INTRODUCTION

Frequency converters, which perform AC to DC and then DC to AC with desired parameters electric energy conversion, become nowadays a typical component of any modern electromechanical system with AC electric motor. While AC to DC conversion of energy can be completed by uncontrolled switching devices, DC to AC inversion requires implementation of controllable devices. For the most electric drive applications, IGBT semiconductor switches are being used due to their ability to conduct large currents with the smallest losses and to be commutated at high frequency rates. However, due to IGBTs resemblance to BJT device, tailing current effect occurs. This mean that after being closed by command signal, switch remains in conducting state for some period of time. Inverter part has, considering common topologies, two switches connected in series to DC voltage source. If both switches are able to conduct on the same time interval, occurrence of short circuit and all its negative consequences is unavoidable. Therefore, some preventive timespan – dead time – need to be placed between command signal.

Thesis actuality. Dead time insertion in command sequence causes a bunch of aftermaths: inverter output voltage magnitude is being decreased, set of harmonics is being intruded in reference voltage signal, energy flow from source to load is being disrupted. When distorted voltage is being applied to motor, stator current decreases and higher harmonics occur in similar fashion to the voltage signal. The latter leads to mechanical torque and rotation speed fluctuations and, in extreme cases, to system instability.

The aforementioned effects can be attenuated by numerous compensation algorithms. They may rely on current feedback data, voltage feedback data, observer information of plant state or can be created by modification of reference action. Despite an issue of numerous articles about dead time compensation, the problem remains unresolved due to its overall complexity and nonlinearity of dead time effect. Necessity of electric drives performance improvement makes dead time compensation problem to be of great importance and relevance.

Thesis relation with science programs, topics and plans. The thesis is based on the research made on department of Automation of electromechanical systems and the electrical drives in the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".

Research goals and tasks. The thesis *goal* is to increase static and dynamic performance of asynchronous motor based electromechanical systems by means of utilization of effective inverter dead time compensation algorithms. *Tasks* of the thesis are following:

1. Analysis of dead-time effect on voltage source inverters controlled using space vector PWM algorithm.
2. Development of valid model of inverter considering dead-time effect.
3. Systematization of knowledge about dead-time effect compensation approaches.
4. Implementation and investigations of dead time compensation strategies.
5. Development of software for pulse width modulation with implemented compensation algorithms on microcontroller.
6. Study of compensation method effectiveness in voltage-frequency and field-oriented vector control systems.

Research object. DC-AC electric energy conversion processes in voltage-source inverters with consideration of dead time.

Research subjects. Dead-time effect compensation strategies for voltage source inverters controlled by space vector PWM.

Research methods. Method of mathematical modelling using Matlab Simulink package. Method of experimental testing using microcontroller unit.

Scientific novelty of obtained results.

1. Simulation program of averaged voltage source inverter with space vector PWM considering dead time and other nonlinearities of electronic switches is developed.

2. It is concluded that compensation methods which are based on model representation of dead time effect, provide better voltage and current magnitude compensation, dead time caused harmonics attenuation in V/f controlled systems and reduction of voltage and current ripple in field-oriented vector controlled systems.

Practical application of obtained results. Designed toolset for studying of negative dead-time effect in the most typical electromechanical systems will be useful for scholars to predict behavior of PWM controlled inverters by mathematical modelling, as well as by experimental testing. Presented research of dead time compensation methods effectiveness unveils the most their significant advantages and drawbacks. Hence, the research may facilitate further compensation algorithm modification or invention process.

Scientific publications. During the work on master thesis two articles publications were done in frames of scientific conferences:

1. A. Otroshko, V. Pyzhov, “Review of dead time compensation methods in voltage-source inverters”, International conference for young scientists and students “Current problems of electroenergetics and automatics”, Faculty of electric power engineering and automatics, Kyiv, 2019 (in Ukrainian).

2. Andrii Otroshko, Serhii Kovbasa, “Modelling of dead-time effect in voltage source inverters”, The Ukrainian internet-conference “Young people in science: research, problems, perspectives”, Vinnytsia National Technical University, 2020 (in Ukrainian).