

AUTOMATION OF THE AC-DC TRANSFER MEASUREMENTS IN UME

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Abstract: This paper describes efforts done in UME aiming to provide efficient ac-dc transfer calibrations. Work includes design of the software and some hardware components.

Keywords: ac-dc transfer, automation, thermal converter, transfer switch

1. INTRODUCTION

High precision measurements of the ac electrical quantities, voltage and current, are performed by linking to the equivalent dc quantities using thermal conversion. Named as ac-dc transfer, in practice, these measurements take quite a lot of time to perform. As an example, calibration of a multirange thermal transfer standard (TTS) have to be done at about 350 points, each point is measured several times and for each measurement ac and dc voltages are applied sequentially several times. In practice, this kind of measurement is long and tedious and very hard to be performed by hand. Fortunately, almost all modern electronic equipment used in these measurements contains GPIB (General Purpose Interfacing Bus) option used to connect and control these devices by a computer. So, the most sensible way to go when dealing with the ac-dc transfer is automation of the measurement process.

2. AC-DC STANDARDS

Reference standards used in our laboratory for ac voltage and current consist of a group of multi-junction thermal converters. They are used in combination with suitable resistors and shunts in a step-up procedure to extend range of ac voltage to 1000 V, and current to 25 A. For low voltages and currents we use micropotentiometers and currents shunts combined with a TTS in a step-down procedure [1]. These standards are then used to calibrate two TTSs, working standards for calibration of ac standards, calibrators and meters.

3. SOFTWARE

First software for TVC comparison was designed in our laboratory in 1996 year [2]. It was redesigned in 2000, enabling wider use, especially electronic equipment, and from then was modified to meet our needs. However, it is a DOS program and we decided to upgrade to windows platform. From previous experience we have set the following targets to be met by new software:

- cover all ac-dc calibration requirements
- user friendly interface
- compatibility with all electronic equipment in laboratory
- minimum operator intervention

Program is written in NI LabWindows/CVI and run on a PC with GPIB interface. It consists of several windows guiding the operator through the measurement procedure.

First, operator has to define the procedure to run selecting test device on the “Test Device” window, Figure 1. Program contains procedures for all devices related to ac-dc transfer or ac voltage we give service. Some information about test unit like manufacturer, model, SN, owner, etc, can be provided here.

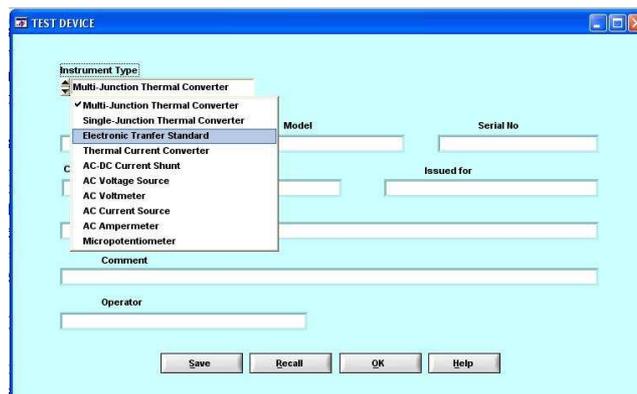


Figure 1. “Test Device” window

Next step is selection of the calibration points and it is done at “Calibration Point” window, Figure 2.

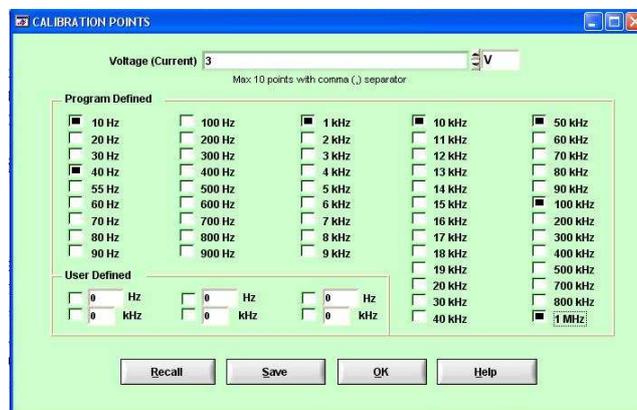


Figure 2. “Calibration Points” window

Program offers large set of predefined frequencies but also leaves possibility to user to select different frequencies. Selected calibration points can be stored in the data base of the program and used later.

Next step is loading transfer differences of the reference device for selected frequencies, on the “Standard Differences” window. Frequencies selected at previous window are highlighted and operator should provide value for each frequency.

Transfer differences for all reference devices can be stored in the programs data base for later use. Program has option to interpolate the set of transfer differences provided by operator and calculate differences for non calibrated frequencies. This is offered for devices with relatively flat response like thermocouple based converters.

The next step is selection of instruments in setup, their GPIB addresses, measurement parameters and file to save results. This is done on the “System Parameters” window (Figure 3).

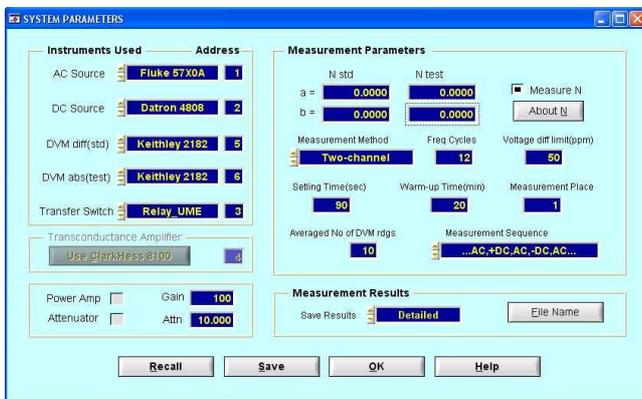


Figure 3. “System Parameters” window

All calibrators and meters present in laboratory are included in program’s data base. Measurement parameters such as sensitivity of TCs, method, repetition per frequency, settling and warm up times, number of reading of monitor meters, sequence of applied voltages are also selected here. Parameters can be stored and reloaded for later use.

Finally, measurement is managed on the “Measurement Monitor” window (Figure 4).

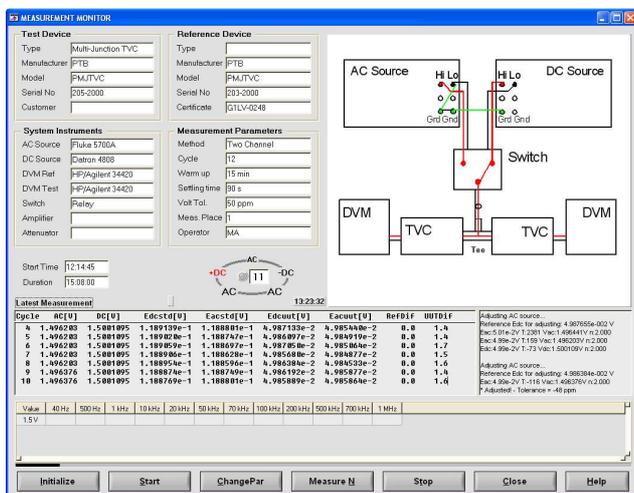


Figure 4. “Measurement Monitor” window

All selected parameters at the previous windows are shown, providing good overview to user. Before the measurement, all connected instruments are initialized to GPIB remote state using “Initialize” button to check if any problem exists. After pressing “Start” button program shows measurement setup warning operator to check system connections before running. During measurement process, program displays updated results in the related fields at window. Using ChangePar button it is possible to change parameters such as settling time, repetition and voltage sequence during program running. Here is also possibility to only measure sensitivity coefficients of thermal converter using Measure N button.

Program has some extra features like ac voltage measurements by sampling using a commercial multimeter, measure reversal error of thermoelements, automatic adjustment procedures for some calibrators and ac standards.

4. AUXILIARY HARDWARE

We have designed several auxiliary units to improve the quality and speed of computer controlled ac-dc transfer measurements.

1. Environment temperature is quite important parameter when thermal converters are used. Changing of the environment temperature during ac-dc calibration will cause unstable and drifting readouts on the TCs, which leads to inconsistent measurements. Despite our laboratory is temperature controlled, we integrated temperature monitor in to our ac-dc measurement system. Basic temperature/humidity (TH) measuring device designed in UME electronic workbench is used for temperature monitoring. Device is connected to PC via RS 232 and controlled by the program. During the measurement, program records the environment temperature, in the case of critical change it alerts or optionally stops measurements until temperature returns back to limits set by operator.

2. Fast switching between ac and dc voltage/current applied to the thermal devices is important for consistent ac-dc transfer measurements. Instead of one multifunction source whose switching time between ac and dc functions may reach several seconds it is more convenient to use separated ac and dc source in the combination with a fast switch. Transfer switch based on stepper we used before is replaced with new one based on fast high voltage relays providing switching time of few milliseconds (Figure 5).



Figure 5. Transfer Switch

It is controlled by computer via GPIB.

3. Calibrations of multi range standards, calibrators and voltmeters are significant part of activities in our laboratory. For these calibrations a reference multirange TTS (Fluke 792A) is used due to advantages it has over classic thermal converters, like linearity and fast settling. This device is manual and it limits automated procedure to one range measurement or requires operator intervention when used on different ranges. Range switch of the TTS is rotary type and it is suitable for automation using a remote controlled step motor [3]. Rotary switch we designed includes also a gear system for torque amplification, positioning system based on opto-couplers and GPIB control (Figure 6). Thanking to the switch, it is possible to perform calibration and verification of the Fluke 5790A AC Measurement Standard in several hours.

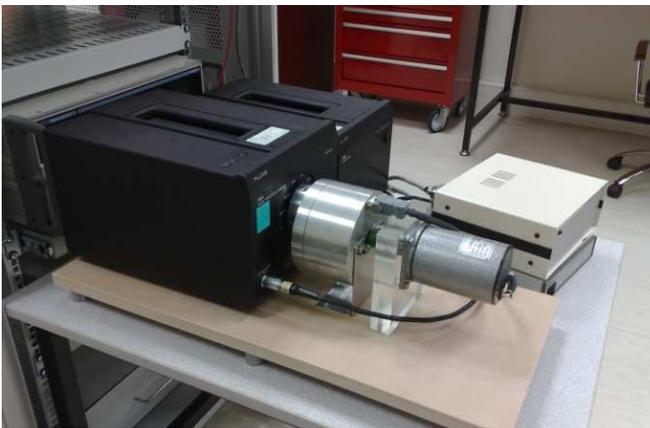


Figure 6. Rotary Switch

5. CONCLUSION

Software designed to perform ac-dc transfer measurements developed in UME has presented. Together with some auxiliary devices it is a powerful assistance in covering all calibration needs of an ac-dc transfer laboratory.

6. REFERENCES

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