

# System for Monitoring the Energy Flow in Electrical Stations

MIRCEA DOBRICEANU, ALEXANDRU BITOLEANU, MIHAELA POPESCU  
and GABRIEL VLADUȚ

Electromechanical Engineering Faculty and IPA-Automation Engineering Institut  
University of Craiova  
Decebal, 107, Craiova, 200440  
ROMANIA

*Abstract:* - Evolution and large scale spreading of the computational techniques allowed the design and realization of some acquisition, processing, storing and sending data taken from the process equipments to a superior 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 is presented the system's architecture underlining the taken signals, the transducers used and the component elements of the system: Local data acquisition equipments (LDAqE), Local data acquisition equipments synchronization subsystem, Data communication subsystem and Processing, storing and data displaying subsystem.

*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.

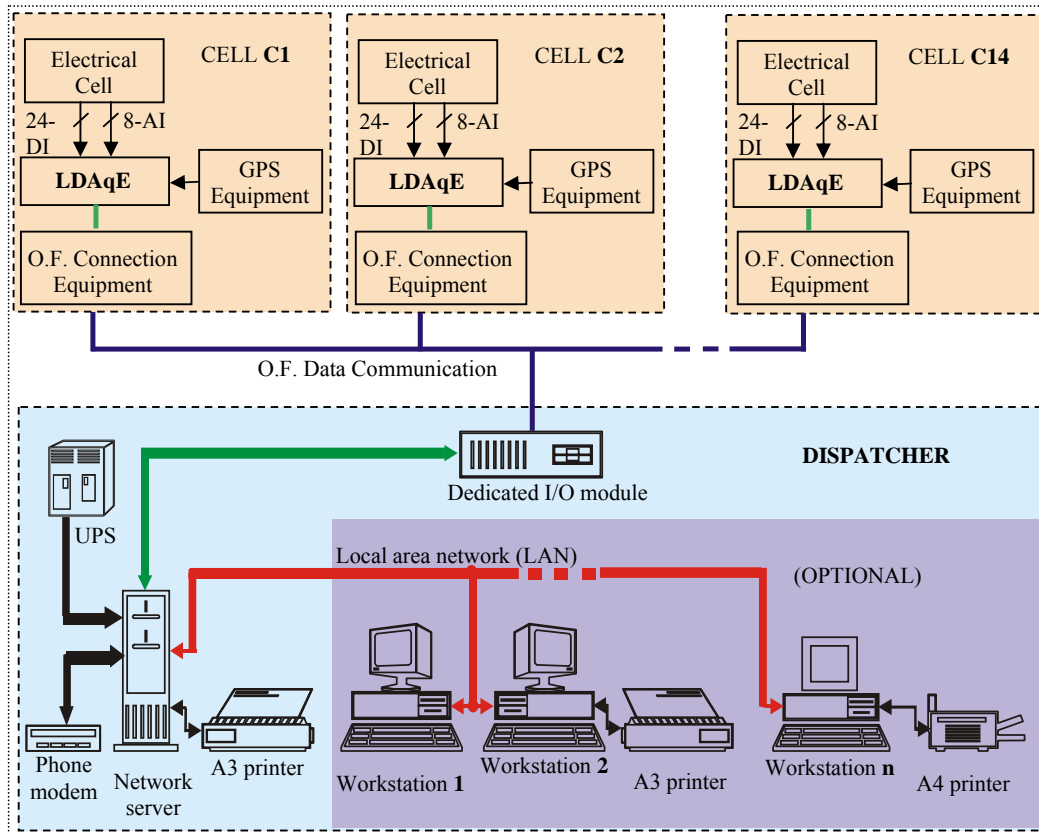


Fig. 1. The Block Diagram of the Monitoring System

### 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 from 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 energy distribution system.

### 2.4 Local data acquisition equipments (LDAqE)

These are dedicated equipments of synchronous data acquisition from the process, mounted at the level of each cell in the supervised electrical station [2], [6], of which block diagram is presented in Fig.2.

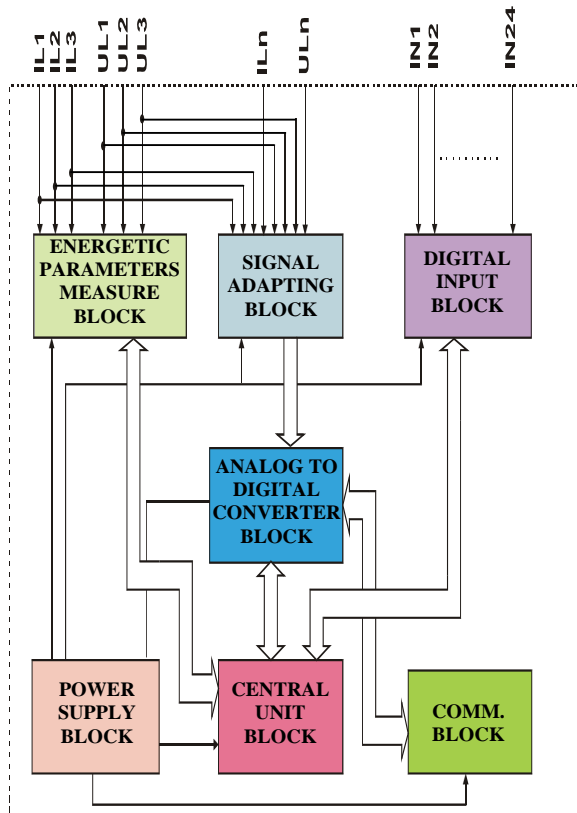


Fig. 2. The Block Diagram of a Local Data Acquisition Equipment (LDAqE)

#### 2.4.1 Signals taken from the electrical station

The taken signals [1] are:

##### ► Analogical signals

- 4 current signals taken directly from the measurement transformers on the line leaving the cell. Regarding the transforming station time, the signals received at the station input are  $I_n/5A_{ef}$  type or  $I_n/1A_{ef}$  type;
- 4 voltage signals taken directly from the measurement transformers mounted on the voltage line. These signals are  $U_n/100V_{ef}$  type.

##### ► Digital signals.

#### 2.4.2 The LDAqE functions

The main functions are:

##### ► Measuring function of the following parameters:

- Current measuring
  - RMS value for the currents on each of the 3 phases and the null current;
  - the top current on each of the 3 phases.
- Voltage measuring
  - null-phase voltages: V1, V2, V3;
  - phase-phase voltages: U21, U32, U13.
- Frequency measuring

- Power measuring (active power, reactive power, apparent power, power factor)

##### ► Storing and diagnosis functions:

- Storing function of the faults at the level of each cell. Values stored in case of a flaw occurrence:
  - storing of the 3 phase currents and of the null current at the occurrence of a flaw for further analysis of the flaw;
  - storing measures: U21, U32, U13, F, P, Q;
  - storing digital signals taken from the switching equipments from each cell.
- Storing function of the sampled values of the analogical measures and of the logical states. The user can set the following parameters:
  - the event which can start the storing;
  - the storing period before the flaw occurrence;
  - the number and duration time of the storing:
    - the number of recordings: adjustable between 1 and 3;
    - the total duration of a recording adjustable between 1 and 20 sec;
    - the automatic starting of the storing;
    - stopping of a storing: automatically when the maximum available time is reached or at request by switching any digital input preset by the user;
    - the sampling frequency: variable (0,5...2ms);
    - the storing duration before the flaw occurrence: selectable between 0 and 99 periods;
    - recorded data: 4 currents, 4 voltages, 24 digital inputs.

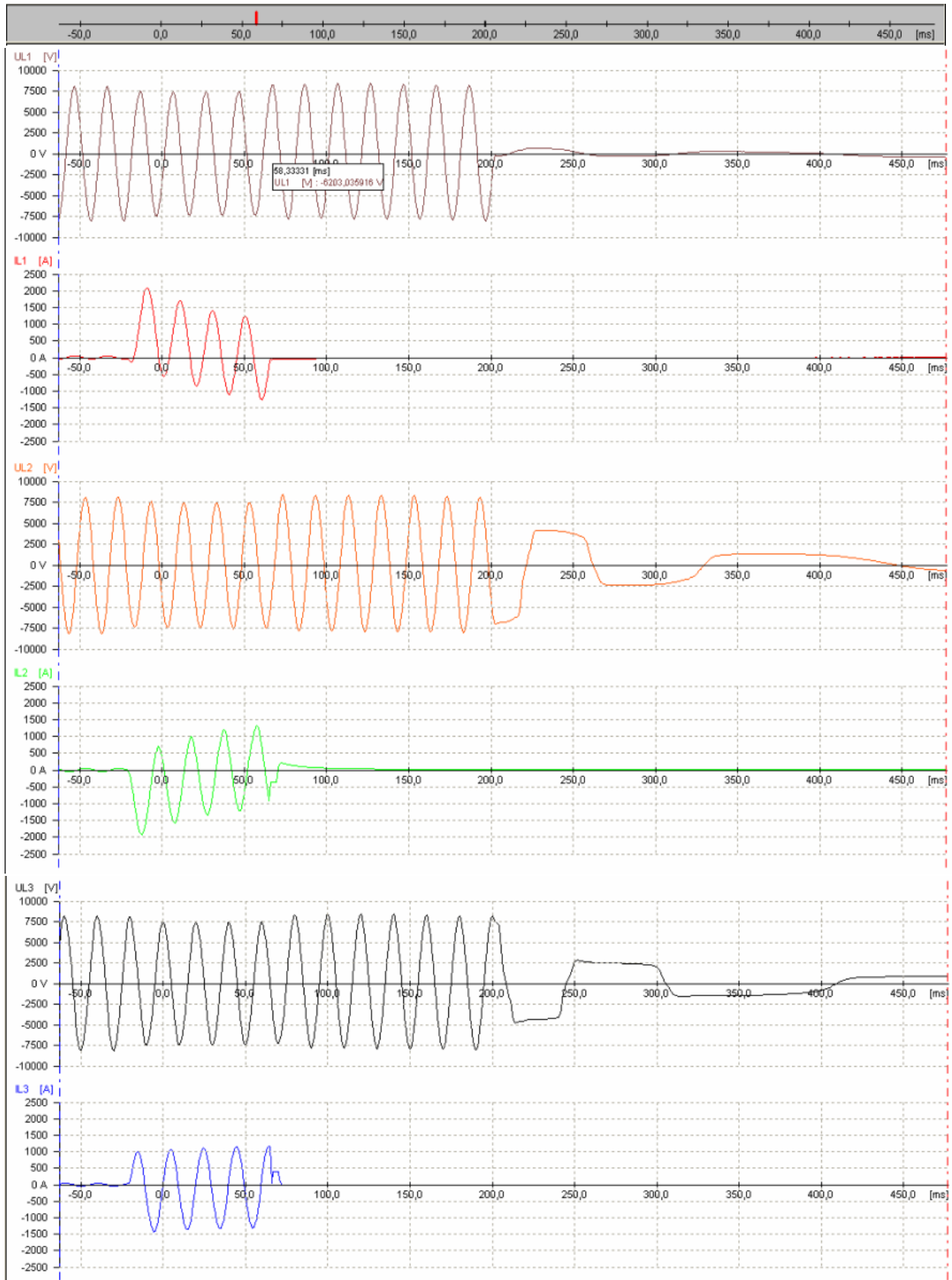
- Diagnosis functions for the switcher.

This equipment is built using a Phillips 80C552 microcontroller and it additionally stores the following parameters: the cumulative starting current, the number of operations and the functioning time [4], [8].

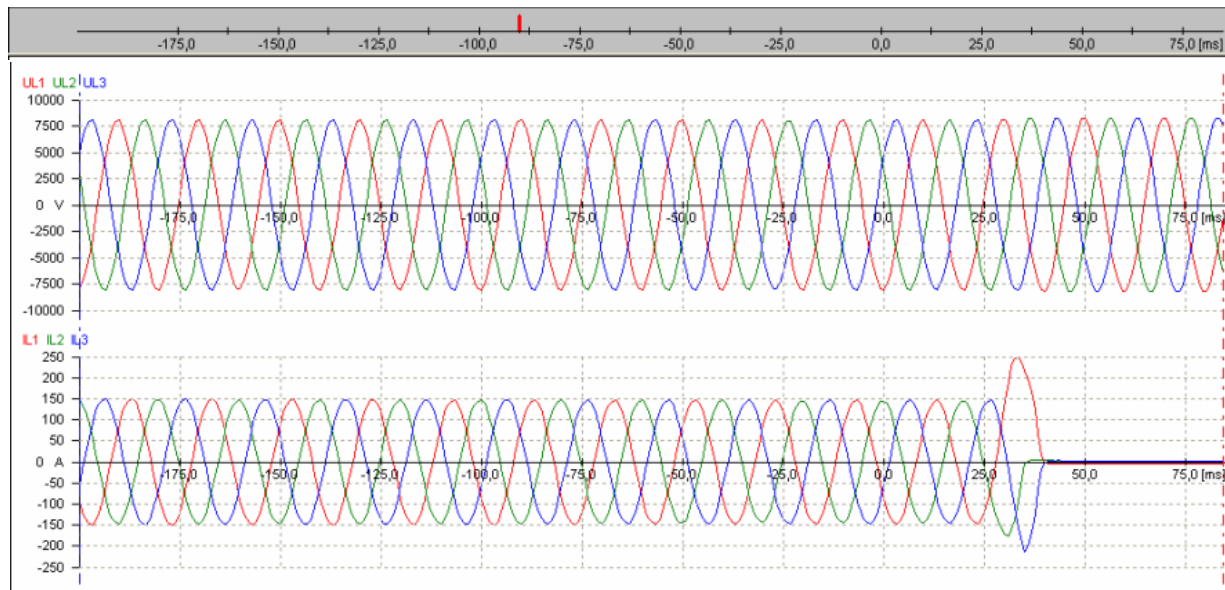
### 3 Diagrams obtained experimentally using local data acquisition equipment - LDAqE

In Fig.3. 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. 3.** The voltages and currents' evolution on all three phases for the case in which a flaw of short-circuit type occurs on the supply line



**Fig. 4. The voltages and currents' evolution on all three phases for the case in which a flaw of over current type occurs**

## 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., *12<sup>th</sup> 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, 2<sup>nd</sup> Volume, Capri, Italy, June, 16<sup>th</sup> – 18<sup>th</sup>, 2004, pp. TID-5...TID-8.
- [7] Dobriceanu M. *Data Acquisition Systems and Microprocessors* (Ro) Ed. Universitaria Craiova, 2003.
- [8] Pop E., Leba M.; *Microcontrolere și automate programabile*, Ed. Didactică și Pedagogică, București, 2003.