Technical Reference

Tektronix

DPO4000 Series
Digital Phosphor Oscilloscopes
Specifications and Performance Verification

071-1843-02

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.

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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.*

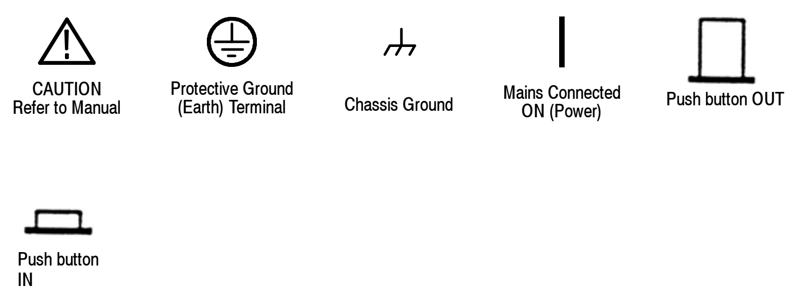
***CAUTION.** Caution statements identify conditions or practices that could result in damage to this product or other property.*

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:



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.)

<table>
<tr><th>Characteristic</th><th colspan="3">Description</th></tr>
<tr><td>✓ DC Balance</td><td colspan="3">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</td></tr>
<tr><td>Delay between channels, full bandwidth, typical</td><td colspan="3">≤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.</td></tr>
<tr><td>Deskew range</td><td colspan="3">-100 ns to +100 ns with a resolution of 20 ps</td></tr>
<tr><td>Crosstalk (channel isolation), typical</td><td colspan="3">≥ 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</td></tr>
<tr><td>TekVPI Interface</td><td colspan="3">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.</td></tr>
<tr><td>Total probe power</td><td colspan="3">DPO4032, DPO4034, DPO4054: 50 W

DPO4104: 50 W with a derating of 0.8 W/°C for ambient temperatures ≥ 25 °C</td></tr>
<tr><td rowspan="3">Probe power per channel</td><td>Voltage</td><td>Max Amperage</td><td>Voltage Tolerance</td></tr>
<tr><td>5 V</td><td>50 mA (250 mW)</td><td>±5%</td></tr>
<tr><td>12 V</td><td>2 A (24 W)</td><td>±10%</td></tr>
<tr><td>Number of digitized bits</td><td colspan="3">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).</td></tr>
<tr><td rowspan="2">Sensitivity range (coarse)</td><td colspan="2">1 MΩ</td><td>50 Ω</td></tr>
<tr><td colspan="2">1 mV/div to 10 V/div in a 1-2-5 sequence</td><td>1 mV/div to 1 V/div in a 1-2-5 sequence</td></tr>
</table>

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

Characteristic	Description			
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 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 MΩ. 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	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 bandwidth, 1 MΩ, 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. 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 using a P6139A probe.			
	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 300 MHz	DC to 175 MHz
	DPO4054	DC to 380 MHz	DC to 300 MHz	DC to 175 MHz

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

Characteristic	Description			
	Instrument	*5 mV/div to 10 V/div*	*2 mV/div to 4.98 mV/div*	*1 mV/div to 1.99 mV/div*
	DPO4034	DC to 350 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4032	DC to 350 MHz	DC to 300 MHz	DC to 175 MHz
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	DC to 500 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4054	DC to 500 MHz	DC to 300 MHz	DC to 175 MHz
	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 350 MHz	DC to 300 MHz	DC to 175 MHz
	DPO4054	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	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	*1 MΩ (P6139A probe): 10 mV/div to 19.9 mV/div*	*1 MΩ (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	

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

Characteristic	Description	
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
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.	

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

Characteristic	Description		
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.		
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.		

[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 Enve-lope 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 records having duration ≤ 1 minute
Number of Wave-forms for Average Acquisition Mode	2 to 128 waveforms Default of 16 waveforms

Table 1-3: Trigger specifications

Characteristic	Description
Aux In (External) trig-ger 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) trig-ger input impedance, typical	1 MΩ ±1% in parallel with 13 pF ±2 pF
Aux In (External) trig-ger 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, Time-out, or Width trigger-ing	*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 1-3: 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 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
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	

Table 1-3: Trigger specifications (Cont.)

<table>
<tr><th>Characteristic</th><th colspan="4">Description</th></tr>
<tr><td rowspan="4">Video-type trigger sensitivity, typical</td><td colspan="4">The limits for both delayed and main trigger are as follows:</td></tr>
<tr><td colspan="2">Source</td><td colspan="2">Sensitivity</td></tr>
<tr><td colspan="2">Any input channel</td><td colspan="2">0.6 to 2.5 divisions of video sync tip</td></tr>
<tr><td colspan="2">Aux In (External)</td><td colspan="2">Video not supported through Aux In (External) input</td></tr>
<tr><td>Video-type trigger formats and field rates</td><td colspan="4">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.</td></tr>
<tr><td>Logic-type or logic qualified trigger or events-delay sensitivities, DC coupled, typical</td><td colspan="4">1.0 division from DC to maximum bandwidth</td></tr>
<tr><td>Pulse-type runt trigger sensitivities, typical</td><td colspan="4">1.0 division from DC to maximum bandwidth</td></tr>
<tr><td>Pulse-type trigger width and glitch sensitivities, typical</td><td colspan="4">1.0 division</td></tr>
<tr><td rowspan="5">Logic-type triggering, minimum logic or rearm time, typical</td><td colspan="4">For all vertical settings, the minimums are:</td></tr>
<tr><td>Trigger type</td><td>Minimum pulse width</td><td>Minimum re-arm time</td><td>Minimum time between channels [1]</td></tr>
<tr><td>Logic</td><td>Not applicable</td><td>2 ns</td><td>1 ns</td></tr>
<tr><td>Time Qualified Logic</td><td>4 ns</td><td>2 ns</td><td>1 ns</td></tr>
<tr><td colspan="4">[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.</td></tr>
<tr><td rowspan="4">Minimum clock pulse widths for setup/hold time violation trigger, typical</td><td colspan="4">For all vertical settings, the minimums are:.</td></tr>
<tr><td colspan="2">Minimum pulse width, clock active[2]</td><td colspan="2">Minimum pulse width, clock inactive[2]</td></tr>
<tr><td colspan="2">User hold time + 2.5 ns[3]</td><td colspan="2">2 ns</td></tr>
<tr><td colspan="4">[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.</td></tr>
</table>

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description		
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
	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		

Table 1-3: Trigger specifications (Cont.)

Characteristic	Description
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 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

<table>
<tr><th>Characteristic</th><th colspan="2">Description</th></tr>
<tr><td>Ethernet interface</td><td colspan="2">Standard on all models: 10/100 Mb/s</td></tr>
<tr><td>USB interface</td><td colspan="2">1 Device and 3 Host connectors (all models)</td></tr>
<tr><td>GPIB interface</td><td colspan="2">Available as an optional accessory that connects to USB Device and USB Host port. with the TEK-USB-488 GPIB to USB Adapter.

Control interface is incorporated in the instrument user interface.</td></tr>
<tr><td>Video signal output</td><td colspan="2">A 15 pin, XGA RGB-type connector</td></tr>
<tr><td>Probe compensator output voltage and frequency, typical</td><td colspan="2">Output voltage: 0 V to 2.5 V ±1% behind 1 kΩ ±2%
Frequency: 1 kHz ±100 ppm</td></tr>
<tr><td rowspan="4">Trigger (Auxiliary) output (AUX OUT)</td><td colspan="2">LOW TRUE; LOW to HIGH transition indicates that the trigger occurred. The logic levels are:</td></tr>
<tr><td>Characteristic</td><td>Limits</td></tr>
<tr><td>Vout (HI)</td><td>≥2.5 V open circuit; ≥1.0 V into a 50 Ω load to ground</td></tr>
<tr><td>Vout (LO)</td><td>≤0.7 V into a load of ≤4 mA; ≤0.25 V into a 50 Ω load to ground</td></tr>
</table>

Table 1-6: 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 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

Table 1-8: Environmental specifications (Cont.)

Characteristic	Description
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 8 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 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		

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:				
Channel 3 Input Impedance, 1 MΩ	10 mV/div	990 kΩ		1.01 M Ω
	100 mV/div	990 kΩ		1.01 M Ω
	1 V/div	990 kΩ		1.01 M Ω
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 M Ω
	100 mV/div	990 kΩ		1.01 M Ω
	1 V/div	990 kΩ		1.01 M Ω
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
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

Performance checks	Vertical scale	Low limit	Test result	High limit
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
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:				
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

Performance checks	Vertical scale	Low limit	Test result	High limit
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
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						
Band-width at Channel	Imped-ance	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:						
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	
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%

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%

Performance checks	Vertical scale	Low limit	Test result	High limit
DPO4104, DPO4054, DPO4034:				
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%
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%

Performance checks	Vertical scale	Low limit	Test result	High limit
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**	**Low limit**	**Test result**	**High limit**
All models:				
Channel 1 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
Channel 1 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
	1 V/div 99.5 V offset	-598.5 mV		598.5 mV
	1 V/div -99.5 V offset	-598.5 mV		598.5 mV

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 2 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
Channel 2 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
	1 V/div 99.5 V offset	-598.5 mV		598.5 mV
	1 V/div -99.5 V offset	-598.5 mV		598.5 mV

Performance checks	Vertical scale	Low limit	Test result	High limit
DPO4104, DPO4054, DPO4034:				
Channel 3 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	-1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
Channel 3 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
	1 V/div 99.5 V offset	-598.5 mV		598.5 mV
	1 V/div -99.5 V offset	-598.5 mV		598.5 mV

Performance checks	Vertical scale	Low limit	Test result	High limit
Channel 4 DC Offset Accuracy, 20 MHz BW, 50 Ω	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
Channel 4 DC Offset Accuracy, 20 MHz BW, 1 MΩ	1 mV/div 1.0 V offset	-5.1 mV		5.1 mV
	1 mV/div -1.0 V offset	-5.1 mV		5.1 mV
	2 mV/div 500 mV offset	-3 mV		3 mV
	2 mV/div -500 mV offset	-3 mV		3 mV
	10 mV/div 500 mV offset	-3.5 mV		3.5 mV
	10 mV/div -500 mV offset	-3.5 mV		3.5 mV
	100 mV/div 5.0 V offset	-35 mV		35 mV
	100 mV/div -5.0 V offset	-35 mV		35 mV
	1 V/div 99.5 V offset	-598.5 mV		598.5 mV
	1 V/div -99.5 V offset	-598.5 mV		598.5 mV

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

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.

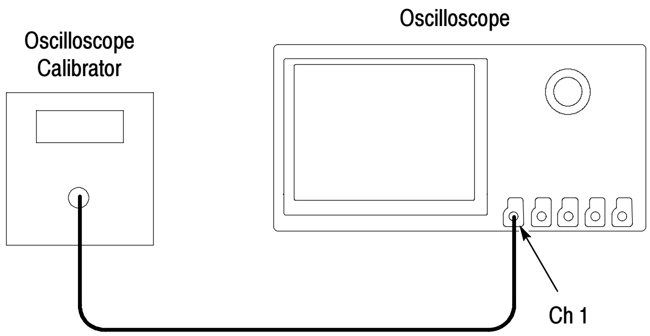
7. Wait while the self test runs. When the self test completes, a dialog box displays the results of the self test.

8. Push the **Menu Off** button to clear the dialog box and Self Test menu.

Check Input Impedance (Resistance)

This test checks the Input Impedance.

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

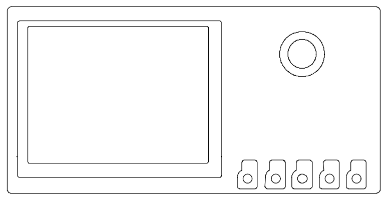


2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings; push the **Menu Off** button.
3. Confirm that the oscilloscope and calibrator impedances are both set to 1 MΩ. On some oscilloscope models, push the relevant channel button (e.g. **1**) and then push the **Coupling** lower-bezel button. Push the **1M Ω** side-bezel button. On other models, push the lower-bezel **Impedance** button, if needed, to select **50 Ω**. Push the **Menu Off** button.
4. Push the channel button for the oscilloscope channel that you are testing, as shown in the test record (e.g. **1**, **2**, **3**, or **4**).
5. Turn **Vertical Scale** knob to set the vertical scale, as shown in the test record (e.g. 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/div setting in the test record.
8. Change the oscilloscope and calibrator impedance to 50 Ω and repeat steps 5 through 7.
9. Repeat steps 3 through 8 for each channel listed in the test record and relevant to the model of oscilloscope that you are testing.

Check DC Balance

This test checks the DC balance.

You do not need to connect the oscilloscope to any other 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 (e.g. **1**, **2**, **3**, or **4**).

4. Set the oscilloscope impedance to 50 Ω. On some models (if needed), push the **Coupling** lower–bezel button, and push the **50 Ω** side–bezel button. On other models (if needed), push the lower–bezel **Impedance** button to select **50 Ω**. Push the **Menu Off** button.

5. Enter the lower-bezel **Bandwidth** button and the side-bezel bandwidth selection (e.g. **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 (e.g. 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. Press the Trigger **Menu** front-panel button.

12. Press the **Source** lower-bezel button.

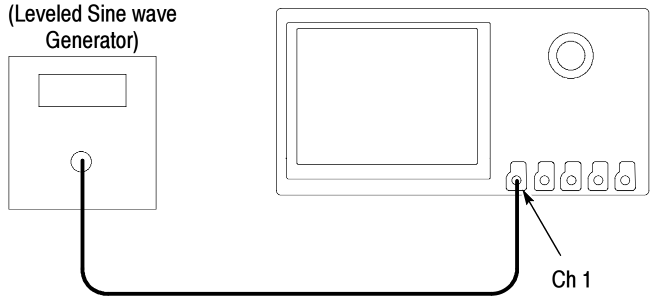
13. Select the **AC Line** trigger source on the side menu. Notice that you do not need to hook up any external signal to the oscilloscope for this DC Balance test.

14. Push the Wave Inspector **Measure** button.
15. Push the **Select Measurement** lower bezel button.
16. Push the **- more -** side bezel button as many times as needed to display the **Mean** measurement (e.g. menu 6 of 7).
17. Push the **Mean** 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. Change the oscilloscope bandwidth (e.g. 20 MHz, 250 MHz, and 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 (e.g. **1**, **2**, **3**, or **4**).

Check Bandwidth

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

1. Connect the output of the leveled sine wave generator (e.g. 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; push the **Menu Off** button.

3. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.

4. Set the calibrator to 50 Ω output impedance (50 Ω source impedance) and to generate a sine wave.

5. Set the oscilloscope impedance to 50 Ω. On some models (if needed), push the **Coupling** lower–bezel button, and push the **50 Ω** side–bezel button. On other models (if needed), push the lower–bezel **Impedance** button to select **50 Ω**. Push the **Menu Off** button.

6. Turn the Vertical **Scale** knob to set the vertical scale, as shown in the test record (e.g. 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 8 vertical divisions at the selected vertical scale with a set frequency of 50 KHz (e.g. at 5 mV/div., use a ≥ 40 mV_{p-p} signal, at 2 mV/div., use a ≥ 16 mV_{p-p} signal, at 1 mV/div., use a ≥ 8 mV_{p-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 **Measure** button, the lower-bezel **Select Measurement** item, and the side-menu **Pk–Pk** measurement. This will provide you with a mean V_{p-p} of the signal. Call this reading V_{in-pp}.

    Record the value of V_{in-pp} (e.g. 816 mV) in the test record.

12. Turn the Horizontal **Scale** knob to 1 ns/division.

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

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

***NOTE**. For more information on the contents of this worksheet, refer to the bandwidth specifications in Table 1-1 on page 1-3 and 1-4.*

Table 2-1: Maximum Bandwidth Frequency Worksheet

Model: DPO4104		
Impedance	**Vertical Scale**	**Maximum bandwidth frequency**
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 MΩ	2 mV/div	300 MHz
1 MΩ	1 mV/div	175 MHz

Model: DPO4054		
Impedance	**Vertical Scale**	**Maximum bandwidth frequency**
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 MΩ	2 mV/div	300 MHz
1 MΩ	1 mV/div	175 MHz

Model: DPO4034 and DPO4032		
Impedance	**Vertical Scale**	**Maximum bandwidth frequency**
50 Ω	5 mV/div	350 MHz

Table 2-1: (Cont.)Maximum Bandwidth Frequency Worksheet

Impedance	Vertical Scale	Maximum bandwidth frequency
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

14. 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.

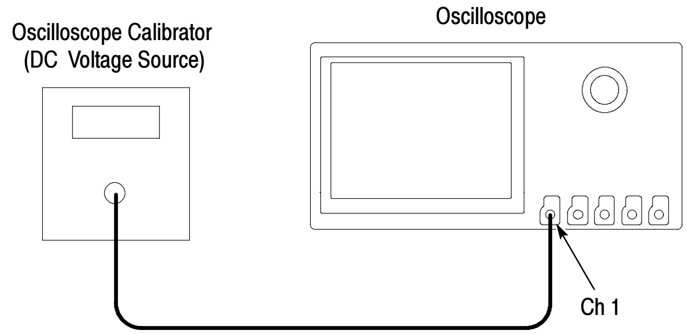
15. Repeat steps 10 through 14 above for the other oscilloscope volts/div listed in the test record.

16. Change the oscilloscope impedance to 1 MΩ, set the calibrator to 1 MΩ impedance (25 Ω source impedance), and repeat steps 10 through 15.

17. Repeat steps 3 through 16 for each channel combination listed in the test record and relevant to your model of oscilloscope (e.g. **1**, **2**, **3**, or **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**, or **4**) for the channel that you want to check.
4. Confirm that the oscilloscope and calibrator impedances are both set to 50 Ω. On some oscilloscope models, push the relevant channel button (e.g. **1**) and then push the **Coupling** lower-bezel button. Push the **50 Ω** side-bezel button. On other models, push the lower-bezel **Impedance** button, if needed, to select **50 Ω**. Push the **Menu Off** button.
5. Push the lower-bezel **Bandwidth** button.
6. Push the side-bezel button to select the bandwidth to **20 MHz**.
7. Push the front-panel **Acquire** button.
8. Check that the **Mode** lower-bezel button is selected. If not, push it to select it, and then, if needed, push the **Average** side bezel button.
9. Check that the menu item next to the **Average** mode side-bezel button mode shows **16**. If not, push the **Average** side-bezel button and adjust the number of averages to **16** by turning the **Multipurpose a** knob.
10. Push the front-panel **Measure** button, the lower-bezel **Select Measurement** button, and the side-bezel **Mean** selection.
11. Push the Trigger **Menu** front-panel button.
12. Push the **Source** lower-bezel button.
13. Select the **AC Line** trigger source on the side menu.

14. Turn the vertical **Scale** knob to the next setting to measure, as shown on the table below.

15. Set the DC Voltage Source to $V_{negative}$ (see table below). Push **Statistics** in the lower–bezel menu and **Reset Statistics** in the side–bezel menu. Enter the mean reading into the table below as $V_{negative-measured}$.

16. Set the DC Voltage Source to $V_{positive}$ (see table below). Push **Statistics** in the lower–bezel menu and **Reset Statistics** in the side–bezel menu. Enter the mean reading into the table below as $V_{positive-measured}$.

Table 2-2: 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				

17. Calculate V_{diff} as follows:

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

Enter V_{diff} in the table above.

18. Calculate *GainAccuracy* as follows:

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

Write down *GainAccuracy* in the table above and in the test record.

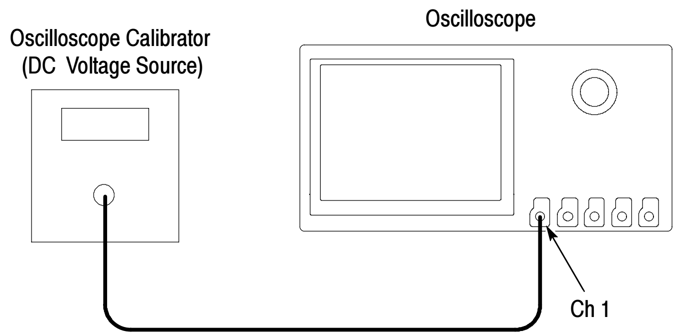
19. Repeat steps 14 through 18 for each volts/division value in the test record.

20. Change the oscilloscope impedance to 1 MΩ, and repeat steps 14 through 19.

21. Repeat steps 3 through 20 for each channel of the oscilloscope that you want to check.

Check Offset Accuracy

This test checks the offset accuracy.



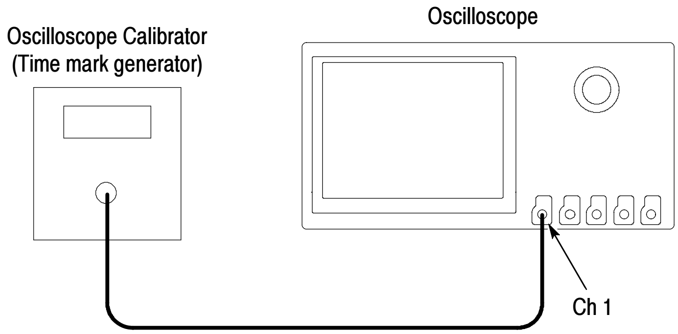
1. Connect the oscilloscope to a DC voltage source to run this test. If using the Wavetek calibrator as the DC voltage source, connect the calibrator head to the oscilloscope channel to test.
2. Push the Save/Recall **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel button (**1**, **2**, **3**, or **4**) for the channel that you want to check.
4. Confirm that the oscilloscope and calibrator impedances are both set to 50 Ω. On some oscilloscope models, push the relevant channel button (e.g. **1**) and then push the **Coupling** lower-bezel button. Push the **50 Ω** side-bezel button. On other models, push the lower-bezel **Impedance** button, if needed, to select **50 Ω**. Push the **Menu Off** button.
5. Set the calibrator to the vertical offset value shown in the test record (e.g. 1.0 V 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 (e.g. 1.0 V for a 1 mV/div setting).
7. Turn the vertical **Scale** to match the value in the test record (e.g. 1 mV/division).
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. Check that the vertical position is set to 0 divs. If not, turn the Vertical **Position** knob to set the position to 0 or press the appropriate **Set to 0 divs** button.
12. Push the front-panel **Acquire** button.
13. If **Mode** is not selected on the lower-bezel menu, push the **Mode** lower-bezel button, and then, if **Average** is not selected on the side-menu, push the **Average** side bezel button.
14. If the number of averages is not already set to **16**, set it to **16** with the **Multipurpose a** knob.
15. Press the Trigger **Menu** front-panel button.
16. Press the **Source** lower-bezel button.
17. Select the **AC Line** trigger source on the side-bezel menu.
18. Determine the mean value by pressing the front-panel **Measure** button, the lower-bezel **Select Measurement** button, and the side-menu **Mean** button. The mean value should appear in a measurement pane at the bottom of the display.
19. Subtract the mean value from the offset value. Enter the difference in the test record (e.g. 1.0 V – 997.3 mV = 2.7 mV).
20. Repeat the procedure for each volts/div setting shown in the test record.
21. Change the impedance to **1 MΩ** and repeat steps 5 through 20.
22. Repeat steps 3 through 21 for each channel of the oscilloscope that you want to check.

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.



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; push the **Menu Off** button.

4. Push the channel **1** button.

5. Set the impedance to 50 Ω. On some models, push channel 1 button (**1**) and then push the **Coupling** lower-bezel button. Push the **50 Ω** side-bezel button. On other models, push the lower-bezel **Impedance** button, if needed, to select **50 Ω**. Push the **Menu Off** button.

6. If adjustable, set the time mark amplitude to approximately **1** $\mathbf{V_{p\text{-}p}}$.

7. Set the Vertical **SCALE** to **500 mV**.

8. Set the Horizontal **SCALE** to **20 ms**.

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**.

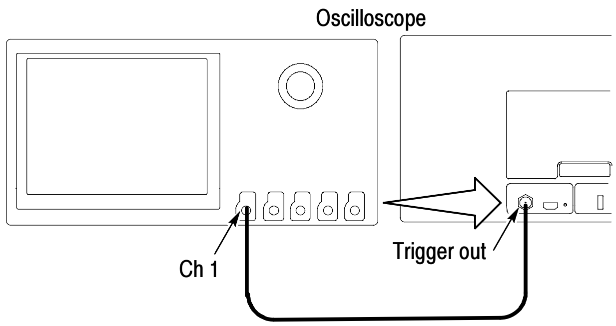
14. Compare the rising edge of the marker with the center horizontal graticule line. The rising edge should be within ±1 divisions of center graticule. Enter the deviation in the test record.

***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; push the **Menu Off** button.
3. Push the channel **1** button.
4. If needed, set the impedance to 1 MΩ. On some models, push channel 1 button (**1**) and then push the **Coupling** lower-bezel button. Push the **1 MΩ** side-bezel button. On other models, push the lower-bezel **Impedance** button, if needed, to select **1 MΩ**. Push the **Menu Off** button.
5. Set the horizontal to 4 uS/div and the vertical to 1 V/div.
6. Push the front-panel **Measure** button.
7. Push the **Select Measurement** lower-bezel button.
8. Push the **– more –** side-bezel menu button repeatedly until the **Low** side-bezel button displays.
9. Push **Low**.
10. If needed, push the **– more –** side-bezel button repeatedly until the **High** side-bezel button displays.
11. Push **High**.
12. Record the high and low measurements (e.g. low = 200 mV and high = 3.52 V).
13. Repeat the procedure, using **50 Ω** instead of **1 MΩ** in step 4.

This completes the performance verification procedure.