Agilent
N6031A Arbitrary Waveform Generator
1.25 GS/s, 10 Bit

Technical Overview

- 1.25 Gigasamples per second (GS/s) and 10 bits of vertical resolution per channel provides wideband waveforms with exceptionally low EVM
- Dual output channels drive both single-ended and balanced designs without the need for baluns or hybrids
- Extended memory and advanced sequencing engine allows for extended simulations of complex waveform propagation models
- Multiple module synchronization provides multi-emitter simulations suitable for MIMO applications
- Multiple programmatic interfaces enable easy integration into existing test environments

Agilent Technologies

Generate Wide Bandwidth *AND* Low EVM Signals, Simultaneously

The N6031A is a wideband arbitrary waveform generator (AWG) capable of creating digitally modulated waveforms for wideband communication systems. Each channel of the N6031A operates at 1.25 GS/s and features 10 bits of vertical resolution, which is ideal for compliance testing of digital radios targeted for use with emerging communication standards such as MB-OFDM ultra wideband, 802.11n, MIMO, and proprietary wideband formats. This 4 slot 3U CompactPCI 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 N6031A 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 N6031A is combined with a wideband I/Q upconverter, modulation bandwidths of 1 GHz can be realized at RF frequencies for signal simulations employed in functional testing of chip sets designed for modern digital communications radios.[1]

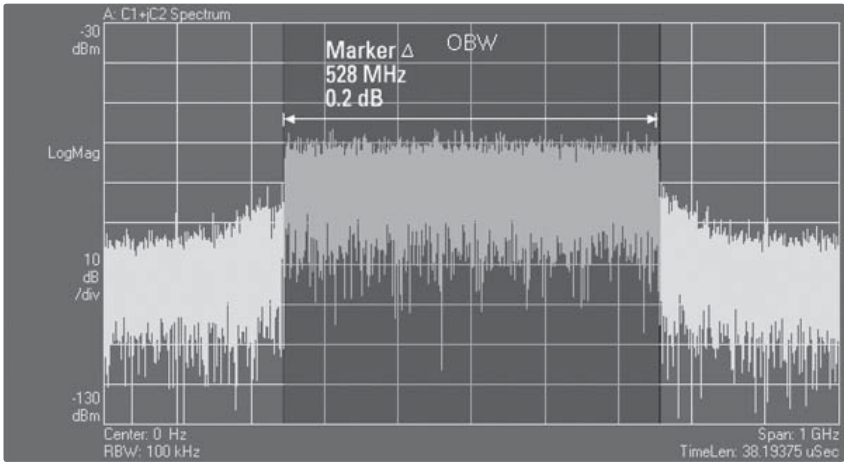

Figure 1a. Generate MB-OFDM compliant UWB waveforms.

Extended performance

The N6031A gives designers access to Digital-to-Analog Converter (DAC) technology capable of generating wideband digital communications signals with ultra-low EVM. Each module incorporates two high-speed DACs to create 500 MHz of signal bandwidth and ≤-50 dBc SFDR across each channel. Users have the choice of driving their designs differentially from the DAC outputs or 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 N6031A 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.

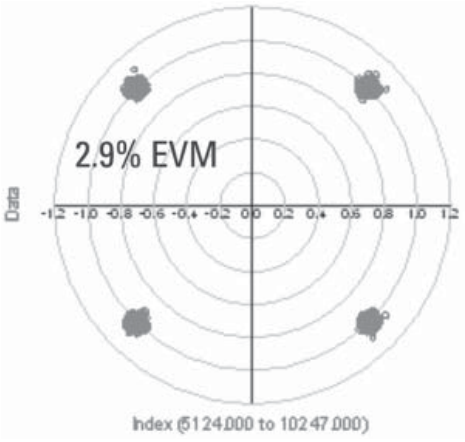

Figure 1b. Create UWB reference waveforms with low EVM.

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

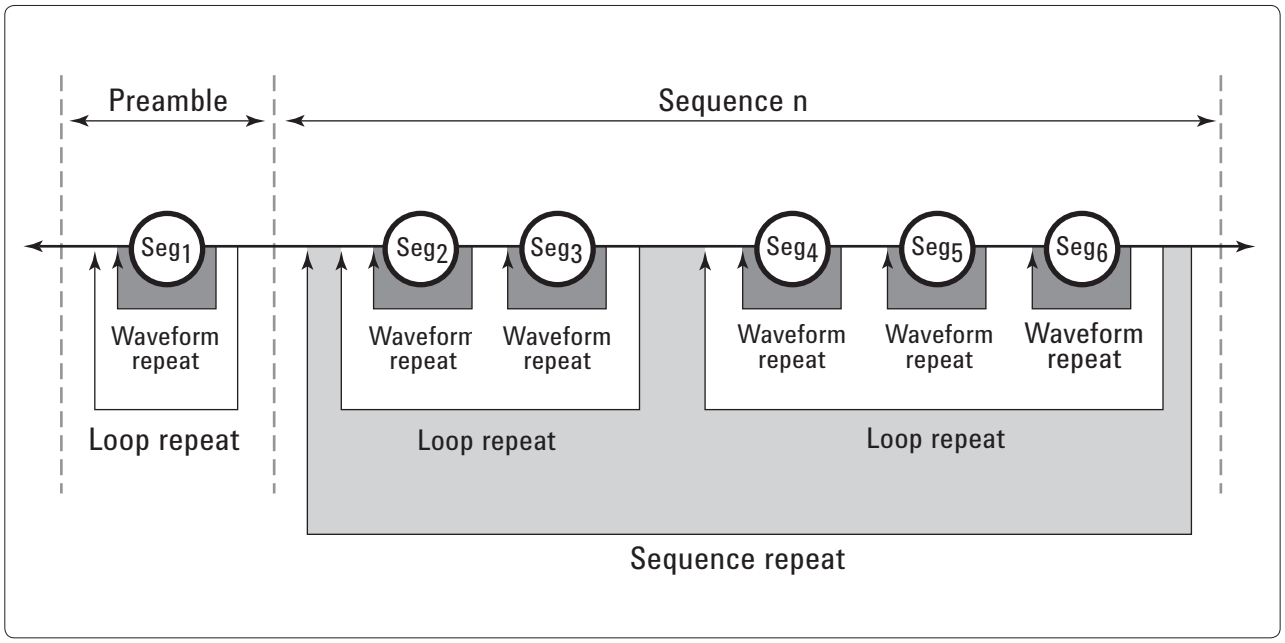

Figure 2. Create sophisticated signal scenarios by looping and nesting waveforms.

Create long scenario simulations

Multiply the effective size of on-board memory through the use of the N6031A's advanced sequencing engine. Uniquely define how waveform Create long scenario simulations Multiply the effective size of on-board memory through the use of the N6031A's advanced sequencing engine. Uniquely define how waveform segments are played through looping and nesting of stored waveform models. This capability gives users the ability to simulate fading and other multi-path effects for extended periods of time. For users developing a large number of propagation models the CompactPCI backplane substantially reduces waveform download times compared to traditional LAN and GPIB interfaces. The N6031A's complete waveform and sequencer memories can be typically reloaded in less than 1 second.

Figure 3. Multi-path effects can be simulated through propagation models.

System scalability

Create phase-coherent, multiemitter simulations using the N6031A's precision SYNC clock. A single N6031A can drive a total of eight AWG modules to synchronize their outputs on a sample-by-samplebasis. Any number modules canbe synchronized with simple driver hardware. The AWG also includes multiple front-panel trigger and markers for complete system synchronization.

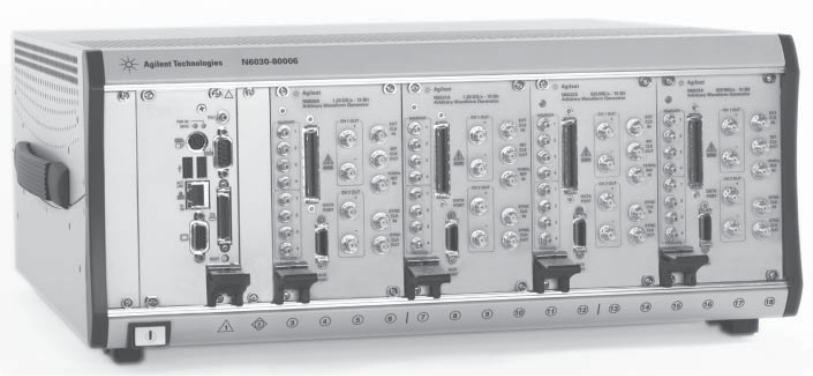

Figure 4. Four N6031A modules fit conveniently inside an 18 slot CompactPCI chassis.

Ease-of-use

The N6031A'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 N6031A supports interfaces for MATLAB®, LabView, IVI-C, and VEE framework.

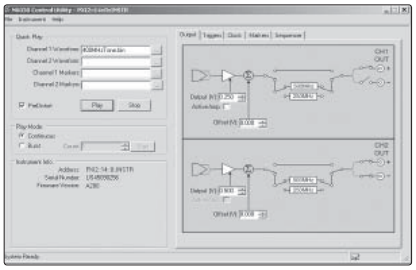

Figure 5. Directly import and play waveforms from the Quick Play menu.

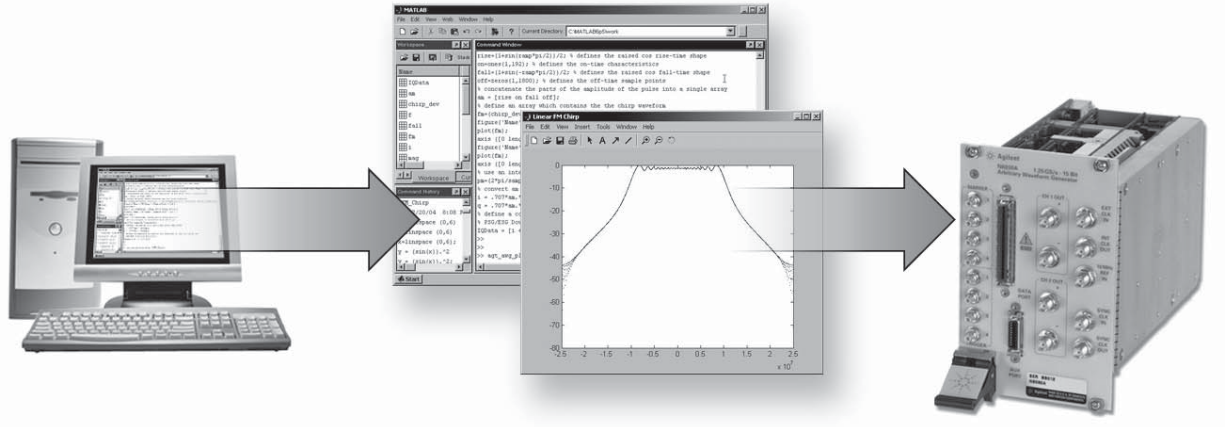

Figure 6. Play waveforms files directly from the MATLAB command line.

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 16k 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.

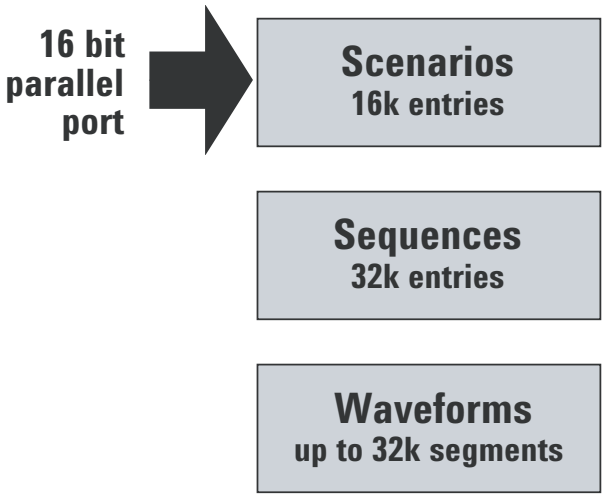

Figure 8. Create signals where the next waveform to be played is not known in advance.

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).

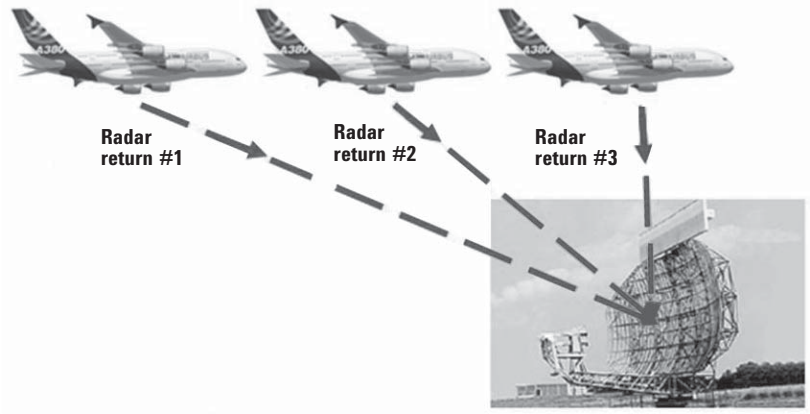

Figure 9. Define signals by carrier frequency and modulation – instant by instant.

Key Characteristics

Channels
Two independent channels available as baseband or IF outputs

- CH1: Single-ended and differential
- CH2: Single-ended and differential

Modulation bandwidth
500 MHz per channel (1 GHz IQ bandwidth)

Resolution
10 bits (1/1024 levels)

Output spectral purity – (CH1 and CH2)

- Harmonic distortion: ≤–50 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 band width

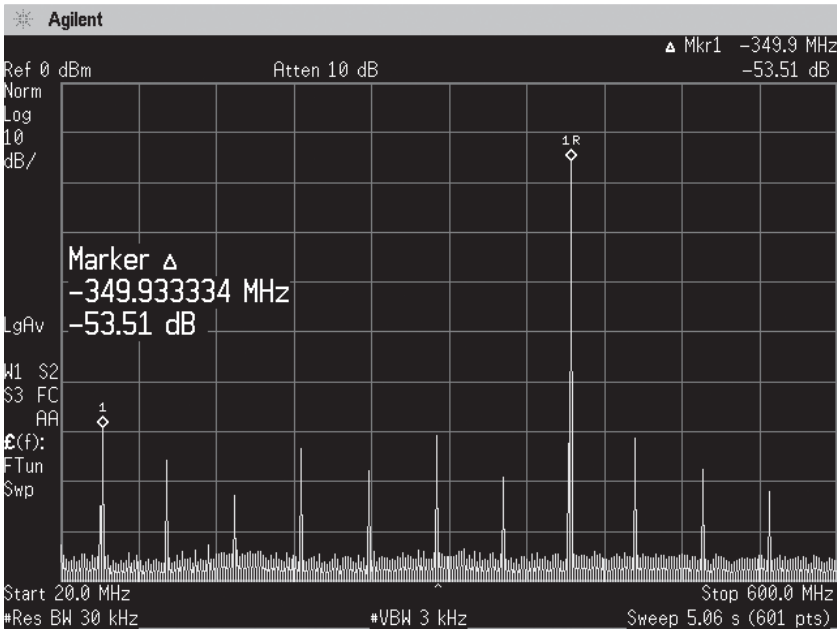

Figure 10. Excellent harmonic and spurious performance are available across the full bandwidth of each channel.

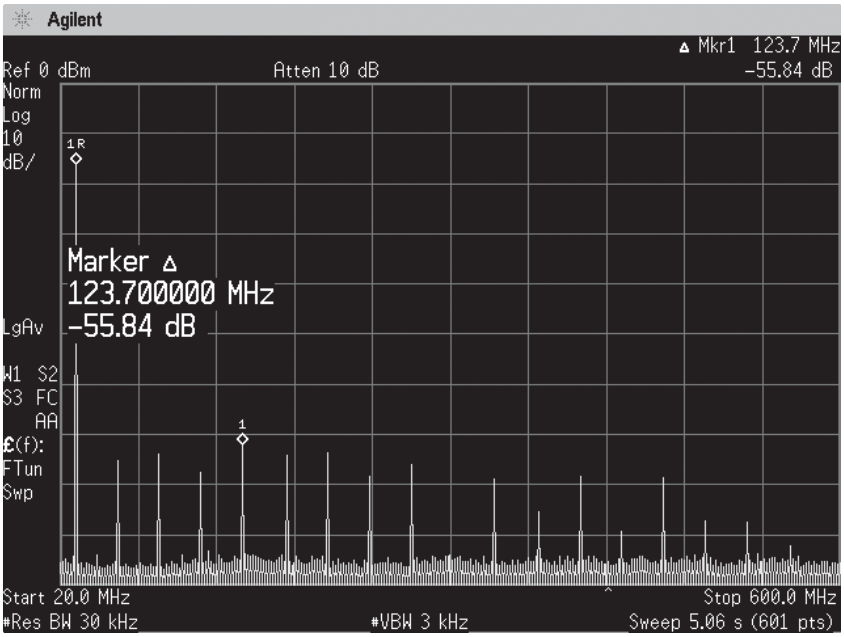

Figure 11. Spurious performance outstanding at low signal frequencies.

Key Characteristics continued

Sample clock

Internal
Fixed 1.25 GS/s

Internal clock output
+3 dBm nominal

External clock input
Tunable 100 MS/s to 1.25 GS/s

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

Segment
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 (220) loops can be defined for each segment. Loops can be configured to advance in one of four modes:

- **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 wave form 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

Scenario jump modes

Scenario jumps determine how a sequence responds to a jump trigger. There are no discontinuities in a scenario jump other than those imposed by the waveform data. Three modes are available to control scenario jumps:

- **Jump immediate**
  Jumps immediately to the next specifie scenario address with a fixed latency.
- **End of waveform**
  The current waveform (including repeats) is completed before jumping to a new scenario.
- **End of scenario**
  The current scenario is completed before jumping to a new scenario. Jump latency is the longer of either the jump immediate latency or the length of the remaining scenario.

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 volts 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 16k

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 over the PCI backplane 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)

External triggers

Number of inputs
8 each (4 SMB female frontpanel connectors plus four software triggers over the PCI backplane from host processor)

Trigger polarity
Negative/positive

Trigger impedance
2k ohms

Maximum input level
±4.5 volts

Input sensitivity
250 mV

Trigger threshold
–4.3 volts to +4.3 volts

Trigger timing resolution
Sample clock/8
(6.4 ns at full rate)

Trigger latency
34* clock/8
(217.6 ns at full rate)

Trigger uncertainty
< 50 ps

Minimum trigger width
12.8 ns at full clock rate

Trigger delay
Programmable from
1 to 256 sync clock cycles with
1 sync clock cycle resolution[1]

[1] 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 full rate)

Marker latency
Marker precedes analog output and is adjustable in 2 sample clock period steps.

Marker latency repeatability
<100 ps

Marker width
Programmable with from 1 to 256 sync clock cycles1

Marker delay
Programmable from –8 to 502 sample clock cycles, with 2 sample clock cycle resolution

Module synchronization

Supports system scaling for any number of N6031A modules. A single module can support a fan-out of 8 N6031A 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

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	N/A
Active mode	1 Vp-p with ±0.2 V offset	N/A
Direct DAC mode	N/A	1 Vp-p (0 volt offset)

Corrected passband flatness
±0.5 dB DC - 500 MHz (with 1.25 GHz clock)

Corrected passband group delay
±150 ps rms 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
0.5 V pk-pk

[1] A sync clock cycle is clock/8.

General Characteristics

Power

Supply	Typical operation (Watts)
+3.3 VDC	11.2
+5 VDC	22
+12 VDC	5
–12 VDC	5
Total power	**43.2**

Environmental

Samples of this product have been type tested in accordance with the Agilent Environmental Test Manual and verified to be robust against the environmental stresses of Storage, Transportation, and End-use; those stresses include but are not limited to temperature, humidity, shock vibration, altitude, and power line conditions. Test methods are aligned with IEC 60068-2 and levels are similar to MIL-PRF-28800F Class 3.

Operating temperature

0 to +55 degrees C

Storage temperature:

-20 to +70 degrees C

Relative humidity

Type tested: 10 to 90% at 40 degrees C (non-condensing)

Altitude

0 to 2000m (6500 ft) above sea level

Safety

Designed for compliance to IEC 61010-1:2001

EMC

Meets the conducted and radiated emissions and immunity requirements of IEC 61326:2002 when tested with EMC shielded filler panels (Agilent P/N N6030-80007, kit of 6) separating the controller and the N6031A module, and in all open slots. The RFI gaskets must be oriented to the right.

Weight

1.14 kg (2.5 lb)

Security

All user data stored in volatile memory

Dimensions

3U, 4 slot CompactPCI module

8.1 x 13 x 21.6 cm
(3.2 x 5.1 x 8.5 inches)

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 10. Agilent N6031A AWG with controller in CompactPCI chassis

N6031A	Arbitrary waveform generator with 8 MS memory per channel
Option	**Description**
N6031A-016	Waveform memory expansion to 16 MSa per channel
N6030A-300	Enabling software for 16-bit dynamic sequencing
N6030A-330	Direct digital synthesis software
N6030A-500	PXI 18-slot chassis
N6030A-501	PXI embedded controller, P4
N6030A-502	PXI MXI-4 kit (includes PC and chassis PCI cards)
N6030A-503	Shielded PXI chassis filler panel kit
N6030A-504	17-inch flat panel monitor
N6030A-505	PS2 keyboard and mouse
N6030A-506	Rack mount kit for PXI chassis

NOTE: For the N6031A to work properly, at least one PXI chassis and one PXI controller type must be available. These should be ordered from the options 500, 501 or 502 choices above or they must be customer-supplied

Web Resources
Visit our web sites for additional product information and literature.

N6031A Arbitrary waveform generator
www.agilent.com/find/awg

Signal simulation systems
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