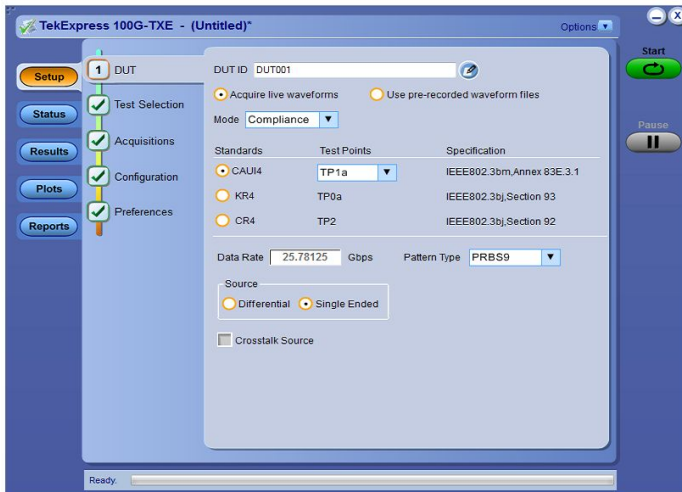


100GBASE-KR4, 100GBASE-CR4, & CAUI-4

100G-TXE Compliance Solution for Real-Time Oscilloscopes

TekExpress 100G-TXE Test Report CAUI4-TX (TP1a)			
Setup Information			
DUT ID	DUT001	Master Scope Information	DPO77002SX , 8300159
Date/Time	2016-12-19 00:45:54	Master Scope F/W Version	10.5.0 Build 24
TekExpress 100G-TXE Version	1.1.0.2	Master Scope SPC Status	INIT
TekExpress Framework Version	4.2.0.48	Extension-1 Scope Information	DPO77002SX , 8300140
Specification Version	IEEE 802.3bm, Annex 83E.3.1	Extension-1 Scope F/W Version	10.5.0 Build 24
Probing Type	Single-Ended	Extension-1 Scope SPC Status	INIT
Compliance Mode	True	Pattern Type	PRBS9
Execution Mode	Live	Bandwidth	Full BW
Overall Test Result	Pass	DPOJET version	10.0.3.4
Overall Execution Time	0:05:53		
DUT COMMENT: 100G-TXE CAUI4			

Test Name Summary Table	
DC Common Mode Output Voltage	Pass
Diff Peak to Peak Output Voltage -Tx Disabled	Pass
Diff Peak to Peak Output Voltage -Tx Enabled	Pass
Transition Time	Pass
Signaling Rate	Pass
AC Common Mode Output Voltage	Pass
Single Ended Output Voltage	Pass
Eye Width	Pass
Eye Height Differential	Pass



TekExpress® 100GBASE-KR4, 100GBASE-CR4, and CAUI-4 solution

The TekExpress 100G-TXE provides turnkey testing and debug solutions for IEEE 802.3bj (100GBASEKR4/100GBASE-CR4) and IEEE 802.3bm (CAUI-4) electrical standards. These three electrical standards make-up the backbone of the current 100G Ethernet industry.

Key Features

- 100G-TXE offers streamlined and fully automated transmitter characterization of 802.3bj (100GBASE-KR4/100GBASE-CR4) electrical transmitter specifications and 802.3bm (CAUI) specifications
- Extends DPOJET for low level debug into 100GBASEKR4/100GBASE-CR4 and CAUI-4 ¹.

¹ CAUI-4 is also known as CAUI

Applications

- Electrical transmitter measurements
- Validation of 100GBASE-KR4/100GBASE-CR4 and CAUI-4

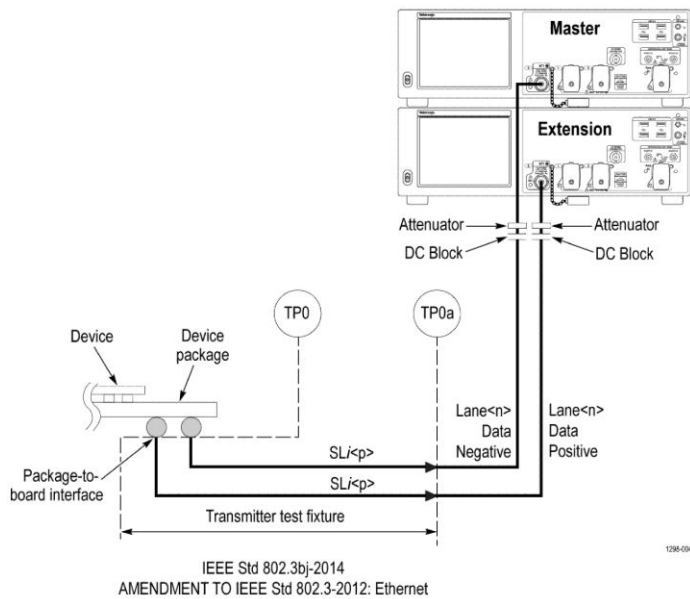
This application package is designed in conjunction with the performance levels offered by a 50 GHz, 70KSX instrument pair. The 100G-TXE loads the required Bessel Thomson roll-off filter which constrains the channel output to the specification mandated 33 GHz point. This is common across all IEEE 100G electrical specifications today. The unique lower noise levels of the ATI architecture serve key signal-to-noise and distortion ratio measurements which are attained with margin on the 70KSX systems. The 100G-TXE solution package is available on non-70KSX systems, such as 23 GHz and higher 70KDX and MSO instruments with the understanding that these are for debug only and not for specification level conformance validation.

IEEE 802.3bj (100GBASE-KR4) electrical real-time transmitter measurements fully automated

Mapping of TP0a 100GBASE-KR4 measurement

Parameter	Subclause reference	Value	Units
Signaling rate	93.8.1.2	25.78125±100 ppm	GBd
Differential peak-to-peak output voltage (max)			
Transmitter disabled	93.8.1.3	30	mV
Transmitter enabled	93.8.1.3	1200	mV
DC common-mode output voltage (max)	93.8.1.3	1.9	V
DC common-mode output voltage (min)	93.8.1.3	0	V
AC common-mode output voltage (RMS, max)	93.8.1.3	12	mV
Output waveform			
steady-state voltage v_f (max)	93.8.1.5.2	0.6	V
steady-state voltage v_f (min)	93.8.1.5.2	0.4	V
Linear fit pulse peak (min)	93.8.1.5.2	$0.71 \times v_f$	V
Normalized coefficient step size (min)	93.8.1.5.4	0.0083	-
Normalized coefficient step size (max)	93.8.1.5.4	0.05	-
Pre-cursor full-scale range (min)	93.8.1.5.5	1.54	-
Post-cursor full-scale range (min)	93.8.1.5.5	4	-
Coefficient initialization ratio			
$(c(0)+c(1)-c(-1))/(c(0)+c(1)+c(-1))$	93.8.1.5.3	1.29±10%	-

Parameter	Subclause reference	Value	Units
$(c(0)-c(1)+c(-1))/(c(0)+c(1)+c(-1))$	93.8.1.5.3	2.57±10%	-
Signal-to-noise and distortion ratio (min)	93.8.1.6	27	dB
Output jitter (max)			
Even-odd jitter	93.8.1.7	0.035	UI
Effective bounded uncorrelated jitter, peak-to-peak	93.8.1.7	0.1	UI
Effective total uncorrelated jitter, peak-to-peak	93.8.1.7	0.18	UI



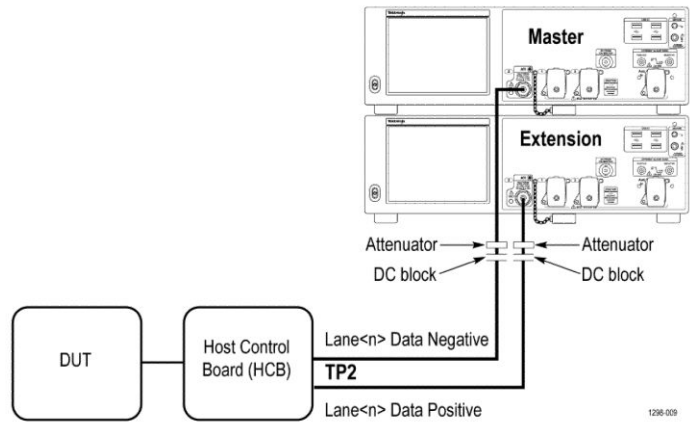
Transmitter test fixture and test points

IEEE 802.3bj (100GBASE-CR4) electrical real-time transmitter measurements fully automated

Mapping of TP2 100GBASE-CR4 measurement

Parameter	Subclause reference	Value	Units
Differential peak-to-peak output voltage (max) with Tx disabled	92.8.3.1	35	mV
DC common-mode output voltage (max)	92.8.3.1	1.9	V
AC common-mode output voltage, v_{cmi} (max., RMS)	92.8.3.1	30	mV
Differential peak-to-peak voltage, v_{di} (max.)	92.8.3.1	1200	mV
Transmitter waveform			
Transmitter steady-state voltage, v_f (min)	92.8.3.5.2	0.34	V
Transmitter steady-state voltage, v_f (max)	92.8.3.5.2	0.6	V

Parameter	Subclause reference	Value	Units
Linear fit pulse peak (min)	92.8.3.5.2	$0.45 \times v_f$	V
Transmitted waveform			
abs coefficient step size (min)	92.8.3.5.4	0.0083	-
abs coefficient step size (max)	92.8.3.5.2	0.05	-
minimum precursor full-scale ratio	92.8.3.5.5	1.54	-
minimum post cursor full-scale ratio	92.8.3.5.5	4	-
Coefficient initialization ratio			
$(c(0)+c(1)-c(-1))/(c(0)+c(1)+c(-1))$	92.8.3.5.3	1.29±10%	-
$(c(0)-c(1)+c(-1))/(c(0)+c(1)+c(-1))$	92.8.3.5.3	2.57±10%	-
Signal-to-noise and distortion ratio (min)	92.8.3.5.7	26	dB
Output jitter (max.)			
Even-odd jitter, peak-to-peak	92.8.3.8.1	0.035	UI
Effective bounded uncorrelated jitter, peak-to-peak	92.8.3.8.2	0.1	UI
Effective total uncorrelated jitter, peak-to-peak	92.8.3.8.2	0.18	UI
Signaling rate per lane	92.8.3.9	25.78125±100 ppm	GBd
Unit interval nominal	92.8.3.9	38.787879	ps



Transmitter test fixture and test points

IEEE 802.3bm (CAUI-4) electrical real-time transmitter measurements fully automated

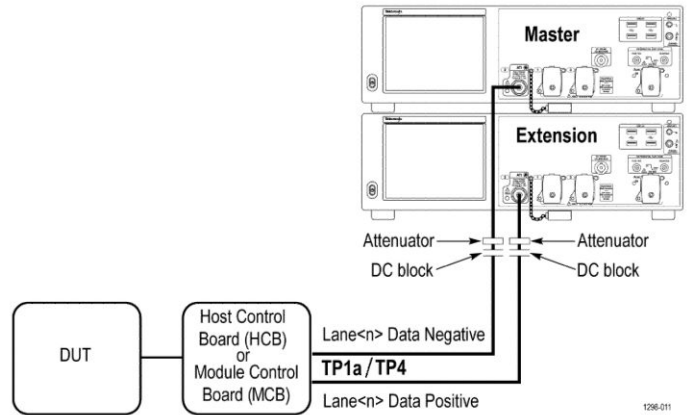
Mapping of TP1a CAUI-4 measurement

Parameter	Subclause reference	Value	Units
Signaling rate per lane (range)	83E.3.1.1	25.78125 ± 100 ppm	GBd
DC common-mode output voltage (max)	83E.3.1.2	2.8	V
DC common-mode output voltage (min)	83E.3.1.2	-0.3	V
Single-ended output voltage (max)	83E.3.1.2	3.3	V
Single-ended output voltage (min)	83E.3.1.2	-0.4	V
AC common-mode output voltage (max, RMS)	83E.3.1.2	17.5	mV
Differential peak-to-peak output voltage (max)			
Transmitter disabled	83E.3.1.2	35	mV
Transmitter enabled	83E.3.1.2	900	mV
Eye width (min)			
Eye width (min)	83E.3.1.6	0.46	UI
Eye height A, differential (min)	83E.3.1.6	95	mV
Eye height B, differential (min)	83E.3.1.6	80	mV
Transition time (min, 20% to 80%)	83E.3.1.5	10	ps

Mapping of TP4 CAUI-4 measurement

Parameter	Subclause reference	Value	Units
Signaling rate per lane (range)	83E.3.1.1	25.78125 ± 100 ppm	GBd
AC common-mode output voltage (max, RMS)	83E.3.1.2	17.5	mV
Differential output voltage (max)	83E.3.1.2	900	mV
Eye width (min)	83E.3.2.1	0.57	UI
Eye height, differential (min)	83E.3.2.1	228	mV
Vertical eye closure (max)	83E.4.2.1	5.5	dB
Transition time (min, 20% to 80%)	83E.3.1.5	12	ps
DC common mode voltage (min) ²	83E.3.1.2	-350	mV
DC common mode voltage (max) ²	83E.3.1.2	2850	mV

² DC common mode voltage is generated by the host. Specification includes effects of ground offset voltage.



Transmitter test fixture and test points

Host Control Board (HCB) and Module Control Board (MCB) are for test points TP1a and TP4 respectively.

Optional system probing setup

The bandwidth requirements of 100GBASE-KR4 are difficult to match with the browser or soldered down probes. However, for debug purposes, these 33 GHz and lower probes offer effective signal access on backplanes and chip-to-chip interconnects.





Backplane and chip-to-chip interconnects can be a significant probing challenge.

Electrical system interconnect setup

Direct electrical connections through 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 100GBASE-CR4 and CAUI-4 designs are the most typical signal access points.

(Image for reference only - see description)
Model No. QSFP28-TPA100G-HCB-6P
Part No. 640-0822-000

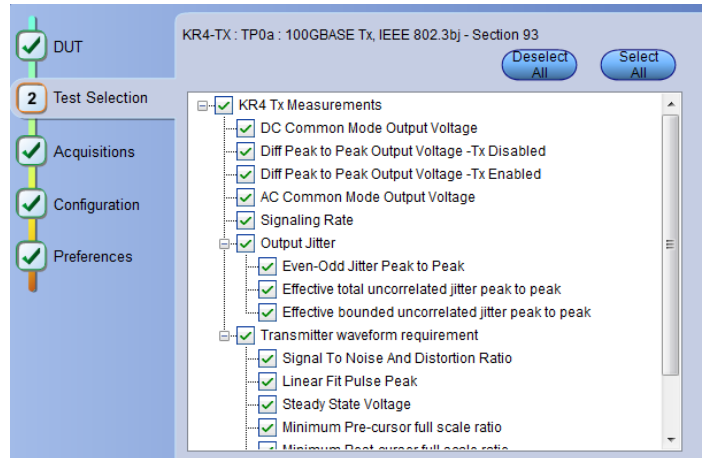
This Adapter Kit contains:

- Qty. 1 - QSFP28 100Gbps Plug Adapter
 - 16 - High Performance Phase Aligned 6" Adapter Coaxial Cables w/ Female SMAs
 - 1 - 12 Position Low Speed Cable and Connector
- CD containing QSFP28 100Gbps User Manual
- Instrument Case

Refer to the Wilder Technologies www.wilder-tech.com/qsfp-28-kits.htm for details regarding the various methods of signal break-out.

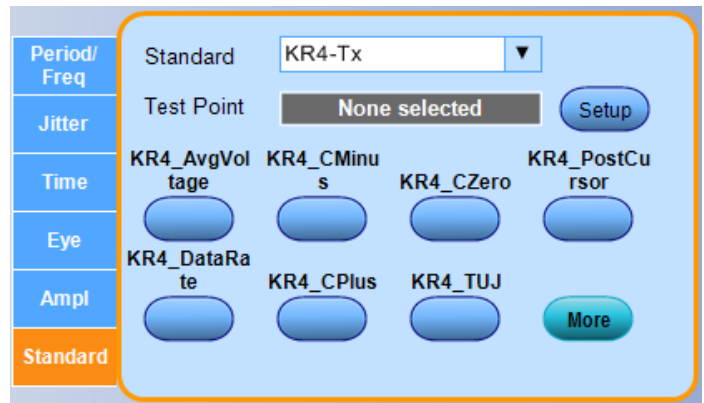
100GBASE-KR4/100GBASE-CR4 measurement selection

The setup and test execution is simple with the 100G-TXE software. The oscilloscope acquisition and analysis are controlled through the 100G-TXE automation solution. The Graphical User Interface (GUI) provides an intuitive and easily repeatable workflow for setup and testing.



TekExpress® 100GBASE-KR4 measurement setup

Alternately, a similar set of measurements without the Standards pass or fail criteria and reporting tools can be found as extensions to the DPOJET product. These would serve the debug user, rather than the compliance user.

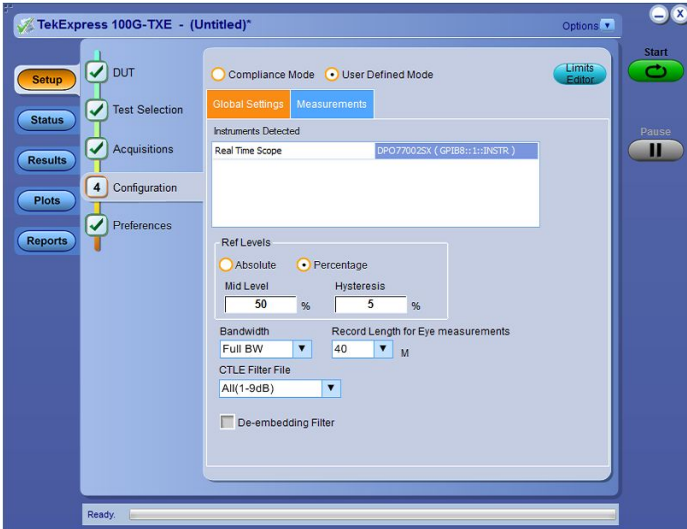


DPOJET Standard: 100GBASE-KR4 measurement setup

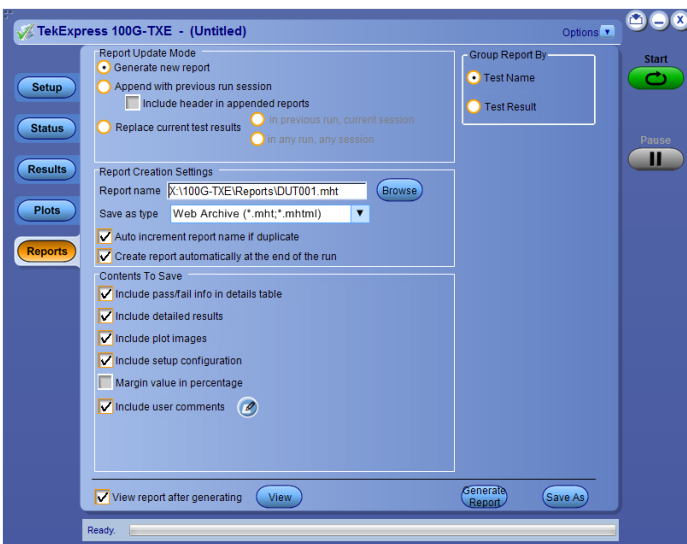
Design characterization is supported beyond 100GBASE-KR4/100GBASE-CR4/CAUI-4 compliance requirements for all measurements. The TekExpress 100G-TXE offers flexible control over test configurations such as analysis windows and other parameters. User-defined mode lets customers make changes to the test limits and perform marginal testing beyond compliance.

User-defined mode

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



Reports & measurement results



TekExpress 100G-TXE Test Report CAUI4-TX (TP1a)			
Setup Information			
DUT ID	DUT001	Master Scope Information	DPO77002SX, B300159
Date/Time	2016-12-19 00:45:54	Master Scope F/W Version	10.5.0 Build 24
TekExpress 100G-TXE Version	1.1.0.2	Master Scope SPC Status	INIT
TekExpress Framework Version	4.2.0.48	Extension-1 Scope Information	DPO77002SX, B300140
Specification Version	IEEE 802.3bm, Annex 83E.3.1	Extension-1 Scope F/W Version	10.5.0 Build 24
Probing Type	Single-Ended	Extension-1 Scope SPC Status	INIT
Compliance Mode	True	Pattern Type	PRBS9
Execution Mode	Live	Bandwidth	Full BW
Overall Test Result	Pass	DPOJET version	10.0.3.4
Overall Execution Time	0:05:53		
DUT COMMENT:	100G-TXE CAUI4		

Test Name Summary Table	
DC Common Mode Output Voltage	Pass
Diff Peak to Peak Output Voltage-Tx Disabled	Pass
Diff Peak to Peak Output Voltage-Tx Enabled	Pass
Transition Time	Pass
Signaling Rate	Pass
AC Common Mode Output Voltage	Pass
Single Ended Output Voltage	Pass
Eye Width	Pass
Eye Height Differential	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	0	1.00000	Pass	L:1.3000 H:1.8000	-0.3	2.8	V	N.A
COMMENTS								DC Common Mode Output Voltage is measured using multimeter

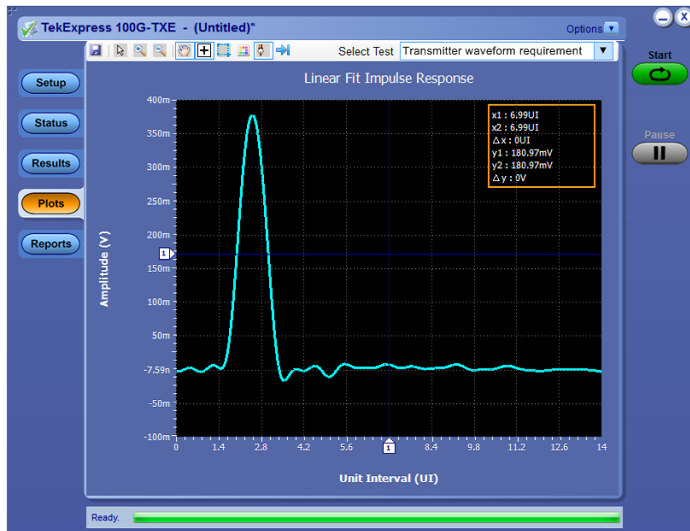
Diff Peak to Peak Output Voltage -Tx Disabled								
Measurement Details	Iteration	Measured Value	Test Result	Margin	Low Limit	High Limit	Units	Comments
Diff Peak to Peak Output Voltage -Tx Disabled	0	12.02930	Pass	H:22.9707	N.A	35	mV	N.A
COMMENTS								

TekExpress 100G-TXE Test Report CR4-TX (TP2)			
Setup Information			
DUT ID	DUT001	Master Scope Information	DPO77002SX, B300159
Date/Time	2016-12-19 01:20:50	Master Scope F/W Version	10.5.0 Build 24
TekExpress 100G-TXE Version	1.1.0.2	Master Scope SPC Status	INIT
TekExpress Framework Version	4.2.0.48	Extension-1 Scope Information	DPO77002SX, B300140
Specification Version	IEEE 802.3bj, Section 92	Extension-1 Scope F/W Version	10.5.0 Build 24
Probing Type	Single-Ended	Extension-1 Scope SPC Status	INIT
Compliance Mode	True	Pattern Type	PRBS9
Execution Mode	Live	Bandwidth	Full BW
Overall Test Result	Pass	DPOJET version	10.0.3.4
Overall Execution Time	0:10:10		
DUT COMMENT:	100G-TXE CR4		

Test Name Summary Table	
DC Common Mode Output Voltage	Pass
Diff Peak to Peak Output Voltage-Tx Disabled	Pass
Diff Peak to Peak Output Voltage-Tx Enabled	Pass
AC Common Mode Output Voltage	Pass
Signaling Rate	Pass
Even-Odd Jitter Peak to Peak	Pass
Effective total uncorrelated jitter peak to peak	Pass
Effective bounded uncorrelated jitter peak to peak	Pass
Signal to Noise And Distortion Ratio	Pass
Linear Fit Pulse Peak	Pass
Steady State Voltage	Pass
Minimum Pre-cursor full scale ratio	Pass
Minimum Post-cursor full scale ratio	Pass
Normalized Coefficient Step Size	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	0	1.00000	Pass	L:1.0000 H:0.9000	0	1.0	V	N.A
COMMENTS								DC Common Mode Output Voltage is measured using multimeter

Diff Peak to Peak Output Voltage -Tx Disabled								
Measurement Details	Iteration	Measured Value	Test Result	Margin	Low Limit	High Limit	Units	Comments
Diff Peak to Peak Output Voltage -Tx Disabled	0	11.46290	Pass	H:23.5371	N.A	35	mV	N.A
COMMENTS								



Overall Test Result: Pass

Test Name	Details	Pass/Fail	Value	Units	Margin
Diff Peak to Peak Output Voltage -Tx Disabled	Diff Peak to Peak Output Voltage -Tx Disabled	Pass	12.07420	mV	H:17.9258
Diff Peak to Peak Output Voltage -Tx Enabled	Diff Peak to Peak Output Voltage -Tx Enabled	Pass	928.49420	mV	H:271.5058
AC Common Mode Output Voltage	AC Common Mode Output Voltage	Pass	7.76930	mV	H:4.2307
Signaling Rate	Signaling Rate	Pass	25.78124	Gbd	L:0.0026 H:0.0026
Even-Odd Jitter Peak to Peak	Even-Odd Jitter Peak to Peak	Pass	0.00243	UI	H:0.0326
Effective total uncorrelated jitter peak to peak	Effective total uncorrelated jitter peak to peak	Pass	0.06847	UI	H:0.1115
Effective bounded uncorrelated jitter peak to peak	Effective bounded uncorrelated jitter peak to peak	Pass	0.00000	UI	H:0.1000
Signal To Noise And Distortion Ratio	Signal To Noise And Distortion Ratio	Pass	29.98806	dB	L:2.9881
Linear Fit Pulse Peak	Linear Fit	Pass	0.37817	V	L:0.1008

Ordering information

Models

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 permanent node locked license With a DPS70KSX Real-Time Oscilloscope

Oscilloscope DPS77704SX, DPS75904SX, DPS75004SX, DPS73308SX option 100G-TXE

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 permanent node locked license With a DPO70KDX Real-Time Oscilloscope

Oscilloscope DPO72304DX, DPO72504DX, DPO73304DX option 100G-TXE

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 permanent node locked license With a MSO70KDX Real-Time Oscilloscope

Oscilloscope MSO72304DX, MSO72504DX, MSO73304DX option 100G-TXE

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 permanent node locked license With a DPO70KSX Real-Time Oscilloscope

Oscilloscope DPO72304SX, DPO72504SX, DPO73304SX option 100G-TXE

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 on a Floating License (any Real-Time Oscilloscope listed above)

DPOFL-100G-TXE

To order 100G-TXE (100GBASE-KR4/100GBASE-CR4) & CAUI-4 on a Free 30-Day Trial License (any Real-Time Oscilloscope listed above)

DPOFT-100G-TXE

Recommended products

Probes	Tek P7633 (33 GHz) or Tek P7720 (20 GHz) probe
Fixture	Wilder MCB/HCB QSFP+ Breakout fixture (640-0786-000)

Certifications

CE Marking Not Applicable.

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



100GBASE-KR4, 100GBASE-CR4, and CAUI-4 Datasheet

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