

Agilent N8241A Arbitrary Waveform Generator Synthetic Instrument Module 1.25 GS/s or 625 MS/s

Technical Overview



- 15 bits of vertical resolution per channel and either 1.25 Gigasamples per second (GS/s) or 625 Megasample per second (MS/s) provides exceptionally realistic wideband waveforms
- Dual output channels drive both single-ended and balanced designs without the need for baluns or hybrids
- Extended waveform memory and advanced sequencing engine offers long scenario simulations
- Multiple module synchronization provides multi-emitter simulations
- Multiple programmatic interfaces enable easy integration into existing test environments
- Fully compliant to LXI Class A standards



Agilent Technologies

Generate wide bandwidth AND wide dynamic range signals. simultaneously

The N8241A is a wideband arbitrary waveform generator (AWG) capable of creating high-resolution waveforms for radar, satellite and frequency agile communication systems. Each channel of the N8241A operates at either 1.25 GS/s sample rate (option 125) or 625 MS/s sample rate (option 062) and features 15 bits of vertical resolution giving designers the most realistic, wideband waveforms available from a commercial AWG. This LXI synthetic instrument module offers dual differential output channels to drive both single-ended and balanced designs. The AWG also supports advanced sequencing and triggering modes to create event-based signal simulations. Multiple N8241A modules can be synchronized for the generation of phase-coherent, multi-emitter scenarios. Waveform development tasks are simplified using the AWG's numerous programmatic interfaces including complete instrument control from the MATLAB® command line. When the N8241A is combined with a wideband I/Q upconverter, modulation bandwidths of 1 GHz can be realized at microwave frequencies for authentic signal simulations for IF and RF subsystem test.¹

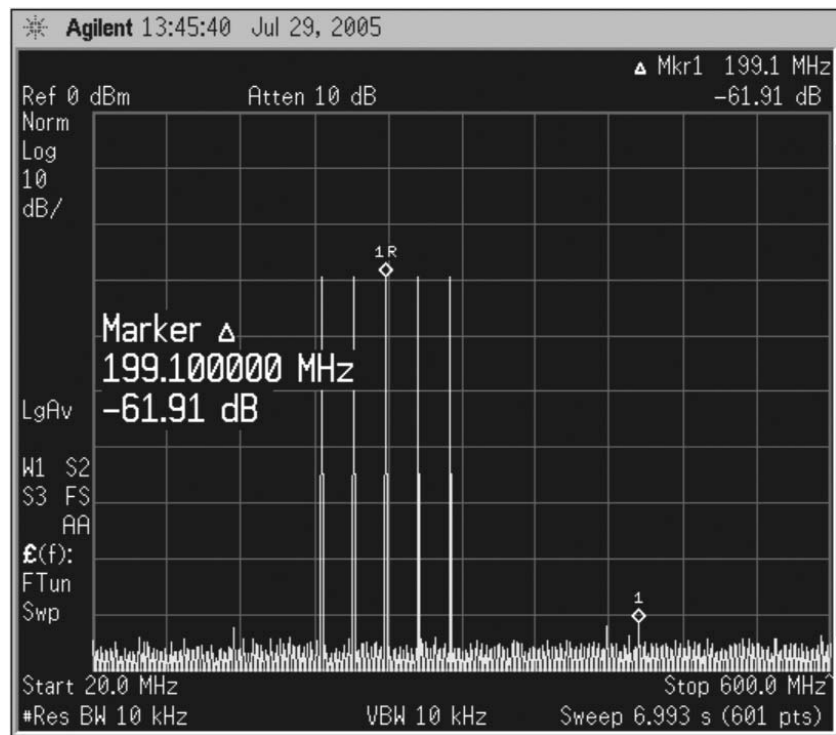


Figure 1. Generate wide band waveforms with unprecedented signal fidelity.

Unprecedented performance

The N8241A gives designers access to the most advanced Digital-to-Analog (DAC) technology available in a commercial AWG. Each module incorporates two high-speed DACs to create 500 MHz of signal bandwidth and ≤ -65 dBc SFDR across each channel. Users have the choice of driving their designs differentially from the DAC outputs or single-ended through

multiple signal-conditioning paths. Although some AWGs require users to make a trade-off between the number of output channels and differential outputs, the N8241A provides both – allowing you to drive your designs and eliminating the need for baluns or hybrids in the test path. In addition, each channel can output waveforms as an IF or as a baseband signal for I/Q upconversion.

¹ Agilent E8267D PSG signal generator with option 015 wideband I/Q inputs.

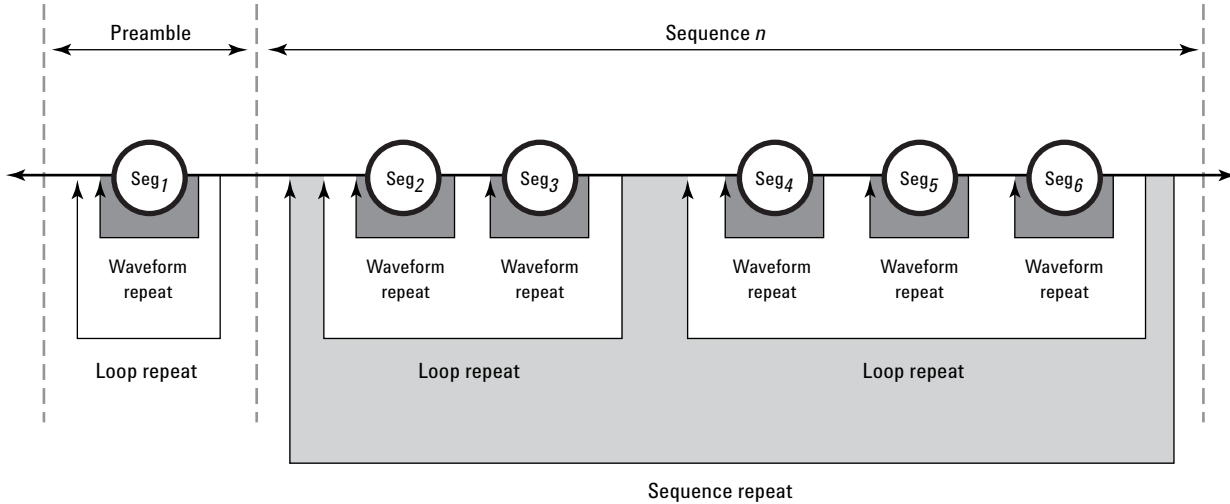


Figure 2. Create sophisticated signal scenarios by looping and nesting waveforms.

Create long scenario simulations

Multiply the effective size of on-board memory through the use of the N8241A's advanced sequencing engine. Uniquely define how waveform segments are played through looping and nesting of stored waveforms. This capability also gives users the ability to create new signals from existing waveforms by playing only subsegments of waveform memory.

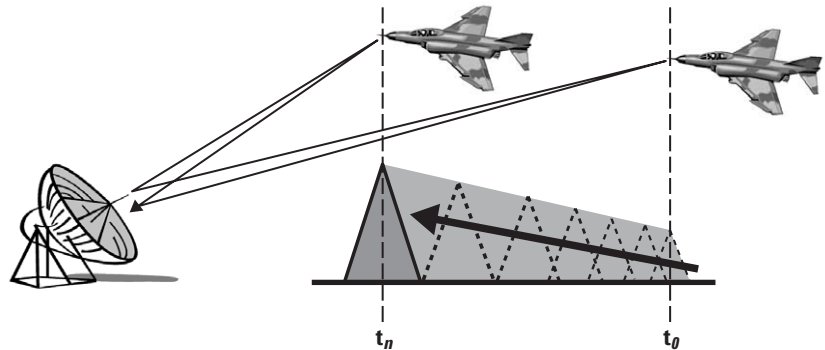


Figure 3. Closing targets can be simulated by ranging parameters on each pulse.

System scalability

Create phase-coherent, multi-emitter simulations using the N8241A's precision SYNC clock. A single N8241A can drive a total of eight AWG modules to synchronize their outputs on a sample-by-sample basis. Any number of modules can be synchronized with simple driver hardware. The AWG also includes multiple front-panel trigger and markers for complete system synchronization.

Ease-of-use

The N8241A's graphical user interface guides developers through module setup and waveform file transfers. Users can quickly configure the instrument's signal conditioning paths, marker and trigger lines, sample and reference clock sources and simple sequencing functions. More sophisticated sequencing functions are available through the instrument's numerous programmatic interfaces. The N8241A supports interfaces for MATLAB, LabView, IVI-C, and VEE framework.



Figure 4. The N8241A's compact modular size is perfect for integrating into ATE system racks.

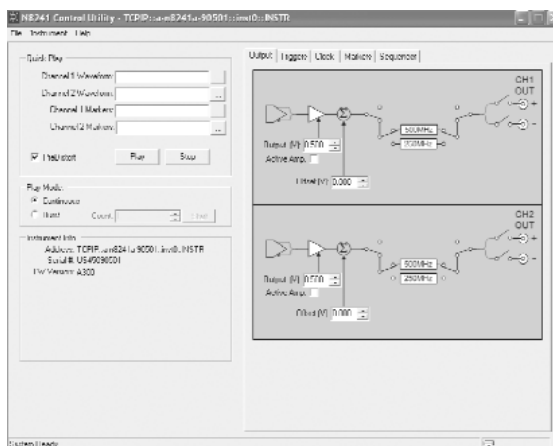


Figure 5. Directly import and play waveforms from the Quick Play menu.

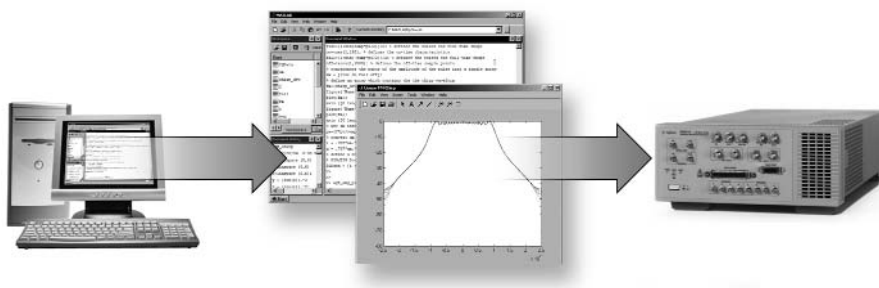


Figure 6. Play waveform files directly from the MATLAB command line.

New! Enhanced Capabilities for the N8241

Additive White Gaussian Noise (option 250) – available in 2007

The additive white Gaussian noise (AWGN) software allows receiver designers to perform front-end receiver testing without expensive external noise signal sources. Controlled amounts of wideband noise pedestals (500 MHz wide) can be added to test waveforms to better understand receiver sensitivity such as E_b/N_0 – ratio of the signal's energy per bit (E_b) to the spectrum noise density (N_0) – versus bit-error rate. Because both the reference waveform and noise pedestal are generated inside the AWG, designers avoid measurement drift and errors normally associated with manually combining the two signals externally.

Dynamic Sequencing (option 300)

The dynamic sequencing software enables radar and military communications engineers to build custom signal scenarios on the fly. Engineers can dynamically access up to 16 k of previously stored sequences through a 16-bit interface and replay these

complex waveforms to respond to changing threat environments, or to create signals where the next waveform to be played is not known in advance. Option 300 requires a U.S. export license.

Direct Digital Synthesis (option 330)

The direct digital synthesis (DDS) enables radar and emerging communications engineers to create basic waveforms in the AWG's memory and then modify their behavior

with profiles for amplitude modulation, phase modulation and frequency modulation. This enables engineers to simulate testing without the time and expense of field trials, such as in-flight and in-orbit testing. This option can also be used to simulate fading profiles in receiver testing for satellite and 4G signals, such as multiple input, multiple output formats (MIMO). Option 330 requires a U.S. export license.

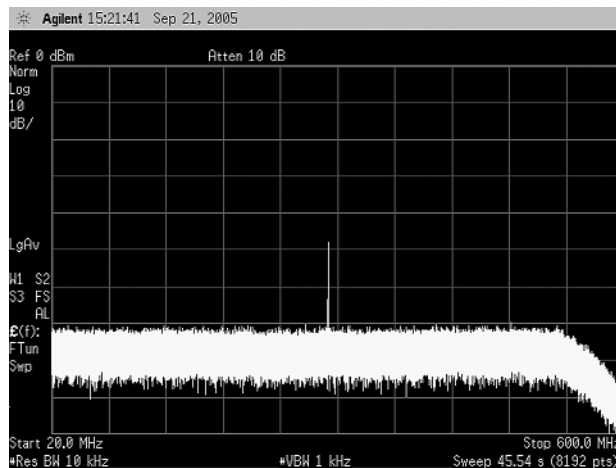


Figure 7. Additive white Gaussian noise providing a calibrated SNR of approximately 23 dB.

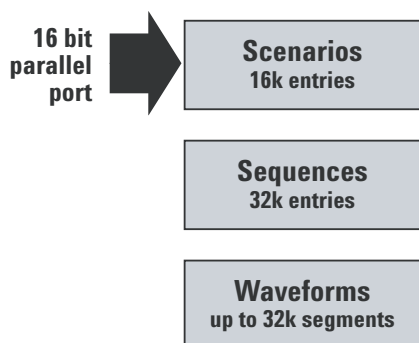


Figure 8. Create signals where the next waveform to be played is not known in advance.

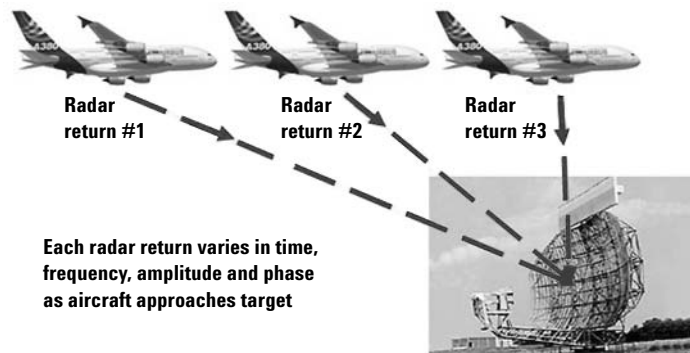


Figure 9. Define signals by carrier frequency and modulation – instant by instant.

Key Characteristics

Channels	Two independent channels available as baseband or IF outputs <ul style="list-style-type: none"> • CH1: Single-ended and differential • CH2: Single-ended and differential 	
Modulation bandwidth	1.25 GS/s sample rate (option 125) 500 MHz per channel (1 GHz IQ bandwidth)	625 MS/s sample rate (option 062) 250 MHz per channel (500 MHz IQ bandwidth)
Resolution	15 bits (1/32,768 levels)	
Output spectral purity – (CH1 and CH2)	1.25 GS/s sample rate (option 125) <ul style="list-style-type: none"> • Harmonic distortion: ≤ -65 dBc for each channel DC to 500 MHz • Non-Harmonic spurious: ≤ -75 dBc for each channel 1 kHz to 500 MHz • Noise floor: ≤ -150 dBc/Hz across the channel bandwidth 	625 MS/s sample rate (option 062) <ul style="list-style-type: none"> • Harmonic distortion: ≤ -65 dBc for each channel DC to 250 MHz • Non-Harmonic spurious: ≤ -75 dBc for each channel 1 kHz to 250 MHz • Noise floor: ≤ -150 dBc/Hz across the channel bandwidth

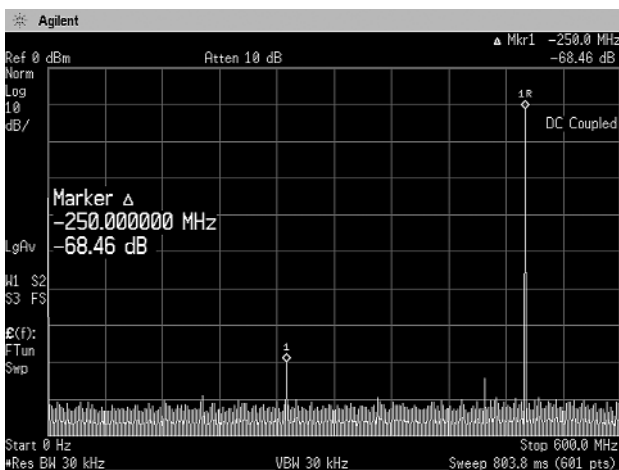


Figure 10. Excellent harmonic and spurious performance are available across the full bandwidth of each channel.

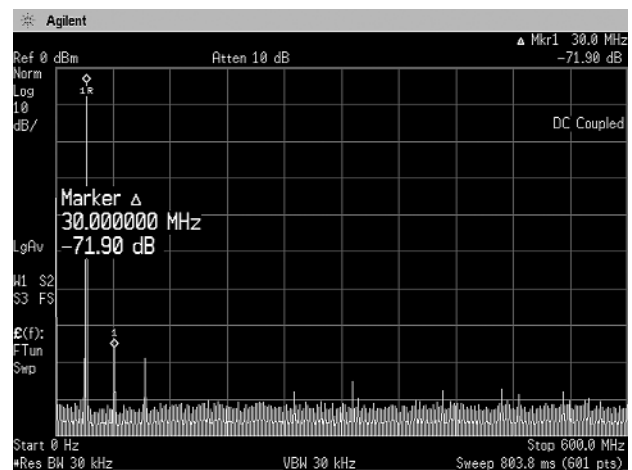


Figure 11. Spurious performance outstanding at low signal frequencies.

Key Characteristics (continued)

Sample clock	
Internal	Fixed 1.25 GS/s (option 125) Fixed 625 MS/s (option 062)
Internal clock output	+3 dBm nominal
External clock input	Tunable 100 MS/s to 1.25 GS/s (option 125) Tunable 100 MS/s to 625 MS/s (option 062)
External clock input drive level	+5 to –15 dBm typical
Phase noise characteristics	1 kHz: –95 dBc/Hz 10 kHz: –115 dBc/Hz 100 kHz: –138 dBc/Hz 1 MHz: –150 dBc/Hz
Noise floor	–150 dBc/Hz
Accuracy	Same as 10 MHz timebase input
Frequency reference	
Input drive level	+2 to +12 dBm into 50 ohms (+2 dBm nominal)
Waveform length	8 MS per channel (16 MS with option 016)
Minimum waveform length	128 samples
Waveform granularity	8 samples
Segments	1 to 32 k unique segments can be defined consisting of waveform start and stop address, repetitions and marker enable flags.
Segment loops	A total of 1 million (2^{20}) loops can be defined for each segment. Loops can be configured to advance in one of four modes: <ul style="list-style-type: none"> • Single: The segment loop plays once and waits at the end of the loop for a trigger. • Continuous: Segment loop is repeated continuously until a trigger is received. • Auto: Automatically advances to the next segment after completing the specified number of loop repetitions. • Repeat: The waveform loop repeats until the number of waveform loop repetitions is met.
Sequences	Up to 32 k total unique waveform sequences can be defined. A sequence is a contiguous series of waveform segments.
Advanced sequencing	Enables users to build and playback scenarios, which are comprised of one or more sequences.
Scenarios	1 to 16 k pointers can be assigned to play pre-defined sequences. Sequence play begins with the first sequence entry and continues uninterrupted until the last entry is played. The table repeats until stopped.

Key Characteristics (continued)

Sequence jump modes	<p>Sequence jumps determine how a sequence responds to a jump trigger. There are no discontinuities in a sequence jump other than those imposed by the waveform data. Three modes are available to control sequence jumps:</p> <ul style="list-style-type: none">• Jump immediate: Jumps immediately to the next specified sequence address with a fixed latency.• End of waveform: The current segment (including waveform repeats) is completed before jumping to a new sequence.• End of sequence: The current sequence is completed before jumping to a new sequence. Jump latency is the longer of either the jump immediate latency or the length of the remaining sequence.
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Additive White Gaussian Noise (option 250) – available in 2007

Noise pedestal bandwidth	500 MHz
Crest factor	15 dB
Noise amplitude accuracy	±0.5 dB

Dynamic Sequencing (option 300)

Input	20-pin mini-D connector
Input levels	All pins configured as 2.5 volt LVCMOS inputs. A logic low must fall within the –0.2 to +0.5 volt window. A logic high must be within the window of +2.0 to +2.8 volts.
Number of address bits	13 bits per channel
Total number of addressable scenarios	16 k
Data rate for dynamic data	100 ns
Data latency	Same as front panel trigger inputs. Software pointers may also be used to point to pre-defined scenarios, though latencies are not deterministic.

Direct Digital Synthesis (option 330)

Output frequency resolution	1 Hz
Frequency modulation	Deviation from 0 to 125 MHz (250 MHz peak-peak)
Phase modulation	Deviation from –180 to +180 degrees in 0.022 degree steps
Amplitude modulation	Modulation depth from 0 to 100% with 15 bit resolution
Single channel bandwidth	400 MHz (800 MHz I/Q)

Key Characteristics (continued)

External triggers

Number of inputs	8 each (4 SMB female front-panel connectors plus four software triggers over the LXI interface from host processor)	
Trigger polarity	Negative/positive	
Trigger impedance	2 k ohms	
Maximum input level	± 4.5 volts	
Input sensitivity	250 mV	
Trigger threshold	–4.3 volts to +4.3 volts	
Trigger timing resolution	Clock/8 (6.4 ns at 1.25 GS/s rate) (option 125)	Clock/8 (12.8 ns at 625 MS/s rate) (option 062)
Trigger latency	34 times clock/8 (217.6 ns at 1.25 GS/s rate) (option 125)	34 times clock/8 (435.2 ns at 625 MS/s rate) (option 062)
Trigger uncertainty	< 50 ps	
Minimum trigger width	12.8 ns at 1.25 GS/s clock rate (option 125)	25.6 ns at 625 MS/s clock rate (option 062)
Trigger delay	Programmable from 1 to 256 sync clock cycles with 1 sync clock cycle resolution ²	

LXI triggering modes

Driver command based	A driver interface on the controlling computer is used to directly transmit a command to the module.
Direct LAN messaging	A data packet containing triggering information (including a time stamp) is sent directly from one module to another via the LAN.
Time based events	An IEEE 1588-based time trigger is set and executed internally in a module.
LXI trigger bus-based	A module function is triggered via a voltage on the LXI trigger bus.

The LXI triggering conforms to the specifications of the LXI standard, revision 1.0,
www.lxistandards.org

² A sync clock cycle is clock/8

Key Characteristics (continued)

External markers

Markers	Can be defined for each waveform segment.	
Number of outputs	4 each SMB female	
Marker polarity	Negative, positive	
Output impedance	50 ohms	
Marker low level	100 mV nominal into high impedance load	
Marker high level	3.2 volts nominal into high impedance load	
Marker timing resolution	Clock/8 (6.4 ns at 1.25 GS/s rate) (option 125)	Clock/8 (42.8 ns at 625 MS/s rate) (option 062)
Marker latency	Marker precedes analog output and is adjustable in 2 sample clock period steps.	
Marker latency repeatability	<100 ps	
Marker width	Programmable from 1 to 256 sync clock cycles ²	
Marker delay	Programmable from 8 to 502 sample clock cycles, with 2 sample clock cycle resolution	
LXI markers	Two LXI markers are available	
Module synchronization	Supports system scaling for any number of N8241A modules. A single module can support a fan-out of 8 N8241A modules for precise triggering and repeatability. Driver boards may be used to scale any number of modules.	
Sync clock output level	800 mV p-p (50 ohms, AC coupled)	
Sync clock input sensitivity	100 mV p-p minimum into 50 ohms AC coupled	

Analog output

Output connector	SMA female	
Output impedance	50 ohms	
Analog output levels	The following output levels are specified into 50 ohms	
	Single-ended	Differential
	Passive mode	0.5 Vp-p
	Active mode	1 Vp-p with ± 0.2 V offset
	Direct DAC mode	N/A
		1 Vp-p (0 volt offset)
Uncorrected passband flatness	± 1 dB DC - 200 MHz; ± 2.5 dB DC - 500 MHz (with 1.25 GHz clock)	
Uncorrected passband group delay	± 500 ps DC - 200 MHz; ± 1 ns DC - 500 MHz (with 1.25 GHz clock)	
Reconstruction filters	500 MHz and 250 MHz realized as 7-pole Cauer Chebychev filters plus thru-line output	
Pulse response	Rise time (10 to 90%): < 1 ns Fall time (10 to 90%): < 1 ns Amplitude: 0.25 V peak	

² A sync clock cycle is clock/8

General Characteristics

LXI Class A Certified

Power

10 to 132 VAC, 50 to 60 Hz, or 195 to 267 VAC, 50 to 60 Hz (automatically selected), 90 watts maximum

Environmental

Operating temperature 0 to +50 degrees C (meets IEC-60068-2-1 and IEC-60068-2-2)

Storage temperature –20 to +70 degrees C (meets IEC-60068-2-1 and IEC-60068-2-2)

Relative humidity 10 to 90% at 40 degrees C, non-condensing

Altitude 0 to 2000 m above mean sea level

Shock and vibration

Transportation shock 50 G peak trapezoidal [meets IEC-60068-2-27]

End use handling shock 75 G peak, 1/2 Sine (2-3 ms) [meets IEC-60068-2-27]

Operating random 5-500 Hz, 0.21 g RMS [meets IEC-60068-2-64]

Survival swept sine 5-500 Hz, 0.5 g [meets IEC-60068-2-6]

Survival random 5-500 Hz, 2.09 g RMS [meets IEC-60068-2-6]

Safety

Designed for compliance to EN 61010-1 (2001)

EMC

Meets the conduction and radiated interference and immunity requirements of EN 61326-1.

Weight

5.0 kg (11 lb)

Security

All user data stored in volatile memory

Dimensions

2U, 1/2 rack wide 8.8 H x 21.6 W x 44.7 D cm (3.5 H x 8.5 W x 17.6 D inches)
(conforms to LXI standards)

ISO compliance

This modular instrument is manufactured in an ISO-9001 registered facility in concurrence with Agilent Technologies, Inc. commitment to quality.

Ordering Information



Figure 12. Agilent N8241A 15-bit arbitrary waveform generator LXI module

N8241A 15-bit arbitrary waveform generator with 8 MS memory per channel

Options

N8241A-125	1.25 GS/s sample rate
N8241A-062	625 MS/s sample rate
N8241A-016	Waveform memory expansion to 16 MSa per channel
N8241A-250	Additive white Gaussian noise (available in 2007)
N8241A-300	Enabling software for 16-bit dynamic sequencing (requires U.S. export license)
N8241A-330	Direct digital synthesis software (requires U.S. export license)

Web Resources

Visit our web sites for additional product information and literature.

N8241A 15-bit arbitrary waveform generator:
www.agilent.com/find/synthetic

N6030A Series of arbitrary waveform generators:
www.agilent.com/find/awg

Signal simulation systems:
www.agilent.com/find/signalsimulation

Aerospace and defense test and measurement products and services:
www.agilent.com/find/ad

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Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you receive your new Agilent equipment, we can help verify that it works properly and help with initial product operation.

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Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.



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