Arbitrary Waveform Generators

AWG7000 Series Data Sheet

Features & Benefits

- Wideband RF/MW Modulation Bandwidth
  - Generates Complex Wideband Signals across a Frequency Range of Up to 9.6 GHz
  - Generates Modulation Bandwidths of Up to 3.5 GHz (1 dB)
- Waveform Sequencing and Subsequencing
  - Enables Creation of Infinite Waveform Loops, Jumps, and Conditional Branches
  - Enhance the Ability to Replicate Real-world Signal Behavior
- Dynamic Jump Capability
  - Enables the Creation of Complex Waveforms that Respond to Changing External Environments
- Vertical Resolution up to 10 bit Available
  - Generate Signals up to 1 GHz Wide with 54 dBc SFDR
- Deep Memory
  - Enables the Creation of Long Complex Waveform Sequences
- Intuitive User Interface Shortens Test Time
- Integrated PC supports Network Integration and provides a Built-in DVD, Removable Hard Drive, LAN, eSATA, and USB Ports
- Playback of Oscilloscope and Real-time Spectrum Analyzer Captured Signals, including Enhancements such as Adding Predistortion Effects
- Waveform Vectors Imported from Third-party Tools such as MathCAD, MATLAB, Excel, and Others

Applications

- Wideband RF/MW for Communications and Defense Electronics
  - Wideband Direct RF/MW Output up to 9.6 GHz Carrier
- High-speed Serial Communications
  - Up to 6 Gb/s Data Rate for Complex Serial Data Streams (4x Oversampling, Interleaved)
  - Provides any Profile Multilevel Signals to allow Timing (Jitter) Margin Testing without External Power Combiners
- Mixed-signal Design and Test
  - 2-channel Analog plus 4-channel Marker Outputs
- High-speed, Low-jitter Data/Pulse and Clock Source
- Real-world, Ideal, or Distorted Signals – Generates Any Combination of Signal Impairments Simultaneously

Tektronix®

Unparalleled Performance

The need for performance arbitrary waveform generation is broad and spans over a wide array of applications. The industry-leading AWG7000 Series arbitrary waveform generators (AWG) represent a cutting edge benchmark in performance, sample rate, signal fidelity, and timing resolution. The ability to create, generate, or replicate either ideal, distorted, or “real-life” signals is essential in the design and testing process. The AWG7000 Series of AWGs, with up to 24 GS/s and 10-bit vertical resolution, delivers the industry’s best signal stimulus solution for ever-increasing measurement challenges. This allows for easy generation of very complex signals, including complete control over signal characteristics.

The capabilities of the AWG7000 Series are further enhanced by the addition of key features:

Equation Editor

The Equation Editor is an ASCII text editor that uses text strings to create waveforms by loading, editing, and compiling equation files. The editor provides control and flexibility to create more complex waveforms using customer-defined parameters.

Waveform Sequencing and Subsequencing

Real-time sequencing creates infinite waveform loops, jumps, and conditional branches for longer pattern-length generation suitable for replicating real-world behavior of serial transmitters.

Dynamic Jump

The Dynamic Jump capability enables the creation of complex waveforms by enabling the ability to dynamically jump to any predefined index in a waveform sequence. Users can define up to 256 distinct jump indexes that respond to changing external environments.

Wideband RF Signal Generation

Creating RF signals is becoming more and more complex, making it more difficult for RF engineers to accurately create the signals required for conformance and margin testing. When combined with RFXpress, the AWG7000 Series can address these tough design challenges. RFXpress is a software package that digitally synthesizes modulated baseband, IF, and RF signals taking signal generation to new levels by fully exploiting the wideband signal generation capabilities of the AWG7000 Series arbitrary waveform generators (AWGs). Together the AWG7000 and RFXpress provide engineers with “bandwidth on demand”, which is the ability to generate wideband modulated signals up to 3.5 GHz (1 dB) anywhere within the 9.6 GHz frequency range.

The latest digital RF technologies often exceed the capabilities of other test instruments because of the need to generate the wide-bandwidth and

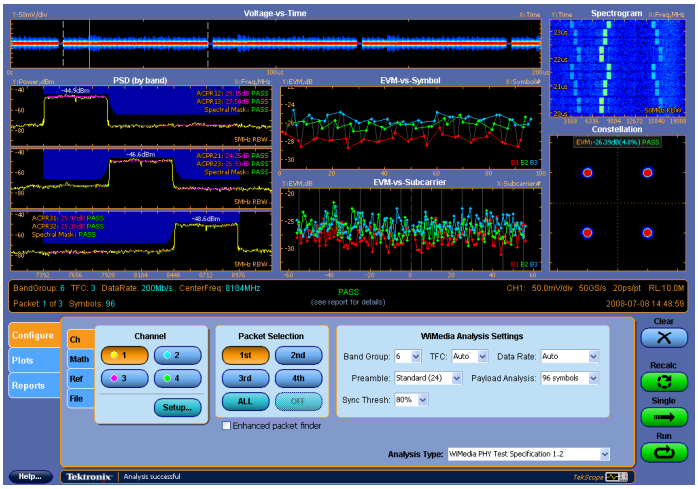
AWG radar pulses created with AWG7000 and RFXpress.

fast-changing signals that are increasingly seen in many RF applications such as radar, RF comms, OFDM, and UWB. When used in conjunction with RFXpress the AWG7000 Series supports a wide range of modulation formats and simplifies the task of creating complex RF waveforms. The AWG7000 Series instruments provide customers with ways to generate fully modulated baseband, intermediate frequency (IF) signals, or directly generated RF waveforms.

Radar Signal Creation

Generating advanced radar signals often demands exceptional performance from an AWG in terms of sample rate, analog bandwidth, and memory. The Tektronix AWG7000 Series sets a new industry standard for advanced radar signal generation, by delivering wide modulation bandwidths up to 3.5 GHz (1 dB). With a sample rate of up to 24 GS/s the AWG7000 Series can directly generate RF signals never before possible from an AWG. In instances where IQ generation is desired, the AWG7000 offers the ability to oversample the signal, thereby improving signal quality.

The AWG7000 and RFXpress are the perfect solution for creating complex radar signals. Customers are provided with 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 RFXpress enables the creation of waveforms requiring customer-defined modulation types. The AWG and RFXpress combo 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 and multipath effects.



Direct WiMedia signals are easily created with the AWG7000 and RFXpress.

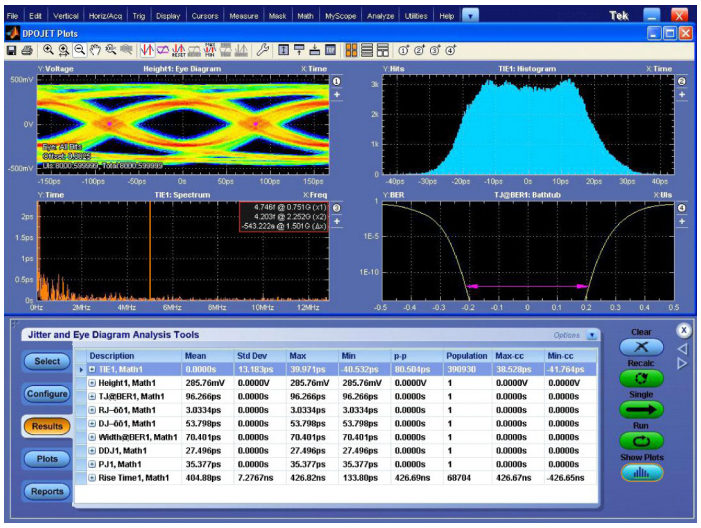
Generic OFDM Creation

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 AWG7000 Series, when coupled with RFXpress, 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 RFXpress software choose default values for some signal aspects. The AWG/RFXpress combo 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 RFXpress software 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.

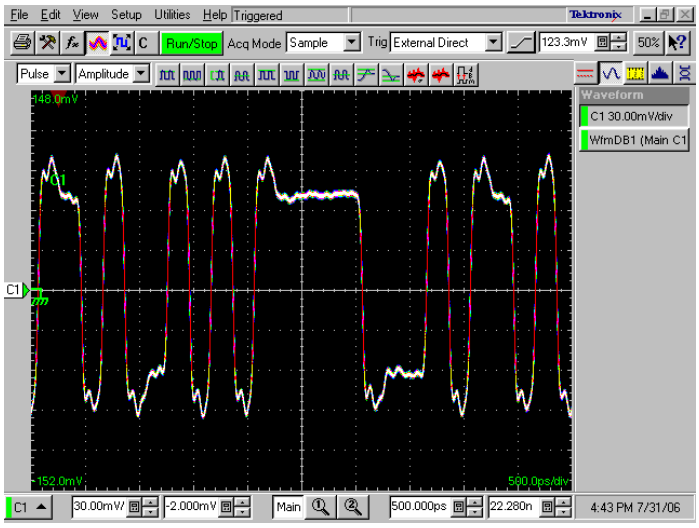
UWB-WiMedia (UWBCF/UWBCT)

Ultra-Wideband (UWB) wireless is a growing technology that is designed for low-power, short-range wireless applications. UWB has emerged as the leading technology for applications like wireless Universal Serial Bus (USB). UWB radios, like generic OFDM radios, require wide signal bandwidths and multiple carriers, but UWB designs also require short-duration pulses and transmit Power Spectral Densities (PSDs) near the thermal noise floor which can make creating UWB test signals very difficult. Fortunately, the AWG7000 Series and RFXpress offer a solid solution for the generation of UWB test signals.

The AWG7000 and RFXpress have the capability to digitally synthesize and generate signals in the UWB spectrum. For either custom UWB signal or ones defined for the latest WiMedia specification, the AWG7000 solution can recreate signals that are required to band hop in real time over a 1.6 GHz modulation bandwidth. The RFXpress software gives users complete control over the characteristics of their UWB signals including the preamble synchronization sequences, cover sequences, and TFCs. For WiMedia applications all six band groups (BG1 to BG6) can be generated in either IQ, IF, or direct RF signals, giving users 3 different options for creating/up-converting the signals when using an AWG7000 instrument.



Easily create digital data impairments with the AWG7000 and SerialXpress.



Digital data with de-emphasis added using the AWG7000 and SerialXpress.

High-speed Serial Signal Generation

Serial signals are made up entirely of simple ones and zeros – binary data. Historically engineers have used data generators to create digital signals. As clock rates have increased these simple ones and zeros have begun to look more like analog waveforms because embedded in the digital data are analog events. The zero rise time and the perfectly 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 AWG7000 Series is an analog waveform source it is the perfect single-box solution that is used to create digital data streams and mimic the analog imperfections that occur in real-world environments. The AWG7000 Series uses direct synthesis techniques which allow engineers to create signals that embody the effects of propagation through a transmission line. Rise times, pulse shapes, delays, and aberrations can all be controlled with the AWG7000 Series instruments. When used in conjunction with the SerialXpress software package, engineers are provided control over every aspect of their digital signals reaching speeds of up to 6 Gb/s. This is exactly what is needed for rigorous receiver testing requirements.

SerialXpress is an integrated SW tool that enables AWG7000 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 board and cables can be emulated using touchstone files uploaded into SerialXpress. The AWG7000 and SerialXpress solution 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 AWG7000 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.

Characteristics

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 (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.

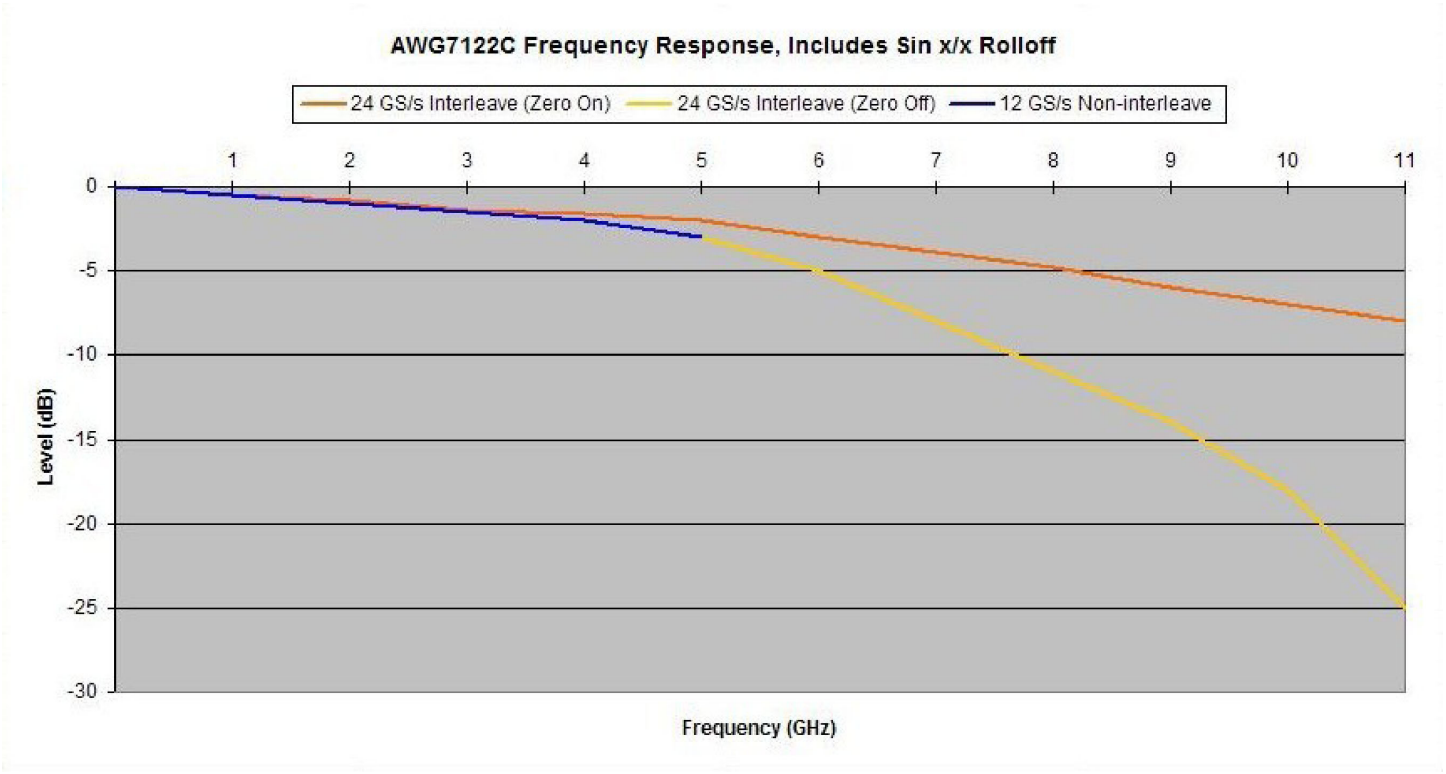
AWG7122C Series Specifications

General Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	Direct: w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Digital to Analog Converter				
Sample rate (nominal)	10 MS/s to 12 GS/s (2 Ch)			12 GS/s to 24 GS/s (1 Ch)
Resolution (nominal)	10 bit (no markers selected) or 8 bit (markers selected)			
Sin (x)/x Roll-off				
Sin (x)/x (–1 dB)	3.1 GHz			6.2 GHz
Sin (x)/x (–3 dB)	5.3 GHz			10.6 GHz

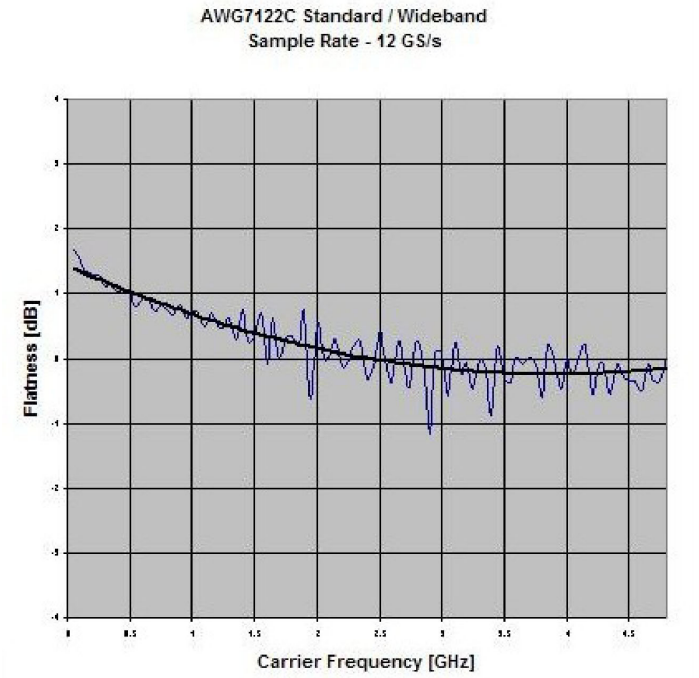
Frequency Domain Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Frequency Characteristics				
Effective Frequency Output	Fmaximum (specified) is determined as "sample rate / oversampling rate" or "SR / 2.5"			
Fmaximum	4.8 GHz			9.6 GHz
Effective Frequency Switching Time	Minimum frequency switching time from selected frequencies F_1 to F_2 is determined as "1/Fmaximum", Option 08 only			
Standard				
Switching time (Ts)	106 µs			106 µs
Option 08 (fast frequency switching)				
Switching time (Ts)	208 ps			104 ps
Modulation Bandwidth	Modulation bandwidth is determined as a combination of Sin (x)/x roll-off and rise-time bandwidth collectively corrected to <1 dB by external measurement and calibration over the applicable frequency range			
Mod bandwidth (–1 dB) (typical)	Up to 420 MHz	Up to 1.7 GHz	Up to 2.5 GHz	Up to 3.5 GHz (Zero On) Up to 2.5 GHz (Zero Off)
Mod bandwidth (–3 dB) (typical)	Up to 740 MHz	Up to 2.9 GHz	Up to 4.3 GHz	Up to 6.2 GHz (Zero On) Up to 4.3 GHz (Zero Off)

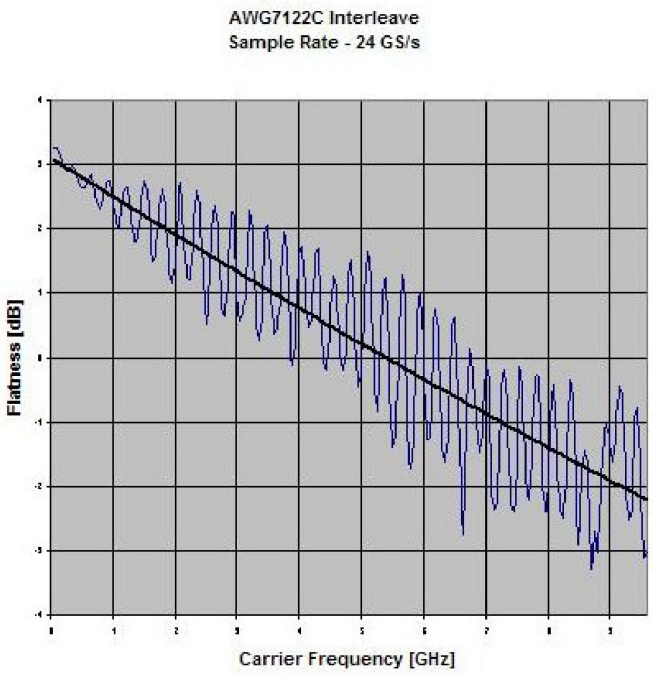


AWG7122C Frequency Response (typical).

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Amplitude Characteristics				
Amplitude	Amplitude levels are measured as single-ended outputs Amplitude level will be 3 dBm higher when using differential (both) outputs			
Range (nominal)	–22 dBm to 10 dBm	–22 dBm to 4 dBm	–2 dBm to 4 dBm	Zero On: –2 dBm to 4 dBm Zero Off: –8 dBm to –2 dBm
Resolution (nominal)	0.01 dB			
Accuracy	At –2 dBm level, with no offset, ±0.3 dB			
Output Flatness	Mathematically corrected for characteristic Sin (x)/x roll-off, uncorrected by external calibration methods			
Flatness (typical)	±1.0 dB, from 50 MHz to 4.8 GHz			±2.5 dB, from 50 MHz to 9.6 GHz



AWG7122C Standard/Wideband Flatness (typical).



AWG7122C Interleave Flatness (typical).

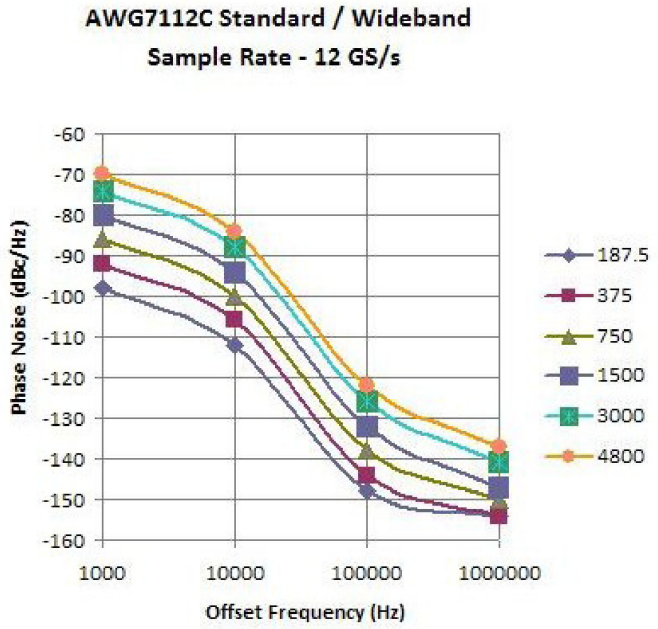
Time Domain Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Data Rate Characteristics				
Data Rate	Bit rate determined as "sample rate / 4 points per cycle", allowing full impairment generation			
Bit rate (nominal)	3 Gb/s			6 Gb/s
Rise/Fall Time Characteristics				
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			
Tr/Tf (typical)	350 ps	75 ps	35 ps	42 ps
Rise Time Bandwidth	Rise-time bandwidth converted from rise-time (0.26/Tr, assumed Gaussian transition) characteristics through analog output circuitry and cabling			
Tr bandwidth (–1 dB) (typical)	430 MHz	2.0 GHz	4.3 GHz	3.6 GHz
Tr bandwidth (–3 dB) (typical)	750 MHz	3.5 GHz	7.5 GHz	6.2 GHz
Low-pass filter	Bessel Type: 50 and 200 MHz			
Output Amplitude Characteristics				
Amplitude	Amplitude levels are measured between differential outputs (+) to (–) For single-ended output the amplitude level will be one-half the voltage levels below			
Range (nominal)	100 mV_{p-p} to 4.0 V_{p-p}	100 mV_{p-p} to 2.0 V_{p-p}	1.0 V_{p-p} to 2.0 V_{p-p}	Zero On: 1.0 V_{p-p} to 2.0 V_{p-p} Zero Off: 500 mV_{p-p} to 1.0 V_{p-p}
Resolution (nominal)	1.0 mV			
Accuracy	At 0.5 V, with no offset, ±(3% of amplitude ±2 mV)			Zero On: ±(4% of level ±2 mV) Zero Off: ±(8% of level ±2 mV)
Offset				
Range (nominal)	±0.5 V			
Resolution (nominal)	1.0 mV			
Accuracy	At minimum amplitude, ±(2.0% of offset ±10 mV)			

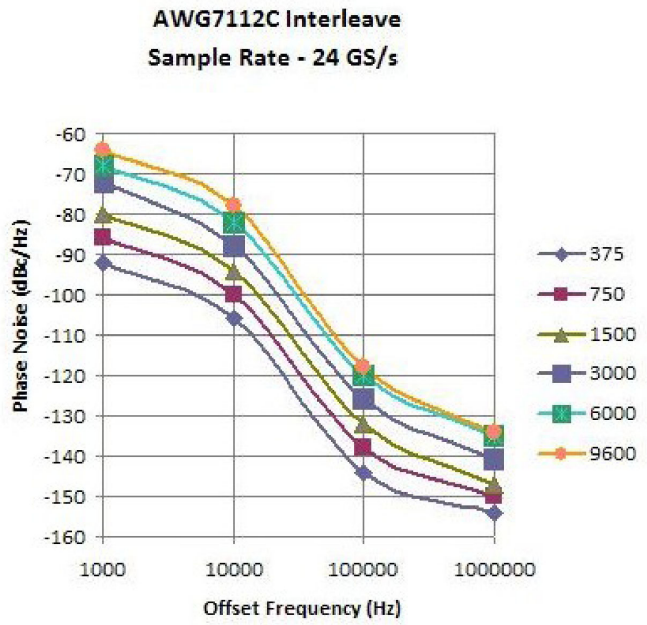
Common Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Distortion Characteristics				
Spurious Free Dynamic Range (SFDR)	SFDR is determined as a function of the directly generated carrier frequency. Harmonics not included			
SFDR (typical)	Clock: 12 GS/s, 10-bit operation Frequency: 50 MHz to 4.8 GHz Level: 4 dBm (1 V_{p-p}) Offset: None			Clock: 24 GS/s, 10-bit operation Frequency: 50 MHz to 9.6 GHz Level: –2 dBm (0.5 V_{p-p})
DC to 1.0 GHz carrier	–54 dBc			–54 dBc
1.0 to 2.4 GHz carrier	–46 dBc			–46 dBc
2.4 to 3.5 GHz carrier	–38 dBc			–38 dBc
3.5 to 4.8 GHz carrier	–30 dBc			–30 dBc
4.8 to 9.6 GHz carrier				–26 dBc
Spurious Free Dynamic Range (SFDR)	When viewed as a modulation bandwidth and used with external frequency up-conversion, the specifications will hold and be independent of carrier frequency with proper conversion circuitry design. Harmonics not included			
SFDR (typical)	Clock: 12 GS/s, 10-bit operation Modulation Bandwidth: Up to 2.5 GHz Level: 4 dBm (1 V_{p-p}) Offset: None			Clock: 24 GS/s, 10-bit operation Modulation Bandwidth: Up to 3.5 GHz Level: –2 dBm (0.5 V_{p-p})
DC to 1.0 GHz bandwidth	–54 dBc			–54 dBc
DC to 2.4 GHz bandwidth	–46 dBc			–46 dBc
DC to 3.5 GHz bandwidth	–38 dBc			–38 dBc

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	Direct: w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Harmonic Distortion	Clock: 12 GS/s, 10-bit operation 32-point waveform 375 MHz output Amplitude: 4 dBm (1 V_{p-p}) Offset: None			Clock: 24 GS/s, 10-bit operation 32-point waveform 750 MHz output Amplitude: –2 dBm (0.5 V_{p-p})
Harmonics	< –35 dBc	< –42 dBc		< –40 dBc
Nonharmonic Distortion	Clock: 12 GS/s, 10-bit operation 32-point waveform 375 MHz output Amplitude: 4 dBm (1 V_{p-p}) Offset: None			Clock: 24 GS/s, 10-bit operation 32-point waveform 750 MHz output Amplitude: –2 dBm (0.5 V_{p-p})
Spurious	< –50 dBc			< –45 dBc
Phase Noise Distortion	Clock: 12 GS/s, 10-bit operation 32-point waveform 375 MHz output Amplitude: 4 dBm (1 V_{p-p}) at 0 offset			Clock: 24 GS/s, 10-bit operation 32-point waveform 750 MHz output Amplitude: –2 dBm (0.5 V_{p-p}) at 0 offset
Phase Noise	< –90 dBc/Hz at 10 kHz offset			< –85 dBc/Hz at 10 kHz offset



AWG7112C Standard/Wideband Phase Noise (typical).



AWG7112C Interleave Phase Noise (typical).

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Jitter				
Random jitter (typical)	1010 clock pattern			
RMS value	1.6 ps	0.9 ps		
Total jitter (typical)	2^{15} – 1 data pattern (at 10^{-12} BER)			
P-P value	50 ps at 0.5 Gb/s	30 ps at 3 Gb/s	20 ps from 2 to 6 Gb/s	
Output Pulse Characteristics				
Pulse Response				
Tr/Tf (typical)	350 ps	75 ps	35 ps	42 ps
Timing skew (typical)	<20 ps (between each channel) (+) Pos and (–) Neg outputs			<12 ps (between each channel) (+) Pos and (–) Neg outputs
Delay from marker output (typical)	50 MHz: 9.7 ns 200 MHz: 3.9 ns	2.1 ns	0.5 ns	0.9 ns
Interleave skew adjustment (typical)				Skew adjust: ±180 degree against sample rate (e.g. 24 GS/s: 83 ps = 360 degrees with 0.1 degree resolution)
Interleave level adjustment (typical)				Level adjust: 1 mV resolution

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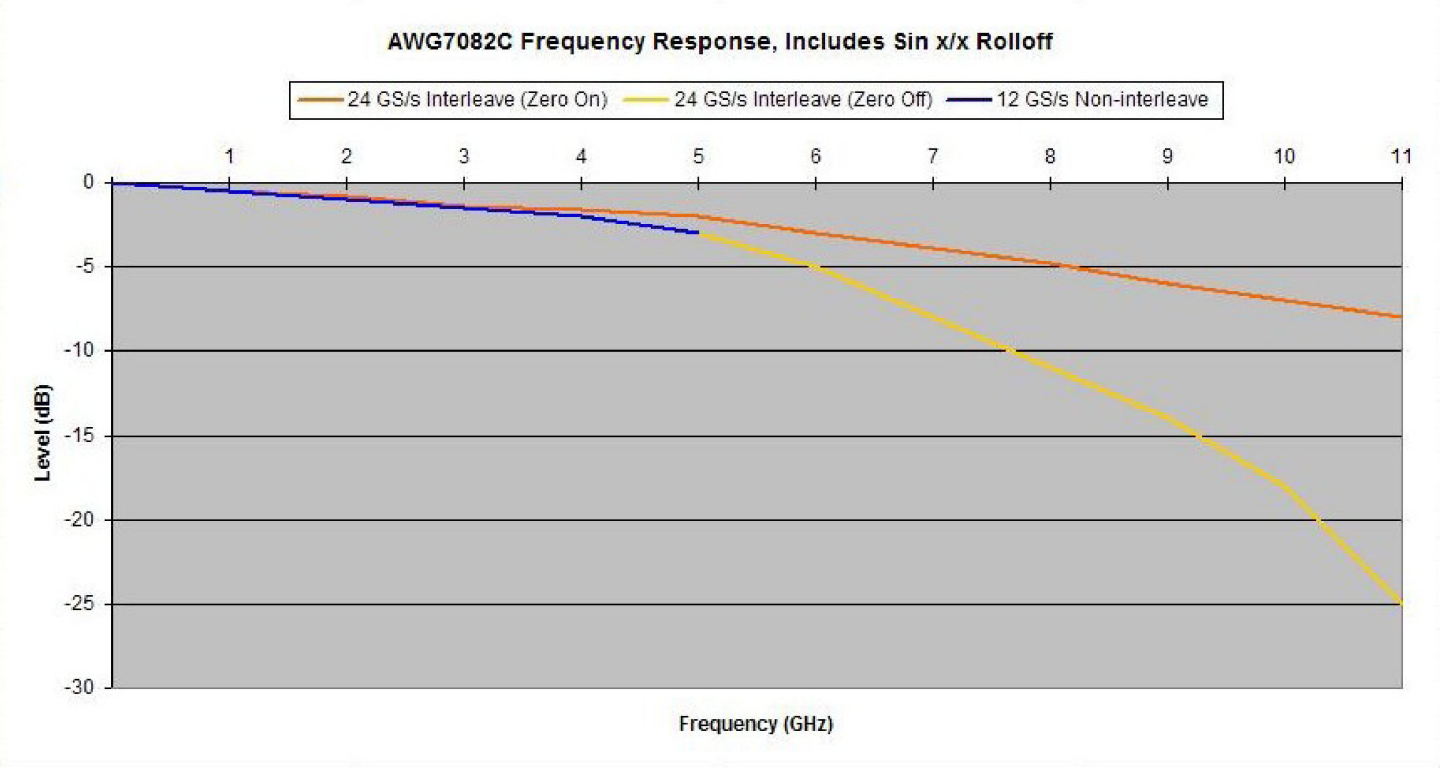
AWG7082C Series Specifications

General Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	Direct: w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Digital to Analog Converter				
Sample rate (nominal)	10 MS/s to 8 GS/s (2 Ch)			8 GS/s to 16 GS/s (1 Ch)
Resolution (nominal)	10 bit (no markers selected) or 8 bit (markers selected)			
Sin (x)/x Roll-off				
Sin (x)/x (–1 dB)	2.0 GHz			4.0 GHz
Sin (x)/x (–3 dB)	3.5 GHz			7.0 GHz

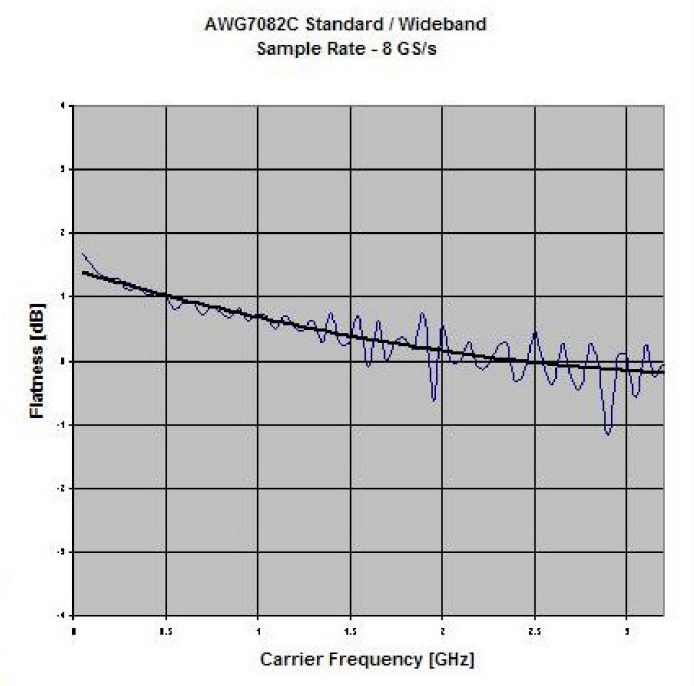
Frequency Domain Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Frequency Characteristics				
Effective Frequency Output	Fmaximum (specified) is determined as "sample rate / oversampling rate" or "SR / 2.5"			
Fmaximum	3.2 GHz			6.4 GHz
Effective Frequency Switching Time	Minimum frequency switching time from selected frequencies F_1 to F_2 is determined as "1/Fmaximum", Option 08 only			
Standard				
Switching time (Ts)	8.0 ns			160 µs
Option 08 (fast frequency switching)				
Switching time (Ts)	313 ps			156 ps
Modulation Bandwidth	Modulation bandwidth is determined as a combination of Sin (x)/x roll-off and rise-time bandwidth collectively corrected to <1 dB by external measurement and calibration over the applicable frequency range			
Mod bandwidth (–1 dB) (typical)	Up to 420 MHz	Up to 1.4 GHz	Up to 1.9 GHz	Up to 3.0 GHz (Zero On) Up to 1.9 GHz (Zero Off)
Mod bandwidth (–3 dB) (typical)	Up to 740 MHz	Up to 2.5 GHz	Up to 3.2 GHz	Up to 5.2 GHz (Zero On) Up to 3.2 GHz (Zero Off)

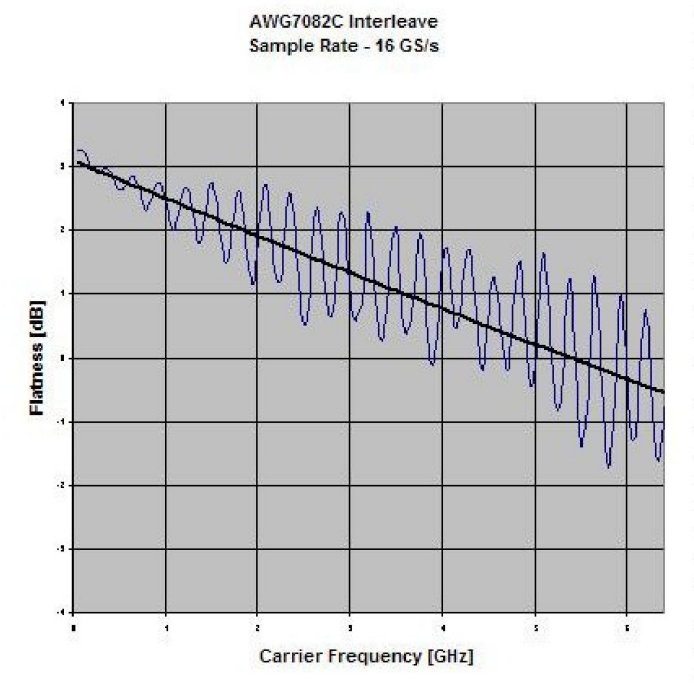


AWG7082C Frequency Response (typical).

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Amplitude Characteristics				
Amplitude	Amplitude levels are measured as single-ended outputs Amplitude level will be 3 dBm higher when using differential (both) outputs			
Range (nominal)	–22 dBm to 10 dBm	–22 dBm to 4 dBm	–2 dBm to 4 dBm	Zero On: –2 dBm to 4 dBm Zero Off: –8 dBm to –2 dBm
Resolution (nominal)	0.01 dB			
Accuracy	At –2 dBm level, with no offset, ±0.3 dB			
Output Flatness	Mathematically corrected for characteristic Sin (x)/x roll-off, uncorrected by external calibration methods			
Flatness (typical)	±1.0 dB, from 50 MHz to 3.2 GHz			±2.5 dB, from 50 MHz to 6.4 GHz



AWG7082C Standard/Wideband Flatness (typical).



AWG7082C Interleave Flatness (typical).

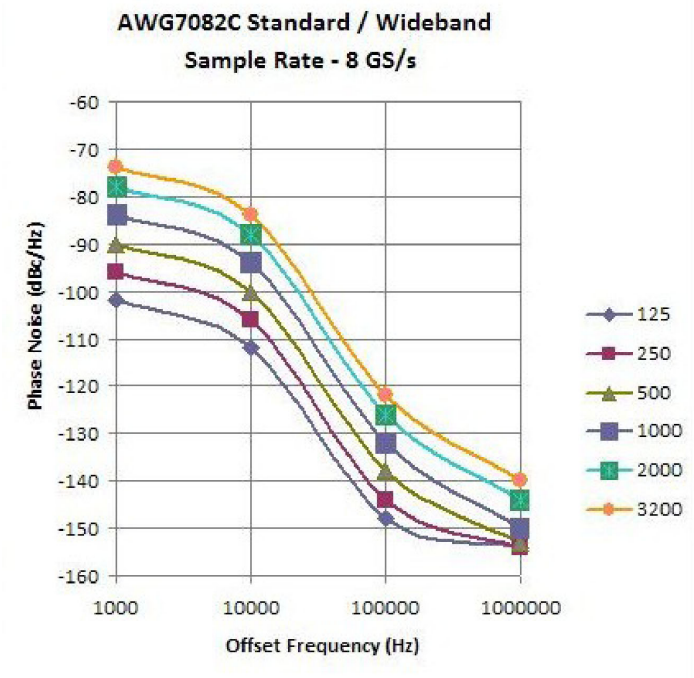
Time Domain Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Data Rate Characteristics				
Data Rate	Bit rate determined as "sample rate / 4 points per cycle", allowing full impairment generation			
Bit rate (nominal)	2 Gb/s			4 Gb/s
Rise/Fall Time Characteristics				
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			
Tr/Tf (typical)	350 ps	75 ps	35 ps	42 ps
Rise-time Bandwidth	Rise-time bandwidth converted from rise-time (0.26/Tr, assumed Gaussian transition) characteristics through analog output circuitry and cabling			
Tr bandwidth (–1 dB) (typical)	430 MHz	2.0 GHz	4.3 GHz	3.6 GHz
Tr bandwidth (–3 dB) (typical)	750 MHz	3.5 GHz	7.5 GHz	6.2 GHz
Low-pass filter	Bessel Type: 50 and 200 MHz			
Output Amplitude Characteristics				
Amplitude	Amplitude levels are measured between differential outputs (+) to (–) Single-ended output amplitude level will be one-half the voltage levels below			
Range (nominal)	100 mV_{p-p} to 4.0 V_{p-p}	100 mV_{p-p} to 2.0 V_{p-p}	1.0 V_{p-p} to 2.0 V_{p-p}	Zero On: 1.0 V_{p-p} to 2.0 V_{p-p} Zero Off: 500 mV_{p-p} to 1.0 V_{p-p}
Resolution (nominal)	1.0 mV			
Accuracy	At 0.5 V, with no offset, ±(3% of amplitude ±2 mV)			Zero On: ±(4% of level ±2 mV) Zero Off: ±(8% of level ±2 mV)
Offset				
Range (nominal)	±0.5 V			
Resolution (nominal)	1.0 mV			
Accuracy	At minimum amplitude, ±(2.0% of offset ±10 mV)			

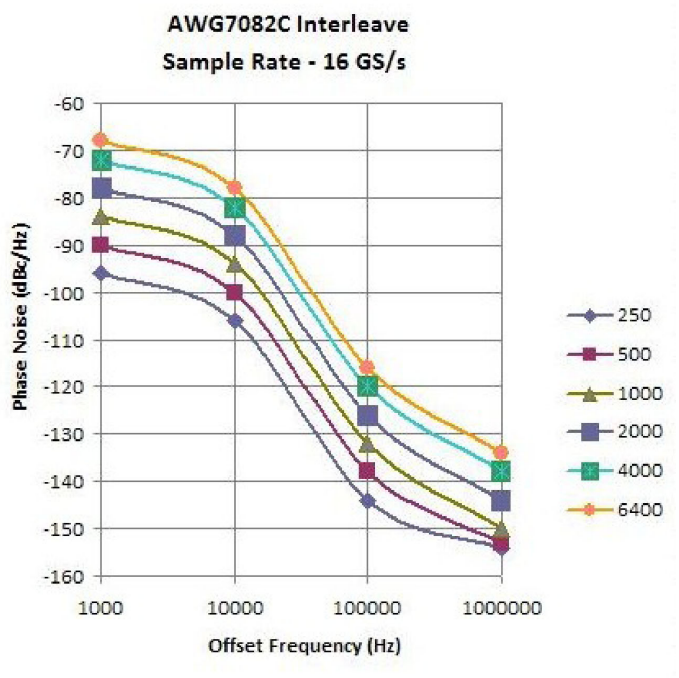
Common Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Output Distortion Characteristics				
Spurious Free Dynamic Range (SFDR)	SFDR is determined as a function of the directly generated carrier frequency. Harmonics not included			
SFDR (typical)	Clock: 12 GS/s, 10-bit operation Frequency: 50 MHz to 3.2 GHz Level: 4 dBm (1 V_{p-p}) Offset: None			Clock: 24 GS/s, 10-bit operation Frequency: 50 MHz to 6.4 GHz Level: –2 dBm (0.5 V_{p-p})
DC to 1.0 GHz carrier	–54 dBc			–54 dBc
1.0 to 2.4 GHz carrier	–46 dBc			–46 dBc
2.4 to 3.5 GHz carrier	–40 dBc			–40 dBc
3.5 to 4.8 GHz carrier				–32 dBc
4.8 to 6.4 GHz carrier				–28 dBc
Spurious Free Dynamic Range (SFDR)	When viewed as a modulation bandwidth and used with external frequency up-conversion, the specifications will hold and be independent of carrier frequency with proper conversion circuitry design. Harmonics not included			
SFDR (typical)	Clock: 8 GS/s, 10-bit operation Modulation Bandwidth: Up to 1.9 GHz Level: 4 dBm (1 V_{p-p}) Offset: None			Clock: 16 GS/s, 10-bit operation Modulation Bandwidth: Up to 3.0 GHz Level: –2 dBm (0.5 V_{p-p})
DC to 1.0 GHz bandwidth	–54 dBc			–54 dBc
DC to 2.4 GHz bandwidth	–46 dBc			–46 dBc
DC to 3.5 GHz bandwidth				–40 dBc

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Harmonic Distortion	Clock: 8 GS/s, 10-bit operation 32-point waveform 250 MHz output Amplitude: 4 dBm (1 V_{p-p}) Offset: None			Clock: 16 GS/s, 10-bit operation 32-point waveform 500 MHz output Amplitude: –2 dBm (0.5 V_{p-p})
Harmonics	< –35 dBc	< –42 dBc		< –40 dBc
Nonharmonic Distortion	Clock: 8 GS/s, 10-bit operation 32-point waveform 250 MHz output Amplitude: 4 dBm (1 V_{p-p}) Offset: None			Clock: 16 GS/s, 10-bit operation 32-point waveform 500 MHz output Amplitude: –2 dBm (0.5 V_{p-p})
Spurious	< –50 dBc			< –45 dBc
Phase Noise Distortion	Clock: 8 GS/s, 10-bit operation 32-point waveform 250 MHz output Amplitude: 4 dBm (1 V_{p-p}) at 0 offset			Clock: 16 GS/s, 10-bit operation 32-point waveform 500 MHz output Amplitude: –2 dBm (0.5 V_{p-p}) at 0 offset
Phase Noise	< –90 dBc/Hz at 10 kHz offset			< –85 dBc/Hz at 10 kHz offset



AWG7082C Standard/Wideband Phase Noise (typical).



AWG7082C Interleave Phase Noise (typical).

Characteristic	Standard Instrument		Option 06 Instrument	
	Normal: w/ Amplifier	**Direct: w/o Amplifier**	**Wideband: Direct DAC Out**	**Interleave: Direct DAC Out – Zeroing On/Off**
Jitter				
Random jitter (typical)	1010 clock pattern			
RMS value	1.6 ps	0.9 ps		
Total jitter (typical)	2^{15} – 1 data pattern (at 10^{-12} BER)			
P-P value	50 ps at 0.5 Gb/s	30 ps at 2 Gb/s	20 ps from 2 to 4 Gb/s	
Output Pulse Characteristics				
Pulse Response				
Tr/Tf (typical)	350 ps	75 ps	35 ps	42 ps
Timing skew (typical)	<20 ps (between each channel) (+) Pos and (–) Neg outputs			<12 ps (between each channel) (+) Pos and (–) Neg outputs
Delay from marker output (typical)	50 MHz: 9.7 ns 200 MHz: 3.9 ns	2.1 ns	0.5 ns	0.9 ns
Interleave skew adjustment (typical)				Skew adjust: ±180 degree against sample rate (e.g. 24 GS/s: 83 ps = 360 degrees with 0.1 degree resolution)
Interleave level adjustment (typical)				Level adjust: 1 mV resolution

AWG7000C Series Common Features

Common Hardware Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	w/ Amplifier	w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Number of Outputs	2 channels, non-interleave			2 channels, non-interleave 1 channel, interleave
Output connector	Differential, SMA (front panel)			
Output impedance (nominal)	50 Ω			
Waveform Length	Standard – to 32M points Extended memory – to 64M points			Standard – to 64M points Extended memory – to 128M points
Number of Waveforms	1 to 16,200			
Sequence Length/Counter	1 to 16,000 steps, 1 to 65,536 count			
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 internal, external, programmatic (GPIB, LAN), or manual trigger is received			
Gated	Waveform begins output when gate is "True" and resets when gate is "False"			
Sequence	Waveform is output as defined by the sequence selected			
Jump	Synchronous and asynchronous			
Sampling Clock				
Resolution	8 digits			
Accuracy	Within ±(1 ppm + Aging), Aging: Within ±1 ppm per year			
Internal Trigger Generator				
Range	1.0 µs to 10.0 s			
Resolution	3 digits, 0.1 µs minimum			
Output Skew Control				
Range	–100 to 100 ps			
Resolution	1 ps			
Accuracy	±(10% of setting + 10 ps)			

Common Software Characteristics

Characteristic	Standard Instrument		Option 06 Instrument	
	w/ Amplifier	w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Operating System / Peripherals / IO	Windows 7 4 GB memory 160 GB hard disk drive (rear-panel removable, optional front mount kit) CD/DVD drive (front panel) Included USB compact keyboard and mouse USB 2.0 compliant ports (6 total – 2 front, 4 rear) PS/2 mouse and keyboard connections (rear panel) RJ-45 Ethernet connector (rear panel) supports 10/100/1000BASE-T DVI-I Video (rear panel) for external monitor eSATA (rear panel)			
Display Characteristics	LED backlit monitor with touch screen, 10.4 in. (264 mm) 1024 × 768 (V) XGA			
Waveform File Import Capability	Import waveform format by series: *.AWG file created by Tektronix AWG5000 or AWG7000 Series *.PAT, *.SEQ, *.WFM and *.EQU file formats created by Tektronix arbitrary waveform generators such as the AWG400/500/600/700 Series *.IQT and *.TIQ files from Tektronix real-time spectrum analyzer *.TFW file created by Tektronix AFG3000 Series arbitrary/function generators *.DTG file created by Tektronix DTG5000 Series data timing generators *.WFM or *.ISF file created by Tektronix TDS/DPO Series oscilloscopes text file (*.TXT)			
Waveform File Export Capability	Export waveform format by series: Tektronix AWG400/500/600/700 (*.wfm or *.pat) and text format			
Software Driver for Third-party Applications	IVI-COM driver, MATLAB library			
Instrument Control / Data Transfer				
GPIB	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)			
TekLink	Remote control and data transfer (proprietary bus for Tektronix product high-speed interconnection and communication)			

Auxiliary Outputs

Characteristic	Standard Instrument		Option 06 Instrument	
	w/ Amplifier	w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Markers				
Number	Total: 4 (2 per channel)			Total: 2 (2 per channel)
Style	Differential			
Connector	SMA (front panel)			
Impedance	50 Ω			
Level (into 50 Ω)	Amplitude levels are measured between differential outputs (+) to (–) Single-ended output amplitude level will be one-half the voltage levels below			
Window	–2.8 V to 2.8 V			
Amplitude	1.0 V_{p-p} to 2.8 V_{p-p}			
Resolution	10 mV			
Accuracy	±(10% of setting + 75 mV)			
Rise/Fall time (20% to 80%)	45 ps (1.0 V_{p-p}, Hi: 1.0 V, Lo: 0.0 V)			
Timing skew				
Intra-skew (typical)	<13 ps (between each channel (+) Pos and (–) Neg output)			
In-channel (typical)	<30 ps (between Marker 1 and Marker 2 outputs)			
Delay control				
Range	0 to 300 ps			
Resolution	1 ps			
Accuracy	±(5% of setting + 50 ps)			
Jitter				
Random RMS (typical)	1 ps			
Total p-p (typical)	30 ps (2^{15} – 1 PN pattern at 10^{-12} BER)			
10 MHz Reference Out				
Amplitude	1.2 V_{p-p} into 50 Ω, maximum 2.5 V open			
Connector	BNC (rear panel)			
Impedance	50 Ω, AC coupled			
DC Outputs				
Number	4, independently controlled			
Range	–3.0 to 5.0 V			
Resolution	10 mV			
Accuracy	±(3% of setting + 120 mV)			
Connector	2×4 pin header (front panel)			
Current (max)	±30 mA			

Auxiliary Inputs

Characteristic	Standard Instrument		Option 06 Instrument	
	w/ Amplifier	w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
Trigger / Gate In				
Polarity	Pos or Neg			
Range	50 Ω: ±5 V, 1 kΩ: ±10 V			
Connector	BNC (front panel)			
Impedance	50 Ω, 1 kΩ			
Threshold				
Level	–5.0 V to 5.0 V			
Resolution	0.1 V			
Trigger to output uncertainty				
Asynchronous (typical)	Between internal/external clock and trigger timing: 0.5 ns at 12 GS/s, 0.7 ns at 10 GS/s, 0.8 ns at 9 GS/s, 0.9 ns at 8 GS/s, 1.0 ns at 6 GS/s			
Synchronous (typical)	Between external clock and trigger timing: 12 GS/s, X1 clock divider, synchronous trigger mode with specific timing (120 ps_{p-p}, 30 ps_{RMS})			
Synchronous (typical)	Between external 10 MHz reference and trigger timing: 12 GS/s setting, synchronous trigger mode with specific timing (120 ps_{p-p}, 30 ps_{RMS})			
Synchronous (typical)	Between external variable reference and trigger timing: 2n (n: integer) clock reference, synchronous trigger and specific timing (50 ps_{p-p}, 10 ps_{RMS})			
Trigger mode				
Minimum pulse width	20 ns			
Trigger hold-off	832 × sampling period – 100 ns			
Delay to output	128 × sampling period + 250 ns			
Gated mode				
Minimum pulse width	1024 × sampling period + 10 ns			
Delay to output	640 × sampling period + 260 ns			
Dynamic Jump				
Connector	15-pin DSUB on rear panel			
Level	TTL +5 V compliant inputs, 3.3 V LV CMOS level			
Impedance	Pull up to 3.3 V by 1 kΩ resistor			
Strobe	Must strobe jump destination			
Event In				
Polarity	Pos or Neg			
Range	50 Ω: ±5 V, 1 kΩ: ±10 V			
Connector	BNC (front panel)			
Impedance	50 Ω, 1 kΩ			
Threshold				
Level	–5.0 to 5.0 V			
Resolution	0.1 V			
Sequence mode				
Minimum pulse width	20 ns			
Event hold-off	900 × sampling period + 150 ns			
Delay to output	1024 × sampling period + 280 ns (Jump timing: asynchronous jump)			

Characteristic	Standard Instrument		Option 06 Instrument	
	w/ Amplifier	w/o Amplifier	Wideband: Direct DAC Out	Interleave: Direct DAC Out – Zeroing On/Off
External Clock In				
Input voltage range	1.4 V_{p-p} to 2.2 V_{p-p}, 7 dBm to 11 dBm			
Frequency range	6 GHz to 12 GHz (acceptable frequency drift of ±0.1%)			
Clock divider	1/1, 1/2, 1/4...1/256			
Connector	SMA (rear panel)			
Impedance	50 Ω, AC coupled			
Fixed Reference Clock In				
Input voltage range	0.2 V_{p-p} to 3.0 V_{p-p}			
Frequency range	10 MHz, 20 MHz, 100 MHz (within ±0.1%)			
Connector	BNC (rear panel)			
Impedance	50 Ω, AC coupled			
Variable Reference Clock In				
Input voltage range	0.2 V_{p-p} to 3.0 V_{p-p}			
Frequency range	5 MHz to 800 MHz (acceptable frequency drift is ±0.1%)			
Multiplier rate	1 to 2400			2 to 4800
Connector	BNC (rear panel)			
Impedance	50 Ω, AC coupled			

Physical Characteristics

Dimension	mm	in.
Height	245	9.6
Width	465	18.0
Depth	500	19.7
Weight	**kg**	**lb.**
Net (instrument)	19	41.9
Net (with packaging)	28	61.7
Mechanical Cooling		
Clearance	**cm**	**in.**
Top/Bottom	2	0.8
Side	15	6
Rear	7.5	3
Power Supply		
Rating	100 to 240 V AC, 47 to 63 Hz	
Consumption	450 Watts	

Environmental Characteristics

Characteristic	Description
Temperature	
Operational	10 to 40 °C
Nonoperational	20 to 60 °C
Humidity	
Operational	5% to 80% relative humidity (% RH) at up to 30 °C, 5% to 45% relative humidity above 30 °C up to 50 °C
Nonoperational	5% to 90% relative humidity (% RH) at up to 30 °C, 5% to 45% relative humidity above 30 °C up to 50 °C
Altitude	
Operational	Up to 10,000 ft. (3,048 m)
Nonoperational	Up to 40,000 ft. (12,192 m)
Vibration	
Sine	
Operational	0.33 mm p-p (0.013 in p-p) constant displacement, 5 to 55 Hz
Nonoperational	NA
Random	
Operational	0.27 g RMS, 5 to 500 Hz, 10 minutes per axis
Nonoperational	2.28 g RMS, 5 to 500 Hz, 10 minutes per axis
Mechanical Shock	
Operational	Half-sine mechanical shocks, 30 g peak, 11 ms duration, 3 drops in each direction of each axis
Nonoperational	Half-sine mechanical shocks, 10 g peak, 11 ms duration, 3 drops in each direction of each axis
Regulatory	
Safety	UL61010-1, CAN/CSA-22.2, No.61010-1-04, 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	EN61326
Australia / New Zealand	AS/NZS 2064

Ordering Information

Arbitrary Waveform Generator

AWG7122C
12.0 GS/s (24 GS/s interleaved), 8/10 bit, 32M point, 2-channel arbitrary waveform generator.

AWG7082C
8.0 GS/s (16 GS/s interleaved), 8/10 bit, 32M point, 2-channel arbitrary waveform generator.

All Models Include: Accessory pouch, front cover, USB mouse, compact USB keyboard, lead set for DC output, stylus for touch screen (2 ea), AWG7000C Series product software CD and instructions, documentation CD with browser, Quick Start User Manual and registration card, Certificate of Calibration, power cable, and 50 Ω SMA terminator (3 ea).

Note: Please specify power cord and language option at time of order.

Instrument Options

Product Options

Option	AWG7122C, AWG7082C
Opt. 01	Waveform record length expansion (from 32M point to 64M point)
Opt. 06	Interleaved output at 24 GS/s (AWG7122C), 16 GS/s (AWG7082C) (includes Option 02 – High-bandwidth output), alternative for standard output (AWG7122C with Option 06 requires export license)
Opt. 08	Fast sequence switching (requires export license)
Opt. 09	Subsequencing and Dynamic Jump option (subsequencing files created for legacy AWG400, AWG500, AWG600, and AWG700 instrument are compatible with this option)

International Power Plugs

Option	Description
Opt. A0	North America
Opt. A1	Universal EURO
Opt. A2	United Kingdom
Opt. A3	Australia
Opt. A5	Switzerland
Opt. A6	Japan
Opt. A10	China
Opt. A11	India
Opt. A99	No power cord or AC adapter

Language Options

Option	Description
Opt. L0	English manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L8	Traditional Chinese manual
Opt. L10	Russian manual

Application Software

Product	Description
RFX100	General-purpose IQ, IF, and RF Signal Creation Software Package
Opt. UWBCF	RFXpress plug-in for UWB-WiMedia IQ, IF, and RF conformance signal creation (requires RFX100 as prerequisite)
Opt. UWBCT	RFXpress plug-in for UWB-WiMedia IQ, IF, and RF custom and conformance signal creation (requires RFX100 as prerequisite and includes Opt. UWBCF)
Opt. OFDM	RFXpress plug-in for generic OFDM signal creation (requires RFX100 as prerequisite)
Opt. RDR	RFXpress plug-in for radar signal creation (requires RFX100 as prerequisite)
Opt. SPARA	S-parameter emulation and DUT characterization (requires RFX100 as prerequisite)
SDX100	Jitter-generation software package (includes USB dongle)
Opt. ISI	S-parameter and ISI creation (requires SDX100 as prerequisite)
Opt. SSC	Spread Spectrum Clock addition option (requires SDX100 as prerequisite)

Service Options

Option	Description
Service Options (e.g. AWG7122C Opt. C3)	
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 Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R3	Repair Service 3 Years
Opt. R5	Repair Service 5 Years
Post Sales Service Options: (e.g. AWG7122C-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

Product	Ordering Options		Description
AWG7122C	AWG70CUP	Opt. M02	Waveform length expansion 32M point to 64M point
AWG7082C	AWG70CUP	Opt. M01	
AWG7122C	AWG70CUP	Opt. S02	Upgrade from Standard to Option 08 (fast sequence switching), requires export license
AWG7082C	AWG70CUP	Opt. S01	
AWG7122C	AWG70CUP	Opt. S49	Upgrade to add subsequencing and dynamic jump
AWG7082C	AWG70CUP	Opt. S29	

Recommended Accessories

Item	Description	Parts Number
Pin Header		
SMA Cable	40 in. (102 cm)	012-1690-xx
SMB Cable	20 in. (51 cm)	012-1503-xx
Rackmount Kit	Rackmount Kit with Instruction	016-1983-xx
Front Removable HDD Bay	Front Removable HDD Bay	016-1979-xx
Replacement Hard Disk for AWG5000/7000 Series	SATA disk assembly (no software installation), instruction sheet	650-5336-xx
Quick Start User Manual	English	071-2481-xx
	Japanese	071-2482-xx
	Simplified Chinese	071-2483-xx
	Traditional Chinese	071-2484-xx
	Russian	020-2971-xx
Service Manual	Service Manual, English	Visit Tektronix website

Warranty

One-year parts and labor.

CE

ISO 9001

Product(s) are manufactured in ISO registered facilities.

GPIB IEEE-488

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

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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**

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