Tektronix®

TBS2000 Series Oscilloscopes

Specification and Performance Verification

077-1148-00

TBS2000 Series Oscilloscopes

Specification and Performance Verification

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.

Supports Product Firmware V1.0 and above

www.tek.com
077-1148-00

Contacting Tektronix

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14150 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.tek.com* to find contacts in your area.

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, see the *Service safety summary* that follows the *General safety summary*.

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

While using this product, you may need to access other parts of a larger system. Read the safety sections of the other component manuals for warnings and cautions related to operating the system.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

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

Use proper power cord. Use only the power cord specified for this product and certified for the country of use. Do not use the provided power cord for other products.

Use proper voltage setting. Before applying power, ensure that the line selector is in the proper position for the source being used.

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. Do not disable the power cord grounding connection.

Ground the product. This product is indirectly grounded through the grounding conductor of the mainframe 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. Do not disable the power cord grounding connection.

Power disconnect. The power switch disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to disconnect the power switch; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it is difficult to operate the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Use proper AC adapter. Use only the AC adapter specified for this product.

Connect and disconnect properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source. Use only insulated voltage probes, test leads, and adapters supplied with the product, or indicated by Tektronix to be suitable for the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all rating and markings on the product. Consult the product manual for further ratings information before making connections to the product. Do not exceed the Measurement Category (CAT) rating and voltage or current rating of the lowest rated individual component of a product, probe, or accessory. Use caution when using 1:1 test leads because the probe tip voltage is directly transmitted to the product.

Observe all terminal ratings. To avoid fire or shock hazard, observe all rating and markings on the product. Consult the product manual for further ratings information before making connections to the product.

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

Do not float the common terminal above the rated voltage for that terminal.

The measurement terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

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

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

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Before use, inspect voltage probes, test leads, and accessories for mechanical damage and replace when damaged. Do not use probes or test leads if they are damaged, if there is exposed metal, or if a wear indicator shows.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Replace batteries properly. Replace batteries only with the specified type and rating.

Recharge batteries properly. Recharge batteries for the recommended charge cycle only.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

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

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product. This product is provided with handles for lifting and carrying.

WARNING. *The product is heavy. To reduce the risk of personal injury or damage to the device get help when lifting or carrying the product.*

WARNING. *The product is heavy. Use a two-person lift or a mechanical aid.*

Use only the Tektronix rackmount hardware specified for this product.

Probes and test leads

Before connecting probes or test leads, connect the power cord from the power connector to a properly grounded power outlet.

Keep fingers behind the finger guards on the probes.

Remove all probes, test leads and accessories that are not in use.

Use only correct Measurement Category (CAT), voltage, temperature, altitude, and amperage rated probes, test leads, and adapters for any measurement.

Beware of high voltages. Understand the voltage ratings for the probe you are using and do not exceed those ratings. Two ratings are important to know and understand:

- The maximum measurement voltage from the probe tip to the probe reference lead.
- The maximum floating voltage from the probe reference lead to earth ground.

These two voltage ratings depend on the probe and your application. Refer to the Specifications section of the manual for more information.

WARNING. *To prevent electrical shock, do not exceed the maximum measurement or maximum floating voltage for the oscilloscope input BNC connector, probe tip, or probe reference lead.*

Connect and disconnect properly. Connect the probe output to the measurement product before connecting the probe to the circuit under test. Connect the probe reference lead to the circuit under test before connecting the probe input. Disconnect the probe input and the probe reference lead from the circuit under test before disconnecting the probe from the measurement product.

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

Connect the probe reference lead to earth ground only.

Do not connect a current probe to any wire that carries voltages above the current probe voltage rating.

Inspect the probe and accessories. Before each use, inspect probe and accessories for damage (cuts, tears, or defects in the probe body, accessories, or cable jacket). Do not use if damaged.

Ground-referenced oscilloscope use. Do not float the reference lead of this probe when using with ground-referenced oscilloscopes. The reference lead must be connected to earth potential (0 V).

Floating measurement use. Do not float the reference lead of this probe above the rated float voltage.

Risk assessment warnings and information

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

Terms in the 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.*

Terms on the product

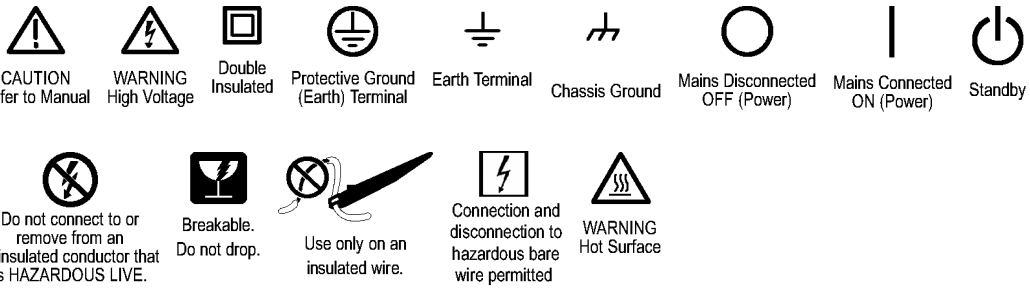
These terms may appear on the product:

- 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.

Symbols on the product

When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbols may appear on the product:



Preface

This manual contains specification and performance verification information for the TBS2000 Series Digital Storage Oscilloscopes.

Specifications

All specifications apply to all models unless noted otherwise.

Model overview

	TBS2072	TBS2102	TBS2074	TBS2104
Analog channels	2	2	4	4
Bandwidth	70 MHz	100 MHz	70 MHz	100 MHz
Sample rate	1 GS/s	1 GS/s	1 GS/s	1 GS/s
Record length	20 M points	20 M points	20 M points	20 M points

Vertical system analog channels

Hardware bandwidth limits	20 MHz
Input coupling	DC, AC, or GND
Input impedance	1 MΩ ± 2 %, 11.5 pF ± 2.5 pF
Sensitivity range	2 mV/Div to 5 V/Div in 1-2-5 sequence with probe attenuation set to 1X.
Vertical resolution	8 bits
Maximum input voltage	300 V RMS; derate above 4 MHz to 6 V RMS at 200 MHz. Based upon sinusoidal or DC input signal. Maximum viewable signal while DC coupled is ±100 V offset ± 5 V/div at 4 divisions, or 120 V. AC coupling allows measuring signals on a DC level up to 300V. For non-sinusoidal waveforms, peak value must be less than 450 V. Excursion above 300 V should be less than 100 ms duration. RMS signal level must be limited to 300 V. If these values are exceeded, damage to the instrument may result.
Number of digitized bits	8 bits
Acquisition modes	Sample, Peak Detect, Average, and Roll

Math modes

All units:	Ch 1 - Ch 2
	Ch 2 - Ch 1
	Ch 1 + Ch 2
	Ch 1 X Ch 2
	FFT
4 channel units:	Ch 3 - Ch 4
	Ch 3 + Ch 4
	Ch 4 - Ch 3
	Ch 3 X Ch 4

DC balance ± (1 mV +0.1 div)

DC gain accuracy ± 3% 10 mV/div through 5 V/div, derated at 0.05%/ °C above 30 °C.

± 4% typical 2 mV/div and 5 mV/div

DC voltage measurement accuracy average mode

Average of ≥ 16 waveforms	±((DC Gain Accuracy) X |reading - (offset - position)| + Offset Accuracy + 0.11 div + 1 mV)
Delta Volts between any two averages of ≥16 waveforms acquired with the same oscilloscope setup and ambient conditions	±(DC Gain Accuracy X |reading| + 0.08 div + 1.4 mV)

Vertical position range ± 5 divisions

Vertical offset ranges

Volts/Div setting	Offset range, 1 MΩ
2 mV/div to 200 mV/div	± 0.8 V
> 200 mV/div to 5 V/div	± 20 V

Vertical offset accuracy ± (0.01 X |offset - position | + DC Balance)

Analog bandwidth, DC coupled

100 MHz models:	DC to ≥100 MHz for 2 mV/div through 5 V/div.
70 MHz models:	DC to ≥70 MHz for 2 mV/div through 5 V/div.

Upper-Frequency limit, 20 MHz bandwidth limited ≥ 20 MHz

Because the digital triggering system uses data that has been BW limited, all Trigger functions on the BW limited analog channel are affected. Each channel is separately limited, allowing different bandwidths on different channels of the same instrument.

Lower-Frequency limit, AC coupled, typical <10 Hz

≤1 Hz when 10X, passive probes are used.

Rise time, typical	3.5 ns for 100 MHz Models. 5 ns for 70 MHz Models.
Common mode rejection ratio (CMMR), typical	100:1 at 60 Hz, reducing to 10:1 with 50 MHz sine wave with equal Volts/div and coupling settings on each channel.
Crosstalk (channel isolation)	100 MHz Models: >100:1 with 100 MHz sine wave and with equal V/div settings on each channel. 70 MHz Models: >100:1 with 70 MHz sine wave and with equal V/div settings on each channel.

Horizontal system analog channels

Sample rate

TBS207x, TBS210x: 500 MS/s all channels, 1 GS/s half channels (at most one channel from each pair {channel1, channel2} and {channel3, channel4} is active);

Sample rate for time/div versus record length (1 GS/s)

Time/Div	Real Time Sampling Rate = 1 GS/s					
	RL= 2 k	RL= 20 k	RL= 200 k	RL= 2 M	RL= 20 M	RL= Auto
2 ns	1 GS/s	1 GS/s	1 GS/s	1 GS/s	1 GS/s	1 GS/s
4 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
10 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
20 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
40 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
100 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
200 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
400 ns	250 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
1 µs	125 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
2 µs	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
4 µs	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
10 µs	12.5 MS/s	125 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
20 µs	6.25 MS/s	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
40 µs	3.125 MS/s	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s	500 MS/s
100 µs	1.25 MS/s	12.5 MS/s	125 MS/s	500 MS/s	500 MS/s	500 MS/s
200 µs	625 kS/s	6.25 MS/s	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s
400 µs	312.5 kS/s	3.125 MS/s	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s
1 ms	125 kS/s	1.25 MS/s	12.5 MS/s	125 MS/s	500 MS/s	500 MS/s
2 ms	62.5 kS/s	625 kS/s	6.25 MS/s	62.5 MS/s	500 MS/s	500 MS/s
4 ms	31.25 kS/s	312.5 kS/s	3.125 MS/s	31.25 MS/s	250 MS/s	250 MS/s
10 ms	12.5 kS/s	125 kS/s	1.25 MS/s	12.5 MS/s	125 MS/s	125 MS/s
20 ms	6.25 kS/s	62.5 kS/s	625 kS/s	6.25 MS/s	62.5 MS/s	62.5 MS/s

Time/Div	Real Time Sampling Rate = 1 GS/s					
	RL= 2 k	RL= 20 k	RL= 200 k	RL= 2 M	RL= 20 M	RL= Auto
40 ms	3.125 kS/s	31.25 kS/s	312.5 kS/s	3.125 MS/s	31.25 MS/s	31.25 MS/s
100 ms	1.25 kS/s	12.5 kS/s	125 kS/s	1.25 MS/s	12.5 MS/s	12.5 MS/s
200 ms	625 S/s	6.25 kS/s	62.5 kS/s	625 kS/s	6.25 MS/s	6.25 MS/s
400 ms	313 S/s	3.125 kS/s	31.25 kS/s	312.5 kS/s	3.125 MS/s	3.125 MS/s
1 s	125 S/s	1.25 kS/s	12.5 kS/s	125 kS/s	1.25 MS/s	1.25 MS/s
2 s	63 S/s	625 S/s	6.25 kS/s	62.5 kS/s	625 kS/s	625 kS/s
4 s	31 S/s	313 S/s	3.125 kS/s	31.25 kS/s	312.5 kS/s	312.5 kS/s
10 s	13 S/s	125 S/s	1.25 kS/s	12.5 kS/s	125 kS/s	125 kS/s
20 s	6 S/s	63 S/s	625 S/s	6.25 kS/s	62.5 kS/s	62.5 kS/s
40 s	3 S/s	31 S/s	313 S/s	3.125 kS/s	31.25 kS/s	31.25 kS/s
100 s	1 S/s	13 S/s	125 S/s	1.25 kS/s	12.5 kS/s	12.5 kS/s

Sample rate for time/div versus record length (500 MS/s)

Time/Div	Real Time Sampling Rate = 500 MS/s					
	RL= 2 k	RL= 20 k	RL= 200 k	RL= 2 M	RL= 20 M	RL= Auto
1 ns						
2 ns						
4 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
10 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
20 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
40 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
100 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
200 ns	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
400 ns	250 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
1 µs	125 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
2 µs	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
4 µs	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
10 µs	12.5 MS/s	125 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
20 µs	6.25 MS/s	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s	500 MS/s
40 µs	3.125 MS/s	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s	500 MS/s
100 µs	1.25 MS/s	12.5 MS/s	125 MS/s	500 MS/s	500 MS/s	500 MS/s
200 µs	625 kS/s	6.25 MS/s	62.5 MS/s	500 MS/s	500 MS/s	500 MS/s
400 µs	312.5 kS/s	3.125 MS/s	31.25 MS/s	250 MS/s	500 MS/s	500 MS/s
1 ms	125 kS/s	1.25 MS/s	12.5 MS/s	125 MS/s	500 MS/s	125 MS/s
2 ms	62.5 kS/s	625 kS/s	6.25 MS/s	62.5 MS/s	500 MS/s	62.5 MS/s
4 ms	31.25 kS/s	312.5 kS/s	3.125 MS/s	31.25 MS/s	250 MS/s	250 MS/s
10 ms	12.5 kS/s	125 kS/s	1.25 MS/s	12.5 MS/s	125 MS/s	125 MS/s
20 ms	6.25 kS/s	62.5 kS/s	625 kS/s	6.25 MS/s	62.5 MS/s	62.5 MS/s

Time/Div	Real Time Sampling Rate = 500 MS/s					
	RL= 2 k	RL= 20 k	RL= 200 k	RL= 2 M	RL= 20 M	RL= Auto
40 ms	3.125 kS/s	31.25 kS/s	312.5 kS/s	3.125 MS/s	31.25 MS/s	31.25 MS/s
100 ms	1.25 kS/s	12.5 kS/s	125 kS/s	1.25 MS/s	12.5 MS/s	12.5 MS/s
200 ms	625 S/s	6.25 kS/s	62.5 kS/s	625 kS/s	6.25 MS/s	6.25 MS/s
400 ms	313 S/s	3.125 kS/s	31.25 kS/s	312.5 kS/s	3.125 MS/s	3.125 MS/s
1 s	125 S/s	1.25 kS/s	12.5 kS/s	125 kS/s	1.25 MS/s	1.25 MS/s
2 s	63 S/s	625 S/s	6.25 kS/s	62.5 kS/s	625 kS/s	625 kS/s
4 s	31 S/s	313 S/s	3.125 kS/s	31.25 kS/s	312.5 kS/s	312.5 kS/s
10 s	13 S/s	125 S/s	1.25 kS/s	12.5 kS/s	125 kS/s	125 kS/s
20 s	6 S/s	63 S/s	625 S/s	6.25 kS/s	62.5 kS/s	62.5 kS/s
40 s	3 S/s	31 S/s	313 S/s	3.125 kS/s	31.25 kS/s	31.25 kS/s
100 s	1 S/s	13 S/s	125 S/s	1.25 kS/s	12.5 kS/s	12.5 kS/s

Waveform interpolation

Only (sin x)/x interpolation is provided.

Waveform interpolation is activated for sweep speeds of 100 ns/div and faster

Record length

20 M, 2 M, 200 k, 20 k, 2 k samples per record, user selectable or in the AUTO mode automatically select the shortest record length which supports the highest sample rate available for the Time/Div settings.

Seconds division range

TBS207x, TBS210x: 2 ns/div to 100 sec/div in a 1-2-4 sequence

Deskew range

Analog channels only:

TBS207x, TBS210x: ±100 ns with 2 ns resolution

Long term sample rate and horizontal position time accuracy

± 25 x 10^{-6} over any ≥ 1 ms interval.

Delta time measurement accuracy

The limits are given in the following table for signals having amplitude ≥ 7 divisions, slew rate at the measurement points of ≥ 2.0 divisions/ns, and acquired at ≥ 10 mV/Div:

Condition	Time Measurement Accuracy
Single shot, full bandwidth selected	± (1 Sample Interval + 25 X 10^{-6} X |reading| + 0.6 ns)
> 16 averages, full bandwidth selected	± (1 Sample Interval + 25 X 10^{-6} X |reading| + 0.4 ns)

Trigger system

Waveform update rate, typical

Minimum triggered acquisition rate is 10,000 wfm/sec.

Trigger types

Edge, Pulse Width, and Runt.

Trigger source

Analog channels and AC Line

Trigger coupling analog channels

DC, Noise Reject, High Freq Reject, Low Freq Reject.

Line trigger characteristics

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.

Sensitivity, edge–type trigger, DC coupled

Trigger Source	Sensitivity
Analog inputs	0.4 division from DC to 50 MHz
	0.6 divisions >50 MHz to 100 MHz

Edge–Type trigger sensitivity, not DC coupled, typical

Trigger Coupling	Typical Sensitivity
HF reject	Same as DC Coupled limits from DC to 85 kHz. Attenuates signals above 85 kHz.
LF reject	1.2 times the DC Coupled limits for frequencies above 65 kHz. Attenuates signals below 65 kHz.
Noise reject	2.5 times the DC Coupled limits.

Trigger level ranges

Input channels: ± 4.90 divisions from center screen

Trigger level accuracy, DC coupled, typical

±0.2 div for signals within ±4 divisions from center screen, having rise and fall times of ≥20 ns.

Lowest frequency for successful operation of Set Level to 50% function.

50 Hz. Using a 10 X probe will not affect the operation of this function.

Pulse–Type runt trigger sensitivity, typical

0.75 divisions, from DC to max bandwidth.

Pulse–Type trigger width sensitivity, typical

3.5 ns.

Pulse–Type trigger, minimum pulse rearm 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

Time range for pulse width or runt triggering

2 ns to 8 s

Time accuracy for pulse width triggering	± 2 ns.
Trigger frequency counter	Provides the user a higher accuracy means of identifying the frequency of trigger signals. Since averaging takes place over a longer time span, the number of stable digits is improved over the Automatic Measurement of the same type.
Resolution	6 digits
Accuracy, typical	±25 x 10^{-6} including all reference errors and ±1 count errors.
Frequency range, typical	AC coupled, 10 Hz minimum to rated bandwidth
Signal source	Edge selected trigger source only. Frequency counter measures the selected trigger source at all times in edge mode, including when the oscilloscope acquisition is halted due to changes in run status, or acquisition of a single shot event has completed. Counts all edges of sufficient amplitude.

Input output ports

TekVPI interface	The probe interface allows installing, powering, compensating and controlling a wide range of probes offering a variety of features.
Total probe power, typical	TBS2xx4: 24 W, derated at 0.3 W/ °C above 30 °C TBS2xx2: 12 W
Ethernet interface	One 10/100M BaseT port
Wi-Fi interface	Available as an optional USB dongle, supports 802.11 b/g/n.
GPIB interface	Available as an optional accessory that connects to USB Device and USB Host Ports, TEK-488 GPIB to USB Adapter. Control interface is incorporated in the instrument UI.
USB interface	2 High Speed 2.0 Host and 1 High Speed Device connector are standard in all models.
Probe compensator	Front-panel pins
Output voltage and frequency, typical	5 V amplitude ± 10% square wave, 1 kHz ± 10%.
Aux Out	HIGH to LOW transition indicates the trigger occurred.

Data storage

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.

Display system

Display type	9 inch (228 mm) wide format liquid crystal TFT color display.
Display resolution	800 horizontal by 480 vertical displayed pixels (WVGA).
Waveform styles	Vectors, Variable Persistence, and Infinite Persistence.
Graticules	Grid, None.
Format	YT and XY.

Power source

Power consumption	30 W typical, 80 W max at 85 to 275 V_{AC} input.
Power source voltage	Full range: 100 to 240 V_{AC} RMS ±10%, Installation Category II (Covers range of 90 to 264 V_{AC})
Source frequency	45 Hz to 65 Hz over entire source voltage range. 360 Hz to 440 Hz, 100 to 132 V_{AC} RMS source voltage

Physical characteristics

Weight	
TBS2xx2:	2.62 kg (5.75 lbs.), standalone instrument.
	5.1 kg (11.2 lbs.), when packaged for domestic shipment.
TBS2xx4:	4.17 kg (9.15 lbs.), stand-alone instrument.
	7 kg (15.4 lbs.), when packaged for domestic shipment.
Dimensions	
TBS2xx2:	Height:
	Handle folded down: 174.9 mm (6.89 in)
	Handle Up: 224.9 mm (8.85 in)
	Width: 372.4 mm (14.66 in)
	Depth: 103.3 mm (4.07 in)
TBS2xx4:	Height:
	Handle folded down: 201.5mm (7.93 in)
	Handle Up: 251.5 mm (9.9 in)
	Width: 412.8 mm (16.25 in)
	Depth: 128.1 mm (5.04 in)
Cooling method	TBS2xx4: Forced air flow, with fan.
	TBS2xx2: Convection air flow, no fan.
Cooling clearance	50 mm (2 in) required on left side and rear of instrument.

EMC, environment, and safety

Temperature	
Operating:	0 °C to +50 °C, with 5 °C/minute maximum gradient, noncondensing, 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, with 5 °C/minute maximum gradient.
Humidity	
Operating:	5% to 95% relative humidity (% RH) at up to +30 °C, 5% to 60% RH above +30 °C up to +50 °C, noncondensing.
Nonoperating:	5% to 95% RH (Relative Humidity) at up to +30 °C,
	5% to 60% RH above +30 °C up to +60 °C, noncondensing.

Altitude

Operating:	Up to 3,000 meters (9,842 feet).
Non-Operating:	Up to 12,000 meters (39,370 feet).
	Altitude is limited by possible damage to LCD at higher altitudes. This damage is independent of operation.

Performance verification

Required equipment

Table 3: Performance verification

Description	Minimum requirements	Examples
DC voltage source	17.5 mV to 7 V, ±0.5% accuracy	Wavetek 9100 Universal Calibration System with Oscilloscope Calibration Module (Option 250) Fluke 5500A Multi-product Calibrator with Oscilloscope Calibration Option (Option 5500A-SC)
Leveled sine wave Generator	50 kHz and 200 MHz, ±3% amplitude accuracy	
Time mark generator	10 ms period, ±10 ppm accuracy	
50Ω BNC cable	BNC male to BNC male, ≈ 1 m (36 in) long	Tektronix part number 012-0482-XX
50Ω BNC cable	BNC male to BNC male, ≈ 25 cm (10 in) long	Tektronix part number 012-0208-XX
50 Ω feed through termination	BNC male and female connectors	Tektronix part number 011-0049-XX
Dual banana to BNC adapter	Banana plugs to BNC female	Tektronix part number 103-0090-XX
BNC T adapter	BNC male to dual BNC female connectors	Tektronix part number 103-0030-XX
Splitter, power	Frequency range: DC to 4 GHz. Tracking: >2.0%	Tektronix part number 015-0565-XX
Adapter (four required)	Male N-to-female BNC	Tektronix part number 103-045-XX
Adapter	Female N-to-male BNC	Tektronix part number 103-0058-XX
Leads, 3 black	Stacking banana plug patch cord, ≈ 45 cm (18 in) long	Pomona #B-18-0
Leads, 2 red	Stacking banana plug patch cord, ≈ 45 cm (18 in) long	Pomona #B-18-2

Test record

Table 4: Test record

Instrument Serial Number: **Temperature:** **Date of Calibration:**	**Certificate Number:** **RH %:** **Technician:**

Instrument performance test	Passed	Failed
Self test		
Signal path compensation (SPC)		

Table 5: 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

Table 6: DC gain accuracy

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

Table 7: Bandwidth

Channel	Low limit	Test result	High limit
Channel 1	2.12 mV		-- --
Channel 2	2.12 mV		-- --
Channel 3[1]	2.12 mV		-- --
Channel 3[1]	2.12 mV		-- --

[1] Channels 3 and 4 are only on four channel instruments

Table 8: Vertical position range

Channel	V/div setting	Trace position	Offset	DC Voltage source	Pass/Fail
Channel 1	200 mV/div	Top	-0.8 V	-1.8 V	
		Bottom	+0.8 V	+1.8 V	
	5 V/div	Top	–20 V	-45 V	
		Bottom	+20 V	+45 V	
Channel 2	200 mV/div	Top	-0.8 V	-1.8 V	
		Bottom	+0.8 V	+1.8 V	
	5 V/div	Top	–20 V	-45 V	
		Bottom	+20 V	+45 V	
Channel 3	200 mV/div	Top	-0.8 V	-1.8 V	
		Bottom	+0.8 V	+1.8 V	
	5 V/div	Top	–20 V	-45 V	
		Bottom	+20 V	+45 V	
Channel 4	200 mV/div	Top	-0.8 V	-1.8 V	
		Bottom	+0.8 V	+1.8 V	
	5 V/div	Top	–20 V	-45 V	
		Bottom	+20 V	+45 V	

Table 9: Sample rate and delay time accuracy

Instrument performance test	Low limit	Test result	High limit
Sample Rate and Delay Time Accuracy	-2.5 divs		+2.5 divs

Performance verification procedures

NOTE.

If your instrument firmware version is v1.02, it should be updated before performing the performance verification procedures. Download the latest firmware from www.tek.com/software.

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

- The instrument must have been operating continuously for twenty (20) minutes in an environment that meets the operating range specifications for temperature and humidity.
- You must perform a signal path compensation (SPC) before beginning these procedures. If the operating temperature changes by more than 10 °C (18 °F), you must perform the signal path compensation again.
- You must connect the instrument and the test equipment to the same AC power circuit. Connect the instrument and test instruments into a common power strip if you are unsure of the AC power circuit distribution. Connecting the instrument 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 instrument 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 instrument 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 bezel button, the Diagnostics bezel button, the Self Test bezel button, and turn Multipurpose knob a to select Loop Times.
5. Push the Multipurpose knob a to select Loop Times, and turn the Multipurpose knob a to select Loop 1 Times.
6. Push the Multipurpose knob a to set the Loop Times to 1.
7. Turn Multipurpose knob a to select Run Self Test, and push the Multipurpose knob a to start the self tests.
8. Wait while the self test runs. When the self test completes, a dialog box displays the results of the self test.
9. Push the Menu Off button to clear the dialog box and Self Test menu.

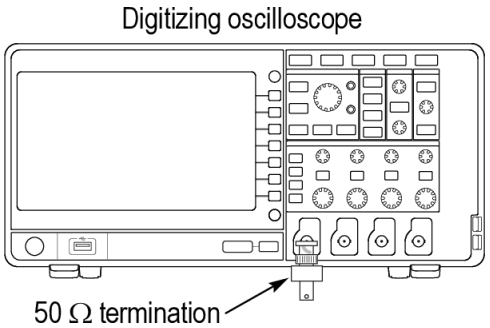
Signal path compensation (SPC)

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 Utility Page bezel button.
3. Push the Calibration bezel button.
4. Turn the Multipurpose button a to select Signal Path, and then push Multipurpose knob a to select Calibration Signal Path.
5. Push the Compensate Signal Paths bezel button.
6. Wait while the Signal Path Compensation runs. On completion a dialog box informs you whether the Compensation completed successfully or not.
7. 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 instrument 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 Measurement source bezel button for the channel you are testing.
5. Select the AC Line trigger source with Multipurpose knob a. You do not need to connect an external signal to the instrument for this DC Balance test.
6. Push the front-panel Acquire button.
7. Push the Acquire Mode bezel button.
8. Turn Multipurpose knob a to select Average, and then push Multipurpose knob a to turn on Average mode.

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

9. If needed, adjust the number of averages to 16 with Multipurpose knob a.
10. Push the front-panel channel button for the instrument channel to test, as shown in the test record (for example, 1, 2, 3, or 4).
11. Set the channel being tested to 200 mV/div using the Vertical Scale knob.
12. Attach a 50 Ω terminator to the instrument input channel being tested.
13. Push the Coupling bezel button and use the Multipurpose knob to select DC or GND coupling, as given in the test record.
14. Push the front-panel Resources Measure button.
15. Push the bezel channel button for the instrument channel to test, as shown in the test record (for example, CH1, CH2, CH3, or CH4).
16. Use Multipurpose knob a to select the Mean measurement.
17. Push the Multipurpose knob to add the Mean measurement, and then push the Menu Off button.
18. View the mean measurement value in the display and enter that mean value as the test result in the test record.
19. Push the front-panel channel button, and repeat steps 13 through 18
20. Repeat steps 5 through 19 for each remaining channel.

Check DC gain accuracy

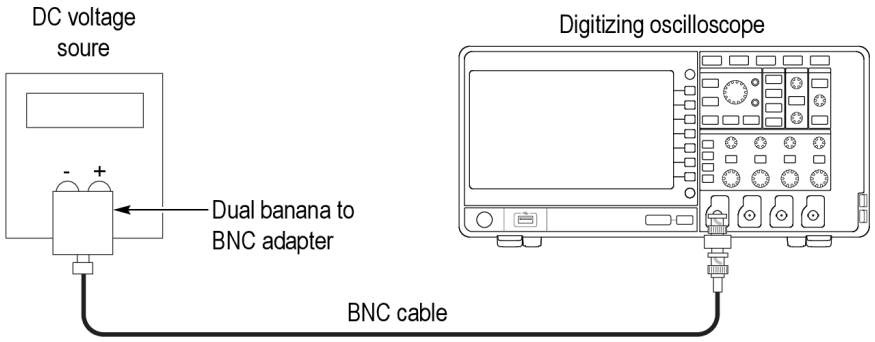
This test checks the DC gain accuracy of all input channels.

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 Mode bezel button, and then use the Multipurpose knob to select and then turn averaging on.

   NOTE. *When using averaging, allow the instrument 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 Probe Setup bezel button, and then use the Multipurpose knob to select Set to 1X.
7. Push the Resources Measure button, and then push the bezel button to select the channel to be tested (1, 2, 3, or 4).
8. Use Multipurpose knob a to select and add the Mean measurement, 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 200 mV/div setting, if V_{pos} is 690 mV and V_{neg} is -685 mV, then V_{diff} is 1.375 V.
   d. Enter V_{diff} in the worksheet, and in the test record.

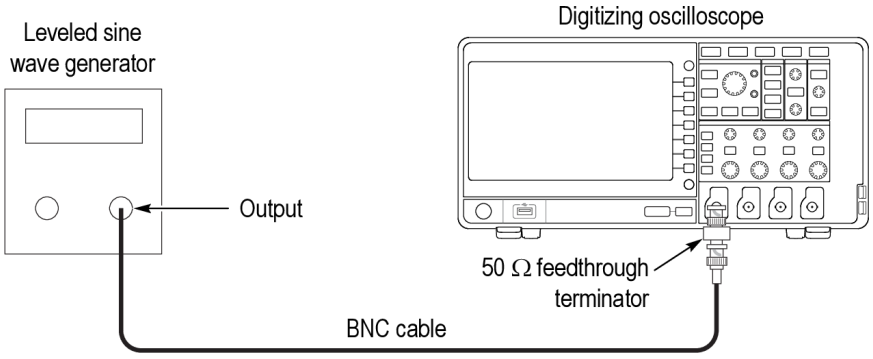
Ch	Volts/div) setting	DC voltage source setting		V_{pos}	V_{neg}	V_{diff}	Accuracy limits for V_{diff}
		Positive	Negative				
Ch 1	200 mV/div	+700 mV,	-700 mV				1.358 V to 1.442 V
Ch 2	200 mV/div	+700 mV,	-700 mV				1.358 V to 1.442 V
Ch 3	200 mV/div	+700 mV,	-700 mV				1.358 V to 1.442 V
Ch 4	200 mV/div	+700 mV,	-700 mV				13.58 V to 14.42 V

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 channel 1 input as shown:

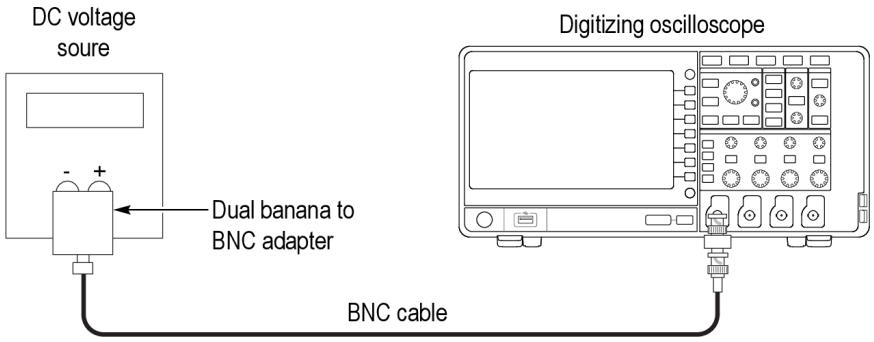


2. Push the front-panel Default Setup button to set the instrument to the factory default settings.
3. Push the front-panel Trigger Menu button.
4. Push the Coupling bezel button, and then use the Multipurpose knob to select and then set Noise Reject (DC Low Sensitivity).
5. Push the front-panel Trigger Menu button.
6. Push the Source bezel 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 Probe Setup bezel button, and then use the Multipurpose knob to select Set to 1 X.
10. Push the front-panel Measure button, and then push the bezel button for the channel you are testing.
11. Use Multipurpose knob a to select the Peak-to-peak measurement.
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 frequency to:
    - **100 MHz** if you are checking a TBS2104 or TBS2102
    - **70 MHz** if you are checking a TBS2074 or TBS2072
17. Use the Horizontal Scale knob to set the instrument 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 3 through 19 for all input channels.

Check vertical offset accuracy

This test checks the offset range for each channel.

1. Connect the instrument 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 instrument channel to test.



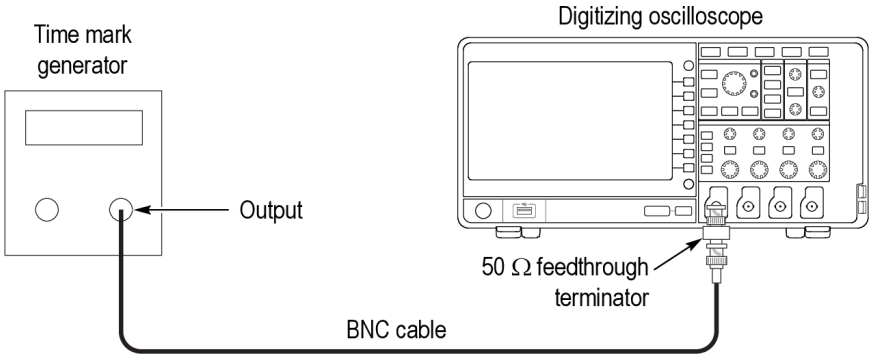
2. Push the front-panel Default Setup button to set the instrument to the factory default settings.
3. Push the channel button (1, 2, 3, or 4) for the channel that you want to check.
4. Push the Probe Setup button, and then use the Multipurpose knob to select Set to 1 X.
5. Use the Vertical Scale knob to set the instrument to 200 mV/div.
6. Use the Vertical Position knob to place the trace at the bottom of the display (-5 divisions).
7. Press the Offset bezel button and use the Multipurpose knob to set the Offset to +0.8 V.
8. Set the DC Voltage source to +1.8 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 Offset bezel button and use the Multipurpose knob to select Set to 0V.
12. Use the Vertical Position knob to place the trace at the top of the display (+5 divisions).
13. Press the Offset bezel button and use the Multipurpose knob to set the Offset to –0.8 V.
14. Set the DC Voltage source to –1.8 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 Offset bezel button and use the Multipurpose knob to select Set to 0V.
18. Use the Vertical Scale knob to set the instrument to 5 V/div.
19. Use the Vertical Position knob to place the trace at the bottom of the display (-5 divisions).
20. Press the Offset bezel button and use the Multipurpose knob to set the Offset to +20.00 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. Push the Offset bezel button and use the Multipurpose knob to select Set to 0V.
24. Use the Vertical Position knob to place the trace at the top of the display (+5 divisions).
25. Press the Offset bezel button and use the Multipurpose knob to set the Offset to –20.00 V.

26. Set the DC Voltage source to –45 V.
27. Check that the vertical trace is now within 0.2 divisions of the Zero volt line. Record Pass or Fail in the test record.
28. Set the DC Voltage source to 0 V.
29. Push the Offset bezel button and use the Multipurpose knob to select Set to 0V.
30. Move the DC Voltage source cable to the next channel to be tested.
31. Push the channel button (1, 2, 3, or 4) for the next channel to check.
32. Repeat steps 4 through 31 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 channel 1 input using a 50 Ω cable and 50 Ω feed through 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 Probe Setup bezel button, and then use the Multipurpose knob to select Set to 1 X.
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 Vp-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.*

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