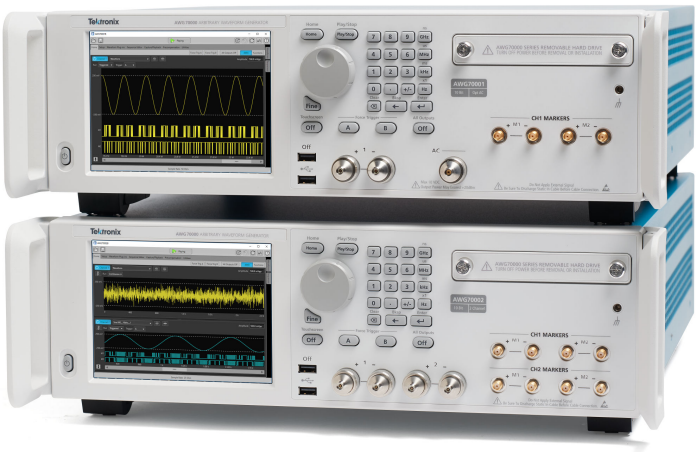
Arbitrary Waveform Generators

AWG70000B Series Datasheet



The AWG70000B Series arbitrary waveform generators (AWG) represent the cutting edge for sample rate, signal fidelity, and waveform memory, making them ideal for design, testing, and operations of complex components, systems and experiments. With up to 50 GS/s and 10-bit vertical resolution, it delivers the industry's best signal stimulus solution for easy generation of ideal, distorted, and "real-life" signals.

Key performance specifications

- Sample rates up to 50 GS/s
- -80 dBc spurious free dynamic range
- 10 bits vertical resolution
- Waveform memory of up to 32 GSamples

Key features

- Complete solution for wideband RF signal generation in a single box
  - Direct generation of wideband signals with carriers up to 20 GHz, removing the need for external RF conversion
- Simulate real-world analog effects on high speed digital data streams
  - Model signal impairments up to speeds of 12.5 GB/s
- Generate high precision RF signals
  - Spurious Free Dynamic Range performance better than -80 dBc
- Create high speed baseband signals for optical transmission with the vertical resolution to handle higher order complex modulation
  - 10 bits of vertical resolution at a sample rate of 50 GS/s
- Create long waveforms scenarios without building complex sequences
  - Up to 32 GSamples of Waveform Memory plays 640 ms of data at 50 GS/s
- Synchronize multiple units (manually or with the AWG Synchronization Hub) to achieve a multi-channel high speed AWG system
- Fully operational without external PC
  - Built-in display and buttons make it possible to quickly select, edit and play waveforms directly from the front panel of the AWG
- Simulate real-world environments by playing back captured signals
  - Waveforms captured with Oscilloscopes or Real-Time Spectrum Analyzers can be played back, edited, or re-sampled on the AWG
- Smooth transition from simulation to the real-world testing environment
  - Waveform vectors imported from third-party tools such as MATLAB
- Sequencer with Streaming ID
  - Control the Sequencer directly via a network interface connection

Applications

- Wideband RF/MW for communications and defense electronics
  - Output wideband RF signals up to 20 GHz
- Validation and compliance testing of high speed silicon and communications devices
  - Easily stress test receivers with a wide array of signal impairments
- Coherent optical research
  - Generation of high Baud rate baseband signals with higher order, complex modulation
- Leading edge research in electronics, physics & chemistry
  - High speed, low jitter signal source generates uniquely specified analog signals, fast pulses, data streams and clocks

Performance you can count on

Depend on Tektronix to provide you with performance you can count on. In addition to industry-leading service and support, this product comes backed by a standard one-year warranty.

Seamless transition from simulation to generation

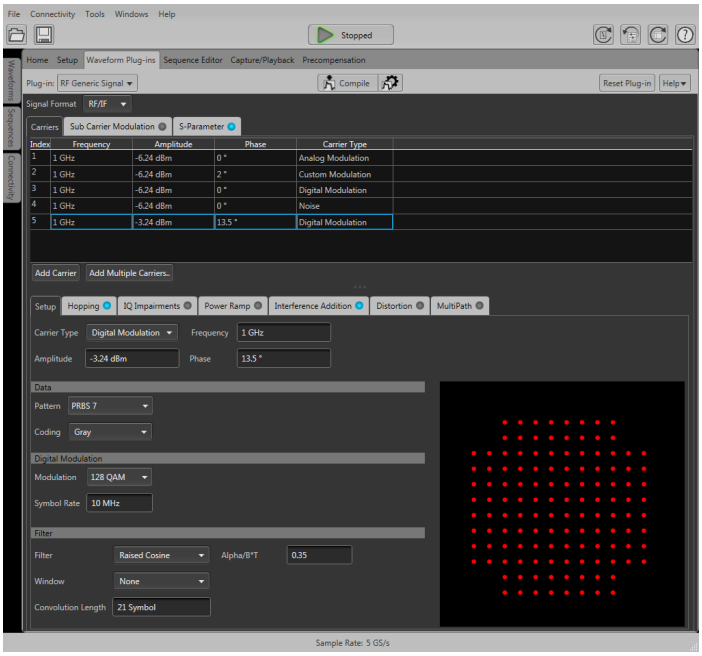
If a waveform can be defined or captured, then the AWG70000B can generate the signal. The creation of the waveform can happen in many ways. Waveform creation plug-ins, which are optimized to work specifically with the Tektronix AWG family, provide specific waveform creation capabilities, while 3rd party solutions like MATLAB, Excel, or others, have the flexibility to create any waveform you desire. Waveforms created in any of these packages can be imported and played back in the AWG70000B, seamlessly transitioning from the simulation world to the real world.

Additionally, any signals captured on Tektronix oscilloscopes or Real-Time Spectrum analyzers can be loaded into the AWG70000B and played back. With the use of the built in waveform generation plug-ins, the captured signal can also be modified or changed to meet any specific requirements that may exist.

Wideband RF signal generation

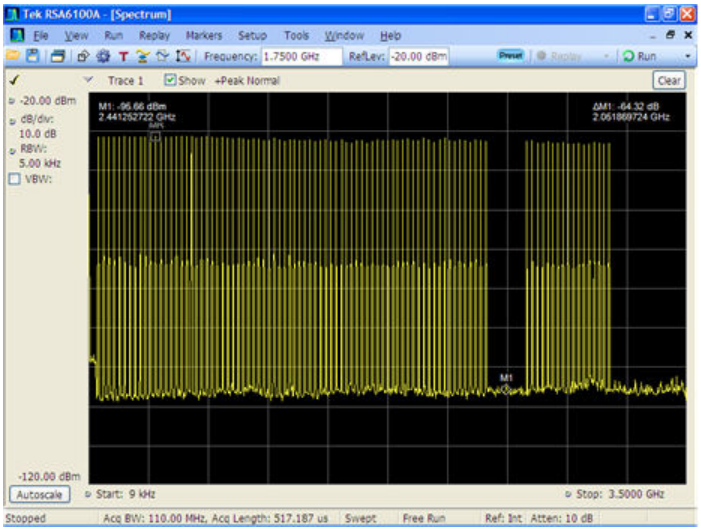
RF signals are becoming more and more complex, making it more difficult to accurately create the signals required for the testing and characterization of RF systems. To address these challenges, RF Generic delivers advanced capabilities to synthesize digitally modulated baseband, IF and RF/microwave signals supporting a wide range of modulation schemes.

The RF Generic, Radar, Multitone, OFDM, and Environment plug-in's easy to use graphical user interfaces integrate seamlessly with the AWG70000B Series user interface or the SourceXpress remote PC application.



The AWG70000B with the RF Generic Plugin allows complex RF Waveform Generation

The latest digital RF technologies often exceed the capabilities of other test instruments because of the need to generate the wide-bandwidth and fast-changing signals that are increasingly seen in many RF applications such as Radar, RF communications, OFDM, and Multi-tone. When used in conjunction with the specific plugin, the AWG70000B Series supports a wide range of modulation formats and simplifies the task of creating complex RF waveforms. The AWG70000B Series instruments provide customers with ways to generate fully modulated baseband, intermediate frequency (IF) signals, or directly generated RF waveforms up to 20 GHz.

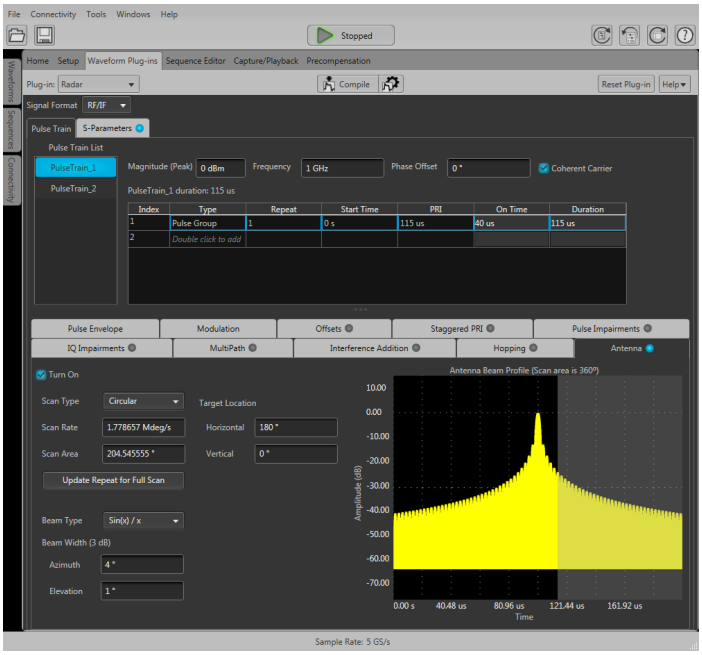


3 GHz wide multi-carrier signal generated on the AWG70000B with over 60 dBC SFDR

Radar signal creation

Generating advanced radar signals often demands exceptional performance from an AWG in terms of sample rate, dynamic range, and memory. The Tektronix AWG70000B Series sets a new industry standard for advanced radar signal generation, by delivering wide modulation bandwidths up to 20 GHz. With a sample rate of up to 50 GS/s, the AWG70000B Series can directly generate RF signals never before possible from an AWG. In instances where IQ generation is desired, the AWG70000B offers the ability to oversample the signal, thereby improving signal quality with its outstanding SFDR performance.

The AWG70000B and the Radar plug-in are the perfect solution for creating complex radar signals. Users get the ultimate flexibility in creating custom radar pulse suites. Modulation types such as LFM, Barker and Polyphase Codes, Step FM, and Nonlinear FM are easily created using the AWG, and the flexibility of the plug-in enables the creation of waveforms requiring customer-defined modulation. The combination AWG and Radar plug-in solution also has the ability to generate pulse trains with staggered PRI to resolve range and doppler ambiguity, frequency hopping for Electronic Counter-Counter Measures (ECCM), and pulse-to-pulse amplitude variation to simulate Swerling target models including antenna scan patterns, clutter, and multipath effects.

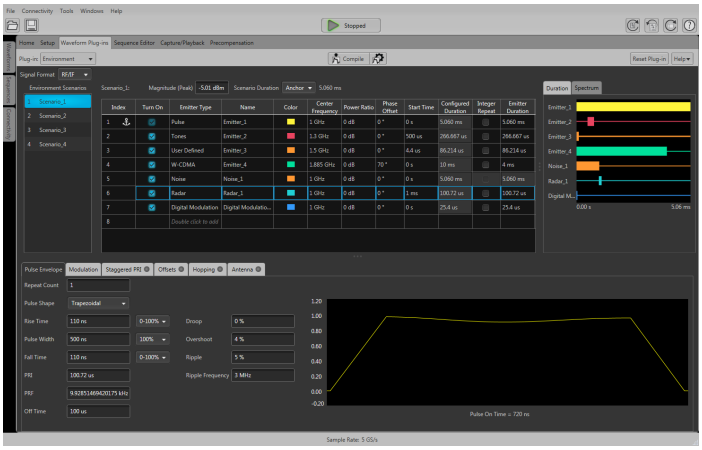


AWG radar pulses created with AWG70000B and Radar plug-in

Environment signal generation

The mission-critical nature of many radar signals requires that they coexist with standards-based commercial signals sharing the same spectrum without performance degradation. To meet this expectation, a radar designer has to thoroughly test all the corner cases at the design/debug stage. The AWG70000B and the Environment plug-in offers extreme flexibility to define and create these worst-case scenarios.

You can specify up to 50 scenarios to define your environment, including WiMAX, WiFi, GSM, CDMA, W-CDMA, DVB-T, Noise, Bluetooth, LTE, OFDM, Radar and more. This plug-in also allows you to seamlessly import signals from other plug-ins (including Radar, RF Generic etc.), as well as from Matlab® and from Tektronix spectrum analyzers and oscilloscopes, into your environment. You can also configure PHY parameters of your standard-specific signals. You can define the carrier frequency, power, start time, and duration for all the signals in your environment, so you have full control over the way these signals interact/interfere with each other.



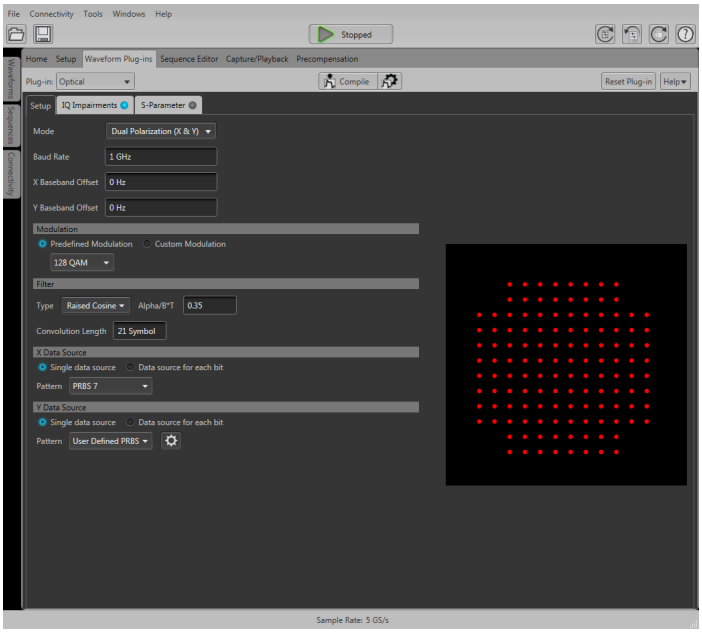
Multiple scenarios with multiple emitters using the Environment plug-in

Coherent optical

Today's high speed and increasingly web driven world is pushing the demand for short and long haul coherent optical development. Phase modulation, high baud rate, high sample rate, bandwidth and resolution are all critical to optical applications. Tektronix understands the challenges and inconsistencies of coherent optical testing and offers a reliable, easy to set up and high performing tool set for optical testing, waveform generation and calibration.

The Tektronix AWG70000B Series Arbitrary Waveform Generator (AWG) can reach sampling rates as high as 50 GS/s with 10 bits vertical resolution. Such level of performance allows for the direct generation of IQ basebands signals required by modern coherent optical communication systems based on quadrature modulation of an optical carrier with data rates well over 200Gb/s. Multiple AWG70000Bs can be synchronized (manually or with the AWG Synchronization Hub) to use the max 50 GS/s on each baseband signal with low EVM and 32 Gbaud performance.

Generating the desired signal is only the first challenge in coherent optical. The quality of the signal, low EVM's and having a clear open eye is crucial. The Optical plug-in, in conjunction with the pre-compensation plug-in, can be used for calibration of the AWG to the device under test and for precompensation of coherent optical signals.



Generic OFDM creation

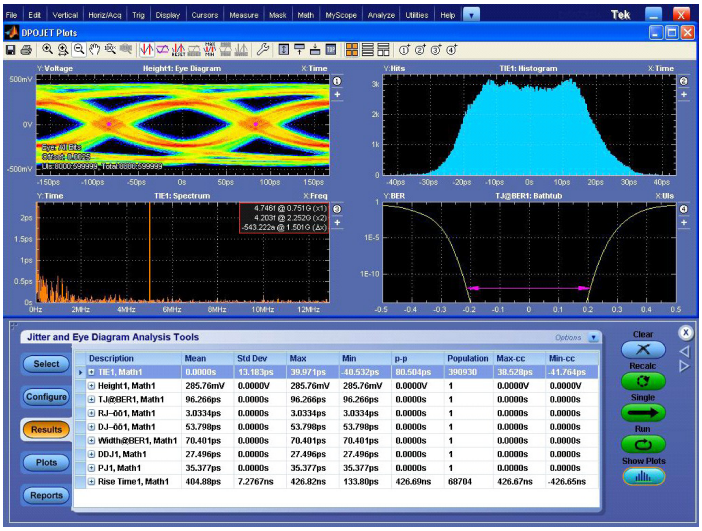
In today's wireless world, OFDM is becoming the modulation method of choice for transmitting large amounts of digital data over short and medium distances. The need for wide bandwidths and multiple carriers create challenges for engineers who need to create OFDM signals to test their RF receivers. The AWG70000B Series, when coupled with the OFDM plug-in, allows users to configure every part of the OFDM signal definition. Engineers can build signals symbol-by-symbol to create a complete OFDM frame or let the plug-in choose default values for some signal aspects. The combined AWG and OFDM plug-in supports a variety of data coding formats that include Reed Solomon, Convolution, and Scrambling. Users also have the ability to define each subcarrier in the symbol which can be configured independently for type, modulation, and base data. The OFDM plug-in gives visibility into all aspects of the OFDM signal by providing a symbol table that gives a summary of all the carriers in the selected symbol. OFDM packets/ frames can be built by specifying the spacing between the symbols/frames and parts of the OFDM packets can be stressed by adding gated noise.

High-speed serial signal generation

Serial signals are made up entirely of binary data — simple ones and zeros. As clock rates have increased, these simple ones and zeros have begun to look more like analog waveforms because analog events are embedded in the digital data. The zero rise time and the perfect flat tops of textbook digital signals no longer represent reality. Electronic environments have noise, jitter, crosstalk, distributed reactances, power supply variations, and other shortcomings. Each takes its toll on the signal. A real-world digital "square wave" rarely resembles its theoretical counterpart.

Since the AWG70000B Series is an analog waveform source, it is the perfect single-box solution used to create digital data streams and mimic the analog imperfections that occur in real-world environments.

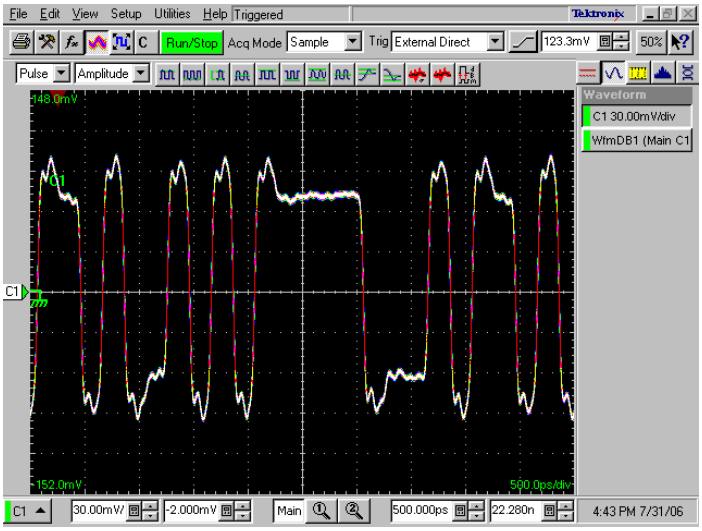
The use of direct synthesis techniques allow engineers to create signals that simulate the effects of propagation through a transmission line. Rise times, pulse shapes, delays, and aberrations can all be controlled. When used in conjunction with the High Speed Serial (HSS) plug-in, engineers are provided control over every aspect of their digital signals, reaching speeds of up to 50 Gb/s. This is exactly what is needed for rigorous receiver testing requirements.



Easily create digital data impairments with the AWG70000B and HSS plug-in

The HSS plug-in allows the AWG70000B Series instruments to create a variety of digital data impairments such as jitter (Random, Periodic, Sinusoidal), noise, pre/de-emphasis, duty cycle distortion, Inter-symbol Interference (ISI), Duty Cycle Distortion (DCD), and Spread Spectrum Clocking (SSC). The transmission environments of both boards and cables can be emulated using S-parameter files that can be applied to any waveform. The AWG70000B and the HSS plug-in also provides base pattern waveforms for many of today's high-speed serial applications such as SATA, Display Port, SAS, PCI-E, USB, and Fibre Channel.

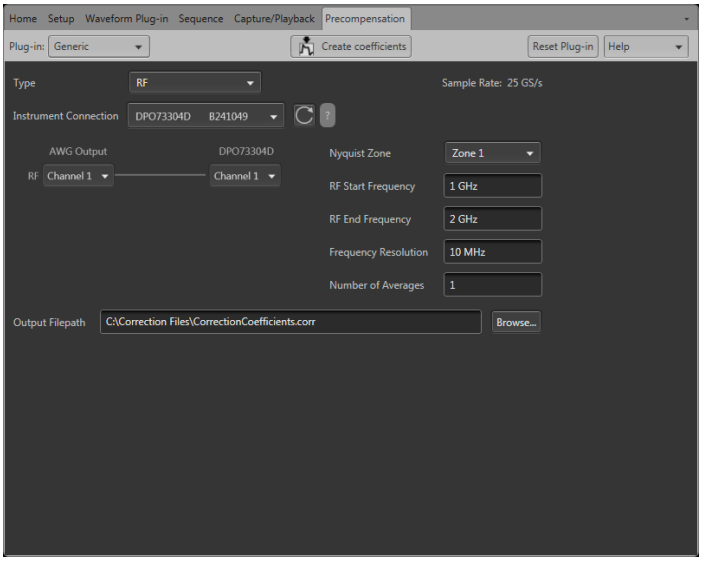
For high-speed serial applications, the AWG70000B Series offers the industry's best solution for addressing challenging signal stimulus issues faced by digital designers who need to verify, characterize, and debug complex digital designs. The file-based architecture uses direct synthesis to create complex data streams and provides users with the simplicity, repeatability, and flexibility required to solve the toughest signal generation challenges in high-speed serial communication applications.



Digital data with de-emphasis added using the AWG70000B and the HSS plug-in

Create correction coefficients

Compensate for imperfections in your test setup introduced by cabling, passive and active RF components and devices to achieve a flat frequency and linear phase response from your AWG. The Precompensation plug-in for current Tektronix AWG instruments and the PC SourceXpress software allows users to compensate for the first and second Nyquist zones of the AWG. Users can define the LO frequency and choose to get correction coefficients for either lower side band or upper side band, as well as define the carrier frequency. In all the modes, users can define the bandwidth of compensation either by specifying start and end frequencies (RF & IF) or bandwidth (in IQ/IQ with modulator).



The AWG70000B with the Generic Precompensation plug-in

Streaming ID

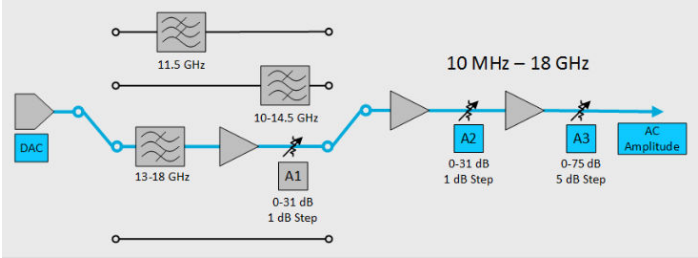
Managing a dynamic reproduction of an RF test environment can sometimes mean keeping track of thousands of individual waveforms. The new Streaming Waveform ID (Streaming WID) option adds a dedicated ethernet port to the rear panel of the instrument. This port allows for direct access to the sequencer hardware via UDP-formatted packets enabling immediate access to over 16000 sequence steps available in system memory. Replicate the chaos of the real world with unprecedented accuracy and accomplish more in less time with Streaming WIDs.

Option AC

The AWG70001B, with Option AC, provides you with an additional high output amplitude connector. Option AC adds a single-ended AC coupled connector to the front panel of the single channel AWG70001B Arbitrary Waveform Generator. User controls are added to allow switching the output path between the standard Direct output connectors or the AC output connector. When switched to the AC path, additional user controlled amplification and attenuation is added to the signal path.

In AC output mode, you can choose one of the four signal filter paths and set the output amplitude, letting the instrument automatically set the step attenuators in the selected filter path. For greater control, you can manually set the attenuation of the step attenuators for your selected filter path.

- No filter: -70 to +25 dBm at 1 GHz CW calibration frequency
- 11.5 GHz Low Pass: -70 to +25 dBm at 1 GHz CW calibration frequency
- 10 GHz - 14.5 GHz Band Pass: -77 to +18 dBm at 11 GHz CW calibration frequency
- 13 GHz - 18 GHz Band Pass: -90 to +20 dBm at 14 GHz CW calibration frequency



LXI Class C

Using the LXI Web Interface, you can connect to the AWG70000B Series through a standard web browser by simply entering the AWG's IP address in the address bar of the browser. The web interface enables viewing of instrument status and configuration, as well as status and modification of network settings. All web interaction conforms to the LXI Class C specification.

Specifications

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

Model overview

		AWG70001B	AWG70002B
Digital to analog converter			
	Sample rate	1.5 kS/s - 50 GS/s	1.5 kS/s - 25 GS/s
	Resolution	10 bit (no markers selected), 9 bit (one marker selected), or 8 bit (two markers selected)	
Number of channels		1	2

Hardware characteristics

Run modes

Continuous	Waveform is continuously repeated
Triggered	Waveform is output only once after a trigger is received
Triggered Continuous	Waveform is continuously repeated after a trigger is received

Waveform memory

AWG70001B	Standard: up to 2 GSamples With extended memory: up to 32 GSamples
AWG70002B	Standard: up to 2 GSamples per channel With extended memory: up to 16 GSamples per channel

Minimum waveform length

Triggered run modes	AWG70001B: 4800 points AWG70002B: 2400 points
Continuous run mode	1 point

Waveform granularity

Continuous run mode	1 point
Triggered run modes	AWG70001B: 2 points AWG70002B: 1 point

Waveform interleaving

AWG70001B	Non-interleaved when ≤ 25GS/s
	Interleaved when > 25GS/s
AWG70002B	Non-interleaved at all sample rates

DAC Resolution 8-bit, 9-bit, or 10-bit

Analog output characteristics

Number of channels

AWG70001B	1 channel
AWG70002B	2 channels

Connector type Aeroflex/Weinschel Planar Crown Universal Connector System with SMA female adapter

Output impedance 50 Ω

Effective frequency output

Fmaximum (specified) is determined as "sample rate / oversampling rate" or "SR / 2.5".

AWG70001B	20 GHz
AWG70002B	10 GHz

Bandwidth

Measured with a multi-sine waveform with equal amplitude across the band. The Sin(x)/x response is mathematically removed from the measured response before recording the -3 dB crossing.

AWG70001B	15 GHz
AWG70002B	13.5 GHz

Output amplitude

Amplitude levels are measured between differential outputs (+) to (-). For single-ended output, the amplitude level will be one-half the specified voltage levels.

Range	500 mV_{p-p} to 1 V_{p-p}
Resolution	1.0 mV
Accuracy	±(2% of amplitude + 1 mV)

Rise/fall time

Rise/fall time measured at 20% to 80% levels, related by a factor of 0.75 to the industry standard of 10% to 90% levels.

AWG70001B	Sampling rate ≤ 25 GS/s: < 23 ps
	Sampling rate at 50 GS/s: < 27 ps
AWG70002B	< 22 ps

Serial data bit rate

Bit rate determined as "sample rate / 4 points per cycle", allowing full impairment generation.

AWG70001B	12.5 Gb/s
AWG70002B	6.25 Gb/s

Output flatness

AWG70001B	±1.8 dB up to 10 GHz, +1.8 dB to -3 dB from 10 GHz to 15 GHz
AWG70002B	+0.8 dB to -1.5 dB up to 10 GHz

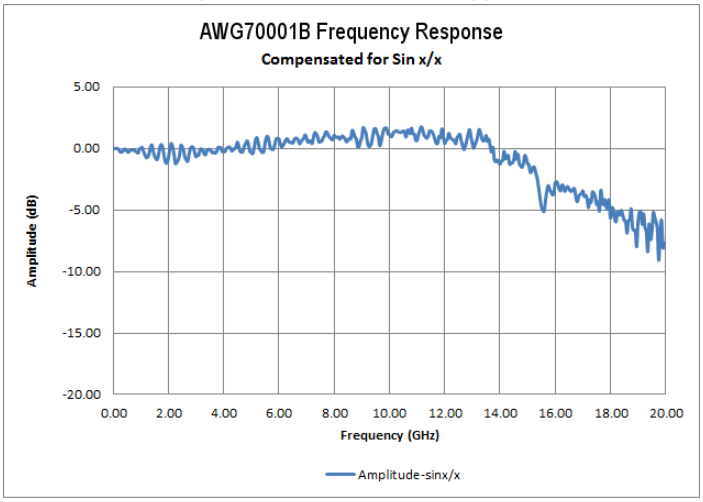
Output match, SWR

AWG70001B	DC to 5 GHz = 1.32:1 5 GHz to 10 GHz = 1.52:1
	10 GHz to 20 GHz = 1.73:1
AWG70002B	DC to 10 GHz = 1.61:1

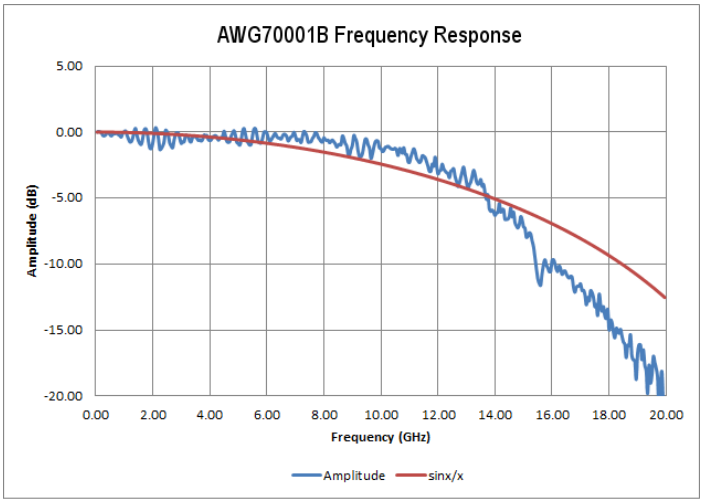
Frequency response

AWG70001B

AWG70001B frequency response at 50 GS/s with Sin(x)/x response mathematically removed from measured data.

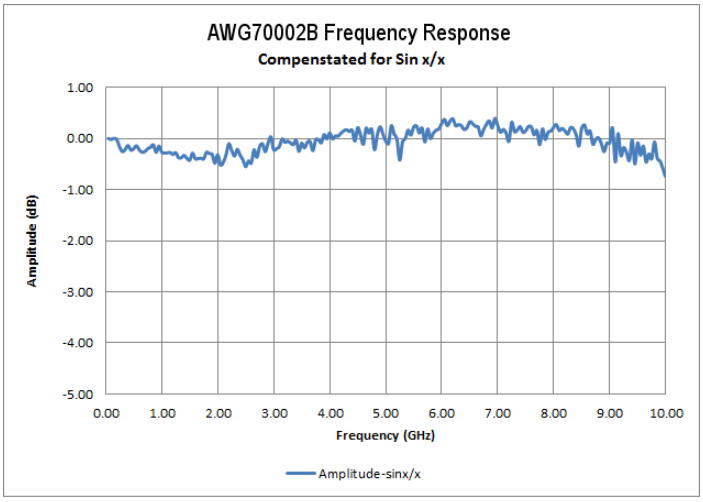


AWG70001B measured frequency response and ideal Sin(x)/x response at 50 GS/s.

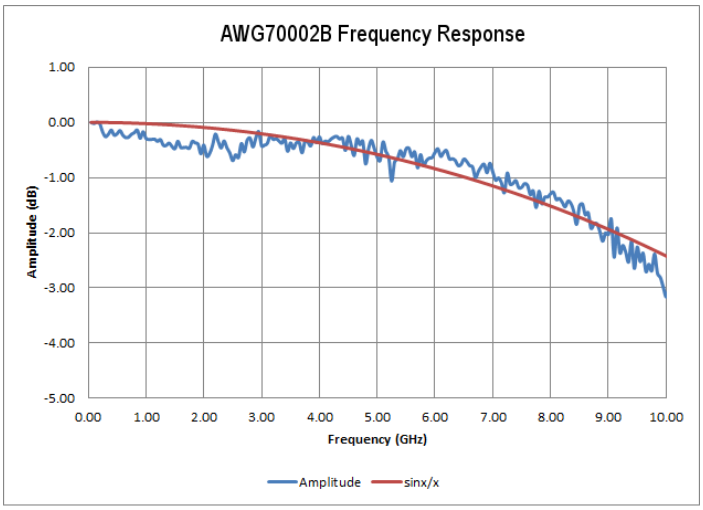


AWG70002B

AWG70002B frequency response at 25 GS/s with Sin(x)/x response mathematically removed from measured data.



AWG70002B measured frequency response and ideal Sin(x)/x response at 25 GS/s.



Waveform characteristics

Waveform file import capability

Import waveform format by series:

.AWGX file created by Tektronix AWG5200/70000 Series

.AWG file created by Tektronix AWG5000 or AWG7000 Series

.PAT and *.WFM file formats created by Tektronix AWG400/500/600/700 Series

.IQT file format created by Tektronix RSA3000 Series

.TIQ file format created by Tektronix RSA6000/5000 Series or MDO4000 Series

.WFM or *.ISF file formats created by Tektronix TDS/DPO/MSO/DSA Series

.TXT file format

.MAT Matlab file format

.SEQX file format created by Tektronix AWG5200/70000 Series

.SEQ file format created by the Tektronix AWG400/500/600/700 Series

.TMP or .PRM file formats; Midas Blue (Data Type 1000/1001; Scalar and complex data; 8-,16-, 32-, and 64-bit integer and 32- and 64-bit float data format types)

Waveform file export capability

.WFMX file format, AWG5200/70000 series native format

.WFM file format, AWG400/500/600/700 waveform file

.TIQ file format, RSA6000/5000 IQ Pair

.TXT file format

Trigger input characteristics

Number	2 (A and B)
Connector	SMA (rear panel)
Polarity	Positive or negative selectable
Impedance	50 Ω, 1 kΩ
Range	
50 Ω	<5 V
1 kΩ	±10 V
Threshold	
Range	-5.0 V to 5.0 V
Resolution	0.1 V
Accuracy	±5% of the setting + 0.1 V
Trigger to output delay	
Asynchronous	8625/(fclk + 20 ns) ±20 ns (710 ns @ fclk = 12.5 GHz, 25 GSps)
Synchronous	8120/(fclk + 20 ns) ±20 ns (670 ns @ fclk = 12.5 GHz, 25 GSps)
where fclk is the frequency of the DAC sampling clock	
Trigger minimum pulse width	20 ns
Trigger hold-off	8320/fclk ±20 ns where fclk is the frequency of the DAC sampling clock

Sequencer

	The sequencer is a firmware upgrade that allows the user to run a sequence of waveforms. The sequencer runs independent channels except for the clock.
Maximum repeat count	2^{20} counts (1,048,576 counts)
Maximum sequencing steps	16,383
Subsequencing	Single level depth
Waveform granularity resolution	
AWG70001B	2
AWG70002B	1
Minimum waveform length	
AWG70001B	4800 points
AWG70002B	2400 points

Spurious Free Dynamic Range (SFDR)

Spurious free dynamic range (SFDR) characteristics

Frequency output of AWG [1] [2]

AWG70001B operating at 50 GS/s

	In band performance		Adjacent band performance	
Analog channel output frequency	Measured across	Specification	Measured across	Specification
100 MHz	DC - 1 GHz	-80 dBc	DC - 10 GHz	-72 dBc
DC - 500 MHz	DC - 500 MHz	-70 dBc	DC - 1.5 GHz	-66 dBc
DC - 1 GHz	DC - 1 GHz	-63 dBc	DC - 3 GHz	-63 dBc
DC - 2 GHz	DC - 2 GHz	-62 dBc	DC - 6 GHz	-60 dBc
DC - 3 GHz	DC - 3 GHz	-60 dBc	DC - 6 GHz	-52 dBc
DC - 5 GHz	DC - 5 GHz	-52 dBc	DC - 6 GHz	-52 dBc
5 GHz - 6 GHz	5 GHz - 6 GHz	-52 dBc	3 GHz - 9 GHz	-40 dBc
6 GHz - 7 GHz	6 GHz - 7 GHz	-42 dBc	4 GHz - 10 GHz	-42 dBc
7 GHz - 8 GHz	7 GHz - 8 GHz	-60 dBc	6 GHz - 12.5 GHz	-52 dBc
8 GHz - 10 GHz	8 GHz - 10 GHz	-50 dBc	6 GHz - 12.5 GHz	-52 dBc
10 GHz - 12 GHz	10 GHz - 12 GHz	-53 dBc	6 GHz - 12.5 GHz	-50 dBc
12 GHz - 13 GHz	12 GHz - 13 GHz	-22 dBc	10 GHz - 15 GHz	-22 dBc
13 GHz - 14 GHz	13 GHz - 14 GHz	-54 dBc	11 GHz - 16 GHz	-20 dBc
14 GHz - 16 GHz	14 GHz - 16 GHz	-46 dBc	13 GHz - 18 GHz	-38 dBc
16 GHz - 18.5 GHz	16 GHz - 18.5 GHz	-42 dBc	14 GHz - 20 GHz	-30 dBc
18.5 GHz - 20 GHz	18.5 GHz - 20 GHz	-28 dBc	16 GHz - 20 GHz	-24 dBc

AWG70001B and AWG70002B operating at 25 GS/s

	In band performance		Adjacent band performance	
Analog channel output frequency	Measured across	Specification	Measured across	Specification
100 MHz	DC - 1 GHz	-80 dBc	DC - 10 GHz	-72 dBc
0 - 500 MHz	DC - 500 MHz	-70 dBc	DC - 1.5 GHz	-66 dBc
DC - 1 GHz	DC - 1 GHz	-63 dBc	DC - 3 GHz	-63 dBc
DC - 2 GHz	DC - 2 GHz	-62 dBc	DC - 6 GHz	-60 dBc
DC - 3 GHz	DC - 3 GHz	-60 dBc	DC - 6 GHz	-52 dBc
DC - 5 GHz	DC - 5 GHz	-52 dBc	DC - 6 GHz	-52 dBc
5 GHz - 6 GHz	5 GHz - 6 GHz	-52 dBc	3 GHz - 9 GHz	-40 dBc
6 GHz - 7 GHz	6 GHz - 7 GHz	-42 dBc	4 GHz - 10 GHz	-42 dBc
7 GHz - 8 GHz	7 GHz - 8 GHz	-55 dBc	6 GHz - 12.5 GHz	-50 dBc
8 GHz - 10 GHz	8 GHz - 10 GHz	-50 dBc	6 GHz - 12.5 GHz	-50 dBc

1 Measured with Balun at maximum sample rate.

2 SFDR is determined as a function of the directly generated carrier frequency. Harmonics not included.

Output distortions

Harmonic distortion

Sample rate = 25 GS/s

2nd harmonic, at output frequency

Frequency range	Value
< 2 GHz	< -60 dBc
2 GHz - 6 GHz	< -50 dBc
> 6 GHz	< -42 dBc

3rd harmonic, at output frequency

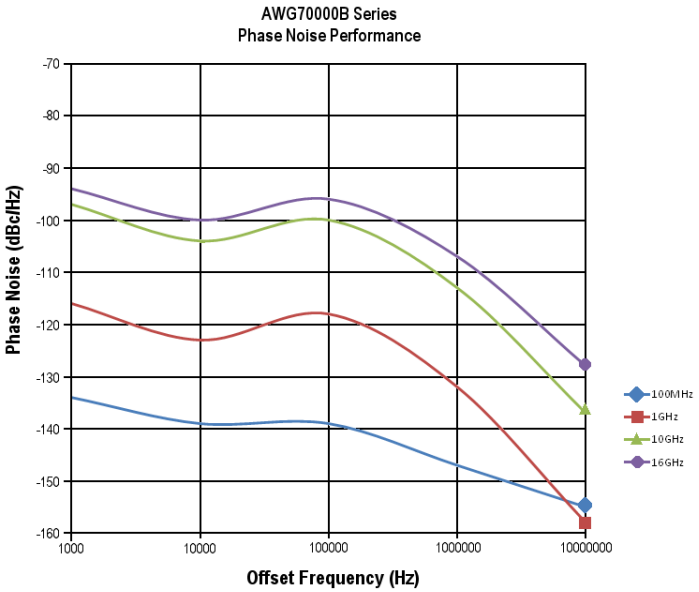
Frequency range	Value
< 1 GHz	< -60 dBc
1 GHz - 2 GHz	< -50 dBc
> 2 GHz	< -40 dBc

Effective number of bits (ENOB)

AWG70001B 4.6 bits at 14.99 GHz All noise and distortion DC - 20 GHz

AWG70002B 5.6 bits at 9.99 GHz All noise and distortion DC - 12.5 GHz

Phase noise Phase noise in reduced jitter mode.



Jitter

Random jitter 250 fs RMS

Total jitter 10 ps $_{p-p}$ at 12.5 Gb/s

Channel timing characteristics

These specifications apply to the AWG70002B only.

Channel to channel skew	±5 ps
Output skew control	
Range	-100 ps to 100 ps
Resolution	500 fs
Accuracy	±5 ps
Intra-channel skew	<5 ps

References

Reference In

Connector	SMA (rear panel)
Impedance	50 Ω, AC coupled
Input amplitude	–5 dBm to +5 dBm
Fixed frequency range	10 MHz, ±40 Hz
Variable frequency range	35 MHz to 250 MHz

10MHz Reference Out

Connector	SMA (rear panel)
Impedance	50 Ω, AC coupled
Amplitude	+4 dBm ±2 dBm
Frequency (guaranteed)	10 MHz ±(1 ppm + aging)

Clock characteristics

Clock In

Connector	SMA (rear panel)
Input impedance	50 Ω, AC coupled
Frequency range	6.25 GHz to 12.5 GHz
Input amplitude	0 dBm to +10 dBm

Clock Out

Connector	SMA (rear-panel)
Output impedance	50 Ω AC coupled
Output amplitude	+5 dBm to +10 dBm

Sync Clock Out

Connector	SMA (rear panel)
Output impedance	50 Ω, AC coupled
Frequency	1/80 of the clock output
Amplitude	1.0 V ±150 mV_{p-p} into 50 Ω

Marker characteristics

Number

AWG70001B Total of 2

AWG70002B Total of 4 (2 per channel)

Style Differential

Connector SMA (front panel)

Impedance 50 Ω

Level into 50 Ω

Characteristic	Value
Window	-1.4 V to 1.4 V
Amplitude	0.5 V_{p-p} to 1.4 V_{p-p}
Resolution	10 mV
Accuracy	±(10% of setting + 50 mV) into 50 Ω
Rise/fall time (20% - 80%)	<35 ps (High: 1.0 V, Low: 0 V)

Timing skew

Characteristic	Value
Intra-channel	<12 ps (between each channel (+) Pos and (-) Neg output)
Inter-channel	<15 ps (between Marker 1 and Marker 2 outputs)

Delay control

Characteristic	Value
Delay from analog output	AWG70001B: 205 ps ±20 ps AWG70002B: 767 ps ±20 ps AWG70001B (Option AC): -353 ps ±20 ps
Range	0 to 100 ps
Resolution	1 ps
Accuracy	±15 ps typical

Jitter

Characteristic	Value
Random RMS	0.4 ps_{RMS}
Total p-p	20 ps_{p-p} (Using PRBS15 pattern)

Auxiliary Outputs

Auxiliary Outputs can be configured as sequencer flags or timers.

Connector SMB (rear panel)

Number of outputs

- **AWG70001B** 4
- **AWG70002B** 8

Impedance 50 Ω

Amplitude

- **High** 3.3 V into 50 Ω
- **Low** 0 V

Period When configured as a timer. 1 Hz (1 s) to 100 kHz (10 µs)

Pattern jump

Pin assignments

Pin		Pin		Pin	
1	GND	6	GND	11	Data bit 5, input
2	Data bit 0, input	7	Strobe, input	12	Data bit 6, input
3	Data bit 1, input	8	GND	13	Data bit 7, input
4	Data bit 2, input	9	GND	14	GND
5	Data bit 3, input	10	Data bit 4, input	15	GND

Input impedance 1 kΩ pull-down to GND

Input levels 3.3 V LVCMOS 5 V TTL compliant

Number of destinations 256

Strobe polarity Negative edge

Strobe Minimum Pulse Width 64 ns

Strobe Setup and Hold

- **Setup** 5 ns
- **Hold** 5 ns

AWG70001B Option AC output characteristics

These characteristics apply to the optional AC output connector available with the AWG70001B models.

Connector Aeroflex/Weinschel Planar Crown Universal Connector System with SMA female adapter

Number of analog AC outputs 1

Type of outputs single ended

Output impedance 50 Ω

Frequency range

Filter	Value
No filter	10 MHz to 18 GHz
Low pass	10 MHz to 11.5 GHz
Band pass (10 to 14.5 GHz)	10 GHz to 14.5 GHz
Band pass (13 to 18 GHz)	14 GHz to 18 GHz

Amplitude

Range (for a CW signal at specified frequencies in each path)

Filter	Value
No filter	25 dBm to -70 dBm at 1 GHz 18 dBm to -77 dBm at 13 GHz
Low pass	25 dBm to -70 dBm at 1 GHz
Band pass (10 to 14.5 GHz)	18 dBm to -77 dBm at 11 GHz
Band pass (13 to 18 GHz)	20 dBm to -90 dBm at 14 GHz 18 dBm to -90 dBm at 18 GHz

Accuracy (at calibration frequency)

Filter	Value
No filter	±0.5 dB at 1 GHz, ambient 16 °C to 26 °C ±1.5 dB at 1 GHz, ambient 0 °C to 50 °C
Low pass	±0.5 dB at 1 GHz, ambient 16 °C to 26 °C ±1.5 dB at 1 GHz, ambient 0 °C to 50 °C
Band pass (10 to 14.5 GHz)	±1.5 dB at 11 GHz, ambient 16 °C to 26 °C ±3.0 dB at 11 GHz, ambient 0 °C to 50 °C
Band pass (13 to 18 GHz)	±1.5 dB at 14 GHz, ambient 16 °C to 26 °C ±3.5 dB at 14 GHz, ambient 0 °C to 50 °C

Resolution 0.01 dB

Amplitude flatness Specifications include the sin(x)/x roll off of the DAC at 50 GS/s.

Filter	Value
No filter	± 3 dB, 10 MHz to 10 GHz ± 4 dB, 10 MH to 13 GHz
Low pass	± 3 dB, 10 MHz to 10 GHz
Band pass (10 to 14.5 GHz)	± 3.5 dB, 10 GHz to 14.5 GHz
Band pass (13 to 18 GHz)	± 4.5 dB from 13 GHz to 18 GHz

Harmonic distortion

Operating at 50 GS/s.

2nd Harmonic at output frequency

Frequency range	Value
< 1 GHz	< -34 dBc
1 GHz - 4 GHz	< -30 dBc
> 4 GHz	< -28 dBc

3rdHarmonic at output frequency

Frequency range	Value
< 1 GHz	< -50 dBc
1 GHz - 4 GHz	< -45 dBc
> 4 GHz	< -33 dBc

Amplifier 1 dB compression

Operating at 50 GS/s

Filter	Frequency	Value
No filter	1 GHz	> 25 dBm
	13 GHz	> 22 dBm
Low pass	1 GHz	> 25 dBm
Band pass (10 to 14.5 GHz)	11 GHz	> 22 dBm
Band pass (13 to 18 GHz)	14 GHz	> 22 dBm
	18 GHz	> 20 dBm

Switching time

The time required for the attenuators and amplifiers to settle to the specified output amplitude after an amplitude change. 20 ms

Power source

AC line input

100 to 240 V AC, 50/60 Hz

Consumption

500 Watts

Computer system

Operating system / peripherals / IO

Microsoft® Windows 10 OS

16 GB

≥ 1 TB solid state drive

	6 USB ports (2 front - USB 2.0) (4 rear - USB 3.0)
	RJ-45 Ethernet connector (rear panel) supports 10/100/1000BASE-T
	VGA video (rear panel) for external monitor
	eSATA (rear panel)
Display characteristics	LED backlit touch screen display, 132 x 99 mm (165 mm diagonal), 1024 × 768 pixels
Software driver for third-part applications	IVI-COM driver IVI-C driver
Instrument control / data transfer	
GPIB through USB B device port (requires external adapter TEK-USB-488)	Remote control and data transfer (conforms to IEEE-Std 488.1, compatible with IEEE-Std 488.2 and SCPI-1999.0)
Ethernet	Remote control and data transfer (conforms to IEEE-Std 802.3)
LAN eXtensions for Instrumentation (LXI)	Class LXI Class C Version 1.4

Physical characteristics

Dimensions	
Height	153.6 mm (6.05 in)
Width	460.5 mm (18.13 in)
Depth	603 mm (23.76 in)
Weight	
Net weight without packaging	37.0 lb (16.8 kg)
	38.56 lb (17.49 kg) (AWG70001B with option AC)
Net weight with packaging	49.4 lb (22.4 kg)
	50.96 lb (23.12 kg) (AWG70001B with option AC)
Cooling clearance	
Top	0 in
Bottom	0 in
Left side	50 mm (2 in)
Right side	50 mm (2 in)
Rear	0 in

EMC, environment, and safety

Temperature	
Operating	0 ºC to +50 ºC (+32 ºF to +122 ºF)
Non-operating	-20 ºC to +60 ºC (-4 ºF to +140 ºF)
Humidity	
Operating	5% to 90% relative humidity (% RH) at up to 30 °C
	5% to 45% relative humidity above 30 °C up to 50 °C

	Non-condensing
Non-operating	5% to 90% relative humidity (% RH) at up to 30 °C
	5% to 45% relative humidity above 30 °C up to 60 °C
	Non-condensing
Altitude	
Operating	Up to 3,000 meters (9,843 feet)
	Derate maximum operating temperature by 1 °C per 300 meters above 1500 meters.
Non-operating	Up to 12,000 meters (39,370 feet)
Vibration	
Operating	Sine: 0.33 mm p-p (0.013 in p-p) constant displacement, 5 to 55 Hz
	Random: 0.27 GRMS from 5 to 500 Hz, 10 minutes per axis
Nonoperating	Random: 2.28 GRMS from 5 to 500 Hz, 10 minutes per axis
Mechanical shock	
Operating	Half-sine mechanical shocks, 30 g peak, 11 ms duration, 3 drops in each direction of each axis
Regulatory	
Safety	UL61010-1, CAN/CSA-22.2, No.61010-1, EN61010-1, IEC61010-1
Emissions	EN55011 (Class A), IEC61000-3-2, IEC61000-3-3
Immunity	IEC61326, IEC61000-4-2/3/4/5/6/8/11
Regional certifications	

Europe	Australia/New Zealand
EN61326	AS/NZS 2064

Ordering information

Models

AWG70001B	Arbitrary Waveform Generator: 1-Channel, 10-bit, up to 50 Gs/s
AWG70001B AC[3]	Amplifier and attenuator option for AWG 70000 series
AWG70001B BASIC[3]	Standard attenuation for AWG 70000 series
AWG70000-150	Mandatory License; 50 Gs/s Sample Rate for AWG70001B; Node Locked
AWG70001B SEQ	Add Sequencing to the AWG70001B; requires export control license
AWG70001B STRID	Add Streaming ID to the AWG70001B; requires SEQ and export control license
AWG70000-MEM	License; Increase memory to 32GS (on AWG70001B) or 16GS per channel (on AWG70002B); Node Locked
AWG70002B	Arbitrary Waveform Generator: 2-Channel, 10-bit, up to 25 Gs/s
AWG70002B BASIC	Mandatory. Base configuration for the AWG 70002B
AWG70000-208[3]	License; 8 Gs/s sample rate for the AWG 70002B; Node Locked
AWG70000-216[3]	License; 16 Gs/s sample rate for the AWG 70002B; Node Locked
AWG70000-225[3]	License; 25 Gs/s sample rate for the AWG 70002B; Node Locked
AWG70002B SEQ	Add Sequencing to the AWG70002B; requires export control license
AWG70002B STRID	Add Streaming ID to the AWG70002B; requires SEQ and export control license
AWG70000-MEM	License; Increase memory to 32GS (on AWG70001B) or 16GS per channel (on AWG70002B); Node Locked

Instrument options

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. A4	North America 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 manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L8	Traditional Chinese manual

[3] Mandatory selection

Opt. L10	Russian manual
Opt. L99	No manual

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. G3	Complete Care 3 Years (includes loaner, scheduled calibration, and more)
Opt. G5	Complete Care 5 Years (includes loaner, scheduled calibration, and more)
Opt. R3	Repair Service 3 Years (including warranty)
Opt. R5	Repair Service 5 Years (including warranty)

Standard accessories

131-8689-xx	Analog output Planar Crown 7005A-1 SMA female adapters (preinstalled) AWG70001B: two (three with Option AC) AWG70002B: four
015-1022-xx	One 50 Ω SMA terminator per channel
—	Installation and safety manual (Specify language option at time of order.)
—	Certificate of calibration
—	Power cord (Specify power cord option at time of order.)

Recommended accessories

Item	Description	Part number
Synchronization Hub	Enables fast synchronization of multiple AWG70000 series instruments	AWGSYNC01 Synchronization Hub
GPIB to USB Adapter	Enables GPIB control through USB B port	TEK-USB-488
Rack mount kit	Rack mount kit for AWG70000 Series	AWGRACK
MDC4500-4B	DC amplifier for MIPI applications	MDC4500-4B
Baluns	300 kHz - 26.5 GHz	Marki BAL-0026
	5 MHz - 20 GHz	Hyperlabs HL9402
Bias Ts	200 kHz - 12 GHz	Mini-Circuits ZX85-12G-S+
Power Splitters	1.5 kHz - 18 GHz	Mini-Circuits ZX10-2-183-S+
	DC-18 GHz	Aeroflex/Weinschel 1515
Amplifiers	0.01 - 20 GHz, 30 dB gain	RF-Lambda RAMP00G20GA
Adapter	SMB female to SMA female	Mouser 565-72979
Programmer manual	Programming commands, English only	077-1452-xx (Visit the Tektronix website)
Hard transit case and foam	-	016206100
Pelican case	-	016-2127-00

Product upgrades

The following instrument upgrades are available post sales.

See the Plug-ins section for a list of software waveform plug-ins available post sales.

AWG70001B

AWG701BUP AC	Adds a single-ended AC coupled output connector with additional amplification and attenuation (factory upgrade only)
AWG701BUP SSD	Replacement / additional Solid State Disc Drive
AWG70000-MEM	Increases waveform record length to 32 G
AWG70000-MEM	Increases waveform record length to 32 G
AWG701BUP SEQ	Adds Sequencing
AWG701BUP STRID	Adds Streaming ID

AWG70002B

AWG70000-MEM	Increases waveform record length to 16 G per channel
AWG70000-0816	License; Upgrade from 8 Gs/s to 16 GS/s sample rate for the AWG 70002B; Node Locked
AWG70000-0825	License; Upgrade from 8 Gs/s to 25 GS/s sample rate for the AWG 70002B; Node Locked
AWG70000-1625	License; Upgrade from 16 Gs/s to 25 GS/s sample rate for the AWG 70002B; Node Locked
AWG702BUP SSD	Replacement / additional Solid State Disc Drive
AWG702BUP SEQ	Adds Sequencing
AWG702BU*P* SEQ	Adds Sequencing
AWG702BU*P* SEQ	Adds Streaming ID
AWG702BUP STRID	Adds Streaming ID

Plug-ins

Plug-ins increase the capabilities of the arbitrary waveform generators. Various plug-ins are available providing unique types of waveforms or additional compensation. Each plug-in has its own installation file which installs seamlessly into the generators. After installation, it simply becomes a new menu selection. No other configuration is necessary.

Plug-in	Description	Nomenclature	Licensed enhancements
Multitone & Chirp plug-in	Create chirps, notches, and tones	MTONENL-SS01 MTONEFL-SS01	
PreCompensation plug-in	Create correction coefficients that can be applied on waveforms to get flat frequency and linear phase response	PRECOMNL-SS01 PRECOMFL-SS01	
High Speed Serial plug-in	Create pre-distorted waveforms to test a device's conformance to standards	HSSNL-SS01 HSSFL-SS01	S-Parameters and Intersymbol Interference unlocked with S-Parameters plug-in license
RF Generic plug-in	Create digitally modulated signals with multiple carrier groups	RFGENNL-SS01 RFGENFL-SS01	S-Parameters unlocked with S-Parameters plug-in license
Optical plug-in	Create waveforms with complex modulation schemes for optical testing	OPTICALNL-SS01 OPTICALFL-SS01	S-Parameters unlocked with S-Parameters plug-in license Spread Spectrum Clocking unlocked with Spread Spectrum Clocking plug-in license
OFDM plug-in	Create Single or Multiple OFDM based Frames with one or more bursts	OFDMNL-SS01 OFDMFL-SS01	S-Parameters unlocked with S-Parameters plug-in license
RADAR plug-in	Create RADAR pulsed waveforms with various modulations and impairments	RADARNL-SS01 RADARFL-SS01	S-Parameters unlocked with S-Parameters plug-in license
Environment plug-in	Create real world scenarios for commercial, electronic warfare, and simulations for monitoring and receiver testing	ENVNL-SS01 ENVFL-SS01	
Spread Spectrum Clocking plug-in	Adds SSC capability to the High Speed Serial and Optical plug-ins	SSCFLNL-SS01 SSCFLFL-SS01	
S-Parameters plug-in	Adds S-Parameter capability to the RF Generic, High Speed Serial, Optical, OFDM, and RADAR plug-ins	SPARANL-SS01 SPARAFL-SS01	
Pattern Generator, Pulse, & LVDS Video Signal Generator plug-ins		Free web download	

Plug-ins require the purchase of a license before they are fully functional.

There are two types of licenses available for each plug-in: node-locked (NL) and floating (FL).

- Node Locked Licenses (NL) provide your own copy of the application on your instrument and are permanently assigned to a product model/serial number.
- Floating Licenses (FL) can be moved between product models.

Warranty

One-year parts and labor.

Certifications

Tektronix is ISO 14001:2015 and ISO 9001:2015 certified by DEKRA.

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

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