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# MODERN MICROPROCESSOR-BASED ELECTRIC HEATING CONTROL SYSTEMS: OPERATING PRINCIPLES AND DEVELOPMENT PROSPECTS

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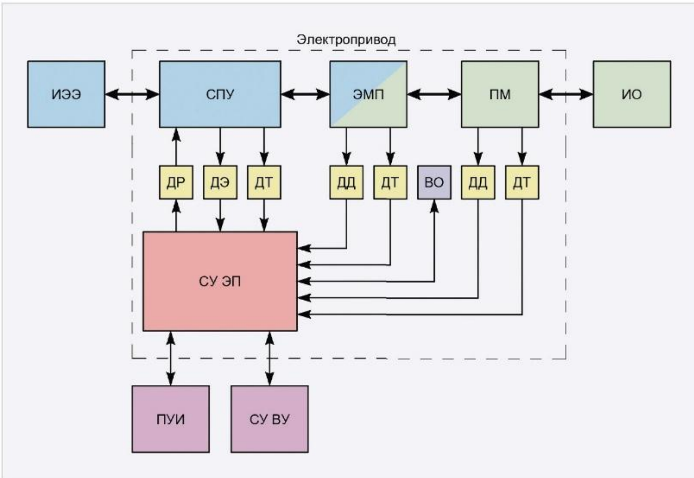
**Annotation:** We constantly encounter objects driven by electric motors (electric motors), not only in industry and transport, but also in the household sphere. Such devices with electric motors as a washing machine, a fan, an elevator, an air conditioner, a coffee grinder, a vacuum cleaner, etc. have firmly entered our lives. In industry, electric motors drive machine tools, lifting mechanisms, compressors, conveyors, winches, etc. It is safe to say that at present, the main means of driving working machines and other technical devices is an electric motor, and the main type of drive is an electric drive or, for short, an electric drive.

**Keywords:** electric drive, mechanical energy, display of information

The number of manufacturers of adjustable electric drives is growing, the volume of production and range of semiconductor converter technology for electric drives are expanding, its weight, size and energy characteristics are improving, electromagnetic compatibility, reliability, quality of operation and service capabilities of the electric drive are increasing. The intensive development of this area is facilitated by significant advances in the improvement of power semiconductor devices and integrated circuits, the development of digital information technologies and microcontroller control systems.

An electric drive is a controlled electromechanical system designed to convert electrical energy into mechanical energy and vice versa in order to set in motion the executive body (IO) of a working machine, as well as to control this process. A working machine is a device that uses mechanical energy to transform the shape, properties, condition, and position of objects of labor. The block diagram of the item instance is shown in Fig. 1.




Any item instance consists of two parts (channels): power (blue and green colors, wide lines in Fig. 1) and information (red and yellow, thin lines in Fig.

1). The first channel transmits the converted energy, the second channel controls the flow of energy, as well as collecting and processing information about the state of the item instance.

The EP power channel consists of two parts: electrical (blue in Fig. 1) and mechanical (green in Fig. 1), which have a connecting link – an electromechanical converter (EMF).

The mechanical part of the EP power channel consists of the following two devices: the movable part of the ED (rotor); PM is a transfer mechanism. They transfer mechanical energy from the rotor of the ED to the IO of the working machine, which performs useful work. PM is a mechanical device designed to transfer and convert mechanical energy from the ED to the IO of

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a working machine. There are three possible ways to transfer and convert mechanical energy: the rotational motion of the ED rotor is transmitted to the IO without conversion; the rotational motion of the ED rotor is transmitted to the IO with a change in rotation speed and torque; The rotational motion of the ED rotor is transformed into the translational motion of the IO.

The SU EP is designed to control the SPU and ED in order to ensure a given movement of the IO and consists of the following three parts (subsystems):

-measuring and information technology that provides reception and processing of signals from motion sensors, electrical parameters and temperature;

-an information control system that implements certain control, monitoring and protection algorithms for SPS and ED, and generates control signals for transistors (thyristors) and other devices that are part of the EP;

-an information and communication system that interacts informationally with a control and display panel (ISM), a higher-level control system (HMS), and other devices external to the item instance.

However, if we analyze their composition, circuitry, design and functions performed, we can conclude that they have a mostly distributed-centralized structure and consist of the following parts (Fig. 2):

LSU – local control systems that control, monitor and protect one of the transistor converters (TP) included in the IF (for example, AVN or AIN); CSU – the central (main) control system that controls the LS and coordinates their work, carries out information interaction with ISPs, control systems and other external devices, as well as general item instance management;

A PLC is a programmable logic controller that expands the capabilities of a data center for digital and analog inputs/outputs, digital and analog interfaces, increasing their number if it is not enough to control the item instance. The LSU receives and processes signals from voltage, current and temperature sensors of the transistor converter, generates IGBT transistor control signals according to a certain algorithm to regulate motion parameters and electrical parameters in accordance with the set values coming from the LSU, and also turns off the transistor converter in case of emergency situations in the electronic control system. The LSU must have an internal, fastest, current (moment) control circuit.

The microprocessor system is based on a microprocessor (processor) that performs information processing and control functions. The rest of the devices included in the microprocessor system serve the processor, helping it in its work. The necessary devices for creating a microprocessor system are input/output ports and partly memory. The I/O ports connect the processor to the outside world, providing input for processing and output of processing results or control actions. Buttons (keyboard) and various sensors are connected to the input ports; devices that allow electrical control are connected to the output ports: indicators, displays, contactors, electric valves, electric motors, etc. Memory is needed primarily to store a program (or a set of programs) necessary for the operation of the processor. A program is a sequence of commands that are understandable to the processor, written by a person (more often a programmer). The structure of the microprocessor system is shown in Figure 1. In a simplified form, the processor consists of an arithmetic logic unit (ALU) that processes digital information and a control unit (MC). Memory usually includes a permanent storage device (ROM), which is non-volatile and designed for long-term storage of information (for example, programs), and an operational storage device (RAM) designed for temporary data storage.

The processor, ports, and memory communicate with each other via buses. A bus is a set of conductors that are functionally connected. A single set of system buses is called an in-system highway, in which there are: The DB data Bus, which is used to exchange data between the CPU, memory, and ports; the Address Bus AB (Address Bus) used for addressing memory cells and ports by the processor; The CB Control Bus, a set of lines that transmit various control signals from the processor to external devices and back. Microprocessors A microprocessor is a software-controlled device designed to process digital information and control the process of this processing, made in the form of one (or several) integrated circuits with a high degree of integration of electronic elements. A microprocessor is characterized by a large number of parameters, since it is both a complex software-controlled device and an electronic device (microcircuit). Therefore, both the type of enclosure and the processor's instruction set are important for a microprocessor. The capabilities of a microprocessor are defined by the concept of microprocessor architecture.

A microcontroller (MC) is a software–controlled device designed to control the operation of the components of control systems, including control of technological processes. An MC can have a large set of built-in hardware, such as timers, counters, analog-to-digital converters (ADCs), pulse width modulators (PWM), digital I/O ports, and others [1]. The scope of microcontrollers is expanding every day. Today, it is difficult to imagine a competitive electric drive or any other complex device that does not contain at least one microcontroller. The use of MK increases the reliability of systems, reduces the time for installation and commissioning. Thus, the cost of the product is significantly reduced. In a modern electric drive, there are about 10 microcontrollers that control the display of information about the control variables of the electric drive on various displays (text, graphic, seven-segment indicators, etc.), the reception and transmission of information from an external control body, the exchange of information with sensors of the coordinates of the state, the implementation of the required control laws, etc. The purpose of this manual is to increase the efficiency of mastering the course "Microprocessor control systems for electric drives and technological complexes" through directional orientation and detailed consideration of specific issues.

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