IEC 60794-5-20

Edition 1.0 2014-02

INTERNATIONAL STANDARD

colour inside

Optical fibre cables –
Part 5-20: Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

IEC 60794-5-20:2014-02(en)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,…). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 14 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

More than 55 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@iec.ch.

IEC 60794-5-20

Edition 1.0 2014-02

INTERNATIONAL STANDARD

colour inside

Optical fibre cables –
Part 5-20: Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE V

ICS 33.180.01, 33.180.10

ISBN 978-2-8322-1420-6

CONTENTS

FOREWORD 4
1 Scope 6
2 Normative references 6
3 Symbols 7
4 General requirements 8
4.1 Construction 8
4.1.1 General 8
4.1.2 Microduct fibre units 9
4.1.3 Microducts 9
4.1.4 Protected microducts 9
4.1.5 Microduct fittings 9
4.1.6 Microduct hardware 10
4.2 Optical fibres 10
4.3 Installation performance tests 10
4.3.1 Installation conditions 10
4.3.2 Tests applicable 11
4.3.3 Mechanical and environmental tests 11
5 Microduct fibre unit 11
5.1 Tests applicable 11
5.2 Family requirements and test conditions for microduct fibre unit tests 12
5.3 Tensile performance 12
5.4 Crush 12
5.5 Repeated bending 13
5.6 Torsion 13
5.7 Kink 13
5.8 Bend 13
5.9 Temperature cycling 13
5.10 Ageing 14
5.11 Water immersion 14
5.12 Buffer removal 14
6 Microduct 14
6.1 Tests applicable 14
6.2 Tensile performance 15
6.3 Crush 15
6.4 Impact 16
6.5 Repeated bending 16
6.6 Torsion 16
6.7 Kink 16
6.8 Bend 16
6.9 Microduct route verification test 17
6.10 Microduct pressure withstand 17
6.11 Ageing 17
7 Protected microducts 17
7.1 Tests applicable 17
7.2 Tensile performance 18
7.3 Crush 18

7.4 Impact 19
7.5 Repeated bending 19
7.6 Kink 19
7.7 Bend 19
7.8 Microduct route verification test 19
7.9 Microduct pressure withstand 20
7.10 Ageing 20
Annex A (informative) Examples of microduct fibre units, microducts, and protected microducts 21
Annex B (informative) Product descriptions (blank detail specification and minimum requirements) 22
Annex C (normative) Product constructions 25
Annex D (normative) Transmission requirements 28
D.1 Attenuation of cabled fibre 28
D.2 Fibre bandwidth requirements 29
Annex E (normative) IEC 60794-1-21 Method Exx – Microduct inner clearance test 30
E.1 Object 30
E.2 General 30
E.3 Sample 30
E.4 Test equipment 30
E.5 Procedure 30
E.6 Requirements 30
E.7 Details to be recorded 31

Figure A.1 – Protected microducts, tight package 21
Figure A.2 – Microduct fibre units 21

Table 1 – Tests applicable for installation performance 11
Table 2 – Tests applicable for mechanical and environmental performance of microduct fibre unit 11
Table 3 – Tests applicable for mechanical and environmental performance of microduct 15
Table 4 – Tests applicable for mechanical and environmental performance of protected microduct 18
Table B.1 – Microduct fibre unit description 22
Table B.2 – Microduct description 23
Table B.3 – Protected microduct description 24
Table C.1 – Typical microduct fibre unit construction 25
Table C.2 – Microduct construction 26
Table C.3 – Protected microduct construction 27
Table D.1 – Multimode maximum cable attenuation coefficient (dB/km) 28
Table D.2 – Single-mode maximum cable attenuation coefficient (dB/km) – Premises cabling applications 28
Table D.3 – Single-mode maximum cable attenuation coefficient (dB/km) – All other applications 29
Table D.4 – Minimum multimode fibre bandwidth (MHz×km) 29

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

OPTICAL FIBRE CABLES –

Part 5-20: Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60794-5-20 has been prepared by subcommittee 86A: Fibres and cables,of IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86A/1497/CDV	86A/1543/RVC

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

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 stability 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

OPTICAL FIBRE CABLES –

Part 5-20: Family specification – Outdoor microduct fibre units, microducts and protected microducts for installation by blowing

1 Scope

This part of IEC 60794 is a family specification that covers outdoor microduct fibre units and corresponding microducts and protected microducts for installation by blowing. The protected microducts are intended for duct, directly buried or lashed applications.

Microduct fibre units differ from microduct optical fibre cables (see IEC 60794-5-10) in that they provide less protection to the fibres that they contain. Specifically, microduct fibre units rely on the structure of the microduct, protected microduct or appropriate housing to support installation and to provide additional mechanical protection for the optical fibre over the lifetime of the product.

Systems built with components covered by this standard are subject to the requirements of sectional specification IEC 60794-5 where applicable.

Annex A gives examples of microduct optical fibre units and microducts.

Annex B describes a blank detail specification for outdoor microduct fibre units and the associated microducts and incorporates some minimum requirements. Detail product specifications may be prepared on the basis of this family specification using Annex B as a guide. Annex C provides normative product constructions for microduct optical fibre units, microducts and protected microducts.

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 should be interpreted with respect to this consideration.

The number of fibres tested is intended to be representative of the microduct fibre unit design and should be agreed between the customer and supplier.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

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

IEC 60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

IEC 60793-2-50, *Optical fibres – Part 2-50: Products specification – Sectional specification for class B single-mode fibres*

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

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

IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods*

IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specificaiton – Basic optical cable test procedures – Environmental test methods*

IEC 60794-3:2001, *Optical fibre cables – Part 3: Sectional specification – Outdoor cables*

IEC 60794-5, *Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing*

IEC 60794-5-10, *Optical fibre cables – Part 5-10: Family specification – Outdoor microduct optical fibre cables, microducts and protected microducts for installation by blowing*

IEC 60811-202, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 202: General tests – Measurement of thickness of non-metallic sheath*

IEC 60811-203, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 203: General tests – Measurement of overall dimensions*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC 60811-601, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 601: Physical tests – Measurement of the drop-point of filling compounds*

IEC 60811-602, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 602: Physical tests – Separation of oil in filling compounds*

IEC 60811-604, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 604: Physical tests – Measurement of absence of corrosive components in filling compounds*

ISO/IEC 11801, *Information technology − Generic cabling for customers premises*

3 Symbols

For the purposes of this part of IEC 60794 the following symbols apply.

λ_{CC}	Cabled fibre cut-off wavelength
ΔD	minimum wall thickness
$\Delta D'$	Minimum thickness of the outer sheath of the protected microduct
d	Nominal outer diameter of the fibre unit
DS	Detail specification
ID	Nominal inner diameter of the microduct

OD Nominal outer diameter of the microduct

OD' Nominal outer diameter of the protected microduct

T_M The acceptable amount of short-term tensile load that can be applied to the fibre unit without permanent degradation of the characteristics of the fibres in the tensile performance test

T_{A1} Temperature cycling test low-temperature limit (usage and storage) according to IEC 60794-1-2, Method F1

T_{A2} Temperature cycling test secondary low-temperature limit for extended storage temperature range according to IEC 60794-1-2, Method F1

T_{B1} Temperature cycling test high-temperature limit (usage and storage) according to IEC 60794-1-2, Method F1

T_{B2} Temperature cycling test secondary high-temperature limit for extended storage temperature range according to IEC 60794-1-2, Method F1

t_1 Temperature cycling dwell time

$n \times d$ The product of a variable and the fibre unit outer diameter used for determining appropriate sizes for bends, mandrels, etc.

$n \times OD$ The product of a variable and the outer diameter of the microduct used for determining appropriate sizes for bends, mandrels, etc.

n $\times$ *OD*' The product of a variable and the outer diameter of the protected microduct used for determining appropriate sizes for bends, mandrels, etc.

W Weight of 1 km of microduct, protected microduct or fibre unit

4 General requirements

4.1 Construction

4.1.1 General

In addition to the constructional requirements in IEC 60794-5, where applicable, the following considerations apply to outdoor microduct fibre units and their corresponding microducts and protected microducts.

The products covered in this specification should be designed and manufactured for expected operating lifetimes of at least 20 years.

The microduct fibre units are designed to be installed in microducts or protected microducts and in appropriate housings. The microducts and protected microducts that are compatible for use with microduct fibre units are defined in this document. Microduct fibre units are optimised for installation and operating lifetime in these microducts.

It shall be possible to install or remove the microduct fibre unit from microduct or protected microduct by blowing during the operational lifetime except under the following conditions:

a) microduct fibre units or microducts are compromised by multiple installation or removal operations;

b) microducts are fouled with sediment, debris, or other foreign matter due to inadequate maintenance;

c) microducts are damaged by extrinsic factors such as dig-ups, earth heaves, etc.

In such cases, the affected section of microduct shall be cleared, repaired or replaced prior to any microduct fibre unit installations.

The microduct fitness should be verified with dimensional clearance and static pressure testing of the microduct route.

The materials in the microduct fibre unit, microduct or protected microduct shall take into consideration local regulations.

4.1.2 Microduct fibre units

In general, microduct fibre units are the smallest and most flexible of all optical cable products for outdoor use and are intended for installation within microducts. The fibre unit structure is designed to improve blowing performance compared to a bare fibre and to provide mechanical and environmental protection for the fibres during installation and over the life of the product. Fibre unit designs are not described in detail but some examples are given in Annex A. The microduct fibre units are not as mechanically robust as traditional outdoor optical fibre cables and, therefore, require the use of suitable installation and handling practices to prevent damage. Ad hoc installation practices could degrade optical performance or reduce the product's operating lifetime.

4.1.3 Microducts

A microduct suitable for installation of microduct fibre units is a small, flexible, lightweight tube with an outer diameter typically 8 mm or less. Compared to microduct optical fibre cables (see IEC 60794-5-10), microduct fibre units place greater reliance on microducts and protected microducts or appropriate closures to provide mechanical protection for the optical fibres. Therefore, a microduct must meet the realistic impact, compression and bending requirements for an application. A protected microduct may be required (see 4.1.4).

Microducts shall be able to resist pressure differences needed for installation by blowing. The microducts shall be circular and uniform in cross-section throughout their length, and their inner surface may have a low coefficient of friction. Inner- and outer-diameters shall be specified. As an option, a supplier may provide a special lining or lubricating coating on the interior of the microduct to aid installation. These layers should not reduce the specified inside diameter of the microduct.

Microducts generally are intended for benign installation within ducts or as components within a protected microduct as described in 4.1.4. In all cases, it shall be possible to identify each individual microduct throughout the length. When using colours they shall be a reasonable match to IEC 60304.

Microducts installed outdoors and not occupied shall be sealed at each end to prevent the introduction of moisture, debris, insects, or other such foreign contaminants that could subsequently hinder the successful installation of fibre unit. Microducts installed outdoors and not immediately occupied shall be tested for obstructions prior to use.

4.1.4 Protected microducts

A protected microduct is one or more microducts surrounded by a protective sheath, a larger protective duct and/or an integral thick sheath (such that it complies with the requirements of Clause 7). A protected microduct can provide additional crush and impact protection compared to a stand-alone microduct. This additional protection may be needed for a specific operating environment or installation method. The protective sheath may include an integrated layer of armouring or thicker outer sheath. In all cases it shall be possible to identify each individual microduct throughout the length. When using colours, they shall be a match to IEC 60304 using visual inspection.

4.1.5 Microduct fittings

Microduct fittings are components needed to physically align, connect and seal the junction between two of more sections of microduct, or to connect microduct to hardware, or to seal the space between a microduct fibre unit and microduct. Multiple microducts may be connected in series in order to support extended microduct fibre unit installation distances, or connected in a branch-type configuration with multiple output terminae for a given input, within the same system. The latter may be employed in campus type local area networks

(LANs) or fibre-to-the-premises (FTTP) applications to allow for additional flexibility that can support frequent changes to the physical optical distribution system.

Fittings should be appropriate to the microduct construction. Also, mechanical and environmental performance requirements of fittings may require that such be tested while attached to sections of ducting (or hardware) to ensure intermateability and operational compatibility. The specific physical and material attributes of any fittings used should be agreed between the customer and supplier.

Microduct fittings shall be able to resist pressure differences needed for installing microduct fibre units by blowing. When attached to microducts the fittings must pass the pressurization test of 6.10. Fittings shall allow for the smooth transition of microduct fibre units between successive sections of microduct, or between microducts and hardware, and shall be constructed and installed to prevent jamming of the microduct fibre unit at splice, branch, or other connection points under maximum installation pressures.

Successive sections of microduct may also be welded or otherwise secured together along the same longitudinal axis without the use of mechanical fittings. Such junctions shall meet the same mechanical and dimensional requirements as for joints made using mechanical fittings.

Translucent or transparent materials may be used to support the identification of populated microducts and for troubleshooting installation related issues.

4.1.6 Microduct hardware

Microduct hardware includes the housings and closures that support the termination of microduct fibre units, including splicing or connectorization. Because microduct fibre units are generally compatible with traditional outdoor fibre optic cable hardware, accounting for the relatively small size, no specific requirements for microduct hardware are included herein. In some applications, it may be appropriate to use hardware that is compatible with the microducts in order to create a sealed microduct cabling system. One example is when empty microducts are pre-installed in hardware to support future microduct fibre unit placement.

4.2 Optical fibres

There shall be no fibre splice in a delivered length, unless otherwise agreed by the customer and supplier.

It shall be possible to identify each individual fibre throughout the length of the microduct fibre unit.

The transmission performance shall be in accordance with Annex D.

4.3 Installation performance tests

4.3.1 Installation conditions

A test route may be used to verify the field performance of a microduct fibre unit , microduct, and/or protected microduct as agreed between the customer and supplier. Ambient conditions can affect installation performance and, therefore should be monitored. Alternatively, the supplier can provide performance data from a specified test route under specific ambient conditions using a specified installation method.

Verifying that a microduct fibre unit or microduct can be installed using a blown installation technique is critical. Any installation performance requirement shall be agreed upon between the customer and supplier.

4.3.2 Tests applicable

Tests that are applicable for installation performance are given in Table 1.

Table 1 – Tests applicable for installation performance

Characteristics	Family requirements	Test methods	Remarks
General requirements	Agreement between customer and supplier		
Route verification inner clearance test	Agreement between customer and supplier	IEC 60794-1-21 Method E23	
Installation test	Agreement between customer and supplier; typically a minimum distance and time of installation over a specified route is required	Agreement between customer and supplier; typically, duct type and size, route terrain, installation device, maximum air pressure and ambient air conditions should be specified or noted with the results	

4.3.3 Mechanical and environmental tests

Based on the expected operating conditions over the life of the product, including the mechanical loads exerted on the product during installation, the following clauses specify product performance for microduct fibre units, microducts and protected microducts.

5 Microduct fibre unit

5.1 Tests applicable

Tests that are applicable for mechanical and environmental performance are given in Table 2.

Table 2 – Tests applicable for mechanical and environmental performance of microduct fibre unit

Characteristics	Family requirements	Test methods	Remarks
Tensile performance[a]	5.3	IEC 60794-1-21 Method E1	
Crush	5.4	IEC 60794-1-21 Method E3	
Repeated bending[a]	5.5	IEC 60794-1-21 Method E6	
Torsion[a]	5.6	IEC 60794-1-2 Method E7	
Kink	5.7	IEC 60794-1-21 Method E10	
Bend	5.8	IEC 60794-1-21 Method E11	
Temperature cycling	5.9	IEC 60794-1-22 Method F1	
Ageing	5.10	IEC 60794-1-22 Method F9	
Water immersion test	5.11	IEC 60793-1-53	
Buffer removal	5.12	As agreed with customer	
Water penetration test	No requirement		Suitable means are used in the microduct cabling system for water blocking
[a] For small units (eg < 2 mm outer diameter; <100 N tensile rating), it may be more appropriate to omit some of these tests in favour of an installation test.			

The above tests may need to be modified for use with these cables. In particular, special care needs to be taken when clamping cables in order to avoid end effects. Unacceptable damage may include rips, tears, splits, delamination or cracks in the microduct fibre unit. However, damage at the clamping interface does not constitute a failure.

5.2 Family requirements and test conditions for microduct fibre unit tests

Tests shall be selected from the following by the product specification.

5.3 Tensile performance

a) Family requirements

Under short-term tensile load the fibre strain shall not exceed 60 % of the fibre proof strain. Other criteria may be agreed between the customer and supplier.

b) Test conditions (loads ≥ 100 N)

Method:	Generally to IEC 60794-1-21 Method E1, with duration as stated below
Length under tension:	Not less than 10 m. Taking into account the measurement accuracy and end effects, shorter lengths may be used by agreement between the customer and supplier.
Fibre length:	Finished microduct fibre unit length.
Tensile load:	Equivalent to weight of 1 km of fibre unit
Duration of load	1 min
Diameter of test pulleys:	As agreed between customer and supplier but not less than the minimum loaded bending diameter specified for the microduct fibre unit. A minimum value of 60 mm is recommended.

Under visual examination without magnification there shall be no damage to the microduct fibre unit and there shall be no change in attenuation after the test.

c) Test conditions (loads < 100 N)

Apparatus:	Vertical tensometer
Length under tension:	Approx 250 mm.
Fibre length:	Finished microduct fibre unit length.
Tensile load:	Equivalent to weight of 1 km of fibre unit
Duration of load	1 min

Under visual examination without magnification there shall be no damage to the microduct fibre unit.

5.4 Crush

a) Family requirements

After removal of the load, there shall be no change in attenuation compared to before the application of the load. Under visual examination, there shall be no damage to the microduct fibre unit . The imprint of the plate on the microduct fibre unit is not considered mechanical damage.

b) Test conditions

Method:	IEC 60794-1-21 Method E3
Load (plate/plate):	100 N
Duration of load:	1 min

5.5 Repeated bending

a) Family requirements

Under visual examination without magnification there shall be no damage to the microduct fibre unit elements.

b) Test conditions

Method:	IEC 60794-1-21 Method E6
Bending diameter:	40 × d or 60 mm whichever is greater.
Load:	Adequate to assure uniform contact with the mandrel.
Number of cycles:	25

5.6 Torsion

a) Family requirements

Under visual examination without magnification there shall be no damage to the microduct fibre unit elements.

There shall be no change in attenuation after the test.

b) Test conditions

Method	Generally in accordance with IEC 60794-1-21 Method E7
Test length:	300 mm
Load:	Adequate to assure test sample is straight at start of test.

5.7 Kink

a) Family requirements

Under visual examination, there shall be no damage to the microduct fibre unit

b) Test conditions

Method:	IEC 60794-1-21 Method E10
Minimum diameter:	40 × d or 60 mm whichever is greater

5.8 Bend

a) Family requirements

There shall be no change in attenuation after the test when measured at room temperature.

b) Test conditions

Method:	IEC 60794-1-21 Method E11A
Diameter of mandrel:	40 × d or 60 mm whichever is greater
Number of turns/helix:	4
Number of cycles:	3

5.9 Temperature cycling

a) Family requirements

For T_{A1} to T_{B1} there shall be no change in attenuation as defined in IEC 60794-1-1.

For T_{A1} to T_{A2} and T_{B1} to T_{B2}, the change in attenuation coefficient shall be:

– ≤ 0,15 dB/km for single-mode fibre and shall be reversible to measurement uncertainty when measured in the 1 550 nm region;

– ≤ 0,3 dB/km for multimode fibre and shall be reversible to measurement uncertainty when measured in the 1 300 nm region.

b) Test conditions

Method:	IEC 60794-1-22 Method F1.
Sample length under test:	Finished microduct fibre unit length of at least 1 000 m.
High temperature, T_{B2}:	+60 °C to +70 °C, depending on customer requirements.
High temperature, T_{B1}:	+30 °C to +60 °C depending on customer requirements.
Low temperature, T_{A1}:	–15 °C.
Low temperature, T_{A2}:	T_{A1} to –30 °C or –40 °C depending on customer requirements
Note (temperatures):	Other temperature values corresponding to specific climate conditions can be agreed between supplier and customer.
Number of cycles:	2

5.10 Ageing

a) Family requirements: as per IEC 60794-1-22, Method F9

b) Test conditions:

Method:	IEC 60794-1-22, Method F9

5.11 Water immersion

a) Family requirements

Attenuation coefficient change at room temperature:

– ≤ 0,05 dB/km at 1 550 nm for single-mode fibre;

– ≤ 0,2 dB/km at 850 nm and 1 300 nm for multimode fibre.

The attenuation shall be monitored throughout the test at least once every 24 h.

b) Test conditions

Method:	IEC 60793-1-53
Water:	Distilled, demineralized or de-ionized water which has a PH of between 5,0 and 8,0
Dwell time:	30 days

5.12 Buffer removal

a) Family requirements

The buffer materials shall be removable such that primary coated fibres or fibre ribbons shall be free from fibre unit sheathing and/or buffer materials and free from damage following the test.

b) Test conditions

The method for buffer removal shall be defined by the supplier.

6 Microduct

6.1 Tests applicable

Tests shall be selected from the following Table 3, in accordance with the relevant product specification. If the microduct is only to be used in a protected microduct, some tests may not be relevant.

Table 3 – Tests applicable for mechanical and environmental performance of microduct

Characteristics	Family requirements	Test methods	Remarks
Tensile performance	6.2	Under consideration, IEC 60794-1-21 Method E1	
Crush	6.3	IEC 60794-1-21 Method E3A	
Impact	6.4	Under consideration, IEC 60794-1-21 Method E4	
Repeated bending	6.5	IEC 60794-1-21 Method E6	
Torsion	6.6	IEC 60794-1-21 Method E7	
Kink	6.7	IEC 60794-1-21 Method E10	
Bend	6.8	IEC 60794-1-21 Method E11B	
Microduct route verification test	6.9	IEC 60794-1-21 Method E23	
Microduct pressure withstand	6.10	IEC 60794-1-22 Method F13	
Ageing	6.11	Under consideration	

The above tests may need to be modified for use with microducts. In particular, special care needs to be taken when clamping in order to avoid end effects. Unacceptable damage may include rips, tears, splits or cracks in the microduct. However, damage at the clamping interface does not constitute a failure.

6.2 Tensile performance

a) Family requirements

Under visual examination, without magnification, there shall be no damage after the test and shall pass the inner clearance test (Annex E).

b) Test conditions

Method:	Generally to IEC 60794-1-21, Method E1 (note: use of IEC 60811-501 is under consideration)
Microduct length under tension:	>1 m
Tensile load on microduct:	1 W
Duration of load:	10 min

6.3 Crush

a) Family requirements

Under visual examination, without magnification, the microduct shall show no damage. After the recovery time the microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage. The imprint of the plate is not considered as mechanical damage.

b) Test conditions

Method:	IEC 60794-1-21, Method E3A
Load (plate/plate):	500 N
Duration time:	1 min

Recovery time	1h

6.4 Impact

a) Family requirements

Under visual examination without magnification there shall be no damage to the microducts. The microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage. The imprint of the striking surface on the microduct is not considered mechanical damage.

b) Test conditions

Method:	IEC 60794-1-21 Method E4
Striking surface radius:	300 mm
Impact energy:	1 J
Recovery time:	1 h
Number of impacts:	One in 3 different places spread not less than 500 mm apart

6.5 Repeated bending

a) Family requirements

Under visual examination without magnification there shall be no damage to the microducts. The microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage.

b) Test conditions

Method:	IEC 60794-1-21 Method E6
Bending diameter:	40 × OD
Load:	Adequate to assure uniform contact with the mandrel
Number of cycles:	25

6.6 Torsion

a) Family requirements

Under consideration

b) Test conditions

Method:	IEC 60794-1-21 Method E7
Maximum gauge length:	2 m

6.7 Kink

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the microducts after the test and shall pass the inner clearance test (Annex E).

The microduct shall attain the required minimum diameter without kinking.

b) Test conditions

Method:	IEC 60794-1-21 Method E10
Minimum diameter:	20 × OD

6.8 Bend

a) Family requirements

The outer and inner diameter of the microducts shall show, under visual examination without magnification, no damage and after the test and shall pass the inner clearance test (Annex E).

b) Test conditions

Method:	IEC 60794-1-21 Method E11B

Diameter of mandrel: 40 × OD

Number of cycles: 3

6.9 Microduct route verification test

a) Family requirements

Objects of the required size, including any blowing tip if used in practice, can be passed through the microduct.

b) Test conditions

Method: IEC 60794-1-21 Method E23

6.10 Microduct pressure withstand

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the microducts.

b) Test conditions

Method: IEC 60794-1-22 Method F13

All microducts shall resist an air pressure of at least 2,5 × the installation pressure at a temperature of 20 °C for a period of 0,5 h.

All microducts shall resist a proof test pressure of at least 1,3 × the installation pressure at a temperature of 40 °C for a period of 24 h.

6.11 Ageing

a) Family requirements

Under consideration

Tests to be performed after the aging period should be agreed between the customer and supplier and could include dimensions, inner clearance test, shrinkage, changes to surface finish, pressurization or installation test of the microduct fibre unit.

b) Test conditions

Method: Under consideration

Aging condition: Under consideration (+60 °C for 3 months;
7 days at 70 °C; 7 days at 85 °C)

7 Protected microducts

7.1 Tests applicable

Tests shall be selected from the following Table 4, in accordance with the relevant product specification.

Table 4 – Tests applicable for mechanical and environmental performance of protected microduct

Characteristics	Family requirements	Test methods	Remarks
Tensile performance	7.2	Under consideration, IEC 60794-1-21 Method E1	
Crush	7.3	IEC 60794-1-21 Method E3A	
Impact	7.4	IEC 60794-1-21 Method E4	
Repeated bending	7.5	IEC 60794-1-21 Method E6	
Torsion	7.6	IEC 60794-1-21 Method E7	
Kink	7.7	IEC 60794-1-21 Method E10	
Bend	7.8	IEC 60794-1-21 Method E11B	
Microduct route verification test	7.9	IEC 60794-1-21 Method E23	
Microduct pressure withstand	7.10	IEC 60794-1-22 Method F13	
Ageing	7.11	Under consideration	

7.2 Tensile performance

a) Family requirements

Under visual examination, without magnification, there shall be no damage after the test and shall pass the inner clearance test (Annex E).

b) Test conditions

Method: Generally to IEC 60794-1-21 Method E1 (note: use of IEC 60811-501 is under consideration)

Microduct length under tension: >1 m

Tensile load on microduct: 1 W or 2 700 N, whichever is the smaller

Duration of load: 10 min

7.3 Crush

a) Family requirements

Under visual examination, without magnification, the microduct shall show no damage. After the recovery time the microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage. The imprint of the plate is not considered as mechanical damage.

b) Test conditions

Method: IEC 60794-1-21 Method E3A

Sample length: 250 mm

Load: 1 kN (duct); 2 kN (buried)

Duration time: 1 min

Recovery time: 1 h

7.4 Impact

a) Family requirements

Under visual examination without magnification there shall be no damage to the microducts. The microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage. The imprint of the striking surface on the microduct is not considered mechanical damage.

b) Test conditions

Method:	IEC 60794-1-21 Method E4
Striking surface radius:	300 mm
Impact energy:	3 J (duct); 15 J (buried)
Recovery time:	1 h
Number of impacts:	One in 3 different places spread not less than 500 mm apart

7.5 Repeated bending

a) Family requirements

Under visual examination without magnification there shall be no damage to the microducts. The microduct shall pass the inner clearance test (Annex E) and there shall be no splitting or permanent damage.

b) Test conditions

Method:	IEC 60794-1-21 Method E6
Bending diameter:	40 × OD
Load:	Adequate to assure uniform contact with the mandrel
Number of cycles:	25

7.6 Kink

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the microducts after the test and shall pass the inner clearance test (Annex E).

The microduct shall attain the required minimum diameter without kinking.

b) Test conditions

Method:	IEC 60794-1-21 Method E10
Minimum diameter:	20 × OD

7.7 Bend

a) Family requirements

The outer and inner diameter of the microducts shall show, under visual examination without magnification, no damage and after the test and shall pass the inner clearance test (Annex E).

b) Test conditions

Method:	IEC 60794-1-21 Method E11B
Diameter of mandrel:	40 × OD
Number of cycles:	3

7.8 Microduct route verification test

a) Family requirements

Objects of the required size, including any blowing tip if used in practice, can be passed through the microduct.

b) Test conditions

Method: IEC 60794-1-21 Method E23

7.9 Microduct pressure withstand

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the microducts.

b) Test conditions

Method: IEC 60794-1-22 Method F13

All microducts shall resist an air pressure of at least 2,5 × the installation pressure at a temperature of 20 °C for a period of 0,5 h.

All microducts shall resist a proof test pressure of at least 1,3 × the installation pressure at a temperature of 40 °C for a period of 24 h.

7.10 Ageing

a) Family requirements

Under consideration

Tests to be performed after the aging period should be agreed between the customer and supplier and could include dimensions, inner clearance test, shrinkage, changes to surface finish, pressurization or installation test of the microduct fibre unit.

b) Test conditions

Method: Under consideration

Aging condition: Under consideration (+60 °C for 3 months; 7 days at 70 °C; 7 days at 85 °C)

Annex A
(informative)

Examples of microduct fibre units, microducts, and protected microducts

Figure A.1 and Figure A.2 give useful examples of microduct fibre units, microducts, and protected microducts.

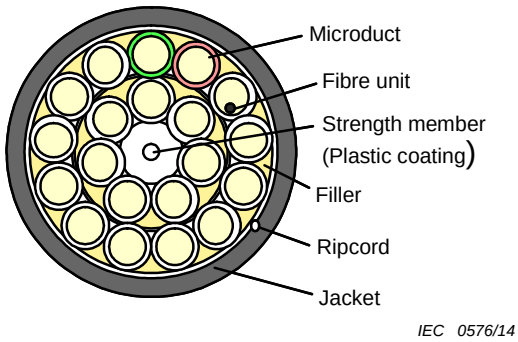

Figure A.1 – Protected microducts, tight package

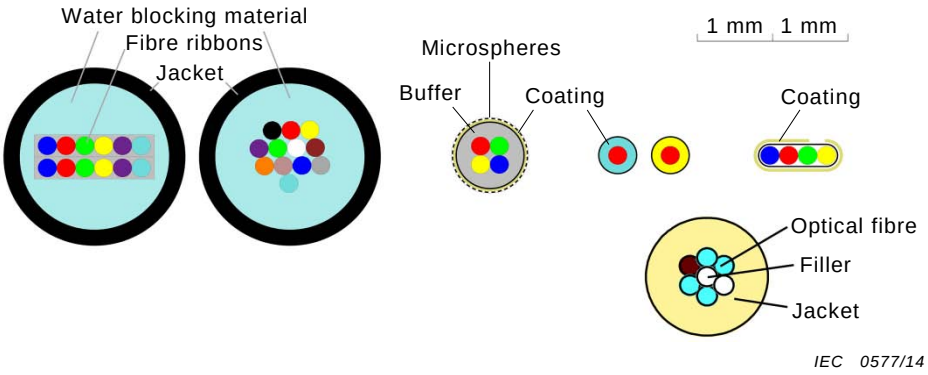

Figure A.2 – Microduct fibre units

Annex B
(informative)

Product descriptions (blank detail specification and minimum requirements)

Tables B.1, B.2, B.3 give templates for the description of microducts fibre unit, microducts and protected microducts.

Table B.1 – Microduct fibre unit description

(1) Prepared by			(2) Document No: Issue: Date:
(3) Available from:	(4)	Generic specifications:	IEC 60794-1-1 and IEC 60794-1-2
		Sectional specification:	IEC 60794-5
		Family specification:	IEC 60794-5-20
(5) Additional references:			
(6) Fibre unit description			
(7) Fibre unit construction			
Optical fibre type (s) Range of fibre count Fibre unit type Ribbons (if used) Fibre count Dimensions Outer material Marking identification (optional) – customer requirement – Identification of supplier			Additional remarks
(8) Application information:			
Maximum outer diameter (d)			mm
Rated maximum tensile load, T_M			N
Minimum bending radius for no-load bending			mm or n × d
Temperature range:			
– Transport and storage			ºC
– Installation			ºC
Operation			ºC
Manufacturing length			
– Typical			m
– Nominal/tolerances			$^{0}_{+1}$ %

Table B.2 – Microduct description

(1) Prepared by		(2) Document No: Issue: Date:
(3) Available from:	(4) Generic specifications: IEC 60794-1-1 and IEC 60794-1-2 Sectional specification: IEC 60794-5 Family specification: IEC 60794-5-20	
(5) Additional references:		
(6) Microduct description		
(7) Microduct construction		Additional remarks
Microduct material Liner (optional) – Low friction liner, type Marking identification – customer requirement – Identification of supplier		
(8) Application information:		
Maximum outer diameter (OD)		mm
Minimum inner diameter (ID)		mm
Note: one or the other of these may be selected		
Minimum wall thickness (ΔD)		mm
Rated maximum tensile load, T_M		N
Minimum bending radius for no-load bending		mm or n × OD
Maximum operating air pressure		Pa
Temperature range:		
– Transport and storage		ºC
– Installation		ºC
– Operation		ºC

Table B.3 – Protected microduct description

(1) Prepared by		(2) Document No: Issue: Date:
(3) Available from:	(4) Generic specifications: IEC 60794-1-1 and IEC 60794-1-2 Sectional specification: IEC 60794-5 Family specification: IEC 60794-5-20	
(5) Additional references:		
(6) Protected microduct description		
(7) Protected microduct construction		Additional remarks
Microduct – Material – Range of microduct count (e.g. 1 or more) – Liner (type/material) Sheath, material Additional armouring (optional) – Non-metallic armouring – Metallic armouring – Moisture barrier Additional outer sheath (optional) Marking identification – customer requirement – Identification of supplier		
(8) Application information:		
Microduct(s) [a]		
– Maximum outer diameter (OD)		mm
Minimum inner diameter (ID)		mm
Note: one or the other of these may be selected		
– Minimum thickness (ΔD)		mm
– Rated maximum tensile load, T_M		N
– Minimum bending radius for no-load bending		mm or n × OD
– Minimum bending radius for rated-load bending		mm or n × OD
Protected microduct [b]		
– Maximum outer diameter (OD')		mm
– Minimum sheath thickness (ΔD')		mm
– Rated maximum tensile load, T_M		N
– Minimum bending radius for no-load bending		mm or n × OD'
– Minimum bending radius for rated-load bending		mm or n × OD'
Maximum operating air pressure, microduct		bar/Pa
Temperature range:		
– Transport and storage		ºC
– Installation		ºC
– Operation		ºC

[a] In general, protected microducts contain microducts.

[b] Not applicable to microducts installed loosely into pre-installed ducts.

Annex C
(normative)

Product constructions

Tables C.1, C.2, C.3 give templates for the product construction of microducts fibre unit, microducts and protected microducts.

Table C.1 – Typical microduct fibre unit construction

Characteristics	Family requirements	Test methods	Remarks
Microduct fibre unit core:			
Filling compound (if used)	According to detail specification	Either IEC 60794-1-21 Method E14 or IEC 60811-601 IEC 60811-602 IEC 60811-604	
Dry blocking compound (if used)	According to detail specification	Under consideration	
Ribbons, dimensions (if used)	According to detail specification		
Strength member	According to detail specification	Visual inspection	
Filler	According to detail specification	Visual inspection	
Ripcord	According to detail specification	Visual inspection	
Outer sheath			
Material	According to detail specification		
Outside diameter	According to detail specification	IEC 60811-203	
Minimum thickness	According to detail specification	IEC 60811-202	
Optional protection			
Armouring, metallic	7.6.3 of IEC 60794-3:2001		
Moisture barrier	According to detail specification		
Microduct fibre unit marking			
Configuration, dimensions	According to detail specification	Visual inspection	
Microduct fibre unit length	According to detail specification	Under consideration	

Table C.2 – Microduct construction

Characteristics	Family requirements	Test methods	Remarks
Material	According to detail specification		
Outer diameter	According to detail specification	IEC 60811-203	
Minimum inner diameter	According to detail specification	IEC 60811-203	This method may be adapted to measure inner diameter
Minimum wall thickness	According to detail specification	IEC 60811-202	
Microduct liner: Type Material	 According to detail specification According to detail specification	 Under consideration Under consideration	
Marking Configuration, dimensions	 According to detail specification	 Visual inspection	
Microduct length		Under consideration	

Table C.3 – Protected microduct construction

Characteristics	Family requirements	Test methods	Remarks
Protected microduct core:			
Microduct size(s) [OD/ID]	According to detail specification		
Microduct count (each size)	According to detail specification	Under consideration	
Microduct liner, type	According to detail specification		
Microduct liner, material	According to detail specification	Under consideration	
Lay-up	According to detail specification	Visual inspection	
Strength member (optional)	According to detail specification	Visual inspection	
Sheath			
Material	7.6.3 of IEC 60794-3:2001		
– Outer diameter [OD']	Acc. DS	IEC 60811-203	
– Minimum thickness	Acc. DS	IEC 60811-202	
Optional protection	According to detail specification		
Additional sheath			
Moisture barrier	According to detail specification		
Metallic tapes	7.6.5 of IEC 60794-3:2001		
Non-metallic tapes			
Sheath marking			
Configuration, dimensions	According to detail specification	Visual inspection	
Abrasion resistance	According to detail specification	IEC 60794-1-21 Method E2B	Steel needle diameter d = 1,0 mm load: 4 N, 30 cycles
Protected microduct length		Under consideration	

Annex D
(normative)

Transmission requirements

D.1 Attenuation of cabled fibre

Depending on the fibre category, the attenuation coefficient of the cabled fibre shall be less than the maximum values in Table D.1 for the multimode fibres and less than the maximum values in Table D.2 for single-mode fibres – for the wavelengths as stated in the tables. These values are relevant for premises cabling covered in certain specifications in the IEC 60794 series and in ISO/IEC 11801, as appropriate. Maximum values for the other specifications in the IEC 60794 series are given in Table D.3.

The fibre category shall be agreed between customer and supplier.

Table D.1 – Multimode maximum cable attenuation coefficient (dB/km)

Fibre category	Attenuation coefficient at 850 nm	Attenuation coefficient at 1 300 nm	Performance code
IEC 60793-2-10, A1a.1	3,5	1,5	OM1, OM2
IEC 60793-2-10, A1a.2	3,5	1,5	OM1, OM2, OM3
IEC 60793-2-10, A1a.3	3,5	1,5	OM1, OM2, OM3, OM4
IEC 60793-2-10, A1b	3,5	1,5	OM1, OM2

Table D.2 – Single-mode maximum cable attenuation coefficient (dB/km) – Premises cabling applications

Fibre category	Wavelengths nm	Maximum attenuation coefficient	Performance code
IEC 60793-2-50, B1.1, B1.3, B6_a1 or B6_a2	1 310, 1 550	1,0	OS1
IEC 60793-2-50, B1.3, B6_a1 or B6_a2	1 310, 1 383, 1 550	0,4	OS2

Table D.3 – Single-mode maximum cable attenuation coefficient (dB/km) – All other applications

Fibre category	Maximum attenuation coefficient (dB/km) at wavelengths (nm)			
	1 310 nm	1 383 nm	1 550 nm	1 625 nm
IEC 60793-2-50, B1.1 (dispersion unshifted)	0,40	N/A	0,35	0,40[b]
IEC 60793-2-50, B1.2 (cut-off shifted)	N/A[a]	N/A	0,30	0,40[b]
IEC 60793-2-50, B1.3 (extended band)	0,40	0,40	0,30	0,40[b]
IEC 60793-2-50, B2 (dispersion shifted)	N/A	N/A	0,35	0,40[b]
IEC 60793-2-50, B4 (non-zero dispersion shifted)	N/A	N/A	0,35	0,40[b]
IEC 60793-2-50, B5 (wideband non-zero dispersion shifted)	N/A	N/A	0,35	0,40[b]
IEC 60793-2-50, B6_a1 or B6_a2 (bending loss insensitive)	0,40	0.40	0,30	0,40[b]

[a] N/A = not applicable.

[b] 1 625 nm performance is optional, depending on agreement between customer and supplier.

Values for IEC 60793-2-50 category B6_b2 and B6_b3 fibres are under consideration.

Test procedure:

Measurements shall be made in accordance with IEC 60793-1-40.

D.2 Fibre bandwidth requirements

There are no bandwidth requirements on single-mode fibre.

For cables containing multimode fibres, the uncabled fibre shall be specified at one of performance levels defined in Table D.4 in terms of minimum bandwidth (MHz×km), wavelength, and type of measurement.

The fibre category and performance level shall be agreed between customer and supplier.

Table D.4 – Minimum multimode fibre bandwidth (MHz×km)

Fibre category	Nominal core diameter µm	Overfilled bandwidth at 850 nm	Overfilled bandwidth at 1300 nm	Effective modal bandwidth at 850 nm	Performance code
IEC 60793-2-10, A1a.1	50	200	500	NA[a]	OM1
IEC 60793-2-10, A1a.1	50	500	500	NA	OM2
IEC 60793-2-10, A1a.2	50	1 500	500	2 000	OM3
IEC 60793-2-10, A1a.3	50	3 500	500	4 700	OM4
IEC 60793-2-10, A1b	62,5	200	500	na	OM1
IEC 60793-2-10, A1b	62,5	500	500	na	OM2

[a] N/A = not applicable.

Annex E
(normative)

IEC 60794-1-21 Method Exx – Microduct inner clearance test

E.1 Object

The purpose of this test is to confirm the maintenance of the inner bore of a microduct, following the manufacture, or the mechanical or environmental testing, of a short length (typically 2 m maximum) of microduct or protected microduct assembly.

E.2 General

An inner clearance test consists of passing a test object, such as a sphere, or a short length (e.g. 100 mm) of the actual microduct optical fibre cable or fibre unit to be installed, through the section of microduct or microduct assembly after manufacture, or that has been subjected to a mechanical or environmental test (for example, following a crush test). A successful test indicates that the microduct has not been significantly damaged by the manufacturing process or the test applied. For practical considerations, the test object shall be no less than 85 % of the nominal microduct bore diameter, unless otherwise agreed between the supplier and the customer.

For testing longer sections of microduct or protected microduct, the test given in IEC 60794-1-21 Method E23 may be more appropriate.

E.3 Sample

The sample is a short (typically 2 m maximum) section of microduct or protected microduct assembly.

E.4 Test equipment

A test object, such as a sphere or a short length (e.g. 100 mm) of the actual cable or fibre unit to be installed, with a diameter that is no less than 85 % of the nominal microduct bore diameter, and a safe method to catch the sphere or other object at the far end of the microduct.

E.5 Procedure

Install the catcher at the far end of the microduct, place the object into the microduct, and allow it to travel through to the far end. The most practical method to do this is by tilting the sample from horizontal to vertical.

E.6 Requirements

The object shall pass through the microduct. This confirms that the permanent deformation of the individual microduct is less than or equal to 15 % of its nominal diameter, which is considered as not significant damage.

E.7 Details to be recorded

– object dimensions;
– object material;
– microduct information (ID, OD);
– sample length.

NOTE This test method will be considered for inclusion in IEC 60794-1-21.

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch