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ACQUISITION, COMMAND AND DATA TRANSFER SYSTEM FOR MEDIUM VOLTAGE ELECTRICAL STATIONS

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***Abstract* – The development of multifunctional high performance intelligent electronic devices with extended communications capabilities allows their integration in automation and monitoring systems of electrical stations. The task of the intelligent electronic devices is to guarantee the safe operation of the electrical energy systems, which quickly and selectively separate the affected operating devices from the electric mains if dangerous states occur. The paper describes medium voltage electrical stations in which there is going to be implemented an automated monitoring system formed of local data acquisition, protection and control equipments mounted at the level of each cell within the electrical stations. This monitoring system is based on software packages for data acquisition, storing, data transmission and processing, monitoring and analysis. Tasks entailing the protection of operating plant, supervision of the system, detection and provision of measured values and messages for cases of operation, recording and evaluating measured values and messages for disturbances, control and locking functions as well as various possibilities of communication are to be mentioned here as being of great importance. In this way, the system is to help the human factor in taking optimal decisions in monitoring the electrical stations, by offering adequate information in a specific format. The internal modular set-up of hardware and software permits flexible inclusion of extensions and customers requirements according to needs.**

Keywords: *data acquisition, protection equipment, system architecture, SCADA system .*

1. INTRODUCTION

Specially the last decades are marked by specialists' preoccupations in the energetic domain with regards to fundamental research referring to methods and advanced technologies for energetic efficiency rise and reduction of the energetic consumption. An important role in this is represented by the monitoring systems implementation in the electrical stations that is based on intelligent equipments, having the role of acquiring and processing of the supervised measures and the usage of the automated diagnosis techniques of the primary equipments. The great amount of primary data, generated by the data acquisition equipments, has to be stored in a rational and efficient manner to avoid situations in which the users spend more time with data acquisition then using this data.

Tasks entailing the protection of operating plant, supervision of the system, detection and provision of measured values and messages for cases of operation, recording and evaluating measured values and messages for disturbances, control and locking functions as well as various possibilities of communication are to be mentioned here as being of great importance.

For the supervision and control systems of type SCADA (Supervisory Control And Data Acquisition) belonging to the electrical networks there were conceived two types of architectures, that are: centralized systems and distributed systems [1], [2].

The centralized system represents the first stage of these systems, in which all the signals from the primary equipments, for instance from the electrical cells of the station, are brought in a central location, usually closely to the command chamber. The main disadvantages would be: the great amount of notification cables, low viability and a reduced computational and intervention speed, and for eliminating these, in the last few years there come the idea of distributed systems, which have as the main feature the data parallel processing and thus the increase of the processing speed.

In this way appears the necessity of developing multifunctional intelligent equipments, with capabilities of acquisition and process of the monitored measures and extended communication possibilities, for real time supervision, destined to permanent monitoring, including processing

procedures in accordance with the international standards and which integrate in the automatization systems of the transformation station, with the purpose of protection, control and supervision of the electrical energy quality

2. SYSTEM FUNCTIONS

The monitoring system within the medium voltage electrical stations, being composed of data acquisition, protection, command and data transmission equipments, is built to assure the following functions, [4], [5]:

- acquisition of specific electrical signals for the functioning of the electrical stations (voltages, currents) and digital signals (auxiliary contact states of the switching equipments);
- command of the switching equipments (separators, switches) within the electrical cells that form the electrical station;
- protection functions for the incoming/outgoing cells within the medium voltage electrical station;
- processing of the data acquired from the process and data send to a superior level (dispatcher) using a physical data transmission media;
- permanent monitoring the energetic parameters;
- detecting and localizing the flaws;

3. SYSTEM ARCHITECTURE

3.1 Protection and Control Subsystem for an Electrical Cell

The task of the protecting and control technique is to guarantee safe operation of the electrical energy systems by use of protective equipment specific to the operating plant, which quickly and selectively separates the operating device affected from the electric mains if dangerous states occur.

In medium-voltage engineering, there are typical applications such as feeder protection, line differential protection, bus bar protection etc. Each of these applications has a variety of specific functions, which were only covered in the past by the combination of a number of devices with individual functions. These solutions were cost-intensive and demand with considerable technical efforts [3], [7], [8], [10].

The objective in the development was to generate a high-quality protection and control system integrating numerous functions in one system and thus taking over practically all the tasks for a specific application, e.g. for feeder protection, cable-/line differential protection or transformer differential protection.

Each cell within the monitored electrical station contains a complex acquisition, protection and control equipment (Fig.1), which contains the following two distinct units:

- one main unit in which there are implemented all the necessary functions and interfaces for acquisition, protection and control;
- one display and operating unit which is used as “Man-Machine Interface” (MMI).

The communication between the two devices is done via a CAN field bus system.

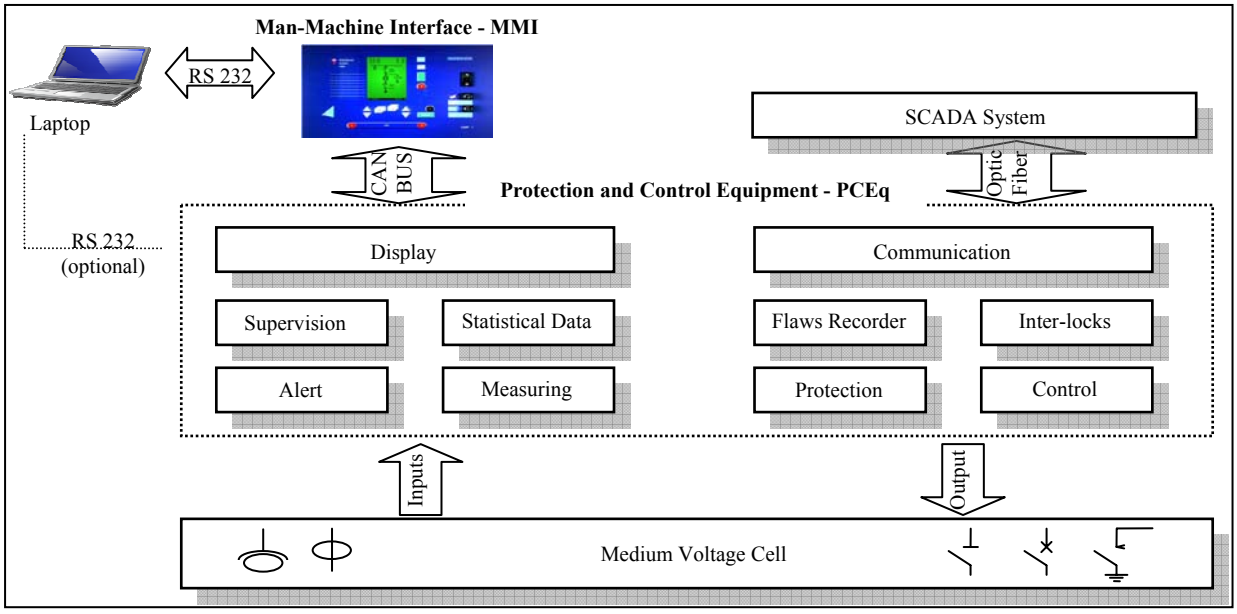

Figure 1: Block diagram of the acquisition, protection and control equipment for an electrical cell.

The main unit is implemented directly, in a medium voltage cell, without using intermediary command relays, thus reducing the manufacturing cost of the respective cell.
The main unit can also work independently, with the need to be coupled to a display and operation unit of MMI type.
The system can also function within an integrated SCADA system, to which it is connected through a RS485 link or using an optical fibre link.
Access to the systems is done via a central PC, making use of the application software, this way enabling comfortable operation: data read, securing disturbance records as well as (remote) parameterization of the connected devices.
The local operation with the acquisition protection and control system is realized using a display unit which is usually installed on the front panel of the medium voltage cell. By this one there can be rapidly accessed the operating data of the switching equipments (switches, separators), local parameterization of the protection functions of the system and local command of the switching elements.
The protection and control equipment assures the following functions:

- Protection function:
  - Over current directional/non-directional;
  - Short circuit current directional/non-directional;
  - Ground current directional/non-directional;
  - Cable/Line differential;
  - Overload with thermal replica;
  - Residual voltage;
  - Over-/Under voltage;
  - Over-/Under frequency;
  - Automatic Reclosing (AR);
  - Programmable protection logic;
  - Voltage transformer supervision;
  - Reverse interlocking;
  - Lock out function;
  - Switch of parameter sets.
- Control functions:
  - No. of recognizable switching devices: 5;
  - No. of controllable switching devices: max. 5;
  - No. of power outputs for control of motor-driven switching devices: 2;
  - No. of signal relays: 6;
  - No. of configurable digital inputs: 22;
  - Command outputs with defined switching and operating times.
- Supervision functions:
  - Fault/differential position;
  - Withdrawal of the circuit breaker;
  - Programmable interlocking conditions at feeder level.

The protection and control equipment (Fig.2), presents the following properties:

- compact construction in robust plastic housing with IP 50 type of enclosure;
- extensive protection and control functions;
- intuitive menu guidance;
- wide-range power pack for auxiliary voltage supply to the device (AC or DC);
- wide-range power pack for auxiliary voltage supply for digital inputs (AC or DC);
- wide-range power pack for auxiliary voltage supply (DC);
- various working ranges (high/low voltage area) for digital inputs;
- flexible administration of the inputs and outputs;
- galvanic de-coupling of the power circuits;
- connection of control technique with various types of protocols via optical or electrical interfaces;
- various PC communication interfaces: CAN-BUS, RS232;
- various SCADA communication interfaces: FO, RS485;
- disturbance recorder with many features for PC/laptop, optionally with extended non-volatile memory;
- extensive self-supervision (hardware and software).

Figure 2: Basic device of the trafo differential system.

The display and operating unit (Fig.3), is integrated into the front door of the medium voltage cell, users interface (MMI). It informs the operating personnel about the current status of the switchboard by displaying all the relevant measured data, messages and parameters. There is the possibility of reading out data, making parameterizations and also controlling switchgears of the field.

The display and operating unit presents the following properties:

- flat and compact design;
- wide-range power pack (AC or DC);
- large, automatically background-illuminated LCD graphic display with:
  - display of a configurable feeder single line;
  - display of switch positions, measured values and operating information;
  - protocolling of events with real-time stamp;

- protocolling of fault events with effective values;
- extensive commissioning support;
- varied test possibilities.

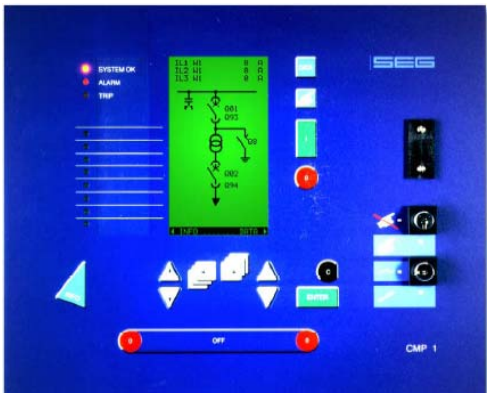

Figure 3: Display and operating unit.

- foil keyboard with IP 54 type of enclosure for the front side;
- multi-coloured function keys for menu guidance, control and in "danger off function";
- two key-operated switches to stipulate the modes of operation:
  - local/remote operation;
  - standard operation/parameterization.
- integrated message relays for system error indication;
- CAN interface for connection with the main unit;
- 2 x RS 232 interfaces for operation via PC/Laptop (front side and bottom edge of the device).

The connection to the basic module is done via a three-cored, screened CAN-BUS line, which is easy to wire together with the voltage supply.

3.2 Command and Data Receiver System for the Medium Voltage Electrical Station

Taking over data from the medium voltage electrical station (Fig.4) and also the command of the switching elements within the component cells is realized with a system organized on three levels [10], [11], [12].

- Level 1: contains data acquisition protection and control equipments,
- Level 2: is realized by the internal data transmission bus, RS485 type, which is operating based on an industrial high speed communication standard, PROFIBUS type.
- Level 3: is represented by the Programmable Logic Controller (PLC) mounted in the automation unit.

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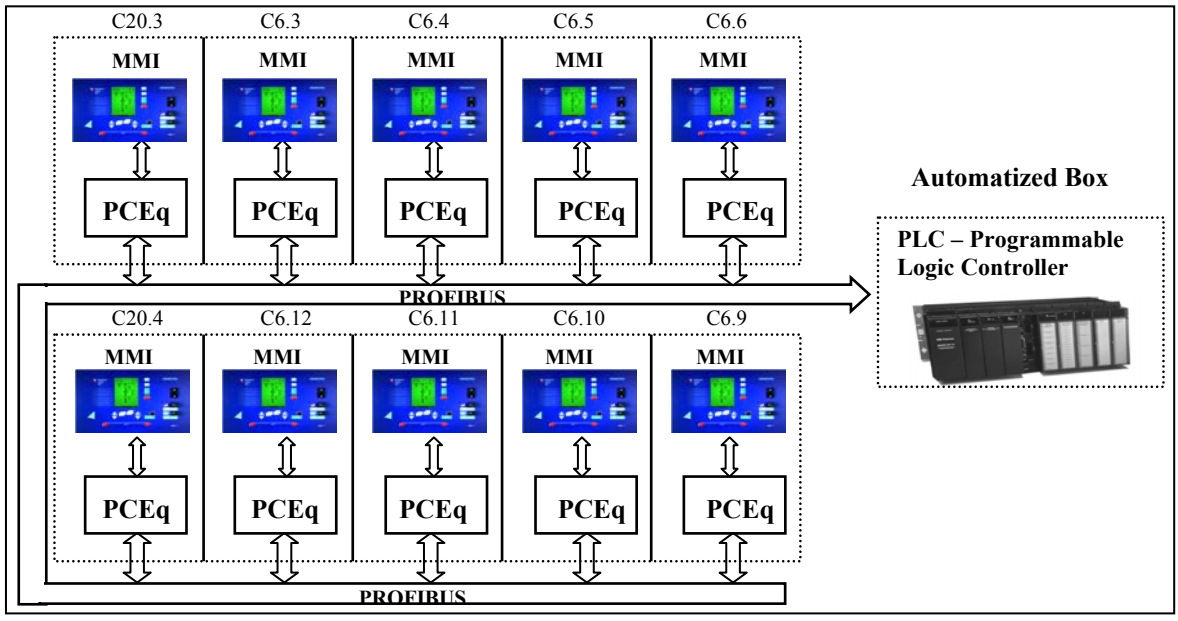

Figure 4: Block diagram of the data command and receiver system .

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