BIPM Capacity Building & Knowledge Transfer Programme

2022 BIPM - TÜBİTAK UME Project Placement

REPORT

Project Name	Mastering theoretical and practical skills in the energy and power measurements
Description	Study and research of various calibration methods and development of the reference system in NMI
Author, NMI	Zhuldyz Saden, Kazakhstan Institute of Standardization and Metrology, Kazakhstan
Mentors at TÜBİTAK UME	Burak AYHAN, Hüseyin ÇAYCI, Power and Energy Laboratory, TÜBİTAK UME, Türkiye
Date	05.09.2022 – 06.10.2022

Motivation & Introduction

Currently, when an energy obtained from renewable sources is becoming a popular and developing industry, the correct measurement of electrical energy plays an important role. In order to make qualitative research and measurements, there is a need to establish a laboratory that provides accurate measurements using high-precision standards.

The purpose of this training was to gain knowledge and practical experience in calibration methods of power and energy meters and instrument transformers, to study the correct calculation of measurement uncertainties and then to transfer the gained knowledge to the laboratory of electrical measurements of KazStandart. The training was both theoretical and practical.

Research

The Power and Energy Laboratory of TÜBİTAK UME provides calibration services for a wide range of high-precision measuring devices such as electricity meters, power and energy meters, power quality analyzers, voltage and current instrument transformers and the references devices used in the calibrations of instrument transformers such as bridges/test sets and standard burdens.

During the training, the working standard CALPORT 400 for energy measurements was calibrated by comparing the active power, reactive power and apparent power measurement functions of CALPORT 400 with the reference three phase Energymeter ZERA COM3003.

The client device KOM 120.1 was calibrated by comparing the active power, reactive power and apparent power measurement functions of KOM 120.1 with the reference power measurement standard based on sampling techniques (DSWM). The DSWM consists of two digital sampling voltmeters (DVMs), a set of resistive voltage dividers (RVD), a set of AC current shunts, a computer controlled phase-locking device, and a PC with software.

The voltage and current signals from a power source Fluke 6105 are applied to the input terminals of the RVD and the AC Current Shunt. The output voltages of RVD and the AC Current Shunt are then applied to the DVMs. Each programmed DVMs samples the applied voltage signals with the help of trigger signals from phase-locking device. The data from both DVMs is transferred to the PC via IEEE488, and analyzed by means of discrete integration. All available

calculated results are displayed during the measurements. The calibration setup is shown in Figure 1.

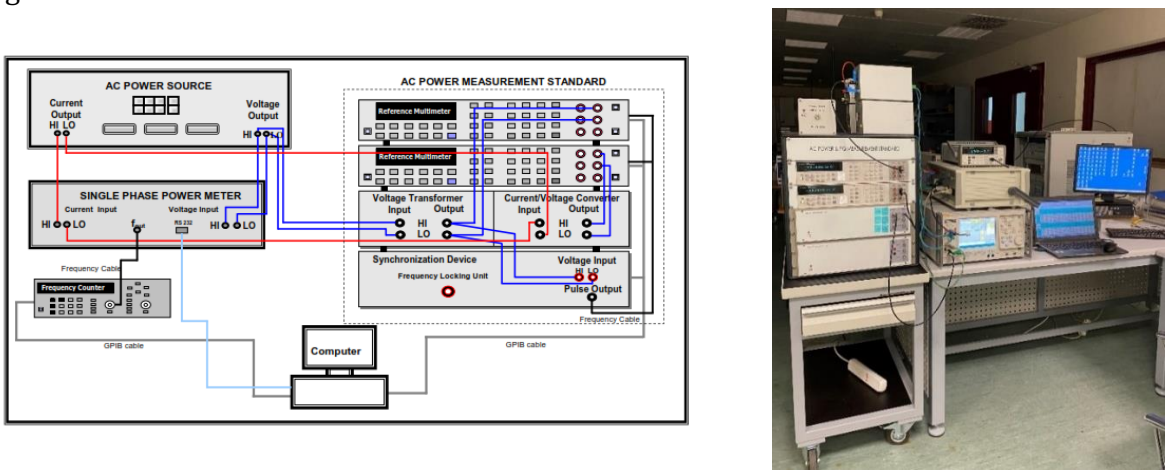

Figure 1. The calibration of KOM 120.1 using the DSWM

Accurate measurement results can be obtained by means of two methods. The first method using ZERA COM3003 is easy for making connection and for getting of the measuring results. The second method using the DSWM which is the primary power measurement standard gives the most accurate results, however it has more complicated connections. As additional information, the DSWM can be used as a reference in calibration of power quality analyzer, instrument transformer bridges/test sets and standard burdens.

The conventional/non-conventional instrument current transformers (CT) with various rated primary currents and rated burdens were calibrated in the laboratory. The general approach for the calibrations of conventional and non-conventional CTs is to apply the rated primary currents serially to both the CT under calibration and the reference CT by using a current booster fed by an electronic power source and to measure the ratio error and phase displacement between secondary outputs of the transformers with the appropriate bridges. Several bridges such as Tettex 2767, WM303I, WM3000I and the modified DSWM are used for the calibration of CT at TÜBİTAK UME. The calibration setup of CT is shown in Figure 2.

Figure 2. The calibration of conventional CT

The conventional/non-conventional instrument voltage transformers (VT) with various rated primary voltages and rated burdens were calibrated in the laboratory. The general approach for the calibrations of conventional and non-conventional VTs is to apply the rated primary voltages to both the VT under calibration and the reference VT in parallel by using a voltage booster fed by an electronic power source and to measure the ratio error and phase displacement between secondary outputs of the transformers with the appropriate bridges.

Several bridges such as Tettex 2767, WM303U, WM3000U and the modified DSWM are used for the calibration of VT at TÜBİTAK UME. The calibration setup of VT is shown in Figure 3.

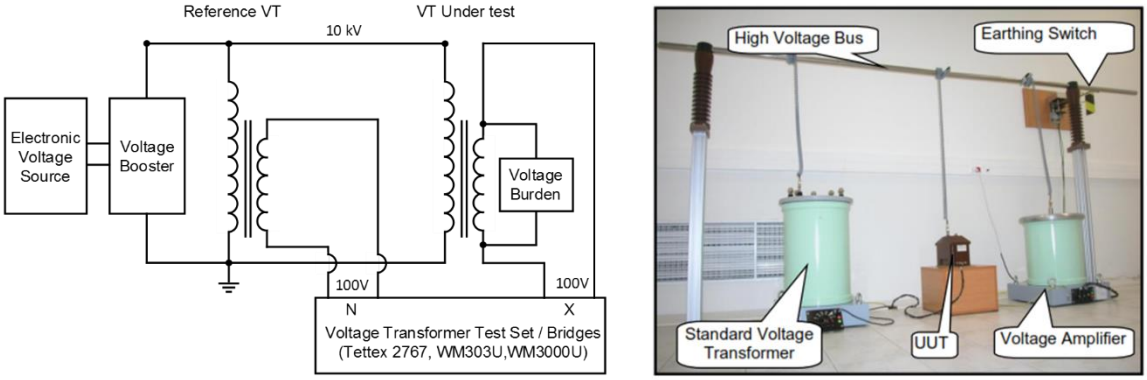

Figure 3. The calibration of conventional VT

The calibration of the reference voltage transformer used in the VT calibration was performed in two steps by using HVCB based on the current comparator and standard capacitors. The calibration methods of CT and VT bridges/test sets and standard burdens, the needed auxiliary and reference devices were discussed and the practical works were made. Finally the CMCs of TÜBİTAK UME and the international comparisons they participated in were examined.

Conclusions and Future Work

In the theoretical part of this training, I learned about the different calibration methods of power and energy meters and instrument transformers, the working principles and manufacturing techniques of measurement standards used in the calibrations and detailed uncertainty calculations. In the practical part of training, I have calibrated many different customer devices and working/reference devices of TÜBİTAK UME in company with TÜBİTAK UME experts. I was informed about the points to be considered during calibrations.

I will use the knowledge and experience gained during the training to determine future prospects of my laboratory with the basic measurement systems and the primary level measurement systems and to help the laboratory to maintain a traceability chain for measurements of electrical power and power related measurements and instrument current and voltage transformers.

Acknowledgements

I would like to express my great gratitude to the organizers of the «BIPM - TÜBİTAK UME Project Placement» program, Mr. Andy Henson, Mr. Chingis Kuanbayev and Mr. Mustafa Çetintaş for the opportunity to gain knowledge and experience for professional development. And I would also like to thank all the interacting persons in the organization of the project. Special thanks to Ms. Müge Atam for her help in organizing my stay and providing constant support during my internship.

In addition, I would like to express my deep gratitude to the staffs of the Power and Energy Laboratory, who have always been open to my questions and shared their knowledge and experience, Ms. Özlem Yilmaz who has always been open to questions and help. Special thanks to Mr. Burak Ayhan for his valuable knowledge and practice in the field of power and energy, for a clear explanation and for his help in solving issues of interest, to Mr. Hüseyin Çaycı for his knowledge and practice in the field of energy measurements.