DPO2000 and MSO2000 Series Oscilloscopes
Specifications and Performance Verification

Technical Reference

077-0096-00

Tektronix

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Technical Reference

Revision A

This document supports firmware version 1.03 and above for both MSO2000 Series instruments and DPO2000 Series instruments.

Warning

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

www.tektronix.com

077-0096-00

Tektronix

Contacting Tektronix

Tektronix, Inc.
14200 SW Karl Braun Drive
P.O. Box 500
Beaverton, OR 97077
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.

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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.

Connect the probe reference lead to earth ground only.

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

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

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

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

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

Use Proper AC Adapter. Use only the AC adapter specified for this product.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

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

Terms in this Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

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

Symbols and Terms on the Product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.

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

Specifications

Specifications

This chapter contains specifications for the DPO2000 and the MSO2000 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 DPO2000 and MSO2000 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 prior to evaluating specifications. (See page 2-7, *Signal Path Compensation (SPC)*.) If the operating temperature changes by more than 10 °C (18 °F), you must perform the SPC operation again.

Table 1-1: Analog channel input and vertical specifications

Characteristic	Description	
Number of input channels	*DPO2012, MSO2012*	*DPO20x4, MSO20x4*
	2 analog, digitized simultaneously	4 analog, digitized simultaneously
Input coupling	DC, AC, or GND AC coupling connects a capacitor in series with the input circuitry. GND coupling provides a reference waveform derived from the values identified during SPC. This reference waveform shows visually where ground is expected to be.	
Input resistance, DC coupled	1 MΩ ±2%	
Input capacitance, DC coupled	11.5 pF ±2 pF	
Maximum input voltage	The maximum input voltage at the BNC, between the center conductor and shield is 450 V_{peak} (<100 ms duration), 300 V_{RMS} to 4 MHz, derated to 6 V_{RMS} at 200 MHz.	
✓ DC Balance	±(1 mV + 0.1 div)	
Deskew range	±100 ns, analog channels only	
Crosstalk (channel isolation), typical	DPO2024, MSO2024	≥100:1 with 200 MHz sinewave and equal V/div settings on each channel.
	DPO201x, MSO201x	≥100:1 with 100 MHz sinewave and equal V/div settings on each channel.
TekVPI Interface	The probe interface allows installing, powering, compensating, and controlling a wide range of probes offering a variety of features If a probe requires 12 V bulk power, it must be supplied by the Optional External Power Adapter The interface is available on all front panel inputs including Aux In	
Total probe power	50 W from optional 12 V VPI External Power Adapter Zero 12 V bulk power without optional External Power Adapter	

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

Characteristic	Description			
Number of digitized bits	8 bits Displayed vertically with 25 digitization levels (DL) per division, 10 divisions dynamic range. Only 8 vertical divisions are displayed "DL" is the abbreviation for "digitization level." A DL is the smallest voltage level change that can be resolved by the 8-bit A-D Converter. This value is also known as the LSB (least significant bit).			
Sensitivity range	2 mV/div to 5 V/div in a 1-2-5 sequence with probe attenuation set to 1X			
✓ Position range	±4 divisions			
✓ Analog bandwidth, DC coupled	*Instrument*	*5 mV/div to 5 V/div with an ambient temperature of 0 °C to 40 °C (0 °F to 104 °F)*	*5 mV/div to 5 V/div with an ambient temperature of 0 °C to 50 °C (0 °F to 122 °F)*	*<5 mV/div*
	DPO2024, MSO2024	DC to ≥200 MHz	DC to ≥160 MHz	20 MHz
	DPO2014, MSO2014, DPO2012, MSO2012	DC to ≥100 MHz		20 MHz
Calculated rise time	The rise time is calculated from the 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	*Risetime*		
	DPO2024, MSO2024	2.1 ns		
	DPO2014, MSO2014, DPO2012, MSO2012	3.5 ns		
Common mode rejection ratio (CMRR), typical	100:1 at 60 Hz, reducing to 10:1 with 50 MHz sinewave with equal Volts/div and Coupling settings on each channel.			
Lower frequency limit, AC coupled, typical	≤10 Hz			
Upper frequency limit, 20 MHz bandwidth limited, typical	20 MHz, +50%, –0%			
✓ DC gain accuracy	±3%, 5 V/div through 10 mV/div ±4%, 5 mV/div and 2 mV/div More than shown above when using variable gain			

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

Characteristic	Description	
DC voltage measurement accuracy, Average acquisition mode, typical	*Measurement type*	*DC Accuracy (in volts)*
	Average of ≥ 16 waveforms	±[DC gain accuracy) × |reading - (offset - position)| + Offset Accuracy]
	Delta Volts between any two averages of ≥16 waveforms acquired with the same oscilloscope setup and ambient conditions	±[DC gain accuracy × |reading|]
	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, and Min. 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.	
✓ Vertical offset ranges	*Volts/div setting*	*Offset range*
	2 mV/div to 200 mV/div	±1 V
	>200 mV/div to 5 V/div	±25 V
Vertical offset accuracy	±[0.01 × |offset - position| + DC Balance] Note: Both the position and constant offset term must be converted to volts by multiplying by the appropriate volts/div term.	

Table 1-2: Digital channel input specifications, MSO2000 only

Characteristic	Description
Threshold voltage range	-20 V to +20 V, selectable in two groups of 8
✓ Digital threshold accuracy	±[100 mV + 3% of the threshold setting after calibration]
Digital channel timing resolution, sample rate	1 ns when the lower ordered group of 8 inputs on the digital probe cable are used exclusively 2 ns whenever inputs from the upper ordered group of 8 inputs on the digital probe cable are used. That is, all 16 digital channels would be sampled at 2 ns intervals
Min Detectable Pulse, typical	5 ns
Number of Input Channels	16 Digital Inputs
Input Resistance, typical	101 kΩ to ground
Input Capacitance, typical	8 pF
Min Input Signal Swing, typical	500 mV_{p-p}
Max Input Signal Swing, typical	±20 V, centered on the threshold voltage
Peak Input Voltage Range (DC + Peak AC)	±40 V
Digital Channel to Digital Channel Skew	2 ns, typical 3 ns, maximum

Table 1-2: Digital channel input specifications, MSO2000 only (cont.)

Characteristic	Description
Digital Record Length	1 Million Samples at all time base settings when a single set of 8 inputs are used, all from the same physical half of the digital probe cable 1 Million Samples at time base settings from 100 sec/div to 200 μs/div when inputs from both halves of the digital probe cable are used 500,000 Samples at time base settings from 100 μs/div to 2 ns/div when inputs from both halves of the digital probe cable are used

Table 1-3: Horizontal and acquisition system specifications

<table>
<tr><th>Characteristic</th><th colspan="2">Description</th></tr>
<tr><td>Long-term sample rate and horizontal position time accuracy</td><td colspan="2">±25 ppm over any ≥1 ms time interval</td></tr>
<tr><td rowspan="5">Delta time measurement accuracy</td><td colspan="2">The limits below are for signals having amplitude >5 divisions, slew rate at the measurement points of >2.0 divisions/ns, and acquired at >10 mV/div:</td></tr>
<tr><td>Condition</td><td>Time Measurement Accuracy</td></tr>
<tr><td>Single shot, full bandwidth selected</td><td>±[1 Sample Interval + 25 ppm × |reading| + 0.6 ns]</td></tr>
<tr><td>>16 averages, full bandwidth selected</td><td>±[1 Sample Interval + 25 ppm × |reading| + 0.4 ns]</td></tr>
<tr><td colspan="2">Note: The Sample Interval is the time between the samples in the waveform record</td></tr>
<tr><td rowspan="3">Seconds/Division range</td><td>Instrument</td><td>Range</td></tr>
<tr><td>DPO2024, MSO2024</td><td>2 ns/div to 100 sec/div in a 1-2-4 sequence</td></tr>
<tr><td>DPO2014, MSO2014, DPO2012, MSO2012</td><td>4 ns/div to 100 sec/div</td></tr>
<tr><td rowspan="4">FilterVu Peak Detect data record pulse response</td><td colspan="2">The minimum single pulse widths for guaranteed 50% or greater amplitude capture:</td></tr>
<tr><td>Instrument</td><td>Minimum pulse width</td></tr>
<tr><td>DPO2024, MSO2024</td><td>3.5 ns</td></tr>
<tr><td>DPO2014, MSO2014, DPO2012, MSO2012</td><td>7 ns</td></tr>
<tr><td>Sample-rate</td><td colspan="2">1 GS/s</td></tr>
<tr><td>Waveform Interpolation</td><td colspan="2">Only (sin x)/x interpolation is provided</td></tr>
<tr><td>Record length</td><td colspan="2">1 Million or 100,000 samples per record, user selectable</td></tr>
<tr><td>Waveform update rate</td><td colspan="2">Minimum triggered acquisition rate is 5,000 wfm/sec</td></tr>
</table>

Table 1-4: Trigger specifications

Characteristic	Description	
Aux In (External) trigger maximum input voltage	At the BNC, between center conductor and shield, is 300 V_{RMS}, installation category II; derate above 4 MHz to 6 V_{RMS} at 200 MHz For non-sinusoidal waveforms, peak value must be less than 450 V. Excursion above 300 V should be less than 100 ms duration. Signal level must be limited to 300 V_{RMS}. If these values are exceeded, damage to the instrument may result	
Aux In (External) trigger input resistance	1 MΩ ±2%	
Aux In (External) trigger input capacitance	11.5 pF ±2 pF	
Line Trigger	Line Trigger mode provides a source to synchronize the trigger with the AC line input Matches the AC power Source Voltage and Source Frequency listed in the Power Supply System section	
Edge-type trigger sensitivity, DC coupled	*Trigger Source*	*Sensitivity*
	Analog inputs	DC to 50 MHz: 0.4 div
		>50 MHz to 100 MHz: 0.6 div
		>100 MHz to 200 MHz: 0.8 div
	Aux in (External Trigger)	200 mV from DC to 100 MHz, X1 attenuation
Edge trigger sensitivity, not DC coupled, typical	*Trigger Coupling*	*Typical Sensitivity*
	HF REJ	Same as DC Coupled limits from DC to 85 kHz. Attenuates signals above 85 kHz
	LF REJ	1.2 times the DC Coupled limits for frequencies above 65 kHz. Attenuates signals below 65 kHz
	NOISE REJ	2.5 times the DC Coupled limits
Trigger level ranges	*Source*	*Sensitivity*
	Any input channel	±4.92 divisions from center of screen
	Aux In (External)	±6.25 V, X1 probe attenuation ±12.50 V, X10 probe attenuation
Lowest frequency for successful operation of "Set Level to 50%" function, typical	50 Hz	
Trigger level accuracy, DC coupled, typical	±0.2 div for signals within ±4 div from center screen, with rise/fall times ≥20 ns Aux In: ±200 mV for signals less than ±800 mV, X1 attenuation	
Trigger holdoff range	20 ns minimum to 8 s maximum	
Video-type trigger sensitivity, typical	Any analog channel, 0.6 divisions of video sync tip Aux In does not support Video trigger	
Video-type trigger formats and field rates	Triggers from negative sync composite video, field 1 or field 2 for interlaced systems, on any field, specific line, or any line for interlaced or non-interlaced systems. Supported systems include NTSC, PAL, and SECAM.	
Logic-type or logic qualified trigger sensitivity, DC coupled, typical	0.75 division from DC to maximum bandwidth Aux In does not support Logic trigger	

Table 1-4: Trigger specifications (cont.)

Characteristic	Description			
Pulse-type runt trigger sensitivity, typical	0.75 division from DC to maximum bandwidth Aux In does not support Pulse trigger			
Pulse-type trigger width sensitivity, typical	3.5 ns when only using digital channels D0-D7 4.5 ns when using any of the digital channels D8-D15 Aux In does not support Pulse trigger			
Logic-type triggering, minimum logic or rearm time, typical	For all vertical settings, the minimums are:			
	Trigger type	*Pulse width*	*Re-arm time*	*Time between channels* [1]
	Logic	Not applicable	2 ns	1 ns
	Time Qualified Logic	4 ns	2 ns	1 ns
	Aux in does not support Logic trigger			
	[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 period for setup/hold time violation trigger, typical	User Setup Time + User Hold Time + 2 ns, with positive User Times			
Setup/hold violation trigger, setup and hold time ranges	*Feature*	*Min*	*Max*	
	Setup time	–100 ns	2 s	
	Hold time	–1 ns	2 s	
	Setup + Hold time	2 ns (Setup and hold times cannot both be negative)	4 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. Aux in does not support this trigger type			
Pulse type trigger, minimum pulse, rearm time, minimum transition time	*Pulse class*	*Minimum pulse width*	*Minimum rearm time*	
	Runt	2 ns	2 ns	
	Width	2 ns	2 ns	
	Rise/Fall time	2 ns	2 ns	
	For the trigger class width and the trigger class runt, the pulse width refers to the width of the pulse being measured. The rearm time refers to the time between pulses. For the trigger class Rise/Fall time, 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.			
Rise.fall time trigger, delta time range	4 ns to 8 s Aux in does not support this trigger type			

Table 1-4: Trigger specifications (cont.)

Characteristic	Description
Time range for pulse width or runt triggering	4 ns to 8 s The digital inputs do not support the runt trigger type
Time accuracy for Pulse Width triggering	±2 ns
Time Resolution, Logic Type Triggers	1 ns
Trigger Frequency Counter	Provides the user a higher accuracy means of identifying the frequency of trigger signals. Averaging takes place over a longer time span, so the number of stable digits is improved over the Automatic Measurement of the same type
Trigger Frequency Counter Resolution	6 digits
Trigger Frequency Counter Accuracy	±25 ppm including all reference errors and ±1 count errors
Trigger Frequency Counter Frequency Range	AC coupled, 10 Hz minimum to rated bandwidth
Trigger Frequency Counter Signal Source	Edge selected trigger source only

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.

Table 1-5: Display specifications

Characteristic	Description
Display type	Display area: 154.8 mm (6.09 inches) (H) x 87.05 mm (3.43 inches) (V), 180 mm (7.0 inches) diagonal, 6-bit RGB full color, WQVGA (480 x 234) TFT liquid crystal display (LCD).
Display resolution	480 horizontal by 234 vertical displayed pixels
Luminance, typical	Maximum 400 cd/m^2

Table 1-6: Input/Output port specifications

Characteristic	Description
Ethernet interface	Available as an optional accessory: DPO2CONN module
USB interface	1 High Speed 2.0 Host and 1 High Speed Device connector (all models)
GPIB interface	Available as an optional accessory that connects to USB Device and USB Host ports: TEK-USB-488 GPIB to USB Adapter. Control interface is incorporated in the instrument user interface.
Video signal output	Available as an optional accessory: DPO2CONN module A 15 pin, VGA RGB-type connector
Probe compensator output voltage and frequency, typical	Output voltage: 0 V to 5 V ±10% Frequency: 1 kHz ±25%

Table 1-7: Power source specifications

Characteristic	Description
Source voltage	100 V_{RMS} to 240 V_{RMS} ±10%, installation category II
Source frequency	(90 V to 264 V) 44 Hz to 65 Hz (100 V to 132 V) 360 Hz to 440 Hz
Power Consumption	<80 W at 85 to 275 V_{AC} input

Table 1-8: Data storage specifications

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

Table 1-9: Environmental specifications

Characteristic	Description
Temperature	Operating: 0 °C to +50 °C (+32 °F to +122 °F), with 5 °C/minute maximum gradient, non-condensing, up to 3000 m altitude. Instrument will be in specification after a 10 minute settling time and performance of SPC Nonoperating: -40 °C to +71 °C (-40 °F to +160 °F), with 5 °C/minute maximum gradient. Instrument will be in specification after 5 minutes powered for each 5 °C change settling time and performance of SPC
Humidity	Operating: High: 5% to 60% relative humidity, 30 °C to 50 °C (86 °F to 122 °F) Low: 5% to 95% relative humidity, 0 °C to 30 °C (32 °F to 86 °F) Nonoperating: High: 5% to 60% relative humidity, 30 °C to 55 °C (86 °F to 131 °F) Low: 5% to 95% relative humidity, 0 °C to 30 °C (32 °F to 86 °F)
Altitude	Operating: 3,000 m (9,843 ft) Nonoperating: 12,000 m (39,370 ft) Altitude is limited by possible damage to LCD at higher altitudes, independent of operation
Pollution Degree	Pollution Degree 2, indoor use only

Table 1-10: Mechanical specifications

Characteristic	Description
Dimensions	Nominal, non-rack mount: Height: Handle down: 175 mm (6.89 in) Handle up: 180 mm (7.09 in) Depth: Handle down: 146 mm (5.74 in) Handle up: 134 mm (5.29 in) Width: 377 mm (14.85 in) from handle hub to handle hub
Weight	Nominal, non-rack mount: Stand-alone instrument: 3.6 kg (7.9 lbs) Packaged for domestic shipment: 6.2 kg (13.7 lbs)
Cooling method	Forced air cooled, one fan
Clearance Requirements	The clearance requirement for adequate cooling is: 50 mm (2 in) on the left side (when looking at the front of the instrument)

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	1 ms period, ±1 ppm accuracy, rise time < 25 ns	
One 50 Ω BNC cable	Male-to-male connectors	Tektronix part number 012-0057-01
One 50 Ω feedthrough termination	BNC male and BNC female connectors	Tektronix part number 011-0049-02
For MSO2000 Series only:		
One P6316 digital probe	16 channel digital probe	Tektronix P6316
One BNC-to-0.1 inch pin adapter	BNC to 0.1 inch spaced pins	An appropriate BNC-to-0.1 inch pin adapter for use between the Fluke 9500 and the P6316 probe

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

These procedures cover all DPO2000 and MSO2000 models. Please disregard checks that do not apply to the specific model you are testing.

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

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

The performance verification procedures verify the performance of your instrument. They do not adjust your instrument. If your instrument fails any of the performance verification tests, you should perform the factory adjustment procedures as described in the *DPO2000 and MSO2000 Series Service Manual*.

NOTE. *If your oscilloscope firmware version is v1.02, it should be updated before performing the Performance Verification procedures. Download the latest firmware from www.tektronix.com/software.*

Upgrade the Firmware

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

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

   If the instrument does not install the firmware, first check the firmware version numbers. This update procedure will fail if the version you are trying to load is the same as the version that is in the instrument. If the version numbers are different, rerun the procedure. If the problem continues, contact qualified service personnel.

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

   The oscilloscope displays a message when the installation is complete.

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

Test Record

Model	Serial	Procedure performed by	Date

Test	Passed	Failed
Self Test		
Signal Path Compensation (SPC)		

Performance Checks

DC Balance

Channel	Coupling	Low limit	Test result	High limit
Channel 1	DC	-21 mV		21 mV
	GND	-21 mV		21 mV
Channel 2	DC	-21 mV		21 mV
	GND	-21 mV		21 mV
Channel 3 [1]	DC	-21 mV		21 mV
	GND	-21 mV		21 mV
Channel 4 [1]	DC	-21 mV		21 mV
	GND	-21 mV		21 mV

1 Channels 3 and 4 are only on four channel oscilloscopes

DC Gain Accuracy

Channel	Vertical scale	Low limit	Test result	High limit
Channel 1	5 mV/div	33.6 mV		36.4 mV
	200 mV/div	1.358 V		1.442 V
	2 V/div	13.58 V		14.42 V
Channel 2	5 mV/div	33.6 mV		36.4 mV
	200 mV/div	1.358 V		1.442 V
	2 V/div	13.58 V		14.42 V
Channel 3 [1]	5 mV/div	33.6 mV		36.4 mV
	200 mV/div	1.358 V		1.442 V
	2 V/div	13.58 V		14.42 V
Channel 4 [1]	5 mV/div	33.6 mV		36.4 mV
	200 mV/div	1.358 V		1.442 V
	2 V/div	13.58 V		14.42 V

1 Channels 3 and 4 are only on four channel oscilloscopes

Bandwidth

Channel	Low limit	Test result	High limit
Channel 1	2.12 V		— —
Channel 2	2.12 V		— —
Channel 3 [1]	2.12 V		— —
Channel 4 [1]	2.12 V		— —

1 Channels 3 and 4 are only on four channel oscilloscopes

Vertical Position Range

Channel	V/div setting	Trace position	Offset	DC Voltage source	Pass/Fail
Channel 1	200 mV/div	Top	–1 V	–1.800 V	
		Bottom	+1 V	+1.800 V	
	5 V/div	Top	–25 V	–45.0 V	
		Bottom	+25 V	+45.0 V	
Channel 2	200 mV/div	Top	–1 V	-1.800 V	
		Bottom	+1 V	+1.800 V	
	5 V/div	Top	–25 V	–45.0 V	
		Bottom	+25 V	+45.0 V	
Channel 3 [1]	200 mV/div	Top	–1 V	–1.800 V	
		Bottom	+1 V	+1.800 V	
	5 V/div	Top	–25 V	–45.0 V	
		Bottom	+25 V	+45.0 V	
Channel 4 [1]	200 mV/div	Top	–1 V	–1.800 V	
		Bottom	+1 V	+1.800 V	
	5 V/div	Top	–25 V	–45.0 V	
		Bottom	+25 V	+45.0 V	

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

Sample Rate and Delay Time Accuracy	Low limit	Test result	High limit
Sample Rate and Delay Time Accuracy	-2.5 divisions		+2.5 divisions

Digital Threshold Accuracy, MSO2000 series only

Digital channel	Threshold	V_{s-}	V_{s+}	Low limit	Test result V_{sAvg}	High limit
D0	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D1	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D2	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D3	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D4	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D5	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D6	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D7	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D8	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D9	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D10	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D11	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D12	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D13	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D14	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V
D15	0 V			-0.1 V		0.1 V
	4 V			3.78 V		4.22 V

Performance Verification Procedures

***NOTE.** If your oscilloscope firmware version is v1.02, it should be updated before performing the Performance Verification procedures. Download the latest firmware from www.tektronix.com/software.*

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) before beginning these procedures. (See page 2-7, *Signal Path Compensation (SPC)*.) If the operating temperature changes by more than 10 °C (18 °F), you must perform the signal path compensation again.
3. You must connect the oscilloscope and the test equipment to the same AC power circuit. Connect the oscilloscope and test instruments into a common power strip if you are unsure of the AC power circuit distribution. Connecting the oscilloscope and test instruments into separate AC power circuits can result in offset voltages between the equipment, which can invalidate the performance verification procedure.

The time required to complete the entire procedure is approximately one hour.

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

Self Test

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

1. Disconnect all probes and cables from the oscilloscope inputs.
2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the **Utility** menu button.
4. Push the **Utility Page** lower-bezel button, and turn Multipurpose knob **a** to select **Self Test**.
5. Push the **Self Test** lower-bezel button. The Loop X Times side-bezel menu will be set to **Loop 1 Times**.

6. Push the **OK Run Self Test** side-bezel button.
7. Wait while the self test runs. When the self test completes, a dialog box displays the results of the self test.
8. Push the **Menu Off** button to clear the dialog box and Self Test menu.

Signal Path Compensation (SPC)

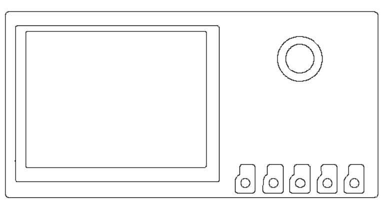
This process corrects for DC inaccuracies caused by temperature variations and/or long term drift.

1. Remove all input signals (probes and cables) from channel inputs. Input signals with AC components adversely affect SPC.
2. Push the front-panel **Utility** button, and then push the bottom-bezel **Utility Page** button.
3. Use Multipurpose knob **a** to select Calibration.
4. Push the bottom-bezel Signal Path button, and then push the side-bezel **OK Compensate Signal Paths** button.
5. Wait while the Signal Path Compensation runs. On completion a dialog box informs you whether the Compensation completed successfully or not.
6. Push the **Menu Off** button to clear the dialog box and Self Test menu.

Check DC Balance

This test checks the DC balance of each channel.

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



1. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
2. Turn the Horizontal **Scale** knob to 1 ms/div.
3. Push the Trigger **Menu** front-panel button.

4. Push the **Source** lower-bezel button.
5. Select the **AC Line** trigger source with Multipurpose knob **a**. You do not need to connect an external signal to the oscilloscope for this DC Balance test.
6. Push the front-panel **Acquire** button.
7. Push the **Average** lower-bezel button, and then push the **Average** side bezel button to turn averaging ON.

NOTE. *When using averaging, allow the oscilloscope to acquire all the samples before taking the measurement.*

8. If needed, adjust the number of averages to **16** with Multipurpose knob **a**.
9. Push the front-panel channel button for the oscilloscope channel to test, as shown in the test record (for example, 1, 2, 3, or 4).
10. Set the channel being tested to 200 mV/div using the Vertical **Scale** knob.
11. Attach a 50 Ω terminator to the oscilloscope input channel being tested.
12. Push the lower-bezel **Coupling** button to select **DC** or **GND** coupling, as given in the test record.
13. Push the front-panel Wave Inspector **Measure** button.
14. Push the **Add Measurement** lower bezel button.
15. Use Multipurpose knob **a** to select the **Mean** measurement.
16. Push the **OK Add Measurement** side-bezel button, and then push the **Menu Off** button.
17. View the mean measurement value in the display and enter that mean value as the test result in the test record.
18. Push the front-panel channel button, and repeat steps 12 through 17.
19. Repeat steps 5 through 18 for each remaining channel.

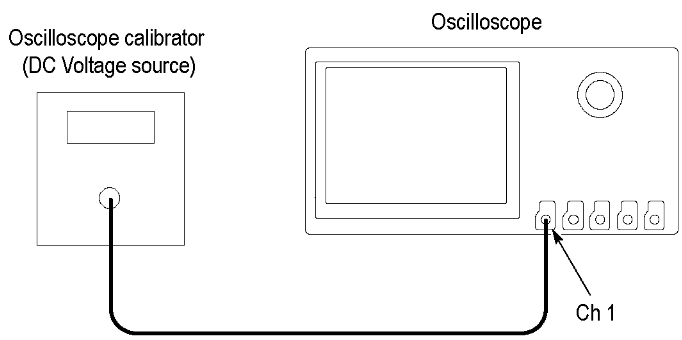
Check DC Gain Accuracy

This test checks the DC Gain Accuracy of each channel.

1. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
2. Push the front-panel Horizontal **Acquire** button, then push the bottom-bezel **Average** button, and then push the side-bezel **Average** button, to turn averaging on.

***NOTE.** When using averaging, allow the oscilloscope to acquire all the samples before taking the measurement.*

3. If necessary, use Multipurpose knob **a** to set the number of averages to 16.
4. Set the DC voltage source to 0 V, and then connect it to channel 1, as shown. If using a Fluke 9500 as the voltage source, connect the calibrator head to channel 1.



5. Push the front panel button to select the channel to be tested (1, 2, 3, or 4)
6. Push the bottom-bezel **Probe Setup** button, and then push the **Set to 1X** side-bezel button.
7. Push the Wave Inspector **Measure** button, and then push the bottom-bezel **Add Measurement** button.
8. Use Multipurpose knob **a** to select the **Mean** measurement, then push the side-bezel **OK Add Measurement** button, and then push the **Menu Off** button.
9. For each Volts/div line in the following worksheet, perform these steps:
   a. Set the DC voltage source output level to the positive voltage listed and record the Mean measurement as V_{pos}.
   b. Set the DC voltage source to the negative level listed, and record the Mean measurement as V_{neg}.
   c. Calculate $V_{diff} = V_{pos} – V_{neg}$, and then enter V_{diff} in the test record. As an example, on the 5 mV/div setting, if V_{pos} is 17.4 mV and V_{neg} is -17.2 mV, then V_{diff} is 34.6 mV.
   d. Enter V_{diff} in the worksheet, and in the test record.

Table 2-1: DC Gain Accuracy Worksheet

	Volts/div setting	DC voltage source setting		V_{pos}	V_{neg}	V_{diff}	Accuracy limits for V_{diff}
		Positive	Negative				
Channel 1	5 mV/div	+17.5 mV	–17.5 mV				33.6 mV to 36.4 mV
	200 mV/div	+700 mV	–700 mV				1.358 V to 1.442 V
	2 V/div	+7.00 V	–7.00 V				13.58 V to 14.42 V
Channel 2	5 mV/div	+17.5 mV	–17.5 mV				33.6 mV to 36.4 mV
	200 mV/div	+700 mV	–700 mV				1.358 V to 1.442 V
	2 V/div	+7.00 V	–7.00 V				13.58 V to 14.42 V
Channel 3 [1]	5 mV/div	+17.5 mV	–17.5 mV				33.6 mV to 36.4 mV
	200 mV/div	+700 mV	–700 mV				1.358 V to 1.442 V
	2 V/div	+7.00 V	–7.00 V				13.58 V to 14.42 V
Channel 4 [1]	5 mV/div	+17.5 mV	–17.5 mV				33.6 mV to 36.4 mV
	200 mV/div	+700 mV	–700 mV				1.358 V to 1.442 V
	2 V/div	+7.00 V	–7.00 V				13.58 V to 14.42 V

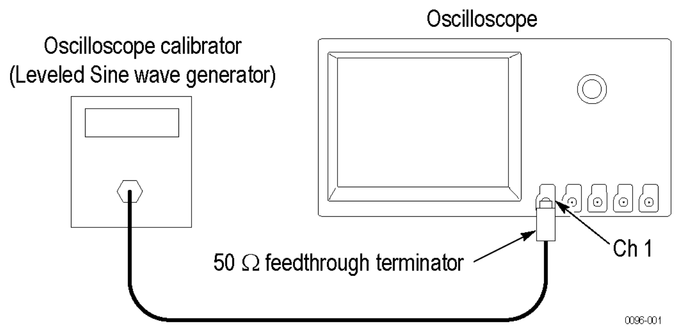
1 Channels 3 and 4 are only on four channel oscilloscopes.

10. Set the DC voltage source to 0 V, and move the BNC cable to the next channel to be tested.
11. Repeat steps 5 through 10 for each remaining channel.

Check Bandwidth

This test checks the bandwidth of all input channels.

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



2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the front-panel Trigger **Menu** button.
4. Push the lower-bezel **Coupling** button, and then push the **Noise Reject (DC Low Sensitivity)** side-bezel button.
5. Push the front-panel Trigger **Menu** button.
6. Push the lower-bezel **Source** button and use Multipurpose knob **a** to select the channel being tested as the trigger source.
7. Push the **Menu Off** button, so you can see the screen.
8. Push the channel button (1, 2, 3, or 4) for the channel that you want to check.
9. Push the lower-bezel **Probe Setup** button, and then push the **Set to 1 X** side-bezel button.
10. Push the front-panel **Measure** button, and then push the bottom-bezel **Add Measurement** button.
11. Use Multipurpose knob **a** to select the **Peak-to-peak** measurement, and then push the **OK Add Measurement** side-bezel button.
12. Turn the Vertical **Scale** knob to set the vertical scale to 500 mV/div.
13. Turn the Horizontal **Scale** knob to 400 μs/div.
14. Set the leveled sine wave generator frequency to **1 kHz**.
15. Set the leveled sine wave generator output level so the peak-to-peak measurement is between **2.98 V** and **3.02 V**.
16. Set the leveled sine wave generator to the frequency shown for the oscilloscope model:

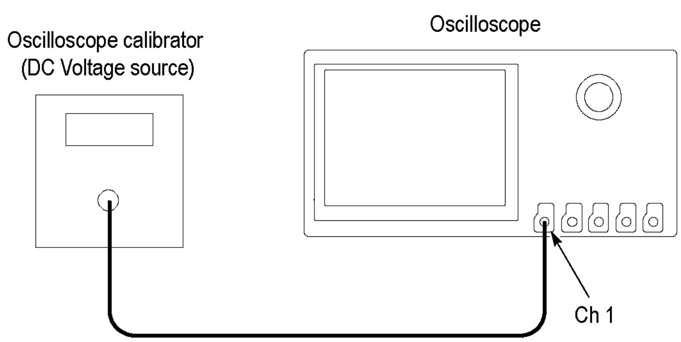
Model	Frequency
DPO2024, MSO2024	200 MHz
DPO2012, DPO2014, MSO2012, MSO2014	100 MHz

17. Use the Horizontal **Scale** knob to set the oscilloscope to **10 ns/div**.
18. Check that the peak-to-peak measurement is ≥**2.12 V**. Enter this measurement in the test record.
19. Move the input cable to the next channel to be tested.
20. Repeat steps 5 through 19 for each remaining channel.

Check Vertical Position Range

This test checks the offset range for each channel.

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



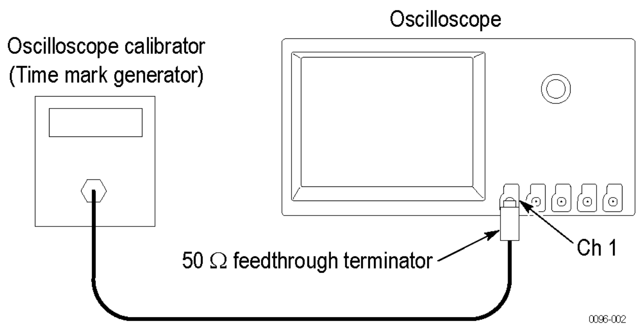
2. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
3. Push the channel button (1, 2, 3, or 4) for the channel that you want to check.
4. Push the bottom-bezel **Probe Setup** button, and then push the **Set to 1 X** side-bezel button.
5. Use the Vertical **Scale** knob to set the oscilloscope to **200 mV/div**.
6. Use the Vertical **Position** knob to place the trace at the bottom of the display (-4 divisions).
7. Set the **Offset** to +1 V:
    a. Push the bottom-bezel **More** button to select **Offset**.
    b. Use Multipurpose knob **a** to set the offset to 1.000 V.
8. Set the DC Voltage source to +1.800 V.

9. Check that the vertical trace is now within 0.2 divisions of the Zero volt line. Record Pass or Fail in the test record.
10. Set the DC Voltage source to 0 V.
11. Push the **Set to 0V** side-bezel button.
12. Use the Vertical **Position** knob to place the trace at the top of the display (+4 divisions).
13. Use Multipurpose knob **a** to set the offset to –1.000 V.
14. Set the DC Voltage source to –1.800 V.
15. Check that the vertical trace is now within 0.2 divisions of the Zero volt line. Record Pass or Fail in the test record.
16. Set the DC Voltage source to 0 V.
17. Push the **Set to 0V** side-bezel button.
18. Use the Vertical **Scale** knob to set the oscilloscope to **5 V/div**.
19. Use the Vertical **Position** knob to place the trace at the bottom of the display (-4 divisions).
20. Use Multipurpose knob **a** to set the offset to +25.00 V.
21. Set the DC Voltage source to +45 V.
22. Check that the vertical trace is now within 0.2 divisions of the Zero volt line. Record Pass or Fail in the test record.
23. Set the DC Voltage source to 0 V.
24. Push the **Set to 0V** side-bezel button.
25. Use the Vertical **Position** knob to place the trace at the top of the display (+4 divisions).
26. Use Multipurpose knob **a** to set the offset to –25.00 V.
27. Set the DC Voltage source to –45 V.
28. Check that the vertical trace is now within 0.2 divisions of the Zero volt line. Record Pass or Fail in the test record.
29. Set the DC Voltage source to 0 V.
30. Push the **Set to 0V** side-bezel button.
31. Move the DC Voltage source cable to the next channel to be tested.
32. Push the channel button (1, 2, 3, or 4) for the next channel to check.
33. Repeat steps 4 through 32 for each of the remaining channels.

Check Sample Rate and Horizontal Position Time Accuracy

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

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



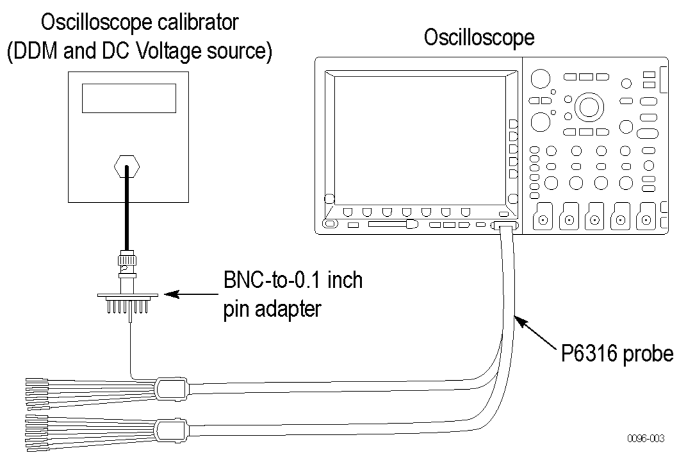
2. Set the time mark generator period to **1 ms**. Use a time mark waveform with a fast rising edge.
3. Push the front-panel **Default Setup** button to set the instrument to the factory default settings.
4. Push the channel **1** button.
5. Push the lower-bezel **Probe Setup** button, and then push the **Set to 1 X** side-bezel button.
6. Set the Vertical **SCALE** to **500 mV/div**.
7. Set the Horizontal **SCALE** to **1 ms/div**.
8. If adjustable, set the time mark generator amplitude to approximately **1** $\mathbf{V_{p\text{-}p}}$.
9. Push the Trigger **Level** knob, to set the trigger level to 50%.
10. Adjust the Vertical **POSITION** knob to center the time mark signal vertically on the screen.
11. If necessary, 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 close to **1 ms**.
13. Set the Horizontal **Scale** to **10 ns/div**.
14. If necessary, turn the Horizontal **Position** knob to set the delay to exactly **1.0000 ms**.
15. Compare the rising edge of the marker with the center horizontal graticule line. The rising edge should cross the 0 V center within ±2.5 divisions (±25 ns) of the center graticule line. Enter the deviation in the test record.

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

Check Digital Threshold Accuracy (MSO2000 Series only)

For the MSO2000 series only, this test checks the threshold accuracy of the digital channels. This procedure applies to digital channels D0 through D15, and to channel threshold values of 0 V and +4 V.

1. Connect the P6316 digital probe to the MSO2000 series instrument.



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

   If using the Fluke calibrator as the DC voltage source, connect the calibrator head to the digital channel to test. You will need a BNC-to-0.1 inch pin adapter to complete the connection. Be sure to connect the digital channel to the corresponding signal pin and to a ground pin on the adapter.

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

   Before you change the threshold value, push the **Fine** front-panel button to turn off the fine adjustment and make adjusting the value quicker.

9. Use Multipurpose knob **a** to set the D7-D0 threshold level to **0 V**.
10. Use Multipurpose knob **b** to set the D15-D8 threshold level to **0 V**.

The thresholds are now set for the 0 V threshold check, shown in steps 11 through 18.

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

12. Push the **Source** lower-bezel button, and turn Multipurpose knob **a** to select the appropriate channel, such as D0.

By default, the Type is set to Edge, Coupling is set to DC, Slope is set to Rising, Mode is set to Auto, and Level is set to match the threshold of the channel being tested.

13. Set the DC voltage source (Vs) to -400 mV. Wait 1 second. Check the logic level of the corresponding digital channel in the display.

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

14. Increment Vs by +10 mV. Wait 1 second and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level high, record the Vs value as $\mathbf{V_{s-}}$ in the 0 V row of the test record.

If the channel is a logic level low or is alternating between high and low, repeat this step (increment Vs by 10 mV, wait 1 second, and check for a static logic high) until a value for $\mathbf{V_{s-}}$ is found.

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

16. Set the DC voltage source (Vs) to +400 mV. Wait 1 second. Check the logic level of the corresponding digital channel in the display.

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

17. Decrement Vs by -10 mV. Wait 1 second and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level low, record the Vs value as $\mathbf{V_{s+}}$ in the 0 V row of the test record.

If the channel is a logic level high or is alternating between high and low, repeat this step (decrement Vs by 10 mV, wait 1 second, and check for a static logic low) until a value for $\mathbf{V_{s+}}$ is found.

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

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

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

20. With the Fine front-panel button turned off, turn Multipurpose knob **a** to set the D7–D0 threshold value to **4.00 V** (+4.0 V/div).

21. Turn Multipurpose knob **b** to set the D15–D8 threshold value to **4.00 V** (+4.0 V/div). To remove the menu from the display, push the front-panel **Menu Off** button.

22. Set the DC voltage source (Vs) to +4.4 V. Wait 1 second. Check the logic level of the corresponding digital channel in the display.

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

23. Decrement Vs by -10 mV. Wait 1 second and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level low, record the Vs value as $\mathbf{V_{s+}}$ in the 4 V row of the test record.

    If the channel is a logic level high or is alternating between high and low, repeat this step (decrement Vs by 10 mV, wait 1 second, and check for a static logic low) until a value for $\mathbf{V_{s+}}$ is found.

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

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

26. Set the DC voltage source (Vs) to +3.6 V. Wait 1 second. Check the logic level of the corresponding digital channel in the display.

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

27. Increment Vs by +10 mV. Wait 1 second and check the logic level of the corresponding digital channel in the display. If the channel is at a static logic level high, record the Vs value as $\mathbf{V_{s-}}$ in the 4 V row of the test record.

    If the channel is a logic level low or is alternating between high and low, repeat this step (increment Vs by 10 mV, wait 1 second, and check for a static logic high) until a value for $\mathbf{V_{s-}}$ is found.

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

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

29. Repeat the procedure starting with step 12 for each remaining digital channel, D1 through D15.

This completes the performance verification procedure.