EQUIPMENT AND SOFTWARE FOR ENERGY SUPPLY MONITORING AND CONTROL PROCESS

Ilkhomjon Siddikov
Head of the Department of "Power suply systems"
TUIT named after Muhammad al-Khwarizmi,
Tashkent, Uzbekistan
E-mail: ikhsiddikov@mail.ru

Muzaffar Sobirov
Assistant-teacher of the Department of "Power supply systems", TUIT named after Muhammad al-Khwarizmi,
Tashkent, Uzbekistan
muzaffar-sobirov@mail.ru

Akmaljon Abdumalikov
Deputy Dean for Academic Affairs of " Computer Engineering" faculty,
TUIT named after Muhammad al-Khwarizmi,
Tashkent, Uzbekistan
E-mail: akmalabdumalikov6@gmail.com

Khurshid Sattarov
Department of "Power suply systems",
TUIT named after Muhammad al-Khwarizmi,
Tashkent, Uzbekistan
*E-mail:*sattarov.khurshid@mail.ru

***Abstract*-The parameters of probability and operation of control units are mainly determined on the basis of research of state of work and failure of elements conversion-formation of control signal. During research of reliability and probability of operational parameters of control units of monitoring and controlling devices, necessary to determine probability parameters of functioning elements, involved to formation of output signal, based on primary electrically, magnetically, thermal and other quantities and values. The results of control are recorded in non-volatile memory for storage if device operates in the measurement mode, and also displayed on the display.**

Keywords—Modeling, sensor, reliability, probability, operational parameters,control units, signal, monitoring

I. INTRODUCTION

A reliable assessment of power quality parameters (PQP) in the power supply nets and the development of effective measures aimed at ensuring power quality are impossible without instrumental control. To carry out such control, specialized measuring instruments – control units (CU) are required. Intensive development of modern technology has allowed domestic developers to create multifunctional CU, designed to control and analyze the quality of PQP. The tasks of PQP determine specific requirements for reliability and probability of operational parameters of CU. The only condition when choosing a CU is that all means must comply with the requirements of GOST 13109-97 in part regarding the measurement algorithms of the PQP and the permissible measurement errors. The list of measured PQP established by GOST 13109-97, but can be expanded depending on the tasks to be solved [1-7].

II. MAIN PART

The structure of a typical units of measuring quality of power energy is given in fig. 1. The measured voltages and currents are supplied to input terminals of the block of scale converters (dividers), in which, by analog processing, signals proportional to parameters of input voltage are formed, i.e., scale transformations occur to level (approximately 1 V) necessary for normal operation of analog block digital conversion. The instantaneous values of signals at the outputs of CU are converted into digital codes bloc analog-discrete converter (BADC), in which timing of input signals and their digitization are carried out. Digitization is based on 256 samples of a 14-bit code for the period of the fundamental frequency. Codes of digitized signals enter from information processing unit [8-11].

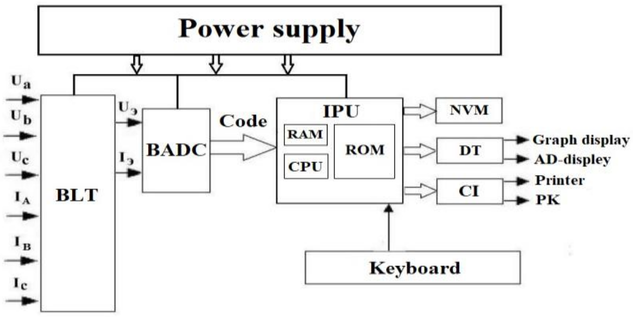

Fig. 1. Model of structure of CU

The structure of control units:
BLT - a block of large-scale transformations;
BADC - block of analog-to-digital converter;
IPU - information processing unit;
RAM - random access memory;
CPU - central processing unit;
ROM - read-only memory;
NVM - non-volatile memory;
DT - display tool;
CI - communication interface;
AD - alphanumeric display.

The central processor processes information, received from the AD, accordance with programs of the permanent storage device.

CU intended for both continuous and periodic monitoring of the quality of electricity should have sufficient non-volatile memory in volume, allowing long-term storage of measurement results. The archives with results of PQP control, accumulated in CU memory, should contain information about time of the control. These archives cannot be adjusted and are most reliable sources of information about control. Currently, there are several approaches to ensure long-term storage of measurement results. Firstly, CU

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PQP can have built-in RAM that can reach tens of megabytes in modern devices. Secondly, information can be stored on removable memory cards, the volume of which reaches tens of gigabytes. And thirdly, if CU is implemented on the basis of a laptop computer, the memory of the device is the hard drive of this computer [1-4, 6-11].

In addition, almost all modern CU are delivered together with software that allows storing control archives of the device on a separate computer through standard interfaces.

Such software significantly simplifies the processing and analysis of measurement results, and also allows you to accumulate long-term statistics on the patterns of changes in PQP.

Measuring tools should provide ability to display both the measurement results of parameters of the mode, and archive information. Most of the existing PQP CU have an alphanumeric display for this, and a small number of devices are additionally equipped with a graphical display, which simplifies the measurement and operational analysis of the results [11.15-20].

The information displayed on the displays should, without additional processing of measurement results, reflect all characteristics of controlling power energy quality, that determine conditions for fulfilling or not meeting the requirements for a given time interval during which these characteristics are obtained, as well as extreme values of controlling parameters in this interval.

The results of control are recorded in non-volatile memory for storage (if device operates in the "measurement" mode), and also displayed on the display. In most instruments, the CO is an alphanumeric display. Some devices also have a graphic display that allows you to display vector diagrams, spectra, histograms and waveforms of currents and voltages. Using the communication interface of the RS-232 (RS-485) type, the measurement results are transduccd via communication channels to an external industrial electronic computer or printer. The instrument keyboard is used to control the instrument during its setup and viewing measure [6-12].

An essential functional feature of CU, which determines the structural and climatic requirements for them, the element base, the power supply system, the ability to store measurement results, is type of measurement - continuous or periodic.

Existing standards recommend periodic monitoring of the quality of electricity at various intervals between subsequent control. So, according to GOST 13109-97, the duration of continuous measurements to monitor compliance with the requirements of this standard is determined by 24 hours as mandatory and seven days as recommended. The frequency of power quality control established by this standard is, depending on the type of PQP [11-15].

III. GENERAL REQUIREMENTS

The design of the CU must comply with similar requirements for measure and control. First of all, it concerns the requirements:

1) ensuring electrical safety (housing design and the presence of a protective earth terminal);
2) protection against unauthorized access (the ability to seal controls and use a password system).

Climatic factors. Measuring instruments should be designed for normal operation at temperatures from -30 to 40 ° C and relative humidity up to 90%.

The power supply of the devices should provide the ability to connect to an alternating voltage nets of 220 V and to secondary circuits of measuring transformers in voltage of 20 V.

CU operation is allowed for dips in the range 40% of the nominal nets voltage. In addition to power from an external voltage network, some CU PQP manufacturers offer the possibility of power from an independent voltage source. When designing autonomous power systems for portable CU, it is necessary to take into account with duration of their work (7 days or more). An important characteristic of the power supply unit is the maximum power consumption, which for modern CU PQP should not exceed 20 V.

The electromagnetic compatibility of devices must satisfy the requirements for immunity to external interference.

CU input channels must provide measurements in three phases of a monitored network with a grounded or isolated neutral. The rated voltage of the input measuring channels is 57.7; 100 and 220 V [33].

Requirements for current input channels are determined by the method of connecting CU to measuring current transformers. Equipping portable devices with clamp meters significantly simplifies their connection to a controlled network. To improve the accuracy of measurements, it is advisable to connect electric power quality control instruments used stationary by inserting current transformers into the secondary circuits without using current clamps, bearing in mind that for most current transformers the secondary rated current is 0,1 A and voltage – 20 V. [33].

The principle of CU operation should in real time provide continuous measurement of the PQP and auxiliary parameters of electricity according to the established GOST 13109-97 algorithms. All modern CU PQP are digital programmable devices using high-bit analog-to-digital converters and high-speed processors. The software is the main part of CU PQP. With a constant design of the device, its functionality can be significantly expanded by improving the software.

IV. PRACTICAL RESULTS OF THE RESEARCH

Decisions on control monitoring and management are made in the information-measuring blocks based on the signal about the availability of resources and consumption norms in real time. The control of the process of uninterrupted supply of the required energy from the source to the consumer is performed by the "information processing and control unit" in Fig.2 in accordance with the information obtained from the "information-measuring block on voltage" and "information-measuring blocks on load current" [34-35].

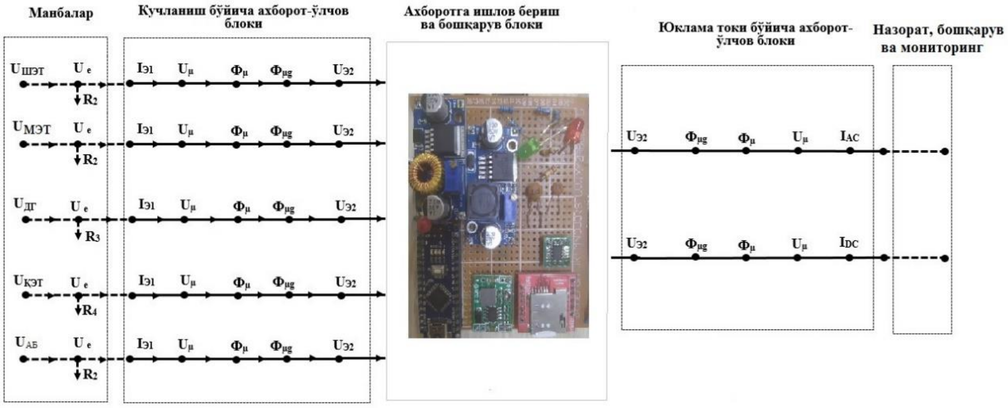


Fig .2. Structure of signal control, monitoring and control system of power supply devices

In signal conversion, primary signal conversion devices are considered as the main means of monitoring and controlling the process of converting primary currents to signal [10].

The structure of the process current monitoring device of power supply control devices is shown in fig 3.

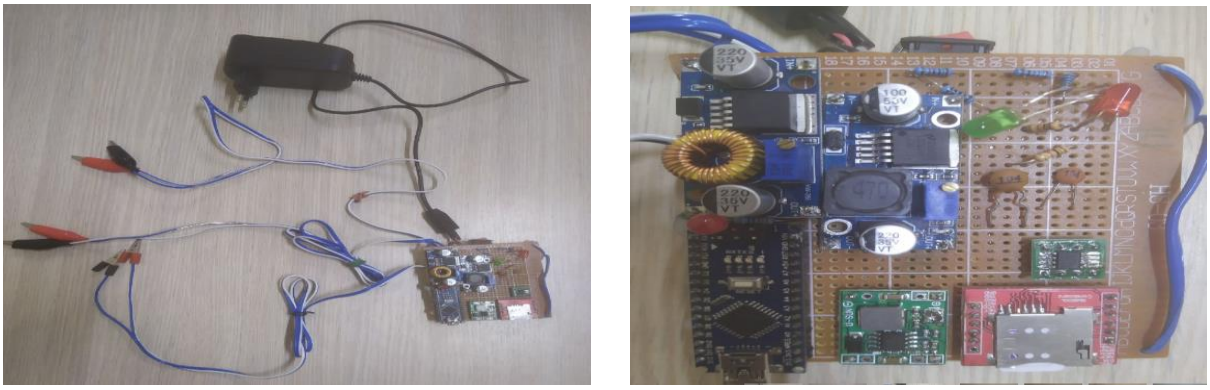


Fig .3. The structure of the monitoring and control device in the power supply system.

TABLE I. DATA OF THE CURRENT MONITORING AND CONTROL DEVICE IN THE PROCESS CONTROL OF POWER SUPPLY DEVICES:

Microcontroller	ATmega 328
Operating voltage	5 V
Input voltage (recommended)	7-12 V
Input voltage (maximum)	6-20 V
digital input / output	(6 of them can be used)
Analog input	6
Alternating current through input / output	40 мA
3.3 V AC for input	50 мA
Flash memory	32 KB (AT mega 328) is used as a 0.5 KB bootloader
Тезкор хотира	2 KB (AT mega 328)
EEPROM	1 KB (AT mega 328)
Frequency	16 MGs

The use of microprocessors and micro-computers installed in the microprocessor-based automatic control unit of power sources serves to reduce damage from damage to electrical networks, electrical and electrical equipment and improve the quality of energy produced [8].

Fig.4 shows an overview of the pwcontrol.uz services provided over the Internet for research of devices in the process control of power supply devices.

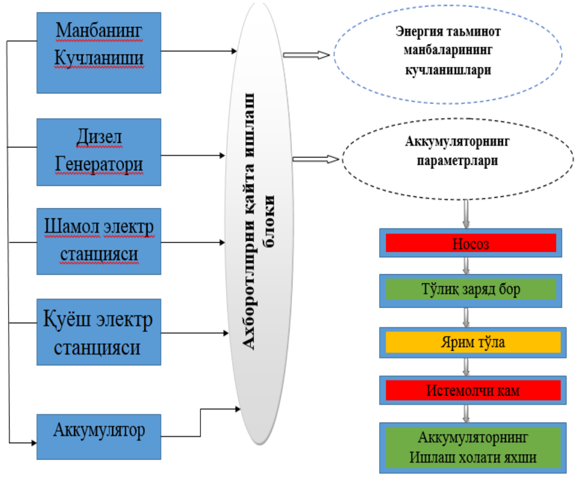
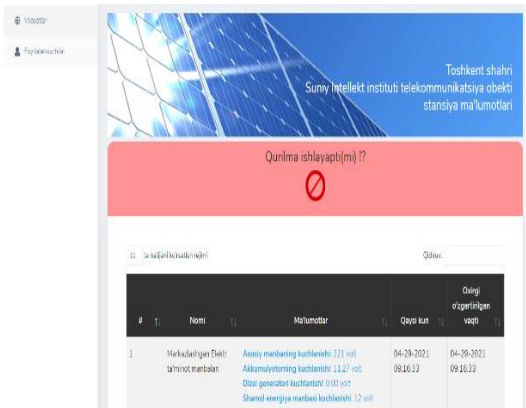


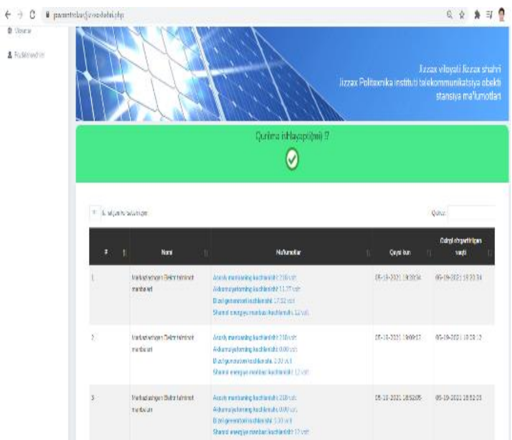
Fig .4. General structural view of the system pwcontrol.uz, designed to study the processes of power supply management devices.

Through the system Pwcontrol.uz it is possible to remotely monitor and control the current state of power supply sources, remotely monitor the operating conditions of the parameters and display the results in graphical form[25-26].

The software tool "Software for monitoring and control of signals of renewable and conventional power sources based on IoT technology" is designed to ensure the selection and continuous remote monitoring of reactive power sources, and its functionality is explained by:

Fig .5. shows the internal parameters of the created software in the main and regional sections.





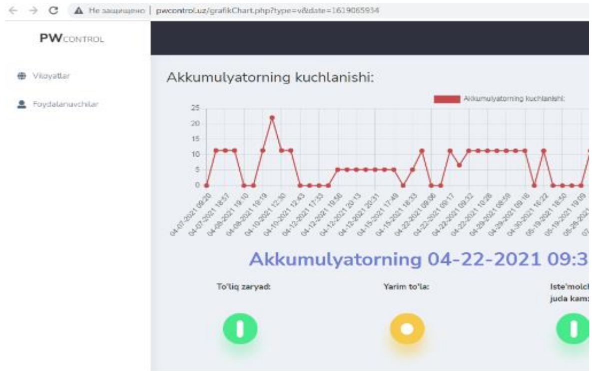


Fig .5. An overview of the system software designed to monitor and manage the processes of power supply management devices across regions.

V. CONCLUSION

1. A calculation method and a model are developed in the form of tables and parameters for determine of reliability and probability of CU and devices, provide high formalization and visibility of research.

2. The results of research conducted on the basis of models of parameterss of reliability and probability of the operating state of CU with microprocessor and electronic communication devices, taking into account the probabilities of operating states, showed that the total probability of four elements CU is equal P_{total}= 0,92.

3. The main advantage of four-element CU can simultaneously provide an appropriate secondary signal as electrical voltage and have possible monitoring and contro on the basis of microprocessor and electronic communication devices.

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