Coordinated proposal for 100GBASE-SR4, 100GBASE-UR4, CPPI-4 and CAUI-4

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Introduction

- Aim to be compatible with:
  - QSFP+
  - 40GBASE-SR4
  - 40GBASE-CR4
  - 100GBASE-CR4
  - CEI-28G-VSR
- Allow retimed modules and active cables now, unretimed for the future
- Leverage 100GBASE-CR4/KR4's 256b/257b FEC but can do without it for lowest latency short links

Names and options 1

- Following Backplane Ethernet practice
- Same name whether FEC used or not
- 100GBASE-SR4 has CDR in module for optical transmitter
  - Can use CPPI-4 or CAUI-4 on Tx side
- 100GBASE-UR4 does not need CDR in optical module
  - Lower power but reduced reach: "SR-lite"
- 100GBASE-SR4 and 100GBASE-UR4 are interoperable
  - Over 100GBASE-UR4 reach
- Specification reaches between 20 and 100 m, aligned to objectives
  - There may be an opportunity to stretch one of these, as we learn just how much the latest lasers and 100GBASE-KR4 FEC help us

Names and options 2

- Following Backplane Ethernet practice
- Same name whether FEC used or not
  - Hosts that support 100GBASE-CR4 will have FEC in the host
    - Could support traditional 64B/66B without FEC
      - Adds additional complexity and latency for 20-lane deskew
      - Not needed for 100GBASE-CR4 or 100GBASE-KR4
  - CFP modules can include FEC in the module
  - PCS can easily tell FEC from non-FEC signals; PMD and PMA don't need to know because line rate is the same
- 100GBASE-SR4 has CDR in module for optical transmitter
  - Can use CPPI-4 or CAUI-4 on Tx side
- 100GBASE-UR4 does not need CDR in optical module
  - Lower power but reduced reach: "SR-lite"
- 100GBASE-SR4 and 100GBASE-UR4 are interoperable
  - Over 100GBASE-UR4 reach
- Specification reaches between 20 and 100 m, aligned to objectives
  - There may be an opportunity to stretch one of these, as we learn just how much the latest lasers and 100GBASE-KR4 FEC help us
  - Reach also depends on fibre type. Base specs on 100 m of OM4, work out reach on OM3

Method

- Assume a host channel as for 100GBASE-CR4 (similar to CEI-28G-VSR)
- Keep the module simple
- Use the host's Tx FFE and Rx equalizer
  - Use same (256b/257b) FEC as 100GBASE-KR4/CR4
- The worst crosstalk in the electrical link is expected to be at the QSFP connector, so make the eye at least partly open there
  - Host uses knowledge of its own channel to set its Tx FFE
- Use a reference equalizer or similar technique for specification where necessary, similar to CEI-28G-VSR
  - But more restricted range of CTLE settings
- Leverage experience from InfiniBand FDR specification especially for signal swings, mixed-mode reflections, testing with crosstalk
- Aim to keep transmitted optical powers same as 40GBASE-SR4

Uncertainties

- Optical specs may be challenging
  - If so, increase Tx optical power: move all Tx powers, Rx overload and budget in step
  - Optical transmitter would need two setups
  - May require higher supply voltage to stop laser driver and transimpedance amplifier running out of headroom
  - May require host to tell the module when to use 25G/lane mode and when to use 10G/lane mode
- Electrical specs may be challenging
  - Longest/worst host traces may need module CDR(s)
  - Other traces can reduce power by switching it off
- Mode partition noise
  - A better understanding of mode partition noise might affect the longer reaches by less than 10%

Not included

- Compliance board details
  - Use a combination of Annex 86A, InfiniBand FDR, OIF, and proposals for 100GBASE-CR4
  - Detail of compliance board loss will affect e.g. transition times, reference CTLE settings
- Chip-to-chip CAUI-4
- Chip-to-module CAUI-4 specs that rely on FEC

Table xA-1 CPPI-4 host electrical output specifications at TP1a

	nPPI				CPPI-4		CAUI-4		
Parameter description	**Min**	**Max**	**Units**	**Conditions**	**Min**	**Max**	**Min**	**Max**	**Comments**
Single ended output voltage	–0.3	4	V	Referred to signal common	–0.3	4	–0.3	4	
AC common-mode output voltage	—	15	mV	RMS	—	20	—	20	Not as important as we feared
Termination mismatch at 1 MHz	—	5	%		*(n/a)*		*(n/a)*		Use Sdc22 spec which controls skew-induced conversion as well as R matching
Differential output return loss	See 86A.4.1.1	—	dB		Eqn. A-1	—	Eqn. A-1	—	
Common-mode output return loss	See 86A.4.1.2	—	dB		Eqn. A-2	—	Eqn. A-2	—	Unwisely deleted from 802.3-2012
Common-mode to differential output return loss					Eqn. A-3	—	Eqn. A-3	—	Sdc22 (see equations for *f* ranges)
Output transition time, 20% to 80%	28	—	ps		Around 10 TBD		Around 10 TBD		
J2 Jitter output	—	0.17	UI		—	0.19	—	0.45	
J9 Jitter output	—	0.29	UI		—	0.31	—	0.63	
Data Dependent Pulse Width Shrinkage (DDPWS)	—	0.07	UI		—	0.10	*(n/a)*		
Equalized J2 Jitter output					—	0.10	—	0.3	With fixed CTLE or similar
Equalized J9 Jitter output					—	0.22	—	0.52	These three items estimate the
Equalized DDPWS					—	0.05	*(n/a)*		"unequalizable jitter"
Q_{sq} for XLPPI	45	—	V/V		45	—	45	—	
Q_{sq} for CPPI	43	—	V/V				*(n/a)*		
	Specification values								
Eye mask coordinates: X1, X2 Y1, Y2	0.11, 0.31 95, 350		UI mV	Hit ratio = 5 × 10^{-5}	0.13, 0.33 95, 350		0.24, 0.45 95, 350		
Crosstalk source VMA, each input lane	700		mV	At TP4	470		470		Same as module output
Crosstalk source transition times, 20% to 80%	34		ps	At TP4	Around 8 to 10 TBD		Around 8 to 10 TBD		Ditto

Eqn. 86A-1 (in S-parameter form for comparison with other specs)

Sddxx <= -12+2sqrt(f) 0.01 <= *f* < 4.11

-6.3+13log10(f/5.5) 4.11 <= *f* <= 11.1

Eqn. xA-1

Sddxx <= -12+fn(*f*) TBD 0.05 <= *f* <= 25.79

Eqn. 86A-2 (in 802.3ba)

Sccxx <= -7 +1.6*f* 0.01 ≤ *f* < 2.5

-3 2.5 ≤ *f* ≤ 11.1

Eqn. xA-2

Sccxx <= -2 0.2 ≤ *f* ≤ 5

-1 -*f*/10 5 ≤ *f* ≤ 25.79

Eqn. xA-3

Sdcxx <= -15+0.5*f* or similar, 0.05 <= *f* <= 25.79

Black: 40GBASE-SR4/nPPI spec
Blue: Proposed 100GBASE-SR4, 100GBASE-UR4, CPPI-4 spec
Purple: Proposed CAUI-4 ("chip to module") spec
Yellow: Tentative numbers

Table xA–2 CPPI-4 module electrical input specifications at TP1 and TP1a

		nPPI				CPPI-4		CAUI-4		
Parameter description	**Test point**	**Min**	**Max**	**Units**	**Conditions**	**Min**	**Max**	**Min**	**Max**	**Comments**
Single ended input voltage tolerancea	TP1a	–0.3	4	V	Referred to TP1 signal common	–0.3	4	–0.3	4	
AC common-mode input voltage tolerance	TP1a	15	—	mV	RMS	20	—	20	—	
Differential input return loss	TP1	See 86A.4.1.1	—	dB	10 MHz to 11.1 GHz	Eqn. A-1	—	Eqn. A-1	0	(see equations for *f* ranges)
Common-mode input return loss	TP1					Eqn. A-2	—	Eqn. A-2	—	
Differential to common-mode input return loss	TP1	10	—	dB	10 MHz to 11.1 GHz	10	—	10	—	50 MHz to 26.79 GHz
J2 Jitter tolerance	TP1a	0.17	—	UI		0.19	—	0.45	—	
J9 Jitter tolerance	TP1a	0.29	—	UI		0.31	—	0.63	—	
Data Dependent Pulse Width Shrinkage (DDPWS) tolerance	TP1a	0.07	—	UI		0.1	—	0.22	—	e.g. J2 not yellow because must be same as another, in this case in Table xA-1
		Specification values								
Eye mask coordinates: X1, X2 Y1, Y2	TP1a	0.11, 0.31 95, 350		UI mV	Hit ratio = 5 × 10–5	0.13, 0.33 95, 350		0.24, 0.45 95, 350		
Crosstalk calibration signal VMA	TP4	850		mV	While calibrating compliance signal	470		470		Same as module output
Crosstalk calibration signal transition times, 20% to 80%	TP4	34		ps		Around 8 to 10 TBD		Around 8 to 10 TBD		Ditto

a The single ended input voltage tolerance is the allowable range of the instantaneous input signals.
b The crosstalk calibration signals are applied to the mated HCB-MCB at TP4a and measured at TP4 following the same principles as the host electrical input calibration (see 86A.5.3.8.5). They are removed before testing.

a [same]

b [Add regular text to explain, replace footnote b with reference to new text]

Table x-6 100GBASE–SR4 or 100GBASE–UR4 optical transmit characteristics

		40GBASE-SR4 or 100GBASE-SR10		100GBASE–SR4	
Description	**Type**	**Value**	**Unit**	**100GBASE–UR4**	
Center wavelength	Range	840 to 860	nm	840 to 860	
RMS spectral width[a]	Max	0.65	nm	0.65	0.6
Average launch power, each lane	Max	2.4	dBm	2.4	
Average launch power, each lane	Min	–7.6	dBm	–7.6	
Optical Modulation Amplitude (OMA), each lane	Max	3	dBm	3	
Optical Modulation Amplitude (OMA), each lane	Min	–5.6[b]	dBm	–5.6[b]	
Difference in launch power between any two lanes (OMA)	Max	4	dB	4	
Peak power, each lane	Max	4	dBm	4	
Launch power in OMA minus TDP, each lane	Min	–6.5	dBm	TBD	TBD
Transmitter and dispersion penalty (TDP), each lane	Max	3.5	dB	TBD	TBD
Extinction ratio	Min	3	dB	3	
Optical return loss tolerance	Max	12	dB	12	
Encircled flux[c]		>= 86% at 19 µm, <= 30% at 4.5 µm		>= 86% at 19 µm, <= 30% at 4.5 µm	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio 5×10–5 hits per sample	Spec values	0.23, 0.34, 0.43, 0.27, 0.35, 0.4		Around 0.25, 0.36, 0.45, 0.27, 0.35, 0.4	Around 0.21, 0.32, 0.45, 0.27, 0.35, 0.4
Average launch power of OFF transmitter, each lane	Max	–30	dBm	–30	

SR contains Tx CDR, UR need not

a RMS spectral width is the standard deviation of the spectrum.

b Even if the TDP < 0.9 dB, the OMA (min) must exceed this value.

c If measured into type A1a.2 or type A1a.3 50 µm fiber in accordance with IEC 61280-1-4.

a [same]

b Even if the TDP < TBD dB, the OMA (min) must exceed this value.

c [same]

Table x–5—SIGNAL_DETECT value definition

Receive conditions	SIGNAL_DETECT value
For any lane; Average optical power at TP3 <= –30 dBm	FAIL
For all lanes; [(Optical power at TP3 >= Minimum OMA, each lane, in Table x–z) and (compliant 100GBASE–SR4 or 100GBASE–UR4 signal input as appropriate)]	OK
All other conditions	Unspecified

Just as Clause 86

Table x-7 Characteristics of signal within, and at the receiving end of, a compliant optical channel

40GBASE-SR4 and 100GBASE-SR10

Description	Minimum		Maximum	Unit	Minimum		Maximum
Fiber type	OM3	OM4			100GBASE–UR4	100GBASE–SR4	
Total average power for 40GBASE–SR4	–3.5	–3.1	+8.4	dBm	-3.3	-3.5	+8.4
Total average power for 100GBASE–SR10	+0.5	+0.9	+12.4	dBm		*(n/a)*	
Average power, each lane	–9.5	–9.1	+2.4	dBm	-9.3	-9.5	+2.4
Optical Modulation Amplitude (OMA), each lane	–7.5	–7.1	+3	dBm	-7.3	-7.5	+3.0

Table x–8 100GBASE–SR4 or 100GBASE–UR4 optical receiver characteristics

		40GBASE-SR4 or 100GBASE-SR10		100GBASE–SR4	
Description	**Type**	**Value**	**Unit**	**100GBASE–UR4**	
Center wavelength, each lane	Range	840 to 860	nm	840 to 860	
Damage threshold[a]	Min	3.4	dBm	3.4	
Average power at receiver input, each lane	Max	2.4	dBm	2.4	
	Min	–9.5	dBm	-9.3	-9.5
Receiver reflectance	Max	–12	dB	–12	
Optical Modulation Amplitude (OMA), each lane	Max	3	dBm	3	
Stressed receiver sensitivity in OMA, each lane[b]	Max	–5.4	dBm	-5.4	–5.4
Peak power, each lane	Max	4	dBm	4	
Conditions of stressed receiver sensitivity test:					
Vertical eye closure penalty (VECP)[c], each lane	—	1.9	dB	2.7	2.7
Stressed eye J2 Jitter[c], each lane	—	0.3	UI	0.34	0.34
Stressed eye J9 Jitter[c], each lane	—	0.47	UI	0.6	0.6
OMA of each aggressor lane	—	–0.4	dBm	–0.4	
Receiver jitter tolerance in OMA, each lane[d]	Max	–5.4	dBm	*As SRS*	*As SRS*
Conditions of receiver jitter tolerance test:					
Jitter frequency and peak-to-peak amplitude	—	(75, 5)	(kHz, UI)	(187.5, 5)	
Jitter frequency and peak-to-peak amplitude	—	(375, 1)	(kHz, UI)	(937.5, 1)	
OMA of each aggressor lane	—	–0.4	dBm	–0.4	

Assuming performance with FEC will follow non-FEC

(Hope that we don't need with-FEC Rx specs if we have non-FEC specs)

a The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.

a [same]

b Measured with conformance test signal at TP3 (see 86.8.4.7).

b Measured with conformance test signal at TP3 (see x.y.z).

c Vertical eye closure penalty and stressed eye jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver. The apparent discrepancy between VECP and TDP is because VECP is defined at eye center while TDP is defined with ±0.15 UI offsets of the sampling instant.

c [same]

d This is a test of the optical receiver's ability to track low-frequency jitter and is inappropriate for any subsystem that does not include a CRU.

d [same]

Table x-9 100GBASE–SR4 and 100GBASE–UR4 illustrative link power budgets

Table x-13 Fiber optic cabling (channel) characteristics at 850 nm

	40GBASE-SR4 or 100GBASE-SR10			100GBASE–UR4		100GBASE–SR4			
Parameter	**OM3**	**OM4**	**Unit**	**OM3**		**OM3**		**OM4**	
				No FEC	**With FEC**	**No FEC**	**With FEC**	**No FEC**	**With FEC**
Effective modal bandwidth at 850 nm[a]	2000	4700	MHz•km	2000		2000		4700	
Power budget (for maximum TDP)	8.3		dB	8.0?	9.5?	8.0?	9.5?	8.0?	9.5?
Operating distance	0.5 to 100	0.5 to 150	m	0.5 to 20	0.5 to 50?	0.5 to 30?	0.5 to 75?	0.5 to 40?	0.5 to 100
Channel insertion loss[b]	1.9	1.5	dB	1.6	1.7	1.6	1.8	1.6	1.9
Allocation for penalties (for maximum TDP)[c]	6.4	6.5	dB	6.4	7.6	6.4	7.6	6.4	7.6
Unallocated margin	0	0.3[d]	dB	0	0.2	0	0.1	0	0
Additional insertion loss allowed	0		dB	0					

a Per IEC 60793-2-10.

b The channel insertion loss is calculated using the maximum distances specified in Table 86–2 and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in x.y.z.

c Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

d This unallocated margin is not available for use.

The reaches in yellow are just placeholders at present

		40GBASE-SR4 or 100GBASE-SR10			100GBASE–UR4		100GBASE–SR4			
Description	**Type**	**OM3**	**OM4**	**Unit**	**OM3**	**OM4**	**OM3**		**OM4**	
					No FEC	**With FEC**	**No FEC**	**With FEC**	**No FEC**	**With FEC**
Operating distance	Max	100	150	m	20	50?	30?	75?	40?	100
Cabling Skew	Max	79		ns	79					
Cabling Skew Variation[a]	Max	2.5		ns	2.5					
Channel insertion loss	Min	0		dB	0					
Channel insertion loss[b]	Max	1.9[c]	1.5[d]	dB	1.6	1.7	1.6	1.8	1.6	1.9

a An additional 300 ps of Skew Variation could be caused by wavelength changes, which are attributable to the transmitter not the channel.

b These channel insertion loss values include cable, connectors, and splices.

c 1.5 dB allocated for connection and splice loss.

d 1 dB allocated for connection and splice loss.

Use notes a, b only

Table x-14 Optical fiber and cable characteristics

Description	OM3[a]	OM4[b]	Unit
Nominal core diameter	50		µm
Nominal fiber specification wavelength	850		nm
Effective modal bandwidth (min)c	2000	4700	MHz•km
Cabled optical fiber attenuation (max)	3.5		dB/km
Zero dispersion wavelength (λ0)	1295 <= λ0 <= 1340		nm
Chromatic dispersion slope (max) (S0)	0.105 for 1295 <= λ0 <= 1310 and 0.000375×(1590 – λ0) for 1310 <= λ0 <= 1340		ps/nm^2 km

a IEC 60793-2-10 type A1a.2

b IEC 60793-2-10 type A1a.3

c When measured with the launch conditions specified in Table x-6.

Just as Clause 86

Table xA–3 CPPI-4 module electrical output specifications at TP4

	nPPI				CPPI-4		CAUI-4		
Parameter description	**Min**	**Max**	**Units**	**Conditions**	**Min**	**Max**	**Min**	**Max**	**Comments**
Single ended output voltage tolerance	–0.3	4	V	Referred to signal common	–0.3	4	–0.3	4	
AC common-mode output voltage (RMS)	—	7.5	mV		—	17.5	—	17.5	Not as important as we feared, matches CEI-28G-VSR
Termination mismatch at 1 MHz	—	5	%		*(n/a)*		*(n/a)*		Use Sdc22 spec which controls skew-induced conversion as well as R matching
Differential output return loss	See 86A.4.2.1	—	dB	10 MHz to 11.1 GHz	Eqn. A-1	—	Eqn. A-1	—	
Common-mode output return loss	See 86A.4.2.2	—	dB	10 MHz to 11.1 GHz	Eqn. A-2	—	Eqn. A-2	—	Unwisely deleted from 802.3-2012
Common-mode to differential output return loss					Eqn. A-3	—	Eqn. A-3	—	
Output transition time, 20% to 80%	28	—	ps		Around 8 to 10 TBD		Around 8 to 10 TBD		
J2 Jitter output	—	0.42	UI		—	0.6	—	0.42	
J9 Jitter output	—	0.65	UI		*(n/a)*		—	0.6	
Equalized J2 Jitter output (when used without FEC)					—	0.5	—	0.28	With adjustable CTLE or similar
Equalized J9 Jitter output (when used without FEC)					—	0.7	—	0.5	Ditto
Equalized J2 Jitter output (when used with FEC)					—	0.5	*(n/a)*		Ditto
Equalized **J5** Jitter output (when used with FEC)					—	0.7	*(n/a)*		Ditto
	Specification values								
Eye mask coordinates: X1, X2 Y1, Y2	0.29, 0.5 150, 425		UI mV	Hit ratio = 5 × 10–5	Around 0.45, 0.5 40, 250		Around 0.22, 0.43 50, 250		
Crosstalk source VMA, each lane	700		mV	At TP1a	660		660		Same as host output
Crosstalk source transition times, 20% to 80%	37		ps	At TP1a	Around 10 TBD		Around 10 TBD		Ditto

Table xA–4 CPPI-4 host electrical input specifications at TP4 and TP4a

Parameter description	Test point	nPPI Min	nPPI Max	Units	Conditions	CPPI-4 Min	CPPI-4 Max	CAUI-4 Min	CAUI-4 Max	Comments
Single ended input voltage[a]	TP4	–0.3	4	V	Referred to signal common	–0.3	4	–0.3	4	
AC common-mode input voltage tolerance	TP4	7.5	—	mV	RMS	17.5	—	17.5	—	
Differential input return loss	TP4a	86A.4.2.1	—	dB		Eqn. A-1	—	Eqn. A-1	—	(see equations for *f* ranges)
Common-mode input return loss	TP4a					Eqn. A-2	—	Eqn. A-2	—	
Differential to common-mode input return loss	TP4a	10	—	dB	10 MHz to 11.1 GHz	10	—	10	—	50 MHz to 26.79 GHz
Host input signal tolerance, interface BER limit (when used without FEC)		—	10^{-12}	—		—	10^{-12}	—	10^{-12}	
Host input signal tolerance, interface BER (when used with FEC)						—	6.7×10^{-5}	*(n/a)*		
Conditions of host electrical receiver signal tolerance test:[b]										
		Specification values				**No FEC**	**With FEC**	**Specification values**		
Eye mask coordinates: X1, X2 Y1, Y2	TP4	0.29, 0.5 150, 425		UI mV	Hit ratio = 5×10–5	Around 0.45, 0.5 40, 250		Around 0.22, 0.43 50, 250		
Transition time, 20% to 80%	TP4	34		ps		Around 17		Around 17		
J2 Jitter	TP4	0.42		UI		0.6		0.42		
J9 Jitter	TP4	0.65		UI		*(n/a)*		0.6		
Data Dependent Pulse Width Shrinkage (DDPWS)	TP4	0.34		UI		0.45		0.4		
Equalized J2 Jitter	TP4					0.5	0.5	0.28		
Equalized J5 Jitter	TP4					0.7	—	*(n/a)*		Could define CAUI-4 with & w/o FEC
Equalized J9 Jitter	TP4					—	0.7	0.5		
VMA of aggressor lanes	TP4	850		mV		470		470		Same as host input
Crosstalk calibration signal VMA	TP1a	700		mV		660		660		Same as host output
Crosstalk calibration signal transition times, 20% to 80%	TP1a	37		ps		Around 10 TBD		Around 10 TBD		Ditto

a The host is required to tolerate (work correctly with) input signals with instantaneous voltages anywhere in the specified range.

b The specification values are test conditions for measuring signal tolerance and are not characteristics of the host (see 86A.5.3.8).

b The specification values are test conditions for measuring signal tolerance and are not characteristics of the host (see xA.y.z).

xA.6 Recommended electrical channel

between the PMA IC (TP0 or TP5) and TP1a or TP4a

Sdd21 >= -0.5 0.01 <= *f* < 0.11
-0.114 - 0.8914sqrt(*f*) - 0.846*f* 0.11 <= *f* < 7
35.91 - 6. 3 291*f* 7 <= *f* < 8
-14.72 8 <= *f* <= 11.1

Sdd21 <= 0.22 -0.46*f* 0.01 <= *f* <= 7
3 7 <= *f* <= 11.1

Sdd21 >= -0.5 0.01 <= *f* < 0.?
-? - ?sqrt(*f*) - ?*f* 0.? <= *f* < 13
? -?*f* 13 <= *f* < 25.79

Sdd21 <= 0.22 -?*f* 0.01 <= *f* <= 25.79

Ratio of about 2.5 to 3, as for nPPI

Add: recommended max ILDrms (might be tighter for CPPI-4 than for CAUI-4)

The recommended maximum loss of the host PCB only (without connector or HCB) at 5.15625 GHz is 4.4 dB.

The recommended maximum loss of the host PCB only (without connector or HCB) at 12.890625 GHz is 6.8? dB.

Comparison with CEI-28G-VSR Host to module

Host-to-Module Electrical Specifications at TP1a (host output)

Parameter	Min	Max	Units	CPPI-4 Min	CPPI-4 Max	CAUI-4 Min	CAUI-4 Max
Differential Voltage pk-pk	-	900	mV	—	700	—	700
Common Mode Noise rms	-	17.5	mV	—	20	—	20
Differential Termination Mismatch	-	10	%	See Sdc22 spec		See Sdc22 spec	
Differential Return Loss	-	Eqn. 1-2	dB	Eqn. A-1		Eqn. A-1	
Common to Differential Mode Conversion (SDC22)	-	Eqn 1-3	dB	Eqn. A-3		Eqn. A-3	
Transition Time: 20/80%	10	-	ps	Around 10 TBD		Around 10 TBD	
Common Mode Voltage	-0.3	2.8	V	Single ended voltage spec -0.3 to +4			
Eye width at 10-15 probability (EW15)[1]	0.46	-	UI	—	EJ9 0.22	—	EJ9 0.52
Eye height at 10-15 probability (EH15)[1]	100	-	mV	?	—	?	—

Host-to-Module Electrical Specifications at TP1 (module input)

Parameter	Min	Max	Units	CPPI-4 Min	CPPI-4 Max	CAUI-4 Min	CAUI-4 Max
Overload Differential Voltage pk-pk	900	-	mV	—	700	—	700
Differential Termination Mismatch	-	10	%	See Sdc22 spec		See Sdc22 spec	
Differential Return Loss	-	Eqn 1-2	dB	Eqn. A-1		Eqn. A-1	
Common to Differential Mode Conversion (SDC11)	-	Eqn 1-3	dB	10	—	10	—
Stressed Receiver Test	See 1.3.10.2.1			Yes		Yes	

Crosstalk parameters for Host Output test and Module input test calibration at TP4

Parameter	Used in test	Target value	units	CPPI-4 Spec value	CAUI-4 Spec value
Crosstalk Amplitude differential voltage pk-pk	Host Output test and module stressed receiver test calibration	900	mV	VMA 470	VMA 470
Crosstalk transition time 20-80%	Host Output test and module stressed receiver test calibration	9.5	ps	Around 8 to 10 TBD	Around 8 to 10 TBD

Comparison with CEI-28G-VSR Module to host

Module-to-Host Electrical Specifications at TP4 (module output)

Parameter	Min	Max	Units	CPPI-4 Min	CPPI-4 Max	CAUI-4 Min	CAUI-4 Max
Differential Voltage, pk-pk	-	900	mV	—	500	—	500
Common Mode Noise, rms	-	17.5	mV	—	17.5	—	17.5
Differential Termination Mismatch	-	10	%	See Sdc22 spec		See Sdc22 spec	
Differential Return Loss	-	Eqn 1-2	dB	Eqn. A-1	—	Eqn. A-1	—
Common Mode to Differential Conversion Return Loss		Eqn 1-3	dB	Eqn. A-3	—	Eqn. A-3	—
Transition Time: 20/80%	9.5	_	ps	Around 8 to 10 TBD		Around 8 to 10 TBD	
Vertical Eye Closure (VEC)	-	6.5	dB	—	?	—	?
Eye width at 10-15 probability (EW15)	0.57	-	UI	—	EJ9 0.7	—	EJ9 0.5
Eye height at 10-15 probability (EH15)	240	-	mV	?	—	?	—

Module-to-Host Electrical Specifications at TP4a (host input)

Parameter	Min	Max	Units	CPPI-4 Min	CPPI-4 Max	CAUI-4 Min	CAUI-4 Max
Overload Differential Voltage pk-pk	900	-	mV	—	500	—	500
Differential Termination Mismatch	-	10	%	See Scd22 spec		See Scd22 spec	
Differential Return Loss	-	Eqn 1-2	dB	Eqn. A-1	—	Eqn. A-1	—
Common Mode to differential conversion Loss	Eqn 1-3	-	dB	See Scd22 spec		See Scd22 spec	
Stressed Receiver Test	See 1.3.10.2.1			Yes		Yes	
Common Mode Voltage common mode voltage is generated by host	-0.3	2.8	V	Single ended voltage spec -0.3 to +4			

Crosstalk parameters for Module Output and Host stressed receiver test calibration at TP1a

Parameter	Used in test	Target value	units	CPPI-4 Spec value	CAUI-4 Spec value
Crosstalk Amplitude differential voltage pk-pk	Module Output test and host stressed receiver test calibration	900	mV	VMA 660	VMA 660
Crosstalk transition time 20%-80%	Module Output test and host stressed receiver test calibration	10	ps	Around 10 TBD	Around 10 TBD