

TECHNICAL REPORT



Guidance for the interpretation of OTDR backscattering traces for single-mode fibres

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.180.10

ISBN 978-2-8322-4553-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Backscattering phenomenon.....	6
4.1 Rayleigh scattering	6
4.2 Fresnel reflections and dead zone fibres.....	6
5 Measurement of the backscattered power (OTDR).....	7
5.1 General.....	7
5.2 Representation of the backscattered power.....	7
5.3 Noise and perturbations	8
6 Interpretation of a backscattering trace.....	8
6.1 General.....	8
6.2 Launch cord	9
6.3 Tail cord	9
6.4 Unidirectional trace.....	9
6.4.1 General	9
6.4.2 Slope as the attenuation coefficient of a fibre	10
6.4.3 Impurity and discontinuity	10
6.4.4 Pulse width.....	10
6.4.5 Polarization effects	10
6.5 Bi-directional trace.....	11
6.5.1 General	11
6.5.2 Attenuation uniformity.....	11
6.5.3 MFD uniformity	12
6.6 Splice loss evaluation	12
6.6.1 General	12
6.6.2 Event measurement methods.....	13
6.6.3 Apparent losers and gainers	14
6.6.4 Example of apparent splice loss evaluation for uni-directional OTDR measurements.....	17
7 Uncertainties, deviation and resolution	18
7.1 General.....	18
7.2 Attenuation coefficient measurements.....	18
7.3 Fault locations	19
Bibliography.....	21
Figure 1 – Unidirectional OTDR trace showing splice and/or macro bend loss.....	9
Figure 2 – Idealized unidirectional OTDR traces corresponding to a non-reflective splice between two fibres	13
Figure 3 – OTDR traces for similar or different fibre types with different MFD and/or different backscatter properties.....	14
Figure 4 – Loss in unidirectional OTDR measurements as function of the MFD difference between two spliced fibres.....	15

Figure 5 – Theoretical power through splice loss due to MFD difference (with $\omega_1 = 9\mu\text{m}$) 16

a) Mean splice loss measured from B6 to B1.3 fibre 17

b) Mean splice loss measured from B1.3 to B6 fibre 18

Figure 6 – Apparent cumulative unidirectional backscattering mismatch distribution for six splice combinations of B1.3 and B6 reported in Table 1 18

Figure 7 – Schematic drawing of a fibre with two consecutive defects 1 and 2 19

Table 1 – Summary for six fibre splice combinations of B1.3 and B6 based on popular 1 310 nm MFD fibre distributions 17

INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDANCE FOR THE INTERPRETATION OF OTDR BACKSCATTERING TRACES FOR SINGLE-MODE FIBRES

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a Technical Report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62316, which is a Technical Report, has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2007. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) the scope has been extended to include single-mode fibres;
- a) backscattered power effects are discussed in case of unidirectional trace, including so-called losers and gainers.
- b) example of apparent splice loss evaluation for unidirectional OTDR measurements has been added:

- c) description of launch and tail cords have been added;
- d) figures have been improved.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
86A/1754/DTR	86A/1768A/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

GUIDANCE FOR THE INTERPRETATION OF OTDR BACKSCATTERING TRACES FOR SINGLE-MODE FIBRES

1 Scope

IEC 62316, which is a Technical Report, aims to provide guidelines for the interpretation of backscattering traces, as obtained by traditional optical time domain reflectometers (OTDRs) – not including polarization OTDRs – for single-mode fibres. Also, backscattered power effects are discussed in case of unidirectional trace.

Full description of the test measurement procedure can be found in Annex C of IEC 60793-1-40:2001.

2 Normative references

There are no normative references in this document.