

# INTERNATIONAL STANDARD

---

**Optical circuit boards –  
Part 3-1: Performance standards – Flexible optical circuit boards using  
unconnectorized optical glass fibres**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2009 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester.

If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland  
Email: [inmail@iec.ch](mailto:inmail@iec.ch)  
Web: [www.iec.ch](http://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.

- Catalogue of IEC publications: [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, withdrawn and replaced publications.

- IEC Just Published: [www.iec.ch/online\\_news/justpub](http://www.iec.ch/online_news/justpub)

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

- Electropedia: [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 20 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary online.

- Customer Service Centre: [www.iec.ch/webstore/custserv](http://www.iec.ch/webstore/custserv)

If you wish to give us your feedback on this publication or need further assistance, please visit the Customer Service Centre FAQ or contact us:

Email: [csc@iec.ch](mailto:csc@iec.ch)  
Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00



IEC 62496-3-1

Edition 1.0 2009-08

# INTERNATIONAL STANDARD

---

**Optical circuit boards –  
Part 3-1: Performance standards – Flexible optical circuit boards using  
unconnectorized optical glass fibres**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

PRICE CODE

**N**

---

ICS 31.180; 33.180.01

ISBN 2-8318-1059-4

## CONTENTS

FOREWORD.....	3
1 Scope.....	5
2 Normative references .....	5
3 Terms and definitions .....	5
4 Tests.....	7
5 Test report.....	7
6 Reference components.....	7
7 Visual inspection .....	7
8 Connectivity inspection.....	7
9 Performance requirements .....	8
9.1 Sample size, test sequencing and grouping.....	8
9.2 Performance details .....	8
Annex A (normative) Test method of bending endurance of fibre flexible OCB.....	10
Annex B (normative) Optical fibre routing pattern and dimension of test specimen.....	11
Annex C (normative) Test sample size, test sequencing and grouping requirements.....	12
Annex D (normative) Test method of static pressure endurance of OCB body .....	13
Bibliography.....	14
Figure 1 – Example of fibre flexible OCB .....	6
Figure A.1 – Configuration of the bending endurance test.....	10
Figure B.1 – Optical fibre routing pattern and the dimensional outline drawing of OCB body for the test specimen .....	11
Figure D.1 – Configuration of static pressure endurance test .....	13
Table 1 – Optical fibres for FFOCB -1 .....	6
Table 2 – Optical fibres for FFOCB -2 .....	7
Table 3 – Performance details .....	8
Table C.1 – Sample size and sequencing for the performance standard.....	12

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## OPTICAL CIRCUIT BOARDS –

**Part 3-1: Performance standards –  
Flexible optical circuit boards using  
unconnectorized optical glass fibres**

## 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 provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.
- 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 62496-3-1 has been prepared by IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86/319/CDV	86/342/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 62496 series, published under the general title *Optical circuit boards*, 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

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

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

## OPTICAL CIRCUIT BOARDS –

### Part 3-1: Performance standards – Flexible optical circuit boards using unconnectorized optical glass fibres

#### 1 Scope

This part of IEC 62496 defines the performance of flexible optical circuit boards (FOCBs) using unconnectorized optical glass fibres for controlled environment. This standard clarifies the requirements for quality classification of the flexible OCBs incorporating optical glass fibres.

#### 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 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-19, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat (steady state)*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-3-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

ISO 5999, *Flexible cellular polymeric materials – Polyurethane foam for load-bearing applications excluding carpet underlay – Specification*

#### 3 Terms and definitions

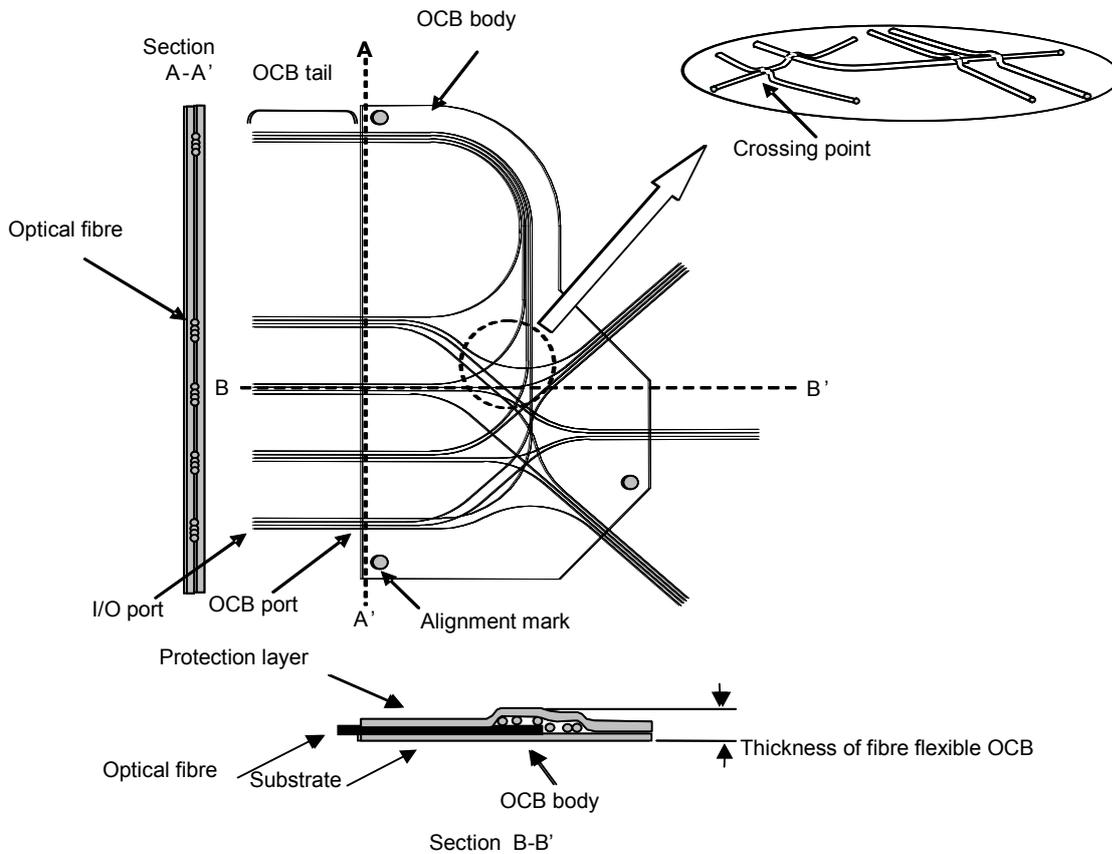
For the purposes of this document, the following terms and definitions apply.

##### 3.1

##### **FFOCB (fibre flexible OCB)**

an OCB on which arbitrary routing patterns are made by fixing optical fibres and covered by a protection layer as illustrated in Figure 1. The fibre flexible OCB consists of a portion where the optical fibre is adhered to the flexible substrate as a routing pattern (OCB body) and “OCB tails” where the optical fibre is stacked out from the OCB body. The substrate for

FFOCB is a mechanically flexible polymer sheet on which optical fibres are adhered using adhesive or attached to the polymer sheet



IEC 1650/09

**Figure 1 – Example of fibre flexible OCB**

**3.2 optical fibres for FFOCB**

categories of optical fibres to be used for fibre flexible OCB are multimode fibres and single-mode fibres with glass core/glass cladding (see Tables 1 and 2)

NOTE 1 IEC 60793-2 provides the specifications for the fibres.

**Table 1 – Optical fibres for FFOCB-1**

Class	Category	Type	Reference
A – Multimode fibres	A1	Graded index fibre	IEC 60793-2-10
	A2	Quasi step index fibre	IEC 60793-2-20
B – Single-mode fibres	B1.1	Dispersion unshifted	IEC 60793-2-50
	B1.2	Cut-off shifted	
	B1.3	Extended band	
	B2	Dispersion shifted	
	B4	Non-zero dispersion shifted	
	B5	Wideband non-zero dispersion-shifted	
	B6	Bending loss insensitive	

NOTE 2 IEC 60793-2-60 also specifies the specification of single-mode intraconnection optical fibres for wiring in OCB.

**Table 2 – Optical fibres for FFOCB-2**

Family	Transmission window	Nominal MFD (mode field diameter)	Reference
C1	1 300 nm to 1 625 nm	8,6 $\mu\text{m}$ -9,5 $\mu\text{m}$ at 1 310 nm	IEC 60793-2-60
C2	1 310 nm	5,0 $\mu\text{m}$ -7,0 $\mu\text{m}$ at 1 310 nm	
C3	1 550 nm	5,5 $\mu\text{m}$ -7,5 $\mu\text{m}$ at 1 550 nm	
C4	980 nm	4,0 $\mu\text{m}$ -7,0 $\mu\text{m}$ at 980 nm	

### 3.3 crossing point of optical fibres

position where optical fibres cross each other in the OCB body. The optical fibre overrides another optical fibre at the crossing point (see Figure 1). Bending endurance and static pressure endurance tests are carried out for checking mechanical strength of this point

## 4 Tests

All test methods shall be in accordance with IEC 61300-2-18, IEC 61300-2-19, IEC 61300-2-22, IEC 61300-3-1, IEC 61300-3-6, and Annexes A through D of this standard. The test method to be used is defined for each test in 9.2, Table 3.

## 5 Test report

Fully documented test reports and supporting evidence shall be prepared and available for inspection as evidence that the tests have been carried out and the results are satisfactory.

## 6 Reference components

No reference components are required to perform the tests described in this standard.

## 7 Visual inspection

The OCB body and OCB tails of a product or a test specimen described in Annex B shall be inspected for confirmation of damage that degrades performance, such as delamination of substrate and protection layer and breaking points of the optical fibres as defined in IEC 61300-3-1. The routing pattern of the test specimen is also checked, comparing it with the design described in Figure B.1. Visual inspection shall be undertaken using an optical magnifier and/or eye observation.

## 8 Connectivity inspection

The correspondence between the input and output ports of a product shall be confirmed, that is, a from/to port table should be obtained. This is because the input and output ports are not regularly placed in a 2D-plane although the positions are defined against the original coordinate. It is recommended that light is transmitted through each optical path, and output light from each output port is observed with a CCD camera or by visual inspection.

NOTE The preferred light source is a laser diode, LED, or lamp source (halogen or xenon). The wavelength is arbitrary.

## 9 Performance requirements

### 9.1 Sample size, test sequencing and grouping

The test sample to be used for the tests shall be as defined in Annex C.

### 9.2 Performance details

Attenuation of fibre flexible optical circuit board shall be measured by using method AT1, method AT2 or method AT3 of IEC 61300-3-4.

**Table 3 – Performance details**

No.	Test	Requirements	Details
1	Bending endurance of OCB body	Change in attenuation: maximum variation of <0,3 dB  There is no delamination of substrate and protection layer and breaking point of fibre for measurement	See Annex A  Use test specimen described in Annex B  Bending radius of OCB body: 30 mm  Number of cycles: 10  Measurement of attenuation shall be made before and after test  Test wavelength to be measured at the following wavelengths: 1 550 nm ± 30 nm (for single-mode) 850 nm ± 30 nm (for multimode)
2	Static pressure endurance of OCB body	Change in attenuation: maximum variation of <0,3 dB  There is no delamination of substrate and protection layer and breaking point of fibre for measurement	See Annex D  Use test specimen described in Annex B  Measurement of attenuation shall be made before and after test  Test wavelength to be measured at the following wavelengths: 1 550 nm ± 30 nm (for single-mode) 850 nm ± 30 nm (for multimode)
3	Dry heat / high temperature	Change in attenuation: maximum variation of <0,3 dB  There is no delamination of substrate and protection layer	IEC 61300-2-18  Use test specimen described in Annex B  Temperature: +60 °C ± 2 °C  Measurement of attenuation shall be made at initial and 96 h  Test wavelength to be measured at the following wavelengths: 1 550 nm ± 30 nm (for single-mode) 850 nm ± 30 nm (for multimode)
4	Damp heat (Steady state)	Change in attenuation: maximum change of attenuation <0,3 dB  There is no delamination of substrate and protection layer	IEC 61300-2-19  Use test specimen described in Annex B  Temperature: +40 °C ± 2 °C  Relative humidity: 93 % +2 %, -3 % RH  Measurement of attenuation shall be made at initial and 96 h  Test wavelength to be measured at the following wavelengths: 1 550 nm ± 30 nm (for single-mode) 850 nm ± 30 nm (for multimode)

No.	Test	Requirements	Details
5	Change of temperature	<p>Change in attenuation: maximum change of attenuation &lt;0,3 dB</p> <p>After the test, bending endurance of OCB body test (No.1) using the same test specimen shall be passed</p> <p>There is no delamination of substrate and protection layer</p>	<p>IEC 61300-2-22, Test Nb</p> <p>Use test specimen described in Annex B.</p> <p>High temperature dwell: +60 °C± 2 °C</p> <p>Low temperature dwell: -10 °C± 2 °C</p> <p>Duration at each dwell temperature: 1 h</p> <p>Ramp time = 1 °C/min</p> <p>Number of cycles: 5</p> <p>Measurement of attenuation shall be made before and after test</p> <p>Test wavelength to be measured at the following wavelengths:</p> <p>1 550 nm ± 30 nm (for single-mode)</p> <p>850 nm ± 30 nm (for multimode)</p>

## Annex A (normative)

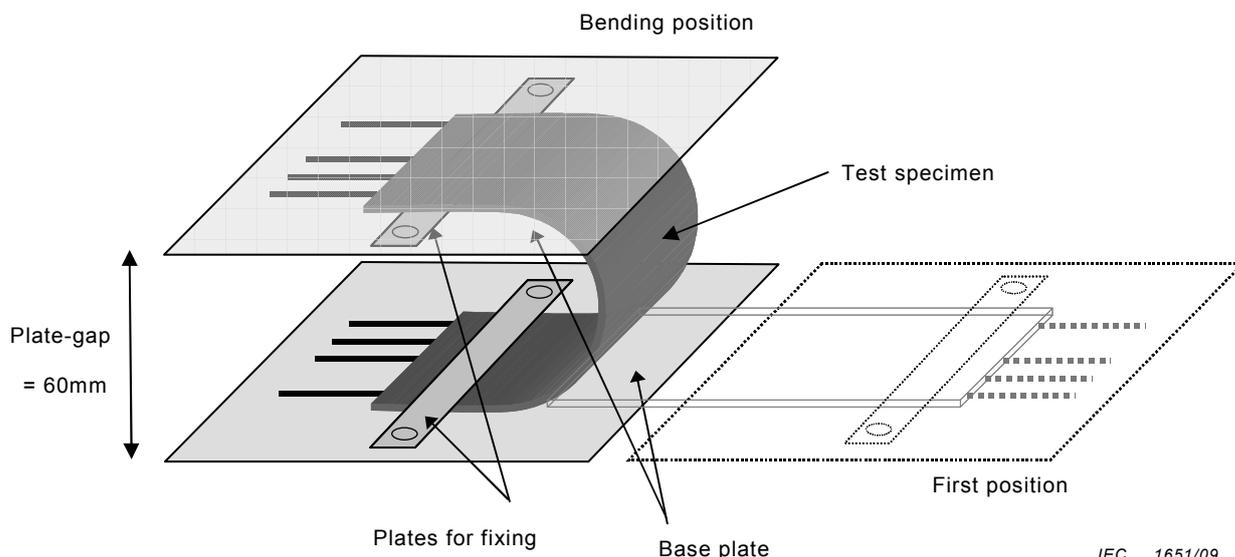
### Test method of bending endurance of fibre flexible OCB

#### A.1 Preparation

The instrument of the bending endurance test consists of a flat base plate and a mandrel to specify the bending radius (30 mm) of a specimen as shown in Figure A.1. Optical attenuation shall be able to be confirmed before and after the test. The test specimen shall be prepared with reference to Annex B.

#### A.2 Test

The purpose of the bending test is to check the degradation of fibres and delamination of the substrate and protection layer due to repeatedly bending. Bending test shall be made with a plate-gap of 60 mm unless otherwise specified by detailed specification of the OCB. The test specimen shall be placed on two base plates and fixed with plates for fixing as shown in Figure A.1. One base plate turns over and is setup above and parallel to another base plate, as shown in Figure A.1. After keeping in this position for 1 min, the top base plate is back to the first position. The number of this cycle is 10. The optical attenuation is measured before and after the test. The construction (optical fibre, substrate, protection layer) of the OCB body of test specimen used shall be reported in the test report. The outer surface at the bending of the test specimen shall be clearly specified if the surfaces at the bend are different due to the structure of the test specimen. The appearance shall be checked, includes break of the optical fibre and apparent deformation of the test specimen.



IEC 1651/09

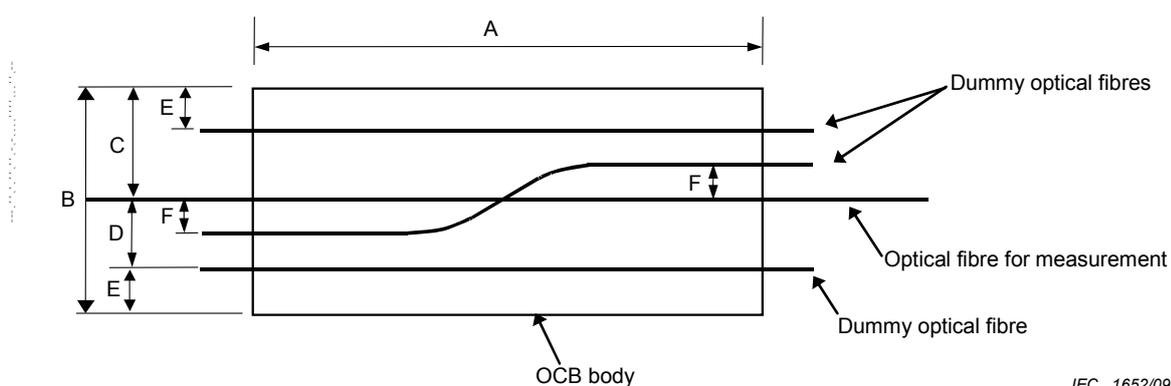
**Figure A.1 – Configuration of the bending endurance test**

## Annex B (normative)

### Optical fibre routing pattern and dimension of test specimen

The optical fibre routing pattern and the dimensional outline drawing of OCB body for the test specimen are given in Figure B.1. The crossing point of optical fibres shall be sited at the centre of OCB body and the optical fibre for measurement of attenuation shall be placed over the crossing.

The construction (optical fibre, substrate, protection layer) of the OCB body test specimen shall be reported in the test report.



IEC 1652/09

A	240 mm
B	40 mm
C	20 mm
D	10 mm
E	10 mm
F	5 mm
Bending radius	30 mm
Crossing angle	5 °

**Figure B.1 – Optical fibre routing pattern and the dimensional outline drawing of OCB body for the test specimen**

**Annex C**  
(normative)

**Test sample size, test sequencing and grouping requirements**

**Table C.1 – Sample size and sequencing for the performance standard**

No	Test	Test object	Number of samples	Source
1	Bending endurance of OCB body	Test specimen (Annex B)	5	New
2	Static pressure endurance of OCB body	Test specimen (Annex B)	5	New
3	Dry heat / high temperature	Test specimen (Annex B)	5	New
4	Damp heat	Test specimen (Annex B)	5	New
5	Change of temperature	Test specimen (Annex B)	5	New

## Annex D (normative)

### Test method of static pressure endurance of OCB body

#### D.1 Purpose

The purpose of this test is to check for breakage of the fibre at the crossing point due to stress during shipping.

#### D.2 Instrument

The instrument for the static pressure test consists of a flat base plate to hold an OCB body and a weight (plate) which is placed to press the specimen and an OCB body, as shown in Figure D.1. The size of the base plate shall be larger than the OCB body. The size of the weight is  $230 \text{ mm} \pm 5 \text{ mm} \times 30 \text{ mm} \pm 5 \text{ mm}$ , slightly smaller than that of the OCB body. The outline of the weight, which is put on the OCB body, is inside of that of the OCB body. The test specimen shall be prepared with reference to Annex B. Insertion of sheets between a test piece and a weight, and also between a test piece and a base plate as in Figure D.1, is recommended for preventing concentration of pressure on the crossing point. The sheet specified in ISO 5999 shall be used.

#### D.3 Test

The static pressure endurance test shall be made at a pressure of 0,98 kPa. The pressure shall be applied for 1 min. Then the pressure is released.

The attenuation of the optical fibre for measurement is checked before and after the test. The degradation of appearance, such as break of the optical fibres and its separation from the adhesion layer, and apparent deformation of the OCB body, is checked.

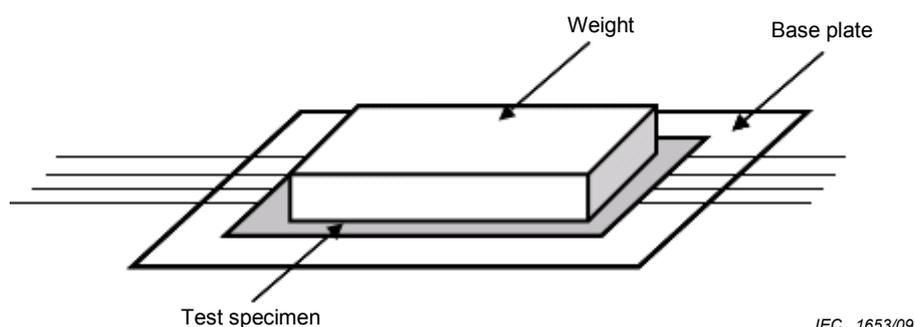


Figure D.1 – Configuration of static pressure endurance test

## Bibliography

IEC 60793-1-1, *Optical Fibres – Part 1-1: Measurement methods and test procedures – General and guidance*

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

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

IEC 60793-2-20, *Optical fibres – Part 2-20: Product specifications – Sectional specification for category A2 multimode fibres*

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

IEC 60793-2-60, *Optical fibres – Part 2-60: Product specification – Sectional specification for category C single-mode intraconnection fibres*

IEC 61753-1, *Fibre optic interconnecting devices and passive components – Part 1: General and guidance for performance standards*

IEC 62496-1, *Optical circuit boards – Part 1: General*

---



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](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)