

Transmitter Functional Symbol Error Mask Test Proposal Update

IEEE P802.3 Interim Session
802.3dj Task Force Meeting
September 15, 2025
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Comments: 227, 315, 448, 450, 510 through 516 inclusive

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Supporters

- To be added

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Introduction

- 802.3dj TF adopted D2.1 with [additional test of 200G/lane Ethernet transmit optics](#)
 - Proposal defined FRx as a compliant optical hardware receiver
 - Definition changed during July Plenary, which now requires name changes.
- Test parameters in D2.1
 - Require updates based on further measurements
 - Starting-point test parameters in this presentation are based on [measurements presented by Roberto Rodes](#).
 - Consensus test parameters will be in a final proposal.
- Over-fiber test, mainly for chromatic dispersion penalty (CD) limit compliance
 - Discussion started by the Author Team prior to July Plenary
 - Deferred to after the meeting to limit initial proposal complexity.

DRn BtB Test: Name Changes in 180.9.7 & 182.9.7

- During the July Plenary meeting the definition of Functional Receiver (FRx) was changed from compliant Optical Receiver (ORx) to VOA & compliant ORx.
- FRx_OMA name now means input to the VOA, whereas equation 180-1 defines the output of the VOA.
 - From: *FRx_OMA* To: *ORx_OMA*
- Tx_TECQ, Tx_TDECQ, Tx_test_margin are repetitive.
 - From: *Tx_TECQ* To: *DUT_TECQ*
 - From: *Tx_TDECQ* To: *DUT_TDECQ*
 - From: *Tx_test_margin* To: *Test_margin*
- *VOA_level* and *Test_SMF_correction* added for clarity, with same functionality.
- Final names and format deferred to the Editors.

DRn BtB Test: 180.9.7 & 182.9.7 Changes

[Tx DUT] → short Test SMF → [FRx = VOA → ORx]

- Tx DUT complies with characteristics in Table 180-7 (or 182-7)
- ORx complies with characteristics in Table 180-8 (or 182-8)
- $FRx_OMA = Tx_DUT_OMA$ (description only; no measurement)
- $ORx_OMA = FRx_OMA - VOA_level$ (description only; no measurement)
180-1: $VOA_level = Test_SMF_correction + RxS_TECQ_correction - Test_margin$
- $Test_SMF_correction$ for delta from parameter values in Table 180-9 (or 182-9):
180-2: $Test_SMF_correction = Channel_insertion_loss$
 $+ MPI + DGD_penalty_allocation$
 $+ max(DUT_TDECQ - DUT_TECQ, 0)$
- $RxS_TECQ_correction$ for delta from $RxS_OMA(max)$ in Figure 180-4 (or 182-4):
180-3: $RxS_TECQ_correction = RxS_OMA(max) - ORx_RxS$ (both @DUT_TECQ)
- $Test_margin$ increases ORx_OMA away from noise limit.

Starting-point Test Parameters

- Test_margin = 1.5dB
- Operating BER = 2.40E-5
- Symbol Error Mask

Test symbol errors per test block, k (see 174A.8.5)	Probability $H_{max}(k)$
1	1.15×10^{-1}
2	7.47×10^{-3}
3	3.24×10^{-4}
4	1.05×10^{-5}
5	2.73×10^{-7}
6	5.88×10^{-9}
7	1.08×10^{-10}

8	1.75×10^{-12}
9	3.50×10^{-13}
10	3.50×10^{-13}
11	3.50×10^{-13}
12	3.50×10^{-13}
13	3.50×10^{-13}
14	3.50×10^{-13}
15	3.50×10^{-13}
16	3.50×10^{-13}

FR4 & LR4 Over-fiber Test: Mainly for CD Limit Compliance

- Same as in 180.9.7:
 - Descriptions
 - Equation 181-1 (or 183-1) (*VOA_level*)
 - Equation 181-3 (or 183-3) (*RxS_TECQ_correction*)
 - *Test_margin*
 - Operating BER
 - Symbol Error Mask
- Different than in 180.9.7, highlighted in green:
 - Tx DUT connected to FRx by longer Test SMF, or emulator mainly for chromatic dispersion penalty (CD)
 - Equation 181-2 (or 183-2) (*Test_SMF_correction*), on next page

FR4 & LR4 Over-fiber Test: 181.9.7 & 183.9.7 Changes

[Tx DUT] → longer Test SMF → [FRx = VOA → ORx]

- Tx DUT complies with characteristics in Table 181-5 (or 183-6)
- ORx complies with characteristics in Table 181-6 (or 183-7)
- $FRx_OMA = Tx_DUT_OMA - Test_SMF_loss$ (description only; no measurement)
- $ORx_OMA = FRx_OMA - VOA_level$ (description only; no measurement)
181-1: $VOA_level = Test_SMF_correction + RxS_TECQ_correction - Test_margin$
- $Test_SMF_correction$ for delta from parameter values in Table 181-7 (or 183-8):
181-2: $Test_SMF_correction = Channel_insertion_loss - Test_SMF_loss$
 $+ MPI+DGD_penalty_allocation - Test_SMF_MPI+DGD_penalty$
 $+ max(DUT_TDECQ - DUT_TECQ, 0) - Test_SMF_DUT_CD$
- $RxS_TECQ_correction$ for delta from $RxS_OMA(max)$ in Figure 181-4 (or 183-4):
181-3: $RxS_TECQ_correction = RxS_OMA(max) - ORx_RxS$ (both @DUT_TECQ)
- $Test_margin$ increases ORx_OMA away from noise limit.

Proposal Text

- Proposal text in Draft Standard format will be added in this section, working with Optics Track Chair and Editor
- Similar to proposed text addition in cole_3dj_01e_2507.pdf made during the July Plenary, except done prior to the Sept. Interim.

Appx 1: FR4-500 (Clause 181) Over-fiber Test Examples

RxS_OMA@TECQ=0		-4.1	RxS_TECQ_correction		0.0		Channel_insertion_loss		3.5		MPI+DGD_penalty_allocation		0.6		Tx_OMA@TECQ=0		0.0	
Case		Tx_DUT						Test_SMF						FRx				
No.	Test_SMF actual DUT_CD	TECQ	TDECQ	max(TECQ, TDECQ)	max(TDECQ - TECQ, 0)	margin	OMA dBm	actual			estimated			Test _margin	VOA _level	ORx _OMA dBm	Test _margin _error	
								loss	MPI+DGD	DUT_CD	loss	MPI+DGD	DUT_CD					
1	max pos penalty	2.0	3.0	3.0	1.0	1.0	4.0	3.5	0.6	1.0	3.5	0.6	1.0	1.5	-1.5	2.0	0.0	
2		2.0	3.0	3.0	1.0	0.0	3.0	3.5	0.6	1.0	3.5	0.6	1.0	1.5	-1.5	1.0	0.0	
3		2.0	3.0	3.0	1.0	1.0	4.0	2.0	0.3	1.0	2.0	0.3	1.0	1.5	0.3	1.7	0.0	
4	typ. pos	2.0	3.0	3.0	1.0	0.0	3.0	2.0	0.3	0.7	2.0	0.3	0.7	1.2	0.9	0.1	0.0	
5	0 penalty	2.0	3.0	3.0	1.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	3.6	-0.6	0.0	
6	eq.181-3 = 180-3	2.0	2.0	2.0	0.0	1.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	0.4	0.0	
7		3.0	2.0	3.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.6	0.4	0.0	
8	min neg penalty	3.0	2.0	3.0	0.0	1.0	4.0	2.0	0.3	-1.0	2.0	0.3	-1.0	1.5	1.3	0.7	0.0	
9		3.0	2.0	3.0	0.0	0.0	3.0	3.5	0.6	-1.0	3.5	0.6	-1.0	1.5	-0.5	0.0	0.0	
10		3.0	2.0	3.0	0.0	1.0	4.0	3.5	0.6	-1.0	3.5	0.6	-1.0	1.5	-0.5	1.0	0.0	
Test_margin_error = (ORx_OMA = Tx_DUT_OMA - Test_SMF_actual_loss - VOA_level) - (ORx_RxS@TECQ + Test_SMF_actual_MPI+DGD+DUT_CD_penalty + Tx_margin + Test_margin)																		

Appx 1: LR4 (Clause 183) Over-fiber Test Examples

RxS_OMA@TECQ=0		-6.9	RxS_TECQ_correction		0.0	Channel_insertion_loss		6.3	MPI+DGD_penalty_allocation		1.1	Tx_OMA@TECQ=0		0.5			
Case		Tx_DUT						Test_SMF						FRx			
No.	Test_SMF actual DUT_CD	TECQ	TDECQ	max(TECQ, TDECQ)	max(TDECQ - TECQ, 0)	margin	OMA dBm	actual			estimated			Test _margin	VOA _level	ORx _OMA dBm	Test _margin _error
								loss	MPI+DGD	DUT_CD	loss	MPI+DGD	DUT_CD				
1	max pos penalty	2.0	3.5	3.5	1.5	1.0	5.0	6.3	1.1	1.5	6.3	1.1	1.5	1.5	-1.5	0.2	0.0
2		2.0	3.5	3.5	1.5	0.0	4.0	6.3	1.1	1.5	6.3	1.1	1.5	1.5	-1.5	-0.8	0.0
3		2.0	3.5	3.5	1.5	0.0	4.0	5.3	0.5	1.5	5.3	0.5	1.5	1.5	0.1	-1.4	0.0
4		2.0	5.5	5.5	3.5	1.0	7.0	5.3	0.5	1.5	5.3	0.5	3.5	1.5	0.1	1.6	2.0
5		2.0	3.5	3.5	1.5	1.0	5.0	5.3	0.5	1.5	5.3	0.5	1.5	1.5	0.1	-0.4	0.0
6	typ. pos	2.0	3.5	3.5	1.5	1.0	5.0	5.3	0.5	1.0	5.3	0.5	1.0	1.0	1.1	-1.4	0.0
7	0 penalty	2.0	3.5	3.5	1.5	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	7.4	-3.4	0.0
8		2.0	2.5	2.5	0.5	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.4	-3.4	0.0
9	eq.181-3 = 180-3	4.0	2.5	4.0	0.0	1.0	5.5	0.0	0.0	0.0	0.0	0.0	0.0	1.5	5.9	-0.4	2.0
10		2.0	2.5	2.5	0.5	1.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	6.4	-2.4	0.0
Test_margin_error = (ORx_OMA = Tx_DUT_OMA - Test_SMF_actual_loss - VOA_level) - (ORx_RxS@TECQ + Test_SMF_actual_MPI+DGD+DUT_CD_penalty + Tx_margin + Test_margin)																	

Appx 2: Eq. 180-2 $\max(DUT_TDECQ - DUT_TECQ, 0)$ Derivation

- [Tx DUT] $\rightarrow$ short Test SMF $\rightarrow$ [FRx = VOA $\rightarrow$ ORx]
 - $Tx_DUT_OMA = Tx_OMA@TECQ=0 + \max(DUT_TECQ, DUT_TDECQ) + Tx_margin$
 - $ORx_OMA = FRx_OMA - VOA_level$
- 180-1:** $VOA_level = Test_SMF_correction + RxS_TECQ_correction - Test_margin$
- 180-2:** $Test_SMF_correction = Channel_insertion_loss + MPI + DGD_allocation + X$
- ORx_OMA_target :
 - $ORx_OMA_target = actual_ORx_RxS + actual_MPI + DGD + DUT_CD_penalty + Tx_margin + Test_margin$
- $ORx_OMA = ORx_OMA_target$:
 - $Tx_OMA@TECQ=0 + \max(DUT_TECQ, DUT_TDECQ) + Tx_margin - (Channel_insertion_loss + MPI + DGD_allocation + X + RxS_TECQ_correction - Test_margin)$
 $= actual_ORx_RxS + actual_MPI + DGD + DUT_CD_penalty + Tx_margin + Test_margin$
 - $\max(DUT_TECQ, DUT_TDECQ) - X = DUT_TECQ$
- $X = \max(DUT_TDECQ - DUT_TECQ, 0)$

Appx 3: “Simplified” Tx Functional Test Proposal Problems

- Fully accurate *Test_SMF_correction* equation “simplified” by red lines:
181-2: Test_SMF_correction = Channel_insertion_loss - Test_SMF_loss
+ MPI+DGD_penalty_allocation ~~*- Test_SMF_MPI+DGD_penalty*~~
~~*+ max(DUT_TDECQ - DUT_TECQ, 0) - Test_SMF_DUT_CD*~~
- Full equation can be “simplified”, however “simplified” equation cannot be expanded
- Simplification 1 (No *Test_SMF_MPI+DGD_penalty*) Problem:
 - MPI+DGD penalty is never zero, especially for longer Test SMF like 10km
 - Zero is a bad estimate, above zero to MPI+DGD_penalty(max) is always better
- Simplification 2 (No *max(DUT_TDECQ - DUT_TECQ, 0) - Test_SMF_DUT_CD*) Problems:
 - Automatic computer VOA adjustment replaced by test over three fiber types, with complex, costlier test set-up and 3x the test time, is not a simplification
 - Extra Tx OMA when TDECQ-TECQ > *Test_SMF_DUT_CD* is not a beneficial “credit”
 - It masks real TDECQ field problems that motivated proposing a functional test.

Transmitter Functional Symbol Error Mask Test Proposal Update

Thank you