

# TDECQ for 400GASE-DR4: proposed change to filter response.

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# TDECQ block diagram set-up.

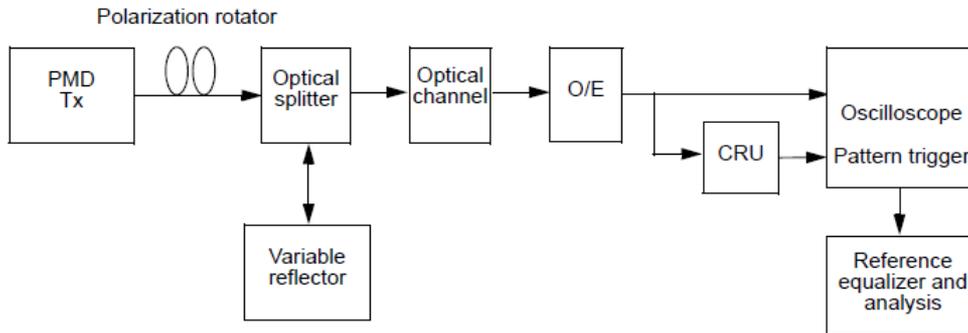


Figure 121-4—TDECQ conformance test block diagram

Table 121-13—Fiber optic cabling (channel) characteristics

Description	200GBASE-DR4	Unit
Operating distance (max)	500	m
Channel insertion loss <sup>a</sup> , <sup>b</sup> (max)	3	dB
Channel insertion loss (min)	0	dB
Positive dispersion <sup>b</sup> (max)	0.8	ps/nm
Negative dispersion <sup>b</sup> (min)	-0.93	ps/nm
DGD_max <sup>c</sup>	2.24	ps
Optical return loss (min)	39	dB

<sup>a</sup>These channel insertion loss values include cable, connectors, and splices.

<sup>b</sup>Over the wavelength range 1304.5 nm to 1317.5 nm

<sup>c</sup>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.

Same as table 124-11 for 400GBASE-DR4

## 124.8.5 Transmitter and dispersion eye closure for PAM4 (TDECQ)

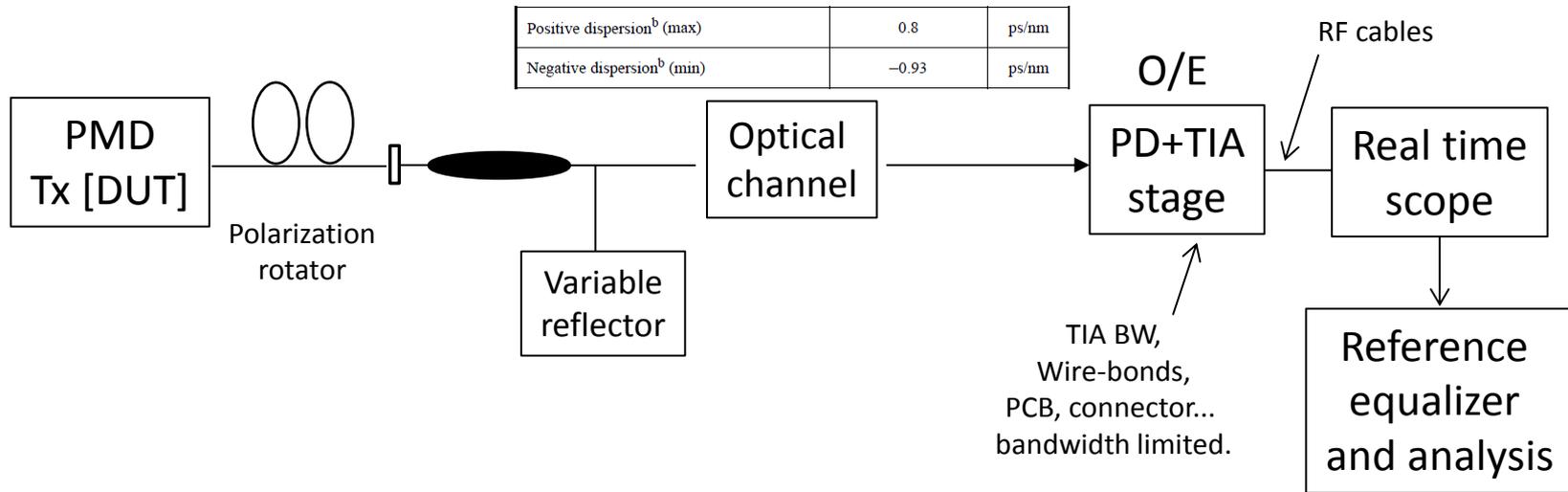
The TDECQ of each lane shall be within the limits given in Table 124-6 if measured using the methods specified in 121.8.5.1, 121.8.5.2, and 121.8.5.3 using a reference equalizer as described in 121.8.5.4, with the following exceptions:

- The signaling rate of the test pattern generator is as given in Table 124-6 [53.125Gbd].
- The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of 38.68 GHz.

### From “121.8.5.2 TDECQ conformance test setup”:

A 200GBASE-DR4 transmitter is to be compliant with a total dispersion at least as negative as the “minimum dispersion” and at least as positive as the “maximum dispersion” columns specified in Table 121-11 for the wavelength of the device under test. This may be achieved with channels consisting of fibers with lengths chosen to meet the dispersion requirements. To verify that the fiber has the correct amount of dispersion, the measurement method defined in IEC 60793-1-42 may be used.

# 400GBASE-DR4: possible real-time implementation for TDECQ.



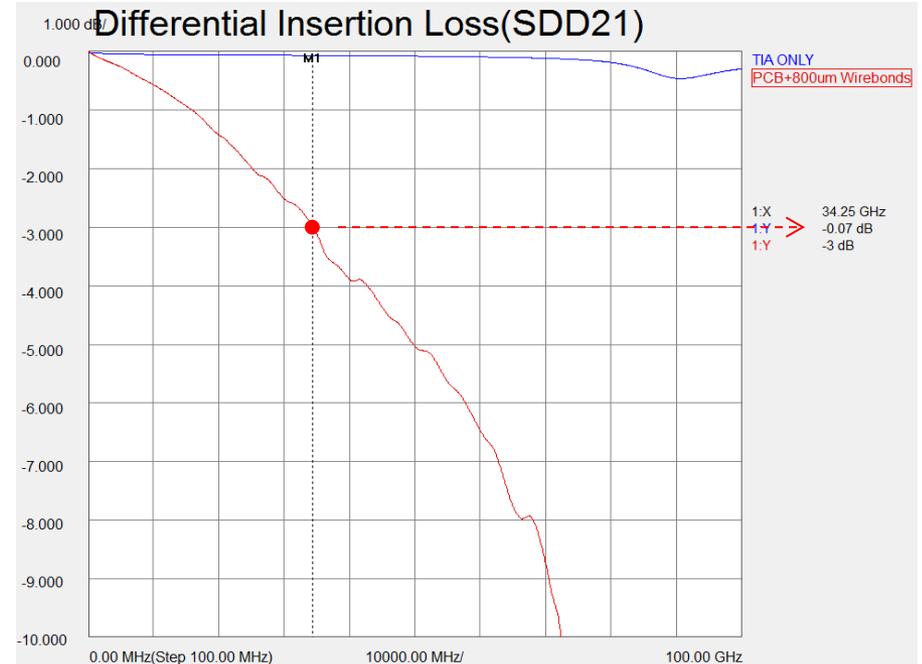
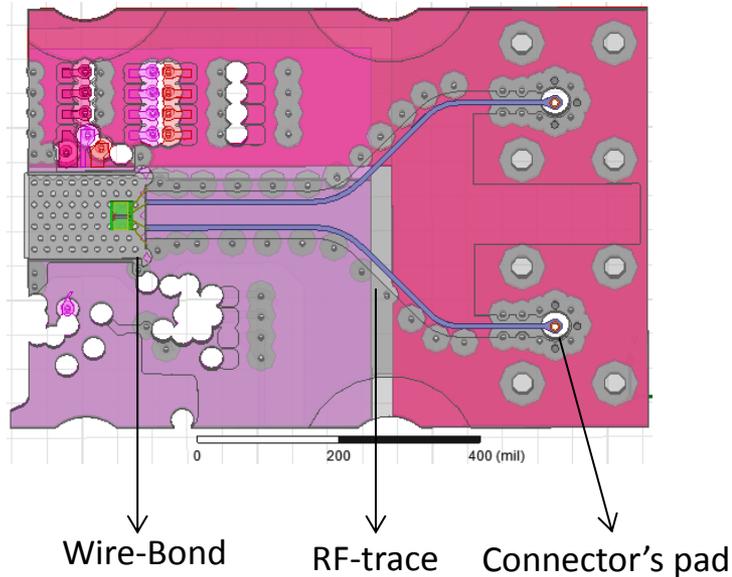
Because O/E converter has to be implemented with separate hardware, TDECQ tester BW is limited when real-time scope option is considered.

Such limitation is not present in case of sampling scope solutions, with variety of optical heads.

- Above set-up should be closer to emulate typical system implementations.
- TDECQ reference equalizer (not yet defined) for 400GBASE-DR4 should take into account this BW limitation too.

# Insertion Loss performance differences.

Dielectric Constant = 3.8  
Loss Tangent = 0.02  
(@ 1GHz)



Connector's and cable's loss are not included.

Left picture is a typical design of a discrete PD+TIA stage, followed by wire-bonds to PCB and connector pad.

Blue and red line is BW comparison between such cascade (red) and the achievable TIA bandwidth (blue): the limitation is not in the TIA itself, but in the channel following it.

# Comments and proposal.

- Implementing TDECQ conformance test set-up with real-time scope can limit the bandwidth because an external O/E is needed.
- Simulation of optimized solutions show a 3dB bandwidth of 34.25GHz, without including cables and connectors losses.
- For this, the value of combination of the O/E converter and the oscilloscope filter response bandwidth of draft 1.4, 124.8.5 should be reduced to take into account real-time implementation.
- From first analysis and available hardware, seems a reasonable minimum value closer to 33GHz rather than 38.68GHz.
- One side advantage is that this will allow (also) to test TDECQ with receiver filter closer to what real system would be, allowing to remove it on higher bandwidth TDECQ set-up implementation too.

From above, into **124.8.5**, we then propose to change:

*“The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a bandwidth of 38.68 GHz”.*

Into:

*“The combination of the O/E converter and the oscilloscope has a fourth-order Bessel-Thomson filter response with a **minimum** bandwidth of **33** GHz”.*

THANK YOU