Monitoring and control system for electrical grid stations

Gabriel VLADUȚ*, Marius FETOIU*, Mircea DOBRICEANU**,

* IPA, Craiova subsidiary, Automation Engineering Institut, Craiova, Romania,
office@ipacv.ro
** University of Craiova, Electromechanical Engineering Faculty,
Decebal, 107, Craiova, 200440, Romania
mdobriceanu@em.ucv.ro mpopescu@em.ucv.ro

Abstract: - The extension of computational technique for the generalization of automatics, information and process monitoring involve the conception and materialization of complex data acquisition equipments, processing, memorizing and sending data taken from those processes at a higher level - dispatcher. In this way, it is presented data acquisition equipment for energetic measures which is incorporated in a dispatching system aiming the monitoring and storing of electrical measures which are taken from electrical cells which compose the supervised electrical station. There are distinguished the component elements of the monitoring system: Local data acquisition equipments (LDAqE), Local data acquisition equipments synchronization subsystem, Data communication subsystem, Processing, storing and data displaying subsystem and the software for data processing at the dispatcher level and also at the local data acquisition equipment level.

Key-Words: - Data transmission, Energy system management, Measurements, Transducers, Daq, Dispatcher

1 Introduction

When it is analyzed the efficiency of a production process there appears the problem of the consumption of the electrical energy which represents a vital source for each factory. A sustained activity for maintaining the internal electrical energy consumptions at reduced levels explains the worries of many managers regarding the way in which the electrical energy is consumed inside the factory they run. The measures taken into consideration included the implementation of a monitoring and control system of the energetic installation, with the purpose of automat supervision of the electrical energy consumed capable to issue the necessary information for the reduction of the energy and installation's automation costs.

The monitoring system for the electrical parameters is designed to go on two main directions:

►The acquisition of the characteristic parameters of the electrical station (voltages, currents, powers, auxiliary contacts of the switching elements), processing these parameters and sending them to a superior level (dispatcher) through a physical data transmission medium. The taken signals are used for permanent monitoring of the functioning of the electrical distribution station.

►Synchronous acquisition, on a determined period of time, of a set of characteristic parameters of the transient regime when an error occurs in the monitored electrical station. The set of data stored during the error period is then sent to a computer where the interpretation of data is done by the help of a dedicated program.

2 The architecture of the monitoring system

To accomplish the two main directions, there was designed a complex data acquisition, data sending and receiving system [5], [7], [8], which has the block diagram presented in Fig.1.

The system functions must provide:

►permanent and real time visualization of the characteristic measures for the electrical station (currents, voltages, powers, energy, power factors, auxiliary contacts);

►visual and sound alarm in case of outrunning pre-established range for any of the monitored measures;

►visual and sound alarm in case any equipment faults (fails of communication lines, fails of data collecting equipments, etc.);

►recording information into a database (dispatcher), assuring the possibility to process data on the network server computer or on any workstation connected to the network;

►graphical display of the measures taken from the process, on time periods defined by the users;

► printing of consumption diagrams and specific diagrams on time periods defined by the user;
► interconnection into a computer network;
► data transfer to a central dispatcher.

2.1 Processing, storing and data displaying subsystem

This subsystem is composed of an IBM–PC compatible computer and the corresponding software which allows storing, processing, displaying and printing data taken from a maximum number of 255 local data acquisition equipments (LDAqE) from electrical cells. This computer can be integrated in a LAN at the dispatcher level, allowing data access to authorized users.

2.2 Data communication subsystem

This subsystem is composed of equipments for connecting to the optical fiber environment (equipment at the dispatcher's level and equipment for each of the electrical cell from the perimeter of the supervised station) which assure communication at high speed and high security between the data processing subsystem and the local data acquisition equipments. The proposed subsystem is immune to the electromagnetic interferences and assures optimal galvanic isolation between the acquisition equipments and the equipments form the dispatcher.

2.3 Local data acquisition equipments synchronization subsystem

This subsystem is composed of dedicated equipments at the level of each electrical cell and assures the synchronization of all the local data acquisition equipments from the respective electrical station after the universal time taken by the means of a local antenna and the GPS modules from the satellites. By mounting these equipments there is assured the synchronous data take over at the level of each cell from the respective electrical house, and also at the level of the electrical station. This fact is extremely useful for the analysis of the acquisitioned data, allowing the user to supervise the propagation of a flaw at the station level and also at the level of the electrical distribution system.

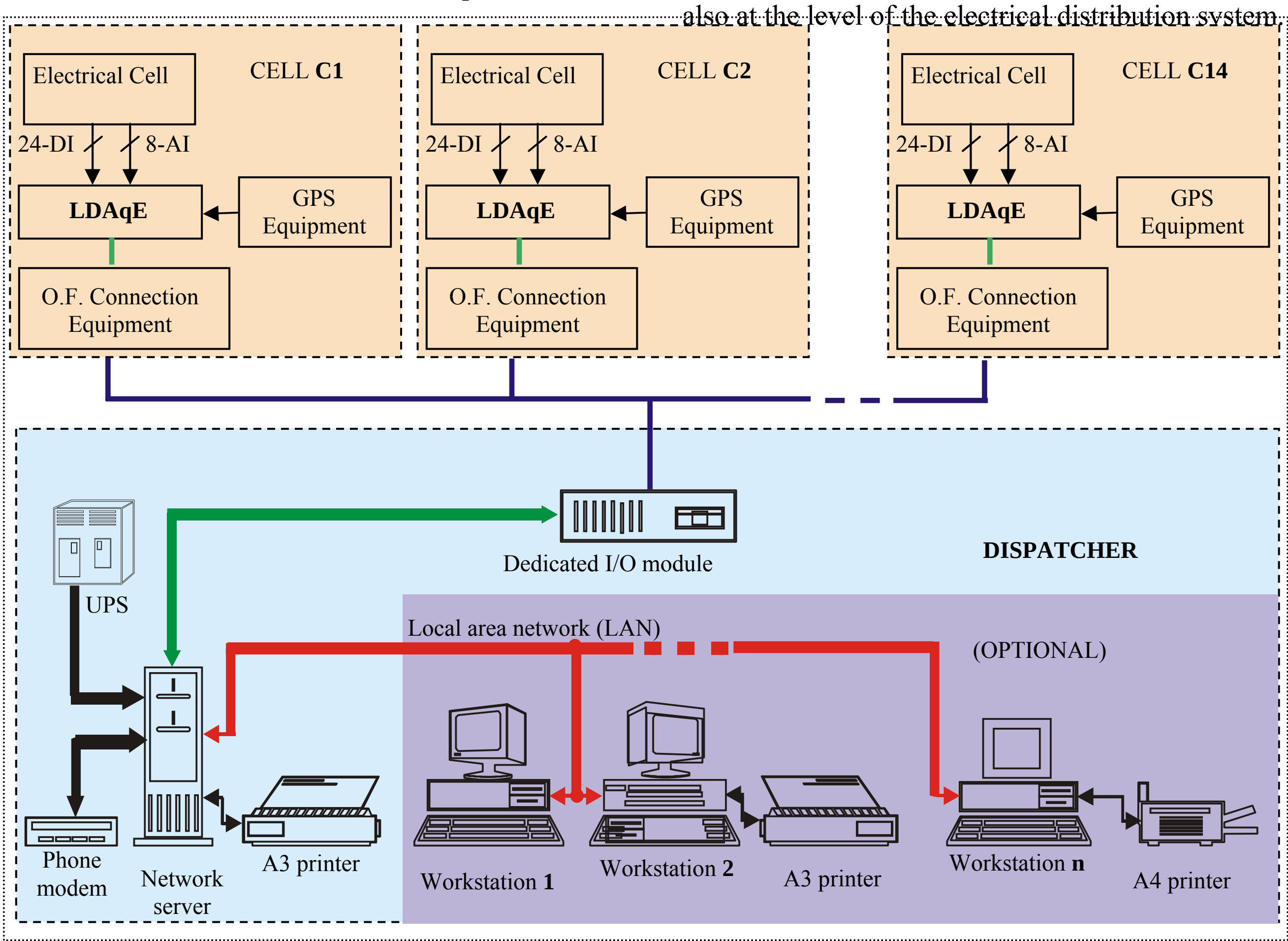

Fig. 1. The block diagram of the monitoring system

3 Data processing software

At the dispatcher's computer [8] level there is implemented a program which can assure the supervision of the functioning of all cells from an electrical distribution station and which can take over, process and display data regarding a flaw, from any of the local data acquisition equipments mounted in the supervised electrical station. The program offers the user many windows, depending on the desired information to be visualized, and which will be presented in the following:

►When the program runs on the computer's display, there appears a window, presented in Fig.2, that displays the electrical scheme with the corresponding state (on-off) of the switching elements (switches, connection to ground separators, etc.). This window displays the values of the currents, voltages and powers corresponding to each supply or output line from the station. So for the electrical supply lines LEA1 and LEA2 there are displayed the values for the supply voltage (at the level of the measurement transformer from the respective line), of the current and of the instantaneous power consumed on the side of the cells leaving the station. At the level of each cell there are displayed the instantaneous values of the current and of the power consumed on the respective leaving line, and the value of the supply voltage is displayed at the level of the measuring voltage cell for each group of line cells. To each switch of each line cell there is a button C1…C7.

►When a mouse click is done on any of the C1…C7 buttons on the screen there will automatically appear a new window, presented in Fig.3, which describes the selected cell with all the signals taken from the local data acquisition equipment mounted in this cell. There are presented all three supply lines L1, L2, L3 from the respective electrical cell, with the three-phased separator Q1.2, the supply switcher of the respective line Q0.2, and the connect to ground separator Q8.2, in which all are in on state represented by the blue color of the mobile contacts. Another group of information taken from local data acquisition equipment is presented in the screen's right side like rectangular LEDs which describe the state of the contacts taken through digital inputs. On the screen there are displayed all of the energetic values: in the superior region, next to the supply lines, there is displayed information regarding the supply voltages of the respective cell, in the left side there is displayed the information regarding the powers and values for the active energy Wp and for the reactive energy Wq consumed on that line until that moment, and continuously there is displayed the value of the frequency for the supply voltage on the respective line. To the right there are 2 buttons: STATIE and CONFIGURARE.

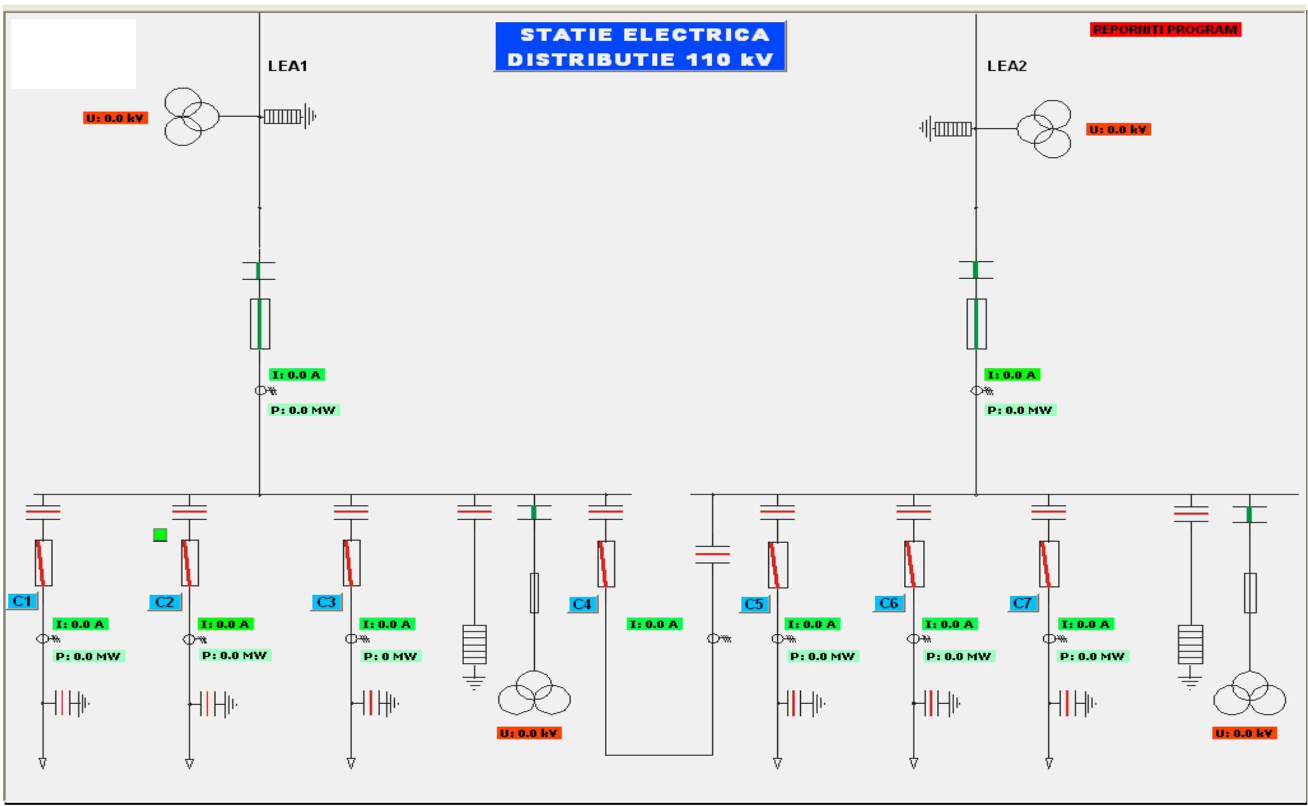

Fig. 2. The electrical scheme of the monitored station

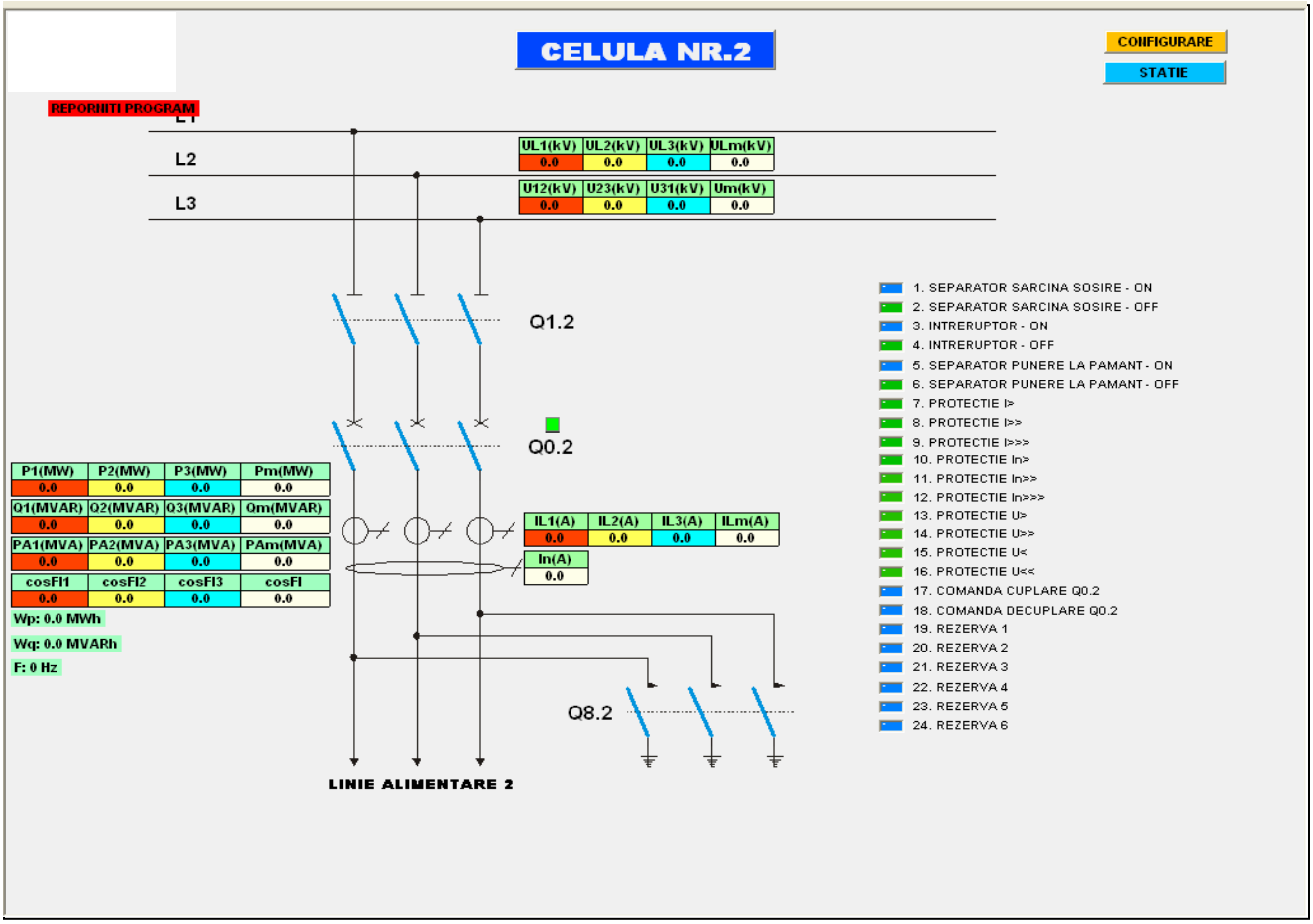

Fig. 3. The scheme corresponding to CELULA 2

Pressing the STATIE button we return to the first data displaying window and by pressing the button CONFIGURARE we access the domain configuration window, presented in Fig. 4

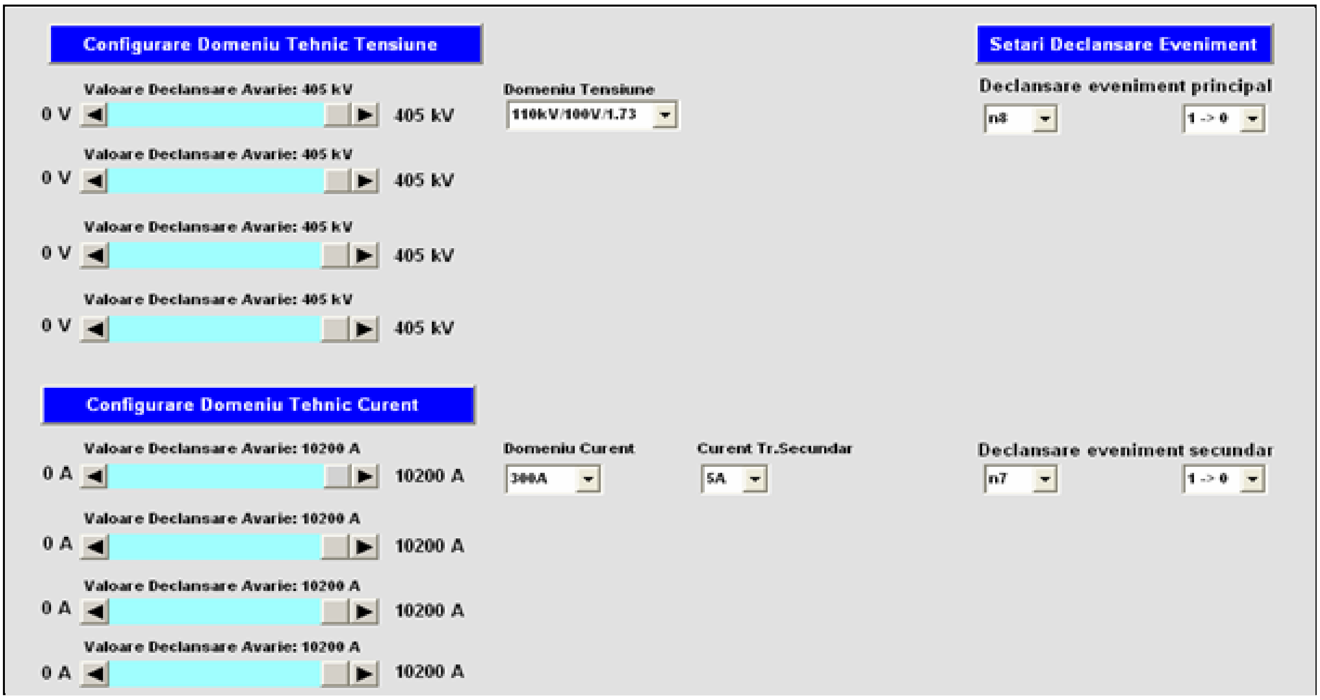

Fig. 4. Window for input domains' state: voltage and current

4 Diagrams obtained experimentally using local data acquisition equipment - LDAqE

In Fig.5. there are shown the diagrams obtained for the case in which a flaw of short-circuit type occurs on the supply line, [3]:

- current on phase rises 40 times over the nominal value;
- voltages on each phase lower by 20%;
- the time in which the protection starts is approximate 80 ms compared to the moment of the occurrence of the flaw.

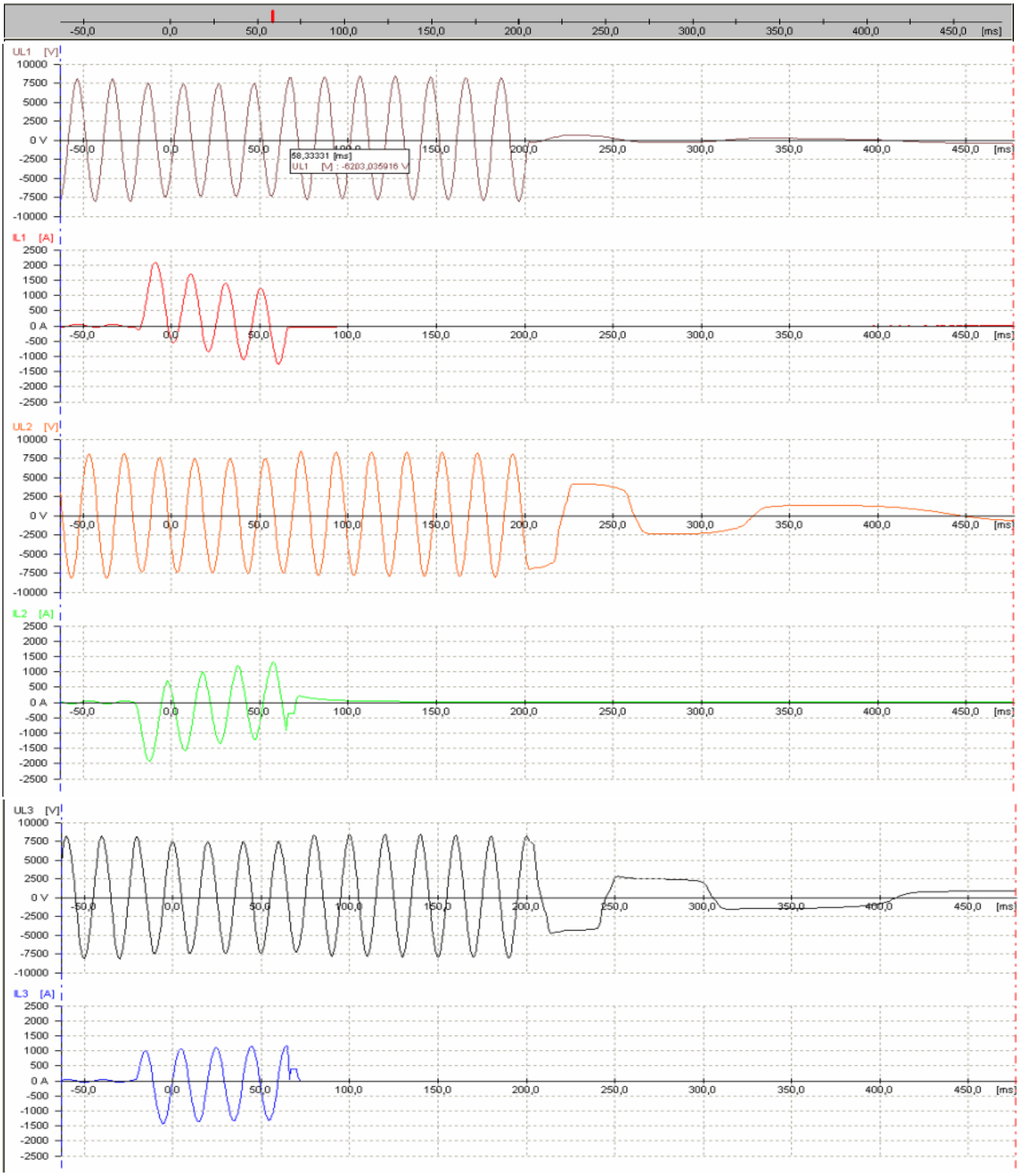

Fig. 5. The voltages and currents' evolution on three phases for the case in which a flaw of short-circuit type occurs on the supply line

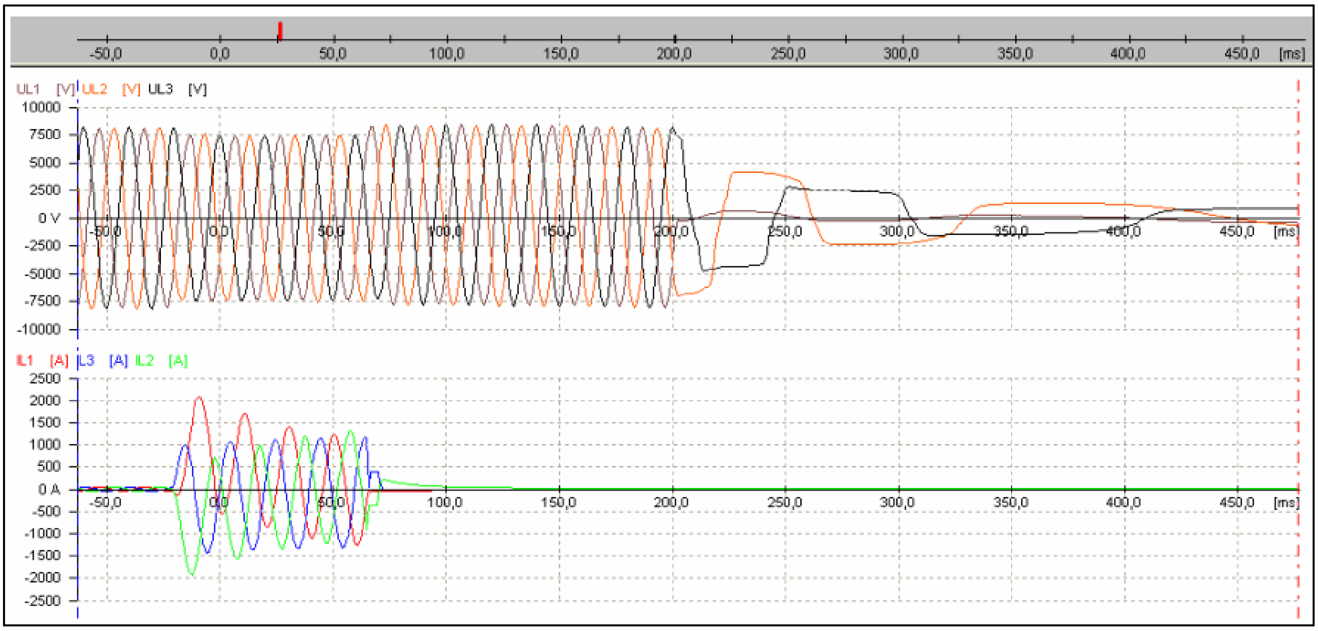

Fig. 6. The mixed voltages and currents' evolution on three phases for the case in which a flaw of short-circuit type occurs on the supply line

4 Conclusion

►The local equipment for energetic data acquisition (LDAqE) is a component element of a complex supervision system for the electrical energetic flow which is implemented in an electrical station from Craiova.

►The system offers the possibility of permanent monitoring of the electrical measures, energetic consumptions on the supply lines, total station and also flaws monitoring.

►Through the possibilities that it offers, the system can work interconnected with other monitoring systems and also with other computational systems in the network, allowing this way access to information, at different decisional levels.

References:

[1] Areny R.P., Webster J.G. *Sensors and Signal Conditionin,*. Wiley-Interscience Publication, John Wiley & Sons, Inc., USA, 1991.

[2] Dobriceanu M., Bitoleanu Alex., Săceanu V.; Data Acquisition System for Energy Analysis in Tri-Phased AC Motor Drives, *11th National Conference on Electric Drives - CNAE,* Galați, 10-12 October, 2002, pp. 142-145.

[3] Dobriceanu M., Bitoleanu A., Popescu M.; Practical Aspects Concerning the Monitoring of the Machines Drives in Industrial Processe,. *12th International Symposium on Power Electronics – Ee 2003*, Novi Sad, Serbia & Montenegro, November 5 -7, 2003, pp. 49.

[4] Dobriceanu M., Bitoleanu Alex., Popescu M., Lincă M.; The usage a programmable logic controller (PLC) for the control of great capacity excavators from carbon exploitations; *11-th International Power Electronics and Motion Control Conference, EPE – PEMC 2004*, 2-4 September 2004, Riga, LATVIA, page 54.

[5] Dobriceanu M., Bitoleanu Alex., Popescu M., Lincă M.; The Dispatching of the Energetic Activity in Industrial Processes using Data Acquisition Equipments, *International Aegean Conference on Electrical Machines and Power Electronics – ACEMP 2004*, Istanbul, Turkey, May 26-28, 2004, pp.492-497.

[6] Dobriceanu M., Bitoleanu Alex., Popescu M., Lincă M.; Energetic data acquisition equipment in industrial processe,. *Symposium on Power Electronics, Electrical Drives, Automation & Motion, - SPEEDAM 2004*, Short Papers Proceedings, 2nd Volume, Capri, Italy, June, 16th – 18th, 2004, pp. TID-5…TID-8.

[7] Dobriceanu M. *Data Acquisition Systems and Microprocessors* (Ro), Ed. Universitaria Craiova, 2003, pp.304.

[8] Dobriceanu M., *Introduction in Virtual Instrumentation and LabVIEW* (Ro), Ed. Universitaria Craiova, 2005. pp. 218.

[9] Pop E., Leba M., *Microcontrollers and PLCs* (Ro), Ed. Didactică şi Pedagogică, Bucureşti, 2003.

[10] G. Vladut, P.M. Nicolae, L. Mandache, C. Cojocaru, I. Purcaru Equipment for measuring of some parameters that characterize the electric energy quality, ICATE 2004, Baile Herculane International Conference.