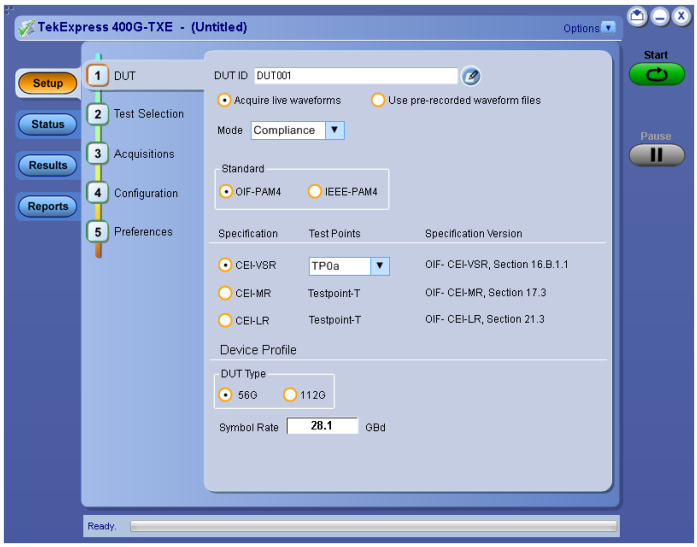
Tektronix®

TekExpress 400G-TXE

Conformance and Characterization Solution for Real Time Oscilloscopes



The new Tektronix real-time instrument based OIF-CEI-56G-VSR/MR/LR, OIF-CEI-112G-VSR, and IEEE: 802.3bs (200GAUI-4 and 400GAUI-8), 802.3cd (CR4, KR4) Transmitter Characterization automation system provides turnkey testing and debug of the industries most common 400G PAM4 electrical interfaces. The silicon designers need to perform the 400G based electrical validation of their silicon; the system designers need to perform the 400G based electrical validation. These tools are brought together in a single 400G-TXE package.

Key Features

- 400G-TXE offers streamlined and fully automated transmitter characterization of OIF-CEI-56G-VSR/MR/LR, OIF-CEI-112G-VSR, and IEEE: 802.3bs (200GAUI-4 and 400GAUI-8), 802.3cd (CR4, KR4) electrical transmitter specifications.
- Extends PAM4 software package for in-depth analysis and debug of fully automated conformance test solution.

Applications

- Validation of OIF-CEI-56G-VSR/MR/LR, OIF-CEI-112G-VSR, and IEEE-802.3bs/cd standards
- Measurements of electrical transmitter

OIF-CEI-56G-VSR/MR/LR, OIF-CEI-112G-VSR, and IEEE-802.3bs/cd fully automated electrical transmitter real-time oscilloscope measurements

This application package is designed in conjunction with the performance levels offered by a 50 GHz, 70KSX instrument pair. The 400G-TXE loads the required Bessel Thomson roll-off filter with appropriate bandwidth. This is common across all 400G electrical specifications in the industry today. The unique lower noise level of the ATI architecture serves the key signal-to-noise and distortion ratio measurements, which are attained with margin on the 70KSX systems. The 400G-TXE solution is also available on a non-70KSX systems, such as 33 GHz, higher 70KDX, and MSO instruments with an understanding that these are for debug only and not for the specification level conformance validation.

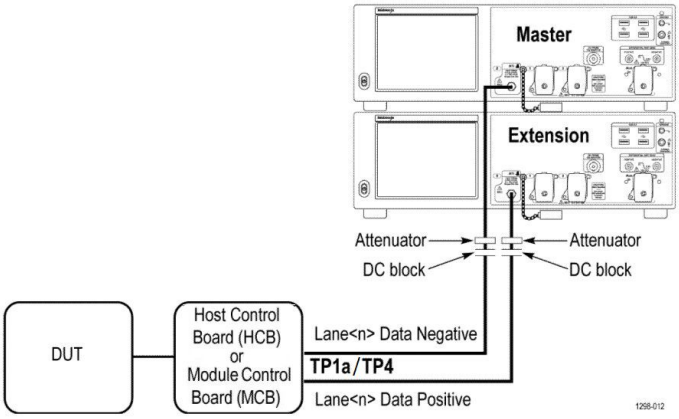
Technology	Specification Section and Table reference
OIF-CEI-56G-VSR	oif2017.346.03, Sections 16.B, Table 16-10
	oif2017.346.03, Sections 16.3.2, Table 16-1
	oif2017.346.03, Sections 16.3.3, Table 16-4
OIF-CEI-56G-MR	oif2014.245.12, section 17.3, Table 17-2, 17-3
OIF-CEI-56G-LR	oif2014.340.08, section 21.3, Table 21-2, 21-3
OIF-CEI-112G-VSR	oif2017.346.03, Table 23-9, Section 23.B.1.1
	oif2017.346.03, Table 23-1, Section 23.3.2
	oif2017.346.03, Table 23-4, Section 23.3
200GAUI-4 and 400GAUI-8	IEEE 802.3bs, Draft 3.5, Annex 120D. 3.1, Table 120D-1
	IEEE 802.3bs, Draft 3.5, Annex 120D. 3.1, Table 120E-1
	IEEE 802.3bs, Draft 3.5, Annex 120E. 3.2, Table 120E-3
50GBASE-CR/100GBASE-CR2/200GBASE-CR4	IEEE802.3cd Draft 3.5 Section 136.9.3, Table 136-11
50GBASE-KR/100GBASE-KR2/200GBASE-KR4	IEEE802.3cd Draft 3.5 Section 137.9.2

Modulation	Data Rate (GBd)	Lanes	Throughput (Gbps)
PAM4	18 to 29	1 to N	Number of lanes*2*Data Rate

OIF-CEI-56G/112G-VSR fully automated electrical transmitter measurements

Mapping of OIF-CEI-56G/112G-VSR measurements

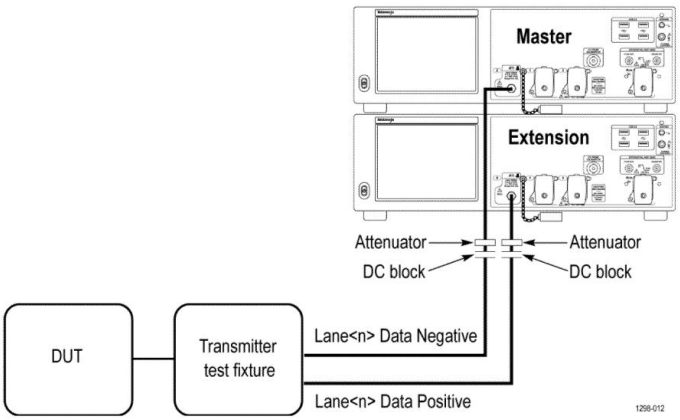
Parameter	Min	Max	Units
DC Common Mode Output Voltage			
TP0a	-0.3	2.8	V
TP1a	-0.3	2.8	V
TP4	-350	2850	mV
Common Mode Noise			
TP0a	-	12	mV
TP1a	-	17.5	mV
TP4	-	17.5	mV
Diff Peak to Peak Output Voltage Tx Enabled			
TP0a	750	-	mV
TP1a	-	880	mV
TP4	-	900	mV
Transition Time			
TP0a	7.5	-	ps
TP1a	12.0	-	ps
TP4	9.5	-	ps
Eye Width (TP1a)	0.2	-	UI
Eye Height (TP1a)	32	-	mV
Eye Linearity (TP1a)	0.85 (56G)	-	-
	0.9 (112G)		
Eye Symmetry Mask Width (TP1a)	0.2	-	UI
Near End Eye Width (TP4)	0.265 (56G)	-	UI
	0.2 (112G)		
Near End Eye Height (TP4)	70 (56G)	-	mV
	37 (112G)		
Near End Eye Linearity (TP4)	0.85 (56G)	-	-
	0.9 (112G)		
Near End Eye Symmetry Mask Width (TP4)	0.265	-	UI
Far End Eye Width (TP4)	0.2	-	UI
Far End Eye Height (TP4)	30	-	mV
Far End Eye Symmetry Mask Width (TP4)	0.2	-	UI
Signal to Noise And Distortion Ratio (TP0a)	31	-	dB
Even Odd Jitter (TP0a)	-	0.019	UI
Uncorrelated Bounded High Probability Jitter (TP0a)	-	0.05	UI_{RMS}
Uncorrelated Unbounded Gaussian Jitter (TP0a)	-	0.01	UI



OIF-CEI-56G-MR and OIF-CEI-56G-LR fully automated electrical transmitter measurements

Mapping of OIF-CEI-56G-MR and OIF-CEI-56G-LR measurements

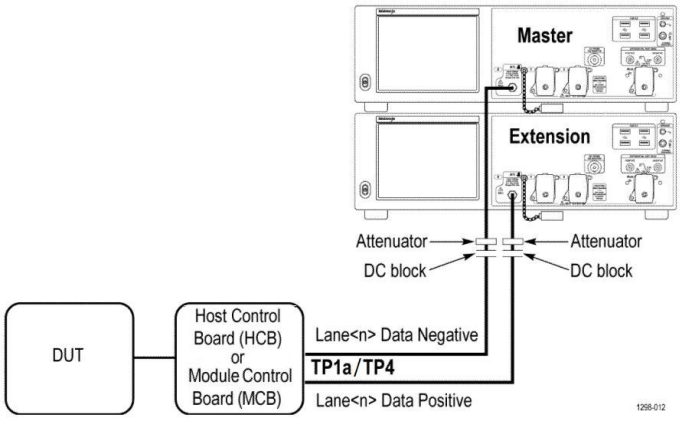
Parameter	Min	Max	Units
DC Common Mode Output Voltage	0	1.9	V
AC Common Mode Output Voltage	-	30	mVrms
Diff Peak to Peak Output Voltage Tx Enabled	-	1200	mVppd
Single Ended Output Voltage	-0.3	1.9	V
Level Separation Mismatch Ratio	0.95	-	%
Steady State Voltage	0.4	0.6	V
Linear Fit Pulse Peak	0.80 * T_V_f	-	V
Signal to Noise And Distortion Ratio	31	-	dB
Uncorrelated Bounded High Probability Jitter	-	0.118	UIpp
Uncorrelated Unbounded Gaussian Jitter	-	0.023	UIrms
Even Odd Jitter	-	0.019	UIpp



IEEE (200GAUI-4 and 400GAUI-8) fully automated electrical transmitter measurements

Mapping of IEEE (200GAUI-4 and 400GAUI-8) measurements

Parameter	Min	Max	Units
DC Common Mode Output Voltage			
TP0a	0	1.9	V
TP1a	-0.3	2.8	V
TP4	-350	2850	mV
AC Common Mode Output Voltage			
TP0a	-	30	mV
TP1a	-	17.5	mV
TP4	-	17.5	mV
Diff Peak to Peak Output Voltage Tx Enabled			
TP0a	-	1200	mV
TP1a	-	880	mV
TP4	-	900	mV
Diff Peak to Peak Output Voltage Tx Disabled			
TP0a	-	30	mV
TP1a	-	35	mV
Transition Time			
TP1a	10	-	ps
TP4	9.5	-	ps
Eye Height (TP1a)	32	-	mV
Eye Symmetry Mask Width (TP1a)	0.22	-	UI
Near End Eye Height (TP4)	70	-	mV
Near End Eye Symmetry Mask Width (TP4)	0.265	-	UI
Far End Eye Height (TP4)	30	-	mV
Far End Eye Symmetry Mask Width (TP4)	0.2	-	UI
Far End pre-cursor ISI ratio (TP4)	-4.5	2.5	%
Signal to Noise And Distortion Ratio (TP0a)	31.5	-	dB
Level separation mismatch ratio RLM	0.95		
Steady state voltage vf	0.4	0.6	V
Linear fit pulse peak	0.76*vf	-	VV
Post-cursor equalization			
Pre-cursor equalization			
Even Odd Jitter (TP0a)	-	0.019	UI
Uncorrelated Bounded High Probability Jitter (TP0a)	-	0.05	UI_{RMS}
Uncorrelated Unbounded Gaussian Jitter (TP0a)	-	0.01	UI

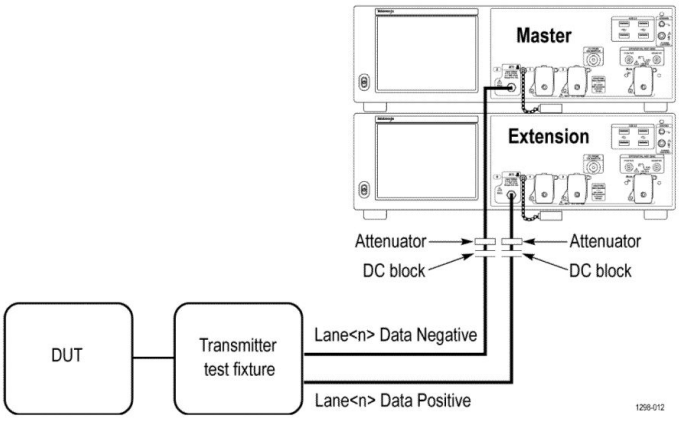


IEEE KR4 fully automated electrical transmitter measurements

Mapping of IEEE KR4 measurements

Parameter	Min	Max	Units
Signaling Rate	26.5625-100 ppm	26.5625+100ppm	GBd
Diff Peak to Peak Output Voltage Tx Disabled	-	30	mV
Diff Peak to Peak Output Voltage Tx Enabled	-	1200	mV
DC Common Mode Output Voltage	-	1.9	V
AC Common Mode RMS Output Voltage	-	30	mV
Transmitter steady-state voltage, vf	0.4	0.6	V
Linear Fit Pulse Peak	0.75*Vf	-	V
Level Separation Mismatch Ratio RLM	0.95	-	-
Signal to Noise And Distortion Ratio	32.5	-	dB
Transmitter output waveform			

Parameter	Min	Max	Units
abs step size for c(–1), c(0), and c(1)	0.005	0.05	-
abs step size for c(–2)	0.005	0.025	-
value at minimum state for c(–1) and c(1)	-	-0.25	-
value at maximum state for c(–2)	0.1	-	-
Output Jitter			
JRMS	-	0.023	UI
J3u	-	0.106	UI
Even Odd Jitter	-	0.019	UI

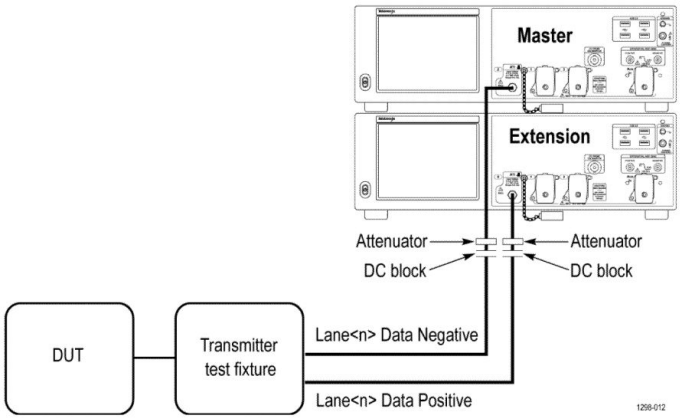


IEEE CR4 fully automated electrical transmitter measurements

Mapping of IEEE CR4 measurements

Parameter	Min	Max	Units
Signaling Rate	26.5625-100 ppm	26.5625+100ppm	GBd
Diff Peak to Peak Output Voltage Tx Disabled	-	30	mV
Diff Peak to Peak Output Voltage Tx Enabled	-	1200	mV
DC Common Mode Output Voltage	-	1.9	V
AC Common Mode RMS Output Voltage	-	30	mV
Transmitter steady-state voltage, vf	0.354	0.6	V
Linear Fit Pulse Peak	0.49*Vf	-	V
Level Separation Mismatch Ratio RLM	0.95	-	-
Signal to Noise And Distortion Ratio	32.2	-	dB
Transmitter output waveform			
abs step size for c(–1), c(0), and c(1)	0.005	0.05	-
abs step size for c(–2)	0.005	0.025	-
value at minimum state for c(–1) and c(1)	-	-0.25	-

Parameter	Min	Max	Units
value at maximum state for c(–2)	0.1	-	-
Output Jitter			
Even Odd Jitter	-	0.019	UI
JRMS	-	0.023	UI
J3u	-	0.115	UI



Electrical system interconnect setup

Direct electrical connections via a precision fixture or 2.92 mm interconnects are the preferred method to access the backplane and cabled signals. The QSFP28 module interconnect point found on the 400G-TXE design is the most typical signal access point.

QSFPDD-TPAK-HCB-TX-P P/N: **640-0890-075**

Qty. 1 - QSFPDD, HCB Plug
- TX Test Adapter
- 16 - High Performance Phase Aligned 2.92 6" Adapter Coaxial Cables with Female SMAs

QSFPDD-TPAHK-MCB-R P/N: **640-0892-000**

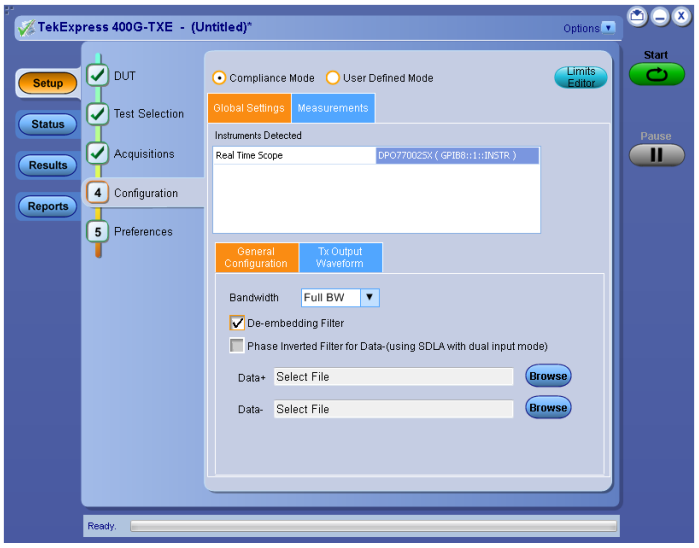
Qty. 1 - QSFPDD, MCB Receptable, w-Pwr Sinking
- 32 - High Performance Phase Aligned 2.92 6" Adapter Coaxial Cables with Female SMAs

Refer to the Wilder Technologies www.wilder-tech.com for details regarding the various methods of signal break-out.

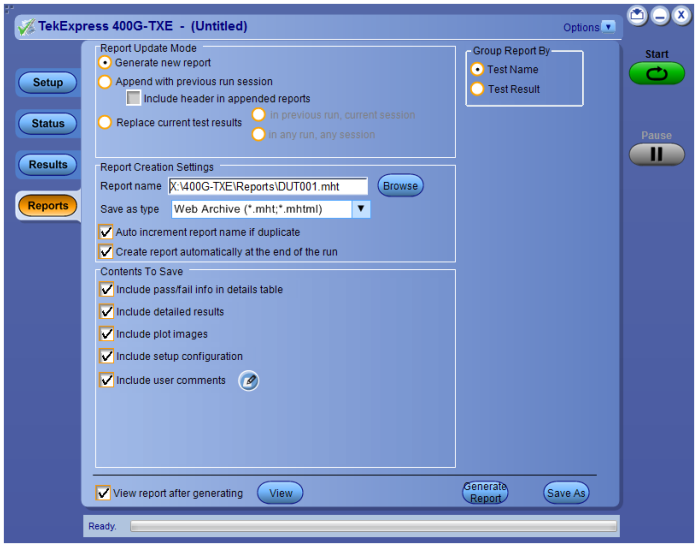
User-defined mode

In user-defined mode, users can configure Global parameters, test specific parameters, measurement repeat parameters, and notification parameters. This supports characterization of measurements rather than developing custom lab setups, reducing the testing time and complexity.

De-embedding filters help in compensating for any loss that happens due to cables/accessories present between specification mentioned test point to analog channel of oscilloscope. SDLA can be used for creating de-embedding filter files.



Reports and measurements results



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TekExpress 400G-TXE

Test Report OIF-PAM4 CEI-VSR (TP1a)

Setup Information			
DUT ID	DUT001	Master Scope Information	DPO77002SX, B300140
Date/Time	2018-04-21 11:21:32	Master Scope F/W Version	10.8.0 Build 37
TekExpress 400G-TXE Version	10.0.1.112	Master Scope SPC Status	PASS
TekExpress Framework Version	4.4.0.36	Extension-1 Scope Information	DPO77002SX, B300159
Specification Version	OIF- CEI-VSR, Section 16.3.2	Extension-1 Scope F/W Version	10.8.0 Build 37
Compliance Mode	True	Extension-1 Scope SPC Status	PASS
Execution Mode	Live	Bandwidth	Full BW
Data Rate	28.1Gbd	PAM4 version	10.5.0.8
Overall Test Result	Pass	DPOJet Version	10.0.7.9
Overall Execution Time	0:18:54	Pattern Length	8191
DUT COMMENT:	400G-TXE CEI-VSR (TP1a)		

Test Name Summary Table	
DC Common Mode Output Voltage	Pass
Diff Peak to Peak Output Voltage Tx Enabled	Pass
AC Common Mode Output Voltage	Pass
Transition Time	Pass
Eye Width	Pass
Eye Height	Pass
Eye Linearity	Pass
Eye Symmetry Mask Width	Pass

DC Common Mode Output Voltage

Measurement Details	Iteration	Measured Value	Test Result	Margin	Low Limit	High Limit	Units	Comments
DC Common Mode Output Voltage_56G	1	1.0000	Pass	L:1.3000 H:1.8000	-0.3	2.8	V	N.A
COMMENTS	DC Common Mode Output Voltage is measured using multimeter							

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Ordering information

Models

400G-TXE permanent node locked license ordered with a DPS70000SX or DPO70000SX Series Real Time Oscilloscope	DPO73304SX, DPS73308SX, DPO75002SX, DPS75004SX, DPO77002SX, DPS77004SX, DPO75902SX, DPS75904SX Option 400G-TXE
400G-TXE permanent node locked license ordered with a DPO73304DX or MSO73304DX Real Time Oscilloscope	DPO73304DX, MSO73304DX Option 400G-TXE
400G-TXE Floating License for use on any Real Time Oscilloscope listed above	DPOFL-400G-TXE
400G-TXE Free 30 Day Trial License for use on any Real Time Oscilloscope listed above	DPOFT-400G-TXE

Prerequisites

The following oscilloscope optional software is required:

PAM4 license	Electrical Transmitter Analysis (version 10.5 or greater)
DJA license	Jitter and Eye Analysis Tools - Advanced (DPOJET)
DJAN license	DPOJET Noise, Jitter and Eye Analysis Tools
SDLA64 license	Serial Data Link Analysis

Tektronix Asset Management System (AMS)

Optional software requires the purchase of a license before they are functional. Some software may require additional software licenses. Licenses are managed within the Tektronix Asset Management System (Tek AMS). The Tek AMS web site address is www.tektronix.com/products/product-license. Product license management requires a login account.

- Node Locked Licenses provide your own copy of the application on your instrument or personal computer and are permanently assigned to a specific Hosti ID or product model/serial number.
- Floating licenses can be moved between different Host IDs or product models.

Use the Tektronix Asset Management system to check in and check out floating licenses.

Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.

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

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* European toll-free number. If not accessible, call: +41 52 675 3777

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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