IEC 61753-057-2

Edition 1.0 2012-12

INTERNATIONAL STANDARD

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Fibre optic interconnecting devices and passive components – Performance standard –
Part 057-2: Single mode fibre plug-receptacle style optical fuse for category C – Controlled environment

IEC 61753-057-2:2012(E)

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE T

ICS 33.180.20

ISBN 978-2-83220-514-3

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FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – PERFORMANCE STANDARD –

Part 057-2: Single mode fibre plug-receptacle style optical fuse for category C – Controlled environment

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International Standard IEC 61753-057-2 has been prepared by subcommittee SC86B: Fibre optic interconnecting devices and passive components, of IEC technical committee TC86: Fibre optics.

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

FDIS	Report on voting
86B/3501/FDIS	86B/3545/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 61753 series, published under the general title *Fibre optic interconnecting devices and passive components – Performance standard*, 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- withdrawn,
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INTRODUCTION

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IEC takes no position concerning the evidence, validity and scope of this patent right.

The holder of this patent right has assured the IEC that he/she is willing to negotiate licences either free of charge or under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information may be obtained from:

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US patent US-7162,114 B2 "Optical Energy switching device and method", granted January 9,2007.

Japan patent 4376632 "Optical Energy switching device and method", granted September 18, 2009

The optical fuse is a passive device, designed to protect equipment and fibre cables from damage due to optical overpower, spikes and surges. The optical fuse produces a controlled, permanent, signal blocking at a predetermined power threshold in an optical fibre transmission line. The optical fuse is wavelength independent over its entire specified spectral range. IEC 60869-1 contains the generic information of the optical fuse. The optical fuse has a maximum allowed power input *P*in max that is allowed. Beyond this power it is dysfunctional and can let light through. Numerical values for *P*in max are given in Annex B.

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS – PERFORMANCE STANDARD –

Part 057-2: Single mode fibre plug-receptacle style optical fuse for category C – Controlled environment

1 Scope

This part of IEC 61753 contains the minimum initial test and measurement requirements and severities which a fibre optical fuse satisfies in order to be categorised as meeting the requirements of single mode fibre plug-receptacle style optical fuse used in controlled environments. Optical performance specified in this document relate to plug-receptacle style configuration fuses only.

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 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

IEC 60869-1, *Fibre optic interconnecting devices and passive components – Fibre optic passive power control devices – Part 1: Generic specification*[1]

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

IEC 61300-2-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-1: Tests – Vibration (sinusoidal)*

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

IEC 61300-2-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-6: Tests – Tensile strength of coupling mechanism*

IEC 61300-2-9, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-9: Tests – Shock*

IEC 61300-2-14, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-14: Tests – High optical power*[1]

IEC 61300-2-17, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-17: Tests – Cold*

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1 To be published.

IEC 61300-2-18, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-18: Tests – Dry heat – High temperature endurance*

IEC 61300-2-19, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-19: Tests – Damp heat (steady state)*

IEC 61300-2-22, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 2-22: Tests – Change of temperature*

IEC 61300-3-2, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-2: Examinations and measurements – Polarization dependent loss in a single-mode fibre optic device*

IEC 61300-3-3, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-3: Examinations and measurements – Active monitoring of changes in attenuation and return loss*

IEC 61300-3-4, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examinations and measurements – Attenuation*

IEC 61300-3-6, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss*

IEC 61300-3-7, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-7: Examinations and measurements – Wavelength dependence of attenuation and return loss of single mode components*

IEC 61300-3-28, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-28: Examinations and measurements – Transient loss*

IEC 61300-3-32, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-32: Examinations and measurements – Polarization mode dispersion measurement for passive optical components*

IEC 61754 series, *Fibre optic connector interfaces*

IEC 61755 series, *Fibre optic connector optical interfaces*

IEC/TR 62627-02:2010, *Fibre optic interconnecting devices and passive components – Part 02: Report of round robin test results on SC plug style fixed attenuators*

3 Tests

All test methods are in accordance with the IEC 61300 series.

Some tests require the use of reference connector plugs and reference connector adaptors. These are specified in Annex C. It is essential and recommended that all connector, plugs and reference connector adaptors be inspected and cleaned if dirty and checked again, according to manufacturers' instructions, prior to every mating in all tests.

All tests are to be carried out to validate performance over the required operating wavelength and power range. As a result, single or multiple spectral bands may be chosen for the qualification in addition to threshold power.

4 Test reports

Fully documented test reports and supporting evidence shall be prepared and shall be available for inspection as evidence that the tests have been carried out and complied with.

5 Performance requirements

5.1 Sample size, sequencing and grouping

Sample sizes for the tests are defined in Annex A.

5.2 Dimensions

Dimensions of mechanical interface for mating, plug and receptacle size, shall comply with IEC optical connector interface standard IEC 61754 series and IEC optical interface standard IEC 61755 series. Other dimensions shall comply with those given in appropriate manufacturer's drawings.

When implementing this standard be aware that there have been problems when using a rigid interface component with SC plug style adaptors and plugs. See Clause 6 of IEC/TR 62627-02:2010.

5.3 Test details and requirements

Table 1 specifies the optical, environment and mechanical performance requirements and related test methods for optical fuses.

Compliance to this standard requires demonstration of the ability to meet the performance requirement in Table 1.

Table 1 – Performance requirements for optical fuses *(1 of 8)*

No.	Test	Requirement	Details	
1	Insertion loss	Operating wavelength range: 1 520 nm to 1 625 nm	Method:	IEC 61300-3-7, Method B2.1, test sample configuration according to IEC 61300-3-4 substitution method
		Insertion loss ≤1,5 dB	Launch patchcord length:	≥ 2 m. Only the fundamental mode shall propagate at the fuse interface and at the detector.
		Insertion loss is measured with input power ≤ –5 dBm	Other requirements:	This test shall be performed against a reference plug[1,2] and reference adaptor.
			Launch conditions:	The wavelength of the source shall be longer than cut-off wavelength of the fibre.
			Source power stability:	≤ ± 0,05 dB over the measuring period or at least 1 h
			Wavelength range:	1 520 nm to 1 625 nm
			Total uncertainty	≤ ± 0,05 dB

Table 1 *(2 of 8)*

No.	Test	Requirement	Details	
2	Return loss Below power threshold	≥ 35 dB Grade T ≥ 40 dB Grade R ≥ 50 dB Grade U ≥ 60 dB Grade V Return loss is measured with input power ≤ –5 dBm	Method: Optical source Wavelength: Total uncertainty	IEC 61300-3-6 (Against 2 reference plugs[1]) measurement method 1, OCWR for grades T,R, U IEC 61300-3-6 (Against 2 reference plugs[1]) measurement method 1, OFDR for grade V 1 520 nm and 1 625 nm Test every sample with the two wavelengths. ≤ ± 2 dB
3	Return loss Above power threshold, after fuse response	≥ 30 dB Return loss is measured with input power ≤ –5 dBm	Method: Optical source Wavelength: Total uncertainty	IEC 61300-3-6 (Against 2 reference plugs[1]) measurement method 1, OCWR 1 520 nm and 1 625 nm Test every sample with the two wavelengths. ≤ ±2 dB
4	Polarization Dependent Loss	≤ 0,2 dB Over the specified operating wavelength The samples shall be terminated onto single-mode fibres as per IEC 60793-2-50, Type B 1.1, in either coated fibres (primary and secondary) or reinforced cable format	Method: Optical source Wavelength: Total uncertainty	IEC 61300-3-2 , all polarization method 1 550 nm ± 10 nm ≤ ±0,05 dB over the dynamic range to be measured
5	Polarization mode dispersion	≤ 0,2 ps (Max value) Over the specified operating wavelength range	Method: Optical source Wavelength: Detector linearity:	IEC 61300-3-32, MPS method 1 550 nm ± 10 nm ± 0,05 dB over the dynamic range to be measured
6	High optical power Below power threshold	The fuse will not change its insertion and return loss up to power threshold Before and after the test the Insertion loss shall meet the requirements of test 1 Before and after the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value.	Method: Optical source Wavelength: Test power: Test temperature: Test duration:	IEC 61300-2-14 1 550 nm ± 10 nm 3 dB below power threshold 25 °C ± 2 °C Duration of long-term test: 96 h at test power

Table 1 *(3 of 8)*

No.	Test	Requirement	Details	
7	High optical power Above power threshold (Destructive test)	The fuse will block the power from power threshold to ≥ 30 dBm input power or higher value specified in Annex B Before the test the Insertion loss shall meet the requirements of test 1 After and during the test the Insertion loss shall meet the requirements of test 9 Before and after the test the return loss shall meet the requirements of test 2	Method: Optical source Wavelength: Test power: Test temperature: Test duration:	IEC 61300-2-14 1 550 nm ± 10 nm 3 dB above power threshold 25 °C ± 2 °C Duration of long-term test: 96 h at test power
8	Power threshold (Destructive test)	The tolerance is ± 1 dB from the specified optical fuse power threshold The fuse will meet the power threshold requirements as specified when operated at the 3 specified temperatures	Method: Optical source Wavelength: Test temperature:	See Annex E for detailed test description. The test power input is 1 dB to 3 dB above power threshold and the blocking attenuation is measured accordingly. Samples from every batch will be destructively tested, all will comply. 1 550 nm 10 °C ± 2 °C 25 °C ± 2 °C 60 °C ± 2 °C
9	Blocking attenuation at threshold (destructive test)	> 30 dB The fuse will meet the requirement as specified, when operated at the 3 specified temperatures for the specified duration	Method: Optical source Wavelength: Test duration: Test temperature:	See Annex E for detailed test description. The test power input is 1 dB to 3 dB above power threshold and the blocking attenuation is measured accordingly. Samples from every batch will be destructively tested, all will comply. 1 550 nm 96 h at test power 10 °C ± 2 °C 25 °C ± 2 °C 60 °C ± 2 °C

Table 1 *(4 of 8)*

No.	Test	Requirement	Details	
10	Response time	< 100 µs The fuse will meet the requirement as specified, when operated at the 3 specified temperatures	Method: Optical source Wavelength: Test temperature:	See Annex E for detailed test description. The test power input is 1 dB to 3 dB above power threshold and the blocking attenuation is measured accordingly. Samples from every batch will be destructively tested, all will comply. 1 550 nm 10 °C ± 2 °C 25 °C ± 2 °C 60 °C ± 2 °C
11	Damp heat (steady state)	By the end of the test the insertion loss shall meet the requirements of test 1 By the end of the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Insertion loss is measured with input power ≤ –5 dBm After the test the power threshold shall meet the requirements of test 8	Method: Pre conditioning procedure: Temperature: Relative Humidity: Duration of exposure: Specimen optically functioning: Optical source Wavelength: Optical power: Recovery procedure:	IEC 61300-2-19 During the test the change in Insertion loss shall be measured by test method IEC 61300-3-3. Standard atmospheric conditions as defined in IEC 61300-1 for 2 hours + 40 ± 2 °C 93 % $^{+2}_{-3}$ RH 96 h Yes 1 550 nm 3 dB lower than power threshold, as defined in Annex B Allow specimens to return to standard atmospheric conditions defined in IEC 61300-1 in 2 h.

Table 1 *(5 of 8)*

No.	Test	Requirement	Details	
12	Change of temperature	By the end of the test the Insertion loss shall meet the requirements of test 1 By the end of the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Insertion loss is measured with input power ≤ –5 dBm After the test the power threshold shall meet the requirements of test 8	Method: Pre conditioning procedure: High Temperature: Low temperature: Number of cycles: Temperature rate of change: Duration at extreme temperatures: Specimen optically functioning: Optical source Wavelength: Optical power: Maximum sampling interval during the test: Recovery procedure:	IEC 61300-2-22 During the test the change in Insertion loss shall be measured by test method IEC 61300-3-3. Standard atmospheric conditions as defined in IEC 61300-1 for 2 h +60 ± 2 °C –10 ± 2 °C 5 1 °C/min 1 h Yes 1 550 nm 3 dB lower than power threshold, as defined in Annex B 15 min Allow specimen to return to standard atmospheric conditions in IEC 61300-1 for in 2 h.
13	Dry heat-high temperature endurance	By the end of the test the insertion loss requirements of test No. 1 shall be met By the end of the test the return loss requirement of test No. 2 shall be met The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Insertion loss is measured with input power ≤ –5 dBm After the test the power threshold shall meet the requirements of test 8	Method: Pre-conditioning procedure: Specimen optically functioning: Temperature: Duration of the exposure: Optical source Wavelength: Maximum sampling interval during the test: Recovery procedure:	IEC 61300-2-18 During the test the change in insertion loss shall be measured. By test method IEC 61300-3-3. Standard atmospheric conditions as defined in IEC 61300-1 for 2 h Yes +60 °C ± 2 °C 96 h 1 550 nm 1 h Allow specimen to return to standard atmospheric conditions in IEC 61300-1 for in 2 h.

Table 1 *(6 of 8)*

No.	Test	Requirement	Details	
14	Cold	By the end of the test the Insertion loss shall meet the requirements of test 1 By the end of the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Insertion loss is measured with input power ≤ –5 dBm After the test the power threshold shall meet the requirements of test 8	Method: Pre-conditioning procedure: Specimen optically functioning: Temperature: Duration of the exposure: Optical source Wavelength: Optical power: Maximum sampling interval during the test: Recovery procedure:	IEC 61300-2-17 During the test the change in Insertion loss shall be measured by test method IEC 61300-3-3. Standard atmospheric conditions as defined in IEC 61300-1 for 2 h Yes –10 °C ± 2 °C 96 h 1 550 nm 3 dB lower than power threshold, as defined in Annex B 1 h Allow specimen to return to standard atmospheric conditions in IEC 61300-1 for in 2 h.
15	Vibration (sinusoidal)	After the test the insertion loss shall meet the requirements of test 1 After the test the return loss shall meet the requirements of test 2 The insertion loss change between value before test and value after test shall be within ± 0,5 dB of the initial value. Insertion loss is measured with input power ≤ –5 dBm After the test the power threshold shall meet the requirements of test 8	Method: Frequency range: Vibration amplitude: Number of cycles: Rate of change: Number of axes: Specimen optically functioning: Optical source Wavelength: Optical power:	IEC 61300-2-1 During the test the change in Insertion loss shall be measured by test method IEC 61300-3-3. 10 Hz to 55 Hz 0,75 mm 15 1 octave/min 3 orthogonal axes No 1 550 nm 3 dB lower than power threshold, as defined in Annex B

Table 1 *(7 of 8)*

No.	Test	Requirement	Details	
16	Shock	After the test the insertion loss shall meet the requirements of test 1 After the test the return loss shall meet the requirements of test 2 After the test the power threshold shall meet the requirements of test 8 Before and after the test specimen tested in mated position	Method: Acceleration force: Number of axes: Number of cycles: Duration per axis: Measurements required: Specimen optically functioning: Optical source Wavelength: Optical power:	IEC 61300-2-9 500 g 3 axes, 2 directions 2 shocks per direction, 12 shocks total Nominal 1 ms duration, half sine pulse Before, after each axis, and after the test No 1 550 nm 3 dB lower than power threshold, as defined in Annex B
17	Strength of coupling mechanism	After the test the insertion loss shall meet the requirements of test 1 After the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Above measurements carried out in power ≤ –5 dBm	Method: Magnitude of the load: Load application point: Duration of the load: Specimen optically functioning: Optical power: Optical source Wavelength:	IEC 61300-2-6 During the test the change insertion loss shall be measured by transient loss test method IEC 61300-3-28 (Transient loss). 40 N, at a rate of 2 N/s 0,2 m from the optical interface 120 s Yes 3 dB lower than power threshold, as defined in Annex B 1 550 nm
18	Mating durability	After the test the return loss shall meet the requirements of test 2 The insertion loss change during the test shall be within ± 0,5 dB of the initial value. Above measurements carried out in power ≤ –5 dBm Return loss is measured with input power ≤ –5 dBm	Method: Number of mating cycles: Specimen optically functioning: Measurements required: Optical source Wavelength:	IEC 61300-2-2 200, all parts (connector fuse-adaptor-connector) shall be demated and mated Yes Change in insertion loss shall be measured after every cycle; Before and after the test the insertion loss shall meet the requirements of test 1. Return loss shall be measured before and after the test and shall meet the requirements of test 2. 1 550 nm

Table 1 *(8 of 8)*

No.	Test	Requirement	Details	
			Other specifications:	Preconditioning procedure: clean plug and adaptor according to manufacturer's instructions. In situ conditioning procedure: clean the mechanical and optical alignment parts of the moving connector according to the manufacturer instructions after cycle 24, 74, 124, and 174. Clean both the moving and stationary connectors and adaptor according to the manufacturer instructions after cycle 49, 99, 149, and 199. No additional cleaning or re-cleaning is allowed. Recovery procedure: the mechanical and optical alignment parts of the specimen may be cleaned according to manufacturer instructions up to 2 times after the final mating cycle.

[1] Reference connector definition is given in Annex C.

[2] Clean connectors, plugs and adaptors according to manufacturer's instructions, prior to every mating, in all tests unless otherwise specified.

Annex A
(normative)

Sample size and product sourcing requirements

Table A.1 gives sample size and product sourcing requirements.

Table A.1 – Sample size and product sourcing requirements

No.	Test	Sample size	Source
N/A	Dimensional	10	New
1	Insertion loss	80	New
2	Return loss below power threshold	80	Test 1
3	Return loss above power threshold	12	Test 8 or 9
4	Polarization dependent loss	4	Test 2
5	Polarization mode dispersion	4	Test 4
6	High optical power. Below power threshold	8	Test 5
7	High optical power. Above power threshold. (Destructive test)	4	Test 2
8	Power threshold (Destructive test) 4 samples at each temperature	12	Test 2
9	Blocking attenuation at threshold (Destructive test)	12	Test 2
10	Response time (Destructive test)	12	Test 2
11	Damp Heat (steady state)	4	Test 2
12	Change of temperature	4	Test 2
13	Dry heat	4	Test 2
14	Cold	4	Test 2
15	Vibration (sinusoidal)	4	Test 2
16	Shock	4	Test 2
17	Strength of coupling mechanism	4	Test 2
18	Mating durability	4	Test 2
NOTE Tests 5 to 18 may be performed in any order. Samples for tests 5 to 18 should be randomly selected from the samples of tests 2 and 4. Some tests are destructive and the samples cannot be used for any further testing. Tests 8 and 9 are performed on the same samples or on different samples.			

Annex B
(normative)

Threshold powers for optical fuses

Table B.1 gives the powers for optical fuses, single-mode.

Table B.1 – Powers for optical fuses, single-mode

Power threshold dBm	**Recommended power for normal CW work** dBm	**Maximum allowed power input, $P_{in\ max}$** dBm
18	Up to 15	Up to 30
19	Up to 16	Up to 32
20	Up to 17	Up to 34
21	Up to 18	Up to 36
22	Up to 19	Up to 36
23	Up to 20	Up to 36
24	Up to 21	Up to 36
25	Up to 22	Up to 36
26	Up to 23	Up to 36
27	Up to 24	Up to 36
28	Up to 25	Up to 36
29	Up to 26	Up to 36
30	Up to 27	Up to 36
NOTE $P_{in\ max}$ of 36 dBm is the maximum allowed power input into an optical fuses having power threshold up to 30 dBm. Beyond this power, $P_{in\ max}$ of 36 dBm, it is dysfunctional and can let light through.		

Annex C
(normative)

Reference connector and adaptor

Table C.1 gives the requirements for the reference connector and the adaptor.

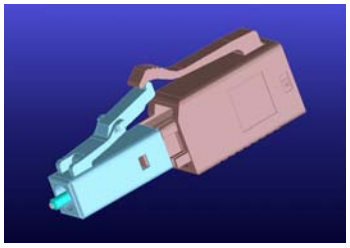
Table C.1 – Requirements for reference connector and adaptor

Items	2,5 mm diameter ferrule PC connector	1,25 mm diameter ferrule PC connector
Ferrule outer diameter	2,499 mm ± 0,000 5 mm	1,249 mm ± 0,000 5 mm
Eccentricity of fibre core centre to ferrule centre	≤ 0,3 μm	≤ 0,3 μm
Deviation of axis of fibre to axis of ferrule	≤ 0,2 degree	≤ 0,2 degree
Eccentricity of spherically polished ferrule endface	≤ 50 μm	≤ 50 μm
Visual examination of fibre end surface with x200 magnification	No defects in core zone	No defects in core zone
Insertion Loss between two reference plugs	≤ 0,2 dB	≤ 0,2 dB
Visual examination	Every 50 mating	Every 50 mating
NOTE Reference adaptors should give 0,2 dB maximum insertion loss when used with two reference plugs.		

Annex D
(informative)

Example of style configuration for optical fuse

The optical fuse, plug-receptacle style, configuration is given in Figure D.1.



IEC 2270/12

Figure D.1 – Optical fuse, plug-receptacle style configuration

Annex E
(normative)

Testing of optical fuses[2]

E.1 Introductory remark

This annex describes the testing of optical fuse functionality and measurement of its parameters. Testing of the following parameters, which do not appear in regular IEC standards, is described:

- power threshold;
- blocking attenuation at threshold;
- response time.

The fuse is a safety device and only destructive testing can test its functionality; it is not functional any more after exposure to powers over the threshold. The actual test requires high power, and needs a dedicated test set up, designed for these measurements.

An example of a test carried out on an optical fuse will be followed according to this Annex, where the optical fuse parameters are

– power threshold: (each fuse in the batch) 20 dBm ± 1 dB

– blocking attenuation at threshold > 30 dB

– response time: < 100 μs

E.2 Power threshold and blocking attenuation at threshold measurement

Measuring the threshold power is the first and most important functional test of the optical fuse, calling to expose the rated, e.g. 20 dBm, optical fuse to slowly varying powers starting at 10 dBm and up to 36 dBm. The powers needed call for an oscillator (e.g. diode laser) followed by fibre amplifiers.

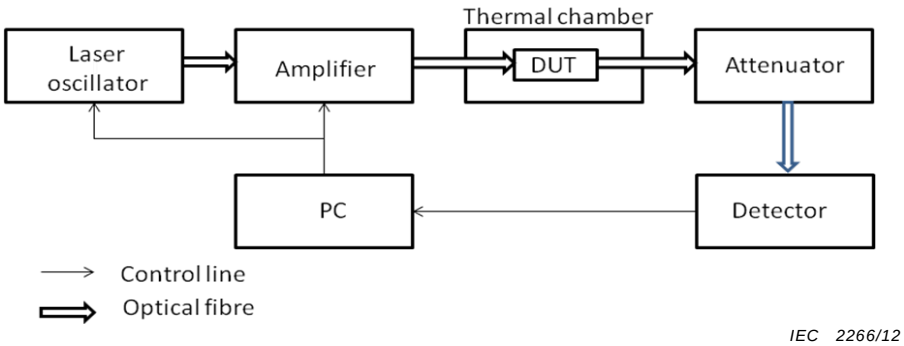


Figure E.1 – Test set-up schematics

The power measured by the detector, as a function of input power, provides both the threshold power as well as the blocking attenuation at the threshold of the DUT. The insertion loss for low and high power is provided as well.

Figure E.2 shows a curve of the change of the IL against the $P_{in.}$ The change of the IL that occurs at threshold can be seen, the IL change from ~0 dB to > 50 dB, giving more than five orders of magnitude "protection", or blocking attenuation at threshold, being > 30 dB needed in this example. The values of the insertion loss before and after activation are part of the collected results.

2 This Annex will be deleted when an IEC standard for a test method for an optical fuse is published.

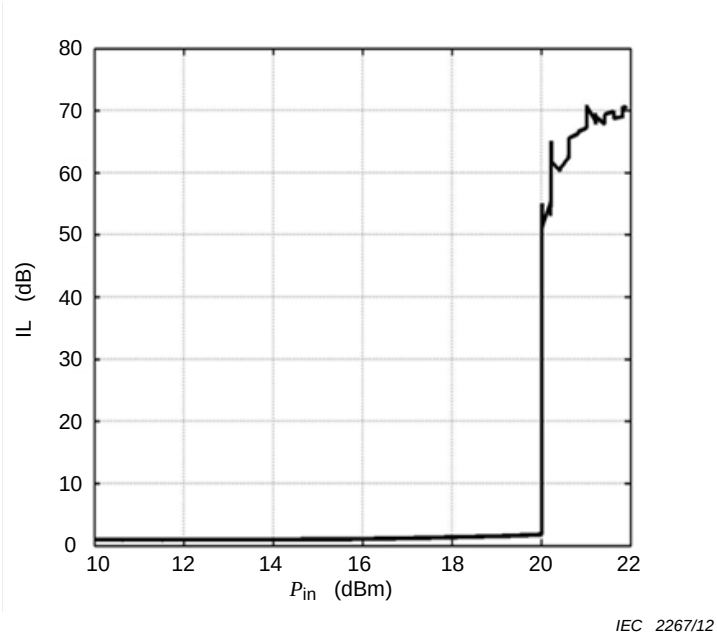


Figure E.2 – Example of power threshold and blocking attenuation at threshold measurements for sample 1280A of an optical fuse

E.3 Response time measurement

The response time of the optical fuse is defined as the total time where the optical fuse output power level is higher than the predetermined optical fuse power threshold by +1 dB. Here the input pulse duration is 1 ms long, having rise time of ~10 μs and a steady state power of fuse power threshold + 3 dB. Figure E.3 illustrates the parameters.

In this case, rise time is the elapsed time for input power to reach 90 % of its steady-state value from the time it starts.

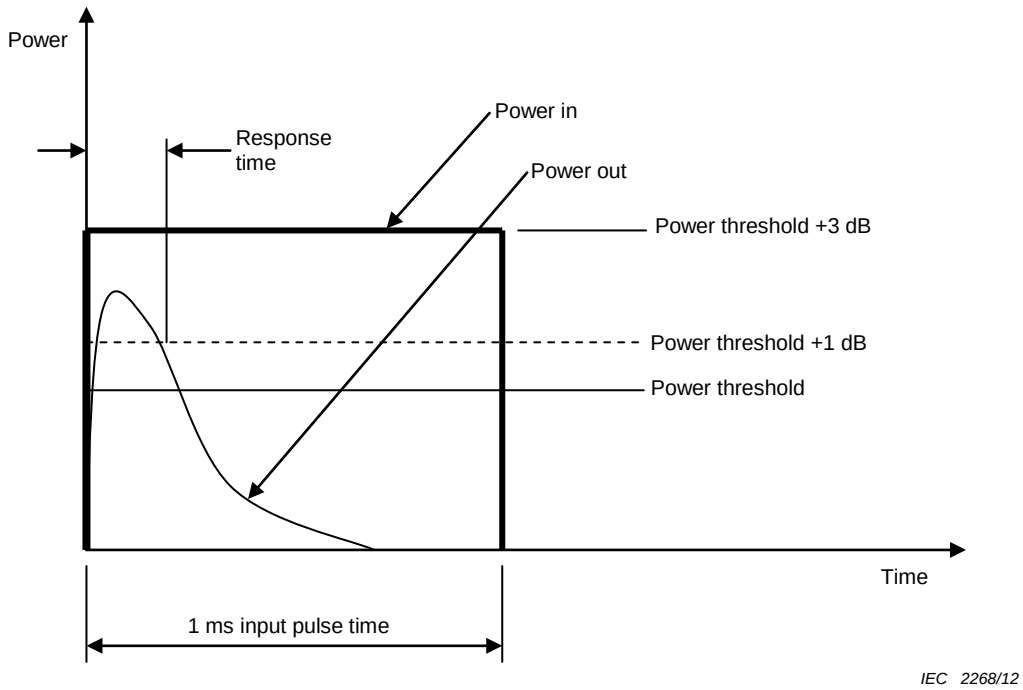


Figure E.3 – Response time curve of an optical fuse

Schematics of the test set-up and description are shown in Figure E.4.

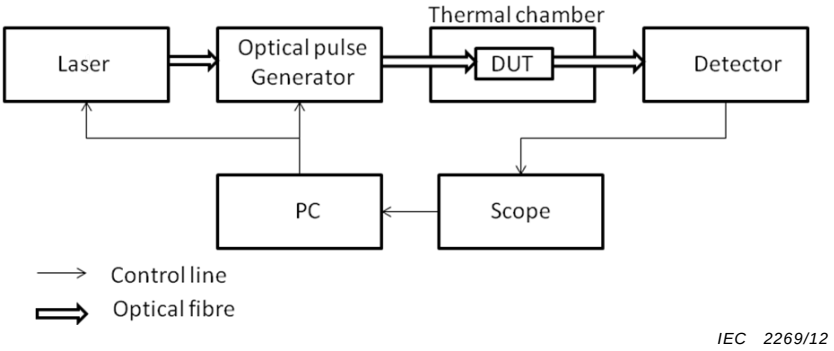


Figure E.4 – Response time testing set-up

A 1 550 nm wavelength laser provides the input signal, which is amplified and regenerated by the optical pulse generator unit, controlled by a designated software program. Output power is measured and presented graphically using an oscilloscope. Analysis of the data is carried out using standard mathematical software.

Since the test is carried out at three different temperatures, the minimal specified temperature, the maximal specified temperature and the average specified temperature of the optical fuse, the DUT is placed in a thermal chamber having stable temperature as required.

Bibliography

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

3, rue de Varembé
PO Box 131
CH-1211 Geneva 20
Switzerland

Tel: + 41 22 919 02 11
Fax: + 41 22 919 03 00
info@iec.ch
www.iec.ch