Tektronix[®]

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

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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 costeffective 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. Userdefined 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)

DP0Jet 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 standardspecific 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.

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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

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Select Configure Results Plots Reports	Period/ Freq Jitter Time Eye Ampl Standard	Standard Test Point VMA F ODPWS (ODPWS (SFP+ QSF SFP+ QSF Var Var Fall-Time	P+ Tx T P+ Tx PRBS	Setur IWDPc		Clear Se Clear	All	Measuremen TWDPc1	Source(s)		tecalc

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 \geq 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.

Setup DUT Compliance Mode User Defined Mode Test Units Editor Status 2 Test Selection Global Settings Measurements 3 Acquisitions - SFF-8431 Table 11 Output Electrical Specifications at 8 - SFF-8431 Table 11 Output Electrical Specifications at 8 - SFF-8431 Table 11 Output Electrical Specifications at 8 - SFF-8431 Table 11 Output Electrical Specifications at 8 - SFF-8431 Table 11 Output Electrical Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Specifications at 8 - SFF-8431 Table 12 Atter and Spe Mask Table 12 Atter and	Options •	TekExpress SFP+ QSFP+ T
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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.

TekExpress SFP+ QSFP+ T	x - (Untitled)*	Options
Setup JUT	Compliance Mode User Defined Mode Global Settings Measurements	Limits Editor
Results Acquisitions	Instruments Detected Real Time Scope DP073304D (GP1B8::11:INSTR)	Pause
Reports 4 Configuration		
5 Preferences	Data Rate(Gbps) SM I Use Filter File for De-embedding (All Test except TWDPC) Use Filter File for De-embedding for TWDPC	
Status Completed.		

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 Generation	
• Generate new report	
O Append with previous run session	
O Replace current test results in previous run session	
Report name X:\SFP+ QSFP+ Tx\Reports\DUT001.r	
Save as type Web Archive (*.mht;*.mhtml)	
Auto increment report name if duplicate	
Contents To Save Contents To Save Control of the summary Control of the sum	
View report after generating View	enerate Save As

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.

1 DUT	DUT ID DUT001	
Tost Salastian	Acquire live waveforms O Use pre-recorded waveform files	
atus	View Advanced T	P
suits	Standard SFP+Tx Version SFF-8431 Revision 4.1 V	
Configuration	Device Profile	
Preferences	💿 Host 🔘 Module	
	✓ 10GSFP+Cu Direct Attach Cable	

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.

ional Type :8180

TekExpress SFP+ QSFP+ T	- (Untitled)*	Options 💌	
Setup DUT	Compliance Mode OUser Defined Mode	Limits Editor	Start
2 Test Selection	Global Settings Measurements		
Results 3 Acquisitions	Instruments Detected Real Time Scope DP073304D (GPIB8::1::INSTR.)		Pause
Reports 4 Preferences	Record Length SM Use Filter File for De-embedding for TWDPC Use Filter File for De-embedding for TWDPC		

Tekt	ronix.	TekExpress QSFP	+					
		Host Test Report						
Setup Inform	ation							
DUT ID : DU	T001		TekExpress Ve	ersion S	FP+/QSFP+	3.0.0.79		
Spec Versio	on : SFF-8635	Revision 0.4	Scope Model	MSO7	1604C			
Date/Time :	2013-06-12 1	8:07:47.083000	FW Version :	5.7.4 Bu	ild 3			
Compliance	Mode : True		DPOJet Versio	on : "6.0	.1 Build 8"			
Overall Exe	cution Time	: 0:01:40	Scope Serial	Scope Serial Number : B130223				
Overall Tes	t Result : Pas	5	Calibration St	atus : P	ASS			
DUT Comme	ent :General C	Comment - QSFP + Transmitter Ho	st DUT					
Test Name:S	Summary Table	e Overall Result						
Signal Rise/F	Fall Time (20%	-80%) Pass						
Uncorrelated	Jitter	Pass						
Signal F	Rise/Fall Tim	ne (20%-80%)						
Lane Name	Measureme	nt Details	Measured Value	Units	Test Result	Margin	Low Limit	High L
Lane0	Signal Rise/	Fall Time (20%-80%) RiseTime	52.7845	ps	Pass	18.7845	34.0	N.A
Lane0 Signal Rise/Fall Time (20%-80%) FallTime 41			47.1486	ps	Pass	13.1486	34.0	N.A

Back To Summary Table

_Uncorrelated Jitter									
Lane Name	Measurement Details	Measured Value	Units	Test Result	Margin	Low Limit	High Limit	Comments	
Lane0	Uncorrelated Jitter	0.004	UI	Pass	0.019	N.A	0.023	Signal Type :PRBS9	

SFP-TX Pass/Fail report.

Multiple data rate support

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		Li	imit		
		type	Min.	Target	Max	Units	
Host trar	nsmitter output electrical sp	ecifications					
1	Single-ended Output Voltage Range	PRBS31	-0.3		4	V	
2	Output AC Common Mode Voltage (RMS)	PRBS31			15	mV (RMS)	
Host trar	nsmitter jitter and eye mask	specifications		1			
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 Tra	nsmitter Output Specification	ons for Cu (SFP+ host supp	orting direct-attach cab	oles)			
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	Matched-pair SMA Cables (TCA-	TF-SFP-TPA-HCB-PK – Host
DPO/DSA/ MSO72004C		SMA connector)	Compliance Board OR TF-
DPO/DSA72504D			Compliance Board Plug
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®



Bluetooth is a registered trademark of Bluetooth SIG, Inc.

LTE is a trademark of ETSI.

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.

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