IEC 61300-3-54

Edition 1.0 2019-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fibre optic interconnecting devices and passive components – Basic test and measurement procedures –
Part 3-54: Examinations and measurements – Angular misalignment between ferrule bore axis and ferrule axis for cylindrical ferrules

Dispositifs d'interconnexion et composants passifs fibroniques – Procédures fondamentales d'essais et de mesures –
Partie 3-54: Examens et mesures – Erreur d'alignement angulaire entre l'axe de l'alésage de férule et l'axe de férule pour les férules cylindriques

IEC 61300-3-54:2019-07(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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

FDIS	Report on voting
86B/4203/FDIS	86B/4215/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 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 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- withdrawn,
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- amended.

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

Part 3-54: Examinations and measurements – Angular misalignment between ferrule bore axis and ferrule axis for cylindrical ferrules

1 Scope

This part of IEC 61300 describes the procedure to measure the angular misalignment between the ferrule bore axis and the outside diameter datum axis of a cylindrical ferrule.

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.

ISO 1938-1, *Geometrical product specifications (GPS) – Dimensional measuring equipment – Part 1: Plain limit gauges of linear size*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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
angular misalignment
angle θ between the ferrule outside diameter datum and the ferrule bore axis

Note 1 to entry: The angular misalignment is measured in degrees.

Note 2 to entry: See Figure 1.

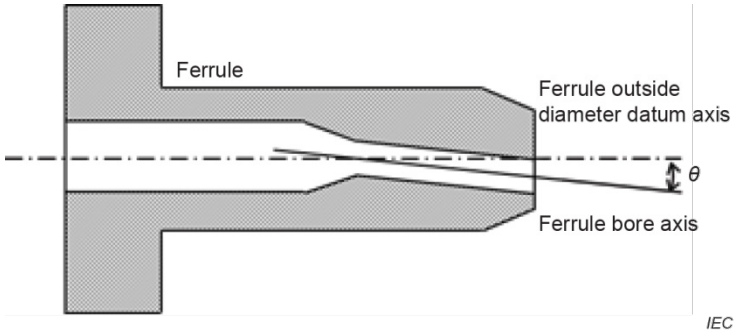


Figure 1 – Angular misalignment between ferrule bore axis and ferrule outside diameter datum axis

3.2
ferrule bore axis
centre axis of the largest cylinder inscribed within the ferrule bore

4 General description

This procedure describes the measurement of the angular misalignment between the ferrule bore axis and the outside diameter datum axis of a cylindrical ferrule.

This procedure measures the angular misalignment θ by measuring the tip image deviation of a pin gauge fitted into the ferrule bore as the ferrule is rotated around its axis.

5 Apparatus

5.1 General

The apparatus shown in Figure 2 consists of the items described in 5.2 to 5.7. Alternative apparatus may be used if it does not have a negative impact on the measurement uncertainty. The most significant terms in the uncertainty budget are described in Annex A.

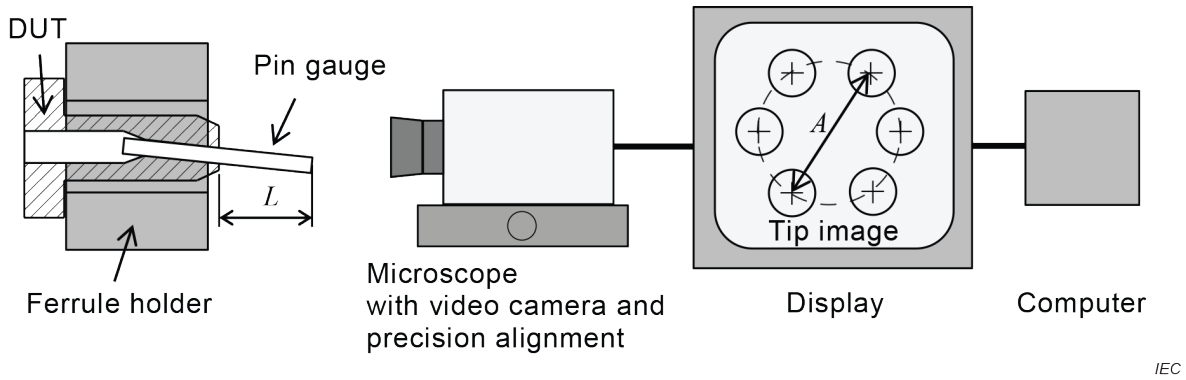


Figure 2 – Example of test apparatus

5.2 Pin gauge

The pin gauge outer diameter shall closely match the bore diameter of the ferrule under test. The pin gauge shall be in accordance with ISO 1938-1.

5.3 Ferrule holder

The ferrule holder shall have a precise V-groove or other outer diameter (OD) reference mechanism so that the ferrule is placed and rotated around its axis. ISO 2538-1 recommends an optimal angle of 108° for the V-groove.

5.4 Microscope with video camera

The microscope shall include a video camera so that the spatial location of the tip of the pin gauge can be measured when the ferrule is rotated in the ferrule holder about its outside diameter datum axis. The video camera and microscope optical axis shall be parallel to the axis of the V-groove or OD reference mechanism to within 0,01°. Recommended video image plane resolution is less than 0,3 μm per pixel.

5.5 Precision alignment stage

The precision alignment stage shall have enough adjustment accuracy to measure the protrusion (L in Figure 2) of the pin gauge from the ferrule endface. Recommended adjustment accuracy is less than 0,01 mm.

5.6 Display

The display shall show the image from the video camera so that the spatial position of the pin gauge can be measured while the ferrule is rotated about its outside diameter datum axis.

5.7 Computer

The computer shall utilize image measurement software that can measure the centre of the pin gauge tip image and calculate a virtual circle by the least square method from multiple measurement points.

6 Procedure

The procedure consists of the following steps.

a) Insert the pin gauge into the bore of the ferrule under test so that the pin gauge protrudes from the ferrule endface. The pin gauge should engage a minimum of 3 mm of the ferrule bore region closest to the ferrule end face. The pin gauge should protrude from the end face by at least 5 mm (L in Figure 2).

b) Place the ferrule into the ferrule holder.

c) Measure the protrusion (L in Figure 2) of the pin gauge by successively focusing the optical system on the ferrule endface and pin gauge endface and noting the distance (L) between the two planes of focus using the precision alignment stage.

d) The ferrule shall be rotated in steps of 60° or less, until a complete rotation is made.

e) Measure each tip image centre position using the computer imaging software as detailed in 5.7.

   To minimize thermal-induced drift, it is recommended all measurements should be made consecutively in a short amount of time (less than one minute).

f) Use the computer and associated software to calculate the diameter (A) of the virtual circle shown in Figure 2.

g) The angular misalignment (θ) between the ferrule bore axis and the ferrule outside diameter datum axis is given by Formula (1):

$$\theta = \arctan\left(\frac{A}{2L}\right) \quad (1)$$

where

L is the protrusion of the pin gauge;

A is the maximum tip image deviation of the pin gauge.

7 Details to be specified

The following details, as applicable, shall be specified in the detail specification:

a) specification and required accuracy of the apparatus;
b) allowable angular misalignment;
c) dimensions of the pin gauge used (length, outer diameter);
d) ferrule bore diameter;
e) protrusion of the pin gauge from the ferrule endface;
f) magnification of the microscope;
g) image plane resolution per pixel;
h) accuracy of the precision alignment stage;
i) deviation from the test procedure;
j) measurement uncertainty of the procedure.

Annex A
(informative)

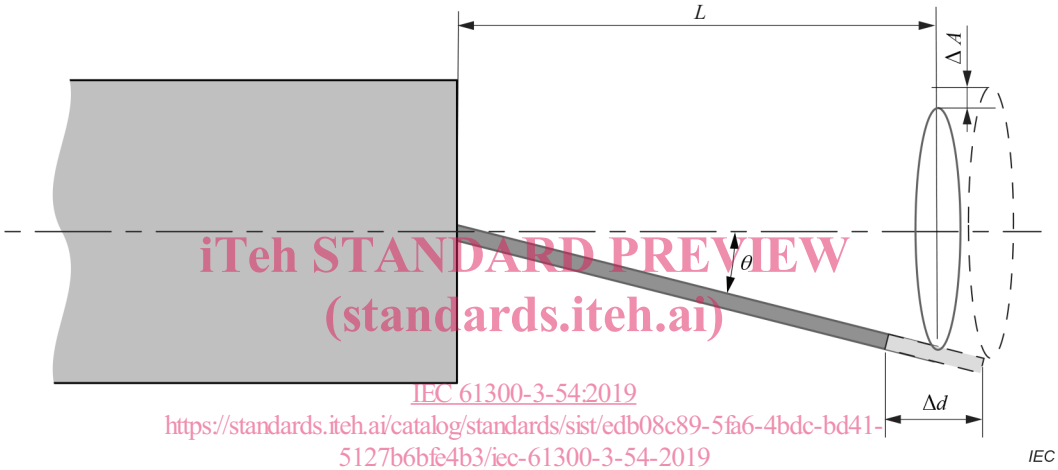
Measurement uncertainty

A.1 General

The measurement uncertainty is considered to be mainly caused by the items described in Clauses A.2 to A.6.

A.2 Precision alignment stage accuracy

The error caused by the precision alignment stage accuracy is shown in Figure A.1.



Key

L pin gauge protrusion

θ angle between the ferrule outside diameter datum axis and the ferrule bore axis

Δd precision alignment stage accuracy

ΔA deviation of virtual circle image caused by precision alignment stage accuracy

Figure A.1 – Diagram of error caused by the precision alignment stage accuracy

The measurement error $\Delta\theta$ associated with Δd can be calculated by Formulae (A.1) and (A.2).

$$\Delta\theta = \arctan\left(\frac{2\Delta A}{2L}\right) = \arctan\left(\frac{\Delta A}{L}\right) \tag{A.1}$$

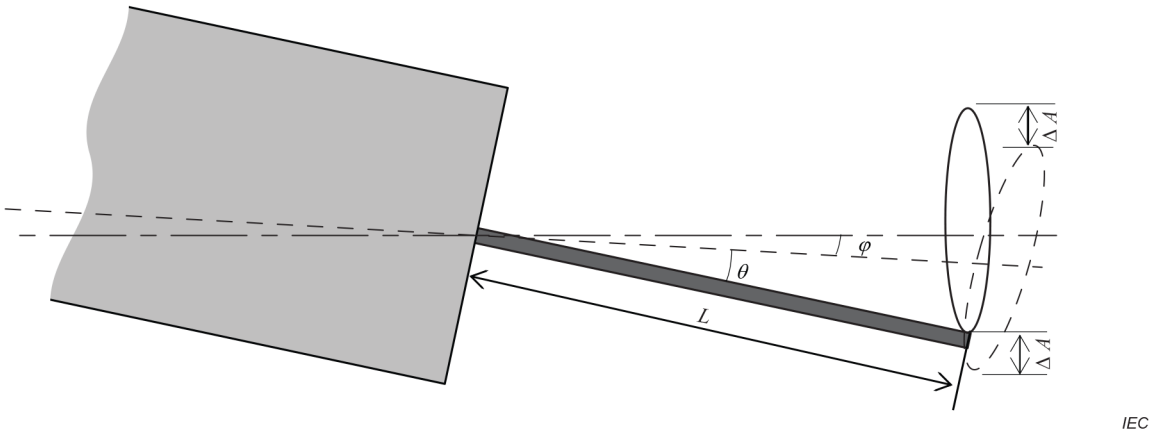
$$\Delta A = \sin\theta \times (L + \Delta d) - \sin\theta \times L = \sin\theta \times (\Delta d) \tag{A.2}$$

The measurement error caused by the precision alignment accuracy is given by Formula (A.3):

$$\therefore \Delta\theta = \arctan\left(\frac{\sin\theta \times (\Delta d)}{L}\right) \tag{A.3}$$

A.3 Misalignment between ferrule holder axis and camera axis

The error caused by the misalignment between the ferrule holder axis and the camera axis is shown in Figure A.2.



Key

L pin gauge protrusion

θ angle between the ferrule outside diameter datum axis and the ferrule bore axis

φ misalignment between the ferrule holder axis and the camera axis

ΔA deviation of virtual circle image by the misalignment between the ferrule holder axis and the camera axis

Figure A.2 – Diagram of error caused by the misalignment between the ferrule holder axis and the camera axis

The measurement error $\Delta\theta$ associated with φ can be calculated by Formulae (A.4) and (A.5).

$$\Delta\theta = \arctan\left(\frac{2\Delta A}{2L}\right) = \arctan\left(\frac{\Delta A}{L}\right) \tag{A.4}$$

$$\Delta A = \frac{A - A\times\cos\varphi}{2} = \frac{2L\times\sin\theta\times(1-\cos\varphi)}{2} = L\times\sin\theta\times(1-\cos\varphi) \tag{A.5}$$

The measurement error caused by the misalignment between the ferrule holder axis and the camera axis is given by Formula (A.6):

$$\therefore \Delta\theta = \arctan\left[\frac{L\times\sin\theta\times(1-\cos\phi)}{L}\right] = \arctan\left[\sin\theta\times(1-\cos\phi)\right] \tag{A.6}$$

A.4 Image plane resolution per pixel

The diagram of maximum error caused by the image plane resolution per pixel is shown in Figure A.3.