Increasing the Reliability of the Power Supply by Applying Modern Relay Protective Equipment

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ABSTRACT

The article examines the issues of increasing the reliability of power supply through the use of modern means of protection in the power supply system, which is an important part of the electric power industry. Recommendations have been developed to create comfort for working personnel by using modern microprocessor protective equipment instead of electromechanical relay protection devices in the current state of power networks, to reduce the gabarit of the constructions, to increase reliability in ensuring electrical safety and continuity of power supply.

Keywords: Energy, electricity, power supply, electromechanical relay, microprocessor relay protection, current and voltage transformers.

Introduction. Currently, the demand for energy, especially electricity, is growing in the world community. The issues of production, transmission and distribution of electrical energy lead to an increase in the salinity of technical and economic losses at all power grid enterprises. The supply of generated electrical energy in a continuous and high-quality manner is an urgent issue of today. Various accidents and injuries that are currently in power grids lead to power outages. In order to prevent these situations in electrical networks, it is possible to use reliable types of relay protection and automation tools and quickly eliminate accidents through them.

The power supply system consists of electrical networks with different voltages. These networks are located in a given area, providing uninterrupted power supply to electricity consumers. Networks with a voltage of 35 - 110 *kV* and above belong to supply networks, networks with a voltage of 0,4 and 6 - 10 *kV* belong to distribution networks. The power supply system includes power networks with a voltage of 35 - 110 *kV* for the power supply of large consumers. They, in turn, are associated with sectors of the 220 - 500 *kV* energy system. Most consumers are provided by a distribution network with a voltage of 6 - 10 *kV*, and a voltage of 0,4 *kV* is used to supply household consumers.

A constant increase in energy consumption in the territory of the power supply requires constant development and improvement of electrical networks. This leads to the inevitable growth and branching of the electrical network. As a result of accidents caused by external and internal factors such as weather conditions, wear and tear of devices and incorrect actions of operational activity, the normal functioning of a part or entire network of the electrical network is disrupted. This is accompanied by a shortage of electricity to consumers and a decrease in its quality, which leads to material damage in the form of a shortage of products or a violation of the basic

protective structures. To eliminate many accidents and prevent their development, it is necessary to quickly turn off the damaged part of the electrical network using relay protection devices.

The most important type of Electrical Automation is relay protection, without which normal and reliable operation of current electrical networks is impossible. Therefore, the state and mode of operation of all parts of the network are constantly monitored, and if there is an accident or breakdown in the operating mode, it will respond to them.

Relay protection began to develop on an electromechanical basis. Over time, its construction became more complicated, and the relay became multifunctional mechanical complexes. After him, semiconductor protective equipment was developed. They did not have as high reliability as mechanical ones, so they could not completely replace them, and today they are used together.

After the emergence and improvement of computer and information technology, digital microprocessor protective devices appeared as a new generation of protective equipment.

The technical rearmament of relay protection began at the end of the last century, but despite this, the share of electromechanical and static relays in operation is quite high and amounts to about 65%. It should be borne in mind that the first microprocessor relay was launched more than 20 years ago, and at that time there were technically flaws in them.

Currently, over the entire development of relay protection, the algorithms for their operation have not changed, only the elementary base and methods for implementing protection have changed.

Devices on the basis of a microprocessor have their own characteristics. They are compact. Special software performs work on the basis of logical action. Structurally, they are made from one or more microprocessors, output relays, measuring procedures and discrete inputs. This version made it possible to distribute various types of protection in one case and link them at the software level. It made it possible to reduce the cost of materials for their manufacture and installation. In addition, the overall dimensions of the device and its power consumption have decreased. The microprocessor, which has many different functions, makes it easy to work on power supply objects with protection. All messages about the normal operation of the device and modes in the event of an accident, in addition, oscillograms of these phenomena are recorded using an operational registrar. Thanks to this, it is possible to more accurately analyze the operation of the defenses.

Problems arise when calculating protection points due to the fact that the distribution network of the power supply system is very widespread. They are a chain from the source to the place of damage consisting of many elements, and the speed of protection of the relay is based on the design features of the relay, which in turn leads to an inevitable increase in time.

Relay protection microprocessor devices are quite advanced in terms of performance and allow more accurate recovery of selectivity stages, which reduces the time the equipment is under high current. The relevance of the work lies in the fact that electromechanical relays are used a lot in terms of the indicator, but still there is a tendency to gradually wear out and switch to modern ones, due to which the release of an electromechanical relay is almost stopped, and the running relay manan is outdated, and every year the percentage of accidents due.

The main part. Currently, at electrical power facilities, you can find a park of very diverse relay protection and automation (*RPA*) devices. Their main part is made up of electromechanical relays, followed by microprocessor relays. Such a situation is due to the fact that a partial reconstruction of the distribution substation was carried out or it was impossible to replace the malfunctioning equipment with a similar one [1, 13].

The use of digital computing and microprocessors for protection purposes using relays has attracted research attention since the late 1960 (Singh, 2004). The first serious proposals for the use of digital computers came from Rockefeller in 1969 (Rockefeller, 1969; Singh, 2004). Soon many publications reported

on the digital relay. But the first microprocessor relay was offered as a commercial device only in 1979 (Sachdev, 1979). During that period, efforts were concentrated to obtain a very high rate of troubleshooting. Various methods and algorithms have been proposed to achieve this goal [12]. Their software configuration is for the implementation of various tasks (Sachdev et al., 2009). includes common hardware platforms. In the late 1980s, a multifunctional digital relay entered the market. These devices dramatically reduce the size and installation costs and have become a microprocessor Relay for powerful tools in modern substations. In the 1990s, the concept of integrated protection and control became very popular, with all the advantages of microprocessor technology for protection, control, control, energy system degradation and event processing and communication [2, 6].

Microprocessor relay protection replaces analog and electromechanical protection everywhere. This process is facilitated by a number of the following advantages of modern microprocessor-based *RPA* devices:

- self-diagnosis (automatic control of the working capacity of individual modules and the device as a whole, indicating the status and blocking the output of the device in case of failure) and checking the primary equipment;

- automatic registration modes, events and emergency processes that shorten the time to identify the causes of the accident;

- facilitate the calculation of installation points, increase their accuracy and reliability of measurements, reduce the selectivity stages, which reduces the duration of protection and the possibility of significant damage to equipment;

- low power consumption in power supply and measurement circuits (basically, there is no need to check the accuracy of current and voltage transformers);

- implementation of new functions and operational capabilities (maintaining several configuration sets and settings, taking into account the resource of the disconnection ability of the circuit breaker, restoring the shape of the current curve at the saturation of the current transformers, etc.).

The general view of the blocks indicating the places of sealing against unauthorized access is shown in figure 1.

Fig. 1. A general view of the microprocessor relay protection units of the БЭМП РУ with an indication of the places of sealing against unauthorized access.

In addition, it is important that a digital device with small dimensions performs the algorithms of all rxa devices necessary for induvidual power objects according to ПУЭ [3]. Microprocessor terminals, cabinets and protective kits are produced by foreign ("ABB", "SES Avlot") and Russian ("Radiosavtomatics", "Bresler", "Parma Prot", "Mechanotronics", "ABB Rele-Cheboksary", "EKRA") enterprises [11, 12]. Regardless of the manufacturer, microprocessor terminals provide:

- local and remote input of protective and automatic installations, as well as their storage and display;

- alarm of protection and automation, indication of the status of the circuit breaker;

- control the position of the circuit breaker and the suitability of its control circuits;

- data transmission through standard communication channels between the protective device and the automatic control system;

- show the measured and calculated parameters of the protected energoobject;

- local and remote control of the circuit breaker;

- monitoring external discrete control signals and circuits during device operation;

- terminal self-diagnosis;

- galvanic isolation of inputs and outputs of the device.

Figure 2 presents the connection scheme of the microprocessor-based relay block, and in the drawing we can see that the relay works on the basis of a specific software and on the basis of it organizes performance activities [4, 9].

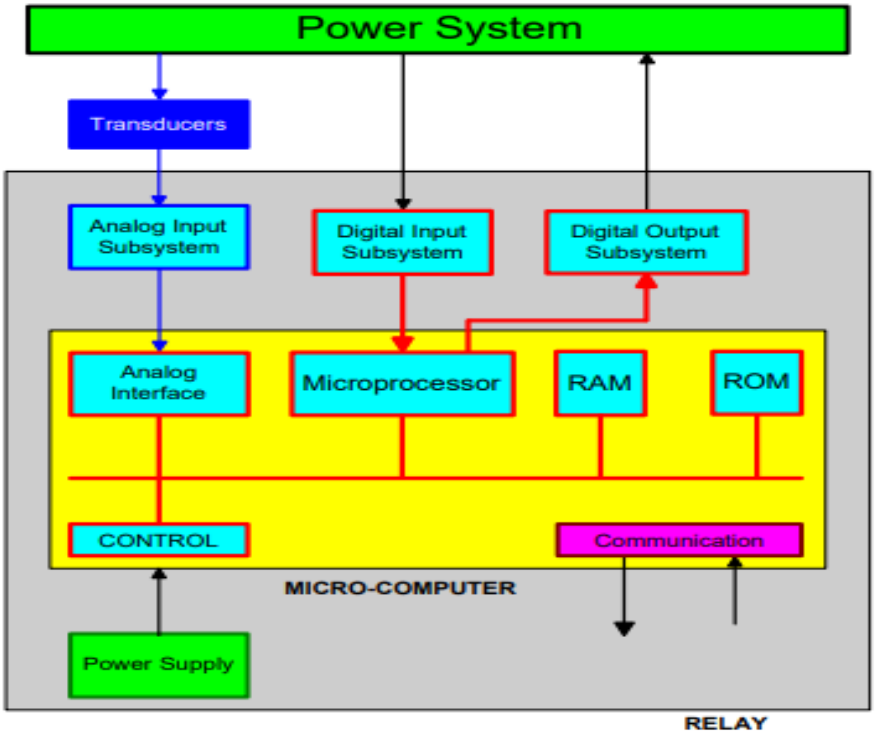

Fig. 2. Block diagram of a typical microprocessor-based relay.

When the functional potential of the terminal (measurement accuracy, input of fixed points from the remote control or through the computer interface, display on an *LED* or liquid crystal display, event registration, protection and set of automation functions) is determined by responsibility, it is necessary to take into account that the value of the protection object and terminal is greatly affected [10, 13]. The list of manufactured RX digital tools includes simple inexpensive compact devices and complex, functional saturated devices at a high price. Some manufacturers call their simple microprocessor protection devices digital relays, positioning them as an inexpensive replacement from an electromechanical relic [5, 7].

The block diagram, organized on the basis of figure 2, organizes the performance based on the comparison of incoming and outgoing signals. The sequence of works that must be performed in this case is shown in figure 3.

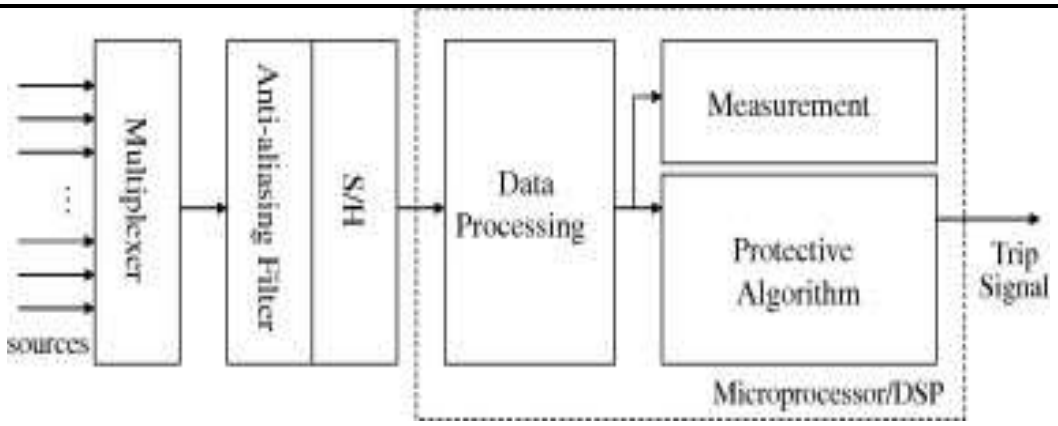

Fig. 3. Block diagram of microprocessor based relay.

Figure 4 shows the movement of outgoing and incoming signals from the relay on the network elements, with which it is possible to ensure the reliability of the power supply.

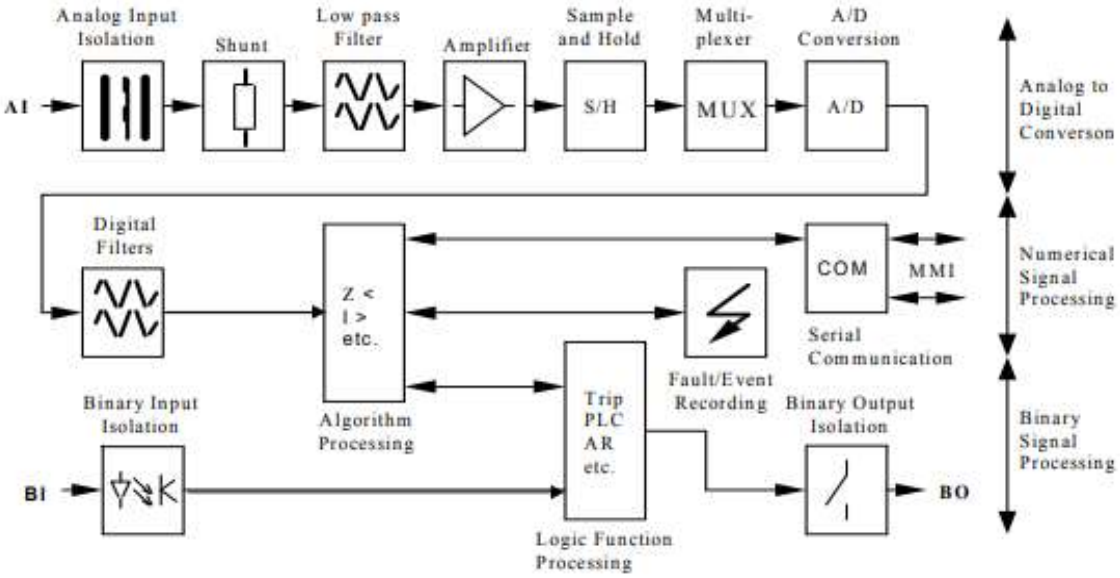

Fig. 4. Signal flow diagram of a numerical relay.

RPA devices with a microprocessor based on the modern element base of the БЭМП РУ series are designed to perform all the necessary functions of relay protection and automation, control, signaling of energy structures with a voltage class from 0.4 *kV* to 750 *kV* [6, 8].

БЭМП РУ devices are designed for installation in the *КСО, КРУ, КРУН* relay units, as well as control cabinets located in panels, relay halls and control panels. БЭМП РУ devices are used as the main device for connecting to distribution substations of power plants and network enterprises in substations with alternating, rectified alternating, alternating current [8].

After choosing a microprocessor relay protection devices, it is necessary to make an economic calculation. It is necessary to determine the total cost of the old relay protection system for the elements of the urban power grid section, since different protection schemes are used to protect each of them. This implies the use of different relays [9]. Then the economic effect of the introduction of microprocessor relay protection is assessed. When calculating the cost of the old relay protection and automation system, only the price of the relay used in the protective circuit is taken into account [7].

Conclusion. Due to the modern development of relay protection, rapid technological progress, the electromechanical relay is increasingly moving away, giving preference to microprocessor electronics. Such a rapid development of this direction is constantly associated with technical and forward movement. Due to the need for modernization in electricity, microprocessor equipment and, in particular, various relay protection units, series and brands are replacing increasingly outdated electromechanical relay systems. Their advantages are quite obvious and obvious. Without relelian means of protection and automation, it is impossible to imagine any technological object or electrical network of the XXI century. All electrical networks are equipped with relay protection, which works autonomously with software. This makes it possible to reduce the number of working personnel and helps to automate technological processes. The ability to install different types of relay protection microprocessor blocks and organize their interconnection is a complex but important and fundamental task in achieving the best results in terms of safety and protection, interconnection and correct operation of various types and target equipment. Competent technical solutions in the field of relay protection of large power lines, from all types of power plants to full-fledged transformer substations for power supply, can greatly contribute to ensuring the safety and improving the reliability of power supply systems of various levels and types. Therefore, changes in this direction are important and valuable, and their results are able to ensure the maximum safety of working personnel.

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