BIPM Capacity Building & Knowledge Transfer Programme

2023 BIPM - TÜBİTAK UME Project Placement

REPORT

Project Name	Precision measurements of AC power and energy, phase angle quantities
Description	Studying of the AC Power Standard (DSWM), Calibration (Resistor Voltages Dividers RVD set) DSWM, Calibration reference standard and voltage transformer by using DSWM
Author, NMI	Yuliia Kulish, State Enterprise "All-Ukrainian state research and production center for standardization, metrology, certification and consumers' right protection" (SE"UKRMETRTESTSTANDART"), Ukraine
Mentor at TÜBİTAK UME	Hüseyin ÇAYCI, Burak AYHAN, Power and Energy Laboratory, TÜBİTAK UME, Türkiye
Date	04.09.2023 – 04.11.2023

Motivation & Introduction

Ukraine has a huge energy system, consisting of about 100 different energy generating stations (nuclear, thermal, hydro, wind, solar) and electric and thermal networks, other electric power facilities, which are united by a common mode of production, transmission and distribution electric and thermal energy, therefore metrological support of AC power and energy measurements is necessary in our country. In addition, since March 2022, energy system of Ukraine is part of the European energy system ENTSO-E. At the moment, the main capabilities of calibration and measurement of AC power and energy are performed by our NMI, which is provided by the National Primary Standard of Electric Power and Power Factor, which was established in 2002, has 10 CMCs published on BIPM KCDB and participation in international comparisons. But the growing demands for control of electricity displays, electricity quality and the use of advanced equipment require improvement of the National Standard of Electric Power and Power Factor.

Tre main objectives of the project were to get new knowledge of methods implementation, transfer and measurement AC Power unit which will help to improve the National Primary Standard of Electric Power and Power Factor; to improve my theoretical and practical skills in calibration methods of power and energy meters, instrument transformers and power quality meters; to study the AC Power Measurement Standard (Digital Sampling Wattmeter – DSWM); to study the correct calculation of measurement uncertainties.

Research

The primary standard DSWM is a digital multifunction sampling wattmeter. It is based on stable power source, the proven 3458A digital multimeters along with current shunts, voltage dividers, trigger unit and PC software (developed in Labview). Shunts and dividers

have very low phase angle errors and cover current ranges from 5 mA to 100 A and voltage ranges from 50 mV to 1000 V at frequencies from 16 Hz to 100 kHz. DSWM has a very wide range of measurements of electrical power and energy parameters, as well as power quality, so our NMI is very interested in using DSWM during the modernization of the National Standard of AC power and energy.

At first, the Resistor Voltages Dividers (RVD set) DSWM were calibrated by step-up method for characterization for both ratio error and phase shift by applying certain voltages within 1 V and 10 V (Figure 1). This method consists of 8 steps. The first step was direct measurement RVD of 4 V: 0.8 V by applying the same signal 4 V from Source Fluke 6105A to DVM1 (set 10 V range) and to input RVD of 4 V: 0.8 V. The output of RVD (0.8 V) was connected to DVM2 (set 1 V range). The ratio and phase correction values for each frequency and each voltage level were saved to be used in the next verification steps. The next steps were comparison measurement of two RVD from RVD of 4 V: 0.8 V to RVD of 1000 V: 0.8 V by order on 50 Hz, 53 Hz, 60 Hz. Successful calibration results were obtained: deviation of ratio does not exceed 10 ppm, phase does not exceed 6 μrad.

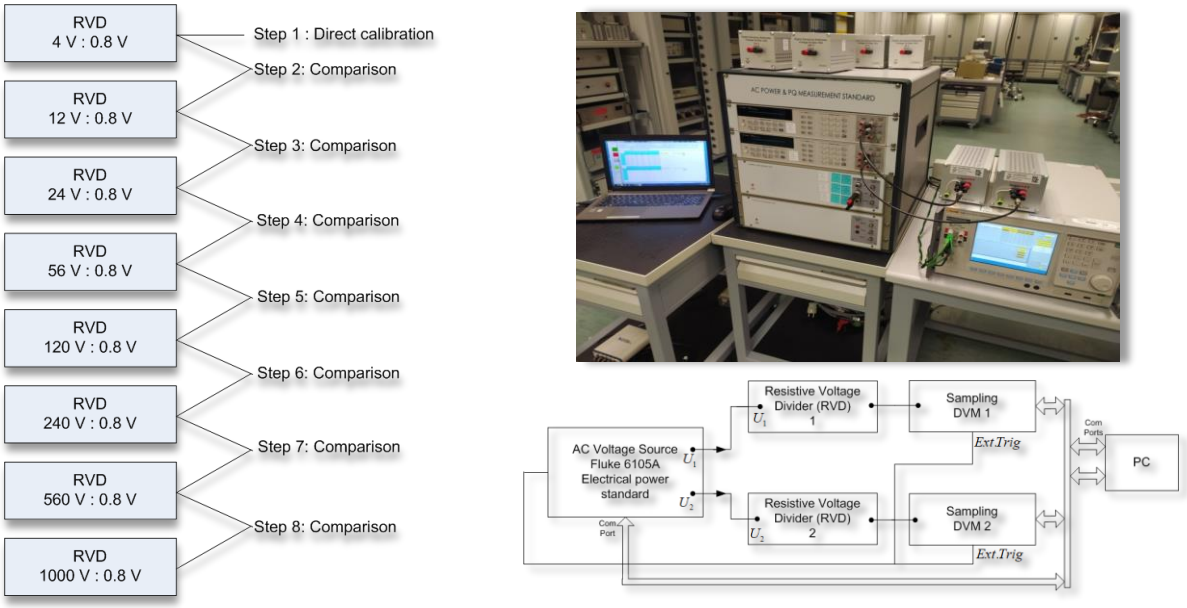

Figure 1. The calibration of the Resistor Voltages Dividers (RVD set) DSWM.

During the training for improving my theoretical and practical skills in calibration, reference standard COM3003 ZERA was calibrated of two methods by using DSWM (from 0.01A to 20 A) and RD-22 (from 50 A to 100 A) (Figure 2). The methods were based on comparison the active power, reactive power and apparent power measurement functions DSWM and device under test (DUT), then reference standard RD-22 and DUT. Also Applied Precision RS2x30 and the client device KOM 120.1 were calibrated by using DSWM, and also power quality meter was calibrated.

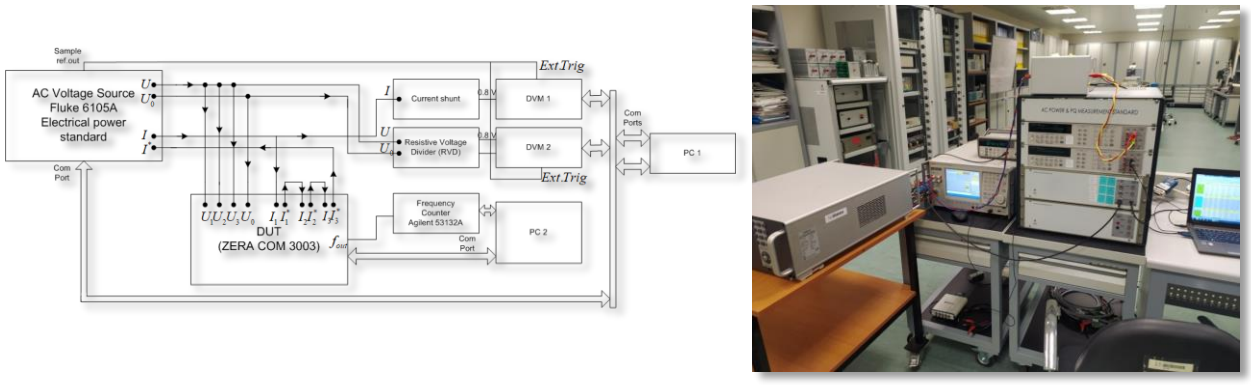

Figure2. Calibration COM 3003 ZERA by using DSWM

The addition work was mastering calibration reference voltage transformer in a points 10 kV, 6 kV, 3 kV by using DSWM and Standard Voltage Transformer for reduce voltage.
During the internship I got information about the sampling methods in power measurements (from the articles of laboratory and the book 'Sampling With 3458A'). Except work in laboratory I learned the classroom lectures about CIPM MRA, comparisons in the CIPM MRA, quality management system, calibration and measurement capabilities, peer-review of CMCs and metrological traceability.

Conclusions and Future Work

During the training I got amazing theoretical and practical experience of AC power measurement. I will apply my new knowledge of methods to implementation, transfer and measurement AC Power unit for modernization National primary measurement standard of electric power and power factor, that we have planning upgrade in a near future; automation of measurements and processing of measurement data by programming in Labview; opportunity for implementation measurement of power quality with high accuracy; upgrade Secondary measurement standard of AC power in our country; improvement methods and quality of calibration of power and energy meters, power converters, wattmeters.

Acknowledgements

I would like to express my deep gratitude to everyone who made my internship "BIPM - TÜBİTAK UME Project Placement" possible. Many thanks to Mr. Chingis Kuanbaev, Mr. Mustafa Çetintaş for organizing this Project, and Ms. Müge Atam, who coordinated the activities before and during the internship and helped in resolving any issue.
In addition, I would like to express my deep gratitude to the staff of the Power and Energy Laboratory, who shared their experience in instrument calibration and were very easy to work with. Special thanks are expressed to the head of the laboratory, Ms. Özlem Yılmaz, for her attention and support, Mr. Hüseyin Çayci, Mr. Burak Ayhan and Mr. Tansu Kefeli, who shared their work experience and theoretical knowledge of measuring power, energy, and applying these skills in practice, for their clear explanation, as well as for their attention and support.