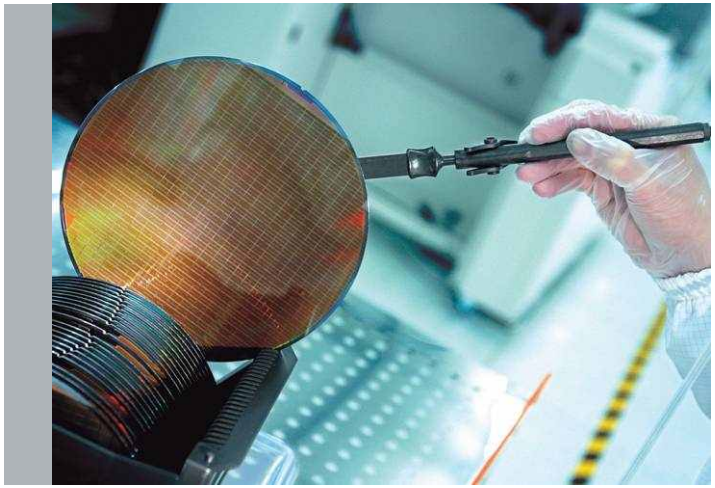
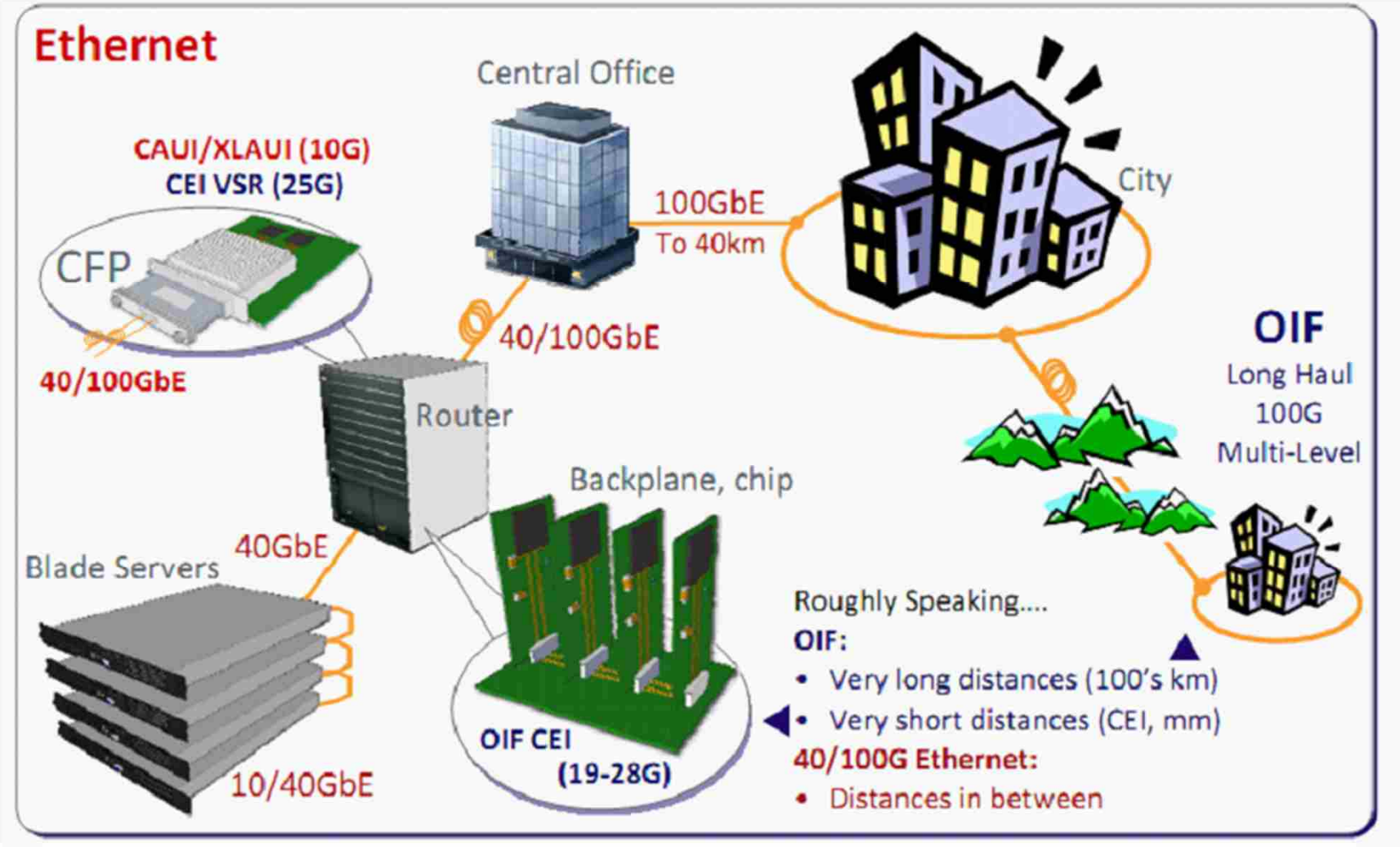
从10M到100G的通讯标准全面解决方案



泰克科技（中国）有限公司 张晓
Tim.Zhang@tektronix.com

Tektronix

High Speed Network Infrastructure



Agenda

- Tektronix Ethernet Solution Overview
- SFP-TX&SFP-WDP – SFP+ Automation and Debug Solution
- 10GBASE-KR/KR4 - 802.3ap
- XGbT – 10GBASE-T Compliance solution
- ET3 & Energy Efficient Ethernet - 802.3az
- Tektronix Optical Solution Overview
- 10G~100G Optical communication Solution
- Long Haul Optical Communication Solution

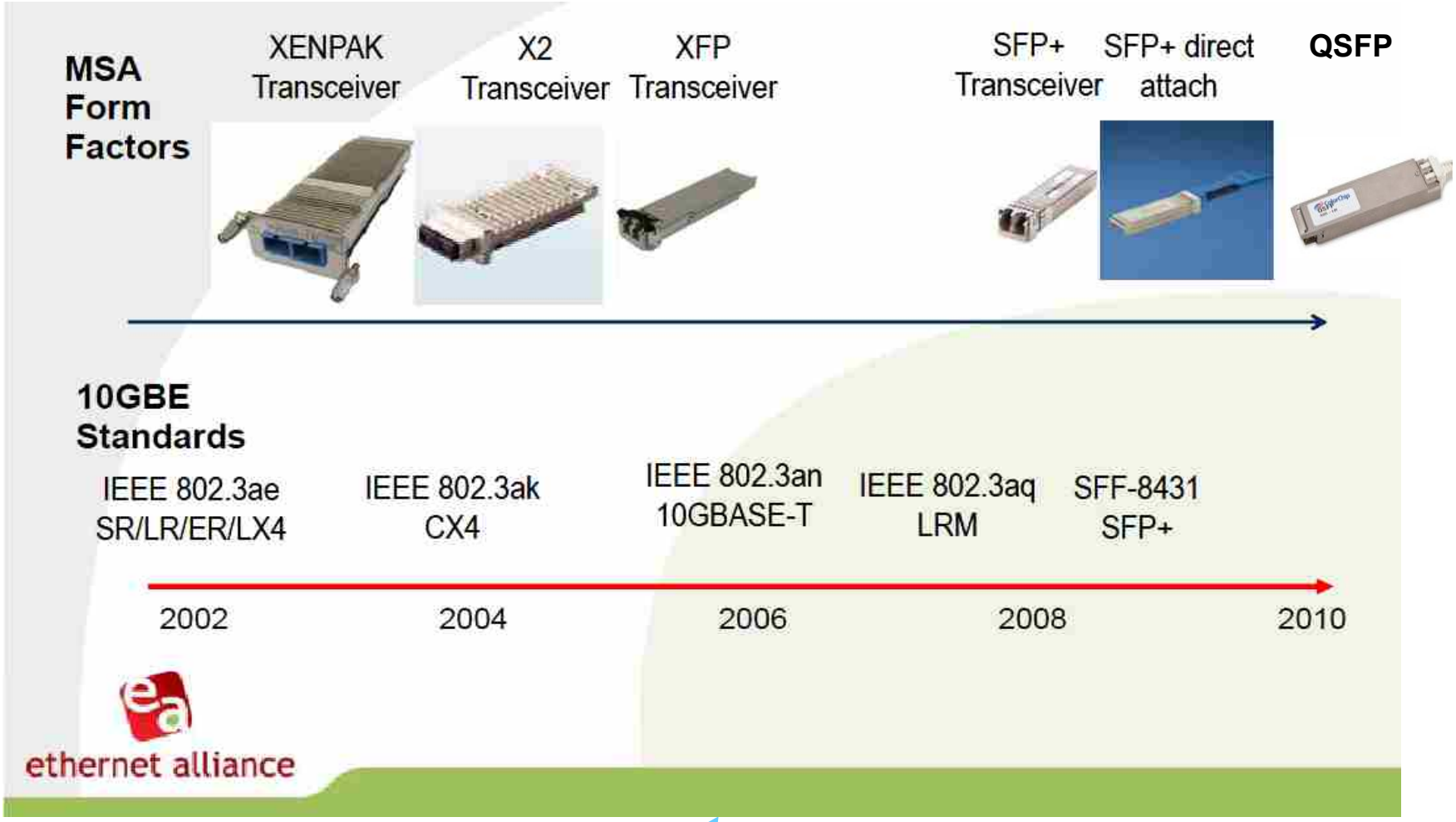
Tektronix Ethernet Solutions

- Tektronix has strong portfolio of products and solution in Ethernet Space – RT Scope, Sampling scope, BERTScope and now Optametra products
- TDSET3 – Available since 2003 with over 2500+ end-users and still growing strong, ET3 is widely used tool across industry
- XGbT – Tektronix released 10GBASE-T Compliance solution in 2009 and we have added many customers worldwide since, XGbT is the only “One Box” solution available in the market
- 802.3az – Energy Efficient Ethernet – Tek Software and Fixture are used by many design and validation engineers worldwide and Tektronix is the only T&M company helping customers in this space
- SFP-TX & SFP-WDP provides comprehensive solution for SFP+, Tektronix is first to market
- 10GBASE-KR - 802.3ap™-2007 – We now have a Compliance and Debug Solution
- 10GBASE-KR and SFP+ RX MOI are available on BERT Scope

SFP-TX&SFP-WDP – SFP+ Automation and Debug Solution

SFP+ Technology and Related Testing Challenges

10Gigabit Ethernet Interface Evolution



Source : Ethernet Alliance

Next Big Thing
SFF-8431
SFP+

SFF-8431 SFP+ Technology overview

- SFP+ is a next-generation hot-pluggable, small footprint, serial-to-serial multi-rate optical transceiver for 8.5GbE to 11.1GbE Datacom and Storage Area Networks (SAN) applications.
- SFP+ technology moved the clock and data recovery units out of the module and onto the line card – Reducing size drastically
- As a result, the modules are smaller, consume less power, allow increased port density, and are less expensive compared to XFP.
- High density capable Up to 48 ports in a rack
- Low power per port - Host Port power < 1 W and Low Latency

SFP+ Test Challenges

- Test Time
  - 48 Port Devices
  - Multiple test points and repetition in setup
- Debug vs. Compliance
  - When and how to make the shift with port replication in the process
  - Difficult to detect low amplitude impact on eye pattern performance
- Connectivity
  - Smaller package with difficulty to access test points
- Ambiguous Test Specification
  - Primary instrument defined for eye pattern measurements is equivalent-time oscilloscope so redefinition needed for real-time oscilloscope
- Test Pattern Setup
  - PRBS31 pattern is treated as an arbitrary waveform

TWDPc Measurement Definitions

- TWDPc
  - **T**ransmitter **W**aveform **D**ispersion **P**enalty for **C**opper
  - *Defined as 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.*
  - The fiber optics concept has been extended to quantify channel performance of high speed copper links “10GSFP+Cu”
  - Critical for performance
  - Requires a special algorithm
  - ClariPhy has IP rights for this algorithm

- Test Specification Requirements for TWDPc
  - 7 measurement samples per unit interval
  - Causes worst-case 0.24 dB TWDPc over 30 measurements

SFP-TX Host Transmitter Measurements

- 15 Defined Measurements for Host Tx Compliance

SL No.	Measuremnts	Signal Type Recommended	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=0.12UI, X2=0.33UI, Y1=95mV, Y2=350mV			
Host Transmitter output specifications for Cu (SFP+ host supporting direct						
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

SFP-TX Module Transmitter Measurements

- 10 Defined Measurements for Tx Module Compliance

SL No.	Measuremnts	Signal Type Recommended	Limit			
			Min	Target	Max	Units
Module Transmitter Input electrical Specifications:						
1	AC common mode voltage tolerance	PRBS31	15			mV
2	Single Ended Input Voltage Tolerance	PRBS31	-0.3		4	V
Module 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	Output AC Common Mode Voltage	PRBS31			15	mV(RMS)
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(RMS)
10	Eye mask hit ratio(Mask hit ratio of 5×10-5)	PRBS31	X1=0.12UI, X2=0.33UI, Y1=95mV, Y2=350mV			

SFP-TX & SFP-WDP – SFP+ Automation and Debug Solution

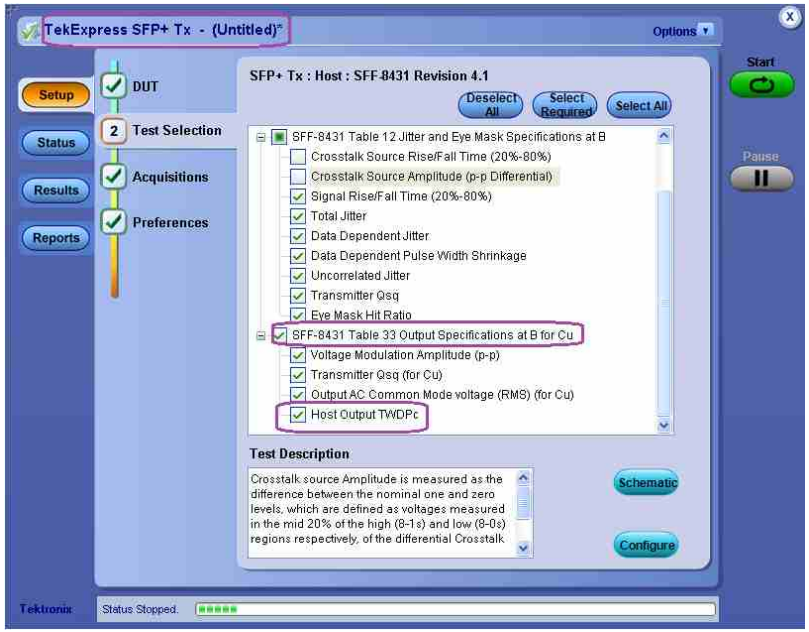
SFP-TX – SFP+ Compliance and Debug Solution

- Automated Tests
  - One-button selection of critical Host & Module Tests reduces testing time
- Integrated Debugging
  - Popular DPOJET-based interface enables deeper debug of timing root cause analysis without moving to a different instrument/measurement setup
- Integrated support for TWDPc measurements
  - Rely on off-the-shelf products to perform this complex measurement rather than developing custom lab setup reducing testing time and complexity
- Documentation/Reporting
  - Real-time waveform capture and pre-recorded waveform support provides ability to share waveform details with other labs, vendors and customers across multiple locations

Tektronix SFP-TX – Automation & DPOJET Option

- Operates on Tektronix DPO/DSA70000C/D Series Oscilloscopes
- Automate setup & quickly generate reports
- Meets Compliance needs of SFF-8431 revision 4.1
- User defined mode enables measurements on signal types like 8180, PRBS9 & PRBS31

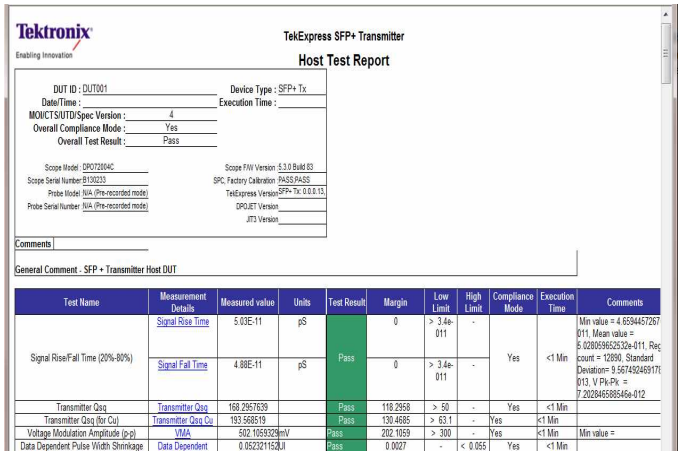
Tektronix SFP-WDP Option – TWDPc Measurement



- Operates on Tektronix DPO/DSA70000C/D Series Oscilloscopes
- Perform Transmitter Waveform Dispersion Penalty measurement with simple setup and test execution
- Ideal for high sample rate acquisition
  - 100GS/sec setting available on DPO/DSA70000C/D

Reporting and Documentation

- Summary-reporting capability in .mht (HTML) format with pass/fail status
- Detailed report includes
  - Measurement results:
    - Test configuration details, waveform plots, and margin analysis
  - Test Setup details:
    - Calibration status, oscilloscope model, probe model, software version, date, execution time etc.
- Flexible report configuration provides options like auto increment, appending etc.


Tektronix
Enabling Innovation

TekExpress SFP+ Transmitter

Host Test Report

DUT ID : DUT001
Date/Time :
MOI/CTS/UTD/Spec Version : 4
Overall Compliance Mode : Yes
Overall Test Result : Pass

Device Type : SFP+ Tx
Execution Time :

Scope Model : DPO72004C
Scope Serial Number: B130233
Probe Model: N/A (Pre-recorded mode)
Probe Serial Number: N/A (Pre-recorded mode)

Scope FW Version :5.3.0 Build 83
SPC, Factory Calibration :PASS,PASS
TekExpress Version:SFP+ Tx: 0.0.0.13,
DPOJET Version
JIT3 Version

Comments

General Comment - SFP + Transmitter Host DUT

Test Name	Measurement Details	Measured value	Units	Test Result	Margin	Low Limit	High Limit	Compliance Mode	Execution Time	Comments
Signal Rise/Fall Time (20%-80%)	Signal Rise Time	5.03E-11	pS	Pass	0	> 3.4e-011	-	Yes	<1 Min	Min value = 4.659445726 011, Mean value = 5.028059652532e-011, Req count = 12890, Standard Deviation= 9.567492469171 013, V Pk-Pk = 7.202845986546e-012
	Signal Fall Time	4.88E-11	pS		0	> 3.4e-011	-			
Transmitter Qsq	Transmitter Qsq	168.2957639		Pass	118.2958	> 50	-	Yes	<1 Min	
Transmitter Qsq (for Cu)	Transmitter Qsq Cu	193.568519		Pass	130.4685	> 63.1	-	Yes	<1 Min	
Voltage Modulation Amplitude (p-p)	VMA	502.1059329mV		Pass	202.1059	> 300	-	Yes	<1 Min	Min value =
Data Dependent Pulse Width Shrinkage	Data Dependent	0.052321152UI		Pass	0.0027	-	< 0.055	Yes	<1 Min	

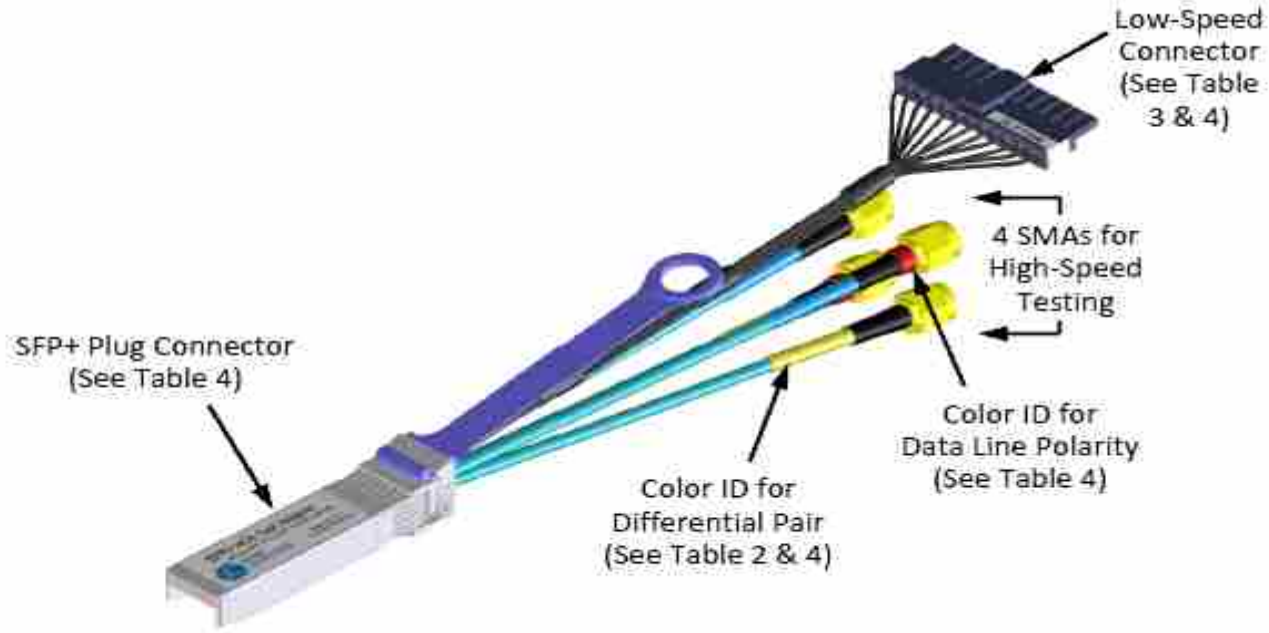
Connectivity for SFP+

- Connectivity Challenges:
  - Fixture required in SFF-8431 spec is difficult to source
  - Low amplitude signaling so DC offset must be carefully removed
  - Fixture/DUT connections can be difficult to lock/unlock

- Tektronix family of SFP+ Fixtures

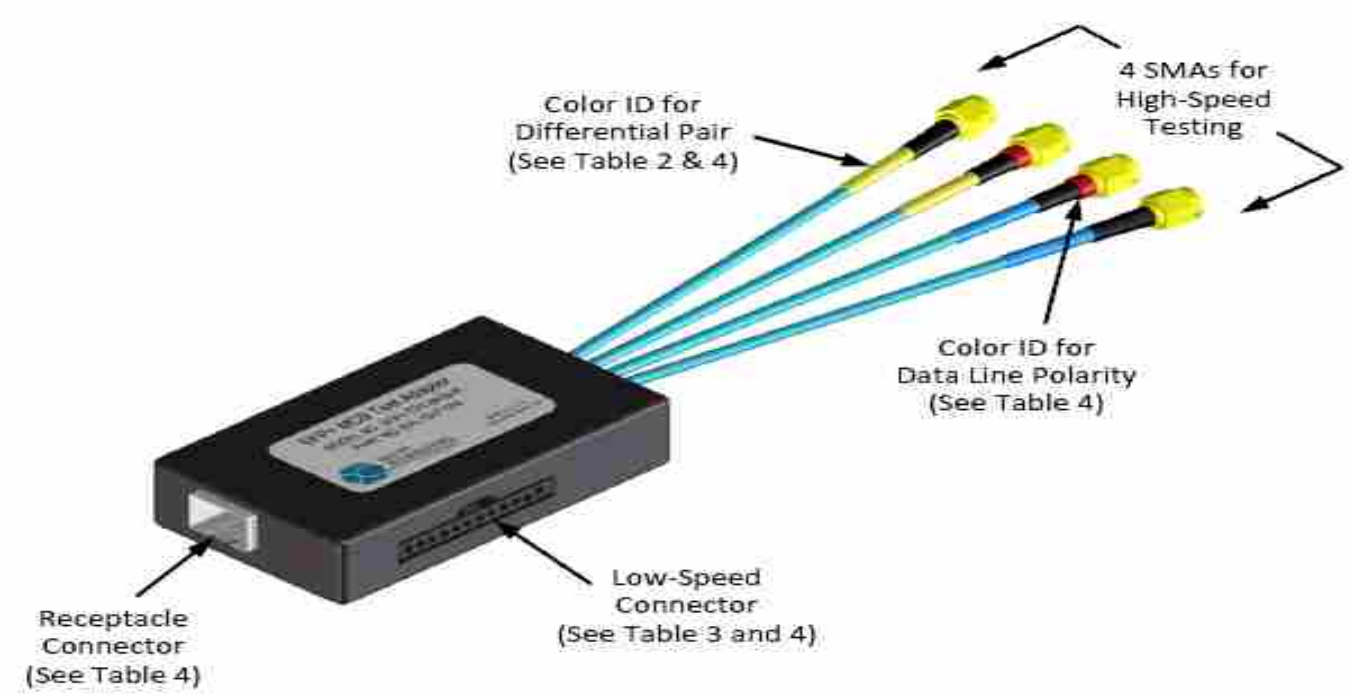
Nomenclature	Description
TF-SFP-TPA-HCB-P	SFP+ Host Compliance Board Plug
TF-SFP-TPA-MCB-R	SFP+ Module Compliance Board Receptacle
TF-SFP-TPA-PR	SFP+ Host Compliance Board Plug and Module Compliance Board Receptacle
TF-SFP-TPA-HCB-PK	SFP+ Host Compliance Board Plug Kit with DC Blocks and Termination
TF-SFP-TPA-MCB-RK	SFP+ Module Compliance Board Receptacle Kit with DC Blocks and Termination
TF-SFP-TPA-PRK	SFP+ Host Module Compliance Board and Module Compliance Board with DC Blocks and Termination

Tektronix Test Fixture – Host Compliance Board (HCB)



- Two variants of the fixture board are available:
  - SFP+ HCB Plug Kit with DC Blocks & Termination
  - SFP+ HCB Plug Kit without DC Blocks & Termination

Tektronix Test Fixture – Module Compliance Board (MCB)



- Two variants of the MCB fixture board are available
  - SFP+ MCB Kit with DC Blocks & Termination
  - SFP+ MCB Kit without DC Blocks & Termination.

SFP-TX Recommended Test Equipment

Mapping Technology to Oscilloscope Bandwidth Requirements

- SFF-8431 SFP+ provides 10.3125 Gb/second connections with the minimum rise time requirement of 34 psec
- Min DPO/DSA/MSO71604C/D 16GHz Oscilloscope (24.5 psec Rt)
- Recommend DPO/DSA/MSO72004C/D 25GHz Oscilloscope (12psec Rt)
  - Option SFP-WDP requires 100GS/sec Sample Rate

Oscilloscope	Software	Fixture
DPO/DSA/MSO 16-33 GHz scope*	SFP-TX, SFP-WDP & DJA	HCB and MCB

*SFP-WDP requires "C" & "D" series scopes with BW greater than equal to 16GHz

SFP-TX Recommended Test Equipment

Mapping Technology to Oscilloscope Bandwidth Requirements

- SFF-8431 SFP+ provides 10.3125 Gb/second connections with the minimum rise time requirement of 34 psec
- DPO/DSA/MSO71604C/D 16GHz Oscilloscope (24.5 psec Rt)
- DPO/DSA/MSO72004C/D 20GHz Oscilloscope (18psec Rt)
  - >16GHz Oscilloscope will meet rise time requirements of SFF-8431 SFP+ signal
  - Option SFP-WDP requires 100GS/sec Sample Rate

Oscilloscope	Software	Fixture
DPO/DSA/MSO 16-33 GHz scope*	SFP-TX, SFP-WDP & DJA	HCB and MCB

*SFP-WDP requires "C" & "D" series scopes with BW greater than equal to 16GHz

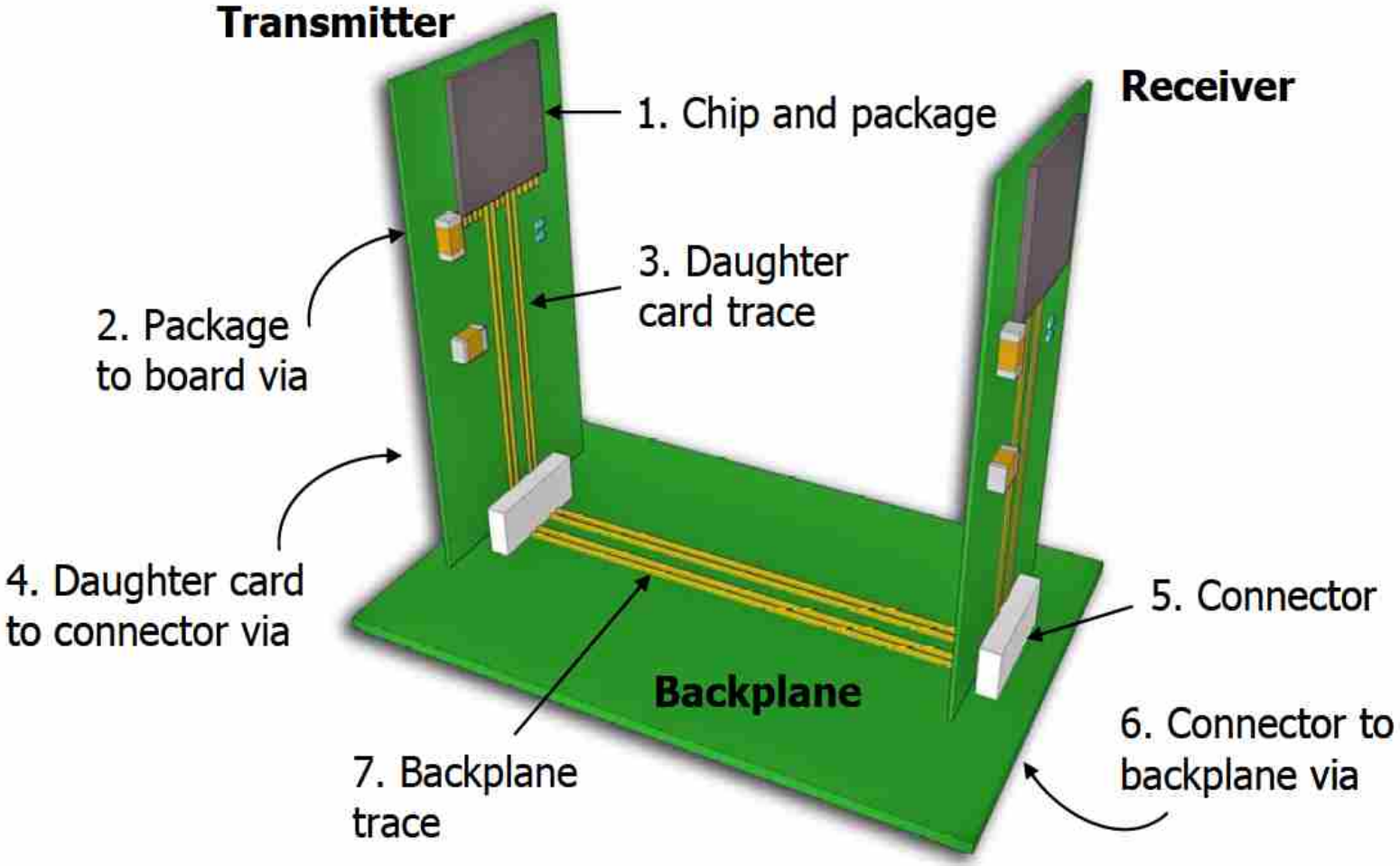
Tektronix SFP-TX - Summary

- A fully automated solution for SFP+ Measurements & Debugging
- Integrated TWDPc measurement capability using 100GS/sec Oscilloscope
- Floating license mechanism for multi-user environment
- Connectivity/Fixtures available directly from Tektronix

10GBASE-KR/KR4 - 802.3ap

KR/KR4 Technology Overview

Typical Backplane Ethernet



Greater need for Conformance Testing

- Greater bandwidth needs due to higher performance demands are leading to increased lanes thereby increasing the complexity of interconnects, resulting in bottleneck
- IEEE Standard 802.3ap™-2007 provides a solution with 10GBe serial backplane connectivity - 10GBASE-KR
- 64B/66B Encoding used
- It also pays way to 40GbE MAC rate by leveraging 4 KR lanes
- With many factors working to degrade signal performance in 10GBASE-KR, compliance testing becomes a critical step for backplane designers.

Compliance Testing becomes a critical step for backplane designers

Test Patterns Defined for KR Testing

Compliance Mode:

- N1 N0 (8<=N<=11)
- PRBS11
- PRBS31

Use defined Mode: Signals in Compliance Plus Mode

- PRBS7
- PRBS9
- PRBS15
- PRBS20
- PRBS23

KR/KR4 Measurements & Testing challenges

Transmitter characteristics for 10GBASE-KR

Table 72–6—Transmitter characteristics for 10GBASE-KR

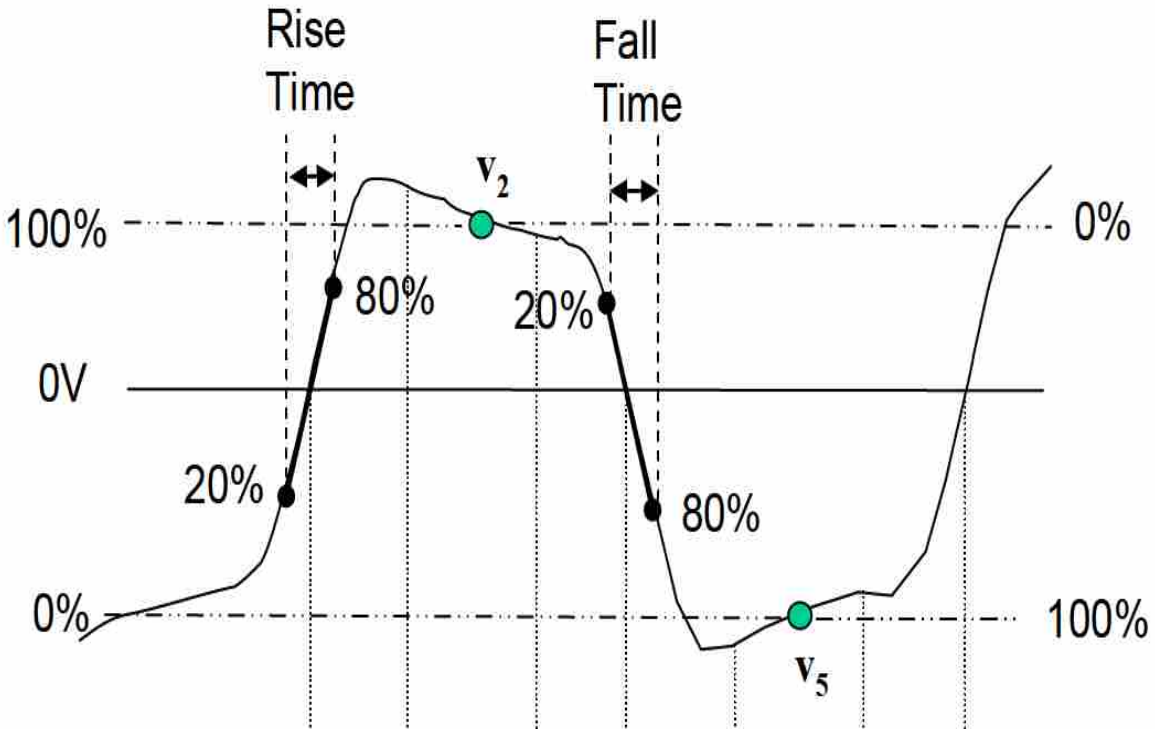
Sub-Clause Reference	Measurement Name	Recommended Pattern for testing	Value	Unit
72.7.1.3	Signaling speed	PRBS11	10.3125 ± 100 ppm	GBd
72.7.1.4	Differential peak-to-peak output voltage (max.)	PRBS11	1200	mV
72.6.5	Differential peak-to-peak output voltage (max.) with TX disabled	PRBS11	30	mV
72.7.1.4	Common-mode voltage limits	PRBS11	0-1.9	V
72.7.1.7	Transition time (20%–80%) - Rise Time - Fall Time	N1N0 (8<=N<=11)	2–47	ps
72.7.1.8	Jitter Measuremnts - Max output jitter (peak-to-peak) - Random jittera - Deterministic jitter - Duty Cycle	PRBS11	0.15 0.15 0.035 0.28	UI UI UI UI
72.7.1.10	Output waveform characteristics	N1N0 (8<=N<=11)	Equalizer Parameter	mV
72.7.1.11	Output waveform coefficient update	N1N0 (8<=N<=11)	Equalizer Parameter	mV
72.7.1.11	Output waveform coefficient status	N1N0 (8<=N<=11)	Equalizer Parameter	mV

Signal Speed measurement - 72.7.1.3

- Test setup : Set the DUT to transmit PRBS11 signal
- Measure the average signal speed
- Compare with limit value +/-100ppm which is 10.3125Gbaud +/- 1.03125Mbaud

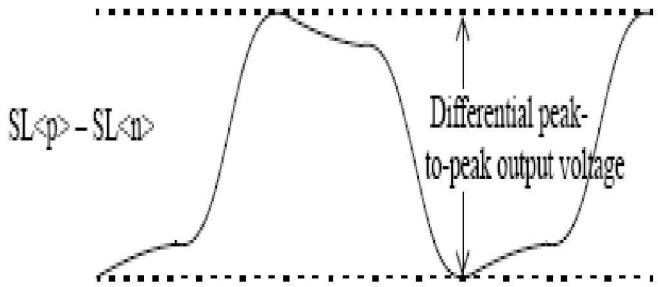
Transition Time measurement - 72.7.1.7

- The transition times are to be measured at the 20% and 80% levels referenced to v^2 and v^5
- The rising and falling edge transition times shall be between 24 ps and 47 ps as measured at the 20% and 80% levels
- N1N0 waveform to be used(8<=N=>11)



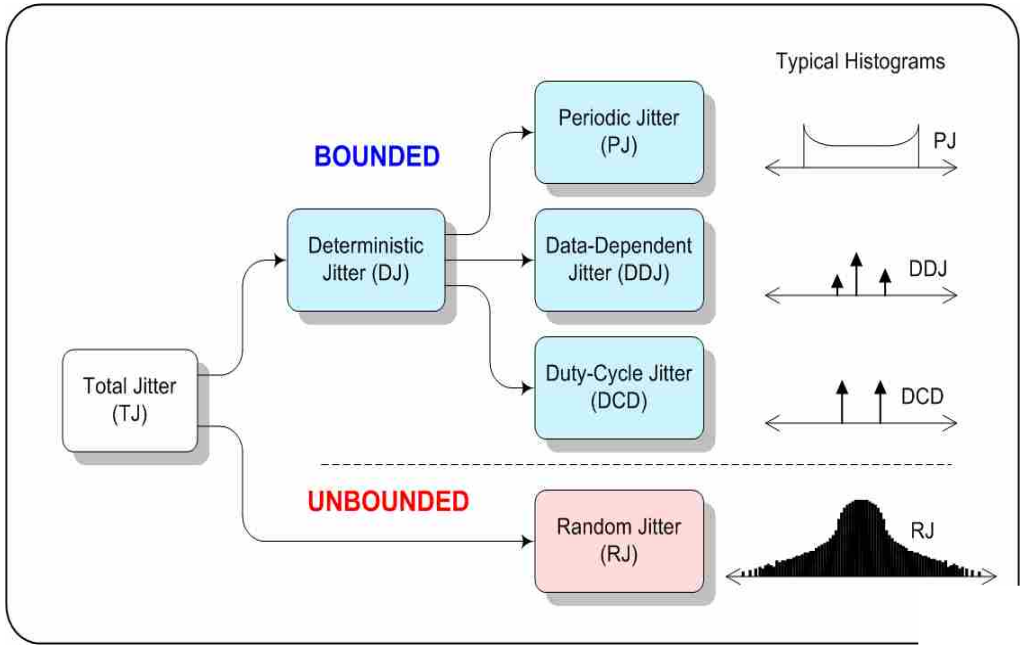
Differential peak-to-peak output & Common Mode voltage - 72.7.1.4, 72.6.5 & 72.7.1.4

- Set the DUT to generate PRBS11 signal
- Locate the 1010 pattern not less than 8 consecutive transition
- Measure Peak to Peak voltage
  - Differential Pk-Pk ≤ 1200 mV
  - When TX Disabled, the voltage should be ≤ 30mV Pk-Pk
    - CM – 0-1.9V
      - Common mode voltage = (P+N)/2
      - Measured with respect to ground



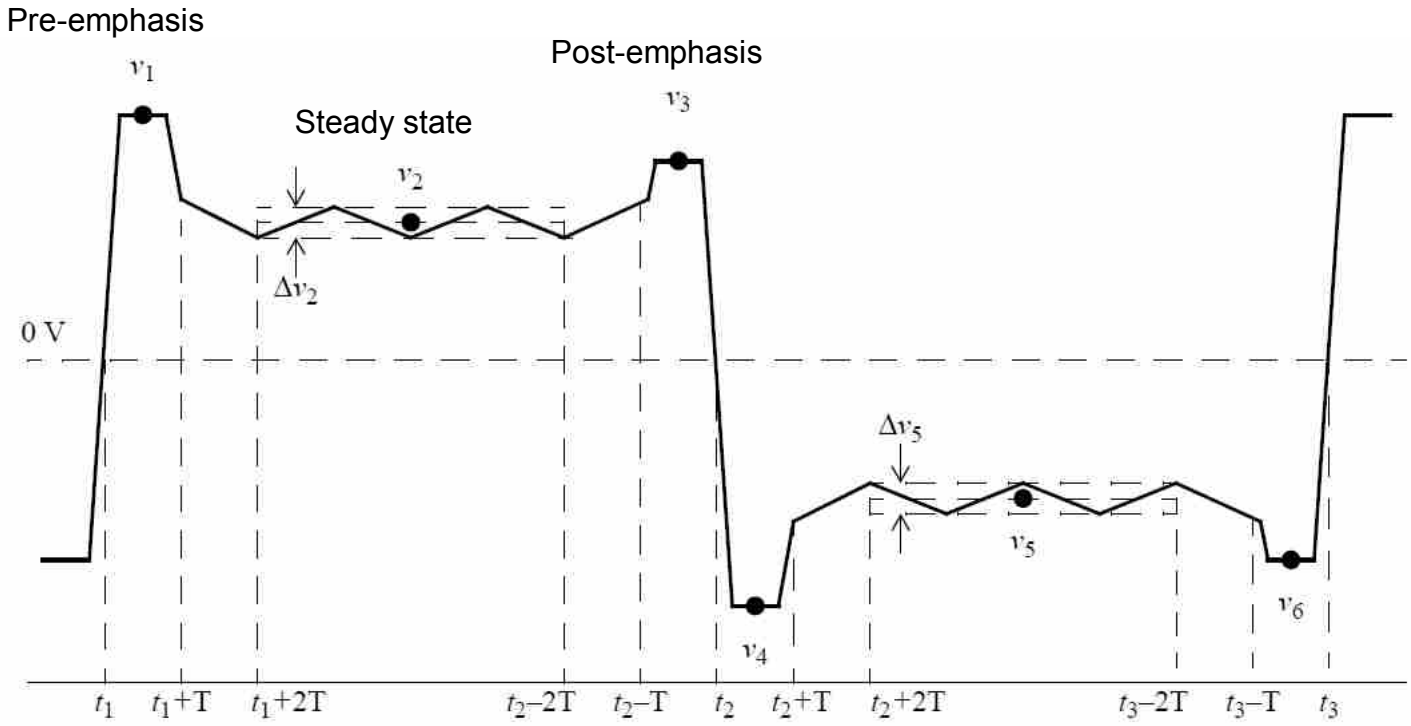
Jitter Measurement - 72.7.1.8

- Set the DUT to generate PRBS11 signal
- Use 4Mhz PLL and Measure the Jitter .
- Measure and decompose to Random Jitter, DJ, DCD & Total Jitter
- Ensure
  - Random Jitter<=0.15UI(14.544 PS)
  - Deterministic Jitter <=0.15UI(14.544 PS)
  - Duty Cycle Distortion <=0.038UI(3.68 PS)
  - Total Jitter <=0.28UI(27.149 PS)



Transmit Output Waveform Requirement - 72.7.1.11 Status and Update

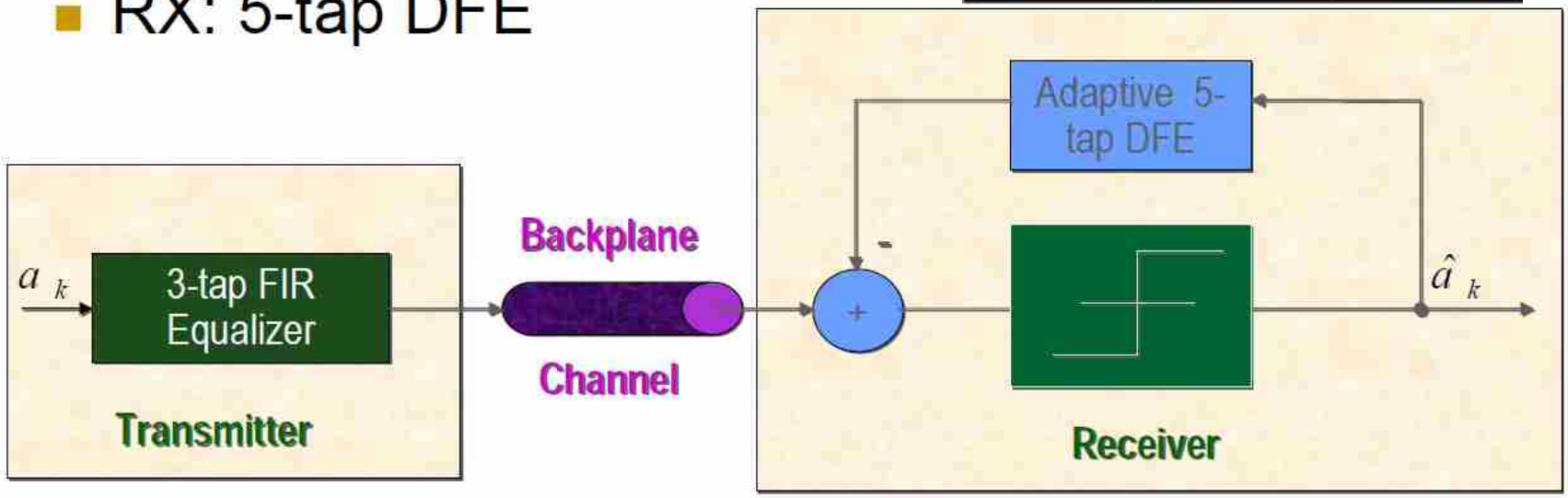
- Test pattern for TX output is NIN0
- This waveform is used for updating the coefficients at the Link partner.
- Receiver measures the levels, determine the waveform deterioration, define the coefficient for equalizer.



10GBASE-KR System Model

- 1/T=10.3125GHz
- TX: 3-tap transmit FIR
- RX: 5-tap DFE

Coefficient update[a]		
c(1)	c(0)	c(−1)
increment	hold	hold
decrement	hold	hold
hold	increment	hold
hold	decrement	hold
hold	hold	increment
hold	hold	decrement



Output Waveform Coefficient update

Table 72–7—Transmitter output waveform requirements related to coefficient update

Coefficient update[a]			Requirements[b]		
$c(1)$	$c(0)$	$c(-1)$	$v_1(k) - v_1(k-1)$ (mV)	$v_2(k) - v_2(k-1)$ (mV)	$v_3(k) - v_3(k-1)$ (mV)
increment	hold	hold	–20 to –5	5 to 20	5 to 20
decrement	hold	hold	5 to 20	–20 to –5	–20 to –5
hold	increment	hold	5 to 20	5 to 20	5 to 20
hold	decrement	hold	–20 to –5	–20 to –5	–20 to –5
hold	hold	increment	5 to 20	5 to 20	–20 to –5
hold	hold	decrement	–20 to –5	–20 to –5	5 to 20

[a]Step size requirements for the tap under test apply regardless of the current value of the other taps.
[b]This difference is measured relative to the voltage prior to the assertion coefficient update k equal to hold

Output Waveform Coefficient status

Table 72–8—Transmitter output waveform requirements related to coefficient status

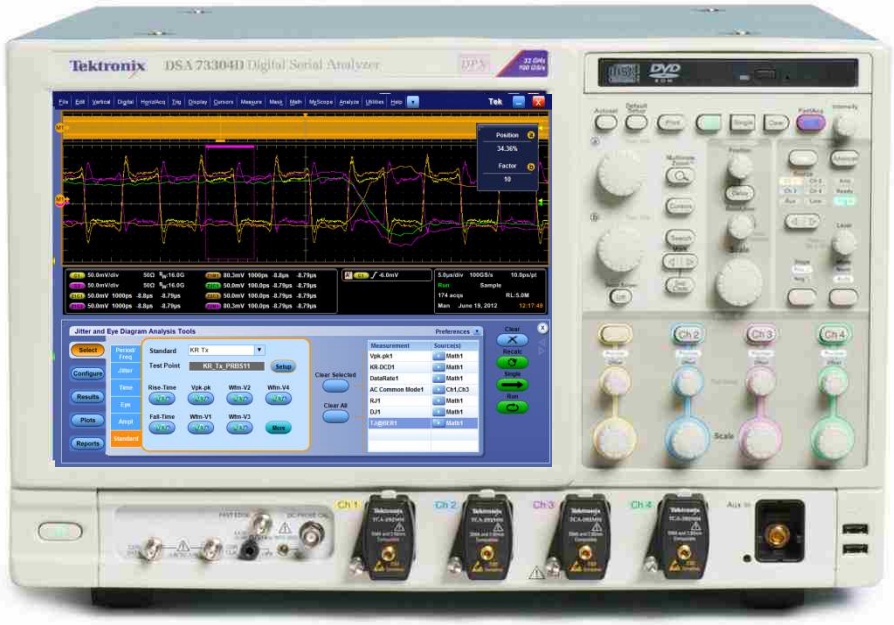
Coefficient status			Requirements		
$c(1)$	$c(0)$	$c(-1)$	R_{pre}	R_{pst}	v_2 (mV)
disabled	minimum	disabled	0.90 to 1.10	0.90 to 1.10	220 to 330
disabled	maximum	disabled	0.95 to 1.05	0.95 to 1.05	400 to 600
minimum	minimum	disabled	—	4.00 (min)	—
disabled	minimum	minimum	1.54 (min)	—	—

10G-KR/KR4
Automation and Debug Solution

10G-KR – 802.3ap Compliance and Debug Solution

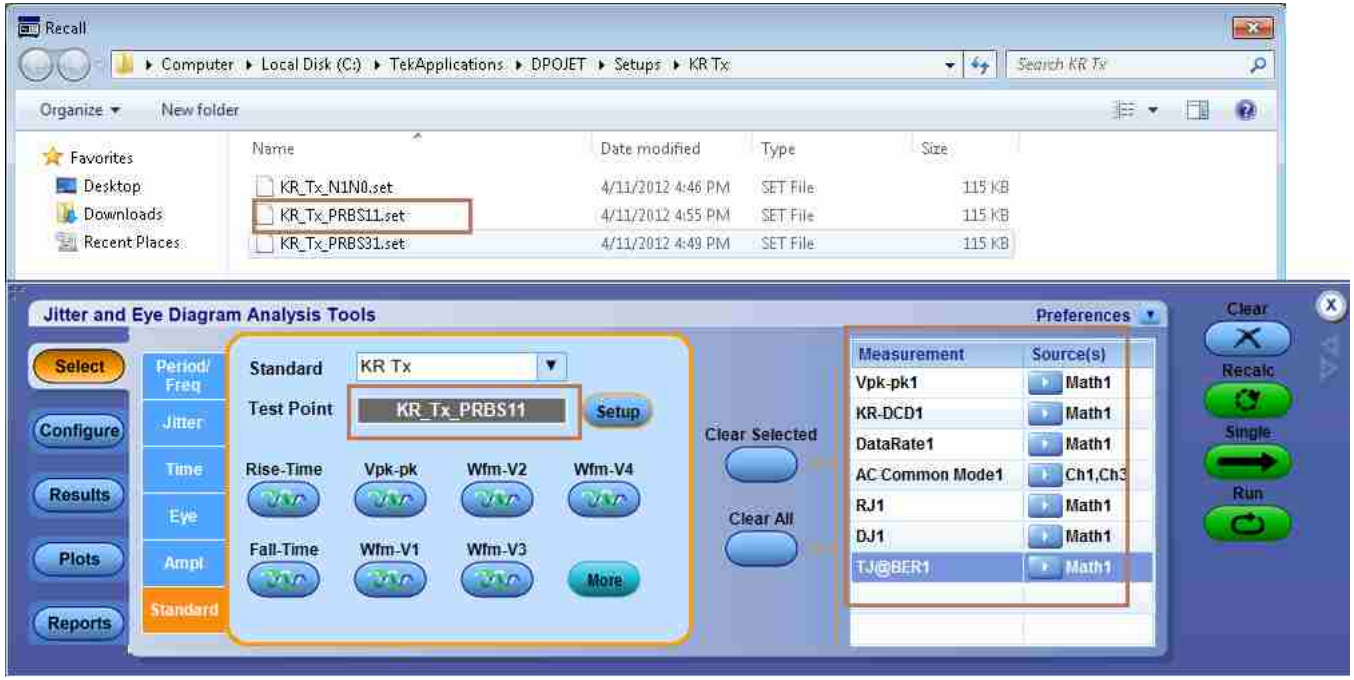
- Automated Tests
  - One-button selection of critical measuremnts reduces testing time
- Integrated Debugging
  - Popular DPOJET-based interface enables deeper debug of timing root cause analysis without moving to a different instrument/measurement setup
- Integrated support for Keithley RF Switch
  - Engineers working on KR4(Four lanes of KR) can make use of Keithley RF Switch to automate their setup, this feature is integrated in the solution
- Documentation/Reporting
  - Real-time waveform capture and pre-recorded waveform support provides ability to share waveform details with other labs, vendors and customers across multiple locations

Tektronix 10G-KR – Automation Option



- Operates on Tektronix DPO/DSA70000C/D Series Oscilloscopes
- Automate setup & quickly generate reports
- Meets Compliance needs of IEEE 802.3ap specifications
- User defined mode enables measurements on signal types like N1N0, PRBS7, PRBS9, PRBS11 PRBS20, PRBS23 & PRBS31

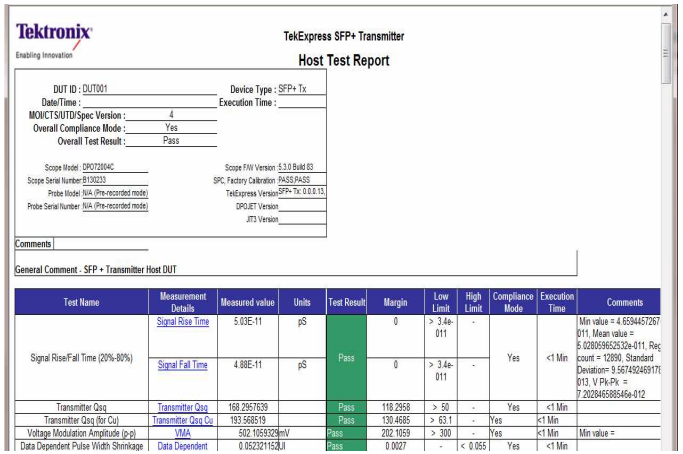
Tektronix 10G-KR – DPOJET Option



- Provides N1N0, PRBS11 and PRBS31 DPOJET Setup files
- Setup files load corresponding measurements with scope setup
- Individual measurement buttons helps engineers change measurement configurations

Reporting and Documentation

- Summary-reporting capability in .mht (HTML) format with pass/fail status
- Detailed report includes
  - Measurement results:
    - Test configuration details, waveform plots, and margin analysis
  - Test Setup details:
    - Calibration status, oscilloscope model, probe model, software version, date, execution time etc.
- Flexible report configuration provides options like auto increment, appending etc.


Tektronix
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TekExpress SFP+ Transmitter

Host Test Report

DUT ID : DUT001
Date/Time :
MOI/CTS/UTD/Spec Version : 4
Overall Compliance Mode : Yes
Overall Test Result : Pass

Device Type : SFP+ Tx
Execution Time :

Scope Model : DPO72004C
Scope Serial Number: B130233
Probe Model: N/A (Pre-recorded mode)
Probe Serial Number: N/A (Pre-recorded mode)

Scope FW Version :5.3.0 Build 83
SPC, Factory Calibration :PASS,PASS
TekExpress Version:SFP+ Tx: 0.0.0.13,
DPOJET Version
JIT3 Version

Comments

General Comment - SFP + Transmitter Host DUT

Test Name	Measurement Details	Measured value	Units	Test Result	Margin	Low Limit	High Limit	Compliance Mode	Execution Time	Comments
Signal Rise/Fall Time (20%-80%)	Signal Rise Time	5.03E-11	pS	Pass	0	> 3.4e-011	-	Yes	<1 Min	Min value = 4.659445726 011, Mean value = 5.028059652532e-011, Rec count = 12890, Standard Deviation= 9.567492469171 013, V Pk-Pk = 7.202845988546e-012
	Signal Fall Time	4.88E-11	pS		0	> 3.4e-011	-			
Transmitter Qsq	Transmitter Qsq	168.2957639		Pass	118.2958	> 50	-	Yes	<1 Min	
Transmitter Qsq (for Cu)	Transmitter Qsq Cu	193.568519		Pass	130.4685	> 63.1	-	Yes	<1 Min	
Voltage Modulation Amplitude (p-p)	VMA	502.1059329	mV	Pass	202.1059	> 300	-	Yes	<1 Min	Min value =
Data Dependent Pulse Width Shrinkage	Data Dependent	0.052321152	UI	Pass	0.0027	-	< 0.055	Yes	<1 Min	

Equipment and software requirement

- Real-time scope: DPO/DSA/MSO BW>=16Ghz
- Matched pair SMA-SMP Cables or Tri mode probes >= 16GHz
- DC Blocks (>16GHz Bandwidth)
- DJA - DPOJET software - Prerequisite
- 10G-KR Automation software
- RF Switch for Keithley S46

XGbT – 10GBASE-T Compliance solution

XGbT – 10GBASE-T Automation Solution

- Comprehensive Automated Solution for 10GBASE-T PHY Compliance
- XGbT performs spectral-based measurements, such as PSD, Power Level, and Linearity, all with a simplified instrument configuration.
- One-button Selection of Multiple Tests and Four-channel Support
- Detailed Test Reports with Margin and Statistical Information Aid Analysis
- Efficient Test Execution on Oscilloscope or PC with Instrument Remote Control
- Call XGbT application programmatically through NI LabVIEW or NI TestStand™ for controlling XGbT test instrumentation along with thermal chambers, power supplies etc.

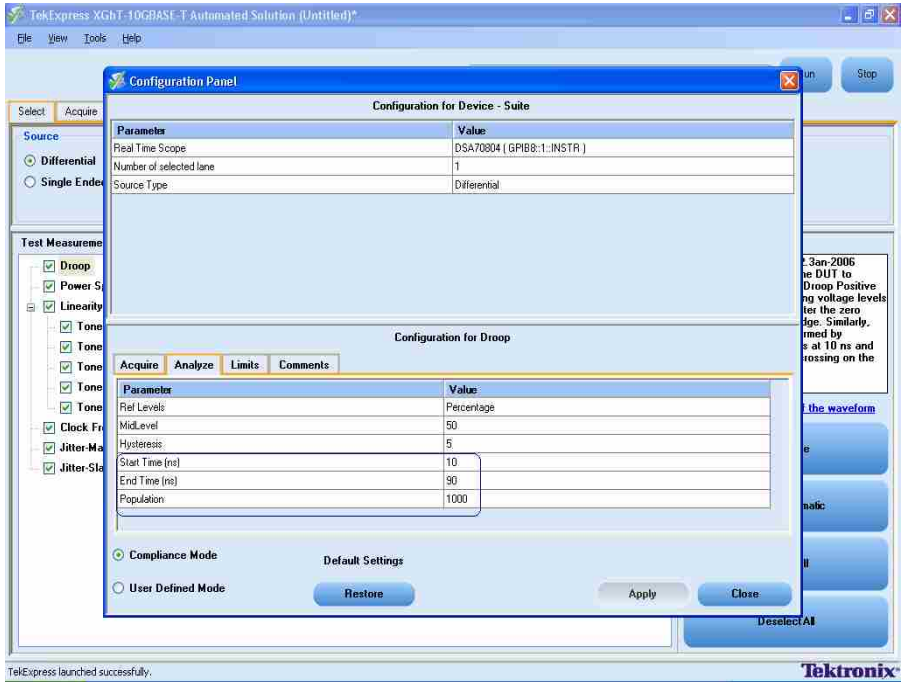
XGbT–10GBASE-T Transmitter Measurements

10GBASE-T Measurements covered in XGbT Solution

	Measurement	Test Mode	XGbT Features / Notes
1	Maximum output droop	Sub clause 55.5.3.1, Test Mode 6	Flexibility to test beyond compliance – XGbT provides the flexibility to perform testing beyond what is specified in IEEE standard 802.3an-2006. It helps users to analyze their PHY in addition to compliance tests.
2	Transmitter timing jitter – Master	Sub clause 55.5.3.3, Test Mode 2	Measure Jitter down to just few picoseconds. Software Filters are designed and applied on the acquired data automatically while performing measurements.
3	Transmit clock frequency	Sub clause 55.5.3.5, Test Mode 2	Exact PPM value for measured clock frequency is shown
4.	Transmitter timing jitter – Slave	Sub clause 55.5.3.3, Test Mode 1 and Mode 3	Measure Jitter down to just few picoseconds. Software filters are designed and applied on the acquired data automatically while performing measurements.
5	Transmitter linearity	Sub clause 55.5.3.2, Test Mode 4 Tones 1-5	Spectral Features of the scope are used to perform the measurement, a methodology that is unique to Tektronix and approved by UNH-IOL
6	Transmitter power spectral density (PSD) and power level	Sub clause 55.5.3.4, Test Mode 5	Spectral Features of the scope are used to perform the measurement, a methodology that is unique to Tektronix and approved by UNH-IOL
7.	Return Loss	Sub clause 55.8.2.1, Test Mode 5	Return Loss is performed using AWG, this method is unique to Tektronix.

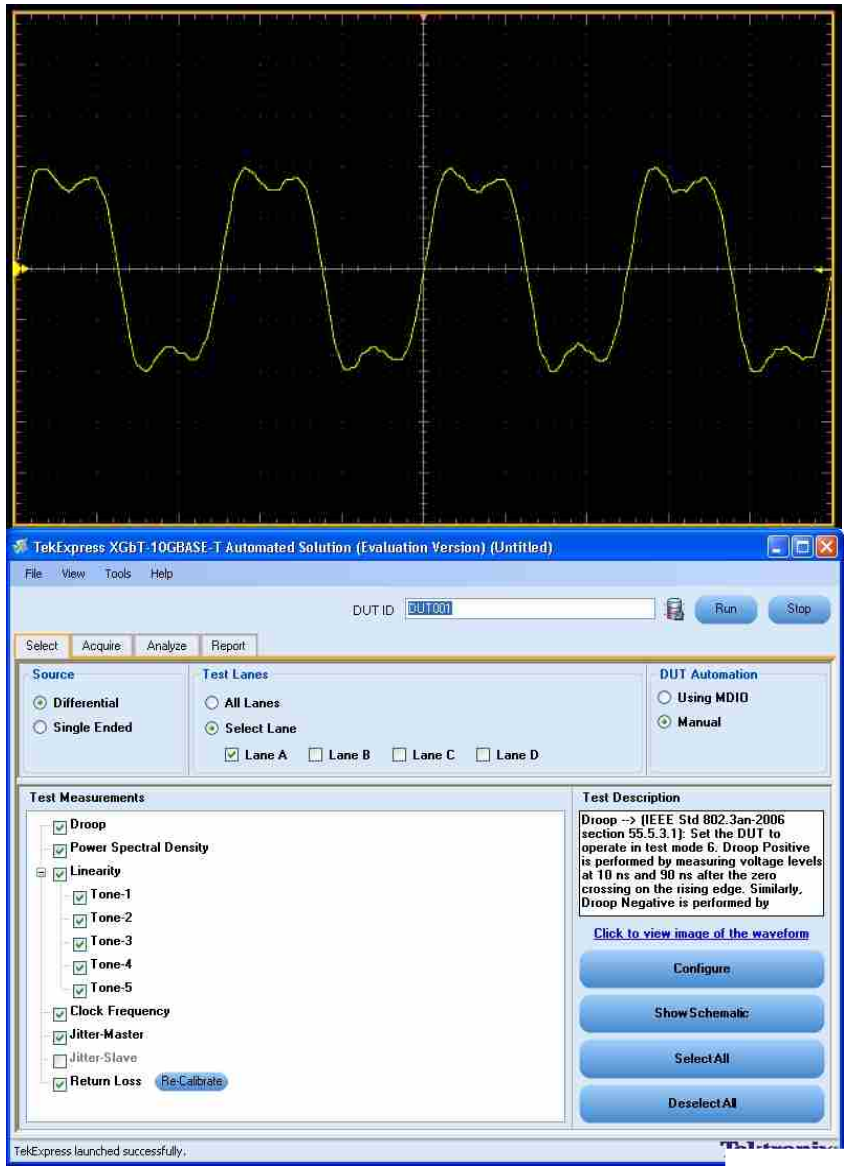
Maximum Output Droop

- **Purpose -** To verify that the transmitter output level does not decay faster than the maximum specified rate.
- The resulting magnitude of both the positive and negative droop shall be less than 10%.
- Flexibility to test beyond compliance – XGbT provides the flexibility to perform testing beyond what is specified in IEEE standard 802.3an-2006. It helps users to analyze their PHY in addition to compliance tests.
- Configure the DUT for Test Mode 6 operation
- IEEE standard 802.3an-2006, sub clause 55.5.3.1



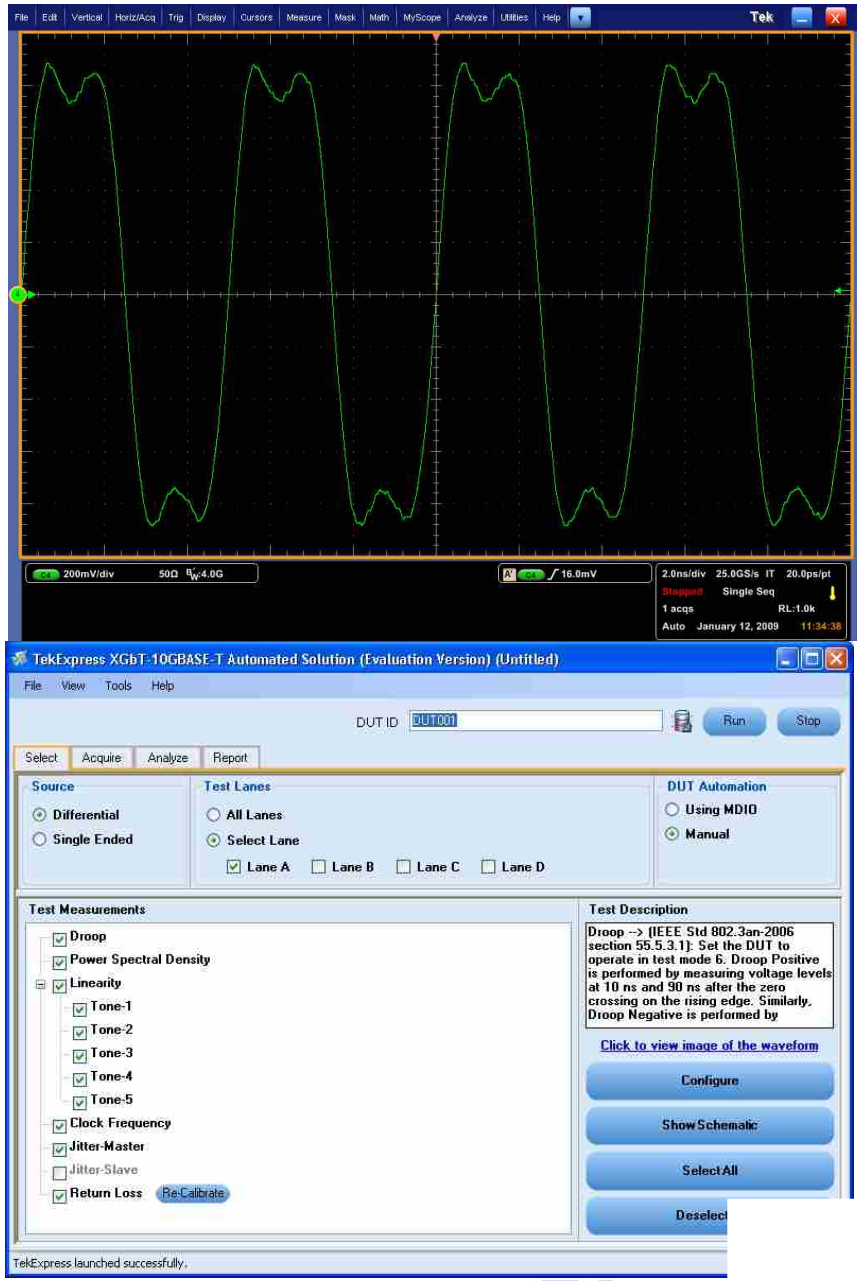
Transmitter Clock Frequency

- **Purpose -** To verify the frequency of the Transmit Clock is within the conformance limits.
- The resulting frequency of the DUT transmit clock shall be 800 MHz ± 50 ppm.
- Configure the DUT for Test Mode 2 operation
- Exact PPM value for measured clock frequency is shown
- IEEE standard 802.3an-2006, sub clause 55.5.3.5

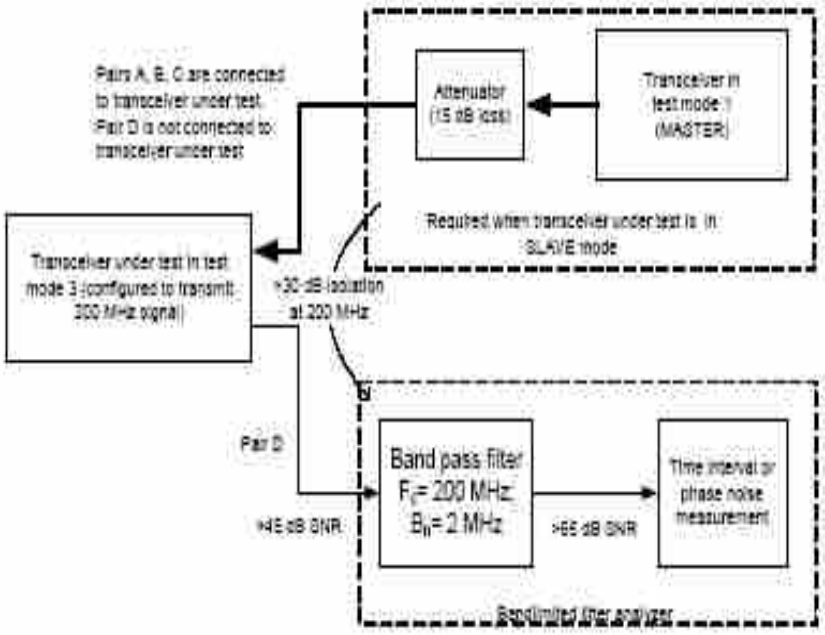


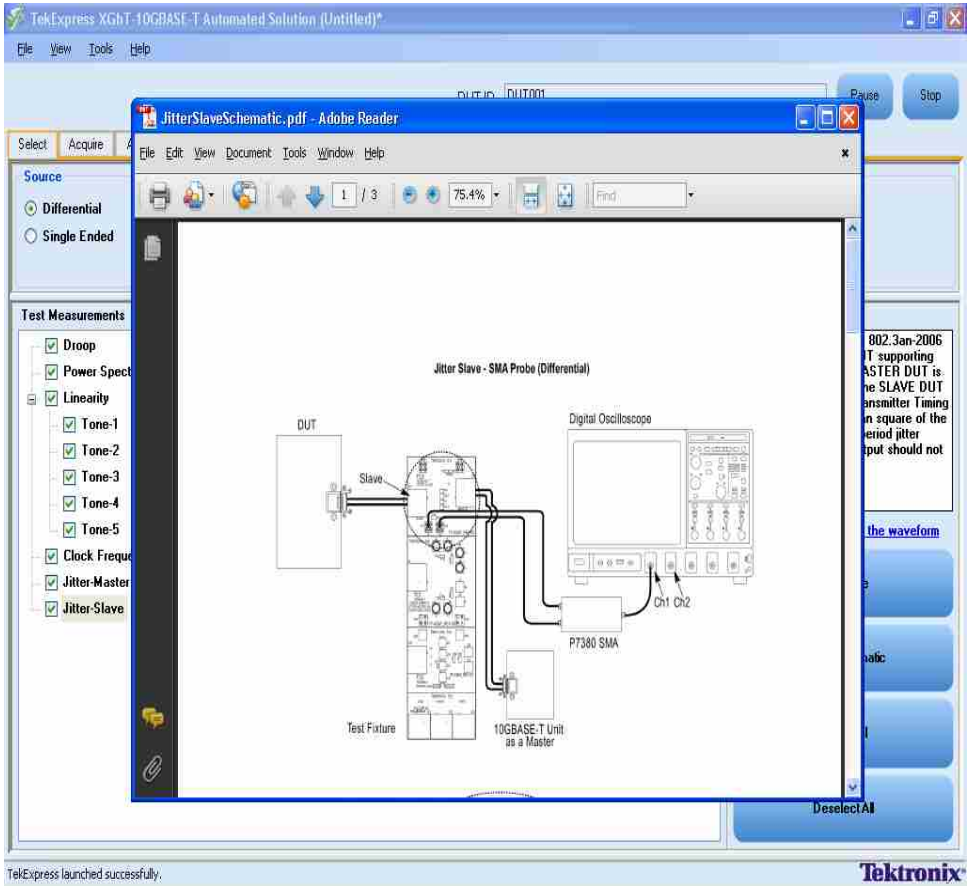
Transmitter Timing Jitter – Master & Slave

- **Purpose -** To verify that the transmitter timing jitter of the PMA is within the conformance limits.
- The resulting RMS period jitter measured at the MDI output shall not exceed 5.5 picoseconds for all cases.
- Configure the DUT for Test Mode 2 operation
- IEEE standard 802.3an-2006, sub-clause 55.5.3.3
- An appropriate software filter available on each oscilloscope is applied to the input waveform.



Transmitter Timing Jitter – Master & Slave …





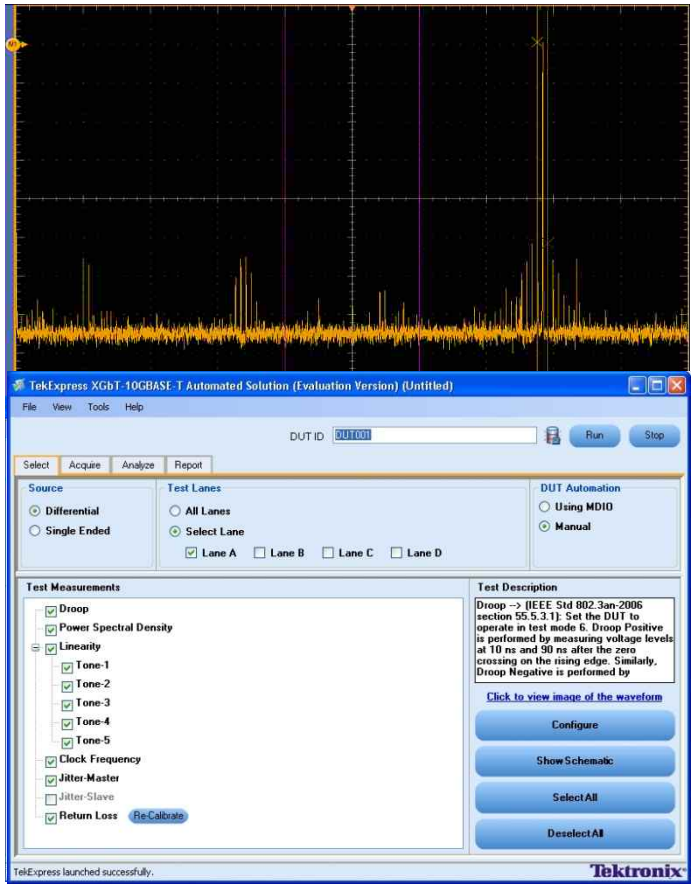
Transmitter Linearity

- **Purpose** : To verify that the output of the transmitter conforms to the transmitter linearity limits.

  Measured on all four lanes i.e. A, B, C & D

- While in Test Mode 4, the SFDR of the transmitter when subject to dual tone inputs producing output peak-to-peak transmit amplitude shall meet the requirement that:

  $SFDR \geq 2.5 + \min\{52, 58 - 20 \times \log10(f/25)\}$



Transmitter Power Spectral Density (PSD) and Power Level

- **Purpose** : To verify the transmitter power level and power spectral density are within the conformance limits.

  Measured on all four lanes i.e. A, B, C & D

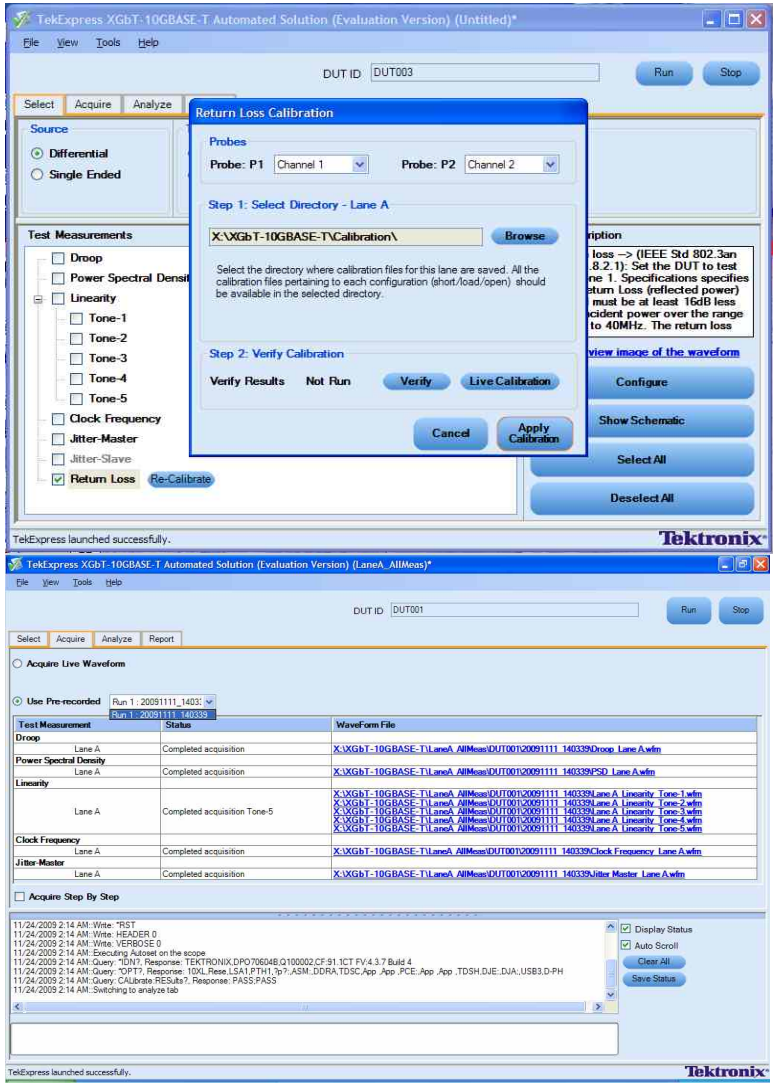
- The transmit power shall lie between 3.2dBm and 5.2dBm

Media Dependent Interface (MDI) Return Loss

- According IEEE Standard 802.3an, for reliable signal transmission, the 10G BASE-T Ethernet DUT must adhere to a return loss limit curve shown in Figure 1. Each link-segment duplex channel shall meet or exceed the return loss at all frequencies from 1 MHz to 500 MHz according to - (Equation 1).

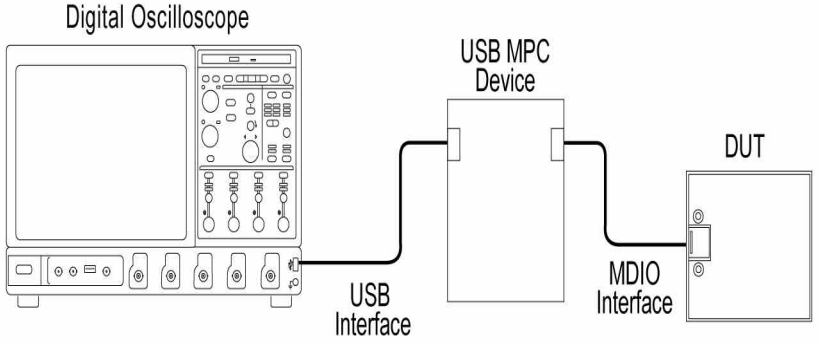
$$10GBASE\ T\ ReturnLoss \quad \begin{cases} 16 & 1 \le f < 40 \\ 16 - 10\log_{10}(f/40) & 40 \le f < 400 \\ 6 - 30\log_{10}(f/400) & 400 \le f \le 500 \end{cases}$$

Equation 1 : Where, f is in MHz.



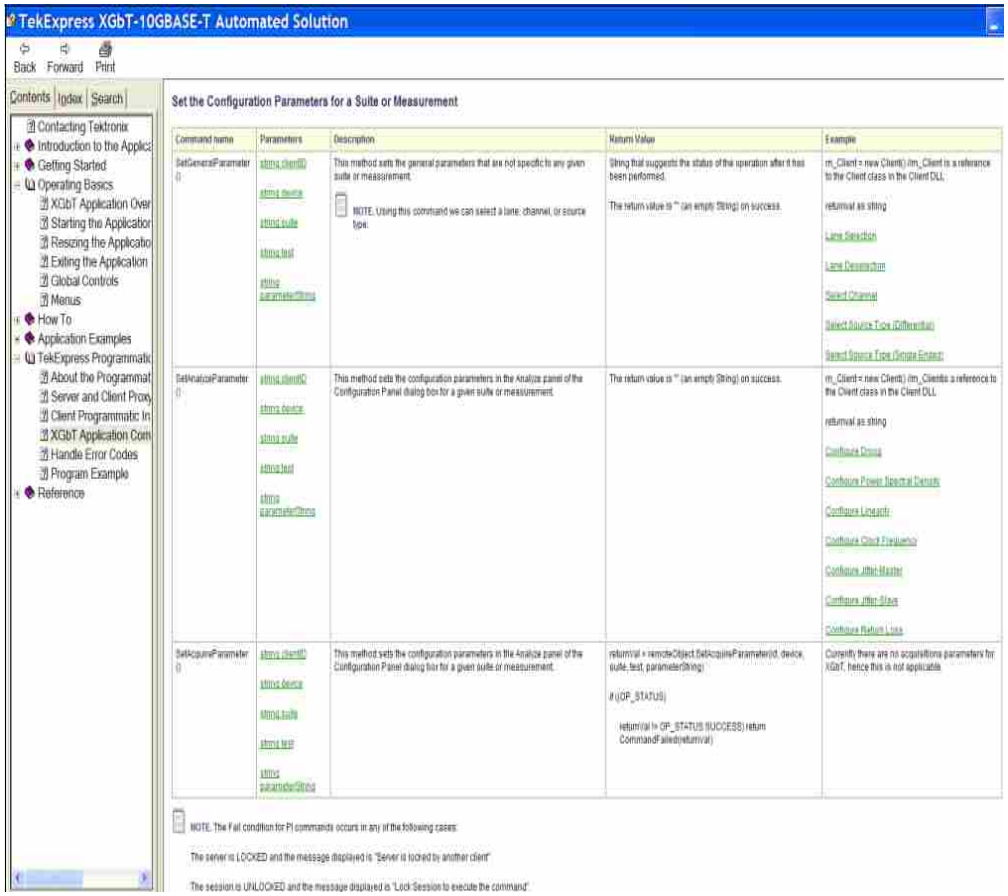
MDIO – DUT Automation

- For those who have worked on ET3 solutions (10/100/1000Base-T Compliance solutions) have always wanted to automatically put the DUT in test mode and then perform required testing automatically.
- XGbT provides a solution for above mentioned problem by using IEEE MDIO interface pins available on a customer's DUT.



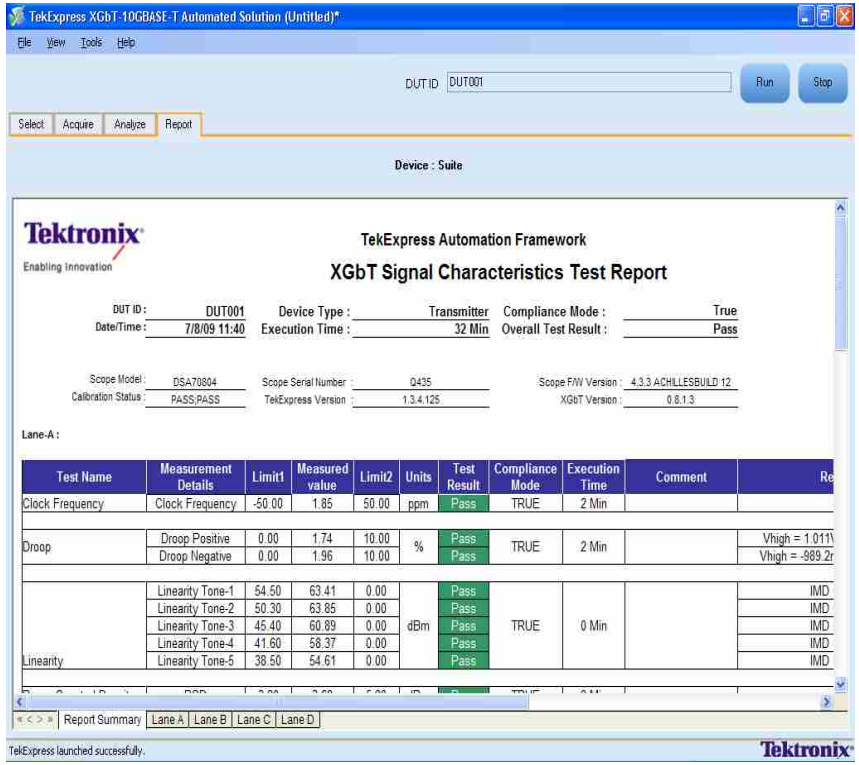
XGbT – Fine Grain Programming Interface

- XGbT provides complete Programming Interface support including fine-grain PI support such as performing individual measurements, configuring each measurement, storing data from reports, etc.
- Customers can now embedded their XGbT-based function call with other T&M equipment function calls.



XGbT - Report

- TEKEXP software provides summary-reporting capability of all lanes in .mht (HTML) format with pass/fail status.
- A detailed report of each lane's performance including test configuration details, waveform plots, and margin analysis is also produced by XGbT providing more insight into compliance efforts underneath the XGbT standard.
- Report also provides additional details like calibration status, scope model, probe model, software version etc



Mapping Technology to Oscilloscope Bandwidth Requirements

- 10GBASE-T provides 10 Gbit/second connections over unshielded or shielded twisted pair cables. To transmit 10Gbps over four lanes, each lane has to carry 2.5Gbit/sec, however, since PAM 16 modulation technique is used, device will be sending 3.125 bit/symbol
- 2.5Gbps/3.125 = 800 MHz
- Fundamental = 800/2 = 400 MHz
- To capture 5th harmonic we require an oscilloscope with minimum bandwidth of 2GHz or higher, PSD requires a Scope with 3 GHz BW
- DPO70404B or higher bandwidth oscilloscope is recommended for maximum margin on the linearity test however the DPO7354 oscilloscope meets all compliance limit requirements and may be used as a lower bandwidth alternative.

XGbT : Features and Benefits

- Simplified Instrument Setup – Save Time and Resources
- Four-channel Support
- Differential or Singled-ended Acquisition Support
- Margin Testing capability
- One-button Testing
- Automation Support / LabVIEW Support
- Detailed report
- Fine Grain Programming Interface
- MDIO – DUT Automation

XGbT Recommended Equipment

Oscilloscopes	Required Software	Required Accessories	Test Fixture	AWG
DPO/DSA70404B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K
DPO/DSA70604B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K
DPO/DSA70804B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K
DPO/DSA71254B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K
DPO/DSA71604B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K
DPO/DSA72004B	TEKEXP & TEKEXP XGbT	P7380SMA / Matched pair SMA cables(TCA-SMA connector)	TF-XGbT – Tektronix Fixture	AWG7K

XGbT Supported Probes		
DPO/DSA/MSO 70K scopes	Return Loss	All Other Measurements
	P6330	P6330
	P7330, P7350	P7330, P7350
	Tri Mode Probes – P7520, P7516, P7513A, P7508, P7506, P7504	Tri Mode Probes – P7520, P7516, P7513A, P7508, P7506, P7504
	P7340A, P7360A, P7380A	SMA Cables
		P7350SMA, P7380SMA, P7313SMA

TF-XGbT Test Fixture

- The XGbT test fixture provides easy access to the 10GBASE-T Electrical signals to perform conformance testing and device characterization as described in of IEEE 802.3an-2006 sub-clause 55.5.3 & 55.8.2.1. This fixture is used with the Tektronix's XGbT- 10GBASE-T Automation Solution to provide fast and accurate design debugging and validation. XGbT fixture covers all seven measurements including Jitter Slave and MDI Return Loss

Fig 1: XGbT Test Fixture main board

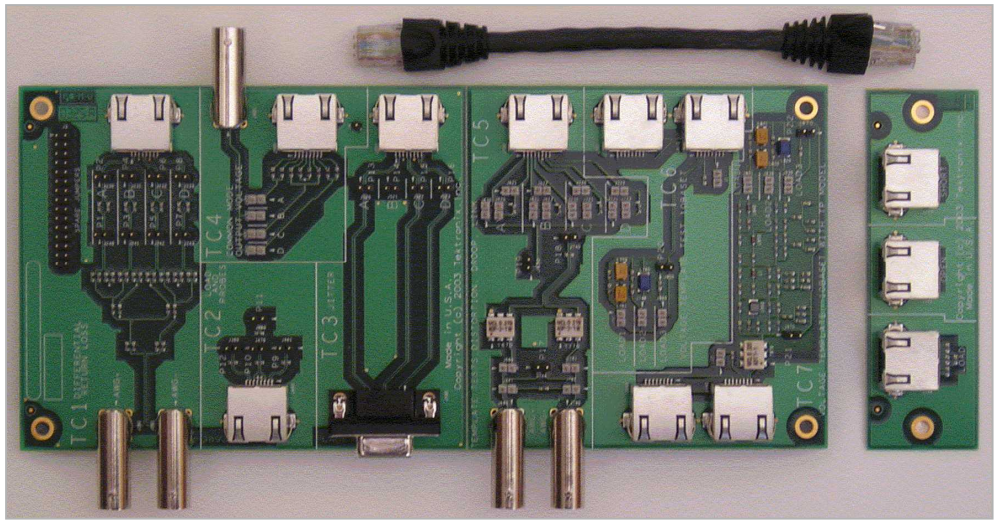
Fig 2: Calibration Board

Figure 3: RJ45 Shielded Patch cord

ET3-10BASE-T,10BASE-Te, 100BASE-TX, 1000BASE-T

Ethernet Application Software – ET3

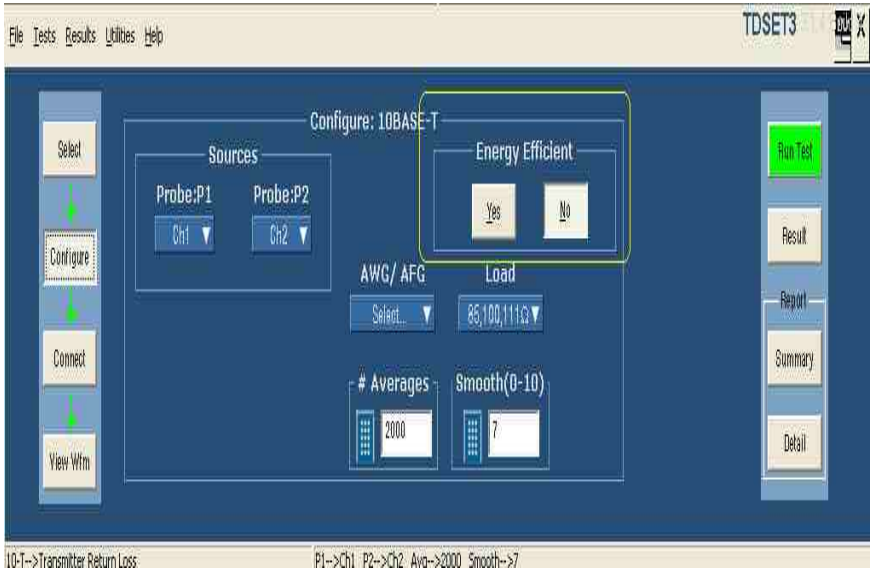
- TDSET3 Ethernet Compliance Testing – Over 2500+ End-Users
  - Automated Compliance Testing for 10, 100, and 1000BASE-T PHY Verification
  - Designed for use with MSO/DPO5000, DPO7000, and DPO/DSA/MSO70000 Series Oscilloscopes
- Applications
  - 10BASE-T Ethernet
  - 10BASE-Te Ethernet(EEE)
  - 100BASE-TX Ethernet
  - 1000BASE-T Ethernet

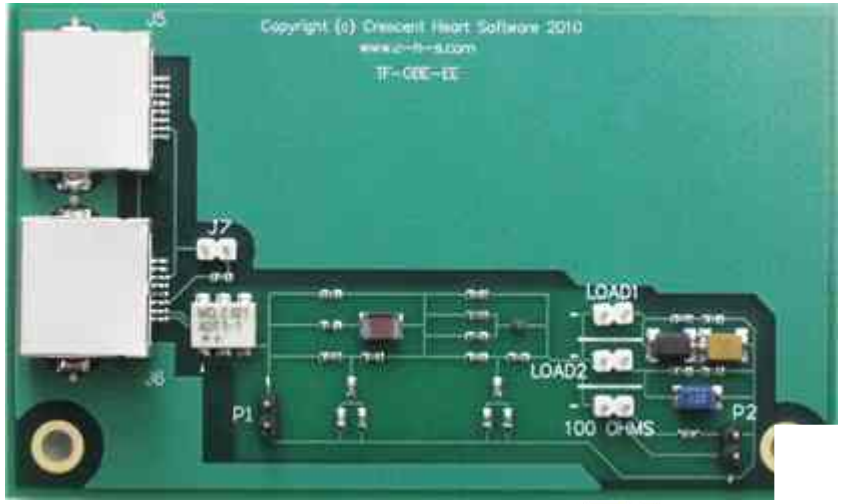


Efficient Ethernet - 802.3az

Energy Efficient Ethernet – 802.3az

- Tektronix is first to market again
- 10BASE-Te measurements sit on top of current ET3 solution
- CHS has designed, developed and manufactured a fixture which is available with our solution
- Presently changes are made to 10BASE-T part of the software and fixture
- 15 Customers added in last 6 months





Tektronix Optical Solution Overview

Introducing the DSA8300 Digital Serial Analyzer
More Performance and Versatility

- Industry's best native time-base jitter performance, 425 fs $_{RMS}$ *typical* (<200 fs $_{RMS}$ when equipped with the 82A04 Phase Reference module)
- 16,000 point native record length
- 300 kSa/s TDR mode maximum sample rate
- 16 bits of vertical resolution
- Optional fully integrated pattern synchronization (replaces 80A06)
- 4X Pattern Sync throughput performance
- Clock Pre-scalar maximum input frequency 20 GHz *typical*
- 3 GHz Intel Core 2™ Duo CPU
- New user interface look and feel leveraging MS Windows 7 Ultimate Operating System
- XVGA (1024 X 768) 10.4 inch display

- Supports all 8K Sampling and Accessory * Modules
  - Except 80A06 which is replaced with available fully integrated ADVTRIG

DSA8300 Digital Serial Analyzer
DSA8300 Optical Module Portfolio

Multi-mode, Broad Wavelength (750 - 1650 nm) Modules	
80C07B	Supports rates to 2.7 Gb/s, high sensitivity, optional integrated clock recovery
80C08D	Supports all of the 8/10 Gb/s applications, high sensitivity, optional integrated clock recovery, optional Integrated CR
80C12B	Supports rates from 155 Mb/s – 11.3 Gb/s, high sensitivity - data pick-off for external CRU e.g. CR125A
80C14	Supports rates from 8.5 Gb/s – 14.063 Gb/s, high sensitivity – data pick-off for external CRU e.g. CR175A

Single-mode, Long Wavelength (1100 - 1650nm) Modules	
80C11B	Optical bandwidth to 30GHz, supports 10Gbit/s up to14G+ standards, optional Integrated CR
80C10C	Optical bandwidth to 80GHz, supports all 25, 40 and 100 Gb/s (4 x 25 Gb/s) standards, optional CR trigger pickoff for e.g. CR286A CRU

155Mbps to100Gbps Optical Compliance Testing DSA8300 ALL-IN-ONE Solution

- The 80C12B Optical Modules provides:
  - Support for all major rates from 155 Mb/s to 12.5 Gb/s
  - Low-noise, wide dynamic range
  - Excellent optical sensitivity
  - Broad wavelength
  - Both single and multi-mode support
- The DSA8300 ALL-IN-ONE Solution provides
  - Support for all major rates from 155 Mb/s to 44.5 Gb/s
- Integrated and calibrated clock recovery
  - Tektronix CR286A up to 28.6 Gb/s
  - Third party CRU to 44.5 Gb/s

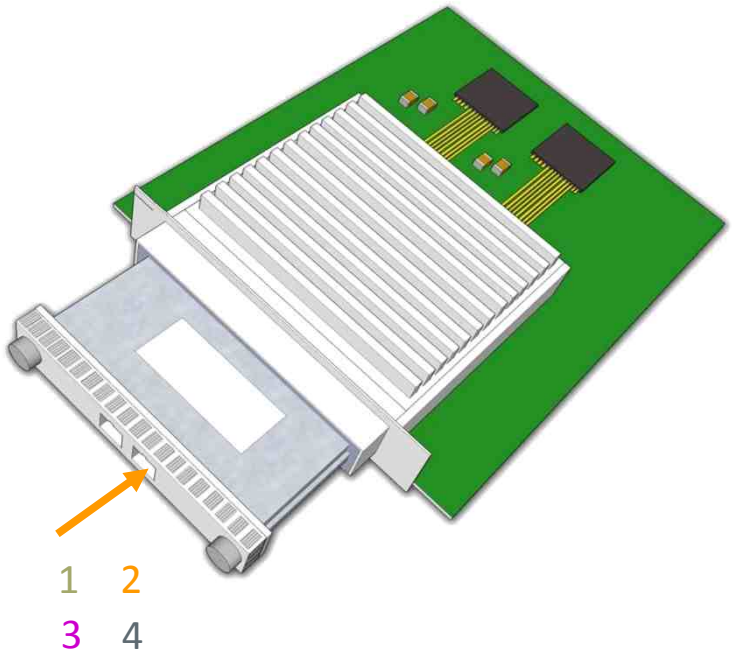
Standard	Line Rate	80C12 B	80C10C Opt F1
OC-3/STM-1	155 Mb/s	✓	
OC-12/STM-4	622 Mb/s	✓	
FC1063	1.0625 Gb/s	✓	
ENET1250	1.250 Gb/s	✓	
FC2125	2.125 Gb/s	✓	
OC48//STM48, GBE, INF2500	2.488 Gb/s 2.500 Gb/s	✓	
FEC2.666	2.666 Gb/s	✓	
!0GBASE-X4, FC3188	3.125 Gb/s 3.188 Gb/s	✓	
FC4250	4.250 Gb/s	✓	
INF5000	5.000 Gb/s	✓	
OBSAI6144	6.144 Gb/s	✓	
CPRI7373	7.373 Gb/s	✓	
FC8500*8, OC-192/STM-64, 8GFC, 10GBASE-W, 10GBASE-R, 40GBASE-R4, 100GBASE-R10, 10GFC, FEC10.66, FEC10.71, FEC11.10, FC11317	8.500, 9.95,10.31, 10.51,10.66,10.71,11.1, 11.3 Gb/s ORR Filters plus Unfiltered bandwidth path (typically 12 GHz)	✓	
100GBase-LR4, 100GBase-ER4 Infiniband EDR (LW)	4 x 25.781 Gb/s		✓
OTU4	4 x 27.952 Gb/s		✓
40GBase-FR	41.25 Gb/s		✓
OC-768 / STM-256, VSR-2000	39.813 Gb/s		✓
OTU3 (OC-768 + G.709 FEC), VSR-2000 , 4x10G LAN-PHY (OTU3)	43.018 Gb/s 44.50 Gb/s		✓

Optical SRS Testing (40GBASE-LR4, 100GBASE-LR4, ER4)

1. CFP Module is used for 40/100GbE

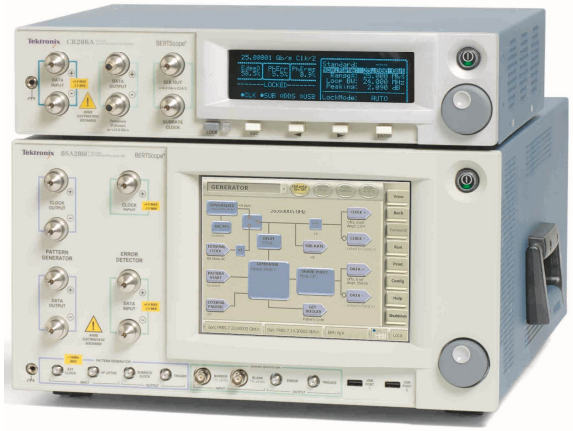
2. Stressed Receiver Sensitivity (SRS) testing of 40GBASE-LR4 and 100GBASE- ER4/LR4 testing is on four separate 1300nm WDM channels:
   a) 40GBASE-LR4 is at 10.3125Gb/s
   b) 100GBASE-LR4, ER4 are both at 25.78125Gb/s

3. Use of 4 channel WDM complicates testing



The Complete BER Analysis Tool 100G PHY Testing

BER, Clock Recovery, Jitter and Failure Analysis



CR286A 28.6G Clock Recovery Module

- Versatile Precision Clock Recovery and Analysis

NEW! BSA286C 28.6G Bit Error Rate Analyzer

- The Confidence of a BERT with the Insight of an Oscilloscope

Generation

- Guaranteed 1 to 28.6Gbps Coverage
- **Industry-best** Jitter Noise Floor
  - Rj (Wide-Band) < 300fSec RMS
  - DDj < 4pSec
  - Tj < 10pSec @ 10e12
- Full Clock Management
  - Full rate (28.6) stressed clock
  - Clock to Data adj skew (150pSec)

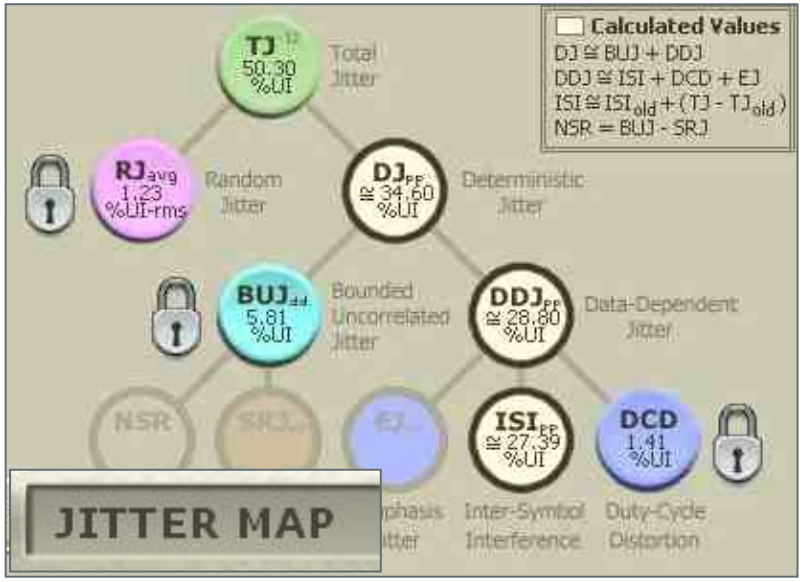
Clock Recovery

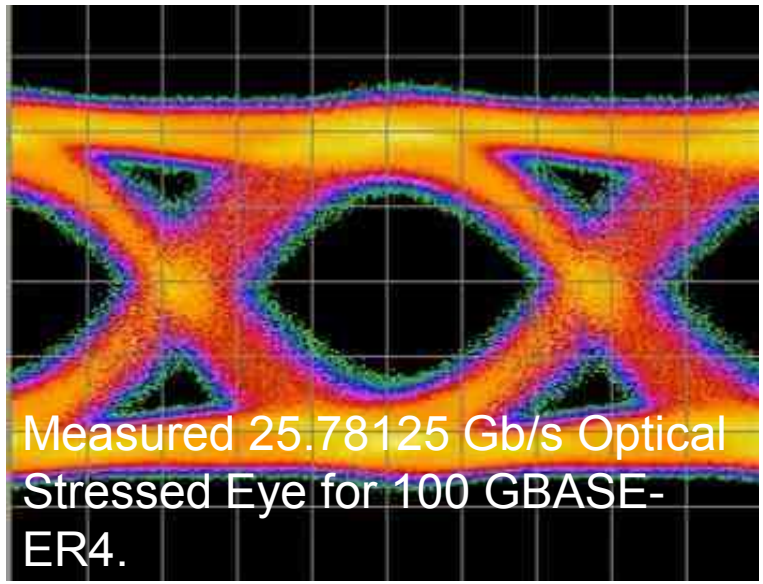
- **Industry's only** turnkey solution to 28.6Gbps
  - No need for mux or 3rd party
- Provides accurate "Golden PLL"
- Clock Recovery Input Equalization
  - Enables clock recovery on high ISI signal

Error Detection

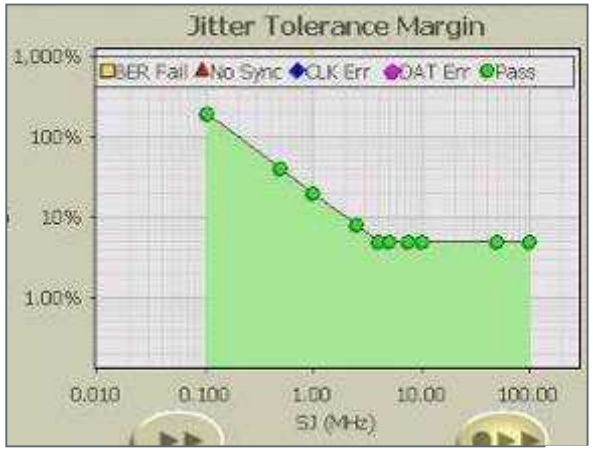
- Easy to Operate User Interface
- **Industry's only BERT** with Jitter mapping, SI and component decomposition

100 GBASE-LR4/ER4 Optical Stressed Eye using Tektronix BERTScope

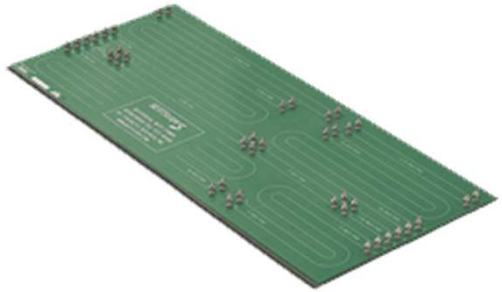




1. Jitter Tolerance test performed by introducing the stressed eye to the DUT, then changing the SJ amplitudes and frequencies to the prescribed template, ensuring there are no errors at each point.
2. Go beyond the required values to assess design margin.



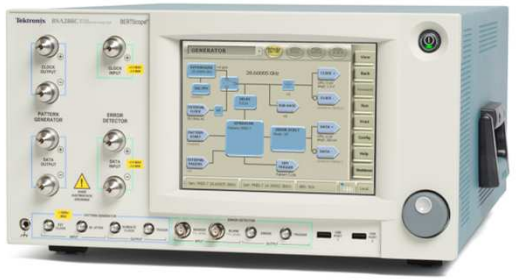
Recommended Test Equipment for 40GBASE-LR4, 100GBASE-LR4 Testing



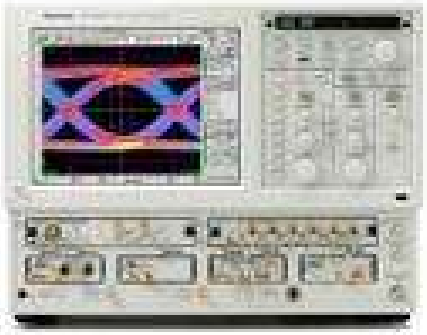
ISI for Compliance

BERTScope CR286A
For Flexible Clock Recovery

BERTScope BSA286C
For Pat Gen and Error Detect



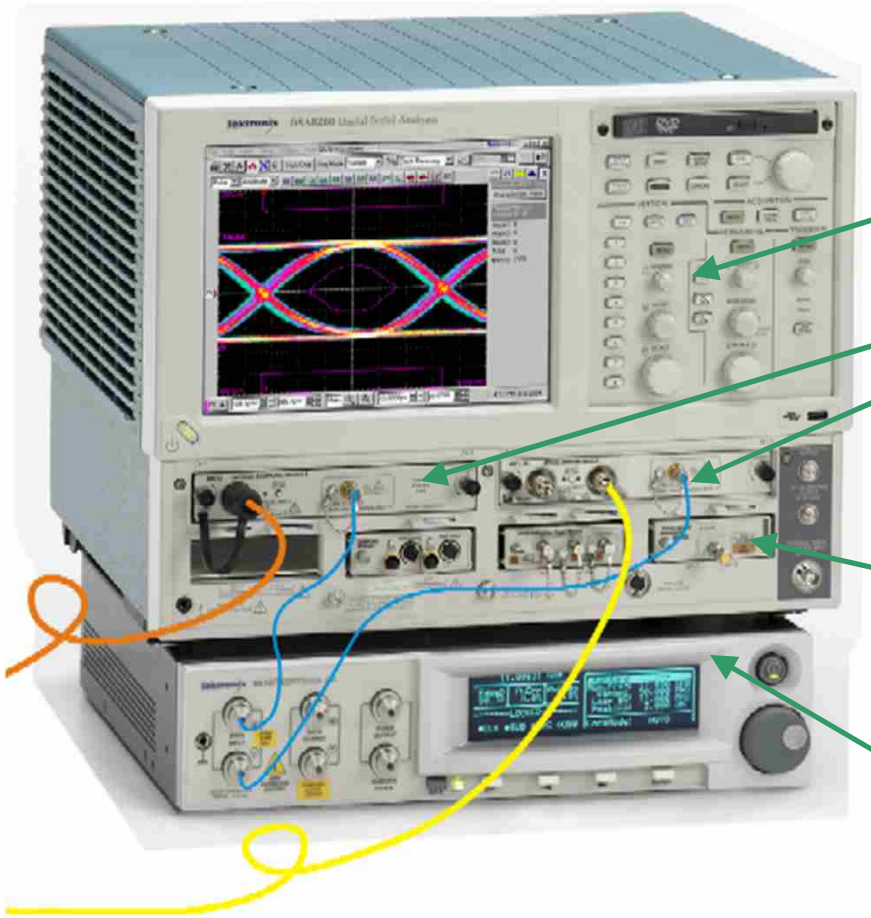
DSA8300 Series Sampling Scope
For Tx Eye Diagram



Eye Diagram for Transmitter Test Compliance

- 100 Gbps Optical Transmitter Test – Datacom / Telecom
  - Compliance for 25.781 Gb/s 100GBASE-R4 and 27.95243 Gb/s OTU4
- 40 Gbps Optical Transmitter Test – Datacom
  - Compliance for 41.25 Gb/s 40GBASE-FR
- 40 Gbps Optical Transmitter Test – Telecom
  - Compliance for OC-768 / STM-256 (39.8Gbps)
  - Compliance for ITU-T G.709 FEC, 4x10G LAN PHY OTU3 (43.02 Gbps)

10, 25, 28, and 40 Gb/s Capable; CRTP Clock Recovery Data out option



- Single DSA mainframe is capable of handling all bit-rates of the standard.

Digital Sampling Oscilloscope:

- Tektronix DSA8300

Optical Modules:

- 80C12-10G or 80C08C for 10 Gb/s signaling
- 80C10B-F1[1] for 25, 28 and 40 Gb/s signaling (40 Gb/s is part of the upcoming 802.3bg)

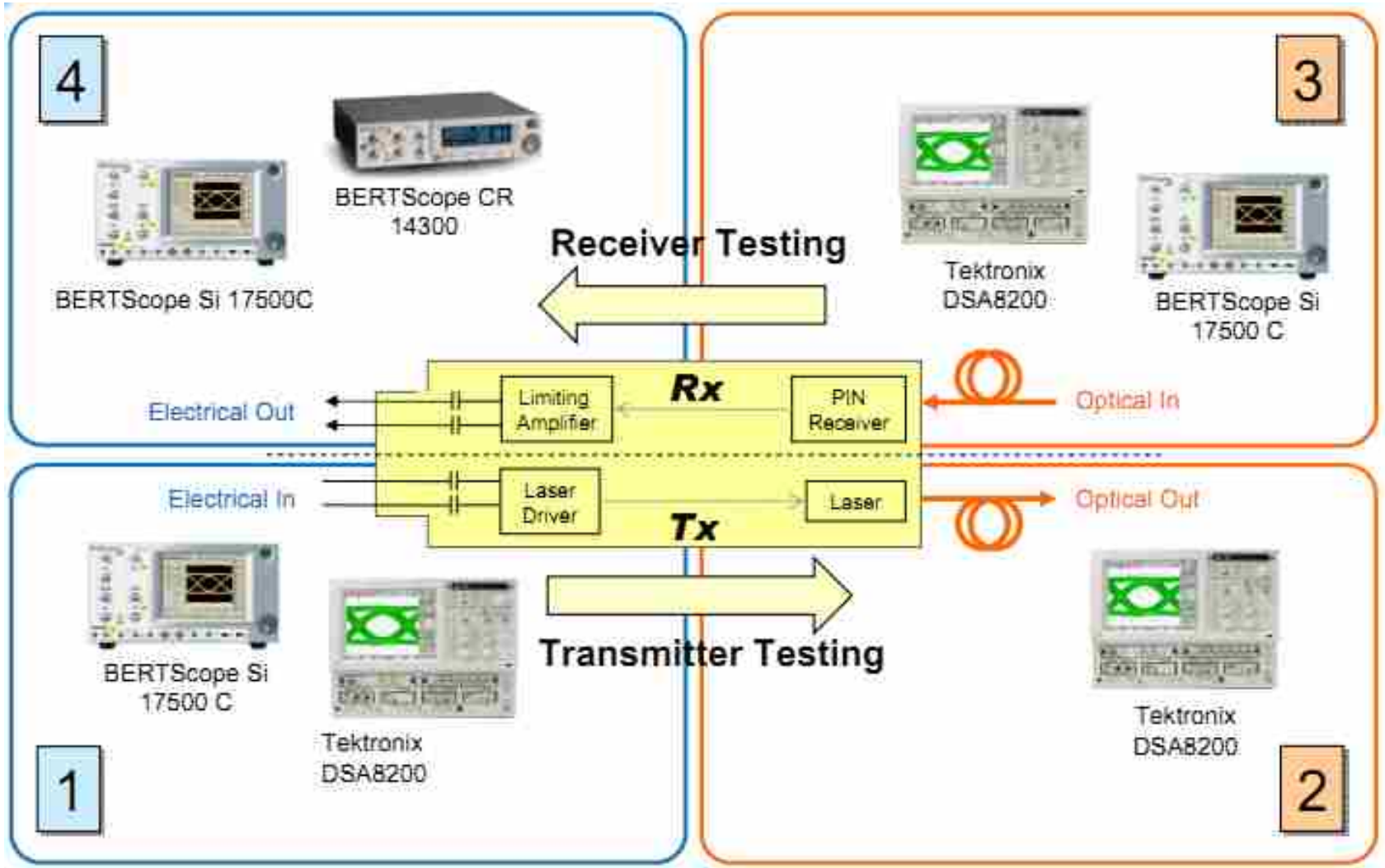
Recommended above 10 Gb/s:

- 82A04 Phase Reference module for high accuracy/ low jitter

Clock Recovery

- Tek 80A07 to 12.5 G, above SyntheSys or future solution up to 28.6 Gb/s; SHF for 40G – or use your own CR

Overview of testing an optical transceiver

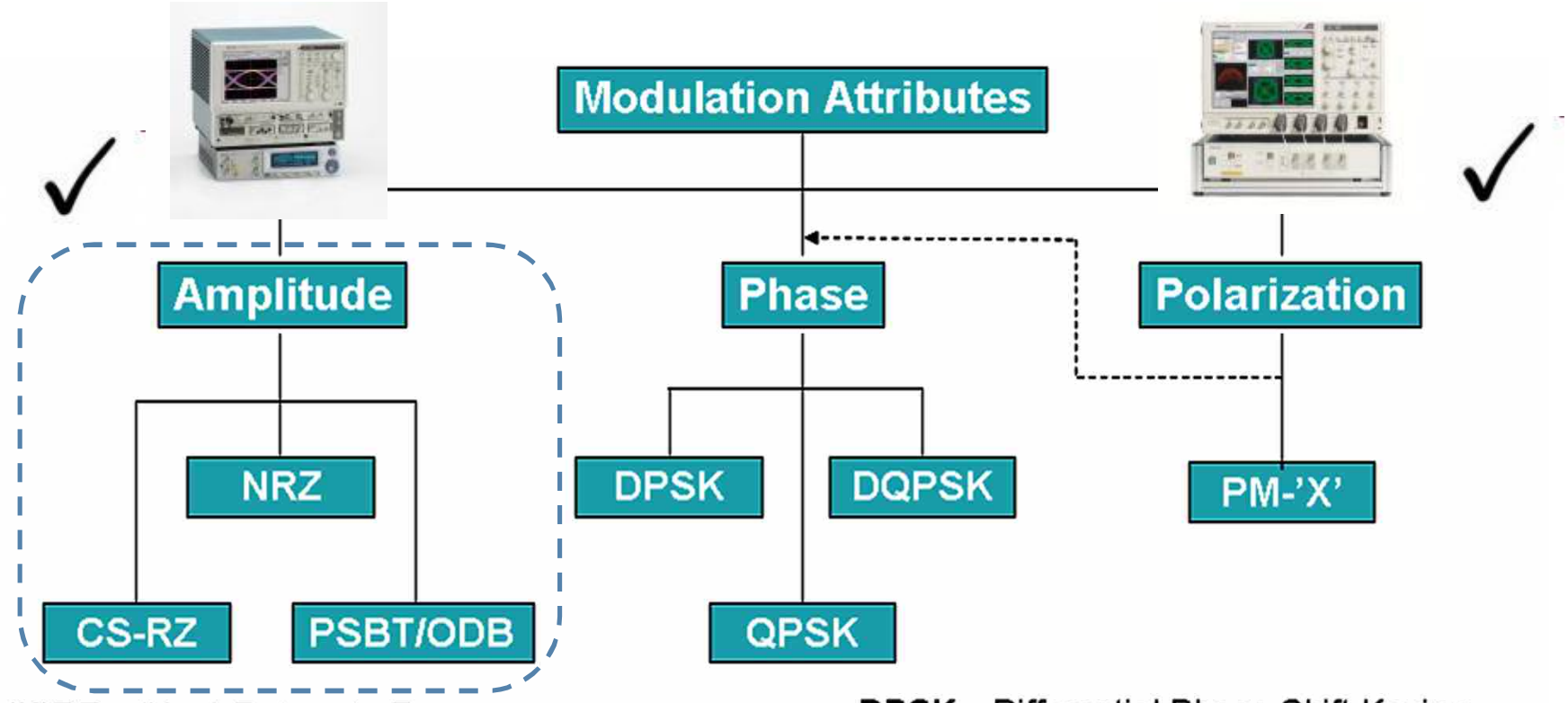


40Gb/s and 100Gb/s Optical Communication Details

Application	Standards	Modulation Formats	Bit Rate	Physical Medium
40 Gb/s Datacom (LAN)	**IEEE P802.3ba** 40GBase-SR4	NRZ	4 x 10.3125 Gb/s	Parallel MMF ribbon cable (OM3) / 100m reach
	40GBase-LR4	NRZ	4 x 10.3125 Gb/s	CWDM SMF / 10km
	40GBase-LR (future serial)	NRZ	41.25 Gb/s	SMF / 10km
100 Gb/s Datacom	100GBase-SR10	NRZ	10 x 10.3125 Gb/s	parallel MMF ribbon cable (OM3)
	100GBase-LR4 100GBase-ER4	NRZ	4 x 25.781 Gb/s	WDM on SMF 10km, 40km
40 Gb/s Telecom (Metro, WAN, Long-haul)	**ITU-T** OC768 / STM256 / OTU3 G.709 VSR-2000	NRZ, RZ Duobinary DPSK	39.813 Gb/s and 43.018 Gb/s	(D)WDM SMF
		DQPSK	2 x 20 Gb/s	(D)WDM SMF
	Nortel proprietary (deployed)	DP-QPSK (with coherent receiver)	4 x 10 Gb/s	DWDM on SMF
	Nortel proprietary (future)	DP-BPSK (coherent RX)	2 x 20 Gb/s	DWDM SMF (ULH)
100 Gb/s Telecom	**OIF** (physical medium layer)	DP-QPSK (with coherent receiver)	Up to 4 x 32Gb/s	DWDM on SMF (ULH) >1000km reach
	ITU-T (higher layers) OTU-4	*not specified*	112 Gb/s (aggregate)	DWDM SMF
	ADVA proprietary (R&D)	DPSK-3ASK	2.5 x 40 Gb/s	Metro DWDM 40 - 600km
	Other early R&D	OFDM, APSK, nQAM		SMF

Long Haul Optical Communication Solution

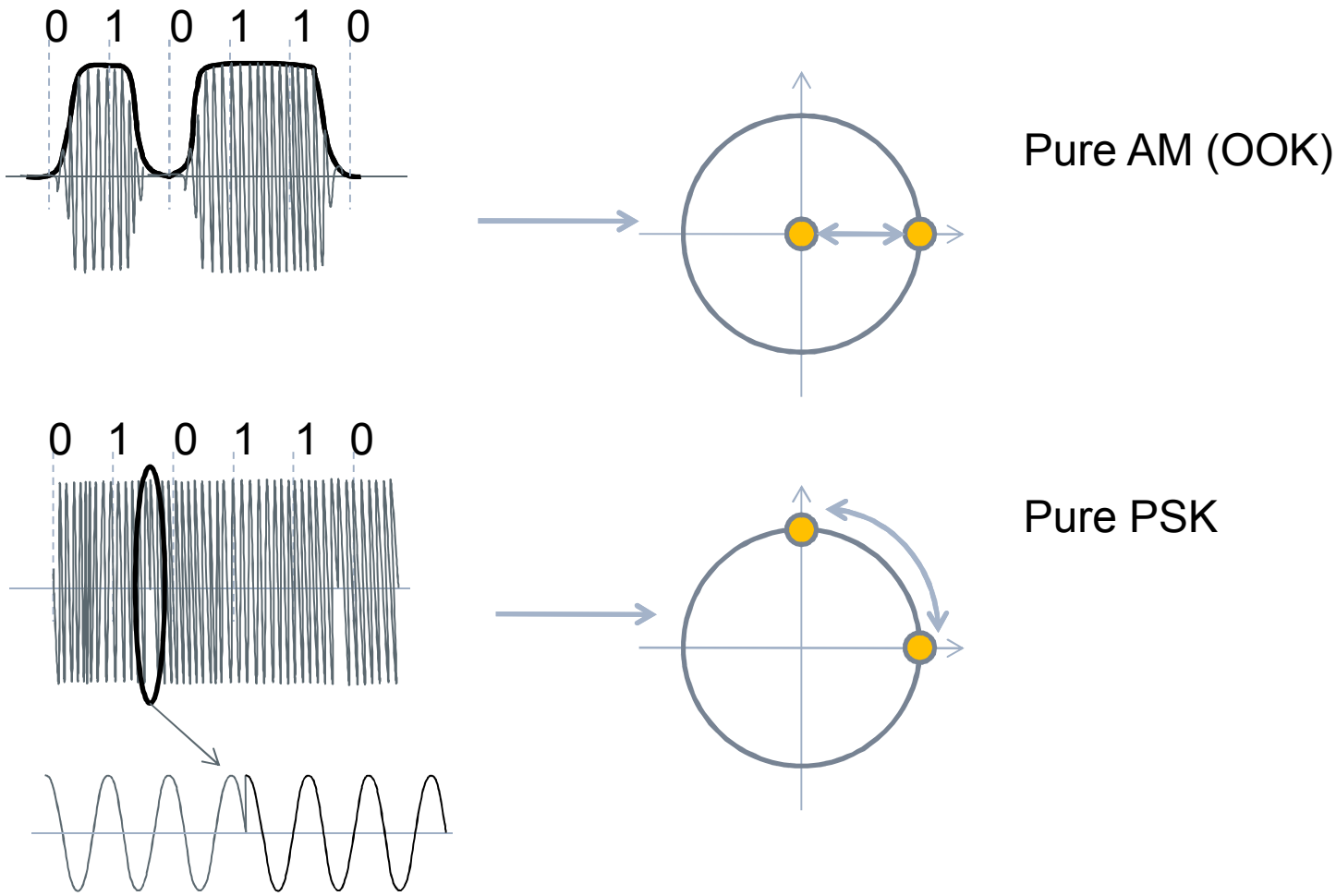
Complex Modulation Formats



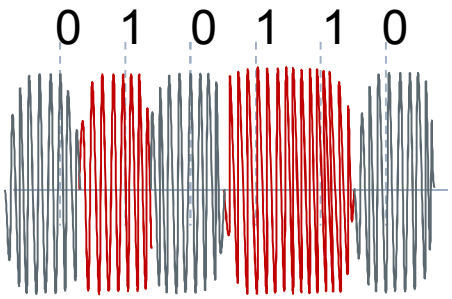
(N)RZ—(Non) Return to Zero
PSBT—Phase Shaped Binary Transmission
ODB—Optical Duo-Binary
CS-RZ—Carrier Suppressed Return to Zero
DQPSK—Differential Quadrature Phase Shift Keying

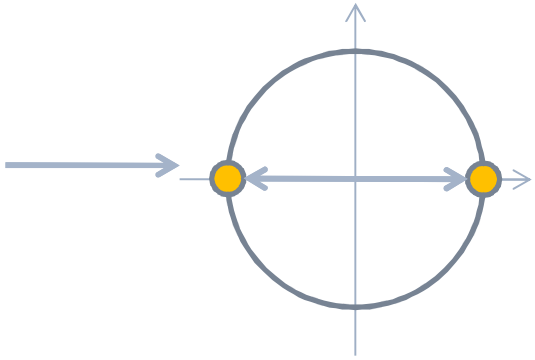
DPSK—Differential Phase Shift Keying
QPSK—Quadrature Phase Shift Keying
PM-'X'—Polarization Multiplexing

Optical modulation methods

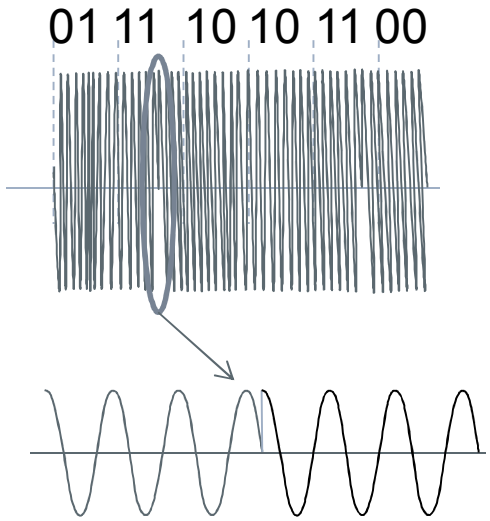


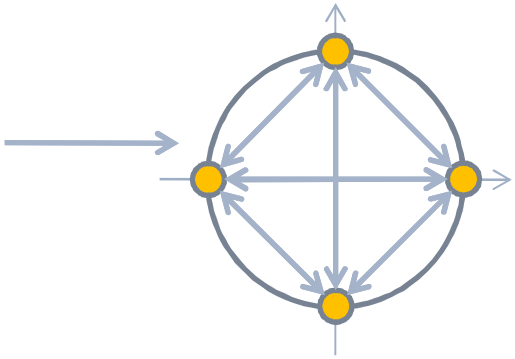
Optical modulation methods cont.





Typical BPSK

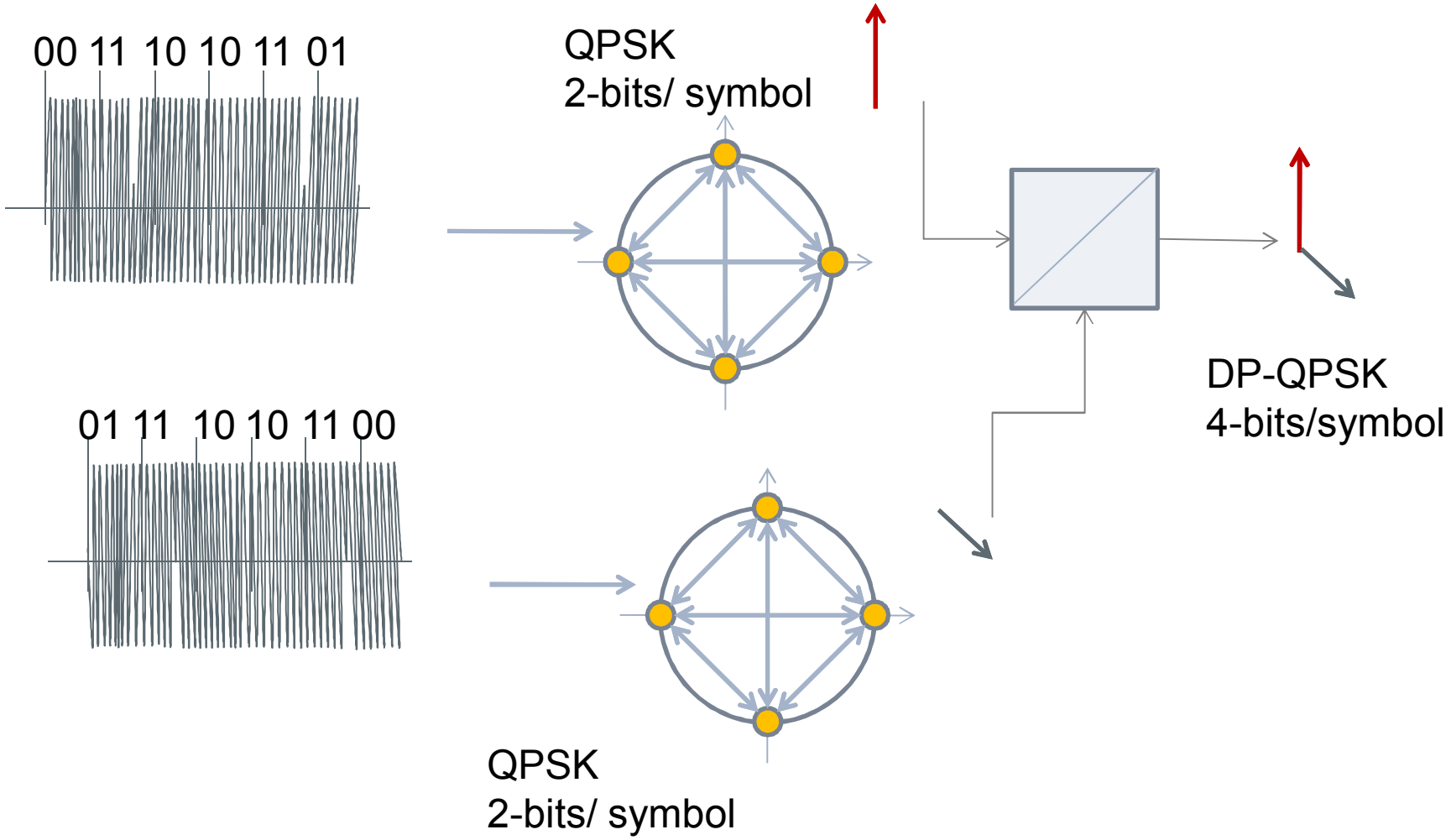




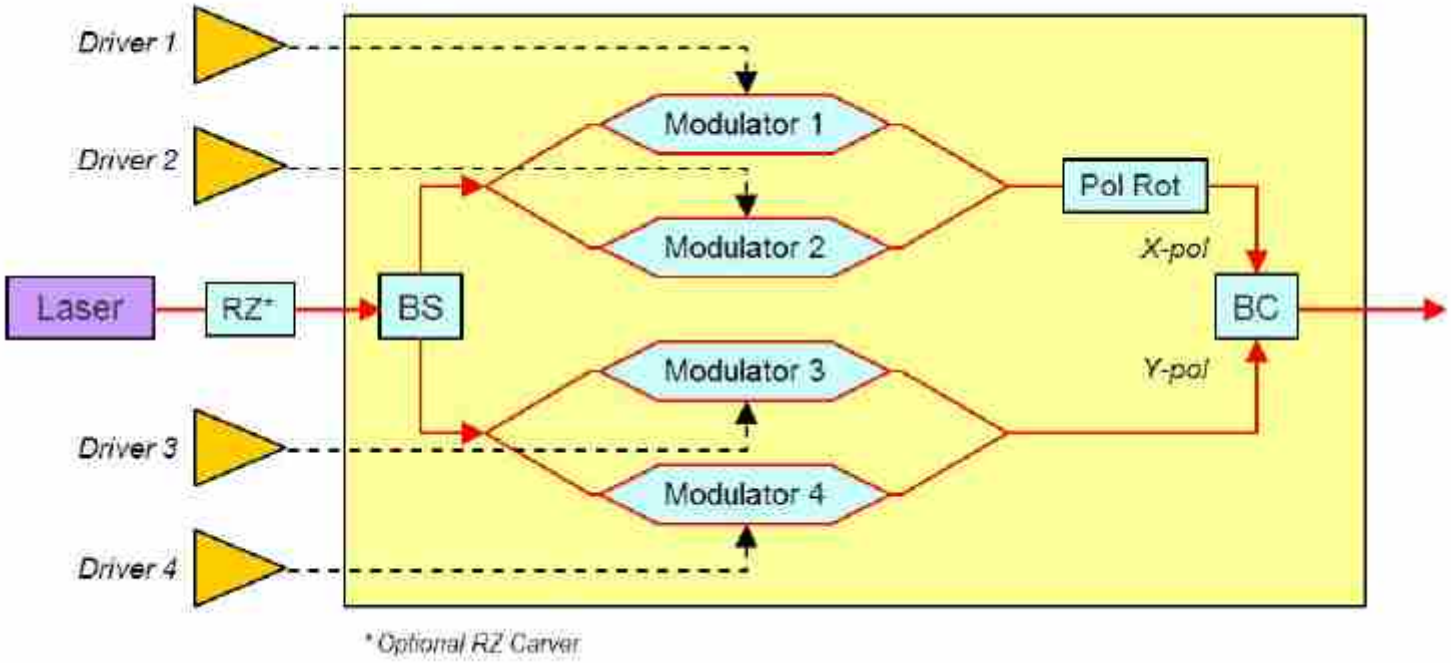
Typical QPSK

2-bits/ symbol

Optical modulation methods cont.

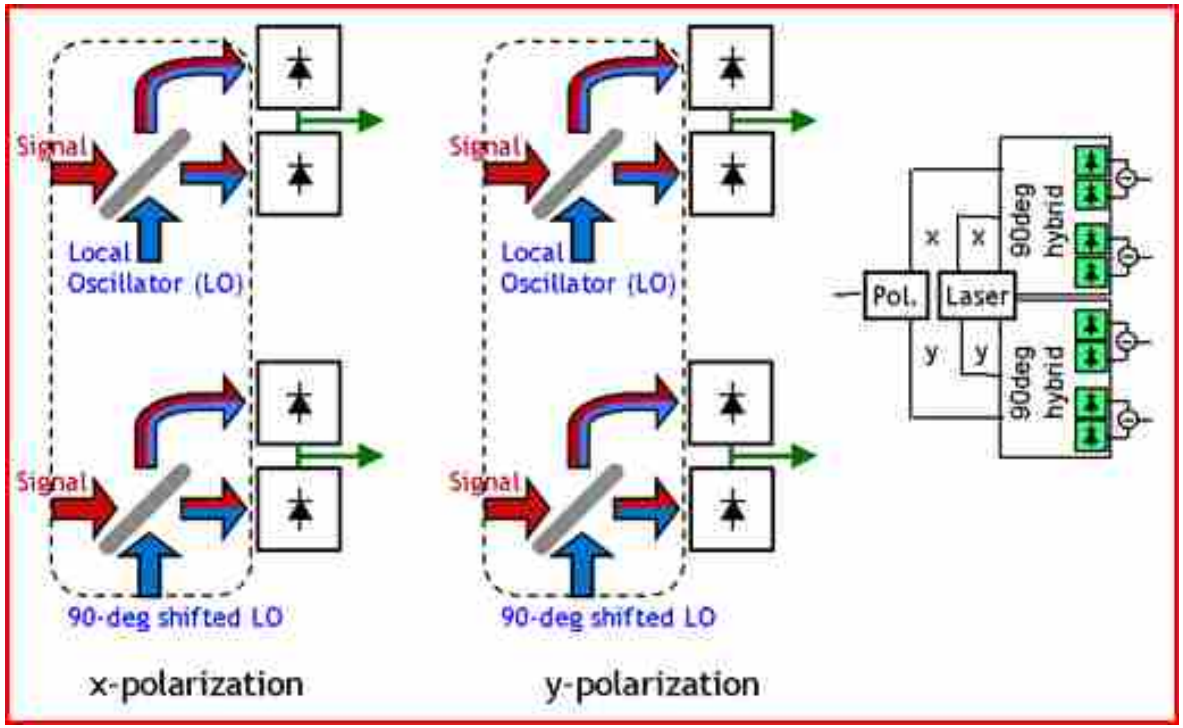


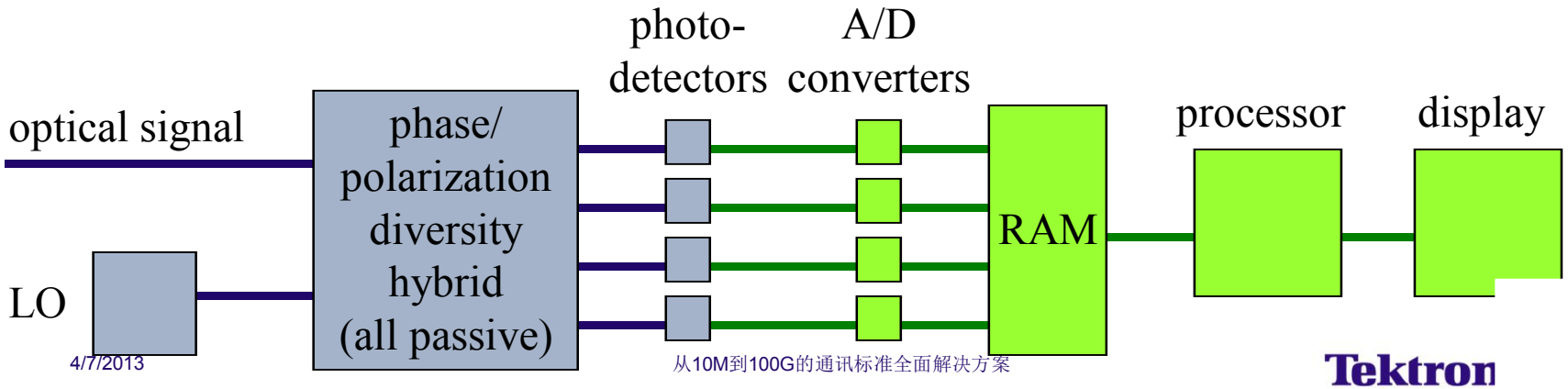
Dual-polarization QPSK Modulator



Coherent detection

- Real-time acquire and analysis
- High sample rate:100GS/s

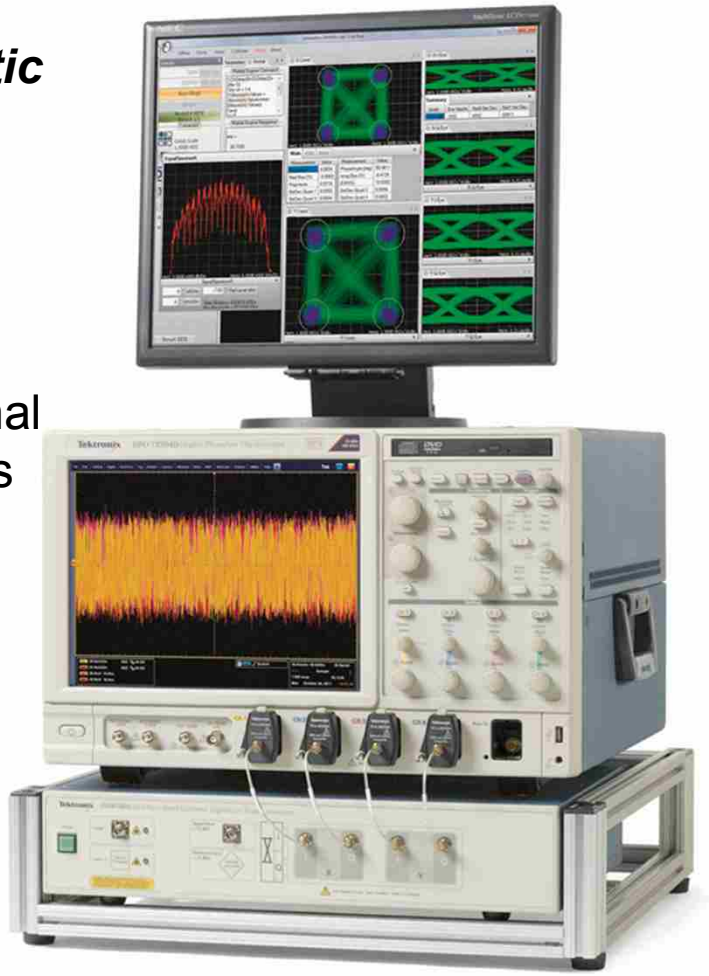




OM4106D 33 GHz Coherent Lightwave Signal Analyzer for > 100 Gb/s Analysis

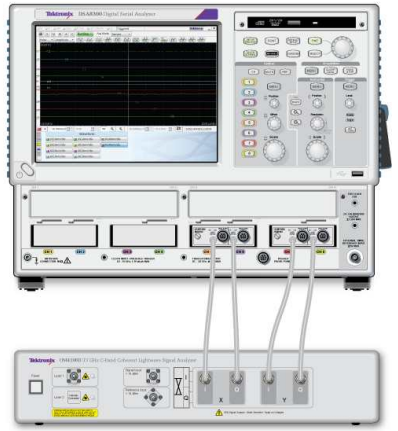
Complete and open solutions to complex measurement challenges in long-haul fiber-optic communications

- Advanced dual-polarization in-phase and quadrature receiver with integrated signal and reference tunable laser sources
- Open-architecture MATLAB-based computational engine offers powerful phase-recovery analyses with polarization, bit-error rates, and record/playback
- Intuitive graphical user interface controls frequently-used instrument functions:
  - Laser control
  - Modulation schemes
  - PRBS or user-generated data
- Accessories available to easily verify optical calibration



NEW

OM4106D support for the DSA8300 Sampling Scope

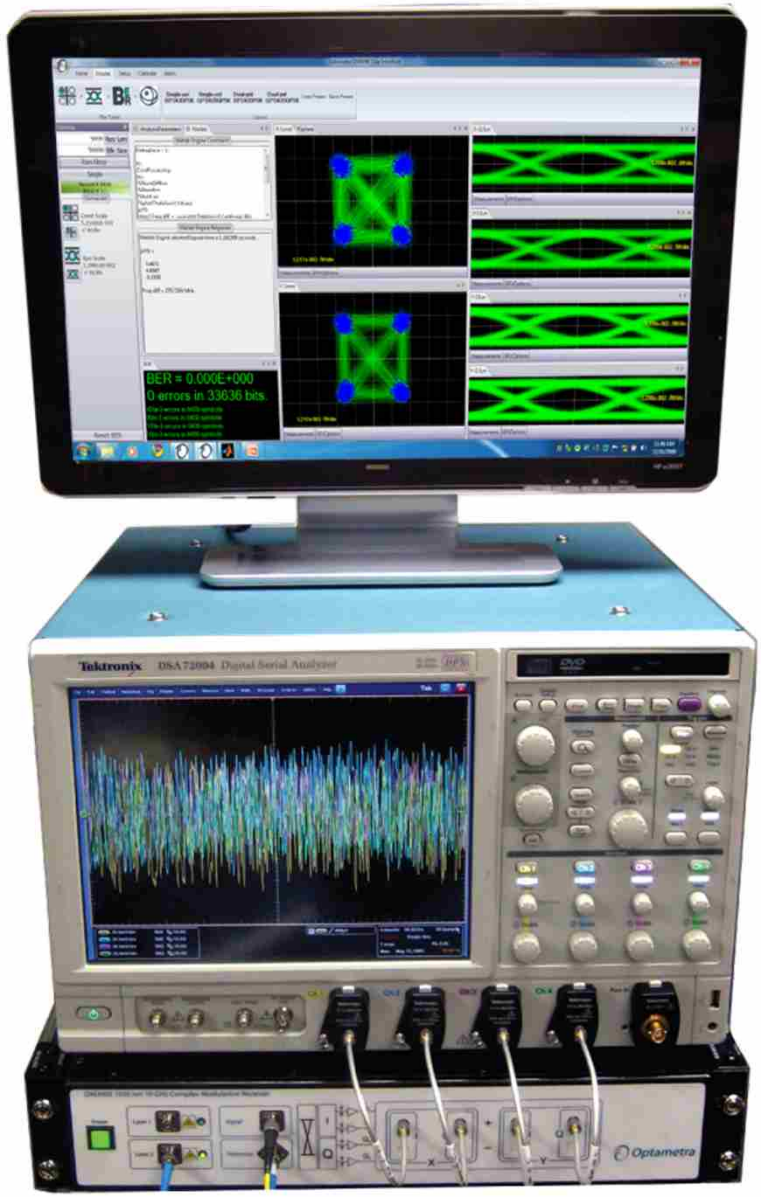


- The OM4106D and the OM1106 software have been modified to support the DSA8300 sampling scope.
- Any existing OM4106D is capable of supporting both DSA/DPO70k real-time scopes and the DSA8300 sampling scopes with a software upgrade.
- Using the sampling scope for acquisition provides greater vertical resolution at a lower total system price compared to real-time solutions.
  - 16 bits vertical resolution and 450uV rms noise floor at 60 GHz provide added dynamic range and accuracy.
  - Up to 60 GHz sampler bandwidth on four channels provides future-proof capability for next-gen baud rates.
  - Timing jitter as low as 450fs RMS lets you see signal jitter. (as low as 200fs when using the 82A04 Phase Reference Module)

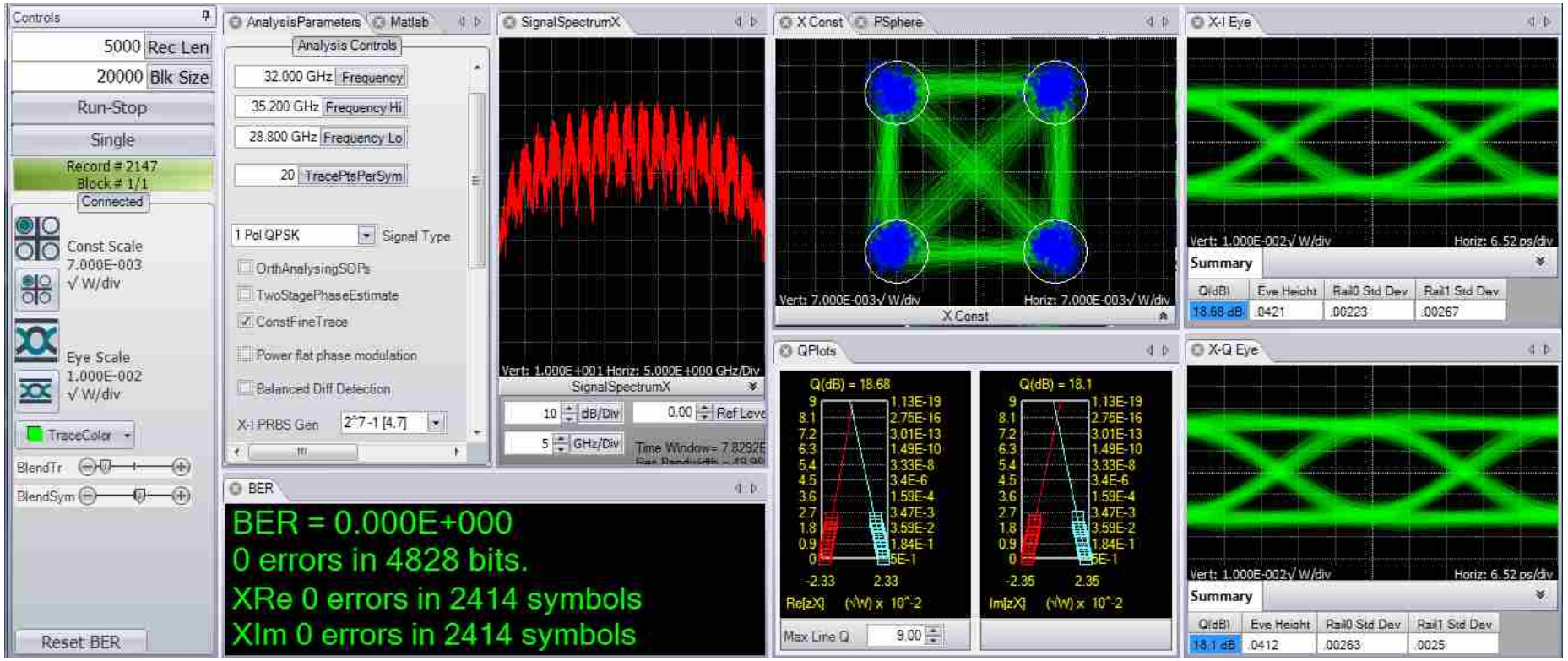
OM4106 Coherent Lightwave Signal Analyzer Pro™ 30 GHz for > 100 Gb/s Analysis

Complete and open solutions to complex measurement challenges in long-haul fiber-optic communications

- Advanced dual-polarization in-phase and quadrature receiver with integrated signal and reference tunable laser sources
- Open-architecture MATLAB-based computational engine offers powerful phase-recovery analyses with polarization, bit-error rates, and record/playback
- Graphical user interface controls frequently-used instrument functions:
  - Laser control
  - Modulation schemes
  - PRBS or user-generated data
- Works with all major real-time oscilloscopes
- Easily upgradable

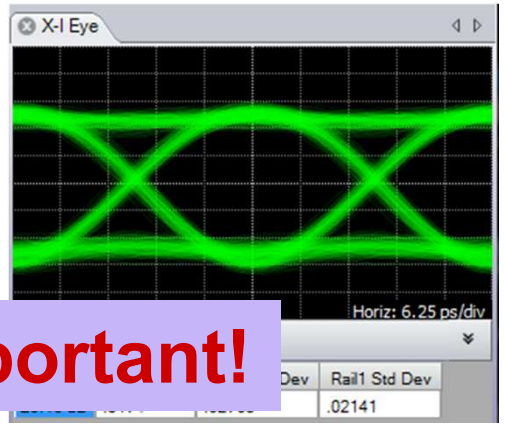


32 Gbaud Optical Signal digitized with the DSA73304D in 50Gs/s mode (~23 GHz BW)

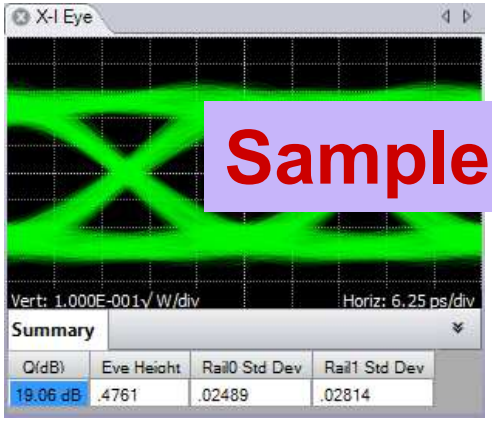


Effect of front-end bandwidth and sampling rate

33GHz DSA73304D 100Gs/s→



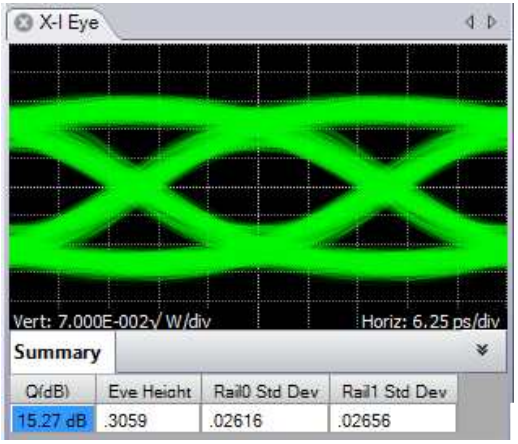
DSA73304D 50Gs/s →



Sample Rate is more important!

20GHz 50Gs/s DSA72004B

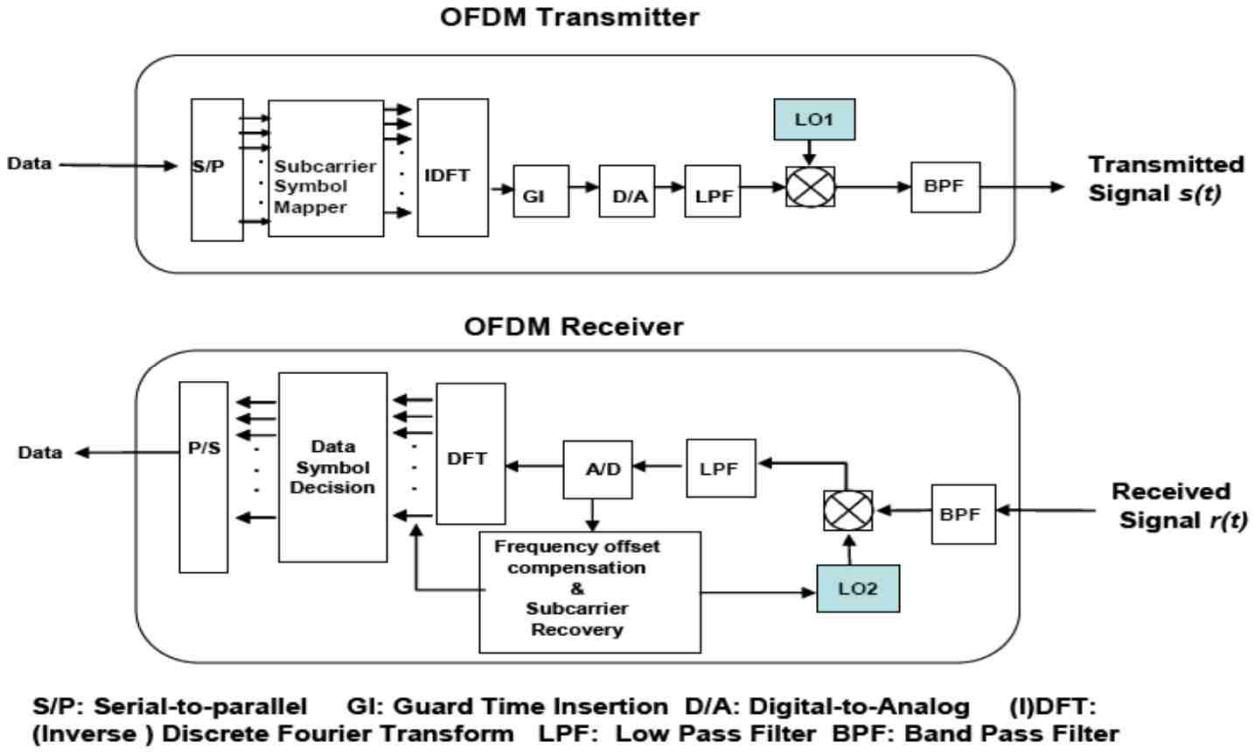
20GHz 40Gs/s →



32 Gb/s electrical data

OFDM基本原理

- 正交频分复用OFDM（OrthogonalFrequencyDivisionMultiplex)是一种多载波调制方式，通过减小和消除码间串扰的影响来克服信道的频率选择性衰落。它的基本原理是将信号分割为N个子信号，然后用N个子信号分别调制N个相互正交的子载波。由于子载波的频谱相互重叠，因而可以得到较高的频谱效率。近几年OFDM在无线通信领域得到了广泛的应用。



Optical OFDM通信

- 光OFDM(O-OFDM)系统结合OFDM技术与光通信的特点，将OFDM技术应用于光通信的一种新技术，构建出高速率、高容量、低成本的光传输网络并且具有较强的信道容量的可扩展性，可以在现有网络的基础上很好的升级与过渡，提供高速率、高容量、高质量的通信服务。O-OFDM技术也可以作为全球微波互联接入(WiMAX)、无线局域网(WLAN)的一部分。

- O-OFDM 能够有效地对抗光通信系统中的色度色散和偏振模色散引起的符号间干扰(ISI) , 而且循环前缀(CP) 的引入, 更进一步的增强了O-OFDM通信系统的抗色散能力, 降低色散管理的复杂度, 同时对提高数据传输率和系统容量起到重要作用。另外,O-OFDM 系统中的各个子信道的不同频谱相互叠加,更有效的利用频谱资源, 提高了带宽利用率。除此之外, 该系统实现简单, 易于优化等优点, 使OFDM技术在光通信领域, 尤其是40Gbit/ s 以上的高速光通信领域具有很好的应用前景。

Optical OFDM通信优点

- O-OFDM由于其独特的优势，在全世界范围内得到了深入的研究，在欧洲光通信展览会(OFC)2008、OFC2009和美国光电光纤通信展览会(ECOC)2007、ECOC2008会议上，O-OFDM传输理论与技术成为了会议的热点之一。

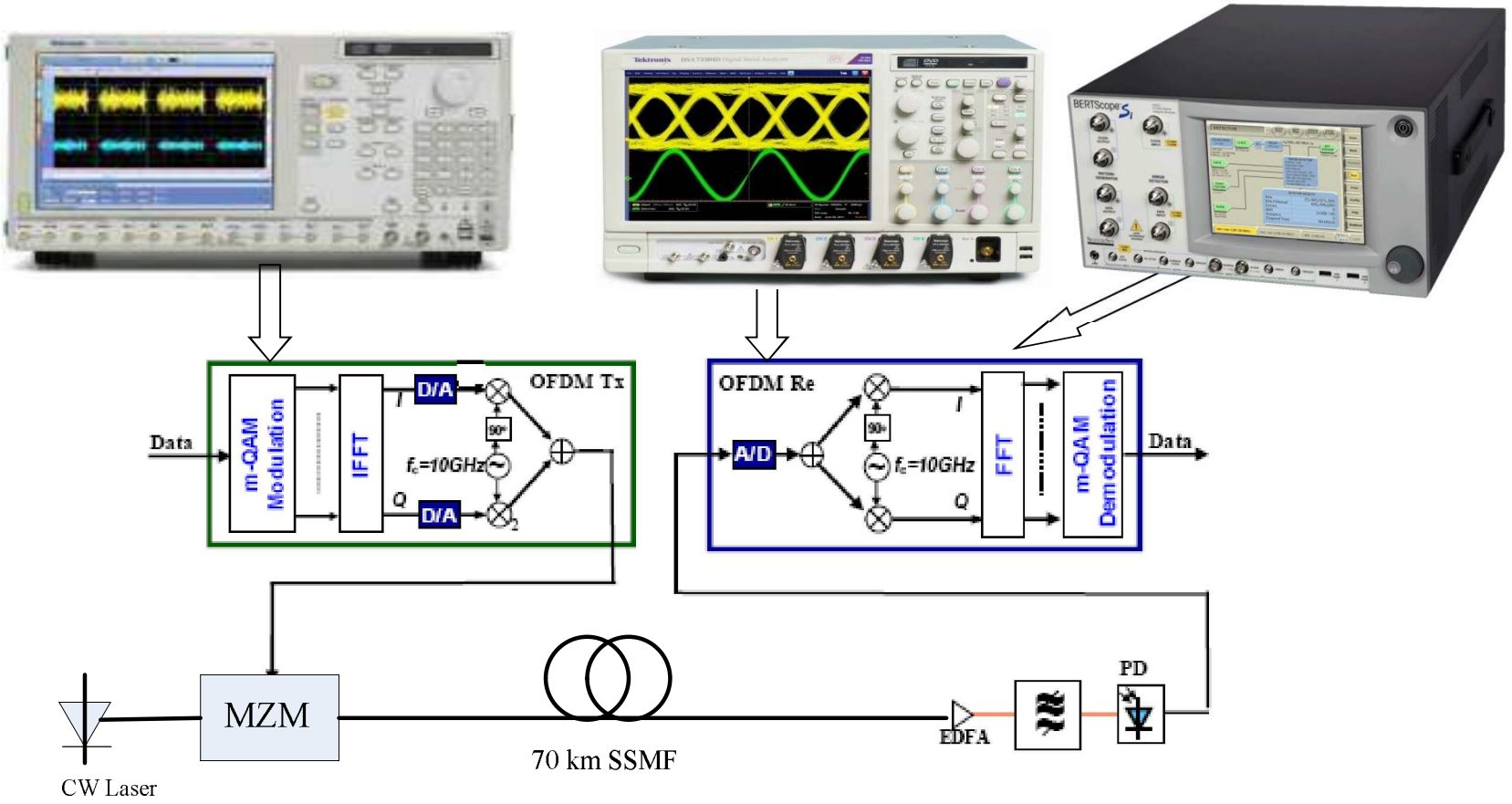
- O-OFDM系统的优势主要表现在如下几个方面：
  - O-OFDM系统在传输过程中不需要复杂的色散管理，这样既能实现高速的数据传输，降低了网络的复杂度和建设、运行、维护的成本，也能适应动态变化的网络环境
  - O-OFDM 系统可以最大限度的利用频谱资源，提高频谱效率
  - O-OFDM系统与原有的波分复用(WDM)系统有很好的兼容性，可充分利用WDM系统在光纤链路和光放大器方面的巨大投资，只需要在发射和接收端进行适应性改造即能够完成升级。

泰克光OFDM通信系统测试解决方案

- 光OFDM通信系统测试系统构建

生成宽带OFDM电信号

验证和分析宽带OFDM电信号



泰克光OFDM通信系统完整的系统测试方案

一、超宽带信号源AWG－业内唯一能产生宽带OFDM信号的信号源

- 超高带宽（9.6G），超高采样率（24GS/s）
- 可以直接产生射频，中频，基带信号
- 基于AWG的高级OFDM信号仿真软件RFXpress，方便产生各种复杂的OFDM信号
- 对实际回波信号进行二次“改造”：如加“噪声”加“干扰”
- 与各种软件兼容如:Matlab等
- 与泰克的宽带示波器搭成无缝环路

二、宽带示波器

- 带宽33GHz
- 采样率达到100GS/s
- DPOJET软件最专业的抖动眼图测试软件
- SignalVu OFDM分析软件
- 与各种软件兼容如:Matlab等

三、BERTScope误码分析仪

- 高达26Gbps码速率
- 专利的Dual ED构架，快速准确完成眼图、抖动测量



ANY QUESTIONS?



Thank You For Attending!