



INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ITs and High Frequency Measurements: view and needs from standardisation

January 2025 – ADMIT Stakeholder Workshop

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**Chair of IEC TC38
Instrument Transformers**

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TC 38 Officers and Working Bodies

TC 38 Scope

Standardisation in the field of AC and/or DC current and/or voltage instrument transformers, including their subparts like (but not limited to) sensing devices, signal treatment, data conversion and analog or digital interfacing.

Secretary:	Filippo Frugoni (IT)
Chair:	Volker Leitloff (FR) Term 2017-08 – 2026-07
Vice-chair	Olga Petrova (RU) - terminology
IEC Officer:	Michael Safronov
IEC SPA:	Nadine Andrey
Members:	46 Members (28 P + 18 O)

Active WG/MT/PT

- **CAG**
- **2 MT, 9 WG (including 2 JWG),**
- **5 PT (including 4 in WG37)**

Liaison: 15 IEC, 3 Type A, 3 WG level
Participation in ACTAD



Overview of TC 38 Standards

IEC 61869

- **Parts 1-99: General parts and parts related to HV applications**
- **Parts 100-199: Technical Reports**
- **Parts 200-299: LV Instrument Transformers**
[<1kV ac and <1,5kV dc]

IEC 62689

- **Fault Passage Indicators (FPI)**

IEC 63253

- **Station Service Voltage Transformers (SSVT)**



TC 38 - Overview of Standards

IEC 61869 Parts 1-5 “Conventional” IT

Reference	Title	Comment
61869-1	General Requirements	Ed.2 - IS: 2023
61869-2	Additional Requirements for CT	IS: 2012 Ed2 MT 58
61869-3	Additional Requirements for Inductive VT	IS: 2012 Ed2 MT 58
61869-4	Additional Requirements for Combined IT	IS: 2012 Ed2 MT 58
61869-5	Additional Requirements for Capacitive VT	IS: 2012 Ed2 MT 58
61869-99	Glossary	IS: 2012



TC 38 - Overview of Standards

IEC 61869 Parts 6-13 Low Power IT

Reference	Title	Out	Comment
61869-6	Additional General Requirements for LPIT	D	deprecated
61869-7	Additional Requirements for Electronic VT	A/D	WG37 PT7/8 CD1 07/24
61869-8	Additional Requirements for Electronic CT	A/D	WG37 PT7/8 CD2 07/24
61869-9	Digital Interface for IT	D	IS: 2016 WG37: AMD1
61869-10	Additional Requirements for LP Passive CT	A	IS: 2018
61869-11	Additional Requirements for LP Passive VT	A	IS: 2018 ISH Sept 21
61869-12	Add. Req. for Combined Electronic IT / LPIT	A	after 7, -8
61869-13	SAMU (Stand Alone Merging Unit)	D	IS: 2021

Notes: Parts -1, -and 16 also apply to LPIT

Part -9: update required for consistency with IEC 61850 ed 2.1

IEC 61869-1:2023 General Requirements

5.5 Rated frequency (f_r)

The standard values of the rated frequency for AC applications are

16,7 Hz – 50 Hz – 60 Hz – 400 Hz.

5.7.3 Accuracy class extension for harmonics

Accuracy class extensions for harmonics are:

- WB0 extension for harmonic frequencies up to the 13th harmonic;
- WB1 extension for harmonic frequencies up to 3 kHz;
- WB2 extension for harmonic frequencies up to 20 kHz;
- WB3 extension for harmonic frequencies up to 150 kHz;
- WB4 extension for wide bandwidth applications up to 500 kHz.

- Accuracy classes defined for frequencies up to 500 kHz based on **amplitude and phase error**

Product standards

- update ongoing based on part-1 ed2
- **transient error limits** for protection accuracy classes
- In published standards: Tests covered, in general no specific procedure specified for higher frequencies

Table 7 – WB0 extension for harmonics

Accuracy class	Ratio error at low frequency		Ratio error at harmonics based on f_r				Phase error at low frequency	Phase error at harmonics based on f_r			
	%		%				Degrees	Degrees			
	DC ^a	1 Hz	2 nd to 4 th	5 th and 6 th	7 th to 9 th	10 th to 13 th	1 Hz	2 nd to 4 th	5 th and 6 th	7 th to 9 th	10 th to 13 th
0,1	+1 -100	+1 -30	±1	±2	±4	±8	±45	±1	±2	±4	±8
0,2 – 0,2 S ^b	+2 -100	+2 -30	±2	±4	±8	±16	±45	±2	±4	±8	±16
0,5 – 0,5 S ^b	+5 -100	+5 -30	±5	±10	±20	±20	±45	±5	±10	±20	±20
1 – 3 – 5	+10 -100	+10 -30	±10	±20	±20	±20	±45	±10	±20	±20	±20

^a DC coupling is allowed but not required.
^b The accuracy classes 0,2 S and 0,5 S apply only for current transformers.

Table 8 – Accuracy class extensions for wide bandwidth applications

Accuracy class	Ratio error at frequencies shown below			Phase error at frequencies shown below		
	%			Degrees		
WB1	$f_r < f \leq 1$ kHz	$1 < f \leq 1,5$ kHz	$1,5 < f \leq 3$ kHz	$f_r < f \leq 1$ kHz	$1 < f \leq 1,5$ kHz	$1,5 < f \leq 3$ kHz
WB2	$f_r < f \leq 5$ kHz	$5 < f \leq 10$ kHz	$10 < f \leq 20$ kHz	$f_r < f \leq 5$ kHz	$5 < f \leq 10$ kHz	$10 < f \leq 20$ kHz
WB3	$f_r < f \leq 20$ kHz	$20 < f \leq 50$ kHz	$50 < f \leq 150$ kHz	$f_r < f \leq 20$ kHz	$20 < f \leq 50$ kHz	$50 < f \leq 150$ kHz
WB4	$f_r < f \leq 50$ kHz	$50 < f \leq 150$ kHz	$150 < f \leq 500$ kHz	$f_r < f \leq 50$ kHz	$50 < f \leq 150$ kHz	$150 < f \leq 500$ kHz
0,1	±1	±2	±5	±1	±2	±5
0,2 – 0,2 S	±2	±4	±5	±2	±4	±5
0,5 – 0,5 S	±5	±10	±10	±5	±10	±20
1	±10	±20	±20	±10	±20	±20
Protection	±10	±20	±30	-	-	-

Table 9 – Harmonic requirements for protection accuracy classes

Ratio error at low frequency		Ratio error at frequencies and harmonics shown below, based on f_r		Phase error at low frequency	Phase error at frequencies and harmonics shown below, based on f_r	
%		%		Degrees	Degrees	
DC	1 Hz	1/3 rd component (16,7 Hz or 20 Hz)	2 nd to 5 th harmonic	1 Hz	1/3 rd component (16,7 Hz or 20 Hz)	2 nd to 5 th harmonic
+10 -100	+10 -30	±10	±10	-	±10	±10

Digitally interfaced Instrument Transformers

IEC 61869-1

- Requirements for anti-aliasing filter
- Definition of transfer function

Table 10 – Anti-aliasing filter requirements

Accuracy class	Anti-aliasing filter attenuation guarding frequencies up to 13 th harmonic $(f_s - 13 \times f_r \leq f < f_s - f_r)$	Anti-aliasing filter attenuation guarding the fundamental $(f_s - f_r \leq f)$
0,1	≥ 17 dB	≥ 34 dB
0,2	≥ 14 dB	≥ 28 dB
0,5	≥ 10 dB	≥ 20 dB
1	≥ 10 dB	≥ 20 dB
Protection classes	≥ 10 dB	≥ 20 dB

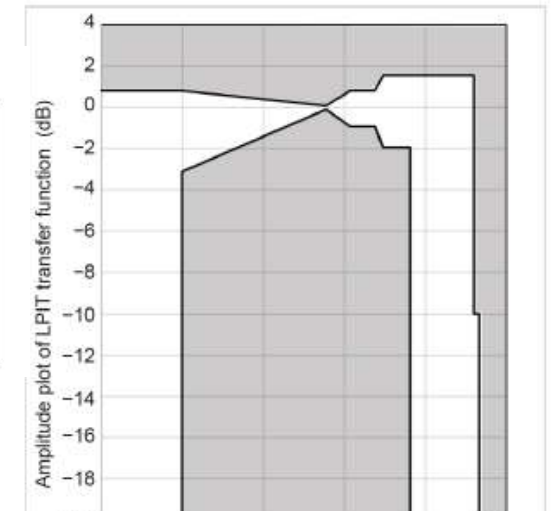


Table 902 – Standard sample rates

Digital output sample rates Hz	Number of ASDUs per frame	Digital output publishing rate frames/s	Remarks
4 000	1	4 000	For use on 50 Hz systems backward compatible with 9-2LE guideline.
4 800	1	4 800	For use on 60 Hz systems backward compatible with 9-2LE guideline, or 50 Hz systems backward compatible with 96 samples per nominal system frequency cycle.
4 800	2	2 400	Preferred rate for general measuring and protective applications, regardless of the power system frequency.
5 760	1	5 760	For applications on 60 Hz systems backward compatible with 96 samples per nominal system frequency cycle.
12 800	8	1 600	Deprecated, only for use on 50 Hz systems.
14 400	6	2 400	Preferred rate for quality metering applications, regardless of the power system frequency including instrument transformers for time critical low bandwidth d.c. control applications.
15 360	8	1 920	Deprecated, only for use on 60 Hz systems.
96 000	1	96 000	Preferred rate for instrument transformers for high bandwidth d.c. control applications.

IEC 61869-9

- Sample frequencies
- max: 96 kHz

WG 47: - Evolution of Instrument transformer requirements for the modern market (convenor Paulo Mazza)

- Structuration in several TT to investigate several technical aspects
- Aim : recommendations how to develop and implement requirements related to new needs in IEC TC38 standards

ID	Task Force	Task Force Leader
1	Accuracy vs. influencing Quantities	Lorenzo Peretto
2	Travelling Waves	Volker Leitloff
3	Use of Instrument Transformers for Power Quality measurement	Ivo Novakovic
4	Phasor Measuring Unit (PMU) - Synchrophasors application	Mario Luiso
5	Questionnaire	to be appointed
6	Asset management and online monitoring of ITs	Li Fuchao
7	Metrological stability	to be appointed
8	New rated values for low power output (< 1 VA) and low secondary current (< 1 A)	to be appointed
9	Configuration and design of HV ITs for DC applications in VSC converter substations	Wei Dong
10	Transient requirements for instrument transformers	Zoltan Roman
11	Ferroresonance in inductive VTs (to be set up for coordination with MT58/PT61869-3)	to be appointed coordinate with MT58/PT61869-3
12	Capacitive discharge test for VTs used to discharge lines with trapped charge	to be appointed coordinate with MT58/PT61869-3

Extended frequency range

PT 61869-106 : - Selection and interfacing of Instrument Transformers for wide bandwidth applications (convenor Wei Dong)

PT 61869-106

Selection and interfacing of Instrument Transformers for wide bandwidth applications

To draft a Technical Report covering the following topics:

- Selection of wide band measuring system according to the requirements of the application
- Interfacing method between instrument transformers and measuring systems
- Matching criteria between measuring system types and IT types and classes according to the relevant application.
- The considered applications demanding wide bandwidth measuring systems are:
 - AC applications: power quality monitoring in renewable energy connected stations, energy storage stations, electric railway power supply stations.
 - DC applications: Line fault identification and rapid protection in LCC-HVDC, VSC-HVDC and DC grid.
 - Applications where composite signals need to be measured. Such as the measuring point between the transformer and the converter valve in a converter station.
 - Other applications.

Letter from TC 38 to ERAMET regarding ADMIT project (2022)

HF related aspects to be evaluated for implementation in TC38 standards

- Power Electronic Converters [PT 106]
- Power Quality measurements [WG47 TF3]
- Measurement methods, test procedures, [product standards]
- Instrumentation and uncertainty evaluation [WG47 TF13, JWG55]

The proposal responds to the following aspects of interest for the standards covered by IEC TC 38:

1. Definition of Instrument Transformer accuracy requirements and tests for the frequency range up to 150 kHz to be used for the development and extension of IEC 61869 standard series.
2. Investigation and definition of traceable calibration services for voltages and currents in this frequency range for Instrument Transformers with analog outputs.
3. Prospective results evaluating the possibility of extension of these aspects to higher frequency ranges.

Published Instrument Transformer Standards

- Accuracy classes defined based on phase and amplitude error up to 500 kHz in IEC 61869-1 ed2
- HF requirements covered **only for LPIT (based on IEC 61869-6)** in published product standards of IEC 61869 series
- No specific requirements for HF test methods
- Requirements for transient phenomena only for protection classes

Open questions and issues

- HF and harmonic requirements will be included in product standards ed2 under development
 - by default based on part-1 ed2
 - any recommendations for complements ?
 - link with transient accuracy requirements ?
 - harmonic / “intra-harmonic”
- HF Test procedures
- Calibration of HF test systems
- Which frequency range and accuracy requirements are needed for the different applications?
- Need for
 - requirements covering superposition of several frequencies ?
 - specific requirements for transient phenomena ?
 - Specific requirements for HF monitoring applications beyond actual PQ
- HF requirements for Instrument Transformers with digital output

Use of ADMIT results