Appendix A: Specifications

This section contains theAWG610 Arbitrary Waveform Generator specifications. All specifications are guaranteed unless labeled "typical". Typical specifications are provided for your convenience but are not guaranteed.

Specifications that are marked with the ✓ symbol in the column Characteristics are checked in *Appendix B: Performance Verification* and the page number referenced to the corresponding performance verification procedures can be found in the column PV reference page.

The characteristics in the specifications are listed in tables that are divided into categories. In these tables, the subcategories may also appear in boldface under the column Characteristics.

Performance Conditions   The performance limits in this specification are valid with these conditions:

■   The AWG610 Arbitrary Waveform Generator must have been calibrated/adjusted at an ambient temperature between +20° C and +30° C.

■   The AWG610 Arbitrary Waveform Generator must be in an environment with temperature, altitude, humidity, and vibration within the operating limits described in these specifications.

■   The AWG610 Arbitrary Waveform Generator must have had a warm-up period of at least 20 minutes.

■   The AWG610 Arbitrary Waveform Generator must be operating at an ambient temperature between +10° C and +40° C.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

Electrical Specification

Table A-1: Operation modes

Characteristics	Description
Continuous	Waveform is continuously output in this mode. When a sequence is defined, waveforms are sequentially or repeatedly output in the order defined by the sequence. The extended sequence functions such as trigger input, event jump, and so on are neglected in this mode.
Triggered	Waveform is output only once when a trigger event is created. A trigger signal is created by the external trigger input signal, GPIB trigger command, and/or pressing the front-panel FORCE TRIGGER button. The extended sequence functions such as trigger input, event jump, and so on are neglected in this mode.
Gated	The waveform is output in the same way as in the continuous mode only when the gate is opened. The gate is opened by the gated signal. Note that the output is made from the top of the first waveform for every gate period. The clock signal continuously outputs from the connector outside the gate period.
Enhanced	The waveforms are sequentially or repeatedly output according to the procedures defined in the sequence. All extended functions such as trigger input, event jump, and so on are effective and waveforms are controlled for output by this functions in this mode.

Table A-2: Arbitrary waveforms

Characteristics	Description
Waveform memory	Memory length: 8 100 032 words (8 bits/1 word)
Marker memory	Memory length: 8 100 032 words (2 markers × 1 bit / 1 word)
Sequence memory	Maximum 8000 steps
Sequence counter	1 to 65 536 or Infinite
Waveform data points	Multiple of 8 in the range from 512 to 8 100 032 points

Table A-3: Clock generator

Characteristics	Description	PV reference page
Sampling frequency	50.000 000 kHz to 2.600 000 0 GHz	
Resolution	8 digits	

Table A-3: Clock generator (Cont.)

Characteristics	Description	PV reference page
Internal clock [1]		
✓ Frequency accuracy	± 1 ppm (20 °C to 30 °C), during 1 year after calibration	Page B-52
Phase noise at 1/4 clock output, Typical	(Data Clock is 1/4th of the output sample rate) –80 dBc / Hz (650 MHz with 10 kHz offset) –100 dBc/Hz (650 MHz with 100 kHz offset)	

[1] The internal reference oscillator is used.

Table A-4: Internal trigger generator

Characteristics	Description	PV reference page
Internal trigger rate [2]		
✓ Accuracy	± 0.1 %	Page B-38
Range	1.0 μs to 10.0 s	
Resolution	3 digits, minimum 0.1 μs	

[2] The internal reference oscillator is used.

Table A-5: Main output

Characteristics [3]	Description	PV reference page
Output connector	front-panel SMA connectors	
Output signal	Complemental; CH1 and $\overline{CH1}$	
DA converter		
Resolution	8 bits	
Differential nonlinearity	Within ± 1/2 bit	
Integral nonlinearity	Within ± 1 bit	
Output impedance	50 Ω	
Normal out		
Output voltage	–2.0 V to +2.0 V, into a 50 Ω load	
Amplitude		
Range	20 mV$_{p-p}$ to 2 V$_{p-p}$, into a 50 Ω load	
Resolution	1 mV	
✓ DC accuracy	± (1.5 % of amplitude + 2 mV), offset: 0 V	Page B-24

Table A-5: Main output (Cont.)

Characteristics [3]	Description	PV reference page
Offset		
Range	−1.000 V to 1.000 V, into a 50 Ω load	
Resolution	1 mV	
✓Accuracy	± (1 % of offset + 10 mV), (20 mV amplitude, waveform data: 0)	Page B-24
✓ Pulse response	(Waveform data: −1 and 1, offset: 0 V, and filter: through)	Page B-34
Rise time (10 % to 90 %)	≦ 750 ps (amplitude = 1.0 $V_{p\text{-}p}$, calculated value ≧ 466 MHz)	
Fall time (10 % to 90 %)	≦ 750 ps (amplitude = 1.0 $V_{p\text{-}p}$, calculated value ≧ 466 MHz)	
Aberration	± 10 % (amplitude = 1.0 $V_{p\text{-}p}$, using 6 GHz bandwidth oscilloscope)	
Flatness	± 3 % (after 20 ns from rise and fall edges)	
Sinewave characteristics	(Clock: 2.6 GS/s, waveform points: 32, frequency: 81.25 MHz, amplitude: 1.0 V, offset: 0 V, filter: through)	
✓Harmonics	≦ −40 dBc (DC to 800 MHz)	Page B-36
✓Noise	≦ −50 dBc (DC to 800 MHz)	
Phase Noise, Typical	≦ −85 dBc / Hz (10 kHz offset)	
Direct DA out		
Amplitude		
Range	20 m$V_{p\text{-}p}$ to 1 $V_{p\text{-}p}$, into a 50 Ω load	
✓DC Accuracy	± (2 % of Amplitude + 2 mV)	Page B-29
Resolution	1 mV	
✓ DC offset accuracy	0 V ± 10 mV, (20 mV amplitude, waveform data: 0)	Page B-29
✓ Pulse response	(Waveform data: −1 and 1, at 0.5 $V_{p\text{-}p}$)	Page B-34
Rise time (10 % to 90 %)	≦ 400 ps (calculated value ≧ 875 MHz)	
Fall time (10 % to 90 %)	≦ 400 ps (calculated value ≧ 875 MHz)	

[3] **The characteristics are specified at the end of the SMA cable (012-1565-00) except for DC accuracy.**

Table A–6: Filter

Characteristics	Description	
Type	Bessel low pass filter, 200 MHz,100 MHz, 50 MHz, and 20 MHz	
Rise time (20 % to 80 %), Typical	20 MHz 50 MIIz 100 MHz 200 MHz	17 ns 7.0 ns 3.5 ns 1.75 ns
Delay from trigger, Typical	20 MHz 50 MHz 100 MHz 200 MHz Through	50 ns + 22 clock 40 ns + 22 clock 35 ns + 22 clock 33 ns + 22 clock 30 ns + 22 clock

Table A-7: Auxiliary outputs

Characteristics	Description	PV reference page
Marker [4]		
Number of markers	2 (Complementary. Marker1, $\overline{\text{Marker1}}$, Marker2, $\overline{\text{Marker2}}$)	
Level (Hi/Lo)	−1.10 V to +3.00 V, into a 50 Ω load −2.20 V to +6.00 V, into a 1 MΩ load	
Maximum Output	2.5 V_{p-p}, into a 50 Ω load	
Resolution	0.05 V	
✓ Accuracy	Within ± (0.1 V +5 % of setting), into a 50 Ω load	Page B-58
Rise and fall times (20 % to 80 %), Typical	150 ps (2 V_{p-p}, Hi: +1 V, Lo: −1 V, into a 50 Ω load)	
Variable delay		
✓ Range	0 ns to +1.5 ns	Page B-61
✓ Accuracy	−30 % to +10%, at 1.5 ns setting	
Resolution	100 ps	
Skew, Typical	70 ps (2 V_{p-p}, Hi: +1 V, Lo: −1 V, at delay 0 ns)	
Period jitter	Measured by TDS694C−1MHD with TDSJIT1	
Typical	Refer to Table A-9.	
Cycle to cycle jitter	Measured by TDS694C−1MHD with TDSJIT1	
Typical	Refer to Table A−10.	
Connector	Front panel SMA connectors	
1/4 Clock output		
✓ Level	ECL 100 K compatible (internally loaded in 50 Ω to −2 V and 43 Ω series terminated)	Page B-54
Period jitter	Measured by TDS694C−1MHD with TDSJIT1	
Typical	Refer to Table A 9.	
Cycle to cycle jitter	Measured by TDS694C−1MHD with TDSJIT1	
Typical	Refer to Table A−10.	
Connector	Rear panel BNC connectors	
10 MHz Reference clock out		
✓ Amplitude	≧ 1 V_{p-p}, into a 50 Ω load Max 3 V_{p-p}, open	Page B-56
Impedance	50 Ω, AC coupling	
Connector	Rear panel BNC connector	

[4]   The characteristics are specified at the end of the SMA cable (012-1565-XX).

Table A-8: Funcion Generator (FG)

Characteristics	Description
Operation Mode	Continuous mode only
Waveform Shape	Sine, Triangle, Square, Ramp, Pulse, DC
Frequency	1.000 Hz to 260.0 MHz
Amplitude	
Range	0.020 V_{p-p} to 2.000 V_{p-p}, into a 50 Ω load
Resolution	1 mV
Offset	
Range	−1.000 V to +1.000 V, into a 50 Ω load
Resolution	1 mV
DC Level	DC waveform only
Range	−1.000 V to +1.000 V, into a 50 Ω load
Resolution	1 mV
Polarity	Normal, Inverted
Duty	
Range	0.1 % to 99.9 %
Resolution	Frequency Resolution 1.000 Hz to 2.600 MHz 0.1 % 2.601 MHz to 13.00 MHz 0.5 % 13.01 MHz to 26.00 MHz 1.0 % 26.01 MHz to 52.00 MHz 2.0 % 52.01 MHz to 65.0 MHz 2.5 % 65.01 MHz to 104.0 MHz 4.0 % 104.1 MHz to 130.0 MHz 5.0 % 130.1 MHz to 260.0 MHz 10.0 %
Marker Out	
Pulse Width	
Mrker1	Hi : 0 % to 20 % of 1 waveform period Lo : 20% to 100 % of 1 waveform period
Marker2	Hi : 0 % to 50 % of 1 waveform period Lo : 50 % to 100 % of 1 waveform period Hi : 0 % to 52 % of 1 waveform period Lo : 52 % to 100 % of 1 waveform period at frequency range is 65.01MHz to 104.0MHz
Level	
Hi	2.0 V min into a 50 Ω load
Lo	0 V max into a 50 Ω load

Table A-9: Period Jitter accuracy

Clock frequency	2.6 GS/s		1.6 GS/s		800 MS/s	
Measurement	StdDev	Pk–Pk	StdDev	Pk–Pk	StdDev	Pk–Pk
Marker1 output	3.5 ps	16.0 ps	3.5 ps	16.0 ps	3.0 ps	14.0 ps
1/4 Clock output	4.5 ps	25.0 ps	4.5 ps	25.0 ps	4.0 ps	23.0 ps

Table A-10: Cycle to Cycle Jitter accuracy

Clock frequency	2.6 GS/s		1.6 GS/s		800 MS/s	
Measurement	StdDev	Pk–Pk	StdDev	Pk–Pk	StdDev	Pk–Pk
Marker1 output	5.5 ps	28.0 ps	5.5 ps	28.0 ps	5.5 ps	28.0 ps
1/4 Clock output	6.5 ps	37.0 ps	6.5 ps	37.0 ps	6.5 ps	37.0 ps

Table A-11: Auxiliary inputs

Characteristics	Description	PV reference page
Trigger input [5]		
Connector	Rear panel BNC connector	
Impedance	1 kΩ or 50 Ω	
Polarity	POS (positive) or NEG (negative)	
Input voltage range	± 10 V, into a 1 kΩ load ± 5 V, into a 50 Ω load	
Threshold		
Level	–5.0 V to 5.0 V	
✓ Accuracy	± (5 % of level + 0.1 V)	Page B-40
Resolution	0.1 V	
Pulse width	Minimum 10 ns, 0.2 V amplitude	
Trigger dead time	≤ 576 clock + 450 ns	
Delay to analog out, Typical	30 ns +22 clock (Triggered mode) 30 ns +880 clock (Gated mode)	
Delay to marker, Typical	28 ns +22 clock	

Table A–11: Auxiliary inputs (Cont.)

Characteristics	Description	PV reference page
Event trigger input		
Connector	9-pin, D type on the rear panel	
Number of events	4 bits	
Input signal	4 event bits and Strobe	
Threshold	TTL level	
Impedance	2.2 kΩ, pull-up to +5 V	
Pulse width	Minimum 128 clocks	
Input voltage range	0 V to +5 V (DC + peak AC)	
Delay to analog out, Typical	850 clock +20 ns (Jump timing : ASYNC)	
Reference 10 MHz clock input		
Input voltage range	0.2 V to 3.0 V$_{p-p}$ (into a 50 Ω load, AC coupling) Maximum $\pm$ 10 V	
Impedance	50 Ω, AC coupling	
Reference frequency	10 MHz $\pm$ 0.1 MHz	
Connector	Rear panel BNC connector	

[5] The characteristics are specified at the end of the BNC cable (012-0482-00).

Table A–12: Display and timer

Characteristics	Description
Display	
Display area	Horizontal: 13.2 cm (5.2 in)
	Vertical: 9.9 cm (3.9 in)
Resolution	640 (H) $\times$ 480 (V) pixels

Table A-13: AC line power

Characteristics	Description
Rating voltage	100 VAC to 240 VAC
Voltage range	90 VAC to 250 VAC
Frequency range	48.0 Hz to 63 Hz
Maximum consumption	400 W
Maximum current	5 A
Fuse rating	10 A fast, 250 V, UL 198G (3 AG) 5 A (T), 250 V, IEC 127

Table A-14: Timer

Characteristics	Description
Timer	
Operation life	6 years
Type	Li 3 V, 190 mAh

Table A-15: Interface connectors

Characteristics	Description
GPIB	24-pin, IEEE 488.1 connector on the rear panel
Ethernet	10 BASE-T, RJ-45 connector on the rear panel
Keyboard connector	6-pin, mini-DIN connector on the rear panel

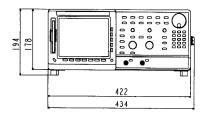### Table A-16: Installation requirement

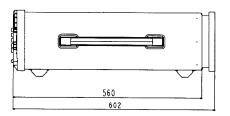| Characteristics	Description	
Heat dissipation		
Maximum power	400 W (maximum line current: 5 A_{rms}, at 50 Hz)	
Surge current	30 A (25 °C) peak for equal to or less than 5 line cycles, after the instrument has been turned off for at least 30s	
Cooling clearance	Bottom	2 cm (0.8 in)
		NOTE: The feet on the bottom provide the required clearance when set on a flat surface.
	Sides	15 cm (6 in)
	Rear	7.5 cm (3 in)

Table A-17: Environmental

Characteristics	Description
Atmospherics	
Temperature	
Operating	+10 °C to +40 °C
Nonoperating	–20 °C to +60 °C
Relative humidity	
Operating	20 % to 80 % (no condensation)
	Maximum wet-bulb temperature 29.4 °C
Nonoperating	5 % to 90 % (no condensation)
	Maximum wet-bulb temperature 40.0 °C
Altitude	(Hard disk drive restriction)
Operating	Up to 3 km (10 000 ft)
	Maximum operating temperature decreases 1 °C each 300 m (1 000 ft) above 1.5 km (5 000 ft)
Nonoperating	Up to 12 km (40 000 ft)
Dynamics	
Random vibration	
Operating	2.65 m/s^2 rms (0.27 Grms), from 5 Hz to 500 Hz, 10 minutes
Nonoperating	22.36 m/s^2 rms (2.28 Grms), from 5 Hz to 500 Hz, 10 minutes
Shock	
Nonoperating	294 m/s^2 (30 G), half-sine, 11 ms duration

Table A-18: Mechanical

Characteristics	Description	
Net weight (without package)	17 kg (37.5 lb)	
Dimensions (without package)	Height	178 mm (7.0 in) 194 mm (7.64 in) with Feet
	Width	422 mm (16.6 in) 434 mm (17.1 in) with Handle
	Length	560 mm (22.0 in) 602 mm (23.71 in) with Rear Feet
Net weight (with package)	25 kg (55.2 lb)	
Dimensions (with package)	Height	370 mm (14.6 in)
	Width	560 mm (22.0 in)
	Length	805 mm (31.7 in)

[mm]

Figure A-1: Dimensions

Certification and Compliances

The certification and compliances for the AWG610 Arbitrary Waveform Generator are listed in Table A–19.

Table A–19: Certifications and compliances

EC declaration of conformity	EC Council EMC Directive 89/336/EEC, amended by 93/68/EEC; EN61326-1: 1997 Product Family Standard for Electrical Equipment for Measurement, Control, and Laboratory Use–EMC Requirements.
	Emmisions:
	EN 55011 — Class A Radiated and Conducted Emissions
	EN 61000-3-2 — Power Line Harmonics
	Immunity:
	EN 61000-4-2 — Electrostatic Discharge Immunity
	EN 61000-4-3 — Radiated RF Electromagnetic Field Immunity
	EN 61000-4-4[1] — Electrical Fast Transient Immunity
	EN 61000-4-5 — Surge Immunity
	EN 61000-4-6 — Conducted Disturbances Induced by RF Field Immunity
	EN 61000-4-11 — Voltage Dips, Short Interruptions and Voltage Variations Immunity
	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:
	Low Voltage Directive 73/23/EEC
	EN 61010-1:1993 — Safety requirements for electrical equipment for measurement, control, and laboratory use
Australian declaration of conformity – EMC \	Conforms with the following standards in accordance with the Electromagnetic Compatibility Framework:
	AS/NZS 2064.1/2 — Class A radiated and Conducted Emissions
Safety	UL3111-1[2] – Standard for electrical measuring and test equipment
Third party certification	CAN/CSA C22.2 No. 1010.1[2] – Safety requirements for electrical equipment for measurement, control and laboratory use
Self declaration	IEC61010-1[2] – Safety requirements for electrical equipment for measurement, control, and laboratory use

[1] Up to 200 mV$_{p-p}$ noise is allowed on the output during this test.

[2] CSA C22.2 No. 1010.1, UL3111-1, IEC61010-1 Safety certification compliance:
Altitude (maximum opertating) : 2000 meters

Table A-19: Certifications and compliances (cont.)

Installation category	Power input — Installation Category II (as defined in IEC 61010 1, Annex J)	
	Terminals on this product may have different installation category designations. The installation categories are:	
	Category	Descriptions
	CAT III	Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location
	CAT II	Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected
	CAT I	Secondary (signal level) or battery operated circuits of electronic equipment
Pollution degree	Pollution Degree 2 (as defined in IEC 61010-1)	
	Secondary (signal level) or battery operated circuits of electronic equipment	