Research and Implementation of New Energy Vehicle Charging Pile

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Abstract. Charging pile is the most important equipment for new energy vehicle power system. According to the demand of new energy vehicle for charging equipment, this paper uses PLC as the core controller to detail the design of AC charging pile control system for new energy vehicles. The hardware circuit includes the design of the main controller module PLC, the touch screen, the power calculation module, the printing module and the like; the software system includes the communication design of the main program design of the PLC, the touch screen, the ic card, etc. Through the communication the modules can be transmit data smoothly, and various data collection in the charging process is completed in real time. The electrical part of the whole system is also provided with double protection for the purpose of safe operation.

Introduction

Along with the rapid development of the global industry, the available resources on the earth are decreasing, and the global environmental pollution is also increasing. Saving energy, reducing emissions of various exhaust gases, and creating a green environment have become a common research in the world, among of which green transportation has become one of the important goals of energy saving and emission reduction in various countries. Compared with fuel vehicles, the most commonly used new energy vehicles in green transportation have outstanding advantages such as environmental protection, saving money, low noise, and energy saving. Therefore, in recent years, research on new energy vehicles in various countries around the world has been increasing, and China’s automobile production is large. It is imperative to develop new energy vehicles with energy conservation and emission reduction. In the past, China produced 1.27 million new energy vehicles and sold 125.6 vehicles, the volume has reached the top in the world for four consecutive years [1].The charging system is a necessary condition for the normal driving of new energy vehicles, the quality of the charging system plays a vital role in the development of new energy vehicles in the future. The establishment of charging piles provides convenience for new energy vehicles. However, at present, it faces some difficulties. First, due to the backward charging facilities in the country, the lack of charging piles makes charging difficult. Second, the battery capacity is insufficient, there is no charging pile to replenish electricity in time, and the driving distance is limited. Therefore, with the mass production of new energy vehicles, the corresponding charging equipment should also be developed together [2].According to the current market prospects of new energy vehicle charging equipment, and the corresponding technical requirements of domestic charging equipment, a new energy vehicle charging pile with reliable and simple charging and convenient using is designed, which can effectively alleviate the problem of charging new energy vehicles.

Overall Design of Charging Pile System

The function of the AC charging pile is to charge the new energy vehicle in time to ensure the normal driving of the car. The users can conveniently and simply operate the charging process. For this reason, the system should have a good human-computer interaction interface and the function
of clear voice prompting. The charging method should be diversified to meet the needs of different users. The new energy charging pile system designed by the article consists of programmable controller PLC, touch screen, smart card reading and writing module, power calculation module, ticket printing, electrical protection, etc. The whole block diagram of the system is shown in Figure 1.

The whole system is mainly composed of plc, touch screen, smart card reading and writing module, and printing module. When the user uses the charging post to charge, the data in the card is read by the touch screen, and a good communication connection is established between the plc and each functional module to complete the collection of the charging smart card information during the user operation, and the real-time electricity charging is performed by the power calculating module, and the corresponding data receipt is printed by the printing module, and the information about the remaining power in the user's smart card is displayed, so that the user can recharge in time without affecting the next charging.

**The Choice of Programmable Controller PLC**

The programmable controller plc is an electronic device operated by digital operation. Through the connection of its input and output ports with other devices, a corresponding program is programmed to control the mechanical actions of various devices. At present Mitsubishi, Siemens and Omron are mostly used.

Most of the car charging piles are built in some outdoor public places such as parking lots. The external air and environment changes, which will affect the reliability of the charging system. Therefore, the system uses the plc of the Mitsubishi fx3u series as the core component of the system. It can meet the requirements of charging piles, because plc has strong anti-interference ability and high reliability, and the input and output ports are all optically isolated, which can effectively isolate the internal circuit of the charging pile from the outside during charging, so that the whole charging process is stable and its appearance is shown in Fig. 2.

![FX3U-16MT](image)

Figure 2. FX3U-16MT.

According to the design requirements of the whole system, the number of input points of plc is only one, and the number of output points only needs five. Therefore, the system chooses
Mitsubishi fx3u-16mt plc, the i/o port of this plc is 8 respectively, which is launched by Mitsubishi Corporation. The three-generation plc [3] is a small and supreme product. It has 8 expansion units and modules, and it has added positioning instructions on the basis of the original plc. It is fully functional and cost-effective.

**Touch Screen**

The touch screen is an inductive liquid crystal display device that can receive input signals such as contacts, and can be used instead of a mechanical button. When the graphic button on the screen is touched, Feedback system will activate various linking devices [4] according to previously programmed programs. The human-computer interaction mode of the charging pile is realized by the touch screen, which makes the user's operation convenient.

The touch screen selects Mitsubishi’s GT15, which is a new generation of human-computer interaction products of Mitsubishi Corporation. It adopts 64-bit processor, built-in USB interface, and the screen designing software is GT Designer2. It can adapt to the extended functions of various applications such as network. The visual experience is perfect during high color operation, and the connection with the PLC is shown in fig. 3.

One port of the touch screen is connected to the plc, and the other port is connected to the micro printer. The two communication ports can communicate with the programmable controller using RS-485.

**Printing Module**

The printing module is mainly used to print the IC card information charged by the user. The GT15 system touch screen selected by the system can be directly connected to the printer. The printer can use serial or PictBridge compatible models. The MS-T850 thermal micro-printer is selected in this design, as shown in Fig.4. The printing machine has a printing speed of 150mm/min. It adopts Japan's EPSON imported movement, which has high reliability and high security and supports multiple languages, with serial port, TTL, USB diversified interface to be choose [5].

The printer can directly communicate with the touch screen, and its working and printing content is controlled by the touch screen. The printed ticket size is 80mm×55.5mm, which satisfies the system requirements and the connection with the touch screen as shown in fig. 5.

**Power Calculation Module**

The function of the power calculation module is to calculate the amount of power used by the user for each charge. The energy meter is the core device of the power calculation module. The calculation of the power is completed by communicating with the energy meter to obtain the power data. In the charging pile, the electric energy meter is installed at the incoming line of the power
socket, and the electric energy meter completes the transmission of the electric energy meter data through communication with the charging device and the monitoring system. In combination with the design requirements of the charging pile, the ddsi2 type electronic intelligent single-phase AC electric energy meter is selected, and the electric energy meter is shown in the Fig. 6.

![Image](image1)

**Figure 7. Electrical protection circuit.**

**Figure 8. Physical of reading and writing module.**

This meter uses far-infrared or RS-485 to communicate, with remote pull-close control, event recording and other functions. The communication speed can be set arbitrarily between 1200~9600bps [6]. RS-485 interface of electric energy meter is adopted to communicate with PLC to transmit data in the design, and the control system displays the obtained electric energy data of the electric energy meter on the touch screen, so that the user can grasp the charging situation in time.

**Electrical Protection Circuit**

The charging pile circuit has two kinds of protections: short circuit protection and leakage protection. The fuse is used to prevent short circuit and the circuit breaker prevents leakage. The output coil of the plc is connected in series with the AC contactor coil [8] to control the action of the contactor, and then control the turning on and off of the charging process to realize the electrical protection of the charging circuit, the part of circuit diagram is shown in Fig. 7.

**Reading and Writing Module of the Smart Card**

The smart card reading and writing module mainly includes two parts, a card reader and an ic card. For the convenience of operation, the most commonly used non-contact type in the market is IC card (radio frequency card), and the data information in the card is read by the reader. The card and the reader are connected to each other by radio waves, and the data communication is realized by RS-485 and plc, and the practicality is shown in figure 8.

The smart card reader is generally installed in a place where the charging pile is conspicuous and convenient for the user to swipe the card. When the user places the ic card on the reader, the reader reads the card number of the card, and if it is not a useful card, it does not respond. When the valid card is read, the charging post enters the card information interface, and the information about the ic card is displayed on the touch screen. When the user presses the OK button, the charging mode can be selected to start charging the car, and when charging is completed, the pile will prompt the user to place the card on the reader again, and the remaining power is written into the card by plc [7].

**The Implementation of the System Software**

Software designing is a necessary condition for system operation. The main purpose is to realize communication between electric energy meter, printer, touch screen and plc controller. The whole software system is divided into two parts: plc control program and touch screen configuration program.

**The Development Environment of Programmable Controller PLC**

The development environment of Mitsubishi FX3U system PLC is programming software GX Works2. This software is a comprehensive PLC programming software which integrates programming software, simulation software and module setting software introduced by Mitsubishi.
Electric. It has programming language such as instruction list, ladder diagram and flow chart SFC, ST, which are dedicated to PLC designing, debugging, maintenance. The software has the data addition with intelligent function module, and the users can add module data to the editing project, and support the editing of each module's data[9].

**General Process of the System**

The charging pile software system is mainly composed of card reading, charging, settlement and corresponding subsystems. The specific flow chart is shown in Fig.9.

The charging pile is operated by the touch screen to complete the human-computer interaction. When the program is executed, the ic card is read first. When it is determined to be a valid card, the information of the current card is read. When the amount of power displayed in the card is enough, the OK button can be pressed, and then enter mode selection interface, the user can connect the car to the charging pile, select the charging mode according to the need and click the OK button to start charging. When the charging is completed, click OK to put the card on the reader again, and the system will automatically deduct the card, and prompt the user to print the small ticket. The plc ladder diagram is shown in Fig. 10.

![Flow chart of System software.](image)

**Interface Designing Touch Screen**

GT Designer3 is a new programming software introduced by Mitsubishi Corporation. It is used for programming software of Mitsubishi Electric automation graphic operation terminal. It can communicate with Mitsubishi FX and A series PLC, Omron C series PLC and other programmable controllers; users can realize the human-machine interaction with the charging pile through the touch screen, and timely grasp the state of the charging pile. There are two main aspects of interface designing, one is the design of various function configurations such as interface buttons, and the
other is parameters setting for communication with PLC and printer. Some interfaces are shown in Fig.11.

(a) Waiting interface  (b) Card information interface  (c) Mode selection interface

**Figure 11. Part of the touch screen interface.**

**Communication Program Designing between Intelligent IC Card and PLC**

When the user operates the IC card, the plc will recognize the card number sent from the card reader, read the data in the card, and send the command according to the communication protocol. The ladder diagram is as follows

In the ladder diagram, rs is a serial communication instruction, which is used to set the address of the data, and complete the data exchange process through the register, thereby realizing the transmission and reception of data between the plc and the reader. For each charge, plc compares the received data with the previous data and drives the charging pile based on the results.

**Conclusions**

The AC charging pile designed by this scheme is based on the PLC programmable controlling system of the Mitsubishi FX3U system. The system software adopts modular programming, which makes the subsequent modification and upgrade simple. Using plc programmable controller as the core controller of the system, the charging pile can work reliably under the bad environment, and the electrical protection link of the system makes the charging operation of the user safer and more assured. The whole system has the functions of simple operation, friendly human-computer interaction and reliable charging, which can effectively meet the requirements of initial charging.

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