IEC 61300-3-47

Edition 1.0 2014-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-47: Examinations and measurements – End face geometry of PC/APC spherically polished ferrules using interferometry

Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures –
Partie 3-47: Examens et mesures – Géométrie de l'extrémité des férules PC/APC polies de façon sphérique par interférométrie

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CONTENTS

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

Part 3-47: Examinations and measurements – End face geometry of PC/APC spherically polished ferrules using interferometry

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This standard merges IEC 61300-3-15, IEC 61300-3-16, IEC 61300-3-17 and IEC 61300-3-23. After publication of this standard IEC 61300-3-15, IEC 61300-3-16, IEC 61300-3-17 and IEC 61300-3-23 will be withdrawn.

This bilingual version (2019-07) corresponds to the English version, published in 2014-07.

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

FDIS	Report on voting
86B/3773/FDIS	86B/3805/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.

This publication 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 and passive components – Basic test and measurement procedures*, can be found on the IEC website.

The French version of this standard has not been voted upon.

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

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- replaced by a revised edition, or
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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – BASIC TEST AND MEASUREMENT PROCEDURES –

Part 3-47: Examinations and measurements – End face geometry of PC/APC spherically polished ferrules using interferometry

1 Scope

This part of IEC 61300 describes a procedure to measure the end face geometry of a spherically polished ferrule or connector. Within this standard the words “ferrule” and “connector” can be used interchangeably.

2 Terms and definitions

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

2.1
radius of curvature
B
radius of curvature of the portion of the spherically polished ferrule end face which is domed for physical contact

Note 1 to entry: It is assumed that the end face is spherical, although in practice the end face is often aspherical (see Figure 1).

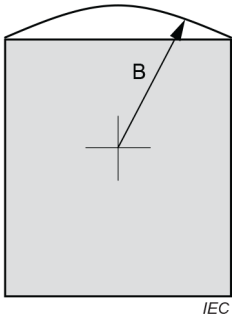

Figure 1 – Radius of curvature of a spherically polished ferrule end face

2.2
apex offset
C
distance between the axis of the ferrule and the line parallel to the axis which passes through the vertex (or highest point on the dome), formed by spherically polishing the ferrule, as shown in Figure 2

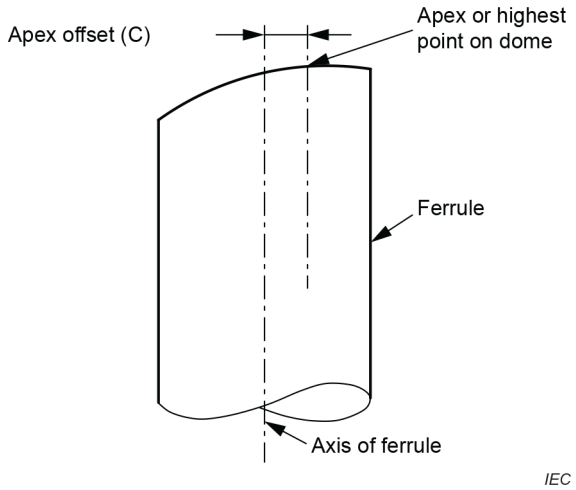

Figure 2 – Apex offset of a spherically polished ferrule end face

2.3
fibre height
average distance between the fibre end face and a virtual spherical surface which is fitted to the spherically polished ferrule end face (see Annex C)

Note 1 to entry: It is assumed that a circular region of the ferrule end face, which is centred to the ferrule axis, is spherical although in practice the end face is often aspherical. A positive value indicates fibre undercut (see Figure 3a). A negative value indicates fibre protrusion (see Figure 3b).

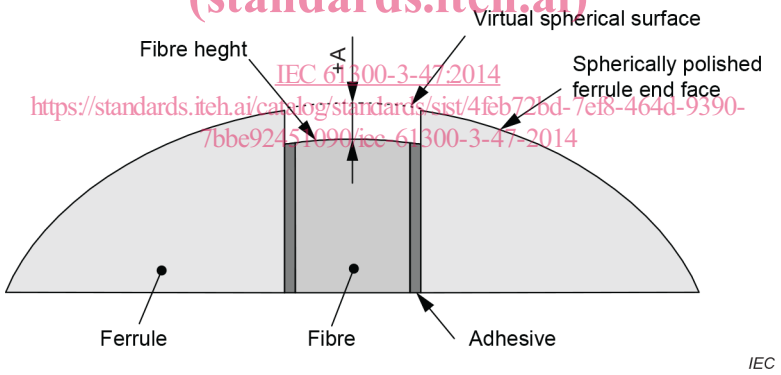

Figure 3a – Fibre height +A

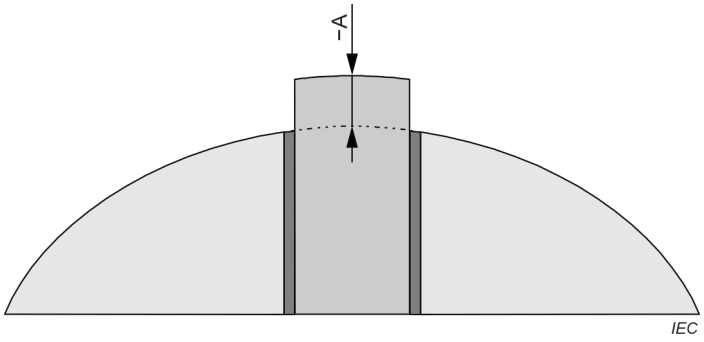

Figure 3b – Fibre height –A (protrusion)

Figure 3 – Fibre height of a spherically polished ferrule end face

2.4
end face angle
angle (θ) between the plane perpendicular to the axis of the ferrule, and the straight line tangent to the polished surface at the fibre centre in the direction of the nominal angle (see Figure 4)

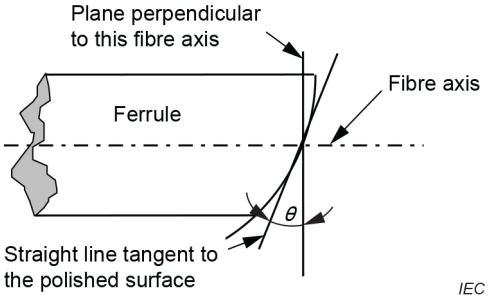

Figure 4 – Ferrule end face angle for spherically polished ferrules

3 Measurement by interferometer

3.1 General

A typical interferometer configuration is shown in Figure 5. The apparatus consists of a suitable ferrule/connector holder, an optical interferometric system combined with a microscope and a camera.

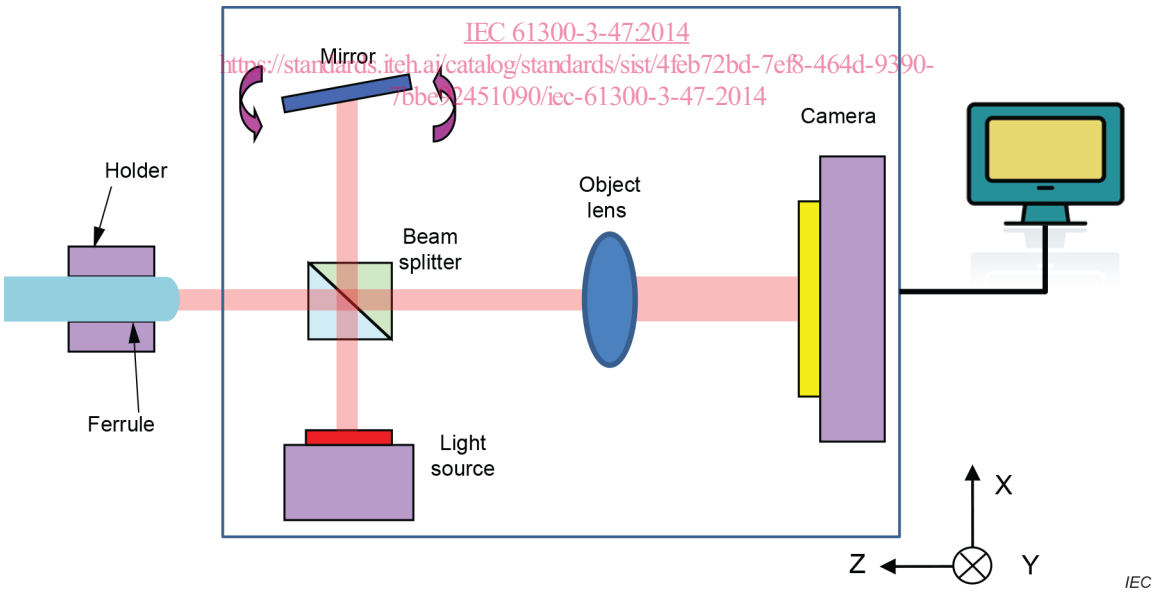

Figure 5 – Interferometer

3.2 Ferrule/connector holder

This is a suitable device to hold the ferrule/connector in a fixed alignment position with respect to the optical axis of the interferometer. The holder is designed such that the portion of the ferrule closest to the end face is secured by the holder. The ferrule shall be aligned by holding it over a distance of at least twice the ferrule diameter. The ferrules axis should be adjustable in order to make it parallel to the optical axis of the interferometer. Alternatively, this can be carried out by positioning the reference mirror of the interferometer. For angled polished ferrules adjustments are necessary to align the polish angle axis with the optical axis of the interferometer.

3.3 Optical interferometric system

A suitable optical interferometric system (for example a Michelson interferometer) displays an image with interference fringes of the ferrule's end face.

3.4 Microscope with camera

The image of the end face is projected on to the camera with a minimum field of view of 250 μm. Software processes the image(s) and calculates the required parameters.

4 Requirements for the interferometer

4.1 XY calibration (radius of curvature)

The interferometer shall have the ability to measure the radius of curvature with measurement uncertainty better than ±0,1 mm for radii from 5 mm to 30 mm. See Annex A.

4.2 Z calibration (fibre height)

The interferometer shall have the ability to measure the fibre height with measurement uncertainty better than ±10 nm. See Annex A.

4.3 Alignment of ferrule axis with the interferometer's optical axis (apex offset calibration)

The interferometer shall have the ability to measure the apex offset with a maximum difference of less than 5 μm between two measurements where the second measurement is made after rotating the ferrule by 180°. See Annex A.

NOTE This test is only possible with non-angled ferrules.

4.4 Tilt and key angle

When measuring angled connectors, calibration of the holder position is required. Measurement of a flat polished ferrule should have a measurement uncertainty better than ±0,1° for the key angle and ±0,03° for the tilt angle.

NOTE The key angle is the angular rotational misalignment between the ferrule mating surface of an angled end face connector, and its design orientation angle with respect to its key (see Annex B).

5 Measurement method

5.1 General

For all measurements, the instrument should be adjusted such that

a) a sample is placed in the measurement holder,

b) the image of the ferrule end face in the fibre zone is seen on the monitor,

c) the interference fringes appear on the ferrule end face,

d) the ferrule axis is correctly aligned with the optical axis of the interferometer ("apex offset calibration"),

e) all other instrument calibrations have been performed,

f) the system is configured according to the type of measurement to be performed (e.g. PC or APC ferrule/connector).

5.2 Measurement regions

Three regions shall be defined on the ferrule end face for the measurement (see Figure 6).

a) Fitting region: the fitting region is set on the ferrule surface, and defined by a circular region having a diameter, D, minus a circular region having a diameter, E, (the extracting region). The fitting region shall be defined in order to cover the contact zone of the ferrule end face when the ferrule is mated.

b) Extracting region: the extracting region, which includes the fibre end face region and the adhesive region, is defined by a circle having a diameter E.

c) Averaging region: the averaging region is set on the fibre surface, and defined by a circular region “having a diameter F”. This region is used for fibre height A averaging.

The 3 regions should be concentric on the ferrule axis. For connectors with 125 μm nominal fibre diameter and a radius of curvature of nominally 5 mm to 30 mm, the values of the diameters D, E and F are as follows:

D = 250 μm

E = 140 μm

F = 50 μm

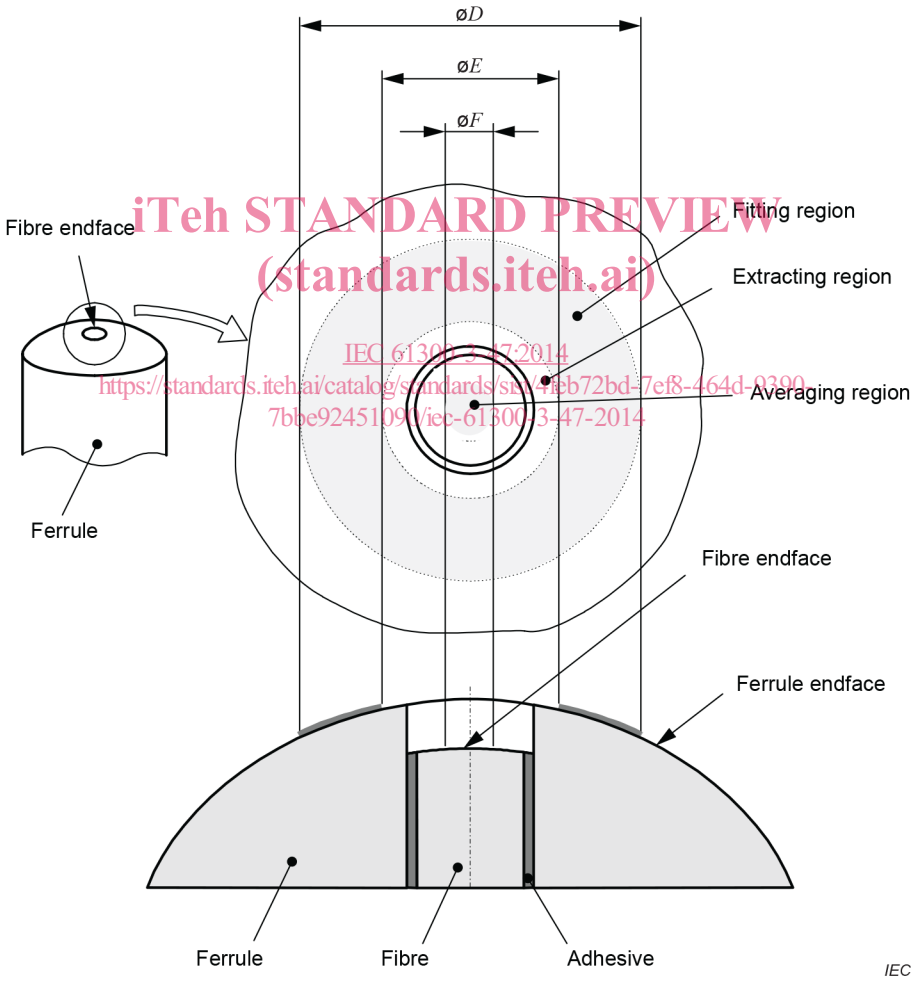

Figure 6 – Ferrule end face and measurement regions

5.3 Measurement procedure for the radius of curvature

The following steps shall be taken:

a) Measure the surface of the end face with the interferometer, recording the three-dimensional surface measurement data on its surface data processing unit (see Figure 7).

b) Correct the surface data, taking into account the refractive indices and the absorption coefficients of the fibre and the ferrule.

c) Using the data from the fitting regions, calculate the “best fit” radius of curvature (Annex C).

5.4 Measurement procedure for the dome eccentricity (apex offset)

The following steps shall be taken:

a) Measure the surface of the end face with the interferometer, recording the three-dimensional surface measurement data on its surface data processing unit (see Figure 7).

b) Correct the surface data, taking into account the refractive indices and the absorption coefficients of the fibre and the ferrule.

c) From the analysis of the interference image(s) the normal distance between the centre of the sphere (Annex C) fitted to the surface over the fitting region and the fibre axis shall be measured. This value corresponds to the apex offset.

5.5 Measurement procedure for fibre height

The following steps shall be taken:

a) Measure the surface of the end face with the interferometer, recording the three-dimensional surface measurement data on its surface data processing unit (see Figure 7).

b) Correct the surface data, taking into account the refractive indices and the absorption coefficients of the fibre and the ferrule.

c) Using only the data within the averaging region and the fitting region evaluate A (see Figure 7 to Figure 10 and Annex C).

The calculation shall be as follows:

1) Create a converted surface from the corrected surface data by subtracting the “best fit” radius of curvature from the spherical surface data between the fitting region. The fitting region of the converted surface may be flat when the ferrule end face has an ideal spherical surface (See Figure 9).

2) Calculate an average surface height on the fibre averaging region and an average surface height on the fitted ferrule portion from the converted surface. The fibre height, A, is measured as the difference between the two average surface heights, as shown in Figure 10. A positive value indicates fibre undercut. A negative value indicates fibre protrusion.