Reaching Concensus on Fiber Specs

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for
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References for Optical Fiber

IEC 793-1, Optical Fibres, Part 1: Generic specifications - measuring methods

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

ISO/IEC 11801, Information technology - Generic cabling for customer premises

ANSI/TIA/EIA-455A, Fiber Optic Test Procedures (FOTPs)

ANSI/TIA/EIA-526, Optical Fiber System Test Procedures (OFSTPs)

ANSI/TIA/EIA-492AAAA-A, (SP 3006-B) Draft Detail Specification for 62.5-µm core diameter/125-µm cladding diameter class Ia graded-index multimode optical fibers

ANSI/TIA/EIA-492BCAAA, Detail Specification for class IVa dispersion-unshifted single-mode optical fibers

ANSI/TIA/EIA-492AAABxxxx, (SP 3832) Draft Detail Specification for 50-µm core diameter/125-µm cladding diameter class Ia graded-index multimode optical fibers

ANSI/TIA/EIA-568A, Commercial building telecommunications cabling standard

Optical Fiber Reference Proposal

Table 1 -- Optical specifications for 62.5 μm fiber

Attribute	Units	802.3z Requirement	TIA 492 (SP3006-B)	IEC 793-2	TIA 568A	ISO/IEC 11801
Attenuation @ 850 nm/1300 nm	dB/km	≤ 3.5/≤ 1.5 ISO 11801 media	≤ 2.8/≤ 0.6 ≤ 2.8/≤ 0.7 ≤ 2.8/≤ 0.9 ≤ 3.0/≤ 0.6 ≤ 3.0/≤ 0.7 ≤ 3.0/≤ 0.9 ≤ 3.2/≤ 0.6 ≤ 3.2/≤ 0.7 ≤ 3.2/≤ 0.9	≤ 3.5/≤ 1.5 ≤ 3.2/≤ 0.9 ≤ 3.0/≤ 0.7	≤ 3.75/≤ 1.5	≤ 3.5/≤ 1.0
Bandwidth @ 850 nm/1300 nm	MHz•km	≥ 160 and 200/≥ 500 ISO 11801 media	≥ 160/≥ 200 ≥ 160/≥ 400 ≥ 160/≥ 500 ≥ 160/≥ 600 ≥ 200/≥ 200 ≥ 200/≥ 400 ≥ 200/≥ 500 ≥ 200/≥ 600 ≥ 250/≥ 200 ≥ 250/≥ 400 ≥ 250/≥ 500 ≥ 250/≥ 600	≥ 160/≥ 200 ≥ 160/≥ 500 ≥ 200/≥ 200 ≥ 200/≥ 400 ≥ 200/≥ 600 ≥250/≥1000 ≥ 300/≥ 800	≥ 160/≥ 500	≥ 200/≥ 500
Zero-dispersion wavelength	nm	13201~~295~~ ≤ λ_0 ≤1365 nm	1320 ≤ λ_0 ≤1365 nm	N/A	N/A	N/A

Zero-dispersion slope	ps/nm2•km	~~≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm~~ ≤ 0.11 for 1300 ≤ λ_0 ≤ 1348 nm and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm	≤ 0.11 for 1320 ≤ λ_0 ≤ 1348 nm and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm	N/A	N/A	N/A

NOTES:

1. TIA-568A references TIA-492AAAA and includes specifications for attenuation and bandwidth
2. ISO/IEC 11801 references IEC-793-2 and includes specifications for attenuation and bandwidth
3. Canada's CSA T529-95 "Telecommunications Cabling Systems in Commercial Buildings" concurs with TIA 568-A.
4. Europe's CENELEC EN 50173 "Information Technology, Generic Cabling Systems" concurs with ISO 11801 and covers the following counties: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.
5. Australian / New Zealand Standard AS/NZS 3080:1996 "Telecommunications Installations - Integrated Telecommunications Cabling Systems for Commercial Buildings" concurs with ISO 11801.
6. Japan's JIS X5150 cabling standard concurs with ISO 11801.

Table 2 -- Optical specifications for 50 μm fiber

Attribute	Units	802.3z Requirement	TIA 492 (SP 3832)	IEC 793-2	TIA 568A	ISO/IEC 11801
Attenuation @ 850 nm/1300 nm	dB/km	≤ 3.5/≤ 1.5 ISO 11801 media	≤ 2.4/≤ 0.5 ≤ 2.5/≤ 0.8	≤ 2.7/≤ 1.0 ≤ 2.5/≤ 0.8 ≤ 2.4/≤ 0.6	N/A	≤ 3.5/≤ 1.0
Bandwidth @ 850 nm/1300 nm	MHz•km	≥ 500/≥ 500 ISO 11801 media	≥ 400/≥ 400 ≥ 400/≥ 600 ≥ 400/≥ 800 ≥ 400/≥ 1000 ≥ 500/≥ 500 ≥ 600/≥ 600	≥ 200/≥ 400 ≥ 200/≥ 600 ≥ 400/≥ 400 ≥ 400/≥ 600 ≥ 400/≥ 800 ≥ 400/≥ 1000 ≥ 400/≥ 1200 ≥ 400/≥ 1500 ≥ 600/≥ 1000	N/A	≥ 200/≥ 500
Zero-dispersion wavelength	nm	1295 ≤ λ_0 ≤132065 nm	~~1297 ≤~~ λ_0 ~~≤1316 nm~~ 1295 ≤ λ_0 ≤1320 nm	N/A	N/A	N/A
Zero-dispersion slope	ps/nm2•km	≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm ≤ 0.11 for 1300 ≤ λ_0 ≤ 132048 nm ~~and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm~~	≤ 0.11 for 1300 ≤ λ_0 ≤ 1320 nm and ≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm	N/A	N/A	N/A

NOTES:
1. ISO/IEC 11801 references IEC-793-2 and includes specifications for attenuation and bandwidth
2. Canada's CSA T529-95 "Telecommunications Cabling Systems in Commercial Buildings" concurs with TIA 568-A.
3. Europe's CENELEC EN 50173 "Information Technology, Generic Cabling Systems" concurs with ISO 11801 and covers the following counties: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

4. Australian / New Zealand Standard AS/NZS 3080:1996 “Telecommunications Installations - Integrated Telecommunications Cabling Systems for Commercial Buildings” concurs with ISO 11801.
5. Japan’s JIS X5150 cabling standard concurs with ISO 11801.

Table 3 -- Optical specifications for single-mode fiber

Attribute	Units	802.3z Requirement	TIA 492	IEC 793-2	TIA 568A	ISO/IEC 11801
Attenuation @ 1310 nm/1550 nm	dB/km	≤ 1.0/≤ NA ISO 11801 media	≤ 0.50/≤ 0.40	≤ 0.50/≤ 0.40	≤ 0.50/≤ 0.50 for OSP ≤ 1.0/≤ 1.0 for ISP	≤ 1.0/≤ 1
Zero-dispersion wavelength	nm	N/A	1300 ≤ λ_0 ≤1324 nm	1300 ≤ λ_0 ≤13242 nm per 1995 amndmnt.1	~~NA~~ 1300 ≤ λ_0 ≤ 1324	NA
Zero-dispersion slope	ps/nm2•km	N/A	≤ 0.093	≤ 0.0935 per 1995 amndmnt.1	~~NA~~ ≤ 0.093	NA
Cut-off Wavelength	nm	N/A	?	NA	≤ 1270	≤ 128(
Mode Field Diameter	mm	N/A	?	9 - 10 +/- 10%	8.7 - 10 +/- 0.5	N/A
Dispersion	ps/nm	18	N/A	N/A	N/A	N/A

NOTES:

1. TIA-568A reference TIA-492BA~~AC~~AA and includes specifications for attenuation, zero dispersion wavelength, dispersion slope, mode field diameter, and cut off wavelength.

2~~1~~. ISO/IEC 11801 reference IEC-793-2 and includes specifications for attenuation and cut-off wavelength

3. Canada's CSA T529-95 "Telecommunications Cabling Systems in Commercial Buildings" concurs with TIA 568-A.

4. Europe's CENELEC EN 50173 "Information Technology, Generic Cabling Systems" concurs with ISO 11801 and covers the following counties: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

5. Australian / New Zealand Standard AS/NZS 3080:1996 "Telecommunications Installations - Integrated Telecommunications Cabling Systems for Commercial Buildings" concurs with ISO 11801.

6. Japan's JIS X5150 cabling standard concurs with ISO 11801.

Optical Fiber Reference Proposal

Table 4 -- Other applications specifying 62.5 μm fiber

Attribute	Units	802.3z Requirement	10BASE-F	FDDI	Fibre Channel	
Attenuation @ 850 nm/1300 nm	dB/km	≤ 3.5/≤ 1.5	≤ 3.75/≤ N/A	N/A	N/A	
Bandwidth @ 850 nm/1300 nm	MHz•km	≥ 160 and 200/≥ 500	≥ 160/≥N/A	≥ N/A/≥ 500	≥ 160/≥ 500	≥ 16
Zero-dispersion wavelength	nm	13201~~1295~~ ≤ λ_0 ≤1365 nm	1320 ≤ λ_0 ≤1365 nm	1295 ≤ λ_0 ≤1365 nm	N/A	
Zero-dispersion slope	ps/nm2•km	~~≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm~~ ≤ 0.11 for 13200 ≤ λ_0 ≤ 1348 nm and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm	≤ 0.11 for 1320 ≤ λ_0 ≤ 1348 nm and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm	≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm ≤ 0.11 for 1300 ≤ λ_0 ≤ 1348 nm and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm	N/A	

NOTES:
1. FDDI and Fibre Channel reference TIA-492AAAA and include specifications for bandwidth
2. ATM reference both TIA-492AAAA and IEC-793-2 and includes specifications for bandwidth
3. 100BASE-FX uses the multimode FDDI PMD (ISO 9314-3:1990) and references ISO 11801 compliant cabling
4. 100VG-AnyLAN requires 62.5 micron cabling meeting ISO 11801 and supports both long and short wavelength PMDs.

Table 5 -- Other applications specifying 50 μm fiber

Attribute	Units	802.3z Requirement	10BASE-F	FDDI	Fibre Channel	ATM
Attenuation @ 850 nm/1300 nm	dB/km	≤ 3.5/≤ 1.5	N/A	N/A	N/A	N/A
Bandwidth @ 850 nm/1300 nm	MHz•km	≥ 500/≥ 500	N/A	N/A	≥ 500/≥ 500	≥160 ~~500~~/≥ 500
Zero-dispersion wavelength	nm	1295 ≤ λ_0 ≤132065 nm	N/A	N/A	N/A	N/A
Zero-dispersion slope	ps/nm2•km	≤0.001(1190-λ_0) for 1295 ≤ λ_0 ≤ 1300 nm ≤ 0.11 for 1300 ≤ λ_0 ≤ 132048 nm ~~and ≤0.001(1458-λ_0) for 1348 ≤ λ_0 ≤ 1365 nm~~	N/A	N/A	N/A	N/A

NOTES:
1. ATM reference IEC-793-2 and includes specifications for bandwidth
2. 100BASE-FX uses the multimode FDDI PMD (ISO 9314-3:1990) and references ISO 11801 cabling.
3. 100VG-AnyLAN does not specify 50 micron

Table 6 -- Other applications specifying single-mode fiber

Attribute	Units	802.3z Requirement	10BASE-F	FDDI	Fibre Channel	ATM
Attenuation @ 1310 nm/1550 nm	dB/km	≤ 1.0/≤ NA	N/A	≤ 0.50/≤ 0.50	N/A ~~≤ 0.50/≤ 0.40~~	N/A ~~≤ 0.50/≤ 0.4~~
Zero-dispersion wavelength	nm	N/A	N/A	1300 ≤ λ_0 ≤1322 nm	N/A ~~1300 ≤ λ_0 ≤1324 nm~~	N/A ~~1300 ≤ λ_0 ≤132~~
Zero-dispersion slope	ps/nm2•km	N/A	N/A	≤ 0.095	N/A ~~≤ 0.093~~	N/A ~~≤ 0.093~~
Cut-off Wavelength	nm	N/A	N/A	≤ 1270	N/A	N/A
Mode Field Diameter	mm	N/A	N/A	8.7 - 10 +/- 0.5	N/A	N/A
Dispersion	ps/nm	18	N/A	N/A	bit rate dependent ~~N/A~~	N/A

NOTES:
1. FDDI and Fibre Channel reference TIA-492BC~~C~~AAA. FDDI defaults to TIA-492BAAA in the event of differences between them.
2~~1~~. ATM references both TIA-492CAAA and IEC-793-2
3. 100BASE-FX does not specify SMF.
4. 100VG-AnyLAN does not specify SMF.

Table 7 -- Current (May 12, 1997) IEEE 802.3z Fiber Specs

Description	Unit	50 μm MMF		62.5 μm MMF[1]			SMF
		@ 850 nm	@ 1300 nm	@ 850 nm	@ 850 nm	@ 1300 nm	@ 1300
Operating Range	m	2 to 518	2 to 575	2 to 250	2 to 300	2 to 635	2 to 30
Attenuation, max.	dB/km	3.5	1.5	3.5	3.5	1.5	1.0
Modal Bandwidth, min.	MHz•km	500	500	160	200	500	N/A
Zero Dispersion Wavelength (λ_0) Range	nm	$1295 \le \lambda_0 \le 1320$		$1320 \le \lambda_0 \le 1365$			$1300 \le \le 132$
Dispersion Slope, max.	ps/km•nm^2	≤ 0.11 for $1300 \le \lambda_0 \le 1320$ nm, and $\le 0.001(1190 - \lambda_0)$ for $1295 \le \lambda_0 \le 1300$ nm		≤ 0.11 for $1320 \le \lambda_0 \le 1348$ nm, and $\le 0.001(1458 - \lambda_0)$ for $1348 \le \lambda_0 \le 1365$ nm			≤ 0.093 $1300 \le \le 1324$
Dispersion, max.	ps/nm, RMS	N/A		N/A			18
Connector Return Loss, min.	dB	20		20			26
Link Attenuation, max. @ max. operating distance	dB	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D
Link Penalties, max.	dB	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D.	T.B.D

[1] Two specifications for 850-nm operation are provided to support the two bandwidth grades of 62.5 mm MMF commonly used today.

Short History of 62.5 micron Specs.

1. 200/500 MHz-km spec in ISO 11801
   - taken from center cells of single-window IEC 793-2 specs

2. 160/500 MHz-km previously established
   - by 10BASE-F/FDDI respectively and adopted by TIA 568A

3. Lucent commented several times on ISO 11801 drafts
   - to harmonized with 160/500 MHz-km specs
   - had no effect

4. Lucent modified products to support ISO 11801

5. 20 countries now specify 200/500 MHz-km within their cabling standards
   - EN 50173 (17 European counties)
   - AS/NZS 3080 (Australia and New Zealand)
   - JIS X5150 (Japan)

Rationale for 200 MHz-km 62.5 micron

1. 802.3z objective to support media from ISO 11801

2. 200 MHz-km @ 850 nm specified by ISO 11801

3. IEC 793-2 and TIA 492 have cells that extend beyond 200 MHz-km @ 850 nm
   - indicates broad industry support

4. Lucent is responding to market demands and needs

5. Others are also free to do so

6. Dual 160 and 200 MHz-km specification is not exclusionary

Potential 50 micron Issues
(that Lucent does not intend to raise for the sake of expediting the standard)

1. Fewer suppliers of 50 than 62.5 micron

2. No 500/500 MHz-km cell in IEC 793-2, TIA 568-A, or ISO 11801

3. 1.5 dB/km @ 1300 nm does not meet ISO 11801 spec of 1.0 dB/km

4. 500 + 50 = 550 meters: Only LWL on 50 micron satisfies
   - 50 micron provides no benefit beyond 62.5 coverage of the 550 m objective
   - therefore eliminate 50 micron for simplification

Lucent Willing to Compromise

1. Include 50 micron in 802.3z
   - even though Lucent has no 50 micron product at this time

2. Accept 500 MHz-km @ 850 nm spec for 50 micron
   - even though it is far in excess of 200 MHz-km spec in ISO 11801

3. Accept 1.5 dB/km @ 1300 nm for both 62.5 and 50 micron
   - even though Lucent sells only the 1.0 dB/km grade
   - because it does not jeopardize reaching 550 meter objective

4. Accept separating the chromatic dispersion specs for 50 and 62.5 micron
   - even though the separation only benefits 50 micron

5. Accept chromatic dispersion specified by equation rather than template to save space
   - even though the template is much easier to comprehend

6. Include specs for 160 MHz-km @ 850 nm fiber performance along with 200 MHz-km
   - even though Lucent sells only the 200 MHz-km grade