

Scaling 100G SR4 Update a

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Presentation Summary

Presentation Objectives:

- Present link model attributes for 100G SR4 (aggregate of 4 lanes at 25.78124 Gb/s/lane)
- Present challenges scaling 25.78125 Gb/s/lane to 28.050 Gb/s/lane
- Suggest next steps
 - Explore tradeoff of link margin and uncorrected BER

Link Model References

Appendix B FC-MSQS-2 (draft 2.2)

http://www.ieee802.org/3/bm/public/may13/petrilla_04_0513_optx.pdf

<http://www.ieee802.org/3/bm/public/may13/ExampleMMF%20LinkModel%20%20130503.xlsx>

<http://www.avagotech.com/docs/AV02-2485EN>

Fiber Optic Links Interfaces

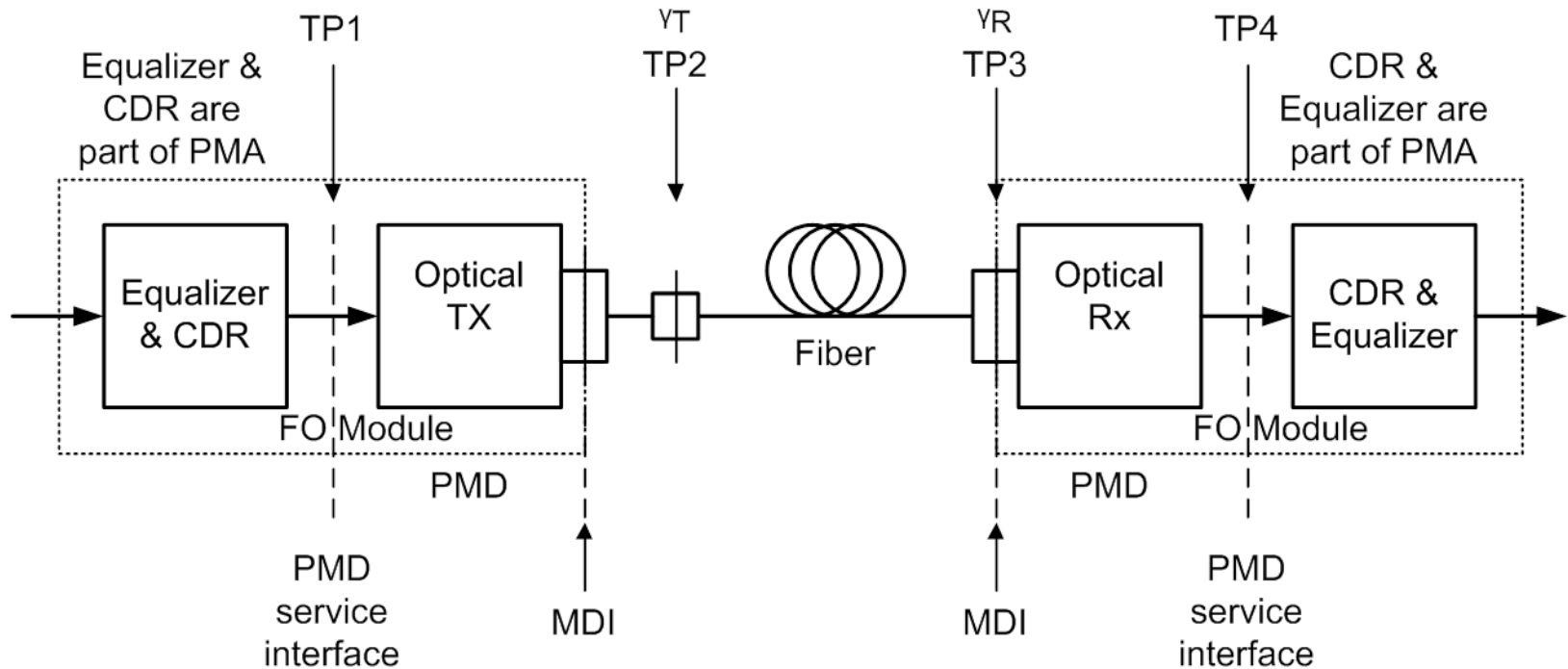


Figure 1

- For cases, as shown above in Figure 1, where retimers are embedded in the optical module, the PMD service interface is not exposed. TP1 and TP4 remain as points on the PMD service interface and, consequently, not exposed.
- For 100GBASE-SR4 the high speed signal inputs and outputs of the optical module are defined by CAUI-4.

100G SR4 with KR4 FEC: Example Link Model Tx Attributes (each lane)

Parameter	Unit	100G SR4		
Signal rate	GBd	25.78125	28.050	
Q (BER)		3.8905 (5.0E-5)	3.8905 (5.0E-5)	KR4 FEC corrects BER to < 1.0E-12 for random errors.
Center Wavelength, min	nm	840	840	
Spectral Width, max	nm	0.60	0.60	
OMA, min	dBm	-3.0	-3.0	
Extinction ratio, min	dB	3.0	3.0	
Tx output transition times, 20% -80%, max	ps	21	21	
RIN ₁₂ OMA, max	dB/Hz	-128	-128	
RIN coefficient		0.7	0.7	
MPN coefficient		0.3	0.3	
Modal Noise Penalty	dB	0.129	0.129	Scaled with Q ²
Tx reflectance, max	dB	-12	-12	
Tx optical return loss tolerance, max	dB	12	12	

Attributes and values in the above table are from 100G SR4 example link model and are not presented as specification recommendations.

KR4 FEC implements RS(528, 514) defined in 802.3bj d3.1 clause 91.

100G SR4 with KR4 FEC: Example Link Model Rx Attributes (each lane)

Parameter	Unit	100G SR4		
Signal rate	GBd	25.78125	28.050	
Q (BER)		3.8905 (5.0E-5)	3.8905 (5.0E-5)	KR4 FEC corrects BER to < 1.0E-12 (actually < ~ 8.5E-14) for random errors.
Center Wavelength, min	nm	840	840	
Rx sensitivity (OMA), max	dBm	-11.2	-11.2	-8.33 dBm at Q = 7.034
Rx Bandwidth, min	MHz	18,047	18,047	
RMS base line wander coefficient		0.025	0.025	
Rx reflectance, max	dB	-12	-12	

Attributes and values in the above table are from 100G SR4 example link model and are not presented as specification recommendations.

KR4 FEC implements RS(528, 514) defined in 802.3bj d3.1 clause 91.

100G SR4 with KR4 FEC: Example Link Model Jitter Attributes (each lane)

Parameter	Unit	100G SR4		
Signal rate	GBd	25.78125	28.050	
Q (BER)		3.8905 (5.00E-5)	3.8905 (5.00E-5)	KR4 FEC corrects BER to < 1.0E-12
TP1 RJrms tolerance, min	UI	0.0079	0.0079	
TP1 DJ tolerance, min	UI	0.11	0.11	
TP3 (λ R) DCD tolerance, min	UI	0.05	0.05	
TP3 (λ R) DJ tolerance, min	UI	0.247	0.254	
Cum DJ at TP4	UI	0.328	0.335	
TP4 J2, max	UI	0.592	0.593	Model output
TP4 TJ at BER, max	UI	0.780	0.780	Model output

Attributes and values in the above table are from 100G SR4 example link model and are not presented as specification recommendations. Various model outputs are provided.

Nomenclature: Terms TP1, TP2, TP3 and TP4 are used as defined in 802.3 clause 86 and shown in above Figure 1. Note that TP1 is downstream of the input CDR and equalizer for an optical transmitter.

TP1, TP4 and TP3 (λ R) DCD jitter allocation are scaled (constant UI) with signal rate. TP3 (λ R) DJ tolerance is a combination of constant Tx contributed DJ (constant ps) and scaled TP1 DJ.

KR4 FEC implements RS(528, 514) defined in 802.3bj d3.1 clause 91.

100G SR4 with KR4 FEC: Example Link Model Ch Attributes (each lane)

Parameter	Unit	100G SR4		
Signal rate	GBd	25.78125	28.050	
Q (BER)		3.8905 (5.0E-5)	3.8905 (5.0E-5)	KR4 FEC corrects BER to < 1.0E-12 for random errors
Reach	m	100	100	
Fiber Attenuation	dB/km	3.5	3.5	For 850 nm center wavelength
Dispersion min Uo	nm	1316	1316	
Dispersion So	ps/nm ² km	0.10275	0.10275	
Fiber modal bandwidth	MHz·km	4400	4400	For 840 nm center wavelength, 4700 MHz·km at 850 nm
Reflection Noise Factor		0	0	
Signal power budget	dB	8.20	8.20	Model output
Connector & splice loss allocation	dB	1.50	1.50	
Fiber Insertion loss	dB	0.36	0.36	Model output
Link power penalties (includes Peye)	dB	6.34	8.46	Model output Includes Peye
Link Margin	dB	0	-2.12	Model output
Additional insertion loss allowed	dB	0	0	Model output

Attributes and values in the above table are from 100G SR4 example link model and are not presented as specification recommendations. Various model outputs are provided. KR4 FEC implements RS(528, 514) defined in 802.3bj d3.1 clause 91.

Other/Summary/Challenges

Parameter	Unit	100G SR4		
Signal rate	GBd	25.78125	25.78125	
Q (BER)		3.8905 (5.0E-5)	4.7534 (1.0E-6)	KR4 FEC corrects BER to < 1.0E-12 for random errors KR4 FEC corrects BER to << 1.0E-18 for random errors
Signal power budget	dB	8.20	7.33	Model output
Link power penalties (includes Peys)	dB	6.34	7.63	Model output Includes Peys
Link Margin	dB	0	-2.16	Model output

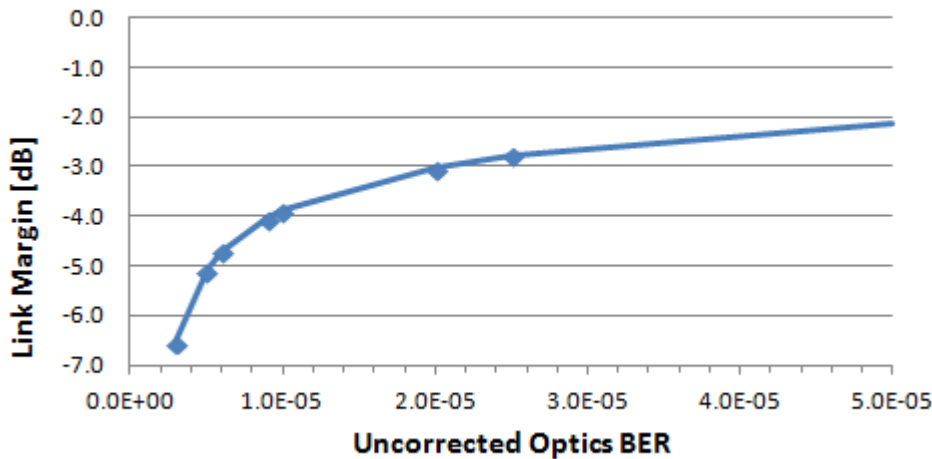
Challenges

The most significant challenges with closing the link budget for scaling 100G SR4 solutions to 128GFC solution are:

- Increasing the signal rate from 25.78125 GBd to 28.05 GBd results in a 2.12 dB link margin deficit (previous page).
- Decreasing BER from 5E-5 to 1E-6 results in a 2.16 dB link margin deficit (this page).
- The combined signal rate & BER effect results in more than a 10 dB link margin deficit with a Pisi central of 4.0 dB.

Next Steps

Link Margin for Uncorrected Optics BER

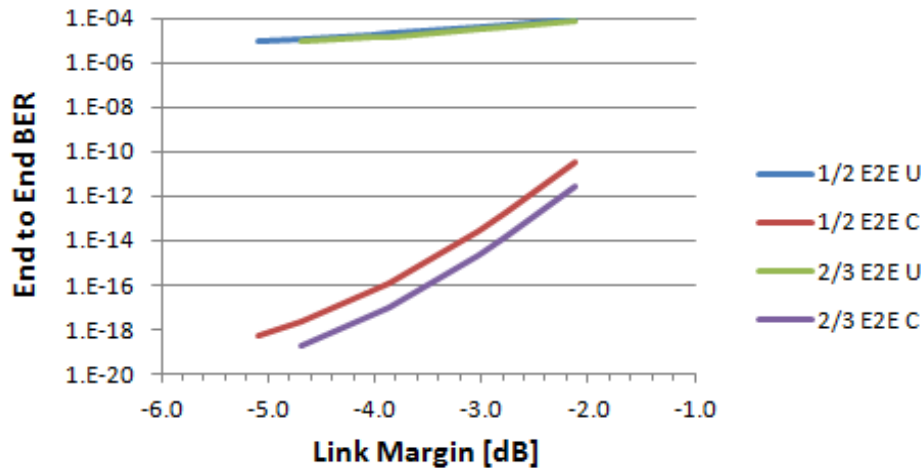


- Consider modifications to the example link model from 100G SR4, in addition to signal rate, to develop an example link model for 128GFC.
- Re-examine objectives and iterate until acceptable balance is found.

The chart on the top left shows link margin for an 100G SR4 link scaled to operate at 28.05 GBd.

- As previously shown, the signal rate change has the link operating at a 2.12 dB link margin deficit at a 5E-5 BER for the optics.

BER: corrected & uncorrected for optics allocations



The chart on the bottom left shows corrected and uncorrected end-to-end BER assuming random error generation for two cases of BER allocations; one where the optics allocation = 1/2 of the end-to-end total, and one where the optics allocation = 2/3.