Design of Coal Mine Power Grid Parameter Monitoring System Based on CAN Bus

Yunlong Ma1, 2,*
1CCTEG Shenyang Research Institute, Fushun Liaoning 113122
2State Key Laboratory of Coal Mine Safety Technology, Fushun Liaoning 113122
*Corresponding author: 707544231@foxmail.com

Abstract. In order to ensure the safe production of coal mine enterprises, a real-time power grid parameter monitoring system is proposed by using modern computer and communication technology, so as to ensure the necessary power supply safety for the safe production of coal mines. Based on the analysis of coal mine safety production form and underground special operation environment, this paper introduces can communication technology and ECAN module in detail, designs the overall structure of coal mine power grid parameter monitoring system based on CAN bus, DSP minimum system, can interface circuit and software flow.

Keywords: Coal mine, Grid parameters, CAN, observation system.

1. Introduction

With the rapid growth of China's economy, the dependence on energy is getting higher and higher. As the main body of China's energy structure, coal mines play an important role in the development of national economy. The overall situation of coal mine safety production in China continues to improve, and the number of safety production accidents and deaths per million tons gradually decreases. However, with the increase of mining depth and intensity, the mining working environment becomes more and more complex, which puts forward higher and higher requirements for the safety of coal mine power grid.

Coal mine safety production accidents are mainly caused by gas explosion when combustible gas meets sparks. The underground mining environment is complex, and the surrounding air contains a lot of flammable and explosive gases. When the gas concentration reaches a certain proportion, a slight spark can also cause gas explosion. Overload, short circuit and poor contact of mine electrical equipment may bring hidden dangers to safety production, and the safety of coal mine power grid has become an important factor restricting the smooth development of underground safety production. Therefore, it is of great theoretical and practical significance to use modern computer and communication technology to study the monitoring technology of coal mine power grid parameters for improving power grid safety, reducing safety production accidents and ensuring the smooth progress of coal mine safety production.
2. Fieldbus technology

2.1. CAN bus
Fieldbus technology is one of the hot topics in the field of automation, which provides powerful technical support for real-time and reliable communication between nodes of distributed control system. CAN is the abbreviation of Control Area Network, which is a serial communication bus that can support distributed control or real-time communication. In recent years, with its simple structure, high reliability, strong flexibility and good error detection ability, CAN bus is widely used in automotive system communication, electrical equipment detection and power grid monitoring and other technical fields.

CAN bus adopts multi-master serial communication protocol, which can effectively support distributed real-time control, and the communication rate can reach up to 1Mb/s. The data frame of CAN bus consists of several bytes (up to 8 bytes), which improves the response time of the bus to new data frames. When the CAN bus transmits data, each message has its own identifier to identify the nodes of different messages on the bus and ensure that messages with higher priority are transmitted without delay when a bus conflict occurs.

2.2. eCAN module
The CAN controller of the eC28x processor provides a complete CAN protocol for the CPU, which reduces the CPU overhead during communication. Figure 1 shows the structure of the eCAN module. The internal structure of the eCAN controller is 32 bits, mainly composed of the CAN protocol core (CPK) and the message controller. After the CAN protocol core receives a valid message, the receiving control unit of the message controller determines whether to store the received message in the mailbox memory. The receiving control unit checks the message status, identifier and filtering of all message objects, determines the position of the corresponding mailbox, and stores the received message in the first mailbox after receiving filtering.

![Figure 1. eCAN module structure.](image)

3. Monitoring system
The parameter monitoring system of coal mine power grid is designed according to the topology mechanism of CAN bus, and the structure of monitoring system is shown in Figure 2. Modularization is adopted in the system design, and the lower computer data acquisition module and CAN bus
communication module are designed respectively. The data acquisition module of the lower computer includes an information feedback unit, a signal processing unit and a DSP minimum system, wherein the information feedback unit is composed of sensors and related circuits, and provides the most original data of each variable of the coal mine power grid for the system. The signal processing unit is composed of signal filtering and conversion circuits, which can extract signals and convert signals output by sensors into signals that can be received by DSP. The DSP minimum system is composed of DSP chips and related peripheral circuits, and realizes the functions of signal operation and transmission. The CAN bus communication module is composed of CAN physical bus, matching resistor and CAN communication interface, which realizes the data communication between the lower computer data acquisition module and the computer.

![Figure 2. Coal mine power grid parameter monitoring system structure.](image)

**3.1. DSP minimum system**

The DSP minimum system is the core of the entire coal mine power grid parameter monitoring system, and its response speed and accuracy are directly related to the sensitivity of the monitoring system, the accuracy of data processing and transmission. In order to ensure the sensitivity of the monitoring system and improve the safety performance, this article chooses the latest digital signal processor TMS320LF28335 as the core processor of the smallest DSP system. The main difference between TMS320LF2833x series processors and TMS320LF281x series processors is the addition of a floating-point processing unit. In addition to the 32-bit fixed-point architecture, it also contains a single-precision (32-bit) IEEE754 floating-point processing unit, which enables it to efficiently process programs written in C/C++, making it easier and more convenient to compile and monitor system programs.

The DSP minimum system is mainly composed of a clock module, a JTAG interface module, an externally expanded memory module, a power supply module, a reset circuit and an external crystal oscillator, as shown in Figure 3. All units of the digital circuit system rely on clock signals as synchronization. The clock frequency determines the number of operations per second of the system. The clock module provides clock signals for the monitoring system. The JTAG interface is a program entry for online programming of the DSP. Expanding memory to improve the storage capacity of DSP. The power supply module provides DSP with dual-channel working voltages of 3.3V and 1.8V, and the current of each channel is not more than 1A. The reset circuit ensures the normal start of the
system, and re-runs the program when the system fails, so as to prevent the system from running away and not working normally. The external crystal oscillator provides a suitable oscillation frequency for the monitoring system, and the selection of crystal oscillator cannot exceed the main frequency of DSP processor.

![Figure 3. DSP minimum system composition.](image)

### 3.2. Communication interface circuit between DSP and CAN

The CAN module inside DSP is a fully functional CAN controller, which includes the functions of transmitting data information processing, receiving management and frame storage, and supports standard frame and extended frame formats. The enhanced eCAN communication module is integrated in TMS320F2335, so the design of CAN communication interface circuit is very simple. CTM8251T is selected as the interface chip between CAN controller and physical bus. Transmit/receive signals CANtx and CANRX of CAN controller of DSP are connected to can physical bus via transceiver CTM8251T with isolation function. CTM8251T has the functions of increasing the communication distance of the system, improving instant anti-interference ability, and reducing radio frequency interference. It is an ideal choice for CAN communication interface chip. A 120Ω resistor is connected to the end of the bus to match the impedance of the transmission line and improve the anti-interference ability of the bus. The hardware connection of the CAN bus and TMS320F28335 is shown in Figure 4.

![Figure 4. Circuit of CAN bus interface.](image)

### 4. Software design of monitoring system

Hardware circuit is the core of monitoring system, and software program is the soul of monitoring system. The software program of coal mine power grid parameter monitoring system mainly includes data acquisition program, CAN bus program, etc., as long as it can calculate, transmit, display and store the data collected by hardware. It is convenient to modify and debug the program online by choosing the programming mode of combining C language and assembly language. The main program of the data acquisition system software firstly initializes the register and clock of DSP, then sets the event manager and digital-to-analog conversion module. Finally, it collects the output signal of the sensor, processes the data, and sends the data to the upper computer through CAN bus. The main program flow of the data acquisition system is shown in Figure 5.
5. Conclusion
By analyzing the current situation of coal mine safety production and CAN bus technology, a coal mine power grid parameter monitoring system based on CAN bus is designed, and the hardware circuit and software program of the system are designed respectively. The system has the characteristics of high sensitivity, good real-time performance and strong stability, which provides guarantee for the safe operation of coal mine power grid.

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