



Accuracy Of The Results Of Scientific Research On An Autonomous Voltage Inverter

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This article examines the reliability of scientific research results on improving the energy characteristics and efficiency of a stand-alone inverter. The study also analyzes the correlation between the reliability of these results and variations in the inverter's input voltage range.

Keywords:

Inverter, IGBT transistor, efficiency improvement, instantaneous, amplitude, effective values, output parameters, electrical energy, and electrical converters.

Introduction

Energy efficiency and energy saving as a priority areas of development of science, engineering and technology in the inclusion of the energy strategy of Uzbekistan for the period up to 2030 emphasizes the importance of this area for the modernization and technological development of the economy of Uzbekistan, increasing its competitiveness. Modern processes of production, transmission and consumption of electricity, without which it is impossible to carry out a modern economy, require its multiple transformations, for which powerful semiconductor autonomous inverters are used, the efficiency and reliability of which depend on the efficiency and reliability of all consumers of electricity. The most important stage of inverter design is the selection of the topology and modulation method that provides the best technical and economic performance for the designed device. The presence of selection criteria and procedures at this stage reduces the likelihood of errors and shortens the design time of the semiconductor device. Thus, the task of ensuring the validity of design solutions and the formation of selection criteria is relevant.

Currently, the field of power electronics has accumulated a large amount of materials on the development of new and improvement of existing circuit solutions in order to increase the efficiency of autonomous voltage inverters. However, the issue of comparing fundamentally different schemes and modulation algorithms remains open.

In turn, with the help of an autonomous inverter based on modern semiconductor devices, it converts the DC voltage into the required AC voltage and synchronizes it with the AC network in the state of connecting to the AC network. Currently, SFU is widely used in the creation of power plants in remote areas of Uzbekistan, in conditions of limited values of generated power, including in spacecraft (KA), as well as as an additional source of energy. Thus, from a scientific, theoretical, and practical point of view, there is a need to study the current issues of developing methods and means of converting electrical energy in order to improve the efficiency of power plants. Based on this, it is very important to develop new functional circuits for high-efficiency autonomous inverters for electrical converters and to justify

their parameters using engineering calculations. This is the basis for the purpose and objectives of this scientific research.

Research methodology

Experimental research of scientific research was carried out in laboratory conditions and on a solar panel. Laboratory tests of the inverter in various modes of operation were carried out and output voltage oscillograms were obtained (Fig. 1).

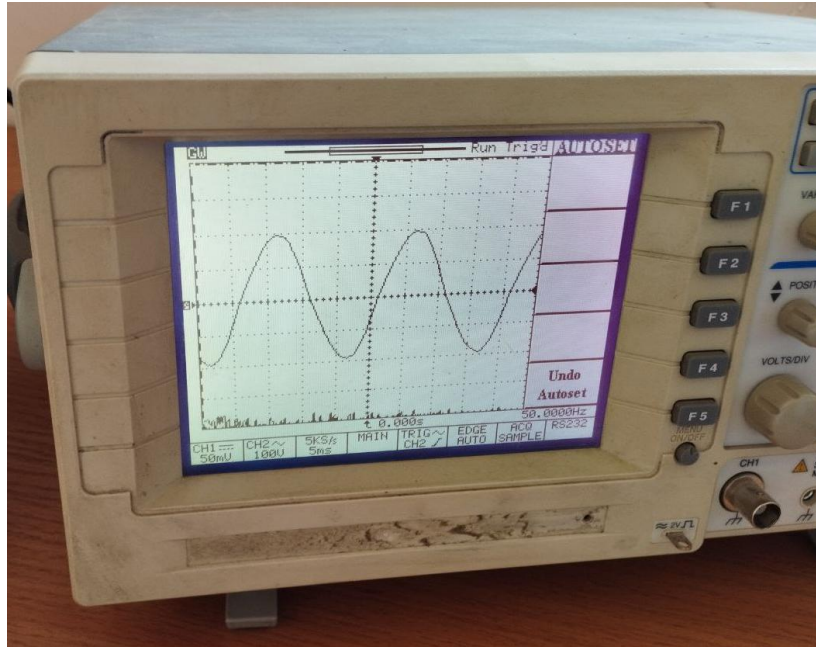


Fig.1. Oscillogram of the inverter output voltage

According to the results of the oscillogram, it is established that the sinusoidal shape affects the amplitude only at high powers without change.

It is established that when the output frequency of the inverter is changed to the minimum and maximum load, the frequency stability changes to $\pm 1.2\%$ (Fig. 2).



Fig.2. Load characteristic of the inverter

When the input voltages of the inverter were changed to 12, 24, 36, and 48 V, the output voltages corresponding to these voltages were determined. The output voltage was tested in a laboratory setting and on solar panels. Based on the results of the laboratory tests, it was found that the input and output voltage limits increased by $\pm 20\%$ according to the load. If the input voltage changed from a maximum of 14.4 V to a minimum of 9.6 V, with a nominal value of 12 V, the inverter's operating time increased. With a nominal output voltage limit of 220 V, the maximum voltage was 264 V and the minimum voltage was 176 V [1-2].

Results and analyses

To analyse the results obtained, the readings of the off-grid inverter were performed on the solar panel. Since the operation of the solar panel depends on the intensity of the sun, therefore the output voltage fluctuates. In addition, on cloudy and rainy days, there is a sharp decrease in voltage. Therefore, it is necessary to determine and analyse the output parameters of the off-grid inverter corresponding to the voltage change, since the voltage regulation of the off-grid inverter output is required. For this, the output voltage depends on the limit of the input voltage change.

The results and characteristics obtained at the inverter output corresponded to the results and characteristics calculated based on theoretical and experimental values. The feasibility of this requirement can be assessed using the average values of the partial correspondence between the characteristics obtained through computer modeling and those obtained through experimental studies. Computer modeling offers an optimal solution for addressing the limitations in theoretical and analytical calculations.

According to the results of the studies conducted in the inverter circuits, the instantaneous, amplitude, and effective values were compared with the transformer parameters obtained from computer simulations, as the output parameters were variable. The comparison criteria included the effective values of the voltage and current of the load, U_H and I_H , as well as the duration of the transient process, τ [3-7].

As a result of the change in the workflow during the experiment, the effective load capacity was selected. To do this, based on the analysis of possible operating modes of the physical model, comparative confidence intervals were determined in the load capacity ranges of 0, $0.5P_N$, and P_N . The reliability of the obtained results is assessed as follows.

The number of measurements of physical parameters in determining the reliability was 10 times for each value. The confidence interval was determined based on the Student's t-test.

$$\Delta Y = \pm t(\beta, k) \frac{S^*}{\sqrt{k}}, \tag{1}$$

where, $k=n-1$; n is the number of repeated measurements; $t(\beta, k)$ is the Student's t-test; S^* is the approximate value of the standard deviations, which is determined by the following expression

$$S^* = \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - y)^2} \tag{2}$$

The main data for the statistical processing of the results is presented in Table 1, where Δ is the deviation of the research result parameters from the average value.

Results of experimental studies and computer modeling
Table 1

P	U			I			t_{III}		
	Average value, V		$\Delta, \%$	Average value, A		$\Delta, \%$	Average value, MS		$\Delta, \%$
	ЭТ	КМ		ЭТ	КМ		ЭТ	КМ	
0	224	219	-2,2	21,6	21,1	-2,2	1,2	0,12	-5,4
$0,5 P_H$	213	222	+4,08	21,1	20,8	-1,09	1,4	1,2	-1

P_H	206	218	+5,4	20,3	21,2	+4,09	1,35	1,39	+0,2
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Comparison of the results of computer modeling and physical models showed that the reliable intervals (difference $\pm 5.4\%$) and average values (difference from -5.4 to +5.4%) coincide.

The coincidence of the results of experimental research and computer modeling confirms the reliability of the theoretical conclusions obtained from the autonomous inverter implemented on its basis, since the method of describing the scheme of replacing the computer and inverter remains the same [8-11].

Conclusions

To analyze the results of theoretical studies, work was carried out to test the working process of a solar panel, a DC power supply, a battery, a multimeter, a digital oscilloscope, an asynchronous motor, and a standalone inverter under various types of loads. With a transformer loss of 15%, it was possible to obtain an output power of more than 3 kW.

The study was conducted using two methods in a laboratory setting and on a solar panel, and the results were analyzed. A sinusoidal voltage was obtained at the output of the standalone inverter. It has been established that when the inverter's output frequency is changed to the minimum and maximum loads, the frequency stability changes to $\pm 1.2\%$.

According to the results of studies conducted in laboratory conditions, it was found that the limit of change in input and output voltages increased by $\pm 20\%$ according to the load.

According to the results of studies conducted on stand-alone inverter circuits, the instantaneous, amplitude, and effective values were compared with the transformer parameters obtained from computer modeling, as the output parameters were variable. A comparison of the results of computer modeling and physical models showed that the reliable intervals (difference of $\pm 5.4\%$) and average values (difference of -5.4 to +5.4%) are consistent.

The coincidence of the results of the experimental study and computer modeling confirms the reliability of the theoretical conclusions obtained from the autonomous inverter based on it, since the method of

describing the computer and inverter replacement scheme remains the same.

In this research work, the technical and economic indicators of the inverter device developed for solar panels and a number of other areas have been determined. The cost of a 3 kW inverter manufactured abroad is currently \$450. The cost of a 3 kW inverter manufactured as part of a research project with accessories is 1,173,000 soums.

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