

Non-linear coefficient measuring methods — Application guide

ICS 33.180.10

National foreword

This Published Document reproduces verbatim IEC TR 62285:2002.

The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/1, Optical fibres and cables, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international publications referred to in this document may be found in the *BSI Catalogue* under the section entitled “International Standards Correspondence Index”, or by using the “Search” facility of the *BSI Electronic Catalogue* or of British Standards Online.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 19 February 2003

Summary of pages

This document comprises a front cover, an inside front cover, the IEC TR title page, pages 2 to 20, an inside back cover and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

© BSI 19 February 2003

**RAPPORT
TECHNIQUE
TECHNICAL
REPORT**

**CEI
IEC
TR 62285**

Première édition
First edition
2002-07

**Méthodes de mesure du coefficient
de non-linéarité –
Guide d'application**

**Non-linear coefficient measuring
methods –
Application guide**



Numéro de référence
Reference number
CEI/IEC/TR 62285:2002

CONTENTS

FOREWORD.....3

1 Scope and object.....5

2 Reference documents.....6

3 Apparatus.....6

 3.1 Light source 6

 3.2 Input optics 6

 3.3 Input positioner 6

 3.4 Cladding mode stripper 6

 3.5 Output positioner.....6

 3.6 Output optics.....6

 3.7 Computer 7

4 Samples and specimens.....7

5 Procedure.....7

6 Calculations of interpretation of results.....7

7 Documentation 8

 7.1 Information to be provided with each measurement 8

 7.2 Information available upon request.....8

Annex A Continuous wave dual-frequency method.....9

Annex B Pulsed single-frequency method (PM)..... 15

Annex C List of acronyms and symbols..... 19

Bibliography.....20

INTERNATIONAL ELECTROTECHNICAL COMMISSION

NON-LINEAR COEFFICIENT MEASURING METHODS – APPLICATION GUIDE

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a worldwide organisation for standardisation comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardisation in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. 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 organisations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organisation for Standardisation (ISO) in accordance with conditions determined by agreement between the two organisations.
- 2) The formal decisions or agreements of the 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 National Committees.
- 3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
- 4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.
- 5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.
- 6) Attention is drawn to the possibility that some of the elements of this technical report may be the subject of patent rights. The 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".

Technical reports do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful by the maintenance team.

IEC 62285, which is a technical report, has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86A/745/CDV	86A/782/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 3.

This document which is purely informative is not to be regarded as an International Standard.

The committee has decided that the contents of this publication will remain unchanged until 2008. At this date, the publication will be

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

NON-LINEAR COEFFICIENT MEASURING METHODS – APPLICATION GUIDE

1 Scope and object

This technical report is intended to provide guidance for uniform measurements of the non-linear coefficient of single-mode fibres (IEC 60793-2-50) in the 1 550 nm region.

The non-linear coefficient (nLc) is the ratio of the Kerr non-linear refractive index, n_2 , to effective area, A_{eff} (see IEC/TR 62284) as:

$$\text{nLc} = \frac{n_2}{A_{\text{eff}}} \quad (1)$$

The non-linear coefficient is related to the following non-linear optical distortion effects as a combined parameter:

- Self-phase modulation (SPM)
- Cross-phase modulation (XPM)
- Four-wave mixing (FWM)

Other fibre attributes, such as chromatic dispersion and polarisation mode dispersion, also influence the transmission.

Two methods are given, with details specific to each in normative annexes. They are:

- Method A Continuous-wave dual-frequency
- Method B Pulsed single-frequency

Both methods require injecting very high powers (5 dBm or more) into the fibre, measurement of this power (absolute), and measurement of the output spectrum which is modified by non-linear effects. Both methods use calculations that combine these measured results with those derived from other measurements such as attenuation (IEC 60793-1-40) and chromatic dispersion (IEC 60793-1-42). Both methods have limitations on the length of fibre that can be measured – in a relationship with the chromatic dispersion at the wavelength being measured.

Method A [1] ¹⁾ requires injecting the light of two wavelengths into the fibre. The light of both wavelengths is constant at various power levels. At higher power, the lights beat due to the non-linear effect and produce an output spectrum that is spread. The relationship of the power level to a particular metric of spectrum spreading is used to calculate the non-linear coefficient.

Method B [2], [3] requires injecting pulsed light at a single wavelength. The pulses should be of duration substantially less than 1 ns and the input peak power of these pulses should be measured and related to the non-linear spreading of the output spectrum.

Measurements of the non-linear coefficient are used to characterise specific single-mode fibre designs for the purpose of system design relative to power levels and distortion or noise effects derived from the non-linear optical behaviour.

Figures in square brackets refer to the bibliography.

2 Reference documents

IEC 60793-1-1, *Optical fibres – Part 1-1: Measurement methods and test procedures – General and guidance* ²⁾

IEC 60793-1-40, *Optical fibres – Part 1-40: Measurement methods and test procedures – Attenuation*

IEC 60793-1-42, *Optical fibres – Part 1-42: Measurement methods and test procedures – Chromatic dispersion*

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

IEC 61315, *Calibration of fibre optic power meters*

3 Apparatus

The following apparatus is common to both measurement methods. Annexes A and B include layout drawings and other equipment requirements for each of the methods, respectively.

3.1 Light source

See annexes A and B for detailed characteristics of the light sources.

3.2 Input optics

The input optics include one or more lasers, amplifiers, variable attenuators, couplers and power meters. Bandpass filters and oscilloscopes may be needed for Method B. See annexes A and B for specific details.

3.3 Input positioner

Provide means of positioning the input end of the specimen to the light source. Typically, this connection is with a fusion splice to a short (1 m) pigtail of type B1.1 fibre.

3.4 Cladding mode stripper

Use a device that extracts cladding modes. Under some circumstances, the fibre coating will perform this function.

3.5 Output positioner

Provide a suitable means for aligning the fibre to the output optics. Typically, this connection is with a fusion splice to a pigtail of type B1.1 fibre.

3.6 Output optics

The output optics include a power meter and optical spectrum analyser. An oscilloscope may be required for Method B. See annexes A and B for details.

2) 2nd edition, to be published.