



“TrafoLoss”: Loss Measurement system instrumentation – voltage transformer

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Stakeholder workshop

17 July 2021

Webmeeting





Project goal



- Develop a voltage transformer prototype for highly accurate measuring system used for loss measurement of power transformer and reactors at very low power factor
- Target accuracy was $40 \mu\text{V/V}$ and $25 \mu\text{rad}$ at voltage level up to 230kV
- Target accuracy related to power is better than $50 \mu\text{W/VA}$, at voltage levels of up to at least 230 kV

Ratio uncertainty	Phase displacement uncertainty
$40 \mu\text{V/V}$	$25 \mu\text{rad}$

Accuracy	Power factor
$50 \mu\text{W / VA}$	Any
$1000 \mu\text{W / W}$ or 0.1%	0.05
$5000 \mu\text{W / W}$ or 0.5%	0.01

EMPIR



The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States





Construction of voltage transformer, his standard and variable compensation and Mbox



Up to 230 kV

Design:

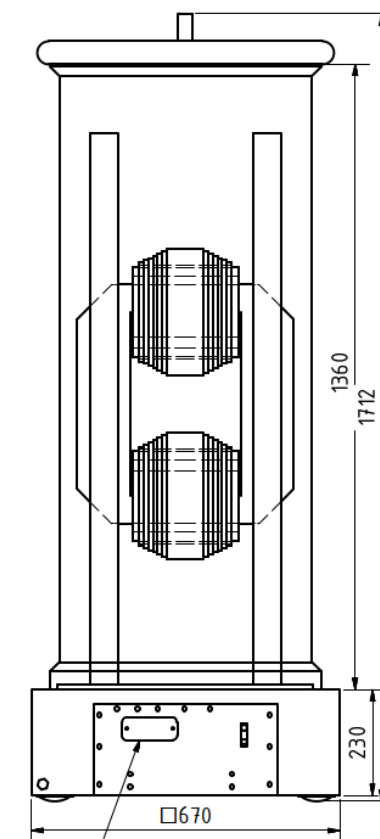
- Improved version of existing design brought two passive compensation
- Easy to scale up the voltage, without any error trade off related to design.
- Design characteristics in terms of accuracy are:
 - Naturally small ratio and angle error
 - Standard error compensation with passive elements (sets the error around zero over the entire range)
 - Variable error compensation also with passive elements (makes natural compensation, but with different amount over the entire measuring range)
- Design with electronic Box for digital conversion. These box are generally part of system which ultimately serve to determine the measuring losses
- Box have possibility of digital error compensation/correction

Voltage transformer

Up to 100 kV



Mbox



Voltage Measuring Box (Voltage channel)

Standard and variable compensation are build in fundation



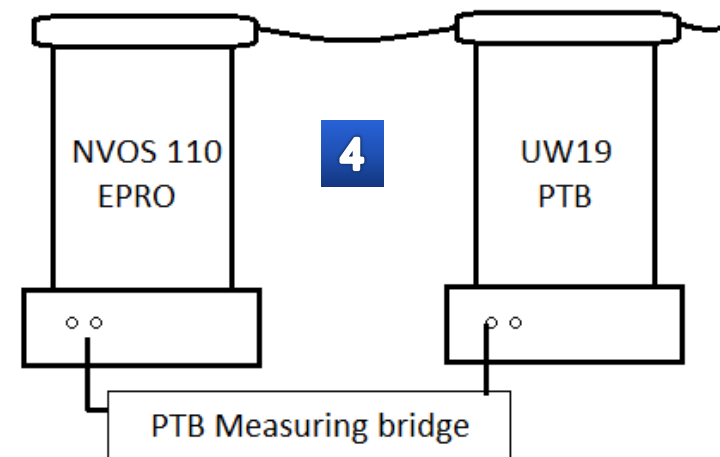
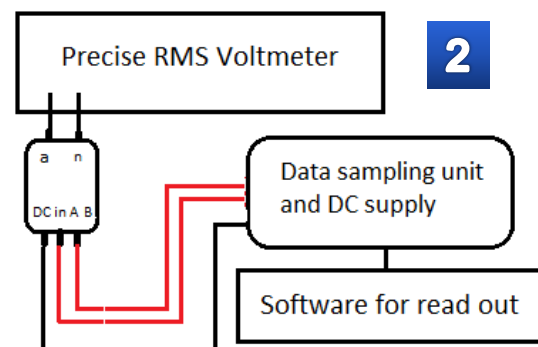
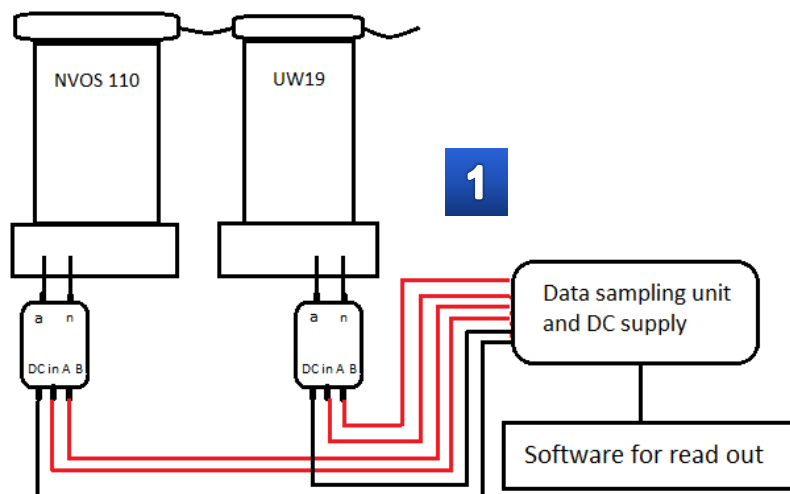
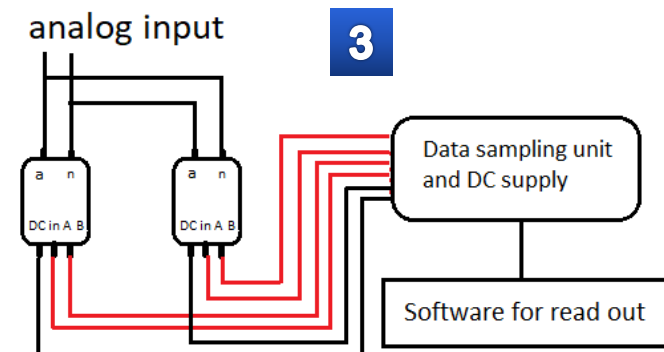
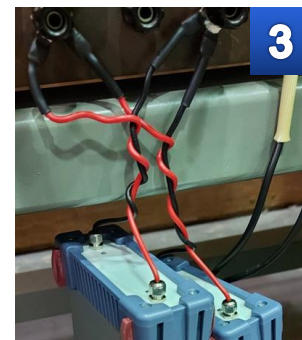
Validation plan for PTB campaign



Aim: Validation of the voltage channel

■ Validation plan:

1. Validate the voltage transformer with Mbox with bridge
2. Validate the two Boxes on absolute error with precise RMS voltmeter
3. Check the ratio and phase displacement of two Boxes when parallel
4. Validate the voltage transformer with passive compensation



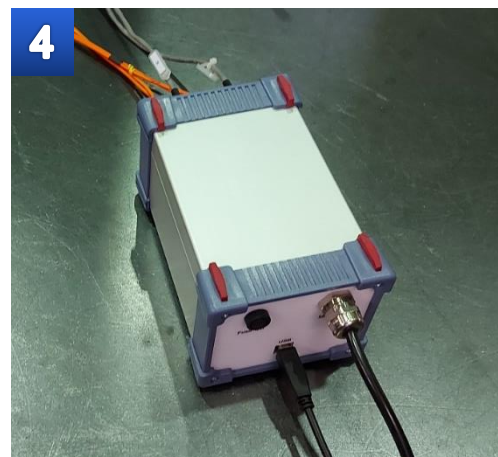
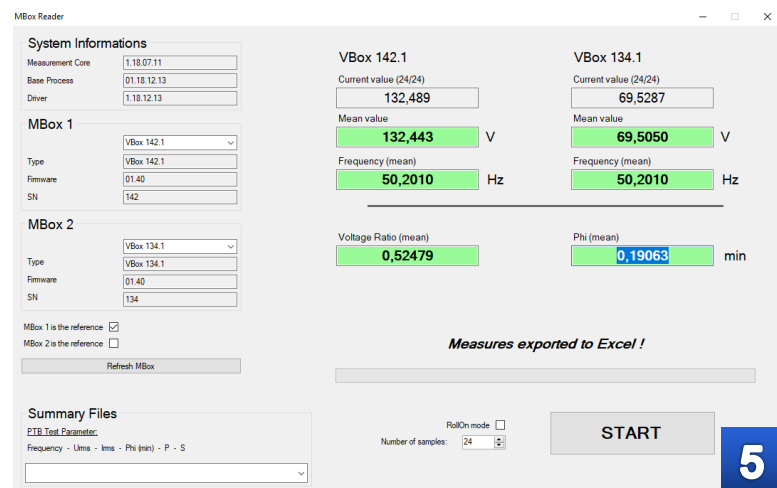
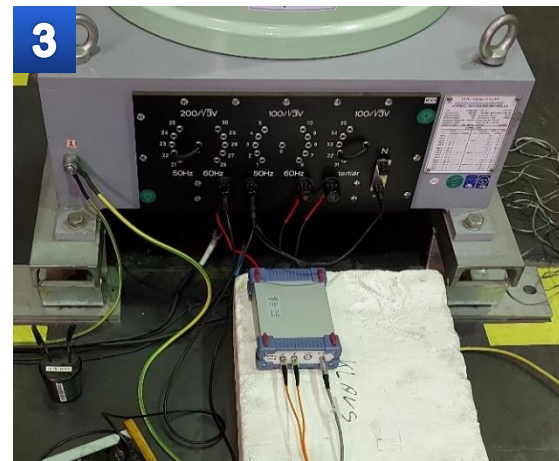


Electronic equipment for validation at PTB campaign



Equipment:

1. Voltage transformer with standard and variable compensation
2. Mbox for voltage transformer under test
3. Mbox (low burden) for reference voltage transformer
4. Data collecting unit and DC supply
5. Software reader



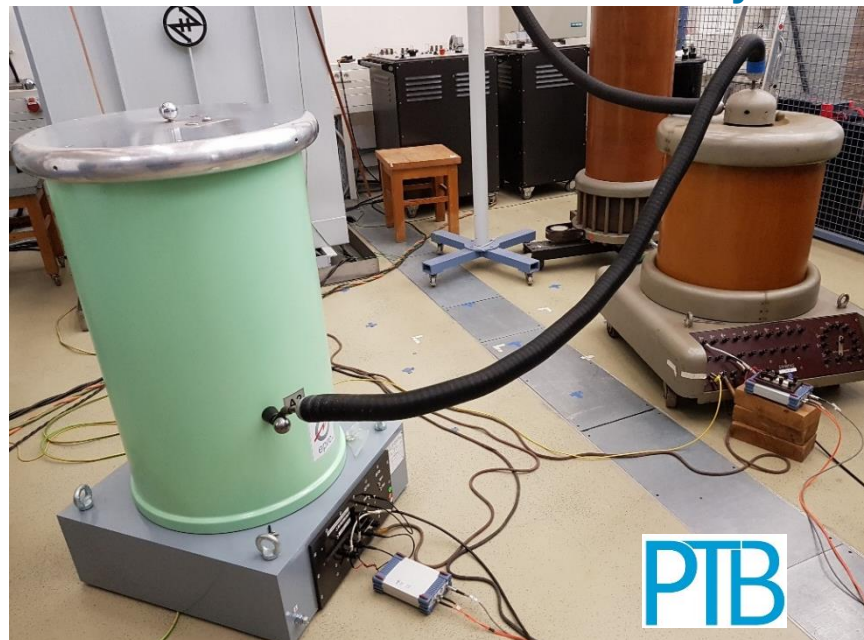


Set up for validation of the voltage transformer with Mbox on PTB and EPRO side



July 2021

June 2021



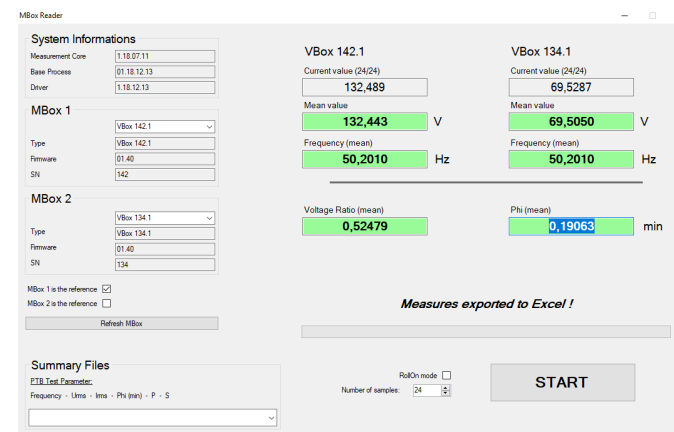
On the left is the test setup at PTB for the voltage transformer + Mbox validation. Right at EPRO.

Rated voltage	Points
85 kV	90% - 20%
15 kV	120% - 40%

Mbox Reader Software



- One Mbox only for this purpose (lower burden) at PTB or EPRO Referenz
- Other Mbox on the Test object
- Both boxes similar design, with optical cable to data sampling unit (specially for this project)
- Mbox software reader is used to show voltage and phase displacement
- The relevant mean voltage value is calculated from 24 current values.
- Measuring points are from 120% to 20%.
- Voltage up to 100 kV.



Data collecting and DC supply



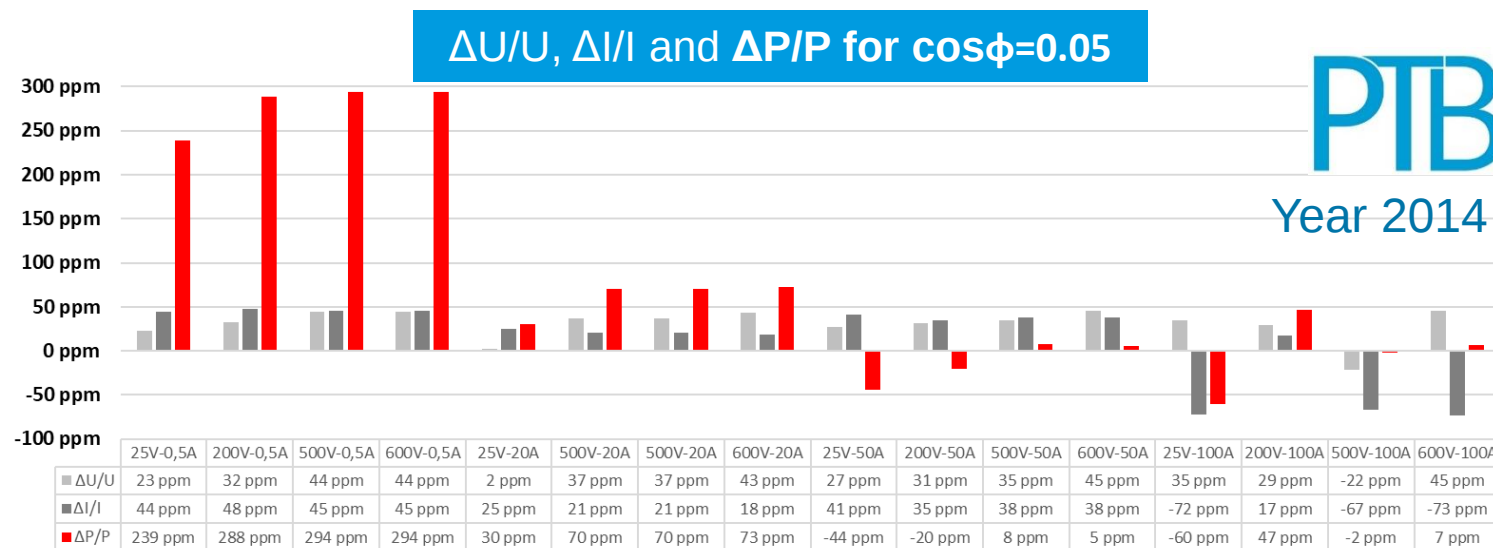


Verification of the complete EPRO loss measurement system (TMS) from PTB Side

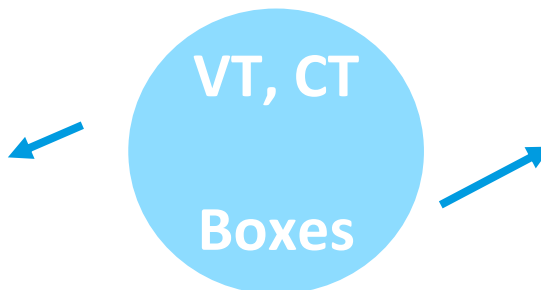


PTB Calibration Certificate for EPRO digital Wattmeter with standard voltage and current transformer

- Relative measurement uncertainty (from PTB) is from 10ppm up to 50ppm depending on range
- Since 2014 PTB calibration certificate is available for any customer
- At power factor 0.01 we can calculate the accuracy on the basis of the angle error we got verified. This amounts to 0.5% of the measured losses.



IEC 17025





Thank you for listening



This project has received funding from the EMPIR programme co-financed by the Participating States and from the European Union's Horizon 2020 research and innovation programme