100G PSM4 Link Model Results Comparison

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100G PSM4 Link Model Results

Presentation Objectives:

- Update set of attribute values for 100G PSM4 500 m SMF example link model
  - Reduced target reach from 2 km to 500 m
  - Increased connector and splice loss allocation from 2.0 dB to 3.0 dB
  - Update of KR4 FEC benefit based on anslow_01_1112_mmf_draft_1
- Provide comparison with link models attributes for 10GBASE-LR and 100GBASE-LR4
- Show tradeoff between connector loss and SMF reach

Conclusions:

- Capturing the benefits of KR4 FEC offers cost reduction opportunities that are not available to 100GBASE-LR4.
- A robust insertion loss budget at the 500 m SMF reach objective offers flexibility where longer reaches are desired.

Fiber Optic Links Interfaces

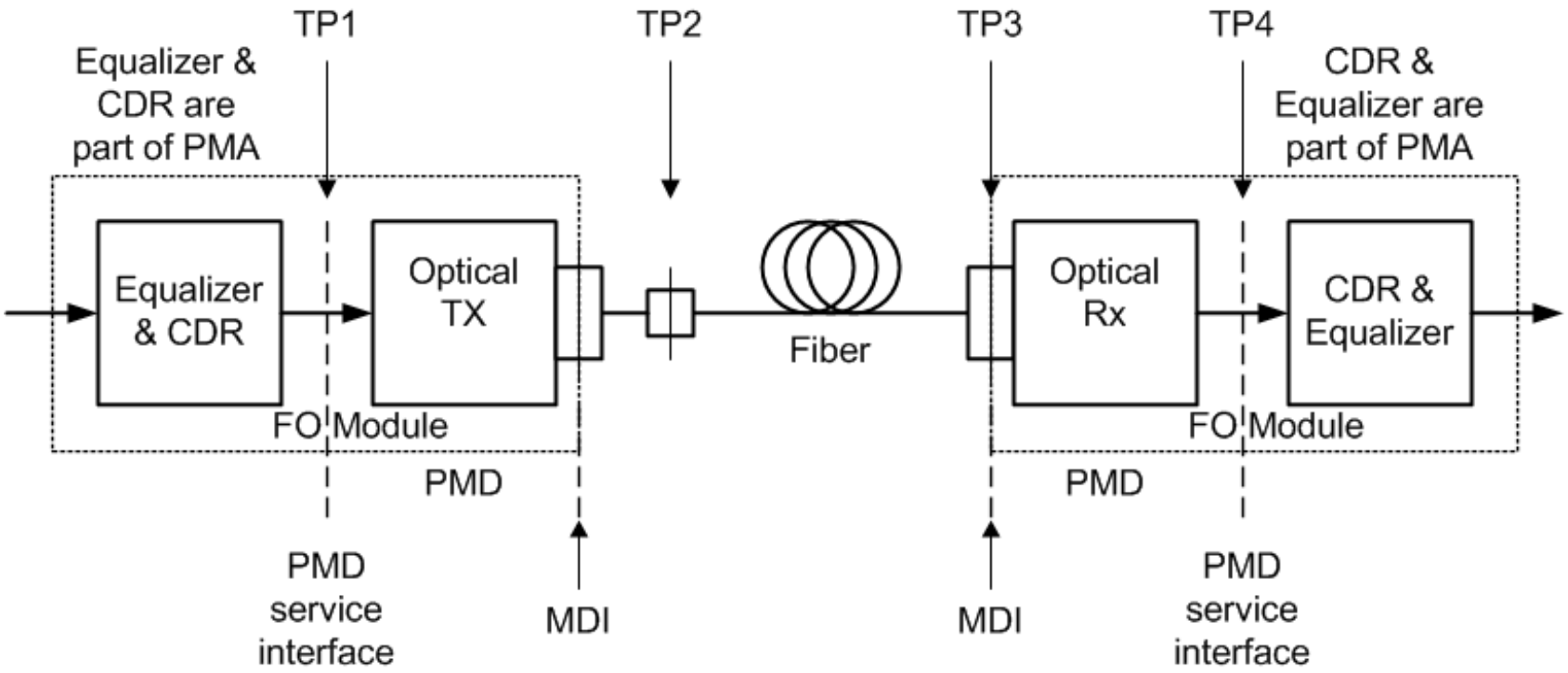


Figure 1

- For cases, as shown above in Figure 1, where retimers are incorporated 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.
- The high speed signal inputs and outputs of the optical module are expected to be defined by CAUI-4.

100G PSM4 Link Model: FEC Update

Optical Link

•Reducing Q for the SMF link from Qo = 7.034 for a BER = 10^{-12} to Qi = 3.8905 for a BER = $5.0x10^{-5}$ enhances the Rx sensitivity by 10Log(Qo/Qi) = 2.57 dB, providing a larger signal power budget.

•FEC benefit is used to reduce Tx signal level, loosen other Tx (ER) and Rx (Sensitivity and Optical Return Loss) requirements and increase connector loss allocation permitting cheaper and lower power consuming devices.

•Sensitivity based measurements (e.g. TDP and SRS) can be simpler, quicker and cheaper for a $5.0x10^{-5}$ BER than for a 10^{-12} BER.

CAUI-4

•Expected to be defined as not relying on FEC & operating at a BER = 10^{-12} or better.

CAUI-4 – PSM4 – CAUI-4 Link

•Maintains signal and Baud rate of NRZ, 64b/66b encoded, 25.78125 Gb/s signal

100G PSM4 with KR4 FEC: Tx Link Model Attributes (each lane)

Parameter	Unit	10G LR	100G LR4	100G PSM4	
Signal rate	GBd	10.3125	25.78125		
Q (BER)		7.034 (E-12)		3.8905 (5E-5)	KR4 FEC corrects PSM4 BER to ≤ E-12
Center Wavelength, min	nm	1260	1294.53	1295	
Center Wavelength Range, max	nm	95	2.1	30	
Spectral Width, max	nm	0.20			Note 1
OMA at max TDP & w.l. offset, min	dBm	-3.0	-0.1	-3.1	Note 2
Extinction ratio, min	dB	3.5	4.0	3.5	
Tx output transition times, 20% -80%, max	ps	47.0	12	18	
RINcOMA, max	dB/Hz	-128	-130	-128	Note 3
RIN coefficient		0.7			
Tx reflectance, max	dB	-12			
Tx optical return loss tolerance, max	dB	12	20	12	

Attributes and values in the above table are provided in order to populate example link models and are not presented as specification recommendations.
Note 1, Model uses 0.2 nm spectral width to generate penalty equivalent to max expected from chirp.
Note 2, Trade-offs are available for min OMA, center wavelength and TDP. See reference to be named.
Note 3, For 10G LR & 100G PSM4, c = 12 and for100G LR4, c = 20.

100G PSM4 with KR4 FEC: Rx Link Model Attributes (each lane)

Parameter	Unit	10G LR	100G LR4	100G PSM4	
Signal rate	GBd	10.3125	25.78125		
Q (BER)		7.034 (E-12)		3.8905 (5E-5)	KR4 FEC corrects PSM4 BER to ≤ E-12
Center Wavelength, min	nm	1260	1294.53	1295	
Center Wavelength Range, max	nm	95	2.1	30	
Rx sensitivity (OMA), max	dBm	-12.6	-8.6	-9.46 (-6.89 at Q = 7.034)	
Rx Bandwidth, min	MHz	7734	19,336		
RMS base line wander coefficient	dB/Hz	0.025			
Rx reflectance, max	dB	-12	-26	-12	

Attributes and values in the above table are provided in order to populate example link models and are not presented as specification recommendations.

100G PSM4 with KR4 FEC: Link Model Channel Attributes (each lane)

Parameter	Unit	10G LR	100G LR4	100G PSM4	
Signal rate	GBd	10.3125	25.78125		
Q (BER)		7.034 (E-12)		3.8905 (5E-5)	KR4 FEC corrects PSM4 BER to ≤ E-12
Reach	km	10	10	0.5	
Fiber Attenuation	dB/km	0.40	0.424		For 1310 nm center wavelength
Dispersion, min Uo	nm	1324			
Dispersion, So	ps/nm^{2}km	0.093			
PolMD DGD max	ps	10	10	2.24	Sq root dependency with length
Reflection Noise Factor		0.6			
Signal power budget at max TDP	dB	9.6	8.50	6.36	Model output
Connector & splice loss allocation	dB	2.0	2.0	3.0	
Fiber Insertion loss	dB	4.20	4.30	0.21	Model output
Allocation for penalties at max TDP	dB	3.26	1.93	2.77	Model output
Allocation for target eye at max TDP	dB	0.14	0.27	0.38	Model output
Additional insertion loss allowed	dB	0.0	0.0	0.0	Model output

Attributes and values in the above table are provided in order to populate example link models and are not presented as specification recommendations. Various model outputs are provided as examples.

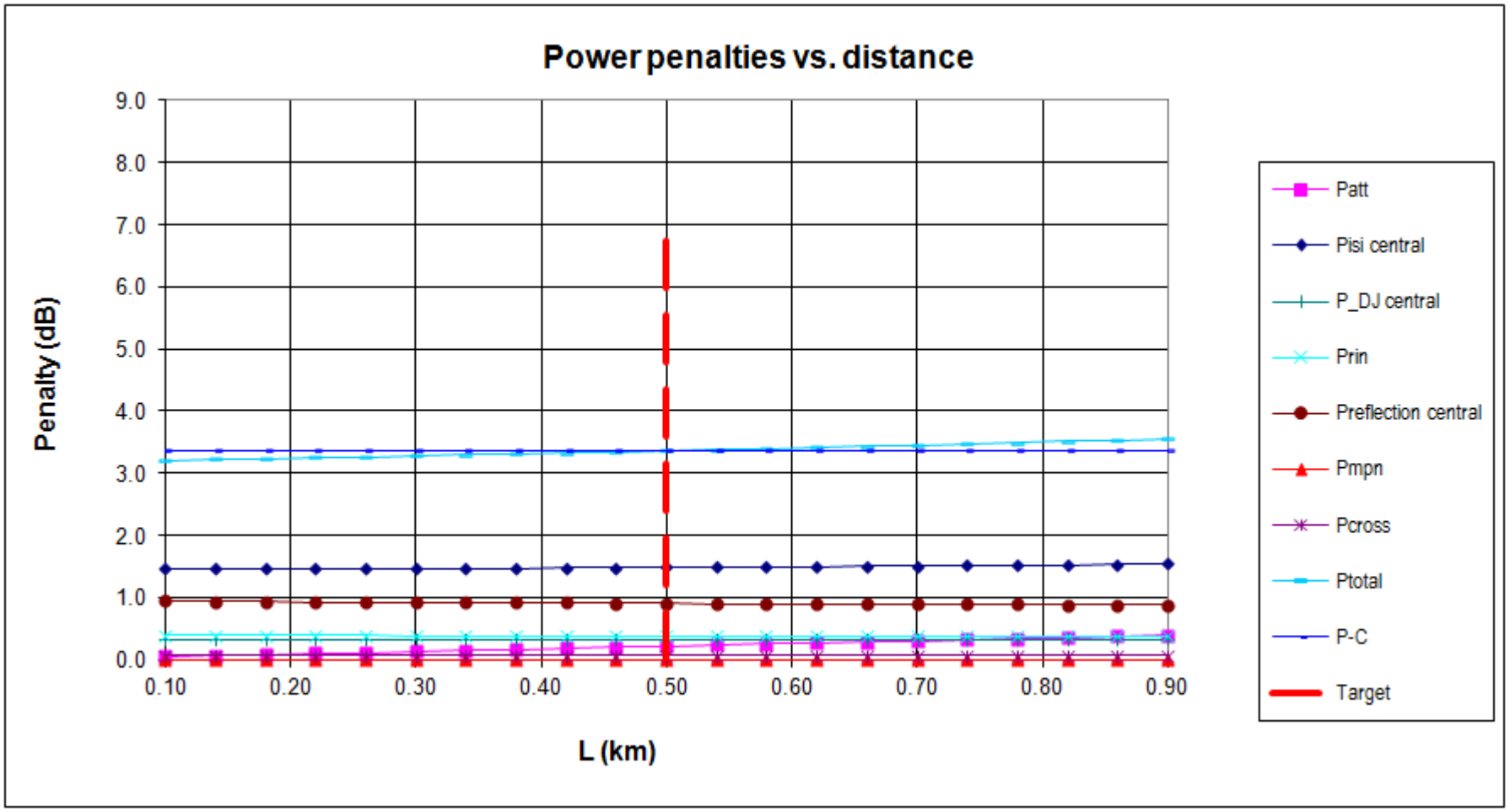
100G PSM4 with KR4 FEC: Link Model Jitter Attributes (each lane)

Parameter	Unit	10G LR	100G LR4	100G PSM4	
Signal rate	GBd	10.3125	25.78125		
Q (BER)		7.034 (E-12)		3.8905 (5E-5)	KR4 FEC corrects PSM4 BER to ≤ E-12
TP1 RJrms tolerance, min	UI	0.0036	0.0054	0.0079	
TP1 DJ tolerance, min	UI	0.083	0.087	0.110	
TP3 DCD tolerance, min	UI	0.0619	0.05	0.050	
TP3 DJ tolerance, min	UI	0.083	0.087	0.150	
TP4 J2, max	UI	0.376	0.359	0.419	Model output
TP4 TJ at BER, max	UI	0.900	0.850	0.900	Model output

Attributes and values in the above table are provided in order to populate example link models and are not presented as specification recommendations. Various model outputs are provided as examples.

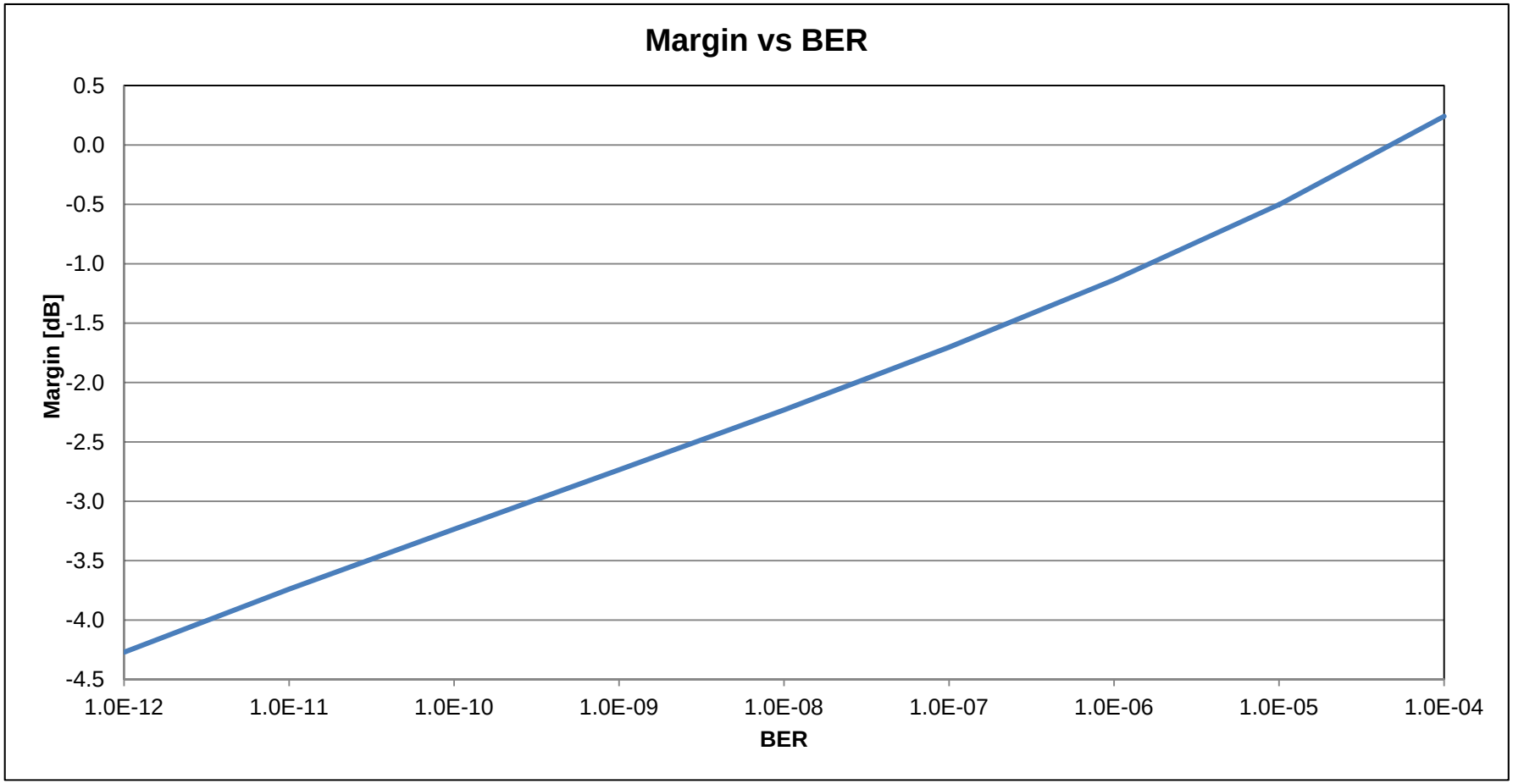
Nomenclature: Terms TP1, TP2, TP3 and TP4 are used as defined in 802.3 clause 88 and shown in above Figure 1. Note that TP1 is downstream of the input CDR and equalizer for an optical transmitter.

100G PSM4 with KR4 FEC: Link Model Penalties (each lane)



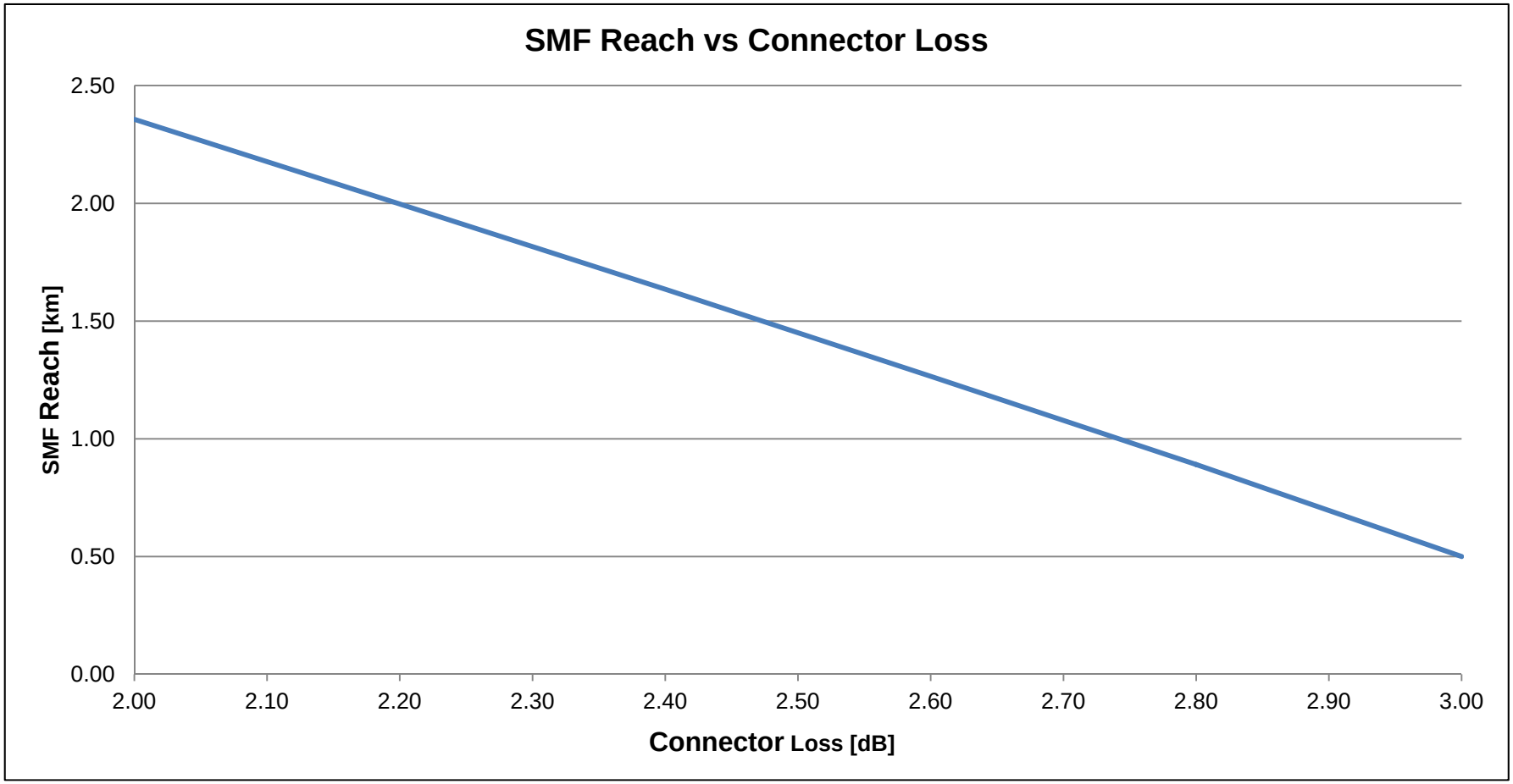
The above chart is taken from the tab Base of the updated Example PSM Link Model. It does not explicity show the power required for the target TP4 eye opening, Peye, but distributes the penalty in other power penalties. For this example, Peye at 500 m equals 0.38 dB.

100G PSM4: Benefit from KR4 FEC



The above chart shows the benefit to an optical link from FEC. Operating at a higher BER not only appears to improve the Rx sensitivity but all the noise related penalties are reduced as is the power required to open the eye to a target width. For 100G PSM4, capturing all the benefit of KR4 FEC enhances the link margin by ~4.3 dB when compared to operating at a BER = 10^{-12} without FEC.

100G PSM4 with KR4 FEC: SMF Reach Tradeoff with Connector Loss



The above chart shows the tradeoff available between SMF reach and connector loss.