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РАЗРАБОТКА ПРИБОРА ДЛЯ ТЕСТИРОВАНИЯ ДАТЧИКОВ ТОКА

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Аннотация

В данной статье представлена специально разработанная система для проверки датчиков тока в тяговых преобразователях, включающая в себя преобразователь с высокой точностью передачи сигнала. Такая технология не только решает одну из основных проблем проверки датчиков тока, но также представляет уникальный инструмент на рынке, которого ранее не было.

Ключевые слова: тяговые преобразователи, датчики измерения тока, автоматизация, векторное управление, напряжение, мощность, плата управления.

DEVELOPMENT OF A DEVICE FOR TESTING CURRENT SENSORS

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ABSTRACT

This paper presents a specially developed system for testing current sensors in traction converters, which includes a transducer with high signal transmission accuracy. This technology not only solves one of the main problems of current sensor verification, but also presents a unique tool on the market that has not been available before.

Keywords: traction converters, current measurement sensors, automation, vector control, voltage, power, control board.

Currently, frequency-controlled or vector-controlled converters are used in electrical equipment, which have been operated for decades. However, the components that make up the converters undergo aging and require repair. Therefore, it is necessary to extend the service life of traction converters and minimize repair costs in modern conditions.

In connection with the requirements for extending the service life of electrical equipment and minimizing the cost of repairs, early detection of malfunctions in elements and parts of converters becomes critically important. Often, the problem arises with the malfunction of current sensors, which can distort or disappear in modes close to maximum currents [1]. In case of a malfunction of one sensor, it is necessary to find and replace it, but in the case of the mutual influence of sensors, for example, when controlling AC motors, a faulty sensor can lead to the distortion of all output signals of the converter, requiring the replacement of all three sensors. Thus, to carry out fast repairs and avoid additional costs, regular checks and timely replacement of faulty sensors are necessary [2].

To solve similar problems, it is necessary to create a system that is able to compare the current flowing through the sensor with the specified value. In case of a mismatch, the operator should manually measure the current and amplitude using, for example, a two-channel oscilloscope. However, the automatic mode will allow this operation to be performed faster and more conveniently. To automate the process, a control board with a microcontroller is required, which will determine the actual current and measure the option issued by the sensor. The measurement results should be provided to the user in the form of values and the definition of "good/bad" [3].

These are the approximate characteristics of the sensor. The frequency of converters from different manufacturers is 20-40 kHz. The higher the frequency, the smaller the mass-dimensional indicators of reactive components, but the higher the requirements for the control unit, especially for the microcontroller. We will limit ourselves to the recommended lower frequency limit of the converter operation. The output voltage of our device will be 16 V [4]. This voltage is selected based on devices that operate on a similar principle, such as welding inverters. It should be minimal to reduce the power of the entire system but not too low to ignite the electric arc. In our case, ignition of the electric arc is not required, but the voltage should not be very low to guarantee the desired current and avoid problems with switching nodes. Therefore, we will choose the maximum voltage - 16 V.

To connect the test sensor, the output of the power unit is used, which converts the 380 V three-phase AC voltage into the required output current. Control actions on the power transistors are formed by the control board based on the measured values of the output current and other sensors, ensuring reliable operation [2]. The power supply board is used to power the test sensor and control board. The operator interface is a control panel that contains the main control elements: buttons for adjusting the output current and starting, as well as two indicators for displaying the set and obtained values of the current from the sensor and a two-color LED that changes color depending on the assessment of the result.

When searching for and eliminating malfunctions, regardless of what property the sensor measures, it is necessary to understand what output signal should be for a given value of the measured property. For example, let's consider a circuit in which a current sensor is installed. First, an ammeter should be applied to determine the current level flowing through the load [5]. Then, we can calculate the expected output signal of the sensor. Suppose that as the current increases to 50 A, the converter generates a 10 V DC output signal. We can divide the output signal value (10 V) by the range 10/50, which is equal to 1/5. Therefore, for every 5 A of current flowing, a 1 V output signal is accepted. Taking this into account, 25 A will cause a 5 V DC output voltage. A similar method is used when the converter has a "live-zero" output, but the output signal should be taken into account when there is no current (or voltage, or other measurable parameter) [4]. This process is known as signal offset. For any analog signal produced by a converter or sensor, the device receiving the output data (e.g. data acquisition system, panel display, PLC, etc.) must be configured to correctly interpret the output data value. For example, if the signal converter has a 4-20 mA range of 16 mA, the ratio will be 0.32 mA/A, taking into account the above range of 0-50. When the load current changes to 37.50 A, the converter output signal will change by 12 mA. When adding a signal offset, the sensor output should be equal to 16 mA (12 mA + 4 mA), which allows equipment malfunctions to be diagnosed without distorting the signals in the sensors.

This prototype can also be used to test multiple sensors simultaneously, making it more versatile. This is achieved by using multiple ADC channels in the control microcontroller.

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