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A Study On Electrical Energy Measuring Device In Installation Place

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A STUDY ON ELECTRICAL ENERGY MEASURING DEVICE IN INSTALLATION PLACE**Plakhtiev Anatoliy¹, Gaziev Gayratjon²**

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Abstract: An analysis of the metrological support of electric energy metering devices has been carried out, which allows us to note a number of shortcomings, which include the insufficiency and imperfection of normative and technical documentation on electric energy metering and control, operation and verification of existing measuring instruments, poor equipment of enterprises and territorial bodies of Uzstandart Agency with high-performance calibration installations, the absence of portable compact installations for checking meters at the place of use, braztsovyh higher accuracy of measuring (standards). Information is provided on the developed device that allows structurally minimizing the error in current conversion and using cheap available magnetic materials for the transformer core. The presence of an electronic circuit allows to reduce the error due to the presence of an air gap of an uncontrolled length and the influence of adjacent conductors with current, as well as to reduce the error caused by a change in position in the window of the magnetic conductor of a controlled current.

Keywords: meter, electro energy, electrical current, accuracy, vector, winding, converter.

Аннотация: Электр энергиясини ҳисобга олишининг метрологик таъминоти таҳлили амалга оширилди, бу бир қатор камчиликларни таъкидлашга имкон беради, улар электр энергиясини ҳисобга олиш ва назорат қилиш, мавжуд ўлчаш воситаларини ишлаши ва калибрлаш бўйича меъёрий-техник ҳужжатларнинг етишмовчилиги ва етишмовчилигини, корхоналар ва “Ўзстандарт” агентлигининг ҳудудий органларининг юқори даражада ишлаши билан жиҳозланган қиёслаш қурилмалари, иш жойида ҳисоблагичларни текшириш учун кўчма ихчам қурилмаларнинг йўқлиги, юқори аниқликдаги намунали ўлчаш воситалари (эталонлар). Ахборот конструкциядаги хатоларни таркибий минималлаштириш ва трансформатор ядроси учун арзон магнит материаллардан фойдаланишга имкони ишлаб чиқилган қурилмада келтирилган. Электрон занжирнинг мавжудлиги назоратсиз узунликдаги ҳаво бўшилигининг мавжудлиги ва қўшни ўтказгичларнинг оқим билан таъсири тўғрисидаги хатоликни камайтиришга имкон беради, шунингдек бошқариладиган оқим билан ўтказгичнинг магнит палласида ойнада позицияни ўзгартириш натижасида юзага келган хатоликни камайтиришга имкон беради.

Таянч сўзлар: ҳисоб, ҳисоблагич, электр энергияси, электр токи, хатолик, вектор, чулғам, контактсиз ўзгарткич.

Аннотация: Проведен анализ метрологического обеспечения средств учета электрической энергии, позволяющий отметить ряд недостатков, к которым можно отнести недостаточность и несовершенство нормативно-технической документации по учету и контролю электрической энергии, эксплуатации и поверке существующих средств измерений, слабую оснащенность предприятий и территориальных органов Агентства «Ўзстандарт» высокопроизводительными поверочными установками, отсутствие передвижных компактных установок для поверки счетчиков на месте эксплуатации, образцовых средств измерений высшей точности (эталонов). Приводятся сведения о разработанном устройстве, позволяющем структурно минимизировать погрешность преобразования тока и использовать для сердечника трансформатора дешевые доступные магнитные материалы. Наличие электронной цепи позволяет уменьшить погрешность обусловленную наличием воздушного зазора неконтролируемой длины и влиянием на магнитопровод рядом расположенных проводников с током, а также уменьшить погрешность вызванную изменением положения в окне магнитопровода проводника с контролируемым током.

Ключевые слова: Учет, счетчик, электрическая энергия, электрический ток, погрешность, вектор, обмотка, бесконтактный преобразователь.

Introduction

In Uzbekistan, about 50 billion kilowatt-hours of electric energy is produced annually, over 5 million electricity-metering devices are used to control the process of production, distribution and consumption. Ensuring uniformity of measurements for such a huge park measuring technology is a challenging task, solution of which involved thousands of professionals working in different sectors of the economy [1].

The accuracy of measurement is determined by technical capabilities of used measuring instruments. Currently in Uzbekistan a large variety of devices to measure the electric energy specifically, electricity meters have been registered. On the one hand, this is positive notion, since it gives opportunity to select a desired device. On the other hand, there is a problem associated with their service and reliability [2].

Analysis of metrological provision of electricity meter system allows to revoke a number of shortcomings, which concern failure and deficiencies of normative and technical documentation on measuring and control of electric energy, operation and calibration of existing measuring instruments, poor equipment of enterprises and territorial bodies of "Uzstandard" Agency with accurate calibration technology as well as lack of compact mobile units for checking meters on site, reference measuring tools with high-accuracy (measuring standards).

Nowadays, when a large amount of power produced and consumed, even a small error in the accuracy of measurement parameters, especially quantitatively, will result in a significant economic loss.

Therefore, reduction of power losses, particularly due to the inadequacy of the accounting system and control is one of the imperative issues of national importance, and demands to strengthen requirements for the accuracy and reliability of electricity measurement.

Based on the analysis of the current state of referenced measuring devices and calibration systems reveal that necessary quality control parameters of meters provided only in the laboratory. Yet, the question of controlling meter's parameters on site remains unattended, although, given the huge number of devices in operation, such type of control appears cost effective, supported by the evidence obtain in a number of works [3-19]. By controlling electricity meter's parameters on – site, following can be achieved:

1. Identify metrologically unfit electricity meters;
2. Gather statistical data, which allows determining an initial calibration interval of meters.

Research Methods and the Received Results

Conventional electricity meters by technical nature consist of electronic measuring element with analog or digital power converter comprising of primary voltage converter and primary electrical current converter, outputs of which connected, respectively, but the first and second inputs of the analog multiplier device with access to the transmitter voltage frequency connected to the input of impulse meter. However, the disadvantage of such measuring device is absence of connection to the circuit without breaking it.

The difficulty of amplitude of the flow configured as a remote current transformer with split magnetic circuit - current clamp.

The question of connecting to the controlled circuit without breaking it can be resolved with primary current transformer configured as a remote current transformer with split magnetic circuit - current clamp.

In this case, let us consider operating principles of current transformer [20]. The figure -1 shows arbitrary direction of delayed secondary current I_2 vector. The voltage on the secondary winding is $U_2 = I_2 Z_H$, where load resistance equals to $Z_H = r_H + jx_H$. The voltage drop in the secondary

winding is equal to $I_2 Z_2$, if winding resistance is $Z_2 = r_2 + jx_2$. Electromotive force, emf E_2 , induced in the secondary winding stream of Φ_0 , preemptive at 90° , U_2 balances U_2 and $I_2 Z_2$.

The amplitude of the flow as follows:

$$\Phi_{0m} = E_2 / 4.44 \omega_1 f,$$

whereas, f – frequency

By knowing core section, an amplitude of the induction B_{0m} , can be determined and on magnetization curve of the core material $B_m = f(H_m)$ – corresponding value of the magnetic field strength H_{0m} and magnetizing current (no-load current) can be found.

$$I_0 = H_{0m} l / \sqrt{2} \omega_1,$$

where, l – average length of power lines in the core.

When applying a sinusoidal current to the current transformer with split magnetic core, there is always a certain amount of energy loss due to viscous friction while rotating dipole molecules, as well as imperfections in the dielectric (i.e. presence of its small conductance).

Because of these losses, I_0 , shall lead flow vector direction to the certain angle δ . From the curve of the induction of specific losses for material core can be determined complete loss of P_m mass for the entire core. I_{0a} , current component, which is in quadrature with stream Φ_0 , will be equal to:

$$I_{0a} = P_m / E_2.$$

Where,

$$\sin \delta = I_{0a} / I_0.$$

Vector current in the primary circuit is defined as the sum of geometric vectors – I_2 and I_0 , i.e. $I_1 = I_0 - I_2$.

By replacing $I_2 = (\omega_2 / \omega_1) / I_2$, we obtain following equation for transformer's magnetomotive force (m.m.f):

$$I_1 \omega_1 + I_2 \omega_2 = I_0 \omega_1.$$

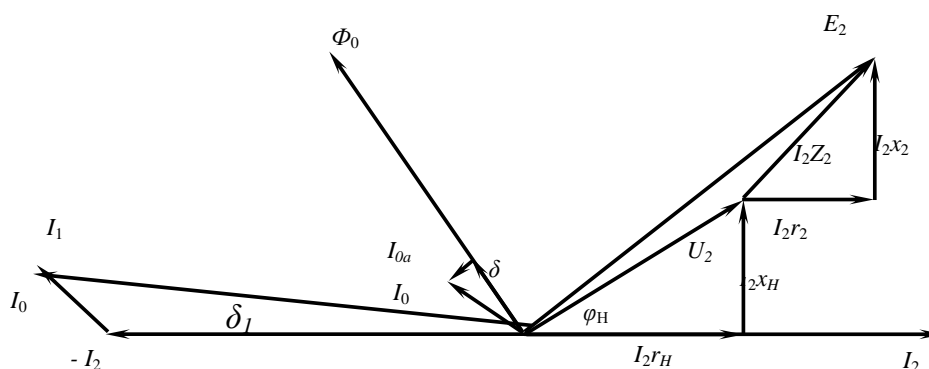


Fig.1. The vector diagram of current transformer.

These losses are accounted for in proposed outline (see fig. 2), in which introduced to the primary circuit resistance in order to take account of impact of the load on the transformer secondary circuit current in its primary circuit [21].

Therefore, device controls parameters of examined electricity meters at their site of installation. The principle of device's operation lies in the fact that primary current transformation made in the form of remote current transformer with split winding magnetic core and additional over-presses, which are connected in cascade to the voltage amplifier, integrator and voltage converter. The inverter output is connected in series with load resistor to the secondary skein-current transformer and load resistor connected parallel to the second input of the multiplier unit. The proposed configuration of the current transducer device controls parameters of electric power meters, which allows using this device on-site installation of controlled meters.

The apparatus comprises of following:

- input primary voltage converter 1;

- input primary current converter 2 which includes current transformer with split magnetic circuit, 3, and with additional 4, and secondary, 5 windings, voltage amplifier 6, integrator 7, voltage-to-current converter 8, resistor 9; and split magnetic core current transformer covering current-carrying conductor with controlled circuit, which is the primary winding of this transformer
- Multiplier device 10, with first, 11 and second, 12 inputs;
- Voltage to frequency converter 13;
- Pulse counter 14.

Ideally, the magnetizing force of the secondary winding 5 is equal to the primary winding of magnetizing force and pauses behind it by 180° . The presence of loss in the magnetic circuit 5 and secondary winding causes that in the secondary winding magnetizing force is less than the first one 5 and phase angle between them will differ by 180° , which leads to inaccuracy in transformer 3. In addition, uncontrolled air gap in the detachable magnetic circuit, 3 and spatial position of the current-carrying conductors on the magnetic window bring about error. In general, this error depends on the magnetic flux in the magnetic core and it will decrease with decrease in the flow.

In the proposed setup, an additional winding 4, electromotive force (EMF) which is proportional to the differential of flux is used. This electromotive force is amplified in 6, integrated with 7 (thereby generating a voltage signal proportional to the magnetic flux in the magnetic circuit 3) and with help of a voltage-current converter 8, it is converted to a current supplied to the secondary winding circuit 5 of the current transformer 3, in order to minimize magnetic flux in the magnetic circuit of the current transformer, which then leads to decrease in error.

The block diagram of the device illustrated in the fig. 2.

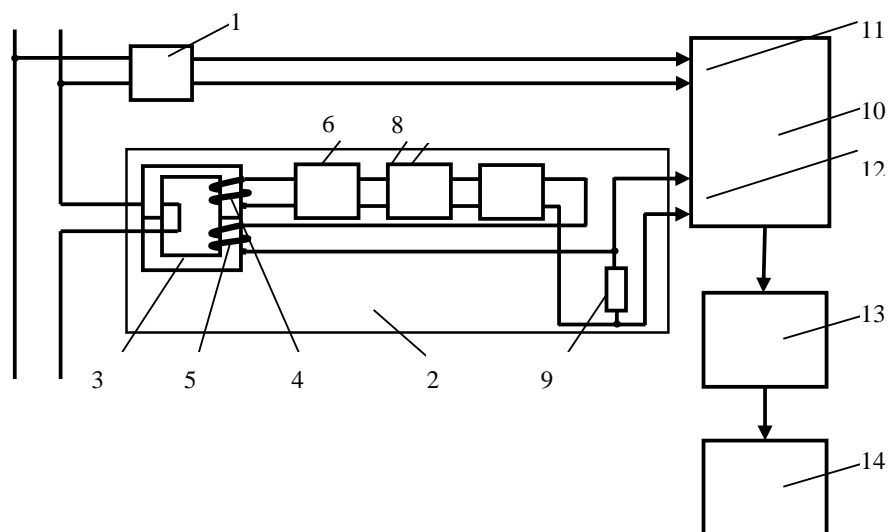


Fig. 2. Block diagram of proposed device for checking electricity meters on site.

The voltage drop across the resistor 9 proportional to the current controlled circuit and primary output inverter voltage 1 applied to the inputs of a multiplying device, which is proportional to power output of the controlled circuit. This signal is an input to the voltage-to-frequency converter, which generates a pulse signal with a frequency proportional to the power controlled chain. The number of output pulses from the voltage-to-frequency converter signal, 13 read by the pulse counter, 14 for a specific interval is proportional to electrical energy passing through the controlled circuit during this period.

Conclusion

The proposed configuration of a magneto - electron current transformer allows structurally minimize conversion error and enables to use inexpensive available magnetic materials for a transformer core. The presence of electronic circuit can reduce inaccuracy due to the presence of an air gap with uncontrolled length and influence magnetic circuit adjacent to current-carrying conductors, as

well as reduce error caused by change of position in the magnetic circuit window with a controlled current conductor.

Apparatus for controlling parameters of electricity meters at their point of installation protected under the Patent Law of the Republic of Uzbekistan.

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