Design of monitoring system for electric vehicle charging station based on LabVIEW and STM32

Qian Liu1*, XiaoJin Yan1, LiPeng Zhang1

1 School of electronic and control engineering, North China Institute of Aerospace Engineering, LangFang, HeBei, 065000, China
*Corresponding author’s e-mail: aisling@nciae.edu.cn

Abstract. Charging-station provides power supply for electric vehicles, which is a necessary and important energy supporting infrastructure for development and large scale commercialization operation of electric. For the current charging-station management is overly dependent on high-cost devices such as industrial computer, this paper develops a charger field test device, which adopts STM32 as the data exchange interface between the host computer and charger. The charge data is sent to PC through STM32, and the monitoring system development is designed by LABVIEW. This method optimizes the decoding of message content, overcomes the defect of over reliance on high cost components, and strengthens the ability of bottom message collection, enhances the system intelligence. The communication is fast, reliable and has a good man-machine interface.

1. Introduction

As a green vehicle, electric vehicles have great advantages and application prospects in coping with the greenhouse effect caused by urban carbon dioxide emissions and changing the energy structure. First, charging stations have become the necessary infrastructure, and their monitoring system is the core of the automation system of charging stations[1]. Second, the data among automobile, enterprise power grids and charging pile are not shared, which brings great inconvenience for power company to maintain the charging pile. In order to ensure the stable and efficient operation of the power grid system, it is necessary to establish a perfect charging monitoring system. In order to ensure the stable and efficient operation of the power grid system, a perfect charging monitoring system is needed to built. This system can monitor, analyze and evaluate the charging power consumption of a charging center at any time, which is convenient for operators to check the charging status and maintenance of each testing station[2]. A complete monitoring center for charging stations can store a large amount of information and provide powerful data support for later fault diagnosis and power grid decision-making [3-6].

The traditional field test of a charger is overly depend on high-cost components such as industrial computer in the decoding and conversion of message content, and the common charging-station adopts CAN bus, while the industrial computer does not have CAN port. STM32 microprocessor has many technical advantages such as small size, light weight, CAN port etc[7]. Therefore, based on STM32 microcontroller, this paper analyzes and transmits CAN message, send the data of each charging station to the upper computer through STM32, and uses LabVIEW software to develop the monitoring interface to complete the monitoring of multiple charging piles.
2. Integrated System Design
Since the PC is large in size and doesn’t have CAN interface, while the computer in the monitoring system has more powerful functions such as data processing and management interaction, this paper adopts STM32 microprocessor as the interface conversion equipment between the CAN port of the charging pile and the upper computer. Each charging pile is equipped with a microprocessor board card. When multiple chargers work at the same time, the main MCU will issue instructions to poll and monitor charging information. The structure diagram of the monitoring system is shown in Figure 1.

![Figure 1 Schematic diagram of monitoring system of EV charging-station.](image)

When a charging pile starts to work, charging information can be quickly detected from STM32. If multiple piles work at the same time, the master MCU will send command, and the follow MCU will send charging information orderly according to the command. In order to prevent data channel congestion, only the current and latest information is sent each time, and the information not sent will be automatically filter out.

This paper mainly completed the lower machine data acquisition work and PC monitoring software development. The monitoring position is shown in figure 1, only collect charge interaction information, and send to upper machine through the RS485 serial port. Hardware device interface of ST32 is rich, and can be developed according to the engineering requirements. The hardware is small in size, low in cost, and easy to maintain.

3. Hardware development of monitoring system

3.1. Hardware equipment
On the basis of the research on charging station monitoring system, this paper proposes to build a miniaturized charging monitoring system, which uses single-chip micro-computer to transmit vehicle messages. The transmission modes include RS232/485 communication, RJ45 network port and 4G communication etc, which can meet the needs of different projects. RS485 communication module is used in this paper, and its transmission distance is up to 1200m. CAN port of charging pile and MCU’s CAN port are connected through plastic optical fiber to ensure the stability and reliability of data, and with key protection to prevent information leakage.

In Figure 1, MCU adopts STM32F407 with high speed, low power consumption and strong anti-interference ability, which can support multi-channel CAN interface. The independent RS485 interface can be used to collect and process CAN bus data. The main advantages include:

1. Support protocol parsing;
2. Small size, convenient installation, low cost;
3. The built-in electrical isolation module prevents the reliability from being affected due to the damage of ground circulation.

3.2. Design of communication module
The interactive data of electric vehicles generally adopts CAN bus communication protocol, and the data format follows GB27930[8-9]. The communication message format uniformly adopts 8-byte data
expansion frame. The communication rate between the charger and the BMS (battery management system) adopts 250 kbit/s, so the CAN port rate of the single chip is synchronized.

MCU monitors the vehicle pile communication message in a ms class cycle, and forwards the information in four stages, namely, charging handshake, matching, charging process and charging end, in hexadecimal system. There are tens of thousands of messages in one charge, and delay forwarding. The message information is forwarded once every 10-15s. Figure2 shows the interactive message of simulated charging, and Figure3 shows part of the communication program of the single chip microcomputer. It has been verified that the data transmission is stable.

![Figure2. Part of received charging messages.](image)

4. Software development of monitoring system
The MCU transmits the original message to the upper computer through the serial port, and the upper computer uses LabVIEW software of NI corporation in the United States as the development of monitoring interface[10]. It has strong expansibility, graphical programming environment, short development time and other characteristics, and is widely used in signal processing and monitoring systems.

4.1 software system
The monitoring system in this paper mainly completes two tasks: one is real-time monitoring of charging status with STM32, ensuring that each charging pile is under monitoring, real-time exchange of charging data with the monitoring host, and analysis of reported data. The second is to provide a good human-computer interaction interface, according to the operation and maintenance requirements to achieve the control operation of the charging pile. For example, when a fault occurs, start and stop action is carried out, and other operations are not allowed to prevent interference with the effective data interaction between the charger and the electric vehicle. The flow diagram of software monitoring is shown in Figure 3.
Figure 3. Schematic diagram of software monitoring

The system developed in this paper obtains data in the serial port buffer every 10s. If any data is received, it will judge the frame type of data according to the ID identifier of the data frame, enter the corresponding data processing program, and display the parsed data results on the monitoring interface synchronously. If multiple charging piles work at the same time, the host computer will send instructions. Then STM32 will orderly send corresponding data according to instructions to prevent line congestion. When a special fault occurs, the monitoring system has the right to issue operation instructions to the charging pile and execute the corresponding data frame commands.

4.2. Monitoring interface
The charging station monitoring system designed in this paper can achieve four main functions: user management, charging management, data storage, battery status monitoring. In addition, you can also view the historical data of the monitoring system, which needs to be viewed from the background database. Some monitoring interfaces are shown in Figure 4.

(1) User management: user rights management can be realized. The monitoring software can only be operated after logging in. Then the user name and password can be changed.

(2) Charging management: real-time monitoring of EV charging process can be realized by uploading BMS data to the monitoring host, and real-time display of voltage, current and battery state of charge (SOC) in the charging process\cite{11}. The designed monitoring interface is shown in Figure 5.

(3) BMS system management: it can view the information of battery modules and individual batteries\cite{12}, and can control the start and stop of charging piles under special faults.

(4) Historical data query management: all data will be saved to the background server for later fault diagnosis and analysis.
5. CONCLUSION
The monitoring system of electric vehicle charging-station designed in this paper is based on LabVIEW and STM32. The MCU is used as the communication interface between BMS and the upper monitoring. The designed communication scheme is reasonable and effective, which overcomes the high cost defect of over-dependence on industrial computer in the conversion link, greatly saves the maintenance cost of charging station, and has strong expansibility. The data transmission rate is fast, safe and reliable, and it has a good man-machine interaction interface, which can realize the real-time monitoring of each charging pile. The proposed design scheme provides an effective realization idea for the rapid construction of charging station monitoring system, which is conducive to promoting the establishment of electric vehicle charging monitoring network [13-14].

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