Tektronix®

Arbitrary Waveform Generators

AWG4000 Series Datasheet

The unmatched performance, versatile functionality, outstanding usability, and upgradability make the AWG4000 an affordable waveform generation platform which helps stretch the specifications of your designs to the limit.

Key performance specifications

- Basic (DDS) mode
  - Two analog channels
  - 600 MHz sine waveforms
  - 2.5 GS/s, 14-bit, 16 kpts arbitrary waveforms
  - Amplitude up to 5 V_{p-p} into 50 Ω load
- Advanced (Arbitrary) mode
  - Two analog channels
  - 16/32-bit digital channels (optional)
  - 1/16/32/64 Mpts per channel arbitrary waveform memory (optional)
  - Up to 750 MHz bandwidth
  - SFDR < -60 dBc

Features & benefits

- Variable sampling rate range from 100 S/s to 2.5 GS/s, with 14-bit vertical resolution, ensures signal integrity in all aspects
- Designed for 100% user-conducted upgrades and configurations, all options activated through SW key
  - Optional and upgradable arbitrary waveform memory up to 64 Mpts for each analog channel and 32 Mbit for each digital channel for long waveforms
  - Optional 16-32 channel digital outputs. Purchasing SW option includes the shipment of digital probe accessory.
- Two operation modes – Basic (DDS AFG mode) and advanced (arbitrary AWG mode), which provide excellent balance between usability and flexibility
- Dual analog channels and up to 32-bit digital channels, ideal for mixed signal circuit designs
- Sync-in and Sync-out interfaces enables the synchronization of multiple units in a daisy chain, to extend the number of output channels
- Digital outputs provide up to 1.25 Gb/s data rate creates high speed digital pattern in parallel
- One marker output for each analog channel for triggering and synchronization
- Three software-configurable output paths fit all test cases
  - Direct DAC mode: 750 MHz bandwidth with differential output
  - AC coupled mode: 750 MHz bandwidth with single ended output for RF applications
  - Amplified mode: 5 V_{p-p} amplitude 400 MHz bandwidth with differential output
- Full functional sequence with up to 16384 user defined waveforms provides the possibility of generating complex signals with the best memory usage, in the form of loops, jumps, and conditional branches
- Channel 1 and 2 (together with the corresponding digital output channels) can work independently on different sampling clocks and sequences
- Direct communication with RFXpress® for easy waveform generation in RF applications
- Windows based platform with 10.1-in touch screen, front panel buttons, keyboard, and mouse
- Compact form factor, convenient for bench top and portability
- Removable hard disk guarantees the security of confidential data
- USB 3.0 and LAN interfaces for remote control

Applications

- Baseband and Intermediate Frequency modulation for wireless communications and defense electronics
- Component and circuit characterization and validation
- Embedded circuit design and test
- Mixed-signal circuit design and test
- Clock and system synchronization
- Replication of real world signals

- Research
- General purpose signal generation

Dual operation mode

The AWG4000 is the industry's first convergent waveform generator with full function AFG (Basic) and AWG (Advanced) 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. The large touch screen displays all related parameters at one glance, and enables you directly click where you want to change. The DDS based technology enables users to switch from one frequency to another by rotating knob or button clicks, without concerning the sampling rate and waveform length

In Advanced mode, users can define complex waveforms with up to 16,384 entries of analog waveforms and digital patterns in a sequence, in terms of loops, jumps, and conditional branches.

In the Multi-sequence mode, two sequences can be defined to control Channel 1 and Channel 2 (and the corresponding digital channels) separately as two units of generator.

Best in class performance in its price range

The AWG4000 gives users access to the best-in-class DAC technology at an affordable price. Up-to 2.5 GS/s sampling rate and 14-bit vertical resolution help users generate ultra wideband communication signals with 750 MHz modulation bandwidth and the < -60 dBc SFDR across each channel. The analog channels can be configured to output differential, single ended, or AC coupled, eliminating the needs of baluns or hybrids in the test path.

Mixed-signal generation

The AWG4000 has optional 16/32-bit digital outputs, synchronized with the corresponding analog channels in two 16-bit groups. Each group can be configured as 8-bit full speed (bit rate at half the sampling rate) or 16-bit low speed (bit rate at 1/4 of the sampling rate). The mixed signal generation is a great solution for digital designs and validation, system synchronization and DAC/ADC tests.

Upgradability protects ROI

The standard configuration of AWG4000 is 1 Mpts for each analog channel and no digital channels. This helps to reduce the ownership threshold of accessing to the product. However, when the test requirement increases, a customer can purchase the option keys to upgrade the memory to 16 Mpts, 32 Mpts or 64 Mpts, or to upgrade the digital channel to 16-bit or 32-bit. It eliminates the need of concerning the risk of lowering ROI in the whole life time.

System extension with multi-unit synchronization

Two or more AWG4000s can be synchronized by connecting the Sync-in and Sync-out interfaces of the master and the slaves. In this way, all units will share the same sampling clock, reference clock, and triggering events. This helps customers expand the number of output channels, which is extremely useful in the applications where multiple channels are needed, like MIMO.

Intuitive user interface

The AWG4000 is built on the Windows platform. The 10.1-in touch screen displays parameters, settings, and on-screen menus/buttons. Together with the similar-to-traditional front panel buttons and rotary knobs, the user friendly user interface provides intuitive ways to operate the instrument easily in the Basic mode. However, if a user works in the Advanced mode to create complex sequenced waveforms, an external keyboard and mouse can be connected to the instrument through the USB interface. This helps the user operate in a normal Windows application.

Easy waveform creation

In the Basic mode, a plug-in called ArbBuilder is embedded in the application. Users can create customized waveforms from standard waveforms, with the equation editor, free hand, point draw tools, or simply import the tfw files generated by ArbExpress®, and then transfer to either channels for replication.

In Advanced mode, RFXpress® can communicate with the application directly and download the waveforms generated by the software running on the instrument or an external PC. Users can also import waveforms captured by Tektronix oscilloscopes, logic analyzers, or created by 3rd party software like Matlab®, FPGA simulation tools.

Specifications

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

Definitions

Specifications (not noted)	Product characteristics described in terms of specified performance with tolerance limits which are warranted/guaranteed to the customer. Specifications are checked in the manufacturing process and in the Performance Verification section of the product manual with a direct measurement of the parameter.
Typical (noted)	Product characteristics described in terms of typical performance, but not guaranteed performance. The values given are never warranted, but most units will perform to the level indicated. Typical characteristics are not tested in the manufacturing process or the Performance Verification section of the product manual.
Nominal (not noted)	Product characteristics described in terms of being guaranteed by design. Nominal characteristics are non-warranted, so they are not checked in the manufacturing process or the Performance Verification section of the product manual.

Model overview

	AWG4162
Analog channels	2
Digital channels	0/16/32-bit optional
Markers	2

Operation modes

Basic	DDS mode
Standard waveforms	Sine, Square, Pulse, Ramp, more (Noise, DC, Sin(x)/x, Gaussian, Lorentz, Exponential Rise, Exponential Decay, Haversine)
Run modes	Continuous, modulation, sweep, burst
Arbitrary waveforms	Sampling clock: 2.5 GS/s, fixed
	Vertical resolution: 14-bit
	Waveform length: 16,384 points
Advanced	AWG mode
Run modes	Continuous, sequencer, triggered, gated
Sampling clock	100 S/s to 2.5 GS/s, variable
Vertical resolution	14-bit
Waveform length	64 to 64 M points (1 M = 2^{20}) in multiple of 64 points for length < 320 points, in multiple of 16 points for length ≥ 320 points
	Standard: 1 M points
	Optional: 16 M, 32 M, 64 M points

Operation modes

Sequence length	1 to 16,384 entries
Sequence control	Repeat Waveform, Wait for Multiple Triggers (up to 7 triggers), Wait for Multiple Events (up to 7 events), Jump if Event (up to 7 events, synchronous or asynchronous), Jump to (synchronous or asynchronous)
Repeat count	1 to 2,097,151 or infinite
Jump timing	Synchronous or asynchronous
Digital waveform	Standard: 0-bit
	Optional: 16 or 32-bit
Built-in standard waveforms	DC, Sine, Cosine, Triangle, Rectangle, Sawtooth, Increase-ramp, Decrease-ramp, Pulse, Sinc, Exponential, Sweep
Arbitrary waveforms	Formula, file, user defined
Additional	Noise, filter can be applied to the waveforms above

General characteristics - Basic mode

Connectors	SMAs for DC AMP on front panel
Output types	Single-ended or differential [1]
Output impedance	50 Ω (Single-ended) or 100 Ω (differential)
Frequency range	
Sine	1 µHz to 600 MHz
Square	1 µHz to 330 MHz
Pulse	1 µHz to 330 MHz
Ramp, Exponential Rise, Exponential Decay	1 µHz to 30 MHz
Sin(x)/X, Gausian, Lorentz, Haversine	1 µHz to 60 MHz
Arbitrary	1 µHz to 400 MHz
Frequency resolution	
sine, square, pulse, arbitrary	1 µHz or 15 digits
Ramp, Sin(x)/X, Gausian, Lorentz, Exponential Rise, Exponential Decay, Haversine	1 µHz or 14 digits
Frequency accuracy	
non-ARB	$\pm 10^{-6}$ of setting
ARB	$\pm 10^{-6}$ of setting ±1 µHz
Sine waves	
Flatness (1 V_{p-p}, relative to 1 kHz)	DC to 600 MHz : ±0.5 dB
Harmonic Distortion (1 V_{p-p})	1 µHz to ≤ 10 MHz: < -60 dBc
	> 10 MHz to ≤ 50 MHz: < -55 dBc
	> 50 MHz to ≤ 200 MHz: < -40 dBc
	> 200 MHz to ≤ 600 MHz: < -28 dBc
Total Harmonic Distortion (1 V_{p-p}, typical)	10 Hz to 20 kHz: < 0.1%

1 When using single-ended, terminate the other end with a 50 Ω SMA terminator.

General characteristics - Basic mode

Spurious (1 V_{p-p})	1 µHz to ≤ 10 MHz: < -65 dBc
	>10 MHz to ≤ 330 MHz: < -55 dBc
	> 330 MHz to ≤ 500 MHz: < -50 dBc
	> 500 MHz to ≤ 600 MHz: < -40 dBc
Phase Noise (1 V_{p-p}, 10 kHz offset, typical)	1 MHZ: < -115 dBc/Hz
	10 MHZ: < -110 dBc/Hz
	100 MHZ: < -105 dBc/Hz
	600 MHZ: < -90 dBc/Hz

Square waves

Rise/fall time (typical)	1 ns
Overshoot (1 V_{p-p}, typical)	< 2%
Jitter (rms, typical)	50 ps

Pulse waves

Pulse width	1 ns to (Period - 1 ns)
Resolution	10 ps or 15 digits
Pulse duty	0.1% to 99.9% (limitations of pulse width apply)
Leading/trailing edge transition time	800 ps to 1000 s
Resolution	1 ps or 15 digits
Overshoot (1 V_{p-p}, typical)	< 2%
Jitter (rms, typical)	50 ps

Ramp waves

Linearity (< 10 kHz, 1 V_{p-p}, 100% Symmetry, typical)	≤ 0.1%
Symmetry	0% to 100%

Other waves

Noise bandwidth (-3 dB, typical)	400 MHz
Noise add	When activated, output signal amplitude is reduced to 50%
Level	0.0% to 50% of amplitude (V_{p-p}) setting
Resolution	0.1%

Arbitrary

Number of samples	2 to 16,384
Analog bandwidth (-3 dB, typical)	400 MHz
Rise/fall time (typical)	≤ 800 ps
Jitter (rms, typical)	400 ps

DC

Range (50 Ω, single-ended)	-2.5 V to 2.5 V
Accuracy	±(1% of |setting| + 5 mV)

General characteristics - Basic mode

Amplitude

Range (50 Ω, single-ended)	1 µHz ~ 350 MHz: 5 mV_{p-p} to 5 V_{p-p}
	350 MHz ~ 550 MHz: 5 mV_{p-p} to 3 V_{p-p}
	550 MHz ~ 600 MHz: 5 mV_{p-p} to 2 V_{p-p}
Range (100 Ω, differential)	1 µHz ~ 350 MHz: 10 mV_{p-p} to 10 V_{p-p}
	350 MHz ~ 550 MHz: 10 mV_{p-p} to 6 V_{p-p}
	550 MHz ~ 600 MHz: 10 mV_{p-p} to 4 V_{p-p}
Accuracy (1 kHz sine wave, 0 V offset, > 5 mV_{p-p} amplitude, 50 Ω load)	±(1% of setting + 5 mV)
Resolution	1 mV_{p-p} or 4 digits
Units	V_{p-p}, V_{rms}, dBm (sine wave only), Volt (high/low settings)
Output impedance	Single-ended: 50 Ω
	Differential: 100 Ω
Isolation	No isolation, all SMA and BNC connectors are connected to earth ground directly

Vocm

Range (50 Ω load, single-ended)	-2.5 V to +2.5 V
Range (High Z load, single-ended)	-5 V to +5 V
Accuracy (50 Ω load, single-ended)	±(1% of |setting| ±5 mV)
Resolution	1 mV or 4 digits

Offset

Range (50 Ω load, single-ended)	±(2.5 Vpk - Amplitude ÷ 2)
Range (High Z load, single-ended)	±(5 Vpk - Amplitude ÷ 2)
Accuracy (50 Ω load, single-ended)	±(1% of |setting| + 5 mV)
Resolution	1 mV or 4 digits

Window

Range (50 Ω, single-ended)	1 µHz ~ 350 MHz: -5 V to +5 V
	350 MHz ~ 550 MHz: -4 V to +4 V
	550 MHz ~ 600 MHz: -3.5 V to +3.5 V
Range (100 Ω, differential)	1 µHz ~ 350 MHz: -10 V to +10 V
	350 MHz ~ 550 MHz: -8 V to +8 V
	550 MHz ~ 600 MHz: -7 V to +7 V
Range (High Z, single-ended)	1 µHz ~ 350 MHz: -10 V to +10 V
	350 MHz ~ 550 MHz: -8 V to +8 V
	550 MHz ~ 600 MHz: -7 V to +7 V

Phase

Range	0º to +360º
Accuracy (typical)	±(0.1% of setting ±0.01°)

General characteristics - Basic mode

Amplitude Modulation (AM)

Carrier waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency	Internal: 500 µHz to 50 MHz External: 10 MHz maximum
Depth	0.00% to 120.00%

Frequency Modulation (FM)

Carrier waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency	Internal: 500 µHz to 50 MHz External: 10 MHz maximum
Peak deviation	DC to 300 MHz

Phase Modulation (PM)

Carrier waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency	Internal: 500 µHz to 50 MHz External: 10 MHz maximum
Phase deviation range	0º to 180º

Frequency Shift Keying (FSK)

Carrier waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Square
Key rate	Internal: 500 µHz to 50 MHz External: 10 MHz maximum
Hop frequency	1 µHz to 600 MHz
Number of keys	2

Phase Shift Keying (PSK)

Carrier waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Modulation source	Internal or external
Internal modulating waveforms	Square
Key rate	Internal: 500 µHz to 50 MHz External: 10 MHz maximum
Hop phase	-180° to +180°
Number of keys	2

General characteristics - Basic mode

Pulse Width Modulation (PWM)

Carrier waveforms	Pulse
Modulation source	Internal or external
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency	Internal: 500 µHz to 50 MHz
	External: 10 MHz maximum
Deviation range	0% to 50% of pulse period

Sweep

Type	Linear, Logarithmic, staircase, and user defined
Waveforms	Standard waveforms (except Pulse, DC and Noise), ARB
Sweep time	50 µs to 2000 s
Hold/return times	0 to (2000 s - 50 µs)
Sweep/hold/return time resolution	20 ns or 12 digits
Total sweep time accuracy (typical)	≤ 0.4%
Start/stop frequency range	Sine: 1 µHz to 600 MHz
	Square: 1 µHz to 300 MHz
Trigger source	Internal/External/Manual

Burst

Waveforms	Standard waveforms (except DC and Noise), ARB
Type	Trigger or gated
Burst count	1 to 1,000,000 cycles or Infinite
Internal trigger delay	0 to 100 s
Internal trigger delay accuracy (typical)	±(0.1% setting + 5 ps)
Internal trigger rate	0 to 500 s
Internal trigger interval range	1 µs to 500 s
Internal trigger resolution	2 ns or 12 digits

General characteristics - Advanced mode

Analog outputs

Connector types	SMAs for AMP, DAC, and AC modes on front panel
Output types	AMP and DAC modes: single-ended or differential [2]
	AC mode: single-ended
Output impedance	50 Ω, single-ended
	100 Ω, differential
Skew between positive and negative outputs (typical)	≤ 20 ps

Skew control	(Between analog channels)
Range	0 to 240,000 ps
Resolution	10 ps

2 When using single-ended, terminate the other end with a 50 Ω SMA terminator.

General characteristics - Advanced mode

Accuracy (typical)	±(10% of setting + 20 ps)
Initial skew	< 200 ps from 1.25 GS/s to 2.5 GS/s
	< 1 ns below 1.25 GS/s
Skew control	(Between analog channel and marker, analog channel to digital channels)
Range	0 to 101,790 ps
Resolution	78 ps
Accuracy (typical)	±(10% of setting + 140 ps)
Initial skew	< 1.4 ns from 1.25 GS/s to 2.5 GS/s
	< 2 ns from 100 MS/s to 1.25 GS/s
	< 4.5 ns below 100 MS/s
Calculated bandwidth (0.35 / rise or fall time, typical) [3]	
AMP	400 MHz
DAC	750 MHz
AC	750 MHz
Amplitude	Range (single-ended, 50 Ω load)
AMP	0 to 5 V_{p-p} (doubled in case of differential or High Z load)
DAC	0 to 0.8 V_{p-p} (doubled in case of differential or High Z load)
AC	0 to 2 V_{p-p} (doubled in case of High Z load)
Accuracy	
AMP, DAC (1 kHz sine, offset 0 V)	±(1% of setting + 5 mV_{p-p})
AC (100 MHz sine, offset 0 V, typical)	±(2% of setting + 5 mV_{p-p}) - 0.1% of |setting| x temperature deviation [4]
Resolution	
AMP, DAC, and AC	0.1 mV or 5 digits
Offset	Range (single-ended, 50 Ω load)
AMP	-2.5 V to +2.5 V (doubled in case of differential or High Z load)
DAC	-0.35 V to +0.35 V (doubled in case of differential or High Z load)
Accuracy	
AMP, DAC	±(1% of |setting| + 5 mV)
Resolution	
AMP, DAC	10 mV or 3 digits
Vocm	Range (single-ended, 50 Ω load)
AMP	-2.5 V to +2.5 V (doubled in case of differential or High Z load)
DAC	-0.35 V to +0.35 V (doubled in case of differential or High Z load)
Accuracy	
AMP	±(1% of setting + 5 mV)
DAC	±(6% of Vocm range + 5 mV)

3 Rise/fall time is 10% to 90% of transition time.

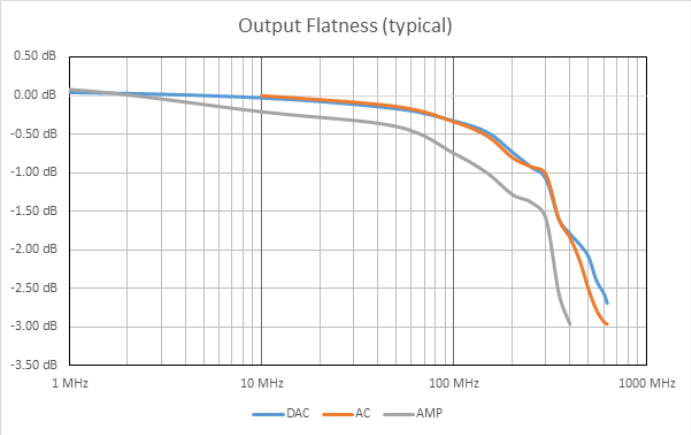
4 Temperature deviation = room temperature - 23 °C, when room temperature is out of the range of 20 °C - 30 °C.

General characteristics - Advanced mode

Resolution	
AMP, DAC	10 mV or 3 digits
Voltage window	Range (single-ended, 50 Ω load)
AMP	1 µHz to 300 MHz: -5 V to 5 V
	> 300 MHz to 550 MHz: -4 V to 4 V
	> 550 MHz to 600 MHz: -3.5 V to 3.5 V
	(doubled in case of differential or High Z load)
DAC	-0.4 V to 0.4 V
	(doubled in case of differential or High Z load)
AC	-1 V to 1 V
	(doubled in case of High Z load)
Harmonic distortion	(Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)
AMP (1 V_{p-p} single-ended)	< -56 dBc (single-ended or differential)
DAC (0.5 V_{p-p} single-ended)	< -60 dBc (single-ended or differential)
AC (1 V_{p-p} single-ended)	< -56 dBc
Spurious	(Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)
AMP (1 V_{p-p} single-ended)	< -62 dBc (single-ended or differential)
DAC (0.5 V_{p-p} single-ended)	< -62 dBc (single-ended or differential)
AC (1 V_{p-p} single-ended)	< -55 dBc
SFDR	(Sine wave 32 points at 2.5 GS/s, 78.125 MHz, typical)
AMP (1 V_{p-p} single-ended)	< -56 dBc (single-ended or differential)
DAC (0.5 V_{p-p} single-ended)	< -60 dBc (single-ended or differential)
AC (1 V_{p-p} single-ended)	< -55 dBc
Rise/fall time	(10% to 90%, typical)
AMP	800 ps
DAC	450 ps
AC	450 ps
Overshoot (typical)	
AMP	< 2%
DAC	< 1%
AC	< 2%

General characteristics - Advanced mode

Level flatness (typical)



AMP (1 V_{p-p} Sine wave, relative to 1 kHz)

1 µHz to ≤ 10 MHz: < ±0.5 dBc

> 10 MHz to ≤ 50 MHz: < ±1 dBc

> 50 MHz to ≤ 150 MHz: < ±1.5 dBc

> 150 MHz to ≤ 300 MHz: < ±2 dBc

> 300 MHz to ≤ 350 MHz: < ±3 dBc

> 350 MHz to ≤ 400 MHz: < ±3.5 dBc

DAC (1 V_{p-p} Sine wave, relative to 1 kHz)

1 µHz to ≤ 10 MHz: < ±0.5 dBc

> 10 MHz to ≤ 100 MHz: < ±1 dBc

> 100 MHz to ≤ 200 MHz: < ±1.5 dBc

> 200 MHz to ≤ 300 MHz: < ±2 dBc

> 300 MHz to ≤ 350 MHz: < ±2.5 dBc

> 350 MHz to ≤ 450 MHz: < ±3 dBc

> 450 MHz to ≤ 550 MHz: < ±3.5 dBc

> 550 MHz to ≤ 650 MHz: < ±4 dBc

> 650 MHz to ≤ 750 MHz: < ±4.5 dBc

AC (1 V_{p-p} Sine wave, relative to 10 MHz)

10 MHz to ≤ 50 MHz: < ±0.5dBc

> 50 MHz to ≤ 150 MHz: < ±1 dBc

> 150 MHz to ≤ 200 MHz: < ±1.5 dBc

> 200 MHz to ≤ 300 MHz: < ±2 dBc

> 300 MHz to ≤ 450 MHz: < ±3 dBc

> 450 MHz to ≤ 550 MHz: < ±3.5 dBc

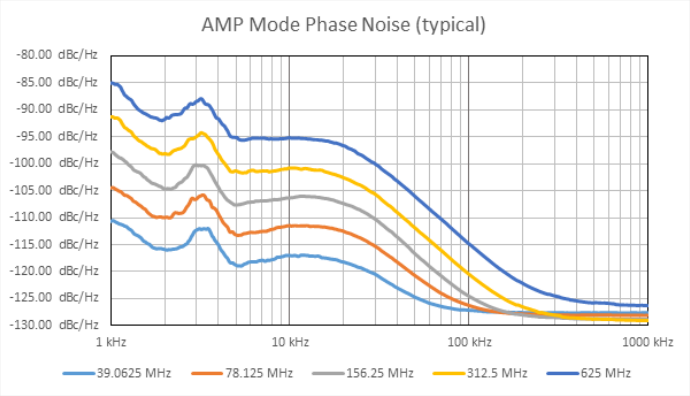
> 550 MHz to ≤ 650 MHz: < ±4.5 dBc

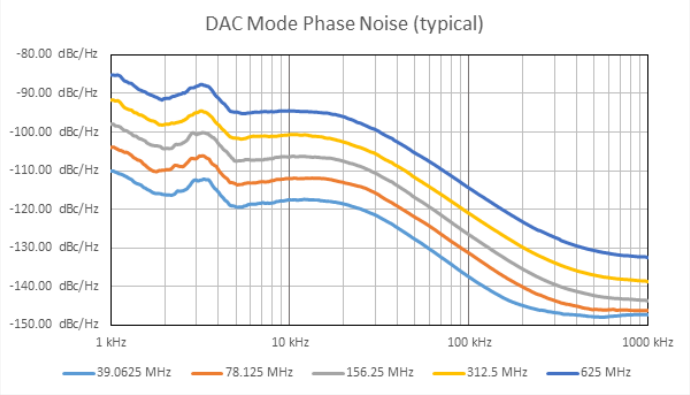
> 650 MHz to ≤ 750 MHz: < ±5 dBc

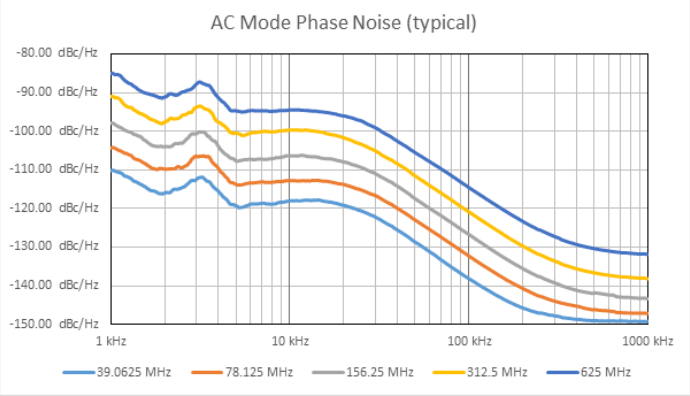
General characteristics - Advanced mode

Phase noise (Sine wave 32 points at 2.5 GS/s, 78.125 MHz, 10 kHz offset, typical)

AMP, DAC, AC -110 dBc/Hz







Random jitter on clock pattern (rms, typical)

AMP, DAC < 5 ps

Total jitter on random pattern (peak-to-peak at 625 Mb/s, PRBS 15 data pattern, typical)

AMP, DAC < 150 ps

Digital outputs (Optional)

Connector type FCI EYE® connector on front panel

Number of connectors 2

Number of outputs 32-bits (16-bits x 2 groups)

General characteristics - Advanced mode

Output impedance	100 Ω differential
Output type	LVDS
Rise/fall time (10% to 90%, typical)	600 ps
Initial skew between digital outputs (typical)	< 500 ps between group A and B
Jitter (peak-to-peak, 2.5 GS/s, 1.25 Gb/s, PN15 pattern, BER = 1e-12)	150 ps
Maximum update rate	1.25 Gbps (full speed mode, maximum 16-bit) 625 Mbps (low speed mode, maximum 32-bit)
Memory depth (optional)	Half of analog waveform length (full speed mode) One fourth of analog waveform length (low speed mode)

Auxiliary input and output characteristics

Marker out

Connector type	SMA on front panel
Number of connectors	two, one for each analog output
Output impedance	50 Ω
Output level (into 50 Ω)	1 V to 2.5 V
Resolution	10 mV
Accuracy (typical)	±(2% setting + 10 mV)
Variable delay control	0 to 60606 ps
Resolution	78 ps
Accuracy (typical)	±(10% of setting + 140 ps)
Rise/fall time (10% to 90%, 2.5 V, typical)	800 ps
Total jitter on random pattern (peak-to-peak, 2.5 GS/s, 1.25 Gb/s, PN15 pattern, output level 2.5 V, BER = 1e-12)	155 ps

Trigger/Gate input

Connector	SMA on the Front Panel
Input impedance	1.1 kΩ
Slope/Polarity	Positive or negative selectable
Input damage level	< -15 V or > +15 V
Threshold control level	-10 V to 10 V
Resolution	50 mv
Threshold control accuracy (typical)	±(10% of |setting| + 0.2 V)
Input voltage swing	0.5 V_{p-p} minimum
Minimum pulse width	12 ns
Initial trigger/gate delay to Analog Output	Basic mode: 332.8 ns ±400 ps Advanced mode: 20 ns + 2288 sampling clock cycles ±1 sampling clock cycle
Trigger In to output jitter (typical)	±2 sampling clock

Auxiliary input and output characteristics

Sync in/out

Connector type	Infiniband 4X connector on rear panel
Master to Slave delay (typical)	48.6 ns

Reference clock input

Connector type	SMA on rear panel
Input impedance	50 Ω, AC coupled
input voltage range	-5 dBm to 4 dBm sine or square wave
Damage level	+8 dBm or ±15 V_{DC} Max
Variable Input Frequency range	10 MHz to 80 MHz

Reference clock output

Connector type	SMA on rear panel
Output impedance	50 Ω, AC coupled
Frequency	10 MHz
Accuracy	± 1.0 x 10^{-6}
Aging	± 1.0 x 10^{-6}/year
Amplitude (typical)	1.6 V_{p-p} into 50 Ω
	3.2 V_{p-p} into High Z
Jitter (rms, typical)	11.5 ps

External Sampling Clock input

Connector type	SMA on rear panel
Input impedance	50 Ω, AC coupled
Number of inputs	Two, one for each channel
Frequency range	1.25 GHz to 2.5 GHz
Input voltage range	-5 dBm to 4 dBm
Damage level	+8 dBm or ±15 V_{DC} Max

External Modulation input

Connector type	BNC on rear panel
Input impedance	10 KΩ
Number of inputs	Two, one for each channel
Bandwidth (typical)	10 MHz with 50 MS/s sampling rate
Input voltage range	-1 V to +1 V (except FSK, PSK)
	FSK, PSK: 3.3 V
Vertical resolution	14-bit

CPU Module and peripherals

CPU	The 4th generation Intel® Core™ i7/i5/i3 Processor
Memory	4 GB x 2, DDR3-DRAM
Hard disk drive	Removable hard disk drive, 500 Gbyte, 2.5-inch SATA
USB host ports	USB 2.0 x 2 on rear panel USB 3.0 x 2 on front panel
USB device port	USB 2.0 x 1 on rear panel Type B
LAN	10/100/1000 BASE-T on rear panel
Real time clock	CR2032 lithium battery with lifetime approximately 3 years
Display	
Size	10.4 in. LCD, 210.4 mm (8.3 in.) x 157.8 mm (6.2 in.)
Resolution	1024 x 768
Luminance (typical)	400 cd/m^2
Touch screen	Built-in, resistive

Power supply

Source voltage and frequency	100 to 240 V_{rms} @ 50 - 60 Hz 115 V_{rms} @ 400 Hz
Power consumption	150 W maximum
Surge current	30 A peak (25 °C) for ≤ 5 line cycles, after product has been turned off for at least 30 s

Physical characteristics

Weight (typical)	
Net weight	6.5 kg (14.2 lbs)
Net weight with packaging	11.5 kg (25.2 lbs)
Dimensions	
Height	233 mm (9.17 in.)
Width	439 mm (17.28 in.)
Depth	199 mm (7.82 in.)
Dimensions with packaging (typical)	
Height	498 mm (19.61 in.)
Width	457 mm (17.99 in.)
Depth	574 mm (22.60 in.)
Clearance	≥50.8 mm (2.0 in.) on left and rear sides of the instrument

EMC, environmental, and safety characteristics

Temperature	
Operating	+5 °C to +50 °C (+41 °F to 122 °F)
Non-operating	-20 °C to +60 °C (-4 °F to 140 °F)
Humidity	
Operating	8% to 90% relative humidity with a maximum wet bulb temperature of 29 °C at or below +50 °C, non-condensing
Non-operating	5% to 98% relative humidity with a maximum wet bulb temperature of 40 °C at or below +60 °C, non-condensing
Altitude	
Operating	3,000 m (9,843 feet)
Non-operating	12,000 m (39,370 feet)
Regulatory	
Safety	UL61010-1, CAN/CSA C22.2 No.61010-1, EN61010-1, IEC61010-1
Emissions	CISPR 11, Class A, EN61000-3-2:2006, EN 61000-3-3:1995
Immunity	EN 61326-1:2006, IEC 61000-4-2:2001, IEC 61000-4-3:2002, IEC 61000-4-4:2004, IEC 61000-4-5:2001, IEC 61000-4-6:2003, IEC 61000-4-11:2004
Regional certifications	
European union	EN61326-1
Australia/New Zealand	CISPR 11:2003

Ordering information

Models

AWG4162	Arbitrary Waveform Generator, 2 analog channels, 2.5 GS/s sampling rate, 14-bit resolution, 1 MSa arbitrary memory depth

Options

-MEM16	16 Mpts arbitrary memory
-MEM32	32 Mpts arbitrary memory
-MEM64	64 Mpts arbitrary memory
-DO16	16-bit digital outputs
-DO32	32-bit digital outputs

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. 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 overlay (default)
Opt. L1	French overlay
Opt. L3	German overlay
Opt. L5	Japanese overlay
Opt. L7	Simplified Chinese overlay
Opt. L8	Traditional Chinese overlay
Opt. L9	Korean overlay
Opt. L10	Russian overlay
Opt. L99	No overlay

Service options

Opt. C3	Calibration Service 3 Years
Opt. C5	Calibration Service 5 Years
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. G3	Complete Care 3 Years (includes loaner, scheduled calibration, and more)
Opt. G5	Complete Care 5 Years (includes loaner, scheduled calibration, and more)
Opt. R5	Repair Service 5 Years (including warranty)
Opt. R5DW	Repair Service Coverage 5 Years (includes product warranty period). 5-year period starts at time of instrument purchase

Accessories

Standard accessories

Power cord	Country specific
Quick start user manual	
Software CD	CD containing all relevant software (ArbExpress, TekVISA, .Net, and system recovery)
Documentation CD	CD containing all relevant documentation
Calibration certificate	Certificate of traceable calibration
Accessory pouch	Captive bag to store accessories
200-5130-xx	Front cover
174-4401-00	USB type A to type B cable – three feet
119-6107-xx	Touch-screen stylus

Optional accessories

RFX100	RFXpress software
AWG4SYNC	Synchronization cable
AWG4DIG16LVDS	Digital output cable (16-bit)
AWG4DIGSCKT	Connector mounted on DUT connects to LVDS cable (manufacture part number: U65-B12-40E0C, Amphenol)
AWG4HDDE	Hard Disk Drive

Recommended accessories

174-6193-00	SMA cable
174-4401-00	USB type A to type B cable – three feet
174-5194-00	USB type A to type B cable – six feet
TEK-USB-488	GPIB-to-USB adapter
HCTEK54	Hard transit case
RMD5000	Rackmount kit
119-7083-xx	Mini keyboard (USB interface)
119-6297-xx	Full-size keyboard with 4-port USB hub
-	USB Mouse

Warranty

Three-year warranty on parts and labor

Instrument upgrades

Instrument upgrades

Item	Before upgrade	After upgrade	Order product
Arbitrary waveform memory	1 Mpts	16 Mpts	AWG4M01T16
	1 Mpts	32 Mpts	AWG4M01T32
	1 Mpts	64 Mpts	AWG4M01T64
	16 Mpts	32 Mpts	AWG4M16T32
	16 Mpts	64 Mpts	AWG4M16T64
	32 Mpts	64 Mpts	AWG4M32T64
Digital output channel	None	16 bit	AWG4D00T16
	None	32 bit	AWG4D00T32
	16 bit	32 bit	AWG4D16T32

CE

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

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

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