VMIC VMIVME-4145-000

Arbitrary Waveform Generator

Limited Availability
Used and in Excellent Condition

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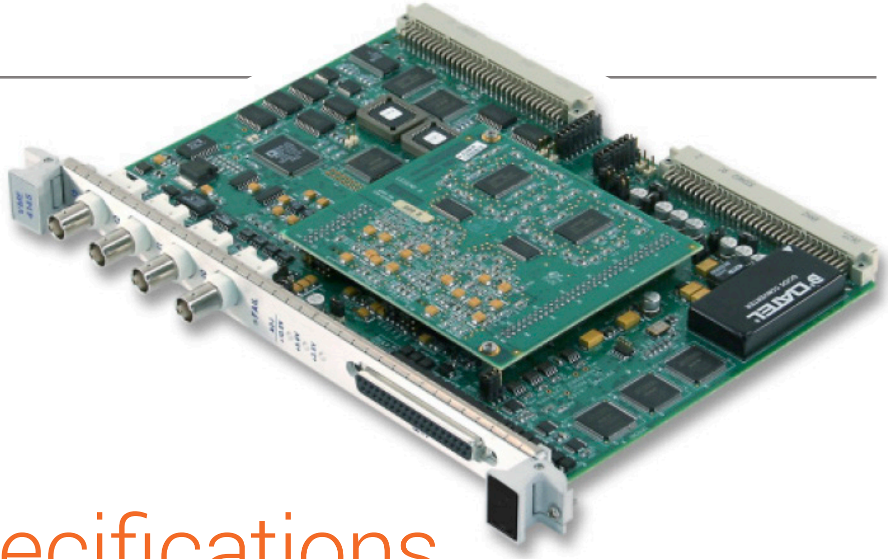

VME-4145* Specifications

Four-Channel 16-bit Arbitrary Waveform Generator Board with Autocalibration

Features:

- Four-channel analog waveform generator
- Autocalibration of all channels
- Continuous, single burst, or burst/idle/burst waveform generation modes of operation
- One 16-bit D/A converter per output
- Programmable per channel internal or external sample clock
- Up to 2.5 million samples/second
- External clock and trigger input per channel
- Variable length (up to 65,536 word) waveform buffer per channel
- Bipolar 2.5, 5.0, and 10.0V ranges programmable per channel and unipolar 0 to 5, 0 to 10 programmable
- 10mA output drive current per channel
- 1.5 Ω output impedance
- Deglitched DAC outputs with optional 4-pole low pass filtering
- External sync output (per channel)
- Onboard digital signal processor and 20-bit analog-to-digital converter for automatic calibration and diagnostic self-test
- Field wiring disconnect for offline self-test diagnostics
- Front panel reference voltage access
- Remote ground sense pseudo-differential outputs
- Low pass filter options

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VME-4145* *Four-Channel 16-bit Arbitrary Waveform Generator Board with Autocalibration*

Ordering Options							
August 29, 2011 800-024145-000 B		A	B	C	D	E	F
VME-4145	–		0		0	0	

A = Filter Options
0 = No Filter
1 = 500kHz Chebyshev
2 = 1MHz Chebyshev
3 = 500kHz Bessel
4 = 1MHz Bessel
B = 0 (Option reserved for future use)
C = Number of Channels
0 = 4 Channels
1 = Reserved
D = 0 (Option reserved for future use)
E = 0 (Option reserved for future use)
F = Conformal Coating
0 = No Conformal Coating
1 = Conformal Coating

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Functional Characteristics

Introduction: The VME-4145* Analog Output Board provides four high-quality analog output channels with 16-bit resolution. Each output has a dedicated D/A Converter (DAC), and can source or sink 10mA at ±10V. The analog outputs can be disconnected from the field wiring for offline testing. Autocalibration and self-test are initiated by a VME system reset or by execution of a software command. An onboard Digital Signal Processor (DSP) and a 20-bit Analog-to-Digital Converter (ADC) are used to calibrate the offset and gain of the DAC. During calibration, a table of offset and gain coefficients is compiled and stored in VME RAM. There is an entry for offset and gain corresponding to each of the four channels configured in each of the five output voltage ranges.

VME Compliance The board complies with the VMEbus specification (ANSI/IEEE STD1014-1987 IEC 821 and 297) with the following mnemonics.

Addressing Mode Responding Address Modifiers

A32	$09 (Extended nonprivileged data access) or $0D (Extended supervisory data access)
A24	$39 (Standard nonprivileged data access) or $3D (Standard supervisory data access)

Data Access: D16, D08 (EO)

Board Address: The base VME address is set by configuration of a jumper field. A jumper exists for each of the addresses A31 through A17; thus, the address space occupied by this board is 128KB.

VME Access: Address modifier bits are jumper selected and decoded to support nonprivileged, supervisory, and either nonprivileged or supervisory board accesses.

Waveform Generation: The Waveform data is entered through a 64k word waveform sample buffer. The buffer size is programmable from 2 to 65,536. The user configures a channel for either continuous, single burst, or continuous burst/idle/burst mode. The local DSP applies gain and offset correction to the waveform samples and then stores them in a channel waveform buffer (not accessible by VME). Waveform generation begins with either a software trigger or an external trigger input. Each channel may use either an internal or external clock timebase input. During waveform generation, the trigger input can be re-triggered and will restart an active waveform to the first location of the waveform table.

Self Test: The Self-test is run automatically after a system reset. A Self-Test register indicates the success or failure of each channel.

System Reset: After a system reset, all outputs are in the offline mode, all Control Registers are in their default state, and self-test is initiated for system diagnostics.

Front Panel Status LED: This indicator is illuminated after a system reset and is extinguished upon the successful completion of self-test and autocalibration. The LED can also be turned on and off under software.

Front Panel Reference Voltage: A connector on the front panel allows access for measuring the reference voltages. Located below the reference voltage connector is a front panel access port to the reference voltage adjustment. Autocalibration is based on this precision voltage reference.

Calibration: When autocalibration is initiated by software command, an embedded DSP loads calibration output values into each of the output DACs which are read back into the DSP through a 20-bit Sigma Delta ADC. This is repeated until a sufficient number of calibration points have been measured. A calibration table consisting of offset and gain corrections for each of the four outputs in each of the five voltage ranges is compiled and stored in VME RAM. These correction factors are recalled when the waveform sample buffer is processed.

Note: The calibrated values will be stored into EEPROM only using the software command.

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Address Map (Offset from base address)

Command & Status Registers	$0 0000
Reserved	$0 2000
Waveform Buffer (56K)	$0 4000 $1 FFFE

64K RAM Memories: The board contains five separate 64K x 16 RAM memories. The first is common and shared between the VME and the onboard DSP processor. The user downloads the waveform into this common memory. The DSP then applies calibration and moves this waveform data into one of the four dedicated channel DAC RAM memories.

Segmentation: Segmentation allows the user to switch waveform outputs in real-time. The user may segment the 64K waveform space into multiple waveforms. A maximum of 64 waveforms of 1,024 words each may be programmed. In real-time, the user may switch between any of these waveforms or program an automatic sequencing of these. Each waveform is generated start to finish, and the next is seamlessly started. A link list approach can be programmed in real-time by the VME host processor.

Sweep Frequency Operation: The board's internal sample rate clock may be changed in real-time while a waveform is being generated. This host control allows the waveform to be swept across a range of frequencies. See the example on page 4 for calculating the accuracy of a swept signal (25ns resolution). This feature requires real-time host interaction.

Electrical Characteristics

(At +25°C and rated power supplies unless otherwise noted.)

Outputs: Four single-ended Analog outputs. One DAC per output channel.

Full-Scale Output: ±10V, ±5V, ±2.5V, 0 to +5V, or 0 to +10V

Output Code: Each 16-bit DAC accepts digital codes in two's complement or offset binary (software selectable)

Resolution: 16 bits

External Sample Clock: 400ns period (minimum)

External Trigger: 50ns (minimum width)

Internal Timebase: 40MHz

Stability: ±10 PPM

Internal Programmable Sample Clock: 400ns to 1.52ms (with 25ns resolution)

External Clock and Trigger Input Buffer:

- Logic: Inverting schmidt-trigger
- Propagation Delay: tpd @ 25°C = 31ns
- Input Voltage: V_H = 3.15V, V_L = 0.9V

Waveform Buffer Size: 2 to 65,536 samples per channel

Burst Period: 2^{24} Sample Clocks maximum

Trigger Latency: 300ns

Output Impedance: 1.5 Ω, online. 10 Mega Ω, offline

Output Current: ±10mA, over the entire output voltage range

Output Short Circuit Protection: 30 second short to common. Transient over voltage protected to ±14V for 1s

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Transfer Characteristics

Transfer Function:

$$E_{OUT} = E_{OUTMIN} + \left[\frac{N_{DATA}}{65{,}536} \times E_{SPAN}\right]$$

EOUT = Channel output voltage

EOUTMIN = Negative end of the range

NDATA = Channel data from the VME

ESPAN = Positive end of the range minus the negative end of the range

Example: for the ±5V range

$$E_{OUT} = -5V + \left[\frac{N_{DATA}}{65{,}536} x 10 V\right]$$

Transfer Time[4]:

Calibrated Waveform Timing Summary

N	VME (ms)+	DSP (ms)=	TOT (ms)	Per sample (µs)
10	0.26	1.54	1.80	180.40
100	1.24	2.85	4.09	40.92
1,000	11.06	15.99	27.05	27.05
10,000	109.16	144.50	253.66	25.37
20,000	218.15	274.51	492.66	24.63
30,000	327.15	404.52	731.67	24.39
40,000	436.16	534.53	970.68	24.27
50,000	545.16	664.54	1209.70	24.19

Uncalibrated Waveform Timing Summary

N	VME (ms)+	DSP (ms)=	TOT (ms)	Per sample (µs)
10	0.27	0.22	0.49	48.80
100	1.25	1.13	2.38	23.76
1,000	11.05	10.22	21.27	21.27
10,000	109.15	99.14	208.29	20.83
20,000	218.16	189.14	407.30	20.36
30,000	327.16	279.15	606.31	20.21
40,000	436.16	369.16	805.32	20.13
50,000	545.15	459.17	1004.32	20.09

Differential Nonlinearity: 0.005 percent of FSR maximum. Monotonic over the operating temperature range.

Integral Nonlinearity: 0.007 percent of FSR maximum

Dynamic Range: 80 dB[3]

Signal-to-Noise Ratio: 73 dB[3]

Initial Voltage Accuracy[1,3]:

VME-4145-001 Channels 0 to 1

Range	Gain Error (% setting)	+Offset/Nonlinearity Error (% span)	+Fixed
±2.5	±0.005	±0.018	±250µV
±5.0	±0.005	±0.018	±250µV
±10.0	±0.005	±0.018	±250µV
0-5.0	±0.005	±0.018	±250µV
0-10.0	±0.005	±0.018	±250µV

VME-4145-000 Channels 2 to 3

Range	Gain Error (% setting)	+Offset/Nonlinearity Error (% span)	+Fixed
±2.5	±0.005	±0.018	±500µV
±5.0	±0.005	±0.018	±500µV
±10.0	±0.005	±0.018	±500µV
0-5.0	±0.005	±0.018	±500µV
0-10.0	±0.005	±0.018	±500µV

Example: for a setting of +2.000V on the ±5VDC (10V span) output range for channel zero:

Accuracy = (±0.005% x 2.00V) ± (0.018% x 10V) ±250µV
= 100µV + 1.8mV + ±250µV = ±2.1mV

Voltage Accuracy Stablity[3]:

Temperature Effects: ±35 PPM of setting ±25 PPM of Span ±30µV maximum drift per °C.

Long Term: ±45 PPM of setting ±30 PPM of Span ±50µV, maximum drift per 1,000 hr

Interchannel Crosstalk Rejection: 80dB minimum, DC to 10.0kHz[3]

Output Noise2: 2 mVp-p maximum at 3σ, 10Hz to 10kHz

Transition Impulse: 5µV - s, maximum spike during data transitions

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Waveform Frequency Accuracy: The frequency of a programmed waveform and its accuracy are dependent on the number of samples downloaded to represent it and the timebase used to clock out each sample. The more samples used to represent a waveform and the finer the resolution of the clock, the more accurate the generated frequency will be.

Number of Samples in Table:

Minimum: 10 to 100 (suggested)
Maximum: 65,536

Internal Programmable Sample Clock:

Period: 400 ns to 2.62 ms
Frequency: 2.5MHz to 657.89Hz
Resolution (Step Size): 25ns (for example, 400ns, 425ns, 450ns)
System Timebase: 40MHz oscillator ±100 PPM

External Sample Clock (User Supplied):

Maximum Frequency (User Provided): 2.5MHz
Minimum Period: 400ns
Resolution: Limited to user-supplied signal

Software Clock:

Maximum Frequency: 2.5MHz
Maximum Period: 400ns
Minimum Period: Infinite
Resolution: Limited to CPU speed and firmware

The software clock lets the host computer take control of the sample clock. This may be used for extremely long waveform periods.

Frequency of Waveform: The following formulas are used to calculate the frequency and number of samples for a waveform:

A.

$$\text{Freq (Hz)} = \frac{1}{(\text{\# samples in table}) \times (\text{sample clock period})}$$

Where:
samples = 1 to 65,536
sample clock period = 400ns to 1.5ms in 25ns steps

B.

$$\text{\# samples required} = \frac{\text{frequency of sample clock}}{\text{frequency desired}}$$

Example 1:

How many samples are required to generate a 1kHz sinewave using the fastest output sample clock frequency?

samples = 2.5MHz/1,000kHz = 2,500 samples

Example 2:

A sinusoidal waveform is 100 samples in length. What is the fastest frequency that can be generated? If the frequency is to be swept, what is the sweep frequency resolution?

f = 1/(100) x (400ns) = 25kHz

The internal timebase works on 25ns steps.

f = 1/(100) x (425ns) = 23,529kHz

Resolution = 25kHz - 23,529kHz = 1.47kHz

Physical/Environmental Specifications

Dimensions: Standard VME double height board

Height	9.2 in. (233.4mm)
Depth	6.3 in. (160mm)
Thickness	0.8 in. (20.3mm)

Power Requirements:
5.0A maximum at +5.0VDC

Temperature:
Operating: 0° to +65°C
Storage: -25° to +85°C

Humidity: Relative humidity 20% to 80%, noncondensing

Cooling: Forced air circulation

MTBF: Contact Factory

Filter Options: For applications requiring low pass output filters, Abaco provides filter options assembled on the board. Each option provides filtering for all ordered channels. All the ordered channels output are filtered with cutoff frequency and filter type. All filters are fourth order, Salenky multiple feedback low pass filters.

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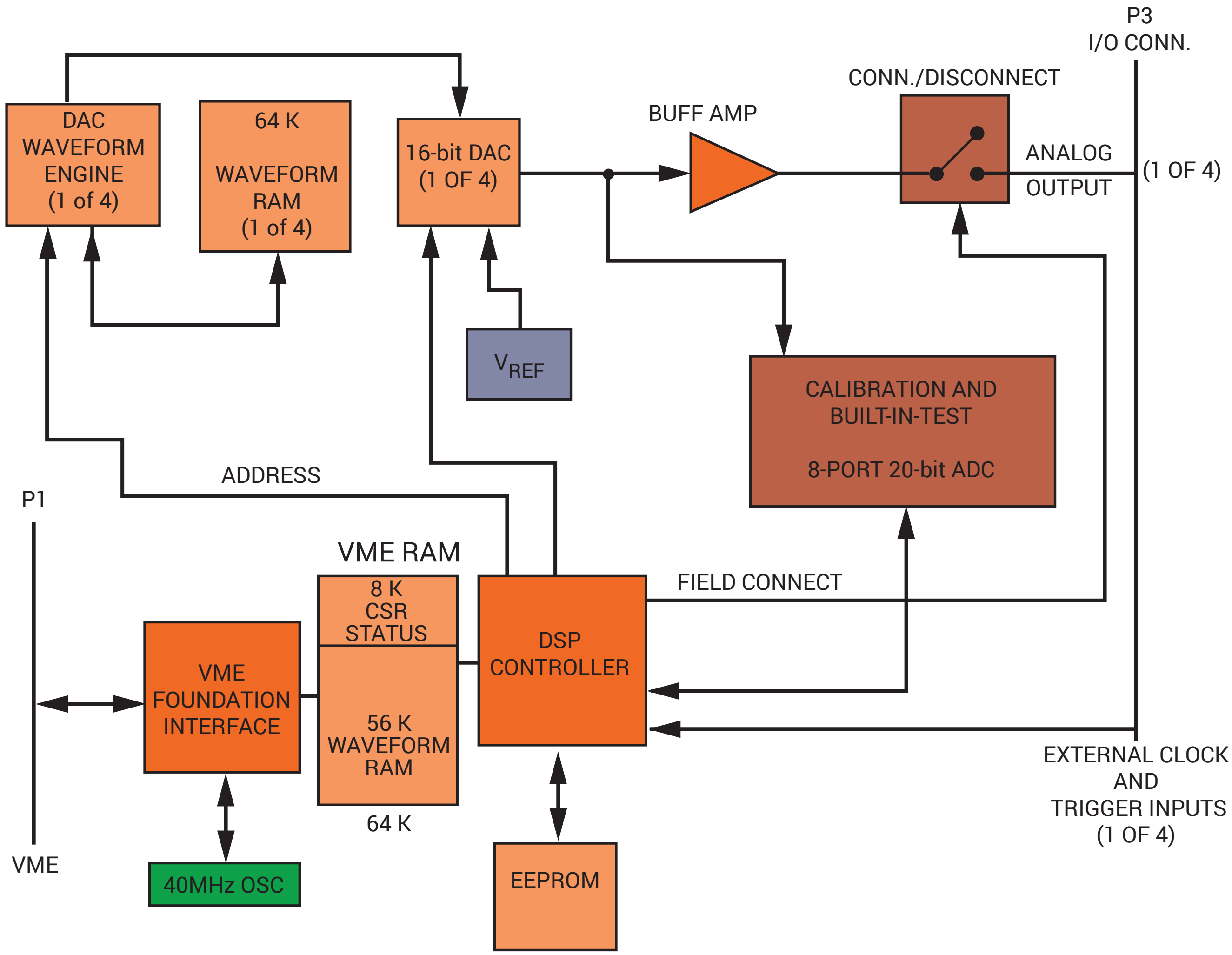

Figure 1. VME-4145 Functional Block Diagram

1. Initial accuracy is established directly after reference calibration and autocalibration. Voltages referenced to common analog ground point.
2. Output noise is specified at 3s standard deviations, which includes 99.7% of all noise peaks for a normal distribution. Glitch (transition) and BIT-switching noise is not included.
3. Output filter is not installed.
4. VME transfer times using CPU-33.

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