

25GBASE-LR and 25GBASE-ER Interoperation

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Outline

1. Several comments indicated that the conditions for interoperability of 25GBASE-LR and 25GBASE-ER needed clarification to ensure that the min/max specifications for OMA and average power (P_{avg}) are satisfied.
2. One possible solution is to make the following 3 additions / changes to the specification:
 1. For channel loss of 0 – 4 dB:
 1. Require 5 ± 1 dB attenuator when connecting 25GBASE-ER transmitter (Tx) to 25GBASE-LR receiver (Rx).
 2. Require 8 ± 1 dB attenuator when connecting 25GBASE-LR Tx to 25GBASE-ER Rx.
 2. For channel loss of 4 – 6.3 dB:
 1. Require 2 ± 1 dB attenuator when connecting 25GBASE-ER Tx to 25GBASE-LR Rx.
 2. Require 5 ± 1 dB attenuator when connecting 25GBASE-LR Tx to 25GBASE-ER Rx.

Specifications (From P802.3cc D2.0)

Table 114-6—25GBASE-LR and 25GBASE-ER transmit characteristics

Description	25GBASE-LR	25GBASE-ER	Unit
Signaling rate (range)	25.78125 ± 100 ppm		GBd
Center wavelength (range)	1295 to 1325	1295 to 1310	nm
Side-mode suppression ratio (SMSR), (min)	30		dB
Average launch power (max)	2	6	dBm
Average launch power ^a (min)	-7	-3	dBm
Optical Modulation Amplitude (OMA), (max)	2.2	6	dBm
Optical Modulation Amplitude (OMA) ^b , (min)	-4	0	dBm
Launch power in OMA minus TDP (min)	-5	-1	dBm
Transmitter and dispersion penalty (TDP), (max)	2.7	2.7	dB
Average launch power of OFF transmitter (max)	-25		dBm
Extinction ratio (min)	3.5	4	dB
RIN ₂₀ OMA (max)	-130		dB/Hz
Optical return loss tolerance (max)	20		dB
Transmitter reflectance ^c (max)	-12		dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio 5x10 ⁻³ hits per sample.	{0.31, 0.4, 0.45, 0.34, 0.38, 0.4}		

^aAverage launch power (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

^bEven if the TDP < 1 dB, the OMA (min) must exceed this value.

^cTransmitter reflectance is defined looking into the transmitter.

Table 114-8—25GBASE-LR and 25GBASE-ER illustrative link power budgets

Parameter	25GBASE-LR	25GBASE-ER		Unit
Power budget (for maximum TDP)	9	20.7		dB
Operating distance	10	30	40 ^a	km
Channel insertion loss (max)	6.3 ^b	15	18	dB
Channel insertion loss (min)	0	10		dB
Maximum discrete reflectance	-26	-26		dB
Allocation for penalties ^c (for maximum TDP)	2.7	2.7		dB
Additional insertion loss allowed	0	3	0	dB

^aLinks longer than 30 km are considered engineered links. Attenuation for such links needs to be less than the worst case for B1.1, B1.3, or B6 a single-mode cabled optical fiber

^bThe channel insertion loss is calculated using the maximum distance specified in Table 114-5 for 25GBASE-LR and fiber attenuation of 0.43 dB/km at 1295 nm plus an allocation for connection and splice loss given in 88.11.2.1.

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

Table 114-7—25GBASE-LR and 25GBASE-ER receive characteristics

Description	25GBASE-LR	25GBASE-ER	Unit
Signaling rate (range)	25.78125 ± 100 ppm		GBd
Center wavelength (range)	1295 to 1325		nm
Damage threshold ^a (min)	5.5	-3	dBm
Average receive power (max)	2	-4	dBm
Average receive power ^b (min)	-13.3	-19.6 -21	dBm
Receive power (OMA), (max)	2.2	-4	dBm
Receiver reflectance (max)	-26		dB
Receiver sensitivity (OMA) ^c , (max)	-11.3	-19	dBm
Stressed receiver sensitivity (OMA) ^d , (max)	-8.8	-16.5	dBm
Conditions of stressed receiver sensitivity test			
Vertical eye closure penalty ^e	1.9	1.9	dB
Stressed eye J2 Jitter ^e	0.27	0.27	UI
Stressed eye J4 Jitter ^e	0.39	0.39	UI
SRS eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio 5x10 ⁻³ hits per sample.	{0.24, 0.5, 0.5, 0.24, 0.24, 0.4}	{0.24, 0.5, 0.5, 0.24, 0.24, 0.4}	

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

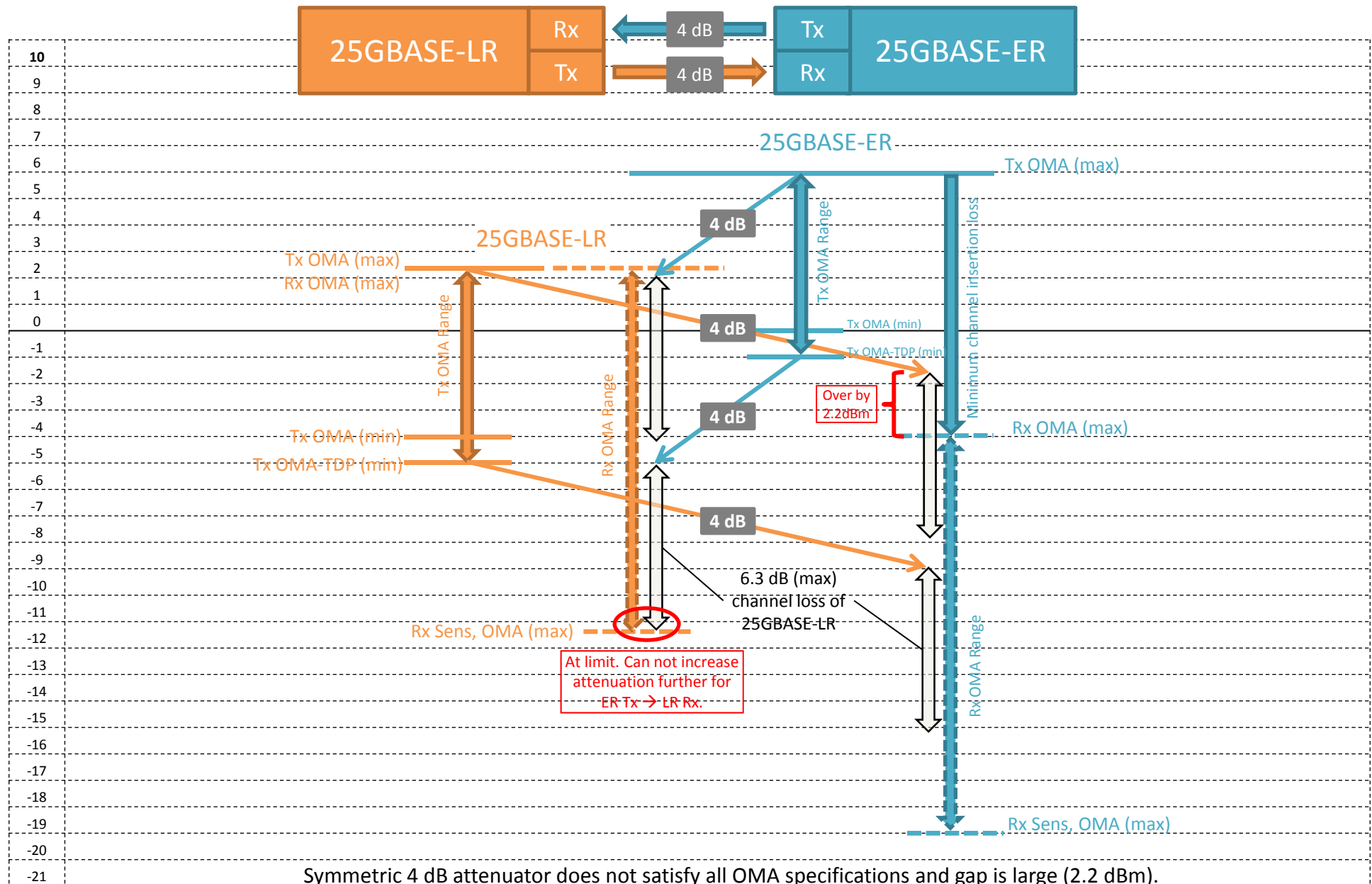
^bAverage receive power (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

^cReceiver sensitivity (OMA), (max) is informative.

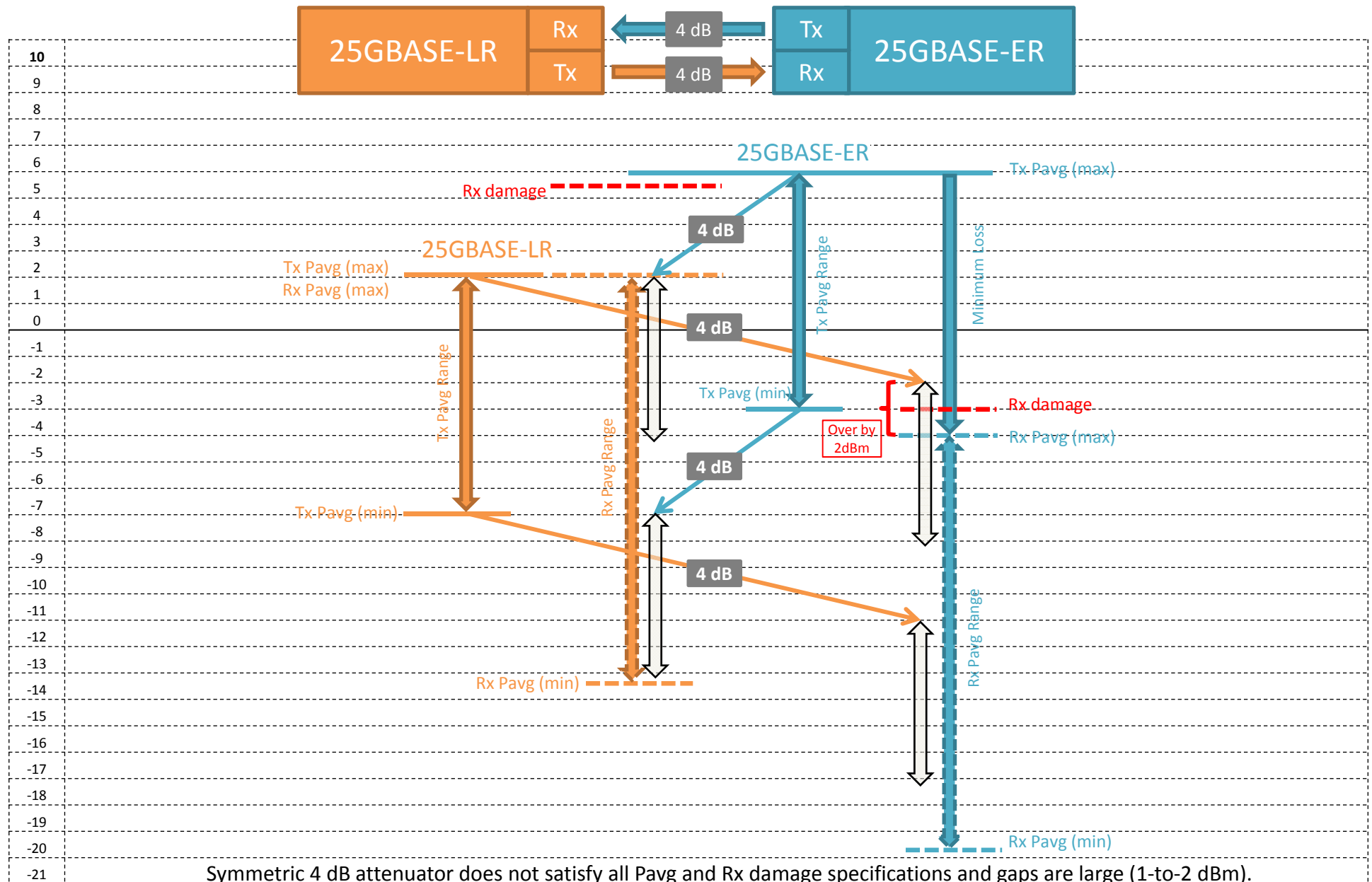
^dMeasured with conformance test signal at TP3 (see 114.7.10) for the BER specified in 114.1.1

^eVertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J4 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

25GBASE-LR and 25GBASE-ER Interconnected With 4dB (min) Attenuator – OMA

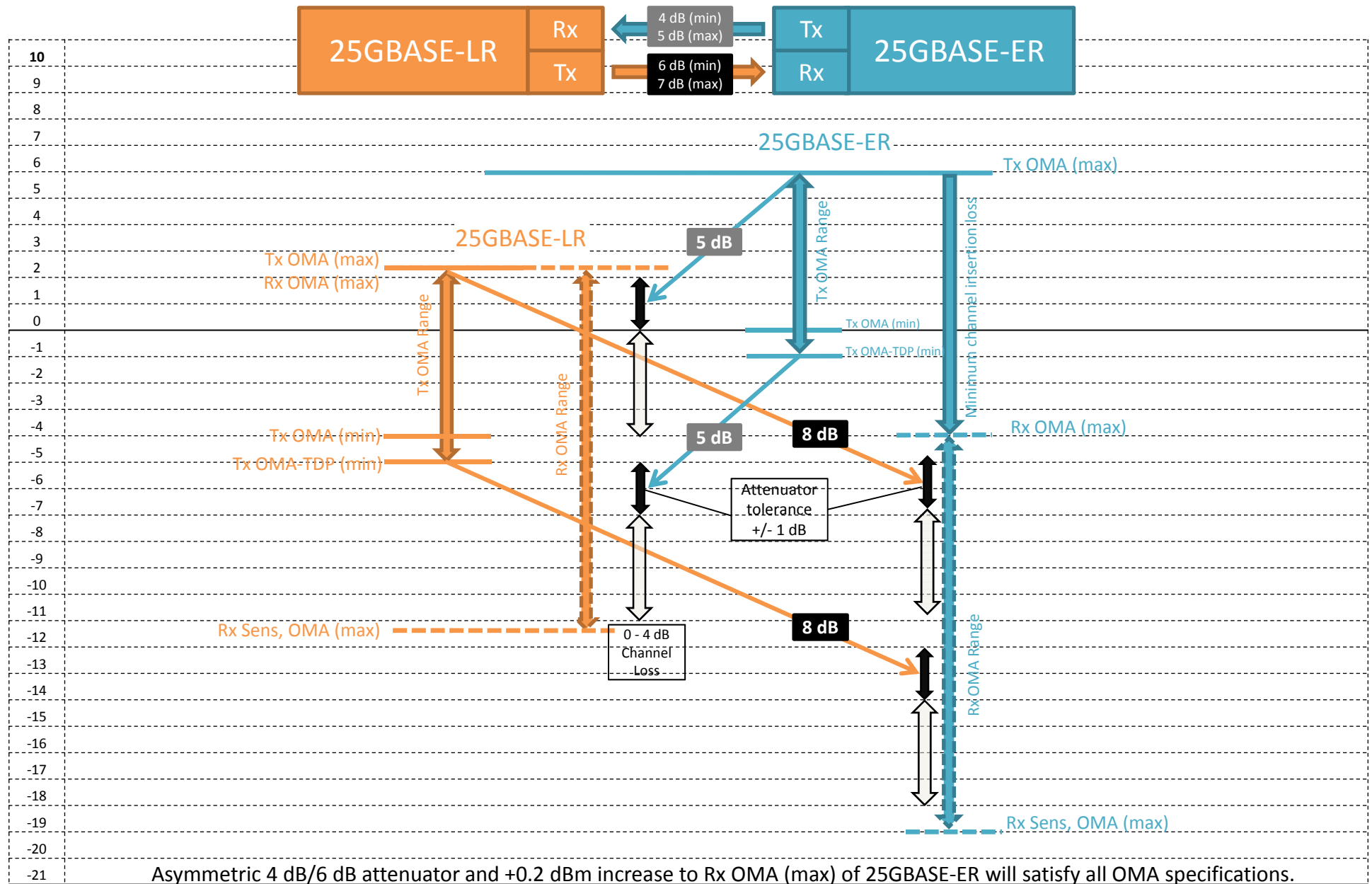


25GBASE-LR and 25GBASE-ER Interconnected With 4dB (min) Attenuator - Pavg



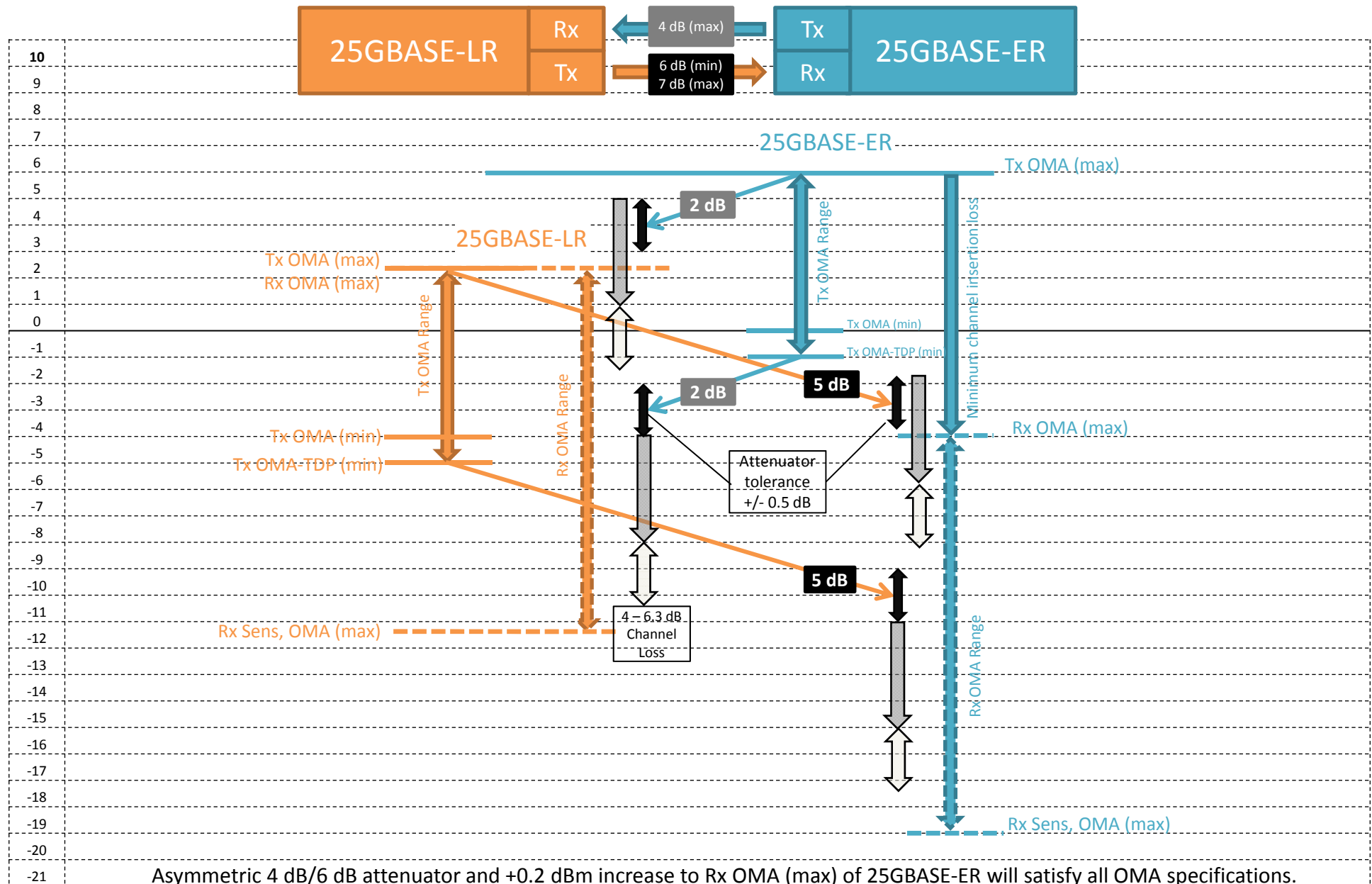
25GBASE-LR and 25GBASE-ER Interconnection Attenuator Tolerance Considerations – OMA

Channel Loss of 0-4 dB



25GBASE-LR and 25GBASE-ER Interconnection Attenuator Tolerance Considerations – OMA

Channel Loss of 4 – 6.3 dB



Summary

1. Interoperation between 25GBASE-LR and 25GBASE-ER can be achieved adding two requirements to the channel loss and making one minor change to the 25GBASE-ER specification:
 1. For channel loss of 0 – 4 dB:
 1. Require 5 ± 1 dB attenuator when connecting 25GBASE-ER transmitter (Tx) to 25GBASE-LR receiver (Rx).
 2. Require 8 ± 1 dB attenuator when connecting 25GBASE-LR Tx to 25GBASE-ER Rx.
 2. For channel loss of 4 – 6.3 dB:
 1. Require 2 ± 1 dB attenuator when connecting 25GBASE-ER Tx to 25GBASE-LR Rx.
 2. Require 5 ± 1 dB attenuator when connecting 25GBASE-LR Tx to 25GBASE-ER Rx.
2. This proposal assumes the current specifications for 25GBASE-ER (i.e. per D2.0 which assumes APD receiver). If the link budget for 25GBASE-ER is shifted to allow for PIN receivers, as has been proposed elsewhere, then further considerations will be needed.

Changes In D2.1 If Adopted

1. *Change the last sentence of the first paragraph of Clause 114.6 on p30 as follows (changes shown in red):*

The operating ranges for the 25GBASE-LR and 25GBASE-ER PMDs are defined in Table 114–5. A 25GBASE-LR or 25GBASE-ER compliant PMD operates on type B1.1, B1.3, or B6_a single-mode fibers according to the specifications defined in Table 114–11. A PMD that exceeds the operating range requirement while meeting all other optical specifications is considered compliant (e.g., a 25GBASE-LR PMD operating at 12.5 km meets the operating range requirement of 2 m to 10 km). **The 25GBASE-ER PMD interoperates with the 25GBASE-LR PMD provided that the channel requirements specified in Table 114-8 and Table 114-11 are met.**

Changes In D2.1 If Adopted (cont.)

2. Insert the following new columns and footnotes (shown in red) in Table 114-8.

Description	25GBASE-ER transmitter, 25GBASE-LR receiver	25GBASE-LR transmitter, 25GBASE-ER receiver	Unit
Power budget (for maximum TDP)	13	15	dB
Operating distance	10		km
Channel insertion loss (max)	10.3 ^d	12.3 ^d	dB
Channel insertion loss (min)	4 ^{e, f}	7 ^e	dB
Maximum discrete reflectance	-26		dB
Allocation for penalties (for maximum TDP)	2.7		dB
Additional insertion loss allowed	0		dB

- a. Links longer than 30 km are considered engineered links. Attenuation for such links needs to be less than the worst case for B1.1, B1.3, or B6_a single-mode cabled optical fiber
- b. The channel insertion loss is calculated using the maximum distance specified in Table 114-5 for 25GBASE-LR and fiber attenuation of 0.43 dB/km at 1295 nm plus an allocation for connection and splice loss given in 88.11.2.1.
- c. Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.
- d. These channel insertion loss values include a fixed attenuation in addition to the channel insertion loss of 25GBASE-LR. The fixed attenuation value is the minimum channel insertion loss.
- e. The minimum channel insertion loss may be obtained by use of a fixed attenuator with tolerance of ± 1 dB.

Changes In D2.1 If Adopted (cont.)

3. *Insert the following new columns and new footnotes (shown in red) in Table 114-12 (Note: Table 114-12 in D2.0 has the wrong numbering. It should be Table 114-11.)*

Description	25GBASE-ER transmitter, 25GBASE-LR receiver	25GBASE-LR transmitter, 25GBASE-ER receiver	Unit
Operating distance (max)	10		km
Channel insertion loss ^{a, b} (max)	10.3 ^d	12.3 ^d	dB
Channel insertion loss (min)	4 ^e	7 ^e	dB
Positive dispersion ^b (max)	22.6		ps/nm
Negative dispersion ^b (min)	-27.9		ps/nm
DGD_max ^c	8		ps
Optical return loss (min)	21		dB

a. These channel insertion loss values include cable, connectors, and splices.

b. Over the wavelength range 1295 nm to 1325 nm for 25GBASE-LR and 1295 nm to 1310 nm for 25GBASE-ER.

c. DGD_max is the maximum differential group delay that the system must tolerate.

d. These channel insertion loss values include a fixed attenuation in addition to the channel insertion loss of 25GBASE-LR. The fixed attenuation value is the minimum channel insertion loss.

e. The minimum channel insertion loss may be obtained by use of a fixed attenuator with tolerance of ± 1 dB..