IEC TR 62627-06

Edition 1.0 2014-05

# TECHNICAL REPORT

colour inside



## Fibre optic interconnecting devices and passive components – Part 06: Mechanical design proving nutation test results for reinforced fibre cable terminated with optical connectors for high density patching applications

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# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

# Part 06: Mechanical design proving nutation test results for reinforced fibre cable terminated with optical connectors for high density patching applications

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IEC TR 62627-06, which is a technical report, has been prepared by subcommittee SC86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

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

| Enquiry draft | Report on voting |
|---|---|
| 86B/3714/DTR | 86B/3751/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- withdrawn,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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# INTRODUCTION

Optical connectors are widely used in a variety of optical communication systems. These connectors are sometimes used in high density equipment. When an optical fibre cable assembly is connected to a receptacle port, the optical fibre cable assembly connected to an adjacent port may be pulled to one side. During this operation, the pulling force has the potential to act on the optical fibre cable in an oblique direction. When an optical fibre cable assembly is pulled to one side, the tensile force acts on the optical connector in various directions. The optical connector has to possess mechanical durability to withstand the tensile force imposed on it, and an allowable tensile force should be defined to ensure that the system can continue to operate. Therefore test methods are used to evaluate the mechanical durability when an optical fibre cable assembly is pulled laterally. One of these tests methods is nutation.

The IEC Japan National Committee (JPNC) undertook research on a nutation test for optical connectors terminated with reinforced fibre cable.

# FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

## Part 06: Mechanical design proving nutation test results for reinforced fibre cable terminated with optical connectors for high density patching applications

## 1 Scope

This part of IEC 62627, which is a technical report, describes the results of mechanical design proving tests for a high density systems application, carried out using the nutation test according to IEC 61300-2-35, performed on reinforced fibre cable terminated with optical connectors. A tensile load is suggested for the design proving requirements to be used to ensure that connectors meet the mechanical design requirements of connectors for specific application.



## 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 60794-2-50, *Optical fibre cables – Part 2-50: Indoor cables – Family specification for simplex and duplex cables for use in terminated cable assemblies*

IEC 61300-2-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-35: Tests – Cable nutation*

IEC 61300-2-51, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-51: Tests – Fibre optic connector test for transmission with applied tensile load – Singlemode and multimode*

## 3 Fibre operation in high density packaged system

Optical connectors maybe used in high density equipment such as fibre termination modules (FTM) and integrated distribution modules (IDM) where several thousands of optical fibres are terminated (see Figure 1a). Today, compact optical transceivers such as small form-factor pluggable (SFP) modules may be densely packaged in system racks (see Figure 1b). When an optical fibre cable assembly is connected to a receptacle port, the optical fibre cable assembly connected to the adjacent port may be pulled to the side. During this operation, the applied pulling force has the potential to act on the optical fibre cable in a lateral direction. The optical signal in the adjacent fibre link should not be degraded by this operation, so the adjacent fibre optic connector has to have sufficient durability to withstand this force. A test method is used to evaluate mechanical durability when an optical fibre cable assembly is pulled sideways in a high density packaged system.


**Figure 1a – Integrated distribution module (IDM)**

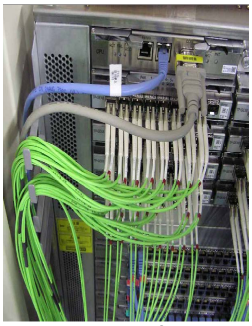



**Figure 1b – System rack with densely packaged SFP**

**Figure 1 – High density packaged equipment**

## 4 Tensile force measurements for reinforced fibre cable assemblies

The tensile force generated when installing an additional connectorized optical fibre cable assembly was measured. Figure 2 shows the experimental set-up for the measurement. The fibre optic connector adaptors are arranged in high density configuration. The tensile load on the fibre cable assembly connected to the adjacent port is measured with a strain gauge as a worker installs another optical fibre cable assembly.

Figure 3 shows a histogram of the tensile load measured. The results were provided by 9 operators, with each one installing the fibre connector 10 times as if in a field installation, without taking any special precautions. The figure also shows a fitting curve using an approximated exponential equation obtained using the frequency data. The maximum tensile load was 8.3 N with an average value of 2,4 N and a standard deviation of 1,8 N.

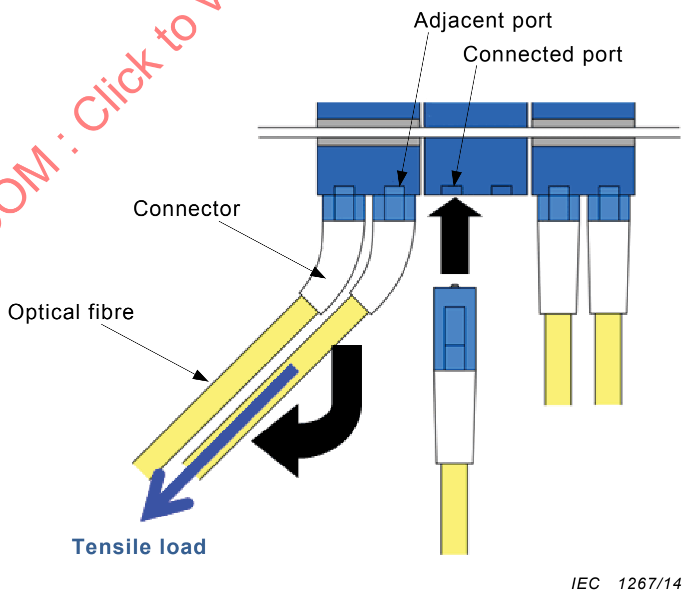



**Figure 2 – Experimental set-up for tensile load measurement**

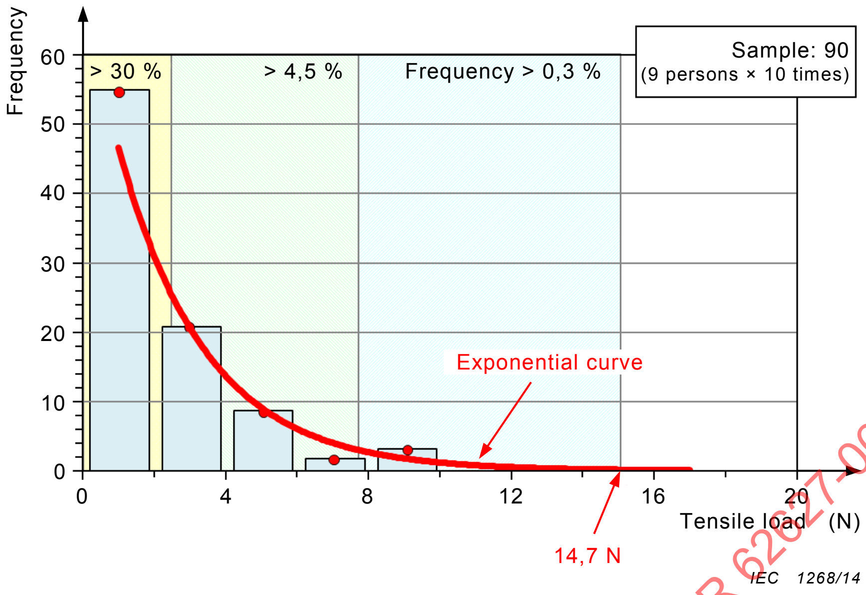



**Figure 3 – Tensile load histogram**



## 5 Adequate tensile force for nutation test

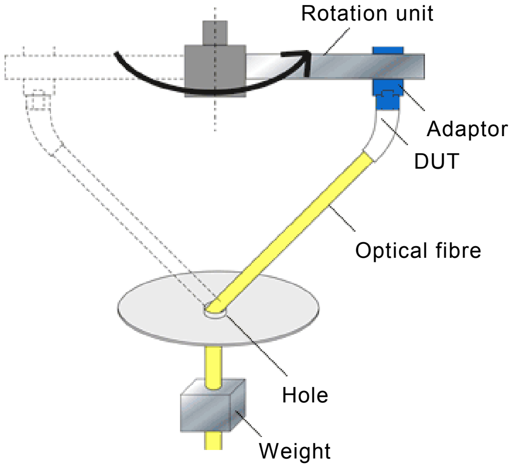
Optical fibre cable assemblies should have sufficient durability to withstand a disturbance by the tensile forces imposed during operation. The quality of the signals being transmitted through an adjacent optical fibre may degrade, and a fatal error may occur, if the force damages the fibre optic connector. To achieve reliable system operation approved cable assemblies are necessary. To define the test requirements a necessary level of the applied tensile load shall be estimated.

Tensile force values can be found in IEC documents to be applied for the nutation test. According to IEC 61300-2-51, the preferred tensile loads are 2,4 N, 6,9 N, 14,7 and 19,6 N. IEC 61300-2-35 also specifies 10 N for the nutation test. When a worker installs a connector, the tensile force acts on the adjacent optical fibre cable assembly in an unknown direction. The optical connector must have mechanical durability to withstand tensile forces in any directions. A nutation test is suitable for evaluating such durability

A tensile load of 10 N in the nutation test is insufficient for field operations because various types of operations may occur. This technical report has calculated with a safety margin determining the load for this sideload to 14,7 N. When the failure mode of a tensile force application is a fracture mode, the result is a fatal failure. A load of 14,7 N has a sufficient margin to ensure a reliable network system.

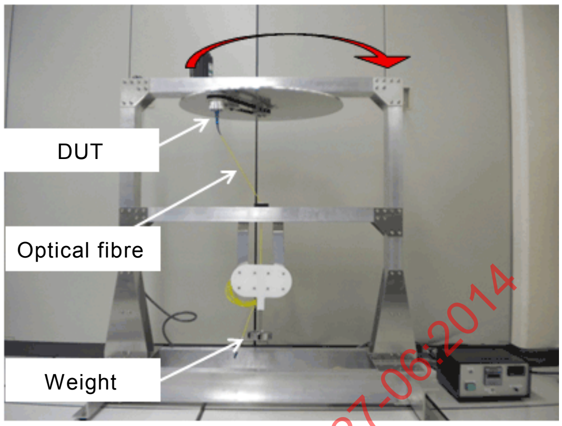
## 6 Nutation test method

A nutation test according to IEC 61300-2-35 evaluates the mechanical durability of an optical fibre cable terminated with an optical connector when the fibre cable is pulled in a direction of 45° from the optical connector. Figure 4 shows the apparatus used for the nutation test. The optical connector plug attached to the fibre cable is connected to an adaptor fixed to the apparatus. The adaptor is rotating through 360° in the rotation fixture. The fibre cable is passed through a hole located in the rotation axis and a weight is attached to the fibre cable to supply the tensile force. The conical path length was set 28 cm which is described as the point of application of the load in IEC 61300-2-51. The apparatus enables the application of tensile force to the optical connector at a direction of 45° while the apparatus and adaptor are rotating.




IEC 1269/14

**Figure 4a – Schematic diagram**




IEC 1270/14

**Figure 4b – Photograph**

**Figure 4 – Nutation test apparatus**

## 7 Example of nutation test results

The validity of the nutation test described above was evaluated by using commercially available fibre optic connectors. In the nutation test, the rotation speed was 10 r/min for 100 revolutions. The test was performed with a tensile force of 14,7 N. Two criteria were considered when analysing the results. First, the attenuation of the cable assembly shall be less than 0,2 dB before and after the test. Second, the connector exhibits no damage during the test. Nine commercially available optical connectors including three types of connector (type I, II and III) terminated on 1,7 mm or 2,0 mm diameter reinforced fibre cable were tested. Table 1 shows the experimental nutation test results. Approximately 86 % of the connectors passed the nutation test and 14 % failed. All of the nutation test failures were the result of the plug breaking. The results indicate that mechanical durability is not directly related to connector type but depends on the connector's materials and design. Furthermore, the connector design of each connector manufacturer also has an effect on mechanical durability.

**Table 1 – Experimental results**

| Manufacturer | Pass rate (n° of passing samples/ n° of samples) for tensile force 14,7 N | Connector type |
|---|---|---|
| A | 100 % (72/72) | I |
| B | 100 % (72/72) | I |
| C | 97 % (35/36) | I |
| D | 100 % (8/8) | II |
| E | 100 % (5/5) | II |
| F | 100 % (18/18) | III |
| G | 99 % (78/80) | I |
| H | 93 % (62/72) | I |
| I | 18 % (11/60) | I |