

# Test Equipment Solutions Datasheet

Test Equipment Solutions Ltd specialise in the second user sale, rental and distribution of quality test & measurement (T&M) equipment. We stock all major equipment types such as spectrum analyzers, signal generators, oscilloscopes, power meters, logic analysers etc from all the major suppliers such as Agilent, Tektronix, Anritsu and Rohde & Schwarz.

We are focused at the professional end of the marketplace, primarily working with customers for whom high performance, quality and service are key, whilst realising the cost savings that second user equipment offers. As such, we fully test & refurbish equipment in our in-house, traceable Lab. Items are supplied with manuals, accessories and typically a full no-quibble 2 year warranty. Our staff have extensive backgrounds in T&M, totalling over 150 years of combined experience, which enables us to deliver industry-leading service and support. We endeavour to be customer focused in every way right down to the detail, such as offering free delivery on sales, covering the cost of warranty returns BOTH ways (plus supplying a loan unit, if available) and supplying a free business tool with every order.

As well as the headline benefit of cost saving, second user offers shorter lead times, higher reliability and multivendor solutions. Rental, of course, is ideal for shorter term needs and offers fast delivery, flexibility, try-before-you-buy, zero capital expenditure, lower risk and off balance sheet accounting. Both second user and rental improve the key business measure of Return On Capital Employed.

We are based near Heathrow Airport in the UK from where we supply test equipment worldwide. Our facility incorporates Sales, Support, Admin, Logistics and our own in-house Lab.

All products supplied by Test Equipment Solutions include:

- No-quibble parts & labour warranty (we provide transport for UK mainland addresses).
- Free loan equipment during warranty repair, if available.
- Full electrical, mechanical and safety refurbishment in our in-house Lab.
- Certificate of Conformance (calibration available on request).
- Manuals and accessories required for normal operation.
- Free insured delivery to your UK mainland address (sales).
- Support from our team of seasoned Test & Measurement engineers.
- ISO9001 quality assurance.

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An innovative series of oscilloscopes built upon Tek's new digitizing scope platform, featuring multi-processor speed and flexibility, advanced acquisition and triggering capabilities and a unique graphical user interface for intuitive operation.

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### THE TDS SERIES FEATURES

- 500 MHz, 350 MHz & 150 MHz Bandwidths
- Sample Rates to 1 GS/s
- 2 and 4 Input Channels
- Time Interval, 2 ns Glitch, Runt, Pattern, State and TV Triggering
- 1 mV/div – 10 V/div Sensitivity
- Infinite and Variable Persistence Displays
- Record Lengths to 50,000 Points Per Channel
- 8-bit Vertical Resolution
- 1% Vertical Accuracy
- Hi-Res Mode
- Tek TriStar™ (DSP) Processor for Fast Waveform Processing and Live Measurement Updates
- Peak Detect Mode for High-speed Glitch Capture
- 22 Automatic Measurements
- Full GPIB Programmability
- 3 Year Warranty

**GPIB**  
IEEE-488

The TDS Series complies with IEEE Standard 488.2-1987 and Tektronix Standard Codes and Formats.



## TDS SERIES

The TDS 520, TDS 540, TDS 420, and TDS 460 represent the next generation of digitizing oscilloscopes, designed to keep pace with current and evolving needs in digital design, manufacturing test, R&D, and telecommunications applications. The portability of the TDS 400 makes it an exceptional choice for demanding field service applications.

The TDS Series introduces powerful advances on four fronts at once, including:

### AN INTUITIVE USER INTERFACE

A Graphical User Interface (GUI) with more than 50 screen icons helps users easily grasp the operating details. A familiar front panel, dedicated knobs, autosep, and on-line help facilitate quick user adaptation.

### HIGH-FIDELITY ACQUISITIONS

The TDS Series offers acquisition performance formerly seen in only the high-end Tektronix 11000/DSA Series. The signal acquisition system provides up to 4 channels, 500 MHz bandwidth, 1 GS/s sampling, record lengths to 50 K, wide dynamic range, 8-bit vertical resolution, fast overdrive recovery, calibrated DC offset, 1 mV/division sensitivity, and internal calibration – all helping ensure the highest accuracy ever in a general purpose oscilloscope. An exclusive Hi-Res acquisition mode increases resolution on single-shot events to up to 12 bits.

### ADVANCED TRIGGERING

Tek's unmatched oscilloscope triggering circuits allow you to trigger on the most complex and erratic signals. The TDS 400's video trigger provides stable triggers for NTSC and PAL broadcast TV and other custom complex video signals. The TDS 500's feature innovative logic, glitch, pulse width and runt pulse triggering. The icon-based user interface makes complex triggering setups easy and unambiguous.

### MULTIPROCESSOR ARCHITECTURE

A Motorola 68020, Tek TriStar™ digital signal processor, and a powerful proprietary display processor combine to provide the power for live display updates, high-speed averaging, selectable interpolation and many other fast waveform processing, display and measurement functions.

### AN EVOLUTION OF PERFORMANCE, FIDELITY, AND EASE OF USE

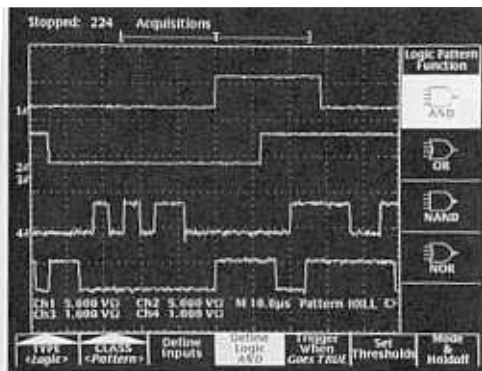
The power of the TDS Series is the result of a number of significant advances in oscilloscope engineering, including:

- An evolution of Tek's multiprocessor architecture that utilizes separate processors for the scope's executive, display, and digitizing functions – a concept originally created for Tek's lab-quality 11000/DSA Series.

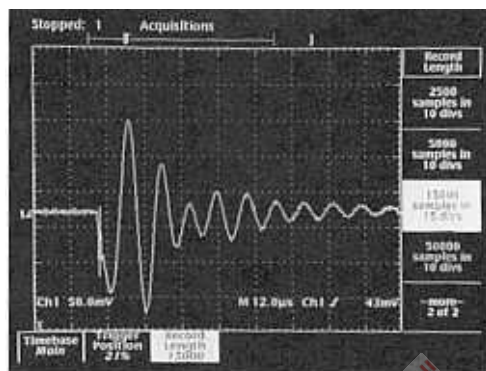
### TDS SERIES SELECTION GUIDE

	TDS 420	TDS 460	TDS 520	TDS 540
GUI	Yes	Yes	Yes	Yes
Bandwidth	150 MHz	350 MHz	500 MHz	500 MHz
Sample Rate	100 MS	100 MS	500 MS	1 GS
Channels	4	4	2	4
Sensitivity	1 mV-10 V	1 mV-10 V	1 mV-10 V	1 mV-10 V
Glitch Capture	10 ns	10 ns	4 ns	4 ns
Record Length	5 k pts. (30 k opt.)	5 k pts. (30 k opt.)	15 k pts. (50 k opt.)	15 k pts. (50 k opt.)
Glitch Trigger			Yes	Yes
Logic Trigger			Yes	Yes
TV Trigger	Opt.	Opt.		





Logic timing analysis is faster and easier with icon-driven state and pattern triggering and four channels of acquisition in the TDS 540.



Record lengths of up to 50,000 points (with Option 1M) on the TDS 500 and 30,000 points (with Option 1M) on the TDS 400 provide high resolution on complex waveforms and help capture elusive transients.

"If you look at the scopes' combination of features and specs, you can legitimately call these products revolutionary."

Dan Strassberg  
Associate Editor  
EDN Magazine

- Unparalleled levels of circuit integration and state-of-the-art surface mount technology, enabling all of the acquisition system to be mounted on a single board.
- Significant advances in intuitive human interface features that enable the addition of productive new capabilities without adding complexity. A design goal for the TDS was to make virtually every feature discoverable and understandable without reference to the manual.

These breakthroughs have helped spawn a multitude of features and capabilities never before seen in a mainstream oscilloscope. These include:

### WIDE DYNAMIC RANGE AND FAST OVERDRIVE RECOVERY

The TDS Series can recover from overdriven signals to within 1% in about 20 ns – approximately 2 orders of magnitude faster than the settling time of competitive amplifiers.

### PEAK DETECT

The TDS digitizers run at full speed at all times. High-speed demultiplexers, downstream from the digitizers, handle the task of acquiring waveform points appropriate to the selected digitizing speed. The peak detect mode instructs the demultiplexers to display all signal peaks, ensuring that glitches as small as 4 ns (10 ns for the TDS 400 Series) are acquired and displayed at any time/division setting.

In addition, because input signals are rarely undersampled, the risk of aliasing is reduced.

### HI-RES MODE

At slower time/division settings, over-sampled data points captured by the high-speed digitizers are normally disregarded. In Hi-Res mode, these extra points are averaged on-the-fly, extending vertical resolution to 12 bits on single-shot events. Hi-Res mode is especially useful for filtering out high-frequency noise and for visually enhancing single-shot events.

### LOGIC AND VIDEO TRIGGERING

Special TDS 500 triggering functions isolate many common fault conditions in logic circuits. Glitch trigger can

single out pulses that are as narrow as 2 ns. Runt triggering can recognize pulses too low to qualify as logic highs and too high to qualify as logic lows, such as those which result from intermittent tri-state bus problems. While glitches and runt pulses are difficult for most oscilloscopes to see, the TDS 500 makes them easy to find and provides up to three other channels for tracing their cause.

The TDS 420 and 460 include high quality video triggering with back porch clamping. The video trigger allows you to trigger on select fields and lines and provides setups for 60/525 and 50/625 broadcast standards and custom video signals.

### LONG RECORD LENGTHS

The TDS Series' enables customized data capture for increased measurement resolution or long event recording. A zoom mode allows detailed signal examination through waveform expansion or compression of the whole record onto one screen. The TDS 500 and TDS 400 offers 15 k points and 5 k points standard. The Option 1M extends the record length from 15 k to 50 k and 5 k to 30 k per channel respectively.

### STABLE TRIGGERS ENSURED

Tek's superb trigger conditioning circuitry provides stable triggering on complex waveforms. Selectable trigger conditioning includes AC or DC Coupled, Noise Reject, High Frequency Reject, and Low Frequency Reject.

### EASY TO LEARN AND OPERATE

On most scopes, advanced features are so cryptic or complicated that they may never be utilized. But while the TDS Series offers more advanced functions than any similar oscilloscope, its unique use of icons, logical grouping of functions and familiar front panel layout make operation easy, even for the unique features.

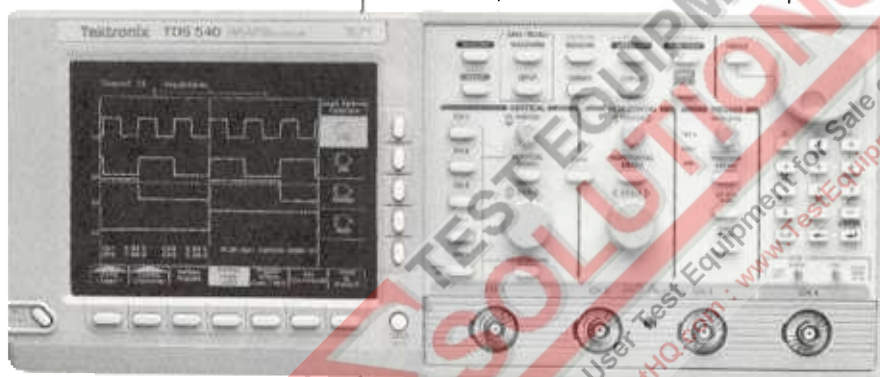
Triggers, setup conditions, measurements, acquisition modes and other functions are clearly illustrated by the TDS system of icons. The scopes' VGA-quality display resolution makes all waveform, icon and text information exceptionally sharp and clear.

NEW

TDS 520/TDS 540

# BENCHTOP DIGITIZING OSCILLOSCOPES

- 500 MHz Bandwidth
- Sampling Rates to 1 GS/s
- 2 and 4 Channel Models
- Time Interval, 2 ns Glitch, runt, Pattern and State Triggering
- Up to 50 K Points Record Length
- 1% Vertical Accuracy



**GPIB** IEEE-488  
 The TDS 520/TDS 540 comply with IEEE Standard 488.2-1987 and Tektronix Standard Codes and Formats.

## SIGNAL ACQUISITION SYSTEM

**DC Gain Accuracy** – ±1.0%.

**Vertical Resolution** – 8 bits (256 levels over 10.24 vertical divisions).

**Analog Bandwidth Selections** – 20 MHz, 100 MHz, and full (Aux 1 and Aux 2 on the TDS 520 are full BW only).

**Input Coupling** – AC, DC or GND.

**Input Impedance Selections** – 1 MΩ in parallel with 10 pF, or 50 Ω (AC and DC coupling).

**Maximum Input Voltage** – ±400 V (DC + peak AC). Derate at 20 dB/decade above 1 MHz. 1 MΩ or GND coupled.

**Channel Isolation** – ≥100:1 at 100 MHz and ≥30:1 at 500 MHz for any two channels having equal Volts/div settings.

**AC Coupled Low Frequency Limit** – ≤10 Hz when AC-1 MΩ coupled. ≤200 kHz when AC-50 Ω coupled.

**Sample** – Sample data only.

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

**Average** – Waveform averages selectable from 2 to 10000.

**Hi-Res** – Vertical resolution improvement and noise reduction on low-frequency signals, e.g. 12 bits at 50 μs/div and slower.

## DISPLAY

**Waveform Style** – Dots or vectors. Infinite and variable persistence from 250 ms to 10 s.

**Gray Scaling** – With variable persistence selected, waveform points gradually decay through 16 levels of intensity, providing “z-axis” information about rapidly changing waveforms.

**Update Rate** – 200 waveforms per sec (500 points per waveform) with infinite persistence mode selected.

**Graticules** – Full, grid, cross hair, frame.

**Format** – YT and XY.

## ZOOM

The zoom feature allows waveforms to be expanded, compressed and positioned 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 of 1000 divisions or 100 screens.

## MEASUREMENT SYSTEM

### AUTOMATIC WAVEFORM MEASUREMENTS

Period	Frequency
High	Low
+ Width	– Width
Maximum	Minimum
Rise	Fall
Peak to Peak	Amplitude
+ Duty cycle	– Duty cycle
+ Overshoot	– Overshoot
Propagation delay	Burst Width
Mean	Cycle Mean
RMS	Cycle RMS

Continuous update of up to four measurements on any combination of waveforms.

**Thresholds** – Adjustable in percentage or voltage.

**Cursor Measurements** – Absolute, delta; Volts, Time Frequency.

**Cursor Types** – Horizontal bars (volts); Vertical bars (time).

## TIME BASE SYSTEM

**Time Bases** – Main, Delayed.

**Time/Division Range** – 500 ps to 10 s/div.

**Time Base Accuracy** – 0.0025% over any interval ≥1 ms.

**Record Length (real time and equivalent time)** – Sample points per channel: 500, 1000, 2500, 5000, 15000; 50000 with Option 1M (except in Average and Hi-Res mode).

**Pre-Trigger Position** – Selectable from 0 to 100% of record.

## TRIGGERING SYSTEM

**Triggers** – Main, Delayed.

**Main Trigger Modes** – Auto, Normal, Single.

**Delayed Trigger** – Delayed by time or events.

**Time Delay Range** – 4 ns to 250 s.

**Events Delay Range** – 2 to 9,999,999 events.

**External Rear Input** – (TDS 540 only) ≥ 1.5 kΩ; Max input voltage is ±20 V (DC + AC peak).

## ACQUISITION MODES

**Peak Detect** – High frequency and random glitch capture. Captures glitches of 4 ns using acquisition hardware at all real-time sampling rates.



# BENCHTOP DIGITIZING OSCILLOSCOPES

## TDS 520/TDS 540

NEW

### WAVEFORM PROCESSING

**Waveform Functions** – Interpolate-selectable sin(x)/x or linear, Average.

**Arithmetic Operators** – Add, Subtract, Multiply, Invert.

**Autosetup** – Single button, automatic setup on selected input signal for vertical, horizontal and trigger systems.

### COMPUTER INTERFACE

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

### HARD COPY

**Printer** – HP ThinkJet, DeskJet, LaserJet, Epson, PostScript, Interleaf (standard configuration requires GPIB compatible hardcopy unit).

**Plotter** – HC100, HPGL

**Film** – C-9 camera.

### STORAGE

**Waveforms** – 4 full 5000 point records or any combination of up to 50,000 points total.

**Setups** – 10 front-panel setups.

### POWER REQUIREMENTS

**Line Voltage Range** – 90 to 250 V rms.

**Power Consumption** – 300 Watts max.

### INPUT CHARACTERISTICS

	TDS 520	TDS 540
Channels	2 + 2 auxiliary	4
Digitizers	2	4
Bandwidth	500 MHz	500 MHz
Sensitivity	CH 1, CH 2 1 mV to 10 V/div (with calibrated fine adjust)	CH 1, CH 2 Same as CH 1 and CH 2
	CH 3, CH 4 NA	CH 3, CH 4 Same as CH 1 and CH 2
	AUX 1, AUX 2 100 mV, 1.0 V, 10 V/div	AUX 1, AUX 2 NA
Position Range	± 5 Divisions	± 5 Divisions
Offset Range	CH 1, CH 2 ± 1 V from 1 to 99.9 mV/div ± 10 V from 100 mV to 999 mV/div ± 100 V from 1 to 10 V/div	CH 1, CH 2 Same as CH 1 and CH 2
	CH 3, CH 4 NA	CH 3, CH 4 Same as CH 1 and CH 2
	AUX 1, AUX 2 100 mV/div ± 5 V 1 V/div ± 5.0 V 10 V/div ± 50 V	AUX 1, AUX 2 NA

### MAXIMUM SAMPLE RATE

	TDS 520	TDS 540
Single Channel	500 MS/s	1 GS/s
Dual Channels	250 MS/s	500 MS/s
Four Channels	NA	250 MS/s

### TRIGGER FUNCTIONS

EDGE (main and delayed)	EDGE	Conventional level-driven trigger. Positive or negative slope on any channel or rear-panel auxiliary input (TDS 540 only). Coupling Selections: DC, AC, noise reject, HF reject, LF reject.
PULSE (main only)	WIDTH	Trigger on width of positive or negative pulse either within or not within selectable time limits. Time limits settable from 2 ns to 1 s.
	GLITCH	Trigger on or reject glitches of positive, negative or either polarity. Minimum glitch width threshold is 2.0 ns, with 200 ps resolution.
	RUNT	Trigger on a pulse that crosses one threshold but fails to cross a second before returning across the first.
LOGIC (main only)	PATTERN	Specifies a logical combination (AND, OR, NAND, NOR) of the four input channels (Hi, Lo, Don't Care). Trigger on the pattern going True or going False.
	STATE	Any logical pattern of channels 1, 2 and 3 plus clock edge on channel 4. Triggerable on positive or negative clock edge.

### ORDERING INFORMATION

**TDS 520** Digitizing Oscilloscope  
**TDS 540** Digitizing Oscilloscope  
 Both include: Probe (2 P6139A Probes); Quick Reference Guide (070-8316-00); Tutorial/User Manual (070-8317-00); Programmer's Manual (070-8318-00); Front Cover (200-3696-00); U.S. Power Cord (161-0230-01).

#### INSTRUMENT OPTIONS

**Opt. 1M** – 50K Memory Length (TDS 540)  
**Opt. 1P** – HC100 4 per plotter  
**Opt. 1R** – Rack Mount  
**Opt. 22** – Two Additional P6139A Probes  
**Opt. 23** – Two P6205 FET Probes  
**Opt. 9C** – NIST and MIL-STD-45662A Calibration Certificate

#### INTERNATIONAL POWER PLUG OPTIONS

**Opt. A1** – Universal Euro 220 V, 50 Hz  
**Opt. A2** – UK 240 V, 50 Hz  
**Opt. A3** – Australian 240 V, 50 Hz  
**Opt. A4** – North American 240 V, 60 Hz  
**Opt. A5** – Switzerland 220 V, 50 Hz

#### WARRANTY INFORMATION

Three years warranty, covering all labor and parts, including CRT, and excluding probes.

**Opt. M2** – Extends warranty coverage through the first five years of product ownership. (TDS 520)

(TDS 540)

**Opt. M3** – Extends warranty coverage through the first five years of product ownership and provides four calibrations; one each in years two, three, four, and five of product ownership. (TDS 520)

(TDS 540)

**Opt. M8** – Provides four calibrations; one each in years two, three, four, and five of product ownership. (TDS 520)

(TDS 540)

#### OPTIONAL ACCESSORIES

See page 37.

#### PHYSICAL CHARACTERISTICS

Dimensions	mm	in
Width	445	17.5
Height	236	7.8
Depth	432	17
Weight	kg	lb
Net	12.3	27
Shipping	22.0	44