Research and Design of Electric Vehicle Charging Pile Control System

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The charging pile is the main equipment for electric vehicle charging station, which can charge power for various types of electric vehicles. According to the different voltage grade, each charging pile is equipped with a recharge control system. The charging pile of electric vehicle can use AC, DC power to supply, which needs a special electric vehicle’s charging card and by using the RFID card and charging the battery pack. The charging pile display is able to show some parameters and data, such as charging voltage, charging current, charging amount, recharge expense, charging time, and so on. This paper gives the research and design of the charging pile control system, which are used to recharge for electric vehicles in the residential area. It can show the charging status that provided by the man-machine interactive hardware and interface, which can realize the charging monitor and charging electric measurement, and can display or print out the electricity consumption, cost, and battery parameters.

Keywords: Charging pile; Electric Vehicle; Battery Pack; Charge Control System; Power Electronics.

1. Introduction

With the development and popularization of electric vehicles, electric vehicles and electric bicycles, electric tricycle all use electricity to provide energy, due to the electric vehicle depends on the rechargeable batteries to provide energy. While bring people convenience, charging time length, easy or nor, and the service life of the battery and so on all affect the use of electric vehicles. In order to convenient for people to use electric vehicles, the residential areas must have enough charging facilities and equipment to satisfy people's travel demand. Convenient and fast charging equipment can effectively promote the reliable usability of electric vehicles, which can be implemented to reduce the use of fuel vehicles, reduce emissions of the automobile exhaust pollutants, and effectively improve the living environment of human beings.
2. Microprocessor Type Selection for Charging Pile Control System

2.1 System Functional Requirements of Charge Pile

To meet the demand of the user's need, the charge pile of electric vehicles must have the following functions: (1) Charging pile support local information display, which can realize the setting of various parameters by keyboard or touch screen in the process of charging work. At the same time the user need to input parameters such as charging time, charging power through the buttons or touch screen. (2) The user can start charging control system to charge the battery of vehicles during the initial parameters setting. (3) The user can select the charging mode through the display screen, which can show charging status, charging billing query, and charging card consumption amount balance query of electric vehicle. (4) Charging pile control system can control the charger for vehicle batteries according to user's choice, and at the same time, which can support user to print the consumption of documents after the charging work is completed. (5) Control system of the charge pile can real-time monitoring the vehicle battery parameters such as voltage, current, temperature and capacity. (6) In order to improve the advantage of control system of the charging pile, the display supports 10.4-inch LCD touch-screen, which can improve the human-computer interaction ability of the system [1].

2.2 Microprocessor Types and Overall Scheme

In order to design the charging pile control system, First selection the control system core of microprocessor. The control system of the charging pile is based on the EPC-9000 series industrial control mainboard in this design scheme for electric vehicle.

To design scheme of electric vehicle charging pile control system, and realize the application solution, here selects the EPC micro-controller. EPC-9000 series motherboard has EPC-9100, EPC-9200 and EPC-9600 series of products, where the EPC-9200 and the EPC-9600 belong to high-end products, for example the EPC-9200 as shown in Figure 1.
The charging pile control system designed based on EPC-9200 is shown in Figure 2. All data processing, human-computer interaction interface for charging pile is realized through the EPC-9200 industrial control mainboard in the process of charging work. The EPC-9200 uses the Cortex-A8 framework, the working frequency up of 800 MHz, offering the WinCE or Linux operating system, and the default system is Linux. Its main advantage lies in: (1) The EPC-9200 interfaces are rich that uses the onboard 6-channel RS232, 2-channel CAN bus. (2) The EPC-9200 has a strong data processing and communication ability, the driver of CAN(Controller Area Network) bus is stable and reliable. When the bus load is high the system don't lost the frame, so it can ensure the reliability of the data transmission. (3) The EPC-9200 can be directly support the LCD display, whose resolution can reach up to 1366 x 768, make sure that the 10.4-inch LCD touch screen can display necessary data, and complete touch input, can be used in software UI and advertising at the same time. (4) The EPC-9200 can support more large size touch screen than 10.4-inch LCD under the special requirements for practice application.
3. Charging Pile System Design

3.1 Detection System of Electric Vehicle Battery

Electric vehicle’s motor generally uses 70V, 220V, 251V, 336 V, 384 V and DC or AC 50Hz or 60Hz voltage. Electric bus’ motor generally uses 580-600V AC power. Motor voltage is higher for electric bus, the speed area of the motor constant power is wider. Now more and more motor of electric vehicle use permanent magnet motor, because it has small volume, easy to decorate in the vehicles. Complex dynamic performance requirements the battery pack must to work properly, so the system need real-time monitoring of battery voltage, current, temperature and implementing necessary intervention. In order to ensure that the power supply is working properly, the electric vehicle battery pack generally adopts 5-parallel and 12-series connection form. The rechargeable battery must be made the necessary testing by charging pile or collecting the parameters accordingly of the battery pack by means of the electric power or battery pack management system [2].

Lithium-ion (li-ion) battery pack or battery unit in electric vehicles is 48V, 12 AH, which as the basis of the combination of the battery pack can solve the problem of voltage and capacity on the combination. The volume unit of power cell is AH, rather than the current unit of A. Take into account not only the capacity of the battery pack size and durable, more to consider power required, otherwise cause underpowered due to lack of power. Assume 1 section 18650 li-ion rechargeable battery is 3.7V, 2AH (The capacity batteries have a variety of specifications, here is assumed to be 2000mAH). In order to realize the electric vehicle battery pack voltage of 48V, that the condition is:

\[ 13 \times 3.7V = 48.1V \]  \hspace{1cm} (1)

So need 13 li-ion rechargeable batteries series fill 48V voltage constitute a group battery unit, the total voltage is 48.1 V, and its capacity is still 2AH. If the electric vehicle system needs the capacity is reaching 12AH, that is:

\[ 6 \times 2AH = 12AH \]  \hspace{1cm} (2)

Namely 6 voltage parallel battery units can meet the capacity requirements of 12AH. Therefore, the battery pack need 6 battery units, that is:

\[ 13 \times 6 = 78 \]  \hspace{1cm} (3)

Consequently, 78 lithium-ion 18650 rechargeable batteries form an electric vehicle battery pack.
Because of different battery and battery pack models, there are a variety of electric vehicle battery parameters mainly has several kinds of battery, such as 36V@12AH, 48V@20AH etc. The battery pack can only be used as a group, cannot be mixed use the different types battery together. For different electric vehicle batteries, different products have various types. Although the size of the battery pack produced by all the companies is slightly different, the difference or peculiarity is not apparent. The selection of specific battery types depends on electric vehicle battery model.

3.2 Stable Communication Based on CAN Bus

In the development of charging pile, the reason for the charging pile control system using CAN bus is as follow: In order to achieve the good compatibility with electric charging pile control system, most electric vehicles using CAN bus, and establish control and information interaction ability need to through the general line and the vehicle's battery management system, which also is the core functions of the charging pile products. It is critical for information exchange not lost frames in the process of communication based on CAN bus. EPC-9200 module adopts AM3352 processor of TI company, whose internal integration of CAN bus controller. CAN bus controller hardware packet FIFO has the buffering capacity with 64 frames data packets, hence charging pile on hardware implementation function without the bottleneck problem of communication for the control system of data transmission. CAN bus driver optimization design is based on EPC - 9200 module, which is not lost data under the condition of high load rate, so using CAN bus to ensure the system safe and the information and data reliable [3].

3.3 Electric Vehicle Charging Credit Card Information Recording

Electric vehicle charging card uses pre-charging method, each charge according to the degree of electric automatic from the card minus have used the charging amount. Users through contact or non-contact IC card charging, charging pile control system records the transaction information in real time, which is also a basic function of electric vehicle charging card. The design adopts a series of electronics card. For example, ZLG522S is a reading and writing module. The module is small in size, and meet the ISO14443 standard, can support a variety of RFID card, such as CPU, Mifare Desfire (CPU card), Mifare S50/S70, Mifare ultralight, Mifare pro and so on. So it uses the ultra small, ultra large scale integrated circuit package solution, which has the characteristics of easy to use, reliable, diverse and small volume, etc. So it can integrate system easily and
quickly, put the most popular non-contact RFID IC card technology into charging pile control, which can improve the intelligent level of the products.

3.4 LCD Touch Screen and Consumption Documents Printer

Charging pile system uses 10.4-inch LCD touch screen to realize the function of human-machine interaction, at the same time the system should have the function of print documents. The print data mainly includes the consumption of electric vehicle charging card content in the system. The printing devices have some characteristic, such as miniaturization, fast printing speed, high reliability and clear printed, etc. This design adopts the ZY-TP12 micro printer, which is launched by Guangzhou EasyARM. The micro printer uses the line thermal technology, which can meet the requirement of the users, the charging pile and its control system function. ZY-TP12 miniature printer uses RS-232 serial port communication, which is simple and powerful.

4. Charging Pile Improvement and Design of Quick Charge

The design electric vehicle charging pile needs to consider two basic principles. One is implementation of electric vehicle battery fast, efficient, safe and reasonable power supply, the other is charging pile applicability for various models of electric vehicles and various kinds of batteries. Charging pile as power supply device of electric vehicle battery, whose charging performance is related to the service life, battery capacity, dynamic performance and charging time of electric vehicle battery. This is one of the most concern when user to purchase and using electric vehicles. The traditional charger adopts continuous current and pulse current charging ways, as shown in figure 3. The fast charging pile system that adopts the intelligent variable pulse charging way is different from the traditional charger power signals [4]. The pulses as shown in figure 4, where the charging current pulse are including charging pulse T1, intermittent pulse T2 and pulse discharge T3.
Figure 3. Scheme of quick charging pile control system.

Figure 4. Charging current pulse of variable pulse charging mode.

Figure 5. Design of control flow of fast charging pile.
Figure 5 is the design of the control flow for the charging pile in the typical surface charging station. The charger is composed of a rectifier and a power converter. The AC power is inputted and converted into DC power by rectifier. The power converter can regulate the DC electric power. By the plug wires inserted into the matching socket of electric vehicles, DC power input for charging the battery. The charger is provided with a locking lever to facilitate insertion and removal of the plug, while the lever also provides an interface signal ON or OFF to determine the locking signal to ensure plug and play safety and reliability. According to the communication between the charging pile and the battery management system, the power converter can regulate the DC charging power online, and the LCD screen can display the charging voltage, the charging current, the charging amount and the charging expenses [5][6].

5. Conclusions

The design scheme of control system for electric vehicle charging pile is presented based on the composition and characteristics of pure electric vehicle battery group in this paper. The types selection of industrial controller is carried out. Combined with CAN bus communication mode on the electric vehicle and the data, which is provided by the battery pack management system mounted on vehicles. The improved design of the charging pile is given. The charging pile can help driver or customer and finish payment by the electric vehicle’s RFID charging card in the residential areas. The quick charging pile control system scheme adopts intelligent variable pulse charging method and control flow are proposed. In view of the fact that pure electric vehicle specification is not really mature, many of the details of the actual research and development will continue to improve in order to get the most convenient electric vehicle charging pile design and implementation scheme.

References
