IEC 62496-2-5

Edition 1.0 2022-12

INTERNATIONAL STANDARD

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Optical circuit boards – Basic test and measurement procedures – Part 2-5: Flexibility test for flexible opto-electric circuits

Cartes a circuits optiques – Procédures fondamentales d'essais et de mesures – Partie 2-5: Essai de flexibilité pour les circuits optoélectriques souples

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The text of this International Standard is based on the following documents:

Draft	Report on voting
86/605/FDIS	86/609/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 62496 series, published under the general title *Optical circuit boards*, can be found on the IEC website.

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- amended.

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OPTICAL CIRCUIT BOARDS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 2-5: Flexibility test for flexible opto-electric circuits

1 Scope

This part of IEC 62496 defines a test method for folding flexibility inspection of flexible opto-electric circuits with a flexibility tester endurance tester and presents a guideline for a step stress test method for finding the predetermined minimum mechanical folding radii below which the flexible opto-electric circuits can be damaged by intended folding distortion. Here, test samples are used instead of products for the flexibility test of their flexible opto-electric circuits, and the test samples have the same material, layer structure, processing technology and equipment as the products.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60793-2 (all parts), *Optical fibres – Part 2: Product specifications*

IEC 62496-2-1, *Optical circuit boards – Part 2-1: Measurements – Optical attenuation and isolation*

ISO 5626:1993, *Paper – Determination of folding endurance*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62496-1 and the following apply.

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- IEC Electropedia: available at https://www.electropedia.org/
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3.1
flexible opto-electric circuit board
flexible circuit board that contains both optic and electric circuits integrated into a flexible sheet

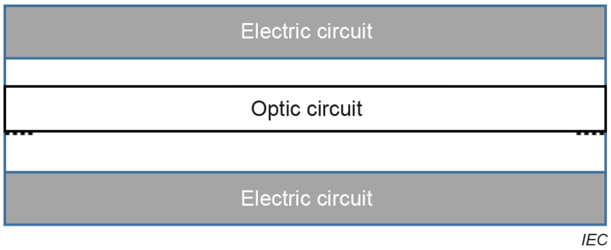


Figure 1 – Schematic diagram of flexible opto-electric circuit board (top view)

Note 1 to entry: Figure 1 shows an example of the top view of a flexible opto-electric circuit board.

Note 2 to entry: There are two types of flexible opto-electric circuit board: optical fibre-types and planer optical waveguide-types.

[SOURCE: ISO 5626:1993, Clause 1]

3.2
flexibility tester
instrument for folding endurance test of flexible sheets with interchangeable folding heads, allowing a range of thickness up to 1,25 mm

Note 1 to entry: In general, it is called the MIT folding endurance tester.

4 Apparatus

4.1 General description

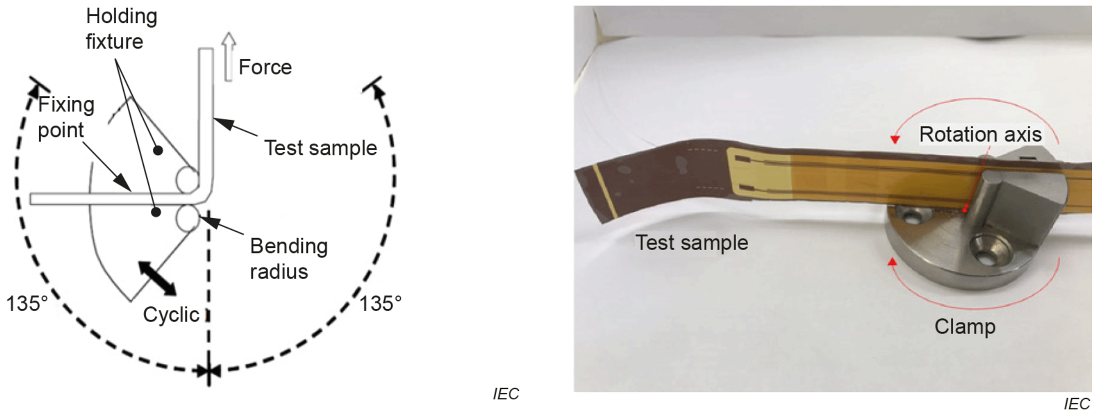
The flexibility test system for flexibility test of the flexible opto-electric circuit board (hereafter FOECB) shall be used for finding of the minimum folding radii of both optic and electric circuits of the FOECB before any functional damage occurs. An existing flexibility folding method has been used for testing the folding flexibility of only electric circuits. However, in this document, it shall be used for testing the folding flexibility of both optic and electric circuits.

Since the test sample for fibre optical type should be connected to the flexibility test system through an optical fibre, real-time monitoring may be possible. Accordingly, the flexibility tester shall be configured with a real-time monitoring system using a laser signal device to accurately know the time of breakage of the optical fibres.

Generally, test samples for planar waveguide optical circuits are difficult to measure through real-time monitoring because it is not easy to connect to a flexibility test device through an optical fibre. Therefore, the test sample should be tested by connecting only electric circuits as in the existing flexibility folding method. The failure time of the test sample should be measured separately using a visual light on the planar waveguide circuits.

But, in case of that the test sample for planar waveguide optical circuits shall use optical fibres with connector to coupling with the optical waveguide, flexibility test of the test samples can be possible with real-time monitoring.

In addition, these tests should be measured in the process of replacing the holding jig.The test sample shall be clamped by the folding jig within the main controller as shown in Figure 2.



a) **Photograph diagram of the folding jig** b) **Photograph of a folding jig and test sample**

Figure 2 – Overview of the folding jig

4.2 Flexibility tester for flexibility test of FOECBs

4.2.1 FOECBs test sample of fibre optical types

The flexibility test system for fibre optical circuits should be configured to stop the folding action of the test sample if any damage starts to appear in its optical and electrical sections. Therefore, the flexibility test system shall be composed of an optic-electric signal control source (hereafter referred as O-E signal control source), test sample, and main controller, as shown in Figure 3.

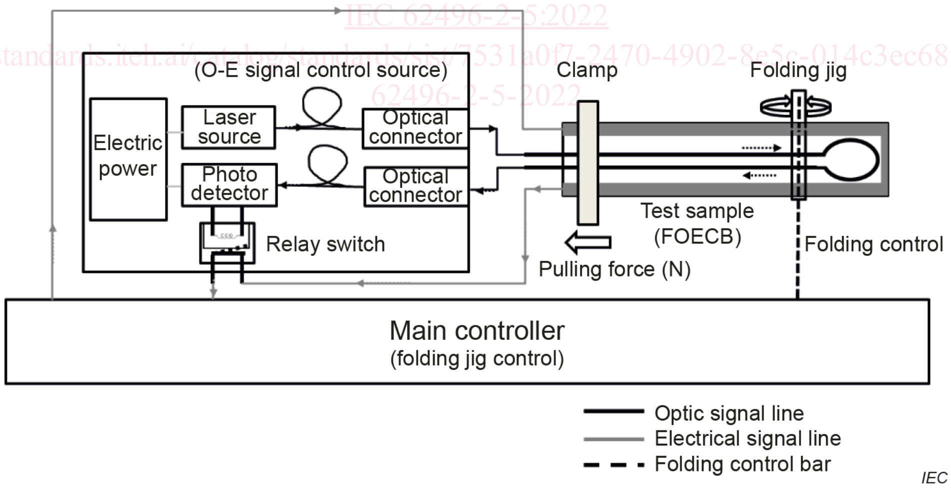


Figure 3 – Schematic diagram of the flexibility test system for fibre optical circuits

4.2.2 FOECBs test sample of planer waveguide optical circuit types

The flexibility test system for planer waveguide optical circuits shall be constructed in the same form as the folding flexibility test method for existing electrical circuits, as shown in Figure 4.

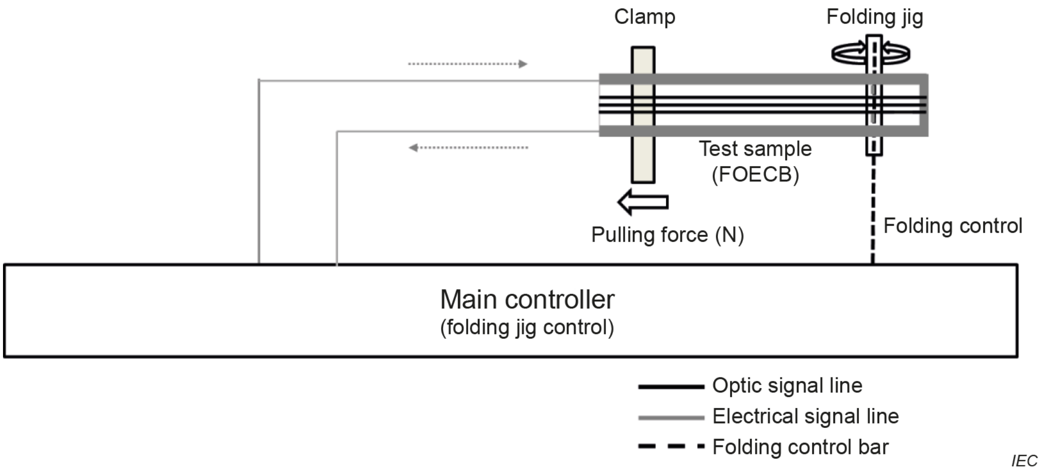


Figure 4 – Schematic diagram of the flexibility test system for planar waveguide optical circuits

4.3 O-E signal control source

An O-E signal control source shall be composed of a laser source, photo detector, relay switch, electric power source, optical fibre, and optical connectors. The O-E signal control source supplies an optical signal to the test sample, and allows the photo detector to control the relay switch based on detected optical signal for on-off switching of the electric signal flow (current) within the flexibility test system.

4.4 Laser source

The optical output power of the laser source shall have enough larger of the minimum detected power of optical detector and attenuation (optical loss) of samples. The laser source in the O-E signal control source sends an optical signal to the test sample via its optical input terminal connected to the protruded optical fibre. The wavelength and mode of the laser source should be chosen according to the application to be used. The launching mode of the laser source should be appropriate to the application of the relevant specification of O-E circuit board.

4.5 Photo detector

The minimum detected optical power of the photo detector shall be enough to detect the optical power after attenuating the optical power by the test sample and light source power. The photo detector detects the optic signal flow in the test sample. The photo detector output controls the relay switch inside the O-E signal control source. Therefore, the output current of the photo detector should be above the minimum operating voltage of the relay switch with a proper resistance for the current output. The photo detector shall have enough response frequency to detect the optical power change (deviation) by the attenuation change caused by the folding distortion. At minimum, the response frequency for the photo detector should be 10 times or more than the folding duration (0° to 90°), or kHz order will be necessary.

4.6 Folding jig

The size of the jig shall be selected according to the test samples. Several types of folding jigs with different bending radii are required to apply various bending tests to the test sample. Folding jigs of 6 different curvature radii (1,0 mm, 2,0 mm, 3,0 mm, 4,0 mm, 5,0 mm, and 10,0 mm) should be prepared (see Figure 5).

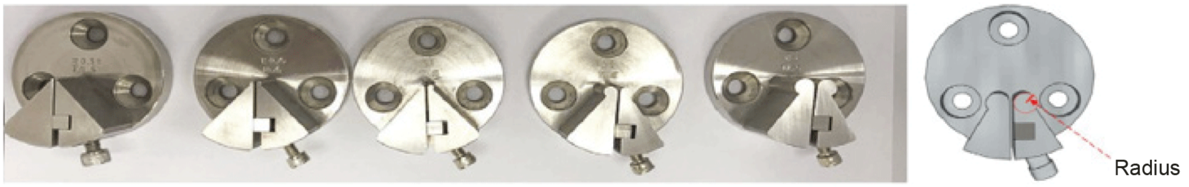


Figure 5 – Flexibility folding jigs (from the left, folding radius r is 1,0 mm, 2,0 mm, 3,0 mm, 4,0 mm, 5,0 mm and 10,0 mm)

4.7 Relay switch

The switching time shall be at least one tenth of the folding speed. The relay switch plays a role of direct on-off switching control of the electric circuit in the flexibility test system. That is, once the photo detector detects the optic signal flow in the test sample, the relay switch stays in the on-state. If the photo detector fails to detect the optic signal flow in the test sample, the relay switch turns to the off-state. The relay switch operates the flexibility test system depending on the detected optical signal output at the photo detector, which is subject to the physical state of the test sample (e.g., either broken or non-broken state of the optic circuit).

4.8 Main controller

The main controller shall control the electrical current to fold the folding jig with enough accuracy to test. The main controller supplies an electric current to the test sample and mechanically controls the folding action of the test sample. The main controller may consist of the main controller and the mechanical control means of folding, separately. Generally, the main controller emits the electric signal by itself to perform the mechanical folding operation on the test sample. The typical electric current flowing through the main controller ranges from 1 mA to 10 mA.

5 Test sample

5.1 FOECB test samples of optical fibre-types

Test samples of optical fibre-types shall have a pigtailed shape (see Figure 6). The optical fibres used in the test samples may be single-mode and/or multimode fibres. Depending on applications, glass optical fibres, polymer optical fibres, and specialty optical fibres may be used to form the optical circuits.

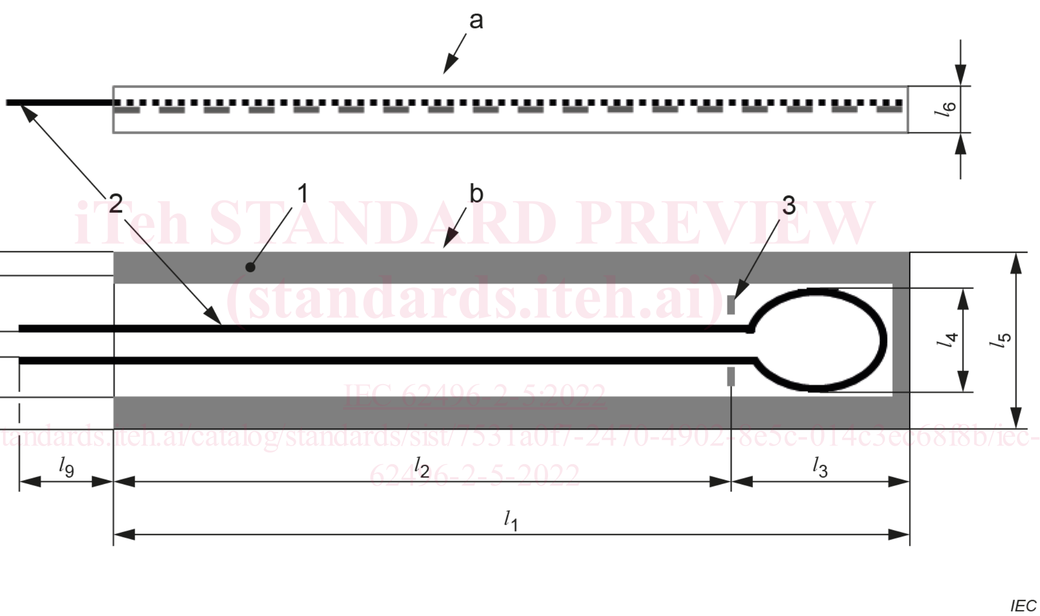
The optical circuits shall be positioned at a central part of the entire FOECB test samples. The electrical circuits shall be positioned at peripheral areas of the optical circuit in a symmetrical structure. The symmetrical structure shall have superior characteristics in size stability from the viewpoint of design and reliability for the FOECB test samples, as shown in Figure 6.

The test samples of the optical fibre-types shall have a protruded structure with a length of l_9 at one side. The protruded length (l_9) shall be maintained with sufficient length over 100 mm for easy connection with other fibres (e.g., fibre fusion splicing). The other side of the test samples shall have a continuous fibre bending area over a 6-mm diameter with a non-end state as shown in Figure 6. The bending state over the 6-mm diameter for glass optical fibres shall be maintained to minimize their optical bending loss.

A detail requirement for structure of FOECB test samples of optical fibre-types is described in Annex A.

A position mark shall be assigned on the test sample for locating the folding position with a clamp of the flexibility test system.

The size of the test samples should be confirmed in accordance with the flexibility folding jigs (see 4.6). As illustrated in Figure 6, the nominal dimensions of the total length (l_1) of the test sample shall be 130 mm within 10 % tolerance, and the nominal dimensions of the width (l_5) of the test sample shall be 2,5 mm to 50 mm within 10 % tolerance. It is recommended that the length (l_2) of the test samples from its one edge to the clamp position mark and the length (l_3) from the clamp position mark of the bending area to the other edge are chosen to be 100 mm and 30 mm, respectively. The bending diameter (l_4) of the optical circuit, spacing (l_8) between two optical circuit lines, and the number of optical circuits shall be decided in accordance with the user's requirements. The pattern width (l_7) of the electrical circuit lines also shall be decided in accordance with the user's requirements. The thickness (l_6) of the FOECB test samples is very critical because it influences the minimum mechanical folding radius r. The thickness of the test sample shall be from 150 µm to 500 µm for the FOECB test samples of the general glass fibres defined in IEC 60793-2 series with polymer over-clad protection. The thickness of the test samples should be same as that for products. If there are any differences, the thickness of the test samples shall be decided in accordance with the user's requirements.



Key

1 electric circuit

2 optic circuit

3 position mark for clamp (folding)

a side view of test sample

b top view of test sample

Figure 6 – Schematic diagram of FOECB test samples of optical fibre-types

5.2 FOECB test samples of planar optical waveguide-types

The optical circuits shall be positioned at a central part of the entire FOECB test samples. The electrical circuits shall be positioned at a peripheral area of the optical circuit in a symmetrical structure. The symmetrical structure shall have superior characteristics in size stability from the viewpoint of design and reliability for the FOECB test samples as shown in Figure 7.

The test samples of the planar optical waveguide-types shall have a non-protruded structure at both side (see Figure 7). The number of optical circuit lines shall be at least three for crosstalk testing.