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INTERNATIONAL STANDARD

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Optical circuit boards – Basic test and measurement procedures – Part 2: General guidance for definition of measurement conditions for optical characteristics of optical circuit boards

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FOREWORD

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International Standard IEC 62496-2 has been prepared by IEC technical committee 86: Fibre optics.

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

CDV	Report on voting
86/509/CDV	86/515/RVC

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

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

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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

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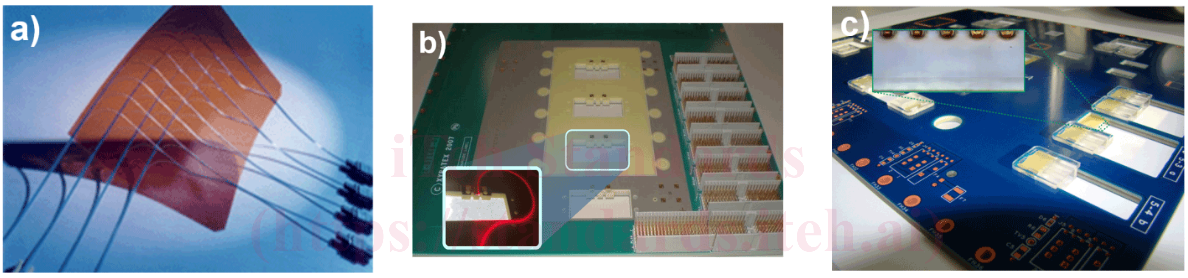
INTRODUCTION

Bandwidth densities in modern data communication systems are driven by interconnect speeds and scalable input/output (I/O) and will continue to increase over the coming years, thereby severely impacting cost and performance in future data communication systems, bringing increased demands in terms of signal integrity and power consumption.

The projected increase in capacity, processing power and bandwidth density in future information communication systems will need to be addressed by the migration of embedded optical interconnects into system enclosures. In particular, this would necessitate the deployment of optical circuit board technologies on some or all key system cards, such as the backplane, motherboard and peripheral circuit boards.

Many varieties of optical circuit board technology exist today, which differ strongly from each other in terms of their intrinsic waveguide technology. As shown in Figure 1, these varieties include, but are not limited to: a) fibre-optic laminate, b) polymer waveguides and c) planar glass waveguides. Annex A provides a detailed overview of the state of the art of such optical interconnect technologies.



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a) Fibre-optic laminate **b) Polymer waveguides** **c) Planar glass waveguides**

Figure 1 – Optical circuit board varieties

One important prerequisite to the commercial adoption of optical circuit boards is a reliable test and measurement definition system that is agnostic to the type of waveguide system under test and, therefore, can be applied to different optical circuit board technologies as well as being adaptable to future variants. A serious and common problem with the measurement of optical waveguide systems has been lack of proper definition of the measurement conditions for a given test regime, and consequently strong inconsistencies ensue in the results of measurements by different parties on the same test sample. To date, no methodology has been established to ensure that test and measurement conditions for such optical waveguide systems are properly identified.

This document specifies a method of capturing sufficient information about the measurement conditions for a given optical circuit board to ensure consistency of measurement results within an acceptable margin.

Given the substantial variety in properties and requirements for different optical circuit board types, some test environments and conditions are more appropriate than others for a given optical circuit board. It is, therefore, crucial that this measurement identification standard encompass a comprehensive range of test and measurement scenarios for all known types of optical circuit boards and their waveguide systems, while also being sufficiently adaptable and extendable to accommodate future waveguide technologies. In addition, a degree of customisation is possible to account for arbitrary test parameters.

OPTICAL CIRCUIT BOARDS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 2: General guidance for definition of measurement conditions for optical characteristics of optical circuit boards

1 Scope

This part of IEC 62496 specifies a method of defining the conditions for measurements of optical characteristics of optical circuit boards. The method comprises the use of code reference look-up tables to identify different critical aspects of the measurement environment. The values extracted from the tables are used to construct a measurement identification code, which, in itself, captures sufficient information about the measurement conditions, so as to ensure consistency of independently measured results within an acceptable margin. Recommended measurement conditions are specified to minimise further variation in independently measured results.

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 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-3-53, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-53: Examinations and measurements – Encircled angular flux (EAF) measurement method based on two-dimensional far field data from step index multimode waveguide (including fibre)*

IEC 62614, *Fibre optics – Launch condition requirements for measuring multimode attenuation*

IEC 62496-2-1:2011, *Optical circuit boards – Part 2-1: Measurements – Optical attenuation and isolation*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62496-2-1 and the following apply.

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

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

3.1
optical channel measurement identification code
MIC
numerical code used to capture sufficient information about the measurement conditions on a waveguide under test in an optical circuit board, such as to ensure independent repeatability of the measurement and consistency of measured results on an identical sample

3.2
optical channel under test
optical circuit board channel subjected to test and measurement regime

3.3
parabolic profile parameter
parameter which describes the refractive index profile of waveguide according to the following equation

$$n(r)=\begin{cases} n_1\sqrt{1-2\Delta\left(\frac{r}{a}\right)^g} & r<a \\ n_1\sqrt{1-2\Delta} & r>a \end{cases}$$

where

g is the parabolic profile parameter;

a is the core radius;

r is the radial distance from core centre;

n_1 is the refractive index at r = 0;

Δ is given by the relation $\Delta=\left(n_1^2-n_2^2\right)/2n_1^2$, where n_1 again is the refractive index at r = 0, i.e. at the axis, and n_2 is the refractive index at the outer edge of the core, i.e. at $r = a$

3.4
launch conduit
structure or mechanism which guides light from the measurement test source to the input facet of the optical channel under test

Note 1 to entry: Examples include optical fibres, optical waveguides or optical trains.

3.5
capturing conduit
structure or mechanism which guides light from the output facet of the optical channel under test to a measurement device

3.6
top input axis of channel under test
axis defined by the tester within the plane of the input facet used as a reference, against which the polarisation axis of the launch conduit can be defined

3.7
top output axis of channel under test
axis defined by the tester within the plane of the output facet used as a reference, against which the polarisation axis of the capturing conduit can be defined

3.8
polarisation maintaining optical fibre
single-mode optical fibre in which linearly polarized light, if properly launched into the fibre, maintains a linear polarisation during propagation, exiting the fibre in a specific linear

polarisation state with little or no cross-coupling of optical power between the two polarisation modes

Note 1 to entry: Such fibre is used in special applications where preserving polarisation is essential and is characterised by a fast axis and a slow axis.

3.9
refractive index matching material
compliant or fixed material with a refractive index equal to the refractive index of the core of the channel under test at the measurement wavelength and measurement conditions, which, unless otherwise stated, is the standard atmospheric conditions as according to IEC 61300-1

3.10
refractive index damping material
compliant or fixed material with a refractive index within 0,05 of the refractive index of the core of the channel under test at the measurement wavelength and measurement conditions, which, unless otherwise stated, is the standard atmospheric conditions as according to IEC 61300-1

4 Measurement definition system for optical circuit boards

4.1 General

A reliable test and measurement definition system for optical interconnect is a crucial prerequisite for future commercial adoption of optical circuit board technology.

Independent repeatability of waveguide measurements is still very difficult to achieve due to the lack of clarity on how measurement conditions are specified.

Therefore, such a definition system shall capture sufficient information about the measurement conditions to ensure that the results of measurement on an identical test sample by independent parties will be consistent within an acceptable margin of error.

Given the large number of measurement parameter permutations possible, the amount of information required to describe sufficiently the measurement conditions is prohibitive. It would be impractical for testers to provide a full textual description for each type of measurement, especially in situations where optical circuit boards are subjected to a variety of different measurement regimes, for instance, as part of a comprehensive quality assurance regime in a commercial optical circuit board foundry.

IEC 62496-2-1 provides details on various types of measurements that can be carried out on optical circuit boards.

4.2 Measurement definition system requirements

4.2.1 Accuracy

The measurement definition system shall capture sufficient information to ensure variability in independently measured results within an acceptable margin.

4.2.2 Accountability

The measurement definition system shall force testers to be accountable to provide sufficient information about the measurement conditions. The system shall therefore comprise a formalised framework to capture the required amount of information about the measurement conditions.

4.2.3 Efficiency

The measurement definition system shall allow the entirety of the measurement condition information to be abbreviated into an optical channel measurement identification code (MIC) such that it can be contained within no more than one line of text.

4.2.4 Convenience

The measurement identification code should be easy to construct and deconstruct using the references look-up tables in this document.

4.2.5 Independent

The measurement definition system shall be independent of the type of optical circuit board under test in order to accommodate different varieties of optical interconnect. To this end, the type of optical channel under test will not be included in the information to be specified; it will be treated as a "black box" bounded by the input facet and output facet of the optical channel under test.

4.2.6 Scalable

The measurement definition system shall be scalable to accommodate new measurement conditions appropriate to existing or as yet unknown optical interconnect types. To this end, the system will have placeholders to allow easy addition of new information in future.

4.2.7 Customised requirements

Where the parameters of a measurement condition are not explicitly provided in the corresponding look-up tables, the MIC shall be extendable to accommodate user-defined parameters.

4.2.8 Prioritised structure

The measurement definition system shall give preference to measurement configurations that are

- accessible, favouring the use of available and affordable equipment,
- viable, favouring measurements which can be easily carried out by most organisations without the requirement for specialised or restricted equipment or expertise, and
- useful, favouring measurement of optical channel characteristics, which are most common and relevant to its deployment and operation, for example insertion loss.

4.3 Measurement definition criteria

4.3.1 General

The measurement definition system shall provide information on the following five critical aspects of the measurement environment:

- source characteristics (4.3.2);
- launch conditions (4.3.3);
- input coupling conditions (4.3.4);
- output coupling conditions (4.3.5);
- capturing conditions (4.3.6).