

91.9 Definition of optical parameters and measurement methods

The following sections describe definitive patterns and test procedures for certain PMDs of this standard. Implementers using alternative verification methods must ensure adequate correlation and allow adequate margin such that specifications are met by reference to the definitive methods. All optical measurements, except TDP and $RIN_{15}OMA$ shall be made through a short patch cable between 2 and 5 m in length.

91.9.1 Test patterns

Compliance is to be achieved in normal operation. Two types of test patterns are used, square wave (52.9.1.2) and other (52.9.1.1) for testing of 10 Gb/s optical PMDs. These 10 Gb/s test patterns for 10GBASE-PR and 10GBASE-PRX are in Table 91-X1. Two types of test frames are used, random and jitter (59.7.1) for 1000 Mb/s tests relevant to the 10GBASE-PRX PHY. All test patterns are listed in Table 91-X1.

Table 91-X1 – Test patterns

Test	10 Gb/s Pattern	1000 Mb/s Pattern	Related subclause
Average optical power	1 or 3	Valid 8B/10B	91.9.3
OMA (modulated optical power)	Square	Idles	91.9.5
Extinction ratio	1 or 3	Idles	91.9.4
Transmit eye	1 or 3	Valid 8B/10B	91.9.7
Receive upper cutoff frequency	1 or 3	Random frame	91.9.12
RIN_xOMA	Square	Idles	91.9.6
Wavelength, spectral width	1 or 3	Valid 8B/10B	91.9.2
Side mode suppression ratio	1 or 3	Valid 8B/10B	–
VECP calibration	2 or 3	Jitter frame	91.9.10
Receiver sensitivity	1 or 3	Random frame	91.9.9
Receiver overload	1 or 3	Valid 8B/10B	–
Stressed receive sensitivity	2 or 3	Random frame	91.9.10
Transmitter and dispersion penalty	2 or 3	Random frame	91.9.8
Jitter	2 or 3	Jitter frame	91.9.11
Laser On/Off	1 or 3	Valid 8B/10B	91.9.13
Receiver settling	1 or 3	Valid 8B/10B	91.9.14

91.9.2 Wavelength and spectral width measurement

The center wavelength and spectral width (RMS) shall meet specifications according to ANSI/TIA/EIA-455-127 under modulated conditions using an appropriate PRBS or a valid 10GBASE-PR signal, 1000BASE-X signal, or another representative test pattern.

NOTE 1 – The allowable range of central wavelengths is narrower than the operating wavelength range by the actual RMS spectral width at each extreme.

NOTE 2 – The 20 dB width for SLM lasers is taken as 6.07 times the RMS width.

91.9.3 Optical power measurements

Optical power shall meet specifications according to the methods specified in ANSI/EIA-455-95. A measurement may be made with the port transmitting any valid encoded 8B/10B or 64B/66B data stream.

91.9.4 Extinction ratio measurements

Extinction ratio shall meet specifications according to IEC 61820-2-2 with the port transmitting a repeating idle pattern /I2/ ordered_set (see 36.2.4.12) or valid 10GBASE-PR signal that may be interspersed with OAM packets per 43.B.2, and with minimal back reflections into the transmitter, lower than -20dB. The test receiver has the frequency response as specified for the transmitter optical waveform measurement.

91.9.5 Optical modulation amplitude (OMA) test procedure

A description of OMA measurements for 1000 Mb/s PHYs is found in Subclause 58.7.5. A description of OMA measurements for 10 Gb/s PHYs is found in Subclause 52.9.5.

91.9.6 Relative intensity noise optical modulation amplitude (RIN_xOMA) measuring procedure

This procedure describes a component test that may not be appropriate for a system level test depending on the implementation. If used, the procedure shall be performed as described in 52.9.6 for 10 Gb/s PHYs and in 58.7.7 for 1000 Mb/s PHYs.

91.9.7 Transmit optical waveform (transmit eye)

The required transmitter pulse shape characteristics are specified in the form of a mask of the transmitter eye diagram as shown in Figure 91-XX and Figure 91-XX.

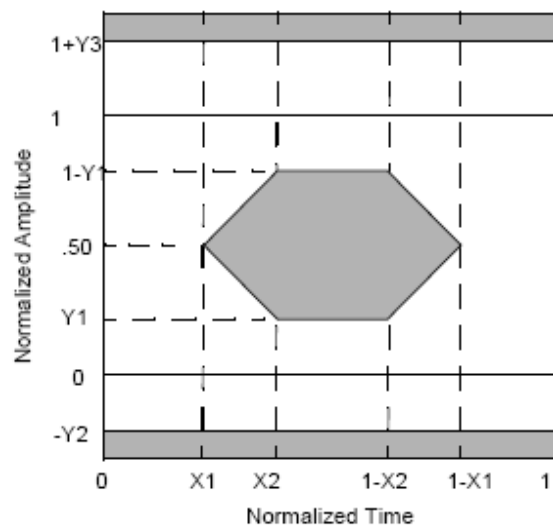


Figure 60-6—Transmitter eye mask definition

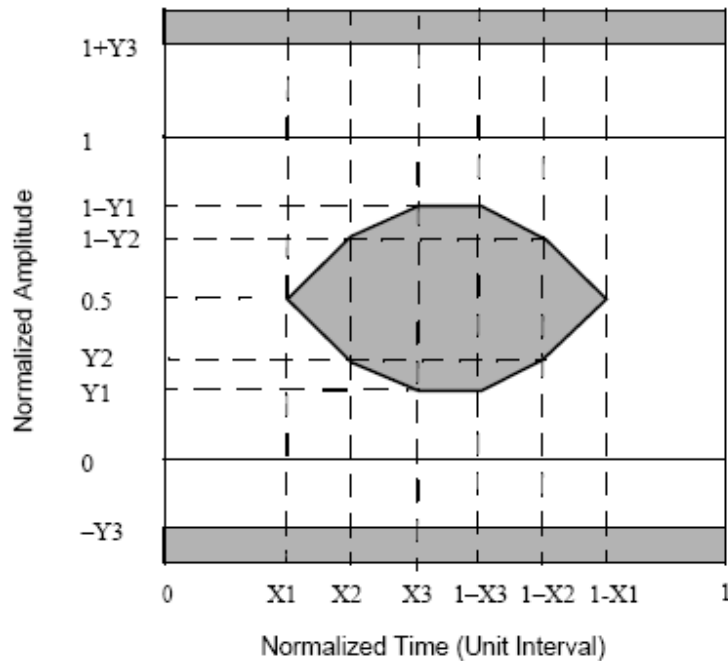


Figure 52-8—Transmitter eye mask definition

The measurement procedure is described in 58.7.8 for 1000 Mb/s PHYs and 52.9.7 for 10 Gb/s PHYs and references therein. The eye shall comply to the mask of the eye using a fourth-order Bessel-Thomson receiver response with $f_r = 0.75 * \text{bitRate}$, and where the relative response vs. relative frequency is defined in ITU-T G.957, Table B.2 (STM-16 values), along with the allowed tolerances for its physical implementation.

NOTE 1 – This Bessel-Thomson filter is not intended to represent the noise filter within an optical receiver, but is intended to provide uniform measurement conditions on the transmitter.

NOTE 2 – The fourth order Bessel-Thomson filter is reactive. In order to suppress reflections, an attenuator may be required at the filter input and/or output.

91.9.8 .Transmitter and dispersion penalty (TDP)

TDP measurement tests for transmitter impairments with chromatic effects for a transmitter to be used with single-mode fiber. Possible causes of impairment include intersymbol interference, jitter, and RIN. Meeting the separate requirements (e.g. eye mask, spectral characteristics) does not in itself guarantee the transmitter and dispersion penalty (TDP). The TDP limit shall be met. See 58.7.9 for details of the measurement for 1000 Mb/s PHYs and 52.9.10 for 10 Gb/s PHYs.

91.9.9 Receive sensitivity

Receiver sensitivity is defined for the random pattern test frame, or test pattern 1, or test pattern 3, and an ideal input signal quality with the specified extinction ratio. The measurement procedure is described in Subclause 58.7.10 for 1000 Mb/s PHYs and 52.9.8 for 10 Gb/s PHYs.

The sensitivity shall be met for the bit error ratio defined in Table 91-6, Table 91-7, and Table 91-11 as appropriate.

91.9.10 Stressed receiver conformance test

The stressed receiver conformance test is intended to screen against receivers with poor frequency response or timing characteristics which could cause errors when combined with a distorted but compliant signal. If stressed receiver compliance is necessary, the receiver shall meet the specified bit error ratio at the power level and signal quality defined in Table 91-6, Table 91-7, and Table 91-11 as appropriate, according to the measurement procedures of Subclause 58.7.11 for 1000 Mb/s PHYs and Subclause 52.9.9 for 10 Gb/s PHYs.

91.9.11 Jitter measurements

Jitter measurements for 1000 Mb/s are described in Subclause 58.7.12. Jitter measurements for 10 Gb/s are described in Subclause 52.8.1.

91.9.12 Measurement of the receiver 3 dB electrical upper cutoff frequency

The receiver 3 dB electrical upper cutoff frequency may be measured as described in Subclause 52.9.11.

91.9.13 Laser On/Off timing measurement

Laser On/Off timing measurement procedure is described in Subclause 60.7.13.1 with the following changes:

T_{on} is defined in Subclause 60.7.13.1.1, value is less than 512 ns (defined in Table 91-8 and Table 91-9).

$T_{receiver_settling}$ is defined in Subclause 60.8.13.2.1 (informative) value is defined in Table 91-6 and Table 91-7.

T_{cdr} is defined in Subclause 92.3.2.1, value less than 400 ns.

$T_{code_group_align}$ is defined in 36.6.2.4 value is less than 4 ten-bit code-groups for 1000 Mb/s PHYs, and is defined as 0 for 10 Gb/s PHYs.

T_{off} is defined in 60.7.13.11.1, value is less than 512 ns (defined in Table 91-8 and Table 91-9).

91.9.14 Receiver settling timing measurement (informative)

The receiver settling time measurement is described in Subclause 60.7.13.2.