The ATM Forum
Technical Committee

155.52 Mbps
Physical Layer Interface Specification
for
Short Wavelength Laser

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1.0 155.52 MBPS SHORT WAVELENGTH LASER PHYSICAL LAYER SPECIFICATION

1.0 155.52 MBPS Short Wavelength Laser Physical Layer Specification

This specification describes a Physical Layer Interface for a 155.52 Mbps private UNI which uses a short wavelength (SW) laser transceiver over multimode fiber (MMF). The functions of the Physical Layer (U-plane) are grouped into the Physical Media Dependent (PMD) sublayer and the Transmission Convergence (TC) sublayer as described in Section 2.1 of UNI 3.1. This specification along with the 1300nm (Long Wavelength, LW) LED multimode fiber specification of ANSI T1.646(Section 7.6.2) provides users the flexibility to use either long wavelength or short wavelength operation over both 62.5/125 and 50/125 um graded index multimode glass optical fiber. Although both transceivers can operate over these two fiber types, the transceivers are not interoperable.
The optical parameters referenced in this standard are compatible with ANSI/TIA/EIA-568-A and ISO/IEC 11801 standards.

1.1 Physical Media Dependent (PMD) Specification

1.1.1 Optical Fiber

(R) The glass optical fiber shall be 62.5/125 um multi-mode, graded index optical fiber as specified in IEC 793-2 Type A1b and TIA/EIA 492 AAAA-A or 50/125m multi-mode, graded index optical fiber as specified in IEC 793-2 Type A1a.

1.1.1.1 Optical Medium Connector Plug and Socket

(R) Each end of the fiber optic cable shall be terminated in either the SC connector as defined in IEC 874-14 or the BFOC/2.5 connector as defined in IEC 874-10. The corresponding mating connector sockets shall be used on all network elements covered by this specification to which the fiber optic cable attaches. In-line or patch panel connectors may be of other types, provided they meet the connector loss requirement defined in Section 1.1.4.1.

1.1.2 Line Code

(R) The optical line coding shall be binary NRZ. A binary 1 shall be represented as a high light level condition.

1.1.3 Error Rate

(R) A SW laser-based MMF interface receiver shall operate with a bit error rate not to exceed 10^{-10} when presented with a transmitter signal as specified in section 1.1.4.2 transmitted through a fiber link consisting of optical fiber specified in 1.1.1 and subject to the system budget constraints specified in 1.1.4.1.

1.1.4 Short Wave Laser-based MMF Interface

1.1.4.1 System Budget

Proper system performance is ensured by considering the attenuation, reflection, and dispersion characteristics of the optical path and including them as a part of the link budget. The power penalty includes the effects of eye closure due to transmitter characteristics (finite rise and fall times, random and systematic jitter) and modal noise.

(R) The total system optical power budget shall be 9 dB, of which 7.2 dB is allocated for cable plant characteristics and 1.8 dB for system power penalties.

Attenuation Range: The attenuation range specification of 7.2dB for 62.5 um optical fiber was based on the use of components meeting the requirements of ANSI/TIA/EIA-568-A and ISO/IEC 11801 and operating up to 1 kilometer. The static attenuation in the optical path includes worst case loss values for the fiber media, connectors, splice, attenuators and any other passive optical devices. The attenuation range is 0 to 7.2 dB for both 62.5/125m and for 50/125m fiber.

(R) Each optical fiber link of 1 km shall have an end to end attenuation not exceeding 7.2 dB at 780nm.

Dispersion: The specifications for fiber dispersion for SW laser-based sources account for the effect of modal dispersion to ensure correct system operation. SW laser-based sources are not limited by chromatic dispersion.

(R) Each optical fiber shall have a minimum modal bandwidth of 160 MHz-km at 850nm when measured in accordance with IEC 793-1-C2A (ANSI/TIA/EIA-455-51A) or IEC 793-1-C2B (ANSI/TIA/EIA-455-30B). Note: The 160 MHz-km bandwidth specified meets the performance requirements for 770 nm laser operation.

Reflections: The effects on the transmitter due to reflections are assumed to be small for this data rate. A specification of a maximum Relative Intensity Noise (RIN) under worst case reflection conditions is included to assure that reflections do not impact system performance.

(R) The source shall not exceed a RIN of -116 dB/Hz with a fiber path return loss of -12 dB.

Modal Noise: A portion of the system power penalty is reserved for performance degradation due to modal noise. A methodology for measuring modal noise is for further study, however, modal noise can be kept within acceptable limits by controlling the connector loss in the link and by proper transmitter design.

(R) The system power penalty due to modal noise shall not exceed 0.5 dB for 62.5/125m fiber and 1.0 dB for 50/125m fiber.

The modal noise system power penalty above assumes that the connector loss is distributed evenly across the link and that the maximum connector loss for a single connector pair does not exceed 0.56 dB. Measurement of modal noise penalty and connector loss in a laser based fiber link is being addressed by the TIA/EIA FO6.5 committee.

1.1.4.2 Transmitter Characteristics

The values prescribed are for worst case operating conditions and end of life; they are to be met over the full range of standard operating conditions, (i.e., voltage, temperature, and humidity) and include aging effects. The following parameters are specified for the transmitter.

(R) The wavelength range shall be from 770nm to 860nm.

(R) The maximum full width half-maximum (FWHM) spectral width shall be 9nm.

The maximum coupled power limit is set by eye safety requirements as specified in IEC 825-1 (11/93).

(R) The mean launched power shall be between -4 and -10 dBm at 860nm and -5 and -10 dBm at 770 nm. At wavelengths between these limits, the maximum power is specified in IEC 825-1 (11/93).

(R) The minimum extinction ratio shall be 9 dB.

(R) The transmitter exit Rise (Fall) time shall be less than 1.85ns.(See Note 3 of Table 1)

(R) The maximum transmitter overshoot shall be 20%.

Both transmitter exit Rise (Fall) time and overshoot requirements are to be measured using a Bessel-Thompson filter as specified in ITU-T Recommendation G.957 to represent the effective receiver and fiber bandwidth.

(R) The total interface jitter at the transmitter output shall be less than 1.9 ns

(R) The systematic jitter at the transmitter output has a maximum value of 1.18 nsec p-p This comprises the SJ of the serializer and the SJ of the laser.

(R) The random interface jitter at the transmitter has a maximum value of 0.72 nsec p-p. This comprises the RJ of the serializer and the RJ of the laser.

1.1.4.3 Receiver Characteristics

The values prescribed are for worst case operating conditions and end of life; they are to be met over the full range of standard operating conditions, (i.e., voltage, temperature, and humidity) and include aging effects. The following parameters are specified for the receiver.

(R) The minimum receiver sensitivity shall be -19 dBm.

(R) The minimum receiver overload shall be 0 dBm.

(R) The receiver optical input rise(fall) time shall be less than 3.25 ns.

(R) The total interface jitter at the receiver input is less than 2.0 ns.

(R) The systematic jitter at the receiver input is 1.28 nsec

(R) The random interface jitter at the receiver input is 0.72 nsec.

(R) The minimum receiver eye opening shall be 1.92 ns

1.1.4.4 Link Budget Summary

The short wave laser-based multi-mode interface parameters are summarized below:

SW laser-based MMF Interface Parameter	62.5m MMF	50m MMF	Units
Transmitter Interface Characteristics			
Wavelength	770-860	770-860	nm
Maximum Spectral Width	9	9	nm
Mean Launched Power (Note 2) @860nm	-10 to -4	-10 to -4	dBm
Mean Launched Power (Note 2) @770nm	-10 to -5	-10 to -5	dBm
Minimum Extinction Ratio	9	9	dB
Maximum Rise (Fall) Time, (10-90%) (Note 3)	1.85	1.85	ns
Maximum Overshoot (Note 3)	20	20	%
Maximum Systematic Interface Jitter	1.18	1.18	ns
Maximum Random Interface Jitter	0.72	0.72	ns
Receiver Interface Characteristics			
Minimum Sensitivity (Note 2)	-19	-19	dBm
Minimum Overload	0	0	dBm
Maximum Rise (Fall) Time, (10-90%) (Note 4)	3.25	3.25	ns
Maximum Systematic Interface Jitter	1.28	1.28	ns
Maximum Random Interface Jitter	0.72	0.72	ns
Minimum Receiver Eye Opening (Note 1)	1.92	1.92	ns

Table 1 SW laser-based Optical Parameters for MMF Interface

Note 1: The receiver eye opening represents the eye opening allocated for the clock recovery function after the optical to electrical conversion at the receiver. This corresponds to +/- 15 % offset from the center of the eye.

Note 2: A 9dB system budget is specified for both 62.5/125m and for 50/125m fiber of which 7.2 dB is allocated for cable plant characteristics and 1.8 dB for system power penalties as described in section 1.1.4.1.

Note 3: This measurement is performed using a 4-pole Bessel-Thompson filter as specified in ITU-T Recommendation G.957 to represent the effective receiver and fiber bandwidth. This is intended to simulate how the source will appear to the receiver, and eliminates some high frequency phenomena in the laser that are filtered out in a real system. However, the Rise and Fall time of the source will appear to be longer when measured under these circumstances due to the presence of the filter. For compatibility with system requirements, the Rise/Fall time should not exceed 3.5nsec when measured under these conditions.

Note 4: This is specified for 1km link length and the specified modal bandwidth.

1.2 Transmission Convergence (TC) Sublayer Specification

(R) The Transmission Convergence (TC) Sublayer shall be as specified in ANSI T1.646(Section 7.4).

2. ACRONYM LIST

ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BFOC	Bayonet Fibre Optic Connector
FE	Far End
FWHM	Full Width, Half Maximum
LED	Light Emitting Diode
MLM	Multi-Longitudinal Mode
MMF	Multi-Mode Fiber
NNI	Network-Network Interface
NRZ	Non-Return to Zero
PMD	Physical Medium Dependent
RIN	Relative Intensity Noise
RMS	Root Mean Square
SDH	Synchronous Digital Hierarchy
SONET	Synchronous Optical Network
SW	Short Wavelength
TC	Transmission Convergence
UNI	User-Network Interface

3. NORMATIVE REFERENCES

The following references contain provisions which, through reference in this text, constitute provisions of this specification. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this specification are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. When the referenced standard is superseded by a revision approved by the issuing standards body, the revision shall apply.

3.1 Referenced American National Standards

ANSI T1.101-1994, Telecommunications - Synchronization Interface Standard for Digital Networks

ANSI T1.105-1991, Telecommunications - Digital Hierarchy - Optical Interface Rates and Formats Specifications (SONET)

ANSI T1.627-1993, Telecommunications - Broadband ISDN - ATM Layer Functionality and Specification

ANSI T1.646-1995, Telecommunications - Boradband ISDN and DS1/ATM User-Network Interfaces: Physical Layer Specification

ANSI/TIA/EIA-455-51A Pulse Distortion Measurement of Multimode Optical Fiber Information Transmission Capacity

ANSI/TIA/EIA-455-30B Frequency Domain Measurement of Multimode Optical Fiber Information Transmission Capacity

ANSI/TIA/EIA-492AAAA-A Detail Specification for 62.5 um Core Diameter/125 um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers

ANSI/TIA/EIA-568-A Commercial Building Telecommunications Cabling Standard

3.2 Referenced ITU and ISO Standards

ITU-T Recommendation G.957, Optical Interfaces for Equipments and Systems Relating to the SDH, 1993

ITU-T Recommendation G.958, Digital Line Systems Based on SDH for use on Optical Fibre Cables

ISO/EIC 11801 Generic Cabling for Customer Premises, 1995

IEC 793-1 Optical Fibres, Part 1: Generic Specification

IEC 793-2 Optical Fibres, Part 2: Product Specifications

IEC 825-1 Safety of Laser Products, First Edition, November 1993