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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Instrument transformers – Part 15: Additional requirements for voltage transformers for DC applications

Transformateurs de mesure – Partie 15: Exigences supplémentaires concernant les transformateurs de tension pour application en courant continu

IEC 61869-15:2018-07(en-fr)

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INSTRUMENT TRANSFORMERS –

Part 15: Additional requirements for voltage 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.
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International Standard IEC 61869-15 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
38/561/FDIS	38/566/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 15 is to be used in conjunction with 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 edition.

This Part 15 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 15, 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 1501 are additional to those in Part 1 and Part 6;
- additional annexes are lettered 15A, 15B, 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**	**OLD STANDARD**
61869-1 GENERAL REQUIREMENTS		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 CAPACITIVE VOLTAGE TRANSFORMERS	60044-5
	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 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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This document applies to voltage transformers (VT) intended to be used in DC applications with the following functions:

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

Two main technologies of DC converters exist today: LCC and VSC

- Line-commutated converters (LCC) are based on thyristor converters. 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.
- 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.

The position of the DCVTs on the DC system is illustrated in Figure 1501.

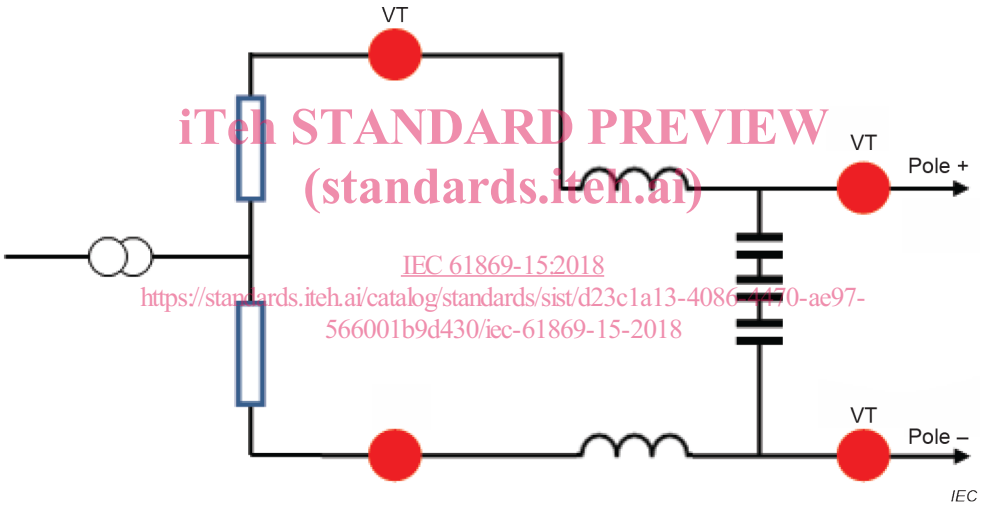
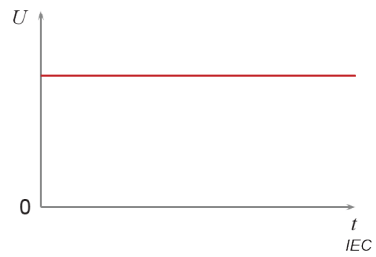


Figure 1501 – Position of the DCVT's in the DC scheme

Table 1501 gives an overview of the voltage waveshape as well as the main characteristics of the VT.

Table 1501 – Voltage on DCVT's

Voltage	Characteristics
	Pure DC application High-accuracy measurement Harmonics measurement Metering, control and protection purpose

The actual technology used for DCVT's are resistive voltage dividers (with or without additional capacitance). However, other technologies could be used in the future (for example, optical voltage sensors).

This document includes some specific requirements applicable to resistive voltage dividers, but can be applied to any technology.

INSTRUMENT TRANSFORMERS –

Part 15: Additional requirements for voltage transformers for DC applications

1 Scope

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

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

This document covers passive voltage dividers as well as active voltage transformers, used for measurement, control and protection.

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

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:

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, *Artificial pollution tests on high-voltage ceramic and glass insulators to be used on DC systems*

IEC 61869-1:2007, *Instrument transformers – Part 1: General requirements*

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*

3 Terms, definitions, abbreviated terms and symbols

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 61869-1:2007, of IEC 61869-6:2016 and of IEC 61869-9:2016 are applicable with the following additions and modifications.

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

3.1 General definitions

3.1.1501
instrument transformer for DC application
instrument transformer intended to be used in DC applications with at least one of the following functions:

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

3.1.1502
voltage transformer for DC application
DCVT
instrument transformer for DC application in which the secondary signal, under normal conditions of use, is substantially proportional to the primary voltage

3.2 Definitions related to dielectric ratings

3.2.2
highest voltage for equipment
U_m
Definition 3.2.2 of IEC 61869-1:2007 is replaced by the following one:

highest value of DC voltage for which the equipment is designed to operate continuously, in respect of its insulation as well as other characteristics that relate to this voltage

3.3 Definitions related to current ratings

3.3.1501
maximum peak fault current
I_{sc}
maximum peak value of current occurring during a fault condition of the DC power system

3.4 Definitions related to accuracy

3.4.1501
absolute error
ε_V
error (expressed in V) that a voltage 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:

$$\varepsilon_V = K_r \cdot U_s - U_p$$

where

K_r is the rated transformation ratio;

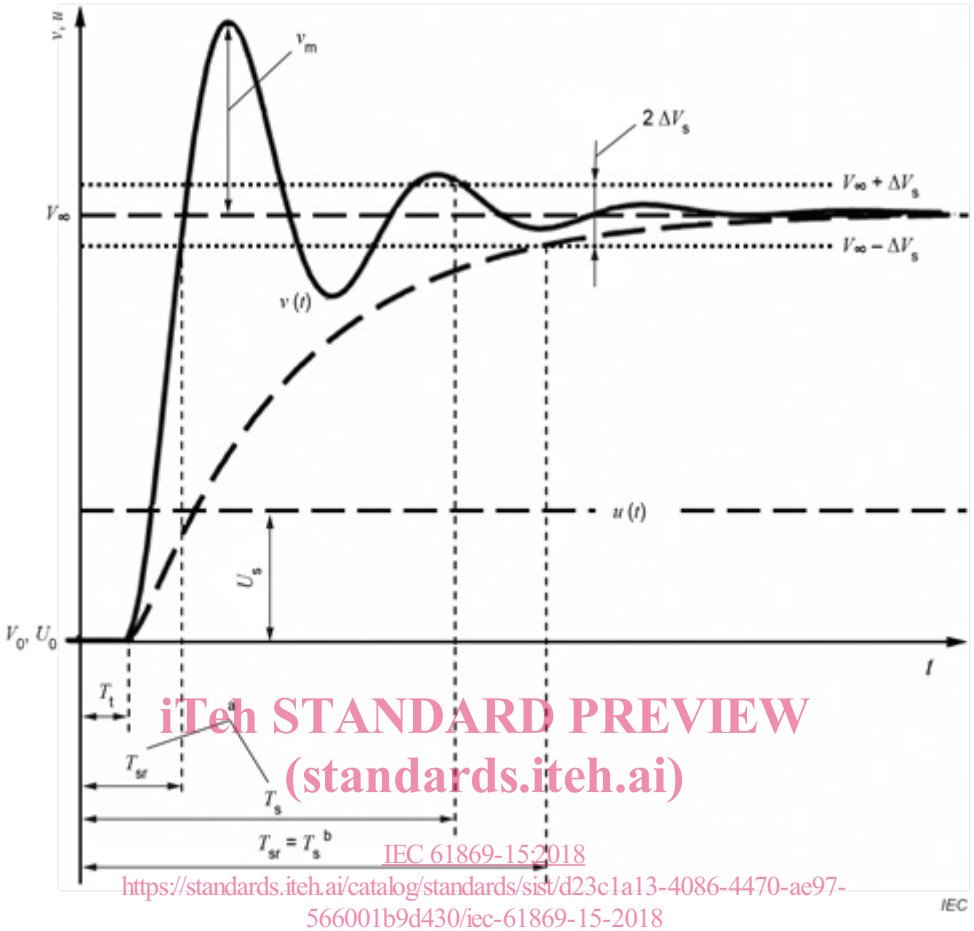
U_p is the DC value of the actual primary voltage in steady state;

U_s is the DC value of the output voltage.

3.5 Definitions related to other ratings

3.5.1501
step response
duration between the instant when the measurand (or quantity supplied) is subjected to a specified abrupt change and the instant when the indication (or quantity supplied) reaches, and remains within specified limits of, its final steady-state value

Note 1 to entry: See graphical explanation in Figure 1502.



[a] For periodic behaviour

[b] For aperiodic behaviour

u	Input variable
U_o	Initial value of the input variable
U_s	Step height of the input variable
v	Output variable
V_0, V_∞	Steady-state values before and after application of the step
v_m	Overshoot
$2\,\Delta v_s$	Specified tolerance limit
T_{sr}	Step response time
T_s	Settling time
T_t	Dead time

Figure 1502 – Typical step responses of a system

Note 2 to entry: The dead time includes the delay time.

[SOURCE: IEC 60050-311:2001, 311-06-04 and IEC 60050-351:2013, 351-45-27, modified – Notes to entry of the sources have been deleted and a new Note 1 to entry has been added.]

3.5.1502
step response time
T_{sr}
for a step response, the duration of the time interval between the instant of the step change of an input variable and the instant when the output variable reaches for the first time a specified percentage of the difference between the final and the initial steady-state values

Note 1 to entry: The step response time includes the delay time of the voltage transformer.

[SOURCE: IEC 60050-351:2013, 351-45-36 modified – Note 1 to entry of the source has been deleted and a new Note 1 to entry has been added, and the symbol has been added.]

3.5.1503
settling time
T_s
for a step response, the duration of the time interval between the instant of the step change of an input variable and the instant when the difference between the step response and their steady-state value remains smaller than the transient value tolerance

Note 1 to entry: The settling time includes the delay time of the voltage transformer.

[SOURCE: IEC 60050-351:2013, 351-45-37 modified – Note 1 to entry of the source has been deleted and a new Note 1 to entry has been added, and the symbol has been added.]

3.5.1504
overshoot
v_m
for a step response of a transfer element, the maximum transient deviation from the final steady-state value of the output variable, usually expressed in percent of the difference between the final and the initial steady-state values and for reference-variable step response or disturbance-variable step response of a control system the maximum transient deviation from the desired value

[SOURCE: IEC 60050-351:2013, 351-45-38, modified – Note 1 to entry has been deleted and the symbol has been replaced.]

3.7 Index of abbreviated terms and symbols

The table in 3.7 of IEC 61869-6:2016 is replaced by the following one:

DCVT	voltage transformer for DC application
F	mechanical load
I_{amax}	maximum supply current
I_{ar}	rated supply current
I_{sc}	maximum peak fault current
IT	instrument transformer
K	actual transformation ratio
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
T_t	dead time
U_{ar}	auxiliary power supply voltage

U_m	highest voltage for equipment
U_{pr}	rated primary voltage
U_{sr}	rated secondary voltage
v_m	overshoot
ε	ratio error
ε_V	absolute error

5 Ratings

5.1 General

Subclause 5.1 of IEC 61869-1:2007 is replaced by the following one:

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

- highest voltage for equipment (U_m);
- rated primary voltage (U_{pr});
- rated delay time (t_{dr});
- rated secondary voltage (U_{sr});
- insulation level;
- rated burden (R_{br});
- rated accuracy class;
- rated step response time (T_{sr}).

The rating applies at the standardized reference atmosphere (temperature 20 °C, pressure 101,3 kPa, and humidity 11 g/m^3) as specified in IEC 60071-1.

NOTE The ratings are specified by the purchaser depending on the characteristics of the whole DC system application.

5.2 Highest voltage for equipment

There are no standard values for highest voltage for equipment.

However, a tentative list of standard values is given in Annex 15A.

5.3 Rated insulation levels

5.3.1 General

Subclause 5.3.1 from IEC 61869-1:2007 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, indication for impulse withstand voltage values are given in Annex 15A.

5.3.3 Other requirements for insulation of primary terminals

5.3.3.1 Partial discharges

Subclause 5.3.3.1 of IEC 61869-1:2007 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 3.

Table 3 – 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 Rated frequency

Subclause 5.4 of IEC 61869-1:2007 is replaced by the following one:

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

5.5 Rated output

5.5.602 Standard values for the rated delay time (t_{dr})

Subclause 5.5.602 of IEC 61869-6:2016 is replaced by the following one:

The standard values for rated delay time are:

5 µs – 25 µs – 100 µs

In the case of a pure passive DCVT, the rated delay time is 0.

5.5.1501 Standard values of rated secondary voltage

The standard values of rated secondary DC voltage are:

5 V – 10V – 50 V

5.6 Rated accuracy class

5.6.1501 Accuracy class designation

The accuracy class is designated by the highest permissible percentage of voltage error at rated primary voltage and with the rated burden.

5.6.1502 Standard accuracy classes

The standard accuracy classes are:

0,1 – 0,2 – 0,5 – 1 – 3