

# E1441A VXI Arbitrary Waveform Generator

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



## Description

The Keysight Technologies E1441A Arbitrary Waveform Generator is a C-size, 1-slot, message-based VXI module. It uses direct digital synthesis to deliver outstanding functionality at a price far below comparable, rival arbitrary function generators.

Standard built-in waveforms include sine, square, triangle, ramp, noise,  $\sin(x)/x$ , exponential rise & fall, cardiac, and DCV. With the E1441A, you can also design your own arbitrary waveform. Standard features include internal AM/FM/FSK/Burst modulation and both linear and logarithmic sweep. The output from the E1441A is isolated from earth ground so that ground loops or other common mode noise are minimized.

With Option 001, the E1441A provides high-stability timebase and external phase lock. This option adds 0.1 ppm/month frequency stability plus phase lock to an external reference or phase lock two or more E1441A's together.

## Key Features

- 1-Slot, C-size, message-based
- 12-bit, 40 MSa/s, four 16k-deep arbitrary waveforms
- 15 MHz sine- and square-wave outputs
- Includes sine, square, triangle, ramp, and noise functions
- Internal lin/log sweep plus AM/FM/FSK/Burst modulation
- Isolated output
- Optional high-stability timebase and external phase lock

## Technical Specifications and Characteristics

Output <sup>1</sup>	
Amplitude (into 50 $\Omega$ )	50 mVp-p to 10 Vp-p, 100 mVpp to 20 Vpp into open-circuit load
Accuracy (at 1 kHz)	$\pm 1\%$ of specified output (spec)
Output impedance	50 $\Omega$ fixed
Output setting resolution	3 digits, amplitude and offset
Output units	Vpp, Vrms, dBm
Isolation	42 Vpk maximum to earth
Protection	Short-circuit protection, $\pm 15$ Vpk overdrive <1 minute
Flatness (sine wave relative to 1 kHz) (spec)	
<100 kHz	$\pm 1\%$ (0.1 dB)
100 kHz to 1 MHz	$\pm 1.5\%$ (0.15 dB)
1 MHz to 15 MHz	$\pm 2\%$ (0.2 dB)
Offset (into 50 $\Omega$ )	
Range <sup>2</sup>	$\pm 5$ Vpk ac + dc
Accuracy <sup>3</sup>	$\pm 2\%$ of setting + 2 mV (spec)
Frequency Characteristics	
Resolution	10 $\mu$ Hz or 10 digits
Temperature coefficient	<2 ppm/ $^{\circ}$ C
Aging	<10 ppm/yr
Resolution Accuracy (18 to 28 $^{\circ}$ C) (spec)	
90 days	10 ppm
1 year	20 ppm
Frequency Range	
Sine	100 $\mu$ Hz - 15 MHz
Square	100 $\mu$ Hz - 15 MHz
Triangle	100 $\mu$ Hz – 100 kHz
Ramp	100 $\mu$ Hz – 100 kHz
Gaussian noise	10 MHz bandwidth
Arbitrary Waveform Size	
8 to 8,192 points	100 $\mu$ Hz - 5 MHz
8,193 to 12,287 points	100 $\mu$ Hz - 2.5 MHz
12,288 to 16,000 points	100 $\mu$ Hz - 200 kHz
General Characteristics	
Number of channels	1
Warm-up time	30 min
Arbitrary waveforms	Stored separately
User configurable stored states	4

<sup>1</sup> Add 1/10th of output amplitude and offset specification per  $^{\circ}$  C for operation outside of 18 $^{\circ}$  C to 28 $^{\circ}$  C range

<sup>2</sup> Offset  $\leq 2X$  peak-to-peak amplitude

<sup>3</sup> For square wave outputs, add an additional 2% of output amplitude error

## Technical Specifications and Characteristics, cont.

Waveform Characteristics	
Built-in waveforms	Sine, square, triangle, ramp, noise, DCV, sine(x)/x, negative ramp, exponential rise, exponential fall, cardiac
Arbitrary Waveform Characteristics	
Waveform length	8 to 16,000 points
Amplitude resolution	12 bits (including sign)
Sample rate	40 MSa/s
Non-volatile memory	Four 16k waveforms

Sinewave Spectral Purity	
Harmonic Distortion	
dc to 20 kHz	<-70 dBc
20 kHz to 100 kHz	<-60 dBc
100 kHz to 1 MHz	<-45 dBc
1 MHz to 15 MHz	<-35 dBc
Total Harmonic Distortion (THD)	
dc to 20 kHz	<0.04%
Spurious (non-harmonic)	
dc to 1 MHz	<-65 dBc
>1 MHz	<-65 dBc + 6dB/octave
Phase Noise	
30 KHz band	<-52 dBc

Signal Characteristics	
Square Wave	
Rise/fall time	<20 ns
Overshoot	<4%
Asymmetry	<1% + 5 ns
Duty Cycle	20% to 80% (to 5 MHz), 40% to 60% (to 15 MHz)
Triangle, Ramp, and Arbitrary Waves	
Rise/fall time	<100 ns (typ)
Linearity	<0.1% of peak output
Settling time	<250 ns to 0.5% of final value
Jitter	<25 ns

## Technical Specifications and Characteristics, cont.

Modulation Characteristics	
<b>AM Modulation</b>	
Carrier (3dB Frequency)	15 MHz (typ)
Modulation	Any internal waveform plus Arb
Frequency	10 mHz to 20 kHz ( $\pm 0.05\%$ to 2.5 kHz, then decreases linearly to $\pm 0.4\%$ at upper limit)
Depth	0% to 120%
Source	Internal/external
<b>FM Modulation</b>	
Modulation	Any internal waveform plus Arb
Frequency	10 mHz to 10 kHz ( $\pm 0.05\%$ to 600 Hz, then decreases linearly to $\pm 0.8\%$ at upper limit)
Peak deviation	10 mHz to 15 MHz
Source	Internal only
<b>Burst Modulation</b>	
Carrier frequency	5 MHz maximum
Count	1 to 50,000 cycles, or Infinite
Start phase	$-360^\circ$ to $+360^\circ$
Internal rate	10 mHz to 50 kHz $\pm 1\%$
Gate source	Internal or external gate
Trigger source	Single, external, or internal rate
<b>FSK Modulation</b>	
Frequency range	10 mHz to 15 MHz ( $\pm 0.05\%$ to 600 Hz, then decreases linearly to $\pm 4\%$ at upper limit)
Internal rate	10 mHz to 50 kHz $\pm 1\%$
Source	Single. external, internal

Frequency Sweep	
Type	Linear or logarithmic
Direction	Up or down
Start F/stop F	10 mHz to 15 MHz
Time	1 ms to 500 sec $\pm 0.1\%$
Source	Single. external, internal

Auxiliary Inputs	
External AM modulation	$\pm 5$ Vpk = 100% modulation
Input resistance	5 k $\Omega$ nominal
<b>External Trigger/FSK Burst Gate</b>	
Logic level	TTL (high true)
Latency	1.3 $\mu$ s
Jitter	25 ns

## Technical Specifications and Characteristics, cont.

Auxiliary Inputs, cont.	
VXIbus TTLTRG Inputs (TTLT<0-7> Trigger/FSK/Burst Gate)	
Logic level	TTLTRG (low true)
Latency	1.15 $\mu$ s
Jitter	25 ns

Configuration Time (Time to change parameter and output new signal)	
Function change (Modulation or sweep off)	80 ms
Frequency change (Modulation or sweep off)	30 ms
Amplitude change	30 ms
Offset change	20 ms
Modulation parameter change	<350 ms
Select user arbitrary	550 ms

Option 001 Phase Lock/TCXO Timebase	
Description	Adds high stability reference, phase lock to second E1441A and control phase offset
Setability	<0.01 ppm
Stability	$\pm$ 1 ppm, 0 to 50° C
Aging	<2 ppm/month in first 30 days, 0.1 ppm/month after 30 days
External Reference Input (Ext Ref In terminal)	
Lock range	10 MHz $\pm$ 50 Hz
Level	-10 dBm to +15 dBm, +25 dBm or 10Vpp absolute maximum input
Impedance	50 $\Omega$ $\pm$ 2%, 42 Vpk isolation from earth
Phase Offset	
Range	-360° to + 360°
Resolution	0.001°
Accuracy	25 ns

VXI Characteristics	
VXI device type	Message-based
Data transfer bus	A16, slave only
Size	C
Slots	1
Connectors	P1/P2
Shared Memory	No
VXI buses	No

Module Cooling	
Watts/slot	25 watts
$\Delta$ P mm H <sup>2</sup> O	0.01
Air Flow liter/s	2.0

## Technical Specifications and Characteristics, cont.

Module Current Requirements (Amps)		
Voltage rail	$I_{PM}$	$I_{DM}$
+5 V	0.5	0.10
+12 V	2.5	0.12
-12 V	0	0
+24 V	0	0
-24 V	0	0
-5.2 V	0	0
-2 V	0	0

## Definitions and Conditions

<b>Specification (spec)</b>
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 50 °C and after a 30-minute warm up period. Data published in this document are specifications (spec) only where specifically indicated.
<b>Typical (typ)</b>
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).
<b>Nominal (nom)</b>
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).
<b>Measured (meas)</b>
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).
<b>Additional Information</b>
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
E1441A	Arbitrary Waveform Generator is a 1-slot, Message-based, C-size VXI
E1441A-001	Phase lock/TCXO timebase
E1441A-A6J	ANSI Z540-1-1994 Calibration
E1441A-FRMT	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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