

**40GBASE-ER4**  
**proposed revision to receive**  
**power max spec**

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Jonathan King, Finisar

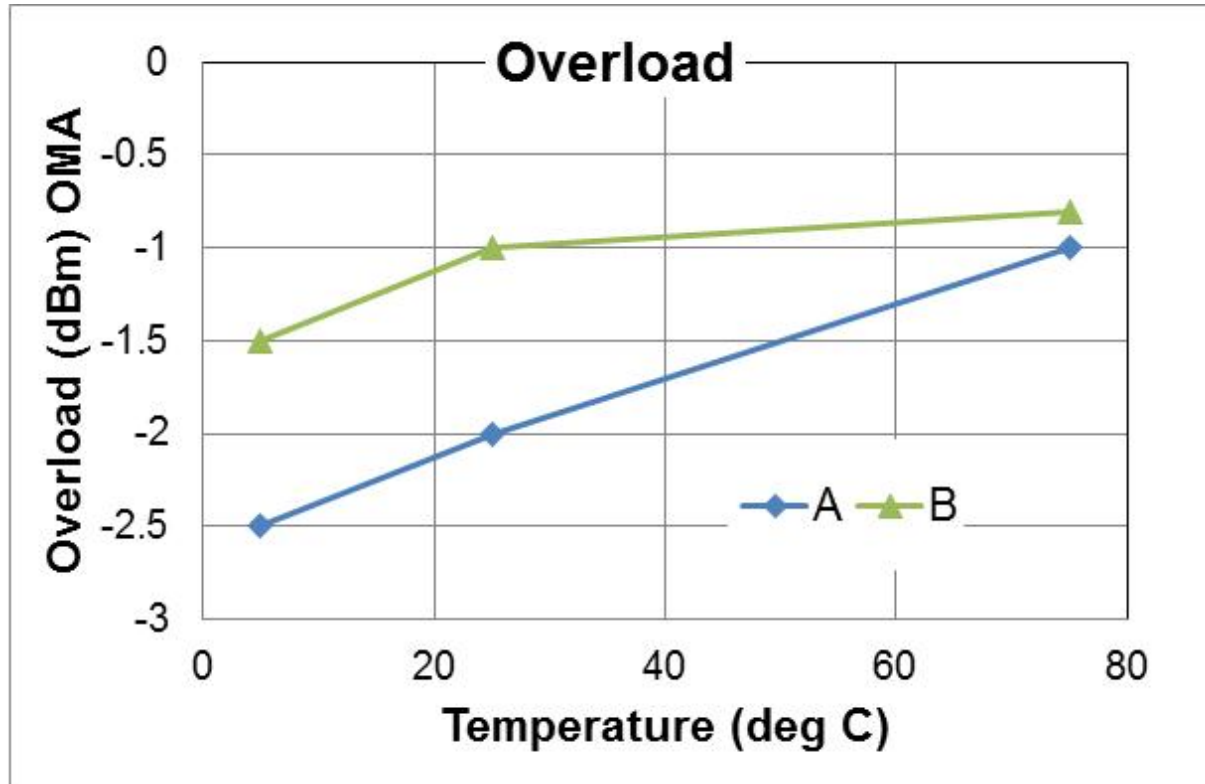
# Current Draft 1p0 for 40GBASE-ER4

- The specified values for max received power are currently -1.5 dBm average and -1 dBm OMA .
  - The rationale: links with insertion loss up to 6.7 dB can be covered by 40GBASE-LR4, links over 6 dB insertion loss can be covered with 40GBASE-ER4. The link loss range slight overlap allows the full range of insertion loss to be covered by using either an –LR4 or –ER4 and without requiring an optical attenuator.
- However, to allow an APD implementation, the max receive power values need to be reduced to accommodate the practical limitations of APD receivers.

# Provisional proposed changes and rationale

- Reduce 40GBASE-ER4 'Receive power, each lane (OMA) (max)' value to -4 dBm (from -1 dBm)
- Reduce 40GBASE-ER4 'Average receive power, each lane (max)' value to -4.5 dBm (from -1.5 dBm)
- Increase 'Channel insertion loss (min)' to 9 dB
- APD overload is determined by several factors; a preliminary breakdown shows -4dBm as a maximum APD receiver input power.
  - Min TIA saturation photocurrent (2 mA)
  - Min losses of mux before APD (0.5 dB)
  - Max responsivity of APD (.8 A/W?)
  - Min working gain of APD (5 linear?)
  - Min margins for temp, life, manufacturing spread (1.5 dB?)
- Confirmed by measurements (next slide)

# Measurements



- Two 10Gb/s APD suppliers, same TIA, overload v. temperature
  - (max 2 mA 'OMA' photo-current input)
- Max input OMA, min APD gain combination, for BER= $10^{-12}$ 
  - Source ER was 5.5 dB (min specified for 40GBASE-ER4 in Clause 87 D1.0)
- Neither APD meets an overload spec of -1 dBm OMA, both meet -4 dBm OMA spec with ~1.5 dB margin

# Proposed changes: Channel insertion loss

Table 87-14—Fiber optic cabling (channel) characteristics for ~~40GBASE-LR4~~

Description	Value <u>40GBASE-LR4</u>	<u>40GBASE-ER4</u>		Unit
		<u>30</u>	<u>40</u>	
Operating distance (max)	10	<u>30</u>	<u>40</u>	km
Channel insertion loss <sup>a, b</sup> (max)	6.7	<u>18.5</u>		dB
Channel insertion loss (min)	0	<u>6</u>	<b>9</b>	dB
Positive dispersion <sup>b</sup> (max)	33.5	<u>100.5</u>	<u>134</u>	ps/nm
Negative dispersion <sup>b</sup> (min)	-59.5	<u>-178.5</u>	<u>-238</u>	ps/nm
DGD_max <sup>c</sup>	10	<u>12</u>		ps
Optical return loss (min)	21	<u>21</u>		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.

Table 87-7—40GBASE-LR4 and 100GBASE-ER4 transmit characteristics

# Transmitter specs

Description	Value		Unit
	40GBASE-LR4	40GBASE-ER4	
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	<u>10.5</u>	dBm
Average launch power, each lane (max)	2.3	<u>4.5</u>	dBm
Average launch power, each lane <sup>a</sup> (min)	-7	<u>-2.7</u>	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3.5	<u>5</u>	dBm
Optical Modulation Amplitude (OMA), each lane (min) <sup>b</sup>	-4	<u>0.3</u>	dBm
Difference in launch power between any two lanes (OMA) (max)	6.5	<u>4.7</u>	dB
Launch power in OMA minus TDP, each lane (min)	-4.8	<u>-0.5</u>	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	<u>5.5</u>	dB
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 < 0.8 dB, the OMA (min) must exceed this value.

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

# Proposed changes to Receiver specs

Table 87–8—40GBASE-LR4 and 100GBASE-ER4 receive characteristics

Description	Value	40GBASE-ER4	Unit
	40GBASE-LR4		
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	<u>3.8</u>	dBm
Average receive power, each lane (max)	2.3	<u>-1.5</u> <b>-4.5</b>	dBm
Average receive power, each lane <sup>b</sup> (min)	-13.7	<u>-21.2</u>	dBm
Receive power, each lane (OMA) (max)	3.5	<u>-1</u> <b>-4</b>	dBm
Difference in receive power between any two lanes (OMA) (max)	7.5	<u>7</u>	dB
Receiver reflectance (max)	-26		dB
Receiver sensitivity (OMA), each lane <sup>c</sup> (max)	-11.5	<u>-19</u>	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	<u>-16.8</u>	dBm
Conditions of stressed receiver sensitivity test:			
Vertical eye closure penalty, <sup>e</sup> each lane	1.9	<u>2.2</u>	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

<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<sup>-12</sup>.

<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.

Thanks !