Tektronix®

8 Series Sampling Oscilloscope
TSO820 and TSO8C17/18 Datasheet

The 8 Series Sampling Oscilloscope provides a comprehensive optical test solution for telecom and datacom applications, as well as general purpose optical component testing. The TSO8C17 and TSO8C18 optical modules provide > 30 GHz optical bandwidth, plus fully integrated Optical Reference Receivers (ORR)[1] enabling both single mode and multi-mode conformance testing at 850 nm, 1310 nm, and 1550 nm bands.

Key performance specifications

- Optical bandwidth above 30 GHz
- Single mode and multi-mode support for short and long wavelength optical testing
- Optical Reference Receiver (ORR)[1] support for standard compliance testing

Applications

- Design/verification of High-Speed Components and Systems
- Signal integrity analysis
- Compliance test for industry NRZ and PAM4 standards: 10G, 50G, 100G, 200G, 400G IEEE 802.3[TM] standards (such as 400GBASE-FR8, 400GBASEDR4) and similar optical direct detect standards.

Key features

- **New system architecture**
  - Disaggregated: The product consists of the TSO820 mainframe, pluggable modules, acquisition hardware, and the TSOVu software analysis application that runs on a user's PC with Windows. Users have the capability to scale their analysis platforms to their needs and can connect from anywhere on the network
  - Configurable: The TSO820 mainframe supports user-swappable current and future optical modules

- **Optical modules**
  - Accurate testing and characterization of short or long wave optical signals using the high sensitivity and low noise performance of the TSO8C17 or TSO8C18 modules
  - Optical reference receivers (ORR)[1] supports specified requirements for standards-mandated compliance testing
  - User configurable bandwidth supported through Bandwidth Enhancement (BWE) filters. Extend the TSO8C17 and TSO8C18 optical bandwidth up to 35 GHz in 0.0001 GHz increments for precise control
  - Extinction ratio measurements with built-in variable ER correction to ensure accuracy and repeatability

- **Analysis with TSOVu®**
  - TSOVu: Oscilloscope software application that runs independent of the oscilloscope mainframe on users' computers or server for both live and post-processing of acquired data
  - TSOVu offers comprehensive analysis of NRZ or PAM4 optical signals. Includes support for eye diagrams, NRZ mask testing, optical measurements such as TDECQ, and other standard measurements
  - New measurement plug-ins can be dynamically installed as needed

- **High test throughput**
  - Simultaneous capture of all channels at a high sample acquisition rate of 300 kS/s
  - Sophisticated Programmatic Interface (PI) for automation environments enables the highest test throughput. Each

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[1] Optical Reference Receiver (ORR) is a 4th order Bessel-Thomson filter with a frequency response and tolerances as defined by the standards. Tektronix optimizes the response for best nominal fit and highest quality mask test results

command supports full data synchronization, eliminating the need for wait / sleep statements

Compliance testing

Compliance test for 10G, 50G, 100G, 200G, and 400G IEEE 802.3™ standards such as 400GBASE-FR8, 400GBASE-DR4, and similar optical direct detect standards. The TSO820 Sampling Oscilloscope is also designed to support high speed NRZ standards such as 100 Gb Ethernet (100GBASE-LR4 or similar) that operates at a rate of 25.78125 Gb/s. Stay up-to-date on the latest standards changes by updating or adding new measurement plug-ins as they are released.

Disaggregated architecture

Traditional oscilloscopes perform signal acquisition and analysis in the same instrument. However, as the instrument ages, the relative processing power becomes obsolete over time. The 8 Series Sampling Oscilloscope turns this notion upside-down and features a disaggregated architecture, which separates the acquisition hardware and analysis platform. TSOVu can be installed on any Windows machine, giving users the freedom to choose the laptop readily available in the lab, a server connected to the network, or anything in between.
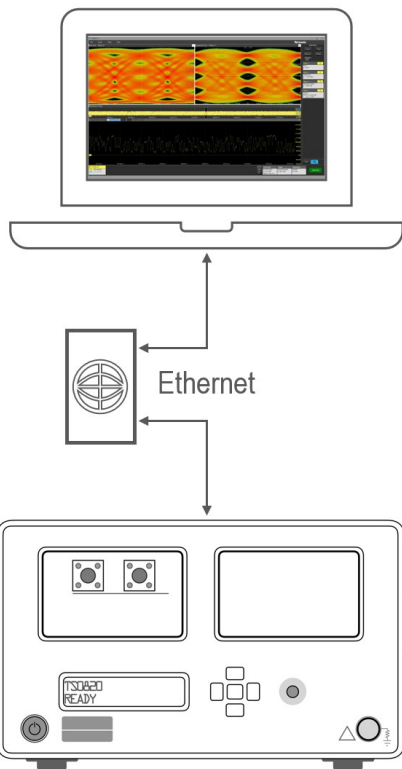
System diagram of client PC connected to a TSO820 mainframe via local area network (LAN)

Flexibility by design

The 8 Series Sampling Oscilloscope has been designed with modularity in mind. The TSO820 mainframe features the two module slots that are compatible with TSO8C17 and TSO8C18 optical modules, as well as future other modules. The oscilloscope mainframe can be reconfigured on the spot by removing or inserting modules through the top of the instrument. As testing requirements evolve, users can scale or change capabilities to match changing testing needs without sending the instrument in for factory reconfiguration.

Changes of the mainframe hardware configuration are reflected by the connected software application (TSOVu). The module type, serial number, calibration information, and so on are accessed via TSOVu GUI or PI queries.
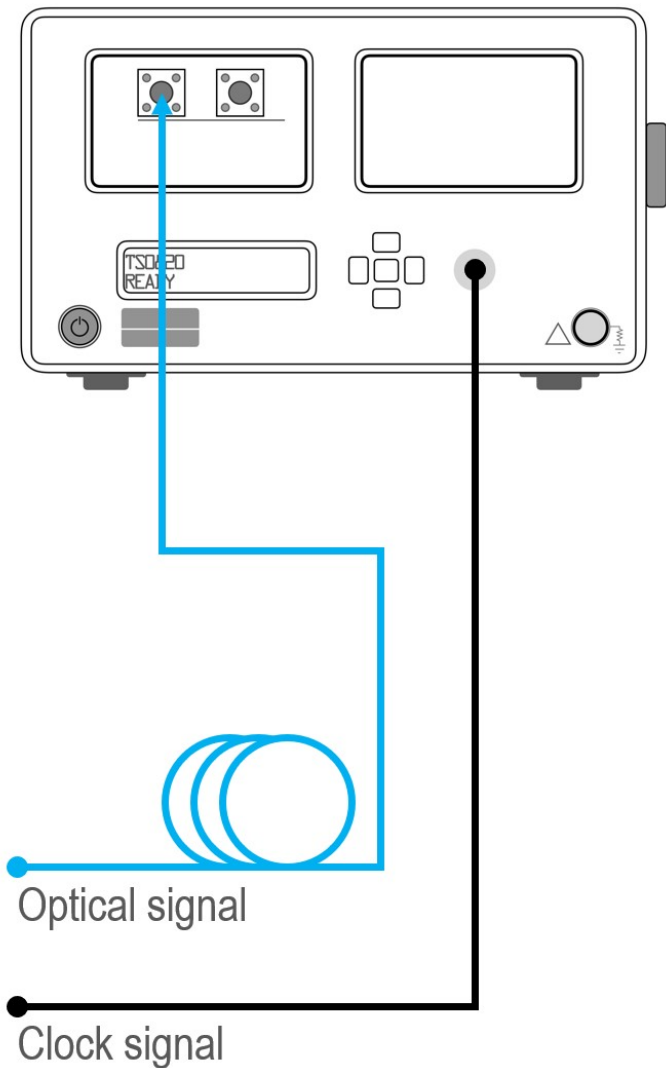

*Plugging TSO8C18 module into TSO820 mainframe.*
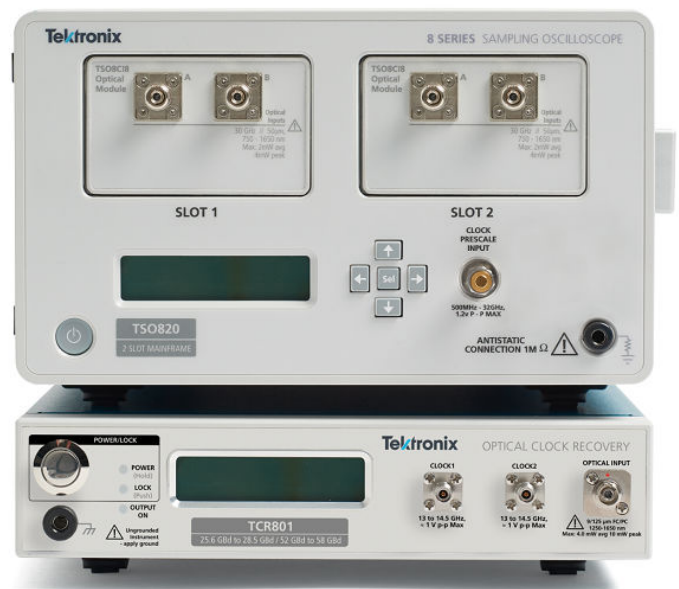
8 Series instruments: TSO820 mainframe, TSO8C17 / TSO8C18 (shown) optical modules

For more information regarding the TCR801, refer TCR801 Optical Clock Recovery Datasheet

Connection diagrams

Connection diagram demonstrating the TSO820 mainframe with one TSO8C18 optical module, triggered directly from DUT or pattern generator
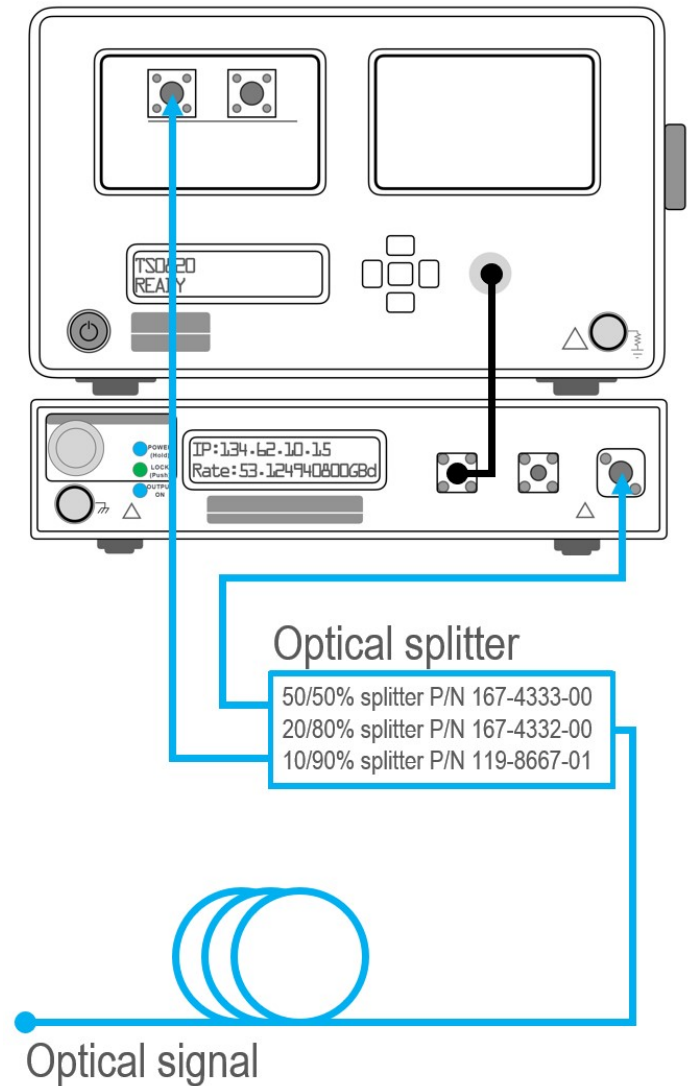
Connection diagram demonstrating the TSO820 mainframe with one TSO8C18 optical module, triggered by the TCR801 Optical Clock Recovery.

User interface

The 8 Series Sampling Oscilloscope features a brand-new sampling oscilloscope software architecture called TSOVu. This new software runs on a user's external Windows PC and features an intuitive user interface and analysis engine for increased measurement throughput and limits oscilloscope downtime.

The communication between the PC running TSOVu and the TSO820 mainframe is based on an IEEE 802.3[TM] Ethernet network, such as 100BASE-T or 1000BASE-T. TSOVu's Programmatic Interface (PI) commands can be used in the automation environments to control instrument functionality and analysis reporting. Use TSOVu with the TSO820 Sampling Oscilloscope Mainframe to acquire multiple channels simultaneously and analyze remotely over Ethernet or Wi-fi.

Note: Wi-fi requires consistent and stable network connection for proper use.
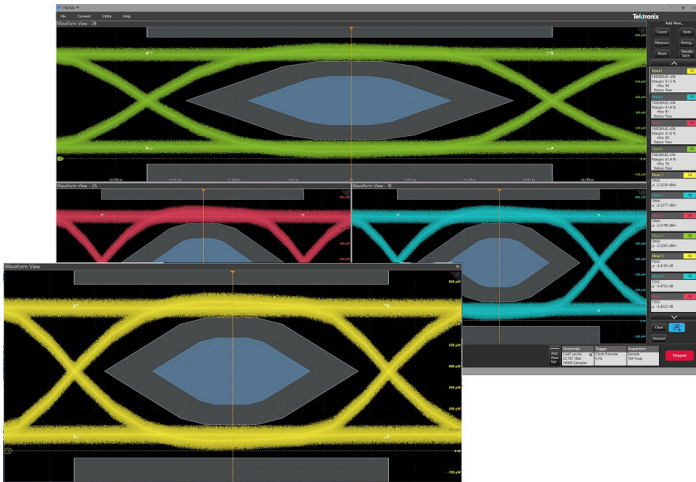

Example of performing four channel NRZ measurement and mask test in TSOVu. Channel M1A is shown in un-docked window.

Adjust vertical channel parameters individually based on the modulation type, channel bandwidth, and inherent signal characteristics like offset, skew, or external attenuation as shown:
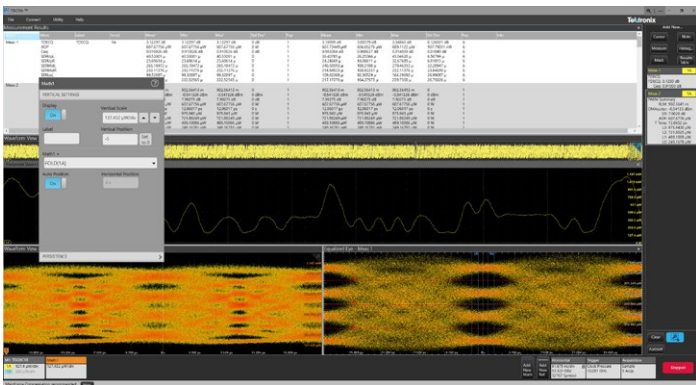

Add reference waveforms for offline processing of previously captured data, view eye diagrams before and after TDECQ FFE equalization, and detach windows from the base software to be rearranged or resized
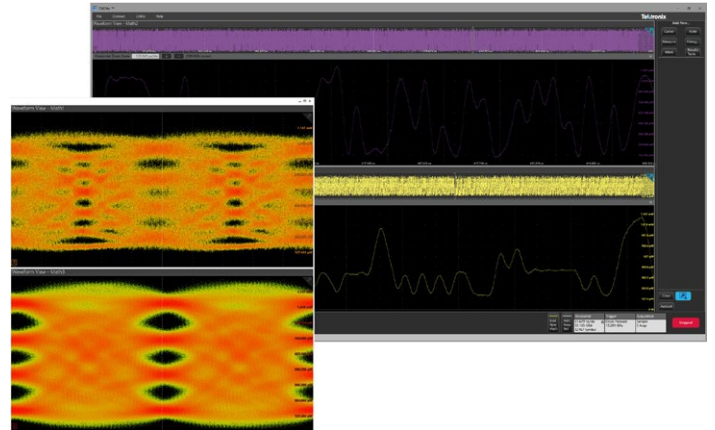
Measurement plug-in interface

Using the flexible plug-in architecture in TSOVu, measurement plug-ins that can interface with TSOVu will display directly in the Add Measurement window. This includes Tektronix' standard Pulse Measurement and PAM4 Optical Measurement plug-ins, and enables quick development of custom measurement libraries that are fully integrated in TSOVu to be called from the user interface or through PI commands.
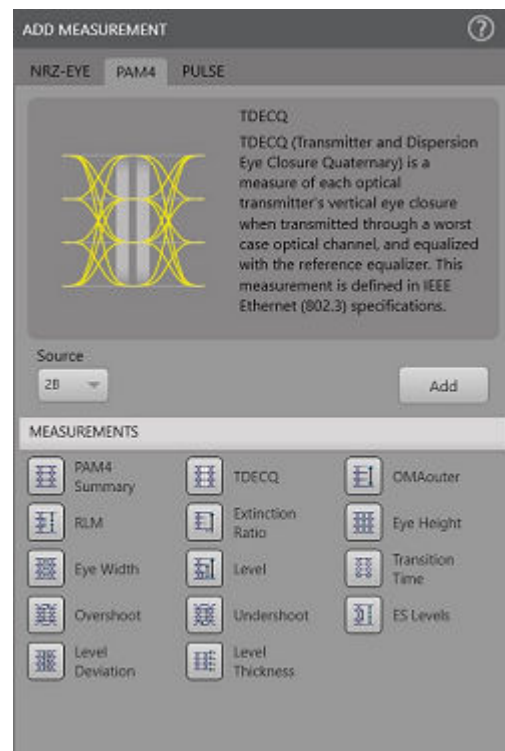

Example of the Add Measurement window displaying available optical PAM4 measurements. All measurements have short descriptions and can be added to live channels or reference waveforms

Native NRZ mask and measurement

Although the industry has started its transition to PAM4 modulated signals, NRZ/PAM2 has remained a prominent medium for high speed ethernet communication. Tektronix' TSOVu delivers a streamlined NRZ measurement and mask testing experience. Measurements such as TDEC, VECP, mask margin, mask ratio, and other common measurements are available alongside industry standard and custom masks. Since all NRZ measurement and mask testing are included in TSOVu as a base feature, these capabilities are available at no charge to the user.
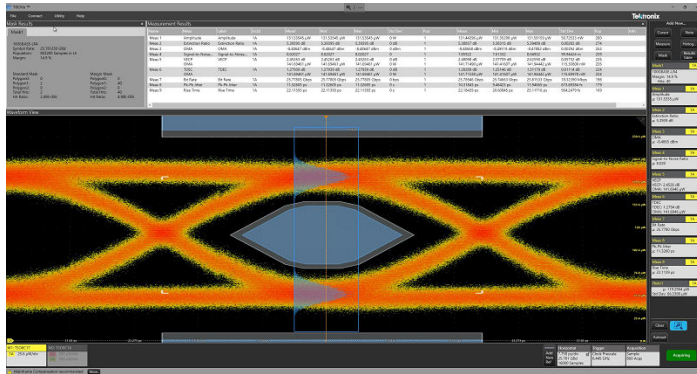

Math expressions and sources

With built-in Math features, TSOVu users can take advantage of simple scaler waveform operations or construct complex math expressions to increase productivity and device insight. Using the expression editor, users can add/subtract, multiply/divide, create eye diagrams, and even perform complex optimization / equalization with a single math source.

Supported math operations include:

- Addition / Subtraction / Multiplication / Division
- Unit Interval Overlay from Pattern Sync waveforms (eye diagrams)
- Waveform resampling
- Feed Forward Equalization (FFE)

Where applicable, all math output sources can be used for additional measurement, mask testing, and histogram data collection.
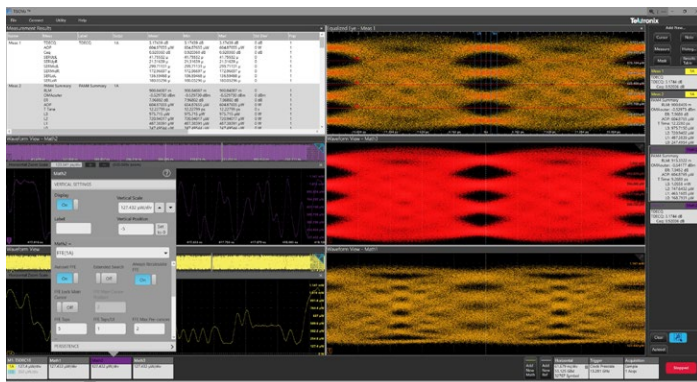
High-sensitivity operation accommodates low amplitude signals

The TSO8C17 and TSO8C18 optical modules feature high input sensitivity for measurement of low power signals. This enables the user to recover full pattern acquisitions with little noise contribution from the oscilloscope, making it possible to take true and accurate measurements in conditions where signal power is low.
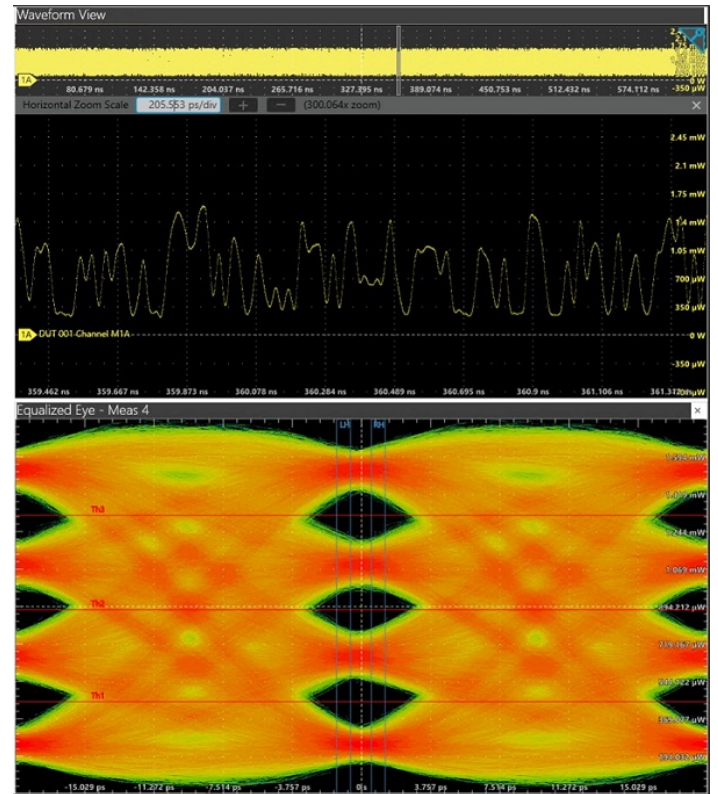
Example of a 53 GBd PRBS15Q signal acquired on the Tektronix TSO820 Sampling Oscilloscope with TSO8C18 optical module, triggered by the TCR801 Optical Clock Recovery

Measurement report and data management
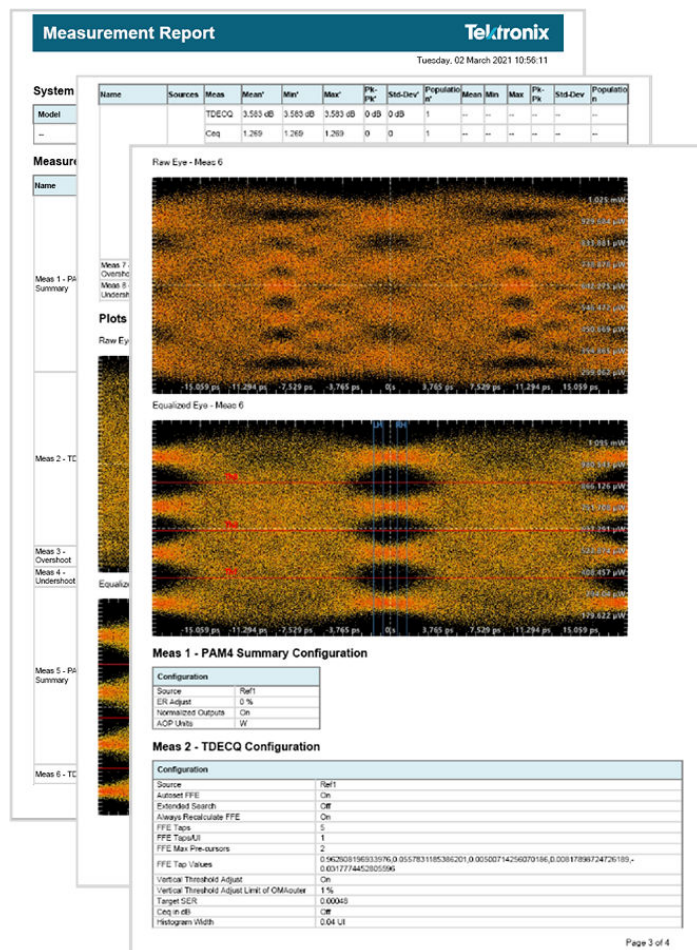
TSOVu supports several methods of sharing work critical data through the use of measurement reports and session files. Create detailed reports automatically in TSOVu and include information pulled from active analysis, plots, and system configuration. Reports can be set up to include complete system details and analysis, or summarized in a per channel brief. For an interactive look at historic data, session files (*.tss) enable full recall of waveform data, scope configuration, and measurements for further analysis. Measurement reports and session files are modern approaches to saving data and measurement results; however, waveform data can still be stored in other accessible formats, such as csv.

PC requirements

- Processor: AMD or Intel:
  - Minimum: AMD Ryzen 5 or Intel i5 with hyperthreading
  - Recommended: AMD Ryzen 7 or Intel i7 class processor or better.

    ⚠️ **Note:** The time to calculate measurements, including TDECQ is inversely proportional to the processor clock speed.

- Memory:
  - Minimum: 8 GB
  - Recommended: 16 GB or more when performing a four channel measurement
- Disk: 256 GB SSD
- OS: Windows 10/11, 64 bit
- Networking: 1 Gigabit Ethernet recommended

Specifications

TSO820 Mainframe Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Vertical system

Rise time / bandwidth	Determined by the sampling modules used
Vertical resolution (nominal)	15.6 bits over the sampling modules' dynamic range

Horizontal system

Main time base / horizontal scale	1 ps/div to 1 ms/div
Record length	> 80 M samples (PRBS23/PRBS23Q x 10 samples)

Trigger system

Trigger source	Clock Prescale Input (front panel)

Clock Prescale Input

Clock input sensitivity	200 mVp-p at 0.5 GHz to 32 GHz
Clock input range	200 mVp-p to 1.0 Vp-p (max); AC coupled
Pattern lengths supported (Pattern Sync)	Up to PRBS23 (8,388,607 symbols) inclusive up to maximum record length
Clock input jitter in clock-eye and clock-pattern trigger modes (max)	500 MHz to 2 GHz: < 1530 fs RMS (sinusoidal trigger waveform; typical square-wave performance similar to below values) 2 to 3 GHz: < 600 fsRMS 3 to 9 GHz: < 580 fsRMS 9 to 32 GHz: < 500 fsRMS

Acquisition system

Acquisition modes	Pattern Sync (sample and average), Sequential [Pattern Sync disabled] (sample and average)
Number of sampling modules accommodated	Two (2) modules
Number of simultaneously acquired inputs	Four (4) inputs
Maximum acquisition rate	300 kSa/s

Waveform measurements

System measurement rate	Supports up to 32 simultaneous measurement[2] with optional display of per-measurement statistics (min, max, mean and standard deviation)

Cursor modes	Vertical bar, horizontal bar, vertical and horizontal bar, and waveform cursors
Waveform processing	Bandwidth Enhancement/Impulse Response Correction (BWE), TDECQ equalized waveform
Histograms	Supports up to 30 histograms on multiple windows
Pulse measurements (standard)	High, Low, Amplitude, Max, Min, Mid, Mean, Peak-Peak, Period, Frequency, Rise, Fall, Positive Cross, Negative Cross, Positive Width, Negative Width, RMS Jitter, Pk-Pk Jitter, Delay
NRZ-Eye measurements (standard)	High, Low, Amplitude, Extinction Ratio, OMA, Signal-to-Noise Ratio, RMS, AC RMS, RMS Noise, Eye Height, VECP, TDEC, Crossing Level, Crossing Percentage, Crossing Time, Bit Time, Bit Rate, Eye Width, RMS Jitter, Pk-Pk Jitter, Rise TIme, Fall Time, DCD
PAM4 measurements (license required)	RLM, Level, Level Deviation, Level Thickness, OMAouter, Extinction Ratio, Effective Symbol Levels, Eye Width, Eye Height, Transition Time, Overshoot, Undershoot, TDECQ

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2   Lower limit which is applicable for complex measurements such as TDECQ

Input / output ports

Front Panel

Anti-static protection connector	Banana-jack connector, 1 MΩ
Clock Prescale Input	200 mVp-p to 1 Vp-p operational, AC coupled with maximum DC offset (-2.2 V to +2.2 V); 2 Vp-p absolute maximum

Rear Panel

Ethernet port	RJ45 connector; supports IEEE 802.3^{TM} Ethernet 100/1000BASE-T

Control

Control interface	

Device information	Instrument serial number, software version, other available using TSOVu

Physical

Height	132 mm (5.18 in.)

Width	217 mm (8.55 in.)

Depth	590 mm (23.22 in.)

Weight (with blank module)	5.4 kg (12.0 lbs.)

Environmental

Temperature

Operating	5 to 45 °C, above 1500 m de-rate 1 °C per 300 m; automatic shutdown for temperature > 55 °C ±5 °C ambient
Nonoperating	–20 to 60 °C

Altitude

Operating	3,000 m (9642 ft.); derate maximum operating temperature by 1 °C per 300 m above 1,500 m (4821 ft.)
Nonoperating	12,000 m (39,370 ft.)

Relative humidity

Operating	5 to 95% relative humidity at or below 30 °C; 5 to 45% above 30 °C to below 45 °C, non-condensing
Nonoperating	5 to 95% relative humidity at or below 30 °C; 5 to 45% above 30 °C to below 60 °C, non-condensing

TSO8C17 and TSO8C18 Specifications

All specifications are guaranteed unless noted otherwise. All specifications apply to all models unless noted otherwise.

Optical inputs

Optical channel count

TSO8C17	One (1) optical channel
TSO8C18	Two (2) optical channels

Wavelength range 750 to 1650 nm

Calibrated wavelength (±20 nm) 850 nm, 1310 nm, and 1550 nm

Unfiltered optical bandwidth

Multi-mode	30 GHz
Single mode	> 30 GHz

Fiber input[3] 50 m FC/PC

Optical return loss

Multi-mode	> 16 dB
Single mode	> 16 dB

Optical inputs

Acquisition delay adjustment range per channel ± 65 ps

Power meter range -38 to +6 dBm at 1310 nm

Power meter accuracy (typical) +/- [100 nW + (External Power Meter Reading) * [5% + 6% Uncertainty]

RMS optical noise (hardware; typical)

Bandwidth[4]	850 nm	1310 nm	1550 nm
12.6 GHz	4.2 W	2.8 W	3.0 W
13.28125 GHz	4.3 W	2.9 W	3.0 W
19.335 GHz	5.3 W	3.7 W	3.9 W
21 GHz	6.2 W	4.2 W	4.4 W
22.5 GHz	8.1 W	5.0 W	5.4 W

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[3] Modules with fiber inputs of 50 m can accommodate 9 m (single mode) fibers
[4] Electrical bandwidth is a 4th order Bessel-Thomson filter

RMS optical noise (hardware; maximum)	Bandwidth[4]	850 nm	1310 nm	1550 nm
	12.6 GHz	6.0 W	3.6 W	3.9 W
	13.28125 GHz	6.0 W	3.6 W	3.9 W
	19.335 GHz	7.5 W	4.5 W	4.8 W
	21 GHz	8.3 W	5.0 W	5.4 W
	22.5 GHz	11.1 W	6.7 W	6.9 W

Supported Optical Reference Receivers[4]	TSO8C17 and TSO8C18	Bandwidth electrical (GHz)	NRZ PAM2 standards	PAM4 standards
		8.96	-	26.5625 GBd MM
		11.2	-	26.5625 GBd MM
		12.6	25.78125 GBd MM	Available
		13.28125	Available	26.5625 GBd SM/MM
		19.335	25.78125 GBd SM/MM	Available
		21	32 GFC	Available
		22.5	Available	Available
		25.5625	-	53.125 GBd SM

Physical

Height

53 mm (2.1 in.)

Width

96 mm (3.76 in.)

Depth

236 mm (10.35 in.)

Weight

    TSO8C17   0.549 kg (1.21 lbs.)

    TSO8C18   0.660 kg (1.46 lbs.)

Environmental

Temperature

    Operating   5 to 45 °C, above 1,500 m derate 1°C per 300 m

    Nonoperating   -20 to 60 °C

Altitude

    Operating   3000 m (9642 ft.); derate maximum operating temperature by 1 °C per 300 m above 1,500 m (4821 ft.).

    Nonoperating   12,000 m (39,370 ft.)

Relative humidity

Operating	5% to 95% relative humidity at or below 30 °C,
Nonoperating	5% to 45% above 30 °C to below 45 °C, non-condensing
	5% to 95% relative humidity at or below 30 °C; 5% to 45% above 30°C to below 60 °C, non-condensing

Ordering information

TSO820 Mainframe

Models

TSO820	8 Series Tektronix Sampling Oscilloscope 2 Slot Mainframe

Standard accessories

Cable, Ethernet	2 m ethernet cable (CAT6/RJ45). Tektronix P/N 174-7292-00
50 Ω termination	50 Ω termination. Tektronix P/N 015-1022-01
Screw driver	T-10 screw driver. Tektronix P/N 003-1962-00
ESD Strap	6 ft coiled ESD strap. Tektronix P/N 006-3415-05

Power plug options

Opt. A0	North America Power Cord
Opt. A1	Universal EURO
Opt. A2	United Kingdom Power Cord
Opt. A3	Australia Power Cord
Opt. A4	240V North America
Opt. A5	Switzerland Power Cord
Opt. A6	Japan Power Cord
Opt. A10	China Power Cord
Opt. A11	India Power Cord
Opt. A12	Brazil Power Cord
Opt. A99	No Power Cord or AC Adapter

Language options

Opt. L0	English manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L9	Korean manual

Service options

Opt. G3	Three Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. G5	Five Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others

Opt. R3	Standard Warranty Extended to 3 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. R5	Standard Warranty Extended to 5 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. C3	Calibration service 3 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 2 years calibration coverage
Opt. C5	Calibration service 5 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 4 years calibration coverage.
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Option C3)
Opt. D5	Calibration Data Report 5 Years (with Option C5)

Recommended accessories

Clock recovery instruments	TCR801: 26 and 53 GBaud Optical Clock Recovery Unit.

Optical Modules

Optical modules plug directly into one of the two slots provided by the TSO820 sampling oscilloscope mainframe.

Models

TSO8C17	8 Series Optical Module: Single Channel, Single / Multi Mode, 30GHz optical bandwidth for 50G/100G/200G/400G
TSO8C18	8 Series Optical Module: Dual Channel, Single / Multi Mode, 30GHz optical bandwidth for 50G/100G/200G/400G

Standard accessories

Optical Fiber Cleaner	Optical connector cleaner; 2.5 m. Tektronix P/N 068-327-00

Language options

Opt. L0	English manual
Opt. L5	Japanese manual
Opt. L7	Simplified Chinese manual
Opt. L9	Korean manual

Service options

Opt. G3	Three Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others
Opt. G5	Five Year Gold Care Plan. Includes expedited repair of all product failures including ESD and EOS, access to a loaner product during repair or advanced exchange to reduce downtime, priority access to Customer Support among others

Opt. R3	Standard Warranty Extended to 3 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. R5	Standard Warranty Extended to 5 Years. Covers parts, labor and 2-day shipping within country. Guarantees faster repair time than without coverage. All repairs include calibration and updates. Hassle free - a single call starts the process
Opt. C3	Calibration service 3 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 2 years calibration coverage
Opt. C5	Calibration service 5 years. Includes traceable calibration or functional verification where applicable, for recommended calibrations. Coverage includes the initial calibration plus 4 years calibration coverage.
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 Years (with Option C3)
Opt. D5	Calibration Data Report 5 Years (with Option C5)

Recommended accessories

Accessories

167-4333-00	50%/50% Single Mode FC/PC Splitter.
167-4332-00	20%/80% Single Mode FC/PC Splitter.
119-8667-01	10%/90% Single Mode FC/PC Splitter.

Software

TSOVu is available for download.

Software licenses for TSOVu are available for purchase to extend the analysis capabilities of the base oscilloscope software. The Pulse Measurement Plug-in is available free with every TSOVu; other measurement plug-ins can be enabled for operation with purchase of a valid license.

Software licensing and activation information

Optional plug-ins for TSOVu require installation of a valid license before initial use. Each software enabled feature requires its own license, and licenses can be managed within the Tektronix Asset Management System (Tek AMS). Product license management requires a login account and can be accessed via the Tek AMS web site address.

There are four types of licenses available for plug-in applications which are explained below:

- **NLP**: Node-locked perpetual licenses enable oscilloscope features permanently, are assigned to the Host ID of an instrument or TSOVu software, and guarantee software updates for the first 12 months. Software updates after the first 12 months are available with 1-year renewal.
- **FLP**: Floating perpetual licenses enable oscilloscope features permanently, can be transferred between Host IDs (mainframe or software), and guarantee software updates for the first 12 months. Software updates after the first 12 months are available with 1-year renewal.
- **NL**: Node-locked subscription licenses enable oscilloscope features for a predefined time period, are assigned to the Host ID of an instrument or TSOVu software, and guarantee software updates for the duration of the license.
- **FL**: Floating subscription licenses enable oscilloscope features for a predefined time period, can be transferred between Host IDs (mainframe or software), and guarantee software updates for the duration of the license.

⚠ **Note:** Use the Tektronix Asset Management system to check in and check out floating licenses.

License

PAM4-O	PAM4 Optical Measurement Plug-in

Tektronix

License options (required)

TSO8SW-NLP	Node-Locked Perpetual License
TSO8SW-FLP	Floating Perpetual License
TSO8SW-NL1	Node-Locked 1-Year Subscription License
TSO8SW-NL3	Node-Locked 3-Year Subscription License
TSO8SW-FL1	Floating 1-Year Subscription License
TSO8SW-FL3	Floating 3-Year Subscription License

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