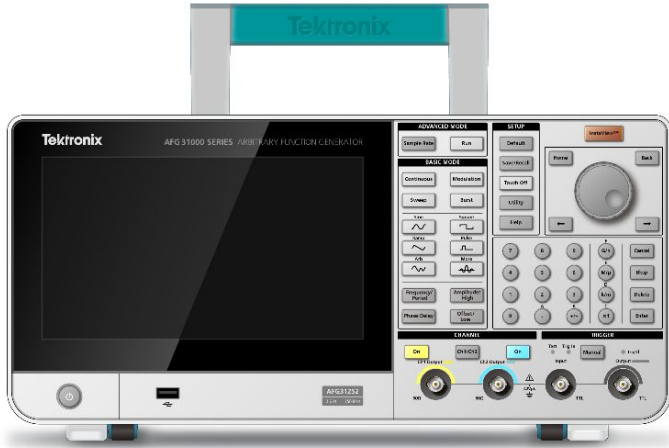


Arbitrary Function Generators

AFG31000 Series Datasheet



The AFG31000 Series is the best-in-class waveform generation platform designed for the most demanding expectations on performance and versatility, throughout the whole process of product realization. The 9-inch capacitive touch screen, built-in arbitrary waveform application, and patented InstaView™ technology bring unprecedented user experience for researchers and engineers, and enable them to focus on their job instead of learning how to use a tool.

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 (DDS) mode:
 - 25 MHz, 50 MHz, 100 MHz, 150 MHz or 250 MHz sine wave waveforms
 - 250 MSa/s, ~~500 MSa/s~~, 1 GSa/s or 2 GSa/s Sampling rate
 - 14-bit vertical resolution
 - Continuous, Modulation, Sweeping and Burst run modes
 - 128 kpts arbitrary waveform memory on each channel
- 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
 - Minimum waveform length 168 pts, with granularity of 1 point

Key features

- Dual operation modes for usability and flexibility
- Patented InstaView™ technology enable users to see the actual waveform at DUT in real time, without the need of an oscilloscope and probe, eliminates the uncertainty caused by unmatched impedance
- 9 inch capacitive touch screen with smartphone-like user interface and short-cut buttons and rotary knob on front panel accommodates all use habits
- The large display and shallow menu tree eases browsing, locating and changing settings
- Built-in ArbBuilder for arbitrary waveform creation and edit, eliminates the need of connecting to a PC or use a USB memory to load arbitrary waveforms
- Output protected from over voltage or current minimize the possibility of destroying the instrument in case of misuse
- Compatible with TekBench®

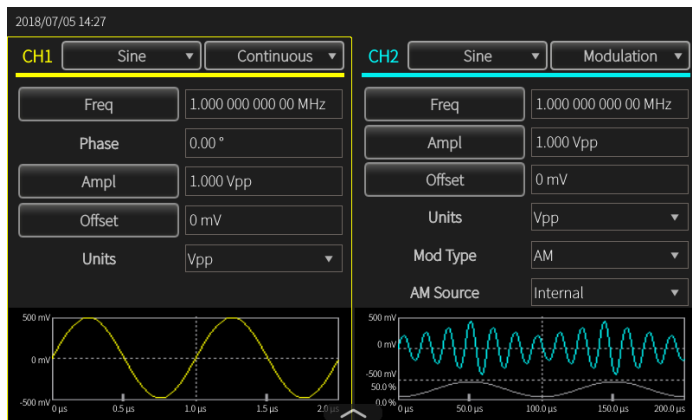
Applications

- 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

Dual Operation Modes Balance Usability and Flexibility

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

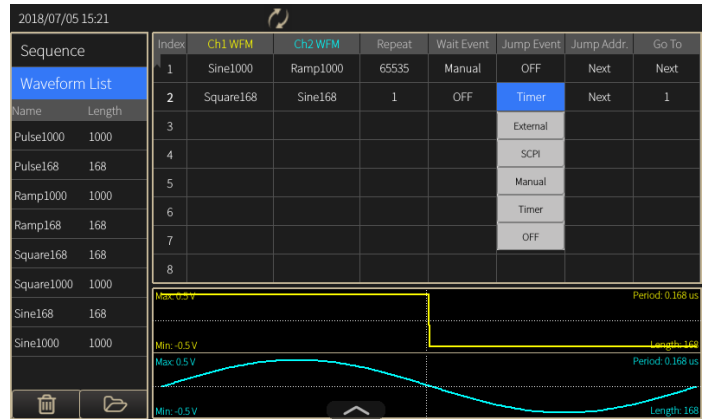
Basic mode has a dedicated user interface similar to traditional AFG for generating function and arbitrary waveforms with minimum button clicks and shallow menu hierarchy. With the maturity of DDS technology, users can switch from one frequency to another on the fly (which is called frequency agility), without the need to worry about waveform length and sampling rate. It is extremely useful in those analog designs like filter/ amplifier frequency response characterization or digital designs where the clock rate needs to change frequently.



Basic mode user interface

Although Basic mode has advantages in ease-of-use, DDS technology has disadvantages that are overcome in Advanced mode:

- Due to the nature of fixed sampling clock, DDS may skip points at high frequencies, which could lead to loss of details in the waveform such as a glitch. Advanced mode is based on variable sampling clock and point-by-point output technology. Every point in an arbitrary waveform is output once and only once in each cycle, at the pace of sampling rate, there will be no skip or repetition. As the results, the details in the waveform are kept. However the price users need to pay is each time frequency is changed, users have to re-calculate the sampling rate with the formula (sampling rate = output frequency x number of samples in the waveform).
- In Basic mode, only one waveform can be output each time. However, in Advanced mode, users can compile a sequence which is a list of steps (each step includes one waveform for each channel), and define how these steps are played back, in the ways of loop or branch (wait, jump or go-to) triggered by variance of events. The sequencer can include up-to 256 steps, and up-to 16 Mpts of waveforms for each channel (128 Mpts optional), it gives users much more flexibility to generate complex timing.



Advanced mode user interface

InstaView™ Technology Eliminates Uncertainty of Waveform at DUT

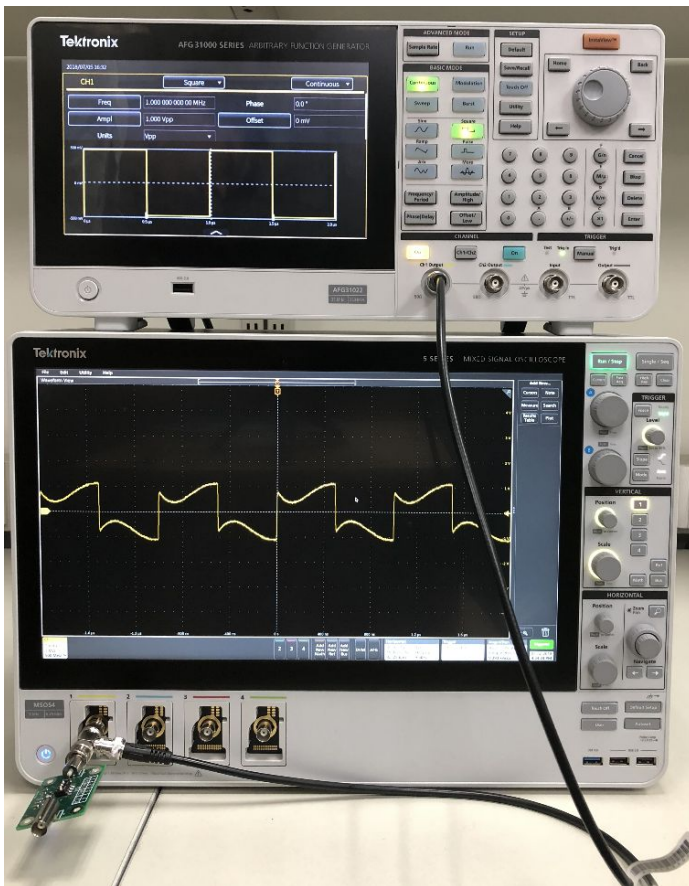
Most existing waveform generators in the market are with a 50 Ω serial resistor on the output signal path, and it requires the output to be connected to a 50 Ω load through a cable with 50 Ω characteristic impedance, to ensure maximum power transmission and minimize the reflection of high speed signals. This is so-called impedance matching and the nominal settings shown on the generators are based on the assumption that all stages in the signal path are a perfect 50 Ω impedance.

Unfortunately, for many users, their devices under test are not 50 Ω terminated. This impedance mismatch will cause the waveform at the device under test being different from the nominal settings on the generator. For example, if a digital designer sets a 3.3 V square waveform as a clock to trigger a TTL circuit, he may likely get a 6.6 V square waveform at the device end, because TTL circuit typically has an input impedance of several thousand ohms. This is not what the user wants!

Even worse, if there is parasitic capacitance or inductance, it will lead to distortion of the waveform - it is not a square waveform anymore! Though on the generator's screen, it still says the output is a 3.3V square waveform. This is very misleading for users, and put them in risky situations!

In the past, experienced users who were aware of these distortions, used an oscilloscope to verify the waveform added at the device under test, but it costed time and efforts, and hooking/removing probe/connectors might change the impedance at the device under test, which made the situation more complex.

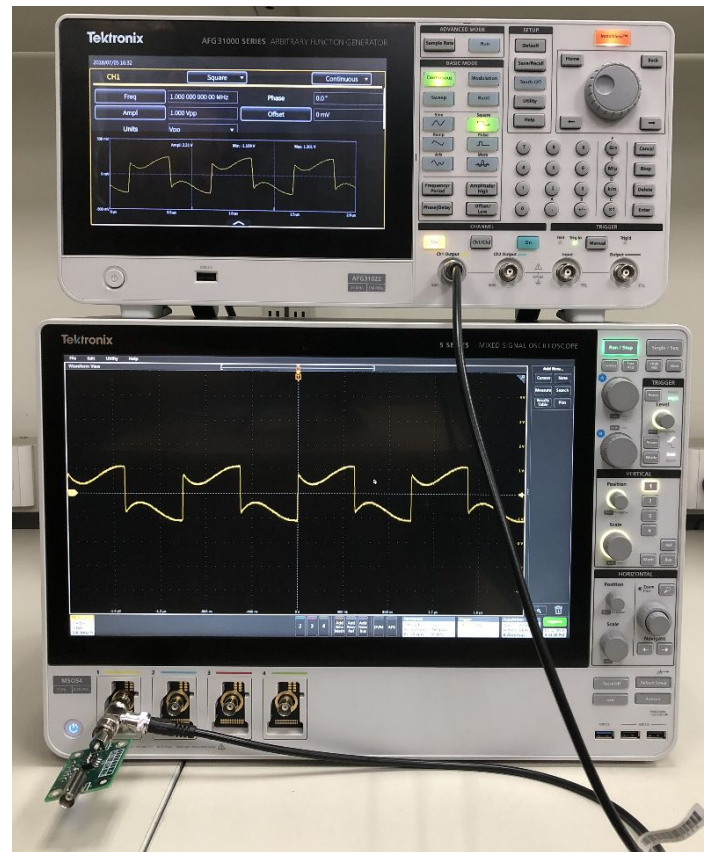
The following image shows a 1 MHz square wave being added on a complex load with resistance, inductance and capacitance. Though the nominal waveform shown on the AFG is a perfect square, the waveform at the DUT has distorted a lot.



AFG showing the nominal waveform with InstaView™ turned off

With the patented InstaView™ technology, the AFG31000 series can measure and show the waveform at the DUT, instead of just the nominal waveform set on the AFG, without any other instrument. All you need is just the cable between the AFG output and the DUT, which has already been there. The shown waveform changes in real time along with the settings like frequency, amplitude and waveform shape changes, or the impedance change at the device under test. The InstaView™ helps users to eliminate the uncertainty and risk caused by the unmatched impedance without extra cost or effort.

The following picture shows the same test setup, with the exception the InstaView™ is turned on. Instead of the “nominal” square waveform, it displays the waveform at the DUT.

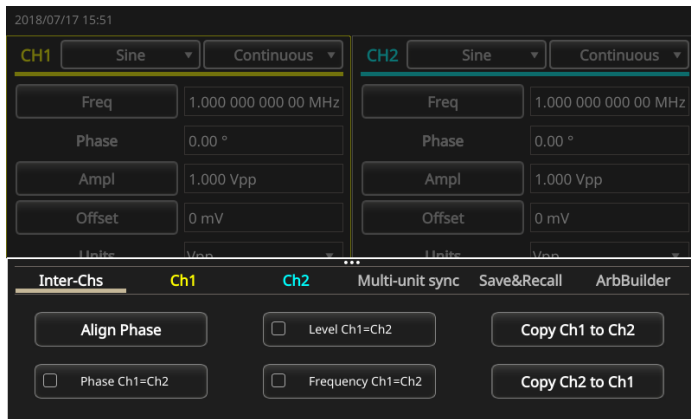


AFG showing the nominal waveform with InstaView™ turned on

Intuitive User Interface Makes the Test Job Enjoyable

The large 9-inch capacitive touch screen displays all related settings and parameters on the same page. Like what you do on their smartphones or tablets, users can click or swipe on the screen to browse, locate and change the parameters easily. Or they can swipe from top/bottom of the screen to callout short-cut menus of frequently-used functions or settings, instead of going back and forth in a comprehensive menu structure in before. This makes the operations more intuitive and much quicker than ever, and save users' time learning and using the tool to let them focus on the jobs on hands.

At the same time, front panel buttons and rotary knob are kept, in order to accommodate the needs of those who prefer sticking to the traditional ways of operation that they have been using for long time.



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

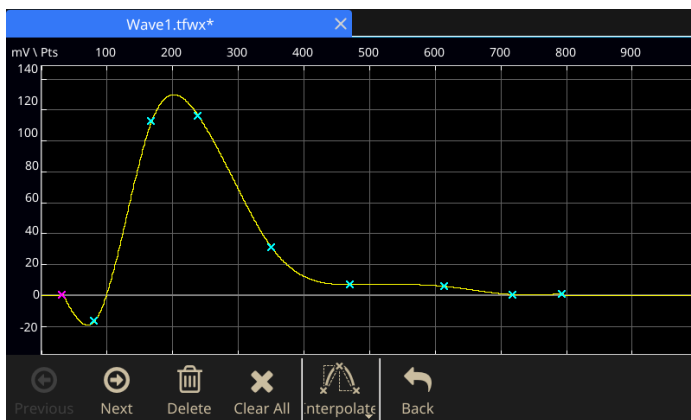
Built-in ArbBuilder tool makes creating and editing arbitrary waveforms easier than ever

In the past, users needed a PC with a waveform edit software being installed, to create or edit their customized arbitrary waveforms, and then use a USB memory stick, or a USB/Ethernet connection, to download the waveforms to the generators. The process is painful, as it costs time and efforts when the waveforms need to be changed frequently.

ArbBuilder is a built-in application on the AFG31000 series, enabling users to create and edit their arbitrary waveforms on the generator. Like in the Tektronix ArbExpress PC based software, users can create an arbitrary waveform with Equation Editor or templates of standard waveforms. Thanks to the large capacitive touch screen, users can drag, pinch and zoom, or do all kinds of edits to the waveform.

For those who want to replicate real world waveforms captured with oscilloscopes, or created by third party software, data files in CSV format can be directly loaded into ArbBuilder from a USB memory stick.

After all edit work is done, the waveform can be seamlessly sent to hardware for replication just by clicking "Send to Ch" button, amplitude and offset will be set automatically, without normalization.

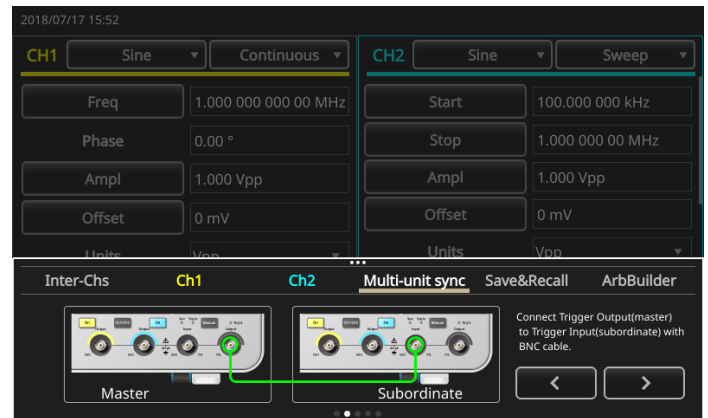


Creating an arbitrary waveform using the easy touch screen interface

Simplified multi-unit synchronization

Most applications just need one or two channels of output, but there are many others need more. In these cases, users need to synchronize two or more units to extend the number of channels. To do this used to be painful, as it required many cable connections between the two units, and setting 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 cable connections and settings.



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

Upgradability protects ROI

The AFG31000 provide upgrade options of bandwidth, memory extension and sequence mode support. These options can be installed at the factory or at any time after purchase. This helps to reduce the product ownership threshold. And when test requirements increase, you can purchase and install upgrade software licenses top 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	Bandwidth	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}			TBD ≤ 100 MHz: 1 mV _{P,P} to 10 V _{P,P} > 100 MHz to ≤ 250 MHz: 1 mV _{P,P} to 5 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}			TBD ≤ 100 MHz: 2 mV _{P,P} to 20 V _{P,P} > 100 MHz to ≤ 250 MHz: 2 mV _{P,P} to 10 V _{P,P}	
Accuracy	± (1% of setting + 1 mV _{P,P}) (1 kHz sine, 0 V offset, amplitude > 1 mV _{P,P} , offset = 0 V)				
Resolution	0.1 mV, 0.1 mV _{P,P} , 0.1 mV _{RMS} , 1 mV, 0.1 dBm or 4 digits, 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

Output characteristics


Short-circuit protection	Signal outputs are robust against permanent shorts against floating ground
Overcurrent protection	Output channels are protected with relays by disconnection from device under test. Connection can be resumed by user after removing the incoming current 

General characteristics - Basic mode



Basic (DDS)

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
Normal 	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
< 5 MHz	±0.15 dB	±0.15 dB	±0.15 dB	TBD	TBD
≥ 5 MHz to 25 MHz	±0.3 dB	±0.3 dB	±0.3 dB	TBD	TBD
> 25 MHz to 50 MHz	-----	±0.5 dB 	±0.5 dB 	TBD	TBD

Amplitude flatness (1 V_{p,p}, relative to 1 kHz), typical

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
TBD 	TBD 	TBD 	TBD	TBD

Harmonic distortion (1 V_{p,p}), typical

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102
10 Hz to <20 kHz	< -70 dB	< -70 dB	< -70 dB
≥20 kHz to <1 MHz	< -60 dB	< -60 dB	< -60 dB
≥1 MHz to <5 MHz	< -50 dB	< -50 dB	< -50 dB
≥5 MHz to ≤25 MHz	< -37 dB	-----	-----
≥5 MHz to ≤50 MHz	-----	< -37 dB	-----
≥5 MHz to ≤100 MHz	-----	-----	< -37 dB

	AFG31151 / AFG31152	AFG31251 / AFG31252
10 Hz to < 1 MHz	< -60 dB	< -60 dB
≥ 1 MHz to < 5 MHz	< -50 dB	< -60 dB 
≥ 5 MHz to ≤ 25 MHz	< -37 dB	< -37 dB
≥ 25 MHz to ≤ 150 MHz	< -30 dB	-----
≥ 25 MHz to ≤ 250 MHz	-----	< -30 dB

General characteristics - Basic mode

THD, typical  $\leq 0.1\%$, 10 Hz to 20 kHz, 1 V_{p,p}


Spurious noise (1 V_{p,p}), typical

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102
≥ 10 Hz to < 1 MHz	< -60 dB	< -60 dB	< -60 dB
≥ 1 MHz to < 25 MHz	< -50 dB	< -50 dB	< -50 dB
≥ 25 MHz to ≤ 50 MHz	-----	< -50 dBc + 6 dBc/octave	-----
≥ 25 MHz to ≤ 100 MHz	-----		< -50 dBc + 6 dBc/octave

	AFG31151 / AFG31152	AFG31251 / AFG31252
10 Hz to < 1 MHz	< -60 dB	< -60 dB
≥ 1 MHz to < 25 MHz	< -47 dB	< -47 dB
≥ 25 MHz to ≤ 150 MHz	< -47 dBc + 6 dBc/octave	-----
≥ 25 MHz to ≤ 250 MHz	-----	< -47 dBc + 6 dBc/octave

Phase noise, typical < -110 dBc/Hz at 20 MHz, 10 kHz offset, 1 V_{p,p}

Residual clock noise

	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
 -63 dBm	-63 dBm	-63 dBm	-63 dBm	-57 dBm	-57 dBm

Square

Frequency range

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
1 μ Hz to 20 MHz	1 μ Hz to 40 MHz	1 μ Hz to 80 MHz	1 μ Hz to 120 MHz	1 μ Hz 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	n/a	n/a

Overshoot, typical

$< 5\%$

Jitter (RMS)

2.5 ps

Ramp

Frequency range

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

Linearity, typical

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

Symmetry

0% to 100%

Pulse

Frequency range

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

Pulse width

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
16 ns to 999.99 s	42 ns to 999.99 s	8 ns to 999.99 s	5 ns to 999.99 s	4 ns to 999.99 s

General characteristics - Basic mode

Pulse 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 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 < 5%

Jitter (RMS) 2.5 ps

DC

Range (into 50 Ω)	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
	-5 V to 5 V	-5 V to 5 V	-5 V to 5 V	-2.5 V to 2.5 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	150 MHz	150 MHz	360 MHz	480 MHz

Noise type White Gaussian

Crest factor 3.1, 4.8, 6.0, or 7.0

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	150 MHz	150 MHz	???	???

Waveform length 2 to 131,072

General characteristics - Basic mode

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	≤ 4.2 ns	≤ 4.2 ns	≤ 4.2 ns	≤ 3 ns	≤ 2 ns
	Amplitude < 5Vpp	≤ 3.5 ns	≤ 3.5 ns	≤ 3.5 ns	≤ 3 ns	≤ 2 ns

Jitter (RMS)	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
	2.5 ps	2.5 ps	2.5 ps	???	???

Modulation

AM, FM, PM	Specification	Characteristic				
	Carrier	All except pulse, noise, DC and PRBS				
	Source	Internal or external				
	Internal modulating waveform	Sine, Square, Ramp, Noise, ARB (maximum waveform length: AM 131,072 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, Arb	10 MHz	20 MHz	40 MHz	60 MHz	80 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°

ASK, FSK, PSK	Specification	Characteristic				
	Carrier	All except pulse, noise, DC and PRBS				
	Source	Internal or external				
	Number of keys	2				
	Internal key rate	1 MHz to 1 MHz				

PMW	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				

General characteristics - Basic mode

Sweep

Type Linear, Logarithmic
Waveforms All, except Pulse, Noise, DC and PRBS
Sweep time 1 ms to 500 s
Hold/return time 0 s to 500 s
Maximum total sweep time 500 s
 Accuracy, typical: $\leq 0.4\%$
Minimum start/stop frequency All except ARB: 1 μ Hz
 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, Arb	20 MHz	40 MHz	80 MHz	120 MHz	160 MHz
Others	500 kHz	800 kHz	1 MHz	1 MHz	2.5 MHz

Burst

Waveform All except Noise, DC and PRBS
Type Triggered, gated
Burst count 1 to 1,000,000 cycles or Infinite
Internal trigger rate 1 μ s to 500.0 s
Gate and trigger sources Internal, external, remote interface

InstaView™

Waveforms All except noise and PRBS
Run mode Continuous in Basic mode
Maximum measurement range (DC + peak AC voltage) -10 V to 10 V

DC level measurement	Specification	Characteristic
	Accuracy (into 50 Ω), typical	$\pm (2 \% \text{ of } \text{setting} + 20 \text{ mVpp})$
	Resolution	1 mV or 4 digits

Amplitude measurement	Specification	Characteristic
	Accuracy (sine, 1 Vp-p, into 50 Ω), typical	$\pm (2 \% \text{ of } \text{setting} + 20 \text{ mV})$
	Resolution	1 mV or 4 digits

Bandwidth (-3 dB)	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
500 MHz				TBD	TBD

General characteristics - Basic mode

Flatness, typical	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
	0 to 100 MHz: ± 1 dB			TBD	TBD

Cable propagation delay measurement	Specification	Characteristic
	Range	0 to 20 ns (approximately 4 m/13 feet in length)
	Accuracy	± 300 ps

General characteristics - Advanced mode

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

Run mode Standard: Continuous, ~~Triggered~~, ~~Gated~~
Optional: Sequence

Number of waveform entries Continuous, Triggered, Gated: 1
Sequence (optional): 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, remote interface

Repeat count 1 to 1,000,000 or infinite

Timer range 2 μ S to 3600 S

Resolution 4 ns or 13 digits

Variable sampling clock		AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
	Range	1 μ Sa/s to 250 MSa/s	1 μ Sa/s to 500 MSa/s	1 μ Sa/s to 1 GSa/s	1 μ Sa/s to 2 GSa/s	1 μ Sa/s to 2 GSa/s
	Accuracy	10^{-6} Sa/s				
	Resolution	1 μ Sa/s or 16 digits				

Rise/Fall time, typical	AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
	Amplitude: $\geq 5 V_{p,p}$: ≤ 4.2 ns Amplitude: $< 5 V_{p,p}$: ≤ 3.5 ns			≤ 3 ns	≤ 2 ns

Overshoot $< 4\%$

General characteristics - Advanced mode

Level flatness, typical (sine, 1 V_{p,p}, relative to 1 kHz)

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< 5 MHz: ±0.3 dB	< 5 MHz: ±0.3 dB	< 5 MHz: ±0.3 dB	< 5 MHz: ±0.3 dB	< 5 MHz: ±0.3 dB ≥ 5 MHz to
≥ 5 MHz to 25 MHz: ±0.5 dB	≥ 5 MHz to 25 MHz: ±0.5 dB	≥ 5 MHz to 25 MHz: ±0.5 dB	≥ 5 MHz to 25 MHz: ±0.5 dB	≥ 5 MHz to 25 MHz: ±0.5 dB
----	≥ 25 MHz to 50 MHz: ±1.0 dB	≥ 25 MHz to 50 MHz: ±1.0 dB	≥ 25 MHz to 50 MHz: ±1.0 dB	≥ 25 MHz to 50 MHz: ±1.0 dB
----	----	≥ 50 MHz to 100 MHz: ±1.5 dB	≥ 50 MHz to 100 MHz: ±1.5 dB	≥ 50 MHz to 100 MHz: ±1.5 dB
----	----	----	≥ 100 MHz to 150 MHz: ±2.0 dB	≥ 100 MHz to 150 MHz: ±2.0 dB
----	----	----	----	≥ 150 MHz to < 200 MHz: ±2.5 dB
----	----	----	----	≥ 200 MHz to 250 MHz: ±3.0 dB

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

AFG31021 / AFG31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -60 dBc at 250 MSa/S or 3.90625 MHz	< -55 dBc at 500 MSa/S or 7.8125 MHz	< -50 dBc at 1 GSa/S or 15.625 MHz	< -45 dBc at 2 GSa/S or 31.25 MHz	< -45 dBc at 2 GSa/S or 31.25 MHz

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

AFG31021 / AF 31022	AFG31051 / AFG31052	AFG31101 / AFG31102	AFG31151 / AFG31152	AFG31251 / AFG31252
< -60 dBc at 250 MSa/S or 3.90625 MHz	< -55 dBc at 500 MSa/S or 7.8125 MHz	< -50 dBc at 1 GSa/S or 15.625 MHz	< -45 dBc at 2 GSa/S or 31.25 MHz	< -45 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
< -60 dBc at 250 MSa/S or 3.90625 MHz	< -55 dBc at 500 MSa/S or 7.8125 MHz	< -50 dBc at 1 GSa/S or 15.625 MHz	< -45 dBc at 2 GSa/S or 31.25 MHz	< -45 dBc at 2 GSa/S or 31.25 MHz

Phase noise, typical

~~(sine with 64 pts/cycle, 1 V_{p,p})~~

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	< -105 dBc at 2 GSa/S or 31.25 MHz	< -105 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	±(10% of setting + 200 ps)

Initial skew

< 200 ps

System characteristics

Output Frequency Resolution

Frequency accuracy $\pm 10^{-6}$ of setting (all except ARB), 0 °C to 50 °C (32 °F to 122 °F)
 $\pm 10^{-6}$ of setting $\pm 1 \mu\text{Hz}$ (ARB), 0 °C to 50 °C (32 °F to 122 °F)
Aging $\pm 1.0 \times 10^{-6}$ per year

Phase

Range -180° to +180°
Resolution 0.01° (sine)
 0.1° (other waveforms)

~~**Internal noise add**~~

~~**Level** 0.0% to 50% of amplitude (V_{pp}) setting~~
~~**Resolution** 1%~~

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

Maximum configuration times

	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, ~~Portuguese~~, 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
ASK, FSK, PSK	3.3 V logic level

Input impedance	40 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)
Jitter (RMS), typical	< 100 ps (signal output, with external trigger input in burst mode)

10 MHz reference clock input

Impedance	1 kΩ, AC coupled
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	Instrument	Characteristic
	AFG31021, AFG31022, AFG31051, AFG31052, AFG31101, AFG31012	10 ps
	AFG31151, AFG31152	TBD
	AFG31251, AFG31252	TBD

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

Auxiliary output characteristics

10 MHz reference clock out

Impedance	50 Ω , AC coupled
Amplitude	1.2 V _{p,p} into 50 Ω load

Physical characteristics

Dimensions

Height	201.4 mm (7.929 in.)
Width	412.8 mm (16.25 in.)
Depth	147.7 mm (5.816 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 (104 °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 (39,367 ft.)

EMC compliance

European Union	EN61326-1:2013, EN 61326-2-1:2013
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Safety

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

Overtemperature protection

~~This spec does not exist for AWC4K~~

Ordering Information

Models

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

Upgrade options

Function	For one channel instruments	For two channel instruments
Enables Sequence mode	AUP-AFG3SEQ-1	AUP-AFG3SEQ-2
Extends arb memory to 128Mpts	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 155 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

ServiceOptions

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

Probes and accessories are not covered by the instrument warranty and Service Offerings. Refer to the datasheet of each probe and accessory model for its unique warranty and calibration terms.

Accessories

Standard accessories

xxx	AFG31000 Series Generators Compliance and Safety Instructions
xxx	Power cord
xxx	USB cable
xxx	BNC cables
xxx	NIST-traceable calibration certificate
xxx	Three-year warranty on parts and labor

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
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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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