Tektronix®

MDO3000 Series
Mixed Domain Oscilloscopes
Specifications and Performance Verification

Technical Reference

077-0979-00

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

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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.

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.

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.

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

Connect and disconnect properly. De-energize the circuit under test before connecting or disconnecting the current probe.

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.

Connect the probe reference lead to earth ground only.

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

Power disconnect. The power cord disconnects the product from the power source. Do not block the power cord; it must remain accessible to the user at all times.

Do not operate without covers. Do not operate this product with covers or panels removed.

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

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

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.

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.

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

Specifications

This chapter contains specifications for the MDO3000 Series oscilloscopes. 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 have associated procedures listed in the *Performance Verification* section.

All specifications apply to all MDO3000 models unless noted otherwise. To meet specifications, two conditions must first be met:

- The oscilloscope must have been operating continuously for twenty minutes within the operating temperature range specified.
- You must perform the Signal Path Compensation (SPC) operation described in this manual prior to evaluating specifications. (See page 71.) If the operating temperature changes by more than 10 °C (18 °F), you must perform the SPC operation again.

Analog Channel Input And Vertical Specifications

Table 1: Analog channel input and vertical specifications

Characteristic	Description	
Number of input channels	MDO3104, MDO3054, MDO3034, MDO3024, MDO3014	4 analog, digitized simultaneously
	MDO3102, MDO3052, MDO3032, MDO3022, MDO3012	2 analog, digitized simultaneously
Input coupling	DC, AC	
Input termination selection	1 MΩ, 50 Ω, or 75 Ω. The 75 Ω setting is not available on MDO310X instruments.	
✓ Input termination, 1 MΩ, DC coupled	1 MΩ, ±1%	

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description	
Input termination, 50 Ω, DC coupled (See page 73.)	50 Ω, ±1%	
	For instruments with 1 GHz bandwidth (includes MDO310X models as well as MDO305X/303X/302X/301X models with 1 GHz upgrade):	VSWR ≤ 1.5:1 from DC to 1 GHz, typical
	For instruments with 500 MHz bandwidth (includes MDO305X models as well as MDO303X/302X/301X models with 500 MHz upgrade):	VSWR ≤ 1.5:1 from DC to 500 MHz, typical
	For instruments with 350 MHz bandwidth (includes MDO303X models as well as MDO302X/301X models with 350 MHz upgrade):	VSWR ≤ 1.5:1 from DC to 350 MHz, typical
	For instruments with 200 MHz bandwidth (includes MDO302X models as well as MDO301X models with 200 MHz upgrade):	VSWR ≤ 1.5:1 from DC to 200 MHz, typical
	For instruments with 100 MHz bandwidth (MDO301X models):	VSWR ≤ 1.5:1 from DC to 100 MHz, typical
Input termination, 75 Ω, DC coupled (See page 73.)	75 Ω, ±1%	
	VSWR ≤ 1.3:1 from DC to 30 MHz, typical	
	VSWR ≤ 1.5:1 from 30 MHz to 60 MHz, typical	
Maximum input voltage (50 Ω and 75 Ω)	5 V_{RMS} with peaks ≤ ±20 V, (DF<=6.25%) There is an over-voltage trip circuit, intended to protect against overloads that might damage termination resistors. A sufficiently large impulse can cause damage regardless of the over-voltage protection circuitry, due to the finite time required to detect the over-voltage condition and respond to it.	
Maximum input voltage (1 MΩ)	The maximum input voltage at the BNC, 300 V_{RMS}. Installation Category II. De-rate at 20 dB/decade between 4.5 MHz and 45 MHz, De-rate 14 db between 45 MHz and 450 MHz. Above 450 MHz, 5 V_{RMS}. Maximum peak input voltage at the BNC, ±424 V	

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description		
DC balance (See page 74.)	0.2 div with the input DC-50Ω coupled and 50 Ω terminated		
	0.25 div at 2 mV/div with the input DC-50 Ω coupled and 50 Ω terminated		
	0.5 div at 1 mV/div with the input DC-50 Ω coupled and 50 Ω terminated		
	0.2 div with the input DC-75 Ω coupled and 75 Ω terminated		
	0.25 div at 2 mV/div with the input DC-75 Ω coupled and 75 Ω terminated		
	0.5 div at 1 mV/div with input DC-75 Ω coupled and 75 Ω terminated		
	0.2 div with the input DC-1 MΩ coupled and 50 Ω terminated		
	0.3 div at 1 mV/div with the input DC-1 MΩ coupled and 50 Ω terminated		
	All the above specifications are increased by 0.01 divisions per °C above 40 °C.		
Delay between channels, full bandwidth, typical	≤ 100 ps between any two channels with input termination set to 50 Ω, DC coupling ≤ 100 ps between any two channels with input termination set to 75 Ω, DC coupling Note: all settings in the instrument can be manually time aligned using the Probe Deskew function		
Deskew range	–125 ns to +125 ns		
Crosstalk (channel isolation), typical		≤100 MHz	>100 MHz
	1 MΩ	100:1	30:1
	50 Ω	100:1	30:1
	75 Ω	100:1	30:1
TekVPI Interface	The probe interface allows installing, powering, compensating, and controlling a wide range of probes offering a variety of features. The interface is available on CH1-CH4 front panel inputs. Aux In is available on the front of two-channel instrument only and is fully VPI compliant. Four-channel instruments have no Aux In input.		
Number of digitized bits	8 bits Displayed vertically with 25 digitization levels (DL) per division, 10.24 divisions dynamic range "DL" is the abbreviation for "digitization level." A DL is the smallest voltage level change that can be resolved by an 8-bit A-D Converter. This value is also known as the LSB (least significant bit).		
Sensitivity range (coarse)	1 M Ω:	1 mV/div to 10 V/div in a 1-2-5 sequence	
	50 Ω and 75 Ω:	1 mV/div to 1 V/div in a 1-2-5 sequence	
Sensitivity range (fine)	Allows continuous adjustment from 1 mV/div to 10 V/div, 1 MΩ Allows continuous adjustment from 1 mV/div to 1 V/div, 75 Ω Allows continuous adjustment from 1 mV/div to 1 V/div, 50 Ω		
Sensitivity resolution (fine), typical	≤ 1% of current setting		
Position range	±5 divisions		

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description				
✓ Analog bandwidth, 50 Ω input termination (See page 76.)	The limits stated below are for ambient temperature of ≤ 30 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 30 °C.				
	Instrument Bandwidth	Vertical Scale Setting			
		10 mV/div to 1 V/div	5 mV/div to 9.98 mV/div	2 mV/div to 4.98 mV/div	1 mV/div to 1.99 mV/div
	1.00 GHz	DC to 1.0 GHz	DC to 500 MHz	DC to 350 MHz	DC to 150 MHz
	500 MHz	DC to 500 MHz		DC to 350 MHz	DC to 150 MHz
	350 MHz	DC to 350 MHz		DC to 350 MHz	DC to 150 MHz
	200 MHz	DC to 200 MHz			DC to 150 MHz
	100 MHz	DC to 100 MHz			
Analog bandwidth, 75 Ω input termination, typical	The limits stated below are for ambient temperature of ≤ 30 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 30 °C.				
	Instrument Bandwidth	Vertical Scale Setting			
		10 mV/div to 1 V/div	5 mV/div to 9.98 mV/div	2 mV/div to 4.98 mV/div	1 mV/div to 1.99 mV/div
	500 MHz, 350 MHz, and 200 MHz	DC to 200 MHz		DC to 140 MHz	DC to 100 MHz
	100 MHz	DC to 100 MHz			
Analog bandwidth, 1 MΩ input termination. The Analog Bandwidth when the instrument is DC-1MΩ coupled, typical	The limits stated below are for ambient temperature of ≤ 30 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 30 °C.				
	Instrument Bandwidth	Vertical Scale Setting			
		2 mV/div to 10 V/div	1 mV/div to 1.99 mV/div		
	1 GHz, 500 MHz, or 350 MHz	DC to 350 MHz	DC to 150 MHz		
	200 MHz	DC to 200 MHz	DC to 150 MHz		
	100 MHz	DC to 100 MHz			

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description				
Analog Bandwidth, 1 MΩ with Standard Probe, typical	The limits stated below are for ambient temperature of ≤ 30 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 30 °C.				
	Instrument Bandwidth	Vertical Scale Setting			
		100 mV/div to 100 V/div	50 mV/div to 99.8 mV/div	20 mV/div to 49.8 mV/div	10 mV/div to 19.9 mV/div
	1 GHz	DC to 1.00 GHz	DC to 400 MHz	DC to 250 MHz	DC to 150 MHz
	500 MHz	DC to 500 MHz	DC to 400 MHz	DC to 250 MHz	DC to 150 MHz
	350 MHz	DC to 350 MHz		DC to 250 MHz	DC to 150 MHz
	200 MHz	DC to 200 MHz			DC to 150 MHz
	100 MHz	DC to 100 MHz			
Calculated rise time, typical	The formula is calculated by measuring –3 dB bandwidth of the oscilloscope. The formula accounts for the rise time contribution of the oscilloscope independent of the rise time of the signal source. All values in the above table are in pS. 1 GHz BW models assume the TPP1000 probe. 500 MHz and 350 MHz models assume the TPP0500B probe. 200 MHz and 100 MHz models assume the TPP0250 probe.				
	Instrument Bandwidth	Vertical Scale Setting (50 Ω)			
		1 mV/div to 1.99 mV/div	2 mV/div to 4.98 mV/div	5 mV/div to 9.98 mV/div	10 mV/div to 1 V/div
	1 GHz	2,666 ps	1,333 ps	800 ps	400 ps
	500 MHz	2,666 ps	1,333 ps	800 ps	800 ps
	350 MHz	2,666 ps	1,333 ps	1,143 ps	1,143 ps
	200 MHz	2,666 ps	2,000 ps	2,000 ps	2,000 ps
	100 MHz	4,000 ps	4,000 ps	4,000 ps	4,000 ps
	Instrument Bandwidth	Vertical Scale Setting (TPPXXX0 probe)			
		10 mV to 19.9 mV	20 mV to 49.8 mV	50 mV to 99.8 mV	100 mV to 100 V
	1 GHz	2,666 ps	1,600 ps	1,000 ps	400 ps
	500 MHz	2,666 ps	1,600 ps	1,000 ps	800 ps
	350 MHz	2,666 ps	1,600 ps	1,143 ps	1,143 ps
	200 MHz	2,666 ps	2,000 ps	2,000 ps	2,000 ps
	100 MHz	4,000 ps	4,000 ps	4,000 ps	4,000 ps
Analog bandwidth limit filter selections	For instruments with 1 GHz, 500 MHz or 350 MHz analog bandwidth: 20 MHz, 250 MHz, and Full				
	For instruments with 200 MHz and 100 MHz analog bandwidth: 20 MHz and Full				

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description	
Lower frequency limit, AC coupled, typical	< 10 Hz when AC to 1 MΩ coupled The AC coupled lower frequency limits are reduced by a factor of 10 when 10X passive probes are used.	
Upper frequency limit, 250 MHz bandwidth limit filter, typical	250 MHz, +25%, and –25% (all models, except 100 MHz and 200 MHz)	
Upper frequency limit, 20 MHz bandwidth limit filter, typical	20 MHz, ±25% (all models)	
DC gain accuracy (See page 79.)	±2.5% for 1 mV/Div, derated at 0.100%/°C above 30 °C ±2.0% for 2 mV/Div, derated at 0.100%/°C above 30 °C ±1.5% for 5 mV/Div and above, derated at 0.100%/°C above 30 °C ±3.0% Variable Gain, derated at 0.100%/°C above 30 °C	
DC voltage measurement accuracy	*Measurement type*	*DC Accuracy (in volts)*
Sample acquisition mode, typical	Any sample	±[DC gain accuracy X | reading – (offset – position) | + Offset Accuracy +0.15 div + 0.6 mV]
	Delta volts between any two samples acquired with the same oscilloscope setup and ambient conditions	±[DC gain accuracy X | reading | + 0.15 div + 1.2 mV]
	NOTE. *Offset, position, and the constant offset term must be converted to volts by multiplying by the appropriate volts/div term.*	
Average acquisition mode	Average of ≥ 16 waveforms	±[DC gain accuracy X | reading – (offset – position) | + Offset Accuracy + 0.1 div]
	Delta volts between any two averages of ≥ 16 waveforms acquired with the same oscilloscope setup and ambient conditions	±[DC gain accuracy X | reading | + 0.05 div]
	NOTE. *Offset, position, and the constant offset term must be converted to volts by multiplying by the appropriate volts/div term.* ***NOTE.*** *The basic accuracy specification applies directly to any sample and to the following measurements: High, Low, Max, Min, Mean, Cycle Mean, RMS, and Cycle RMS. The delta volt accuracy specification applies to subtractive calculations involving two of these measurements.* *The delta volts (difference voltage) accuracy specification applies directly to the following measurements: Positive Overshoot, Negative Overshoot, Peak-Peak, and Amplitude.*	

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic	Description		
Offset ranges	*Volts/div setting*	*Offset range*	
		1 MΩ input	*50 Ω and 75 Ω input*
	1 mV/div to 50 mV/div	±1 V	±1 V
	50.5 mV/div to 99.5 mV/div	±0.5 V	±0.5 V
	100 mV/div to 500 mV/div	±10 V	±5 V
	505 mV/div to 995 mV/div	±5 V	±5 V
	1 V/div to 10 V/div [1]	±100 V	±5 V
	NOTE. *The input signal cannot exceed the maximum input voltage for the 50 Ω and 75 Ω input paths. Refer to the Maximum input voltage specifications (earlier in this table) for more information.*		
✓ Offset accuracy (See page 83.)	±[0.005 X | offset - position | + DC Balance] ***NOTE.*** *Both the position and constant offset term must be converted to volts by multiplying by the appropriate volts/div term.*		

✓ Random noise, sample acquisition mode, 50 Ω termination setting (See page 86.)	50Ω, RMS, unit in mV				
	MDO31xx	**MDO305x**	**MDO303x**	**MDO302x**	**MDO301x**
1 mV, Full BW	0.21	0.2	0.2	0.2	0.19
2 mV, Full BW	0.33	0.27	0.25	0.23	0.21
5 mV, Full BW	0.5	0.36	0.36	0.3	0.3
10 mV, Full BW	0.7	0.5	0.5	0.45	0.45
20 mV, Full BW	1	0.9	0.9	0.9	0.9
50 mV, Full BW	3	2.75	2.75	2.75	2.25
100 mV, Full BW	4.5	4.15	4.15	4.15	4.15
200 mV, Full BW	9	8.15	8.15	8.15	8.15
500 mV, Full BW	20	20	20	20	20
1 V, Full BW	40	40	40	40	40

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic		Description				
	1 mV, 250 MHz BW	0.21	0.2	0.2	—	—
	2 mV, 250 MHz BW	0.25	0.23	0.23	—	—
	5 mV, 250 MHz BW	0.35	0.3	0.3	—	—
	10 mV, 250 MHz BW	0.5	0.5	0.5	—	—
	20 mV, 250 MHz BW	1	1	1	—	—
	50 mV, 250 MHz BW	2.75	2.75	2.75	—	—
	100 mV, 250 MHz BW	4.15	4.15	4.15	—	—
	200 mV, 250 MHz BW	10	10	10	—	—
	500 mV, 250 MHz BW	20	20	20	—	—
	1 V, 250 MHz BW	40	40	40	—	—
	1 mV, 20 MHz BW	0.12	0.12	0.12	0.12	0.12
	2 mV, 20 MHz BW	0.15	0.15	0.15	0.15	0.15
	5 mV, 20 MHz BW	0.25	0.25	0.25	0.25	0.25
	10 mV, 20 MHz BW	0.45	0.4	0.4	0.4	0.4
	20 mV, 20 MHz BW	0.8	0.75	0.75	0.75	0.75
	50 mV, 20 MHz BW	2.1	2.1	2.1	2.1	2.1
	100 mV, 20 MHz BW	4.1	4.1	4.1	4.1	4.1
	200 mV, 20 MHz BW	8	8	8	8	8
	500 mV, 20 MHz BW	20	20	20	20	20
	1 V, 20 MHz BW	40	40	40	40	40

Table 1: Analog channel input and vertical specifications (cont.)

Characteristic		Description				
Random noise, sample acquisition mode, 50 Ω termination setting, typical		Typical, 50Ω, RMS				
		MDO31xx	**MDO305x**	**MDO303x**	**MDO302x**	**MDO301x**
	1 mV, Full BW	0.179	0.178	0.169	0.178	0.162
	100 mV, Full BW	2.4	2.05	1.98	1.94	1.88
	1 V, Full BW	24.67	20.99	20.03	19.41	18.8

1 For 50 Ω and 75Ω path, 1 V/div is the maximum vertical setting.

Digital Channel Acquisition System Specifications

Table 2: Digital channel acquisition system specifications

Characteristic	Description
Threshold voltage range	–15 V to +25 V
Digital channel timing resolution	Minimum: 2 ns for the main memory Minimum: 121.2 ps for MagniVu memory
✓ Threshold accuracy (See page 89.)	± [100 mV + 3% of threshold setting after calibration], after valid SPC
Minimum detectable pulse	2.0 ns Using MagniVu memory. Specified at the input to the P6316 probe with all eight ground inputs connected to the user's ground. Use of lead sets, grabber clips, ground extenders, or other connection accessories may compromise this specification.
Channel to channel skew (typical)	500 ps Digital Channel to Digital Channel only This is the propagation path skew, and ignores skew contributions due to bandpass distortion, threshold inaccuracies (see Threshold Accuracy), and sample binning (see Digital Channel Timing Resolution).

Horizontal And Acquisition System Specifications

Table 3: Horizontal and acquisition system specifications

<table>
<tr><th colspan="2">Characteristic</th><th colspan="4">Description</th></tr>
<tr><td colspan="2">✓ Long-term sample rate and delay time accuracy (See page 85.)</td><td colspan="4">±10 ppm over any ≥ 1 ms time interval</td></tr>
<tr><td colspan="2">Seconds/division range</td><td colspan="4">MDO30XX models: 1 ns/div to 1000 sec/div
MDO310X models: 400 ps/div to 1000 sec/div</td></tr>
<tr><td colspan="2" rowspan="6">Peak detect or
envelope mode pulse response, typical</td><td colspan="2">Instrument</td><td colspan="2">Minimum pulse width</td></tr>
<tr><td colspan="2">Models at 1 GHz BW</td><td colspan="2">> 1.5 ns</td></tr>
<tr><td colspan="2">Models at 500 MHz BW</td><td colspan="2">> 2.0 ns</td></tr>
<tr><td colspan="2">Models at 350 MHz BW</td><td colspan="2">> 3.0 ns</td></tr>
<tr><td colspan="2">Models at 200 MHz BW</td><td colspan="2">> 5.0 ns</td></tr>
<tr><td colspan="2">Models at 100 MHz BW</td><td colspan="2">> 7.0 ns</td></tr>
<tr><td colspan="2">Sample-rate range</td><td colspan="4">See Sample Rate Range detail table. (See page 13.)</td></tr>
<tr><td colspan="2">Record length range</td><td colspan="4">1K, 10K, 100K, 1M, 5M, 10M</td></tr>
<tr><td colspan="2">Maximum triggered acquisition rate</td><td colspan="2">1 and 2 channels</td><td colspan="2">3 and 4 channels</td></tr>
<tr><td rowspan="3"></td><td>Bandwidth</td><td>FastAcq</td><td>DPO</td><td>FastAcq</td><td>DPO</td></tr>
<tr><td>1 GHz</td><td>> 280,000 wfm/sec</td><td>> 80,000 wfm/sec</td><td>> 230,000 wfm/sec</td><td>> 50,000 wfm/sec</td></tr>
<tr><td>< 1 GHz</td><td>> 230,000 wfm/sec</td><td>> 50,000 wfm/sec</td><td>> 230,000 wfm/sec</td><td>> 50,000 wfm/sec</td></tr>
<tr><td colspan="2">Aperture uncertainty, typical
(also called “sample rate jitter”)</td><td colspan="4">$\leq (5 \text{ ps} + 1 \times 10^{-6} \text{X record duration})_{RMS}$, for records having duration ≤ 1 minute
Record duration = (Record Length) / (Sample Rate)</td></tr>
<tr><td colspan="2">Number of waveforms for average acquisition mode</td><td colspan="4">2 to 512 waveforms
Default of 16 waveforms</td></tr>
<tr><td colspan="2" rowspan="2">✓ Delta time measurement accuracy (See page 87.)</td><td colspan="4">The formula to calculate delta-time measurement accuracy (DTA) for a given instrument setting and input signal is given below (assumes insignificant signal content above Nyquist).</td></tr>
<tr><td colspan="4">SR_1 = Slew Rate (1st Edge) around the 1st point in the measurement
SR_2 = Slew Rate (2nd Edge) around the 2nd point in the measurement
N = input-referred noise (volts_{rms}, refer to the Random Noise, Sample acquisition mode specification)
t_{sr} = 1 / (Sample Rate)
TBA = timebase accuracy (refer to the Long-term sample rate and delay time accuracy specification above)
t_p = delta-time measurement duration
RD = (Record Length) / (Sample Rate)</td></tr>
</table>

Table 3: Horizontal and acquisition system specifications (cont.)

	$$DTA_{PP} = \pm 5 \times \sqrt{2 \times \left[\frac{N}{SR_1}\right]^2 + 2 \times \left[\frac{N}{SR_2}\right]^2 + (5ps + 1E^{-6} \times RD)^2} + 2 \times t_{sr} + TBA \times t_p$$ $$DTA_{RMS} = \sqrt{2 \times \left[\frac{N}{SR_1}\right]^2 + 2 \times \left[\frac{N}{SR_2}\right]^2 + (5ps + 1E^{-6} \times RD)^2 + \left[\frac{2 \times t_{sr}}{\sqrt{12}}\right]^2} + TBA \times t_p$$
	Assumes that error due to aliasing is insignificant. The term under the square-root sign is the stability, and is related to the TIE (Time Interval Error). The errors from this term occur throughout a single-shot measurement. The second term is a result of both the absolute center-frequency accuracy and the center-frequency stability of the timebase, and varies between multiple single-shot measurements over the observation interval (the amount of time from the first single-shot measurement to the final single-shot measurement).

Sample Rate Range

**Table 4: Sample rate range
(MDO310X with 3 or 4 channels enabled or all other MDO3000 with 1, 2, 3, or 4 channels enabled)**

<table>
<tr><th>Characteristic</th><th colspan="7">Description</th></tr>
<tr><td rowspan="24">Sample rate range (Analog Channels)</td><td>Time-/Div</td><td>10 M record</td><td>5 M record</td><td>1 M record</td><td>100 K record</td><td>10 K record</td><td>1 K record</td></tr>
<tr><td>1 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>2 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>4 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>10 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>20 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>40 ns</td><td colspan="6">2.5 GS/s</td></tr>
<tr><td>80 ns</td><td colspan="5"></td><td>1.25 GS/s</td></tr>
<tr><td>100 ns</td><td colspan="5">2.5 GS/s</td><td></td></tr>
<tr><td>200 ns</td><td colspan="5">2.5 GS/s</td><td>500 MS/s</td></tr>
<tr><td>400 ns</td><td colspan="5">2.5 GS/s</td><td>250 MS/s</td></tr>
<tr><td>800 ns</td><td colspan="4"></td><td>1.25 GS/s</td><td></td></tr>
<tr><td>1 µs</td><td colspan="4">2.5 GS/s</td><td></td><td>100 MS/s</td></tr>
<tr><td>2 µs</td><td colspan="4">2.5 GS/s</td><td>500 MS/s</td><td>50 MS/s</td></tr>
<tr><td>4 µs</td><td colspan="4">2.5 GS/s</td><td>250 MS/s</td><td>25 MS/s</td></tr>
<tr><td>8 µs</td><td colspan="3"></td><td>1.25 GS/s</td><td colspan="2"></td></tr>
<tr><td>10 µs</td><td colspan="3">2.5 GS/s</td><td></td><td>100 MS/s</td><td>10 MS/s</td></tr>
<tr><td>20 µs</td><td colspan="3">2.5 GS/s</td><td>500 MS/s</td><td>50 MS/s</td><td>5 MS/s</td></tr>
<tr><td>40 µs</td><td colspan="3">2.5 GS/s</td><td>250 MS/s</td><td>25 MS/s</td><td>2.5 MS/s</td></tr>
<tr><td>80 µs</td><td colspan="2"></td><td>1.25 GS/s</td><td colspan="3"></td></tr>
<tr><td>100 µs</td><td colspan="2">2.5 GS/s</td><td></td><td>100 MS/s</td><td>10 MS/s</td><td>1 MS/s</td></tr>
<tr><td>200 µs</td><td colspan="2">2.5 GS/s</td><td>500 MS/s</td><td>50 MS/s</td><td>5 MS/s</td><td>500 KS/s</td></tr>
<tr><td>400 µs</td><td>2.5 GS/s</td><td>1.25 GS/s</td><td>250 MS/s</td><td>25 MS/s</td><td>2.5 MS/s</td><td>250 KS/s</td></tr>
<tr><td>800 µs</td><td>1.25 GS/s</td><td>625 MS/s</td><td colspan="4"></td></tr>
</table>

Table 4: Sample rate range (MDO310X with 3 or 4 channels enabled or all other MDO3000 with 1, 2, 3, or 4 channels enabled) (cont.)

Characteristic	Description						
Sample rate range (Analog Channels) (Cont.)	**Time-/Div**	**10 M record**	**5 M record**	**1 M record**	**100 K record**	**10 K record**	**1 K record**
	1 ms			100 MS/s	10 MS/s	1 MS/s	100 KS/s
	2 ms	500 MS/s	250 MS/s	50 MS/s	5 MS/s	500 KS/s	50 KS/s
	4 ms	250 MS/s	125 MS/s	25 MS/s	2.5 MS/s	250 KS/s	25 KS/s
	10 ms	100 MS/s	50 MS/s	10 MS/s	1 MS/s	100 KS/s	10 KS/s
	20 ms	50 MS/s	25 MS/s	5 MS/s	500 KS/s	50 KS/s	5 KS/s
	40 ms	25 MS/s	12.5 MS/s	2.5 MS/s	250 KS/s	25 KS/s	2.5 KS/s
	100 ms	10 MS/s	5 MS/s	1 MS/s	100 KS/s	10 KS/s	1 KS/s
	200 ms	5 MS/s	2.5 MS/s	500 KS/s	50 KS/s	5 KS/s	500 S/s
	400 ms	2.5 MS/s	1.25 MS/s	250 KS/s	25 KS/s	2.5 KS/s	250 S/s
	1 s	1 MS/s	500 KS/s	100 KS/s	10 KS/s	1 KS/s	100 S/s
	2 s	500 KS/s	250 KS/s	50 KS/s	5 KS/s	500 S/s	50 S/s
	4 s	250 KS/s	125 KS/s	25 KS/s	2.5 KS/s	250 S/s	25 S/s
	10 s	100 KS/s	50 KS/s	10 KS/s	1 KS/s	100 S/s	10 S/s
	20 s	50 KS/s	25 KS/s	5 KS/s	500 S/s	50 S/s	5 S/s
	40 s	25 KS/s	12.5 KS/s	2.5 KS/s	250 S/s	25 S/s	2.5 S/s
	100 s	10 KS/s	5 KS/s	1 KS/s	100 S/s	10 S/s	
	200 s	5 KS/s	2.5 KS/s	500 S/s	50 S/s	5 S/s	
	400 s	2.5 KS/s	1.25 KS/s	250 S/s	25 S/s	2.5 S/s	
	1000 s	1 KS/s	500 S/s	100 S/s	10 S/s		

Table 5: Sample rate range, (MDO310X models with 1 or 2 channels enabled)

Characteristic	Description						
Sample rate range (Analog Channels)	**Time-/Div**	**10 M record**	**5 M record**	**1 M record**	**100 K record**	**10 K record**	**1 K record**
	400 ps	5 GS/s					
	1 ns	5 GS/s					
	2 ns	5 GS/s					
	4 ns	5 GS/s					
	10 ns	5 GS/s					
	20 ns	5 GS/s					
	40 ns	5 GS/s					2.5 GS/s
	100 ns	5 GS/s					1 GS/s
	200 ns	5 GS/s					500 MS/s
	400 ns	5 GS/s				2.5 GS/s	250 MS/s
	1 µs	5 GS/s				1 GS/s	100 MS/s
	2 µs	5 GS/s				500 MS/s	50 MS/s
	4 µs	5 GS/s			2.5 GS/s	250 MS/s	25 MS/s
	10 µs	5 GS/s			1 GS/s	100 MS/s	10 MS/s
	20 µs	5 GS/s			500 MS/s	50 MS/s	5 MS/s
	40 µs	5 GS/s		2.5 GS/s	250 MS/s	25 MS/s	2.5 MS/s
	100 µs	5 GS/s		1 GS/s	100 MS/s	10 MS/s	1 MS/s
	200 µs	5 GS/s	2.5 GS/s	500 MS/s	50 MS/s	5 MS/s	500 KS/s
	400 µs	2.5 GS/s	1.25 GS/s	250 MS/s	25 MS/s	2.5 MS/s	250 KS/s

Table 5: Sample rate range, (MDO310X models with 1 or 2 channels enabled) (cont.)

Characteristic	Description						
Sample rate range (Analog Channels) (Cont.)	**Time-/Div**	**10 M record**	**5 M record**	**1 M record**	**100 K record**	**10 K record**	**1 K record**
	1 ms	1 GS/s	500 MS/s	100 MS/s	10 MS/s	1 MS/s	100 KS/s
	2 ms	500 MS/s	250 MS/s	50 MS/s	5 MS/s	500 KS/s	50 KS/s
	4 ms	250 MS/s	125 MS/s	25 MS/s	2.5 MS/s	250 KS/s	25 KS/s
	10 ms	100 MS/s	50 MS/s	10 MS/s	1 MS/s	100 KS/s	10 KS/s
	20 ms	50 MS/s	25 MS/s	5 MS/s	500 KS/s	50 KS/s	5 KS/s
	40 ms	25 MS/s	12.5 MS/s	2.5 MS/s	250 KS/s	25 KS/s	2.5 KS/s
	100 ms	10 MS/s	5 MS/s	1 MS/s	100 KS/s	10 KS/s	1 KS/s
	200 ms	5 MS/s	2.5 MS/s	500 KS/s	50 KS/s	5 KS/s	500 S/s
	400 ms	2.5 MS/s	1.25 MS/s	250 KS/s	25 KS/s	2.5 KS/s	250 S/s
	1 s	1 MS/s	500 KS/s	100 KS/s	10 KS/s	1 KS/s	100 S/s
	2 s	500 KS/s	250 KS/s	50 KS/s	5 KS/s	500 S/s	50 S/s
	4 s	250 KS/s	125 KS/s	25 KS/s	2.5 KS/s	250 S/s	25 S/s
	10 s	100 KS/s	50 KS/s	10 KS/s	1 KS/s	100 S/s	10 S/s
	20 s	50 KS/s	25 KS/s	5 KS/s	500 S/s	50 S/s	5 S/s
	40 s	25 KS/s	12.5 KS/s	2.5 KS/s	250 S/s	25 S/s	2.5 S/s
	100 s	10 KS/s	5 KS/s	1 KS/s	100 S/s	10 S/s	
	200 s	5 KS/s	2.5 KS/s	500 S/s	50 S/s	5 S/s	
	400 s	2.5 KS/s	1.25 KS/s	250 S/s	25 S/s	2.5 S/s	
	1000 s	1 KS/s	500 S/s	100 S/s	10 S/s		

Trigger Specifications

Table 6: Trigger specifications

<table>
<tr><th>Characteristic</th><th colspan="3">Description</th></tr>
<tr><td rowspan="5">Trigger level ranges</td><td colspan="2">Source</td><td>Sensitivity</td></tr>
<tr><td colspan="2">Any input channel</td><td>±8 divisions from center of screen,
±8 divisions from 0 V when vertical LF reject trigger coupling is selected</td></tr>
<tr><td colspan="2">Aux In (External)</td><td>±8 V</td></tr>
<tr><td colspan="2">Line</td><td>Not applicable</td></tr>
<tr><td colspan="3">The line trigger level is fixed at about 50% of the line voltage.
This specification applies to logic and pulse thresholds.</td></tr>
<tr><td rowspan="5">Trigger level accuracy, DC coupled, typical</td><td colspan="3">For signals having rise and fall times ≥ 10 ns, the limits are as follows:</td></tr>
<tr><td colspan="2">Source</td><td>Range</td></tr>
<tr><td colspan="2">Any channel</td><td>±0.20 divisions</td></tr>
<tr><td colspan="2">Aux In (external trigger)</td><td>±(10% of setting + 25 mV)</td></tr>
<tr><td colspan="2">Line</td><td>Not applicable</td></tr>
<tr><td>Lowest frequency for "Set Level to 50%" function, typical</td><td colspan="3">45 Hz</td></tr>
<tr><td>Trigger holdoff range</td><td colspan="3">20 ns minimum to 8 seconds maximum</td></tr>
<tr><td rowspan="9">Trigger sensitivity</td><td rowspan="4">Edge trigger,
DC coupled, typical</td><td>Trigger Source</td><td>Sensitivity</td></tr>
<tr><td>Any analog channel</td><td>1 mV/div to 4.98 mV/div: 0.75 div from DC to 50 MHz, increasing to 1.3 div at instrument bandwidth.
≥ 5 mV/div: 0.40 divisions from DC to 50 MHz, increasing to 1 div at instrument bandwidth</td></tr>
<tr><td>Aux in (External)</td><td>200 mV from DC to 50 MHz, increasing to 500 mV at 200 MHz</td></tr>
<tr><td>Line</td><td>Not applicable</td></tr>
<tr><td rowspan="5">Edge trigger,
not DC coupled, typical</td><td>Trigger Coupling</td><td>Typical Sensitivity</td></tr>
<tr><td>AC</td><td>1.5 times the DC Coupled limits for frequencies above 10 Hz.
Attenuates signals below 10 Hz</td></tr>
<tr><td>NOISE REJ</td><td>2.5 times the DC-coupled limits</td></tr>
<tr><td>HF REJ</td><td>1.5 times the DC-coupled limit from DC to 50 kHz.
Attenuates signals above 50 kHz</td></tr>
<tr><td>LF REJ</td><td>1.5 times the DC-coupled limits for frequencies above 50 kHz.
Attenuates signals below 50 kHz</td></tr>
</table>

Table 6: Trigger specifications (cont.)

Characteristic	Description		
	Logic (pattern) trigger, DC coupled, typical:		1.0 division from DC to maximum bandwidth
	Trigger using a logic qualifier, DC coupled, typical:		1.0 division from DC to maximum bandwidth
	Delay-by-events sequence trigger, DC coupled, typical:		1.0 division from DC to maximum bandwidth
	Runt trigger, typical:		≥1.0 division from DC to maximum bandwidth
	Pulse-width and glitch trigger, typical:		1.0 division, from DC to Max Bandwidth.
	Video trigger, typical	The limits for both delayed and main trigger are as follows:	
		Source	*Typical Sensitivity*
		Any analog input channel	0.6 to 2.5 divisions of video sync tip
		Aux In (External)	Video not supported through Aux In (External) input
Aux In (External trigger)	Maximum input voltage:		At front panel connector, 300 V_{RMS}, Installation Category II; Derate at 20 dB/decade above 3 MHz to 30 V_{RMS} at 30 MHz, 10 dB/decade above 30 MHz Based upon sinusoidal or DC input signal. Excursion above 300 V should be less than 100 ms duration and the duty factor is limited to < 44%. RMS signal level must be limited to 300 V. If these values are exceeded, damage to the instrument may result.
	Bandwidth, typical:		> 250 MHz
Edge, Pulse, and Logic trigger bandwidth, typical	For instruments with 1 GHz bandwidth (includes MDO310X models as well as MDO305X/303X/302X/301X models with 500 MHz upgrade):		≥1 GHz
	For instruments with 500 MHz bandwidth (includes MDO305X models as well as MDO303X/302X/301X models with 500 MHz upgrade):		≥500 MHz
	For instruments with 350 MHz bandwidth (includes MDO303X models as well as MDO302X/301X models with 350 MHz upgrade):		≥500 MHz
	For instruments with 200 MHz bandwidth (includes MDO302X models as well as MDO301X models with 200 MHz upgrade):		≥200 MHz
	For instruments with 100 MHz bandwidth (MDO301X models):		≥200 MHz
Time accuracy for Pulse-width triggering	*Time range*		*Accuracy*
	1 ns to 500 ns		±(20% of setting + 0.5 ns)
	520 ns to 8 s		±(0.01% of setting + 100 ns)

Table 6: Trigger specifications (cont.)

Characteristic	Description
Video trigger formats and field rates	Triggers from negative sync composite video, field 1 or field 2 for interlaced systems, any field, specific line, or any line for interlaced or non-interlaced systems. Supported systems include NTSC, PAL, SECAM. Standard Video formats are: Trigger on 480p/60, 576p/50, 720p/30, 720p/50, 720p/60, 875i/60, 1080i/50, 1080i/60, 1080p/24, 1080p/24sF, 1080p/25, 1080p/30, 1080p/50, 1080p/60, and custom bi-level and tri-level sync video standards.
Logic trigger, minimum logic or re-arm time, typical	For all vertical settings, the minimums are:

Trigger type	*Minimum pulse width*	*Minimum re-arm time*	*Minimum time between channels* [1]
Logic	Not applicable	2 ns	2 ns
Time Qualified Logic	4 ns	2 ns	2 ns

Characteristic	Description
Setup/hold time violation trigger	
Minimum clock pulse widths, typical	For all vertical settings, the minimum clock pulse widths are:

Clock Active [2]	*Clock Inactive* [2]
User hold time + 2.5 ns [3]	2 ns

Characteristic	Description
Setup and hold time ranges	The limits are as follows;

Feature	*Min*	*Max*
Setup time [4]	–0.5 ns	1.024 ms
Hold time [4]	1 ns	1.024 ms
Setup + Hold time [4]	0.5 ns	2.048 ms

***NOTE.** Input coupling on clock and data channels must be the same.*

Minimum pulse width and rearm time

Trigger type	*Minimum pulse width*	*Minimum rearm time*
Glitch	4 ns	2 ns + 5% of glitch width setting
Pulse-width	4 ns	2 ns + 5% of width upper limit setting
	***NOTE.** For the pulse-width trigger class, pulse-width refers to the width of the pulse being measured. The rearm time refers to the time between pulses.*	
Runt	4 ns	2 ns
	***NOTE.** For the runt trigger class, pulse width refers to the width of the pulse being measured. The rearm time refers to the time between pulses.*	
Time-qualified runt	4 ns	8.5 ns + 5% of width setting
Slew rate	4 ns	8.5 ns + 5% of delta time setting
	***NOTE.** For the slew rate trigger class, pulse width refers to the delta time being measured. The rearm time refers to the time it takes the signal to cross the two trigger thresholds again.*	

Table 6: Trigger specifications (cont.)

Characteristic	Description		
Rise/fall time trigger, delta time range	4 ns to 8 seconds		
Glitch, pulse-width, or time-qualified runt trigger, time range	4 ns to 8 seconds		
B trigger (A/B sequence trigger), time range	Trigger after events, minimum pulse width, typical: [5]		1 / (2 X Rated Instrument Bandwidth)
	Trigger after events, maximum event frequency, typical: [5]		[Rated Instrument Bandwidth] or 500 MHz, whichever is lower
	Minimum time between arm and trigger		8 ns
	B trigger after time, time range:		8 ns to 8 s
	B trigger after events, event range:		1 to 4,000,000
Standard serial bus interface triggers	Maximum serial trigger bits:	128 bits	
I^2C (Requires an MDO3EMBD app. module)	Address Triggering:	7 and 10 bit user specified address, as well as General Call, START byte, HS-mode, EEPROM, and CBUS	
	Data Trigger:	1 to 5 bytes of user specified data	
	Trigger On:	Start Repeated Start Stop, Missing Ack Address Data Address and Data	
	Maximum Data Rate:	10 Mb/s	
SPI (Requires an MDO3EMBD app. module)	Data Trigger:	1 to 16 bytes of user specified data	
	Trigger On:	SS Active MOSI MISO MOSI and MISO	
	Maximum Data Rate:	10 Mb/s	

Table 6: Trigger specifications (cont.)

Characteristic	Description	
RS-232/422/485/UART (Requires a MDO3COMP app. module)	Data Trigger:	Tx Data, Rx Data
	Trigger On:	Tx Start Bit Rx Start Bit Tx End of Packet Rx End of Packet Tx Data Rx Data Tx Parity Error Rx Parity Error
	Maximum Data Rate:	10 Mb/s
CAN (Requires an MDO3AUTO app. module)	Data Trigger:	1 to 8 bytes of user specified data, including qualifiers of equal to (=), not equal to (<>), less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=)
	Trigger On:	Start of Frame Type of Frame Identifier, Data Identifier and Data End of Frame Missing Ack Bit Stuffing Error
	Frame Type:	Data, Remote, Error, Overload
	Identifier:	Standard (11 bit) and Extended (29 bit) identifiers
	Maximum Data Rate:	1 Mb/s
LIN (Requires a MDO3AUTO app. module)	Data Trigger:	1 to 8 Bytes of user-specified data, including qualifiers of equal to (=), not equal to (<>), less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=)
	Trigger On :	Sync Identifier Data Identifier & Data Wakeup Frame Sleep Frame Error
	Maximum Data Rate:	1 Mb/s (by LIN definition, 20 kbit/s)

Table 6: Trigger specifications (cont.)

Characteristic	Description	
FlexRay (Requires a MDO3FLEX app. module)	Indicator Bits	Normal Frame, Payload Frame, Null Frame, Sync Frame, Startup Frame
	Identifier Trigger	11 bits of user-specified data, equal to (=),not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), Inside Range, Outside Range.
	Cycle Count Trigger	6 bits of user-specified data, equal to (<=), greater than or equal to (>=), Inside Range, Outside Range.
	Header Fields Trigger	40 bits of user-specified data comprising Indicator Bits, Identifier, Payload Length, Header CRC, and Cycle Count, equal to (=).
	Data Trigger	1 – 16 Bytes of user-specified data, with 0 to 253, or “don’t care” bytes of data offset, including qualifiers of equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), Inside Range, Outside Range.
	End Of Frame	User-chosen types Static, Dynamic (DTS), and All.
	Error	Header CRC, Trailer CRC, Null Frame-static, Null Frame-dynamic, Sync Frame, Startup frame
	Trigger on	Start of Frame, Indicator Bits, Identifier, Cycle Count, Header Fields, Data, Identifier & Data, End of Frame, or Error
MIL-STD-1553 (Requires a MDO3AERO app. module)	Trigger on:	Sync Word Type (Command, Status, Data) Command Word (set the following individually: RT Address (trigger when equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range), T/R, Sub-Address/Mode, Data Word Count/Mode Code, And Parity) Status Word (set the following individually: RT address (trigger when equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range), message error, instrumentation, service request bit, broadcast command received, busy, subsystem flag, dynamic bus control acceptance (DBCA), terminal flag, and parity) Data Word (user-specified 16-bit data value) Error (Sync, Parity, Manchester, Non-Contiguous Data Idle Time (minimum time selectable from 4 µs to 100 µs; maximum time selectable from 12 µs to 100 µs; trigger on < minimum, > maximum, inside range, outside range)
	Maximum Data Rate:	Up to 1 Mb/s (for automated decoding of bus)

Table 6: Trigger specifications (cont.)

Characteristic	Description	
I^{2}S (Requires a MDO3AUDIO app. module)	Data Trigger:	32 bits of user-specified data in a left word, right word, or either, including qualifiers of equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range.
	Trigger on:	Word Select Data
	Maximum Data Rate:	12.5 Mb/s
Left Justified (Requires a MDO3AUDIO app. module)	Data Trigger:	32 bits of user-specified data in a left word, right word, or either, including qualifiers of equal to (=), not equal to (<>), less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range
	Trigger on:	Word Select Data
	Maximum Data Rate:	12.5 Mb/s
Right Justified (Requires a MDO3AUDIO app. module)	Data Trigger:	32 bits of user-specified data in a left word, right word, or either, including qualifiers of equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range
	Trigger on:	Word Select Data
	Maximum Data Rate:	12.5 Mb/s
TDM (Requires a MDO3AUDIO app. module)	Data Trigger:	32 bits of user-specified data in a channel 0-7, including qualifiers of equal to (=), not equal to <>, less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), inside range, outside range
	Trigger on:	Frame Sync Data
	Maximum Data Rate:	25 Mb/s

1 For logic, time between channels refers to the length of time a logic state derived from more than one channel must exist to be recognized. For Time Qualified Logic events, the time is the minimum time between a main and delayed event that will be recognized if more than one channel is used.

2 An active pulse width is the width of the clock pulse from its active edge (as defined through the Define Inputs button on the lower menu and the Clock Edge button on the side menu) to its inactive edge. An inactive pulse width is the width of the pulse from its inactive edge to its active edge.

3 The User hold time is the number selected by the user through the Setup and Hold trigger menu.

4 Setup + Hold time is the algebraic sum of the Setup Time and the Hold Time programmed by the user.

For Setup time, positive numbers mean a data transition before the clock.

For Hold time, positive numbers mean a data transition after the clock edge.

5 Trigger after events is the time between the last A trigger event and the first B trigger event.

Trigger after time is the time between the end of the time period and the B trigger event.

Display Specifications

Table 7: Display specifications

Characteristic	Description
Display type	9” WVGA LCD display Display Area: 198 mm (H) X 111.696 mm (V).
Display resolution	800 X 480 pixels, each made up of 3 vertical stripe sub-pixels colored red, green, and blue
Minimum Luminance, typical	300 cd/m^2 at IBL = 5.0 mA_{rms}/lamp

Input/Output Port Specifications

Table 8: Input/Output port specifications

<table>
<tr><th>Characteristic</th><th colspan="2">Description</th></tr>
<tr><td>Ethernet interface</td><td colspan="2">Standard on all models: 10/100 Mb/s</td></tr>
<tr><td>GPIB interface</td><td colspan="2">Available as an optional accessory that connects to USB Device and USB Host port, with the TEK-USB-488 GPIB to USB Adapter
Control interface is incorporated in the instrument user interface</td></tr>
<tr><td>USB interface</td><td colspan="2">1 Device and 2 Host connectors (all models)</td></tr>
<tr><td>Device port</td><td colspan="2">One USB 2.0 High Speed port. Also supports Full Speed and Slow Speed Modes</td></tr>
<tr><td>Host ports</td><td colspan="2">Two USB 2.0 High Speed ports. One on front, one on rear</td></tr>
<tr><td>Video signal output</td><td colspan="2">A 15 pin, VGA RGB-type connector</td></tr>
<tr><td>Probe compensator output voltage and frequency, typical</td><td colspan="2">Output voltage:
Default Mode: 0 to 2.5 V amplitude, ±2% (Source Impedance of 1 KΩ)
TPPXXXX Cal Mode: 0 to 2.5 V amplitude, ±5% (Source Impedance of ≤25 Ω)
Frequency: 1 kHz ±25%</td></tr>
<tr><td rowspan="4">✓ Auxiliary output (AUX OUT)</td><td colspan="2">Selectable Output: Main Trigger, Event, or AFG
Main Trigger: HIGH to LOW transition indicates the trigger occurred
Event Out: The instrument will output a negative edge during a specified trigger event in a test application.
A falling edge occurs when there is a specified event in a test application (i.e. the waveform crosses the violation threshold in the limit / mask test application).
A rising edge occurs when the trigger system begins waiting for the next test application event.
AFG: The trigger output signal from the AFG.</td></tr>
<tr><td>Characteristic</td><td>Limits</td></tr>
<tr><td>Vout (HI)</td><td>≥ 2.25 V open circuit; ≥ 0.9 V into a 50 Ω load to ground</td></tr>
<tr><td>Vout (LO)</td><td>≤ 0.7 V into a load of ≤ 4 mA; ≤ 0.25 V into a 50 Ω load to ground</td></tr>
</table>

Power Source Specifications

Table 9: Power source specifications

Characteristic	Description	
Source voltage	100 V to 240 V ±10%	
Source frequency	100 V to 240 V:	50/60 Hz
	115 V:	400 Hz ±10%
Fuse rating	T3.15 A, 250 V The fuse is not customer replaceable.	

Data Storage Specifications

Table 10: Data storage specifications

Characteristic	Description
Nonvolatile memory retention time, typical	No time limit for front-panel settings, saved waveforms, setups, and calibration constants
Real-time clock	A programmable clock providing time in years, months, days, hours, minutes, and seconds

Environmental Specifications

Table 11: Environmental specifications

Characteristic	Description	
Temperature	Operating:	–10 °C to +55 °C (+14 °F to +131 °F)
	Nonoperating:	–40 °C to +71 °C (–40 °F to +160 °F)
Humidity	Operating: 5% to 90% relative humidity (% RH) at up to +40 °C, 5% to 60% RH above +40 °C up to +55 °C, non-condensing	
	Nonoperating: 5% to 90% RH (Relative Humidity) at up to +40 °C, 5% to 60% RH above +40 °C up to +55 °C 5% to 40% RH above +55 °C up to +71 °C, non-condensing	
Altitude	Operating:	3,000 m (9,843 feet)
	Nonoperating:	12,000 m (39,370 feet)
Acoustic noise emission	Sound power level:	32.0 dBA in accordance with ISO 9296

Mechanical Specifications

Table 12: Mechanical specifications

Characteristic	Description		
Dimensions	Height	**mm**	**In.**
	Handle down	203.2	8.0
	Handle up	254	10.3
	Width	416.6	16.4
	Depth	147.4	5.8
	Weight	**kg**	**Lb.**
	Stand alone, no front cover	4.2	9.2
	With accessories & carry case	6.8	15.0
	Packaged for domestic shipment	8.6	19.0

P6316 Digital Probe Input Characteristics

Table 13: P6316 Digital probe input characteristics

Characteristic	Description
Number of input channels	16 Digital Inputs
Input resistance, typical	101 KΩ to ground
Input capacitance, typical	8 pF [1]
Minimum Input Signal Swing, typical	500 mV_{p-p} [1]
Maximum Input Signal Swing, typical	+30 V, –20 V
Maximum Input Dynamic Range	50 V_{p-p}, dependent on threshold setting
Channel-to-channel skew	500 ps Digital channel to digital channel only. This is the propagation path skew. It ignores skew contributions due to bandpass distortion, threshold inaccuracies, and sample binning.

1 Specified at the input to the P6316 probe with all eight ground inputs connected to the user's ground. Use of leadsets, grabber clips, ground extenders, or other connection accessories may compromise this specification.

RF Input Specifications

The following table shows the RF input specifications for the MDO3000 Series oscilloscopes.

Table 14: RF input specifications

Characteristic	Description
Center frequency range	9 kHz to 3.0 GHz (with MDO3SA installed) 9 kHz to 1.0 GHz (Any model at 1 GHz BW without MDO3SA installed) 9 kHz to 500 MHz (Any model at 500 MHz BW without MDO3SA installed) 9 kHz to 350 MHz (Any model at 350 MHz BW without MDO3SA installed) 9 kHz to 200 MHz (Any model at 200 MHz BW without MDO3SA installed) 9 kHz to 100 MHz (Any model at 100 MHz without MDO3SA installed)
Resolution bandwidth range	RBW Range for Windowing functions as follows: Kaiser (default): 30 Hz – 150 MHz Rectangular: 20 Hz – 150 MHz Hamming: 20 Hz – 150 MHz Hanning: 20 Hz – 150 MHz Blackman-Harris: 30 Hz – 150 MHz Flat-Top: 50 Hz – 150 MHz Adjusted in 1-2-3-5 sequence
Kaiser RBW shape factor	60 db/3 db Shape factor ≤ 4:1
✓ Reference frequency error (cumulative)	Cumulative Error: ±10 x 10^{-6} Includes allowances for Aging per Year, Reference Frequency Calibration Accuracy, and Temperature Stability. Valid over the recommended 1 year calibration interval, from –10 °C to +55 °C . ***NOTE.** The RF and analog channels share the same reference frequency. Reference frequency accuracy is tested by the Long-term Sample Rate and Delay Time Accuracy checks.*
Marker frequency measurement accuracy	±(([Reference Frequency Error] x [Marker Frequency]) + (span / 750 + 2)) Hz Reference Frequency Error = 10 ppm (10 Hz/MHz) Example, assuming the span is set to 10 kHz and the marker is at 1,500 MHz, this would result in a Frequency Measurement Accuracy of ±((10 Hz/1 MHz x 1,500 MHz) + (10 kHz / 750 + 2)) = ±15.015 kHz. Marker Frequency with Span/RBW ≤ 1000:1 Reference Frequency Error with Marker level to displayed noise level > 30 dB
Phase noise	10 kHz: < –81 dBc/Hz (–85 dBc/Hz, typical) 100 kHz: < –97 dBc/Hz (–101 dBc/Hz, typical) 1 MHz: < –118 dBc/Hz (–122 dBc/Hz, typical) Phase noise measured offset from 1 GHz CW signal

Characteristic	Frequency range	DANL
✓ Displayed average noise level (DANL)	9 kHz – 50 kHz	< –109 dBm/Hz (< –113 dBm/Hz, typical)
	50 kHz – 5 MHz	< –126 dBm/Hz (< –130 dBm/Hz, typical)
	5 MHz – 2 GHz	< –136 dBm/Hz (< –140 dBm/Hz, typical)
	2 GHz – 3 GHz	< –126 dBm/Hz (< –130 dBm/Hz, typical)

Table 14: RF input specifications (cont.)

✓ Displayed average noise level (DANL) with TPA-N-PRE Preamp attached	9 kHz - 50 kHz	–117 dBm/Hz
	50 kHz - 5 MHz	–138 dBm/Hz
	50 kHz - BW (MDO3SA not installed)	–148 dBm/Hz
	5 MHz - 2 GHz (MDO3SA installed)	–148 dBm/Hz
	2 GHz - 3 GHz (MDO3SA installed)	–138 dBm/Hz
Input vertical range	Vertical Measurement range: +20 dBm to DANL. Vertical setting of 1 dB/div to 20 dB/div in a 1-2-5 sequence.	
Attenuation range	Attenuator Settings from 10 to 30 dB, in 5 dB steps	
Spectrum trace length (points)	751 points	
Spurious response (SFDR)	**2nd harmonic distortion >100 MHz:** < –55 dBc (< –60 dBc typical) with auto settings on and signals 10 dB below reference level	
	2nd harmonic distortion: 9 kHz to 100 MHz: < –55 dBc (< –60 dBc typical) with auto settings on, signals 10 dB below reference level, and reference level ≤ –5 dBm	
	3rd harmonic distortion >100 MHz: < –53 dBc (< –58 dBc typical) with auto settings on and signals 10 dB below reference level	
	3rd harmonic distortion: 9 kHz to 100 MHz: < –55 dBc (< –60 dBc typical) with auto settings on, signals 10 dB below reference level, and reference level ≤ –5 dBm	
	2nd order intermodulation distortion: >15 MHz: < –55 dBc (< –60 dBc typical) with auto settings on and signals 10 dB below reference level	
	2nd order intermodulation distortion: 9 kHz to 15 MHz: < –47 dBc (< –52 dBc, typical) with auto settings on, signals 10 dB below reference level, and reference level ≤ –5 dBm	
	3rd order intermodulation distortion: > 15 MHz < –55 dBc, (<–60 dBc, typical), with auto settings on and signals 10 dB below reference level	
	3rd order intermodulation distortion: 9 kHz to 15 MHz < –55 dBc (<–60 dBc, typical), with auto settings on and signals 10 dB below reference level and reference level ≤ –5 dBm –45 dBc (-50 dBc typical) for side bands < 25 kHz offset from the carrier. –55 dBc (–60 dBc typical) for side bands ≥ 25 kHz offset from the carrier	
✓ Residual spurious response	< –78 dBm < -67 dBm at 2.5 GHz < -76 dBm at 1.25 GHz ≤ –15 dBm reference level and RF input terminated with 50 Ω	

Table 14: RF input specifications (cont.)

<table>
<tr><td>Adjacent channel power ratio dynamic range, typical</td><td>–58 dBc</td></tr>
<tr><td>Frequency measurement resolution</td><td>1 Hz</td></tr>
<tr><td>Span</td><td>Span adjustable in 1-2-5 sequence
Variable Resolution = 1% of the next span setting</td></tr>
<tr><td>Level display range</td><td>Log Scale and Units: dBm, dBmV, dBμV, dBμW, dBmA, dBμA
Measurement Points: 1,000
Marker Level Readout Resolution: Log Scale: 0.1 dB
Maximum Number of RF Traces: 4
Trace Functions: Maximum Hold; Average; Minimum Hold; Normal; Spectrogram Slice (Uses normal trace)
Detectors: Positive-Peak, negative-peak, sample, average</td></tr>
<tr><td>Reference level</td><td>Setting Range: –130 dBm to +20 dBm, in steps of 5 dBm
Default Setting: 0 dBm ref level</td></tr>
<tr><td>Vertical position</td><td>–100 divs to +100 divs (displayed in dB)</td></tr>
<tr><td>Maximum operating input level</td><td>Average Continuous Power: +20 dBm (0.1 W)
DC maximum before damage: ±40 V_{dc}
Max “No damage” 33 dBm (2 W) CW
Peak Pulse Power: +45 dBm (32 W)
Peak Pulse Power defined as <10 μs pulse width, <1% duty cycle, and reference level of ≥ +10 dBm.</td></tr>
<tr><td>Resolution bandwidth (RBW) accuracy</td><td>Max RBW % Error = (0.5/(25 x WF)) * 100
“WF” represents the Window Factor and is set by the window method being used.
<table>
<tr><th>Method</th><th>WF</th><th>RBW error</th></tr>
<tr><td>Rectangular</td><td>0.89</td><td>2.25%</td></tr>
<tr><td>Hamming</td><td>1.30</td><td>1.54%</td></tr>
<tr><td>Hanning</td><td>1.44</td><td>1.39%</td></tr>
<tr><td>Blackman-Harris</td><td>1.90</td><td>1.05%</td></tr>
<tr><td>Kaiser</td><td>2.23</td><td>0.90%</td></tr>
<tr><td>Flat-Top</td><td>3.77</td><td>0.53%</td></tr>
</table></td></tr>
<tr><td>✓ Level measurement uncertainty</td><td>< ±1.2 dBm, < ±0.6 dBm (typical), 18 ºC - 28 ºC temperature range
< ±2.0 dBm, –10 ºC to 55 ºC
Specification applies to when the signal-to-noise ratio > 40 dB.</td></tr>
<tr><td>Occupied bandwidth accuracy, typical</td><td>± Span/750</td></tr>
</table>

Arbitrary Function Generator Features

Table 15: AFG Features

<table>
<tr><th>Characteristic</th><th colspan="3">Description</th></tr>
<tr><td>Function types</td><td colspan="3">Arbitrary, Sine, Square, Pulse, Ramp, Triangle, DC Level, Gaussian, Lorentz, Exponential Rise/Fall, Sine(x)/x, Random Noise, Haversine, Cardiac</td></tr>
<tr><td rowspan="16">Amplitude range</td><td colspan="3">Values are peak-to-peak voltages</td></tr>
<tr><td>Waveform</td><td>50 Ω</td><td>1 MΩ</td></tr>
<tr><td>Arbitrary</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Sine</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Square</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Pulse</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Ramp</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Triangle</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Gaussian</td><td>10 mV to 1.25 V</td><td>20 mV to 2.5 V</td></tr>
<tr><td>Lorentz</td><td>10 mV to 1.2 V</td><td>20 mV to 2.4 V</td></tr>
<tr><td>Exponential rise</td><td>10 mV to 1.25 V</td><td>20 mV to 2.5 V</td></tr>
<tr><td>Exponential fall</td><td>10 mV to 1.25 V</td><td>20 mV to 2.5 V</td></tr>
<tr><td>Sine(x)/x</td><td>10 mV to 1.5 V</td><td>20 mV to 3.0 V</td></tr>
<tr><td>Random noise</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Haversine</td><td>10 mV to 1.25 V</td><td>20 mV to 2.5 V</td></tr>
<tr><td>Cardiac</td><td>10 mV to 2.5 V</td><td>20 mV to 5 V</td></tr>
<tr><td>Maximum sample rate</td><td colspan="3">250 MS/s</td></tr>
<tr><td>Arbitrary function record length</td><td colspan="3">128k samples</td></tr>
</table>

Arbitrary Function Generator Characteristics

Table 16: AFG Characteristics

Characteristic	Description
Sine waveform	Frequency range: 0.1 Hz to 50 MHz
	Frequency setting resolution: 0.1 Hz
	Amplitude flatness (typical): ±0.5 dB at 1 kHz ±1.5 dB for <20 mV_{pp} amplitudes
	Total harmonic distortion (typical): 1% at 50 Ω
	Spurious free dynamic range (typical): –40 dB (V_{pp} ≥ 0.1 V); 30 dB (V_{pp} <0.1 V), 50 Ω load
Square/pulse waveform	Frequency range: 0.1 Hz to 25 MHz
	Frequency setting resolution: 0.1 Hz
	Duty cycle range: 10% - 90% or 10 ns minimum pulse, whichever is larger
	Duty cycle resolution: 0.1%
	Minimum pulse width (typical): 10 ns
	Rise/fall time (typical): 5 ns, 10% to 90%
	Pulse width resolution: 100 ps
	Overshoot (typical): <2% for signal steps greater than 100 mV
	Asymmetry (typical): ±1% ±5 ns, at 50% duty cycle
Ramp/Triangle waveform	Frequency range: 0.1 Hz to 500 kHz
	Frequency setting resolution: 0.1 Hz
	Variable symmetry: 0% to 100%
	Symmetry resolution: 0.1%
	DC level range (typical): ±2.5 V in to Hi-Z; ±1.25 V into 50 Ω
	Gaussian Pulse, Lorentz Pulse, Haversine Maximum Frequency (typical): 5 MHz
	Exponential rise/fall maximum frequency (typical): 5 MHz
	Sine(x)/x maximum frequency (typical): 2 MHz
Random noise waveform	Amplitude range: 20 mV_{pp} to 5 V_{pp} in to Hi-Z; 10 mV_{pp} to 2.5 V_{pp} into 50 Ω
✓ Sine and ramp frequency accuracy	130 ppm (frequency ≤10 kHz); 50 ppm (frequency > 10 kHz)
✓ Square and pulse frequency accuracy	130 ppm (frequency ≤10 kHz); 50 ppm (frequency > 10 kHz)
Signal amplitude resolution	500 µV (50 Ω) 1 mV (HiZ)
✓ Signal amplitude accuracy	±[(1.5% of peak-to-peak amplitude setting) + (1.5% of DC offset setting) + 1 mV] (frequency = 1 kHz)

Table 16: AFG Characteristics (cont.)

DC offset range	±2.5 V into Hi-Z ±1.25 V into 50 Ω
DC offset resolution	500 µV (50 Ω) 1 mV (HiZ)
✓ DC offset accuracy	±[(1.5% of offset setting) + 1 mV] Add 3 mV of uncertainty per 10 °C change from 25 °C ambient

Digital Voltmeter/Counter

Table 17: Digital voltmeter/counter

Characteristic	Description
Measurement types	AC+DC$_{rms}$, DC$_{rms}$, AC$_{rms}$, frequency count
Voltage resolution	4 digits
✓ Voltage accuracy	DC: ±(2 mV + [(((4 * (Vertical Scale Voltage)) / (Absolute Input Voltage)) + 1)% of Absolute Input Voltage] + (0.5% of Absolute Offset Voltage)) DC example: an input channel set up with +2 V offset and 1 V/div measuring a –5 V signal would have ±(2 mV + [(((4 * 1) / 5) + 1)% of 5 V] + [0.5% of 2 V]) = ±(2 mV + [1.8% of 5 V] + [0.5% of 2 V]) = ±(2 mV + 90 mV + 10 mV) = ±102 mV. This is roughly ±2% of the input voltage. AC: ±2% (40 Hz to 1 kHz) AC (typical): ±2% (20 Hz to 10 kHz) For AC measurements, the input channel vertical settings must allow the V$_{pp}$ input signal to cover between 4 and 8 divisions.
Frequency resolution	5 digits
✓ Frequency accuracy	±(10 µHz/Hz + 1 count)
Frequency counter source	Any analog input channel.
✓ Frequency counter maximum input frequency	100 MHz for 100 MHz models 150 MHz for all other models Trigger Sensitivity limits must be observed for reliable frequency measurements.

Performance Verification

This chapter contains performance verification procedures for the specifications marked with the ✓ symbol. The following equipment, or a suitable equivalent, is required to complete these procedures.

Table 18: Required equipment

Description	Minimum requirements	Examples
DC voltage source	3 mV to 4 V, ±0.1% accuracy	Fluke 9500B Oscilloscope Calibrator with a 9530 Output Module An appropriate BNC-to-0.1 inch pin adapter between the Fluke 9530 and P6316 probe
Leveled sine wave generator	9 kHz to 3,000 MHz, ±4% amplitude accuracy	
Time mark generator	80 ms period, ±1 ppm accuracy, rise time < 50 ns	
One 50 Ω BNC cable	Male-to-male connectors	Tektronix part number 012-0057-01 (43 inch)
One BNC feed-through terminator	50 Ω	

You may need additional cables and adapters, depending on the actual test equipment you use.

These procedures cover all MDO3000 models. Please disregard any checks that do not apply to the specific model you are testing.

Print the test record on the following pages and use it to record the performance test results for your oscilloscope.

NOTE. *Completion of the performance verification procedure does not update the stored time and date of the latest successful adjustment. The date and time are updated only when the adjustment procedures in the service manual are successfully completed.*

The performance verification procedures verify the performance of your instrument. They do not adjust your instrument. If your instrument fails any of the performance verification tests, you should perform the factory adjustment procedures as described in the *MDO3000 Series Service Manual*.

Upgrade the Firmware

For the best functionality, you can upgrade the oscilloscope firmware. To upgrade the firmware, follow these steps:

1. Open a Web browser and go to www.tektronix.com/software/downloads to locate the most recent firmware upgrade.
2. Download the latest firmware for your oscilloscope onto your PC.
3. Unzip the files and copy the "firmware.img" file into the root folder of a USB flash drive.
4. Power off your oscilloscope.
5. Insert the USB flash drive into a USB Host port on the front or back of the oscilloscope.
6. Power on the oscilloscope. The oscilloscope automatically recognizes the replacement firmware and installs it.

   If the instrument does not install the firmware, rerun the procedure. If the problem continues, contact qualified service personnel.

NOTE. *Do not power off the oscilloscope or remove the USB flash drive until the oscilloscope finishes installing the firmware.*

7. Power off the oscilloscope and remove the USB flash drive.
8. Power on the oscilloscope.
9. Push the **Utility** button on the front-panel.
10. Push **Utility Page** on the lower menu.
11. Turn **Multipurpose knob "a"** and select **Config**.
12. Push **About** on the lower menu. The oscilloscope displays the firmware version number.
13. Confirm that the version number matches that of the new firmware.

The oscilloscope displays a message when the installation is complete.

Test Record

Print this section for use during the Performance Verification.

Model number	Serial number	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Input Termination Tests

Input Impedance

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 1				
Channel 1 Input Impedance, 1 MΩ	10 mV/div	990 kΩ		1.01 MΩ
	100 mV/div	990 kΩ		1.01 MΩ
	1 V/div	990 kΩ		1.01 MΩ
Channel 1 Input Impedance, 50 Ω	10 mV/div	49.5 Ω		50.5 Ω
	100 mV/div	49.5 Ω		50.5 Ω
Channel 1 Input Impedance, 75 Ω ***NOTE.*** *This setting is not available on MDO310X models.*	10 mV/div	74.25 Ω		75.75 Ω
	100 mV/div	74.25 Ω		75.75 Ω
Channel 2				
Channel 2 Input Impedance, 1 MΩ	10 mV/div	990 kΩ		1.01 MΩ
	100 mV/div	990 kΩ		1.01 MΩ
	1 V/div	990 kΩ		1.01 MΩ
Channel 2 Input Impedance, 50 Ω	10 mV/div	49.5 Ω		50.5 Ω
	100 mV/div	49.5 Ω		50.5 Ω
Channel 2 Input Impedance, 75 Ω ***NOTE.*** *This setting is not available on MDO310X models.*	10 mV/div	74.25 Ω		75.75 Ω
	100 mV/div	74.25 Ω		75.75 Ω
Channel 3 [1]				
Channel 3 Input Impedance, 1 MΩ	10 mV/div	990 kΩ		1.01 MΩ
	100 mV/div	990 kΩ		1.01 MΩ
	1 V/div	990 kΩ		1.01 MΩ
Channel 3 Input Impedance, 50 Ω	10 mV/div	49.5 Ω		50.5 Ω
	100 mV/div	49.5 Ω		50.5 Ω
Channel 3 Input Impedance, 75 Ω ***NOTE.*** *This setting is not available on MDO310X models.*	10 mV/div	74.25 Ω		75.75 Ω
	100 mV/div	74.25 Ω		75.75 Ω
Channel 4 [1]				
Channel 4 Input Impedance, 1 MΩ	10 mV/div	990 kΩ		1.01 MΩ
	100 mV/div	990 kΩ		1.01 MΩ
	1 V/div	990 kΩ		1.01 MΩ

Input Impedance

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 4, Input Impedance, 50 Ω	10 mV/div	49.5 Ω		50.5 Ω
	100 mV/div	49.5 Ω		50.5 Ω
Channel 4, Input Impedance, 75 Ω ***NOTE.*** *This setting is not available on MDO310X models.*	10 mV/div	74.25 Ω		75.75 Ω
	100 mV/div	74.25 Ω		75.75 Ω

1 Channels 3 and 4 are only on four-channel oscilloscopes.

DC Balance Tests

Table 19: DC Balance

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 1				
Channel 1 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 75 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 75 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

Table 19: DC Balance (cont.)

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 1 DC Balance, 50 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 75 Ω, Full BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	–0.500		0.500
	10 mV/div	–0.250		–.250
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 1 DC Balance, 1 MΩ, Full BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2				
Channel 2 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance, 75 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

Table 19: DC Balance (cont.)

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 2 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance, 75 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance 1 MΩ, 250 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.2000		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance, 50 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 2 DC Balance, 75 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	0.200		0.200
Channel 2 DC Balance, 1 MΩ, Full BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

Table 19: DC Balance (cont.)

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 3 [1]				
Channel 3 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 75 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0200		0.200
Channel 3 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 75 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

Table 19: DC Balance (cont.)

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 3 DC Balance, 50 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 75 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 3 DC Balance, 1 MΩ, Full BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 [1]				
Channel 4 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 75 Ω, 20 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

Table 19: DC Balance (cont.)

Performance checks	Vertical scale	Low limit (div)	Test result	High limit (div)
Channel 4 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 75 Ω, 250 MHz BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.2000		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 50 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 75 Ω, Full BW	1 mV/div	–0.500		0.500
	2 mV/div	–0.250		0.250
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200
Channel 4 DC Balance, 1 MΩ, Full BW	1 mV/div	–0.300		0.300
	2 mV/div	–0.200		0.200
	10 mV/div	–0.200		0.200
	100 mV/div	–0.200		0.200
	1 V/div	–0.200		0.200

1 Channels 3 and 4 are only on four-channel oscilloscopes.

Analog Bandwidth Tests, 50 Ω

Table 20: Bandwidth

Bandwidth at Channel	Termination	Vertical scale	V_{in-pp}	V_{bw-pp}	Limit	Test result *Gain* = V_{bw-pp}/V_{in-pp}
1	50 Ω	10 mV/div			≥ 0.707	
	50 Ω	5 mV/div			≥ 0.707	
	50 Ω	2 mV/div			≥ 0.707	
	50 Ω	1 mV/div			≥ 0.707	
2	50 Ω	10 mV/div			≥ 0.707	
	50 Ω	5 mV/div			≥ 0.707	
	50 Ω	2 mV/div			≥ 0.707	
	50 Ω	1 mV/div			≥ 0.707	
3 [1]	50 Ω	10 mV/div			≥ 0.707	
	50 Ω	5 mV/div			≥ 0.707	
	50 Ω	2 mV/div			≥ 0.707	
	50 Ω	1 mV/div			≥ 0.707	
4 [1]	50 Ω	10 mV/div			≥ 0.707	
	50 Ω	5 mV/div			≥ 0.707	
	50 Ω	2 mV/div			≥ 0.707	
	50 Ω	1 mV/div			≥ 0.707	

1 Channels 3 and 4 are only on four-channel oscilloscopes

DC Gain Accuracy Tests

Table 21: DC Gain Accuracy

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 1 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	–2.5%		2.5%
	2 mV/div	–2.0%		2.0%
	4.98 mV/div	–3.0%		3.0%
	5 mV/div	–1.5%		1.5%
	10 mV/div	–1.5%		1.5%
	20 mV/div	–1.5%		1.5%
	49.8 mV	–3.0%		3.0%
	50 mV/div	–1.5%		1.5%
	100 mV/div	–1.5%		1.5%
	200 mV/div	–1.5%		1.5%
	500 mV/div	–1.5%		1.5%
	1 V/div	–1.5%		1.5%
Channel 2 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	–2.5%		2.5%
	2 mV/div	–2.0%		2.0%
	4.98 mV/div	–3.0%		3.0%
	5 mV/div	–1.5%		1.5%
	10 mV/div	–1.5%		1.5%
	20 mV/div	–1.5%		1.5%
	49.8 mV	–3.0%		3.0%
	50 mV/div	–1.5%		1.5%
	100 mV/div	–1.5%		1.5%
	200 mV/div	–1.5%		1.5%
	500 mV/div	–1.5%		1.5%
	1 V/div	–1.5%		1.5%

Table 21: DC Gain Accuracy (cont.)

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 3 [1] 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	–2.5%		2.5%
	2 mV/div	–2.0%		2.0%
	4.98 mV/div	–3.0%		3.0%
	5 mV/div	–1.5%		1.5%
	10 mV/div	–1.5%		1.5%
	20 mV/div	–1.5%		1.5%
	49.8 mV	–3.0%		3.0%
	50 mV/div	–1.5%		1.5%
	100 mV/div	–1.5%		1.5%
	200 mV/div	–1.5%		1.5%
	500 mV/div	–1.5%		1.5%
	1 V/div	–1.5%		1.5%
Channel 4 [1] 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	–2.5%		2.5%
	2 mV/div	–2.0%		2.0%
	4.98 mV/div	–3.0%		3.0%
	5 mV/div	–1.5%		1.5%
	10 mV/div	–1.5%		1.5%
	20 mV/div	–1.5%		1.5%
	49.8 mV	–3.0%		3.0%
	50 mV/div	–1.5%		1.5%
	100 mV/div	–1.5%		1.5%
	200 mV/div	–1.5%		1.5%
	500 mV/div	–1.5%		1.5%
	1 V/div	–1.5%		1.5%

1 Channels 3 and 4 are only on four-channel oscilloscopes.

DC Offset Accuracy Tests

Table 22: DC Offset Accuracy

Performance checks	Vertical scale	Vertical offset [1]	Low limit	Test result	High limit
All models					
Channel 1 20 MHz BW, 1 MΩ	1 mV/div	700 mV	696.2 mV		703.8 mV
	1 mV/div	–700 mV	–703.8 mV		–696.2 mV
	2 mV/div	700 m	696.1 mV		703.9 mV
	2 mV/div	–700 mV	–703.9 mV		–696.1 mV
	10 mV/div	1 V	993 mV		1007 mV
	10 mV/div	–1 V	–1007 mV		–993 mV
	100 mV/div	10.0 V	9.930 V		10.07 V
	100 mV/div	–10.0 V	–10.07 V		–9.930 V
	1 V/div	100 V	99.30 V		100.7 V
	1 V/div	–100 V	–100.7 V		–99.30 V
	1.01 V/div	100 V	99.30 V		100.7 V
	1.01 V/div	–100 V	–100.7 V		–99.30 V
Channel 2 20 MHz BW, 1 MΩ	1 mV/div	700 mV	696.2 mV		703.8 mV
	1 mV/div	–700 mV	–703.8 mV		–696.2 mV
	2 mV/div	700 mV	696.1 mV		703.9 mV
	2 mV/div	–700 mV	–703.9 mV		–696.1 mV
	10 mV/div	1 V	993 mV		1007 mV
	10 mV/div	–1 V	–1007 mV		–993 mV
	100 mV/div	10.0 V	9.930 V		10.07 V
	100 mV/div	–10.0 V	–10.07 V		–9.930 V
	1 V/div	100 V	99.30 V		100.7 V
	1 V/div	–100 V	–100.7 V		–99.30 V
	1.01 V/div	100 V	99.30 V		100.7 V
	1.01 V/div	–100 V	–100.7 V		–99.30 V

Table 22: DC Offset Accuracy (cont.)

Performance checks	Vertical scale	Vertical offset [1]	Low limit	Test result	High limit
Channel 3 [2] 20 MHz BW, 1 MΩ	1 mV/div	700 mV	696.2 mV		703.8 mV
	1 mV/div	–700 mV	-703.8 mV		–696.2 mV
	2 mV/div	700 mV	696.1 mV		703.9 mV
	2 mV/div	–700 mV	–703.9 mV		–696.1 mV
	10 mV/div	1 V	993 mV		1007 mV
	10 mV/div	–1 V	–1007 mV		–993 mV
	100 mV/div	10.0 V	9.930 V		10.07 V
	100 mV/div	–10.0 V	–10.07 V		–9.930 V
	1 V/div	100 V	99.30 V		100.7 V
	1 V/div	–100 V	–100.7 V		–99.30 V
	1.01 V/div	100 V	99.30 V		100.7 V
	1.01 V/div	–100 V	–100.7 V		–99.30 V
Channel 4 [2] 20 MHz BW, 1 MΩ	1 mV/div	700 mV	696.2 mV		703.8 mV
	1 mV/div	–700 mV	–703.8 mV		–696.2 mV
	2 mV/div	700 mV	696.1 mV		703.9 mV
	2 mV/div	–700 mV	–703.9 mV		–696.1 mV
	10 mV/div	1 V	993 mV		1007 mV
	10 mV/div	–1 V	–1007 mV		–993 mV
	100 mV/div	10.0 V	9.930 V		10.07 V
	100 mV/div	–10.0 V	–10.07 V		–9.930 V
	1 V/div	100 V	99.30 V		100.7 V
	1 V/div	–100 V	–100.7 V		–99.30 V
	1.01 V/div	100 V	99.30 V		100.7 V
	1.01 V/div	–100 V	–100.7 V		–99.30 V

1 Use this value for both the calibrator output and the oscilloscope offset setting.

2 Channels 3 and 4 are only on four-channel oscilloscopes.

Sample Rate and Delay Time Accuracy

Table 23: Sample Rate and Delay Time Accuracy

Performance checks	Low limit	Test result	High limit
Sample Rate and Delay Time Accuracy	–2 division		+2 division

Random Noise, Sample Acquisition Mode Tests

Table 24: Random Noise, Sample Acquisition Mode

Random Noise, Sample Acquisition Mode		Bandwidth Selection	Test result	High limit
For instruments with 1 GHz bandwidth (includes MDO310X models as well as MDO305X/303X/302X/301X models with 1 GHz upgrade)	Channel 1	Full		4.50 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 2	Full		4.50 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 3 [1]	Full		4.50 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 4 [1]	Full		4.50 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
For instruments with 500 MHz bandwidth (includes MDO305X models as well as MDO303X/302X/301X models with 500 MHz upgrade)	Channel 1	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 2	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 3 [1]	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 4 [1]	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV

Table 24: Random Noise, Sample Acquisition Mode (cont.)

Random Noise, Sample Acquisition Mode		Bandwidth Selection	Test result	High limit
For instruments with 350 MHz bandwidth (includes MDO303X models as well as MDO302X/301X models with 350 MHz upgrade)	Channel 1	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 2	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 3 [1]	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
	Channel 4 [1]	Full		4.15 mV
		250 MHz		4.15 mV
		20 MHz		4.10 mV
For instruments with 200 MHz bandwidth (MDO302X models as well as MDO301X models with 200 MHz upgrade)	Channel 1	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 2	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 3	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 4	Full		4.15 mV
		20 MHz		4.10 mV
For instruments with 100 MHz bandwidth (MDO301X models)	Channel 1	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 2	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 3 [1]	Full		4.15 mV
		20 MHz		4.10 mV
	Channel 4 [1]	Full		4.15 mV
		20 MHz		4.10 mV

1 Channels 3 and 4 are only on four-channel oscilloscopes.

Delta Time Measurement Accuracy Tests (MDO30XX models)

Table 25: Delta Time Measurement Accuracy

Channel 1				
	MDO = 4 ns/Div, Source frequency = 240 MHz (does not apply to 100 and 200 MHz models)			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		233 ps
	500 mV	4 V		233 ps
	1 V	4 V		237 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		435 ps
	100 mV	800 mV		359 ps
	500 mV	4 V		356 ps
	1 V	4 V		583 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.68 µs

Table 25: Delta Time Measurement Accuracy (cont.)

	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs
Channel 2				
	MDO = 4 ns/Div, Source frequency = 240 MHz (does not apply to 100 and 200 MHz models)			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		233 ps
	500 mV	4 V		233 ps
	1 V	4 V		237 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		435 ps
	100 mV	800 mV		359 ps
	500 mV	4 V		356 ps
	1 V	4 V		583 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			

Table 25: Delta Time Measurement Accuracy (cont.)

	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		3.68 µs
	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs
Channel 3 [1]				
	MDO = 4 ns/Div, Source frequency = 240 MHz (does not apply to 100 and 200 MHz models)			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		233 ps
	500 mV	4 V		233 ps
	1 V	4 V		237 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		435 ps
	100 mV	800 mV		359 ps
	500 mV	4 V		356 ps
	1 V	4 V		583 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns

Table 25: Delta Time Measurement Accuracy (cont.)

	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.68 µs
	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs
Channel 4 [1]				
	MDO = 4 ns/Div, Source frequency = 240 MHz (does not apply to 100 and 200 MHz models)			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		233 ps
	500 mV	4 V		233 ps
	1 V	4 V		237 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		435 ps
	100 mV	800 mV		359 ps
	500 mV	4 V		356 ps
	1 V	4 V		583 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns

Table 25: Delta Time Measurement Accuracy (cont.)

	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 μs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.68 μs
	100 mV	800 mV		2.74 μs
	500 mV	4 V		2.70 μs
	1 V	4 V		5.35 μs

1 Channels 3 and 4 are only on four-channel oscilloscopes.

Delta Time Measurement Accuracy Tests (MDO310X models)

Table 26: Delta Time Measurement Accuracy

Channel 1				
	MDO = 4 ns/Div, Source frequency = 240 MHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	100 mV	800 mV		119 ps
	500 mV	4 V		119 ps
	1 V	4 V		128 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		386 ps
	100 mV	800 mV		298 ps
	500 mV	4 V		294 ps
	1 V	4 V		584 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		3.68 µs

Table 26: Delta Time Measurement Accuracy (cont.)

	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs
Channel 2				
	MDO = 4 ns/Div, Source frequency = 240 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		119 ps
	500 mV	4 V		119 ps
	1 V	4 V		128 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		386 ps
	100 mV	800 mV		298 ps
	500 mV	4 V		294 ps
	1 V	4 V		584 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			

Table 26: Delta Time Measurement Accuracy (cont.)

	MDO V/Div	Source V_{pp}	Test Result	High Limit
	5 mV	40 mV		3.68 µs
	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs
Channel 3 [1]				
	MDO = 4 ns/Div, Source frequency = 240 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		119 ps
	500 mV	4 V		119 ps
	1 V	4 V		128 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		386 ps
	100 mV	800 mV		298 ps
	500 mV	4 V		294 ps
	1 V	4 V		584 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 µs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 µs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns
	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns

Table 26: Delta Time Measurement Accuracy (cont.)

	1 V	4 V		535 ns
	MDO = 400 μs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.68 μs
	100 mV	800 mV		2.74 μs
	500 mV	4 V		2.70 μs
	1 V	4 V		5.35 μs
Channel 4 [1]				
	MDO = 4 ns/Div, Source frequency = 240 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	100 mV	800 mV		119 ps
	500 mV	4 V		119 ps
	1 V	4 V		128 ps
	MDO = 40 ns/Div, Source frequency = 24 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		386 ps
	100 mV	800 mV		298 ps
	500 mV	4 V		294 ps
	1 V	4 V		584 ps
	MDO = 400 ns/Div, Source frequency = 2.4 MHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.69 ns
	100 mV	800 mV		2.75 ns
	500 mV	4 V		2.71 ns
	1 V	4 V		5.36 ns
	MDO = 4 μs/Div, Source frequency = 240 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		36.8 ns
	100 mV	800 mV		27.4 ns
	500 mV	4 V		27.0 ns
	1 V	4 V		53.5 ns
	MDO = 40 μs/Div, Source frequency = 24 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		368 ns

Table 26: Delta Time Measurement Accuracy (cont.)

	100 mV	800 mV		274 ns
	500 mV	4 V		270 ns
	1 V	4 V		535 ns
	MDO = 400 µs/Div, Source frequency = 2.4 kHz			
	MDO V/Div	**Source V_{pp}**	**Test Result**	**High Limit**
	5 mV	40 mV		3.68 µs
	100 mV	800 mV		2.74 µs
	500 mV	4 V		2.70 µs
	1 V	4 V		5.35 µs

1 Channels 3 and 4 are only on four-channel oscilloscopes.

Digital Threshold Accuracy Tests (with MDO3MSO option)

Table 27: Digital Threshold Accuracy (with MDO3MSO option)

Digital Threshold Accuracy (with MDO3MSO option)						
Digital channel	Threshold	V_{s-}	V_{s+}	Low limit	Test result $V_{sAvg} = (V_{s-} + V_{s+})/2$	High limit
D0	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D1	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D2	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D3	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D4	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D5	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D6	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D7	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D8	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D9	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D10	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D11	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D12	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D13	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D14	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V

Table 27: Digital Threshold Accuracy (with MDO3MSO option) (cont.)

Digital Threshold Accuracy (with MDO3MSO option)						
Digital channel	Threshold	V_{s-}	V_{s+}	Low limit	Test result $V_{sAvg} = (V_{s-} + V_{s+})/2$	High limit
D15	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V

Displayed Average Noise Level Tests (DANL)

Table 28: Displayed Average Noise Level

Displayed Average Noise Level (DANL)				
Performance checks		Low limit	Test result	High limit
All models	9 kHz – 50 kHz	N/A		–109 dBm/Hz
	50 kHz – 5 MHz	N/A		–126 dBm/Hz
	5 MHz – BW (MDO3SA not installed)	N/A		–136 dBm/Hz
	5 MHz – 2 GHz (MDO3SA installed)	N/A		–136 dBm/Hz
	2 GHz – 3 GHz (MDO3SA installed)	N/A		–126 dBm/Hz

Residual Spurious Response Tests

Table 29: Residual Spurious Response

Residual Spurious Response				
Performance checks		Low limit	Test result	High limit
All models	9 kHz to 50 kHz	N/A		–78 dBm
	50 kHz to 5 MHz	N/A		–78 dBm
	5 MHz to 2 GHz (not 1.25 GHz)	N/A		–78 dBm
	1.25 GHz (MDO3SA installed)	N/A		–76 dBm
	2 GHz to 3 GHz (not 2.5 GHz) (MDO3SA installed)	N/A		–78 dBm
	2.5 GHz (MDO3SA installed)	N/A		–69 dBm

Level Measurement Uncertainty Tests

Table 30: Level Measurement Uncertainty

Level Measurement Uncertainty					
Performance checks			**Low limit**	**Test result**	**High limit**
+10 dBm	All models	9 kHz	–1.2 dB		+1.2 dB
		50 kHz	–1.2 dB		+1.2 dB
		100 kHz – 900 kHz	–1.2 dB		+1.2 dB
		1 MHz – 9 MHz	–1.2 dB		+1.2 dB
		10 MHz - 90 MHz	–1.2 dB		+1.2 dB
		100 MHz – BW	–1.2 dB		+1.2 dB
0 dBm	All models	9 kHz	–1.2 dB		+1.2 dB
		50 kHz	–1.2 dB		+1.2 dB
		100 kHz – 900 kHz	–1.2 dB		+1.2 dB
		1 MHz – 9 MHz	–1.2 dB		+1.2 dB
		10 MHz - 90 MHz	–1.2 dB		+1.2 dB
		100 MHz – BW	–1.2 dB		+1.2 dB
–15 dBm	All models	9 kHz	–1.2 dB		+1.2 dB
		50 kHz	–1.2 dB		+1.2 dB
		100 kHz – 900 kHz	–1.2 dB		+1.2 dB
		1 MHz – 9 MHz	–1.2 dB		+1.2 dB
		10 MHz – 90 MHz	–1.2 dB		+1.2 dB
		100 MHz – BW	–1.2 dB		+1.2 dB

Functional check with a TPA-N-PRE Preamp Attached

Table 31: Functional check with a TPA-N-PRE Preamp attached

Functional check with a TPA-N-PRE Preamp attached			
Performance checks		**Limit**	**Test result**
All models	1.7 GHz	≤ 1.5 dB	
	2.9 GHz	≤ 1.5 dB	

Displayed Average Noise Level (DANL) with a TPA-N-PRE Preamp Attached

Table 32: Displayed Average Noise Level (DANL) with a TPA-N-PRE Preamp Attached

Displayed Average Noise Level (DANL) with a TPA-N-PRE Preamp Attached				
Performance checks		**Low limit**	**Test result**	**High limit**
All models	9 kHz - 50 kHz	N/A		–117 dBm/Hz
	50 kHz - 5 MHz	N/A		–138 dBm/Hz
	50 kHz - BW (MDO3SA not installed)	N/A		–148 dBm/Hz
	5 MHz - 2 GHz (MDO3SA installed)	N/A		–148 dBm/Hz
	2 GHz - 3 GHz (MDO3SA installed)	N/A		–138 dBm/Hz

Auxiliary (Trigger) Output Tests

Table 33: Auxiliary (Trigger) Output Tests

Auxiliary (Trigger) Output Tests				
Performance checks		**Low limit**	**Test result**	**High limit**
Trigger Output	High 1 MΩ	≥ 2.25 V		—
	Low 1 MΩ	—		≤ 0.7 V
	High 50 Ω	≥ 0.9 V		—
	Low 50 Ω	—		≤ 0.25 V

AFG Sine and Ramp Frequency Accuracy Tests

Table 34: AFG Sine and Ramp Frequency Accuracy Tests

AFG Sine and Ramp Frequency Accuracy				
Performance checks		**Low limit**	**Test result**	**High limit**
All models	Sine Wave at 10 kHz, 2.5 V, 50 Ω	9.9987 kHz		10.0013 kHz
	Sine Wave at 50 MHz, 2.5 V, 50 Ω	49.9975 MHz		50.0025 MHz

AFG Square and Pulse Frequency Accuracy Tests

Table 35: AFG Square and Pulse Frequency Accuracy Tests

AFG Square and Pulse Frequency Accuracy				
Performance checks		**Low limit**	**Test result**	**High limit**
All models	Square Wave at 25 kHz, 2.5 V, 50 Ω	24.99875 kHz		25.00125 kHz
	Square Wave at 25 MHz, 2.5 V, 50 Ω	24.99875 MHz		25.00125 MHz

AFG Signal Amplitude Accuracy Tests

Table 36: AFG Signal Amplitude Accuracy Tests

AFG Signal Amplitude Accuracy				
Performance checks		**Low limit**	**Test result**	**High limit**
All models	Square Wave 20 mV_{pp} @ 1 kHz, 50 Ω, 0 V Offset	9.5 mV		10.5 mV
	Square Wave 1 V_{pp} @ 1 kHz, 50 Ω, 0.2 V Offset	492 mV		508 mV

AFG DC Offset Accuracy Tests

Table 37: AFG DC Offset Accuracy Tests

AFG DC Offset Accuracy				
Performance checks		**Low limit**	**Test result**	**High limit**
All models	20 mV DC @ 50 Ω	19 mV		21 mV
	1 V DC @ 50 Ω	0.984 V		1.016 V

DVM Voltage Accuracy Tests (DC)

Table 38: DVM Voltage Accuracy (DC)

Channel 1					
Vertical Scale	**Input Voltage**	**Offset Voltage**	**Low Limit**	**Test Result**	**High Limit**
1	–5	–5	–5.117		–4.883
0.5	–2	–2	–2.052		–1.948
0.5	–1	–0.5	–1.0345		–0.9655
0.2	–0.5	–0.5	–0.5175		–0.4825
0.01	0.002	0	0.00042		0.00442
0.2	0.5	0.5	0.4825		0.5175
0.5	1	0.5	0.9655		1.0345
0.5	2	2	1.948		2.052
1	5	5	4.883		5.117
Channel 2					
Vertical Scale	**Input Voltage**	**Offset Voltage**	**Low Limit**	**Test Result**	**High Limit**
1	–5	–5	–5.117		–4.883
0.5	–2	–2	–2.052		–1.948
0.5	–1	–0.5	–1.0345		–0.9655
0.2	–0.5	–0.5	–0.5175		–0.4825
0.01	0.002	0	0.00042		0.00442
0.2	0.5	0.5	0.4825		0.5175
0.5	1	0.5	0.9655		1.0345
0.5	2	2	1.948		2.052
1	5	5	4.883		5.117
Channel 3 [1]					
Vertical Scale	**Input Voltage**	**Offset Voltage**	**Low Limit**	**Test Result**	**High Limit**
1	–5	–5	–5.117		–4.883
0.5	–2	–2	–2.052		–1.948
0.5	–1	–0.5	–1.0345		–0.9655
0.2	–0.5	–0.5	–0.5175		–0.4825
0.01	0.002	0	0.00042		0.00442
0.2	0.5	0.5	0.4825		0.5175
0.5	1	0.5	0.9655		1.0345
0.5	2	2	1.948		2.052
1	5	5	4.883		5.117

Table 38: DVM Voltage Accuracy (DC) (cont.)

Channel 4 [1]					
Vertical Scale	**Input Voltage**	**Offset Voltage**	**Low Limit**	**Test Result**	**High Limit**
1	–5	–5	–5.117		–4.883
0.5	–2	–2	–2.052		–1.948
0.5	–1	–0.5	–1.0345		–0.9655
0.2	–0.5	–0.5	–0.5175		–0.4825
0.01	0.002	0	0.00042		0.00442
0.2	0.5	0.5	0.4825		0.5175
0.5	1	0.5	0.9655		1.0345
0.5	2	2	1.948		2.052
1	5	5	4.883		5.117

1 Channels 3 and 4 are only on four-channel oscilloscopes.

DVM Voltage Accuracy Tests (AC)

Table 39: DVM Voltage Accuracy (AC)

Channel 1				
Vertical Scale	**Input Signal**	**Low Limit**	**Test Result**	**High Limit**
5 mV	20 mV_{pp} at 1 kHz	9.800 mV		10.200 mV
10 mV	50 mV_{pp} at 1 kHz	24.5 mV		25.500 mV
100 mV	0.5 V_{pp} at 1 kHz	245.000 mV		255.000 mV
200 mV	1 V_{pp} at 1 kHz	490.000 mV		510.000 mV
1 V	5 V_{pp} at 1 kHz	2.450 mV		2.550 mV
Channel 2				
Vertical Scale	**Input Signal**	**Low Limit**	**Test Result**	**High Limit**
5 mV	20 mV_{pp} at 1 kHz	9.800 mV		10.200 mV
10 mV	50 mV_{pp} at 1 kHz	24.5 mV		25.500 mV
100 mV	0.5 V_{pp} at 1 kHz	245.000 mV		255.000 mV
200 mV	1 V_{pp} at 1 kHz	490.000 mV		510.000 mV
1 V	5 V_{pp} at 1 kHz	2.450 mV		2.550 mV
Channel 3 [1]				
Vertical Scale	**Input Signal**	**Low Limit**	**Test Result**	**High Limit**
5 mV	20 mV_{pp} at 1 kHz	9.800 mV		10.200 mV
10 mV	50 mV_{pp} at 1 kHz	24.5 mV		25.500 mV
100 mV	0.5 V_{pp} at 1 kHz	245.000 mV		255.000 mV
200 mV	1 V_{pp} at 1 kHz	490.000 mV		510.000 mV
1 V	5 V_{pp} at 1 kHz	2.450 mV		2.550 mV
Channel 4 [1]				
Vertical Scale	**Input Signal**	**Low Limit**	**Test Result**	**High Limit**
5 mV	20 mV_{pp} at 1 kHz	9.800 mV		10.200 mV
10 mV	50 mV_{pp} at 1 kHz	24.5 mV		25.500 mV
100 mV	0.5 V_{pp} at 1 kHz	245.000 mV		255.000 mV
200 mV	1 V_{pp} at 1 kHz	490.000 mV		510.000 mV
1 V	5 V_{pp} at 1 kHz	2.450 mV		2.550 mV

1 Channels 3 and 4 are only on four-channel oscilloscopes.

DVM Frequency Accuracy Tests and Maximum Input Frequency

Table 40: DVM Frequency Accuracy

	Nominal	Low Limit	Test Result	High Limit
Channel 1				
	9.0000 Hz	8.9998 Hz		9.0002 Hz
	99.000 Hz	98.998 Hz		99.002 Hz
	999.00 Hz	998.98 Hz		999.02 Hz
	99.000 kHz	98.998 kHz		99.002 kHz
	999.00 kHz	998.98 kHz		999.02 kHz
	150 MHz [2]	149.99 MHz		150.01 MHz
Channel 2				
	9.0000 Hz	8.9998 Hz		9.0002 Hz
	99.000 Hz	98.998 Hz		99.002 Hz
	999.00 Hz	998.98 Hz		999.02 Hz
	99.000 kHz	98.998 kHz		99.002 kHz
	999.00 kHz	998.98 kHz		999.02 kHz
	150 MHz [2]	149.99 MHz		150.01 MHz
Channel 3 [1]				
	9.0000 Hz	8.9998 Hz		9.0002 Hz
	99.000 Hz	98.998 Hz		99.002 Hz
	999.00 Hz	998.98 Hz		999.02 Hz
	99.000 kHz	98.998 kHz		99.002 kHz
	999.00 kHz	998.98 kHz		999.02 kHz
	150 MHz [2]	149.99 MHz		150.01 MHz
Channel 4 [1]				
	9.0000 Hz	8.9998 Hz		9.0002 Hz
	99.000 Hz	98.998 Hz		99.002 Hz
	999.00 Hz	998.98 Hz		999.02 Hz
	99.000 kHz	98.998 kHz		99.002 kHz
	999.00 kHz	998.98 kHz		999.02 kHz
	150 MHz [2]	149.99 MHz		150.01 MHz

1 Channels 3 and 4 are only on four-channel oscilloscopes.

2 Verifies the maximum frequency.

Performance Verification Procedures

The following three conditions must be met prior to performing these procedures:

1. The oscilloscope must have been operating continuously for twenty (20) minutes in an environment that meets the operating range specifications for temperature and humidity.
2. You must perform a signal path compensation (SPC). (See *Self Tests — System Diagnostics and Signal Path Compensation* section below.) If the operating temperature changes by more than 10 °C (18 °F), you must perform the signal path compensation again.
3. You must connect the oscilloscope and the test equipment to the same AC power circuit. Connect the oscilloscope and test instruments into a common power strip if you are unsure of the AC power circuit distribution. Connecting the oscilloscope and test instruments into separate AC power circuits can result in offset voltages between the equipment, which can invalidate the performance verification procedure.

The time required to complete all the procedures is approximately one hour.

WARNING. *Some procedures use hazardous voltages. To prevent electrical shock, always set voltage source outputs to 0 V before making or changing any interconnections.*

Self Tests — System Diagnostics and Signal Path Compensation

These procedures use internal routines to verify that the oscilloscope functions and passes its internal self tests. No test equipment or hookups are required. Start the self test with these steps:

Run the System Diagnostics (may take several minutes):

1. Disconnect all probes and cables from the oscilloscope inputs.
2. Push **Default Setup** on the front-panel to set the instrument to the factory default settings.
3. Push **Utility** .
4. Push **Utility Page** on the lower menu, and turn **Multipurpose knob "a"** to select **Self Test**.
5. Push **Self Test** on the lower menu. The Loop X Times side menu button will be set to **Loop 1 Times**.
6. Push **OK Run Self Test** on the side menu.
7. Wait while the self test runs. When the self test completes, a dialog box displays the results of the self test.
8. Cycle the oscilloscope power off and back on before proceeding.

NOTE. *Remember to cycle the oscilloscope power off and back on before proceeding.*

Run the signal path compensation routine (may take 5 to 15 minutes):

1. Push **Default Setup** on the front panel.
2. Push **Utility** .
3. Push **Utility Page** on the lower menu.
4. Turn **Multipurpose knob "a"** to select **Calibration**.
5. Push **Signal Path** on the lower menu.

6. Push **OK-Compensate Signal Paths** on the side menu.
7. When the signal path compensation is complete, push **Menu Off** twice to clear the dialog box and Self Test menu.
8. Check the **Signal Path** button on the lower menu to verify that the status is **Pass**. If it does not pass, run the test again. If it still does not pass, recalibrate the instrument or have the instrument serviced by qualified service personnel.

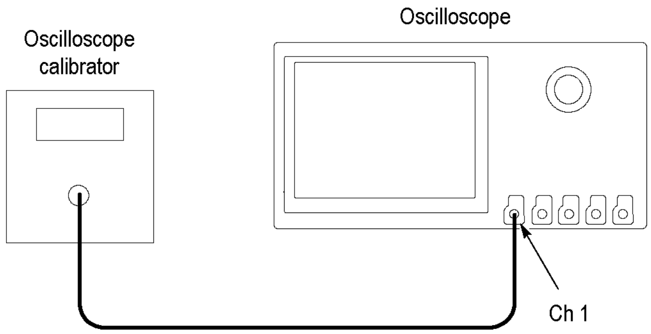
   This completes the procedure.

Check Input Termination, DC Coupled (Resistance)

This test checks the Input Termination for 1 MΩ, 75 Ω or 50 Ω settings.

NOTE. The 75 Ω setting is not available on MDO310X instruments.

1. Connect the output of the oscilloscope calibrator (for example, Fluke 9500) to the oscilloscope channel 1 input, as shown below.



2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push the channel button on the front panel for the oscilloscope channel that you are testing, as shown in the test record (for example, **1**, **2**, **3**, or **4**).
4. Confirm that the oscilloscope termination and calibrator impedance are both set to 1 MΩ. The default **Termination** setting is **1 MΩ**.
5. Turn the **Vertical Scale** knob to set the vertical scale, as shown in the test record (for example, 10 mV/div, 100 mV/div, 1 V/div). (See page 36, *Input Termination Tests*.)
6. Measure the input resistance of the oscilloscope with the calibrator. Record this value in the test record.
7. Repeat steps 5 and 6 for each volt/division setting in the test record.
8. Change the oscilloscope termination to 75 Ω and calibrator impedance to 50 Ω and repeat steps 5 through 7.
9. Change the oscilloscope termination to 50 Ω and repeat steps 5 through 7.
10. Repeat steps 4 through 9 for each channel listed in the test record and relevant to the model of oscilloscope that you are testing, as shown in the test record (for example, **2**, **3**, or **4**).

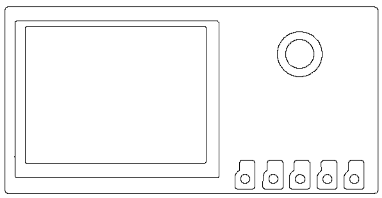
    This completes the procedure.

Check DC Balance

This test checks the DC balance.

You do not need to connect the oscilloscope to any equipment to run this test. The only piece of equipment needed is a BNC feed-through 50 Ω terminator.

1. For 50 Ω coupling, attach a 50 Ω terminator to the channel input of the oscilloscope being tested.



2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push the channel button on the front panel for the oscilloscope channel that you are testing, as shown in the test record (for example, **1**, **2**, **3**, or **4**).
4. Set the oscilloscope termination to 50 Ω. Push **Termination** on the lower menu to select **50 Ω**.
5. Push **Bandwidth** on the lower menu, and push the appropriate bandwidth button on the side menu for **20MHz**, **150MHz**, or **Full**, as given in the test record.
6. Turn the Horizontal **Scale** knob to 1 ms/division.

NOTE. *Step 6 only needs to be done once, at the beginning of the test.*

7. Turn the Vertical **Scale** knob to set the vertical scale, as shown in the test record (for example, 1 mV/div, 2 mV/div, 10 mV/div, 100 mV/div, 1 V/div).
8. Push **Acquire** on the front panel.

NOTE. *Steps 8, 9, and 10 only need to be performed once, at the beginning of this test.*

9. Push **Mode** on the lower menu, and then, if needed, push **Average** on the side menu.
10. If needed, adjust the number of averages to **16** using **Multipurpose knob "a"** .
11. Push the Trigger **Menu** button on the front panel.

NOTE. *Steps 11, 12, and 13 only need to be performed once, at the beginning of this test.*

12. Push **Source** on the lower menu.
13. Select the **AC Line** trigger source on the side menu using **Multipurpose knob "a"**. You do not need to connect an external signal to the oscilloscope for this DC Balance test.
14. On the front panel, push the **Measure** button on the Wave Inspector.

NOTE. Steps 14 though 17 must be performed once for each input channel under test.

15. Push **Add Measurement** on the lower menu.
16. Use **Multipurpose knob "b"** to select the **Mean** measurement. If needed, use **Multipurpose knob "b"** to select the channel input being tested.
17. Push **OK Add Measurement** on the side menu, and then **Menu Off** on the front panel.
18. View the mean measurement value in the display and enter that mean value as the test result in the test record. (See page 38, *DC Balance Tests*.)

NOTE. Translate the mean value into divisions for use in the test record. To do this, divide the voltage value by the vertical scale value. (e.g.0.2 V / (1 V / division) = 0.2 divisions)

19. Repeat step 7 and step 18 for each volts/division value listed in the results table.
20. Push the channel button on the front panel, then change the oscilloscope bandwidth (for example, 20 MHz, 150 MHz, or Full), and repeat step 7, step 18, and step 19.
21. For 1 MΩ coupling, change the oscilloscope termination to 1 MΩ and repeat steps 5 through 20.
22. Repeat steps 3 through 20 for each channel combination listed in the test record and relevant to your model of oscilloscope (for example, **1**, **2**, **3**, or **4**).

NOTE. The BNC 50 Ω terminator needs to be moved to next input channel.

23. For 75 Ω coupling, change the oscilloscope termination to 75 Ω and repeat steps 5 through 20.

NOTE. The BNC 50 Ω terminator needs to be moved to next input channel.

24. Repeat steps 3 through 20 for each channel combination listed in the test record and relevant to your model of oscilloscope (for example, **1**, **2**, **3**, or **4**).

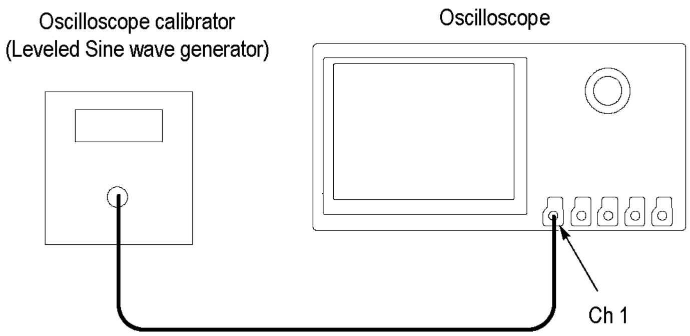
NOTE. The BNC 50 Ω terminator needs to be moved to next input channel.

This completes the procedure.

Check Analog Bandwidth, 50 Ω

This test checks the bandwidth at 50 Ω for each channel.

1. Connect the output of the leveled sine wave generator (for example, Fluke 9500) to the oscilloscope channel 1 input as shown below.



2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push channel button **1**, **2**,**3**, or **4** for the channel that you want to check.
4. Set the calibrator to 50 Ω output impedance (50 Ω source impedance) and to generate a sine wave.
5. Set the oscilloscope termination to 50 Ω. Push **Termination** on the lower menu to select **50 Ω**.
6. Turn the Vertical **Scale** knob to set the vertical scale, as shown in the test record (for example, 1 mV/div, 2 mV/div, 5 mV/div).
7. Push **Acquire** on the front panel.
8. Confirm that the mode is set to **Sample**. If not, push **Mode** on the lower menu, if needed, and then push the **Sample** side bezel button.
9. Adjust the signal source to at least 6 vertical divisions at the selected vertical scale with a set frequency of 50 kHz. For example, at 5 mV/div, use a ≥ 30 mV$_{p-p}$ signal; at 2 mV/div, use a ≥ 12 mV$_{p-p}$ signal; at 1 mV/div, use a ³ 6 mV$_{p-p}$ signal. Use a sine wave for the signal source.
10. Turn the Horizontal **Scale** knob to 40 µs/division.
11. On the front panel, push the **Measure** button on the Wave Inspector, and then push **Add Measurement** on the lower menu.

***NOTE.** Steps 11 though 14 must be performed once for each input channel under test.*

---

12. Use **Multipurpose knob "b"** to select the **Peak-to-peak** measurement. Use **Multipurpose knob "a"** to select the input channel being tested, and then push **OK Add Measurement** on the side menu.
13. Push **More** on the lower menu to select **Gating**, and then push **Off (Full Record)** on the side menu.
14. Push **Menu Off** on the front panel. This will allow you to see the display. Note the mean V_{p-p} of the signal. Call this reading V_{in-pp} .

    Record the mean value of V_{in-pp} (for example, 816 mV) in the test record. (See page 44, *Analog Bandwidth Tests, 50 Ω*.)
15. Turn the Horizontal **Scale** knob to 10 ns/division.

16. Adjust the signal source to the maximum bandwidth frequency for the bandwidth and model desired, as shown in the following worksheet. Measure $V_{p\text{-}p}$ of the signal on the oscilloscope using statistics, as in the previous step, to get the mean $V_{p\text{-}p}$. Call this reading $V_{bw\text{-}pp}$.

Record the value of $V_{bw\text{-}pp}$ in the test record.

NOTE. For more information on the contents of this worksheet, refer to the Analog Channel Input and Vertical Specifications table. *(See page 1, Analog Channel Input And Vertical Specifications.)*

Table 41: Maximum Bandwidth Frequency worksheet

Termination	Vertical Scale	Maximum Bandwidth Frequency
For instruments with 1 GHz bandwidth (includes MDO310X models as well as MDO305X/303X/302X/301X models with 1 GHz upgrade):		
50 Ω	**10 mV/div**	**1 GHz**
50 Ω	**5 mV/div**	**500 MHz**
50 Ω	**2 mV/div**	**350 MHz**
50 Ω	**1 mV/div**	**150 MHz**
For instruments with 500 MHz bandwidth (includes MDO305X models as well as MDO303X/302X/301X models with 500 MHz upgrade):		
50 Ω	5 mV/div	500 MHz
50 Ω	2 mV/div	350 MHz
50 Ω	1 mV/div	150 MHz
For instruments with 350 MHz bandwidth (includes MDO303X models as well as MDO302X/301X models with 350 MHz upgrade):		
50Ω	5 mV/div	350 MHz
50Ω	2 mV/div	350 MHz
50Ω	1 mV/div	150 MHz
For instruments with 200 MHz bandwidth (includes MDO302X models as well as MDO301X models with 200 MHz upgrade):		
50 Ω	**2 mV/div**	**200 MHz**
50 Ω	**1 mV/div**	**150 MHz**
For instruments with 100 MHz bandwidth (MDO301X models):		
50 Ω	1 mV/div	100 MHz

17. Use the values of $V_{bw\text{-}pp}$ and $V_{in\text{-}pp}$ obtained above and stored in the test record to calculate the *Gain* at bandwidth with the following equation:

$Gain = V_{bw\text{-}pp} / V_{in\text{-}pp}$.

18. To pass the performance measurement test, Gain should be ≥ 0.707. Enter *Gain* in the test record.

19. Repeat steps 9 through 17 for the other oscilloscope volts/div settings listed in the test record.

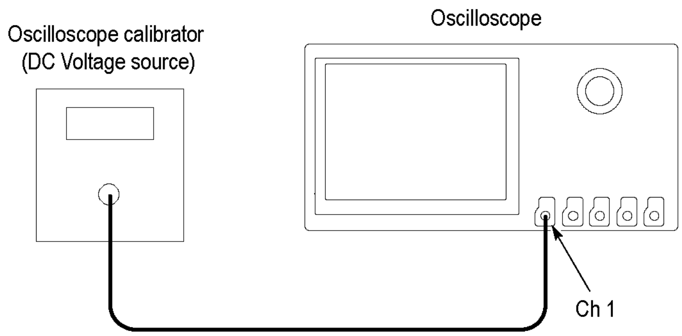
20. Repeat steps 3 through 18 for each channel combination listed in the test record and relevant to your model of oscilloscope (for example, **1**, **2**, **3**, or **4**).

    This completes the procedure.

Check DC Gain Accuracy

This test checks the DC gain accuracy.

1. Connect the oscilloscope to a DC voltage source. If using the Fluke 9500 calibrator, connect the calibrator head to the oscilloscope channel to test.



2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push channel button **1**, **2**,**3**, or **4** to select the channel that you want to check.
4. Confirm that the oscilloscope termination and calibrator impedance are both set to 1 MΩ. On the oscilloscope, push **Termination** on the lower menu to select **1 M Ω.**
5. Push **20 MHz** on the side menu to select the bandwidth (push **Bandwidth** on the lower menu, if necessary, to activate the Bandwidth menu).
6. Push **Acquire** on the front panel.
7. Push **Mode** on the lower menu, and then push **Average** on the side menu. Use the default number of averages (16).
8. On the front panel, push the **Measure** button on the Wave Inspector, and then **Add Measurement** on the lower menu.
9. Use **Multipurpose knob "b"** to select the **Mean** measurement. Use **Multipurpose knob "a"** to select the input channel to be tested.
10. Push **OK Add Measurement** on the side menu.
11. Push the Trigger **Menu** button on the front panel.
12. Push **Source** on the lower menu.
13. Turn **Multipurpose knob "a"** to select **AC Line** as the trigger source. Push Menu Off on the front panel.
14. Turn the vertical **Scale** knob to the next setting to measure, as shown in the Gain Expected worksheet below.
15. Set the DC Voltage Source to $V_{negative}$. Push **Measure** on the front panel, then push **More** on the lower menu to select **Statistics**. Push **Reset Statistics** on the side menu, and then push **Menu Off** on the front panel.
16. Enter the mean reading into Gain Expected worksheet below as $V_{negative\text{-}measured}$.
17. Set the DC Voltage Source to $V_{positive}$. Push **More** on the lower menu to select **Statistics**, push the **Reset Statistics** on the side menu, and then push **Menu Off** on the front panel. Enter the mean reading into the Gain Expected worksheet as $V_{positive\text{-}measured}$.

Table 42: Gain Expected worksheet - channel 1

Oscilloscope Vertical Scale Setting	$V_{diffExpected}$	$V_{negative}$	$V_{positive}$	$V_{negative-measured}$	$V_{positive-measured}$	V_{diff}	Test Result (Gain Accuracy)
1 mV/div	7 mV	–3.5 mV	+3.5 mV				
2 mV/div	14 mV	–7 mV	+7 mV				
4.98 mV	34.86 mV	–17.43 mV	+17.43 mV				
5 mV	35 mV	–17.5 mV	+17.5 mV				
10 mV	70 mV	–35 mV	+35 mV				
20 mV	140 mV	–70 mV	+70 mV				
49.8 mV	348.6 mV	–174.3 mV	+174.3 mV				
50 mV	350 mV	–175 mV	+175 mV				
100 mV	700 mV	–350 mV	+350 mV				
200 mV	1400 mV	–700 mV	+700 mV				
500 mV	3500 mV	–1750 mV	+1750 mV				
1.0 V	7000 mV	–3500 mV	+3500 mV				

Table 43: Gain Expected worksheet - channel 2

Oscilloscope Vertical Scale Setting	$V_{diffExpected}$	$V_{negative}$	$V_{positive}$	$V_{negative-measured}$	$V_{positive-measured}$	V_{diff}	Test Result (Gain Accuracy)
1 mV/div	7 mV	–3.5 mV	+3.5 mV				
2 mV/div	14 mV	–7 mV	+7 mV				
4.98 mV	34.86 mV	–17.43 mV	+17.43 mV				
5 mV	35 mV	–17.5 mV	+17.5 mV				
10 mV	70 mV	–35 mV	+35 mV				
20 mV	140 mV	–70 mV	+70 mV				
49.8 mV	348.6 mV	–174.3 mV	+174.3 mV				
50 mV	350 mV	–175 mV	+175 mV				
100 mV	700 mV	–350 mV	+350 mV				
200 mV	1400 mV	–700 mV	+700 mV				
500 mV	3500 mV	–1750 mV	+1750 mV				
1.0 V	7000 mV	–3500 mV	+3500 mV				

Table 44: Gain Expected worksheet - channel 3

Oscilloscope Vertical Scale Setting	$V_{diffExpected}$	$V_{negative}$	$V_{positive}$	$V_{negative-measured}$	$V_{positive-measured}$	V_{diff}	Test Result (Gain Accuracy)
1 mV/div	7 mV	–3.5 mV	+3.5 mV				
2 mV/div	14 mV	–7 mV	+7 mV				
4.98 mV	34.86 mV	–17.43 mV	+17.43 mV				
5 mV	35 mV	–17.5 mV	+17.5 mV				
10 mV	70 mV	–35 mV	+35 mV				
20 mV	140 mV	–70 mV	+70 mV				
49.8 mV	348.6 mV	–174.3 mV	+174.3 mV				
50 mV	350 mV	–175 mV	+175 mV				
100 mV	700 mV	–350 mV	+350 mV				
200 mV	1400 mV	–700 mV	+700 mV				
500 mV	3500 mV	–1750 mV	+1750 mV				
1.0 V	7000 mV	–3500 mV	+3500 mV				

Table 45: Gain Expected worksheet - channel 4

Oscilloscope Vertical Scale Setting	$V_{diffExpected}$	$V_{negative}$	$V_{positive}$	$V_{negative-measured}$	$V_{positive-measured}$	V_{diff}	Test Result (Gain Accuracy)
1 mV/div	7 mV	–3.5 mV	+3.5 mV				
2 mV/div	14 mV	–7 mV	+7 mV				
4.98 mV	34.86 mV	–17.43 mV	+17.43 mV				
5 mV	35 mV	–17.5 mV	+17.5 mV				
10 mV	70 mV	–35 mV	+35 mV				
20 mV	140 mV	–70 mV	+70 mV				
49.8 mV	348.6 mV	–174.3 mV	+174.3 mV				
50 mV	350 mV	–175 mV	+175 mV				
100 mV	700 mV	–350 mV	+350 mV				
200 mV	1400 mV	–700 mV	+700 mV				
500 mV	3500 mV	–1750 mV	+1750 mV				
1.0 V	7000 mV	–3500 mV	+3500 mV				

18. Calculate V_{diff} as follows:

$V_{diff} = |V_{negative\text{-}measured} - V_{positive\text{-}measured}|$

Enter V_{diff} in the Gain Expected worksheet.

19. Calculate *GainAccuracy* as follows:

$GainAccuracy = ((V_{diff} - V_{diffExpected})/V_{diffExpected}) \times 100\%$

Write down *GainAccuracy* in the Gain Expected worksheet and in the test record. (See page 45, *DC Gain Accuracy Tests*.)

20. Repeat steps 14 through 18 for each volts/division value in the test record.

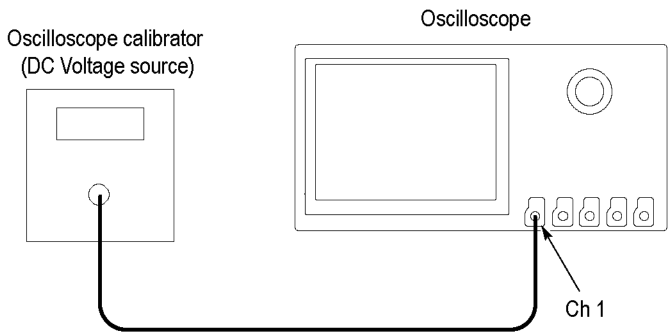
21. Repeat steps 3 through 19 for each channel of the oscilloscope that you want to check.

This completes the procedure.

Check Offset Accuracy

This test checks the offset accuracy.

1. Connect the oscilloscope to a DC voltage source to run this test. If using the Fluke 9500 calibrator as the DC voltage source, connect the calibrator head to the oscilloscope channel to test.



2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push channel button **1**,**2**,**3**, or **4** to select the channel you want to check.
4. Confirm that the oscilloscope termination and calibrator impedance are both set to 1 MΩ. Push **Termination** on the lower menu to select **1 MΩ**.
5. Set the calibrator to the vertical offset value shown in the test record (for example, 700 mV for a 1 mV/div setting). Set the calibrator impedance to match the termination setting for the oscilloscope.
6. On the oscilloscope, push **More** on the lower menu repeatedly, to select **Offset**.
7. Set the oscilloscope to the vertical offset value shown in the test record (for example, 700 mV for a 1 mV/div setting).
8. Turn the vertical **Scale** knob to match the value in the test record (for example, 1 mV/division).
9. Turn the Horizontal **Scale** knob to 1 ms/div.
10. Push **Bandwidth** on the lower menu.
11. Push **20 MHz** on the side menu.
12. Check that the vertical position is set to 0 divs. If not, turn the appropriate **Vertical Position** knob to set the position to 0 divs.

    Or, push **More** on the lower menu repeatedly to select **Position**, and then push **Set to 0 divs** on the side menu.
13. Push **Acquire** on the front panel.
14. Push **Mode** on the lower menu, and then push **Average** on the side menu. Use the default number of averages (16).
15. Push the Trigger **Menu** button on the front panel.
16. Push **Source** on the lower menu.
17. Turn **Multipurpose knob “a”** to select **AC Line** as the trigger source.
18. On the front panel, push the **Measure** button on the Wave Inspector.
19. Push **Add Measurement** on the lower menu.
20. Use **Multipurpose knob “b”** to select the **Mean** measurement. Use **Multipurpose knob “a”** to select the input channel to be tested.

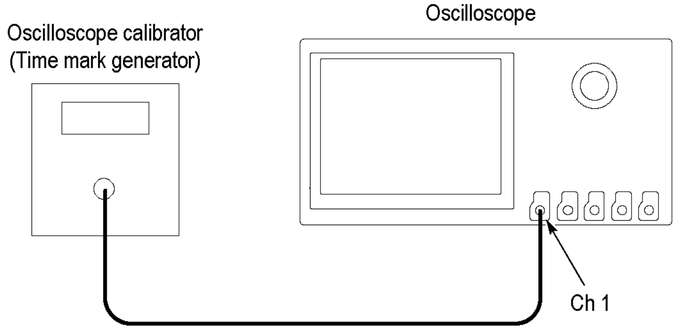
21. Push **OK Add Measurement** on the side menu, and then **Menu Off** on the front panel. The mean value should appear in a measurement pane at the bottom of the display.
22. Enter the measured value in the test record. (See page 47, *DC Offset Accuracy Tests*.)
23. Repeat the procedure (steps 6, 7, 8 and 22) for each volts/division setting shown in the test record.
24. Repeat all steps, starting with step 1, for each oscilloscope channel you want to check.

    This completes the procedure.

Check Long-term Sample Rate and Delay Time Accuracy

This test checks the sample rate and delay time accuracy (time base).

1. Push **Default Setup** on the oscilloscope front panel to set the instrument to the factory default settings.
2. Connect the output of the time mark generator to the oscilloscope channel 1 input using a 50 Ω cable. Use the time mark generator with a 50 Ω source with the oscilloscope set for internal 50 Ω termination.



3. Set the time mark generator to 80 ms. Use a time mark waveform with a fast rising edge.
4. Set the mark amplitude to 1 V_{pp}.
5. Set the oscilloscope vertical **Scale** to 500 mV/div.
6. Set the **Horizontal Scale** to 20 ms/div.
7. Adjust the **Trigger Level** for a triggered display.
8. Adjust the vertical **Position** knob to center the time mark on center screen.
9. Adjust the **Horizontal Position** knob counterclockwise to set the delay to exactly 80 ms.
10. Set the **Horizontal Scale** to 400 ns/div.
11. Compare the rising edge of the marker to the center horizontal graticule. The rising edge should be within ±2 divisions of the center graticule. Enter the deviation in the test record. (See page 49, *Sample Rate and Delay Time Accuracy*.)

***NOTE.** One division of displacement from graticule center corresponds to a 5 ppm time base error.*

This completes the procedure.

Check Random Noise, Sample Acquisition Mode

This test checks random noise. You do not need to connect any test equipment to the oscilloscope for this test.

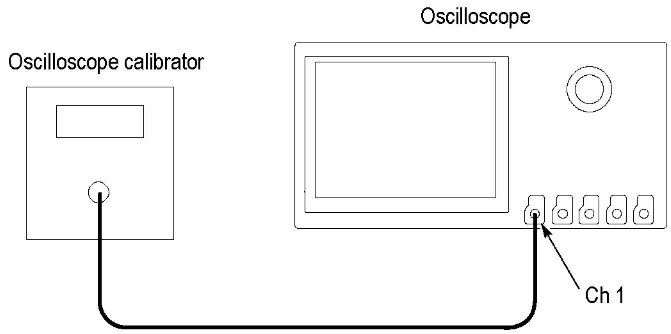
1. Disconnect everything connected to the oscilloscope inputs.
2. Push **Default Setup** on the front panel to set the instrument to the factory default settings. This sets the oscilloscope to Channel 1, Full Bandwidth, 1 MΩ input termination, 100 mV/div, and 4.00 μs/div.
3. Set **Horizontal** to 10 ms/div.
4. Set CH**1** Vertical Channel Setting to 50 Ω termination and the desired bandwidth.
5. Set up the measurements to do RMS and Mean measurement of selected channel and record the measurement.
6. Calculate RMS noise voltage = Square root of (RMS^2 – $Mean^2$), and record the result.
7. The calculated RMS noise voltage from step 6 should be less than the high limit in the test record (the calculated maximum RMS noise).
8. Repeat the above test for all other input channels. Channels 3 and 4 are only available on three or four channel oscilloscopes.

This completes the procedure.

Check Delta Time Measurement Accuracy

This test checks the Delta time measurement accuracy (DTA) for a given instrument setting and input signal.

1. Set the sine wave generator output impedance to 50 Ω.
2. Push the oscilloscope front-panel **Default Setup** button, and then push **Menu Off**.
3. Connect a 50 Ω coaxial cable from the signal source to the oscilloscope channel being tested.



4. Push the channel **1** button to display the channel 1 menu.
5. Push **Termination** on the lower menu to set the channel to **50 Ω**.
6. Push the Trigger **Menu** button on the front panel, and then, if necessary, set the trigger source to the channel being tested:
   a. Push **Source** on the lower menu.
   b. Use the **Multipurpose a** knob to select the channel being tested.
7. On the front panel, push the **Measure** button on the Wave Inspector, and then push **Add Measurement** on the lower menu.
8. Use **Multipurpose Knob "b"** to select the **Burst Width** measurement, and then push **OK Add Measurement** on the side menu. Use **Multipurpose Knob "a"** to select the input channel to be tested.
9. Push **More** on the lower menu to select **Statistics** and, if necessary, use **Multipurpose Knob "a"** to set the **Mean & Std Dev Samples** to 100, as shown in the side menu.
10. Push **Menu Off** on the front panel to remove the Statistics menu.
11. Refer to the Test Record *Delta Time Measurement Accuracy* table. (See page 57, *Delta Time Measurement Accuracy Tests (MDO310X models)*.) Set the oscilloscope and the signal source as directed there.
12. Push **More** on the lower menu to select **Statistics**, and then push **Reset Statistics.** Wait five or 10 seconds for the oscilloscope to acquire all the samples before taking the reading.
13. Verify that the **Std Dev** is less than the upper limit shown for each setting, and note the reading in the Test Record.
14. Repeat steps 11 through 13 for each setting combination shown in the Test Record for the channel being tested.
15. Push the channel button on the front panel for the current channel to shut off the channel. Push the channel button for the next channel to be tested, and move the coaxial cable to the appropriate input on the oscilloscope. Only the channel being tested should be enabled
16. Repeat steps 5 through 15 until all channels have been tested.

***NOTE.** For this test, enable only one channel at a time. If three or more channels are enabled at the same time, the maximum sample rate is reduced and the limits in the Test Record are no longer valid.*

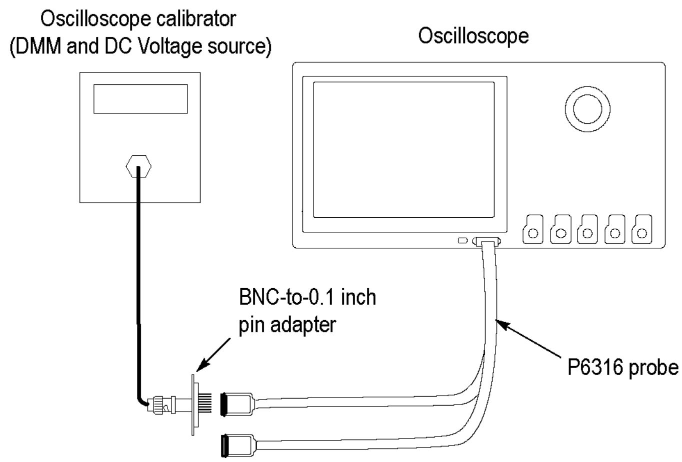
This completes the procedure.

Check Digital Threshold Accuracy (with MDO3MSO option)

For models with the MDO3MSO option only, this test checks the threshold accuracy of the digital channels. This procedure applies to digital channels D0 through D15, and to channel threshold values of 0 V and +4 V.

1. Connect the P6316 digital probe to the MDO3000 series instrument.
2. Connect the P6316 Group 1 pod to the DC voltage source to run this test. You will need a BNC-to-0.1 inch pin adapter to complete the connection.

***NOTE.** If using the Fluke 9500 calibrator as the DC voltage source, connect the calibrator head to the P6316 Group 1 pod. You will need a BNC-to-0.1 inch pin adapter to complete the connection.*



3. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
4. Push **D15-D0** on the front panel.
5. Push **D15-D0 On/Off** on the lower menu.
6. Push **Turn On D7 - D0** and **Turn On D15 - D8** on the side menu. The instrument will display the 16 digital channels.
7. Push **Thresholds** on the lower menu.
8. Before you change the threshold value, push **Fine** on the front panel to turn off the fine adjustment and make adjusting the value quicker.

   Turn **Multipurpose knob "a"** (for channels D7 - D0) or **Multipurpose knob "b"** (for channels D15 - D8) to set the threshold value to **0.00 V** (0 V/div).

   The thresholds are set for the 0 V threshold check. You need to record the test values in the test record row for 0 V for each digital channel. (See page 62, *Digital Threshold Accuracy Tests (with MDO3MSO option)*.)
9. Push the Trigger **Menu** button on the front panel.
10. Push **Source** on the lower menu, and then turn **Multipurpose knob "a"** to select the appropriate channel, such as D0.

    By default, the Type is set to Edge, Coupling is set to DC, Slope is set to Rising, Mode is set to Auto, and Level is set to match the threshold of the channel being tested.
11. Set the DC voltage source (Vs) to -400 mV. Wait 3 seconds. Check the logic level of the corresponding digital channel in the display.

If the channel is a static logic level high (green), change the DC voltage source Vs to -500 mV.

12. Increment Vs by +20 mV. Wait 3 seconds and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level high (green), record the Vs value as in the 0 V row of the test record.

If the channel is a logic level low (blue) or is alternating between high and low, repeat this step (increment Vs by 20 mV, wait 3 seconds, and check for a static logic high). Continue until a value for **Vs-** is found.

NOTE. *In this procedure, the channel might not change state until after you pass the set threshold level.*

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13. Push **Slope** on the lower menu to change the slope to **Falling**.

14. Set the DC voltage source (Vs) to +400 mV. Wait 3 seconds. Check the logic level of the corresponding digital channel in the display.

If the channel is a static logic level low (blue), change the DC voltage source Vs to +500 mV.

15. Decrement Vs by -20 mV. Wait 3 seconds and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level low, record the Vs value as **Vs+** in the 0 V row of the test record.

If the channel is a logic level high (green) or is alternating between high and low, repeat this step (decrement Vs by 20 mV, wait 3 seconds, and check for a static logic low). Continue until a value for **Vs+** is found.

16. Find the average, V_{sAvg} = (Vs- + Vs+)/2. Record the average as the test result in the test record.

Compare the test result to the limits. If the result is between the limits, continue with the procedure to test the channel at the +4 V threshold value.

17. The remaining part of this procedure is for the +4 V threshold test. Push **D15-D0** on the front panel. The **Thresholds** menu should display.

18. With the Fine button on the front panel turned off, turn **Multipurpose knob "a"** (for channels D7 - D0) or **Multipurpose knob "b"** (for channels D15 - D8) to set the threshold value to **4.00 V** (+4.0 V/div). To remove the menu from the display, push **Menu Off** on the front panel.

19. Set the DC voltage source (Vs) to +4.4 V. Wait 3 seconds. Check the logic level of the corresponding digital channel in the display.

If the channel is a static logic level low (blue), change the DC voltage source Vs to +4.5 V.

20. Decrement Vs by -20 mV. Wait 3 seconds and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level low, record the Vs value as **Vs+** in the 4 V row of the test record.

If the channel is a logic level high (green) or is alternating between high and low, repeat this step (decrement Vs by 20 mV, wait 3 seconds, and check for a static logic low). Continue until a value for **Vs+** is found.

21. Push the Trigger **Menu** button on the front panel.

22. Push the **Slope** lower-bezel button to change the slope to **Rising**.

23. Set the DC voltage source (Vs) to +3.6 V. Wait 3 seconds. Check the logic level of the corresponding digital channel in the display.

If the channel is a static logic level high (green), change the DC voltage source Vs to +3.5 V.

24. Increment Vs by +20 mV. Wait 3 seconds and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level high, record the Vs value as in the 4 V row of the test record.

If the channel is a logic level low (blue) or is alternating between high and low, repeat this step (increment Vs by 20 mV, wait 3 seconds, and check for a static logic high). Continue until a value for **Vs-** is found.

25. Find the average, V_{sAvg} = (Vs- + Vs+)/2. Record the average as the test result in the test record.

Compare the test result to the limits. If the result is between the limits, the channel passes the test.

26. Push **D15-D0** on the front panel. The **Thresholds** menu should display.

27. Repeat the procedure starting with step 8 for each remaining digital channel in the pod.

28. Disconnect the P6316 Group 1 pod from the BNC-to-0.1 inch pin adapter and connect the Group 2 pod in its place.

29. Repeat the procedure starting with step 8 for each digital channel in the Group 2 pod.

This completes the procedure.

Check Displayed Average Noise Level (DANL)

This test does not require an input signal.

The test measures the average internal noise level of the instrument, ignoring residual spurs.

It checks these ranges:

- 9 kHz to 50 kHz (all models)
- 50 kHz to 5 MHz (all models)
- 5 MHz to BW (MDO3SA not installed)
- 5 MHz to 2 GHz (MDO3SA installed)
- 2 GHz to 3 GHz (MDO3SA installed)

NOTE. *If the specific measurement frequency results in measuring a residual spur that is visible above the noise level, the DANL specification applies not to the spur but to the noise level on either side of the spur. Please refer to the Spurious Response specifications.*

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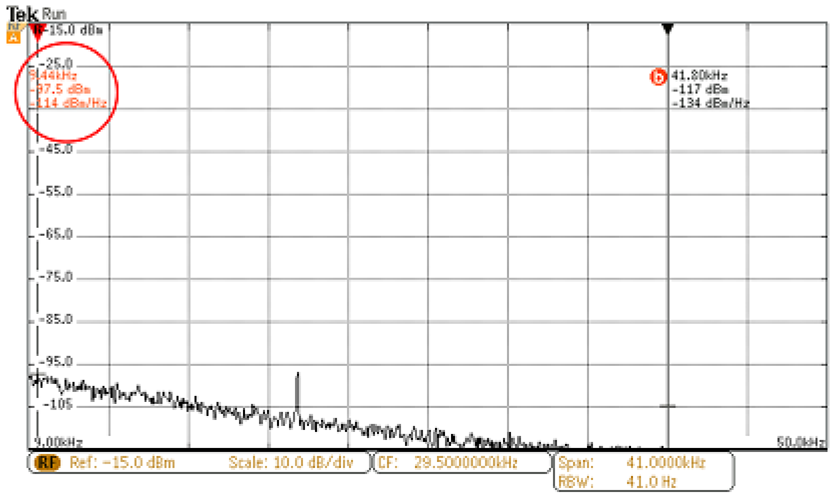
1. *Initial oscilloscope setup:*
   a. Terminate the RF input in 50 Ω with no input signal applied.
   b. Push the **Default Setup** button on the front panel.
   c. Push the front-panel **RF** button to turn on the RF channel and display the bottom-bezel RF menu.
   d. *Turn on the average trace as follows:* Push the bottom-bezel **Spectrum Traces** button and set Normal to Off. Push the side-bezel **Average** button to set the Average Traces to On.
   e. *Turn on the average detection as follows:* Push the bottom-bezel **Detection Method** button. Push the side-bezel button to set the detection method to **Manual**. Push the side-bezel **Average Trace** button. Set the detection method to Average.
   f. *Set the reference level to –15 dBm as follows:* Push the front-panel **Ampl** button. Push the side-bezel **Ref Level** button. Set the Ref Level to –15.0 dBm.
   g. *Set the start and stop frequency as follows:* Push the front-panel **Freq/Span** button. Push the side-bezel **Start** button. Set the start frequency to 9 kHz. Push the side-bezel **Stop** button. Set the stop frequency to 50 kHz.
2. *Check from 9 kHz to 50 kHz (all models):*
   a. Set Manual Marker (a) at the frequency with the highest noise level as follows: Push the **Markers** front-panel button. Push the **Manual Markers** side bezel button to turn on the markers. Turn Multipurpose knob **a** to move the marker to the frequency at the noise threshold (highest point of noise), ignoring any spurs. For this span, it should be near 9 kHz on the far left of the screen. See the following figure.



b. Record the noise threshold value (in dBm/Hz) in the test record and compare it to the instrument specification.

3. In the test record, enter the result at this frequency (9 kHz).

4. *Check from 50 kHz to 5 MHz (all models):*

a. Set the stop frequency to 5 MHz.

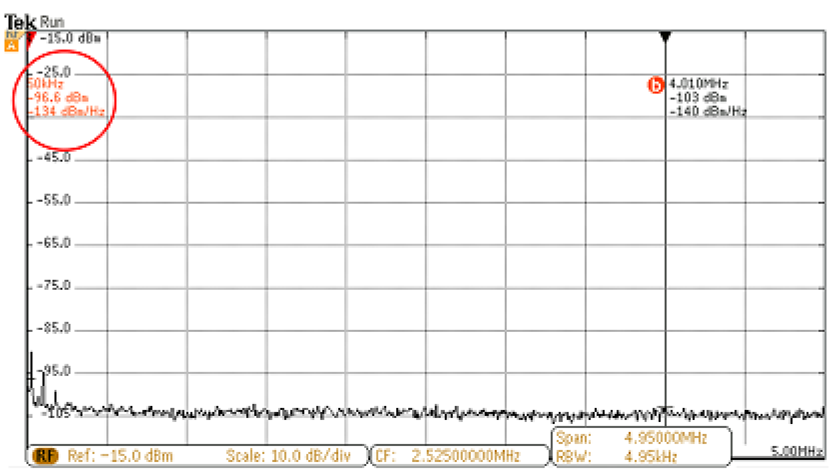
b. Set the start frequency to 50 kHz.

c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.

d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.

e. *Set the span to 10 MHz as follows:* Push the side-bezel **Span** button. Set the Span to 10 MHz.

f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.



5. In the test record, enter the result at this frequency (50 kHz).

6. *Check from 5 MHz to BW (MDO3SA not installed):*
   a. Set the stop frequency to the maximum bandwidth.
   b. Set the start frequency to 5 MHz.
   c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.
   d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.
   e. *Set the span to 10 MHz as follows:* Push the side-bezel **Span** button. Set the Span to 10 MHz.
   f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.
7. *Check from 5 MHz to 2 GHz (MDO3SA installed).*
   a. Set the stop frequency to 2 GHz.
   b. Set the start frequency to 5 MHz.
   c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.
   d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.
   e. *Set the span to 10 MHz as follows:* Push the side-bezel **Span** button. Set the Span to 10 MHz.
   f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.
8. *Check from 2 GHz to 3 GHz (MDO3SA installed).*
   a. Set the stop frequency to 3 GHz.
   b. Set the start frequency to 2 GHz.
   c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.
   d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.
   e. *Set the span to 10 MHz as follows:* Push the side-bezel **Span** button. Set the Span to 10 MHz.
   f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.

This completes the procedure.

Check Residual Spurious Response

This check verifies that the oscilloscope meets the specification for residual spurious response. This check does not require an input signal.

1. *Initial Setup:*
   a. Terminate the oscilloscope RF input in 50 Ω with no input signal applied.
   b. Push **Default Setup**.
   c. Turn on **RF**.
   d. Turn on **Average Trace**. Push the bottom-bezel **Spectrum Traces** button and set **Normal** to **Off**. Push the side-bezel **Average** button to set **Average Traces** to **On**.
   e. Set **Ref Level** to –15 dBm. Push the front-panel **Ampl** button. Push the side-bezel **Ref Level** button. Set the Ref Level to –15 dB.
2. *Check in the range of 9 kHz to 50 kHz (all models).*
   a. Set **Start Frequency** to 9 kHz. Push the front-panel **Freq/Span** button. Push the side-bezel **Start** button. Set the start frequency to 9 kHz.
   b. Set **Stop Frequency** to 50 kHz. Push the side-bezel **Stop** button. Set the stop frequency to 50 kHz.
   c. Observe any spurs above –78 dBm and note them in the test record.
3. *Check in the range of 50 kHz to 5 MHz (all models).*
   a. Set **Stop Frequency** to 5 MHz.
   b. Set **Start Frequency** to 50 kHz.
   c. Observe any spurs above –78 dBm and note them in the test record.
4. *Check in the range of 5 MHz to Maximum Bandwidth (MDO3SA not installed):*
   a. Set **Stop Frequency** to the maximum bandwidth.
   b. Set **Start Frequency** to 5 MHz.
   c. Set RBW to 100 kHz. Push the **BW** front-panel button. Turn the **Multipurpose a** knob counter-clockwise to change the RBW to 100 kHz.
   d. Observe any spurs above –78 dBm and note them in the test record.
5. *Check in the range of 5 MHz to 2 GHz (MDO3SA installed):*
   a. Set **Stop Frequency** to 2 GHz.
   b. Set **Start Frequency** to 5 MHz.
   c. Set RBW to 100 kHz. Push the **BW** front-panel button. Turn the **Multipurpose a** knob counter-clockwise to change the RBW to 100 kHz.
   d. Check the spur level at 1.25 GHz, if present. Push the **Markers** front-panel button and then push the **Manual Markers** side-bezel button to turn on manual markers. Turn the **Multipurpose a** knob to line up **Marker a** on the

1.25 GHz spur, if it is present. Adjust the marker until the horizontal dash on the marker sits on top of the spur. Note the spur level in the test record.

e. Observe any spurs above –78 dBm in the rest of the span, and note them in the test record.

6. *Check in the range of 2 GHz to 3 GHz (MDO3SA installed):*

a. Set **Stop Frequency** to the 3 GHz.

b. Set **Start Frequency** to 2 GHz.

c. Set **RBW** to 100 kHz.

d. Check the spur level at 2.5 GHz, if present. Push the **Markers** front-panel button and then push the **Manual Markers** side-bezel button to turn on manual markers. Turn the **Multipurpose a** knob to line up **Marker a** on the 2.5 GHz spur, if it is present. Adjust the marker until the horizontal dash on the marker sits on top of the spur. Note the spur level in the test record.

e. Observe any spurs above –78 dBm in the rest of the span, and note them in the test record.

This completes the procedure.

Check Level Measurement Uncertainty

This test checks the level measurement uncertainty at three reference levels: +10 dBm, 0 dBm, and –15 dBm. This check uses the generator to step frequencies across four spans to verify that the instrument meets the specification.

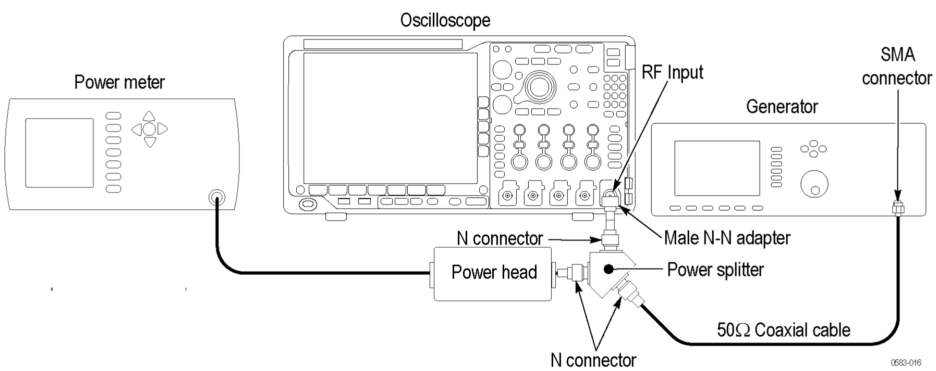
For this check, you will need the following equipment, which is described in the Required Equipment table. (See Table 18 on page 33.)

- Generator, such as the Anritsu generator
- Power meter
- Power head
- Power splitter
- Adapters and cables as shown in the following figure.

WARNING. *The generator is capable of providing dangerous voltages. Be sure to set the generator to off or 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure.*

NOTE. *Use an SMA connector with the Anritsu generator. Equipment damage will result if an N connector is used.*

1. *Connect the equipment as shown in the following figure.*



2. *Initial oscilloscope setup:*

a. Push the **Default Setup** button on the front panel.

b. Push the front-panel **RF** button to turn on the RF channel.

3. *Check at +10 dBm:*

   a. Set the reference level to +10 dBm as follows: Push the front-panel **Ampl** button. Push the side-bezel **Ref Level** button. Set the Ref Level to +10 dBm.

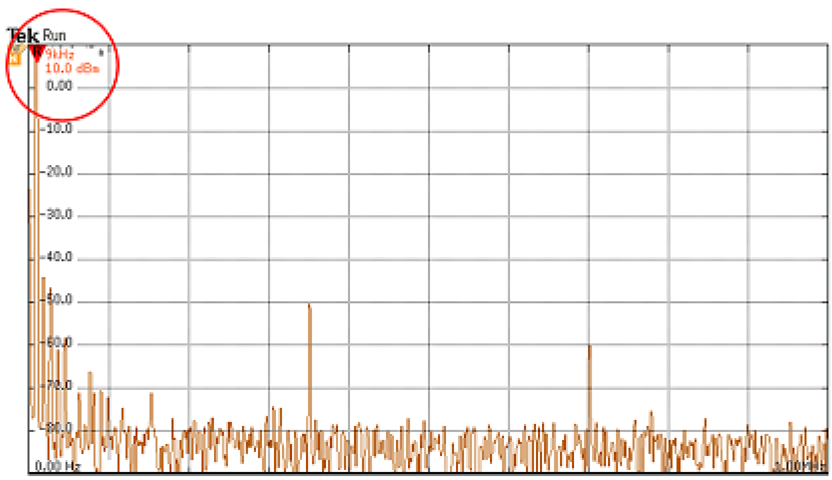
   b. *Set the frequency range as follows:*

      - Push the front-panel **Freq/Span** button.
      - Push the side-bezel **Start** button.
      - Set the start frequency to 0 Hz.
      - Push the side-bezel **Stop** button.
      - Set the stop frequency to 1 MHz.

   c. Set the generator to provide a 9 kHz, +10 dBm signal.

   d. At 9 kHz, determine the test result as follows:

      - Note the reading on the power meter and the readout for the Reference marker on the oscilloscope. See the following figure.



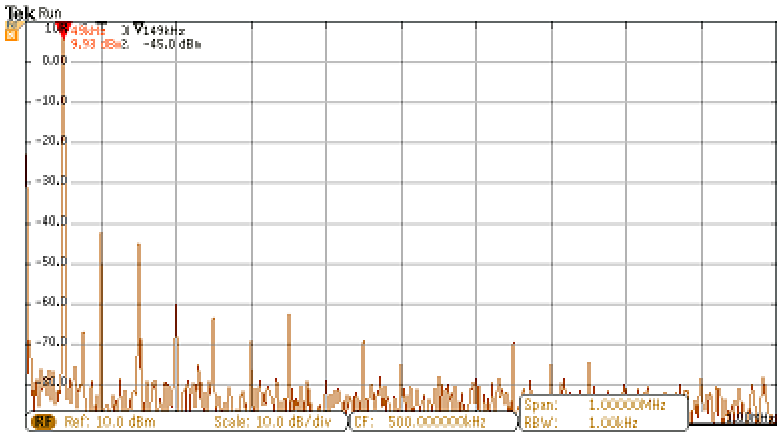
      - Calculate the difference between the two readings. This is the test result.

   e. In the test record, enter the result at this frequency (9 kHz).

   f. Set the generator to provide a 50 kHz, +10 dBm signal.

   g. At 50 kHz, determine the test result as follows:

      - Note the reading on the power meter and the readout for the Reference marker on the oscilloscope. See the following figure.



- Calculate the difference between the two readings. This is the test result.

h. In the test record, enter the result at this frequency (50 kHz).

i. Step the generator, in 100 kHz intervals, through frequencies from 100 kHz to 900 kHz. At each interval, determine the test result as follows:

- Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.
- Calculate the difference between the two readings. This is the test result.

j. In the test record, enter the greatest result determined within this frequency range (100 kHz – 900 kHz).

k. *Change the frequency range as follows:*

- Change the stop frequency to 9.2 MHz.
- Change the start frequency to 980 kHz.

l. Set the generator to provide a 1 MHz, +10 dBm signal.

m. Step the generator, in 1 MHz intervals, through frequencies from 1 MHz to 9 MHz. At each interval, determine the test result as follows:

- Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.
- Calculate the difference between the two readings. This is the test result.

n. In the test record, enter the greatest result determined within this frequency range (1 MHz to 9 MHz).

o. *Change the frequency range as follows:*

- Change the stop frequency to 92 MHz.
- Change the start frequency to 9.8 MHz.

p. Set the generator to provide a 10 MHz, +10 dBm signal.

q. Step the generator, in 10 MHz intervals, through frequencies from 10 MHz to 90 MHz. At each interval, determine the test result as follows:

- Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.
- Calculate the difference between the two readings. This is the test result.

r. In the test record, enter the greatest result determined within this frequency range (10 MHz to 90 MHz).

For all models without the MSO3MDO 3 GHz option (steps p through u)

p. *Change the frequency range as follows:*

- Change the stop frequency to the maximum bandwidth.
- Change the start frequency to 99 MHz.

s. Set the generator to provide a 100 MHz, +10 dBm signal.

t. Step the generator, in 100 MHz intervals, through frequencies from 100 MHz to the maximum bandwidth. At each interval, determine the test result as follows:

- Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.
- Calculate the difference between the two readings. This is the test result.

u. In the test record, enter the greatest result determined within this frequency range (100 MHz to 3 GHz).

For models with the MSO3MDO 3 GHz option (steps v through y).

v. *Change the frequency range as follows:*

- Change the stop frequency to 3 GHz.
- Change the start frequency to 99 MHz.

w. Set the generator to provide a 100 MHz, +10 dBm signal.

x. *Step the generator, in 100 MHz intervals, through frequencies from 100 MHz to 3 GHz. At each interval, determine the test result as follows:*

- Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.
- Calculate the difference between the two readings. This is the test result.

y. In the test record, enter the greatest result determined within this frequency range (100 MHz to 3 GHz).

4. *Repeat the previous step with these changes:*

a. Set the reference level to 0 dBm.

b. Set the generator level to 0 dBm.

5. *Repeat the previous step with these changes:*

a. Set the reference level to –15 dBm.

b. Set the generator level to –15 dBm.

Functional Check of the MDO3000 with a TPA-N-PRE Attached to its RF Input

The following instructions apply to situations where the MDO3000 has a TPA-N-PRE preamplifier attached to its RF input

Perform the following functional check to ensure proper operation of the TPA-N-PRE/MDO3000 system.

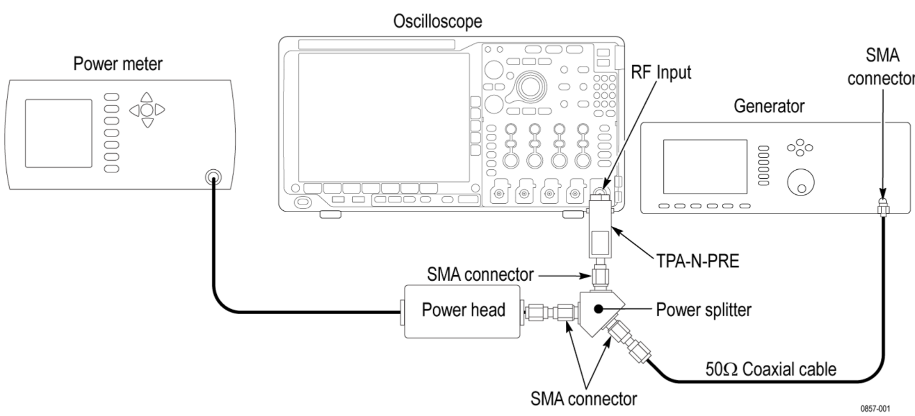
For this check, you will need the following equipment, which is described in the Required Equipment table. (See Table 18 on page 33.)

- Generator, such as the Anritsu generator
- Power meter
- Power head
- Power splitter
- Adapters and cables as shown in the following figure.

WARNING. *The generator is capable of providing dangerous voltages. Be sure to set the generator to off or 0 volts before connecting, disconnecting, and/or moving the test hookup during the performance of this procedure.*

NOTE. *Use an SMA connector with the Anritsu generator. Equipment damage will result if an N connector is used.*

1. *Connect the equipment as shown in the following figure.*



2. *Initial oscilloscope setup:*

   a. Push the front-panel **Default Setup** button.

   b. Push the front-panel **RF** button to turn on the RF channel.

   c. Push the Menu button on the TPA-N-PRE preamplifier. On the MDO3000, verify that the side-menu **Mode** button is set to **Auto**.

3. Check at 1.7 GHz

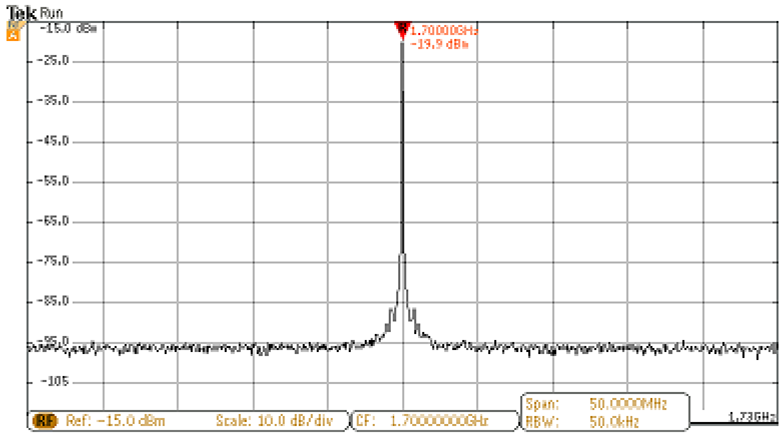
a. Set the reference level to –15 dBm as follows: Push the front-panel **Ampl** button. Push the side-bezel **Ref Level** button. Set the Ref Level to –15 dBm.

b. *Set the frequency range as follows:*

- Push the front-panel **Freq/Span** button.
- Push the side-bezel **Center Frequency** button.
- Set the center frequency to 1.7 GHz.
- Push the side-bezel **Span** button.
- Set the span to 50 MHz.

c. Set the generator to provide a 1.7 GHz, –20 dBm signal.

d. Note the reading on the power meter and the readout for the Reference marker on the oscilloscope. See the following figure:



e. The absolute difference between the two readings should be small (~ 1.5 dB or less). If the MDO3000 reading is too low, tighten the preamp more firmly to the MDO3000 by hand and check the reading again.

f. Check at the –30 dBm reference level.

- Set the generator to provide a 1.7 GHz, –35 dBm signal.
- Set the MDO3000’s reference level to –30 dBm.
- Compare the MDO3000 and the power meter readings as before. The absolute difference between the readings should be ~1.5 dB or less. If the MDO3000 reading is too low, tighten the preamp more firmly to the MDO3000 by hand and check the reading again.

4. Check at 2.9 GHz

a. Set the reference level to –15 dBm as follows: Push the front-panel **Ampl** button. Push the side-bezel **Ref Level** button. Set the Ref Level to –15 dBm.

b. *Set the frequency range as follows:*

- Set the center frequency to 2.9 GHz.
- Set the span to 50 MHz.

c. Set the generator to provide a 2.9 GHz, –20 dBm signal.

d. Note the reading on the power meter and the readout for the Reference marker on the oscilloscope.

e. The absolute difference between the two readings should be small (~ 1.5 dB or less). If the MDO3000 reading is too low, tighten the preamp more firmly to the MDO3000 by hand and check the reading again.

f. Check at the –30 dBm reference level.

- Set the generator to provide a 2.9 GHz, –35 dBm signal.
- Set the MDO3000’s reference level to –30 dBm.
- Compare the MDO3000 and the power meter readings as before. The absolute difference between the readings should be ~1.5 dB or less. If the MDO3000 reading is too low, tighten the preamp more firmly to the MDO3000 by hand and check the reading again.

This completes the procedure.

Check Displayed Average Noise Level (DANL) with a TPA-N-PRE Attached:

This test does not require an input signal.

The test measures the average internal noise level of the instrument, ignoring residual spurs.

It checks these ranges:

- 9 kHz to 50 kHz (all models)
- 50 kHz to 5 MHz (all models)
- 5 MHz to BW (MDO3SA not installed)
- 5 MHz to 2 GHz (MDO3SA installed)
- 2 GHz to 3 GHz (MDO3SA installed)

***NOTE.** If the specific measurement frequency results in measuring a residual spur that is visible above the noise level, the DANL specification applies not to the spur but to the noise level on either side of the spur. Please refer to the Spurious Response specifications.*

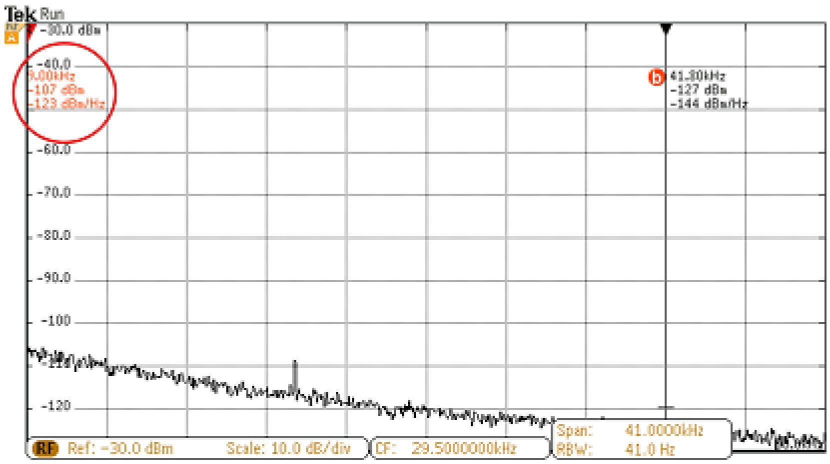
---

1. *Initial oscilloscope setup:*
   a. Terminate the TPA-N-PRE preamp input in 50 Ω and make sure that no input signal is applied.
   b. Push the front-panel **Default Setup** button.
   c. Push the front-panel **RF** button to turn on the RF channel and display the bottom-bezel RF menu.
   d. *Turn on the average trace as follows:*
      - Push the bottom-bezel **Spectrum Traces** button.
      - Push the side-bezel **Average** button to set average trace to **On**.
      - Set the side-bezel **Normal** to **Off**.
   d. *Turn on average detection as follows:*
      - Push the bottom-bezel **Detection Method** button.
      - Push the side-bezel button to set the detection method to **Manual**.
      - Push the side-bezel **Average Trace** button.
      - Set the detection method to **Average**.
   e. Push the **Menu** button on the TPA-N-PRE preamplifier. On the MDO3000, verify that the side-bezel **Mode** button is set to **Auto**.
   f. *Set the reference level to –30.0 dBm as follows:*
      - Push the front-panel **Ampl** button.
      - Push the side-bezel **Ref Level** button.
      - Set the Ref Level to –30.0 dBm.
2. *Check from 9 kHz to 50 kHz (all models):*
   a. *Set the stop and start frequencies as follows:*

- Push the front-panel **Freq/Span** button.
- Push the side-bezel **Stop** button.
- Set the stop frequency to 50 kHz.
- Push the side-bezel **Start** button.
- Set the start frequency to 9 kHz.
- Wait 60 seconds. Due to the low RBW for this span, it takes a little while for the instrument to compute a valid average.

b. Set Manual Marker (a) at the frequency with the highest noise level as follows:

- Push the **Markers** front-panel button.
- Push the **Manual Markers** side-bezel button to turn on the markers.
- Turn Multipurpose knob **a** to move the marker to the frequency at the noise threshold (highest point of noise), ignoring any spurs. See the following figure.



c. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.

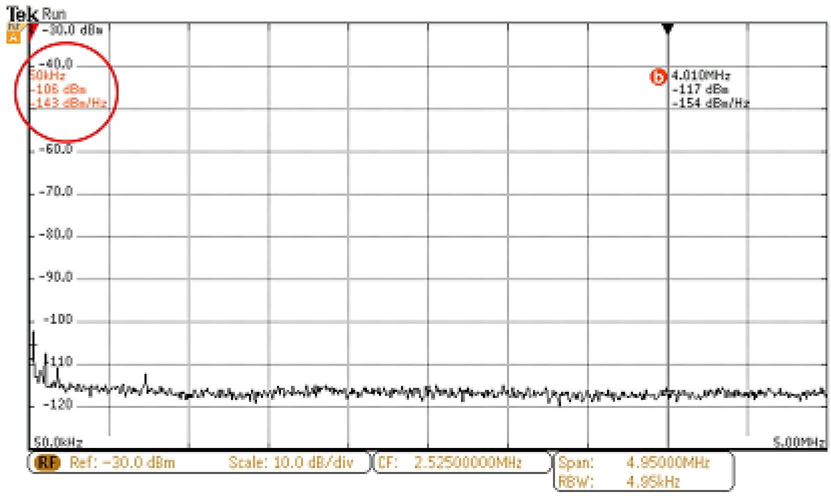
3. *Check from 50 kHz to 5 MHz (all models):*

a. *Set the start and stop frequency as follows:*

- Push the front-panel **Freq/Span** button.
- Push the side-bezel **Stop** button.
- Set the stop frequency to 5 MHz.
- Push the side-bezel **Start** button.
- Set the start frequency to 50 kHz.

b. *Set Manual Marker (a) at the frequency with the highest noise level as follows:*

- Push the **Markers** front-panel button.
- Push the **Manual Markers** side-bezel button to turn on the markers.
- Turn Multipurpose knob **a** to move the marker to the frequency at the noise threshold (highest point of noise), ignoring any spurs. See the following figure.



c. Record the noise threshold value (in dBm/Hz) in the test record and compare it to the instrument specification.

4. *Check from 5 MHz to BW (MDO3SA not installed)*
   a. Set the stop frequency to the maximum BW.
   b. Set the start frequency to 5 MHz.
   c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.
   d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.
   e. Set the Span to 10 MHz.
      - Push the side-bezel **Span** button.
      - Set the Span to 10 MHz.
   f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.
5. *Check from 5 MHz to 2 GHz (MDO3SA installed)*
   a. Set the stop frequency to 2 GHz.
   b. Set the start frequency to 5 MHz.
   c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.
   d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.
   e. Set the Span to 10 MHz.
      - Push the side-bezel **Span** button.
      - Set the Span to 10 MHz.
   f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.
6. *Check from 2 GHz to 3 GHz (MDO3SA installed):*
   a. Set the stop frequency to 3 GHz.
   b. Set the start frequency to 2 GHz.

c. Set Manual Marker (a) at the frequency of the highest noise, ignoring any spurs.

d. *Set the center frequency as follows:* Push the **R To Center** side-bezel button.

e. *Set the Span to 10 MHz as follows.*

- Push the side-bezel **Span** button.
- Set the Span to 10 MHz.

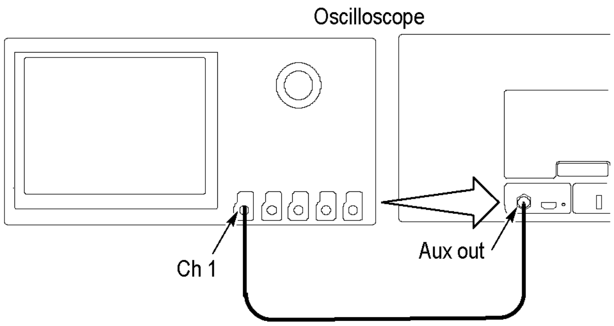
f. Record the highest noise value (in dBm/Hz) in the test record and compare it to the instrument specification.

This completes the procedure.

Check Auxiliary Output

This test checks the Auxiliary Output.

1. Connect the Aux Out signal from the rear of the instrument to the channel 1 input using a 50 Ω cable.



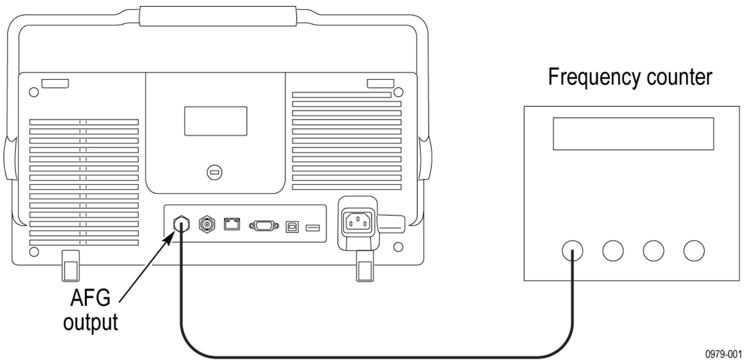
2. Push the **Default Setup** button on the front panel to set the instrument to the factory default settings.
3. Push the channel **1** button.
4. Set the oscilloscope termination to 1 MΩ. The default **Termination** setting is **1M Ω**.
5. Set the horizontal to 4 uS/div and the vertical to 1 V/div.
6. On the front panel, push the **Measure** button on the Wave Inspector.
7. Push **Add Measurement** on the lower menu.
8. Use **Multipurpose Knob "b"** to select **Low** in the Measurements menu, and then push **OK Add Measurement** on the side menu.
9. Use **Multipurpose Knob "b"** to select **High** in the Measurements menu, and then push **OK Add Measurement** on the side menu.
10. Push **Menu Off** on the front panel.
11. Record the high and low measurements in the test record (for example, low = 200 mV and high = 3.52 V). (See page 65, *Auxiliary (Trigger) Output Tests*.)
12. Repeat the procedure, using **50 Ω** instead of **1 MΩ** in step 4.

    This completes the procedure.

Check AFG Sine and Ramp Frequency

This test checks the AFG Sine and Ramp Frequency.

1. Connect AFG output to the frequency counter.

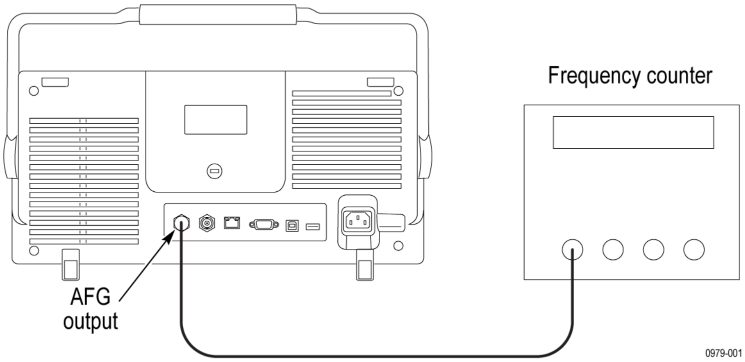


2. Push the **Default Setup** button on the oscilloscope front panel.
3. Push the **AFG** button on the front panel.
4. Under Waveform Settings, set amplitude and frequency to those shown in the test record.
5. Set Waveform to Sine wave (or Ramp).
6. Push **Output Settings** on the bottom menu. Push **Load Impedance** on the side menu to select **50 Ω**.
7. Measure frequency in the frequency counter. Compare results to the limits in the test record.
8. Repeat steps 3 - 7 above for all rows in the test record.

   This completes the procedure.

Check AFG Square and Pulse Frequency Accuracy

This test checks the AFG Square and Pulse Frequency Accuracy.



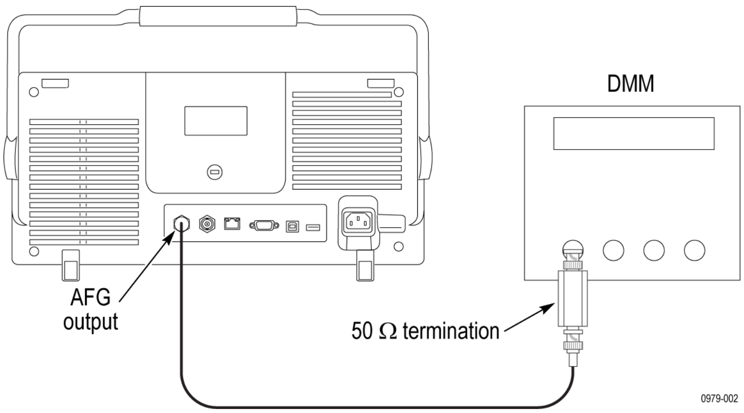
1. Connect the AFG output to the frequency counter.
2. Push the **Default Setup** button on the oscilloscope front panel.
3. Push the **AFG** button on the front panel.
4. Under Waveform Settings, set Amplitude and frequency to that shown in the test record.
5. Set output to Square wave (or Pulse).
6. Push **Output Settings** on the bottom menu. Push **Load Impedance** on the side menu to select **50 Ω**.
7. Measure frequency in the frequency counter. Compare results to the limits in the test record.
8. Repeat steps 3 - 7 for all rows in the test record.

   This completes the procedure.

Check AFG Signal Amplitude Accuracy

This test checks the AFG Signal Amplitude Accuracy.

1. Connect the AFG output to the DMM through a 50 Ω termination.



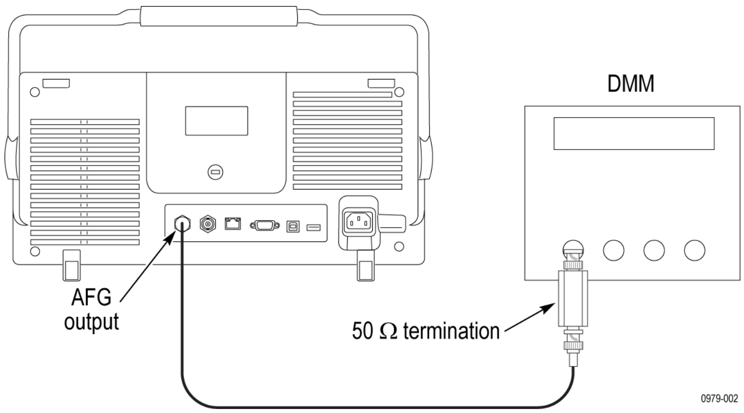
2. Push the **Default Setup** button on the oscilloscope front panel.
3. Push the **AFG** button on the front panel.
4. Under Waveform Settings, set amplitude and frequency to the value shown in the test record.
5. Under Waveform set the signal to Square.
6. Push **Output Settings** on the bottom menu. Push **Load Impedance** on the side menu to select **50 Ω**.
7. Measure voltage on the DMM. Compare the result to the limits in the test record.
8. Repeat steps 3 - 7 above for all rows in the test record.

   This completes the procedure.

Check AFG DC Offset Accuracy

This test checks the AFG DC Offset Accuracy.

1. Connect the AFG output to the DMM through a 50 Ω termination.



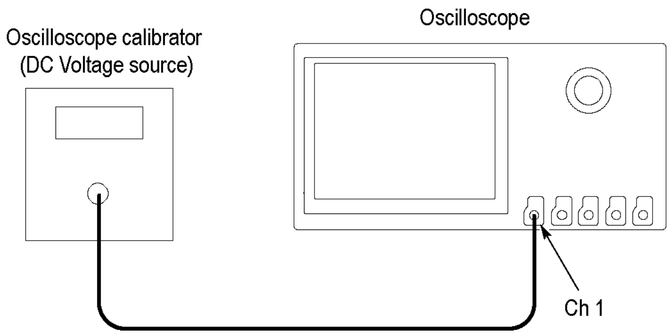
2. Push the **Default Setup** button on the oscilloscope front panel.
3. Push the **AFG** button on the front panel.
4. Under Waveform set the signal to DC.
5. Under Waveform Settings, set Amplitude to the value shown in the test record.
6. Push **Output Settings** on the bottom menu. Push **Load Impedance** on the side menu to select **50 Ω**.
7. Measure voltage on the DMM. Compare the value to the limits in the test record.
8. Repeat steps 3 - 7 above for each line in the test record.

   This completes the procedure.

Check DVM Voltage Accuracy (DC)

This test checks the DVM voltage accuracy (DC).

1. Connect the oscilloscope to a DC voltage source to run this test. If using the Fluke 9500 calibrator as the DC voltage source, connect the calibrator head to the oscilloscope channel to test.



2. Push the **Default Setup** button on the front panel to set the instrument to the factory default settings.
3. Push channel button **1**, **2**, **3**, or **4** to select the channel you want to check.
4. Confirm that the oscilloscope termination and calibrator impedance are both set to 1 MΩ. Push **Termination** on the lower menu to select **1 MΩ**.
5. Set the calibrator to the input voltage shown in the test record (for example, –5 V for a 1 V/div setting). Set the calibrator impedance to match the termination setting for the oscilloscope.
6. On the oscilloscope, push **More** on the lower menu repeatedly, to select **Offset**.
7. Set the oscilloscope to the vertical offset value shown in the test record (for example, –5 V for –5 V input and 1 V/div setting).
8. Turn the vertical **Scale** knob to match the value in the test record (for example, 1 V/division).
9. Turn the Horizontal **Scale** knob to 1 ms/div.
10. Push **Bandwidth** on the lower menu.
11. Push **20 MHz** on the side menu.
12. Check that the vertical position is set to 0 divs. If not, turn the appropriate **Vertical Position** knob to set the position to 0 divs.

    Or, push **More** on the lower menu repeatedly to select **Position**, and then push **Set to 0 divs** on the side menu.
13. Push **Acquire** on the front panel.
14. Push **Mode** on the lower menu, and then push **Average** on the side menu. Use the default number of averages (16).
15. Push the Trigger **Menu** button on the front panel.
16. Push **Source** on the lower menu.
17. Turn **Multipurpose knob “a”** to select **AC Line** as the trigger source.
18. On the front panel, push the **Measure** button.
19. Push the **DVM** lower-bezel button to turn on the DVM function.
20. Turn the **Multipurpose a** knob to select **DC** mode

21. Turn the **Multipurpose b** knob to select the input channel to be tested.

22. Push **Menu Off** on the front panel. The measured value should appear in a measurement pane at the top of the display.

23. Enter the measured value in the test record. (See page 67, *DVM Voltage Accuracy Tests (DC)*.)

24. Repeat the procedure (steps 6, 7, 8 and 22) for each volts/division setting shown in the test record.

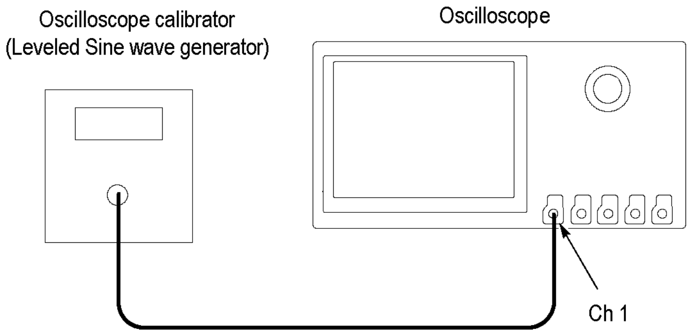
25. Repeat all steps, starting with step 1, for each oscilloscope channel you want to check.

This completes the procedure.

Check DVM Voltage Accuracy (AC)

This test checks the DVM voltage accuracy (AC).

1. Connect the output of the leveled sine wave generator (for example, Fluke 9500) to the oscilloscope channel 1 input as shown below.



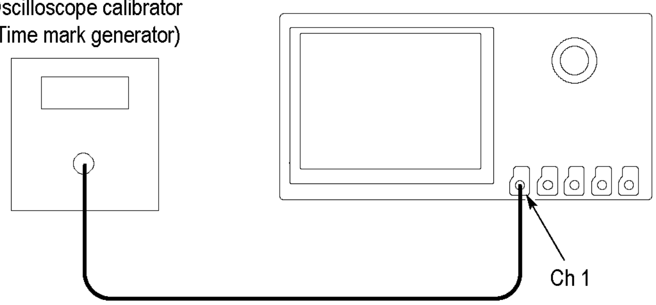
2. Push **Default Setup** on the front panel to set the instrument to the factory default settings.
3. Push channel button **1**, **2**, **3**, or **4** for the channel that you want to check.
4. Set the generator to 50 Ω output impedance (50 Ω source impedance).
5. Set the oscilloscope termination to 50 Ω. Push **Termination** on the lower menu to select **50 Ω**.
6. Set the generator to produce a square wave of the amplitude and frequency listed in the test record (for example, 20 mV_{pp} and 1 kHz).
7. Turn the vertical scale knob so that the signal covers between 4 and 8 vertical divisions on screen.
8. Push the **Measure** button, then the **DVM** lower-bezel button to turn on the DVM function.
9. Use the multipurpose knob **a** to select **AC RMS** mode
10. Use the multipurpose knob **b** to select the input channel being tested.
11. Enter the measured value in the test record.
12. Repeat procedure for each voltage and frequency combination shown in the record.
13. Repeat all steps for each oscilloscope channel.

    This completes the procedure.

Check DVM Frequency Accuracy and Maximum Input Frequency

This test checks DVM Frequency Accuracy.

1. Push **Default Setup** on the oscilloscope front panel to set the instrument to the factory default settings.
2. Connect the output of the time mark generator to the oscilloscope channel 1 input using a 50 Ω cable. Use the time mark generator with a 50 Ω source with the oscilloscope set for internal 50 Ω termination.



3. Set the time mark generator to the value shown in the test record. For example, use 9 Hz. Use a time mark waveform with a fast rising edge (square wave), except at 150 MHz use a sine wave.
4. Set the mark amplitude to 1 V_{pp}.
5. Set the oscilloscope vertical **Scale** to 200 mV/div.
6. Set the **Horizontal Scale** to 20 ms/div.
7. Adjust the **Trigger Level** for a triggered display.
8. Adjust the vertical **Position** knob to center the time mark on center screen.
9. Push the **Measure** button on the front panel, and then the **DVM** lower-bezel button to turn on the DVM feature.
10. Turn multipurpose knob **a** to select Frequency mode.
11. Turn multipurpose knob **b** to select the input channel being tested.
12. Enter the measured value in the test record.
13. Repeat this procedure for each frequency setting shown in the record. (Keep the same vertical and horizontal scales as set in steps 5 and 6.)
14. Repeat all these steps for each oscilloscope channel.

    This completes the procedure.

This completes the Performance Verification procedures