# 100G-LR1-20, 100G-ER1-30, 100G-ER1-40 Technical Specifications

100G Lambda MSA

**Rev 1.1 June 29, 2021**

**Chair** – Mark Nowell, Cisco Systems
**Co-Chair** - Jeffery J. Maki, Juniper Networks
**Editor** – Tom Palkert, Macom

The following companies were members of the 100G Lambda MSA at the release of this specification:

| Company | | |
|---|---|---|
| II-VI | HiSilicon | Nokia |
| Alibaba | Innolight | Nvidia |
| Applied Optoelectronics | Intel | Panduit |
| Arista Networks | Juniper Networks | Renesas |
| Broadcom | Keysight | Rockley Photonics |
| Cambridge Industries Group | Lightwave Logic | Semtech |
| China Unicom | Lumentum | SiFotonics Technologies |
| Ciena | Macom | Sicoya |
| Cisco | Marvell | Source Photonics |
| Color Chip | Maxim | Sumitomo Electric |
| Credo | MaxLinear | TE Connectivity |
| Delta | Microsoft | Tektronix |
| Eoptolink | Mitsubishi | TFC Optical Communications |
| Fujitsu Optical Components | Molex | ZTE |
| HGGenuine | Multilane | |
| HiSense | NeoPhotonics | |

**Revisions**

| Rev | Date | Description |
|---|---|---|
| 1.0 | December 1, 2020 | Initial Release |
| 1.1 | June 29, 2021 | ER1-30: Adjusted Tx wavelength range, fixed Rx wavelength range, ER1-40: relaxed ER requirement, adjusted Tx output power and Rx input sensitivity. Editorial reconciliation with 802.3cu |

# CONTENTS

# TABLES



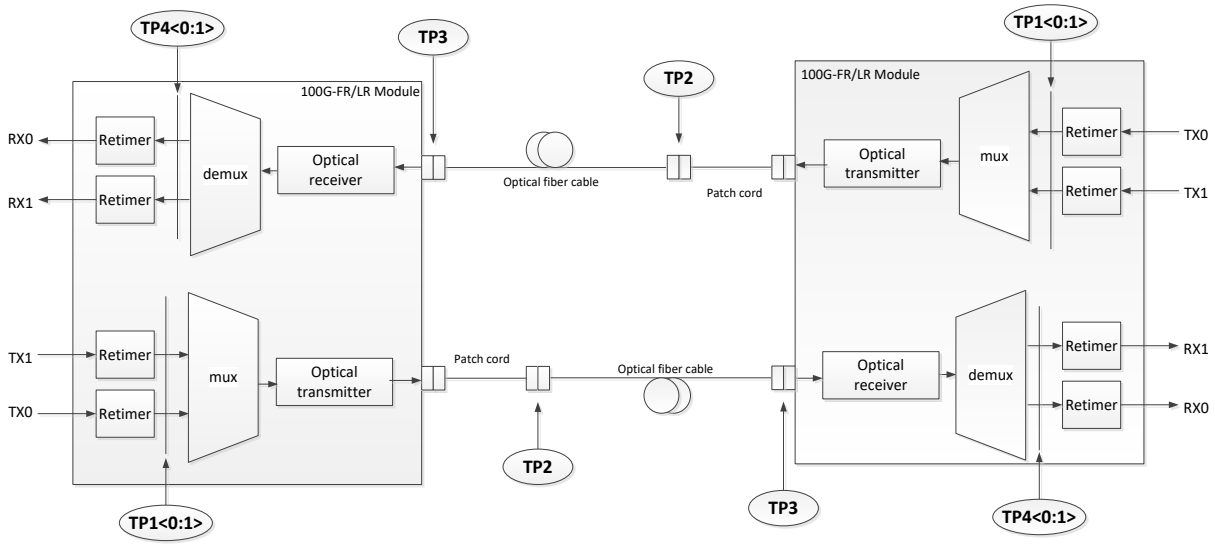
# FIGURES

# 1 GENERAL

## *1.1 SCOPE*

This Multi-Source Agreement (MSA) specification defines single lane 100 Gbps 20 km, 30 km and 40 km optical interfaces. Forward error correction (FEC) is required to be implemented by the host in order to ensure reliable system operation. Compliant transceivers communicate over single mode fibers (SMF) that meet the requirements of Table 4-1 and Table 5-1 with distances of 2 m to 20 km for the 100G-LR1-20, 2 m to 30 km for 100G-ER1-30 and 2 m to 40 km for 100G-ER1-40. The transceiver electrical interface is not specified by this MSA but can have, for example, four lanes in each direction with a nominal signaling rate of 26.5625 Gbps, two lanes in each direction with a nominal signaling rate of 53.125 Gbps per lane or a single lane in each direction with a nominal signaling rate of 106 .25 Gbps per lane.
A variety of form factors for the 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 transceivers are possible and none are precluded by this MSA.

## *1.2 100G-LR1-20, and 100G-ER1 MODULE BLOCK DIAGRAM*




NOTE – Specification of the retime function is beyond the scope of this MSA.

**Figure 1-1: Block diagram for transmit/receive paths**

## *1.3 FUNCTIONAL DESCRIPTION*

100G-LR1 and 100G-ER1 modules comply with the requirements of this document and have the following common features: one optical transmitter; one optical receiver with signal detect and a duplex optical connector for single-mode fiber. The optical connector type is vendor specific but can include SC, LC, MPO or CS types.

## *1.4 HARDWARE SIGNALING PINS*

Hardware signaling pins are specified in the respective module form factor MSA specifications.

## *1.5 MODULE MANAGEMENT INTERFACE*

The contents of the various ID registers shall comply with the requirements of the module MSA and the respective standards.

## *1.6 BIT ERROR RATIO*

The Bit Error Ratio (BER) is required to be less than $2.4 \times 10^{-4}$ in accordance with Clause 140.1.1 of IEEE Std 802.3-2018™.

## *1.7 MULTIPLEXING*

If the signaling rate of the electrical interface is a sub-rate of 106.25 Gbps (for example, four lanes in each direction with a nominal signaling rate of 26.5625 Gbps or two lanes in each direction with a nominal signaling rate of 53.125 Gbps per lane), the bit level multiplexing is required to comply with clause 135.5.2 of IEEE Std 802.3-2018™.

## *1.8 FEC REQUIREMENTS*

The host system is required to enable RS(544,514) FEC ("KP4 FEC") in accordance with clause 91 of IEEE Std 802.3-2018™. Operation with other FEC codes is beyond the scope of this MSA.

## *1.9 HIGH SPEED ELECTRICAL CHARACTERISTICS*

The detailed high speed electrical characteristics are not defined by this MSA. 100GE modules could be implemented in compliance with applicable electrical interface specifications.

## *1.10 MECHANICAL DIMENSIONS*

Mechanical dimensions are defined in module form factor MSA specifications.

# 2 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 OPTICAL SPECIFICATIONS

## *2.1 OPTICAL SPECIFICATIONS*

The operating range for the 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 PMDs are defined in Table 2-1. A compliant PMD operates on single-mode fibers according to the specifications defined in Table 4-1 and characteristics in Table 5-1. A PMD that exceeds the required operating range while meeting all other optical specifications is considered compliant (e.g., operating at 25 km meets the operating range requirement of 2 m to 20 km).

**Table 2-1: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 operating range**

| PMD type | Required operating range |
|---|---|
| 100G-LR1-20 | 2 m to 20 km |
| 100G-ER1-30 | 2 m to 30 km |
| 100G-ER1-40 | 2 m to 40 km |

### 2.1.1 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 transmitter optical specifications

The 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 transmitters shall meet the specifications defined in Table 2-2.

**Table 2-2: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 transmit characteristics**

| Description | 100G-LR1-20 | 100G-ER1-30 | 100G-ER1-40 | Unit |
|---|---|---|---|---|
| PAM4 Signaling rate (range) | 53.125 ± 100 ppm | 53.125 ± 100 ppm | 53.125 ± 100 ppm | GBd |
| Wavelength (range) | 1304.5- 1317.5 | 1304.5-1317.5[a] | 1308.09-1310.19 | nm |
| Side-mode suppression ratio (SMSR) (min) | 30 | 30 | 30 | dB |
| Average launch power (max) | 6.6 | 5.6 | 7.1 | dBm |
| Average launch power[b] (min) | -0.2 | 0 | 1.7 | dBm |
| Outer Optical Modulation Amplitude ($OMA_{outer}$) (max) | 6.8 | 6.4 | 7.9 | dBm |
| Outer Optical Modulation Amplitude ($OMA_{outer}$) (min)<br>for TDECQ < 1.4 dB<br>for 1.4 dB ≤ TDECQ ≤ TDECQ (max) | <br>2.8<br>1.4 + TDECQ | <br>3.0<br>1.6 + TDECQ | <br>4.7<br>3.3 + TDECQ | <br>dBm<br>dBm |
| Transmitter and dispersion eye closure for PAM4 (TDECQ) (max) | 3.6 | 3.9 | 3.9 | dB |
| Transmitter eye closure for PAM4 (TECQ) (max) | 3.4 [c] | 3.9 | 3.9 | dB |
| \|TDECQ-TECQ\| (max) | 2.7 | 2.7 | 2.7 | dB |
| Transmitter over/under-shoot (max) | 22 | 22 | 22 | % |
| Transmitter power excursion (max) | 4.3 | 3.9 | 5.4 | dBm |
| Extinction ratio (min) | 3.5 | 5 | 5 | dB |
| Transmitter transition time (max) | 17 | 17 | 17 | ps |
| Average launch power of OFF transmitter (max) | -15 | -15 | -15 | dBm |
| $RIN_x$OMA (max) where x is the optical return loss tolerance (max) | -136 | -136 | -136 | dB/Hz |
| Optical return loss tolerance (max) | 15.6 | 15 | 15 | dB |
| Transmitter reflectance[d] (max) | -26 | -26 | -26 | dB |

[a]The transmitter wavelength range supports a broad range of transmitter types which may have different chirp characteristics. Compliance to the TDECQ and TECQ specifications may require a tighter wavelength range depending on the chirp characteristics of the transmitter.

[b]Average 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.

[c] TECQ is 3.4 dB to maintain compatibility/compliance with the 100G-LR1 specification.

[d]Transmitter reflectance is defined looking into the transmitter.

### 2.1.2 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 receive optical specifications

The 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 receiver shall meet the specifications defined in Table 2-3.

**Table 2-3: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 receive characteristics**

| Description | 100G-LR1-20 | 100G-ER1-30 | 100G-ER1-40 | Unit |
|---|---|---|---|---|
| PAM4 Signaling rate (range) | 53.125 ± 100 ppm | 53.125 ± 100 ppm | 53.125 ± 100 ppm | GBd |
| Wavelength (range) | 1304.5 to 1317.5 | 1304.5 to 1317.5 | 1304.5 to 1317.5 | nm |
| Damage threshold[a] | 7.6 | -2.4 | -2.4 | dBm |
| Average receive power (max) | 6.6 | -3.4 | -3.4 | dBm |
| Average receive power[b] (min) | -10 | -14.7 | -16.0 | dBm |
| Receive power ($OMA_{outer}$) (max) | 6.8 | -2.6 | -2.6 | dBm |
| Receiver reflectance (max) | -26 | -26 | -26 | dB |
| Receiver sensitivity ($OMA_{outer}$) (max)<br>For TECQ < 1.4 dB<br>For 1.4 ≤ TECQ ≤ 3.6 dB<br>For 1.4 ≤ TECQ ≤ 3.9 dB | <br>-7.6<br>-9 + TECQ | <br>-12.5<br><br>-13.9 + TECQ | <br>-13.8<br><br>-15.2 + TECQ | dBm |
| Stressed receiver sensitivity ($OMA_{outer}$)[c] (max) | -5.4 | -10.0 | -11.3 | dBm |
| Conditions of stressed receiver sensitivity test[d]: | | | | |
| Stressed eye closure for PAM4 (SECQ) | 3.6 | 3.9 | 3.9 | dB |
| [a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical signal having this average power level. The receiver does not have to operate correctly at this input power. | | | | |
| [b]Average 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. | | | | |
| [c]Measured with conformance test signal at TP3 (see 3.14) for the BER specified in IEEE Std 802.3cd clause 140.1.1. | | | | |
| [d]These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver. | | | | |

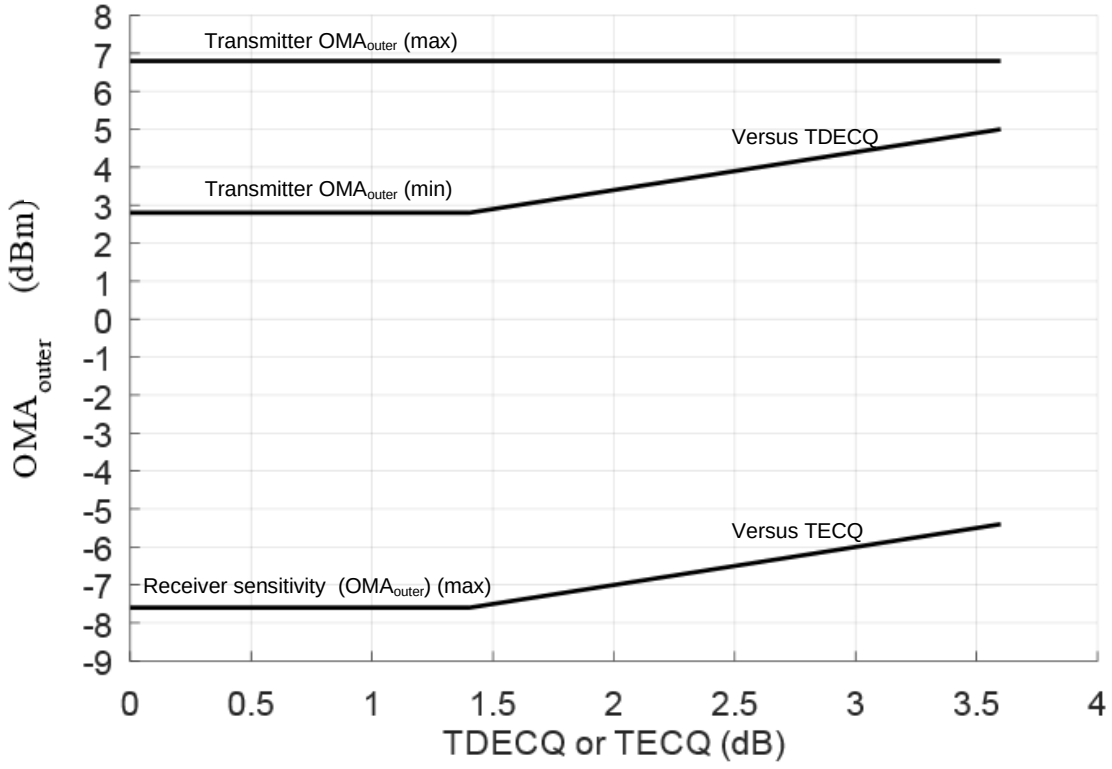



**Figure 2-1: Transmitter $OMA_{outer}$ versus TDECQ and receiver sensitivity ($OMA_{outer}$) versus TECQ for 100G-LR1-20**

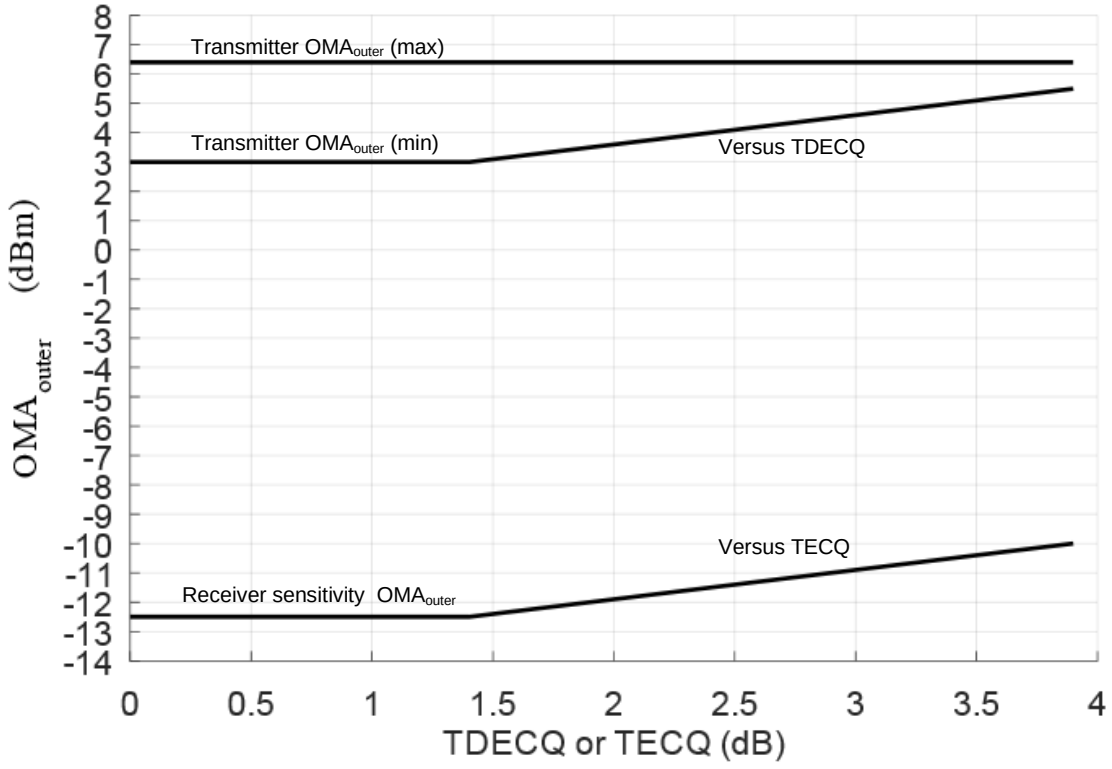



**Figure 2-2 Transmitter $OMA_{outer}$ versus TDECQ and receiver sensitivity ($OMA_{outer}$) versus TECQ for 100G-ER1-30**

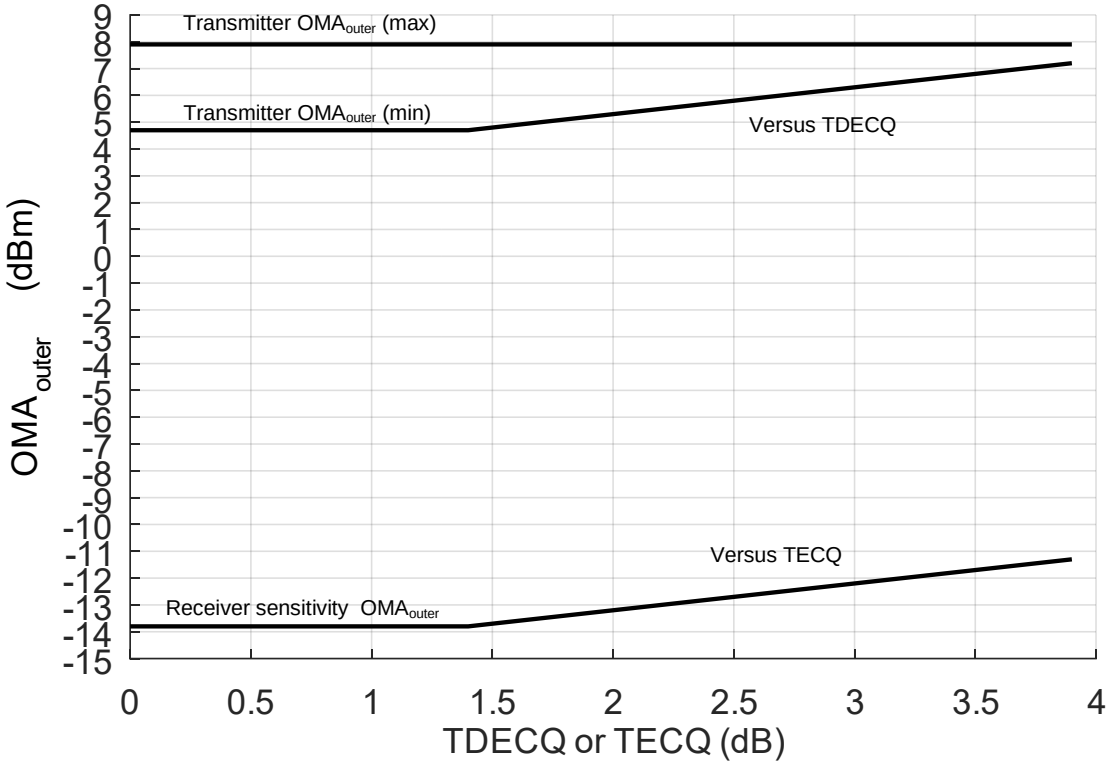



**Figure 2-3 Transmitter $OMA_{outer}$ versus TDECQ and receiver sensitivity ($OMA_{outer}$) versus TECQ for 100G-ER1-40**

### 2.1.3 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 illustrative link power budget

An illustrative power budget and penalties for 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 are shown in Table 2-4.

**Table 2-4: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 illustrative power budget**

| Description | 100G-LR1-20 | 100G-ER1-30 | 100G-ER1-40 | Unit |
|---|---|---|---|---|
| Power budget (for max TDECQ) | 14.0 | 19.4 | 22.4 | dB |
| Operating distance | 20 | 30 | 40 | km |
| Channel insertion loss (max)[a] | 9.8 | 15 | 18 | dB |
| Channel insertion loss (min) | 0 | 9 | 10.5 | dB |
| Maximum discrete reflectance [b,c] | -35 | -35 | -35 | dB |
| Allocation for penalties[d] (for max TDECQ) | 4.2 | 4.4 | 4.4 | dB |
| Additional insertion loss allowed | 0 | 0 | 0 | dB |
| [a]The channel insertion loss is calculated using the maximum distance specified in Table 2-1 and cabled optical fiber attenuation of 0.43 dB/km at 1311 nm plus an allocation for connection and splice loss given in 5.2.1. | | | | |
| [b]See Table 2-5 for details and specifications as a function of the number of discrete reflectances within the channel. | | | | |
| [c] Maximum value for each discrete reflectance with 6 discrete reflectances above –55 dB within the channel. | | | | |
| [d]Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested. | | | | |

**Table 2-5: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 Maximum value for each discrete reflectance**

| Number of discrete reflectances above -55dB | Maximum value for each discrete reflectance for LR1-20 | Maximum value for each discrete reflectance for ER1-30 and ER1-40 | Unit |
|---|---|---|---|
| 1 | -22 | -19 | dB |
| 2 | -29 | -27 | dB |
| 4 | -33 | -32 | dB |
| 6 | -35 | -35 | dB |
| 8 | -37 | -37 | dB |
| 10 | -39 | -39 | dB |

# 3 DEFINITION OF OPTICAL PARAMETERS AND MEASUREMENT METHODS

All optical measurements shall be made through a short patch cable, between 2 m and 5 m in length, unless otherwise specified.

## *3.1 TEST PATTERNS FOR OPTICAL PARAMETERS*

**Table 3-1: Test patterns**

| Pattern | Pattern Description | Defined in[a] |
|---|---|---|
| Square wave | Square wave (8 threes, 8 zeroes) | 120.5.11.2.4 |
| 3 | PRBS31Q | 120.5.11.2.2 |
| 4 | PRBS13Q | 120.5.11.2.1 |
| 5 | Scrambled idle encoded by RS-FEC | 82.2.11, 91 |
| 6 | SSPRQ | 120.5.11.2.3 |
| [a]These sub-clauses make reference to relevant clauses of IEEE Std 802.3-2018. | | |

**Table 3-2: Test pattern definitions and related subclauses**

| Parameter | Pattern | Reference |
|---|---|---|
| Wavelength | Square wave, 3, 4, 5, 6 or valid 100GBASE-R signal | 3.3 |
| Side mode suppression ratio | 3, 5, 6 or valid 100GBASE-R signal | 140.7.2[a] |
| Average optical power | 3, 5, 6 or valid 100GBASE-R signal | 3.4 |
| Optical modulation amplitude ($OMA_{outer}$) | 4 or 6 | 3.5 |
| Transmitter and dispersion eye closure for PAM4 (TDECQ) | 6 | 3.6 |
| Transmitter eye closure for PAM4 (TECQ) | 6 | 140.7.5a[b] |
| Over/under-shoot | 6 | 140.7.5b[b] |
| Transmitter power excursion | 6 | 140.7.5c[b] |
| Extinction ratio | 4 or 6 | 3.7 |
| Transmitter transition time | Square wave or 6 | 3.11 |
| $RIN_X$ OMA | Square-wave | 3.12 |
| Receiver sensitivity | 3 or 5 | 140.7.9[b] |
| Stressed receiver conformance test signal calibration | 6 | 3.14 |
| Stressed receiver sensitivity | 3 or 5 | 3.14 |
| [a]IEEE Std 802.3cd-2018. | | |
| [b]IEEE Std 802.3cu-2021. | | |

## *3.2 SKEW AND SKEW VARIATION*

The skew and skew variation is specified in IEEE Std 802.3-2018 clause 121.3.2.

## *3.3 WAVELENGTH AND SIDE MODE SUPPRESSION RATIO (SMSR)*

The wavelength and SMSR shall be within the range given in Table 2-2 if measured per IEC 61280-1-3. The transmitter is modulated using the test pattern defined in Table 3-2.

## *3.4 AVERAGE OPTICAL POWER*

The average optical power shall be within the limits given in Table 2-2 if measured using the methods given in IEC 61280-1-1. The average optical power is measured using the test pattern defined in Table 3-2, per the test setup in IEEE Std 802.3-2018 Figure 53-6.

## *3.5 OPTICAL MODULATION AMPLITUDE ($OMA_{outer}$)*

Refer to IEEE Std 802.3cd clause 140.7.4.

## *3.6 TRANSMITTER AND DISPERSION EYE CLOSURE FOR PAM4 (TDECQ)*

TDECQ shall be within the limits given in Table 2-2 if measured using the methods specified in IEEE Std 802.3cd clause 140.7.5 using a reference equalizer as described in section 3.6.1 with the following exceptions:

- The optical return loss of the transmitter compliance channel is 15.6 dB.
- The signaling rate of the test pattern generator is as given in Table 2-2 and uses a test pattern specified for TDECQ in Table 3-2.

The transmitter is tested using an optical channel that meets the requirements listed in Table 3-3.

**Table 3-3: Transmitter compliance channel specifications**

| Type | Dispersion[a] (ps/nm) | | Insertion loss[b] | Optical return loss[c] | Max mean DGD |
|---|---|---|---|---|---|
| | Minimum | Maximum | | | |
| 100G-LR1-20 | $0.46*\lambda*[1-(1324/\lambda)^4]$ | $0.46*\lambda*[1-(1300/\lambda)^4]$ | Minimum | 15.6 dB | 0.8 ps |
| 100G-ER1-30 | $0.69*\lambda*[1-(1324/\lambda)^4]$ | $0.69*\lambda*[1-(1300/\lambda)^4]$ | Minimum | 15 dB | 0.8 ps |
| 100G-ER1-40 | $0.92*\lambda*[1-(1324/\lambda)^4]$ | $0.92*\lambda*[1-(1300/\lambda)^4]$ | Minimum | 15 dB | 0.8 ps |
| [a] The dispersion is measured for the wavelength of the device under test ($\lambda$ in nm). The coefficient assumes 20 km for 100G-FR1-20, 30km for 100G-ER1-30 and 40 km for 100G-ER1-40. | | | | | |
| [b] There is no intent to stress the sensitivity of the BERT's optical receiver. | | | | | |
| [c] The optical return loss is applied at TP2, i.e. after a 2 meter patch cord. | | | | | |

### 3.6.1 TDECQ reference equalizer

The reference equalizer for 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 is as specified in IEEE Std 802.3cd clause 140.7.5.1 with the following exception:

— Tap1, tap2 or tap3 has the largest magnitude coefficient, which is constrained be at least 0.8.

## *3.7 TRANSMITTER EYE CLOSURE FOR PAM4 (TECQ)*

The transmitter eye closure for PAM4 (TECQ) is a measure of the optical transmitter's eye closure at TP2. The TECQ shall be within the limits given in Table 2-2 if measured using a test

pattern specified for TECQ in Table 3-2. The TECQ shall be measured using the methods specified for TDECQ in 3.6, except that the test fiber is not used.

## *3.8 TRANSMITTER OVER/UNDER-SHOOT*

The transmitter over/under-shoot percentage shall be within the limits given in Table 2-2 if measured using a test pattern specified for transmitter over/under-shoot in Table 3-2.

The test description for transmitter over/under-shoot is in IEEE Std 802.3cu-2021 clause 140.7.5b.

## *3.9 TRANSMITTER POWER EXCURSION*

The transmitter power excursion shall be within the limits given in Table 2-2 if measured using a test pattern specified for transmitter power excursion in Table 3-2.

The test description for power excursion is in IEEE Std 802.3cu-2021 clause 140.7.5c.

## *3.10 EXTINCTION RATIO*

Extinction ratio is measured using the method specified in IEEE Std 802.3cd-2018 clause 140.7.6.

## *3.11 TRANSMITTER TRANSITION TIME*

The transmitter transition time shall be within the limits given in Table 2-2 if measured using a test pattern specified for transmitter transition time in Table 3-2.
The test description for transmitter transition time is in IEEE Std 802.3cd-2018 clause 140.7.7.

## *3.12 RELATIVE INTENSITY NOISE ($RIN_x$OMA)*

RIN shall be as defined by the measurement methodology of IEEE Std 802.3-2018 clause 52.9.6 with the following exceptions:

a) The upper –3 dB limit of the measurement apparatus is to be approximately equal to the signaling rate (i.e., 53.2 GHz).
   Note: x is the 'optical return loss tolerance (max)' using the values listed in Table 2-2.

## *3.13 RECEIVER SENSITIVITY*

The receiver sensitivity ($OMA_{outer}$) for 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 shall be within the limits given in Table 2-3 if measured using a test pattern for receiver sensitivity in Table 3-2.

The conformance test signal at TP3 meets the requirements for a 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 transmitter followed by an attenuator.

The TECQ of the conformance test signal is measured according to 802.3cu-2021 clause 140.7.5, except that the test fiber is not used. The measured value of TECQ is then used to calculate the limit for receiver sensitivity ($OMA_{outer}$) as specified in Table 2-3.

### *3.14 STRESSED RECEIVER SENSITIVITY*

Stressed receiver sensitivity shall be within the limits given in Table 2-3 if measured using the method defined in IEEE Std 802.3cu-2021 140.7.10 with the following exceptions:

- With the Gaussian noise generator on and the sinusoidal jitter and sinusoidal interferer turned off, the $RIN_x$OMA of the SRS test source should be no greater than the value specified in Table 2-2.
- The signaling rate of the test pattern generator and the extinction ratio of the E/O converter are as given in Table 2-3 using test patterns specified in Table 3-2.
- The required values of the Stressed receiver sensitivity ($OMA_{outer}$) (max) and Stressed eye closure for PAM4 (SECQ) are as given in Table 2-3.
- The transition time of the stressed receiver conformance test signal is no greater than the value specified in Table 2-2.
- For 100GBASE-LR1-20, 100G-ER1-30 and 100GBASE-ER1-40 the values of over/under-shoot and transmitter power excursion of the stressed receiver conformance test signal are within the limits specified in Table 2-2.

# 4 FIBER OPTIC CABLING MODEL

The fiber optic cabling model is shown in Figure 4-1.

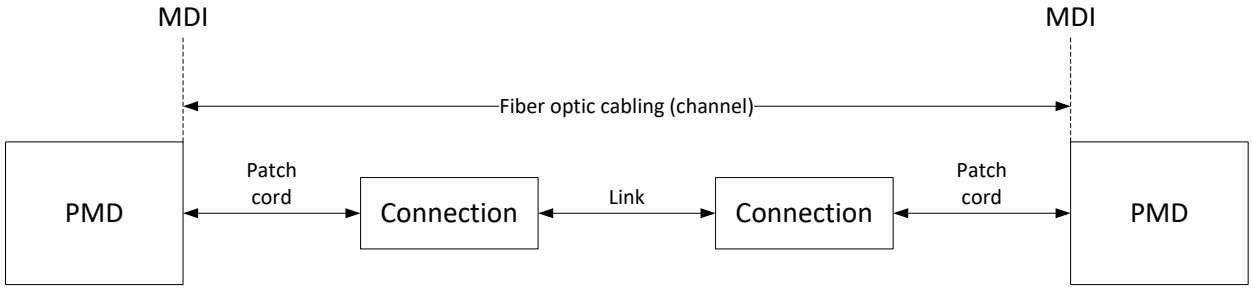



**Figure 4-1: Fiber optic cabling model**

The channel insertion loss is given in Table 4-1. A channel may contain additional connectors as long as the optical characteristics of the channel, such as attenuation, dispersion, reflections and polarization mode dispersion meet the specifications. Insertion loss measurements of installed fiber cables are made in accordance with IEC 61280-4-2 using the one-cord reference method. The fiber optic cabling model (channel) defined here is the same as a simplex fiber optic link segment. The term channel is used here for consistency with generic cabling standards.

**Table 4-1: Fiber optic cabling (channel) characteristics**

| Description | 100G-LR1-20 Values | 100G-ER1-30 Values | 100G-ER1-40 Values | Unit |
|---|---|---|---|---|
| Operating distance (max) | 20 | 30 | 40 | km |
| Channel insertion loss[a,b](max) | 9.8 | 15 | 18 | dB |
| Channel insertion loss (min) | 0 | 9 | 10.5 | dB |
| Positive dispersion[b] (max) | 31.6 | 47.3 | 37.1 | ps/nm |
| Negative dispersion[b] (min) | -36.7 | -55 | -59.6 | ps/nm |
| DGD_max[c] | 3.5 | 4.3 | 4.9 | ps |
| Optical return loss (min) | 22 | 19 | 19 | dB |
| [a]These channel loss values include cable, connectors and splices. | | | | |
| [b]Over the wavelength range for each PMD. | | | | |
| [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 must tolerate. | | | | |

# 5 CHARACTERISTICS OF THE FIBER OPTIC CABLING (CHANNEL)

The 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 fiber optic cabling shall meet the specifications defined in Table 4-1. The fiber optic cabling consists of one or more sections of fiber optic cable and any intermediate connections required to connect sections together.

## *5.1 OPTICAL FIBER CABLE*

The fiber optic cable requirements are satisfied by cables containing IEC 60793-2-50 type B1.1 (dispersion un-shifted single-mode), type B1.3 (low water peak single-mode), or type B6_a (bend insensitive) fibers and the requirements in Table 5-1 where they differ.

**Table 5-1: Optical fiber and cable characteristics**

| Description | Value | Unit |
|---|---|---|
| Nominal fiber specification wavelength | 1310 | nm |
| Cabled optical fiber attenuation (max) | 0.43[a] | dB/km |
| Zero dispersion wavelength ($\lambda_0$) | $1300 \leq \lambda_0 \leq 1324$ | nm |
| Dispersion slope (max) ($S_0$) | 0.092 | $ps/nm^2km$ |
| [a]The 0.43 dB/km attenuation is provided for Outside Plant cable as defined in Appendix I of ITU-T G.695. | | |

## *5.2 OPTICAL FIBER CONNECTION*

An optical fiber connection, as shown in Figure 4-1, consists of a mated pair of optical connectors.

### 5.2.1 Connection insertion loss

The maximum link distance for 100G-LR1-20 is based on an allocation of 1.2 dB total connection and splice loss. For example, this allocation supports two connections with an average insertion loss per connection of 0.5 dB. The maximum link distance for 100GBASE-ER1-30 is based on an allocation of 2.1 dB total connection and splice loss. The maximum link distance for 100GBASE-ER1-40 is based on an allocation of 0.8 dB total connection and splice loss. Connections with different loss characteristics may be used provided the requirements of Table 4-1 are met.

### 5.2.2 Maximum discrete reflectance

The maximum discrete reflectance shall be less than the value shown in Table 2-5.

## *5.3 MEDIUM DEPENDENT INTERFACE (MDI) REQUIREMENT*

The PMD is coupled to the fiber optic cabling at the MDI. The MDI is the interface between the PMD and the "fiber optic cabling" (as shown in Figure 4-1). Examples of an MDI include the following:

a) Connectorized fiber pigtail
b) PMD receptacle

When the MDI is a connector plug and receptacle connection, it shall meet the interface performance specifications of IEC 61753-1-1 and IEC 61753-021-2.
NOTE---Transmitter compliance testing is performed at TP2 i.e. after a 2 meter patch cord, not at the MDI.

# 6 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 Module Color Coding

Transceiver modules compliant to the 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 Specifications use a color code to indicate the application. This color code can be on a module bail latch, pull tab, or other visible feature of the module when installed in a system. The color code scheme is specified in Table 6-1.

**Table 6-1: 100G-LR1-20, 100G-ER1-30 and 100G-ER1-40 Module Color Coding**

| Color Code | Application |
|---|---|
| Brown | 100G-LR1-20 |
| Red | 100G-ER1-30 |
| Tangerine | 100G-ER1-40 |