

# Digital Phosphor Oscilloscopes

## ► TDS7000 Series



## Unmatched Performance, Simplicity and Connectivity

TDS7000 Series digital phosphor oscilloscopes provide the industry's best solution to the challenging signal integrity issues faced by designers verifying, characterizing and debugging sophisticated electronic designs. The family features exceptional signal acquisition and analysis, operational simplicity and complete connectivity to your design environment and third party analysis software. The intuitive user interface, developed after months of customer research, was pioneered in the TDS7000 Series and is quickly becoming an industry standard.

### Superior Performance Solves Signal Integrity Problems and Speeds Verification and Debug

#### Signal Fidelity

TDS7000 models, with bandwidths from 500 MHz to 4 GHz and single-shot sample rates to 20 GS/s, easily meet the demands of the latest high-speed logic families and multi-Gigabit communication standards. Acquisition memory up to 32 Megasamples maximizes the value of the high sample rate and ensures that critical events are captured with fine detail.

### ► Features & Benefits

4 GHz, 2.5 GHz, 1.5 GHz, 1 GHz and 500 MHz Bandwidth Models

Up to 20 GS/s Real-time Sample Rate

Up to 32 Megasamples Memory Depth

>400,000 Wfms/second Maximum Waveform Capture Rate

Exceptional Delta-time Accuracy for High-confidence in Critical Timing Measurements

Communications Mask Testing Up to 2.5 Gb/s Rates

Clock Recovery from Serial Data Streams

32-Bit Serial Trigger for Isolation of Pattern-dependent Effects

Intuitive User Interface

Open Microsoft Windows Environment

### ► Applications

Signal Integrity, Jitter and Timing Analysis

Verification, Debug and Characterization of Sophisticated Designs

Design Development and Compliance Testing of Serial Data Streams Up to 2.5 Gb/s Rates for Telecom and Datacom Industry Standards

Spectral Analysis

Disk Drive Analysis

COMPUTING

COMMUNICATIONS

VIDEO

# Digital Phosphor Oscilloscopes

## ► TDS7000 Series

### Why is Delta-time Accuracy a Critical Specification?

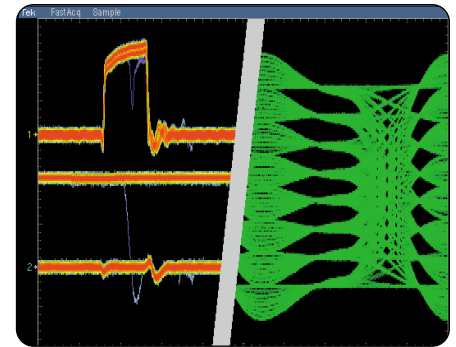
Accurate time interval (delta-time) measurements are critical when validating and characterizing design performance. New standards such as 3GIO, Hyper-Transport and InfiniBand operate at extreme clock speeds and timing margins. Delta-time accuracy is the most important specification for timing measurements because it determines how close these measurements will be to the real values. It takes into account both repeatability and resolution specifications and includes effects from both the horizontal and vertical systems.

Delta-time accuracy specifies the deviation from the actual value. It is based upon a number of factors, including sample interval, quantization error, interpolation error, amplifier noise, time base accuracy and sample clock jitter. Because each of these factors contributes to the timing error, the combination of them determines the delta-time accuracy specification. While individual factors such as time base accuracy or sample interval are important, it is the aggregate performance of the entire digitizing system that determines measurement accuracy. Thus, delta-time accuracy is a critical specification for applications such as setup and hold time verification, characterization of skew and jitter analysis where timing is the fundamental characteristic being measured.

Exceptional delta-time measurement performance provides dependably accurate measurements of the time interval between two events. And, the combination of exceptional trigger and acquisition performance, deep memory and application-specific software make the TDS7000 Series a high-performance jitter and timing analysis tool.

Superior probing performance is critical to the fidelity of your measurement system. The P7240 4 GHz (120 ps rise time) active probe faithfully acquires real-time signal information from high-speed designs with high-impedance, high-frequency circuit elements that demand minimal loading. The P7260 provides 6 GHz bandwidth and switchable 5x and 25x attenuation modes for wide dynamic range. The P7330 3.5 GHz (<130 ps typical rise time) differential probe provides high CMRR, broad frequency range, and minimal time skew between inputs.

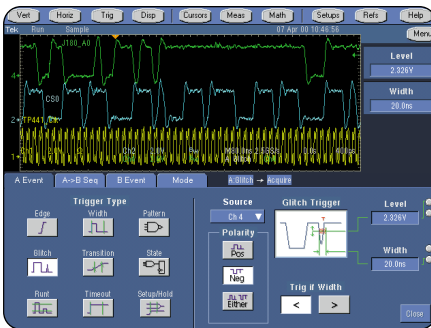
The TDS7154, TDS7254 and TDS7404 models include the TekConnect™ signal interconnect system, which further ensures superior signal fidelity, while offering unparalleled versatility with the world's widest array of accessory signal acquisition solutions for high-performance, real-time oscilloscopes. This convenient, positive locking interface replaces the traditional BNC connectors and is compatible with the P7000 Series probes. The TCA-1 MEG high-impedance buffer amplifier allows you to make high-voltage and micro-volt differential, current and other general-purpose voltage measurements using existing Tektronix probing solutions that require a 1 M $\Omega$  termination. In addition, this amplifier provides input coupling (AC/DC/GND) and bandwidth limit (100 MHz, 20 MHz).



► **Figure 1.** Advanced digital phosphor technology provides unprecedented waveform capture rate, maximizing the probability of discovering hidden faults and revealing dynamic signal behavior.

### Industry-leading Waveform Capture Rate

The successful discovery of intermittent faults and characterization of complex, dynamic signals depend on the amount of time the signal is observed by the oscilloscope. With the TDS7000 Series you can fully visualize signal activity, because third-generation digital phosphor technology (DPX) provides waveform capture rates of more than 400,000 waveforms per second. DPX has saved countless designers minutes, hours, or even days, by quickly revealing the nature of faults so you can apply the TDS7000's sophisticated triggering to isolate them.



▶ **Figure 2.** Extensive use of illustrations helps users locate advanced features quickly and apply them with confidence.

### Application-specific Measurement Extensions

Optional application-specific measurement and analysis packages extend TDS7000 capabilities. These packages build on the precision acquisition performance of the TDS7000 Series to address the need for application-specific measurements to quickly quantify device and system performance.

Applications include:

- ▶ Jitter and timing analysis for high speed clock and data signal characterization
- ▶ Compliance testing for signaling defined in ITU-T G.703 and ANSI T1.102 communications standards
- ▶ Compliance testing for signaling defined in USB1.0 standard and USB2.0 draft standard
- ▶ Disk drive read channel, head and media measurements to IDEMA standards; PRML measurements
- ▶ Power measurement and analysis

## Operational Simplicity Makes Any Task Easier

### Intuitive User Interface

The TDS7000 Series graphical user interface delivers sophisticated capability to advanced users without intimidating occasional users. The front panel includes a complete set of classic analog-style controls for most commonly used features. The combination of a large 10.4 in. (264 mm) touch sensitive display and graphical interface creates a highly visual environment with explicit illustration of instrument features. The waveform display area remains visible even when control windows are displayed, so you won't miss changes in the waveform when making selections or adjustments. Context-sensitive Help supplements graphic control windows and makes it easy to apply advanced capabilities to solve problems.

The adaptable TDS7000 Series human interface readily supports any operating style and environment. Select traditional instrument-style buttons for navigation or switch to a Microsoft Windows menu bar. You can use the touch screen or a mouse to drag waveform positions, cursor locations and trigger levels. Easily select a waveform area for zooming, histogram analysis or measurement gating using a graphical drag box. Add a mouse, keyboard or other peripherals without powering off the instrument with the USB interface.

### Serial Communications Signal Analysis

The serial mask testing option (Option SM) and the serial trigger option (Option ST) add powerful features for the analysis and testing of serial communications signals, including:

- ▶ Mask testing
- ▶ Clock recovery
- ▶ Waveform database acquisition
- ▶ Eye pattern measurements
- ▶ Serial pattern triggering

### Mask Testing

Option SM provides a complete portfolio of masks for verifying compliance to serial communications standards up to 2.5 Gb/s rates. Easily tailor mask testing to your specific requirements:

- ▶ One-button mask autoselect
- ▶ Auto-fit process minimizes hits
- ▶ Mask margin control adjusts tolerance during testing
- ▶ Hit-counting identifies location and degree of failures
- ▶ Test-related actions including notification, logging and hardcopy
- ▶ Built-in mask editing

The TDS7000 includes masks for a wide range of electrical standards, plus optical standards for use with external optical reference receivers (ORR) or O/E converters.\*1

\*1 The CSA7000 Series of real-time communication signal analyzers includes optical input, ORR filters, clock recovery and serial pattern trigger to provide a versatile solution for verifying compliance to optical and electrical communications standards.

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## ► TDS7000 Series

### Clock Recovery

Option SM\*<sup>2</sup> includes clock recovery for serial data streams from 1.5 Mbaud to 2.5 Gbaud. With a single connection, trigger on data or recovered clock to identify clock-to-data jitter.

### Communications Measurements

Option SM also adds a broad suite of eye-pattern related measurements fundamental to analysis of serial communications signals, including eye width, eye height, jitter, noise and extinction ratio. These are built on the waveform database acquisition mode which provides information over a much larger sample of data, ensuring stable and accurate results.

### Serial Pattern Trigger

Option ST\*<sup>2</sup> provides hardware-based serial pattern trigger to discriminate patterns within serial data streams and analyze pattern dependent issues, even on a single-shot basis. Specify patterns with up to 32 bits, including “don’t care” bits. You gain single connection convenience by applying internal clock recovery. Or, clock the serial trigger system from an external source.

### External Timebase Reference

Match stability or synchronize multiple instruments by phase-locking the reference oscillator to an external 10 MHz source. You can also use this phase-lock technique to characterize very low frequency wander and modulation effects.

### Intuitive Zooming

Use the waveform zoom feature to select areas of specific interest, without losing the “big picture.” TDS7000-acquired waveforms are always horizontally scaled to fit into the display. Control waveform zoom directly with knobs or the graphical user interface.

### Parametric Measurements

The TDS7000 includes a complete parametric measurement system for signal characterization. Select your measurement choice directly from a graphical palette. The ability to quickly reassign measurements to a different waveform simplifies verification tasks. Split cursors make it easy to measure trace-to-trace timing characteristics. You can gather measurement statistics for deeper insight, and measurement results for inclusion in a document or analysis in a spreadsheet.

### Powerful Math

With the TDS7000 Series, you can quickly transform raw waveform data into powerful information that is readily interpreted. Define and apply math expressions to waveform data for on-screen results in terms that you can use. Access common waveform math functions with the touch of a button. For advanced applications, create algebraic expressions consisting of waveform sources, math functions, measurement values and scalars with an easy-to-use calculator-style editor.

### Enhanced Spectral Analysis

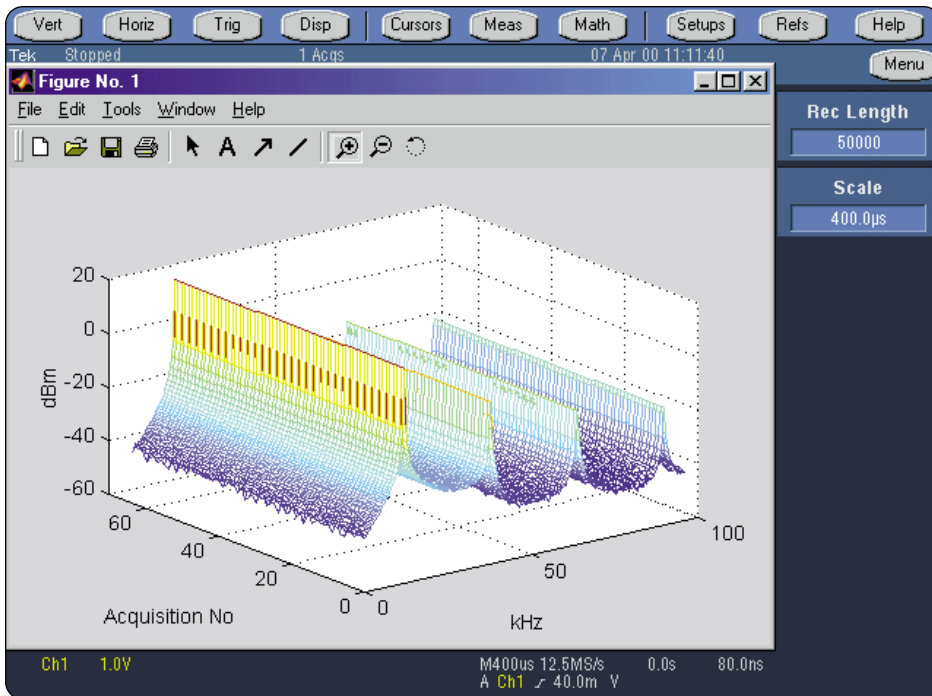
The TDS7000 Series includes a unique spectrum-analyzer style interface for performing frequency domain analysis. Controls such as center frequency, frequency span, resolution bandwidth and reference level provide access to wide- or narrow-band frequency, phase and group delay information. A gating function allows you to select only a portion of the time-domain signal for analysis.

### Complete Connectivity Adds Virtually Unlimited Analysis Capability

The connectivity of a TDS7000 Series oscilloscope means you can easily document waveforms and test results, enjoy open access to your work environment, run sophisticated third party analysis software and even create your own customized software programs directly on your oscilloscope.

Built-in applications such as WordPad, Paint and Internet Explorer concurrently maintain lab notes and reference design information while working with the instrument, saving time and reducing errors. Standard network interfaces make file sharing and transporting results easy.

\*<sup>2</sup>Available on TDS7154, TDS7254, TDS7404 only.



► **Figure 3.** Leverage standard tools for documentation, analysis, information browsing and communications using open access to the Microsoft Windows desktop.

### Advanced Waveform Analysis Made Easy

A comprehensive software infrastructure results in faster, more versatile operations. Move waveform data directly from the acquisition system to analysis applications quickly and easily. Industry-standard protocols, such as VISA and ActiveX Controls, simplify use of Windows applications such as Excel for data analysis and documentation. Or, create custom software to automate multi-step processes in waveform collection and analysis with Visual BASIC, C, C++, MATLAB, HP VEE, and other common development environments.

The TDS7000 Series also supports integration with external PCs and non-Windows hosts. Plug-and-play drivers enable fast and easy communication with LabVIEW, Lab Windows and HP VEE programs using GPIB and LAN connections. Connect applications on a local area network directly to a TDS7000 Series using the included VXI 11.2 server.

### View the Microsoft Windows Desktop on a Separate Monitor

TDS7000 can also be expanded with the addition of an external monitor. In dual-monitor mode, the instrument retains live oscilloscope displays while other applications such as publishing, analysis or browsing tools reside on the external monitor.

### Observe How the Digital and Analog Worlds Interact

Connecting your oscilloscope to a Tektronix logic analyzer gives you an integrated measurement solution that captures and displays both digital and analog domains in a single time-correlated view.

Use the breakthrough P6860/80 connectorless logic analyzer probe to make both digital and analog measurements.

# Digital Phosphor Oscilloscopes

## ► TDS7000 Series

### ► Characteristics

#### ► Vertical System

	TDS7054	TDS7104	TDS7154	TDS7254	TDS7404
Input Channels	4	4	4	4	4
Analog Bandwidth (-3 dB)	500 MHz	1 GHz	1.5 GHz	2.5 GHz	4 GHz
Calculated Rise Time 10 mV/div to 1 V/div	800 ps	400 ps	240 ps	160 ps	100 ps
Hardware Bandwidth Limits	250 MHz or 20 MHz		Requires TCA-1 MEG		
Input Coupling	AC, DC, Gnd		DC, Gnd		
Input Impedance	1 M $\Omega$ $\pm$ 0.5% or 50 $\Omega$ $\pm$ 1%		50 $\Omega$ $\pm$ 2.5%		
Input Sensitivity, 1 M $\Omega$	1 mV/div to 10 V/div		—		
Input Sensitivity, 50 $\Omega$	1 mV/div to 1 V/div		2 mV/div to 1 V/div		
Vertical Resolution	8-Bit (>11-Bit with averaging)		8-Bit (>11-Bit with averaging)		
Max Input Voltage, 1 M $\Omega$	$\pm$ 150 V CAT I Derate at 20 dB/decade to 9 V <sub>RMS</sub> above 200 kHz		—		
Max Input Voltage, 50 $\Omega$	5 V <sub>RMS</sub> , with peaks less than $\pm$ 30 Volts		Determined by TekConnect™ Accessory		
DC Gain Accuracy	1%		$\pm$ (2% + (2% * offset))		
<b>Offset Range</b>					
	1 mV/div to 100 mV/div: $\pm$ 1 V		2 mV to 50 mV/div: $\pm$ 0.5 V		
	101 mV/div to 1 V/div: $\pm$ 10 V		50.5 mV to 99.5 mV: $\pm$ 0.25 V		
	1.01 V/div to 10 V/div: $\pm$ 100 V		100 mV to 500 mV: $\pm$ 5 V 505 mV to 1 V/div: $\pm$ 2.5 V		
Channel-to-channel Isolation Any Two Channels at Equal Vertical Scale Settings	$\geq$ 100:1 at 100 MHz and $\geq$ 30:1 at the Rated Bandwidth		$\geq$ 100:1 at <2.5 GHz and $\geq$ 40:1 at 4 GHz		

**Note:** Typical system bandwidth of TDS7404 with P7240: 4 GHz.

**Note:** Typical system bandwidth of TDS7404 with P7330: 3.5 GHz.

#### ► Timebase System

	TDS7054/TDS7104	TDS7154/TDS7254/TDS7404
Timebase Range	200 ps/div to 40 s/div	50 ps to 10 s/div
Timebase Delay Time Range	16 ns to 250 s	16 ns to 250 s
Channel-to-channel Deskew Range	$\pm$ 25 ns	$\pm$ 25 ns
Delta Time Measurement Accuracy	$\pm$ ((0.06/sample rate) + (15 ppm * reading)) RMS	$\pm$ ((0.06/sample rate) + (2.5 ppm * reading)) RMS
Trigger Jitter (RMS)	8 ps <sub>RMS</sub> (typical)	6 ps <sub>RMS</sub> (typical)
Long Term Sample Rate and Delay Time Accuracy	$\pm$ 15 ppm over $\geq$ 1 ms interval	$\pm$ 2.5 ppm over any $\geq$ 100 ms interval

## ▶ Acquisition System

	TDS7054	TDS7104	TDS7154/TDS7254/TDS7404
<b>Real-time Sample Rates</b>			
1 channel (max)	5 GS/s	10 GS/s	20 GS/s
2 channels (max)	5 GS/s	5 GS/s	10 GS/s
3-4 channels (max)	2.5 GS/s	2.5 GS/s	5 GS/s
Equivalent Time Sample Rate (max)	250 GS/s	250 GS/s	1 TS/s
Maximum Record Length per Channel with Standard Memory	400 k (1-CH.), 200 k (2-CH.), 100 k (4-CH.)		
with Memory Opt. 1M	2 M (1-CH.), 1 M (2-CH.), 500 k (4-CH.)		
with Memory Opt. 2M	8 M (1-CH.), 4 M (2-CH.), 2 M (4-CH.)		
with Memory Opt. 3M	16 M (1-CH.), 8 M (2-CH.), 4 M (4-CH.)		
with Memory Opt. 4M			32 M (1-CH.), 16 M (2-CH.), 8 M (4-CH.)

## ▶ Maximum Duration at Highest Real-time Resolution (1-CH)

	TDS7054	TDS7104	TDS7154/TDS7254/TDS7404
Time Resolution (Single-shot)	200 ps (5 GS/s)	100 ps (10 GS/s)	50 ps (20 GS/s)
Max Duration with Standard Memory	80 $\mu$ s	40 $\mu$ s	20 $\mu$ s
Max Duration with Opt. 1M	400 $\mu$ s	200 $\mu$ s	100 $\mu$ s
Max Duration with Opt. 2M	1.6 ms	800 $\mu$ s	400 $\mu$ s
Max Duration with Opt. 3M	3.2 ms	1.6 ms	800 $\mu$ s
Max Duration with Opt. 4M			1.6 ms

## ▶ Acquisition Modes

	TDS7054/TDS7104	TDS7154/TDS7254/TDS7404
FastAcq Acquisition	FastAcq optimizes the instrument for analysis of dynamic signals and capture of infrequent events	
Maximum FastAcq Waveform Capture Rate	>200,000 wfms/sec	>400,000 wfms/sec
Waveform Database (requires Option SM)	Accumulate Waveform Database providing three-dimensional array of amplitude, time and counts	
Sample	Acquire sampled values	
Peak Detect	Captures narrow glitches at all real-time sampling rates	
Minimum Peak Detect Pulse Width	$\leq 1$ ns	400 $\mu$ s
Averaging	From 2 to 10,000 waveforms included in average	
Envelope	From 2 to $2 \times 10^9$ waveforms included in min-max envelope	
Hi-Res	Real-time boxcar averaging reduces random noise and increases resolution	
FastFrame™ Acquisition	Acquisition memory divided into segments; maximum trigger rate >160,000 waveforms per second. Time of arrival recorded with each event	

# Digital Phosphor Oscilloscopes

## ► TDS7000 Series

### ► Trigger System

	TDS7054	TDS7104	TDS7154/TDS7254/TDS7404
<b>Sensitivity</b>			
Internal DC Coupled	0.35 div DC to 50 MHz increasing to 1 div at 500 MHz	0.35 div DC to 50 MHz increasing to 1 div at 1 GHz	0.35 div DC to 50 MHz increasing to 1.5 div at 3 GHz TDS7404: 2.7 div at 4 GHz (typical)
External (Auxiliary Input)	400 mV from DC to 50 MHz increasing to 750 mV at 100 MHz	250mV from DC to 50 MHz increasing to 500mV at 100 MHz	250mV from DC to 50 MHz increasing to 350mV at 500 MHz
Main Trigger Modes	Auto, Normal and Single		
Trigger Sequences	Main, Delayed by Time, Delayed by Events. All sequences can include separate horizontal delay after the trigger event to position the acquisition window in time		
<b>Trigger Characteristics</b>			
Standard Trigger Types	Edge, Glitch, Runt, Width, Transition Time, Timeout, Pattern, State, Setup/Hold		
Communications-related Triggers (requires Option SM)	Support for AMI, HDB3, BnZS, CMI, MLT3 and NRZ encoded communications signals. Select among isolated positive or negative one, zero pulse form or eye patterns as applicable to standard.		
Serial Pattern Trigger (requires Option ST)	32-Bit serial word recognizer, bits specified in binary (high, low, don't care) or hex format. Trigger on NRZ-encoded data up to 1.25 GBaud.		
<b>Trigger Level Range</b>			
Internal	±12 divisions from center of screen		
External (Auxiliary In)	±8 V		
Line	fixed at 0 V		
Trigger Coupling	DC, AC (attenuates <60 Hz), HF Rej (attenuates >30 kHz), LF Rej (attenuates <80 kHz), Noise Reject (reduces sensitivity)		
Trigger Holdoff Range	250 ns minimum to 12 s maximum		

### Trigger Modes

**Edge** – Positive or negative slope on any channel or front panel auxiliary input. Coupling includes DC, AC, noise reject, HF reject and LF reject.

**Glitch** – Trigger on or reject glitches of positive, negative or either polarity. Minimum glitch width is 1.0 ns with 200 ps resolution.

**Width** – Trigger on width of positive or negative pulse either within or out of selectable time limits (1 ns to 1 s).

**Runt** – Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again. Optional time qualification.

**Timeout** – Trigger on an event which remains high, low or either, for a specified time period, selectable from 1 ns to 1 s with 200 ps resolution.

**Transition** – Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative or either.

**Setup/Hold** – Trigger on violations of both setup time and hold time between clock and data present on any two input channels.

**Pattern** – Trigger when pattern goes false or stays true for specified period of time. Pattern (AND, OR, NAND, NOR) specified for four input channels defined as HIGH, LOW or Don't Care.

**State** – Any logical pattern of channels (1, 2, 3) clocked by edge on channel 4. Trigger on rising or falling clock edge.

**Trigger Delay by Time** – 16 ns to 250 seconds.

**Trigger Delay by Events** – 1 to 10,000,000 Events.

### Waveform Measurements

**Amplitude** – Amplitude, High, Low, Maximum, Minimum, Peak to Peak, Mean, Cycle Mean, RMS, Cycle RMS, Positive Overshoot, Negative Overshoot.

**Time** – Rise time, Fall time, Positive Width, Negative Width, Positive Duty Cycle, Negative Duty Cycle, Period, Frequency, Delay.

**Combination** – Area, Cycle Area, Phase, Burst Width.

**Histogram-related** – Waveform count, Hits in box, Peak hits, Median, Maximum, Minimum, Peak to Peak, Mean ( $\mu$ ), Standard Deviation ( $\sigma$ ),  $\mu+1\sigma$ ,  $\mu+2\sigma$ ,  $\mu+3\sigma$ .



## Waveform Processing/Math

**Algebraic Expressions** – Define extensive algebraic expressions including waveforms, scalars and results of parametric measurements e.g. (Integral (CH.1-Mean(CH.1))\*1.414).

**Arithmetic** – Add, subtract, multiply, divide waveforms and scalars.

**Relational** – Boolean result of comparison >, <, >=, <=, ==, !=.

**Calculus** – Integrate, differentiate.

**Frequency Domain Functions** – Spectral magnitude and phase, real and imaginary spectra.

**Vertical Units** – Magnitude: Linear, dB, dBm; Phase: Degrees, radians.

**Window Functions** – Rectangular, Hamming, Hanning, Kaiser-Bessel, Blackman-Harris, Gaussian, Flattop2, Tek Exponential.

## Display Characteristics

**Display Type** – Liquid crystal active-matrix color display.

**Display Size** –

Width: 211.2 mm (8.32 in.);

Height: 158.4 mm (6.24 in.);

Diagonal: 264 mm (10.4 in.).

**Display Resolution** – 640 horizontal x 480 vertical pixels.

**Waveform Styles** – Vectors, Dots, Variable Persistence, Infinite Persistence.

## Computer System and Peripherals

**CPU** – Intel Celeron processor, 566 MHz.

**PC System Memory** – 512 MB.

**Hard Disk Drive** – Rear-panel, removable hard disk drive, 20 GB capacity.

**Floppy Disk Drive** – Front-panel 3.5 in floppy disk drive, 1.44 MB capacity.

**CD-R/W Drive** – Rear-panel CD-R/W drive with CD creation software application.

**Mouse** – Logitech thumb wheel model included, USB interface.

**Keyboard** – Order 118-9402-00 for small keyboard (fits in pouch); PS-2 interface. Order 119-6297-00 for full-size keyboard; USB interface and hub.

## Input/Output Ports

**Probe Compensator Output** – Front panel BNC connector, requires Probe Cal-Deskew Fixture (included) for probe attachment. Amplitude 200 mV  $\pm$ 20% into a  $\geq$ 50  $\Omega$  load, frequency 1 kHz  $\pm$ 5%.

**Analog Signal Output Amplitude** – Front-panel BNC connector, provides a buffered version of the signal that is attached to the Ch 3 input when Ch 3 is selected as trigger source. 20 mV/div  $\pm$ 20% into a 1 M $\Omega$  load, 10 mV/div  $\pm$ 20% into a 50  $\Omega$  load.

**Analog Signal Output Bandwidth, Typical** – TDS7054, TDS7104: 100 MHz into a 50  $\Omega$  load. TDS7154/TDS7254/TDS7404: 1 GHz into a 50  $\Omega$  load.

**External Timebase Reference In** – Rear-panel BNC connector, timebase system can phase-lock to external 10 MHz reference.

**Timebase Reference Out** – Rear-panel BNC connector, accepts TTL-compatible output of internal 10 MHz reference oscillator.

**Auxiliary Output Levels** – Front-panel BNC connector, provides a TTL-compatible, polarity switchable pulse when the oscilloscope triggers.

**Parallel Port** – IEEE 1284, DB-25 connector.

**Audio Ports** – Miniature phone jacks for stereo microphone input and stereo line output.

**USB Port** – Allows connection or disconnection of USB keyboard and/or mouse while oscilloscope power is on.

**Keyboard Port** – PS-2 compatible.

**Mouse Port** – PS-2 compatible.

**LAN Port** – RJ-45 connector, supports 10Base-T and 100Base-T.

**Serial Port** – DB-9 COM1 port.

**SVGA Video Port** – DB-15 female connector; connect a second monitor to use dual-monitor display mode. Supports basic requirements of PC99 specifications.

**GPIO Port** – IEEE 488.2 standard.

**Scope VGA Video Port** – DB-15 female connector, 31.6 kHz sync, EIA RS-343A compliant, connect to show the oscilloscope display, including live waveforms on an external monitor or projector.

## Power Source

**Power** – 100 to 240 V<sub>RMS</sub>,  $\pm$ 10%, 50/60 Hz; 115 V<sub>RMS</sub>  $\pm$ 10%, 400 Hz; CAT II, <300 W (450 VA).

## Physical Characteristics Benchtop Configuration

Dimensions	mm	in.
Height	277	10.9
Width	455	17.9
Depth	425	16.75
<b>Weight</b>	<b>kg</b>	<b>lbs.</b>
Net	18	39
Shipping	37	80

## Physical Characteristics Rackmount Configuration

Dimensions	mm	in.
Height	277	10.5
Width	502	19.75
Depth	486	19.125
<b>Weight</b>	<b>kg</b>	<b>lbs.</b>
Net	19	41
Kit	5.6	12.25

## Mechanical

### Cooling – Required Clearance

	mm	in.
Top	0 or >76	0 or >3
Bottom	0	0
Left side	76	3
Right side	76	3
Front	0	0
Rear	0	0

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### Environmental

#### Temperature

**Operating** – 0°C to +50°C, excluding floppy disk and CD-R/W drives; +10°C to +45°C, including floppy disk and CD-ROM drives.

**Nonoperating** – –22°C to +60°C.

#### Humidity

**Operating** – 20% to 80% relative humidity with a maximum wet bulb temperature of +29°C at or below +50°C, noncondensing. Upper limit derated to 25% relative humidity at +50°C.

**Nonoperating** – With no diskette in floppy disk drive. 5% to 90% relative humidity with a maximum wet bulb temperature of +29°C at or below +60°C, noncondensing. Upper limit derated to 20% relative humidity at +60°C.

#### Altitude

**Operating** – 10,000 ft. (3,048 m).

**Nonoperating** – 40,000 ft. (12,190 m).

#### Random Vibration

**Operating** – 0.000125 G<sup>2</sup>/Hz from 5 to 350 Hz, –3 dB/octave from 350 to 500 Hz, 0.0000876 G<sup>2</sup>/Hz at 500 Hz. Overall level of 0.24 G<sub>RMS</sub>.

**Nonoperating** – 0.0175 G<sup>2</sup>/Hz from 5 to 100 Hz, –3 dB/octave from 100 to 200 Hz, 0.00875 G<sup>2</sup>/Hz from 200 to 350 Hz, –3 dB/octave from 350 to 500 Hz, 0.006132 G<sup>2</sup>/Hz at 500 Hz. Overall level of 2.28 G<sub>RMS</sub>.

**Electromagnetic Compatibility** – 89/336/EEC.

#### Safety

UL 3111-1, CSA1010.1, EN61010-1, IEC 61010-1.

### ► Ordering Information

#### TDS7054

500 MHz Digital Phosphor Oscilloscope.

#### TDS7104

1 GHz Digital Phosphor Oscilloscope.

#### TDS7154

1.5 GHz Digital Phosphor Oscilloscope.

#### TDS7254

2.5 GHz Digital Phosphor Oscilloscope.

#### TDS7404

4 GHz Digital Phosphor Oscilloscope.

**All Models Include:** Accessory pouch, front cover, mouse, probe calibration and deskew fixture (067-0405-xx), TDS7000 Series product software CD-ROM, TDS7000 Series operating system restoration CD-ROM, TDS7000 Series optional applications software CD-ROM, performance verification procedure PDF file, GPIB programmer's reference (on product software CD-ROM), calibration certificate documenting NIST traceability, 2 540-1 compliance and ISO9000, power cord, one year warranty.

**TDS7054 Also Includes:** (4) P6139A 500 MHz, 10x Passive Probes, quick reference kit (020-2335-xx), user manual (071-0700-xx).

**TDS7104 Also Includes:** Quick reference kit (020-2335-xx), user manual (071-0700-xx).

**TDS7154/TDS7254 Also Includes:** (4) TekConnect™ to BNC adapters (TCA-BNC), user manual (071-0879-xx), quick reference kit (020-2368-xx).

**TDS7404 Also Includes:** (4) TekConnect to SMA adapters (TCA-SMA), user manual (071-0879-xx), quick reference kit (020-2368-xx).

### Power Cord Options for All Models

**Opt. A1** – Universal European power cord (220 V, 50 Hz).

**Opt. A2** – UK power cord (240 V, 50 Hz).

**Opt. A3** – Australia power cord (240 V, 50 Hz).

**Opt. A5** – Switzerland power cord (220 V, 50 Hz).

**Opt. A99** – No power cord.

**Opt. AC** – China power cord.

### Cables

**GPIB Cable (1 m)** – Order 012-0991-01.

**GPIB Cable (2 m)** – Order 012-0991-00.

**RS-232 Cable** – Order 012-1298-00.

**Centronics Cable** – Order 012-1250-00.

### Recommended Accessories

**P7260** – 6 GHz active probe recommended for TDS7404.

**AFTDS** – Telecom differential electrical interface adapter (for line rates < 8 MB/sec; requires TCA-BNC adapter for TDS7404).

**Keyboard (USB interface)** – Order 119-6297-00.

**Service Manual** – Order 071-0711-00.

**Transit Case** – Order 016-1522-00.

### TekConnect Adapters –

**TCA-1MEG** – TekConnect high-impedance buffer amplifier.

**TCA-SMA** – TekConnect-to-SMA Adapter.

**TCA-N** – TekConnect-to-N Adapter.

**TCA-BNC** – TekConnect-to-BNC Adapter.

**Scope Cart** – Order K4000.

**TDSUSBF** – USB Test Fixture; used in conjunction with Opt. USB, USB2.0 Compliance Test Software.

### Software

**WSTR0** – WaveStar™ waveform capture and documentation software.

**VCLNKP/VCLNKB** – VocalLink™ voice control software.

## ▶ Instrument Options (available on models indicated by "x")

Acquisition Memory Options		TDS7054	TDS7104	TDS7154	TDS7254	TDS7404
1M	2 Msamples max, 500 ksamples/ch	x	x	x	x	x
2M	8 Msamples max, 2 Msamples/ch	x	x	x	x	x
3M	16 Msamples max, 4 Msamples/ch	x	x	x	x	x
4M	32 Msamples max, 8 Msamples/ch			x	x	x
Mounting Options						
1K	K4000 Scope Cart	x	x	x	x	x
1R	Rackmount Kit	x	x	x	x	x
Software Options						
JT3	TDSJIT3 Jitter Analysis Software	x	x	x	x	x
J1	TDSJIT2 Jitter Analysis Software	x	x	x	x	x
J2	TDSDDM2 Disk Drive Analysis Software	x	x	x	x	x
CP2* <sup>1</sup>	TDSCPM2 – ANSI/ITU Telecom Pulse Compliance Testing	x	x	x	x	x
USB* <sup>2</sup>	TDSUSBS – USB2.0 Compliance Test S/W Only	x	x	x	x	x
Probe Options						
33	Add (1) P6158 3 GHz, 20x Low C Probe		x			
34	Add (1) P6247 1.0 GHz Differential Probe	x				
35	Add (1) P6243 1.0 GHz Active Probe	x				
36	Add (1) P6139A 500 MHz, 10x Passive Probe	x	x			
37	Add (1) P6245 1.5 GHz Active Probe		x	x		
39	Add (1) P6248 1.7 GHz Differential Probe		x	x		
51	Add (1) P7240 4 GHz Active Probe				x	x
52	Add (1) P7330 3.5 GHz Differential Probe				x	x
Service Options						
D1	Calibration Data Report	x	x	x	x	x
C3	Additional 2 Years of Calibration	x	x	x	x	x
D3	Calibration Data Report for Option C3	x	x	x	x	x
R3	Additional 2 Years of Repair	x	x	x	x	x
Additional Options						
SM	Serial Comm Mask Testing	x	x	x	x	x
ST	Serial Pattern Trigger			x	x	x
USF	USB Test Fixture	x	x	x	x	x

\*<sup>1</sup>Requires Option SM.\*<sup>2</sup>Requires Option TDSUSBF (USB Test Fixture).

# Digital Phosphor Oscilloscopes

## ► TDS7000 Series

### After-purchase Upgrades

Order a TDS7UP kit and select the appropriate option from the following list according to current and intended configuration.

#### Software

**Opt. JT3** – TDSJIT3 Jitter Analysis Software.

**Opt. J1** – TDSJIT2 Jitter Analysis Software.

**Opt. J2** – TDSDDM2 Disk Drive Analysis Software.

**Opt. CP2** – TDSCPM2 Compliance Testing for ITU-T G.703 and ANSI T1.102 communications standards. Requires Option SMx.

**Opt. SM1** – Upgrade to Serial Mask testing (incl. clock recovery) for TDS7154 and TDS7254, TDS7404 with serial numbers >B030000.

**Opt. SM2** – Upgrade to Serial Mask testing (incl. clock recovery) for TDS7254 and TDS7404 with serial numbers <B030000.\*<sup>3</sup>

**Opt. SM3** – Upgrade to Serial Mask testing for TDS7104 and TDS7054.

**Opt. ST1** – Upgrade to Serial Pattern Trigger (incl. clock recovery) for TDS7154 and TDS7254, TDS7404 with serial numbers <B030000.

**Opt. ST2** – Upgrade to Serial Pattern Trigger (incl. clock recovery) for TDS7254 and TDS7404 with serial numbers <B030000.\*<sup>3</sup>

**Opt. USB** – TDSUSBS USB2.0 compliance test software; used in conjunction with TDSUSBF USB test fixture.

\*<sup>3</sup>Requires TDS7UP Opt. 1F for service installation and calibration.

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### ► Acquisition Memory

Acquisition memory upgrades equivalent to Options 1M to 4M can be ordered to extend instrument performance after initial purchase. Users can install upgrades without opening the instrument case or requiring on-site service.

	To Opt. 1M	To Opt. 2M	To Opt. 3M	To Opt. 4M* <sup>4</sup>
From Standard Memory	Opt M01	Opt M02	Opt M03	Opt M04
From Opt. 1M		Opt M12	Opt M13	Opt M14
From Opt. 2M			Opt M23	Opt M24
From Opt. 3M				Opt M34

\*<sup>4</sup>Not available for TDS7054 or TDS7104.

For example, to upgrade from Standard Memory to Option 4M, order TDS7UP Option M04.



For the most up-to-date product information visit our web site at [www.tektronix.com](http://www.tektronix.com)

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