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TECHNICAL REPORT

colour inside

Guidance of measurement methods and test procedures – Basic tests for polarization-maintaining optical fibres

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GUIDANCE OF MEASUREMENT METHODS AND TEST PROCEDURES – BASIC TESTS FOR POLARIZATION-MAINTAINING OPTICAL FIBRES

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IEC/TR 62349, which is a technical report, has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2005. It constitutes a technical revision.

In this edition, guidance of measurement methods and test procedures for dimensional characteristics, cut-off wavelength, mode field diameter and beat length of polarization-maintaining optical fibres have been added. Thus, the title of the technical report is changed to "Guidance of measurement methods and test procedures – Basic tests for polarization-maintaining optical fibres" from "Guidance for polarization crosstalk measurement of optical fibre".

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86A/1488/DTR	86A/1507/RVC

Full information on the voting for the approval of this technical report 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.

The committee has decided that the contents of this publication 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- withdrawn,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.

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

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GUIDANCE OF MEASUREMENT METHODS AND TEST PROCEDURES – BASIC TESTS FOR POLARIZATION-MAINTAINING OPTICAL FIBRES

1 Scope and object

This technical report applies to polarization-maintaining (PM) optical fibres.

The object of this report is to define test procedures to be used in establishing uniform requirements for the geometrical and transmission properties of PM fibres.

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 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60793-1-20:2001, *Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry*

IEC 60793-1-44, *Optical fibres – Part 1-44: Measurement methods and test procedures – Cut-off wavelength*

IEC 60793-1-45:2001, *Optical fibres – Part 1-45: Measurement methods and test procedures – Mode field diameter*

IEC 60793-1-48, *Optical fibres – Part 1-48: Measurement methods and test procedures – Polarization mode dispersion*

3 Terms and definitions

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

NOTE IEC 60793-1-1[1][1] provides general definitions for testing.

3.1
polarization-maintaining optical fibre
PM fibre
optical fibre capable of transmitting, under external perturbations such as bending or lateral pressure, both independently of or either of the polarization modes HE^{X}_{11} and HE^{Y}_{11} whose directions of electric field vector intersect orthogonally with each other and which have different propagation constants

.

[1] Numbers in square brackets refer to the bibliography.

3.2
phase beat length
one cycle of the periodical coupled polarization state by the phase difference of two linear-polarization modes intersecting orthogonally in the PM fibre

Note 1 to entry: Small beat length results in high polarization maintaining capability

3.3
group beat length
one cycle of the periodical coupled polarization state by the group delay difference of two linear-polarization modes intersecting orthogonally in the PM fibre

Note 1 to entry: Small beat length results in high polarization maintaining capability.

3.4
polarization crosstalk
strength of coupling of the two polarization modes intersecting orthogonally with each other within a polarization-maintaining optical fibre, representing the ratio in optical strength exiting the fibre of one polarization mode launched at the input end to the optical power of the other polarization mode exiting the fibre when only the former polarization mode is excited (see also 9.2.2.4.2)

4 Testing conditions

Unless otherwise specified, the test is conducted under the standard conditions specified in IEC 60068-1. However, when it is difficult to make measurements in the standard conditions, the test can be conducted in conditions other than the standard conditions provided that no doubts will arise about judgments.

5 Guidance for dimensional characteristics measurement of polarization-maintaining optical fibres

5.1 Object

Clause 5 describes measurement methods and test procedures for the dimensional characteristics of uncoated PM optical fibres.

5.2 Overview of method

This technical report gives measurement methods for dimensional characteristics of PM fibre which are given in terms of the following parameters:

- cladding diameter;
- cladding non-circularity;
- core concentricity error.

Two methods are described for measuring dimensional characteristics of PM fibre:

- Method A: Refracted near-field;
- Method B: Grey-scale technique of near-field light distribution.

Information pertaining to each individual method is given in Annexes A and C of IEC 60793-1-20:2001. Only notes for PM fibre are described below.

For a general optical fibre, a circle-fitting is used to determine the core centre. However, as for the PM fibre, in particular the elliptical core PM fibre, the core centre cannot be determined if an ellipse-fitting is not used, because the fibre has an oval core.

5.3 Reference test method

Method B is the reference test method (RTM), which is the one used to settle disputes.

6 Guidance for cut-off wavelength measurement of polarization-maintaining optical fibres

6.1 Object

Clause 6 describes a measurement method and a test procedure for the cut-off wavelength, λ_c of PM fibres.

6.2 Overview of method

The measurement method in this technical report describes procedures for determining the cut-off wavelength of a sample fibre in a short length, uncabled and primary coated condition (λ_c).

Information pertaining to each individual method is given in IEC 60793-1-44. Only notes for PM fibre are described below.

As shown in Annex A, the cut-off wavelength of the PM fibre is measured paying attention to excite a LP_{11} mode sufficiently and not to impose an extra, small bending more carefully than the cut-off wavelength measurement of a single-mode (SM) optical fibre.

The recommended deployment configuration of the sample fibre is as defined for the fibre cut-off wavelength in IEC 60793-1-44.

7 Guidance for mode field diameter measurement of polarization-maintaining optical fibres

7.1 Object

Clause 7 describes measurement methods and test procedures for the mode field diameter (MFD) of PM fibres.

7.2 Overview of method

Three methods are described for measuring the MFD of the PM fibre:

- Method A: direct far-field scan;
- Method B: variable aperture in the far field;
- Method C: near-field scan.

Information pertaining to each individual method is given in Annexes A, B and C of IEC 60793-1-45:2001. Only notes for PM fibre are described below.

The MFD of the PM fibre is non-axisymmetric in principle. The MFD is measured in the same directions by rotating the fibre around the axis properly. The azimuthal dependence of the MFD of a stress induced PM fibre and an elliptical sheath PM fibre are relatively small. On the other hand, the azimuthal dependence of the MFD of an elliptical core PM fibre is relatively large. The MFD of a stress induced fibre and an elliptical sheath PM fibre may be measured without rotating the fibre complying with the demand of a required accuracy of the customer depending on the measurement method.

In Method A, the MFD of a stress induced PM fibre and an elliptical sheath PM fibre may be measured without rotating the fibre complying with the demand of a required accuracy by the customer.

In Method B, the MFD of a stress induced PM fibre and an elliptical sheath PM fibre may be measured complying with the demand of a required accuracy of the customer. The MFD is measured as an axisymmetric electromagnetic field in Method B. Therefore, the MFD of the PM fibre cannot be measured in Method B. However, the MFD of a stress induced PM fibre and an elliptical sheath PM fibre may be measured in Method B because of the relatively small azimuthal dependence of the MFD. Method B cannot be used to measure the MFD of an elliptical core PM fibre.

In Method C, a two-dimensional detector is used. The fibre is rotated around the axis properly on measurement with a one dimensional detector.

8 Guidance for beat length measurement of polarization-maintaining optical fibres

8.1 Object

Clause 8 describes measurement methods and test procedures for the beat length of PM fibres.

8.2 Overview of methods

This technical report gives two methods for measuring the beat length of the PM fibre:

- Method A: Phase beat length measurement method (Direct measurement method);
- Method B: Group beat length measurement methods (Indirect measurement method).

Phase beat length, $L_{B\ (phase)}$ and group beat length, $L_{B\ (group)}$ are measured in Method A and B, respectively. As shown in Annex B, the beat lengths obtained by Methods A and B are based on different definitions, and will often give different results depending on the type of PM fibre. Differences of more than 100 % have been reported [2]. Therefore, the definition of the measured beat length parameter (phase or group) and the measurement method need to be stated in the measurement result of beat length. Mentioning of the measurement method may be excluded according to an agreement between the customer and the supplier.

8.3 Reference test method

Method A is the reference test method (RTM), which is the one used to settle disputes.

8.4 Specimen

A specimen length is the minimum necessary to set up the test apparatus. If the specimen is extra long, care shall be taken that no stresses will be induced in the specimen.

8.5 Beat length measuring method

8.5.1 Method A: Phase beat length measurement method

8.5.1.1 General

The phase beat length measurement method is based on applying a point-like perturbation along a short length of the fibre under test, and either monitor the changes in output power, or monitor changes in output SOP at one wavelength versus travel distance.

The perturbation can either be a lateral force or an electromagnet.