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THE THREE-PHASES ELECTROMAGNETIC CURRENT TRANSDUCERS FOR CONTROL OF REACTIVE POWER OF ELECTRICITY CONSUMPTION

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Abstract

As known, within the world more than 60-70% of produced power is devoured by three-phases acceptance electric gadgets - offbeat engines. In acceptance electric gadgets as nonconcurrent machines, converters, transformers and ets, responsive control expend for creation of magneto moving drive (m.m.f.) and attractive flux. The control of responsive control of power depend from values and parameters of current transducers, which utilize in forms of control control utilizations. Advanced control frameworks of values and parameters of power ask creating and execution of modern sorts computerized advances and gadgets. In article given comes about of inquire about of modern three-phases current transducers, which utilize in forms of control of receptive control supply of acceptance gadgets and have conceivable outcomes change topsy-turvy and non-sinusoidal values of responsive control, rule of developing three-phases electromagnetic current transducers, which answers for necessities of compactness, unwavering quality, speed, utilize present day advanced innovations and devises for observing responsive control utilization.

Keywords: Three-phase currents, induction electric devices, reactive power consume, sensor converters, sensing elements, primary current, secondary voltage, error of sensor.

Introduction

The Hall Company's current transformers, which are based on the idea of converting the magnetic field produced by m.m.f., are widely used in electromagnetic transducers, or transformers of power systems during control in power equipment and nets of power production, transmission, distribution, and consumption processes. Traditionally, the Hall effect was used to convert primary electrical current of reactive power to secondary signals. Current transducers built on the Hall element effect provide very low output signals. The results of our study demonstrate that while classical one-phase primary current transducers are capable of measuring both alternating and direct currents, they are unable to measure the parameters and value of magnetic flux of reactive three-phase currents of reactive power of electricity consumption [1-4].

The measurement of primary current for reactive power predominantly employs conventional single-phase current transformers (CTs). This transformer is primarily designed to measure only the primary phase of alternating current in power networks, with a secondary output of 5 A when the primary current is at nominal values and parameters. Classical primary current transformers for current regulation primarily consist of a magnetic core, which houses closely formed primary and secondary windings. They are reporting measurement errors above the installed capacity when the equipment operates within a system utilizing digital devices, which exhibit deficiencies in geometric characteristics and power factors [4-6].

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The transducer of primary three-phase current to secondary voltage as a signal for control was identified from research and analysis results. It was built using the principles and recommendations of transforming transducer sensitivity element constructions, which are secondary windings positioned in a suitable order between the stators slots. This method gave opportunities to improve the accuracy of measuring and controlling the magnetic flux in the stator of an asynchronous motor, have been free from external influences, have been high-reliability, fast, easy to control, and have been monitored [3].

MATERIALS AND METHODS

One of the main issues in controlling the three-phase currents needed for generating magnetic fields in the stator and rotor of asynchronous devices is providing power from single-phase electrical networks. These networks have uneven and distorted values and parameters when creating magnetic fields and flux, as mentioned in reference [7].

Studying how to control reactive power in single-phase power transmission devices and sources needs the use of phase-shifting components and three-phase current sensors that measure reactive power to create a rotating magnetic field. The way the study was done on how the three-phase electromagnetic current transducers work and are built, along with the dates when they were made, is described in this article. The research showed that the signals at the output windings of an electromagnetic current transducer depend on the type of connection used: delta, and they change in proportion to the primary reactive currents supplied to the stator winding of the consumers [8].

The construction of electromagnetic transducer of three-phase reactive powers currents to a signal as a secondary voltage given in Fig. 1.

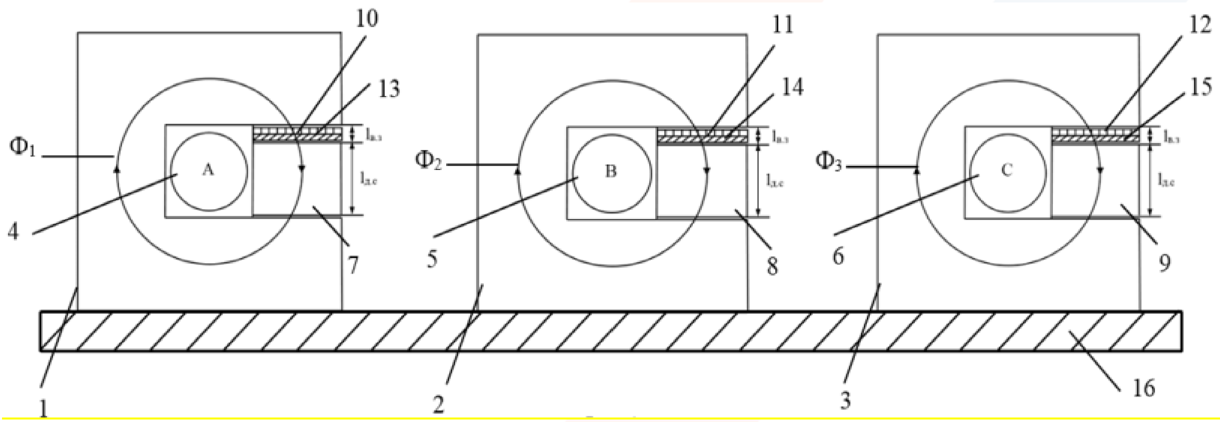

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Fig. 1. The construction of electromagnetic converter of three-phase reactive currents into a signal in the form of a secondary voltage. *Source:* Compiled by the authors

where: 1, 2, 3 – magnetic core of three-phase primary current transducers (phases A, B and C); 4, 5, 6 - three-phases conductors of power supply net – primary windings of transducer; 7, 8, 9 – air gaps; 10, 11, 12 - sensitive elements – secondary measure windings, 13, 14, 15 - insulating boards; 16 -isolation basis

The device created is part of converter technology and can be used to monitor and measure reactive power used by induction devices without touching them.

The electromagnetic converter for three-phase reactive power current's job is to create a signal based on the output voltages from the measuring windings. This signal acts as a converter that shows the magnetic flux levels, which are caused by the reactive power used by induction devices and electrical equipment [9-13].

The issue is resolved because in this device used to monitor and measure reactive power values and indicators, which come from the magnetic fluxes made by the primary three-phase currents, the converter's measuring windings are built as a flat structure. These windings separately give output signals for each phase current of the converter's primary winding, which connects to the electrical power supply network for induction electrical equipment.

The designs of the measuring windings - sensitive elements of the electromagnetic converter of three-phase reactive power current are presented in Fig. 2.

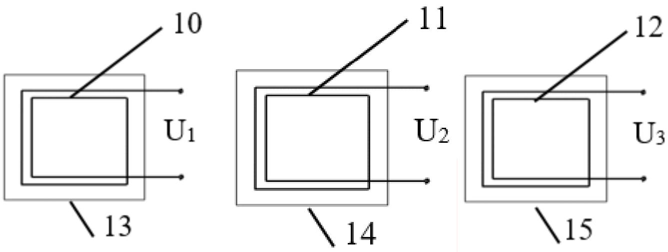

Fig. 2. Designs of flat measuring windings - sensitive elements of an electromagnetic converter of three-phase currents of reactive power of electrical energy. *Source:* Compiled by the authors.

Output signals in the form of output secondary voltages from the terminals of flat measuring windings based on the values of the primary currents of phases A, B and C of the electrical network - the primary windings of the electromagnetic reactive power current converter are determined as follows [14, 15]:

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$$U_1 = 4{,}44 f W_1 \frac{I_A W_1}{R_{\mu 1\Sigma}}$$
$$U_2 = 4{,}44 f W_2 \frac{I_B W_2}{R_{\mu 2\Sigma}}$$
$$U_3 = 4{,}44 f W_3 \frac{I_C W_3}{R_{\mu 3\Sigma}}$$

where: f- AC frequency,

I_A, I_B and I_C - phase currents of the primary windings of the electromagnetic converter of three-phase reactive power current,

W_{11}, W_{12}, W_{13} - number of turns of primary windings (phases A, B and C),

w_1, w_2, w_3 - number of turns of measuring windings,

$R_{\mu 1\Sigma}$, $R_{\mu 2\Sigma}$ и $R_{\mu 3\Sigma}$ - total magnetic resistance of the magnetic part of the stator and the interpolar air gaps of the stator, where the measuring windings are located.

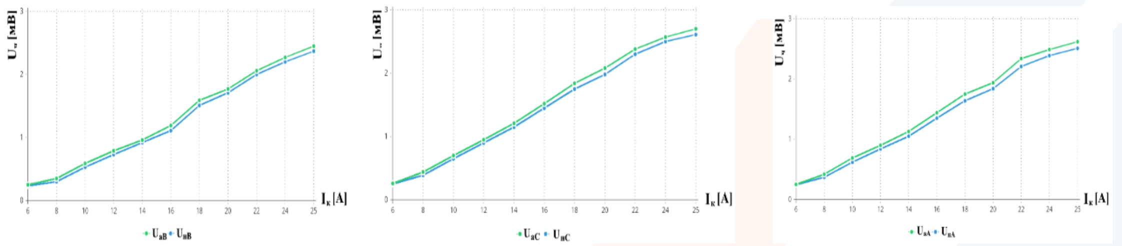
Based on the path of magnetic fluxes created by primary three-phase reactive power currents, the total magnetic resistances of the magnetic part of the induction electrical equipment, where the measuring windings are located, are determined as follows [9, 10, 16]:

$$R_{\mu 1\Sigma} = R_{\mu 1\text{в}} + R_{\mu 1\text{c}}$$
$$R_{\mu 2\Sigma} = R_{\mu 2\text{в}} + R_{\mu 2\text{c}}$$
$$R_{\mu 3\Sigma} = R_{\mu 3\text{в}} + R_{\mu 3\text{c}}$$

Results of research of output voltages from secondary measure windings of primary three-phases reactive power current with values In = 25 A given in Fig. 3 a, b, c.

RESULTS AND DISCUSSION

The leads of the three phases reactive currents electromagnetic transducer, which used during research, can be connected in a form star and delta connection, and they located in the air gape which determine by value and parameters of output signal from lead of electromagnetic transducer value of reactive power as a output secondary voltages (Fig. 3).



a) b) c)

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Fig. 3. Results of research of output voltages from secondary measure windings of primary three-phases reactive power current with values: In = 25 A (a – in phase A, b – in phase C, c – in phase C. *Source:* Compiled by the authors.

During research used the next values and parameters power use devices: nominate active power P = 250 Wt [5]. The number of secondary windings providing output signals of the three phases reactive currents of the electromagnet transducer is w = 10 windings [9, 10, 17].

The analysis of the error of measure and accuracy indicators of the electromagnetic three-phases reactive power currents transducer mean square deviation and entropy error are found according to the probability distribution law [9].

For an electromagnetic transducer of three-phases currents of reactive power error of measure determine as:

$$\sigma_\Sigma = \sqrt{{\sigma_1}^2 + \sigma_2^2 + \sigma_3^2 + \sigma_4^2} = \sqrt{0,1^2 + 0,1^2 + 0,1^2 + 0,1^2} = 0,2$$

$$\Delta_1 = K_E \cdot \sigma_\Sigma = 2,07 \cdot 0,2 = 0,414$$

Based on the results of the research, the entropy errors of the single-phase electromagnetic current transducer were determined. Based on the results, it can be concluded that specified entropy error for control and management devices is Δ= 0,5. This electromagnetic current transducer offer is accurate, fast, compact, and the ability to be remotely controlled.

CONCLUSION

After looking at the research and analysis, these are the conclusions we came up with:

The use of measuring windings in the converter allows for providing the standard output voltages (5 V) needed by digital control and measurement devices. This helps improve the quality of output signals, which are secondary voltages used to monitor and control reactive power sources, ensuring better quality of electrical energy.

Determine the possible ways to measure sensitive rings using an individual connection, star, or triangle configuration, which enables the distribution of magnetic values and parameters generated in the magnetic components of the

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output voltage from a current transducer, to assess the asymmetry and non-sinusoidal indicators of reactive power.

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