22NRM06 ADMIT

Characterisation of AC and DC MV instrument transformers in extended frequency range up to 150 kHz

METROLOGY PARTNERSHIP | EURAMET

ADMIT
AC & DC High Frequency Instrument Transformers

Project aims, challenges and work plan overview

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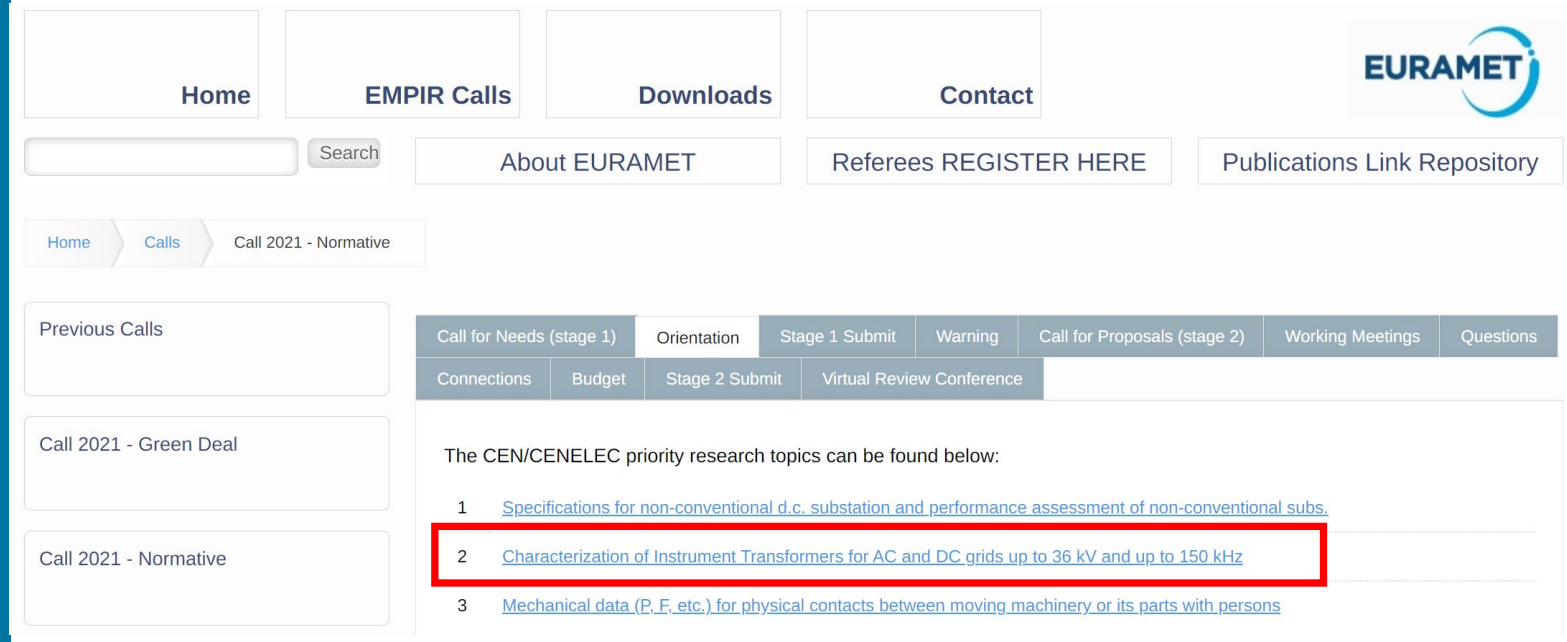
Acknowledgement

The project 22NRM06 ADMIT has received funding from the European Partnership on Metrology, co-financed by the European Union's Horizon Europe Research and Innovation Programme and by the Participating States.

Standardization Needs

- Standardization needs from IEC TC38 sent to STAIR EMPIR and published on EURAMET website



Version 7 – 8 July 2020
See : ftp://ftp.cencenelec.eu/EN/ResearchInnovation/STAIR/STAIR-EMPIR-needs/EMPIR_responseform.docx

CEN CENELEC

RESEARCH AND STANDARDISATION

RESPONSE FORM for Standardisation groups

Opportunity for standardisation to contribute to the *European Partnership on Metrology EPM* under Horizon Europe

Objective: to collect standardization needs and suggestions to develop research projects in testing and measurements for the upcoming European Partnership on Metrology (EPM) calls in 2021

Deadline for the consultation: **11 December 2020**.

Source of the identified need (identification of TC, WG, etc, incl. title)	☐ CEN/TC 0/WG 0 / ☐ CLC/TC 0/WG 0 ☐ ISO/TC 0/SC 0 / WG 0 / ☒ IEC/TC 38/SC 0 / WG 0 ☐ Other, namely *Identification, Title*
European entity responsible for submission of the need	*CEN/CLC TC 38* *Instrument Transformers*
Person that can be contacted for more detail	*Filippo Frugoni* *filippo@frugoni.it* *+39 049 5384606* *Italy*
Title:	*Characterization of Instrument Transformers for AC and DC grids up to 36 kV and up to 150 kHz*
Unaddressed need	*Traceable measurement methods and instrumentation for accurate characterization of Instrument Transformers used to measure disturbances up to 150kHz in Medium Voltage AC and DC grids*

Unaddressed standardization needs

- IEC TC 38 asked for scientific research to address the specific standardization need

Currently
no standard fully covers this topic!!

- Traceable measurement methods and instrumentation for accurate characterization of **Instrument Transformers** used to measure disturbances up to **150 kHz** in **Medium Voltage AC** and **DC** grids

Measurement and industrial needs

CAUSES

- **Switching power converters**, both generators and loads
  - Switching frequencies
  - Low voltage ~ 1MHz @ ~ 1W & 230V
  - **Medium voltage** ~ 10kHz @ ~ 100kW & 10kV
- Switching behaviour originates harmonics of the switching fundamental tone (~ 10kHz) up to **hundreds of kilohertz**
- These tones are **not synchronous** with the power frequency (50/60 Hz)

PROBLEMS!!

- Interfere with Power Line Communication -> Failure of **grid automation** and **meter reading**
- High Frequency -> Increase Losses -> Reduce Equipment Life -> **More Economical Losses**
- Couple with **control system** of inverters -> Possible local blackouts

Over 9 kHz....

- To avoid disasters, it is of vital importance to measure emissions, at least **up to 150 kHz**, in LV but **also in MV grids**
- ITs are **necessary** for these kinds of measurements
- Recently, an Italian DSO required LPITs up to **800 kHz**!!
- Currently, **NO ONE** around the world is able to verify IT accuracy up to so high frequency

NEEDS!!

Project aims

- Metrological framework to allow the accuracy verification of Instrument Transformers for AC & DC Medium Voltage grids up to 150 kHz
  - Performance requirements, accuracy parameters, waveforms
  - Uncertainty evaluation
  - Voltage generation and measurement
  - Current generation and measurement
  - Simplified procedures for calibration laboratories
  - Material for Standardization

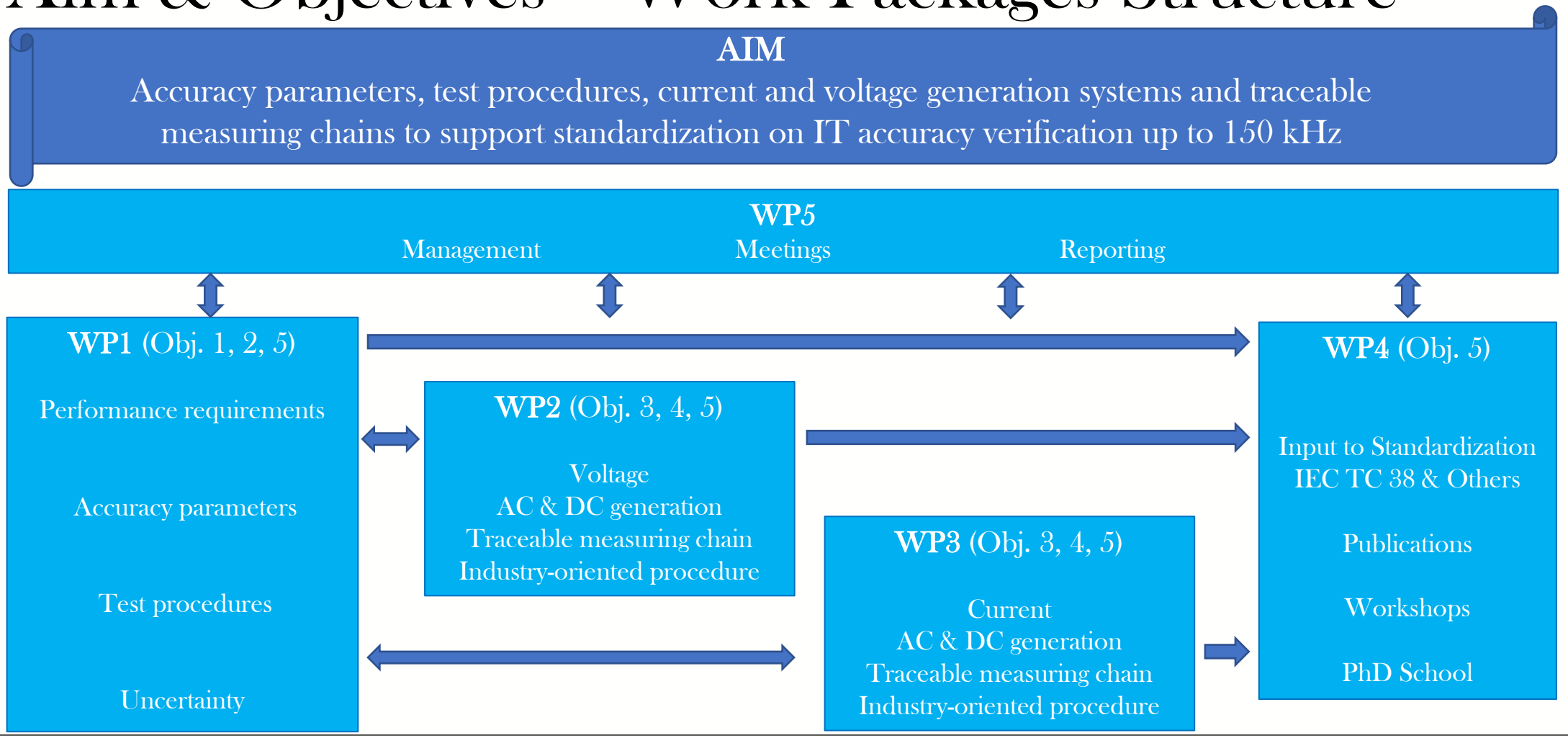
Objectives

1. To identify **performance requirements** both for Instrument Transformers as well as for the measuring instruments connected to them, based on disturbances in AC and DC MV grids (system voltage < 36 kV) and on future measurement needs in the frequency range up to 150 kHz.
2. To establish **suitable parameters** for the definition of the **accuracy** of voltage and current transformers in the frequency range up to 150 kHz. To define suitable **calibration conditions** and procedures for the accuracy evaluation.
3. To facilitate the laboratory set up to **generate test voltage** (AC or DC at <36 kV system voltage) and **test current** (AC or DC at <2 kA). Preference should be for generation of the power frequency quantity with superimposed components with frequencies **up to 150 kHz**, but at a fraction of the magnitude of the power frequency components.
4. To develop **reference measuring systems** for the calibration of Instrument Transformers in the frequency range up to 150 kHz at voltage level up to 36 kV system voltage and current levels up to 2 kA and to develop traceable calibration chains for these new systems.
5. To contribute to a revision of written standards by providing the **data, methods, guidelines and recommendations**, which are necessary for the accuracy verification of Instrument Transformers used up to 150 kHz, to **IEC TC 38 Instrument Transformers**. Outputs should be in a form that can be incorporated into standards (IEC 61869 standard family) at the earliest opportunity and communicated through a variety of media to the standards community and to end users (Transmission System Operators, Distribution System Operators, customers). In addition, to interact with the **European Metrology Network on Smart Electricity Grids**.

Work packages

1. Performance requirements, parameters and test procedures for accuracy evaluation
   - Objectives 1 & 2
2. Infrastructure for voltage generation and traceable measurement chains
   - Objectives 3 & 4 (voltage)
3. Infrastructure for current generation and traceable measurement chains
   - Objectives 3 & 4 (current)
4. Creating impact
   - Objective 5

Aim & Objectives – Work Packages Structure



Excellence and Progress beyond the state of the art

STATE OF THE ART

• IT ratio and phase error • Test procedures • Uncertainty Standardized only @DC or @AC 50/60 Hz	Voltage generation and measurement • AC, 30 kV, 9 kHz • DC, 3 kV, 5 kHz	Current generation and measurement • AC, 2 kA, 9 kHz • DC, 600 A, 5 kHz	IEC TR 61869-103 (ITs for PQ measurement) IEC 61000-4-30 PQ measurements up to 150 kHz (doesn't care of ITs)

BEYOND STATE OF THE ART

WP1	WP2	WP3	All WPs
• Accuracy Parameters • Test procedures • Uncertainty evaluation From DC up to 150 kHz	Voltage generation and measurement • AC or DC, 36-50 kV, 150 kHz • New CMCs	Current generation and measurement • AC or DC, 2 kA, 150 kHz • New CMCs	Reference procedures Industrial procedures For IT accuracy verification up to 150 kHz To IEC TC 38 and other TCs

Simplified calibration methods

A2.3.5 M36	**Submission of a joint paper** A paper dealing with industry-oriented test procedure for the accuracy evaluation of VTs in the frequency range up to 150 kHz will be jointly prepared by METAS with the support of ARTECHE, FFII, LNE, RSE, SUN and UNIBO, and submitted to an open-access journal.	**METAS,** ARTECHE, FFII, LNE, RSE, SUN, UNIBO

- VT simplified calibration method

A3.3.5 M36	**Submission of a joint paper** A paper dealing with industry-oriented test procedure for the accuracy evaluation of CTs in the frequency range up to 150 kHz will be jointly prepared by METAS with the support of ARTECHE, FFII, RISE, SUN, UNIBO, UNIGE, VTT and VSL and submitted to an open-access journal.	**METAS**, ARTECHE, FFII, RISE, SUN, UNIBO, UNIGE, VTT, VSL

- CT simplified calibration method

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