AWG4162
Arbitrary Waveform Generator
Specifications and Performance Verification

Technical Reference

Rev C
www.tek.com

077-1197-00

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For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tek.com to find contacts in your area.

Warranty

Tektronix warrants that the product will be free from defects in materials and workmanship for a period of three (3) years from the date of original purchase from an authorized Tektronix distributor. If the product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Batteries are excluded from this warranty. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, shipping charges prepaid, and with a copy of customer proof of purchase. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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[W16 – 15AUG04]

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page vii, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Do not use the provided power cord for other products.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Use only insulated voltage probes, test leads, and adapters supplied with the product, or indicated by Tektronix to be suitable for the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component of a product, probe, or accessory. Use caution when using 1:1 test leads because the probe tip voltage is directly transmitted to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged, if there is exposed metal, or if a wear indicator shows.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

Use only the Tektronix rackmount hardware specified for this product.

Keep product surfaces clean and dry. Remove the input signals before you clean the product. Inspect the instrument as often as operating conditions require. To clean the exterior surface, perform the following steps:

1. Remove loose dust on the outside of the instrument with a lint-free cloth. Use care to avoid scratching the clear glass display filter.
2. Use a soft cloth dampened with water to clean the instrument. Use an aqueous solution of 75% isopropyl alcohol for more efficient cleaning.

CAUTION. *Avoid getting moisture inside the unit during external cleaning. Use only enough cleaning solution to dampen the cloth or swab. To avoid damage to the instrument, do not expose it to sprays, liquids, or solvents, and do not use any abrasive or chemical cleaning agents.*

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

Terms in this manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

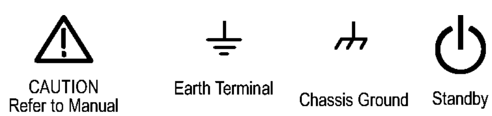
Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect Power. To avoid electric shock, disconnect the mains power by means of the power cord or, if provided, the power switch.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This manual provides product specifications and instructions to verify performance of the AWG4162 Arbitrary Waveform Generator.

To prevent personal injury or damage to the instrument, consider the following before attempting service:

- The procedures in this manual should be performed only by a qualified service person.
- Read the *General Safety Summary* and the *Service Safety Summary* at the beginning of this document.

When using this manual for servicing, be sure to follow all warnings, cautions, and notes.

The manual consists of the following sections:

- *Specifications* contains a description of the instrument and the characteristics that apply to it.
- *Performance Verification* contains procedures for confirming that the instrument functions properly and meets warranted limits.

  The procedures described in this document should be performed every 12 months or after module replacement.

  If the instruments do not meet performance criteria, repair is necessary.

Finding other information

See the following list for other documents supporting your instrument. These documents are available online at www.tek.com/manuals.

Document	Description
AWG4162 Printable Help	A help system, integrated with the User Interface, that provides operating instructions. A PDF of this document is also available online at www.tek.com/manuals.
AWG4162 Advanced Application Programmer Manual	A manual that provides programmers with the commands and syntax for remotely controlling the instrument when the Advanced Application mode is running.
AWG4162 Basic Application Programmer Manual	A manual that provides programmers with the commands and syntax for remotely controlling the instrument when the Basic Application mode is running.

Manual conventions

This manual uses certain conventions that you should become familiar with.

Some sections of the manual contain procedures for you to perform. To keep those instructions clear and consistent, this manual uses the following conventions:

- Front-panel controls and menu names appear in the same case (initial capitals, all uppercase, and so on) in the manual as is used on the instrument front-panel and menus. Front-panel labels are all upper case letters (for example, MENU, SELECT, PULSE GEN, and so on).
- Instruction steps are numbered unless there is only one step.

Modules

Throughout this manual, any replaceable component, assembly, or part of the instrument is referred to generically as a module. In general, a module is an assembly (such as a circuit board). Sometimes a single component is a module; for example, the chassis of the instrument is a module.

Safety

Symbols and terms related to safety appear in the Safety Summary near the beginning of this manual.

Specifications

All specifications are guaranteed unless labeled "typical". Typical specifications are provided for your convenience, but are not guaranteed.

Specifications that are check marked with the ✓ symbol are checked directly in the Performance Verification section.

All specifications apply to the arbitrary function generator unless noted otherwise. These specifications are valid under the following conditions:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must be operating at an ambient temperature between 5 °C and +50 °C.
- The instrument must have had a warm-up period of at least 30 minutes.
- The instrument must be in an environment with temperature, altitude, and humidity within the operating limits described in these specifications.

NOTE. *For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Electrical specifications

Table 1: Clock generator

Characteristic	Description
Sampling rate control	100 S/s to 2.5 GS/s Resolution: 8 digits; 100 S/s 2 channels can be set to different sampling rates. Each channel's sampling clock is individual.
Internal clock stability	±0.28 x 10^{-6} (Frequency stability vs. change in temperature.) Holdover stability: ±0.32 x 10^{-6} (Inclusive of frequency stability, supply voltage changes (±1%), aging, for 24 hours.) Constant temperature stability: ±40 x 10^{-9}
Internal clock aging, typical	Per life (20 years): within ±3 x 10^{-6} Per day: within ±40 x 10^{-9}
Reference oscillator error (cumulative)	Total reference frequency error, one year after factory adjustment, at any temperature within operating limits. ±1.6 x 10^{-6} /year Includes allowances for Aging per Year, Reference Frequency Calibration Accuracy, and Temperature Stability. Aging Per Year: ±1.0 x 10^{-6}
Reference oscillator calibration accuracy	±1.0 × 10^{-6} when operated within 25 °C ±5 °C, after 30 minute warm-up
Reference oscillator aging	Within ±1.0 x 10^{-6} /year

Table 2: Skew control (analog to analog skew)

Characteristic	Description
Range	0 ps to 240000 ps (at 2.5 GS/s) (Shift clock using delay line.)
Resolution	10 ps
Accuracy, typical	±(10% of effective setting + 20 ps) at 2.5 GS/s
Internal	< 200 ps from 1.25 GSa/s to 2.5 GSa/s < 1 ns below 1.25 GSa/s

Table 3: Skew control (analog to digital skew)

Characteristic	Description
Range	0 ps to 101790 ps (at 2.5 GS/s)
Resolution	78 ps
Accuracy, typical	±(10% of effective setting + 140 ps)
Internal	< 1.4 ns from 1.25 GSa/s to 2.5 GSa/s < 2 ns from 100 MSa/s to 1.25 GSa/s < 4.5 ns below 100 MSa/s

Table 4: Skew control (analog to trigger/marker skew)

Characteristic	Description
Range	0 ps to 101790 ps (at 2.5 GS/s)
Resolution	78 ps
Accuracy, typical	±(10% of effective setting + 140 ps)
Internal	< 1.4 ns from 1.25 GSa/s to 2.5 GSa/s < 2 ns from 100 MSa/s to 1.25 GSa/s < 4.5 ns below 100 MSa/s

Table 5: Operating mode for Basic, nominal

Characteristic	Description
Basic mode	Uses Direct Digital Synthesis (DDS) techniques. It is the prevailing signal generator architecture in the industry today. This mode offers fewer waveform variations than Advanced mode, but with excellent stability and fast response to frequency change. It can switch almost instantly between two frequencies/waveforms. Basic mode also offers a way to modulate the signal from internal or external sources, which is essential for some types of standards compliance testing. In this mode, the sampling clock is fixed.
Run mode	Continuous, Modulation, Sweep, and Burst
Burst count	1 to 1,000,000 cycles or infinite
Internal trigger delay	0 to 100 s Resolution: 1 ps, 15 digits

Table 5: Operating mode for Basic, nominal (cont.)

Characteristic	Description
Internal trigger delay accuracy, typical	±(1% setting + 50 ps)
Internal trigger interval range	1 µs to 500 s Resolution: 2 ns, 12 digits

Table 6: Waveforms (Basic mode), nominal

Characteristic	Description
Standard	Sine, Square, Pulse, Ramp, More (Sin(x)/x, Noise, DC, Gaussian, Lorentz, Exponential Rise, Exponential Decay, and Haversine)
Arbitrary waveform	User defined waveforms. Users can edit and save their own waveforms.
Waveform length	16384/Channel
Sampling rate	2.5 GS/s
Resolution	14 bits

Table 7: Analog output (Basic mode), Frequency/Period

Characteristic	Description
Frequency/Period	
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, Gaussian, Lorentz, Haversine	1 µHz to 60 MHz
Arbitrary	1 µHz to 400 MHz
Noise, typical	1 µHz to 400 MHz
Resolution	1 µHz or 15 digits (sine, square, pulse, arbitrary)
	1 µHz or 14 digits (ramp, Sin(x)/x, Gaussian, Lorentz, exponential rise, exponential decay, Haversine)
Accuracy ✓	±10^{-6} setting (except Arbitrary), 5°C to 50°C ±10^{-6} setting ±1 µHz (Arbitrary), 5°C to 50°C
Stability ✓	±1.6 x 10^{-6} / year
Accuracy aging	±1.0 x 10^{-6} / year
Range	
50 Ω load, single ended	–2.5 V to +2.5 V
High Z load, single ended	–5 V to +5 V
Resolution	1 mV or 4 digits
Accuracy ✓	50 Ω load, single ended: 1% of |setting| +5 mV

Table 8: Analog output (Basic mode), Amplitude

Characteristic	Description
Amplitude	
Range	
50 Ω load, single ended	1 µHz to 350 MHz: 5 mVpp to 5 Vpp 350 MHz to 550 MHz: 5 mVpp to 3 Vpp 550 MHz to 600 MHz: 5 mVpp to 2 Vpp
100 Ω load, differential ended	1 µHz to 350 MHz: 10 mVpp to 10 Vpp 350 MHz to 550 MHz: 10 mVpp to 6 Vpp 550 MHz to 600 MHz: 10 mVpp to 4 Vpp
Accuracy	At Frequency: 1 kHz (Sine waveform), Amplitude >5 mVpp, Offset: 0 V and Unit: Vpp; 50 Ω load. 1% of |setting| +5 mV
Resolution	1 mVpp or 4 digits
Unit	Vpp, Vrms, dBm, Volt (high level and low level)
Output impedance	Single ended: 50 Ω Differential: 100 Ω
Isolation	No Isolation. All SMA and BNC grounds are connected to earth directly

Table 9: Analog output (Basic mode), Vocm

Characteristic	Description
Vocm (50 Ω)	
Range	
50 Ω load, single ended	–2.5 V to +2.5 V
High Z load, single ended	–5 V to +5 V
Resolution	1 mV or 4 digits
Accuracy	50 Ω load, single ended: 1% of |setting| +5 mV

Table 10: Analog output (Basic mode), Offset

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

Table 11: Analog output (Basic mode), Window

Characteristic	Description
Window	
Range	
50 Ω load, single ended	1 µHz to 350 MHz: –5 V to +5 V 350 MHz to 550 MHz: –4 V to +4 V 550 MHz to 600 MHz: –3.5 V to +3.5 V
100 Ω load, differential ended	1 µHz to 350 MHz: –10 V to +10 V 350 MHz to 550 MHz: –8 V to +8 V 550 MHz to 600 MHz: –7 V to +7 V
High Z load, single ended	1 µHz to 350 MHz: –10 V to +10 V 350 MHz to 550 MHz: –8 V to +8 V 550 MHz to 600 MHz: –7 V to +7 V

Table 12: Analog output (Basic mode), Sine wave

Characteristic	Description
Sine wave characteristics (50 Ω, single ended)	
Flatness ✓	At amplitude 1.0 Vpp (+4 dBm), relative to 1 kHz: DC to 600 MHz: ±0.5 dB
Harmonic distortion ✓	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 (THD), typical	At amplitude 1 Vpp 10 Hz to 20 kHz: <0.1%
Spurious (non-harmonic) ✓	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, typical	1 MHz: < –115 dBc/Hz 10 MHz: < –110 dBc/Hz 100 MHz: < –105 dBc/Hz 600 MHz: < –90 dBc/Hz

Table 13: Analog output (Basic mode), Square wave

Characteristic	Description
Square wave	
Rise/fall time, typical	1 ns at 1 Vpp
Jitter (rms), typical	50 ps
Overshoot, typical	<–2% at 1 Vpp

Table 14: Analog output (Basic mode), Pulse

Characteristic	Description
Pulse	
Pulse width	1 ns to (period-1 ns) Resolution: 10 ps or 15 digits
Pulse duty	0.1% to 99.9% Resolution: 0.1%, 3 digits
Leading/Trailing Edge Transition Time	Leading Time and Trailing Time can be set independently: At 10% to 90% of amplitude for leading time: 800 ps to 1000 s Resolution: 1 ps or 15 digits
Overshoot, typical	< –2% at 1 Vpp
Jitter (rms), typical	50 ps

Table 15: Ramp

Characteristic	Description
Linearity, typical	Frequency: <10 kHz, Amplitude: 1 Vpp, Symmetry: 100% ≤ 0.1% of peak output at 10% to 90% of amplitude range
Symmetry	0% to 100.0%

Table 16: Arbitrary

Characteristic	Description
Analog bandwidth, typical	400 MHz
Rise/fall time	0% to 100.0%
Jitter (rms), typical	400 ps
Waveform length	2 to 16384 points per channel at 2.5 GHz

Table 17: DC

Characteristic	Description
Range	–2.5 V to +2.5 V
Accuracy	±(1% of | DC setting | + 5 mV)

Table 18: Basic Mode Modulation

Characteristic	Description
Carrier waveform (Except PWM)	Standard Waveforms (except Pulse, DC and Noise), ARB
Carrier waveform (PWM only)	Pulse
Modulation source	Internal or External (from Mod Input)
Internal modulating waveforms	Sine, Square, Ramp, Noise, ARB
Modulating frequency (For AM, FM, PM only)	Internal: 500 µHz to 50 MHz External: Max 10 MHz
Key rate (For FSK, PSK only)	Internal: 500 µHz to 50 MHz External: Max 10 MHz
Amplitude modulation (AM)	
Depth	0.00% to +120.00%
Frequency modulation (FM)	
Peak deviation	DC to 300 MHz
Phase modulation (PM)	
Phase deviation range	0.00 to +180.00 degrees
Frequency Shift Keying (FSK)	

Table 18: Basic Mode Modulation (cont.)

Characteristic	Description
Hop frequency	1 µHz to 600 MHz
Numbers of key	2
Phase Shift Keying (PSK)	
Hop phase	–180.00 to +180.00 degrees
Numbers of key	2
Pulse Width Modulation (PWM)	
Deviation range	0% to 50% of pulse period

Table 19: Sweep

Characteristic	Description
Type	Linear, Logarithm, staircase and user defined
Start/Stop frequency	1 µHz to 600 MHz
Sweep time	Range: 50 µs to 2000 s Resolution: 20 ns or 12 digits Total Sweep Time = Sweep Time + Hold Time + Return Time ≤2000s
Hold/return time	Range: 0 µs to 2000 s – 50 µs Resolution: 20 ns or 12 digits Total Sweep Time = Sweep Time + Hold Time + Return Time ≤2000s
Total sweep time accuracy, typical	Less than 0.4%
Trigger source	Internal, External, Manual

Table 20: Advanced channel functionality

Characteristic	Description
Arbitrary	In Arbitrary mode it can define different waveforms by means of a sequencer. The sequence decides how these waveforms are generated at the outputs of the device. There are three different kinds of waveforms that can be defined: analog waveforms, digital waveforms or mixed (analog digital) waveforms.

Table 21: Operating mode for Advanced, nominal

Characteristic	Description
Advanced mode	Can produce any waveform imaginable. A variety of methods are available to draw the waveform to create the needed output. It is a sophisticated playback system that delivers waveforms based on stored digital data that describes the constantly changing voltage levels of an AC signal. In this mode, the sampling clock is variable.
Run mode	Continuous, Sequence, Triggered, Gated

Table 22: Advanced run mode

Characteristic	Description
Continuous mode	The specified waveform outputs continuously and iteratively. A continuous waveform is output. Only one entry is allowed in the Sequence Window.
Sequence mode	The sequence mode outputs the waveform according to the sequence table, including loop and conditional jump. Waveform is output as defined by the sequence selected. Multiple waveforms can be output in the order specified in the Sequence Window.
Triggered mode	An arbitrary waveform is output only once when it get trigger signal. After the waveform is output the instrument waits for the next trigger signal. The trigger condition is defined in terms of event. The event could be defined as a logical operation of trigger in, timer, force trigger and marker. Only one entry is allowed in the Sequence Window. Using the PI commands, the instrument Run Mode can be programmed in the same mode of advanced UI, so triggered mode can be selected.
Gated mode	The gated mode continuously outputs the waveform or sequence as long as the trigger remains enabled. Every time the trigger is asserted, the output starts from the beginning. The start and stop conditions are defined in terms of event. The event could be defined as a logical operation of trigger in, timer, force trigger and marker. Only one entry is allowed in the Sequence Window. Using the PI commands, the instrument Run Mode can be programmed in the same mode of advanced UI, so gated mode can be selected.

Table 23: Waveforms (Advanced mode), nominal

Characteristic	Description
Standard	
Analog waveforms	DC, Sine, Cosine, Triangle, Rectangle, Sawtooth, Increase-ramp, Decrease-ramp, Pulse, Sinc, Exponential, Sweep
Arbitrary	Formula, file, user defined
Additional	Noise and Filter can be applied to the waveforms above

Table 23: Waveforms (Advanced mode), nominal (cont.)

Characteristic	Description
Digital waveforms	Support 32 channels of digital waveform output
Waveform length	64 to 64M points (1M = 1024x1024) In multiple of 64 points for length <320 points In multiple of 16 points for length ≥320 points
Number of waveforms	Up to 16,384 user defined waveforms Pre-defined waveforms are not included
Resolution	14 bits
Sequence length	1 to 16,384
Sequence controls	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, sync. or asynch), Jump to (sync. or asynch). Both groups can operate either in single or dual sequence modes: Groups1 includes analog1 and digital[15:0], Groups2 includes analog2 and digital[31:16]. In multi-sequencer mode, each channel has its own sequence. In single sequencer mode, all channels share the same sequence.
Repeat count	1 to 2,097,151 or Infinite
Jump timing	Synchronous or asynchronous selectable

Table 24: Analog output of Advanced Mode (AMP/Direct DAC/AC)

Characteristic	Description
Common characteristics	
Connector	SMA on front panel
Output type	(+) and (-) Differential output and AC coupling output
Output impedance	50 Ω, single-ended 100 Ω, differential
On/Off control	Output relay is available for each channel. A control is common to the complementary output.
Skew between (+) and (–) output, typical	Less than 20 ps, when in Direct output mode; Normal mode
Bandwidth	
Calculated bandwidth, typical	AMP: 400 MHz Direct DAC: 750 MHz AC: 750 MHz
Amplitude	

Table 24: Analog output of Advanced Mode (AMP/Direct DAC/AC) (cont.)

Characteristic	Description
Range	50 Ω load, single ended. AMP: 0 - 5 Vpp Direct DAC: 0 - 0.8 Vpp AC: 0 - 2 Vpp In the case of differential output or high Z load, the amplitude is twice that of single ended with 50 Ω load. AMP mode: At frequency: >300 Hz to 550 MHz 0 Vpp to 3 Vpp, single ended, 50 Ω load At frequency: >550 Hz to 600 MHz 0 Vpp to 2 Vpp, single ended, 50 Ω load
Accuracy (For AMP and Direct DAC mode) ✓	At frequency: 1 KHz (sine waveform) Offset 0 V and Unit: Vpp Accuracy (AMP, Direct DAC): ±(1% of |setting| + 5 mV) At frequency: 100 MHz (sine waveform) Offset 0 V and Unit: Vpp AC amplitude changes 1 mV/degree (1Vpp)
Accuracy, typical (For AC mode)	At frequency: 100 MHz (sine waveform) Offset 0 V and Unit: Vpp AC: ±(2% of |setting| + 5 mV) – (room temperature –23) x 0.1% setting. AC amplitude changes 1 mV/degree (1Vpp)
Resolution	AMP, Direct DAC, AC: 0.1 mV or 5 digits
Offset	
Range	50 Ω load, single ended. AMP: –2.50 V - + 2.50 V Direct DAC: –0.35 V - + 0.35 V In the case of differential output or high Z load, the amplitude is twice that of single ended with 50 Ω load.
Accuracy ✓	50 Ω load Direct DAC: ±(1% of |setting| + 5 mV) AMP: ±(1% of | setting| + 5 mV)
Resolution	AMP mode, DAC, AC: 10 mV or 3 digits
Vocm	
Range	50 Ω load, single ended. AMP: –2.50 V - + 2.50 V Direct DAC: –0.35 V - + 0.35 V In the case of differential output or high Z load, the amplitude is twice that of single ended with 50 Ω load.

Table 24: Analog output of Advanced Mode (AMP/Direct DAC/AC) (cont.)

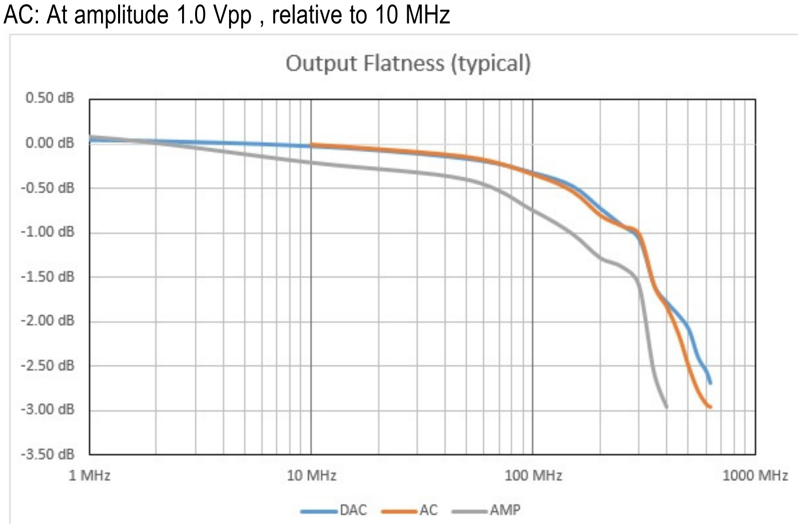
Characteristic	Description
Accuracy	50 Ω load Direct DAC: ±(6% of │Vocm output range│+ 5 mV) AMP: ±(1% of │setting│+ 5 mV)
Resolution	AMP mode, DAC, AC: 10 mV or 3 digits
Voltage window range	In the case of differential output or high Z load, the amplitude is twice that of single ended with 50 Ω load. No DC offset applied in AC mode. Window includes Max DC Vocm (± 2.5 V) for AMP. 50 Ω load, single ended.
1 µHz to 300 MHz	AMP: –5 V - + 5 V Direct DAC: –0.4 V - + 0.4 V AC: –1 V - +1 V
>300 MHz to 550 MHz	AMP: –4 V - + 4 V
>300 MHz to 600 MHz	Direct DAC: –0.4 V - + 0.4 V AC: –1 V - +1 V
>550 MHz to 600 MHz	AMP: –3.5 V - + 3.5 V
Main output	
Level flatness, typical	In different mode: AMP: At amplitude 1.0 Vpp , relative to 100 kHz; AMP mode is LPF ON DAC: At amplitude 0.5 Vpp , relative to 100 kHz AC: At amplitude 1.0 Vpp , relative to 10 MHz 

Table 24: Analog output of Advanced Mode (AMP/Direct DAC/AC) (cont.)

Characteristic	Description
Harmonic distortion, typical	Direct DAC: amplitude 0.5 Vpp (single-ended) AMP: amplitude 1 Vpp (single-ended) AC: amplitude 1 Vpp Sampling clock: 2.5 GS/s
Sine wave 32 points (78.125 MHz)	AMP (single): < -56 dBc AMP (differential): < -56 dBc Direct DAC (single): < -60 dBc Direct DAC (differential): < -60 dBc AC: < -56 dBc
Spurious (non-harmonic), typical	Direct DAC: amplitude 0.5 Vpp (single-ended) AMP: amplitude 1 Vpp (single-ended) AC: amplitude 1 Vpp Sampling clock: 2.5 GS/s
Sine wave 32 points (78.125 MHz)	AMP (single): < -62 dBc AMP (differential): < -62 dBc Direct DAC (single): < -62 dBc Direct DAC (differential): < -62 dBc AC: < -55 dBc
Spurious free dynamic range (SFDR), typical	Direct DAC: amplitude 0.5 Vpp (single-ended) AMP: amplitude 1 Vpp (single-ended) AC: amplitude 1 Vpp Sampling clock: 2.5 GS/s
Sine wave 32 points (78.125 MHz)	AMP (single): < -56 dBc AMP (differential): < -56 dBc Direct DAC (single): < -60 dBc Direct DAC (differential): < -60 dBc AC: < -55 dBc
Phase noise, typical (10 kHz offset)	
39.0625 MHz	AMP: –115 dBc/Hz Direct DAC: –115 dBc/Hz AC: –115 dBc/Hz
78.125 MHz	AMP: –110 dBc/Hz Direct DAC: –110 dBc/Hz AC: –110 dBc/Hz
156.25 MHz	AMP: –105 dBc/Hz Direct DAC: –105 dBc/Hz AC: –105 dBc/Hz

Table 24: Analog output of Advanced Mode (AMP/Direct DAC/AC) (cont.)

Characteristic	Description
312.5 MHz	AMP: –100 dBc/Hz Direct DAC: –100 dBc/Hz AC: –100 dBc/Hz
Rise/fall time, typical (10% to 90%)	AMP: 800 ps Direct DAC: 450 ps AC: 450 ps
Overshoot, typical	AMP: <2% Direct DAC: <1% AC: <2%
Random jitter on clock pattern, typical (By 0101.. clock pattern, Amplitude = 1.0 Vpp, Offset = 0 V)	AMP: <5 ps rms Direct DAC: <5 ps rms
Total jitter on random pattern, typical (PN15 pattern, Amplitude = 1.0 Vpp, Offset = 0 V) (Measured at Bit Error Rate = 1e-12)	AMP: <150 ps peak to peak at 625 Mbit/s Direct DAC: <150 ps peak to peak at 625 Mbit/s

Table 25: Auxiliary ports: Marker output

Characteristics	Description
Connector	SMA on the front panel
Number of outputs	Marker-1 and Marker-2 are available for analog channel 1 and analog channel 2, respectively
Output impedance	50 Ω
Output level	Range: 1 to 2.5 V into 50 Ω Resolution: 10 mV
Output level accuracy, typical	±(2% of setting + 10 mV)
Variable delay controls	Available for Marker-1 and Marker-2, relative to analog channels. Range: 0 to 60606 ps Resolution: 78 ps
Variable delay accuracy, typical	±(10% of setting + 140 ps)
Rise/fall time, typical	<800 ps (10% to 90% of swing), when Hi = 2.5 V, Low = 0 V
Total jitter on random pattern, typical	155 ps peak-peak (PN15 Pattern, when Hi = 2.5 V, Low = 0 V) (Measured at bit error rate = $1e^{-12}$)

Table 26: Auxiliary ports: Trigger/Gate input

Characteristics	Description
Connector	SMA on the front panel
Input impedance	1.1 kΩ
Slope/polarity	Positive or negative selectable
Input damage level	< -15V or > +15V
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 Vpp min
Minimum pulse width	12 ns
Initial trigger delay to analog output, typical	Basic mode: 832 sampling clock cycles ± 1 cycle (at 2.5 GSps fixed sampling rate) Advanced mode: 20 ns + 2288 sampling clock cycles ± 1 cycle
Initial gate delay to analog output, typical	Basic mode: 832 sampling clock cycles ± 1 cycle (at 2.5 GSps fixed sampling rate) Advanced mode: 20 ns + 2288 sampling clock cycles ± 1 cycle
Trigger IN to output jitter, typical	Basic mode, Advanced mode, Digital output, Analog output, DAC, AMP, Marker out:, ±2 sampling periods

Table 27: Auxiliary ports: Digital output (with option)

Characteristics	Description
Connector	FCI EYE on the front panel
Number of outputs	32 (16 bits x 2 groups)
Output impedance	100 Ω differential
Type of output	LVDS
Rise/fall time, typical	600 ps (10% to 90%)
Initial skew between digital output, typical	Less than 500 ps between each group output
Total jitter random pattern, typical	150 ps peak-peak at 1.25 Gbps By PN15 Pattern, when Hi = 2.5 V, Low = 0 V Measured at bit error rate = $1e^{-12}$
Maximum update rate	Arb mode 16 Ch: 1.25 Gbps Arb mode 32 Ch: 625 Mbps

Table 28: Auxiliary ports: Memory depth (Digital output (with option))

	Analog memory depth			
	1M	**16M**	**32M**	**64M**
Arb mode 16 Ch	0.5M	8M	16M	32M
Arb mode 32 Ch	0.25M	4M	8M	16M

Table 29: Auxiliary ports: Sync In/Out

Characteristics	Description
Function	Sync In and Out provide a mechanism to synchronize multiple instruments
Connector	Infiniband 4X on rear panel
Master to slave delay, typical	48.6 ns

Table 30: Auxiliary ports: Reference clock input

Characteristics	Description
Connector	SMA on the rear panel
Input impedance	50 W, AC coupled
Input voltage range	–5 dBm to 4 dBm sine or square wave Damage level: +8 dBm max; ±15 V DC max
Variable input frequency range	10 MHz to 80 MHz Resolution: 1 MHz

Table 31: Auxiliary ports: 10 MHz reference clock output

Characteristic	Description
Connector	SMA on rear panel
Output impedance	50 Ω, AC coupled
Frequency	10 MHz Accuracy: $\pm 1.0 \times 10^{-6}$ Aging: $\pm 1.0 \times 10^{-6}$ /year
Amplitude, typical	1.6 Vpp into 50 Ω 3.2 Vpp into high impedance
Jitter, typical	11.5 psrms

Table 32: Auxiliary ports: External sampling clock input

Characteristic	Description
Connector	SMA on rear panel
Input impedance	50 Ω, AC coupled
Number of inputs	2, one for each input
Frequency range	1.25 GHz to 2.5 GHz
Input voltage range	-5 dBm to 4 dBm Damage level: +8 dBm max Damage level: ±15 V DC max

Table 33: Auxiliary ports: External modulation input

Characteristic	Description
Connector	BNC on rear panel
Input impedance	10 kΩ
Number of inputs	2, one for each input
Bandwidth	10 MHz with 50 MS/s sampling rate
Input voltage range	-1 V to +1 V (except FSK, PSK) 3.3 V, FSK, PSK
Vertical resolution	14 bits

General specifications

Table 34: Power

Characteristic	Description
Source voltage and frequency	100 V to 240 V, 45 Hz to 66 Hz 115 V, 360 to 440 Hz
Power consumption	Less than 150 W
Surge current	30 A peak (25° C) for ≤5 line cycles, after product has been turned off for at least 30 s.

Table 35: Environmental

Characteristic	Description
Temperature range	
Operating	5 °C to +50 °C
Non operating	-20 °C to +60 °C
Humidity	
Operating (non condensing)	8% to 90% relative humidity with a maximum wet bulb temperature of 29° C at or below +50° C, (upper limit de–rates to 29.8% relative humidity at +60° C)
Non operating (non condensing)	5% to 98% relative humidity with a maximum wet bulb temperature of 40° C at or below +60° C, (upper limit de–rates to 29.8% relative humidity at +60° C)
Altitude	
Operating	Up to 3,000 meters (9,843 feet)
Non operating	Up to 12,000 meters (39,370 feet)

Table 36: Physical characteristics

Characteristic	Description
Net weight, typical	6.5 kg (14.2 lbs)
Net weight with packaging, typical	11.5 kg (25.2 lbs)

Table 36: Physical characteristics (cont.)

Characteristic	Description
Dimensions	Height: 233 mm (9.173 in) Width: 439 mm (17.283 in) Depth: 199 mm (7.835 in)
Clearance required for cooling	50.8 mm (2.0 in) Left side (when looking at the front of the instrument) and rear.

Performance verification

The following types of performance verification procedures can be performed on this product. You may not need to perform all of these procedures, depending on what you want to accomplish.

- Self tests: Perform to quickly confirm that the instrument is operating properly. These tests take little time and check the overall functionality of the internal hardware of the instrument.
- Performance tests: Perform to directly check warranted specifications. These tests require additional equipment and time to execute than the self tests.

NOTE. *The performance verification procedures are not calibration procedures. The performance verification procedure only verifies that your instrument meets key specifications. For your instrument to be calibrated, it must be returned to a Tektronix service facility.*

Prerequisites

All of the tests in this section confirm performance and functionality when the following requirements are met:

- The instrument is operating in an environment that meets the temperature, altitude, and humidity characteristics listed in the specifications.
- The instrument is completely assembled and covers installed per factory specification.
- The instrument has been operating for a warm-up period of at least for 30 minutes.
- The instrument must be operating at an ambient temperature between +5 °C and +50 °C.

Performance conditions

In addition to the above requirements, all of the performance tests in this section comprise an extensive, valid confirmation of performance and functionality when the following additional requirement is met:

- The instrument must have been performed and passed the calibration and diagnostics self tests.

Self tests

Diagnostics

This procedure uses internal routines to verify that the instrument is operating correctly. It should be performed in Basic mode.

1. Power on the instrument and allow it to warm up for 30 minutes. The instrument must be operating at an ambient temperature between +5 °C and +50 °C.
2. Press the Basic button to launch the Basic application.
3. Select System > Tools > Warm up Timer.
4. After the 30 minutes of warm up time, press or click the Self Diagnostics button to start the test.
5. Wait until the test is complete.
6. Check the diagnostics results:
   - PASSED: Displays if the test completes without finding any problems.
   - Error code: An error code is displayed when an error is detected. Error codes are described in the Error Codes section of this document. (See page 27, *Error codes*.)
7. Press the X icon in the application to exit the diagnostics.

Calibration

This procedure uses internal routines to verify that the instrument is operating correctly. It should be performed in Basic mode.

CAUTION. *Do not turn off the power while executing a calibration. If the power is turned off during calibration, data stored in internal nonvolatile memory may be lost.*

1. Power on the instrument and allow it to warm up for 30 minutes. The instrument must be operating at an ambient temperature between +5 °C and +50 °C.
2. Press the Basic button to launch the Basic application.
3. Select System > Tools > Warm up Timer.
4. After the 30 minutes of warm up time, press or click the Self Calibration button to start the test.
5. Wait until the test is complete.

6. Check the calibration results:
   - PASSED: Displays if the test completes without finding any problems.
   - Error code: An error code is displayed when an error is detected. Error codes are described in the Error Codes section of this document. (See page 27, *Error codes*.)
7. Press the X icon in the application to exit the calibration.

Error codes

If a malfunction is detected during a self test, the instrument displays the character string "Fail" and error codes. There is also a log file with detailed information. The following tables show error codes.

Table 37: INIT and SYNCH error codes

Sub error code	Step description
1300000	GET_DEVICE_NUM
1300010	CREATE_DEVICE_DATA
1300020	CREATE_DEVICE
1300030	SET_TIMING
1300040	SET_CHANNEL_ON
1300050	CHECK_DEVICE
1301000	CHECK_DEVICE_DATA
1301010	GET_SERIAL_NUMBER
1301020	GET_DEVICE_MODEL
1301030	GET_MEMORY_OPTION
1301040	GET_DIGITAL_OPTION
1301050	LOAD_CONTROL_FPGA_FIRMWARE
1301060	RESET_RELAIS
1301070	CHECK_DEVICE_MODEL
1301080	SET_REFERENCE_CLOCK
1301090	LTC2265_INITIALIZATION
1301100	AD5390_RESET
1301110	AD5390_SET_REFERENCE
1301120	TRIGGER_INITIALIZATION
1301130	SET_MARKER_LEVEL
1301140	READ_FREQUENCY_TUNING_PARAMETER
1301150	SET_FREQUENCY_TUNING
1301160	CREATE_CHANNEL_DATA
1301170	CREATE_CHANNEL

Table 37: INIT and SYNCH error codes (cont.)

Sub error code	Step description
1001000	CHECK_DEVICE_DATA
1001180	SET_SIMULATE_START_FROM_MASTER
1001190	RESET_SIMULATE_START_FROM_MASTER
1001200	GET_PRESCALER
1302001	CHECK_CHANNEL _DATA_CHANNEL A
1302011	TURN_OFF_RELAY_OUTPUT_CHANNEL A
1302021	DISABLE_ANALOG_OUT_CHANNEL A
1302031	LOAD_CHANNEL_FPGA_FIRMWARE_CHANNEL A
1302041	GET_CALIBRATION_PARAMETERS_CHANNEL A
1302051	SET_VARICAP_VOLTAGE_CHANNEL A
1302061	WRITE_FLATNESS_COMPENSATION_CHANNEL A
1302071	ADF4351_ENABLE_CHANNEL A
1302081	SET_DAC_CLOCK_SOURCE_CHANNEL A
1302091	ADF4351_CONFIGURATION_CHANNEL A
1302101	GET_ADF4351_STATUS_CHANNEL A
1302111	CHECK_ADF4351_STATUS_CHANNEL A
1302121	RESET_DAC_DELAY_LINE_CHANNEL A
1302131	SET_SYNC_DATA_DELAY_CHANNEL A
1302141	RESET_VARIABLE_DCM_CHANNEL A
1302151	RESET_FIXED_DCM_CHANNEL A
1302161	DAC_INITIALIZATION_CHANNEL A
1302171	SET_AS_MASTER_CHANNEL A
1302181	SET_AS_SLAVE_CHANNEL A
1302191	SET_SEQUENCER_MODE_CHANNEL A
1302201	TURN_ON_DC_DIRECT_OUTPUT_CHANNEL A
1302211	RESET_VOCM_DC_DIRECT_CHANNEL A
1302221	RESET_VOCM_DC_AMP_CHANNEL A
1302231	GET_FPGA_VERSION_CHANNEL A
1302241	SET_FILTER_PARAMETER_CHANNEL A
1302251	RESET_ATTENUATOR_CHANNEL A
1302261	CHECK_DIGITAL_POD_CONNECTION_CHANNEL A
1302271	SET_DIGITAL_POD_LEVEL_CHANNEL A
1302281	GET_IDENTIFIER_CHANNEL A
1302291	SET_SIGNAL_POLARITY_CHANNEL A
1302301	GET_FUNCTIONALITY_CHANNEL A
1302311	CHECK_FUNCTIONALITY_CHANNEL A
1302321	EXTERNAL_MODULATION_CALIBRATION_CHANNEL A

Table 37: INIT and SYNCH error codes (cont.)

Sub error code	Step description
1302002	CHECK_CHANNEL_DATA_CHANNEL B
1302012	TURN_OFF_RELAY_OUTPUT_CHANNEL B
1302022	DISABLE_ANALOG_OUT_CHANNEL B
1302032	LOAD_CHANNEL_FPGA_FIRMWARE_CHANNEL B
1302042	GET_CALIBRATION_PARAMETERS_CHANNEL B
1302052	SET_VARICAP_VOLTAGE_CHANNEL B
1302062	WRITE_FLATNESS_COMPENSATION_CHANNEL B
1302072	ADF4351_ENABLE_CHANNEL B
1302082	SET_DAC_CLOCK_SOURCE_CHANNEL B
1302092	ADF4351_CONFIGURATION_CHANNEL B
1302102	GET_ADF4351_STATUS_CHANNEL B
1302112	CHECK_ADF4351_STATUS_CHANNEL B
1302122	RESET_DAC_DELAY_LINE_CHANNEL B
1302132	SET_SYNC_DATA_DELAY_CHANNEL B
1302142	RESET_VARIABLE_DCM_CHANNEL B
1302152	RESET_FIXED_DCM_CHANNEL B
1302162	DAC_INITIALIZATION_CHANNEL B
1302172	SET_AS_MASTER_CHANNEL B
1302182	SET_AS_SLAVE_CHANNEL B
1302192	SET_SEQUENCER_MODE_CHANNEL B
1302202	TURN_ON_DC_DIRECT_OUTPUT_CHANNEL B
1302212	RESET_VOCM_DC_DIRECT_CHANNEL B
1302222	RESET_VOCM_DC_AMP_CHANNEL B
1302232	GET_FPGA_VERSION_CHANNEL B
1302242	SET_FILTER_PARAMETER_CHANNEL B
1302252	RESET_ATTENUATOR_CHANNEL B
1302262	CHECK_DIGITAL_POD_CONNECTION_CHANNEL B
1302272	SET_DIGITAL_POD_LEVEL_CHANNEL B
1302282	GET_IDENTIFIER_CHANNEL B
1302292	SET_SIGNAL_POLARITY_CHANNEL B
1302302	GET_FUNCTIONALITY_CHANNEL B
1302312	CHECK_FUNCTIONALITY_CHANNEL B
1302322	EXTERNAL_MODULATION_CALIBRATION_CHANNEL B
1003000	CHECK_SYNCHRONIZATION_DATA
1003010	SET_DCO_DAC_DIVISOR
1003020	ACTIVATE_SYNCHRONIZATION
1003030	GET_CHANNEL_FPGA_TEMPERATURE

Table 37: INIT and SYNCH error codes (cont.)

Sub error code	Step description
1003040	SYNCHRONIZATION_CIRCUIT_INITIALIZATION
1003050	SET_RELAYS
1003060	DISABLE_DIGITAL_OUTPUTS
1003070	DISABLE_MARKER_OUTPUTS
1003080	LOAD_DELAY_LINES_CALIBRATION_VALUES
1003090	DELAY_LINES_CHARACTERIZATION
1003100	GET_SUBPERIOD_SKEW_BETWEEN_CHANNELS
1003110	SET_SUBPERIOD_COMPENSATION
1003120	GET_SKEW_BETWEEN_CHANNEL_A_AND_REFERENCE
1003130	GET_SKEW_BETWEEN_CHANNELS_WITH_LOW_FREQUENCY
1003140	GET_SKEW_BETWEEN_CHANNELS_WITH_MIDDLE_FREQUENCY
1003150	GET_SKEW_BETWEEN_CHANNELS_WITH_HIGH_FREQUENCY
1003160	SET_COMPENSATION
1003170	ENABLE_MARKER_OUTPUTS
1003180	GET_SKEW_BETWEEN_CHANNEL_A_AND_MARKER_1
1003190	GET_SKEW_BETWEEN_CHANNEL_A_AND_MARKER_2
1003200	GET_SKEW_BETWEEN_CHANNEL_A_AND_DIGITAL_1
1003210	GET_SKEW_BETWEEN_CHANNEL_A_AND_DIGITAL_2
1003220	SET_LAST_COMPENSATION
1003230	DEACTIVATE_SYNCHRONIZATION
1003240	SET_DIGITAL_OUTPUT
1003250	RESET_RELAYS

Table 38: Diagnostic error codes

Error code	Step description
1400000	TEST_USB_CONNECTION FAILED
1401000	TEST_NVMEMORY_ACCESS FAILED
1402000	TEST_LOAD_CONTROL_FPGA_FW FAILED
1403000	TEST_CONTROL_FPGA_REGISTRY_ACCESS FAILED
1404000	TEST_I2C_EPROM FAILED
1405000	TEST_LOAD_CHANNEL_FPGA_DIAGNOSTIC_FW FAILED_CHANNEL_A
1405010	TEST_CHANNEL_FPGA_REGISTRY_ACCESS FAILED_CHANNEL_A
1405020	TEST_CHANNEL_MEMORY FAILED_CHANNEL_A
1405030	TEST_CHANNEL_SPI_DAC_9739 FAILED_CHANNEL_A
1405040	TEST_CHANNEL_ADC_LTC2265_COMMUNICATION FAILED_CHANNEL_A
1406000	TEST_LOAD_CHANNEL_FPGA_DIAGNOSTIC_FW FAILED_CHANNEL_B

Table 38: Diagnostic error codes (cont.)

Error code	Step description
1406010	TEST_CHANNEL_FPGA_REGISTRY_ACCESS FAILED_CHANNEL_B
1406020	TEST_CHANNEL_MEMORY FAILED_CHANNEL_B
1406030	TEST_CHANNEL_SPI_DAC_9739 FAILED_CHANNEL_B
1406040	TEST_CHANNEL_ADC_LTC2265_COMMUNICATION FAILED_CHANNEL_B
1407000	TEST_DEVICE_INITIALIZATION FAILED
1408000	TEST_CHANNEL_ADC_LTC2265 FAILED_CHANNEL_A
1408010	TEST_CHANNEL_PLL FAILED_CHANNEL_A
1408020	TEST_CHANNEL_ADF4351 FAILED_CHANNEL_A
1408031	TEST_CHANNEL_OFFSET_DC_AMP FAILED_CHANNEL_A_BRANCH_N
1408041	TEST_CHANNEL_VOCM_DC_AMP FAILED_CHANNEL_A_BRANCH_N
1408051	TEST_CHANNEL_VAO_DC_AMP FAILED_CHANNEL_A_BRANCH_N
1408061	TEST_CHANNEL_OFFSET_GAIN_DC_AMP_CHANNEL_A_BRANCH_N
1408071	TEST_CHANNEL_DIFFERENTIAL_OFFSET_DC_DIRECT FAILED_CHANNEL_A_BRANCH_N
1408081	TEST_CHANNEL_OFFSET_DC_DIRECT FAILED_CHANNEL_A_BRANCH_N
1408091	TEST_CHANNEL_VOCM_DC_DIRECT FAILED_CHANNEL_A_BRANCH_N
1408101	TEST_CHANNEL_VAO_DC_DIRECT FAILED_CHANNEL_A_BRANCH_N
1408111	TEST_CHANNEL_ATTENUATOR FAILED_CHANNEL_A_BRANCH_N
1408032	TEST_CHANNEL_OFFSET_DC_AMP FAILED_CHANNEL_A_BRANCH_P
1408042	TEST_CHANNEL_VOCM_DC_AMP FAILED_CHANNEL_A_BRANCH_P
1408052	TEST_CHANNEL_VAO_DC_AMP FAILED_CHANNEL_A_BRANCH_P
1408062	TEST_CHANNEL_OFFSET_GAIN_DC_AMP_CHANNEL_A_BRANCH_P
1408072	TEST_CHANNEL_DIFFERENTIAL_OFFSET_DC_DIRECT FAILED_CHANNEL_A_BRANCH_P
1408082	TEST_CHANNEL_OFFSET_DC_DIRECT FAILED_CHANNEL_A_BRANCH_P
1408092	TEST_CHANNEL_VOCM_DC_DIRECT FAILED_CHANNEL_A_BRANCH_P
1408102	TEST_CHANNEL_VAO_DC_DIRECT FAILED_CHANNEL_A_BRANCH_P
1408112	TEST_CHANNEL_ATTENUATOR FAILED_CHANNEL_A_BRANCH_P
1409000	TEST_CHANNEL_ADC_LTC2265 FAILED_CHANNEL_B
1409010	TEST_CHANNEL_PLL FAILED_CHANNEL_B
1409020	TEST_CHANNEL_ADF4351 FAILED_CHANNEL_B
1409031	TEST_CHANNEL_OFFSET_DC_AMP FAILED_CHANNEL_B_BRANCH_N
1409041	TEST_CHANNEL_VOCM_DC_AMP FAILED_CHANNEL_B_BRANCH_N
1409051	TEST_CHANNEL_VAO_DC_AMP FAILED_CHANNEL_B_BRANCH_N
1409061	TEST_CHANNEL_OFFSET_GAIN_DC_AMP_FAILED_CHANNEL_B_BRANCH_N
1409071	TEST_CHANNEL_DIFFERENTIAL_OFFSET_DC_DIRECT FAILED_CHANNEL_B_BRANCH_N

Table 38: Diagnostic error codes (cont.)

Error code	Step description
1409081	TEST_CHANNEL_OFFSET_DC_DIRECT FAILED_CHANNEL_B_BRANCH_N
1409091	TEST_CHANNEL_VOCM_DC_DIRECT FAILED_CHANNEL_B_BRANCH_N
1409101	TEST_CHANNEL_VAO_DC_DIRECT FAILED_CHANNEL_B_BRANCH_N
1409111	TEST_CHANNEL_ATTENUATOR FAILED_CHANNEL_B_BRANCH_N
1409032	TEST_CHANNEL_OFFSET_DC_AMP FAILED_CHANNEL_B_BRANCH_P
1409042	TEST_CHANNEL_VOCM_DC_AMP FAILED_CHANNEL_B_BRANCH_P
1409052	TEST_CHANNEL_VAO_DC_AMP FAILED_CHANNEL_B_BRANCH_P
1409062	TEST_CHANNEL_OFFSET_GAIN_DC_AMP_FAILED_CHANNEL_B_BRANCH_P
1409072	TEST_CHANNEL_DIFFERENTIAL_OFFSET_DC_DIRECT FAILED_CHANNEL_B_BRANCH_P
1409082	TEST_CHANNEL_OFFSET_DC_DIRECT FAILED_CHANNEL_B_BRANCH_P
1409092	TEST_CHANNEL_VOCM_DC_DIRECT FAILED_CHANNEL_B_BRANCH_P
1409102	TEST_CHANNEL_VAO_DC_DIRECT FAILED_CHANNEL_B_BRANCH_P
1409112	TEST_CHANNEL_ATTENUATOR FAILED_CHANNEL_B_BRANCH_P

Required equipment

The following performance verification procedures use external, traceable signal sources to directly check warranted characteristics. The following table lists the equipment required for these procedures.

Table 39: Required test equipment

Item	Minimum requirements	Recommended equipment	Purpose
Digital Multi Meter (DMM)	AC volts, true rms, AC coupled Accuracy: ±0.1% to 1 kHz DC volts Accuracy: 50 ppm, resolution 100 µV Resistance Accuracy: ± 0.05 Ω	Keithley 2700	Measures voltage. Used in multiple procedures.
Power sensor	100 kHz to 1GHz 1 µW to 100 mW (-30 dBm to +20 dBm) Accuracy: 0.02 dB Resolution: 0.01 dB	Rhode & Schwartz NRP	Measures voltage. Used in multiple procedures.
Power sensor adaptor	100 kHz to 1GHz 1 µW to 100 mW (-30 dBm to +20 dBm)	Rhode & Schwartz NRP-Z91	Measures voltage. Used in multiple procedures.
Frequency counter	Accuracy: 0.01 ppm Phase measurement	Tektronix FCA3103	Checks clock frequency.
Oscilloscope	4 GHz Bandwidth 50 Ω input. Termination 25 GS/s	Tektronix MSO70804C	Checks output signals. Used in multiple procedures.
Spectrum analyzer	20 kHz to 6 GHz	Tektronix RSA5106B	Checks output signals. Harmonics Spurious.

Table 39: Required test equipment (cont.)

Item	Minimum requirements	Recommended equipment	Purpose
SMA coaxial cable	50 Ω, male to male connector, 91 cm	Tektronix part number 174-6193-00	Signal interconnection
SMA terminator	50 Ω, ±1 Ω , 2 W, DC to 1 GHz	Tektronix part number 136-7162-00	Signal termination
Adapter, dual banana plug	Adapter BNC (male) to SMA (female)	Tektronix part number 103-0090-00	Signal interconnection to a DMM
Adapter, BNC (male) to SMA (female)	BNC (male) to SMA (female)	Tektronix part number 015-0572-00	Signal interconnection to a oscilloscope

Basic mode: Frequency/Period test

This test verifies the frequency accuracy of the generator. All output frequencies are derived from a single generated frequency. Both channel + is required to be checked. The generator should be set to Basic mode operation.

1. Connect the generator to the frequency counter as shown in the following figure.

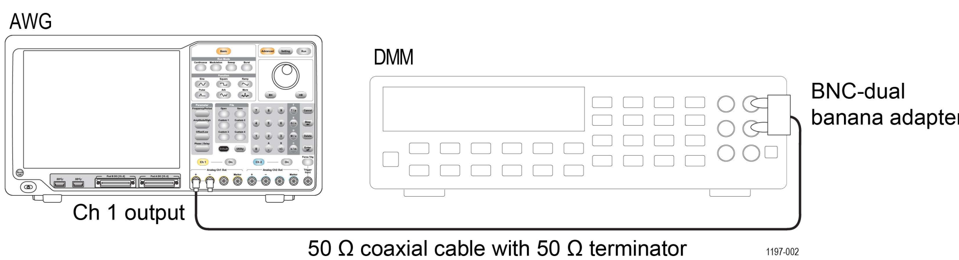


Figure 1: Frequency/period test

2. Push the Default front-panel button and the OK menu button to recall the generator default setup.

3. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Sine	Sine (front)
Frequency	1.000000 MHz	Frequency/Period (front)
Amplitude	1.00 Vpp	Amplitude/High (front)
Channel 1 Output	On	On (front)

4. Check that reading of the frequency counter is between 0.9999984 MHz and 1.0000016 MHz.

5. Record the result in the test record.
6. Repeat steps 2 through 5 for CH2.

Amplitude test

This test should be done once in Basic mode and once in Advanced mode to verify the amplitude accuracy of the generator. This test uses a 50 Ω terminator. It is necessary to know the accuracy of the 50 Ω terminator in advance of this amplitude test. This accuracy is used as a calibration factor.

Basic mode

1. Connect the 50 Ω terminator to the DMM as shown in the following figure and measure the register value.

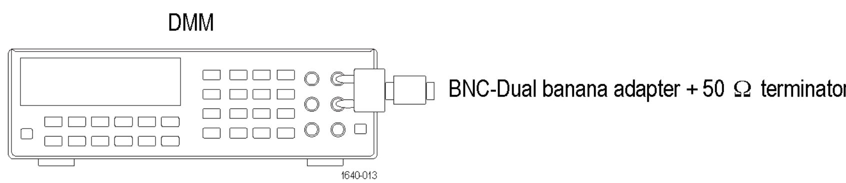


Figure 2: 50 Ω terminator accuracy

2. Calculate the 50 Ω calibration factor (CF) from the reading value and record as follows:

CF (Calibration Factor) = 2 / (1 + 50 Ω / Measurement Ω)

Measurement (reading of the DMM)	CF
Ω	
Examples	
50.50 Ω	1.0050 (= 2 / (1 + 50 / 50.50))
49.62 Ω	0.9962 (= 2 / (1 + 50 / 49.62))

3. Connect the generator to the DMM as shown in the following figure. Be sure to connect the 50 Ω terminator to the generator's side output connector.

Figure 3: Amplitude test, Basic mode

4. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.

5. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Sine	Sine (front)
Frequency	1.000000 kHz	Frequency/Period (front)
Amplitude Units	V rms The voltage unit should be matched to that of DMM.	Home > Units > Vrms
Amplitude	35.36 mVrms	Amplitude/High (front)
Channel 1 Output	On	On (front)

6. Verify that each amplitude measurement is within the range specified in the test record table.
7. Record the results in the test record.
8. Repeat steps 5 through 7 for the CH1–, CH2+, and CH2– outputs.
9. Record the results in the test record.

NOTE. *For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Advanced mode

Use the same equipment setup as in the Basic mode test. This will test both DC direct and DC amplified mode.

1. Close Basic mode and launch Advanced mode in the generator.
2. Check that the generator is still connected to the DMM as shown in the following figure and that the 50 Ω terminator is still connected to the generator's side output connector.

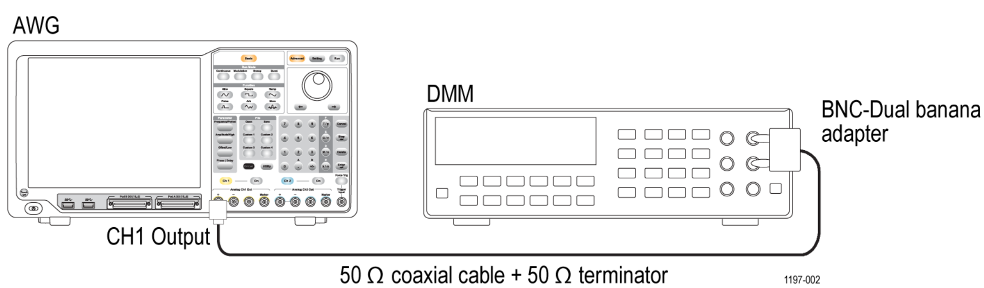


Figure 4: Amplitude test, Advanced mode

3. Use the 50 Ω terminator to terminate the channel 1 analog connector on the AWG4000.

4. Set up the generator using the following steps:

Select menu	Setting	Operation
New waveform	Sine, 64k points	Home > ArbBuilder> New Std Set Function to Sine and Total Number of Points to 64
Sampling rate	64 MS/s	Setting/Timing

Amplitude Unit	Amplitude setting in new waveform is half of Vpp	New mixed waveform /Sine/Amplitude
Amplitude	DC direct: 5 mV DC amplified: 50 mV	New mixed waveform /Sine/Amplitude
Output type	DC direct: 5 mV DC amplified: 50 mV (step 6)	Setting/Analog Ch1/Output type

5. Verify that each amplitude measurement is within the range specified in the test record table.
6. Record the results in the test record.
7. Repeat steps 4 through 6 for the CH1–, CH2+, and CH2– DC amplified outputs.
8. Record the results in the test record.

NOTE. *For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

DC Offset and Vocm tests

This test should be done once in Basic mode and once in Advanced mode to verify the DC offset and Vocm accuracy of the generator. This test uses a 50 Ω terminator. It is necessary to know the accuracy of a 50 Ω terminator in advance of this test. This accuracy is used for as a calibration factor.

Basic mode

1. Connect the 50 Ω terminator to the DMM as shown in the following figure and measure the register value.

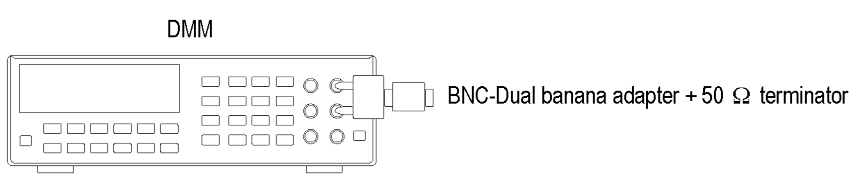


Figure 5: 50 Ω terminator accuracy

2. Calculate the 50 Ω calibration factor (CF) from the reading value and record as follows: CF (Calibration Factor) = 2 / (1 + 50 Ω/ Measurement Ω)

Measurement (reading of the DMM)	CF
Ω	
Examples	
50.50 Ω	1.0050 (= 2 / (1 + 50 / 50.50))
49.62 Ω	0.9962 (= 2 / (1 + 50 / 49.62))

3. Connect the generator to the DMM as shown in the following figure. Be sure to connect the 50 Ω terminator to the generator's side output connector.

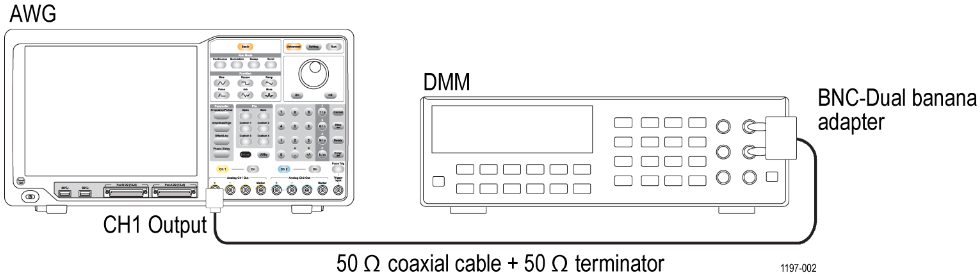


Figure 6: DC offset/Vocm tests, Basic mode

4. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.
5. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	DC	Home > More > DC
Offset	1 V	Home > Offset
Channel 1 Output	On	On (front)

6. Verify that each offset measurement is within the range specified in the test record.
7. Record the results in the test record.
8. Repeat steps 5 through 7 for the CH1–, CH2+, and CH2– outputs.
9. Test the V_{ocm} as follows:
   a. Set DC offset to 0 V (Home > More > DC > Offset).
   b. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Vocm	System > Output CH1
Vocm	1 V	System > Output CH1 > Vocm
Channel 1 Output	On	On (front)

10. Verify that each Vocm measurement is within the range specified in the test record.
11. Record the results in the test record.
12. Repeat steps 9 through 11 for the CH1–, CH2+, and CH2– outputs.

Advanced mode

Use the same equipment setup as in the Basic mode test. Offset and Vocm are only available in DC direct and DC amplified when in Advanced mode.

1. Close Basic mode and launch Advanced mode in the generator.
2. Check that the generator is still connected to the DMM as shown in the following figure and that the 50 Ω terminator is still connected to the generator's side output connector.

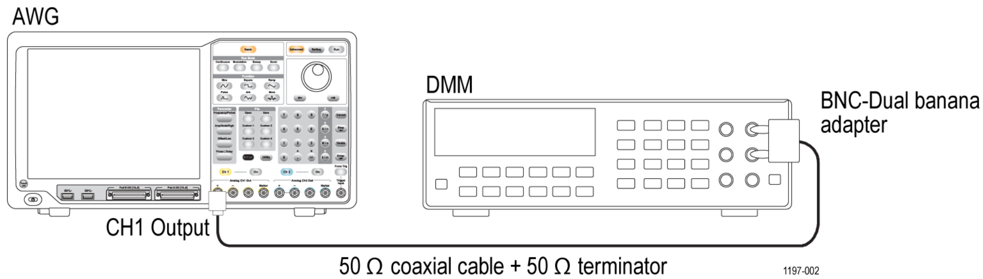


Figure 7: DC offset/Vocm test, Advanced mode

3. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.

4. Set up the generator using the following steps and then press Run.

Select menu	Setting	Operation
New waveform	DC, 64k points	New mixed waveform
Sampling rate	64 MS/s	Setting/Timing
Waveform amplitude	0 V	New mixed waveform /DC level/offset
Output Offset	DC direct: +0.350 V DC amplified: +2.500 V	Setting/Analog Ch1/offset
Output type	DC direct DC amplified	Setting/Analog Ch1/output type

5. Verify that each offset measurement is within the range specified in the test record.
6. Record the results in the test record.
7. Repeat steps 4 through 6 for the CH1–, CH2+, and CH2– outputs.
8. Test the V_{ocm} as follows:
9. Set DC offset to 0 V.
10. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Vocm	Quick Settings menu
Vocm	1 V	Quick Settings menu
Channel 1 Output	DC direct: +0.350 V DC amplified: +2.500 V	On (front)

8. Verify that each Vocm measurement is within the range specified in the test record.
9. Record the results in the test record.
10. Repeat steps 7 through 9 for the CH1–, CH2+, and CH2– outputs.

NOTE. *For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Basic mode: AC Flatness test

This test verifies the flatness of a sine wave to the 1 kHz reference waveform. The generator should be set to Basic mode operation.

1 kHz test setup

1. Connect a 50 Ω terminator to the DMM as shown in the following figure and measure the register value.

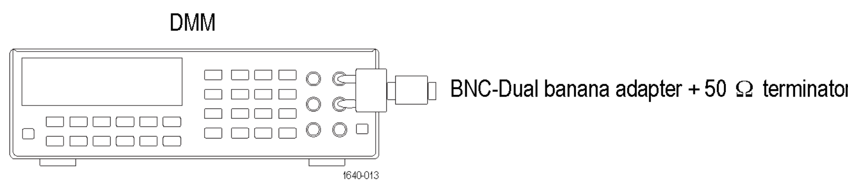


Figure 8: 50 Ω terminator accuracy

2. Calculate the 50 Ω calibration factor (CF) from the reading value and record as follows:

CF (Calibration Factor) = 2 / (1 + 50 Ω / Measurement Ω)

Measurement (reading of the DMM)	CF
Ω	
Examples	
50.50 Ω	1.0050 (= 2 / (1 + 50 / 50.50))
49.62 Ω	0.9962 (= 2 / (1 + 50 / 49.62))

3. Connect the generator to the DMM as shown in the following figure. Be sure to connect the 50 Ω terminator to the generator's side output connector.

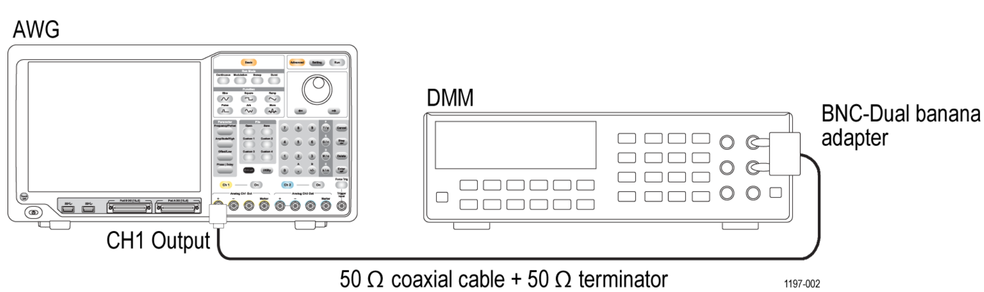


Figure 9: 1 kHz setup for AC Flatness test

4. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.
5. Generate a 1 kHz, 1 Vpp sine waveform with the generator.
6. Read the AC V_{RMS} value on the DMM.
7. Find the reference of flatness at 1 kHz by converting V_{RMS} to dBm as follows:

   $10 \times \log_{10}(20(V_{RMS}/CF)^2)$□

>100 kHz test setup

1. Connect the generator to the power meter with a power head as shown in the following figure.

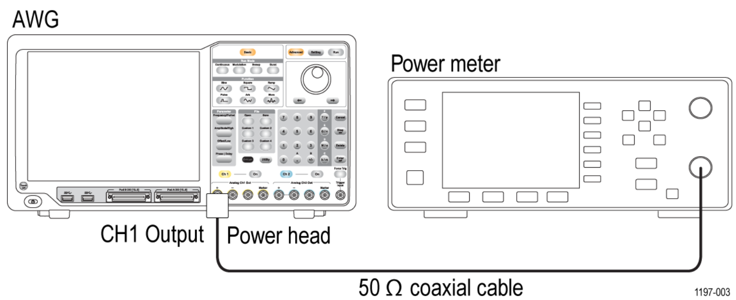


Figure 10: >1 kHz setup for AC Flatness test

2. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Sine	Home > Sine
Frequency	500 kHz	Home > Freq
Amplitude Units	Vpp	Home > Units > Vpp
Amplitude	+ 1.0 Vpp	Home > Ampl
Channel 1 Output	On	On (front)

3. Set the frequency of the Power Meter to match the frequency setting of the generator.
4. Verify that the power measurement is within the limits specified in the test record tables, relative to the 1 kHz reference power level.
5. Record the results in the test record.
6. Repeat steps 3 through 5 with the generator set to each of the other frequencies specified in the test record tables.
7. Repeat this procedure starting at step 3 of the 1 kHz test setup for the CH1–, CH2+, and CH2– outputs.

***NOTE.** For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Basic mode: Harmonics distortion test

This test verifies the harmonic distortion using a spectrum analyzer. The generator should be set to Basic mode operation.

1. Connect the generator to the spectrum analyzer as shown in the following figure.

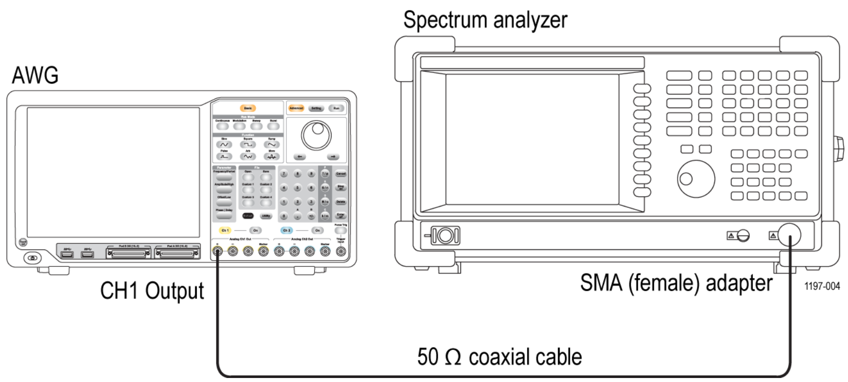


Figure 11: Harmonic distortion tests

2. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.
3. Push the Default front-panel button and OK menu button to recall the generator default setup.
4. Set up the generator using the following steps:

Select menu	Setting	Operation
Function	Sine	Home > Sine
Frequency	5 MHz	Home > Freq
Amplitude Units	Vpp	Home > Units > Vpp
Amplitude	1.00 Vpp	Home > Ampl
Channel 1 Output	On	On (front)

5. Set up the spectrum analyzer according the frequency setup of the generator.
6. Set the Ref Level of the spectrum analyzer to 10 dBm.
7. Read the signal level in the Fundamental frequency for each signal. Use this level as a reference value.
8. Verify that the differences between the reference level and the signal level in the frequency of higher-order at each frequency are below the limit specified in the following tables.
9. Repeat steps 3 through 5 for the CH1–, CH2+, and CH2– outputs.

***NOTE.** For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Basic mode: Spurious test

This test verifies the spurious using a spectrum analyzer. The generator should be set to Basic mode operation.

1. Connect the generator to the spectrum analyzer as shown in the following figure.

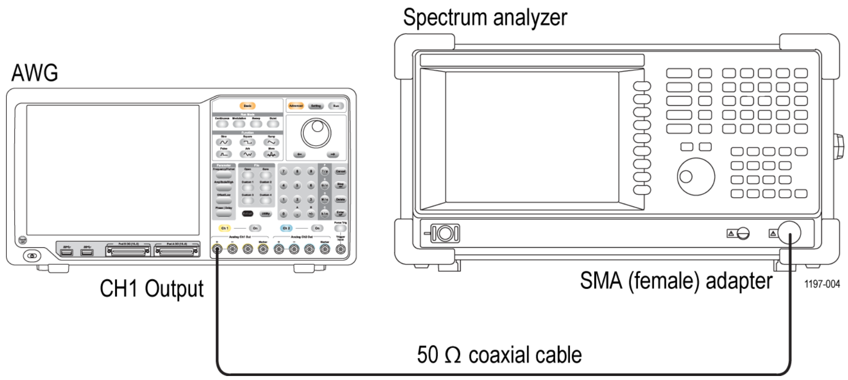


Figure 12: Spurious tests

2. Use the 50 Ω SMA terminator to terminate the channel 1 analog connector on the AWG4000.

3. Set up the arbitrary function generator using the following steps:

Select menu	Setting	Operation
Function	Sine	Home > Sine
Frequency	5 MHz	Home > Freq
Amplitude Units	Vpp	Home > Units> Vpp
Amplitude	1.00 Vpp	Home > Ampl
Channel 1 Output	On	On (front)

4. Set the center frequency of the spectrum analyzer to 10 MHz. Other settings are shown in the following tables.

5. Set the Ref Level of the spectrum analyzer to 10 dBm.

6. Measure the maximum spurious level other than harmonic distortion of 1 Vpp sine wave in each frequency.

7. Set the center frequency of the spectrum analyzer to 625 MHz. Other settings are shown in the following tables.

8. Measure the maximum spurious level other than harmonic distortion of 1 Vpp sine wave in each frequency.

9. Verify that the spurious signal at each frequency is equal to or less than the limit specified in the following tables.

10. Record the results in the test record.

11. Repeat steps 3 through 10 for the CH1–, CH2+, and CH2– outputs.

NOTE. *For differential analog output, when one connector is used as single ended output, another connector should be terminated with a 50 Ω terminator.*

Test record

Photocopy the test records and use them to record the performance test results for your AWG4162 Arbitrary Waveform Generator.

Table 40: AWG4162 Performance Test Record

Instrument Serial Number:	Certificate Number:
Temperature:	RH %:
Date of Calibration:	Technician:

Basic mode Frequency Test Record

	Minimum	Test result	Maximum
Frequency			
CH1			
Sine at 1.000000 MHz	0.9999984 MHz		1.0000016 MHz
CH2			
Sine at 1.000000 MHz	0.9999984 MHz		1.0000016 MHz

Basic mode Amplitude Test Record

Amplitude

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+	Minimum	Test result	Maximum
100 mVpp, 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF + 2.122) mVrms
1 Vpp, 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6× CF + 5.304) mVrms
5 Vpp, 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF + 0.019) Vrms
CH1–			
100 mVpp, 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF + 2.122) mVrms
1 Vpp, 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6× CF + 5.304) mVrms
5 Vpp, 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF + 0.019) Vrms
CH2+	**Minimum**	**Test result**	**Maximum**
100 mVpp, 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF + 2.122) mVrms
1 Vpp, 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6× CF + 5.304) mVrms
5 Vpp, 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF + 0.019) Vrms
CH2–			
100 mVpp, 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF + 2.122) mVrms

Basic mode Amplitude Test Record (cont.)

Amplitude

CF = 2 / (1 + 50 Ω / Measurement Ω) =

1 Vpp, 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6× CF + 5.304) mVrms
5 Vpp, 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF + 0.019) Vrms

Advanced mode DAC Amplitude Test Record

DAC Amplitude

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+	Minimum	Test result	Maximum
10 mVpp: 3.536 mVrms at 1.00 kHz	(3.536 × CF - 1.803) mVrms		(3.536 × CF +1.803) mVrms
400 mVpp: 141.4 mVrms at 1.00 kHz	(141.4 × CF - 3.182) mVrms		(141.4 × CF +3.182) mVrms
800 mVpp: 282.9 mVrms at 1.00 kHz	(282.9 × CF - 4.597) mVrms		(282.9 × CF +4.597) mVrms
CH1–			
10 mVpp: 3.536 mVrms at 1.00 kHz	(3.536 × CF - 1.803) mVrms		(3.536 × CF +1.803) mVrms
400 mVpp: 141.4 mVrms at 1.00 kHz	(141.4 × CF - 3.182) mVrms		(141.4 × CF +3.182) mVrms
800 mVpp: 282.9 mVrms at 1.00 kHz	(282.9 × CF - 4.597) mVrms		(282.9 × CF +4.597) mVrms
CH2+	**Minimum**	**Test result**	**Maximum**
10 mVpp: 3.536 mVrms at 1.00 kHz	(3.536 × CF - 1.803) mVrms		(3.536 × CF +1.803) mVrms
400 mVpp: 141.4 mVrms at 1.00 kHz	(141.4 × CF - 3.182) mVrms		(141.4 × CF +3.182) mVrms
800 mVpp: 282.9 mVrms at 1.00 kHz	(282.9 × CF - 4.597) mVrms		(282.9 × CF +4.597) mVrms
CH2–			
10 mVpp: 3.536 mVrms at 1.00 kHz	(3.536 × CF - 1.803) mVrms		(3.536 × CF +1.803) mVrms
400 mVpp: 141.4 mVrms at 1.00 kHz	(141.4 × CF - 3.182) mVrms		(141.4 × CF +3.182) mVrms
800 mVpp: 282.9 mVrms at 1.00 kHz	(282.9 × CF - 4.597) mVrms		(282.9 × CF +4.597) mVrms

Advanced mode DC Amplified Amplitude Test Record

DC Amplified Amplitude

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+	Minimum	Test result	Maximum
100 mVpp: 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF +2.122) mVrms
1 Vpp: 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6 × CF +5.304) mVrms
5 Vpp: 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF +0.019) Vrms
CH1–			
100 mVpp: 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF +2.122) mVrms
1 Vpp: 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6 × CF +5.304) mVrms
5 Vpp: 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF +0.019) Vrms
CH2+	**Minimum**	**Test result**	**Maximum**
100 mVpp: 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF +2.122) mVrms
1 Vpp: 353.6 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6 × CF +5.304) mVrms
5 Vpp: 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF +0.019) Vrms
CH2–			
100 mVpp: 35.36 mVrms at 1.00 kHz	(35.36 × CF - 2.122) mVrms		(35.36 × CF +2.122) mVrms
1 Vpp: 141.4 mVrms at 1.00 kHz	(353.6 × CF - 5.304) mVrms		(353.6 × CF +5.304) mVrms
5 Vpp: 1.768 Vrms at 1.00 kHz	(1.768 × CF - 0.019) Vrms		(1.768 × CF +0.019) Vrms

Basic mode DC Offset/Vocm Test Record

DC Offset/Vocm

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+ offset	Minimum	Test result	Maximum
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03 Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH1– offset			

Basic mode DC Offset/Vocm Test Record (cont.)

+2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03 Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
CH2+ offset	**Minimum**	**Test result**	**Maximum**
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH2– offset			
+2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
CH1+ Vocm	**Minimum**	**Test result**	**Maximum**
+2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03) Vdc
CH1– Vocm			
+2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03) Vdc
CH2+ Vocm	**Minimum**	**Test result**	**Maximum**
+2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03) Vdc
CH2– Vocm			
+2.500 Vdc	(+2.500 × CF - 0.03) Vdc		(+2.500 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.500 Vdc	(-2.500 × CF - 0.03) Vdc		(-2.500 × CF + 0.03) Vdc

Advanced mode DC Offset/Vocm (AMP out) Test Record

DC Offset/Vocm

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+ offset	**Minimum**	**Test result**	**Maximum**
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc

Advanced mode DC Offset/Vocm (AMP out) Test Record (cont.)

CH1– offset			
+2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03 Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
CH2+ offset	**Minimum**	**Test result**	**Maximum**
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.000 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH2– offset			
+2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
CH1+ Vocm	**Minimum**	**Test result**	**Maximum**
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH1– Vocm			
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH2+ Vocm	**Minimum**	**Test result**	**Maximum**
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc
CH2– Vocm			
+2.50 Vdc	(+2.50 × CF - 0.03) Vdc		(+2.50 × CF + 0.03) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-2.50 Vdc	(-2.50 × CF - 0.03) Vdc		(-2.50 × CF + 0.03) Vdc

Advanced mode DC Offset/Vocm (DAC out) Test Record

DC Offset/Vocm

CF = 2 / (1 + 50 Ω / Measurement Ω) =

CH1+ offset	**Minimum**	**Test result**	**Maximum**
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc

Advanced mode DC Offset/Vocm (DAC out) Test Record (cont.)

-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
CH1– offset			
+0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
CH2+ offset	**Minimum**	**Test result**	**Maximum**
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
CH2– offset			
+0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
CH1+ Vocm	**Minimum**	**Test result**	**Maximum**
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
CH1– Vocm			
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
CH2+ Vocm	**Minimum**	**Test result**	**Maximum**
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc
CH2– Vocm			
+0.35 Vdc	(+0.35 × CF - 0.0085) Vdc		(+0.35 × CF + 0.0085) Vdc
0.00 Vdc	-5.00 mVdc		+5.00 mVdc
-0.35 Vdc	(-0.35 × CF - 0.0085) Vdc		(-0.35 × CF + 0.0085) Vdc

Basic mode AC Flatness Test Record

CH1+ AC flatness	Minimum	Test result	Maximum
Frequency 1.00 kHz (Ampl: +1 Vpp)	———-	dB (= Reference)	———-
Frequency 500 kHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 1.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB

Basic mode AC Flatness Test Record (cont.)

Frequency 5.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 10.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 50.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 100.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 150.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 200.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 300.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 400.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 500.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 600.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
CH1– AC flatness	**Minimum**	**Test result**	**Maximum**
Frequency 1.00 kHz (Ampl: +1 Vpp)	——-	dB (= Reference)	——-
Frequency 500 kHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 1.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 5.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 10.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 50.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 100.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 150.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 200.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 300.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 400.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 500.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
Frequency 600.00 MHz	Reference - 0.5 dB	dB	Reference + 0.5 dB
CH2+ AC Flatness	**Minimum**	**Test result**	**Maximum**
Frequency 1.00 kHz (Ampl: +1 Vpp)	——-	dB (= Reference)	——-
Frequency 500 kHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 1.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 5.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 10.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 50.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 100.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 150.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 200.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 300.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB

Basic mode AC Flatness Test Record (cont.)

Frequency 400.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 500.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 600.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
CH2– AC Flatness	**Minimum**	**Test result**	**Maximum**
Frequency 1.00 kHz (Ampl: +1 Vpp)	———-	dB (= Reference)	———-
Frequency 500 kHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 1.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 5.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 10.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 50.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 100.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 150.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 200.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 300.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 400.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 500.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB
Frequency 600.00 MHz	Reference - 0.5 dB	dB	Reference + 0.50 dB

Table 41: Basic Mode Harmonic Distortion Test Record

Harmonic Distortion (amplitude 1 V_{p-p})	Fundamental = reference	2nd	3rd	4th	5th	Limit
AWG4162	**Spectrum Analyzer reading**					
Sine 5 MHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	
CH1+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -60 dBc
CH1– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -60 dBc
Sine 100 MHz	100 MHz	200 MHz	300 MHz	400 MHz	500 MHz	
CH1+ Harmonic Distortion (dBc)						

Table 41: Basic Mode Harmonic Distortion Test Record (cont.)

Harmonic Distortion (amplitude 1 V_{p-p})	Fundamental = reference	2nd	3rd	4th	5th	Limit
reading - reference (dBc)	0 dBc					Nth - reference < -40 dBc
CH1– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -40 dBc
Sine 300 MHz	300 MHz	600 MHz	900 MHz	1200 MHz	1500 MHz	
CH1+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
CH1– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
Sine 600 MHz	600 MHz	1200 MHz	1800 MHz	2400 MHz	3 GHz	
CH1+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
CH1– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
AWG	**Spectrum Analyzer reading**					
Sine 5 MHz	5 MHz	10 MHz	15 MHz	20 MHz	25 MHz	
CH2+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -60 dBc
CH2– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -60 dBc

Table 41: Basic Mode Harmonic Distortion Test Record (cont.)

Harmonic Distortion (amplitude 1 V_{p-p})	Fundamental = reference	2nd	3rd	4th	5th	Limit
Sine 100 MHz	100 MHz	200 MHz	300 MHz	400 MHz	500 MHz	
CH2+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -40 dBc
CH2– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -40 dBc
Sine 300 MHz	300 MHz	600 MHz	900 MHz	1200 MHz	1500 MHz	
CH2+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
CH2– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
Sine 600 MHz	600 MHz	1200 MHz	1800 MHz	2400 MHz	3 GHz	
CH2+ Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc
CH2– Harmonic Distortion (dBc)						
reading - reference (dBc)	0 dBc					Nth - reference < -28 dBc

Basic Mode Spurious Test Record

	Spectrum Analyzer			Measurement		
Frequency	Center Frequency	Span	RBW	Spurious Frequency	Spurious (Max)	Limit
CH1+						
Sine 5 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -65 dBc
Sine 150 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -55 dBc
Sine 450 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -50 dBc
Sine 600 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -40 dBc
CH1–						
Sine 5 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -65 dBc
Sine 150 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -55 dBc
Sine 450 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -50 dBc
Sine 600 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -40 dBc
CH2+						
Sine 5 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -65 dBc
Sine 150 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -55 dBc
Sine 450 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -50 dBc
Sine 600 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -40 dBc
CH2–						
Sine 5 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -65 dBc
Sine 150 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -55 dBc
Sine 450 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -50 dBc
Sine 600 MHz	10 MHz / 625 MHz	20 MHz / 1250 MHz	20 kHz / 20 kHz	MHz MHz	dBc dBc	< -40 dBc