



DPC: 23 / 30477062 DC

BSI Group Headquarters

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 20 July 2023
Origin: International**Latest date for receipt of comments: 6 September 2023**

Project No. 2023/01549

Responsible committee: GEL/86/3 Fibre optic systems and active devices

Interested committees:

Title: BS EN IEC 62007-2 Semiconductor optoelectronic devices for fibre optic system applications

Part 2: Measuring methods

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

**WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD.
THIS DRAFT IS NOT CURRENT BEYOND 6 September 2023**

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email cservices@bsigroup.com. British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <http://standardsdevelopment.bsigroup.com>

Responsible Committee Secretary: **Committee Service Centre (BSI)**
Direct tel: **020 8996 7009**
E-mail: csc@bsigroup.com

AVA Documents
Document Sharing Hub

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
------------------	------------------------

1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



86C/1881/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 62007-2 ED3

DATE OF CIRCULATION:

2023-07-14

CLOSING DATE FOR COMMENTS:

2023-10-06

SUPERSEDES DOCUMENTS:

86C/1878/RR

IEC SC 86C : FIBRE OPTIC SYSTEMS AND ACTIVE DEVICES

SECRETARIAT:

United States of America

SECRETARY:

Mr Fred Heismann

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☒ QUALITY ASSURANCE

☐ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any local regulations or technical reasons that may exist and should be considered should this proposal proceed, recognizing that failure to address such requirements could result in the need for new or existing "In Some Countries" clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Semiconductor optoelectronic devices for fibre optic system applications - Part 2: Measuring methods

NOTE FROM TC/SC OFFICERS:

CONTENTS

1		
2		
3	FOREWORD	4
4	INTRODUCTION	6
5	1 Scope	7
6	2 Normative references	7
7	3 Terms, definitions, and abbreviated terms	7
8	3.1 Terms and definitions	7
9	3.2 Abbreviated terms	7
10	4 Measuring methods for photoemitters	8
11	4.1 Outline of the measuring methods	8
12	4.2 Radiant power and forward current of LEDs and LDs with or without optical fibre pigtails	8
13	4.3 Small signal cut-off frequency f_c of LEDs and LDs with or without optical fibre pigtails	9
14	4.4 Threshold current of LDs with or without optical fibre pigtails	11
15	4.5 Relative intensity noise of LEDs and LDs with or without optical fibre pigtails	12
16	4.6 S_{11} parameter of LEDs, LDs and LD modules with or without optical fibre pigtails	13
17	4.7 Tracking error for LD modules with optical fibre pigtails, with or without cooler	15
18	4.8 Spectral linewidth of LDs with or without optical fibre pigtails	17
19	4.9 Modulation current at 1 dB efficacy compression of LEDs	19
20	4.10 Differential efficiency of an LD module or an LD with or without pigtail	21
21	4.11 Differential (forward) resistance r_d of an LD with or without pigtail	22
22	5 Measuring methods for receivers	23
23	5.1 Outline of the measuring methods	23
24	5.2 Noise of a PIN photodiode	24
25	5.3 Excess noise factor of an APD with or without optical fibre pigtails	25
26	5.4 Small-signal cut-off frequency of a photodiode with or without optical fibre pigtails	27
27	5.5 Multiplication factor of an APD with or without optical fibre pigtails	28
28	5.6 Responsivity of a PIN-TIA module	30
29	5.7 Frequency response flatness ($\Delta S/S$) of a PIN-TIA module	32
30	5.8 Output noise power (spectral) density $P_{no,\lambda}$ of a PIN-TIA module	33
31	5.9 Low frequency output noise power (spectral) density ($P_{no,\lambda,LF}$) and corner frequency (f_{cor}) of a PIN-TIA module	35
32	5.10 Minimum detectable power of PIN-TIA module	37
33	Bibliography	39
34		
35	Figure 1 – Equipment setup for measuring radiant power and forward current of LEDs or LDs	9
36	Figure 2 – Circuit diagram for measuring the small-signal cut-off frequency of LEDs or LDs 10	
37	Figure 3 – Circuit diagram for measuring threshold current of a LD	11
38	Figure 4 – Graph to determine threshold current of lasers	12

47	Figure 5 – Circuit diagram for measuring RIN of LEDs and LDs	12
48	Figure 6 – Circuit diagram for measuring the S_{11} parameter of LEDs, LDs, and LD	
49	modules	14
50	Figure 7– Circuit diagrams for LDs with cathode or anode connected to package	16
51	Figure 8 – Output radiant power versus time	17
52	Figure 9 – Output radiant power versus case temperature	17
53	Figure 10 – Equipment setup for measuring the spectral linewidth of LDs	18
54	Figure 11 – Circuit diagram for measuring 1-dB efficacy compression of LEDs	19
55	Figure 12 – Plot of $20 \times \log(V_2)$ versus $20 \times \log(I_1)$	20
56	Figure 13 – Circuit diagram for measuring differential efficiency of an LD	21
57	Figure 14 – Current waveform for differential efficiency measurement	21
58	Figure 15 – Circuit diagram for measuring differential resistance	22
59	Figure 16 – Current waveform for differential resistance	23
60	Figure 17 – Circuit diagram for measuring noise of a PIN photoreceiver	24
61	Figure 18 – Circuit diagram for measuring noise with synchronous detection	25
62	Figure 19 – Circuit diagram for measuring excess noise of an APD	26
63	Figure 20 – Circuit diagram for measuring small-signal cut-off wavelength of a	
64	photodiode	28
65	Figure 21 – Circuit diagram for measuring multiplication factor of an APD	29
66	Figure 22 – Graph showing measurement of I_{R1} and I_{R2}	30
67	Figure 23 – Circuit diagram for measuring responsivity of a PIN-TIA module	31
68	Figure 24 – Circuit diagram for measuring frequency response flatness of a PIN-TIA	
69	module	32
70	Figure 25 – Circuit diagram for measuring output noise power (spectral) density of a	
71	PIN-TIA module under matched output conditions	34
72	Figure 26 – Circuit diagram for measuring output noise power (spectral) density of a	
73	non-irradiated PIN-TIA module in the low frequency region	35
74	Figure 27 – Graph of V_m versus frequency	37
75	Figure 28 – Circuit diagram for measuring minimum detectable power of a PIN-TIA	
76	module	38
77		
78		
79		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SEMICONDUCTOR OPTOELECTRONIC DEVICES
FOR FIBRE OPTIC SYSTEM APPLICATIONS –****Part 2: Measuring methods**

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of patents, which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch> and www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 62007-2 has been prepared by subcommittee 86C: Fibre optic systems and active devices, of IEC technical committee 86: Fibre optics. It is an International Standard.

This third edition cancels and replaces the second edition published in 2009. This edition constitutes a technical revision.

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

- a) Correction of an error in Formula (1) for relative intensity noise;
- b) Correction of errors in the title of Figure 11 and the text of 4.9 (replaced "LD" with "LED");
- c) Clarification of how to calculate the 1 dB compression in 4.9;

d) Correction of an error in Figure 21 (added missing label “SA”);

e) Clarification of the measurement setup (Figure 28) in 5.10.

The text of this International Standard is based on the following documents:

Draft	Report on voting
86C/XX/FDIS	86C/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 62007 series can be found, under the general title *Semiconductor optoelectronic devices for fibre optic system applications*, on the IEC website

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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.

157

INTRODUCTION

158 Semiconductor optical signal transmitters and receivers play important roles in optical
159 information networks. This standard covers the measurement procedures for their optical and
160 electrical properties that are intended for digital communication systems. These properties are
161 essential to specify their performance.

162

SEMICONDUCTOR OPTOELECTRONIC DEVICES FOR FIBRE OPTIC SYSTEM APPLICATIONS –

Part 2: Measuring methods

1 Scope

This part of IEC 62007 specifies measuring methods for characterizing semiconductor optoelectronic devices that are used in the field of fibre optic digital communication systems and subsystems.

2 Normative references

There are no normative references in this document.

3 Terms, definitions, and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms, definitions and abbreviations apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1.1.1

PIN photodiode

photodiode with a large intrinsic region sandwiched between p- and n-doped semiconducting regions used for the detection of optical radiation

[SOURCE: IEC 731-06-29]

3.1.1.2

avalanche photodiode

photodiode operating with a bias voltage such that the primary photocurrent undergoes amplification by cumulative multiplication of charge carriers

[SOURCE: IEC 731-06-30]

3.1.1.3

pigtail

short optical fibre or optical fibre cable that is attached to a device being measured

3.2 Abbreviated terms

AC	alternating current
APD	avalanche photodiode
BER	bit-error ratio
DC	direct current
LED	light emitting diode
LD	laser diode
NEP	noise-equivalent power

202	PD	photodetector
203	RF	radio frequency
204	RIN	relative intensity noise
205	RMS	root mean square
206	TIA	transimpedance amplifier

207 **4 Measuring methods for photoemitters**

208 **4.1 Outline of the measuring methods**

209 Light emitting diodes (LEDs) and laser diodes (LDs) have important opto-electronic properties,
210 which need to be specified when they are used in optical communication systems. The
211 measurement methods for characterizing these opto-electronic properties are described in
212 subclauses 4.2 to 4.11, where each subclause covers the following topics.

- 213 a) Purpose;
- 214 b) One of the following items
 - 215 • Measurement equipment;
 - 216 • Equipment setup;
 - 217 • Circuit diagram;
 - 218 • Circuit design and current waveform for measurement.
- 219 c) Equipment / circuit description and requirements;
- 220 d) Precautions to be observed;
- 221 e) Measurement procedures;
- 222 f) Specified conditions.

223 If a device is equipped with an optical fibre pigtail, all optical fibres and cables defined in the
224 IEC 60793 and IEC 60794 series are applicable. If a pigtail is to be terminated with an optical
225 connector, all optical connectors defined in the IEC 61754 and IEC 61755 series are applicable.

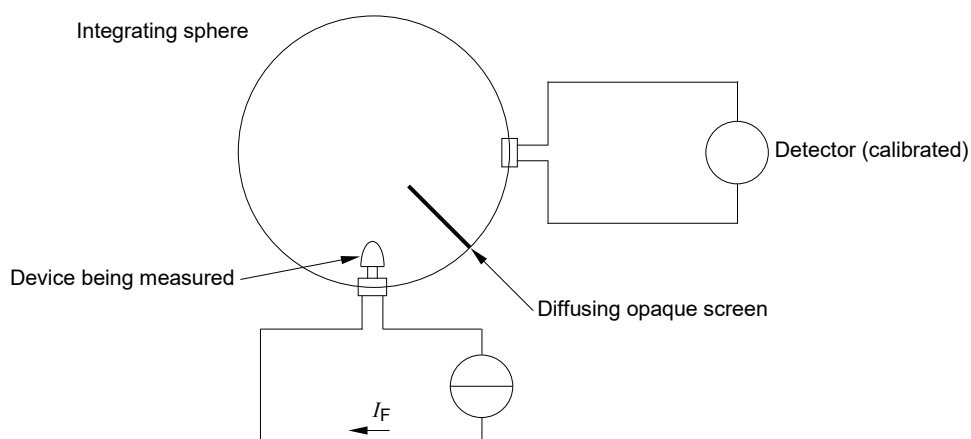
226 **4.2 Radiant power and forward current of LEDs and LDs with or without optical fibre** 227 **pigtails**

228 *a) Purpose*

229 To measure the radiant power Φ_e and the forward current I_F of light-emitting diodes (LED)
230 and laser diodes, with or without optical fibre pigtails, under specified conditions.

231 *b) Measurement equipment*

232 Figure 1 shows the equipment setup for measuring the radiant power and forward current
233 of LEDs and LDs.



IEC 2305/08

Figure 1 – Equipment setup for measuring radiant power and forward current of LEDs or LDs

c) Equipment description and requirements

The radiation emitted by the device is subjected to multiple reflections from the walls of the integrating sphere; this leads to a uniform irradiance of the surface proportional to the emitted flux. A detector located in the walls of the sphere measures this irradiance. An opaque screen shields the detector from the direct radiation of the device being measured.

d) Precautions to be observed

The device being measured, the screen, and the apertures shall be small compared to the sphere surface.

The inner surface of the sphere and screen shall have a diffusing coating with a high uniform reflection coefficient (0,8 minimum).

The sphere and detector assembly shall be calibrated.

Variations in peak-emission wavelength and in radiation flux due to power dissipation shall be taken into account.

When the radiation emitted by the device being measured is pulsed, the detector shall time-average the measured radiation.

e) Measurement procedures

The emitting device is positioned at the entrance of the integrating sphere, so that no direct radiation will reach the detector.

For measurements of radiant power, the specified forward current I_F is applied to the device, and the radiant power is measured by the photodetector.

For measurements of forward current, the current applied to the device is increased until the specified radiant power Φ_e is achieved. The value of this current is recorded.

f) Specified conditions

- Ambient or case temperature.
- Radiant power (when measuring forward current).
- Forward current (when measuring radiant power).

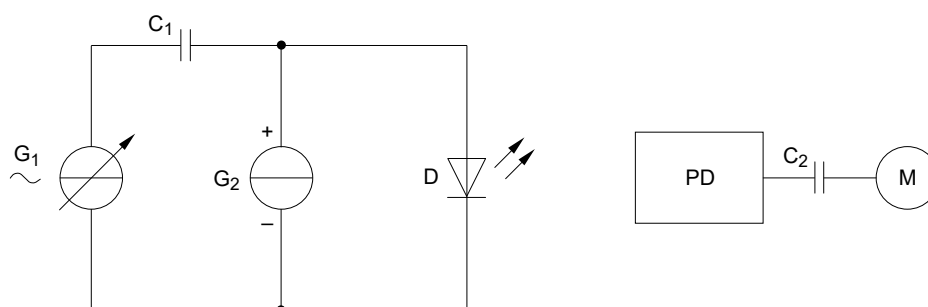
4.3 Small signal cut-off frequency f_c of LEDs and LDs with or without optical fibre pigtails

a) Purpose

To measure the small-signal cut-off frequency f_c of light-emitting diodes (LEDs) and laser diodes (LDs) with or without optical fibre pigtails, under specified conditions.

b) Circuit diagram

Figure 2 shows a circuit diagram for measuring the small-signal cut-off frequency of LEDs and LDs.



IEC 2306/08

Key

D	device being measured
G_1	AC generator with adjustable frequency
G_2	DC generator
PD	photodetector
M	measuring instrument for AC radiant power
C_1, C_2	coupling capacitors

Figure 2 – Circuit diagram for measuring the small-signal cut-off frequency of LEDs or LDs

c) Equipment description and requirements

No requirements for this item.

d) Precautions to be observed

The radiant power reflected back into the laser diode shall be minimized to avoid modulation distortions, which could affect the accuracy of the measurement. The photodetector must have a frequency response greater than f_c .

e) Measurement procedure

For LEDs, the specified direct forward current or the direct forward current required to obtain the specified radiant power is applied to the device being measured.

For laser diodes, the forward current is adjusted to a value which is equal to the continuous forward current above threshold or which generates a specified radiant power.

The forward current is modulated using generator G_1 at a low frequency f_1 (less than $f_c/100$) and the AC radiant power is measured by instrument M (see Figure 2).

Keeping the modulation level constant, the modulation frequency is increased until the output radiant power measured by M is reduced to 50 % of the value obtained at f_1 .

This frequency is the small-signal cut-off frequency f_c .

f) Specified conditions

For light-emitting diodes (LED):

- ambient or case temperature;
- DC forward current or radiant power.

For the laser diodes (LD):

- ambient, case, or submount temperature;
- radiant power or difference between applied DC forward current and threshold current of LD.

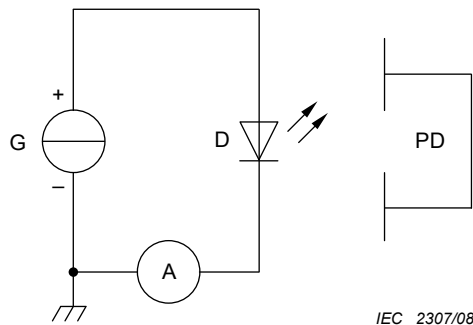
4.4 Threshold current of LDs with or without optical fibre pigtails

a) Purpose

To measure the threshold current of a laser diode, with or without optical fibre pigtails.

b) Circuit diagram

Figure 3 shows a circuit diagram for measuring threshold current of a laser diode.



Key

D	device being measured
PD	photodetector measuring incident radiant power
A	ammeter
G	generator (DC or pulsed current)

Figure 3 – Circuit diagram for measuring threshold current of a LD

c) Circuit description and requirements

For pulse measurement, the current generator, G, shall provide current pulses of the required amplitude, duration and repetition rate.

d) Precautions to be observed

Radiant power reflected back into the laser diode shall be minimized. The limiting values of the laser diode (I_F and Φ_e) shall not be overstepped.

e) Measurement procedure

A forward current is applied to the diode and the relation between the incident radiant power from the diode and the forward current is recorded.

The forward current at which the second derivative of the recorded curve showing incident radiant power versus the forward current has its first maximum is determined (see Figure 4). The forward current at this point is the threshold current I_{TH} .

f) Specified conditions

- Ambient, case or submount temperature.
- For pulse measurement, repetition frequency and pulse duration of the forward current.

Figure 4 illustrates how to determine the threshold current of LDs.