

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Instrument transformers –
Part 6: Additional general requirements for low-power instrument transformers**

**Transformateurs de mesure –
Partie 6: Exigences générales supplémentaires concernant les transformateurs
de mesure de faible puissance**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2016 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
Fax: +41 22 919 03 00
info@iec.ch
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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub

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

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

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions 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

65 000 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.

IEC Customer Service Centre - 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: csc@iec.ch.

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.

Catalogue IEC - webstore.iec.ch/catalogue

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub

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

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

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions 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

65 000 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.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Instrument transformers –
Part 6: Additional general requirements for low-power instrument transformers**

**Transformateurs de mesure –
Partie 6: Exigences générales supplémentaires concernant les transformateurs
de mesure de faible puissance**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 17.220.20

ISBN 978-2-8322-4534-7

**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.....	6
1 Scope.....	10
2 Normative reference	10
3 Terms and definitions	13
3.1 General terms and definitions	13
3.2 Terms and definitions related to dielectric ratings and voltages	17
3.3 Terms and definitions related to current ratings	17
3.4 Terms and definitions related to accuracy	21
3.5 Terms and definitions related to other ratings.....	26
3.7 Index of abbreviations and symbols	26
4 Normal and special service conditions	28
4.2 Normal service conditions	28
4.2.3 Vibrations or earth tremors	28
4.2.601 Partially outdoor LPIT	28
5 Ratings.....	28
5.3 Rated insulation levels and voltages	28
5.3.5 Insulation requirements for secondary terminals	28
5.3.601 Rated auxiliary power supply voltage (U_{ar}).....	28
5.4 Rated frequency	29
5.5 Rated output	29
5.5.601 Rated burden (R_{br})	29
5.5.602 Standard values for the rated delay time (t_{dr})	29
5.6 Rated accuracy class.....	30
6 Design and construction	30
6.7 Mechanical requirements	30
6.11 Electromagnetic compatibility (EMC).....	30
6.11.3 Requirements for immunity	30
6.11.4 Requirement for transmitted overvoltages.....	32
6.11.601 Emission requirements	32
6.13 Markings.....	33
6.601 Requirements for optical transmitting system and optical output link	33
6.601.1 General	33
6.601.2 Optical connectors.....	33
6.601.3 Fibre optic terminal box	33
6.601.4 Total cable length	33
6.602 Requirements for electrical transmitting system and electrical wires for output link.....	33
6.602.1 Connectors.....	33
6.602.2 Earthing of the output cable	34
6.603 Signal-to-noise ratio.....	34
6.604 Failure detection and maintenance announcement.....	35
6.605 Operability	35
6.606 Reliability and dependability	35
6.607 Vibrations	35
7 Tests	36
7.1 General.....	36

7.1.2	List of tests	36
7.2	Type tests	37
7.2.1	General	37
7.2.2	Temperature-rise test	37
7.2.3	Impulse voltage withstand test on primary terminals	37
7.2.5	Electromagnetic compatibility (EMC) tests	37
7.2.6	Test for accuracy	41
7.2.601	Low-voltage component voltage withstand test	43
7.3	Routine tests	44
7.3.1	Power-frequency voltage withstand tests on primary terminals	44
7.3.4	Power-frequency voltage withstand tests on secondary terminals	45
7.3.5	Test for accuracy	45
7.3.601	Power-frequency voltage withstand test for low-voltage components	45
7.4	Special tests	45
7.4.601	Vibration tests	45
601	Information to be given with enquiries, tenders and orders	46
601.1	Designation	46
601.2	Dependability	46
Annex 6A (normative)	LPIT frequency response and accuracy requirements for harmonics	47
6A.1	General	47
6A.2	Requirements for noise and distortion	47
6A.3	Anti-aliasing filter requirements for LPIT using digital data processing	47
6A.4	LPIT accuracy requirements for harmonics and low frequencies	49
6A.4.1	General	49
6A.4.2	Measuring accuracy classes	49
6A.4.3	Accuracy class extension for quality metering and low bandwidth d.c. applications	50
6A.4.4	Protective accuracy classes	51
6A.4.5	Special high bandwidth protection accuracy class	51
6A.4.6	Special accuracy classes for d.c. coupled low-power voltage transformers	52
6A.5	Tests for accuracy versus harmonics and low frequencies	52
6A.6	Test arrangement and test circuit	53
6A.6.1	Test for accuracy for harmonics and low frequencies	53
6A.6.2	Type test for proper anti-aliasing	53
Annex 6B (informative)	Transient performances of low-power current transformers	55
6B.1	General	55
6B.2	Short-circuit currents in power systems	55
6B.3	Conventional current transformer equivalent circuit	58
6B.4	Types of current transformers	60
6B.4.1	Types of conventional CTs	60
6B.4.2	Types of low-power current transformers	61
6B.5	Transient performance of current transformers	62
6B.5.1	Transient performance of conventional current transformers	62
6B.5.2	Transient performance of low-power current transformers	63
6B.6	Summary	64
Annex 6C (informative)	Transient performances of low-power voltage transformers	65
6C.1	Overview	65

6C.2	General.....	65
6C.2.1	Defining primary and secondary voltages.....	65
6C.2.2	Normal service conditions of the network.....	65
6C.2.3	Abnormal service conditions of the network.....	66
6C.2.4	Rated secondary voltages.....	66
6C.2.5	Steady-state conditions.....	66
6C.3	Transient conditions.....	66
6C.3.1	Theoretical considerations.....	66
6C.3.2	Definition of transient error.....	73
6C.3.3	Test of transient performance.....	73
Annex 6D	(informative) Test circuits.....	78
6D.1	Test circuits for accuracy measurements in steady state for low-power current transformers.....	78
6D.2	Test circuits for accuracy measurements in steady state for low-power voltage transformers.....	81
Annex 6E	(informative) Graph explaining the accuracy requirements for multi-purpose low-power current transformer.....	84
Bibliography	85
Figure 601	– General block diagram of a single-phase LPIT.....	10
Figure 602	– Primary time constant T_p	19
Figure 603	– Duty cycles, single energization.....	20
Figure 604	– Duty cycles, double energization.....	21
Figure 605	– Examples of subassembly subjected to EMC tests – Usual structure used in HV AIS applications.....	38
Figure 606	– Examples of subassembly subjected to EMC tests – Usual structure used in MV applications.....	39
Figure 607	– Examples of subassembly subjected to EMC tests – Usual structure used in HV GIS applications.....	39
Figure 608	– Temperature cycle accuracy test.....	42
Figure 6A.1	– Digital data acquisition system example.....	48
Figure 6A.2	– Frequency response mask for metering accuracy class 1 ($f_r = 60$ Hz, $f_s = 4\ 800$ Hz).....	49
Figure 6B.1	– Illustration of a fault in a power system.....	56
Figure 6B.2	– Short-circuit current a.c. and d.c. components.....	56
Figure 6B.3	– Symmetric fault current.....	57
Figure 6B.4	– Asymmetric fault current.....	57
Figure 6B.5	– Equivalent electrical circuit of a conventional CT.....	58
Figure 6B.6	– Flux-current characteristic for a conventional CT without remanence representation.....	59
Figure 6B.7	– Representation of hysteresis and remanent flux for a conventional CT.....	60
Figure 6B.8	– Comparison of flux-current characteristics for gapped and gapless CTs.....	62
Figure 6B.9	– Secondary current distorted due to the CT saturation.....	63
Figure 6B.10	– AC component for non-saturated and saturated CT.....	63
Figure 6C.1	– Schematic diagram explaining the trapped charge phenomena.....	69
Figure 6C.2	– Voltages during trapped charges phenomena.....	70
Figure 6C.3	– Modelization example of a simplified low-power voltage transformer.....	72

Figure 6C.4 – Testing arrangement for short time constant	76
Figure 6C.5 – Testing arrangement for long time constant	77
Figure 6C.6 – Typical waveform of $e(t)$ during test	77
Figure 6D.1 – Test circuit for analogue accuracy measurements in steady state	78
Figure 6D.2 – Test circuit for analogue accuracy measurements in steady state (alternative solution)	79
Figure 6D.3 – Test circuit for digital accuracy measurements in steady state	80
Figure 6D.4 – Test circuit for analogue accuracy measurements in steady state	81
Figure 6D.5 – Test circuit for analogue accuracy measurements in steady state (alternative solution)	82
Figure 6D.6 – Test circuit for digital accuracy measurements in steady state	83
Figure 6E.1 – Accuracy limits of a multi-purpose low-power current transformer	84
Table 601 – Secondary terminal and low voltage component withstand capability	28
Table 602 – Immunity requirements and tests	30
Table 603 – Connectors	34
Table 10 – List of tests	36
Table 6A.1 – Anti-aliasing filter	48
Table 6A.2 – Measuring accuracy classes	50
Table 6A.3 – Accuracy classes extension for quality metering and low bandwidth d.c. applications	50
Table 6A.4 – Accuracy classes extension for high bandwidth d.c. applications	51
Table 6A.5 – Protective accuracy classes	51
Table 6A.6 – Accuracy classes for special high bandwidth protection	52
Table 6A.7 – Accuracy classes for special d.c. coupled low-power voltage transformers	52
Table 6A.8 – Accuracy classes for harmonics	53
Table 6B.1 – Protective CTs	61
Table 6C.1 – Primary short circuit	71
Table 6C.2 – Trapped charges	71
Table 6C.3 – Limits of instantaneous voltage error for protective electronic voltage transformers in case of trapped charges reclose	71

INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSTRUMENT TRANSFORMERS –

Part 6: Additional general requirements for low-power instrument transformers

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 61869-6 has been prepared by IEC technical committee 38: Instrument transformers.

This first edition of IEC 61869-6 cancels and replaces the relevant parts of IEC 60044-7, published in 1999, and of IEC 60044-8, published in 2002¹.

This bilingual version (2017-07) corresponds to the English version, published in 2016-04.

¹ IEC 60044-7 and IEC 60044-8 will eventually be replaced by the IEC 61869 series, but until all the relevant parts will be published, these two standards are still in force.

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

FDIS	Report on voting
38/501/FDIS	38/507/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.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61869 series, published under the general title *Instrument transformers*, can be found on the IEC website.

This Part 6 is to be read in conjunction with, and is based on, IEC 61869-1:2007, *General Requirements* – however, the reader is encouraged to use its most recent edition.

This Part 6 follows the structure of IEC 61869-1:2007 and supplements or modifies its corresponding clauses.

When a particular clause/subclause of Part 1 is not mentioned in this Part 6, that clause/subclause applies. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

For additional clauses, subclauses, figures, tables, annexes or notes, the following numbering system is used:

- clauses, subclauses, tables, figures and notes that are numbered starting from 601 are additional to those in Part 1;
- additional annexes are lettered 6A, 6B, etc.

An overview of the planned set of standards at the date of publication of this document is given below. The updated list of standards issued by IEC TC 38 is available at the website: www.iec.ch.

PRODUCT FAMILY STANDARDS		PRODUCT STANDARD IEC	PRODUCTS	OLD STANDARD IEC
IEC 61869-1 GENERAL REQUIREMENTS FOR INSTRUMENT TRANSFORMERS		61869-2	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS	60044-1 60044-6
		61869-3	ADDITIONAL REQUIREMENTS FOR INDUCTIVE VOLTAGE TRANSFORMERS	60044-2
		61869-4	ADDITIONAL REQUIREMENTS FOR COMBINED TRANSFORMERS	60044-3
		61869-5	ADDITIONAL REQUIREMENTS FOR CAPACITOR VOLTAGE TRANSFORMERS	60044-5
	IEC 61869-6 ADDITIONAL GENERAL REQUIREMENTS FOR LOW-POWER INSTRUMENT TRANSFORMERS	61869-7	ADDITIONAL REQUIREMENTS FOR ELECTRONIC VOLTAGE TRANSFORMERS	60044-7
		61869-8	ADDITIONAL REQUIREMENTS FOR ELECTRONIC CURRENT TRANSFORMERS	60044-8
		61869-9	DIGITAL INTERFACE FOR INSTRUMENT TRANSFORMERS	
		61869-10	ADDITIONAL REQUIREMENTS FOR LOW-POWER PASSIVE CURRENT TRANSFORMERS	
		61869-11	ADDITIONAL REQUIREMENTS FOR LOW-POWER PASSIVE VOLTAGE TRANSFORMERS	60044-7
		61869-12	ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED PASSIVE TRANSFORMERS	
		61869-13	STAND ALONE MERGING UNIT	
		61869-14	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS FOR DC APPLICATIONS	
		61869-15	ADDITIONAL REQUIREMENTS FOR DC VOLTAGE TRANSFORMERS FOR DC APPLICATIONS	

The committee has decided that the contents of this publication will remain unchanged until the stability 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
- amended.

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.

INSTRUMENT TRANSFORMERS –

Part 6: Additional general requirements for low-power instrument transformers

1 Scope

This part of IEC 61869 is a product family standard and covers only additional general requirements for low-power instrument transformers (LPIT) used for a.c. applications having rated frequencies from 15 Hz to 100 Hz covering MV, HV and EHV or used for d.c. applications. This product standard is based on IEC 61869-1:2007, in addition to the relevant product specific standard.

This part of IEC 61869 does not cover the specification for the digital output format of instrument transformers.

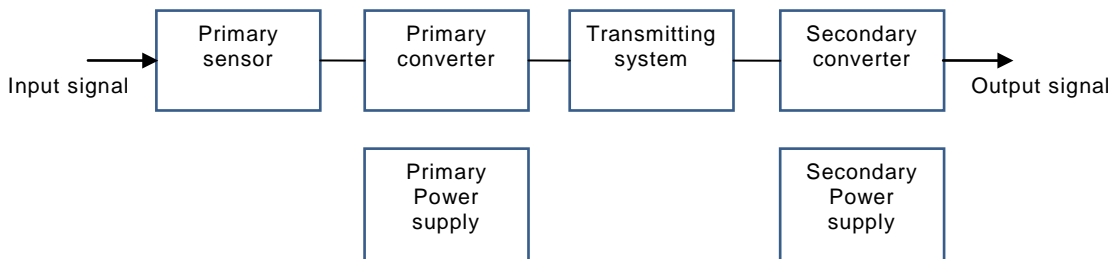
This part of IEC 61869 defines the errors in case of analogue or digital output. The other characteristics of the digital interface for instrument transformers are standardised in IEC 61869-9 as an application of the standards, the IEC 61850 series, which details layered substation communication architecture.

This part of IEC 61869 considers additional requirements concerning bandwidth. The accuracy requirements on harmonics and requirements for the anti-aliasing filter are given in the normative Annex 6A.4.

The general block diagram of single-phase LPITs is given in Figure 601.

According to the technology, it is not absolutely necessary that all parts described in Figure 601 are included in the instrument transformer.

As an example, for low-power passive transformers (LPITs without active electronic components) the blocks are composed only with passive components and there is no power supply.



IEC

Figure 601 – General block diagram of a single-phase LPIT

2 Normative reference

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.