

Service Manual



TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscope

070-8713-03

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 the Safety Summary prior to performing service.

Specifications

This subsection begins with a general description of the traits of the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes. Three subsections follow, one for each of three classes of traits: *nominal traits*, *warranted characteristics*, and *typical characteristics*.

General Product Description

The Tektronix TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes are portable, four-channel instruments suitable for use in a variety of test and measurement applications and systems. Key features include:

- 500 MHz maximum analog bandwidth.
- 1 Gigasample/second maximum digitizing rate (TDS 540A and 544A); 500 Megasamples/second maximum digitizing rate (TDS 520A and 524A).
- Four-channel acquisition — the TDS 540A and 544A offer four full-featured channels; the TDS 520A and 524A offer two full-featured channels and two channels with limited vertical scale selections: 100 mV, 1 V, and 10 V.
- Extensive triggering capabilities: such as edge, logic, and glitch. Video trigger (Option 05) is also available. The video trigger modes are NTSC, PAL, SECAM, HDTV, and FlexFormat™ (user definable format).
- Waveform Math — Invert a single waveform and add, subtract, and multiply two waveforms. On the TDS 524A, 544A, and other TDS 500A equipped with option 2F, integrate or differentiate a single waveform or perform an FFT (fast fourier transform) on a waveform to display its magnitude or phase versus its frequency.
- Eight-bit digitizers.
- Up to 15,000-point record length per channel (50,000-point with option 1M).
- Full GPIB software programmability. Hardcopy output using GPIB, RS-232, or Centronics ports (RS-232 and Centronics is standard on the TDS 524A and 544A and optional, as option 13, on the TDS 520A and 540A).
- Complete measurement and documentation capability.
- Intuitive graphic icon operation blended with the familiarity of traditional horizontal and vertical knobs.
- On-line help at the touch of a button.
- A full complement of advanced functions, like continuously-updated measurements, results and local pass/fail decision making.

Warranted Characteristics

This subsection lists the electrical and environmental *warranted characteristics* that describe the TDS 520A, 524A, 540A, & 544A Digitizing Oscilloscopes.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted.

NOTE

*In these tables, those warranted characteristics that are checked in the procedure Performance Verification, found in Section 4, appear in **boldface type** under the column **Name**.*

As stated above, this subsection lists only warranted characteristics. A list of *typical characteristics* starts on page 1-21.

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply when the scope has been adjusted at an ambient temperature between +20° C and +30° C, has had a warm-up period of at least 20 minutes, and is operating at an ambient temperature between +4° C and +50° C (unless otherwise noted).

Table 1-8: Warranted Characteristics — Signal Acquisition System

Name	Description	
Accuracy, DC Gain	$\pm 1\%$ (For all sensitivities from 1 mV/div to 10 V/div with offsets from 0 V to ± 100 V.)	
Accuracy, Offset TDS 540A and 544A (all channels), TDS 520A and 524A (CH1 and CH2)	Volts/Div Setting 1 mV/div – 99.5 mV/div	Offset Accuracy $\pm(0.2\% \times \text{Net Offset}^1 + 1.5 \text{ mV} + 0.1 \text{ div} \times \text{volts/div setting})$
	100 mV/div – 995 mV/div	$\pm(0.35\% \times \text{Net Offset}^1 + 15 \text{ mV} + 0.1 \text{ div} \times \text{volts/div setting})$
	1 V/div – 10 V/div	$\pm(0.35\% \times \text{Net Offset}^1 + 150 \text{ mV} + 0.1 \text{ div} \times \text{volts/div setting})$
Accuracy, Offset TDS 520A and 524A (AUX1 and AUX2)		Offset Accuracy $\pm(1\% \times \text{Net Offset}^1 + 0.1 \text{ div} \times \text{volts/div setting})$

Table 1-8: Warranted Characteristics — Signal Acquisition System (Cont.)

Name	Description
Analog Bandwidth, DC-50 Ω Coupled or DC-1 MΩ Coupled	Volts/Div
	5 mV/div – 10 V/div
	2 mV/div – 4.98 mV/div
	1 mV/div – 1.99 mV/div
	Bandwidth⁴
	DC – 500 MHz
	DC – 350 MHz
	DC – 250 MHz
Cross Talk (Channel Isolation)	$\geq 100:1$ at 100 MHz and $\geq 30:1$ at the derated bandwidth for any two channels having equal volts/division settings
Input Impedance, DC-1 M Ω Coupled	1 M $\Omega \pm 0.5\%$ in parallel with 10 pF ± 2 pF
Input Impedance, DC-50 Ω Coupled	50 $\Omega \pm 1\%$ with VSWR $\leq 1.3:1$ from DC – 500 MHz
Input Voltage, Maximum, DC-1 M Ω , AC-1 M Ω , or GND Coupled	± 400 V (DC + peak AC); derate at 20 dB/decade above 1 MHz
Input Voltage, Maximum, DC-50 Ω or AC-50 Ω Coupled	5 V _{RMS} , with peaks $\leq \pm 30$ V
Lower Frequency Limit, AC Coupled	≤ 10 Hz when AC-1 M Ω Coupled; ≤ 200 kHz when AC – 50 Ω Coupled ⁵

- 1 Net Offset = Offset – (Position \times Volts/Div). Net Offset is the nominal voltage level at the center of the A-D converter dynamic range. Offset Accuracy is the accuracy of this Voltage level.
- 2 The samples must be acquired under the same setup and ambient conditions.
- 3 To ensure the most accurate measurements possible, run an SPC calibration first. When using the oscilloscope at a Volts/Div setting ≤ 5 mV/div, an SPC calibration should be run once per week to ensure that instrument performance levels meet specifications.
- 4 The limits given are for the ambient temperature range of 0° C to +30° C. Reduce the upper bandwidth frequencies by 2.5 MHz for each ° C above +30° C.
- 5 The AC Coupled Lower Frequency Limits are reduced by a factor of 10 when 10X, passive probes are used.

Table 1-9: Warranted Characteristics — Time Base System

Name	Description
Accuracy, Long Term Sample Rate and Delay Time	± 25 ppm over any ≥ 1 ms interval

Table 1-10: Warranted Characteristics — Triggering System

Name	Description		
Accuracy (Time) for Pulse-Glitch or Pulse-Width Triggering	Time Range	Accuracy	
	2 ns to 1 μ s	\pm (20% of setting + 0.5 ns)	
	1.02 μ s to 1 s	\pm (100 ns + .0025% of setting)	
Sensitivity, Edge-Type Trigger, DC Coupled ¹	Trigger Source	Sensitivity	
	TDS 540A, 544A (CH1 – CH4)	0.35 division from DC to 50 MHz, increasing to 1 division at 500 MHz	
	TDS 520A, 524A (CH1, CH2)		
	TDS 520A, 524A (AUX1, AUX2)	0.55 division from DC to 50 MHz, increasing to 1.5 division at 500 MHz	
Width, Minimum Pulse and Rearm, for Pulse Triggering	Auxiliary (TDS 540A, 544A only)	0.25 volts from DC to 50 MHz	
	Pulse Class	Minimum Pulse Width	Minimum Rearm Width
	Glitch	2 ns	2 ns + 5% of Glitch Width Setting
	Runt	2.5 ns	2.5 ns
Jitter (Option 05 Video Trigger)	Width	2 ns	2 ns + 5% of Width Upper Limit Setting
	17 ns _{p-p} on HDTV signal; 60 ns _{p-p} on NTSC or PAL signal		
Input Signal Sync Amplitude for Stable Triggering (Option 05 Video Trigger)	0.6 division to 4 division (1 division to 4 divisions in Numerical Field)		

¹ The minimum sensitivity for obtaining a stable trigger. A stable trigger results in a uniform, regular display triggered on the selected slope. The trigger point must not switch between opposite slopes on the waveform, and the display must not “roll” across the screen on successive acquisitions. The TRIG'D LED stays constantly lighted when the SEC/DIV setting is 2 ms or faster but may flash when the SEC/DIV setting is 10 ms or slower.

Table 1-11: Warranted Characteristics — Interfaces, Output Ports and Power Requirements

Name	Description	
Logic Levels, Main- and Delayed-Trigger Outputs	Characteristic	Limits
	Vout (HI)	≥ 2.5 V open circuit; ≥ 1.0 V into a $50\ \Omega$ load to ground
	Vout (LO)	≤ 0.7 V into a load of ≤ 4 mA; ≤ 0.25 V into a $50\ \Omega$ load to ground
Output Voltage and Frequency, Probe Compensator	Characteristic	Limits
	Output Voltage	0.5 V (base-top) $\pm 1\%$ into a $\geq 50\ \Omega$ load
	Frequency	1 kHz $\pm 5\%$
Output Voltage, Channel 3 Signal Out	20 mV/division $\pm 10\%$ into a $1\ \text{M}\Omega$ load; 10 mV/division $\pm 10\%$ into a $50\ \Omega$ load	
Source Voltage	90 to 250 VAC _{RMS} , continuous range	
Source Frequency	47 Hz to 63 Hz	
Power Consumption	≤ 300 W (450 VA)	

Table 1-12: Warranted Characteristics — Environmental, Safety, and Reliability

Name	Description
Atmospherics	<p>Temperature with floppy disk (optional on TDS 520A and 540A):</p> <p>Operating: +4° C to +50° C;</p> <p>Non-operating: –22° C to +60° C</p> <p>Temperature without floppy disk:</p> <p>Operating: 0° C to +50° C;</p> <p>Non-operating: –40° C to +60° C</p> <p>Relative humidity with floppy disk (optional on TDS 520A and 540A):</p> <p>Operating: To 80%, at or below +29° C;</p> <p>Operating: To 20%, at or below +50° C</p> <p>Non-operating: To 90%, at or below +40° C;</p> <p>Non-operating: To 5%, at or below +50° C</p> <p>Relative humidity without floppy disk:</p> <p>Operating: To 95%, at or below +40° C;</p> <p>Operating: To 75%, from +41° C to +55° C</p> <p>Altitude:</p> <p>To 4570 m (15,000 ft.), operating;</p> <p>To 12190 m (40,000 ft.), non-operating</p>
Dynamics	<p>Random vibration without floppy disk installed:</p> <p>0.31 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, operating;</p> <p>3.07 g_{RMS}, from 5 to 500 Hz, 10 minutes each axis, non-operating</p>
Emissions	<p>Meets or exceeds the requirements of the following standards:</p> <p>Vfg. 243/1991 Amended per Vfg. 46/1992</p> <p>FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, Class A</p>
User-Misuse Simulation	<p>Electrostatic Discharge Susceptibility: Up to 8 kV with no change to control settings or impairment of normal operation; up to 15 kV with no damage that prevents recovery of normal operation by the user</p>