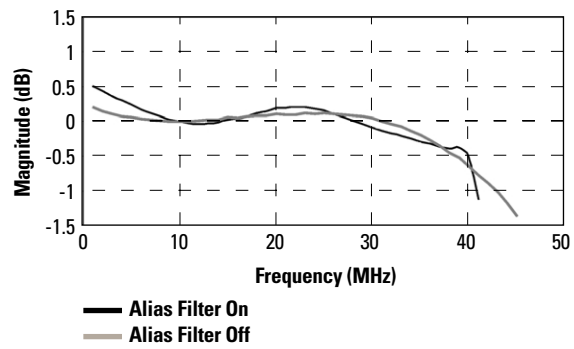
The following charts are included as supplemental, non-warranted characteristics

## Performance Benchmarks (Benchmarks are included as supplemental, non-warranted characteristics)

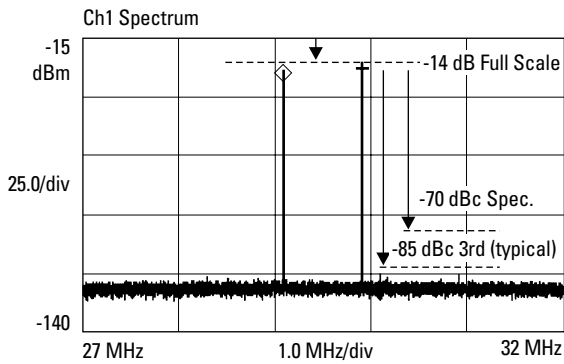
|   |              |
|---|--------------|
| VXI/VME continuous data transfer rate (From E1438C/D to MXI-II VXI controller, D32 VME word size) | 2.2 MBytes/s |
| Local bus data transfer rate (From E1438D to ideal consumer)                                      | 66 MBytes/s  |
| Library function control of module (MXI-II VXI controller)  |              |
| Measurement start   | 8.5 $\mu$ s  |
| Center frequency change (raw)   | 600 $\mu$ s  |



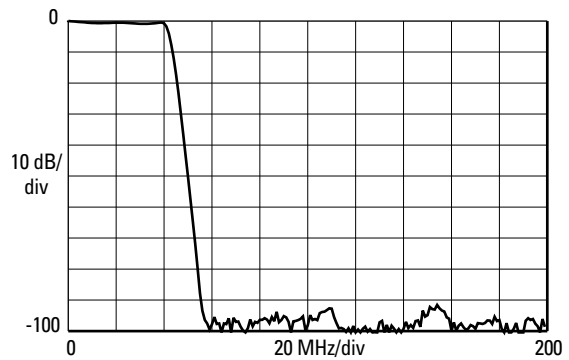
Harmonic Distortion performance with a -25 dBm 13 MHz signal on the -15 dBm range



Response versus Frequency - Pass Band



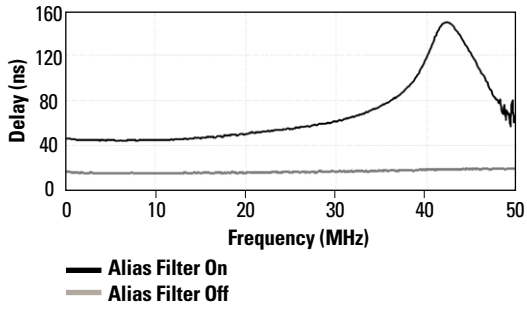
Intermodulation Distortion performance with two -14 dBfs tones near 30 MHz on the -15 dBm range



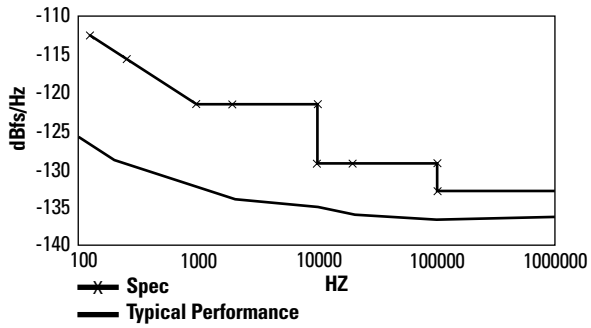
Filter Characteristics for Analog Anti Alias Filter, Magnitude (dB) versus Frequency (MHz)

## Typical Performance Charts (continued)

The following charts are included as supplemental, non-warranted characteristics

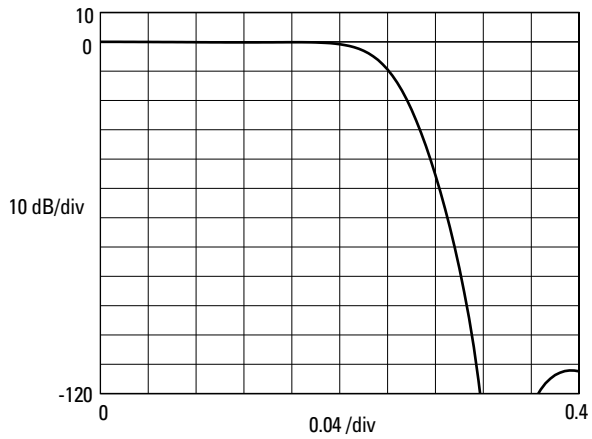


Analog Anti Alias Filter Group Delay vs. Frequency

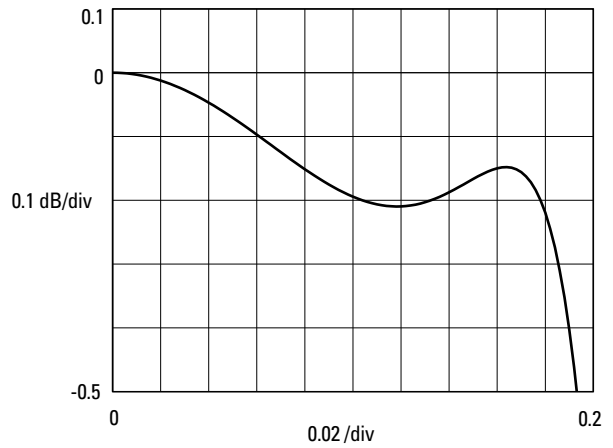


Input Noise Performance

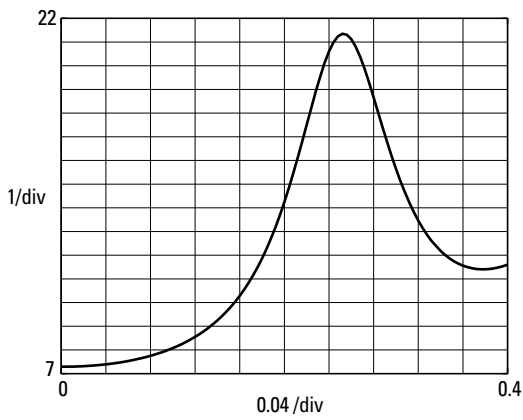
# Filter Characteristics for Low-pass Digital Filter Without Decimation $\text{sigBw} = 3$



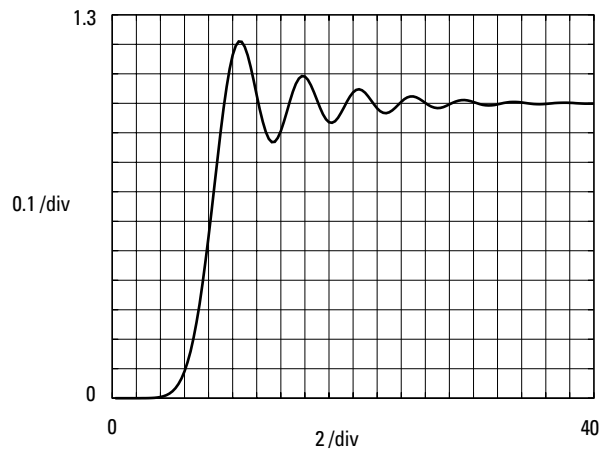
Magnitude (dB) versus Frequency (f/fs)



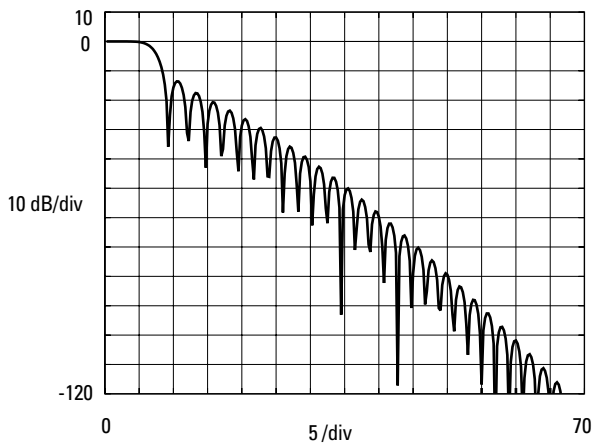
Magnitude (dB) versus Frequency (f/fs)



Delay (samples) versus Frequency (f/fs)



Response versus Time (sample) (normalized to step size)



Response versus Time (sample) (normalized to step size)

$f_s$  = output sample rate

## General

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|                          |   |
|--------------------------|---|
| VXI standard information | Conforms to VXI revision 1.4. See Note 1, page 3 concerning section B.8.6, Conducted Susceptibility.<br>C-size, single slot width.<br>Register based programming.<br>"Slave" Data Transfer Bus functionality.<br>A16 address capability.<br>D16/D32 data capability.<br>Local Bus capability.<br>Requires ECLTRG0 and ECLTRG1 lines for module synchronization. |
|--------------------------|---|

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| VXI power requirements | dc Current | Dynamic Current |
|------------------------|------------|-----------------|
| +5V (E1438C):          | 5 A        | 0.8 A           |
| +5V (E1438D):          | 7 A        | 0.8 A           |
| -5.2V:                 | 2 A        | 0.1 A           |
| -2V:                   | 1 A        | 0.1 A           |
| +12V:                  | 0.6 A      | 0.3 A           |
| -12V:                  | 0.4 A      | 0.06 A          |
| +24V:                  | 0.05 A     | 0.06 A          |
| -24V:                  | 0.05 A     | 0.06 A          |
| +5V Standby:           | 0.0 A      | 0.0 A           |

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|                               |   |
|-------------------------------|---|
| VXI cooling requirements      |   |
| E1438C                        |   |
| For 10° C rise above < 55° C: | 3.3 liters/second, 0.67 mm H <sub>2</sub> O |
| For 15° C rise above < 50° C: | 2.2 liters/second, 0.30 mm H <sub>2</sub> O |
| E1438D                        |   |
| For 10° C rise above < 55° C: | 4.2 liters/second, 1.00 mm H <sub>2</sub> O |
| For 15° C rise above < 50° C: | 2.8 liters/second, 0.50 mm H <sub>2</sub> O |

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|              |            |
|--------------|------------|
| Warm-up time | 15 Minutes |
|--------------|------------|

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|                      |                               |
|----------------------|-------------------------------|
| Calibration interval | 1 Year (no field adjustments) |
|----------------------|-------------------------------|

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### Agilent accessories available

The E1438C/D “sync” and “clk” connectors may be connected to other E1438C/D modules in synchronized multi-channel applications. The following cable and terminator to connect the modules are available from Agilent. (See the Agilent VXI Source Book for additional cables.)

|           |                                  |
|-----------|----------------------------------|
| 1250-0676 | SMB 50 $\Omega$ load             |
| 8120-5623 | 175 mm cable with SMB connectors |

### Backplane connector shields

The backplane connector shields are required for RFI compliance with the EN55011 and CISPR11 standards. Order optional RFI backplane shields for your VXI mainframe. They are not required for MFRAME1.

### Warranty

This product is distributed, warranted, and supported by Agilent Technologies.

The E1438C/D comes with a 1-year warranty. During that period, the unit will either be replaced or repaired, at Agilent Technologies' option, and returned to the customer without charge.

### Ordering Information

|              |                                     |
|--------------|-------------------------------------|
| E1438C/D     | 100 MSa/s AD with filter and memory |
| E1438C/D-001 | 1.2 GB FIFO memory                  |
| E1438C/D-144 | 144 MB FIFO memory                  |
| E1438C/D-288 | 288 MB FIFO memory                  |

### Product Web site

For the most up-to-date and complete application and product information, please visit our product Web site at:

[www.agilent.com/find/vxi](http://www.agilent.com/find/vxi)

Agilent Communications Intelligence Information:

[www.agilent.com/find/AD](http://www.agilent.com/find/AD)

### Related Literature

| Publication Title  | Publication Type         | Publication Number |
|--|--------------------------|--------------------|
| <i>E1437A 20 MSample/Second ADC with Filter and FIFO</i>         | Product Overview         | 5965-6893E         |
| <i>E1437A 20 MSample/Second ADC with Filter and FIFO</i>         | Technical Specifications | 5965-9774E         |
| <i>E1438C/D 100 MSample/Second Digitizer with DSP and Memory</i> | Product Overview         | 5968-7348E         |
| <i>E1439C/D VXI 70 MHz IF ADC with Filters and Memory</i>        | Product Overview         | 5980-1261E         |
| <i>E1439C/D VXI 70 MHz IF ADC with Filters and Memory</i>        | Data Sheet               | 5980-1260E         |
| <i>E9830A Delay Memory Module</i>                                | Product Overview         | 5968-7349E         |
| <i>Agilent Test System and VXI</i>                               | Products Catalog         | 5980-0307E         |

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