Proposal for 400GBASE-ZR DWDM Optical Specs Baseline

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Supporters

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Introduction

- This contribution is a follow on from March Vancouver Plenary contributions towards 400GBASE-ZR optical specs baseline

  www.ieee802.org/3/ct/public/19_03/lyubomirsky_3ct_01a_0319.pdf

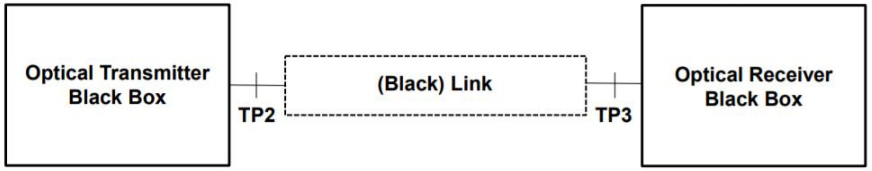
  www.ieee802.org/3/ct/public/19_03/stassar_3ct_01_0319.pdf

- We propose to build consensus using both OIF 400ZR Tx/Rx specs as well as ITU-T black link specification methodologies for baselining 400GBASE-ZR optical specs

Concerns on Previous proposal

From stassar_3ct_01_0319.pdf (slide #6 and #16)

Optical specification methodology principles



- Optical Transmitter is Black Box. Inside not specified. Implementation freedom
- At TP2 transmitter output signal is specified via (measurable) parameters and values
- The (black) link is characterized by its transfer characteristics as TP2 to TP3.
- Only limited link design elements are specified like maximum discrete reflectance.
- The optical signal at TP3 is created via "combining" optical signal at TP2 with link transfer characteristics TP2 to TP3.
- Optical receiver is also Black Box. Inside not specified. Implementation freedom.
- The only Receiver requirement: provide the specified Receiver performance under worst case receiver input optical signal at TP3.
- Example of non appropriate receiver parameter: receiver bandwidth.

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400GBASE-ZR receive characteristics

Parameter Name	Units	OIF Value	Alt Value
Maximum mean input power	dBm	0	
Minimum mean input power [amplified]	dBm	–12	
Minimum mean input power [unamplified]	dBm	–20	TBD
Minimum OSNR(193.6) [amplified]	dB (0.1 nm)	TBD	
Minimum OSNR(193.6) [unamplified]	dB (0.1 nm)	37	
Receiver OSNR tolerance(193.6)	dB (0.1 nm)	26	
Maximum reflectance of receiver	dB	–20	–27

Concern 1: to test receiver at TP3, one would need to incorporate a "black link emulator", which is very challenging, if not impossible, to include as worst case. [E.g. there is no standards for CD and/or PMD emulator for coherent]

Concern 2: the receiver spec table deviates from the current OIF 400ZR Rx specs. It's very unclear how one could test this "minimum OSNR (193.6) [amplified]" spec.

Our Proposal

- We propose to specifically mention the normative and informative parameters in the black link table

- We propose to keep as intact as possible the OIF 400ZR Rx specs (lyubomirsky_3ct_01a_0319.pdf) which captures **measurable** individual impairment tolerance spec [as opposed to the minimum OSNR spec in stassar_3ct_01_0319.pdf]

- We therefore propose the 400GBASE-ZR line system operators comply to the black link table, and the transceiver suppliers comply to the Tx and Rx spec tables.

Black Link Channel Characteristics

Largely adopted from ***stassar_3ct_01_0319*** slide#17, changed into IEEE format.
Recommend the **line items highlighted in black** as normative spec parameters.
Recommend the **line items highlighted in green** as informative spec parameters.

Description	Value	Unit
Channel Spacing	100	GHz
Ripple (max)	TBD	dB
(Residual) chromatic dispersion (max)	2000	ps/nm
(Residual) chromatic dispersion (min)	-200	ps/nm
Optical return loss at TP2 (min)	24	dB
Discrete reflectance between TP2 and TP3 (max)	-27	dB
Differential group delay (max)	33	ps
Polarization dependent loss (max)	2	dB
Polarization rotation speed (max)	50	krad/s
Inter-channel crosstalk at TP3 (max)	TBD	dB
Interferometric crosstalk at TP3 (max)	TBD	dB
Optical path OSNR penalty (max)	4	dB

Rx Optical Specs

Description	Value	Unit
Input Power Range (min)	-12	dBm
Input Power Range (max)	0	dBm
Frequency Offset Tolerance (min)[a]	± 1.8	GHz
OSNR Tolerance (min)[b]	26	dB
CD Tolerance (min) [c]	2000	ps/nm
DGD (max)[d]	33	ps
SOPMD (max)[d]	272	ps^2
Peak PDL Tolerance (min)[e]	3.5	dB
Change in SOP Tolerance (min)[f]	50	rad/ms
Optical Power Transient Tolerance (min)[g]	± 2	dB
Optical return Loss (min)	20	dB
Optical filtering bandwidth tolerance (min)[h]	TBD	GHz

a). Rx must tolerate this amount of Tx frequency offset from the nominal ITU center frequency grid.
b). Minimum value of OSNR (referred to 0.1 nm noise bandwidth @ 193.6 THz) that can be tolerated while maintaining the maximum BER below the CFEC threshold. Must be met for a back-to-back measurement configuration at all input powers defined above.
c). Tolerance to chromatic dispersion with <0.5 dB OSNR penalty
d). Tolerance to max DGD and max SOPMD [according to 10ps mean PMD] with < 0.5 dB OSNR penalty and change in SOP < 1 rad/ms.
e). Peak PDL includes both transmitter polarization imbalance and black link PDL. Tolerance to peak PDL with < 1.3 dB OSNR penalty. Tested with noise injected after PDL emulator and PSP < 1 rad/ms.
f). Tolerance to change in SOP with < 0.5 dB OSNR penalty.
g). Tolerance to change in input power with < 0.5 dB OSNR penalty.
h). Tolerance to link bandwidth narrowing effect together with TX spectral excursion with <0.5dB OSNR penalty; bandwidth in GHz defined with double side band in regards to the ITU grid.

Tx Optical Specs I

Description	Value	Unit
Signaling rate, (range) per polarization	59.84375 +/-20ppm	GBd
Modulation Format	DP-16QAM	
Start Channel Frequency	191.3	THz
Stop Channel frequency	196.1	THz
Laser frequency accuracy	± 1.8	GHz
Laser line-width (max)[a]	500	kHz
Laser relative intensity noise (ave)[b]	-145	dB/Hz
Laser relative intensity noise (peak)[c]	-140	dB/Hz
Optical Output Power (max)	-6	dBm
Optical Output Power (min)	-10	dBm
Transmitter reflectance (min)[d]	TBD	dB
Transmitter back reflection tolerance (min)[e]	TBD	dB

a). Full Width Half Maximum (FWHM) high frequency component of the Tx laser phase noise.
b). Average over 0.2GHz < f < 10GHz.
c). Peak over 0.2GHz < f < 10GHz.
d). Optical power ratio of the reflected light of Tx output port back to fiber network vs. the external incident light into the Tx output port.
e). Maximum light power (relative in decibel w.r.t. Tx output) reflected back to transmitter while still meeting performance requirements.

Tx Optical Specs II

Description	Value	Unit
Transmitter polarization power imbalance	1.5	dB
In-band OSNR (min) per 0.1 nm[a]	37	dB
Out-of-band OSNR (min) per 0.1 nm[b]	23	dB
Total output power with transmitter disabled (min)	-20	dBm
Total output power during channel change (min)	-20	dBm
X-Y polarization skew	5	ps
I-Q DC offset[c]	-26	dB
Error Vector Magnitude (max)[d]	TBD	%
Spectral excursion (max)	TBD	GHz

a). Signal power over noise power in-band, measured with 12.5 GHz noise bandwidth.
b). Signal power over peak noise power in the whole frequency range, measured with 12.5 GHz noise bandwidth.
c). Ratio of unmodulated power to total signal power.
d). Currently the EVM spec is not in the normative spec yet in OIF 400ZR.

Next Steps

- Incorporate feedback from .3ct Task Force participants toward reaching a consensus on 400GBASE-ZR optical specs baseline proposal