

Changes to other optical specs when TDECQ spec limit is adjusted.

P802.3cd ad hoc, 2nd May 2018

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Background

- 802.3cd draft 3.2 includes optimization of threshold by up to $\pm 1\%$ of OMA_{outer} as part of TDECQ measurement method.
- During the March (Rosemont) meeting there was generic consensus to review TDECQ values after threshold optimization was adopted.
 - http://www.ieee802.org/3/cd/public/Mar18/king_3cd_01a_0318.pdf indicated that TDECQ limits should be reduced by 0.4 dB to avoid increasing the sub-eye inequality allowed as a result of threshold optimization (summary on slide 13).
- Subsequently, [mazzini_041118_3cd_adhoc](#) presented experimental work following some of the eye inequality cases shown in [king_011018_3cd_adhoc](#).
- The experimental results show that TDECQ and SECQ are strong functions of signal distortion, and confirm that 0.4 dB of TDECQ and SECQ reduction due to $\pm 1\%$ threshold adjustment is a reasonable value.
- In this contribution, we detail the changes to all other 802.3cd optical specs when TDECQ/SECQ spec limit are adjusted.

Clause 138 (50GBASE-SR).

Table 138-8—Transmit characteristics

Description	Value	Unit
Signaling rate, each lane (range)	26.5625 ± 100 ppm	GBd
Modulation format	PAM4	
Center wavelength (range)	840 to 860	nm
RMS spectral width ^a (max)	0.6	nm
Average launch power, each lane (max)	4	dBm
Average launch power, each lane (min)	-6	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane (max)	3	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane (min) ^b	-4	dBm
Launch power in OMA _{outer} minus TDECQ (min)	-5.9	dBm
Transmitter and dispersion eye closure (TDECQ), each lane (max)	4.9	dB
Average launch power of OFF transmitter, each lane (max)	-30	dBm
Extinction ratio, each lane (min)	3	dB
Optical return loss tolerance (max)	12	dB
Encircled flux ^c	≥ 86% at 19 μm ≤ 30% at 4.5 μm	

^aRMS spectral width is the standard deviation of the spectrum.

^bEven if the TDECQ < 1.9 dB, the OMA (min) must exceed this value.

^cIf measured into type A1a.2 or type A1a.3, or A1a.4, 50 μm fiber, in accordance with IEC 61280-1-4.

138.8.7 Receiver sensitivity

Receiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 4.9 dB. Receiver sensitivity should meet Equation (138-1), which is illustrated in Figure 138-4.

$$RS = \max(-6, SECQ - 7.9) \quad (\text{dB}) \quad (138-1)$$

where

RS is the receiver sensitivity
SECQ is the SECQ of the transmitter used to measure the receiver sensitivity

Table 138-9—Receive characteristics

Description	Value	Unit
Signaling rate, each lane (range)	26.5625 ± 100 ppm	GBd
Modulation format	PAM4	
Center wavelength (range)	840 to 860	nm
Damage threshold ^a (min)	5	dBm
Average receive power, each lane (max)	4	dBm
Average receive power, each lane ^b (min)	-7.9	dBm
Receive power, each lane (OMA _{outer}) (max)	3	dBm

Table 138-9—Receive characteristics (continued)

Description	Value	Unit
Receiver reflectance (max)	-12	dB
Stressed receiver sensitivity (OMA _{outer}), each lane ^c (max)	-3	dBm
Receiver sensitivity (OMA _{outer}), each lane ^d (max)	Equation (138-1)	dBm
Conditions of stressed receiver sensitivity test: ^e		
Stressed eye closure (SECQ), lane under test	4.9	dB
OMA _{outer} of each aggressor lane ^f	3	dBm

^aThe receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level on one lane. The receiver does not have to operate correctly at this input power.

^bAverage 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.

^cMeasured with conformance test signal at TP3 (see 138.8.8) for the BER specified in 138.1.1.

^dReceiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 4.9 dB.

^eThese test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

^fOnly applies to 100GBASE-SR2 and 200GBASE-SR4.

Table 138-10—Illustrative link power budget

Parameter	OM3	OM4	OM5	Unit
Effective modal bandwidth at 850 nm ^a	2000	4700		MHz km
Power budget (for max TDECQ)	6.9			dB
Operating distance	0.5 to 70	0.5 to 100		m
Channel insertion loss ^b	1.8	1.9		dB
Allocation for penalties ^c (for max TDECQ)	5			dB
Additional insertion loss allowed	0.1	0		dB

^aPer IEC 60793-2-10.

^bThe channel insertion loss is calculated using the maximum distance specified in Table 138-7 and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in 138.10.2.2.1.

^cLink penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

Clause 139 (50GBASE-FR, 50GBASE-LR).

Table 139-6—50GBASE-FR and 50GBASE-LR transmit characteristics

Description	50GBASE-FR	50GBASE-LR	Unit
Signaling rate (range)	26.5625 ± 100 ppm		GBd
Modulation format	PAM4		—
Wavelengths (range)	1304.5 to 1317.5		nm
Side-mode suppression ratio (SMSR), (min)	30		dB
Average launch power (max)	3	4.2	dBm
Average launch power ^a (min)	4.1 -3.9	4.5 -4.3	dBm
Outer Optical Modulation Amplitude (OMA _{outer}) (max)	2.8	4	dBm
Outer Optical Modulation Amplitude (OMA _{outer}) (min) ^b	2.5 -2.3	1.5 -1.3	dBm
Launch power in OMA _{outer} minus TDECQ (min)	3.9 -3.7	2.9 -2.7	dBm
Transmitter and dispersion eye closure for PAM4 (TDECQ) (max)	3.2 2.8	3.4 3.0	dB
Average launch power of OFF transmitter (max)	-16		dBm
Extinction ratio (min)	3.5		dB
RIN _{17,1} OMA (max)	-132	—	dB/Hz

139.7.8 Receiver sensitivity

For 50GBASE-FR, receiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 3.2 dB. Receiver sensitivity should meet Equation (139-1), which is illustrated in Figure 139-6.

For 50GBASE-LR, receiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB. Receiver sensitivity should meet Equation (139-2), which is illustrated in Figure 139-6.

$$RS = \max(-6.9, SECQ - 8.3) \text{ (dB)} \quad (139-1)$$

$$RS = \max(-8.4, SECQ - 9.8) \text{ (dB)} \quad (139-2)$$

where

RS is the receiver sensitivity
SECQ is the SECQ of the transmitter used to measure the receiver sensitivity

Table 139-7—50GBASE-FR and 50GBASE-LR receive characteristics

Description	50GBASE-FR	50GBASE-LR	Unit
Signaling rate (range)	26.5625 ± 100 ppm		GBd
Modulation format	PAM4		—
Wavelengths (range)	1304.5 to 1317.5		nm
Damage threshold ^a	5.2	5.2	dBm
Average receive power (max)	3	4.2	dBm
Average receive power ^b (min)	-8.1 -7.9	-10.8 -10.6	dBm
Receive power (OMA _{outer}) (max)	2.8	4	dBm
Receiver reflectance (max)	-26		dB
Receiver sensitivity (OMA _{outer}) ^c (max)	Equation (139-1)	Equation (139-2)	dBm
Stressed receiver sensitivity (OMA _{outer}) ^d (max)	-5.1 -5.3	-6.4 -6.6	dBm
Conditions of stressed receiver sensitivity test: ^e			
Stressed eye closure for PAM4 (SECQ)	3.2 2.8	3.4 3.0	dB

^aThe receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.

^bAverage receive power (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.

^cReceiver sensitivity (OMA_{outer}) (max) is informative and is defined for a transmitter with a value of SECQ up to 3.2 dB for 50GBASE-FR and 3.4 dB for 50GBASE-LR.

^dMeasured with conformance test signal at TP3 (see 139.7.9) for the BER specified in 139.1.1.

^eThese test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

Table 139-8—50GBASE-FR and 50GBASE-LR illustrative link power budgets

Parameter	50GBASE-FR	50GBASE-LR	Unit
Power budget (for maximum TDECQ)	7.6 7.2	10.3 9.9	dB
Operating distance	2	10	km
Channel insertion loss	4 ^a	6.3 ^b	dB
Maximum discrete reflectance	See 139.10.2.2	See 139.10.2.2	dB
Allocation for penalties ^c (for maximum TDECQ)	3.6 3.2	4 3.6	dB
Additional insertion loss allowed	0	0	dB

Clause 140 (100GBASE-DR).

Table 140-6—100GBASE-DR transmit characteristics

Description	Value	Unit
Signaling rate (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Wavelength (range)	1304.5 to 1317.5	nm
Side-mode suppression ratio (SMSR), (min)	30	dB
Average launch power (max)	4	dBm
Average launch power ^a (min)	-2.9	dBm
Outer Optical Modulation Amplitude (OMA _{outer}) (max)	4.2	dBm
Outer Optical Modulation Amplitude (OMA _{outer}) (min) ^b	-0.8	dBm
Launch power in OMA _{outer} minus TDECQ (min): for extinction ratio ≥ 5 dB for extinction ratio < 5 dB	-2.2	dBm
	-1.9	dBm
Transmitter and dispersion eye closure for PAM4 (TDECQ) (max)	3.4	dB
Average launch power of OFF transmitter (max)	-15	dBm
Extinction ratio (min)	3.5	dB

-2.7

-0.6

-2.0

-1.7

3.0

140.7.8 Receiver sensitivity

Receiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB. Receiver sensitivity should meet Equation (140-1), which is illustrated in Figure 140-5.

$$RS = \max(-3.9, SECQ - 5.3) \quad (\text{dB}) \quad (140-1)$$

where
 RS is the receiver sensitivity
 SECQ is the SECQ of the transmitter used to measure the receiver sensitivity

The normative requirement for receivers is stressed receiver sensitivity.

Table 140-7—100GBASE-DR receive characteristics

Description	Value	Unit
Signaling rate (range)	53.125 ± 100 ppm	GBd
Modulation format	PAM4	—
Wavelengths (range)	1304.5 to 1317.5	nm
Damage threshold ^a	5	dBm
Average receive power (max)	4	dBm
Average receive power ^b (min)	-5.9	dBm
Receive power (OMA _{outer}) (max)	4.2	dBm
Receiver reflectance (max)	-26	dB
Receiver sensitivity (OMA _{outer}) ^c (max)	Equation (140-1)	dBm
Stressed receiver sensitivity (OMA _{outer}) ^d (max)	-1.9	dBm
Conditions of stressed receiver sensitivity test: ^e		
Stressed eye closure for PAM4 (SECQ)	3.4	dB

5.7

3.0

^aThe 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.

^bAverage receive power (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.

^cReceiver sensitivity (OMA_{outer}) (max) is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB.

^dMeasured with conformance test signal at TP3 (see 140.7.9) for the BER specified in 140.1.1.

^eThese test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

Table 140-8—100GBASE-DR illustrative link power budget

Parameter	Value	Unit
Power budget (for max TDECQ): for extinction ratio ≥ 5 dB for extinction ratio < 5 dB	6.5 6.8	dB dB
Operating distance	500	m
Channel insertion loss ^a	See 140.9	dB
Maximum discrete reflectance	-35	dB
Allocation for penalties ^b (for max TDECQ): for extinction ratio ≥ 5 dB for extinction ratio < 5 dB	6.5 minus max channel insertion loss per Table 140-12 6.8 minus max channel insertion loss per Table 140-12	dB dB
Additional insertion loss allowed	0	dB

^aThe channel insertion loss is calculated using the maximum distance specified in Table 140-5 and cabled optical fiber attenuation of 0.5 dB/km at 1304.5 nm plus an allocation for connection and splice loss given in 140.10.2.1.

^bLink penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

THANK YOU