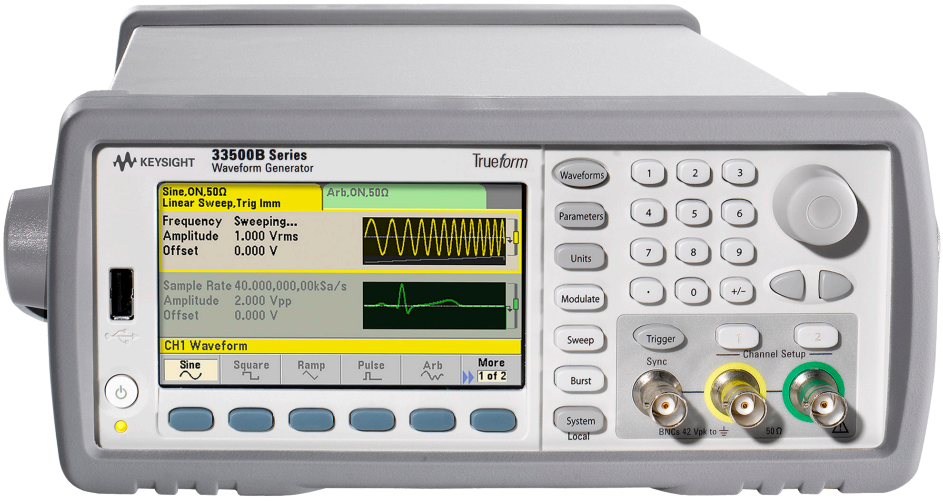
Keysight Technologies
33500B Series
Waveform Generators

Data Sheet



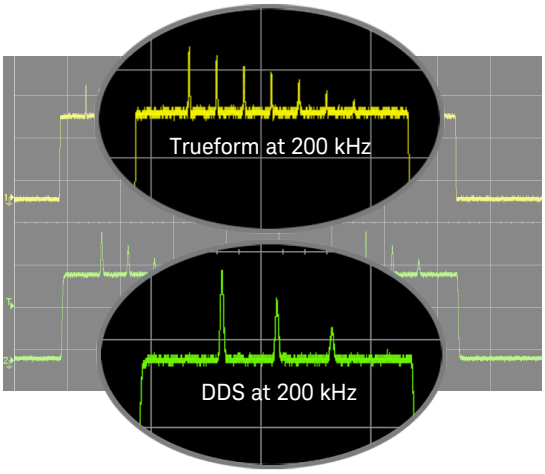
KEYSIGHT TECHNOLOGIES

Unlocking Measurement Insights

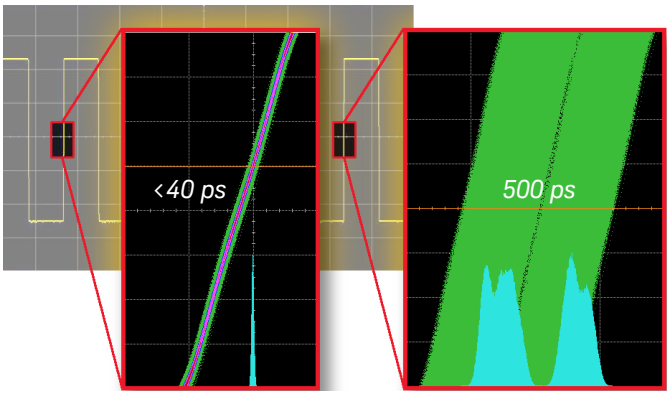
Trueform Technology
Generate true point-by-point arbitrary waveforms with less jitter, more fidelity and greater resolution

Revolutionary advances over traditional DDS

Better signal integrity

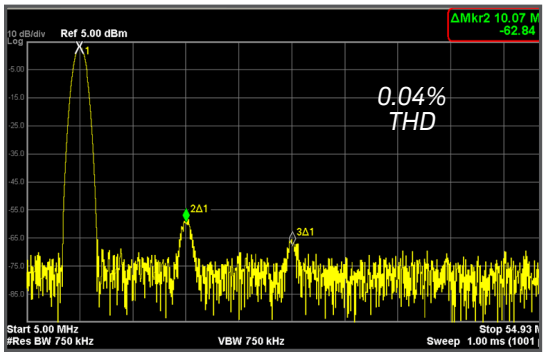


Reduced jitter



Trueform technology DDS technology

Lower distortion



33500B Series waveform generators with exclusive Trueform signal generation technology offer more capability, fidelity and flexibility than traditional DDS generators. Use them to accelerate your development process from start to fi nish.

Over the past two decades, direct digital synthesis (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 intrinsic downsides and limitations as well. Engineers with exacting requirements have had to either work around the compromised performance or spend up to 10 times more for a high-end, point-by-point waveform generator.

The Keysight Technologies, Inc. Trueform technology offers a new alternative that blends the best of DDS and point-by-point architectures, giving you the benefits of both without the limitations of either. Trueform 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 Trueform technology.

	DDS: Traditional 25 MHz waveform generator	**Trueform: Keysight 30 MHz 33511B waveform generator**	**Improvement**
Edge jitter	500 ps	40 ps	12x better
Custom waveform replication	Skips waveform points	100% point coverage	Exact waveform replication
Total harmonic distortion	0.2%	0.04%	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**

Revolutionary signal generation with unmatched capabilities and fidelity

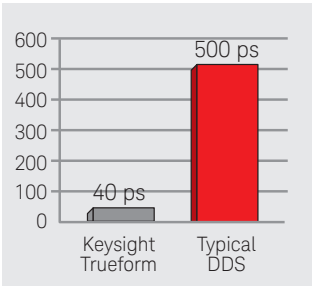
- Easily generate the full range of signals you need for the most demanding measurements
- Test your devices with confidence that the waveform generator is outputting the signals you expect
- Select just the capabilities you need now, then upgrade easily when your needs change



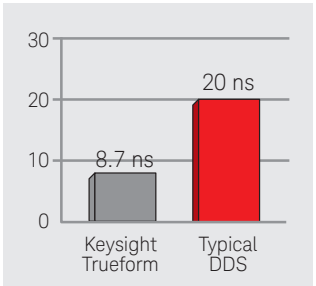
Unique features of the 33500B Series waveform generators

Full bandwidth pulse	Full-bandwidth pulse to 20 or 30 MHz Set leading and trailing edge times independently
2 channels	Dual channel coupling, frequency and amplitude, equal and inverted Set start phase for each channel, set phase shift between channels
Sum modulate	Sum two signals together, frequency and amplitude independent 2-tone, square-sine, noise on pulse
Point-by-point arb	Create up to 1 million samples standard, 16 million optional Connect arbs together, create up to 512 sequences
Voltage settings	Lowest voltage range at 1 mVpp, a 10x improvement Set high and low voltage limits to prevent overload on DUT
PRBS patterns	Provides standard PRBS patterns, PN7 ... PN23 Select PN type, set bit rate, set edge time

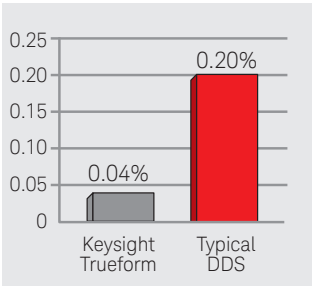
Key attributes



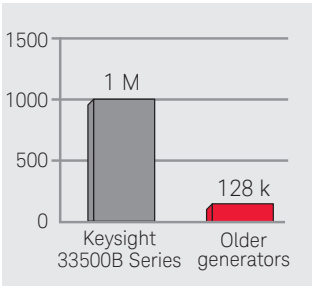
Jitter



Rise time



Total harmonic distortion



Standard memory

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

The 33500B Series waveform generators offer the common signals and features you expect, such as modulation, sweep, and burst. But the 33500B Series offers many more features that give you the capabilities and flexibility you need to get your job done. Like an intuitive front-panel user interface that makes it easy to quickly relearn it when you've been focused elsewhere. Like built-in LAN, USB and GPIB interfaces that make it easy to control your instruments or transfer your waveforms to your instrument.

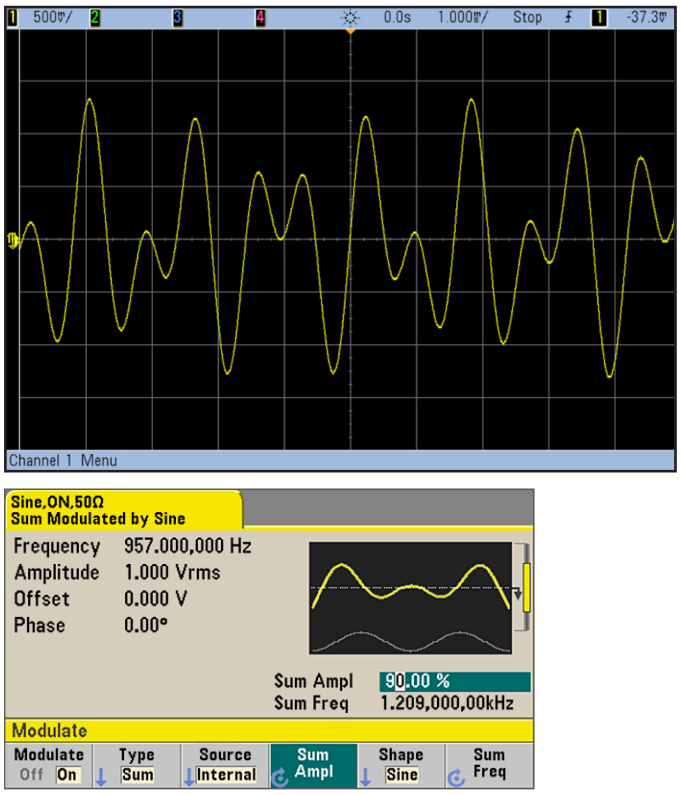
But the 33500B Series doesn't stop there. It offers a variety of capabilities you won't find elsewhere—capabilities that help you accelerate your testing and get your project wrapped up faster:

Waveform summing and combining capability

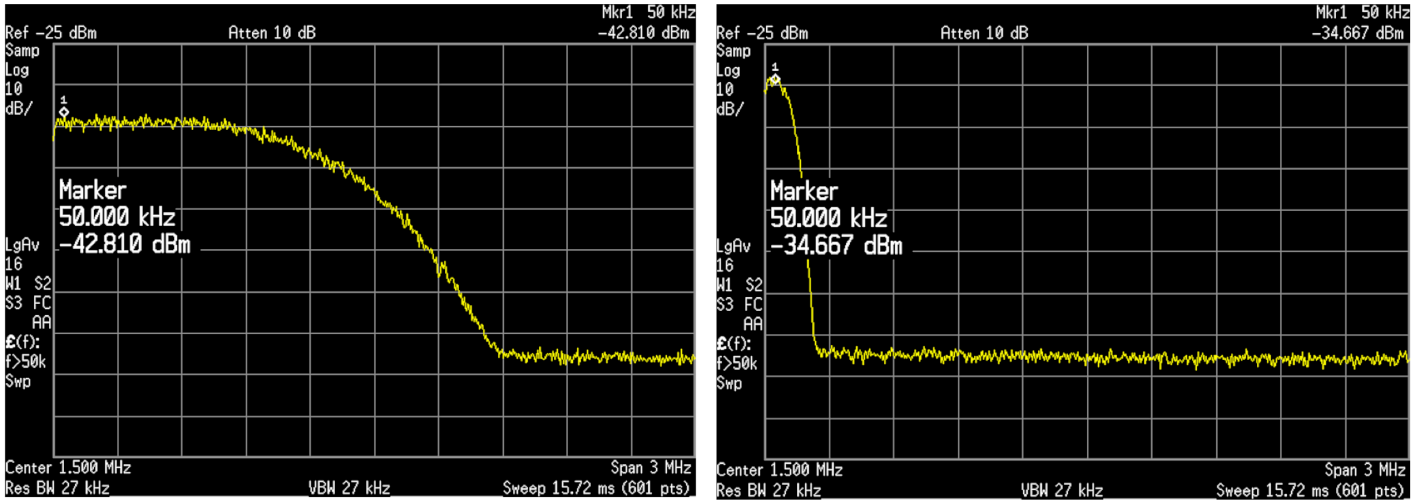
Easily add noise to your signal for margin and distortion testing using only a single channel. You can create dual-tone multifrequency signals without a dual-channel generator, which means you can preserve your budget for other test needs. On a two-channel model, you can sum and combine up to four signals.

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."

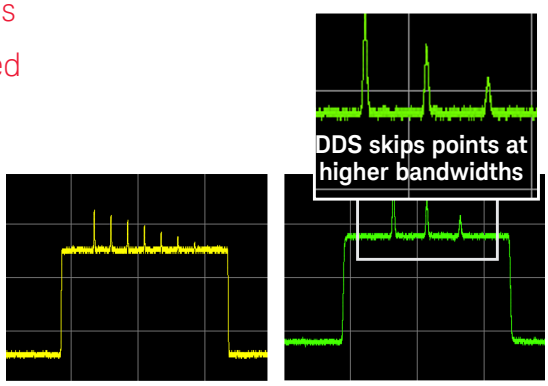


The images show approximately 10 dB increase in amplitude at 50 kHz when the bandwidth is reduced 10x. You can see how the signal energy is increased in the frequencies of interest when the bandwidth is reduced, instead of being spread over a very wide bandwidth with lower amplitude at all frequencies.

DDS technology may skip points at higher frequencies

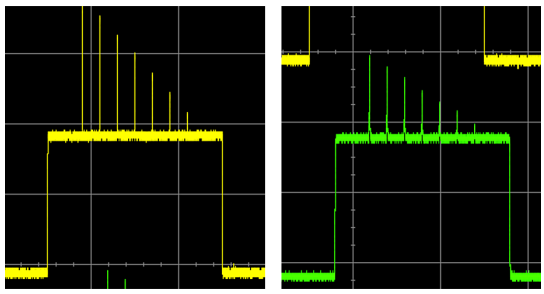
Trueform never skips points, and is always anti-aliased

Define any waveform shape and any waveform length using point-by-point 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 at 200 kHz

DDS at 200 kHz misses details



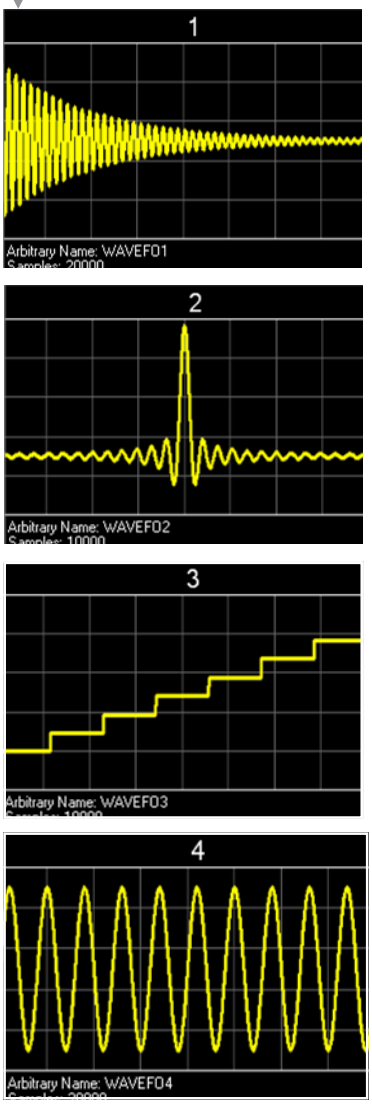
Trueform at 50 kHz

DDS at 50 kHz

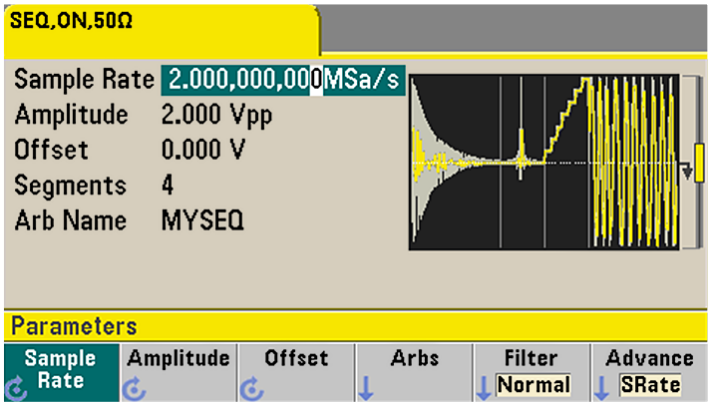
Waveform sequencing

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

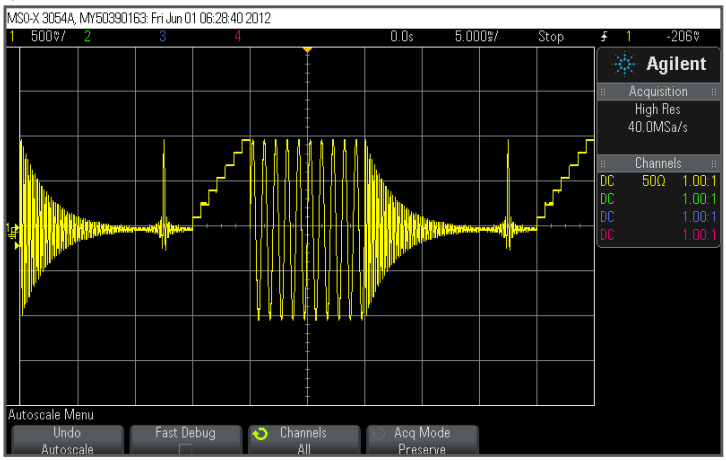
Create the waveform in the 33503A Waveform Builder Pro and download it to the waveform generator.



Waveform generator display with downloaded waveform.



Scope display of waveform



Trueform Technology Capabilities *continued*

Pseudo-random binary sequence (PRBS) pattern generation

Test your digital serial buses by streaming standard PRBS patterns—like PN7 and PN19—without the need for a separate pulse generator. With fewer instruments, setting up your tests is easier. You won't find these built-in PRBS patterns in competitive waveform generators.

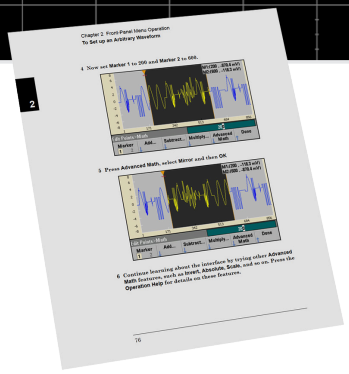


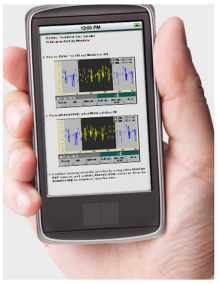
Easily generate PRBS waveforms on the 33500B Series waveform generators.

You can select multiple sequence lengths (such as PN15) and bit rates up to 50 Mbit/sec to create PRBS signals.

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.



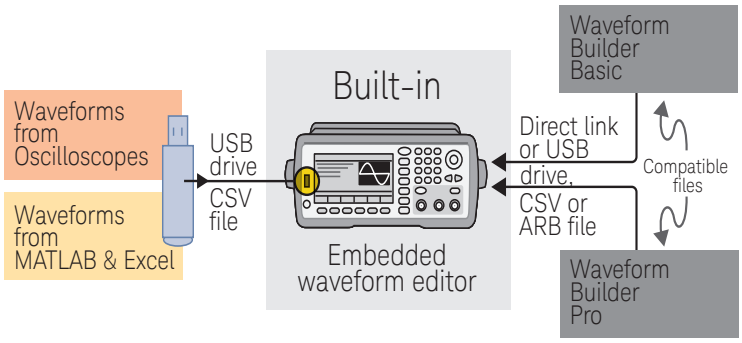


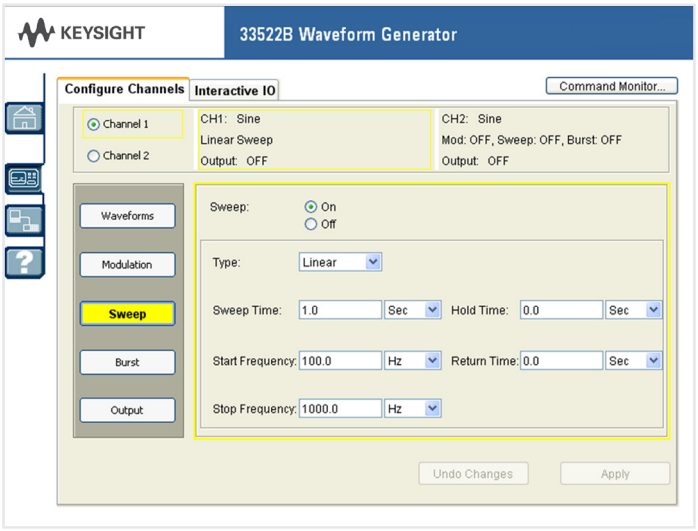
Flexibility in creating and playing waveforms

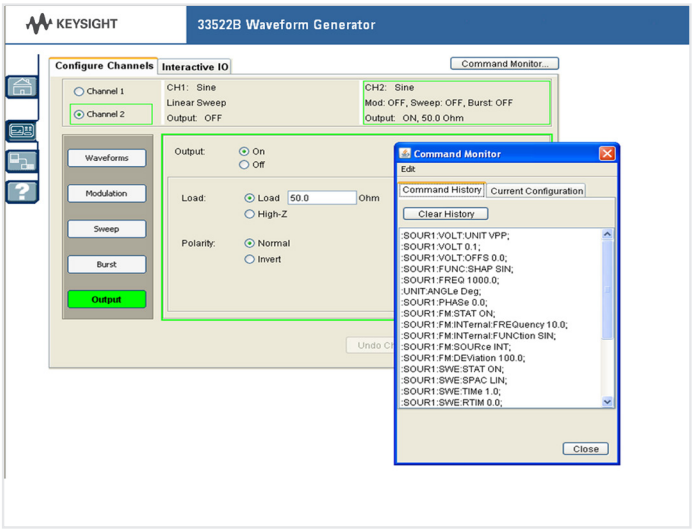
There are five ways to create arbitrary waveforms for use with the 33500B generator.

1. Use the included Waveform Builder Basic software to edit and download a waveform file to the generator
2. Use 33503A Waveform Builder Pro software to create more complex waveforms and sequencing
3. Capture a waveform from an oscilloscope and download it to the generator
4. Create a waveform in MATLAB, Excel, etc. and download it to the generator
5. 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.







Built-in Web browser

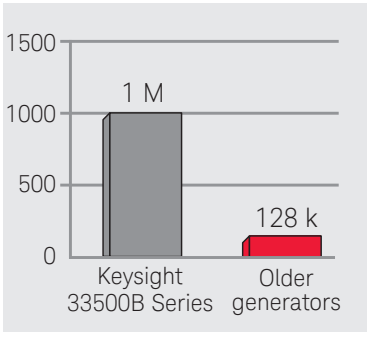
Easily set up and control your 33500B Series generator remotely over a LAN connection using the built-in LXI Web browser. You can monitor your tests and adjust settings from another office or room, or even from home.

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.

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 33500B Series' standard memory is 1 MSamples deep. Typical DDS generators offer only a fraction of that amount but with the 33500B Series there is even a 16 MSample memory option available.



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

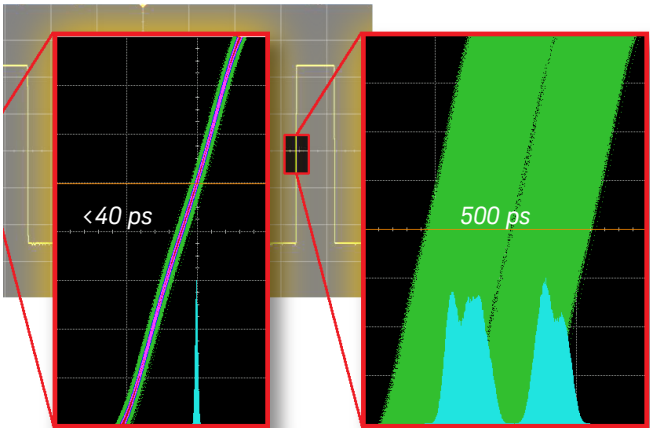
If your generator is introducing spurious signals or harmonics, you'll have a hard time producing reliable designs. To be successful, you need to test with clean, precise, low-noise signals. Keysight 33500B Series waveform generators offer the highest signal fidelity so you can generate the exact waveforms you need for your most challenging measurements. You can be confident you are seeing your design's characteristics, not your waveform generator's, in your measurements.

33500B Series waveform generators offer the following advantages:

Lowest jitter

With 12x better jitter than anything in their class, 33500B 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.



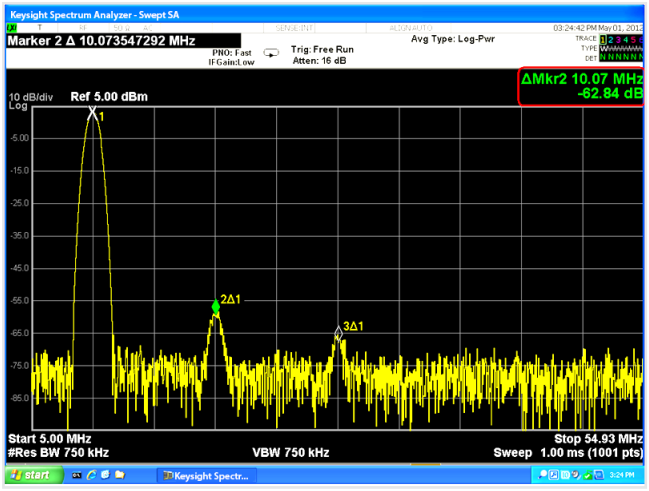
Trueform technology | Traditional DDS technology

Faster edge times

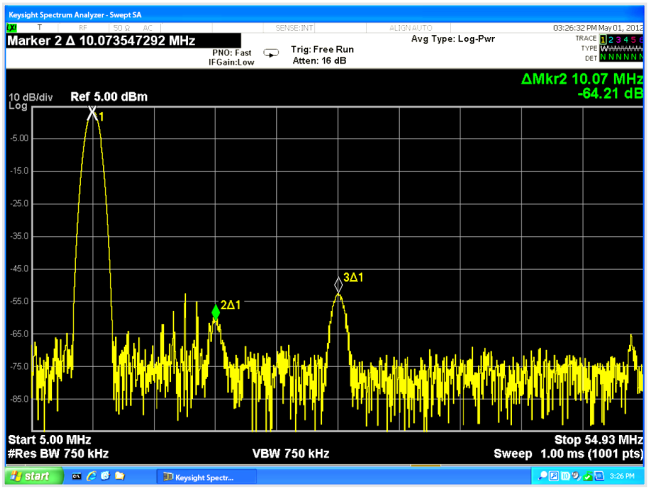
The 33500B Series' 8.4-ns rise and fall times are more than twice as fast as you'll find in typical waveform generators. You can place edges with more confidence and more accurately set trigger points. Because of the faster transition, higher harmonic content is created, which helps you expand your understanding of your circuit.

Lowest harmonic distortion

With total harmonic distortion of just 0.04%, the 33500B 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 33500B Series waveform generators offer the lowest total harmonic distortion (THD) in its class.



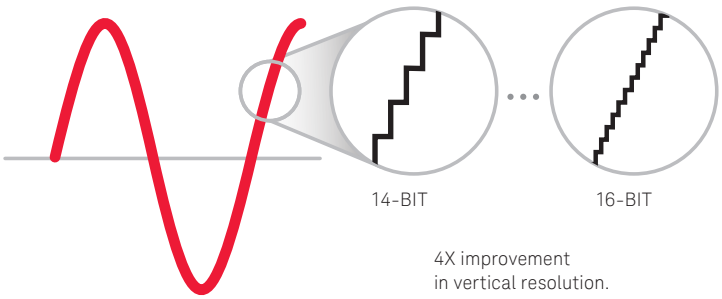
Typical DDS generator has a higher noise floor and greater harmonics.

Reproduce lower-voltage output signals

Today's ultra-low-power products such as pacemakers, hearing aids and remote sensors use very low voltages. The 33500B Series lets you create signals as low as 1 mVpp. That's 10x better amplitude resolution than typical waveform generators offer.

Highest amplitude resolution

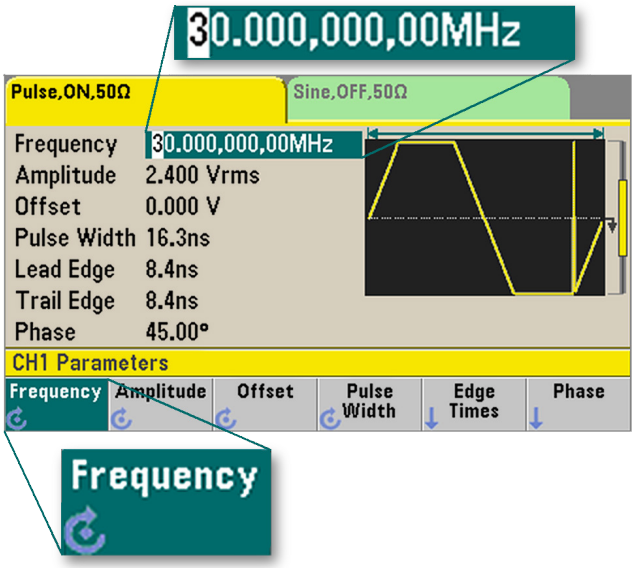
The 33500B Series' 16 bits of resolution is 4x that of most waveform generators. You can make output changes all the way down to 1 µV—exactly what you need for testing today's low-voltage circuits and designs.



4X improvement
in vertical resolution.

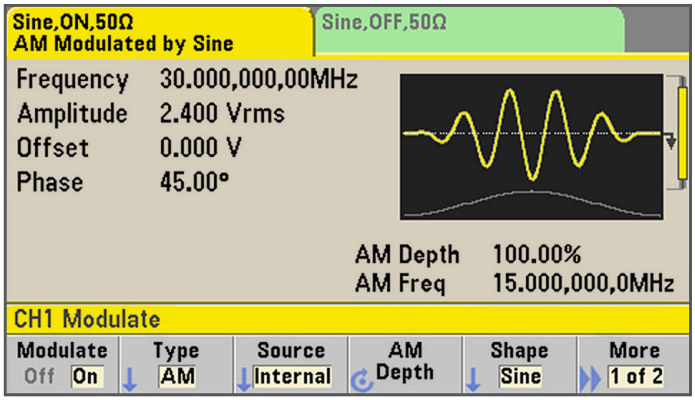
Full bandwidth pulses

Create pulses up to 30 MHz with the 33500B 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

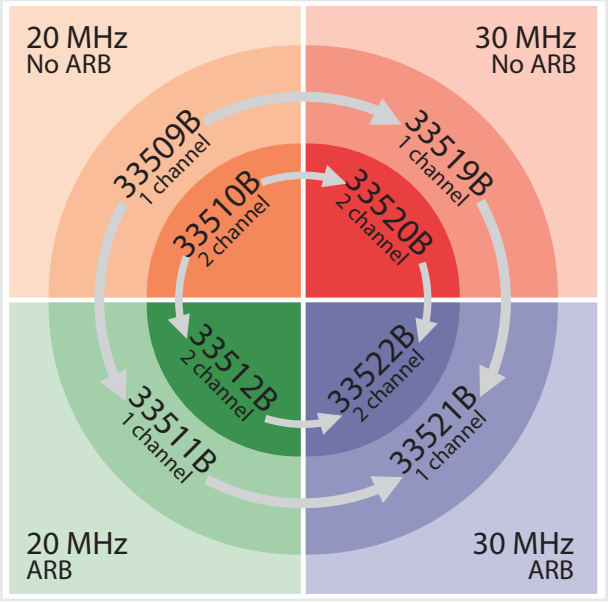
Eliminate the need for an external modulation source. The 33500B Series has a modulation frequency up to the frequency of the waveform being modulated. Existing DDS-based generators have a much lower internal modulation frequency. Now you can create your complex signals all within a single generator.



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

Investment protection

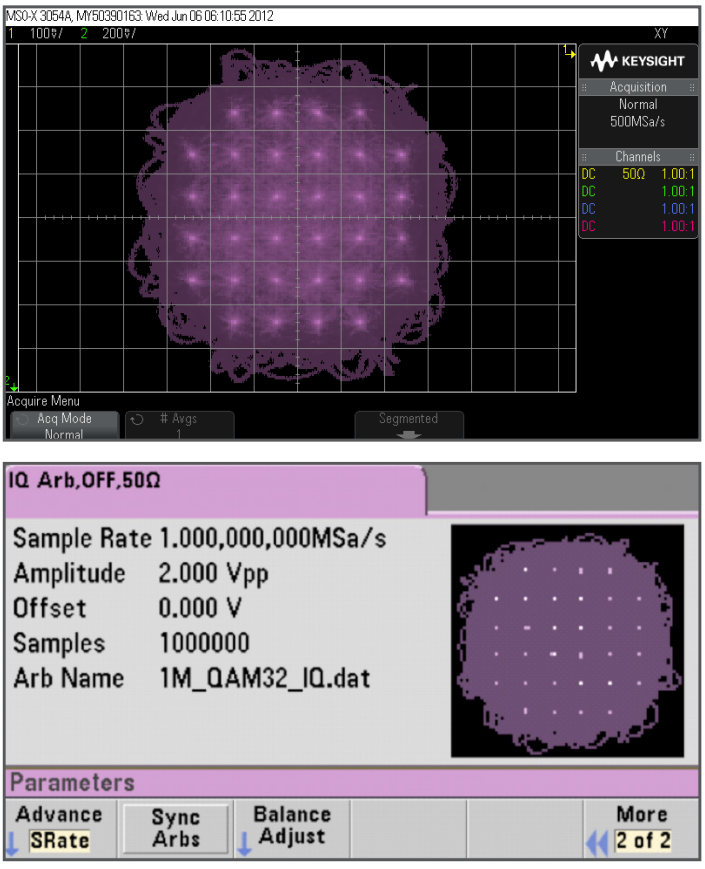
With most waveform generators, you get only what you pay for when you buy your instrument. But with 33500B Series waveform generators, there are eight different models to choose from so you can purchase the capability you need now and upgrade later when your project needs change. Your investment in test equipment is protected. If you need to generate 30 MHz waveforms or arbitrary 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.



Select from eight 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 function generator.



Optional IQ player allows you to play Q files on your 2-channel arb function generator.



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

Model No.	Description	ARB
33509B	20 MHz, 1-channel	
33510B	20 MHz, 2-channel	
33511B	20 MHz, 1-channel	X
33512B	20 MHz, 2-channel	X
33519B	30 MHz, 1-channel	
33520B	30 MHz, 2-channel	
33521B	30 MHz, 1-channel	X
33522B	30 MHz, 2-channel	X

8 models to choose from

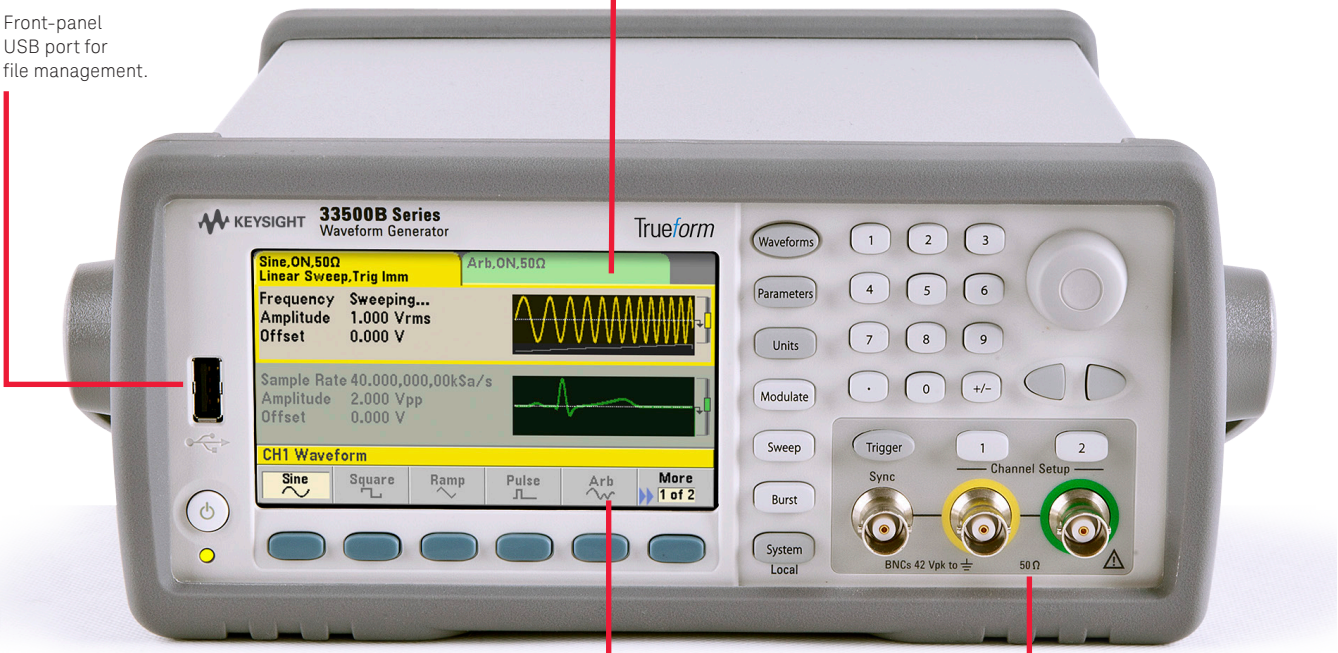
Choose the model with the capability you need now, knowing you can upgrade later. All models come with a rich set of built-in, standard features, including LAN, USB and GPIB interfaces, 1 MSample of memory, an external timebase input, and basic waveform generation software. You get everything you need 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.

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

Front-panel USB port for file management.



True point-by-point arbitrary waveforms with sequencing for more accurate representation of user-defined signals.

Dual-channel mode with independent or coupled channels.

Other Productivity tools



View measurements across multiple instruments Keysight BenchVue Software

Click. Capture. Done.

Keysight BenchVue software for the PC reinvents your bench testing by making it simple to connect and record results with your instruments with no programming. You will derive answers faster than ever by easily viewing, logging and exporting measurement data and screen images with a few clicks from a single environment.

Use BenchVue to:
- Visualize multiple measurements simultaneously
- Easily log data, screen images and system state
- Recall past state of your bench to replicate results
- Rapidly prototype custom test sequences

Save time with:
- Fast measurement data export in desired formats
- Quickly access manuals, drivers, FAQs and videos

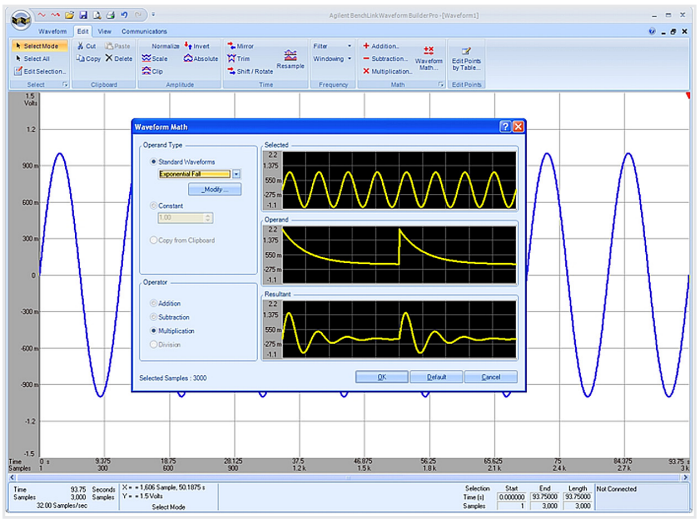
From anywhere:
- Monitor and control your bench from mobile devices

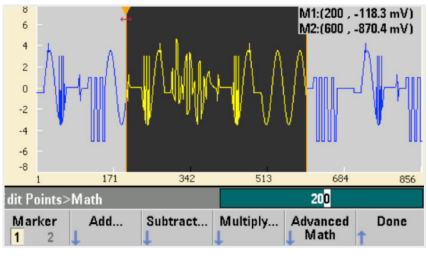


See your measurements across instruments in one place to quickly correlate measurement activities and obtain actionable insights. Control your waveform generator to set waveform properties and load custom arbitrary waveform from files or drag-and-drop from an oscilloscope.

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.

Configuration Guide

Step 1. Choose your bandwidth, channel count, and arbitrary waveforms

33500B Series waveform generators with Trueform technology				
Bandwidth	20 MHz	20 MHz	30 MHz	30 MHz
Number of channels	1	2	1	2
Waveform generator	33509B	33510B	33519B	33520B
Waveform generator with arb capability	33511B	33512B	33521B	33522B

Step 2. Tailor your waveform generator for more demanding applications

Application	**Order option**
Additional memory for long waveforms	MEM (only available on models with arb)
Baseband IQ Player with adjustments	IQP (only available on 33512B/33522B)
Security features with NISPOM	SEC
Ultra-high stability timebase	OCX

Step 3. Upgrade your waveform generator in the future[1]

Upgrade desired	**Order upgrade option**
Increase bandwidth to 30 MHz	335BW1U on 1-channel models 335BW2U on 2-channel models
Add arbitrary waveform capability	335ARB1U on 1-channel models 335ARB2U on 2-channel models
Add 16M memory to arb	335MEM1U on 1-channel arb models 335MEM2U on 2-channel arb models
Add NISPOM and file security	335SECU
Add IQ baseband signal player to 2-channel arb	335IQPU
Add high-stability timebase	33500U-OCX (must return to Keysight)

1. 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 auto range ON.

Instrument characteristics

Models & options	
33509B/11B/19B/21B	1-channel
33510B/12B/20B/22B	2-channel
Option MEM	Increases arbitrary waveform memory to 16 MSa/channel [1]
Option OCX	OCXO timebase for ultra-high stability
Option IQP	IQ player (only available on 33512B and 33522B)
Waveforms	
Standard	Sine, square, ramp, pulse, triangle, Gaussian noise, PRBS (pseudorandom binary sequence), DC
Built-in arbitrary [1]	Cardiac, exponential fall, exponential rise, Gaussian pulse, Haversine, Lorentz, D-Lorentz, negative ramp, sinc (Sin X/X)
User-defined arbitrary [1]	Up to 1 MSa (16 MSa with Option MEM) with multi-segment sequencing
Operating modes & modulation types	
Operating modes	Continuous, modulate, frequency sweep, burst, output gate
Modulation types	AM, FM, PM, FSK, BPSK, PWM, Sum (carrier + modulation)

Waveform characteristics

Sine		
Frequency range	1 µHz to 20 MHz or 30 MHz, 1 µHz resolution	
Amplitude flatness (spec) [3, 4] (relative to 1 kHz)	< 100 kHz:	± 0.10 dB
	100 kHz to 5 MHz:	± 0.15 dB
	5 to 20 MHz:	± 0.30 dB
	20 to 30 MHz: [2]	± 0.40 dB
Harmonic distortion (typ) [4, 5]	< 20 kHz:	< -70 dBc
	20 to 100 kHz:	< -65 dBc
	100 kHz to 1 MHz:	< -50 dBc
	1 to 20 MHz:	< -40 dBc
	20 to 30 MHz: [2]	< -35 dBc
THD (typ)	20 Hz to 20 kHz:	< 0.04%
Non-harmonic spurious (typ) [4, 5]	Standard: < -75 dBc, increasing +20 dB/decade above 2 MHz Option OCX: < -75 dBc, increasing +20 dB/decade above 10 MHz *(or < -100 dBm, whichever is greater, below 500 MHz)*	
Phase noise (SSB) (typ)	Standard	Option OCX
1 kHz offset	-105	-110 dBc/Hz
10 kHz offset	-115	-125 dBc/Hz
100 kHz offset	-125	-135 dBc/Hz

1. Only available on 33511B/12B/21B/22B
2. Only available on 33519B/20B/21B/22B
3. Add 1/10th of the output amplitude and offset accuracy specification per °C for operation at temperatures beyond 23°C ± 5°C.
4. Auto range ON.
5. DC offset set to zero.

Specifications

Waveform characteristics, *continued*

Square & pulse	
Frequency range	1 µHz to 20 MHz or 30 MHz, 1 µHz resolution
Rise and fall times (nom)	Square: 8.4 ns, fixed Pulse: 8.4 ns to 1 µs, independently variable, 100-ps or 3-digit resolution
Overshoot (typ)	< 2%
Duty cycle	0.01% to 99.99% [1]
Pulse width	16 ns minimum, 100-ps resolution
Jitter (cycle-to-cycle, typ)	< 40 ps rms
Ramp & triangle	
Frequency range	1 µHz to 200 kHz, 1 µHz resolution
Ramp symmetry	0.0% to 100.0%, 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	
Bandwidth (typ)	1 mHz to 20 MHz or 30 MHz, variable
Crest factor (nom)	4.6
Repetition period	> 50 years
Pseudorandom binary sequence (PRBS)	
Bit rate	1 mbps to 50 Mbps, 1 mbps resolution
Sequence length	2^m-1, m = 7, 9, 11, 15, 20, 23
Rise and fall times (nom)	8.4 ns to 1 µs, variable, 100-ps or 3-digit resolution

Arbitrary waveform characteristics

General	
Waveform length	8 Sa to 1 MSa per channel (16 MSa with Option MEM in increments of 1 sample
Sample rate	30 MHz models: 1 µSa/s to 250 MSa/s, 1 µSa/s resolution 20 MHz models: 1 µSa/s to 160 MSa/s, 1 µSa/s resolution
Voltage resolution	16 bits
Bandwidth (-3 dB, nom)	Filter off: 40 MHz "Normal" filter on: 0.27 x (sample rate) "Step" filter on: 0.13 x (sample rate)
Rise and fall time	0.35 / bandwidth (10 ns min) with "Normal" or "Step" filter on
Settling time (typ)	< 200 ns to 0.5% of final value
Jitter (typ)	Filter off: < 40 ps rms "Normal" or "Step" filter on: < 5 ps

IQ Player Characteristics

Balance adjust	
Amplitude gain (channel to channel amplitude balance)	-30% to +30%
Delta offset Ch 1 and Ch 2	± (5 VDC - peak AC) into 50 Ω ± (10 VDC - peak AC) into open circuit
IQ signal skew (adjusts channel to channel skew)	-4.00 ns to +4.00 ns
Views	
Amplitude vs. time	
X-Y (constellation diagram)	

1. Subject to pulse width limits.

Specifications

Arbitrary waveform characteristics, continued

Waveform sequencing (available only on 33511B/12B/21B/22B)	
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 can be specified in each step. To improve throughput, up to 32 sequences totalling up to 1,024 segments can be pre-loaded into volatile memory.
Segment length	8 Sa to 1 MSa per channel (16 MSa with Option MEM) in increments of 1 sample
Sequence length	1 to 512 steps
Segment repeat count	1 to $1x10^{10}$, or infinite

Output characteristics

Isolation	
Outputs	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 shells is ±42 Vpk
Signal output	
Output impedance (nom)	50 Ω
On, off, inverted	User-selectable for each channel
Voltage limit	User-definable V_{MAX} and V_{MIN} limits
Overload protection	Output turns off automatically when an overload is applied, Instrument will tolerate a short-circuit to ground indefinitely
Amplitude	
Range	1 mVpp to 10 Vpp into 50 Ω 2 mVpp to 20 Vpp into open circuit
Resolution	4 digits
Units	Vpp, Vrms, or dBm, selectable
Accuracy [1, 2] (spec)	± 1% of setting ± 1 mVpp at 1 kHz
DC offset	
Range [3]	± (5 VDC - peak AC) into 50 Ω ± (10 VDC - peak AC) into open circuit
Resolution	4 digits
Units	VDC
Accuracy [1, 2] (spec)	± 1% of offset setting ± 0.25% of amplitude setting ± 2mV

Frequency accuracy

Standard frequency reference (spec)	
1 year, 23° C ± 5° C	± 1 ppm of setting ± 15 pHz
1 year, 0° C to 55° C	± 2 ppm of setting ± 15 pHz
High-stability frequency reference (spec): Option OCX	
1 year, 0° C to 55° C	± 0.1 ppm of setting ± 15 pHz

1. Add 1/10th of the output amplitude and offset accuracy specification per °C for operation at temperatures beyond 23°C ± 5°C.
2. Auto range on.
3. Output noise is typically 20 dB lower when (DC + Peak AC) < 320 mV (into 50) or 640 mV (into open circuit).

Specifications

Modulation types and operating modes

Carrier	AM	FM	PM	FSK	BPSK	PWM	Sum	Burst	Sweep
Sine and Square	X	X	X	X	X		X	X	X
Pulse	X	X	X	X	X	X	X	X	X
Triangle and Ramp	X	X	X	X	X		X	X	X
Gaussian Noise	X						X	X[2]	
PRBS	X	X	X				X	X	
Single ARB [1]	X		X[3]		X[3]		X	X	
Sequenced ARB [1]	X						X		

Modulating signals

Carrier	Sine	Square	Triangle / Ramp	Noise	PRBS	ARB [1]	External
Sine	X	X	X	X	X	X	X
Square and Pulse	X	X	X	X	X	X	X
Triangle and Ramp	X	X	X	X	X	X	X
Gaussian Noise	X	X	X		X	X	X
PRBS	X	X	X	X		X	X
ARB [1]	X	X	X	X	X		X

Modulation characteristics

Amplitude modulation (AM)	
Source	Internal or external, or either channel with 2-channel models
Type	Full-carrier or double-sideband suppressed-carrier
Depth [4]	0% to 120%, 0.01% resolution
Frequency modulation (FM) 7	
Source	Internal or external, or either channel with 2-channel models
Deviation	1 µHz to 15 MHz, 1 µHz resolution
Phase modulation(PM)	
Source	Internal or external, or either channel with 2-channel models
Deviation	0° to 360°, 0.1° resolution
Frequency shift key modulation (FSK) 7	
Source	Internal timer or ext trig connector
Mark & space	Any frequency within the carrier signal's range
Rate	0 Hz to 1 MHz
Binary phase shift key modulation (BPSK)	
Source	Internal timer or ext trig connector
Phase shift	0° to 360°, 0.1° resolution
Rate	0 Hz to 1 MHz
Pulse width modulation (PWM)	
Source	Internal or external, or either channel with 2-channel models
Deviation [5]	0% to 100% of pulse width, 0.01% resolution
Additive modulation (Sum)	
Source	Internal or external, or either channel with 2-channel models
Ratio [6]	0% to 100% of carrier amplitude, 0.01% resolution

1. Only applies to 33511B/12B/21B/22B.
2. Gated burst only.
3. Applies to sample clock, not whole waveform.
4. Add 1/10th of the output amplitude and offset accuracy specification per °C for operation at temperatures beyond 23°C ± 5°C.
5. Subject to pulse width limits.
6. Subject to maximum output voltage limits.

Specifications

Burst [1]

Type	Counted or gated
Count	1 to $1x10^8$ cycles, or infinite
Gated	Produces complete cycles while Ext Trig is asserted
Start/stop phase [2]	-360° to 360°, 0.1° resolution
Trigger source	Internal timer or Ext Trig connector
Marker	Adjustable to any cycle; indicated by the trailing edge of the sync pulse

Sweep [3]

Type	Linear, logarithmic, 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 freq < stop freq) or down (start freq > stop freq)
Start and stop frequencies	Any frequency within the waveform's range
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
Hold time	0 s to 3600 s, 1 ms resolution
Return time	0 s to 3600 s, 1 ms resolution
Trigger source [4]	Immediate (continuous), external, single, bus, or timer
Marker	Adjustable to any frequency between start and stop for Linear and logarithmic types or any frequency in the list for list type; indicated by the trailing edge of the sync pulse

Internal timer for FSK, BPSK, BURST, and SWEEP

Range	1 µs to 8000 s, 6-digit or 8 ns resolution

2-channel characteristics (only applies to 33510/12/20/22B)

Operating modes	Independent, coupled parameter(s), combined (Ch 1 + Ch 2), Equal (Ch 2 = Ch 1), or differential (Ch 2 = negative Ch 1)
Parameter coupling	None, frequency (ratio or difference) and/or amplitude and DC offset
Relative phase	0° to 360°, 0.001° resolution
Skew (typ)	< 200 ps (when performing identical operations)
Crosstalk (typ)	< -85 dB

1. Counted burst operation is not allowed for Gaussian noise.
2. Limited to arbitrary waveforms that are < 1 million points; phase resolution limited by number of points in arbitrary waveforms < 3,600 points.
3. All frequency changes are phase-continuous.
4. External trigger only for sweep time > 8000 sec.

Specifications

Sync/marker output

Connector	Front-panel BNC, isolated from chassis
Functions	Sync, sweep marker, burst marker, or arbitrary waveform marker
Assignment	Channel 1 or channel 2
Polarity	Normal or inverted
Voltage level (nom)	3 Vpp into open circuit, 1.5 Vpp into 50 Ω
Output impedance (nom)	50 Ω
Minimum pulse width (nom)	16 ns

External trigger/gate

Connector	Rear-panel BNC, chassis-referenced
Function	Input or output
Assignment	Channel 1, channel 2, or both (as input) Channel 1 or channel 2 (as output)
Polarity	Positive or negative slope
Voltage level (nom)	0 V to 0.4 V for low, > 2.3 V for high, 3.5 V maximum (as input) 3 Vpp (nom) into open circuit, 1.5 Vpp (nom) into 50 Ω (as output)
Impedance (nom)	10k Ω, DC-coupled (as input) 50 Ω (as output)
Minimum pulse width (nom)	16 ns
Input rate	DC to 1 MHz
Minimum pulse width	100 ns (as input)
Duty cycle (nom)	50% (as output)
Trigger delay	0 s to 1000 s, 4 ns resolution; applies to all trigger events
Input latency (typ)	< 135 ns with trigger delay set to zero
Input jitter (typ)	< 2.5 ns, rms
Fanout	≤ 4 total Keysight 33500B Series waveform generators

Modulation input

Connector	Rear-panel BNC, isolated
Assignment	Channel 1, channel 2, or both
Voltage level	±5 V full-scale
Input impedance (nom)	5k Ω
Bandwidth (-3 dB, typ)	0 Hz to 100 kHz

Frequency reference input

Connector	Rear-panel BNC, isolated from chassis and all other connectors
Reference selection	Internal, external, or auto
Frequency range	Standard: 10 MHz ± 20 Hz Option OCX: 10 MHz ± 1 Hz
Lock time (typ)	<2 s
Voltage level	200 mVpp to 5 Vpp
Input impedance (nom)	1k Ω || 20 pF, AC-coupled

Specifications

Frequency reference output

Connector	Rear-panel BNC, chasis-referenced
Frequency (nom)	10 MHz
Output impedance (nom)	50 Ω, AC-coupled
Level (nom)	0 dBm, 632 mVpp into 50 Ω

Real-time clock/calendar

Set and read	Year, month, day, hour, minute, second
Battery	CR-2032 coin-type, replacable, > 5-year life (typ)

Programming times (meas.)

Configuration change speed				
	LAN (socket)	LAN (VXI-11)	USB 2.0	GPIB
Change function	5 ms	6 ms	5 ms	5 ms
Change frequency	2 ms	3 ms	2 ms	3 ms
Change amplitude	20 ms	20 ms	19 ms	22 ms
Select user arb (16 k)	9 ms	11 ms	9 ms	9 ms

Arbitrary waveform download speed to volatile				
(Binary transfer)	LAN (socket)	LAN (VXI-11)	USB 2.0	GPIB
4 k sample	6 ms	18 ms	8 ms	39 ms
1 M sample	1.3 s	2.6 s	13 s	9.1 s

Memory

Arbitrary waveform and instrument state memory	
Volatile	$1x10^6$ samples per channel or $16x10^6$ samples per channel (Option MEM) 512 sequence steps per channel
Non-volatile	File sytem file space is limited to 64 MB (~32 MSa of arbitrary waveform records)
Instrument state	
Store / Recall	User defined instrument states
Power off	Power Off state automatically saved
Power on	Factory default settings or last power off settings
USB file system	
Front-panel port	USB 2.0 high-speed mass storage (MSC) class device
Capability	Read or write instrument configuration settings, instrument states and user arbitrary waveform and sequence files.
Speed	10 MB/s (nom)

Specifications

General characteristics

Computer interfaces	
LXI- C (rev1.3)	10/100Base-T Ethernet (Sockets & VXI-11 protocol) USB2.0 (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 compatibile
Graphical display	4.3" Color TFT WQVGA (480x272) with LED backlight
Mechanical	
Size	261.1mm W x 103.8mm H x 303.2mm D (with bumpers installed) 212.8mm W x 88.3mm H x 272.3mm D (with bumpers removed) 2U x 1/2 rack width
Weight (nom)	3.3 kg (7.2 lbs)
Environmental	
Storage temperature	-40°C to 70°C
Warm-up time	1 hour
Operating environment	EN61010, polution degree 2; indoor locations
Operating temperature	0°C to 55°C
Operating humidity	5% to 80% RH, non-condensing
Operating altitude	Up to 3000 meters

Regulatory	
Safety	Complies with European Low Voltage Directive and carries the CE-marking. Conforms to UL 61010-1, CSA C22.2 61010-1, and IEC 61010-1:2001
EMC	Complies with European EMC Directive for test and measurement products. – IEC/EN 61326-1 – CISPR Pub 11 Group 1, class A – AS/NZS CISPR 11 – ICES/NMB-001 *Complies with Australian standard and carries C-Tick mark* *This ISM device complies with Canadian ICES-001* *Cet appareil ISM est conforme a la norme NMB-001 du Canada*
Acoustic noise (nom)	*SPL 35 dB(A)*
Line power	
Voltage	100 V - 240 V 50/60 Hz -5%, +10% 100 V - 120 V 400 Hz ±10%
Power consumption (typ)	< 45 W, < 130 VA
Warranty	3-year standard warranty

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° C – 55° C and after a 45-minute warm up period. All specifications include measurement uncertainty 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, which 80% or more of manufactured instruments will meet. This data is not warranted, does not include measurement 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 development for purposes of communicating the expected performance. This data is not warranted and is measured at room temperature (approximately 23 °C).

Accuracy

Represents the traceable accuracy of a specified parameter. Includes measurement error and timebase error, and calibration source uncertainty.

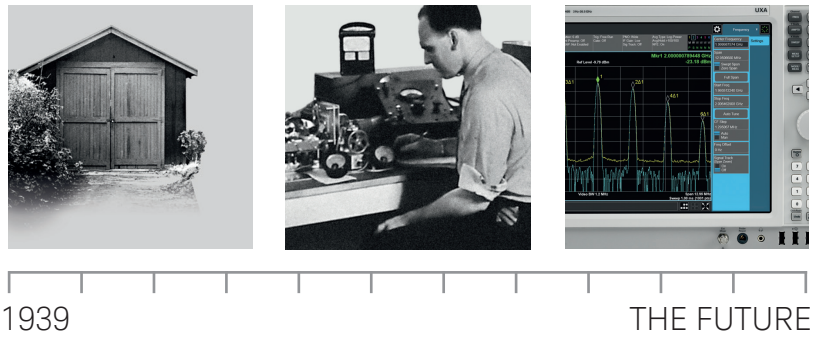
Random measuremet errors are combined using the root-sum-square method and are multiplied by M for the desired Confidence Level. Syatematic errors are added linearly and include time skew errors, trigger timing errors, and timebase errors as appropriate for each measurement type.

Confidence level

For 99% Confidence use k= 2.5 in accuracy calculations.
For 95% Confidence use k= 2.0 in accuracy calculations.

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