Examples for Virtual Laboratory Exercises by Electrical Measurements Based on NI ELVIS II

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Abstract – **ELVIS II is leading education platform, based on graphic programmable software LabVIEW. ELVIS II allows education on different technical subjects, in particular by "Electrical measurements". Technical devices and programmable software of the main kit of tools are combined in one structure. In this report are represented examples by laboratory educational tasks on "Electrical measurements". These developments consist of two main components: interactive device for control and LabVIEW virtual instrument for programming functions and control of the workstation.**

Keywords – **Education, NI ELVIS II, LabVIEW, Electrical Measurements, Laboratory Exercises.**

I. INTRODUCTION

During last few years development of the computer technology concerns also education process. In this relation, one present decision is integrated educational platform NI ELVIS (Educational Laboratory Virtual Instrumentation Suite). This educational station is basic decision for development and creation of different laboratory exercises and educational laboratories.

The main character for NI ELVIS is its versatility. It gives possibility of the first knowledge for measurement devices and basic laws of the electrical circuits, connection methods and principle of operation, as well as it gives opportunities for students to design different analog and digital systems, to simulate prototypes of systems and devices in visual modeling environment Multisim 9, realization of the prototype over real platform and its own research with the help of integrated virtual instruments in ELVIS. In this way, students can get unique chance to pass the whole cycle of education – from modeling, through synthesis, till test real prototype over integrated platform.

The platform consists of:

1. Plate for modeling (with 2800 terminals) for independent development from students or teachers of the electrical circuits and patterns, fitting sensors and control mechanisms of the schemes. Generated signals, can be sent to the data save unit.

2. Laboratory station NI ELVIS II with versatility card for saving data PCI, for coordination of the signals, applied

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from data save device within the plate for modeling.

3. Virtual software, consist of 12 instruments, which are most used in the electrical measurements – oscilloscope, digital multimeter, spectrum analyzer, functional generator, variable power supplies etc.

4. Software Multisim 9.

5. Necessary drivers and group of some useful examples for LabVIEW.

6. Personal computer or laptop.

7. Multimedia projector.

II. STATEMENT

Virtual instruments from soft panel (fig.1) of the platform are used for conducting exercises with NI ELVIS II. In discipline "Electrical measurements" in Technical University of Varna are developed complex laboratory exercises, some examples of which are discussed in the present paper.

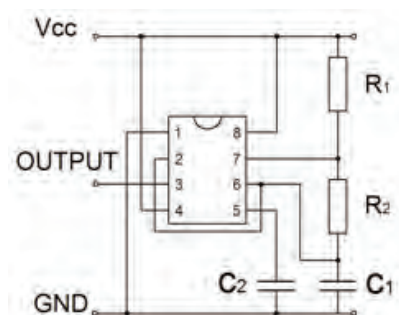Fig.1. Soft panel of NI ELVIS II

Fig.2. Connection diagram of timer LM555

In the first example are investigated quality of pulses generated from timer LM 555, upon frequency and time domain. Fig.2 shows connection diagram of the timer, and Fig.3 the real connection of the elements over platform NI ELVIS II. It is generated signal with frequency about 11 kHz. Frequency defining components are: R_1, R_2 and C_1. They determinate and the duty coefficient, which can be represented with equation:

$$K=T_1/T, \qquad (1)$$

were T_1 is duty period and T is the whole time period of the signal. Using potentiometers in this positions, duty coefficient and frequency can be altered in wide borders. For research the square impulse, generated from timer, are used oscilloscope (SCOPE) and digital spectrum analyzer (DSA) from the soft

panel. In this way, by measuring upon time and frequency domain its easily to see distortion in the shape of generated square signal. Mathematically, this rectangular impulse can be represented by Fourier series:

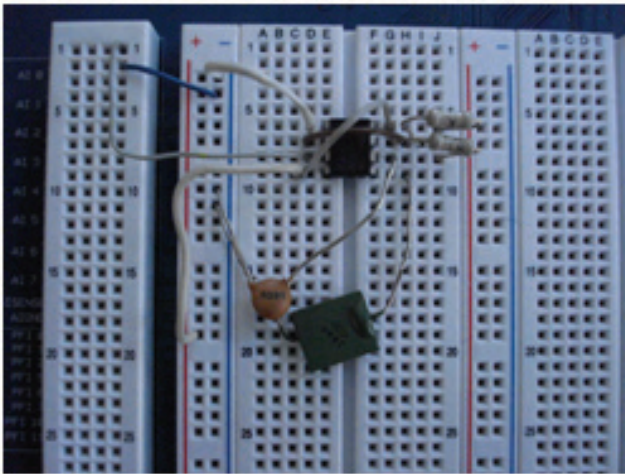$$f(\omega) = \frac{4A}{\pi} \sum_{n=1}^{\infty} \frac{1}{2n-1} cos((2n-1)\omega) \qquad (2)$$

Fig.3. Screenshot of real connection of the timer

In other words signal is composed from odd harmonics with fading amplitude. Fig.4 and Fig.5 shows measurements with the SCOPE and DSA. Diagram from Fig.4 shows real form of the generated impulses.
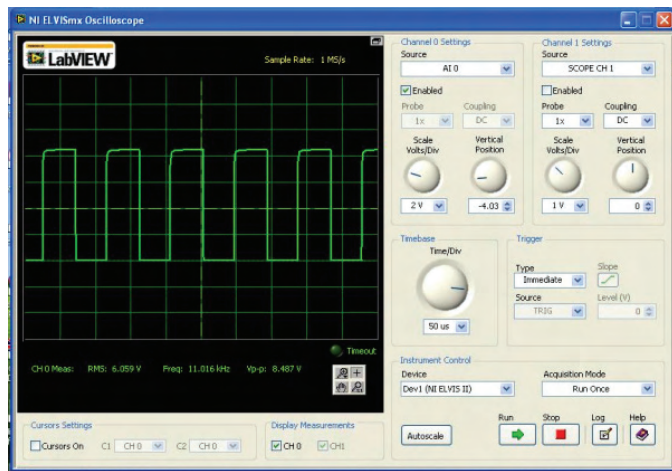

Fig.4 Time domain diagram

Asymmetry at the front of the pulse is due to transient process in the scheme and when we look carefully to the spectrum of signal, can be noticed presence of high order odd harmonics (from 15-th by 19-th) with high level and also presence of even harmonics, which shouldn't be there if consider mathematically. With appropriate filters can be find out that high order harmonics, has influence on the fronts of the impulses and low order - on the stability of the levels. Changing duty coefficient and frequency, students can meet different kinds of square signal and their spectrums, as well as the potentialities of the timer LM 555.
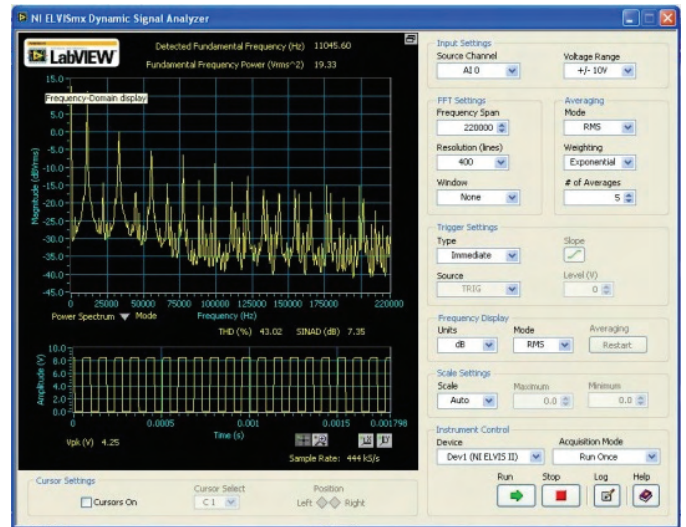

Fig.5 Frequency domain diagram

Second example shows measurement of voltage by method of comparison with the help of the compensator. Wiring diagram (Fig.6) is well known from the theory, and its realization by NI ELVIS II is shown on the Fig.7.
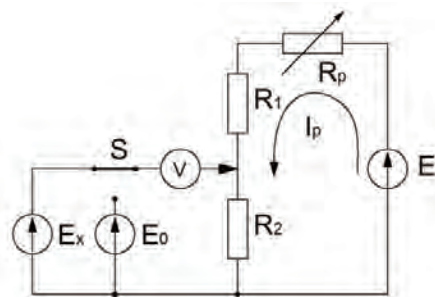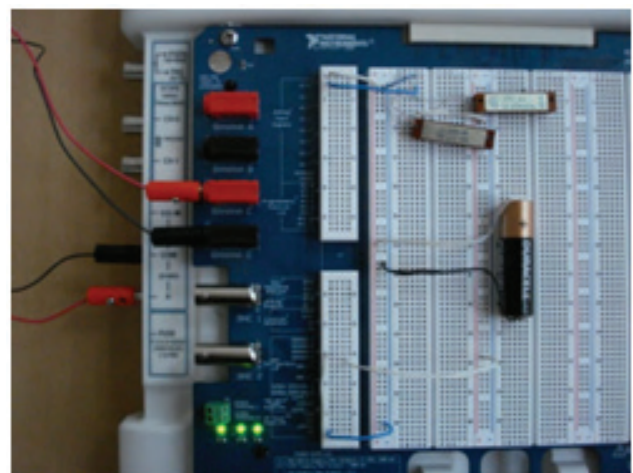

Fig.6. Diagram of the compensator.

Fig. 7. Screenshot of real connection of the compensator

For zero indicator is used virtual oscilloscope (SCOPE), and by DMM, can be measured working current Ip in the compensator's circuit. Standard voltage E0 is applied from variable power supplies of the platform (VPS), which is known near hundredth, but this can be improved using real

standard element providing voltage with a high precision. First one of the helical potentiometers (Rp) is for adjustment of working current (Ip) and other one is a voltage divider (R_1, R_2) for balance the compensator during measurement. In this case is shown measurement the voltage of a small battery. After balance of the compensator SCOPE shows zero volts (Fig.8), with the help of the virtual instrument for impedance measurement (IMPED) is read the resistance of divider (R2) (Fig.9).
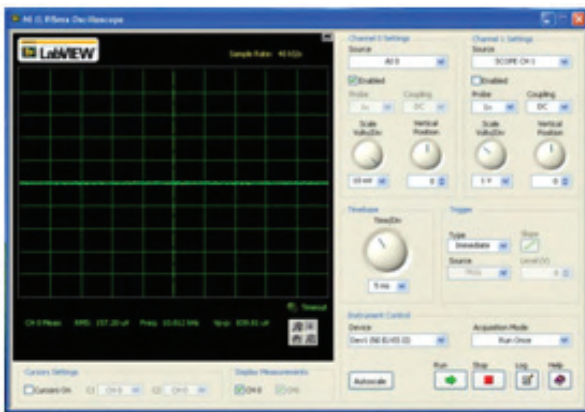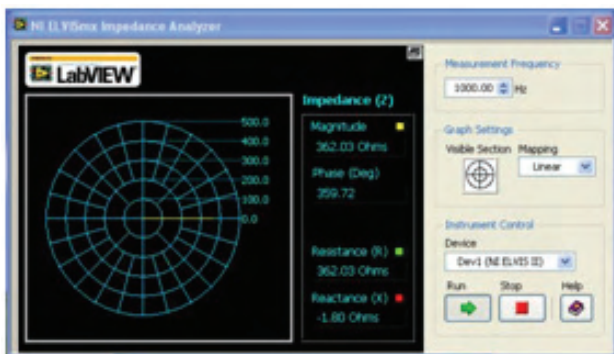

Fig.8. Reading of the Zero Indicator

Fig.9. Reading from the IMPED

Unknown voltage can be calculated with:
$$U=Ip.R_2 \qquad (3)$$
Another example for usage this device is for calibration of electromechanical voltmeters, but this case is possible if is used more accurate standard source instead of VPS.
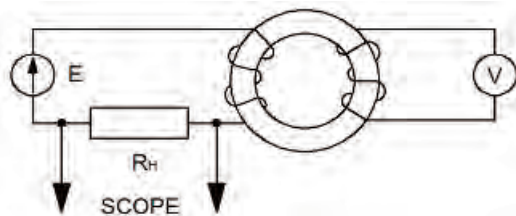

Fig.10. Examination of ferromagnetic materials by ammeter and voltmeter's method

Next example concerns investigation of ferromagnetic materials by ammeter and voltmeter's method (Fig.10).

Connection over the NI ELVIS II platform is shown in Fig.11. Examined material is electrical steel with magnetic line length l=0,1 m. and section $S=5.10^{-6}$ m^2. Magnetization coil L_1 has $w_1=1400$ windings and measurement coil L_2 has $w_2=450$ windings.
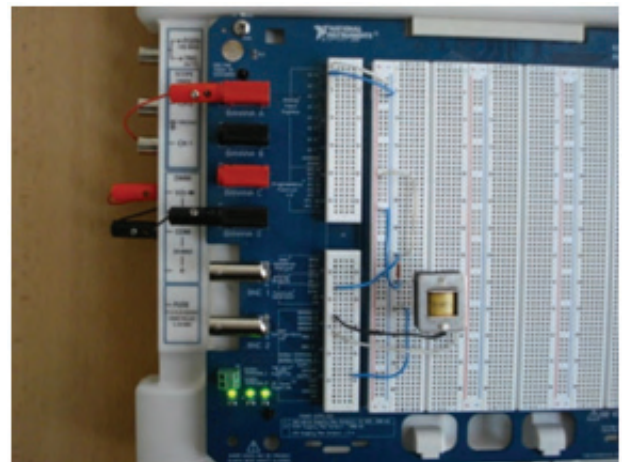

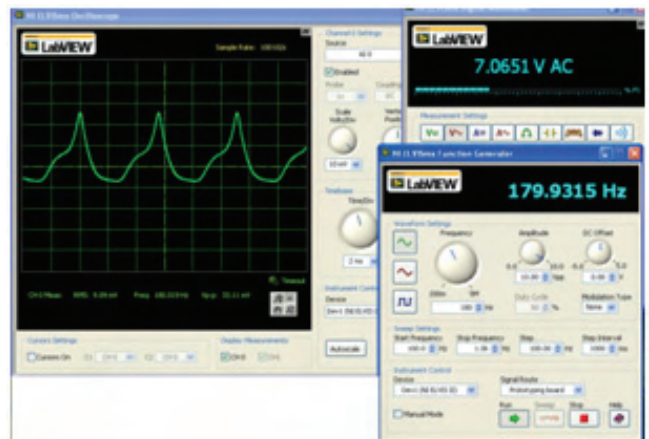Fig. 11. Real connection of the pattern

Fig. 12. Screenshot of the process of magnetization

For magnetization source is used integrated functional generator (FGEN), which can be activated from soft panel. The frequency in our case is 180 Hz. In magnetization circuit is connected resistance $R_H=12\Omega$, for measurement drop of the voltage over it and calculation of magnetization current $Im = Um/R_H$, with the help of the SCOPE from the soft panel. Non-linear character of the input current, enforces usage of the SCOPE. In the circuit of the measurement coil w_2 is connected voltmeter (DMM), which shows induced electromotive force. By this way is realized magnetization of the examined pattern with FGEN and primary coil L_1 and measurement of the induced electromotive force in secondary coil L_2 by DMM. Measurement current of the magnetization become possible with the SCOPE and its regulation is from virtual panel of the FGEN. A screenshot of this process is represented in Fig.12. By using measured electric values (Um and U_2), student can easily obtain amplitudes of the magnetic values (Hm and Bm), which correspond to the electrical, with the relations:

$$B_m = 4{,}44.f.w_2.S \qquad (4)$$

$$H_m = \frac{U_2 w_1}{R_H.l} \qquad (5)$$

From upper measurements and calculations is obtained one point of the magnetization curve B=f(H). By changing the level of magnetization of used pattern and reaching the saturation point, student can obtain necessary number of points of this dependence and trace entire curve out. With further calculation, can be received other main parameters like magnetic looses in the pattern and permeability.

The last example in this paper is linear Wheatstone bridge (Fig.13) and it illustrate accurately measurement of resistance in the environment of the NI ELVIS II workstation. On the Fig.14 is represented working scheme and used elements. Power of the bridge is applied from VPS, and for zero indicator is included DMM. Adjustment of the bridge can be accomplished with helical potentiometer (R_1, R_2).
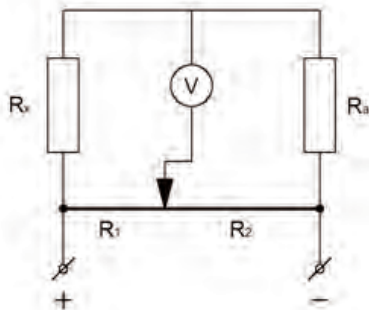

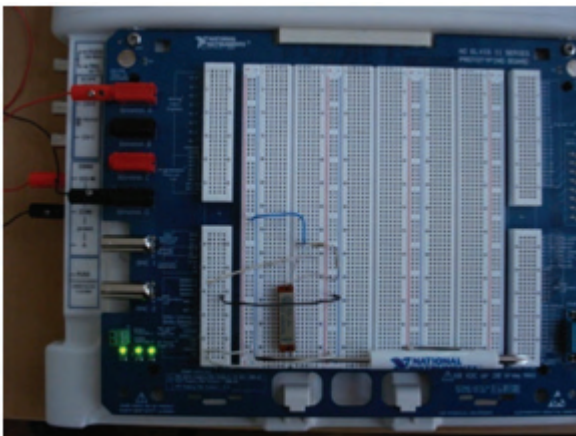Fig.13. Wiring diagram of the linear Wheatstone bridge.

Fig.14. Real connection of the linear Wheatstone bridge.

When bridge is balanced, should be measured the resistance between endmost points of the potentiometer to the middle point, which are two of bridge's branches (R_1, R_2). These resistances are obtained with the virtual instrument IMPED from soft panel. The unknown resistance is calculated with:

$$R_X = \frac{R_1 R_A}{R_2} \qquad (6)$$

III. CONCLUSION

The shown examples illustrate usage of the platform NI ELVIS II by construction and execution of different by kinds and complexity laboratory exercises, made in discipline "Electrical measurements". Advantages of the used virtual instruments obviously are: easy and quickly realization of the examined schemes and components, compactness by using different measurement units (almost all of the required instruments in electrical measurements laboratory are available), possibility of easy combination, reconstruction and enlargement of the investigated scheme, clarity, simplicity, and presence of built in defenses. These virtual instruments are more interesting for students and more understandable. This virtualization in laboratories reveals big opportunities for improving process of education and this new approach also lets materially to expand variation of the exercises, rising individual work with the students.

REFERENCES

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[3] www.ni.com/elvis/