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Title: BS EN IEC 61869-14 Instrument transformers

Part 14: Additional requirements for current transformers for DC applications

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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.

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UK Vote

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Template for comments and secretariat observations

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



38/797/CD

COMMITTEE DRAFT (CD)

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SECRETARIAT:

Italy

SECRETARY:

Mr Filippo Frugoni

OF INTEREST TO THE FOLLOWING COMMITTEES:

TC 33,TC 57,SC 77A,TC 85,TC 95,TC 115

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

Electricity transmission and distribution,Electromagnetic Compatibility

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TITLE:

Instrument transformers - Part 14: Additional requirements for current transformers for DC applications

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSTRUMENT TRANSFORMERS –

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

FOREWORD

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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/XX/FDIS	38/XX/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 61869-1:2023, *General requirements*, – however the reader is encouraged to use the most recent editions.

This Part 14 follows the structure of IEC 61869-1:2023 and supplements or modifies the corresponding clauses.

When a subclause of Part 1 is not mentioned in this Part 14, that 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 1401 are additional to those in Part 1;
- 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

PRODUCT FAMILY STANDARDS	PRODUCT STANDARD	PRODUCTS
61869-1 GENERAL REQUIREMENTS	61869-2	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS
	61869-3	ADDITIONAL REQUIREMENTS FOR INDUCTIVE VOLTAGE TRANSFORMERS
	61869-4	ADDITIONAL REQUIREMENTS FOR COMBINED TRANSFORMERS
	61869-5	ADDITIONAL REQUIREMENTS FOR CAPACITIVE VOLTAGE TRANSFORMERS
	61869-7	ADDITIONAL REQUIREMENTS FOR ELECTRONIC VOLTAGE TRANSFORMERS
	61869-8	ADDITIONAL REQUIREMENTS FOR ELECTRONIC CURRENT TRANSFORMERS
	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
	61869-12	ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED LOW-POWER PASSIVE TRANSFORMERS
	61869-13	STAND ALONE MERGING UNIT
	61869-14	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS FOR DC APPLICATIONS
	61869-15	ADDITIONAL REQUIREMENTS FOR VOLTAGE TRANSFORMERS FOR DC APPLICATIONS

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

- 70 • reconfirmed,
- 71 • withdrawn,
- 72 • replaced by a revised edition, or
- 73 • amended.

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INTRODUCTION

General

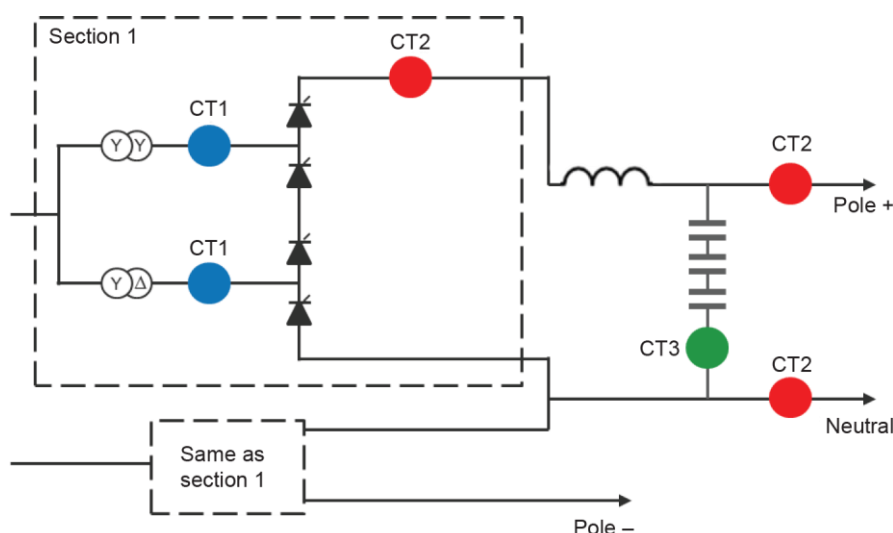
This document applies to current transformers intended to be used in DC applications with at least one of the following functions:

- 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

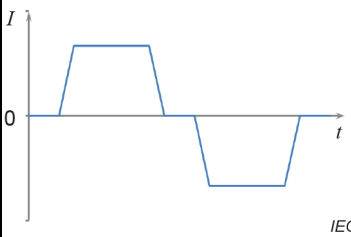
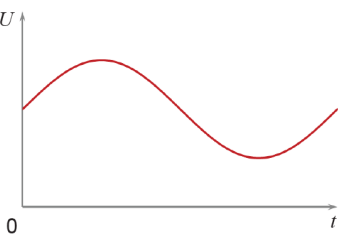
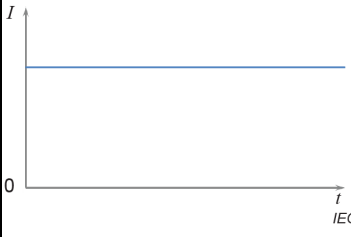
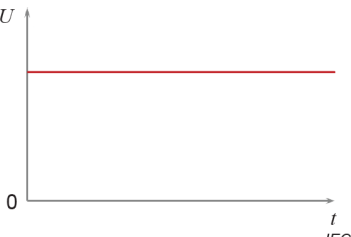
Figure 1401 – Example of LCC scheme

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.

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

	Current	Voltage	Characteristics
CT1			AC current AC voltage with DC offset Large amount of current harmonics Mainly for protection purposes
CT2			DC voltage stress with AC ripple (definition of ripple?) High-accuracy measurement Harmonics measurement Metering, control and protection purposes
CT3			DC voltage stress with harmonics DC current = 0 Harmonics measurement Mainly for protection purposes

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100 **Voltage-source converters (VSC)**

101 Voltage-source converters (VSC) are based on transistor converters. They are characterized

102 by a bi-directional current flow and a single voltage polarity. Voltage and current harmonics

103 exist up to frequencies of about 20 kHz.

104 Two variants of VSC schemes exist: symmetrical monopoles (using one single converter) and

105 asymmetrical monopole or bipole (with one converter for each polarity).

106 Both schemes are shown in Figure 1402 and Figure 1403.

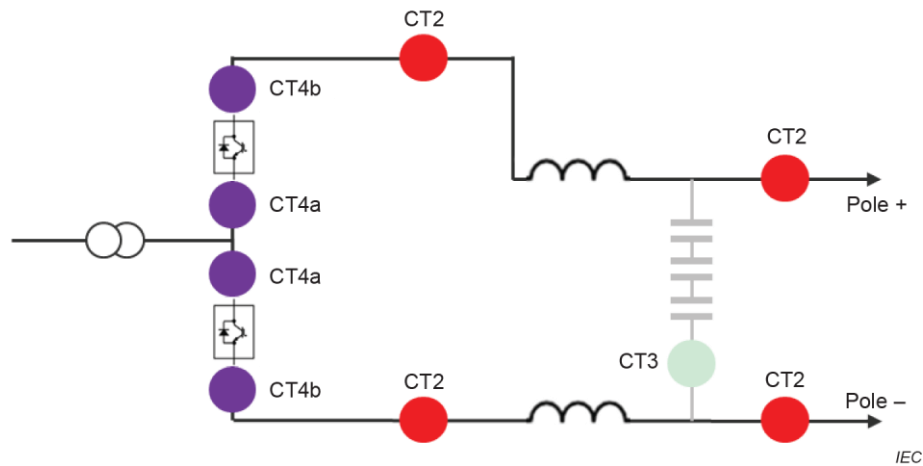


Figure 1402 – Typical scheme for VSC – symmetrical monopole

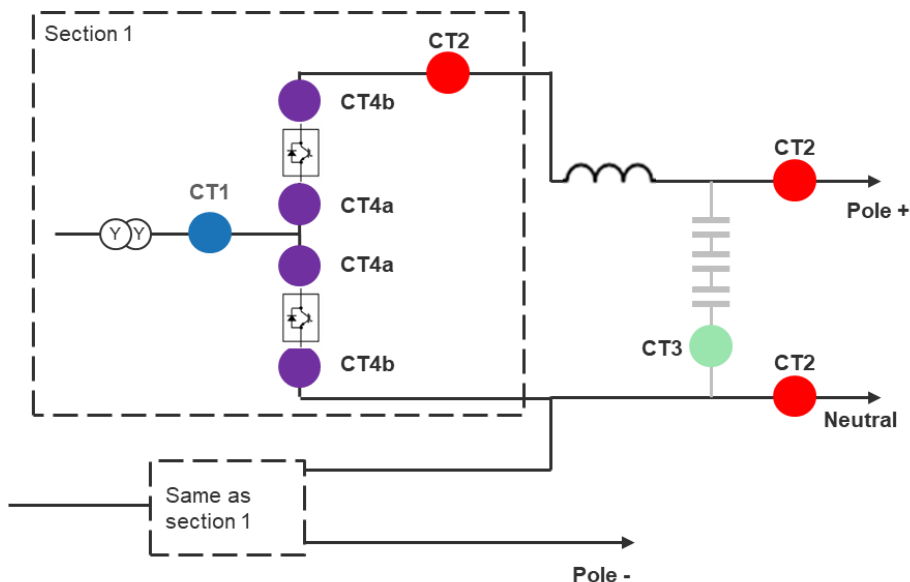


Figure 1403 – Typical scheme for VSC – asymmetrical monopole or bipole

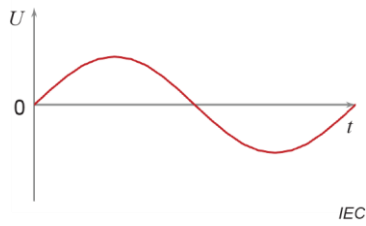
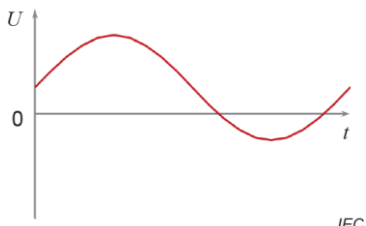
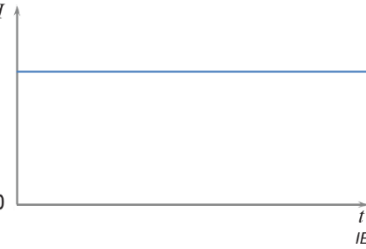
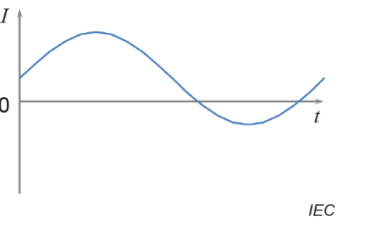
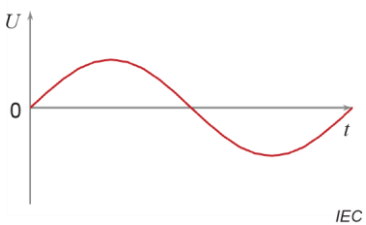
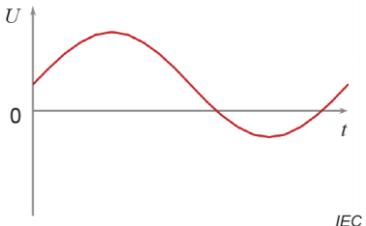
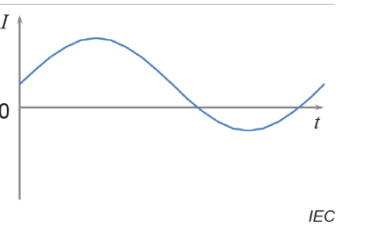
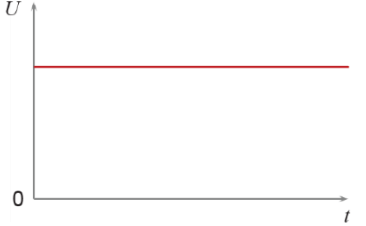
We distinguish four different current-measurement functions:

- CT1: measurement of the current at the AC side of the converter;
- 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.

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

	Current	Voltage	Characteristics
CT1			Pure AC current AC voltage with DC offset High-accuracy measurement Short step response time
CT2			Pure DC application High accuracy measurement Harmonics measurement Metering, control and protection purposes Short step response time
CT3			DC voltage stress with harmonics DC current = 0 Harmonics measurement Mainly for protection purposes
CT4a		Symmetrical monopole:  Asymmetrical monopoles / bipoles: 	Pure AC voltage or with DC offset AC current with DC component High-accuracy measurement Short step response time
CT4b			DC voltage stress AC current with DC component High-accuracy measurement Short step response time

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INSTRUMENT TRANSFORMERS –

Part 14: Specific 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 power systems with a rated voltage above 1,5 kV DC.

The general configuration of a single-pole low-power instrument transformer is described in Figure 1 of IEC 61869-1:2023.

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 61869-1:2023 applies with the following additions and modifications:

IEC 60071-11:2022 Insulation coordination - Part 11: *Definitions, principles and rules for HVDC systems*

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

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

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

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

For the purposes of this document, the terms and definitions of IEC 61869-99 apply with the following addition.

3.1.1401**Absolute error** ε_A

error (expressed in A) that a current transformer introduces into the measurement, and which arises from the fact that the actual transformation ratio is not equal to the rated transformation ratio

Note 1 to entry: The absolute error is defined by the following formula:

$$\varepsilon_A = K_r \cdot U_s - I_p$$

where

K_r is the rated transformation ratio in A/V;

I_p is the DC value of the actual primary current in steady state;

U_s is the DC value of the output voltage.

3.2 Symbols and abbreviated terms

The table in 3.2 of IEC 61869-1:2023 is replaced by the following one:

DCCT	current transformer for DC application
F	mechanical load
I_{cth}	rated continuous thermal current
I_{pr}	rated primary current
I_{lov}	long-time overload current
I_{sov}	short-time overload current
I_{sc}	maximum peak fault current
IT	instrument transformer
K_{ALF}	accuracy limit factor
K_{pcr}	extended primary current factor
K_r	rated transformation ratio
R_{br}	rated burden
t_d	delay time
t_{dr}	rated delay time
T_s	settling time
T_{sr}	step response time
U_{ar}	auxiliary power supply voltage
U_m	highest voltage for equipment
U_{sr}	rated secondary voltage
ε	ratio error
ε_A	absolute error

4 Normal and special environmental conditions

Clause 4 of IEC 61869-1:2023 applies.

5 Ratings

5.1 General

Subclause 5.1 of IEC 61869-1:2023 is replaced by the following one:

If applicable, the ratings of DC current transformers, including their auxiliary equipment, shall be selected from the following ones:

- a) highest voltage for equipment (U_m);
- b) rated primary current (I_{pr});
- c) rated delay time (t_{dr});
- d) rated continuous thermal current (I_{cth});
- e) long-time overload current (I_{lov});
- f) short time overload current (I_{sov}); or rated short-time thermal current (for CT) (I_{th});
- g) maximum peak fault current (I_{sc});
- h) rated secondary voltage (U_{sr});
- i) rated insulation level;
- j) rated burden (R_{br});
- k) rated accuracy class;
- l) accuracy limit factor (K_{ALF});
- m) rated extended primary current factor (K_{ep});
- n) rated step response time (T_{sr}).

5.2 Voltage ratings

5.2.1 Highest voltage for equipment (U_m)

Subclause 5.2.1 of IEC 61869-1:2023 is replaced by the following one:

There are no standard values for highest voltage for equipment.

However, IEC 60071-11:2022 lists typical DC voltages and possible insulation levels.

5.2.2 Power system earthing

Subclause 5.2.2 of IEC 61869-1:2023 is replaced by the following one:

The considered power system earthing can be:

- a) isolated neutral system;
- o) solidly earthed neutral system:

5.2.3 Standard values for rated primary voltage (U_{pr})

Subclause 5.2.3 of IEC 61869-1:2023 is replaced by the following one:

There are no standard values for highest voltage for equipment.

However, IEC 60071-11:2022 lists typical DC voltages and possible insulation levels.

5.2.4 Standard values for rated secondary voltage (U_{sr})

The standard values of rated secondary DC voltage are:

50 mV – 150 mV – 1,66 V – 3 V – 5 V

NOTE Generally, DC current transformers are multipurpose CTs.

5.2.5 Rated auxiliary power supply voltage (U_{ar})

Subclause 5.2.5 of IEC 61869-1:2023 applies.

5.3 Current ratings**5.3.1 Standard values for rated primary current (I_{pr})**

There are no standard values for rated primary current.

5.3.2 Standard values for rated secondary current (I_{sr})

Subclause 5.3.2 of IEC 61869-1:2023 is not applicable.

5.3.3 Standard values for rated continuous thermal current (I_{cth})

The standard value for rated continuous thermal current is the rated primary current. When a rated continuous thermal current greater than the rated primary current is specified, the preferred value is 120%.

5.3.4 Short-time current ratings**5.3.4.1 Rated short-time thermal current (I_{th})**

A rated short-time thermal current I_{th} shall be assigned to the transformer. The standard value for duration of the rated short-time thermal current is 1 s.

5.3.4.2 Rated dynamic current (I_{dyn})

Subclause 5.3.4.2 of IEC 61869-1:2023 is not applicable.

5.3.4.3 Rated internal arc fault current (I_{arc})

Subclause 5.3.4.3 of IEC 61869-1:2023 is replaced by the following one:

If optionally specified, the value of the rated internal arc fault current (I_{arc}) shall be declared by the manufacturer.

5.3.1401 Long-time overload current (I_{lov})

There are no standard values for long-time overload current I_{lov} .

5.3.1402 Short-time overload current (I_{sov})

There are no standard values for short-time overload current I_{sov} .

5.4 Dielectric ratings

5.4.1 General

Subclause 5.4.1 of IEC 61869-1:2023 is replaced by the following one:

The standard values of insulation level of IEC 60071-1 are not applicable to DC systems.

Methods of calculation for applied dielectric test voltages are given in the relevant clauses of this document.

Additionally, indications for impulse withstand voltage values are given in IEC 60071-11.

5.4.2 Rated primary terminal insulation level

Subclause 5.4.2 of IEC 61869-1:2023 is replaced by the following one:

The value of rated voltage of an equipment connected between one line and earth is the value of the maximum DC-system voltage U_{DCmax} .

The rated primary terminal insulation level of a DC instrument transformer shall be based on its highest voltage for equipment U_m in accordance with IEC 60071-11:2022

For DC application with significant AC voltage (CT4a in Figure 1403), these must be included in the rated voltage according to following equation:

$$U_m = U_{DCmax} + \sqrt{2} \cdot U_{hmax} + \sqrt{2} \cdot \sqrt{\sum_{h, h \neq hmax} U_h^2}$$

$\sqrt{\sum U_h^2}$: RMS voltage of AC voltage components

U_h represents a single harmonic voltage with its frequency according to the harmonic order h based on the corresponding AC network frequency. The peak value of the AC component can be reduced by harmonic modulation, for reference consider **Error! Reference source not found.** and 0.

$hmax$ is the harmonic order for the harmonic voltage component with the largest amplitude of all harmonics on the equipment. The value of h can also be 1, i.e., the fundamental frequency.

Note For CT2 (see Figure 1401 to Figure 1403) the harmonic content on the DC voltage is usually negligible for insulation design purposes

For instrument transformers mounted on GIS, the rated insulation levels shall be in accordance with IEC 62271-203:2022, Table 2 and Table 3, phase-to-earth insulation.

5.4.3 Other requirements for primary terminals insulation

5.4.3.1 Partial discharges

Subclause 5.4.3.1 of IEC 61869-1:2023 is replaced by the following one:

The partial discharge level measured during the power-frequency voltage withstand test, shall not exceed the limits specified in Table 1403

Table 1403 – Partial discharge test voltages and permissible levels

PD test voltage (r.m.s.) kV	Maximum permissible PD level	
	pC	
	Type of insulation	
	immersed in liquid or gas	solid
$1,5 U_m/\sqrt{2}$	10	50
$1,2 U_m/\sqrt{2}$	5	20

5.4.3.2 Chopped lightning impulse

Subclause 5.4.3.2 of IEC 61869-1:2023 is replaced by the following one:

Instrument transformers with $U_m \geq 20$ kV, other than GIS devices, shall be capable to withstand a chopped lightning impulse voltage of negative polarity applied to its primary terminals with a peak value of 115 % of the rated lightning impulse withstand voltage.

5.4.3.3 Capacitance and dielectric dissipation factor ($\tan \delta$)

Subclause 5.4.3.3 of IEC 61869-1:2023 is replaced by the following one:

This requirement applies only to the following instrument transformers with $U_m \geq 20$ kV:

- with liquid immersed primary insulation;
- with solid insulation;

The dielectric dissipation factor ($\tan \delta$) is dependent on the type of insulation, and on both voltage and temperature. Its value at ambient temperature shall not exceed the values indicated in Table 1404.

Table 1404 – Maximum values of $\tan \delta$

Type of insulation	Maximum value of $\tan \delta$ Measured at $U_m/\sqrt{2}$
Oil-impregnated paper	0,005
Solid insulation	a
Other (e.g.: new technologies)	a
a To be indicated and justified by the manufacturer	

5.4.4 Between-section insulation requirements

Subclause 5.4.4 of IEC 61869-1:2023 applies.

5.4.5 Insulation requirements for secondary terminals and low-voltage components

Subclause 5.4.5.1 of IEC 61869-1:2023 is not applicable. Subclauses 5.4.5.2 and 5.4.5.3 of IEC 61869-1:2023 are applicable.

5.5 Rated frequency

Subclause 5.5 of IEC 61869-1:2023 is replaced by the following one:

The rated frequency is equal to 0 (which means DC).