Design of Monitoring System for Operation Parameters of Hoisting Motor in Coal Mine

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Abstract: In order to improve the safety and reliability of coal mine hoist motor, the design method of mine hoist motor operation parameter monitoring system is proposed. Based on the analysis of coal mine safety production situation, this paper combines power electronics technology with microprocessor control to design coal mine hoisting motor, and designs voltage monitoring unit, current monitoring unit and temperature protection unit in detail.

1. Introduction

Coal is the main body of China's energy structure. Although hydropower, solar energy, wind energy and nuclear energy are developing continuously, coal's main dynamic position in China's energy structure will not be shaken due to the limitation of China's energy structure with more coal, less oil and less whistle. Under the comprehensive influence of scientific and technological progress, the development of comprehensive mechanized mining technology, the attention of national policies and other factors, the safety production forms of coal mines in China have improved year by year, and the total number of accidents and the mortality rate of one million tons have decreased year by year. However, the hidden dangers of coal mine safety production still exist, and coal mine safety production is still the hot spot of safety work in the future.

Coal mine hoisting system is the main component of coal production, which is mainly used to transport coal mine production equipment and personnel, and its performance is directly related to coal mine production efficiency. In traditional mine hoisting, mine flameproof electromagnetic starter is used to control the hoisting motor. The electromagnetic starting equipment is designed according to the requirements of national standards and industry standards, and regular maintenance and fault maintenance are generally adopted. Its automation and intelligence level is low, which can not meet the needs of modern mine development. In recent years, with the continuous development of power electronics technology, intelligent control theory and condition monitoring technology, the automation and intelligence level of mine equipment has been continuously improved. The condition monitoring of mine hoist motor operation parameters can detect the main parameters of motor operation in real time, and can give early warning and alarm before the motor fails, thus ensuring the safety of transportation system. Hoisting motor coal mine is shown in Figure 1.

Figure 1 Hoisting motor coal mine

2. Monitoring system design

The monitoring system of coal mine hoist motor operation parameters takes PIC single chip microcomputer as the core, which is mainly composed of PIC single chip microcomputer, voltage monitoring unit, current monitoring unit, temperature protection unit, communication unit, display unit, alarm unit and instruction input unit. The structure of the monitoring system is shown in Figure 2. PIC MCU is used to receive the control signal of the command input unit, to calculate the voltage, current and temperature signal of the output signal of the monitoring unit, and compare it with the safety value, and to give state warning or alarm when the lifting motor is abnormal. The voltage monitoring unit, current monitoring unit and temperature protection unit are used to test the voltage, current and temperature parameters of the lifting motor and conduct signal conversion. The communication unit is used to feed back the running state parameters of the hoist motor to the central monitoring system.

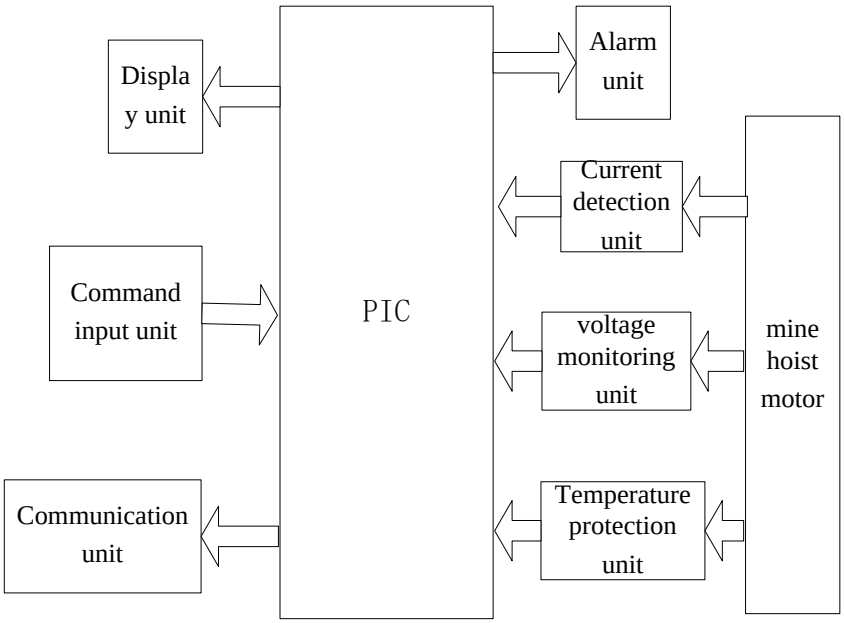

Figure 2 The overall structure of the monitoring system

2.1 Voltage monitoring unit

The voltage feedback circuit is designed based on the 380V coal mine hoist motor. The processor calculates the deviation between the feedback value and the demand value, and then dynamically adjusts the output voltage to ensure the accuracy of the test voltage. As the tested voltage is rated at 380V, the voltage signal cannot be obtained directly from the port. The voltage signal that the processor AD can receive is designed to be divided by a high-power resistor. In order

to ensure the stability of the circuit, a voltage follower with high input impedance is added in the circuit to obtain the voltage signal. The voltage feedback circuit is shown in Figure 3. The role of C5 in the figure is to filter out impurities in the signal, stabilize the input voltage of the circuit, and reduce signal drift. Usually, high-frequency non-inductive capacitors are selected. Resistors R5 and R6 play the role of voltage dividing. The voltage measured by the voltage feedback circuit is equal to the voltage across the resistor R6, and its voltage value is R6/R5+R6 of the total voltage. Zener diode D5 and capacitor C6 play a protective role to prevent the input level of the op amp from being higher than its supply voltage.

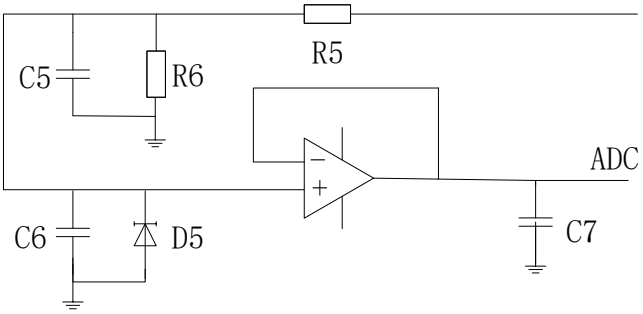

Figure 3 Voltage feedback circuit

2.2 Current monitoring unit

Coal mine hoist motor has overload capability, but different overload currents allow different working hours, so the system should have stable and reliable current detection circuit. In order to reduce the interference of main circuit to current signal and improve the accuracy of current detection, a current sensor based on Hall effect is selected to collect bus current. CS600E2 current sensor has a rated input current of 600A on the primary side, the measurement current range of the primary side is 0～±1000A, the response time is less than or equal to 5μs, the working power supply is ±12V, and the sensor output voltage range is 0-4V. The sensor output signal is isolated and the voltage composed of LM324 follows its processing and is sent to the AD conversion pin of the processor. The circuit detection circuit principle diagram is shown in Figure 4.

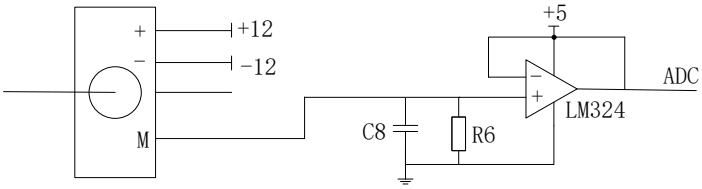

Figure 4 Current detection circuit

2.3 Temperature protection unit

The temperature test of the casing and rotor surface of coal mine hoist motor is an important performance index to check the running state of the motor. The temperature test is of great significance to the analysis of internal faults and temperature field of the motor. In recent years, the infrared temperature measurement technology has been developing continuously. The infrared temperature measurement technology uses the pyroelectric effect to transform thermal signals into electrical signals. It has the advantages of sensitive response, wide temperature measurement range, and no direct contact with the measured objects. It also has certain applications in the field of motor temperature measurement. OS136-V1 temperature sensor is selected in the test system, and the sensor outputs 0-5V DC voltage signal, with spectral response distance of 5-14 microns and response time of 150 milliseconds. Working process of temperature control circuit of coal mine hoist motor: the temperature protection circuit starts to work after the power supply is powered on. When the temperature value is higher than the set value, the resistance value of the thermistor becomes larger. At this time, the terminal voltage at the noninverting input of the operational amplifier M is higher than 0V, and the signal is amplified and output to N, which makes the

terminal voltage at the noninverting input of the operational amplifier higher than the inverting terminal. The operational amplifier outputs a voltage of +5V to drive the FET to conduct, and the thermoelectric cooler starts to work to reduce the system temperature. When the temperature reaches normal temperature, the FET is turned off and the thermoelectric cooler stops working. At the same time, the system is provided with a temperature acquisition circuit, and the processor calculates and processes the signal of the high-precision temperature sensor and sends it to the display screen for real-time display of the system temperature.

3. Conclusion

Coal mine hoisting motor is one of the main transportation equipments in China's coal mines, and its safety is directly related to the smooth development of coal mine safety production. The monitoring system designed in this paper has the characteristics of stable output, safety and reliability, and provides reference for the development of intelligent motor in coal mine.

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