BS EN 61869-3:2011

BSI Standards Publication

Instrument transformers

Part 3: Additional requirements for inductive voltage transformers

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National foreword

This British Standard is the UK implementation of EN 61869-3:2011. It is identical to IEC 61869-3:2011. It supersedes BS EN 60044-2:1999, which will be withdrawn on 17 August 2014.

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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(IEC 61869-3:2011)

Transformateurs de mesure - Partie 3: Exigences supplémentaires concernant les transformateurs inductifs de tension (CEI 61869-3:2011)

Messwandler - Teil 3: Zusätzliche Anforderungen für induktive Spannungswandler (IEC 61869-3:2011)

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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.

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CENELEC

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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 38/410/FDIS, future edition 1 of IEC 61869-3, prepared by IEC/TC 38, "Instrument transformers", was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61869-3:2011.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2012-05-17
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2014-08-17

This document supersedes EN 60044-2:1999 + A1:2000 + A2:2003.

EN 61869-3:2011 shall be read in conjunction with, and is based on, EN 61869-1:2009, Instrument Transformers – Part 1: General Requirements.

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

When a particular clause/subclause of Part 1 is not mentioned in this Part 3, that clause/subclause applies as far as is reasonable. When this standard states “addition”, “modification” or “replacement”, the relevant text in Part 1 shall 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 301 are additional to those in Part 1;

– additional annexes are lettered 3A, 3B, etc.

Annex ZZ of EN 61869-1 is not applicable for this part of the series.

An overview of the planned set of standards at the date of publication of this document is given below. The updated list of standards prepared by IEC TC38 is available at the website: www.iec.ch.

The updated list of standards prepared by IEC TC38 and approved by CENELEC is available at the website: www.cenelec.eu.

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

PRODUCT FAMILY STANDARDS		PRODUCT STANDARD	PRODUCTS	OLD STANDARD
61869-1 GENERAL REQUIREMENTS FOR INSTRUMENT TRANSFORMERS		**61869-2**	ADDITIONAL REQUIREMENTS FOR CURRENT TRANSFORMERS	60044-1
		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 REQUIREMENT FOR ELECTRONIC INSTRUMENT TRANSFORMERS AND LOW POWER STAND ALONE SENSORS	**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 SENSOR	60044-7
		61869-12	ADDITIONAL REQUIREMENTS FOR COMBINED ELECTRONIC INSTRUMENT TRANSFORMER OR COMBINED STAND ALONE SENSORS	
		61869-13	STAND ALONE MERGING UNIT	

Endorsement notice

The text of the International Standard IEC 61869-3:2011 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 referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Annex ZA of EN 61869-1:2009 applies with the following additions:

Publication	Year	Title	EN/HD	Year
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

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		61869-13	STAND ALONE MERGING UNIT	

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 3: Additional requirements for inductive voltage transformers

1 Scope

This part of IEC 61869 applies to new inductive voltage transformers for use with electrical measuring instruments and electrical protective devices at frequencies from 15 Hz to 100 Hz.

NOTE 301 Requirements specific to three-phase voltage transformers are not included in this standard but, so far as they are relevant, the requirements in clauses 4 to 10 apply to these transformers and a few references to them are included in those clauses (e.g. see 3.1.303, 5.301.1, 5.301.2, 5.5.301, 6.13.301.1 and Table 304).

All the transformers shall be suitable for measuring purposes, but, in addition, certain types may be suitable for protection purposes. Transformers for the dual purpose of measurement and protection shall comply with all clauses of this standard.

2 Normative references

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

IEC 60028, *International Standard of resistance for copper*

IEC 60038, *IEC standard voltages*

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

3 Terms, definitions and abbreviations

For the purposes of this document, the terms and definitions in IEC 61869-1:2007 apply with the following additions:

3.1 General definitions

3.1.301
voltage transformer
instrument transformer in which the secondary voltage, in normal conditions of use, is substantially proportional to the primary voltage and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

[IEC 60050-321:1986, 321-03-01]

3.1.302
unearthed voltage transformer
voltage transformer which has all parts of its primary winding, including terminals, insulated from earth to a level corresponding to its rated insulation level

3.1.303
earthed voltage transformer
single-phase voltage transformer which is intended to have one end of its primary winding directly earthed or a three-phase voltage transformer which is intended to have the star-point of its primary winding directly earthed

3.1.304
measuring voltage transformer
voltage transformer intended to transmit an information signal to measuring instruments, integrating meters and similar apparatus

[IEC 60050-321:1986 , 321-03-04 modified]

3.1.305
protective voltage transformer
voltage transformer intended to transmit an information signal to electrical protective and control devices

[IEC 60050-321:1986 , 321-03-05]

3.1.306
primary winding
winding to which the voltage to be transformed is applied

3.1.307
secondary winding
winding which supplies the voltage circuits of measuring instruments, meters, relays or similar apparatus

3.1.308
residual voltage winding
winding of a single-phase voltage transformer intended, in a set of three single-phase transformers, for connection in broken delta for the purpose of:

a) producing a residual voltage under earth-fault conditions;

b) damping of relaxation oscillations (ferro-resonances).

3.2 Definitions related to dielectric ratings

3.2.301
rated primary voltage
U_{pr}
value of the primary voltage which appears in the designation of the transformer and on which its performance is based

[IEC 60050-321:1986, 321-01-12 modified]

3.2.302
rated secondary voltage
U_{sr}
value of the secondary voltage which appears in the designation of the transformer and on which its performance is based

[IEC 60050-321:1986, 321-01-16 modified]

3.2.303
rated voltage factor
F_v
multiplying factor to be applied to the rated primary voltage to determine the maximum voltage at which a transformer must comply with the relevant thermal requirements for a specified time and with the relevant accuracy requirements

3.4 Definitions related to accuracy

3.4.3

ratio error

ε

Definition 3.4.3 of IEC 61869-1:2007 is applicable with the following additional text:

The ratio error (voltage error), expressed in per cent, is given by the formula:

$$\varepsilon = \frac{k_r \times U_S - U_P}{U_P} \times 100 \ [\%]$$

where

k_r is the rated transformation ratio;

U_p is the actual primary voltage;

U_s is the actual secondary voltage when U_p is applied under the conditions of measurement.

3.5 Definitions related to other ratings

3.5.301
thermal limiting output
value of the apparent power at rated voltage which can be taken from a secondary winding without exceeding the limits of temperature rise.

NOTE 301 In this condition the limits of voltage error and phase displacement, for all secondary windings, most probably may be exceeded.

NOTE 302 In the case of more than one secondary winding, the thermal limiting output is to be given separately.

3.7 Index of abbreviations

Subclause 3.7 of IEC 61869-1 is replaced by the following:

IT	Instrument Transformer
CT	Current Transformer
CVT	Capacitive Voltage Transformer
VT	Voltage Transformer
AIS	Air-Insulated Switchgear
GIS	Gas-Insulated Switchgear
k	actual transformation ratio
k_r	rated transformation ratio
ε	ratio error
$\Delta\varphi$	phase displacement
S_r	rated output
U_{sys}	highest voltage for system
U_m	highest voltage for equipment
U_{Pr}	rated primary voltage
U_{Sr}	rated secondary voltage
F_V	rated voltage factor
f_R	rated frequency
F	mechanical load
F_{rel}	relative leakage rate

5 Ratings

Clause 5 of IEC 61869-1 is applicable with the following modifications:

NOTE 301 Please note that additional voltage ratings, to be considered together with Subclause 5.2: Highest voltage for equipment, are given in 5.301: Standard values of rated voltages. In future revision of IEC 61869 the layout of this clause will be rearranged.

5.3 Rated insulation levels

5.3.3.301 Power-frequency withstand voltage for the earthed terminal

The rated power-frequency short-duration withstand voltage shall be 3 kV (r.m.s.).

5.5 Rated output

5.5.301 Rated output values

The standard values of rated output at a power factor of 1, expressed in voltamperes, are:

1,0 - 2,5 - 5,0 - 10 VA (burden range I)

The standard values of rated output at a power factor of 0,8 lagging, expressed in voltamperes, are:

10 - 25 - 50 - 100 VA (burden range II)

The rated output of a three-phase transformer shall be the rated output per phase.

NOTE 301 For a given transformer, provided one of the values of rated output is standard and associated with a standard accuracy class, the declaration of other rated outputs, which may be non-standard values but associated with other standard accuracy classes, is not precluded.

5.5.302 Rated thermal limiting output

The rated thermal limiting output shall be specified in voltamperes; the standard values are:

25 - 50 - 100 VA and their decimal multiples,

related to the rated secondary voltage with unity power factor.

5.5.303 Rated output values for residual voltage windings

The rated output of windings intended to be connected in broken delta with similar windings to produce a residual voltage shall be specified in voltamperes and the value shall be chosen from the values specified in 5.5.301.

5.5.304 Rated thermal limiting output for residual voltage windings

The rated thermal limiting output of the residual voltage winding shall be specified in voltamperes; the standard values are:

25 - 50 - 100 VA and their decimal multiples,

related to the rated secondary voltage with unity power factor.

NOTE 301 Where a thermal limiting output is assigned to a residual voltage winding connected in a broken delta, it should be noted that these windings are only loaded under fault conditions and therefore for a limited duration. Deviating from the definition in 3.5.301, the rated thermal output of the residual voltage winding should be referred to a duration of 8 h.

5.6 Rated accuracy class

5.6.301 Accuracy requirements for single-phase inductive measuring voltage transformers

5.6.301.1 Accuracy class designation for measuring voltage transformers

For measuring voltage transformers, the accuracy class is designated by the highest permissible percentage voltage error at rated voltage and with rated burden, prescribed for the accuracy class concerned.

5.6.301.2 Standard accuracy classes for measuring voltage transformers

The standard accuracy classes for single-phase inductive measuring voltage transformers are:

0,1 – 0,2 – 0,5 – 1,0 – 3,0

NOTE 301 Guidance on appropriate accuracy classes will be included in a future annex.

5.6.301.3 Limits of voltage error and phase displacement for measuring voltage transformers

The voltage error and phase displacement at rated frequency shall not exceed the values given in Table 301 at any voltage between 80 % and 120 % of rated voltage and with burdens:

- any value from 0 VA to 100 % of the rated burden, at a power factor equal to 1 for burden range I.
- between 25 % and 100 % of rated burden at a power factor of 0,8 lagging for burden range II.

The errors shall be determined at the terminals of the transformer and shall include the effects of any fuses or resistors as an integral part of the transformer.

For transformers with tappings on the secondary winding, the accuracy requirements refer to the highest transformation ratio, unless otherwise specified.

Table 301 – Limits of voltage error and phase displacement for measuring voltage transformers

Class	Voltage (ratio) error ε_u ±%	Phase displacement $\Delta\varphi$	
		±Minutes	±Centiradians
0,1	0,1	5	0,15
0,2	0,2	10	0,3
0,5	0,5	20	0,6
1,0	1,0	40	1,2
3,0	3,0	Not specified	Not specified

NOTE Where transformers have two separate secondary windings, allowance must be made for the mutual interdependence. It is necessary to specify an output range for each winding under test and each should meet the accuracy requirements within this range with the untested windings at any burden from zero to rated value.

If no specification of output ranges is supplied, these ranges for the winding under test shall be from 25 % to 100 % of the rated output for each winding.

If one of the windings is loaded only occasionally for short periods or only used as a residual voltage winding, its effect upon other windings may be neglected.

5.6.302 Additional requirements for single-phase inductive protective voltage transformers

5.6.302.1 Accuracy class designation for protective voltage transformers

All voltage transformers intended for protective purposes, with the exception of residual voltage windings, shall be assigned a measuring accuracy class in accordance with 5.6.301.1 and 5.6.301.2. In addition, they shall be assigned one of the accuracy classes specified in 5.6.302.2.

The accuracy class for a protective voltage transformer is designated by the highest permissible percentage voltage error prescribed for the accuracy class concerned, from 5 % of rated voltage to a voltage corresponding to the rated voltage factor (see 5.302). This expression is followed by the letter P.

5.6.302.2 Standard accuracy classes for protective voltage transformers

The standard accuracy classes for protective voltage transformers are 3P and 6P, and the same limits of voltage error and phase displacement will normally apply at both 5 % of rated voltage and at the voltage corresponding to the rated voltage factor. At 2 % of rated voltage, the error limits will be twice as high as those at 5 % of rated voltage.

5.6.302.3 Limits of voltage error and phase displacement for protective voltage transformers

The voltage error and phase displacement at rated frequency shall not exceed the values in Table 302 at 5 % of rated voltage and at rated voltage multiplied by the rated voltage factor (1,2, 1,5 or 1,9) with burdens of:

- any value from 0 VA to 100 % of the rated burden, at a power factor equal to 1 for burden range I.
- between 25 % and 100 % of rated burden at a power factor of 0,8 lagging for burden range II.

At 2 % of rated voltage, the limits of voltage error and phase displacement will be twice as high as those given in Table 302.

Table 302 – Limits of voltage error and phase displacement for protective voltage transformers

Class	Voltage (ratio) error ε_u ±%	Phase displacement $\Delta\varphi$	
		±Minutes	±Centiradians
3P	3,0	120	3,5
6P	6,0	240	7,0
NOTE When ordering transformers having two separate secondary windings, because of their interdependence, the user should specify two output ranges, one for each winding, the upper limit of each output range corresponding to a standard rated output value. Each winding should fulfill its respective accuracy requirements within its output range, whilst at the same time the other winding has an output of any value from zero up to 100 % of the upper limit of its output range. In proving compliance with this requirement, it is sufficient to test at extreme values only. If no specification of output ranges is supplied, these ranges are deemed to be from 25 % to 100 % of the rated output for each winding			

5.6.302.4 Accuracy class for residual voltage windings

The accuracy class for a residual voltage winding shall be 6P or better, as defined in 5.6.302.1 and 5.6.302.2.

NOTE 301 If a residual voltage winding is used for special purposes, another standard accuracy class in accordance with 5.6.301.1, 5.6.301.2, 5.6.302.1 and 5.6.302.2 can be agreed between manufacturer and purchaser.

NOTE 302 If the residual voltage winding is used only for damping purposes, an accuracy class designation is not mandatory.

5.301 Standard values of rated voltages

5.301.1 Rated primary voltages

The standard values of rated primary voltage of three-phase transformers and of single-phase transformers for use in a single-phase system or between lines in a three-phase system shall be one of the values of rated system voltage designated as being usual values in IEC 60038. The standard values of rated primary voltage of a single-phase transformer connected between one line of a three-phase system and earth or between a system neutral point and earth shall be $1/\sqrt{3}$ times one of the values of rated system voltage.

NOTE 301 The performance of a voltage transformer as a measuring or protection transformer is based on the rated primary voltage, whereas the rated insulation level is based on one of the highest voltages for equipment of IEC 60038.

5.301.2 Rated secondary voltages

The rated secondary voltage shall be chosen according to the practice at the location where the transformer is to be used. The values given below are considered standard values for single-phase transformers in single-phase systems or connected line-to-line in three-phase systems and for three-phase transformers.

a) Based on the current practice of a group of European countries:
   - 100 V and 110 V;
   - 200 V for extended secondary circuits.

b) Based on the current practice in the United States and Canada:
   - 120 V for distribution systems;
   - 115 V for transmission systems;
   - 230 V for extended secondary circuits.

For single-phase transformers intended to be used phase-to-earth in three-phase systems where the rated primary voltage is a number divided by $\sqrt{3}$, the rated secondary voltage shall be one of the fore-mentioned values divided by $\sqrt{3}$, thus retaining the value of the rated transformation ratio.

NOTE 301 The rated secondary voltage for windings intended to produce a residual secondary voltage is given in 5.301.3

5.301.3 Rated voltages for residual voltage windings

Rated secondary voltages of windings intended to be connected in broken delta with similar windings to produce a residual voltage are given in Table 303.

Table 303 – Rated voltages for secondary windings intended to produce a residual voltage

Preferred values V		Alternative (non-preferred) values V
100	110	200
$\frac{100}{\sqrt{3}}$	$\frac{110}{\sqrt{3}}$	$\frac{200}{\sqrt{3}}$
$\frac{100}{3}$	$\frac{110}{3}$	$\frac{200}{3}$
NOTE Where system conditions are such that the preferred values of rated secondary voltages would produce a residual voltage that is too low, the non-preferred values may be used, but attention is drawn to the need to take precautions for purposes of safety.		

5.302 Standard values of rated voltage factor

The voltage factor is determined by the maximum operating voltage which, in turn, is dependent on the system and the voltage transformer primary winding earthing conditions.

The standard voltage factors appropriate to the different earthing conditions are given in Table 304, together with the permissible duration of maximum operating voltage (i.e. rated time).

Table 304 – Standard values of rated voltage factors

Rated voltage factor	Rated time	Method of connecting the primary winding and system earthing conditions
1,2	Continuous	Between phases in any network Between transformer star-point and earth in any network
1,2	Continuous	Between phase and earth in an effectively earthed neutral system (IEC 61869-1:2007, 3.2.7a)
1,5	30 s	
1,2	Continuous	Between phase and earth in a non-effectively earthed neutral system (IEC 61869-1:2007, 3.2.7b) with automatic earth-fault tripping
1,9	30 s	
1,2	Continuous	Between phase and earth in an isolated neutral system (IEC 61869-1:2007, 3.2.4) without automatic earth-fault tripping or in a resonant earthed system (IEC 61869-1:2007, 3.2.5) without automatic earth-fault tripping
1,9	8 h	
NOTE 1 The highest continuous operating voltage of an inductive voltage transformer is equal to the highest voltage for equipment (divided by √3 for transformers connected between a phase of a three-phase system and earth) or the rated primary voltage multiplied by the factor 1,2, whichever is the lowest. NOTE 2 Reduced rated times are permissible by agreement between manufacturer and purchaser.		

6 Design and construction

6.4 Requirements for temperature rise of parts and components

6.4.1 General

Clause 6.4.1 of IEC 61869-1:2007 is applicable with the following additional text:

Unless otherwise specified, the temperature rise of a voltage transformer at the specified voltage, at rated frequency and at rated burden, or at the highest rated burden if there are several rated burdens, at any power factor between 0,8 lagging and unity, shall not exceed the appropriate value given in Table 5 of IEC 61869-1:2007.

When the transformer is fitted with a conservator tank or has an inert gas above the oil, or is hermetically sealed the temperature rise of the oil at the top of the tank or housing shall not exceed 55 K.

When the transformer is not so fitted or arranged, the temperature rise of the oil at the top of the tank or housing shall not exceed 50 K.

The temperature rise measured on the external surface of the core and other metallic parts where in contact with, or adjacent to, insulation shall not exceed the appropriate value in Table 5 of IEC 61869-1:2007.

6.13 Markings

6.13.301 Terminal markings

6.13.301.1 General rules

These markings are applicable to single-phase voltage transformers and also to sets of single-phase voltage transformers assembled as one unit and connected as a three-phase voltage transformer or to a three-phase voltage transformer having a common core for the three phases.

6.13.301.2 Method of marking

Capital letters A, B, C and N denote the primary-winding terminals and the lower-case letters a, b, c and n denote the corresponding secondary-winding terminals.

The letters A, B and C denote fully insulated terminals and the letter N denotes a terminal intended to be earthed and the insulation of which is less than that of the other terminal(s).

The letters da and dn denote the terminals of windings intended to supply a residual voltage.

6.13.301.3 Markings to be used

Markings shall be in accordance with Figures 301 to 310 as appropriate.

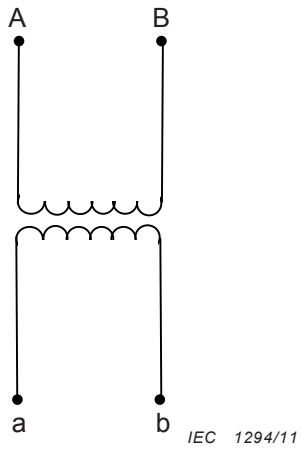


Figure 301 – Single-phase transformer with fully insulated terminals and a single secondary

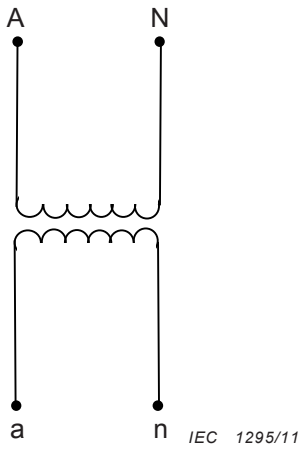


Figure 302 – Single-phase transformer with a neutral primary terminal with reduced insulation and a single secondary

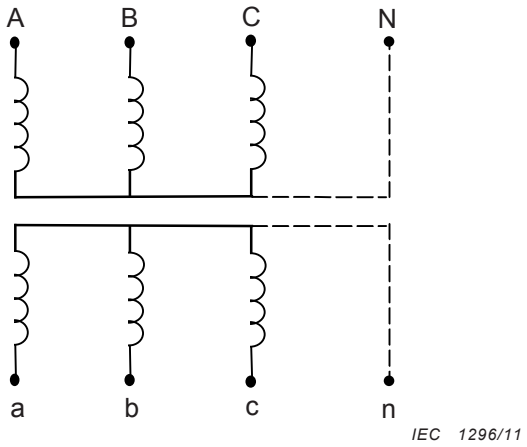


Figure 303 – Three-phase assembly with a single secondary

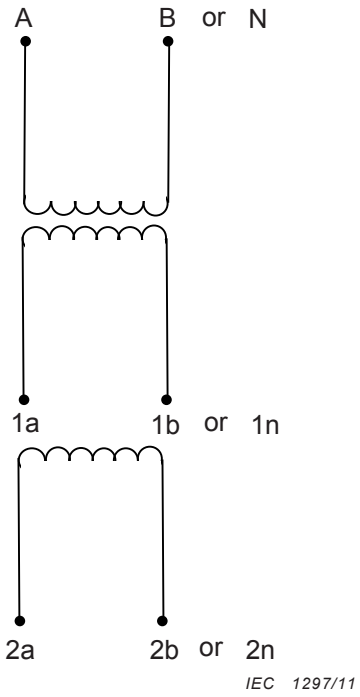


Figure 304 – Single-phase transformer with two secondaries

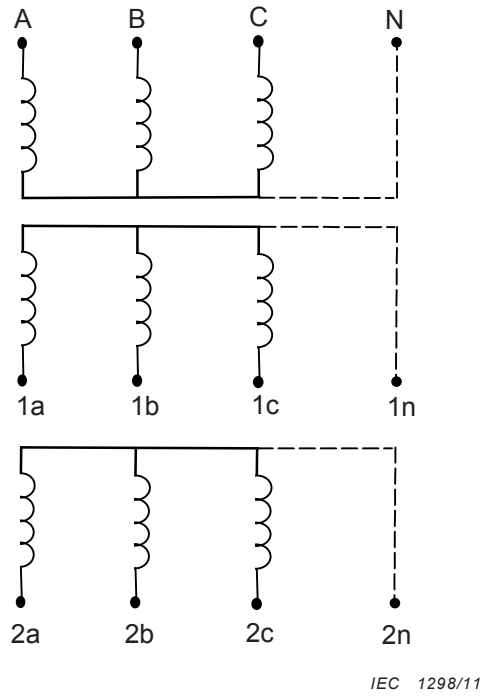


Figure 305 – Three-phase assembly with two secondaries

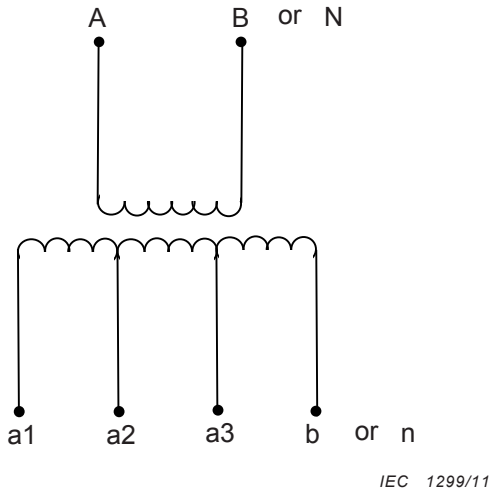


Figure 306 – Single-phase transformer with one multi-tap secondary

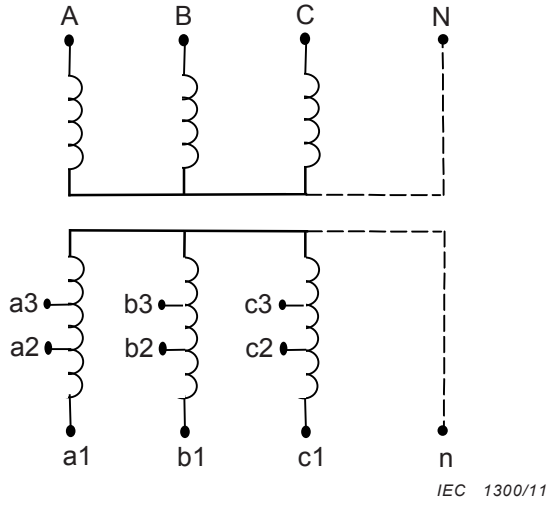


Figure 307 – Three-phase assembly with one multi-tap secondary

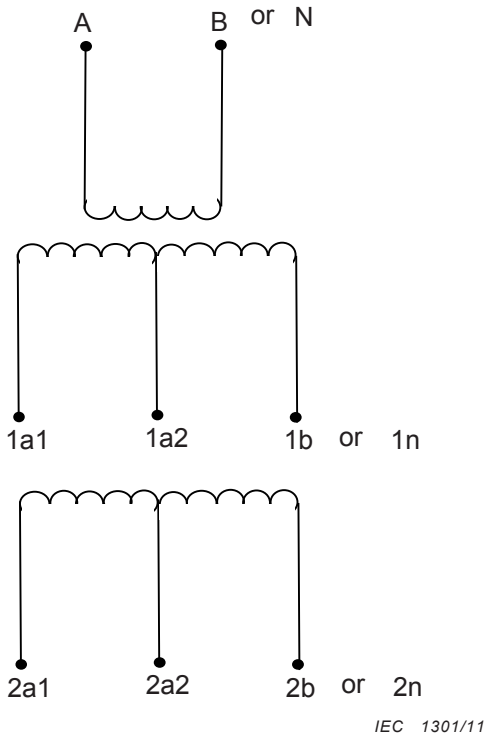


Figure 308 – Single-phase transformer with two multi-tap secondaries

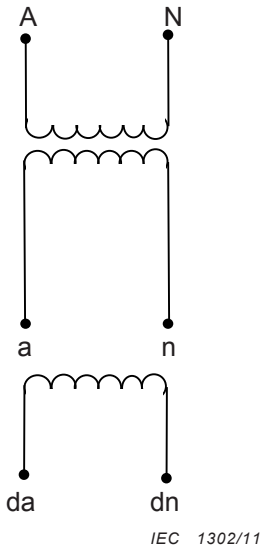


Figure 309 – Single-phase transformer with one residual voltage winding

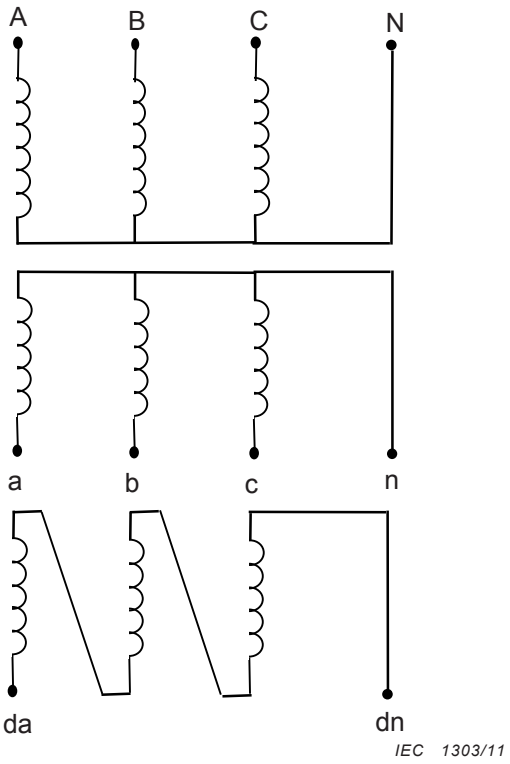


Figure 310 – Three-phase transformer with one residual voltage winding

6.13.301.4 Indication of relative polarities

Terminals having corresponding capital and lower-case markings shall have the same polarity at the same instant.

6.13.302 Rating plate markings

6.13.302.1 General

In addition to those markings stated in IEC 61869-1:2007, Clause 6.13, all voltage transformers shall carry the following markings:

a) the rated primary and secondary voltage (e.g. 66/0,11 kV);

b) rated output and the corresponding accuracy class (e.g. 50 VA Class 1.0);

NOTE 301 When two separate secondary windings are provided, the marking should indicate the output range of each secondary winding in VA, the corresponding accuracy class and the rated voltage of each winding.

In addition, the following information should be marked:

c) rated voltage factor and corresponding rated time.

NOTE 302 For gas insulated voltage transformers, the highest voltage of the voltage transformer shall be indicated on the rating plate as the rated voltage for equipment.

For voltage transformers belonging to burden range I, this rating shall be indicated immediately before the burden indication (for example, 0 VA-10 VA class 0,2).

NOTE 303 The rating plate may contain information concerning several combinations of output and accuracy class that the transformer can satisfy.

An example of a typical rating plate is given in Figure 311 and one showing typical data in Figure 312.

6.13.302.2 Marking of the rating plate of a measuring voltage transformer

The rating plate shall carry the appropriate information in accordance with 6.13.302.1.

The accuracy class shall be indicated following the indications of the corresponding rated output (e.g. 100 VA, class 0,5).

6.13.302.3 Marking of the rating plate of a protective voltage transformer

The rating plate shall carry the appropriate information in accordance with 6.13.302.1. In the case of small voltage transformers with limited space, it may be necessary to restrict the data and/or split the data into separate labels.

The accuracy class shall be indicated after the corresponding rated output.

MANUFACTURER'S NAME		**VOLTAGE TRANSFORMER TYPE** _____	
YEAR _____		SERIAL _____	MASS _____ kg
A - N ____/√3 kV	1a – 1n _____ V	2a - 2n _____ V	da - dn _____ V
	VA _____	VA _____	VA _____
	Class _____	Class _____	Class _____
Frequency _____Hz	Um _____ kV	LI/SI/AC ___ kV/ ____kV / _____kV __sec	
Mech. ___kN	Temp. -___/+___°C	F_v ___ for ____	Ins. Class _____

Additional markings when required

Filling fluid _____	Filling pressure __kPa	Min pressure __kPa	Fluid volume __ litre

IEC 1304/11

Figure 311 – Example of a typical rating plate

MANUFACTURER'S NAME		**VOLTAGE TRANSFORMER TYPE** Type designation	
YEAR 2007		SERIAL as required	MASS 500 kg
A - N 220/√3 kV	1a – 1n 63.5 V	2a - 2n - V	da - dn 110 V
	VA 25/50*	VA -	VA 25
	Class 0.5/3P	Class -	Class 6P
Frequency 50 Hz	Um 245 kV	LI/SI/AC 1050 kV / --- kV / 460 kV 60sec	
Mech. 1,25 kN	Temp. - 25/+ 40 °C	F_v 1.5 for 30 s	Ins. Class A
Filling fluid Oil Type (Grade)	Filling pressure 120 kPa	Min. pressure 100 kPa	Fluid volume 300 litre
Note* - Thermal limit burden 100 VA		**Sealed Unit – Do not tamper**	

IEC 1305/11

Figure 312 – Example of a rating plate with typical data

(In this case: 220 kV unit with two secondary windings)

6.301 Short-circuit withstand capability

The voltage transformer shall be designed and constructed to withstand without damage, when energized at rated voltage, the mechanical and thermal effects of an external short-circuit for the duration of 1 s.

7 Tests

7.1 General

7.1.2 List of tests

Replace Table 10 of IEC 61869-1: 2007 with the following:

Table 10 – List of tests

Tests	Clause/Subclause
Type tests	**7.2**
Temperature-rise test	7.2.2
Impulse voltage test on primary terminals	7.2.3
Wet test for outdoor type transformers	7.2.4
Electromagnetic Compatibility tests	7.2.5
Test 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
Short-circuit withstand capability test	7.2.301
Routine tests	**7.3**
Power-frequency voltage withstand tests on primary terminals	7.3.1
Partial discharge measurement	7.3.2
Power-frequency voltage withstand tests between sections	7.3.3
Power-frequency voltage withstand tests on secondary terminals	7.3.4
Test 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
Special tests	**7.4**
Chopped impulse voltage withstand test on primary terminals	7.4.1
Multiple chopped impulse test on primary terminals	7.4.2
Measurement of capacitance and dielectric dissipation factor	7.4.3
Transmitted overvoltage test	7.4.4
Mechanical tests	7.4.5
Internal arc fault test	7.4.6
Enclosure tightness test at low and high temperatures	7.4.7
Gas dew point test	7.4.8
Corrosion test	7.4.9
Fire hazard test	7.4.10
Sample tests	**7.5**

7.2 Type tests

7.2.2 Temperature-rise test

IEC 61869-1:2007, 7.2.2 is applicable with the following addition:

When there is more than one secondary winding, the test shall be made with the appropriate rated burden connected to each secondary winding, unless otherwise agreed between manufacturer and purchaser. The residual voltage winding shall be loaded in accordance with 6.4.1 .

For voltage transformers in three-phase gas-insulated metal enclosed switchgear, all three phases shall be tested at the same time.

The voltage transformer shall be mounted in a manner representative of the mounting in service. However, because the position of the voltage transformer in each switchgear can be different, the manufacturer shall decide the configuration of the test arrangement.

The voltage to be applied to the transformer shall be in accordance with item a), b) or c) below, as appropriate.

a) All voltage transformers irrespective of voltage factor and time rating shall be tested at 1,2 times the rated primary voltage.

   If a thermal limiting output is specified, the transformer shall be tested at rated primary voltage, at a burden corresponding to the thermal limiting output at a unity power factor without loading the residual voltage winding.

   If a thermal limiting output is specified for more than one secondary windings, the transformer shall be tested separately with each of these windings connected, one at a time, to a burden corresponding to the relevant thermal limiting output at a unity power factor.

   The test shall be continued until the temperature of the transformer has reached a steady state.

b) Transformers having a voltage factor of 1,5 for 30 s or 1,9 for 30 s shall be tested at their respective voltage factor for 30 s starting after attaining stability at 1,2 times rated voltage. The temperature rise shall not exceed by more than 10 K the value specified in Table 5 of IEC 61869-1:2007.

   NOTE 301 The relatively short duration of 30 s for the overvoltage is unlikely to produce a measurable temperature rise following the measurement at rated voltage. Consequently, any detrimental effect due to the overvoltage on the transformer can best be assessed indirectly from observed deficiencies during the dielectric type tests.

c) Transformers having a voltage factor of 1,9 for 8 h shall be tested at 1,9 times the rated voltage for 8 h following the transformer attaining stability at 1,2 times rated voltage. The temperature rise shall not exceed by more than 10 K the values specified in Table 5 of IEC 61869-1:2007.

If one of the secondary windings is used as a residual voltage winding, a test shall be made in accordance with the test procedure described above, starting with the test in accordance with item a) at 1,2 times the rated primary voltage and directly followed by the test in accordance with item c).

During the preconditioning test with 1,2 times the rated primary voltage, the residual voltage winding is unloaded. During the test, at 1,9 times the rated primary voltage for 8 h, the residual voltage winding shall be loaded with the burden corresponding to the rated thermal limiting output (see 5.5.304) while the other windings are loaded with the rated burden.

NOTE 302 The voltage measurement has to be performed on the primary winding, as the actual secondary voltage may be appreciably smaller than the rated secondary voltage multiplied by the voltage factor.

7.2.3 Impulse voltage withstand test on primary terminals

7.2.3.1 General

IEC 61869-1:2007, 7.2.3.1 is applicable with the following addition:

The test voltage shall be applied between each line terminal of the primary winding and earth. The earthed terminal of the primary winding or the non-tested line terminal in the case of an unearthed voltage transformer, at least one terminal of each secondary winding, the frame, case (if any) and core (if intended to be earthed) shall be earthed during the test.

NOTE 301 The earth connections may be made through suitable current recording devices.

For three-phase voltage transformers for gas-insulated substations all phases shall be tested one after another. While each phase is being tested, all other phases shall be earthed.

For the acceptance criteria of gas-insulated, metal enclosed voltage transformers, refer to IEC 62271-203:2003, 6.2.4.

7.2.3.2 Lightning impulse voltage test on primary terminals

7.2.3.2.1 Instrument transformers having U_m < 300 kV

IEC 61869-1:2007, 7.2.3.2.1 is applicable with the following addition:

For unearthed voltage transformers, approximately half the number of impulses shall be applied to each line terminal in turn with the other line terminal connected to earth.

7.2.3.3 Switching impulse voltage test

7.2.3.3.1 General

IEC 61869-1:2007, 7.2.3.3.1 is applicable with the following addition:

NOTE 301 To counteract the effect of core saturation, it is permitted, between consecutive impulses, to modify the magnetic conditions of the core by a suitable procedure.

7.2.5 Electromagnetic Compatibility (EMC) tests

7.2.5.2 Immunity test

Not applicable.

7.2.6 Test for accuracy

7.2.6.301 Type Tests for accuracy of measuring voltage transformers

To prove compliance with 5.6.301.3, type tests shall be made at 80 %, 100 % and 120 % of rated voltage, at rated frequency and with output values in accordance with Table 305 at a power factor of 1 (range I) or at a power factor of 0,8 lagging (range II).

Table 305 – Burden ranges for accuracy tests

Burden range	Preferred values of rated output VA	Test output values % (of rated)
I	1,0 - 2,5 – 5 - 10	0 and 100
II	10 – 25 – 50 - 100	25 and 100

7.2.6.302 Type Tests for accuracy of protective voltage transformers

To prove compliance with 5.6.302.3, type tests shall be made at 2 %, 5 % and 100 % of rated voltage and at rated voltage multiplied by the rated voltage factor (1,2, 1,5 or 1,9) and with values of output in accordance with Table 305 and a power factor of 1 (range I) or at a power factor of 0,8 lagging (range II).

When the transformer has several secondary windings, they are to be loaded as stated in the note to Table 302.

A residual voltage winding is unloaded during the tests with voltages up to 100 % of rated voltage and loaded with rated burden during the test with a voltage equal to rated voltage multiplied by the rated voltage factor.

7.2.301 Short-circuit withstand capability test

This test shall be made to prove compliance with 6.301.

For this test, the transformer shall initially be at a temperature between 10 °C and 30 °C.

The voltage transformer shall be energized from the primary side and the short circuit applied between the secondary terminals.

One short circuit shall be applied for the duration of 1 s.

NOTE 301 This requirement applies also where fuses are an integral part of the transformer.

During the short circuit, the r.m.s. value of the applied voltage at the transformer terminals shall be not less than the rated voltage.

In the case of transformers provided with more than one secondary winding, or section, or with tappings, the test connection shall be agreed between manufacturer and purchaser.

NOTE 302 For inductive type transformers, the test may be carried out by energizing the secondary winding and applying the short circuit between the primary terminals.

The transformer shall be deemed to have passed this test if, after cooling to ambient temperature, it satisfies the following requirements:

a) it is not visibly damaged;
b) its errors do not differ from those recorded before the tests by more than half the limits of error in its accuracy class;
c) it withstands the dielectric tests specified in 7.3.1, 7.3.2, 7.3.3 and 7.3.4, but with the test voltage reduced to 90 % of those given;
d) on examination, the insulation next to the surface of both the primary and the secondary windings does not show significant deterioration (e.g. carbonization).

The examination d) is not required if the current density in the winding does not exceed 180 A/mm^2 where the winding is of copper of conductivity not less than 97 % of the value given in IEC 60028. The current density is to be based on the measured symmetrical r.m.s. short-circuit current in the secondary winding (divided by the rated transformation ratio in the case of the primary).

7.3 Routine tests

7.3.1 Power-frequency voltage withstand tests on primary terminals

Replace IEC 61869-1:2007, 7.3.1 with the following:

7.3.1.301 General

The power-frequency withstand tests shall be performed in accordance with IEC 60060-1.

Inductive voltage transformers shall be submitted to the following tests:

a) Common mode (separate source) power-frequency withstand test on primary terminals
b) Differential mode (induced) AC voltage test on primary terminals

The test is successful if no collapse of the test voltage occurs.

Repeated power-frequency tests on primary terminals should be performed at 80 % of the specified test voltage.

7.3.1.302 Common mode (separate source) power-frequency withstand test

7.3.1.302.1 General

For common mode withstand test the duration shall be 60 s.

The test voltage shall be applied between the primary terminals and earth. The secondary terminals, the frame, case (if any) and core (if there is a special earth terminal) shall be connected to earth.

See also Figure 313.

7.3.1.302.2 Unearthed voltage transformers

For unearthed voltage transformers with windings having $U_m < 300$ kV the test voltages shall have the appropriate values given in Table 2 of IEC 61869-1:2007 depending on the highest voltage for equipment.

7.3.1.302.3 Earthed voltage transformers

For earthed voltage transformers the test voltage shall have the appropriate value given in 5.3.3.301.

7.3.1.303 Differential mode (induced) AC voltage test

7.3.1.303.1 General

For differential mode AC voltage test, the frequency of the test voltage may be increased above the rated value to prevent saturation of the core. The duration of the test shall be 60 s. If, however, the test frequency exceeds twice the rated frequency, the duration of the test may be reduced from 60 s as below:

$$\text{duration of test} = \frac{\text{(twice the rated frequency)}}{\text{test frequency}} \times 60 \ \text{[s]}$$

with a minimum of 15 s.

The test voltage shall be applied between primary terminals.

At the manufacturer's discretion, the test can be made by exciting the secondary winding with a voltage of sufficient magnitude to induce the specified test voltage in the primary winding, or by exciting the primary winding directly at the specified test voltage.

The test voltage shall be measured at the high-voltage side in each case. The frame, case (if any), core (if intended to be earthed) and one terminal of each secondary winding and the other terminal of the primary winding shall be connected together and to earth.

See also Figures 314 and 315.

The test voltages for windings having $U_m < 300$ kV shall have the appropriate values given in Table 2 of IEC 61869-1:2007 depending on the highest voltage for equipment.

When there is a considerable difference between the specified highest voltage for equipment (U_m) and the specified rated primary voltage, the induced voltage shall be limited to five times the rated primary voltage.

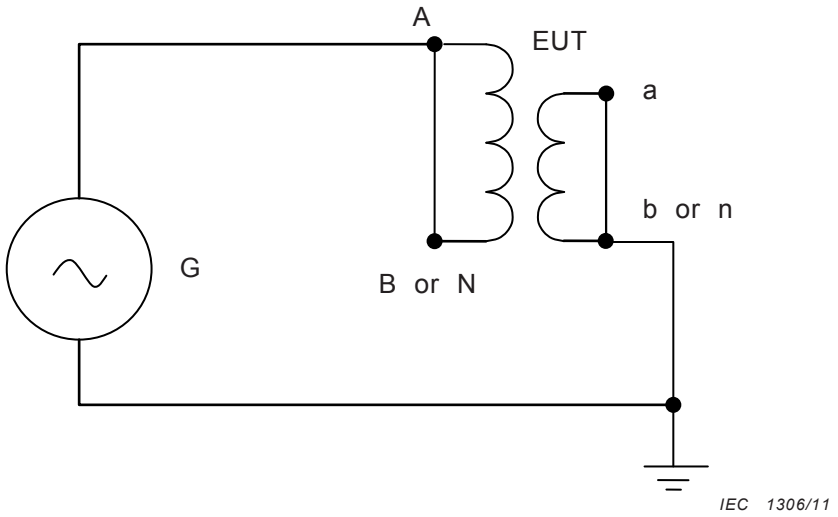
The test voltage for windings having $U_m > 300$ kV shall have the appropriate value given in Table 2 of IEC 61869-1:2007, depending on the rated lightning impulse withstand voltage.

7.3.1.303.2 Unearthed voltage transformers

For unearthed voltage transformers the test should be performed by test voltage applications to each line terminal for half the required time, with a minimum of 15 s for each terminal.

7.3.1.303.3 Earthed voltage transformers

For earthed voltage transformers the primary voltage terminal intended to be earthed in service is earthed during the test.



Key
EUT= Equipment Under Test
G= Test Voltage Generator

Figure 313 – Common mode (separate source) test voltage application

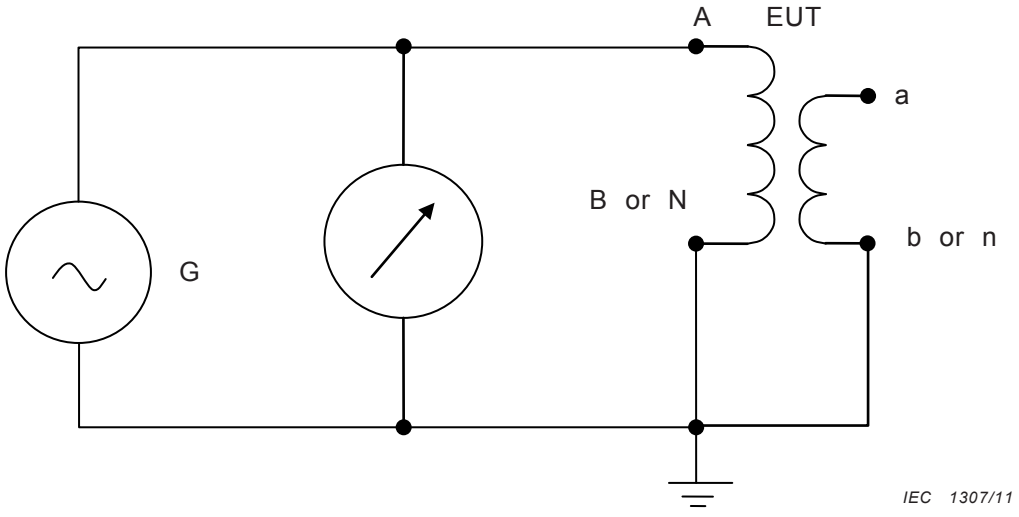


Figure 314 – Differential mode (induced) test voltage application – Primary excitation

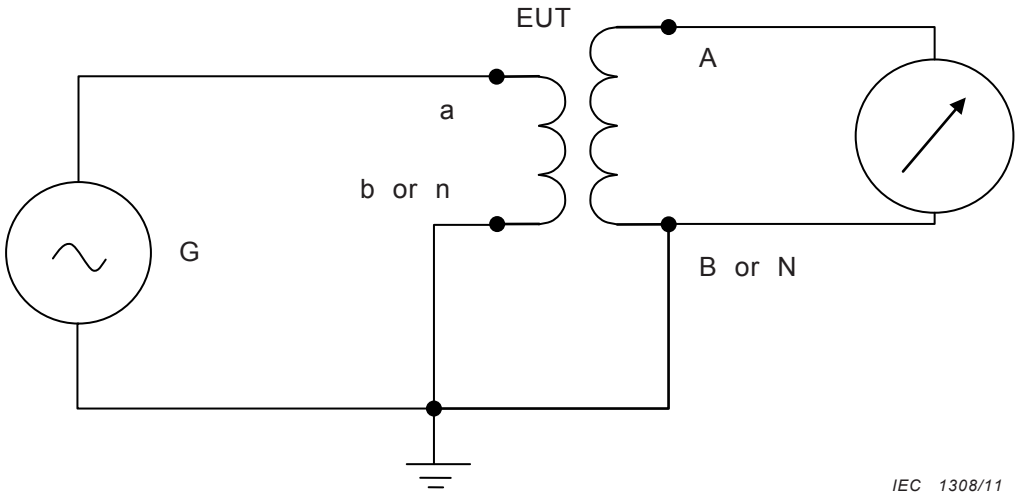


Figure 315 – Differential mode (induced) test voltage application – Secondary excitation

7.3.2 Partial discharge measurements

7.3.2.1 Test circuit and instrumentation

7.3.2.2 Partial discharge test procedure

IEC 61869-1:2007, 7.3.2.2 is applicable with the following addition:

NOTE 301 When the rated voltage of a voltage transformer is considerably lower than its highest system voltage U_m, lower pre-stress voltages and measuring voltages may be agreed between manufacturer and purchaser. When this applies, the PD test voltage shall be reduced in the same proportion as the pre-stress voltage.

The test circuit for unearthed voltage transformers shall be the same as for earthed voltage transformers but two tests shall be performed by applying the voltages alternately to each of the high voltage terminals with the other high voltage terminal connected to a low-voltage terminal, frame and case (if any). Refer to IEC 61869-1:2007, Figures 5 and 6.

7.3.5 Test for accuracy

7.3.5.301 Routine tests for accuracy of measuring voltage transformers

The routine tests for accuracy are in principle the same as the type tests in 7.2.6.301, but routine tests at a reduced number of voltages and/or burdens are permissible, provided it has been shown by type tests on a similar transformer that such a reduced number of tests is sufficient to prove compliance with 5.6.301.3.

7.3.5.302 Routine tests for accuracy of protective voltage transformers

The routine tests for accuracy are in principle the same as the type tests in 7.2.6.302, but routine tests at a reduced number of voltages and/or burdens are permissible, provided it has been shown by type tests on a similar transformer that such a reduced number of tests is sufficient to prove compliance with 5.6.302.3.

7.4 Special tests

7.4.3 Measurement of capacitance and dielectric dissipation factor

IEC 61869-1:2007, 7.4.3 is applicable with the following addition:

The test circuit shall be agreed between manufacturer and purchaser, the bridge method being preferred.

If the primary winding of the voltage transformer is constructed as a multiple coil winding and each coil is connected to the corresponding grading layer inside main insulation, only part of the insulation which refers to the coil connected to the earth potential is checked. In this case, test voltages according 7.4.3 of IEC 61869-1:2007 shall be reduced. The dielectric dissipation factor shall be corrected taking into account the resistance of the coil.

7.4.6 Internal arc fault test

IEC 61869-1:2007, 7.4.6 is applicable with the following addition:

NOTE 301 For most post-type oil-immersed voltage transformers, the location of the primary insulation most susceptible to failure is the transition region between the primary winding and primary conductor.

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