

Fibre optic sensors - Part 4-3: Electric current  
measurement - Polarimetric method

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

See Eesti standard EVS-EN IEC 61757-4-3:2020 sisaldab Euroopa standardi EN IEC 61757-4-3:2020 ingliskeelset teksti.	This Estonian standard EVS-EN IEC 61757-4-3:2020 consists of the English text of the European standard EN IEC 61757-4-3:2020.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 11.09.2020.	Date of Availability of the European standard is 11.09.2020.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile [standardiosakond@evs.ee](mailto:standardiosakond@evs.ee).

ICS 33.180.99

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:  
Koduleht [www.evs.ee](http://www.evs.ee); telefon 605 5050; e-post [info@evs.ee](mailto:info@evs.ee)

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:

Homepage [www.evs.ee](http://www.evs.ee); phone +372 605 5050; e-mail [info@evs.ee](mailto:info@evs.ee)

English Version

**Fibre optic sensors - Part 4-3: Electric current measurement -  
Polarimetric method  
(IEC 61757-4-3:2020)**

Capteurs fibroniques - Partie 4-3: Mesure du courant  
électrique - Méthode polarimétrique  
(IEC 61757-4-3:2020)

Lichtwellenleitersensoren - Teil 4-3: Strommessung -  
Polarimetrisches Verfahren  
(IEC 61757-4-3:2020)

This European Standard was approved by CENELEC on 2020-09-03. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

**CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels**

## European foreword

The text of document 86C/1578/CDV, future edition 1 of IEC 61757-4-3, prepared by SC 86C "Fibre optic systems and active devices" of IEC/TC 86 "Fibre optics" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61757-4-3:2020.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2021-06-03 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2023-09-03 document have to be withdrawn

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

## Endorsement notice

The text of the International Standard IEC 61757-4-3:2020 was approved by CENELEC as a European Standard without any modification.

## **Annex ZA**

(normative)

### **Normative references to international publications with their corresponding European publications**

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: [www.cenelec.eu](http://www.cenelec.eu).

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61757	-	Fibre optic sensors - Generic specification	EN IEC 61757	-

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Fibre optic sensors –  
Part 4-3: Electric current measurement – Polarimetric method**

**Capteurs fibroniques –  
Partie 4-3: Mesure du courant électrique – Méthode polarimétrique**



## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

### About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

### About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

#### IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

#### IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

### A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

### A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### Recherche de publications IEC -

[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

#### Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

**Electropedia** - [www.electropedia.org](http://www.electropedia.org)

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE

**Fibre optic sensors –**

**Part 4-3: Electric current measurement – Polarimetric method**

**Capteurs fibroniques –**

**Partie 4-3: Mesure du courant électrique – Méthode polarimétrique**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

ICS 33.180.99

ISBN 978-2-8322-8729-3

**Warning! Make sure that you obtained this publication from an authorized distributor.**  
**Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**



## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 Components of optical current sensor using polarimetric method.....	10
4.1 General descriptions .....	10
4.2 Classification of Faraday elements.....	11
5 Characteristic test .....	12
5.1 General information .....	12
5.2 Output power of light source .....	12
5.3 Input power of light detector.....	13
5.4 I/O characteristics.....	13
5.4.1 General .....	13
5.4.2 Test method .....	14
5.4.3 Test procedure .....	16
5.4.4 Evaluation .....	18
5.5 Warm-up time .....	19
5.5.1 General .....	19
5.5.2 Test method .....	19
5.5.3 Evaluation .....	19
5.6 Current conditions for obtaining each parameter .....	19
5.7 Input parameter dependency.....	20
5.7.1 Frequency characteristic.....	20
5.7.2 Transient characteristic .....	20
5.8 External environment dependency .....	22
5.8.1 Steady state temperature characteristic test .....	22
5.8.2 Transient temperature characteristic test .....	25
5.8.3 External magnetic field test.....	27
5.8.4 Conductor position test .....	28
5.8.5 Vibration test .....	29
Annex A (informative) Principle of optical current sensor .....	30
A.1 Outline .....	30
A.2 Faraday effect.....	30
A.3 Types of Faraday element.....	31
A.4 Conversion of the Faraday effect into an electric signal .....	31
A.4.1 Detection of the Faraday effect of nonmagnetic material.....	31
A.4.2 Detection of the Faraday effect of ferromagnetic material .....	31
A.5 Current detection method.....	32
A.5.1 General .....	32
A.5.2 Examples of current detection method .....	32
Annex B (informative) Features of optical current sensor technology .....	35
Annex C (informative) Design considerations .....	36
C.1 General information .....	36
C.2 Performance restricting factors .....	36
C.3 Procedure for determining the specifications of the equipment.....	37

Annex D (informative) Optical current sensor output in the application of other phase magnetic fields.....	39
D.1 Ampere's circulation integral law.....	39
D.2 Influence of other phase magnetic fields .....	39
Annex E (informative) Measurement parameter performance table .....	41
E.1 General.....	41
E.2 Output power of light source .....	41
E.3 Input power of light detector.....	41
E.4 I/O characteristics .....	41
E.5 Frequency characteristics .....	42
E.6 Transient characteristics .....	43
E.7 Steady state temperature characteristics .....	43
E.8 Transient temperature characteristics .....	44
E.9 External magnetic field.....	45
E.10 Conductor positions .....	46
E.11 Vibration .....	47
Bibliography.....	48
Figure 1 – Measurement system using optical current sensor .....	10
Figure 2 – Construction of optical current sensor .....	11
Figure 3 – Classification of Faraday elements.....	12
Figure 4 – Example of an optical power monitor.....	13
Figure 5 – Example of the amplifying circuit of a light detector .....	13
Figure 6 – I/O characteristics of an optical current sensor.....	14
Figure 7 – Measurement system of waveform comparison method .....	15
Figure 8 – Measurement system of AC bridge method .....	16
Figure 9 – Transient characteristics of AC dedicated system .....	21
Figure 10 – Transient characteristics of DC/AC system.....	22
Figure 11 – Configuration example of steady state temperature characteristic test and transient temperature characteristic test of sensor part.....	24
Figure 12 – Example of temperature profile.....	24
Figure 13 – Birefringence change during temperature change.....	25
Figure 14 – Example of temperature programme.....	27
Figure 15 – Position of the outer conductor in the external magnetic field test when the Faraday element is an optical fibre .....	28
Figure 16 – Position of the conductor in the conductor position test when the Faraday element is an optical fibre .....	29
Figure A.1 – Faraday effect.....	30
Figure A.2 – Configuration of current detection method using Faraday effect.....	32
Figure A.3 – Basic configuration of intensity modulation type optical current sensor .....	33
Figure A.4 – Configuration example of intensity modulation type reflective optical current sensor.....	33
Figure A.5 – Configuration example of interference type optical current sensor.....	34
Figure D.1 – The law of Ampere's circulation integral.....	39
Figure D.2 – Image diagram of incomplete closed loop .....	40
Figure E.1 – Example of the transient characteristic .....	43

Figure E.2 – Example of the temperature characteristics at current 0 .....	43
Figure E.3 – Example of the temperature characteristics at rated current .....	44
Figure E.4 – Example of the transient temperature characteristics at input current 0 .....	44
Figure E.5 – Example of the transient temperature characteristics at rated current .....	45
Figure E.6 – Positions of the outer conductor .....	46
Figure E.7 – Positions of the conductor in the conductor positions test .....	46
Figure E.8 – Example of the vibration test at current 0 .....	47
Figure E.9 – Example of the vibration test at rated current .....	47
Table 1 – List of parameters to be obtained .....	12
Table 2 – Test method .....	15
Table 3 – Current conditions for obtaining each parameter .....	19
Table E.1 – Output power of light source .....	41
Table E.2 – Input power of light detector .....	41
Table E.3 – I/O characteristics .....	41
Table E.4 – Frequency characteristics .....	42
Table E.5 – External magnetic field .....	45
Table E.6 – Conductor position .....	46

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIBRE OPTIC SENSORS –

**Part 4-3: Electric current measurement –  
Polarimetric method**

## 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.

International Standard IEC 61757-4-3 has been prepared by subcommittee SC 86C: Fibre optic systems and active devices, of IEC technical committee TC 86: Fibre optics.

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

CDV	Report on voting
86C/1578/CDV	86C/1611/RVC

Full information on the voting for the approval of this International Standard 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.

A list of all parts in the IEC 61757 series, published under the general title *Fibre optic sensors*, can be found 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 "<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.

## INTRODUCTION

Current measuring techniques are essential for controlling and diagnosing apparatus that support industry and society. As current measuring devices, optical current sensors based on magneto-optic effect have been developed. As these sensors enable advanced current measurement free from the issues related to conventional current sensors based on electromagnetic induction, they have been applied in various fields including power systems.

Given the expectations for the potential of this sensing technology, various kinds of optical current sensors for various applications have been proposed by manufacturers. With this background, there are many kinds (target current for measurement, configuration of sensor, signal processing method, installation method) of optical current sensors for various applications. When developing a new optical current sensor, the evaluation and design of performance and characteristics are carried out in each case.

For promoting the dissemination of optical current sensors, it is important to define the terms representing performance and functionality of the optical current sensor, which is manufactured on the basis of sensing technology. It is also important to make clear how to evaluate such terms. This makes it possible to design the sensor efficiently and properly and to transfer the sensor smoothly from a supplier to a user by settling these issues. Under these circumstances, a set of methods is summarized in this document for evaluating the performance and characteristics of optical current sensors. As the required performance for a sensor depends on its application, the performance is not defined quantitatively in this document. However, with the help of this document, the quantitative measures of sensor performance will be defined in designing the sensor itself in anticipation of its practical application.

This document is based on standard OITDA FS 01 published by the Optoelectronics Industry and Technology Development Association (OITDA).