

Agilent N6033A Arbitrary Waveform Generator 625 MS/s, 10 Bit

Technical Overview



- 625 megasamples per second (MS/s) and 10 bits of vertical resolution per channel 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



Generate wide bandwidth AND wide dynamic range signals, simultaneously

The N6033A is a wideband arbitrary waveform generator (AWG) capable of creating digitally modulated waveforms for wideband communication systems. Each channel of the N6033A operates at 625 MS/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 N6033A 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 N6033A is combined with a wideband I/Q upconverter, modulation bandwidths of 500 MHz can be realized at RF frequencies for signal simulations employed in functional testing of chip sets designed for modern digital communications radios.¹

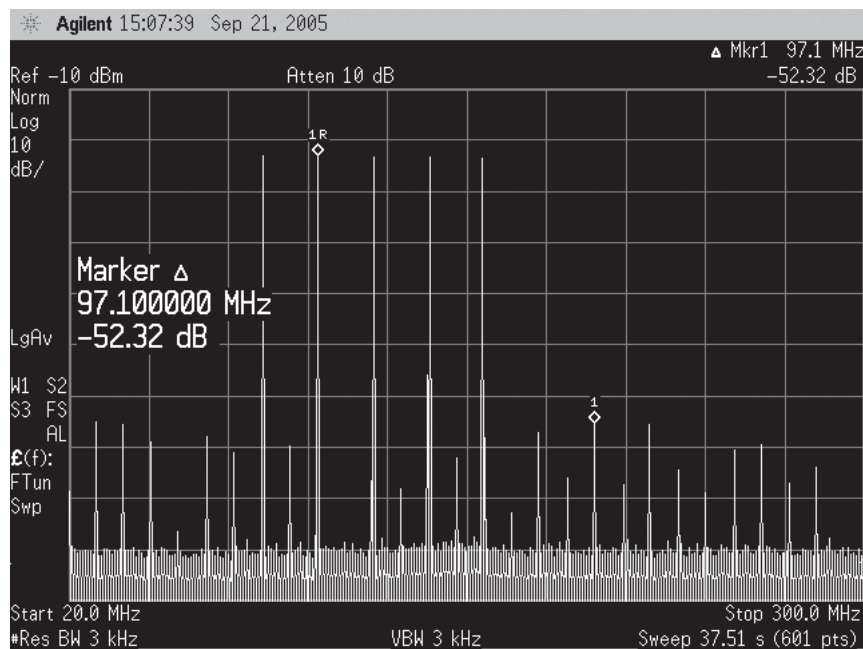


Figure 1. Generate wideband waveforms with unprecedented signal fidelity.

Extended performance

The N6033A 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 250 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 N6033A 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

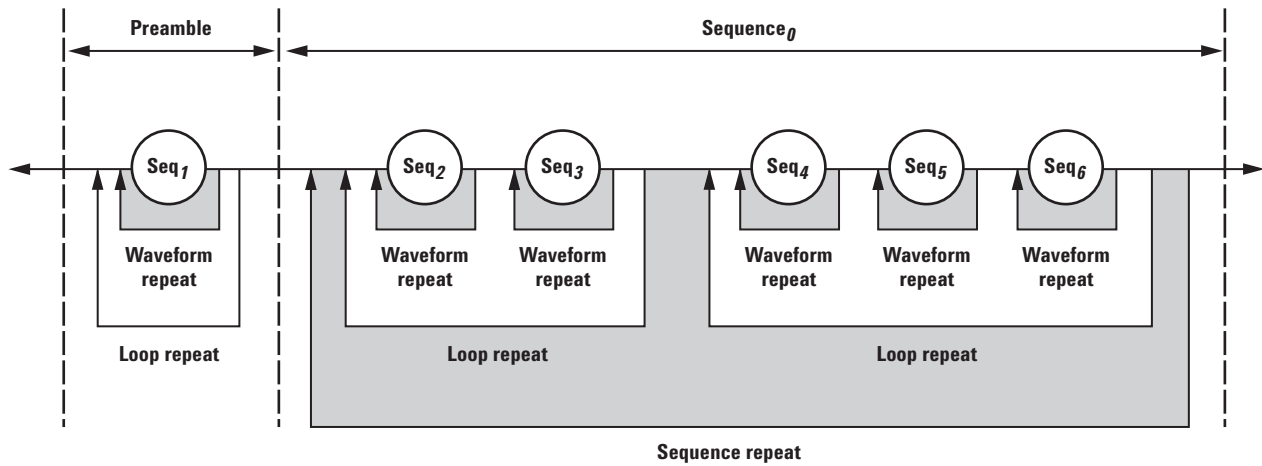


Figure 2. Create sophisticated signal scenarios by looping and nesting waveforms.

Create long scenario simulations

Multiply the effective size of on-board memory through the use of the N6033A'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 N6033A's complete waveform and sequencer memories can be typically reloaded in less than 1 second.

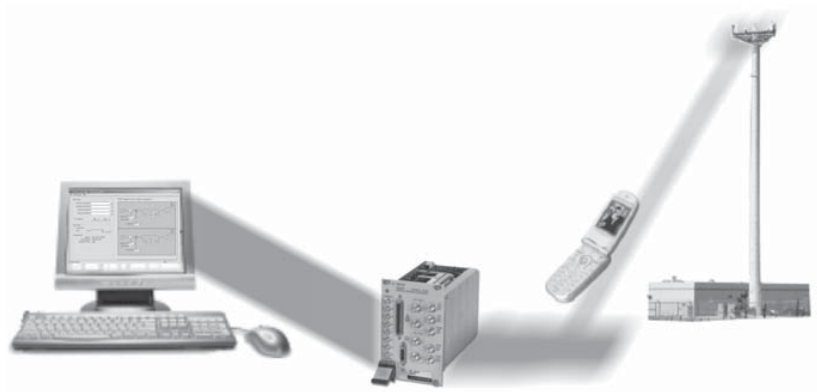


Figure 3. Multi-path effects can be simulated through propagation models.

System scalability

Create phase-coherent, multi-emitter simulations using the N6033A's precision SYNC clock. A single N6033A can drive a total of eight AWG modules to synchronize their outputs on a sample-by-sample basis. Any number 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 N6033A'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 N6030A supports interfaces for MATLAB®, LabView, IVC and VEE framework.

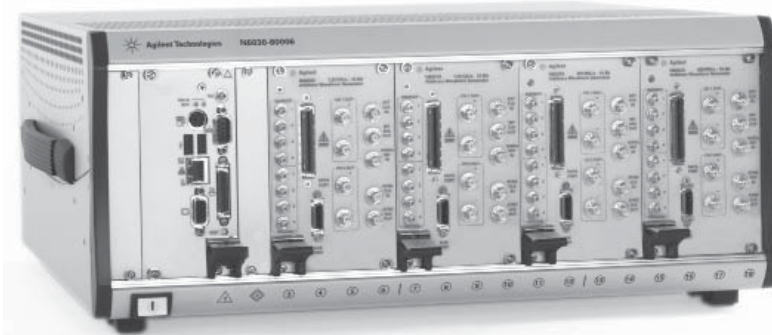


Figure 4. Four N6033A modules fit conveniently inside an 18 slot CompactPCI chassis.

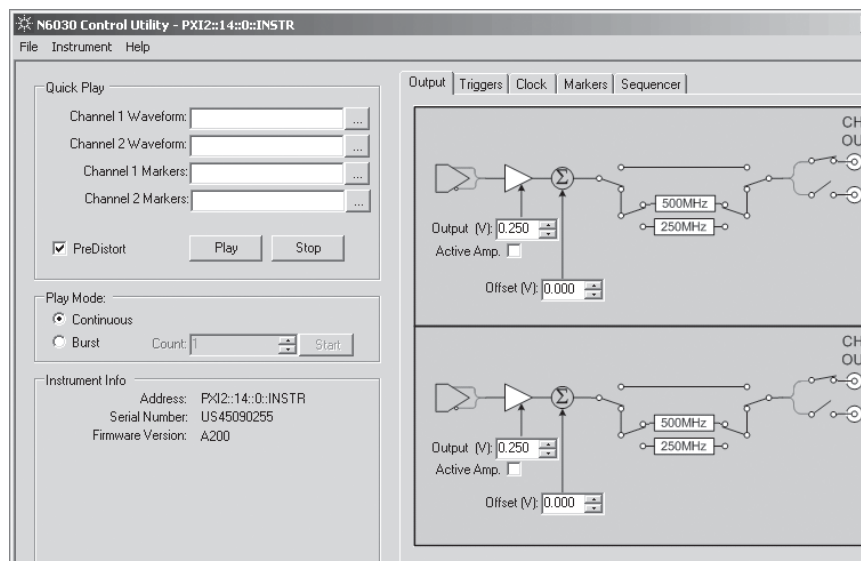


Figure 5. Directly import and play waveforms from the Quick Play menu.

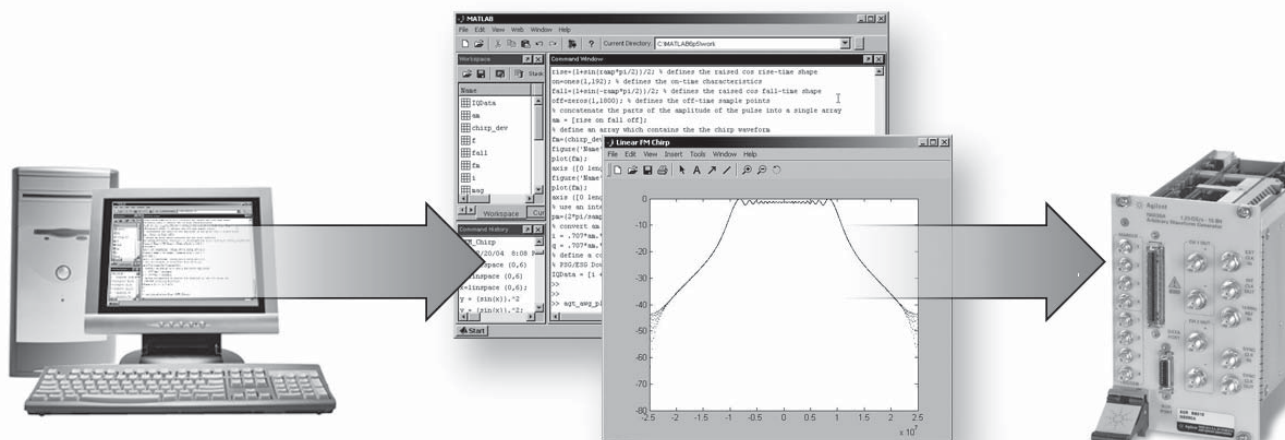
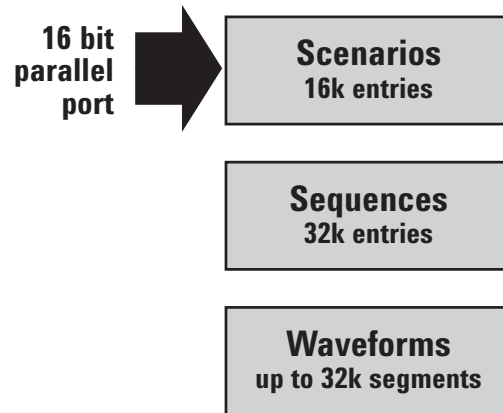


Figure 6. Play waveforms files directly from the MATLAB command line.

Enhanced capabilities for the N6030 Series!

Dynamic Sequencing (option 300)

The dynamic sequencing software enables radar and military communications engineers to build custom signal scenarios the fly. Engineers can dynamically access up to 16k of previously stored sequences through a 16-bit interface replay these complex waveforms to respond changing threat environments, or to create signals where the next waveform played is not known in advance.



Direct Digital Synthesis (option 330)

The direct digital synthesis software enables radar and emerging communications engineers to create waveforms in the AWG's memory and modify their behavior with profiles for amplitude modulation, phase modulation and frequency modulation. This enables engineers to simulate testing without time and expense of field trials, such as inflight and in-orbit testing. This option also be used to simulate fading profiles receiver testing for satellite and 4G signals, such as multiple input, multiple output formats (MIMO).

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

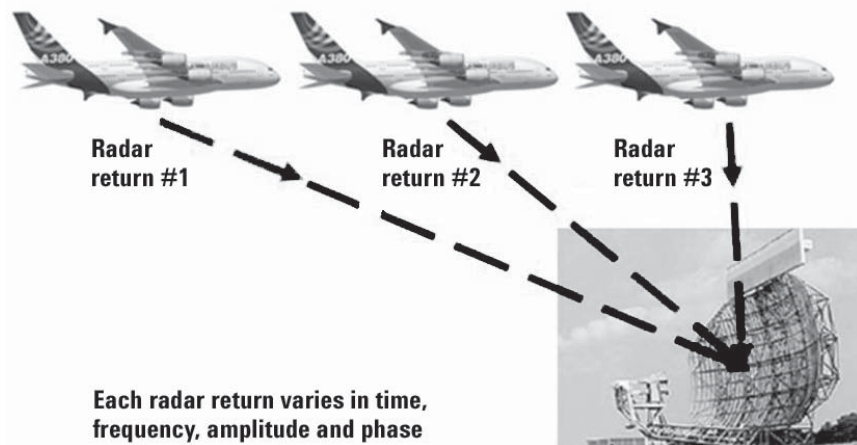


Figure 9. Define signals by carrier frequency and modulation—*instant by instant*.

Key characteristics

Channels

Two independent channels available as baseband or IF outputs

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

Modulation bandwidth

250 MHz per channel
(500 MHz IQ bandwidth)

Resolution

10 bits (1/1024 levels)

Output spectral purity— (CH1 and CH2)

- **Harmonic distortion:**
≤ -50 dBc for each channel DC to 250 MHz
- **Non-harmonic spurious:**
≤ -75 dBc for each channel DC to 250 MHz
- **Noise floor:**
≤ -150 dBc/Hz across the channel bandwidth

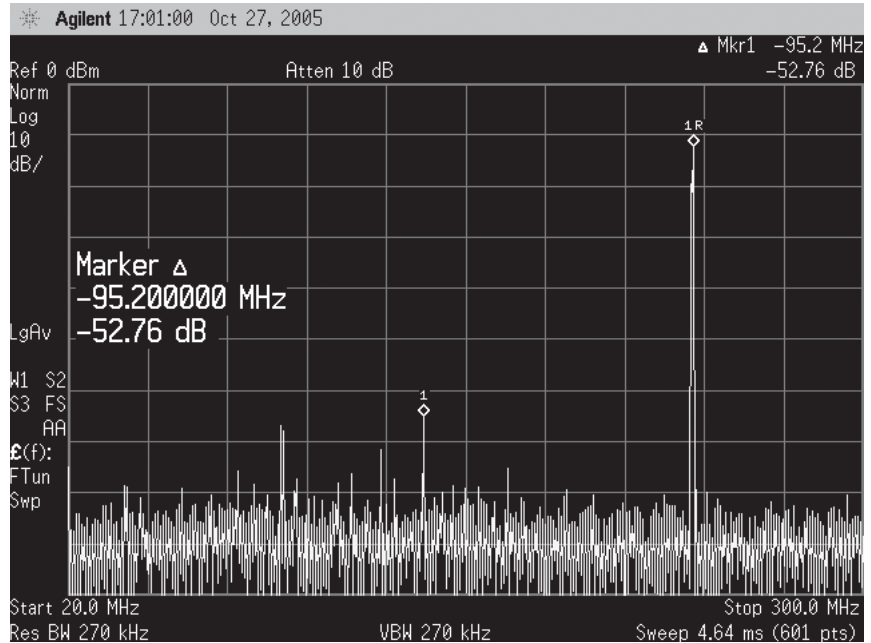


Figure 10. Excellent harmonic and spurious performance are available across the full bandwidth of each channel.

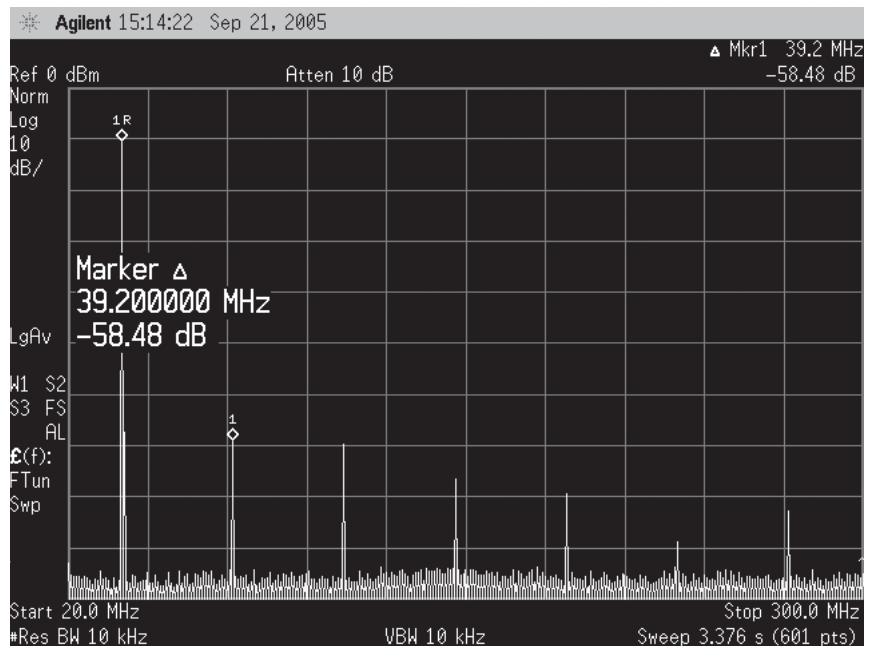


Figure 11. Spurious performance outstanding at low signal frequencies.

Key characteristics continued

Sample clock

Internal

Fixed 625 MS/s

Internal clock output

+3 dBm nominal

External clock input

Tunable 100 MS/s to 625 MS/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

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:

- **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

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:

- **Jump immediate**

Jumps immediately to the next specified sequence 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 sequence 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 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: 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)**

0 to 62.5 MHz peak;
(125 MHz peak-peak)

Output frequency resolution:
0.125 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:
250 MHz (500 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 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

Clock/8 (12.8 ns at full rate)

Trigger latency

34 * Clk/8 (435.2 ns at full rate)

Trigger uncertainty

< 50 ps

Minimum trigger width

12.8 ns at full clock rate

Trigger delay

Programmable from 1 to 255 sync clock cycles with 1 sync clock cycle resolution

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 1 sync clock cycle resolution

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 N6033A modules. A single module can support fan-out of 8 N6033A 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 V _{p-p}	N/A
Active mode	1 V _{p-p} with ±0.4 V _{p-p} offset	N/A
Direct DAC mode	N/A	1 V _{p-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%): < 1ns
Fall time (10 to 90%): < 1ns
Amplitude: 0.25V peak

General characteristics

Power

Supply	Typical operation (watts)
+3.3 VDC	11.2
+5 VDC	22.0
+12 VDC	5.0
-12 VDC	5.0
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 N6033A 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)

Calibration cycle

1 year warranty, platform calibration not required.

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 N6033A AWG with controller in CompactPCI chassis

N6033A Arbitrary waveform generator with 8 MS memory per channel

Options

N6033A-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

Web resources

Visit our web sites for additional product information and literature.

N6033A Arbitrary waveform generator

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

Test and measurement accessories

www.agilent.com/find/accessories

NOTE: For the N6033A 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.



Agilent Email Updates

www.agilent.com/find/emailupdates
Get the latest information on the products and applications you select.



Agilent Direct

www.agilent.com/find/agilentdirect
Quickly choose and use your test equipment solutions with confidence.



www.agilent.com/find/open
Agilent Open simplifies the process of connecting and programming test systems to help engineers design, validate and manufacture electronic products. Agilent offers open connectivity for a broad range of system-ready instruments, open industry software, PC-standard I/O and global support, which are combined to more easily integrate test system development.



www.lxistandard.org
LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Agilent is a founding member of the LXI consortium.

Remove all doubt

Our repair and calibration services will get your equipment back to you, performing like new, when promised. You will get full value out of your Agilent equipment throughout its lifetime. Your equipment will be serviced by Agilent-trained technicians using the latest factory calibration procedures, automated repair diagnostics and genuine parts. You will always have the utmost confidence in your measurements. For information regarding self maintenance of this product, please contact your Agilent office.

Agilent offers a wide range of additional expert test and measurement services for your equipment, including initial start-up assistance, onsite education and training, as well as design, system integration, and project management.

For more information on repair and calibration services, go to:

www.agilent.com/find/removealldoubt

For more information on Agilent Technologies' products, applications or services, please contact your local Agilent office. The complete list is available at:

www.agilent.com/find/contactus

Americas

Canada	(877) 894-4414
Latin America	305 269 7500
United States	(800) 829-4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Thailand	1 800 226 008

Europe & Middle East

Austria	01 36027 71571
Belgium	32 (0) 2 404 93 40
Denmark	45 70 13 15 15
Finland	358 (0) 10 855 2100
France	0825 010 700
Germany	07031 464 6333
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
Switzerland	0800 80 53 53
United Kingdom	44 (0) 118 9276201

Other European Countries:

www.agilent.com/find/contactus

Revised: October 1, 2008

Product specifications and descriptions in this document subject to change without notice.

© Agilent Technologies, Inc. 2009
Printed in USA, July 22, 2009
5989-4079EN

