Shortened test time for Block-Error RX Sensitivity (Comment #593)

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Overview

180.2 Error ratio allocation

A complete PHY is expected to meet the frame loss ratio specifications in 174A.5.

With a compliant input signal, a PMD receiver is expected to meet the block error ratio of 1.45×10^{-11} (see 174A.5), measured at the PMA adjacent to the PMD using the method described in 174A.8, with BER_{added} equal to 6.4×10^{-5}.

With a compliant input signal, a PHY receiver is expected to meet the block error ratio of 1.45×10^{-11} (see 174A.5), measured at the PCS using the method described in 174A.10, with BER_{added} equal to 3.2×10^{-5}.

Table 174A–1—Error ratio allocations for optical PHYs with no FEC sublayer or with an Inner FEC sublayer

ISL	Frame loss ratio for entire PCS-to-PCS link	Codeword error ratio for entire PCS-to-PCS link	BER for entire PCS-to-PCS link (BER_{total})	BER per ISL [a]
xAUI-n C2C[b]	6×10^{-11}	1.45×10^{-11}	2.92×10^{-4}	0.08×10^{-4}
xAUI-n C2M				0.24×10^{-4}
PMD-to-PMD				2.28×10^{-4}
xAUI-n C2M				0.24×10^{-4}
xAUI-n C2C[b]				0.08×10^{-4}

[a] Measured at the PMA closest to the PMD or AUI component and after Inner FEC decoding, if present, except measured at the Inner FEC for 800GBASE-LR1.

[b] If the PMD is a type defined in Clause 180, Clause 181, Clause 182, Clause 183, or Clause 185, and xAUI-n C2C is a type defined in Annex 120D (i.e., 50 Gb/s per lane) or Annex 120F (i.e., 100 Gb/s per lane), the xAUI-n C2C is expected to meet the BER allocations in this table.

174A.8.1.3 PMA error histogram measurement

Using the count accumulated during a test, a set of test block error histograms is calculated.

$H_m^{(i)}(k)$ is a set of p measured 17-bin histograms, one histogram for each lane i, defined as follows:

— $H_m^{(i)}(k)$ where $k < 16$ is the is the probability of k test symbol errors in a test block for lane i.

— $H_m^{(i)}(16)$ is the probability of more than 15 test symbol errors in a test block for lane i.

Histograms $H_m^{(i)}(k)$ are measured according the following method for each lane i:

a) At the transmitting device generate a PRBS31 or PRBS31Q test pattern in the PMA.

b) In the receiving PMA, identify errored bits from the physical link using the PRBS31 or PRBS31Q block error checker.

c) Divide the stream into a series of test symbols and test blocks as defined in 174A.8.1.2.

d) For each test block, count the number of test symbols with one or more bit errors and, based on the total number of test symbol errors in the test block, increment the appropriate bin counter.

e) The total number of test blocks analyzed is determined according to Equation (174A–1). The value of test_block_total_count_i should be sufficiently large to reliably verify that the expected block error ratio is met, either by direct measurement or statistical projection. The projection should provide an accurate prediction of the value of $H_m^{(i)}(k)$ that would be observed over longer-term testing or at least provide an upper bound on the value.

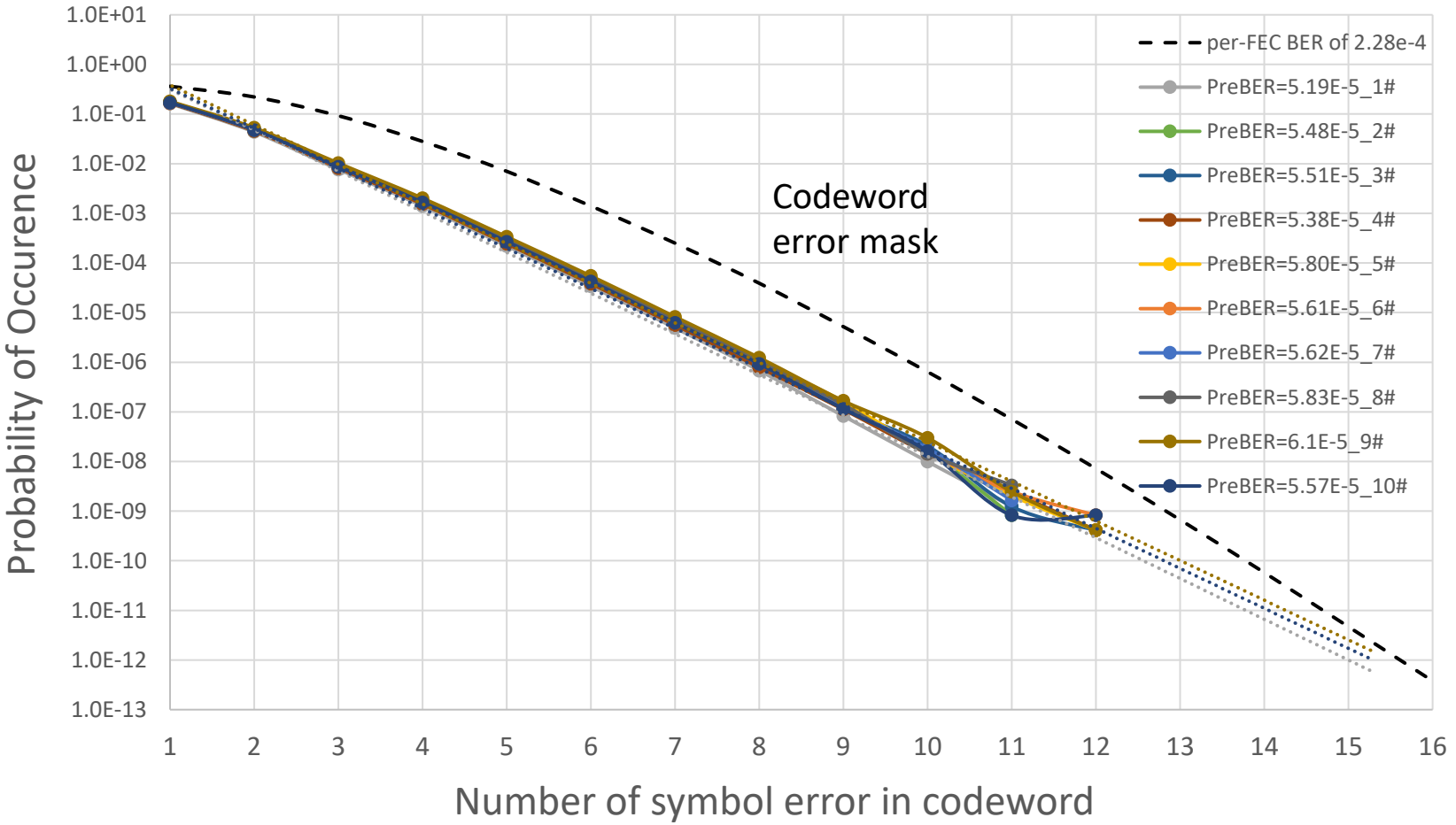
f) Calculate the histogram bins $H_m^{(i)}(k)$ according to Equation (174A–2).

$$\text{test\_block\_total\_count\_}i = \text{test\_block\_error\_bin\_}i\text{\_16p} + \sum_{k=0}^{15} \text{test\_block\_error\_count\_}i\text{\_}k \qquad (174A\text{–}1)$$

$$H_m^{(i)}(k) = \frac{\text{test\_block\_error\_count\_}i\text{\_}k}{\text{test\_block\_total\_count\_}i} \qquad (174A\text{–}2)$$

FEC error histogram tests at 1 minute scale

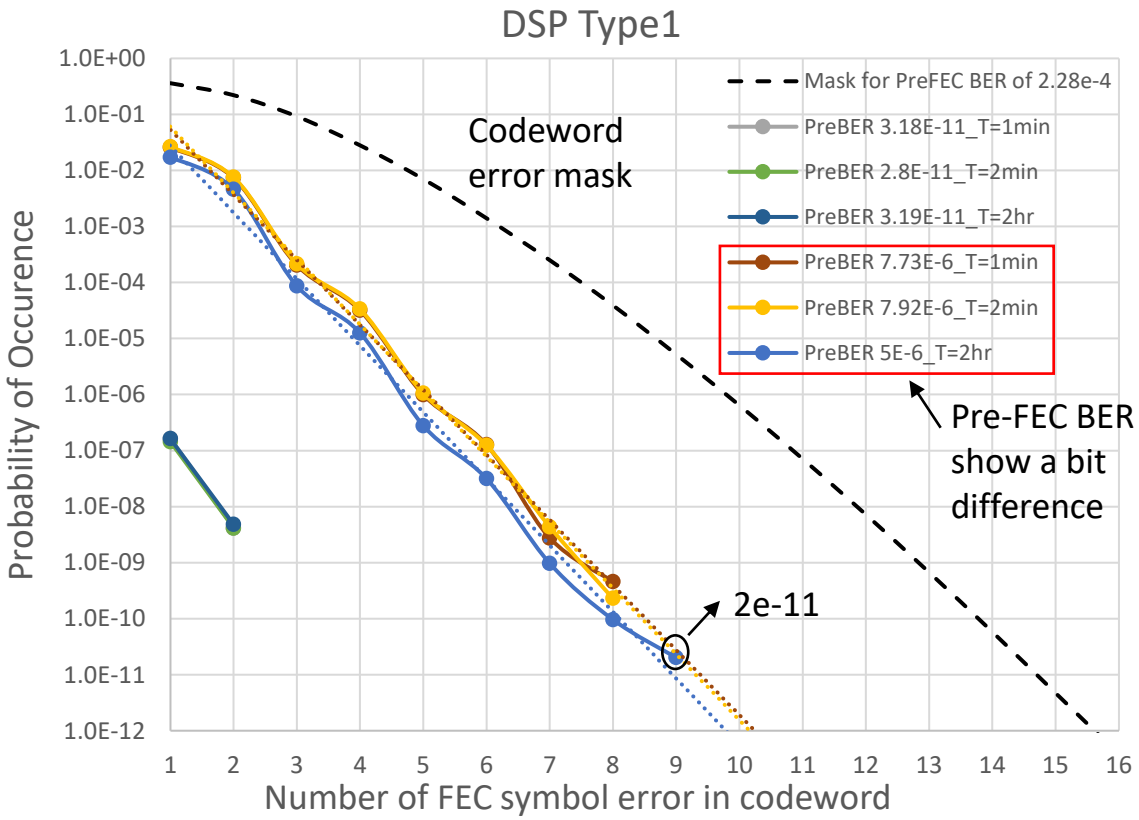
- Test of FEC tail curves over 10 x 1min show good repeatability except the final 11, 12 bin
- The error histogram is not sufficient large to plot a complement curve out to 16 bin

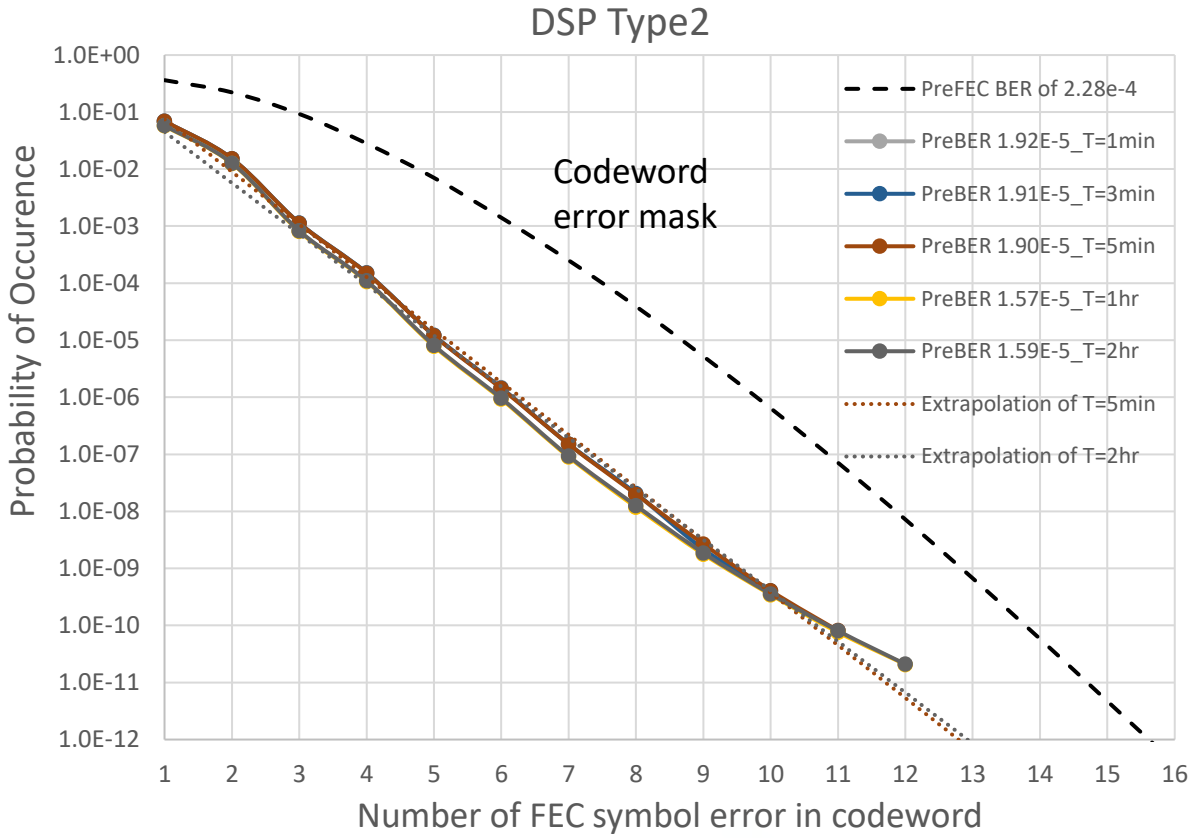


Errored Symbol 10	Errored Symbol 11	Errored Symbol 12
24	3	0
39	2	0
50	3	1
35	6	1
37	5	1
37	6	2
44	4	0
35	8	0
73	6	1
39	2	2

Comparison for test time of mins vs hours

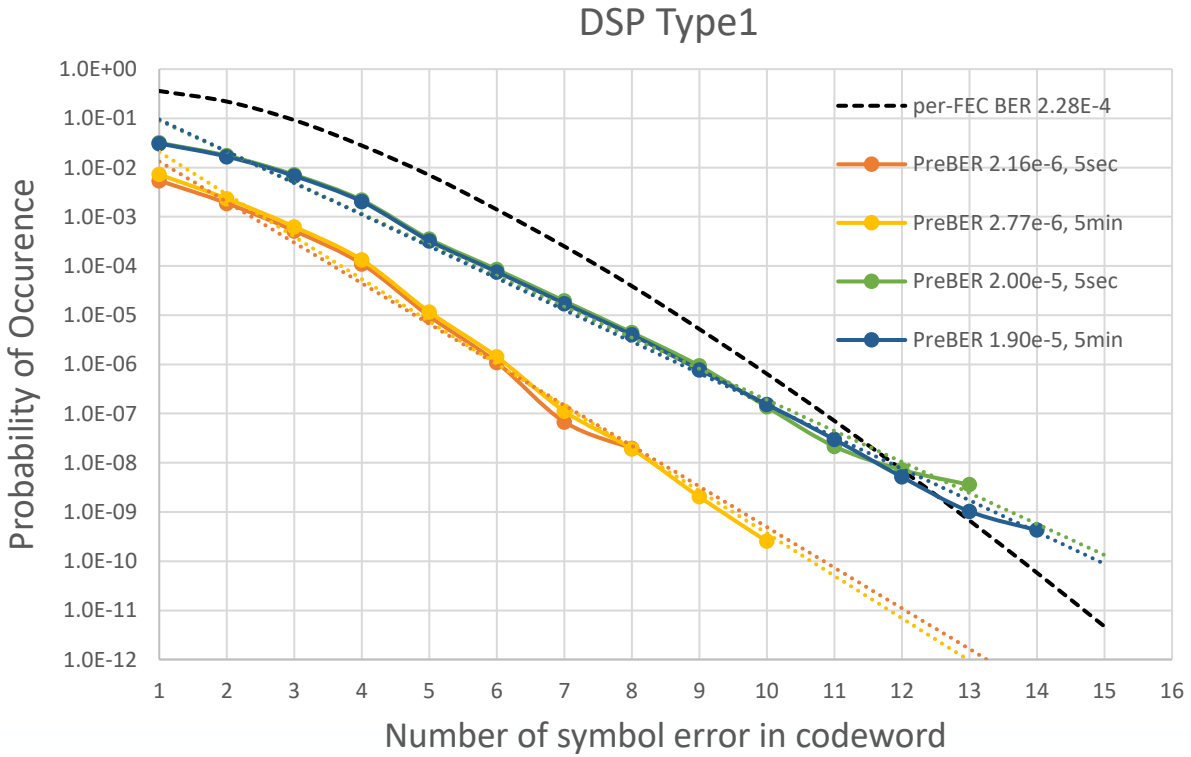
- At same/similar high Pre-FEC BER levels (lower input power), FEC tail grows longer at lower probability with longer test time
  - At Low Pre-FEC/high input power level, FEC tail changes very little
- FEC-tail slope follows extrapolation curve well over short and long test time

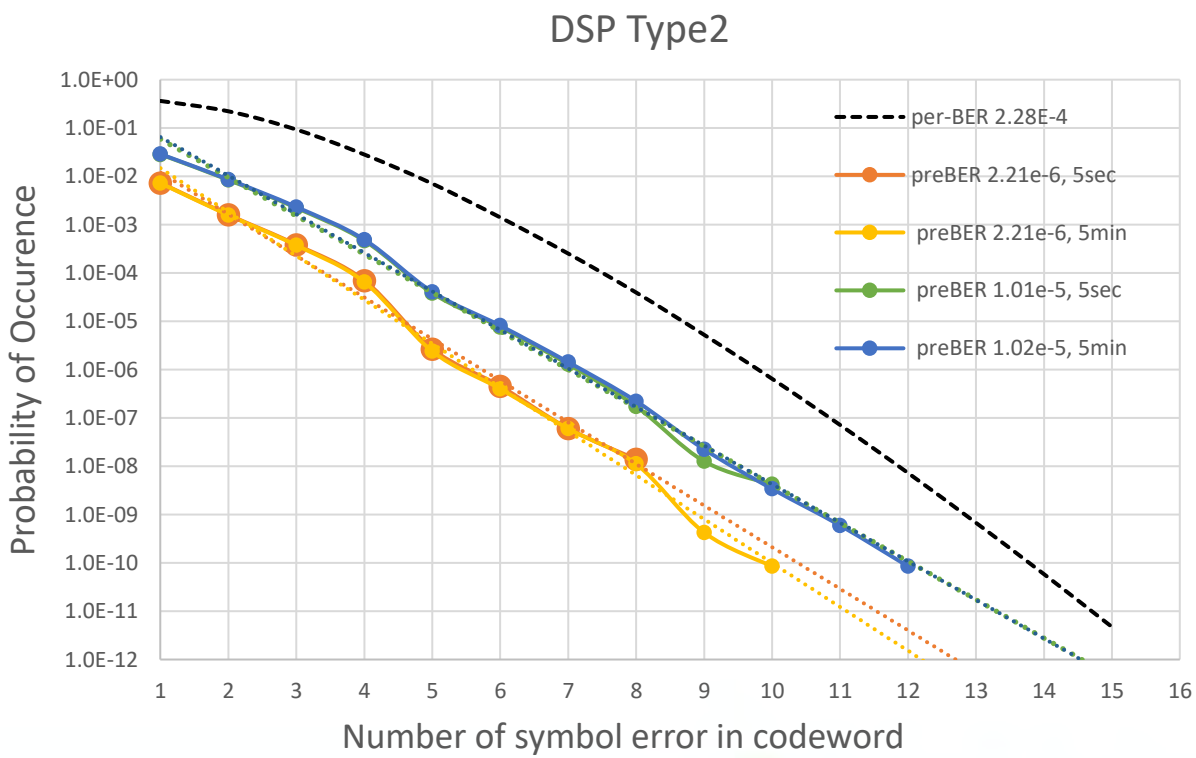




Recommendation for shortening the test time

- FEC tail curve for test time of 5 sec. and 5 min. overlaps well
  - The exponential fitting lines for FEC tail also overlaps well for 5 sec. and 5 min. test time
  - 2 representative DSPs are tested for comparison, and conclusions are similar
- Recommendation:
  - At pre-set input power to receiver, collect FEC Tail data with 5 seconds of test time
  - Extrapolate the measured histogram out to bin 16 with linear fit (log10 Y-axis unit)
  - Receiver sensitivity determined by minimum input power achievable shall not violate codeword mask





FEC tail curves with fiber transmission

Table 183–9—Optical channel characteristics

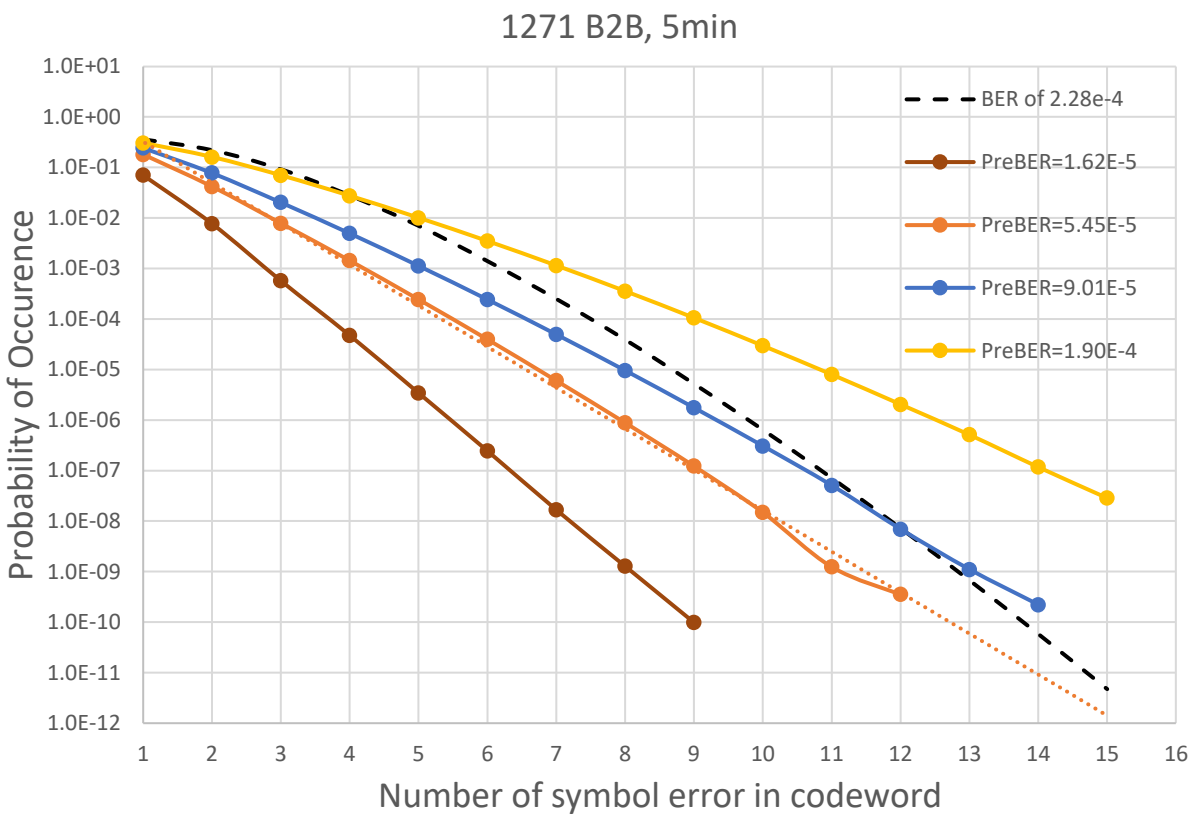
Description	800GBASE-FR4	800GBASE-LR4	Unit
Operating distance (max)	2	10	km
Channel insertion loss[a, b] (max)	4	6.3	dB
Channel insertion loss (min)	0		dB
Positive dispersion[b] (max)	6.02	2.8	ps/nm
Negative dispersion[b] (min)	–11.26	–24.6	ps/nm
DGD_max[c]	2.3	4	ps
Optical return loss (min)	25	22	dB

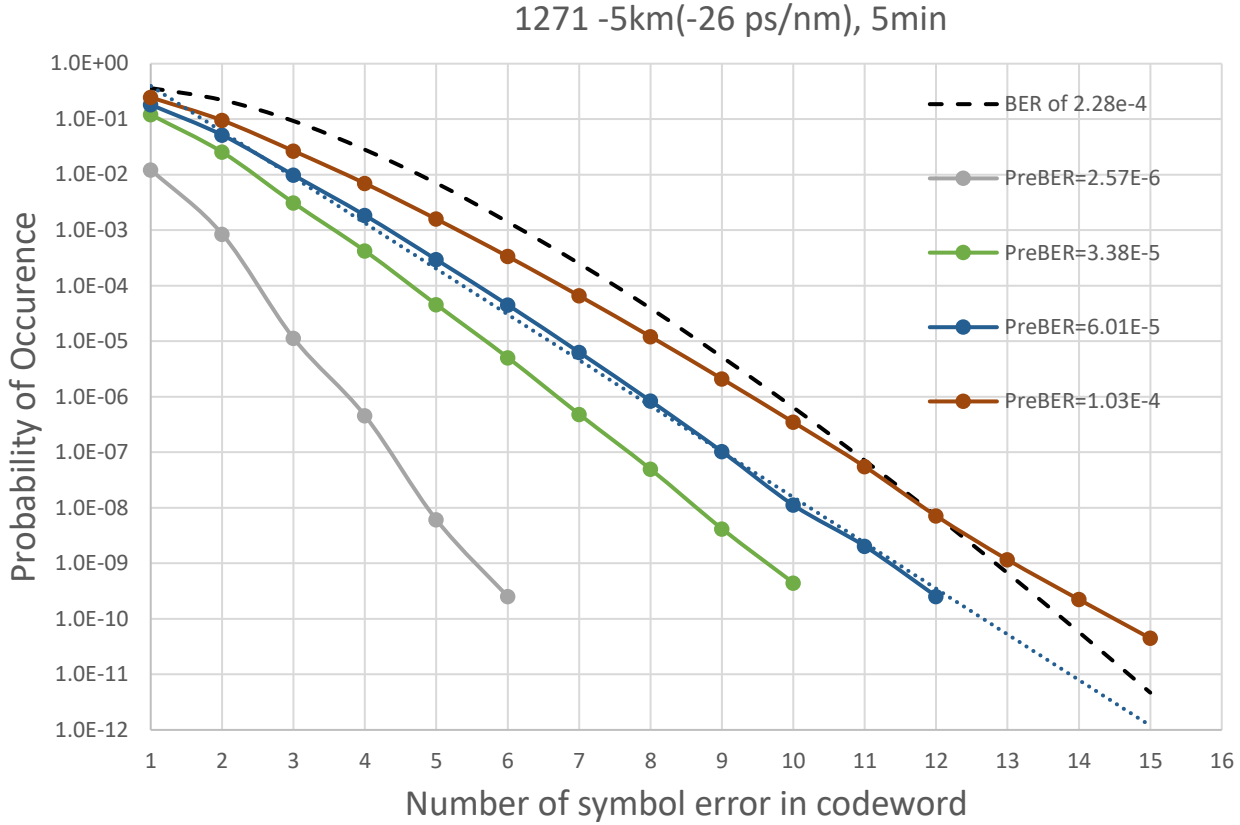
[a] These channel insertion loss values include cable, connectors, and splices.
[b] Over the wavelength range 1264.5 nm to 1337.5 nm for 800GBASE-FR4, and 1294.53 nm to 1310.19 nm for 800GBASE-LR4. The dispersion specifications are based on the statistical link design methodology documented in ITU-T REC G.652, Appendix I.
[c] 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 is required to tolerate.

	@1331nm	@1271nm
Positive DC fiber (3km)	+8.2 ps/nm	-
Negative CD fiber (5km)	-	-26 ps/nm

FEC tail curves with fiber transmission

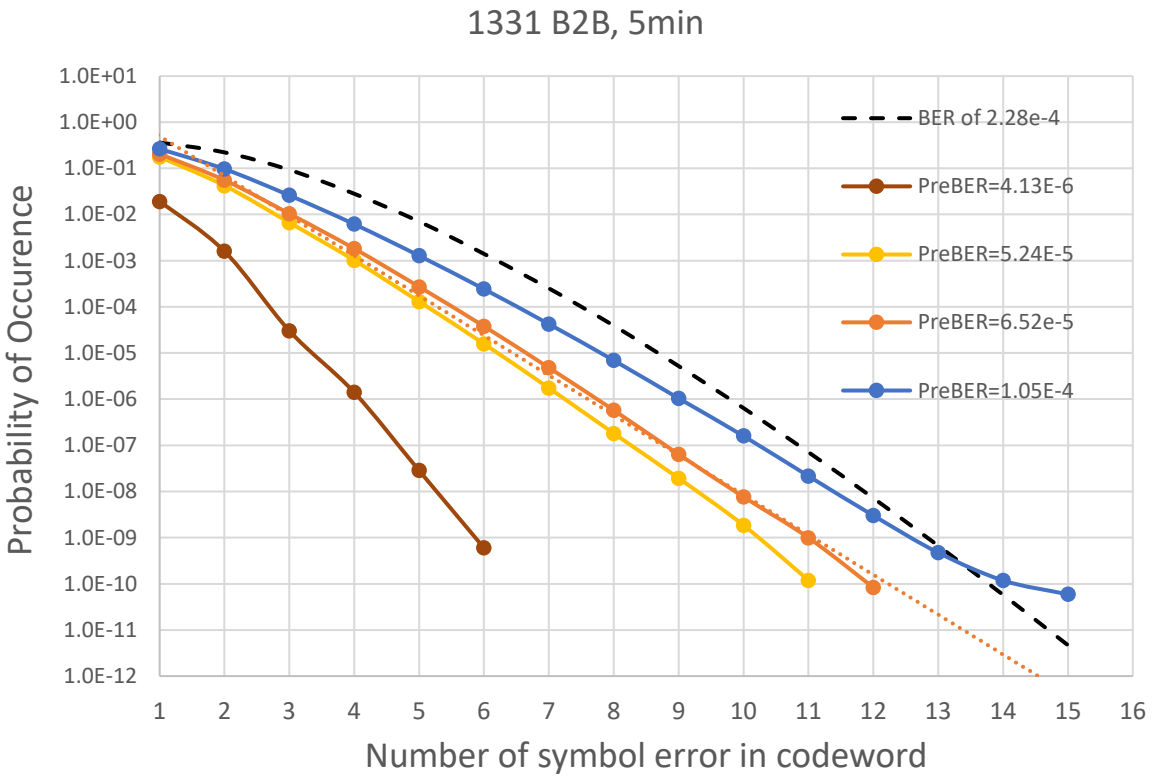
- No distortion or bending occur for the BLER curves with (negative dispersion) fiber transmission

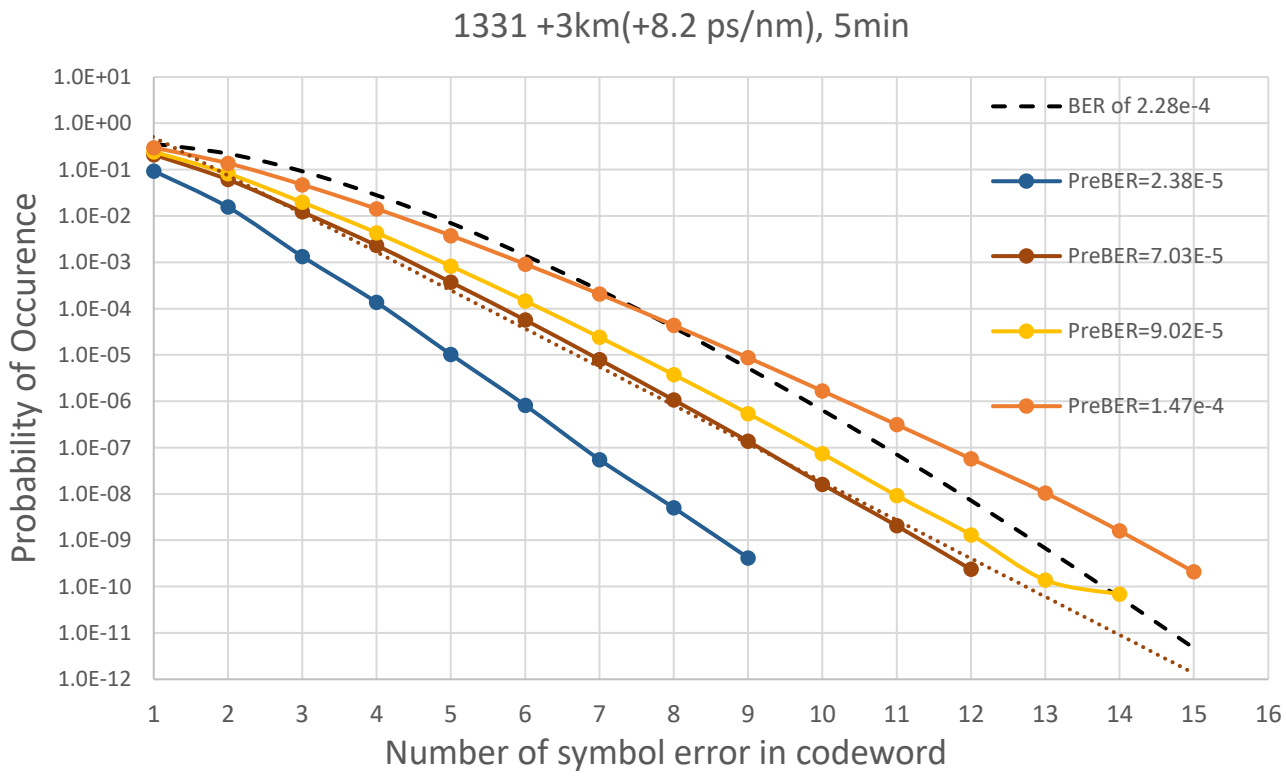




FEC tail curves with fiber transmission

- No distortion or bending occur for the BLER curves with (positive dispersion) fiber transmission





Summary

- Test data show consistent FEC tail results with different test time with a given pre-FEC BER (or receiver input power)
  - Over 5 seconds, 5 minutes, to 2 hours
  - Over repeated tests
  - Over 2 different DSPs
  - BTB and over fiber dispersion max/min.
- Short test time (5 seconds) data with linear extrapolation (log10 Y-axis unit) for FEC tail showing a good representation to determine receiver sensitivity or do the pass/fail criteria
- **Suggest remedy:** propose to add an annex 174B (informative) Block Error Ratio estimation, with editorial license.

TERAHOP

THANK YOU