SMPTE 435-3-2009
Revision of
SMPTE 435-3-2007

SMPTE STANDARD

10 Gb/s Serial Signal/Data Interface — Part 3: 10.692[1] Gb/s Optical Fiber Interface

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[1]Nominal bit rate. The interface is also capable of transmitting streams with the data rate of 10.692/1.001 Gb/s.

Approved
March 4, 2009

Foreword

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SMPTE 435-3 was prepared by Technology Committee N26.

Intellectual Property

At the time of publication no notice had been received by SMPTE claiming patent rights essential to the implementation of this Standard. However, attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. SMPTE shall not be held responsible for identifying any or all such patent rights.

1 Scope

This Standard defines the optical fiber interface for the serial stream operating at data rates of 10.692 Gb/s and 10.692/1.001 Gb/s. The interface specification defined in this part applies to implementations covering a distance up to 2 km using single-mode fiber.

2 Conformance Notation

Normative text is text that describes elements of the design that are indispensable or contains the conformance language keywords: "shall", "should", or "may". Informative text is text that is potentially helpful to the user, but not indispensable, and can be removed, changed, or added editorially without affecting interoperability. Informative text does not contain any conformance keywords.

All text in this document is, by default, normative, except: the Introduction, any section explicitly labeled as "Informative" or individual paragraphs that start with "Note:"

The keywords "shall" and "shall not" indicate requirements strictly to be followed in order to conform to the document and from which no deviation is permitted.

The keywords, "should" and "should not" indicate that, among several possibilities, one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required; or that (in the negative form) a certain possibility or course of action is deprecated but not prohibited.

The keywords "may" and "need not" indicate courses of action permissible within the limits of the document.

The keyword “reserved” indicates a provision that is not defined at this time, shall not be used, and may be defined in the future. The keyword “forbidden” indicates “reserved” and in addition indicates that the provision will never be defined in the future.

3 Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this recommended practice. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this recommended practice are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

SMPTE RP 184-2004, Specification of Jitter in Bit-Serial Digital Systems

IEC 60793-2 Ed. 5.0:2003: Optical Fibres — Part 2: Product Specifications — General

IEC 61754-20 (2002-08): Fibre Optic Connector Interfaces — Part 20: Type LC Connector Family

4 Serial Fiber Interface Optical and Electrical Specifications

The interface consists of one transmitter and one receiver in a point-to-point connection.

4.1 Optical source characteristics shall be as defined in Table 1.

The eye pattern shall be measured with respect to the mask of the eye using a receiver with a fourth-order Bessel-Thomson response with a 3 dB frequency of 0.75 × 10.692 GHz = 8 GHz. See Annex A.

Table 1 – Optical source characteristics

Parameter	Min	Typ	Max
Optical Wavelength	1260 nm	1310 nm	1355 nm
Maximum RMS spectral width			1 nm
Average launch power (Note 1)	-5.5 dBm		0.5 dBm
Extinction Ratio	6 dB		
Maximum reflected power (Note 1)			-12 dB
Eye mask (Note 2)	See Figure 1		
Jitter	See § 5.1		
Electrical/optical transfer function	Logic ”1” = Higher optical power / Logic “0” = Lower optical power		

NOTES

1. Power is average power measured with an average-reading power meter.

2. One thousand accumulated waveforms is recommended for transmitter optical output eye mask compliance test.

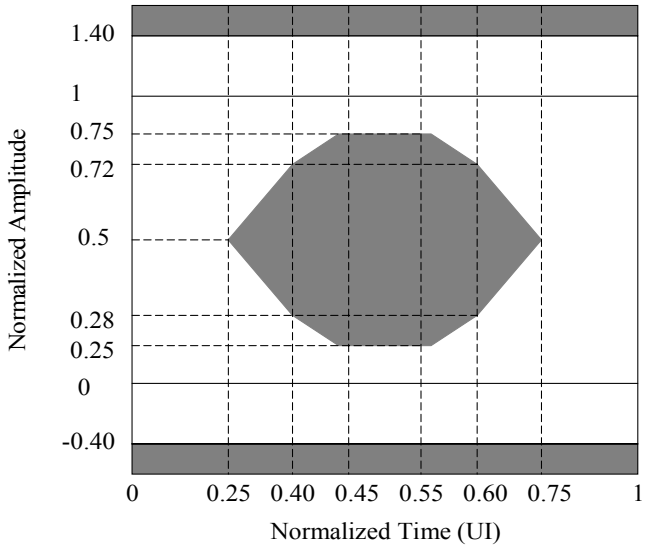

Figure 1 – Transmitter eye mask definition

4.2 Optical fiber characteristics shall be as defined in Table 2.

The specified connectors for the optical transceiver shall be LC simplex/duplex as defined by IEC 61754-20. The connectors on the other side of adapter cables installed between the optical transceivers and patch panels may optionally be specified as SC, ST, FC, MU etc.

Table 2 – Optical fiber link characteristics

Fiber type	Single mode (as defined by IEC 60793-2)
Connector	LC/PC simplex/duplex (as defined by IEC 61754-20)

Receiver characteristics shall be as defined in Table 3.

The electrical output at the connector of a receiver module on a host board is defined in Figure 2, Table 3, Table 4 and Table 5**.**

Within the receiver input range a BER < 10^{-12} should be achieved with SMPTE color bars (when testing equipment installed in video systems) or PRBS 2^{31}-1 pattern (when testing system components with BER testers).

A BER < 10^{-14} is recommended.

Note: The PRBS31 pattern generator is defined in IEEE 802.3ae–2002 listed in Annex A.

Table 3 – Optical receiver characteristics

Parameter	Min	Typ	Max
Average receive power MAX (Note 1)			0.5 dBm
Average receive power(BER = 10^{-12}) (Note 1, 2)			-13.5 dBm
Detector damage threshold	+1 dBm		
Eye mask (Note 3)	See Figure 2, Table 4 and Table 5		
Jitter	See § 5.1		
Optical/electrical transfer function	Higher optical power = Logic “1” / Lower optical power = Logic “0”		
NOTES 1. Power is average power measured with an average-reading power meter. 2. Measurement for 5 minutes is recommended for verifying BER = 10^{-12} when using a BER-based test equipment. 3. One thousand accumulated waveforms is recommended for receiver electrical output eye compliance test.			

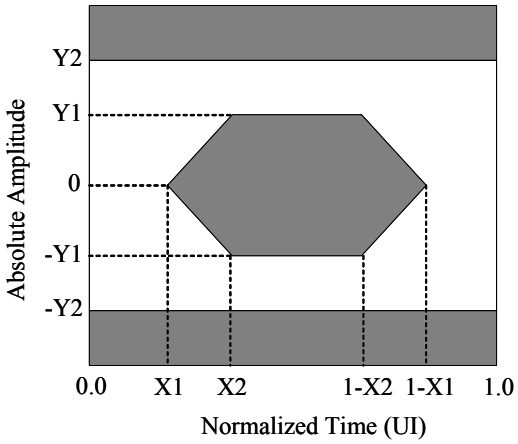

Figure 2 – Optical Receiver Differential Output Mask

Table 4 – Optical transceiver input/output electrical specifications

Parameter	Symbol	Min	Typ	Max	Remarks
Differential Input/Output Impedance			100 ohm		
Termination Mismatch				5%	
Differential Input/Output Return Loss	SDD11 / SDD22	20 dB			0.05 - 0.1 GHz
		8 dB			0.1 - 5.5 GHz
		Note 1			5.5 – 12 GHz
Common Mode Input/Output Return Loss	SCC11 / SCC22	3 dB			0.1 – 15 GHz
NOTE 1 Differential Return Loss is given by the equation SDD11 (dB) and SDD22 (dB) = 8 – 20.66 $\log_{10}$ (f / 5.5), with f in GHz.					

Table 5 – Output jitter specifications

Parameter	Symbol	Min	Typ	Max
Eye Mask	X1			0.17 UI
Eye Mask	X2			0.42 UI
Eye Mask	Y1	170 mV		
Eye Mask	Y2			425 mV

5 Serial Fiber Interface Jitter Specifications

5.1 Jitter in the timing of transitions of the data signal shall be measured in accordance with SMPTE RP 184. Measurement parameters are defined in SMPTE RP 184 and shall have the values defined in Table 6.

Table 6 – Jitter specifications

Parameter	Value	Description
f1	10 Hz	Low-frequency specification limit
f2	20 kHz	Upper band edge for A1
f3	4 MHz	Lower band edge for A2
f4	> 1/10 the clock rate	High-frequency specification limit
A1	10 UI	Timing jitter: Sinusoidal jitter amplitude shall be less than $2 \times 10^5 / f +$ 0.1 UI at 20 kHz < f ≤ 4 MHz.
A2	0.15 UI	Alignment jitter Sinusoidal jitter amplitude shall be less than 0.15 UI at f > 4 MHz.
Error criterion	BER = 10^{-12}	Criterion for onset of errors
Test signal	PRBS 2^{31}-1 or Color bars signal	Data rate of PRBS 2^{31}-1 shall be 10.692 Gb/s or 10.692/1.001 Gb/s. Color bars shall be encoded into each basic stream according to part 2 of this standard. (Note 1, 2)

NOTES

1. Any of applicable image system and mapping mode may be used for the measurement.
2. Color bars are chosen as a test signal for on site jitter measurements.
3. See SMPTE RP 184 for definition of terms.

5.2 Optical transmitter and receiver shall meet the requirements defined in Table 7 and Table 8.

Table 7 – Optical Module Transmitter Requirements

Parameter	Symbol	Conditions	Min	Typ	Max
Jitter Transfer Bandwidth	BW	PRBS 2^{31}-1			8 MHz
Jitter Peaking		Frequency > 50 kHz			1 dB

Table 8 – Optical Module Receiver Requirements

Parameter	Symbol	Conditions	Min	Typ	Max
Jitter Transfer Bandwidth	BW	PRBS 2^{31}-1			8 MHz
Jitter Peaking		Frequency > 50 kHz			1 dB

Annex A (Informative)
Bibliography

XFP MSA, XFP (10 Gigabit Small Form Factor Pluggable Module) Specification Revision 4.5 :2005

IEEE 802.3ae–2002, Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation