Electric Vehicle Automatic Timing Charging Controller Design

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Abstract

This topic is based on theintelligent charging system controlled by STC12C5A60S2 single-chip microcomputer. Its main circuit system is composed of rectifier circuit, pulse width modulation circuit and drive circuit. The control loop is composed of single-chip microcomputer minimum system, voltage and current detection circuit, button and display circuit. By collecting the voltages at both ends of the battery, charging current and other parameters, it is sent to the MCU for analysis and processing, and the corresponding PWM control signal is obtained to control the main circuit to realize intelligent charging of the battery. The system has the characteristics of high charging efficiency, short charging time, etc., can improve the storage capacity and cycle utilization of the battery, meet the charging requirements of the electric vehicle battery, and has a good application prospect.

Keywords

Electric vehicle charging; switching power supply circuit; single chip microcomputer; circuit protection; intelligent charging control.

1. Introduction

Electric vehicles are popular among people because of their environmental protection, economy and light weight. More and more young people choose electric vehicles as their means of transportation. Electric vehicles not only solve energy and environmental problems to a certain extent, but also solve the traffic congestion problems caused by people's travel. In the growing market demand, the investment in research on electric vehicles is also deepening, and the fierce competition among enterprises has promoted the technical level of the electric vehicle industry[1-2]. Even so, on the basis of some mature theories and techniques, there are still some difficulties to overcome. For example, the core of electric vehicles is batteries and chargers, and their development has been unable to meet the current needs. According to the survey, most of the batteries are shortened due to charging, and the voltages that are too high or too low cause serious damage to the battery, and the general charger does not automatically turn off the power when the battery is fully charged. In such cases, it is easy to cause damage and there are security risks.

This paper designs an intelligent and scientific charging method to charge the battery and improve the service life of the lead-acid battery, so that the charging of the battery is more intelligent, safe and fast, and the battery charger has wider application and development prospects.

2. Subject Content and Requirements

This topic is mainly to design a smart charging controller controlled by a single chip microcomputer. The charger adopts adaptive technology to detect the charging situation in real time, and can automatically adjust the charging mode to realize intelligent charging control, and has a complete protection circuit to ensure the stability and reliability of the charger.

Basic requirements of the project:

(1) Real-time detection of battery current and voltage charging conditions, charging the charger according to the designed program flow;

(2) Charger charging can control the main parameters in real time to ensure the safety of the battery during the charging process;

(3) The analog quantity of the real-time acquisition of charging can be immediately converted and displayed by AD;

(4) Design the function of automatically adjusting the charging mode to achieve optimal mode control;

(5) Design complete circuit protection function to ensure the safety and reliability of the charger work to the utmost.

3. System Design Block Diagram

This topic is to design an intelligent charging system based on STC12C5A60S2 single-chip microcomputer control[3]. It consists of four parts: main circuit, drive control circuit, protection circuit and display button circuit. The main circuit and drive control circuit are mainly used to protect circuit and display. The button circuit is supplemented. The system block diagram of the smart charger is shown in Fig. 1.

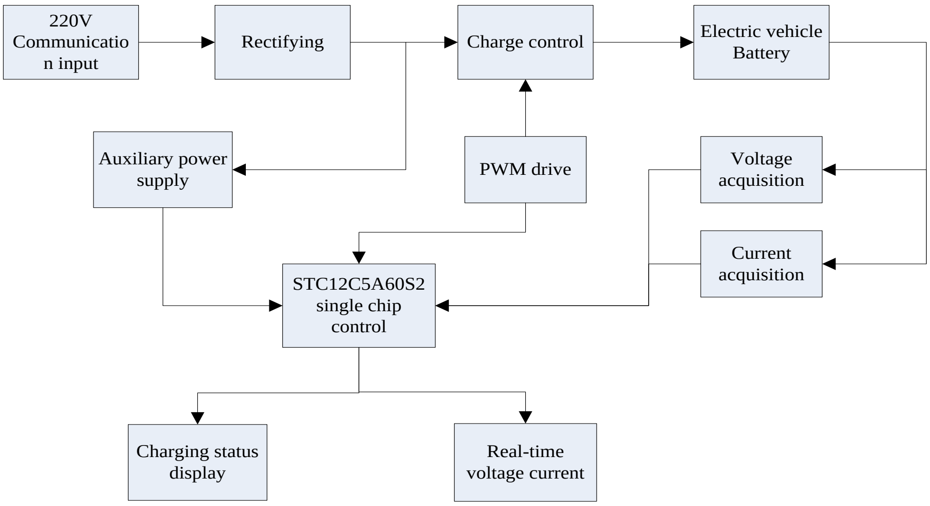

Fig. 1 System block diagram

The battery charger is input by 220V AC voltage. After a rectifier bridge and filter circuit, the AC voltage is converted into DC voltage. The DC voltage is directly output to the positive and negative poles of the battery through the charging control circuit, thereby realizing the basic battery. Charging part.

The control part of the battery is mainly composed of STC12C5A60S2 single-chip microcomputer, which respectively performs charging control, display control and button control for each module's function circuit, which also includes the real-time current and voltage function circuit of battery charging, and inputs the collected data into the single-chip microcomputer for analysis. Judging the processing, so that the MCU sends the corresponding pulse width modulation wave (PWM wave)[4] to control the charging of the main circuit, so that the charger can perform precise control according to the four-stage charging method, and sequentially enter the turbulent flow, the constant current, and the constant Pressure, floating charge stage.

The protection circuit is a simple hardware protection that protects the input and output circuits from damage to the charger and battery when the input or output current is too large. The display button circuit mainly displays the real-time charging voltage charging current collected in real time, and functions as a design to detect the charging condition of the battery in real time. The charging state indicating circuit is an LED indicator light, which is convenient for the user to understand the current state of charge.

4. Circuit Design

4.1 Design of Rectifier Filter Circuit

Since the 220V AC voltage used by the utility power cannot be directly used as the charging of the battery, it is necessary to provide a DC power supply[5] for the electric vehicle battery through the rectifying and filtering circuit. This design uses a capacitor filter and a bridge rectifier circuit. Generally, a voltage regulator circuit is needed to adjust the current stability. The voltage regulator circuit uses a negative feedback circuit to further stabilize the rectified DC voltage. The schematic diagram of the filter circuit is shown in Fig. 2.

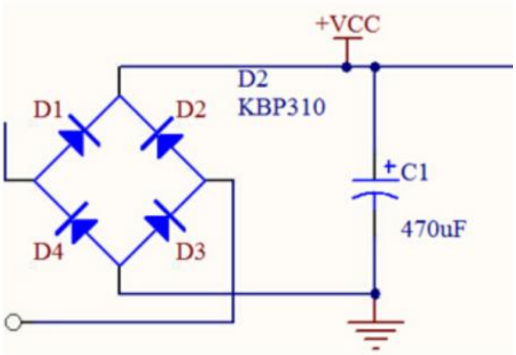

Fig. 2 Bridge rectifier filter circuit diagram

4.2 Introduction of STC12C5A60S2 MCU

The control brain of the charger is mainly from the single-chip microcomputer, so the choice of the single-chip microcomputer is crucial for the charger, and its performance directly affects the charging performance of the battery[6]. Under the premise of considering the overall scheme design and battery charging effect, the single-chip model selected for this design is STC12C5A60S2. This single-chip microcomputer is a new-generation enhanced 8051 single-chip microcomputer with high-speed low-power anti-interference super-strong. The instruction code is not only fully compatible with the traditional 8051, fully meets the needs of the control charger, as shown in Fig. 3 is the pin diagram of the STC12C5A60S2.

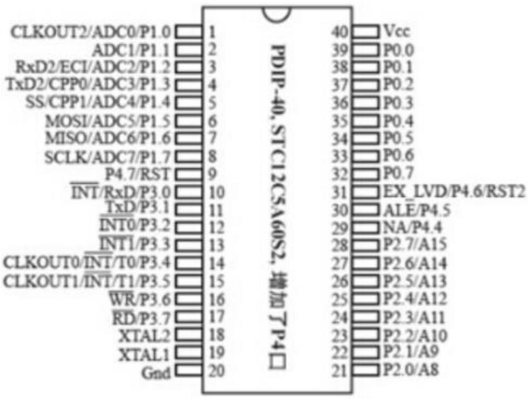

Fig. 3 Pin Diagram of STC12C5A60S2

4.3 Microcontroller External Circuit Design

4.3.1. Single Chip Power Supply Circuit

For a complete single-chip system, the power supply module of the single-chip microcomputer provides power for the single-chip microcomputer to ensure the smooth operation of the circuit.Since theMCU is easily disturbed and the program runs away, a very effective means to solve this problem is to provide a stable and reliable power supply module for the MCU system. The power module circuit is shown in Fig. 4.

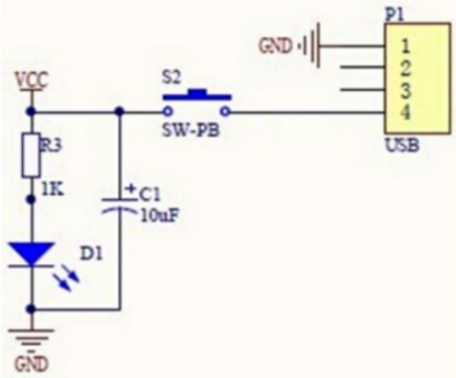

Fig. 4 power module circuit diagram

4.3.2. Button Reset Circuit

The reset input pin RET of the MCU provides initialization for the MCU. It can start the program from the specified position. After the clock circuit of the MCU works, as long as there is a high level above two machine cycles on the RET pin, the MCU starts internally. Reset, so as long as RET is held high, the microcontroller cycles reset. The reset circuit of the charger MCU system is a circuit that uses button reset. The working principle is that the RC circuit is charged when the system is powered on, and the RST pin is high. As long as the RST terminal maintains a high level of about 10ms, The microcontroller is reset, and its circuit diagram is shown in Fig. 5.

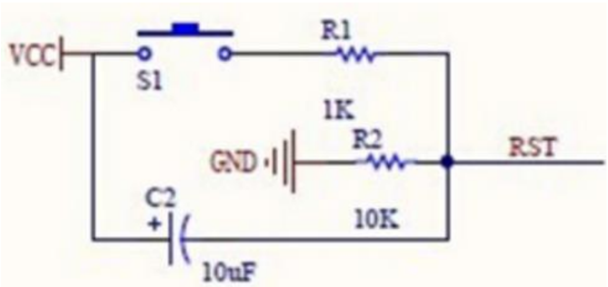

Fig. 5 MCU button reset circuit

4.4 Design of the Sampling Circuit

In this charger, resistor-divider current sampling is designed.The sampling circuit includes sampling the charging current and the charging battery terminal voltage, and the sampled voltage and current are sent to the single chip control chip through the ADC module of the single chip microcomputer, and the single chip computer analyzes, processes and saves the data.The ADC module of the MCU supports 8 input channels, and the maximum output error is ±3mV. This can sample multiple analog input signals. The schematic diagram of the current and voltage sampling circuit is shown in Fig. 6.

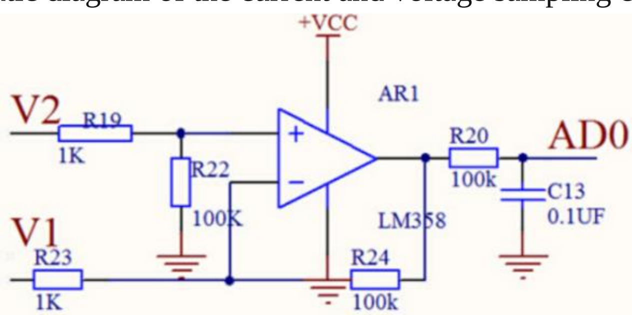

Fig. 6 Schematic diagram of the sampling circuit

4.5 Design of Main Charging Control Circuit

TL494 is a fixed frequency pulse width modulation chip, which contains all the functionsof switching power supply control,integrates all pulse width modulation circuits to meet the requirements of battery chargers.Fig. 7 shows the main charger circuit diagram of the battery charger designed by TL494. By comparing the high and low voltages of the two signals, the PWM width of the output PWM is controlled to adjust the charging voltage and current.

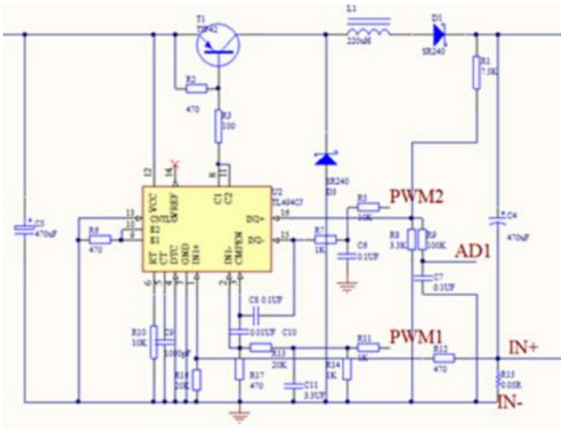

Fig. 7 battery charger main charging circuit diagram

5. System Programming

5.1 Main Program Design

The main program flow chart is shown in Fig. 8. The charger is connected to the positive and negative poles of the battery. After the system is powered on, the system is initialized and starts normal operation. At the beginning of the program, the P1 port, PWM program, AD program and interrupt are first configured accordingly, and the initial configuration is performed. The I/O connected to the button is periodically scanned and the charging is turned off when a low level is detected. The system detects the voltage and current during charging in real time. The AD conversion ports of the current and voltage respectively set two I/O ports of P1.6 and P1.7, and input the AD converted data to the single chip microcomputer. When the corresponding phase of the battery is detected, the battery is charged. When the voltage is applied, it immediately enters the charging phase. The charger starts charging when the charging current is greater than 150MA. The red light is illuminated. At this time, the charging enters the constant current mode. When the charging current is reduced to 150mA or less and the charging voltage is greater than 1.36V, the battery is fully charged. Lights up and goes directly to the next floating charge mode. When the charge current is less than 200mA, the battery is charged with a voltage of 1.32V. When the charge current is greater than 200mA, the voltage of 1.40V is used to charge the battery at a constant voltage.

5.2 Software Design Assistant Program

5.2.1. Button Program

The switch and reset button programs are used to detect if the button is active and to resolve the button debounce problem. By continuously scanning whether the level of the button port changes, it is determined whether the button is pressed, the switch button is pressed, the charging is turned off, the charging indicator is turned off, and when the reset button is pressed, the program is reset. The button flow structure diagram is roughly as shown in Fig. 9, detecting whether the button is pressed and debounced by the delay, and when it is determined that the button is pressed, the program jumps to the corresponding subroutine.

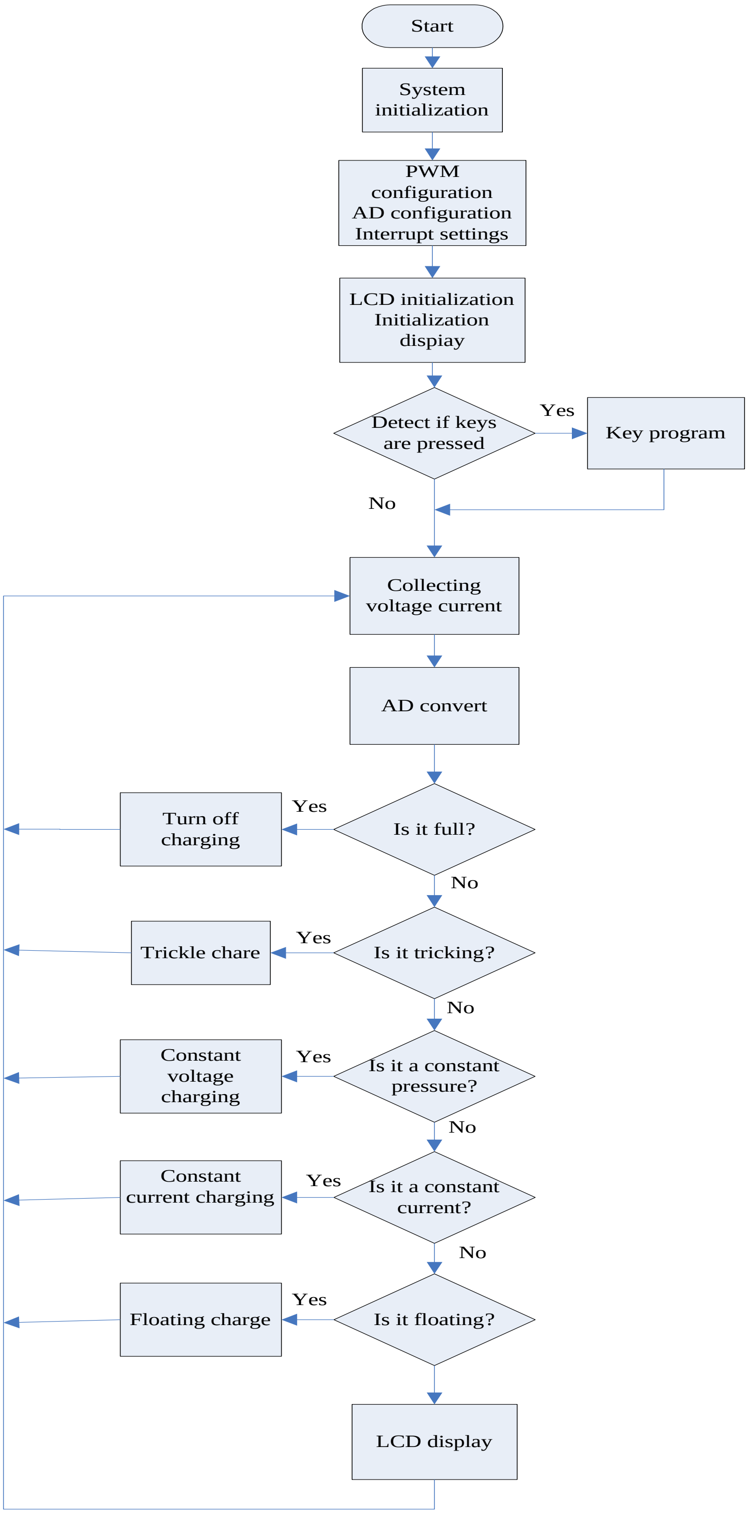

Fig. 8 main program flow chart

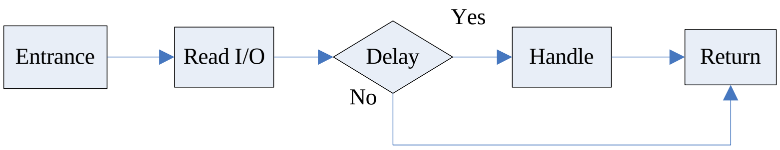

Fig. 9 button flow chart

5.2.2. Design of Charging Test Program

The charging mode that the charger should currently use is judged based on the collected current and voltage signals. If the charging current is greater than 150mA, the charger starts to charge and enters the first mode. The charging status indicator lights up. When the charging voltage is greater than 1.36 volts and the current is below 150 mA, the battery is fully charged. The full power indicator is illuminated and goes directly to the next floating charge mode. When the charge current is less than 200mA, the battery is charged with a voltage of 1.32V. When the charge current is greater than 200 mA, use 1.40V. The voltage is used to charge the battery at a constant voltage.

6. Conclusion

This design studies the electric vehicle automatic timing charging controller system. The charger uses the single-chip microcomputer for intelligent control during the charging process. The main charging circuit uses the switching power supply circuit of TL494 to control the mode of the charger through PWM pulse width modulation. It realizes four-stage intelligent charging, and can display the charging condition of the electric storage device in real time, realize the optimal mode control, and has a complete protection circuit to ensure the stability and reliability of the charger work, and to charge the electric vehicle. Strong practical value meets thedesign requirements.Through this design, I have an understanding of the charge and discharge characteristics of lead storage batteries, especially the battery charging method and application. In the process of redesigning the circuit, searching for data, comprehensively arranging and applying, and improving the ability of learning and research.

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