

# 40GBASE-ER4 PMD Specification Baseline - Working View

Jon Anderson, Oclaro

Eddie Tsumura, Sumitomo Electric Industries

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# Introduction

- This contribution provides an updated view of a small group of interested parties working on 40GBASE-ER4 PMD specifications.
- This update takes into consideration parameter specifications proposed in anslow\_01\_0812 presented at the 21 August 2012 SMF Ad Hoc meeting. In particular, values for the following parameters are proposed:
  - OMA, each lane (max)
  - ER (min)
  - Difference in launch power between any two lanes (OMA ) (max)
  - Channel insertion loss (min)
- Also, consideration is given to the 19dB channel loss proposal made in anslow\_01\_0812 for the 40km engineered link. It is proposed the 19dB channel loss link budget be specified as an additional option for the 40km engineered link, along with the 18dB channel loss link budget option.
- The 19dB channel loss link budget is proposed to be closed by increased receiver sensitivity only.

# Table 87-6: 40GBASE-LR4 and 40GBASE-ER4 operating ranges

<b>PMD Type</b>	<b>Required operating range</b>
40GBASE-LR4	2 m to 10 km
40GBASE-ER4	2 m to 30 km
	2 m to 40 km <sup>a</sup>

<sup>a</sup> Links longer than 30 km for the same link power budget are considered engineered links. Attenuation for such links needs to be less than the worst case specified for B1.1, B1.3, or B6\_A single-mode fiber.

Table 87-9: 40GBASE-LR4 and 40GBASE-ER4  
illustrative link power budgets

Parameter	40GBASE-LR4	40GBASE-ER4 18dB link budget		40GBASE-ER4 19dB link budget		Unit
Power budget (for max TDP)	9.3	20.6		21.6		dB
Operating distance <sup>a</sup>	10	30	40	30	40	km
Channel insertion loss	6.7 <sup>b</sup>	16.5 <sup>b</sup>	18.0 <sup>c</sup>	16.5 <sup>b</sup>	19 <sup>d</sup>	dB
Maximum discrete reflectance	-26	-26				dB
Allocation for penalties <sup>e</sup> (for max TDP)	2.6	2.6				dB
Additional insertion loss allowed	0	1.5	0	2.5	0	dB

<sup>a</sup> Links longer than 30km are considered engineered links. Attenuation for such links needs to be less than the worst case for B1.1, B1.3 or B6\_a single-mode cabled optical fiber.

<sup>b</sup>The channel insertion loss is calculated using the maximum distance specified in Table 87-6 and cabled optical fiber attenuation of 0.47 dB/km at 1264.5 nm plus an allocation for connection and splice loss given in 87.11.2.1.

<sup>c</sup>The channel insertion loss is calculated using the maximum distance specified in Table 87-6 and cabled optical fiber attenuation of 0.40 dB/km at 1264.5 nm plus an allocation for connection and splice loss given in 87.11.2.1.

<sup>d</sup> The channel insertion loss is calculated using the maximum distance specified in Table 87-6 and cabled optical fiber attenuation of 0.425 dB/km at 1264.5 nm plus an allocation for connection and splice loss given in 87.11.2.1.

<sup>e</sup>Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

Table 87-7: 40GBASE-LR4 [and 40GBASE-ER4](#) transmit characteristics

Description	40GBASE-LR4	40GBASE-ER4	Unit
Signaling rate, each lane (range)	10.3125 ± 100 ppm		GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5		nm
Side-mode suppression ratio (SMSR), (min)	30		dB
Total average launch power (max)	8.3	10.5	dBm
Average launch power, each lane (max)	2.3	4.5	dBm
Average launch power, each lane <sup>a</sup> (min)	-7	-2.7	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3.5	5.0	dBm
Optical Modulation Amplitude (OMA), each lane (min) <sup>b</sup>	-4	0.3	dBm
Difference in launch power between any two lanes (OMA) (max)	6.5	4.7	dB
Launch power in OMA minus TDP, each lane (min)	-4.8	-0.5	dBm
Transmitter and dispersion penalty (TDP), each lane (max)	2.6		dB
Average launch power of OFF transmitter, each lane (max)	-30		dBm
Extinction ratio (min)	3.5	5.5	dB

Table 87-7: 40GBASE-LR4 and 40GBASE-ER4 transmit characteristics (cont.)

Description	40GBASE-LR4	40GBASE-ER4	Unit
RIN <sub>20</sub> OMA (max)	-128		dB/Hz
Optical return loss tolerance (max)	20		dB
Transmitter reflectance <sup>c</sup> (max)	-12		dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		

<sup>a</sup> Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

<sup>b</sup> Even if the TDP < 0.8dB, the OMA (min) must exceed this value.

<sup>c</sup> Transmitter reflectance is defined looking into the transmitter.

# Table 87-8: 40GBASE-LR4 and 40GBASE-ER4 receive characteristics

Description	40GBASE-LR4	40GBASE-ER4 18dB link	40GBASE-ER4 19dB link	Unit
Signaling rate, each lane (range)	10.3125 ± 100 ppm			GBd
Lane wavelengths (range)	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5			nm
Damage threshold <sup>a</sup> (min)	3.3	3.8		dBm
Average receive power, each lane (max)	2.3	-1.5		dBm
Average receive power, each lane <sup>b</sup> (min)	-13.7	-20.7	-21.7	dBm
Receive power, each lane (OMA) (max)	3.5	-1.0		dBm
Difference in receive power between any two lanes (OMA) (max)	7.5	7.0		dB
Receiver reflectance (max)	-26			dB
Receiver sensitivity (OMA), each lane <sup>c</sup> (max)	-11.5	-18.5	-19.5	dBm
Receiver 3 db electrical upper cutoff frequency, each lane (max)	12.3			GHz
Stressed receiver sensitivity (OMA), each lane <sup>d</sup> (max)	-9.6	-16.3	-17.3	dBm
Conditions of stressed receiver sensitivity test:				
Vertical eye closure penalty, <sup>e</sup> each lane	1.9	2.2		dB
Stressed eye J2 Jitter, <sup>e</sup> each lane	0.3			UI
Stressed eye J9 Jitter, <sup>e</sup> each lane	0.47			UI

## Table 87-8: 40GBASE-LR4 and 40GBASE-ER4 receive characteristics (cont.)

- <sup>a</sup> The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.
- <sup>b</sup> Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
- <sup>c</sup> Receiver sensitivity (OMA), each lane (max) is informative.
- <sup>d</sup> Measured with conformance test signal at TP3 (see 87.8.11) for BER =  $10^{-12}$ .
- <sup>e</sup> Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.



# Table 87-14: Fiber optic cabling (channel) characteristics

Parameter	40GBASE-LR4	40GBASE-ER4 18dB link budget		40GBASE-ER4 19dB link budget		Unit
Operating distance (max)	10	30	40	30	40	km
Channel insertion loss <sup>a,b</sup> (max)	6.7	18.0		19.0		dB
Channel insertion loss (min)	0	6				dB
Positive dispersion <sup>b</sup> (max)	33.5	100.5	134	100.5	134	ps/nm
Negative dispersion <sup>b</sup> (min)	-59.5	-178.5	-238	-178.5	-238	ps/nm
DGD_max <sup>c</sup>	10	12				ps
Optical return loss (min)	21	21				dB

<sup>a</sup> These channel insertion loss values include cable, connectors and splices.

<sup>b</sup> Over the wavelength range 1264.5 nm to 1337.5 nm.

<sup>c</sup> Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD\_max is the maximum differential group delay that the system must tolerate.

# Summary

- A working view of a 40GBASE-ER4 PMD specification proposal has been presented.
- Two options are proposed for engineered links with distances greater than 30km:
  - a) 18dB link loss budget
  - b) 19dB link loss budget
- Optical parameter values are proposed for both options.

End of Contribution

Thanks!