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Modeling Of Calculation Of Voltage Unbalance Factor Using Simulink (Matlab)

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ABSTRACT

This paper presents the problem of power quality in asymmetric modes in low-voltage electrical networks. The modeling of determination of power value, voltages and currents and, accordingly, their symmetric components, using the Simulink package in the MatLab program is shown.

KEYWORDS

Power quality, asymmetric modes, method of symmetrical components.

INTRODUCTION

Power quality - compliance of power parameters with the set values. The parameter of electrical energy is a quantity that quantitatively characterizes any property of electricity. The parameters of electrical energy are voltage, frequency, shape of the electric current curve. The power quality is the basis for electromagnetic compatibility, which characterizes the electromagnetic environment.

A decrease in the power quality leads to significant changes in the operating modes of electrical receivers and as a result of a decrease in the productivity of the components of the working mechanisms, a decrease in product quality, a decrease in the service life of electrical equipment, and an increase in the probability of accidents.

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In the Republic of Uzbekistan, the norms for the quality of electricity in electrical networks of power supply systems of alternating three-phase and single-phase current with a frequency of 50 Hz at the points to which electrical networks or electrical installations of consumers are connected are established by GOST 13109-97 "Electrical energy. Electromagnetic compatibility of technical means. Power quality standards in general-purpose power supply systems "[1].

THEORETICAL PART

Unbalance of currents is one of the factors increasing losses in networks and elements of electrical energy distribution. The economic damage resulting from the effect of unbalanced currents and voltages is caused by deterioration in energy performance and reduced service life of electrical equipment, a general decrease in the reliability of the operation of electrical networks, an increase in active power losses and consumption of active and reactive power [2].

Asymmetric values of phase voltages lead to the fact that additional power losses appear in electrical networks. In this case, the service life of asynchronous motors is significantly reduced due to additional thermal heating of the rotor and stator, due to the fact that the negative sequence current is superimposed on the positive sequence current. In this case, it is advisable to choose motors with a higher rated power than the required one [2].

The asymmetry of phase voltages in alternating current (AC) electric machines is equivalent to the appearance of magnetic fields, the magnetic induction vectors of which rotate in the opposite direction with a doubled synchronous frequency, which can disrupt technological processes.

If the mains voltage is unbalanced through which the synchronous motors are supplied, hazardous vibrations can additionally occur. With a significant asymmetry of the phase voltage, vibrations can be so significant that there is a danger of destruction of the foundations on which the motors are installed, and damage to welded joints.

The unbalance of the phase voltages has a noticeable effect on the operation of power transformers, causing a reduction in their service life.

An analysis of the operation of three-phase power transformers showed that at a rated load and a current unbalance ratio of 10%, the transformer insulation service life is reduced by 16% [3].

Voltage and current unbalance in a three-phase system is one of the most important indicators of power quality. The reason for the appearance of asymmetry of voltage and currents is various asymmetric modes of loads of the power supply system. Short-term unbalanced modes are usually associated with various emergency processes, for example, asymmetrical short-circuit, open circuit of one or two line wires with a ground fault, disconnection of one phase during single-phase automatic reclosing, etc. Long-term asymmetric modes are usually caused by the presence of unbalance in the elements of electrical networks (longitudinal unbalance) or when unbalanced (one-, two-, three-phase) loads are connected to power supply systems (transverse unbalance) [4, 5].

The phase-to-phase voltage asymmetry is caused by the presence of negative sequence components, and phase asymmetry is also caused by the presence of zero sequence components.

Voltage unbalance is characterized by the following indicators [5]:

- The coefficient of voltage unbalance in the reverse sequence;
- Coefficient of voltage unbalance in zero sequence.

Normally permissible and maximum permissible values of the voltage unbalance coefficient in the reverse sequence at the points of common connection to electric networks are 2.0 and 4.0%, respectively [1, 4, 5,6].

Negative sequence voltage unbalance factor K_{2U} [1, 4, 5]:

$$K_{2U} = \frac{U_{2(1)}}{U_1} \cdot 100\% \,, \qquad (1)$$

where U_2 (1) is the effective value of the negative sequence voltage of the fundamental frequency of the three-phase voltage system; U_1 – positive sequence voltage.
Zero-sequence voltage unbalance coefficient K_{0U} [1, 4, 5,7]:

$$K_{0U} = \frac{U_{0(1)}}{U_1} \cdot 100\% \,, \qquad (2)$$

where U_0 (1) is the effective value of the zero sequence voltage of the fundamental frequency of the three-phase voltage system; U_1 – positive sequence voltage.

INVESTIGITION

In this study, a virtual model of the power supply circuit was created in the MatLab program (Fig. 1). The model is based on ready-made standard Simulink blocks required to determine the values of powers, voltages and currents and, accordingly, their symmetrical components.

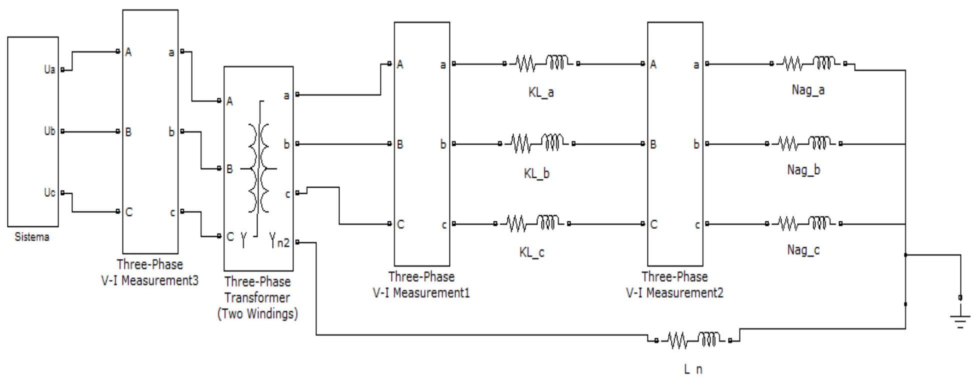

Fig. 1. Simulation model of the power supply system in Matlab (Simulink)

In fig. 2, as an example, a schematic diagram of the subsystem model is shown the parameters of the low side, which determines the voltage and current levels at the point relative to the beginning of the line, realizing the calculation of the parameters of the quality indicators of electrical energy, the values of active and reactive powers, the power factor and the levels of symmetrical components of voltage and current.

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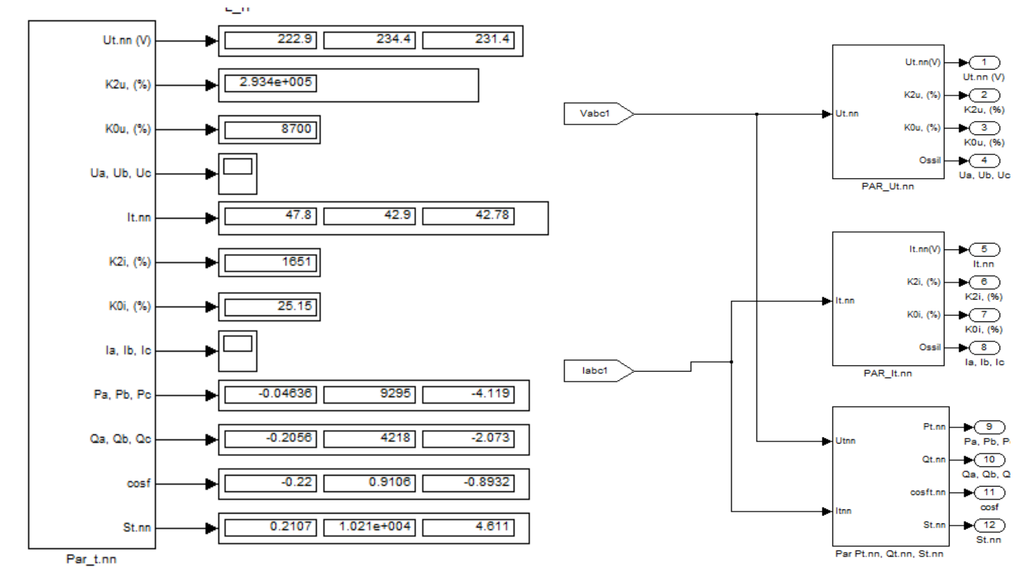

a) b)

Fig. 2. Block diagram of the model a) parameters on the low voltage side,
b) subsystems
c)

To calculate the voltage unbalance coefficients in accordance with (1) and (2), a model was formed from the blocks shown in Fig. 3, which receives the values of the symmetrical voltage components using the 3-Phase Sequence Analyzer.

The generated model allows for each of the phases to carry out at any point of measurement of the following quantities: voltages (U) and currents (I), active (P), reactive (Q) and apparent powers (S), power factors (cosφ), symmetric voltage components (U_1, U_2, U_o) and currents (I_1, I_2, I_o), unbalance coefficients of voltages and currents in reverse (K_{2U}, K_{2I}) and zero sequences (K_{oU}, K_{oI}).

CONCLUSION

In addition, the model is suitable for studying and researching long-term asymmetric operating modes of a network section of a real power supply system, based on data obtained as a result of measuring the quality indicators of electrical energy. In this case, the simulation of long unbalanced operation is carried out using the Controlled Voltage Source ABC and Controlled Current Source ABC components. In these modules, using an algorithm based on blocks of controlled voltage sources and controlled current sources for simulation, real load graphs are set, obtained during experimental measurements of the main energy indicators of the current power supply system.

REFERENCES

1. GOST 13109-97 "Electrical energy. Electromagnetic compatibility of technical means. Power quality standards in general-purpose power supply systems" (in Russian).
2. Kholiddinov I.Kh., Ponomarenko O.I. Influence of asymmetric modes on the amount of power losses in electrical networks of distribution power supply systems. // Energetik, 2015. - No. 12. - P. 6-8.1. (in Russian).
3. Kholiddinov I. Kh. Electric power quality analysis 6-10/0.4 kV distribution networks. Journal Energy and Power Engineering

(EPE) 2016 y. USA. (in English). www.scirp.org/journal/epe

4. Kholiddinov I.Kh., Musinova G.F., Kholiddinova M.M. Reactive power management to improve power quality. // ACADEMICIA. An international multidisciplinary research journal, 2020. – P. 161-167. (in English).
5. Kholiddinov I.Kh., Ponomarenko O.I. Providing the instrumental base of the power quality control system in modern power supply systems. // Universum: Engineering: electron. scientific. zhurn. 2016. No. 8 (29). (in Russian). URL: http: //7universum.com/ru/tech/archive/item/3527
6. Chernykh I.V. Modeling of electrical devices in MatLab, SimPowerSystems and Simulink / I.V. Black. - M .: DMK Press; SPb .: Peter, 2008.- 288 p. (in Russian).
7. Ded A.V. Simulation modeling in Matlab of long-term asymmetric modes of power supply systems / A.V. Grandfather, S.V. Biryukov, A.V. Parshukova // Omsk Scientific Bulletin. - 2015. - No. 3 (143). - S. 248-251. (in Russian).