

THE IMPLEMENTATION OF A PROGRAMMABLE LOGIC CONTROLLER FOR THE AUTOMATION OF THE BELT CONVEYOR

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Abstract: The modernization of the electrical automation, of the machines from the surface carbon exploitation, represents a continuous preoccupation for specialists within the respective exploitations and for those collaborators from the high grade learning institutes and experienced specialist from firms witch work in domain. This paper presents some of the main aspects regarding the use of programmable logic controller (PLC) for commanding and controlling a belt conveyor. In the system's development it is used a programmable logic controller made by the german group of firms Moeller witch is one of the main manufacturers of equipment and distribution of electric energy equipments, industrial and civil automations.

1. INTRODUCTION

The modernization of the drive installation for an electrical house of a machine consists in achieving the two main aspects:

- the modernization of the conventional command equipment for the machines' drives by replacing the commutation and protection components with modern ones, made by well known firms (SIEMENS, MOELLER, SCHNEIDER, etc);

- the replacement of the classical command parts (contactors, relays, safeties, time relays, etc.) with a programmable logical controller capable of taking over all the necessary functions for commanding the machine.

2. THE AUTOMATION SYSTEM WITH A PROGRAMMABLE LOGICAL CONTROLLER

For the realization of the command and control function of the high capacity belt conveyor from carbon exploitations drive, a configuration of the programmable logical controller was chosen (fig.1) made by the german group of firms Moeller, that assures:

- taking over input measures relay contact type witch describe the conveyor's state at one given time;
- taking over analogical signals through some transducers (currents through the drive motors, motors and reducers temperatures, vibration level of the drive couple motor-reducer);
- generating command signals, contact relay type, necessary to the correct functioning of the drive;
- permanent displaying to a local console the main functional parameters of the machine and also the current state in witch the machine is in.

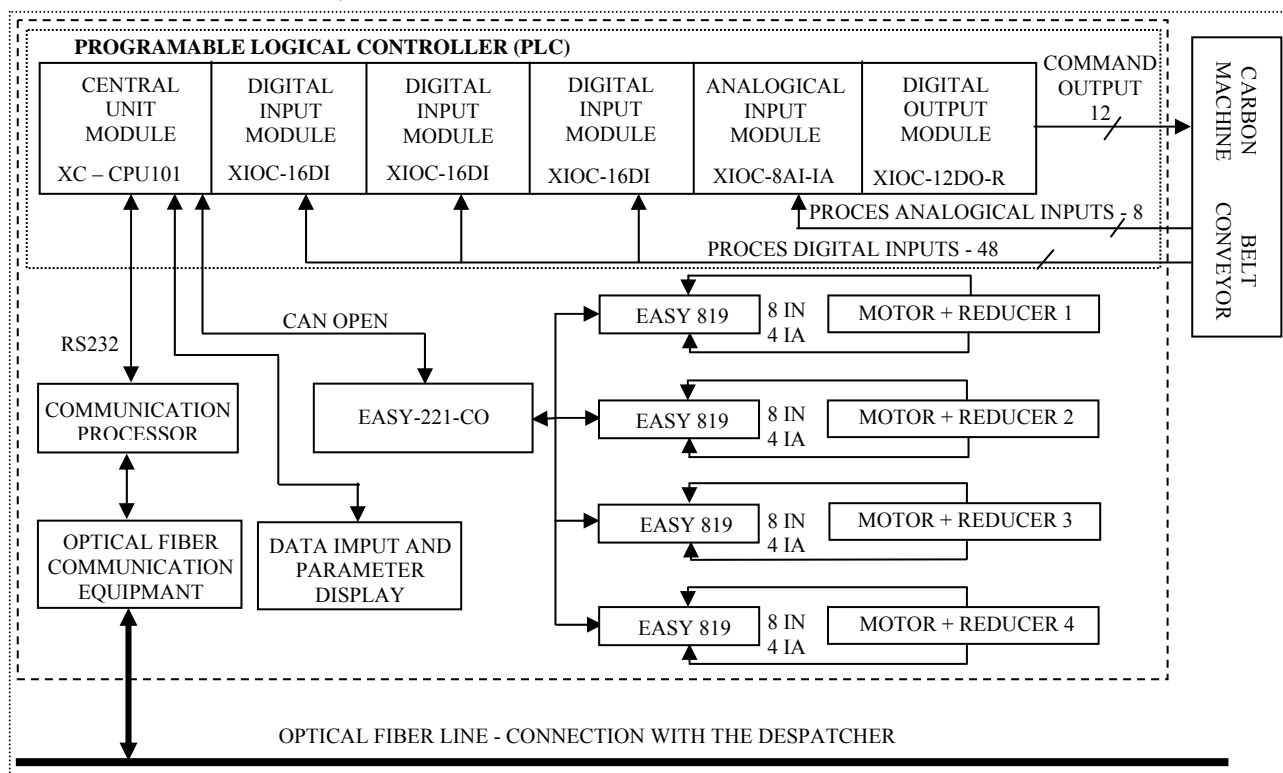


Fig.1. Block diagram of the automation system with programmable logical controller

The presented block diagram assures the functioning of a belt conveyor equipped with 4 drive motors and is composed of the following blocks:

- ▶central unit module;
- ▶digital input module;
- ▶analogical input module;
- ▶digital outputs module;
- ▶the data display console and parameter input module;
- ▶the optical fiber communication equipment;
- ▶intelligent EASY800 series relays.

2.1. Central unit module

Is made by the german firms group Moeller, XC-CPU100 type, having the storing capacity and addressing possibilities of a number of 8 maximum specialized input/output modules which are sufficient for this application, achieving the command and control function of the conveyor and assures:

- ▶▶taking over data from the process through specialized digital or analogical input modules;
- ▶▶taking over, through EASY relays, of the distributed parameters from the process;
- ▶▶performing logical operations over data taken over from the process according to the functioning algorithm of the machine written in its memory;
- ▶▶generating commands to the execution elements from the force part of the drive (contactors, electro brakes, separators, etc.);
- ▶▶adjusting the functioning program according to the specified requests and to the modifications occurred in the process;
- ▶▶displaying, through the local display data module, of the states in which the machine is in at a certain time, and also of the faults occurred during the machine's functioning;
- ▶▶sending, through the optical fiber communication equipment, of data referring to the machine's functioning to a computer from the central dispatcher.

2.2. Digital input module

The structure of the programmable logic controller used contains a number of 3 digital input module type XIOC-16DI, which each allow the taking over from the process of a number of 16 signals contact relay type and the sending of them to the central unit through the internal data communication bus.

Each of the inputs is galvanic isolated and accepts at the input signals up to 30 Vcc (Vca) as follows:

- ▶▶signals form the command keys which impose the specific work regime of the machine;
- ▶▶signals form the command keys for auxiliary services;
- ▶▶signals from the protection elements of the main drive and also of the auxiliary drives;
- ▶▶signals from the auxiliary contacts of the force elements (contactors, interlocking, separators);
- ▶▶signals from the curse limiters and from the safety elements of the machine;
- ▶▶signals form the command keys for stopping the machine in case of emergency.

2.3. Analogical input module

The programmable logic controller contains an analogical input module XIOC-8AI-IA type which accepts at the inputs a number of 8 analogical signals in the domain of 4..20mA, galvanic isolated. The input signals are converted on 12 bits and are sent to the central unit through internal data bus.

Through the module are taken over from the process the following measures:

- ▶▶signal form the transducers which measure the current through the main drive motors (the transducers are capable of measuring currents in the domain of 0..5Aef, from the output of the measuring transformers mounted on the drive motors supply);
- ▶▶signal in the domain of 4..20mA from the transducer which measures the supply voltage of 6KV of the machine.
- ▶▶signal in the domain of 4..20mA from the transducer which measures the extension of the conveyor belt carpet force.

2.4. Digital outputs module

Commands generated by the programmable logic controller for the machine's drives in every chosen work modes, are sent through an output module XIOC-12DO-R type with 12 output channels each equipped with a relay and galvanic isolated to the data bus of the automaton.

Through the module are generated to the process the following measures:

- ▶▶two signals for the command of the stator contactors for the supply of the main drive motors;
- ▶▶a signal which command the lifting up of the electro brakes when it is commanded the turning on of the belt conveyor;
- ▶▶a temporized signal at 20 sec. which commands the warning hupa at the starting moment of the machine;
- ▶▶a signal which commands the dispatching of the switcher of 6 kV at the moment of noticing a fault on the supply force circuit on the medium voltage part (6kV);
- ▶▶a signal which commands the dispatching of the switcher of 380Vca/400A at the moment of noticing a fault on the supply force circuit on low voltage part (380 Vca);
- ▶▶a signal which is sent to the next conveyor from the technological line and which indicates the fact that the machine is functioning;
- ▶▶a signal which attests the fact that the EXTENSION/DISTENTION conditions are achieved;
- ▶▶a signal which attests the fact that the MARS BELT conditions are achieved;
- ▶▶a signal for the command of the conveyor's cleaning belt.

2.5. Data display console module

The data display console and parameter input module is a device which is connected to the programmable logic controller through a serial dedicated line, with a

specialized communication protocol (SUKONET K), and which allows:

- displaying on a alpha digital display with two rows of 20 character, of the specific functioning parameters of the machine, of the current state in witch it is in. And also on the console are displayed the error messages in case of anomalies in the machine functioning;
- the input of specific working parameters. This is interactively realized through the 10 buttons and messages on the display.

2.6. The optical fiber communication equipment

Is composed of the specific equipments (signal converters) witch assure the data transfer (through the communication processor) from the programmable logical controller to the dispatcher and commands transfer from the dispatcher to the programmable logical controller.

2.7. Intelligent EASY800 series relays

Are specialized equipments produced by the Moeller firm, witch assures the process of a number of 4 analogical signals and a number of 8 digital signals and which generate a number of 6 output relay contact type measures, according to the algorithm written in its internal memory (fig.2). Through the central unit module, of the alpha digital display with liquid crystals, of the 5 keys and of the program written in its memory, the relay is capable of solving the problems of a local automation.

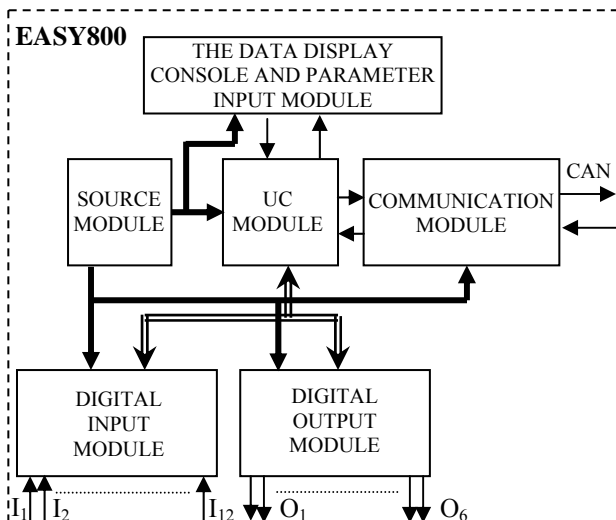


Fig.2. Block diagram of the EASY 800 relay

The EASY800 relay has implemented the following main functions:

- 32 logical functions (AND, OR, NAND, NOR, etc.);
- 32 arithmetical functions (sum, extraction, multiply, ratio, etc.);
- 32 time relays (0,01 sec....99h59min);
- 32 reversible counters (domain $\pm 2^{31}$);
- 4 counters (maximum fervency 5 kHz);
- 32 weekly time switchers;
- 32 annual time switchers;

- 32 analogical comparators (domain 0..10Vcc).

In the situation in which the number of inputs and outputs is not sufficient for the achievement of the proposed automation, the relay has a serial communication module, according to the CAN (Controller Area Network) protocol specialized for the sending of signals in industrial medium, through which there can be connected in the network a number of maximum 8 relays, in which situation one of them becomes MASTER and the rest are declared SLAVE, fact used in the presented application.

Through each EASY module are taken over from the process the following measures:

- a signal relay contact type from the break limiter of the drive motor;
- a signal relay contact type from the used brake bandage sensor;
- two signals term contact type which take over the temperature from the two motor cells;
- an analogical signal in the domain of 4..20mA from the measuring adaptor for the term resistance which measures the temperature of the drive motor;
- an analogical signal in the domain of 4..20mA from the measuring adaptor for the term resistance which measures the temperature of the drive reducer;
- an analogical signal in the domain of 4..20mA from the measuring adaptor for the term resistance which measures the temperature of the attack pinion of the drive reducer;
- an analogical signal in the domain of 4..20mA from the measuring adaptor for the term resistance which measures the vibration level of the drive reducer.

3. CONCLUSIONS

1. The modernization of the belt conveyer drive with programmable logical controller is already implemented in the surface carbon exploitation, and the analysis in time of its functioning marks the correction of the chosen technical solution.

2. This solution offers the customer the following advantages:

- the supervising, control and intervention stuff reduction;
- machine maintaining in optimal functioning conditions;
- afferent time reduction in electrical and mechanical installation maintenance;
- the reduction of the specific consumption of replacement devices (pieces), materials and electrical energy;
- the trace and quick replacement of the faults witch occur in the machine's electrical installation;
- the drive machine system's liability enlargement;
- the growth of work and machines due exploitation security grade.

3. Through distance data transfer to a central dispatcher, is offered the possibility of tracing the machine's functioning and commands transfer to those, any time the exact field situation imposes it.

4. Through the facilities that they offer, the programmable logical controllers can work

interconnected and so allowing the optimum driving of a technological line (composed of many belt conveyers) with the possibility of command from distance of the component machines.

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