

# Transmitter Spectral Mask and DWDM Black Link Spectral Specification Proposal

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# Summary

An approach to define a methodology for specifying crosstalk in DWDM systems has been developed.

This approach provides a means of defining the required parameters to bound adjacent channel crosstalk and filtering penalty.

The issues associated with inter-channel crosstalk definitions are detailed in:

[https://www.ieee802.org/3/cw/public/adhoc/21\\_0201/maniloff\\_3cw\\_01a\\_210201.pdf](https://www.ieee802.org/3/cw/public/adhoc/21_0201/maniloff_3cw_01a_210201.pdf)

The modifications in this proposal are a summary from:

[https://www.ieee802.org/3/cw/public/adhoc/21\\_0312/maniloff\\_3cw\\_01a\\_210312.pdf](https://www.ieee802.org/3/cw/public/adhoc/21_0312/maniloff_3cw_01a_210312.pdf)

# 802.3cw 0.9 draft Tx Spectrum

Table 156–8—400GBASE-ZR transmit characteristics

Description	Value	Unit
Signaling rate (range)	59.84375 +/- 20ppm	GBd
Modulation format	DP-16QAM	—
Minimum channel spacing	75	GHz
Average channel output power (max)	-6	dBm
Average channel output power (min)	-10	dBm
Nominal center frequency	The frequency in Table 156–6 corresponding to the variable TX_optical_channel_index	THz
Spectral excursion (max)	TBD	GHz
Side-mode suppression ratio (SMSR) (min)	TBD	dB
Laser linewidth (max)	500	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)	5	ps
Error vector magnitude (max)	TBD	%
I-Q offset (max)	TBD	dB
Transmitter Inband OSNR(193.6) (min)	34	dB (0.1nm)
Average launch power of OFF transmitter (max)	-20	dBm
Optical return loss tolerance <sup>a</sup> (max)	-24	dBm
Transmitter reflectance <sup>b</sup> (max)	-20	dB

<sup>a</sup>Maximum light power (relative in decibel w.r.t Tx output) reflected back to transmitter while still meeting performance requirements.

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



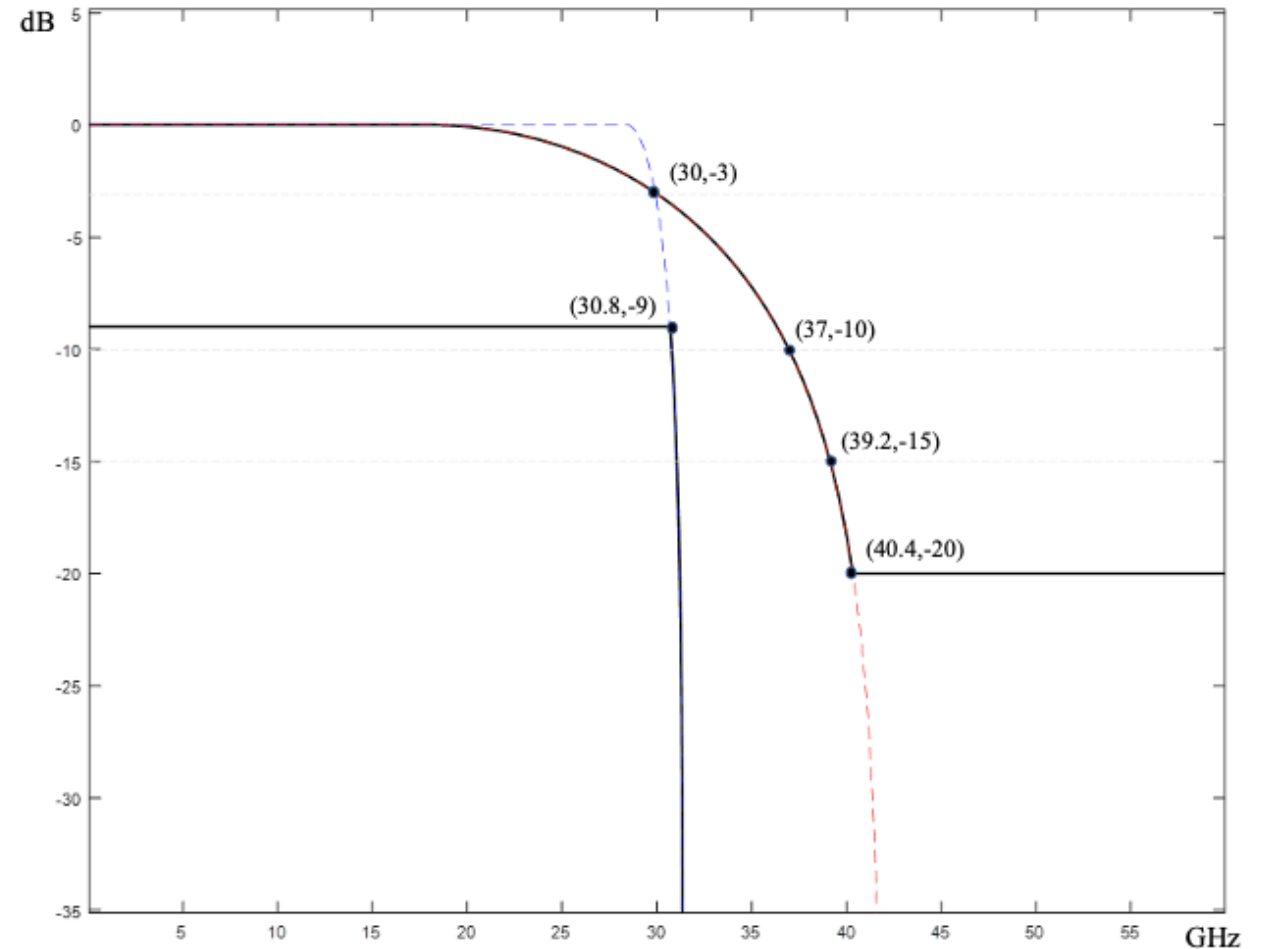
# TX Spectrum

- 802.3 cw will specify:
  - The maximum Tx Spectrum based on an RRC curve
    - Roll-off ( $\beta$ ) = 0.4
    - Floor = -20dB
  - Defined as a continuous spectrum
    - Using discrete points can be discussed in the future
  - The minimum Tx Spectrum based on discrete points on an RRC curve
    - Roll-off ( $\beta$ ) = 0.05
    - Defined for attenuation > 9dB
- This is following the specifications in:  
[https://www.ieee802.org/3/ct/public/20\\_11/way\\_cw\\_01b\\_201116.pdf](https://www.ieee802.org/3/ct/public/20_11/way_cw_01b_201116.pdf)

# Spectral mask Max and Min

The solid curves define the upper and lower limits of the mask.

Dashed lines show RRC with roll-offs 0.4 and 0.05



# Recommendation for Tx Spectrum

- Replace Spectral Excursion (max) (GHz) with:
  - Transmit Spectrum (max): 0.4 RRC Roll-Off
    - For frequencies > 3dB point
  - Transmit Spectrum (min): 0.05 RRC Roll-Off
    - For frequencies > 9dB point
  - Spectral Floor: -20 dB
- Some updates likely needed on definition for the mask, to include averaging of max

Table 156–6—400GBASE-ZR transmit characteristics

# Clause 156 transmit update

Define as continuous spectrum

- Spectral roll-off max defined for frequencies > 3dB point
- Spectral roll-off min defined for frequencies > 9dB point

Description	Value	Unit
Signaling rate (range)	59.84375 +/- 20ppm	GBd
Modulation format	DP-16QAM	—
Minimum channel spacing	75	GHz
Average channel output power (max)	-6	dBm
Average channel output power (min)	-10	dBm
Nominal center frequency	The frequency in Table 156–4 where the channel index number equals the variable Tx_optical_channel_index	THz
<del>Spectral excursion</del>		
Spectral roll-off (max)	0.4	RRC $\beta^a$
Spectral roll-off (min)	0.05	RRC $\beta^a$ <sup>b</sup>
Spectral floor (max)	-20	dB
Side-mode suppression ratio (SMSR) (min)	TBD	dB
Laser linewidth (max)	500	kHz
Offset between the carrier and the nominal center frequency (max)	1.8	GHz
Power difference between X and Y polarizations (max)	1.5	dB
Skew between X and Y polarizations (max)	5	ps
Error vector magnitude (max)	TBD	%
I-Q offset (max)	TBD	dB
Transmitter In-band OSNR (min)	34	dB(12.5 GHz)
Average launch power of OFF transmitter (max)	-20	dBm
Transmitter reflectance <sup>c</sup> (max)	-20	dB

<sup>a</sup>Root raised cosine [equation to be inserted]...

<sup>b</sup>Spectral roll-off min defined for RRC 0.05 for attenuation greater than 9 dB

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

# Channel Passband

Table 156–10—400GBASE-ZR black link characteristics

Description	Value	Unit
Channel spacing (min)	75	GHz
Ripple (max)	TBD	dB
Optical path OSNR penalty (max)	TBD	dB
Chromatic dispersion (max)	2000	ps/nm
Chromatic dispersion (min)	0	ps/nm
Fiber chromatic dispersion slope at channel center frequencies <sup>a</sup> (min)	TBD	ps/nm <sup>2</sup> km





# Specifications for Passband

- Passband width Specified to the center of the channel  $f_0$
- The following parameters for Mux & Demux will be used to derive the DWDM black link:
  - BW min = 70GHz
  - BW max = 76GHz
  - Filter order = 3
  - |Maximum center frequency variation|  $\leq 4$  GHz
  - Insertion loss variation  $\leq 1.5$ dB
  - Adjacent channel floor  $> 30$ dB
- Transmission, T, Normalized by the attenuation at the center channel frequency ( $f_0$ )

Attenuation (dB)	Full Width Min (GHz)	Full Width Max (GHz)
0.5	42	50
3	60	68
20	84	93

# Channel Width Specification

- Replace ripple with Channel Passband Specs
  - Note: Ripple spec will be maintained to bound allowable loss variation within passband
- Specify at 3 points
  - 0.5, 3, 20 dB
  - Define the specs relative to averaged loss across  $\pm 10$  GHz from  $f_0$

# Clause 156 passband update

Table 156–8—400GBASE-ZR DWDM black link characteristics

Description	Value	Unit
Channel spacing (min)	75	GHz
Ripple (max)	TBD	dB
Channel passband at 0.5 dB (max)	50	GHz
Channel passband at 3 dB (max)	68	GHz

Table 156–8—400GBASE-ZR DWDM black link characteristics

Description	Value	Unit
Channel passband at 20 dB (max)	93	GHz
Channel passband at 0.5 dB (min)	42	GHz
Channel passband at 3 dB (min)	60	GHz
Channel passband at 20 dB (min)	84	GHz

# Inter-channel Crosstalk

**Table 156–10—400GBASE-ZR black link characteristics**

Description	Value	Unit
Optical return loss at TP2 (min)	24	dB
Differential group delay, (DGD) <sup>b</sup> (max)	28	ps
Polarization dependent loss (max)	2.0	dB
Polarization rotation speed (max)	50	krad/s
Inter-channel crosstalk at TP3 (max)	TBD	dB
Interferometric crosstalk at TP3 (max)	TBD	dB



# Specification for adjacent channel isolation

- Specification can be defined:
  - The spectral attenuation from an adjacent channel frequency divided by the attenuation at the center frequency of a signal channel will be less than (values to be filled in)

Frequency Offset	Isolation (dB)
0	-TBD
±15	
±20	
±25	
±30	
±35	
±40	
±45	
±50	
±55	
±60	
±65	
±70	
±75	

# Inter-channel Crosstalk specification

- Add adjacent channel isolation
  - Needs DWDM Link clarification to include port indexing
- Specification will be:
  - The spectral attenuation for frequencies at Demux port  $n$ , will be defined for light transmitted into the adjacent channels ( $n \pm 1$ )
  - Attenuation will be defined relative to the attenuation at the center of the measurement channel

# Table 156-8 Update to incorporate adjacent channel isolation

Adjacent channel isolation	See Table 156-9	
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**Table 156-9 Adjacent channel isolation**

Frequency Offset	Isolation	Unit
0 GHz	TBD	dB
+/- 15 GHz	TBD	dB
+/- 20 GHz	TBD	dB
+/- 25 GHz	TBD	dB
+/- 30 GHz	TBD	dB
+/- 35 GHz	TBD	dB
+/- 40 GHz	TBD	dB
+/- 45 GHz	TBD	dB
+/- 50 GHz	TBD	dB
+/- 55 GHz	TBD	dB
+/- 60 GHz	TBD	dB
+/- 65 GHz	TBD	dB
+/- 70 GHz	TBD	dB
+/- 75 GHz	TBD	dB

# Summary

- Modifications to the adopted baseline are proposed to address the definition of spectral parameters for:
  - Transmitter
  - Passband
  - Adjacent channel isolation



Thanks!