Technical Reference

Tektronix

TDS3000C Series
Digital Phosphor Oscilloscopes
Specifications and Performance Verification

071-2508-00

This document applies to firmware version 4.00 and above.

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

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.

Warranty 16

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

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

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

THIS WARRANTY IS GIVEN BY TEKTRONIX WITH RESPECT TO THE PRODUCT IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

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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.

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. Connect the probe output to the measurement instrument before connecting the probe to the circuit under test. Disconnect the probe input and the probe ground from the circuit under test before disconnecting the probe from the measurement instrument.

Ground the Product. When operating with AC power, 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.

When operating with battery power, this product must still be grounded. To prevent electric shock, always connect a grounding wire between the ground terminal on the rear panel and earth ground.

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 ground lead of the probe to earth ground only.

Replace Batteries Properly. Replace batteries only with the proper type and rating specified.

Recharge Batteries Properly. Recharge batteries for the recommended charge cycle only.

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

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

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

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.

Safety Terms and Symbols

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.*

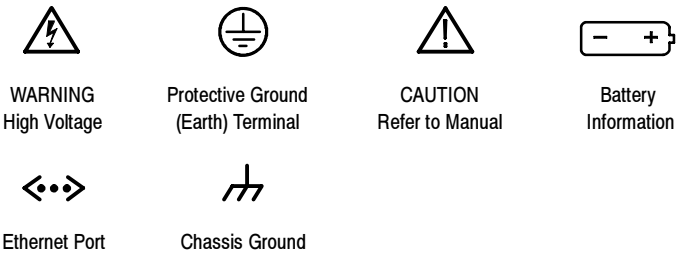
Terms on the Product. These terms may appear on the product:

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. These symbols may appear on the product:



Preventing Electrostatic Damage

CAUTION. *Electrostatic discharge (ESD) can damage components in the oscilloscope and its accessories. To prevent ESD, observe these precautions when directed to do so.*

Use a Ground Strap. Wear a grounded antistatic wrist strap to discharge the static voltage from your body while installing or removing sensitive components.

Use a Safe Work Area. Do not use any devices capable of generating or holding a static charge in the work area where you install or remove sensitive components. Avoid handling sensitive components in areas that have a floor or benchtop surface capable of generating a static charge.

Handle Components Carefully. Do not slide sensitive components over any surface. Do not touch exposed connector pins. Handle sensitive components as little as possible.

Transport and Store Carefully. Transport and store sensitive components in a static-protected bag or container.

Specifications

Specifications

This chapter contains specifications for the TDS3000C 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 TDS3000C Series 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 described on page 2–5 prior to evaluating specifications. If the operating temperature changes by more than 10 °C, you must perform the Signal Path Compensation again.

Table 1-1: Acquisition characteristics

Characteristic	Description	
Acquisition modes	Sample (Normal), Peak detect, Envelope, and Average	
Single Sequence	*Acquisition mode*	*Acquisition stops after*
	Sample, Peak Detect	One acquisition, all channels simultaneously
	Average, Envelope	N acquisitions, all channels simultaneously, N is settable from 2 to 256 (or ∞ for Envelope)

Table 1-2: Input characteristics

Characteristic	Description
Input coupling	DC, AC, or GND Channel input remains terminated when using GND coupling.
Input resistance selection	1 MΩ or 50 Ω
Input impedance, DC coupled	1 MΩ ±1% in parallel with 13 pF ±2 pF 50 Ω ±1%; VSWR ≤ 1.5:1 from DC to 500 MHz, typical

Table 1-2: Input characteristics (Cont.)

Characteristic	Description	
Maximum voltage at input BNC (1 MΩ)	*Overvoltage category*	*Maximum voltage*
	CAT I Environment (refer to page 1-14)	150 V_{RMS} (400 V_{pk})
	CAT II Environment (refer to page 1-14)	100 V_{RMS} (400 V_{pk})
	For steady-state sinusoidal waveforms, derate at 20 dB/decade above 200 kHz to 13 V_{pk} AC at 3 MHz and above.	
Maximum voltage at input BNC (50 Ω)	5 V_{RMS} with peaks ≤ ±30 V	
Maximum floating voltage	0 V from chassis (BNC) ground to earth ground, or	
Under battery power	30 V_{RMS} (42 V_{pk}) only under these conditions: no signal voltages >30 V_{RMS} (>42 V_{pk}), all common leads connected to the same voltage, no grounded peripherals attached	
Channel-to-channel crosstalk, typical	Measured on one channel, with test signal applied to another channel, and with the same scale and coupling settings on each channel	
	Frequency range	*Crosstalk*
All models	≤ 100 MHz	≥ 100:1
TDS303x, TDS305x	≤ 300 MHz	≥ 50:1
TDS305x only	≤ 500 MHz	≥ 30:1
Differential delay, typical	100 ps between any two channels with the same scale and coupling settings	

Table 1-3: Vertical characteristics

Characteristic	Description	
Number of channels	*TDS30x2C*	*TDS30x4C*
	2 plus external trigger input	4 plus external trigger input
	Digitized simultaneously	
Digitizers	9-bit resolution, separate digitizers for each channel sampled simultaneously	
Sensitivity range	*1 MΩ*	*50 Ω*
	1 mV/div to 10 V/div	1mV/div to 1 V/div
	Sensitivity ranges are in a 1-2-5 sequence. Between coarse settings, sensitivity can be finely adjusted with ≥ 1% resolution	

Table 1-3: Vertical characteristics (Cont.)

Characteristic	Description			
Polarity	Normal and Invert			
Position range	±5 divisions			
⩘ Analog bandwidth, 50 Ω (also typical at 1 MΩ with standard probe)	Bandwidth limit set to Full, operating ambient ≤30 °C, derate 1%/°C above 30 °C			
	Scale range	*TDS301xC*	*TDS303xC*	*TDS305xC*
	10 mV/div to 1 V/div	100 MHz	300 MHz	500 MHz
	5 mV/div to 9.98 mv/div			400 MHz
	2 mV/div to 4.98 mV/div		250 MHz	250 MHz
	1 mV/div to 1.99 mV/div	90 MHz	150 MHz	150 MHz
Calculated rise time, typical	TDS301xC		3.5 ns	
	TDS303xC		1.2 ns	
	TDS305xC		0.7 ns	
Analog bandwidth limit, typical	Selectable between 20 MHz, 150 MHz (not available on TDS301xC), or Full			
Lower frequency limit, AC coupled, typical	7 Hz for 1 MΩ, reduced by a factor of ten when using a 10X passive probe; 140 kHz for 50 Ω			
Upper frequency limit, typical				
150 MHz BW limited (TDS303x, TDS305x)	150 MHz			
20 MHz BW limited (all models)	20 MHz			
Peak detect or Envelope pulse response, typical	Minimum width of pulse with amplitude of ≥2 div to capture 50% or greater amplitude			
	Sample rates ≤125 MS/s		*Sample rates ≥250 MS/s*	
	1 ns		1/sample rate	
Delay Between Channels, Full Bandwidth, typical	100 ps for any two channels with equal Volts/Div and Coupling settings on each channel			
DC gain accuracy	± 2%, derated at 0.025%/°C for temperatures above +30 °C, in Sample or Average acquisition mode			

Table 1-3: Vertical characteristics (Cont.)

Characteristic	Description	
DC measurement accuracy	*Measurement type*	*DC Accuracy (in volts)*
Sample acquisition mode, typical	Any sample	± [0.02 [1] × | reading - (offset - position) | + offset accuracy + 0.15 div + 0.6 mV]
	Delta voltage between any two samples, same scope setup and conditions	± [0.02 [1] × | reading | + 0.15 div + 1.2 mV]
✓ Average acquisition mode (≥16 averages)	Average of ≥16 waveforms	± [0.02 [1] × | reading - (offset - position) | + offset accuracy + 0.1 div]
	Delta voltage between any two averages of ≥16 waveforms, same scope setup and conditions	± [0.02 [1] × | reading | + 0.05 div]
Offset range	*Scale range*	*Offset range*
	1 mV/div to 9.95 mV/div	±100 mV
	10 mV/div to 99.5 mV/div	±1 V
	100 mV/div to 995 mV/div	±10 V
	1 V/div to 10 V/div	±100 V
Offset accuracy, all ranges	± [0.005 × | offset - position | + 0.1 div] Note: Convert both the constant offset and position terms to volts by multiplying by the volts/div setting	

[1] **0.02 term (gain component) derated at 0.00025/°C above 30 °C**

Table 1-4: Horizontal characteristics

Characteristic	Description		
Sample rate range	*TDS301xC*	*TDS303xC*	*TDS305xC*
Normal (10,000 point record)	100 S/s to 1.25 GS/s	100 S/s to 2.5 GS/s	100 S/s to 5 GS/s
Fast trigger (500 point record)	5 S/s to 1.25 GS/s	5 S/s to 2.5 GS/s	5 S/s to 5 GS/s
✓ Long term sample rate and delay time accuracy	±20 ppm over any ≥1 ms time interval		
Record Length	500 or 10,000 samples		

Table 1-4: Horizontal characteristics (Cont.)

Characteristic	Description
Seconds/division range	1-2-4 sequence
TDS301x	4 ns/div to 10 s/div
TDS303x	2 ns/div to 10 s/div
TDS305x	1 ns/div to 10 s/div

Table 1-5: Trigger characteristics

Characteristic	Description	
External Trigger Input Impedance, typical		
TDS30x2C	1 MΩ in parallel with 17 pF	
TDS30x4C	1 MΩ in parallel with 52 pF	
External Trigger Maximum Voltage	*Overvoltage category*	*Maximum voltage*
	CAT I Environment (refer to page 1-14)	150 V_{RMS} (400 V_{pk})
	CAT II Environment (refer to page 1-14)	100 V_{RMS} (400 V_{pk})
	For steady-state sinusoidal waveforms, derate at 20 dB/decade above 200 kHz to 13 V_{pk} at 3 MHz and above	
External Trigger Maximum Floating Voltage	0 V from chassis (BNC) ground to earth ground, or 30 V_{RMS} (42 V_{pk}) only under these conditions: battery powered, no signal voltages >30 V_{RMS} (>42 V_{pk}), all common leads connected to the same voltage, no grounded peripherals attached	
⌿ Edge Trigger Sensitivity	*Source*	*Sensitivity*
	Any channel, DC coupled	≤0.6 div from DC to 50 MHz, increasing to 1 div at oscilloscope bandwidth

Table 1-5: Trigger characteristics (Cont.)

Characteristic	Description		
Edge Trigger Sensitivity, typical	*Source*	*Sensitivity*	
DC coupled	External trigger	100 mV from DC to 50 MHz, increasing to 500 mV at 300 MHz	
	External/10 trigger	500 mV from DC to 50 MHz, increasing to 3 V at 300 MHz	
	Line	Fixed	
Other	NOISE REJ coupled	3.5 times the DC-coupled limits	
	HF REJ coupled	1.5 times the DC-coupled limit from DC to 30 kHz, attenuates signals above 30 kHz	
	LF REJ coupled	1.5 times the DC-coupled limits for frequencies above 80 kHz, attenuates signals below 80 kHz	
Logic Trigger Sensitivity, typical	*Class*	*Sensitivity*	
	Pattern	1.0 division	
	State	1.0 division	
	Delay	1.0 division	
Pulse Trigger Sensitivity, typical	*Class*	*Sensitivity*	
	Width	1.0 division	
	Runt	1.0 division	
	Slew rate	Same as edge trigger	
Video Trigger Sensitivity, typical	Triggers on negative sync of NTSC, PAL, or SECAM signal		
	Source	*Sensitivity*	
	Any channel	0.6 to 2.5 divisions of video sync tip	
	External trigger	150 mV to 625 mV of video sync tip	
	External/10 trigger	1.5 V to 6.25 V of video sync tip	
SET LEVEL TO 50%, typical	Operates with input signals ≥45 Hz		
Logic Trigger Minimum Logic And Rearm Time, typical	*Trigger class*	*Logic time*	*Rearm time*
	Pattern	2 ns	2 ns
	State	2 ns	4 ns
	Delay	5 ns	5 ns

Table 1-5: Trigger characteristics (Cont.)

Characteristic	Description		
Pulse Trigger Minimum Pulse And Rearm Time, typical	*Trigger class*	*Pulse width*	*Rearm time*
	Width	5 ns	5 ns
	Runt	5 ns	5 ns
	Slew rate	5 ns	5 ns
Time Qualified Trigger	*Δ time*	*Accuracy*	
	39.6 ns to 10 s	±13.2 ns	
Trigger Level Range	*Source*	*Sensitivity*	
	Any channel	±8 divisions from center of screen, ±8 divisions from 0 V if LF REJ trigger coupled	
	External trigger	±800 mV	
	External/10 trigger	±8 V	
	Line	N/A	
Trigger Level Accuracy, typical (Signal rise and fall times ≥20 ns)	*Source*	*Range*	
	Any channel	0.20 divisions	
	External trigger	20 mV	
	External/10 trigger	200 mV	
	Line	N/A	
Trigger Holdoff Range	250.8 ns to 10 s		
Video Trigger	Negative sync composite video, field 1 or field 2 for interlaces systems, any field, specific line, or any line for interlaced or non-interlaced systems.		
Supported systems	NTSC, PAL, SECAM, and HDTV 1080/24sF, 1080p/25, 1080i/50, 1080i/60, 1080p/24, 720p/60, 480p/60		

Table 1-5: Trigger characteristics (Cont.)

Characteristic	Description	
B Trigger	*Trigger After Time*	*Trigger After Events*
Range	13.2 ns to 50 s	1 event to 9,999,999 events
Minimum time between arm and trigger	5 ns from the end of the time period and the B trigger event	5 ns between the A trigger event and the first B trigger event
Minimum pulse-width, typical	—	B event width, 2 ns
Maximum frequency, typical	—	B event frequency, 250 MHz

Table 1-6: Display characteristics

Characteristic	Description	
Display type	in.	mm
Height	5.22	132.59
Width	3.91	99.31
Diagonal	6.50	165.10
	6-bit (operated at 4-bit) RGB full color, TFT liquid crystal display (LCD)	
Display resolution	640 horizontal by 480 vertical displayed pixels	
Backlight intensity, typical	200 cd/m^2	
Display Update Rate, typical	*500 Point Record*	*10,000 Point Record*
	≤3,600 wfms/s, 1 channel, sample mode, no measurements	≤700 wfms/s, 1 channel, sample mode, no measurements
Display Color	Up to 16 colors	

Table 1-7: I/O Port characteristics

Characteristic	Description
Ethernet port	IEEE802.3 10BaseT
Pinout (See Figure 1-1)	Pin 1: Transmit+ Pin 2: Transmit- Pin 3: Receive+ Pin 6: Receive- All others: NC

Table 1-7: I/O Port characteristics (Cont.)

Characteristic	Description
USB Interfaces	
Host interface (Front panel)	Front Panel provides USB 2.0 Full Speed host. 12Mb/sec maximum. Supports USB Mass Storage Class, Bulk Only Subclass only. Provides full 0.5A of 5V. Other Classes and Subclasses may be active to support other USB storage devices only.
Host Pinout (See Figure 1-2)	Pin 1: VBus Pin 2: D- Pin 3: D+ Pin 4: GND Shell: Chassis
GPIB interface	Available with optional accessory TDS3GV
RS-232 interface	DB-9 male connector, available with optional accessory TDS3GV
VGA signal output	DB-15 female connector, 31.6 kHz sync rate, EIA RS-343A compliant, available with optional accessory TDS3GV
TekProbe Interface, front panel BNCs	Supports TekProbe Level 1 probe coding for all probes Supports TekProbe Level 2 probe coding for the following probes and adaptors. When using multiple Level 2 probes, the Load Factors for the installed probes must total less than 10: *Probe* — *Load Factor* ADA400A — 5 AFTDS — 0 AMT75 — 0 P5205 — 6 P5210 — 6 P6205 — 0 P6243 — 0 TCP202 — 4 013-0278-02 — 5 Offset is not supported for any Level 2 probe.
Probe compensator output, typical	5.0 V into ≥1 MΩ load, frequency = 1 kHz

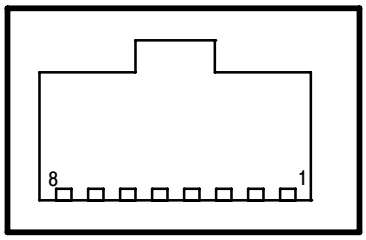


Figure 1-1: Ethernet pinout

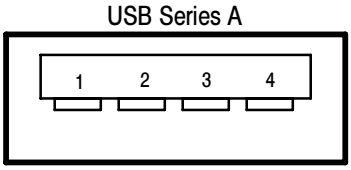


Figure 1-2: USB Host pinout

Table 1-8: Miscellaneous characteristics

Characteristic	Description
Nonvolatile memory	Typical retention time ≥ 5 years for front-panel settings, unlimited for saved waveforms, setups, and calibration constraints
Real-Time clock	A programmable clock providing time in years, months, days, hours, minutes, and seconds

Table 1-9: Power sources

Characteristic		Description
AC line power		Operates the oscilloscope and charges the optional internal battery
	Source voltage	100 V_{RMS} to 240 V_{RMS}, ±10%, installation category II
	Source frequency	
	100 V_{RMS} to 120 V_{RMS}	45 Hz to 440 Hz
	120 V_{RMS} to 240 V_{RMS}	45 Hz to 66 Hz
	Power consumption	<75 W at 90 to 264 V_{AC} input
Battery power		Optional accessory TDS3BATC, rechargeable battery pack
	Operating time, typical	3 hours, depending on operating conditions
	Line fuse	Internal, not user replaceable

Table 1-10: Environmental characteristics

Characteristic	Description
Temperature	
Operating	0 °C to +50 °C, with 5 °C/minute maximum gradient, non-condensing
Nonoperating	-40 °C to +71 °C, with 5 °C/minute maximum gradient
Humidity	
Operating	5% to 95% Relative Humidity (RH) ≤+30 °C, 5% to 45% RH +30 °C to +50 °C
Nonoperating	5% to 95% Relative Humidity (RH) ≤+30 °C, 5% to 45% RH +30 °C to +50 °C
Altitude	
Operating	3,000 m (3,280 yd.)
Nonoperating	15,000 m (16,404 yd.)

Table 1-11: Mechanical characteristics

Characteristic	Description
Size	Height: 176 mm (6.9 in), 229 mm (9.0 in) including handle Width: 375 mm (14.75 in) Depth: 149 mm (5.9 in)
Weight	Oscilloscope only: 3.2 kg (7.0 lbs) With accessories and carry case: 4.1 kg (9.0 lbs) When packaged for domestic shipment: 5.5 kg (12.0 lbs) Optional TDS3BATC battery pack: 0.85 kg (1.9 lbs)

Certifications and Compliances

Meets the intent of Directive 2004/108/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326:1997. EMC requirements for Class A electrical equipment for measurement, control, and laboratory use. Annex D. [1] [2] [3]

- IEC 61000-4-2:1999. Electrostatic discharge immunity
- IEC 61000-4-3:2002. RF electromagnetic field immunity [4] [5]
- IEC 61000-4-4:2004. Electrical fast transient/burst immunity
- IEC 61000-4-5:2005. Power line surge immunity
- IEC 61000-4-6:2003. Conducted RF immunity
- IEC 61000-4-11:2004. Voltage dips and interruptions immunity

EN 61000-3-2:2000. AC power line harmonic emissions

EN 61000-3-3:1995. Voltage changes, fluctuations, and flicker

European Contact.
Tektronix UK, Ltd.
Western Peninsula
Western Road
Bracknell, RG12 1RF
United Kingdom

1 **This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.**

2 **Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.**

3 **To ensure compliance with the EMC standards listed here, high quality shielded interface cables should be used. High quality shielded cables typically are braid and foil types that have low impedance connections to shielded connectors at both ends.**

4 **The increase in trace noise while subjected to a test field (3 V/m over the frequency range 80 MHz to 1 GHz, with 80% amplitude modulation at 1 kHz) is not to exceed 8 major divisions peak-to-peak. Ambient conducted fields may induce triggering when the trigger threshold is offset less than 4 major divisions from ground reference.**

5 **The increase in trace noise while subjected to a test field (3 V/m over the frequency range 150 kHz to 80 MHz, with 80% amplitude modulation at 1 kHz) is not to exceed 2 major divisions peak-to-peak. Ambient conducted fields may induce triggering when the trigger threshold is offset less than 1 major divisions from ground reference.**

Australia / New Zealand Declaration of Conformity - EMC

Complies with the EMC provision of the Radiocommunications Act per the following standard, in accordance with ACMA:

- EN 61326:1997. EMC requirements for electrical equipment for measurement, control, and laboratory use.

FCC - EMC

Emissions are within the limits of FCC 47 CFR, Part 15, Subpart B for Class A equipment.

EC Declaration of Conformity - Low Voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities:

Low Voltage Directive2006/96/EC.

- EN 61010-1: 2001. Safety requirements for electrical equipment for measurement control and laboratory use.

U.S. Nationally Recognized Testing Laboratory Listing

UL 61010-1: 2004, 2nd Edition. Standard for electrical measuring and test equipment.

Canadian Certification

CAN/CSA C22.2 No. 61010-1:2004. Safety requirements for electrical equipment for measurement, control, and laboratory use. Part 1.

Additional Compliances

IEC 61010-1: 2001. Safety requirements for electrical equipment for measurement, control, and laboratory use.

Equipment Type

Test and measuring equipment.

Safety Class

Class 1 - grounded product.

Pollution Degree Description

A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.

- Pollution Degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms.
- Pollution Degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.
- Pollution Degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.
- Pollution Degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.

Pollution Degree

Pollution Degree 2 (as defined in IEC 61010-1). Note: Rated for indoor use only.

Installation (Overvoltage) Category Descriptions

Terminals on this product may have different installation (overvoltage) category designations. The installation categories are:

- Measurement Category IV. For measurements performed at the source of low-voltage installation.
- Measurement Category III. For measurements performed in the building installation.
- Measurement Category II. For measurements performed on circuits directly connected to the low-voltage installation.
- Measurement Category I. For measurements performed on circuits not directly connected to MAINS.

Overvoltage Category

Overvoltage Category II (as defined in IEC 61010-1)

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	Wavetek 9500 Oscilloscope Calibrator with two 9510 Output Modules
Leveled Sine Wave Generator	50 kHz to 600 MHz, ±4% amplitude accuracy, ±0.01% frequency accuracy	
Time Mark Generator	10 ms period, ±5 ppm accuracy	
50 Ω feedthrough termination	BNC connectors	Tektronix part number 011-0099-00

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

These procedures cover all TDS3000C series oscilloscope models. Please disregard checks that do not apply to the specific model you are testing.

Photocopy the test record on the next two pages and use them to record the performance test results for your oscilloscope.

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

Successful completion of the Adjustment Procedure in Section 5 does automatically update the instrument Calibration Due date and time.

Test Record

Model number	Serial number	Procedure performed by	Date

Test	Passed	Failed
Self Test		

Performance checks		Low limit	Test result	High limit
Channel 1 DC measurement accuracy	1 mV/div	99.25 mV		100.8 mV
	2 mV/div	-7.540 mV		-6.460 mV
	5 mV/div	-101.8 mV		-98.24 mV
	50 mV/div	982.4 mV		1.018 V
	50 mV/div	632.4 mV		667.6 mV
	50 mV delta	340.5 mV		359.5 mV
	90 mV/div	-339.3 mV		-290.7 mV
	200 mV/div	9.900 V		10.10 V
	1 V/div	-10.30 V		-9.698 V
Channel 2 DC measurement accuracy	1 mV/div	99.25 mV		100.8 mV
	2 mV/div	-7.540 mV		-6.460 mV
	5 mV/div	-101.8 mV		-98.24 mV
	50 mV/div	982.4 mV		1.018 V
	50 mV/div	632.4 mV		667.6 mV
	50 mV delta	340.5 mV		359.5 mV
	90 mV/div	-339.3 mV		-290.7 mV
	200 mV/div	9.900 V		10.10 V
	1 V/div	-10.30 V		-9.698 V

Performance checks		Low limit	Test result	High limit
Channel 3 DC measurement accuracy	1 mV/div	99.25 mV		100.8 mV
	2 mV/div	-7.540 mV		-6.460 mV
	5 mV/div	-101.8 mV		-98.24 mV
	50 mV/div	982.4 mV		1.018 V
	50 mV/div	632.4 mV		667.6 mV
	50 mV delta	340.5 mV		359.5 mV
	90 mV/div	-339.3 mV		-290.7 mV
	200 mV/div	9.900 V		10.10 V
	1 V/div	-10.30 V		-9.698 V
Channel 4 DC measurement accuracy	1 mV/div	99.25 mV		100.8 mV
	2 mV/div	-7.540 mV		-6.460 mV
	5 mV/div	-101.8 mV		-98.24 mV
	50 mV/div	982.4 mV		1.018 V
	50 mV/div	632.4 mV		667.6 mV
	50 mV delta	340.5 mV		359.5 mV
	90 mV/div	-339.3 mV		-290.7 mV
	200 mV/div	9.900 V		10.10 V
	1 V/div	-10.30 V		-9.698 V
Channel 1 bandwidth		150 mV		—
Channel 2 bandwidth		150 mV		—
Channel 3 bandwidth		150 mV		—
Channel 4 bandwidth		150 mV		—
Channel 1 trigger sensitivity at BW	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 2 trigger sensitivity at BW	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 3 trigger sensitivity at BW	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 4 trigger sensitivity at BW	rising slope	stable trigger		—
	falling slope	stable trigger		—

Performance checks		Low limit	Test result	High limit
Channel 1 trigger sensitivity at 50 MHz	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 2 trigger sensitivity at 50 MHz	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 3 trigger sensitivity at 50 MHz	rising slope	stable trigger		—
	falling slope	stable trigger		—
Channel 4 trigger sensitivity at 50 MHz	rising slope	stable trigger		—
	falling slope	stable trigger		—
Sample rate and delay time accuracy		-2 divisions		+2 divisions

Performance Verification Procedures

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

1. The oscilloscope must have been operating continuously for twenty (20) minutes in an environment the meets the operating range specifications for temperature and humidity.
2. You must perform the Signal Path Compensation procedure, described below. If the operating temperature changes by more than 10 °C, 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.*

Signal Path Compensation (SPC)

The signal path compensation (SPC) routine optimizes the oscilloscope signal path for maximum measurement accuracy. You can run the routine anytime but you should always run the routine if the ambient temperature changes by 10 °C (18 °F) or more.

To compensate the signal path, do the following steps:

1. Disconnect any probes or cables from the channel input connectors.
2. Push the **Utility** button.
3. Push the **System** screen button to select **Cal**.
4. Push the **Signal Path** screen button.
5. Push **OK Compensate Signal Path**. This procedure takes several minutes to complete.

Self Test

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

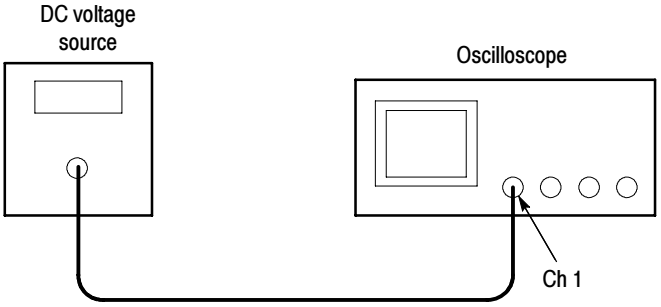
1. Disconnect all probes and cables from the oscilloscope inputs.
2. Push the **Utility** menu button.
3. Push the **System** screen button to select **Diags**.
4. Push the **Loop** screen button and choose **Once**.
5. Push the **Execute** screen button.
6. Push the **OK Confirm Run Test** screen button.

A dialog box displays the result when the self test completes. Push the **Menu Off** screen button to continue operation.

Check DC Voltage Measurement Accuracy

This test checks the DC voltage measurement accuracy in the average acquisition mode.

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



3. Push the **Save/Recall** menu button.
4. Push the **Recall Factory Setup** screen button and then push the **OK Confirm Factory Init** screen button.
5. Push the acquire **Menu** button.
6. Push the **Mode** screen button and then push the **Average** screen button.
7. Adjust the number of averages to **16** with the general purpose knob.
8. Go to step 11.

9. Move the DC voltage source output cable to the oscilloscope channel you want to check.
10. Push the channel button (**CH 1**, **CH 2**, **CH 3**, or **CH 4**) for the channel you want to check.
11. Push the **Measure** menu button.
12. Push the **Select Measurement** screen button.
13. Push the **- more -** screen button until you can select the **Mean** measurement.
14. Push the vertical **Menu** button.

Vertical Scale setting	Invert setting	Bandwidth limit setting	Offset	Input voltage	Low limit	High limit
1 mV/div	Off	20 MHz	96.5 mV	100 mV	99.25 mV	100.8 mV
2 mV/div	Off	20 MHz	0.0 V	-7 mV	-7.540 mV	-6.460 mV
5 mV/div	Off	20 MHz	-82.5 mV	-100 mV	-101.8 mV	-98.24 mV
50 mV/div	Off	Full	825 mV[1]	1.0 V	982.4 mV	1.018 V
50 mV/div	Off	Full	825 mV[1]	650 mV	632.4 mV	667.6 mV
50 mV delta[2]					340.5 mV	359.5 mV
90 mV/div [3]	Off	Full	0.0 V	-315 mV	-339.3 mV	-290.7 mV
200 mV/div	Off	150 MHz [4]	9.3 V	10 V	9.900 V	10.10 V
1 V/div	On [5]	150 MHz [4]	-6.5 V	10 V	-10.30 V	-9.698 V

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

2 Refer to step 15e on page 2-8 to calculate 50 mV delta measurement.

3 Push the Vertical MENU button, push the Fine Scale screen button, then use the general purpose knob to adjust the setting to 90 mV/div.

4 Use the Full bandwidth setting on the TDS3012C or TDS3014C oscilloscopes.

5 Make sure to turn Invert setting to On for this measurement.

15. For each row of the table, do these steps:
    a. Set the vertical **Scale** control to the setting in the table.
    b. Set the **Invert** and **Bandwidth Limit** controls to the settings in the table.
    c. Set the output of the DC voltage source to the voltage level in the table.
    d. Verify that the oscilloscope **Mean** measurement is within the limits listed in the above table.

e. For the 50 mV delta measurement, subtract the second 50 mV measurement from the first 50 mV measurement; verify that the difference is within the limits stated in the Delta row of the table.

16. Repeat steps 15a through 15e for each row in the table.

17. Push the waveform off button.

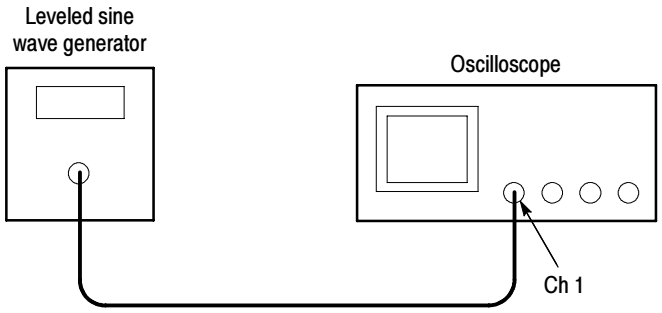
18. Repeat steps 9 through 17 for each channel of the oscilloscope (not including the external trigger input).

Check Bandwidth

This test checks the bandwidth for each channel.

NOTE. *Source frequency accuracy is important for this check. Refer to the equipment list on page 2-1 for frequency accuracy requirements.*

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



2. Push the **Save/Recall** menu button.

3. Push the **Recall Factory Setup** screen button and then push the **OK Confirm Factory Init** screen button.

4. Push the Trigger **Menu** button.

5. Push the **Source** screen button, and then push the **Vert** screen button.

6. Push the **Coupling** screen button, and then push the **Noise Reject** screen button.

7. Go to step 10.

8. Move the output cable of the leveled sine wave generator to the oscilloscope channel you want to check.

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

10. Set the horizontal **Scale** to **10 µs/div**.

11. Push the vertical **Menu** button.

12. Push the **Coupling** screen button and select **50 Ω** input resistance.

13. Push the **Meas** menu button.

14. Push the **Select Measurement** screen button.

15. Push the **- more -** screen button until you can select the **RMS** measurement.

16. Set the vertical **Scale** to **100 mV/div**.

17. Set the output frequency of the leveled sine wave generator to **50 kHz**.

18. Set the output amplitude of the leveled sine wave generator so the RMS measurement is **212 mV**.

NOTE. *Test frequencies at rated bandwidths are offset to avoid coherence effects.*

19. Set the output frequency of the leveled sine wave generator to the frequency shown in the table below.

Oscilloscope model	Frequency
TDS301xC	101 MHz
TDS303xC	301 MHz
TDS305xC	501 MHz

20. Verify that the RMS measurement is **≥150 mV**.

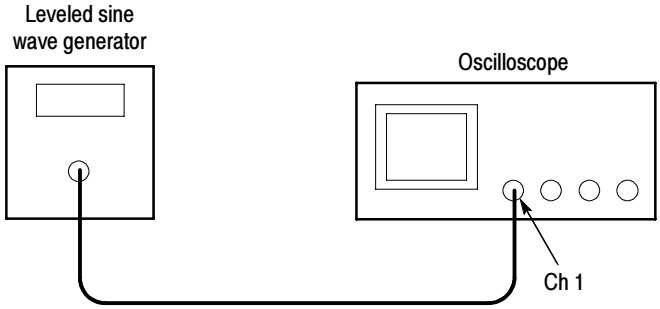
21. Push the waveform off button.

22. Repeat steps 8 through 21 for each channel of the oscilloscope (not including the external trigger input).

Check Channel Edge-Trigger Sensitivity at Maximum Bandwidth

This test checks the edge-trigger sensitivity for each channel, at the oscilloscope maximum bandwidth.

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



2. Push the **Save/Recall** menu button.
3. Push the **Recall Factory Setup** screen button and then push the **OK Confirm Factory Init** screen button.
4. Push the acquire **Menu** button.
5. Push the **Mode** screen button and then push the **Average** screen button.
6. Adjust the number of averages to **16** with the general purpose knob.
7. Push the trigger **Menu** button.
8. Push the **Source** screen button and then push the **Vert** screen button.
9. Set the horizontal **Scale** to **10 ns/div**.
10. Go to step 13.
11. Move the output cable of the leveled sine wave generator to the oscilloscope channel you want to check.
12. Push the channel button (**CH 1**, **CH 2**, **CH 3**, or **CH 4**) for the channel you want to check.
13. Push the vertical **MENU** button.
14. Push the **Coupling** screen button and select **50 Ω** input resistance.
15. Push the **Measure** menu button.
16. Push the **Select Measurement** screen button.
17. Push the **- more -** screen button until you can select the **Pk-Pk** measurement.

18. Set the vertical **Scale** to **500 mV/div**.

19. Set the output frequency of the leveled sine wave generator to the frequency shown in the table below.

Oscilloscope model	Frequency
TDS301xC	100 MHz
TDS303xC	300 MHz
TDS305xC	500 MHz

20. Set the output amplitude of the leveled sine wave generator so that the oscilloscope peak-to-peak measurement is approximately **2.5 V**. Note the generator output amplitude setting.

21. Set the leveled sine wave generator output amplitude to one-fifth of the output amplitude value that was set in step 20.

22. Push the **SET TO 50%** button. Adjust the trigger **Level** as necessary and then verify that triggering is stable.

23. Push the trigger **MENU** button.

24. Push the **Slope** screen button and select the \ (**falling**) slope.

25. Push the **SET TO 50%** button. Adjust the trigger **Level** as necessary and then verify that triggering is stable.

26. Push the **Slope** screen button and select the / (**Rising**) slope.

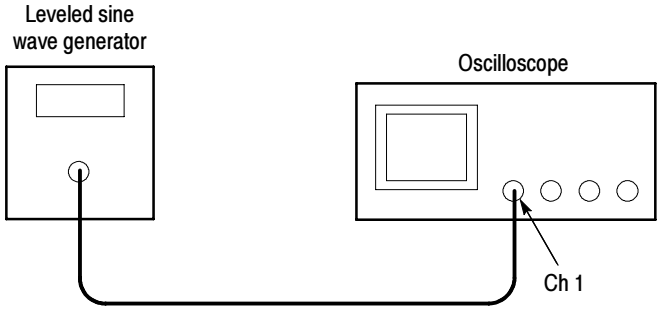
27. Push the waveform off button.

28. Repeat steps 11 through 27 for each channel of the oscilloscope (not including the external trigger input).

Check Channel Edge-Trigger Sensitivity at 50 MHz

This test checks the edge-trigger sensitivity for each channel at 50 MHz.

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



2. Push the **Save/Recall** menu button.
3. Push the **Recall Factory Setup** screen button and then push the **OK Confirm Factory Init** screen button.
4. Push the acquire **Menu** button.
5. Push the **Mode** screen button and then push the **Average** screen button.
6. Adjust the number of averages to **16** with the general purpose knob.
7. Push the trigger **Menu** button.
8. Push the **Source** screen button and then push the **Vert** screen button.
9. Set the horizontal **Scale** to **100 ns/div**.
10. Go to step 13.
11. Move the output cable of the leveled sine wave generator to the oscilloscope channel you want to check.
12. Push the channel button (**CH 1**, **CH 2**, **CH 3**, or **CH 4**) to activate the channel you want to check.
13. Push the vertical **Menu** button.
14. Push the **Coupling** screen button and select **50 Ω** input resistance.
15. Push the **Measure** menu button.
16. Push the **Select Measurement** screen button.
17. Push the **- more -** screen button until you can select the **Pk-Pk** measurement.
18. Set the vertical **SCALE** to **500 mV/div**.

19. Set the output frequency of the leveled sine wave generator to **50 MHz**.

20. Set the output amplitude of the leveled sine wave generator so that the oscilloscope peak-to-peak measurement is approximately **3.0 V**. Note the generator output amplitude setting.

21. Set the leveled sine wave generator output amplitude to one-tenth of the output amplitude value that was set in step 20. If you are using the recommended signal generator model, select the **÷10** soft key.

22. Push the **Set to 50%** button. Adjust the trigger **Level** as necessary and then verify that triggering is stable.

23. Push the trigger **Menu** button.

24. Push the **Slope** screen button and select the \ **(falling)** slope.

25. Push the **Set to 50%** button. Adjust the trigger **Level** as necessary and then verify that triggering is stable.

26. Push the **Slope** screen button and select the / **(rising)** slope.

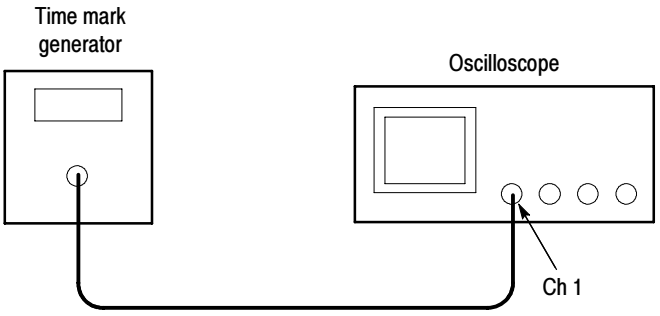
27. Push the waveform off button.

28. Repeat steps 11 through 27 for each channel of the oscilloscope (not including the external trigger input).

Check Sample Rate and Delay Time Accuracy

This test checks the time base accuracy.

1. Connect the output of the time mark wave generator to the oscilloscope channel 1 input as shown below.



2. Push the **Save/Recall** menu button.
3. Push the **Recall Factory Setup** screen button and then push the **OK Confirm Factory Init** screen button.
4. Push the **Delay** button to turn delay off.
5. Push the vertical **Menu** button.
6. Push the **Coupling** screen button and select **50 Ω** input resistance.
7. Set the time mark generator period to **100 ms**. Use a time mark waveform with a fast rising edge.
8. If adjustable, set the time mark amplitude to approximately **1 V_{p-p}**.
9. Set the vertical **Scale** to **500 mV/div**.
10. Set the horizontal **Scale** to **20 ms/div**.
11. Adjust the vertical **Position** control to center the time mark signal on the screen.
12. Adjust the trigger **Level** as necessary to obtain a triggered display.
13. Adjust the horizontal **Position** control to move the trigger location to the center of the screen (50%).
14. Push the **Delay** button to turn delay on.

15. Turn the horizontal **Position** control counter-clockwise to set the delay to exactly **100 ms**.

16. Set the horizontal scale to **1 µs/div**.

17. Check that the rising edge of the marker crosses the center horizontal graticule line within ±2 divisions of center graticule.

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

This completes the performance verification procedure.