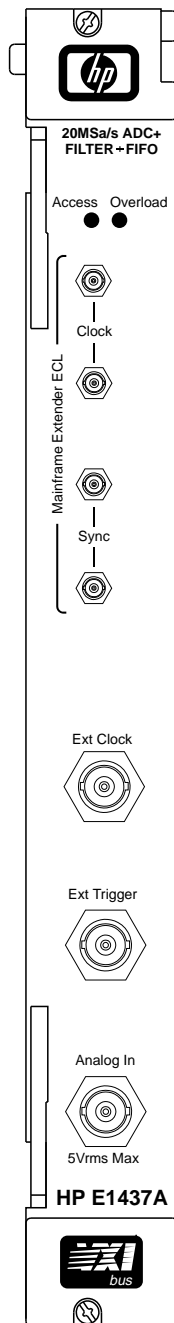


# HP E1437A 20 MSa/s ADC with filter and FIFO

## Product Overview

**High-precision digitizing  
for time and frequency  
domain applications**



### Key Features

- Up to -110 dBfs spurious free dynamic range
- Noise density: -140 dBfs/Hz
- Input bandwidth: 8 MHz with alias filter, 40 MHz without alias filter
- Frequency tunable digital filters
- 8 MB FIFO memory (64 MB optional)
- Full analog input signal conditioning
- Flexible triggering and synchronization
- Two sample clocks standard
- Local bus data transfers up to 60 MB/sec
- VXI *plug&play* compatible for Win 3.1®, Win95, WinNT™ and HP-UX\*

The HP E1437A VXI ADC module will uncover signal details you may never have seen before with its 23 bits of raw resolution and 20 MSa/s sample rate—twice as fast as the previous generation of this ADC.

With up to -110 dBfs (18 bits) of spurious free dynamic range the HP E1437A is the highest resolution 20 MSa/s digitizer available on the commercial market today.

This module is especially effective in systems that use digital signal processing to analyze signals. Such processing can range from simple averaging, to filtering, Fourier transforming, curve

fitting, and demodulating. The high precision data samples supplied by the HP E1437A mean these processes will describe the signals under analysis more accurately than ever before.

### A Remarkable Digitizer

Whether you are building a high dynamic range, wideband digital receiver or a precision waveform analysis system, success starts with the digitizer you select.

The heart of the HP E1437A is a 20 MSa/s digitizer with real-time distortion correction processing, and exceptionally low spurious and noise.

The distortion correction processing algorithm reduces the fixed non-linearity's, caused by digital components in the ADC, to at least 110 dB below full scale (dBfs). The soft distortion, caused by analog components such as the buffer amplifiers, is at least 75 dB below the applied carrier level (dBc).

Careful design and layout keep spurious signal contamination down at least -110 dBfs.

The noise density of the HP E1437A ADC is -140 dBfs/Hz, comparable to the best available ADCs at any sample rate. On the lowest input range the noise figure is 16 dB.

Signal analysis algorithms produce even more precise results with these highly linear and pure samples. The output precision of algorithms like RMS averaging, the Fast Fourier Transform, and various curve fitting algorithms is limited by spurs and distortion in the data. Reduce these contaminants, apply the algorithm longer, and you get more precise results. Sample linearity and purity are the key and the HP E1437A provides the answer.

### Built-in digital filtering and LO

The HP E1437A has an analog alias protection filter as well as 24 digital filters. Call these filters into use at any time to vary your sampling bandwidth from 8 MHz to less than 1 Hz, in octave steps. Use this real time digital processing to reduce noise and improve signal to noise ratio, or to filter out unwanted signals. Input bandwidth without alias protection is 40 MHz (typical).

These filters also help your data efficiency. The data from each filter is decimated to reduce data rate and data quantity without sacrificing signal information.

Included in the filter section is a digital LO. Use this complex frequency shifter to tune the center frequency of the digital filters anywhere in the alias protected 8 MHz input bandwidth of the HP E1437A.

The LO is a big help when your downstream signal processing includes demodulating digital modulation formats. The LO automatically multiplies the incoming signal by sine and cosine waves producing the I/Q data needed for this task. These I and Q results are like the I/Q signals produced by analog means but are much better matched and have very low spurious content, less than -110 dBfs. And, the LO's 20  $\mu$ Hz tuning resolution will come in handy for the precise tuning needed to stop a rotating constellation diagram.

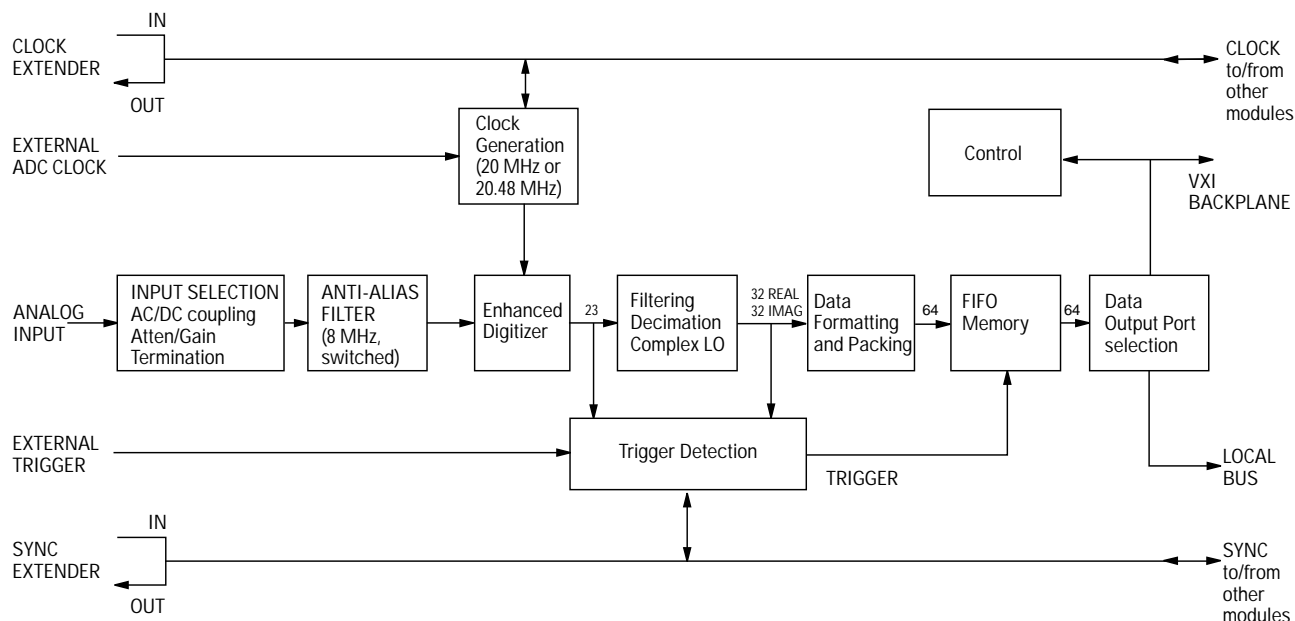
### Analog signal conditioning includes alias protection

The HP E1437A comes standard with analog signal conditioning, including a bypassable 8 MHz anti-alias filter. The anti-alias filter assures the Nyquist compatible sampling needed by most signal processing algorithms. The signal conditioning makes it easy to match the HP E1437A operating point to your signal amplitude, protects the digitizer from harmful voltages, and has a "pseudo-floating" mode to break up signal contaminating ground loops.

### Flexible triggering and synchronization

Select one of five ways to trigger the HP E1437A. Use immediate mode to begin sampling automatically. Select the external trigger mode when sampling must start coincident with an external event. Use the level mode to trigger on the level of the input signal itself.

**Figure 1:**  
**HP E1437A**  
**Block Diagram**



Use the log magnitude mode to trigger on the magnitude of the signal after it has been filtered by the HP E1437A. A software trigger command is also provided.

Large pre- and post-trigger delays (> 1 MSamples) are standard and the external trigger modes support slope selection.

Use the external synchronization and external clock features of the HP E1437A when your application requires closely coordinated sampling with multiple HP E1437As. Simply connect the ECL synchronization and clock ports between the modules, and start sampling. All sampling and digital filter timing will be coordinated between modules with less than 10 ns timing skew within a mainframe. This skew is a constant and can be measured and compensated if more precise timing is needed.

### Selection of sample clocks

You have a choice of sample clocks with the HP E1437A. The module comes standard with two crystal controlled internal sample clocks. Select the 20 MHz clock for convenient, decimal compatible, time domain sampling. Use the 20.48 MHz internal clock when downstream signal processing, like the FFT algorithm, needs a binary compatible sample rate.

The HP E1437A ADC can run with an external clock, or lock sampling to a master 1 MHz, 5 MHz or 10 MHz timing reference.

### Large built-in memory

Many digital signal processing algorithms use blocks of data. The HP E1437A comes standard with an 8 MByte FIFO memory to assemble these blocks so downstream DSP doesn't have to. The FIFO type design of the HP E1437A ensures that new data

will not be lost while a data block is being transferred out.

The FIFO also acts as signal capture memory. With the 64 MB FIFO option installed the HP E1437A has a 1.6 sec long time capture buffer (20 MSa/s, 16 bit real data format). With the lower data rate 1 MHz decimating filter selected the FIFO will hold 12.8 seconds of data. Using the narrower filters will result in even longer signal capture times.

### VXI *plug&play* programming

The HP E1437A is shipped with software and documentation to support a broad set of controllers, I/O interfaces, programming languages and operating systems.

Included standard with the HP E1437A are: compiled C libraries (with source code), example programs, on-line help files, and an installation program. An executable front panel program allows the HP E1437A to be turned on, verified, and used for simple tasks without writing any user programs.

The HP E1437A is fully VXI *plug&play* compliant and is easily controlled in Win3.1, WinNT, and Win95, VXI *plug&play* frameworks. If you are programming in Microsoft Visual Basic, the HP E1437A offers a .bas file to simplify your use of the VXI *plug&play* libraries.

For those preferring the UNIX<sup>®</sup> operating system, the same set of software is provided for HP-UX running on HP series 700 workstations.

If you are programming in C in a non-VXI *plug&play* environment you will want to use the HP E1437A C libraries. The source code is shipped with these

libraries so you can modify them to work with your specific I/O and processor.

The VXI *plug&play* libraries use the HP E1437A register based interface for highest performance. A lower speed message based interface is also supported for programmers familiar with instrument control using ASCII string commands. The ASCII commands are IEEE-488.2 compatible and are similar to the Standard Commands for Programmable Instruments (SCPI) protocol. The ASCII command interface can be used on any computer/interface platform capable of message based VXI interfacing. It does not need the VXI *plug&play* library.

### High speed data transfer

Sample linearity and signal processing features are wasted if the data stream has gaps because the module output ports can not keep up with the data generation processes. The HP E1437A provides two ports to move data to other VXI modules.

The VXIbus port on the P1 connector will move data at 1 MB/s (typical). This is sufficient for continuous sampling of signals with bandwidths below 250 kHz.

For wider signal bandwidths, or multi-channel applications, the Local Bus is key. Using this port, the HP E1437A can move data at 60 MB/s in bursts, 40.96 MB/s continuously.

Data transfer is further aided by a selection of data output formats. Select from four choices:

Component/Sample	Format
Real only (I)	16 bit
Real & imaginary (I/Q)	16 bit
Real only (I)	32 bit
Real & imaginary (I/Q)	32 bit

## Technical Specification Summary

(refer to HP E1437A technical data sheet, publication number 5965-6816E for more data)

### Input

**Ranges:** +30 dBm to -24 dBm,  
6 dB steps  
**Impedance:** 50 Ohm  
**Bandwidth:** 8 MHz (alias filter in),  
40 MHz (alias filter out)

### Accuracy

**Raw resolution:** 23 bits  
**Absolute accuracy:** ±0.03 dB (<100 kHz,  
25 °C, analog alias filter on, digital decimation filter off, DC coupled)

### Dynamic Range

**Harmonics:** < -75 dBc or < -110 dBfs,  
whichever is greater  
**Spurious:** -110 dBfs  
**Noise:** -140 dBfs/Hz  
(-6 dBm input range)

### Clock

**Internal:** 20 MHz, 20.48 MHz,  
20 MHz phase lock to external reference.  
**External:** DC to 20 MHz

### Trigger

**Sources:** Immediate, Level,  
Log Magnitude,  
External, Software

### Filter

One analog anti-alias filter (8 MHz), 23 digital decimation filters (4 MHz to 0.95 Hz, octave steps) with digital LO (20 µHz tuning resolution)

### Memory

**Type:** FIFO  
**Capacity:** 8 MB (4 MSa, 16 bits)  
16 MB  
32 MB  
64 MB

### Accessories Available

The HP E1437A sync and clk connectors may be connected to other HP E1437A modules in synchronized multi-channel applications. The following cable and terminator are available from HP to connect the modules. (See the HP VXI Source Book for more additional cables.)

1250-0676 SMB 50 Ohm load  
8120-5623 175 mm cable with  
SMB connectors

### Backplane Connector Shields

Required for RFI compliance specified in standards EN55011 and CISPR11; specify quantity 1 opt 918 with purchase of an HP VXI mainframe: HP E1401B or HP E1421A; specify this kit for retrofitting an existing HP mainframe. E1400-80920 or E1421-80920

### Ordering Information

HP E1437A 20 MSa/s AD with filter and FIFO  
**Option UFC** 16 MB FIFO memory  
**Option ANC** 32 MB FIFO memory  
**Option ANE** 64 MB FIFO memory  
**Option 0B0** Delete manual set  
**Option 0B1** Add manual set

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**Data subject to change.**

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Printed in U.S.A. 1/97  
5965-6893E**