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TOSHKENT DAVLAT TRANSPORT UNIVERSITETI
Tashkent state transport university

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Research on the reactive power consumption of an asynchronous motor powered by energy generated by solar panels

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Abstract: In order to meet the world's demand for high-quality and uninterrupted electricity, there is increasing reliance on renewable energy sources, including solar energy sources, which play a special role in this regard. In this regard, based on the climatic conditions of our country and in order to ensure the implementation of the Resolution No. PF-158 No. 52 of the Strategy of Action of the President of our country for 2023-2030 on uninterrupted energy supply of the economy and industrial sectors, introduction of technologies No. 57, further improvement of the green energy system No. 65, and the location of all regions and cities of our republic in industrial production sectors at the regional level, based on the Resolution No. PQ-222 of July 14, 2024, on measures to reduce electricity consumption by 10%, the results of a study in the Matlab simulation program of the constituent quantities of electricity and harmonic currents generated by solar panels installed in our country are presented.

Keywords: electric current generated by solar panels, inverter, asynchronous motor, symmetrical and non-symmetrical current characteristics, reactive power, steady and stable operating modes

1. Introduction

In the climatic conditions of our republic, more than three hundred days of sunlight shines, based on this opportunity, a number of studies are being conducted on satisfying the need for electricity with the electricity generated by solar panels and studying the quality indicators of the electricity generated. The largest consumer of electricity in industrial production is asynchronous motors, and a number of research works are being conducted to further improve the control and management system for the amount of reactive power consumed by asynchronous motors and reduce energy consumption. In these studies, one of the main tasks is to provide quality signals for the control and management of the amount and angle indicators of the reactive power of electricity consumed by asynchronous motors. Modeling and researching the signal generation processes used in the control and management systems for the reactive power of electricity generated by solar panels based on comprehensive algorithms is an important issue in energy and resource conservation. The control and management of the symmetric and non-sinusoidal magnitudes of the reactive power of alternating current electricity generated by solar panels requires the use of advanced measurement systems, in this process the development and implementation of new types of primary signal converters is relevant. To measure the amount of electric energy, the balance of active and reactive power of asynchronous motors supplied with electric energy generated by solar panels, current transformers are widely used today.

2. Research methodology

The principle of operation of current transformers, like other transformers, a current transformer consists of a magnetic core, a primary winding and a secondary winding, which are signal converters. This transformer is mainly an instrument transformer, in which the current values from the secondary winding of the core are produced in the range from 1A to 5A [2; 6-b]. Current transformers measure and control the amount of current flowing through the inductive wire wound around the magnetic core, and when the magnetic core reaches a certain value, the ability to sense the amount of electrical energy decreases, and as a result, the indicator shows the same amount. This represents an uncertainty in the full calculation of the amount of electrical energy coming out of the inverter device.

Current transformers are connected in series to the measuring device circuit, and the primary W1 is connected to the device being measured. The connection of the secondary W2 winding to the measuring protection device I1 and I2 is shown in Figure 1.

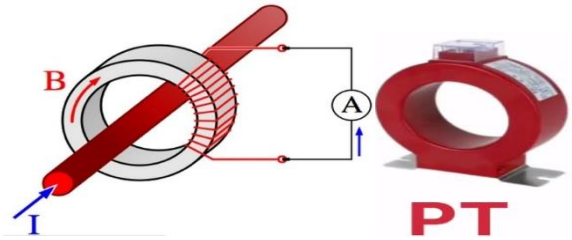

Fig. 1. Current transformers:
they are connected in series to the measuring device circuit
W1 primary is connected to the measured device W2
secondary winding is connected to the measuring
protection device I1 and I2

Short-term accidents and long-term unsymmetrical modes can occur in single- and three-phase consumers supplied with energy generated by solar panels. Short-term and unsymmetrical modes are mainly associated with various emergency processes, including short-circuiting of solar power lines with ground, which occurs when they are continuous. They are most common in lighting equipment, small-power motors, heaters, single-phase welding

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equipment. The presence of unsymmetrical currents creates negative and zero sequences. These currents, in turn, lead to deviations of the voltage in the elements of the solar power network from the permissible values. The electromagnetic current transformer is considered to be reliable, accurate, and compact in its form. The asymmetry of the electric current is much greater than the asymmetry of the voltage.

This, in turn, leads to the heating of the solar electric conductors and the jerking operation of the consumer, the asynchronous motor. It is the non-sinusoidal current indicators that affect the quality indicators of electric energy that occur when elements of various characteristics, inductive, capacitive, semiconductor and other types of elements are connected to a network that is not connected to each other. Figure 2 shows the non-sinusoidal indicators of the voltage signal received from the electromagnetic current transformer when the asynchronous motor is connected to the network using a capacitor bank to start the asynchronous motor powered by the energy generated by the solar panels.

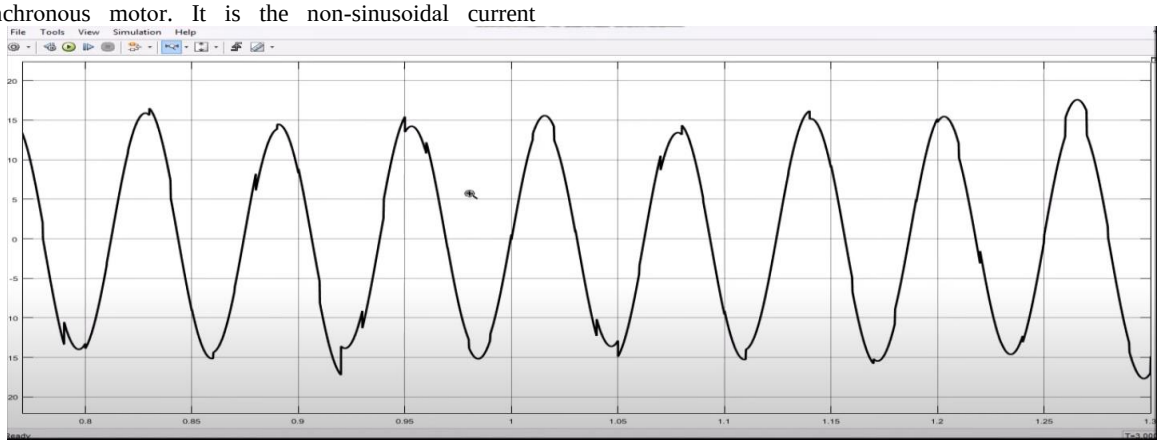

Fig. 2. The output signal of the electromagnetic converter when the asynchronous motor is connected to the network with a capacitor bank

These influencing factors certainly have a negative impact on the solar panels and the inverter, as a result, the reactive power loss of the asynchronous motor increases, the operating time is shortened, and the useful working coefficient decreases sharply. In solving these problems, we consider that when the asynchronous motor is connected to the network through a phase-shifting inductive coil, starting and working capacitor bank, the voltage signals are sinusoidal. Figure 3 shows the principle diagram of the proposed converter.

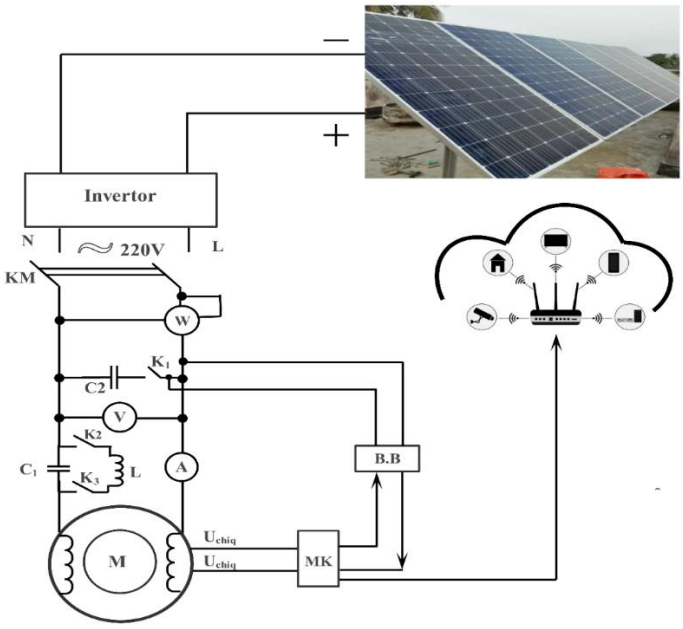

Fig. 3. Single-phase solar-powered asynchronous motor: single-phase solar-powered asynchronous motor

M - asynchronous motor, C1,2 - capacitor bank, L - inductive element, W - wattmeter, KM - magnetic starter, K1,K2,K3 - switch, A1 - ammeter, BB - control unit, Uchiq - output voltage of the current transformer, MK - microcontroller

When studying the dynamic characteristics of the proposed electromagnetic current transformer, it was found that the voltage signal of the current transformer device, obtained according to the scheme shown in Figure 3 above, is sinusoidal and symmetrical. The results of this study and the assembled scheme obtained in the Matlab simulnik package are presented in Figure 4.

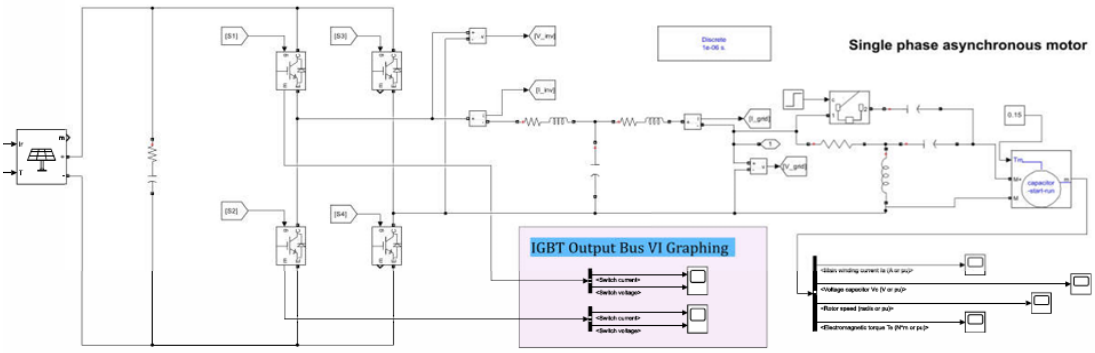

Fig. 4. The scheme of the electromagnetic current converter of an asynchronous motor powered by solar panels is presented in the Matlab package

The result of the study of the dynamic characteristics obtained according to the scheme assembled in order to ensure that the asynchronous motor is designed to be highly efficient and operates according to the data given in the passport indicators is presented in Figure 5.

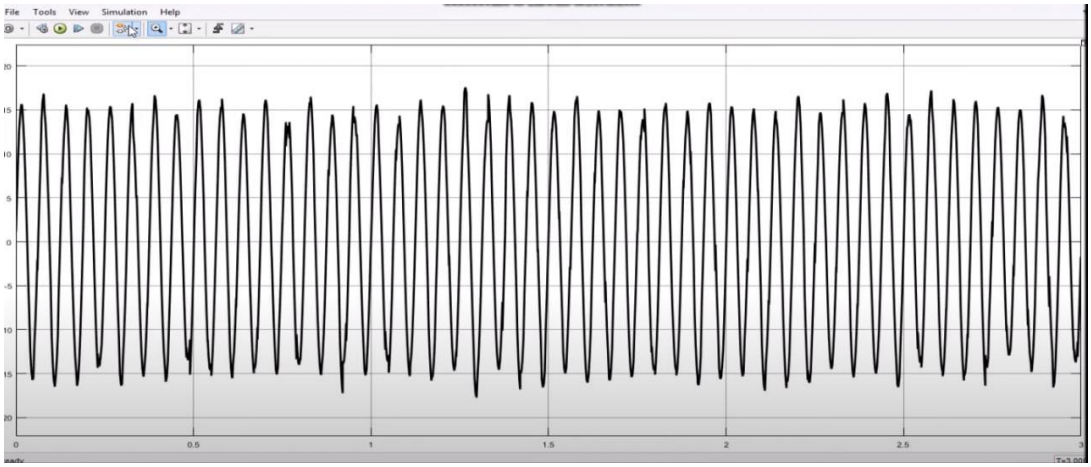

Fig. 5. The dynamic characteristics of the asynchronous motor electromagnetic converter device

In order to improve the control and management system of the reactive power consumption of the asynchronous motor under study, the dynamic characteristics of the asynchronous motor electromagnetic converter device are presented in Figure 5.

3. Conclusion

Based on the above descriptions and images, it can be concluded that by improving the control and management system of the reactive power consumption of asynchronous motors supplied with energy generated by solar panels, an asynchronous motor can extend the efficiency and service life of the asynchronous motor, prevent the burning of the inventory and solar panels, which are solar energy supply devices, and increase their economic performance.

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