

© Copyright SEK Svensk Elstandard. Reproduction in any form without permission is prohibited.

## **Mättransformatorer – Del 14: Tilläggsfordringar för strömtransformatorer för likström**

*Instrument transformers –*

*Part 14: Additional requirements for current transformers for DC applications*

Som svensk standard gäller europastandarden EN IEC 61869-14:2019. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 61869-14:2019.

### **Nationellt förord**

Europastandarden EN IEC 61869-14:2019

består av:

- **europastandardens ikraftsättningsdokument**, utarbetat inom CENELEC
- **IEC 61869-14, First edition, 2018 - Instrument transformers - Part 14: Additional requirements for current transformers for DC applications**

utarbetad inom International Electrotechnical Commission, IEC.

Standarden ska användas tillsammans med SS-EN 61869-1, utgåva 1, 2009 och SS-EN 61869-6, utgåva 1, 2017.

### *Standarder underlättar utvecklingen och höjer elsäkerheten*

Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

### *SEK är Sveriges röst i standardiseringsarbetet inom elområdet*

SEK Svensk Elstandard svarar för standardiseringen inom elområdet i Sverige och samordnar svensk medverkan i internationell och europeisk standardisering. SEK är en ideell organisation med frivilligt deltagande från svenska myndigheter, företag och organisationer som vill medverka till och påverka utformningen av tekniska regler inom elektrotekniken.

SEK samordnar svenska intressenters medverkan i SEKs tekniska kommittéer och stödjer svenska experters medverkan i internationella och europeiska projekt.

### *Stora delar av arbetet sker internationellt*

Utformningen av standarder sker i allt väsentligt i internationellt och europeiskt samarbete. SEK är svensk nationalkommitté av International Electrotechnical Commission (IEC) och Comité Européen de Normalisation Electrotechnique (CENELEC).

Standardiseringsarbetet inom SEK är organiserat i referensgrupper bestående av ett antal tekniska kommittéer som speglar hur arbetet inom IEC och CENELEC är organiserat.

Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

### *Var med och påverka!*

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

### **SEK Svensk Elstandard**

Box 1284  
164 29 Kista  
Tel 08-444 14 00  
[www.elstandard.se](http://www.elstandard.se)

English Version

**Instrument transformers - Part 14: Additional requirements for  
current transformers for DC applications  
(IEC 61869-14:2018)**

Transformateurs de mesure - Partie 14: Exigences  
supplémentaires concernant les transformateurs de courant  
pour application en courant continu  
(IEC 61869-14:2018)

Messwandler - Teil 14: Besondere Anforderungen für  
Gleichstromwandler  
(IEC 61869-14:2018)

This European Standard was approved by CENELEC on 2018-08-21. 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 38/560/FDIS, future edition 1 of IEC 61869-14, prepared by IEC/TC 38 "Instrument transformers" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61869-14:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-01-05
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-07-05

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.

This document has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For the relationship with EU Directive(s) see informative Annex ZZ, which is an integral part of this document.

## **Endorsement notice**

The text of the International Standard IEC 61869-14:2018 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).

Clause 2 of IEC 61869-6:2016 is applicable, with the following additions and modifications:

| <u>Publication</u> | <u>Year</u> | <u>Title</u>  | <u>EN/HD</u>   | <u>Year</u> |
|--------------------|-------------|---|----------------|-------------|
| IEC/TS 60815-4     | 2019        | Selection and dimensioning of high-voltage - insulators intended for use in polluted conditions - Part 4: Insulators for d.c. systems |                | -           |
| IEC/TS 61245:2015  | 2015        | Artificial pollution tests on high-voltage - ceramic and glass insulators to be used on d.c. systems                                  |                | -           |
| IEC 61869-6        | 2016        | Instrument transformers - Part 6: Additional general requirements for low-power instrument transformers                               | EN 61869-6     | 2016        |
| IEC 61869-9        | 2016        | Instrument transformers - Part 9: Digital interface for instrument transformers   | EN IEC 61869-9 | 2019        |

## CONTENTS

|  |    |
|--|----|
| FOREWORD.....  | 4  |
| INTRODUCTION.....  | 7  |
| 1 Scope.....   | 11 |
| 2 Normative references .....   | 11 |
| 3 Terms and definitions .....  | 11 |
| 5 Ratings.....   | 16 |
| 6 Design and construction .....  | 20 |
| 7 Tests .....  | 25 |
| Annex 14A (informative) Equivalent thermal current in CTs for DC application .....                                 | 37 |
| 14A.1 General.....   | 37 |
| 14A.2 Current harmonic content.....  | 37 |
| 14A.3 Losses in primary conductor due to harmonic content .....  | 38 |
| 14A.4 Thermal test with AC current.....  | 40 |
| Annex 14B (informative) Proposed rated insulation level applicable to current transformers for DC application..... | 41 |
| Bibliography.....  | 42 |
| Figure 1401 – Example of LCC scheme .....  | 7  |
| Figure 1402 – Typical scheme for VSC – symmetrical monopole.....   | 8  |
| Figure 1403 – Typical scheme for VSC – asymmetrical monopole or bipole .....                                       | 9  |
| Figure 1404 – Typical step responses of a system .....   | 14 |
| Figure 1405 – Accuracy limits of a DCCT .....  | 19 |
| Figure 1406 – Polarity reversal test profile .....   | 30 |
| Figure 1407 – Measurement of the step response time .....  | 32 |
| Figure 14A.1 – Typical waveform of current flowing in the primary conductor for LCC applications .....             | 37 |
| Figure 14A.2 – The two terms that make up the total losses in the primary conductor .....                          | 39 |
| Figure 14A.3 – Additional losses in conductors due to typical current harmonics .....                              | 40 |
| Figure 14A.4 – Power-frequency losses in conductors compared to DC losses .....                                    | 40 |
| Table 1401 – Current and voltage in current transformers for LCC application .....                                 | 8  |
| Table 1402 – Current and voltage in current transformers for VSC application .....                                 | 10 |
| Table 3 – Partial discharge test voltages and permissible levels .....   | 17 |
| Table 1403 – Limits of ratio error for DCCT (classes from 0,1 to 1) .....  | 19 |
| Table 7 – Static withstand test loads .....  | 21 |
| Table 8 – Arc fault duration and performance criteria .....  | 22 |
| Table 1404 – Markings of terminals .....   | 23 |
| Table 1405 – Rating plate marking for common rating plate .....  | 24 |
| Table 1406 – Rating plate marking for each secondary converter .....   | 24 |
| Table 1407 – Rating plate marking for auxiliary power supply .....   | 25 |

|   |    |
|---|----|
| Table 10 – List of tests.....   | 26 |
| Table 14A.1 – Typical harmonic current values (800 kV LCC) .....  | 38 |
| Table 14B.1 – Proposed rated primary terminal insulation levels for current<br>transformers for DC application..... | 41 |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INSTRUMENT TRANSFORMERS –****Part 14: Additional requirements for current transformers for DC applications****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 61869-14 has been prepared by IEC technical committee 38: Instrument transformers.

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

|             |                  |
|-------------|------------------|
| FDIS        | Report on voting |
| 38/560/FDIS | 38/565/RVD       |

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 61869 series, published under the general title *Instrument transformers*, can be found on the IEC website.

This Part 14 is to be used in conjunction with, and is based on, IEC 61869-1:2007, *General requirements*, and IEC 61869-6:2016, *Additional general requirements for low-power instrument transformers* – however the reader is encouraged to use the most recent editions.

This Part 14 follows the structure of IEC 61869-1:2007 and IEC 61869-6:2016 and supplements or modifies their corresponding clauses.

When a subclause of Part 1 or Part 6 is not mentioned in this Part 14, that subclause applies. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 or Part 6 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 1401 are additional to those in Part 1 and Part 6;
- additional annexes are lettered 14A, 14B, 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](http://www.iec.ch)

| PRODUCT FAMILY STANDARDS               | PRODUCT STANDARD  | PRODUCTS  | OLD STANDARD       |
|--|---|---|--------------------|
| <b>61869-1</b><br>GENERAL REQUIREMENTS | 61869-2   | ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS            | 60044-1<br>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 CAPACITIVE VOLTAGE TRANSFORMERS | 60044-5            |
|  | <b>61869-6</b><br>ADDITIONAL GENERAL REQUIREMENTS FOR LOW-POWER INSTRUMENT TRANSFORMERS | 61869-7   | 60044-7            |
|  |   | 61869-8   | 60044-8            |
|  |   | 61869-9   |                    |
|  |   | 61869-10  |                    |
|  |   | 61869-11  | 60044-7            |
|  |   | 61869-12  |                    |
|  |   | 61869-13  |                    |
|  |   | 61869-14  |                    |
|  |   | 61869-15  |                    |
|  |   |   |                    |
|  |   |   |                    |
|  |   |   |                    |
|  |   |   |                    |
|  |   |   |                    |

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.

**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.**

## INTRODUCTION

### General

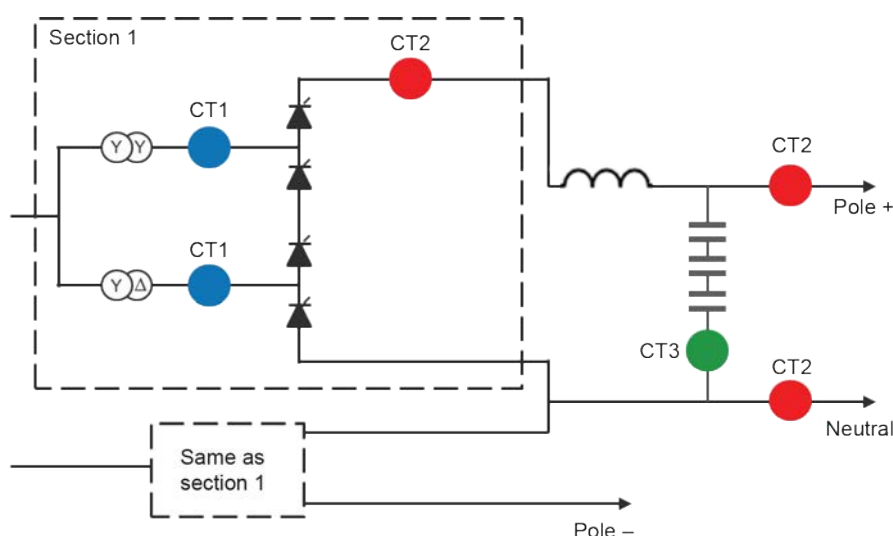
This document applies to current transformers intended to be used in DC applications with at least one of the following functions:

- measure DC current (with significant harmonics);
- withstand DC voltage.

Depending on the position of the current transformer on the DC system, different kinds of application exist, which are briefly described below, together with the approximate voltage or current wave shape.

### Line-commutated converters (LCC)

Line-commutated converters (LCC) are based on thyristor converters (see Figure 1401). They are characterized by a single direction of current flow, and a voltage polarity reversal possibility. Significant voltage and current harmonics exist up to frequencies of about 3 kHz to 4 kHz.



IEC

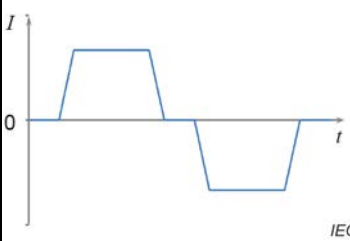
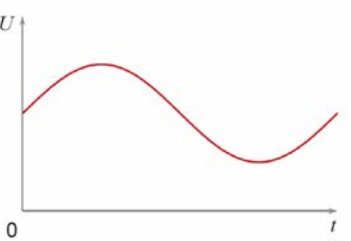
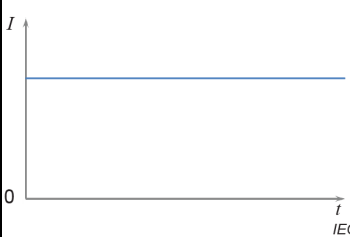
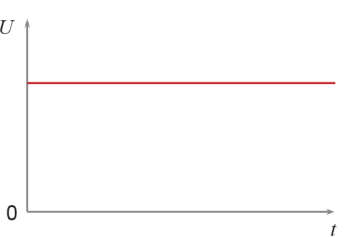
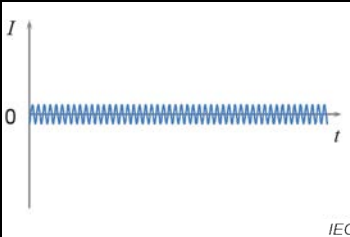
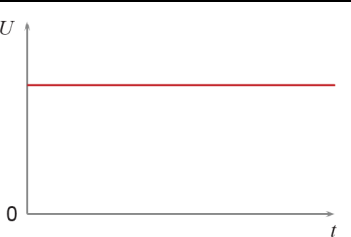
**Figure 1401 – Example of LCC scheme**

We distinguish three different current-measurement functions:

- CT1: measurement of the current at the AC side of the converter;
- CT2: measurement of the current at the DC side of the converter;
- CT3: measurement of the current in the DC filter.

Table 1401 gives an overview of the current and voltage waveshapes as well as the main characteristics of the different applications of the CT.

**Table 1401 – Current and voltage in current transformers for LCC application**

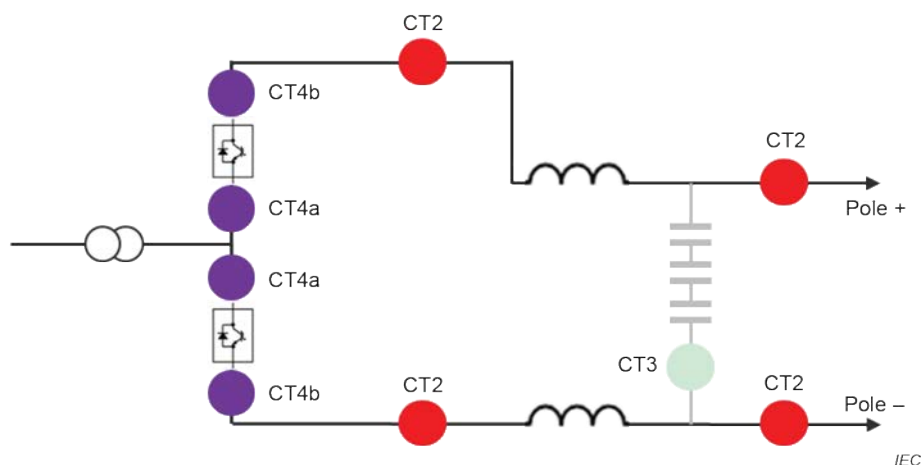
|     | Current  | Voltage  | Characteristics  |
|-----|--|--|--|
| CT1 |   |   | AC current<br>AC + DC voltage<br>Large amount of current harmonics<br>Mainly for protection purposes                   |
| CT2 |   |   | Pure DC application<br>High-accuracy measurement<br>Harmonics measurement<br>Metering, control and protection purposes |
| CT3 |  |  | DC voltage stress with harmonics<br>DC current = 0<br>Harmonics measurement<br>Mainly for protection purposes          |

### Voltage-source converters (VSC)

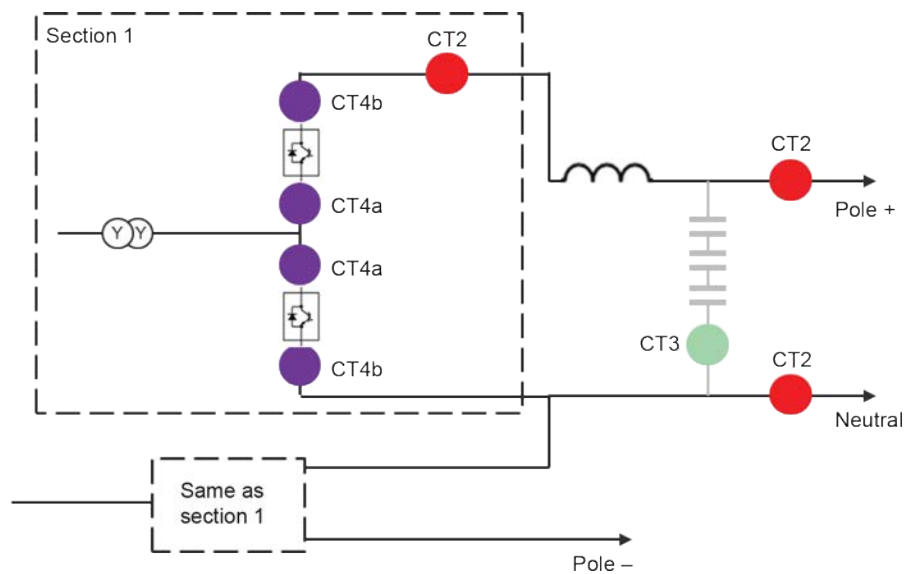
Voltage-source converters (VSC) are based on transistor converters. They are characterized by a bi-directional current flow and a single voltage polarity. Voltage and current harmonics exist up to frequencies of about 20 kHz.

Two variants of VSC schemes exist: symmetrical monopoles (using one single converter) and asymmetrical monopole or bipole (with one converter for each polarity).

Both schemes are shown in Figure 1402 and Figure 1403.



**Figure 1402 – Typical scheme for VSC – symmetrical monopole**



IEC

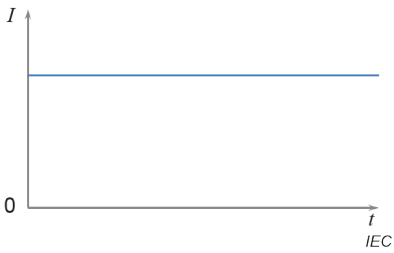
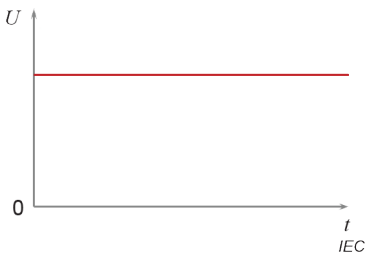


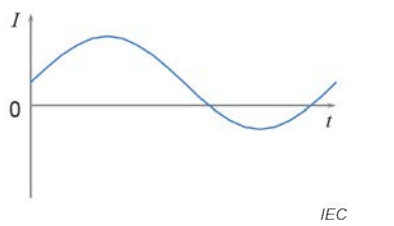
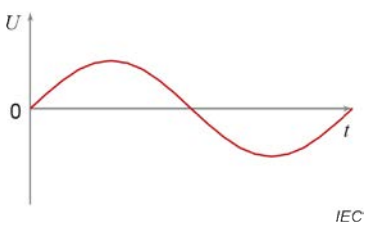
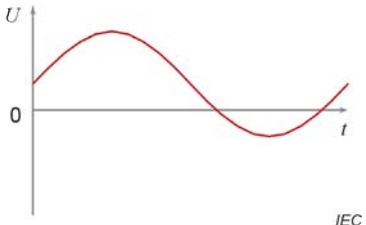
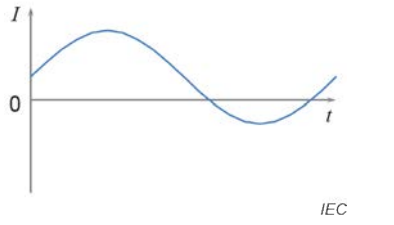
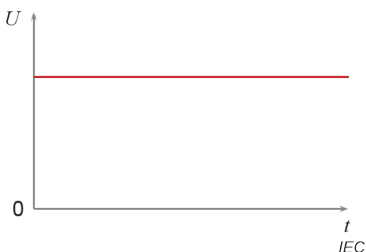
**Figure 1403 – Typical scheme for VSC – asymmetrical monopole or bipole**

We distinguish three different current-measurement functions:

- CT4: measurement of the current in the transistor branches of the converter.  
The CT can be placed before (CT4a) or after the transistor branch (CT4b);
- CT2: measurement of the current at the DC side of the converter;
- CT3: measurement of the current in the DC filter (not always present in this scheme).

Table 1402 gives an overview of the current and voltage waveshapes as well as the main characteristics of the different applications of the CT.

**Table 1402 – Current and voltage in current transformers for VSC application**

|      | Current   | Voltage   | Characteristics  |
|------|---|---|--|
| CT2  |    |   | Pure DC application<br>High accuracy measurement<br>Harmonics measurement<br>Metering, control and protection purposes<br>Short step response time |
| CT3  |    |   | DC voltage stress<br>DC current = 0<br>Harmonics measurement<br>Mainly for protection purposes   |
| CT4a |   | Symmetrical monopole:<br><br>Asymmetrical monopoles / bipoles:<br> | Pure AC voltage or DC + AC voltage<br>DC + AC current<br>High-accuracy measurement<br>Short step response time                                     |
| CT4b |  |   | DC voltage stress<br>DC + AC current<br>High-accuracy measurement<br>Short step response time  |

## INSTRUMENT TRANSFORMERS –

### Part 14: Additional requirements for current transformers for DC applications

#### 1 Scope

This part of IEC 61869 provides all requirements specific to current transformers to be used in DC applications (DCCTs), whatever the technology used. The output signal can be analogue or digital.

It is applicable to newly manufactured current transformers used for measuring, protection and/or control applications in DC power systems with a rated voltage above 1,5 kV.

The general configuration of a single-pole low-power instrument transformer is described in Figure 601 of IEC 61869-6:2016.

The DCCTs intended for current measurement in the transistor branch of the VSC valve (referred to as CT4a and CT4b in Figure 1403 and Table 1402) are not covered by this document, and will be considered in a future revision.

#### 2 Normative references

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.

Clause 2 of IEC 61869-6:2016 is applicable, with the following additions and modifications:

IEC TS 60815-4:2016, *Selection and dimensioning of high-voltage insulators intended for use in polluted conditions – Part 4: Insulators for DC systems*

IEC TS 61245:2015, *Artificial pollution tests on high-voltage ceramic and glass insulators to be used on DC systems*

IEC 61869-6:2016, *Instrument transformers – Part 6: Additional general requirements for low-power instrument transformers*

IEC 61869-9:2016, *Instrument transformers – Part 9: Digital interface for instrument transformers*