Realization of station for testing asynchronous three-phase motors

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Abstract. Nowadays, you cannot imagine the construction and operation of machines without the use of electric motors [13-15]. The proposed position is designed to allow testing of asynchronous three-phase motors. The position consists of a tested engine and the engine running as a load, both engines combined with a mechanical clutch [2]. The value of the load is recorded by measuring shaft created with Strain Gauge Bridge. This concept will allow to study the basic parameters of the engines, visualization motor parameters both vector and scalar controlled, during varying load drive system. In addition, registration during the variable physical parameters of the working electric motor, controlled by a frequency converter or controlled by a contactor will be possible. Position is designed as a teaching and research position to characterize the engines. It will be also possible selection of inverter parameters.

1. Introduction
At first rarely used control systems electric motors. Seen mainly composed of integrated motors and mechanical systems, such as gears or the pump. Most systems have been star-delta or special design to allow parameter changes. Technological developments have made it impossible to use them well, they were used only for systems often associated with atypical type of work. These solutions were expensive and uneconomical.

With the development of semiconductor technology and microprocessor electronic systems were first used to control electric motors. The development of automation required a stable control of various systems parameters, such as speed, torque and acceleration. Formed different control electric motors. Currently, the most popular, are frequency converters. They allow you to control many parameters of the drive system. This facilitated the use of simple in construction and vital phase asynchronous motors, which were previously omitted in applications where required to adjust the parameters of the system. Currently, the most can be observed systems, which include asynchronous induction motor and frequency converter.

2. Measuring station
The project to design a test bench for testing drives controlled by frequency converters. The position should have a security system in the form of fuses redundantly current, key safety and mechanical shields prevent physical contact with rotating elements position.
The measuring system was built on the Arduino platform and software designed for it. The system is based on communication with peripherals I2C, and SPI OneWire. The basic measuring systems are analog to digital converters that convert voltage 0-5 [V] into a digital value. The next step is the temperature measurement using digital sensors Maxim / Dallas Semiconductor DS18B20. Then measuring the rotational speed by means of a Hall sensor A3144. The data are displayed on the LCD display 20x4 with I2C communication module. Control of the system is possible by joystick X / Y. In addition, the system sends the recorded data UART interface to a PC and save on your microSD card via SPI bus. Microcontroller communication with external devices, require network interfaces consistent with the standard of the manufacturer used systems. They allow the reduction of the number and minimizing the number of input/output ports of the microcontroller. Depending on the application and needs have been used of said bus network.
Current and voltage is performed by transformers. For voltages are transformers 230 [V] / 6 [V] voltage dividers 1:10. This enables the recording of peak values up to 350 [V]. The zero point signal was set to 2.5 [V] using a voltage divider 1:1.

The initial noise reduction is carried out by electrolytic capacitors 1 [uF]. Increasing the capacitor values negatively affects the characteristics of the signal under test. This is due to low power consumption by the analog to digital converters.

Large values of inrush currents require the use of current transformers, where the primary winding is the power cord. The increase in current value of the secondary winding is proportional to the current flowing through the lines drive system. The maximum current flowing through the circuit is 10 [A], which corresponds to 10 [mA] flowing through the resistor 220 [Ω]. The voltage generated across the resistor is sampled by the analog-to-digital circuit. As in the case of voltage measurement, the zero point is set as the voltage of 2.5 [V] was applied and an electrolytic capacitor 22 [uF] to pre-filter the
signal. Wires analog signals are grounded screen. Also included is a screen that separates the part of
the measurement from the rest of the measurement system.

Figure 4. Scheme of measurement voltages.

Interference occurring in the system, need to minimize the distance between the elements. Wires
responsible for the communication and analog signals dismissed from power supply and measurement
part [11,12,16]. A thorough analysis of powertrains requires the registration of motor parameters
during the time-varying loads and speeds. Control of frequency converters allow two MOSFETs
IRF520, controlled by the PWM signal from the microcontroller. Mounted terminals enable the
connection of temperature sensors DB18B20, speed sensor and LCD display 20x4.

Figure 5. Scheme of the current measurement.
An additional device is a system with correct the supply voltage filter CLC. The individual data are displayed as tabs. Subsequent screens provide information about transferring data to a PC or record to SD card. Changing the parameters of the load and speed is available for each screen, regardless of the job microcontroller. The measuring system uses a microcontroller ATmega32u4, programming the Arduino IDE 1.6.7. Installation is done by the programmer AVRISP MKII. Device programming is facilitated by the possibility of using ready-made libraries containing formulated orders and commands. The system required a change in the parameters of libraries, such as baud rate and delay ADS1115 converters. Increased operating frequency of 100kHz I2C bus to 400kHz, which significantly improved the speed of communication. In turn reduced the waiting time for analog measurements of 8ms to 1ms. Initially obtained measurements every 70ms, the change reduced the time to 7MS.

**Figure 6.** The block diagram displaying the recorded data.

MATLAB R2010a software enables interference filtering analog signals, calculating the parameters of the system and present the results. Simulink environment of the module, allows you to build a measurement system that processes all data at the same time.

**Figure 7.** One of the displayed tabs.
The contents of data packets:

- **Data1.txt**
  - temperature T1, T2, T3, T4

- **Data2.txt**
  - of operating time in milliseconds
  - a step of speed the value of the ADC ADS1115

- **Data3.txt**
  - operating time in milliseconds a step of speed
  - the value of the AC / DC converter ADC of the microcontroller

### 3. Conclusions

Designing a measuring station for phase asynchronous motors requires a combination of different fields of engineering [3, 5-9]. Starting with the construction project, together with a strength analysis, the programming of the microcomputer, which allows measurement of the drive system with variable operating parameters. The project required a combination of several methods of measuring one integral diagnostic system [1, 4, 10]. The experimental demonstration of the effect of variable load on the drive systems lets you explore the characteristics of induction motors. An important element is the understanding of the microcontroller, it allows the generation of an optimal program code for the controller.

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