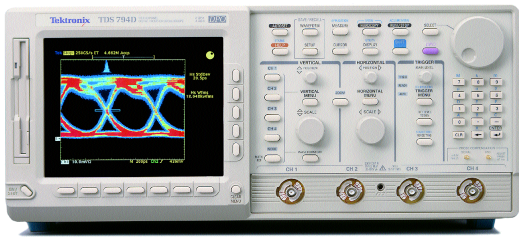# Digital Phosphor Oscilloscopes

TDS 500D • TDS 700D

Features and Benefits

2 GHz, 1 GHz and 500 MHz Bandwidths

Sample Rates to 4 GS/s

Captures and Displays up to 200,000 Waveforms per Second

2 or 4 Channels

1% Vertical Accuracy

1 mV/div to 10 V/div Sensitivity

Record Lengths to 8 M Points

Advanced Triggering

FFT and Advanced Math

Histograms

Histogram Statistics

Limit Test

Communication Signal Analysis Including Mask Testing and SONET/SDH and Fibre Channel Optical Reference Receivers

3 Year Warranty

Applications

Communication Compliance Testing

Digital Design and Debugging

Jitter Analysis

Fast Edge Characterization

Video Design and Debug

Disk Drive Measurements

Power Measurements

The TDS 500D/TDS 700D Family of Digital Phosphor Oscilloscopes

The TDS 500D/700D oscilloscopes are the first in the TDS family of Digital Phosphor Oscilloscopes (DPOs) designed to keep pace with current and evolving needs in advanced electronic design and debug. DPOs deliver a new level of insight that makes dealing with complex signals elementary – a new level of insight that must be seen to be believed.

DPOs capture, store, display and analyze, in real-time, three dimensions of signal information: amplitude, time and distribution of amplitude over time. The benefit of this new third dimension of information is an interpretation of the signal dynamics, including instantaneous changes and the frequency of occurrence displayed in the form of quantitative intensity information.

HIGH FIDELITY SIGNAL ACQUISITION

The high waveform capture rate of the TDS 500D/700D DPO, together with its high bandwidth and sample rate, delivers instantaneous signal feedback to show the true signals that other scopes may be missing. The DPO acquisition acquires over 1000 times more data than traditional DSOs, allowing the capture of complex signals, reducing debugging times from hours to seconds.

Channels can be transparently combined to achieve higher sample rates and longer record lengths. The record length can be optionally increased to 8 M points, providing a high-resolution representation of the signal over a long period of time.

Tektronix®
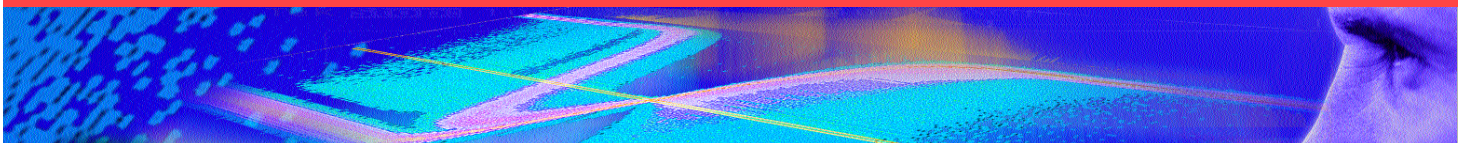
All of the TDS products provide wide dynamic range, flat response, fast overdrive recovery, calibrated DC offset, 1 mV/div sensitivity (10 mV maximum sensitivity on TDS 794D), 1 ns peak detect and internal calibration.

POWERFUL AND FLEXIBLE TRIGGERING

In addition to basic triggering such as edge and pulse-width, these Digital Phosphor Oscilloscopes have several trigger modes tailored for specific design and debug applications. Logic and pulse triggers, including setup/hold, glitch, slew rate and timeout triggers, capture hard-to-catch digital design problems. The optional video trigger provides line and field selection for NTSC, PAL and HDTV standards. The optional communications trigger capability addresses needs to acquire a wide variety of AMI, CMI, NRZ and Ethernet communication signals.

ADVANCED PERFORMANCE FEATURES

Automatic Measurements eliminate the need for manually measuring the waveform against the graticule or with cursors. Measurement gating, (gating not available for DPO operation) allows the user to select a specific part of the live waveform for measurement. Measurement statistics (min, max, mean and standard deviation), give additional information about the variations in the measurements over time (for example, worst case excursions), increasing the confidence in the quality of the measurements.

Waveform Histograms allow the examination of the statistical nature of the signal. Horizontal histograms, which are useful for evaluating signal jitter, sample the waveform within a specified region, sort the values into time bins and plot the accumulated bin values versus time. Vertical histograms, which are useful for evaluating signal noise, sample the waveform within a specified region, sort the values into amplitude bins and plot the accumulated bin values versus amplitude.

For histograms of DPO acquisitions (both live and stored), the specified region can be repositioned and will update to reflect the underlying 3 dimensional data base (32 bits in shallow mode, 64 bits in deep mode).

Communication Mask Testing (available as an option) allows mask compliance testing of a wide variety of communication signals to industry standards. Specialized measurement accessories, unique trigger modes, built-in optical reference receiver filters, mask autoset and mask violation counting make these measurements easily and repeatably.
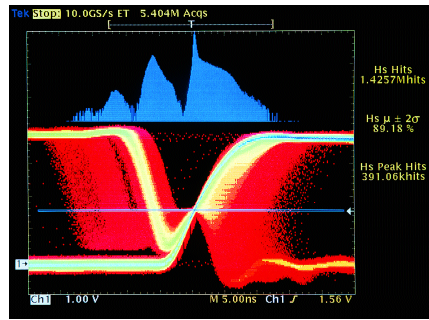
The horizontal histogram of the selected region of the waveform shows the character of a metastable flip-flop output.

Applications Software Packages

These Java™ based applications packages reduce the cost, time and complexity common to many application-specific test procedures. Application-specific capabilities are available on TDS500D/600C/700D Series oscilloscopes with a hard disk drive (Opt. HD or Opt. 2M).

TDSDDM1 provides users with industry standard measurements such as Track Average Amplitude (TAA), 50% Pulse Width (PW^{50}), Non-Linear Transition Shift (NLTS) and Signal to Noise Ratio (SNR). This capability gives disk drive designers direct measurements in industry standard terminology.

TDSPWR1 gives designers interested in power consumption applications the ability to automatically calculate True Power, Apparent Power, Power Factor, Instantaneous Power and Energy to eliminate manual calculations.

TDSJIT1 performs a suite of jitter measurements with unprecedented accuracy on single-shot waveforms. Jitter information can be displayed as statistics, histograms or profiled.

TDSPSM1 introduces a revolutionary way for making timing measurements by providing statistics on specific data and clock edges that are fully time-correlated. This application also performs automated AC timing measurements on all parameters in single-shot acquisitions.

TDSCEM1 performs a suite of automated eye diagram measurements on SONET/SDH and Fibre Channel standards. These measurements include eye height, eye width and quality factor.

TDSCPM1 performs automated parametric measurements of pulse amplitude, spectral power and pulse symmetry to standards requirements. Standards include ANSI T1.102 and ITU-T G.703.

COMPLEMENTARY MEASUREMENT ACCESSORIES

Tektronix provides a wide range of measurement accessories optimized for the TDS family. These accessories are designed to operate via the TEKPROBE® interface, which provides power and automatic scaling, to complete the DPO measurement solutions.

Active Probes such as the P6249 and P6245 active probes were designed specifically for the DPO products. For example, the P6249 (4 GHz probe only) is capable of achieving the full 2 GHz bandwidth on a TDS 794D, while providing low loading.

The P6339A Buffered Passive Probe is designed to provide 500 MHz bandwidth at the probe time for the TDS 794D.

Optical-to-electrical Converters (P6701B, P6703B) allow convenient analysis of optical transmission signals with the oscilloscope. Both short– and long-wavelength optical converters are compatible with the industry-standard wavelengths for SONET/SDH and Fibre Channel.

High-bandwidth Differential Probes (P6248, P6247) enable high bandwidth (up to 1.7 GHz) differential measurements while maintaining high common-mode rejection.

Current Probes such as the **TCP202** and **High-Voltage Differential Probes** such as the P5205 and P5210 allow safe, high-power measurements. Direct Probe Readouts use information from the probes to display measurements in units of Amps, Volts and Watts.

SOPHISTICATED DOCUMENTATION

Save screen displays in a number of standard desktop publishing formats to the internal 3.5 in. DOS-compatible floppy disk drive. Transfer the disk to a PC for import into word processing applications. Make hardcopies directly to monochrome or color printers and plotters connected to the computer network (LAN), GPIB, RS-232 or Centronics ports, or acquire waveforms, screen displays and scope settings using Tektronix WaveStar™ software running on a PC interfaced to the GPIB port.

TDS 500D/700D Series Electrical Characteristics

	TDS 794D	TDS 784D	TDS 754D	TDS 724D	TDS 580D	TDS 540D	TDS 520D
Bandwidth	2 GHz*5	1 GHz*1	500 MHz*2	500 MHz*2	1 GHz	500 MHz*2	500 MHz*2
# Channels	4	4	4	2 + 2 aux.	4	4	2 + 2 aux.
# Samplers	4	4	4	2	4	4	2
Max Real-time Sample Rate							
1 Channel	4 GS/s	4 GS/s	2 GS/s	2 GS/s	4 GS/s	2 GS/s	2 GS/s
2 Channels	2 GS/s	2 GS/s	2 GS/s	1 GS/s	2 GS/s	2 GS/s	1 GS/s
3-4 Channels	1 GS/s	1 GS/s	1 GS/s	NA	1 GS/s	1 GS/s	NA
Equivalent-time Sample Rate	250 GS/s max.	250 GS/s max.	100 GS/s max.	100 GS/s max.	250 GS/s max.	100 GS/s max.	100 GS/s max.
Maximum Record Length							
1 Channel	50 K (Opt.1M: 500K, Opt.2M: 8M)	50 K (Opt.1M: 500K, Opt.2M: 8M)	50 K (Opt.1M: 500K, Opt.2M: 8M)	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 500K, Opt.2M: 8M)	50 K (Opt.1M: 500K, Opt.2M: 8 M)	50 K (Opt.1M: 250 K, Opt. 2M: 4M)
2 Channels	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 130 K, Opt.2M: 2M)	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 250 K, Opt.2M: 4M)	50 K (Opt.1M: 130 K, Opt.2M: 2M)
3-4 Channels	50 K (Opt.1M: 130 K, Opt.2M: 2M)	50 K (Opt.1M: 130 K, Opt. 2M: 2M)	50 K (Opt.1M: 130 K, Opt. 2M: 2M)	NA	50 K (Opt.1M: 130 K, Opt.2M: 2M)	50 K (Opt.1M: 130 K, Opt. 2M: 2M)	NA
Max Sample Rate Window*3	2 ms	2 ms	4 ms	4 ms	2 ms	4 ms	4 ms
Display	NuColor™ Display	NuColor™ Display	NuColor™ Display	NuColor™ Display	monochrome	monochrome	monochrome

*1 In 50 Ω mode: 5 mV/div: 750 MHz, 2 mV/div: 600 MHz, 1 mV/div: 500 MHz. Reduce the upper bandwidth frequencies by 5 MHz for each degree C above 30°C.

*2 In 50 Ω mode: 1 mV/div: 450 MHz. Reduce the upper bandwidth frequencies by 2.5 MHz for each degree C above 30°C.

*3 Single-channel operating at full sample rate and maximum record length (Opt. 2M).

*4 ≥ 10 mV/div in 50 Ω mode.

*5 Reduce the upper bandwidth frequency by 20 MHz for each degree C above 30°C.

TDS 500D/700D Series Vertical System

	TDS 794D	TDS 784D	TDS 754D	TDS 724D	TDS 580D	TDS 540D	TDS 520D
Sensitivity	10 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)	1 mV/div to 10 V/div (1M mode), 1 mV/div to 1V/div (50 mode)
DC Gain Accuracy	±1.0% (0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)	±1.0% (±0.7% typical)
Effective Bits (typical)	5.0 (2 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	5.5 (1 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (500 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (490 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	5.5 (1 GHz @ 4 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (500 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)	6.8 (490 MHz @ 2 GS/s), 9.7 with Hi-res (1 MHz @ 10 MS/s)
Vertical Resolution	8-Bits (256 levels on 10.25 divisions), >11-Bits with averaging, >13-Bits typical with Hi-res (TDS 794D, TDS 784D, TDS 580D), >12-Bits typical with Hi-res (TDS 754D, TDS 724D, TDS 540D, TDS 520D)						
Position Range	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions	±5 divisions
Offset Range	±1 V from 1 mV to 100 mV/div, ±10 V from 101 mV to 1V/div, ±100V from 1.01 V to 10 V/div (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D) ±0.5V from 10 mV to 50 mV/div						
Analog Bandwidth Selections	Full only	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full	20 MHz, 250 MHz, full
Input Coupling	DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND	AC, DC, GND
Input Impedance Selections	1 M in parallel with 10 pF, or 50 (AC and DC coupling) (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D) 50 only (DC coupling only) (TDS 794D only)						
AC-coupled Low Frequency Limit	N/A	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.	10 Hz when AC 1 M coupled. 200kHz when AC 50 coupled.
Channel Isolation	>100:1 at 100 MHz and >30:1 at the rated bandwidth						
Max. Input Voltage	5 V$_{RMS}$, with peaks ± 20 Volts	300V CAT II ±400V (peak). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.	300V CAT II ±400V (peak). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.	300V CAT II ±400V (peak). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.	300V CAT II ±400 V (DC + peak AC). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.	300V CAT II ±400V (peak). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.	300V CAT II ±400V (peak). Derate at 20 dB/decade above 1 MHz. 1 M or GND coupled.

TDS 500D/700D Series Timebase System

	TDS 794D	TDS 784D/TDS 580D	TDS 754D/TDS 724D/ TDS 540D/TDS 520D
Time Bases	Main, delayed	Main, delayed	Main, delayed
Time Base Range	200ps to 10 s/div	200ps to 10 s/div	500ps to 10 s/div
Time Base Accuracy		±25 ppm (over any interval 1 ms)	
Delta Time Measurement Accuracy		±(0.15/sample rate) + (25 ppm x [reading])	
Trigger Jitter	7 ps (typical)	7 ps (typical)	8 ps (typical)
Pre-trigger Position		0% to 100% of any record	
Delay Between Channels		50 ps (any 2 channels with equalV/div and coupling)	

ACQUISITION MODES

DPO – Captures and displays complex waveforms, random events and subtle patterns in actual signal behavior. By acquiring up to 100 M points/sec TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D (50M points/sec; TDS 724D and TDS 520D) DPOs are able to provide 3 dimensions of signal information, in real-time; amplitude, time, and the distribution of amplitude over time. The DPX™ Waveform Imaging Processor automatically selects record lengths between 500 and 500,000 points and sample rate up to 1 GS/s, based on horizontal time base setting, to optimize displayed sample density.

Peak Detect – High frequency and random glitch capture. Captures glitches of 1 ns using acquisition hardware at all real-time sampling rates.

Sample – Sample data only.

Envelope – Max/min values acquired over one or more acquisitions.

Average – Waveform data from 2 to 10,000 (selectable) is averaged.

Hi-res – Vertical resolution improvement and noise reduction on low-frequency signal (e.g., 12-Bits typical).

FastFrame™ Time Stamp – Acquisition memory size segmentable with trigger rate up to 80,000 per second from 50 to 5,000 points per frame (independent of the number of channels).

Single Sequence – Use RUN/STOP button to capture a single triggered acquisition at a time, which may be automatically saved to NVRAM with AutoSave.

TRIGGER SYSTEM

Triggers – Main and delayed.
Main Trigger Modes – Auto, Normal, Single.
Delayed Trigger – Delayed by time, events, or events and time.
Time Delay Range – 16 ns to 250 s.
Events Delay Range – 1 to 9,999,999 events.
External Rear Input – 1.5 kW; Max input voltage is ±20 V (DC + peak AC).

TRIGGER TYPES

EDGE (Main and Delayed) –
Conventional level-driven trigger. Positive or negative slope on any channel or rear panel auxiliary input. Coupling selections: DC, AC, noise reject, HF reject, LF reject.

LOGIC (Main) –
PATTERN: Specifies a logical combination (AND, OR, NAND, NOR) of the four input channels (high, low, don't care). Trigger when pattern stays true or false for a specified time.
STATE: Any logical pattern of channels 1, 2, and 3 (AUX1 on 2-CH products) plus a clock edge on channel 4 (AUX2 on 2-CH products). Triggerable on rising or falling clock edge.
SETUP/HOLD: Trigger on violations of both setup time and hold time between clock and data which are on two input channels.

PULSE (Main) –
GLITCH: Trigger on or reject glitches of positive, negative, or either polarity. Minimum glitch width is 1.0 ns (typical) 2 ns (warranted) with 200 ps resolution.
RUNT: Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
WIDTH: Trigger on width of positive or negative pulse either within or out of selectable time limits (1 ns to 1 s).
SLEW RATE: Trigger on pulse edge rates that are either faster or slower than a set rate. Edges can be rising, falling or either.
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.

COMM (Optional) –
AMI: Trigger on standard communications signals (including DS1, DS1A, DS1C, DS2, DS3, E1, E2, E3, STS-1 or a custom bit rate). Select between "isolated ones" (positive or negative) and eye diagrams.
CMI: Trigger on standard communications signals (including STS-3, STM1E, DS4NA, E4 or a custom bit rate). Select between positive or negative one pulses, zero pulses and eye diagrams.
NRZ: Trigger on standard communications signals (including OC1/STM0, OC3/STM1, OC12/STM4, E5, FC133, FC266, FC531, FC1063, FDDI HALT, 143 Mb/s serial digital composite video, 270 Mb/s serial digital component video or a custom bit rate). Select between an eye diagram, rising or falling edges or any of eight 3-Bit serial patterns.

VIDEO (Optional) –
Trigger on a particular line of individual, odd/even, or all fields. Trigger on a specific pixel of a line by using the video trigger with delay by events. Choose positive or negative horizontal sync polarity.
525/NTSC: Choose monochrome or color (studio-quality NTSC) sync formats.
625/PAL: Choose color or monochrome (studio-quality PAL) sync formats.
HDTV: Choose from 1125/60, 1050/60, 1250/50, and 787.5/60 HDTV formats.

MEASUREMENT SYSTEM

Automatic Waveform Measurements – Period, frequency, + width, – width, rise time, fall time, + duty cycle, – duty cycle, delay, phase, burst width, high, low, max. min, peak to peak, amplitude, + overshoot, – overshoot, mean, cycle mean, RMS, cycle RMS, area, cycle area, extinction ratio (ratio, dB, %) and mean optical power. Continuous update of up to four measurements on any combination of waveforms.

Measurement Statistics – Display minimum and maximum or mean and standard deviation on any displayed single-waveform measurements.

Thresholds – Settable in percentage or voltage.

Gating – Any region of the waveform may be isolated for measurement using vertical bars.

Snapshot – Performs all measurements on any one waveform showing results from one instant in time.

Cursor Measurements – Absolute, Delta: Volts, Time, Frequency and NTSC IRE and line number (with video trigger option).

Cursor Types – Horizontal bars (volts), vertical bars (time); operated independently or in tracking mode.

WAVEFORM PROCESSING

Waveform Functions – Sin(x)/x or linear interpolation, Average, Envelope.
Advanced Waveform Functions (optional on TDS 500D) – FFT, Integration, Differentiation.
Arithmetic Operators – Add, Subtract, Multiply, Divide, Invert.
Autoset – Single-button, automatic setup on selected input signal for vertical, horizontal and trigger systems. Also automatically normalizes signals to standard masks when used with the mask testing option.
Waveform Limit Testing – Compares incoming or math waveform to a reference waveform's upper and lower limits.
Waveform Histograms – Both vertical and horizontal histograms, with periodically updated measurements, allow statistical distributions to be analyzed over any region of the signal. For histograms on DPO acquisitions, both live and stored, the specified region can be repositioned and will update to reflect the underlying 3 dimensional data base, in both YT and XY modes (32 bits in shallow mode, 64 bits in deep mode).
Mask Testing (Optional) – In addition to the standard communication masks in the instrument, the masks can be edited on the screen. Together with automatic waveform scaling, the mask tests give rapid verification of a digital bit stream's conformance to pulse templates and eye pattern masks. For optical conformance testing, the internal Fibre Channel and SONET/SDH optical reference receiver filters provide convenient test setup which is compliant to industry standards.

ZOOM CHARACTERISTICS
The zoom feature allows waveforms to be expanded or compressed in both vertical and horizontal axes. Allows precise comparison and study of fine waveform detail without affecting

ongoing acquisitions. When used with Hi-res or Average acquisition modes, Zoom provides an effective vertical dynamic range or 1000 divisions or 100 screens. Zoom features not available on DPO operations.

Dual Window Zoom – Dual graticules simultaneously show selected and zoomed waveforms. Up to two zoom boxes show areas on the selected trace that are being magnified, and the two magnified areas can be overlapped for quick comparison. Color of zoomed trace matches selected trace.

DISPLAY CHARACTERISTICS

Waveform Style – Dots, vectors, variable persistence from 32 ms to 10 s, infinite persistence, and intensified samples.

Color (TDS 794D, TDS 784D, TDS 754D, TDS 724D) – Standard palettes and user-definable color for waveforms, text, graticules and cursors. Measurement text and cursor colors matched to waveform. Waveform collision areas highlighted with different color. Statistical waveform distribution shown with color grading through variable persistence.

Color Grading (TDS 794D, TDS 784D, TDS 754D, TDS 724D) – With variable persistence selected, historical timing information is represented by temperature or spectral color scheme (or gray scale on TDS 580D, TDS 540D, TDS 520D) providing "z-axis" information about rapidly-changing waveforms.

Graticules – Full, grid, cross-hair, frame, NTSC and PAL (with video trigger option).

Format – YT and XY (and XYZ and dual XY in DPO operation).

Type – 7 in. diagonal, NuColor™ liquid crystal full color shutter display, 256 color levels (TDS 700D); 7 in. diagonal, magnetic deflection, horizontal raster-scan monitor with P4 white phosphor (TDS 500D).

Resolution – 640 horizontal by 480 vertical displayed pixels (VGA).

COMPUTER INTERFACE

GPIB (IEEE-488.2) Programmability – Full talk/listen modes. Control of all modes, settings, and measurements.

HARDCOPY

Printer – Phaser 740N and 740D, HP Thinkjet, Deskjet, Laserjet, Epson, Interleaf, PostScript, TIFF, PCX, BMP, DPU411/412, RLE.

Plotter – HPGL.

Data – MathCad, spreadsheet formats.

Interface – GPIB standard.

Hardcopy Interface (optional on TDS 500D) – Centronics and RS-232 (talk only).

STORAGE

Non-volatile Waveform Storage – 4 full 50 K records (Opt. 1M or 2M: 4 full 130 K records, 2 full 250 K records, or 1 compressed 500 K record) (TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D); 2 full 50 K records (Opt. 1M or 2M: 2 full 130 K records or 1 full 250 K record) (TDS 724D, TDS 520D).

Non-volatile storage for setups – 10 front panel setups.

Floppy Disk Drive – Store reference waveforms, setups, and image files on 3.5 in. 1.44 MB or 720 K DOS-format floppy disk.

Iomega Zip and Zip Plus Drive Compatible – Compatible for waveform and front panel setup file transfer to Iomega Zip and Zip Plus Drives.

POWER REQUIREMENTS

Line Voltage Range – 100 to 240 V RMS.

Line Frequency – 45 to 440 Hz.

Power Consumption – 350 W max.

ENVIRONMENTAL AND SAFETY

Temperature –
Operating: +4 to +50°C (floppy not used), +10 to +50°C (floppy in use).
Nonoperating: –22 to +60°C.

Humidity –
Operating: To 80% RH at 32°C. Derates to 30% RH at +45°C.
Nonoperating: To 90% RH at 40°C. Derates to 30% RH at +60°C.

Altitude –
Operating: 15,000 ft. (hard disk not used), 10,000 ft. (hard disk in use).
Nonoperating: 40,000 ft.

Electromagnetic Compatibility – UL1244.

Safety – UL3111-1, CSA1010.1, EN61010-1, IEC61010-1.

Physical Characteristics

Dimensions	mm	in.
Height with feet	193	7.6
Height without feet	178	7
Width with handle	445	17.5
Depth with front cover installed	434	17.1
Weight	kg	lbs.
Net approx.	14.1	31
Shipping Weight approx.	25.4	56

COMMUNICATION SIGNAL ANALYZER PACKAGE APPLICATIONS

- Advanced triggering, including triggering for AMI, CMI and NRZ communication signals
- Automatic measurements with measurement statistics including extinction ratio and average optical power
- Waveform histograms on DPO and normal waveform acquisitions
- Custom mask generation on-board
- Autoset signals to standard masks
- SONET/SDH and fibre channel optical reference receivers
- Internal standard communication signal masks provided for compliance testing from over 50 communication standards
- Debugging communications designs
- Mask testing per comm/video standards
- Optical eye pattern testing

The Tektronix TDS Communication Signal Analyzer package gives you the most comprehensive oscilloscope solutions for connecting to, capturing and characterizing optical and electrical signals in high-speed communication designs. Based on the TDS 500D/700D family of Digital Phosphor Oscilloscopes (DPOs), the Communication Signal Analyzer options and measurement accessories tailor the oscilloscopes for engineers debugging, characterizing and verifying the compliance of communication systems to international standards.

These communications options complement the Tektronix 11801C Digital Sampling Oscilloscope and the CSA 803C Communication Signal Analyzer, which provide bandwidths up to 50 GHz and measurement features tailored for optical component manufacturing and research and development applications.

CONNECTING TO THE SIGNAL

Whether the signals are electrical (differential or single-ended) or optical, connecting the design to the measurement system is no easy matter. A wide selection of complementary measurement accessories, optimized for use with the TDS oscilloscopes, are available to make probing convenient and reliable, while maintaining high accuracy.

Electrical Communication Adapters such as the AFTDS ease connection to differential communication signals, such as DS1, DS2 and E1, by terminating the signal in 100 , 110 or 120 and adapting various connector styles (bantam, Siemens and RJ-11) to the oscilloscope's 50 BNC environment.

The AMT75 75 Adapter simplifies connection of video and communication signals such as DS3 and E3 to the oscilloscope. This adapter supplies a precise termination to signals up to 1 GHz.

Optical-to-electrical Converters allow convenient analysis of optical transmission signals. The P6701B can be used for Fibre Channel signals and the P6703B can be used for SONET/SDH signals. They provide high gain (1 V/mW) for signals up to 1 GHz and as large as 1 mW (0 dBm). The P6723 optical logic probe converts SONET/SDH signals into PECL digital signals suitable for use as triggers.
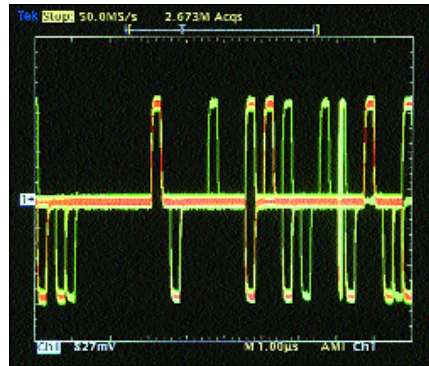
CAPTURING THE SIGNAL

High Bandwidth and Sample Rates, up to 2 GHz and 1 GS/s per channel, enable the user to capture the signal with high fidelity. Channels can be transparently combined to achieve higher sample rates, up to 4 GS/s.

Digital Phosphor Oscilloscopes capture, store, display and analyze, in real-time, three dimensions of signal information: amplitude, time and distribution of amplitude over time. The benefit of this new third dimension of information is an interpretation of the signal dynamics, including instantaneous changes and the frequency of occurrence displayed in the form of quantitative intensity information.

In addition to standard **Advanced Trigger** modes such as edge, pulse-width, logic and optional video trigger, these oscilloscopes have trigger modes tailored for communication design and debug. The optional Comm trigger addresses the need to acquire a wide variety of Alternate-Mark Inversion (AMI), Code-Mark Inversion (CMI) and Non-Return to Zero (NRZ) communication signals. These trigger modes may be selected manually during routine troubleshooting, but are automatically selected when mask testing is enabled.

AMI mode triggers on standard AMI signals (including DS1, DS3, E1, E2, E3 and STS-1). "Isolated ones" triggering is available on ANSI T1.102 AMI signals (including DS1 and DS3). **CMI** triggering isolates positive or negative one pulses and zero pulses in standard CMI signals (including STS-3, STM1E, DS4 and E4). **NRZ** trigger selects rising or falling edges, or any of eight 3-Bit serial patterns in NRZ signals (including SONET/SDH, Fibre Channel, FDDI, 143, 270, 360 and 1485 Mb/s serial video signals). The **serial** trigger mode allows identification of data-dependent anomalies in eye diagrams.

Long streams of serial data, up to 4 ms at full resolution, can be captured with optional long record length (up to 8 M points).


An example of the selection of isolated-one AMI trigger mode.

CHARACTERIZING THE SIGNAL

Optional Communication Mask Testing allows mask compliance testing of a wide variety of communication signals against industry standards. The instruments are set up for mask testing by selecting the standard from the user interface. This selection sets up the trigger system and vertical and horizontal scaling and displays the appropriate mask. A specialized autoset scales and offsets the signal to the selected standard mask, making mask testing easy and repeatable. The standard communication masks in the instrument can be edited directly on the screen to create custom masks, allowing up to 8 regions with 50 vertices.

In addition to the specialized optical measurement accessories, the oscilloscopes have nominal internal 4th-order Bessel-Thompson filters for diagnostic testing of Fibre Channel and SONET/SDH signals. Optional internal SONET/SDH (Opt. 3C) and Fibre Channel (Opt. 4C) optical reference receiver filters on channel 1 of the products are also available. These reference receivers, required for optical compliance testing by ANSI FC-PH, Bellcore GR-253-Core and ITU-T G.957, can be switched in and out at the touch of a button.

Automatic Measurements eliminate the need for manually measuring waveform parameters. Measurements include average optical power (in dBm) and extinction ratio (expressed as a ratio, in % for FDDI and in dB for SONET/SDH and Fibre Channel applications).
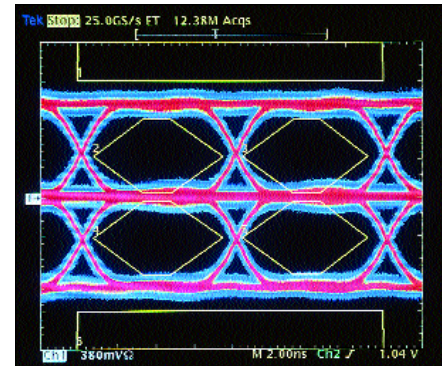
A DS-1 isolated-one signal is compared with the standard pulse mask, showing a compliant waveform.

OPTION 2C[8]

Communication Signal Analyzer Package Includes:

AMI, CMI, and NRZ Comm triggers, communication mask testing, nominal Bessel-Thompson filtering, automatic pass/fail testing, mask margin testing, inverted masks and mask autoset.

Standards Supported: OC1/STM0, OC3/STM1, OC12/STM4, FC133, FC266, FC513, FC1063, DS0, DS1, DS1A, DS1C, DS2, DS3, DS4NA, E1, E2, E3, E4, E5, STM1E, STS-1, STS-3, FDDI, D1, D2, 259M-D, 292M video and Ethernet (10 Base-T, 100 Base-TX, 1000 Base-SX, 1000 Base-LX).

OPTION 3C[9]

Fibre Channel Optical Reference Receiver Includes:

P6701B and reference receiver calibration.
Standards Supported: FC133, FC266, FC531[6] and FC1063[7].

OPTION 4C[9]

SONET/SDH Optical Reference Receiver Includes:

P6703B and reference receiver calibration.
Standards Supported: OC1/STM0, OC3/STM1 and OC12/STM4[6].

[6]   Available on TDS 784D, TDS 754D and TDS 540D.

[7]   Available on TDS 784D and TDS 580D only. Frequency response controlled to 1.5 * bit rate.

[8]   TDS 794D does not provide nominal Bessel-Thompson filtering.
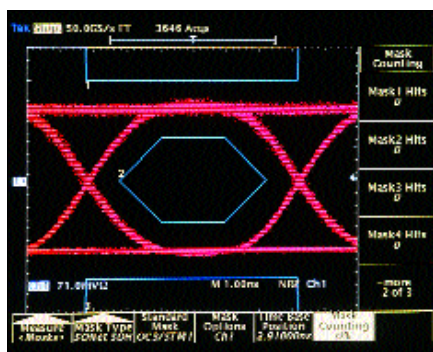
[9]   Not compatible with TDS 794D.

OPTION 1M

Record Length:

TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D: 500 K maximum.
TDS 724D, TDS 520D: 250 K maximum.

OPTION 2M

Record Length 2 M/Channel:

TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D: 8 M maximum.
TDS 724D, TDS 520D: 4 M maximum.
Includes hard disk drive.

A SONET/SDH (OC-3/STM-1) signal is compared with the standard mask, showing a compliant waveform.

ACCESSORIES

High Bandwidth Differential Probes:
Probe Bandwidth:
P6248: 1.7 GHz.
P6247: 1 GHz.
P6246: 400 MHz.

AFTDS Differential Signal Adapter:
Input Impedance (selectable): 100 Ω, 110 Ω or 120 Ω, ±3%.
Available Connectors: Bantam, Siemens, RJ-11.
Electrical Standards Supported: DS1, DS1A, E1, DS1C, DS2.

AMT75 75 Ω Adapter:
Input Impedance: 75 Ω ± 1.5%.
Adapter Bandwidth: DC to 1 GHz (typical).
VSWR (Return Loss): 1.1:1 (>26 dB, up to 1 GHz typical).
Connectors: 75 Ω BNC.

Electrical Standards Supported: E2, E3, DS3, STS-1, DS4, E4, STM-1, STS-3, D1, D2 and 259M-D, 292M video.

P6701B Optical-to-electrical Converter:
Wavelength Response: 500 to 950 nm.
Optical Bandwidth: DC to 1 GHz.
Conversion Gain (at 780 nm): 1V/mW.
Standards Supported: Fibre Channel, FDDI.

P6703B Optical-to-electrical Converter:
Wavelength Response: 1100 to 1700 nm.
Optical Bandwidth: DC to 1.2 GHz.
Conversion Gain (at 1310 nm): 1V/mW.
Standards Supported: SONET/SDH.

P6723 Optical Logic Probe:
Wavelength Response: (1310/1550 nm).
Standards Supported: SONET/SDH 650 Mb/s.

OPTICAL ATTENUATORS
OA5002: 10 μm single-mode.
OA5012: 50 μm multimode.
OA5022: 62.5 μm multimode.
OA5032: 100 μm multimode.

TDS 794D
Digital Phosphor Oscilloscope.

TDS 784D
Digital Phosphor Oscilloscope.

TDS 754D
Digital Phosphor Oscilloscope.

TDS 724D
Digital Phosphor Oscilloscope.

TDS 580D
Digital Phosphor Oscilloscope.

TDS 540D
Digital Phosphor Oscilloscope.

TDS 520D
Digital Phosphor Oscilloscope.

INCLUDED ACCESSORIES
Probes – 4 each P6139A passive probes (TDS 754D, TDS 540D), 2 each P6139A (TDS 724D, TDS 520D).

Documentation – Quick Reference in 9 languages (020-2235-00), User Manual (071-0130-00), Technical Reference (071-0135-00), Programmer's Manual (063-3120-00) in MS-Help format on floppy disk, and ANSI, NCSL Z 540-1-1994 (ISO Guide 25) calibration certificate.

Accessories – Front Cover (200-3696-01), US power cord (161-0230-01), and accessory pouch (016-1268-00; TDS 794D, TDS 784D, TDS 754D, TDS 724D).

INSTRUMENT OPTIONS
Opt. 05 – Add video trigger (NTSC, PAL, HDTV, FlexFormat™). (Not available on the TDS 794D)

Opt. 1M – Add 130 K/channel memory length (500 K max on TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D) 250 K max (TDS 724D, TDS 520D).

Opt. 2M – Add 2 M/channel memory length (8 M max on TDS 794D, TDS 784D, TDS 754D, TDS 580D, TDS 540D; 4 M max on TDS 724D, TDS 520D). Includes internal hard disk drive.

Opt. 13 (TDS 580D, TDS 540D, TDS 520D only) – Add RS-232C and Centronics hardcopy interfaces.

Opt. 2F (TDS 580D, TDS 540D, TDS 520D only) – Extended waveform math: FFT, integration and differentiation.

COMMUNICATION SIGNAL ANALYZER OPTIONS
Opt. 2C – Communication Signal Analyzer; includes comm triggers and communication mask testing.

Opt. 3C – Short-wavelength (Fibre Channel FC133, FC266, FC513, FC1063) Optical Reference Receiver; includes P6701B and system calibration (Not Available on the TDS 794D).

Opt. 4C – Long-wavelength (SONET/SDH OC1/STM0, OC3/STM1, OC12/STM4) Optical Reference Receiver; includes P6703B and system calibration (Not Available on the TDS 794D).

INSTRUMENT PROBE OPTIONS*[1]
Opt. 31 (TDS 794D only) – Add 1 each P6339A buffered passive probe.

Opt. 33 (TDS 794D, TDS 784D, TDS 580D only) – Add 1 each P6158 low capacitance probe.

Opt. 34 – Add 1 each P6247 differential probe.

Opt. 35 (TDS 754D, TDS 724D, TDS 540D, TDS 520D only) – Add 1 each P6243 active probe.

Opt. 36 (TDS 784D, TDS 754D, TDS 724D, TDS 580D, TDS 540D, TDS 520D only) – Add 1 each P6139A passive probe. (4 standard on TDS 754D, TDS 540D, 2 standard on TDS 724D, TDS 520D).

Opt. 37 (TDS 784D and TDS 580D only) – Add 1 each P6245 active probe.

Opt. 38 (TDS 794D only) – Add 1 each P6249 4 GHz active probe.

Opt. 39 (TDS 794D only) – Add 1 each P6248 1.7 GHz differential probe.

INSTRUMENT APPLICATIONS MEASUREMENT SOFTWARE
Note: Requires TDS 500/600/700 Option HD or 2M.

TDSPRT1 – Printing Utility.

TDSDDM1 – Disk drive measurement package.

TDSPWR1 – Power measurement package.

TDSJIT1 – Jitter analysis measurement package.

TDSPSM1 – Processor specifications measurement package.

TDSCEM1 – Communications eye-diagram measurement package.

WSTRO – WaveStar™ software for Oscilloscopes, Windows 95/98/NT application for waveform capture, analysis, documentation and control from your PC.

WSTROU – Upgrade from WSTR31 to WSTRO.

WSTR31 – WaveStar™ software for Windows 3.1.

WSTR31U – Upgrade from DocuWave® software to WSTR31.

LVWIN95 – LabVIEW® for Windows 95.

LVWCVI95 – LabWindows/CVI for Windows 95.

S3FT400 – WaveWriter™ AWG and waveform creation software.

INTERNATIONAL POWER PLUGS
Opt. A1 – European power cord (220 V, 50 Hz).
Opt. A2 – UK power cord (240 V, 50 Hz).
Opt. A3 – Australian power cord (240V, 50 Hz).
Opt. A4 – North American power cord (240V, 60Hz).
Opt. A5 – Swiss power cord (220 V, 50 Hz).

OPTIONAL ACCESSORIES
Opt. 1K – Add K420 scope cart.
Opt. 1R – Rackmount kit.
Opt. L1 – Substitute French user manual for English user manual.
Opt. L3 – Substitute German user manual for English user manual.
Opt. L5 – Substitute Japanese user manual for English user manual.
Opt. L9 – Substitute Korean user manual for English user manual.

RECOMMENDED PROBES
ADA400A – Differential Preamplifier.
AM503S – DC/AC Current Measurement System.
AFTDS – Electrical communication differential signal adapter.
AMT75 – 1 GHz electrical communication 75 Ω adapter.
P5100 – 2.5 kV High-voltage probe.
P5205 – 1.3 kV High-voltage 100 MHz differential probe.
P5210 – 5.6 kV High-voltage 50 MHz differential probe.
P6139A – 500 MHz passive 10X voltage probe.
P6205 – 750 MHz active voltage probe.
P6243 – 1 GHz active voltage probe.
P6245 – 1.5 GHz active voltage probe.

P6247 – 1 GHz differential probe.

P6158 – 3 GHz low capacitance voltage probe.

P6339A – 500 MHz buffered passive voltage probe (TDS 794D only).

P6246 – 400 MHz differential probe.

P6248 – 1.5 GHz differential probe.

P6249 – 4 GHz active voltage probe.

P6563A – SMD passive voltage probes.

P6701B – Short-wavelength (500-950 nm) optical-to-electrical converter.

P6703B – Long-wavelength (1100-1700nm) optical-to-electrical converter.

P6723 – Optical logic probe (1310/1550 nm).

TCP202 – DC to 50 MHz current probe.

RECOMMENDED ACCESSORIES

Service Manual – TDS 500D/600B/700D. Order 071-0136-00.

GPIB – LAN Adapter – Order AD007.

Transit Case – Order 016-1135-00.

Scope Cart – Order K420.

MEASUREMENT SERVICE OPTIONS

Opt. C3 – Three years of Calibration Services.

Opt. D1 – Cal Data Report.

Opt. D3 – Test Data (requires Opt. C3).

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