

# 400GBASE-LR4 Baseline Proposal

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# Supporters

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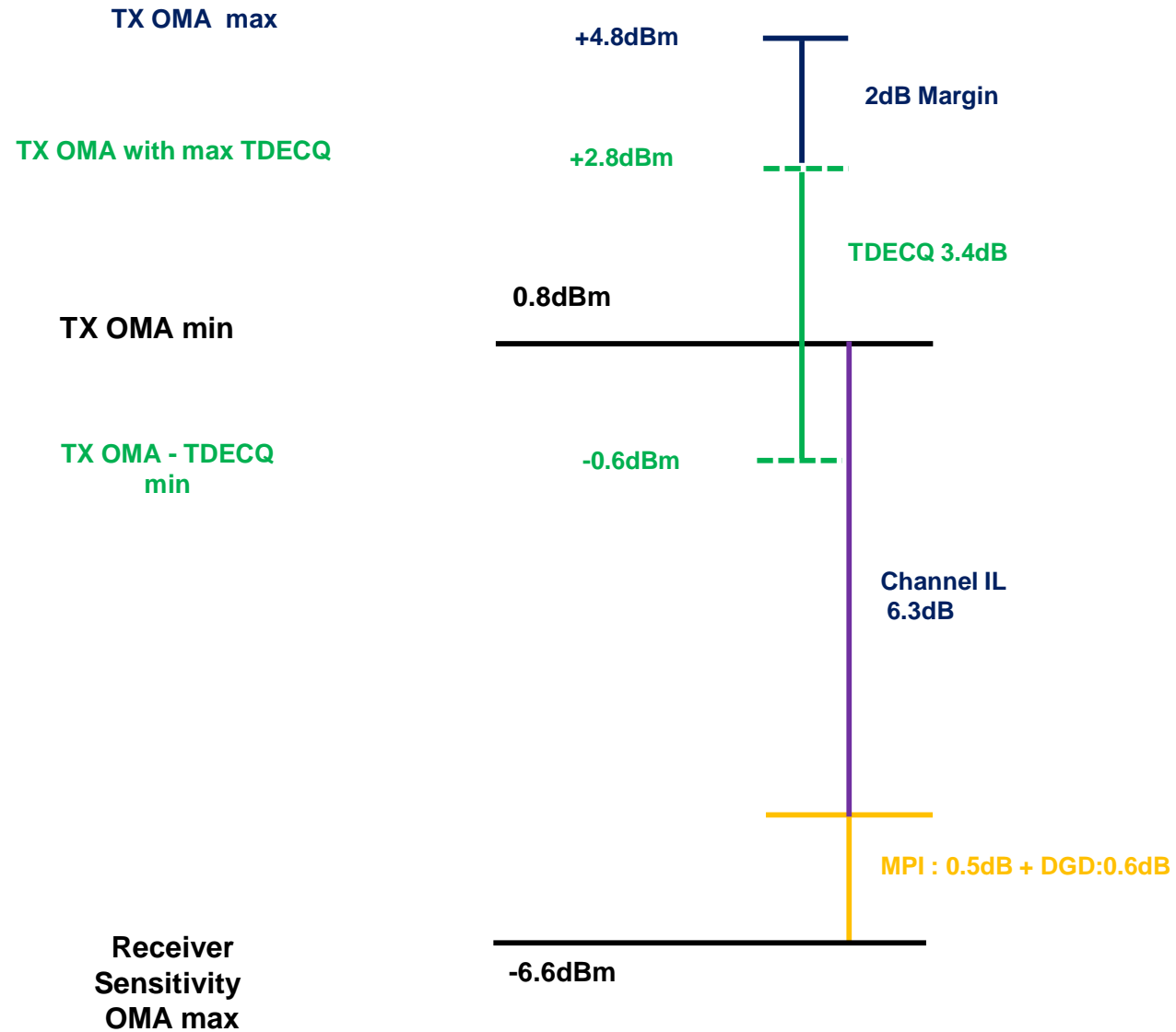
- Ralf-Peter Braun, Deutsche Telekom
- Shikui Shen, China Unicom
- Mark Kimber, Semtech
- Jim Theodoras, HGGenuine
- Mizuki Shirao, Mitsubishi Electric
- Keisuke Kojima, Mitsubishi Electric Research Lab
- Weiqiang Cheng, China Mobile
- Ruibo Han, China Mobile
- Steve Trowbridge, Nokia
- Wenyu Zhao, CAICT

# Introduction

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- We fully understand the desire of a 20 nm spaced CWDM grid as noted on slide 3 of [http://www.ieee802.org/3/cu/public/cu\\_adhoc/cu\\_archive/stassar\\_cu\\_adhoc\\_041719.pdf](http://www.ieee802.org/3/cu/public/cu_adhoc/cu_archive/stassar_cu_adhoc_041719.pdf) because of the anticipated lowest device cost.
- Currently we are not convinced that the shown results of CWDM devices are sufficient to support stable and “plug-and-play” capable BER performance.
- Therefore this presentation includes a proposal for a baseline specification on the basis of an 800 GHz DWDM grid (also known as LAN-WDM or LWDM).

# Specification Highlights



# Transmitter Specifications

Description	Value	Unit
PAM4 Signaling rate, each lane (range)	53.125 ± 100 ppm	GBd
Lane wavelengths (range)	1294.53 to 1296.59	nm
	1299.02 to 1301.09	
	1303.54 to 1305.63	
	1308.09 to 1310.19	
Side-mode suppression ratio (SMSR), (min)	30	dB
Total average launch power (max)	10	dBm
Average launch power, each lane (max)	4	dBm
Average launch power, each lane <sup>a</sup> (min)	-2.2	dBm
Outer Optical Modulation Amplitude (OMA <sub>outer</sub> ), each lane (max)	4.8	dBm
Outer Optical Modulation Amplitude (OMA <sub>outer</sub> ), each lane <sup>b</sup> (min)	0.8	dBm
Difference in launch power between any two lanes (OMA <sub>outer</sub> ) max	4	dB
Launch power in OMA <sub>outer</sub> minus TDECQ, each lane (min): for extinction ratio ≥ 4.5 dB for extinction ratio ≥ 4.5 dB	-0.6 -0.5	dBm
Transmitter and dispersion penalty eye closure for PAM4 (TDECQ), each lane (max)	3.4	dB
TDECQ – 10*log <sub>10</sub> (C <sub>eq</sub> ), each lane (max) <sup>d</sup>	3.4	dB
Average launch power of OFF transmitter, each lane (max)	-20	dBm
Extinction ratio (min)	3.5	dB
Transmitter transition time (max)	17	ps
RIN <sub>15,6</sub> OMA (max)	-136	dB/Hz
Optical return loss tolerance (max)	15.6	dB
Transmitter reflectance <sup>c</sup> (max)	-26	dB

# Transmitter Compliance channel (for TDECQ test)

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Type	Dispersion (ps/nm)		Insertion Loss	Optical Return Loss	Max Mean DGD
	Minimum	Maximum			
400GBASE-LR4	$0.2325 \cdot \lambda \cdot [1 - (1324/\lambda)^4]$	$0.2325 \cdot \lambda \cdot [1 - (1300/\lambda)^4]$	Minimum	15.6 dB	0.8 ps

# Fiber optic cabling (channel) characteristics

Description	Value	Unit
Operating distance (max)	10	km
Channel insertion loss <sup>a,b</sup> (max)	6.3	dB
Channel insertion loss (min)	0	dB
Positive dispersion <sup>b</sup> (max)	9.5	ps/nm
Negative dispersion <sup>b</sup> (min)	-28.4	ps/nm
DGD_max <sup>c</sup>	8	ps
Optical Return Loss (min)	22	dB
a These channel loss values include cable, connectors and splices		
b Over the wavelength range 1294.53 to 1310.19 nm.		
c 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.		

# Optical fiber and cable characteristics

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Description	Value	Unit
Nominal fiber specification wavelength	1310	nm
Cable optical fiber attenuation (max)	0.47 <sup>a</sup> or 0.5 <sup>b</sup>	dB/km
Zero dispersion wavelength ( $\lambda_0$ )	$1300 \leq \lambda_0 \leq 1324$	nm
Dispersion slope (max) ( $S_0$ )	0.093	ps/nm <sup>2</sup> km
<sup>a</sup> The 0.47dB/km attenuation for optical fiber cables is derived from Appendix I of ITU-T G.695. <sup>b</sup> The 0.5dB/km attenuation is provided for Outside Plant cables as defined in ANSI/TIA 568-C.3.		



# Receiver Specifications

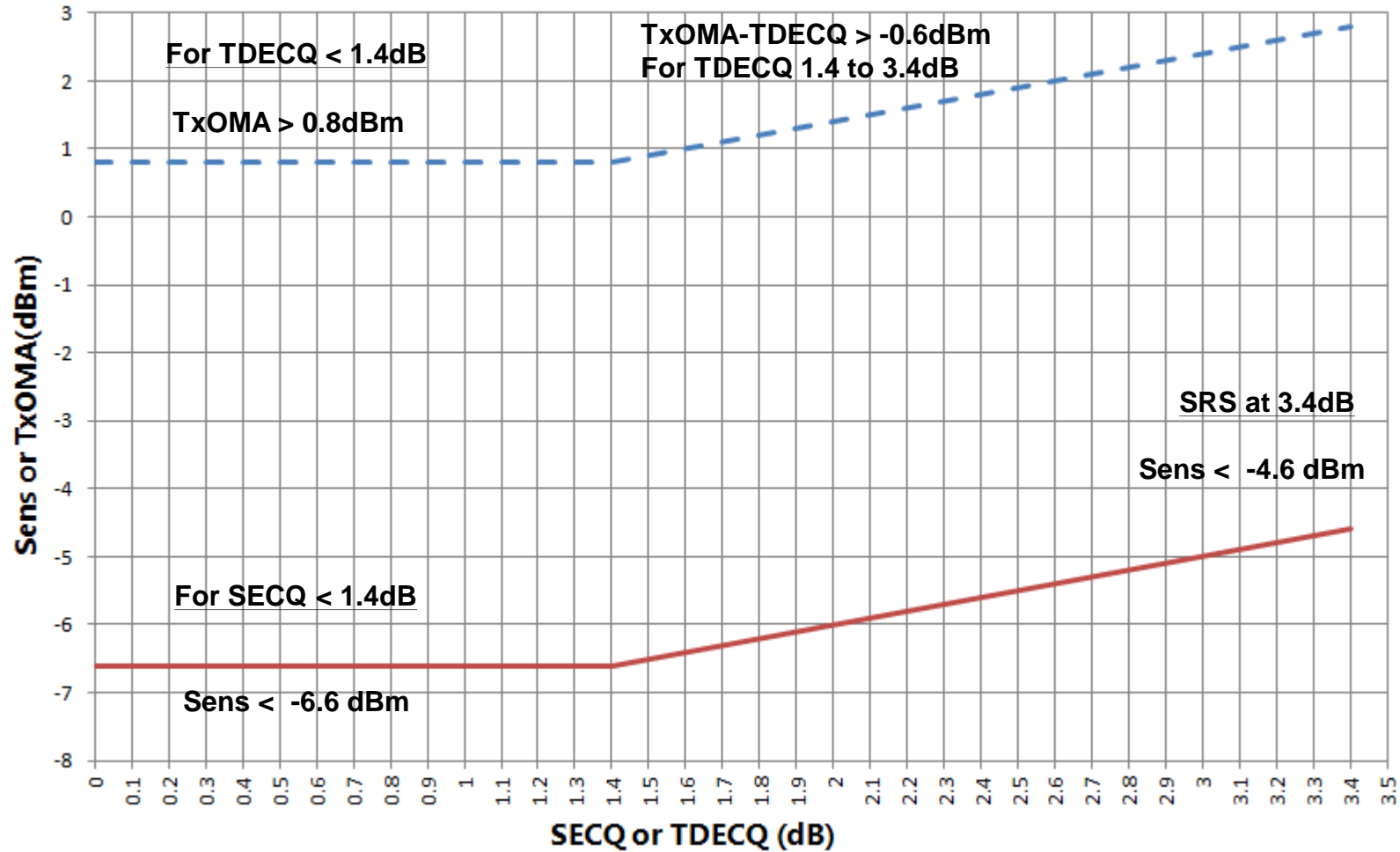
Description	Value	Unit
PAM4 Signaling rate, each lane (range)	53.125 ± 100 ppm	GBd
Lane wavelengths (range)	1294.53 to 1296.59	nm
	1299.02 to 1301.09	
	1303.54 to 1305.63	
	1308.09 to 1310.19	
Damage threshold, each lane (min) <sup>a</sup>	5.0	dBm
Average receive power, each lane (max)	4.0	dBm
Average receive power, each lane <sup>b</sup> (min)	-8.5	dBm
Receive power, each lane (OMA <sub>outer</sub> ) (max)	4.8	dBm
Difference in receive power between any two lanes (OMA <sub>outer</sub> ) (max)	4.1	dB
Receiver reflectance (max)	-26	dB
Receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>c</sup> (max)	MAX(-6.6,SECQ-8.0)	
Stressed receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>d</sup> (max)	-4.6	dBm
Conditions of stressed receiver sensitivity test:		
Stressed eye closure for PAM4 (SECQ), lane under test	3.4	dB
SECQ – 10*log <sub>10</sub> (C <sub>eq</sub> ), lane under test (max) <sup>e</sup>	3.4	dB
OMA <sub>outer</sub> of each aggressor lane	-0.5	dBm

# Power Budget

Description	Value	Unit
Power budget (for max TDECQ) for extinction ratio $\geq 4.5$ dB for extinction ratio $< 4.5$ dB	10.8 10.9	dB
Operating distance	10.0	km
Channel insertion loss <sup>a</sup>	6.3	dB
Maximum discrete reflectance	See Table Below	dB
Allocation for penalties <sup>b</sup> (for max TDECQ) for extinction ratio $\geq 4.5$ dB for extinction ratio $< 4.5$ dB	4.5 4.6	dB
Additional insertion loss allowed	0	dB
<p><sup>a</sup> The channel insertion loss is calculated using the maximum distance specified in Table 2-2 and cabled optical fiber attenuation of 0.43 dB/km plus an allocation for connection and splice loss given in 5.2.1.</p> <p><sup>b</sup> Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.</p>		

Number of discrete reflectance above -55dB	Maximum value for each discrete reflectance	Unit
1	-22	dB
2	-29	dB
4	-33	dB
6	-35	dB
8	-37	dB
10	-39	dB

# Illustration of receiver sensitivity mask



# Recommendation

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**Adopt the proposed baseline specification for 400GBASE-LR4**

