

## FINAL VERSION

## VERSION FINALE



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

**Câbles à fibres optiques –  
Partie 1-21: Spécification générique – Procédures fondamentales d'essais  
des câbles optiques – Méthodes d'essai mécanique**

## CONTENTS

FOREWORD .....	9
INTRODUCTION to Amendment .....	11
1 Scope and object .....	12
2 Normative references .....	12
3 Method E1: Tensile performance .....	13
3.1 Object .....	13
3.2 Sample length .....	13
3.3 Apparatus .....	13
3.4 Procedure .....	13
3.4.1 General requirements .....	13
3.4.2 Procedure .....	14
3.5 Requirements .....	14
3.6 Details to be specified .....	14
3.7 Details to be reported .....	15
4 Method E2: Abrasion .....	16
4.1 Object .....	16
4.2 Sample .....	16
4.3 Method E2A: Abrasion resistance of optical fibre cable sheaths .....	16
4.3.1 Apparatus .....	16
4.3.2 Procedure .....	17
4.3.3 Requirements .....	17
4.3.4 Details to be specified .....	17
4.4 Method E2B: Abrasion resistance of optical fibre cable markings .....	17
4.4.1 Apparatus .....	17
4.4.2 Procedure .....	18
4.4.3 Requirements .....	18
4.4.4 Details to be specified .....	18
5 Method E3: Crush .....	19
5.1 Object .....	19
5.2 Sample .....	19
5.3 Method E3A: Plate/plate .....	19
5.3.1 Apparatus .....	19
5.3.2 Procedure .....	19
5.4 Method E3B: Mandrel/plate .....	20
5.4.1 Apparatus .....	20
5.4.2 Procedure .....	20
5.5 Requirements .....	20
5.6 Details to be specified .....	20
6 Method E4: Impact .....	22
6.1 Object .....	22
6.2 Sample .....	22
6.2.1 Sample length .....	22
6.2.2 Termination .....	22
6.3 Apparatus .....	22
6.4 Procedure .....	23
6.5 Requirements .....	23

6.6	Details to be specified.....	23
9	Method E5C: Strippability of buffered optical fibres.....	25
9.1	Object.....	25
9.2	Sample .....	25
9.3	Apparatus .....	25
9.4	Procedure .....	25
9.5	Requirements .....	26
9.6	Details to be specified.....	26
10	Method E6: Repeated bending.....	26
10.1	Object.....	26
10.2	Sample .....	26
10.2.1	Sample length .....	26
10.2.2	Termination .....	26
10.3	Apparatus .....	26
10.4	Procedure .....	27
10.5	Requirements .....	27
10.6	Details to be specified.....	27
11	Method E7: Torsion .....	28
11.1	Object.....	28
11.2	Sample .....	28
11.3	Apparatus .....	28
11.4	Procedure .....	29
11.5	Requirements .....	30
11.6	Details to be specified.....	30
11.7	Details to be reported .....	30
12	Method E8: Flexing.....	32
12.1	Object.....	32
12.2	Sample .....	32
12.3	Apparatus .....	32
12.4	Procedure .....	32
12.5	Requirements .....	32
12.6	Details to be specified.....	32
13	Method E9: Snagging (deleted) .....	33
14	Method E10: Kinking .....	33
14.1	Object .....	33
14.2	Sample .....	33
14.3	Apparatus .....	33
14.4	Procedure .....	34
14.5	Requirements .....	34
14.6	Details to be specified.....	34
15	Method E11: Bend .....	35
15.1	Object.....	35
15.2	Sample .....	35
15.3	Apparatus .....	35
15.4	Procedure .....	35
15.4.1	Procedure 1 – Test method E11A (standard test procedure).....	35
15.4.2	Procedure 2 – Test method E11B (alternative test procedure) .....	35
15.5	Requirements .....	36

15.6	Details to be specified.....	36
16	Method E12: Cut-through resistance (deleted).....	37
17	Method E13: Shotgun damage.....	37
17.1	Object.....	37
17.2	General.....	37
17.3	Method E13A: Shotgun test.....	37
17.3.1	Sample.....	37
17.3.2	Apparatus.....	37
17.3.3	Procedure.....	37
17.3.4	Requirements.....	38
17.3.5	Details to be specified.....	38
17.4	Method E13B: Shotgun simulation.....	38
17.4.1	Sample.....	38
17.4.2	Apparatus.....	38
17.4.3	Procedure.....	39
17.4.4	Requirements.....	39
17.4.5	Details to be specified.....	39
17.4.6	Calculation of drop weight and height.....	39
20	Method E16: [Title unknown] (deleted).....	43
21	Method E17: Bending stiffness.....	43
21.1	Object.....	43
21.2	General.....	43
21.3	Method E17A: Three-point bend.....	43
21.3.1	Sample.....	43
21.3.2	Apparatus.....	43
21.3.3	Procedure.....	43
21.3.4	Requirements.....	44
21.3.5	Details to be specified.....	44
21.4	Method E17B: cantilever bend.....	44
21.4.1	Sample.....	44
21.4.2	Apparatus.....	44
21.4.3	Procedure.....	45
21.4.4	Requirements.....	45
21.4.5	Details to be specified.....	45
21.5	Method E17C: Buckling bend.....	45
21.5.1	Sample.....	45
21.5.2	Apparatus.....	45
21.5.3	Procedure.....	45
21.5.4	Requirements.....	46
21.5.5	Details to be specified.....	46
22	Method E18A: Bending under tension.....	47
22.1	Object.....	47
22.2	Sample.....	48
22.3	Apparatus.....	48
22.4	Procedure.....	48
22.5	Requirements.....	49
22.6	Details to be specified.....	49
23	Method E18B: Sheave test (primarily for OPGW and OPAC).....	51

23.1	Object	51
23.2	Sample	51
23.3	Apparatus	51
23.4	Procedure	51
23.5	Requirements	53
23.6	Details to be specified	53
24	Method E19: Aeolian vibration	54
24.1	Object	54
24.2	Sample	54
24.3	Apparatus	54
24.4	Procedure	55
24.5	Requirements	56
24.6	Details to be specified	56
25	Method E20: Cable coiling performance	57
25.1	Object	57
25.2	Sample	57
25.3	Apparatus	57
25.4	Procedure	57
25.5	Requirements	58
25.6	Details to be specified	58
26	Method E21: Sheath pull-off force for optical fibre cable for use in patch cords	58
26.1	Object	58
26.2	General	58
26.3	Sample	58
26.4	Apparatus	58
26.4.1	General	58
26.4.2	Tensile test rig	58
26.4.3	Recording equipment	59
26.4.4	Stripping tools	59
26.4.5	Pulling	59
26.4.6	Cable anchor	59
26.5	Procedure	59
26.6	Requirements	59
26.7	Details to be specified	59
27	Method E22: Buffered fibre movement under compression in optical fibre cables for use in patch cords	61
27.1	Object	61
27.2	Sample	61
27.3	Apparatus	61
27.4	Procedure	62
27.5	Requirements	62
27.6	Details to be specified	62
28	Method E23: Microduct route verification test	63
28.1	Object	63
28.2	General	63
28.3	Sample	63
28.4	Apparatus	63
28.5	Procedure	64

28.6	Requirements .....	64
28.7	Details to be reported .....	64
29	Method E24: Installation test for microduct cabling .....	64
29.1	Object .....	64
29.2	General .....	64
29.3	Sample .....	64
29.4	Apparatus .....	64
29.5	Procedure .....	65
29.6	Requirements .....	65
29.7	Details to be specified .....	65
29.8	Details to be reported .....	66
30	Method E25: Rip cord functional test .....	66
30.1	Object .....	66
30.2	Sample .....	67
30.3	Apparatus .....	67
30.4	Procedure .....	67
30.5	Requirements .....	67
30.6	Details to be specified .....	67
30.7	Details to be reported .....	68
31	Method E26: Galloping .....	68
31.1	Object .....	68
31.2	Sample .....	68
31.3	Apparatus .....	68
31.4	Procedure .....	69
31.5	Requirements .....	69
31.6	Details to be specified .....	69
32	Method E27: Indoor simulated installation test .....	70
32.1	Object .....	70
32.2	Sample .....	70
32.3	Apparatus .....	70
32.4	Procedure .....	72
32.5	Requirements .....	72
32.6	Details to be specified .....	73
33	Method E28: Cable and fibre mechanical reliability test .....	73
33.1	Object .....	73
33.2	Sample .....	73
33.3	Apparatus .....	73
33.4	Procedure .....	73
33.5	Requirements .....	74
33.6	Detail to be specified .....	74
34	Method E29: Straight midspan access to optical elements .....	74
34.1	Object .....	74
34.2	Apparatus .....	75
34.3	Sample .....	75
34.4	Procedure .....	75
34.4.1	General .....	75
34.4.2	Procedure 1 .....	75
34.4.3	Procedure 2 .....	77

34.4.4	Overview .....	77
34.5	Requirements .....	77
34.6	Details to be specified.....	77
35	Method E30: Coefficient of friction between cables.....	78
35.1	Object.....	78
35.2	Sample .....	78
35.3	Apparatus .....	78
35.4	Procedure .....	79
35.5	Requirement .....	80
35.6	Details to be specified.....	80
36	Method E31: Microduct inner clearance test: under consideration.....	80
37	Method E32: Creep behaviour tension test (for ADSS).....	80
37.1	Object.....	80
37.2	Sample .....	80
37.3	Apparatus .....	81
37.4	Procedure .....	81
37.4.1	General procedure requirements .....	81
37.4.2	Procedure steps .....	82
37.5	Calculations .....	83
37.6	Details to be specified.....	84
37.7	Details to be reported .....	84
37.8	Additional information .....	84
38	Method E33: Multiple cable coiling and uncoiling performance.....	85
38.1	Object.....	85
38.2	Sample .....	85
38.3	Apparatus .....	85
38.4	Procedure .....	85
38.5	Requirements .....	86
38.6	Details to be specified.....	86
39	Method E34: Coefficient of dynamic friction between cables.....	86
39.1	Object.....	86
39.2	Sample .....	86
39.3	Apparatus .....	87
39.4	Procedure .....	87
39.5	Details to be specified.....	87
	Bibliography.....	88
	Figure 1 – Tensile performance measuring apparatus.....	15
	Figure 2 – Example of tensile performance measuring apparatus using transfer devices and chuck drums .....	16
	Figure 3 – Typical test set-up for tests E2A and E2B method 1 .....	18
	Figure 4 – Typical test set-up for test E2B, apparatus 2.....	19
	Figure 5 – Apparatus for crush test, Method E3A, details of plate/plate option .....	21
	Figure 6 – Apparatus for crush test, Method E3B, details of plate/mandrel option .....	22
	Figure 7 – Impact test .....	25
	Figure 8 – Repeated bending test for cable/connector assembly.....	28
	Figure 9 – Cable torsion apparatus .....	31

Figure 10 – Cable torsion apparatus with tension applied .....	31
Figure 11 – Alternative cable torsion apparatus with tension applied.....	31
Figure 12 – Flexing apparatus.....	33
Figure 13 – Kink test.....	34
Figure 14 – Bend test apparatus .....	36
Figure 15 – Method E13B test set-up .....	41
Figure 16 – Drop weight incorporating shot support pin.....	42
Figure 17 – Alternative drop weight and shot support pin .....	42
Figure 19 – Method E17A – Test set-up .....	46
Figure 20 – Example of results of applied force and displacement .....	47
Figure 21 – Method E17B – Test set-up .....	47
Figure 22 – Method E17C – Test set-up.....	47
Figure 23 – Single-bend.....	50
Figure 24 – S-bend .....	51
Figure 25 – Partial-bend .....	54
Figure 26 – Partial-bend, multiple pulley .....	54
Figure 27 – Aeolian vibration test.....	57
Figure 28 – Schematic of test arrangement.....	60
Figure 29 – Example of pulling jig .....	60
Figure 30 – Cable sample preparation .....	61
Figure 31 – Test set-up for fibre movement under compression .....	63
Figure 32 – Schematic representation of test route, with leg-length $L$ .....	66
Figure 33 – Cable galloping test .....	70
Figure 34 – Indoor installation simulation apparatus .....	71
Figure 35 – Mechanical reliability test apparatus.....	74
Figure 36 – Stapling and bending test fixture .....	72
Figure 37 – Concept of straight midspan access .....	75
Figure 38 – Straight midspan access – Procedure 1 .....	76
Figure 39 – Straight midspan access – Procedure 2 .....	77
Figure 40 – Coefficient of friction test apparatus (drum test) .....	79
Figure 41 – Tensile cycling test apparatus .....	81
Figure 42 – Control cable length arrangement.....	82
Figure 43 – Delineating zero strain baseline for high load level and low load level .....	83
Figure 44 – Load applied on cable sample .....	83
Figure 45 – Strain of ADSS cable at high load as function of load cycles .....	84
Figure 46 – Coefficient of friction test apparatus (flat plate test).....	86
Table 2 – Typical test gauge length .....	29
Table 3 – Test values for cable galloping test schematic.....	70

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OPTICAL FIBRE CABLES –**

**Part 1-21: Generic specification –  
Basic optical cable test procedures –  
Mechanical test methods**

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 most recent 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 60794-1-21 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

**DISCLAIMER**

**This Consolidated version is not an official IEC Standard and has been prepared for user convenience. Only the current versions of the standard and its amendment(s) are to be considered the official documents.**

**This Consolidated version of IEC 60794-1-21 bears the edition number 1.1. It consists of the first edition (2015-03) [documents 86A/1638/FDIS and 86A/1655/RVD] and its amendment 1 (2020-03) [documents 86A/1975/FDIS and 86A/1990/RVD]. The technical content is identical to the base edition and its amendment.**

**This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.**

International Standard IEC 60794-1-21 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This first edition constitutes a technical revision.

It has been decided to split the second edition of IEC 60794-1-2 into six new documents:

- IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures*
- IEC 60794-1-20, *Optical fibre cables – Part 1-20: Generic specification – Basic optical cable test procedures – General and definitions*
- IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods*
- IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental tests methods*
- IEC 60794-1-23, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable elements tests methods*
- IEC 60794-1-24, *Optical fibre cables – Part 1-24: Generic specification – Basic optical cable test procedures – Electrical tests methods*

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

This standard is intended to be used in conjunction with IEC 60794-1-1.

A list of all parts in the 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 the base publication and its amendment 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.

**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.

## INTRODUCTION to Amendment

This Amendment adds new test methods and revises existing ones in a timely fashion until the next full revision of IEC 60794-1-21:2015.

Both the E-series numbering of the test methods, clause numbers, figures and equations of the technical section are aligned with IEC 60794-1-21:2015.

As part of the ongoing rationalization of the test methods specification set, several tests of IEC 60794-1-21 were determined to be more properly aligned with others of the set and have been moved. To that end, the proposed text to affect these moves has been inserted in this document.

Clause 7 has been redesignated as a cable element test method. It has been moved to IEC 60794-1-23 Ed2 and given the test method number G10A.

Clause 8 has been redesignated as a cable element test method. It has been moved to IEC 60794-1-23 Ed2 and given the test method number G10B.

Clause 18 has been redesignated as an environmental test method. It has been moved to IEC 60794-1-22 Ed2 and given the test method number F16.

Clause 19 has been redesignated as a cable element test method. It has been moved to IEC 60794-1-23 Ed2 and given the test method number G9.

## OPTICAL FIBRE CABLES –

### Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical test methods

#### 1 Scope and object

This part of IEC 60794 applies to optical fibre cables for use with telecommunication equipment and devices employing similar techniques, and to cables having a combination of both optical fibres and electrical conductors.

The object of this standard is to define test procedures to be used in establishing uniform requirements for mechanical requirement performance.

Throughout this standard the wording “optical cable” may also include optical fibre units, microduct fibre units, etc.

See IEC 60794-1-2 for general requirements and definitions and for a complete reference guide to test methods of all types.

#### 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 60227-2, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 2: Test methods*

IEC 60793-1-22:2001, *Optical fibres – Part 1-22: Measurement methods and test procedures – Length measurement*

IEC 60793-1-32:2010, *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*

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

IEC 60793-1-46:2001, *Optical fibres – Part 1-46: Measurement methods and test procedures – Monitoring of changes in optical transmittance*

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

IEC 60794-1-2:2013, *Optical fibre cables – Part 1-2: Generic specification – Cross reference table for optical cable test procedures*

IEC 60794-1-20:2014, *Optical fibre cables – Part 1-20: Generic specification – Basic optical cable test procedures – General and definitions*