

# Appendix A: Specifications

This section contains the AWG610 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
<b>Internal clock <sup>1</sup></b>		
✓ Frequency accuracy	$\pm 1$ 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)	

<sup>1</sup> The internal reference oscillator is used.

**Table A-4: Internal trigger generator**

Characteristics	Description	PV reference page
<b>Internal trigger rate <sup>2</sup></b>		
✓ Accuracy	$\pm 0.1$ %	Page B-38
Range	1.0 $\mu$ s to 10.0 s	
Resolution	3 digits, minimum 0.1 $\mu$ s	

<sup>2</sup> The internal reference oscillator is used.

**Table A-5: Main output**

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

**Table A-5: Main output (Cont.)**

Characteristics <sup>3</sup>	Description	PV reference page
Offset		
Range	–1.000 V to 1.000 V, into a 50 $\Omega$ load	
Resolution	1 mV	
✓ Accuracy	$\pm$ (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 %)	$\leq$ 750 ps (amplitude = 1.0 V <sub>p-p</sub> , calculated value $\geq$ 466 MHz)	
Fall time (10 % to 90 %)	$\leq$ 750 ps (amplitude = 1.0 V <sub>p-p</sub> , calculated value $\geq$ 466 MHz)	
Aberration	$\pm$ 10 % (amplitude = 1.0 V <sub>p-p</sub> , using 6 GHz bandwidth oscilloscope)	
Flatness	$\pm$ 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	$\leq$ –40 dBc (DC to 800 MHz)	Page B-36
✓ Noise	$\leq$ –50 dBc (DC to 800 MHz)	
Phase Noise, Typical	$\leq$ –85 dBc / Hz (10 kHz offset)	
Direct DA out		
Amplitude		
Range	20 mV <sub>p-p</sub> to 1 V <sub>p-p</sub> , into a 50 $\Omega$ load	
✓ DC Accuracy	$\pm$ (2 % of Amplitude + 2 mV)	Page B-29
Resolution	1 mV	
✓ DC offset accuracy	0 V $\pm$ 10 mV, (20 mV amplitude, waveform data: 0)	Page B-29
✓ Pulse response	(Waveform data: –1 and 1, at 0.5 V <sub>p-p</sub> )	Page B-34
Rise time (10 % to 90 %)	$\leq$ 400 ps (calculated value $\geq$ 875 MHz)	
Fall time (10 % to 90 %)	$\leq$ 400 ps (calculated value $\geq$ 875 MHz)	

<sup>3</sup> 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 MHz 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
<b>Marker <sup>4</sup></b>		
Number of markers	2 (Complementary. Marker1, $\overline{\text{Marker1}}$ , Marker2, $\overline{\text{Marker2}}$ )	
Level (Hi/Low)	-1.10 V to +3.00 V, into a 50 $\Omega$ load -2.20 V to +6.00 V, into a 1 M $\Omega$ load	
Maximum Output	2.5 V <sub>p-p</sub> , into a 50 $\Omega$ load	
Resolution	0.05 V	
✓ Accuracy	Within $\pm$ (0.1 V +5 % of setting), into a 50 $\Omega$ load	Page B-58
Rise and fall times (20 % to 80 %), Typical	150 ps (2 V <sub>p-p</sub> , Hi: +1 V, Lo: -1 V, into a 50 $\Omega$ 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 <sub>p-p</sub> , Hi: +1 V, Lo: -1 V, at delay 0 ns)	
Period jitter Typical	Measured by TDS694C-1MHD with TDSJIT1 Refer to Table A-9.	
Cycle to cycle jitter Typical	Measured by TDS694C-1MHD with TDSJIT1 Refer to Table A-10.	
Connector	Front panel SMA connectors	
<b>1/4 Clock output</b>		
✓ Level	ECL 100 K compatible (internally loaded in 50 $\Omega$ to -2 V and 43 $\Omega$ series terminated)	Page B-54
Period jitter Typical	Measured by TDS694C-1MHD with TDSJIT1 Refer to Table A-9.	
Cycle to cycle jitter Typical	Measured by TDS694C-1MHD with TDSJIT1 Refer to Table A-10.	
Connector	Rear panel BNC connectors	
<b>10 MHz Reference clock out</b>		
✓ Amplitude	$\geq 1$ V <sub>p-p</sub> , into a 50 $\Omega$ load Max 3 V <sub>p-p</sub> , open	Page B-56
Impedance	50 $\Omega$ , AC coupling	
Connector	Rear panel BNC connector	

<sup>4</sup> The characteristics are specified at the end of the SMA cable (012-1565-XX).

Table A-8: Funcion Generator (FG)

Characteristics	Description																		
<b>Operation Mode</b>	Continuous mode only																		
<b>Waveform Shape</b>	Sine, Triangle, Square, Ramp, Pulse, DC																		
<b>Frequency</b>	1.000 Hz to 260.0 MHz																		
<b>Amplitude</b>																			
Range	0.020 V <sub>p-p</sub> to 2.000 V <sub>p-p</sub> , into a 50 Ω load																		
Resolution	1 mV																		
<b>Offset</b>																			
Range	-1.000 V to +1.000 V, into a 50 Ω load																		
Resolution	1 mV																		
<b>DC Level</b>	DC waveform only																		
Range	-1.000 V to +1.000 V, into a 50 Ω load																		
Resolution	1 mV																		
<b>Polarity</b>	Normal, Inverted																		
<b>Duty</b>																			
Range	0.1 % to 99.9 %																		
Resolution	<table> <tr> <th>Frequency</th><th>Resolution</th></tr> <tr> <td>1.000 Hz to 2.600 MHz</td><td>0.1 %</td></tr> <tr> <td>2.601 MHz to 13.00 MHz</td><td>0.5 %</td></tr> <tr> <td>13.01 MHz to 26.00 MHz</td><td>1.0 %</td></tr> <tr> <td>26.01 MHz to 52.00 MHz</td><td>2.0 %</td></tr> <tr> <td>52.01 MHz to 65.0 MHz</td><td>2.5 %</td></tr> <tr> <td>65.01 MHz to 104.0 MHz</td><td>4.0 %</td></tr> <tr> <td>104.1 MHz to 130.0 MHz</td><td>5.0 %</td></tr> <tr> <td>130.1 MHz to 260.0 MHz</td><td>10.0 %</td></tr> </table>	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 %
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 %																		
<b>Marker Out</b>																			
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
<b>Trigger input <sup>5</sup></b>		
Connector	Rear panel BNC connector	
Impedance	1 k $\Omega$ or 50 $\Omega$	
Polarity	POS (positive) or NEG (negative)	
Input voltage range	$\pm 10$ V, into a 1 k $\Omega$ load $\pm 5$ V, into a 50 $\Omega$ load	
Threshold		
Level	-5.0 V to 5.0 V	
✓ Accuracy	$\pm (5 \% \text{ of level} + 0.1 \text{ V})$	Page B-40
Resolution	0.1 V	
Pulse width	Minimum 10 ns, 0.2 V amplitude	
Trigger dead time	$\leq 576 \text{ clock} + 450 \text{ ns}$	
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
<b>Event trigger input</b>		
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 k $\Omega$ , 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)	
<b>Reference 10 MHz clock input</b>		
Input voltage range	0.2 V to 3.0 V <sub>p-p</sub> (into a 50 $\Omega$ load, AC coupling) Maximum $\pm 10$ V	
Impedance	50 $\Omega$ , AC coupling	
Reference frequency	10 MHz $\pm 0.1$ MHz	
Connector	Rear panel BNC connector	

<sup>5</sup> The characteristics are specified at the end of the BNC cable (012-0482-00).

**Table A-12: Display and timer**

Characteristics	Description
<b>Display</b>	
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
<b>Timer</b>	
Operation life	6 years
Type	Li 3 V, 190 mAh

**Table A-15: Interface connectors**

Characteristics	Description
GPIOB	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
<b>Heat dissipation</b>	
Maximum power	400 W (maximum line current: 5 A <sub>rms</sub> , at 50 Hz)
<b>Surge current</b>	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
<b>Cooling clearance</b>	<div>Bottom      2 cm (0.8 in)</div> <div><i><b>NOTE:</b> The feet on the bottom provide the required clearance when set on a flat surface.</i></div> <div>Sides        15 cm (6 in)</div> <div>Rear         7.5 cm (3 in)</div>

**Table A-17: Environmental**

<b>Characteristics</b>	<b>Description</b>
<b>Atmospherics</b>	
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)
<b>Dynamics</b>	
Random vibration	
Operating	2.65 m/s <sup>2</sup> rms (0.27 Grms), from 5 Hz to 500 Hz, 10 minutes
Nonoperating	22.36 m/s <sup>2</sup> rms (2.28 Grms), from 5 Hz to 500 Hz, 10 minutes
Shock	
Nonoperating	294 m/s <sup>2</sup> (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)

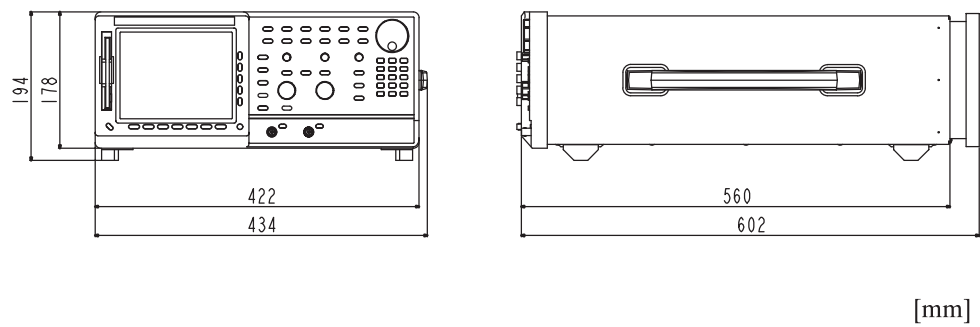


Figure A-1: Dimensions