ANNALS
OF THE UNIVERSITY OF PETROŞANI

ELECTRICAL ENGINEERING

VOL. 15 (XXXXII)

CONTENTS

ACTUATION SYSTEM OF AN ELECTROMAGNETIC CONTROL ELEMENT DEVELOPED IN LABVIEW

CORINA CUNȚAN[1], IOAN BACIU[2]

Abstract: The paper presents the actuation system of an electromagnetic element whose control is developed in LabView. The actuation is performed when the entered code is identical to the previously stored one. If someone enters another code, the circuit blocks.

Keywords: digital control, actuating element, parallel port, Sub-VI blocks.

1. INTRODUCTION

For analysing the synchronous sequential logic circuits, we know the circuit diagram which meets all the requirements of proper operation, and we must deduct, from the inputs $X(t_i)$ and the circuit state $Q(t_i)$, the outputs $Y(t_i)$ and the subsequent state $Q(t_{i-1})$.

The analysis should be done for each *state - input vector* combination. We are going to illustrate the analysis on the machine diagram shown in Fig. 1.

After examining the diagram, we begin the analysis by writing the expressions of the transition variables (D_1 and D_2), and the output quantity. We can deduct the following expressions:

$$D_1 = \overline{X} \cdot \overline{Q_2} + X \cdot Q_2 \tag{1}$$

$$D_2 = \overline{X} \cdot Q_1 + X \cdot \overline{Q_1} \tag{2}$$

$$Y = \overline{X} \tag{3}$$

[1] *Lecturer Ph.D. eng. Corina Daniela Cunţan, Politehnica University of Timişoara, Faculty of Engineering of Hunedoara, corina.cuntan@fih.upt.ro*
[2] *Lecturer Ph.D. eng. Ioan Baciu, Politehnica University of Timişoara, Faculty of Engineering of Hunedoara, baciu.ioan@fih.upt.ro*
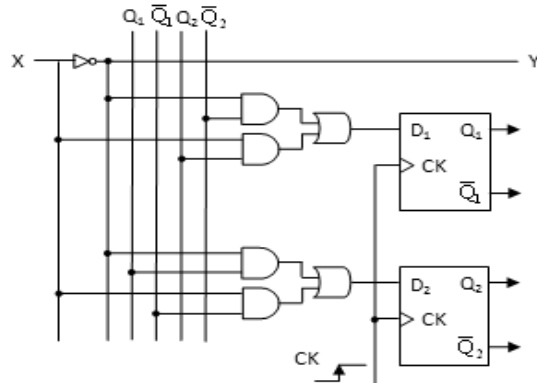
Fig.1. Diagram of a synchronous sequential logic mono-register circuit

Using the equations (1) and (2), we can fill in the transition table (Table1).

Table 1. **The transition table**

		X=0		X=1	
Q₁	**Q₂**	**D₁**	**D₂**	**D₁**	**D₂**
0	1	0	0	0	1
0	0	0	0	1	1
1	1	1	1	0	0
1	0	1	1	1	0
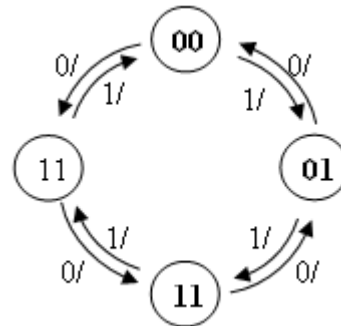
Fig.2. The state diagram

From the transition tables, taking into account the fact that the flip-flops that make up the state register are D-type, active on the positive edge of clock, we can deduct the state table - $Q_{(t_{i+1})} = D_{(t_{i+1})}$ - shown in Table 2.

In table 2, the output quantity variation has been added to the state table.

Table 2. **The state table**

$Q_1(i)\ Q_2(i)$		X = 0		X = 1		X = 0	X = 1
		$Q_1(i+1)\ Q_2(i+1)$		$Q_1(i+1)\ Q_2(i+1)$		$Y(i)$	$Y(i)$
0	0	1	0	0	1	1	0
0	1	0	0	1	1	1	0
1	0	1	1	0	0	1	0
1	1	0	1	1	0	1	0

The combined data included in table 2 describe perfectly the operation, for each *state - input quantity* couple being specified the next state and output signal.

The operation description can also be done using the transition graph shown in Fig.2. As can be seen, the machine has four states, determined by the quantities Q_1 and Q_2. [6]

2. THEORETICAL PRESENTATION

2.1 Synthesis of a synchronous sequential logic circuit

If for analysis we know the diagram and we need the description of machine operation by filling in the state & output tables or by showing the transition graph, in case of synthesis, we know the description of the desired operation and we seek to find the machine diagram, consisting of gates and flip-flops able to perform the desired function.

Below we show a synthesis example for a synchronous sequential circuit. [6]
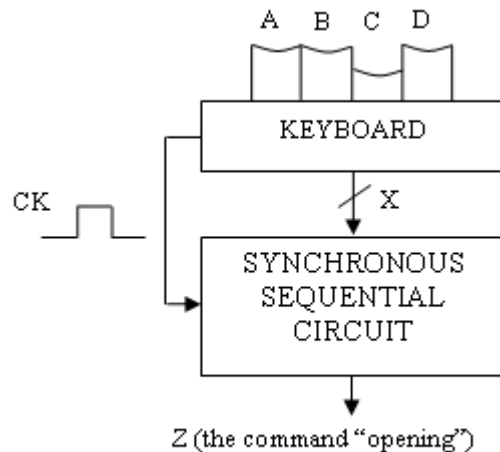
Fig.3. The block diagram of the machine

1. Formulation of the working conditions
- Any time we press the keys A, B, C or D, a clock pulse is generated towards the sequential circuit;
- The keys may be pressed repeatedly, but only one at a time;
- The output quantity Z commands the locking system as follows: Z = 0 (locking) and Z = 1 (opening);
- During pressing a key, the keyboard generates a linear sequence X. The quantity X will indicate, in encoded form, the key that was pressed, will be synchronized with the clock and will represent, for our machine, the input vector.

2. Formulation of the problem

- A sequence of commands (pressed keys) will be specified, which allow (at any time) the door closing and correspond to bringing the machine to its original state;
- Starting from the initial state, the door will open once the DBAC sequence has been typed.

3. *Drawing the transition graph by using coded states*

The transition graph, which describes the machine operation, is shown in Fig. 4.

The machine states were marked with the letters a, b, c, d and e; their encoding is going to be decided in the next step. The number of states and the shifting conditions from one state to another are known from the problem formulation.

The significances of the states are:

- **state a**: initial state;
- **state b**: the state that corresponds to starting a sequence with the letter D;
- **state c:** the state that corresponds to the recognized subsequence DB;
- **state d**: the state that corresponds to the recognized subsequence DBA;
- **state e**: the recognized sequence DBCA and actuation of the opening system.
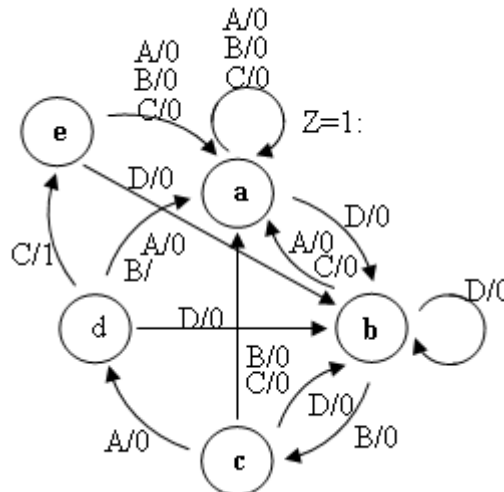
Fig.4. The transition graph associated to the machine

The shifts are designed so that the machine returns to its initial state if the letter *D* is not typed first, and goes back immediately to its initial state if the partial sequences are not continued correctly. The opening mechanism will be triggered as soon as the system is in state *d* and the key *C* is pressed. After the door has been opened, it can be closed by pressing any key once. The initial state can be reached from any state, by pressing the key *A* not more than twice (the condition provided in the first paragraph of problem formulation).[6]

2.2 Encoding of states and input quantities

At this point of synthesis, we have to decide the modality to encode the input quantities X, which correspond to the keys A, B, C and D and, in the same time, to

decide the modality to encode the internal states of the machine, noted with a, b, c, d, and e.

<table>
<tr><td colspan="2">Table 3 State encoding</td><td colspan="2">Table 4 Input quantities</td></tr>
</table>

Machine states	**Q[1 : 3]**			**Input quantities**	**X[1 : 2]**	
a	0	0	0	A	0	0
b	0	0	1	B	0	1
c	0	1	0	C	1	0
d	0	1	1	D	1	1
e	1	0	0			

There are no strict rules regarding the encoding, but it should be taken into consideration that it affects directly the machine complexity.

Given the fact that the machine has five states, their encoding requires binary words whose minimum length is equal to three, which will require the use of three flip flops in the state register structure.

$$Q[1:3] = \{Q_1, Q_2, Q_3\}$$

(4)

The state encoding is shown in Table 3. Regarding the input vector X, it must ensure the correspondence between each pressed key and a binary codeword (Table 4). Theoretically, the codeword length is arbitrary, but it should be taken into account the fact that, in case of long words, the number of gates needed to generate them will be great. If we want to realise a machine with a minimum number of gates, then the four keys will be encoded with code words whose minimum length is equal to two (Table 3). [6]

3. PAPER PRESENTATION

3.1 Presentation of the electronic cipher operation

The control circuit shown below encodes a number in sufficient variants to prevent breaking the code by an unauthorized person. If the three numbers that compose the code are correctly entered via a keyboard, the circuit commands a certain execution element. When typing a wrong number, the execution section is automatically blocked. The diagram has a slightly higher level of complexity compared to other similar diagrams, but offers several advantages that will be described further.

The code number sequence is essential. Also, there is no interdiction to repeat the same digit in the code number. If entering a wrong number, the diagram does not shift to the initial standby state until a special key is pressed to unlock it. The most important aspect is the extremely flexible possibility to change the code. For changing

the code we use the keyboard, the code being stored in three memory registers. Of course, it is required to firstly enter the prior code. [2]

3.2. Realization of the control circuit in the LABVIEW program

The application was realised in LabView, starting from the block diagram of the electronic cipher (Fig. 5). The control panel of the electronic cipher contains the keys for entering the code, the keys for resetting the diagram, and the LEDs for indicating the cipher state. [1]
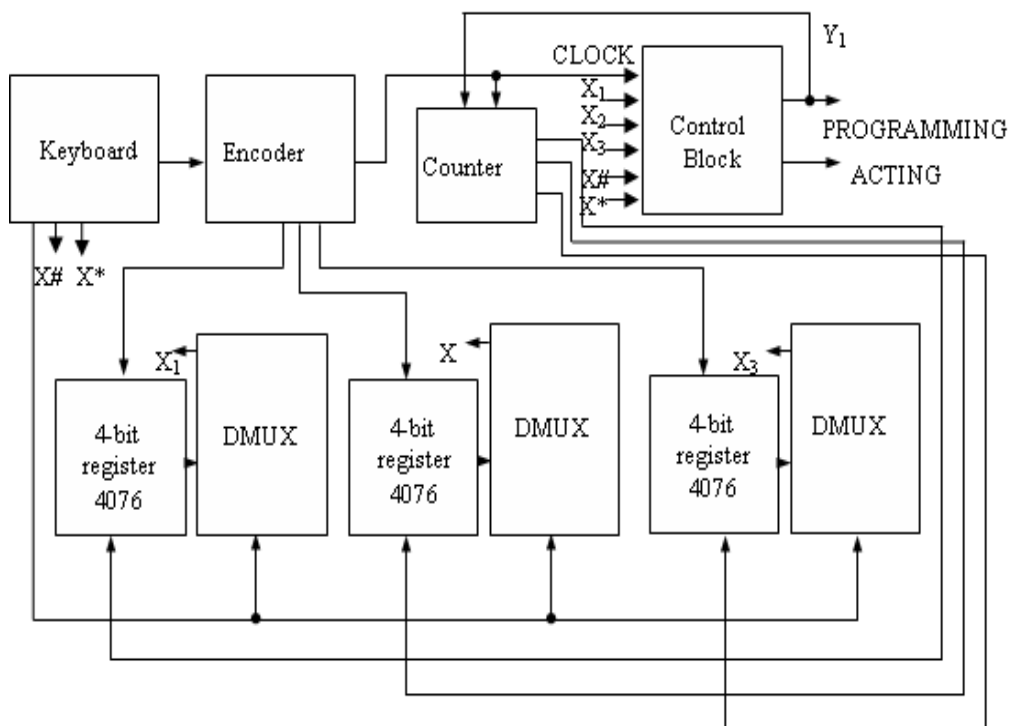
Fig.5. Block diagram for the programmable electronic cipher

The electronic diagram of the control circuit presented in Fig. 6 contains the following functional blocks: the encoder, the 4-bit memory registers (MMC 4076), the multiplexers (MMC 4067), the counter and the control block. [4], [5]

The control block consists of a Moore state machine.

The encoder allows obtaining a sequence of 4 bits for all 10 entries, sequence which corresponds to the selection keys of the circuit code.

This one contains 10 Boolean controls and 4 Boolean indicators to display the output sequence.

The Moore machine realised in LabView (Fig. 7) allows obtaining the states corresponding to the control stages at the flip-flop output. [3]
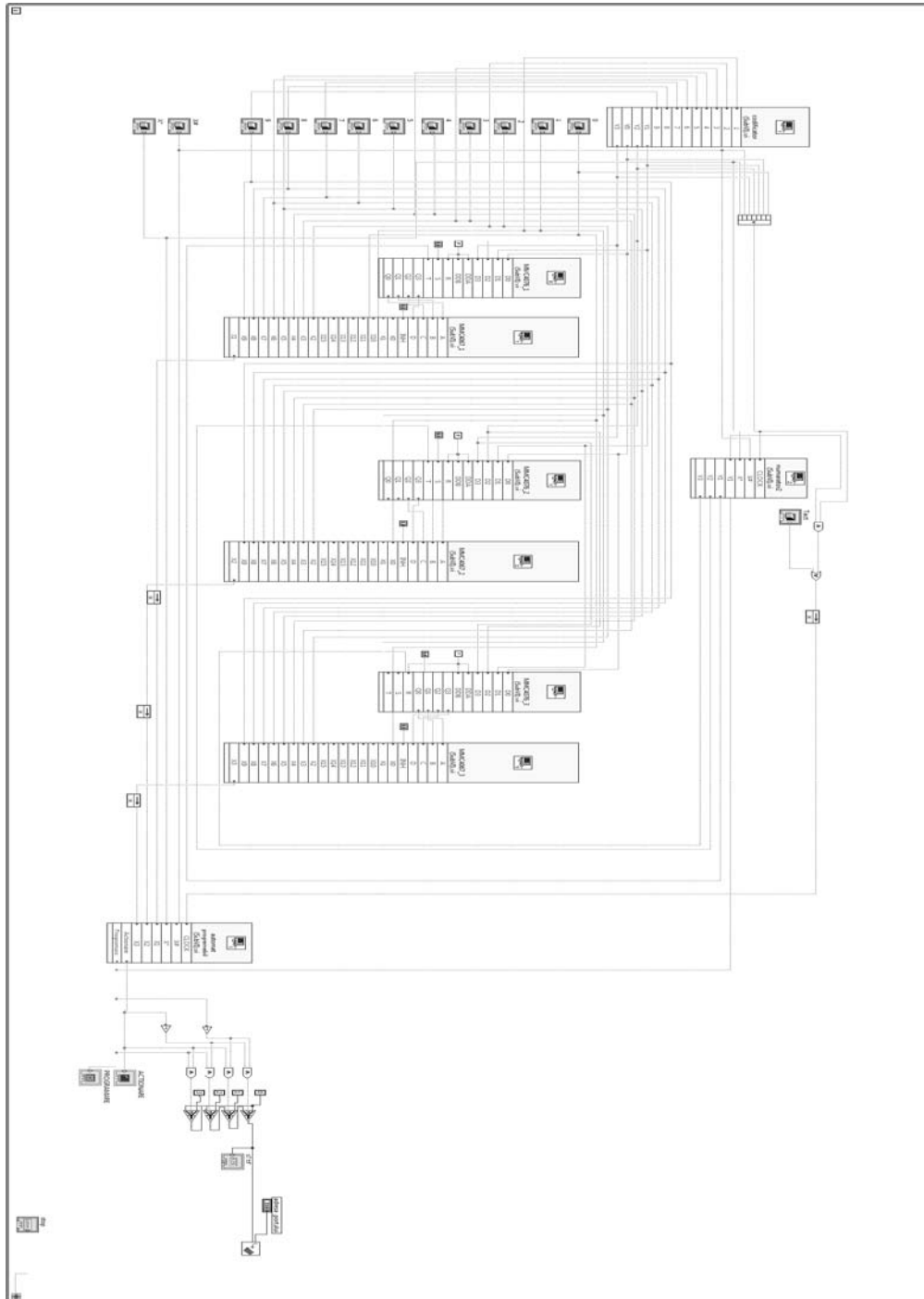
Fig.6. The general electronic diagram of the control circuit

After sequentially entering of the stored code numbers, we can see the states of the flip-flops which are components of the state machine, states that correspond to those included in the actuation state diagram. (Fig. 8)

In case of failure to comply with the number sequence, or if a wrong code is typed, the circuit is blocked and must be reset.

To change the code, the circuit must be switched to the programming state, and the new code is entered following the steps mentioned above.

The Moore machine realised in LabView (Fig. 7)_allows obtaining the states corresponding to the command stages at the output of flip-flops. [3]

After sequentially entering of the stored code numbers, we can see the states of the flip-flops found in the state machine, states corresponding to those found in the state diagram at actuation. (Fig. 8)

In case of failure to comply with the number sequence, or if a wrong code is typed, the circuit is blocked and must be reset.

To change the code, we shift the circuit to the programming state and enter the new code by following the steps mentioned above.
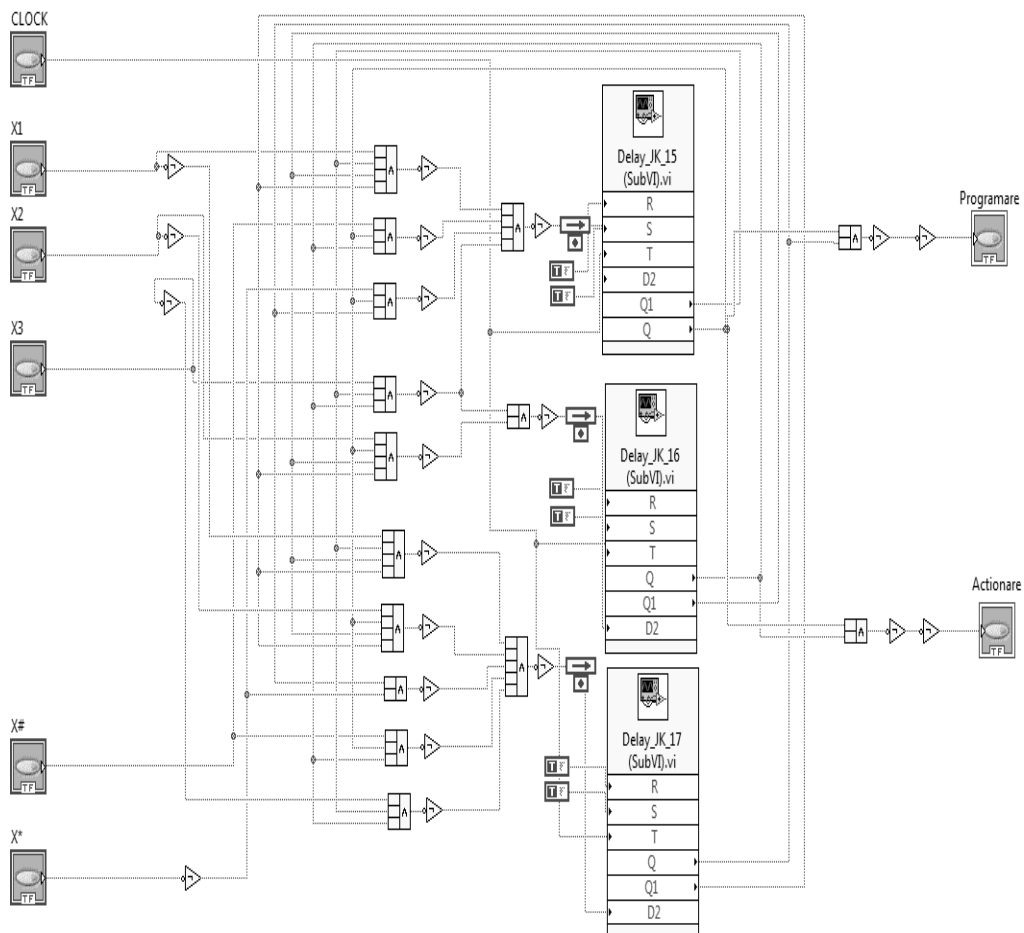
Fig.7. The Moore state machine realised in LabView
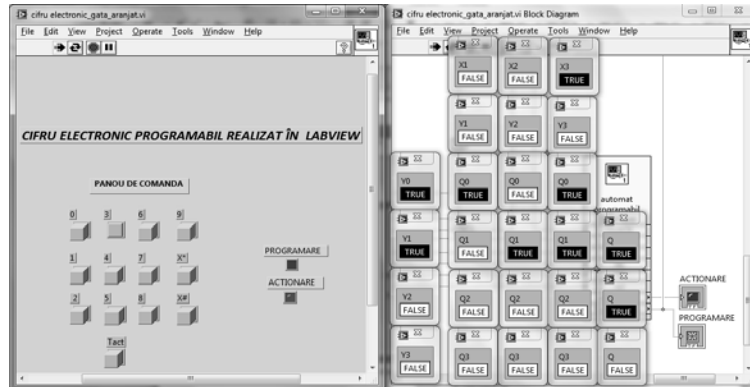
Fig.8. The front panel and flip-flops status in the state machine corresponding to the actuation command

3.3 REALIZATION OF ELECTROMAGNETIC ACTUATORS

3.3.1 The Parallel Port Programming in LabView

The parallel port is used for computer communication with the peripheral equipment and PC supervision of the various processes. The standard connector of the D-type parallel port is a female connector with 25 pins. The standard IEEE 1284 defines 5 modes of operation of the parallel port:

  1. Mode "Compatibility" or standard;
  2. Mode "Nibble";
  3. Mode "Byte";
  4. Mode EPP (Enhanced Parallel Port);
  5. Mode ECP (Extended Capabilities Port).

The first 3 modes use only the hardware found on the ordinary parallel port plates, while the EPP and ECP modes require additional hardware [1]

In the *Compatibility* mode or SPP, the parallel port is unidirectional. Because most of the bits with which the parallel port is working have a correspondent in the connector, they shall have a correspondent pin with which they are directly connected.

The SPP registers and the significance of bits are given in the following table:

The pin number is the number written on the connector next to each pin. "In" represents data transfer from the peripheral to the port, and "Out" from the port to the peripheral.

At the pins 1, 11, 14, and 17, the signal is inverted by the hardware board, and the pins from 18 to 25 are neutral.

The first byte labelled "Base+0" is called data register or data port, because it ensures data exchange between the computer and the peripheral (e.g. the printer) through the parallel port. All its bits are data bits.

The second byte labelled "Base+1" is called state register; it is an input register that enables reading the peripheral equipment state.

The third byte labelled "Base+2" is called control register; it is an output register that enables the control of peripherals.

Table 5 **SPP registers and significance of the bits**

Offset	Register	In/Out	Bit no.	Pin no.	Use
Basis+0	Data register	Out	7	9	Data 7
			6	8	Data 6
			5	7	Data 5
			4	6	Data 4
			3	5	Data 3
			2	4	Data 2
			1	3	Data 1
			0	2	Data 0
Basis+1	State register	In	7	11	Busy
			6	10	Ack
			5	12	Paper Out
			4	13	Select In
			3	15	Error
			2	-	IRQ
			1	-	Reserved
			0	-	Reserved
Basis+2	Control register	Out	7	-	Unused
			6	-	Unused
			5	-	Enables the port as bidirectional
			4	-	Enables IRQ
			3	17	Select Printer
			2	16	Reset
			1	14	Auto Linefeed
			0	1	Strobe

3.3.2 Sizing and realization of the magnetic actuation circuit
The power supply
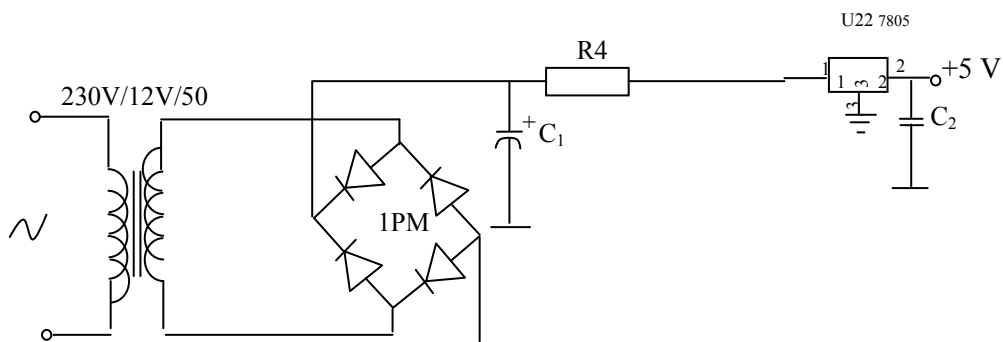
Fig.9 The wiring diagram of power supply

The wiring diagram supply is made through a transformer powered by 230V, which outputs a voltage of 12V / 9W.(Fig.9)

The bridge rectifier must be 1PM1-type, supporting a current of 1A. The selected filter capacitor must have the capacity C = 1000 μF / 25 V.

For the stabilized 5V-source, we use the integrated source of LM7805 type, which is connected to 12 V through a current limiting resistor.

$$R_4 = \frac{12-5}{1,5} = 46,95\Omega$$

(5)

R_4 must have 47Ω.

For protection against voltage peaks, a capacitor of 22nF is connected to the source terminal of 5V.

The actuator is controlled by a relay contact, the command view being made by using a signal lamp, powered by 12V. (Fig.10) For controlling the relay, we choose a BD237-type transistor. The maximum current passing through the transistor is determined by the relation:

$$I_C = \frac{U_{CC_1}}{R_L} = \frac{12\ V}{350\ \Omega} = 0,35\ A$$

(6)
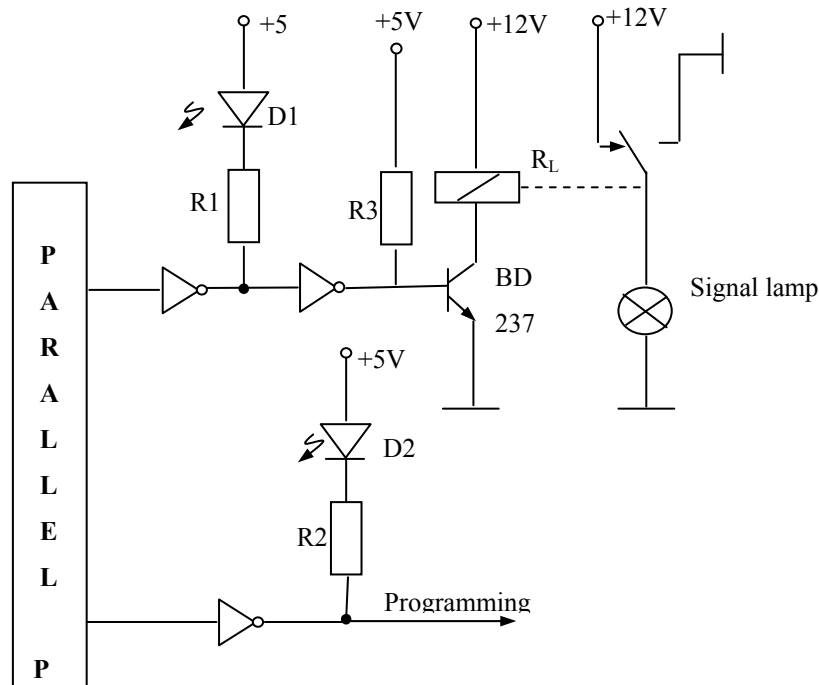
Fig.10 Wiring diagram of the actuation circuit

The maximum current of the chosen transistor exceeds this value and requires no heater. Its control is made through a BM7406N-type inverter with open collector, capable of supporting a low current of 48mA.

To obtain the control current, we need a bias resistor in the BD237 transistor base, where

$$R_3 = \frac{U_{CC_1}}{I_b + I_0} = \frac{5V}{2,8\,mA} = 1,8\,k\Omega$$

(7)

To view the commands, we use 2 LEDs controlled from the parallel port through a DM7406N-type inverter, and the LED current limitation is realised by means of the resistors R_1 and R_2, with the following values:

$$R_1, R_2 = \frac{U_{CC_1}}{6\,mA} = \frac{5V}{6\,mA} = 0,63\,k\Omega$$

(8)

To illustrate the operation, we show two states of the circuit: standby state and actuation state, which are visually indicated by means of their corresponding LEDs.(Fig.11, Fig.12)
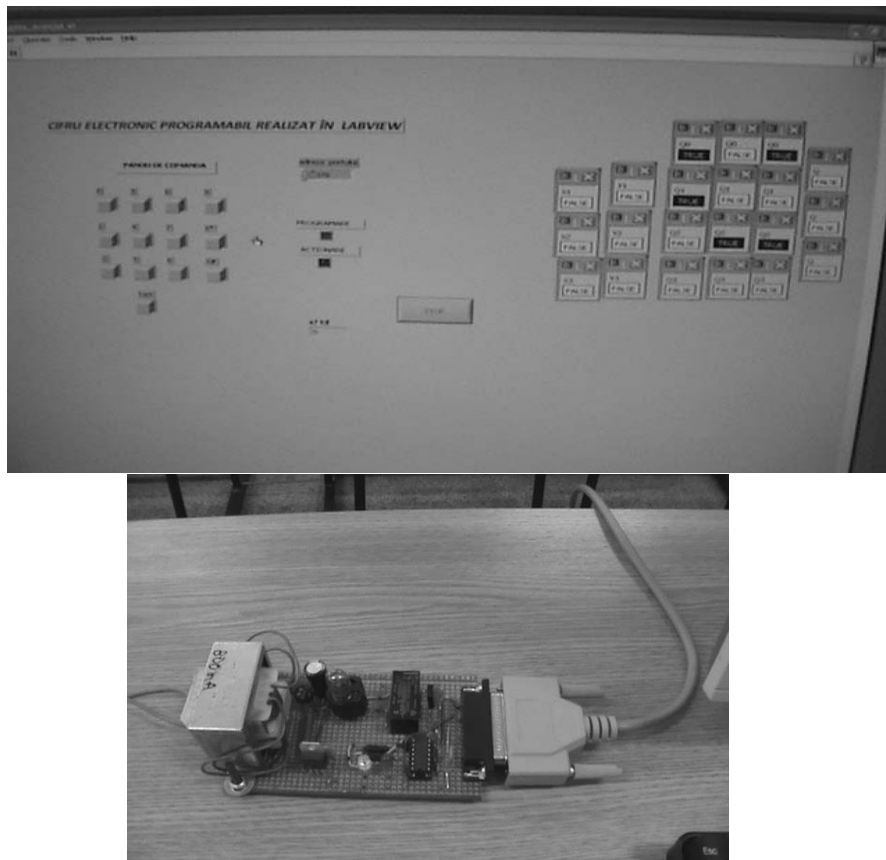
Fig.11 The state of the front panel of the control circuit and the actuation module connected to the parallel port in the standby state.
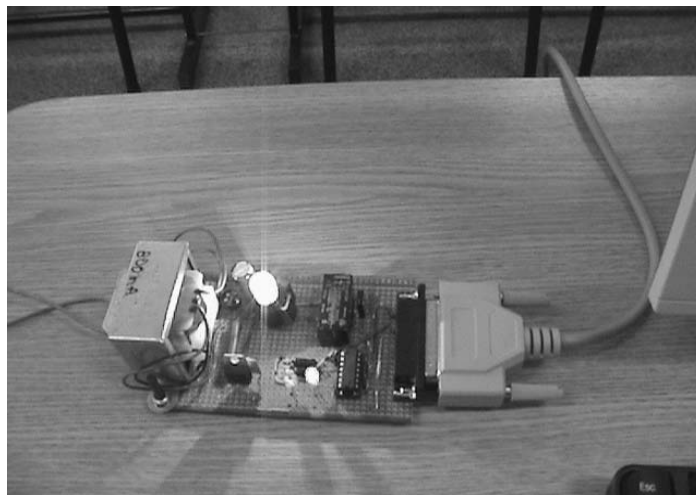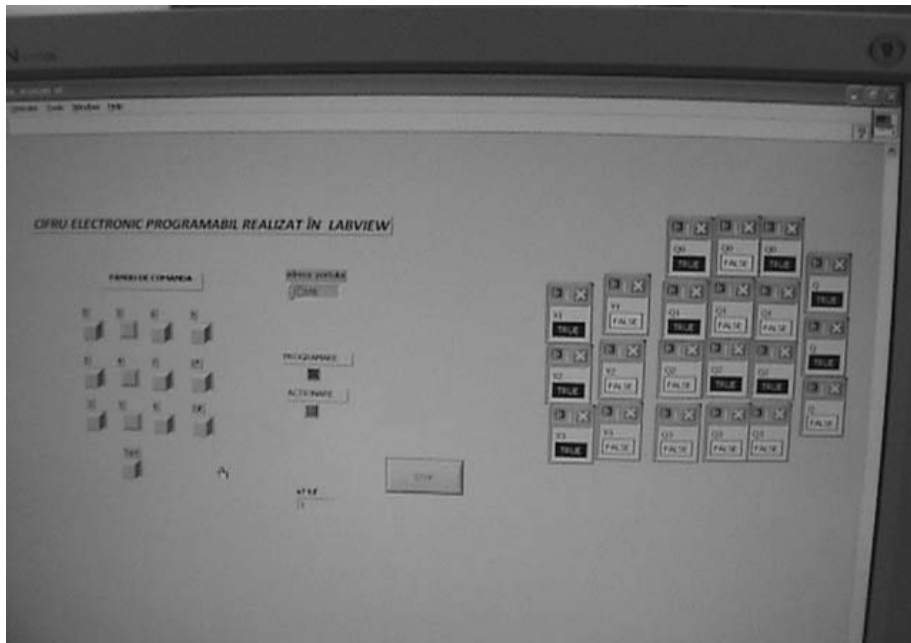
Fig.12 The state of the front panel of the control circuit and the actuation module connected to the parallel port in the actuation state

4. CONCLUSIONS

The electronic circuit diagram is realised using functional blocks. Because the diagram contains multiple identical blocks, we have used the facilities provided by LabView, consisting of the possibility to use Sub-VI blocks.

Each block was individually made and tested, and then its operation has been checked. Using the program LabView and its facilities to provide control signals to the parallel port, we obtained an actuation command.

The obtained command is brought to the actuation system input via a parallel cable. The control signal is amplified in current by means of the integrated circuit DM 7406 and brought under the control transistor.

The transistor controls a K1CK012W-type time relay actuating the execution element represented in this application of a signal lamp.

To obtain a higher power control, another execution element must be inserted between the relay and the controlled element.

The visualisation of the commands obtained at the parallel port is realised by two LEDs, one for the programming command and one for the actuation command.

REFERENCES

[1]. **Francis Cottet, Octavian Ciobanu,** *Bazele Programării în LabView* [LabVIEW Programming Fundamentals], Publisher: Matrix Rom, Bucharest, Romania, 1998.

[2]. **Cristian Pîrvu,** *Note de Aplicaţie în Electronica Digitală* [Application Notes in Digital Electronics], Publisher: Albastră, Cluj Napoca, Romania, 2007.

[3]. **Nicolae Robu,** *Arhitectura Calculatoarelor* [Computer Architecture], Publisher: Politehnica, Timişoara, Romania, 2001.

[4]. **Ardelean I. (team),** *Circuite integrate CMOS. Manual de utilizare* [CMOS integrated circuits. User's manual], Publisher: Tehnică, Bucharest, 1986.

[5]. **Stojanov I. (team),** *De la poarta TTL la Microprocesor* [From the TTL gate to the microprocessor], Publisher: Tehnică, 1987.

[6]. **Istvan Sztojnov, Sever Paşca, Nicolae Tomescu**, *Electronică Anologică şi Digitală* [Analogue and digital electronics], Publisher: Albastră, Romania, 2008.

[7]. *www.alstom.com/power.*

DETERMINATION OF THE DETONATORS EQUIVALENT CAPACITY IN ACCORDANCE WITH THE REQUIREMENTS OF DIRECTIVE 93/15/EEC

DANIELA CARMEN RUS[1], ATTILA KOVACS[2], EMILIAN GHICIOI[3], GABRIEL VASILESCU[4]

Abstract: This paper concerns the development of the testing and evaluation of the essential safety requirements for determining equivalent initiation capability to initiate detonators in the project PN 07 45 03 09 NUCLEU/2012-2013 under the program.

The project aims at development the test and evaluation of the essential safety requirements set out in Directive 93/15/EEC on explosives for civil uses which include electrical and non-electrical detonators.

CEN has developed a series of harmonized standards with describing the technical requirements to be applied to perform laboratory and function (blasting) tests in order to assess the essential safety requirements in accordance with series of standards EN 13763 adopted in the Standardization Committee ASRO CT 358 "Explosives for civil uses" whose presidency is held by INCD-INSEMEX.

The project is important because development of the test is required to record technical and scientific progress in the field of thought and increased confidence of the accredited and other authorities.

Keywords: initiation capacity, detonators, explosion pressure, hydrodynamic conditions.

1. GENERAL ASPECT

Essential safety requirements on explosives for civil uses are listed in the Annex I to the Directive, HG 207/2005, and these requirements describe to the Directive, HG

[1]*Ph.D.Student Eng.- scientific researcher IIIrd degree at INCD-INSEMEX Petrosani, daniela.rus@insemex.ro*

[2] *Ph.D. Eng.- scientific researcher IIIrd degree at INCD-INSEMEX Petrosani, attila.kovacs@insemex.ro*

[3] *Ph.D. Eng.- scientific researcher IInd degree at INCD-INSEMEX Petrosani, emilian.ghicioi@insemex.ro*

[4] *Ph.D. Eng.- scientific researcher IIIrd degree at INCD-INSEMEX Petrosani, gabriel.vasilescu@insemex.ro*

207/2005, and these requirements describe measures to evaluate any risk of explosives for civil use in all situations and all operations related thereto.

These requirements are structured as follows:

- − General requirements;
- − Special requirements:
  - o For all types (groups) of explosives for civil use;
  - o A for different (groups) such as:
    - • Blasting explosives;
    - • Detonating cords, safety fuses, other fuses and shock tubes;
    - • Detonators (including delay detonators) and relays;
    - • Propellants and rocket propellants.

Assessment of requirements primarily involves identifying and selecting specific requirements that are applicable to a particular product, evaluating and recording their witch did not apply to some other requirements set out in Directive / HG 207/2005.

For blasting detonators are in force harmonized standards taken as Romanian standards, SR EN 13763 series of standards.

The group of means of initiation including detonators and detonating cords containing explosive substances characterized by high sensitivity, intended to initiate explosives and detonate very easily when are subjected to a heat, shock or dynamic impulse. In this way dynamic or initiating impulse wave forms, the energy producing the blasting explosives detonation. (Dumitru F, „*Ingineria împuşcărilor materiale şi tehnici de lucru*", Volumul 1).

2. DEVELOPING OF THE TEST EQUIPMENT REGARDING SR EN 13763-15

INCD INSEMEX had accredited and applied a procedure "Evaluation / Determination of initiation (capacity) of electric detonators (including serial functioning), of pyrotechnic detonators, non-electric initiation systems and relays retarders". A change and adjustment procedure was required after applying new techniques to test and integrate it in quality system INSEMEX.

The procedure describes how to check the operation of electric detonators in series and the ability to initiate (capacity) for all types of detonators in order to ensure full satisfaction of the requirements of Directive 93/15/EEC Annex 1 and in the technical file of the product.

The main modules of the testing equipment and their functional roles are:

- - a 1000 l capacity tank in metal grille to ensure hydraulic environment of plastic sono absorbent, with appropriate size requirements;
- - a sensor positioning system that is trying the detonators in the tail;
- - thermo - Hydro - Barometer PCE type - THB 40;
- - blasting system (blasting machine and blasting cable);
- - data acquisition system consists of piezoelectric pressure transducer KISTLER type 603B (P_{max} = 200 bar, response time <2μs), KISTLER type 5018 signal amplifier (analog output controlled by PC) and with an

appropriate sensitivity amplification factortype oscilloscope OX 6152-C METRIX which takes the data measured with the possibilities of receiving and signal processing, data storage and provide it to the IT facilities;

- computing platform from test results consisting in laptop computer on that have been run processing programs and data post processing from oscilloscope (SX-METRO Version 4.4./04.dec.2006 and Microsoft Excel).

The integrated system has been mounted inside the ground test facilities of INSEMEX and pilot tests were conducted using electric blasting detonators type ERGODET no. RO/01/2013 and MMSED no.68/E/2012 of various batches with different numbers of delay steps. The data acquisition and processing proved to be compatibility with the objectives of the test, introducing database record results.

Pilot tests were conducted applying a new accredited procedure, which transposes the requirements of SR EN 13763-15, as alternative to the old procedure „Determination of equivalent initiating capability for detonators and relays".

3. FULFILLING THE REQUIREMENTS OF SR EN 13763-15 „EXPLOSIVES FOR CIVIL USES. DETONATORS AND RELAYS. PART 15: DETERMINATION OF EQUIVALENT INITIATING CAPABILITY" APPLYING THE NEW EQUIPMENT

The project had as objectives the achieve the use of performant equipment to conduct the test to determine equipment for initiation capacity regarding the requirements in Annex I of Directive 93/15/EEC to ensure a higher technical level.

The initiation of the explosive charge of detonators should provide a boost with energy sufficient to initiate the explosive or detonating wire / shock tube with which it is intended to use.

Test on "ability to initiate underwater" - is based on the principle that an explosive charge detonated under water generates a shock wave and a spherical volume of gas that expands and then break as the bubbles rise on water surface. The shock wave and gas volumes are a finite relation to the energy released. Thus, by measuring:

- Pressure shock wave;
- Time interval between the peak pressure of the shock wave and the first burst of bubbles of gas and calculating the proportional parameters:
- Equivalent energy of the shock wave;
- Equivalent energy of the gas bubble;

The developed energy of detonators can be compared with the energy developed by reference detonators to whom producer declares equivalence.

To test ability to initiate underwater following equipment was used mounted on the new stand.

♦ **Explosion tank (pool)** (capacity 1000 l) with metal grille, to ensure hydraulic environment of sono-absorbent plastic, with appropriate size (Figure 1).

Fig.1. Tank with capacity of 1000 l

♦ **Positioning system for pressure sensor and detonator.** The distance between the sensor and the position of the detonator should be (400 ± 5) mm. The bottom of detonator and the sensor must be at (400 ± 5) mm below the surface of the water. The distance from the every wall from detonator must be at least 200 mm. (Figure 2).
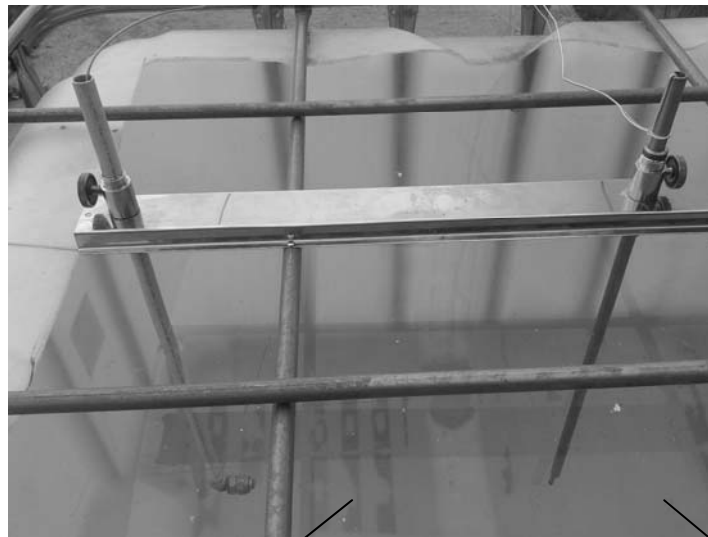
Pressure sensor with a response time of <2 m   Detonator.
Fig.2. Positioning system

♦ **Amplifier with proper amplification and facilities for connecting sensors and oscilloscope.** (Figure 3).

Fig.3. KISTLER signal amplifier type 5018

♦**Memory oscilloscope with a sampling frequency of min.10 MHz.** (Figure 4).

Fig.4. METRIX type memory oscilloscope OX 6152-C.

♦ **Thermo hydro barometer to measure atmospheric pressure.** (Figure 5).

Fig.5. Thermo hydro barometer type PCE-THB 40

Fig.6. The water tank for carrying out the test, measurement system and data processing.

4. CALCULATION AND PROCESSING OF RESULTS OF MEASUREMENT

4.1. Equivalent energy of shock wave

By means of the output voltage of the pressure sensor, the computer software based on the curve calculated full pressure / time square, from which one can obtain equivalent impact energy E_s Pa^2 s, with the general formula:

$$E_s = \int_{t=0}^{t=\theta} (P^2)\, dt \qquad [\text{Pa}^2 . \text{s}] \qquad (1)$$

where
P - is the pressure measured in Pascals;
θ - is the time in seconds at which the sensor power down to P max / E, where P max is the maximum measured pressure and e is the base of natural logarithms.

It will calculate the individual values, the mean and standard deviation for detonators tested and the reference detonators.

Calculate it will the individual values, the mean and standard deviation for detonators test and the detonators staples.

4.2. Energy equivalent of the bubble generated by the explosion of the detonator

Energy of the bubble in s^3 can be calculated using the following formula based on the elapsed time between the peak pressure of the shock wave and the first burst of gas bubbles produced by the reference detonation:

$$E_b = (t_b)^3 \qquad [s^3] \tag{2}$$

where:
t_b - the bubble period, in seconds, from the tip of the shock wave pressure and breaking the first gas bubbles produced by the detonation gases.

Should be calculated individual values, mean and standard deviation of test detonators and reference detonators.

Sample results from underwater testing
Typical curves for peak pressure and bubble period according to SR EN 13763-15 determined with the new equipment
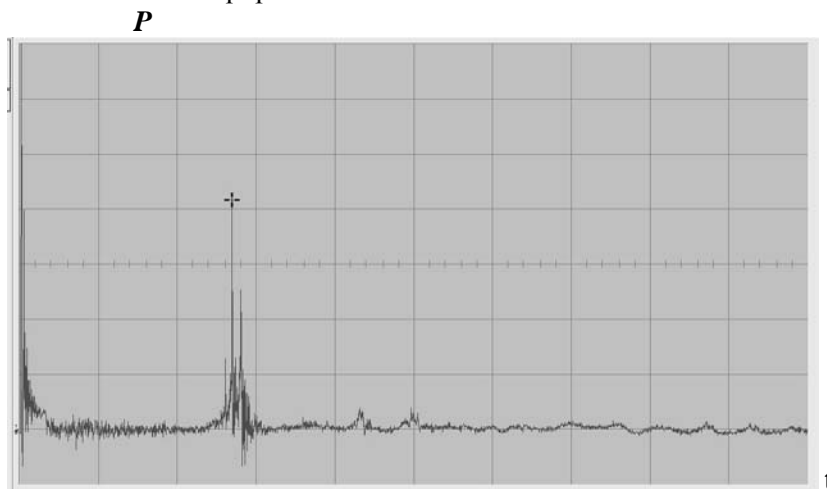
Legend: 1- Pressure (kPa); 2- Time (ms)
Fig. 7 Example of pressure curve of commercial detonators tested, detonated underwater in accordance with the method described in this document (ERGODET / type)
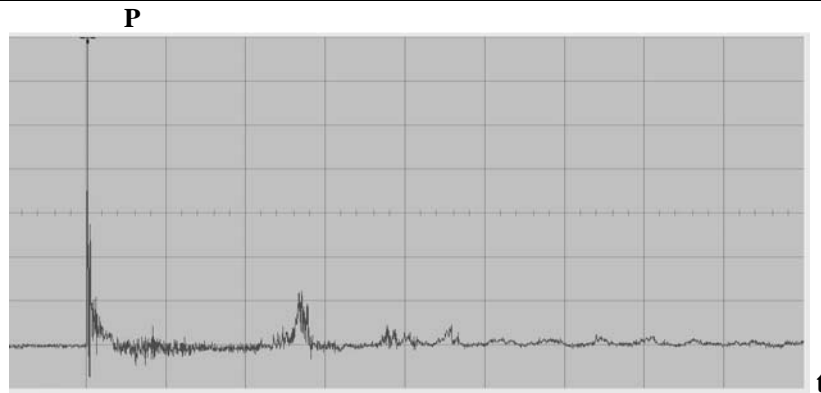
Legend:1 - Pressure (kPa); 2 - Time (ms); 3 - Bubble period.
Fig. 8 Registered data of bubble, base period of elapsed time according to EN 13763-15
(detonator MMSED / type)

The first part of the curve (from 0 ms to 5 ms) is showed the compressed version of the reading. Loop period is the time between the peak and the peak shock of the explosion wave of the first burst of the bubble.

5. CONCLUSIONS

The test for determining the equivalent initiating capability consist in tests measurement according to SR EN 13763-15 ensure explosion pressure measurement in a hydrostatic environment, accurate records for two indicators, namely equivalent shock wave energy expressed in Pa^2x s, respectively in equivalent energy of the gas bubble that expressed in s^3.

The development of stand allows for testing and evaluation of different types of detonators (electric, non-electric) with various explosive charges as type of explosive and quantity.

Tests carried out on the stand are designed for on assessments certification of products, technical expertise as a result of events, at the request of the authorities, namely the use of new research projects aimed detonators.

REFERENCES

[1]. Dumitru F, „*Engineering materials and techniques of blasting work*", Volume 1, Publisher NAMASTE Timişoara, and Publishing CORVIN, Deva, 2007.

[2]. Council Directive 93/15/EEC of 5 April 1993 on the harmonization of the provisions relating to the placing on the market and supervision of explosives for civil use.

[3]. EN 13763-15 „*Explosives for civil uses. Detonators and relays. Part 15: Determination of equivalent initiating capability*" ASRO, Novembre 2005.

[4]. Test procedure PI-ETI-05.1 "Evaluation / Determination of initiation (capacity) for electric detonators (including serial functioning) of pyrotechnic detonators, non-electric initiation systems and relays" - INCD INSEMEX Petroşani, February 2011.

[5]. PN 07 45 03 09 "Development of laboratory logistics by creating a test equipment for detonators to determine the initiation capacity". National Research Program, 2013.

[6]. D.C., Rus, E., Ghicioi, A., Kovacs, C. Jitea „*Modern end sustainable infrastructure for determining equivalent initiation capability for detonators*", International Symposium - October 2013, Sibiu.

CONSIDERATIONS ABOUT THE EVALUATION OF DOMESTIC GAS DETECTORS IN ACCORDANCE WITH RELEVANT LEGISLATION

JEANA IONESCU[1], SORIN BURIAN[2], MARIUS DARIE[3], TIBERIU CSASZAR[4], ADRIANA ANDRIŞ[5]

Abstract: Domestic gas detection apparatus is not certified in accordance with Directive 94/9/EC. However, the manufacturer may require an evaluation at the notified body in the voluntary domain to verify if the product which will be put on the market is within the parameters required by the standard SR EN 50194:2009.

1. INTRODUCTION

Natural gas is considered as the fuel of the century, same as oil was in the past century and coal two centuries ago, being considered a "clean" fuel which does not pollute the environment.

Being a clean energy source, safe and economic, the natural gas is destined both for domestic and industrial use, the domestic use being the most known form of use.

2. LEGAL ASPECTS

The technical rules in force for designing, execution and exploitation of natural gas supply systems - NTPEE of 2008 (approved by order no. 19/2010 of ANRE) states that

[1] *Ph.D. Eng.- scientific researcher IInd degree at INCD-INSEMEX Petrosani, jeana.ionescu@insemex.ro*

[2] *Ph.D. Eng.- scientific researcher IInd degree at INCD-INSEMEX Petrosani, sorin.burian@insemex.ro*

[3] *Ph.D. Eng.- scientific researcher IInd degree at INCD-INSEMEX Petrosani, marius.darie@insemex.ro*

[4] *Ph.D. Eng.- scientific researcher IIIrd degree at INCD-INSEMEX Petrosani, tiberiu.csaszar@insemex.ro*

[5] *Eng.- scientific researcher at INCD-INSEMEX Petrosani, adriana.andris@insemex.ro*

all the rooms in which gaseous fuels consumers are installed must have windowed surfaces, with a minimum surface of 0,03 m^2 for each 1 m^3 room net volume, in case of reinforced concrete constructions and 0,05 m^2 for each 1 m^3 room net volume, in case of brickwork constructions.

In case the window thickness is more than 4 mm or there are in special construction (safety glass, double glazed window type etc.) is compulsory to mount automated gas detectors, with lower detection limit of 2% CH_4 in air, to act on the closing valve (electrovalve) of the natural gas supply pipe of gaseous fuels consumers.

3. SELECTION AND USE REQUIREMENTS FOR HOUSING GAS DETECTION APPARATUS

The gas detector will be installed in the room where exists the highest possibility of gas leakage to occur. This can be the kitchen, because of the cooking machine presence and other gas operated apparatus.

The gas will have the tendency to ascend and will fill the whole space over the leakage point level. Also, this behavior can be influenced by many factors such as heating sources, ventilation. Generally, the concentrations above the leakage point will be equal or even higher than the concentrations bellow that point.

The gas detector will be installed above the areas with possible gas leakage and near the ceiling level (normally 0,3 m from the ceiling), in a place where the air currents are not blocked by obstacles (furniture etc.). Also, the mechanically triggered alarms will be so positioned that the user can reset the alarm.

The gas detector shall not be installed:
- In a closed area;
- Directly above the wash basin;
- Near the door or window;
- Near the chimney hood;
- Into an area where the temperature can decrease bellow -10°C or can exceed +40°C;
- Into an area where dust and dirt can block up the sensors;
- Into an area with moisture.

It shall not be placed near the ventilation holes or pipes because the air current in these areas can be strong and can lead to gas concentration decrease.

The apparatus shall not be installed above or near the gas operated apparatus, because small leaks can occur that could initiate unwanted alarms. It must be noted that these installations mounted near the cooking machines can lead to:
- trigger the alarm because of the food vapors and not because of gas leaks;
- loading with grease, that can impair the normal operation of apparatus.

4. TEST RIG FOR ACHIEVING THE TESTS ACCORDING SR EN 50194-1:2009

According the legislation in force, the gas detectors are not under the scope of Directive 94/9/EC adopted by HG 752/2004. However, the manufacturer is liable to place on the market products that comply with SR EN 50194-1:2009.

In order to demonstrate products conformity to this standard, inside of testing laboratories of INSEMEX Petroşani was conceived a testing rig (Figure 1), to make the tests according the product standard.

Fig. 1. Test rig for testing domestic gas detectors

The test rig comprises the following:
- Supply network for test gases;
- Pressure regulators;
- Mass flow fine adjustment;
- Flowmeters (rotameters);
- Element for measuring the mixture temperature;
- Gas mixture outlet;
- Testing chamber;
- Equipment for measuring the concentration of gas mixture;
- Equipment under test;
- Gas mixture exhaust;
- Elements for monitoring the testing conditions;
- Air dryer, mounted on compressed air layout;
- Silica gel filters.

On the created test rig were made the following tests:
- The test for functioning of visual indicators and acoustic alarms;
- Testing of alarm during heating time;

- The test for response time.

The tested gas detectors were found to fit in the parameters required by standard, and can be used according the product specification.

5. CONCLUSIONS

• The relative gas density towards air is very important to determine the vertical placement of combustible gas detector.

• A testing rig was conceived to study the safety requirements of domestic gas detectors, for verifying the characteristics of gas detectors (according SR EN 50194-1:2009).

• Functional verification of the test rig was made by using three testing samples, and the following tests were made:
- The test for functioning of visual indicators and acoustic alarms;
- Testing of alarm during heating time;
- The test for response time.

• After the tests, the test reports were elaborated, which confirms the possibilities of using the tested gas detectors, according specification.

REFERENCES:

[1]. Ionescu Jeana, Burian S., Bratu D.N., *Aspects of the dynamics of the process of clearance and dilution of combustible gaseous substances*, Minelor Magazine, no. 9-10/2006, ISSN 1220-2053, pages. 44-55.

[2]. Simion S., Vasilescu D., *The risk of explosion*, Europrint Publisher, Oradea, 2004, ISBN 973-7735-08-0.

[3]. *** SR EN 60079-14:2009-*Explosive atmospheres. Part 14: Electrical installations design, selection and erection.*

[4]. *** SR EN 50194-1:2009-*Electrical apparatus for the detection of combustible gases in domestic premises. Part 1: Test methods and performance requirements.*

SIMULATION OF A SOLAR CELL WITH SIMPLE DIODE MODEL

RAZVAN SLUSARIUC[1], BRANA LILIANA SAMOILA[2], FLORIN GABRIEL POPESCU [3]

Abstract: The most important device which converts solar radiation to electric energy is photovoltaic cell.A photovoltaic system directly converts sunlight into electricity. The main device of a PV system is a solar cell. Cells may be grouped to form panels or arrays. Power electronic converters are usually required to process the electricity from the PV device.

Keywords: solar energy, solar cells, photovolatic system, electricity, diode.

1. INTRODUCTION

In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. These advantages are global. The most important device which converts solar radiation to electric energy is photovoltaic cell.

A photovoltaic system directly converts sunlight into electricity. The main device of a PV system is a solar cell. Cells may be grouped to form panels or arrays. Power electronic converters are usually required to process the electricity from the PV device.

These converters may be used to regulate the voltage and current at the load, to control the power flow in grid-connected systems, and for the maximum power point tracking (MPPT) of the device. The solar cell is basically a semiconductor diode exposed to light. Solar cells are made of several types of semiconductors using different manufacturing processes.

---

[1] *PhD. Student Eng. at University of Petrosani*
[2] *PhD. Associate Professor Eng. University of Petrosani*
[3] *Ph.D. Lecturer, Eng. University of Petrosani*

The electrical energy produced by a solar cell at any time instant depends on its intrinsic properties and the incoming solar radiation.

The solar radiation is composed of photons of different energies, and some are absorbed at the *p-n* junction.

Photons with energies lower than the bandgap of the solar cell are useless and generate no voltage or electric current. Photons with energy superior to the bandgap generate electricity, but only the energy corresponding to the bandgap is used. The remainder of energy is dissipated as heat in the body of the solar cell.

A single-diode PV cell model is considered in this paper, including the effect of the series resistance. The paper uses the equivalent circuit of a solar cell with its parameters as a tool to simulate in order to consider the irradiance and temperature change, the I-V characteristics of PV cell.

The simplified equivalent circuit of a solar cell consists of a diode and a current source connected in parallel. The current source produces the photocurrent Iph, which is directly proportional to solar irradiance G. The two key parameters often used to characterize a PV cell are its short-circuit current and its open-circuit voltage which are provided by the manufacturer's data sheet.
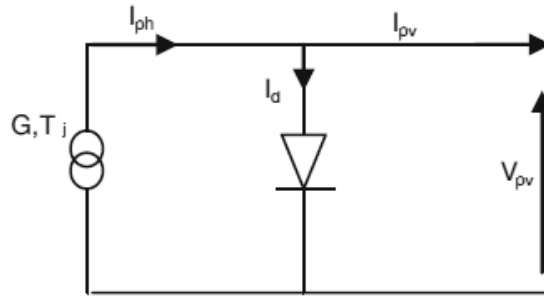
Fig.1. Simplified equivalent circuit of solar cell

The equation of the current voltage I$_{pv}$–V$_{pv}$ simplified equivalent circuit is derived from Kirchhoff's law:

$$I_{pv} = I_{ph} - I_d \tag{1}$$

Where

$$I_d = I_0 \left[e^{\frac{(V_{pv})}{AKT_{J-1}}} \right] \tag{2}$$

So it becomes:

$$I_{pv} = I_{ph} - I_0 \left[e^{q\frac{(V_{pv})}{AKT_{J-1}}} \right] \tag{3}$$

Where:

I_{ph} is the photocurrent that is equal to short-circuit current,

I_0 (A) is the reverse saturation current of the diode,

q is the electron charge (1.6029×10^{-19} C)

k Botzman's constant (1.3819×10^{-23} J/K)

A is diode ideality factor

T_j is junction temperature of the panels (^{0}K)

I_d is the current shunted through the intrinsic diode

V_{pv} is the voltage across the PV cell.

$$I_{pv} = I_{sc} - I_0 \left[e^{q\frac{(V_{pv})}{AKT_{J-1}}} \right] \tag{4}$$

We can determine the reverse saturation current I_0 by setting $I_{pv} = 0$

$$I_{pv} = 0 \tag{5}$$

$$V_{pv} = V_{oc}$$

$$0 = I_{ph} - I_0 \left[e^{q\frac{(V_{oc})}{AKT_{J-1}}} \right] \tag{6}$$

Thus we obtain, taking into account the fact that, with this model, the photocurrent is equal to the short-circuit current:

$$I_0 = \frac{I_{sc}}{\left[e^{q\frac{(V_{oc})}{AKT_{J-1}}} \right]} \tag{7}$$

The solar cell is modeled and simulated using Matlab software. The simulation is based on the datasheet of Siemens SM110-24 photovoltaic module. The parameters of this solar module are given in Table 1. The module is made of 72 solar cells connected in series to give a maximum power output of 110 W.

Table 1. **Electrical parameters of Siemens SM110-24 photovoltaic module**

Parameter	Value
P_{mpp}	110W
I_{mpp}	3.15A
V_{mpp}	35V
I_{sc}	3.45A
V_{oc}	43.5V
α_{sc}	1,4mA/ ºC
β_{oc}	-152mV/ ºC

2. MODEL WITH OHMIC LOSSES

To obtain a better representation of the electrical behavior of the cell of the ideal model, the second model takes account of material resistivity and the ohmic losses due to levels of contact. These losses are represented by a series resistance Rs in the equivalent circuit
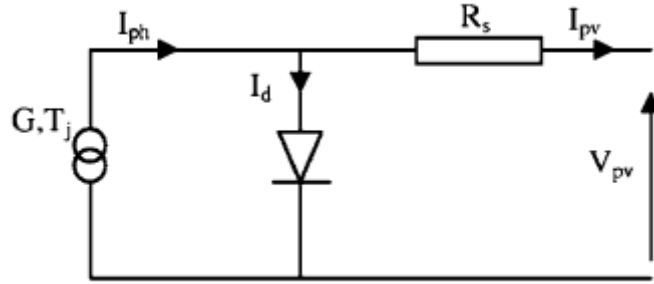
Fig.2. Simplified equivalent circuit of solar cell with R_s

The current voltage equation is given as follows:

$$I_{pv} = I_{ph} - I_0 \left[e^{q\frac{(V_{pv}+I_{pv} \cdot R_s)}{AKT_J}} \right] \tag{8}$$

or, making the approximation that $I_{ph} \sim I_{sc}$,

$$I_{pv} = I_{sc} - I_0 [e^{q\frac{(V_{pv}+I_{pv} \cdot R_s)}{AKT_j}} - 1] \tag{9}$$

The short-circuit I_{sc} can be calculated at a given temperature T_j:

$$I_{sc-Gref} = I_{sc-ref} [1 + \alpha_{sc} \cdot \Delta T] \tag{10}$$

$$\Delta T = T_j - T_{jref} \tag{11}$$

Where:

$I_{sc-Gref}$ is measured under irradiance G_{ref} =1000W/m^2 and T_{j-ref} =25^{0}C and is given on the datasheet,

α_{sc} is the temperature coefficient of short-current (^{0}K), and found on the data sheet,

T_{j-ref} is the reference temperature of the PV cell (^{0}K),

T_j is the junction temperature (^{0}K).

The output power is given by:

$$P = V[I_{sc} - I_0(e^{\frac{q(V+R_sI)}{mkT}} - 1)] \tag{12}$$

The mathematical model of the l solar cell with series resistance have been implemented in the Matlab/Simulink software.
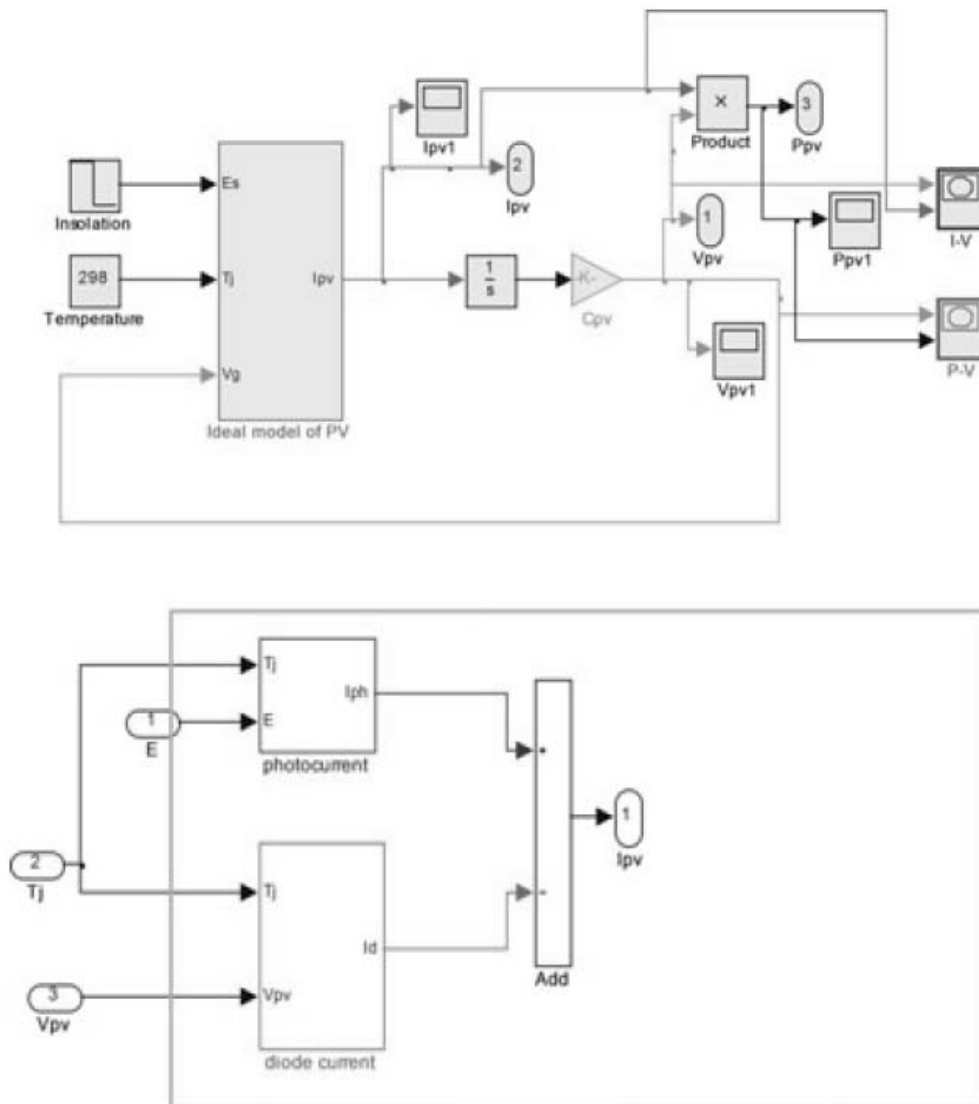
Fig.3. Block diagram of the solar cell model used in Matlab/Simulink software

The I-V characteristics for various conditions of solar radiation and $m =1.66$, considering the ideal solar cell, are shown in Figure 4.
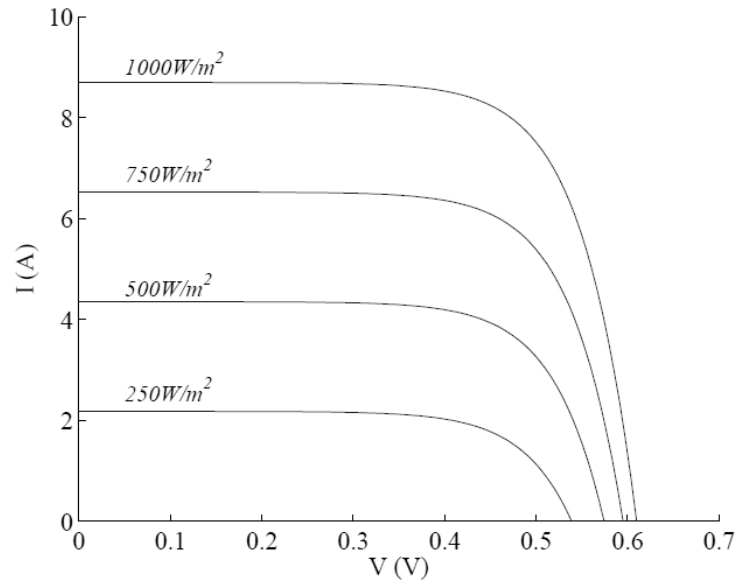
Fig.4. I-V characteristics for various conditions of solar radiation.

The I-V characteristics for a temperature variation between 0 and 75ºC and $m =1.66$, considering the ideal solar cell, are shown in Figure 5:
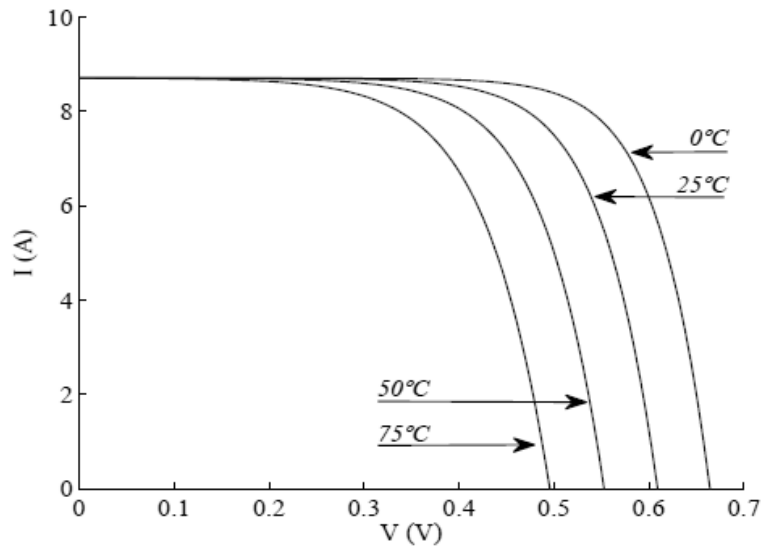
Fig.5. I-V characteristics for the temperature variation between 0 and 75 ºC

The P-V characteristics for the temperature variation between 0 and 75ºC and *m* =1.66, considering the ideal solar cell, are shown in Figure 6:
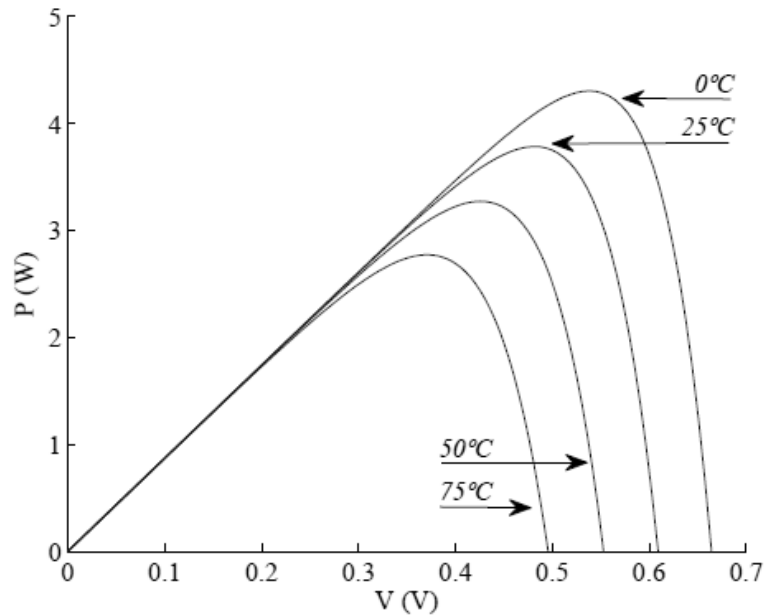
Fig.6. P-V characteristics for the temperature variation between 0 and 75 ºC

The P-V characteristics for the *Rs* variation between 0 and 20 *m*Ω are shown in Figure 7:
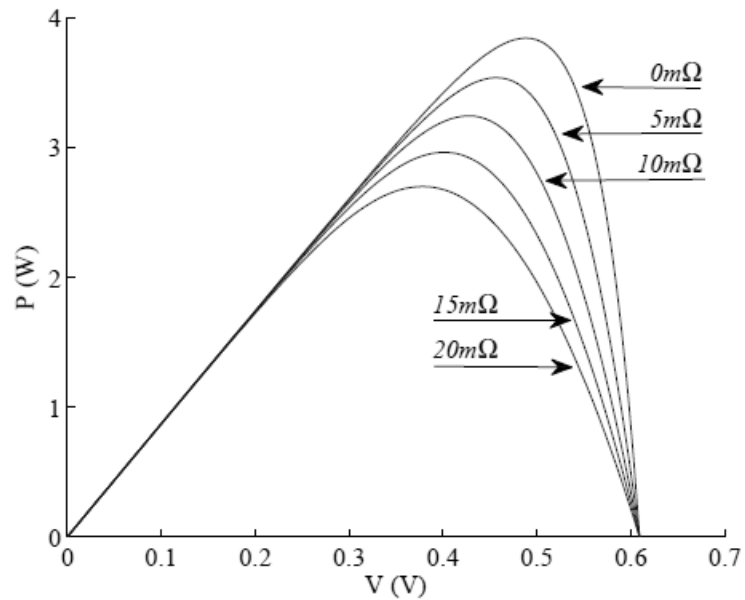
Fig.7. P-V characteristics for the *Rs* variation

3. CONCLUSIONS

Using the Matlab/Simulink software it has been demonstrated the influence of temperature cell's junction and solar radiation upon the performances and therefore the efficiency of solar cell.

The behavior of ideal solar cell model and the behavior of the solar cell with series resistance model are studied in this paper. Included effects are: temperature dependence, solar radiation change, diode ideality factor and series resistance influence.

The solar cell with series resistance model offers a more realistic behavior for the photovoltaic systems. Particularly, this model is to be considered in panels with series cells, because the series resistance is proportional to the number of solar cells in the panel.

REFERENCES

[1]. Villalva M. G, Gazoli J.R., Filho E. R, *Comprehensive approach to modeling and simulation of photovoltaic arrays, IEEE Transactions on Power Electronics*, Vol. 24, No. 5, pp. 1198-1208, 2009.

[2]. Rekioua D., Matagne E., O*ptimization of Photovoltaic Power Systems, Hardcover ,* XII, 283 pp, 2012.

[3]. Yuncong J, Qahouq J.A.A., Batarseh I, *Improved solar PV cell Matlab simulation model and comparison*, *Proc. 2010 IEEE International Symposium on Circuits and Systems — ISCAS'10*, Tuscalosa, Alabama, USA, 2010.

[4]. Sedra A.S., Smith K. C., *Microelectronic Circuits.* London, U.K.: Oxford Univ. Press, 2006.

[5]. Dezso S, Teodorescu R., Rodriguez P., *PV panel model based on datasheet values,* International Symposium on Industrial Electronics, ISIE 2007. IEEE, pp. 2393 – 2396, 2007.

[6]. González-Longatt F. M, *Model of Photovoltaic Module in Matlab™*, II CIBELEC, 2005.

[7]. *http://solargis.info.*

PROCESSING THE DATA ACQUIRED FROM POTENTIALLY EXPLOSIVE ATMOSPHERE

NICOLAE PĂTRĂŞCOIU[1] , IOANA CAMELIA BARBU [2]

Abstract: The processes located in the environments such as the underground mining, mineral oil or natural gases, chemical processes are subject to risk factors like explosions, fires, contamination with gas or toxic substances. Monitoring and prediction of both environment and equipments parameters from these processes represent a priority in conditions because by the maintaining of these parameters in correct limits and taken actions at the right time depends: preventions of humans, technological or environment accidents, assurance the microclimate conditions for humans in respective works. This requires data collection through data acquisition systems, comparing them with accurate and possibly setting limits on the values of measurements and predictions of its dangerous. In this paper we propose a system structure of a data acquisition and data processing procedure for obtaining a prediction on the evolution of the measured values.

Keywords: data acquisition, data proccesing, LabVIEW, statistical model.

1. DATA ACQUISITION STRUCTURE

The realization of the measurement and data acquisition in high risk environment, mostly in explosive gas environment, it must be made with equipments which must fulfill some specific requirements for these particular conditions. Such conditions are specified at national and european levels through normative acts.

The utilization of the data acquisition and processing systems represent a modern solution by using digital equipments dedicated to data processing. The general structure of these systems includes informational elements represented by sensors and transducers, conditional and signal adaptation circuits, the acquisition elements witch is connected to the PC using the external ports (parallel or Serial/USB) or intern bus (old ISA, but mostly PCI or PCIe).

The existent trend in domain (met in projects by the type Enhanced Mine Communications, Information System for Real-time Risk Management or

---

[1] *Assoc.Prof., PhD., University of Petrosani*
[2] *Lecturer, PhD., University of Petrosani*

Nexsys Real-time Risk Management System) is to use the protection module Inherent Safety for informational elements found in high risk explosion environment and the transmission of the data through optic fiber, wireless or serial RS-485.

In order to build transducers is the possibility of choosing the proper sensors for the combustible gas control (methane, ethane, LPG) or toxic (CO, CO_2). The functional principles of this can be resistive type whereon the increasing the gas concentration determine the variation of the sensor resistance pellistor (VQ2) or Metal Oxide Semiconductor MOS (TGS813, TGS2611), Fig. 1.a, or infrared type whereon the increasing the gas concentration determine the increasing of the absorption degree of the IR radiation.
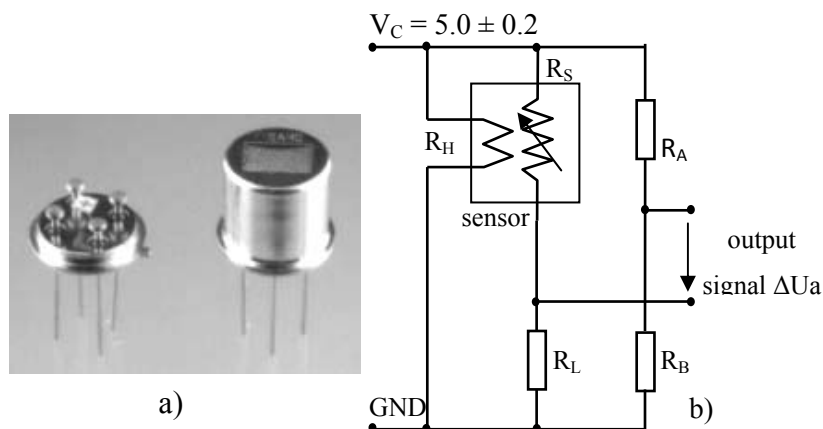
Fig.1. Using gas sensor TGS2611
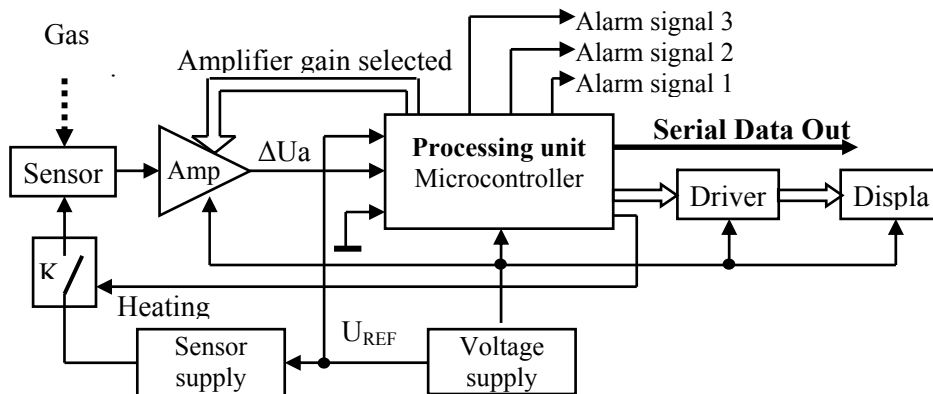
Fig. 2. Connecting a gas sensor to microcontroller system

In case of the resistive sensors the conversion of the resistance variation of the sensor due by the variation of the gas concentration in voltage variation is made with a Wheatstone bridge, Fig. 1.b. and the output signal ΔUa is processing by a microcontroller with the possibility of analog-numeric conversion. For this kind of aplications can be used microcontrollers made by different manufacturers like: Philips (80C552, P87LPC769), Microchip (16F87X, 18F2431), Atmel (ATMega8,

AT90S2333), etc. A possible scheme of the microcontroller utilisation in such kind of aplication is presented in Fig. 2.

The utilization of the microcontrollers give, beside the possibility of the processing and transmitting of the information through processing systems, also the possibility of the local displaying of the results or transmitting of a local controls.

In order to locally displaying of the results of the measure we must consider that the sensors for the parameters from high risk explosion environment have a non-linear characteristic so that the resistance R_s of the TGS261 sensor is depending by the concentration C of the methane from the atmosphere according to the relation:

$$R_s = A \cdot [C]^{-a} \tag{1}$$

where A is a constant which depending of the measurement conditions and a represent the local sensibility of this characteristic. Such kind of characteristic can be linear by using the classic method *look-up table* by reading the calculated values based on the theoretic characteristic from a vector stored in memory zone by the location address.

Forcing the condition of the local displaying of the values, but also the condition of the transmitting the local commands on the case of overflow of a specified alarms level is necessary for the possibility of study the utilization in sensor structure of the VLSI circuits with configurable structures by ASIC or FPGA type. These kinds of structures are use at the addressable memory in content (MAC) which represent a special category of memory, which realized the acceleration of the retrievable operations of the information. Unlike of common memory, with random access (RAM-Random Access Memory), where the data retrieval is realized on the base of the location where this is storage, at MAC is explore on different ways (parallel/serial at word/bit level etc.) all the memory locations for establish those who have, eventually, the looking data. The target data must correspond to a comparand (C). This can be use also for generating the command type.
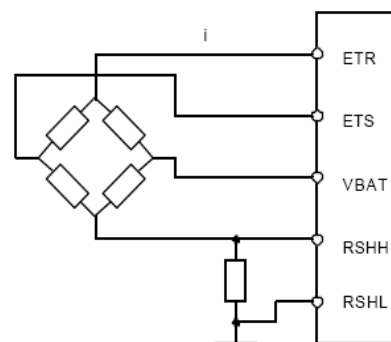
Fig. 3. Connecting a measure bridge on an ASIC circuit

In Fig. 3. is present the connection mode of a measure bridge on an ASIC circuit by IHM-A-1500 type. The bridge is activated from an internal current supply through ETR terminal and the unbalance voltage is taking at the ETS and VBAT terminals. Because between RSHH and RSHL we can measure the activation current we have the possibility of the adjustment the effect cause by the environment temperature.

For the transmitting of the information are used different protocols, one of this being Modbus. Modbus is a communication protocol on the 7 level in OSI Reference,

the closest level to the user, the same like Telnet, File Transfer Protocol (FTP), and Simple Mail Transfer Protocol (SMTP). This is based on master/slave or client/server architecture. The protocol is made by Modicon to be used at the proper PLCs, but he become an industrial communication standard. The most important reasons for this utilization are:

- is an open protocol, with available documentation;
- can be implemented in short time;
- it work with bits or octets and, in this manner, don't impose special requirements and can be realized with a hard structure witch contain a microcontroller from the presented category.

Modbus admit the administration of the devices net, like measurement systems to which output dates communicate to a computer. Modbus is frequently used to connect a supervise computer with a RTU (Remote Terminal Unit) from a monitoring and data acquisition system SCADA. There are versions of the MODBUS protocol for the serial port (Modbus/RTU, Modbus/ASCII), and also for the Ethernet (Modbus/TCP).

Any device which communicate using Modbus have a unique address and can send commands, but usually only the master-device can do this. The Modbus commands contain verification information to assure the probability of the answer. The various implementations of the Modbus are used for transmission with or without wire. This protocol is used, for example, for combustible gas transducers or methane type 4688-IR Combustible Gas Transmitter, DPT CH4-IS, MC-4210-CH4, but also for toxic gas transducers or other environments parameters.

Fig. 4. Data collection system

Using the corresponding communications channels and protocols are gathered information considering to the security of the process this is develop in high risk environment suck as the concentration of the combustible of toxic gas, oxygen concentration, pressures or the fluids levels using in this process. Using specialized software's in data acquisition and processing domain like LabWindows/CVI or LabView are determined overflows of the measured values thereby co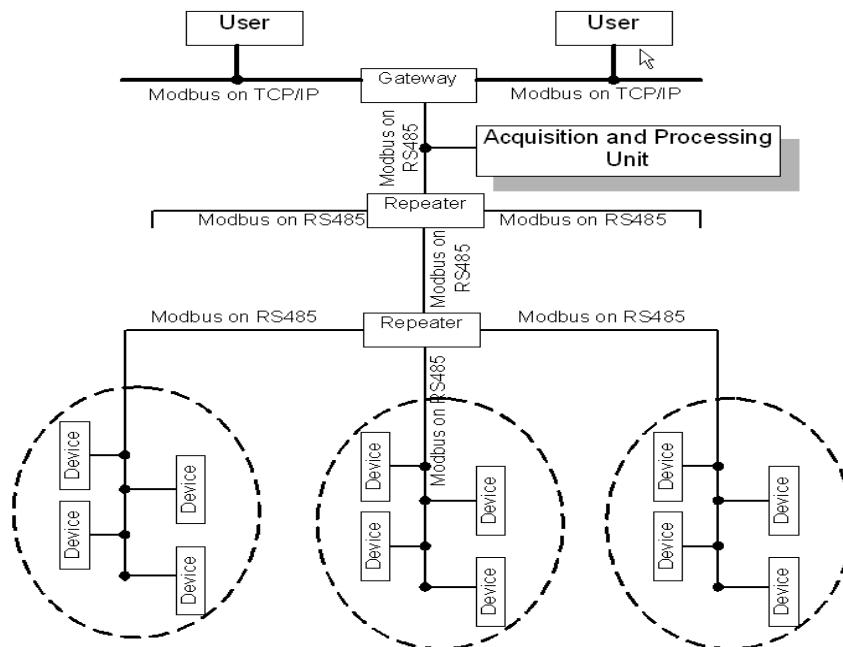nstantly are verified regarding to the process security and environment in which are developed this process. Are certified the alarm levels and are generated the commands for different alarm levels on the base of a risk analyze made on-line and real time.

The acquisition and recording system in his assembly, Fig. 4, will be represent a complete acquisition solution, data transmission, processing and risk analyze with the probability of tracking the security elements of the monitoring process by any computer connected to a local net through Ethernet.

2. DATA PROCESSING PROCEDURE

For data acquisition and processing can be used for various environments including the graphical programming environment LabView. Through operations, functions and programming structures this programming environmental allows both data acquisition and processing of data collected from the process.

Considering a set of measured values through a program developed in LabView that is called Virtual Instrument (VI) the measured data can be organized as a histogram. It is thus possible to identify those values that have the highest occurrence rate in the measured data set. Also on the same set of data values measured by means of interpolation methods is possible to determine the polynomial that can approximate the distribution function of these values. This polynomial will be a statistical model prediction as to allow the evolution of the values for the variable under observation.

If consecutive measured values are fall between two limits is considered that they will follow a law what is described mathematically by polynomial predictive statistical model. A time interval of 30 seconds is used in collecting measured values. Time intervals, that can be half-hour, one hour or even days, are used for calculating the moving average for the estimated trend curve. The two limits, upper limit U_L and lower limit L_L, are calculated by:

$$U_L = \overline{V} + 3\sigma$$
$$L_L = \overline{V} - 3\sigma$$

(2)

where $\overline{V}$ is the arithmetic mean and σ is the standard deviation of the set of measured values.

In Fig. 5 is shown the block diagram, which is the program itself, of the virtual instrument used for statistical processing for a set of measured values divided into bundles 1000 values.

The basic function that is used in creating virtual instrument is **General Polynomial Fit VI** that returns the polynomial fit of polynomial order for a data set (X, Y) using the Least Square, Least Absolute Residual, or Bisquare method. In this case is used Bisquare method. Are used also the **Statistics** and **Mask and Limit Testing** funtions.
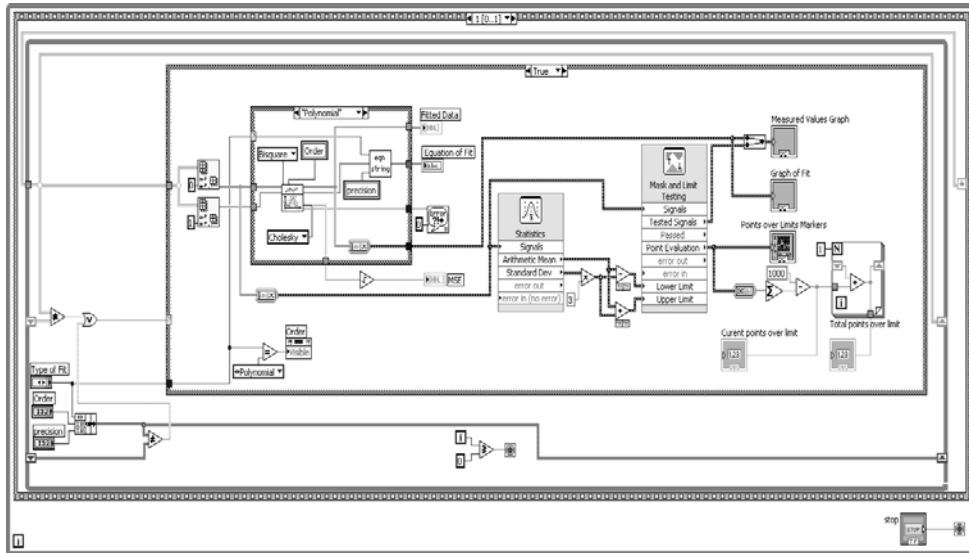
Fig. 5. Diagram bloc of the virtual instrument used for build a statistical model

With **General Polynomial Fit VI** is created the interpolation function which can be selected between exponential or polynomial type through the element **Type of Fit** of the virtual instrument's front panel. If polynomial form is selected the user can select also the order of the polynomial interpolation through an proper element **Order** of the virtual instrument's front panel. Also through the element **Precision** the user can set the decimal precision coefficients choosing their decimals. The interpolation can be obtained by using one of the following methods: Least Square, Least Absolute Residual or Bisquare. The function generates the polynomial approximation with general form described by the following equation:

$$f_i = \sum_{j=0}^{m} a_j \cdot x_i^j \tag{3}$$

where *f* represents the output sequence Best Polynomial Fit, *x* represents the input sequence X, *a* represents Polynomial Coefficients**,** and *m* represents polynomial order.

This VI finds the value of *a* that best fits the observations **(**X, Y**)**. The following equation specifically describes the polynomial curve resulting from the general polynomial fit algorithm.

If is used the Least Square method, the **General Polynomial Fit VI** finds the coefficients of the polynomial model by minimizing the residue according to the following relation:

$$y[i] = \sum_{j=0}^{m} a_j \cdot \left(x[i]\right)^j \tag{4}$$

$$\frac{1}{N} \sum_{i=0}^{N-1} wi \cdot \left(f_i - y_i\right)^2 \tag{5}$$

also is used the Least Absolute Residual method, the coefficients are finds by minimizing the residue according to the following relation:

In realations (5) and (6) N is the length of Y, w_i is the ith element of Weight, f_i is the ith element of Best Polynomial Fit, and y_i is the ith element of **Y**

In Fig. 6 is shown the front panel of the virtual instrument used for statistical processing. On the front panel are provided graphical elements used to represent the measured values (Measured Values Graph), calculated limits, graph for and expression

$$\frac{1}{N} \sum_{i=0}^{N-1} wi \cdot \left|f_i - y_i\right|^2 \tag{6}$$

for interpolation function (Graph of Fit and Equation of Fit), markers for the over limits (Points over Limits Markers) and the histogram of the values (Histogram).
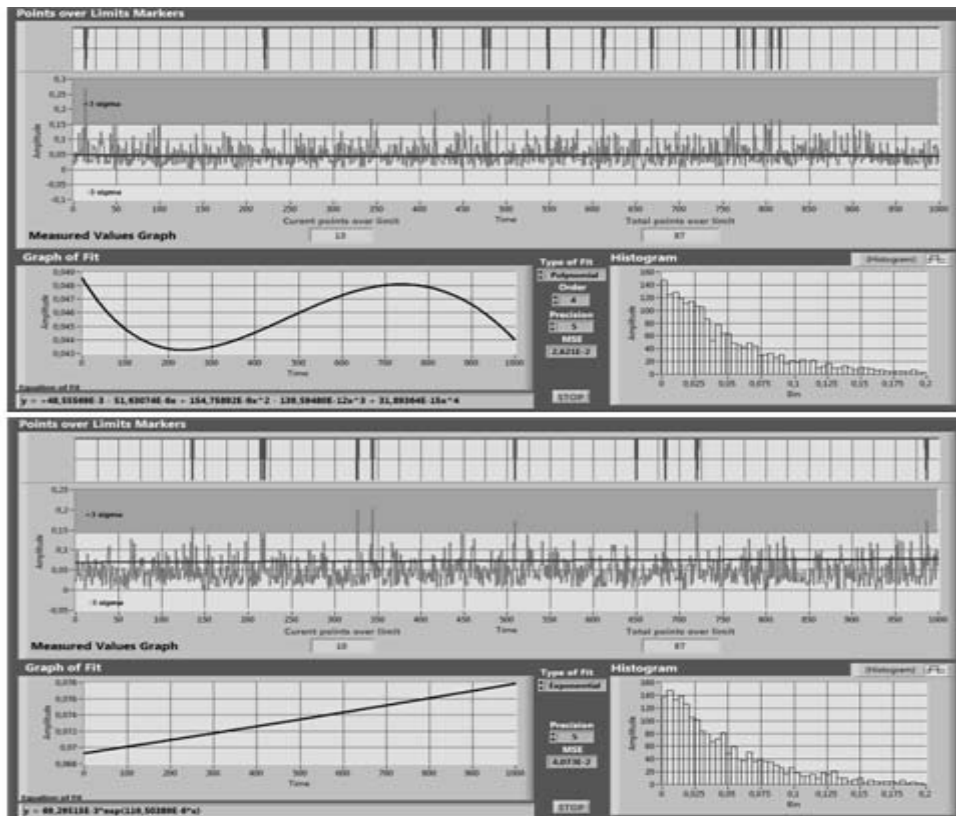
Fig. 6. Front panel of the virtual instrument used for build a statistical model

3. CONCLUSIONS

Through a data acquisition system in which primary data acquisition should be done with sensors connected to the microprocessor and transmit data via protocols such as Modbus to a higher level is possible to measure a long time as values for example the concentration of methane. Measured values will be a data set based on which it is possible to build a statistical model of variable under observation. Once obtained the model it can be used to predictions that observing variable values if they follow the trend given by the interpolation function.

REFERENCES

[1]. Bailey D. (2003), *Practical SCADA for Industry.* Elsevier. Burlington, MA 01803. 2003

[2]. Bottrill G. (2005), *Practical Electrical Equipment and Installations in Hazardous Areas*. Elsevier. Burlington, MA 01803.

[3]. Connell B. (2003), *Basic Math for Process Control* ISA-The Instrumentation, Systems, and Automation Society, Research Triangle Park, NC 27709

[4]. Park J. (2003), *Practical Data Acquisition for Instrumentation and Control Systems*. Elsevier. Burlington, MA 01803.

[5].Patrascoiu N. (2004), *Sisteme de achizitie si prelucrare a datelor. Instrumentatie virtuala*. Ed. Didactica si Pedagogica. Bucuresti.

[6]. Salkind N.J. (2007), *Encyclopedia of Measuremets and Statistics*. Sage Publications. London.

[7]. Tominaga Y. *The early detection of spontaneous combustion and the evaluation of the effectiveness of fire extinguishing countermeasures based on CO time series data*. Mine Ventilation. Proceedings of the Tenth US/North American Mine Ventilation Symposium, 16-19 May 2004, Anchorage, Alaska, USA2.

VIRTUAL INSTRUMENTS USED IN DIRECT CURRENT CIRCUITS LEARNING PROCESS

BRANA LILIANA SAMOILA[1], FLORIN-GABRIEL POPESCU[2], RAZVAN SLUSARIUC[3]

Abstract: This paper deals with some of the virtual instruments we achieved in order to study the d. c. circuits and the resistance measurement methods. These are effectively used in teaching and learning activities where they turned out to be very helpful for the students. We made them simple, easy to use and intuitive, being an alternative, more flexible, method of practice in the laboratories.

Keywords: virtual instrument, measurement, learning, d. c. circuit.

1. GENERAL CONSIDERATION ABOUT THE VIRTUAL INSTRUMENTS

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a programming environment used to achieve measurement and monitoring of automated processes based on a graphical programming language [5]. This 5th generation programming language contains several predefined library for the data acquisition, processing, display and transmission. Thus, together with related hardware devices, modern complex systems for data acquisition and processing can be developed. Graphical programming makes not necessary to know a programming language itself, using algorithms designed as a flowchart (diagram) instead of text instructions. This operating mode is more intuitive and easier and can be used even by those who have no software programming experience.

Programs developed in LabVIEW are called virtual instruments (VI) as they use graphical structure that mimics actual instrumentation (oscilloscopes, multimeters, etc.) [3]. The main characteristics of a virtual instrument are:

- o interactive user interface called front panel window containing buttons, controls, indicators, and so on;
- o the source code in graphical form, i.e. the block diagram window;

[1] Associate Professor, Eng., PhD, University of Petrosani
[2] Lecturer, Eng., PhD, University of Petrosani
[3] PhD. Student Eng. at University of Petrosani

o   virtual instruments used as sub-VI like hierarchical and modular routines in classical programming.

The input data is the information that a program receives from any source. Data entry can be: user input via keyboard or mouse; extracted even by the program of data files located on various memory devices; received via different equipment (video camera, network card, data acquisition system, etc.); extracted by the program from memory, if it were stored by other programs.

The output data are generated by the program and transmitted to the user. Data transmission can be carried out: by displaying them on the screen; by saving the data files so that these will then be accessed by the user or by other programs.

2. VIRTUAL INSTRUMENT FOR STUDYING A DIRECT CURRENT CIRCUIT

It was important to achieve a friendly user interface in modeling. The items chosen for the front panel are easily identifiable as compared to the actual situation.

LabVIEW provides different types and forms of controls. In our applications, we used slide and knob type numeric controls and meter type indicators.

Measurement instruments are considered ideal and wires have negligible resistance.

The simulated circuit [2] is shown in fig.1.
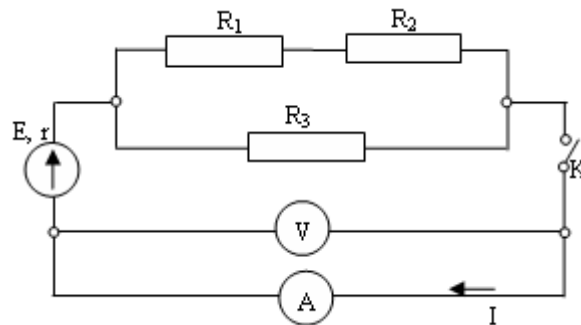
Fig.1 Simulated circuit diagram

The application includes: three resistors (R1 and R2 are grouped in series and R3 is connected in parallel), a DC source with the electromotive force E and the resistance r, a switch K, an ammeter and a voltmeter.
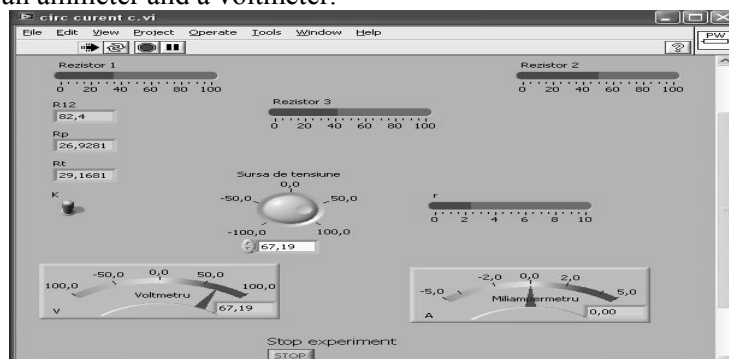
a)
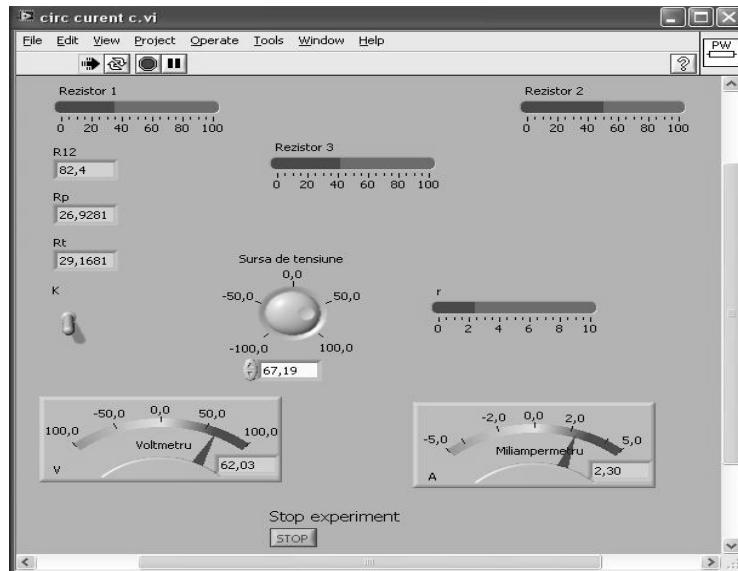
b)

Fig. 2 Virtual Instrument Front Panel for studying a DC circuit behavior switch out;
b) switch in

Using the switch K (Vertical Toggle Switch), we can study the two cases:
- if K is out: $I = 0$ and $U = E$ (false in the Case structure), Figure 1a;
- if K is in: $I = E / (R_p + r)$ şi $U = E - I \cdot r$ (true in the Case structure), Figure 1b.

The block diagram is presented in Figure 3.
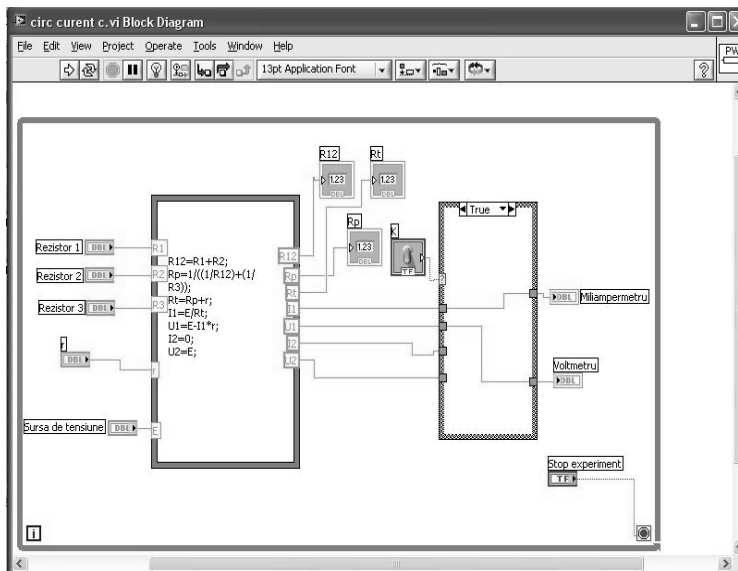
Fig. 3 Block Diagram of the DC current circuit virtual instrument

3. VIRTUAL INSTRUMENT TO SIMULATE A RESISTANCE MEASUREMENT

The Virtual Instrument simulates a resistance measurement circuit with ammeter and voltmeter connected upstream and downstream [1] and allows comparing the two connection options depending on the measured resistance value that can be changed in the control "fill slide" [4].

The circuit is shown in Figure 4, the Front Panel in Figure 5 and the Block Diagram in Figure 6.

The unknown resistance value is given by a numerical indicator and a "gauge" type indicator.

Also, the relative errors are computed in both cases and can be compared with each other for the same value of the resistance to be measured.

The voltage and the current can be set with "meter" type controls and, by changing the switch position "upstream" and "downstream"; the unknown resistance value and the relative error are displayed.
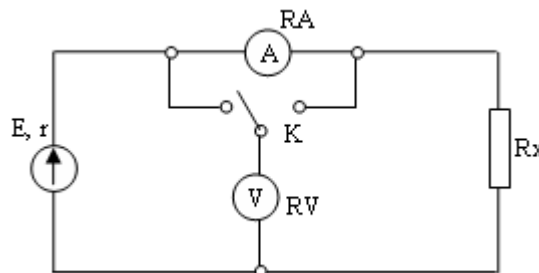
Fig. 4 Resistance measurement method
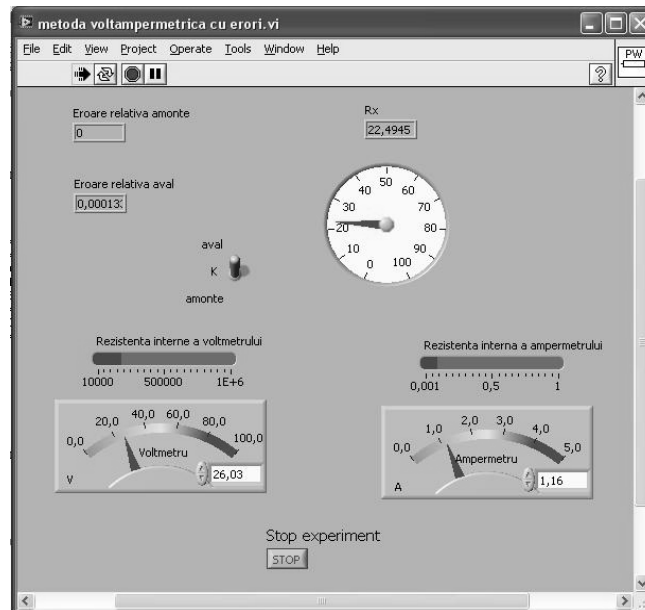
a)
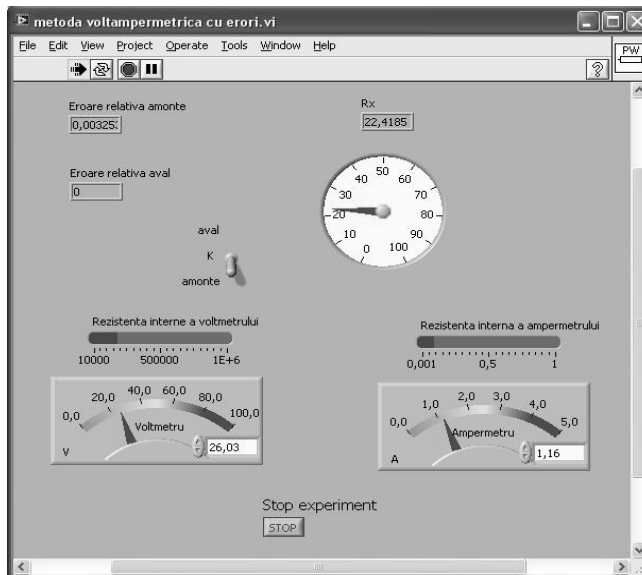
b)
Fig. 5 Front Panel of the application for a resistance measurement
a)   upstream ; b) downstream
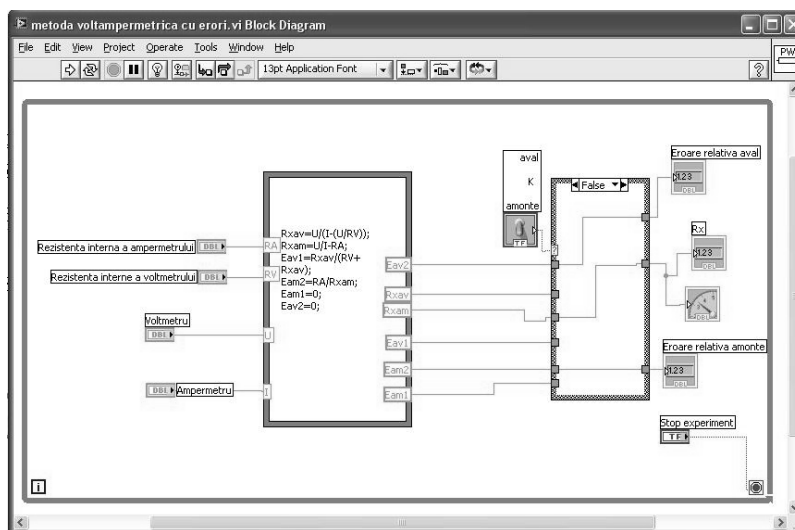
Fig. 6 The Block Diagram of the resistance measurement virtual instrument

4. CONCLUSIONS

The virtual instruments we achieved for studying the direct current circuits proved to be very helpful during the teaching activities. They allowed an intuitive laboratory practice, at the same time being more flexible than using physical measurement instrumentation.

Besides, we made more VI-s in order to study other DC circuits' laws (Ohm's law, calculation of equivalent resistance for resistors connected in series or parallel) or resistance measuring methods such as: Wheatstone bridge, substitution method, comparison method.

The virtual instruments can be used as sub-VI-s in more complex applications.

REFERENCES

[1]. **M. Pop,** *Masurari electrice***,** Universitas Publishing House Petrosani, 2010.

[2]. **I. Utu, L. Samoila,** *Masurarea marimilor electrice,* Universitas Publishing House Petrosani, 2010.

[3]. **N. Patrascoiu,** *Achizitie de date. Instrumentaţie virtuala,* Didactic and Pedagogic Publishing House, Bucharest, 2004.

[4]. **L. Samoila, I. Utu,** *Senzori şi instrumentaţie pentru sisteme electromecanice,* Universitas Publishing House, Petrosani, 2011.

[5]. * * *, *www.ni.com/labview/.*

WIND - DIESEL SYSTEMS FOR SMALL GRIDS

TEODOR TĂBĂCARU[1]

Abstract: The path to a wider application of renewable energy sources lies via a hybrid supply system**.** Using a wind turbine-diesel generator system is attractive usually working as "fuel saver", and at the same time the environmental pollution caused by the diesel exhaust gases is reduced, furthermore, in the recent years, the oil prices have increased dramatically. The supply system is based on two diesel generators with 1800 kW each, the waste heat of which was recovered for the local district heating system. In addition, a large WKA-60 type wind turbine was used as a "fuel saver" for the diesel engines.

Keywords: energy, wind, power, diesel.

1. INTRODUCTION

A combination which could be used widely in the future is the energy supply by a diesel power station combined with one or several wind turbines working as "fuel savers", called wind-diesel systems for short by the professionals.

Diesel power stations are used in many countries, especially in the Third World. Frequently these are generators with a maximum power of several hundred kilowatts up to a few megawatts, supplying surrounding consumers via a local grid. But this technically simple and reliable concept is increasingly affected by high fuel costs. Cheaper heavy oil can be used in large diesel engines, but smaller diesel units up to one megawatt need the far more expensive light diesel oil. Using a wind turbine is especially attractive under these conditions. In locations with good wind conditions, the fuel consumption of such an electricity supply system can be reduced to a fraction and at the same time the environmental pollution caused by the diesel exhaust gases is reduced. Operating a wind turbine in a local grid fed by a diesel generator is the essential isolated application. The largest and technically most sophisticated wind-diesel system was built on the German North Sea island of Heligoland.

2. WIND-DIESEL SYSTEM DESCRIPTION

The supply system is based on two diesel generators with 1800 kW each, the waste heat of which was recovered for the local district heating system. In addition, a large WKA-60 type wind turbine was used as a "fuel saver" for the diesel engines. In times when the wind energy exceeded the instantaneous load in the grid, the electrical energy

---

[1] *Associate Professor, Eng., PhD, University of Petrosani*

was used for powering a seawater desalination plant and the drinking water produced there was stored. In this way, the overall system also had an, albeit limited, energy storage capacity (Fig.1.). A wind turbine of the WKA-60 type was modified especially for this application. The turbine's synchronous generator with a static frequency converter was operated at variable speed over a relatively wide range of speeds.
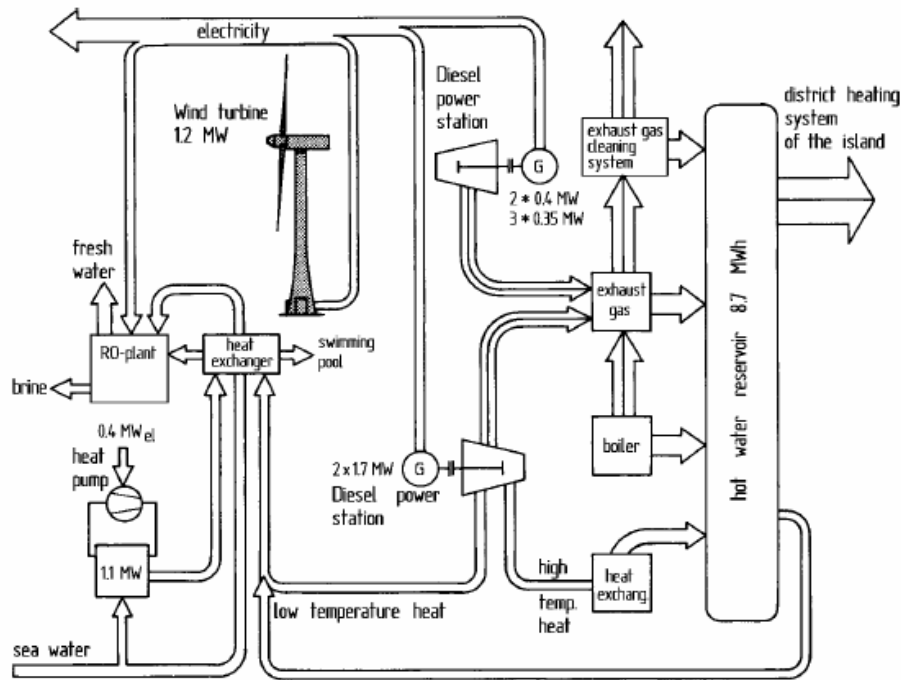
Fig.1. Energy and water supply system on the german island of Heligoland

Considering the high wind-power input in the small, isolated grid, the resultant smoothed power output was an essential precondition for overall system control interaction with the diesel generators. Moreover, the wind turbine was equipped with an autonomous reactive power supply, a synchronous generator in parallel operation, and the harmonic frequencies produced by the inverter were largely filtered out (Fig.2).
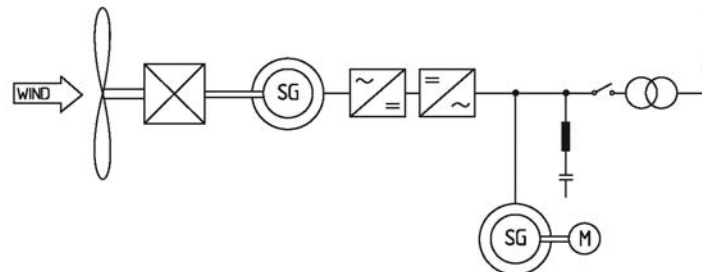
Fig.2. Electric generator system of the WKA-60 wind turbine with synchronous generator and static inverter including rotating phase shifter and harmonic frequency filter for use in a weak grid (AEG system)

However, the practical experience gained was not satisfactory. The overall load management of the island's grid gave preference to the diesel generators to such an extent that the wind turbine could not be used to its full potential. The wind turbine itself was damaged considerably several times by lightning strikes so that the local utility removed the turbine from operation and had it dismantled not much later.

The higher the wind power proportion in the grid, the greater the influence of the wind turbine on the grid frequency, taking into consideration the instantaneous conditions. It is obvious that the control system of the wind turbine plays a decisive role in this context.

A wind turbine with blade pitch control can itself contribute to the frequency stability, thus making it possible to achieve a higher proportion of wind power content than with a turbine without blade pitch control, which must be controlled completely by the grid frequency.

The second factor limiting the size of a wind turbine has to do with the behaviour of the diesel generator at partial load. If diesel engines are run at less than approximately 25 % of their rated power, their efficiency drops sharply, resulting in an increase in the specific fuel consumption.

Some further problems arise with regard to the operational sequence control. In principle, alternating operation of diesel generator and wind turbine is possible but is difficult to implement, as, in this case, the grid frequency must be maintained by the wind turbine alone from time to time. In a simpler case, the wind turbine will be run only in parallel with the diesel generator the power of which is restricted in dependence on the power input by the wind turbine. Operating the wind turbine and diesel unit in parallel also has the advantage that the diesel unit, which is usually equipped with a synchronous generator, can control the grid frequency as well as provide the excitation current for the wind turbine.

The technical problems of isolated grids are simplified if several diesel units are available. This is usually the case, anyway, for reasons of redundancy. It permits individual units to be switched on and off instead of having to drastically reduce power, which is undesirable. It must be ensured, though, that excessively frequent warm-up phases of the diesel engines should be avoided, as they cause high fuel consumption. The frequently voiced concern that increased non-steady operation of a diesel engine in combination with a wind turbine could unfavourably affect fuel consumption has not been confirmed. Compared with cold runs, these influences proved to be negligible. The system consists of a number of small wind turbines which are equipped with electro-hydraulic blade-pitch control. The turbines are fitted with induction generators. The synchronous generator of the diesel unit is connected to the engine via a switchable clutch. In addition, there is a storage battery which can be charged and discharged by an inverter or rectifier (Fig.3).

Being equipped in this way, the system can operate completely autonomously in both parallel and alternating modes of operation. When the wind turbines are operating without the diesel generator, the grid frequency is held within an acceptable range by the rotors' speed control. Decoupled from the diesel engine, the synchronous generator works as a rotating phase shifter and takes care of voltage control in the grid.

The storage battery, the capacity of which is designed for approximately 30 minutes of operation at rated power, can bridge short periods of low winds, thus avoiding excessively frequent start-ups of the diesel generator. In addition, the back-up battery can be used for smoothing out the load variations for the diesel engine, so that it can be kept within an advantageous operating range. Control of the overall system is handled by an overall load management system using the instantaneous grid frequency as reference variable.
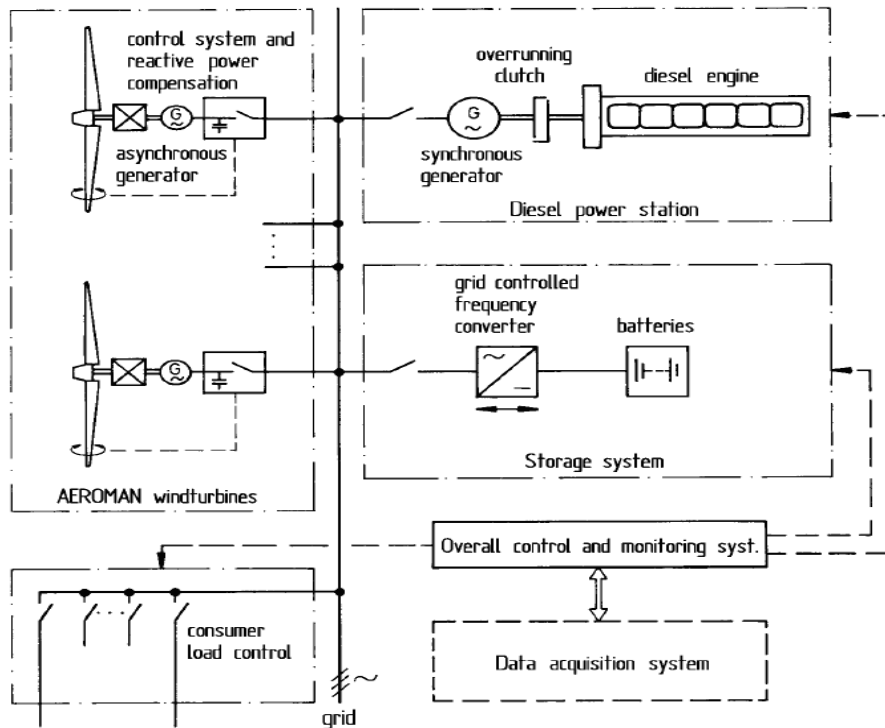
Fig.3. Concept of an autonomous wind-diesel system for alternating and parallel operation of wind turbines and diesel units

3. CONCLUSIONS

Unfortunately, the experience gained during the operation such systems was not favourable enough for an economical operation to be kept up over a longer period of time. It was found that these as yet rather improvised systems require intensive technical servicing which cannot be guaranteed in remote sites. The implementation of "wind-diesel systems" which are really commercially viable is obviously still a task for the future.

REFERENCES

[1]. Weier Electric GmbH, *Generator Systems for Wind Turbines*, Firmenprospekt 2001.
[2]. Feustel, J., *A Medium Large Wind Power Plant for the New Diesel-Powered Energy Supply System of Helgoland*, European Wind Energy Conference Oct., Hamburg, 1984.
[3]. Loher A.G., *Generator Systems for Wind Turbines*, Prospectus, 2001.
[4]. www.alxion.com/ *Brushless alternators for Wind Turbines from 200W up to 100KW.*

THE CONTRIBUTION OF "MICA" MINING COMPANY (1920-1948) TO THE ELECTRIFICATION OF THE APUSENI MOUNTAINS GOLD QUADRANGLE

MIRCEA BARON [1]

Abstract: "Mica" Mining Company, the major interwar gold producer in Romania, operating in Brad area, in the Crişul Alb Valley, inherited and expanded the Gurabarza Power Plant, indispensable for the development of its own industrial complex. At the same time, for economic and social purposes, it set up a power distribution network, "so that the entire area bordering the gold mining sites should benefit from the progress of modern civilization", as it was stated in the 1946 electrification program, and thus, making a capital contribution to the electrification of large sections of the Apuseni Mountains gold quadrangle.

Keywords: "Mica" Mining Company, Gurabarza Power Plant, electrification policy, the Apuseni Mountains gold quadrangle.

1. INTRODUCTION

"Mica" Mining Company was set up at the beginning of 1920 in Bucharest and, immediately after, it managed to buy "Ruda 12 Apostoli" cuxa Mining Association in Brad, a private company that owned the most important precious metals mining complex in Romania[2].

Among the inherited installations was the Gurabarza Power Plant, started in the '90s of the XIXth century, and later modernized and expanded in 1924, 1936, and 1938-1940 up to a power of 7,810 kW.

Up to 1924, when electrical power starts to be sold to private consumers, the power produced at "Mica" was used just for the industrial necessities of the Company, and the extension of the Gurabarza power distribution network began in the '30s. This was to ensure industrial and household lighting not only for the installations and settlements in the "Mica" Company mining complex, but also for the villages in the Mureş Valley and the Apuseni Mountains and, through the high voltage networks, the electrical power supply for the mining units in the Apuseni Mountains gold quadrangle, described by Baia de Criş, Săcărâmb, Zlatna and Baia de Arieş.

2. THE POWER INSTALLATIONS OF "RUDA 12 APOSTOLI" MINING ASSOCIATION

Between 1898-1920, **"Ruda 12 Apostoli" cuxa mining association** built adequate installations meant to produce the energy necessary for the operation of the stamps - 274 H.P. – of the ropeway, as well as for lighting, the operation of mine locomotives, and the drive of various electric motors.

Thus, mainly for the supply of stamp rows, two Compound condensation steam machines produced by "Sächsische Maschinenfabrik, vorm. Rich. Hartmann A.G." Company, Chemnitz (Saxony) were installed. The machines were built for 8 atm. and a power of 390 HP, with a maximum yield of 550 HP, and later modified for an individual yield of 10-11 atm. and 650 HP.

The Power Plant was situated within the Processing Plant at Gurabarza and consisted of three distinct installations:

1. In the new station of the machine department there was an A.E.G. alternating current generator, installed in 1910, which produced at 3,200 V, 50 Hz and a power of 520 kW. The generator was connected directly with a condensation steam machine, together with a direct current generator of 120 V and 12.6 kW; the alternating current generator yielded, on a reducing transformer, 3,200 V/120V.

2. The backup station near the machine department consisted of: an alternating current generator with a power of 250 kW at 3,000 V, probably the oldest, dating back to 1898; two dynamos, probably set up before 1900, one of 550/575 V for the drive of electric trains in Barza Mine, and the other of 120 V for lighting, all belt driven from the machine department; a 3,200 V alternating current generator, directly connected to a 180 HP Compound steam machines, which had initially been the power station of Musariu Mine and Racova stamps.

3. Near the stamps building there were four large Babcock - Wilcox boilers, equipped with water pipes, built by "Erste Brünner Maschinenfabrik A.G." Company; the heating surface was of 268 m^2, and the boilers produced 300^0 C steam, at 12 atm. Water heating was ensured by using brown coal from Țebea, the daily necessary quantity being 30 to of coal. These boilers were preceded by other four, each with a heating surface of 100 m^2, gauged for 10 atm. and fueled both by brown coal and beech wood[3].

3. GURABARZA POWER PLANT

The Power Plant of "Mica" Company (1920-1948) continued its operation after the takeover of "Ruda 12 Apostoli" mining complex and was structured as described above.

---

[3] F. Schumacher, *Die Golderzlagerstätten und Goldbergbau der Rudaer Zwölf - Apostel - Gewerkschaft zu Brád in Siebenbürgen*, Max Krahmann, Bureau für praktische Geologie, Berlin, 1912, p. 104-105.

These units functioned until 1924, when a turbo generator was installed and the operation of the plant was optimized. A 1932 *Report* [4] shows that, at that moment, Gurabarza Power Plant consisted of a 1,250 kW operating unit and the 1,220 kW backup units, as it follows:

1. A 1.250 kW Brown–Boveri turbo generator, made by "Brown-Boveri & Co." Company, Baden (Switzerland), set up in 1924.

2. Backup power units, composed of:

a. a two-cylinder Compound-Tandem A.E.G steam machine, built in 1909, with a power of 620 HP/12 atm/320^0 C and two 550 HP Compound machines with horizontal cylinders, 12 atm/320^0 C, built by A.E.G.-Union, which ceased operating in October 1934 being subsequently dismantled[5];

b. the 520 kW A.E.G.Union three- phase alternating current generator;

c. a three-phase alternating generator made by "ASEA", Westeras (Sweden), installed in 1932, transmission driven by one of the steam machines, with a power of 545 kW/3,200 V/98 A/50 Hz;

d. a Siemens & Halske three-phase alternating generator, driven by the second steam machine, with a power of 155 kW/3,200 V/28.1 A/50 Hz;

e. the 250 kW generator, which was part of the backup unit, was replaced in 1932 by the ASEA generator operating as a synchronic condenser at a voltage of 3,200 V/48 A/50 Hz.

3. The Babcock & Wilcox four-boiler unit, built by "Erste Brünner Maschinenfabrik A.G.", Brünn, with a heating surface of 260 m^2, operation pressure of 12 atm, and overheating temperature 320^0 C.

Up to 1924, the electric power provided by Gurabarza Plant was used exclusively for the necessities of the Company. Later on, most of it was used for the operation of the motors at Gurabarza Processing Plant and at the mines of the Company, which yielded a power of 2,548 HP, only a small amount being directed towards the private users in Brad and, after 1932, the villagers in Crişcior and Baia de Criş[6].

Table 1 **Power produced and sold at "Mica" Brad (1924-1931)[7]**

Year	Produced power kWh	Sold power kWh	%	Year	Produced power kWh	Sold power kWh	%
1924	3,648,474	17,223	0.47	1928	3,616,172	71,694	1.98
1925	3,081,256	22,253	0.72	1929	4,162,060	72,218	1.73
1926	3,050,294	23,845	0.78	1930	4,915,560	55,963	1.04
1927	3,303,520	28,506	0.86	1931	5,377,425	56,378	1.04

[4] Hunedoara County National Archives Service (*hereafter referred to as* SJHAN), *Fond Societatea „Mica",* dos. 8/1930, f. 32-40.

[5] *Ibidem*, dos. 19/1934, f. 270.

[6] *Ibidem*, dos. 8/1930, f. 35-36.

[7] *Ibidem*, f. 4, 14.

The development of "Ruda 12 Apostoli" mining complex, the modern installations, the demand of electric power for household and industrial consumption, and the aging of some of the units in Gurabarza Power Plant called for the building of a new turbo generator. The company chose a 2,500 kW Siemens-Schuckert turbo generator, produced at Mühlheim, Germany, by "Siemens-Schuckert A.G.", which was set into operation on January 22, 1936[8]. Thus, in 1936, at Gurabarza Power Plant the following were in operation: a 2,500 kW turbo generator and a 650 HP/12 atm Compound - Tandem steam machine, connected with a 550 kW A.E.G.-Union generator, and a backup turbo generator, composed of a 1,450 HP/12 atm Brown-Boveri-Parsons steam turbine, directly connected with a 1,250 kW/3.000 V/50 Hz generator[9]. This installation was authorized to operate by the Ministry of Industry and Commerce (M.I.C.) in 1935, its license being withdrawn on July 11, 1938 by the Ministry of National Economy[10], following the approval for the building of the new power plant at Gurabarza[11].

This stage was considered temporary, being an important step towards the radical change of the structure of power installations in Gurabarza Plant that was to take place in 1937-1940.

There was hope that the new power station would make effective use of the coal from Țebea by producing more electric power at lower prices. The power was to be supplied within a radius of 45 km through a 100 km long network to the benefit of the major gold mining units in the area.

Thus, "Mica" Company tended to become an important electric power supplier.

The new power plant was also built in Gurabarza, on a different site, between July 15 1938-April 20 1940, and 93,754,226 lei were spent for the erection of the building, the fitting of the new boilers and of the new 5,000 kW turbo generator, the relocation of the 2,450 kW turbo-aggregate, etc.[12].

The setting up and the putting into operation of the new turbo generator was over by the end of 1939, which allowed the 650 HP Compound-Tandem steam machine and the 1,450 HP Brown-Boveri-Parsons steam turbine to cease operation on December 28, 1939[13]. The 2,500 kW turbo generator also ceased to operate in this period to be upgraded to 2,760 kW and moved to the new plant by April 1940; at the same time, the turbo pump meant to supply cooling water for the turbines was set up[14].

The new power plant now consisted of:

---

[8] *Ibidem*, dos. 19/1934, f. 133; dos. 2/1940, f. 1.
[9] Societatea „Mica", *Darea de seamă din 12 mai 1937. Exercițiul 1936*, Institutul de Arte Grafice „Imprimeria", București, 1937, p. 13.
[10] SJHAN, *Fond Societatea „Mica"*, dos. 3/1927, f. 137.
[11] *Ibidem*, dos. 8/1930, f. 124.
[12] SJHAN, *Fond Societatea „Mica"*, dos. 8/1930, f. 124; Societatea „Mica", *Darea de seamă din 27 mai 1939. Exercițiul 1938*, Institutul de Arte Grafice „Imprimeria", București, 1939, p. 30.
[13] SJHAN, *Fond Societatea „Mica"*, dos. 8/1930, f. 107.
[14] *Ibidem*; Societatea „Mica", *Darea de seamă din 30 iunie 1941. Exercițiul 1940*, Tiparul „Luceafărul", București, 1941, p. 25.

1. three Babcock-Wilcox steam boilers, with a total heating surface of 1,260 m^2 and a total capacity of 1,488 to overheated steam in 24 hours, at a temperature of 410^0 and a pressure of 35 atm. the boilers were fitted by "Vulcan" Works Bucharest, in collaboration with "Deutsche Babcock-Wilcox Damfkessel Werke AG.", Oberhausen, which provided most of the parts, and was completed in August 1939[15].

2. a 5,250 kW/34 atm/400^0 C Siemens-Schuckert steam turbine, connected to a 7.500 kW Siemens - Schuckert electric generator, at a voltage of 3,200 V;

3. a 2.560 kW Siemens-Schuckert steam turbine, connected to a 3,400 kW generator, at a voltage of 3,200 V[16].

On completion, this achievement was appreciated as very important for the future development of "Mica" Company, for the affiliated mining companies and for the welfare of the whole mining community in Ţara Moţilor, supplied with electric power by the Plant. It was also pointed out that, most of the operations, with the exception of the sporadic presence of specialists sent by the equipment suppliers, were almost entirely carried out with Company personnel, who "are entitled to our thanks for their skill and their zeal"[17].

4. THE DEVELOPMENT OF ELECTRICAL POWER DISTRIBUTION NETWORK

The efficient use of the produced electric power involved the development of an adequate network to distribute it. As early as 1932, there was a network consisting of 14.5 km of high voltage lines, 10.4 km of underground electric cables, and 15.5 km of lighting networks[18]. In the years to follow, the program was to be developed intensely.

The first achievement was the 25,000 V line between Gurabarza Power Plant and Certej, granted to "Mica" Company by a M.I.C. decision, and set into operation in November 1934. Inauguration was delayed because the state mines at Săcărâmb had not completed the installations that were supposed to consume the electric power[19].

The second high voltage line, of 60,000 V, set up between Gurabarza and Zlatna, was completed in December 1936 and started supplying electric power on February 7, 1937[20]. The line, conceded to "Mica" Company by a M.I.C. decision in 1935, was 34.6 km long, running from Gurabarza, along a part of the Apuseni Mountains, crossing the communes of Crişcior, Bucureşci, Şesuri, Curechiu, Stănija, Almaşul Mare, and ending at the transformer station of the Head Office of the State Mining and Metallurgical Companies in Transylvania (R.I.M.M.A.) in Zlatna; it had transformer stations at Gurabarza, Stănija, Haneş, Breaza, Pucioasa.
This main line branches into two other lines:

[15] SJHAN, *Fond Societatea „Mica"*, dos. 11/1937, f. 2-22; dos. 125/1939, f. 1, 4.

[16] *Ibidem*, dos. 3/1927, f. 137.

[17] Societatea „Mica", *Darea de seamă din 27 mai 1939. Exerciţiul 1938*, p. 30.

[18] *Ibidem*, dos. 8/1930, f. 36.

[19] *Ibidem*, f. 125.

[20] *Ibidem*, f. 129 Societatea „Mica", *Darea de seamă din 11 mai 1936. Exerciţiul 1935*,
Institutul de Arte Grafice şi Legătorie „Apollo", Bucureşti, 1936, p. 18.

a. Pucioasa-Boteş-Bucium line, 14.42 km long, granted to "Mica" Company by a M.I.C. decision in 1935. set into operation in March 1937, the line had two sectors: a 60,000 V sector, 9.5 km long, between Pucioasa and Boteş, which supplied the electric power necessary to the mining sites of "Gold" Company in Valea Ruzii-Gura Ruzii-Boteş, and the concessions of "Mica" Company in Dosului Valley; a 4.85 km long sector between Boteş and Bucium and charged at 3,000 V;

b. Pillar 163 line- mine of "Albini" Mining Association, granted to "Mica" Company in 1937. It was 400 m long, charged at 60,000 V and started operation in 1937[21].

This almost 50 km long line crossed the whole gold mining area between Brad-Zlatna and Bucium, supplying the electric power for the sites of the affiliated mining companies or for those to which "Mica" Company was a shareholder, namely: "Mines d'Or de Stănija", "Pyrit", "Gold Mines Breaza - Zlatna" and "Gold", "Albini" Mining Associations, as well as for the installations of Zlatna Metallurgical Plant. Moreover, negotiations were in progress with R.I.M.M.A. to extend this high voltage line from Boteş to the mining units of Roşia Montană, on a distance of 16 km. Taking into consideration the 25,000 V from Gurabarza to the state mining site at Săcărâmb, it can be noticed that the power distribution network of "Mica" Company crossed the entire gold quadrangle in the Apuseni Mountains[22].

In 1939, the 15,000 V Ţebea-Căraciu line was added to the existing high voltage lines in order to enhance the operations at Căraciu Mine and for the operation of the local processing plant[23], and on March 1, 1940, the 25,000 V Certej-Deva line was set into operation, on a length of 12.1 km, meant to supply electric power for Deva and the Romanian Railways works in Simeria; the main line later branched into pillar 103-Căinel, with a length of 0.450 km, meant to supply electric power for the mine at Căinelul de Sus[24].

This new extension of the electric network of "Mica" Company was possible as a result of the 1939 contract between the company and the Transylvanian Electricity Company (SETA) in Sibiu. By virtue of this contract, a junction was made between the networks of the two companies, and "Mica" Company was to provide electric current to the electricity company for the supply of Deva – Simeria area[25].

In 1940, concession was obtained by M.I.C. decision on July 30, 1940, and the building of the 60,000 V Boteş (Valea Dosului)-Roşia Montană line was started. The 12.821 km long line, which ended at the transformer station of Roşia Montană State

[21] Societatea „Mica, *Darea de seamă din 12 mai 1937. Exerciţiul 1936*, p. 13; SJHAN, *Fond Societatea „Mica"*, dos. 14/1933, f. 272; dos. 8/1930, f. 129-130.

[22] Societatea „Mica", *Darea de seamă din 14 mai 1938. Exerciţiul 1937,* Institutul de Arte Grafice „Imprimeria", Bucureşti, 1938, p. 22-23.

[23] Societatea „Mica", *Darea de seamă din 25 mai 1940. Exerciţiul 1939*, Imprimeriile „Adeverul", Bucureşti, 1940, p. 30.

[24] Societatea „Mica", *Darea de seamă din 30 iunie 1941. Exerciţiul 1940*, p. 25.

[25] SJHAN, *Fond Societatea „Mica"*, dos. 5/1939, f. 1, 20-27. In January 1945, electric power was distributed through "SETA" to Deva, Orăştie, Simeria, Sântandrei, the Romanian Railways Works at Simeria, "Astra" Plant at Orăştie, and Brănişca stone quarry (SJHAN, *Fond Societatea „Mica"*, dos. 2/1940, f. 42).

Mines, was set into operation on June 29, 1941[26] and supplied the Roşia Montană mining sites belonging to "Minaur" (the former R.I.M.M.A.), "Sft. Gh. Suluţiu" Mining Association and also covered the household consumption of Abrud town. In the same year, the 15,000 V Brad – Ţebea line was rebuilt and shortened, so that the total length of the power distribution lines belonging to "Mica" Company from the Apuseni Mountains area to Deva was now of 129.938 km[27], with a positive impact on the whole region.

The completion of this project, and possibly the low price at which "Mica" Company sold the electric power (1.70 lei/kWh for R.I.M.M.A. and 2.20 lei/kWh for "Albini" Mining Association in 1938, in comparison with the price of 3 lei/kWh imposed by the regulations of the time[28]) were factors that determined certain institutions to request "Mica" Company to continue this development, mainly to the benefit of the small gold producers in the Apuseni Mountains, an idea that was not feasible in the '40s of the XXth century.

Besides the extension of the power distribution line necessary for industrial development, especially in the filed of mining in the Apuseni area, "Mica" Company contributed to the increase of household consumption, an activity that pertained to modernity and also to the social policy led by "Mica" Company in the area of its mining complex at Brad. Apart from the price of the kilowatt supplied to private beneficiaries, "Mica" Brad accepted numerous exceptions. Thus, in January 1936, a number of 43 de persons and institutions, namely: the catholic and the orthodox church; the Romanian Casino; the Railway station; "Avram Iancu" High School, including the gym and the boarding premises; the Court of Justice; the Police station; the Pretor's Office and the Notary Public Office; the primary schools and the kindergarten were supplied with electric power free of charge; 41 persons benefited from electric power at a 50% discount, and 67of the Company enjoyed a 50 W bonus for the consumed power[29].

We also have to mention, however, that the total domestic consumption did not display a dramatic growth, representing, for instance, 4.19% of the sold electric power in 1944.

It is also known how the electric power distribution network was introduced in three communes in the area in the '20s and the 30s of the XXth century.

In Brad the network was built by "Ruda 12 Apostoli" Mining Association in 1919, "Mica" Company being its owner for many years to come. The network ensured public and private lighting, and also supplied a number of motors and domestic and industrial electric appliances. In January 1928, 226 private and public consumers in Brad, Racova, Gurabarza, Tărăţel and Musariu were connected to the network that ran from Gurabarza Electric Plant to Brad. Among the 200 de consumers in Brad, there are:

---

[26] *Ibidem*, dos. 8/1930, f. 133.

[27] Societatea „Mica", *Darea de seamă din 30 iunie 1942. Exerciţiul 1941*, Tiparul „Luceafărul", Bucureşti, 1942, p. 24.

[28] SJHAN, *Fond Societatea „Mica"*, dos. 3/1937, f. 124.

[29] *Ibidem*, dos. 1/1928, f. 166-171.

"Avram Iancu" High School and its boarding premises; the Town hall; the Police and Public Safety Station; the church parishes; schools and kindergartens; hotels and their restaurants; the Hospital; the Cinema Hall; the Railway Station; public institutions, etc.[30].

The network, operating at a voltage of 110 V until October 1926, and later on at a voltage of 220 V, was initially connected through a direct line with Gurabarza Electric Plant and, after the building of the 15,000 V Gurabarza-Țebea line in the '20s, the connection was made through three 20, 30, and 80 kVA transformers. The network, built in 1919, operated without approval or concession from M.I.C. until 1932, when "Mica" Company starting taking steps for obtaining such an acknowledgment of its rights over one of its assets[31].

Under the pressure of the commune, but also for its own interests, "Mica" Company was involved in maintaining and extending the network in compliance with the necessities. Thus, the network was successfully rebuilt in 1935-1938, being re-dimensioned in order to meet the requirements and to reduce losses. "Mica" did not give up its ownership of the network, a memo of the Brad Mines Central Office on Jnuary16, 1943 pointing out that Gurabarza Electric Plant distributed the electric power directly to the communes of Brad and Tărăţel and the Company colonies at Gurabarza, Barza, Valea Morii, Valea Arsului, Musariu, Racova, Şteampurile Vechi, Ţebea, Căraciu[32].

The second commune connected by "Mica" Brad Gurabarza Electric Plant was Crişcior. In January 1929, "Mica" Brad agreed to build the whole network, which was completed by March 1931[33].

According to the *Concession contract* for the distribution of electric power on March 7, 1931, the commune of Crişcior granted "Mica" Company, for a period of 45, beginning with April 1, 1932, the exclusive right for the distribution of electric power in the entire locality. In its turn "Mica" was to ensure, on its expense, the following: the high voltage line Gurabarza-Crişcior; the 50 kVA transformer and its house; the counter for measuring the 220 V electric power supplied to the commune, tall this being Company property. The distribution network in the commune, built by "Mica" Brad, was commune property, and "Mica" Company maintained and repaired it on the expense of the former, pledging to supply energy continuously, with the exception of fortuitous situations; failure in the payment for the supplied power for three consecutive months led to the ceasing of services[34]; on August 25, 1939, "Mica" Brad agreed with the general price decrease in accordance with the amount of consumed electric power and consented to extend and repair the whole network in the commune on its expense[35].

---

[30] *Ibidem*, f. 1-322.
[31] SJHAN, *Fond Societatea „Mica"*, dos. 1/1928, f. 82-83.
[32] *Ibidem*, dos. 69/1943, f. 10.
[33] *Ibidem*, f. 24, 29.
[34] *Ibidem*, f. 33-35; 72-74.
[35] *Ibidem*, f. 169-172.

Baia de Criş was the commune that benefited from electric power beginning with December 1932. As early as February 1929, "Mica" Brad presented the general conditions on grounds of which Baia de Criş could be supplied with electric power. The power was to be supplied directly to the commune, which was in charge with distribution and consumer tax collection, being allowed to charge more than it actually paid to "Mica". The building of the high voltage line Ţebea - Baia de Criş, the setting up of the converter and its house at Baia de Criş, and the main counter were the responsibility of the Company, which was to remain their owner; the distribution network was also built by "Mica" Brad, with the possibility of being bought by the commune[36]. On March 7, 1929 the Communal Council at Baia de Criş, as well as the commune of Ţebea, agreed with the setting up of an electric power distribution network, also drawing up a list of private and public consumers willing to be supplied with electric power[37].

The distribution involved the extension of the 15,000 V Gurabarza - Ţebea line with 3.8 km, crossing the communes of Ţebea and Baia de Criş up to the converter installed in the yard of the local Courthouse, meant to lower the voltage from 15,000 V to 220 V[38]. On February 18, 1932 "Mica" Brad signed the concession contract with Baia de Criş[39], and on December 20, 1932, Ţebea - Baia de Criş line and the communal network were connected to electricity[40].

This represented the end of a stage, a statistics from 1935 showing that "Mica" Brad supplied electrical power in the area of "Ruda 12 Apostoli" Complex to: Baia de Criş, Ţebea[41], Tărăţel, Ruda, Brad, Crişcior[42], and the subsequent attempts of other communes to obtain such a facility elicited no response from the management of "Mica" Company[43].

In 1944, the Electric Station provided electric power, on a monthly basis, to the following consumers[44]:

Table 2

Consumers	Sold power kWh	Selling price lei	Cost price lei
Small consumers: Gurabarza, Barza, Musariu	690	7.34	22.67
Commune of Crişcior	2,230	10.00	25.70

---

[36] *Ibidem*, dos. 2/1929, f. 9-10.

[37] *Ibidem*, f. 1-5.

[38] *Ibidem*, f. 71.

[39] *Ibidem*, f. 113-116.

[40] *Ibidem*, f. 147.

[41] It is known that in 1935 Ţebea was among the first communes to be electrified, but it is uncertain whether this information referred to the locality as such or to Ţebea mine; what is certain is that in 1945 the communal network measured 2.4 km (*Ibidem*, dos. 35/1946, f. 8).

[42] *Ibidem*, dos. 8/1930, f. 69.

[43] *Ibidem*, dos. 2/1929, f. 160.

[44] *Ibidem*, dos.11/1945, f. 138.

Commune of Baia de Criş	2,140	7.00	24.05
Commune of Brad	22,030	7.66	40.27
Commune of Tărăţel	2,450	7.06	46.61
"Minaur" Certej	131,540	6.17	23.84
SETA Deva	212,840	3.88	23.84
Mines d'Or de Stănija	19,760	2.86	23.68
"Gold" Valea Dosului Company	2,320	2.20	23.68
"Albini" Mining Association Zlatna	13,450	6.61	23.68
"Minaur" Zlatna	62,040	6.17	23.68
"Minaur" Roşia Montană	233,410	6.17	23.68

The next stage took place in 1944-1947 and was meant to have a strongly social character, being carried out in the communes nearby the Company mines and plants.
In the 1944 Report it was shown that electric power was introduced in the commune of Tărăţel, and other communes, such as Zdrapţi, Bucureşci, Ţebea[45], were to benefit from electrification in the near future. In order to implement this project, the 3,000 V and 9.25 km long Crişcior-Zdrapţi-Bucureşci distribution line was set up to supply the two communes, and another 500 V and 862 m long line was built to supply the commune of Tărăţel.

Consequently, the power distribution line in Bradului area – Zdrapţi, Bucureşti, Ţebea Musariu, Valea Arsului, Tărăţel, Brad, Crişcior, Baia de Criş – charged at 220 V, reached a length of 29.395 km.

The electrification of such communes as Ormindea, Valea Bradului, Căinel, Hărţăgani, Luncoi and Mesteacăn was also intended "so that the entire area bordering the gold mining sites should benefit from the developments of modern civilization".
It should also be shown that, besides the localities mentioned above, "Mica" supplied electric power to Baia de Criş, Crişcior, Deva, Zlatna and Abrud[46].

In 1946 the 120, 220, 500, 3,000 V aerial and underground electric lines network managed by "Mica" Brad, measured 100.532 km, compared to 75.404 km in 1945, and the length of the distribution lines was 138.668 km[47].

As a result of these preoccupations, the amount of electric power sold by "Mica" Brad to domestic and primarily to industrial consumers increased[48]:

Table 3

Year	Production kWh	Of which					
		Own consumption kWh	%	Sold kWh	%	Losses kWh	%

[45] Societatea „Mica", *Darea de seamă din 22 septembrie 1945. Exerciţiul 1944*, Institutul de Arte Grafice „Curierul Judiciar", Bucureşti, 1945, p. 25.
[46] Societatea „Mica", *Darea de seamă din 24 mai 1947. Exerciţiul 1945*, Institutul de Arte Grafice „Curierul Judiciar", Bucureşti, 1947, p. 19.
[47] SJHAN, *Fond Societatea „Mica"*, dos. 226/1946, f. 29-30.
[48] Societatea „Mica", *Dările de seamă…Exerciţiile 1937-1944*; SJHAN, *Fond Societatea „Mica"*, dos. 4/1945, f. 29; dos. 226/1946, f. 29; dos.35/1947, f. 33.

1937	10,921,510	7,283,080	66.70	3,015,144	27.60	623,286	5.70
1938	12,906,040	7,968,182	61.80	4,147,101	32.10	790,757	6.10
1939	14,093.211	9,098,932	64.40	4,158,733	29.60	835,546	6.00
1940	16,240,619	10,074,318	61.90	5,401,541	33.40	764,760	4.70
1941	18,333,484	10,504,521	57.60	6,930,975	38.00	797,988	4.40
1942	20,463,687	10,533,772	51.60	9,051,869	44.20	878,046	4.20
1943	20,541,357	10,181,727	49.60	9,292,150	45.20	1,067,480	5.20
1944	20,933,732	11,413,844	54.50	8,445,760	40.40	1,074,128	5.10
1945	20,223,652	11,744,593	58.07	7,347,773	36.33	1,131,286	5.60
1946	17,744,849	9,683,374	54.57	7,007,140	39.49	1,054,335	5.94
1947	17,297,189	9,169,228	53.01	7,007,140	40.58	1,107,959	6.41

All this activity called for adequate work force, most of which skilled[49]:

Table 4

Personnel	Year					
	1940	*1941*	*1942*	*1943*	*1944*	*1945*
Administrative personnel	6	6	5	6	6	6
Technical personnel	13	14	14	13	13	13
Skilled workers	46	40	38	40	44	54
Unskilled workers	51	52	44	43	50	51
Total	*116*	*112*	*101*	*102*	*113*	*124*

5. CONCLUSIONS

Our study attempts to point out the way in which a strong industrial company managed, in the inter-war period, to develop its own power installations absolutely necessary for the optimization of gold and silver ore mining and processing, also being involved in the economic development of the Apuseni Mountains mining region and the improvement of the living standard of the local population.

REFERENCES

[1]. Schumacher, F., *Die Golderzlagerstätten und Goldbergbau der Rudaer Zwölf - Apostel - Gewerkschaft zu Brád in Siebenbürgen*, Max Krahmann, Bureau für praktische Geologie, Berlin, 1912.
[2]. Serviciul judeţean Hunedoara al Arhivelor Naţionale, *Fond Societatea „Mica"* (1920-1948).
[3]. Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 19 februarie 1922. Exerciţiul 1921*, Tipografia Curţii Regale, F. Göbl Fii, Bucureşti, 1922.

---

[49] *Ibidem*, dos.11/1945, f. 75.

[4]. Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 12 mai 1937. Exerciţiul 1936*, Institutul de Arte Grafice „Imprimeria", Bucureşti, 1937.

[5]. Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 27 mai 1939. Exerciţiul 1938*, Institutul de Arte Grafice „Imprimeria", Bucureşti, 1939.

[**6**]. **Societatea „Mica"**, *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 30 iunie 1941. Exerciţiul 1940*, Tiparul „Luceafărul", Bucureşti, 1941.

[7]. Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 11 mai 1936. Exerciţiul 1935*, Institutul de Arte Grafice şi Legătorie „Apollo", Bucureşti, 1936.

[8] Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 14 mai 1938. Exerciţiul 1937,* Institutul de Arte Grafice „Imprimeria", Bucureşti, 1938.

[9] Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 25 mai 1940. Exerciţiul 1939*, Imprimeriile „Adeverul", Bucureşti, 1940.

[10] Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 30 iunie 1942. Exerciţiul 1941*, Tiparul „Luceafărul", Bucureşti, 1942.

[11] Societatea „Mica", *Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 22 septembrie 1945. Exerciţiul 1944*, Institutul de Arte Grafice „Curierul Judiciar", Bucureşti, 1945.

[12] Societatea „Mica"*, Darea de seamă a Consiliului de Administraţie şi Raportul cenzorilor către Adunarea generală ordinară a acţionarilor din 24 mai 1947. Exerciţiul 1945*, Institutul de Arte Grafice „Curierul Judiciar", Bucureşti, 1947.

THE DISTRIBUTED SUPPLY AND THE IMPACT ABOVE THE ELECTRICAL WEBS

MARIA DANIELA STOCHIŢOIU[1], ALIN CRISTIAN GRUBER[2]

Abstract: Energy is a product with great economic, social, strategic and political values. It is indispensable for any country's economy as for industries, services and human activities. The distributed supply can be define as the model of producing the electrical energy using devices and machines with reduced gauge in comparison with the electrical power plant, as it can be connected almost everywhere in the electro energetically system.

Keywords: distributed sources, installed power, renewable energy, power losses.

1. THE DISTRIBUTED SUPPLY CONCEPT

The huge power plant as thermo, hydro and nuclear assures the electrical energy production through the criteria based on the centralized and hierarchy control and command system.
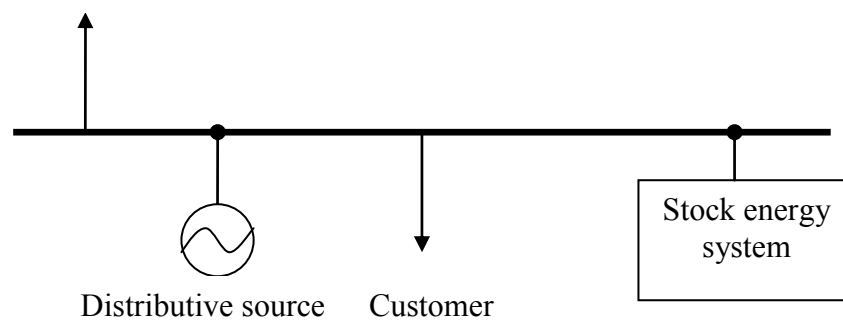

Fig.1. The distributed supply installation using the stock energy system

---

[1] *Associate Professor Eng., Ph.D. at University of Petrosani*
[2] *Professor at School Group Aurel Vlaicu Lugoj*

The exhaust forecast of primary energetically resources as fossils fuel (coal, lignite), the climate changes imminences and environmental degradation have led of international communities mobilization for diminishing the negative consequences of these effects. The problem of increasing the concentration of gases with greenhouse effect stopping was an important point of view for majority international meetings. Romanian engagement has took appoint the increasing electrical energy production using renewable energy sources from 14% in 2010 to 20% in 2020.

The developed countries have an energetically policy which recommend the reduction or even giving up of nuclear plane on long term. This fact involves to use another primary energy to assure the necessary of energy for a normally function of society. So, it is properly to appear and to develop the distributive electrical energy supply. The distributed sources represent a way to generate the electrical energy almost all over it is necessary. The distributed sources can be used for supplying the solitary customers or for to shoot the energy and electrical power in the electrical webs.

For establishing the solution of connection of distributed sources at electrical webs it can take into account some factors as:
- installed power;
- the emplacement from the electrical webs;
- type of primary energy conversion, etc.

In the below table is presenting some distributed sources in dependence with the used primary energy sources, the supply safety and the type of operating generator.

Table 1 **Examples of distributed sources**

	Type of production	Primary source energy	Supply safety	Generator type
1	Hydro power plant (low power)	Renewable energy (hydro)	high	Synchronous and asynchronous machines
2	Wind power plant	Renewable energy (wind power)	low	Asynchronous and synchronous machines
3	Photovoltaic cells	Renewable energy	low	Power converter
4	Co-generating	Fossil fuel (oil, lignite, natural gasses) Renewable energy biomass	high	Synchronous and asynchronous machines
5	Gasses turbines	Fossil fuel	high	Synchronous and asynchronous machines

Nowadays, energetically systems pass through important change-over due to the settlements gradually form a monopolist structure characterized by only owner to a concurrencies situation characterized by existing of different owners.

The power/currents flow from the electrical webs is modified in the upward from the connecting point through introducing the distributed generators.

The levels of voltages used for connecting the distributed generators are shown in the table 2.

Table 2 **The recommended levels of voltage for distributed sources connection**

Customer class	Permanent maximum load (MVA)	Load on km (MVAkm)	The voltage step in the connecting point (kV)	Possibility for customer connecting	
				Direct to the web voltage (kV)	Through transformer
A	>50	>1500	400 220 110	- 220 110	400/110 kV 220/110 kV 220/MT 110/MT
B	7,5-50	<1500	110	110	110/MT
C	2,5-7,5	30-80	110 20	110(20)	110/MT 20/6(10)kV 20/0,4kV
D	0,1-2,5	8 3	20 10 6	6-20	20/0,4 kV 10/0,4kV 6/0,4kV
E	0,03-0,1	0,05	0,4MT	0,4	MT/0,4kV
F	<0,03		0,4	0,4	

2. OPERATING REGIME OPTIMIZATION

One of the actions which can enterprise in the distributed electrical webs is based on the optimisation of the permanent stage of operation as:
- the minimization of the energy and power losses;
- the coordination of the adjustable devices for the voltage level optimization;
- the diminution of transformers and the electrical lines loads.

The main devices which are allowing for optimisation of permanent regime in electrical distribute webs are:
- using the adjustment plugs of transformers;
- introducing the FACTS line-ups.

2.1 Choosing the emplacement for diminution the power losses

For discuss this main aspect it takes into account that the power/currents low through the line with the distributed generators is modified. It can modify the power flow through the lines in dependence with the efficiency between the supplied power and consumed power downward the connection point. The power/currents flow through the lines placed downward the connection point is not sensitive modified when the voltage of distributed source connection is almost constant. In these conditions, the generators affect the power losses only through the lines between the connection point and web supply point.

The power losses variation is so important that the generator point connection is far away as the supply source of electrical webs.

The optimum generated power it can be obtained matching zero the partial derivates of active power losses with the component Δi_{ka} and Δi_{kr} of the complex current $\Delta \underline{i}_k$, and the active power losses are demined.

$$\Delta \underline{i}_k = \Delta i_{ka} + j \Delta i_{kr} \tag{1}$$

$$\delta P = 3\left[R\left(\Delta i^2_{ka} + \Delta i^2_{kr} \right) + 2\Delta i_{ka}\Delta U_a + 2\Delta i_{kr}\delta U_a \right] \tag{2} \qquad R = \sum_{i=1}^{k} r_i \tag{3}$$

R- represents the resistances of lines between source point and another point k.

$$\Delta U_a = \sum_{i=1}^{k} r_i I_{ia} \quad ; \qquad \delta U_a = \sum_{i=1}^{k} r_i I_{ir} \tag{4}$$

$$\left\{ \begin{array}{l} \dfrac{\partial(\delta P_k)}{\partial(\Delta i_{ka})} = 0 \Rightarrow \Delta i_{ka} = -\dfrac{\Delta U_a}{R} = -\dfrac{\displaystyle\sum_{i=1}^{k} r_i I_{ia}}{\displaystyle\sum_{i=1}^{k} r_i} = I_{ka,g} \\[2em] \dfrac{\partial(\delta P_k)}{\partial(\Delta i_{kr})} = 0 \Rightarrow \Delta i_{kr} = -\dfrac{\partial U_a}{R} = -\dfrac{\displaystyle\sum_{i=1}^{k} r_i I_{ir}}{\displaystyle\sum_{i=1}^{k} r_i} = I_{kr,g} \end{array} \right\} \tag{5}$$

3. CONCLUSIONS

Power is carried through this transmission network of high voltage lines for hundreds of kilometres and delivers the power as an interconnected power pool called

the electric grid. The grid really performs a balancing function - enabling local power generators across a country to synchronise their power outputs and thus readily share generated power.

REFERENCES:

[1]. **Carmen Ionescu Golovanov**, *Masurarea marimilor electrice in sistemul electroenergetic,* Editura Academiei Romane, Bucuresti 2009.

[2]. Adrian Badea, s.a., *Surse regenerabile de energie*, Editura Agir, Bucuresti 2013.

[3]. Maria Daniela Stochitoiu, Gruber Alin, *The electric power plant impact reduction above the environment,* International Symposium SESAM , oct. 2013, Sibiu.

INDEX OF AUTHORS

REVIEWERS:

Assoc. prof. dr. ing. Susana Arad

Prof. dr. ing. Ion Fotau

Dr. ing. Emilian Ghicioi

Assoc. Prof. dr. ing. Nicolae Patrascoiu

Prof. dr. ing. Aron Poanta

Prof. dr. ing. mat. Emil Pop