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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Instrument transformers – Part 2: Additional requirements for current transformers

Transformateurs de mesure – Partie 2: Exigences supplémentaires concernant les transformateurs de courant

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INSTRUMENT TRANSFORMERS –

Part 2: Additional requirements for current transformers

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This International Standard IEC 61869-2 Ed.1.0 has been prepared by committee 38: Instrument transformers.

This first edition of IEC 61869-2 cancels and replaces the first edition of IEC 60044-1, published in 1996, and its Amendment 1 (2000) and Amendment 2 (2002), and the first edition of IEC 60044-6, published in 1992. Additionally it introduces technical innovations in the standardization and adaptation of the requirements for current transformers for transient performance.

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

FDIS	Report on voting
38/435/FDIS	38/437/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.

A list of all the parts in the IEC 61869 series, published under the general title *Instrument transformers*, can be found on the IEC website.

This Part 2 is to be used in conjunction with, and is based on, IEC 61869-1:2007, *General Requirements* – however the reader is encouraged to use its most recent edition.

This Part 2 follows the structure of IEC 61869-1:2007 and supplements or modifies its corresponding clauses.

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

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

– clauses, subclauses, tables, figures and notes that are numbered starting from 201 are additional to those in Part 1;
– additional annexes are lettered 2A, 2B, 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.

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Since the publication of IEC 60044-6 (*Requirements for protective current transformers for transient performance*) in 1992, the area of application of this kind of current transformers has been extended. As a consequence, the theoretical background for the dimensioning according to the electrical requirements has become much more complex. In order to keep this standard as user-friendly as possible, the explanation of the background information will be transferred to the Technical Report IEC 61869-100 TR, which is now in preparation.

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 2: Additional requirements for Current Transformers

1 Scope

This part of IEC 61869 is applicable to newly manufactured inductive current transformers for use with electrical measuring instruments and/or electrical protective devices having rated frequencies from 15 Hz to 100 Hz.

2 Normative references

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

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

3 Terms and definitions

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

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3.1 General definitions

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3.1.201
current transformer
instrument transformer in which the secondary current, under normal conditions of use, is substantially proportional to the primary current and differs in phase from it by an angle which is approximately zero for an appropriate direction of the connections

[SOURCE: IEC 60050-321:1986, 321-02-01]

3.1.202
measuring current transformer
current transformer intended to transmit an information signal to measuring instruments and meters

[SOURCE: IEC 60050-321:1986, 321-02-18]

3.1.203
protective current transformer
a current transformer intended to transmit an information signal to protective and control devices

[SOURCE: IEC 60050-321: 1986, 321-02-19)

3.1.204
class P protective current transformer
protective current transformer without remanent flux limit, for which the saturation behaviour in the case of a symmetrical short-circuit is specified

3.1.205
class PR protective current transformer
protective current transformer with remanent flux limit, for which the saturation behaviour in the case of a symmetrical short-circuit is specified

3.1.206
class PX protective current transformer
protective current transformer of low-leakage reactance without remanent flux limit for which knowledge of the excitation characteristic and of the secondary winding resistance, secondary burden resistance and turns ratio, is sufficient to assess its performance in relation to the protective relay system with which it is to be used

3.1.207
class PXR protective current transformer
protective current transformer with remanent flux limit for which knowledge of the excitation characteristic and of the secondary winding resistance, secondary burden resistance and turns ratio, is sufficient to assess its performance in relation to the protective relay system with which it is to be used

Note 1 to entry: An increasingly number of situations occur where low DC currents are continuously flowing through current transformers. Therefore, in order to stop the current transformer from saturating, current transformers with air gaps, but with the same performance as Class PX, are used.

Note 2 to entry: The air gaps for remanence reduction do not necessarily lead to a high-leakage reactance current transformer (see Annex 2C).

3.1.208
class TPX protective current transformer for transient performance
protective current transformer without remanent flux limit, for which the saturation behaviour in case of a transient short-circuit current is specified by the peak value of the instantaneous error

3.1.209
class TPY protective current transformer for transient performance
protective current transformer with remanent flux limit, for which the saturation behaviour in case of a transient short-circuit current is specified by the peak value of the instantaneous error

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3.1.210
class TPZ protective current transformer for transient performance
protective current transformer with a specified secondary time-constant, for which the saturation behaviour in case of a transient short-circuit current is specified by the peak value of the alternating error component

3.1.211
selectable-ratio current transformer
current transformer on which several transformation ratios are obtained by reconnecting the primary winding sections and / or by means of taps on the secondary winding

3.3 Definitions related to current ratings

3.3.201
rated primary current
I_{pr}
value of the primary current on which the performance of the transformer is based

[SOURCE: IEC 60050-321:1986, 321-01-11, modified title, synonym and definition]

3.3.202
rated secondary current
I_{sr}
value of the secondary current on which the performance of the transformer is based

[SOURCE: IEC 60050-321:1986, 321-01-15, modified title, synonym and definition]

3.3.203
rated short-time thermal current
I_{th}
maximum value of the primary current which a transformer will withstand for a specified short time without suffering harmful effects, the secondary winding being short-circuited

[SOURCE: IEC 60050-321:1986, 321-02-22]

3.3.204
rated dynamic current
I_{dyn}
maximum peak value of the primary current which a transformer will withstand, without being damaged electrically or mechanically by the resulting electromagnetic forces, the secondary winding being short-circuited

[SOURCE: IEC 60050-321:1986, 321-02-24]

3.3.205
rated continuous thermal current
I_{cth}
value of the current which can be permitted to flow continuously in the primary winding, the secondary winding being connected to the rated burden, without the temperature rise exceeding the values specified

[SOURCE: IEC 60050-321:1986, 321-02-25]

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3.3.206
rated primary short-circuit current
I_{psc}
r.m.s. value of the a.c. component of a transient primary short-circuit current on which the accuracy performance of a current transformer is based

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Note 1 to entry: While I_{th} is related to the thermal limit, I_{psc} is related to the accuracy limit. Usually, I_{psc} is smaller than I_{th}.

3.3.207
exciting current
I_e
r.m.s. value of the current taken by the secondary winding of a current transformer, when a sinusoidal voltage of rated frequency is applied to the secondary terminals, the primary and any other windings being open-circuited

[SOURCE: IEC 60050-321:1986, 321-02-32]

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 addition of the following note:

Note 201 to entry: The current ratio error, expressed in per cent, is given by the formula:

$$\varepsilon = \frac{k_r I_s - I_p}{I_p} \times 100\ \%$$

where

k_r is the rated transformation ratio;
I_p is the actual primary current;
I_s is the actual secondary current when I_p is flowing, under the conditions of measurement.
An explicative vector diagram is given in 2A.1.

3.4.4
phase displacement
$\Delta\varphi$
The definition 3.4.4 of IEC 61869-1:2007 is applicable with the addition of the following note:

Note 1 to entry: An explicative vector diagram is given in 2A.1.

3.4.201
rated resistive burden
R_b
rated value of the secondary connected resistive burden in ohms

3.4.202
secondary winding resistance
R_{ct}
actual secondary winding d.c. resistance in ohms corrected to 75 ºC or such other temperature as may be specified

Note 1 to entry: R_{ct} is an actual value. It shall not be confused with the upper limit for R_{ct}, which can be specified otherwise.

3.4.203
composite error
ε_c
under steady-state conditions, the r.m.s. value of the difference between

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a) the instantaneous values of the primary current, and

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b) the instantaneous values of the actual secondary current multiplied by the rated transformation ratio,

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the positive signs of the primary and secondary currents corresponding to the convention for terminal markings

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Note 1 to entry: The composite error ε_c is generally expressed as a percentage of the r.m.s. values of the primary current:

$$\varepsilon_c = \frac{\sqrt{\frac{1}{T}\int_0^T (k_r i_s - i_p)^2 \, dt}}{I_p} \times 100\ \%$$

where

k_r is the rated transformation ratio;

I_p is the r.m.s. value of the primary current;

i_p is the instantaneous value of the primary current;

i_s is the instantaneous value of the secondary current;

T is the duration of one cycle.

For further explanation, refer to 2A.4.

[SOURCE: IEC 60050-321:1986, 321-02-26, modified note to entry]

3.4.204
rated instrument limit primary current
I_{PL}
value of the minimum primary current at which the composite error of the measuring current transformer is equal to or greater than 10 %, the secondary burden being equal to the rated burden

[SOURCE: IEC 60050-321:1986, 321-02-27]

3.4.205
instrument security factor
FS
ratio of rated instrument limit primary current to the rated primary current

Note 1 to entry: Attention should be paid to the fact that the actual instrument security factor is affected by the burden. When the burden value is significantly lower than rated one, larger current values will be produced on the secondary side in the case of short-circuit current.

Note 2 to entry: In the event of system fault currents flowing through the primary winding of a current transformer, the safety of the apparatus supplied by the transformer is at its highest when the value of the rated instrument security factor (FS) is at its lowest.

[SOURCE: IEC 60050-321:1986, 321-02-28, modified notes to entry]

3.4.206
secondary limiting e.m.f. for measuring current transformers
E_{FS}
product of the instrument security factor FS, the rated secondary current and the vectorial sum of the rated burden and the impedance of the secondary winding

Note 1 to entry: The secondary limiting e.m.f. for measuring current transformers E_{FS} is calculated as

$$E_{\mathrm{FS}} = FS \times I_{sr} \times \sqrt{(R_{ct} + R_b)^2 + X_b^2}$$

where: R_{b} is the resistive part of the rated burden;

X_{b} is the inductive part of the rated burden.

This method will give a higher value than the actual one. It was chosen in order to apply the same test method as used for protective current transformers. Refer to 7.2.6.202 and 7.2.6.203.

[SOURCE: IEC 60050-321:1986, 321-02-31, modified title, synonym and note to entry]

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3.4.207
rated accuracy limit primary current
value of primary current up to which the current transformer will comply with the requirements for composite error

[SOURCE: IEC 60050-321:1986, 321-02-29]

3.4.208
accuracy limit factor
ALF
ratio of the rated accuracy limit primary current to the rated primary current

[SOURCE: IEC 60050-321:1986, 321-02-30]

3.4.209
secondary limiting e.m.f. for protective current transformers
E_{ALF}
product of the accuracy limit factor, the rated secondary current and the vectorial sum of the rated burden and the impedance of the secondary winding

Note 1 to entry: The secondary limiting e.m.f for class P and PR protective current transformers E_{ALF} is calculated as

$$E_{\mathrm{ALF}} = ALF \times I_{sr} \times \sqrt{(R_{ct} + R_b)^2 + X_b^2}$$

where: R_{b} is the resistive part of the rated burden;

X_{b} is the inductive part of the rated burden.

3.4.210
saturation flux
Ψ_{sat}
maximum value of secondary linked flux in a current transformer, which corresponds to the magnetic saturation of the core material

Note 1 to entry: The most suitable procedure for the determination of the saturation flux Ψ_{sat} is given with the d.c. saturation method described in 2B.2.3.

Note 2 to entry: In the former standard IEC 60044-6, Ψ_s was defined as a knee point value, which characterized the transition from the non-saturated to the fully saturated state of a core. This definition could not gain acceptance because the saturation value was too low, and led to misunderstandings and contradictions. Therefore, it was replaced by Ψ_{sat}, which defines the condition of complete saturation.

3.4.211
remanent flux
Ψ_r
value of secondary linked flux which would remain in the core 3 min after the interruption of a magnetizing current of sufficient magnitude to induce saturation flux (Ψ_{sat})

3.4.212
remanence factor
K_R
ratio of the remanent flux to the saturation flux, expressed as a percentage

3.4.213
secondary loop time constant
T_s
value of the time constant of the secondary loop of the current transformer obtained from the sum of the magnetizing and the leakage inductances (L_s) and the secondary loop resistance (R_s)

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$$T_s = L_s / R_s$$

3.4.214
excitation characteristic
graphical or tabular presentation of the relationship between the r.m.s. value of the exciting current and a sinusoidal voltage applied to the secondary terminals of a current transformer, the primary and other windings being open-circuited, over a range of values sufficient to define the characteristics from low levels of excitation up to 1.1 times the knee point e.m.f.

3.4.215
knee point voltage
r.m.s. value of the sinusoidal voltage at rated frequency applied to the secondary terminals of the transformer, all other terminals being open-circuited, which, when increased by 10 %, causes the r.m.s. value of the exciting current to increase by 50 %

[SOURCE: IEC 60050-321:1986, 321-02-34]

3.4.216
knee point e.m.f.
e.m.f. of a current transformer at rated frequency, which, when increased by 10 %, causes the r.m.s. value of the exciting current to increase by 50 %

Note 1 to entry: While the knee point voltage can be applied to the secondary terminals of a current transformer, the knee point e.m.f. is not directly accessible. The values of the knee point voltage and of the knee point e.m.f. are deemed as equal, due to the minor influence of the voltage drop across the secondary winding resistance.