Insert the new clauses and corresponding annexes as follows:

95. Physical Medium Dependent (PMD) sublayer and medium, type 100GBASE-SR4

95.1 Overview

This clause specifies the 100GBASE-SR4 PMD together with the multimode fiber medium. The PMD sublayer provides a point-to-point 100 Gb/s Ethernet link over four pairs of multimode fiber, up to at least 100 m. When forming a complete Physical Layer, a PMD shall be connected to the appropriate PMA as shown in Table 95–1, to the medium through the MDI and optionally with the management functions that may be accessible through the management interface defined in Clause 45, or equivalent.

Table 95–1—Physical Layer clauses associated with the 100GBASE-SR4 PMD

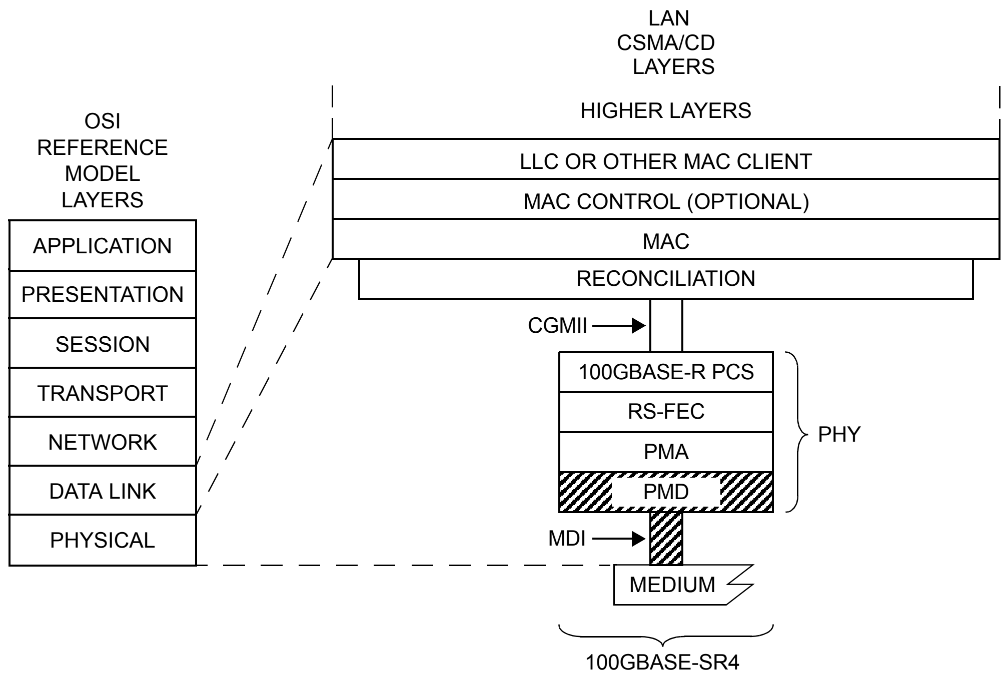
Associated clause	100GBASE-SR4
81—RS	Required
81—CGMII[a]	Optional
82—PCS for 100GBASE-R	Required
83—PMA for 100GBASE-R	Required
91—RS-FEC[b]	Required
83A—CAUI-10	Optional
83B—Chip-to-module CAUI-10[c]	Optional
83D—CAUI-4	Optional
83E—Chip-to-module CAUI-4	Optional
78—Energy Efficient Ethernet	Optional

[a]The CGMII is an optional interface. However, if the CGMII is not implemented, a conforming implementation must behave functionally as though the RS and CGMII were present.
[b]The option to bypass the Clause 91 RS-FEC correction function is not supported.
[c]This option requires the RS-FEC sublayer to be within the module. See 91.3.

Figure 95–1 shows the relationship of the PMD and MDI (shown shaded) with other sublayers to the ISO/IEC Open System Interconnection (OSI) reference model. 40 Gb/s and 100 Gb/s Ethernet is introduced in Clause 80 and the purpose of each PHY sublayer is summarized in 80.2.

100GBASE-SR4 PHYs with the optional Energy Efficient Ethernet (EEE) fast wake capability may enter the Low Power Idle (LPI) mode to conserve energy during periods of low link utilization (see Clause 78). The deep sleep mode of EEE is not supported.

Further relevant information may be found in Clause 1 (terminology and conventions, references, definitions and abbreviations) and Annex A (bibliography, referenced as [B1], [B2], etc.).



CGMII = 100 Gb/s MEDIA INDEPENDENT INTERFACE
LLC = LOGICAL LINK CONTROL
MAC = MEDIA ACCESS CONTROL
MDI = MEDIUM DEPENDENT INTERFACE
PCS = PHYSICAL CODING SUBLAYER
PHY = PHYSICAL LAYER DEVICE
PMA = PHYSICAL MEDIUM ATTACHMENT
PMD = PHYSICAL MEDIUM DEPENDENT
RS-FEC = REED-SOLOMON FORWARD ERROR CORRECTION
SR = PMD FOR MULTIMODE FIBER

Figure 95–1—100GBASE-SR4 PMD relationship to the ISO/IEC Open Systems Interconnection (OSI) reference model and the IEEE 802.3 CSMA/CD LAN model

95.1.1 Bit error ratio

The bit error ratio (BER) shall be less than 5×10^{-5} provided that the error statistics are sufficiently random that this results in a frame loss ratio (see 1.4.210a) of less than 6.2×10^{-10} for 64-octet frames with minimum inter-packet gap when processed according to Clause 91.

If the error statistics are not sufficiently random to meet this requirement, then the BER shall be less than that required to give a frame loss ratio of less than 6.2×10^{-10} for 64-octet frames with minimum inter-packet gap when processed according to Clause 91.

95.2 Physical Medium Dependent (PMD) service interface

This subclause specifies the services provided by the 100GBASE-SR4 PMD. The service interface for this PMD is described in an abstract manner and does not imply any particular implementation. The PMD service interface supports the exchange of encoded data between the PMA entity that resides just above the PMD, and the PMD entity. The PMD translates the encoded data to and from signals suitable for the specified medium.

The PMD service interface is an instance of the inter-sublayer service interface defined in 80.3. The PMD service interface primitives are summarized as follows:

PMD:IS_UNITDATA_*i*.request
PMD:IS_UNITDATA_*i*.indication
PMD:IS_SIGNAL.indication

The 100GBASE-SR4 PMD has four parallel bit streams, hence $i = 0$ to 3.

In the transmit direction, the PMA continuously sends four parallel bit streams to the PMD, one per lane, each at a nominal signaling rate of 25.78125 GBd. The PMD converts these streams of bits into appropriate signals on the MDI.

In the receive direction, the PMD continuously sends four parallel bit streams to the PMA corresponding to the signals received from the MDI, one per lane, each at a nominal signaling rate of 25.78125 GBd.

The SIGNAL_DETECT parameter defined in this clause maps to the SIGNAL_OK parameter in the PMD:IS_SIGNAL.indication(SIGNAL_OK) inter-sublayer service primitive defined in 80.3.

The SIGNAL_DETECT parameter can take on one of two values: OK or FAIL. When SIGNAL_DETECT = FAIL, the rx_bit parameters are undefined.

NOTE—SIGNAL_DETECT = OK does not guarantee that the rx_bit parameters are known to be good. It is possible for a poor quality link to provide sufficient light for a SIGNAL_DETECT = OK indication and still not meet the BER defined in 95.1.1.

95.3 Delay and Skew

95.3.1 Delay constraints

The sum of the transmit and receive delays at one end of the link contributed by the 100GBASE-SR4 PMD including 2 m of fiber in one direction shall be no more than 2048 bit times (4 pause_quanta or 20.48 ns). A description of overall system delay constraints and the definitions for bit times and pause_quanta can be found in 80.4 and its references.

95.3.2 Skew constraints

The Skew (relative delay) between the lanes must be kept within limits so that the information on the lanes can be reassembled by the RS-FEC sublayer. Skew and Skew Variation are defined in 80.5 and specified at the points SP0 to SP7 shown in Figure 80–5a.

If the PMD service interface is physically instantiated so that the Skew at SP2 can be measured, then the Skew at SP2 is limited to 43 ns and the Skew Variation at SP2 is limited to 400 ps.

The Skew at SP3 (the transmitter MDI) shall be less than 54 ns and the Skew Variation at SP3 shall be less than 600 ps.

The Skew at SP4 (the receiver MDI) shall be less than 134 ns and the Skew Variation at SP4 shall be less than 3.4 ns.

If the PMD service interface is physically instantiated so that the Skew at SP5 can be measured, then the Skew at SP5 shall be less than 145 ns and the Skew Variation at SP5 shall be less than 3.6 ns.

For more information on Skew and Skew Variation see 80.5. The measurements of Skew and Skew Variation are defined in 86.8.3.1 with the exception that the clock and data recovery units' high-frequency corner bandwidths are 10 MHz.

95.4 PMD MDIO function mapping

The optional MDIO capability described in Clause 45 defines several variables that may provide control and status information for and about the PMD. If the MDIO interface is implemented, the mapping of MDIO control variables to PMD control variables shall be as shown in Table 95–2 and the mapping of MDIO status variables to PMD status variables shall be as shown in Table 95–3.

Table 95–2—MDIO/PMD control variable mapping

MDIO control variable	PMA/PMD register name	Register/bit number	PMD control variable
Reset	PMA/PMD control 1 register	1.0.15	PMD_reset
Global PMD transmit disable	PMD transmit disable register	1.9.0	PMD_global_transmit_disable
PMD transmit disable 3	PMD transmit disable register	1.9.4	PMD_transmit_disable_3
PMD transmit disable 2	PMD transmit disable register	1.9.3	PMD_transmit_disable_2
PMD transmit disable 1	PMD transmit disable register	1.9.2	PMD_transmit_disable_1
PMD transmit disable 0	PMD transmit disable register	1.9.1	PMD_transmit_disable_0

Table 95–3—MDIO/PMD status variable mapping

MDIO status variable	PMA/PMD register name	Register/ bit number	PMD status variable
Fault	PMA/PMD status 1 register	1.1.7	PMD_fault
Transmit fault	PMA/PMD status 2 register	1.8.11	PMD_transmit_fault
Receive fault	PMA/PMD status 2 register	1.8.10	PMD_receive_fault
Global PMD receive signal detect	PMD receive signal detect register	1.10.0	PMD_global_signal_detect
PMD receive signal detect 3	PMD receive signal detect register	1.10.4	PMD_signal_detect_3
PMD receive signal detect 2	PMD receive signal detect register	1.10.3	PMD_signal_detect_2
PMD receive signal detect 1	PMD receive signal detect register	1.10.2	PMD_signal_detect_1
PMD receive signal detect 0	PMD receive signal detect register	1.10.1	PMD_signal_detect_0

95.5 PMD functional specifications

The 100GBASE-SR4 PMD performs the Transmit and Receive functions, which convey data between the PMD service interface and the MDI.

95.5.1 PMD block diagram

The PMD block diagram is shown in Figure 95–2. For purposes of system conformance, the PMD sublayer is standardized at the points described in this subclause. The optical transmit signal is defined at the output end of a multimode fiber patch cord (TP2), between 2 m and 5 m in length. Unless specified otherwise, all transmitter measurements and tests defined in 95.8 are made at TP2. The optical receive signal is defined at the output of the fiber optic cabling (TP3) at the MDI (see 95.11.3). Unless specified otherwise, all receiver measurements and tests defined in 95.8 are made at TP3.

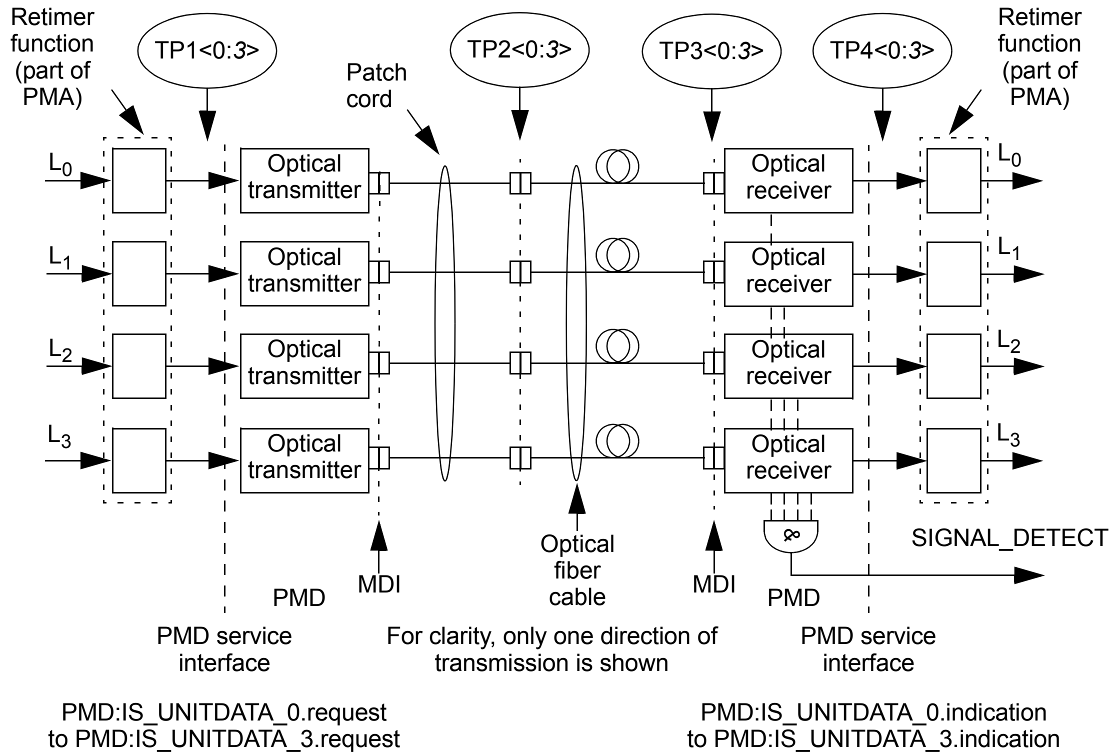


Figure 95–2—Block diagram for 100GBASE-SR4 transmit/receive paths

TP1<0:3> and TP4<0:3> are informative reference points that may be useful to implementors for testing components (these test points will not typically be accessible in an implemented system).

95.5.2 PMD transmit function

The PMD Transmit function shall convert the four bit streams requested by the PMD service interface messages PMD:IS_UNITDATA_0.request to PMD:IS_UNITDATA_3.request into four separate optical signal streams. The four optical signal streams shall then be delivered to the MDI, which contains four parallel light paths for transmit, according to the transmit optical specifications in this clause. The higher optical power level in each signal stream shall correspond to tx_bit = one.

95.5.3 PMD receive function

The PMD Receive function shall convert the four parallel optical signal streams received from the MDI into separate bit streams for delivery to the PMD service interface using the messages PMD:IS_UNITDATA_0.indication to PMD:IS_UNITDATA_3.indication, all according to the receive optical specifications in this clause. The higher optical power level in each signal stream shall correspond to rx_bit = one.

95.5.4 PMD global signal detect function

The PMD global signal detect function shall report the state of SIGNAL_DETECT via the PMD service interface. The SIGNAL_DETECT parameter is signaled continuously, while the PMD:IS_SIGNAL.indication message is generated when a change in the value of SIGNAL_DETECT occurs. The SIGNAL_DETECT parameter defined in this clause maps to the SIGNAL_OK parameter in the inter-sublayer service interface primitives defined in 80.3.

SIGNAL_DETECT shall be a global indicator of the presence of optical signals on all four lanes. The value of the SIGNAL_DETECT parameter shall be generated according to the conditions defined in Table 95–4. The PMD receiver is not required to verify whether a compliant 100GBASE-SR4 signal is being received. This standard imposes no response time requirements on the generation of the SIGNAL_DETECT parameter.

Table 95–4—SIGNAL_DETECT value definition

Receive conditions	SIGNAL_DETECT value
For any lane; Average optical power at TP3 ≤ –30 dBm	FAIL
For all lanes; [(Optical power at TP3 ≥ average receive power, each lane (min) in Table 95–7) AND (compliant 100GBASE-SR4 signal input)]	OK
All other conditions	Unspecified

As an unavoidable consequence of the requirements for the setting of the SIGNAL_DETECT parameter, implementations must provide adequate margin between the input optical power level at which the SIGNAL_DETECT parameter is set to OK, and the inherent noise level of the PMD including the effects of crosstalk, power supply noise, etc.

Various implementations of the Signal Detect function are permitted by this standard, including implementations that generate the SIGNAL_DETECT parameter values in response to the amplitude of the modulation of the optical signal and implementations that respond to the average optical power of the modulated optical signal.

95.5.5 PMD lane-by-lane signal detect function

Various implementations of the Signal Detect function are permitted by this standard. When the MDIO is implemented, each PMD_signal_detect_*i*, where *i* represents the lane number in the range 0:3, shall be continuously set in response to the magnitude of the optical signal on its associated lane, according to the requirements of Table 95–4.

95.5.6 PMD reset function

If the MDIO interface is implemented, and if PMD_reset is asserted, the PMD shall be reset as defined in 45.2.1.1.1.

95.5.7 PMD global transmit disable function (optional)

The PMD_global_transmit_disable function is optional and allows all of the optical transmitters to be disabled.

a) When the PMD_global_transmit_disable variable is set to one, this function shall turn off all of the optical transmitters so that each transmitter meets the requirements of the average launch power of the OFF transmitter in Table 95–6.

b) If a PMD_fault is detected, then the PMD may set the PMD_global_transmit_disable to one, turning off the optical transmitter in each lane.

95.5.8 PMD lane-by-lane transmit disable function (optional)

The PMD_transmit_disable_*i* (where *i* represents the lane number in the range 0:3) function is optional and allows the optical transmitter in each lane to be selectively disabled.

a) When a PMD_transmit_disable_*i* variable is set to one, this function shall turn off the optical transmitter associated with that variable so that the transmitter meets the requirements of the average launch power of the OFF transmitter in Table 95–6.

b) If a PMD_fault is detected, then the PMD may set each PMD_transmit_disable_*i* to one, turning off the optical transmitter in each lane.

If the optional PMD_transmit_disable_*i* function is not implemented in MDIO, an alternative method may be provided to independently disable each transmit lane.

95.5.9 PMD fault function (optional)

If the PMD has detected a local fault on any of the transmit or receive paths, the PMD shall set PMD_fault to one.

If the MDIO interface is implemented, PMD_fault shall be mapped to the fault bit as specified in 45.2.1.2.1.

95.5.10 PMD transmit fault function (optional)

If the PMD has detected a local fault on any transmit lane, the PMD shall set PMD_transmit_fault to one.

If the MDIO interface is implemented, PMD_transmit_fault shall be mapped to the transmit fault bit as specified in 45.2.1.7.4.

95.5.11 PMD receive fault function (optional)

If the PMD has detected a local fault on any receive lane, the PMD shall set the PMD_receive_fault variable to one.

If the MDIO interface is implemented, PMD_receive_fault shall be mapped to the receive fault bit as specified in 45.2.1.7.5.

95.6 Lane assignments

There are no lane assignments (within a group of transmit or receive lanes) for 100GBASE-SR4. While it is expected that a PMD will map electrical lane *i* to optical lane *i* and vice versa, there is no need to define the physical ordering of the lanes, as the RS-FEC sublayer is capable of receiving the lanes in any arrangement. The positioning of transmit and receive lanes at the MDI is specified in 95.11.3.1.

95.7 PMD to MDI optical specifications for 100GBASE-SR4

The operating range for the 100GBASE-SR4 PMD is defined in Table 95–5. A 100GBASE-SR4 compliant PMD operates on 50/125 µm multimode fibers, type A1a.2 (OM3) or type A1a.3 (OM4), according to the specifications defined in Table 95–12. A PMD that exceeds the operating range requirement while meeting all other optical specifications is considered compliant (e.g., a 100GBASE-SR4 PMD operating at 120 m meets the operating range requirement of 0.5 m to 100 m).

Table 95–5—100GBASE-SR4 operating range

PMD type	Required operating range[a]
100GBASE-SR4	0.5 m to 70 m for OM3
	0.5 m to 100 m for OM4

[a]The RS-FEC correction function may not be bypassed for any operating distance.

95.7.1 100GBASE-SR4 transmitter optical specifications

Each lane of a 100GBASE-SR4 transmitter shall meet the specifications in Table 95–6 per the definitions in 95.8.

Table 95–6—100GBASE-SR4 transmit characteristics

Description	Value	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm	GBd
Center wavelength (range)	840 to 860	nm
RMS spectral width[a] (max)	0.6	nm
Average launch power, each lane (max)	2.4	dBm
Average launch power, each lane (min)	–9.1	dBm
Optical Modulation Amplitude (OMA), each lane (max)	3	dBm
Optical Modulation Amplitude (OMA), each lane (min)[b]	–7.1	dBm
Launch power in OMA minus TxVEC (min)	–8	dBm
Transmitter vertical eye closure (TxVEC), each lane (max)	5	dB
Average launch power of OFF transmitter, each lane (max)	–30	dBm
Extinction ratio (min)	2	dB
Optical return loss tolerance (max)	12	dB
Encircled flux[c]	≥ 86% at 19 µm ≤ 30% at 4.5 µm	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} Hit ratio 1.5×10^{-3} hits per sample	{0.3, 0.38, 0.45, 0.35, 0.41, 0.5}	

[a]RMS spectral width is the standard deviation of the spectrum.
[b]Even if the TxVEC < 0.9 dB, the OMA (min) must exceed this value.
[c]If measured into type A1a.2 or type A1a.3 50 µm fiber in accordance with IEC 61280-1-4.

95.7.2 100GBASE-SR4 receive optical specifications

Each lane of a 100GBASE-SR4 receiver shall meet the specifications in Table 95–7 per the definitions in 95.8.

Table 95–7—100GBASE-SR4 receive characteristics

Description	Value	Unit
Signaling rate, each lane (range)	25.78125 ± 100 ppm	GBd
Center wavelength (range)	840 to 860	nm
Damage threshold[a] (min)	3.4	dBm
Average receive power, each lane (max)	2.4	dBm
Average receive power, each lane[b] (min)	–11	dBm
Receive power, each lane (OMA) (max)	3	dBm
Receiver reflectance (max)	–12	dB
Stressed receiver sensitivity (OMA), each lane[c] (max)	–5.6	dBm
Conditions of stressed receiver sensitivity test:[d]		
TxVEC of stressed receiver conformance test signal, lane under test	5	dB
Stressed eye J2 Jitter, lane under test	0.41	UI
Stressed eye J4 Jitter, lane under test	0.55	UI
OMA of each aggressor lane	3	dBm
Stressed receiver eye mask definition {X1, X2, X3, Y1, Y2, Y3}	{0.28, 0.5, 0.5, 0.33, 0.33, 0.4}	

[a]The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level on one lane. The receiver does not have to operate correctly at this input power.
[b]Average receive power, each lane (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 95.8.8) for the BER specified in 95.1.1.
[d]These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

95.7.3 100GBASE-SR4 illustrative link power budget

An illustrative power budget and penalties for 100GBASE-SR4 channels are shown in Table 95–8.

95.8 Definition of optical parameters and measurement methods

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

Table 95–8—100GBASE-SR4 illustrative link power budget

Parameter	OM3	OM4	Unit
Effective modal bandwidth at 850 nm[a]	2000	4700	MHz.km
Power budget (for max TxVEC)	8.2		dB
Operating distance	0.5 to 70	0.5 to 100	m
Channel insertion loss[b]	1.8	1.9	dB
Allocation for penalties[c] (for max TxVEC)	6.3		dB
Additional insertion loss allowed	0.1	0	dB

[a]per IEC 60793-2-10.
[b]The channel insertion loss is calculated using the maximum distance specified in Table 95–5 and cabled optical fiber attenuation of 3.5 dB/km at 850 nm plus an allocation for connection and splice loss given in 95.11.2.1.
[c]Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

95.8.1 Test patterns for optical parameters

While compliance is to be achieved in normal operation, specific test patterns are defined for measurement consistency and to enable measurement of some parameters. Table 95–10 gives the test patterns to be used in each measurement, unless otherwise specified, and also lists references to the subclauses in which each parameter is defined. Any of the test patterns given for a particular test in Table 95–10 may be used to perform that test. As Pattern 3 is more demanding than Pattern 5 (which itself is the same or more demanding than other 100GBASE-R bit streams) an item that is compliant using Pattern 5 is considered compliant even if it does not meet the required limit using Pattern 3. The test patterns used in this clause are shown in Table 95–9.

Table 95–9—Test patterns

Pattern	Pattern description	Defined in
Square wave	Square wave (8 ones, 8 zeros)	83.5.10
3	PRBS31	83.5.10
4	PRBS9	83.5.10
5[a]	RS-FEC encoded scrambled idle	82.2.10[a]

[a]The pattern defined in 82.2.10 as encoded by Clause 91 RS-FEC for 100GBASE-SR4

95.8.1.1 Multi-lane testing considerations

Stressed receiver sensitivity is defined for an interface at the BER specified in 95.1.1. The interface BER is the average of the four BERs of the receive lanes when they are stressed.

Measurements with Pattern 3 (PRBS31) allow lane-by-lane BER measurements. Measurements with Pattern 5 (RS-FEC encoded scrambled idle) give the interface BER if all lanes are stressed at the same time. If each lane is stressed in turn, the BER is diluted by the three unstressed lanes, and the BER for that stressed

Table 95–10—Test-pattern definitions and related subclauses

Parameter	Pattern	Related subclause
Wavelength, spectral width	3, 5 or valid 100GBASE-SR4 signal	95.8.2
Average optical power	3, 5 or valid 100GBASE-SR4 signal	95.8.3
Optical modulation amplitude (OMA)	Square wave or 4	95.8.4
Transmitter vertical eye closure (TxVEC)	3 or 5	95.8.5
Extinction ratio	3, 5 or valid 100GBASE-SR4 signal	95.8.6
Transmitter optical waveform	3, 5 or valid 100GBASE-SR4 signal	95.8.7
Stressed receiver sensitivity	3, 5 or valid 100GBASE-SR4 signal	95.8.8
TxVEC of stressed receiver conformance test signal calibration	3, 5 or valid 100GBASE-SR4 signal	95.8.8

lane alone must be found, e.g., by multiplying by four if the unstressed lanes have low BER. In stressed receiver sensitivity measurements, unstressed lanes may be created by setting the power at the receiver under test well above its sensitivity and/or not stressing those lanes with ISI and jitter, or by other means. Each receive lane is stressed in turn while all are operated. All aggressor lanes are operated as specified. To find the interface BER, the BERs of all the lanes when stressed are averaged.

Where relevant, parameters are defined with all co-propagating and counter-propagating lanes operational so that crosstalk effects are included. Where not otherwise specified, the maximum amplitude (OMA or VMA) for a particular situation is used, and for counter-propagating lanes, the minimum transition time is used. Alternative test methods that generate equivalent results may be used. While the lanes in a particular direction may share a common clock, the Tx and Rx directions are not synchronous to each other. If Pattern 3 is used for the lanes not under test using a common clock, there is at least 31 UI delay between the PRBS31 patterns on one lane and any other lane.

95.8.2 Center wavelength and spectral width

The center wavelength and RMS spectral width of each optical lane shall be within the range given in Table 95–6 if measured per TIA/EIA-455-127-A or IEC 61280-1-3. The lane under test is modulated using one of the test patterns specified in Table 95–10.

95.8.3 Average optical power

The average optical power of each lane shall be within the limits given in Table 95–6 if measured using the methods given in IEC 61280-1-1. The average optical power is measured using the test pattern defined in Table 95–10.

95.8.4 Optical Modulation Amplitude (OMA)

OMA shall be within the limits given in Table 95–6 if measured as defined in 52.9.5 for measurement with a square wave (8 ones, 8 zeros) test pattern or 68.6.2 (from the variable MeasuredOMA in 68.6.6.2) for measurement with a PRBS9 test pattern, with the exception that each optical lane is tested individually. See 95.8.1 for test pattern information.

95.8.5 Transmitter vertical eye closure (TxVEC)

TxVEC of each lane shall be within the limits given in Table 95–6 if measured using the methods specified in 95.8.5.1 and 95.8.5.2.

TxVEC is a measure of each optical transmitter's vertical eye closure; it is based upon vertical histogram data from an eye diagram measured through an optical to electrical converter (O/E) with a bandwidth equivalent to a combined reference receiver and worst case optical channel. Table 95–10 specifies the test patterns to be used for measurement of TxVEC.

95.8.5.1 TxVEC conformance test set-up

A block diagram for the TxVEC conformance test is shown in Figure 95–3. Other measurement implementations may be used with suitable calibration.

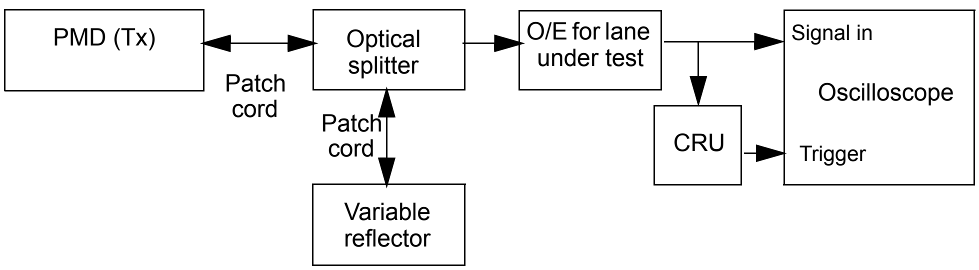


Figure 95–3—TxVEC conformance test block diagram

Each optical lane is tested individually with all other lanes in operation. The optical splitter and variable reflector are adjusted so that each transmitter is tested with an optical return loss of 12 dB.

The combination of the O/E and the oscilloscope used to measure the optical waveform has a fourth-order Bessel-Thomson filter response with a bandwidth of 12.6 GHz. Compensation may be made for any deviation from an ideal fourth-order Bessel-Thomson response.

The clock recovery unit (CRU) has a corner frequency of 10 MHz and a slope of 20 dB/decade.

95.8.5.2 TxVEC measurement method

The oscilloscope is set up to accumulate samples of the optical eye diagram for the transmitter under test, as illustrated in Figure 95–4.

OMA is measured according to 95.8.4.

The standard deviation of the noise of the O/E and oscilloscope combination, S, is determined with no optical input signal and the same settings as used to capture the histograms described below.

The average optical power (P_{ave}) and the crossing points of the eye diagram, and the four vertical histograms used to calculate TxVEC, are measured using Pattern 3 or Pattern 5. The 0 UI and 1 UI crossing points are determined by the time average of the eye diagram crossing points, as measured at P_{ave}, as illustrated in Figure 95–4.

Four vertical histograms are measured through the eye diagram, centered at 0.4 UI and 0.6 UI, and above and below P_{ave}, as illustrated in Figure 95–4.

Each histogram window has a width of 0.04 UI. Each histogram window has an inner height boundary which is set close to P_{ave} (so that no further samples would be captured by moving it closer to P_{ave}), and an outer height boundary which is set beyond the outer-most samples of the eye diagram, so that no further samples would be captured by increasing the outer boundary of the histogram.

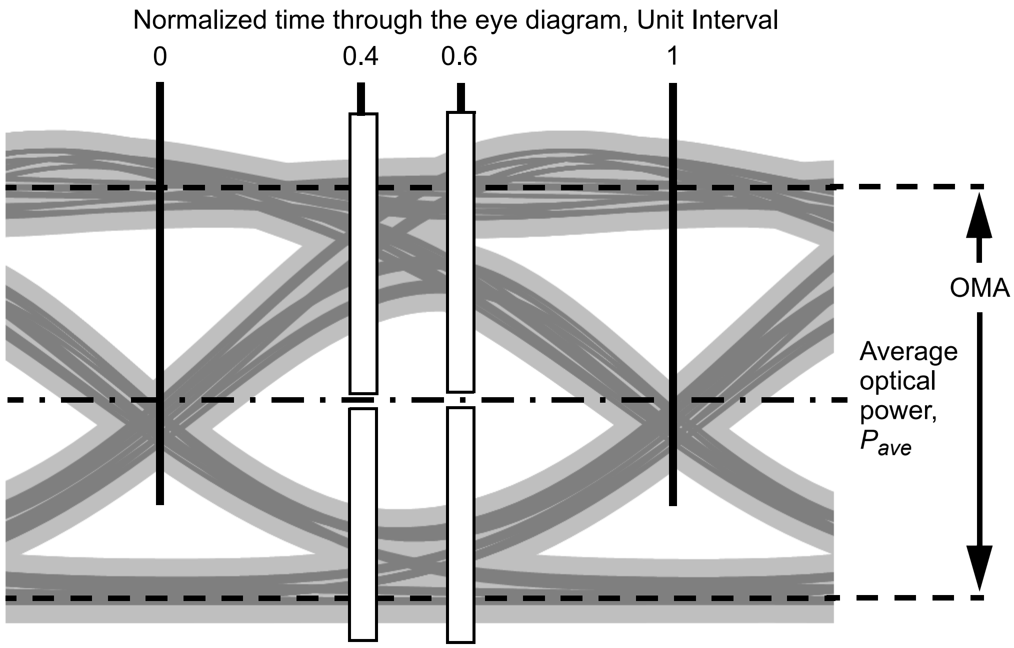


Figure 95–4—Illustration of the TxVEC measurement

The distributions of the two histograms on the left are each multiplied by Q functions which represent an estimate of the probability of errors caused by each part of the distribution for the greatest tolerable noise that could be added by an optical channel and a receiver. The resulting distributions are integrated and each integral is divided by the integral of the distribution it was derived from, giving two bit error probabilities. The Q function uses a standard deviation, σ_L, chosen so that the average of these two bit error probabilities is 5×10^{-5}. Similarly, for the two histograms on the right, a standard deviation, σ_R, is found.

Q(x) is the area under a Normal curve for values larger than *x* (the tail probability, related to the “complementary error function”), as shown in Equation (95–1):

$$Q(x) = \int_x^{\infty} \frac{e^{(-z^2/2)}}{\sqrt{2\pi}} dz \quad (95–1)$$

where

x is $(y - P_{ave})/\sigma_G$ or $(P_{ave} - y)/\sigma_G$, as in Equation (95–2).

This procedure finds a value of σ_G such that Equation (95–2) is satisfied:

$$\frac{1}{2}\left(\frac{\int fu(y)Q\left(\frac{y-P_{ave}}{\sigma_G}\right)dy}{\int fu(y)dy}\right)+\frac{1}{2}\left(\frac{\int fl(y)Q\left(\frac{P_{ave}-y}{\sigma_G}\right)dy}{\int fl(y)dy}\right) = 5\times10^{-5} \quad (95\text{–}2)$$

where

fu(y), fl(y)	are the upper and lower distributions
σ_G	is the left or right standard deviation, σ_L or σ_R.

The lesser of σ_L and σ_R is *N*.

The noise, *R*, that could be added by a receiver is given by:

$$R = \sqrt{N^2+S^2-M^2} \quad (95\text{–}3)$$

where

M	is a term to account for mode partition noise and modal noise that could be added by the optical channel, defined in Equation (95–4), and
S	is the standard deviation of the noise of the O/E and oscilloscope combination.

$$M = \sqrt{(0.0257OMA)^2+(0.01P_{ave})^2} \quad (95\text{–}4)$$

where

OMA	is the optical modulation amplitude as defined in 95.8.4, and
P_{ave}	is the average optical power of the eye diagram.

TxVEC is given by:

$$TxVEC = 10\log_{10}\left(\frac{OMA}{2}\times\frac{1}{3.8906R}\right) \quad (95\text{–}5)$$

The factor 3.8906 is chosen for consistency with the BER of 5×10^{-5} given in 95.1.1.

The method described in 95.8.5.1 and 95.8.5.2 is the reference measurement method. Other equivalent measurement methods may be used with suitable calibration.

95.8.6 Extinction ratio

The extinction ratio of each lane shall be within the limits given in Table 95–6 if measured using the methods specified in IEC 61280-2-2. The extinction ratio is measured using one of the test patterns specified for extinction ratio in Table 95–10.

NOTE—Extinction ratio and OMA are defined with different test patterns (see Table 95–10).

95.8.7 Transmitter optical waveform (transmit eye)

The required optical transmitter pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram as shown in Figure 86-4 with the Transmitter eye mask coordinates and hit ratio in Table 95–6. The transmitter optical waveform of a port transmitting the test pattern specified in Table 95–10 shall meet specifications according to the methods specified in 86.8.4.6.1 with the exceptions that:

- The clock recovery unit's high-frequency corner bandwidth is 10 MHz.
- The filter nominal reference frequency f_r is 19.34 GHz and the filter tolerances are as specified for STM-64 in ITU-T G.691.

Compensation may be made for variation of the reference receiver filter response from an ideal fourth-order Bessel-Thomson response, and for any excess reference receiver noise.

95.8.8 Stressed receiver sensitivity

Stressed receiver sensitivity shall be within the limits given in Table 95–7 if measured using the method defined by 95.8.8.1 and 95.8.8.5, with the conformance test signal at TP3 as described in 95.8.8.2.

Stressed receiver sensitivity is defined with all transmit and receive lanes in operation. Pattern 3 or Pattern 5, or a valid 100GBASE-SR4 signal, is sent from the transmit section of the PMD under test. The signal being transmitted is asynchronous to the received signal. The interface BER of the PMD receiver is the average of the BER of all receive lanes while stressed and at the specified receive OMA.

95.8.8.1 Stressed receiver conformance test block diagram

A block diagram for the receiver conformance test is shown in Figure 95–5. The patterns used for the received compliance signal are specified in Table 95–10. The optical test signal is conditioned (stressed) using the stressed receiver methodology defined in 95.8.8.2, and has sinusoidal jitter applied as specified in 95.8.8.5. A suitable test set is needed to characterize and verify that the signal used to test the receiver has the appropriate characteristics. The low-pass filter is used to create ISI. The low-pass filter, when combined with the E/O converter, should have a frequency response that results in the appropriate level of TxVEC before the sinusoidal terms are added.

The sinusoidal amplitude interferer 1 causes jitter that is intended to emulate instantaneous bit shrinkage that can occur with DDJ. This type of jitter cannot be created by simple phase modulation. The sinusoidal amplitude interferer 2 causes additional eye closure, but in conjunction with the finite edge rates from the limiter, also causes some jitter. The sinusoidally jittered clock represents other forms of jitter and also verifies that the receiver under test can track low-frequency jitter. The sinusoidal amplitude interferers may be set at any frequency between 100 MHz and 2 GHz, although care should be taken to avoid harmonic relationships between the sinusoidal interferers, the sinusoidal jitter, the signaling rate, and the pattern repetition rate. The Gaussian noise generator, the amplitude of the sinusoidal interferers, and the low-pass filter are adjusted so that the TxVEC, stressed eye J2 Jitter, and stressed eye J4 Jitter specifications given in Table 95–7 are met simultaneously while also passing the stressed receiver eye mask in Table 95–7 according to the methods specified in 95.8.7 (the random noise effects such as RIN, or random clock jitter, do not need to be minimized).

For improved visibility for calibration, all elements in the signal path (cables, DC blocks, E/O converter, etc.) should have wide and smooth frequency response, and linear phase response, throughout the spectrum of interest. Baseline wander and overshoot and undershoot should be minimized.

The stressed receiver conformance signal verification is described in 95.8.8.4.

Stressed receiver sensitivity is defined with all transmit and receive lanes in operation. Each receive lane is tested in turn while all aggressor receive lanes are operated as specified in Table 95–7. Pattern 3 or Pattern 5, or a valid 100GBASE–SR4 signal is sent from the transmit section of the receiver under test. The signal being transmitted is asynchronous to the received signal. If Pattern 3 is used for the transmit and receive lanes not under test, there is at least 31 UI delay between the PRBS31 patterns generated on one lane and any other lane.

For 100GBASE-SR4 the relevant BER is the interface BER at the PMD service interface. The interface BER is the average of the four BER of the receive lanes when stressed: see 95.8.1.1. If present, the RS-FEC sublayer can measure the lane symbol error ratio at its input. The lane BER can be assumed to be one tenth of the lane symbol error ratio. If each lane is stressed in turn, the PMD interface BER is the average of the BERs of all the lanes when stressed: see 95.8.1.1.

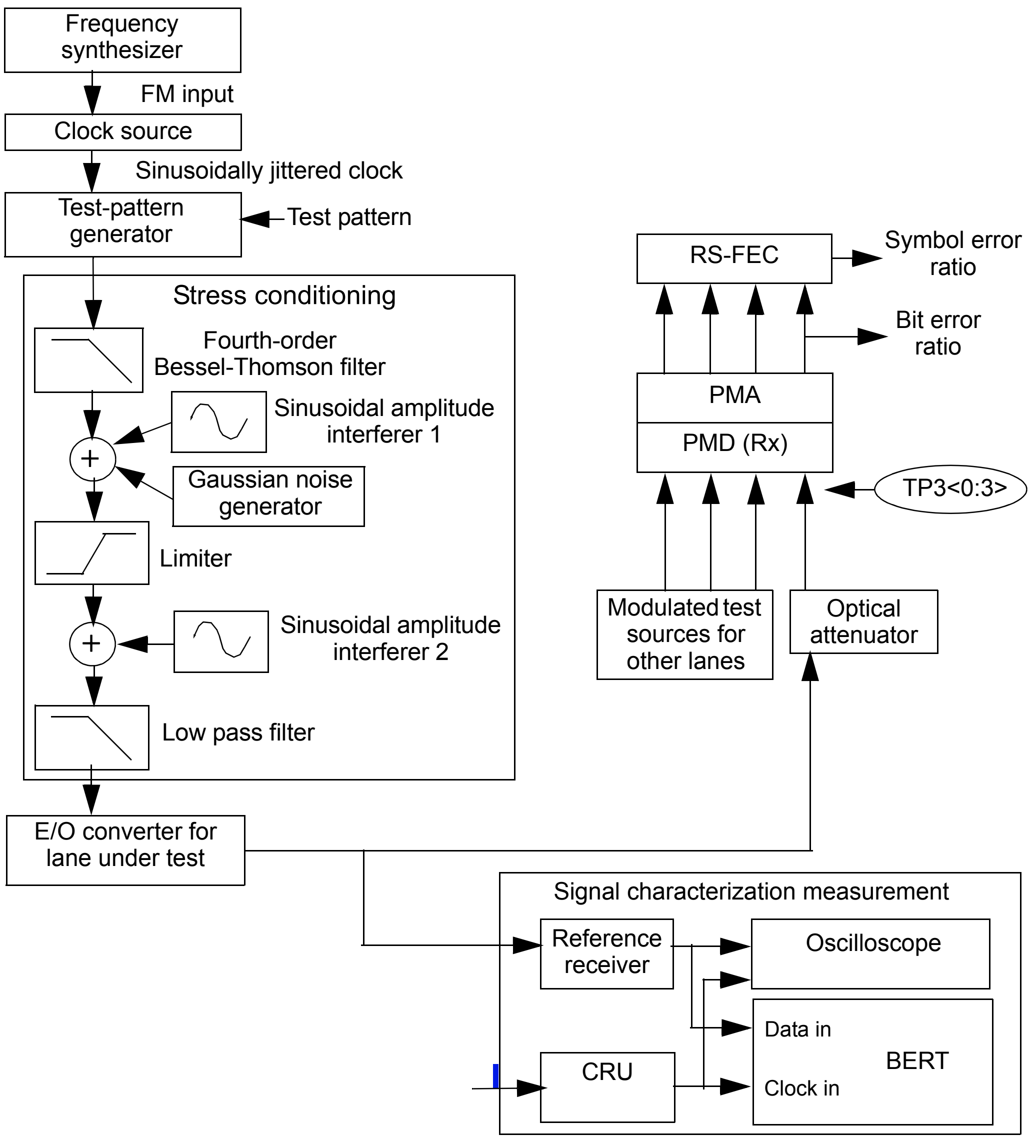


Figure 95–5—Stressed receiver conformance test block diagram

95.8.8.2 Stressed receiver conformance test signal characteristics and calibration

The conformance test signal is used to validate that the PMD receiver of the lane under test meets BER requirements with near worst-case waveforms at TP3.

The primary parameters of the stressed receiver conformance test signal are its TxVEC, stressed eye J2 Jitter and stressed eye J4 Jitter. The TxVEC of the stressed receiver conformance test signal is measured according to 95.8.5, except that the combination of the O/E and the oscilloscope used to measure the waveform has a fourth-order Bessel-Thomson filter response with a bandwidth of 19.34 GHz. Stressed eye J2 Jitter and stressed eye J4 Jitter are defined in 95.8.8.3.

An example stressed receiver conformance test setup is shown in Figure 95–5, however any approach that modulates or creates the appropriate levels and frequencies of the TxVEC and jitter components is acceptable.

The following steps describe a possible method for setting up and calibrating a stressed eye conformance signal when using a stressed receiver conformance test setup as shown in Figure 95–5:

1) Set the signaling rate of the test pattern generator to meet the requirements in Table 95–7.
2) With the sinusoidal interferers, sinusoidal jitter, and Gaussian noise generator turned off, set the extinction ratio of the E/O to approximately the minimum specified in Table 95–6.
3) The required values of TxVEC, J2 Jitter and J4 Jitter of the stressed receiver conformance signal are given in Table 95–7.

   With sinusoidal amplitude interferer 1, sinusoidal amplitude interferer 2, sinusoidal jitter, and the Gaussian noise generator turned off, greater than two thirds of the dB value of the TxVEC should be created by the selection of the appropriate bandwidth for the low-pass filter. Any remaining TxVEC must be created with a combination of sinusoidal jitter, sinusoidal interference, and Gaussian noise.

   The sinusoidal amplitude interferers may be set at any frequency between 100 MHz and 2 GHz, although care should be taken to avoid harmonic relationships between the sinusoidal interferers, the sinusoidal jitter, the signaling rate, and the pattern repetition rate. The instantaneous bit shrinkage introduced by sinusoidal amplitude interferer 1 should be no more than 0.1 UI.

   Sinusoidal jitter is added as specified in Table 95–11. When calibrating the conformance signal, the sinusoidal jitter frequency should be within the 10 MHz to 10 times LB as defined in Table 95–11. Sinusoidal jitter amplitude may be calibrated by measuring the jitter on the oscilloscope, while transmitting the square wave pattern, and using a clean clock in place of the CRU to trigger the oscilloscope.

   Iterate the adjustments of sinusoidal interferers and Gaussian noise generator and extinction ratio until the values of TxVEC, stressed eye J2 Jitter and stressed eye J4 Jitter meet the requirements in Table 95–7, the extinction ratio is approximately the minimum specified in Table 95–6, and sinusoidal jitter is as specified in Table 95–11.

Each receiver lane is conformance tested in turn. The source for the lane under test is adjusted to supply a signal at the input to the receiver under test at the “Stressed receiver sensitivity (OMA), each lane (max)” specified in Table 95–7, and the test sources for the other lanes is set to the “OMA of each aggressor lane” specified in Table 95–7.

95.8.8.3 J2 and J4 Jitter

J2 Jitter is defined as the time interval at the average optical power level that includes all but 10^{-2} of the jitter distribution, which is the time interval from the 0.5th to the 99.5th percentile of the jitter histogram. J2 Jitter is defined using a clock recovery unit as in 95.8.7. If measured using an oscilloscope, the histogram should include at least 10 000 hits, and should be taken over about 1% of the signal amplitude. If measured by plotting BER vs. decision time, J2 is the time interval between the two points with a BER of 2.5×10^{-3}.

J4 Jitter is defined as the time interval at the average optical power level that includes all but 10^{-4} of the jitter distribution. J4 Jitter is defined using a clock recovery unit as in 95.8.7. If measured using an oscilloscope, the histogram should include at least 1 000 000 hits, and should be taken over about 1% of the signal amplitude. If measured by plotting BER vs. decision time, J4 is the time interval between the two points with a BER of 2.5×10^{-5}.

95.8.8.4 Stressed receiver conformance test signal verification

The stressed receiver conformance test signal can be verified using an optical reference receiver with an ideal fourth-order Bessel-Thomson response with a reference frequency f_r of 19.34 GHz. Use of G.691 tolerance filters may significantly degrade this calibration. The clock output from the clock source in Figure 95–5 is modulated with the sinusoidal jitter. To use an oscilloscope to calibrate the final stressed eye J2 Jitter and stressed eye J4 Jitter that includes the sinusoidal jitter component, a clock recovery unit (CRU of Figure 95–5) is required.

Care should be taken when characterizing the test signal because excessive noise/jitter in the measurement system will result in an input signal that does not fully stress the receiver under test. Running the receiver tolerance test with a signal that is under-stressed may result in the deployment of non-compliant receivers. Care should be taken to minimize the noise/jitter introduced by the reference O/E, filters and BERT and/or to correct for this noise. While the details of a BER scan measurement and test equipment are beyond the scope of this standard, it is recommended that the implementor fully characterize the test equipment and apply appropriate guard bands to ensure that the stressed receiver conformance input signal meets the stress and sinusoidal jitter specified in 95.8.8.2 and 95.8.8.5.

95.8.8.5 Sinusoidal jitter for receiver conformance test

The sinusoidal jitter is used to test receiver jitter tolerance. The amplitude of the applied sinusoidal jitter is dependent on frequency as specified in Table 95–11.

Table 95–11—Applied sinusoidal jitter

Frequency range	Sinusoidal jitter peak-to-peak (UI)
$f < 100$ kHz	Not specified
100 kHz $< f \leq$ 10 MHz	$5 \times 10^5/f$
10 MHz $< f \leq 10\, LB$[a]	0.05

[a]*LB* = loop bandwidth; upper frequency bound for added sine jitter should be at least 10 times the loop bandwidth of the receiver being tested.

95.9 Safety, installation, environment, and labeling

95.9.1 General safety

All equipment subject to this clause shall conform to IEC 60950-1.

95.9.2 Laser safety

100GBASE-SR4 optical transceivers shall conform to Hazard Level 1M laser requirements as defined in IEC 60825-1 and IEC 60825-2, under any condition of operation. This includes single fault conditions whether coupled into a fiber or out of an open bore.

Conformance to additional laser safety standards may be required for operation within specific geographic regions.

Laser safety standards and regulations require that the manufacturer of a laser product provide information about the product's laser, safety features, labeling, use, maintenance, and service. This documentation explicitly defines requirements and usage restrictions on the host system necessary to meet these safety certifications.[4]

95.9.3 Installation

It is recommended that proper installation practices, as defined by applicable local codes and regulation, be followed in every instance in which such practices are applicable.

95.9.4 Environment

Normative specifications in this clause shall be met by a system integrating a 100GBASE-SR4 PMD over the life of the product while the product operates within the manufacturer's range of environmental, power, and other specifications.

It is recommended that manufacturers indicate, in the literature associated with the PHY, the operating environmental conditions to facilitate selection, installation, and maintenance.

It is recommended that manufacturers indicate, in the literature associated with the components of the optical link, the distance and operating environmental conditions over which the specifications of this clause will be met.

95.9.5 Electromagnetic emission

A system integrating a 100GBASE-SR4 PMD shall comply with applicable local and national codes for the limitation of electromagnetic interference.

95.9.6 Temperature, humidity, and handling

The optical link is expected to operate over a reasonable range of environmental conditions related to temperature, humidity, and physical handling (such as shock and vibration). Specific requirements and values for these parameters are considered to be beyond the scope of this standard.

[4]A host system that fails to meet the manufacturer's requirements and/or usage restrictions may emit laser radiation in excess of the safety limits of one or more safety standards. In such a case, the host manufacturer is required to obtain its own laser safety certification.

95.9.7 PMD labeling requirements

It is recommended that each PHY (and supporting documentation) be labeled in a manner visible to the user, with at least the applicable safety warnings and the applicable port type designation (e.g., 100GBASE-SR4).

Labeling requirements for Hazard Level 1M lasers are given in the laser safety standards referenced in 95.9.2.

95.10 Fiber optic cabling model

The fiber optic cabling model is shown in Figure 95–6.

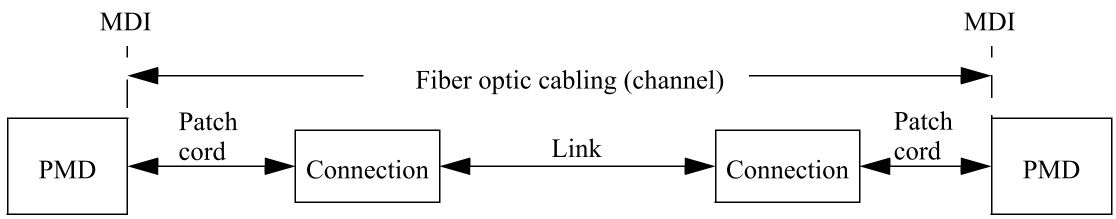


Figure 95–6—Fiber optic cabling model

The channel insertion loss is given in Table 95–12. A channel may contain additional connectors as long as the optical characteristics of the channel, such as attenuation, modal dispersion, reflections and losses of all connectors and splices meet the specifications. Insertion loss measurements of installed fiber cables are made in accordance with IEC 61280-4-1:2009. As OM4 optical fiber meets the requirements for OM3, a channel compliant to the “OM3” column may use OM4 optical fiber, or a combination of OM3 and OM4. The term channel is used here for consistency with generic cabling standards.

Table 95–12—Fiber optic cabling (channel) characteristics for 100GBASE-SR4

Description	OM3	OM4	Unit
Operating distance (max)	70	100	m
Cabling Skew (max)	79		ns
Cabling Skew Variation[a] (max)	2.4		ns
Channel insertion loss[b] (max)	1.8	1.9	dB
Channel insertion loss (min)	0		dB

[a]An additional 400 ps of Skew Variation could be caused by wavelength changes, which are attributable to the transmitter not the channel.
[b]These channel insertion loss values include cable loss plus 1.5 dB allocated for connection and splice loss, over the wavelength range 840 nm to 860 nm.

95.11 Characteristics of the fiber optic cabling (channel)

The 100GBASE-SR4 fiber optic cabling shall meet the specifications defined in Table 95–12. The fiber optic cabling consists of one or more sections of fiber optic cable and any intermediate connections required to connect sections together.

95.11.1 Optical fiber cable

The fiber contained within the 100GBASE-SR4 fiber optic cabling shall comply with the specifications and parameters of Table 95–13. A variety of multimode cable types may satisfy these requirements, provided the resulting channel also meets the specifications of Table 95–12.

Table 95–13—Optical fiber and cable characteristics

Description	OM3[a]	OM4[b]	Unit
Nominal core diameter	50		µm
Nominal fiber specification wavelength	850		nm
Effective modal bandwidth (min)[c]	2000	4700	MHz.km
Cabled optical fiber attenuation (max)	3.5		dB/km
Zero dispersion wavelength (λ_0)	$1295 \le \lambda_0 \le 1340$		nm
Chromatic dispersion slope (max) (S_0)	0.105 for $1295 \le \lambda_0 \le 1310$ and $0.000375 \times (1590 - \lambda_0)$ for $1310 \le \lambda_0 \le 1340$		ps/nm^2 km

[a]IEC 60793-2-10 type A1a.2
[b]IEC 60793-2-10 type A1a.3
[c]When measured with the launch conditions specified in Table 95–6

95.11.2 Optical fiber connection

An optical fiber connection, as shown in Figure 95–6, consists of a mated pair of optical connectors.

95.11.2.1 Connection insertion loss

The maximum link distance is based on an allocation of 1.5 dB total connection and splice loss. For example, this allocation supports 3 connections with an average insertion loss per connection of 0.5 dB. Connections with lower loss characteristics may be used provided the requirements of Table 95–12 are met. However, the loss of a single connection shall not exceed 0.75 dB

95.11.2.2 Maximum discrete reflectance

The maximum discrete reflectance shall be less than –20 dB.

95.11.3 Medium Dependent Interface (MDI)

The 100GBASE-SR4 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 95–6). The 100GBASE-SR4 PMD is coupled to the fiber optic cabling through one connector plug into the MDI optical receptacle as shown in

Figure 95–7. Example constructions of the MDI include the following:

a) PMD with a connectorized fiber pigtail plugged into an adapter;
b) PMD receptacle.

95.11.3.1 Optical lane assignments

The four transmit and four receive optical lanes of 100GBASE-SR4 shall occupy the positions depicted in Figure 95–7 when looking into the MDI receptacle with the connector keyway feature on top. The interface contains eight active lanes within twelve total positions. The transmit optical lanes occupy the left-most four positions. The receive optical lanes occupy the right-most four positions. The four center positions are unused.

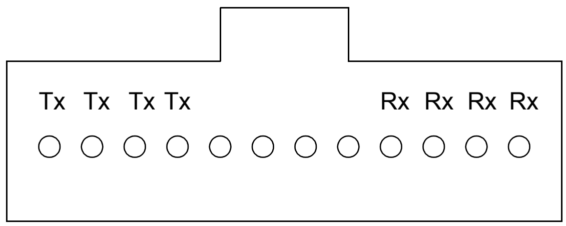


Figure 95–7—100GBASE-SR4 optical lane assignments

95.11.3.2 Medium Dependent Interface (MDI) requirements

The MDI adapter or receptacle shall meet the dimensional specifications for interface 7-1-3: *MPO adapter interface - opposed keyway configuration*, or interface 7-1-10: *MPO active device receptacle, flat interface*, as defined in IEC 61754-7-1. The plug terminating the optical fiber cabling shall meet the dimensional specifications of interface 7-1-4: *MPO female plug connector, flat interface for 2 to 12 fibres*, as defined in IEC 61754-7-1. The MDI shall optically mate with the plug on the optical fiber cabling. Figure 95–8 shows an MPO female plug connector with flat interface, and an MDI.

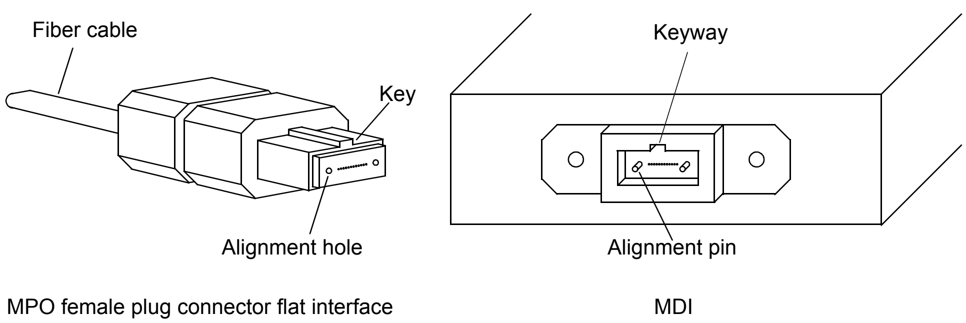


Figure 95–8—MPO female plug with flat interface and MDI

The MDI shall meet the interface performance specifications of IEC 61753-1 and IEC 61753-022-2.

NOTE—Transmitter compliance testing is performed at TP2 as defined in 95.5.1, not at the MDI.

95.12 Protocol implementation conformance statement (PICS) proforma for Clause 95, Physical Medium Dependent (PMD) sublayer and medium, type 100GBASE-SR4[5]

95.12.1 Introduction

The supplier of a protocol implementation that is claimed to conform to Clause 95, Physical Medium Dependent (PMD) sublayer and medium, type 100GBASE-SR4, shall complete the following protocol implementation conformance statement (PICS) proforma.

A detailed description of the symbols used in the PICS proforma, along with instructions for completing the PICS proforma, can be found in Clause 21.

95.12.2 Identification

95.12.2.1 Implementation identification

Supplier[1]	
Contact point for enquiries about the PICS[1]	
Implementation Name(s) and Version(s)[1,3]	
Other information necessary for full identification—e.g., name(s) and version(s) for machines and/or operating systems; System Name(s)[2]	
NOTE 1—Required for all implementations. NOTE 2—May be completed as appropriate in meeting the requirements for the identification. NOTE 3—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

95.12.2.2 Protocol summary

Identification of protocol standard	IEEE Std 802.3bm-201x, Clause 95, Physical Medium Dependent (PMD) sublayer and medium, type 100GBASE-SR4
Identification of amendments and corrigenda to this PICS proforma that have been completed as part of this PICS	
Have any Exception items been required? No [ ] Yes [ ] (See Clause 21; the answer Yes means that the implementation does not conform to IEEE Std 802.3bm-201x.)	

Date of Statement	

[5]*Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this subclause so that it can be used for its intended purpose and may further publish the completed PICS.

95.12.3 Major capabilities/options

Item	Feature	Subclause	Value/Comment	Status	Support
SR4	100GBASE-SR4 PMD	95.7	Device supports requirements for 100GBASE-SR4 PHY	O	Yes [ ] No [ ]
*INS	Installation / cable	95.11	Items marked with INS include installation practices and cable specifications not applicable to a PHY manufacturer	O	Yes [ ] No [ ]
CTP1	Reference point TP1 exposed and available for testing	95.5.1	This point may be made available for use by implementors to certify component conformance	O	Yes [ ] No [ ]
CTP4	Reference point TP4 exposed and available for testing	95.5.1	This point may be made available for use by implementors to certify component conformance	O	Yes [ ] No [ ]
CDC	Delay constraints	95.3.1	Device conforms to delay constraints	M	Yes [ ]
CSC	Skew constraints	95.3.2	Device conforms to Skew and Skew Variation constraints	M	Yes [ ]
*MD	MDIO capability	95.4	Registers and interface supported	O	Yes [ ] No [ ]

95.12.4 PICS proforma tables for Physical Medium Dependent (PMD) sublayer and medium, type 100GBASE-SR4

95.12.4.1 PMD functional specifications

Item	Feature	Subclause	Value/Comment	Status	Support
CF1	Compatible with 100GBASE-R RS-FEC, PCS, and PMA	95.1		M	Yes [ ]
CF2	Integration with management functions	95.1		O	Yes [ ] No [ ]
CF3	Bit error ratio	95.1.1	Meets the BER specified in 95.1.1	M	Yes [ ]
CF4	Transmit function	95.5.2	Conveys bits from PMD service interface to MDI	M	Yes [ ]
CF5	Mapping between optical signal and logical signal for transmitter	95.5.2	Higher optical power is a one	M	Yes [ ]
CF6	Receive function	95.5.3	Conveys bits from MDI to PMD service interface	M	Yes [ ]
CF7	Conversion of four optical signals to four electrical signals	95.5.3	For delivery to the PMD service interface	M	Yes [ ]
CF8	Mapping between optical signal and logical signal for receiver	95.5.3	Higher optical power is a one	M	Yes [ ]
CF9	Global Signal Detect function	95.5.4	Report to the PMD service interface the message PMD:IS_SIGNAL.indication(SIGNAL_DETECT)	M	Yes [ ]
CF10	Global Signal Detect behavior	95.5.4	SIGNAL_DETECT is a global indicator of the presence of optical signals on all four lanes	M	Yes [ ]
CF11	Lane-by-lane Signal Detect function	95.5.5	Sets PMD_signal_detect_*i* values on a lane-by-lane basis per requirements of Table 95–4	MD:O	Yes [ ] No [ ] N/A [ ]
CF12	PMD reset function	95.5.6	Resets the PMD sublayer	MD:O	Yes [ ] No [ ] N/A [ ]

95.12.4.2 Management functions

Item	Feature	Subclause	Value/Comment	Status	Support
CM1	Management register set	95.4		MD:M	Yes [ ] N/A [ ]
CM2	Global transmit disable function	95.5.7	Disables all of the optical transmitters with the PMD_global_transmit_disable variable	MD:O	Yes [ ] No [ ] N/A [ ]
CM3	PMD_lane_by_lane_transmit_disable function	95.5.8	Disables the optical transmitter on the lane associated with the PMD_transmit_disable_*i* variable	MD:O	Yes [ ] No [ ] N/A [ ]
CM4	PMD lane-by-lane transmit disable	95.5.8	Disables each optical transmitter independently if CM3 = No	!MD:O	Yes [ ] No [ ]
CM5	PMD_fault function	95.5.9	Sets PMD_fault to one if any local fault is detected	MD:O	Yes [ ] No [ ] N/A [ ]
CM6	PMD_transmit_fault function	95.5.10	Sets PMD_transmit_fault to one if a local fault is detected on any transmit lane	MD:O	Yes [ ] No [ ] N/A [ ]
CM7	PMD_receive_fault function	95.5.11	Sets PMD_receive_fault to one if a local fault is detected on any receive lane	MD:O	Yes [ ] No [ ] N/A [ ]

95.12.4.3 PMD to MDI optical specifications for 100GBASE-SR4

Item	Feature	Subclause	Value/Comment	Status	Support
	Transmitter meets specifications in Table 95–6	95.7.1	Per definitions in 95.8	M	Yes [ ] N/A [ ]
CSR2	Receiver meets specifications in Table 95–7	95.7.2	Per definitions in 95.8	M	Yes [ ] N/A [ ]

95.12.4.4 Optical measurement methods

Item	Feature	Subclause	Value/Comment	Status	Support
COM1	Measurement cable	95.8	2 m to 5 m in length	M	Yes [ ]
COM2	Center wavelength and spectral width	95.8.2	Per TIA/EIA-455-127-A or IEC 61280-1-3 under modulated conditions	M	Yes [ ]
COM3	Average optical power	95.8.3	Per IEC 61280-1-1	M	Yes [ ]
COM4	OMA measurements	95.8.4	Each lane	M	Yes [ ]
COM5	Transmitter vertical eye closure (TxVEC)	95.8.5	Each lane	M	Yes [ ]
COM6	Extinction ratio	95.8.6	Per IEC 61280-2-2	M	Yes [ ]
COM7	Transmit eye	95.8.7	Each lane	M	Yes [ ]
COM8	Stressed receiver sensitivity	95.8.8	See 95.8.8	M	Yes [ ]

95.12.4.5 Environmental specifications

Item	Feature	Subclause	Value/Comment	Status	Support
CES1	General safety	95.9.1	Conforms to IEC 60950-1	M	Yes [ ]
CES2	Laser safety—IEC Hazard Level 1	95.9.2	Conforms to Hazard Level 1 laser requirements defined in IEC 60825-1 and IEC 60825-2	M	Yes [ ]
CES3	Electromagnetic interference	95.9.5	Complies with applicable local and national codes for the limitation of electromagnetic interference	M	Yes [ ]

95.12.4.6 Characteristics of the fiber optic cabling and MDI

Item	Feature	Subclause	Value/Comment	Status	Support
COC1	Fiber optic cabling	95.11	Meets requirements specified in Table 95–12	INS:M	Yes [ ] N/A [ ]
COC2	Maximum discrete reflectance	95.11.2.2	Less than –20 dB	INS:M	Yes [ ] N/A [ ]
COC3	MDI layout	95.11.3.1	Optical lane assignments per Figure 95–7	M	Yes [ ]
COC4	MDI dimensions	95.11.3.2	Per IEC 61754-7-1 interface 7-1-3 or interface 7-1-10	M	Yes [ ]
COC5	Cabling connector dimensions	95.11.3.2	Per IEC 61754-7-1 interface 7-1-4	INS:M	Yes [ ] N/A [ ]
COC6	MDI mating	95.11.3.2	MDI optically mates with plug on the cabling	M	Yes [ ]
COC7	MDI requirements	95.11.3.2	Meets IEC 61753-1 and IEC 61753-022-2	INS:M	Yes [ ] N/A [ ]