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Arbitrary Waveform Generator

▶ AWG5000 Series (AWG5014 • AWG5012 • AWG5004 • AWG5002)



▶ AWG5000 Series.

The AWG5000 Series of Arbitrary Waveform Generators Delivers the Industry's Best Mixed Signal Stimulus Solution for Today's Complex Measurement Challenges

The AWG5000 Series of Arbitrary Waveform Generators delivers the optimal combination of industry leading sample rate, vertical resolution, signal fidelity and waveform memory length, all in an easy-to-use self-contained package.

The series offers the industry's best solution to the challenging signal stimulus issues faced by designers verifying, characterizing and debugging sophisticated electronic designs.

Meeting the needs of today's design engineers, the series provides excellent signal dynamic range and integrity.

AWG5000 Series models, with a 14 bits DA converter based sample rate from 600 MS/s to 1.2 GS/s, two to four output channels, synchronized four to eight digital marker outputs, and 28-channels of digital data outputs, easily solve the toughest measurement challenges in wireless base band I/Q communications, digital consumer product design such as imaging devices, data conversion equipment and semiconductor design and test.

The open Windows (Windows XP)-based instruments are easy and convenient to use and connect easily with peripherals and third-party software.

▶ Features & Benefits

1.2 Gs/s and 600 MS/s Models

14 bit Vertical Resolution

2 or 4 Arbitrary Waveform Differential/Single-ended Outputs
- Up to 4.5 V_{p-p} Single-ended and 9 V_{p-p} at Differential Output into 50 Ω
- 0.95 ns Tr/Tf (10 to 90%) at 0.6 V_{p-p}
- +/– 5 ns Range (50 ps Resolution) Inter Channel Skew Control
- SFDR: 80 dBc (1 MHz), 64 dBc (10 MHz)

4 or 8 Variable Level Marker Outputs
- Up to 3.7 V_{p-p} Single-ended Output into 50 Ω
- 300 ps Tr/Tf (20 to 80%) at 0 to 1 V
- Up to 1 ns Range (50 ps Resolution) Delay Control

28 Bits Ch 1/Ch 2 Variable Level Digital Data Output
- Up to 3.7 V_{p-p}Single-ended Output into 50 Ω
- 300 ps Tr/Tf (20 to 80%) at 0 to 1 V

Up to 32 M Point Record Length For Longer Data Streams

Down to 800 ps Resolution Edge Timing Shift Control

Real-time Sequencing Creates Infinite Waveform Loops, Jumps, and Conditional Branches

Easy to Use and Learn Shortens Test Time

Intuitive User Interface Based on Windows 2000 XP

Convenient Bench Top Form Factor

Integrated PC Supports Network Integration and Provides a Built-in DVD, Removable Hard Drive, LAN and USB ports

▶ Applications

Designing, Testing and Deploying Wireless Communications:
- High Fidelity Quadrature Modulation I and Q Base-band Signals (Polar Modulation: I/Q + Magnitude Control, Two Pair of I/Q for MIMO)

Imaging
- Stimulus Signals for Imaging Display and Recording Devices (CCD, LCD)

Data Conversion
- Stimulus Signals for Data Conversion Devices (ADC, DAC)

Mixed Signal Design and Test
- 2/4Ch Analog + 4/8Ch Marker Outputs + 28 Bit Digital Data Outputs

Real-world, Ideal or Distorted Signal Generation – Including All the Glitches, Anomalies and Impairments

Enhanced/Corrupted Playback of DSO Captured Signals

Waveform Vectors Imported from Third-party Tools such as MathCAD, MATLAB, Excel and Others

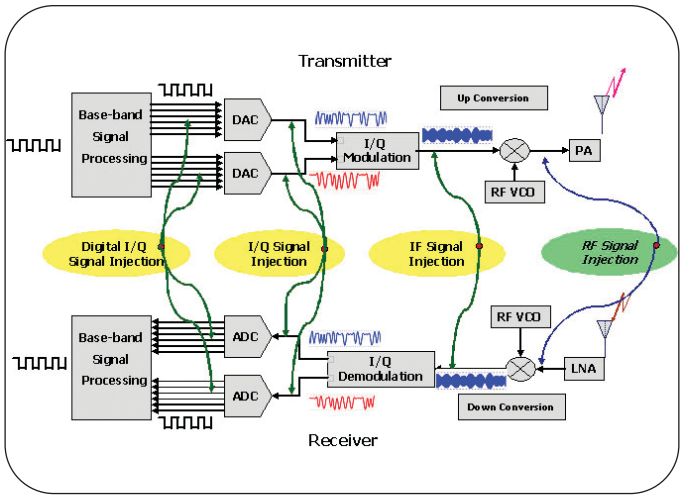
Tektronix

Enabling Innovation

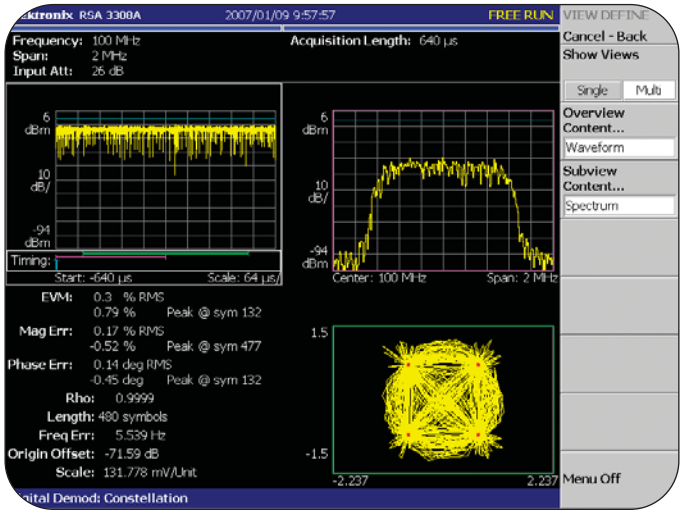
Wireless I/Q and IF Signal Generation

Tektronix AWGs support "Wireless Everywhere" by enabling the latest Digital RF technology, increasing wireless network capacity and delivering the performance that supports higher modulation bandwidth and modulation schemes.

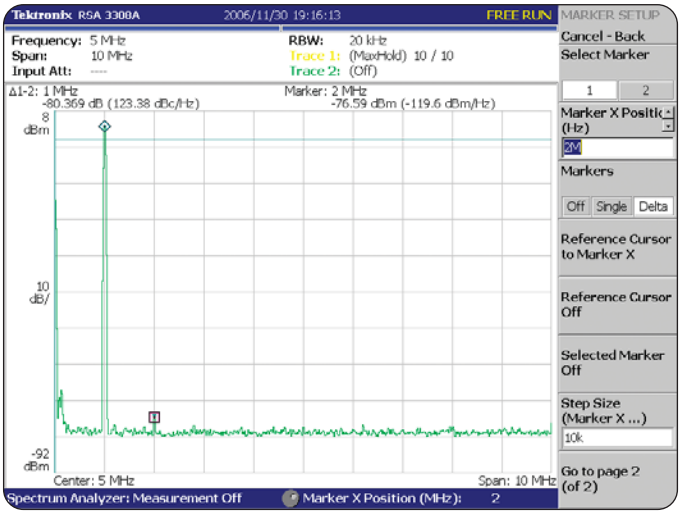
The AWG 5000 Series' 1.2 GS/s, (600 MS/s), with enough signal dynamic range and SFDR via 14 bit vertical resolution meets narrowband IQ applications to broadband IF applications. The AWG5000 is able to generate not only analog IQ/IF signals, but digital data IQ/IF. The MIMO (Multiple Input Multiple Output) system that supports W-LAN /Wi-Max using space-multiplex with multiple antennas is a leading edge technology for reliable and faster data rate communication. The AWG5000 Series generates up to four analog channels (eight channels via two instruments) to simultaneously generate MIMO signals. The series can generate two pairs of IQ signals (four pairs with two instruments) as an IQ generator, and four pairs of IF signals (eight pairs with two instruments) as an IF generator. With the two channels models, ch 1 and ch 2 digital data output is available as an option.



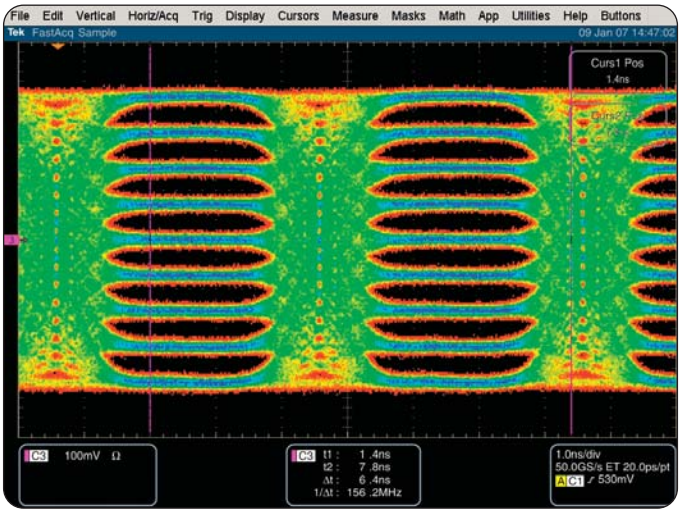
► Typical Signal Injection.



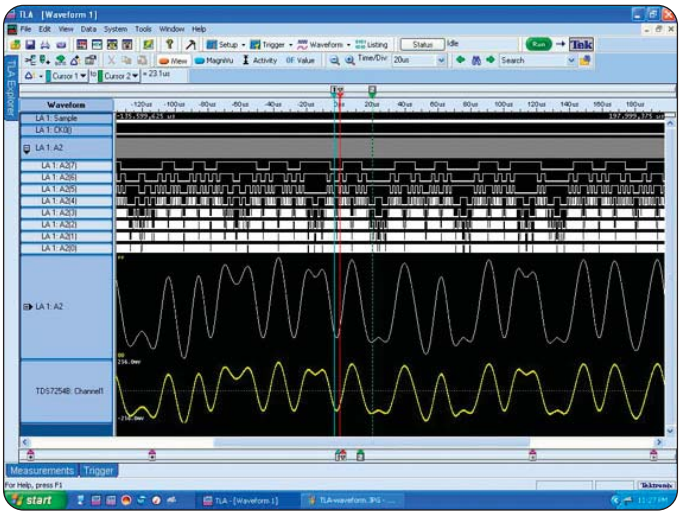
► EVM/Constellation measurement.



► RTSA Spectrum view.



► 9-PAM with 250 Mbps.



► Mixed signal test by TDS/TLA iView.™

Spurious Performance

The 14 bit vertical resolution and sophisticated design of the AWG5000 Series provides ample signal dynamic range and purity. The SFDR performance is 80 dBc for 1 MHz signal and 64 dBc for 10 MHz signal.

Multi-Level Logic Signal

One technique to increase the data rate without increasing the transition rate is applying multi-level signals, wherein a signal can assume more than the standard binary two levels. In multi-level signaling, one can think of multi-level discrete amplitudes of a signal. This phenomenon is known as pulse amplitude-modulation or PAM. A 9PAM signal, a signal with nine different amplitudes, increases the data rate by four without increasing the transition rate of the signal.

The AWG5000 Series enables you to test your latest design by generating any kind of mixed or multi-level signal.

Mixed Signal Generation

AWG5012 and AWG5002 models can generate two analog signals with four-digital marker outputs, supporting 28 digital outputs (ch 1 and ch 2 data) as an option. They deliver a mixed analog and digital signal generator and the most versatile solution for a broad range of applications, including consumer electronics such as ADC/DAC converter and imaging or display devices.

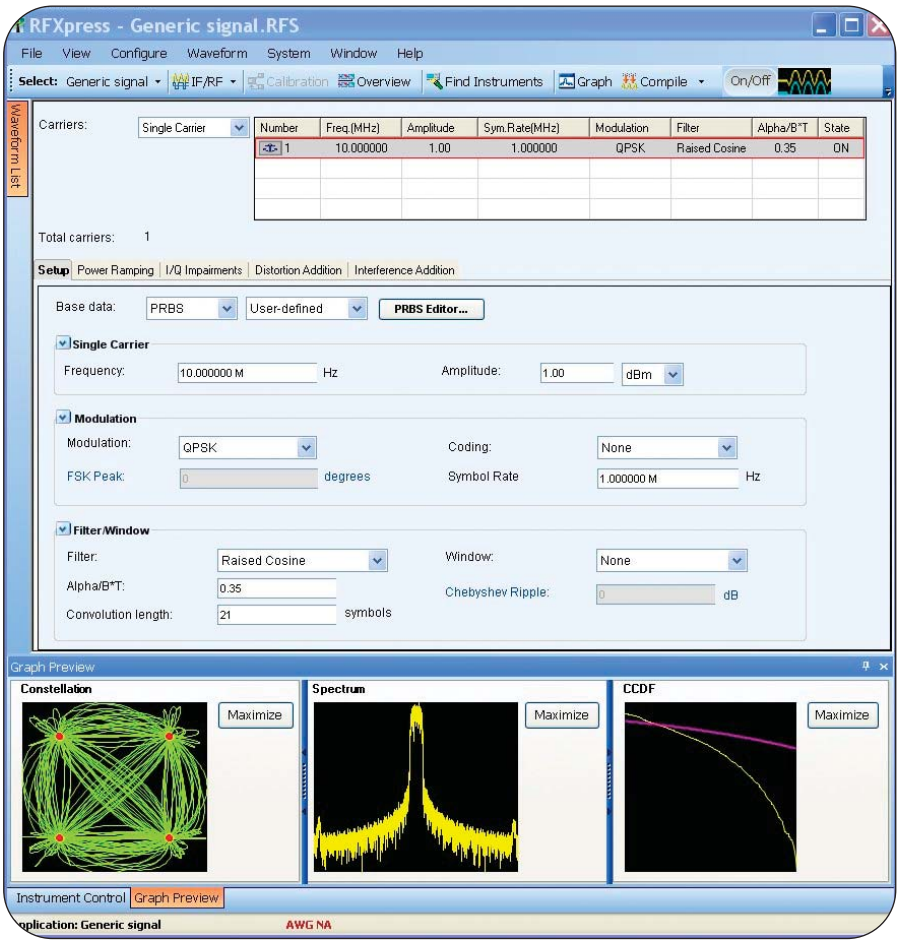
Additional Software Application Tools to Extend Waveform Generation

RFXpress (RFX100)

RFXpress is a software package that synthesizes digitally modulated base band IQ and IF signals. It takes IQ and IF signal generation to the next level and fully exploits the wideband signal generation capabilities of Arbitrary Waveform Generators (AWGs). Supporting a wide range of modulations, as well as the symbol map functions, the software allows you to define your own modulation.

RFXpress is a powerful easy-to-use software package to synthesize IQ and IF signals for arbitrary waveform generators (AWG). It runs as an integral part of the AWG5000 series arbitrary waveform generators or from an external PC.

For more details on RFXpress visit www.tek.com.



► Characteristics

	AWG5014	AWG5012	AWG5004	AWG5002
Arbitrary Waveforms				
Waveform Length	1 to 16,200,000 points (or 1 to 32,400,000 points, option 01)			
Number of Waveforms	1 to 16,000			
Sequence Length	1 to 4,000 steps			
Sequence Repeat Counter	1 to 65,536 or infinite			
Sequence Control	Repeat count, Trigger, Go-to-N and Jump			
Jump Mode	Synchronous and Asynchronous			
Run Modes				
Continuous	Waveform is iteratively output. If a sequence is defined, the sequence order and repeat functions are applied			
Triggered	Waveform is output only once when an external, internal, GPIB, LAN or manual trigger is received			
Gated	Waveform begins output when gate is true and resets to beginning when false			
Sequence	Waveform is output as defined by the sequence			
Clock Generator				
Sampling Frequency	10 MS/s to 1.2 GS/s		10 MS/s to 600 MS/s	
Resolution	8 digits			
Internal Clock				
Accuracy	Within ± (1 ppm + Aging), Aging: within ± 1 ppm/year			
Clock Phase Noise	Less than –90 dBc/Hz at 100 kHz offset			
Internal Trigger Generator				
Internal Trigger Rate				
Range	1.0 µs to 10.0 s			
Resolution	3 digits, 0.1 µs minimum			
Skew Control Between Outputs				
Range	– 5 ns to + 5 ns			
Resolution	5 ps			

	AWG5014	AWG5012	AWG5004	AWG5002
Main Arbitrary Waveform Output				
Resolution	14 bits			
Analog Output (in to 50 Ω) (Twice for Hi_Z input)				
Number of Arb Outputs	4	2	4	2
Output Style	Differential			
Output Impedance	50 Ω			
Connector	BNC Front			
Amplitude				
Output Voltage	Normal: –4.5 V to + 4.5 V, Direct –0.3 V to +0.3 V			
Amplitude	Normal: 20 mV_{p-p} to 4.5 V_{p-p}, Direct; 20 mV_{p-p} to 0.6 V_{p-p}			
Resolution	1 mV			
DC Accuracy	±(2.0% of Amplitude + 2 mV) at offset = 0 V			
Offset (into 50 Ω)				
Range	Normal: –2.25 V to +2.25 V, Direct: N/A			
Resolution	1 mV			
Accuracy	±(2% of offset +10 mV at minimum amplitude			
Pulse Response				
Rise/Fall time: (10% to 90%).	Normal: 1.4 ns (2.0 V_{p-p}), Direct: 0.95 ns (0.6 V_{p-p})			
Bandwidth (–3dB)	Normal: 250 MHz (2.0 V_{p-p}), Direct: 370 MHz (0.6 V_{p-p})			
Ringing	Normal: 750 mV_{p-p} (4.5 V_{p-p} filter through), 80 mV_{p-p} (2.0 V_{p-p} filter through), Direct: 60 mV_{p-p} (0.6 V_{p-p})			
Low Pass Filter	High range: 100 MHz, 20 MHz, Low range: through, 100 MHz, 20 MHz, Direct: N/A			
Delay from Marker	Normal: 17.5 ns to 19.4 ns (20 MHz filter), 3.8 ns to 5.7 ns (100 MHz filter), 0 to 1.9 ns (Through), Direct: –1.5 ns to 0.4 ns			
Sine Wave Characteristics	(1.2 GS/s clock, 32 waveform points, 37.5 MHz signal frequency) (600 MS/s clock, 32 waveform points, 18.75 MHz signal frequency)			
Harmonics	Normal: ≤–40 dBc (2.0 V_{p-p}), Direct ≤=–49 dBc (0.6 V_{p-p}) Normal: ≤–46 dBc (2.0 V_{p-p}), Direct ≤=–55 dBc (0.6 V_{p-p})			
Non Harmonics	Normal: ≤–60 dBc (2.0 V_{p-p}, DC to 600 MHz) Normal: ≤–60 dBc (2.0 V_{p-p}, DC to 300 MHz)			
Phase noise	≤ –85 dBc/Hz (2.0 V_{p-p}, 10 kHz offset) –85 dBc/Hz (2.0 V_{p-p}, 10 kHz offset)			
SFDR	50 dBc (Normal, 37.5 MHz, 1.2 GS/s, 2.0 V_{p-p}) 60 dBc (Normal, 10 MHz, 600 MS/s, 1.0 V_{p-p}) 80 dBc (Normal, 1 MHz, 600 MS/s, 1.0 V_{p-p}) 64 dBc (Direct, 10 MHz, 600 MS/s, 0.6 V_{p-p}) 80 dBc (Direct, 1 MHz, 600 MS/s, 0.6 V_{p-p})		56 dBc (Normal, 18.75 MHz, 600 MS/s, 2.0 V_{p-p}) 60 dBc (Normal, 10 MHz, 600 MS/s, 1.0 V_{p-p}) 80 dBc (Normal, 1 MHz, 600 MS/s, 1.0 V_{p-p}) 64 dBc (Direct, 10 MHz, 600 MS/s, 0.6 V_{p-p}) 80 dBc (Direct, 1 MHz, 600 MS/s, 0.6 V_{p-p})	

	AWG5014	AWG5012	AWG5004	AWG5002
Auxiliary Outputs				
Marker Output				
Number of Outputs	8 (2 per ch)	4 (2 per ch)	8 (2 per ch)	4 (2 per ch)
Output Style	Single-ended			
Output Impedance	50 Ω			
Connector	BNC Front			
Level (into 50 Ω) (Twice for Hi_Z input)				
Output Windows	–1.00 V to + 2.7 V			
Amplitude	0.10 V_{p-p} to 3.7 V_{p-p}			
Resolution	10 mV			
DC Accuracy	±(10% of setting +120 mV)			
Maximum Output Current	± 54 mA /ch			
Rise/Fall Time (20% to 80%)	300 ps (1.0 V_{p-p}, Hi +1.0 V, Lo 0 V)			
Skew Adjust Between Markers				
Range	0 to 1000 ps			
Resolution	50 ps			
Random Jitter (Typical)	1010 clock pattern			
RMS	5 ps_{rms}			
Total Jitter (Typical)	$2^{\wedge 15-1}$ PN data pattern			
Peak to Peak (p-p)	80 ps_{p-p}			
Clock (VCO) Out				
Range	600 MHz to 1.2 GHz			
Amplitude	0.4 V_{p-p} into 50 Ω to GND			
Impedance:	50 Ω, AC coupling			
Connector	BNC Rear			
10 MHz Reference Out				
Amplitude	1.2 V_{p-p} into 50 Ω. Max 2.5 V_{p-p} open			
Impedance	50 Ω, AC coupling			
Connector	BNC Rear			
DC Outputs				
Number of Outputs	4: independently controlled outputs			
Range	–3.0 to +5.0 V			
Resolution	10 mV			
Max. Current	*± 100 mA*			
Connector	2x4 pin header on front panel			
Digital Data Output (Option 03)				
Number of Output	NA	14 bits output on channel 1 and channel 2 (28 total)	NA	14 bits output on channel 1 and channel 2 (28 total)
Output Style		Single-ended		Single-ended
Output Impedance		50 Ω		50 Ω
Connector		SMB rear		SMB rear
Level (into 50 Ω) (Twice for Hi_Z input)				
Output Windows		–1.00 V to + 2.7 V		–1.00 V to + 2.7 V
Amplitude		0.10 V_{p-p} to 3.7 V_{p-p}		0.10 V_{p-p} to 3.7 V_{p-p}
Resolution		10 mV		10 mV
DC Accuracy		± (10% of setting +120 mV)		± (10% of setting +120 mV)
Maximum Output current		± 54 mA /ch		± 54 mA /ch
Rise/Fall Time (20% to 80%)		300 ps (1.0 V_{p-p}, Hi +1.0 V, Lo 0 V)		300 ps (1.0 V_{p-p}, Hi +1.0 V, Lo 0 V)

Auxiliary Inputs

Trigger In		
Impedance	1 kΩ or 50 Ω	
Polarity	POS or NEG	
Connector	BNC Front	
Input Voltage Range	1 kΩ: ±10 V. 50 Ω: ±5 V	
Threshold		
Level	–5.0 V to 5.0 V	
Resolution	0.1 V	
Trigger Jitter	2.0 ns to 4.5 ns (Typical)	
Trigger Mode		
Minimum Pulse Width	20 ns	
Trigger Hold-off	832* sampling_period – 100 ns	
Delay to Analog Out	128* sampling_period + 250 ns	
Gate Mode		
Minimum Pulse Width	1024* sampling_period + 10 ns	
Delay to Analog Out	640* sampling_period + 260 ns	
Event Input		
Impedance	1 kΩ or 50 Ω	
Polarity	POS or NEG	
Connector	BNC Front	
Input Voltage Range	1 kΩ: ±10 V. 50 Ω: ±5 V	
Threshold	–5.0 V to 5.0 V	
Resolution	0.1 V	
Sequence Mode Mode		
Minimum Pulse Width	20 ns	
Event Hold Off	1024* Sampling Period + 10 ns	
Delay to Analog Out	640* Sampling Period + 280 ns (Jump timing: Asynchronous jump)	
External Clock IN		
Input Voltage Range	0.2 V_{p-p} to 0.8 V_{p-p}	
Impedance	50 Ω, AC coupled	
Frequency Range	600 MHz to 1.2 GHz	
Clock Divider	1/1, 1/2, 1/4…1/32	1/2, 1/4…1/32
Connector	BNC Rear	
Reference Clock IN		
Input Voltage Range	0.2 V_{p-p} to 3.0 V_{p-p}	
Impedance	50 Ω, AC coupled	
Frequency Range	10 MHz, 20 MHz, 100 MHz (with ±0.1%)	
Connector	BNC Rear	
Phase Lock IN		
Input Ranges	5 MHz to 600 MHz (acceptable frequency drift is ±0. 5%)	
Input Voltage Range	0.2 V_{p-p} to 3 V_{p-p}	
Impedance	50 Ω, AC coupled	
Multiple Rate	1 to 240	1 to 120
Connector	BNC Rear	
Add IN	For each analog channel	
Impedance	50 Ω, DC coupled	
DC Gain	1	
Bandwidth	DC to 100 MHz at –3 dB	
Input Voltage Range	± 1.0 V	
Connector	BNC Rear	

AWG5000 Series Common Features

Waveform File Import Capability	Tektronix TDS5000/6000/7000, DPO4000/7000/70000, DSA70000 (*.wfm). TDS3000 (*.wfm) AWG400s/500s/610/615/710/710B (*.wfm, *.pat, *.seq), DTG5000s (*.DAT) Text data file (Third party software creation waveform data: MATLAB, MathCad, Excel)
S/W driver for 3rd party S/W	IVI-com driver and MATLAB library
Instrument Control/Data Transfer Ports	
GPIB	Remote control and data transfer. (Conforms to IEEE-Std 488.1, compatible with IEEE 488.2 and SCPI-1999.0)
Ethernet (10/100/1000Base-T)	Remote control and data transfer. (Conforms to IEEE 802.3). RJ-45
Computer System & Peripherals	Windows XP Professional, 512 MB SDRAM, 80 GB removable Hard Drive at rear (available front mount kit), CD-RW/DVD drive at front, included USB compact keyboard and mouse
PC I/O Ports	USB 2.0 compliant ports (6 total, 2 front, 4 rear), PS/2 mouse and keyboard connectors (rear panel), RJ-45 Ethernet connector (rear panel) supports 10/100/1000BASE-T, XGA out
Display Characteristics	10.4 inch, LCD color display with touch screen, 1024 (H)x768 (V) (XGA)
Power Supply	100 to 240 VAC, 47 to 63 Hz
Power Consumption	450 W
Safety	UL61010-1, CAN/CSA-22.2, No.61010-1-04, EN61010-1, IEC61010-1
Emissions	EN 55011 (Class A), IEC61000-3-2, IEC61000-3-3
Immunity	IEC61326, IEC61000-4-2/3/4/5/6/8/11
Regional Certifications	
Europe	EN61326
Australia/New Zealand	AS/NZS 2064

Physical Characteristics

	mm/kg	lbs/in.
Dimension	**mm**	**in.**
Height	245	9.6
Width	465	18.0
Length	500	19.7
Weight (approx.)	**kg**	**lbs.**
Net19.5		43.0
Net with Package	28.5	62.8
Mechanical Cooling		
Required Clearance		
Top and Bottom	2 cm	0.8 inch
Side	15 cm	6 inch
Rear	7.5 cm	3 inch

Environmental

	Operating	Non-operating
Temperature	+10º C to +40º C	–20º C to +60º C
Humidity	5% to 80% relative humidity (% RH) at up to +30º C, 5% to 45% RH above +30º C up to +50º C	5% to 90% RH (Relative Humidity) at up to +30º C, 5% to 45% RH above +30º C up to +50º C
Altitude	Up to 3,048 meters (10,000 feet)	Up to 12,192 meters (40,000 feet)
Random Vibration	0.27 G_{RMS}, 5 to 500 Hz, 10 minutes per axis	2.28 G_{RMS}, 5 to 500 Hz, 10 minutes per axis
Sine Vibration	0.33 mm_{p-p} (0.013 $inch_{p-p}$) constant displacement, 5 to 55 Hz	NA
Mechanical shock	Half-sine mechanical shocks, 30 g peak amplitude, 11 msec duration, 3 drops in each direction of each axis	NA

► Ordering Information

Arbitrary Waveform Generator Mainframe

AWG5014

1.2 GS/s, 4-channel, 14bits, 16 M point/channel Arbitrary Waveform Generator.

AWG5012

1.2 GS/s, 2-channel, 14bits, 16 M point/channel Arbitrary Waveform Generator.

AWG5004

600 MS/s, 4-channel, 14bits, 16 M point/channel Arbitrary Waveform Generator.

AWG5002

600 MS/s, 2-channel, 14bits, 16 M point/channel Arbitrary Waveform Generator.

All Models Include: Accessory pouch, front cover, USB mouse, compact USB key board, lead set for DC output, stylus for touch screen 2 each, Windows® XP operating system restore DVD and instructions, AWG5000 Series product software CD and instructions, Document CD with Browser, Quick Start User Manual, registration card, Certificate of Calibration, power cable.

Note: Please specify power cord and language option when ordering.

Instrument Options

AWG5014/AWG5012, AWG5004/AWG5002

Opt. 01 – Waveform Length Expansion (from 16 M to 32 M).

AWG5012/AWG5002

Opt. 03 – 28 bits digital data outputs (digital data of ch 1 and ch 2).

Common Options

International Power Plugs

Opt. A0 – North America power.
Opt. A1 – Universal EURO power.
Opt. A2 – United Kingdom power.
Opt. A3 – Australia power.
Opt. A5 – Switzerland power.
Opt. A6 – Japan power.
Opt. A10 – China power.
Opt. A99 – No power cord or AC adapter.

Language Options

Opt. L0 – English.
Opt. L5 – Japanese.
Opt. L7 – Simplified Chinese.
Opt. L8 – Traditional Chinese.

Service

Opt. CA1 – A single calibration event.
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 option C3).
Opt. D5 – Calibration data report 5 years (with option C5).
Opt. R3 – Repair service 3 years.
Opt. R5 – Repair service 5 years.
Post-sales Service Options: (e.g., AWG5012-CA1).
CA1 – A single calibration event.
R3DW – Repair service coverage 3 years.
R5DW – Repair service coverage 5 years.
R2PW – Repair service coverage 2 years post warranty.
R1PW – Repair service coverage 1 year post warranty.

Product Upgrade AWG5014, AWG50UP

Opt. M14 – Waveform Length Expansion from 16 M point to 32 M point.

Product Upgrade AWG5012, AWG50UP

Opt. M12 – Waveform Length Expansion from 16 M point to 32 M point.
Opt. D13 – Digital Data Outputs.

Product Upgrade AWG5004, AWG50UP

Opt. M04 – Waveform Length Expansion from 16 M point to 32 M point.

Product Upgrade AWG5002, AWG50UP

Opt. M02 – Waveform Length Expansion from 16 M point to 32 M point.
Opt. D03 – Digital Data Outputs.

Recommended Accessories

Item	Description	Parts Number
Transition Time Converter	150 ps (10% to 90%)	015-0710-00
	250 ps (10% to 90%)	015-0711-00
	500 ps (10% to 90%)	015-0712-00
	1000 ps (10% to 90%)	015-0713-00
	2000 ps (10% to 90%)	015-0714-00
Pin Header		
SMA Cable	102 cm (40 inch)	012-1690-00
SMB Cable	51 cm (20 inch)	012-1503-00
Rack Mount kit	Rack Mount Kit with instruction	016-1983-00
Front Removable HDD Bay	Front removable HDD kit	016-1979-01
Replacement Hard Disk	SATA disk assembly (no software installation)	065-0753-00
Documentation		
Quick Start User Manual	English	071-2078-00
	Japanese	071-2079-00
	Simplified Chinese	071-2080-00
	Traditional Chinese	071-2081-00
Service Manual	English	071-2083-00

Warranty

One-year parts and labor.

Arbitrary Waveform Generator

► AWG5000 Series (AWG5014 • AWG5012 • AWG5004 • AWG5002)

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For Further Information

Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

Product(s) are manufactured in ISO registered facilities.

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

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