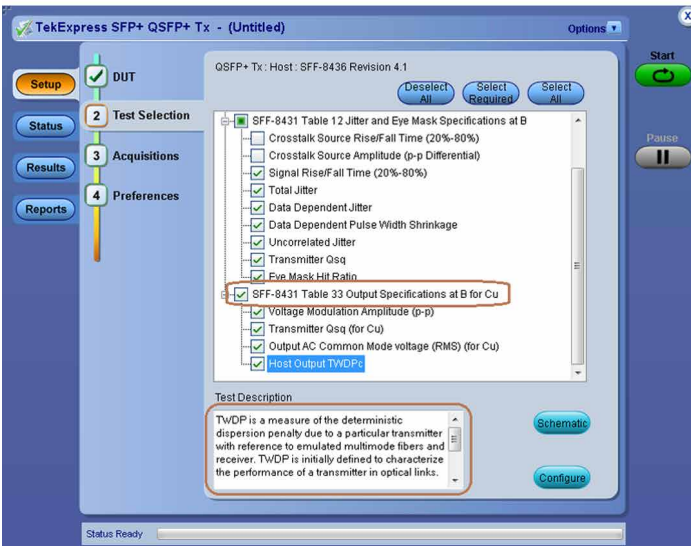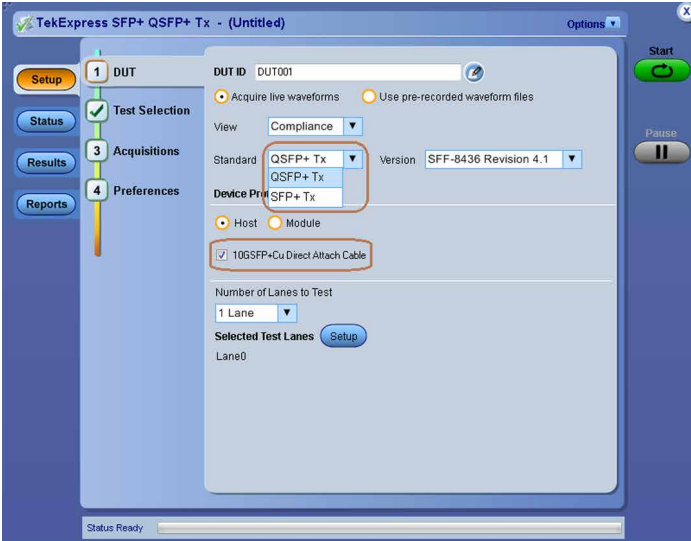# Tektronix®

Ethernet SFP+ QSFP+ Tx Compliance & Debug Solution
SFP–TX, SFP–WDP Datasheet

TekExpress SFP-TX user interface for PHY measurements including SFP+ Direct Attach Cable Specifications "10GSFP+CU and QSFP+ specification".

Features and benefits

- Tektronix SFP+ QSFP+ Tx Automated Compliance and Debug Solution (SFP-TX and SFP-WDP option) meets the compliance and debug needs of design and test engineers working on SFF-8431 & SFF-8635 Designs.

- Tektronix SFP+ QSFP+ Tx is developed on a real time oscilloscope platform, which is the platform of choice for engineers working on designing their products around SFF-8431 & SFF-8635 technology.

- Option SFP-TX and SFP-WDP enable both an automation solution (for compliance) and DPOJET Option (for debug). Users can save up to 80% on testing time as compared to manual testing.

- TWDPc – Transmitter Waveform Distortion Penalty for Copper measurements are available to customers with Option SFP-WDP. SFF-8431 SFP+ TWDPc based Matlab code has been integrated into the SFP-WDP option to make sure engineers can use this measurement in the automated setup.

- Design engineers can seamlessly move from compliance to debug environment and use world-class debug tool from Tektronix (such as, DPOJET).

- User-defined mode enables flexible parameter control for characterization and margin analysis.

- User defined mode supports PRBS7, PRBS11, PRBS15, PRBS20 & PRBS23 in addition to patterns supported in compliance mode including PRBS9, PRBS31 and 8180.

- Tektronix application supports multiple data rates including 9.95328 Gbps, 10.3125 Gbps, 10.51875 Gbps and 11.10 Gbps.

- Complete programmatic interface available; users can call SFP-TX functions using their automation scripts.

- SFP-TX Compliance solution performs automatic signal validation before performing tests and throws an error if the signal does not meet acceptable limits.

- Signal acquisition and analysis support available using cost-effective SMA cables.

- DPOJET setup files for N1N0, PRBS11 and PRBS31 patterns are provided with the SFP-TX which help set oscilloscope and load measurements in DPOJET. This helps reduce debug time and set the oscilloscope for debug environment.

- New intuitive user Interface and framework decreases testing time and learning curve for end users.

- Measurements are grouped on signal types best suited for the measurement, which reduces user intervention.

- End-users can receive e-mail notification on measurement results and stay connected with their test setup.

- Design engineers can use many built-in reporting features such as, appending the report, auto-incrementing the report, and including user comments to tailor their reporting requirements.

- Provides customers with a Tektronix floating license installation option.

- Detailed test reports with margin and statistical information aid analysis.

Applications

Ethernet SFP+/QSFP+ PHY transmitter and direct attach cable testing for:

- Device Silicon Validation
- Cable and Connector Validation
- System Compliance and Debug
- Manufacturing Test

TekExpress SFP-TX measurement setup

The SFP-TX solution helps customers to easily select measurements for SFF-8431 (SFP+ Tx) & SFF-8635 (QSFP+ Tx) testing. Simple and easy-to-use measurement setup helps customers perform all measurements with a single button click. Automation options help customers meet compliance needs and generate detailed reports. User-defined mode lets customers make changes to the test limits and perform margin testing beyond compliance.
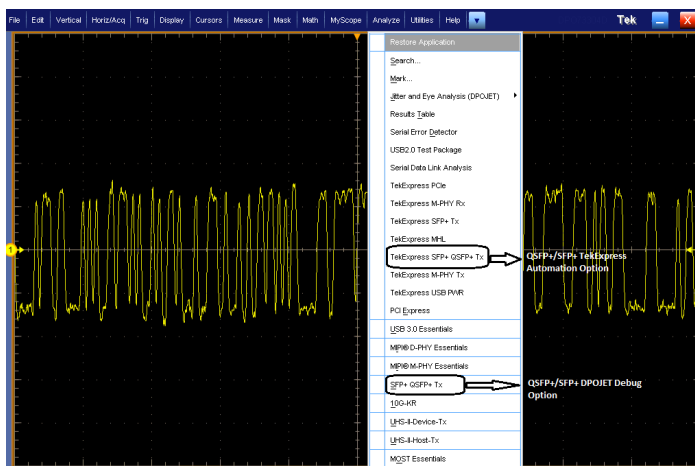
Option SFP-TX enables both an automation solution (for compliance) and DPO option (for debug)

DPOJet SFP-TX measurement setup

The SFP-TX solution helps customers to easily select measurements for SFF-8431 (SFP+ Tx) & SFF-8635 (QSFP+ Tx) testing. All masks, limits, and measurement parameters are automatically configured for the customer. Additionally, customers have the flexibility to change selected measurements and measurement configurations within DPOJET. SFP-TX DPOJET options provide a new standard-specific UI.


DPOJET SFP-TX user interface

Seven new additional measurements have been added including VMA, Rise Time, Tx-Qsq, DDPWS, Fall Time, UJ, and TWDPc which were not part of the original DPOJET package. Setup files are provided based on different signal types such as 8180, PRBS9, and PRBS31. Signal-specific setup files allow design engineers to perform measurements on different signal types, letting them go into Analysis and Debug mode.

Simplified instrument setup – Save time and resources

Setup and test execution is simple with the SFP-TX software. The oscilloscope acquisition and analysis are all controlled through the SFP-TX automation solution. The software's Graphical User Interface (GUI) provides an intuitive workflow for setup and testing.

Margin testing

Design characterization is supported beyond SFF-8431 (SFP+ Tx) & SFF-8635 (QSFP+ Tx) compliance requirements for all measurements. Qualify PHY with flexible control over test configurations such as analysis windows and other parameters. User-defined mode lets customers make changes to the test limits and perform marginal testing beyond compliance.
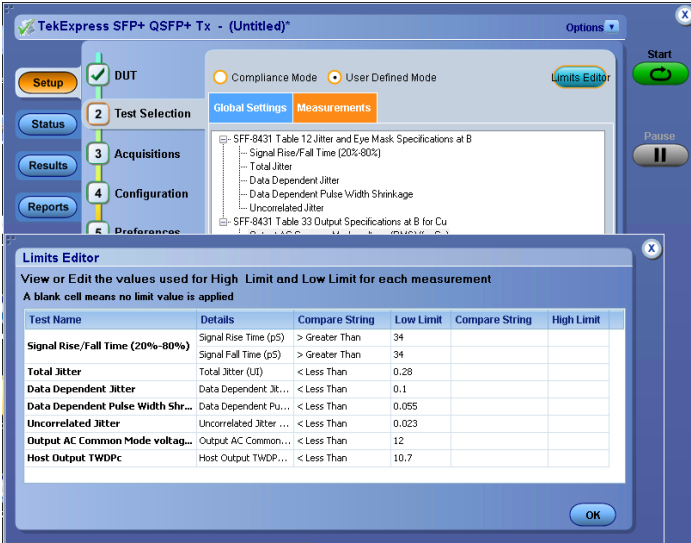
User-defined mode enables flexible parameter control for characterization and margin analysis

TWDPc – Transmitter Waveform Distortion Penalty for Copper

SFF-8431 SFP+ suggests that this measurement should be performed on SFP+ Host Transmitter Output Specifications at B for Cu.
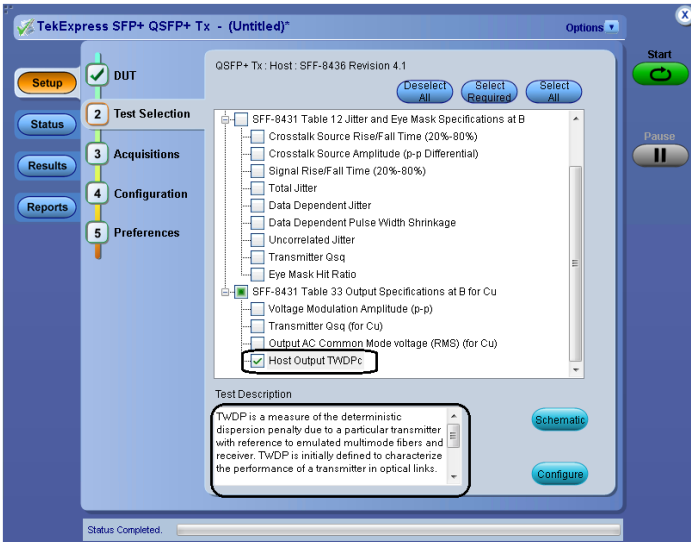

SFP-TX TWDPc measurement – TekExpress user interface

SFP-TX TWDPc measurement – DPOJET user interface.

Customers who plan to use TWDPc measurements need to purchase Option SFP-WDP. TWDPc is a measure of the deterministic dispersion penalty due to a particular transmitter with reference to the emulated multi-mode fibers and a well-characterized receiver. TWDPc is initially defined to characterize the performance of a transmitter in optical links. The same concept has been extended to quantify channel performance as well, especially in high-speed copper links. SFF-8431 Revision 4.1 Table 33 – Host Transmitter Output Specifications at point B for Cu.

For TWDPc compliance, a simulated cable response is required. The response is modeled as a set of delta functions with specific amplitudes and delays. The copper stressor was created from measurements of commonly available direct attach SFP+ cables with the transmitter response de-convolved. The stressor is shown in the following figure and the values are listed in Table 34 of the SFF-8431 SFP+ specification. The sum of all stressor components is normalized to an approximate value of 1.
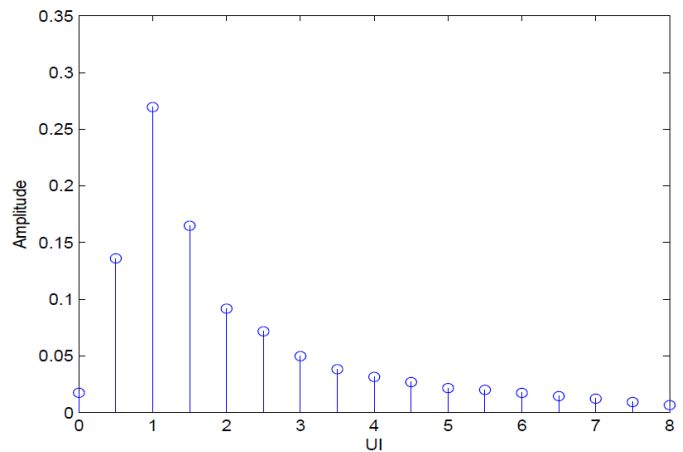

TWDPc stressor impulse response.

TWDPc measurements are supported only on C and D Series real-time oscilloscopes with a sampling rate of 100 GS/s and ≥16 GHz bandwidth due to the following:

- The TWDPc script (of 802.3aq, 10GBASE-LRM) processes a PRBS9 pattern requiring at least 16 samples per unit interval.

- Out of concern for the large installed base of sampling oscilloscopes with a record length of around 4000 samples the requirement for 16 samples per unit interval is relaxed to 7 samples per unit interval.

- The relaxation of the requirement for 16 samples per unit interval to just 7 samples per unit interval causes worst-case 0.24 dB TWDPc pessimism over 30 measurements. For DUTs that already have a high WDP, 0.24 dB can be the difference between a Pass or Fail result.

- With a DPO/DSA/MSO70000C/D/DX/SX Series oscilloscope, a 100 GS/s sampling rate is available. Around 10 samples per UI will be obtained from the hardware.

Tektronix recommends to only run TWDPc measurements on DPO/DSA/MSO70000C/D/DX/SX Series oscilloscopes.

SFP module measurements

SFP-TX supports 10 new measurements for the SFP+ module. These include AC Common Mode Voltage Tolerance, Single-ended Input Voltage Tolerance, Crosstalk Source Rise/Fall Time (20-80%), Crosstalk Source Amplitude (P-P Differential), Output AC Common Mode Voltage (RMS), Total Jitter, Data Dependent Jitter, Data Dependent Pulse Width Shrinkage, Uncorrelated Jitter, and Eye Mask Hit Ratio.
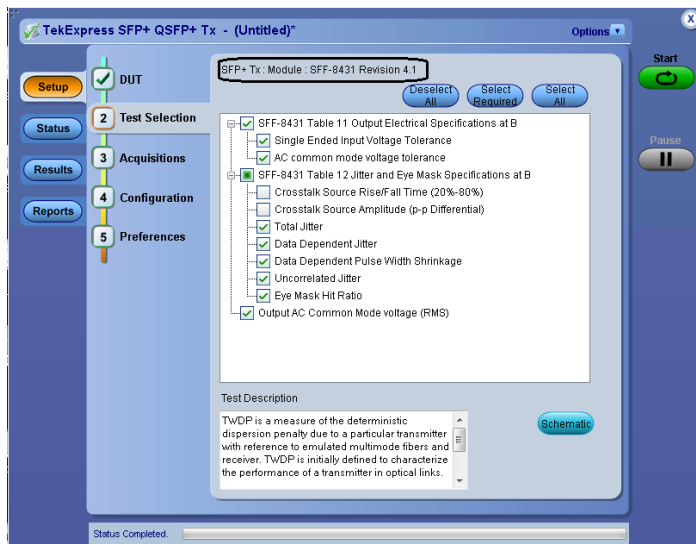

SFP-TX Module Measurements – user interface.

SFP total jitter measurements

SFP-TX allows users to enter BER value of in the range of BER e^–2 to –18, providing them the flexibility to calculate Total Jitter at various BER values.
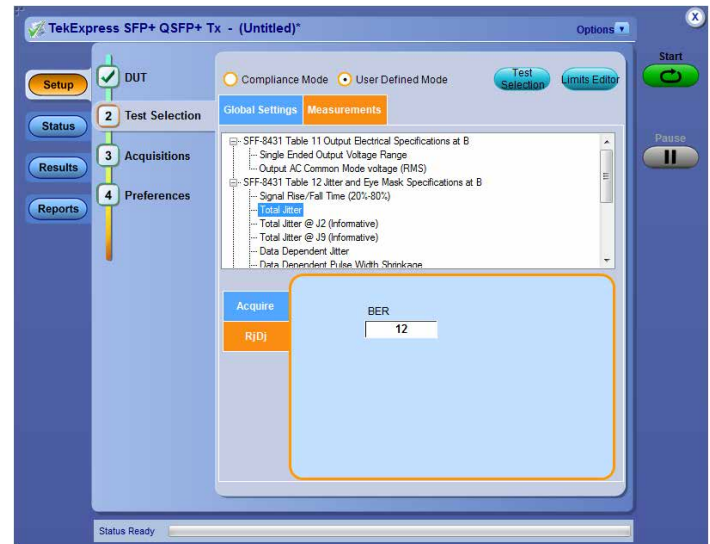
QSFP+ User Defined mode TJ@BERe^–12 (BER range from e^–2 to –18)

J2 and J9 (under QSFP+ dropdown menu) measurements have been added as informative measurements to SFP-TX, these measurements are part of other 10G standards like 40GBASE-CR4 and XLPPI.
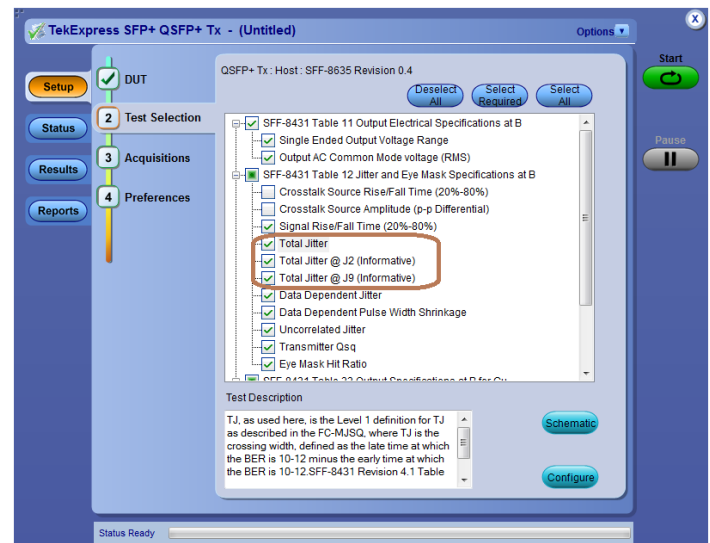
QSFP+ Total Jitter measurements – J2 and J9.

De-embedding feature

As data rates increase, high-speed serial technologies have introduced new test methodologies and requirements for compliance testing. As technologies such as SFP+ increase in data rates, the eye is closed and different components such as SMA cables can be de-embedded to

get better results. SFP-TX provides an option to de-embed the signal using .FLT files.

De-embedding feature in SFP-TX.

Report Configuration menu

The Report Configuration menu lets users configure reports, and it provides options such as auto increment and appending.

*Report Configuration menu*

One-button testing

Once the test bench is set up and the DUT is properly connected, press the Run button to perform the selected test suite. The SFP-TX solution prompts the end-user to put the DUT into different test modes by displaying messages at regular intervals.
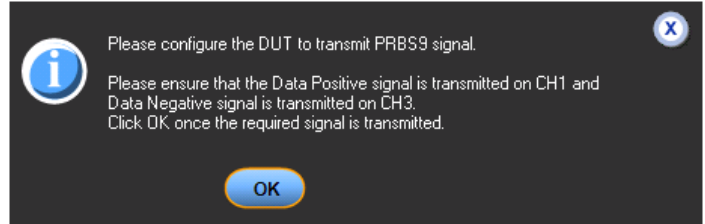
Pop-up messages allow users to configure the DUT to transmit a particular signal type.

Automation support

Save and recall setup files in automation script, with an option to automate the complete test bench. Tektronix end-users can call the SFP-TX application programmatically through NI LabVIEW, NI TestStand™, or any other scripting language for controlling SFP-TX along with other instrumentation such as thermal chambers and power supplies.
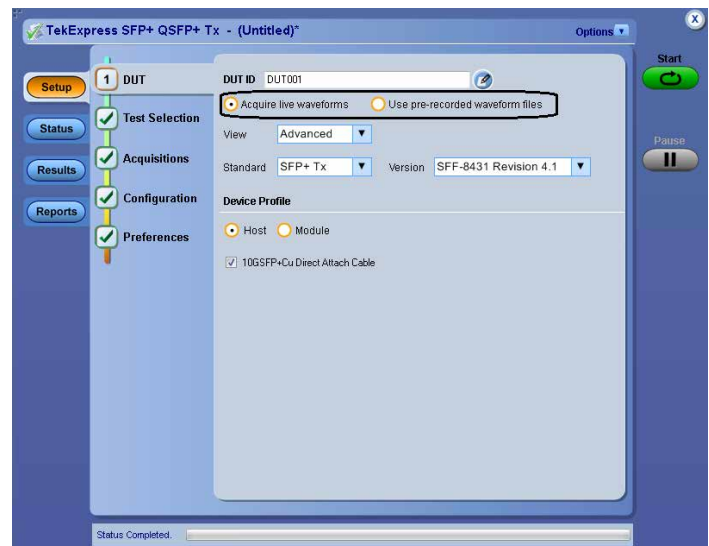
Automation support — use prerecorded waveforms

Multiple data rate support

Tektronix application supports multiple speeds. Many products available in market support multiple data rates including 9.95328Gbps, 10.3125 Gbps, 10.51875 Gbps and 11.10 Gbps.

Multiple data rate support
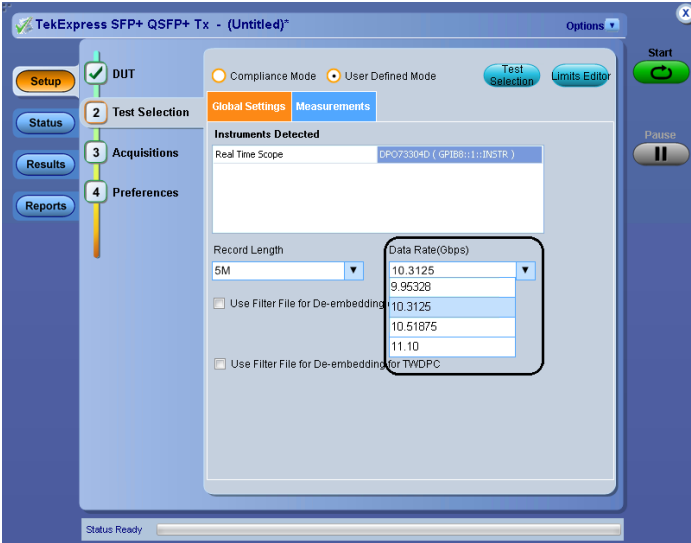
SFP-TX Pass/Fail report.

Multiple pattern support

Tektronix application supports multiple patterns in user defined mode. Various products available in market support patterns over and above what is specified in SFF-8431 and SFF-8635. User defined mode supports PRBS7, PRBS11, PRBS15,PRBS20 & PRBS23 in addition to patterns supported in Compliance mode including PRBS9, PRBS31 and 8180.
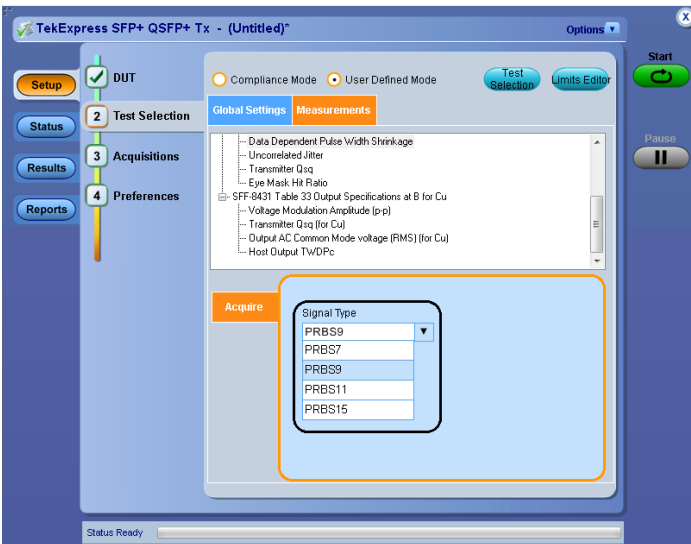
Multiple pattern support.

Pass/Fail report

A summary report in .MHT (MHTML) format with Pass/Fail status is automatically generated after tests complete. The report includes test configuration details, waveform plots, and margin analysis to provide more insight into your design.

Specifications

SFF–8431 (SFP+) & SFF–8635 (QSFP+) measurements covered in SFP-TX/SFP-WDP solution

Model overview

| SL No.	Measurements	Recommended signal type	Limit			
			Min.	Target	Max	Units
Host transmitter output electrical specifications						
1	Single-ended Output Voltage Range	PRBS31	–0.3		4	V
2	Output AC Common Mode Voltage (RMS)	PRBS31			15	mV (RMS)
Host transmitter jitter and eye mask specifications						
3	Crosstalk Source Rise/Fall Time (20%-80%) (Tr, Tf)	8180		34		ps
4	Crosstalk Source Amplitude (p-p differential)	8180		1000		mV
5	Signal Rise/Fall Time (20%-80%) (Tr, Tf)	8180	34			ps
6	Total Jitter (p-p) (Tj)	PRBS31			0.28	UI (p-p)
7	Data Dependent Jitter (p-p) (DDJ)	PRBS9			0.1	UI (p-p)
8	Data Dependent Pulse Width Shrinkage (p-p) (DDPWS)	PRBS9			0.055	UI (p-p)
9	Uncorrelated Jitter (RMS) (UJ)	PRBS9			0.023	UI (p-p)
10	Transmitter Qsq	8180	50			
11	Eye Mask Hit Ratio (Mask hit ratio of 5×10^{-5})	PRBS31	X1 = 0.12 UI, X2 = 0.33 UI, Y1 = 95 mV, Y2 = 350 mV			
Host Transmitter Output Specifications for Cu (SFP+ host supporting direct-attach cables)						
12	Voltage Modulation Amplitude (p-p)	8180	300			mV
13	Transmitter Qsq Output AC Common Mode Voltage	8180	63.1			
14	Output AC Common Mode Voltage	PRBS31			12	mV (RMS)
15	Host Output TWDPc	PRBS9			10.7	dBe

Ordering information

SFP-TX SFP-WDP

SFF-8431 (SFP+ Tx) & SFF-8635 (QSFP+ Tx) compliance and debug solution.
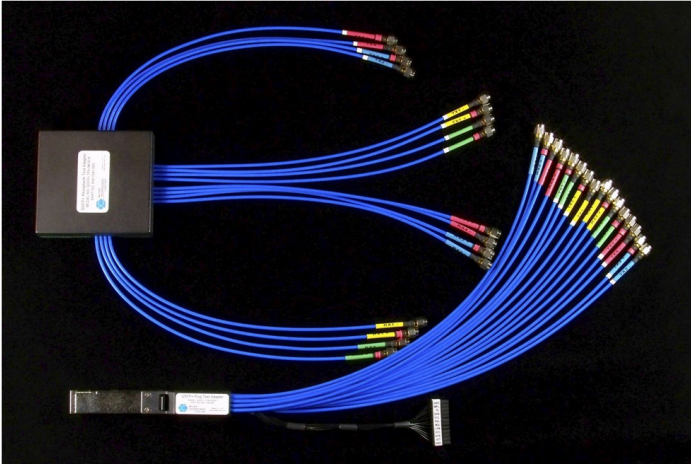
QSFP+ HCB and MCB
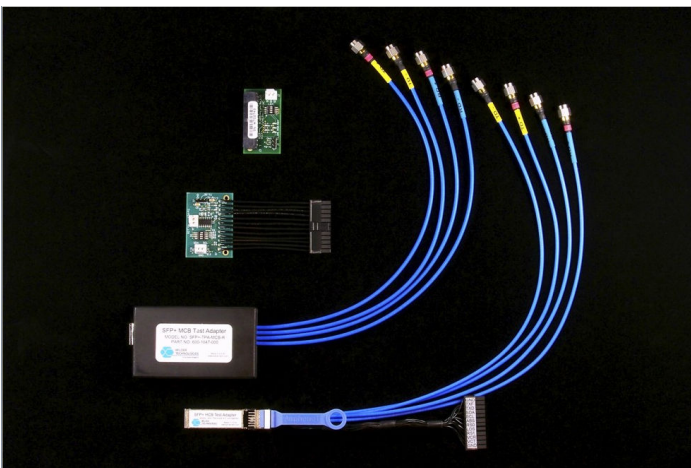
SFP+ HCB and MCB

To order along with oscilloscope

Oscilloscope	Option
SFP-TX	
DPO/DSA/MSO70000C/D/DX/SX	Order SFP-TX
SFP-WDP	
DPO/DSA/MSO70000C/D/DX/SX	Order SFP-WDP

To upgrade an existing oscilloscope

Oscilloscope	Option
SFP-TX	
Table continued…	

Oscilloscope	Option
DPO/DSA/MSO70000C/D/DX/SX	Order DPO-UP SFP-TX
DPO/DSA/MSO70000C/D/DX/SX	Order DPOFL-SFP-TX (Floating License)
DPO/DSA/MSO70000C/D/DX/SX	Order DPOFT-SFP-TX (Floating Trial)
SFP-WDP	
DPO/DSA/MSO70000C/D/DX/SX	Order DPO-UP SFP-WDP
DPO/DSA/MSO70000C/D/DX/SX	Order DPOFL-SFP-WDP (Floating License)
DPO/DSA/MSO70000C/D/DX/SX	Order DPOFT-SFP-WDP (Floating Trial)

Recommended equipment

Oscilloscope	Required software	Required accessories	Test fixture
DPO/DSA/ MSO71604C	SFP-TX, DJA [1] SFP-WDP [2] [3]	Matched-pair SMA Cables (TCA-SMA connector)	TF-SFP-TPA-HCB-PK – Host Compliance Board OR TF-QSFP-TPA-HCB-P QSFP+ Host Compliance Board Plug
DPO/DSA/ MSO72004C			
DPO/DSA72504D			
DPO/DSA73304D			

Recommended oscilloscopes for SFF-8431 (SFP+ Tx) & SFF-8635 (QSFP+ Tx) PHY testing

DPO/DSA/MSO71604C

DPO/DSA/MSO72004C

DPO/DSA72504D

DPO/DSA73304D

Tektronix is ISO 14001:2015 and ISO 9001:2015 certified by DEKRA.

Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

Bluetooth is a registered trademark of Bluetooth SIG, Inc.

LTE is a trademark of ETSI.

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[1] Prerequisite for SFP-TX.

[2] SFP-TX is a prerequisite for SFP-WDP.

[3] Option SFP-WDP is only available on C and D Series Tektronix oscilloscopes with 100 GS/s sampling rate and ≥16 GHz bandwidth.

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit *www.tek.com*.

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