E1445A VXI Arbitrary Waveform Generator

13-bit, 40 MSa/s, C-Size

Description

The Keysight E1445A Arbitrary Function Generator is a C-size, 1-slot, message-based VXI module. It provides the flexibility to produce virtually any waveform needed.

The deep memory allows downloading a large number of waveforms at once and can store up to 128 waveforms using SCPI programming. The memory sequencer lets you link waveform segments together in any order. These sequences can be repeated 1 to 64 k times or continuously. Within a sequence, the segments can be repeated up to 4,096 times using only one sequence memory entry. This memory structure lets you build large, complex waveforms out of small segments.

Key Features

- 1-Slot, C-size, message-based
- 13-bit, 40 MSa/s
- 256 kSa waveform segment memory
- Waveform and frequency hopping with sweep function
- Direct access to high-speed registers
- Built-in self-test

Produce Complex Waveforms

Essentially, there are two memories built into the E1445A:

1. 256 kSa segment memory that supplies the digital-to-analog converter (DAC) with its output values

2. 32 k-segment sequence memory that defines how the segments are consecutively linked together at full speed.

The memory sequencer lets you link waveform segments together in any order. These sequences can be repeated 1 to 64 k times or continuously. Within a sequence, the segments can be repeated up to 4,096 times using only one sequence memory entry. This memory structure lets you build large, complex waveforms out of small segments.

Precisely Control the Frequency

One of the clocks is created by the Direct Digital Synthesis (DDS) technique. With DDS, you get very high resolution. This allows you to precisely set the frequencies you need. For signals with the lowest phase noise, crystal oscillators with divider circuits are also on-board to clock the DAC. This allows you to set values like 20 MSa/s with minimal jitter.

Hop Frequencies

Frequency hopping is done easily by programming a list of frequencies and instructing the internal microprocessor to step through the list. As an added benefit, the frequency changes are phase continuous. Using this feature, you can produce bursts of several tones.

Drive the DAC Directly

When you have an extremely long or indeterminate waveform, you can use the VXI Local Bus or the faceplate connector to drive the DAC directly. This lets your process define the waveform being produced by the E1445A. Local Bus speed is limited to 7.4 MSa/s typical. Neither is paced by the internal time base, they must be paced externally.

Control and Synchronize Other Instruments

A programmable marker places a pulse on the Marker Out BNC. This marker can appear in any location in the segment memory. You can use the marker to synchronize other instruments, such as an oscilloscope or a digital functional tester.
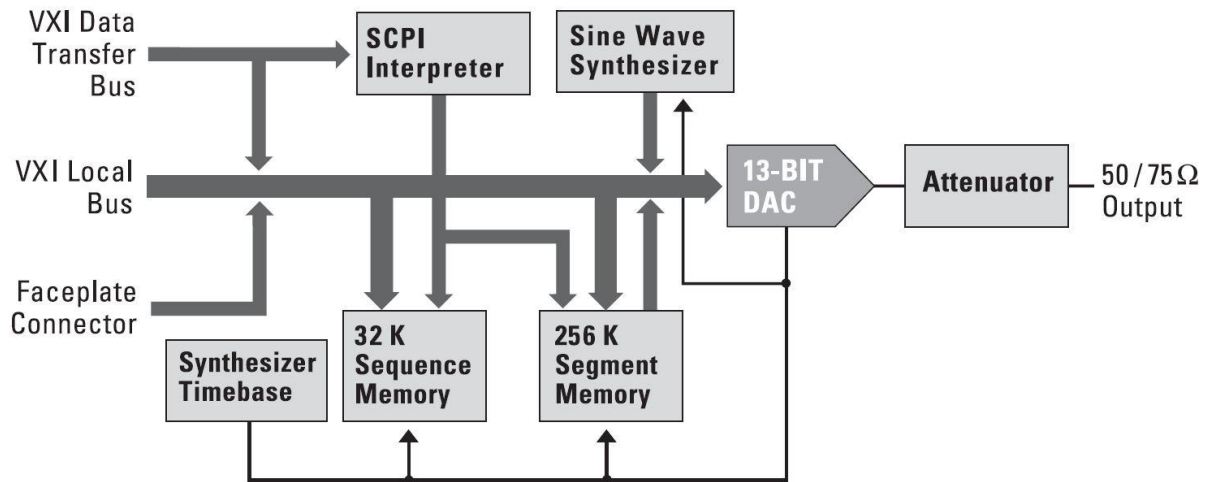

Figure 1. E1445A Block Diagram

Technical Specifications and Characteristics

Output Characteristics	
Amplitude (into 50 Ω)	± 10.2 V max. (open circuit)
Maximum output	± 5.5 V AC+DC into 50 Ω
Maximum offset	± 5 V into 50 Ω
Output impedance (software selectable)	50 or 75 Ω (output also calibrated for open circuit)
Voltage amplitude range	± 5.1 V in 1.25 mV steps in 50 Ω, ± 10.2 V in 2.5 mV steps in to high impedance.
Monotonicity	>11 bits
Differential nonlinearity (dc)	4 LSB
Accuracy (spec)	
DC accuracy	± (0.3% + 5 mV) into 50 Ω
AC accuracy	± (0.1 dB + attenuator error + ac flatness) (Absolute)

Frequency Characteristics	
Time base sources	Internal 40 MHz and 42.9 MHz crystals (50 ppm); VXI CLK10 line; VXI ECLTrig lines; faceplate BNC
Maximum waveform frequency	10.7 MHz sine, 5 MHz square, 100 kHz ramp/triangle using 100 samples per cycle
Sweep	Linear and log frequency
Frequency sweep range	0.01 Hz to 10 MHz
Frequency hop range	0.01 Hz to 10 MHz
Frequency hop rate	Up to 500 kHz using registers, 800 Hz using SCPI
Frequency shift (FSK) rate	Up to 2 M changes/s
Phase modulation rate	Up to 500 kHz
Phase modulation source	Software, VXI Local Bus (P2), or faceplate connector
Square waveform rise time	17 ns (typ)

Sample Rate Characteristics		
Maximum sample rate	40 MSa/s	
Sample rate generation method	Direct digital synthesis (DDS) or time base sources with digital dividers	
Sample Rate with DDS[1]	**Resolution**	**Range Sa/s**
DDS normal	0.01 Sa/s	0.01 to 10.7M
DDS doubled	0.02 Sa/s	0.02 to 21.4M
Sample Rate with non-DDS timebase		
Resolution	Timebase frequency/Divider, divider = 1, 2, 3, 2N (N = 1 to 64 k), max. 40 MSa/s	

[1] Internal 42.94 MHz crystal

Technical Specifications and Characteristics, cont.

Waveform Characteristics	
Standard waveforms	Sine, square, ramp, and triangle
Arbitrary waveform function	Yes
Resolution	13 bits (12 bits plus sign)
Waveform segment memory	256 kSa
Maximum number of segments	256 using SCPI
Sequence memory	32,768 segments
Maximum number of waveforms in memory	128 using SCPI
Waveform sequence looping	1 to 65,536 cycles or continuous using burst output mode
Segment looping	1 to 4,096
Waveform hopping	Programmed in memory or randomly using register access via VXI Data Transfer Bus (P1), VXI Local Bus (P2), or faceplate connector
Modulation	FSK, PM

AC Performance	
Attenuator range	0 to 30 dB in 0.01 steps
Attenuator error	0 dB at max output level, 0.05 dB at other
Output filters (software selectable)	250 kHz, 5-pole Bessel; 10 MHz, 7-pole Bessel; no filter applied
Harmonic Distortion (with internal filters applied) (spec)	
0.1 - 250 kHz	<–60 dBc
0.25 - 4 MHz	<–60 dBc + 20 log (f/250k) where f = output frequency
4 MHz - 10 MHz	<–36 dBc
Spurious (non-harmonic) Distortion (with internal filters applied) (spec)	
10 Hz - 1 MHz	–60 dBc or –60 dBm, (whichever is greater)
100 - 250 kHz	–50 dBc
4 MHz - 10 MHz	–45 dBc
AC Flatness (relative to 1 kHz with internal filters)(spec)	
0.1 Hz - 100 kHz	0.05 dB
100 - 250 kHz	0.1 dB
250 kHz - 10 MHz	0.2 dB

Auxiliary Input/Output	
VXI Local Bus	Data to DAC (not synchronized to time base and limited to 7.4 MSa/s typical), data to segment memory, waveform selection, phase modulation
Trigger sources	Auto, hold, software, VXI TTLTRG, VXI ECLTRG, or faceplate BNC

Technical Specifications and Characteristics, cont.

Faceplate Connectors	
Ref/sample in BNC	Frequency reference, sample clock
Start arm in BNC	Start arm
Stop trig/FSK/gate in BNC	Trigger clock gate, Trigger stop, FSK
Marker out	Any point, start of sequence, sample clock, reference frequency, frequency/phase change
Digital port	Data to DAC or segment memory, waveform selection, phase modulation
VXI TTLTRG lines	Sample clock, gate, sweep arm/trigger, FSK
VXI ECLTRG lines	Sample clock, reference frequency, start arm, all marker outputs

VXI Characteristics	
VXI device type	Message-based
Data transfer bus	A16, A32, D8/16/32 slave only
Size	C
Slots	1
Connectors	P1/P2
Shared Memory	No
VXI buses	Local Bus A-row, Local Bus C-row, TTL Trigger Bus, ECL Trigger Bus

Module Cooling	
Watts/slot	44 watts
ΔP mm H^{2}O	0.50
Air Flow liter/s	3.50

Module Current Requirements (Amps)		
Voltage rail	I_{PM}	I_{DM}
+5 V	3.5	0.2
+12 V	0.1	0.1
-12 V	0.13	0.06
+24 V	0.22	0.17
-24 V	0.34	0.17
-5.2 V	2.5	0.12
-2 V	1.2	0.2

Definitions and Conditions

Specification (spec)

The warranted performance of a calibrated instrument that has been stored for a minimum of 1 hour within the operating temperature range of 0 to 55 °C and after a 30-minute warm up period. Data published in this document are specifications (spec) only where specifically indicated.

Typical (typ)

The characteristic performance, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement uncertainty or calibration-source, and is valid only at room temperature (approximately 25°C).

Nominal (nom)

The mean or average characteristic performance, or the value of an attribute that is determined by design such as a connector type, physical dimension, or operating speed. This data is not warranted and is measured at room temperature (approximately 25°C).

Measured (meas)

An attribute measured during the design phase for purposes of communicating expected performance, such as amplitude drift vs. time. This data is not warranted and is measured at room temperature (approximately 25°C).

Additional Information

All data are measured from multiple units at room temperature and are representative of product performance within the operating temperature range unless otherwise noted. The data contained in this document is subject to change.

Ordering Information

Model	Description
E1445A	Arbitrary Waveform Generator is a 1-slot, Message-based, C-size VXI
E1445A-0B3	Service manual
E1445A-FRMK	Factory refurbished product
Related Products	
E8401A	13-slot, C-size, VXI Mainframe with 550W Power Supply and basic monitoring
E8403A	13-slot, C-size, VXI Mainframe with 1000W Power Supply and basic monitoring
E8404A	13-slot C-size VXI Mainframe, 1000W PS, Enhanced monitor, color graphic display
E1406A	VXI GPIB Command Module; C-size

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