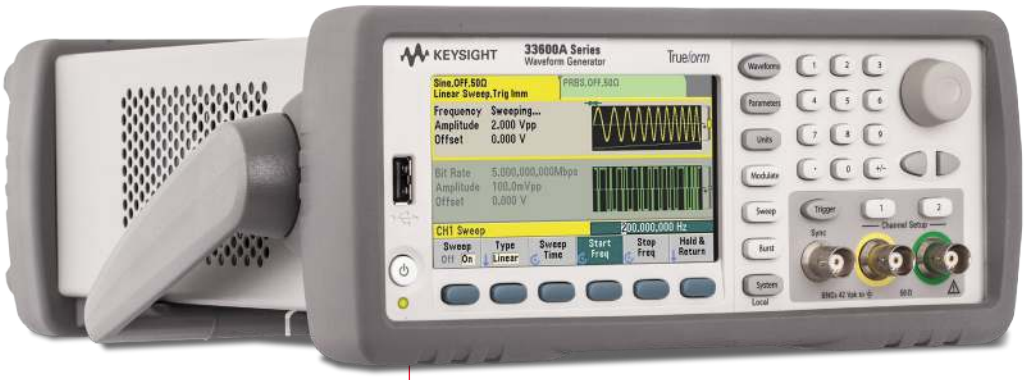
Keysight Technologies
33600A Series True*form* Waveform Generators

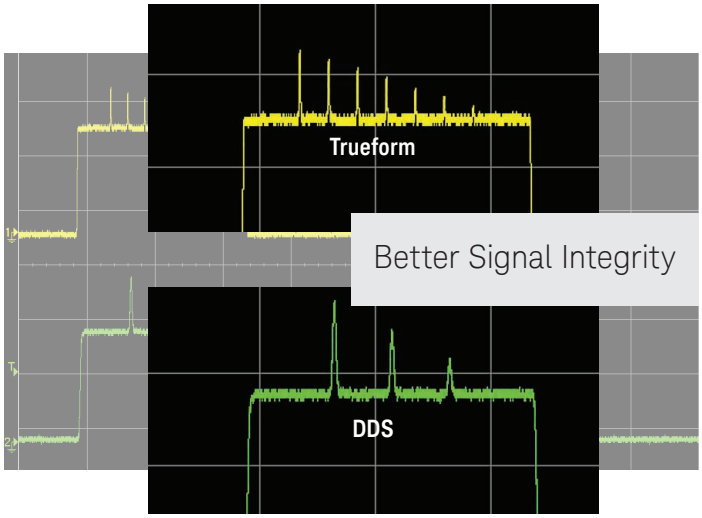


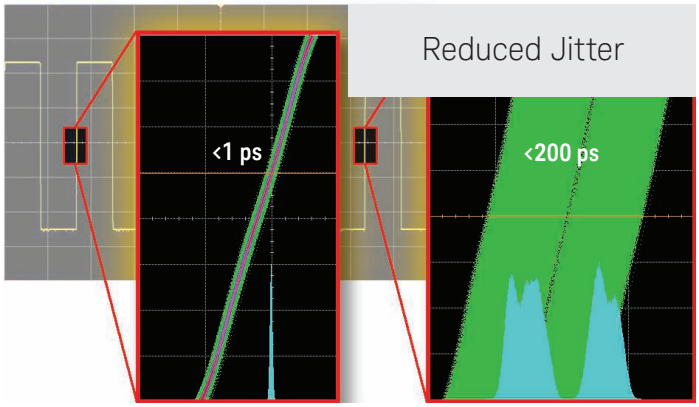
Data Sheet

KEYSIGHT TECHNOLOGIES

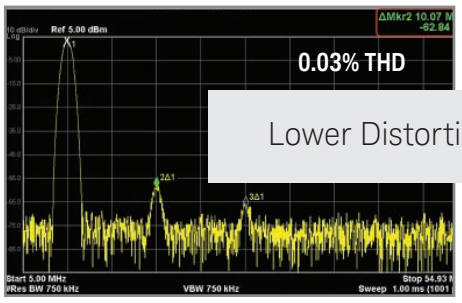
Generate True*form* arbitrary waveforms with less jitter, more fidelity and greater resolution

Revolutionary advances over previous generation DDS





Trueform technology DDS technology



33600A Series waveform generators with exclusive True*form* signal generation technology offer more capability, fidelity and flexibility than previous generation Direct Digital Synthesis (DDS) generators. Use them to accelerate your development process from start to finish.

- 1 GSa/s sampling rate and up to 120 MHz bandwidth
- Arbs with sequencing and up to 64 MSa memory
- 1 ps jitter, 200x better than DDS generators
- 5x lower harmonic distortion than DDS
- Compatible with Keysight Technologies, Inc. BenchVue software

Over the past two decades, DDS has been the waveform generation technology of choice in function generators and economical arbitrary waveform generators. DDS enables waveform generators with great frequency resolution, convenient custom waveforms, and a low price.

As with any technology, DDS has its limitations. Engineers with exacting requirements have had to either work around the compromised performance or spend up to 5 times more for a high-end, point-per-clock waveform generator.

Keysight Technologies, Inc. Trueform technology offers an alternative that blends the best of DDS and point-per-clock architectures, giving you the benefits of both without the limitations of either. True*form* technology uses an exclusive digital sampling technique that delivers unmatched performance at the same low price you are accustomed to with DDS.

The table below highlights the revolutionary capabilities of True*form* technology.

	DDS: Traditional 100 MHz waveform generator	**Trueform: Keysight 80 and 120 MHz waveform generator**	**Improvement**
Edge jitter	<200 ps	<1 ps	200x better
Custom waveform replication	Skips waveform points	100% point coverage	Exact waveform replication
Total harmonic distortion	0.2%	0.03%	5x better
Anti-alias filtering	Must provide externally	Always anti-aliased	No anti-aliasing artifacts
Sequenced arb	Not possible	Standard	Easily create complex waveform sequences

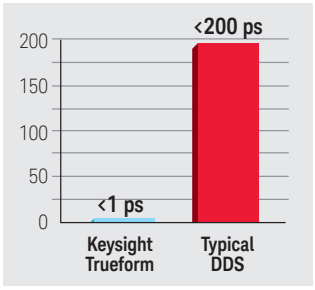
For more information about Keysight Trueform technology please visit: www.keysight.com/find/trueform

- Easily generate the full range of signals you need for the most demanding measurements
- Test your devices with confidence that the waveform generator is outputting the signals you expect
- Select just the capabilities you need now, then upgrade easily when your needs change

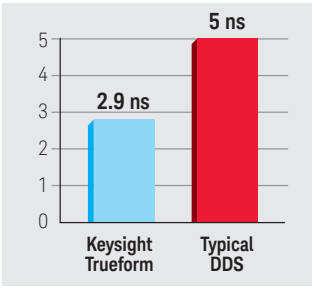
Unique features of the 33600A Series waveform generators

100 MHz PULSE	High-bandwidth pulse, 100 MHz, DDS pulse limited to 50 MHz Set leading and trailing edge times independently
PRBS PATTERNS	Provides standard PRBS patterns, PN3 through PN32 Select PN type, set bit rate, set edge times
2-CHANNEL COUPLING	Dual-channel coupling, frequency and amplitude, and tracking Set start phase for each channel, phase shift between channels
COMBINING SIGNALS	Sum two signals together, frequency and amplitude independent 2-tone (4-tone on 2-ch), square-sine, noise on pulse, and others
TRUEFORM ARBS	Create up to 4 million samples standard, 64 million optional Connect arb segments together, with up to 512 segments
LOW VOLTAGE SETTINGS	Lower voltage range at 1 mVpp, DDS is only 10 mVpp Set high and low voltage limits to prevent overload on DUT
BAND-LIMITED NOISE	Adjust bandwidth to concentrate the energy of the noise Noise source goes to full 120 MHz bandwidth

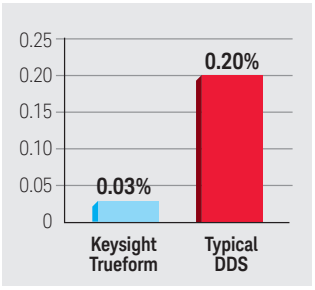
Key attributes



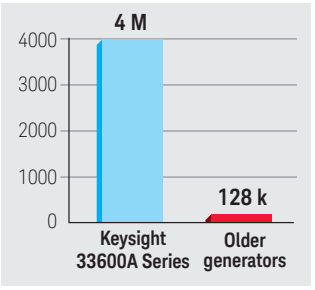
Jitter



Risetime



Total harmonic distortion



Standard memory

Unmatched capabilities for generating a full range of signals for the most demanding requirements

The 33600A Series waveform generators offer the common signals and features you expect, such as modulation, sweep and burst. However, it also offers features that give you the capabilities and flexibility you need to get your job done quickly, no matter how complex. An intuitive front-panel user interface, for example, can be quickly and easily relearned when your attention has been focused elsewhere. Built-in LAN, USB and optional GPIB interfaces allow you to easily control your instruments or transfer waveforms to your instrument. And that's just the beginning.

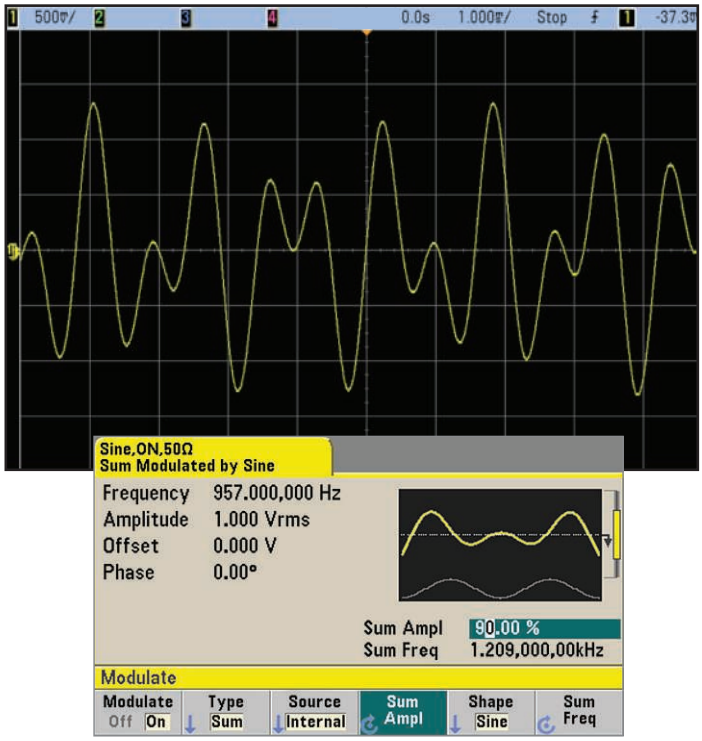
The 33600A Series waveform generators offer a variety of capabilities you can't find anywhere else—capabilities designed to help you accelerate your testing and get your project wrapped up faster:

Waveform summing and combining capability

Easily add noise to your signal for margin and distortion testing using only a single channel. You can create dual-tone multifrequency signals without a dual-channel generator, which means you can preserve your budget for other test needs. On a two-channel model, you can sum and combine up to four signals.

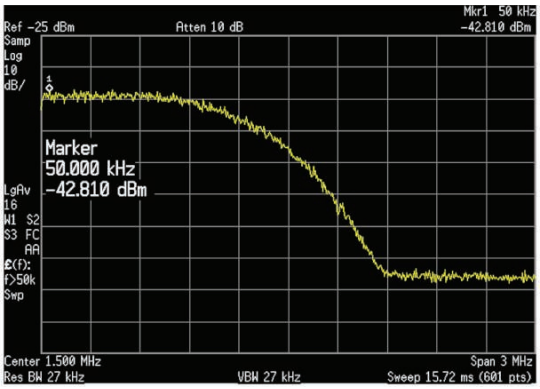
Variable-bandwidth noise

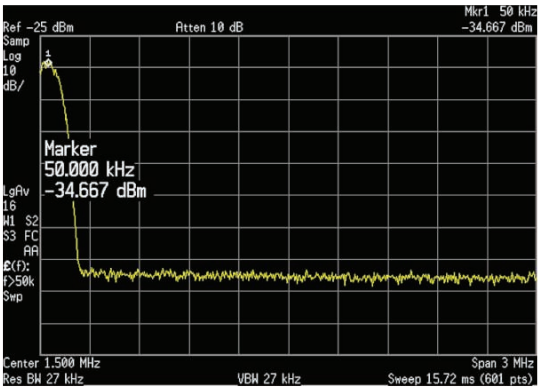
You can adjust the bandwidth of the built-in noise generator to control the frequency content of your signal. Apply just the frequency stimulus you need so you concentrate the energy of your waveform in frequency bands-of-interest.



Dual-tone signal created by summing waveforms using the modulation type "Sum."

The images at right show an approximate 10 dB increase in amplitude at 50 kHz when the bandwidth is reduced 10x. Note how the signal energy is increased in the frequencies-of-interest when the bandwidth is reduced, instead of being spread over a very wide bandwidth with lower amplitude at all frequencies.

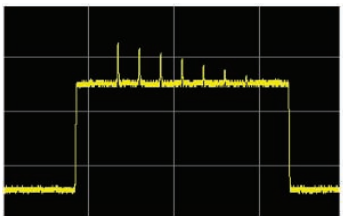




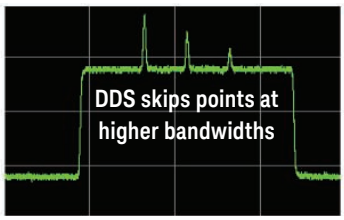
Capabilities (continued)

While DDS technology may skip points at higher frequencies, Trueform never skips points, and is always anti-aliased

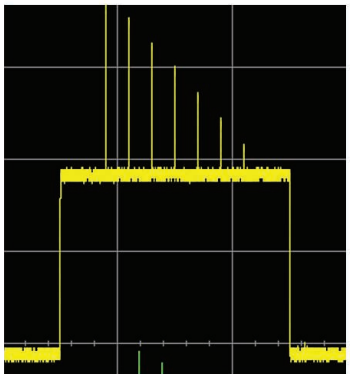
Define any waveform shape and any waveform length using the Trueform arbitrary waveform capability. Your waveforms are always anti-aliased for exceptional accuracy, and you can play them at any rate you select. Play your signals as defined, at your exact sample rate, without the chance of missing short-duration anomalies that are critical for testing device reliability.



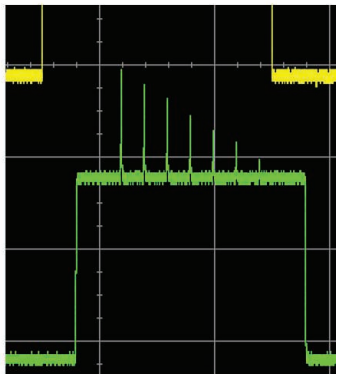
Trueform



DDS misses details



Trueform

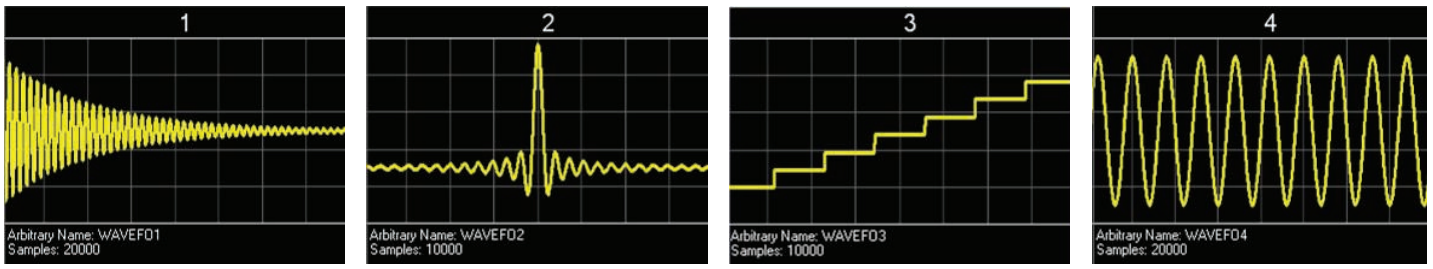


DDS

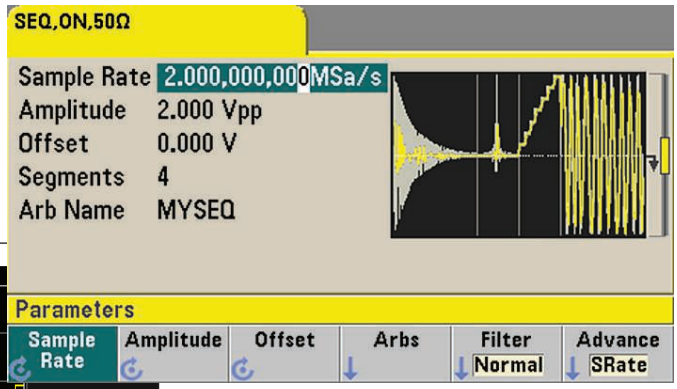
Waveform sequencing

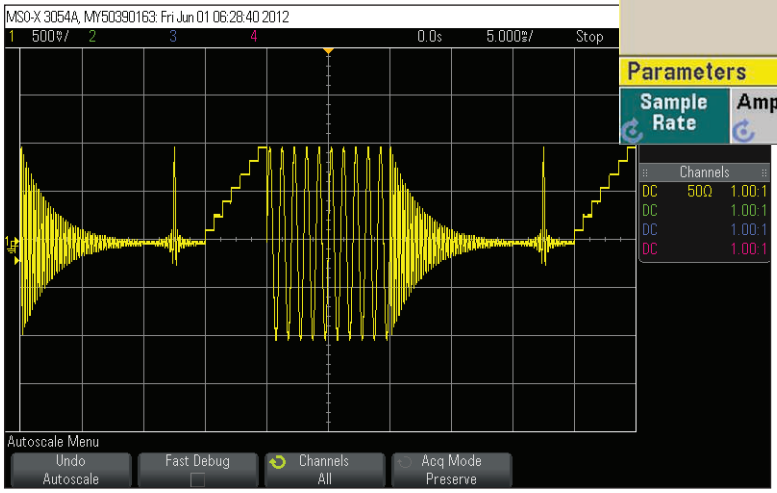
Waveform sequencing lets you create multiple configured waveforms with several common segments and lets you build long, complex waveforms using minimal instrument memory.

Create the waveform in the 33503A Waveform Builder Pro and download it to the waveform generator.



Waveform generator display with downloaded waveform.





Scope display of waveform.

Capabilities (continued)

Pseudo-random binary sequence (PRBS) pattern generation

Test your digital serial buses by streaming standard PRBS patterns—PN3 through PN32—without the need for a separate pulse generator. With fewer instruments, setting up your tests has never been easier. You won't find these built-in PRBS patterns in competitive waveform generators.

Smart phone and tablet access to full documentation

Need a quick answer? Get instant access to instrument documentation in seven different languages in smart-phone-friendly WebHelp format. You can access all user documentation in the palm of your hand—no PC or hardcopy manuals required. Another feature you won't find in competitive function/arb generators.

Flexibility in creating and playing waveforms

There are five ways to create arbitrary waveforms for use with the 33600A generator.

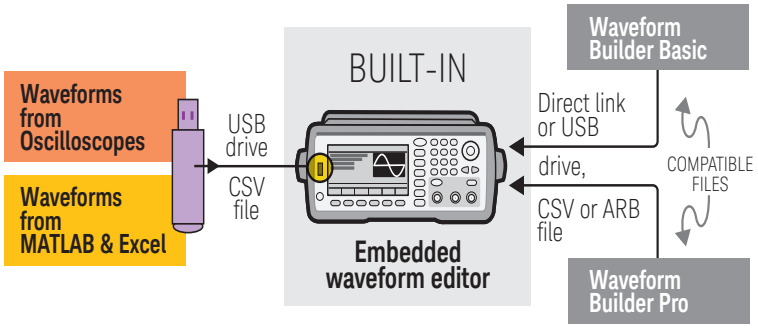
- Use the included Waveform Builder Basic software to edit and download a waveform file to the generator.
- Use 33503A Waveform Builder Pro software to create more complex waveforms and sequencing.
- Capture a waveform from an oscilloscope and download it to the generator.
- Create a waveform in MATLAB, Excel, etc. and download it to the generator.
- Use the generator's front panel to edit a waveform once it is in the generator.

You have lots of flexibility to choose the way you want to work.

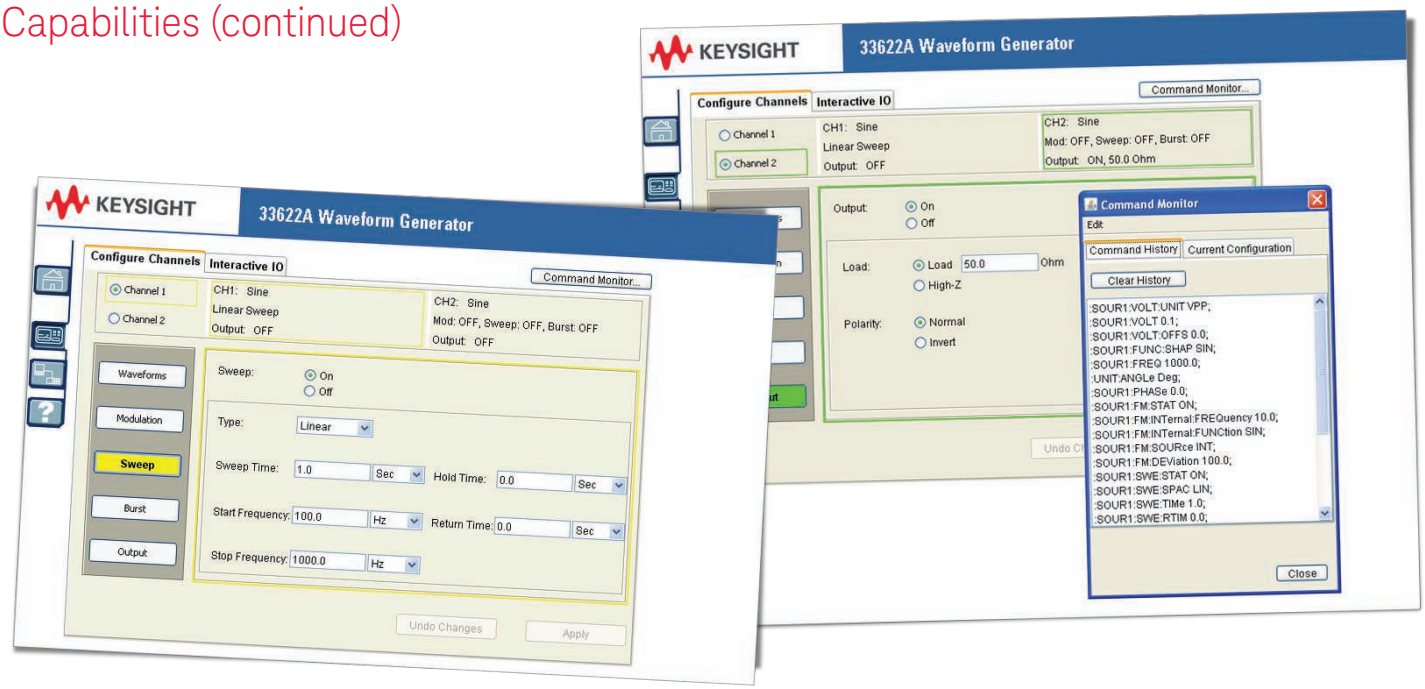
Easily generate PRBS waveforms on the 33600A Series waveform generators.

You can select multiple sequence lengths (such as PN15) and bit rates up to 200 Mbit/sec to create PRBS signals.

Scan this QR code to access instrument documentation.



Capabilities (continued)

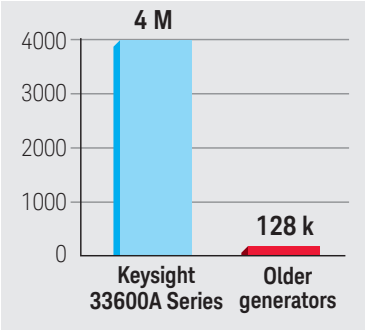


Built-in Web browser

Easily set up and control your 33600A Series generator remotely over a LAN connection using the built-in LXI Web browser. You can monitor your tests and adjust settings from another office or room, or even from home.

Standard deep memory

If you want to test your design with long, complex waveforms with a variety of anomalies, you need to make sure your waveform generator has sufficient memory. The 33600A Series' standard memory is 4 MSamples deep. Typical DDS generators offer only a fraction of that amount but with the 33600A Series there is even a 64 MSample memory option available.



Use the optional high-stability timebase for even better accuracy

Get improved timebase stability and frequency accuracy using the optional high-stability timebase. The optional timebase offers 0.1 ppm stability, which is 20x more stable than the standard timebase over one year.

Signal integrity: test your devices with confidence that your signal generator is outputting the signals you expect

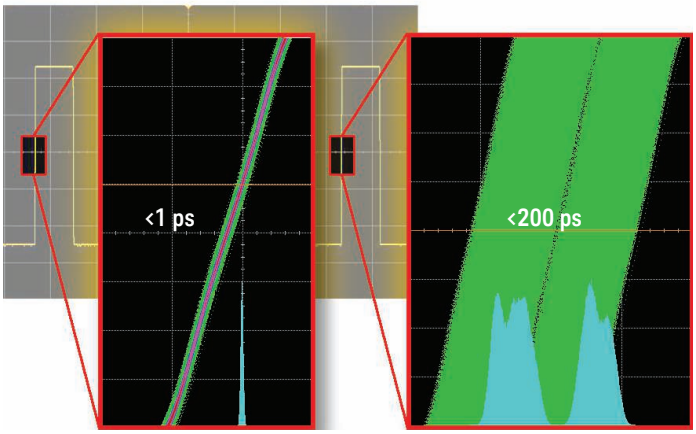
If your generator is introducing spurious signals or harmonics, you'll have a hard time producing reliable designs. To be successful, you need to test with clean, precise, low-noise signals. Keysight 33600A Series waveform generators offer the highest signal fidelity so you can generate the exact waveforms you need for your most challenging measurements. You can be confident you are seeing your design's characteristics, and not that of your waveform generator, in your measurements.

33600A Series waveform generators offer the following advantages:

Lowest jitter

With 1 ps jitter, 200x better than DDS generators, 33600A Series waveform generators offer unparalleled edge stability. You can even use them as a system clock for timing and triggering your other instruments. With better jitter performance, you can place edges more accurately, helping you reduce timing errors in your circuit design.

Trueform technology significantly improves jitter performance.



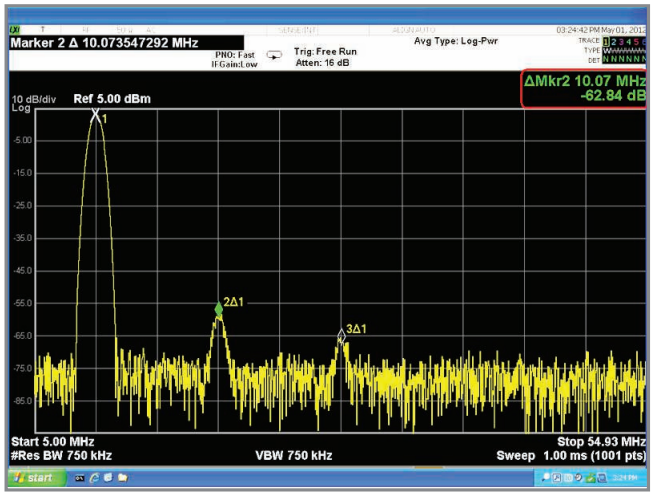
Trueform technology | Traditional DDS technology

Faster edge times

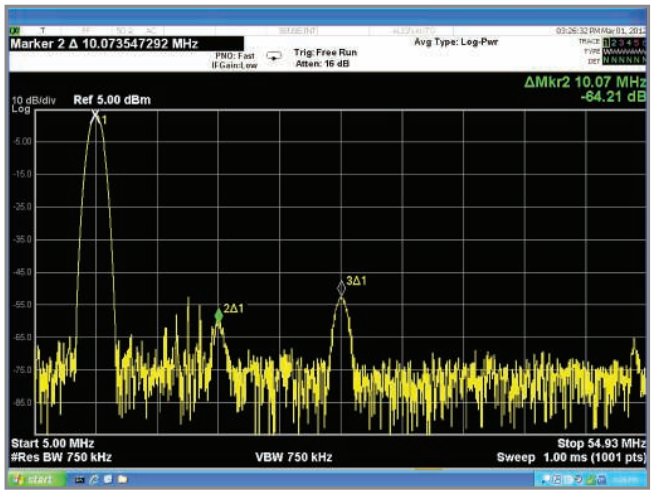
The 33600A Series' 2.9-ns rise and fall times are more than twice as fast as you'll find in typical waveform generators. You can place edges with more confidence and more accurately set trigger points. Because of the faster transition, higher harmonic content is created, which helps you expand your understanding of your circuit.

Lowest harmonic distortion

With total harmonic distortion of just 0.03%, the 33600A Series offers 5x better fidelity than other generators. Clean, spurious-free signals don't introduce noise or artifacts. See your design's characteristics, not the waveform generator's, in your measurements.



Keysight 33600A Series waveform generators offer the lowest total harmonic distortion (THD) in its class.



Typical DDS generator has a higher noise floor and greater harmonics.

Signal Integrity (continued)

Reproduce lower-voltage output signals

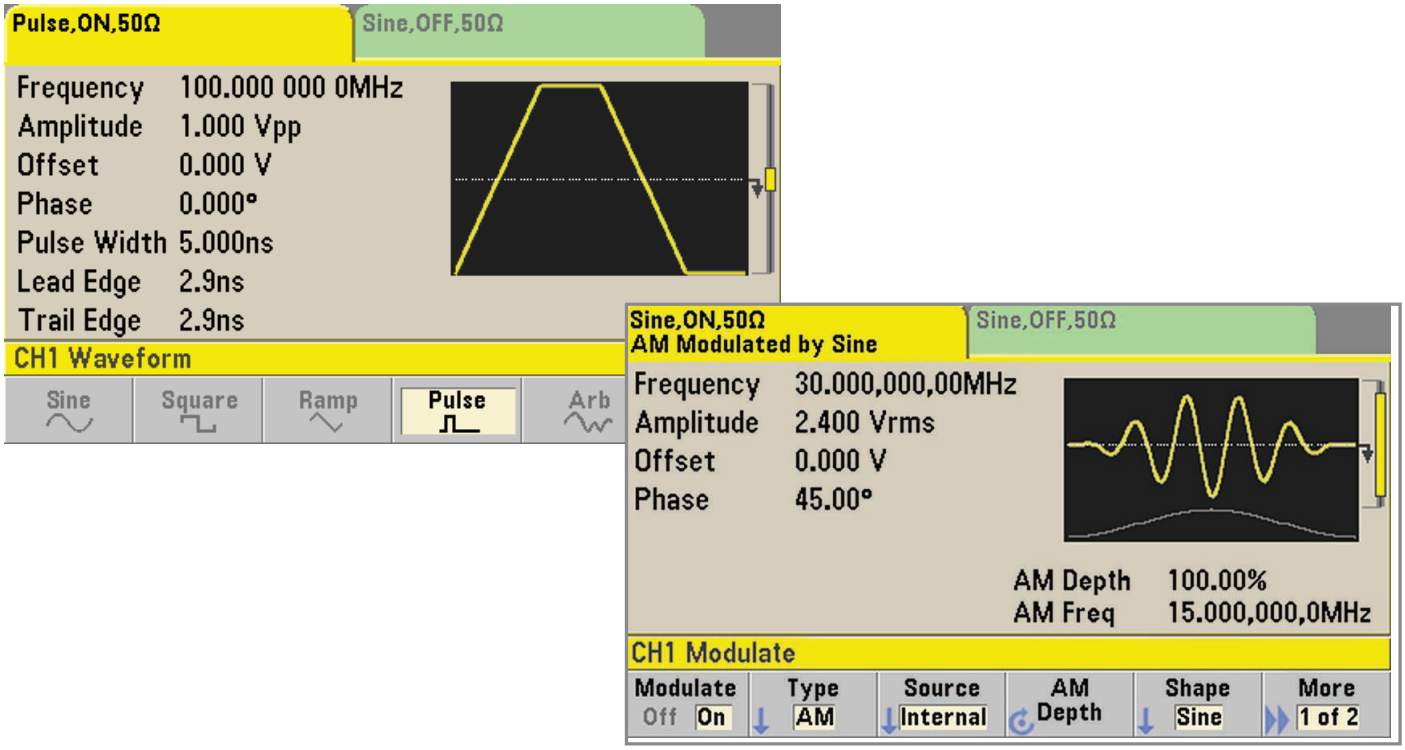
Today's ultra-low-power products such as pacemakers, hearing aids and remote sensors use very low voltages. The 33600A Series lets you create signals as low as 1 mVpp. That's a 10x lower voltage range than typical waveform generators.

High-bandwidth pulses

Create pulses up to 100 MHz with the 33600A Series. Most DDS-based generators offer reduced bandwidth when generating pulses. With a broader operating range, you have the frequency you need for a wider range of applications.

Full bandwidth modulation sources

Eliminate the need for an external modulation source. The 33600A Series has a modulation frequency up to the frequency of the waveform being modulated. Existing DDS-based generators have a much lower internal modulation frequency. Now you can create your complex signals all within a single generator.



Select the capabilities you need now, then upgrade easily when your needs change

Investment protection

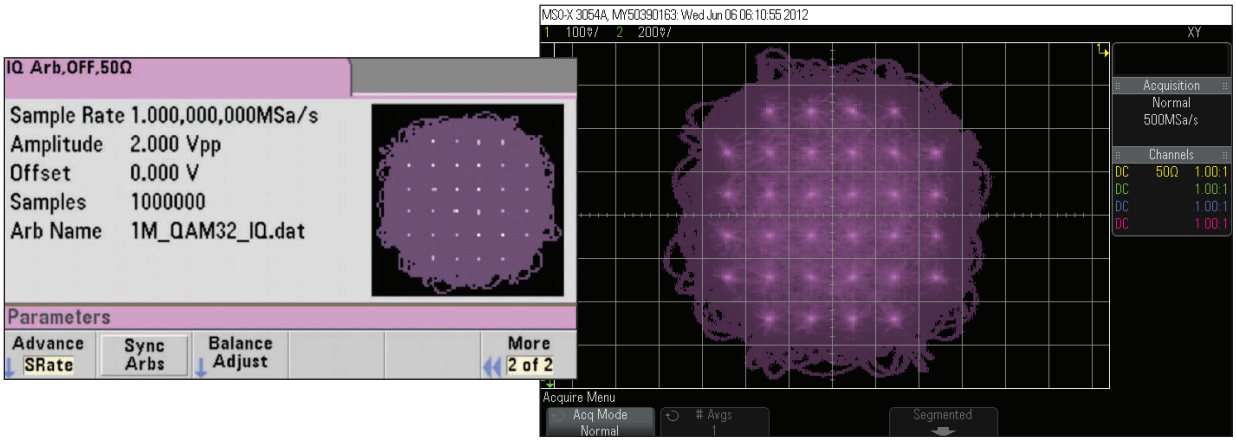
With most waveform generators, you get only what you pay for when you buy your instrument. But with 33600A Series waveform generators, there are four different models to choose from so you can purchase the capability you need now and upgrade later when your project needs change. Your investment in test equipment is protected. If you need to generate 120 MHz waveforms, or if you need deeper memory for generating more complex signals, you can easily add the capability after the fact with software upgrades. And there's no price penalty for adding the capability later.

Model No.	Description
33611A	80 MHz, 1-channel
33612A	80 MHz, 2-channel
33621A	120 MHz, 1-channel
33622A	120 MHz, 2-channel

Select from four models to get the capability that fits your budget now—then take advantage of easy software upgrades to expand your instrument's capabilities when you are ready.

Application-specific options

If you are doing simple experiments in digital communications, use the optional IQ player to play IQ files on your 2-channel waveform generator.



Optional IQ player allows you to play IQ files on your 2-channel waveform generator.

LAN (LXI Class C), USB and optional GPIB connectivity for quick and easy connectivity to a PC or network.

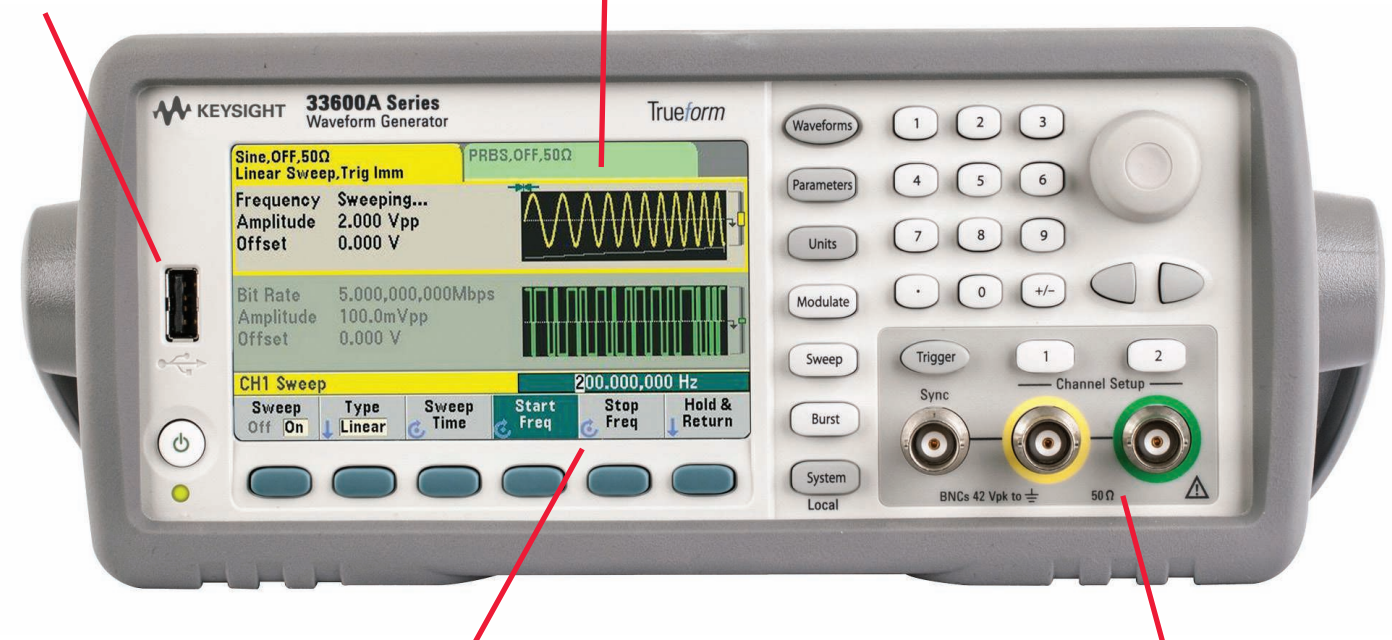
4 models to choose from

Choose the model with the capability you need now, knowing you can upgrade later. All models come with a rich set of built-in, standard features, including LAN, USB and optional GPIB interfaces, 4 MSample of memory, an external timebase input, and basic waveform generation software. You get everything you need to generate clean, precise, low-noise signals for testing your designs.

Supports remote operation using a Web browser to connect to a built-in web page.

Front-panel USB port for file management.

Large, color, graphical display offers simultaneous parameter setup, signal viewing and editing for easy operation.



Trueform arbitrary waveforms with sequencing for more accurate representation of user-defined signals.

Dual-channel mode with independent or coupled channels.

33600A Series Trueform Waveform Generator Test Challenges

Generating the signals you need for your measurements can be a tedious and time-consuming task, one that's often complicated by uncertainty whether your signal generator is outputting the signals you expect. Keysight's 33600A Series of waveform generators with exclusive Trueform technology offer you the capabilities, fidelity and flexibility you need to easily and confidently generate signals for even your most complex tests. Superior signal integrity guarantees you the highest resolution and lowest distortion for playing arbitrary waveforms with a complete representation of signals and creating complex waveform sequences. The ability to choose from a range of different upgradeable models means you have the functionality you need to easily address your test challenges today and in the future.

Shown at right are some of the key test challenges for which the 33600A Series Trueform waveform generators are especially well suited.

For more details and to download measurement briefs on these topics above visit: **www.keysight.com/find/trueformTC**

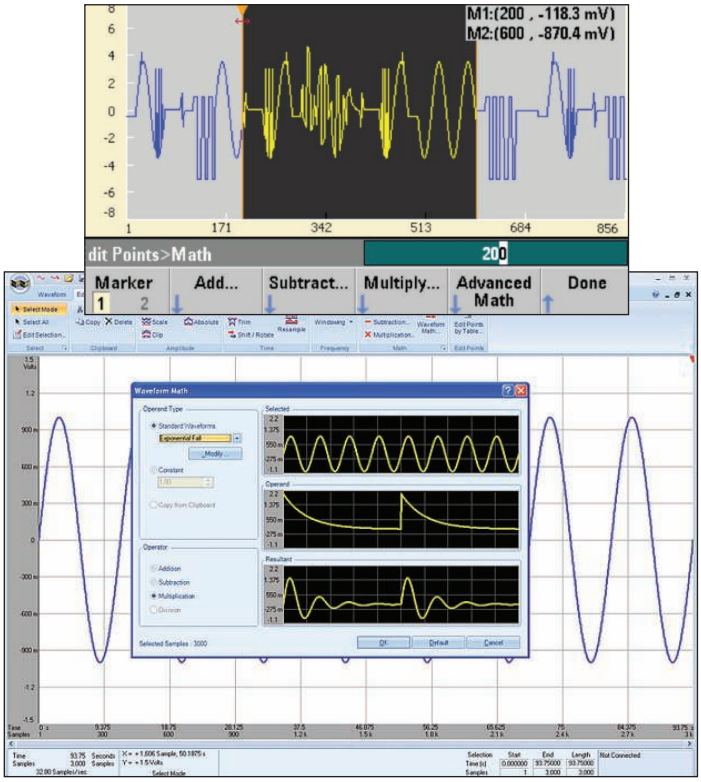
Test challenge	How Trueform can help
Generating a waveform with many points EXAMPLES – Long non-repeating signals – Simple signals requiring a lot of time resolution – Simulating a digital data protocol – Simulating a digitally modulated carrier	– Deep waveform memory – 1 GSa/s arb sampling rate – Trueform waveform generator accuracy – Ample onboard memory to store all of your waveforms
Simulating signals with the highest integrity EXAMPLES – Reproduce an arb with designed glitches – Run arbs at a fast frequency with the same signal from cycle to cycle – Simulate a complex signal – Need the best signal quality possible	– Trueform waveform generators are the best in the industry – Jitter at < 1 ps – Plays every point as designed without having to force fit a number of samples – Output voltage with load settings – None of the weaknesses of DDS (e.g., distorted signals and stretched points) – 14-bit resolution
Effortlessly couple or synchronize two signals on a waveform generator EXAMPLES – IQ modulation testing – Provide a stimulus for device and trigger signals – Simulate a differential pair – Creating a frequency relationship on two signals	– Dual channels – Easy frequency coupling – Easy amplitude coupling – Match or mirror signals between two channels
Using a waveform generator to generate a PRBS signal EXAMPLES – Test a transmission line – Acoustic testing – Noise simulation – Generate an eye pattern stimulus	– Built-in PRBS functions – PN3 through PN32 – Up to 100-Mbps bit rate – Jitter at < 1 ps – Synchronized output for external clocking – Channel coupling
Creating a differential signal with a waveform generator EXAMPLES – Simulate an IC output – Simulate balance twisted pair outputs – Simulate a biomedical signal – Generate an LVDS stimulus signal	– Dual channels – Frequency or amplitude coupling – Identical or inverted signals between two channels – Floating outputs up to 42 V – 1 mVpp to 10 Vpp outputs
Be more efficient designing and using your arbitrary waveforms EXAMPLES – Change one segment of an arb without redesigning the whole signal – Reuse your proven signal designs but put them together in a different order – Have a signal continuously playing until an event starts another signal – Need to sweep your arb through a set of different frequencies	– Need to sweep your arb through a set of different frequencies – Arbitrary waveform sequencing – Arbitrary waveform triggering model – 1 GSa/s – Change amplitude, sample rate and filter settings with arb metadata – Deep waveform memory – Easy drag and drop file system

Other Productivity Tools

Keysight BenchLink Waveform Builder Pro Software

Easily create custom waveforms with advanced waveform creation and editing software

Get advanced signal creation/editing capability without tedious programming with optional 33503A BenchLink Waveform Builder Pro software. The Microsoft Windows-based program provides easy-to-use creation tools, such as an equation editor, waveform math and drawing tools, that make it easy to create custom signals. It features a standard function library, waveform sequencer and filters as well as windowing functions that allow you to easily modify and further refine your waveform. A library of built-in signals helps you quickly create more complex waveforms. The result is quicker, easier creation of custom waveforms, coupled with deeper analysis insight into your signals. For additional information and to download a 30-day trial version of the software, visit: **www.keysight.com/find/33503trial**



Create and edit complex waveforms using 33503A Waveform Builder Pro software.

Keysight BenchVue Software

Data capture simplified

Keysight 34840B BenchVue software for the PC accelerates your testing by providing intuitive, multiple instrument measurement visibility and data capture with no programming. You can derive answers faster than ever by easily viewing, capturing and exporting measurement data and screen shots. The integrated library feature includes access to manuals, FAQs, videos, and more—enabling you to expand your measurement knowledge and reduce test setup time. Mobile apps let you monitor and respond to long-running tests from anywhere. With BenchVue, it's as simple as: click, capture, done.

- Visualize multiple-instrument measurements simultaneously
- Easily capture data and screen shots and export in a few clicks
- Recall past state of your bench to replicate results
- Monitor and control your bench from mobile devices

Capture and analyze your data where you need to. Download the software today at: **www.keysight.com/find/BenchVue**

Configuration Guide

Step 1. Choose your bandwidth and channel count

33600A Series waveform generators with Trueform technology				
Bandwidth	80 MHz	80 MHz	120 MHz	120 MHz
Number of channels	1	2	1	2
Waveform generator	33611A	33612A	33621A	33622A

Step 2. Tailor your waveform generator for more demanding applications

Application	**Order option**
Additional memory for long waveforms	MEM
Baseband IQ Player with adjustments	IQP (only available on 33612A, 33622A)
Security features with NISPOM	SEC
OCXO-high stability timebase	OCX

Step 3. Upgrade your waveform generator in the future

Upgrade desired	**Order upgrade option**
Increase bandwidth to 120 MHz	336BW1U on 1-channel models 336BW2U on 2-channel models
Increase arb memory to 64 MSa per channel	336MEM1U on 1-channel models 336MEM2U on 2-channel models
Add NISPOM and file security	336SECU
Add IQ baseband signal player to 2-channel arb	336IQPU
Add high-stability timebase	33600U-OCX (Must return to Keysight)
Add GPIB	3446GPBU (Customer installable)

NOTE: Cannot upgrade a 1-channel generator to a 2-channel generator

Specifications

Unless otherwise stated, all specifications apply with a 50-Ω resistive load and automatic amplitude range selection enabled.

Instrument characteristics

Models & options				
Model number	33611A	33612A	33621A	33622A
Maximum frequency	80 MHz	80 MHz	120 MHz	120 MHz
Number of channels	1	2	1	2
Option MEM	Increases arbitrary waveform memory from 4 MSa/channel to 64 MSa/channel			
Option IQP	IQ player (33612A/22A only)			
Option SEC	Enables NISPOM and file security			
Option OCX	Oven-controlled frequency reference for improved stability, jitter, and phase noise			
Waveforms				
Standard	Sine, Square, Ramp, Pulse, Triangle, Gaussian Noise, PRBS (Pseudorandom Binary Sequence), DC			
Built-in arbitrary	Cardiac, Exponential Fall, Exponential Rise, Gaussian Pulse, Haversine, Lorentz, D-Lorentz, Negative Ramp, Sinc			
User-defined arbitrary	Up to 4 MSa (64 MSa with Option MEM) with multi-segment sequencing			
Operating modes & modulation types				
Operating modes	Continuous, Modulate, Frequency Sweep, Counted Burst, Gated Burst			
Modulation types	AM, FM, PM, FSK, BPSK, PWM, Sum (carrier + modulation)			

Waveform characteristics (all 33600A models)

Sine				
Frequency ranges				
V_{OUT} ≤ 10 Vpp	1 µHz to 60 MHz, 1-µHz resolution			
V_{OUT} ≤ 8 Vpp	1 µHz to 80 MHz, 1-µHz resolution			
V_{OUT} ≤ 4 Vpp	1 µHz to 120 MHz, 1-µHz resolution [1]			
Amplitude flatness (rel. to 1 kHz) (spec) [2, 3]	**V_{OUT} = 1 Vpp**	**V_{OUT} > 1 Vpp**		
f_{OUT} < 10 MHz	± 0.10 dB	± 0.10 dB		
f_{OUT} = 10 MHz to 60 MHz	± 0.20 dB	± 0.25 dB		
f_{OUT} = 60 MHz to 80 MHz	± 0.30 dB	± 0.40 dB		
f_{OUT} = 80 MHz to 120 MHz [1]	± 0.40 dB	± 0.50 dB		
Harmonic distortion (typ) [2]	**V_{OUT} = 1 Vpp**	**V_{OUT} = 4 Vpp**	**V_{OUT} = 8 Vpp**	**V_{OUT}=10 Vpp**
f_{OUT} < 1 MHz	–70 dBc	–69 dBc	–68 dBc	–67 dBc
f_{OUT} < 1 MHz to 10 MHz	–61 dBc	–58 dBc	–54 dBc	–51 dBc
f_{OUT} > 10 MHz	–43 dBc	–36 dBc	–40 dBc	–39 dBc
THD (typ) [2]	**V_{OUT} = 1 Vpp**	**V_{OUT} > 1 Vpp**		
f_{OUT} = 20 Hz to 20 kHz	0.03%	0.04%		
Non-harmonic spurious (V_{OUT} ≥ 300 mVpp) (typ) [2, 4]				
f_{OUT} < 10 MHz	–80 dBc			
f_{OUT} = 10 MHz to 60 MHz	–75 dBc			
f_{OUT} > 60 MHz	–70 dBc			
Phase noise (SSB) (meas) [5]	**f_{OUT} = 80 MHz**	**f_{OUT} = 80 MHz, Opt OCX**	**f_{OUT} = 120 MHz** [1]	**f_{OUT}= 120 MHz, Opt OCX** [1]
100-Hz offset	–105 dBc/Hz	–114 dBc/Hz	–101 dBc/Hz	–110 dBc/Hz
1-kHz offset	–116 dBc/Hz	–122 dBc/Hz	–112 dBc/Hz	–118 dBc/Hz
10-kHz offset	–122 dBc/Hz	–125 dBc/Hz	–118 dBc/Hz	–121 dBc/Hz
100-kHz offset	–129 dBc/Hz	–131 dBc/Hz	–125 dBc/Hz	–127 dBc/Hz

Footnotes referenced on page 22

Waveform characteristics (continued)

Square & pulse				
Frequency ranges				
V_{OUT} ≤ 10 Vpp	1 µHz to 50 MHz, 1-µHz resolution			
V_{OUT} ≤ 4 Vpp	1 µHz to 100 MHz, 1-µHz resolution [1]			
Rise & fall time (nom)	**Square**	**Pulse**		
V_{OUT} ≤ 4 Vpp	2.9 ns	2.9 ns to 1 ms, independently variable, 100-ps resolution		
V_{OUT} > 4 Vpp	4.0 ns	3.3 ns to 1 ms, independently variable, 100-ps resolutio		
Overshoot (typ)	**Square**	**Pulse, min. edge**	**Pulse, 4-ns edge**	**Pulse, ≥ 6-ns edge**
V_{OUT} ≤ 4 Vpp	**< 4%**	**< 4%**	**< 2%**	**< 2%**
V_{OUT} > 4 Vpp	**< 4%**	**< 7%**	**< 4%**	**< 2%**
Duty cycle [6]	**0.01% to 99.99%, 0.01% resolution**			
Pulse width				
V_{OUT} ≤ 4 Vpp	5 ns minimum (high or low), 1-ps resolution			
V_{OUT} > 4 Vpp	8 ns minimum (high or low), 1-ps resolution			
Jitter (rms) (meas) [7]	**Standard**	**Opt OCX**		
10-Hz to 40-MHz band	1 ps	0.5 ps		
Ramp & triangle				
Frequency range	1 µHz to 800 kHz, 1-µHz resolution			
Ramp symmetry	0% to 100%, 0.1% resolution, (0% is negative ramp, 100% is positive ramp, 50% is triangle)			
Nonlinearity (typ)	< 0.05% from 5% to 95% of the signal amplitude			
Gaussian noise				
Variable bandwidth (nom)				
V_{OUT} ≤ 10 Vpp	1 mHz to 60 MHz			
V_{OUT} ≤ 8 Vpp	1 mHz to 80 MHz			
V_{OUT} ≤ 4 Vpp	1 mHz to 120 MHz [1]			
Crest factor (nom)	**4.6**			
Repetition period	**> 100 years**			
Pseudorandom binary sequence (PRBS)				
Bit rate				
V_{OUT} ≤ 10 Vpp	1 mbps to 100 Mbps, 1-mbps resolution			
V_{OUT} ≤ 4 Vpp	1 mbps to 200 Mbps, 1-mbps resolution [1]			
Sequence length	**2^m-1, m = 3 to 32**			
Rise & fall time (nom)				
V_{OUT} ≤ 4 Vpp	2.9 ns to 1 ms, independently variable, 100-ps resolution			
V_{OUT} > 4 Vpp	3.3 ns to 1 ms, independently variable, 100-ps resolution			
Arbitrary waveforms				
Waveform length	**32 Sa to 4 MSa per channel (64 MSa with Option MEM) in increments of 1 Sa**			
Sample rate (F_S)				
33611A/12A	1 µSa/s to 660 MSa/s, 1-µSa/s resolution [8]			
33621A/12A	1 µSa/s to 1 GSa/s , 1-µSa/s resolution [8]			
Voltage resolution	**14 bits**			
Waveform filters	**"Normal" (highest bandwidth, ~5% preshoot and overshoot),** **"Step" (lower bandwidth, ~0% preshoot or overshoot), or** **"Off" (transitions from point to point occur as quickly as possible)**			
Frequency and time characteristics	**Filter = "Normal"**	**Filter = "Step"**	**Filter = "Off"**	
Bandwidth (-3 dB)(nom)	0.27 x F_S (100 MHz max)	0.13 x F_S (100 MHz max)	100 MHz	
Rise & fall time (nom)	0.35/bandwidth (3.5 ns min)	0.35/bandwidth (3.5 ns min)	3.5 ns	
Jitter (rms) (meas) [8]	< 2 ps	< 1 ps	< 10 ps	

Footnotes referenced on page 22

Waveform characteristics (continued)

Arbitrary waveform sequencing	
Operation	Individual arbitrary waveforms (segments) can be combined into user-defined lists (sequences) to form longer, more complex waveforms. Each sequence step specifies whether to repeat the associated segment a certain number of times, to repeat it indefinitely, to repeat it until a Trigger event occurs, or to stop and wait for a Trigger event. Additionally, the behavior of the Sync output (Marker) can be specified in each step. To improve throughput, multiple sequences and segments can be pre-loaded into volatile memory.
Segment length	32 Sa to 4 MSa per channel (64 MSa with Option MEM) in increments of 1 Sa
Sequence length	1 to 512 steps
Segment repeat count	1 to 10^6 or "Infinite"

Waveform output characteristics

General	
Connector	Front-panel BNC, shell and pin isolated from chassis (±42 V maximum)
Function	On, Off, or Inverted
Output impedance (nom)	50 Ω
Isolation	Connector shells for channel output(s), Sync, and Mod In are connected together but isolated from the instrument's chassis. Maximum allowable voltage on isolated connector shell or pin is ±42 V relative to chassis.
Overload protection	Output turns off automatically when an overload is applied. Instrument will tolerate a short circuit to ground indefinitely.
Amplitude	
Range [9]	1 mVpp to 10 Vpp into 50 Ω, 4-digit resolution 2 mVpp to 20 Vpp into open circuit, 4-digit resolution
Units	Vpp, Vrms, or dBm
Accuracy (at 1 kHz) (spec) [3]	± (1% of setting in Vpp) ± (1 mVpp)
Voltage limit function	User-definable maximum and minimum voltage limits
DC offset	
Range	± (5 VDC - Peak AC) into 50 Ω, 4-digit resolution ± (10 VDC - Peak AC) into open circuit, 4-digit resolution
Accuracy (spec) [3]	± (1% of Offset setting) ± (0.25% of amplitude in Vpp) ± (2 mV)
Frequency accuracy (spec)	
Standard frequency reference	
1 year, 18 to 28 °C	± (1 ppm of setting + 15 pHz)
1 year, 0 to 55 °C	± (2 ppm of setting + 15 pHz)
High-stability frequency reference (Option OCX)	
1 year, 0 to 55 °C	± (0.1 ppm of setting + 15 pHz)

Modulation, burst, and sweep capability

Carrier	AM	FM	PM	FSK	BPSK	PWM	Sum	Burst	Sweep
Sine & square	▪	▪	▪	▪	▪		▪	▪	▪
Pulse	▪	▪	▪	▪	▪	▪	▪	▪	▪
Ramp & triangle	▪	▪	▪	▪	▪		▪	▪	▪
Gaussian noise	▪						▪	▪ [10]	
PRBS	▪	▪	▪				▪	▪	
Single arbitrary	▪	▪	▪		▪		▪	▪	▪
Sequenced arbitrary	▪						▪		

Footnotes referenced on page 22

Specifications

Modulating signals

Carrier	Sine	Square	Ramp	Triangle	Noise	PRBS	Arbitrary	External
Sine	▪	▪	▪	▪	▪	▪	▪	▪
Square & pulse	▪	▪	▪	▪	▪	▪	▪	▪
Ramp & triangle	▪	▪	▪	▪	▪	▪	▪	▪
Gaussian noise	▪	▪	▪	▪		▪	▪	▪
PRBS	▪	▪	▪	▪	▪		▪	▪
Arbitrary	▪	▪	▪	▪	▪	▪		▪

Modulation, burst, and sweep characteristics

Amplitude modulation (AM)	
Source	Internal or external (all models), or other channel (33612A/22A only)
Type	Full-Carrier or Double-Sideband Suppressed-Carrier (DSSC)
Depth [11]	0% to 120%, 0.01% resolution
Frequency modulation (FM) [12]	
Source	Internal or external (all models), or other channel (33612A/22A only)
Deviation	1 µHz to 40 MHz (33611A/12A) or 60 MHz (33621A/22A), 1-µHz resolution
Phase modulation (PM)	
Source	Internal or external (all models), or other channel (33612A/22A only)
Deviation	0° to 360°, 0.1° resolution
Frequency-shift key modulation (FSK) [12]	
Source	**Internal timer or rear-panel connector**
Mark & space	**Any frequency within the carrier signal's range**
Rate	**≤ 1 MHz**
Binary phase-shift key modulation (BPSK)	
Source	Internal timer or rear-panel connector
Phase shift	0° to 360°, 0.1° resolution
Rate	≤ 1 MHz
Pulse-width modulation (PWM)	
Source	Internal or external (all models), or other channel (33612A/22A only)
Deviation [6]	0% to 100% of pulse width, 0.01% resolution
Additive modulation (Sum)	
Source	Internal or external (all models), or other channel (33612A/22A only)
Ratio [11]	0% to 100% of carrier amplitude, 0.01% resolution
Burst characteristics [10]	
Type	Counted or gated
Counted burst operation	Each trigger event causes the instrument to produce from 1 to 10^8 or an "infinite" number of waveform cycles.
Gated burst operation	Instrument produces waveforms while the trigger is in the "on" state. For Gaussian Noise, waveform generation stops immediately when the trigger is in the "off" state. All other waveforms stop at the completion of a cycle; more than one cycle might elapse before generation stops.
Start/stop phase	-360° to +360°, 0.1° resolution
Trigger source	Internal timer or rear-panel connector
Marker	Indicated by the trailing edge of the Sync pulse; adjustable to any cycle of the burst.

Footnotes referenced on page 22

Specifications (continued)

Modulation, burst, and sweep characteristics, continued

Sweep characteristics[12]	
Type	Linear, Logarithmic, or List (up to 128 user-defined frequencies)
Operation	Linear and Logarithmic sweeps are characterized by a Sweep time (during which the frequency changes smoothly from Start to Stop), a Hold time (during which the frequency stays at the Stop frequency), and a Return time (during which the frequency changes smoothly from Stop to Start). Returns are always linear.
Direction	Up (start < stop) or Down (start > stop)
Sweep time	
Linear	1 ms to 3600 s, 1-ms resolution; 3601 s to 250,000 s, 1-s resolution
Logarithmic	1 ms to 500 s, 1-ms resolution
Hold time	0 to 3600 s, 1-ms resolution
Return time	0 to 3600 s, 1-ms resolution
Trigger source [14]	Immediate (continuous), external (rear-panel connector), manual (front-panel button), bus, or Internal timer
Marker	Indicated by the trailing edge of the Sync pulse; adjustable to any frequency between Start and Stop for Linear and Logarithmic types or any frequency in the list for List type.
Internal timer for FSK, BPSK, burst, and sweep	
Range	1 µs to 4000 s, 4-ns resolution

Two-channel characteristics (33612A/22A only)

Standard	
Operating modes	Independent, Coupled parameter(s), Combined (Ch 1 + Ch 2), Equal (Ch 1 = Ch 2), or Differential (Ch 1 = –Ch 2)
Parameter coupling	None, Frequency (ratio or difference) and/or Amplitude and DC offset
Relative Phase	0° to 360°, 0.1° resolution
Channel-to-channel skew (typ)	< 100 ps (both channels configured identically)
Crosstalk (typ)	< –85 dB
IQ Player (Option IQP)	
Operation	This option enables a two-channel model with arbitrary waveform capability to function as a baseband IQ (quadrature modulation) source. Programmable impairments include amplitude imbalance, DC offset difference, and channel-to-channel time skew.
Channel-to-channel amplitude imbalance [11]	–30% to +30%, 0.001% resolution
Channel-to-channel DC offset difference	± (5 VDC - Peak AC), 0.1-mV resolution into 50 Ω ± (10 VDC - Peak AC), 0.2-resolution into open circuit
Channel-to-channel time skew	–1 to +1 ns, 10-ps resolution
Display views	Voltage-vs-Time or Constellation (Ch 1-vs-Ch 2)

Sync/marker output

Connector	Front-panel BNC, shell and pin isolated from chassis (± 42 V maximum)
Functions	Sync, Sweep Marker, Burst Marker, Arbitrary Waveform Marker, or Off
Assignment	Channel 1 or Channel 2
Polarity	Normal or Inverted
Output level (nom)	0 to +1.5 V into 50 Ω; 0 to +3.0 V into high impedance
Output impedance (nom)	50 Ω
Minimum pulse width (nom)	5 ns

Footnotes referenced on page 22

Specifications (continued)

Modulation input

Connector	Rear-panel BNC, shell and pin isolated from chassis (±42 V maximum)
Assignment	Channel 1, Channel 2, or both
Voltage level (nom)	±1 V or ±5 V full scale, selectable
Input Impedance (nom)	5 kΩ
Bandwidth (–3 dB) (typ)	0 Hz to 100 kH

External trigger/gate input/output

General characteristics	
Connector	Rear-panel BNC, chassis-referenced (functions as Input or Output)
Assignment: Input	Channel 1, Channel 2, or both
Output	Channel 1 or Channel 2
Polarity	Positive or Negative slope
Maximum Rate	1 MHz
Input characteristics	
Threshold voltage (nom)	(Output Level setting)/2
Impedance (nom)	10 kΩ, DC-coupled
Minimum pulse width	100 ns
Variable Trigger Delay	0 to 1000 s, 1-ns resolution
Latency (typ) [15]	< 140 ns
Jitter (typ)	< 320 ps, rms
Output characteristics	
Output voltage (nom)	
Low level	0 V
High level	0.9 V to 3.8 V into high impedance, 0.1-V resolution
Impedance (nom)	50 Ω
Duty cycle (nom)	50%
Fan-out	Up to four Keysight 33600A Series waveform generators

External frequency reference input/output

Input characteristics	
Connector	Rear-panel BNC, shell and pin isolated from chassis and all other connectors (±42 V max.)
Frequency range: Standard	10 MHz ± 20 Hz
Option OCX	10 MHz ± 1 Hz
Voltage	200 mVpp to 5 Vpp
Impedance	1 kΩ ll 20 pF, AC-coupled
Lock time (typ)	< 2 s
Output characteristics	
Connector	Rear-panel BNC, chassis-referenced
Frequency (nom)	10 MHz
Level (nom)	0 dBm (632 mVpp) into 50 Ω
Impedance (nom)	50 Ω

Footnotes referenced on page 22

Specifications (continued)

Programming times

Configuration changes (meas)	LAN (socket)	LAN (VXI-11)	USB 2.0	GPIB
Change function (meas)	29.2 ms	29.7 ms	29.4 ms	29.2 ms
Change frequency (meas)	2.7 ms	3.3 ms	2.8 ms	2.7 ms
Change amplitude (meas)	8.3 ms	9.0 ms	8.3 ms	8.3 ms
Select Arb. waveform (16 k samples)(meas)	12.7 ms	13.9 ms	13.1 ms	12.6 ms
Arbitrary waveform download to volatile				
4 K samples (binary transfer) (meas)	6.4 ms	13.2 ms	6.6 ms	52.3 ms
1 M samples (binary transfer) (meas)	1.26 s	2.40 s	1.25 s	12.3 s

Memory

Arbitrary waveform	
Volatile	4 MSa/channel (64 MSa/channel with Option MEM). 512 sequence steps per channel
Non-volatile	970 MB in file system (~485 MSa of arbitrary waveform records)
Instrument state	
Store/recall	User-defined instrument states with user-defined names in file system
Power-On state	Default settings or state at power-off, selectable
USB file system	
Front-panel port	USB 2.0 high-speed mass storage class (MSC) device
Capability	Read or write instrument configuration settings, instrument states, arbitrary-waveform, and sequence files.
Speed (nom)	10 MB/s

General characteristics

Computer interfaces	
LXI-C (rev. 1.3)	10/100Base-T (Sockets & VXI-11 protocols) USB 2.0 (USB-TMC488 protocol) GPIB/IEEE-488.1, IEEE-488.2
Web user interface	Remote operation and monitoring
Programming language	SCPI-1999, IEEE-488.2 Keysight 33210A, 33220A, 33250A, and 33500A/B Series compatible
Graphical display	4.3-inch color TFT, WQVGA (480x272) with LED backlight
Real-time clock/calendar battery	CR-2032 coin-type, replaceable, >5-year life (typ)
Mechanical	
Size (nom)	261.1 mm W x 103.8 mm H x 303.2 mm D (with bumpers installed) 212.8 mm W x 88.3 mm H x 272.3 mm D (with bumpers removed) 2U x ½ rack width
Weight (nom)	3.5 Kg (7.7 lbs.)

Footnotes referenced on page 22

Specifications (continued)

General characteristics (continued)

Environmental	
Storage temperature	–40 to 70 °C
Warm-up time	1 hour
Operating environment	EN61010, pollution degree 2, indoor locations
Operating temperature	0 to 55 °C
Operating humidity	5% to 80% RH, non-condensing
Operating altitude	< 3000 meters
Regulatory	
Refer to the Declaration of Conformity	
Sound pressure level (1-m free-field) (nom)	35 dB(A) at $T_{AMBIENT} \leq 28$ °C
Line power	
Line voltage	100 to 240 V, 50/60 Hz 100 to 120 V, 400 Hz
Power consumption	75 W, 150 VA
Warranty	
Standard	3 years

FOOTNOTES

1. Applies to 120-MHz models (33621A/22A) only.
2. DC Offset set to zero.
3. Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C.
4. At low amplitude, non-harmonic spurious level is -100 dBm (typ).
5. Measured with a Keysight E5052B signal source analyzer. Phase noise improves by 20 dB/decade as output frequency is decreased.
6. Subject to pulse width limits.
7. Measured with a Keysight E5052B signal source analyzer.
8. Maximum sample rate with Filter “Off” is 160 MSa/s for 80-MHz models and 250 MSa/s for 120-MHz models.
9. Maximum amplitude is less at high frequency for certain waveforms.
10. Counted burst is not available for Gaussian Noise.
11. Subject to amplitude limits.
12. All frequency changes are phase-continuous.
13. External trigger only for sweep time > 8000 s.
14. Measured with a Square or Pulse waveform, edge time set to minimum, and trigger delay set to zero. Trigger latency is generally greater for other instrument settings. For some waveforms, trigger latency is a function of output frequency.

Definitions

Specification (spec)

The warranted performance of a calibrated instrument that has been stored for a minimum of 2 hours within the operating temperature range of 0 to 55 °C and after a 1-hour warm up period. All specifications account for the effects of measurement and calibration-source uncertainties, and were created in compliance with ISO-17025 methods. Data published in this document are specifications (spec) only where specifically indicated.

Typical (typ)

The characteristic performance that 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement or calibration-source uncertainty, and is valid only at room temperature (approximately 23 °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 23 °C).

Measured (meas)

An attribute measured during product development for the purpose of communicating expected performance. This data is not warranted and is measured at room temperature (approximately 23 °C).