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TECHNICAL REPORT

Instrument transformers –
Part 100: Guidance for application of current transformers in power system protection

colour inside

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INSTRUMENT TRANSFORMERS –

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FOREWORD

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IEC TR 61869-100, which is a technical report, has been prepared by IEC technical committee 38: Instrument transformers.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
38/469/DTR	38/475A/RVC

Full information on the voting for the approval of this technical report 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.

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- withdrawn,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.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Since the publication of IEC 60044-6:1992[1], *Requirements for protective current transformers for transient performance*, the area of application of this kind of current transformers has been extended. As a consequence, the theoretical background for the dimensioning according to electrical requirements has become much more complex. For IEC 61869-2 to remain as user-friendly as possible, the explanation of the background information has been transferred to this part of IEC 61869.

1 Withdrawn and replaced by IEC 61869-2:2012.

INSTRUMENT TRANSFORMERS –

Part 100: Guidance for application of current transformers in power system protection

1 Scope

This part of IEC 61869 is applicable to inductive protective current transformers meeting the requirements of the IEC 61869-2 standard.

It may help relay manufacturers, CT manufacturers and project engineers to understand how a CT responds to simplified or standardized short circuit signals. Therefore, it supplies advanced information to comprehend the definition of inductive current transformers as well as their requirements.

The document aims to provide information for the casual user as well as for the specialist. Where necessary, the level of abstraction is mentioned in the document. It also discusses the question about the responsibilities in the design process for current transformers.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60255 (all parts), *Measuring relays and protection equipment*

IEC 60909-0:2016, *Short circuit currents in three-phase a.c. systems – Calculation of currents*

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

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

3 Terms and definitions and abbreviations

3.1 Terms and definitions

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

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

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

3.1.1
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

[SOURCE: IEC 61869-2:2012, 3.3.206]

3.1.2
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; IEC 61869-2:2012, 3.3.203]

3.1.3
initial symmetrical short circuit current
I''_k
r.m.s. value of the a.c. symmetrical component of a prospective (available) short-circuit current, applicable at the instant of short circuit if the impedance remains at zero-time value

[SOURCE: IEC 60909-0:2001, 1.3.5]

Note 1 to entry: While I_{th} is a basic parameter of a plant and of its components, I_{psc} is an accuracy requirement, and has a determining influence on the saturation behaviour of a current transformer. The protection system will ensure tripping at a current I''_k, which is usually lower than I_{th}. Depending on the protection requirement, a current transformer may saturate much before reaching I''_k. Therefore, in certain cases, I_{psc} may be much lower than I''_k.

3.1.4
primary current
I_p
current flowing through the primary winding of a current transformer

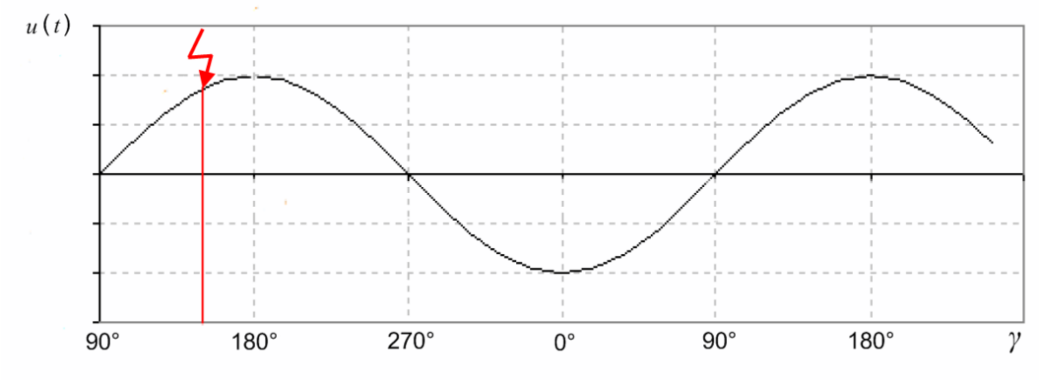
3.1.5
secondary current
I_s
current flowing through the secondary winding of a current transformer

3.1.6
angular frequency
ω
angular frequency of the primary current

3.1.7
time
t
time

3.1.8
phase angle of the system short circuit impedance
φ
phase angle of the system short circuit impedance

3.1.9
fault inception angle
γ
inception angle of the primary short circuit, being 180° at voltage maximum (see Figure 1)



Key

u primary voltage

γ fault inception angle

Figure 1 – Definition of the fault inception angle γ

3.1.10
minimum fault inception angle
γ_{m}
lowest value of fault inception angle γ to be considered in the design of a current transformer

3.1.11
alternative definition of fault inception angle
θ
inception angle of the primary short circuit, defined as $\gamma - \varphi$

3.2 Index of abbreviations

This table comprises Table 3.7 of IEC 61869-2:2012, complemented with the terms and definitions given in 3.1.1 to 3.1.11.

AIS	Air-Insulated Switchgear
ALF	Accuracy limit factor
CT	Current Transformer
CVT	Capacitive Voltage Transformer
E_{al}	rated equivalent limiting secondary e.m.f.
E_{ALF}	secondary limiting e.m.f. for class P and PR protective current transformers
E_{FS}	secondary limiting e.m.f. for measuring current transformers
E_{k}	rated knee point e.m.f.
f	frequency
F	mechanical load
F_{c}	factor of construction
f_{R}	rated frequency
F_{rel}	relative leakage rate
FS	instrument security factor
GIS	Gas-Insulated Switchgear
I''_{k}	Initial symmetrical short circuit current
$\hat{I}_{\mathrm{al}}$	peak value of the exciting secondary current at E_{al}
I_{cth}	rated continuous thermal current

I_{dyn}	rated dynamic current
I_e	exciting current
I_{PL}	rated instrument limit primary current
I_p	primary current
I_{pr}	rated primary current
I_{psc}	rated primary short circuit current
I_s	secondary current
I_{sr}	rated secondary current
IT	Instrument Transformer
I_{th}	rated short-time thermal current
i_{ε}	instantaneous error current
k	actual transformation ratio
k_r	rated transformation ratio
K_R	remanence factor
K_{ssc}	rated symmetrical short circuit current factor
K_{td}	transient dimensioning factor
K_{tf}	transient factor
K_x	dimensioning factor
L_{ct}	non-linear inductance of a current transformer
L_m	linearized magnetizing inductance of a current transformer
L1,L2,L3	designation of the phases in the electrical three-phase system
n_s	number of secondary turns
R_b	rated resistive burden
R_{ct}	secondary winding resistance
R_s	secondary loop resistance
S_r	rated output
t	time
t'	duration of the first fault
t''	duration of the second fault
t'_{al}	specified time to accuracy limit in the first fault
t''_{al}	specified time to accuracy limit in the second fault
t_{fr}	fault repetition time
T_p	specified primary time constant
T_s	secondary loop time constant
U_m	highest voltage for equipment
U_{sys}	highest voltage for system
VT	Voltage Transformer
$\Delta\varphi$	phase displacement
ε	ratio error
ε_c	composite error
$\hat{\varepsilon}$	peak value of instananeous error