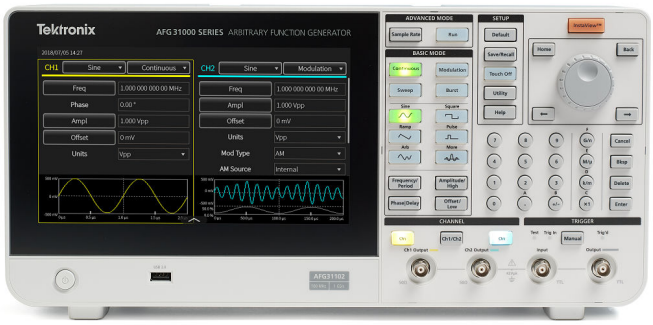
Arbitrary Function Generators

AFG31000 Series Datasheet



The Tektronix AFG31000 Series is a high-performance AFG with built-in arbitrary waveform generation, real-time waveform monitoring, and the largest touchscreen on the market. Providing advanced waveform generation and programming capabilities, waveform verification, and a modern touch-screen interface, the new AFG31000 is sure to delight and simplify the job of every researcher and engineer.

Key performance specifications

- 1 or 2 channel models
- Output amplitude range 1 mV_{P-P} to 10`$V_{P-P}$ into 50`Ω loads
- Basic (AFG) mode:
  - 25 MHz, 50 MHz, 100 MHz, 150 MHz, or 250 MHz sine waveforms
  - 250 MSa/s, 1 GSa/s or 2 GSa/s sample rates
  - 14-bit vertical resolution
  - Built-in waveforms include sine, square, ramp, pulse, noise, and other frequently used waveforms
  - Sweep, Burst, and Modulation modes (AM, FM, PM, FSK, and PWM)
- Advanced (Sequence) mode:
  - Continuous mode (optional Sequence, Triggered and Gated modes)
  - 16 Mpts arbitrary waveform memory on each channel (128 Mpts optional)
  - Up to 256 steps in sequence mode with loop, jump and wait events
  - Variable sampling clock 1 µSa/s to 2 GSa/s

Key features

- Patented InstaView™ technology enables engineers to see the actual waveform at the Device Under Test (DUT) in real time, without the need of an oscilloscope and probe, eliminating the uncertainty caused by mismatched impedance
- Sequencing option adds the ability to program long, complex waveforms with up to 256 steps
- The 9-inch capacitive touch screen works like a smart phone and has short-cuts to frequently used settings
- Built-in ArbBuilder lets you create and edit arbitrary waveforms on the instrument, eliminating the need to connect to a PC
- Outputs are protected from over voltage and current to minimize potential instrument damage
- Built-in Double Pulse Test application to generate voltage pulses with varying pulse widths onto the DUTs

Applications

- Advanced research
- Clock and system synchronization
- Replication of real world signals
- Component and circuit characterization and validation
- Embedded circuit design and test
- General purpose signal generation
- Double pulse test

Basic and Advanced Modes

The AFG31000 series is the industry's first arbitrary function generator with full function Basic (AFG) and Advanced (Sequence) modes.

In Basic mode, the AFG31000 generates traditional functions and arbitrary waveforms. The touchscreen and front-panel controls make it simple to set up.

Basic mode lets you change frequency without the need to worry about waveform length and sample rate. This feature is useful in analog designs that characterize filter/amplifier frequency responses or in digital designs where clock rates change frequently.

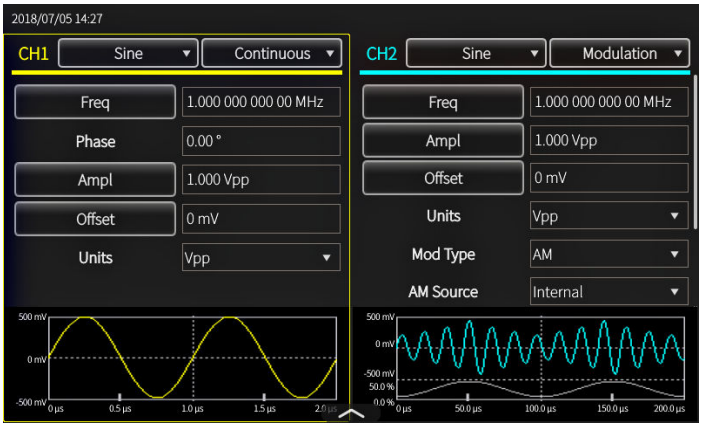


Figure 1: Key settings are visible at a glance, and are easy to adjust using touch, numeric keypad, or rotary controls

New with the AFG31000, Advanced mode provides the ability to generate multiple waveforms with complex timing. In this mode, you can compose a list (or a sequence) of 1 to 256 waveforms, with total waveform length up to 16 Mpts/ch (128 Mpts/ch optional) and define the ouput sequence of these waveforms. Repeat, go-to, wait, jump, and triggered events are all supported and the large memory provides space to store many waveforms or long waveforms.

This feature is very useful in applications where many test cases need to be performed sequentially. Instead of loading the test cases one by one, you can put all of them in a sequence and load at one time, switching from one to another seamlessly to greatly improve the test efficiency.

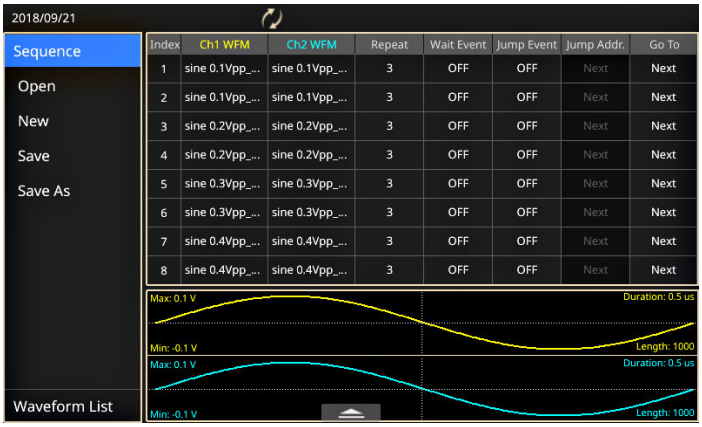


Figure 2: Advanced mode lets you build complex waveform sequences with flexible step controls

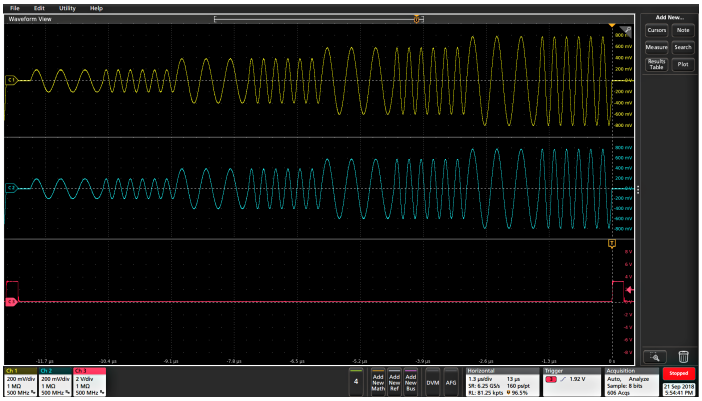


Figure 3: Sequenced sine waveforms with different frequency and amplitude.

Additionally, Advanced mode uses variable sample rate technology. Every sample in a waveform is output once and only once in each cycle, synchronized to the sample rate. Since there is no skipping or repetition, all details in the waveforms are kept. This feature is very useful for applications in which signal fidelity is extremely critical, such as IQ modulation and pulse train generation.

InstaView™ technology shows the actual waveform at the DUT

Most waveform generators assume they are driving a 50 Ω impedance. However, most devices under test do not have a 50 Ω impedance. This mismatch results in an inconsistency between the waveform as set on the AFG and the signal at the DUT.

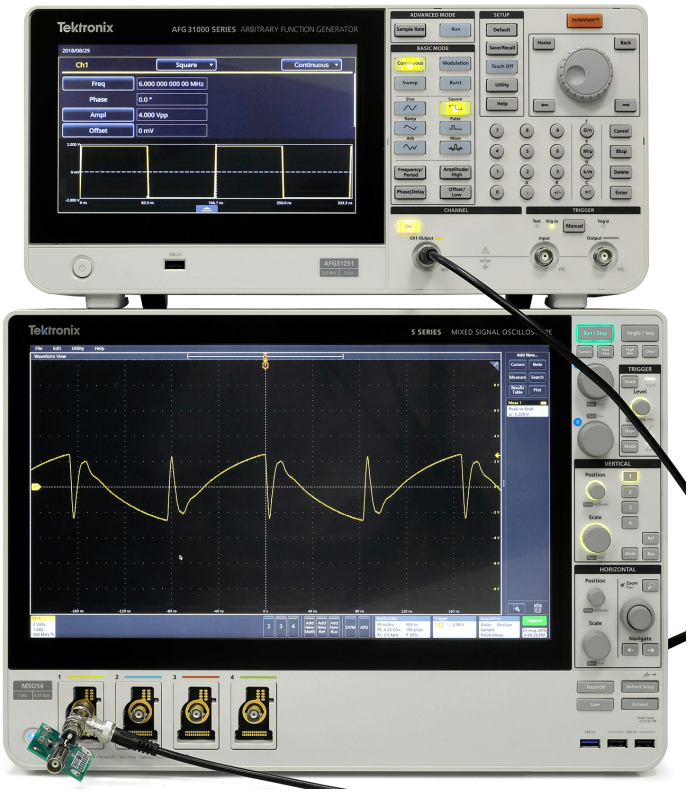


Figure 4: With InstaView turned off, the AFG31000 works like a traditional function generator. Due to an impedance mismatch, the AFG display shows a different waveform from the one observed at the DUT.

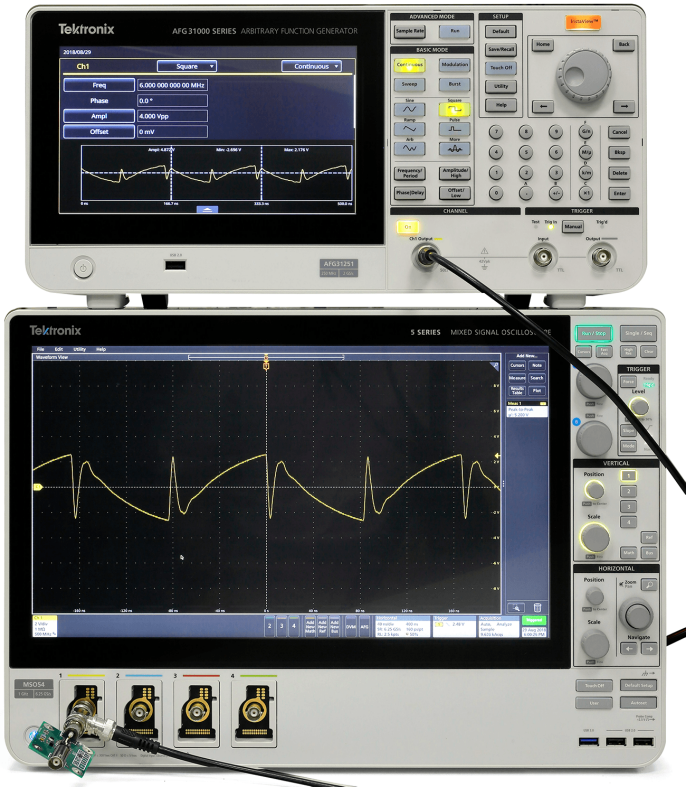


Figure 5: With InstaView turned on, the AFG31000 shows the waveform as observed at the DUT.

With the patented InstaView ™ technology, the AFG31000 Series can display the actual waveform at the DUT, instead of just the nominal waveform as set on the AFG. The waveform displayed on the AFG instantly responds to changes in frequency, amplitude, waveform shape, and impedance changes at the DUT. InstaView helps eliminate the uncertainty and measurement risk caused by impedance mismatches, without requiring additional cables, instruments, or effort.

A large touch screen and smart user interface

The large 9-inch capacitive touch screen displays all related settings and parameters on a single screen. Similar to smart devices, you can tap or swipe to easily select, browse, locate and change settings and parameters. Frequently-used functions are immediately accessible. Familiar buttons and rotary knob controls are available for more traditional navigation.

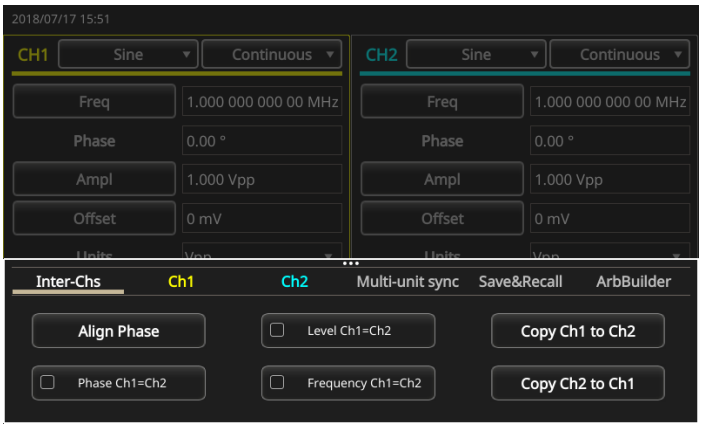


Figure 6: Frequently used settings are easy to access from the swipe-up menu

Built-in ArbBuilder tool makes creating and editing arbitrary waveforms easier than ever

In the past, you needed a PC with waveform editing software to create or edit your arbitrary waveforms. The waveform would then need to be downloaded to the AFG using either a USB stick or a data cable connection. The process was time-consuming, especially when waveforms required frequent changes.

ArbBuilder is a built-in application on the AFG31000 series that lets you create and edit your arbitrary waveforms directly on the generator. You can create arbitrary waveforms with the Equation Editor tool or start from a library of standard templates. Thanks to the large capacitive touch screen, you can drag, pinch and zoom to get the detail you need.

You can quickly replicate real-world waveforms captured with oscilloscopes or created by third-party software by loading CSV format data files directly into ArbBuilder from a USB memory stick.

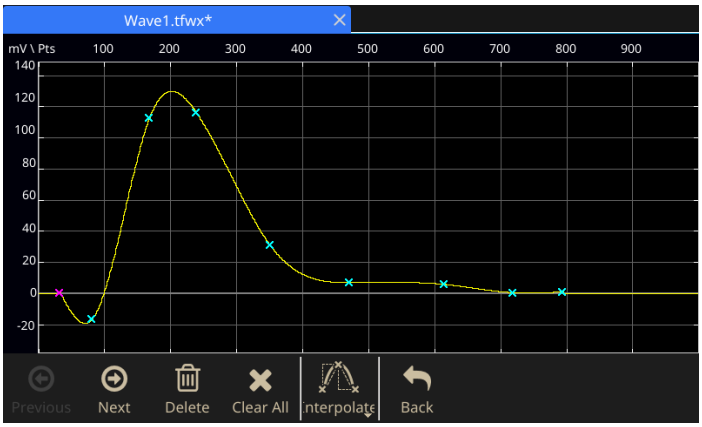


Figure 7: Creating an arbitrary waveform using the easy touch screen interface

Simplified multi-unit synchronization

Most applications need one or two channels of output, but some applications require more channels. For example, in order to simulate 3-phase power signals, engineers often need to synchronize three 2-channel generators; one for the voltage and current on each phase. To do this used to be time-consuming, as it required many cable connections between the AFG units, and making changes in deep branches of the menu trees on all instruments.

The AFG31000 simplifies this process with an onscreen wizard that leads you through the process of making cable connections and configuring settings to synchronize multiple generators.

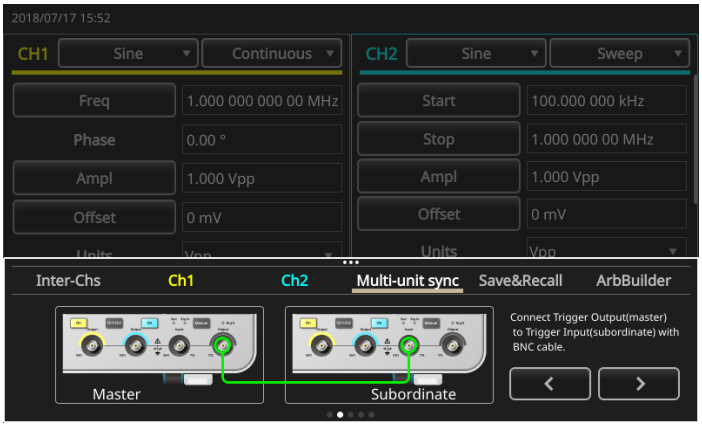


Figure 8: An on-screen wizard guides you through the process of multiple-unit synchronization

Double Pulse Test

The AFG31000 includes Double PulseTest, a downloadable plugin software application that enables double pulse applications for the power and semiconductor markets. The Double Pulse Test user interface provides touch-and-swipe or point-and-click control for generating at least two varying pulse widths. These pulses can be output to an isolated gate driver to trigger power devices such as MOSFETs or IGBTs.

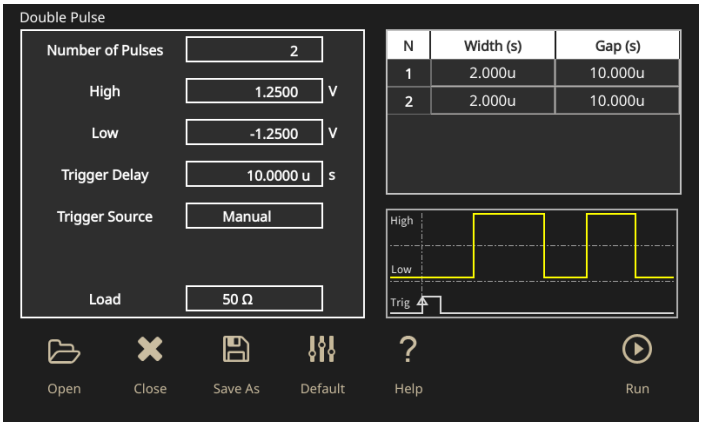


Figure 9: Double Pulse user interface

Key features

- Ready-to-use, ease of use, built-in applications that reduce test development time
- Generate pulses with varying pulse widths
- Pulse widths from 20 ns to 150 µs
- GUI and large touchscreen display
- Multi-triggers method: Manual, Continuous and External
- Up to 30 pulses
- Ohm or High Z output modes
- Free to download from the website
- Works on all of the AFG31000 Series models

Reduce development time with ready-to-use, built-in applications

The Double Pulse Test on the AFG31000 offers the design and test engineer the ability to generate voltage pulses with varying pulse widths onto their DUTs. The design and test engineers are able to perform the Double Pulse Test in less than one minute, saving them hours when compared to using a PC software or a microcontroller to perform the test with varying configurations.

Typical applications

- R&D engineer and test engineer of semiconductor industry (power device and power module with SiC/GaN/Si)
- Automotive industry (EV, EHV, FCV), laboratory and university of power electronics
- Power device manufacturer
- Heavy user of power device and module
- Inverter and motor drive system

Upgradability protects your investment

The AFG31000 provides upgrade options for bandwidth, memory extension, and sequence mode support. These options can be installed at the factory or at any time after purchase. This upgradability helps to reduce the product ownership threshold. And when your test requirements change, you can purchase and install upgrade software licenses to add higher performance features. Upgrades eliminate the concern about the return on investment during the instrument lifetime.

Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Model overview

Model	Sine frequency range	Number of channels
AFG31021	25 MHz	1
AFG31051	50 MHz	
AFG31101	100 MHz	
AFG31151	150 MHz	
AFG31251	250 MHz	
AFG31022	25 MHz	2
AFG31052	50 MHz	
AFG31102	100 MHz	
AFG31152	150 MHz	
AFG31252	250 MHz	

Output characteristics

Amplitude

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Range (into 50 Ω)	≤ 60 MHz: 1 mV_{P-P} to 10`$V_{P-P}$ > 60 MHz to ≤ 80 MHz: 1 $mV_{P-P}$ to 8`V_{P-P} > 80 MHz to ≤ 100 MHz: 1 mV_{P-P} to 6`V_{P-P}			≤ 200 MHz: 1 mV_{P-P} to 5`$V_{P-P}$ > 200 MHz to ≤ 250 MHz: 1 $mV_{P-P}$ to 4`V_{P-P}	
Range (into open circuit or High-Z)	≤ 60 MHz: 2 mV_{P-P} to 20`$V_{P-P}$ > 60 MHz to ≤ 80 MHz: 2 $mV_{P-P}$ to 16`V_{P-P} > 80 MHz to ≤ 100 MHz: 2 mV_{P-P} to 12`V_{P-P}			≤ 200 MHz: 2 mV_{P-P} to 10`$V_{P-P}$ > 200 MHz to ≤ 250 MHz: 2 $mV_{P-P}$ to 8`V_{P-P}	
Accuracy	± (1% of setting +1 mV_{P-P}) (1 kHz sine, 0 V offset, amplitude > 1 mV_{P-P})				
Resolution	0.1 mV_{P-P}, 0.1`$mV_{RMS}$, 1`mV, 0.1`dBm or 4`digits				
Units	Vpp, Vrms (excluding Arb and Noise), dBm (sine wave only), Volt (High Level and Low Level)				

Offset

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Range (into 50 Ω)	±(5 V_{PK} - $Amplitude_{P-P}$ ÷ 2)			±(2.5 V_{PK} - $Amplitude_{P-P}$ ÷ 2)	
Range (into open circuit or High-Z)	±(10 V_{PK} - $Amplitude_{P-P}$ ÷ 2)			±(5 V_{PK} - $Amplitude_{P-P}$ ÷ 2)	
Accuracy	± (1% of |setting| +1 mV + 0.5% of Amplitude (V_{P-P}))				
Resolution	1 mV or 4 digits				

Output impedance	50 Ω
Load impedance setting	Selectable: 50 Ω, 1 Ω to 10.0 kΩ, High Z (Adjusts displayed amplitude according to selected load impedance)
Isolation	42 Vpk maximum to earth ground
Short-circuit protection	Signal outputs are robust against permanent shorts against floating ground
Overcurrent protection	When incoming current is greater than 250 mA, the output channels are protected with relays that disconnect the AFG from the device under test. Connection can be resumed by user after removing the incoming current

General characteristics - Basic mode

Basic (AFG)

Run modes	Continuous, Modulation, Sweep and Burst
Standard waveforms	Sine, Square, Pulse, Ramp, More (Noise, DC,Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine)
Arbitrary waveforms	Sampling clock: 250 MSa/s, 1 GSa/s or 2 GSa/s (model and waveform length apply) Vertical resolution: 14 bits Waveform length: 2 to 131,072 points

Sine

Frequency range

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Continuous mode	1 µHz to 25 MHz	1 µHz to 50 MHz	1 µHz to 100 MHz	1 µHz to 150 MHz	1 µHz to 250 MHz
Burst mode	1 µHz to 12.5 MHz	1 µHz to 25 MHz	1 µHz to 50 MHz	1 µHz to 75 MHz	1 µHz to 125 MHz

Effective maximum frequency out

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
25 MHz	50 MHz	100 MHz	150 MHz	250 MHz

Amplitude flatness (1 V_{P-P}, relative to 1`kHz)

Frequency range	AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102	AFG31151, AFG31152, AFG31251, AFG31252
< 5 MHz	±0.2 dB	±0.2dB
≥ 5 MHz to 25 MHz	-----	±0.3 dB
≥ 5 MHz to 100 MHz	±0.3 dB	-----
> 25 MHz to 100 MHz	-----	±0.5 dB
> 100 MHz to 200 MHz	-----	±1.0 dB
> 200 MHz to 250 MHz	-----	±2.0 dB

Amplitude flatness (1 V_{P-P}, relative to 1`kHz), typical

AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102, AFG31151, AFG31152	AFG31251 / AFG31252
±0.1 dB	≤ 150 MHz: ±0.1 dB > 150 MHz to 250 MHz: ±0.3 dB

Harmonic distortion (1 V_{P-P}), typical

Frequency range	AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102
10 Hz to <20 kHz	< -77 dBc
≥20 kHz to <1 MHz	< -72 dBc
≥1 MHz to <5 MHz	< -65 dBc
≥5 MHz to ≤100 MHz	< -56 dBc

Frequency range	AFG31151, AFG31152, AFG31251, AFG31252
10 Hz to < 1 MHz	< -72 dBc
≥ 1 MHz to < 5 MHz	< -74 dBc
≥ 5 MHz to < 25 MHz	< -69 dBc
≥ 25 MHz to ≤ 250 MHz	< -37 dBc

THD, typical

≤ 0.04%, 10 Hz to 20 kHz, 1 V_{P-P}

Spurious noise (1 V_{P-P}), typical

Frequency range	AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102
≥ 10 Hz to < 1 MHz	< -78 dBc
≥ 1 MHz to < 25 MHz	< -73 dBc
≥ 25 MHz to ≤ 100 MHz	< -78 dBc

Frequency range	AFG31151, AFG31152, AFG31251, AFG31252
10 Hz to < 1 MHz	< -80 dBc
≥ 1 MHz to < 25 MHz	< -75 dBc
≥ 25 MHz to ≤ 250 MHz	< -75 dBc + 6 dBc/octave

Phase noise, typical

< -125 dBc/Hz at 20 MHz, 10 kHz offset, 1 V_{P-P}

Residual clock noise, all models

-63 dBm

Square

Frequency range

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
1 µHz to 20 MHz	1 µHz to 40 MHz	1 µHz to 80 MHz	1 µHz to 120 MHz	1 µHz to 160 MHz

Rise/fall time, typical

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Amplitude ≤ 5 Vpp	≤ 7.0 ns	≤ 5.0 ns	≤ 3.5 ns	≤ 3.0 ns	≤ 2.0 ns
Amplitude > 5 Vpp	≤ 8.0 ns	≤6.0 ns	≤ 4.2 ns	-----	-----

Overshoot, typical < 3%

Jitter (RMS), typical 2.5 ps

Ramp

Frequency range

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
1 µHz to 500 kHz	1 µHz to 800 kHz	1 µHz to 1 MHz	1 µHz to 1.5 MHz	1 µHz to 2.5 MHz

Linearity, typical (1 kHz, 1 V_{P-P}, 100% symmetry)

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
≤ 0.1% of peak output	≤ 0.1% of peak output	≤ 0.15% of peak output	≤ 0.2% of peak output	≤ 0.2% of peak output

Symmetry 0% to 100%

Pulse

Frequency range

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
1 mHz to 20 MHz	1 mHz to 40 MHz	1 mHz to 80 MHz	1 mHz to 120 MHz	1 mHz to 160 MHz

Pulse width

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
16 ns to 999.99 s	10 ns to 999.99 s	6 ns to 999.99 s	4 ns to 999.99 s	3 ns to 999.99 s

Pulse width resolution 10 ps or 5 digits

Pulse Duty 0.001% to 99.999% (limitations of pulse width apply)

Edge transition time

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
8 ns to 0.625 * Pulse Period	6 ns to 0.625 * Pulse Period	4 ns to 0.625 * Pulse Period	3 ns to 0.625 * Pulse Period	2 ns to 0.625 * Pulse Period

Edge transition time resolution 10 ps or 4 digits

Lead delay range

Mode	Characteristic
Continuous	0 ps to Period
Burst	0 ps to Period – [Pulse Width + 0.8 * (Leading Edge Time + Trailing Edge Time)]

Lead delay resolution 10 ps or 8 digits

Overshoot, typical < 2%

Jitter (RMS), typical 2.5 ps

DC

Range (into 50 Ω)

AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102	AFG31151, AFG31152, AFG31251, AFG31252
-5 V to 5 V	-2.5 V to 2.5 V

Resolution (into 50 Ω) 1 mV or 4 digits

Accuracy ± (1% of |setting | +1mV)

Noise

Bandwidth (-3 dB)

AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102	AFG31151, AFG31152, AFG31251, AFG31252
150 MHz	360 MHz

Noise type White Gaussian

Internal noise

	Characteristic
Add	When activated, output signal amplitude is reduced to 50%
Level	0.0% to 50% of amplitude (V_{P-P}) setting
Resolution	1%

Other waveforms

Frequency range

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
1 µHz to 500 kHz	1 µHz to 800 kHz	1 µHz to 1 MHz	1 µHz to 1.5 MHz	1 µHz to 2.5 MHz

Arbitrary waveforms

Frequency range

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Normal	1 mHz to 12.5 MHz	1 mHz to 25 MHz	1 mHz to 50 MHz	1 mHz to 75 MHz	1 mHz to 125 MHz
Burst mode	1 mHz to 6.25 MHz	1 mHz to 12.5 MHz	1 mHz to 25 MHz	1 mHz to 37.5 MHz	1 mHz to 62.5 MHz

Effective analog bandwidth (-3 dB)

AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102	AFG31151, AFG31152, AFG31251, AFG31252
150 MHz	360 MHz

Waveform length 2 to 131,072

Sample rate

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Waveform length ≤ 16,384	250 MSa/s	1 GSa/s	1 GSa/s	2 GSa/s	2 GSa/s
Waveform length > 16,384	250 MSa/s	250 MSa/s	250 MSa/s	250 MSa/s	250 MSa/s

Vertical resolution 14 bit

Rise/fall time, typical

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Amplitude ≤ 5Vpp	≤ 3.5 ns	≤ 3.5 ns	≤ 3.5 ns	≤ 2 ns	≤ 2 ns
Amplitude > 5Vpp	≤ 4.2 ns	≤ 4.2 ns	≤ 4.2 ns	-----	-----

Jitter (RMS), typical 2.5 ps

Modulation

AM, FM, PM

Specification	Characteristic
Carrier	All except pulse, noise, DC
Source	Internal or external
Internal modulating waveform	Sine, Square, Ramp, Noise, ARB (maximum waveform length: AM 4,096 pts; FM/PM/PWM 2,048 pts)
Internal modulating frequency	1 mHz to 1 MHz

AM modulation depth 0.0 % to 120 %

AM modulation resolution 0.1%

Minimum FM peak deviation DC

Maximum FM peak deviation

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Sine	12.5 MHz	25 MHz	50 MHz	75 MHz	125 MHz
Square,	10 MHz	20 MHz	40 MHz	60 MHz	80 MHz
Arb	6.25 MHz	12.5 MHz	25 MHz	37.5 MHz	62.5 MHz
Others	250 kHz	400 kHz	500 kHz	750 kHz	1.25 MHz

PM phase deviation range 0° to 180°

PM phase resolution 0.1°

FSK

Specification	Characteristic
Carrier	All except pulse, noise, DC
Source	Internal or external
Number of keys	2

Table continued…

Specification	Characteristic
Internal key rate	1 mHz to 1 MHz

PWM

Specification	Characteristic
Carrier	Pulse
Source	Internal or external
Internal modulating waveform	Sine, Square, Ramp, Noise, ARB (maximum waveform length: 2,048 pts)
Internal modulating frequency	1 mHz to 1 MHz
Deviation range	0% to 50.0% of pulse period

Sweep

Type Linear, Logarithmic

Waveforms All, except Pulse, Noise, DC

Sweep time 1 ms to 500 s

Hold/return time 0 s to 500 s

Maximum total sweep time 500 s Accuracy, typical: ≤ 0.4%

Minimum start/stop frequency All except ARB: 1 µHz ARB: 1 mHz

Maximum start/stop frequency

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Sine	25 MHz	50 MHz	75 MHz	125 MHz	250 MHz
Square	20 MHz	40 MHz	80 MHz	120 MHz	160 MHz
Arb	12.5 MHz	25 MHz	50 MHz	75 MHz	125 MHz
Others	500 kHz	800 kHz	1 MHz	1 MHz	2.5 MHz

Burst

Waveform All except Noise, DC

Type Triggered, gated

Burst count 1 to 1,000,000 cycles or Infinite

Intenal trigger rate 1 µs to 500.0 s

Gate and trigger sources Internal, external, remote interface

InstaView™

Waveforms All except noise

Cable (channel output to load) 50 Ω BNC to BNC

Run mode Continuous in Basic mode

Maximum measurement range (DC + peak AC voltage)

AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31102	AFG31151, AFG31152, AFG31251, AFG31252
-10 V to 10 V	-5 V to 5 V

DC level measurement

Specification	Characteristic
Accuracy (into 50Ω), typical	± (2 % of |setting| + 20 mVpp)
Resolution	1 mV or 4 digits

Amplitude measurement

Specification	Characteristic
Accuracy (sine, 1 kHz, 1 V_{P-P}, into 50 Ω, typical)	± (2 % of setting + 20 mV)
Resolution	1 mV or 4 digits

Bandwidth (-3 dB) 500 MHz

Flatness, sine, 1 V_{P-P}, into 50 ohm, relative to 1 kHz, typical

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
0 to 100 MHz: ±1 dB			0 to 200 MHz: ±1 dB 200 MHz to 250 MHz: ±2 dB	

Cable propagation delay measurement, typical

Specification	Characteristic
Range	0 to 20 ns (approximately 4 m/13 feet in length)
Accuracy, typical	± 500 ps

General characteristics - Advanced mode

Waveform memory size 16 Mpts (128 Mpts optional) each channel

Run mode Standard: Continuous

Optional: Sequence, Triggered, Gated

Number of waveform entries Continuous, Triggered, Gated: 1

Sequence: 1 to 256

Minimum waveform length 168 pts

Waveform granularity 1 pt

Vertical resolution 14 bits

Jump/trigger events External trigger (rising or falling edge), manual trigger, timer, SCPI commands

Repeat count 1 to 1,000,000 or infinite

Timer range

2 µS to 3600 S

Timer resolution

4 ns or 8 digits

Variable sample rate

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Range	1 µSa/s to 250 MSa/s	1 µSa/s to 500 MSa/s	1 µSa/s to 1 GSa/s	1 µSa/s to 2 GSa/s	1 µSa/s to 2 GSa/s
Accuracy	10^{-6} Sa/s				
Resolution	1 µSa/s or 12 digits				

Rise/Fall time, typical

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
Amplitude ≥ 5 V_{P-P}: ≤`4.2`ns Amplitude < 5 V_{P-P}: ≤`3.5`ns			≤ 3.0 ns	≤ 2.0 ns

Overshoot, typical

< 2%

Level flatness, typical (sine, 1 V_{P-P}, relative to 1`kHz)

Frequency range	All models
< 5MHz	±0.3 dB
≥ 5 MHz to 25 MHz	±0.5 dB
≥ 25 MHz to 50 MHz	±0.6 dB
≥ 50 MHz to 100 MHz	±1.0 dB
≥ 100 MHz to 150 MH	±1.5 dB
≥ 150 MHz to 250 MHz	±2.3 dB

Harmonic distortion, typical (sine with 64 pts/cycle, 1 V_{P-P})

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -76 dBc at 250 MSa/S or 3.90625 MHz	< -67 dBc at 500 MSa/S or 7.8125 MHz	< -61 dBc at 1 GSa/S or 15.625 MHz	< -63 dBc at 2 GSa/S or 31.25 MHz	< -63 dBc at 2 GSa/S or 31.25 MHz

Spurious, typical (sine with 64 pts/cycle, 1 V_{P-P})

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -81 dBc at 250 MSa/S or 3.90625 MHz	< -74 dBc at 500 MSa/S or 7.8125 MHz	< -75 dBc at 1 GSa/S or 15.625 MHz	< -64 dBc at 2 GSa/S or 31.25 MHz	< -64 dBc at 2 GSa/S or 31.25 MHz

Spurious free dynamic range, typical (sine with 64 pts/cycle, 1 V_{P-P})

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -76 dBc at 250 MSa/S or 3.90625 MHz	< -67 dBc at 500 MSa/S or 7.8125 MHz	< -61 dBc at 1 GSa/S or 15.625 MHz	< -63 dBc at 2 GSa/S or 31.25 MHz	< -63 dBc at 2 GSa/S or 31.25 MHz

Phase noise, typical (sine with 64 pts/cycle, 1 V_{P-P}, at 10`kHz offset)

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -132 dBc at 250 MSa/S or 3.90625 MHz	< -130 dBc at 500 MSa/S or 7.8125 MHz	< -125 dBc at 1 GSa/S or 15.625 MHz	< -113 dBc at 2 GSa/S or 31.25 MHz	< -113 dBc at 2 GSa/S or 31.25 MHz

Skew control

Range -320 ns to 320 ns (channel 1 to channel 2 on dual channel models, at maximum sample rate)

Resolution 100 ps or 4 digits

Accuracy, typical ±(1% of |setting| + 500 ps)

Initial skew, typical < 500 ps

System characteristics

Output Frequency Resolution

Frequency accuracy ±10^{-6} of setting (all except ARB), 0`°C to 50`°C (32 °F to 122`°F)

±10^{-6} of setting ± 1`µHz (ARB), 0`°C to 50`°C (32 °F to 122`°F)

Aging ±1.0 x 10^{-6} per year

Phase

Range -180° to +180°

Resolution 0.01° (sine)

0.1° (other waveforms)

Remote program interface GPIB, Ethernet 10BASE-T / 100BASE-TX / 1000BASE-T, USB 2.0

Maximum configuration times, typical

	USB	LAN	GPIB
Function change	61 ms	61 ms	63 ms
Frequency change (except Pulse)	3 ms	4 ms	6 ms
Frequency change (Pulse)	2.5 ms	3 ms	8 ms
Amplitude change	65 ms	66 ms	77 ms
Select user ARB (4k points from USB Memory)	43 ms	40 ms	53 ms
Select user ARB (128k points from USB Memory)	86 ms	92 ms	92 ms
Data download time for 4k points	36 ms	21 ms	21 ms

Power source

Source 100-240 V, 47-63 Hz 115 V, 360-440 Hz

Consumption 120 W

Warm up time, typical	20 minutes minimum
Power on self diagnosis time	< 24 s
Acoustic noise	< 50 dBA
Display	9-inch capacitive touch screen with 800 * 480 resolution
User interface and Help languages	English, French, German, Japanese, Korean, Simplified and Traditional Chinese, Russian (user selectable)

Auxiliary input characteristics

External modulation input, channel 1 and channel 2

Input range

	Characteristic
AM, FM, PM, PWM	±1 V full range
FSK	3.3 V logic level

Input impedance 5.2 kΩ

Frequency range 125 kHz (1 MSa/s)

External Trigger input

Level	TTL compatible
Impedance	10 kΩ
Minimum pulse width	100 ns
Slope	Positive or negative selectable
Trigger delay range	0 ns to 85 s
Trigger delay resolution	100 ps or 5 digits
Trigger latency, typical	390 ns (trigger input to signal output, , 1.5 µs for Advanced mode)
Jitter (RMS), typical	100 ps (signal output, with external trigger input in burst mode)

10 MHz reference clock input

Impedance	1 kΩ
Input coupling	AC
Required input voltage swing	100 mV_{P-P} to 5`V_{P-P}
Lock range	10 MHz ±35 kHz

Channel 1 external add input

Impedance	50 Ω
Input range	-1 V to +1 V (DC + peak AC)
Bandwidth	DC to 10 MHz (-3 dB) at 1 V_{P-P}

Auxiliary output characteristics

Channel 1 trigger output

Level Positive TTL level pulse into 1 kΩ

Impedance 50 Ω

Jitter, RMS, typical 10 ps for all models

Output frequency

	Characteristic
Waveform frequency < 4.9 MHz	Same as the waveform frequency
Waveform frequency ≥ 4.9 MHz < 50 MHz	A fraction of the waveform frequency
Waveform frequency ≥ 50 MHz	No output

10 MHz reference clock out

Impedance 50 Ω, AC coupled

Amplitude 1.2 V_{P-P} into 50`Ω load

Impedance 50 Ω, AC coupled

Amplitude 1.2 V_{P-P} into 50`Ω load

Physical characteristics

Dimensions

Height 191.8 mm (7.55 in.)

Width 412.8 mm (16.25 in.)

Depth 143.3 mm (5.64 in.)

Weight

Net 4.7 kg (10.4 lb.)

Shipping 7.0 kg (15.4 lb.)

EMC, environment, and safety

Temperature

Operating 0 °C to +50 °C (32 °F to 122 °F)

Nonoperating -30 °C to +70 °C (-22 °F to 158 °F)

Humidity

Operating ≤ 80%, 0 °C to 40 °C (32 °F to104 °F)

≤ 60%, > 40°C to 50°C (104 °F to 122 °F), noncondensing

Nonoperating 5% to 90%, < 40 °C (< 104 °F), noncondensing

5% to 80%, ≥ 40 °C to 60 °C (≥ 104 °F to 140 °F), noncondensing

5% to 40%, > 60 °C to 70 °C (> 140 °F to 158 °F), noncondensing

Altitude

Operating	Up to 3,000 m (9,842 ft.)
Nonoperating	Up to 12,000 m (39,370 ft.)

EMC compliance

EN61326-1:2013, EN 61326-2-1:2013

European Union	EU Council Directive 2004/108/EC

Safety	UL 61010-1:2004
	CAN/CSA C22.2 No. 61010-1:2004
	IEC 61010-1:2001

Over-temperature protection	Instrument is protected from over-temperature by turning off outputs

Ordering Information

Models

AFG31021	1 µHz to 25 MHz sine wave, 1-channel arbitrary function generator
AFG31022	1 µHz to 25 MHz sine wave, 2-channel arbitrary function generator
AFG31051	1 µHz to 50 MHz sine wave, 1-channel arbitrary function generator
AFG31052	1 µHz to 50 MHz sine wave, 2-channel arbitrary function generator
AFG31101	1 µHz to 100 MHz sine wave, 1-channel arbitrary function generator
AFG31102	1 µHz to 100 MHz sine wave, 2-channel arbitrary function generator
AFG31151	1 µHz to 150 MHz sine wave, 1-channel arbitrary function generator
AFG31152	1 µHz to 150 MHz sine wave, 2-channel arbitrary function generator
AFG31251	1 µHz to 250 MHz sine wave, 1-channel arbitrary function generator
AFG31252	1 µHz to 250 MHz sine wave, 2-channel arbitrary function generator

Options

Factory options

MEM	Extends arbitrary waveform memory to 128 Mpts/ch in Advanced mode
SEQ	Enables Sequence, Triggered and Gated modes in Advanced mode

Feature upgrade after purchase

The AFG31000 products offer several ways to easily add functionality after the initial purchase.

Description (node locked licenses)	For one channel instruments	For two channel instruments
Enables Sequence, Triggered, and Gated modes in Advanced mode	AUP-AFG3SEQ-1	AUP-AFG3SEQ-2
Extends arb memory to 128 Mpts/ch in Advanced mode	AUP-AFG3MEM-1	AUP-AFG3MEM-2
Bandwidth extension from 25 MHz to 50 MHz	AUP-AFG3BW25T50-1	AUP-AFG3BW25T50-2
Bandwidth extension from 25 MHz to 100 MHz	AUP-AFG3BW25T100-1	AUP-AFG3BW25T100-2
Bandwidth extension from 50 MHz to 100 MHz	AUP-AFG3BW50T100-1	AUP-AFG3BW50T100-2
Bandwidth extension from 150 MHz to 250 MHz	AUP-AFG3BW150T250-1	AUP-AFG3BW150T250-2

Power plug options

Opt. A0	North America power plug (115 V, 60 Hz)
Opt. A1	Universal Euro power plug (220 V, 50 Hz)
Opt. A2	United Kingdom power plug (240 V, 50 Hz)
Opt. A3	Australia power plug (240 V, 50 Hz)
Opt. A5	Switzerland power plug (220 V, 50 Hz)
Opt. A6	Japan power plug (100 V, 50/60 Hz)
Opt. A10	China power plug (50 Hz)
Opt. A11	India power plug (50 Hz)
Opt. A12	Brazil power plug (60 Hz)
Opt. A99	No power cord

Language options

Opt. L0	English front panel overlay (default)
Opt. L1	French front panel overlay
Opt. L2	Italian front panel overlay
Opt. L3	German front panel overlay
Opt. L4	Spanish front panel overlay
Opt. L5	Japanese front panel overlay
Opt. L6	Portuguese front panel overlay
Opt. L7	Simplified Chinese front panel overlay
Opt. L8	Traditional Chinese front panel overlay
Opt. L9	Korean front panel overlay
Opt. L10	Russian front panel overlay
Opt. L99	No front panel overlay

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R5	Repair Service 5 Years (including warranty)
Opt. T3	Three Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance. Including a 5 day turnaround time and priority access to customer support
Opt. T5	Five Year Total Protection Plan, includes repair or replacement coverage from wear and tear, accidental damage, ESD or EOS plus preventative maintenance. Including a 5 day turnaround time and priority access to customer support

Accessories are not covered by the instrument warranty and Service Offerings.

Accessories

Standard accessories

-----	AFG31000 Series Arbitrary Function Generator Compliance, Installation, and Safety Instructions
012-1732-xx	BNC cable shielded, 3 ft.
174-4401-xx	USB cable, A to B, 3 ft.
-----	Power cord
-----	NIST-traceable calibration certificate

Recommended accessories

012-1732-xx	BNC cable shielded, 3 ft.
012-0991-xx	GPIB cable, double shielded
011-0049-02	50 Ω BNC terminator

ACD4000B	Soft transit case
HCTEK54	Hard transit case (requires ACD4000B)

Warranty

Product warranty	Three-year warranty on parts and labor

CE

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Product Area Assessed: The planning, design/development and manufacture of electronic Test and Measurement instruments.

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