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# SCHEMATICHESKIY ANALYSIS TSIFROVYX IZMERITELNYX PRIBOROV

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**ABSTRACT**

In the article, the conversion of the measured value entered into digital measuring instruments into a digital code occurs automatically. Information about digital measuring devices for automatic conversion of the measured value into a digital code is highlighted. Based on this, the article reflects some types of digital measuring devices, and you will get a conclusion about the measurement results of digital computing devices and the quantitative qualities of their products.

**K E Y W O R D S**

Analog, compensator, quantization, discrete error, digital voltmeter, electromechanical relay, microprocessor.

## Introduction

There are different types of measuring instruments. They can be simple or complex, high or low precision. Measuring instruments must have standardized metrological properties, and these metrological properties are checked periodically. The correct determination of the value of the quantity being measured in the process of measurement depends on the correct selection and operation of this measuring tool.

During the millennia BC, the development of the commodity exchange led to the appearance of weighing scales and balances; primitive measuring instruments; setting a daily and daytime schedule, developing a calendar (measuring time); in astronomical observations and shipwrecks (measurement of angles and distances) [1]. In the course of scientific research, some measurements were made during the active period, for example, the angles of the rays were measured, the arc of the earth's meridian was determined. Until the 15th century, measurement techniques were not separated from mathematics, such as "geometry" (measurement of the Earth), "trigonometry" (triangle measurement), "three-dimensional area" and others. Improvement of measurement technology based on experimental methods in XVI-XVIII centuries. This period includes relative clocks, microscopes, barometers, thermometers, first electrical measuring instruments and other measuring instruments used in scientific research. In the late 16th and early 17th centuries, increasing the accuracy of measurements led to a revolutionary scientific discovery. For example, accurate astronomical measurements of T. Brop allowed I. Kepler to determine the elliptical orbit of hundreds of planets [2]. Galileo Galilei, I. Newton, H. Huygens and others participated in the creation of large-scale instruments and the development of their theory, each physical phenomenon was manifested in the corresponding instrument, which in turn helped to determine the value of the studied quantity gave and laws of influence between different quantities. For example, the concept of temperature gradually evolved and the temperature scale was created [3].

The operation of many digital measuring devices is based on the conversion of a continuous (analog) measured quantity into a digital quantity. Except for some instruments designed to measure discrete quantities. The process of digital coding of a continuous quantity is a set of quantization (discretization) of this quantity in terms of level and time.

In digital measuring instruments, the input measured value is automatically converted into a digital code. Automatic conversion of the measured amount into a digital code is a sign of identification of digital measuring instruments. Based on this, even if the measurement results are output to a digital computing device, they are not included in the digital instruments because these results are generated due to manual operations. For example, voltage compensators with manual calibration and decade-magazine resistance bridges are not considered digital instruments.

Digital measuring instruments include two mandatory functional links: an analog-to-digital converter and a digital countdown device [4].

Digital measurement is used not only as a tool joint, but also as an autonomous device.

As a result of the quantization of the measured quantity by level, a discrete error appears, which is based only on the fact that an infinite number of values of the measured quantity are expressed in a limited number of indicators of digital measuring devices [5].

Discrete error is characteristic of digital measuring instruments, it does not exist in analog instruments. But this error is not an obstacle to improve the accuracy of the instruments, because by choosing the number of quantization levels appropriately, the discrete error can be made much smaller. Practice shows that digital measuring instruments, as a rule, have much smaller errors than analog instruments designed to measure the same physical quantities.

Discretization of the continuous quantity x(t) in time is carried out in order to transform it into a discrete (continuous) quantity in time, which coincides with the corresponding values of x(t) only at certain moments of time. The interval between two adjacent time instants of the discretization is called the discretization step, and it can be variable or fixed [6].

The time discretization of a continuous measurand is a source of error in digital measuring instruments. However, by choosing an appropriate discretization step (such as choosing the quantization level), the observed error can be minimized.

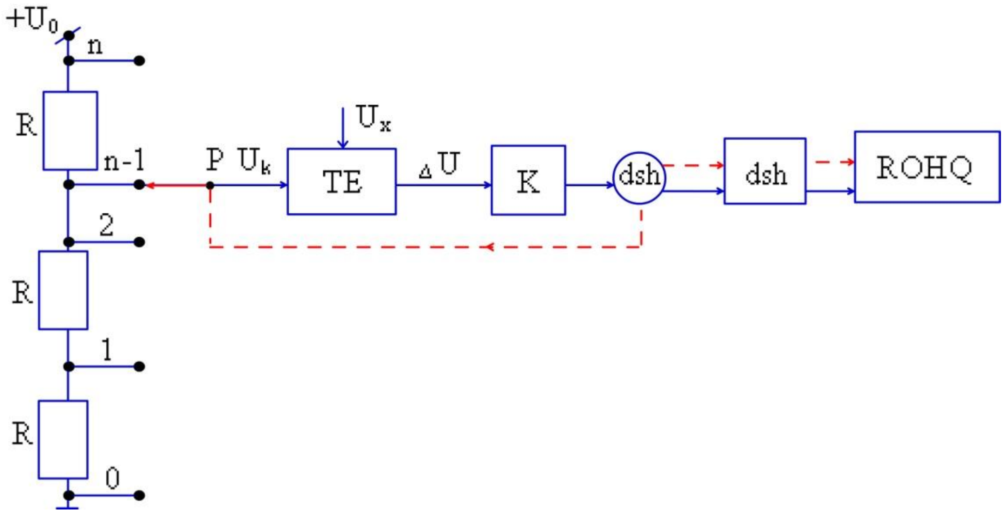
Constructive expression digital measuring devices can be divided into electromechanical and electronic types. Electromechanical types have contact elements (stepper motors, relays), and electronic types have contact elements (electronic or semiconductor). The development of digital measuring devices is progressing by replacing contact devices with non-contact ones [7].

As an example of digital measuring devices, we can give an example of an octanometer based on metrological standards.

When we drive, we pass by gas stations every day or every other day. Have you ever wondered what gasoline brands actually mean and how to determine its quality while you're waiting for your gas tank to be filled? Poor quality fuel will cause unpleasant situations with the engine in the future. In order to prevent this from happening, it is important to check the quality of the fuel poured into our car!

**Electromechanical digital instruments**

Electromechanical digital devices ("contact") for motors, relays, reconnection switches, etc. has s. They are not widely used because they have a long measurement time and a short service life. A small error in them is the advantage of these tools. As an example, an electromechanical digital voltmeter designed for measuring direct voltage is considered below (Fig. 1) [8].




1 - picture. A simplified diagram of an electromechanical digital voltmeter:

Ux is the measured voltage; DV - stepping motor; Uo - base voltage; DSh - decoder; TE – comparison element; ROHQ is a device that starts a digital account; K – amplifier; P - reconnection key (perekluchatel) Figure 1 shows electrical circuits with a solid line, and mechanical connections with a dotted line. Stepper motor DV, depending on the design of the specific device type, can be electrically or mechanically connected to DSh and ROHQ, which is indicated by two (solid and dotted) lines in the figure [9].

For comparison with the measured voltage Ux, the compensating (replacing) voltage Uk transmitted to the TE is determined by the following expression:

$$U_k = \frac{U_0}{n} \cdot n_i \qquad (1)$$

where n is the number of R resistors (the total number of steps of the voltage divider); ni is the number of connected steps of the voltage divider. We note that Uk changes with steps ΔUk = U0/n with discontinuities. The value ΔUk determines the error of the instrument's discreteness. Theoretically, the discrete error can be very small (the limitation has a constructive and technical description). It depends on the number of resistors forming the voltage divider. The value of ΔU is equal to the difference between the voltages Ux and Uk at the output of the voltage comparison element:

$$\Delta U = U_x - U_k \qquad (2)$$

If Ux ≠ Uk, then ΔU ≠ 0, it is transmitted to the input of the amplifier and, after amplification, affects the DV stepper motor, which starts to move the sliding contact of the reconnection switch (perekluchatel). In this case, the compensating voltage Uk obtained from the divider changes. The increase of Uk (if Ux>Uk) or its decrease (if Ux<Uk) continues until Uk is approximately equal to the measured voltage Ux. In this case, the DV engine will stop and the calculation of indicators from ROHQ will be started. DSh decoder is usually associated with engine and ROHQ (like ROHQ) - an electronic device. In this case, the connections between DV, DSh and ROHQ are electrical. But the devices in question can be electromechanical. At that time, communication between them will be mechanical.

It should be mentioned that instead of a stepper motor, an electromechanical relay is often used, which performs the necessary switching in the measurement circuits. Divisors of the voltage, as a rule, are carried out by decade (for example, a decade of whole units of the measured quantity, a decade of decimal parts, a decade of hundredth parts, etc.) [10].

The speed of electromechanical digital measurement tools is equal to 1-2 measurements per second. A typical accuracy class is 0.05. Electromechanical digital instruments and an even higher class of accuracy (from 0.01 to 0.005) are known.

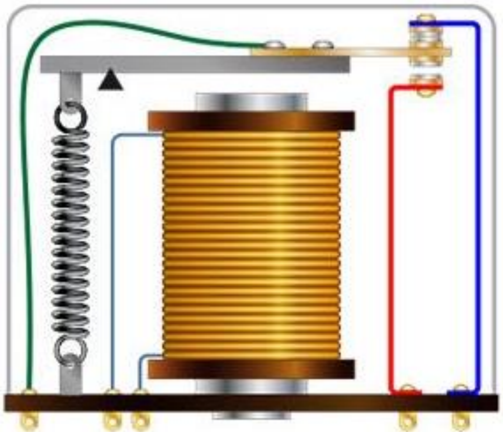


Fig. 2. Electromechanical relay scheme

Digital multimeters measure constant and alternating currents, constant and alternating voltages, resistances of resistors, frequencies of electrical oscillations, etc. used to measure .

In digital measuring instruments, the following tasks are assigned to the microprocessor:

1) management of analog-digital and digital-analog conversion processes;

2) managing the conversion of various physical quantities into electrical quantities (for their subsequent measurement);

3) automatic selection of the measurement limit;

4) tool interface management;

5) control of a digital computing device;

6) statistical processing of measurement results;

7) automatic editing of systematic errors and autocalibration;

8) diagnosis of disorders.


Fig. 3. Microprocessor circuit

The presence of microprocessors in multimeters increases the reliability of digital measuring devices, improves their metrological and operational characteristics. At the same time, the trend in the development of digital measuring techniques leads to a sharp increase in the value of digital measuring devices (the value of digital devices is usually 2-3 times higher than the value of a computer). The high cost makes it difficult to widely use digital measuring devices, which can be replaced by expanding the use of analog measuring devices (electromechanical and electronic), as well as using measuring-computer systems.

## Conclusion

In conclusion, digital measuring devices are widely used not only in the oil and gas industry, but also in various fields. The effectiveness side is that we have seen that time and quality have been formed at a high level during our research.

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