GOCE DELCEV UNIVERSITY, SHTIP, NORTH MACEDONIA

FACULTY OF ELECTRICAL ENGINEERING

ETIMA 2021

FIRST INTERNATIONAL CONFERENCE

19-21 OCTOBER, 2021

TECHNICAL SCIENCES APPLIED IN ECONOMY, EDUCATION AND INDUSTRY

УНИВЕРЗИТЕТ „ГОЦЕ ДЕЛЧЕВ” - ШТИП
ЕЛЕКТРОТЕХНИЧКИ ФАКУЛТЕТ

UNIVERSITY „GOCE DELCHEV” - SHTIP
FACULTY OF ELECTRICAL ENGINEERING

ПРВА МЕЃУНАРОДНА КОНФЕРЕНЦИЈА
FIRST INTERNATIONAL CONFERENCE

ЕТИМА / ETIMA 2021

ЗБОРНИК НА ТРУДОВИ
CONFERENCE PROCEEDINGS

19-21 Октомври 2021| 19-21 October 2021

Главен и одговорен уредник / Editor in Chief
Проф.д-р Сашо Гелев
Prof.d-r Saso Gelev

Јазично уредување / Language Editor
Весна Ристова (Македонски) / Vesna Ristova (Macedonian)

Техничко уредување / Technical Editing
Доц.д-р Далибор Серафимовски / d-r Dalibor Serafimovski

Издавач / Publisher
Универзитет „Гоце Делчев" - Штип / University Goce Delchev - Stip
Електротехнички факултет / Faculty of Electrical Engineering

Адреса на организационен комитет / Adress of the organizational committee
Универзитет „Гоце Делчев" – Штип / University Goce Delchev - Stip
Електротехнички факултет / Faculty of Electrical Engineering
Адреса: ул. „Крсте Мисирков" бр. 10-А / Adress: Krste Misirkov, 10 - A
Пош. фах 201, Штип - 2000, С.Македонија / PO BOX 201, Stip 2000, North Macedonia
E-mail: conf.etf@ugd.edu.mk

CIP - Каталогизација во публикација
Национална и универзитетска библиотека "Св. Климент Охридски", Скопје

62-049.8(062)
004-049.8(062)

МЕЃУНАРОДНА конференција ЕТИМА (1 ; 2021)
Зборник на трудови [Електронски извор] / Прва меѓународна конференција ЕТИМА 2021, 19-21 Октомври 2021 = Conference proceedings / First international conferece ETIMA 2021, 19-21 October 2021 ; [главен и одговорен уредник Сашо Гелев]. - Штип: Универзитет "Гоце Делчев", Електротехнички факултет = Shtip: University "Goce Delchev", Faculty of Electrical Engineering, 2021

Начин на пристапување (URL): https://js.ugd.edu.mk/index.php/etima. - Текст во PDF формат, содржи 358 стр.илустр. - Наслов преземен од екранот. - Опис на изворот на ден 15.10.2021. - Трудови на мак. и англ. јазик. - Библиографија кон трудовите

ISBN 978-608-244-823-7

1. Напор. ств. насл.
а) Електротехника -- Примена -- Собири б) Машинство -- Примена -- Собири
в) Автоматика -- Примена -- Собири г) Информатика -- Примена -- Собири

COBISS.MK-ID 55209989

Прва меѓународна конференција ЕТИМА
19-21 Октомври 2021
First International Conference ETIMA
19-21 October 2021

ОРГАНИЗАЦИОНЕН ОДБОР
ORGANIZING COMMITTEE

Василија Шарац / Vasilija Sarac
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Сашо Гелев / Saso Gelev
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Тодор Чекеровски / Todor Cekerovski
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Далибор Серафимовски / Dalibor Serafimovski
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Маја Кукушева Панева / Maja Kukuseva Paneva
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Билјана Читкушева Димитровска / Biljana Citkuseva Dimitrovska
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Весна Конзулова / Vesna Konzulova
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Прва меѓународна конференција ЕТИМА
19-21 Октомври 2021
First International Conference ETIMA
19-21 October 2021

ПРОГРАМСКИ И НАУЧЕН ОДБОР
SCIENTIFIC COMMITTEE

Со Ногучи / So Noguchi
Висока школа за информатички науки и технологии
Универзитет Хокаидо, Јапонија
Graduate School of Information Science and Technology
Hokkaido University, Japan

Дионис Гашпаровски / Dionýz Gašparovský
Факултет за електротехника и информациони технологии,
Словачки Технички Универзитет во Братислава, Словачка
Faculty of Electrical Engineering and Information Technology
Slovak Technical University in Bratislava, Slovakia

Антон Белан / Anton Beláň
Факултет за електротехника и информациони технологии
Словачки Технички Универзитет во Братислава, Словачка
Faculty of Electrical Engineering and Information Technology
Slovak Technical University in Bratislava, Slovakia

Георги Иванов Георгиев / Georgi Ivanov Georgiev,
Технички Универзитет во Габрово, Бугарија
Technical University in Gabrovo, Bulgaria

Ивелина Стефанова Балабанова / Ivelina Stefanova Balabanova,
Технички Универзитет во Габрово, Бугарија
Technical University in Gabrovo, Bulgaria

Бојан Димитров Карапенев / Boyan Dimitrov Karapenev
Технички Универзитет во Габрово, Бугарија
Technical University in Gabrovo, Bulgaria

Сашо Гелев / Saso Gelev
Електротехнички факултет,
Универзитет „Гоце Делчев” - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Влатко Чингоски / Vlatko Cingoski
Електротехнички факултет,
Универзитет „Гоце Делчев” - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Божо Крстајиќ / Bozo Krstajic
Електротехнички факултет
Универзитет во Црна Гора, Црна Гора
Faculty of Electrical Engineering,
University in Montenegro, Montenegro

Милован Радуловиќ / Milovan Radulovic
Електротехнички факултет
Универзитет во Црна Гора, Црна Гора
Faculty of Electrical Engineering,
University in Montenegro, Montenegro

Гоце Стефанов / Goce Stefanov
Електротехнички факултет,
Универзитет „Гоце Делчев” - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Мирјана Периќ / Mirjana Peric
Електронски факултет
Универзитет во Ниш, Србија
Faculty of Electronic Engineerig,
University of Nis, Serbia

Ана Вучковиќ / Ana Vuckovic
Електронски факултет
Универзитет во Ниш, Србија
Faculty of Electronic Engineerig,
University of Nis, Serbia

Тодор Чекеровски / Todor Cekerovski
Електротехнички факултет,
Универзитет „Гоце Делчев” - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Далибор Серафимовски / Dalibor Serafimovski
Електротехнички факултет,
Универзитет „Гоце Делчев” - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Мирослава Фаркаш Смиткова / Miroslava Farkas Smitková
Факултет за електротехника и информациони технологии
Словачки Технички Универзитет во Братислава, Словачка
Faculty of Electrical Engineering and Information Technology
Slovak Technical University in Bratislava, Slovakia

Петер Јанига / Peter Janiga
Факултет за електротехника и информациони технологии
Словачки Технички Универзитет во Братислава, Словачка
Faculty of Electrical Engineering and Information Technology
Slovak Technical University in Bratislava, Slovakia

Јана Радичова / Jana Raditschová,
Факултет за електротехника и информациони технологии
Словачки Технички Универзитет во Братислава, Словачка
Faculty of Electrical Engineering and Information Technology
Slovak Technical University in Bratislava, Slovakia

Драган Миновски / Dragan Minovski
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Василија Шарац / Vasilija Sarac
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Александар Туџаров / Aleksandar Tudzarov
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

Владимир Талевски / Vladimir Talevski
Електротехнички факултет,
Универзитет „Гоце Делчев" - Штип, Северна Македонија
Faculty of Electrical Engineering,
Goce Delchev University - Stip, North Macedonia

PREFACE

The Faculty of Electrical Engineering at University Goce Delcev (UGD), has organized the International Conference ***Electrical Engineering, Informatics, Machinery and Automation - Technical Sciences applied in Economy, Education and Industry-ETIMA*.**
ETIMA has a goal to gather the scientists, professors, experts and professionals from the field of technical sciences in one place as a forum for exchange of ideas, to strengthen the multidisciplinary research and cooperation and to promote the achievements of technology and its impact on every aspect of living. We hope that this conference will continue to be a venue for presenting the latest research results and developments on the field of technology.
Conference ETIMA was held as online conference where contributed more than sixty colleagues, from six different countries with forty papers.
We would like to express our gratitude to all the colleagues, who contributed to the success of ETIMA'21 by presenting the results of their current research activities and by launching the new ideas through many fruitful discussions.
We invite you and your colleagues also to attend ETIMA Conference in the future. One should believe that next time we will have opportunity to meet each other and exchange ideas, scientific knowledge and useful information in direct contact, as well as to enjoy the social events together.

The Organizing Committee of the Conference

ПРЕДГОВОР

Меѓународната конференција ***Електротехника, Технологија, Информатика, Машинство и Автоматика-технички науки во служба на економија, образование и индустрија-ЕТИМА*** е организирана од страна на Електротехничкиот факултет при Универзитетот Гоце Делчев.
ЕТИМА има за цел да ги собере на едно место научниците, професорите, експертите и професионалците од полето на техничките науки и да представува форум за размена на идеи, да го зајканува мултидисциплинарното истражување и соработка и да ги промовира технолошките достигнувања и нивното влијание врз секој аспект од живеењето. Се надеваме дека оваа конференција ќе продолжи да биде настан на кој ќе се презентираат најновите резултати од истражувањата и развојот на полето на технологијата.
Конференцијата ЕТИМА се одржа online и на неа дадоа свој допринос повеќе од шеесет автори од шест различни земји со четириесет труда.
Сакаме да ја искажеме нашата благодарност до сите колеги кои допринесоа за успехот на ЕТИМА'21 со презентирање на резултати од нивните тековни истражувања и со лансирање на нови идеи преку многу плодни дискусии.

Ве покануваме Вие и Вашите колеги да земете учество на ЕТИМА и во иднина. Веруваме дека следниот пат ќе имаме можност да се сретнеме, да разменime идеи, знаење и корисни информации во директен контакт, но исто така да уживаме заедно и во друштвените настани.

Организационен одбор на конференцијата

Содржина / Table of Contents

UDC: 621.317.2:006.91

AUTOMATED SYSTEM FOR SMART METER TESTING

Peter Janiga[1], Boris Cintula[2]
[1]Slovak University of Technology in Bratislava, Faculty of Electrical Engineering and Information Technology, email: *peter.janiga@stuba.sk*
[2]Slovak University of Technology in Bratislava, Faculty of Electrical Engineering and Information Technology, email: *boris.cintula@stuba.sk*

Abstract
Smart metering is debated issue currently. It is a consequence of the introduction of this technology into practice, a many of pilot operations and the effort find the optimum technology for each area. The aim of the paper is a system for testing of selected functionalities of smart meters. In particular, the ability to evaluate the power quality parameters such as waveform distortion, detection of maximum and minimum values and other parameters defined in the standard STN EN 50160. Described system is under development and testing, so some functionality will put the finishing touches according to current requirements.

Key words
Smart meter, measuring, harmonics, testing

Introduction

Incoming technology of smart metering brings new opportunities for power system operation. Smart metering provides in addition to measurement of voltage, current, and then calculating other indicators, for example distortions, interruptions, etc.
Functionalities adding to the meter a makes question about validity of obtained data. Not all parameterizations of smart meters are set correctly and identifying incorrect setting is not easy. If the problem with incorrect settings is appear after installing to the network, then many problems arise with subsequent disposal problems. Therefore, precision testing is the pursuit of prior to commissioning. Developed measuring system allows testing the most common errors in parameterization of smart meter and variability of the system allows adjusting the measuring system to identify any problems.
Between the problems which the system wants to identify include, for example, influence current flow and data transfer error. In the case specify distorted current flow may cause the increasing the error rate of data transmission. The proposed system allows generating currents up to 100th harmonic distortion.
A further possibility of presented system is the use when smart meters are tested at different operating temperatures. For example, the smart meter verification of accuracy of measurements of limitary low and limitary high temperature by placing smart to the conditioning chamber, using high precise power supply source and reference standard using an accurate measurement can be verified by measurement bias and quantify uncertainty smart meter.

1. Components of testing system

Developed system consists of a programmable source, reference standard, measuring the stand and control software. Programmable source Applied Precision 8325B has a separate current and voltage circuits. If necessary, there is possible to connect these circuits but it is necessary to carry out to safety. Output circuits of power source can generate the signal in the range of 0-

300 V and 0-120 A. Signal generator, which generates shape of voltage and current, can generate a waveform with 100 harmonics.

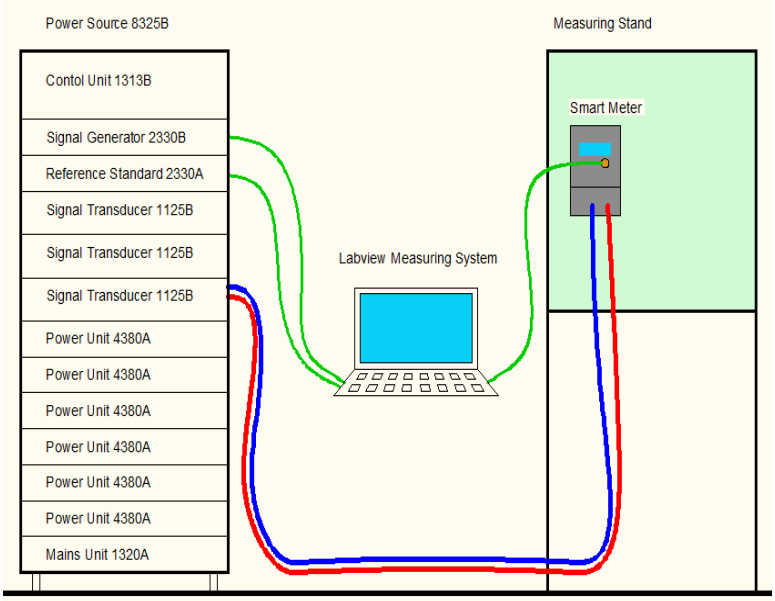

Fig. 1 Scheme of measuring system

Programmable source Applied Precision 8325B has a separate current and voltage circuits. If necessary, there is possible to connect these circuits, but it is necessary to carry out to safety. Output circuits of power source can generate the signal in the range of 0-300 V and 0-120 A. Signal generator, which generates shape of voltage and current, can generate a waveform with 100 harmonics.

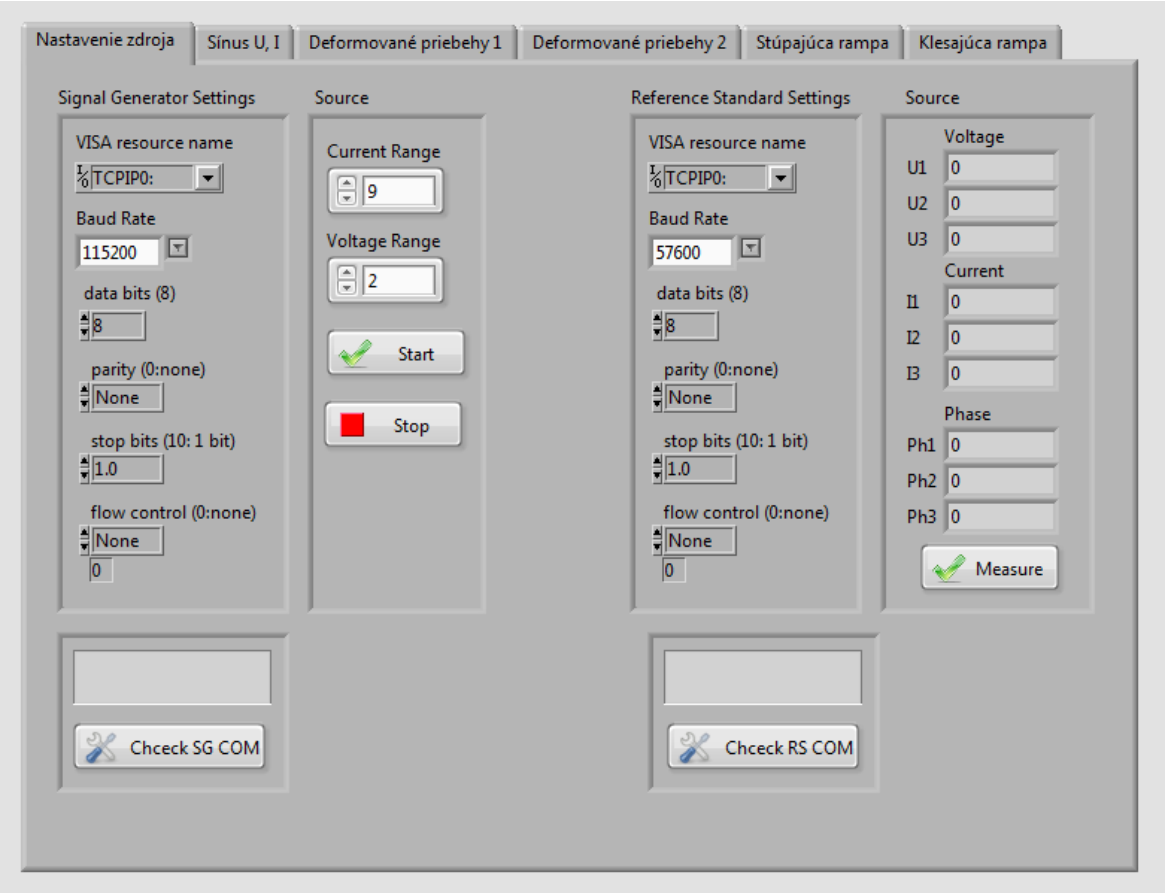

Fig. 2 Main window of software

Source has separate three phases of voltage and current circuits. This allows verifying the meters with indirect measurement. On the other hand, if is necessary to measure more than two meters with interconnected current and voltage circuits (disconnection is not technically possible) then use isolation transformers is required.
The main program window Fig. 2 shows a set of communication paths with signal generator and the reference standard. Those are standard serial port settings. At the bottom there is a button to test communication. For correct communication window lists the name of the signal generator and the reference standard.

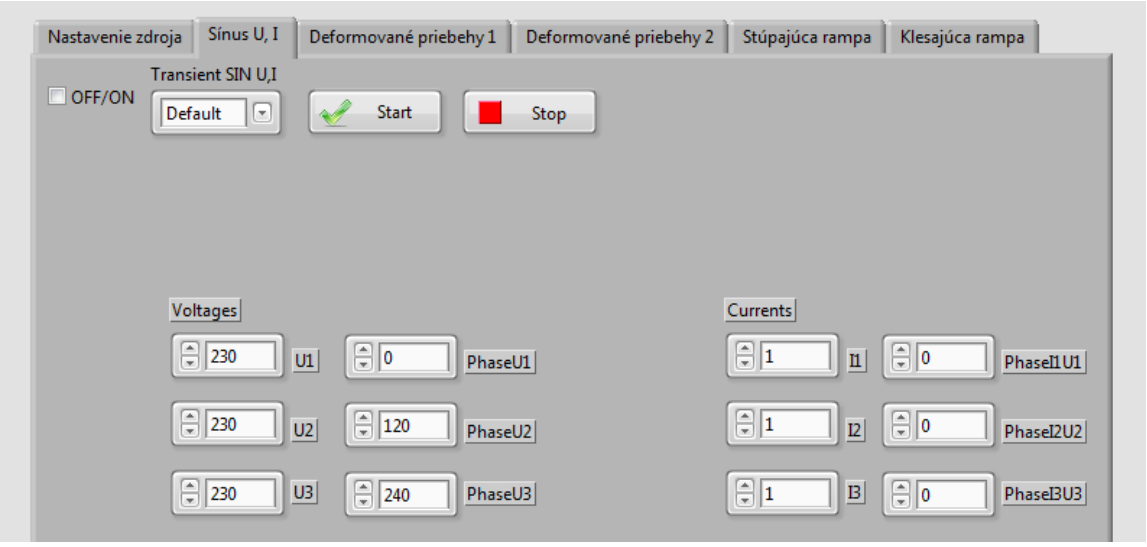

Fig. 3 Window for testing with sinusoidal signal

Second window Fig. 3 allows setting voltages and currents to generate sinusoidal signals. On the top of the window is transient option set, which means how will run output source. It is possible to choose between three options: default (signal will be generated according to the default setting source), generate soft (gradual onset signal under the curve, which is defined in the source) and immediate (ramp signals will be immediate). If there is immediate set, then must be careful about shocks. In some cases, must be range chose with a margin that starting do not disconnect internal resource protection.
Created system allows generating distorted waveforms of voltages and currents. System in conjunction with the above described source can generate harmonics up to order 100. For each harmonic can also enter the angle, which can change the shape of the resulting waveform. When entering the deflection voltage parameter can be entered manually or choose from predefined signals. Harmonic distortion of predefined signal based on EN 50160th. The options are All harmonics (0 to 100th harmonic of EN 50160) Even harmonics (0 to 100 odd harmonic of EN 50160) Odd harmonics (0 to 100 odd harmonic of EN 50160) Tripplen harmonics (0 to 100 tripplen harmonic of EN 50160).

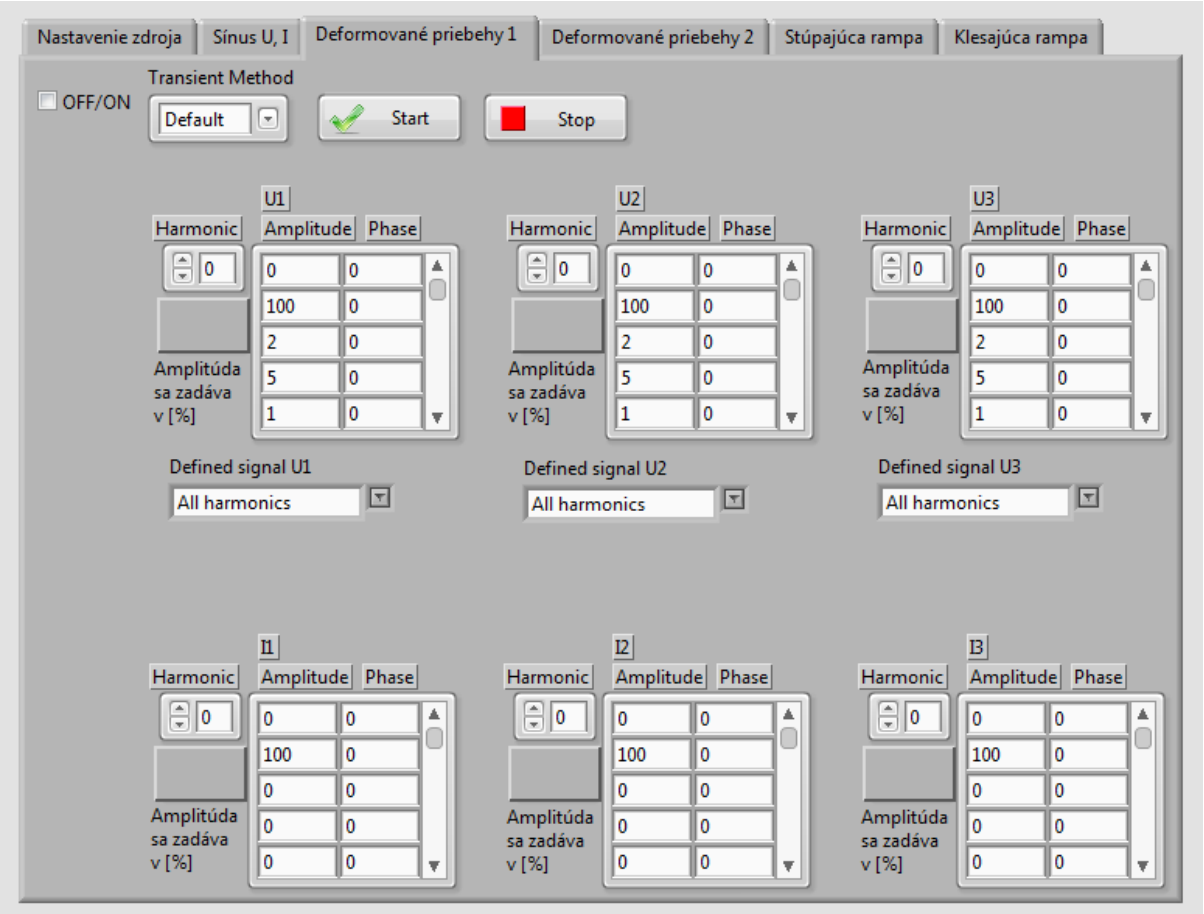

Fig. 4 Window for testing with distorted signal

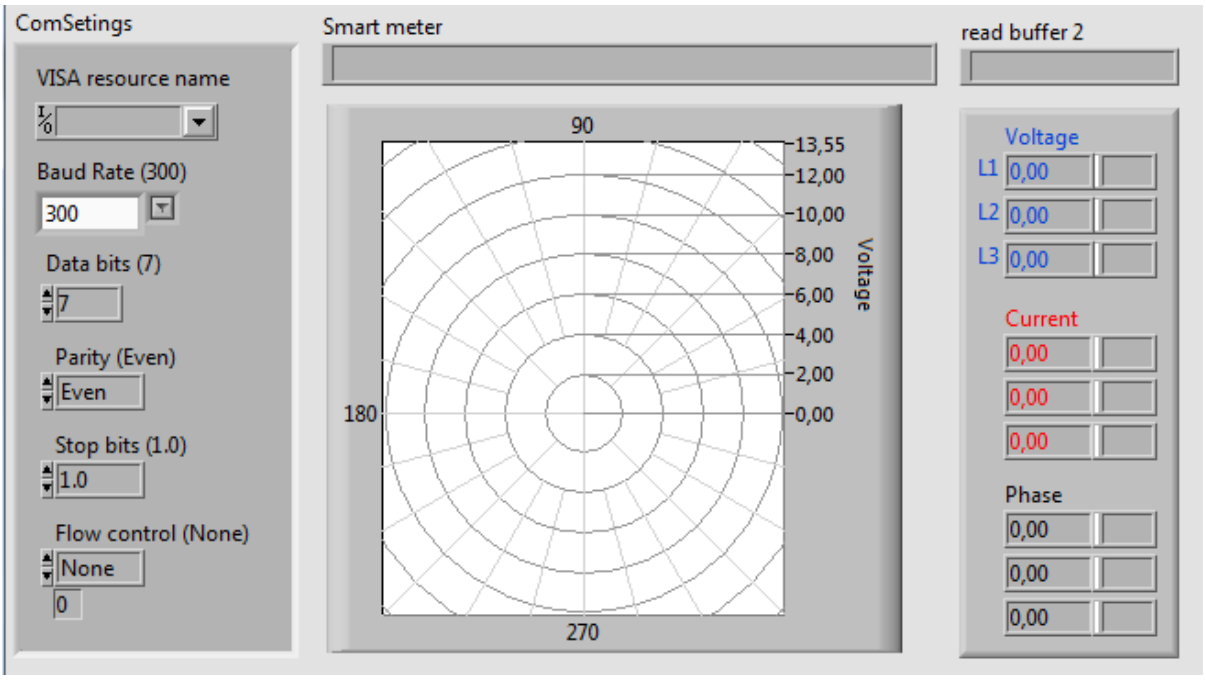

Fig. 5 Smart meter data window

Test panel allow comparing the values measured by reference standard and read from smart meter by optic head. Before communication start with smart meter is necessary to set

communication parameters for optic head adapter. This is particularly the speed of communication, which can be in a variety of smart meters is defined differently.
Smart meter data window reads the actual values recorded to smart meter. Phase diagram can by created from the values. All measured values are shown numerically. A graphical representation is showed for better orientation in the results.

3. Testing the measuring set

The system has been tested only on simple tests when running sine and also when running distorted waveforms. Test and subsequent consultation with distribution network operators showed justify the system and the requirement from technical practice. Based on the responses to the created system will be modified next steps for the tests were focused on the most common problems.
During tests are compared values from the Main window and Window Smart metering data. Form and expression of the measured differences can be defined arbitrarily due to variability of Labview.
Block of Smart metering data currently read 9 registers:

- 32.25(),52.25(),72.25() for voltages
- 31.25(),51.25(),71.25() for currents
- 33.25(),53.25(),73.25() for phases

The registers mentioned above correspond to the actual measured values. In case that were analyzed other values that can detect the smart meter, a simple method adds read registers and values are displayed.
The important thing is to have the exact address of the register to be read. The values obtained can be compared with the reference standard outputs or with data from other measuring devices.
The system could be made for the case that the data were compared with those consigned to the data centers. Such a solution but requires parameterized settings headquarters and create a working data connection created with the database system. At this stage, the aim of verifying the measured data and they are stored in memory registers.

Conclusions

Developed system is under debugging. Highlights include established software modularity and easy adaptability according to current requirements. This variability is given variability of LABVIEW program, through which the whole system is created. Even in developing parts of the program, emphasis was placed on creating blocks that can be configured as a different edit.

Developed system has great potential for testing smart meters and supports the different parties to deploy the technology and also to eliminate some problems.
Additional steps that could finalize the generation of power interruption and monitoring how these interruptions evaluates the smart meter.
Since it is possible for smart meters to define many functionalities, it is also necessary to leave the system in an optimal manner designed to be customizable open to emerging needs.

References

Standards

[1] IEC 736 Testing equipment for electricalenergy meters
[2] IEC 387 Symbols for alternating-current electricity meters
[3] STN EN 60521 Class 0.5, 1 and 2 alternating-current watthour meters
[4] STN 35 6111 Induction var-meters. Technical requirements and test methods
[5] STN 35 6113 Maximum demand indicators for electricity meters. Technical requirement and test methods