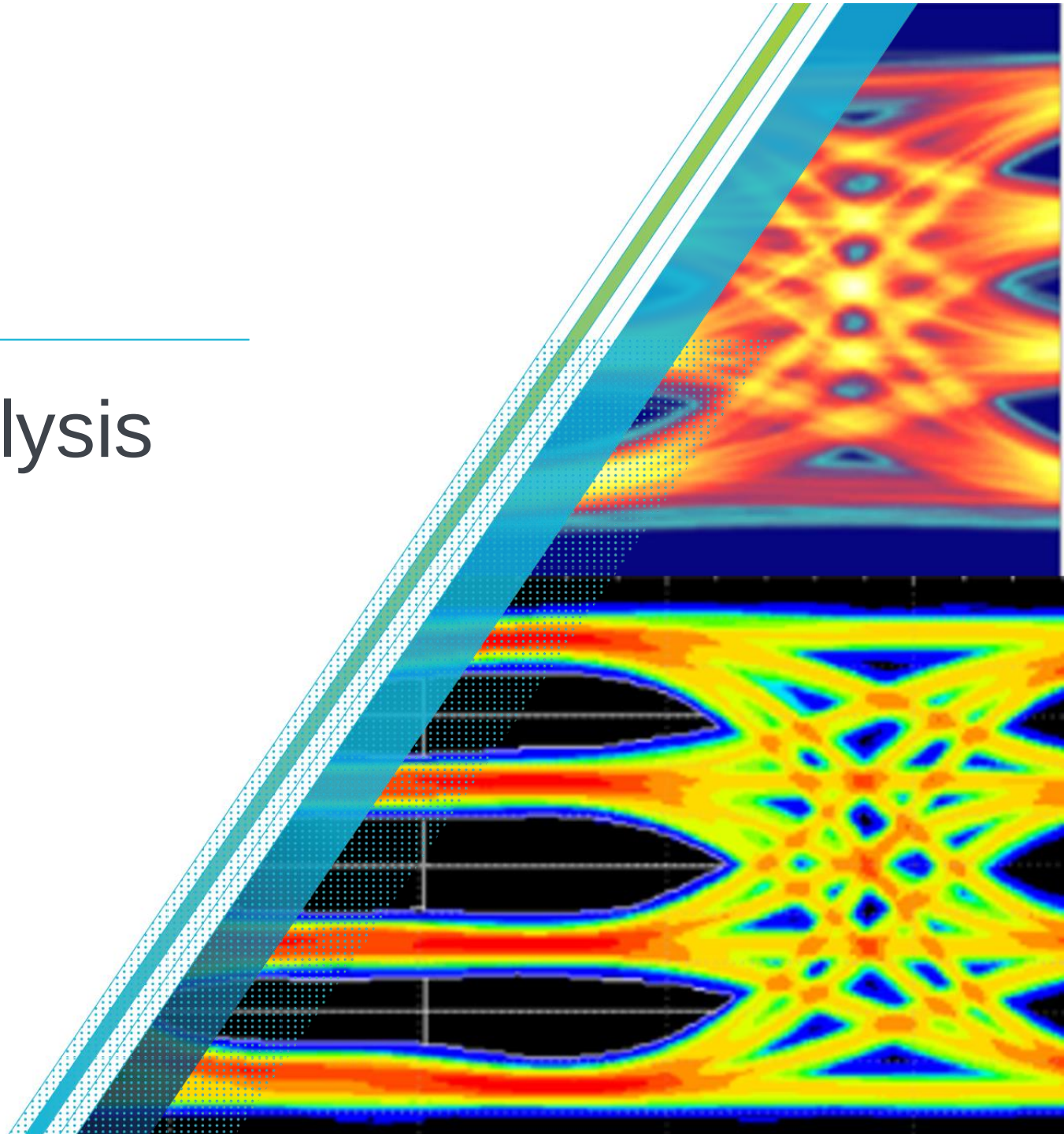




PAM-4 Analysis

19 JULY 2018



Slides Subject

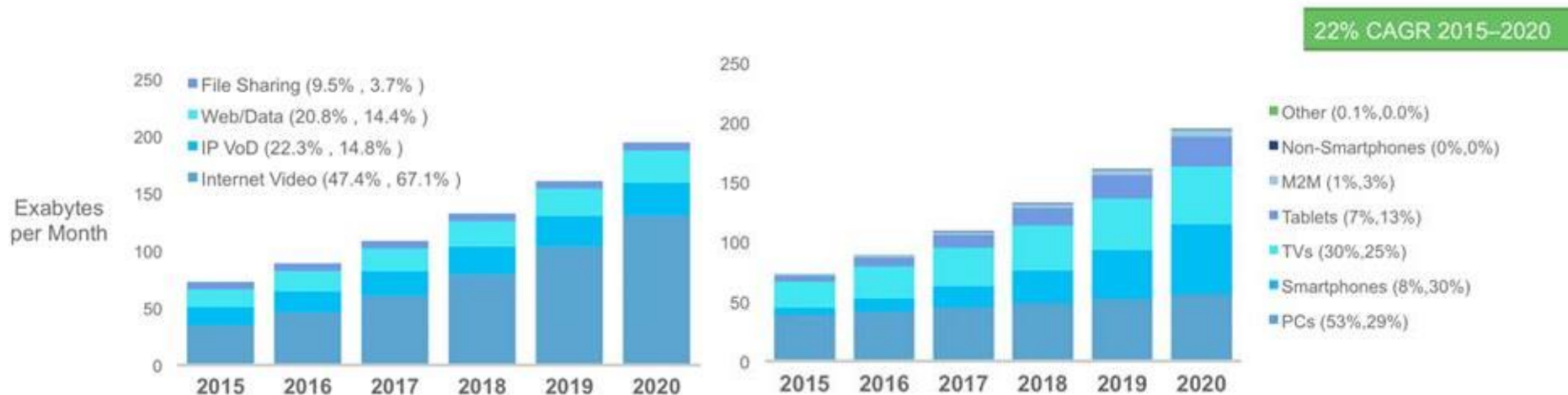
- PAM-4 Overview
- ET vs RT Test Solution
 - DSA8300 Sampling Scope
 - DPO70kSX ATI RT Scope
- New OE Modules Introduction
 - DPO7OE1/2 For RT
 - 80C17/18 80C20/21 For ET
- New PAM4 Test Software Introduction
 - 400G-M4

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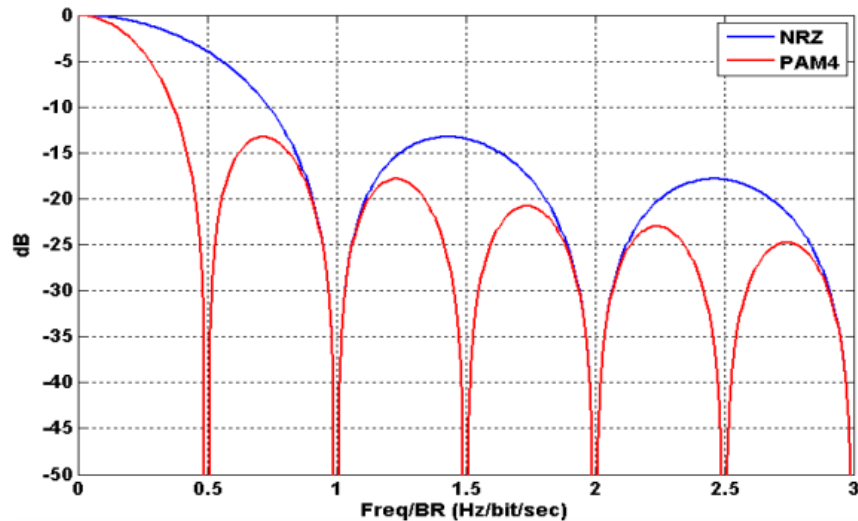
Datacom and Networking Trends

- Global IP traffic to triple over next 5 years
- Smart phone traffic to exceed PC traffic by 2020
- Traffic from wireless devices will account for two thirds of the traffic
- Number of devices on IP networks will be more than 3x global population
- Broadband speeds to double by 2020
- PAM-4 signaling is being considered to double throughput to meet expected growth in IP traffic

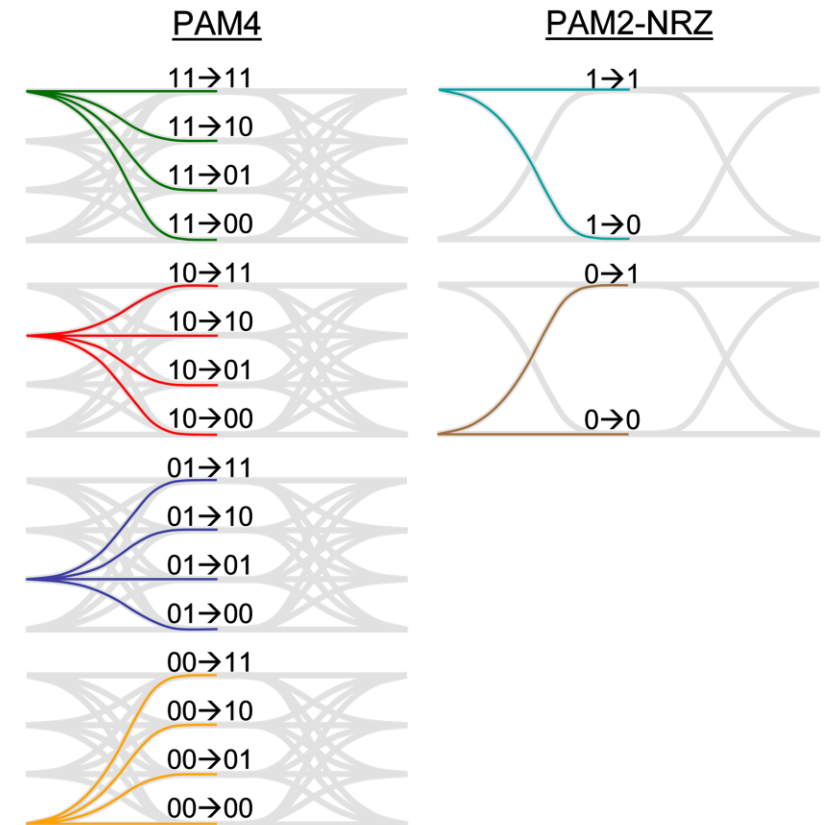


What is PAM4 ?

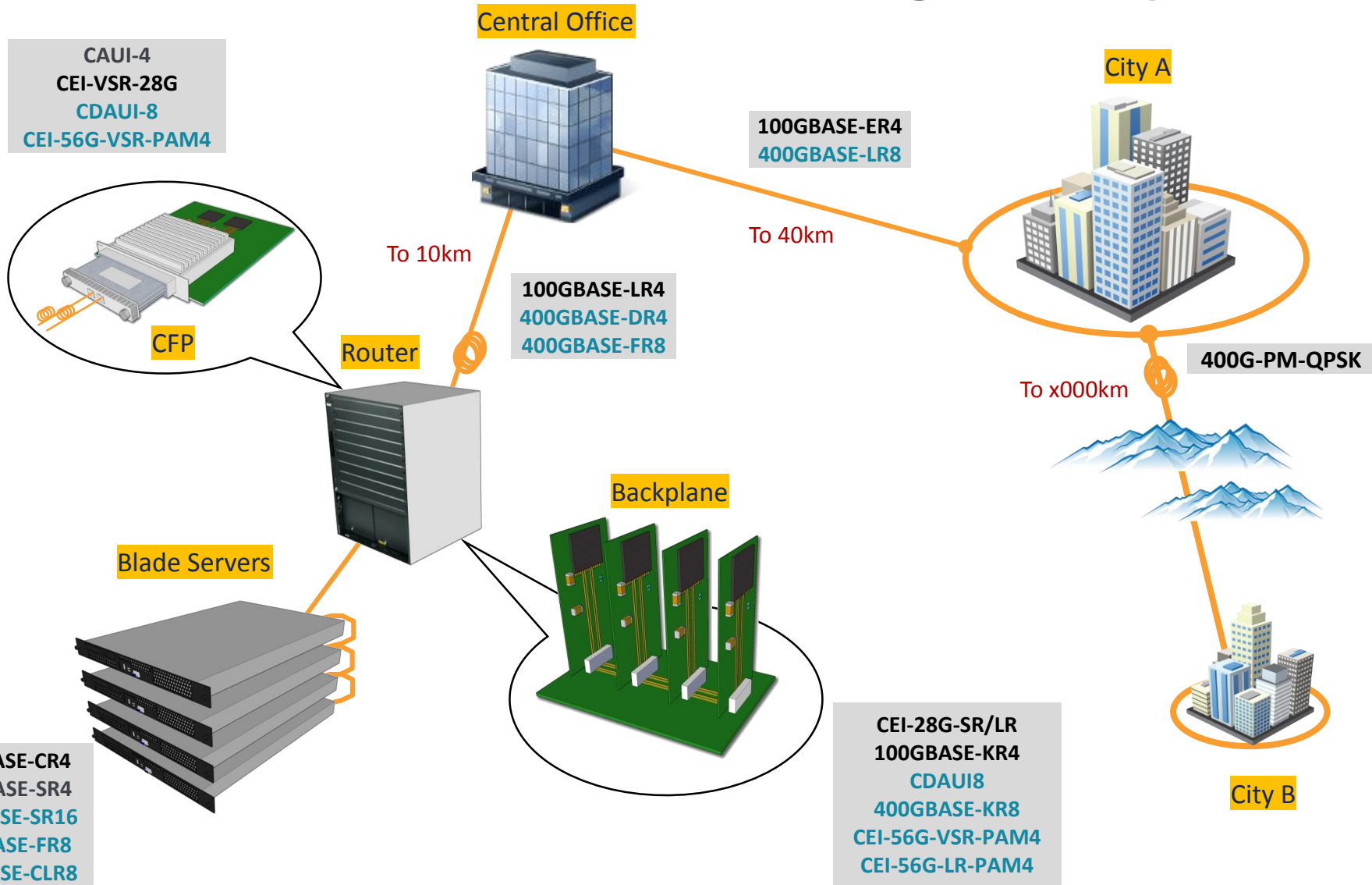
- Pulse Amplitude Modulation
- 4-level signaling
- Transmit 2 bits per UI
- PAM4 requires half of the BW of NRZ for the same data throughput



	PAM-4	NRZ
Bits per UI	2	1
Levels	4	2
Rising/Falling Edges	6	2
Transitions	12	2
Eye Diagrams per UI	3	1



400G Datacenter Networking Ecosystem



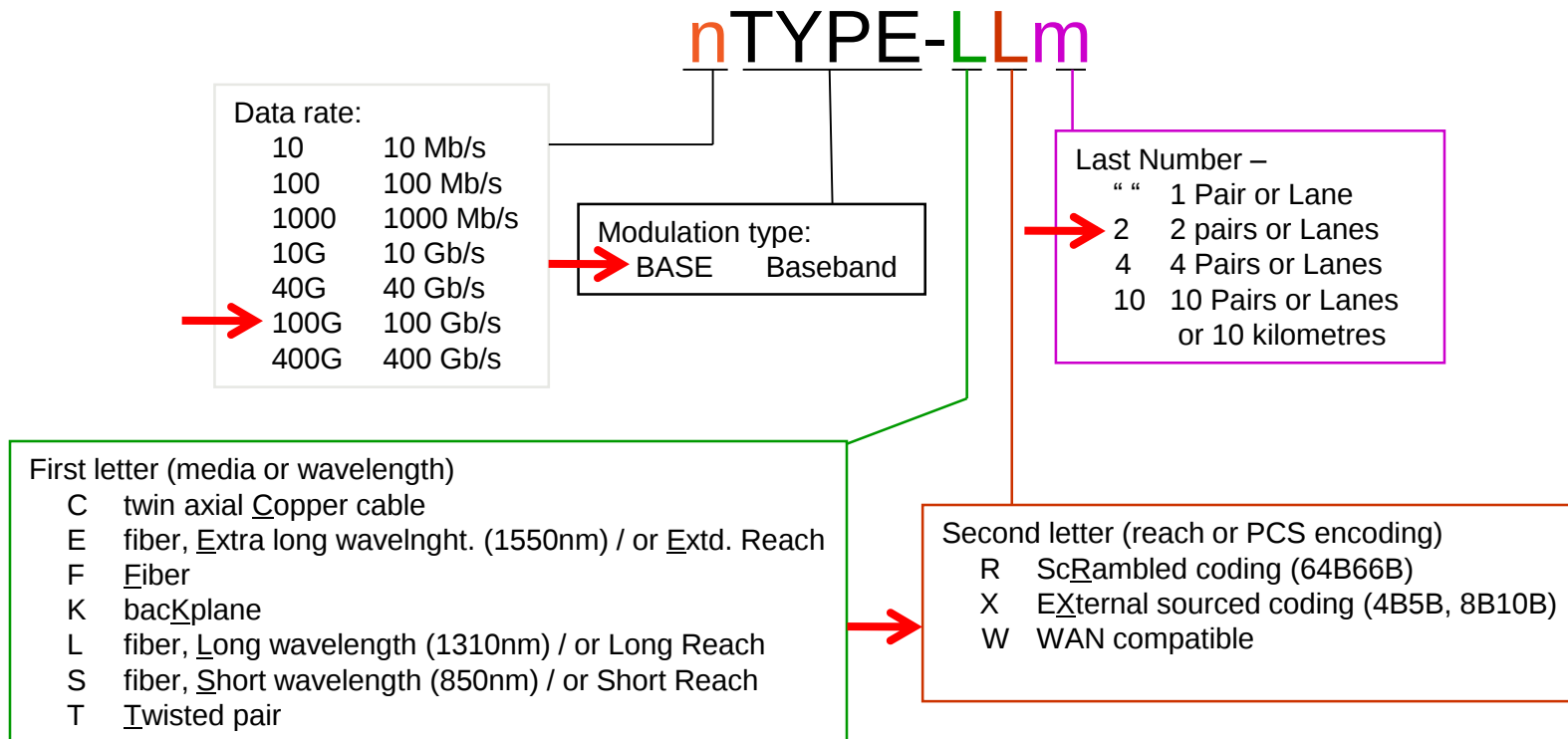
PAM4 Standards

Optical Standard	Modulation	Distance	Data Rate	Multiplex	Signaling Rate
200GBASE-SR4 (802.3cd) similar: 100GBASE-SR2, 50GBASE-SR	PAM4	70m, 100m	N lane x 50Gbps	<n> parallel MMF	26.56 GBd
200GBASE-DR4 (802.3bs)	PAM4	500m	4 lane x 50Gbps	4 parallel SMF	26.56 GBd
400GBASE-DR4 (802.3bs) similar: 100GBASE-DR	PAM4	500m	<n> lane x 100Gbps	4 parallel SMF	53.125 GBd
400GBASE-FR8 (802.3bs) similar: 200GBASE-FR4, 50GBASE-FR	PAM4	2km	<n> lane x 50Gbps	1 SMF 8λ WDM	26.56 GBd
400GBASE-LR8 (802.3bs) similar: 200GBASE-LR4, 50GBASE-LR	PAM4	10km	<n> lane x 50Gbps	1 SMF 8λ WDM	26.56 GBd

Electrical Standard	Modulation	Distance	Data Rate	Multiplex	Signaling Rate
CEI-56G-VSR-PAM4	PAM4	100mm	n lane x 56Gbps	1-n lanes	18-29 GBd
CEI-56G-MR-PAM4	PAM4	500mm	n lane x 56Gbps	1-n lanes	18-29 GBd
CEI-56G-LR-PAM4	PAM4	1m	n lane x 56Gbps	1-n lanes	18-29 GBd
50GAUI-1/100GAUI-2/ 200GAUI-4/400GAUI-8	PAM4	250mm	50Gbps	1,2,4,8 lanes	26.56 GBd
50GBASE-KR/100GBASE-KR2/ 200GBASE-KR4	PAM4	<1m	50Gbps	1,2,4 lanes	26.56 GBd
50GBASE-CR/100GBASE-CR2/ 200GBASE-CR4	PAM4	<3m	50Gbps	1,2,4 lanes	26.56 GBd

Ethernet Nomenclature

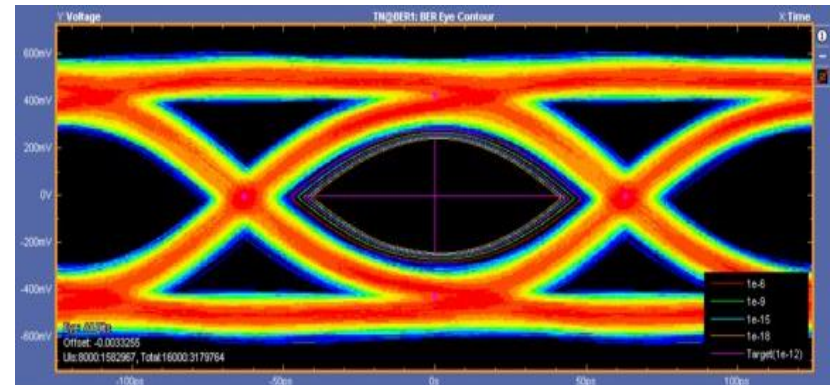
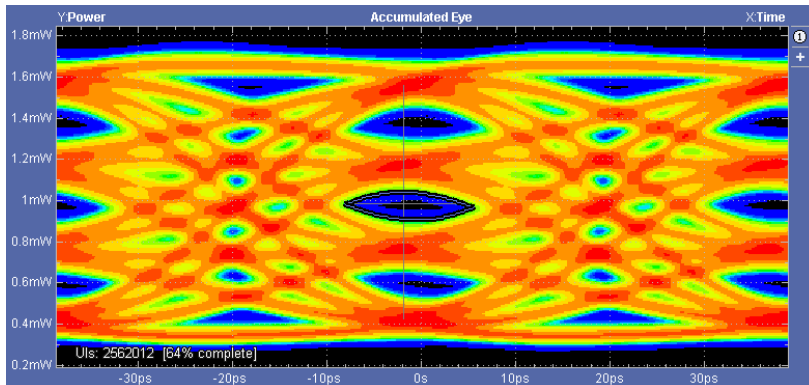
- Common interpretation* is as follows:
- Example: 100GBASE-LR2



- The IEEE does not specify the meanings of the letters, rather it simply identifies PHYs by combinations of letters. There is no guarantee that in the future these interpretations will retain whatever meaning they presently have. Slide based on an Ethernet Alliance slide by Scott Kipp, with Tektronix extensions.

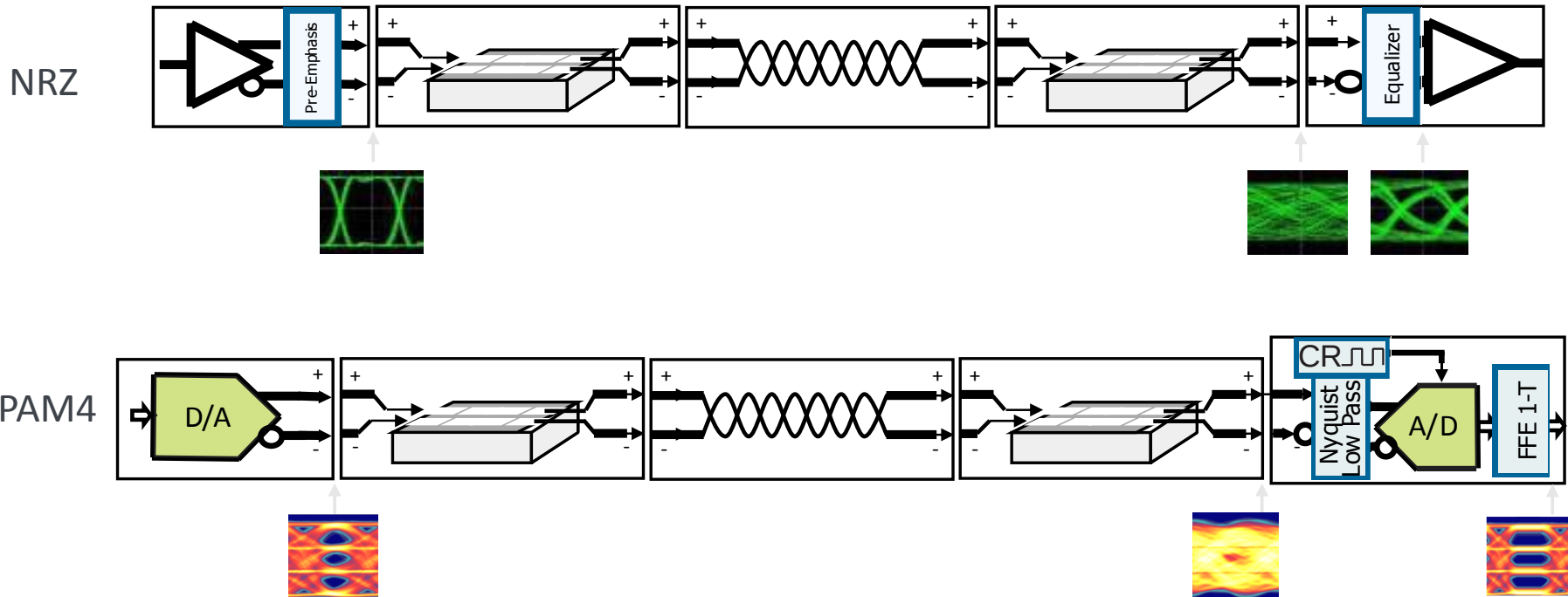
Test Challenges

- Two bits are grouped and mapped to one symbol resulting in four signal levels, which form 3 eyes
- Vertical eye opening (eye height) @ BER
 - PAM-4 individual eye height 33% of NRZ at same supply voltage
 - PAM-4 endures lower loss due to half baud rate
- Horizontal eye opening (eye width) @ BER
 - PAM-4 individual eye width 200% of NRZ due to half baud rate
 - PAM-4 eye width is reduced by transitions between non-adjacent levels



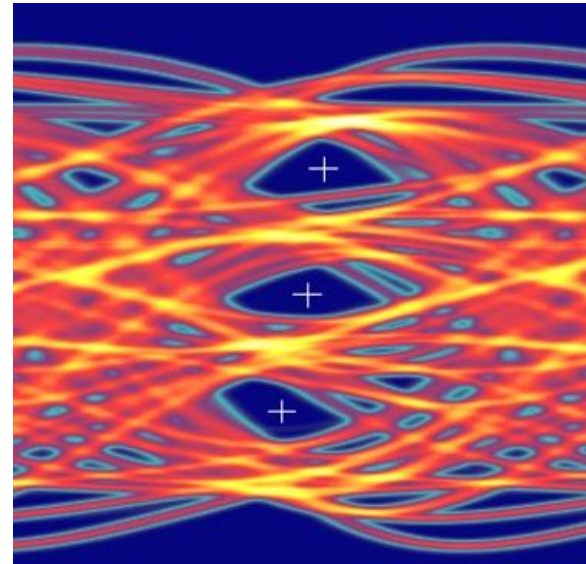
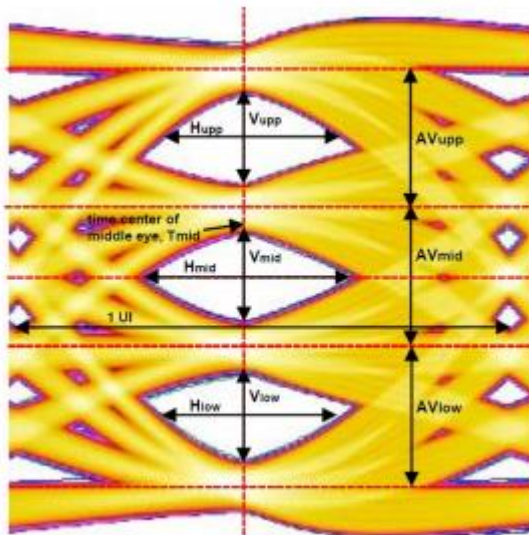
The Bandwidth Question

WHAT HAS CHANGED?



Test Challenges

- PAM4 is more susceptible to noise due to reduced eye height
- Three different eye's require additional care in making sure that all of them are symmetric
- Multi Level Signaling introduces additional complexity in clock recovery, Pattern detection and Jitter measurements
- As PAM4 evolves newer more complex measurements are being defined into the standards



Slides Subject

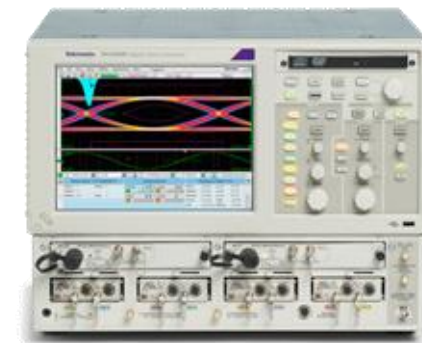
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 - 400G-M4

Test Requirements

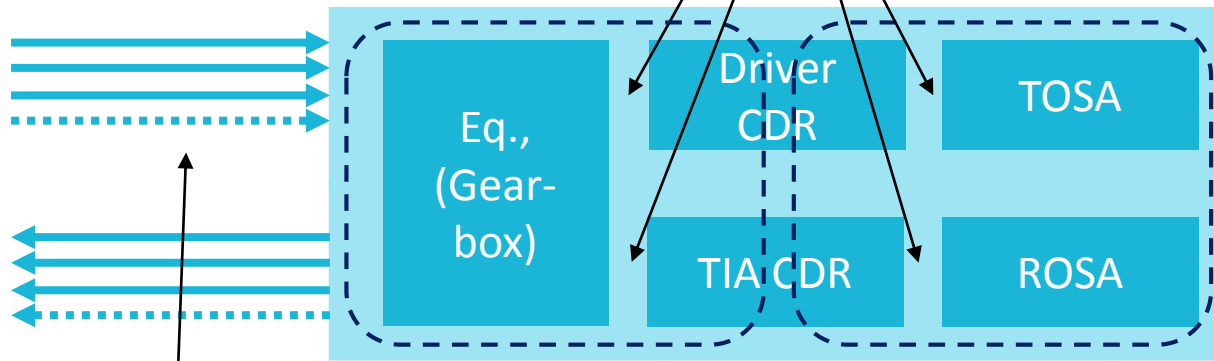
OPTICAL TRANSCEIVERS

Electrical interface
CDAUI, 400GAUI,

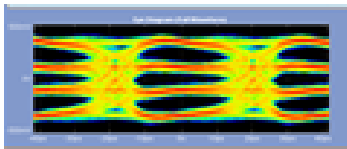
Intermediate test points
Characterization on evaluation
boards



Optical
LR8/DR4/...
IEEE 802.3



and debug everywhere!!!



Clock recovery
Channel modelling
Equalization
Error Detection post-equalization
Error rate and location
DSP simulation

Tektronix 400G Acquisition Solutions

Equivalent Time Scope

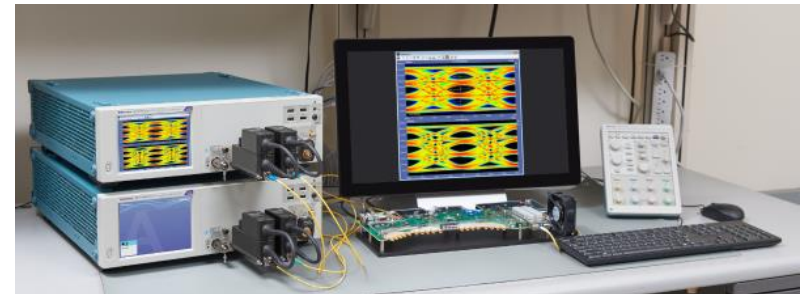
- 85GHz Optical Bandwidth
- 70GHz Electrical Bandwidth
- <100fs jitter noise floor
- 20nW to .6uW Optical Resolution
- Automated test of 80+ Industrial Standards
- Best overall Optical solution



ET

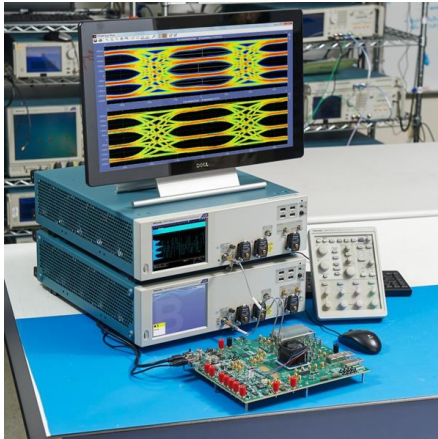
Real Time Scope

- 70GHz Analog Bandwidth
- 4.3ps rise time (20%-80%)
- 200GS/s Sample Rate
- <125fs jitter noise floor
- ≥25GHz Edge trigger bandwidth
- Compact 5 ¼" Oscilloscope package
- SW clock recovery required (key to 400G)
- Comprehensive CTLE, DFE, FFE signal processing
- Lowest noise real time acquisition system

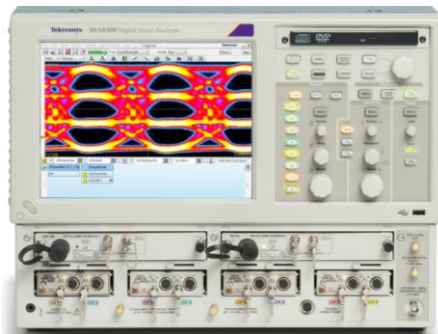
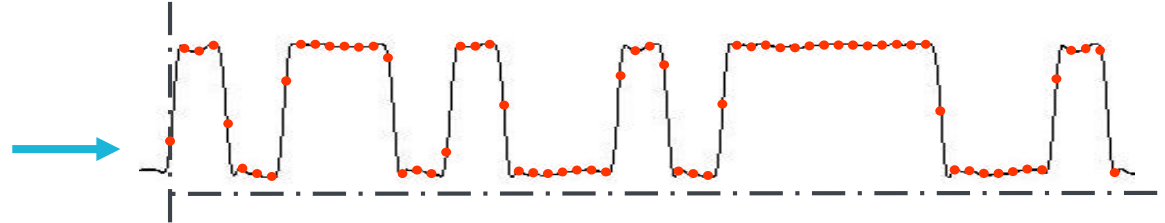


RT

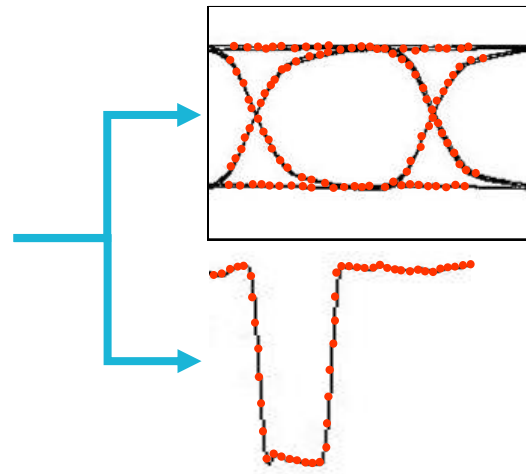
Real-Time Solution



RT

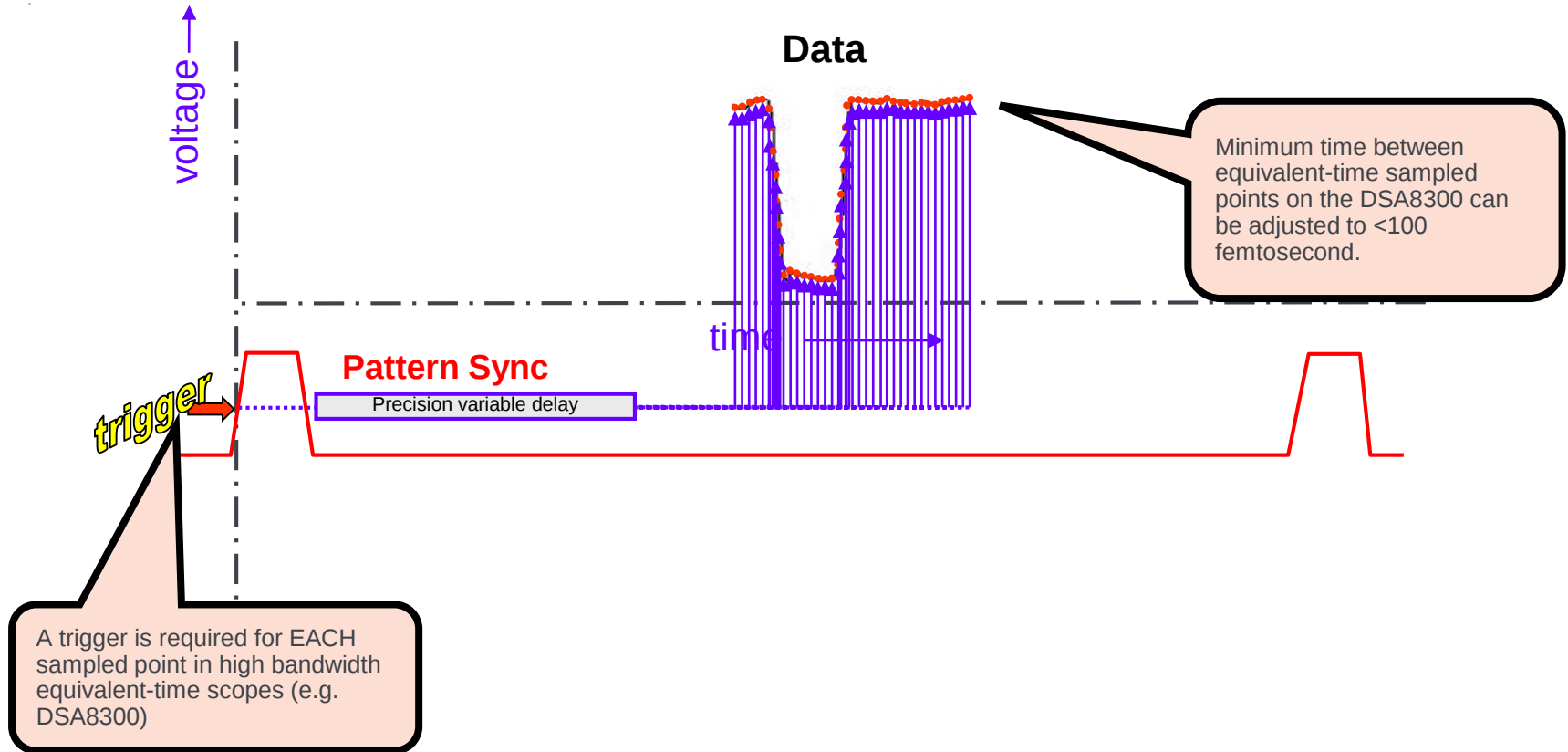


ET



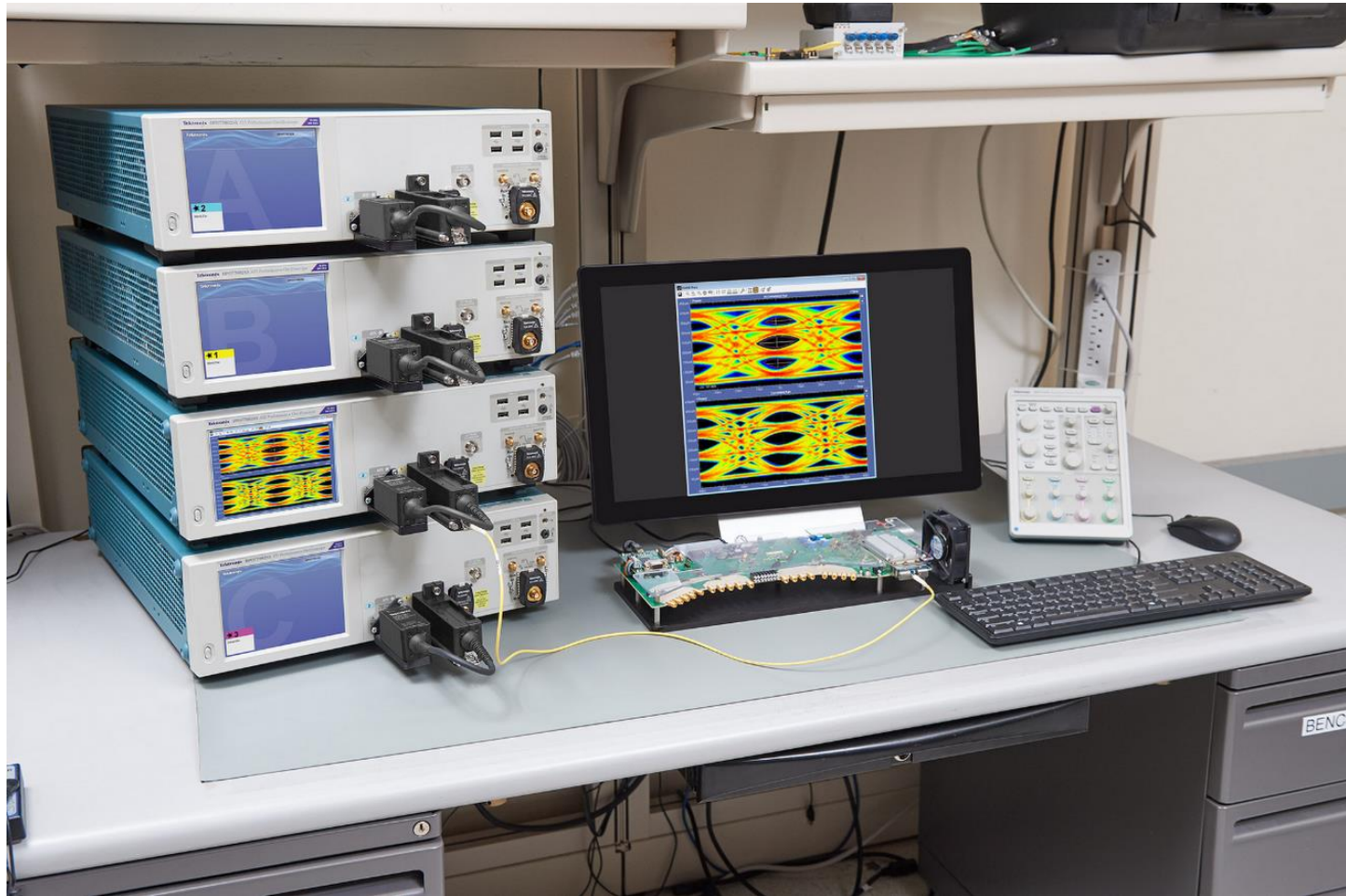
ET vs RT Basics: ET with Repetitive Pattern

ONE-SAMPLE-PER-TRIGGER REPETITIVE PATTERN REQUIRED FOR PULSE STREAMS



An equivalent-time sampling oscilloscope (such as the DSA8300) requires a trigger signal: this is generally a user-supplied clock, a recovered clock, or a pattern sync signal synchronous to the signal.

Industries Most Comprehensive PAM4 & NRZ Optical Analysis Solution

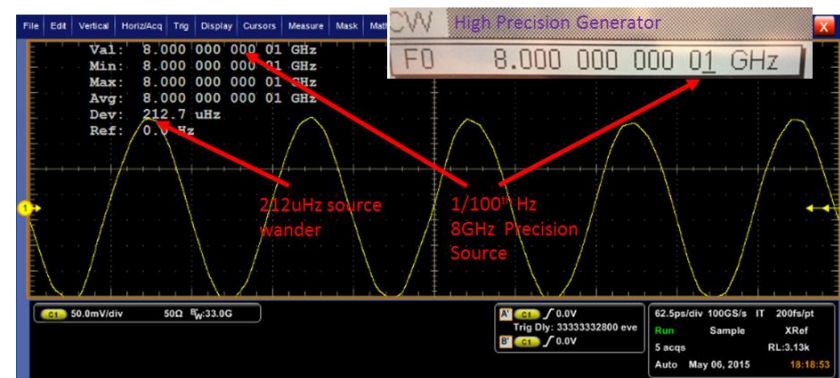
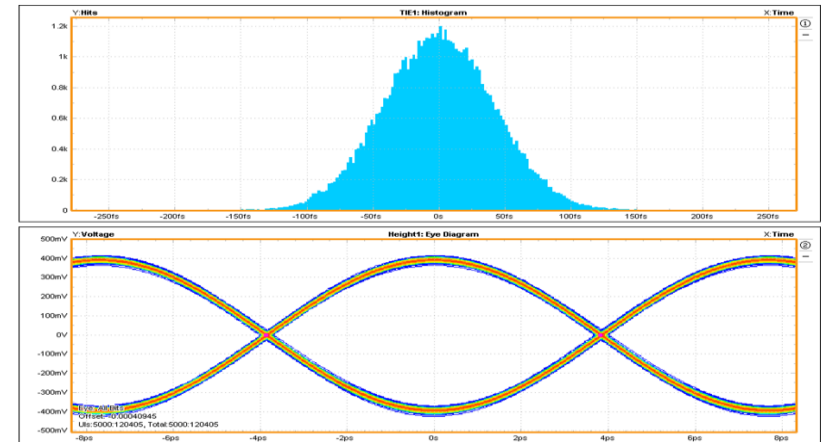


Tektronix 100G/400G Signal Acquisition Systems

Equivalent Time Signal Acquisition • Real Time Signal Acquisition Software Control and Analysis

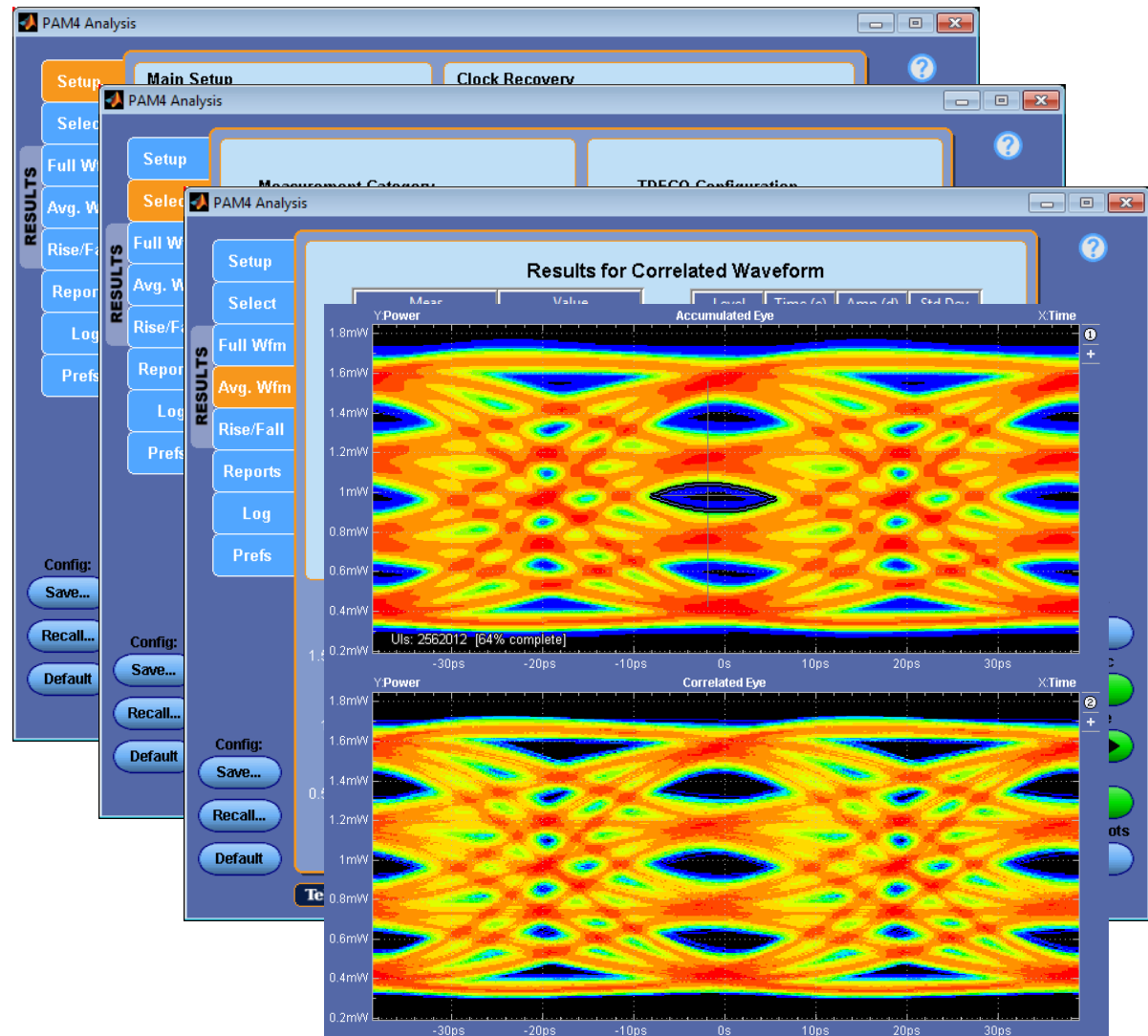


- Multi channel time synchronized operation.
- Unprecedented jitter noise floor.
 - ~ 40fs RMS clock jitter (64 GHz clock)
 - <125fs jitter noise floor (64Gbps PRBS)
- New HW trigger performance level easily triggers on 100G tributary Runt
- New Internal 13-digit precision frequency counter (54bit) provides frequency analysis to 25GHz, with 200fs resolution
- Highly accurate clock stability measurements
 - Accurate to < 1 part per billion



PAM4 Analysis

- Single Application for PAM4 analysis
- Dashboard style setup
- Robust Clock Recovery
- Integrated Equalizer
- Fixture embed / De-embed
- Autodetect Waveform properties
- IEEE and OIF-CEI electrical and Optical Measurements
- Comprehensive Analysis and Visualization
- Report with measurement results and plots



Comprehensive Measurement Suite

PAM4 Optical Measurements

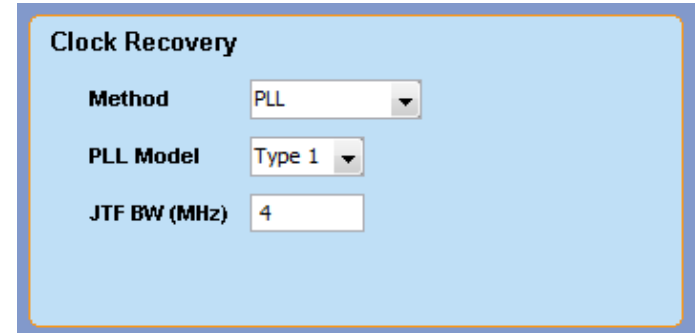
Error Analysis	• Symbol Errors, • SER • BER
Linearity	
Jitter	• R_j • D_j • T_j@BER
Statistical Eye Analysis	• Vertical Eye Closure • EW6 / EW5 • EH6 / EH5 • V_{upp} / V_{mid} / V_{low} • H_{upp} / H_{mid} / H_{low}
Optical	• ER • OMA • AOP
IEEE Specific	• TDECQ
Correlated Waveform	• Level Deviation • Level Thickness • Time Deviation • Rise and Fall

PAM4 Electrical Measurements

Error Analysis	• Symbol Errors, • SER • BER
Linearity	
Jitter	• R_j • D_j • T_j@BER
Statistical Eye Analysis	• Vertical Eye Closure • EW6 / EW5 • EH6 / EH5 • V_{upp} / V_{mid} / V_{low} • H_{upp} / H_{mid} / H_{low}
SNDR	• SNDR • P_{max} • σ_e • σ_n
OIF-CEI	• UUGJ • UBHPJ • EOJ
IEEE Specific	• J_{rms} • J₄ • EOJ • Rise Time • Fall Time • SNR_ISI
Correlated Waveform	• Level Deviation • Level Thickness • Time Deviation • Rise and Fall

PAM4 Analysis

- Clock Recovery
 - Enables recovery of the sample clock from the acquired waveform
 - Uses a noise tolerant software model of PLL with programmable options
- Waveform Filter
 - Test fixtures used for signal access have effect on the signal
 - De-embed to remove effect of test fixtures
 - Embed to study effect of different channels

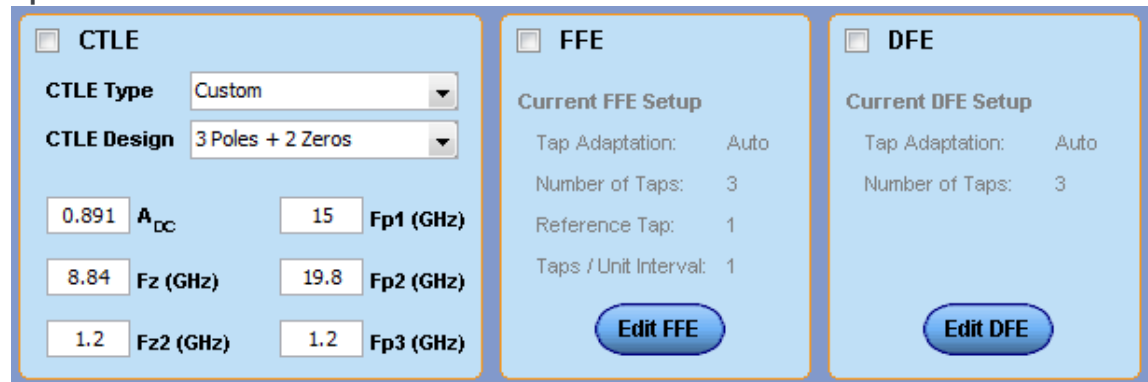
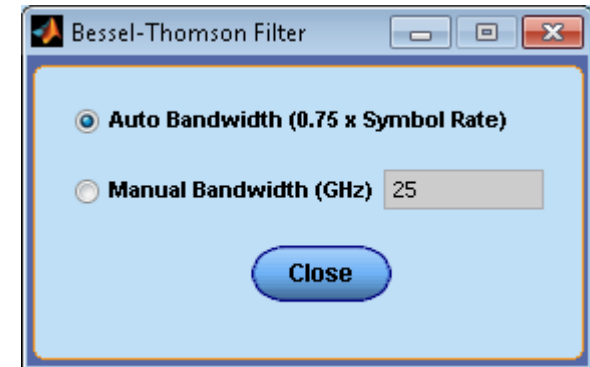


The screenshot shows a configuration panel titled "Clock Recovery" with a light blue background. It contains three settings: "Method" set to "PLL", "PLL Model" set to "Type 1", and "JTF BW (MHz)" set to "4". Each setting is represented by a label followed by a dropdown or text input field.

Clock Recovery	
Method	PLL
PLL Model	Type 1
JTF BW (MHz)	4

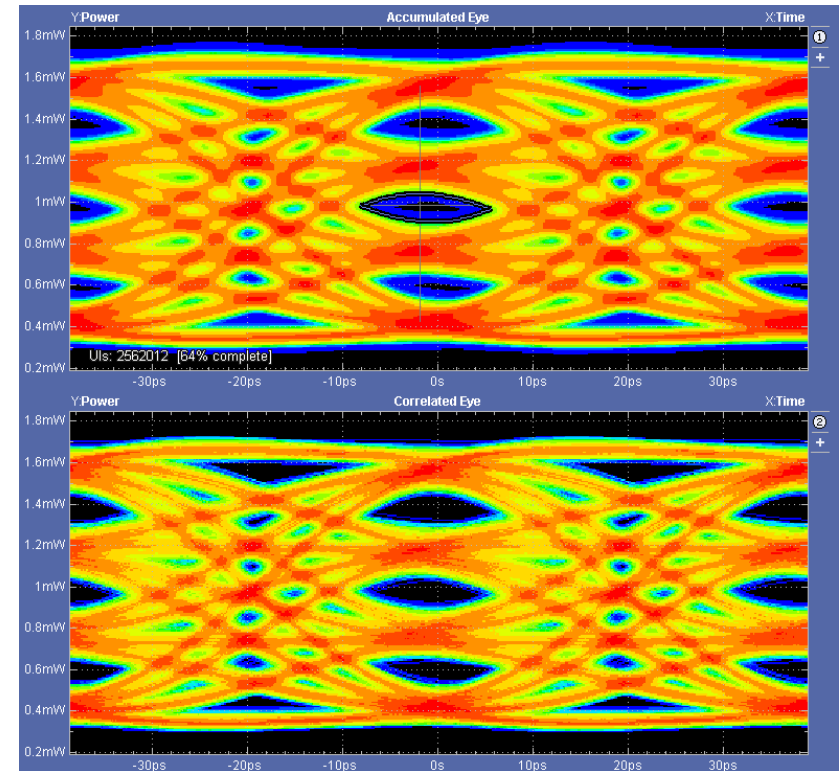
PAM4 Analysis

- BT Filter
 - Automatically apply BT filter based on detected bandwidth
- Equalizer
 - Enables the acquired eye to be opened by applying equalizers
 - Generic equalizer with programmable CTLE, FFE DFE offered
 - Load standard specific equalizer settings with single click
 - Auto-optimization of tap values per selected optimization criteria



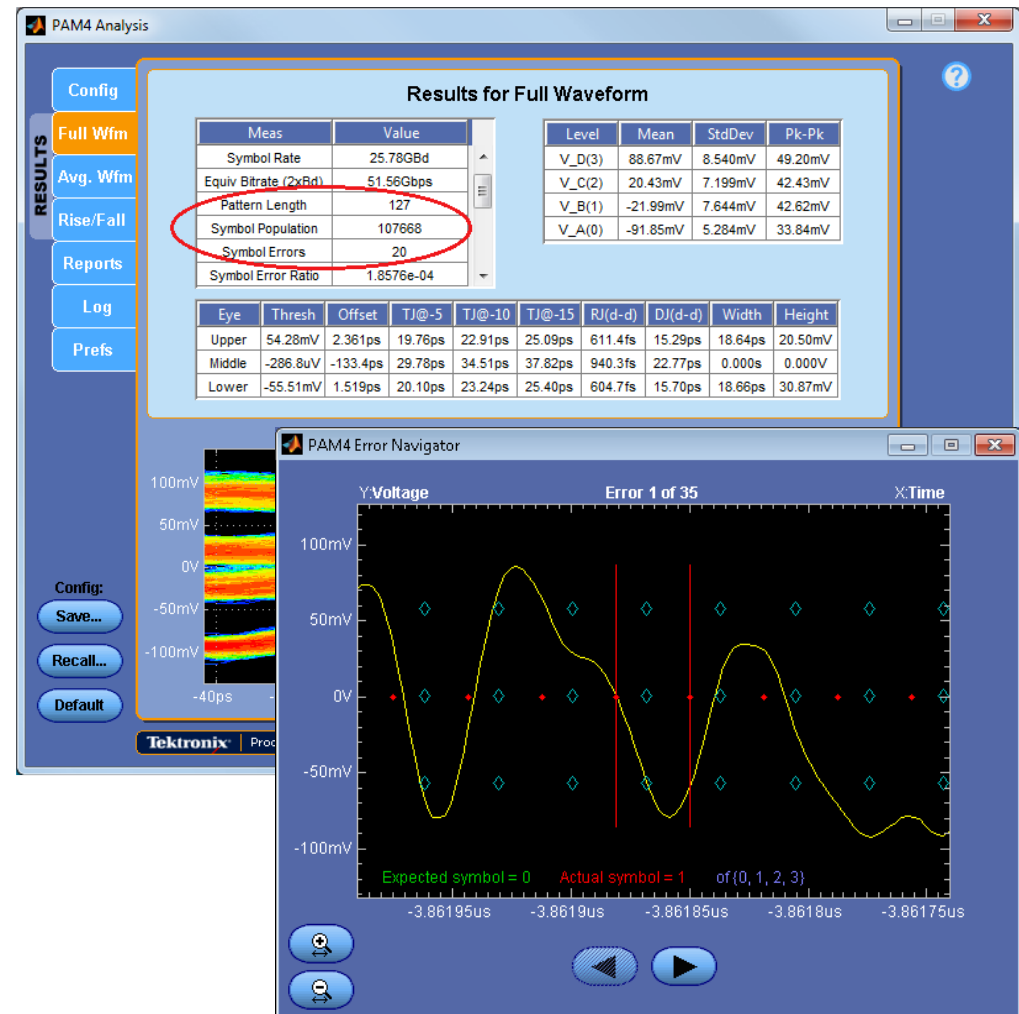
Full vs Correlated Waveform

- Full Waveform
 - Can be defined for waveforms with repeating or non repeating pattern
 - Fold the entire waveform to create eye
- Correlated Waveform
 - Only defined on waveform with repeating patterns
 - Single repeat of the pattern that shows only deterministic effects
 - Fold the single repeat to create eye



Error Detector

- Automatically detect symbol errors
- Visualize Symbol errors on error navigator
- Navigate to individual symbol / bit errors
- Clock recovery, eye centers and expected symbols annotated
- Accumulate SER and BER over multiple acquisition cycles



PAM4 TX Optical – Real Time

Only with the Tektronix DPO7OE1/OE2 ...

Robust Clock Recovery

- PAM4 clock recovery that works reliably in the presence of higher ISI or noise found in PAM4 signaling
- PAM4 analysis even if you don't have access to a clock
- Fully configure clock recovery parameters for rates up to 64GBd

PAM4 Bit-Error Detection and Rate Analysis

- Overcome Low PAM4 Signal-to-Noise Ratio and Channel Effects
- Perform powerful PAM4 error rate analysis including debug of individual bit errors

PAM4 Optical Signal Measurements

- ORR (Optical Reference Receiver) performance for 28GBd & 56GBd PAM4/NRZ
- Optical measurements for both NRZ & PAM4 signals: ER, AOP, OMA, Eye Height, and Eye Width
- PAM4 IEEE and OIF-CEI standard specific measurements including TDECQ with best in class optical sensitivity and noise

Advanced Debug Capability

- Use Visual Triggering to isolate PAM4 events of interest
- Full-bandwidth long-time capture and a time-correlated/contiguous record of your signal allowing offline DSP analysis

DSA8300 Digital Serial Analyzer

- Industry's best native time-base jitter performance, 425 fs_{RMS} *typical* (on up to 8 simultaneously acquired channels)
- <100 fs RMS time-base jitter when equipped with the 82A04B
- 16,000 point native record length
- 16 bits of vertical resolution
- 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



Electrical/TDR Products Summary

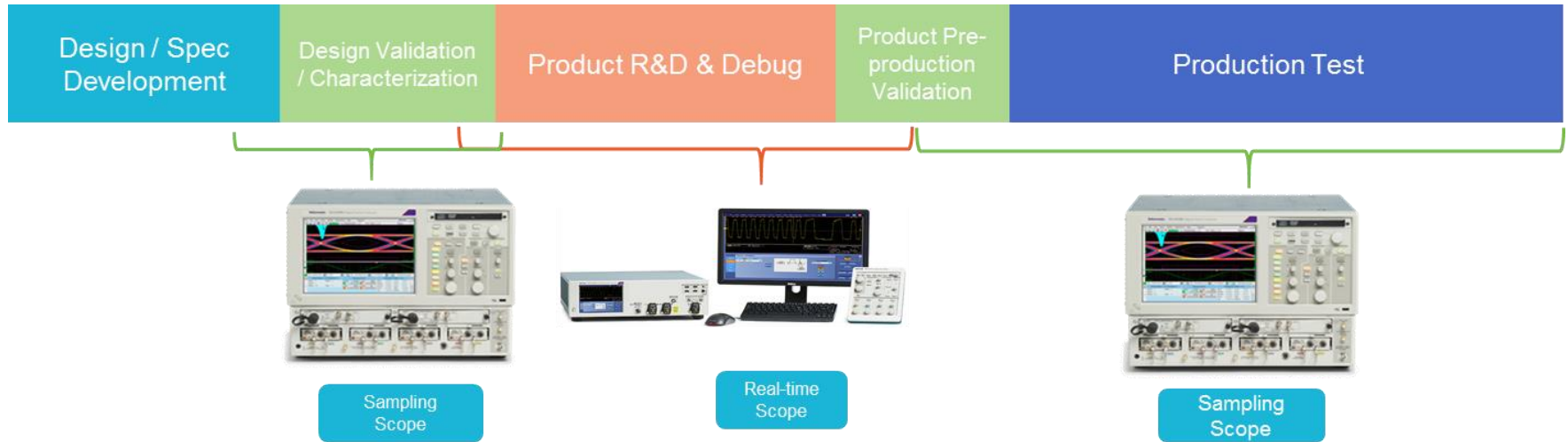
- Enhanced phase reference module and electrical sampling modules
 - 80E11, 80E11X1 – ultra-low jitter (85 fs RMS, typical), 70 GHz dual and single channel samplers
 - Highest bandwidth, ultra-low jitter, high fidelity signal acquisition
 - 80E07B, 80E08B, 80E09B, 80E10B – ultra-low jitter (95 fs RMS, typical) versions of the existing remote samplers
 - Remote samplers minimize aberrations due to cabling and test fixturing.
 - Select modules to meet bandwidth and noise requirements (20 GHz – 60 GHz)
 - 80E08B and 80E10B include highest performance integrated TDR capability
- 80E03. 80E04
 - 20 GHz Electrical and TDR dual channel modules
 - Monolithic design TDR and electrical modules
- 82A04B – enhanced phase reference module that enables <100 fs instrument jitter
 - Highest performance, multi-channel, low jitter solution



DSA8300 Optical Module Portfolio

Single and Multi-mode, Broad Wavelength (750 - 1650 nm) Modules	
80C07B	Supports standard 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 standard 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
80C15	Supports standard rates from 25.73 Gb/s – 28.05 Gb/s (maximum optical bandwidth > 32 GHz)
Single-mode, Long Wavelength (1100 - 1650nm) Modules	
80C11B	Optical bandwidth to 30GHz, supports 10Gbit/s up to 14G+ standards, optional Integrated CR
80C10C	Optical bandwidth to 80GHz, supports all 40 and 100 Gb/s (4 x 25 Gb/s) standards, optional CR trigger pickoff for e.g. CR286A CRU, optional high sensitivity photo-receiver for use with external equipment (e.g. for optical BER testing with BERTScope)

Proposed Solutions



Slides Subject

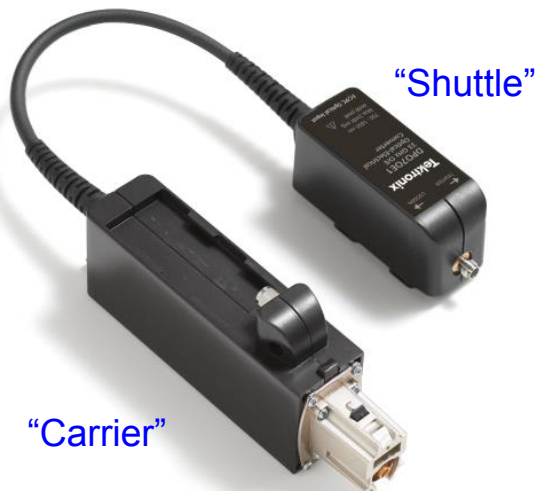
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 - 400G-M4

Introducing DPO7OE1 Optical Probe

- Broad wavelength O/E optimized for 28G Data Center Network App's
- 33 GHz Optical bandwidth, DC coupled
- Single mode, multi-mode, 750nm – 1650nm
- Compatible with TekConnect and ATI inputs
- Use with DPO/MSO70kC/D/DX and DPO70kSX



TekConnect – 33 GHz O/E



ATI – 28G ORR



ATI – Mechanical support deck

DPO70E1 Optical Probe – Key Specs

Feature / Function	Key Specs
Connector Type	FC/PC & FC/APC
Input Fiber Type	9 μm - 50 μm (SMF & MMF)
Wavelength Range	750 nm – 1650 nm (Opt FC/PC) 1260 nm – 1650 nm (Opt FC/APC)
Calibrated Wavelengths	850 nm, 1310 nm, 1550 nm (Opt FC/PC) 1310 nm, 1550 nm (Opt FC/APC)
Optical Bandwidth	33 GHz
RMS Optical Noise (Typ @ 1310nm @ 28GBd ORR @ Min uW/div on ATI/TekConnect)	6.6 μW / 6.6 μW
Dynamic Range	4 mW [TekConnect] 2.5 mW [ATI]
Max Power (avg / peak)	2 mW / 4 mW
Coupling	DC
RT PAM4/NRZ Measurements	ER, AOP, OMA, Eye Height (EH6) for all 3 PAM-4 eyes, Eye Width (EW6) for all 3 PAM-4 eyes

DPO7OE1 Target Applications

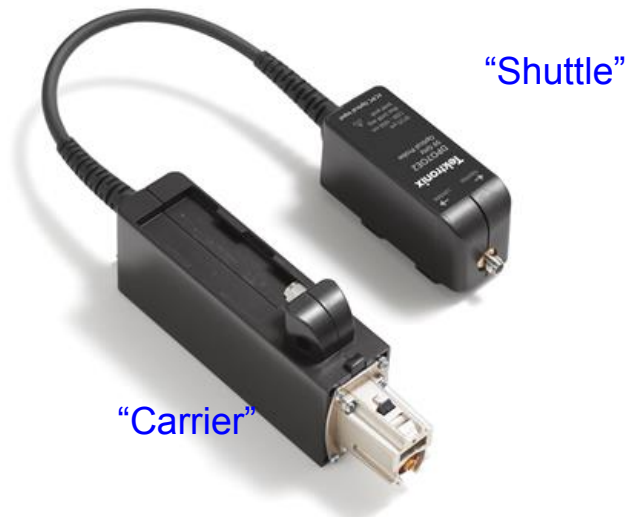
- 100G R&D users developing 2nd & 3rd generations of 100G lower power and/or lower cost devices
- R&D users using a sampling oscilloscope (ET) but also want to utilize real time (RT) oscilloscope's unique debug features including continuous real time acquisition, triggering, clock recovery and error detection

Distance	Technology	Per Lane Rate Modulation	Nomenclature	80C17/18	DPO7OE1
40km	Ethernet	PAM2 at 25.78GBd (25.7Gbps)	100GBASE-ER4	✓	✓
10km	Ethernet	PAM2 at 25.78GBd (25.78Gbps)	100GBASE-LR4	✓	✓
100m (MMF)	Ethernet	PAM2 at 28GBd (28Gbps)	100GBASE-SR4	✓	✓
100m (MMF)	Ethernet	PAM2 at 28GBd (28Gbps)	400GBASE-SR16	✓	✓
10km	Ethernet	PAM4 at 28GBd (56Gbps)	400GBASE-LR8	✓	✓
2km	Ethernet	PAM4 at 28GBd (56Gbps)	400GBASE-FR8	✓	✓

- Sampling oscilloscopes (ET) continue to have lower optical noise and lower cost than real time (RT) oscilloscopes making them excellent characterization tools, thus **complementing** the debug features of a real time oscilloscope

Introducing DPO70E2 Optical Probe

- Optimized for 56G Data Center Network App's
- 59 GHz Optical bandwidth, DC coupled
- Single mode, 1200nm – 1650nm
- Compatible with TekConnect and ATI inputs
- Use with DPO70kSX



ATI – 56G ORR



ATI – Mechanical support deck

DPO70E2 Optical Probe – Key Specs

Feature / Function	Key Specs
Connector Type	FC/PC & FC/APC
Input Fiber Type	9 μm - 50 μm (SMF & MMF)
Wavelength Range	1200 nm – 1650 nm (Opt FC/PC) 1200 nm – 1650 nm (Opt FC/APC)
Calibrated Wavelengths	1310 nm, 1550 nm (Opt FC/PC) 1310 nm, 1550 nm (Opt FC/APC)
Optical Bandwidth	59 GHz
RMS Optical Noise (Typ @ 1310nm @ 28GBd ORR @ Min uW/div on ATI)	10 μW
Dynamic Range	2.5 mW [ATI]
Max Power (avg / peak)	2 mW / 3 mW [ATI]
Coupling	DC
RT PAM4/NRZ Measurements	ER, AOP, OMA, Eye Height (EH6) for all 3 PAM-4 eyes, Eye Width (EW6) for all 3 PAM-4 eyes

DPO7OE2 Target Applications

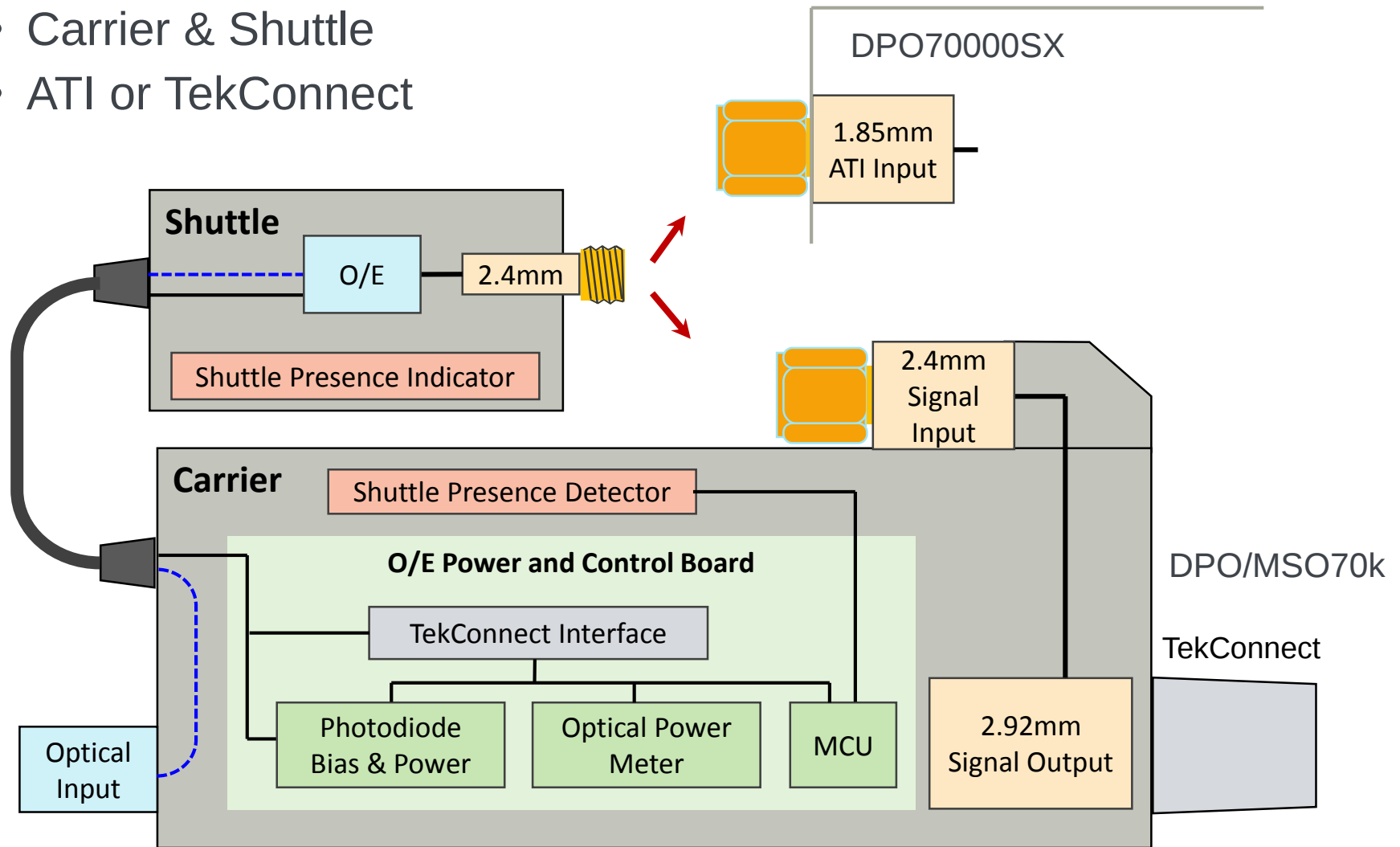
- 400G R&D users developing devices transitioning from 28GBd → 56GBd and/or NRZ → PAM4
- R&D users using a sampling oscilloscope (ET) but also want to utilize real time (RT) oscilloscope's unique debug features including continuous real time acquisition, triggering, clock recovery and error detection

Optical Standard	Modulation	Distance	Data Rate	Multiplex	Signaling Rate	80C20/21	DPO7OE2
200GBASE-SR4 (802.3cd) similar: 100GBASE-SR2, 50GBASE-SR	PAM4	70m, 100m	N lane x 50Gbps	<n> parallel MMF	26.56 GBd	✓	✓
200GBASE-DR4 (802.3bs)	PAM4	500m	4 lane x 50Gbps	4 parallel SMF	26.56 GBd	✓	✓
400GBASE-DR4 (802.3bs) similar: 100GBASE-DR	PAM4	500m	<n> lane x 100Gbps	4 parallel SMF	53.125 GBd	✓	✓
400GBASE-FR8 (802.3bs) similar: 200GBASE-FR4, 50GBASE-FR	PAM4	2km	<n> lane x 50Gbps	1 SMF 8λ WDM	26.56 GBd	✓	✓
400GBASE-LR8 (802.3bs) similar: 200GBASE-LR4, 50GBASE-LR	PAM4	10km	<n> lane x 50Gbps	1 SMF 8λ WDM	26.56 GBd	✓	✓

- Sampling oscilloscopes (ET) continue to have lower optical noise and lower cost than real time (RT) oscilloscopes making them excellent characterization tools, thus **complementing** the debug features of a real time oscilloscope

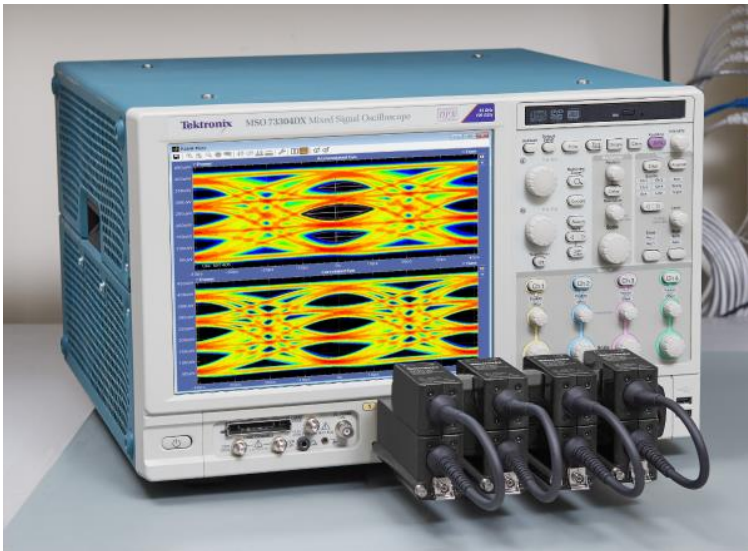
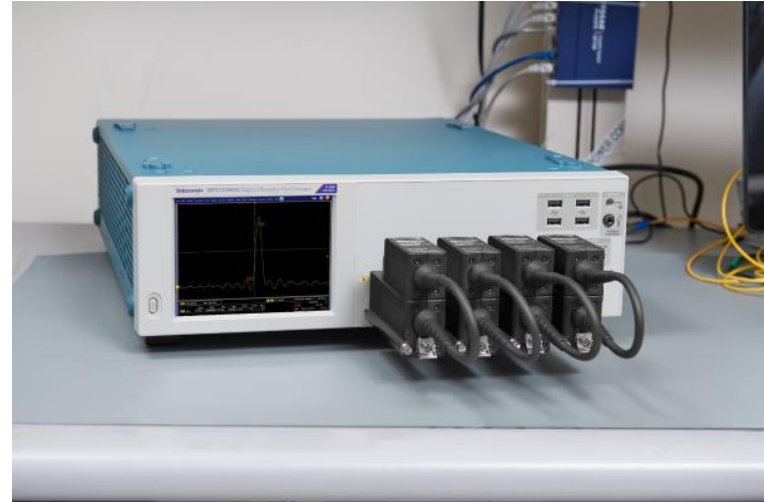
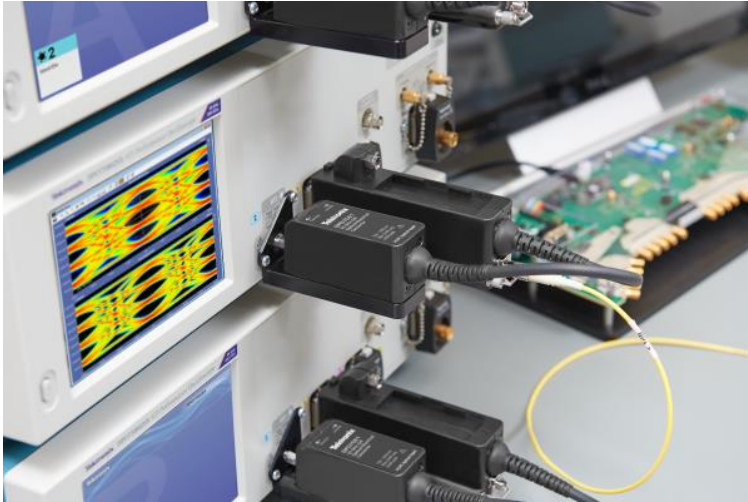
DPO70E1/OE2 Block Diagram

- Carrier & Shuttle
- ATI or TekConnect



DPO70E1/OE2 – Typical Configurations

MSO/DPO70KC/D/DX AND DPO70KSX - ATI OR TEKCONNECT

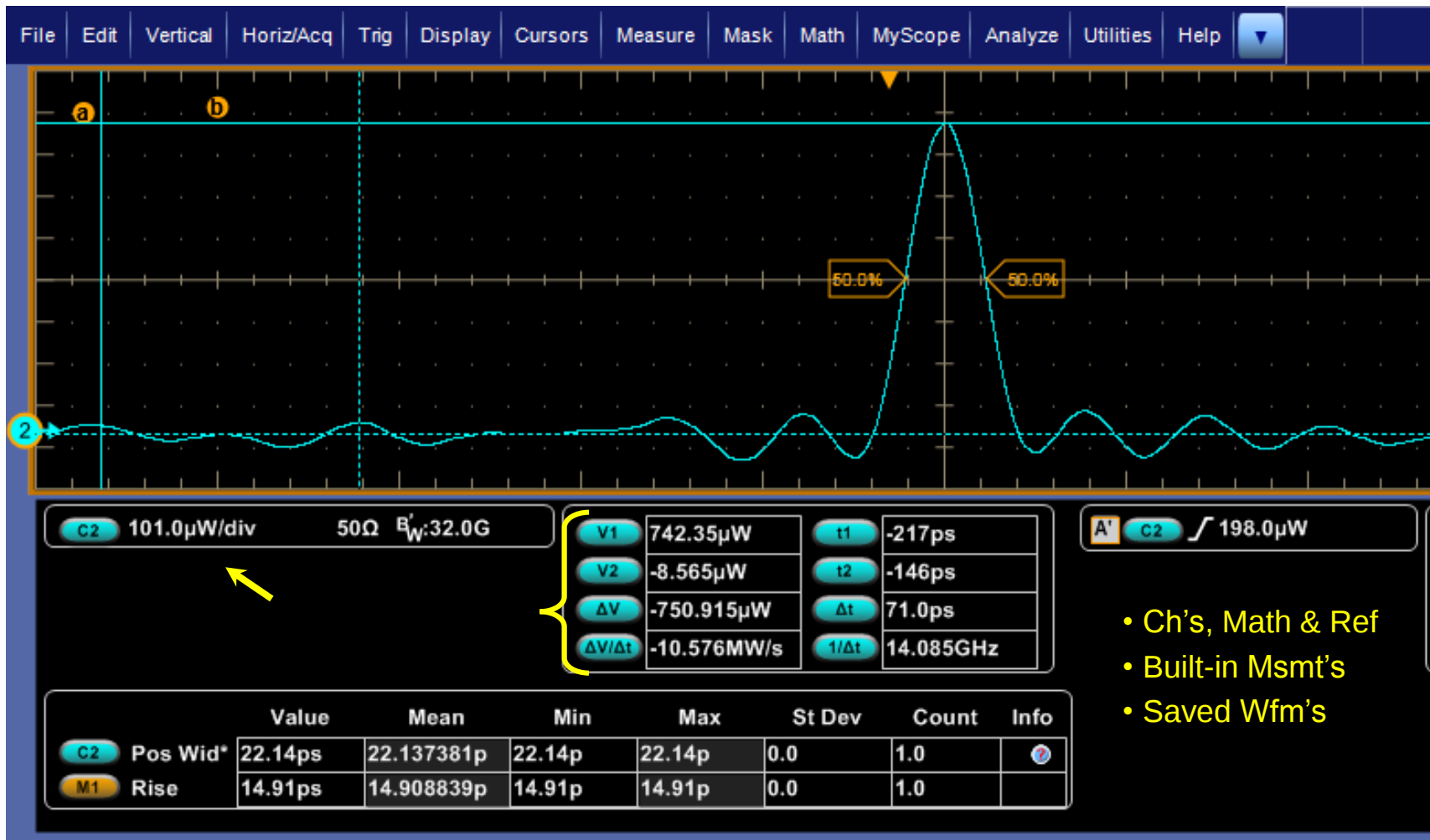


Fully Scalable System to Meet Changing Needs

- DPS77004SX system building block
 - 2 channels @ 70GHz, 200GS/s
 - 4 channels @ 33GHz, 100GS/s
- Aggregate units to build system
- Distribute units for individual needs



DPO70E1/OE2 – Optical Power Scaled in Watts



- Ch's, Math & Ref
- Built-in Msmt's
- Saved Wfm's

DPO70E1/2 – Control Panel (Frequency Response)

The image displays two screenshots of the DPO70E1/2 control panel, specifically the 'Probe Setup' window. Both screenshots show the 'Frequency Response' section with three radio button options: 'Unfiltered O/E response' (selected), 'Flat to maximum bandwidth', and 'BT4: User specified electrical BW'. The 'Power Meter' section shows a reading of '0.0W' in the top screenshot and '-7.3nW' in the bottom screenshot. The 'Wavelength' section shows three radio button options: '850nm', '1310nm', and '1550nm' (selected). The 'Dark Compensation' section shows three buttons: 'Cal', 'Add', and 'Erase'. The 'Probe Type' section shows 'DPO70E1' in the top screenshot and 'DPO70E2' in the bottom screenshot. The 'Properties' button is also visible in both screenshots.

Probe Setup

Chan 1
Chan 2
Chan 3
Chan 4
Aux

Probe Type: DPO70E1

Dark Compensation: Cal

Add User Wavelength: Add

Erase User Wavelengths: Erase

Wavelength: 850nm, 1310nm, 1550nm

Frequency Response: Unfiltered O/E response, Flat to maximum bandwidth, BT4: User specified electrical BW

Power Meter: 0.0W

On

Probe Setup

Chan 1
Chan 2
Chan 3
Chan 4
Aux

Probe Type: DPO70E2

Dark Compensation: Cal

Add User Wavelength: Add

Erase User Wavelengths: Erase

Wavelength: 1310nm, 1550nm

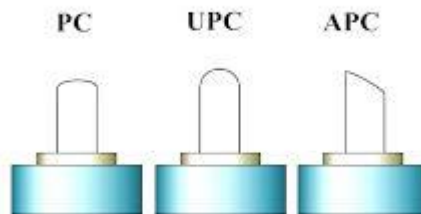
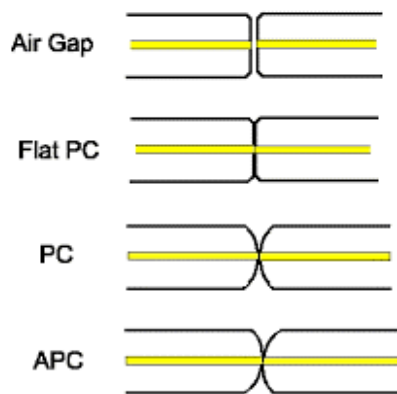
Frequency Response: Unfiltered O/E response, Flat to maximum bandwidth, BT4: User specified electrical BW

Power Meter: -7.3nW

On

Optical Input Connector Types

- Two (2) ordering options:
 1. FC/PC – “Physical Contact”
 2. FC/APC – “Angled Physical Contact”



UPC
<-50dB
Back Reflection





80C17/18 28GBd

80C20/21 56GBd

New Optical Modules for DSA8300 Series

05-MAR-2018



Overview

KEY OBJECTIVES

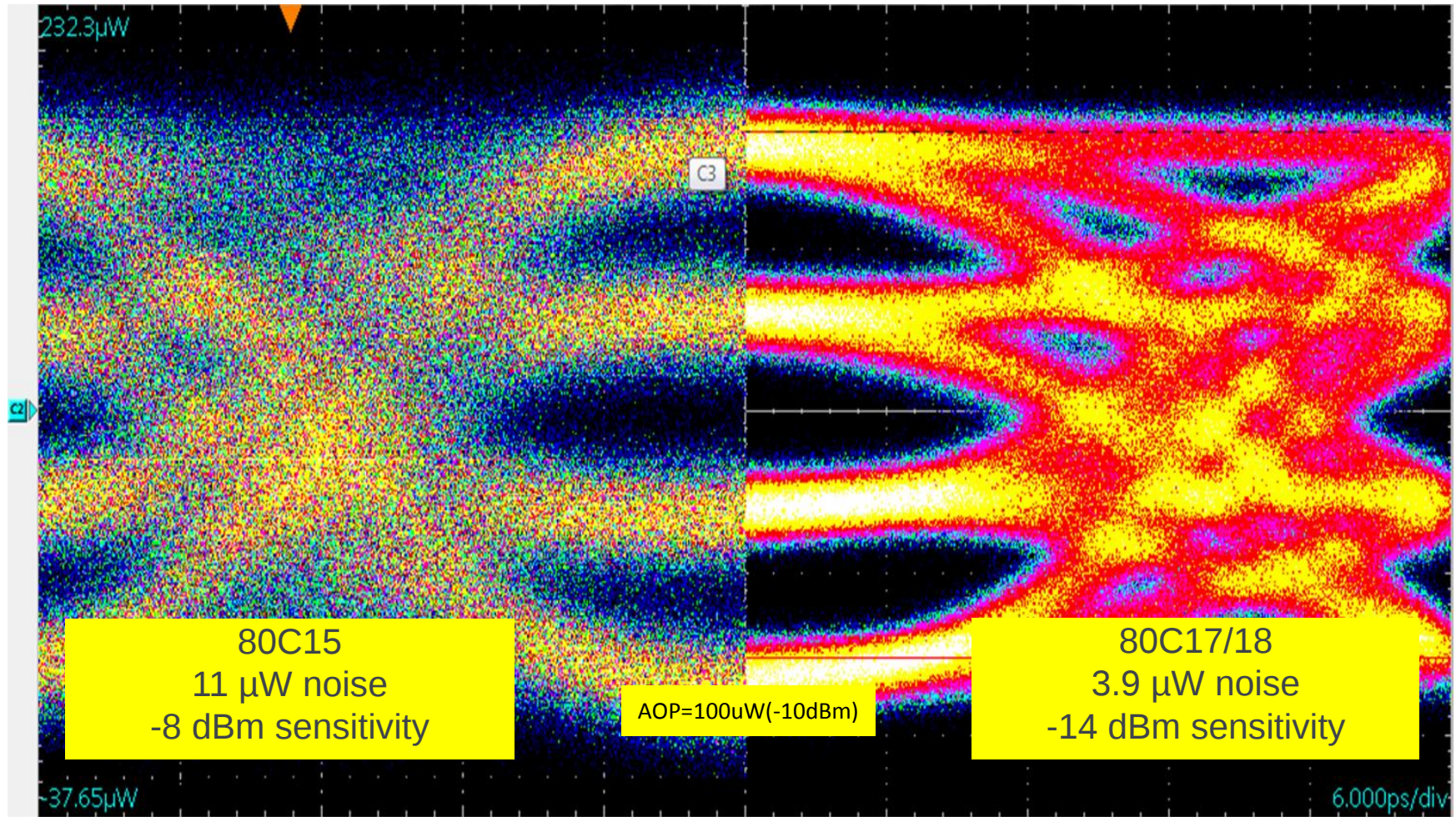
- Better optical performance than previous generation
 - Lower noise
 - Higher mask margin
 - More optical channels
- 28GBd & 56GBd NRZ measurements with higher margin, higher yield, at lower optical powers
- 28GBd & 56GBd PAM4 measurements with multi-level analysis, TDECQ, and eye mask at 56Gbd
- Optimized for parallel, multi-port testing in manufacturing environment.

80C17/18 vs 80C15

Feature / Function	80C17/18 <i>Target Specs</i>	80C15 <i>Current Specs</i>
# Channels	1 or 2	1
Input Fiber Type	MM + SM 9, 50 μm (no 62.5 μm)	MM + SM 9, 50, 62.5 μm
Wavelength Range	800nm - 1650nm	800nm - 1650nm
Unfiltered Optical Bandwidth	>30 GHz	>32 GHz
Unfiltered Risetime (typical)	14 ps	14 ps
Optical Reference Receivers	25.78 – 28.05 Gb/s	25.78 – 28.05 Gb/s
RMS Optical Noise Typical @ 1310 nm @ 25.78 Gb/s	3.9 μW	11 μW
Mask Test Sensitivity Typical @ 1310nm	-14 dBm	-8 dBm
Power Meter Zero Level Performance - Sample rate reduced by increasing channels	None	2 ch – half 4 ch - quarter

80C17/18 vs 80C15

Impact of Noise and Sensitivity

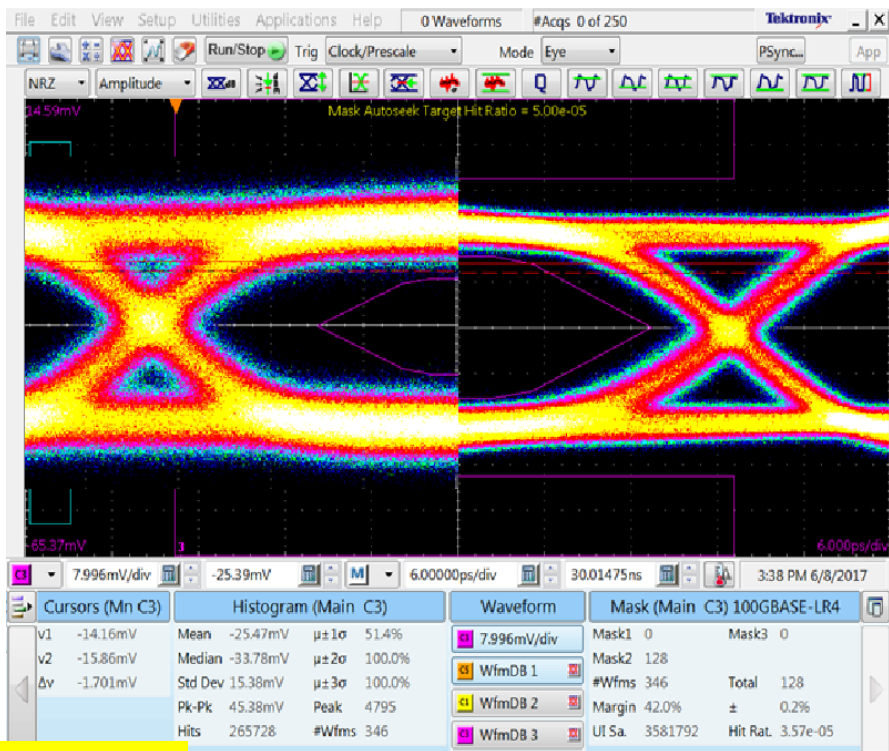


80C20/21 vs 80C10C

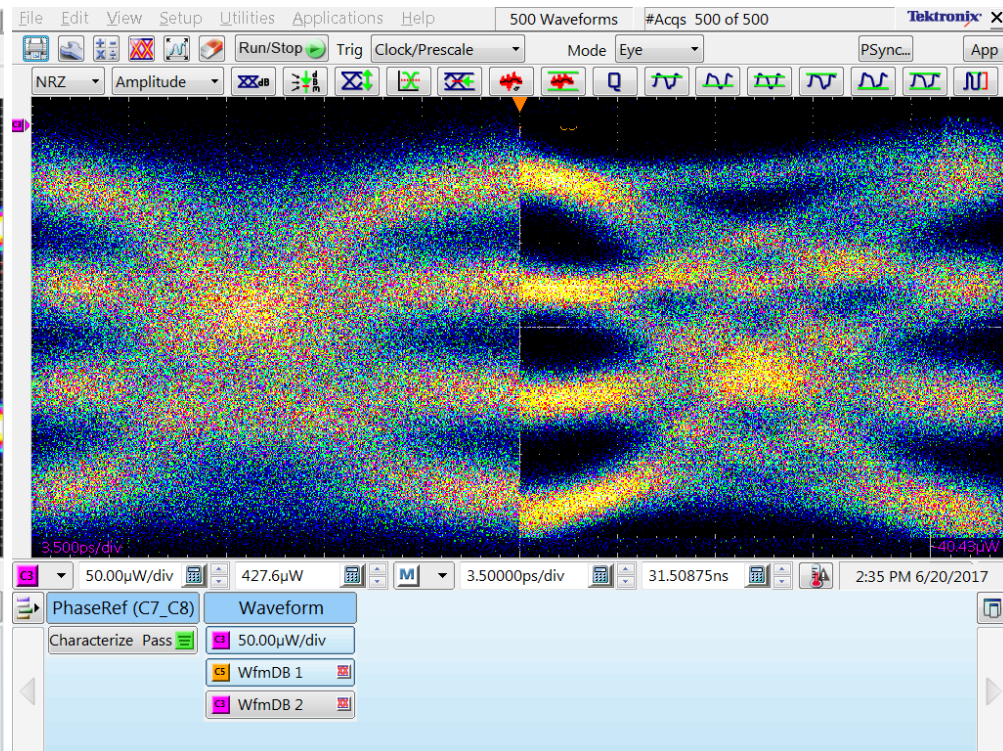
Feature / Spec	80C20/21 <i>Target Specs</i>	80C10C <i>Current Specs</i>
# Channels per Module / System	1 or 2 / 1, 2, 3, 4	1 / 1, 2
Unfiltered Optical Bandwidth (-3dBo)	53 GHz	80 GHz
Wavelength Range	1200 to 1650 nm	1290 to 1620 nm
Calibrated Wavelengths	1310 nm / 1550 nm	1310 nm / 1550 nm
Optical Noise (RMS) @ 1310 nm @ 37 GHz, Typical / Maximum	9 μ W / 12 μ W	29.9 μ W / 52 μ W
Optical Sensitivity @ 1310 nm	-10 dBm	-6 dBm
Max input power, non-destruct, average/peak	4 mW / 8 mW	30 mW
Dynamic range (full scale)	3 mW	15 mW
Optical return loss	>25 dB	>30 dB
Acquisition delay adjustment range on each channel	+/- 65 ps	---
Power meter range	+6 dBm to -27 dBm	+13 dBm to -21 dBm
Input Fiber Type	9 μ m	9 μ m
Clock Recovery Trigger Pick-off Option	No	Yes

80C20/21 vs 80C10C

Impact of Noise and Sensitivity



AOP = -6dBm

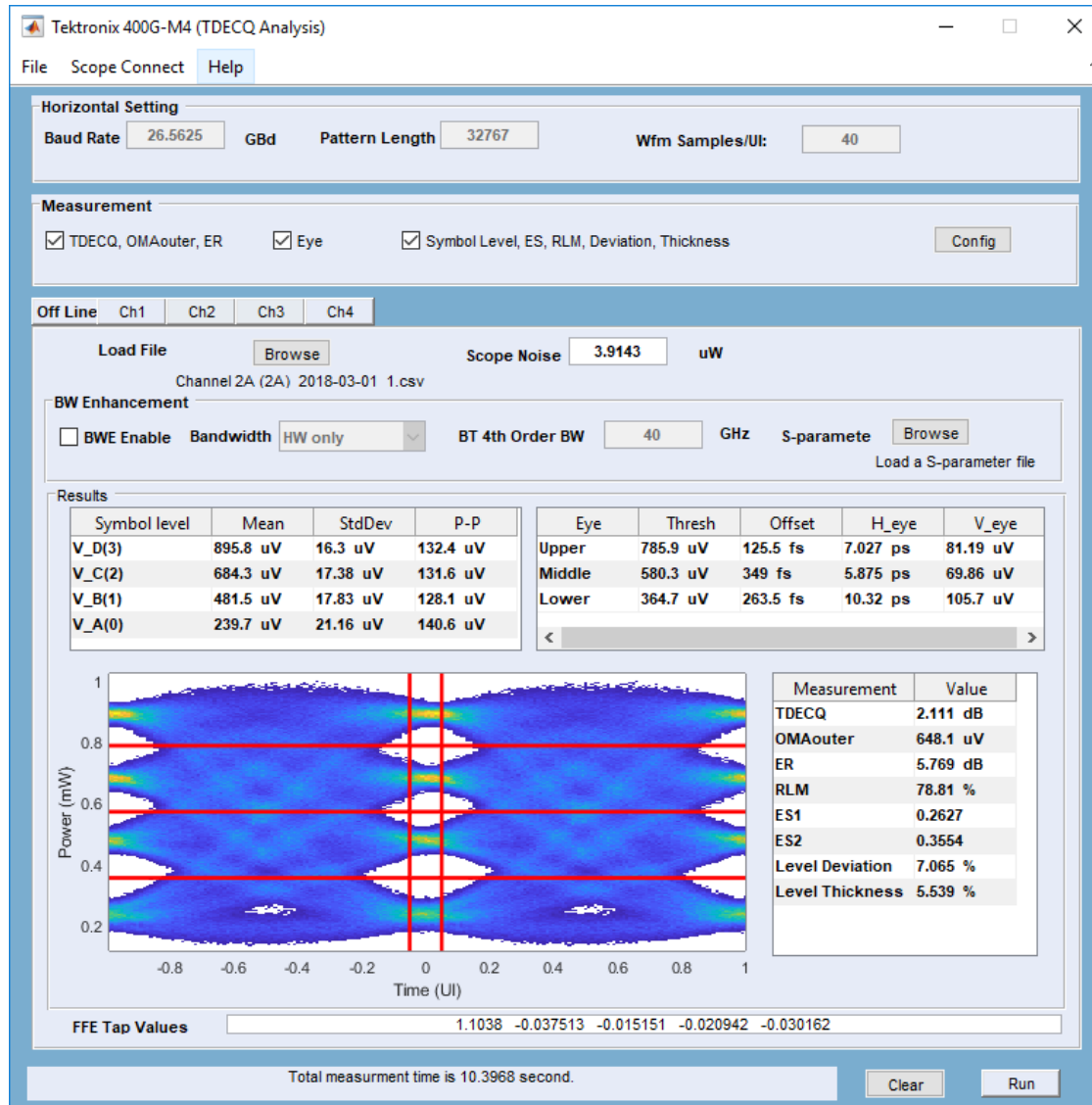


AOP = -6dBm

DSA8300 400G-M4 Overview

- DSA8300 400G-M4 Software application
- New 64-bit PC based PAM4 Optical Manufacturing Solution
 - Support for online mode through 4 channel simultaneous acquisition
 - Limited set of measurements targeted at PAM4 Optical Signal measurement
 - Levels
 - Level Deviation
 - Level Thickness
 - Linearity
 - OMA
 - ER
 - Eye Width / Eye Height
 - TDECQ
- Support for auto-optimization and user defined equalizer taps values
- Support for user defined bandwidth enhancement filters- adjustable filters
- Support for BWE Filters
- Independent control for vertical channel set up
- Dashboard style UI with simplified setup

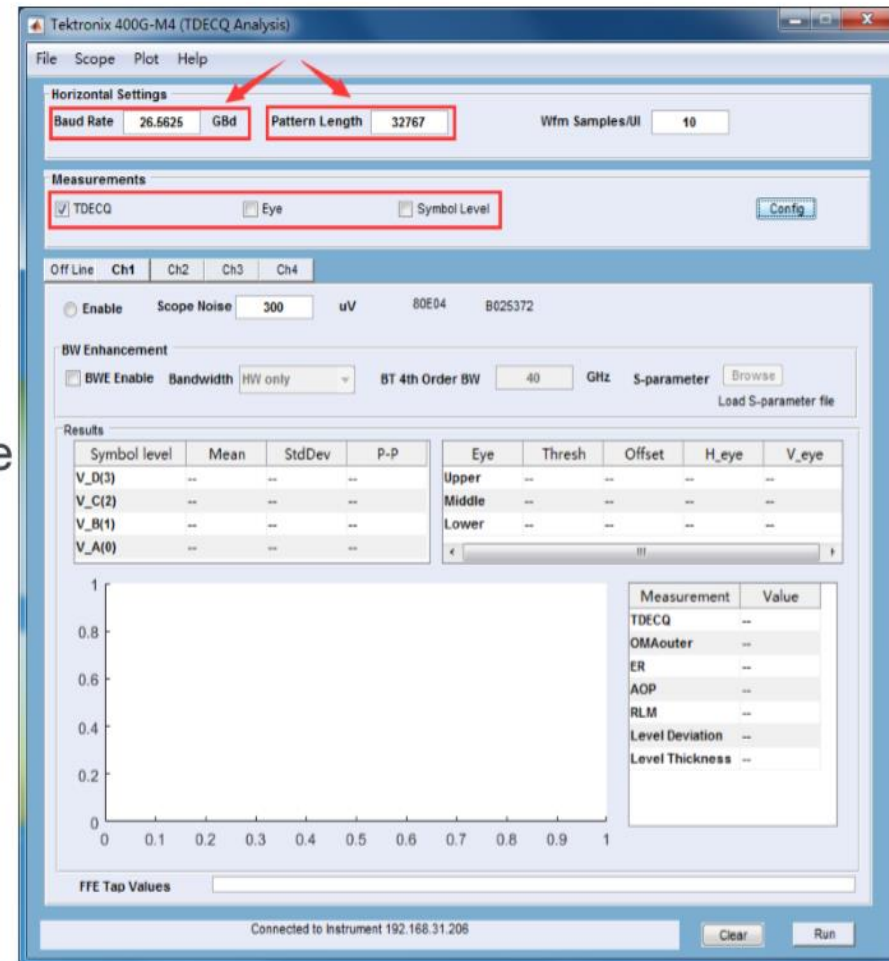
DSA8300 400G-M4 UI



400G-M4 UI

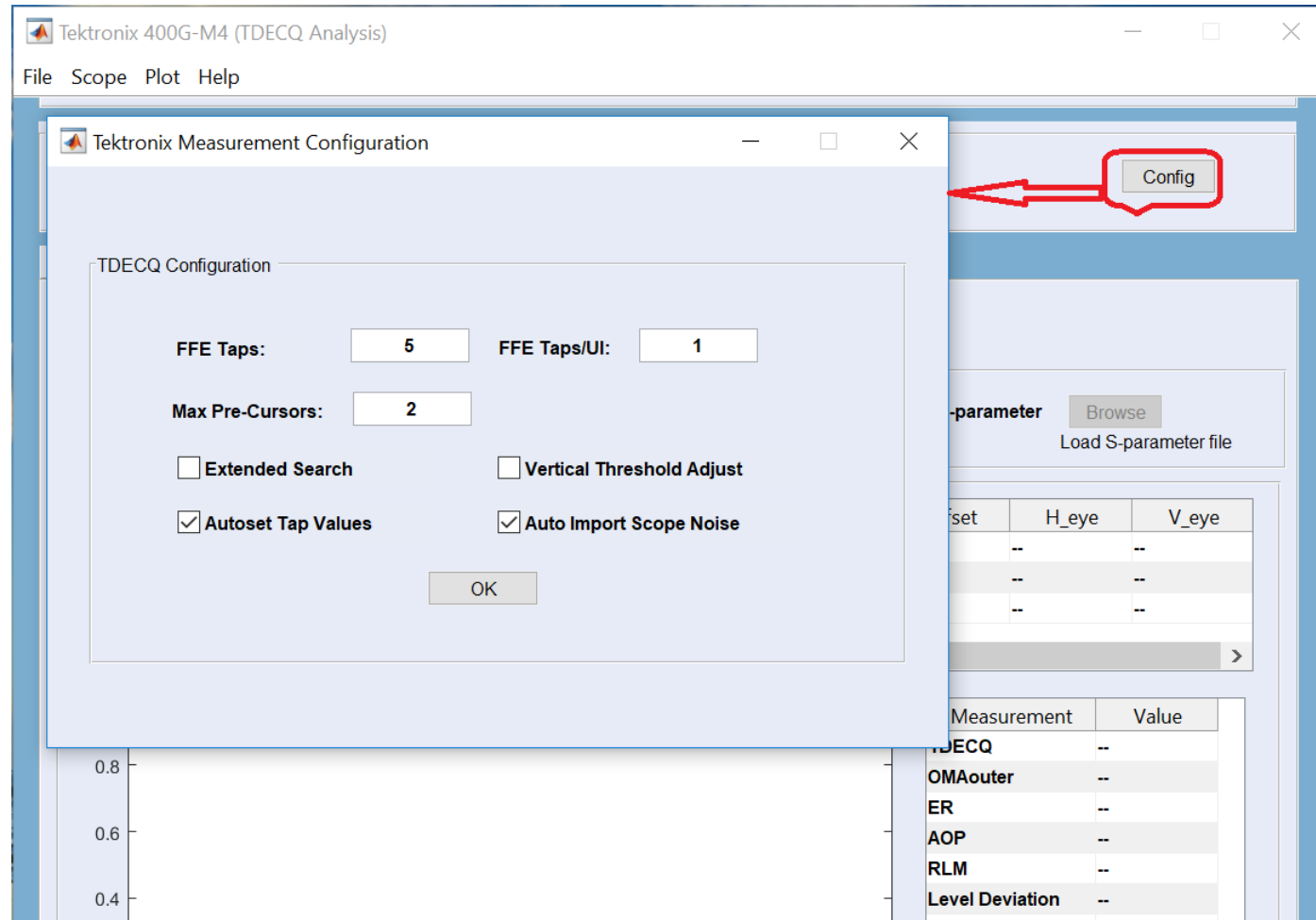
400G-M4 setting

- Baud Rate / Pattern Length and test items
 - Baud Rate: Key in the baud rate of your DUT, default is 26.5625GBd
 - Pattern Length: Key in the pattern length of your DUT, default is 32767 UI
 - TDECQ: if check this item you will get the results: TDECQ/OMAouter/ER/AOP
 - Eye: if you check this item you will get the results:Threshold/Offset/Eye-horizontal/Eye-vertical
 - Symbol Level: if you check this item you will get the results:RLM/Level Deviation/Level Thickness and 4 levels value



400G-M4 UI

TDECQ Configuration



Test Time Improvements

	80SJNB- Fast TDECQ		DSA 8300 400G-M4	
	1 Channel	4 Channels	1 Channel	4 Channels
PRBS-15	20 sec	80 sec	12 sec	24 sec
Measurements	TDECQ		TDECQ	
	OMAouter		OMAouter	
	ER		ER	
	AOP			

Q&A

Thanks!