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NANOPHOTONIC INTEGRATED CIRCUITS

Common Electrical I/F proposal

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1/11/08

Agenda:

- 10GBASE-KR overview
- SFF-8431 overview
- Comparison
- Recommendations and discussion

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Supporters

- Jim Mcgrath Molex
- Gourgen Ogenessan Quellan

10GBASE-KR overview

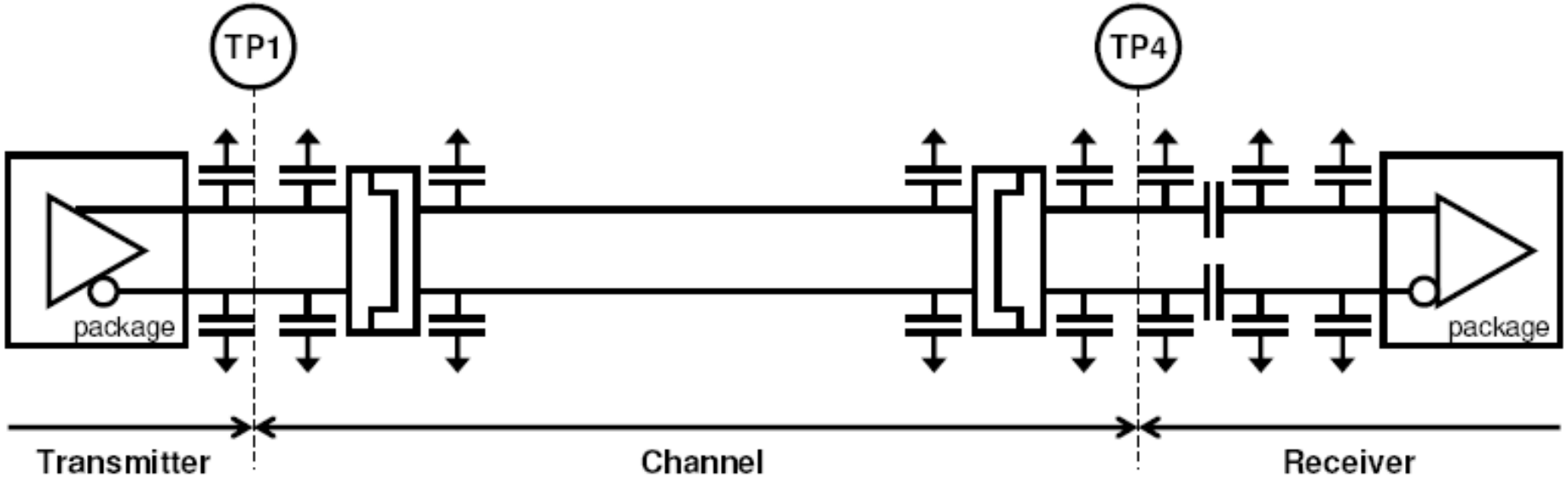
- Overview
- Architecture
- Example
- Compliance points
- Channel types
- Channel assumptions

10GBASE-KR Overview

- 10GBASE-KR was defined by the IEEE 802.3ap working group as a solution for blade server to blade switch communications over an ATCA or equivalent backplane.

KR compliance points

- TX spec. (TP1) is specified at the package pin
- RX spec (TP4) is specified at the AC coupling capacitors

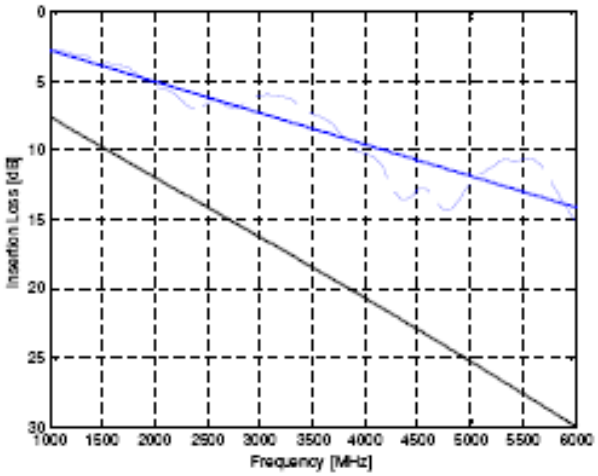


Attenuation limits

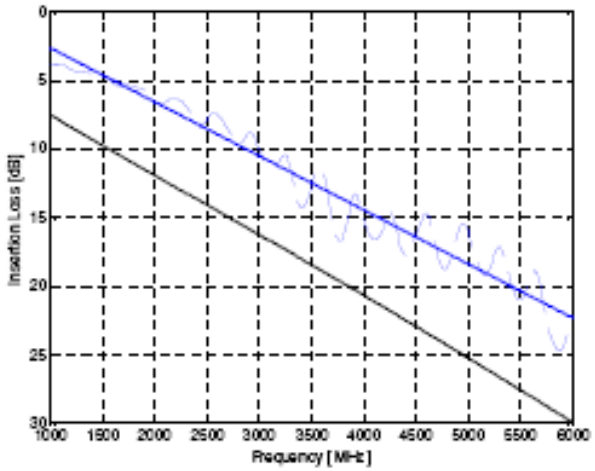
Goal is to give guidance on dielectric loss of channels

- Based on a 6mil trace using Nelco 13SI material

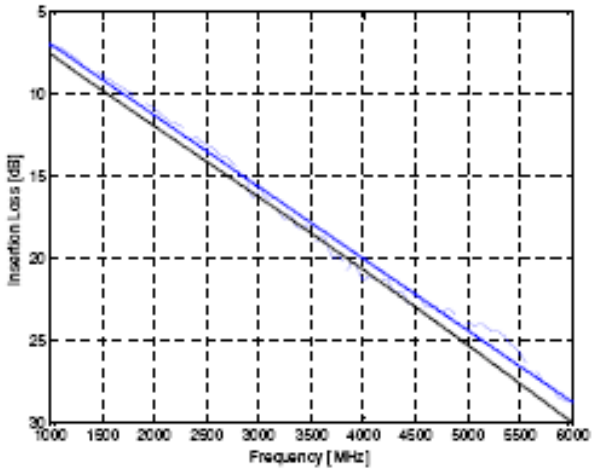
- See Chris Diminico presentation for application to 10m copper



Example #1



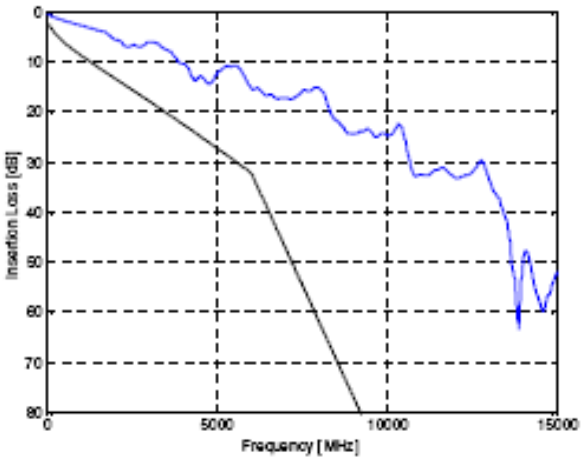
Example #2



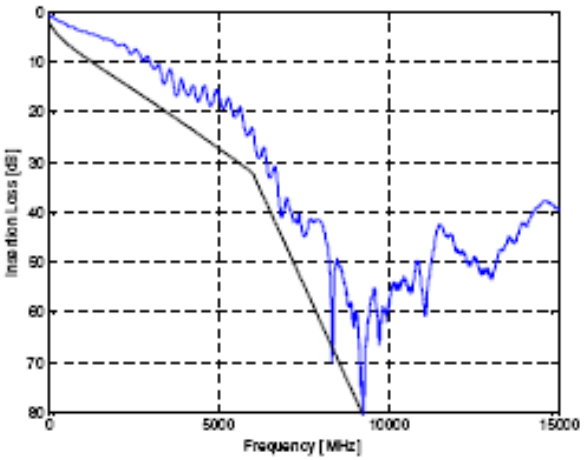
Example #3

Insertion loss limits

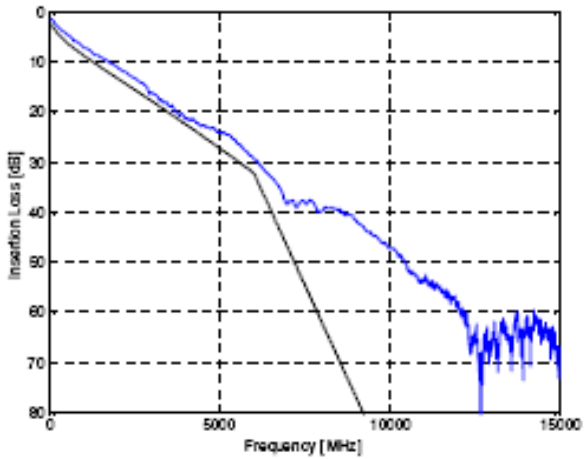
- An attempt to put a limit on stub effects
  - Stub effects proved to be the worst problem
    - Difficult to put limits based on S21 measurements or pulse response.



Example #1



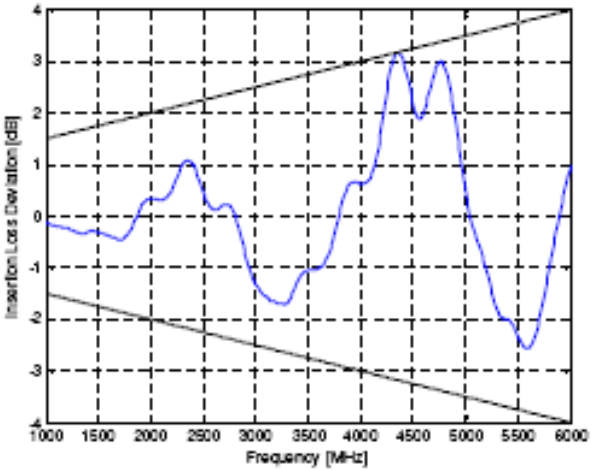
Example #2



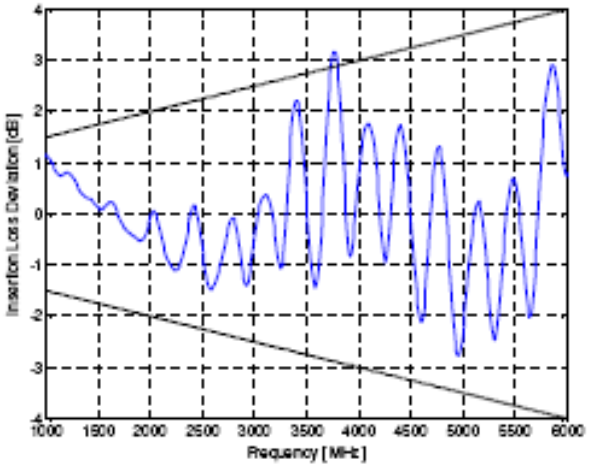
Example #3

Insertion loss deviation

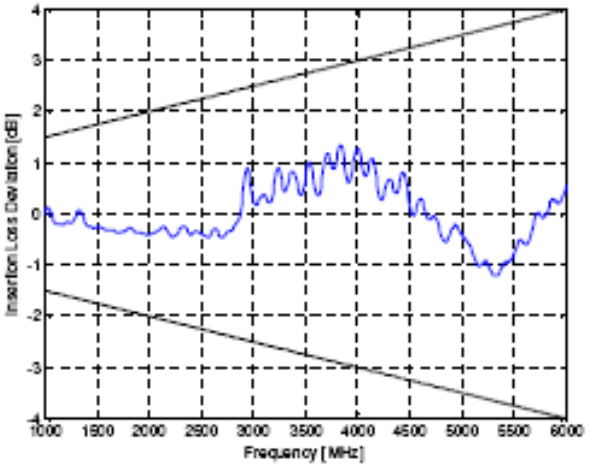
- Gives guidance on limits for stub effects



Example #1



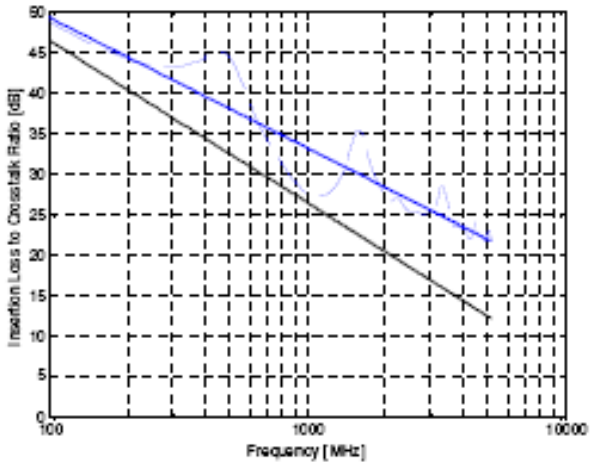
Example #2



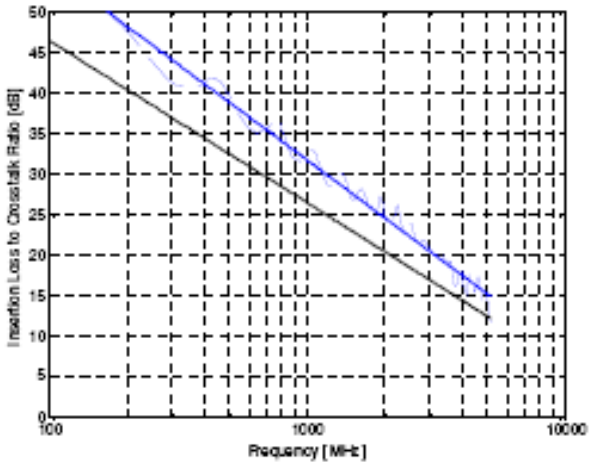
Example #3

ICR (Insertion loss to crosstalk ratio)

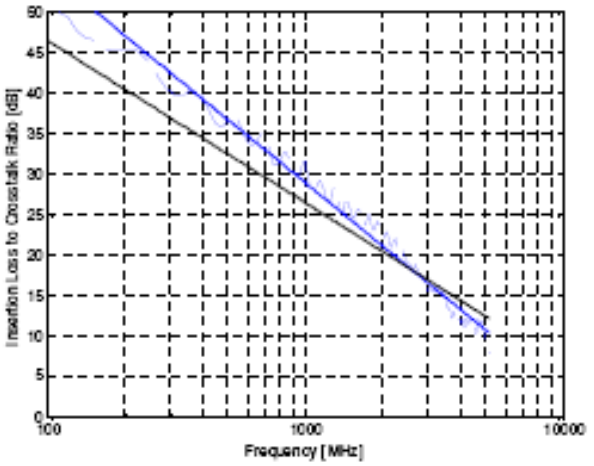
- Invented by the group to allow designers to trade off crosstalk with insertion loss.
  - Longer channels must have better control of crosstalk



Example #1



Example #2



Example #3

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

Parameter	Subclause reference	Value	Units
Signaling speed	72.7.1.3	10.3125 ± 100 ppm	GBd
Differential peak-to-peak output voltage (max.)	72.7.1.4	1200	mV
Differential peak-to-peak output voltage (max.) with TX disabled	72.6.5	30	mV
Common-mode voltage limits	72.7.1.4	0–1.9	V
Differential output return loss (min.)	72.7.1.5	[See Equation (72–4) and Equation (72–5)]	dB
Common-mode output return loss (min.)	72.7.1.6	[See Equation (72–6) and Equation (72–7)]	dB
Transition time (20%–80%)	72.7.1.7	24–47	ps
Max output jitter (peak-to-peak) Random jitter[a] Deterministic jitter Duty Cycle Distortion[b] Total jitter	72.7.1.8	 0.15 0.15 0.035 0.28	 UI UI UI UI

[a]Jitter is specified at BER 10^{-12}.
[b]Duty Cycle Distortion is considered part of the deterministic jitter distribution.

KR Transmitter output waveform

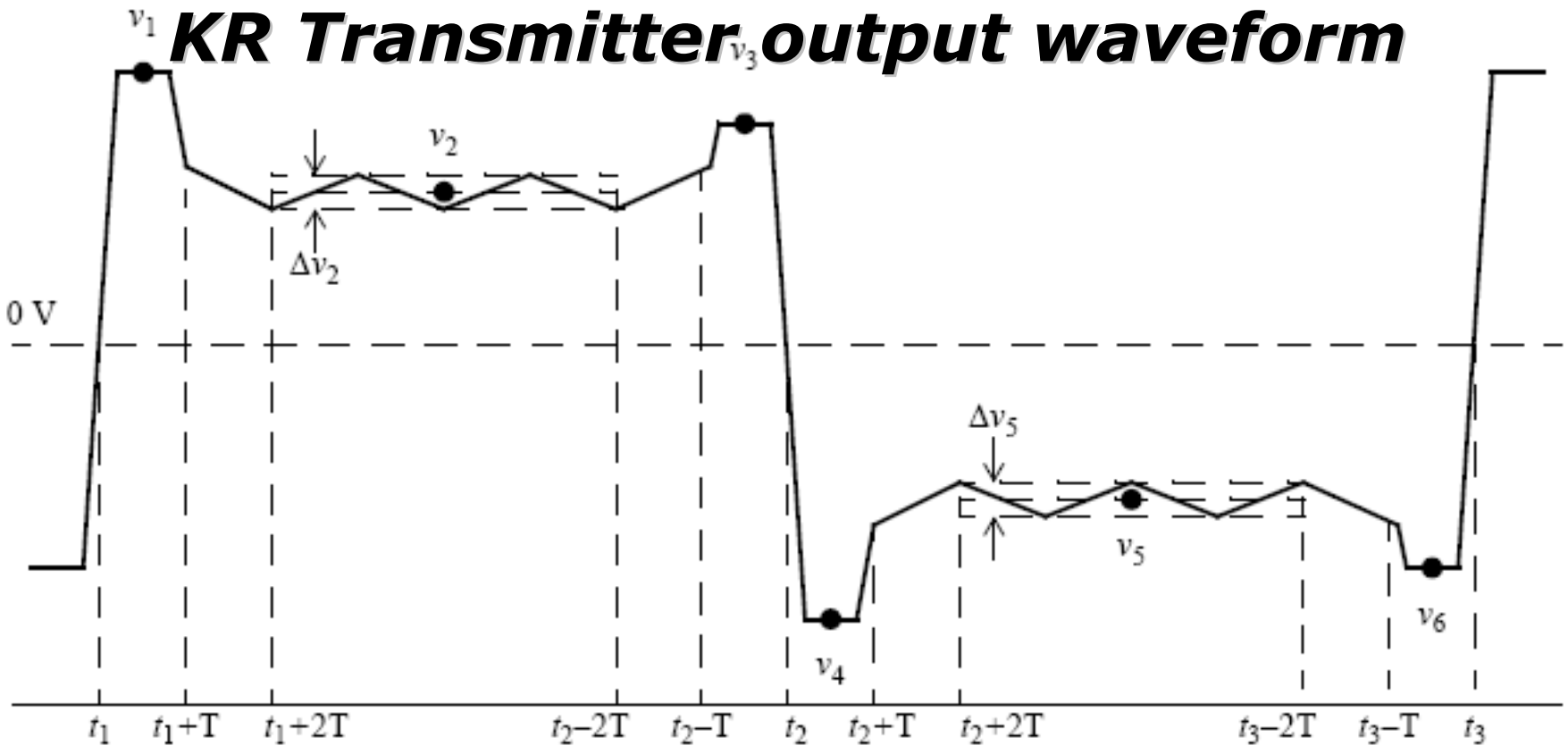


Figure 72–12—Transmitter output waveform

KR RX spec

Table 72–9—Receiver characteristics for 10GBASE-KR

Parameter	Subclause reference	Value	Units
Bit error ratio	72.7.2.1	10^{-12}	
Signaling speed	72.7.2.2	10.3125 ± 100 ppm	GBd
Receiver coupling	72.7.2.3	AC	
Differential input peak-to-peak amplitude (maximum)	72.7.2.4	1200[a]	mV
Differential input return loss (minimum)[b]	72.7.2.5	[See Equation (72–4) and Equation (72–5)]	dB

[a]The receiver shall tolerate amplitudes up to 1600 mV without permanent damage
[b]Relative to 100 Ω differential.

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Interference Tolerance test limits

Table 72–10—10GBASE-KR interference tolerance parameters

Parameter	Test 1 values	Test 2 values	Units
Target BER	10^{-12}	10^{-12}	
m_{TC} (min.)[a]	1.0	0.5	
Amplitude of broadband noise (min. RMS)	5.2	12	mV
Applied transition time (20%–80%, min.)	47	47	ps
Applied Sinusoidal jitter (min. peak-to-peak)	0.115	0.115	UI
Applied random jitter (min. peak-to-peak)[b]	0.130	0.130	UI
Applied Duty Cycle Distortion (min. peak-to-peak)	0.035	0.035	UI

[a] m_{TC} is defined in Equation (69A–6) of Annex 69A.
[b] Applied random jitter is specified at a BER of 10^{-12}.

RX jitter tolerance test setup

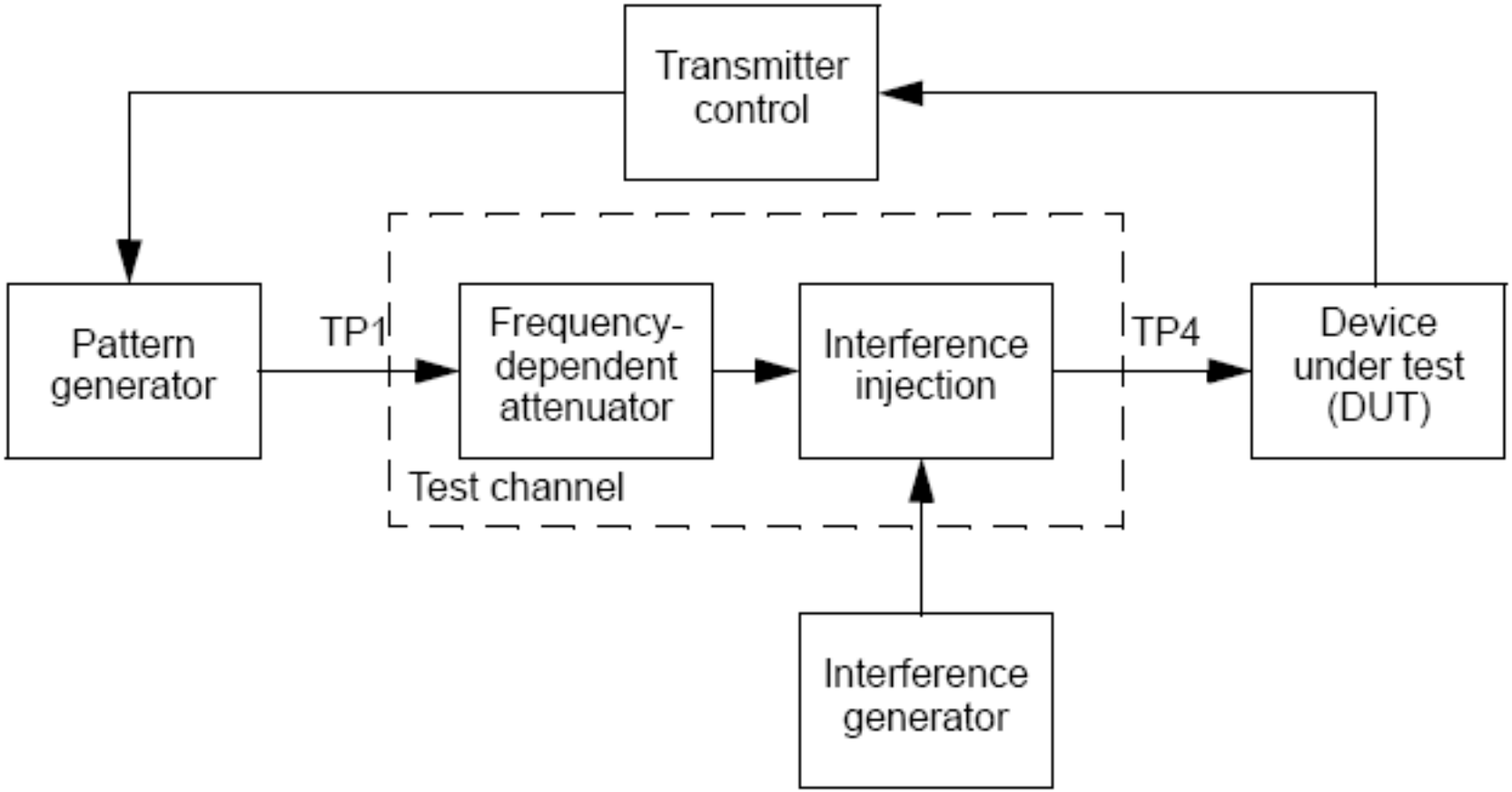

Figure 69A–1—Interference tolerance test setup

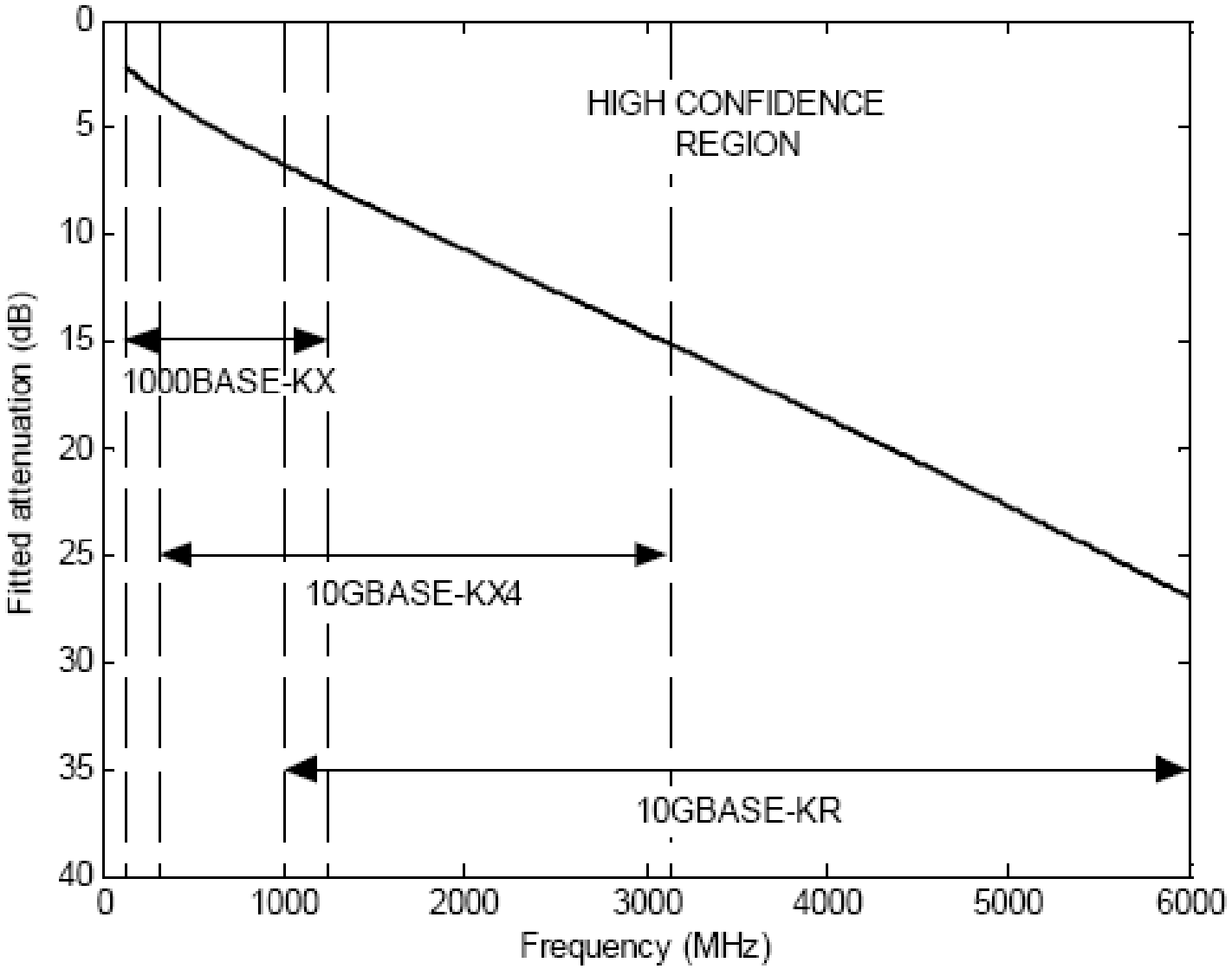

Figure 69B–2—Fitted attenuation limit

SFF-8431 overview

- SFF-8431 is being defined by the Small Form Factor 8431 group. It is primarily defined for 8 and 10G optical (limiting and linear), and short reach copper.
  - Operates from 9.95G (SONET OC-192) to 11.1G (10G ethernet with G.709 FEC)

SFP+ electrical interface

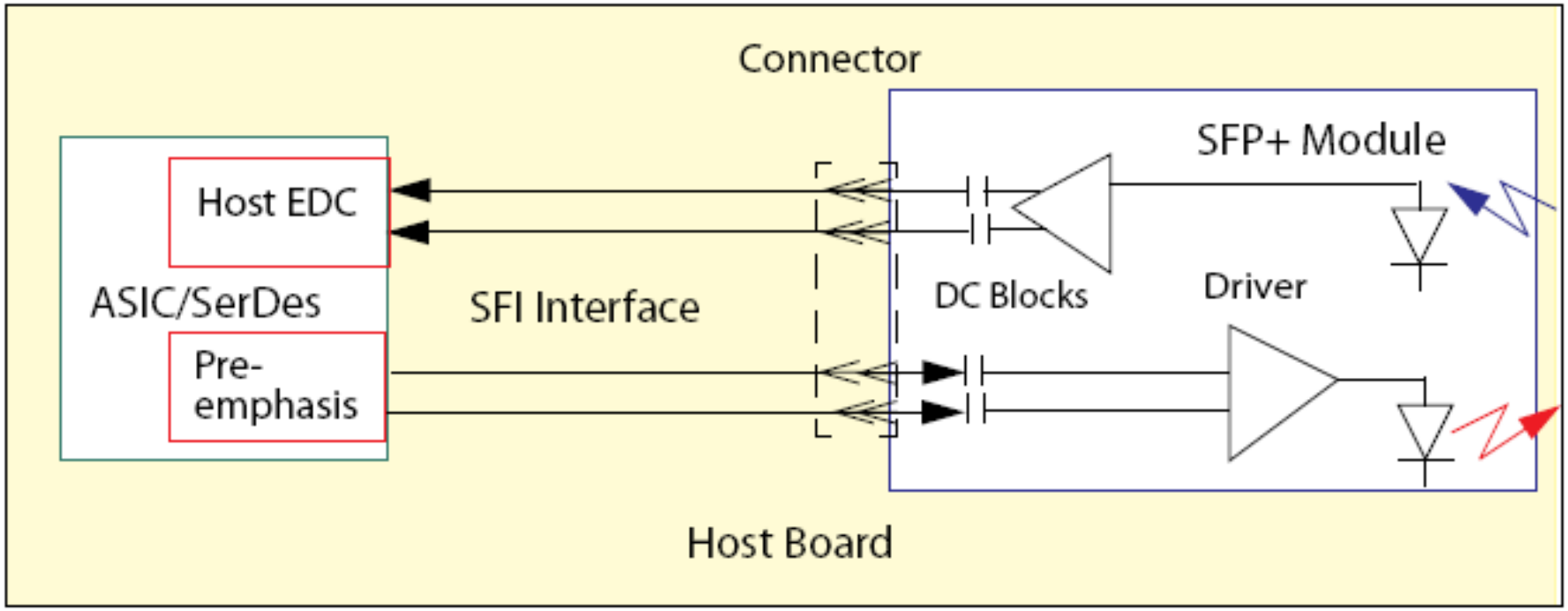

Figure 12 SFI Application Reference Model

SFP+ SERDES test board

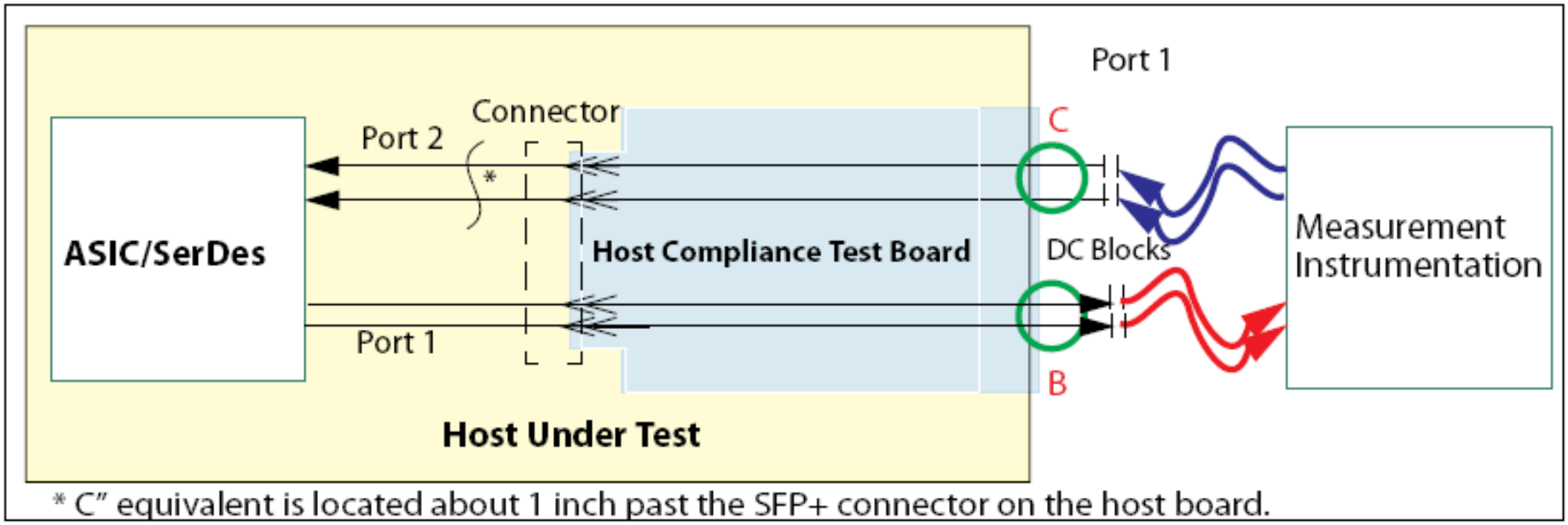

Figure 13 Host Compliance Test Board

SFP+ module test card

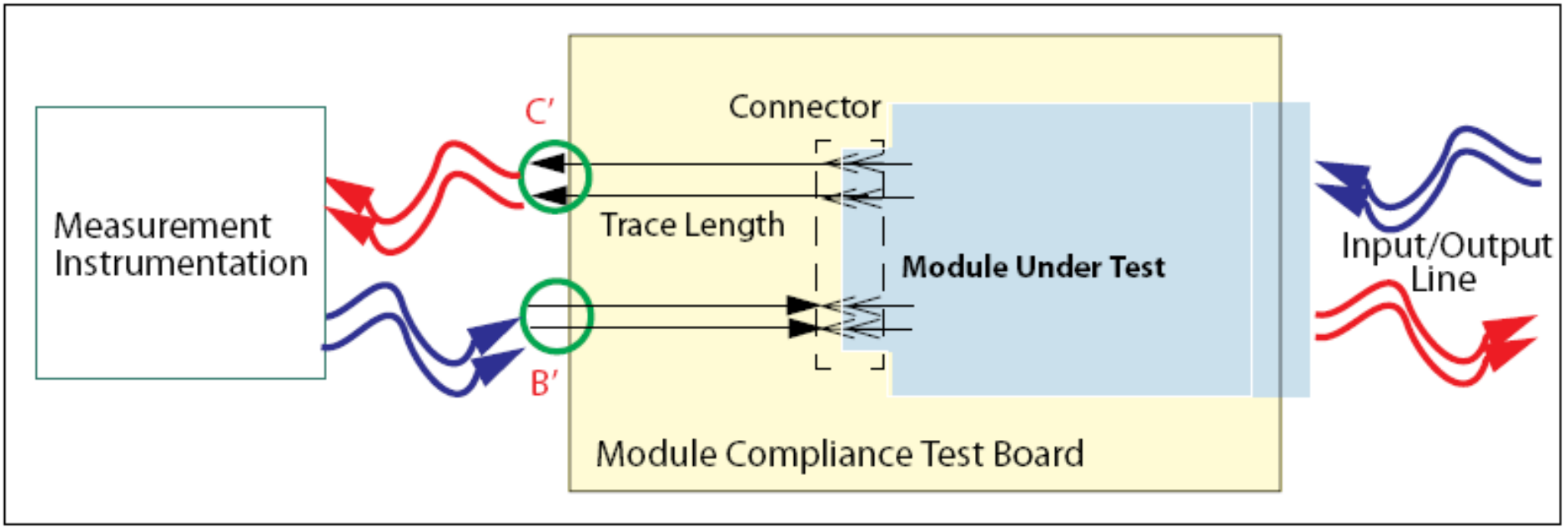

Figure 14 Module Compliance Test Board

SFP+ TX jitter specs

Table 13 SFP+ Host Transmitter Output Jitter and Eye Mask Specifications at B

Parameters- B	*Symbol*	*Conditions*	*Target Value*	*Max*	*Units*
Total Jitter	TJ	See 1, D.5		0.28	UI(p-p)
Data Dependent Jitter	DDJ	See D.3		0.1	UI(p-p)
Data Dependent Pulse Width Shrinkage	DDPWS			0.055	UI (p-p)
Uncorrelated Jitter	UJ	See D.4		0.023	UI (RMS)
Eye Mask	X1	See D.2 and Figure 19	0.14		UI
Eye Mask	X2		0.35		UI
Eye Mask	Y1		90		mV
Eye Mask	Y2		350		mV
1. The data pattern for the Total Jitter Measurement is one of IEEE 802.3 CL52.9 Pattern 1, Pattern 3, or valid 64/66B data traffic.					

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SFP+ RX specs

- Note: D.5 describes the Dual Dirac model for jitter separation
- DJ is considered non-compensable

Table 20 SFP+ Limiting Module Receiver Output Jitter and Eye Mask Specifications at C'

Parameters - C'	*Symbol*	*Conditions*	*Min*	*Target*	*Max*	*Units*
Crosstalk source rise/fall time (20% to 80%)	Tr, Tf	See D.10.5		35		ps
Output Rise and Fall time (20% to 80%)	Tr, Tf	See 1	28			ps
Total Jitter	TJ	See 2, D.5			0.70	UI (p-p)
Deterministic Jitter	DJ	See D.5,			0.42	UI (p-p)
Eye Mask	X1	See D.2, D.10			0.35	UI
Eye Mask	Y1		150			mV
Eye Mask	Y2				425	mV

1. Measured with Module Compliance Test Board and OMA test pattern. Use of four 1's and four 0's sequence in the PRBS 9 is an acceptable alternative.
2. The data pattern for the total jitter measurement is one of IEEE 802.3 CL52.9 Pattern 1, Pattern 3, or valid 64B/66B data traffic.

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KR equivalent RJ calculation

Parameter	Value	Units
Amplitude	50	mv
Tr	80	ps
Slope	0.375	mv/ps
Amplitude noise	5.2	mv rms
Jitter	13.86	ps
Calculated RJ	0.1386	UI rms

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KR vs SFP+ RJ comparison

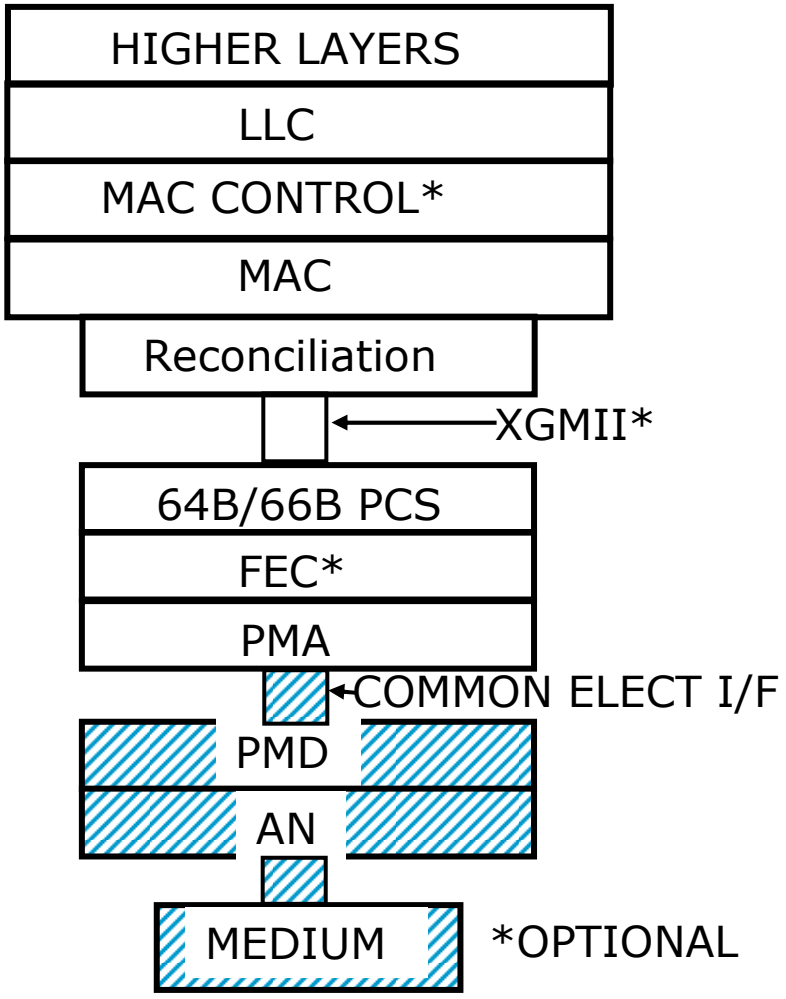
Parameters	KR values	SFP+ values	Units
Specified RJ	0.13	0.28	UI
Added RJ due to random noise	0.13		UI
Total RJ	0.26	0.28	UI p-p

Excel spreadsheet DJ comparison

Parameter	Value	Units
SJ (KR)	0.115	UI
DCD (KR)	0.035	
DJ introduced by KR channel	Approx 1	UI
DJ equalized by KR DFE	Approx .6	UI
Total KR DJ jitter tolerance after DFE	0.55	UI
SFP+ DJ jitter tolerance	0.42	UI

Common Electrical I/F discussion

- CEI exists between PMA and PMD layers. (PMAI?)
- Needs to supports multiple PMD layers
  - Optical
  - Copper



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What happens w/o a CEI?

- OEMs will design hardware to support multiple PMDs using integrated SERDES and SFF modules
- Support for copper will have to be done via simulations of a combination of line card traces, SFF connectors and copper cables
  - Testing a TP1/TP4 spec is difficult
- Support for optics will be done via compliance with SFF specs (SFF8431)
- Separate tests is not good.