ASYNCHRONOUS MOTORS CONTROLLER ON BASIS OF ATMEGA32 MICROCONTROLLERS

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Introduction. Most specific weight in electric machine production belongs to asynchronous engines the structure of which is relatively simple and labor content is little. Such engine application and destination range may be judged by the fact that asynchronous engines of 0.12 … 400 kWt capacity consumes over 40% of all electricity output in Russia [1, p. 11].

Such wide application range of asynchronous electric engines in different fields of industry as well as in pumping unit control lays down strict requirements on their protection and control. Just because of such reason, most attention is paid to this question and different blocks and devices for asynchronous engine control and protection in different element base with different function packages are designed. The most modern of them is BMD 5000 [2] asynchronous engine control block, UZD [3] asynchronous electric engine protector, UBZ-301 [4] asynchronous electric engine universal protective block.

In spite of many various protectors, the problem on equipping with modern and affordable control and protective devices ensuring performance under supervisory control remains as a very actual one in asynchronous electric engine industry.

The fact is that application of universal controllers for such purposes is redundant and makes them unaffordable, and usual integral microcircuitry make them functionally limited, morally out-of-date, bulky and, naturally, unreliable as all functionality is performed by hardware.

Commercial development of single – chip micro computers i.e. microcontrollers [5] and their wide application in all engineering fields makes actual a new approach to development of asynchronous electric engine controllers allowing ease adjustment of their control and protection algorithms.

On the other hand, under industrial conditions, the signals received from the control object are, as a rule, noised. And new technologies [6] allowing detection of microchanges in state of a controlled object are most effective to process noised signals. However, in turn it sets more strict requirements against operation speed of microcontrollers and ADC.

The problem definition. In this report, widespread and more modern control and protection blocks of asynchronous engines are reviewed. The development problem of one of possible variants of structural and schematic diagrams, constructive drawings of printed circuit boards, performance algorithms, software and engineering performance of microcontroller-based asynchronous electric engine controller complying with criteria of low price, simplicity, remote control, reliability, flexibility and operation speed.

The problem solution procedures. There is a range of microprocessors and microcontrollers among which the most appropriate one is to be chosen to achieve the assigned purpose. Analysis of microcontroller characteristics and architectures has shown that most simple and appropriate for such purposes are RISC (Reduced Instruction Set Commands) controllers of architecture. They are characterized by abbreviated dealing of quick executable commands and AVR structure. Microcontrollers of AVR structure have 32 registers directly connected with arithmetic and logic unit (ALU) that enables performing operations for one step. As a result, its operation speed exceeds usual microcontrollers of CISC (Complex Instruction Set Command) architecture for tens times. Most known microcontrollers of RISC architecture are AT90S, ATMEGA, ARM families by Atmel firm, microcontrollers by PIC, Scenix, Holtek companies.

AVR microcontrollers are from ATMEGA family and 8-charge microcontrollers designed for embedded applications. They are equipped with Electrically Erasable Programmable Read-Only Memory (FLASH) and data (EEPROM) as well as different peripheral devices. They are made from low consumable KMOP – the technology that together with advanced RISC architecture enables getting best correlation operation speed / electricity consumption. Microcontrollers of such family are most developed AVR representatives [7, p. 8].

Subject to features mentioned above, we have chosen ATMEGA 32 microcontroller by Atmel firm as a reference microcontroller. We’ll consider features of ATMEGA 32 microcontroller-based asynchronous engine controller (AE controller) manufacture, its performance on asynchronous engine protection and malfunction diagnostics.

Figure 1 shows one of possible structural diagram of ATMEGA 32 microcontroller-based asynchronous engine controller. AE controller consists of current transformer node (CTN), power and current control module (PCCM) and controller module (CM). Basic diagrams and constructive drawings of PCCM and C modules are developed.

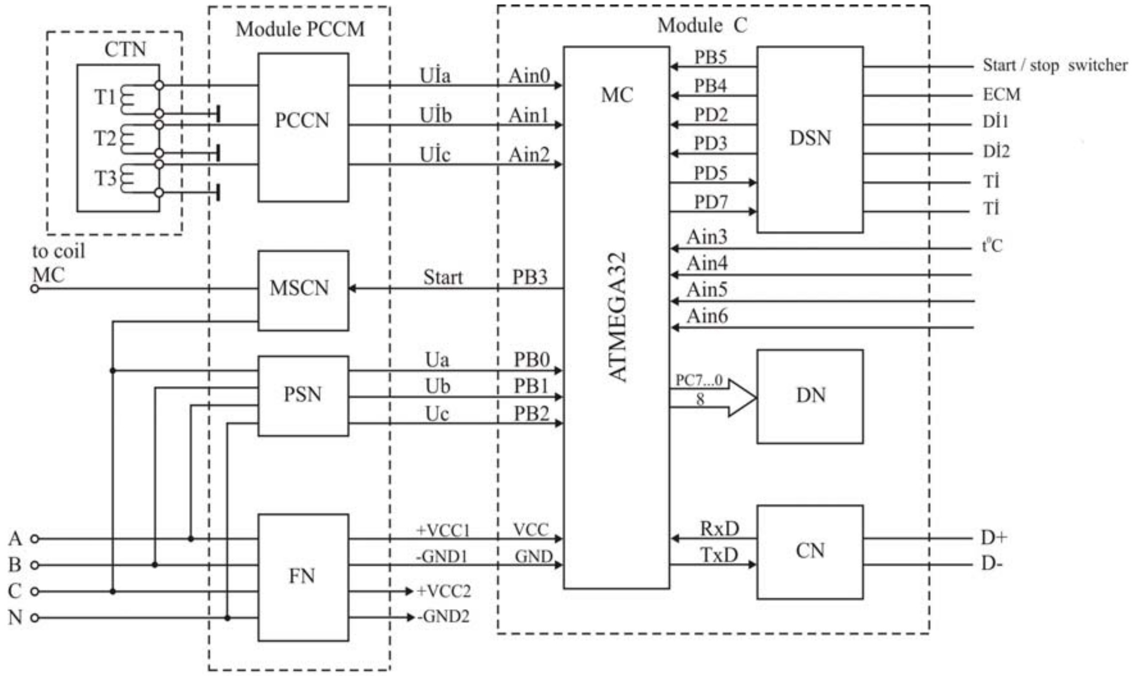

Figure 1. Constructive diagram of asynchronous motors controller on basis of atmega32 microcontrollers.

CTN - current transformer node; PCCN - phase current control node; MSCN - magnetic starter control node; PSN - phase sequence node; FN - feeding node; MC - microcontroller; DSN - discrete signal node; DN - display node; CN - communication node.

Output current of T1, T2 and T3 transformers being proportional to current of the consumer’s appropriate phases are converted into proportional voltage U_{Ia}, U_{Ib}, U_{Ic} through phase current control node (PCCN) and transferred to analog input AInO, AIn1, AIn2 for further conversion into 10-charged binary code. Network phase voltages in phase sequence node (PSN) are formed into TTL level impulses for transfer to PB0, PB1, PB2 discrete inputs of microcontroller. Similar to phase voltages of 3-phase network, such impulses are shifted from each other at 120^0 (figure 2). Microcontroller controlling phase availability and sequence protects engine against desequencing and phase losses.

Feeding node (FN) forms power supply of direct and stabilized voltage from three-phase rectifier, required for functioning IBUZ and LCD service commutator. If one of phase is lost, output voltage provides normal functioning AE controller, and it is very important for transferring accident – related information to upper level.

In magnetic starter control node (MSCN), output signal of microprocessor is intensified through optron isolation and symistor up to the level being sufficient for magnetic starter coil control (380V, 1A).

In discrete signal node (DSN), optron isolation of signals received from signalization objects both from dry contact and open collectors of transistors and their transfer to the input of microcontroller (MC) take place. Particularly, by this node MC controls state of start/ stop switcher and electric contact manometer.

Display node (DN) is installed in light-emitting diodes and designed to display accident conditions of controlled object and functioning IBUZ as whole in the faceplate.

Communication node (CN) ensures IBUZ operation with LCD service communicator or computer through RS485 interface by MOD BUS RTU protocol.

Based on information gathering and processing program recorded in permanent memory, MC performs all functions on engine protection and control as well as transfer of information to computer for further analysis of control results.

Assembler language program of version applicable for operation with AVR microcontrollers has been developed on the basis of such block diagram of AE controller algorithm, and this program is debugged by hardware. AE controller structure has been designed. It is made in two plates and placed to a box of 180 x150 x180 size with IP-54 level sealing protection. General appearance of ATMEGA 32 microcontroller-based AE controller is shown in figure 2.

Laboratory tests were carried out and a prototype form pumping unit control station passed through industrial tests in "Binagadi OIL" oil field, Azerbaijan.

Conclusion. During operating period of asynchronous electric engines, their different control and protection diagrams were developed. With the times, along development of technology such functions were implemented in different element bases. However, today's development stage of information engineering and technology requires to return once again to the matter on asynchronous engine controller (AE controller) development on the basis of single-chip microcontrollers and to extend their functions, to improve reliability, competitiveness, flexibility, durability by implementing many functions early performed by hardware- software method.

Figure 2. General appearance of asynchronous motors controller on basis of atmega32 microcontrollers.

Structural, schematic diagrams and constructive drawings of ATMEGA-32 structure AVR microcontroller-based asynchronous engine controller (AE controller) by Atmel firm (USA).

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