



STUDY OF CONVERSION CIRCUITS AND DESIGN OF THE ELECTROMAGNETIC PRIMARY CURRENT AND VOLTAGE TRANSDUCER OF MONITORING AND CONTROL SYSTEMS

A. B. Abubakirov

Karakalpak State University named after Berdak, Nukus.

A. A. Yuldashev

Karakalpak State University named after Berdak, Nukus.

I.K. Baimuratov

Karakalpak State University named after Berdak, Nukus.

M.T. Sharipov

Karakalpak State University named after Berdak, Nukus.

A.D. Utemisov

Karakalpak State University named after Berdak, Nukus.

ANNOTATION

The conversion and construction circuits of electromagnetic current and voltage transducers of monitoring and control systems of quantities and parameters of power supply as new physical and technical effects are used, poses the problem of their systematization and selection of parameters of their elements and design. The paper presents materials on the study of circuits and conversion designs of the primary electromagnetic transducer of electric current and voltage in power supply systems.

KEYWORDS: *control, control, current, voltage, parameter, power supply, electromagnetic converter, magnetic circuit.*

DISCUSSION

The values and parameters in the designs of the primary electromagnetic transducer of current and voltage of electric energy of power supply systems are distributed in the conversion space, which, depending on the purpose and purpose, have a complex geometric configuration. Given the distribution, heterogeneity, nonlinearity, etc. the values, parameters, nature of the medium and the transformation space of the electromagnetic converters of the primary electric current and voltage of the power supply system, we can imagine that their research and calculation in full is a difficult task even with the widespread use of modern computer systems.

The design of the elements and conversion circuits of primary electromagnetic current and voltage transducers, the number of which continuously increases as various physical and technical effects are used in them, determines the problem of their systematization and selection of rational quantities and transformation parameters and a design that meets the requirements of modern control and management of quantities and parameters power supply systems.



In the presented graph model, the conversion sections of the primary electromagnetic current and voltage transducer are the conversion coefficients for each phase output voltage $W_a(x, y, z, t); W_b(x, y, z, t)$ и $W_c(x, y, z, t)$ is determined based on the following analytical expressions:

$$\begin{aligned} \frac{F_{\mu 11} - F_{\mu 12}}{\Pi_{\mu 11}} + \frac{F_{\mu 11} - F_{\mu 12}}{\Pi \Pi_{\mu 11}} &= K_{IF_A} I_A \\ \frac{F_{\mu 12} - F_{\mu 11}}{\Pi_{\mu 11}} + \frac{F_{\mu 12} - F_{\mu 22}}{\Pi \Pi_{\mu 12}} &= -K_{FU_a} U_a \\ \frac{F_{\mu 21} - F_{\mu 11}}{\Pi \Pi_{\mu 11}} + \frac{F_{\mu 21} - F_{\mu 22}}{\Pi_{\mu 21}} &= K_{IF_B} I_B \\ \frac{F_{\mu 22} - F_{\mu 21}}{\Pi_{\mu 21}} + \frac{F_{\mu 22} - F_{\mu 32}}{\Pi \Pi_{\mu 22}} &= -K_{FU_b} U_b \\ \frac{F_{\mu 31} - F_{\mu 21}}{\Pi \Pi_{\mu 21}} + \frac{F_{\mu 31} - F_{\mu 32}}{\Pi_{\mu 31}} &= K_{IF_C} I_C \\ \frac{F_{\mu 32} - F_{\mu 31}}{\Pi_{\mu 31}} + \frac{F_{\mu 32} - F_{\mu 22}}{\Pi \Pi_{\mu 22}} &= -K_{FU_c} U_c \end{aligned}$$

in the form of a system of equations

$$\begin{aligned} \left(\frac{1}{\Pi_{\mu 11}} + \frac{1}{\Pi \Pi_{\mu 11}} \right) F_{\mu 11} - \frac{1}{\Pi_{\mu 11}} F_{\mu 12} - \frac{1}{\Pi \Pi_{\mu 11}} F_{\mu 21} &= K_{IF_A} \cdot I_A \\ -\frac{1}{\Pi_{\mu 11}} F_{\mu 11} + \left(\frac{1}{\Pi_{\mu 11}} + \frac{1}{\Pi \Pi_{\mu 12}} \right) F_{\mu 12} - \frac{1}{\Pi \Pi_{\mu 12}} F_{\mu 22} &= -K_{FU_a} U_a \\ -\frac{1}{\Pi \Pi_{\mu 11}} F_{\mu 11} + \left(\frac{1}{\Pi \Pi_{\mu 11}} + \frac{1}{\Pi_{\mu 21}} \right) F_{\mu 21} - \frac{1}{\Pi_{\mu 21}} F_{\mu 22} &= K_{IF_B} \cdot I_B \\ -\frac{1}{\Pi_{\mu 21}} F_{\mu 21} + \left(\frac{1}{\Pi_{\mu 21}} + \frac{1}{\Pi \Pi_{\mu 22}} \right) F_{\mu 22} - \frac{1}{\Pi \Pi_{\mu 22}} F_{\mu 32} &= -K_{FU_b} U_b \\ -\frac{1}{\Pi \Pi_{\mu 21}} F_{\mu 21} + \left(\frac{1}{\Pi \Pi_{\mu 21}} + \frac{1}{\Pi_{\mu 31}} \right) F_{\mu 31} - \frac{1}{\Pi_{\mu 31}} F_{\mu 32} &= K_{IF_C} \cdot I_C \\ -\frac{1}{\Pi_{\mu 31}} F_{\mu 31} + \left(\frac{1}{\Pi_{\mu 31}} + \frac{1}{\Pi \Pi_{\mu 22}} \right) F_{\mu 32} - \frac{1}{\Pi_{\mu 22}} F_{\mu 22} &= -K_{FU_c} U_c \end{aligned}$$



where:

$$\begin{aligned}
 A_{11} &= \frac{1}{\Pi_{\mu 11}} + \frac{1}{\Pi 1_{\mu 11}}; A_{12} = -\frac{1}{\Pi_{\mu 11}}; A_{13} = -\frac{1}{\Pi 1_{\mu 11}}; A_{14} = A_{15} = A_{16} = 0; \\
 A_{21} &= -\frac{1}{\Pi_{\mu 11}}; A_{22} = \frac{1}{\Pi_{\mu 11}} + \frac{1}{\Pi 1_{\mu 12}}; A_{23} = 0; A_{24} = -\frac{1}{\Pi 1_{\mu 12}}; A_{25} = A_{26} = 0; \\
 A_{31} &= -\frac{1}{\Pi 1_{\mu 11}}; A_{32} = 0; A_{34} = -\frac{1}{\Pi 1_{\mu 21}}; A_{35} = A_{36} = 0; \\
 A_{41} &= A_{42} = 0; A_{43} = -\frac{1}{\Pi_{\mu 21}}; A_{44} = \frac{1}{\Pi_{\mu 21}} + \frac{1}{\Pi 1_{\mu 22}}; A_{45} = 0; A_{46} = -\frac{1}{\Pi 1_{\mu 22}}; \\
 A_{51} &= A_{52} = 0; A_{53} = -\frac{1}{\Pi 1_{\mu 21}}; A_{54} = 0; A_{55} = \frac{1}{\Pi_{\mu 31}} + \frac{1}{\Pi 1_{\mu 21}}; \\
 A_{61} &= A_{62} = A_{63} = 0; A_{64} = -\frac{1}{\Pi_{\mu 22}}; A_{65} = -\frac{1}{\Pi_{\mu 32}}; A_{66} = \frac{1}{\Pi_{\mu 32}} + \frac{1}{\Pi 1_{\mu 22}}; \\
 \Pi_{\mu 11} \div \Pi_{\mu 31} &= \Pi 1_{\mu 11} \div \Pi 1_{\mu 33} = \frac{l_{\mu i}}{\mu_i S_i}
 \end{aligned}$$

l_{μ} - the length of the path i - that sections of the magnetic flux, m;

μ_i or μ_{0i} - magnetic permeability of i - that part;

S - section sections m^2 , i - that sections of the conversion chain.

Limitations are defined as follows:

$$\begin{aligned}
 B_1 &= K_{IF_A} \cdot \overset{\square}{I}_A; B_2 = -K_{FU_a} \cdot \overset{\square}{U}_a; B_3 = K_{IF_B} \cdot \overset{\square}{I}_B; B_4 = -K_{FU_b} \cdot \overset{\square}{U}_b; B_5 = K_{IF_C} \cdot \overset{\square}{I}_C; \\
 B_4 &= -K_{FU_c} \cdot \overset{\square}{U}_c.
 \end{aligned}$$

or in matrix form

$$\begin{bmatrix}
 A_{11} & A_{12} & A_{13} & A_{14} & A_{15} & A_{16} \\
 A_{21} & A_{22} & A_{23} & A_{24} & A_{25} & A_{26} \\
 A_{31} & A_{32} & A_{33} & A_{34} & A_{35} & A_{36} \\
 A_{41} & A_{42} & A_{43} & A_{44} & A_{45} & A_{46} \\
 A_{51} & A_{52} & A_{53} & A_{54} & A_{55} & A_{56} \\
 A_{61} & A_{62} & A_{63} & A_{64} & A_{65} & A_{66}
 \end{bmatrix}
 \begin{bmatrix}
 F_{\mu 11} \\
 F_{\mu 12} \\
 F_{\mu 21} \\
 F_{\mu 22} \\
 F_{\mu 31} \\
 F_{\mu 32}
 \end{bmatrix}
 =
 \begin{bmatrix}
 B_1 \\
 B_2 \\
 B_3 \\
 B_4 \\
 B_5 \\
 B_6
 \end{bmatrix}.$$



The results of the study of the electromagnetic conversion sections of the primary current converter are presented in Fig. 2. a and b).

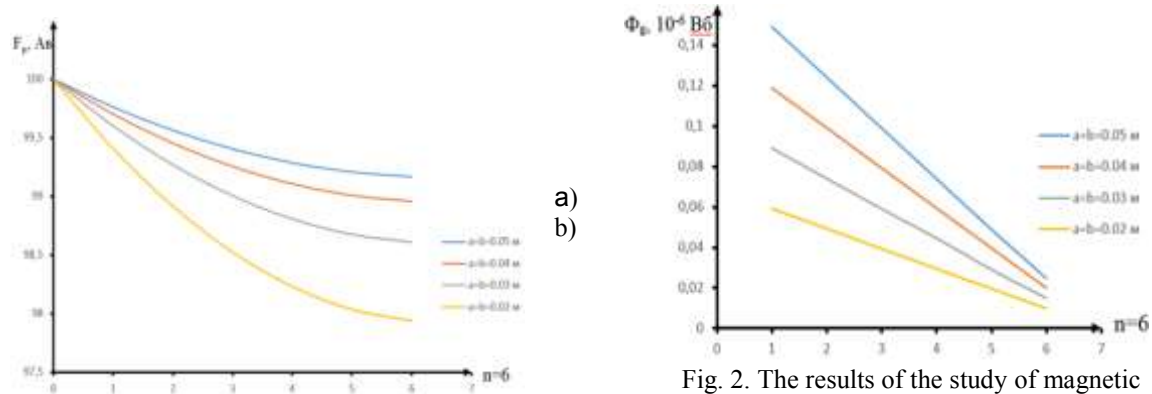


Fig. 2. The results of the study of magnetic conversion sections:

a - change in p.m. from the number of sections of the partition - n,
b - change in magnetic flux from the number of sections of the partition - n.

The graph model for studying the magnitude of the electromagnetic transformation of the primary current and voltage transducers for monitoring and controlling the values of the power supply system allows us to analyze the rationality of the choice of both the geometric dimensions of the conversion sections (Fig. 2, dimensions $a = b = 0.01-0.04$), and the number sections of the partition n - allowing to increase the accuracy of calculation and research of sections of the conversion of the primary current of electric energy of power supply systems, is clear and highly formal zivania when forming dependencies representing the main characteristics of a general form. The unified value of the output signal in the form of electric voltage depends on the rationalized shapes and parameters of the magnetic circuit sections (air gap, where the sensing element is installed - a flat measuring coil), which ensure the perpendicularity and uniformity of the intersection of the area of the sensitive element with the magnetic flux created by the primary currents of the electric network of the power supply system.

REFERENCES

1. Siddikov I.Kh. *The Electromagnetic Transducers of Asymmetry of Three-phases Electrical Currents to Voltage*. Universal Journal of Electrical and Electronic Engineering. Horizon Research Publishing Corporation USA. 2015, Vol.3, N5, -p.146–148. <http://www.hrpub.org>.
2. Siddikov I.Kh., Khakimov M.Kh., Anarbaev M., Bedritskiy I.M. *Research of the electromagnetic transducers of the primary current to secondary voltage // Science and Education. Materials of the II International Research and practice conference. Vol. I, Publishing office of «Vela Verlag Waldkraiburg», Munich, Germany, December, 18-19, 2012. – p.p. 222-225. <http://www.ew-a.org>.*
3. Siddikov I., Sattarov Kh., Khujamatov H. *Modeling and research of circuits of intelligent sensors and measurement systems with distributed parameters and values// International scientific and technical journal Chemical technology control and management, Tashkent, 2018 - №4-5 P. 50-54.*
4. Siddikov I., Sattarov Kh., Khujamatov H. *Modeling of the Transformation Elements of Power Sources Control// 2017 International Conference on Information Science and Communications Technologies (ICISCT), November, 2017, Tashkent, Session 5. <https://www.tuit.uz/en/post/ilmiyanjuman>*
5. Azimov R.K., Choriev A.A., Himmatkulov Sh.A., Saidakbarov O.Kh. *Information - probabilistic methods for estimating the errors of sensors of various sizes // STANDART. – Tashkent: 2010. - No. 3. - S. 29-31.*
6. Amirov S.F., Safarov A.M., Khushbokov B.Kh. *Current Converters for Secondary Electric Power Systems // Current Status and Prospects for the Development of Energy. Thes. doc. Int. scientific and technical conf. December 18 - 20, 2006. -- Tashkent, 2006. -- S. 206-208.*
7. Amirov S.F., Khushbokov B.Kh., Balgaev N.E. *Multiband current transformers // Electrical Engineering. - M.: 2009. - No. 2. - S. 61-64.*
8. Zaripov M.F., Zaynullin N.R., Petrova I.Yu. *Graph method of scientific and technical creativity. - M.: VNIPI SCST, 1988. -- 124 p.*
9. Lukashkin V.G., Garipov V.K., Sleptsov V.V., Vishnekov A.V. *Automation of measurements, control and management. - M.: Mechanical Engineering, 2005. – 663 p.*



10. Patent of the Republic of Uzbekistan. No. 04185. Three-phase current asymmetry converter to voltage / Amirov S.F., Azimov R.K., Siddikov I.Kh., Khakimov M.Kh., Khushbokov B.Kh., Sattarov Kh.A. // Rasmus achborotnoma. - 2010. - No. 6.
11. Patent of the Republic of Uzbekistan. No. 04475. Current to voltage converter / Amirov SF, Azimov RK, Siddikov I.Kh., Khakimov M.Kh., Khushbokov B.Kh., Nazarov FD, Rustamov D. // Rasmiy achborotnoma. - 2012. No. 2.
12. International standard EN-50160, "Instrument transformers – Part 1: Current transformers".
13. Schaumburg H. Werkstoffe und Bauelemente der Elektrotechnik. Sensoren. Stuttgart: B.G. Teubner, 1992.– 517 p.
14. Dominic M., Yiannos M. CMOS Circuits for Electromagnetic Vibration Transducers: Interfaces for Ultra-Low Voltage Energy Harvesting, 2015. – 300p. <https://www.springer.com>.
15. Reza J. Electromagnetic Acoustic Transducer Analysis, LAP LAMBERT Academic Publishing (October 26, 2011), 164p. <https://www.springer.com>.
16. John G. Webster, Halit Eren. Measurement, Instrumentation, and Sensors Handbook: Two-Volume Set 2nd Edition, 2014. – 3559p. <https://www.springer.com>.
17. Bessonov L.A. Theoretical foundations of electrical engineering. Electrical circuits. - M.: Gardariki, 2006. -- 701 p.
18. Demirchyan K.S., Neumann L.R., Korovkin N.V., Chechurin V.L. Theoretical foundations of electrical engineering: In 3 t. Textbook for universities. Ed. 4th - St. Petersburg: Peter, 2006. -- 576 p.
19. Zaripov M.F., Petrova I.Yu. The subject-oriented environment for the search for new technical solutions "Intellect" // IV St. Petersburg International Conf. "RI-95": Thesis. doc. - St. Petersburg, 1995. -- S. 60-61.
20. Bronstein I.N., Semendyaev K.A. Math reference for engineers and students of technical colleges. Ed. 13th, corrected. - Moscow: science, 1986. - 544 p.