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TECHNICAL REPORT

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Fibre optic interconnecting devices and passive components – Part 03-02: Reliability – Report of high power transmission test of specified passive optical components

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FOREWORD

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IEC 62627-03-02, which is a technical report, has been prepared by subcommittee 86B: 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/3228/DTR	86B/3277/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

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INTRODUCTION

Optical transmission power has increased in recent years due to the growing demands for ultra-long haul transmission systems and more applications of fibre optic amplifiers for cable television broadcasting systems. In view of these advances, concerns arise about optical fibres, fibre optic connectors and passive optical components installed in fibre optic communication systems due to the fact that these components may harm human beings due to a leakage of high-power light and the possibility of fire caused by melting and damage of these components. However, mechanisms, conditions, and factors that cause such accidents have not yet been clearly identified. Furthermore, industry standards on the reliability and long-term evaluation of optical components do not include testing with high optical power.

This technical report is based on the Optoelectronic Industry and Technology Development Association (OITDA) – Technical Paper (TP), TP04/SP_PD-2008, "Technical paper of investigation of high-power reliability for passive optical components for optical communication application".

FIBRE OPTIC INTERCONNECTING DEVICES AND PASSIVE COMPONENTS –

Part 03-02: Reliability – Report of high power transmission test of specified passive optical components

1 Scope

This part of IEC 62627 describes test data relating to high power damage of fixed optical attenuators, optical isolators and optical splitters (non-wavelength selective branching devices). It also describes the test of thermal simulation and failure mechanism analysis for the above passive optical components on high power transmission.

2 Samples for transmission test

Fixed optical attenuators, optical isolators and optical splitters (non-wavelength selective branching devices) were selected for the high power test, as these passive optical components are widely used for fibre optic transmissions systems and it is highly possible that these are used under high power conditions. Table 1 shows the specifications of the samples and Table 2 shows the manufacturer names and product codes of samples.

Table 1 – Specifications of the passive optical components use for the high power damage threshold test

Samples	Specifications
Fixed optical attenuator	Plug-style fixed attenuator (SC connector) Attenuation: 10 dB, 20 dB and 30 dB.
Optical isolator (Polarization independent)	Inline isolator (pigtail type), double stage.
Optical splitter (non-wavelength selective branching device)	Planar lightwave circuit (PLC) type, 1 input, 8 output ports.

Table 2 – Manufacturer names and product codes of samples

Samples	Manufacture names and product codes
Fixed optical attenuator	Showa Cable Systems Co., LTD., KSCAT10SL (10 dB attenuation), KSCAT20SL (20 dB attenuation) and KSCAT30D (30 dB attenuation) Seikoh-Giken Co., Ltd., FA115-10-HP5 (10 dB attenuation) and FA115-20-HP5 (20 dB attenuation)
Optical isolator	FDK Corporation, YD-4600-1-155S NEC TOKIN Corporation, IL-1550IW5038EC-011
Optical splitter	Furukawa Electric Co. Ltd., PS202-1x8-N

3 High power damage threshold test

3.1 Test conditions

Test details and measuring performances are shown in Tables 3 and 4, respectively. A step stress test was adopted in which incident power level rose step by step. Duration time was five minutes per each power level, considering the stabilization time of the temperature of the tested passive optical components. Furthermore, the tested temperature was set at 70 °C according to IEC 61300-2-14:2005. The insertion loss (IL) and return loss (RL) changes and the outer surface temperature of components were monitored, assuming that the high optical power absorbed by the passive optical component converts into heat.

Table 3 – Test details

Items	Details
Input wavelength	1 480 nm (Raman laser)
Input power	Maximum 4,4 W (forward direction test) and 5 W (backward direction test)
Test method	Step stress test in which incident power level rises step by step
Duration	Five minutes per each power level
Ambient test temperature	70 °C

Table 4 – Measurement requirements

Categories	Measurement requirements
Online monitoring	IL (1 480 nm), RL (1 480 nm) and outer surface temperature of passive optical components
Before and after the test	IL, RL Polarisation dependent loss (PDL) for optical splitters and optical isolators and isolation for optical isolators

For the measurements, an input light with a wavelength of 1 480 nm was used that is different from the signal wavelength. The reasons for the use of 1 480 nm are as follows:

a) High-power light sources with several watt levels are readily available at this wavelength;

b) There is no difference in absorption coefficient of metal doped fibres that are used for optical attenuators with wavelengths from 1 480 nm to 1 550 nm;

c) Various wavelengths (such as signal light, remaining excitation light, amplified spontaneous emission light) enter the optical isolator. Among them, the optical power of the excitation wavelength of 1 480 nm by an optical amplifier is stronger. The absorption coefficient of Faraday rotator at a wavelength of 1 480 nm is approximately 1 % higher than that at a 1 550 nm wavelength. Additionally, the dependency on temperature by the rotation angle of Faraday rotator is from 0,07 °C to 0,1 °C. The loss of wavelength of 1 480 nm in the forward direction is slightly larger than that of wavelength of 1 550 nm. Therefore, when evaluating the high power light, it is more appropriate to use the wavelength of 1 480 nm;

d) The absorption coefficient of adhesive in the connecting points between the optical fibre and the waveguide in the optical splitter does not have a wavelength dependency. Moreover, in the light going through the optical splitter, the light energy is stronger in the remaining excitation light wavelength of 1 480 nm.

3.2 Apparatus and measurement conditions

The measurement setup was based on the conditions specified in IEC 61300-2-14:2005. The setup is shown in Figure 1 and Figure 2. A RL monitoring coupler and an optical power meter were added to IEC 61300-2-14:2005. Two 2 × 2 20 dB optical couplers were used for high power monitoring at both the input terminal and the output terminal of the device under test (DUT).

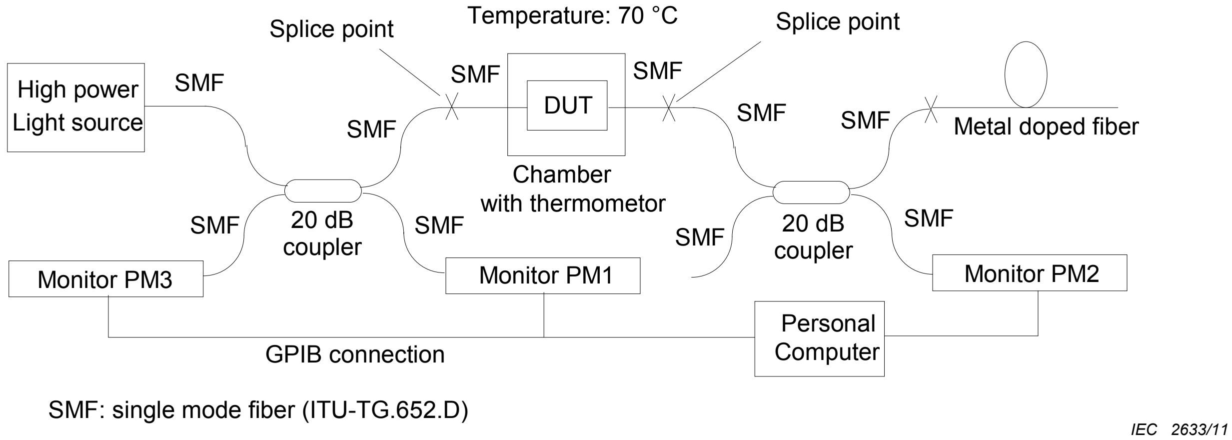

Figure 1 – Measurement setup

Table 5 shows the measuring conditions for the test. IL, PDL and isolation were measured using the signal wavelength of each device. RL was measured using the RL measuring instrument (the built-in wavelength of the light source is 1 310 nm) after the test. Due to their designs the DUTs used in this test do not have any RL wavelength dependency.

Table 5 – Measurement conditions in the test

Measurement Samples	Measurement performances	Measurement Wavelengths
Optical Attenuators	IL (dB)	1 550 nm
	RL (dB)	1 310 nm
Optical Isolators	IL (dB)	1 550 nm
	PDL (dB)	1 550 nm
	Isolation (dB)	1 550 nm
	RL (dB)	1 310 nm
Optical Splitters	IL (dB)	1 310 nm
	PDL (dB)	1 310 nm
	RL (dB)	1 310 nm

3.3 Test results

Table 6 shows the test results. In the optical isolators and the optical splitters, the outer surface temperature became stable after four minutes. No correlation was found between the attenuation of fixed optical attenuator and the incident light power at the RL reduction. However, in all the fixed optical attenuators, the change in return power was more than 10 dB. The RL of one optical isolator was observed to decrease in the return direction at an input power of 5 W. The backward direction test result of optical isolators is explained in 3.5. No damage to optical splitters was observed until an incident power of 4,4 W for forward direction and 5 W for backward direction was reached.

Table 6 – Results of high power damage threshold test

Components	Directions	Numbers of samples	Surface Temperatures	Duration times for surface temperature stability	Results
10 dB Attenuators	Plug to socket	6	89 °C	> 5 min	RL reduction at 1,4 to 2,3 W (All samples).
20 dB Attenuators	Plug to socket	3	85 °C	> 5 min	RL reduction at 1,7 to 1,9 W (All samples).
30 dB Attenuators	Plug to socket	2	75 °C	> 5 min	RL reduction at 1,4 to 1,6 W (All samples).
Optical Isolators	Forward	5	86 °C	4 min	No failure by 4,4 W.
	Backward	4	174 °C	4 min	RL reduction at 5 W (One sample).
Optical Splitters	Forward	3	87 °C	4 min	No failure by 4,4 W.
	Backward	3	158 °C	4 min	No failure by 5 W.

Figures 2(a), (b) and (c) show the test results of 10 dB attenuator. In Figure 3(a), when the incident power was 2,3 W, the return power significantly changed. At that power, the surface temperature was 89 °C (see Figure 2(b)). The change of IL was within ± 0,5 dB (see Figure 2(c)).

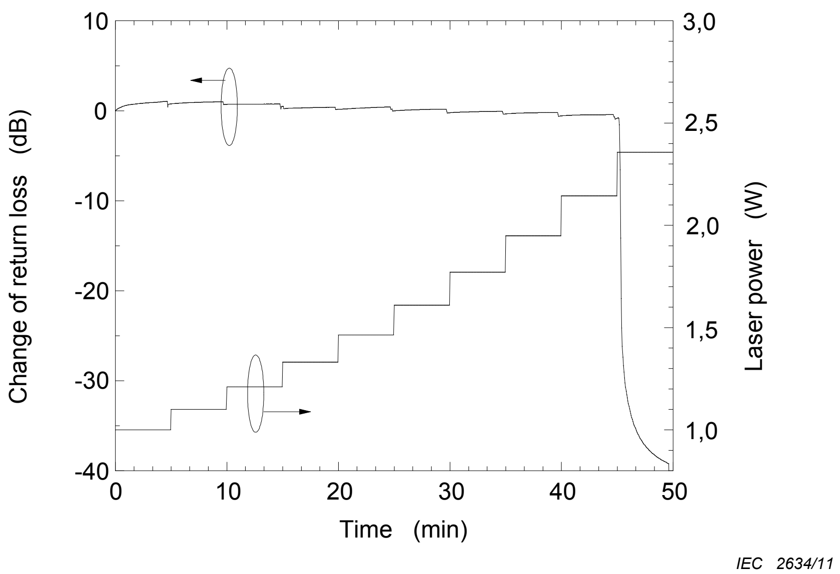

Figure 2(a) – PM3 monitor output for the measurement of RL