IEC 61300-3-30

Edition 2.0 2020-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-30: Examinations and measurements – Endface geometry of rectangular ferrule

Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures –
Partie 3-30: Examens et mesures – Géométrie de la face terminale de la ferrule rectangulaire

IEC 61300-3-30:2020-12(en-fr)

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

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FOREWORD

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International Standard IEC 61300-3-30 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) measurement of the individual fibre tip radii;
b) introduction of the geometry limit (GL) metric;
c) introduction of the minus coplanarity metric;
d) new method for measuring the core dips;
e) all measurement regions are now identical for MM and SM fibres;

f) the ferrule surface angle sign convention has been changed.

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

FDIS	Report on voting
86B/4357/FDIS	86B/4378/RVD

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 61300 series, published under the general title *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures*, can be found on the IEC website.

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- withdrawn,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.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-30: Examinations and measurements – Endface geometry of rectangular ferrule

1 Scope

This part of IEC 61300 describes a method of measuring the end face geometry of rectangular multifibre ferrules having an IEC defined optical interface. The primary attributes are fibre position relative to the end face, either withdrawal or protrusion, end face angle relative to the guide pin bores, fibre tip radii and core dip for multimode fibres.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 General description

Guide pin based multifibre connector plugs typically have a rectangular end face with a long axis and a short axis. Ideally, a flat polish is desired on the end face with the fibres protruding slightly and all in the same plane to assure physical contact of the fibre cores when two connectors are intermated. In practice, the end face typically has two different curvatures across the surface along the long and short axis. Since mated ferrules are aligned by pins in the guide holes, the end face of the ferrule shall be properly oriented (S_x and S_y angles) with respect to the guide holes to achieve positive contact. The end face angle S_x in the x axis and the end face angle S_y in the y axis are measured by finding the best fit plane based on a percentage of the highest points in a specified region of interest. The highest points typically show the greatest modulation from an interferometric standpoint. This allows for more robust measurements and greater repeatability between different interferometers.

The angle of the best fit plane is calculated by comparing it to the reference plane which is perpendicular to the axis of each guide hole. The height H (positive is a protrusion) of the fibres is a planar height defined as the distance between the fibre end face and the best fit plane. Core dip is of more relevance to multimode fibres because the large core is softer than the cladding of the fibre and tends to polish away faster. Core dip is calculated using the paraboloid method described in Annex E.

One method is described for measuring polish angle and fibre position for a single ferrule multifibre connector by analysing the endface with a three-dimensional interferometry type surface analyser.

5 Measurement regions

The following regions shall be defined on the ferrule end face.

a) Region of interest (ROI): the ROI is set on the ferrule surface and defined by a rectangular region having a long axis (x axis) of length, L, and a short axis (y axis) of height, H. The region of interest is chosen to cover the intended contact zone of the ferrule end face when the ferrules are mated. The region of interest shall be centred on the fibre array. See Figure 1. Refer to Table 1 for measurement areas to be used for different connectors.

b) Extracting region*:* the extracting region, which includes the fibre end face regions and the associated adhesive regions, is defined by circles having a diameter E, centred on each fibre;

c) Averaging region*:* the averaging region is set on the fibre surfaces to be used to calculate the fibre height, and is defined by a circle having a diameter F. The averaging region is the same for singlemode (SM) fibres and multimode (MM) fibres.

d) Core dip region*:* the core dip region is set on the fibre surfaces to be used to calculate the fibre core-dip using the paraboloid method, and is defined by circles having a diameter CD, centred on each fibre.

Core dip adjustment constant*:* the calculated core dip amplitude following the fit of a paraboloid function to the fibre endface is adjusted by means of constant R_1.

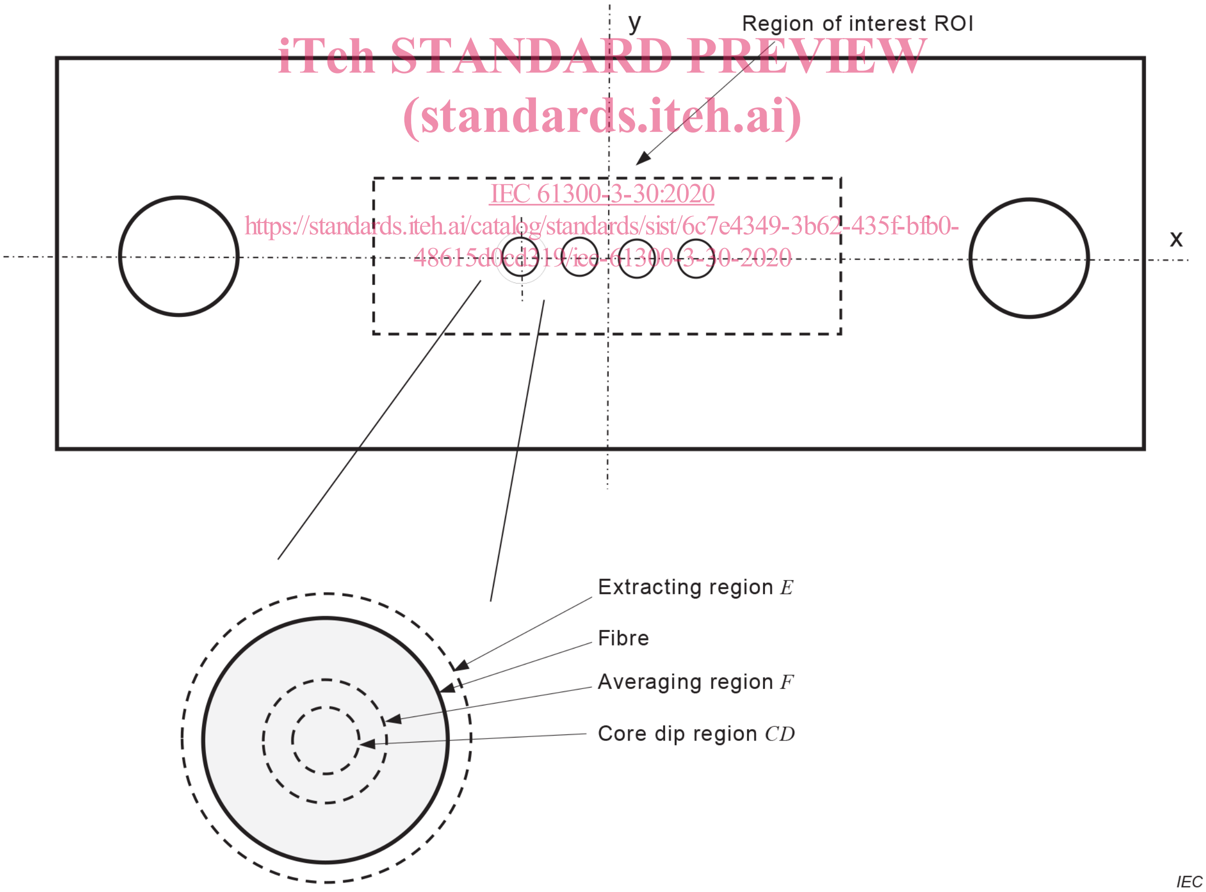


Figure 1 – Measurement regions on ferrule and fibre

Table 1 – Ferrule measurement areas and parameters

Ferrule type (variant number) [a]	Descrip-tion	Region of interest, ROI ($L \times H$) mm[2]	% top pixels excluded	Next % top pixels used	Extracting region (diameter E) mm	Averaging region- SM + MM (diameter F) mm	Core dip fitting region (diameter CD) mm	Core dip adjustment constant R_1 (see Annex E)
x104	MT-04	2,900 × 0,675	3	20	0,140	0,05	0,03	0,03
x108	MT-08	2,900 × 0,675	3	20	0,140	0,05	0,03	0,03
x112	MT-12	2,900 × 0,675	3	20	0,140	0,05	0,03	0,03
x124	MT-24	2,900 × 1,160	3	20	0,140	0,05	0,03	0,03
1002	MiniMT	0,900 × 0,675	3	20	0,140	0,05	0,03	0,03

[a] The x defines 1 for polyphenylene sulfide (PPS) resin ferrule materials and 2 for thermoset materials; the second digit represents 2,45 mm × 4,4 mm with 0 and 2,45 mm × 6,4 mm with 1; and the last two digits designates the number of fibres (see Table 1 of IEC 61755-3-31:2015 and Table 1 of IEC 61755-3-32:2015).

6 Apparatus

6.1 General

The apparatus shown in Figure 2 consists of a positioning stage, a ferrule holder, an interferometric video microscope, a Personal Computer based fringe interpretation unit and a monitor to view the ferrule endface interferogram and display the analysis results.

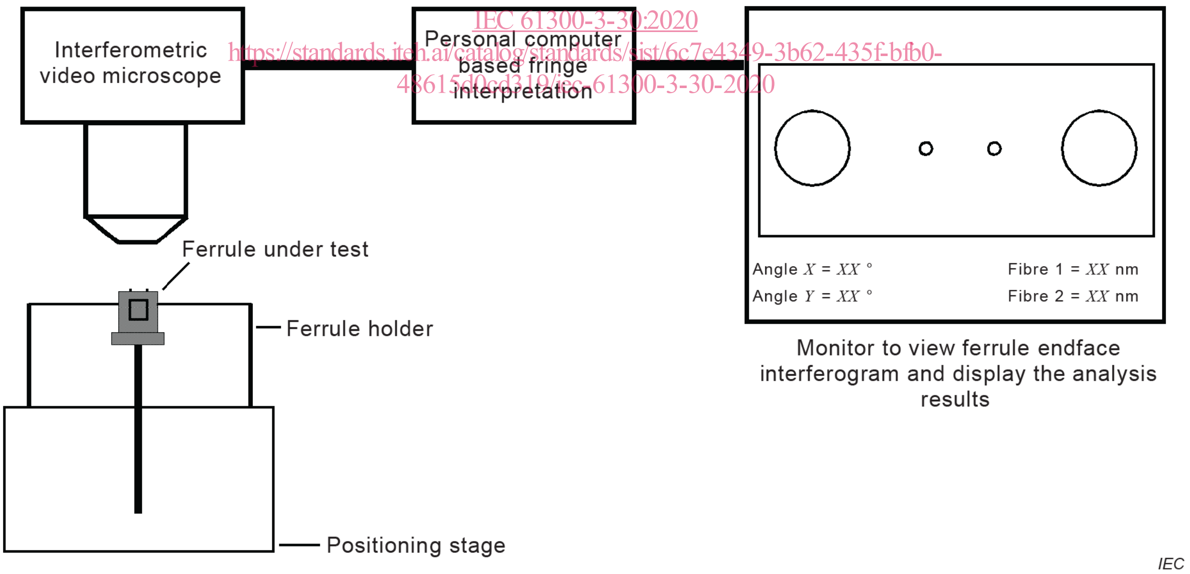


Figure 2 – Measurement setup

6.2 Ferrule holder

The ferrule holder is a suitable device to hold the ferrule in a fixed position, either vertical or horizontal, or in a tilted position in the case of an angled ferrule type. Some method shall be used to determine the axis of each guide hole and the average plane perpendicular to the guide hole axes. This plane shall be considered as the reference plane P for reference to subsequent measurements.

6.3 Positioning stage

The ferrule holder is fixed to the positioning stage, which shall enable the ferrule holder to be moved to the appropriate position. The stage shall have sufficient rigidity to allow measurement of the ferrule end face parameters within the required uncertainties detailed in 6.4.

6.4 Three-dimensional interferometry analyser

The three-dimensional interferometry analyser shall have the ability to measure the fibre heights on the ferrule end face with an uncertainty better than ±50 nm and the core dips with an uncertainty better than ±20 nm. The analyser shall consist of an interferometric video microscope unit, a Personal Computer based fringe interpretation (surface data processing) unit and a monitor.

The interferometric video microscope unit shall consist of an interference microscope, a phase shift actuator, an image detector and an image acquisition and processing setup. The interference microscope equipped with an objective is arranged so as to view the end face of the ferrule.

The following parameters of the interference microscope shall be calibrated:

- optical magnification of the microscope;
- Z travel of the phase shift actuator;
- ferrule holder tilt angle in the case of an angled ferrule type.

The surface data processing unit shall be able to process the surface height information so as to measure the following parameters:

- ferrule surface x-angle S_x (refer to Figure B.1 a) for the sign convention);
- ferrule surface y-angle S_y (refer to Figure B.1 b) for the sign convention);
- fibre array minus coplanarity CF;
- fibre plane x-angle G_x;
- fibre plane y-angle G_y;
- fibre tip spherical radii RF (some conditions apply; see Clause 7, m); refer to Figure C.1 for fibre counting convention);
- core dip CD (some conditions apply; see Clause 7, l); refer to Figure C.1 for fibre counting convention);
- geometry limit GL;
- ferrule surface x-radius R_x;
- ferrule surface y-radius R_y;
- fibre height H (refer to Figure C.1 for fibre counting convention);
- adjacent fibre height differential HA (refer to Figure C.1 for fibre counting convention);

The monitor shall display the measured and calculated surface profiles along each axis.

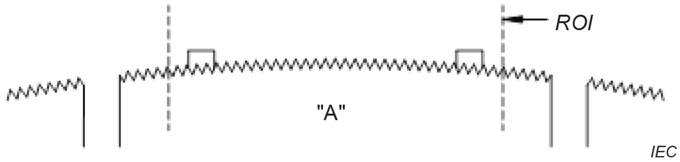
7 Procedure

The following procedure shall be used for this measurement.

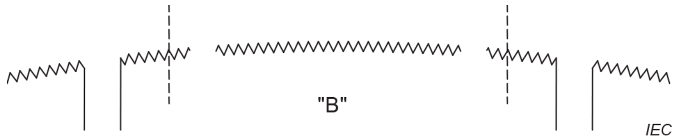
a) Affix the ferrule in the ferrule holder so that the end face is held sufficiently steady with respect to the interferometer.

b) Focus the microscope and/or the sample until the fringes are in position to scan the surface.

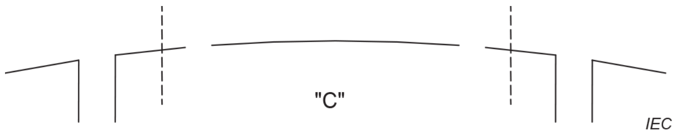
c) Map the surface of the ferrule. To create data set "A", use only the pixels contained within the ROI.



d) Create data set "B" by removing the extracting regions around the fibres.



e) Create surface "C" by fitting a bi-parabolic curve to data set "B" (see Annex A for the curve fitting routine).

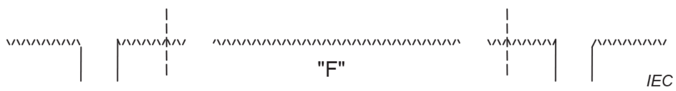


f) Create data set "D" by subtracting surface "C" from data set "B"

g) Create data set "E" by removing the highest 3 % of all pixels in data set "D". This removes any small points that are extremely high compared to the others. It is assumed these will break off when the connectors contact.

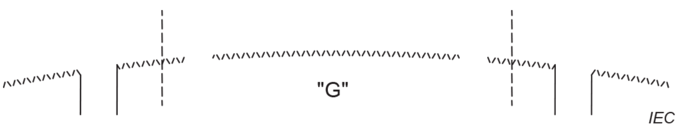
NOTE Points are selected as a percentage of the total area which includes pixels for which heights could not be determined.

h) Create data set "F" by identifying the highest 20 % of all pixels in data set "E".

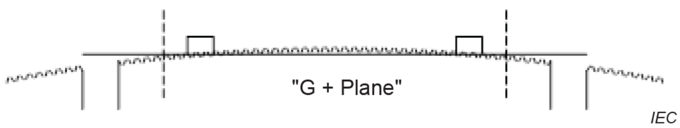


NOTE Points are selected as a percentage of the total area which includes pixels for which heights could not be determined.

i) Create data set "G" by eliminating all pixels from data set "A" except for those identified in data set "F".



j) Fit a plane to data set "G" and use the plane to calculate S_x and S_y angles using plane P as a reference (see Annex B for end face angle sign conventions). "Add" the extracting regions back in.



Calculate the fibre heights H as the distance normal to the plane at the corresponding fibre centre locations (see Annex C for fibre counting conventions). Calculate the adjacent fibre height differential HA for each fibre. For a given fibre, HA is the largest height difference to the two (single row ferrule case) or four (multi row ferrule case) neighbour fibres.

k) Fit a bi-parabolic curve to data set "G" (see Annex A for the curve fitting routine). Calculate the ferrule surface R_X and R_Y radii values.

l) Determine the core dip (for multi-mode and singlemode fibres) CD of each fibre. See Annex E for a detailed procedure.

If CD of a given fibre is positive and larger than 10 nm, report CD and skip step m) for that given fibre.

If CD of a given fibre is negative or smaller than 10 nm, do not report CD for that given fibre and proceed to step m).

m) Determine the radius RF of a given fibre tip. This is accomplished by fitting a sphere to the surface points of the averaging region of the fibre (see Annex A for the curve fitting routine). The radius of the fitted sphere is then taken as the fibre tip radius.

n) Determine the minus coplanarity CF. See Annex D for a detailed procedure. Use the fibre plane to calculate G_X and G_Y angles using the average of the guide pin bore axes as a reference (see Annex B for end face angle sign conventions).

o) If CD is negative or smaller than 10 nm for more than 50 % of the fibres, determine the geometry limit GL using the median value of the RF values of the fibres which exhibited a negative CD. See Annex F.

8 Details to be specified

The following items shall be specified for this measurement:

– type of interferometry;
– nominal angle of tilt, for example Physical contact (PC)/angled PC (APC);
– any deviation from this method;
– measurement uncertainty.