IEC 63251

Edition 1.0 2023-11

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Test method for mechanical properties of flexible opto-electric circuit boards under thermal stress

Méthode d'essai des propriétés mécaniques des circuits optoélectriques souples sous contrainte thermique

IEC 63251:2023-11(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.180

ISBN 978-2-8322-7750-8

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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TEST METHOD FOR MECHANICAL PROPERTIES OF FLEXIBLE OPTO-ELECTRIC CIRCUIT BOARDS UNDER THERMAL STRESS

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

Draft	Report on voting
91/1898/FDIS	91/1914/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/publications.

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- withdrawn, or
- revised.

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TEST METHOD FOR MECHANICAL PROPERTIES OF FLEXIBLE OPTO-ELECTRIC CIRCUIT BOARDS UNDER THERMAL STRESS

1 Scope

This International Standard defines the thermal endurance test methods for reliability assessment of flexible opto-electric circuit boards. The purpose of this document is to accommodate the uniform thermal characteristics required by the flexible opto-electric circuit in high temperature environments such as automobiles. In particular, this document specifies a test method to inspect the occurrence of colour exchange, deformation and delamination of flexible opto-electric circuit boards under thermal stress.

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 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

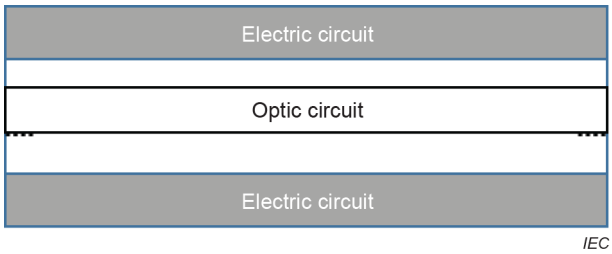
3.1
optic circuit
circuit that is composed of optical waveguides and can transmit optical signals

3.2
glass optic fibre
GOF
optic fibre made of glass material

3.3
polymer optic fibre
POF
optic fibre made of polymer material

3.4
opto-electric circuit
O-E circuit
circuit that contains both optic circuit and electric circuit

3.5
flexible opto-electric circuit board
FOECB
flexible circuit board that contains both optic and electric circuits integrated into a flexible sheet



NOTE Figure 1 shows an example of the top view of a flexible opto-electric circuit board.

Figure 1 – Schematic diagram of FOECB (top view)

4 Test method

4.1 General

The FOECBs shall include optical and electrical circuits on a same board. Since the materials used for the O-E circuits have different thermal properties from those used for the conventional electric circuits, the requirements for the thermal performance tests will be different between the two types of circuits. Thus, the thermal properties of the materials, such as glass optic fibre (hereafter referred as GOF), polymer optic fibre (hereafter referred as POF), polymer film, etc., shall be identified in advance for applications to optic circuits in the given applications.

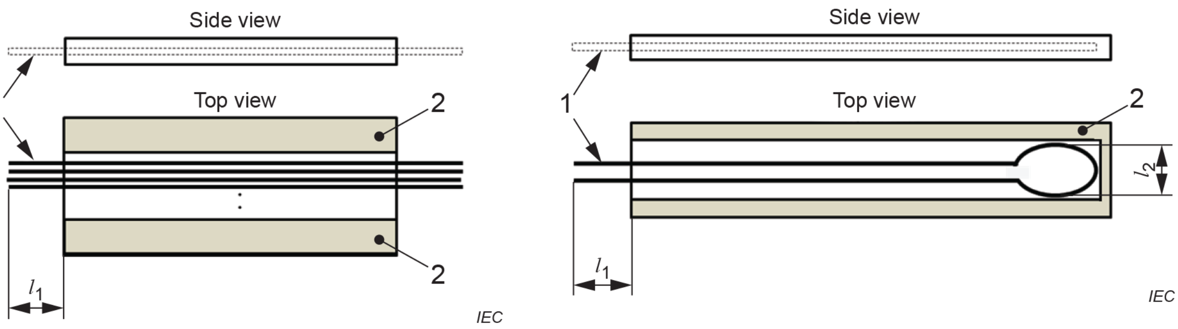
4.2 Test sample

The test samples of the FOECBs consist of electric and optic film circuits. The optic circuit shall be positioned at the central part of the entire FOECB. An electric circuit shall be positiond at the periphery part of the optic circuit in a symmetrical structure. The symmetrical structure shall have superior characteristics in terms of size stability from the point of view of design and reliability of the FOECBs.

The test samples shall be divided into two groups: a parallel array structure for multichannel photonic circuit test (Figure 2a)) and a round loop structure for long-distance photonic circuit test (Figure 2b)). If the test sample contains a fibre optic circuit, it shall have a protruded structure with a length of l_1 at one side, and this structure shall allow an easy connection to another fibre with fusion splicing (or with another optical connection means). The protruded length l_1 shall have a sufficiently long length over 10 cm for easy connections with other fibres (for an example, via the fibre fusion splicing). In the case of the round loop structure, the closed side of the test sample shall have a structure of continuous fibre bending with a bending diameter larger than 6 mm (Figure 2b)). The bending diameter l_2 of larger than 6 mm for optic fibre should be maintained to minimize the optical bending loss.

An example of the test results from measurement of the optical bending loss of an FOECB with the general optic glass fibre as a function of the bending radius is shown in Annex A.

The size of the test samples can be determined from the user's requirements.



a) **Parallel array structure (type 1)**

b) **Round loop structure (type 2)**

Key

1 Optic circuit

2 Electric circuit

Figure 2 – Schematic diagrams of the FOECB test samples of fibre type

For each test group a minimum of three samples having the same physical conditions shall be prepared in the same fabrication processes.

Details of the preparation for the FOECB test samples (optic fibre type) are shown in Annex B.

4.3 Test process

4.3.1 General description of the test

In order for the FOECBs to be used in harsh environments, the thermal properties of the FOECB test sample shall be specified with four severe test conditions of reflow assembly simulation, thermal shock endurance, high temperature endurance and humidity storage.

It is recommended to use different test samples to perform each test.

A flow chart for each test should be as follows. The test process should be started with the loading of the test sample into the test chamber, and proceed in the order of preconditioning, test, recovery, final measurement, etc (see Figure 3).

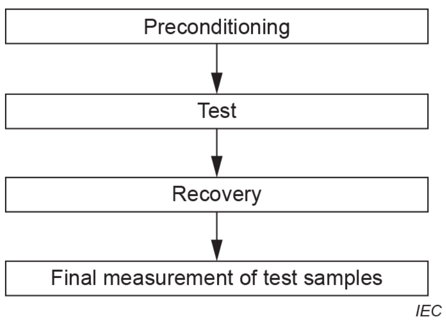


Figure 3 – Schematic diagram of the FOECB test samples of fibre type

The thermal endurance test conditions of the test sample shall be classified as two grades (class 1, class 2) according to the application area (see Table 1).

Table 1 – Thermal endurance test class for FOECB

Classify	Temperature cycling	High temperature exposure	Humidity Storage
Class 1 (harsh area)	5 cycles (−55 °C to +125 °C)	Duration 1 000 h at 150 °C	Duration 56 days at 85 °C, 85 % RH
Class 2 (room area)	5 cycles (−40 °C to +82 °C)	Duration 1 000 h at 82 °C	Duration 12 h at 85 °C, 85 % RH

4.3.2 Preconditioning

The test sample shall be at the ambient temperature of the laboratory, +25 °C ± 5 K. If required by the relevant specification, the test sample shall be brought into the operating conditions.

4.3.3 Test

4.3.3.1 Reflow assembly simulation test

The reflow assembly simulation test conditions (260 °C, 20 s to 30 s, 2 cycles to 3 cycles) for the FOECB test samples follow the detailed guidelines given in IPC-TM-650 2.6.27.

4.3.3.2 Thermal shock endurance test

The thermal shock endurance test conditions for the FOECB test samples shall follow the detailed guidelines (test Na) given in IEC 60068-2-14.

The preferred number of test cycles shall be five with 30 min at extreme temperature of the technical data sheet, unless otherwise specified in the relevant specification.

4.3.3.3 High temperature endurance test

The high temperature endurance test conditions for the FOECB test samples shall follow the detailed guidelines given in IEC 60068-2-2.

The preferred number of test cycles shall be 1 000 h at extreme temperature of the technical data sheet, unless otherwise specified in the relevant specification.

4.3.3.4 Humidity storage test

The humidity storage test conditions for the FOECB test samples shall follow the detailed guidelines given in IEC 60068-2-78.

The preferred test durations are 12 h, 16 h, 24 h, 2 d, 4 d, 10 d, 21 d or 56 d at humidity storage condition (85 °C, 85 %RH).

4.3.4 Recovery

At the end of the test cycle, the test samples shall remain in the standard atmospheric conditions for testing for a period adequate for the attainment of temperature stability.

The duration of recovery shall be 24 h ± 2 h at room temperature conditions.

4.3.5 Final measurements

When the thermal test for the test samples is completed, the following additional tests should be carried out to check any changes in their characteristics:

– identification of changes in the mechanical properties;
– after the thermal endurance test for the test samples, any appearance change, such as colour change, deformation, and delamination, of the test samples can be checked visually first;
– the delamination can be checked by polishing the cross section of the test samples and by performing microscopic examination on the polished sections;
– finally, the flexibility of the test samples should be checked according to the methods described in the bending test (IEC 62496-3-1), the MIT test (ISO-5626), and the folding flexible cable (IPC-TM-650 2.4.31).

Annex C shows an example of the simulation test results for the reflow assembly of an FOECB test sample.

Annex D shows an example of the high temperature endurance test results for an FOECB test sample.

Annex E shows an example of the humidity storage test results for an FOECB test sample.

5 Report

a) test sample.....(size and number)
b) customer .....(name and address)
c) test laboratory ..... (name and address and details of accreditation – if any)
d) test dates .....(dates when test was run)
e) type of test .....(reflow assembly simulation, themal shock endurance, ...high temperature endurance, humidity storage)
f) test standard, edition .....(IEC 63251, edition used)
g) any variations/deviation from the sample .....(change or not)
h) test sample description.....(drawing, photo, quantity build status, etc.)
i) any variation from the defined test method .....(change or not)
j) performance of test sample .....(results of functional tests, ... optic & electric properties, mechanical properties etc.)
k) summary of test..... (test summary)