

ER, FR and LR interoperability requirements

Pete Anslow, Ciena

IEEE P802.3cn Task Force, Ad Hoc, 4 April 2019

Missing interoperability requirements

- Clause 122 contains interoperability requirements between 400GBASE-FR8 and 400GBASE-LR8
 - This contribution proposes that three new subclauses are created (similar to 114.11)
 - For 200GBASE-ER4 and 200GBASE-LR4 interop requirements (122.11a)
 - For 400GBASE-ER8 and 400GBASE-FR8 interop requirements (122.11b)
 - For 400GBASE-ER8 and 400GBASE-LR8 interop requirements (122.11c)

- Clause 139 contains interoperability requirements between 50GBASE-FR and 50GBASE-LR
 - This contribution proposes that two new subclauses are created (similar to 114.11)
 - For 50GBASE-ER and 50GBASE-FR interop requirements (139.10a)
 - For 50GBASE-ER and 50GBASE-LR interop requirements (139.10b)

200GBASE-ER4 and 200GBASE-LR4 interoperation

- ER4 Tx and LR4 Rx overload
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER4 Tx $\text{OMA}_{\text{outer}}$ max = 7.4 dBm and LR4 Rx $\text{OMA}_{\text{outer}}$ max = 5.1 dBm
 - Consequently, the minimum channel insertion loss is 2.3 dB
- ER4 Tx and LR4 Rx sensitivity
 - For this combination of PMDs the limiting requirement is the same for average power and $\text{OMA}_{\text{outer}}$
 - ER4 Tx ave power min = 0.4 dBm and LR4 Rx ave power min = -9.7 dBm
 - Consequently, the maximum channel insertion loss is 10.1 dB
- LR4 Tx and ER4 Rx overload
 - For this combination of PMDs the limiting requirement is on average power
 - LR4 Tx ave power max = 5.3 dBm and ER4 Rx ave power max = -3.4 dBm (rounded to nearest 0.1 dB)
 - Consequently, the minimum channel insertion loss is 8.7 dB
- LR4 Tx and ER4 Rx sensitivity
 - For this combination of PMDs the limiting requirement is the same for average power and $\text{OMA}_{\text{outer}}$
 - LR4 Tx ave power min = -3.4 dBm and ER4 Rx ave power min = -17.6 dBm
 - Consequently, the maximum channel insertion loss is 14.2 dB

400GBASE-ER8 and 400GBASE-FR8 interoperation

- ER8 Tx and FR8 Rx overload
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER8 Tx $\text{OMA}_{\text{outer}}$ max = 6.4 dBm and FR8 Rx $\text{OMA}_{\text{outer}}$ max = 5.7 dBm
 - Consequently, the minimum channel insertion loss is 0.7 dB
- ER8 Tx and FR8 Rx sensitivity
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER8 Tx $\text{OMA}_{\text{outer}}$ min = 2.4 dBm, FR8 Rx $\text{OMA}_{\text{outer}}$ for SECQ of 1.4 dB = -4.8 dBm and assumed MPI penalty for FR8 channel = 0.3 dB
 - Consequently, the maximum channel insertion loss is 6.9 dB
- FR8 Tx and ER8 Rx overload
 - For this combination of PMDs the limiting requirement is on average power
 - FR8 Tx ave power max = 5.3 dBm and ER8 Rx ave power max = -4.4 dBm
 - Consequently, the minimum channel insertion loss is 9.7 dB
- FR8 Tx and ER8 Rx sensitivity
 - For this combination of PMDs the limiting requirement is on average power
 - FR8 Tx ave power min = -3.5 dBm and ER8 Rx ave power min = -18.1 dBm
 - Consequently, the maximum channel insertion loss is 14.6 dB

400GBASE-ER8 and 400GBASE-LR8 interoperation

- ER8 Tx and LR8 Rx overload
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER8 Tx $\text{OMA}_{\text{outer}}$ max = 6.4 dBm and LR8 Rx $\text{OMA}_{\text{outer}}$ max = 5.7 dBm
 - Consequently, the minimum channel insertion loss is 0.7 dB
- ER8 Tx and LR8 Rx sensitivity
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER8 Tx $\text{OMA}_{\text{outer}}$ min = 2.4 dBm, LR8 Rx $\text{OMA}_{\text{outer}}$ for SECQ of 1.4 dB = -6.6 dBm and assumed MPI penalty for LR8 channel = 0.5 dB
 - Consequently, the maximum channel insertion loss is 8.5 dB
- LR8 Tx and ER8 Rx overload
 - For this combination of PMDs the limiting requirement is on average power
 - LR8 Tx ave power max = 5.3 dBm and ER8 Rx ave power max = -4.4 dBm
 - Consequently, the minimum channel insertion loss is 9.7 dB
- LR8 Tx and ER8 Rx sensitivity
 - For this combination of PMDs the limiting requirement is on average power
 - LR8 Tx ave power min = -2.8 dBm and ER8 Rx ave power min = -18.1 dBm
 - Consequently, the maximum channel insertion loss is 15.3 dB

50GBASE-ER and 50GBASE-FR interoperation

- ER Tx and FR Rx overload
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER Tx $\text{OMA}_{\text{outer}} \text{ max} = 7.4 \text{ dBm}$ and FR Rx $\text{OMA}_{\text{outer}} \text{ max} = 2.8 \text{ dBm}$
 - Consequently, the minimum channel insertion loss is 4.6 dB
- ER Tx and FR Rx sensitivity
 - For this combination of PMDs the limiting requirement is on average power
 - ER Tx ave power min = 0.4 dBm and FR Rx ave power min = -8.1 dBm
 - Consequently, the maximum channel insertion loss is 8.5 dB
- FR Tx and ER Rx overload
 - For this combination of PMDs the limiting requirement is on average power
 - FR Tx ave power max = 3 dBm and ER Rx ave power max = -3.4 dBm (rounded to nearest 0.1 dB)
 - Consequently, the minimum channel insertion loss is 6.4 dB
- FR Tx and ER Rx sensitivity
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - FR Tx $\text{OMA}_{\text{outer}} \text{ min} = -2.5 \text{ dBm}$, ER Rx $\text{OMA}_{\text{outer}}$ for SECQ of 1.4 dB = -15.1 dBm and assumed MPI penalty for FR channel = 0.4 dB
 - Consequently, the maximum channel insertion loss is 12.2 dB

50GBASE-ER and 50GBASE-LR interoperation

- ER Tx and LR Rx overload
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - ER Tx $\text{OMA}_{\text{outer}} \text{ max} = 7.4 \text{ dBm}$ and LR Rx $\text{OMA}_{\text{outer}} \text{ max} = 4 \text{ dBm}$
 - Consequently, the minimum channel insertion loss is 3.4 dB
- ER Tx and LR Rx sensitivity
 - For this combination of PMDs the limiting requirement is the same for average power and $\text{OMA}_{\text{outer}}$
 - ER Tx ave power min = 0.4 dBm and LR Rx ave power min = -10.8 dBm
 - Consequently, the maximum channel insertion loss is 11.2 dB
- LR Tx and ER Rx overload
 - For this combination of PMDs the limiting requirement is on average power
 - LR Tx ave power max = 4.2 dBm and ER Rx ave power max = -3.4 dBm (rounded to nearest 0.1 dB)
 - Consequently, the minimum channel insertion loss is 7.6 dB
- ER Tx and LR Rx sensitivity
 - For this combination of PMDs the limiting requirement is on $\text{OMA}_{\text{outer}}$
 - LR Tx $\text{OMA}_{\text{outer}} \text{ min} = -1.5 \text{ dBm}$, ER Rx $\text{OMA}_{\text{outer}}$ for SECQ of 1.4 dB = -15.1 dBm and assumed MPI penalty for LR channel = 0.6 dB
 - Consequently, the maximum channel insertion loss is 13 dB

Subclause 122.7 changes

- Add three sentences to 122.7 as below.

Change the title and contents of 122.7 and its subclauses as follows:

122.7 PMD to MDI optical specifications for 200GBASE-FR4, 200GBASE-LR4, 200GBASE-ER4, 400GBASE-FR8, ~~and~~ 400GBASE-LR8, ~~and~~ 400GBASE-ER8

The operating ranges for the 200GBASE-FR4, 200GBASE-LR4, 200GBASE-ER4, 400GBASE-FR8, ~~and~~ 400GBASE-LR8, and 400GBASE-ER8 PMDs are defined in Table 122–8. A 200GBASE-FR4, 200GBASE-LR4, 200GBASE-ER4, 400GBASE-FR8, ~~or~~ 400GBASE-LR8, or 400GBASE-ER8 compliant PMD operates on type B1.1, B1.3, or B6_ a single-mode fibers according to the specifications defined in Table 122–18. A PMD that exceeds the operating range requirement while meeting all other optical specifications is considered compliant (e.g., a 400GBASE-FR8 PMD operating at 2.5 km meets the operating range requirement of 2 m to 2 km). The 200GBASE-ER4 PMD interoperates with the 200GBASE-LR4 PMD provided that the channel requirements defined in 122.11a are met. The 400GBASE-LR8 PMD interoperates with the 400GBASE-FR8 PMD provided that the channel requirements for 400GBASE-FR8 are met. The 400GBASE-ER8 PMD interoperates with the 400GBASE-FR8 PMD provided that the channel requirements defined in 122.11b are met. The 400GBASE-ER8 PMD interoperates with the 400GBASE-LR8 PMD provided that the channel requirements defined in 122.11c are met.

Subclause 139.6 changes

- Add two sentences to the end of 139.6 as below.

Change the title and contents of 139.6 and its subclauses as follows:

139.6 PMD to MDI optical specifications for 50GBASE-FR, and 50GBASE-LR, and 50GBASE-ER

The operating ranges for the 50GBASE-FR, and 50GBASE-LR, and 50GBASE-ER PMDs are defined in Table 139–5. A 50GBASE-FR, or 50GBASE-LR, or 50GBASE-ER compliant PMD operates on type B1.1, B1.3, or B6_a single-mode fibers according to the specifications defined in Table 139–13. A PMD that exceeds the operating range requirement while meeting all other optical specifications is considered compliant (e.g., a 50GBASE-FR PMD operating at 2.5 km meets the operating range requirement of 2 m to 2 km). The 50GBASE-LR PMD interoperates with the 50GBASE-FR PMD provided that the channel requirements for 50GBASE-FR are met. The 50GBASE-ER PMD interoperates with the 50GBASE-FR PMD provided that the channel requirements defined in 139.10a are met. The 50GBASE-ER PMD interoperates with the 50GBASE-LR PMD provided that the channel requirements defined in 139.10b are met.

Add subclause 122.11a

- Add 122.11a as below.

Insert 122.11a, 122.11b, and 122.11c after 122.11 as follows:

122.11a Requirements for interoperation between 200GBASE-ER4 and 200GBASE-LR4

The 200GBASE-ER4 and 200GBASE-LR4 PMDs can interoperate with each other (over an engineered link) provided that the fiber optic cabling (channel) characteristics for 200GBASE-LR4 given in 122.10 are met, with the exception of the maximum and minimum channel insertion loss values, which are given in Table 122–20 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 122–20—Channel insertion loss requirements for interoperation between 200GBASE-ER4 and 200GBASE-LR4

Direction	Min loss	Max loss	Unit
200GBASE-ER4 transmitter to 200GBASE-LR4 receiver	2.3	10.1	dB
200GBASE-LR4 transmitter to 200GBASE-ER4 receiver	8.7	14.2	dB

Add subclause 122.11b

- Add 122.11b as below.

122.11b Requirements for interoperation between 400GBASE-ER8 and 400GBASE-FR8

The 400GBASE-ER8 and 400GBASE-FR8 PMDs can interoperate with each other (over an engineered link) provided that the fiber optic cabling (channel) characteristics for 400GBASE-FR8 given in 122.10 are met, with the exception of the maximum and minimum channel insertion loss values, which are given in Table 122–21 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 122–21—Channel insertion loss requirements for interoperation between 400GBASE-ER8 and 400GBASE-FR8

Direction	Min loss	Max loss	Unit
400GBASE-ER8 transmitter to 400GBASE-FR8 receiver	0.7	6.9	dB
400GBASE-FR8 transmitter to 400GBASE-ER8 receiver	9.7	14.6	dB

Add subclause 122.11c

- Add 122.11c as below.

122.11c Requirements for interoperation between 400GBASE-ER8 and 400GBASE-LR8

The 400GBASE-ER8 and 400GBASE-LR8 PMDs can interoperate with each other (over an engineered link) provided that the fiber optic cabling (channel) characteristics for 400GBASE-LR8 given in 122.10 are met, with the exception of the maximum and minimum channel insertion loss values, which are given in Table 122–22 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 122–22—Channel insertion loss requirements for interoperation between 400GBASE-ER8 and 400GBASE-LR8

Direction	Min loss	Max loss	Unit
400GBASE-ER8 transmitter to 400GBASE-LR8 receiver	0.7	8.5	dB
400GBASE-LR8 transmitter to 400GBASE-ER8 receiver	9.7	15.3	dB

Add subclause 139.10a

- Add 139.10a as below.

Insert 139.10a and 139.10b after 139.10 as follows:

139.10a Requirements for interoperation between 50GBASE-ER and 50GBASE-FR

The 50GBASE-ER and 50GBASE-FR PMDs can interoperate with each other (over an engineered link) provided that the fiber optic cabling (channel) characteristics for 50GBASE-FR given in 139.9 are met, with the exception of the maximum and minimum channel insertion loss values, which are given in Table 139–15 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 139–15—Channel insertion loss requirements for interoperation between 50GBASE-ER and 50GBASE-FR

Direction	Min loss	Max loss	Unit
50GBASE-ER transmitter to 50GBASE-FR receiver	4.6	8.5	dB
50GBASE-FR transmitter to 50GBASE-ER receiver	6.4	12.2	dB

Add subclause 139.10b

- Add 139.10b as below.

139.10b Requirements for interoperation between 50GBASE-ER and 50GBASE-LR

The 50GBASE-ER and 50GBASE-LR PMDs can interoperate with each other (over an engineered link) provided that the fiber optic cabling (channel) characteristics for 50GBASE-LR given in 139.9 are met, with the exception of the maximum and minimum channel insertion loss values, which are given in Table 139–16 for the two link directions separately. Attenuators may be used to achieve the required losses.

Table 139–16—Channel insertion loss requirements for interoperation between 50GBASE-ER and 50GBASE-LR

Direction	Min loss	Max loss	Unit
50GBASE-ER transmitter to 50GBASE-LR receiver	3.4	11.2	dB
50GBASE-LR transmitter to 50GBASE-ER receiver	7.6	13	dB

Thanks!