InfiniBand NDR (400G) Active Time Domain Testing – MOI

NOVEMBER 2022 REV 1.1

I² NDC

Keysight Technologies



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InfiniBand NDR ATD AOC Revision History

Initial posting of draft NDR ATD MOI

Modified Date -	Modified By
Mar 25, 2022 Revision .75 (1 total)	John Calvin Keysight Technologies

Configured and tested at IBTA 39th InfiniBand™ and

Draft Keysight NDR ATD MOI.pdf

Download (3.19 MB)

RoCE Plugfest #39, May 2, 2022



Company

Keysight

Technologies

Posted revised (workshop feedback) NDR ATD MOI, release candidate 1.0, September 2, 2022

Posted revised (October 5, 2022 review feedback) NDR ATD MOI, release candidate 1.1; November 30, 2022

- Work in progress regarding NDR mask implementation << Future update.
- MTF Calibration/Test procedure



ID

A 8779

Title

Infiniband NDR

OUTLINE

The InfiniBand NDR Interface

NDR Test Platform

Tx Test Procedure

Rx Test Procedure



Infiniband NDR interface

OVERVIEW



Infiniband

SPEED & CABLE TYPES

Characteristics											
	\$	SDR ÷	DDR +	QDR +	FDR10 ÷	FDR \$	EDR 🗢	HDR 🕈	NDR +	XDR ÷	GDR \$
Signaling r	ate (Gbit/s)	2.5	5	10	10.3125	14.0625 ^[18]	25.78125	50	100	200	400
Theoretical	for 1 link	2	4	8	10	13.64	25	50	100	200	400
effective	for 4 links	8	16	32	40	54.54	100	200	400	800	1600
throughput	for 8 links	16	32	64	80	109.08	200	400	800	1600	3200
(Gb/s) ^[19]	for 12 links	24	48	96	120	163.64	300	600	1200	2400	4800
Encodir	ng (bits)		8b/10	0b ^[20]			64b/66)		t.t	.d
Modu	lation				NRZ			PAM	4	t.t	.d
Adapter late	ency (µs) ^[21]	5	2.5	1.3	0.7	0.7	0.5	< 0.6 ^[22]		t.b.d.	
Yea	r ^[23]	2001, 2003	2005	2007	2011	2011	2014 ^[24]	2018 ^[24]	2022 ^[24]	t.b	.d.

This MOI is focusing on full limiting active cable

- Far-end & near-end limiting not relevant at this speed
- Host Tx & Rx responsible for equalization

Cable type	Tx card	Connector	Cable	Connector	Rx card
Full limiting active copper or fiber (Active Optical)	Tx responsible for equalizing	Redriver		Redriver	Rx responsible for equalizing





Separable electrical connector

Figure 87 High-level topology block diagram



Transceiver module

Figure 88 Optical Fiber Interconnect Topology



Figure 89 Full limiting active cable topology



Infiniband

NDR INTERFACE - LEVERAGING HDR & IEEE 802.3CK

Layer 1 specification not yet released for NDR

→ Leverage HDR test strategy & IEEE 802.3ck C2M specifications

IBTA Active Time Domain (ATD) Testing for Active Cables

- Anritsu ATD MOI for Active FDR Cables
- Anritsu Keysight ATD MOI for Active EDR Cables
- Anritsu Keysight ATD MOI for Active HDR Cables

CHAPTER	IER 6: HIGH SPEED ELECTRICAL INTERFACES								
6.1 INTROL	DUCTION								
	Thi nal sig	is chapter de ing rates are naling rate a	escribes e for enco as specifi	the high speed in oded data on the ed below. The s	media, and co upported data	se with InfiniBand prrespond to the e rates are listed in	■ links. The sign encoding for the Table 52 ¹ .		
		1	able 52	InfiniBand Li	nk Data Rate	es			
InfiniBand rate	Per-lane signaling	Unit Interval (UI) or bit	Codec	Aggrega	nk Data Rate ate full duplex th Link D	PS roughput, GB/s (GB Designator	ytes/sec)		
InfiniBand rate designator	Per-lane signaling rate, GBd	Unit Interval (UI) or bit period, ps	Codec	Aggrega 4X inte	nk Data Rate ate full duplex th Link D	roughput, GB/s (GB Designator 12X in	ytes/sec) terface		
InfiniBand rate designator SDR	Per-lane signaling rate, GBd	Unit Interval (UI) or bit period, ps 400	Codec 8b/10b	Aggrega 4X into (1+1) GB/s	nk Data Rate ate full duplex th Link D erface 10G-IB-SDR	Poesignator 12X in (3+3) GB/s	ytes/sec) terface 30G-IB-SDR		
InfiniBand rate designator SDR DDR	Per-lane signaling rate, GBd 2.5 5.0	Unit Interval (UI) or bit period, ps 400 200	able 52 Codec 8b/10b 8b/10b	Aggreg: 4X into (1+1) GB/s (2+2) GB/s	nk Data Rate ate full duplex thi Link D erface 10G-IB-SDR 20G-IB-DDR	Proughput, GB/s (GB Designator 12X in (3+3) GB/s (6+6) GB/s	ytes/sec) terface 30G-IB-SDR 60G-IB-DDR		
InfiniBand rate designator SDR DDR QDR	Per-lane signaling rate, GBd 2.5 5.0 10.0	Unit Interval (UI) or bit period, ps 400 200 100	Codec 8b/10b 8b/10b 8b/10b	Aggreg: 4X int (1+1) GB/s (2+2) GB/s (4+4) GB/s	nk Data Rate ate full duplex thi Link D erface 10G-IB-SDR 20G-IB-DDR 40G-IB-QDR	12X in (3+3) GB/s (6+6) GB/s (12+12) GB/s	ytes/sec) terface 30G-IB-SDR 60G-IB-DDR 120G-IB-QDR		
InfiniBand rate designator SDR DDR QDR FDR	Per-lane signaling rate, GBd 2.5 5.0 10.0 14.0625	Unit Interval (UI) or bit period, ps 400 200 100 71.11	Codec 8b/10b 8b/10b 8b/10b 8b/10b 64b/66b	Aggrega 4X into (1+1) GB/s (2+2) GB/s (4+4) GB/s (6.8+6.8) GB/s	nk Data Rate ate full duplex th Link D erface 10G-IB-SDR 20G-IB-DDR 40G-IB-QDR 56G-IB-FDR	Image: second system Second system 12X im 12X im (3+3) GB/s (6+6) GB/s (12+12) GB/s (12+12) GB/s (20.4+20.4) GB/s 20.4+20.4) GB/s	terface 30G-IB-SDR 60G-IB-DDR 120G-IB-QDR 168G-IB-FDR		
InfiniBand rate designator SDR DDR QDR FDR EDR	Per-lane signaling rate, GBd 2.5 5.0 10.0 14.0625 25.78125	Unit Interval (UI) or bit period, ps 400 200 100 71.11 38.78	Codec 8b/10b 8b/10b 8b/10b 64b/66b 64b/66b	4X into (1+1) GB/s (2+2) GB/s (4+4) GB/s (6.8+6.8) GB/s (12.5+12.5) GB/s	nk Data Rate ate full duplex th Link C erface 10G-IB-SDR 20G-IB-DDR 40G-IB-DDR 40G-IB-DDR 56G-IB-FDR 104G-IB-EDR	Pesignator 12X int (3+3) GB/s (6+6) GB/s (12+12) GB/s (20.4+20.4) GB/s (37.5+37.5) GB/s	ytes/sec) terface 30G-IB-SDR 60G-IB-DDR 120G-IB-QDR 168G-IB-FDR 312G-IB-EDR		

High Speed Electrical Interface

April 7, 2020

InfiniBandTM Architecture Release 1.4

IEEE P802.3ck[™]/D3.3, 10 June 2022

(Amendment of IEEE Std 802.3[™]-2022 as amended by [list to be populated during publication process])

IEEE P802.3ck™/D3.3

Draft Standard for Ethernet

Amendment 4:

Physical Layer Specifications and Management Parameters for 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Based on 100 Gb/s Signaling

Note: While current specifications are limited to four lanes (400Gbps), some devices and interfaces can accommodate up to eight lanes. In this document, we assume <u>OSFP112G</u> interface but the procedure is identical for <u>QSFP-DD800</u> interface (8 lanes), and <u>QSFP112</u> interface (4 lanes).



NDR Test Platform

TEST POINTS

にバリン



NDR Cable Test References

LEVERAGING IEEE 802.3CK C2M



Cable output and input test procedures follow

- IEEE Annex 120G 3.2 (Module output test at TP4)
- IEEE Annex 120G 3.4 (Module input test at TP1)
 - Long & short channels

MCB characteristics follows

 IEEE Annex 162B (Test fixture for 100GBASE-CR1...400GAUI-4 C2M)

Notable differences

crosstalk amplitude (see <u>NEXT calibration slide</u>)

MODULE OUTPUT (TP4) Table 1200-3-Medule output	I characterist	ics at TP4			(TP1)	anon		
Parameter	Reprint 1	Yalar	THE	ule stressed in	le 1295-19-Module stresse	d input parameters		
Signaling on, each lase (scenical)		8128	GBA		Farameter	Taler	Take	1
Peak-to-peak AC common-mode with go (met) Low-droppings, PCM _{LF} Full-band, PCM _{ER}	1200.5.1	22	10		ini (hipit)	1	p	1
Bitliemetial peak to peak enipsi veltage (nam) Sheet mode Losse mode	1300.84		5		dd jiter	3kir161-17		-
Try legiticoust	1290332	10			iii)	12		1
Variand opt classes, VISC (mat)	1096332	10	-00		40	12.5		1
Common-mode to differential mode owner loss, RAI: (min)	12903.13	Tapation (1290-1)	- 69		ceak robus	640	aV.	-
Tillector etam ion, TBL (min)	206333	84	-60				-	-
Differential terminetics minureth (met)	12963.13					4.5	P	1
Transition time (min)	12063-14	11	pa.					
IPC common-mode to have to have charged tapped limit Lower limit	12963.2.4	210	÷					



Host Compliance Testing

IDENTICAL TO IEEE 802.3CK

TP7

TP8

Figure 94 Host compliance board test points

HCB PCB



TP8a

The proposal is to make a separate document for host - Eye mask test (tbd by Nvidia) still open

For host compliance test procedures refer to a separate document

Host output and input test procedures follow

- IEEE Annex 120G 3.1 (Host output test at TP1a)
- IEEE Annex 120G 3.3 (Host input test at TP4a)

HCB characteristics follows

 IEEE Annex 162B (Test fixture for 100GBASE-CR1...400GAUI-4 C2M)



Host Board

NDR Test Platform

EQUIPMENT

1. 50.22



EQUIPMENT OVERVIEW (OPTIONS ON NEXT PAGES)



M8040A system

- M8045A pattern generator for victim lane generation
- M8046A error detector
- M8194/96A arbitrary waveform generator for aggressor channels



2x Wilder Technologies MCB

- 2x **OSFP**-TPA1.85-MCB-R **or**
- 2 x QSFPDD-TPA1.85-MCB-R
 - OSFP, 1.85mm connector
 - CMIS control (on MCB or Aardvark)
 - Incl. power supply (16Watt)



1x Wilder Technologies HCB

- 1x **OSFP**-TPA1.85-HCB-P or
- 1x QSFPDD-TPA1.85-HCB-P
 - 1.85mm connector



N1000A+N1060A

- Reference Rx for
 - Tx test at TP4
 - victim lane calibration at TP1





Cables & RF adapters

- 1.85mm Matched cable pairs for M8045A
- 2.4mm Matched cable pair M8196A



1x ISI board

- Compliant with IEEE 8023.ck
- MTF+Trace
 - ~18.2dB @Nyquist,
 - C2M COM>3dB



Equipment List

RECOMMENDED HW

Item #	Vendor	Part Number	Description	Options	Qty	Details
1	Keysight	M8040A	5 slot AXIe chassis	M8040A-BU2	1	Chassis
2	Keysight	M8045A	Pattern generator and clock module 64GBaud M8045A-G64/-0G2/-0G3/-0G4/-0P6/-801 802/-803		1	Signal source for pattern generator and jitter impairment
	Keysight	M8057B	Remote head		2	
3	Keysight	M8046A	Analyzer module 64GBaud	M8046A-A64/-0A3/-0A4/-0A5/-0P3/-0P6/- 801/-802	1	Error Detector
4	Keysight	M8196A	4 Channel 92 GSa/s Arbitrary Waveform Generator	M8196A-001	1	Aggressor lane generation
5	Keysight	N1000A + N1060A	DCA-X Wide-Bandwidth Oscilloscope Mainframe + N1060A Precision Waveform Analyzer	N1000A-PLK/-STB N1060A-050/-EVA/-264/-PTB/-JSA	1 1	For TX test and stressed signal calibration
6	Multilane	ML4067	Channel emulation board or any other ISI trace compliant with IEEE 802.3ck.	-	1	For C2M long channel calibration and testing
7	Wilder	SP060x	SP0603A for OSFP or SP0607A for QSFP-DD 112G HCB Test Adapter	SP0603A/ SP0607A	1	For Crosstalk calibration (TX & RX Tests)
8	Wilder	SP060x	SP0602A for OSFP or SP0606A for QSFP-DD 112G MCB Test Adapter incl. fan to cool down the device	SP0602A/ SP0606A	2	Module Compliance Board for active cable testing
9	Keysight	M8196A-810	Matched Cable Pair for M8196A AWG, 2.4 mm	-	4	From AWG Output to MCB
10	Keysight	M8045A-801	Short Cable 1.85 mm (m) to 1.85 mm (m), 0.15 m, absolute matching 699 ps +- 1 ps	-	8	2 for BERT Remote Heads; 2 for MCB to ED; 2 from ISI Board to MCB
11	Total Phase	TP240141	Aardvark I2C/ SPI Host adapter	-	1	Require additional jumper cables.



Equipment List

LAPTOP & SW

ltem #	Vendor	Part Number	Description	Revision	Details
			Laptop with at least 3 UBS ports (USB hub possible), Windows 10, 64bits and valid license for the SW products listed below		Use Keysight demo laptop
12	Keysight	FlexDCA		06.92.13	Beta version used
13	Keysight	M8070B	System software for M8000 series of BER test solutions	9.0	
14	Keysight	M8070EDAB	Error Distribution Analysis Package for M8000 Series BER Test Solutions	1.8.160.2	for FLR estimation using M8046A error analyzer
15	Keysight	M8070ADVB	Advanced Measurement Package for M8000 Series BER Test Solutions	1.8.160.2	For automated jitter tolerance test
16	Keysight Technologies	N1091CKCA	DCA TX test application for IEEE802.3ck	1.19.9038	Automation TX test for C2M at TP4; Beta version used
17	Keysight Technologies	M8091CKPA	RX conformance test application for IEEE 802.3ck Rev. 2.50.8	2.50.8	Automation RX test for C2M Input at TP1

ALTERNATIVE EQUIPMENT

Item #	Vendor	Part Number	Description	Revision	Details
1	Any vendors	N.A	2x 100MHz Low Pass filter		For Low-frequency peak-to-peak AC common mode test Example: <u>https://www.fairviewmicrowave.com/low-pass-filter-dc-100-</u> <u>mhz-sma-female-connectors-fmfl019-p.aspx</u>
2	Any vendors		Matched Cable Pair for MCB loopback (see this <u>slide</u>)		from AWG Output to MCB. Can be skipped if the active cable offers local loopback capabilities (mandatory for IEEE 802.3ck)
3	Any vendors		50 ohm termination 1.85mm		For MCB

Setup Configuration

AEC Testing for TX and RX

- M8045A & M8196A as Reference Transmitters
- M8046A as Bit Error Detector
- N1000A + N1060A as Reference Receiver
- Wilder MCB as Mated Test Fixture*
 *Keysight part number SP0602A for OSFP or SP0606A for QSFP-DD 112G
- ISI Board as "host channel"
- AEC Cable or AOC Device Under Test
- M8045A-801 Short Cable 1.85mm
- M8045A-802 Matched Cable Pairs
- M8196A-810 Matched Cable Pair for M8196A AWG, 2.4 mm

Notes:

- Counter-propagating channels (leading to near-end crosstalk) come from the AWG and are connected directly to MCB#2
- · The second PG is used as victim lane for Tx test





NDR Test Platform

DUT CONFIGURATION

107



NDR Cable configuration

RECOMMENDED BUT OPTIONAL

Note: Following steps are recommended for DUTs that don't automatically turn on high power mode during testing; Programmed DUT may skip these steps; User are free to choose own I2C/SPI adapter from MCB supplier & its software for programming the DUT, to achieve the same goal; Below steps are done using Aardvark I2C/SPI adapter;

- 1. Tools needed for the DUT configuration:
 - Aardvark I2C/SPI Host adapter
 - Total Phase Installer exe file
 - Jumper cable
 - MCB
- 2. Preparation before config
 - Follow the <u>quick start guide</u> instructions to install the USB driver & Control Center SW
 - Once completed, launch the "Total Phase Control Center"





NDR Cable configuration

RECOMMENDED BUT OPTIONAL

- 3. Connect MCB (preferred vendor: Wilder Technologies) with Aardvark I2C/SPI Host adapter using Jumper cable
 - Connection diagram in below



4. Insert the DUT into MCB and power on



NDR Cable configuration

RECOMMENDED BUT OPTIONAL

- 5. On the Total Phase Launch Control, connect to DUT by pressing Master Read button
- 6. Insert "5D 05" (high power mode) into message and click Master Write button
- 7. Click Master Register Read button and read from transaction log to ensure this has been written into it
 - Note: configuration on the DUT need to done on each end of the cable

💣 Total Phase Control Center v4.3.0 - 🗆 🗙 File Adapter Help	Published	Rev 5.0
I2C Control Bit rate Div Pit Pit rate Refer Refer	Re Abstract: This document defines the Common by pluggable or on-board modules, such as e.g. as by future module developments with host interface. This specification is targeted for sys compliant modules.	ex 5.0 May 8, 2021 Management Interface Specification (CMIS), which may be used g. QSFP Double Density (QSFP-DD), OSFP, COBO, QSFP, as well to module management communication based on a two-wire stems manufacturers, system integrators, and suppliers of CMIS

Cable Output Test Procedure

CONNECTION



Active Cable Test Configuration

VICTIM & AGGRESSOR LANES

1. Choose your test lane. E.g. TX1 to RX1





Active Cable Test Configuration

VICTIM & AGGRESSOR LANES

2. Connect Co-prop FEXT Aggressor from M8075B set #2 to MCB TX2 lane





Active Cable Test Configuration

VICTIM & AGGRESSOR LANES

- **3**. Connect Counter-prop FEXT Aggressor from AWG to MCB 2.
 - See <u>near-end aggressor (NEXT) calibration slide</u> for counter-propagating channel calibration
 - Note: Alternative method to use the loopback connection (see next slide), to fill up rest of the open ports of MCB 1 & MCB2



Loopback Connection Concept

USING CMIS LOCAL LOOPBACK AND PRBS GENERATORS





Check if the PRBS generator and Media Side *Input Loopback* functionalities are supported by the DUT (see <u>loopback</u> slide and <u>PRBS generator</u> slide)

If DUT doesn't support these functionalities, go to the next slide



Loopback Connection Concept

WITH CABLES



	-	MCB 1		MCB 2	
PG 1		TX1		RX1	
PG2		TX2		RX2	
		TX3		RX3	→ 50 Ω
		TX4		RX4	
		TX5		RX5	
		TX6		RX6	
		TX7		RX7	50 O
		TX8		RX8	
		RX1	•	TX1	• · · · · · · · · · · · · · · · · · · ·
Direct signal from		RX2	•	TX2	•
		RX3	•	TX3	
Daisy-chaining for 4 lanes		RX4	<	TX4	
Deiev chaining for 9 Januar		RX5		TX5	
		RX6		TX6	←↓↓↓
r		RX7		TX7	←
	50 Ω	RX8		TX8	<-+



Cable Output Test Procedure

ACTIVE CABLE TESTING



LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

Note: Below tests are conducted using N1091CKCA DCA TX Test application.

1. Peak-to-peak AC common-mode voltage test (VCMPP)

- VCMPP-LF max limit at 32 mV
- o VCMPP-FB max limit at 80mV

Using N1091CKCA IEEE802.3ck TX test app

o In the app, select Peak-to-peak AC common-mode voltage (Low Frequency & Full-band) test to run.



- Note: Due Equivalent Time Sampling scope aliasing on the noise spectrum, DCA will provides the measurement on the full band with internal hardware filters (no additional filter is needed).
- Note: App will measure using 10E-5 of probability
- **Note:** For peak-to-peak AC common mode (Low Frequency), additional 2x of 100MHz LP filter will be needed.

LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

Differential Output Voltage test (short mode max limit: 600mV, long mode max limit: 845mV) & DC common-mode voltage tolerance (spec limit range: -0.35 to 2.85V)

Using N1091CKCA IEEE802.3ck TX test app

o In the app, select Differential output voltage test & DC common-mode voltage tolerance test to run.





LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

3. Transition time measurement (min spec limit: 8.5 ps)

Using N1091CKCA IEEE802.3ck TX test app

- Select transition test measurement test
 - Run rise-time and fall-time test
 - Note: Observed through a fourth-order Bessel-Thomson low-pass response with a 3dB bandwidth of 40GHz; Done
 internally using time-equivalent hardware filter





LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

Before run EH and VEC test, **recommended** to find the optimal eye opening (gdc and gdc2 of CTLE) using Auto-tune utility tool by N1091CKCA.

- On the N1091CKCA IEEE802.3ck TX test app, run the auto-tune test for Near-end and Far-end (short and long mode)
 - o Recommended to use default configuration settings to run Auto-tune and let app do the rest
 - OR select to run all the CTLE option. It takes approx. 40 mins for one auto-tune test, total 4 tests (Near-End short & long, Far-end short and long) will be approx. 160 mins. User can choose to reduce the searching range to minimize the time consume (only use this if you know what is the best range for your DUT, otherwise you could miss other option of CTLE combinations)
 - o Note: During the auto-tune, app will add the respective insertion loss file for near-end and far end tests

IEEE 802.3 ck Application New Device1	IEEE 802.3 ck Application New Device1 File View Tools Help	Parameter	Limits to meet for Autotune utility	
File View Tools Help Set Up Select Tests Configure Connect Run Automate Results HTML Report	Set Up Select Tests Configure Connect Run Automate Results HTML Report Mode: Compliance Debug Utilities COM tool settings COM tool setting		test to report optimal eye opening	
PAM4 IEEE Tests PAM-4 Transmitter Characteristics at TP0v	Search using COURCE STATES and States	Eye Height	15mV (min)	
 PAM-4 Host Output Characteristics at TP1a PAM-4 Module Output Characteristics at TP4 	Start value for gDC CTLE auto-tune (-2dB) Stop value for gDC CTLE auto-tune (-11dB) Start value for gDC2 CTLE auto-tune (0dB) Stop value for gDC2 CTLE auto-tune (-3dB)	VEC	12dB (max)	
Vtilities Auto-tune CTLE,DFE Eye Opening TP1a ✓ Auto-tune Near-end CTLE Eye Opening TP4 (Short)	Start value for Near-end gDC CTLE auto-tune (Short) (5:dB) Stop value for Near-end gDC CTLE auto-tune (Short) (5:dB) Start value for Near-end gDC2 CTLE auto-tune (Short) (0:dB) Stop value for Near-end gDC2 CTLE auto-tune (Long) (-1:dB) Start value for Near-end gDC2 CTLE auto-tune (Long) (-1:dB) Start value for Near-end gDC2 CTLE auto-tune (Long) (-3:dB) Start value for Near-end gDC2 CTLE auto-tune (Long) (-2:dB) Start value for Near-end gDC2 CTLE auto-tune (Long) (-2:dB) Start value for Near-end gDC2 CTLE auto-tune (Short) (-2:dB)	*App will not repo limit, even it is op	ort result if failed to meet the above bened eyes signal	
Auto-tune Near-end CTLE Eye Opening TP4 (Long) Auto-tune Far-end CTLE Eye Opening TP4 (Short) Auto-tune Far-end CTLE Eye Opening TP4 (Long) InfiniBand NDR	Stop value for Far-end gDC CTLE auto-tune (Short) (-9dB) Stat value for Far-end gDC2 CTLE auto-tune (Short) (-1dB) Stop value for Far-end gDC2 CTLE auto-tune (Short) (-3dB) Stat value for Far-end gDC CTLE auto-tune (Long) (-2dB) Stop value for Far-end gDC CTLE auto-tune (Long) (-9dB) Stat value for Far-end gDC CTLE auto-tune (Long) (-1dB) Stat value for Far-end gDC2 CTLE auto-tune (Long) (-3dB)		30	

LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

4. Near-end Eye Height (min 15mV; short/long mode)

Using N1091CKCA IEEE802.3ck TX test app

- o Select Near-end Eye Height test and run the test
 - For the short mode, app will include Zp=0 insertion loss file for measurement
 - For the long mode, app will include Zp=80 insertion loss file for measurement
- 5. Near-end VEC (max 12dB; short/long mode)

Using N1091CKCA IEEE802.3ck TX test app

o Select Near-end Eye Height test and run the test

- For the short mode, app will include Zp=0 insertion loss file for measurement
- For the long mode, app will include Zp=80 insertion loss file for measurement

Table 120G–5—PCB len	ngth for module	output measurements
	.g	e alpar measurements

Module output mode	Host channel type	PCB length, z_p (mm)
Short	near-end	0
Short	far-end	133
Long	near-end	80
Long	far-end	244.7





IEEE 802.3 ck Application New Device1										
File Vi	ew Tools He	lp								
Set Up	Select Tests	Configure	Connect	Run	Automate	Results	HTML Report			
	PAM-4	Module Out;	out Charac	teristic	s at TP4					
	🕗 🌗 📃 Shor	t Module Ou	itput Mode							
	🔶 🕨 🚺 M	ain Voltage	Measurem	ents T	P4 (pattern:	PRBS130	2)			
	🔰 🕨 🔜 Tr	ansition Tim	ne Measure	ements	s TP4 (patter	rn: PRBS1	L3Q)			
S	🕘 🔁 Si	gnaling Rate	e and Eye I	Mask I	Measuremen	ts TP4 (p	attern: PRBS13	3Q)		
m		Signaling R	ate (Short	:)						
🖬 🚽 Near-end Eye Height (Short)										
C	Near-end Vertical Eye Closure (Short)									
7	Far-end Eye Height (Short)									
TE		Far-end Ve	rtical Eye (Closure	e (Short)					



IEEE 802.3 ck Application New Device1							
File Vi	ew Tools He	lp					
Set Up	Select Tests	Configure	Connect	Run	Automate	Results	HTML Report
Set Up Select Tests Configure Connect Run Automate Results HTML Report PAM-4 Module PAM-4 Module PAM-4 Module PAM-4 Main Short Module Main Module PAM-4 PAM-4 Main Main Main Main PAM-4 PAM-4 Main Main Main Pameria Pameria Pameria Main Main Main Pameria Pameria Pameria Main Main Pameria Pameria Pameria Pameria Main Signaling Rate and Eye Mask Measurements TP4 (pattern: PRBS13Q) Signaling Rate (Short) Mar-end Signaling Rate (Short) Par-end Eye Height (Short) Par-end Eye Height (Short) Far-end Vertical Eye Closure (Short) Far-end Vertical Eye Closure (Short) Pameria							

LEVERAGE TEST SPECS FROM IEEE802.3CK 120G3.2 C2M, MODULE OUTPUT TEST

6. Far-end Eye Height (min 15mV; short/long mode)

Using N1091CKCA IEEE802.3ck TX test app

- Select Far-end Eye Height test and run the test
 - For the short mode, app will include Zp=133 insertion loss file for measurement
 - For the long mode, app will include Zp=244.7 insertion loss file for measurement

7. Far-end VEC (max 12dB; short/long mode)

Using N1091CKCA IEEE802.3ck TX test app

- o Select Far-end Eye Height test and run the test
 - For the short mode, app will include Zp=133 insertion loss file for measurement
 - For the long mode, app will include Zp=244.7 insertion loss file for measurement

Table 120G–5—PCB	length for module	e output measurements
------------------	-------------------	-----------------------

Module output mode	Host channel type	PCB length, z_p (mm)
Short	near-end	0
Short	far-end	133
Long	near-end	80
Long	far-end	244.7





Noise/Jitter

IEEE 802.3 ck Application New Device1							
File View Tools He	lp						
Set Up Select Tests	Configure	Connect	Run	Automate	Results	HTML Report	
- 🌔 🗖 PAM-4	Module Outp	out Charac	teristi	s at TP4			
🕖 🛑 🗖 Shor	t Module Ou	itput Mode					
> 🌒 🗌 М	ain Voltage I	Measurem	ents T	P4 (pattern:	PRBS130	2)	
🛛 🔶 🔵 Tr	ansition Tim	e Measure	ments	s TP4 (patter	m: PRBS1	L3Q)	
ဖာ 🚽 🚺 🗖 Si	gnaling Rate	e and Eye I	Mask I	Measuremen	ts TP4 (p	attern: PRBS13	Q)
<u> </u>	Signaling R	ate (Short)				
🖬 🛛 🚽 📃 Near-end Eye Height (Short)							
Near-end Vertical Eye Closure (Short)							
	Far-end Ey	e Height (S	Short)				
≓	Far-end Ve	rtical Eye (Closur	e (Short)			

Cable Input test procedure

OVERVIEW



Cable Test- Rx test

PRINCIPLE

- Stress input test & Jitter tolerance test
 - BER & FLR (Frame Loss Ratio)
 - Calibrated stress signal
 - Sinusoidal **jitter** amplitude & frequency tested according to a test template



- Input voltage tolerance test
 - Vary Tx amplitude





Rx test overview

STRESSED SIGNAL CALIBRATION

- Use a reference receiver
- To calibrate victim lane
- Through a test channel
- in presence of aggressors
- by adjusting the transmitter

victim lane

toward worst-case*

- **Step1**: optimize Tx de-emphasis and reference Rx equalizer for the current channel
- **Step2**: Adjust Tx RJ and amplitude toward target metrics

Transmitter

- 50mUI SJ, 5 taps FIR
- *Adjustable amplitude, RJ, BUJ

*12-12.5dB VEC & 15mV EH (1e-5) for IEEE 802.3ck module input test



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Cable Test Calibration

VICTIM & AGGRESSOR LANES



Far-end aggressors can be skipped for calibration & test. If used for the test, they must be present for calibration as well (injected Jrms in victim lane will be lower as without).

- Ref. Rx following IEEE 802.3ck C2M
- Two calibrations necessary
 - Low-loss (w/o host channel)
 - High-loss (w/ host channel)



Cable Input test procedure

INSTRUMENT & AGGRESSOR LANE CALIBRATION



Instrument calibration

JITTER SOURCE AND AGGRESSOR CALIBRATION

- 1. Jitter source calibration
 - Connect the PG directly to the scope





Note: A detailed step-by-step of using the M8091CKPA pre-compliance app for calibrations and tests are in the following section. Refer to slide <u>"Co-propagating aggressors"</u> onwards.



Instrument calibration

JITTER SOURCE AND AGGRESSOR CALIBRATION

2. Transmitter Characterization

- Remain the same setup as per Jitter source calibration and run the Tx
 Characterization
- You can run the app in **Compliance mode.** However, the **Debug mode** offers the flexibility to change the reference transmitter characteristics such as intrinsic jitter profile (SJ, BUJ) and rise-time (Transmitter Post-Cursor)





Transmitter characterization connections for C2M Host and C2M Module

Parameter	Value	Value					
Transmitter Measurements - IEEE 802.3ck PAM4	C2M Host TP0a Pass						
Additional Info							
Transition Time	10 ps						
	Measurement Name	Status	Measured Value	Margin %	Pass Limits		
	Jrms	Pass	19.0 mUI	17.4 %	<= 23.0 mUI		
Transmitter Measurements	J4u	Pass	110.0 mUI	6.8 %	<= 118.0 mUI		
	Level mismatch ratio RLM	Pass	0.96	1.1 %	>= 0.95		
	Signal-to-noise-and-distortion ratio(Np=200)	Pass	33.69 dB	3.7 %	>= 32.50 dB		
Output Jitter Measurement	(See image)	(See image)					
Linear Fit Pulse Response(Np=200)	(See image)	(See image)					

Example of Transmitter Characterization Results

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Instrument calibration

NEAR END AGGRESSOR CALIBRATION

3. Near-end aggressor calibration (from AWG)



- Use IQ tools to perform in-situ de-emphasis (up to 30GHZ) see details here
- Adjust the near-end aggressor @ the scope (TP7a) as follows* using PRBS13Q and scope response (SIRC) set to 4th order BT with 40GHz bandwidth
 - 9ps 20-80% rise-time
 - **450mV** pk-pk amplitude amplitude can be adjusted for each lane separately

* leveraging Table 103 HDR limiting active cable input electrical specifications. The corresponding IEEE 802.bs C2M foresees higher crosstalk amplitude (900mV)



Cable Input test procedure

STRESS SIGNAL CALIBRATION





Mode: O Compliance O Debug ✓ IEEE 802.3ck Tests Baud Rate (53.125e9) Target Error Ratio (1E-5) ✓ C2M Module Input (100GAUI-1, 200GAUI-2, and 400 Host Channel (Low Loss) PAM4 Symbol 1 Level (33.0) PAM4 Symbol 2 Level (67.0) ✓ Calibrations ✓ Tests

KEYSIGH1

How many lanes? Should we take only lane #1? Should we take the worst channel (COM?)? OSFP → all lanes should be the same? Guess the worse lane for OSFP?

Example Setup Configuration

VICTIM LANE - C2M MODULE INPUT CALIBRATION

- C2M Module Input (long channel) calibration for victim lane with ISI board
- For short channel calibration, pattern generator is directly connected to victim lane without the ISI board
- Counter-propagating aggressor lanes (near-end crosstalk) are generated by the AWG



Example for long channel test (with ISI baord) Counter-propagating channels are not shown on this picture



Cable Input test procedure

DUT TEST



Cable Test

DUT TEST (4 LANES)

6. Load the calibration project

7. Run stress input test for each lane

• Switch to PRBS31, sweep jitter & measure BER



- Verify FLR & FEC margin & characterize error bursts (if any)
- Detailed procedure on slide #63
- Repeat the procedure for each lane in long and short channel scenario
 - Use **flags** (Run tab) to distinguish tests for each lane and long/short channels

Generate Test report

KEYSIGH1

Note: A detailed step-by-step of using the M8091CKPA pre-compliance app for calibrations and tests are in the following section. Refer to <u>"Using M8091CKPA for Cable Input Test"</u> onwards.



Use SW for

automated test

Example Test Setup

Stress Input Test for the Calibrated Test Channel

- M8091CKPA conformance app for IEEE 802.3ck (112G) is required for automated test and calibration
- When testing an individual lane, other copropagating and counter-propagating lanes should be terminated

Note: PG2 is used for Tx test

KEYSIGHT



Example of Test Report

ACTIVE CABLE TESTING



Test Report

Pass

Test Configuration Details				
	Application			
Name	M8091CKPA IEEE 802.3ck RX Test			
Version	2.50.0.0			
	Device Description			
Standard Option	C2M Module Input (100GAUI-1, 200GAUI-2, and 400GAUI-4)			
Noise Channel S-Parameter Profile C:\Program Files\Keysight\M80708\Apps\M8091CKPA\app\SParameterProfiles\NoiseChannel.s4p				
Excel Config File	C:\Program			
	Files\Keysight\M8070B\Apps\M8091CKPA\app\ExcelConfigFiles\config_com_ieee8023_93a=3ck_d2p3_120F_C2C.xlsx			
	Test Session Details			
BERT SW Version	8.5.380.14			
BERT Model Number	M8070B			
BERT Serial Number	MY58C01063			
Debug Mode Used	Yes			
Compliance Limits	C2M Module Input (100GAUI-1, 200GAUI-2, and 400GAUI-4) Test Limit (official)			
Last Test Date	2022-05-04 15:33:25 UTC -04:00			

Summary of Results

Test	Statistics	Margi	n Thresholds
Failed	0	Warning	< 5 %
Passed	5	Critical	< 0 %
Total	5		

Pass	# Failed	# Trials	Test Name (click to jump)	Actual Value	Margin	Pass Limits
\odot	0	1	Amplitude Calibration	Pass	100.000 %	Pass/Fail
0	0	1	SJ Calibration	Pass	100.000 %	Pass/Fail
\bigcirc	0	1	<u>Iransmitter Characterization</u>	Pass	100.000 %	Pass/Fail
 Image: A start of the start of	0	1	Stressed Eye Calibration	Pass	100.000 %	Pass/Fail
\bigcirc	0	1	Multi-lane Stressed Input Test	Pass	100.000 %	Pass/Fail



RX Stress Input Test Report

Discussion

1-2.50221



Co-propagating aggressors

CO-PROPAGATING AGGRESSOR LANES

Why do we skip FEXT for Rx test?

- Stress lane is calibrated as worst-case eye that includes the impact of co-propagating crosstalk
- FLR (post-FEC) can be estimated from single lane error statistics
- Use the same signal for all lanes

A1.2.3 CABLE CHARACTERIZATION

Cables are characterized using two Module Compliance Boards, one on each end of the cable under test (CUT) as shown in <u>Figure 224 on page 667</u>, using the method described in IEEE 802.3-2015 Annex 86A. Note that the MCBs supply power to the connected cables and provide access to the Management Interface. Passive cable testing requires only the use of the vector network analyzer.



 \rightarrow FEXT can be omitted if the stress lane is calibrated without FEXT



Using M8091CKPA for Cable Input Test



OVERVIEW #1 - C2M MODULE INPUT DEFAULT SETTINGS

	Pre-Compliance RX Test Automation	for IEEE 802.3ck New Device1	
F	ile View Tools Help		
	Set Up Calibration View Run Autor	mate HTML Report Select Tests	Connect Results Configure
r	Standard Option		-^ Mode: 🔿 Compliance 🔵 Debug
L	🔵 C2M Host Input (100GAUI-1, 20	00GAUI-2, and 400GAUI-4)	IEEE 802.3ck Tests Settings For: Host Chan
L	O C2M Module Input (100GAUI-1,	, 200GAUI-2, and 400GAUI-4)	Target Error Ratio (1E-5) Select a value:
L	🔵 C2C (100GAUI-1, 200GAUI-2, a	and 400GAUI-4)	C2M Module Input (100GAUI-1, 200GAUI-2, Low Loss Y Host Channel (Low Loss)
N			PAM4 Symbol 1 Level (33.0) PAM4 Symbol 2 Level (67.0) Loss and High Loss
Т	#1 Soloct C2M	modulo Input toet ^{pps}	Calibrations
		TestChannel_9p8dB_at_12p89GHz.s4p	#4 compliance mode, select host
	Noise Channel S-Parameter (C2C):	C:\Program Files\Keysight\M8070B\Apps \M809256PB\app\SParameterProfiles	channel type (Low loss or High loss)
		\NoiseChannel.s4p	
Т	Excel Config File (C2C):	\M8091CKPA\app\ExcelConfigFiles	Amplitude Calibration BUJ Calibration
	Excer coming rile (C2C).	\config_com_ieee8023_93a=3ck_d2p3_	BUJ (0.01)
	Instrument Setun		Stressed Eye Calibration
	M8070		> lests
	ElexDCA:		
U P		Che	
	ElexDCA Setup		
	InfiniiSim Setup	#2 connect to M8070	B & FlexDCA
	Calibration Data Persistence		Connect to M8070 System Software for M8000 Series of BER Test Solutions (M8070)
	Load Calibration Data		Currently connected to: <nothing></nothing>
	Course Colliburations Dates		Change to
	Tech Depart Comparison Data		Alias/Address: TCPIP0::DESKTOP-DTRHK8L::inst0::INSTR
	Devise Identifier		DIN: < Unknown>Get
	Device User Description:	400G NDR cable	
			Select from Keysight Connection Expert 'My Instruments':
	Comments:	IBTA plugfest	OK Cance
			Ready
	<	#3 device info	
		Close	The second se
3	2022-03-07 08:54:22:262 DM Action	names (click for details) Filter Clear	The connection to MR070 System Software for M8000 Series of REP. Test
A G	2022-03-07-08.54.52.363 PM Acuor		Solutions (M8070) is unchanged.
	(BETA VERSION) Unsaved Changes	0 Tests	
~	TECHNOLOGIES		

OVERVIEW #2 - EQUIPMENT CALIBRATION



 Do not run *crosstalk calibration* you're using an AWG / 3rd party source for the NEXT(nearend crosstalk)



OVERVIEW #3 STRESSED CALIBRATION FOR "LOW LOSS" CHANNEL



#7 after successful calibration, save the project as "Stress signal for host low_loss"

Pre-Compliance RX Test Automation for IEEE 802.3ck						
File View Tools Help						
New Project	Automate					
Open Project	•					
Save Project	JI-1, 200GAUI-					
Save Project As						
Save Project (Settings Only) As						
Export Results	•					
User Defined	►					
Print						
Print Preview	ion					
Page Setup						
Exit	ıput Test					
Voltage Tolerance T	est					
0						



OVERVIEW #4 STRESS CALIBRATION FOR "HIGH-LOSS" CHANNEL

ur							_	_	_		
	Con	nect Results Co	nfigure								•
L		Test Name				Actual Value	Margin %	Pass	Limits	# Trials	
L	\checkmark	Amplitude Calibra	Pass	100.000	Pass	/Fail	1				
L	\checkmark	SJ Calibration	Pass	100.000	Pass	/Fail	1				
L	UUGJ Calibration					Pass	100.000	Pass	/Fail	1	
L	\checkmark	BUJ Calibration				Pass	100.000	Pass	/Fail	1	
L	\checkmark	Crosstalk Calibrat	ion			Pass	100.000	Pass	/Fail	1	
L	\checkmark	Multi-lane Stresse	d Input 1	Test		Pass	100.000	Pass	/Fail	1	
L		Voltage Tolerance	Test			Pass	100.000	Pass	/Fail	1	
;	\checkmark	Stressed Evo Colil	aration	ata		Pass	100.000	Pass	/Fail		
ļ	\checkmark	Transmitte Run checked tests				Pass	100.000	Pass	/Fail	6	
č		Delete	all result	s for selected	test						
	Tr	ial Summa Delete	all result	s for all test	.s	Prameter			Stress	ed Eye (Calibrati
Û		*8 delete	stre	essed	eye	calibra	ation		:		
L	۱r	esults 10	Min Max		100.0 =	Optimum CT					
L	м	ax Displayeu. 10	Sum		1.000	Optimum CTLE DC gain Optimum CTLE DC gain					
L			Trial 10	Pass	Pass						
L			Trial 8	Pass	Pass	Stressed Ev	e Calibrati	_			
L			Trial 7	Pass	Pass	Stressed Lyt	c Calibrati				
L			Trial 6	Pass	Pass			v			
L				Pass	>	< ()	;				
											÷
		Details	_		_		_				
	Location: C:\Users\hlouchet\Downloads\C2M_Module_NewBehaviour										





OVERVIEW #5 CONFIGURATION BEFORE THE RX TEST

#12 after successful calibrations, configure the analyzer settings before starting the tests.

Set '**BERT Analyzer**' for Victim Analyzer Module and select '**CDR**' for Clock Source if M8046A is used.

Select '**True**' for 'Pause before starting Receiver tests'. This allows user to configure the Error Detector settings on M8070B before the test

Tests

- Victim Analyzer Module (BERT Analyzer) -
- Victim Analyzer Clock Source (CDR)
- Target Confidence Level (95.0)
- DUT Control Interface Script File (C:\Program Files\Keysight\M8070B\Apps\M8091CKPA\app\Scripts\VirtualDUT.py)
- DUT Control Interface Location (Lane1)
- Pause before starting Receiver tests (true) 🔫 🗕
- Stressed Input Test Manual Frequency List (40000,400000,1333000,4000000,12000000,40000000)
- Voltage Tolerance Test
 Differential Pk-Pk Voltage (0.75)



OVERVIEW #5 RUN TEST FOR EACH LANE





Using Error Detector on M8070B

OVERVIEW #6 CONFIGURE ED ON M8070B



SW Requirements

.

.

- M8070B, rev. 6.0 or higher
- M8070EDAB error distribution analysis package, rev. 1.0 or higher
- M8070ADVB advanced measurement package

#14 Adjust ED Settings (coding, equalization) and "Auto-align" for BER measurement

_		
\odot	Clock	M2.DataIn
•	Equalization	M2.DataIn
	Equalizer Level	0
•	Line Coding	M2.DataIn
		PAM-4 🔻
	Symbol Mapping	Gray Coded 🔻
•	Comparator	M2.DataIn
	Compare mode	Differential 🔻
	Upper Threshold	125 mV ႕
	Middle Threshold	0 mV 🖌
	Lower Threshold	-125 mV ႕
	Polarity	Non-Inverted 🔻
	Input Range	500 mV
•	Input Timing	M2.DataIn



CREATING TEST REPORT

	Pre-Compliance RX Test Automation for IEEE 802.3ck New Device1											
	File Vi	iew Tools He	lp									
	Set Up	Select Tests	Configure	Calibration View	Run	Automate	HTML Report	<u> </u>	Cor			
		InfiniiSin	n Setup					^	Г			
I	Cali	bration Data Pe	ersistence	Update	e fo	r eac	h new	DUT	II.			
I		Load Calibr	ation Data									
9		Save Calibr	ation Data						0			
ŀ	Test	Report Comme	ents (Option	al)					N			
0	De	vice Identifier:		ххххх-уууу	ххххх-ууууу-							
ľ	De	vice User Descr	ription:	NDR 400G c	NDR 400G cable							
	Co	mments:	measureme	measurement made by hadrien								
L	<							}				
	Messag	jes										
	(BETA	VERSION) Un	saved Chan	ges 0 Tests								





OPTIONAL - FLR MEASUREMENT

#16 Run Error Analysis:

Configure "Acquisition Parameters" to match the PRBS characteristics







OPTIONAL - SWITCHING TO EDAB FOR FLR MEASUREMENT



#18 Example of test result in Histogram



KEYSIGHT

TX IEEE802.3ck Specification

MODULE OUTPUT (TP4)

Table 120G–3—Module output characteristics at TP4

Parameter	Reference	Value	Units
Signaling rate, each lane (nominal)		53.125 ^a	GBd
Peak-to-peak AC common-mode voltage (max) Low-frequency, <i>VCM</i> _{LF} Full-band, <i>VCM</i> _{FB}	120G.5.1	32 80	mV
Differential peak-to-peak output voltage (max) Short mode Long mode	120G.5.1	600 845	mV mV
Eye height (min)	120G.3.2.2	15	mV
Vertical eye closure, VEC (max)	120G.3.2.2	12	dB
Common-mode to differential-mode return loss, RLdc (min)	120G.3.1.1	Equation (120G-1)	dB
Effective return loss, ERL (min)	120G.3.2.3	8.5	dB
Differential termination mismatch (max)	120G.3.1.3	10	%
Transition time (min)	120G.3.1.4	8.5	ps
DC common-mode voltage tolerance (range) Upper limit Lower limit	120G.3.2.4	2.85 -0.35	V V



RX IEEE802.3ck Specification

MODULE INPUT (TP1)

Table 120G–10—Module stressed input parameters

Parameter	Value	Value
Pattern generator transition time (target)	9	ps
Applied peak-to-peak sinusoidal jitter	Table 162–17	_
Eye height (target)	10	mV
Vertical eye closure, VEC (min)	12	dB
Vertical eye closure, VEC (max)	12.5	dB
Crosstalk differential peak-to-peak voltage	845	mV
Crosstalk transition time	8.5	ps



Near-end aggressor calibration using IQ tools

- 1. Important: In FlexDCA change General Trigger Setup from CDR (Slot 1) (the N1060A internal CDR) to Front Panel Clock ch#4
 - not doing this may result in **damaging** the N1060A CDR
- 2. Set up the connection as described
 - AWG channel 1 in N1060A input
 - AWG channel 4 in DCA trig (adapter required)
- 3. Start IQ tools on the PC
 - Connect to AWG and DCA
 - Perform an in-situ calibration (see attached pdf)
- 4. When in-situ cal. is done
 - Disconnect channel 4
 - change back the *FlexDCA Trigger Setup* to **CDR (Slot 1)**
 - In IQ tools t generate a 53.125 Gbaud PAM4 using the in-situ correction.
- 5. Verify rise-time and adjust amplitude



Adobe Acrobat Document





CMIS 4.0 control

LOOPBACK

Table 8-69 Loopback Capabilities (Page 13h)

Byte	Bits	Name	Description	Туре
128	7	Reserved		RO
	6	Simultaneous Host and Media Side Loopback supported	0b=Simultaneous host and media side loopback not supported 1b=Simultaneous host/media side loopback supported	RQD
	5	Per-lane Media Side Loopback supported	0b=Individual lane media side loopback not supported 1b=Individual lane media side loopback supported	1
	4	Per-lane Host Side Loopback supported	0b=Individual lane host side loopback not supported 1b=Individual lane host side loopback supported]
	3	Host Side Input Loopback supported	0b=Host side input loopback not supported 1b=Host side input loopback supported]
	2	Host Side Output Loopback supported	0b=Host side output loopback not supported 1b=Host side output loopback supported	
	1	Media Side Input Loopback supported	0b=Media side input loopback not supported 1b=Media side input loopback supported	Byte
	0	Media Side output Loopback supported	0b=Media side output loopback not supported 1b=Media side output loopback supported	180

See CMIS 4.0 - page 13h

- 1. Check capabilities (13h Byte 128)
- 2. Activate Media Side input loopback (13h Byte 181) e.g. for ch 1-8: 1111111

Bits Name Description Туре Media side output loopback lane 8 enable Ob=normal non-loopback operation 7 RW Media side output loopback lane 7 enable 1b=loopback operation enabled. 6 Opt. 5 Media side output loopback lane 6 enable If the Per-lane Media Side Loopback Media side output loopback lane 5 enable 4 Supported field=1, loopback control is per Media side output loopback lane 4 enable 3 lane. Otherwise, if any loopback enable bit is 2 Media side output loopback lane 3 enable set to 1, all Media side lanes are in output Media side output loopback lane 2 enable 1 loopback. Media side output loopback lane 1 enable 0 7 Media side input loopback lane 8 enable Ob=normal non-loopback operation RW 181 Media side input loopback lane 7 enable 1b=loopback operation enabled. 6 Opt. 5 Media side input loopback lane 6 enable If the Per-lane Media Side Loopback Media side input loopback lane 5 enable 4 Supported field=1, loopback control is per Media side input loopback lane 4 enable 3 lane. Otherwise, if any loopback enable bit is 2 Media side input loopback lane 3 enable set to 1, all media side lanes are in input Media side input loopback lane 2 enable 1 loopback. 0 Media side input loopback lane 1 enable

Table 8-88 Loopback Controls (Page 13h)



CMIS 4.0 control

PRBS GENERATOR



See CMIS 4.0 - page 13h

- 1. Check capabilities (13h Byte 134-135)
- 2. Active Media side Generator e.g. for ch3-8: 11111100

The pattern checking capabilities of the module are advertised in Table 8-74. The pattern number corresponds to the pattern coding in Table 8-72.

Table 8-72 Pattern coding

PRBS Pattern code	Name	Description
0	PRBS-31Q	As defined in 802.3-2018 clause
1	PRBS-31	120.5.11.2.2
2	PRBS-23Q	ITU-T Recommendation 0.172,
3	PRBS-23	2005
4	PRBS-15Q	x^15 + x^14 + 1
5	PRBS-15]
6	PRBS-13Q	As defined in 802.3-2018 clause
7	PRBS-13	120.5.11.2.1
8	PRBS-9Q	As defined in 802.3-2018 clause
9	PRBS-9	120.5.11
10	PRBS-7Q	x^7 + x^6 + 1
11	PRBS-7	
12	SSPRQ	As defined in 802.3-2018 clause 120.5.11.2.3
13	Reserved	
14	Custom	Vendor Pattern
15	User Pattern	Pattern provided in bytes 224-255
TECHNOLOGIE	S	

Table 8-78 Media Side Pattern Generator Controls (Page 13h)

Byte	Bits	Name	Description	Туре
152	7	Media Side Generator Lane 8 enable	1b=Enable generator, using the	RW
	6	Media Side Generator Lane 7 enable	configuration defined in bytes 153-159	Opt.
	5	Media Side Generator Lane 6 enable	0b=Disable pattern generator	
	4	Media Side Generator Lane 5 enable		
	3	Media Side Generator Lane 4 enable		
	2	Media Side Generator Lane 3 enable		
	1	Media Side Generator Lane 2 enable		
	0	Media Side Generator Lane 1 enable		

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Annex A1

MTF CALIBRATION AND ELECTRICAL VERIFICATION



Wilder 800G QSFPDD MTF Response Example

- A 4-port s-parameter set is measured for each channel of a mated pair test fixture (MTF).
- The mixed mode s-parameters are calculated from the single-ended s-parameters and plotted against the 802.3CK specification limit lines.
- The Figure of Merit (FOMild) is calculated based on the method outlined in the 802.3CK specification.
- ERL of MTF is calculated using the Channel Operating Margin tool with the proper input parameters for MTF.



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Wilder 800G QSFPDD MTF Response Example

WILDER TECHNOLOGIES





TX victim is on HCB side and aggressors for TX victim are TX1in-TX[n]in on MCB (excluding thru channel) and TX1in-TX[n]in on MCB which make up the FEXT and NEXT responses, respectively.

RX victim is on MCB side and aggressors for RX victim are RX1in-RX[n]in on HCB (excluding thru channel) and TX1in-TX[n]in on MCB which make up the FEXT and NEXT responses, respectively

For each victim, all FEXT aggressors are power summed, and all NEXT aggressors are power summed then each are integrated as outlined in the CK and CEI specifications. Both single valued integrated noise levels are then added RSS to give the total ICN value.





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WILDER TECHNOLOGIES It's all about integrity

The two figures below are the multi-disturber responses (FEXT and NEXT) for TX victims and RX victims.





Wilder 800G QSFPDD ICN Example

ICN (mV) from TX FEXT	Victim (HC	B) p=port3,	n=port4					
Aggressor (MCB) p=port1, n-port2	TX1 (mV)	TX2 (mV)	TX3 (mV)	TX4 (mV)	TX5 (mV)	TX6 (mV)	TX7 (mV)	TX8 (mV)
TX1	NA	0.18	2.75	0.16	1.02	0.19	0.22	0.16
TX2	0.20	NA	0.18	1.54	0.26	0.87	0.15	0.31
TX3	2.55	0.19	NA	0.17	0.31	0.19	0.15	0.15
TX4	0.17	1.98	0.15	NA	0.19	0.27	0.15	1.00
TX5	1.17	0.27	0.32	0.25	NA	0.97	2.02	0.46
TX6	0.23	1.23	0.21	0.32	1.10	NA	0.39	1.75
TX7	0.27	0.32	1.11	0.24	1.89	0.57	NA	0.86
TX8	0.12	0.33	0.17	1.12	0.39	1.81	0.93	NA
TX MDFEXT	2.85	2.41	3.01	1.98	2.49	2.33	2.28	2.27
ICN (mV) from TX NEXT	Victim (HC	B) p=port3,	n=port4					
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2	Victim (HC TX1 (mV)	B) p=port3, TX2 (mV)	n=port4 TX3 (mV)	TX4 (mV)	TX5 (mV)	TX6 (mV)	TX7 (mV)	TX8 (mV)
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1	Victim (HC TX1 (mV) 0.24	B) p=port3, TX2 (mV) 0.39	n=port4 TX3 (mV) 0.28	TX4 (mV) 0.42	TX5 (mV) 0.22	TX6 (mV) 0.28	TX7 (mV) 0.18	TX8 (mV) 0.38
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2	Victim (HC TX1 (mV) 0.24 0.35	B) p=port3, TX2 (mV) 0.39 0.25	n=port4 TX3 (mV) 0.28 0.36	TX4 (mV) 0.42 0.23	TX5 (mV) 0.22 0.18	TX6 (mV) 0.28 0.17	TX7 (mV) 0.18 0.23	TX8 (mV) 0.38 0.19
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3	Victim (HC TX1 (mV) 0.24 0.35 0.16	B) p=port3, TX2 (mV) 0.39 0.25 0.36	n=port4 TX3 (mV) 0.28 0.36 0.17	TX4 (mV) 0.42 0.23 0.47	TX5 (mV) 0.22 0.18 0.19	TX6 (mV) 0.28 0.17 0.23	TX7 (mV) 0.18 0.23 0.18	TX8 (mV) 0.38 0.19 0.41
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21	n=port4 TX3 (mV) 0.28 0.36 0.17 0.46	TX4 (mV) 0.42 0.23 0.47 0.19	TX5 (mV) 0.22 0.18 0.19 0.19	TX6 (mV) 0.28 0.17 0.23 0.16	TX7 (mV) 0.18 0.23 0.18 0.26	TX8 (mV) 0.38 0.19 0.41 0.14
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22	n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21	TX4 (mV) 0.42 0.23 0.47 0.19 0.28	TX5 (mV) 0.22 0.18 0.19 0.19 0.33	TX6 (mV) 0.28 0.17 0.23 0.16 0.39	TX7 (mV) 0.18 0.23 0.18 0.26 0.35	TX8 (mV) 0.38 0.19 0.41 0.14 0.45
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5 RX6	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16 0.19	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22 0.18	n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21 0.26	TX4 (mV) 0.42 0.23 0.47 0.19 0.28 0.24	TX5 (mV) 0.22 0.18 0.19 0.19 0.33 0.37	TX6 (mV) 0.28 0.17 0.23 0.16 0.39 0.30	TX7 (mV) 0.18 0.23 0.18 0.26 0.35 0.25	TX8 (mV) 0.38 0.19 0.41 0.14 0.45 0.29
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5 RX5 RX6 RX7	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16 0.19 0.14	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22 0.18 0.21	n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21 0.26 0.17	TX4 (mV) 0.42 0.23 0.47 0.19 0.28 0.24 0.29	TX5 (mV) 0.22 0.18 0.19 0.19 0.33 0.37 0.30	TX6 (mV) 0.28 0.17 0.23 0.16 0.39 0.30 0.37	TX7 (mV) 0.18 0.23 0.18 0.26 0.35 0.25 0.42	TX8 (mV) 0.38 0.19 0.41 0.44 0.45 0.29 0.70
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5 RX6 RX6 RX7 RX8	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16 0.19 0.14 0.21	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22 0.18 0.21 0.21	n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34	TX4 (mV) 0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20	TX5 (mV) 0.22 0.18 0.19 0.19 0.33 0.37 0.30 0.28	TX6 (mV) 0.28 0.17 0.23 0.16 0.39 0.30 0.37 0.32	TX7 (mV) 0.18 0.23 0.18 0.26 0.35 0.25 0.42 0.40	TX8 (mV) 0.38 0.19 0.41 0.14 0.45 0.29 0.70 0.52
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5 RX6 RX6 RX7 RX7 RX8 TX MDFEXT	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16 0.19 0.14 0.21 0.67	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22 0.18 0.21 0.21 0.21	<pre>n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34 0.34</pre>	TX4 (mV) 0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20 0.20	TX5 (mV) 0.22 0.18 0.19 0.19 0.33 0.37 0.37 0.30 0.28 0.75	TX6 (mV) 0.28 0.17 0.23 0.16 0.39 0.30 0.37 0.32 0.32	TX7 (mV) 0.18 0.23 0.18 0.26 0.35 0.25 0.42 0.40 0.84	TX8 (mV) 0.38 0.19 0.41 0.44 0.45 0.29 0.70 0.52 1.20
ICN (mV) from TX NEXT Aggressor (HCB) p=port1, n=port2 RX1 RX2 RX3 RX4 RX4 RX5 RX5 RX6 RX7 RX7 RX8 TX MDFEXT	Victim (HC TX1 (mV) 0.24 0.35 0.16 0.34 0.16 0.19 0.14 0.21 0.67	B) p=port3, TX2 (mV) 0.39 0.25 0.36 0.21 0.22 0.18 0.21 0.21 0.21 0.74	<pre>n=port4 TX3 (mV) 0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34 0.34</pre>	TX4 (mV) 0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20 0.20 0.86	TX5 (mV) 0.22 0.18 0.19 0.19 0.33 0.37 0.30 0.28 0.28	TX6 (mV) 0.28 0.17 0.23 0.16 0.39 0.30 0.37 0.32 0.32 0.82	TX7 (mV) 0.18 0.23 0.18 0.26 0.35 0.25 0.42 0.42 0.40 0.84	TX8 (mV) 0.38 0.19 0.41 0.45 0.29 0.70 0.52 1.20



The table to the left is ICN data calculated as outlined in 802.3CK for the TX victim responses.

Note that each row represents an ICN value as each aggressor is added to the power sum.



Wilder 800G QSFPDD ICN Example

ICN (mV) for RX FEXT	Victim (MC	CB) p=port3	, n=port4					
Aggressor (HCB) p=port1, n-port2	RX1 (mV)	RX2 (mV)	RX3 (mV)	RX4 (mV)	RX5 (mV)	RX6 (mV)	RX7 (mV)	RX8 (mV)
RX1	NA	0.21	2.75	0.16	1.20	0.33	0.33	0.31
RX2	0.21	NA	0.18	1.54	0.25	1.27	0.16	0.34
RX3	1.79	0.17	NA	0.17	0.32	0.30	1.18	0.28
RX4	0.15	2.77	0.15	NA	0.21	0.28	0.15	1.18
RX5	0.90	0.16	0.32	0.25	NA	0.99	1.97	0.58
RX6	0.26	1.09	0.21	0.32	1.28	NA	0.57	2.09
RX7	0.26	0.11	1.11	0.24	1.76	0.57	NA	0.84
RX8	0.18	0.26	0.17	1.12	0.44	2.72	1.06	NA
RX MDFEXT	2.06	3.00	3.01	1.98	2.56	3.25	2.63	2.67
ICN (mV) for RX NEXT	Victim (MC	CB) p=port3	, n=port4					
Aggressor (MCB) p=port1, n=port2	RX1 (mV)	BX2 (m)/)	RX3 (m\/)	RX4 (m)/	RX5 (mV)	PVG(m)/)	DVZ (me)/	RX8 (mV)
	· · ·		10.5 (11.7)	N/4 (IIIV)			RX7 (mv)	10.0 (111)
TX1	0.16	0.32	0.28	0.42	0.16	0.20	0.15	0.20
TX1 TX2	0.16 0.43	0.32	0.28	0.42	0.16 0.22	0.20	0.15 0.17	0.20
TX1 TX2 TX3	0.16 0.43 0.15	0.32 0.25 0.26	0.28 0.36 0.17	0.42 0.23 0.47	0.16 0.22 0.17	0.20 0.25 0.27	0.15 0.17 0.17	0.20 0.18 0.29
TX1 TX2 TX3 TX4	0.16 0.43 0.15 0.21	0.32 0.25 0.26 0.12	0.28 0.36 0.17 0.46	0.42 0.23 0.47 0.19	0.16 0.22 0.17 0.19	0.20 0.25 0.27 0.24	0.15 0.17 0.17 0.17 0.18	0.20 0.18 0.29 0.19
TX1 TX2 TX3 TX4 TX5	0.16 0.43 0.15 0.21 0.22	0.32 0.25 0.26 0.12 0.19	0.28 0.36 0.17 0.46 0.21	0.42 0.23 0.47 0.19 0.28	0.16 0.22 0.17 0.19 0.39	0.20 0.25 0.27 0.24 0.43	0.15 0.17 0.17 0.18 0.35	0.20 0.18 0.29 0.19 0.40
TX1 TX2 TX3 TX4 TX5 TX6	0.16 0.43 0.15 0.21 0.22 0.24	0.32 0.25 0.26 0.12 0.19 0.23	0.28 0.36 0.17 0.46 0.21 0.26	0.42 0.23 0.47 0.19 0.28 0.24	0.16 0.22 0.17 0.19 0.39 0.45	0.20 0.25 0.27 0.24 0.43 0.50	0.15 0.17 0.17 0.18 0.35 0.33	0.20 0.18 0.29 0.19 0.40 0.25
TX1 TX2 TX3 TX4 TX5 TX6 TX7	0.16 0.43 0.15 0.21 0.22 0.24 0.18	0.32 0.25 0.26 0.12 0.19 0.23 0.16	0.28 0.36 0.17 0.46 0.21 0.26 0.17	0.42 0.23 0.47 0.19 0.28 0.24 0.29	0.16 0.22 0.17 0.19 0.39 0.45 0.30	0.20 0.25 0.27 0.24 0.43 0.50 0.31	0.15 0.17 0.17 0.18 0.35 0.33 0.37	0.20 0.18 0.29 0.19 0.40 0.25 0.37
TX1 TX2 TX3 TX4 TX5 TX6 TX7 TX8	0.16 0.43 0.15 0.21 0.22 0.24 0.18 0.25	0.32 0.25 0.26 0.12 0.19 0.23 0.16 0.14	0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34	0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20	0.16 0.22 0.17 0.19 0.39 0.45 0.30 0.36	0.20 0.25 0.27 0.24 0.43 0.50 0.31 0.35	0.15 0.17 0.17 0.18 0.35 0.33 0.37 0.52	0.20 0.18 0.29 0.19 0.40 0.25 0.37 0.34
TX1 TX2 TX3 TX4 TX5 TX6 TX7 TX8 RX MDFEXT	0.16 0.43 0.15 0.21 0.22 0.24 0.18 0.25 0.69	0.32 0.25 0.26 0.12 0.19 0.23 0.16 0.14 0.62	0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34 0.84	0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20 0.86	0.16 0.22 0.17 0.19 0.39 0.45 0.30 0.36 0.84	0.20 0.25 0.27 0.24 0.43 0.50 0.31 0.35 0.94	RX7 (mv) 0.15 0.17 0.17 0.18 0.35 0.33 0.37 0.52 0.87	0.20 0.18 0.29 0.19 0.40 0.25 0.37 0.34 0.82
TX1 TX2 TX3 TX4 TX5 TX6 TX7 TX8 RX MDFEXT	0.16 0.43 0.15 0.21 0.22 0.24 0.18 0.25 0.69	0.32 0.25 0.26 0.12 0.19 0.23 0.16 0.14 0.62	0.28 0.36 0.17 0.46 0.21 0.26 0.17 0.34 0.84	0.42 0.23 0.47 0.19 0.28 0.24 0.29 0.20 0.86	0.16 0.22 0.17 0.19 0.39 0.45 0.30 0.36 0.84	0.20 0.25 0.27 0.24 0.43 0.50 0.31 0.35 0.94	0.15 0.17 0.17 0.18 0.35 0.33 0.37 0.52 0.87	0.20 0.18 0.29 0.19 0.40 0.25 0.37 0.34 0.82

The table to the left is ICN data calculated as outlined in 802.3CK for the RX victim responses.

WILDER

TECHNOLOGIES

It's all about integrity

Note that each row represents an ICN value as each aggressor is added to the power sum.

