Automated test bench for researching the characteristics of an AC motor based on the altivar variable-frequency drive

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Abstract. The article is devoted to the development of an automated test bench for studying the characteristics of an alternating current motor based on the Altivar variable-frequency drive, which allows automatic or manual recording of various characteristics of an asynchronous motor. A block diagram of the test bench and its technical structure are presented, algorithms for the functioning of the software are developed.

1. Introduction
Currently, due to increased requirements for production efficiency, industrial enterprises tend to replace adjustable DC electric drives with adjustable drives based on squirrel-cage induction motors. Moreover, in the near future, with the inevitable increase in energy prices, the number of installed frequency converters, and, accordingly, asynchronous motors will only grow from year to year [1, 2].

Asynchronous drive is actively conquering the market, so now it is extremely important to educate students and improve the skills of engineering personnel. In addition, the current Federal state educational standards of both higher and secondary vocational education are aimed at the fact that the training of specialists of secondary vocational education, as well as bachelors, should for the most part be aimed at acquiring practical skills, that is, conducting practical and laboratory work, which requires modern laboratory facilities [3, 4].

A modern laboratory test bench should allow the study of an asynchronous squirrel-cage electric motor, in particular, the following characteristics should be investigated:

- natural mechanical and electromechanical characteristics.
- energy diagrams.

Carry out an open-loop study of the VDF - asynchronous motor (VFD – AM) and take:
- mechanical characteristics;
- adjusting characteristics;
- energy diagrams;

Carry out a study of the closed-loop system VFD – AM:
- with setting the speed control loop;
- with the study of a closed system;
- take energy diagrams.

In addition, the following additional signaling devices must be present at the test bench:
- switching on the QF1 — test bench ON;
- switching on the contactor KM1 — VFD ON;
- switching on the ET6 load converter;
• emergency stop of the operation (shutdown of ET6 DC drive or VFD).

2. Results and discussion
For these purposes and taking into account previously defined requirements, a stand was designed at the Department of Electrical Engineering, Electric Drive and Industrial Electronics to replace the existing laboratory installation of a frequency-controlled electric drive VFD-AM in the discipline “Electric Drive” for laboratory work on the discipline “Electric Drive” in the areas of training “Electric Drive and Automation” and “Electronics and Nanoelectronics”. The proposed laboratory test bench allows you to manually or automatically record the characteristics of an induction motor.

Figure 1 shows a block diagram of an automated laboratory test bench.

![Block diagram of an automated laboratory test bench.](image)

The test bench includes:
• Programmable Fastwel CPC10701 controller with a control panel (OP), an LCD display (LCD) and a power supply (PW);
• Asynchronous AC motor (M1);
• DC load motor (M2);
• Variable-frequency drive Altivar 5 (VFD) [5];
• Thyristor converter ET-6 (ET6) [6];
• The power part, including an automatic switch (Q1), a control contactor (KM1), a transformer of a DC drive (TV1), as well as current sensors (RS1, RS2, RS3) and voltage in the circuits of the tested and load motors.
• Personal computer — a student's workplace (PC) with software installed on it.

Based on the presented functional diagram, the technical structure of the stand hardware was developed, with the possibility of conducting an automated experiment, shown in figure 2. This structure shows the technical connections between the devices included in the data acquisition and control system and external systems.
Software was developed for an automated data collection system of the stand. The software was created on the principle of modularity, which implies that each independent function is a separate
module that has its own input and output parameters and operates independently of other modules based only on the values of the input parameters [7].

To obtain the normalized execution time of the program cycle, and guaranteed metrological characteristics of the system, the program is divided into two parts: the called and the calling. The calling part works with the data collection equipment, and all the basic functions of the system that require metrological regulation are met, and the functions of working with the user and information processing are located in the called part. The algorithm of the main program with a timer binding is shown in figure 3, and the algorithm of the subroutine for working with signals and generating control actions is shown in figure 4.

On the basis of the presented stand, it is planned to conduct laboratory work on the following topics:

- Experiment “Study of the mechanical and electromechanical characteristics of an asynchronous motor with a phase rotor” – a study of the main characteristics of an asynchronous motor.
- Experiment “Study of the main characteristics of a frequency-controlled asynchronous electric drive” – a study of the main characteristics of an asynchronous motor with frequency regulation.

![Figure 3. Timer-bound main program algorithm.](image-url)
3. Conclusion
A laboratory test bench is proposed that allows, in an automated or manual mode, to take various characteristics of asynchronous motors. The proposed approach to the construction of a laboratory bench and its electric drive control system allows you to speed up the process of developing such systems.

References
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