BS EN 61869-4:2014

BSI Standards Publication

Instrument transformers

Part 4: Additional requirements for combined transformers

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National foreword

This British Standard is the UK implementation of EN 61869-4:2014. It is identical to IEC 61869-4:2013. It supersedes BS EN 60044-3:2003 which will be withdrawn on 24 December 2016.

The UK participation in its preparation was entrusted to Technical Committee PEL/38, Instrument transformers.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Instrument transformers - Part 4: Additional requirements for combined transformers (IEC 61869-4:2013)

Transformateurs de mesure - Partie 4: Exigences supplémentaires concernant les transformateurs combinés (CEI 61869-4:2013)

Messwandler - Teil 4: Zusätzliche Anforderungen an kombinierte Wandler (IEC 61869-4:2013)

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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 38/468/FDIS, future edition 1 of IEC 61869-4, prepared by IEC/TC 38 "Instrument transformers" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61869-4:2014.

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)	2014-12-06
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-12-24

This document supersedes EN 60044-3:2003.

This Part 4 is to be read in conjunction with, and is based on, EN 61869-1:2009, *General requirements*, EN 61869-2:2012, *Additional requirements for current transform*, and EN 61869-3:2011, *Additional requirements for inductive voltage transformers*. However, the reader is encouraged to use the most recent edition of these documents.

This Part 4 follows the structure of EN 61869-1, EN 61869-2 and EN 61869-3 and supplements or modifies its corresponding clauses.

When a particular subclause of Part 1, 2 or 3 is not mentioned in this Part 4, that subclause applies as far as is reasonable. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1, 2 or 3 is to be adapted accordingly.

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

– clauses, subclauses, tables and figures that are numbered starting from 401 are additional to those in Part 1, 2 or 3;

– additional annexes are lettered 4A, 4B, etc.

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

This standard covers the Principle Elements of the Safety Objectives for Electrical Equipment Designed for Use within Certain Voltage Limits (LVD - 2006/95/EC).

Endorsement notice

The text of the International Standard IEC 61869-4:2013 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, 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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Clause 2 of EN 61869-1:2009 is applicable with the following modifications:

Publication	Year	Title	EN/HD	Year
Addition:				
IEC 60028	-	International standard of resistance for copper	-	-
IEC 60038	-	IEC standard voltages	EN 60038	-
IEC 61869-1 (mod)	2007	Instrument transformers - Part 1: General requirements	EN 61869-1	2009
IEC 61869-2	2012	Instrument transformers - Part 2: Additional requirements for current transformers	EN 61869-2	2012
IEC 61869-3	2011	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers	EN 61869-3	2011

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSTRUMENT TRANSFORMERS –

Part 4: Additional requirements for combined 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.
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This International Standard IEC 61869-4 has been prepared by IEC technical committee 38: Instrument transformers.

This standard replaces IEC 60044-3: Combined transformers.

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

FDIS	Report on voting
38/468/FDIS	38/472/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.

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

This standard is Part 4 of IEC 61869, published under the general title *Instrument transformers*.

This Part 4 is to be read in conjunction with, and is based on, IEC 61869-1 *General Requirements* – first edition (2007), IEC 61869-2, *Additional requirements for current transformers* first edition (2012) and IEC 61869-3, *Additional requirements for inductive voltage transformers* first edition (2011) – however, the reader is encouraged to use the most recent edition of these documents.

This Part 4 follows the structure of IEC 61869-1, IEC 61869-2 and IEC 61869-3 and supplements or modifies its corresponding clauses.

When a particular subclause of Part 1, 2 or 3 is not mentioned in this Part 4, that subclause applies as far as is reasonable. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1, 2 or 3 is to be adapted accordingly.

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

– clauses, subclauses, tables and figures that are numbered starting from 401 are additional to those in Part 1, 2 or 3;

– additional annexes are lettered 4A, 4B, 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 TC38 is available at the website: www.iec.ch

PRODUCT FAMILY STANDARDS		PRODUCT STANDARD	PRODUCTS	OLD STANDARD
		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
61869-1 GENERAL REQUIREMENTS FOR INSTRUMENT TRANSFORMERS	**61869-6** ADDITIONAL GENERAL REQUIREMENT 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 STAND-ALONE CURRENT SENSORS	
		61869-11	ADDITIONAL REQUIREMENTS FOR LOW POWER STAND ALONE VOLTAGE SENSORS	60044-7
		61869-12	ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED STAND ALONE SENSORS	
		61869-13	STAND ALONE MERGING UNIT	
		61869-14	ADDITIONAL REQUIREMENTS FOR DC CURRENT TRANSFORMERS	
		61869-15	ADDITIONAL REQUIREMENTS FOR DC VOLTAGE TRANSFORMERS	

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.

INSTRUMENT TRANSFORMERS –

Part 4: Additional requirements for combined transformers

1 Scope

This part of IEC 61869 applies to newly-manufactured combined transformers for use with electrical measuring instruments and electrical protective devices at frequencies from 15 Hz to 100 Hz.

The requirements and tests of this standard, in addition to the requirements and tests of IEC 61869-1, IEC 61869-2 and IEC 61869-3 cover current and inductive voltage transformers that are necessary for combined instrument transformers.

2 Normative references

Clause 2 of IEC 61869-1:2007 is applicable with the following modifications:

Addition:

IEC 60028, *International Standard of resistance for copper*

IEC 60038, *IEC standard voltages*

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

IEC 61869-2:2012, *Instrument Transformers – Part 2: Additional requirements for current transformers*

IEC 61869-3:2011, *Instrument Transformers – Part 3: Additional requirements for inductive voltage transformers*

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions given in IEC 61869-1:2007, IEC 61869-2:2012 and IEC 61869-3:2011, as well as the following apply.

3.1 General definitions

3.1.401
combined instrument transformer
instrument transformer consisting of a current and a voltage transformer in the same enclosure

3.1.402
error of voltage transformer
ε_v
ratio error of voltage transformer determined with disconnected current transformer

3.1.403
phase displacement of voltage transformer
δ_v
phase displacement of voltage transformer determined with disconnected current transformer

3.1.404
voltage induced by rated continuous thermal current
U_v
the voltage induced by the rated continuous thermal current of the current transformer in the voltage transformer defined as a measure of the maximum variation of the voltage error

3.1.405
greatest variation of voltage error
$\Delta\varepsilon_v$
the greatest possible variation of the ratio error of the voltage transformer due to voltage induced by the rated continuous thermal current of the current transformer

3.1.406
greatest variation of phase displacement
$\Delta\delta_v$
the greatest possible variation of the phase displacement of the voltage transformer due to voltage induced by the rated continuous thermal current of the current transformer

3.1.407
absolute value of the variations of voltage error
ε'_v
sum of the absolute values of the ratio error of the voltage transformer and the greatest variation of the voltage error obtained at specified voltage

3.1.408
absolute value of the variations of phase displacement of voltage transformer
δ'_v
sum of the absolute values of the phase displacement of the voltage transformer and the greatest variation of the phase displacement obtained at specified voltage

3.1.409
voltage induced at rated short-time thermal current
U_e
the voltage induced by the short-time thermal current of the current transformer in the voltage transformer and marked on the rating plate

3.1.410
error of current transformer
ε_i
ratio error of current transformer determined with unexcited voltage transformer

3.1.411
phase displacement of current transformer
δ_i
phase displacement of current transformer determined with unexcited voltage transformer

3.1.412
voltage generated in the current transformer by capacitive current
U_i
voltage generated in the current transformer by capacitive current due to applied voltage of the voltage transformer and defined as a measure of the maximum variation of the current error

3.1.413
greatest variation of current error
$\Delta\varepsilon_i$
the greatest possible variation of the ratio error of the current transformer due to voltage generated in the current transformer by capacitive current

3.1.414
greatest variation of phase displacement
$\Delta\delta_i$
the greatest possible variation of the phase displacement of the current transformer due to voltage generated in the current transformer by capacitive current

3.1.415
absolute value of the variations of current error
ε'_i
sum of the absolute values of the ratio error of the current transformer and the greatest variation of the current error obtained at specified current

3.1.416
absolute value of the variations of phase displacement of current transformer
δ'_i
sum of the absolute values of the phase displacement of the current transformer and the greatest variation of the phase displacement obtained at specified current

3.7 Index of abbreviations and symbols

Replacement:

ε_v	error of voltage transformer
δ_v	phase displacement of the voltage transformer
U_v	voltage induced by the rated continuous thermal current
$\Delta\varepsilon_v$	the greatest variation of the voltage error
U_{sr}	rated secondary voltage
$\Delta\delta_v$	the greatest variation of the phase displacement of the voltage transformer
ε'_v	the absolute value of the variations of the voltage error
δ'_v	the absolute value of the variations of the phase displacement of voltage transformer
I_{th}	rated short-time thermal current
I_{cth}	rated continuous thermal current
U_e	the voltage induced at rated short-time thermal current
ε_i	error of current transformer
δ_i	phase displacement of the current transformer
U_i	voltage generated in the current transformer by capacitive current
$\Delta\varepsilon_i$	the greatest variation of the current error
$\Delta\delta_i$	the greatest variation of the phase displacement of the current transformer
ε'_i	the absolute value of the variations of the current error
δ'_i	the absolute value of the variations of the phase displacement of current transformer
I_{sr}	rated secondary current

4 Normal and special service conditions

Clause 4 of IEC 61869-1:2007 is applicable.

5 Ratings

Clause 5 of IEC 61869-1:2007, Clause 5 of IEC 61869-2:2012 and Clause 5 of IEC 61869-3:2011 are applicable with the following modifications:

Additional subclause:

5.401 Additional requirements for measuring and protective combined transformer

5.401.1 General

The error limits for measuring combined transformers shall correspond to the requirements for measuring current transformers, indicated in 5.6.201 of IEC 61869-2:2012, and to the requirements for measuring voltage transformers indicated in 5.6.301 of IEC 61869-3:2011. The limits of error for protective combined transformers shall correspond to the requirements for protective current transformers indicated in 5.6.202 of IEC 61869-2:2012, and to the requirements for protective voltage transformers indicated in 5.6.302 of IEC 61869-3:2011.

5.401.2 Mutual influence

When operating the current transformer between 5 % of the rated current and the rated continuous thermal current, the voltage transformer shall not exceed the limits of voltage error and phase displacement corresponding to its class within the specified range of burden and between 80 % and 120 % of the rated voltage.

When operating the voltage transformer between 80 % of the rated voltage and the rated voltage multiplied by the rated voltage factor, the current transformer shall not exceed the limits of current error and phase displacement within the range of current corresponding to its class and within the specified range of burden.

See 7.2.6.401 and 7.2.6.402 and Annex 4A.

6 Design and construction

Clause 6 of IEC 61869-1:2007, Clause 6 of IEC 61869-2:2012 and Clause 6 of IEC 61869-3:2011 are applicable with the following modifications:

6.4 Requirements for temperature rise of parts and components

6.4.1 General

Subclause 6.4.1 of IEC 61869-2:2012 is applicable with the following modifications:

Addition:

The temperature rise of a combined instrument transformer shall not exceed the appropriate values of 6.4 of IEC 61869-1:2007, if a voltage as indicated in 7.2.2 of IEC 61869-3:2011, is applied to it and the current transformer is carrying a primary current equal to the rated continuous thermal current. The current transformer is connected to a unity power factor burden corresponding to the rated output and with the voltage transformer being loaded at rated burden, or at the highest rated burden if there are several rated burdens, and at a power factor between 0,8 lagging and unity. The additional tolerance of 10 K proposed in some

cases for the voltage transformers (see clause 7.2.2 of IEC 61869-3:2011) is also applicable for the current transformers of the combined instrument transformers.

6.13 Markings

Additional subclauses:

6.13.401 Terminal markings

The terminals of the current and voltage transformer parts of combined instrument transformers shall be marked in the same way as for individual transformers as specified in 6.13.201 of IEC 61869-2:2012 and 6.13.301 of IEC 61869-3:2011.

6.13.402 Rating plate marking

6.13.402.1 General rules

The specifications for the current transformer according to 6.13.202 of IEC 61869-2:2012 and the voltage transformer according to 6.13.302 of IEC 61869-3:2011 shall be marked separately on the rating plate.

6.13.402.2 Marking of the rating plate of a combined transformer

The voltage transformer shall carry on the rating plate the value of the voltage U_e induced by the r.m.s. value of the rated short-time thermal current flowing through the current transformer, when the primary winding of the voltage transformer is short-circuited. The induced voltage is measured at the terminals of the secondary winding of the voltage transformer loaded with 15 VA or the rated burden.

NOTE Instead of the voltage U_e induced by the r.m.s. value of the rated short-time thermal current, the rating plate can carry the indication of the proportion of the induced voltage to the current flowing through the current transformer in millivolts per kiloampere.

7 Tests

Clause 7 of IEC 61869-1:2007, Clause 7 of IEC 61869-2:2012 and Clause 7 of IEC 61869-3:2011 are applicable with the following modifications:

7.1 General

7.1.2 List of tests

Replacement of Table 10:

Table 10 – List of tests

Tests	Subclause
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage withstand test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Tests for accuracy	7.2.6
Verification of the degree of protection by enclosures	7.2.7
Enclosure tightness test at ambient temperature	7.2.8
Pressure test for the enclosure	7.2.9

Tests	Subclause
Short-time current tests	7.2.201
Short-circuit withstand capability test	7.2.301
Routine tests	**7.3**
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Power-frequency voltage withstand tests on secondary terminals	7.3.4
Tests for accuracy	7.3.5
Verification of markings	7.3.6
Enclosure tightness test at ambient temperature	7.3.7
Pressure test for the enclosure	7.3.8
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Chopped impulse voltage withstand test on primary terminals	7.4.1
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Fire hazard test	7.4.10
Sample tests	**7.5**
Determination of the remanence factor	7.5.1
Determination of the instrument security factor (FS) of measuring current transformers	7.5.2

7.2 Type tests

7.2.2 Temperature-rise test

Replacement of the first sentence by the following:

A test shall be made in order to prove compliance with 6.4.1.

Addition:

When there is more than one secondary winding, the tests shall be made with the appropriate rated burden connected to each secondary winding unless otherwise agreed between manufacturer and user. For the test, the transformer shall be mounted in a manner representative of the mounting in service. The prescribed current and voltage are applied simultaneously to the combined instrument transformer. For this purpose, it is necessary that the primary winding and the secondary winding of the transformer generating the high current

which excites the current transformers are insulated in relation to one another for the full voltage of the network.

If such a transformer is not available, two other test arrangements are recommended.

1) The combined instrument transformer may be installed insulated. The high voltage is then applied simultaneously to the frame, to the casing, to the terminal of the primary winding usually earthed in service, and to one terminal of each secondary winding, whilst the terminal of the primary winding applied to the mains line in service is earthed. Thus the insulation of the transformer generating the current need not be constructed for high voltage.
2) The high voltage is applied to the terminal which is connected to the main line in service. Primary terminals of the current transformer are short-circuited and connected to the high voltage. The rated continuous thermal current in the short-circuited primary winding shall be obtained by energizing one or more secondary windings of the current transformer.

The results of all three methods are the same and the choice of the method is left to the manufacturer.

The temperature rise of windings shall be measured by the increase in resistance method. For primary windings of the current transformer with very low resistance, thermocouples may be employed. The temperature rise of parts other than windings may be measured by means of thermometers or thermocouples.

7.2.3 Impulse voltage withstand test on primary terminals

7.2.3.1 General

Addition:

The impulse voltage waves shall be applied to the short-circuited primary winding of the current transformer connected to the terminal of the voltage transformer primary winding, which is at high voltage when in operation. The same connection is valid for chopped and multiple chopped impulse tests.

7.2.6 Test for accuracy

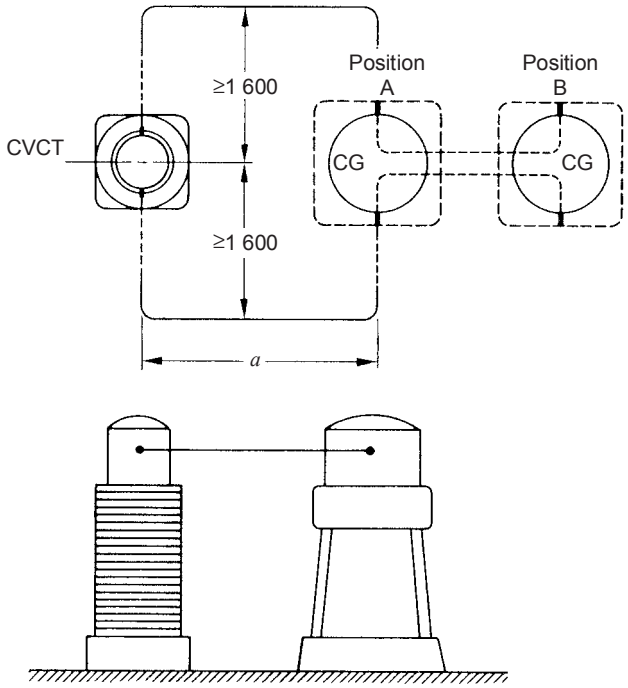
Additional subclauses:

7.2.6.401 Influence of the current transformer on the voltage transformer

The influence of the current transformer on the voltage transformer shall be tested as follows.

First, the voltage error ε_V and the phase displacement δ_V of the voltage transformer are determined with no current supplied to the current transformer and in accordance with 7.2.6.301 and 7.2.6.302 of IEC 61869-3:2011 within the specified range of burden (measurement 1). Then the current transformer is supplied with the rated continuous thermal current.

The supply line to the current transformer shall form a horizontal loop at the height of the primary terminals (see Figure 401). The distance, indicated as a in Figure 401, of the return conductor shall correspond to the distance of the other phase in the mains line. The remaining lengths of the current loop shall each be at least 1,6 m. The primary winding of the voltage transformer is short-circuited with a connection as short as possible, which is placed in the vertical plane of the primary terminals of the current transformer.



Combined voltage current transformer (CVCT)

The CG transformer generates the current. The stray field of this transformer shall not influence the combined voltage current transformer. If in position A an influence is detected, then position B shall be used.

The distance of return a of the conductor corresponds to the distance of the other phase conductors of the mains line.

	Highest system voltage kV	**Minimum values of distance** a mm
	12	150
	24	215
	36	325
	72,5	700
Full	123	1 100
insulation	245	2 200
	123	950
Reduced	245	1 850
insulation	420	2 900

Figure 401 – Geometrical construction of the circuit

The voltage induced by the current in the voltage transformer is measured by a millivoltmeter or an oscilloscope at the secondary terminals. This voltage U_v is a measure of the maximum variation of the voltage error.

It is recommended that the voltage transformer is loaded with the rated burden or 15 VA to avoid errors by externally influenced voltage (measurement 2). For protective transformers, it is sufficient to bring the variation $\Delta\varepsilon$ only into relation to 2 % and for measuring transformers into relation to 80 % of rated secondary voltage.

The greatest possible variation of the voltage error is then:

$$\Delta\varepsilon_V = \frac{U_v}{0{,}8\ U_{sr}} \times 100\ [\%] \text{ at 80 \% of the rated secondary voltage}$$

$$\Delta\varepsilon_V = \frac{U_v}{0{,}02\ U_{sr}} \times 100\ [\%] \text{ at 2 \% of the rated secondary voltage}$$

where

U_{sr} is the secondary rated voltage, in volts (V), and

U_v is expressed in volts (V).

The greatest possible variation of the phase displacement is then

$\Delta\delta_v = \Delta\varepsilon_v \times 34{,}4$, in minutes (min), or

$\Delta\delta_v = \Delta\varepsilon_v$, in centiradians (crad).

If the absolute values of the variations of the voltage error $\pm\Delta\varepsilon_v$ and of the phase displacement $\pm\Delta\delta_v$ are added to the absolute values of the measuring results ε_v and δ_v obtained in measurement 1 at 80 % of rated primary voltage for measuring transformer and 2% of the rated primary voltage for protective transformer within the specified range of burden, then the values obtained

$$\pm\varepsilon'_v = |\varepsilon_v| + |\Delta\varepsilon_v| \quad \text{and} \quad \pm\delta'_v = |\delta_v| + |\Delta\delta_v|$$

shall not exceed the limits of error for the voltage transformer given in 5.6.301.3 and 5.6.302.3 of IEC 61869-3:2011 (see Figure 404).

Additionally, it shall be ensured that the voltage errors due to the influence of the current do not exceed the limits of error, even at 100 % and 120 % of the rated voltage.

To prove compliance with 6.13.402 the value of the voltage induced by the rated short-time thermal current which shall be indicated on the rating plate, may be calculated with the voltage U_v measured at the rated continuous thermal current.

The voltage U_e induced at rated short-time thermal current is:

$$U_e = U_v \times p$$

where

$$p = \frac{I_{th}}{I_{cth}}$$

U_v is the voltage induced by the rated continuous thermal current;

I_{th} is the rated short-time thermal current;

I_{cth} is the rated continuous thermal current.

To obtain greater accuracy, it is better to measure the induced voltage U_v at the highest possible current.

7.2.6.402 Influence of the voltage transformer on the current transformer

In the case of combined instrument transformers, the influence of the voltage transformer on the current transformer has to be tested as follows.

With an unexcited voltage transformer, the current error ε_i and the phase displacement δ_i of the current transformers are determined according to 7.2.6.201, 7.3.5.202 or 7.3.5.204 of IEC 61869-2:2012 (measurement 3).

A voltage equal to 120 % of the rated voltage and the rated voltage multiplied by the rated voltage factor shall then be applied to the terminal of the voltage transformer which is directly connected to a terminal of the current transformer, the latter not being excited. A capacitive current is generated in the current transformer by the voltage and this is measured as the voltage drop U_i across a resistor R connected to the secondary terminals of the current transformer. The burden of the secondary windings of the voltage transformer does not affect the results. They may therefore be open-circuited.

At the rated secondary current of 1 A or 5 A, this recommended resistor can be respectively 100 Ω or 4 Ω. It is sufficient for the accuracy of the resistor R to be ±10 % of the value. Two measurements shall then be made. First, the voltage drop U_i is measured when one terminal of the secondary winding of the current transformer is earthed (Figure 402, measurement 4) and then, when the other terminal of the secondary winding is earthed (Figure 403, measurement 5). The greater value of the two measurements is to be considered.

NOTE It is sufficient to earth only the terminal which is earthed in service if agreed upon between the manufacturer and user.

It generally suffices to calculate the influence of voltage at 5 % of the rated current.

The variation of the current error is then

$$\pm\Delta\varepsilon_i = \frac{U_i}{R \times 0{,}05\ I_{sr}} \times 100\ [\%] \text{ at 5 \% of the rated current.}$$

where

R is expressed in ohms (Ω);

U_i is expressed in volts (V);

I_{sr} is the rated secondary current in amperes (A).

The variation of the phase displacement is then

$\pm\Delta\delta_i = \Delta\varepsilon_i \times 34{,}4$, in minutes (min), or

$\pm\Delta\delta_i = \Delta\varepsilon_i$, in centiradians (crad).

If the variations of the current error $\pm\Delta\varepsilon_i$ and of the phase displacement $\pm\Delta\delta_i$ are added to the absolute values of the measuring results ε_i and δ_i obtained in Measurement 1 at 5 % of the rated current within the specified range of burden, then the values obtained

$$\pm\varepsilon'_i = |\varepsilon_i| + |\Delta\varepsilon_i| \qquad \text{and} \qquad \pm\delta'_i = |\delta_i| + |\Delta\delta_i| \qquad \text{(see Figure 405)}$$

shall not exceed the limits of error for the current transformer given in 5.6.201.3, 5.6.202.2.4 or 5.6.202.3.4 or 5.6.202.5.1 of IEC 61869-2:2012. It shall be ensured, however, that current errors do not exceed the limits of error, even between 5 % and 120 % of the rated current and in the case of extended current rating at the rated continuous thermal current.

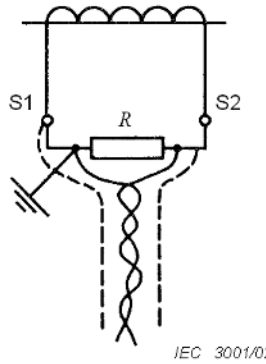


Figure 402 – Measurement 4

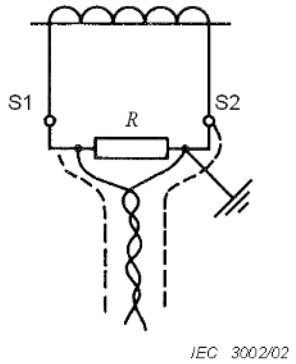
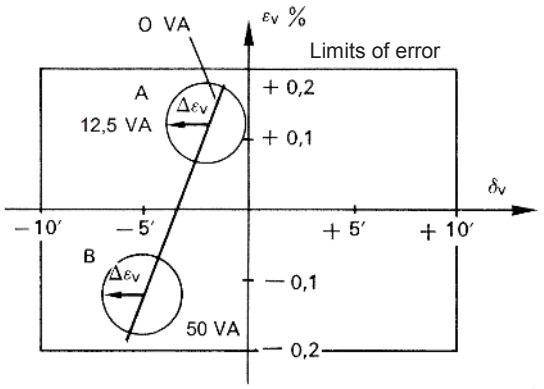


Figure 403 – Measurement 5



Key

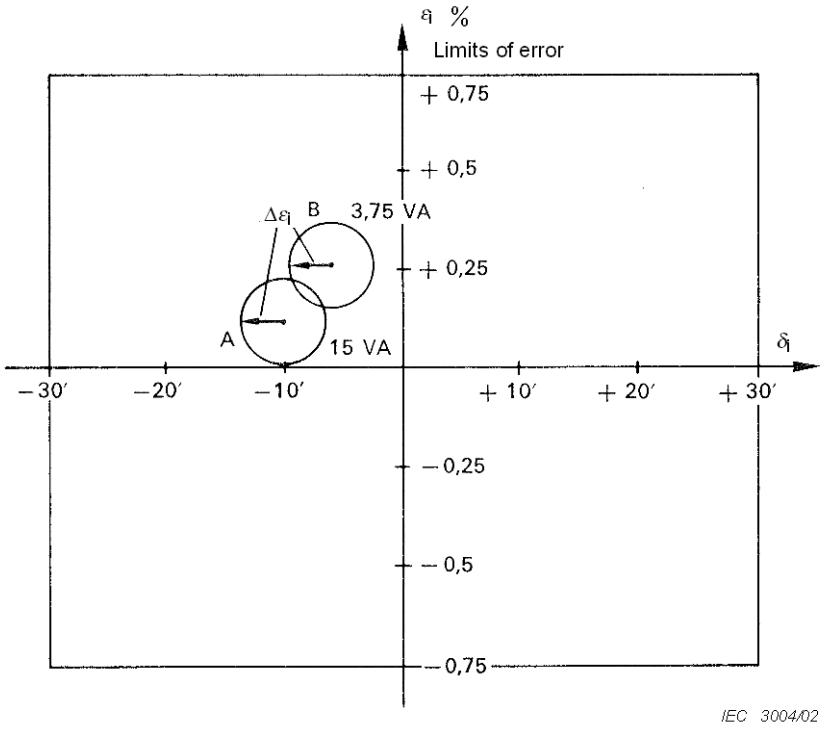
$\Delta\varepsilon_V$ is the variation of the error caused by a current.

According to the angle between the current and the voltage phasors, the end points of $\Delta\varepsilon_V$ lie on circles round the points of the voltage transformer errors without current influence.

A is the error of the voltage transformer at an output of 12,5 VA.

B is the error of the voltage transformer at an output of 50 VA.

Figure 404 – Error diagram of a voltage transformer class 0,2



Key

$\Delta\varepsilon_i$ is the variation of the error caused by the applied voltage.

According to the angle between the voltage and the current phasors, the end points of $\Delta\varepsilon_i$ lie on circles round the points of current transformer errors without applying voltage.

A error of the current transformer at an output of 15 VA.

B error of the current transformer at an output of 3,75 VA.

Figure 405 – Error diagram of a current transformer class 0,2 at 5 % of rated current

7.3 Routine tests

7.3.1 Power-frequency voltage withstand tests on primary terminals

Subclause 7.3.1 of IEC 61869-3:2011 is applicable with the following modifications:

7.3.1.301 General

Addition, after item b):

The differential mode (induced) AC voltage test for the voltage transformer is also the power-frequency test for the primary winding of the current transformer.

7.3.5 Test for accuracy

Additional subclause:

7.3.5.401 General

The test for accuracy of the current transformer shall be carried out in accordance with 7.3.5 of IEC 61869-2:2012 for current transformers.

The test for accuracy of the voltage transformer shall be carried out in accordance with 7.3.5 of IEC 61869-3:2011 for voltage transformers.

The variation of error determined at the type test according to 7.2.6.401 and 7.2.6.402 shall be taken into account.

8 Rules for transport, storage, erection, operation and maintenance

Clause 8 of IEC 61869-1:2007 is applicable.

9 Safety

Clause 9 of IEC 61869-1:2007 is applicable.

10 Influence of products on the natural environment

Clause 10 of IEC 61869-1:2007 is applicable.

Annexes

The annexes of IEC 61869-1:2007 and IEC 61869-2:2012 are applicable with the following modifications:

Additional annex:

Annex 4A
(normative)

The mutual influence of current and voltage transformers

4A.1 The influence of the magnetic field of a current-carrying conductor on the error of a voltage transformer

The errors of a voltage transformer can be influenced by the magnetic field of a current-carrying conductor in the vicinity. The influence is greatest when the conductor is positioned horizontally at right angles to the longitudinal direction of the iron core and when the magnetic flux encircling the conductor passes through the coil opening (Figure 4A.1, influence shown for a transformer rated at 10 kV). However, in the case where the conductor is located parallel to the longitudinal direction of the iron core, the influence is practically negligible. This fact is of importance for combined instrument transformers as care shall be taken during construction that the voltage transformer is mounted in the correct position, that is, with the longitudinal direction of the iron core parallel to the current conductor running through the transformer top.

Knowing the influence of the magnetic field of a current conductor on the error of a voltage transformer is important in particular for protection with directional relay.

It is necessary to be assured of the accuracy of the voltage transformers, particularly in relation to the phase shift of the secondary voltage with respect to the primary voltage, since the voltage induced by the current has a phase shift of 90° with respect to the primary voltage.

If, in the case of a fault, the secondary voltage is 0,5 V and the induced voltage is 50 mV, the resultant error on the secondary voltage would be greater than 10 %.

A current conductor can, of course, also have an influence on any voltage transformer with highest system voltage of 0,6 kV or more, and not only on the combined instrument transformer, if the current conductor of the network is laid near the voltage transformer. This requirement therefore also applies to each voltage transformer.

4A.2 Influence of the applied voltage on the error of a current transformer

The errors of the current transformers, irrespective of whether they are constructed for low or high voltages, are normally determined at a relatively low potential of a few volts which is just sufficient to generate the necessary current. If high voltage is applied to the primary winding of the transformer, the error may change more or less because the voltage gives rise to a capacitive current from the primary winding to the secondary winding which – in the case of an unshielded secondary winding – partly flows through the instruments connected to it and partly direct to the earthed terminal of the secondary winding. Furthermore, the capacitive current flowing through the primary winding is inductively induced in the secondary winding even when flowing to a secondary electrostatic screen. In particular with 5 % of the rated current, the errors may become so great that the limits of error are exceeded. If the errors of the current transformer are measured applying the high voltage simultaneously, the reference current transformer (standard transformer) used for this purpose as well as the transformer generating the current shall be insulated from the high voltage. It is possible to use two separate transformers for the measurement but it is more practical to have only one high current winding for both the reference transformer and the current-generating transformer and to insulate this winding for the high voltage. It is important to screen the core and the secondary winding of the reference transformer as well as the core and the primary winding of the current-generating transformer.

This high current winding shall also be shielded by a screen connected to the high-voltage transformer side of the current winding in order to have the capacitive current from the high voltage to earth flowing immediately from the high-voltage transformer and not via the high current winding.

The methods for measuring the influence of a current conductor on the voltage transformer described in 7.2.6.401 are indirect methods which may be performed more easily than the direct methods whilst giving the same measuring results. For the indirect methods, the transformer previously described which is insulated for the high voltage is not necessary.

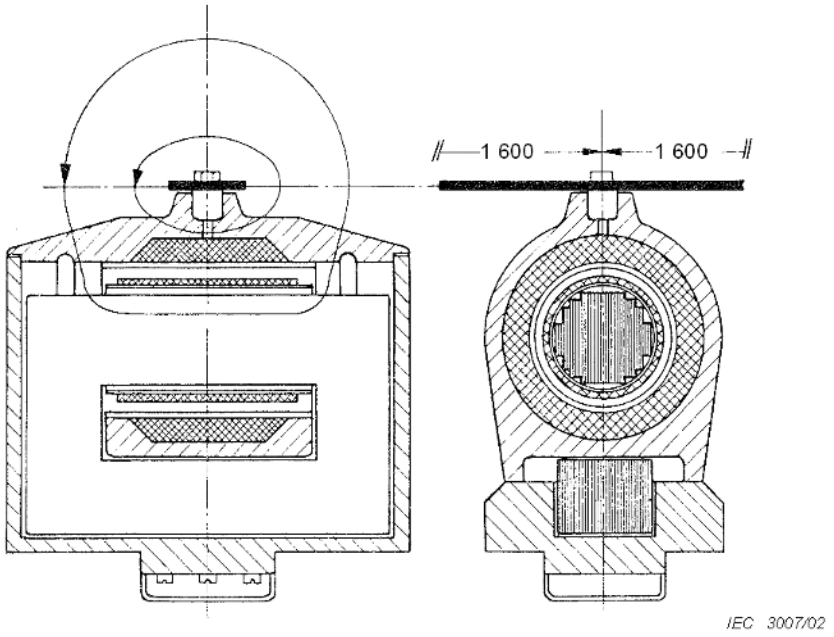


Figure 4A.1 – Current conductor and magnetic field influencing a voltage transformer

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