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Silica glass single-mode optical fibers

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Optoelectronics Industry and Technology Development Association (OITDA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently, **JIS C 6835 : 2005** is replaced with this Standard.

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Silica glass single-mode optical fibers

Introduction

This Japanese Industrial Standard has been prepared based on the third edition of **IEC 60793-2-50** published in 2008, but adding some specification contents (colour of primary coating, standard atmosphere condition, fiber symbol correspondence, etc.) not given in the corresponding International Standard.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies dimensions, mechanical requirements, transmission requirements, environmental requirements and testing methods thereof of the silica glass single-mode optical fibers for the core and cladding of which silica glass is used.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

IEC 60793-2-50 : 2008 *Optical fibres — Part 2-50 : Product specifications — Sectional specification for class B single-mode fibres* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21-1**.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS C 6820 *General rules of optical fibers*

NOTE : Corresponding International Standards : **IEC 60793-1-1** *Optical fibres — Part 1-1 : Measurement methods and test procedures — General and guidance* and **IEC 60793-2** *Optical fibres — Part 2 : Product specifications — General* (overall evaluation : MOD)

JIS C 6821 *Test methods for mechanical characteristics of optical fibers*

NOTE : Corresponding International Standards : **IEC 60793-1-30** *Optical fibres — Part 1-30 : Measurement methods and test procedures — Fibre proof test*, **IEC 60793-1-31** *Optical fibres — Part 1-31 : Measurement methods and test procedures — Tensile strength*, **IEC 60793-1-32** *Optical fibres — Part 1-32 : Measurement methods and test procedures — Coating strippability*, **IEC 60793-1-33** *Optical fibres — Part 1-33 : Measurement*

methods and test procedures — Stress corrosion susceptibility and IEC 60793-1-34 Optical fibres — Part 1-34 : Measurement methods and test procedures — Fibre curl (overall evaluation : MOD)

JIS C 6822 *Test methods for structural parameters of optical fibers — Dimensional characteristics*

NOTE : Corresponding International Standards : **IEC 60793-1-20** *Optical fibres — Part 1-20 : Measurement methods and test procedures — Fibre geometry*, **IEC 60793-1-21** *Optical fibres — Part 1-21 : Measurement methods and test procedures — Coating geometry* and **IEC 60793-1-22** *Optical fibres — Part 1-22 : Measurement methods and test procedures — Length measurement (overall evaluation : MOD)*

JIS C 6823 *Measuring methods for attenuation of optical fibers*

NOTE : Corresponding International Standards : **IEC 60793-1-40** *Optical fibres — Part 1-40 : Measurement methods and test procedures — Attenuation*, **IEC 60793-1-46** *Optical fibres — Part 1-46 : Measurement methods and test procedures — Monitoring of changes in optical transmittance* and **IEC 60793-1-47** *Optical fibres — Part 1-47 : Measurement methods and test procedures — Macrobending loss (overall evaluation : MOD)*

JIS C 6825 *Test methods for structural parameters of optical fibers — Optical characteristics*

NOTE : Corresponding International Standards : **IEC 60793-1-44** *Optical fibres — Part 1-44 : Measurement methods and test procedures — Cut-off wavelength* and **IEC 60793-1-45** *Optical fibres — Part 1-45 : Measurement methods and test procedures — Mode field diameter (overall evaluation : MOD)*

JIS C 6827 *Test methods for chromatic dispersion of optical fibers*

NOTE : Corresponding International Standard : **IEC 60793-1-42** *Optical fibres — Part 1-42 : Measurement methods and test procedures — Chromatic dispersion (MOD)*

JIS C 6870-3 *Outdoor optical fiber cables — Part 3 : Sectional specification*

NOTE : Corresponding International Standard : **IEC 60794-3** *Optical fibre cables — Part 3 : Sectional specification — Outdoor cables (MOD)*

JIS C 60068-1 *Environmental testing Part 1 : General and guidance*

IEC 60304 *Standard colours for insulation for low-frequency cables and wires*

IEC 60793-1-48 *Optical fibres — Part 1-48 : Measurement methods and test procedures — Polarization mode dispersion*

IEC 60793-1-50 *Optical fibres — Part 1-50 : Measurement methods and test procedures — Damp heat (steady state)*

IEC 60793-1-51 *Optical fibres — Part 1-51 : Measurement methods and test procedures — Dry heat*

IEC 60793-1-52 *Optical fibres — Part 1-52 : Measurement methods and test proce-*

dures — Change of temperature

IEC 60793-1-53 *Optical fibres — Part 1-53 : Measurement methods and test procedures — Water immersion*

3 Terms and definitions

For the purposes of this Standard, the terms and definitions given in **JIS C 6820** apply.

4 Classification and type name

The classification and the type name of silica glass single-mode optical fibers shall be as specified in **JIS C 6820**. Examples are shown in table 1. See Annex I for the map of symbols among corresponding International Standards.

Table 1 Example of classification and type name

Classification	Type name
Silica glass single-mode 1 310 nm zero dispersion type optical fiber 9.3/125	SSMA-9.3/125
Silica glass single-mode 1 550 nm cut-off shifted type optical fiber 10.5/125	SSMA-T-10.5/125
Silica glass single-mode 1 310 nm zero dispersion/low OH type optical fiber 9.3/125	SSMA-U-9.3/125
Silica glass single-mode 1 550 nm dispersion shifted type optical fiber 8/125	SSMB-8/125
Silica glass single-mode non-zero dispersion shifted type optical fiber 9/125	SSMD-9/125
Silica glass single-mode wideband non-zero dispersion shifted type optical fiber 8.5/125	SSME-8.5/125
Silica glass single-mode low OH/bending loss insensitive type optical fiber 9/125	SSMF-A-9/125
Silica glass single-mode bending loss insensitive type optical fiber 6.5/125	SSMF-B-6.5/125

5 Material, shape and dimensions

5.1 Material and shape

The material and the shape of the silica glass single-mode optical fibers shall be as follows.

- The core is made of silica glass and of circular cross-section.
- The cladding is made of the silica glass of lower refractive index than that for the core, and is located on the core closely and concentrically.
- The primary coating for which plastic materials such as UV curing resin and silicon resin are used is located on the cladding closely and concentrically.

The primary coating consists of one layer or more. The primary coating shall be capable of being removed for the purpose of the connection excluding the case of

using as a reference surface. The method to remove the primary coating is upon the agreement between the interested parties concerned with delivery.

5.2 Dimensions

The dimensions are shown in table 2.

Table 2 Dimensions

Item	Specified value
Cladding diameter μm	125 ± 1
Cladding non-circularity %	2.0 max. ^{a)}
Core concentricity error μm	0.8 max. ^{a)}
Primary coating diameter (uncoloured) μm	235 to 255 ^{b)}
Primary coating diameter (coloured) μm	235 to 265 ^{b)}
Primary coating-cladding concentricity error μm	12.5 max.
Fiber length km	^{c)}
Notes ^{a)} Some optical fibers may have tighter tolerances according to the type thereof. ^{b)} The primary coating diameter is also called the fiber diameter. The values on primary coating diameter in this table are most commonly used in telecommunications cables. There are other applications such as optical fibers for use within optical sub-systems, pigtails or submarine cables, to which other primary coating diameters and tolerances listed below may be used. — 400 $\mu\text{m} \pm 40 \mu\text{m}$ — 700 $\mu\text{m} \pm 100 \mu\text{m}$ — 900 $\mu\text{m} \pm 100 \mu\text{m}$ ^{c)} Upon the agreement between the interested parties concerned with delivery.	

5.3 Colour of primary coating

The primary coating may be coloured with different colours of two or more.

The colour shall be as specified in IEC 60304.

For example, the following colours may be used as monochrome.

- natural colour or white
- yellow
- blue
- green

Marking may be given above or beneath the colour coating. The marking shall be the coloured ring, line or spiral that is clearly distinguishable. Printing or coating mark shall be sufficiently adhered. The marking shall be within 30 mm in length and be easily discernible.

6 Mechanical requirements

Mechanical requirements common to the silica glass single-mode optical fibers are shown in table 3.

Table 3 Mechanical requirements

Item	Specified value
Proof stress level GPa	0.69 min. ^{a)}
Coating strip force (average) ^{b)} N	1.0 to 5.0
Coating strip force (peak) ^{b)} N	1.0 to 8.9
Fiber curl radius m	2 min. ^{c)}
Tensile strength (0.5 m) GPa	3.8 min.
Stress corrosion susceptibility constant n_d	18 min.
Notes ^{a)} The proof stress level value of 0.69 GPa equals the condition of 1 % strain or the condition of 8.8 N force on the optical fibers.	
^{b)} Either the average coating strip force or the peak coating strip force shall be specified upon the agreement between the parties concerned with delivery.	
^{c)} Depending on splicing methods, a minimum of 4 m may be specified for such as optical fiber ribbon cables.	

7 Transmission requirements

Transmission requirements of the silica glass single-mode optical fibers are shown in table 4.

Table 4 Mechanical requirements

Item	Specified value
Attenuation dB/km	See Annex A, Annex B, Annex C, Annex D, Annex E, Annex F, Annex GA and Annex GB.
Chromatic dispersion ps/nm·km	
Mode field diameter μm	
Tolerances on mode field diameter μm	
Cut-off wavelength nm	
Macrobending loss dB	
Designed value (PMD_Q) of link polarization mode dispersion (PMD) coefficient ps/ $\sqrt{\text{km}}$	^{a)}
Note ^{a)} The maximum value of PMD_Q of optical fibers shall be specified so as to satisfy PMD of cabled optical fibers as specified in JIS C 6870-3.	

8 Environmental requirements

Environmental requirements of the silica glass single-mode optical fibers are as follows.

- a) **Change in attenuation** The environmental requirements of the change in attenuation are shown in table 5.

The attenuation shall be measured during testing and after testing.

Table 5 Environmental requirements of change in attenuation

Test method	Wavelength nm	Attenuation increase dB/km
Damp heat test	1 550	0.05 max.
Dry heat test	1 550	0.05 max.
Temperature cycle test	1 550	0.05 max.
Water immersion test	1 550	0.05 max.
NOTE 1 The change in attenuation at wavelengths shorter than 1 550 nm is smaller than the change in attenuation at 1 550 nm.		
NOTE 2 The wavelength 1 625 nm is optional, and the specification of this case shall be upon the agreement between the parties concerned with delivery.		

- b) **Coating strip property** The environmental requirements of the coating strip are shown in table 6.

The environmental requirements of the coating strip of the optical fibers shall be verified after the environmental test.

Table 6 Environmental requirements of coating strip

Test method	Average coating strip force N	Peak coating strip force N
Damp heat test	1.0 to 5.0	8.9 or under
Water immersion test	1.0 to 5.0	8.9 or under

- c) **Tensile strength property** The environmental requirements of the tensile strength are shown in table 7.

The environmental requirements of the tensile strength of the optical fibers shall be verified after the environmental test.

Table 7 Environmental requirements of tensile strength

Test method	Tensile strength (median) GPa Specimen length : 0.5 m	Tensile strength (15 percentile) GPa Specimen length : 0.5 m
Damp heat test	3.03 min.	2.76 min.
NOTE : These requirements do not apply to hermetically coated optical fibers.		

- d) **Stress corrosion susceptibility constant** The environmental requirements of the stress corrosion susceptibility constant are shown in table 8.

The environmental requirements of stress corrosion susceptibility constant of the optical fibers shall be verified after the environmental test.

Table 8 Environmental requirements of stress corrosion susceptibility

Test method	Stress corrosion susceptibility constant n_d
Damp heat test	18 min.
NOTE : These requirements do not apply to hermetically coated fibers.	

9 Tests

9.1 Condition of test place

The condition of the test place shall be the standard atmosphere condition (15 °C to 35 °C in temperature, 25 % to 75 % in relative humidity and 86 kPa to 106 kPa in air pressure) specified in 5.3 of JIS C 60068-1. The environmental tests shall be as specified in table 12.

9.2 Test item and test method

The test items and test methods are shown in table 9 to table 13.

Table 9 Structural parameter test

Item	Test method	Applicable Standard
Cladding diameter	Refraction near field method, near field pattern method and side observation method	JIS C 6822
Cladding non-circularity	Refraction near field method, near field pattern method and side observation method	JIS C 6822
Core concentricity error (mode field concentricity error)	Refraction near field method, near field pattern method and side observation method	JIS C 6822
Primary coating diameter	Mechanical outside diameter measuring method and side observation method	JIS C 6822
Primary coating-cladding concentricity error	Side observation method	JIS C 6822
Fiber length	Delay measuring method, back-scattering method, mechanical measuring method and phase shift method	JIS C 6822

Table 10 Mechanical requirements test

Item	Test method	Applicable Standard
Proof test	Constant stress method, constant elongation strain method and constant strain method	JIS C 6821
Coating strip property	Coating strip force	JIS C 6821
Tensile strength	Tensile strength measuring method	JIS C 6821
Fiber curl radius	Side microscopic method and laser scattering method	JIS C 6821
Stress corrosion susceptibility constant	Tensile method and bending method	JIS C 6821

Table 11 Transmission requirements test

Item	Test method	Applicable Standard
Attenuation ^{a)}	Cut-back method, insertion loss method and OTDR method (pulse test method)	JIS C 6823
Chromatic dispersion	Phase shift method, pulse method, differential phase shift method and interferometry method	JIS C 6827
Mode field diameter	Far-field scan method, variable aperture method and near-field scan method	JIS C 6825
Cut-off wavelength ^{b)}	Bending method and multi-mode reference technique method	JIS C 6825
Macrobending loss	Bending loss test method	JIS C 6823
Polarization mode dispersion	Fixed analyser measuring method, stokes parameter evaluation method and interferometry method	IEC 60793-1-48
NOTE : Maximum value of attenuation is applicable to uncabled optical fibers. See JIS C 6870-2 for the maximum value of attenuation of uncabled optical fibers. Notes ^{a)} The attenuation at various wavelengths can be calculated using the measured values at a few wavelengths using a spectral attenuation model given in JIS C 6823. For example, the attenuation at 1 480 nm is calculated according to this method, and used for the design of systems that employ remote pumping of optical amplifiers. When using OTDR method, additional guidance information in IEC/TR 62316 should be taken into account. ^{b)} There are three ways to measure the cut-off wavelength: on fiber cut-off wavelength (λ_c), on cable cut-off wavelength (λ_{cc}) and on jumper cut-off wavelength (λ_{cj}). The correlation of the measured values of λ_c, λ_{cc} and λ_{cj} depends on the the type of optical fiber, cable design and test conditions. While in general, this quantitative relationship $\lambda_{cc} < \lambda_{cj} < \lambda_c$ is established, it cannot be easily established depending on the fiber length. The importance of ensuring single-mode transmission in the minimum cable length between joints at the minimum operating wavelength is paramount. This is ensured by assuming the maximum cable cut-off wavelength λ_{cc} of a cabled single-mode optical fiber to be 1 260 nm, or for typical jumpers, by assuming a maximum jumper cable cut-off λ_{cj} to be 1 250 nm, or for worst case length and bending radius, etc. by assuming a maximum fiber cut-off wavelength λ_c to be 1 250 nm.		

Table 12 Environmental test method

Test method	Applicable Standard
Damp heat test	IEC 60793-1-50
Dry heat test	IEC 60793-1-51
Change of temperature test	IEC 60793-1-52
Water immersion test	IEC 60793-1-53

Table 13 Environmental requirements test

Item	Test method	Applicable Standard
Change in attenuation	Transmit power monitor method	JIS C 6823
Attenuation	Cut-back method, insertion loss method and OTDR method	JIS C 6823
Coating strip property	Coating strip force	JIS C 6821
Tensile strength	Tensile strength measuring method	JIS C 6821
Stress corrosion susceptibility constant	Tensile method and bending method	JIS C 6821