Update to stassar_3ct_01a_201116.pdf, Related to comments # i-42 and # i-65

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Introduction

This presentation contains **UPDATED** considerations on and proposals for responses to comments to D3.0 in https://www.ieee802.org/3/ct/public/20_11/stassar_3ct_01a_201116.pdf on the topics:

- 193.6 in the parameter name OSNR(193.6)
  - (Improved) Definition of OSNR
- Black link specification methodology:
  - (Re)Definition of receiver performance
  - (Re)Definition of black link

Background of OSNR(193.6) parameter name

- Traditionally OSNR is defined over a measurement bandwidth of 0.1 nm.
- Commercially available optical spectrum analyzers are set up to perform the testing over such a bandwidth.
- However setting a fixed value for OSNR over all relevant optical frequencies, while maintaining the measurement bandwidth of 0.1 nm, results in a more stringent OSNR requirement for higher optical frequencies because 0.1 nm becomes narrower in frequency terms towards the highest wavelengths or lowest frequencies.
- This would not be desirable. Over the C-band the total variation is 0.21 dB, but over the combination of C-band and L-band it is 0.46 dB, which is too much to be ignored, especially in demanding applications (e.g. 400GBASE-ZR).

Background of OSNR(193.6) parameter name - continued

- This issue was identified in a Huawei contribution to the ITU-T SG15/Q6 plenary meeting in October 2018. Q6 decided to couple the OSNR specification in G.698.2 to a “calibration” frequency of 193.6 THz, effectively defining OSNR for a measurement bandwidth of 12.5 GHz instead of 0.1 nm. G.698.2 contains the following:

> For 100 Gbit/s applications, specified in Tables 8-7 and 8-8, the minimum optical signal-to-noise ratio OSNR(*f*) is specified as a function of channel frequency *f* and referred to its value at 193.6 THz, OSNR(193.6), according to the following relationship:
>
> $$OSNR(f) = OSNR(193.6) - 20\log_{10}(f\ /\ 193.6) \qquad \text{(dB)}$$
>
> where:
>
> *f*: is the channel central frequency in THz.
>
> *OSNR*(*f*): is the minimum optical signal-to-noise ratio of the channel with channel central frequency *f* in dB (0.1 nm).
>
> *OSNR*(193.6): is the minimum optical signal-to-noise ratio referred to 193.6 THz in dB (0.1 nm).

- A side effect of maintaining a measurement bandwidth of 0.1 nm would have been an optical frequency dependency of EVM, which is also not desirable.

Proposal for OSNR specification

- Remove “193.6” from parameter name.
- Replace measurement bandwidth of 0.1 nm by 12.5 GHz, thus replace unit for OSNR “dB (0.1 nm)” by “dB (12.5 GHz)”.
- Then we have created a specification for OSNR that is “flat” over the applicable frequency / wavelength ranges.
- Because clause 154 is the first clause in the 802.3 standard that specifies OSNR there is no compatibility issue with existing clauses.

Amplified versus unamplified black links

- The current version of Clause 154 has been written for black links that may contain optical amplifiers, while also allowing operation over unamplified black links.
- Concerns have been raised, and comments submitted, that the current optical specifications could imply two PMDs instead of one.
- The draft will need to be modified in such a way that it is clear that it is one PMD only.
- In that way both amplified and unamplified applications can be supported as requested in the CSD.

Proposals

- The following slides contain (hopefully) complete proposals for modification of Clause 154:
  - Removing “amplified” and “unamplified” from parameter names.
  - Removing 193.6 from OSNR related parameter names.
  - Introduction of coupling of OSNR and link output/Rx input power levels.
  - Introduction of “Optical path penalty” for OSNR ≥ 35 dB
  - Introduction of new Figure from slide 10 of https://www.ieee802.org/3/ct/public/19_07/stassar_3ct_02_0719.pdf, without the labelling of “amplified” and “unamplified”.

Proposal for revised Table 154-8, Tx

Description	Value	Unit
Signaling rate (range)	27.9525 ± 20 ppm	GBd
Modulation format	DP-DQPSK	—
Minimum channel spacing	100	GHz
Average channel output power (max)	0	dBm
Average channel output power (min)	–8	dBm
Nominal center frequency	The frequency in Table 154–6 where the channel index number equals the variable Tx_optical_channel_index	THz
Spectral excursion (max)	±15	GHz
Side-mode suppression ratio (SMSR), (min)	30	dB
Laser linewidth (max)	1000	kHz
Offset between the carrier and the nominal center frequency (max)	1.8	GHz
Power difference between X-Y polarizations (max)	1.5	dB
Skew between X-Y polarizations (max)	10	ps
Error vector magnitude (max)	23	%
I-Q offset (max)	–25	dB
Transmitter in-band OSNR~~(193.6)~~ (min)	35	dB (12.5 GHz)
Average launch power of OFF transmitter (max)	–35	dBm
Transmitter reflectance[a] (max)	–20	dB

[a]Transmitter reflectance is defined looking into the transmitter.

Proposals for revised Table 154-8, Tx

Nominal center frequency	The frequency in Table 154–6 where the channel index number equals the variable Tx_optical_channel_index	THz

Transmitter in-band OSNR~~(193.6)~~ (min)	35	dB (12.5 GHz)

Proposal for revised Table 154-9, Rx

Description	Value	Unit
Signaling rate (range)	27.9525 ± 20 ppm	GBd
Modulation format	DP-DQPSK	—
Nominal center frequency	The frequency in Table 154–6 where the channel index number equals the variable Rx_optical_channel_index	THz
Damage threshold[a]	3	dBm
Average receive power (max)	0	dBm
Average receive power ~~[unamplified]~~[b] (min)	–30	dBm
Receiver OSNR~~(193.6) [amplified]~~ (min): For average receive power < –16 dBm For average receive power ≥ –16 dBm	 35 19.5	 dB (12.5 GHz) dB (12.5 GHz)
~~Receiver OSNR(193.6) [unamplified][b] (min)~~	~~35~~	~~dB (0.1 nm)~~
Receiver OSNR tolerance~~(193.6)~~	16.5	dB (12.5 GHz)
Receiver reflectance (max)	–20	dB

[a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level. The receiver does not have to operate correctly at this input power.

~~[b]This parameter is not necessary to support amplified DWDM links up to at least 80 km of single-mode fiber, but has been added to allow operation on unamplified links.~~

UPDATE, new proposal for separate new clause on black link

- The editorial team has become aware of concerns that requirements for a black link, now contained in subclause 154.7.3, does not fit with the heading of subclause 154.7 "*PMD to MDI optical specifications for 100GBASE-ZR*"
- There are 2 solutions to this issue:
  - Change the heading of 154.7
  - Put the requirements for the black link in a separate, new subclause 154.8
- Creating a separate new subclause is the cleanest solution, whereby consistency with existing, in-force PMD to MDI optical specifications for 100GBASE-ZR is maintained
- This approach is being proposed to be included in resolution to comment # i-42, with editorial license to create text around a modified Table 154-10

UPDATED Proposal for revised Table 154-10, black link

Description	Value	Unit
Channel spacing (min)	GHz	100
Ripple (max)	2.5	dB
Average output power at TP3 (max)	0	dBm
Average output power at TP3 (min): for OSNR at TP3 < 35 dB (12.5 GHz) for OSNR at TP3 ≥ 35 dB (12.5 GHz)	 –16 –29	 dBm dBm
OSNR at TP3 (min)	19.5	dB (12.5 GHz)
Optical path OSNR penalty (max), for OSNR at TP3 < 35 dB (12.5 GHz)	3	dB
Optical path penalty (max), for OSNR at TP3 ≥ 35 dB (12.5 GHz)	1	dB
Chromatic dispersion (max)	2000	ps/nm
Chromatic dispersion (min)	0	ps/nm
Fiber chromatic dispersion slope at channel center frequencies[a] (min)	0.05	ps/nm^2 km
Optical return loss at TP2 (min)	25	dB
Differential group delay, DGD[b] (max)	20	ps
Polarization dependent loss (max)	1.5	dB
Polarization rotation speed (max)	50	krad/s
Inter-channel crosstalk at TP3 (max)	–16	dB
Interferometric crosstalk at TP3 (max)	–25	dB

[a]The applicable channel center frequencies are specified in Table 154–6.
[b]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.

Change -29 dBm to -27 dBm

Change 1 dB to 3 dB

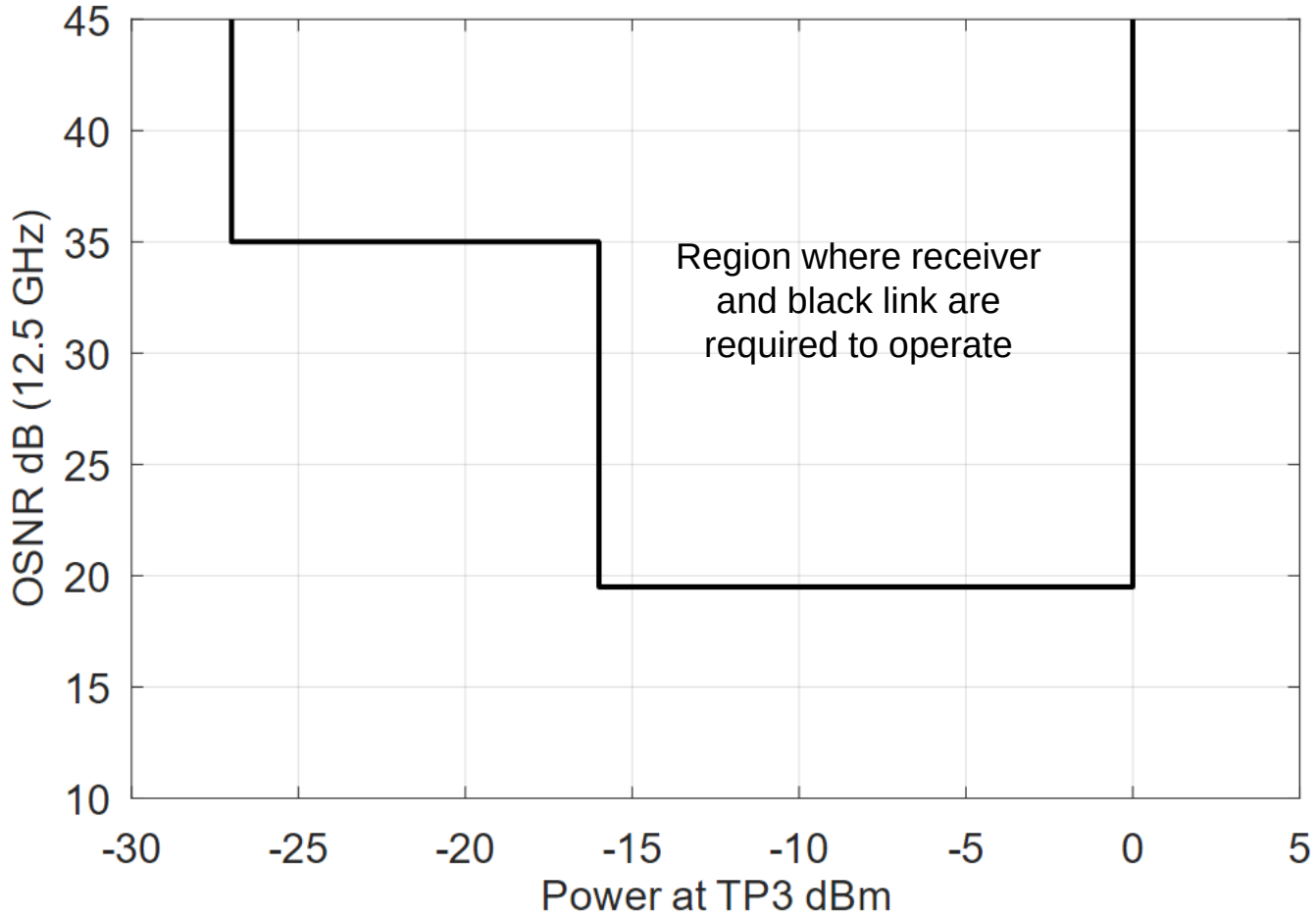
UPDATED Proposals for revised Table 154-10, black link

Average output power at TP3 (max)	0	dBm
Average output power at TP3 (min): for OSNR at TP3 < 35 dB (12.5 GHz) for OSNR at TP3 ≥ 35 dB (12.5 GHz)	 –16 **-27**	 dBm dBm
OSNR at TP3 (min)	19.5	dB (12.5 GHz)
Optical path OSNR penalty (max), for OSNR at TP3 < 35 dB (12.5 GHz)	3	dB
Optical path penalty (max), for OSNR at TP3 ≥ 35 dB (12.5 GHz)	**3**	dB

Remarks have been made that an optical penalty of 3 dB for OSNR ≥ 35 dB (12.5 GHz) is a better starting value than 1 dB, proposed in https://www.ieee802.org/3/ct/public/20_11/stassar_3ct_01a_201116.pdf

Further proposals, UPDATED

Add the following figure with associated text (with editorial license) to new inserted subclause 154.8 with 100GBASE-ZR black link specifications



UPDATED proposal for revised Table 154-9, Rx

Description	Value	Unit
Signaling rate (range)	27.9525 ± 20 ppm	GBd
Modulation format	DP-DQPSK	—
Nominal center frequency	The frequency in Table 154–6 where the channel index number equals the variable Rx_optical_channel_index	THz
Damage threshold[a]	3	dBm
Average receive power (max)	0	dBm
Average receive power ~~[unamplified]~~[b] (min)	**-27**	dBm
Receiver OSNR~~(193.6) [amplified]~~ (min): For average receive power < –16 dBm For average receive power ≥ –16 dBm	 35 19.5	 dB (12.5 GHz) dB (12.5 GHz)
~~Receiver OSNR(193.6) [unamplified][b] (min)~~	~~35~~	~~dB (0.1 nm)~~
Receiver OSNR tolerance~~(193.6)~~	16.5	dB (12.5 GHz)
Receiver reflectance (max)	–20	dB

[a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level. The receiver does not have to operate correctly at this input power.

[b]~~This parameter is not necessary to support amplified DWDM links up to at least 80 km of single-mode fiber, but has been added to allow operation on unamplified links.~~

Introduce extra row with new parameter "Receiver sensitivity (max)", value -30dBm and note: "Receiver sensitivity (max) for OSNR >= 35 dB (12.5 GHZ) is informative."

Further proposals

- Add new informative annex with title “Examples of black links compliant to Table 154-10”.

- With editorial license.

Thanks!