Optical Fiber and Cable Characteristics

Completing Table 141-15
and preceding text

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Supporters

We need to fill in this table and update preceding text

141.9.2 Optical fiber and cable

The fiber optic cable requirements are satisfied by the fibers specified in IEC 60793-2-50 Type B1.1 (dispersion un–shifted SMF), Type B1.3 (low water peak SMF), and Type B6 (bend-insensitive SMF); ITU–T G.652 and ITU–T G.657 (bend–insensitive SMF).

Table 141–15—Optical fiber and cable characteristics

Description[a]	IEC 60793-2-50 B.1.1, B1.3, and B6 SMF; ITU–T G.652 and G.657 SMF[b]				Unit
Nominal wavelength[c]					nm
Cable attenuation (max)[d]					dB/km
Zero dispersion wavelength[e]	$1300 \leq \lambda_0 \leq 1324$				nm
Dispersion slope (max)	0.093				ps/nm^2 · km

[a]The fiber dispersion values are normative, all other values in the table are informative.
[b]Other fiber types are acceptable if the resulting ODN meets channel insertion loss and dispersion requirements.
[c]Wavelength specified is the nominal wavelength and typical measurement wavelength. Power penalties at other wavelengths are accounted for.
[d]Attenuation for single-mode optical fiber cables for 1310 nm and 1550 nm is defined in ITU–T G.652. The attenuation values in the 1270 nm and 1577 nm windows were calculated using spectral attenuation modelling method (5.4.4) included in G.650.1 and the matrix coefficients included in Appendix III therein. 1310 nm (0.4 dB/km), 1380 nm (0.5 dB/km) and 1550 nm (0.35 dB/km) attenuation values were used as the input for the predictor model.
[e]See IEC 60793 or ITU–T G.652.

Previous versions of this table:

Table 60–19—Optical fiber and cable characteristics

Description[a]	Type B1.1, B1.3 SMF		Unit
Nominal wavelength[b]	1310	1550	nm
Cabled optical fiber attenuation (max)[c]	0.4	0.35	dB/km
Zero dispersion wavelength[d]	$1300 \leq \lambda_0 \leq 1324$		nm
Dispersion slope (max)	0.093		ps / nm^2 · km

[a]The fiber dispersion values are normative, all other values in the table are informative.
[b]Wavelength specified is the nominal wavelength and typical measurement wavelength. Power penalties at other wavelengths are accounted for.
[c]Attenuation for single-mode optical fiber cables is defined in ITU-T G.652.
[d]See IEC 60793 or ITU-T G.652.

Table 75–14—Optical fiber and cable characteristics

Description[a]	IEC 60793–2 B1.1, B1.3 SMF, ITU–T G.652, G.657 SMF[b]				Unit
Nominal wavelength[c]	1270	1310	1550	1577	nm
Cable attenuation (max)[d]	0.44	0.4	0.35	0.35	dB/km
Zero dispersion wavelength[e]	$1300 \leq \lambda_0 \leq 1324$				nm
Dispersion slope (max)	0.093				ps/nm^2 · km

[a]The fiber dispersion values are normative, all other values in the table are informative.
[b]Other fiber types are acceptable if the resulting ODN meets channel insertion loss and dispersion requirements.
[c]Wavelength specified is the nominal wavelength and typical measurement wavelength. Power penalties at other wavelengths are accounted for.
[d]Attenuation for single-mode optical fiber cables for 1310 nm and 1550 nm is defined in ITU–T G.652. The attenuation values in the 1270 nm and 1577 nm windows were calculated using spectral attenuation modelling method (5.4.4) included in G.650.1 and the matrix coefficients included in Appendix III therein. 1310 nm (0.4 dB/km), 1380 nm (0.5 dB/km) and 1550 nm (0.35 dB/km) attenuation values were used as the input for the predictor model.
[e]See IEC 60793 or ITU–T G.652.

Storyboard

ITU-T and IEC have implemented multiple changes to their respective documents regarding Single Mode Fiber (SMF) since the last IEEE document was published.

These have included:

- Updates to the attenuation specifications
- Updates to the dispersion specification and the addition of a lower boundary
- Naming alignment between the 2 standards to reduce confusion

It is our recommendation that we apply all of these changes to the 802.3ca draft and work with other groups to update previous standards

Dispersion specification for ITU-T and IEC

Description	ITU-T Designation	IEC Designation	New IEC Designation*	λ_0 (nm)	Max Slope (ps/nm^2*km)	Min Slope (ps/nm^2*km)
Dispersion Unshifted	G.652.B	B1.1	B-652.B	1300-1324	0.092	0.073
Dispersion Unshifted	G.652.D	B1.3	B-652.D	1300-1324	0.092	0.073
Bend Loss Insensitive	G.657.A	B6_a	B-657.A	1300-1324	0.092	0.073
Bend Loss Insensitive	G.657.B	B6_b	B-657.B	1250-1350	0.11	n/a

* IEC 60793-2-50 edition 6, to be published Mar 2019

- We recommend excluding G.657.B and IEC B6_b from the table due to loose chromatic dispersion specs
- We recommend changing the dispersion slope value from 0.093 to 0.092 to be consistent with ITU-T and IEC
- We recommend adding Min dispersion slope
- We recommend incorporating the new IEC designation into our table

Cable attenuation values

- Informative in previous specification documents
- Normative values have been defined in latest revision of the ITU-T and IEC standards
- For 25G and 50G EPON, relevant wavelengths range from 1260 to 1360nm

Description	IEC 60793-2-50 B-652.D and B-657.A1/A2 SMF; ITU-T G.652.D and G.657.A SMF		Unit
Wavelength	1260-1280	1290-1360	nm
Cable attenuation	0.47	0.40	dB/km

- We recommend updating the table to the normative values stated in the most recent versions of the standards
- We recommend removing IEC Type B-652.B (ITU-T G.652.B) as that specification only applies at discreet wavelengths and not across the wavelength spectrum

The new text

141.9.2 Optical fiber and cable

The fiber optic cable requirements are satisfied by the fibers specified in IEC 60793-2-50 ~~Type B1.1 (dispersion un–shifted SMF),~~ Type B-652.D (low water peak, dispersion un-shifted SMF), and Type B-657.A1/A2 (bend-insensitive SMF); ITU– T G.652.D (low water peak, dispersion un-shifted SMF) and ITU–T G.657.A1/A2 (bend–insensitive SMF).

- Updated IEC nomenclature to reflect upcoming revision of the specification
- Removed IEC Type B-652.B (ITU-T G.652.B) as that specification only applies at discreet wavelengths and not across the wavelength spectrum

The completed table

Description[a]	IEC 60793-2-50 B-652.D and B-657.A1/A2 SMF; ITU-T G.652.D and G.657.A SMF[a]		Unit
~~Nominal~~ Wavelength[c]	1260-1280	1290-1360	nm
Cable attenuation[d]	0.47	0.40	dB/km
Zero dispersion wavelength[b]	$1300 \leq \lambda_0 \leq 1324$		nm
Dispersion slope (min, max)	0.073, 0.092		ps/nm^2*km

~~[a]The fiber dispersion values are normative, all other values in the table are informative.~~

[a]Other fiber types are acceptable if the resulting ODN meets channel insertion loss and dispersion requirements.

~~[c]Wavelength specified is the nominal wavelength and typical measurement wavelength. Power penalties at other wavelengths are accounted for.~~

~~[d]Attenuation for single-mode optical fiber cables for 1310 nm and 1550 nm is defined in ITU-T G.652. The attenuation values in the 1270 nm and 1350 nm windows were calculated using spectral attenuation modelling method (5.4.4) included in G.650.1 and the matrix coefficients included in Appendix III therein. 1310 nm (0.4 dB/km), 1380 nm (0.5 dB/km) and 1550 nm (0.35 dB/km) attenuation values were used as the input for the predictor model.~~

[b]See IEC 60793-2-50 or ITU-T G.652.

The cleaned up version

141.9.2 Optical fiber and cable

The fiber optic cable requirements are satisfied by the fiber specified in IEC 60793-2-50, Type B-652.D (low water peak, dispersion un-shifted SMF), and Type B-657.A1/A2 (bend insensitive SMF); ITU-T G.652.D (low water peak, dispersion un-shifted SMF) and ITU-T G.657.A1/A2 (bend insensitive SMF)

Description	IEC 60793-2-50 B-652.D and B-657.A1/A2 SMF; ITU-T G.652.D and G.657.A SMF[a]		Unit
Wavelength	1260-1280	1290-1360	nm
Cable attenuation	0.47	0.40	dB/km
Zero dispersion wavelength[b]	$1300 \leq \lambda_0 \leq 1324$		nm
Dispersion slope (min, max)	0.073, 0.092		ps/nm^2*km

[a]Other fiber types are acceptable if the resulting ODN meets channel insertion loss and dispersion requirements.

[b]See IEC 60793-2-50 or ITU-T G.652.

Backup Slides

ITU 652 Edition 9 Changes

Edition 9	(xx/2016)	Tables 1 and 3 of edition 8 have not been changed. These tables are not included in this version of Recommendation ITU-T G.652, but are in the 2009 edition. The tables in this edition have been renumbered. Tables 1 and 2 of this edition 9 correspond respectively to Tables 2 and 4 of edition 8. New clause 5 “Conventions” has been added. Following clause numbers have been renumbered. Chromatic dispersion specification for G.652.D fibres has been changed into boundary line specification. In clause 6.10 the text concerning chromatic dispersion for G.652.D fibres has been modified. In clause 7.2 (PMD) a note has been added about usability of high PMD fibre and cable for systems with less stringent PMD requirements. In clause 8 only Table 1 (G.652.B) and Table 2 (G.652.D) are indicated. Here also a reference to IEC fibre designations is mentioned. In Table 1 (G.652.B) and Table 2 (G.652.D) Note 1 has been extended with text concerning attenuation coefficient at a wavelength longer than 1625 nm. In Table 1 (G.652.B) new Note 3 and Table 2 (G.652.D) new Note 5 describe usability of high PMD fibre and cable for system with less stringent PMD requirements. In Table 2 (G.652.D) the nominal mode field diameter upper range has been reduced. In Table 2 (G.652.D) the mode field diameter tolerance has been tightened. In Table 2 (G.652.D) the cladding diameter tolerance has been tightened. In Table 2 (G.652.D) new specification has been introduced for chromatic dispersion. In Table 2 (G.652.D) text has been added and renewed concerning attenuation coefficient at 1383 nm. In Table 2 (G.652.D) the attenuation specifications have been edited to two decimal places. Added in Appendix I a new clause I.6 “An example of statistical methodology” New Appendix II has been added highlighting the data collection on maximum and minimum chromatic dispersion over wavelength range 1270 nm to 1625 nm for the boundary line specification of G.652.D fibres

IEC to ITU-T Map

Table 1 – Map of IEC designation to ITU-T Recommendations and IEC 60793-2-50:2015 designation

Annex	Category	Sub Category	Description	IEC 60793-2-50:2015	ITU-T Rec
	B-652		Dispersion unshifted fibre		G.652
A		B-652.B		B1.1	G.652.B
A		B-652.D		B1.3	G.652.D
	B-653		Dispersion shifted fibre		G.653
B		B-653.A		B2_a	G.653.A
B		B-653.B		B2_b	G.653.B
	B-654		Cut-off shifted fibre		G.654
C		B-654.A		B1.2_a	G.654.A
C		B-654.B		B1.2_b	G.654.B
C		B-654.C		B1.2_c	G.654.C
C		B-654.D		N/A	G.654.D
C		B-654.E		N/A	G.654.E
C	B-655		Non-zero dispersion shifted fibre	B4	G.655
D		B-655.C		B4_c	G.655.C
D		B-655.D		B4_d	G.655.D
D		B-655.E		B4_e	G.655.E
E	B-656		Wideband non-zero dispersion shifted fibre	B5	G.656
F	B-657		Bending loss insensitive fibre	B6	G.657
F		B-657.A1		B6_a1	G.657.A1
F		B-657.A2		B6_a2	G.657.A2
F		B-657.B2		B6_b2	G.657.B2
F		B-657.B3		B6_b3	G.657.B3

ITU-T G.652.D

Table 2 – ITU-T G.652.D attributes

Fibre attributes			
Attribute	**Detail**	**Value**	**Unit**
Mode field diameter	Wavelength	1310	nm
	Range of nominal values	8.6-9.2	µm
	Tolerance	± 0.4	µm
Cladding diameter	Nominal	125.0	µm
	Tolerance	± 0.7	µm
Core concentricity error	Maximum	0.6	µm
Cladding noncircularity	Maximum	1.0	%
Cable cut-off wavelength	Maximum	1260	nm
Macrobending loss	Radius	30	mm
	Number of turns	100	
	Maximum at 1625 nm	0.1	dB
Proof stress	Minimum	0.69	GPa
Chromatic dispersion parameter	λ_{0min}	1300	nm
	λ_{0max}	1324	nm
3-term Sellmeier fitting (1260 nm to 1460 nm)	S_{0min}	0.073	ps/(nm² × km)
	S_{0max}	0.092	ps/(nm² × km)
Linear fitting (1460 nm to 1625 nm)	Minimum at 1550 nm	13.3	ps/(nm × km)
	Maximum at 1550 nm	18.6	ps/(nm × km)
	Minimum at 1625 nm	17.2	ps/(nm × km)
	Maximum at 1625 nm	23.7	ps/(nm × km)

Cable attributes			
Attribute	**Detail**	**Value**	**Unit**
Attenuation coefficient (Note 1)	Maximum from 1310 nm to 1625 nm (Note 2)	0.40	dB/km
	Maximum at 1383 nm ±3 nm after hydrogen ageing (Note 3)	0.40	dB/km
	Maximum at 1530-1565 nm	0.30	dB/km
PMD coefficient (Note 4,5)	M	20	cables
	Q	0.01	%
	Maximum PMD_Q	0.20	ps/$\sqrt{km}$

NOTE 1 – The attenuation coefficient values listed in this table should not be applied to short cables such as jumper cables, indoor cables and drop cables. For example, [b-IEC 60794-2-11] specifies the attenuation coefficient of indoor cable as 1.0 dB/km or less at both 1310 and 1550 nm. Attenuation coefficient at a wavelength longer than 1625 nm (for monitoring purpose) is not well known. In general, the attenuation increases as the wavelength increases, and it may show steep wavelength dependence due to both macro- and microbending losses.

NOTE 2 – This wavelength region can be extended to 1260 nm by adding 0.07 dB/km induced Rayleigh scattering loss to the attenuation value at 1310 nm.

Table 2 – ITU-T G.652.D attributes

Fibre attributes

NOTE 3 – The hydrogen ageing is a type test that shall be done to a set of sampled fibres, according to [IEC 60793-2-50] regarding the B1.3 fibre category.

NOTE 4 – According to clause 7.2, a maximum PMD_Q value on uncabled fibre is specified in order to support the primary requirement on cable PMD_Q.

NOTE 5 – Optical fibre cables with higher PMD coefficient can be used for systems with less stringent PMD requirements.