Technical Reference

Tektronix

DPO4000 Series
Digital Phosphor Oscilloscopes
Specifications and Performance Verification

071-1843-01

This document supports firmware version 1.00 and above for DPO4000 Series instruments only.

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.

Contacting Tektronix

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USA

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

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

Warranty 4

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

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

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

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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.

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

Do Not Operate With Suspected Failures. If you suspect 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 symbols may appear on the product:


CAUTION
Refer to Manual


Protective Ground
(Earth) Terminal


Chassis Ground

Mains Connected
ON (Power)


Push button OUT


Push button
IN

Specifications

Specifications

This chapter contains specifications for the DPO4000 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 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 *DPO4000 Series Digital Phospor 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 1-1: Channel input and vertical specifications

Characteristic	Description	
Number of input channels	*DPO4032*	*DPO4104, DPO4054, DPO4034*
	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's input load.	
Input resistance selection	1 MΩ or 50 Ω DPO4104: 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: VSWR ≤ 1.5:1 from DC to 1 GHz, typical DPO4054: VSWR ≤ 1.5:1 from DC to 500 MHz, typical DPO4034, DPO4032: 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}.	

Table 1-1: Channel input and vertical specifications (Cont.)

Characteristic	Description		
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		
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 -100ns to +100ns with a resolution of 20ps.		
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.		
Total probe power	50 W		
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 an LSB (least significant bit).		
Sensitivity range (coarse)	*1 MΩ*		*50 Ω*
	1 mV/div to 10 V/div in a 1-2-5 sequence		1mV/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 MΩ 1 mV/div to 1 V/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 MΩ. Allows continuous adjustment from 1 mV/div to 1 V/div, 50 Ω.		

Table 1-1: Channel input and vertical specifications (Cont.)

Characteristic	Description			
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 ≤25 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 25 °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	DC to 1 GHz	DC to 350 MHz	DC to 200 MHz
	DPO4054	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	DC to 350 MHz	DC to 200 MHz	
	DPO4032	DC to 350 MHz	DC to 200 MHz	
✓ Analog High Frequency bandwidth, 1 MΩ	The limits stated below are for ambient temperature of ≤25 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 25 °C. For DPO4104 and DPO4054 bandwidth verification, 380 MHz, rather than 500 MHz, is used due to an impedance mismatch between the signal generator and the oscilloscope. Passing this test with a 380 MHz signal verifies 500 MHz performance on the 1 MΩ path on models DPO4104 and DPO4054.			
	Instrument	*5 mV/div to 10 V/div*	*2 mV/div to 4.98 mV/div*	*1 mV/div to 1.99 mV/div*
	DPO4104	DC to 380 MHz	DC to 350 MHz	DC to 200 MHz
	DPO4054	DC to 380 MHz	DC to 350 MHz	DC to 200 MHz
	Instrument	*2 mV/div to 10 V/div*	*1 mV/div to 1.99 V/div*	
	DPO4034	DC to 350 MHz	DC to 200 MHz	
	DPO4032	DC to 350 MHz	DC to 200 MHz	

Table 1-1: 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 ≤25 °C and the bandwidth selection set to FULL. Reduce the upper bandwidth frequency by 1% for each °C above 25 °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	DC to 500 MHz	DC to 350 MHz	DC to 200 MHz
	DPO4054	DC to 500 MHz	DC to 350 MHz	DC to 200 MHz
	Instrument	*20 mV/div to 100 mV/div*	*10 mV/div to 19.9 mV/div*	
	DPO4034	DC to 350 MHz	DC to 200 MHz	
	DPO4032	DC to 350 MHz	DC to 200 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	*50Ω: 1 mV/div to 1.99 mV/div*	*50Ω: 2 mV/div to 4.99 mV/div*	*50Ω: 5 mV/ div to 1 V/div*
	DPO4104	1.75 ns	778 ps	350 ps
	DPO4054	1.75 ns	778 ps	700 ps
	DPO4034	1.75 ns	1 ns	1 ns
	DPO4032	1.75 ns	1 ns	1 ns
	Instrument	*1M Ω (P6139A probe): 10 mV/div to 19.9 mV/div*	*1M Ω (P6139A probe): 20 mV/div to 100 V/div*	
	DPO4104	1 ns	700 ps	
	DPO4054	1 ns	700 ps	
	DPO4034	1 ns	1 ns	
	DPO4032	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)			

Table 1-1: Channel input and vertical specifications (Cont.)

Characteristic	Description	
Upper frequency limit, 20 MHz bandwidth limited, typical	20 MHz, ±20% (all models)	
DC gain accuracy	For 1 M Ω path:	For 50 Ω path:
	± 1.5%, derated at 0.100%/°C above 25 °C	± 1.5%, derated at 0.050%/°C above 25 °C
	± 3.0% Variable Gain, derated at 0.100%/°C above 25 °C	± 3.0% Variable Gain, derated at 0.050%/°C above 25 °C
DC voltage measurement accuracy	*Measurement type*	*DC Accuracy (in volts)*
Sample acquisition mode, typical	Any sample	± [DC gain accuracy × | 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 × | 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 × | 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 × | 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.	

Table 1-1: Channel input and vertical specifications (Cont.)

Characteristic	Description		
Offset ranges	*Volts/div setting*	*Offset range*	
		1 M Ω 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.		

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

Table 1-2: 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	DPO4104: 400 ps/div to 1,000 sec/div in a 1-2-4 sequence DPO4054, DPO4034, DPO4032: 1 ns/div to 1,000 sec/div
Peak Detect or Envelope mode pulse response, typical	*Minimum pulse width*
	DPO4104: > 200 ps DPO4054, DPO4034, DPO4032: > 400 ps
Sample-rate range	DPO4104: 5 GS/s-0.1 S/s DPO4054, DPO4034, and DPO4032: 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: 3,700 wfm/s
Aperture Uncertainty, typical‘	≤(3 ps + 0.1 ppm * record duration)$_{RMS}$, for real-time or interpolated records having duration ≤1 minute ≤(3 ps + 0.1 * waveform interval)$_{RMS}$, for equivalent time records
Number of Waveforms for Average Acquisition Mode	2 to 128 waveforms Default of 16 waveforms

Table 1-3: 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 transient	
Aux In (External) trigger input impedance, typical	1 MΩ ±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: 1 GHz DPO4054: 500 MHz DPO4034, DPO4032: 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)
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 Couling*	*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

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description	
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 shown below.	
	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 are as follows for both delayed and main trigger	
	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, any field, specific line, or any line for interlaced or non-interlaced systems. Supported sytems include NTSC, PAL, and SECAM.	
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	

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description			
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
	[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.			
Minimum clock pulse widths for setup/hold time violation trigger, typical	For all vertical settings, the minimums are as shown below.			
	Minimum pulse width, clock active[2]		*Minimum pulse width, clock inactive*[2]	
	User hold time + 2.5 ns[3]		2 ns	
	[2] An active pulse width is the width of the clock pulse from its active edge (as defined in the Clock Edge selection in the Clock Source menu) to its inactive edge. An inactive pulse width is the width of the pulse from its inactive edge to its active edge. **[3] User hold time is the number selected by the user in the "Setup & Hold Times" side-bezel menu.**			
Setup/hold violation trigger, setup and hold time ranges	*Feature*	*Min*	*Max*	
	Setup time	0 ns	8 s	
	Hold time	4 ns	8 s	
	Setup and hold time	4 ns	16 s	
	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.			
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	

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description		
	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, 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 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		

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description
Standard serial 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 12 bytes of user specified data Trigger On: Start, Repeated Start, Stop, Missing Ack, Data, or Address and Data Maximum Data Rate: 10 Mb/s
	SPI Data Trigger: 1 to 16 bytes of user specified data Trigger On: SS Active, MOSI, MISO, or MOSI and MISO Maximum Data Rate: 10 Mb/s
	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, or Missing Ack Frame Type: Data, Remote, Error, Overload Identifier: Standard (11 bit) and Extended (29 bit) identifiers Maximum Data Rate: 1 Mb/s

Table 1-4: 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 1-5: Input/Output port specifications

Characteristic	Description	
Ethernet interface	Standard on all models. 10/100 Mb/s	
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. 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 ±100 ppm	
⌐Auxiliary output (AUX OUT)	LOW TRUE; LOW to HIGH transition indicates that the trigger occurred. The logic levels are given in the following table:	
	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 1-6: Power source specifications

Characteristic	Description
Source voltage	100 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 1-7: 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 1-8: 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)
Pollution Degree	Pollution Degree 2, indoor use only
Altitude	Operating: 3,000 m (9,843 ft) Nonoperating: 12,000 m (39,370 ft)
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 1-9: Mechanical specifications

Characteristic	Description
Dimensions	Nominal, non-rack mount: 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, rack mount (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 rack mount, without front cover 9.5 kg (21.0 lbs), when packaged for domestic shipment and without rack mount
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 1-10: Safety certification

Characteristic	Description
Safety certification	Listed UL61010-1: 2004, CAN/CSA-C22.2 No. 61010.1: 2004; Complies with EN61010-1: 2001, Complies with the Low-Voltage Directive 73/23/ECC for Product Safety

Table 1-11: Electromagnetic compatibility (EMC)

European Union	EC Council EMC Directive 89/336/EEC, amended by 93/68/EEC; Demonstrated using: EN 61326/A2 Electical equipment for measurement, control, and laboratory, Use Annex D[1,2] Emissions EN 61326, Class A Immunity IEC 61000-4-2 IEC 61000-4-3 [3] IEC 61000-4-4 IEC 61000-4-5 IEC 61000-4-6 [4] IEC 61000-4-11 EN 61000-3-2 EN 61000-3-3
Australia	EMC Framework, demostrated per Emission Standard AS/NZS 2064 (Industrial, Scientific, and Medical Equipment).

1 Emissions that exceed the levels required by this standard may occur when this equipment is connected to a test object.

2 Use Low-EMI Shielded cables to maintain compliance.

3 The increase in trace noise, while subjected to the test field (3 V/m over the frequency range 80 MHz to 1 GHz with 80% amplitude modulation at 1 kHz), is not to exceed 2 major divisions peak-to-peak. Ambient fields may induce triggering when the trigger threshold is offset less than 4 minor divisions from ground reference.

4 The increase in trace noise, while subjected to the injected 3 V test signal, is not to exceed 2 major divisions peak-to-peak. Ambient fields may induce triggering when the trigger threshold is offset less than 1 major division from ground reference.

Performance Verification

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
Leveled sine wave generator	50 kHz to 1000 MHz, ±4% amplitude accuracy	
Time mark generator	10 ms period, ±5 ppm accuracy	
One 50 Ω BNC cable	Male-to-male connectors	Tektronix part number 012-0057-01

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

These procedures cover all DPO4000 oscilloscope models. Please disregard checks that do not apply to the specific model you are testing.

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

***NOTE**. Successful completion of the performance verification procedure does not update the instrument Calibration Due date and time.*

The performance verification procedures verify the performance of your instrument, they do not calibrate your instrument. If your instrument fails any of the performance verification tests, you should perform the factory calibration procedures as described in the *DPO4000 Series Service* manual.

Test Record

Serial number	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Performance checks		Low limit	Test result	High limit
Channel 1 DC voltage measurement accuracy 1 MΩ	1 mV/div	99.1 mV		101 mV
	2 mV/div	-7.71 mV		-6.30 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	9.88 V		10.1 V
Channel 2 DC voltage measurement accuracy 1 MΩ	1 mV/div	99.1 mV		101 mV
	2 mV/div	-7.71 mV		-6.30 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	9.88 V		10.1 V
Channel 3 DC voltage measurement accuracy 1 MΩ	1 mV/div	99.1 mV		101 mV
	2 mV/div	-7.71 mV		-6.30 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	9.88 V		10.1 V

Performance checks		Low limit	Test result	High limit
Channel 4 DC voltage measurement accuracy 1 MΩ	1 mV/div	99.1 mV		101 mV
	2 mV/div	-7.71 mV		-6.30 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	9.88 V		10.1 V
Channel 1 DC voltage measurement accuracy 50 Ω	1 mV/div	98.9 mV		101 mV
	2 mV/div	-7.81 mV		-6.2 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	2.42 V		2.58 V
Channel 2 DC voltage measurement accuracy 50 Ω	1 mV/div	98.9 mV		101 mV
	2 mV/div	-7.81 mV		-6.2 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 mV
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	2.42 V		2.58 V
Channel 3 DC voltage measurement accuracy 50 Ω	1 mV/div	98.9 mV		101 mV
	2 mV/div	-7.81 mV		-6.2 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 mV
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	2.42 V		2.58 V

Performance checks		Low limit	Test result	High limit
Channel 4 DC voltage measurement accuracy 50 Ω	1 mV/div	98.9 mV		101 mV
	2 mV/div	-7.81 mV		-6.2 mV
	5 mV/div	-102 mV		-97.8 mV
	50 mV/div	978 mV		1.02 V
	50 mV/div	628 mV		672 mV
	90 mV/div	-351 mV		-279 mV
	200 mV/div	2.42 V		2.58 V
Channel 1 bandwidth 50 Ω		425 mV		—
Channel 2 bandwidth 50 Ω		425 mV		—
Channel 3 bandwidth 50 Ω		425 mV		—
Channel 4 bandwidth 50 Ω		425 mV		—
Channel 1 bandwidth 1 MΩ		425 mV		—
Channel 2 bandwidth 1 MΩ		425 mV		—
Channel 3 bandwidth 1 MΩ		425 mV		—
Channel 4 bandwidth 1 MΩ		425 mV		—
Sample rate and delay time accuracy		-1 divisions		+1 divisions
Trigger Out logic levels	Low	≤0.25 V		—
	High	—		≥1.0 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 *DPO4000 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

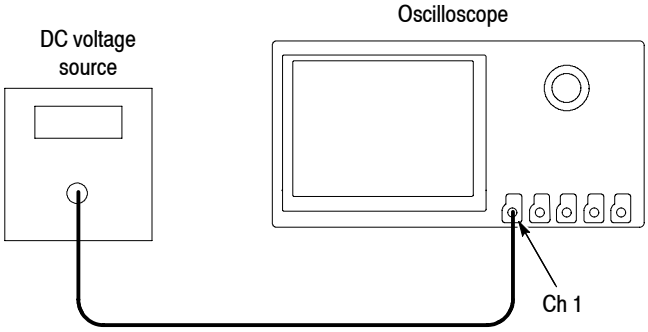
This procedure uses internal routines to verify that the oscilloscope functions and passes its internal self tests. No test equipment or hookups are required. Start the self test with these steps:

1. Disconnect all probes and cables from the oscilloscope inputs.
2. Push the **Utility** menu button.
3. Push the **System** lower bezel button to select Self Test.
4. Push the **Self Test** lower bezel button.
5. Push the **Loop X Times** side bezel button, and use the **Multipurpose a** knob to select 1.
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 DC Voltage Measurement Accuracy 1 MΩ

This test checks the DC voltage measurement accuracy in the average acquisition mode with a 1 MΩ termination.

1. Set the DC voltage source output level to **0 V**.
2. Connect the DC voltage source to the oscilloscope channel 1 input as shown below. Push the channel 1 button (**1**).



3. Push the Save/Recall **Default Setup** button to set the instrument to the factory default settings.
4. Push the Horizontal **Acquire** button.
5. Push the **Mode** lower bezel button, and then push the **Average** side bezel button.
6. Adjust the number of averages to **16** with the **Multipurpose a** knob.
7. Go to step 10.
8. Move the DC voltage source output cable to the oscilloscope channel that you want to check.
9. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.
10. Push the Wave Inspector **Measure** button.
11. Push the **Select Measurement** lower bezel button.
12. Push the **– more –** side bezel button until you display the **Mean** measurement.
13. Push the **Mean** side bezel button.
14. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.

Table 2-1: DC voltage measurement accuracy 1 MΩ

Vertical scale	Invert	Bandwidth limit	Offset	Input voltage	Low limit	High limit
1 mV/div	Off	20 MHz	96.5 mV	100 mV	99.1 mV	101 mV
2 mV/div	Off	20 MHz	0.00 mV	-7.00 mV	-7.71 mV	-6.30 mV
5 mV/div	Off	20 MHz	-82.5 mV	-100 mV	-102 mV	-97.8 mV
50 mV/div	Off	Full	825[1] mV	1.00 V	978 mV	1.02 V
50 mV/div	Off	Full	825[1] mV	650 mV	628 mV	672 mV
90 mV/div [2]	Off	Full	0.00 mV	-315 mV	-351 mV	-279 mV
200 mV/div	Off	250 MHz	9.30 V	10.0 V	9.88 V	10.1 V

1 Set the vertical offset to 0 V before adjusting the vertical offset to 825 mV.

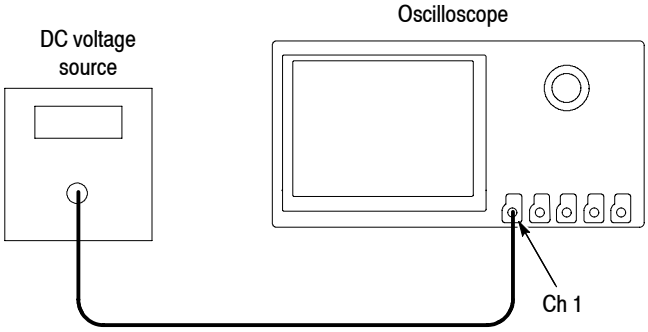
2 Push the **Fine Scale** lower bezel button, and use the general purpose knob to adjust the setting to 90 mV/div.

15. For each row of the preceding table, do these steps:
    a. Set the Vertical **Scale** knob to the setting in the table.
    b. Set the **Invert** to the setting in the table.
    c. Set the **Bandwidth Limit** controls to the setting in the table.
    d. Set the **Offset** to the setting in the table.
    e. Set the output of the DC voltage source to the voltage level in the table.
    f. Verify that the oscilloscope Mean Value measurement is within the limits listed in the table.
16. Repeat steps 15a through 15f for each row in the table.
17. Push the channel button to turn off the channel display.
18. Repeat steps 8 through 17 for each channel of the oscilloscope (not including the **Aux In** input).

Check DC Voltage Measurement Accuracy 50 Ω

This test checks the DC voltage measurement accuracy in the average acquisition mode with a 50 Ω termination.

1. Set the DC voltage source output level to **0 V**.
2. Connect the DC voltage source to the oscilloscope channel 1 input as shown below. Push the channel 1 button (**1**).



3. Push the Save/Recall **Default Setup** button to set the instrument to the factory default settings.
4. Push channel 1 button (**1**) and then push the **Coupling** lower bezel button. Push the **50 Ω** side bezel button.
5. Push the Horizontal **Acquire** button.
6. Push the **Mode** lower bezel button, and then push the **Average** side bezel button.
7. Adjust the number of averages to **16** with the **Multipurpose a** knob.
8. Go to step 11.
9. Move the DC voltage source output cable to the oscilloscope channel that you want to check.
10. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.
11. Push the Wave Inspector **Measure** button.
12. Push the **Select Measurement** lower bezel button.
13. Push the **– more –** side bezel button until you display the **Mean** measurement.
14. Push the **Mean** side bezel button.
15. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.

Table 2-2: DC voltage measurement accuracy 50 Ω

Vertical scale	Invert	Bandwidth limit	Offset	Input voltage	Low limit	High limit
1 mV/div	Off	20 MHz	96.5 mV	100 mV	98.9 mV	101 mV
2 mV/div	Off	20 MHz	0.00 mV	-7.00 mV	-7.81 mV	-6.2 mV
5 mV/div	Off	20 MHz	-82.5 mV	-100 mV	-102 mV	-97.8 mV
50 mV/div	Off	Full	825[1] mV	1.00 V	978 mV	1.02 V
50 mV/div	Off	Full	825[1] mV	650 mV	628 mV	672 mV
90 mV/div [2]	Off	Full	0.00 mV	-315 mV	-351 mV	-279 mV
200 mV/div	Off	Full	3.00 V	2.50 V	2.42 V	2.58 V

1 Set the vertical offset to 0 V before adjusting the vertical offset to 825 mV.

2 Push the **Fine Scale** lower bezel button, and use the general purpose knob to adjust the setting to 90 mV/div.

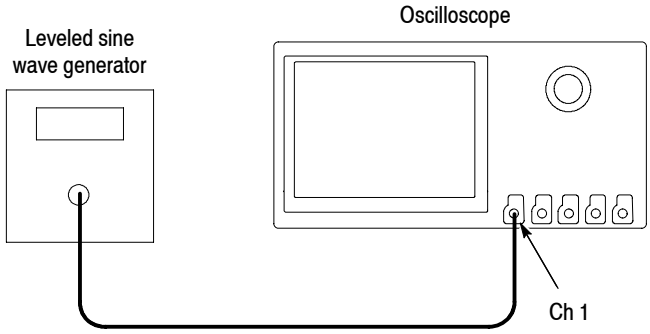
16. For each row of the preceding table, do these steps:
    a. Set the Vertical **Scale** knob to the setting in the table.
    b. Set the **Invert** to the setting in the table.
    c. Set the **Bandwidth Limit** controls to the setting in the table.
    d. Set the **Offset** to the setting in the table.
    e. Set the output of the DC voltage source to the voltage level in the table.
    f. Verify that the oscilloscope Mean Value measurement is within the limits listed in the table.
17. Repeat steps 16a through 16f for each row in the table.
18. Push the channel button to turn off the channel display.
19. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you next want to check. Then push the **Coupling** lower bezel button. Push the **50 Ω** side bezel button.
20. Repeat steps 9 through 18 for each channel of the oscilloscope (not including the **Aux In** input).

Check Bandwidth

This test checks the bandwidth at 50 Ω and 1 MΩ for each channel. Begin by testing the bandwidth at 50 Ω and then repeat steps 12 through 29 to test the bandwidth at 1 MΩ.

Check bandwidth at 50 Ω.

1. Connect the output of the leveled sine wave generator to the oscilloscope channel 1 input as shown below.



2. Push the Save/Recall **Default Setup** button to set the instrument to the factory default settings; push the **Menu Off** button.
3. Push the Horizontal **Acquire** button.
4. Push the **Mode** lower bezel button, and then push the **Average** side bezel button.
5. Adjust the number of averages to **16** with the **Multipurpose a** knob; push the **Menu Off** button.
6. Push the Trigger **Menu** button.
7. Push the **Source** lower bezel button.
8. Push the **1** side bezel button.
9. Push the **Coupling** lower bezel button.
10. Push the **Noise Reject (DC Low Sensitivity)** side bezel button; push the **Menu Off** button.
11. Go to step 13.
12. Move the output cable of the leveled sine wave generator to the oscilloscope channel that you want to check.
13. Set the Horizontal **Scale** to **10 µs**.

14. Push the channel button for the channel (**1**, **2**, **3**, or **4**) and the trigger source to match the channel that you are testing.
15. Push the channel button again for the channel (**1**, **2**, **3**, or **4**) that you are testing and then push the **Coupling** lower bezel button.
16. Push the **Ω** side bezel button, and then select **50**. If you are testing 1 MΩ, select **1M**.
17. Push the **Menu Off** button.
18. Push the Wave Inspector **Measure** button.
19. Push the **Select Measurement** lower bezel button.
20. Push the **- more -** screen button until the **Pk-Pk** side bezel button displays.
21. Push the **Pk-Pk** side bezel button; push the **Menu Off** button.
22. Set the Vertical **Scale** to **100 mV**.
23. Set the output frequency of the leveled sine wave generator to **50 kHz**.
24. Set the output amplitude of the leveled sine wave generator so that the peak-to-peak Mean measurement is between **599 mV** and **601 mV**.
25. Set the Horizontal **Scale** to **10 ns**.
26. Set the output frequency of the leveled sine wave generator to the frequency shown in the table below.

Oscilloscope model	Frequency 50 Ω	Frequency 1 MΩ
DPO4104	1000 MHz	380 MHz, *Note: 380 MHz, rather than 500 MHz, is used due to an impedance mismatch between the signal generator and the oscilloscope. Passing this test with a 380 MHz signal verifies 500 MHz performance on the 1 MΩ path on models DPO4054 and DPO4104.*
DPO4054	500 MHz	
DPO4034	350 MHz	350 MHz
DPO4032	350 MHz	350 MHz

27. Verify that the peak-to-peak Mean measurement is **≥425 mV**.
28. Push the channel button (**1**, **2**, **3**, or **4**) twice to turn off the channel display.
29. Repeat steps 12 through 28 for each channel of the oscilloscope, except the Aux In input.

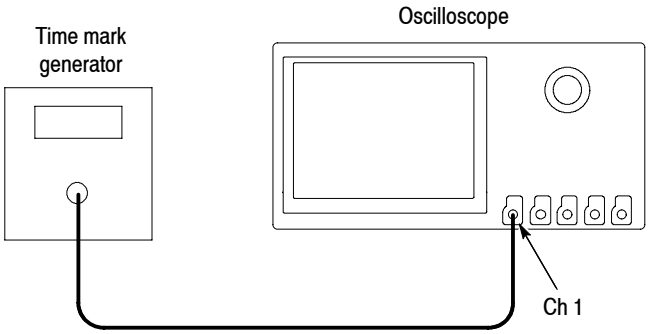
Check bandwidth at 1 MΩ.

1. Repeat steps 12 through 29 to test the bandwidth at 1 MΩ.

Check Sample Rate and Delay Time Accuracy

This test checks the time base accuracy.

1. Connect the output of the time mark generator to the oscilloscope channel 1 input using a 50 Ω cable as shown below.
2. Set the time mark generator period to **80 ms**. Use a time mark waveform with a fast rising edge.



3. Push the Save/Recall **Default Setup** button to set the instrument to the factory default settings; push the **Menu Off** button.
4. Push the channel **1** button.
5. Push the **Coupling** lower bezel button.
6. Push the **Ω** side bezel button to select **50**; push the **Menu Off** button.
7. If adjustable, set the time mark amplitude to approximately **1 V_{p-p}**.
8. Set the Vertical **SCALE** to **500 mV**.
9. Set the Horizontal **SCALE** to **20 ms**.
10. Adjust the Vertical **POSITION** knob to center the time mark signal on the screen.
11. Adjust the Trigger **LEVEL** knob as necessary for a triggered display.
12. Adjust the Horizontal **POSITION** knob to move the trigger location to the center of the screen (50%).
13. Turn the Horizontal **POSITION** knob counterclockwise to set the delay to exactly **80 ms**.
14. Set the Horizontal **Scale** to **400 ns/div**.

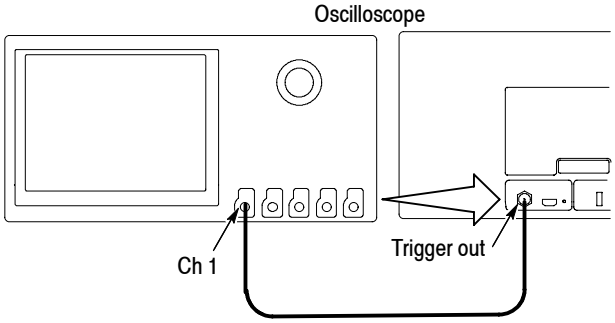
15. Check that the rising edge of the marker crosses the center horizontal graticule line within ±1 divisions of center graticule.

***NOTE**. One division of displacement from graticule center corresponds to a 10 ppm time base error.*

Check Trigger Out

This test checks the Trigger Out logic levels.

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 Save/Recall **Default Setup** button to set the instrument to the factory default settings; push the **Menu Off** button.
3. Push the channel **1** button.
4. Push the **Coupling** lower bezel button.
5. Push the **Ω** side bezel button to select **50**; push the **Menu Off** button.
6. Set the Vertical **SCALE** to **500 mV**.
7. Push the Wave Inspector **Measure** button.
8. Push the **Select Measurement** lower bezel button.
9. Push the **- more -** screen button until the **High** side bezel button displays.
10. Push the **High** side bezel button.
11. Push the **Low** side bezel button.
12. Push the **Menu Off** button.
13. Check that the High measurement is ≥1.0 V.
14. Check that the Low measurement is ≤0.25 V.

This completes the performance verification procedure.