

# TERAHOP

## Refine the Rx Sensitivity/Tx OMA for DR and FR4-500 D3.0 Comment # I-72, I-73

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TeraHop

# Background revisit

- The real product samples data we presented in [he\\_3dj\\_01\\_2603](#) showing Rx sensitivities with good margin ( $>2$  dB) can be achievable for 800GBASE DR4 and 800GBASE FR4-500
- Reducing Rx sensitivity spec for FR4 (2km) was also proposed but only based on simulation results. No consensus has been made due to lack of test data for inner FEC
- The straw poll for direction of lowering Tx/Rx OMA power for DR/FR-500 was show below

Straw Poll # 8

I support the direction to shift the optical Tx and Rx budget lower for the optical DR/FR4-500 optical specs as discussed in [he\\_3dj\\_01\\_2603](#) and [fan\\_3dj\\_01a\\_2603](#).

Yes  
No

Result: Y: 44 N: 28

- Two remain comments left:
  - How is BER margin at OMA\_sens spec?
  - How is the impact for interoperating with linear optics (LPO, TRO)?



# Updated Proposal for Tx OMA/Rx\_sens OMA

Current Specs	DRx	FR4-500	DRx-2	FR4	LR4	Unit
Tx OMA <sub>outer</sub> , each lane (min) for TECQ ≤ 0.9 dB	-0.1	0.9	-0.1	0.8	1.9 (TECQ ≤ 1.4dB)	dBm
Rx sensitivity (OMA <sub>outer</sub> ), each lane (max) for TECQ ≤ 0.9 dB	-3.4	-3.2	-4.4	-3.7	-5.5 (TECQ ≤ 1.4dB)	dBm

↓ 0.6 dB

↓ 0.8 dB

↓ 0.7 dB

Proposed Specs	DRx	FR4-500	DRx-2	FR4	LR4	Unit
Tx OMA <sub>outer</sub> , each lane (min) for TECQ ≤ 0.9 dB	-0.7	0.1	-0.1	0.8	1.9 (TECQ ≤ 1.4dB)	dBm
Rx sensitivity (OMA <sub>outer</sub> ), each lane (max) for TECQ ≤ 0.9 dB	-4.0	-4.0	-4.4	-3.7	-5.5 (TECQ ≤ 1.4dB)	dBm



# Rx\_sens\_OMA margin and BER margin at reduced Rx sensitivity limit

- The Rx DUTs are Siphon based **1.6T 2xDR4**, the TECQ of the test Tx is in range of **2.4-2.9 dB**
- Tested upper boundary of Pre-FEC BER @-2.5dBm (OMA) still has **more than 2 decades** margin from **2e-5** BER limit

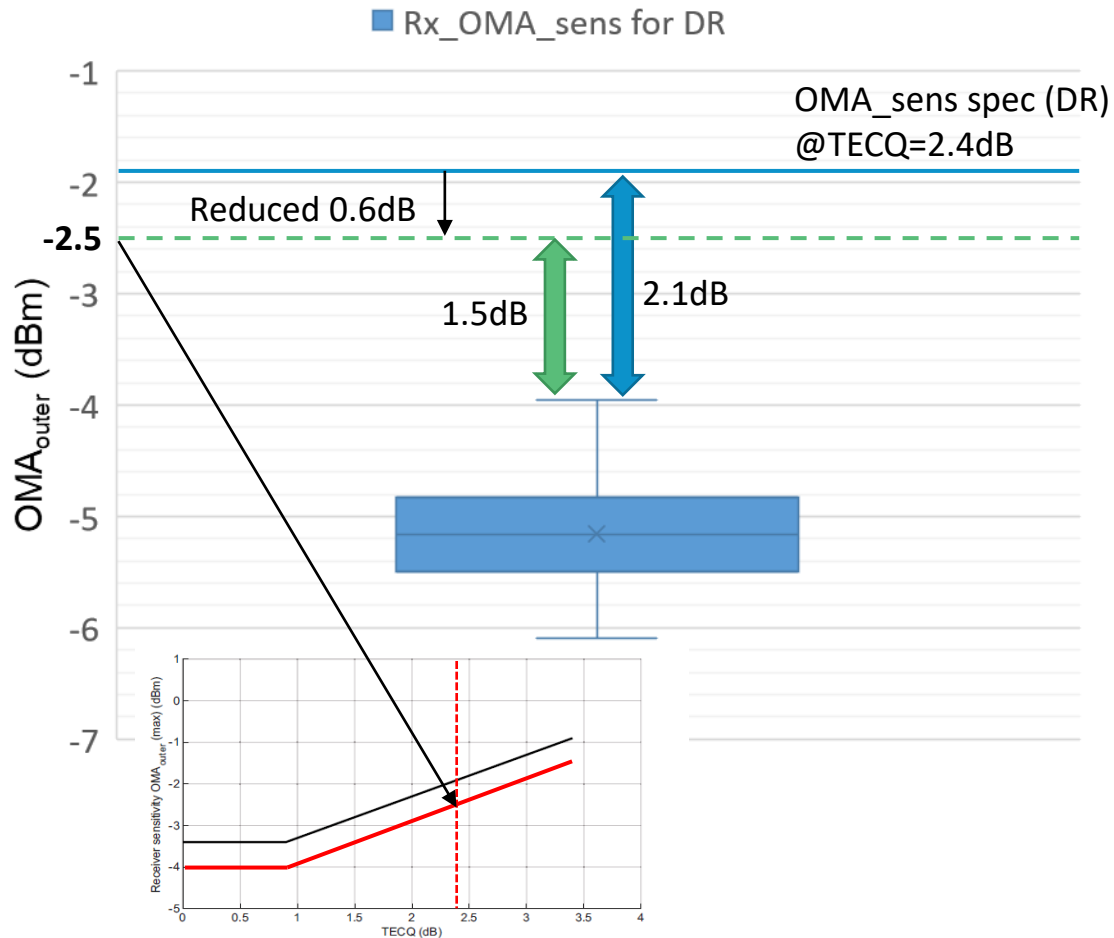
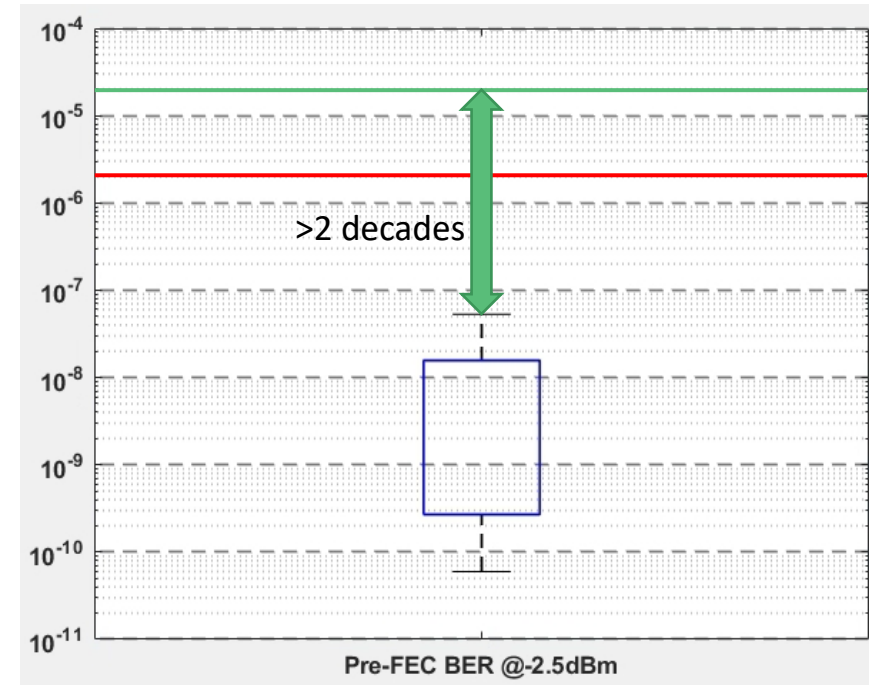
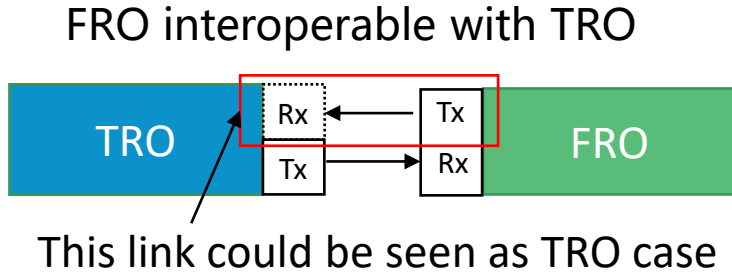


Figure 180-4—Receiver sensitivity ( $OMA_{outer}$ ), each lane (max)

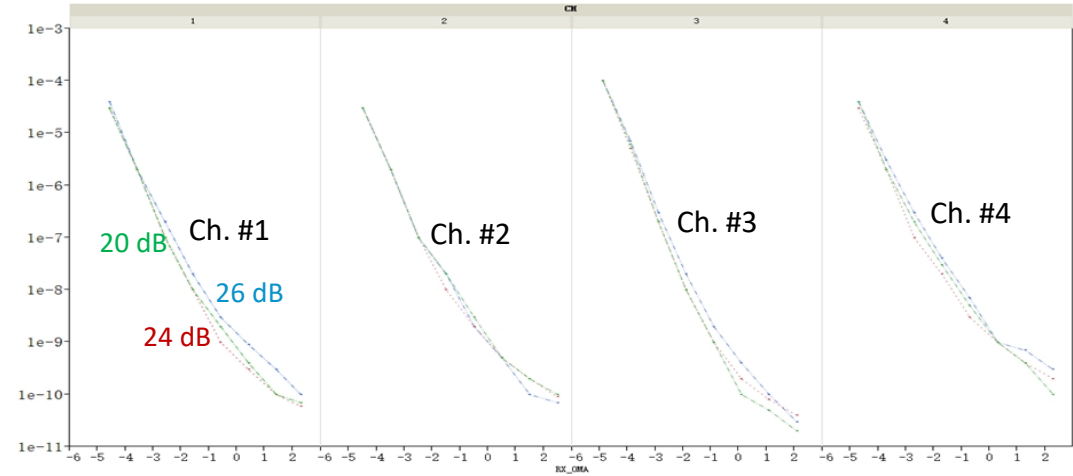


# FRO interoperable with TRO



- **TRO:** Transmitter Retimed Optics
- **FRO:** Full Retimed Optics
- The simulation result for TRO in the reference paper below (page 7) shows max C2M channel loss (27dB) for TRO will probably induce ~1.2dB SNR penalty (according to **0.6dB** optical link penalty). This little penalty could probably be compensated by EQ of module (or host) Rx
- The BER test data show almost no penalty with 26dB Rx side C2M channel loss

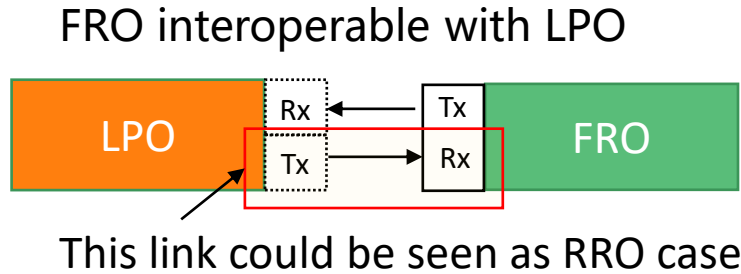
1.6T TRO test BER with (Rx C2M bump to bump) channel losses



Reference: [Linear Pluggable Optics Beyond 112G: Where are the use cases ?](#)



# FRO interoperable with LPO



- **LPO:** Linear Pluggable Optics
- The simulation result for RRO (Rx-retimed optics) in the reference paper below (page 8) shows max C2M channel loss (22dB) for LPO (w/ 10dB peaking) will probably induce ~7dB SNR penalty (according to **3.5dB** optical link penalty). It is difficult to be compensated

Reference: [Linear Pluggable Optics Beyond 112G: Where are the use cases ?](#)



# Summary

- BER curves show **more than 2 decades** BER margin from **2e-5 BER limit**
- The simulation results by Google team show very little optical penalty for **FRO Tx to TRO Rx direction** at 27dB C2M loss. Our test results also show no penalty at 26dB loss
- The interop for **LPO Tx to FRO Rx direction** is difficult due to large SNR penalty



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**THANK YOU**

# Suggested remedy for DR Tx (reduce 0.6dB)

Table 180-7—200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, and 1.6TBASE-DR8 transmit characteristics

Description	Reference	200GBASE-DR1	400GBASE-DR2 800GBASE-DR4 1.6TBASE-DR8	Unit
Signaling rate, each lane (range)	—	106.25 ± 50 ppm		GBd
Modulation format	—	PAM4		—
Lane wavelength (range)	180.9.3	1304.5 to 1317.5		nm
Side-mode suppression ratio (SMSR), each lane (min)	180.9.3	30		dB
Average launch power, each lane (max)	180.9.4	4		dBm
Average launch power, each lane <sup>a</sup> (min)	180.9.4	<del>-3.1</del> <sup>b</sup> -3.7		dBm
Outer optical modulation amplitude (OMA <sub>outer</sub> ), each lane (max)	180.9.5	4.2		dBm
Outer optical modulation amplitude (OMA <sub>outer</sub> ), each lane (min) for max(TECQ, TDECQ) < 0.9 dB for 0.9 dB ≤ max(TECQ, TDECQ) ≤ 3.4 dB	180.9.5	<del>-0.1</del> -0.7 -1.6 -1+ max(TECQ, TDECQ)		dBm dBm

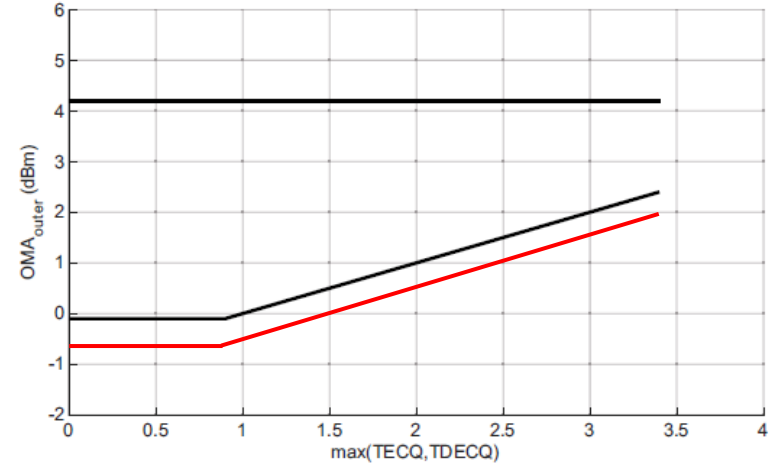


Figure 180-3—OMA<sub>outer</sub> each lane (max) and OMA<sub>outer</sub> each lane (min) versus max(TECQ, TDECQ)

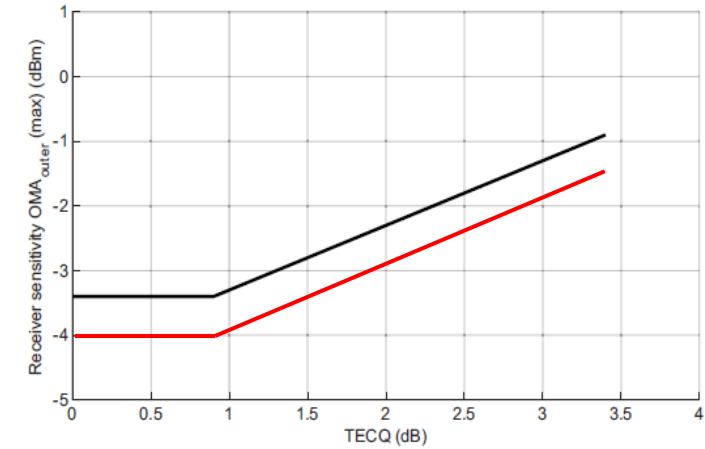


# Suggested remedy for DR Rx (reduce 0.6dB)

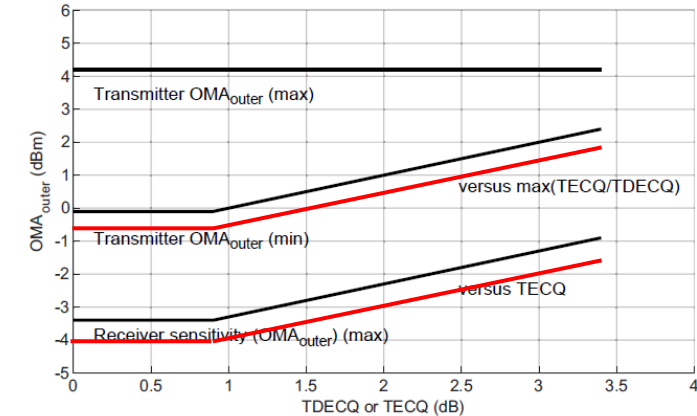
**Table 180–8—200GBASE-DR1, 400GBASE-DR2, 800GBASE-DR4, and 1.6TBASE-DR8 receive characteristics**

Description	Reference	Value	Unit
Signaling rate, each lane (range)	—	106.25 ± 50 ppm	GBd
Modulation format	—	PAM4	—
Lane wavelengths (range)	180.9.3	1304.5 to 1317.5	nm
Damage threshold <sup>a</sup> , each lane	—	5	dBm
Average receive power, each lane (max)	—	4	dBm
Average receive power, each lane <sup>b</sup> (min)	—	<del>-6.1</del> -6.7	dBm
Receive power (OMA <sub>outer</sub> ), each lane (max)	—	4.2	dBm
Receiver reflectance (max)	—	-26	dB

Description	Reference	Value	Unit
Receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>c</sup> (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	180.9.15	<del>-3.4 -4.0</del> -4.9 -4.3 + TECQ	dBm
Stressed receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>c</sup> (max)	180.9.16	<del>-0.9 -1.5</del>	dBm
Conditions of stressed receiver sensitivity test <sup>d</sup> :			
Stressed eye closure for PAM4 (SECQ), lane under test	—	3.4	dB
OMA <sub>outer</sub> of each aggressor lane <sup>e</sup>	—	4.2	dBm



**Figure 180–4—Receiver sensitivity (OMA<sub>outer</sub>), each lane (max)**



**Figure 180–5—Transmitter OMA<sub>outer</sub> each lane versus max(TECQ, TDECQ) and receiver sensitivity (OMA<sub>outer</sub>) each lane versus TECQ**



# Suggested remedy for FR4-500 Tx (reduce 0.8dB)

Table 181-5—800GBASE-FR4-500 transmit characteristics

Description	Reference	800GBASE-FR4-500	Unit
Signaling rate, each lane (range)	—	106.25 ± 50 ppm	GBd
Modulation format	—	PAM4	—
Lane wavelengths (range)	181.9.3	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Side-mode suppression ratio (SMSR), each lane (min)	181.9.3	30	dB
Total average launch power (max)	181.9.4	10.9	dBm
Average launch power, each lane (max)		4.9	dBm
Average launch power, each lane <sup>a</sup> (min)		-2.1 <sup>b</sup> -2.9	dBm
Outer optical modulation amplitude (OMA <sub>outer</sub> ), each lane (max)	181.9.5	4.8	dBm
Outer optical modulation amplitude (OMA <sub>outer</sub> ), each lane (min) for max(TECQ, TDECQ) < 0.9 dB for 0.9 dB ≤ max(TECQ, TDECQ) ≤ 3.4 dB		0.9 0.1 -0.8 + max(TECQ, TDECQ)	dBm dBm

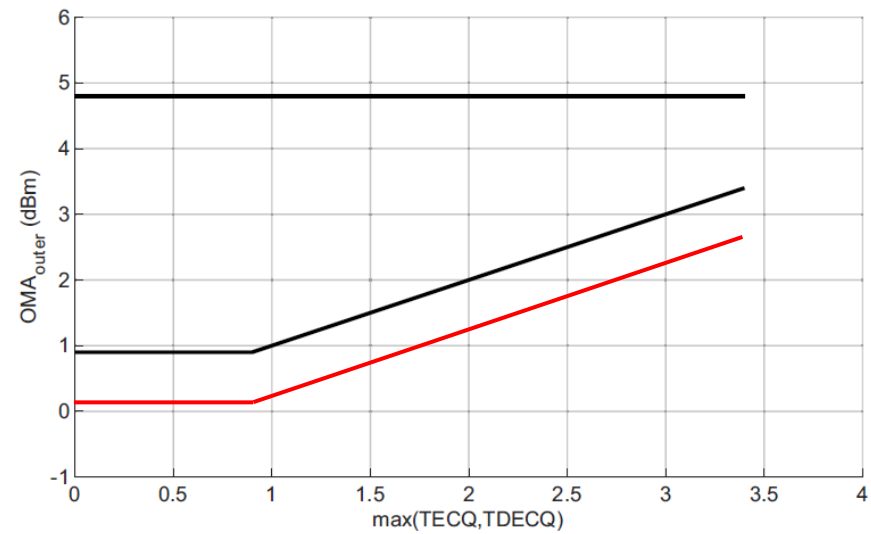


Figure 181-3—OMA<sub>outer</sub> each lane (max) and OMA<sub>outer</sub> each lane (min) versus max(TECQ, TDECQ)



# Suggested remedy for FR4-500 Rx (reduce 0.8dB)

Table 181-6—800GBASE-FR4-500 receive characteristics

Description	Reference	800GBASE-FR4-500	Unit
Signaling rate, each lane (range)	—	106.25 ± 50 ppm	GBd
Modulation format	—	PAM4	—
Lane wavelengths (range)	181.9.3	1264.5 to 1277.5 1284.5 to 1297.5 1304.5 to 1317.5 1324.5 to 1337.5	nm
Damage threshold <sup>a</sup> , each lane	—	5.9	dBm
Average receive power, each lane (max)	—	4.9	dBm
Average receive power, each lane <sup>b</sup> (min)	—	-5.6 -6.4	dBm
Receive power (OMA <sub>outer</sub> ), each lane (max)	—	4.8	dBm
Difference in receive power between any two lanes (OMA <sub>outer</sub> ) (max)	—	4.1	dB
Receiver reflectance (max)	—	-26	dB
Receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>c</sup> (max) for TECQ < 0.9 dB for 0.9 dB ≤ TECQ ≤ SECQ	181.9.15	-3.2 -4.0 -4.9 -4.1 + TECQ	dBm dBm
Stressed receiver sensitivity (OMA <sub>outer</sub> ), each lane <sup>c</sup> (max)	181.9.16	-0.7 -1.5	dBm
Conditions of stressed receiver sensitivity test: <sup>d</sup>			
Stressed eye closure for PAM4 (SECQ), lane under test	—	3.4	dB
OMA <sub>outer</sub> of each aggressor lane	—	1.3	dBm

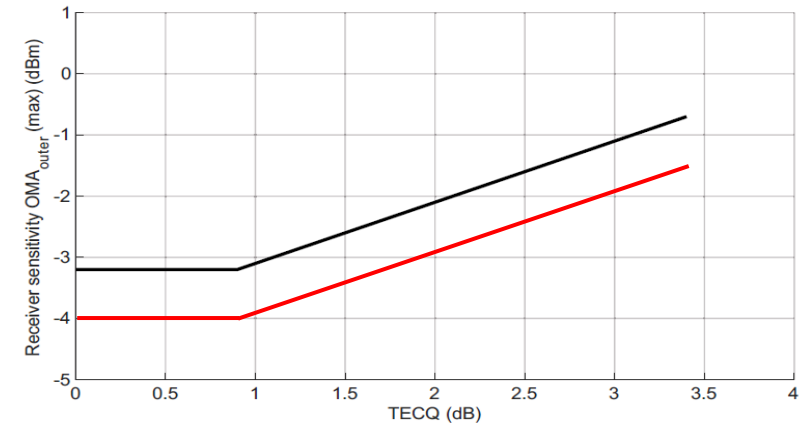


Figure 181-4—Receiver sensitivity (OMA<sub>outer</sub>), each lane (max)

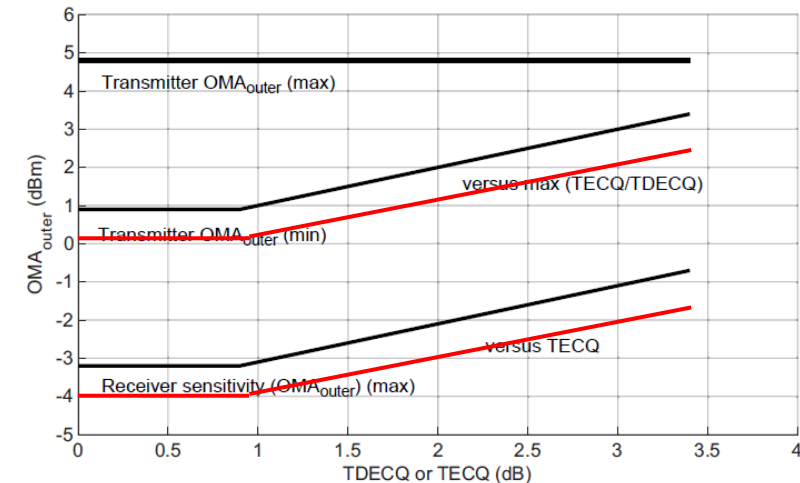


Figure 181-5—Transmitter OMA<sub>outer</sub> each lane versus max(TECQ, TDECQ) and receiver sensitivity (OMA<sub>outer</sub>) each lane versus TECQ

