IEC Committees towards functional interoperability for IEC 61850 based protection and automation applications

ENERGIFORSK
Program Digitalisering & IT-säkerhet
IEC61850 nätverk 2019

Nätverksträff I

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Stockholm 24 maj 2019

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What is functional interoperability ?

Functional interoperability between two units
is when they
Exchange information to each other
(have the same communication protocol)

and

have a common understanding
about
the exchanged message

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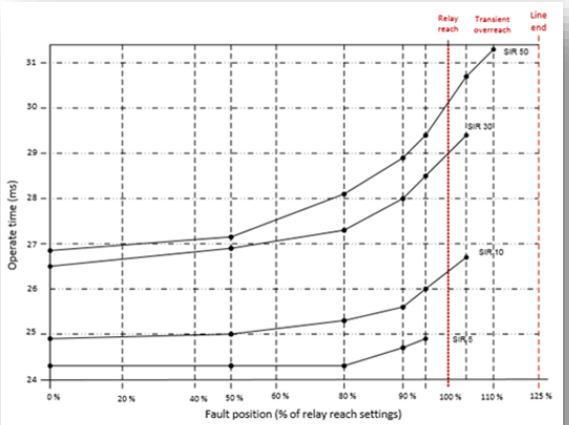
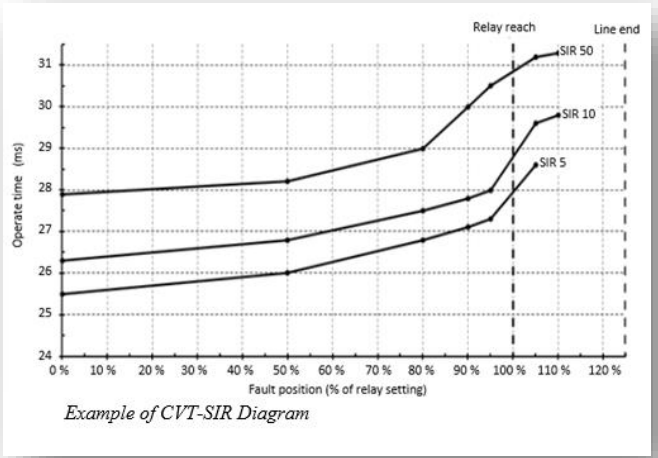
What is functional interoperability ?

Can I connect ANY any VT (conventional) to my protection relay and ensure that the protection functionality is achieved?

CVTs have different performances (transient performances) than magnetic VTs. This has impact for instance on the operate time and transient overreach of distance protection relays.



Example of SIR diagram according to IEC 60255-121



Example of CVT-SIR Diagram

TC 95 Measuring relays and protection equipment

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What is functional interoperability ?

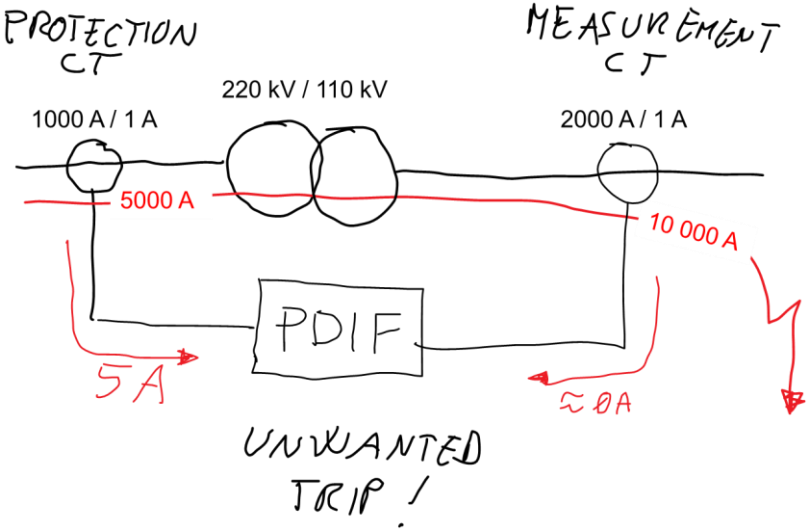
Can I connect ANY any CT (conventional) to my protection relay and ensure that the protection functionality is achieved?

CTs need to be validated in terms of ”knee point voltage”, with fault current calculations based on the application of the protection relay (Current Transformer Requirements)

$$E_{alreq} = \frac{I_f}{I_{pr}} \cdot K_{tot} \cdot I_{sr} \left(R_{ct} + R_{ba} \right)$$

where

I_f	is the maximum primary fault current for the considered fault case
I_{pr}	is the CT rated primary current
I_{sr}	is the CT rated secondary current
K_{tot}	is the total over-dimensioning factor (including the transient dimensioning factor and the remanence dimensioning factor)
R_{ct}	is the CT secondary winding resistance
R_{ba}	is the total resistive burden, including the secondary wires and all relays in the circuit.



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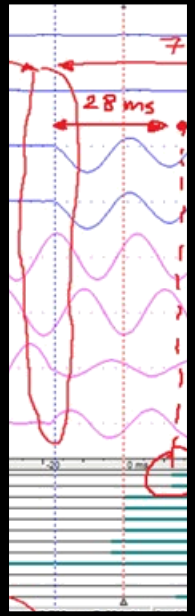
Why is it so difficult?



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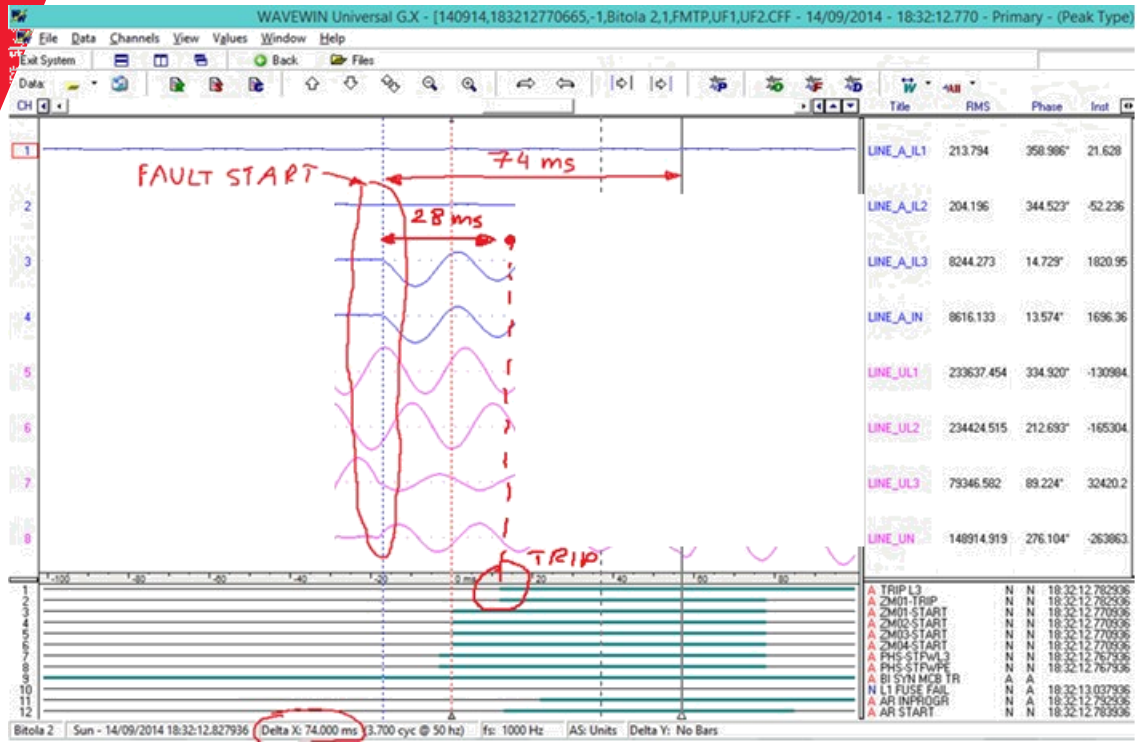

The protection relay takes the decision during the power system TRANSIENT!

VERY LITTLE TIME AND VERY LITTLE AMOUNT OF INFORMATION, NO MATTER HOW FAST WE SAMPLE THE SYSTEM!

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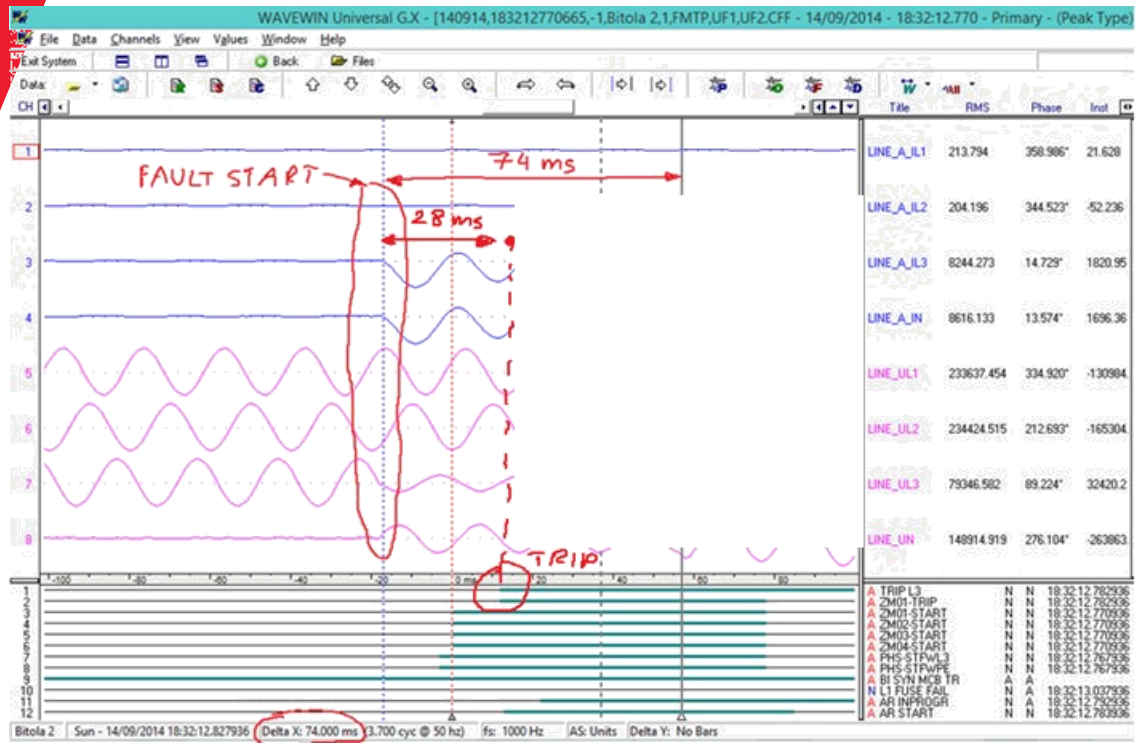
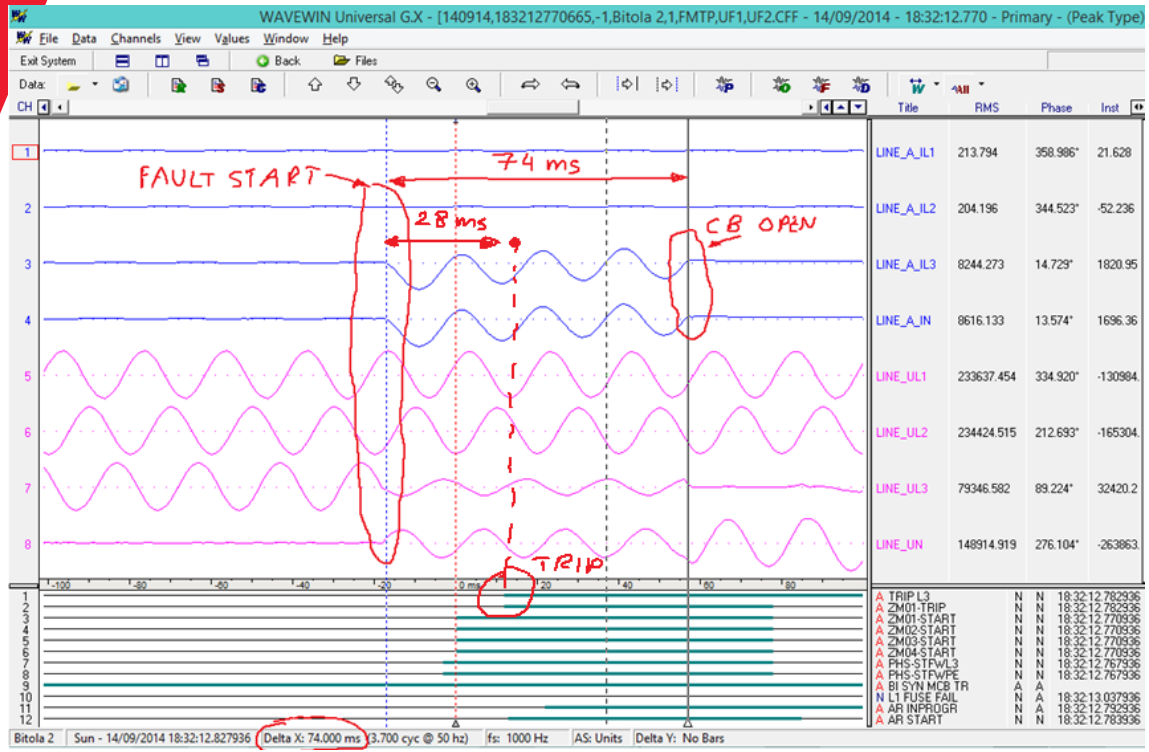
Why is it so difficult?



The Pre-fault information can help sometimes..

From pre-fault information we can better estimate several situations like Switch Onto Fault, Direction of the fault…

Why is it so difficult?



The **post-faut information** help for post-fault analysis…

The decision has already been taken!

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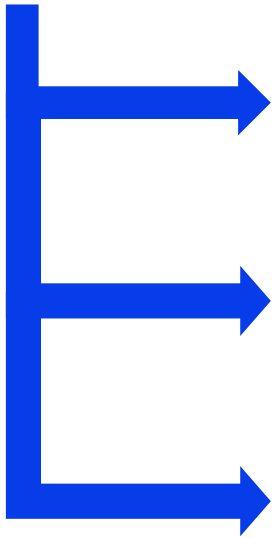
Relevant IEC Committees for IEC 61850 Protection Applications

TC 57 Power systems management and associated information exchange

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools



TC 38 Instrument transformers

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools

TC 95 Measuring relays and protection equipment

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools

TC 17 High-voltage switchgear and controlgear

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools

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IEC 61850 “splits” the protection relay

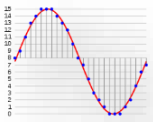
PRIMARY QUANTITIES (I, U)

CT, VT

IEC 61869-2, 3

SAMU

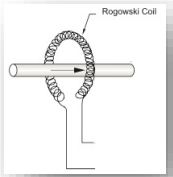
IEC 61869-13



IEC 61869-6,9

DIGITAL INTERFACE, SV

LPIT



IEC 61869-7,8

COMM NETWORK

User Specific Design

P&C IED

IEC 60255-1xx (Conventional)

IEC 60255-1xx (IEC 61850)

TC 38

Instrument Transformers

IEC 61869 series

TC 95

Measuring relays and protection equipment

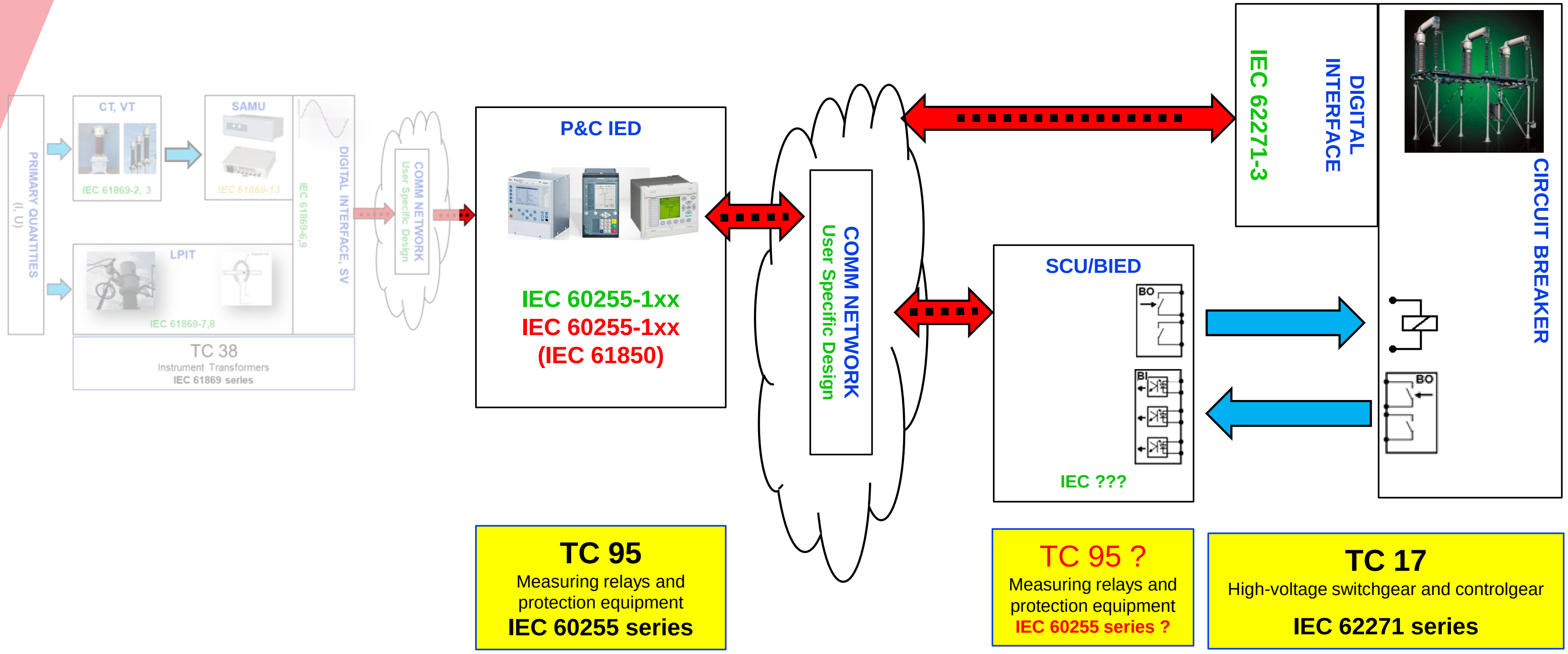
IEC 60255 series

IEC 61850 communication

Wired signal

Megger Power on

IEC 61850 “splits” the protection relay

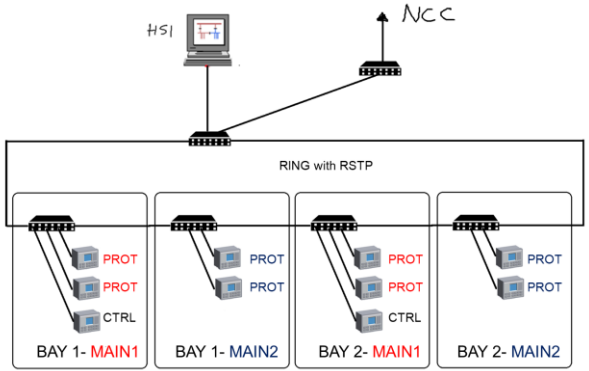


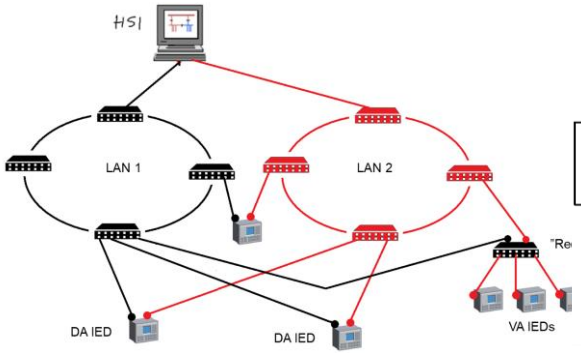
IEC 61850 communication

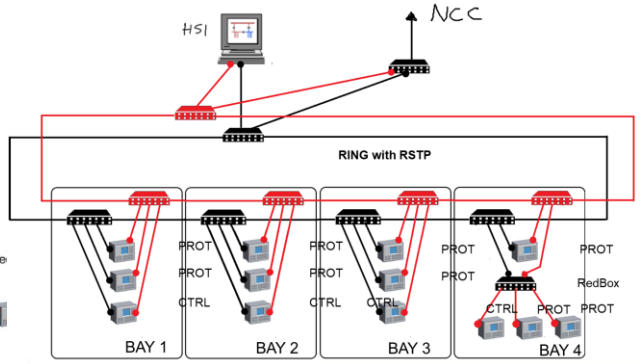
Wired signal

The Communication Network

- Only partially covered by IEC 61850 standards: technical reports, guidelines, best practices
- No general statements over performances are possible as they are very much depending on the architecture
- Responsibility on the architecture choice is on the user/ system integrator (customer requirements, engineering solutions)

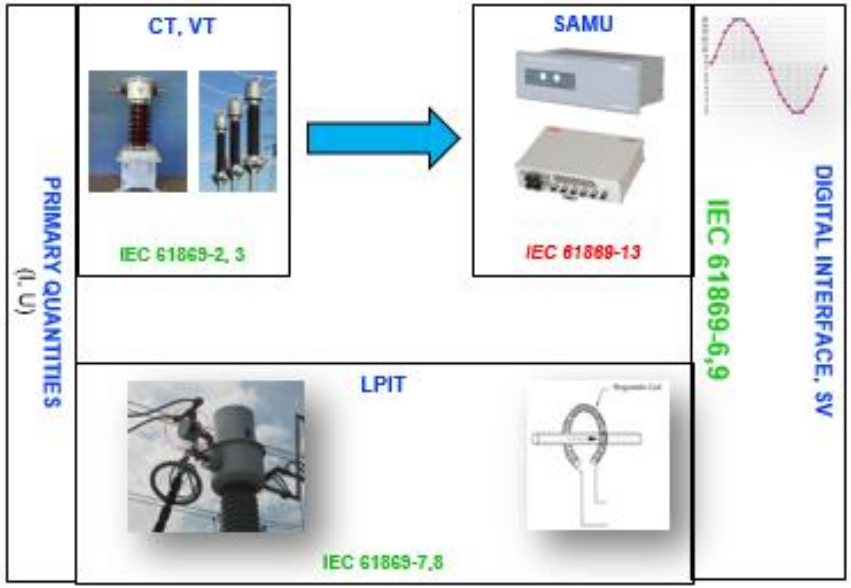






TC 38 and IEC 61869 Series

IEC Committee TC 38



- Standardisation of Instrument Transformers (CTs, VTs, LPIT)
- Standardisation of SV profiles for Instrument Transformers
- Standardisation of Transient Performances of MUs, SAMUs

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TC 38 and IEC 61869 Series

IEC 61869-9: Instrument Transformers - Part 9: Digital interface for instrument transformers

Project number Numéro de projet	IEC 61869-9 Ed.1.0
IEC/TC or SC: **38** CEI/CE ou SC:	Secretariat / Secrétariat **Italy**

Approved May 2016

"Already"
2 years old!

PROTECTION

Legacy "9-2 LE"

PREFERRED FROM "NOW"!
Sampling rate = 4800 Hz always

Legacy "9-2 LE" PQ 50 Hz

Legacy "9-2 LE" PQ 60 Hz

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.

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TC 38 and IEC 61869 Series

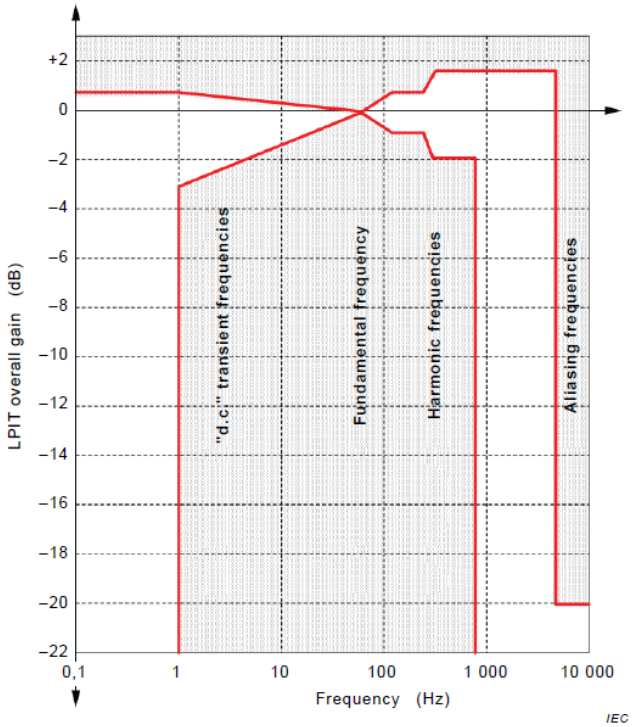
IEC 61869-6

Edition 1.0 2016-04

Instrument transformers –
Part 6: Additional general requirements for low-power instrument transformers

- Defines the transient response (transfer function) of LPIT / Merging Units / SAMU. **Approved.**
- Defines the requirements for **ratio error and phase error** in case of harmonics and sub harmonics for protective purposes.

- For SAMU: IEC 61869-13. Expected release: 2020 (accuracy classes, input CTs saturation aspects)



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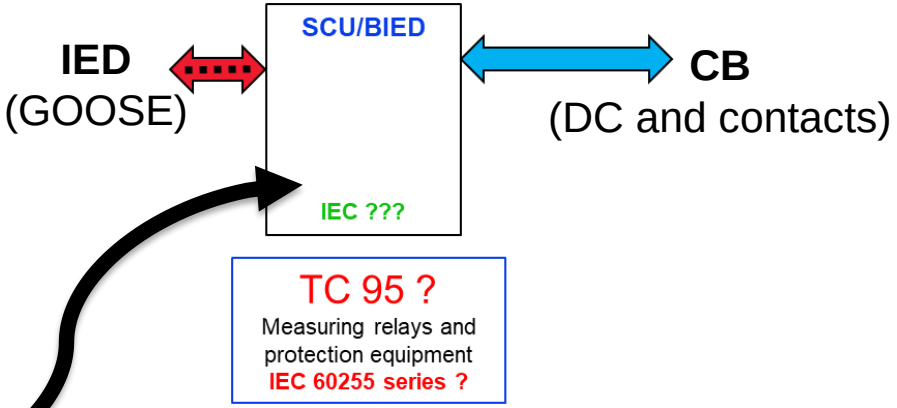
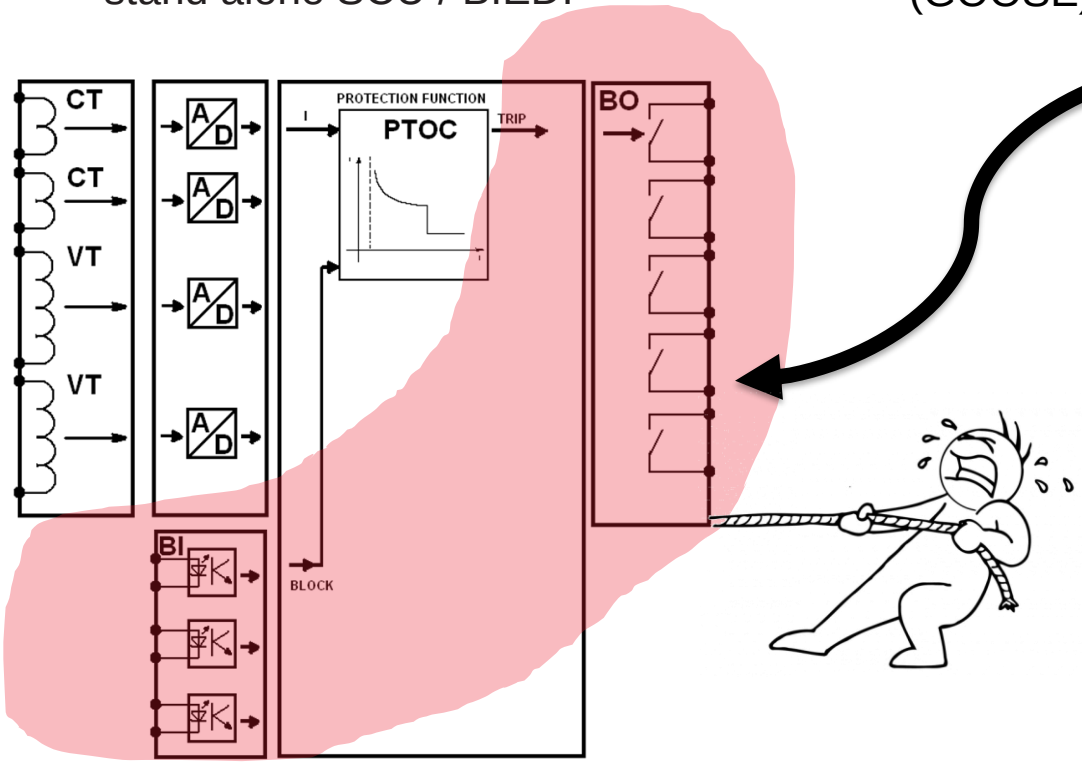
SCU / BIED Binary Inputs and Outputs Interface

- No applicable standard is available for stand alone SCU / BIED.





- Breaking capacity of the contacts
- Making capacity of contacts
- Latency of contacts
- Latency of Bis / Debouncig filters

TC 17 and IEC 62217 Series

TC 17 High-voltage switchgear and controlgear

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Tools

IEC 62271-3:2015

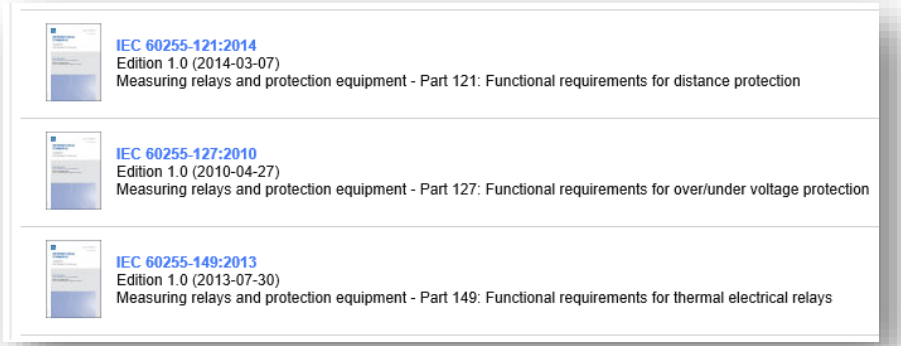
High-voltage switchgear and controlgear - Part 3: Digital interfaces based on IEC 61850

TC 17 | Additional information

- IEC 61850 modelling (LNs) for the Circuit Breaker XCBR, XSWI… (no CSWI)
- Timing requirements
- Communication access points

TC 95 and IEC 60255 Series

- Relay standards are under the series IEC 60255-1xx



IEC Committee TC 95 MT4 M

- Definition of relay performances
- Standardized tests to assess relay performance
- Standardized methods to report the results
- Minimum requirements for type testing
- Mandatory manufacturer declaration of CT dimensioning formulae
- Consider impact of IEC 61850 on relay behavior

(partially, today)

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TC 95, IEC 60255 Series and IEC 61850

What IEC 60255-1xx series covers TODAY about IEC 61850:

- The Operate Time shall be declared with “contact” and with “IEC 61850 GOOSE”

6.3.5.4 Reporting of typical operate times

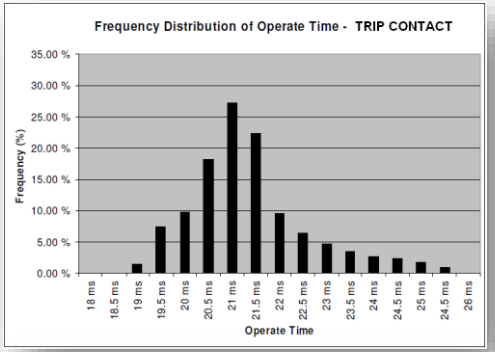
The manufacturer shall report the histograms and the calculated mode, median and mean, when stating the typical operate time of the distance protection function.

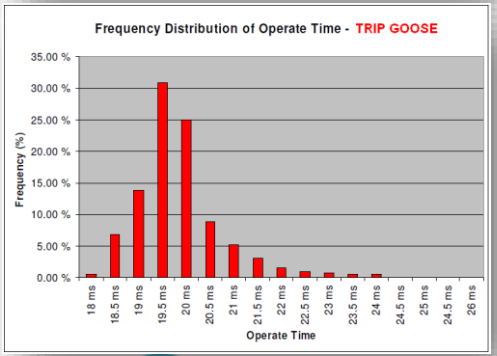
The typical operate times shall be published for the selected frequency and selected rated current of the protection relay.

Operate media (trip media)

The manufacturer shall declare with which output the operate time has been measured (trip binary output contact, or solid state output, or GOOSE message of the IEC 61850 series). If the relay can provide different output media, then the manufacturer shall declare how the SIR diagrams are affected.

From IEC 60255-121:2014





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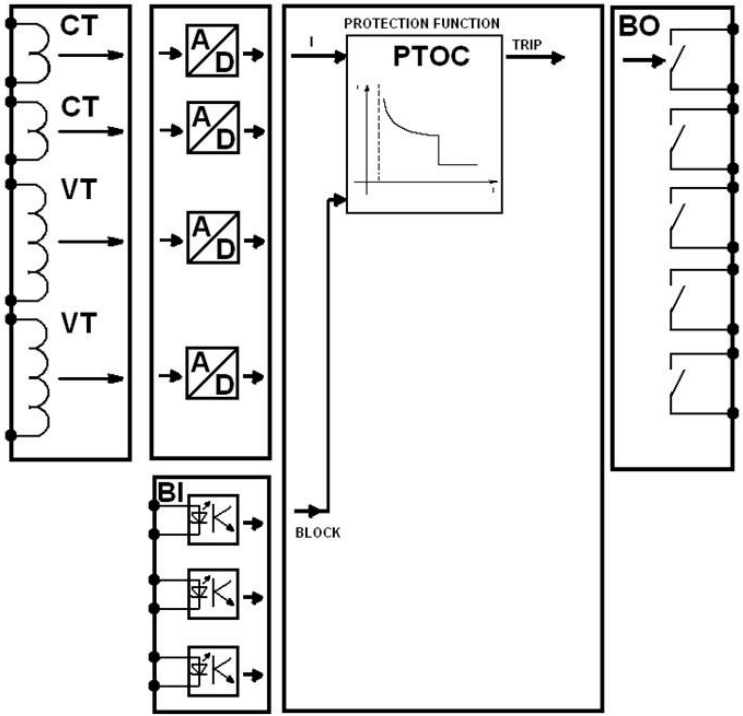
TC 95, IEC 60255 Series and IEC 61850

What is the principle of the testing in TODAY´s 60255-1xx series?

- The tests are mainly referred to the “conventional” representation of the protection relay:



- The tests described are made for applications when conventional current transformers are directly connected to the protection relay. For process bus applications, these tests should be adapted by mutual agreement of all of the parties involved.

TC 95, IEC 60255 Series and IEC 61850

CT Requirements in today's IEC 60255-1xx series

- The 60255-1xx series details how relay manufacturers shall declare the requirements for the CT sizing

$$E_{alreq} = \frac{I_f}{I_{pr}} \cdot K_{tot} \cdot I_{sr} \left(R_{ct} + R_{ba} \right)$$

- Users are able to verify that the used CTs are ok for the given application, or are able to size them in the initial project phase (from IEC 60255-121).

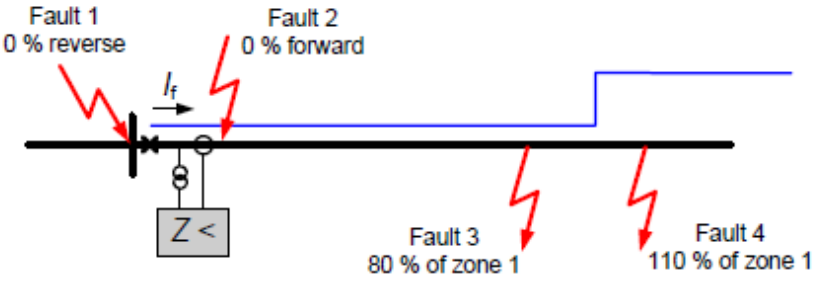


Figure F.1 – Fault positions to be considered

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Characteristic of the analog acquisition chain

Questions to be considered for full IEC 61850 implementation in relay standards

- TC 95 may require relay manufacturers to declare criteria to "select the correct Merging Unit" depending on the application, as today it is done for CTs. Definition of accepted pattern of the Transfer Function? (see IEC 61869-6, TC 38)
- What about the SV profile?
  Relay manufacturer shall also describe the profiles they can accept (see IEC 61869-9, TC 38)
- Other requirements from special applications?
  Jitter of time delay of the Sampled Values?
  Number of accepted missing samples?

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TC 95, IEC 60255 Series and IEC 61850

Characteristic of the analog acquisition chain

How to handle the “quality”?

- GOOSE and SV signals have a “quality attribute” from the publisher.
  What to do if the quality is “not good” in the receiving protection IED?

  - Blocking signal (invalid)
  - Current or voltage signal (out of range)

All these “application issues” must be defined and tested!

IEC 61850 says “process as questionable”…
what does it mean for ”us” (eg blockig signal)?

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Who is trying to answer all these questions?

INTERNATIONAL ELECTROTECHNICAL COMMISSION

TECHNICAL COMMITTEE 95: MEASURING RELAYS AND PROTECTION EQUIPMENT

Creation of a new Ad hoc Group (AHG 3), "Use case of digital sampled values instead of analog input", in response to the decision taken at the TC 95 plenary meeting in Paris (2016-10-21)

TC 95 – AHG 3

Report to TC95 given in Autumn 2018

Paris 2018

Nanjing 2018

Vienna 2019

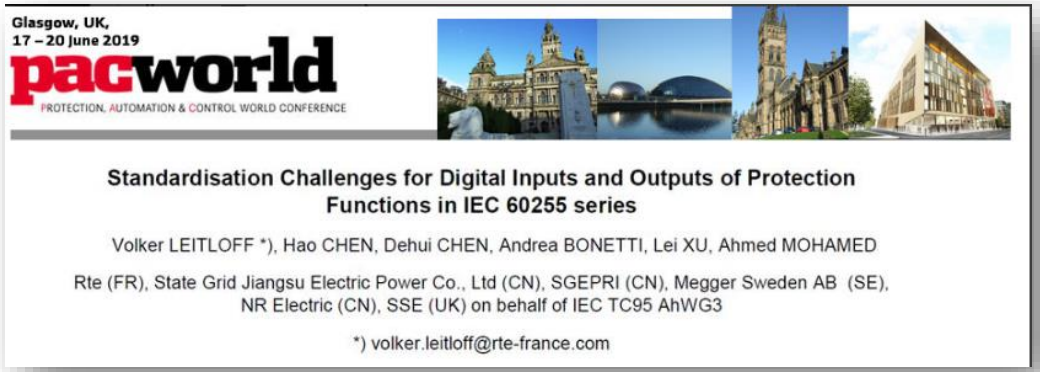
Work in progress from the Ad Hoc Group 3

Summary: Outcome from the Ad Hoc Group 3:

- Some definitions applicable for protections with analog inputs will need to be adapted/modified:
  - effective range, operative range, accuracy, rated quantities…
- New notions and requirements will be defined:
  - behavior in case of missing GOOSE / SV
  - behavior in case of "non good" quality for published data
  - behavior in case of lack of time synchronization
- Inputs to TC 95 for new requirements in the existing parts of IEC 60255 series
- Inputs/Recommendations to TC 95 for new general parts to the IEC 60255 series:
  - accuracy and ranges definitions
  - requirement for a new part for SCU / BIED
- Inputs/Recommendations to TC 38 (IEC 61869 series)
- Inputs/Recommendations to TC 17 (IEC 62271 series)
- **Final Technical Report**

From TC 95/AHG 3 to TC 95/WG 2

- Report to TC 95 done in autumn 2018.
- Ad Hoc Working Group 3 is, since March 2019, TC 95/WG 2
- Work continues, paper will be presented at PAC World, Glasgow, June 2019


Glasgow, UK,
17 – 20 June 2019
pacworld
PROTECTION, AUTOMATION & CONTROL WORLD CONFERENCE

Standardisation Challenges for Digital Inputs and Outputs of Protection Functions in IEC 60255 series

Volker LEITLOFF *), Hao CHEN, Dehui CHEN, Andrea BONETTI, Lei XU, Ahmed MOHAMED

Rte (FR), State Grid Jiangsu Electric Power Co., Ltd (CN), SGEPRI (CN), Megger Sweden AB (SE), NR Electric (CN), SSE (UK) on behalf of IEC TC95 AhWG3

*) volker.leitloff@rte-france.com

TC 95 Measuring relays and protection equipment

Scope | Structure | Projects / Publications | Documents | Votes | Meetings | Collaboration Platform

Subcommittee(s) and/or Working Group(s) > TC 95/WG 2

WG 2 Convenor & Members

Convenor	National Committee
Mr Volker LEITLOFF	FR

Member	National Committee
Mr Marc Achterkamp	NL
Mr Andreas Aichhorn	AT
Mr C.P. Awasthi	IN
Mr Jörg Blumschein	DE
Mr Andrea Bonetti	SE
Mr Carl Byman	SE
Mr Dehui CHEN	CN
Mr Hao Chen	CN
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Mr Frej Suomi	FI
Mr Yi Tang	CN
Mr Dustin Tessier	CA
Mr Guillaume Valembois	FR
Mr Lei Xu	CN

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Thank you!

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question