IEC 60794-3-10

Edition 2.0 2009-01

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Optical fibre cables –
Part 3-10: Outdoor cables – Family specification for duct, directly buried and lashed aerial optical telecommunication cables

Câbles à fibres optiques –
Partie 3-10: Câbles extérieurs – Spécification de famille pour les câbles optiques de télécommunication destinés à être installés dans des conduites, directement enterrés ou attachés en aérien

IEC 60794-3-10:2009

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FOREWORD

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International Standard IEC 60794-3-10 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2002. It constitutes a technical revision.

The main changes are listed below:

- the title of the specification has been updated to include lashed applications;
- the fibres specification clause (Clause 4) has been enlarged to include fibre Types B5 and B6.a;
- an annex has been added for additional requirements according to the MICE table.

This bilingual version (2013-01) corresponds to the monolingual English version, published in 2009-01.

The text of this standard is based on the following documents:

FDIS	Report on voting
86A/1245/FDIS	86A/1252/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of IEC 60794 series, published under the general title *Optical fibre cables,* can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,
- replaced by a revised edition, or
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OPTICAL FIBRE CABLES –

Part 3-10: Outdoor cables – Family specification for duct, directly buried and lashed aerial optical telecommunication cables

1 Scope

This part of IEC 60794 which is a family specification covers optical telecommunication cables to be used in ducts or direct buried applications. The cable may also be used for lashed aerial applications. Requirements of the sectional specification IEC 60794-3 for duct, buried and aerial cables are applicable to cables covered by this standard.

Clause A.2 contains requirements that supersede the normal requirements in case the cables are intended to be used in installation governed by the MICE table of ISO/IEC 24702.

Annex B gives information on the lashed aerial application.

The parameters specified in this standard may be affected by measurement uncertainty arising either from measurement errors or calibration errors due to lack of suitable standards. Acceptance criteria shall be interpreted with respect to this consideration (see IEC 60794-3 Clause 8).

The number of fibres tested shall be representative of the cable design and shall be agreed between the customer and the supplier.

2 Normative references

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

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

IEC 60654-4, *Operating conditions for industrial-process measurement and control equipment – Part 4: Corrosive and erosive influences*

IEC 60721-1, *Classification of environmental conditions – Part 1: Environmental parameters and their severities*

IEC 60721-3-3, *Classification of environmental conditions – Part 3-3: Classification of groups of environmental parameters and their severities – Stationary use at weatherprotected locations*

IEC 60793-1-20, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

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

IEC 60793-2-50, *Product specifications – Sectional specification for class B single-mode fibres*

IEC 60794-1-1, *Optical fibre cables – Part 1: Generic specification – General*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*

IEC 60794-3, *Optical fibre cables – Part 3: Sectional specification – Outdoor cables*

IEC 60811-1-1, *Common test methods for insulating and sheathing materials of electric cables and optical cables – Part 1-1: Methods for general application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties*

IEC 60811-5-1, *Insulating and sheathing materials of electric and optic cables – Common test methods – Part 5-1: Methods specific to filling compounds – Drop-point – Separation of oil – Lower temperature brittleness – Total acid number – Absence of corrosive components – Permittivity at 23 °C – DC resistivity at 23 °C and 100 °C*

IEC 61000-2-5, *Electromagnetic compatibility (EMC) – Part 2: Environment – Section 5: Classification of electromagnetic environments. Basic EMC publication*

IEC 61000-6-2, *Electromagnetic compatibility (EMC) – Part 6-2: Generic standards – Immunity for industrial environments*

IEC 61326-1, *Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 1: General requirements*

IEC 62363, *Radiation protection instrumentation – Portable photon contamination meters and monitors*

ISO/IEC 24702, *Information technology – Generic cabling – Industrial premises*

3 Symbols

For the purposes of this standard the following symbols apply.

λ_{cc} Cabled fibre cut-off wavelength.

d Nominal outer diameter of the cable.

DS Detail specification.

T_L The acceptable amount of long term tensile load which is expected that the cable may experience during operation (i.e. after installation is completed). This load may be due to residual loading from the installation process and/or environmental effect.

T_M The acceptable amount of short term tensile load which is expected that the cable experience during installation and/or handling .

T_{A1} Temperature cycling test temperature limit according to IEC 60794-1-2, Method F1.

T_{A2} Temperature cycling test temperature limit according to IEC 60794-1-2, Method F1.

T_{B1} Temperature cycling test temperature limit according to IEC 60794-1-2, Method F1.

T_{B2} Temperature cycling test temperature limit according to IEC 60794-1-2, Method F1.

t_1 Temperature cycling test dwell time.

$n \times d$ A value, n, times cable outer diameter, d, used for bends, mandrels, etc.

4 Optical fibre, cable construction and tests applicable for optical telecommunication cables to be used in ducts, direct buried or lashed aerial applications

4.1 Optical fibres

Attenuation at the wavelength 1 625 nm is optionally specified by the customer.

4.1.1 Common single-mode fibre requirements

Table 1 – Common single-mode fibre requirements

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Uncabled optical fibre	5.1	IEC 60793-2-50		
Attenuation discontinuities at 1 310 nm and 1 550 nm	5.2.2	≤ 0,10 dB	IEC 60793-1-40	
Cabled fibre cut-off wavelength	5.3	$\lambda_{cc} < \lambda$ operational	IEC 60793-1-44	
Fibre colouring	5.4	IEC 60304	Visual inspection	
Polarisation mode dispersion PMD_Q	5.5	IEC 60794-3	IEC 60793-1-48	
Outer diameter including colouring	8.2.1.1	IEC 60793-2-50	IEC 60793-1-20	

4.1.2 Single-mode dispersion unshifted (B1.1) optical fibre

Table 2 – Single-mode dispersion unshifted (B1.1) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 310 nm at 1 550 nm at 1 625* nm	5.2.1	≤ 0,40 dB/km ≤ 0,30 dB/km ≤ 0,40 dB/km		

4.1.3 Single-mode dispersion unshifted (B1.2) optical fibre

Table 3 – Single-mode dispersion unshifted (B1.2) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 550 nm at 1 625* nm	5.2.1	≤ 0,30 dB/km ≤ 0,40 dB/km		

* 1 625 nm performance is optional depending on agreement between customer and supplier.

4.1.4 Single-mode dispersion unshifted (B1.3) optical fibre

Table 4 – Single-mode dispersion unshifted (B1.3) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 310 at 1 383 ± 3 nm at 1 550 at 1 625* nm	5.2.1	≤ 0,40 dB/km ≤ 0,40 dB/km ≤ 0,30 dB/km ≤ 0,40 dB/km		

4.1.5 Single-mode dispersion shifted (B2) optical fibre

Table 5 – Single-mode dispersion shifted (B2) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 550 nm	5.2.1	≤ 0,30 dB/km		

4.1.6 Single-mode non-zero dispersion (B4) optical fibre

Table 6 – Single-mode non-zero dispersion (B4) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 550 nm at 1 625* nm	5.2.1	≤ 0,30 dB/km ≤ 0,40 dB/km		

4.1.7 Single-mode non-zero dispersion shifted (B5) optical fibre

Table 7 – Single-mode non-zero dispersion shifted (B5) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 460 nm at 1 550 nm and at 1 625* nm	5.2.1	≤ 0,40 dB/km ≤ 0,30 dB/km ≤ 0,40 dB/km		

* 1 625 nm performance is optional depending on agreement between customer and supplier.

4.1.8 Single-mode (B6.a) optical fibre

Table 8 – Single-mode (B6.a) optical fibre

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Attenuation coefficient (cabled fibres)	5.2.1	According to DS	IEC 60793-1-40	
at 1 310 nm at 1 310 nm -1625 nm at 1 383 nm at 1 550 nm at 1 625* nm	5.2.1	NS ≤ 0,40 dB/km ≤ 0,40 dB/km ≤ 0,30 dB/km NS		

4.2 Cable element

Table 9 – Cable element

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Cable element				
Compatibility	6	According to DS	Under consideration	
Slotted core	6.3	According to DS	Visual inspection	
Tube	6.4	According to DS	Visual inspection	
Compound flow and evaporation		According to DS	IEC 60794-1-2, Methods E14 and E15	
Outer diameter	8.2.1.1	According to DS	IEC 60811-1-1	
Ribbon	6.5	According to DS	Visual inspection	
Filler		According to DS		
Insulated copper conductor		According to DS		
Central strength member		According to DS		

4.3 Installation and operating conditions

Table 10 – Tests applicable

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
General requirements	8.1	Agreement between customer and supplier		
Bend of cable element	8.2.1.2	According to DS	IEC 60794-1-2, Method G1	
Tube kinking	8.2.2.1	According to DS	IEC 60794-1-2, Method G7	
Ribbons :				
- dimensions	8.2.3.1	IEC 60794-3,	IEC 60794-3,	

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
		Table 1	8.2.3.1	
- separability of individual fibres from ribbon	8.2.3.2.1	IEC 60794-3, 8.2.3.2.1 or according to DS	IEC 60794-1-2, Method G5 or according to DS	
- ribbon stripping	8.2.3.2.2	According to DS		
- torsion	8.2.3.2.3	According to DS	IEC 60794-1-2, Method G6	

4.4 Mechanical and environmental tests

4.4.1 Tests applicable

Table 11 – Mechanical and environmental applicable tests

Characteristics (9)	IEC 60794-3 clause/subclause (10)	Family requirements (11)	Test methods (12)	Remarks (13)
Tensile performance	9.1	See 4.4.2.1 and according to DS	IEC 60794-1-2, Methods E1A and E1B	See 4.4.2.1
Installation capability (selection from the following)	9.2			
- bending under tension	9.2.1	According to DS	IEC 60794-1-2, Method E18	
- repeated bending	9.2.2	See 4.4.2.2	IEC 60794-1-2, Method E6	
- impact	9.2.3	See 4.4.2.3	IEC 60794-1-2, Method E4	
- kink	9.2.4	According to DS	IEC 60794-1-2, Method E10	
- torsion	9.2.5	See 4.4.2.4	IEC 60794-1-2, Method E7	
Cable bend	9.3	See 4.4.2.5	IEC 60794-1-2, Method E11	
Crush	9.4	According to DS	IEC 60794-1-2, Method E3	See 4.4.2.6
Temperature cycling	9.5	According to DS	IEC 60794-1-2, Method F1	See 4.4.2.7
Ageing	9.6			
- coating adhesion stability	9.6.1	According to DS	IEC 60794-1-2, Method E5	
- finished cable	9.6.2	Under consideration		
Water penetration	9.7	According to DS	IEC 60794-1-2, Method F5B	
Pneumatic resistance (for unfilled pressurised cables)	9.8	According to DS	IEC 60794-1-2, Method F8	
Special installation conditions (selection from the following as suitable)				

4.4.2 Details of family requirements and test conditions for optical fibre cable tests

NOTE For some of the parameters specified in this standard, the objective is no change in attenuation.

These parameters may be affected by measurement uncertainty arising either from measurement errors or calibration errors due to a lack of suitable standards. Acceptance criteria should be interpreted with respect to this consideration. The total uncertainty of measurement for this standard is ≤ 0,05 dB for attenuation or 0,05 dB/km for attenuation coefficient.

Any measured value within this range, either positive or negative, should be considered as "no change in attenuation". The requirement for these parameters is indicated as "No change (≤ 0,05 dB or ≤ 0,05 dB/km)".

By agreement between customer and supplier, minor deviation from this limit may be accepted at some low frequency, for example less than 10 %. However, for mechanical tests no deviation in excess of 0,15 dB is acceptable. For environmental tests, no deviation in excess of 0,10 dB/km is acceptable.

4.4.2.1 Tensile performance

This subclause identifies family requirements and test conditions that are referred to in Table 11.

a) Family requirements

Under long term tensile load (T_L) the fibre strain shall not exceed 20 % of the fibre proof strain and there shall be no change in attenuation during the test. Under short term tensile load (T_M) the fibre strain shall not exceed 60 % of the fibre proof strain and the attenuation change during test shall be measured and recorded. For aerial cables, the long term tensile load may be ≥ to the short term tensile load. Other criteria may be agreed between the customer and the supplier.

Depending on application and cable construction and agreement between customer and supplier, a maximum tensile force less than the calculation, for example 2 700 N, may be allowed.

Where $T_M \geq 9{,}8 \times a \times m$

with m: weight of 1 km of cable,

typical value of a: 1 for direct burial or blowing in duct
1,5 for pulling in duct

Maximum long term tensile load shall be 30 % of short term tensile load.

Under visual examination without magnification, there shall be no damage to the sheath or to the cable elements.

b) Test conditions

Cable length under tension: not less than 50 m. Taking into account the measurement accuracy and end effects, shorter lengths may be used by agreement between the customer and the supplier.

Fibre length: finished cable length.

Tensile load on cable: long term tensile load (T_L) and short term tensile load (T_M) Other loads may be applied in accordance with particular user conditions.

Diameter of test pulleys: 1 m but not less than the minimum loaded bending diameter specified for the cable.

4.4.2.2 Repeated bending

This subclause identifies family requirements and test conditions that are referred to in Table 11.

a) Family requirements

Under visual examination without magnification there shall be no damage to the sheath and to the cable elements.

b) Test conditions

Bending radius: 20 d.

Load: Adequate to assure uniform contact with the mandrel.

Number of cycles: 25 or different number of cycles may be applied in accordance with particular user conditions.

Duration of cycle: Approximately 2 s.

4.4.2.3 Impact

This subclause identifies family requirements and test conditions that are referred to in Table 11.

a) Family requirements

Under visual examination without magnification there shall be no damage to the sheath or to the cable elements. The imprint of the striking surface on the sheath is not considered mechanical damage.

The variation in attenuation for each fibre shall be ≤ 0,10 dB at 1 550nm after the test. For 1 625 nm applications, performance criteria shall be mutually agreed upon between the customer and supplier.

b) Test conditions

Striking surface radius: 10 mm or 300 mm.

Impact energy: 3 J with striking surface radius of 10 mm or 10 J with striking surface radius of 300 mm.

Armoured cable: 10 J with striking surface radius of 10 mm or 20 J to 30 J with striking surface radius of 300 mm depending on particular user conditions.

Number of impacts: one in 3 different places spaced not less than 500 mm apart.

4.4.2.4 Torsion

This subclause identifies family requirements and test conditions that are referred to in Table 11.

a) Family requirements