FG33530 Series

100 MHz function / arbitrary waveform generators

Introduction

The Keysight FG33530 Series function / arbitrary waveform generators offer up to 100 MHz with all the essential signals and features you expect, including modulation, sweep, and burst capabilities. Enjoy seamless navigation through the intuitive front-panel interface, allowing you to effortlessly adjust and review your settings for maximum efficiency. The Trueform technology replicates every waveform point, providing up to 16 Mega Samples (MSa) record length per channel. Enhance your waveform creation process with Keysight BenchVue software and BenchLink Waveform Builder, making it simple to create and edit even your most complex waveforms.

Features

- Seven-inch color display for parameter setup, signal viewing, and editing.
- Jitter of less than 50 ps.
- Total harmonic distortion of less than 0.06%.
- Six built-in modulation types and seventeen popular waveforms to simulate typical applications for testing.
- 16-bit arbitrary waveform capability with maximum sampling rate of 320 MSa/s and memory of up to 16 MSa per channel.



KEYSIGHT



Figure 1. Keysight FG33531A 100 MHz, single-channel function / arbitrary waveform generator



Figure 2. Keysight FG33532A 100 MHz, dual-channel function / arbitrary waveform generator

Ease of use: Simple setup and operation

The seven-inch color display shows the waveform setting and other parameter details in one view. The large display also accommodates dual-channel displays, providing an uncluttered view and making complex tasks seamless, such as setting up sync, sum, track, or differential waveform generation from both channels. Color-coded keypads, display, and output connectors help prevent setup and connection errors.

The FG33530 Series ships standard with USB and LAN connectivity, making it easy to access and control remotely. It supports operation using Standard Commands for Programmable Instruments (SCPI) language, Interchangeable Virtual Instruments (IVI) driver, web browser, or Keysight's Pathwave BenchVue software.

Additionally, it features a built-in USB memory port, enabling you to store setup parameters with a USB flash drive. This feature maximizes efficiency when restoring the same setup into all the function / arbitrary waveform generators in your lab. It also lets you quickly import your arbitrary waveform file to the function generator.



Modulation and built-in waveforms

The FG33530 Series has all the fundamental waveforms plus seventeen built-in arbitrary waveforms. The waveform functions include — sine, square, ramp, triangle, pulse, PRBS, DC, Gaussian noise, and more (Figures 1 and 2). Additional specialty waveforms such as cardiac, exponential fall, exponential rise, Gaussian pulse, haversine, Lorentz, D-Lorentz, negative ramp, and sinc are also available (Figure 3). There are six built-in analog and digital modulations including Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM), Frequency-Shift Keying (FSK), Binary Phase Shift Keying (BPSK), and Pulse Width Modulation (PWM) (Figure 4).

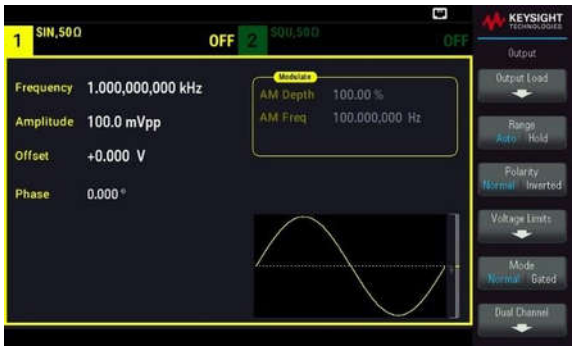


Figure 1. Standard sine wave and parameter settings



Figure 2. Dual-screen display of standard sine and square wave



Figure 3. Cardiac specialty waveform

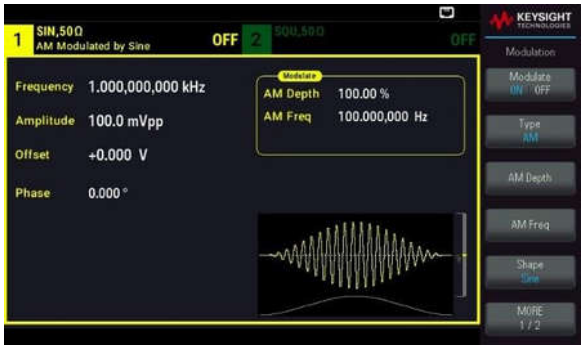


Figure 4. AM modulated with a standard sine wave

Standard deep memory

If you want to test your design with long, complex waveforms with various anomalies, you must ensure your waveform generator has sufficient memory. The FG33530 Series comes standard with 8 MSa memory and 320 MSa/s sampling rate. In addition, a higher memory upgrade option of up to 16 MSa is available to handle your most complex waveforms.

Seamlessly replay signals

The FG33530 series function generators can seamlessly replay signals from various brands of oscilloscopes by importing a CSV file (up to 3.5 MB file size). Using instrument UI, you can easily convert these signals into ARB format. Regardless of your .csv file header, the smart import can recognize and extract the waveform traces, including even if your file contains the first column timestamp, the FG33530 series will automatically adjust the correct sampling rate up to 320 Msa/s, preserving your waveform without distortion.

Additionally, if your .csv file contains multiple data trace columns (up to 4 data columns), you can select the specific column you want to import and then preview the signal of interest on the display (Figures 5 and 6). The smart import is also able to accommodate high resolution of your data traces up to 10 characters per data point.

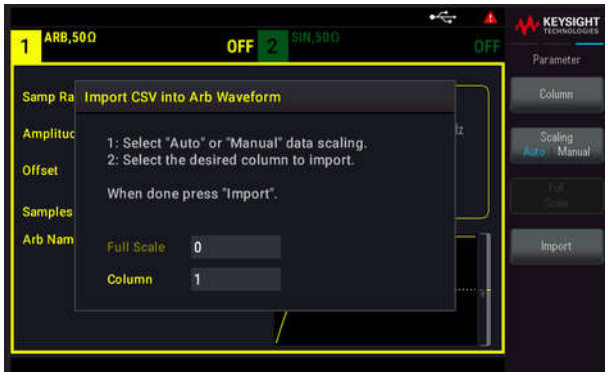


Figure 5. Smartly import a CSV data file to replay signals captured from your oscilloscope.

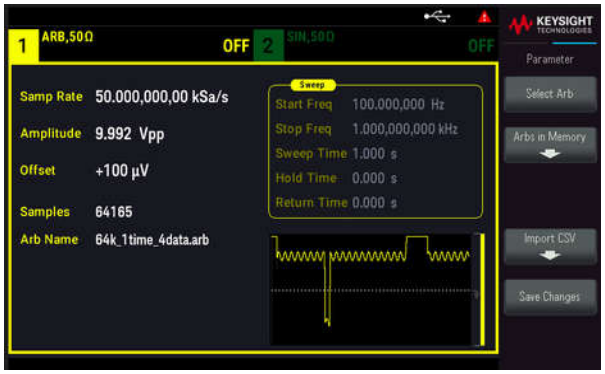


Figure 6. Quick preview of your ARB files

Keysight BenchVue Software

Keysight BenchVue software for the PC makes it simple to connect, control instruments, and automate test sequences. With just a few clicks, you can quickly move past the test development phase and access results faster.

Note: We have fully transitioned the BenchVue Included license that comes with your instrument purchase to the BenchVue Basic App, making it easier for you to access and use BenchVue software. You can now download PathWave BenchVue Basic for free. PathWave BenchVue Basic apps provide unlimited access and features that are available in the version just before the latest version of the BenchVue software. Visit www.keysight.com/find/BVBasic for more information.

BV0002B function generator control and automation app

You can purchase BV0002B separately or get the basic version free at www.keysight.com/find/BVBasic. The BV0002B enables you to:

- Point and click to control your function generators
- Create and edit advanced waveforms with 33503B Keysight BenchLink Waveform Builder Pro (purchased separately)
- Load custom arbitrary waveforms from files
- Drag-and-drop measured traces easily from the BenchVue Oscilloscope App
- Rapidly build custom test sequences with Test Flow
- Access deeper instrument controls with Command Expert integration
- Intuitively control, automate, and simplify testing with your function generators and hundreds of other Keysight instruments

33503B Keysight BenchLink Waveform Builder Pro software

The FG33530 Series is supported by the 33503B Keysight BenchLink Waveform Builder Pro software, therefore allowing you to create any waveform sequences, whether building from scratch or combining several common segments with the software's comprehensive editing tools (Figure 7). Now you can build long, complex waveforms to simulate any signals or scenarios.

In addition, you can easily modify and save your waveforms in various formats, including .csv, for example, scaling into a specific sample rate, adjusting the amplitude, or converting into an .arb file format in which you can quickly and accurately load to the FG33530 series.

Purchase the 33503B separately to unlock your FG33530 Series' full potential and create your custom waveforms with advanced waveform creation and editing software (Figure 8). Visit www.keysight.com/find/33503 for more information. The 33503B enables you to:

- Access a library of signals
- Perform freeform drawing and editing
- Edit equations and apply waveform math
- Apply filters and windowing functions
- Create waveform sequences

Download BenchVue software at www.keysight.com/find/benchvue_apps.

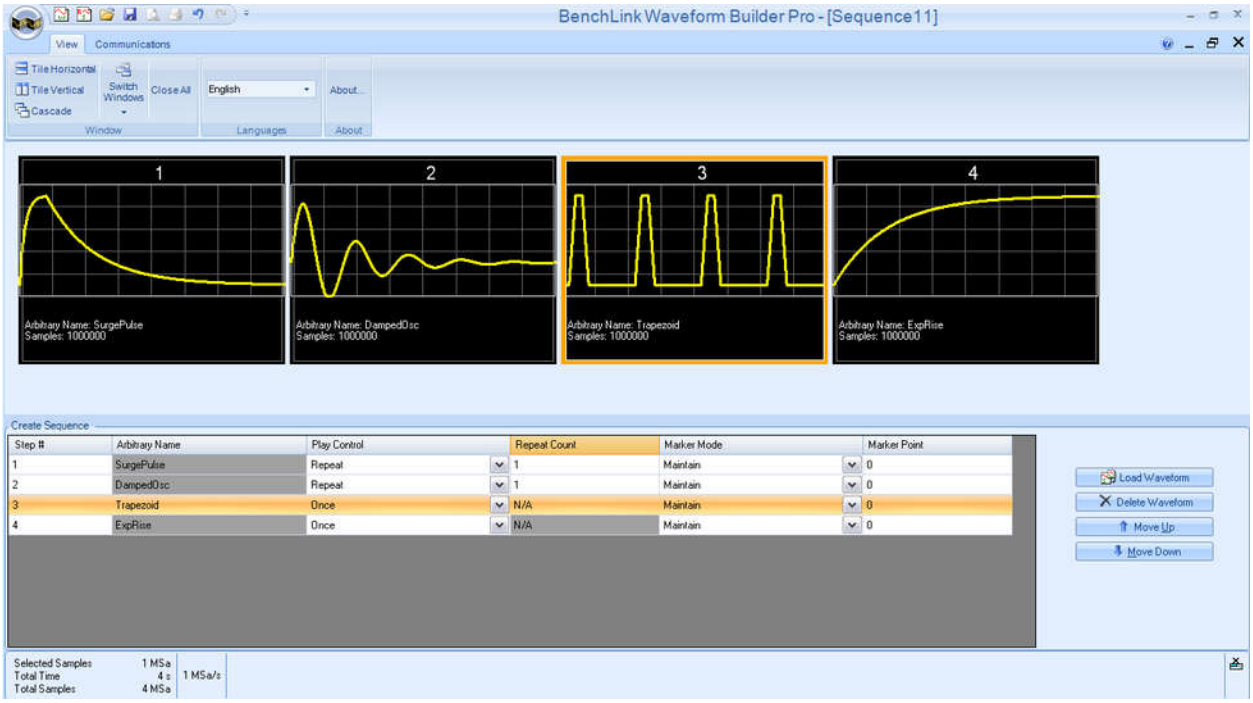


Figure 7. Create arbitrary waveform sequences using the 33503B Keysight Benchlink Waveform Builder Pro Software. You can easily create custom waveforms by linking waveforms together with the software's Sequence Tool.

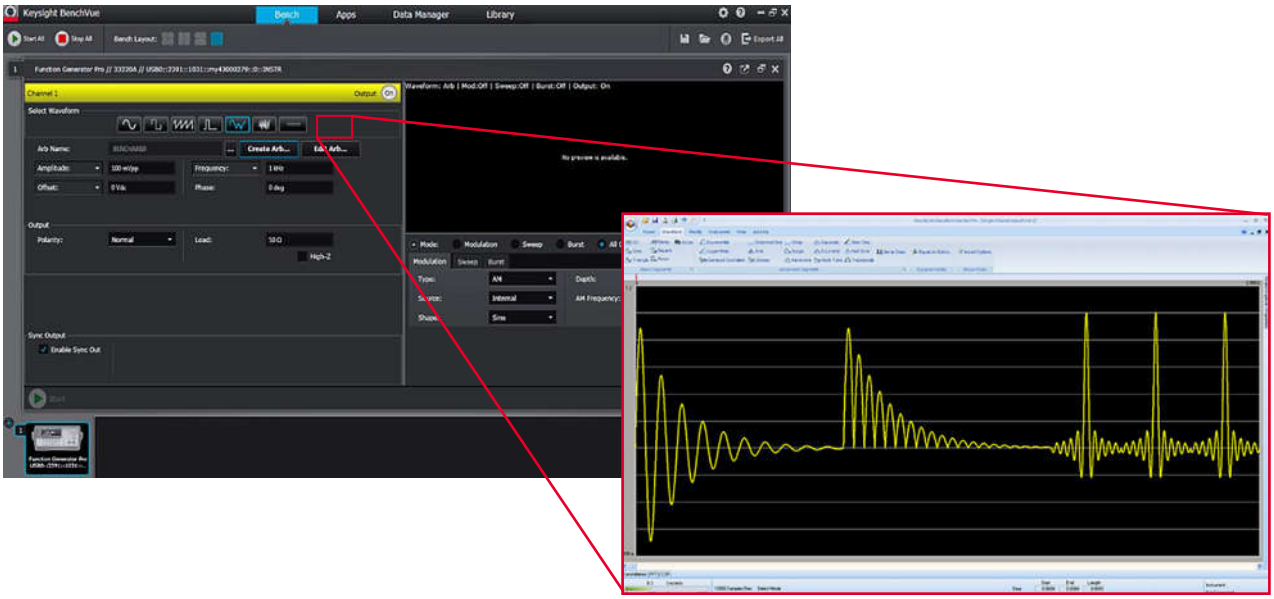


Figure 8. Design and build arbitrary waveforms with BenchLink Waveform Builder Pro

Specifications

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

Instrument characteristics

Models and options		
Model number	FG33531A	FG33532A
Maximum frequency	100 MHz	100 MHz
Number of channels	1	2
Standard	Sine, square, ramp, pulse, triangle, Gaussian noise, pseudorandom binary sequence (PRBS), DC	
Built-in arbitrary	Cardiac, exponential fall, exponential rise, Gaussian pulse, Haversine, Lorentz, D-Lorentz, negative ramp, sinc	
User-defined arbitrary	Up to 8 MSa (16 MSa with Option MEM)	
Operating modes and modulation types		
Operating modes	Continuous, modulate, frequency sweep, counted burst, gated burst	
Modulation types	Amplitude Modulation (AM), Frequency Modulation (FM), Phase Modulation (PM), Frequency Shift Keying (FSK), Binary Phase Shift Keying (BPSK), Pulse Width Modulation (PWM), sum (carrier + modulation)	

Waveform characteristics

Sine

Frequency range	V_{out} ≤ 10 V_{pp} : 1 µHz to 30 MHz, 1 µHz resolution V_{out} ≤ 4 V_{pp} : 1 µHz to 100 MHz, 1 µHz resolution
Amplitude flatness (specification) [1,2,3] (relative to 1 kHz)	1 V_{pp} < = V_{out} < = 10 V_{pp} (50Ω load) f_{out} ≤ 5 MHz: ±0.1 dB 5 MHz ≤ f_{out} < 15 MHz: ±0.2 dB 15 MHz ≤ f_{out} < 20 MHz: ±0.3 dB 20 MHz ≤ f_{out} < 30 MHz: ±0.4 dB 30 MHz ≤ f_{out} < 100 MHz: ±0.6 dB
Harmonic distortion (typical) [1,3]	1 V_{pp} < = V_{out} < = 10 V_{pp} (50Ω load) f_{out} < = 100 KHz: -60 dBc 100 kHz to 1 MHz : < -50 dBc 1 MHz to 20 MHz : < -40 dBc 20 MHz to 30 MHz : < -35 dBc 30 MHz to 100 MHz: < -30 dBc
Total Harmonic Distortion (typical) [1]	f_{OUT} = 10 Hz to 20 kHz: < 0.06%
Non-harmonic spurious (typical) [1,3,4]	f_{OUT} ≤ 2 MHz: < -70 dBc f_{OUT} > 2 MHz: < -70 dBc + 20 dB/decade
Phase noise (SSB) (typical) [5]	• 1 kHz offset: -105 dBc/Hz • 10 kHz offset: -105 dBc/Hz • 100 kHz offset: -105 dBc/Hz

Square and pulse

Frequency ranges	1 µHz to 30 MHz, 1 µHz resolution
Rise and fall times (nominal)	Square at 8.4 ns, fixed
	Pulse at 8.4 ns to 1 µs, independently variable, 100 ps resolution
Overshoot (typical)	≤ 3%
Duty cycle [6]	0.01% to 99.99%, 0.01% resolution
Pulse width	16 ns minimum (adjustable with 100 ps resolution)
Jitter (rms) (measured) [7]	≤ 5 MHz: 2ppm of the period + 50ps
	> 5 MHz: < 50 ps

Ramp and triangle

Frequency range	1 µHz to 200 kHz, 1 µHz resolution
Ramp symmetry	0% to 100%, 0.1% resolution (0% is a negative ramp, 100% is a positive ramp, 50% is a triangle)
Linearity (typical)	≤ 0.1% from 5% to 95% of the signal amplitude (V_{out} ≥ 1 V_{pp})

[1] DC offset set to zero
[2] Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
[3] Auto range "ON"
[4] At low amplitude, the non-harmonic spurious level is -100 dBm (typical)
[5] Measured with a Keysight N9030B PXA X-Series signal analyzer
[6] Subject to pulse width limits
[7] Measured with a Keysight N9030B PXA X-Series signal analyzer

Gaussian noise	
Variable bandwidth	$V_{out} \leq 10\ V_{pp}$: 1 MHz to 30 MHz
Crest factor (nominal)	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	8.4 ns to 1 µS, independently variable, 100 ps resolution
Arbitrary waveforms	
Waveform length	8 MSa per channel (Upgradeable to 16 MSa per channel with MEM option)
Sample rate	1 µSa/s to 320 MSa/s, 1 µSa/s resolution
Voltage resolution	16 bits
General	
Connector	The front-panel BNC, chassis reference, functions as an output.
Function	On, off, or inverted
Output impedance (nominal)	50 Ω
Isolation	Connector shells for channel output(s), sync, and modulation "in" are connected.
Overload protection	The output turns off automatically when an overload is applied; the instrument will tolerate a short circuit to the ground indefinitely.
Amplitude	
Range [1]	1 mV_{pp} to 10 V_{pp} into 50 Ω, 4-digit resolution
	2 mV_{pp} to 20 V_{pp} into open circuit, 4-digit resolution
Units	V_{pp}, V_{rms}, or dBm
Accuracy (at 1 kHz sine) (specification) [2,3]	± (2% of setting in V_{pp}) ± (10 mV_{pp})
Accuracy (at 1 kHz sine) (typical) [3]	± (2% of setting in V_{pp}) ± (5 mV_{pp})
Voltage limit function	User-definable maximum and minimum voltage limits
DC offset	
Range [4]	± (5 VDC minus peak AC) into 50 Ω, 4-digit resolution ± (10 VDC minus peak AC) into open circuit, 4-digit resolution
Units	VDC
Accuracy (into 50 Ω) (typical) [2,3]	± (1% of offset setting) ± (1% of amplitude in V_{pp}) ± 5 mV
Resolution	0.1 mV_{pp} or 4 digits
Frequency accuracy (spec)	
Standard frequency reference	± (1 ppm of setting + 15 pHz), 1 year, 23 ºC ± 5 ºC
	± (2 ppm of setting + 15 pHz), 1 year, 0 ºC to 55 ºC

[1] Maximum amplitude is less at high frequency for specific waveforms
[2] Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
[3] Auto range "ON"
[4] Output noise is typically 20 dB lower when DC and peak AC are < 320 mV and 50 Ω or 640 mV into open circuits

Modulation, burst, and sweep

Amplitude modulation (AM)	
Source	Internal only
Carrier waveform	Sine, square, ramp, arb
Modulating waveform	Sine, square, ramp, noise, arb
Depth[1,2]	0% to 120%, 0.01% resolution
Frequency modulation (FM) [3]	
Source	Internal only
Carrier waveform	Sine, square, ramp, arb
Modulating waveform	Sine, square, ramp, noise, arb
Deviation	1 µHz to 15 MHz, 1 µHz resolution
Phase modulation (PM)	
Source	Internal only
Carrier waveform	Sine, square, ramp, arb
Modulating waveform	Sine, square, ramp, noise, arb
Modulation frequency	2 mHz to 1 MHz
Deviation	0º to 360º, 0.1º resolution
Frequency-shift key modulation (FSK) [4]	
Source	Internal only
Carrier waveform	Sine, square, ramp, arb
Modulating waveform	Square with 50% duty cycle
Rate	≤ 1 MHz
Binary Phase-Shift Key modulation (BPSK)	
Source	Internal or external connector
Phase shift	0º to 360º, 0.1º resolution
Rate	≤ 1 MHz
Pulse Width Modulation (PWM)	
Source	Internal only
Carrier waveform	Pulse
Modulating waveform	Sine, square, ramp, noise, arb
Deviation [5]	0% to 100% of pulse width, 0.01% resolution

[1] Add 1/10 of the specification per °C for operation at temperatures below 18 °C or above 28 °C
[2] Subject to amplitude limits
[3] All frequency changes are phase continuous
[4] Auto range "ON"
[5] Subject to pulse width limits

Burst characteristics [1]	
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	The 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 after the completion of a cycle; more than one cycle might elapse before generation stops.
Start/stop phase [2]	-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
Sweep characteristics [3]	
Type	Linear, logarithmic, or list (up to 128 user-defined frequencies)
Operation	Characterization of linear and logarithmic sweeps occur 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.
Direction	Up (start frequency < stop frequency) or down (start frequency > stop frequency)
Sweep time	
Linear	1 millisecond to 3,600 seconds, 1 ms resolution
	3,601 seconds to 250,000 seconds, 1-second resolution
Logarithmic	1 millisecond to 500 seconds, 1 ms resolution
Hold time	0 to 3,600 seconds, 1 ms resolution
Return time	0 to 3,600 seconds, 1 ms resolution
Trigger source [4,5]	Immediate (continuous), external (rear-panel connector), manual (front-panel button), bus or internal timer

[1] Counted burst is not available for Gaussian noise
[2] Limited to arbitrary waveforms that are < 1 million points; phase resolution limited by the number of points in arbitrary waveforms < 3,600 points
[3] All frequency changes are phase continuous
[4] External trigger only for sweep time > 8,000 seconds
[5] 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 the output frequency

Two-channel characteristics – FG33532A only

Standard	
Operating modes	Independent, coupled parameter(s), combined (Channels 1 and 2); equal (Channel 1 = Channel 2) or differential (Ch 1 = -Ch 2)
Relative phase	0° to 360°, 0.1° resolution
Channel-to-channel skew (typical); both channels configured identically	< 0.8 ns
Crosstalk (typical)	< -75 dB

Sync out / trigger out

General	
Connector	Front BNC, chassis-referenced; functions as an output
Minimum output high voltage	Minimum 1.3 V
Maximum output low voltage	Maximum 0.1 V

External trigger input/gate, input/burst, input/FSK input

General	
Connector	Front BNC, chassis-referenced; functions as an input
Polarity	Positive or negative slope
Maximum rate	1 MHz
Input	
Minimum input high voltage	2.2 V
Maximum input low voltage	0.6 V
Minimum pulse width	16 ns
Variable trigger delay	0 to 1,000 s; 4 ns resolution
Latency (typical) [1]	< 160 ns with trigger delay set to zero
Jitter	< 2.5 ns, rms

[1] Only apply to 1 kHz and above

Memory

Instrument state

Store / recall	User-defined instrument states with user-defined names in the 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
Speed (nominal)	10 MB/s

General characteristics

USB file system

LXI-C (rev1.5)	10/100Base-T (sockets and VXI-11 protocols); USB 2.0 (USB-TMC488 protocol)
Web user interface	Remote operation and monitoring
Programming language	SCPI-1999, IEEE-488.2
Real-time clock / calendar battery	CR-2032 coin type, replaceable, > 5-year life (typical)
Mechanical	
Size (nominal)	314 mm W x 130 mm H x 165 mm D (12.36 in W x 5.12 in H x 6.50 in D)
Weight (nominal)	3.1 kg (6.8 lbs.)
Environmental	
Storage temperature	-40 °C to 70 °C
Warm-up time	1 hour
Operating environment	Indoor use, installation category II for AC input; pollution degree 2
Operating temperature	0 °C to 55 °C
Operating humidity	Up to 80% RH at 40 °C non-condensing
Altitude	Up to 3,000 meters (9842.5 ft)

Regulatory	
Electromagnetic compatibility	Compliant with EMC directive (2014/30/EU) IEC 61326-1/EN 61326-1 Group 1 Class A Canada: ICES/NMB-001 Australia / New Zealand: AS/NZS CISPR 11 South Korea: KC mark (South Korean Class A EMC declaration: Information to the user: This equipment has been conformity assessed for use in business environments. In a residential environment, this equipment may cause radio interference.)
Safety	IEC 61010-1 / EN 61010-1 USA: ANSI/UL Std. No. 61010-1 Canada: CAN/CSA-C22.2 No.61010-1
Acoustic noise	Sound pressure level (1 m free field) (nominal) 31 dB(A) at ambient ≤ 28 °C
Line power	
Line voltage	100 to 240 V, 50 / 60 Hz; 100 to 120 V, 50 / 60 Hz
Power consumption	< 45 W

Definitions

Specification (spec)

The specification refers to the warranted performance of a calibrated instrument stored for at least two hours within the operating temperature range of 0 to 55 ºC and after a one-hour warm-up period. Measurement and calibration uncertainties comply with ISO-17025 methods. The data published in this document are specified as indicated.

Typical (typ)

The characteristic performance that 80% or more of the manufactured instruments will meet. Warranty for this is not available and does not include measurement or calibration uncertainty, and is valid only at approximately 23 ºC (room temperature).

Nominal (nom)

Nominal represents the mean or average characteristic performance, or the value of an attribute determined by design, such as a connector type, physical dimension, or operating speed. The warranty for this data is unavailable, and the measurement is at approximately 23 ºC (room temperature).

Measured (meas)

Measured is an attribute taken during product development to communicate expected performance. Warranty for this data is unavailable, and the measurement is at approximately 23 ºC (room temperature).

Ordering Information

FG33530A Series function / arbitrary waveform generators

FG33531A	Waveform generator, 100 MHz, 1-channel
FG33532A	Waveform generator, 100 MHz, 2-channel

Standard shipped accessory

AC power cord (based on destination country)

Optional upgrade model

MEM33531U	Memory upgrade to 16 MSa for 1-channel FG33531A waveform generators
MEM33532U	Memory upgrade to 16 MSa for 2-channel FG33532A waveform generators

Other Smart Bench Essential Plus series products

E36441A	Four-outputs autoranging DC power supply
DM34460A	6.5-digit TrueVolt Digital Multimeter, 1-channel
DM34461A	6.5-digit TrueVolt Digital Multimeter, 2-channel

For more information

For more information about the FG33530 Series function / arbitrary waveform generators, visit www.keysight.com/find/FG33530

Keysight enables innovators to push the boundaries of engineering by quickly solving design, emulation, and test challenges to create the best product experiences. Start your innovation journey at www.keysight.com.

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