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INTERNATIONAL STANDARD

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

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International Standard IEC 61300-3 has been prepared by subcommittee 86B: Fibre optic interconnecting devices and passive components, of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2003. This edition constitutes a minor revision.

The change with respect to the previous edition is the structure of the document.

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

FDIS	Report on voting
86B/2808/FDIS	86B/2830/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 of 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 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- withdrawn,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
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A bilingual version of this publication may be issued at a later date.

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

1 Scope

This part of IEC 61300 describes the procedure to monitor changes in attenuation and/or return loss of a component or an interconnecting device, when subjected to an environmental or mechanical test. Such a procedure is commonly referred to as active monitoring. In many instances, it is more efficient to monitor attenuation and return loss at the same time.

The procedure may be applied to measurements on single samples or to simultaneous measurements on multiple samples, both at single wavelengths and multiple wavelengths, by using branching devices and/or switches as appropriate.

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.

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

IEC 61300-3-1, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-1: Examinations and measurements – Visual examination*

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 61300-3-35, *Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-35: Examinations and measurements – Fibre optic cylindrical connector endface visual and automated inspection*[1]

3 General description

3.1 Test method

The procedure describes a number of active monitoring measurement methods. Method 1 describes the situation where a single sample is subject to mechanical or environmental stress testing. Methods 2 and 3 describe methods for monitoring changes in the optical performance of multiple samples. Methods 4 and 5 measure changes in the optical performance of samples using an OTDR. Methods 4 and 5 may be used only when the OTDR averaging time is much less than the variation time of the test conditions. Where there is any form of uncertainty over the measurement method used, method 1 shall be considered to be the reference method.

[1] To be published.

All methods are capable of being configured to monitor changes in attenuation and return loss at the same time. The required optical test parameters shall be defined in the relevant specification.

Where a group of samples is being monitored over a period of time, say several days or weeks, it is usual to employ some form of automated data acquisition. Also, since the changes in optical performance can be very small, it is important to ensure high measurement stability over time.

3.2 Precautions

The following requirements shall be met.

a) Precautions shall be taken to ensure that cladding modes do not affect the measurement.

b) Precautions shall be taken to prevent movement in the position of the fibre cables between the sample(s) and the test apparatus, to avoid changes in optical performance caused by bending losses.

c) The stability performance of the test equipment shall be ≤ 0,05 dB or 10 % of the attenuation to be measured, whichever is the lower value. The stability shall be maintained over the measurement time. The required measurement resolution shall be 0,01 dB for both multimode and single-mode.

d) To achieve consistent results, clean and inspect all samples prior to measurement in accordance with the manufacturer's instructions. Visual examination shall be undertaken in accordance with IEC 61300-3-1 and IEC 61300-3-35.

e) The power in the fibre shall be at a level that does not generate non-linear scattering effects (typically < 3 mW).

f) It is common to be monitoring changes in optical performance that are small in comparison with the polarization dependence of the components under test (DUT) and of parts of the test apparatus such as branching devices, switches and detectors. Therefore, it is usually necessary to specify light sources with a low degree of polarization or to couple the source to low polarization-inducing optics.

g) Particularly, when measuring wavelength dependent components such as multiplexers or attenuators, it is necessary to use a light source that does not emit light at extraneous wavelengths at levels that can affect the measurement accuracy.

h) Reflected powers from the test apparatus shall be at a level that does not affect the measurement accuracy.

i) Care must be taken when using switches or branching devices for multimode measurements. In many cases, these devices will modify the launched mode power distribution or result in modal detection non-uniformity, which will give rise to measurement inaccuracies.

4 Apparatus

4.1 Methods 1, 2 and 3

4.1.1 General

The apparatus used for methods 1, 2 and 3 of this procedure is shown in Figures 1, 2 and 3. The apparatus consists of the following.

4.1.2 Source (S)

The source consists of an optical emitter, the means to connect to it, and associated drive electronics. In addition to meeting the stability and power level requirements, the source shall have the following characteristics.

Centre wavelength: as detailed in the performance and product standard

Spectral width: filtered LED ≤ 150 nm full width at half maximum (FWHM)

Spectral width: LD < 10 nm FWHM

For multimode fibres, broadband sources such as an LED shall be used.

NOTE 1 The interference of modes from a coherent source will create speckle patterns in multimode fibre. These speckle patterns give rise to speckle or modal noise and are observed as power fluctuations, since their characteristic times are longer than the resolution time of the detector. As a result, it may be impossible to achieve stable launch conditions using coherent sources for multimode measurements. Consequently, lasers should be avoided in favour of LEDs or other incoherent sources for measuring multimode components.

For single-mode fibres, either an LED or an LD may be used.

There are a number of methods of monitoring performance at multiple wavelengths. One method, illustrated in Figure 3, shows independent light sources joined by an optical switch SW3.

NOTE 2 It is particularly important to consider the wavelength dependence of the test apparatus when monitoring multiple wavelengths. For example, different switch ports may not have the same wavelength dependence. This can affect comparative measurements made between any channel “i” and the reference channel, since they will be connected to different switch ports. It is therefore necessary, in such circumstances, to complete an accurate spectral characterization of the test set-up prior to use.

4.1.3 Launch condition (E)

The launch condition shall be specified in accordance with Annex B of IEC 61300-1.

4.1.4 Monitoring equipment

Where multiple measurements are made, suitable apparatus is required to permit monitoring of the light through the multiple paths.

In Figure 2, individual monitoring channels are established by dividing the light into N paths using a 1 × N branching device (BD). This method is practical for a small number of DUTs, since it requires a multiplicity of branching devices and detectors.

In Figure 3, active switching of the light paths through the DUTs is used. The apparatus consists of a directional branching device and two 1 × N computer-controlled optical switches. The channel number of these switches is sufficiently large to accommodate the DUTs under test, one or more reference lines, and a reference reflectance channel.

NOTE The design of systems to test multiple samples requires the trade-off of a number of factors such as cost and measurement capability. When testing multimode samples, for example, it may be inappropriate to use branching devices and/or optical switches, due to the problems surrounding modal losses and the associated cost of the test apparatus. However, optical switches may be cost-effective for testing single-mode samples, particularly when the cost of suitable sources and detectors and the measurement stability requirements are considered.

Switch parameters which shall be considered for this test include the following.

a) Repeatability

   The switches shall be capable of high repeatability in per-channel insertion loss, since this parameter will directly detract from the accuracy of the measurement of attenuation or return loss of the DUT. Furthermore, since environmental tests are generally carried out over extended periods the switch repeatability shall be considered over the full duration of the test.

b) Return loss

   The return loss characteristics of the switch shall be such that they do not unduly influence the measurement in methods 2 and 3.

c) Wavelength dependence

When undertaking multiple wavelength measurements, the wavelength dependence characteristics of the switch shall be taken into account, to ensure they do not unduly influence the measurement in methods 2 and 3.

4.1.5 Detector (D)

The detector consists of an optical detector, the means to connect to it, and associated electronics. The connection to the detector will be an adaptor that accepts a connector plug of the appropriate design. The detector shall capture all light emitted by the connector plug.

In addition to meeting the stability and resolution requirements, the detector shall have the following characteristics.

Linearity: Multimode ±0,25 dB (over –5 dBm to –60 dBm)

Single-mode ±0,1 dB (over –5 dBm to –60 dBm)

NOTE The power meter linearity should be referenced to a power level of –23 dBm at the operational wavelength.

The detectors shall have a high dynamic range with an operational wavelength range consistent with that of the DUT and the capability to zero the reference level.

4.1.6 Stress fixture

The stress fixture consists of a suitable mechanism for applying the required stress level(s) to the DUTs. In the case of environmental stress testing, the fixture will typically consist of an environmental chamber capable of meeting the required temperature and/or humidity extremes. In the case of mechanical stress testing, a number of different fixtures will often be required depending on the requirements of the relevant specification, for example, impact rigs, tensile testers, vibration beds, etc.

4.1.7 Branching device (BD)

The splitting ratio of the BD shall be stable. It shall also be insensitive to polarization. The directivity should be at least 10 dB higher than the maximum return loss to be measured.

4.1.8 Temporary joints

Temporary joints are typically used for connecting the DUTs to the test apparatus. Generally, the stability requirements of a test will require that the temporary joints be mechanical or fusion splices.

4.1.9 Data acquisition

Data recording may be done either manually or automatically. Measurements shall be made at intervals as defined in the relevant specification. Appropriate data acquisition apparatus shall be used where measurements are performed automatically.

4.1.10 Monitor sample

A monitor sample provides a direct performance comparison with the sample(s) under test and shall be used for environmental testing of samples. The monitor sample is similar to those under test, except that it does not contain a DUT. For example, where the DUT is a connector, the monitor sample is simply a length of fibre cable of the same type, located in the same environment as the DUT. The monitor sample shall be placed as close as possible to the DUT(s).

4.1.11 Reference fibre

A reference fibre is typically employed for the purpose of monitoring and compensating for source instability. Reference fibres shall be used where there is no monitor sample and the source does not have sufficient stability to give the required measurement accuracy.

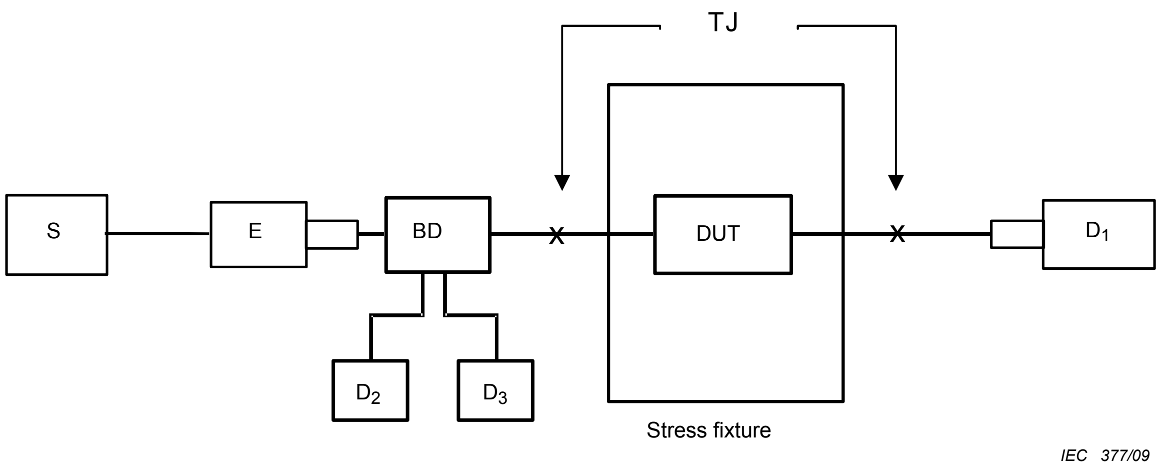

Figure 1 – Method 1 – Monitoring attenuation and return loss of a single sample undergoing stress testing

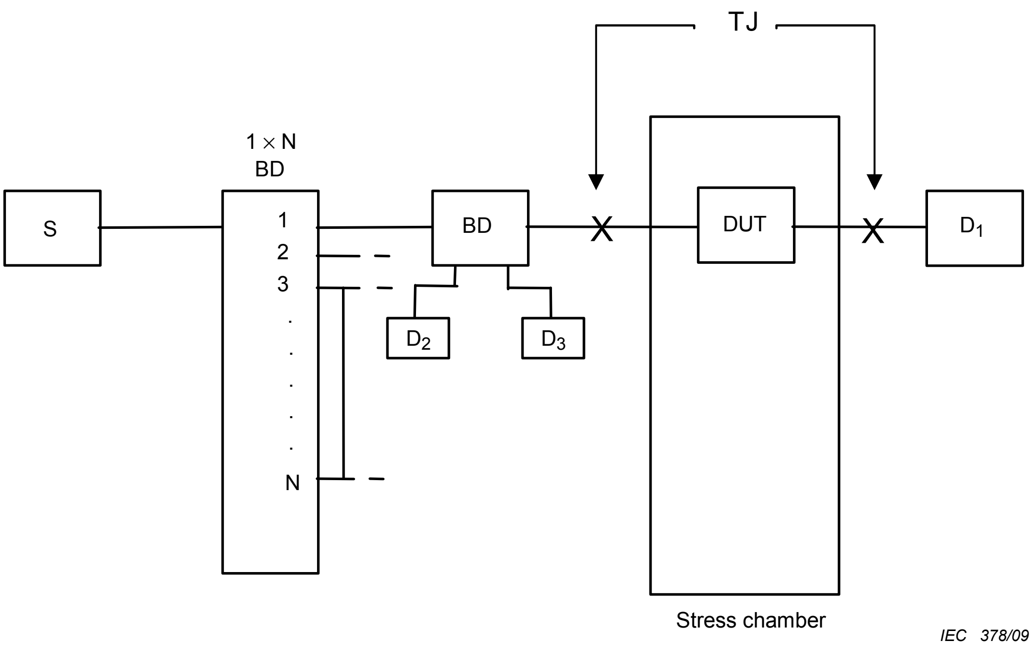

Figure 2 – Method 2 – Monitoring attenuation and return loss of multiple samples using a 1 × N branching device

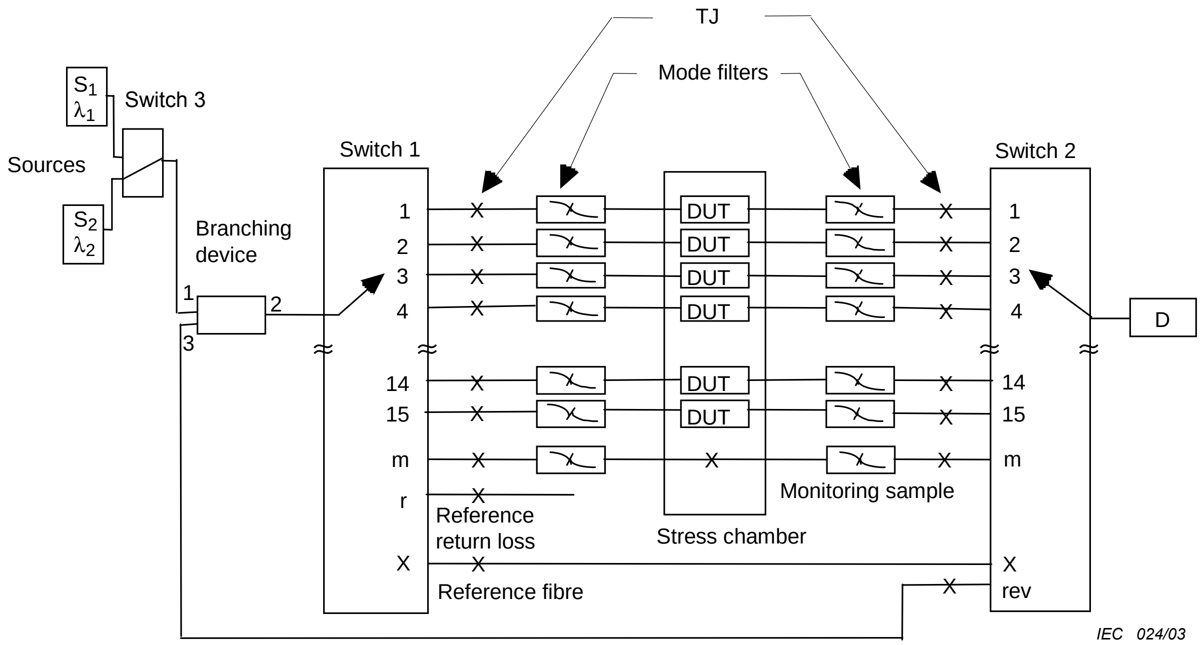

Figure 3 – Method 3 – Monitoring attenuation and return loss of multiple samples using two 1 × N optical switches

4.2 Methods 4 and 5

4.2.1 General

The apparatus for these methods and its arrangement to monitor multiple DUTs is shown in Figures 4 and 5. Additional or alternative apparatus required to conduct these tests consists of the following elements.

4.2.2 OTDR

In these methods, an OTDR is employed as an automated test set. The OTDR shall be capable of producing one or more pulse durations and pulse repetition rates. The precise characteristics shall be compatible with the measurement requirements and shall be specified in the relevant specification.

NOTE The long averaging times required for return-loss measurements may limit the minimum time period for sequential measurements.

4.2.3 Buffer fibre

Lengths of fibre are used to permit spatial discrimination of the DUT(s) by the OTDR.

4.2.4 Optical switches

The key differences from those switches described in methods 2 and 3 are as follows.

a) Repeatability

There is less need in methods 4 and 5 for extremely high levels of long-term repeatability of per-channel attenuation, since the OTDR is able to distinguish the switches from the DUT(s).

b) Return loss

In methods 3 and 4 very high values of switch return loss are required, since these reflections can, depending on the particular OTDR, obscure the measurement.

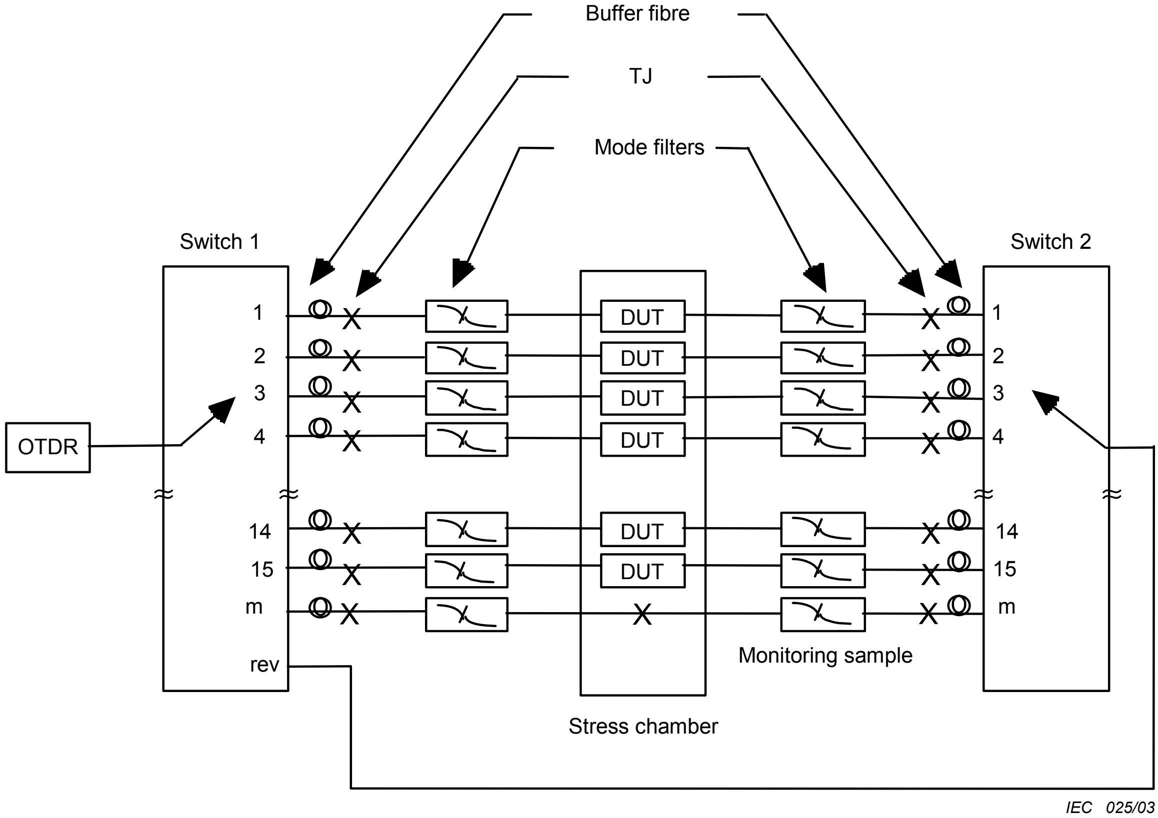

Figure 4 – Method 4 – Bidirectional OTDR monitoring of attenuation and return loss of multiple samples

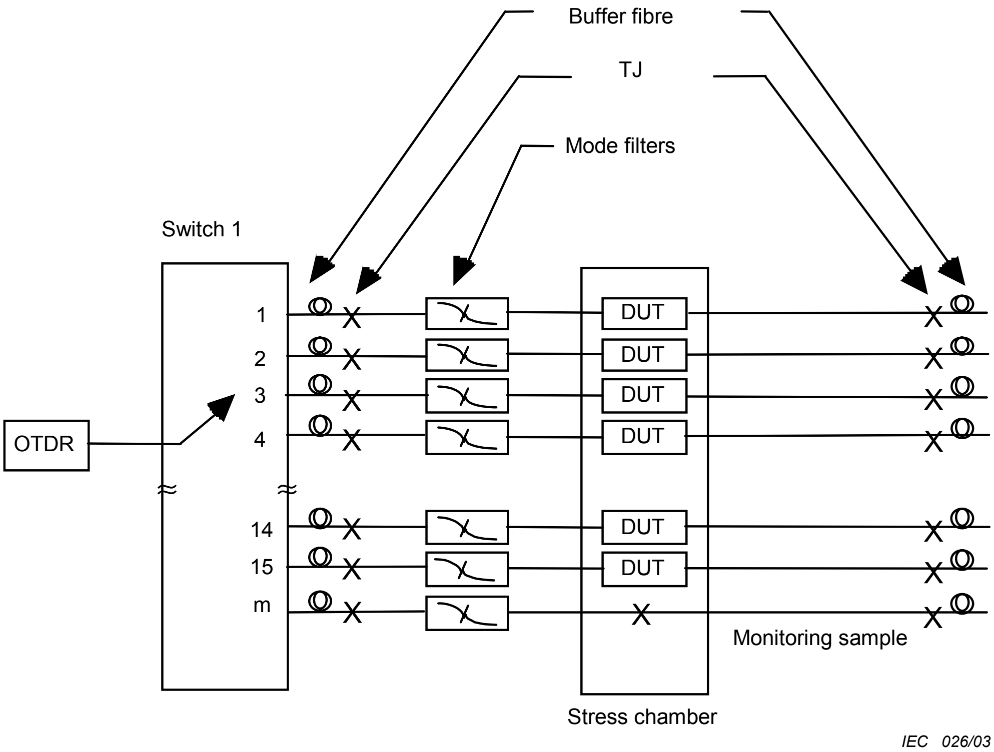

Figure 5 – Method 5 – Unidirectional OTDR monitoring of attenuation and return loss of multiple samples

5 Procedure

5.1 Monitoring attenuation and return loss of a single sample – method 1

5.1.1 General

This method involves the monitoring of attenuation and/or return loss of a DUT in a stress fixture, by using a branching device. The measured throughput power (measured at D_1) and reflected power (measured at D_2) are compared with the reference power level measured at D_3.

NOTE For short-term monitoring of attenuation only, it is possible to eliminate the BD. In this case, care must be exercised to ensure that changes in attenuation are a result of stress-testing the DUT and are not due to variation in the test apparatus. It is recommended that such measurements of the DUT be made in accordance with IEC 61300-3-4.[2]

5.1.2 Attenuation monitoring – method 1

Take readings of D_1 and D_3 at the specified periods. The common logarithm of the ratio of these readings is proportional to the attenuation (in dB) of the DUT. Changes in this ratio are monitored to determine any variation in the attenuation of the DUT due to the stress test. The typical method for presentation of the test results is to plot changes in the ratio of D_1 and D_3 against time.

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

5.1.3 Return loss monitoring – method 1

Take the readings of D_2 and D_3 at the specified periods. The common logarithm of the ratio of these readings is proportional to the return loss (in dB) of the DUT. Changes in this ratio are monitored to determine any variation in the return loss of the DUT due to the stress test. The typical method for presentation of the test results is to plot changes in the ratio of D_2 and D_3 against time.

5.2 Monitoring attenuation and return loss of multiple samples using a 1 × N branching device – method 2

5.2.1 General

This method involves the monitoring of attenuation and/or return loss of multiple DUTs in a stress fixture, by using a 1 × N branching device and a number of 1 × 2 or 2 × 2 branching devices, depending on the number of samples being tested. The measured through-put power (measured at D_1) and reflected power (measured at D_2) are compared with the reference power level measured at D_3 for each of the samples.

The combination of the light source, S, and the 1 × N branching device should be characterized for stability of splitting ratio to each of the output ports since this constancy will determine the accuracy of the monitoring measurements.

5.2.2 Attenuation monitoring – method 2

Take readings of D_1 and D_3 for each of the DUTs at the specified periods. The common logarithm of the ratio of these readings is proportional to the attenuation (in dB) of the DUT. Changes in this ratio are monitored to determine any variation in the attenuation of each DUT due to the stress test. The typical method for presentation of the test results is to plot changes in the ratio of D_1 and D_3 for each sample against time.

5.2.3 Return loss monitoring – method 2

Take readings of D_2 and D_3 for each of the DUTs at the specified periods. The common logarithm of the ratio of these readings is proportional to the return loss (in dB) of the DUT. Changes in this ratio are monitored to determine any variation in the return loss of each DUT due to the stress test. The typical method for presentation of the test results is to plot changes in the ratio of D_2 and D_3 for each sample against time.

5.3 Monitoring attenuation and return loss of multiple samples using two 1 × N optical switches – method 3

5.3.1 General

Due to the complexity of the test set-up, it is typical for the various parts of the apparatus to be computer-controlled. This control ensures that the 1 × N switches are stepped synchronously and that the sources are switched at the appropriate time to make the necessary number of measurements. The control also ensures that the sequence is repeated periodically as defined in the relevant specification for the duration of the stress test.

5.3.2 Attenuation – method 3

A measurement of attenuation of the component under test in channel "i" at time "t" is as follows:

$$L_{\mathrm{i,t}} = J_{\mathrm{i}} - P_{\mathrm{i,t}} \quad (1)$$

where

$P_{\mathrm{i,t}} = p_{\mathrm{i,t}} - p_{\mathrm{m,t}}$ is the normalized power, in decibels (dB);

$p_{m,t}$ is the power through the monitor channel, in decibels referenced to one miliwatt (dBm);

$p_{i,t}$ is the power measured with switches 1 and 2 both set to channel “i”, in decibels referenced to miliwatt (dBm);

J_i is the constant for channel “i”, in decibels (dB).

Where more than one reference channel is used, the value of $p_{m,t}$ is the average of all reference channels.

NOTE 1 Upper-case letters are used to denote normalized power and lower-case letters to denote measured values. Normalized power in channel “i” is the power transmitted through channel “i”, minus the average of the power transmitted through the reference channels. The use of normalized power allows the determination of loss to be independent of variations in source intensity.

NOTE 2 Subscript “t” refers to a set of measurements, i.e. the measurement set at a specific test condition.

NOTE 3 In the apparatus of Figures 3, 4 and 5, the monitor sample denoted as “m” is used to monitor for changes which may occur in the fibre itself as opposed to the DUT in the stress chamber.

During the time in which a set of measurements for the determination of $p_{i,t}$ is being made, care must be taken that no change that would alter power levels in the system is made.

The constant J_i is determined with a cut-back measurement (see Figure 6) made at the completion of the test sequence.

$$J_i = B_i - A_i + P_{i,c} \tag{2}$$

where

A_i is the cut-back measurement of power in fibre “i” at point “a” (see Figure 6);

B_i is the cut-back measurement of power in fibre “i” at point “b” (see Figure 6);

$P_{i,c}$ is the value of $P_{i,t}$ at the time when the cut-back measurements are made.

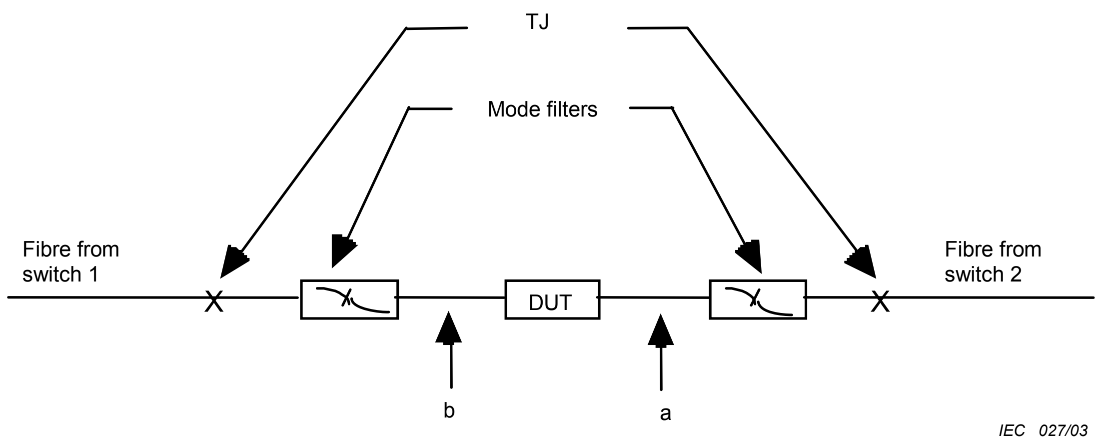

Figure 6 – Cut-back measurement location (transmission)

The sequence of measurements in the determination of J_i is: first, make the measurements for $P_{i,c}$, then make the cut-back measurement A_i and then B_i. The measurements of A_i and B_i are made using a power meter with a bare fibre adapter.

5.3.3 Return loss – method 3

Set switch 1 to channel “i” and switch 2 to channel “rev”. A measurement of return loss of a component under test in channel “i” at time “t” is as follows.

$$RL_{i,t} = P_{i,t} - G_i + 10 \times \log\left(1 - 10^{-\Delta P/10}\right) \quad (3)$$

where

$P_{i,t} = p_{i,t} - p_{r,t}$ is the normalized power in channel "i", in decibels (dB);

G_i is a constant.

NOTE In calculations for return loss, normalized power is the power in channel "i" minus the power in channel "r". $p_{r,t}$ is the power, measured with switch 1 on channel "r" and switch 2 on channel "rev", in decibels referenced to one milliwatt (dBm);

$$\Delta P = p_{i,t} - p_{i,o} \quad (4)$$

where

$P_{i,o} = p_{i,o} - p_{r,o}$ is the normalized reflected power, measured with the fibres from channel "i" of switches 1 and 2 spliced directly together without a component between the switches, in decibels (dB);

When $|\Delta P| > 10$ dB, the following approximation for return loss may be used.

$$RL_{i,t} \cong P_{i,t} - G_i \quad (5)$$

The constant G_i is evaluated using measurements made with the fibre from channel "i" of switch 1 terminated with a reference return loss. The reference return loss is a length of fibre one end of which is terminated with a known return loss.

$$G_i = P_{i,r} - S + 10 \times \log\left(1 - 10^{-\Delta P/10}\right) \quad (6)$$

where

S is the reference return loss, in decibels (dB);

$P_{i,s}$ is the normalized power in channel "i" terminated with reference return loss S, in decibels (dB);

$$\Delta P = P_{i,s} - P'_{i,o} \quad (7)$$

where

$P'_{i,o}$ is the normalized reflected power with a high attenuation in the fibre using, for example, a mandrel wrap between the reference return loss S and SW1.

5.4 Bidirectional OTDR monitoring of attenuation and return loss of multiple samples – method 4

5.4.1 General

Due to the complexity of the test set-up, it is typical for the various parts of the apparatus, including the OTDR, to be computer-controlled. This control ensures that the 1 × N switches are stepped synchronously and that the sources are switched at the appropriate time to make the necessary number of measurements. The control also ensures that the sequence is repeated periodically as defined in the relevant specification for the duration of the stress test.

5.4.2 Attenuation – method 4

A measurement of attenuation of the DUT in channel "i" at time "t" is carried out as follows:

$$L_{i,t} = \frac{Xf_{i,t} + Xr_{i,t}}{2} + J_i \quad (8)$$

where

$Xf_{i,t}$ is the change in power in the OTDR display for the component under test with switch 1 set on channel "i";

$Xr_{i,t}$ is the same as $Xf_{i,t}$ except that switch 2 is set on channel "i", and switch 1 is set on channel "rev";

J_i is a constant for channel "i".

The values of Xf and Xr are values of loss as seen in both the forward and reverse directions of transmission plus loss in the temporary joints (see Figure 7).

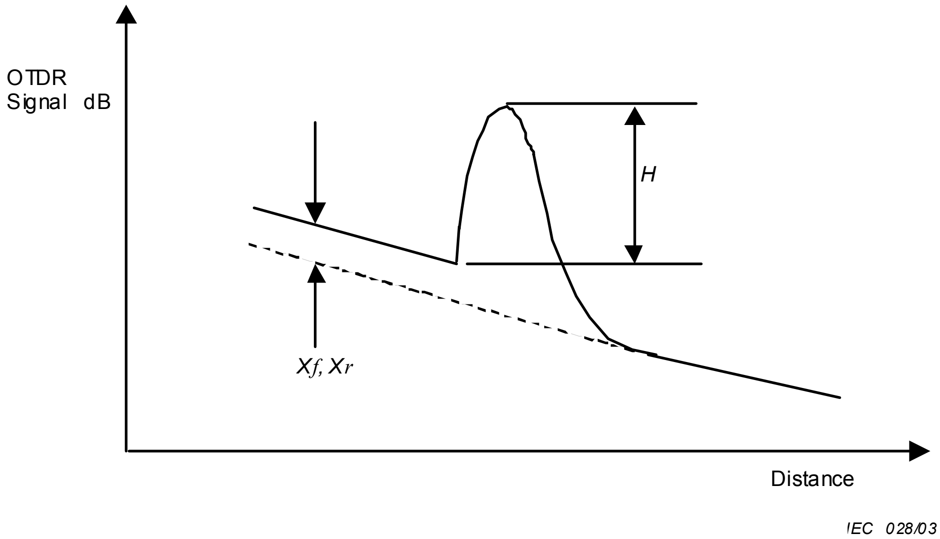

Figure 7 – Typical OTDR trace caused by the reflection from a DUT

NOTE Since this is a monitoring experiment, only the change in attenuation is considered significant. Thus the change in $L_{i,t}$ from the initial measurement is the important factor, rather than the absolute value of $L_{i,t}$

The constant J_i is determined with a cut-back measurement made at the completion of the test sequence.

The sequence of measurements in the determination of J_i is, first, to make the measurements $Xf_{i,c}$ and $Xr_{i,c}$, replace the OTDR with a dual-wavelength source, make cut-back measurement A_i and then cut-back measurement B_i . The measurements of A_i and B_i are made using a bare fibre adapter and power meter. These are the only measurements that are not made with the OTDR.

$$J_i = B_i - A_i - \frac{Xf_{i,c} + Xr_{i,c}}{2} \qquad (9)$$

where

A_i is a cut-back measurement of power in fibre "i" at point "a" (see Figure 8);

B_i is a cut-back measurement of power in fibre "i" at point "b" (see Figure 8);

$Xf_{i,c}$ and $Xr_{i,c}$ are the measurements made at the time of the cut-back measurements.

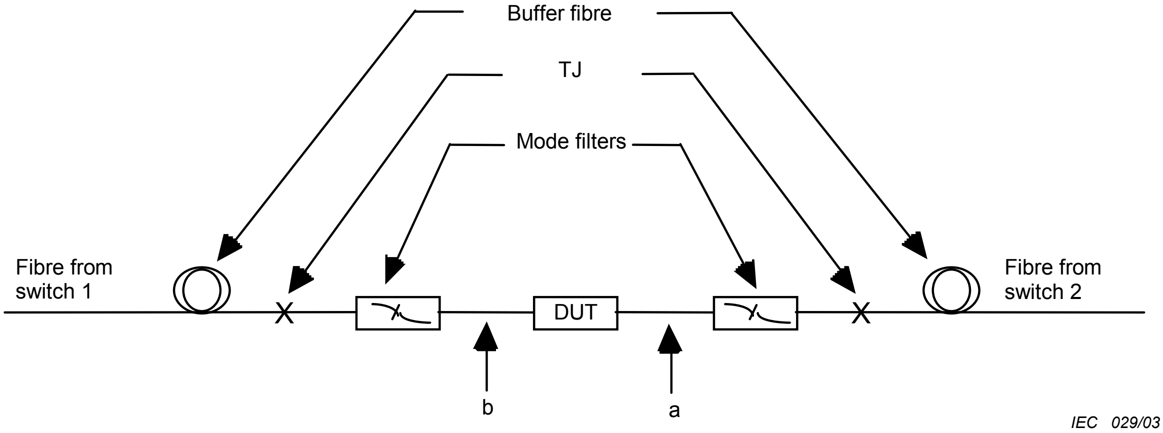

Figure 8 – Cut-back measurement location (OTDR)

5.4.3 Return loss – method 4

Set switch 1 to the channel for which return loss is being measured. A measurement of return loss is made as follows.

NOTE For short light pulses (less than 1 ms duration), the bandwidth of response of the OTDR detector can limit the measurement accuracy. In this case, the return loss should be calibrated against a reference back-reflection element.

Return loss of the DUT in channel "i" at time "t" is given by the following.

$$RL_{\mathrm{i,t}} = -10 \times \log\left(10^{H_{\mathrm{i,t}}/5} - 1\right) + K_{\mathrm{i}} \tag{10}$$

where

$H_{\mathrm{i,t}}$ is the height of the reflectance in the OTDR trace, as shown in Figure 7;

K_{i} is a constant for channel "i".

The constant K_{i} may be evaluated with the following equation:

$$K = B - 10 \times \log (T) \tag{11}$$

where

T is the time duration of the OTDR pulse in nanoseconds (ns);

B is the Rayleigh backscatter coefficient.

B can be obtained from the value recommended by the fibre manufacturer, or by calculation as shown in IEC 61300-3-6. Table 1 gives example values of B for various fibre types:

Table 1 – Example values for Rayleigh backscatter coefficient

Fibre type	Wavelength nm	B (dB) (for T in ns)
Dispersion-unshifted single-mode	1 310	−80
	1 550	−82,5
Dispersion-shifted single-mode	1 550	−81
Graded-index multimode with 62,5 µm core diameter and 0,275 numerical aperture	850	−67
	1 300	−74

Where $H_{i,t}$ > 5 dB, the following approximation for return loss may be used.

$$RL_{i,t} = -2 \times H_{i,t} + K_i \tag{12}$$

An alternative method for evaluating K_i is to splice a known return loss to the fibre from channel "i" of switch 1. In this case, K_i is given by the formula:

$$K_i = -10 \times \log\left(10^{H_{i,t}/5} - 1\right) + R \tag{13}$$

where R is the value of the reference return loss.

5.5 Unidirectional OTDR monitoring of attenuation and return loss of multiple samples – method 5

This method is functionally similar to method 4 but highlights the fact that, in a monitoring test, it is possible to obtain a good measure of the performance of a DUT without making bidirectional OTDR measurements. Figure 5 shows how changes in the value of attenuation or return loss of the DUT(s) can be measured using an OTDR in one direction. Therefore, the apparatus includes only one 1 × N switch.

Relative attenuation of the DUT in channel "i" at time "t" is then:

$$L_{i,t} = Xf_{i,t} \tag{14}$$

NOTE As in method 4, the important factor for a monitoring experiment is the change in $L_{i,t}$ from the initial value.

Return loss is measured as in 5.4.3.

6 Details to be specified

6.1 Method 1

The details to be specified for method 1 are as follows:

- stress parameters;
- test duration or number of cycles;
- periodicity of measurements;
- source parameters;
- acceptance or failure criteria;
- deviations.

6.2 Methods 2 and 3

The details to be specified for methods 2 and 3 are as follows:

- stress parameters;
- test duration or number of cycles;
- periodicity of measurements;
- source parameters;
- switch or 1 × N branching device parameters;
- 1 × 2 or 2 × 2 branching device parameters;
- requirements for the monitor sample or reference fibre;
- procedures to reduce reflected powers;
- acceptance or failure criteria;
- deviations.

6.3 Methods 4 and 5

The details to be specified for methods 4 and 5 are as follows:

- stress parameters;
- test duration or number of cycles;
- periodicity of measurements;
- OTDR parameters;
- switch parameters;
- requirements for the monitor sample or reference fibre;
- fibre lengths and characteristics (buffer fibre);
- acceptance or failure criteria;
- deviations.

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