MSO4000 and DPO4000 Series
Digital Phosphor Oscilloscopes
Specifications and Performance Verification

Technical Reference

077-0247-01

Tektronix

MSO4000 and DPO4000 Series Digital Phosphor Oscilloscopes Specifications and Performance Verification

Technical Reference

Revision B

This document supports firmware version 2.00 and above for both MSO4000 Series instruments and DPO4000 Series instruments.

Warning

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

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- Worldwide, visit www.tektronix.com to find contacts in your area.

Table of Contents

List of Tables

General safety summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To avoid fire or personal injury

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

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

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.

The inputs are not rated for connection to mains or Category II, III, or IV circuits.

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 switch disconnects the product from the power source. See instructions for the location. Do not block the power switch; 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.*

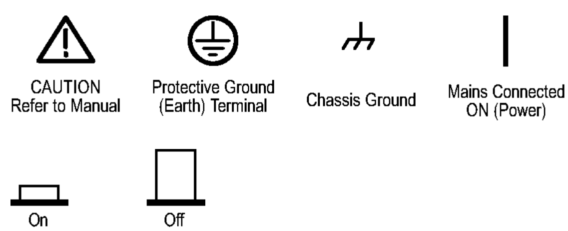
CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

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 DPO4000 and the MSO4000 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 are checked in *Performance Verification*.

All specifications apply to all DPO4000 and MSO4000 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 the *Tektronix 4000 Series Digital Phosphor Oscilloscopes User Manual* prior to evaluating specifications. If the operating temperature changes by more than 10 °C (18 °F), you must perform the SPC operation again.

Table 1: Analog channel input and vertical specifications

Characteristic	Description	
Number of input channels	*DPO4032, MSO4032*	*DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034*
	2 analog, digitized simultaneously	4 analog, digitized simultaneously
Input coupling	DC, AC, or GND GND coupling approximates ground reference by measuring the CVR output set to GND. The signal being measured on the BNC is not disconnected from the channel input load.	
Input resistance selection	1 MΩ or 50 Ω DPO4104, MSO4104: Bandwidth is limited to 500 MHz with 1 MΩ impedance selected.	
✔ Input impedance, DC coupled	1 MΩ ±1% in parallel with 13 pF ±2 pF 50 Ω ±1% DPO4104, MSO4104: VSWR ≤1.5:1 from DC to 1 GHz, typical DPO4054, MSO4054: VSWR ≤1.5:1 from DC to 500 MHz, typical DPO4034, DPO4032, MSO4034, MSO4032: VSWR ≤1.5:1 from DC to 350 MHz, typical	
Maximum input voltage (50 Ω)	5 V_{RMS} with peaks ≤ ±20 V (DF ≤ 6.25%)	
Maximum input voltage (1 MΩ)	The maximum input voltage at the BNC, between the center conductor and shield is 400 V_{peak} (DF ≤ 39.2%), 250 V_{RMS} to 130 kHz derated to 2.6 V_{RMS} at 500 MHz. The maximum transient withstand voltage is ±800 V_{peak}	
✔ DC Balance	0.2 div with the input DC 50 Ω 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 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	

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

Characteristic	Description			
Delay between channels, full bandwidth, typical	≤100 ps between any two channels with input impedance set to 50 Ω, DC coupling Note: all settings in the instrument can be manually time aligned using the Probe Deskew function from -100 ns to +100 ns with a resolution of 20 ps.			
Deskew range	-100 ns to +100 ns with a resolution of 20 ps			
Crosstalk (channel isolation), typical	≥100:1 at ≤100 MHz and ≥30:1 at >100 MHz up to the rated bandwidth for any two channels having equal Volts/Div settings			
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 all front panel inputs including Aux In. Aux In only provides 1 MΩ input impedance and does not offer 50 Ω as do the other input channels.			
Total probe power	DPO4032, DPO4034, DPO4054, MSO4032, MSO4034, MSO4054: 50 W DPO4104, MSO4104: 50 W with a derating of 0.8 W/°C for ambient temperatures ≥25 °C			
Probe power per channel	*Voltage*	*Max Amperage*	*Voltage Tolerance*	
	5 V	50 mA (250 mW)	±5%	
	12 V	2 A (24 W)	±10%	
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 MΩ*		*50 Ω*	
	1 mV/div to 10 V/div in a 1-2-5 sequence		1 mV/div to 1 V/div in a 1-2-5 sequence	
Sensitivity range (fine)	1 mV/div to 5 V/div: <-50% to >+50% of selected setting, 1 MΩ 10 V/div: <-50% to 0%, 1 M Ω 1 mV/div to 500 mV/div: <-50% to >+50% of selected setting, 50 Ω 1 V/div: <-50% to 0%, 50 Ω Allows continuous adjustment from 1 mV/div to 10 V/div, 1 M 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			
✓ Analog bandwidth, 50 Ω	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	*5 mV/div to 1 V/div*	*2 mV/div to 4.98 mV/div*	*1 mV/div to 1.99 mV/div*
	DPO4104, MSO4104	DC to 1 GHz	DC to 350 MHz	DC to 200 MHz
	DPO4054, MSO4054	DC to 500 MHz	DC to 350 MHz	DC to 200 MHz
	Instrument	*2 mV/div to 1 V/div*		*1 mV/div to 1.99 V/div*
	DPO4034, MSO4034	DC to 350 MHz		DC to 200 MHz
	DPO4032, MSO4032	DC to 350 MHz		DC to 200 MHz

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

Characteristic	Description			
Analog bandwidth, 1 MΩ with P6139A 10X 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	*50 mV/div to 100 V/div*	*20 mV/div to 49.8 mV/div*	*10 mV/div to 19.9 mV/div*
	DPO4104, MSO4104	DC to 500 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4054, MSO4054	DC to 500 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4034, MSO4034	DC to 350 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4032, MSO4032	DC to 350 MHz	DC to 300 MHz	DC to 175 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.			
	Instrument	*50 Ω : 1 mV/div to 1.99 mV/div*	*50 Ω : 2 mV/div to 4.99 mV/div*	*50 Ω : 5 mV/div to 1 V/div*
	DPO4104, MSO4104	1.75 ns	778 ps	350 ps
	DPO4054, MSO4054	1.75 ns	778 ps	700 ps
	DPO4034, MSO4034	1.75 ns	1 ns	1 ns
	DPO4032, MSO4032	1.75 ns	1 ns	1 ns
	Instrument	*1 MΩ (P6139A probe): 10 mV/div to 19.9 mV/div*	*1 MΩ (P6139A probe): 20 mV/div to 100 V/div*	
	DPO4104, MSO4104	1 ns	700 ps	
	DPO4054, MSO4054	1 ns	700 ps	
	DPO4034, MSO4034	1 ns	1 ns	
	DPO4032, MSO4032	1 ns	1 ns	
Analog bandwidth selections	20 MHz, 250 MHz and Full (all models)			
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 limited, typical	250 MHz, ±20% (all models)			
Upper frequency limit, 20 MHz bandwidth limited, typical	20 MHz, ±20% (all models)			
✓ DC gain accuracy	For 1 MΩ path:		For 50 Ω path:	
	±1.5%, derated at 0.100%/°C above 30 °C ±3.0% Variable Gain, derated at 0.100%/°C above 30 °C		±1.5%, derated at 0.050%/°C above 30 °C ±3.0% Variable Gain, derated at 0.050%/°C above 30 °C	

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

Characteristic	Description		
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. 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, Pk-Pk, and Amplitude.		
Offset ranges	*Volts/div setting*	*Offset range*	
		1 MΩ input	50 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	±10 V
	505 mV/div to 995 mV/div	±5 V	±5 V
	1 V/div to 5 V/div [1]	±100 V	±5 V
	5.05 V/div to 10 V/div [1]	±50 V	Not applicable
	Input Signal cannot exceed Max Input Voltage for the 50 Ω input path. Refer to the Max Input Voltage specification for more information.		
Offset accuracy	±[0.005 × | 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.		

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

Characteristic	Description			
✓ Random Noise, Sample Acquisition Mode			RMS Noise	
	Model	Bandwidth selection	1 MΩ	50 Ω
	DPO4104	Full Bandwidth	≤(133 μV + 7.3% of Volts/div Setting)	≤(72.3 μV + 6% of Volts/div Setting)
		250 MHz	≤(99.5 μV + 5.0% of Volts/div Setting)	≤(49.6 μV + 3.7% of Volts/div Setting)
		20 MHz	≤(20.8 μV + 3.3% of Volts/div Setting)	≤(12.8 μV + 3.3% of Volts/div Setting)
	DPO4054	Full Bandwidth	≤(130 μV + 7.6% of Volts/div Setting)	≤(77.9 μV + 3.1% of Volts/div Setting)
		250 MHz	≤(96.2 μV + 5.2% of Volts/div Setting)	≤(56.7 μV + 3.3% of Volts/div Setting)
		20 MHz	≤(22.7 μV + 3.8% of Volts/div Setting)	≤(13.6 μV + 3.3% of Volts/div Setting)
	DPO4034	Full Bandwidth	≤(139 μV + 6.4% of Volts/div Setting)	≤(77.7 μV + 3.3% of Volts/div Setting)
		250 MHz	≤(94.0 μV + 4.8% of Volts/div Setting)	≤(76.6 μV + 3.2% of Volts/div Setting)
		20 MHz	≤(22.3 μV + 3.4% of Volts/div Setting)	≤(16.0 μV + 3.1% of Volts/div Setting)
	DPO4032	Full Bandwidth	≤(141 μV + 7.2% of Volts/div Setting)	≤(81.6 μV + 3.1% of Volts/div Setting)
		250 MHz	≤(87.9 μV + 4.9% of Volts/div Setting)	≤(73.8 μV + 3.9% of Volts/div Setting)
		20 MHz	≤(18.5 μV + 3.1% of Volts/div Setting)	≤(12.7 μV + 3.6% of Volts/div Setting)
Aperture uncertainty	≤(3 ps + 0.1 ppm × Record Duration)$_{RMS}$, for records having duration ≤1 minute			

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

Characteristic	Description
✓ Delta Time Measurement Accuracy	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) SR_1 = Slew Rate (1st Edge) around 1st point in measurement SR_2 = Slew Rate (2nd Edge) around 2nd point in measurement N = input-referred noise ($volts_{rms}$, Refer to Random Noise, Sample Acquisition Mode) TBA = timebase accuracy (5 ppm, Refer to Long-term sample rate and delay time accuracy) $t_{reading}$ = delta-time measurement duration (sec) RecordDuration = (Record Length) / (Sample Rate)

$$DTA_{PP} =$$

$$5 \times \sqrt{\left(\frac{N}{SR_1}\right)^2 + \left(\frac{N}{SR_2}\right)^2 + (3\,ps + 1\,E^{-7} \times RecordDuration)^2 + \left[\frac{0.25 \times t_{samplerate}}{\sqrt{12}}\right]^2} + TBA \times t_{reading}$$

$$DTA_{RMS} =$$

$$\sqrt{\left(\frac{N}{SR_1}\right)^2 + \left(\frac{N}{SR_2}\right)^2 + (3\,ps + 1\,E^{-7} \times RecordDuration)^2 + \left[\frac{0.25 \times t_{samplerate}}{\sqrt{12}}\right]^2} + TBA \times t_{reading}$$

Assumes that error due to aliasing is insignificant

The term under the square-root sign is the stability, and is due to TIE (Time Interval Error). The errors due to this term occur throughout a single-shot measurement. The second term is due to both the absolute center-frequency accuracy and the center-frequency stability of the time base 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).

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

Table 2: Digital channel input specifications, MSO4000 only

Characteristic	Description
Threshold voltage range	-2 V to +5 V
✓ Digital threshold accuracy	±[100 mV + 3% of the threshold setting after calibration]
Timing resolution	2 ns for the main memory and 60.6 ps for MagniVu memory

Table 3: Horizontal and acquisition system specifications

Characteristic	Description	
✓ Long-term sample rate and delay time accuracy	±5 ppm over any ≥1 ms time interval	
Seconds/Division range Record Length	*DPO4104, MSO4104*	*DPO4054, DPO4034, DPO4032, MSO4054, MSO4034, MSO4032*
1 K	400 ps – 40 s	1 ns – 40 s
10 K	400 ps – 400 s	1 ns – 400 s
100 K 1 M 10 M	400 ps – 1,000 s	1 ns – 1,000 s
	1-2-4 sequence	1-2-4 sequence except one position in each record length selection, which is 0.8-2-4.
Peak Detect or Envelope mode pulse response, typical	*Minimum pulse width* DPO4104, MSO4104: > 200 ps DPO4054, DPO4034, DPO4032, MSO4054, MSO4034, MSO4032: > 400 ps	
Sample-rate range	DPO4104, MSO4104: 5 GS/s-0.1 S/s DPO4054, DPO4034, DPO4032, MSO4054, MSO4034, MSO4032: 2.5 GS/s – 0.1 S/s	
Record length range	10 M, 1 M, 100 k, 10 k, 1 k	
Maximum update rate	Maximum triggered acquisition rate: 50,000 wfm/s	
Aperture Uncertainty, typical	≤(3 ps + 0.1 ppm × record duration)$_{RMS}$, for records having duration ≤1 minute	
Number of Waveforms for Average Acquisition Mode	2 to 512 waveforms Default of 16 waveforms	

Table 4: Trigger specifications

Characteristic	Description	
Aux In (External) trigger maximum input voltage	The maximum input voltage at the BNC, between center conductor and shield, is 400 V_{peak} (DF ≤39.2%), 250 V_{RMS} to 2 MHz derated to 5 V_{RMS} @ 500 MHz. The maximum transient withstand voltage is ±800 V_{peak}.	
Aux In (External) trigger input impedance, typical	1 M Ω ±1% in parallel with 13 pF ±2 pF	
Aux In (External) trigger bandwidth, typical	250 MHz ±20%	
Trigger bandwidth, Edge, Pulse, and Logic, typical	DPO4104, MSO4104: 1 GHz DPO4054, MSO4054: 500 MHz DPO4034, DPO4032, MSO4034, MSO4032: 350 MHz	
Time accuracy for Pulse, Glitch, Timeout, or Width triggering	*Time range*	*Accuracy*
	1 ns to 500 ns	±(20% of setting + 0.5 ns)
	520 ns to 1 s	±(0.01% of setting + 100 ns)

Table 4: Trigger specifications (cont.)

Characteristic	Description	
Edge-type trigger sensitivity, DC coupled, typical	*Trigger Source*	*Sensitivity*
	Any input channel	0.40 div from DC to 50 MHz, increasing to 1 div at oscilloscope bandwidth
	Aux in (External)	200 mV from DC to 50 MHz, increasing to 500 mV at 250 MHz
	Line	Fixed
Edge trigger sensitivity, not DC coupled, typical	*Trigger Coupling*	*Typical Sensitivity*
	NOISE REJ	2.5 times the DC-coupled limits
	HF REJ	1.5 times the DC-coupled limit from DC to 50 kHz. Attenuates signals above 50 kHz
	LF REJ	1.5 times the DC-coupled limits for frequencies above 50 kHz. Attenuates signals below 50 kHz
Trigger level ranges	*Source*	*Sensitivity*
	Any input channel	±8 divisions from center of screen, ±8 divisions from 0 V when vertical LF reject trigger coupling is selected
	Aux In (External)	±8 V
	Line	Not applicable
	The line trigger level is fixed at about 50% of the line voltage. This specification applies to logic and pulse thresholds.	
Lowest frequency for successful operation of "Set Level to 50%" function, typical	45 Hz	
Trigger level accuracy, DC coupled typical	For signals having rise and fall times ≥10 ns, the limits are as follows:	
	Source	*Range*
	Any channel	±0.20 divisions
	Aux In (external trigger)	±(10% of setting + 25 mV)
	Line	Not applicable
Trigger holdoff range	20 ns minimum to 8 s maximum	
Video-type trigger sensitivity, typical	The limits for both delayed and main trigger are as follows:	
	Source	*Sensitivity*
	Any input channel	0.6 to 2.5 divisions of video sync tip
	Aux In (External)	Video not supported through Aux In (External) input
Video-type trigger formats and field rates	Triggers from negative sync composite video, field 1 or field 2 for interlaced systems, on any field, specific line, or any line for interlaced or non-interlaced systems. Supported systems include NTSC, PAL, and SECAM.	

Table 4: Trigger specifications (cont.)

Characteristic	Description			
Logic-type or logic qualified trigger or events-delay sensitivities, DC coupled, typical	1.0 division from DC to maximum bandwidth			
Pulse-type runt trigger sensitivities, typical	1.0 division from DC to maximum bandwidth			
Pulse-type trigger width and glitch sensitivities, typical	1.0 division			
Logic-type triggering, minimum logic or rearm 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	1 ns
	Time Qualified Logic	4 ns	2 ns	1 ns
Minimum clock pulse widths for setup/hold time violation trigger, typical	For all vertical settings, the minimums are:			
	Minimum pulse width, clock active [2]		*Minimum pulse width, clock inactive* [2]	
	User hold time + 2.5 ns [3]		2 ns	
Setup/hold violation trigger, setup and hold time ranges, DPO4000 only	*Feature*	*Min*	*Max*	
	Setup time	0 ns	8 s	
	Hold time	4 ns	8 s	
	Setup + Hold time	4 ns	16 s	
MSO4000 only	*Feature*	*Min*	*Max*	
	Setup time	-0.5 ns	1.0 ms	
	Hold time	1 ns	1.0 ms	
	Setup + Hold time	0.5 ns	2.0 ms	
	Input coupling on clock and data channels must be the same. 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. Setup + Hold time is the algebraic sum of the Setup Time and the Hold Time programmed by the user.			

Table 4: Trigger specifications (cont.)

Characteristic	Description		
Pulse type trigger, minimum pulse, rearm time, minimum transition time	*Pulse class*	*Minimum pulse width*	*Minimum rearm time*
	Glitch	4 ns	2 ns + 5% of glitch width setting
	Runt	4 ns	2 ns
	Time-qualified runt	4 ns	8.5 ns + 5% of width setting
	Width	4 ns	2 ns + 5% of width upper limit setting
	Slew rate	4 ns	8.5 ns + 5% of delta time setting
	For the trigger class width and the trigger class runt, the pulse width refers to the width of the pulse being measured. The rearm time refers to the time between pulses. For the trigger class slew rate, the 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.		
Transition time trigger, delta time range	4 ns to 8 s		
Time range for glitch, pulse width, timeout, time-qualified runt, or time-qualified window triggering	4 ns to 8 s		
B trigger after events, minimum pulse width and maximum event frequency, typical	4 ns, 500 MHz		
B trigger, minimum time between arm and trigger, typical	4 ns For trigger after time, this is the time between the end of the time period and the B trigger event. For trigger after events, this is the time between the last A trigger event and the first B trigger event.		
B trigger after time, time range	4 ns to 8 seconds		
B trigger after events, event range	1 to 9,999,999		
Maximum serial trigger bits	128 bits		
Standard Parallel bus interface triggering (MSO4000 only)	Data Trigger: 1 to 20 bits of user specified data on 4-channel models and 1 to 18 bits of user specified data on 2-channel models.		

Table 4: Trigger specifications (cont.)

Characteristic	Description
Standard serial bus interface triggering	
I^2C	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, Data, or Address and Data
	Maximum Data Rate: 10 Mbps
SPI	Data Trigger: 1 to 16 bytes of user specified data
	Trigger On: SS Active, Start of Frame, MOSI, MISO, or MOSI and MISO
	Maximum Data Rate: 10 Mbps
CAN	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, or Bit Stuffing Error
	Frame Type: Data, Remote, Error, Overload
	Identifier: Standard (11 bit) and Extended (29 bit) identifiers
	Maximum Data Rate: 1 Mbps
RS-232	Trigger On: Tx Start Bit, Rx Start Bit, Tx End of Packet, Rx End of Packet, Tx Data, Rx Data, Tx Parity Error, or Rx Parity Error
	Maximum Data Rate: 10 Mbps
LIN [4]	Identifier Trigger: 6 bits of user-specified data, equal to (=)
	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 (>=), inside range, or outside range
	Error: Sync, Identifier Parity, Checksum
	Trigger On: Sync, Identifier, Data, ID & Data, Wakeup Frame, Sleep Frame, or Error
	Maximum Data Rate: 100 kbps

Table 4: Trigger specifications (cont.)

Characteristic	Description
FlexRay [4]	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, or Outside Range Cycle Count Trigger: 6 bits of user-specified data, equal to (=) Header Fields Trigger: 40 bits of user-specified data comprising Indicator Bits, Identifier, Payload Length, Header CRC, Cycle Count, or equal to (=) Data Trigger: 1 to 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 Maximum Data Rate: 10 Mbps
I^{2}S [4]	**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 Mbps
Left Justified [4]	**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 Mbps
Right Justified [4]	**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 Mbps
TDM [4]	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 Mbps

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 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 lower-bezel button and the Clock Edge side-bezel 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 Times lower-bezel button and the Hold Time side-bezel menu.

4 DPO4000 Series: S/N CO20000/B020000 and above; MSO4000 Series: all units.

Table 5: Display specifications

Characteristic	Description
Display type	Display area: 210.4 mm (8.28 inches) (H) x 157.8 mm (6.21 inches) (V), 264 mm (10.4 inches) diagonal, 6-bit RGB full color, XGA (1024 x 768) TFT liquid crystal display (LCD).
Display resolution	1000 horizontal by 651 vertical displayed pixels
Luminance, typical	Minimum 240 cd/m^2, typical 300 cd/m^2
Waveform display color scale	The TFT display can support up to 262,144 colors. A subset of these colors are used for the oscilloscope display, all of which are fixed colors and not changeable by the customer.

Table 6: Input/Output port specifications

Characteristic	Description	
Ethernet interface	Standard on all models: 10/100 Mbps	
USB interface	1 Device and 3 Host connectors (all models)	
GPIB interface	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.	
Video signal output	A 15 pin, XGA RGB-type connector	
Probe compensator output voltage and frequency, typical	Output voltage: 0 V to 2.5 V ±1% behind 1 kΩ ±2% Frequency: 1 kHz ±5%	
Trigger (Auxiliary) output (AUX OUT)	LOW TRUE; LOW to HIGH transition indicates that the trigger occurred. The logic levels are:	
	Characteristic	*Limits*
	Vout (HI)	≥2.5 V open circuit; ≥1.0 V into a 50 Ω load to ground
	Vout (LO)	≤0.7 V into a load of ≤4 mA; ≤0.25 V into a 50 Ω load to ground

Table 7: Power source specifications

Characteristic	Description
Source voltage	100 V to 240 V ±10%
Source frequency	(90 V to 264 V) 47 Hz to 66 Hz (100 V to 132 V) 360 Hz to 440 Hz
Fuse rating	T6.3AH, 250 V The fuse is not customer replaceable.

Table 8: 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		
Compact Flash card	Used to store reference waveforms and front-panel settings		
	Supply Voltage	*Form factor*	*Data bits*
	Switched 3.3 V only	Type 1 only	16 bit data transfer

Table 9: Environmental specifications

Characteristic	Description
Temperature	Operating: 0 °C to +50 °C (+32 °F to +122 °F) Nonoperating: -20 °C to +60 °C (-4 °F to +140 °F)
Humidity	Operating: High: 10% to 60% relative humidity, 40 °C to 50 °C (104 °F to 122 °F) Low: 10% to 90% relative humidity, 0 °C to 40 °C (32 °F to 104 °F) Nonoperating: High: 5% to 60% relative humidity, 40 °C to 60 °C (104 °F to 140 °F) Low: 5% to 90% relative humidity, 0 °C to 40 °C (32 °F to 104 °F)
Altitude	Operating: 3,000 m (9,843 ft) Nonoperating: 12,000 m (39,370 ft)
Pollution Degree	Pollution Degree 2, indoor use only
Random vibration	Operating: 0.31 g_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis, 3 axes Nonoperating: 2.46 g_{RMS} from 5 Hz to 500 Hz, 10 minutes on each axis, 3 axes (30 minutes total).

Table 10: Mechanical specifications

Characteristic	Description
Dimensions	Nominal, non-rackmount: Height: 229 mm (9.0 in), including feet: 272 mm (10.7 in), including vertical handle and feet Width: 439 mm (17.3 in) from handle hub to handle hub Depth: 137 mm (5.4 in) from feet to front of knobs 145 mm (5.7 in) from feet to front of front cover Nominal, rackmount (5U rack sizes): Height: 218 mm (8.6 in) Width: 488 mm (19.2 in) from outside of handle to outside of handle Depth: 559 mm (22.0 in) from outside of handle to back of slide
Weight	5.1 kg (11.3 lbs), stand-alone instrument, without front cover 8.7 kg (19.1 lbs), instrument with rackmount, without front cover 9.5 kg (21.0 lbs), when packaged for domestic shipment and without rackmount
Clearance Requirements	The clearance requirement for adequate cooling is: 50.8 mm (2 in) on the left side (when looking at the front of the instrument) and on the rear of the unit

Table 11: P6516 Digital Probe specifications

Characteristic	Description
Number of channels	16
Threshold accuracy	±(100 mV + 3% of threshold)
Maximum signal swing	6.0 V peak-to-peak centered around the threshold voltage
Minimum signal swing	500 mV peak-to-peak
Input resistance	20 kΩ
Input capacitance	3.0 pF typical
Temperature	Operating: 0 °C to +50 °C (+32 °F to +122 °F) Nonoperating: -55 °C to +75 °C (-67 °F to +167 °F)
Altitude	Operating: 4,500 m (15,000 ft) Nonoperating: 15,000 m (50,000 ft)
Pollution Degree	2, indoor use only
Humidity	10% to 95% relative humidity

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.

Description	Minimum requirements	Examples
DC voltage source	3 mV to 4 V, ±0.1% accuracy	Fluke 9500 Oscilloscope Calibrator with a 9510 Output Module An appropriate BNC-to-0.1 inch pin adapter between the Fluke 9500 and P6516 probe
Leveled sine wave generator	50 kHz to 1000 MHz, ±4% amplitude accuracy	
Time mark generator	80 ms period, ±1 ppm accuracy, rise time < 50 ns	
Digital Multimeter (DMM)	0.1% accuracy or better	
One 50 Ω BNC cable	Male-to-male connectors	Tektronix part number 012-0057-01
One BNC to 0.1 inch pin adapter	Female BNC to 2x16 0.1 inch pin headers	Tektronix part number 679-6240-00

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

These procedures cover all DPO4000 and MSO4000 models. Please disregard 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 *Tektronix 4000 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 up a Web browser and go to www.tektronix.com/software. Use the Software and Firmware Finder 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.*

   The oscilloscope displays a message when the installation is complete.

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

Test Record

Model	Serial	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Input Impedance

Performance checks	Vertical scale	Low limit	Test result	High limit
All models:				
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 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
DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034:				
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 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
Channel 4, Input Impedance, 50 Ω	10 mV/div	49.5 Ω		50.5 Ω
	100 mV/div	49.5 Ω		50.5 Ω

DC Balance

Performance checks	Vertical scale	Low limit	Test result	High limit
All models:				
Channel 1 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV

DC Balance

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 1 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 1 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 1 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 1 DC Balance, 50 Ω, Full BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 1 DC Balance, 1 MΩ, Full BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 2 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 2 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 2 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 2 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 2 DC Balance, 50 Ω, Full BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV

DC Balance

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 2 DC Balance, 1 MΩ, Full BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034:				
Channel 3 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 3 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 3 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 3 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 3 DC Balance, 50 Ω, Full BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 3 DC Balance, 1 MΩ, Full BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 4 DC Balance, 50 Ω, 20 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 4 DC Balance, 1 MΩ, 20 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 4 DC Balance, 50 Ω, 250 MHz BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV

DC Balance

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 4 DC Balance, 1 MΩ, 250 MHz BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 4 DC Balance, 50 Ω, Full BW	1 mV/div	-0.5 mV		0.5 mV
	2 mV/div	-0.5 mV		0.5 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV
Channel 4 DC Balance, 1 MΩ, Full BW	1 mV/div [1]	-0.3 mV		0.3 mV
	100 mV/div	-20 mV		20 mV
	1 V/div	-200 mV		200 mV

1 Immediately after calibration, the specification is -0.2 div to 0.20 div. For performance verification testing, the specification is -0.3 to 0.3 div.

Performance checks: Bandwidth

Bandwidth at Channel	Impedance	Vertical scale	V_{in-pp}	V_{bw-pp}	Limit	Test result Gain = V_{bw-pp}/V_{in-pp}
All models:						
1	50 Ω	5 mV/div			≥ 0.707	
1	50 Ω	2 mV/div			≥ 0.707	
1	50 Ω	1 mV/div			≥ 0.707	
1	1 MΩ	5 mV/div			≥ 0.707	
1	1 MΩ	2 mV/div			≥ 0.707	
1	1 MΩ	1 mV/div			≥ 0.707	
2	50 Ω	5 mV/div			≥ 0.707	
2	50 Ω	2 mV/div			≥ 0.707	
2	50 Ω	1 mV/div			≥ 0.707	
2	1 MΩ	5 mV/div			≥ 0.707	
2	1 MΩ	2 mV/div			≥ 0.707	
2	1 MΩ	1 mV/div			≥ 0.707	
DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034:						
3	50 Ω	5 mV/div			≥ 0.707	
3	50 Ω	2 mV/div			≥ 0.707	
3	50 Ω	1 mV/div			≥ 0.707	
3	1 MΩ	5 mV/div			≥ 0.707	
3	1 MΩ	2 mV/div			≥ 0.707	
3	1 MΩ	1 mV/div			≥ 0.707	
4	50 Ω	5 mV/div			≥ 0.707	

Performance checks: Bandwidth						
Bandwidth at Channel	Impedance	Vertical scale	V_{in-pp}	V_{bw-pp}	Limit	Test result Gain = V_{bw-pp}/V_{in-pp}
4	50 Ω	2 mV/div			≥ 0.707	
4	50 Ω	1 mV/div			≥ 0.707	
4	1 MΩ	5 mV/div			≥ 0.707	
4	1 MΩ	2 mV/div			≥ 0.707	
4	1 MΩ	1 mV/div			≥ 0.707	

DC Gain Accuracy

Performance checks	Vertical scale	Low limit	Test result	High limit
All models:				
Channel 1 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 50 Ω	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	4.98 mV	-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%
	1.0 V/div	-1.5%		1.5%
Channel 1 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	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%

DC Gain Accuracy

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 2 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 50 Ω	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	4.98 mV	-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%
	1.0 V/div	-1.5%		1.5%
Channel 2 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	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%
DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034:				
Channel 3 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 50 Ω	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	4.98 mV	-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%
	1.0 V/div	-1.5%		1.5%

DC Gain Accuracy

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 3 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	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 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 50 Ω	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	4.98 mV	-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%
	1.0 V/div	-1.5%		1.5%
Channel 4 DC Gain Accuracy, 0 V offset, 0 V vertical position, 20 MHz BW, 1 MΩ	1 mV/div	-1.5%		1.5%
	2 mV/div	-1.5%		1.5%
	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%

DC Offset Accuracy

Performance checks	Vertical scale	Vertical offset [1]	Low limit	Test result	High limit
All models:					
Channel 1 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div	900 mV	895.0 mV		905.0 mV
	1 mV/div	-900 mV	-905.0 mV		-895.0 mV
	2 mV/div	500 mV	497.0 mV		503.0 mV
	2 mV/div	-500 mV	-503.0 mV		-497.0 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
Channel 1 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div	900 mV	895.2 mV		904.8 mV
	1 mV/div	-900 mV	-904.8 mV		-895.2 mV
	2 mV/div	500 mV	497.1 mV		502.9 mV
	2 mV/div	-500 mV	-502.9 mV		-497.1 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
	1.01 V/div	99.5 V	98.80 V		100.2 V
	1.01 V/div	-99.5 V	-100.2 V		-98.80 V
Channel 2 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div	900 mV	895.0 mV		905.0 mV
	1 mV/div	-900 mV	-905.0 mV		-895.0 mV
	2 mV/div	500 mV	497.0 mV		503.0 mV
	2 mV/div	-500 mV	-503.0 mV		-497.0 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
Channel 2 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div	900 mV	895.2 mV		904.8 mV
	1 mV/div	-900 mV	-904.8 mV		-895.2 mV
	2 mV/div	500 mV	497.1 mV		502.9 mV
	2 mV/div	-500 mV	-502.9 mV		-497.1 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
	1.01 V/div	99.5 V	98.80 V		100.2 V
	1.01 V/div	-99.5 V	-100.2 V		-98.80 V

DC Offset Accuracy

Performance checks	Vertical scale	Vertical offset [1]	Low limit	Test result	High limit
DPO4104, DPO4054, DPO4034, MSO4104, MSO4054, MSO4034:					
Channel 3 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div	900 mV	895.0 mV		905.0 mV
	1 mV/div	-900 mV	-905.0 mV		-895.0 mV
	2 mV/div	500 mV	497.0 mV		503.0 mV
	2 mV/div	-500 mV	-503.0 mV		-497.0 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.04.5 V		-4.955 V
Channel 3 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div	900 mV	895.2 mV		904.8 mV
	1 mV/div	-900 mV	-904.8 mV		-895.2 mV
	2 mV/div	500 mV	497.1 mV		502.9 mV
	2 mV/div	-500 mV	-502.9 mV		-497.1 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
	1.01 V/div	99.5 V	98.80 V		100.2 V
	1.01 V/div	-99.5 V	-100.2 V		-98.80 V
Channel 4 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div	900 mV	895.0 mV		905.0 mV
	1 mV/div	-900 mV	-905.0 mV		-895.0 mV
	2 mV/div	500 mV	497.0 mV		503.0 mV
	2 mV/div	-500 mV	-503.0 mV		-497.0 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.5 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V

DC Offset Accuracy

Performance checks	Vertical scale	Vertical offset [1]	Low limit	Test result	High limit
Channel 4 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div	900 mV	895.2 mV		904.8 mV
	1 mV/div	-900 mV	-904.8 mV		-895.2 mV
	2 mV/div	500 mV	497.1 mV		502.9 mV
	2 mV/div	-500 mV	-502.9 mV		-497.5 mV
	10 mV/div	500 mV	495.5 mV		504.5 mV
	10 mV/div	-500 mV	-504.5 mV		-495.1 mV
	100 mV/div	5.0 V	4.955 V		5.045 V
	100 mV/div	-5.0 V	-5.045 V		-4.955 V
	1.01 V/div	99.5 V	98.80 V		100.2 V
	1.01 V/div	-99.5 V	-100.2 V		-98.80 V

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

Performance checks		Low limit	Test result	High limit
Sample Rate and Delay Time Accuracy		-1 divisions		+1 divisions
Auxiliary (Trigger) Output				
Trigger Output	High 1 MΩ	≥ 2.5 V		–
	Low 1 MΩ	–		≤ 0.7 V
Trigger Output	High 50 Ω	≥ 1.0 V		–
	Low 50 Ω	–		≤ 0.25 V

Random Noise, Sample Acquisition Mode

Performance checks		Vertical sensitivity = 100 mV/div			
		1 MΩ		50 Ω	
	Bandwidth	Test result (mV)	High limit (mV)	Test result (mV)	High limit (mV)
DPO4104/MSO4104					
Channel 1	Full		7.43		6.07
	250 MHz		5.10		3.75
	20 MHz		3.32		3.31
Channel 2	Full		7.43		6.07
	250 MHz		5.10		3.75
	20 MHz		3.32		3.31
Channel 3	Full		7.43		6.07
	250 MHz		5.10		3.75
	20 MHz		3.32		3.31
Channel 4	Full		7.43		6.07
	250 MHz		5.10		3.75
	20 MHz		3.32		3.31

Random Noise, Sample Acquisition Mode

Performance checks		Vertical sensitivity = 100 mV/div			
		1 MΩ		50 Ω	
	Bandwidth	Test result (mV)	High limit (mV)	Test result (mV)	High limit (mV)
DPO4054/MSO4054					
Channel 1	Full		7.73		3.18
	250 MHz		5.30		3.36
	20 MHz		3.82		3.31
Channel 2	Full		7.73		3.18
	250 MHz		5.30		3.36
	20 MHz		3.82		3.31
Channel 3	Full		7.73		3.18
	250 MHz		5.30		3.36
	20 MHz		3.82		3.31
Channel 4	Full		7.73		3.18
	250 MHz		5.30		3.36
	20 MHz		3.82		3.31
DPO4034/MSO4034					
Channel 1	Full		6.54		3.38
	250 MHz		4.89		3.28
	20 MHz		3.42		3.12
Channel 2	Full		6.54		3.38
	250 MHz		4.89		3.28
	20 MHz		3.42		3.12
Channel 3	Full		6.54		3.38
	250 MHz		4.89		3.28
	20 MHz		3.42		3.12
Channel 4	Full		6.54		3.38
	250 MHz		4.89		3.28
	20 MHz		3.42		3.12
DPO4032/MSO4032					
Channel 1	Full		7.34		3.18
	250 MHz		4.99		3.97
	20 MHz		3.12		3.61
Channel 2	Full		7.34		3.18
	250 MHz		4.99		3.97
	20 MHz		3.12		3.61

Delta Time Measurement Accuracy
50 ohm, Full BW RMS

Channel 1–4 (MSO/DPO4104)			
MSO/DPO = 4 ns/Div, Source freq = 240 MHz			
MSO/DPO V/Div	**Source V_{pp}**	**Test result**	**High limit**
5 mV	40 mV		118 ps
100 mV	800 mV		117 ps
500 mV	4 V		117 ps
1 V	4 V		122 ps
MSO/DPO = 40 ns/Div, Source freq = 24 MHz			
1 mV	8 mV		456 ps
5 mV	40 mV		275 ps
100 mV	800 mV		234 ps
500 mV	4 V		233 ps
1 V	4 V		417 ps
MSO/DPO = 400 ns/Div, Source freq = 2.4 MHz			
1 mV	8 mV		4.42 ns
5 mV	40 mV		2.50 ns
100 mV	800 mV		2.05 ns
500 mV	4 V		2.03 ns
1 V	4 V		4.01 ns
MSO/DPO = 4 µs/Div, Source freq = 240 kHz			
1 mV	8 mV		44.2 ns
5 mV	40 mV		25.0 ns
100 mV	800 mV		20.5 ns
500 mV	4 V		20.3 ns
1 V	4 V		40.1 ns
MSO/DPO = 40 µs/Div, Source freq = 24 kHz			
1 mV	8 mV		442 ns
5 mV	40 mV		250 ns
100 mV	800 mV		205 ns
500 mV	4 V		203 ns
1 V	4 V		401 ns
MSO/DPO = 400 µs/Div, Source freq = 2.4 kHz			
1 mV	8 mV		4.42 µs
5 mV	40 mV		2.50 µs
100 mV	800 mV		2.05 µs
500 mV	4 V		2.03 µs
1 V	4 V		4.01 µs

Delta Time Measurement Accuracy

Channel 1–4 (MSO/DPO4054)			
MSO/DPO = 4 ns/Div, Source freq = 240 MHz			
MSO/DPO V/Div	**Source V_{pp}**	**Test result**	**High limit**
5 mV	40 mV		232 ps
100 mV	800 mV		231 ps
500 mV	4 V		231 ps
1 V	4 V		232 ps
MSO/DPO = 40 ns/Div, Source freq = 24 MHz			
1 mV	8 mV		431 ps
5 mV	40 mV		280 ps
100 mV	800 mV		256 ps
500 mV	4 V		255 ps
1 V	4 V		312 ps
MSO/DPO = 400 ns/Div, Source freq = 2.4 MHz			
1 mV	8 mV		3.66 ns
5 mV	40 mV		1.63 ns
100 mV	800 mV		1.17 ns
500 mV	4 V		1.15 ns
1 V	4 V		2.13 ns
MSO/DPO = 4 µs/Div, Source freq = 240 kHz			
1 mV	8 mV		36.4 ns
5 mV	40 mV		15.8 ns
100 mV	800 mV		11.0 ns
500 mV	4 V		10.8 ns
1 V	4 V		20.9 ns
MSO/DPO = 40 µs/Div, Source freq = 24 kHz			
1 mV	8 mV		364 ns
5 mV	40 mV		158 ns
100 mV	800 mV		110 ns
500 mV	4 V		108 ns
1 V	4 V		209 ns
MSO/DPO = 400 µs/Div, Source freq = 2.4 kHz			
1 mV	8 mV		3.64 µs
5 mV	40 mV		1.58 µs
100 mV	800 mV		1.10 µs
500 mV	4 V		1.08 µs
1 V	4 V		2.09 µs

Delta Time Measurement Accuracy

MSO/DPO V/Div	Source V_{pp}	Test result	High limit
Channel 1–4 (MSO/DPO4034)			
MSO/DPO = 4 ns/Div, Source freq = 240 MHz			
5 mV	40 mV		232 ps
100 mV	800 mV		231 ps
500 mV	4 V		231 ps
1 V	4 V		232 ps
MSO/DPO = 40 ns/Div, Source freq = 24 MHz			
1 mV	8 mV		436 ps
5 mV	40 mV		284 ps
100 mV	800 mV		259 ps
500 mV	4 V		258 ps
1 V	4 V		321 ps
MSO/DPO = 400 ns/Div, Source freq = 2.4 MHz			
1 mV	8 mV		3.72 ns
5 mV	40 mV		1.70 ns
100 mV	800 mV		1.23 ns
500 mV	4 V		1.21 ns
1 V	4 V		2.26 ns
MSO/DPO = 4 μs/Div, Source freq = 240 kHz			
1 mV	8 mV		37.0 ns
5 mV	40 mV		16.5 ns
100 mV	800 mV		11.6 ns
500 mV	4 V		11.4 ns
1 V	4 V		22.3 ns
MSO/DPO = 40 μs/Div, Source freq = 24 kHz			
1 mV	8 mV		370 ns
5 mV	40 mV		165 ns
100 mV	800 mV		116 ns
500 mV	4 V		114 ns
1 V	4 V		223 ns
MSO/DPO = 400 μs/Div, Source freq = 2.4 kHz			
1 mV	8 mV		3.70 μs
5 mV	40 mV		1.65 μs
100 mV	800 mV		1.16 μs
500 mV	4 V		1.14 μs
1 V	4 V		2.23 μs

Delta Time Measurement Accuracy			
Channel 1–2 (MSO/DPO4032)			
MSO/DPO = 4 ns/Div, Source freq = 240 MHz			
MSO/DPO V/Div	**Source V_{pp}**	**Test result**	**High limit**
5 mV	40 mV		232 ps
100 mV	800 mV		231 ps
500 mV	4 V		231 ps
1 V	4 V		232 ps
MSO/DPO = 40 ns/Div, Source freq = 24 MHz			
1 mV	8 mV		441 ps
5 mV	40 mV		281 ps
100 mV	800 mV		256 ps
500 mV	4 V		255 ps
1 V	4 V		312 ps
MSO/DPO = 400 ns/Div, Source freq = 2.4 MHz			
1 mV	8 mV		3.78 ns
5 mV	40 mV		1.66 ns
100 mV	800 mV		1.17 ns
500 mV	4 V		1.15 ns
1 V	4 V		2.13 ns
MSO/DPO = 4 µs/Div, Source freq = 240 kHz			
1 mV	8 mV		37.6 ns
5 mV	40 mV		16.1 ns
100 mV	800 mV		11.0 ns
500 mV	4 V		10.8 ns
1 V	4 V		21.0 ns
MSO/DPO = 40 µs/Div, Source freq = 24 kHz			
1 mV	8 mV		376 ns
5 mV	40 mV		161 ns
100 mV	800 mV		110 ns
500 mV	4 V		108 ns
1 V	4 V		210 ns
MSO/DPO = 400 µs/Div, Source freq = 2.4 kHz			
1 mV	8 mV		3.76 µs
5 mV	40 mV		1.61 µs
100 mV	800 mV		1.10 µs
500 mV	4 V		1.08 µs
1 V	4 V		2.10 µs

Performance checks: Digital Threshold Accuracy, MSO4000 series only

Digital channel	Threshold	V	V	Low limit	Test result	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
D15	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V

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 *Signal Path Compensation* in the *Tektronix 4000 Series Digital Phosphor Oscilloscopes User Manual*. 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 the entire procedure 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 Test

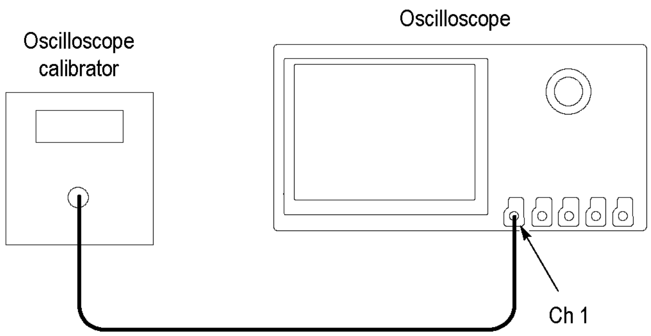
This procedure uses internal routines to verify that the oscilloscope functions and passes its internal self tests. No test equipment or hookups are required. Start the self test with these steps:

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

Check Input Impedance (Resistance)

This test checks the Input Impedance.

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

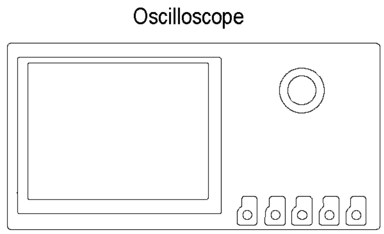


2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the front-panel channel button for the oscilloscope channel that you are testing, as shown in the test record (for example, 1,2,3,4).
4. Confirm that the oscilloscope and calibrator impedances are both set to 1 MΩ.The default **Impedance** 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).
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 and calibrator impedance to 50 Ω and repeat steps 5 through 7.
9. Repeat steps 4 through 8 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).

Check DC Balance

This test checks the DC balance.

You do not need to connect the oscilloscope to any equipment to run this test.



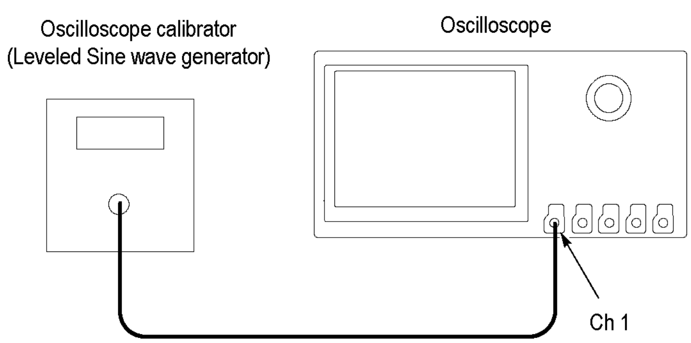
1. Attach a 50 Ω terminator to the channel input of the oscilloscope being tested.
2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the front-panel channel button for the oscilloscope channel that you are testing, as shown in the test record (for example, 1,2,3,4).
4. Set the oscilloscope impedance to 50 Ω. Push the **Impedance** lower-bezel button to select **50 Ω**.
5. Push the lower-bezel **Bandwidth** button and push the appropriate bandwidth side-bezel button for **20MHz**, **250MHz**, or **Full**, as given in the test record.
6. Turn the Horizontal **Scale** knob to 1 ms/division.
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, 100 mV/div, 1 V/div).
8. Push the front-panel **Acquire** button.
9. Push the **Mode** lower-bezel button, and then, if needed, push the **Average** side bezel button.
10. If needed, adjust the number of averages to **16** with the Multipurpose **a** knob.
11. Push the Trigger **Menu** front-panel button.
12. Push the **Source** lower-bezel button.
13. Select the **AC Line** trigger source with the Multipurpose **a** knob. You do not need to connect an external signal to the oscilloscope for this DC Balance test.
14. Push the front-panel Wave Inspector **Measure** button.
15. Push the **Add Measurement** lower bezel button.
16. Use the Multipurpose **a** knob to select the **Mean** measurement.

17. Push the **OK Add Measurement** side-bezel button.
18. View the mean measurement value in the display and enter that mean value as the test result in the test record.
19. Repeat steps 7 through 18 for each volts/division value listed in the results table.
20. Push the front-panel channel button, change the oscilloscope bandwidth (for example, 20 MHz, 250 MHz, or Full), and repeat steps 5 through 19.
21. Change the oscilloscope impedance 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).

Check Bandwidth

This test checks the bandwidth at 50 Ω and 1 M Ω for each channel.

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



2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel button (1,2,3,4) 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 impedance to 50 Ω. Push the **Impedance** lower-bezel button 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 the front-panel **Acquire** button.
8. Confirm that the mode is set to **Sample**. If not push the **Mode** lower-bezel button, and then push the **Sample** side bezel button.
9. Adjust the signal source to at least 8 vertical divisions at the selected vertical scale with a set frequency of 50 kHz. For example, at 5 mV/div, use a

≥40 $mV_{p\text{-}p}$ signal, at 2 mV/div, use a ≥16 $mV_{p\text{-}p}$ signal, at 1 mV/div, use a ≥8 $mV_{p\text{-}p}$ signal. Use a sine wave for the signal source.

10. Turn the Horizontal **Scale** knob to 10 µs/division.
11. Push the front-panel Wave Inspector **Measure** button, and the lower-bezel **Add Measurement** button.
12. Use the Multipurpose **a** knob to select the **Peak-to-Peak** measurement.
13. Push the **OK Add Measurement** side-bezel button. This will provide you with a mean $V_{p\text{-}p}$ of the signal. Call this reading $V_{in\text{-}pp}$.

    Record the value of $V_{in\text{-}pp}$ (for example, 816 mV) in the test record.
14. Turn the Horizontal **Scale** knob to 1 ns/division.
15. Adjust the signal source to the maximum bandwidth frequency for the bandwidth and model desired, as shown in worksheet below. 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 bandwidth specifications. (See Table 1 on page 1.)*

Table 12: Maximum Bandwidth Frequency worksheet

Impedance	Vertical Scale	Maximum bandwidth
Model: DPO4104, MSO4104		
50 Ω	5 mV/div	1 GHz
50 Ω	2 mV/div	350 MHz
50 Ω	1 mV/div	200 MHz
1 MΩ	5 mV/div	380 MHz [1]
1 MΩ	2 mV/div	300 MHz
1 MΩ	1 mV/div	175 MHz
Model: DPO4054, MSO4054		
50 Ω	5 mV/div	500 MHz
50 Ω	2 mV/div	350 MHz
50 Ω	1 mV/div	200 MHz
1 MΩ	5 mV/div	380 MHz [1]

Table 12: Maximum Bandwidth Frequency worksheet (cont.)

Model: DPO4054, MSO4054		
1 MΩ	2 mV/div	300 MHz
1 MΩ	1 mV/div	175 MHz
Model: DPO4034, DPO4032, MSO4034, MSO4032		
50 Ω	5 mV/div	350 MHz
50 Ω	2 mV/div	350 MHz
50 Ω	1 mV/div	200 MHz
1 MΩ	5 mV/div	350 MHz
1 MΩ	2 mV/div	300 MHz
1 MΩ	1 mV/div	175 MHz

1 For DPO4104, MSO4104, DPO4054, and MSO4054 bandwidth verification, use 380 MHz, rather than 500 MHz, on the 5 mV/div vertical scale due to an impedance mismatch between the calibrator and the oscilloscope. When the calibrator is set to 1 MΩ load, it has a Thevenin equivalent 25 Ω source impedance. Passing the test with a 380 MHz signal verifies 500 MHz performance with a P6139A probe on models DPO4104, MSO4104, DPO4054, and MSO4054.

16. 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:

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

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

17. Repeat steps 9 through 16 for the other oscilloscope volts/div settings listed in the test record.

18. Set the calibrator to 1 MΩ output impedance to generate a sine wave.

19. Push the channel button (1,2,3,4) for the same channel that you used in step 3.

20. Change the oscilloscope impedance to 1 MΩ. Push the **Impedance** lower-bezel button to select 1 M Ω.

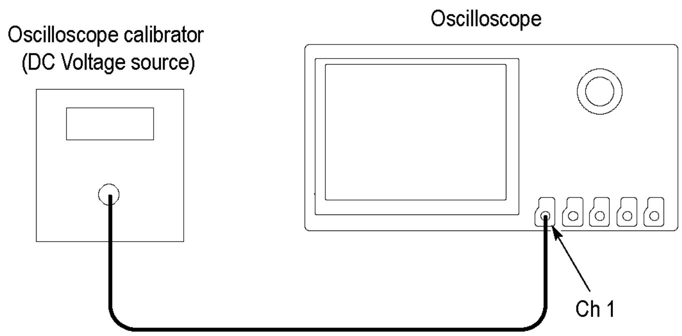
21. Repeat steps 9 through 17.

22. Repeat steps 3 through 21 for each channel combination listed in the test record and relevant to your model of oscilloscope (for example, 1,2,3,4).

Check DC Gain Accuracy

This test checks the DC gain accuracy.

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



2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel button (1,2,3,4) for the channel that you want to check.
4. Confirm that the oscilloscope and calibrator impedances are both set to 50 Ω. Push the **Impedance** lower-bezel button to select 50 Ω.
5. Push the lower-bezel **Bandwidth** button.
6. Push the **20 MHz** side-bezel button to select the bandwidth.
7. Push the front-panel **Acquire** button.
8. Push the **Mode** lower-bezel button, and push the **Average** side bezel button. The default number of averages is **16**.
9. Push the front-panel Wave Inspector **Measure** button, and the **Add Measurement** lower-bezel button.
10. Use the Multipurpose **a** knob to select the **Mean** measurement.
11. Push the **OK Add Measurement** side-bezel button.
12. Push the Trigger **Menu** front-panel button.
13. Push the **Source** lower-bezel button.
14. Turn the Multipurpose **a** knob to select the **AC Line** as the trigger source.
15. Turn the vertical **Scale** knob to the next setting to measure, as shown in the table. (See Table 13.)
16. Set the DC Voltage Source to $V_{negative}$. (See Table 13.) Push the **Measure** front-panel button, push the **Statistics** lower-bezel button, and push **Reset Statistics** in the side-bezel menu. Enter the mean reading in a table as $V_{negative\text{-}measured}$. (See Table 13.)

17. Set the DC Voltage Source to $V_{positive}$. (See Table 13.) Push **Statistics** in the lower-bezel menu and **Reset Statistics** in the side-bezel menu. Enter the mean reading in the following table as $V_{positive-measured}$.

Table 13: Gain Expected worksheet

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	9 mV	-4.5 mV	+4.5 mV				
2 mV/div	18 mV	-9 mV	+9 mV				
4.98 mV	44.82 mV	-22.41 mV	+22.41 mV				
5 mV	45 mV	-22.5 mV	+22.5 mV				
10 mV	90 mV	-45 mV	+45 mV				
20 mV	180 mV	-90 mV	+90 mV				
49.8 mV	448.2 mV	-224.1 mV	+224.1 mV				
50 mV	450 mV	-225 mV	+225 mV				
100 mV	900 mV	-450 mV	+450 mV				
200 mV	1800 mV	-900 mV	+900 mV				
500 mV	4900 mV	-2450 mV	+2450 mV				
1.0 V	9000 mV	-4500 mV	+4500 mV				

18. Calculate V_{diff} as follows:

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

    Enter V_{diff} as shown in the table. (See Table 13.)

19. Calculate *GainAccuracy* as follows:

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

    Write down *GainAccuracy* in a table and in the test record. (See Table 13.)

20. Repeat steps 15 through 19 for each volts/division value in the test record.

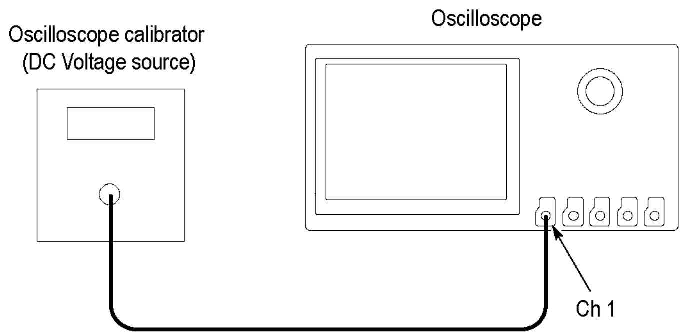
21. Change the oscilloscope impedance to 1 MΩ and repeat steps 15 through 20.

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

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 Wavetek calibrator as the DC voltage source, connect the calibrator head to the oscilloscope channel to test.



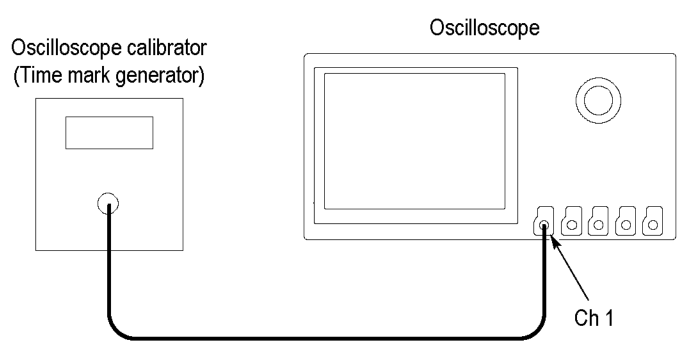
2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel button (1,2,3,4) for the channel that you want to check.
4. Confirm that the oscilloscope and calibrator impedances are both set to 50 Ω. Push the **Impedance** lower-bezel button to select 50 Ω.
5. Set the calibrator to the vertical offset value shown in the test record (for example, 900 mV for a 1 mV/div setting). Set the calibrator to the same impedance as you set for the oscilloscope.
6. Set the oscilloscope to the vertical offset value shown in the test record (for example, 900 mV for a 1 mV/div setting).
7. Turn the vertical **Scale** to match the value in the test record (for example, 1 mV/div).
8. Turn the Horizontal **Scale** knob to 1 ms/div.
9. Push the lower-bezel **Bandwidth** button.
10. Push the side-bezel button to select the bandwidth to **20 MHz**.
11. Push the **More** lower-bezel button repeatedly to select **Offset**.
12. Check that the vertical position is set to 0 divs. If not, turn the Vertical **Position** knob to set the position to 0 or push the appropriate **Set to 0 divs** button.
13. Push the front-panel **Acquire** button.
14. Push the **Mode** lower-bezel button, and push the **Average** side bezel button. The default number of averages is **16**.
15. Push the front-panel Trigger **Menu** button.
16. Push the **Source** lower-bezel button.

17. Turn the Multipurpose **a** knob to select the **AC Line** as the trigger source.
18. Push the front-panel Wave Inspector **Measure** button.
19. Push the **Add Measurement** lower bezel button.
20. Use the Multipurpose **a** knob to select the **Mean** measurement.
21. Push the **OK Add Measurement** side-bezel button. The mean value should appear in a measurement pane at the bottom of the display.
22. Enter the measured value in the test record.
23. Repeat the procedure for each volts/division setting shown in the test record.
24. Change the impedance to 1 MΩ and repeat steps 5 through 23.
25. Repeat steps 3 through 24 for each channel of the oscilloscope that you want to check.

Check Sample Rate and Delay Time Accuracy

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

1. Connect the output of the time mark generator to the oscilloscope channel 1 input using a 50 Ω cable.



2. Set the time mark generator period to **80 ms**. Use a time mark waveform with a fast rising edge.
3. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
4. Push the channel **1** button.
5. Set the impedance to 50 Ω. Push the **Impedance** lower-bezel button to select 50 Ω.
6. If adjustable, set the time mark amplitude to approximately **1** $\mathbf{V_{p\text{-}p}}$.
7. Set the Vertical **SCALE** to **500 mV/div**.
8. Set the Horizontal **SCALE** to **20 ms/div**.

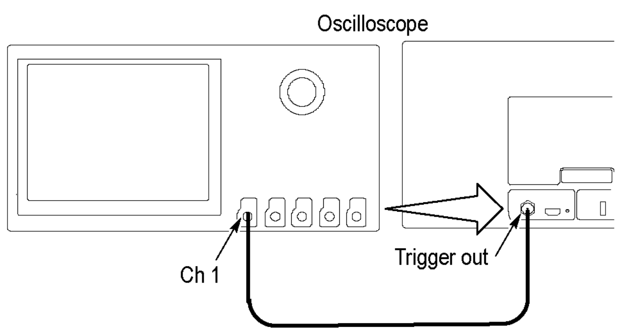
9. Adjust the Vertical **POSITION** knob to center the time mark signal on the screen.
10. Adjust the Trigger **LEVEL** knob as necessary for a triggered display.
11. Adjust the Horizontal **POSITION** knob to move the trigger location to the center of the screen (50%).
12. Turn the Horizontal **POSITION** knob counterclockwise to set the delay to exactly **80 ms**.
13. Set the Horizontal **Scale** to **400 ns/div**.
14. Compare the rising edge of the marker with the center horizontal graticule line. The rising edge should be within ±1 divisions of center graticule. Enter the deviation in the test record.

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

Check Trigger Out

This test checks the Trigger Output.

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



2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel 1 button.
4. Set the oscilloscope impedance to 1 MΩ. The default **Impedance** setting is 1MΩ.
5. Set the horizontal to 4 µS/div and the vertical to 1 V/div.
6. Push the front-panel Wave Inspector **Measure** button.
7. Push the **Add Measurement** lower-bezel button.
8. Use the Multipurpose **a** knob to select the **Low** measurement.
9. Push the **OK Add Measurement** side bezel button.

10. Use the Multipurpose **a** knob to select the **High** measurement.
11. Push the **OK Add Measurement** side bezel button.
12. Record the high and low measurements (for example, low = 200 mV and high = 3.52 V).
13. Repeat the procedure, using 50 Ω instead of 1 MΩ in step 4.

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 the front-panel **Default Setup** button to set the instrument to the factory default settings. This sets the oscilloscope to Channel 1, Full Bandwidth, 1 MΩ input impedance, 100 mV/div, and 4.00 µs/div.
3. Set **Gating** to **Off**:
   a. Push the front-panel Wave Inspector **Measure** button.
   b. Push the bottom-bezel **More** button to select **Gating**.
   c. Push the side-bezel **Off (Full Record)** button.
4. Select the RMS measurement:
   a. Push the bottom-bezel **Add Measurement** button.
   b. Use the Multipurpose **a** knob to select the **RMS** measurement.
   c. If necessary, use the Multipurpose **b** knob to select the channel being tested as the source for the RMS measurement.
   d. Push the side-bezel **OK Add Measurement** button.
5. Push the bottom-bezel **More** button to select **Statistics**, and then push the side-bezel **Reset Statistics** button.
6. Push the front-panel **Menu Off** button to remove the menus from the display.
7. Read the RMS Mean value. This is the Sampled Mean Value (SMV).
8. Push the Horizontal **Acquire** button and then, if necessary, push the bottom-bezel **Mode** button to display the Acquisition Mode menu.
9. Push the side-bezel **Average** button and, if necessary, use the multipurpose **a** knob to set the number of averages to 16.
10. Push the front-panel Wave Inspector **Measure** button and then, if necessary, push the bottom-bezel **More** button to select **Statistics**, and then push the side-bezel **Reset Statistics** button.
11. Push the front-panel **Menu Off** button to remove the menus from the display.
12. Read the RMS Mean value. This is the Averaged Mean Value (AMV).

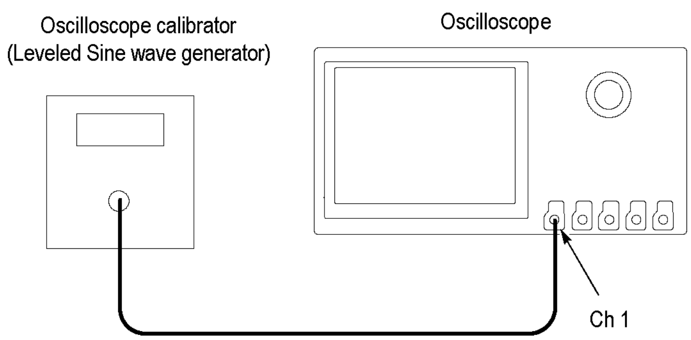
13. Calculate the RMS noise (RMS noise = SMV – AMV), and enter the calculated RMS noise into the appropriate segment of the Test Record.
14. Set the Acquisition Mode to Sample:
    a. Push the front-panel Horizontal **Acquire** button.
    b. If necessary, push the bottom-bezel **Mode** button to display the Acquisition Mode menu.
    c. Push the side-bezel **Sample** button.
15. Set the input impedance to 50 Ω:
    a. Push the front-panel button for the channel being tested (1, 2, 3, or 4) [1].
    b. Push the bottom-bezel **Impedance** button to select **50 Ω**.
16. Push the front-panel Wave Inspector **Measure** button, and repeat steps 5 through 14.
17. Set the channel under test to 1 MΩ impedance, and set the bandwidth to 250 MHz:
    a. Push the front-panel button for the channel being tested (1, 2, 3, or 4) [1].
    b. Push the bottom-bezel **Impedance** button to select **1 MΩ**.
    c. Push the bottom-bezel **Bandwidth** button, and then push the side-bezel **250MHz** button.
18. Push the front-panel Waveform Inspector **Measure** button, and then repeat steps 5 through 16.
19. Set the channel under test to 1 MΩ impedance, and set the bandwidth to 20 MHz:
    a. Push the front-panel button for the channel being tested (1, 2, 3, or 4) [1].
    b. Push the bottom-bezel **Impedance** button to select **1 MΩ**.
    c. Push the bottom-bezel **Bandwidth** button, and then push the side-bezel **20MHz** button.
20. Push the front-panel Wave Inspector **Measure** button, and then repeat steps 5 through 16.
21. Select the next channel (2, 3, or 4) [1] to test, and then push the front-panel Wave Inspector **Measure** button.
22. Repeat steps 5 through 21 until all channels have been tested.

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

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 the **Menu Off** button to remove the side-bezel menu.
3. Connect a 50 Ω coaxial cable from the signal source to the oscilloscope channel being tested.



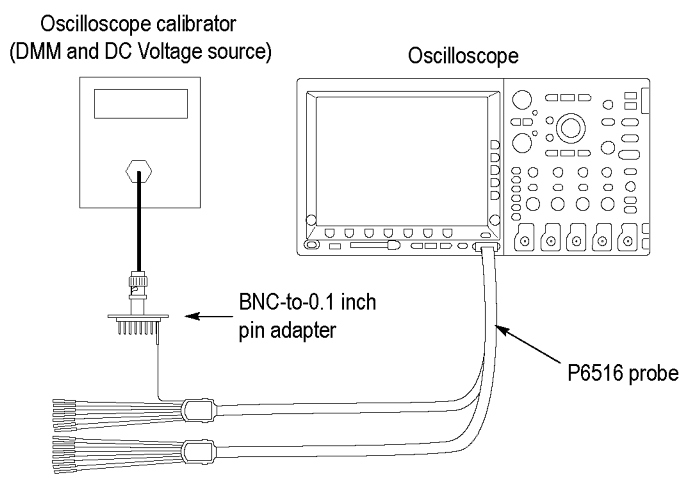
4. Push the channel **1** button to display the channel 1 menu.
5. Push the bottom-bezel **Impedance** button to set the channel to **50 Ω**.
6. Push the front-panel Trigger **Menu** button and then, if necessary, set the trigger source to the channel being tested:
   a. Push the bottom-bezel **Source** button.
   b. Use the Multipurpose **a** knob to select the channel being tested.
7. Push the Wave Inspector **Measure** button, and then push the bottom-bezel **Add Measurement** button.
8. Use the Multipurpose **a** knob to select the **Burst Width** measurement, and then push the side-bezel **OK Add Measurement** button.
9. Push the bottom-bezel **More** button to select **Statistics** and, if necessary, use the mutipurpose **a** knob to set the **Mean & Std Dev Samples** to 100, as shown in the side menu.
10. Push the front-panel **Menu Off** button to remove the Statistics menu.
11. Refer to the Test Record **Delta Time Measurement Accuracy** table. Set the oscilloscope and the signal source as directed there,
12. Push the bottom-bezel **More** button to select **Statistics** and the push the side-bezel **Reset Statistics** button and wait five or 10 seconds for the oscilloscope to acquired 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 front-panel channel button for the next channel to be tested, and move the coaxial cable to the appropriate input on the oscilloscope.
16. Repeat steps 5 through 15, until all channels have been tested.

Check Digital Threshold Accuracy (MSO4000 only)

For the MSO4000 series 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 P6516 digital probe to the MSO4000 series instrument.



2. Connect one of the digital channels, such as D0, to the DC voltage source to run this test.

   If using the Wavetek calibrator as the DC voltage source, connect the calibrator head to the digital channel to test. You will need a BNC-to-0.1 inch pin adapter (Tektronix part number 679-6240-00) to complete the connection. Be sure to connect the digital channel to the corresponding signal pin and to a ground pin on the adapter.

3. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
4. Push the front-panel **D15-D0** button.
5. Push the **D15-D0 On/Off** lower-bezel button.
6. Push the **Turn On D7 - D0** and the **Turn On D15 - D8** side-bezel buttons. The instrument will display the 16 digital channels.
7. Push the **Thresholds** lower-bezel button.
8. Turn the Multipurpose **a** knob and select the D15-D0 group.

9. Before you change the threshold value, push the **Fine** front-panel button to turn off the fine adjustment and make adjusting the value quicker. Turn the Multipurpose **b** knob and set the 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 row for 0 V in the test record for each digital channel.

10. Push the front-panel Trigger **Menu** button.

11. Push the **Source** lower-bezel button, and turn Multipurpose **a** knob 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.

12. 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, change the DC voltage source Vs to -500 mV.

13. Increment Vs by +10 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 0 V row of the test record.

    If the channel is a logic level low or is alternating between high and low, repeat this step (increment Vs by 10 mV, wait 3 seconds, and check for a static logic high) until a value for $\mathbf{V_{s-}}$ is found.

14. Push the **Slope** lower-bezel button to change the slope to **Falling**.

15. 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, change the DC voltage source Vs to +500 mV.

16. Decrement Vs by -10 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 $\mathbf{V_{s+}}$ in the 0 V row of the test record.

    If the channel is a logic level high or is alternating between high and low, repeat this step (decrement Vs by 10 mV, wait 3 seconds, and check for a static logic low) until a value for $\mathbf{V_{s+}}$ is found.

17. Find the average, $V_{sAvg} = (V_{s-} + V_{s+})/2$. 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.

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

19. Turn Multipurpose **a** knob and select the appropriate channel, such as D0.
20. With the Fine front-panel button turned off, turn Multipurpose **b** knob and set the value to **4.00 V** (+4.0 V/div). To remove the menu from the display, push the front-panel **Menu Off** button.
21. 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, change the DC voltage source Vs to +4.5 V.
22. Decrement Vs by -10 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 $\mathbf{V_{s+}}$ in the 4 V row of the test record.

    If the channel is a logic level high or is alternating between high and low, repeat this step (decrement Vs by 10 mV, wait 3 seconds, and check for a static logic low) until a value for $\mathbf{V_{s+}}$ is found.
23. Push the front-panel Trigger **Menu** button.
24. Push the **Slope** lower-bezel button to change the slope to **Rising**.
25. 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, change the DC voltage source Vs to +3.5 V.
26. Increment Vs by +10 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 or is alternating between high and low, repeat this step (increment Vs by 10 mV, wait 3 seconds, and check for a static logic high) until a value for $\mathbf{V_{s-}}$ is found.
27. Find the average, $V_{sAvg} = (V_{s-} + V_{s+})/2$. 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.
28. Repeat the procedure starting with step 11 for each remaining digital channel, D1 through D15.

This completes the performance verification procedure.