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Technical Reference

Tektronix

AWG7000 Series
Arbitrary Waveform Generators
Specifications and Performance Verification

077-0172-01

Warning
The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

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.

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, ensure that the product is properly grounded.

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 Operate Without Covers. Do not operate this product with covers or panels removed.

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

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Provide Proper Ventilation. Refer to the manual's installation instructions for details on installing the product so it has proper ventilation.

No Power Switch. Power supply cord is considered the disconnecting device, disconnect the main power by means of the power cord.

Symbols and Terms

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.*

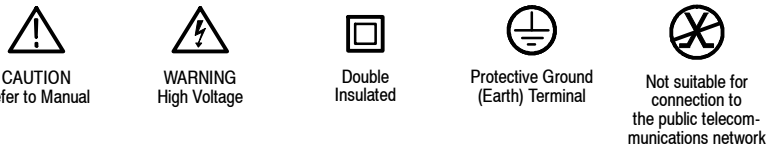
Terms on the Product. These terms may appear on the product:

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.

Symbols on the Product. The following symbols may appear on the product:



Preface

This manual contains specifications and performance verification procedures for the AWG7000 Series Arbitrary Waveform Generators.

Related Documents

The following user documents are also available for this product:

- *AWG7000 Series Arbitrary Waveform Generators Quick Start User Manual*. This document describes the functions and use of the instrument.
- *AWG7000 Series Arbitrary Waveform Generators Service Manual*. This is an optional accessory that provides module-level service information.

Specifications

Specifications

This section contains the specifications for the AWG7101, AWG7102, AWG7051, and AWG7052 Arbitrary Waveform Generators.

All specifications are guaranteed unless noted as “typical”. Typical specifications are provided for your convenience but are not guaranteed. Specifications that are marked with the ✓ symbol are checked in the Performance Verification section of this manual.

Performance Conditions

To meet specifications, following conditions must be met:

- The instrument must have been calibrated/adjusted at an ambient temperature between +20 °C and +30 °C.
- The instrument must have been operating continuously for 20 minutes within the operating temperature range specified.
- The instrument must be in an environment where the temperature, altitude, humidity, and vibration conditions are within the operating limits described in these specifications.

Electrical Specifications

Table 1-1: Run mode

Characteristics	Description
Continuous mode	An arbitrary waveform is output continuously.
Triggered mode	An arbitrary waveform is output only once when a trigger signal is applied. After the waveform is output, the instrument waits for the next trigger signal.
Gated mode	An arbitrary waveform is output only when a gate signal is asserted. The waveform output is repeated while the gate signal stays asserted. When the gate signal is deasserted, the waveform output stops immediately.
Sequence mode	A sequence of arbitrary waveforms are output.

Table 1-2: Arbitrary waveform

Characteristics	Description
Waveform length	
Without Option 01	1 to 32,400,000 points (interleave is off)
	1 to 64,800,000 points (interleave is on)
With Option 01	1 to 64,800,000 points (interleave is off)
	1 to 129,600,000 points (interleave is on)
Waveform granularity	1 point
DAC resolution	10 bits or 8 bits selectable (when the 10 bits DAC mode is selected, marker output is disabled.)
Number of waveforms	1 to 32,000 waveforms
Sequence length	1 to 4,000 steps
Sequence controls	Repeat count, Wait-for-Trigger, Go-to-N, and Jump are available.
Repeat count	1 to 65,536 or infinite (all channels operate the same sequence)
Jump timing	Synchronous or Asynchronous selectable

Table 1-3: Clock generator

Characteristics	Description
Sampling rate control	
Range	
AWG7101 and AWG7102	10.0000 MS/s to 10.0000 GS/s (interleave is off)
AWG7102 Option 06[1]	10.0000 GS/s to 20.0000 GS/s (interleave is on)
AWG7051 and AWG7052	10.0000 MS/s to 5.0000 GS/s
Resolution	8 digits
✓ Internal clock frequency accuracy	Within ± (1 ppm +aging)
Internal clock frequency accuracy, typical	Aging: within ± 1 ppm/year
Reference oscillator accuracy	Within ± (1 ppm +aging)
Reference oscillator accuracy, typical	Aging: within ± 1 ppm/year

1 Interleaving is applied to analog output. When interleaving is on, marker data with even numbers will be output.

Table 1-4: Trigger generator

Characteristics	Description
Trigger rate	
Range	1.0 μs to 10.0 s
Resolution	3 digits and 0.1 μs minimum
Accuracy	Same as the reference oscillator

Table 1-5: Inter-channel skew control (2 channels model only)

Characteristics	Description
Skew control	
Range	-100 ps to +100 ps
Resolution	1 ps
Skew accuracy	±(10% of setting +10 ps)

Table 1-6: Analog output (standard)

Characteristics	Description
Connector type	SMA
Type of output	(+) and (-) complementary output
Output impedance	50 Ω
Amplitude controls	
Range	
Normal mode	50 mV to 2.0 V peak-peak
Direct D/A mode	50 mV to 1.0 V peak-peak
Resolution	1 mV
Offset controls	
Range	
Normal mode	-0.5 V to +0.5 V
Direct D/A mode	N/A
Resolution	1 mV
✓ Amplitude accuracy	Within ± (3% of amplitude + 2 mV) at offset=0V
✓ Offset accuracy	Within ± (2% of amplitude + 10 mV) at minimum amplitude
Bandwidth, typical	
Normal mode	750 MHz, at -3 dB
Direct D/A mode	3.5 GHz, at -3 dB
Rise/fall time, typical	
Normal mode	350 ps (20% to 80%), when amplitude= 2.0 Vp-p, offset=0 V
Direct D/A mode	75 ps (20% to 80%), when amplitude=1.0 Vp-p
Overshoot, typical	< 10%, when amplitude=1.0 Vp-p
Low pass filter	
Normal mode	50 MHz, 200 MHz, Through (Bessel type)
Direct D/A mode	N/A
Delay from marker, typical	9.7 ns: low pass=50 MHz 3.9 ns: low pass=200 MHz 2.1 ns: low pass=through 0.5 ns: direct D/A mode (when amplitude=1.0 Vp-p, offset=0 V)
Skew between (+) and (-) outputs, typical	< 20 ps (direct D/A mode)
ON/OFF control	Output relay is available for each channel. A control is common to the complementary output.

Table 1-6: Analog output (standard) (Cont.)

Characteristics	Description
✓ Harmonic distortion	Amplitude=1.0 Vp-p, offset=0 V, DAC resolution =8 bit, measured with 32 points sine waveform
AWG710x Normal mode	< -35 dBc, when clock=10 GS/s, signal=312.5 MHz
AWG710x Direct D/A mode	< -42 dBc, when clock=10 GS/s, signal=312.5 MHz
AWG705x Normal mode	< -40 dBc, when clock=5 GS/s, signal=156 MHz
AWG705x Direct D/A mode	< -45 dBc, when clock=5 GS/s, signal=156 MHz
✓ Non harmonic spurious	Amplitude=1.0 Vp-p, offset=0 V, measured with 32 points sine waveform
AWG7101 and AWG7102	< -50 dBc, DC to 5 GHz, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	< -50 dBc, DC to 2.5 GHz, when clock=5 GS/s, signal=156 MHz
SFDR, typical	Normal output mode, amplitude=1.0 Vp-p, offset=0 V, DAC resolution =10 bits
AWG7101 and AWG7102	45 dB, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	51 dBc, when clock=5 GS/s, signal=156 MHz
✓ Phase noise	Normal output mode, amplitude=1.0 Vp-p, offset=0 V, DAC resolution =8 bits
AWG7101 and AWG7102	< -90 dBc/Hz at 10 kHz offset, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	< -90 dBc/Hz at 10 kHz offset, when clock=5 GS/s, signal=156 MHz
Random jitter on clock pattern, typical	By 0101... clock pattern, amplitude=1.0 Vp-p, offset=0 V
Normal mode	1.6 ps
Direct D/A mode	0.9 ps
Total jitter on random pattern, typical	PN15 pattern, amplitude=1.0 Vp-p, offset=0 V, measured at bit error rate=1e-12
Normal mode	50 ps p-p at 500 MS/s
Direct D/A mode	30 ps p-p from 1 GS/s to 6 GS/s

Table 1-7: Analog output (Option 02 and Option 06)

Characteristics	Description
Connector type	SMA
Type of output	(+) and (-) complementary outputs
Output impedance	50 Ω
Amplitude controls	
Range	0.5 V to 1.0 V peak-peak
Resolution	1 mV
✓ Amplitude accuracy	Within ± (2% of amplitude + 2 mV) at offset=0V
✓ DC offset accuracy	Within ± 10 mV
Bandwidth, typical	5.8 GHz at -3 dB
Rise/fall time, typical	45 ps (20% to 80%), when amplitude= 1.0 Vp-p
Overshoot, typical	< 3%, when amplitude=1.0 Vp-p
Delay from marker, typical	
Option 02	0.2 ns, when amplitude=1.0 Vp-p
Option 06	1.0 ns, when amplitude=1.0 Vp-p
Skew between (+) and (-) outputs, typical	< 20 ps
ON/OFF control	Output relay is available for each channel. A control is common to the complementary output.
✓ Harmonic distortion	Amplitude=1.0 Vp-p, measured with 32 points sine waveform
AWG7101 and AWG7102	< -42 dBc, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	< -45 dBc, when clock=5 GS/s, signal=156 MHz
✓ Non harmonic spurious	Amplitude=1.0 Vp-p, measured with 32 points sine waveform
AWG7101 and AWG7102	< -50 dBc, DC to 5 GHz, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	< -50 dBc, DC to 2.5 GHz, when clock=5 GS/s, signal=156 MHz
SFDR, typical	Amplitude=1.0 Vp-p, DAC resolution=10 bits
AWG7101 and AWG7102	44 dB, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	48 dB, when clock=5 GS/s, signal=156 MHz
✓ Phase noise	Amplitude=1.0 Vp-p, measured with 32 points sine waveform
AWG7101 and AWG7102	< -90 dBc/Hz at 10 kHz offset, when clock=10 GS/s, signal=312.5 MHz
AWG7051 and AWG7052	< -90 dBc/Hz at 10 kHz offset, when clock=5 GS/s, signal=156 MHz
Random jitter on clock pattern, typical	0.9 ps rms, by 0101... clock pattern, amplitude=1.0 Vp-p
Total jitter on random pattern, typical	20 ps p-p from 2 GS/s to 10 GS/s, PN15 pattern, amplitude-1.0 Vp-p, measured at bit error rate =1 e-12.

Table 1-8: Interleave analog output (AWG7102 Option 06)

Characteristics	Description
Connector type	SMA
Type of output	(+) and (-) complementary output
Output impedance	50 Ω
Zeroing control	Zeroing On and Off is selectable.
Amplitude controls	
Range	
When Zeroing is On	0.25 V to 0.5 V peak-peak
When Zeroing is Off	0.5 V to 1.0 V peak-peak
Resolution	1 mV
Amplitude accuracy, typical	Within ± (8% of amplitude + 2 mV) at offset=0V
✓ DC offset accuracy	Within ± 10 mV
Bandwidth, typical	5.8 GHz at -3 dB, when amplitude=0.5 Vp-p, zeroing=On
Rise/fall time, typical	45 ps (20% to 80%), when amplitude= 0.5 Vp-p, zeroing=On
Delay from marker, typical	1.0 ns when amplitude=0.5 Vp-p, zeroing=On
Skew between (+) and (-) outputs, typical	< 20 ps
ON/OFF control	Output relay is available for each channel. A control is common to the complementary output.
Harmonic distortion, typical	Measured with 32 points sine waveform
When Zeroing is On	< -40 dBc, when amplitude=0.5 Vp-p, clock=20 GS/s, signal=625 MHz
When Zeroing is Off	< -40 dBc, when amplitude=1.0 Vp-p, clock=20 GS/s, signal=625 MHz
Non harmonic spurious, typical	Measured with 32 points sine waveform
When Zeroing is On	< -45 dBc, DC to 5 GHz, when amplitude=0.5 Vp-p, clock=20 GS/s, signal=625 MHz
When Zeroing is Off	< -45 dBc, DC to 5 GHz, when amplitude=1.0 Vp-p, clock=20 GS/s, signal=625 MHz
SFDR, typical	clock=20 GS/s, signal=2.5 GHz
When Zeroing is On	30 dB, when amplitude=0.5 Vp-p
When Zeroing is Off	40 dB, when amplitude=1.0 Vp-p
✓ Phase noise	Measured with 32 points sine waveform
When Zeroing is On	< -85 dBc/Hz at 10 kHz offset, when amplitude=0.5 Vp-p, clock=20 GS/s, signal=625 MHz
When Zeroing is Off	< -85 dBc/Hz at 10 kHz offset, when amplitude=1.0 Vp-p, clock=20 GS/s, signal=625 MHz

Table 1-9: Marker output

Characteristics	Description
Connector type	SMA
Number of outputs	Marker 1 and Marker 2 are available for each channel.
Type of output	(+) and (–) complementary output
Level controls	
Voltage window	–1.4 V to +1.4 V into 50 Ω
Amplitude	0.5 Vp-p to 1.4 Vp-p into 50 Ω
Resolution	0.01 V
✓ Level accuracy	± (10% of setting + 50 mV) into 50 Ω
Output current	± 28 mA max
Variable delay control	Available for Marker 1 and Marker 2
Range	0 to 300 ps
Resolution	1 ps
✓ Variable delay accuracy	± (5% of setting + 50 ps)
Rise/fall time, typical	45 ps (20% to 80% of swing), when Hi= 1.0 V, Low=0V
Random jitter on clock pattern, typical	1 ps rms (by 0101... clock pattern), when Hi= 1.0 V, Low=0V
Total jitter on random pattern, typical	30 ps p-p (by PN15 pattern pattern, when Hi= 1.0 V, Low=0V, measured at bit error rate=1e–12)
Skew between (+) and (–) outputs, typical	< 13 ps
Skew between Marker 1 and Marker 2 outputs, typical	< 30 ps

Table 1-10: Trigger and gate input

Characteristics	Description
Connector type	BNC
Input impedance	1 kΩ or 50 Ω selectable
Polarity	Positive or negative selectable
Input voltage range	
When 1 kΩ selected	–10 V to 10 V
When 50 Ω selected	< 5 V rms

Table 1-10: Trigger and gate input (Cont.)

Characteristics	Description
Threshold control	
Level	-5.0 V to 5.0 V
Resolution	0.1 V
Accuracy, typical	± (5% of setting + 0.1 V)
Input voltage swing	0.5 Vp-p minimum
Minimum pulse width	
Trigger mode	20 ns
Gate mode	1024 * sampling period + 10 ns
Trigger delay to analog output, typical	128 * sampling period + 250 ns
Trigger hold off, typical	832 * sampling period – 100 ns
Gate delay to analog output, typical	640 * sampling period + 260 ns
Trigger jitter, typical	3 ns

Table 1-11: Event input

Characteristics	Description
Connector type	BNC
Input impedance	1 kΩ or 50 Ω selectable
Polarity	Positive or negative selectable
Input voltage range	
When 1 kΩ selected	-10 V to 10 V
When 50 Ω selected	< 5 Vrms
Threshold control	
Level	-5.0 V to 5.0 V
Resolution	0.1 V
Accuracy, typical	± (5% of setting + 0.1 V)
Input voltage swing	0.5 Vp-p minimum
Minimum pulse width	20 ns
Delay to analog output, typical	1024 * sampling period + 280 ns
Hold off time, typical	900 * sampling period + 10 ns

Table 1-12: Reference clock input

Characteristics	Description
Connector type	BNC
Input impedance	50 Ω (AC coupled)
Input voltage swing	0.2 Vp-p to 3 Vp-p
Fixed mode input frequency	10 MHz, 20 MHz, and 100 MHz within ± 0.1%
Variable mode input frequency range	5 MHz to 800 MHz Acceptable frequency drift while running is ± 0.1%
Variable mode multiplier rate	
AWG710x without interleave	1 to 2000
AWG7102 with interleave	2 to 4000
AWG705x	1 to 1000

Table 1-13: Oscillator (external clock) input

Characteristics	Description
Connector type	SMA
Input impedance	50 Ω (AC coupled)
Frequency range	5 .0 GHz to 10 .0 GHz
Input voltage swing	+ 5 dBm to +11 dBm
Divider	
AWG710x	1/1, 1/2, 1/4, 1/8, ... ,1/256
AWG705x	1/2, 1/4, 1/8, ... ,1/256

Table 1-14: DC output

Characteristics	Description
Connector type	2 x 4 pin header, 2.54 mm pitch (female)
Number of outputs	4
Output voltage control	
Range	-3.0 V to +5.0 V
Resolution	10 mV
Control	Independent for each output
✓ Output voltage accuracy	± (3% of setting + 80 mV) into Hi-Z load
Output current	±100 mA maximum
Output impedance, typical	1 Ω

Table 1-15: 10 MHz clock output

Characteristics	Description
Connector type	BNC
Output impedance	50 Ω (AC coupled)
Amplitude, typical	1.2 Vp-p into 50 Ω 2.4 Vp-p into 1 MΩ

Table 1-16: TekLink port

Characteristics	Description
Connector type	40 pin
Function	Future capability.

Table 1-17: CPU module and peripheral devices

Characteristics	Description
CPU	Celeron D processor
Memory	512 MB DDR2-SDRAM
Hard disk drive	More than 80 GB
Optical disk drive	CD-RW/DVD drive
USB 2.0 port	6 (2 x front, 4 x rear)
LAN port	1000/100/10 BASE-T
Video output port	D-sub, 15 pin
GPIB port	IEEE 488.2 standard interface, 24 pin
Keyboard port	PS-2 compatible, mini-DIN, 6-pin
Mouse port	PS-2 compatible, mini-DIN, 6-pin
Serial port	RS-232C, D-sub, 9 pin
Parallel port	D-sub, 25 pin
Audio connectors	Line output, line input, mic input, stereo jack
Real time clock	Lifetime $>$ 3 years (CR2032: Li 3 V 220 mAh)

Table 1-18: Display

Characteristics	Description
Size	210 mm X 158 mm
Resolution	1024 X 768 pixels
Touch screen	Built-in touch screen

Table 1-19: Power supply

Characteristics	Description
Source voltage and frequency	
Rating voltage	100 VAC to 240 VAC
Voltage range	90 VAC to 250 VAC
Frequency range	47 Hz to 63 Hz
Power consumption	450 W
Surge current	30 A peak (25 °C) for ≤ 5 line cycles, after product has been turned off for at least 30 s.

Mechanical (Physical) Characteristics

Table 1-20: Mechanical characteristics

Characteristics	Description
Net weight	
Without package	Approximately 19 kg (41.9 lb)
With package	Approximately 28 kg (61.7 lb)
Dimensions	
Height	245 mm (9.6 in)
Width	465 mm (18.3 in)
Length	500 mm (19.7 in)

Environmental Characteristics

Table 1-21: Environmental characteristics

Characteristics	Description
Temperature	
Operating	+10 °C to +40 °C
Non-operating	-20 °C to +60 °C
Relative humidity	
Operating	5% to 80% (no condensation) Maximum wet-bulb temperature 29 °C
Non-operating	5% to 90% (no condensation) Maximum wet-bulb temperature 29 °C
Altitude	
Operating	Up to 3,000 m (approximately 10,000 feet) Maximum operating temperature decreases 1 °C each 300 m above 1.5 km
Non-operating	Up to 12,000 m (approximately 40,000 feet)
Dynamics	
Vibration	
Operating	2.65 m/s^2 rms (0.27 $Grms_)$, 5 Hz to 500 Hz, 10 min, three axes
Non-operating	22.3 m/s^2 rms (2.28 Grms), 5 Hz to 500 Hz, 10 min, three axes
Shock	
Non-operating	294 m/s^2 (30 G), half-sine, 11 ms duration
Installation requirements	
Power dissipation	560 W (600 VA maximum)
Surge current	30 A peak (25 °C) for $\leq$ 5 line cycles, after product has been turned off for at least 30 s.
Cooling clearance	
Top and bottom clearance	2 cm (0.8 in)
Side clearance	15 cm (5.9 in)
Rear clearance	7.5 cm (3.0 in)

Performance Verification

Performance Verification Procedures

Two types of performance verification procedures can be performed on the instrument: *Brief Procedures* and *Performance Tests*. You may not need to perform all of these procedures, depending on what you want to accomplish.

- To rapidly confirm that the instrument functions and was adjusted properly, perform *Diagnostics* and *Calibration* beginning on page 2-3.

  Advantages: These procedures are quick to do and require no external equipment or signal sources. These procedures perform extensive functional and accuracy testing to provide high confidence that the instrument will perform properly.

- To further check functionality, first perform Diagnostics and Calibration, and then perform *Functional Test* beginning on page 2-5.

  Advantages: The procedure requires minimal additional time to perform, and requires minimal equipment. The procedure can be used when the instrument is first received.

- If more extensive confirmation of performance is desired, complete the self tests and functional test, and then do the *Performance Tests* beginning on page 2-9.

  Advantages: These procedures add direct checking of warranted specifications. These procedures require suitable test equipment and more time to execute (refer to *Equipment Required* on page 2-9).

If you are not familiar with operating this instrument, refer to the online help or the user information supplied with the instrument.

Brief Procedures

There are three procedures in this section that provide a quick way to confirm basic functionality and proper adjustment:

- *Diagnostics*
- *Calibration*
- *Functional Test*

Diagnostics

The following steps run the internal routines that confirm basic functionality and proper adjustment.

Equipment	None
Prerequisites	None

1. Disconnect all the cables from the output channels.
2. Select **System > Diagnostics** to open the **Diagnostics** dialog box. See Figure 2-1 on page 2-4.

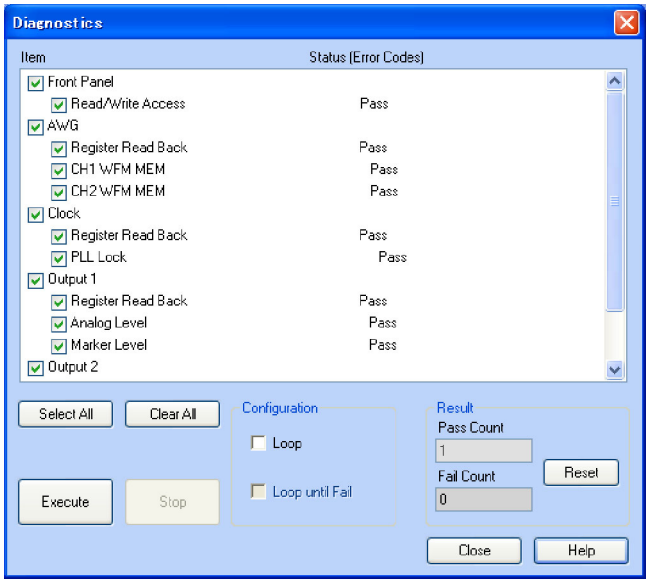


Figure 2-1: Diagnostics dialog box

3. In the Diagnostics dialog box, confirm that all the check boxes are selected. If they are not all selected, click the **Select All** button.
4. Click the **Execute** button to execute the diagnostics.

   The internal diagnostics perform an exhaustive verification of proper instrument function. This verification may take several minutes. When the verification is completed, the resulting status will appear in the dialog box.
5. Verify that **Pass** appears as Status in the dialog box when the diagnostics complete.
6. Click the close button to close the dialog box.

Calibration

Equipment	None
Prerequisites	Power on the instrument and allow a 20 minute warm-up before doing this procedure.

1. Select **System > Calibration** to open the **Calibration** dialog box. See Figure 2-2.

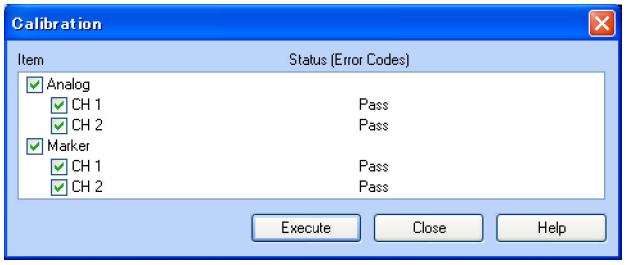


Figure 2-2: Calibration dialog box

2. Click the **Execute** button to start the routine.
3. Verify that **Pass** appears in the status column for all items when the calibration completes.
4. Click the close button to close the dialog box.

Functional Test

The purpose of the procedure is to confirm that the instrument functions properly. The equipment required is SMA cables, SMA terminators, SMA female to BNC male adapters, and an oscilloscope.

Checking the Analog and Marker Outputs

Equipment required	Oscilloscope (TDS5054B or equivalent) Three 50 Ω SMA cables Three 50 Ω SMA terminators Three SMA female to BNC male adapters
Prerequisites	None

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use a 50 Ω SMA cable and a SMA female to BNC male adapter to connect the Channel 1 Analog connector on the AWG7000 to the CH1 connector on the oscilloscope. See Figure 2-3 on page 2-6.
3. Use a 50 Ω SMA cable and a SMA female to BNC male adapter to connect the Channel 1 Mkr 1 connector on the AWG7000 to the CH2 connector on the oscilloscope. See Figure 2-3 on page 2-6.

4. Use the 50 Ω SMA cable and the SMA female to BNC male adapter to connect the Channel 1 Mkr 2 connector on the AWG7000 to the CH3 connector on the oscilloscope. See Figure 2-3.
5. Use a 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-3.
6. Use a 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Mkr 1}}$ connector on the AWG7000. See Figure 2-3.
7. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Mkr 2}}$ connector on the AWG7000. See Figure 2-3.

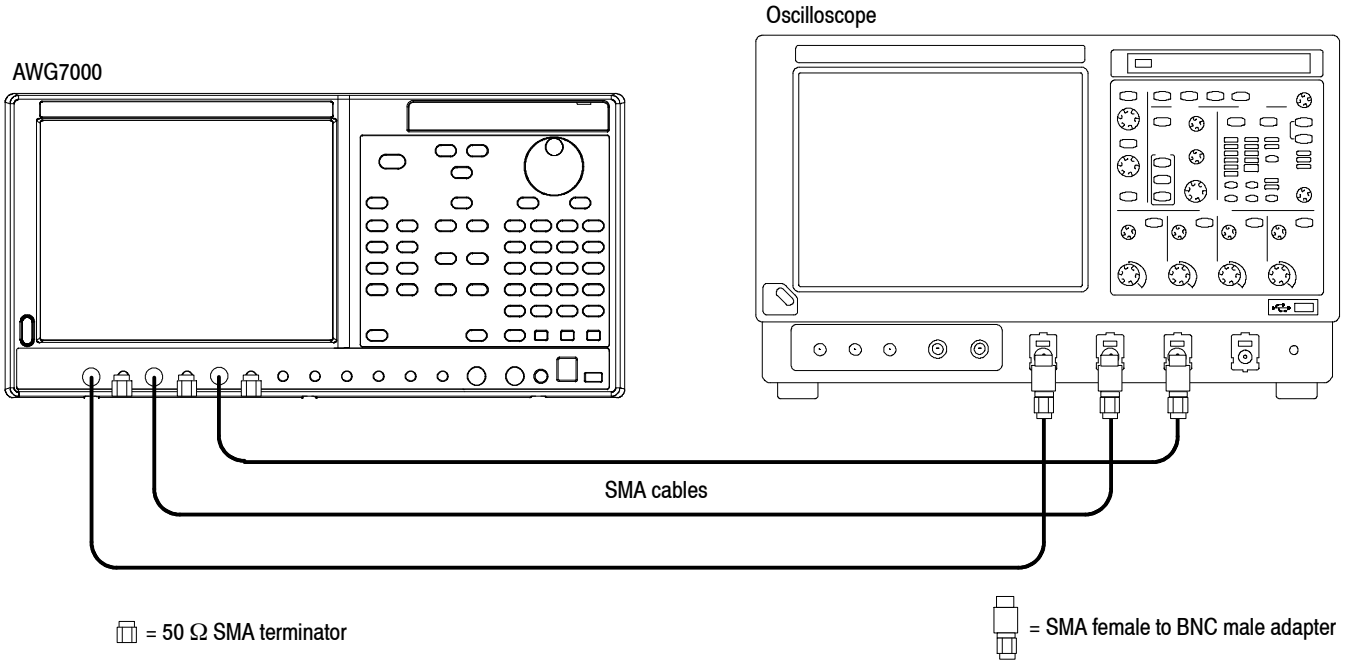


Figure 2-3: Equipment connections for checking the analog and marker outputs

8. Set the oscilloscope settings as indicated below:

Vertical scale	1 V/div (CH1, CH2, and CH3)
Horizontal scale	20 ns/div (for the AWG710x) 40 ns/div (for the AWG705x)
Input coupling	DC
Input impedance	50 Ω
CH 1 position	+1 div (if necessary)
CH 2 position	–1 div (if necessary)
CH 3 position	–3 div (if necessary)
Trigger source	CH1
Trigger level	0 mV
Trigger slope	Positive
Trigger mode	Auto

9. Press the **Factory Default** button on the AWG7000.

10. Press the **Ch1 Select** button on the AWG7000.

11. On the AWG7000, load the **sine_mk1_mk2** waveform as an output waveform.

a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.

b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.

***NOTE**. If your instrument is the AWG7051 or AWG7052, a warning message is displayed when you open the pv_awg7000.awg file. Press the OK button.*

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c. In the window, select (drag and drop) the **sine_mk1_mk2** waveform on the **User Defined** tab.

12. Press the **Ch 1 On** button on the AWG7000 to enable the cannel 1 output.

13. Press the **Run** button on the AWG7000 to output the waveform.

14. Check that the Channel 1 Analog, Mkr 1, and Mkr 2 waveforms are properly displayed on the oscilloscope screen as shown in Figure 2-4.

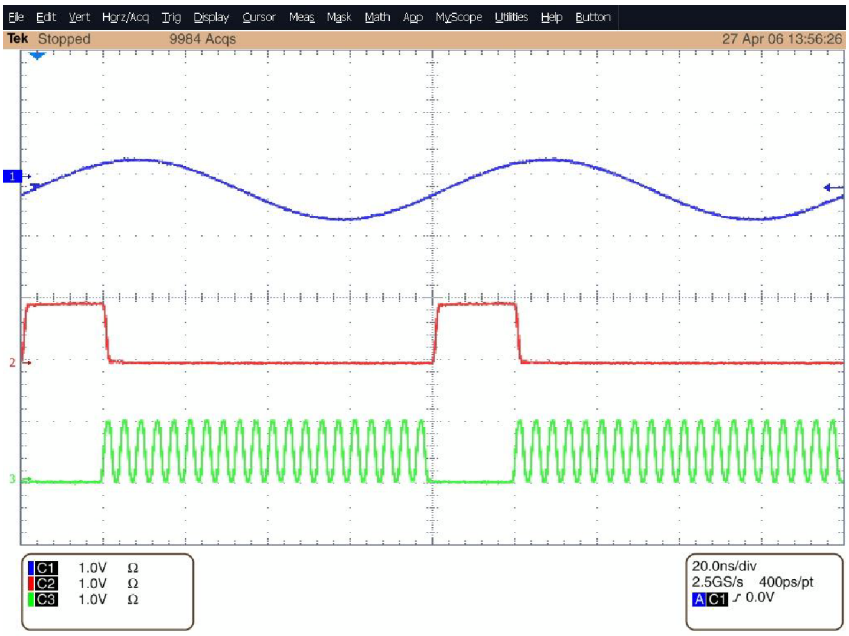


Figure 2-4: Output waveform from the Analog, Mkr1, and Mkr 2 connectors

15. Press the **Ch 1 On** button again to disable the channel 1 output.

16. *For the AWG7102 or AWG7052:* Repeat the test for the Channel 2 Analog, Mkr 1, and Mkr 2 outputs.

Performance Tests

This section contains performance verification procedures for the specifications marked with the ✓ symbol.

Prerequisites

The tests in this section comprise an extensive, valid confirmation of performance and functionality when the following requirements are met:

- The cabinet must be installed on the instrument.
- You must have performed and passed the procedure *Diagnostics* and *Calibration* beginning on page 2-3, and the procedure *Functional Tests* beginning on page 2-5.
- The instrument must have been last adjusted at an ambient temperature between +20 °C and +30 °C, must have been operating for a warm-up period of at least 20 minutes, and must be operating at an ambient temperatures between +10 °C and +40 °C.

Equipment Required

Table 2-1 lists the test equipment required to perform all of the performance verification procedure. The table identifies examples of recommended equipment and lists the required precision where applicable. If you substitute other test equipment for the listed examples, the equipment must meet or exceed the listed tolerances.

Table 2-1: Equipment required

Item	Qty.	Minimum requirements	Recommended equipment
Frequency counter	1 ea.	Frequency accuracy: within ±0.01 ppm	Agilent Technologies 53181A
Sampling oscilloscope	1 ea.	Bandwidth: 20 GHz or higher 2 channels	Tektronix CSA8200 with 80E03
Spectrum analyzer	1 ea.	Bandwidth: DC to 8 GHz	Tektronix RSA3308A
Digital multimeter	1 ea.	DC accuracy: within ±0.01%	Keithley 2000 DMM
50 Ω BNC cable	1 ea.	DC to 2 GHz	Tektronix part number 012-0057-01
50 Ω SMA cable	2 ea.	DC to 20 GHz	Tensolite 1-3636-465-5236
50 Ω SMA terminator	2 ea.	DC to 18 GHz	Tektronix part number 015-1022-01 (supplied with the AWG7000)
50 Ω BNC terminator	1 ea.	DC to 1 GHz, feedthrough	Tektronix part number 011-0049-02

Table 2-1: Equipment required (Cont.)

Item	Qty.	Minimum requirements	Recommended equipment
50 Ω SMA attenuator	2 ea.	5 X, 14 dB, DC to 18 GHz	Tektronix part number 015-1002-01
SMA-BNC adapter	1 ea.	SMA male to BNC female connectors	Tektronix part number 015-0554-00
SMA-N adapter	1 ea.	SMA female to N male connectors	Tensolite 5004CCSF
BNC-dual banana adapter	1 ea.	BNC to dual banana plugs	Tektronix part number 103-0090-00
DC output lead set	1 ea.	8-pin twisted pair, 24 inch	Tektronix part number 012-1697-00 (supplied with the AWG7000)

Test Waveforms

Table 2-2 lists the test waveforms that are used for the performance verification procedures and functional test. These are included in the pv_awg7000.awg file on the C: drive.

Table 2-2: Test waveforms

No.	Waveform name	Purpose
1	dc_minus	For checking the analog amplitude accuracy
2	dc_plus	For checking the analog amplitude accuracy
3	dc_zero	For checking the analog offset accuracy
4	marker_hi	For checking the marker high level accuracy
5	marker_low	For checking the marker low level accuracy
6	sine32	For checking analog harmonic distortion, analog non-harmonic spurious signal, and analog phase noise
7	sine_mk1_mk2	For the functional test (refer to page 2-5)
8	square1	For checking the marker output delay accuracy test

***NOTE**. If your instrument is the AWG7051 or AWG7052, a warning message is displayed when you open the pv_awg7000.awg file. Press the OK button.*

Test Record

Photocopy this page and the next eight pages, and use them to record the performance test results for your instrument.

AWG7000 Series Performance Test Record

Instrument Model: ☐ AWG7101 ☐ AWG7102 ☐ AWG7051 ☐ AWG7052

Instrument Serial Number: _____ Certificate Number: _____

Temperature: _____ RH %: _____

Date of Calibration: _____ Technician: _____

Performance Test		Minimum	Incoming	Outgoing	Maximum
10 MHz Reference Frequency Accuracy		9.99998 MHz			10.00002 MHz
Analog Offset Accuracy					
AWG7000 standard					
Ch 1	Offset:				
	+0.5 V	480 mV			520 mV
	0.0 V	-10 mV			+10 mV
	-0.5 V	-520 mV			- 480 mV
$\overline{\text{Ch 1}}$	Offset:				
	+0.5 V	480 mV			520 mV
	0.0 V	-10 mV			+10 mV
	-0.5 V	-520 mV			- 480 mV
Ch 2	Offset:				
	+0.5 V	480 mV			520 mV
	0.0 V	-10 mV			+10 mV
	-0.5 V	-520 mV			- 480 mV
$\overline{\text{Ch 2}}$	Offset:				
	+0.5 V	480 mV			520 mV
	0.0 V	-10 mV			+10 mV
	-0.5 V	-520 mV			- 480 mV
AWG7000 Option 02					
Ch 1	Offset:				
	N/A (0V)	-10 mV			+10 mV
$\overline{\text{Ch 1}}$	Offset:				
	N/A (0V)	-10 mV			+10 mV
Ch 2	Offset:				
	N/A (0V)	-10 mV			+10 mV
$\overline{\text{Ch 2}}$	Offset:				
	N/A (0V)	-10 mV			+10 mV

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
AWG7102 Option 06						
Ch 1	Offset					
	N/A (0 V)		-10 mV			10 mV
$\overline{\text{Ch 1}}$	Offset					
	N/A (0 V)		-10 mV			10 mV
Ch 2	Offset					
	N/A (0 V)		-10 mV			10 mV
$\overline{\text{Ch 2}}$	Offset					
	N/A (0 V)		-10 mV			10 mV
Interleave	Offset	Output mode				
	N/A (0 V)	Interleave: On	-10 mV			10 mV
Analog Amplitude Accuracy						
AWG7000 standard						
Ch1	Amplitude	Output mode				
	50 mVp-p	Direct D/A out: Off	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: Off	192 mV			208 mV
	500 mVp-p	Direct D/A out: Off	483 mV			517 mV
	1.0 Vp-p	Direct D/A/out: Off	0.968 V			1.032 V
	2.0 Vp-p	Direct D/A/out: Off	1.938 V			2.062 V
	50 mVp-p	Direct D/A out: On	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: On	192 mV			208 mV
	1.0 Vp-p	Direct D/A out: On	0.968 V			1.032 V
$\overline{\text{Ch1}}$	Amplitude	Output mode				
	50 mVp-p	Direct D/A out: Off	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: Off	192 mV			208 mV
	500 mVp-p	Direct D/A out: Off	483 mV			517 mV
	1.0 Vp-p	Direct D/A/out: Off	0.968 V			1.032 V
	2.0 Vp-p	Direct D/A/out: Off	1.938 V			2.062 V
	50 mVp-p	Direct D/A out: On	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: On	192 mV			208 mV
	1.0V p-p	Direct D/A out: On	0.968 V			1.032 V

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
Ch2	Amplitude	Output mode				
	50 mVp-p	Direct D/A out: Off	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: Off	192 mV			208 mV
	500 mVp-p	Direct D/A out: Off	483 mV			517 mV
	1.0 Vp-p	Direct D/A/out: Off	0.968 V			1.032 V
	2.0 Vp-p	Direct D/A/out: Off	1.938 V			2.062 V
	50 mVp-p	Direct D/A out: On	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: On	192 mV			208 mV
	1.0 Vp-p	Direct D/A out: On	0.968 V			1.032 V
$\overline{\text{Ch2}}$	Amplitude	Output mode				
	50 mVp-p	Direct D/A out: Off	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: Off	192 mV			208 mV
	500 mVp-p	Direct D/A out: Off	483 mV			517 mV
	1.0 Vp-p	Direct D/A/out: Off	0.968 V			1.032 V
	2.0 Vp-p	Direct D/A/out: Off	1.938 V			2.062 V
	50 mVp-p	Direct D/A out: On	46.5 mV			53.5 mV
	200 mVp-p	Direct D/A out: On	192 mV			208 mV
	1.0 Vp-p	Direct D/A out: On	0.968 V			1.032 V
AWG7000 Option 02						
Ch 1	Amplitude:					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 V			1.022 V
$\overline{\text{Ch 1}}$	Amplitude:					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 V			1.022 V
Ch 2	Amplitude:					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 V			1.022 V
$\overline{\text{Ch 2}}$	Amplitude:					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 V			1.022 V

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
AWG7102 Option 06						
Ch 1	Amplitude					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 mV			1.022 mV
$\overline{\text{Ch 1}}$	Amplitude					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 mV			1.022 mV
Ch 2	Amplitude					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 mV			1.022 mV
$\overline{\text{Ch 2}}$	Amplitude					
	500 mVp-p		488 mV			512 mV
	1.0 Vp-p		0.978 mV			1.022 mV
Analog Harmonic Distortion						
AWG710x standard						
Ch 1	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-35 dBc
	1.0 V	Direct D/A out: On	none			-42 dBc
Ch 2	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-35 dBc
	1.0 V	Direct D/A out: On	none			-42 dBc
AWG705x standard						
Ch 1	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-40 dBc
	1.0 V	Direct D/A out: On	none			-45 dBc
Ch 2	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-40 dBc
	1.0 V	Direct D/A out: On	none			-45 dBc
AWG7101 Option 02						
Ch 1	Amplitude					
	1.0 V		none			-42 dBc
AWG705x Option 02						
Ch 1	Amplitude					
	1.0 V		none			-45 dBc
Ch 2	Amplitude					
	1.0 V		none			-45 dBc

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
AWG7102 Option 06						
Ch 1	Amplitude					
	1.0 V		none			-42 dBc
Ch 2	Amplitude					
	1.0 V		none			-42 dBc
Analog Non-Harmonic Spurious						
AWG7000 standard						
Ch1	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-50 dBc
	1.0 V	Direct D/A out: On	none			-50 dBc
Ch 2	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-50 dBc
	1.0 V	Direct D/A out: On	none			-50 dBc
AWG7000 Option 02						
Ch 1	Amplitude					
	1.0 V		none			-50 dBc
Ch 2	Amplitude					
	1.0 V		none			-50 dBc
AWG7102 Option 06						
Ch 1	Amplitude					
	1.0 V		none			-50 dBc
Ch 2	Amplitude					
	1.0 V		none			-50 dBc

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
Analog Phase Noise (at 10 kHz offset)						
AWG7000						
Ch 1	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-90 dBc/Hz
	1.0 V	Direct D/A out: On	none			-90 dBc/Hz
Ch 2	Amplitude	Output mode				
	1.0 V	Direct D/A out: Off	none			-90 dBc/Hz
	1.0 V	Direct D/A out: On	none			-90 dBc/Hz
AWG7000 Option 02						
Ch 1	Amplitude					
	1.0 V		none			-90 dBc/Hz
Ch 2	Amplitude					
	1.0 V		none			-90 dBc/Hz
AWG7102 Option 06						
Ch 1	Amplitude					
	1.0 V		none			-90 dBc/Hz
Ch 2	Amplitude					
	1.0 V		none			-90 dBc/Hz
Interleave	Amplitude	Output mode				
	0.5 V	Interleave: On Zeroing: On	none			-85 dBc/Hz
	1.0 V	Interleave: On Zeroing: Off	none			-85 dBc/Hz

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
Marker High and Low Level Accuracy						
AWG7000						
Ch 1	Mkr 1	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	$\overline{\text{Mkr 1}}$	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	Mkr 2	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	$\overline{\text{Mkr 2}}$	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V

AWG7000 Series Performance Test Record (Cont.)

Performance Test			Minimum	Incoming	Outgoing	Maximum
Ch 2	Mkr 1	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	$\overline{\text{Mkr 1}}$	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	Mkr 2	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V
	$\overline{\text{Mkr 2}}$	High level setting				
		+1.4 V	1.21 V			1.59 V
		0.0 V	-50 mV			+50 mV
		-0.9 V	-1.04 V			-0.76 V
		Low level setting				
		+0.9 V	0.76 V			1.04 V
		0.0 V	-50 mV			+50 mV
		-1.4 V	-1.59 V			-1.21 V

AWG7000 Series Performance Test Record (Cont.)

Performance Test		Minimum	Incoming	Outgoing	Maximum
Marker Output Delay Accuracy					
AWG7000					
Ch 1	Mkr 1	92.5 ps			207.5 ps
	Mkr 2	92.5 ps			207.5 ps
Ch 2	Mkr 1	92.5 ps			207.5 ps
	Mkr 2	92.5 ps			207.5 ps
DC Output Accuracy					
AWG7000					
	DC output:				
	+5 V	4.77 V			5.23 V
	+3 V	2.83 V			3.17 V
	0.0 V	-80 mV			+80 mV
	-3 V	-3.17 V			-2.83 V

10 MHz Reference Frequency Accuracy

Equipment required	Frequency counter 50 Ω BNC cable
Prerequisites	As listed under *Prerequisites* on page 2-9.

1. Use the 50 Ω BNC cable to connect the 10 MHz Reference Output connector on the AWG7000 to the frequency counter CH1 input. See Figure 2-5.

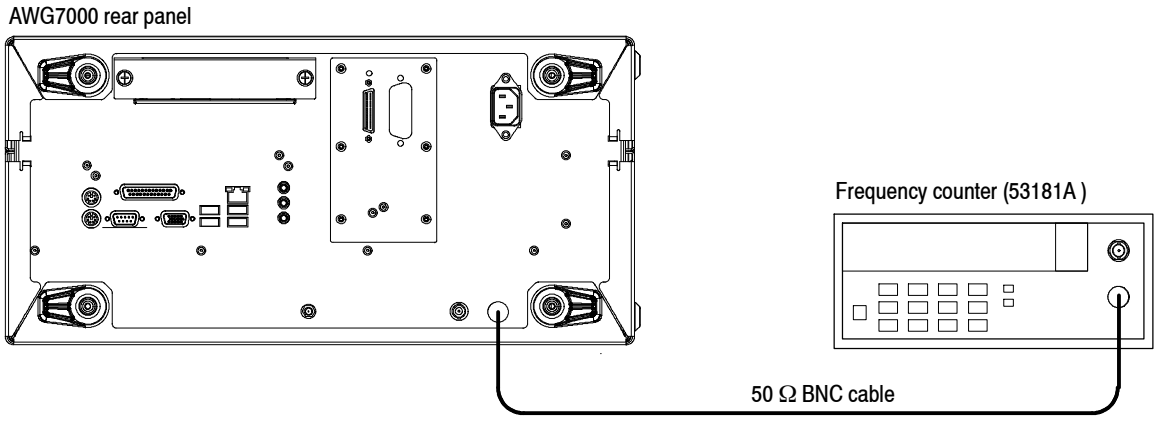


Figure 2-5: Equipment connection for verifying the 10 MHz reference frequency accuracy

2. Set the frequency counter settings as indicated below:

   MEASURE Frequency1
   Gate Time: 0.10 s
   CHANNEL1 . . . . . Coupling: AC
   Impedance: 50 Ω

3. Press the **Factory Default** button on the AWG7000.
4. Verify that the frequency counter reading falls within the range of 9.99998 MHz to 10.00002 MHz (± 0.2 ppm).
5. Disconnect the test setup.

Analog Offset Accuracy

Equipment required	Digital multimeter 50 Ω BNC cable SMA-BNC adapter 50 Ω BNC terminator BNC-dual banana adapter 50 Ω SMA terminator
Prerequisites	As listed under *Prerequisites* on page 2-9.

Measuring the Terminator Resistance

Before verifying the analog offset accuracy, you need to measure the resistance of the 50 Ω BNC terminator.

1. Connect the BNC-dual banana adapter and 50 Ω BNC terminator to the HI and LO inputs on the digital multimeter. See Figure 2-6.

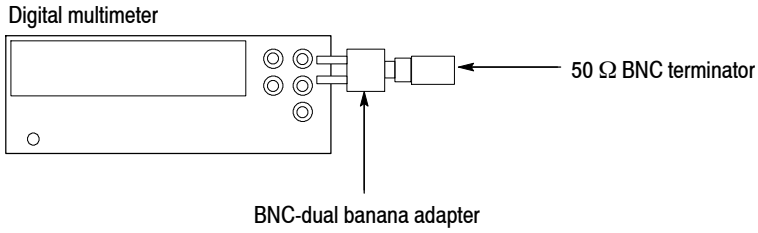


Figure 2-6: Equipment connection for measuring the terminator resistance

2. Set the digital multimeter to the **Ω 2 wires** mode.
3. Measure the resistance and note the value as **Term_R**.
4. Set the digital multimeter to the **VDC** mode.
5. Disconnect the test setup.

Verifying the Analog Offset Accuracy

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use the 50 Ω BNC cable, SMA-BNC adapter, 50 Ω BNC terminator, and BNC-Banana adapter to connect the Channel 1 Analog connector on the AWG7000 to the HI and LO inputs on the digital multimeter. See Figure 2-7.
3. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-7.

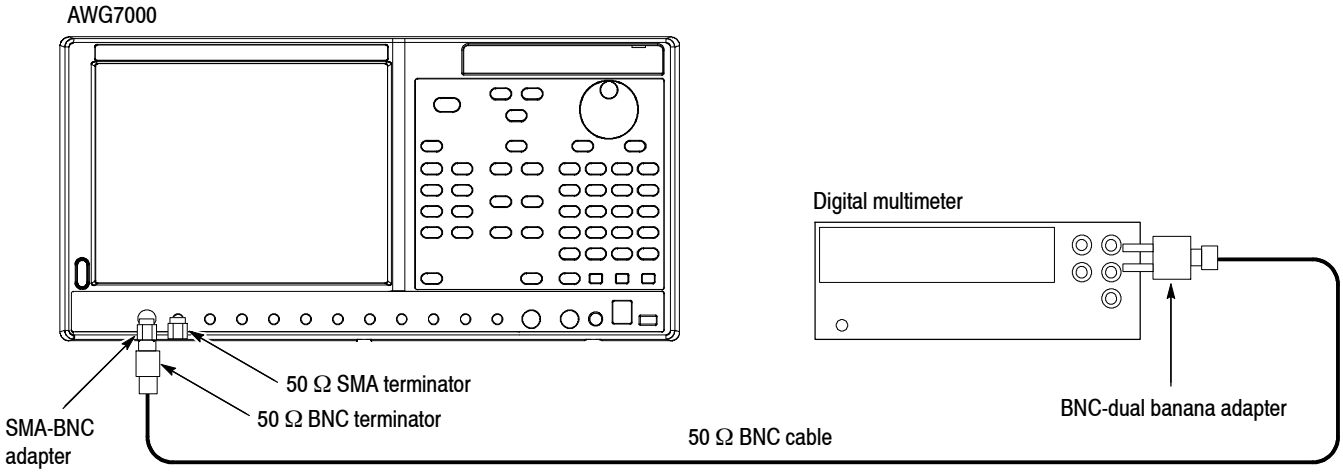


Figure 2-7: Equipment connection for verifying the analog offset accuracy

4. Press the **Factory Default** button on the AWG7000.
5. Press the **Ch1 Select** button on the AWG7000.
6. On the AWG7000, load the **dc_zero** waveform as an output waveform.
   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.
   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.
   c. In the window, select (drag and drop) the **dc_zero** waveform on the **User Defined** tab.
7. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
8. Press the **Run** button on the AWG7000 to output the waveform.

9. Set the offset of the AWG7000 to the level shown in the first row (or the corresponding row for your instrument) of Table 2-3.

Table 2-3: Analog offset accuracy

Model	Offset settings	Accuracy limits
AWG7000	+0.5 V	480 mV to 520 mV
	0.0 V	-10 mV to +10 mV
	-0.5 V	-520 mV to -480 mV
AWG7000 Option 02	N/A (0 V)	-10 mV to + 10 mV
AWG7000 Option 06	N/A (0 V)	-10 mV to +10 mV

10. Measure the output voltage on the digital multimeter and note the value as **Measured_voltage**.

11. Use the following formula to compensate the voltage for the 50 Ω BNC terminator:

    Voltage = [(Term_R + 50) / (2 × Term_R)] × Measured_voltage

    Where Term_R is the resistance of the 50 Ω BNC terminator measured in step 3.

12. Verify that the calculated value falls within the limits given in Table 2-3.

13. Repeat steps 9 through 12 for each offset setting in Table 2-3.

14. Move the SMA-BNC adapter from the Channel 1 Analog connector to the Channel 1 Analog connector and move the 50 Ω SMA terminator from the Channel 1 Analog connector to the Channel 1 Analog connector.

15. Repeat steps 9 through 13.

16. *For the AWG7102 or AWG7052:* Repeat steps 7 through 14 for the Channel 2 output.

17. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.

18. Disconnect the test setup.

Analog Amplitude Accuracy

Equipment required	Digital multimeter 50 Ω BNC cable SMA-BNC adapter 50 Ω BNC terminator BNC-dual banana adapter 50 Ω SMA terminator
Prerequisites	As listed under *Prerequisites* on page 2-9.

1. Perform *Measuring the Terminator Resistance* on page 2-21.
2. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
3. Use the 50 Ω BNC cable, SMA-BNC adapter, 50 Ω BNC terminator, and BNC-Banana adapter to connect the Channel 1 Analog connector on the AWG7000 to the HI and LO inputs on the digital multimeter. See Figure 2-7 on page 2-22.
4. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-7 on page 2-22.
5. Press the **Factory Default** button on the AWG7000.
6. Press the **Ch 1 Select** button on the AWG7000.
7. On the AWG7000, load the **dc_plus** waveform as an output waveform.
   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.
   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.
   c. In the window, select (drag and drop) the **dc_plus** waveform on the **User Defined** tab.
8. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
9. Press the **Run** button on the AWG7000 to output the waveform.
10. Set the the amplitude and output mode of the AWG7000 as shown in the first row (or the corresponding row for your instrument) of Table 2-4.

Table 2-4: Analog amplitude accuracy

Model	Amplitude settings	Output mode settings	Accuracy limits
AWG7000	50 mVp-p	----------	46.5 mV to 53.5 mV
	200 mVp-p	----------	192 mV to 208 mV
	500 mVp-p	----------	483 mV to 517 mV
	1.0 Vp-p	----------	0.968 V to 1.032 V
	2.0 Vp-p	----------	1.938 V to 2.062 V
	50 mVp-p	Direct D/A out: On	46.5 mV to 53.5 mV
	200 mVp-p	Direct D/A out: On	192 mV to 208 mV
	1.0 Vp-p	Direct D/A out: On	0.968 V to 1.032 V
AWG7000 Option 02/ 06	500 mVp-p	Interleave: Off (Option 06)	488 mV to 512 mV
	1.0 Vp-p	Interleave: Off (Option 06)	0.978 V to 1.022 V

11. Measure the output voltage on the digital multimeter and note the value as **Measured_voltage_1**.

12. Use the following formula to compensate the voltage for the 50 Ω BNC terminator:

    V_high = [(Term_R + 50) / (2 × Term_R)] × Measured_voltage_1

    Where Term_R is the resistance of the 50 Ω BNC terminator measured in step 3 on page 2-21.

13. In the **Waveform List** window, select the **dc_minus** waveform on the **User Defined** tab.

14. Measure the output voltage on the digital multimeter and note the value as **Measured_voltage_2**.

15. Use the following formula to compensate the voltage for the 50 Ω BNC terminator:

    V_low = [(Term_R + 50) / (2 × Term_R)] × Measured_voltage_2

    Where Term_R is the resistance of the 50 Ω BNC terminator measured in step 3 on page 2-21.

16. Verify that the voltage difference |(V_high–V_low)| falls within the limits given in Table 2-4.

17. Repeat steps 7 through 16 for each amplitude setting in Table 2-4.

18. Move the SMA-BNC adapter from the Channel 1 Analog connector to the Channel 1 $\overline{\text{Analog}}$ connector and move the 50 Ω SMA terminator from the Channel 1 $\overline{\text{Analog}}$ connector to the Channel 1 Analog connector.
19. Repeat steps 10 through 17.
20. *For the AWG7102 or AWG7052:* Repeat steps 6 through 18 for the Channel 2 output.
21. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
22. Disconnect the test setup.

Analog Harmonic Distortion

Equipment required	Spectrum analyzer 50 Ω SMA cable SMA-N adapter 50 Ω SMA terminator
Prerequisites	As listed under Prerequisites on page 2-9.

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use the 50 Ω SMA cable and SMA-N adapter to connect the Channel 1 Analog connector on the AWG7000 to the INPUT connector on the spectrum analyzer. See Figure 2-8.
3. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-8.

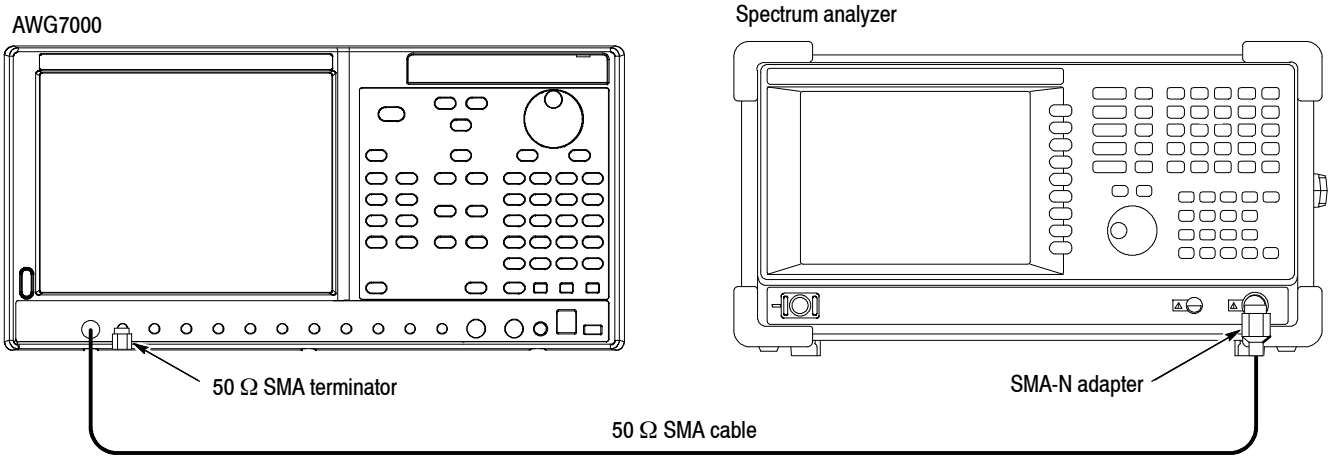


Figure 2-8: Equipment connections for verifying the analog harmonic distortion

4. Set the spectrum analyzer settings as indicated below:

   Center frequency . . . . . 1.5 GHz
   2 GHz (for the AWG7102 Option 06, Interleave: On)
   Span . . . . . 3 GHz
   RBW . . . . . 1 MHz

5. Press the **Factory Default** button on the AWG7000.

6. Press the **Ch 1 Select** button on the AWG7000.

7. On the AWG7000, load the **sine_32** waveform as an output waveform.

   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.

   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.

   c. In the window, select (drag and drop) the **sine_32** waveform on the **User Defined** tab.

8. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.

9. Press the **Run** button on the AWG7000 to output the waveform.

10. Make the AWG7000 settings shown in the first row (or corresponding row for your instrument) of Table 2-5 on page 2-28.

Table 2-5: Analog harmonic distortion

AWG7000 model and settings				Measurement frequency (MHz)				Accuracy Limit
Model	**Output mode**	**Amplitude**	**Sampling rate (output frequency)**	**2nd**	**3rd**	**4th**	**5th**	**Nth reference**
AWG710x	Direct out: Off	1.0 Vp-p	10 GS/s (312.5 MHz)	625	937.5	1250	1562.5	< -35 dBc
	Direct out: On							< -42 dBc
AWG7101 Option 02	-------	1.0 Vp-p	10 GS/s (312.5 MHz)	625	937.5	1250	1562.5	< -42 dBc
AWG7102 Option 06	Interleave: Off	1.0 Vp-p	10 GS/s (312.5 MHz)	625	937.5	1250	1562.5	< -42 dBc
AWG705x	Direct out: Off	1.0 Vp-p	5 GS/s (156.25 MHz)	312.5	468.75	625	781.25	< -40 dBc
	Direct out: On							< -45 dBc
AWG705x Option 02	-------	1.0 Vp-p	5GS/s (156.25 MHz)	312.5	468.75	625	781.25	< -45 dBc

11. Use the delta measurement function of the spectrum analyzer to measure harmonic distortion of each measurement frequency.

12. Verify that the harmonic distortion falls within the limits given in Table 2-5.

13. Repeat steps 10 through 12 for each setting in Table 2-5.

14. *For the AWG7102 or AWG7052:* Repeat the test for the Channel 2 output.

15. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.

16. Disconnect the test setup.

Analog Non-Harmonic Spurious Signal

Equipment required	Spectrum analyzer 50 Ω SMA cable SMA-N adapter 50 Ω SMA terminator
Prerequisites	As listed under Prerequisites on page 2-9.

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use the 50 Ω SMA cable and SMA-N adapter to connect the Channel 1 Analog connector on the AWG7000 to the INPUT connector on the spectrum analyzer. See Figure 2-9.
3. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-9.

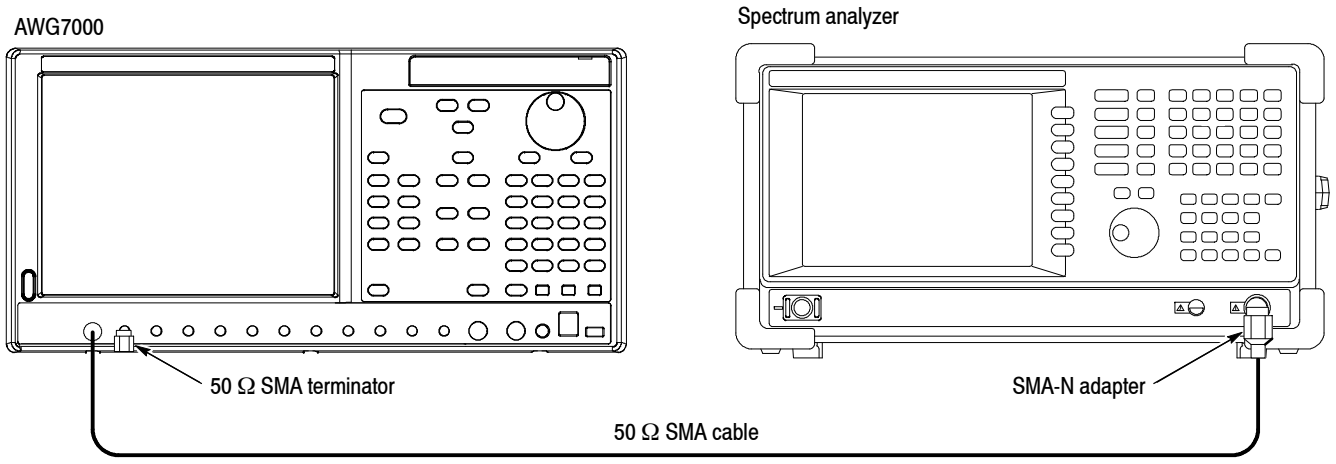


Figure 2-9: Equipment connections for verifying the non-harmonic spurious signal

4. Press the **Factory Default** button on the AWG7000.
5. Press the **Ch1 Select** button on the AWG7000.

6. On the AWG7000, load the **sine_32** waveform as an output waveform.
   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.
   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.
   c. In the window, select (drag and drop) the **sine_32** waveform on the **User Defined** tab.
7. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
8. Press the **Run** button on the AWG7000 to output the waveform.
9. Make the AWG7000 and spectrum analyzer settings shown in the first row (or the corresponding row for your instrument) of Table 2-6.

Table 2-6: Analog non-harmonic spurious signal

AWG7000 model and settings				Spectrum analyzer settings			
Model	**Output mode**	**Amplitude**	**Sampling rate (output frequency)**	**Center frequency**	**Span**	**RBW**	**Accuracy Limit**
AWG710x	Direct out: On/Off	1.0 Vp-p	10 GS/s (312.5 MHz)	1.5 GHz	3 GHz	1 MHz	< -50 dBc
				2 GHz	3 GHz	1 MHz	
				4 GHz	3 GHz	1 MHz	
AWG7101 Option 02	-------	1.0 Vp-p	10 GS/s (312.5 MHz)	1.5 GHz	3 GHz	1 MHz	< -50 dBc
				2 GHz	3 GHz	1 MHz	
				4 GHz	3 GHz	1 MHz	
AWG7102 Option 06	Interleave: Off	1.0 Vp-p	10 GS/s (312.5 MHz)	1.5 GHz	3 GHz	1 MHz	< -50 dBc
				2 GHz	3 GHz	1 MHz	
				4 GHz	3 GHz	1 MHz	
AWG705x	Direct out: On/Off	1.0 Vp-p	5 GS/s (156.25 MHz)	1.5 GHz	3 GHz	1 MHz	< -50 dBc
AWG705x Option 02	-------	1.0 Vp-p	5GS/s (156.25 MHz)	1.5 GHz	3 GHz	1 MHz	< -50 dBc

10. Use the spectrum analyzer to measure non-harmonic spurious signal of the Analog output over a frequency range of DC to 5 GHz (for the AWG705x, DC to 2.5 GHz). For example, note the reference level of the fundamental waveform, and then measure each spurious.
11. Verify that the non-harmonic spurious signal falls within the limits given in Table 2-6.
12. Repeat steps 9 through 12 for each setting in Table 2-6.
13. *For the AWG7102 or AWG7052:* Repeat the test for the Channel 2 output.
14. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
15. Disconnect the test setup.

Analog Phase Noise

Equipment required	Spectrum analyzer 50 Ω SMA cable SMA-N adapter 50 Ω SMA terminator
Prerequisites	As listed under *Prerequisites* on page 2-9.

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use the 50 Ω SMA cable and SMA-N adapter to connect the Channel 1 Analog connector on the AWG7000 to the INPUT connector on the spectrum analyzer. See Figure 2-10 on page 2-32.
3. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-10 on page 2-32.

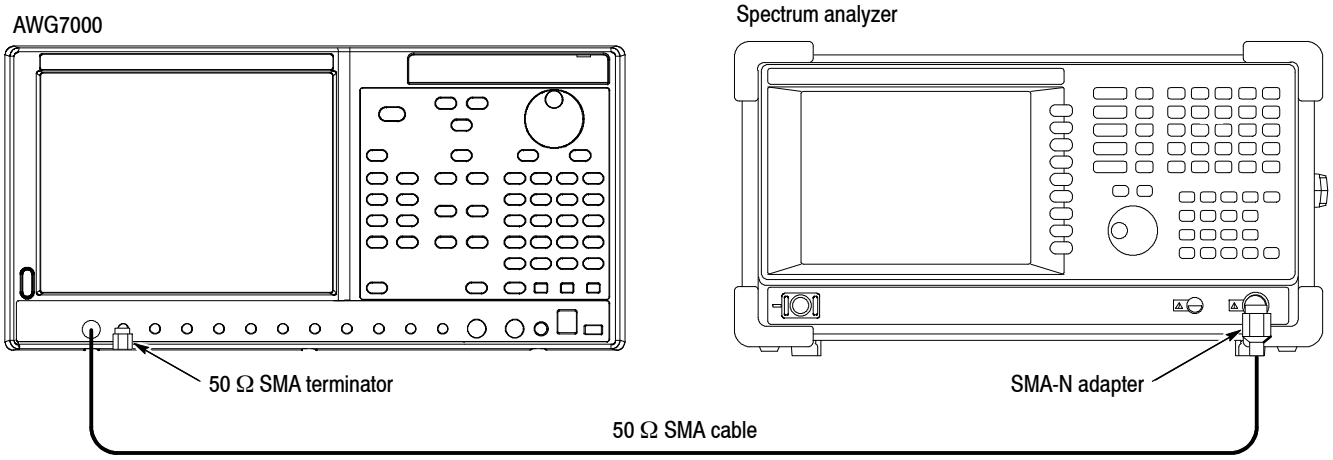


Figure 2-10: Equipment connections for verifying the analog phase noise

4. Press the **Factory Default** button on the AWG7000.
5. On the AWG7000, load the **sine_32** waveform as an output waveform.
   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.
   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.
   c. In the window, select (drag and drop) the **sine_32** waveform on the **User Defined** tab.
6. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
7. Press the **Run** button on the AWG7000 to output the waveform.
8. Make the AWG7000 and spectrum analyzer settings shown in the first row (or the corresponding row for your instrument) of Table 2-7.
9. Use the spectrum analyzer to measure phase noise of the Analog output.
10. Verify that the analog phase noise at 10 kHz offset falls within the limits given in Table 2-7.
11. Repeat steps 8 through 12 for each row in Table 2-7.
12. *For the AWG7102 or AWG7052:* Repeat the test for the Channel 2 output.
13. *For the AWG7102 Option 06:* Repeat the test for Interleave output.

Table 2-7: Analog phase noise

AWG7000 model and settings				Spectrum analyzer settings			Accuracy Limit at 10 kHz offset
Model	Output mode	Amplitude	Sampling rate	Center frequency	Span	RBW	
AWG710x	Direct out: On/Off	1.0 Vp-p	10 GS/s	312.5 MHz	50 kHz	100 Hz	< -90 dBc/Hz
AWG7101 Option 02	-------	1.0 Vp-p	10 GS/s	312.5 MHz	50 kHz	100 Hz	< -90 dBc/Hz
AWG7102 Option 06	Interleave: Off	1.0 Vp-p	10 GS/s	312.5 MHz	50 kHz	100 Hz	< -90 dBc/Hz
	Interleave: On Zeroing: Off	1.0 Vp-p	20 GS/s	625 MHz	50 kHz	100 Hz	< -85 dBc/Hz
	Interleave: On Zeroing: On	0.5 Vp-p	20 GS/s	625 MHz	50 kHz	100 Hz	< -85 dBc/Hz
AWG705x	Direct out: On/Off	1.0 Vp-p	5 GS/s	156.25 MHz	50 kHz	100 Hz	< -90 dBc/Hz
AWG705x Option 02	------	1.0 Vp-p	5GS/s	156.25 MHz	50 kHz	100 Hz	< -90 dBc/Hz

14. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.

15. Disconnect the test setup.

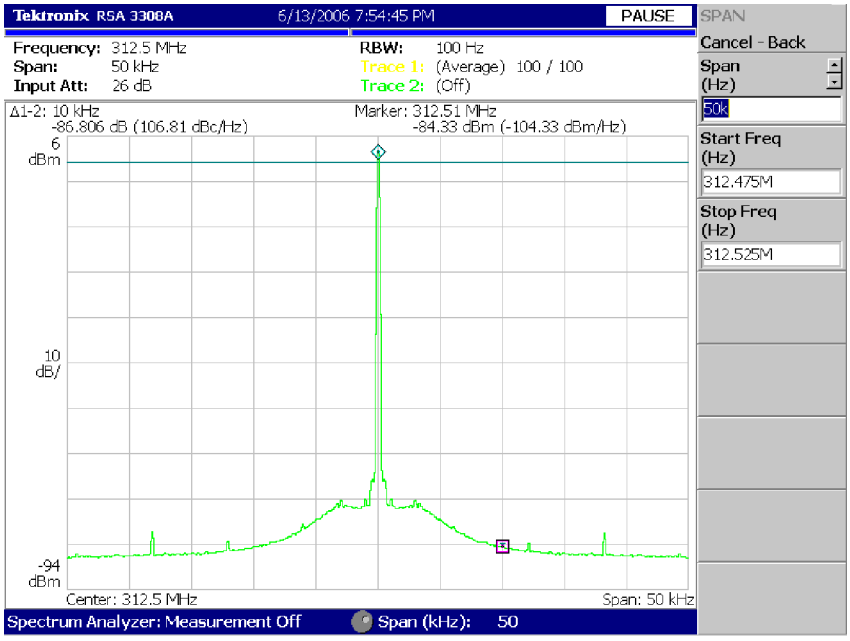


Figure 2-11: Example of the analog phase noise measurement

Marker High and Low Level Accuracy

Equipment required	Digital multimeter 50 Ω BNC cable SMA-BNC adapter 50 Ω BNC terminator BNC-dual banana adapter 50 Ω SMA terminator
Prerequisites	As listed under *Prerequisites* on page 2-9.

1. Perform *Measuring the Terminator Resistance* on page 2-21.
2. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
3. Use the 50 Ω BNC cable, SMA-BNC adapter, 50 Ω BNC terminator, and BNC-Banana adapter to connect the Channel 1 Mkr 1 connector on the AWG7000 to the HI and LO inputs on the digital multimeter. See Figure 2-12.
4. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Mkr 1}}$ connector on the AWG7000. See Figure 2-12.

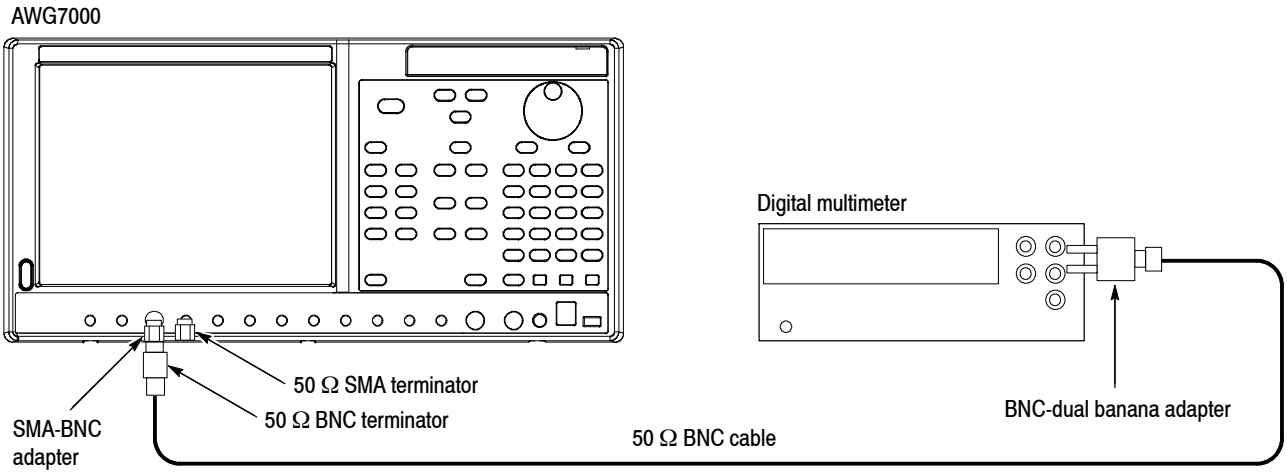


Figure 2-12: Equipment connection for verifying the marker high and low level accuracy

5. Press the **Factory Default** button on the AWG7000.
6. Press the **Ch1 Select** button on the AWG7000.
7. On the AWG7000, load the **marker_hi** waveform as an output waveform.
   a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.
   b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.
   c. In the window, select the **marker_hi** waveform on the **User Defined** tab.
8. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
9. Press the **Run** button on the AWG7000 to output the waveform.
10. Make the AWG7000 High Level setting shown in the first row of Table 2-8.

Table 2-8: Marker High and Low level accuracy

High level settings	Accuracy limits
+ 1.4 V	1.21 V to 1.59 V
0.0 V	-50 mV to +50 mV
-0.9 V	-1.04 V to -0.76 V
Low level settings	**Accuracy limits**
+ 0.9 V	0.76 V to 1.04 V
0.0 V	-50 mV to +50 mV
-1.4 V	-1.59 V to -1.21 V

11. Measure the output voltage on the digital multimeter and note the value as **Measured_voltage_1**.
12. Use the following formula to compensate the voltage for the 50 Ω BNC terminator:

    Marker_High = (Term_R + 50) / (2 × Term_R) × Measured_voltage_1
13. Verify that the marker High level falls within the limits given in Table 2-8.
14. Repeat steps 10 through 13 for each row in Table 2-8.
15. In the **Waveform List** window, select the **marker_low** waveform on the **User Defined** tab.

16. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
17. Press the **Run** button on the AWG7000 to output the waveform.
18. Make the AWG7000 Low Level setting shown in the first row of Table 2-8 on page 2-35.
19. Measure the output voltage on the digital multimeter and note the value as **Measured_voltage_2**.
20. Use the following formula to compensate the voltage for the 50 Ω BNC terminator:

    Marker_Low = (Term_R + 50) / (2 × Term_R) × Measured_voltage_2
21. Verify that the marker Low level falls within the limits given in Table 2-8 on page 2-35.
22. Repeat steps 18 through 21 for each row in Table 2-8 on page 2-35.
23. Press the **Ch 1 On** button to disable the channel 1 output.
24. Move the SMA-BNC adapter from the Channel 1 Mkr 1 connector to the Channel 1 $\overline{\text{Mkr 1}}$ connector and move the 50 Ω SMA terminator from the Channel 1 $\overline{\text{Mkr 1}}$ connector to the Channel 1 Mkr 1 connector.

***NOTE**. For the $\overline{\text{Mkr 1}}$ output, read marker_hi and marker_low as marker_low and marker_hi respectively.*

---

25. Repeat steps 8 through 22.
26. Repeat steps 8 through 25 for Channel 1 Mkr 2 and $\overline{\text{Mkr 2}}$.
27. *For the AWG7102 or AWG7052:* Repeat the test for the Channel 2 marker outputs.
28. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
29. Disconnect the test setup.

Marker Output Delay Accuracy

Equipment required	Sampling oscilloscope Two 50 Ω SMA cables Two 50 Ω SMA terminators Two 50 Ω SMA attenuators
Prerequisites	As listed under Prerequisites on page 2-9.

1. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
2. Use a 50 Ω SMA cable and 50 Ω SMA attenuator to connect the Channel 1 Mkr 1 connector on the AWG7000 to the CH1 connector on the sampling oscilloscope. See Figure 2-13.
3. Use the 50 Ω SMA cable and 50 Ω SMA attenuator to connect the Channel 1 Analog connector on the AWG7000 to the TRIGGER DIRECT connector on the sampling oscilloscope. See Figure 2-13.
4. Use a 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Analog}}$ connector on the AWG7000. See Figure 2-13.
5. Use the 50 Ω SMA terminator to terminate the Channel 1 $\overline{\text{Mkr 1}}$ connector on the AWG7000. See Figure 2-13.

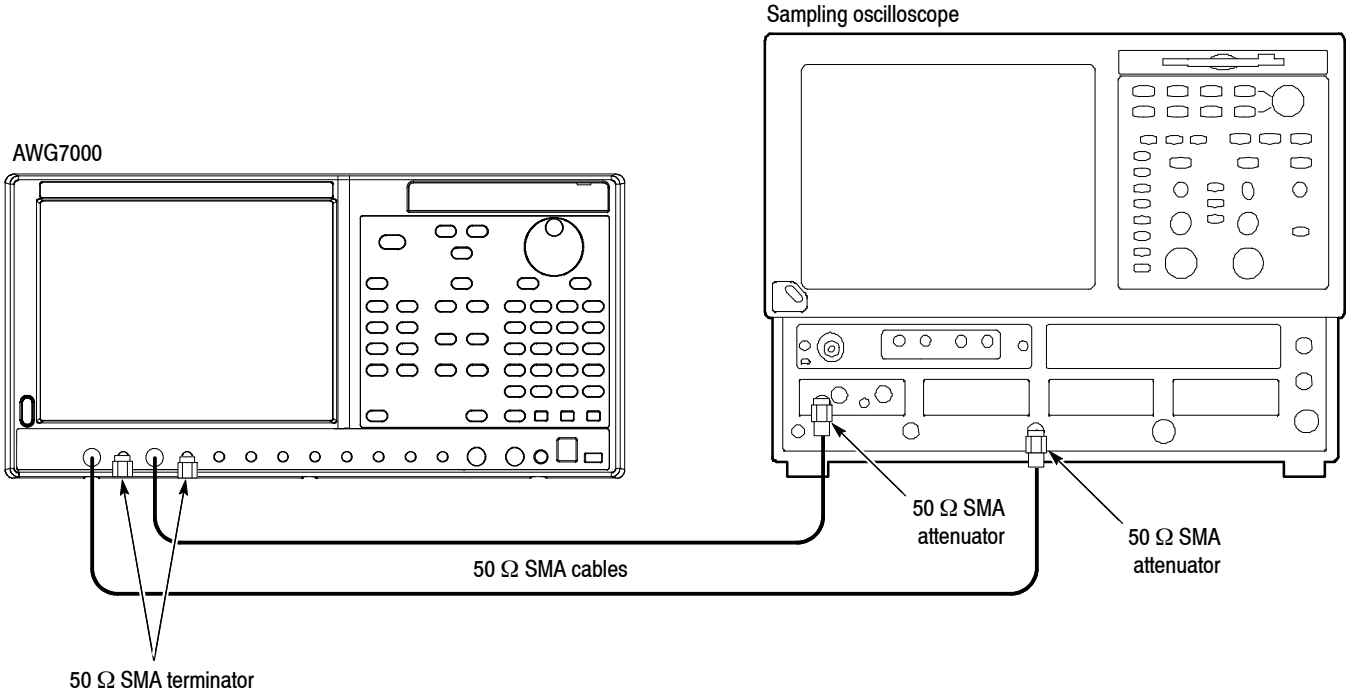


Figure 2-13: Equipment connections for verifying the marker output delay accuracy

6. Set the sampling oscilloscope settings as indicated below:

Vertical scale . . . . . 250 mV/div
Horizontal scale . . . . . 100 ps/div
Trigger source . . . . . External Direct
Trigger level . . . . . 0 V
Trigger slope . . . . . positive
Measure . . . . . Pulse measurement > Pulse Time > Delay

7. Press the **Factory Default** button on the AWG7000.

8. On the AWG7000, load the **square1** waveform as an output waveform.

a. Press the **File Open** button or select **File > Open File** to open the Open dialog box.

b. In the dialog box, navigate to the **C:\Program Files\Tektronix\AWG\System\PV** directory, and then select the **pv_awg7000.awg** file. The **Waveform List** window appears.

c. In the window, select the **square1** waveform on the **User Defined** tab.

9. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.

10. Press the **Run** button on the AWG7000 to output the waveform.

11. On the oscilloscope, store the channel 1 waveform to **Ref 1** as a reference waveform.
12. On the AWG7000, set the **Marker 1** delay value to **150 ps**.
13. Use the oscilloscope to measure the delay time between the Ref 1 waveform and channel 1 waveform at the 50% level.
14. Verify that the delay time is within the range of 92.5 ps to 207.5 ps.
15. Press the **Ch 1 On** button on the AWG7000 to disable the channel 1 output.
16. Move the SMA cable from the Channel 1 Mkr 1 connector to the Channel 1 Mkr 2 connector.
17. Move the SMA terminator from the Channel 1 $\overline{\text{Mkr 1}}$ connector to the Channel 1 $\overline{\text{Mkr 2}}$ connector.
18. Press the **Ch 1 On** button on the AWG7000 to enable the channel 1 output.
19. On the oscilloscope, store the channel 1 waveform to **Ref 1** as a reference waveform.
20. On the AWG7000, set the **Marker 2** delay value to **150 ps**.
21. Repeat steps 13 and 14.
22. *For the AWG7102 and AWG7052:* Repeat the test for the Marker 1 and Marker 2 of the Channel 2.
23. Press the **All Outputs On/Off** button on the AWG7000 to turn off all the outputs.
24. Disconnect the test setup.

DC Output Voltage Accuracy

Equipment required	Digital multimeter DC output lead set Test leads (provided with the digital multimeter)
Prerequisites	As listed under *Prerequisites* on page 2-9.

1. Use the test leads to connect the HI and LO inputs on the digital multimeter. See Figure 2-14.
2. Use the DC output lead set to connect the DC Output connector on the AWG7000. See Figure 2-14.

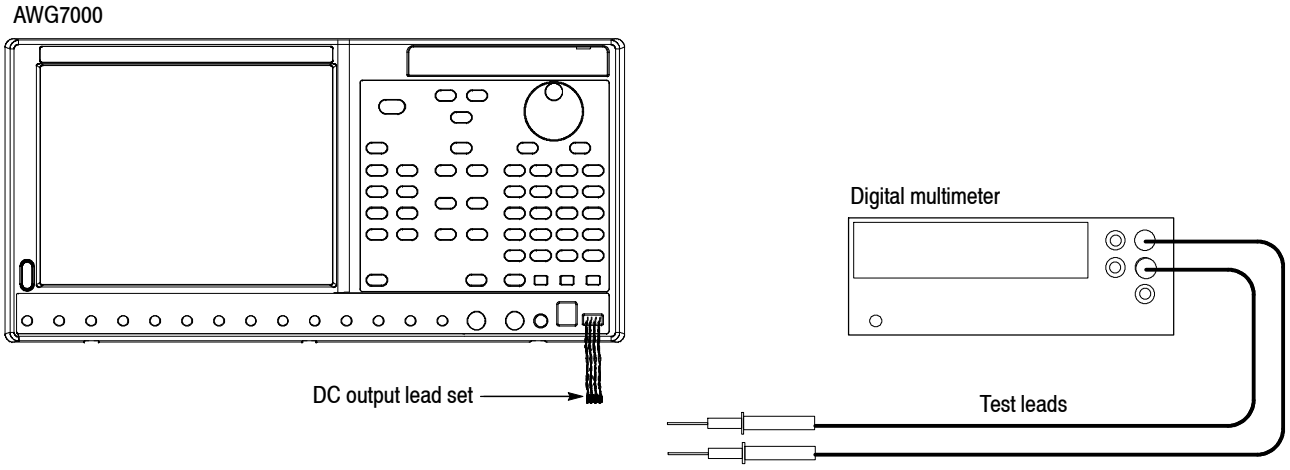


Figure 2-14: Equipment connection for verifying the DC output voltage accuracy

3. Set the digital multimeter to the **VDC** mode.
4. On the AWG7000, select the **DC Outputs** tab in the **Settings** window.
5. On the DC Output tab, set the DC 1, DC 2, DC 3, and DC 4 levels to the setting shown in the first row of Table 2-9 on page 2-41.

Table 2-9: DC output voltage accuracy

Model	DC output settings	Accuracy limits
AWG7000	+5 V	4.77 V to 5.23 V
	+3 V	2.83 V to 3.17 V
	0.0 V	-80 mV to +80 mV
	-3 V	-3.17 V to -2.83 V

6. On the DC Outputs tab, select the **DC Output** check box to enable the DC output. The DC Output LED on the front panel lights.
7. Attach the black test lead to the connector lead from DC1 GND.
8. Attach the red test lead to the connector lead from DC1.
9. Verify that the DC output level falls within the limits given in Table 2-9.
10. Repeat steps 8 through 9 for DC 2, DC 3, and DC 4.
11. Repeat steps 5 through 10 for each row in Table 2-9.

This completes the AWG7000 performance verification.

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