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INTERNATIONAL STANDARD

Fibre optic interconnecting devices and passive components – Mechanical splices and fusion splice protectors for optical fibres and cables – Part 1: Generic specification

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – MECHANICAL SPLICES AND FUSION SPLICE PROTECTORS FOR OPTICAL FIBRES AND CABLES –

Part 1: Generic specification

FOREWORD

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International Standard IEC 61073-1 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This fourth edition cancels and replaces the third edition published in 1999. This edition constitutes a technical revision. The main changes with respect to the previous edition are as follows:

- terms and definitions have been reconsidered;
- style has been added in classification of requirement;
- environmental category has been deleted from classification of requirement;
- standardisation structure and standards interlink have been reconsidered.

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

FDIS	Report on voting
86B/2773/FDIS	86B/2805/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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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- withdrawn,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.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – MECHANICAL SPLICES AND FUSION SPLICE PROTECTORS FOR OPTICAL FIBRES AND CABLES –

Part 1: Generic specification

1 Scope

This part of IEC 61073 applies to fibre optic splice hardware (mechanical splices and fusion splice protections) for optical fibres and cables.

It includes:

– fibre optic splice hardware requirements;

– quality assessment procedures.

This standard does not cover test and measurement procedures, which are described in IEC 61300-1, IEC 61300-2 series and IEC 61300-3 series.

2 Normative references

The following referenced documents are indispensable for the application 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.

References made to a specific clause or subclause of a standard include all subclauses of the reference unless otherwise specified.

IEC QC 001002-3, *IEC Quality Assessment System for Electronic Components (IECQ) – Rules of Procedure – Part 3: Approval procedures*

IEC Guide 102, *Electronic components – Specification structures for quality assessment (Qualification approval and capability approval)*

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050-731, *International Electrotechnical Vocabulary – Chapter 731: Optical fibre communication*

IEC 60617 (all parts), *Graphical symbols for diagrams*

IEC 60695-11-5, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60793-1 (all parts), *Optical fibres – Measurement methods and test procedures*

IEC 60825-1, *Safety of laser products – Part 1: Equipment classification and requirements*

IEC 61300-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 1: General and guidance*

IEC 61300-2 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2: Tests*

IEC 61300-3 (all parts), *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3: Examinations and measurements*

IEC 61930: *Fibre optic graphical symbology*

IEC 61931, *Fibre optic – Terminology*

ISO 129-1, *Technical drawings – Indication of dimensions and tolerances – Part 1: General principles*

ISO 286-1, *ISO system of limits and fits – Part 1: Bases of tolerances, deviations and fits*

ISO 1101, *Geometrical Product Specifications (GPS) – Geometrical tolerancing – Tolerances of form, orientation, location and run-out*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

3 Terms and definitions

For the purposes of this document, the terms and definitions contained in IEC 60050-731, IEC 61931, and IEC 60874-1 as well as the following definitions apply.

3.1
cable joint
protective joint of two or more optical fibre cables. It may consist of fibre splices, organizers and closures

3.2
capillary mechanical splice
mechanical splice where the fibres are aligned by inserting them in a precision capillary tube

3.3
fibre splice
permanent or separable splice (see **separable splice**)

3.4
fusion splice
splice in which fibre ends are joined in a permanent manner by means of fusion

3.5
hybrid splice
cable splice with fibre splice(s) and electrical conductor splice(s)

3.6
interchangeable splice sets
splice sets are considered to be interchangeable when they both have the same installation geometry and functional performance

3.7
mechanical splice
splice in which the fibre ends are joined either permanently or separably by any mechanical means as long as the fibre ends are not fused together

3.8
permanent splice
splice which cannot be separated

3.9
precision rods mechanical splice
mechanical splice where the fibres are aligned using two or more precision rods

3.10
separable splice
splice which can be disassembled and reassembled but is intended for permanent use

3.11
shape memory alloy splice
mechanical splice where the fibres are aligned by using special materials which have the property to regain their original macroscopic shape when they are heated up (shape memory effect) or after an applied load is released, at higher temperature (superelasticity)

3.12
splice protector
protection of bare fibre after the primary coating has been stripped off for the splice procedure

NOTE Additionally, the splice protector reinforces the splice area and provides a possibility to mount this in a holder.

3.13
splice sub-family
range of fibre optic splice technologies as defined in the relevant specification

3.14
V- groove mechanical splice
mechanical splice where the fibres are aligned by using a precision V-groove

4 Requirements

The requirements for fibre optic splice hardware and accessories covered by this specification are specified in this clause and in the relevant specification.

4.1 Classification

Fibre optic splice hardware and accessories are classified, either totally or in part, by the following categories (see Table 1):

– type;
– arrangement ;
– style;
– variant;
– assessment level;
– normative reference extensions.

See Table 1 for an example of a complete fibre optic splice hardware classification.

Table 1 – Example of a typical mechanical splice and fusion splice protection hardware

Type	Name: V-groove mechanical splice Type of splice: mechanical splice Configuration: separable splice	Name: fusion splice protection Type of splice: fusion splice hardware Configuration: permanent splice
Arrangement	Kit arrangement with assembling tool	Splice protection kit
Style	Splice method: V-groove Alignment method: cladding (outside surface, axis) Number of simultaneously spliced fibres: one or more Index matching: gel Fibre coating removal: required, mechanical Splice protection hardware: sandwich or others	Fibre category: B1, A1 Single fibre protection Splice protection: shrinkable tubing
Variants	……	……

4.1.1 Type

Mechanical splices and fibre optic splice hardware shall be defined by the following items.

– Type name
  Example: "brand name" mechanical splice
  "brand name" splice protector
– Type of splice
  Examples: mechanical splice
  fusion splice hardware
– Configuration
  Examples: permanent splice
  separable splice

4.1.2 Arrangement

The fibre optic splice hardware arrangement shall define the delivered form of the item and the assembling tool, if needed.

Examples: kit arrangement
splice hardware arrangement

4.1.3 Style

Fibre optic splice style shall be defined by the following items, which may differ depending on the type of splice hardware.

4.1.3.1 Mechanical splice

Fibre category (according to the series IEC 60793-1)

– Splice method
  Examples: V-groove

capillary tube
ferrule/sleeve
shape memory-based shrinkable tube
precision rod
adhesive bonding
crimping

– Alignment method
  Examples: cladding (outside surface, axis)
  core (transmitted power, visual)
  self-alignment
  secondary reference surface (for example termini)

– Number of simultaneously spliced fibres
  Examples: single/multiple (state the maximum number)

– Index matching
  Examples gel
  fluid
  cured resin
  none

– Fibre coating removal
  Examples: not required
  required • mechanical
  • chemical

4.1.3.2 Fusion splice

– Fibre category (according to the series IEC 60793-1)
– Number of simultaneously spliced fibres
  Examples: single
  multiple (state the maximum number)

4.1.3.3 Splice protection hardware

Examples: shrinkable tubing
capillary tubing
metal crimping
gel or fluid
cured resin
injection moulding
sandwich
soft layer

4.1.4 Variant

The splice hardware variants shall define additional features of structurally similar components (see 3.2).

Examples of feature variables which creates variants:

additional fibre and coating sizes accommodated

alternative mounting or fixing points

4.1.5 Assessment level

Assessment level defines the inspection levels and the acceptable quality level (AQL) of groups A and B and the periodicity of inspection of groups C and D. Detail specifications shall specify one or more assessment levels, each of which shall be designated by a capital letter.

The following are preferred levels.

– Assessment level A
  - Group A inspection: inspection level II, AQL = 4 %
  - Group B inspection: inspection level II, AQL = 4 %
  - Group C inspection: 24-month periods
  - Group D inspection: 48-month periods
– Assessment level B
  - Group A inspection: inspection level II, AQL = 1 %
  - Group B inspection: inspection level II, AQL = 1 %
  - Group C inspection: 18-month periods
  - Group D inspection: 36-month periods
– Assessment level C
  - Group A inspection: inspection level II, AQL = 0,4 %
  - Group B inspection: inspection level II, AQL = 0,4 %
  - Group C inspection: 12-month periods
  - Group D inspection: 24-month periods

4.1.6 Normative reference extensions

Normative reference extensions are utilised to identify integration of independent standards specifications or other reference documents into blank detail specifications.

Unless specified exception is noted, additional requirements imposed by an extension are mandatory. Usage is primarily intended to merge associated components to form hybrid devices, or can involve integrated functional application requirements that are dependent on technical expertise other than fibre optics.

Published reference documents produced by ITU consistent with the scope statements of the relevant IEC specification series may be utilised as extensions. Published documents produced by other regional standardisation bodies such as TIA, ETSI, JIS, etc., may be referenced in an informative annex attached to the generic specification.

Some optical fibre splice configurations require special qualification provisions that are not necessary to impose universally. These accommodate individual component design configurations, specialised field tooling, or specific application processes. In such cases, requirements may be necessary to assure repeatable performance or adequate safety, and provide additional guidance for complete product specification. These extensions are mandatory whenever utilised to prepare, assemble or install an optical fibre splice, either for field application usage or preparation of qualification test specimens. The relevant specification shall clarify all stipulations. However, design- and style-dependent extensions shall not be imposed universally.

In the event of conflicting requirements, precedence shall be given, in descending order, as follows: generic over mandatory extension, over blank detail, over detail, over application specific extension.

Examples of requirements in normative extensions include the following:

- some commercial or residential building applications may require direct reference to specific safety codes and regulations or incorporate other specific material flammability or toxicity requirements for specialised locations;
- specialised field tooling may require an extension to implement specific ocular safety, electrical shock or burn hazard avoidance requirements, or require isolation procedures to prevent potential ignition of combustible gases.

4.2 Documentation

4.2.1 Symbols

Graphical and letter symbols shall, whenever possible, be taken from the series IEC 60027, the series IEC 60617 and IEC 61930.

4.2.2 Specification system

This specification is part of a three-level IEC specification system. Subsidiary specifications shall consist of blank detail specifications and detail specifications. This system is shown in Table 2.

Table 2 – Three-level specification structure

Specification level	Examples of information to be included	Applicable to
Basic	Assessment system rules Inspection rules Optical measurement methods Environmental test methods Sampling plans Identification rule Marking standards Dimensional standards Terminology Symbol standards Preferred number series SI units	Two or more component families or sub-families
Generic	Specific terminology Specific symbols Specific units Preferred values Marking Quality assessment procedures Selection test Qualification approval procedures Capability approval procedure	Component family
Blank detail *	Quality conformation test schedule Inspection requirements Information common to a number of types	Groups of types having a common test schedule
Detail	Individual values Specific information Completed quality conformance test schedules	Individual type
* Blank detail specifications do not, by themselves, constitute a specification level. They are associated to the generic specification		

4.2.2.1 Blank detail specifications

Blank detail specifications do not, by themselves, constitute a specification level. They are associated to the generic specification.

A blank detail specification shall contain:

– the minimum mandatory test schedules and performance requirements;
– one or more assessment levels;
– the preferred format for stating the required information in the detail specification;
– the reference normative document, document title and issue date.

4.2.2.2 Detail specifications

Detail specifications shall specify, as a minimum, the following information:

– type (see 4.1.1);
– arrangement (see 4.1.2);
– style (see 4.1.3);
– variants (see 4.1.4);

– assessment level (see 4.1.5);
– qualification procedure method (see IECQ procedures);
– part identification number for each variant (see 4.6.1);
– drawings, dimensions and performance criteria necessary to produce all required reference components (see 4.2.3);
– drawings and dimensions necessary to produce all required gauges (see 4.2.3);
– quality assessment test schedules (see IECQ procedures);
– performance requirements (see 4.5).

4.2.3 Drawings

The drawings and dimensions given in detail specification shall not restrict details of construction nor shall they be used as manufacturing drawings.

4.2.3.1 Projection system

Either first-angle or third-angle projection shall be used for the drawings covered by this specification. All drawings within a document shall use the same projection system and the drawings shall state which system is used.

4.2.3.2 Dimensional system

All dimensions shall be given in accordance with ISO 129-1, ISO 286-1 and ISO 1101.

The metric system shall be used in all specifications.

Dimensions shall not contain more than five significant digits.

When units are converted, a note shall be added in each relevant specification and the conversion between systems of units shall use a factor of 25,4 mm to 1 inch.

4.2.4 Performance

The performance requirements for fibre optic mechanical and fusion splice are defined in the performance standard series IEC 61753.

4.2.5 Measurements

4.2.5.1 Measurement method

The relevant specification shall define the size measurement method to be used for dimensions specified within a total tolerance zone of millimetres (0,01 mm) or less.

4.2.5.2 Reference components

Reference components, if required, shall be specified in the relevant specification.

4.2.5.3 Gauges

Gauges, if required, shall be specified in the relevant specification.

4.2.6 Test reports

Test reports shall be prepared for each test conducted. The reports shall be included in the qualification approval report and in the periodic inspection report.

Test reports shall contain the following information as a minimum:

– title of test and date;
– specimen description, including the type of fibre. The description shall also include the variant identification number (see 4.6.1);
– test equipment used and date of latest calibration;
– all applicable test details;
– all measurement values and observations;
– sufficiently detailed documentation to provide traceable information for failure analysis.

4.2.7 Instructions for use

Instructions for use shall be given by the manufacturer and shall consist of

– assembly and termination instructions;
– cleaning method;
– additional information as necessary.

4.3 Standardisation system

4.3.1 Performance standards

Performance standards contain a series of test and measurement sets (which, depending on the requirements of that standard, may or may not be grouped into a specified schedule) with clearly defined conditions, severities and pass/fail criteria. The tests are intended to be run on a "once-off" basis to prove a given product's ability to satisfy the "performance standards" requirement. Each performance standard has a different set of tests and/or severities (and/or groupings), and represents the requirements of a market sector, user group or system location.

A product that has been shown to meet all the requirements of a performance standard can be declared as complying with a performance standard, but should then be controlled by a quality assurance /quality conformance programme.

4.3.2 Reliability standards

Reliability standards are intended to ensure that a component can meet performance specifications under stated conditions for a stated time period.

For each type of component, the following need to be identified (and appear in the reliability standard):

– failure modes (observable general mechanical or optical effects of failure);
– failure mechanisms (general causes of failure, common to several components); and
– failure effects (detailed causes of failure, specific to component).

These are all related to environmental and material aspects.

Initially, just after component manufacture, there is an "infant mortality phase" during which many components would fail if they were deployed in the field. To avoid early field failure, all components may be subjected to a screening process in the factory, involving environmental stresses that may be mechanical, thermal or humidity-related. This involves inducing known failure mechanisms in a controlled environmental situation to occur earlier than would normally be the case in an unscreened population. For those components that survive (and are then sold), there is a reduced failure rate, since these mechanisms have been eliminated.

Screening is an optional part of the manufacturing process, rather than a test method. It will not affect the "useful life" of a component, defined as the period during which it performs according to specifications. Eventually other failure mechanisms appear, and the failure rate

increases beyond a specifically defined threshold. At this point the useful life of the component ends and the “wear-out region” begins, and the component must be replaced.

At the beginning of the useful life, performance testing on a sampled population of components may be applied by the supplier, by the manufacturer, or by a third party. This is to ensure that the component meets performance specifications over the range of intended environments at this initial point in time. Reliability testing, on the other hand, is applied to ensure that the component meets performance specifications for at least a specified minimum useful lifetime or a specified maximum failure rate. These tests are usually carried out by utilising the performance testing, but increasing duration and severity to accelerate the failure mechanisms.

A reliability theory relates component reliability testing to component parameters and to lifetime or failure rate under testing. The theory then extrapolates these to lifetime or failure rate under less stressful service conditions. The reliability specifications include values of the component parameters needed to ensure the specified minimum lifetime or maximum failure rate in service.

4.3.3 Interlinking

The standards currently under preparation are given in Figure 1. A large number of the test and measurement standards are already in place. The quality assurance/qualification approval standards produced under the banner of the IECQ have already been in place for many years. As previously mentioned, other alternative methods of quality assurance/quality conformance are being developed under the rubrics of Capability Approval and Technology Approval which are covered by IEC QC 001002-3 and IEC Guide 102.

With regard to performance and reliability standards, the matrix given in Table 3 demonstrates some of the options available for product standardisation once these two standards are in place.

Product A is fully IEC standardised and meeting defined performance and reliability standards requirements.

Product B is a product which complies with a performance standard, but does not meet any reliability requirements.

Product C is a product which does not meet the requirement of either an IEC performance or reliability standard.

In addition, the products may all be subject to a quality assurance programme that could be conducted under IEC Qualification, Capability or Technology Approval, or even under a national or company quality assurance system.

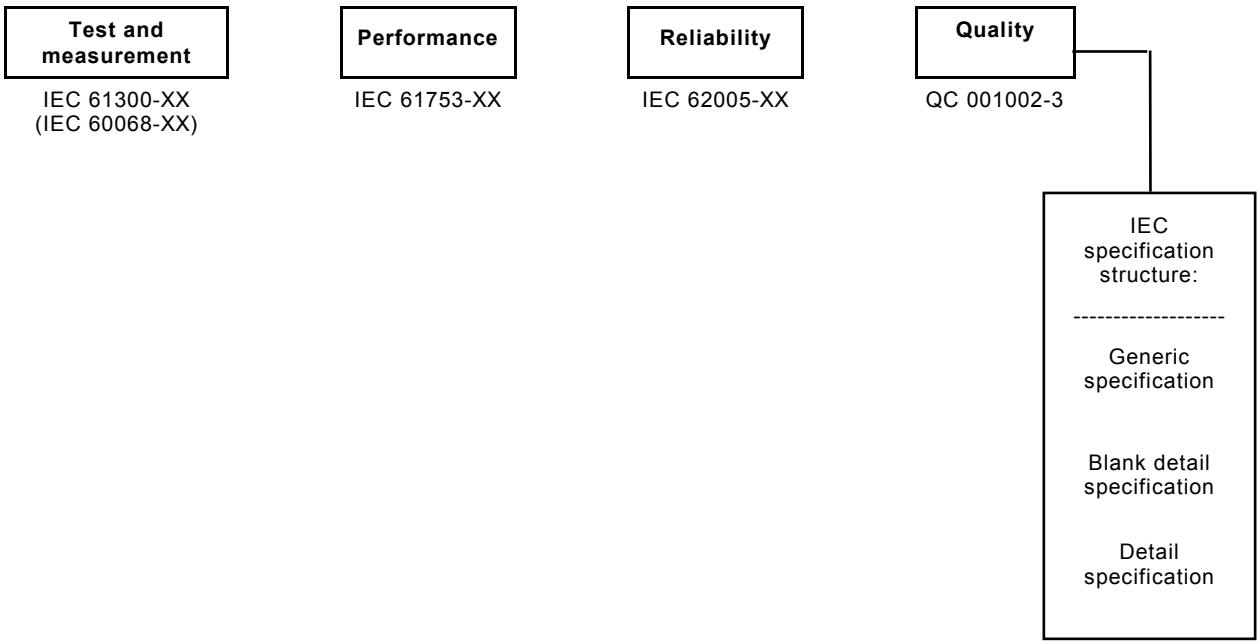


Figure 1 – Standardisation structure

Table 3 – Standards interlink matrix

	Performance standard	Reliability standard
Product A	YES	YES
Product B	YES	NO
Product C	NO	NO

4.4 Design and construction

4.4.1 Materials

4.4.1.1 Corrosion resistance

All materials used in the construction of mechanical splice and fusion splicer protector sets shall meet the requirements of the relevant specification.

4.4.1.2 Non-flammable materials

When non-flammable materials are required, the requirement shall be specified in the specification, and IEC 60695-11-5 shall be referenced.

4.4.2 Workmanship

Components and associated hardware shall be manufactured to a uniform quality and shall be free of sharp edges, burrs or other defects liable to affect life, serviceability or appearance. Particular attention shall be given to neatness and thoroughness of marking, plating, soldering, bonding, etc.

4.5 Performance

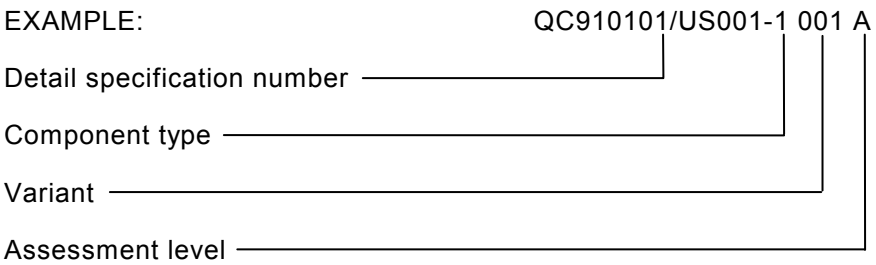
Splice hardware and accessories shall meet the performance requirements specified in the relevant specification.

4.6 Identification and marking

Components, associated hardware, and packages shall be permanently and legibly identified and marked when required by the relevant specification.

4.6.1 Variant identification number

Each variant in a detail specification shall be assigned an identification number, consisting of the detail specification number followed by a dash, a four-digit number and a letter designating the assessment level. The first digit of the four-digit number shall be sequentially assigned to each component type covered by the detail specification. The other three digits shall be sequentially assigned to each variant of the component.



4.6.2 Component marking

Component marking, if required, shall be specified in the relevant specification. The preferred order of marking is as follows:

a) supplier's identification mark;
b) supplier date code;
c) supplier's part number;
d) variant identification number.

4.6.3 Package marking

Package marking, if required, shall be specified in the relevant specification. The preferred order of marking is as follows:

a) supplier's identification mark;
b) supplier's part number;
c) supplier date code (year/week, see ISO 8601);
d) variant identification number(s) (see 4.6.1);
e) type (see 4.1.1);
f) assessment level;
g) environmental category;
h) any additional marking required by the relevant specification.

When applicable, individual unit packages (within the sealed package) shall be marked with the reference number of the certified record of released lots, the supplier's factory identity code and the component identification.

4.7 Packaging

Packages shall include instructions for use when required by the relevant specification (see 4.2.6).

4.8 Storage conditions

Where short-term degradable materials, such as adhesives, are supplied with the package of mechanical splice and fusion splice protector parts, the manufacturer shall mark these with the expiry date (year and week numbers, see ISO 8601) together with any requirements or precautions concerning safety hazards or environmental conditions for storage.

4.9 Safety

Optical fibre mechanical splice and fusion splice protectors, when used on an optical fibre transmission system and/or equipment, may emit potentially hazardous radiation from an uncapped or unterminated output port or fibre end.

Splice hardware and accessories manufacturers shall make available sufficient information to alert system designers and mechanical splice and fusion splice protector users about the potential hazard and shall indicate the required precautions and working practices.

In addition, each relevant specification shall include the following:

WARNING NOTE

Care should be taken when handling small diameter fibres to prevent puncturing the skin, especially in the eye area. Direct viewing of the end of an optical fibre or an optical fibre mechanical splice and fusion splice protector when it is propagating energy is not recommended unless prior assurance has been obtained as to the safety energy output level.

Reference shall be made to IEC 60825-1, the relevant standard on safety.

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