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YD/T 1447-2013

Replacing YD/T 1447-2006

Plastic Optical Fibre for Communication

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Foreword

This Standard was drafted in accordance with the rules given in GB/T 1.1-2009.

This Standard replaces YD/T 1447-2006 "Plastic Optical Fibre for Communication". Compared with YD/T 1447-2006, the main changes, except the editorial modifications, in this Standard are as follows:

- the application scope of the standard was added "for the plastic optical fibre in the field of decorative lighting, this Standard may also be applied by reference" (see Clause 1; Clause 1 in Edition 2006);
- the Type of A4a.2 optical fibre and its technical requirements were added in Type A4a optical fibre; the name of the original Type A4a optical fibre was changed as A4a.1 (see Clause 4.1 and Appendix A);
- the pattern and marking of tight buffer fibre were added (see Clauses 4.2 and 4.3);
- the requirements "it shall be easy to strip the tight buffer layer, not less than 20mm, from the optical fibre; the force for stripping shall not be greater than 25 N and shall not be less than 5N" were added (see Clause 5.3.3.5);
- the methods and requirements of tensile property test for tight buffer fibre were added (see Clause 6.5.2);
- the duration time of flattening test for tight buffer fibre was changed from "1 min" to "3 min" (see Clause 6.5.3; 6.5.3 in Edition 2006);
- the test requirements for strippability of tight buffer layer were added (see Clause 6.5.8);
- the injection numerical aperture of A4e optical fibre in Table A.2 when testing the attenuation coefficient was modified from "NA= 0.1" to "NA = 0.3" (see Table A.2; Table A.2 in Edition 2006);
- the requirement of attenuation coefficient of A4d optical fibre at 650nm when adopting balance mode distribution was modified from " ≤ 20 " to " ≤ 18 " at 650nm when NA= 0.3 (see Table A.2; Table A.2 in Edition 2006);
- the bandwidth testing requirements of A4f, A4g and A4h was modified from "100~400m" to "100~500m" (see Table B.2; Table B.2 in Edition 2006);
- the Appendix C (Normative) "Interference Mode Device and Parameter of Plastic Optical Fibre" was added.

This Standard was formulated by reference to IEC 60793-2-40:2009 "Optical Fibres -

Plastic Optical Fibre for Communication

1 Scope

This Standard specifies the product classification, requirements, test methods, inspection rules, marking, operating instructions as well as packaging, transportation and storage of the plastic optical fibre for communication (hereinafter referred to as optical fibre).

This Standard is applicable to plastic optical fibre whose refractive profile is step index, multi-step index or graded index, with plastic core and plastic cladding; and which are used for short distance communication in industrial equipment, electrical equipment, consumer electronics equipment, transducer, access network and local area network as well as vehicle, ship and aircraft. For the plastic optical fibre in the field of decorative lighting, this Standard may also be applied by reference.

2 Normative References

The following documents are essential for the application of this document. For the dated reference, only the edition cited applies. For the undated references, the latest edition of the normative document (including any amendments) applies.

GB/T 191-2008	Packaging - Pictorial Marking for Handling of Goods
GB/T 2421-1999	Environmental Testing for Electric and Electronic Products - Part 1: General and Guidance (IEC 60068-1:1988, IDT)
GB/T 4892-2008	Dimensions of Rigid Rectangular Packages - Transport Packages (ISO 3394:1984, NEQ)
GB/T 5048-1999	Moistureproof Packaging
GB/T 7424.2-2008	Optical Fibre Cable Generic Specification - Part 2: Basic Optical Cable Test Procedures (IEC 60794-1-2, 2003, MOD)
GB/T 15972.10-2008	Specifications for Optical Fibre Test Methods - Part 10: Measurement Methods and Test Procedures - General and Guidance (IEC 60793-1-1:2002, MOD)
GB/T 15972.20-2008	Specifications for Optical Fibre Test Methods - Part 20: Measurement Methods and Test Procedures for Dimensions - Fibre Geometry (IEC 60793-1-2:2001,

MOD)

- GB/T 15972.40-2008 Specifications for Optical Fibre Test Methods - Part 40: Measurement Methods and Test Procedures for Transmission and Optical Characteristics – Attenuation (IEC 60793.1-40:2001, MOD)
- GB/T 15972.41-2008 Specifications for Optical Fibre Test Methods - Part 41: Measurement Methods and Test Procedures for Transmission and Optical Characteristics – Bandwidth (IEC 60793-1-41:2001, MOD)
- GB/T 15972.43-2008 Specifications for Optical Fibre Test Methods - Part 43: Measurement Methods and Test Procedures for Transmission and Optical Characteristics - Numerical Aperture (IEC 60793.1-43:2001, MOD)
- GB/T 15972.46-2008 Specifications for Optical Fibre Test Methods - Part 46: Measurement Methods and Test Procedures for Transmission and Optical Characteristics - Monitoring of Changes in Optical Transmittance (IEC 60793-1-46:2001, MOD)
- GB/T 15972.47-2008 Specifications for Optical Fibre Test Methods - Part 47: Measurement Methods and Test Procedures for Transmission and Optical Characteristics - Macrobending Loss (IEC 60793-1-47:2001, MOD)
- GB/T 15972.50-2008 Specifications for Optical Fibre Test Methods - Part 50: Measurement Methods and Test Procedures for Environmental Characteristics - Damp Heat (Steady State) (IEC 60793-1-50:2001, MOD)
- GB/T 15972.51-2008 Specifications for Optical Fibre Test Methods - Part 51: Measurement Methods and Test Procedures for Environmental Characteristics - Dry Heat (IEC 60793-1-51:2001, MOD)
- YD/T 1258.2-2009 The Series of Indoor Optical Fibre Cables Part 2: Simplex and Duplex Cable for Use in Terminated Cable Assemblies

3 Terms and Definitions

For the purposes of this document, the following term and definition applies.

Figure 4 Pattern of Optical Fibre Refractive Index profile

5.2 Length

The typical fabrication length nominal value of optical fibre should meet the requirements specified in Table 2. The fabrication length of tight buffer fibre is the same as that of the corresponding optical fibre.

Table 2 Typical Fabrication Length of Type A4 Optical Fibre

In: m

Type	A4a.1	A4a.2	A4b	A4c	A4d	A4e	A4f	A4g	A4h
Length	1500	1500	2700	6000	1500	2700	4000	4000	16000

The delivery length of optical fibre and tight buffer fibre may be decided by the Buyer and the Supplier through negotiation; the length error shall not be greater than $\pm 1\%$.

5.3 Property Requirements

5.3.1 Geometric dimension

Optical fibre dimension requirements include cladding diameter, cladding non-circularity, core diameter, core non-circularity and concentricity error between core and cladding; as for tight buffer fibre, the requirements shall also include tight buffer layer diameter. The geometric dimension requirements of PMMA plastic optical fibre and tight buffer fibre shall meet those specified in Table A.1 of Appendix A, and that of the fluorinated plastic optical fibre shall meet those specified in Table B.1 of Appendix B.

5.3.2 Optical and transmission characteristic

The optical and transmission characteristic of optical fibre and tight buffer fibre shall include attenuation, mode bandwidth, (theoretical) numerical aperture and macrobending loss; as for fluorinated plastic optical fibre, the optical and transmission characteristic shall also include zero dispersion wavelength λ_0 and zero dispersion slope S_0 . The optical and transmission characteristic requirements of PMMA plastic optical fibre and its tight buffer fibre shall meet those specified in Table A.2 of Appendix A, and the optical and transmission characteristic requirements of fluorinated plastic optical fibre shall meet those specified in Table B.2 of Appendix B.

5.3.3 Mechanical property

5.3.3.1 General

The mechanical properties of optical fibre shall include tensile yield; as for tight buffer PMMA plastic optical fibre, the mechanical properties shall also include such items as flattening, impact, reverse bending, torsion and winding. Such mechanical properties shall be inspected according to the test methods and test conditions specified in 6.5.

5.3.3.2 Tensile property

6.5.2.5 Acceptance criteria

The value of test result of the sample from PMMA plastic optical fibre and its tight buffer fibre shall meet those specified in Table A.3, and that of fluorinated plastic optical fibre shall meet those specified in Table B.3. The additional attenuation value of tight buffer plastic optical fibre before and after tensile shall not exceed 0.2 dB.

6.5.3 Flattening of tight buffer fibre

Requirements for flattening test of tight buffer fibre are as follows:

- a) Test method: Method E3 "flattening" in GB/T 7424.2-2008;
- b) Load: 7 N/mm;
- c) Duration: 3min;
- d) Acceptance criteria: additional attenuation value of the sample shall not exceed 0.2 dB after 1 min at the end of the test.

6.5.4 Impact of tight buffer fibre

Requirements for impact test of tight buffer fibre are as follows:

- a) Test method: Method E4 "impact" in GB/T 7424.2-2008;
- b) Radius of the impacted cylindrical surface: 12.5mm;
- c) Impact energy: 0.2N·m;
- d) Impact times: at least three, once at each impact point with an interval of at least 500mm;
- e) Acceptance criteria: tight buffer layer shall be free from visual cracking; additional attenuation value of the sample shall not exceed 0.2 dB after 1 min at the end of the test.

6.5.5 Reverse bend of tight buffer fibre

Requirements for reverse bend test of tight buffer fibre are as follows:

- a) Test method: Method E6 "reverse bend" in GB/T 7424.2-2008;
- b) Bending radius: 15mm;
- c) Load: 5N;
- d) Cycle times: 1, 000;
- e) Acceptance criteria: tight buffer layer shall be free from visual cracking;

additional attenuation value of the sample shall not exceed 0.2 dB after 1 min at the end of the test.

Note: In case of cracking of tight buffer layer at the clamping point, the result is considered invalid, and the test shall be re-conducted by resampling.

6.5.6 Torsion of tight buffer fibre

Requirements for torsion test of tight buffer fibre are as follows:

- a) Test method: Method E7 "torsion" in GB/T 7424.2-2008;
- b) Axial tensile: 20N;
- c) Torsion length: 250mm;
- d) Torsion angle: $\pm 180^\circ$;
- e) Number of torsions: 20;
- f) Acceptance criteria: tight buffer layer shall be free from visual cracking; additional attenuation value of the sample shall not exceed 0.2 dB after 1 min at the end of the test.

Note: In case of cracking of tight buffer layer at the clamping point, the result is considered invalid, and the test shall be re-conducted by resampling.

6.5.7 Winding of tight buffer fibre

Requirements for winding test of tight buffer fibre are as follows:

- a) Test method: Method E11A "winding" in GB/T 7424.2-2008;
- b) Mandrel diameter: 50mm;
- c) Winding number: 6;
- d) Cycle times: 10;
- e) Acceptance criteria: additional attenuation value of the sample shall not exceed 0.2 dB at the end of the test.

6.5.8 Strippability of tight buffer layer

Requirements for stripping test of tight buffer fibre are as follows:

- a) Test method: "pull-out test method of fibre cable sheath" in Appendix F of YD/T 1258.2-2009;
- b) Tensile rate: 100mm/min;

- f) When it is required in the acceptance by the Buyer of the products in mass production.

7.4.3 Sampling plan

Generally, one sample unit of each type shall be randomly sampled from inspection lot for each inspection, however, the sampling plan may be determined by the competent agency during type approval.

7.4.4 Judgment rules

First of all, items included in the exit-factory inspection shall be inspected; in case of any unacceptable item, new sample unit shall be taken for the re-inspection. The sample unit shall not be used for inspection of other items until the exit-factory inspection items are acceptable. If any sample unit fails to pass any test of other inspections, double sample unit shall be taken to inspect the unacceptable item; if all sample units pass the test, then the type inspection is judged as acceptable; if there is still one item failing to pass the test, then the type inspection is judged as unacceptable.

7.4.5 Re-test

If the products fail to pass the type inspection, the manufacturer shall correct all the products according to the causes. Product appraisal or acceptance shall be stopped before the acceptable improvement measures are taken. Type inspection shall be re-conducted by resampling, and all the tests shall be re-conducted for the new sample unit after the improvement measures are taken, however, part of the acceptable test items may be reduced as appropriate after being determined by the competent agency or being determined through consultation between the deliverer and receiver.

7.4.6 Handling of sample unit

Sample units which have passed the type inspection may be delivered as finished product after the parts damaged in the test are cut off.

8 Operating Instructions

The operating instructions shall include those specified in 9.1.4 and operating requirements of optical fibre and tight buffer fibre in this Standard, including:

- a) Allowable tensile strength of optical fibre and tight buffer fibre and flattening pressure of tight buffer fibre;
- b) Allowable bending radius of optical fibre and tight buffer fibre;
- c) Permissible working temperature range of optical fibre and tight buffer fibre;

- d) Typical value of effective group refractive index of optical fibre.

9 Packaging, Transportation and Storage

9.1 Packaging

Optical fibres shall be delivered after being placed on the delivery drums with the same production length and the core diameter not less than 100mm. The products shall be suitably protected, e.g. box, from being damaged during storage.

The distance from the outermost layer of the reeled optical fibre to the edge of side plate of optical fibre drum shall not be less than 20mm, and both ends of optical fibre shall be fixed in the drum.

Packaging and its marking shall meet the relevant requirements of GB/T 191-2008, GB/T 4892-2008 and GB/T 5048-1999.

Optical fibre drum and packaging box shall be marked with the following contents:

- a) Manufacturer's name and product trademark;
- b) Optical fibre marking;
- c) Optical fibre length (m);
- d) Gross weight (kg);
- e) Manufacture date and (or) production batch No.;
- f) Arrow indicating correct direction of rotation of the optical fibre drum;
- g) Other marks which guarantee the safety of transportation and storage.

9.2 Transportation and Storage

Attention shall be paid to the following contents during transportation and storage of the optical fibres:

- a) The drum shall not be placed horizontally, and the reeled optical fibre without box shall not be stacked;
- b) The reeled optical fibre shall be rolled according to the direction of the rotating arrow indicated on the drum, but shall not be rolled for a long distance;
- c) There shall be free from any impact, extrusion or any mechanical damage;
- d) Moisture and long-time sunlight exposure shall be prevented;

Item	Unit	Index					
		A4a.1	A4a.2	A4b	A4c	A4d	A4e
Theoretical numerical aperture		0.50±0.15	0.485±0.045	0.50±0.15	0.30±0.05	0.25±0.07	
Macrobending loss of 650 nm	dB	≤0.5					
^a Attenuation coefficient should be measured at 100m, and the value measured at other lengths may be converted to that at 100m. When the attenuation of A4a, A4b, A4c and A4d optical fibres is tested by adopting balance mode distribution injection method, the interference mode device and requirements shall meet those specified in Appendix C. Mode bandwidth should be measured at 100m~400m, and the measured value may be converted to that at 100m.							

A.3 Mechanical performance

Tensile property of PMMA plastic optical fibre and its tight buffer fibre shall be in accordance with those specified in Table A.3.

Table A.3 Tensile Property of PMMA Plastic Optical Fibre and its Tight Buffer Fibre

Item	Unit	Index					
		A4a.1	A4a.2	A4b	A4c	A4d	A4e
Yield tensile strength of optical fibre	N	≥56	≥56	≥32	≥14	≥56	≥32
Yield elongation of optical fibre	%	≥4.0					
Tensile strengths at 4 % elongation of tight buffer fibre	N	≥70	≥70	≥45	≥20	≥70	>45

A.4 Environmental property

A.4.1 Additional attenuation and attenuation temperature characteristic of PMMA plastic optical fibre and its tight buffer fibre after damp heat and dry heat tests shall be in accordance with those specified in Table A.4.

Table A.4 Requirements for Damp Heat, Dry Heat and Temperature Cycling Tests of PMMA Plastic Optical Fibre and its Tight Buffer Fibre

Item	Index					
	A4a.1	A4a.2	A4b	A4c	A4d	A4e
Additional attenuation after damp heat test (at 650nm wavelength)	≤5					
Additional attenuation after dry heat test (at 650nm wavelength)	≤2					
Additional attenuation of temperature cycling test (at 650nm wavelength)	≤2					

A.4.2 Yield elongation of PMMA plastic optical fibre after damp heat test 4.0 %.

Mechanical performance of fluorinated plastic optical fibre shall be in accordance with those specified in Table B.3.

Table B.3 Mechanical Performance of Fluorinated Plastic Optical Fibre

Item	Unit	Index		
		A4f	A4g	A4h
Yield tensile strength of optical fibre	N	≥ 7		≥ 1.75
Yield elongation of optical fibre	%	≥ 4		
Tensile strength at 4% elongation of optical fibre	N	≥ 7		≥ 1.75

B.4 Environmental property

B.4.1 Additional attenuation and attenuation temperature characteristic of fluorinated plastic optical fibre after damp heat and dry heat test shall be in accordance with those specified in Table B.4.

Table B.4 Requirements for Damp Heat, Dry Heat and Temperature Cycling Tests of Fluorinated Plastic Optical Fibre
 In: dB/100 m

Item	Index		
	A4f	A4g	A4h
Additional attenuation after damp heat test ^a (850nm or (and) 1300nm wavelength)	≤1 (including attenuation caused by water absorption)		
Additional attenuation after dry heat test (850nm or (and) 1300nm wavelength)	≤0.5		
Additional attenuation of temperature cycling test (850nm or (and) 1300nm wavelength)	≤0.5		
^a The sample may be tested after it is recovered for at least 24h under the atmosphere condition of standard ambient temperature after the damp heat test as water absorption has great influence.			

B.4.2 Yield elongation of fluorinated plastic optical fibre after damp heat test shall not be less than 4.0 %.

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Contact: Wayne Zheng, Sales@ChineseStandard.net

Linkin: <https://www.linkedin.com/in/waynezhengwenrui/>

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