

End-face image analysis procedure for the calibration of optical fibre geometry test sets

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The UK participation in its preparation was entrusted to Technical Committee GEL/86, Fibre optics, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the IEC title page, pages ii to iv, pages 1 to 25 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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INTERNATIONAL STANDARD

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End-face image analysis procedure for the calibration of optical fibre geometry test sets



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Foreword

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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International Standard IEC 61745 has been prepared by IEC technical committee 86: Fibre optics.

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

FDIS	Report on voting
86/125/FDIS	86/134/RVD

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

Annex C forms an integral part of this standard.

Annex A, Annex B, Annex D, Annex E, Annex F and Annex G are for information only.

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

1 General

1.1 Scope and object

In the research and production environments there exists a range of test methods for characterizing the geometry of optical fibres. Furthermore, each test method may determine one or more of the many parameters required for complete geometrical characterization. This International Standard describes the calibration of test sets which perform end-face image analysis, also known as near-field or grey-scale analysis. The principles, however, may be applied to test sets of a different type.

This standard addresses the calibration of measurements made on single-mode fibres only; however, this type of test set may also be used to measure the geometrical parameters of the cores of multimode fibres, but the evaluation of uncertainties associated with these measurements is beyond the scope of this standard.

The procedures outlined are to be performed by calibration laboratories and by the manufacturers or users of geometry test sets, for the purpose of calibrating geometry test sets and for evaluating the uncertainties in measurements made on calibrated test sets. The calibration of fibre coating or cable measurement test sets is not covered by this standard. The object of this standard is to define a standard procedure for the calibration of test sets for measuring the glass geometry of optical fibres.

1.2 Definitions

For the purpose of this International Standard, the following definitions apply.

1.2.1

accredited calibration laboratory

calibration laboratory authorised by the appropriate National Standards laboratory to issue calibration certificates with a specified uncertainty, which demonstrate traceability to national standards

1.2.2

artefact

any object that is measured on or used to calibrate a geometry test set. An artefact may be, for example, an optical fibre or a chromium-on-glass pattern

1.2.3

calibration

process by which the relationship between the values indicated by the geometry test set under calibration and the known values of the calibration standard is established. The purpose of calibration is to bring all geometry test sets into substantial agreement with a national standards laboratory. This may be performed either by adjustment of the geometry test set or by documentation of a calibration factor(s) in a calibration certificate. The pertaining environment and instrument conditions at the time of calibration are usually recorded. Calibration includes estimation of all uncertainties

1.2.4

calibration chain

chain of transfers from a national standard to the geometry test set through intermediate or working standards (see Figure 1)

1.2.5

calibration checking

establishing that a geometry test set that has been previously calibrated but has reached its calibration due date remains within specified uncertainty limits. If the geometry test set has drifted outside these limits, then re-calibration is required. Otherwise, the re-checking period can be extended for a stated period. The test set may be checked using a working standard

1.2.6

calibration standard

artefact that is calibrated against a reference standard and is used to calibrate test sets. The artefact may be a fibre or a chromium-on-glass pattern. Proper use of a calibration standard ensures traceability. The term includes the reference standard, the transfer standard and the working standard(s), in descending order of metrological uncertainty

1.2.7**combined standard uncertainty**

combination of a number of individual standard uncertainties

the term “accuracy” should be avoided in this context

in calibration reports and technical data sheets, the combined standard uncertainty in the geometry test set measurement is reported as an overall expanded uncertainty with the applicable confidence level, for example 95,5 % or 99,7 %

1.2.8**confidence level**

estimation of the probability that the true value of a measured parameter lies within a given range (expanded uncertainty)

1.2.9**correction offset**

number that is added to or subtracted from the measurement result of a test set to correct for a known physical effect

1.2.10**coverage factor, k**

factor used to calculate the expanded uncertainty U from the standard uncertainty

1.2.11**expanded uncertainty, U**

range of values within which the true value of the measured parameter, at the stated confidence level, can be expected to lie. It is also called the confidence interval and is equal to the coverage factor k times the standard uncertainty u :

$$U = k \cdot u$$

the measurement uncertainty of a geometry test set should be specified in the form of expanded uncertainty

NOTE When the distribution of uncertainties is assumed to be normal and a large number of measurements are made, then confidence levels of 68,3 %, 95,5 % and 99,7 % correspond to values for k of 1, 2, and 3 respectively (see clause C.3).

1.2.12**geometry test set**

instrument used to measure the geometrical parameters of an optical fibre. The parameters measured will depend on the type of geometry test set

1.2.13**infant fibre**

fibre whose geometry is to be measured on a calibrated geometry test set

1.2.14**instrument state**

description of the measurement conditions of the geometry test set during calibration and measurement, for instance form-fits used, data filtering schemes employed and other important information concerning the test set such as warm-up time and date of calibration

1.2.15**national standard**

standard whose measurement is traceable to fundamental quantities, such as the wavelength of light, and which is used as the basis for fixing the value, in a country, of all other standards of the quantity concerned

1.2.16**national standards laboratory**

body or laboratory that maintains and operates the national standard

1.2.17**operating range**

range of conditions under which the geometry test set is designed to perform within the stated expanded uncertainty; for example diameter of the fibre being measured and environmental conditions, such as temperature

1.2.18**reference standard**

artefact measured at a calibration laboratory, with the measurement traceable to national standards

1.2.19**scaling factor**

ratio of the known standard values for a calibration standard to the values indicated by the geometry test set when no correction offsets are applied

1.2.20**standard uncertainty**

standard uncertainty may be evaluated either by statistical methods, termed type A evaluation, or by other means, termed type B evaluation (see Annex C for a more detailed description)

a type A evaluation of uncertainty consists of a statistical analysis of a series of measurements, such as when evaluating certain random effects of measurement

a type B evaluation of uncertainty is used when a statistical analysis is not appropriate. It consists of an estimation of the probable sources of uncertainty, such as when evaluating certain systematic effects of measurement

NOTE In order to combine standard uncertainties from different sources it is important that they all be stated at the same confidence level. This may be achieved by use of the coverage factor k , which is determined with reference to Student's t distribution for each individual uncertainty component.

1.2.21**traceability**

ability to demonstrate, for a measurement result or a geometry test set, a calibration chain originating from a national standard

geometry test sets calibrated by the procedures in this standard are traceable. Direct traceability of the measurement result to either a national standards laboratory or to an accredited calibration laboratory needs to be demonstrated. Such traceability includes the calibration schedules of all artefacts in the calibration chain and detailed calculations of all (cumulative) transfer uncertainties in the calibration chain. The use of a working standard alone to compare or monitor geometry test set calibration cannot establish or re-establish traceability, but can only extend the duration of the traceability certification if no change is found

1.2.22**transfer standard**

standard that is calibrated against a reference standard and is used for calibrating geometry test sets

1.2.23**transfer uncertainty**

estimate characterizing the uncertainty of a measurement caused by uncertainties in the transfer process, at the given confidence level (such as changes in environmental conditions). These uncertainties may arise from the calibration standards used as well as from the geometry test set

1.2.24**working standard**

standard that is usually calibrated against a transfer standard or a reference standard and is used on a routine basis to check geometry test sets