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Design and Simulation of Automatic Control Circuit Based on Single Chip Microcomputer

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Abstract: ***In order to solve the problems of complex control circuit structure, poor system performance reliability and control instability, this paper proposes an automatic control circuit design scheme based on single chip microcomputer. The control circuit structure is simplified on the same single chip microcomputer. Then, according to the automation requirements of system performance, the design of the control system architecture based on single chip microcomputer is analyzed, and the hardware circuit and software of the automatic control system are designed respectively. The control circuit is simulated by using keiluvision and Proteus simulation software. Experiments show that the control circuit meets the automation requirements of system performance. This shows that the automatic control circuit design based on single-chip microcomputer has certain reference significance for the design of other single-chip microcomputer control systems.***

Keywords: Automatic control, Power system analysis, Single chip microcomputer, Circuit design, Simulation analysis**.**

1. Introduction

With the continuous development and progress of power electronic technology, as a commonly used embedded system, single-chip microcomputer is widely used in household appliances to realize automatic control because of its low cost, small size, intelligent control and other characteristics. It actually brings convenience to people's daily life. Embedding the single chip microcomputer into the washing machine and realizing the automatic control of the washing machine has been a hot topic in recent years. It can not only effectively reduce the cost of the washing machine, but also improve its automation, accuracy and reliability. Therefore, in this paper, the AT89S52 single-chip microcomputer is mainly used, and the hardware circuit design of the control system is realized according to the design of the button circuit, the design of the inlet/outlet circuit, the design of the indicator circuit and the design of the motor drive circuit, and the software design of the control system is realized by C language programming[1]. Finally, by using the Proteus electronic design automation simulation software, the simulation of the function of the automatic control circuit is realized.

2. Overview of Proteus Simulation Software

Proteus simulation software is a kind of MCU simulation electronic design automation software. Applying it in the development of single-chip microcomputer control circuit can realize the optimization of control circuit design, save costs, and improve the progress and efficiency of product development. At the same time, because of its powerful functions and convenient peripheral devices, it is more suitable for simulation analysis of AT89 type single chip microcomputer. In addition, the simulation software provides commonly used instruments and tools for the test of the single-chip control circuit in the simulation process, and realizes the real-time simulation of the control system. At the same time, the monitoring of circuit parameters and states is realized, and the results are displayed along with the dynamic changes of the simulation, thereby effectively reducing the development cost and saving the testing time of the product. In addition, the Proteus simulation software can directly load the compiled program into the schematic virtual single-chip microcomputer. Under the action of running, the function design of the single-chip microcomputer control system is realized. And the accuracy and reliability of the simulation software are comparable to the actual physical circuit[2].

3. Design of Automatic Control Circuit Based on Single Chip Microcomputer

This paper takes the control circuit of AT89S52 microcontroller as an example, realizes the hardware design and software design of the control circuit with the help of simulation software, and realizes the functional requirements of the automatic control circuit of the single-chip microcomputer under the system simulation, and finally proves the feasibility of the control circuit through verification.

3.1 Overall Frame Design

The control system of the household appliance washing machine is mainly used. The overall frame design of the control system mainly includes the AT89S52 single-chip microcomputer, the minimum system circuit, the button control input circuit, the indicator light circuit, the prompt sound circuit, the water inlet/outlet circuit, and the circuit motor drive, etc.[3], and the specific schematic diagram is shown in Figure 1.

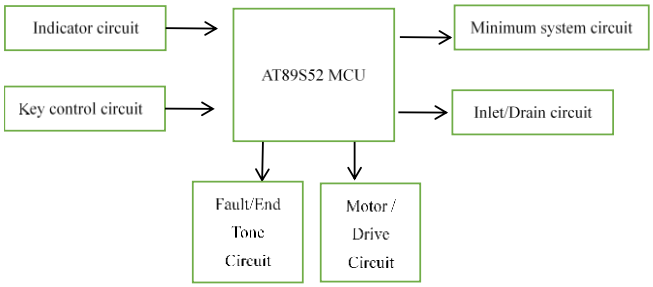

Figure 1: Schematic diagram of control circuit design

Among them, the minimum system based on single-chip microcomputer is the normal working circuit of AT89S52 single-chip microcomputer. The drive circuit design realizes

the drive operation of the motor. And the whole control system, under the operation of the single-chip microcomputer, is controlled by the key input circuit, which triggers the operation of each program of the whole system.

3.2 Minimal System Design of Single Chip Microcomputer

The design of the system circuit mainly provides a guarantee for the normal operation of the single-chip microcomputer. At the same time, the circuit design mainly includes three parts: power supply circuit, AT89S52 microcontroller and reset circuit crystal oscillator circuit. Among them, the single-chip microcomputer is a microcontroller with low power consumption and high performance, with programmable Flash function, which can fully meet the application requirements of the control system. Therefore, when a fault occurs in the control circuit based on the single-chip microcomputer, it only needs to be reset, that is, it can be restored to the initialization state, and the program can be re-executed. Therefore, its reset function has a direct impact on the stability and reliability of the microcontroller control system. Moreover, the reset circuit problem can be solved by means of a button power-on reset. The RESET terminal is grounded through the resistor, the capacitor is connected to the power supply, and the two ends of the capacitor are connected in parallel. When the button is turned on and off, the microcontroller system can be reset. The crystal oscillator circuit design can generate a clock signal, and the clock signal provides the concept of time for the normal operation of the single-chip microcomputer, so that the normal operation of the single-chip microcomputer has a time function.

3.3 Button Control Input Circuit

The washing mode button of the control system is connected to the I/O pin, so that the normal washing mode, energy saving, reading and writing, and dehydration mode of the washing machine can be realized. Under normal circumstances, when the system is turned on by default, the mode is normal washing mode. At this time, if you want to realize other modes, you need to gradually realize other functions through button control. When the system enters a certain mode, the indicator light will flash to prompt, waiting for the mode selection. After the selection is completed, the buttons such as start, pause, end, and prompt will be interconnected with the INTO interface to realize the entire laundry process. At the same time, jobs can be paused and started, etc., through the buttons[4].

3.4 Design of Indicator Light Circuit and Prompt Sound Circuit

First of all, from the design of the indicator light circuit, the design of the circuit is to provide indications for the operating modes of the washing machine, such as washing, boosting, and soft washing. In addition, it also provides indications for other functions. At the same time, in the circuit design process, the anode of the diode is powered on by using a 220 ohm resistor. The 220 ohm resistor is connected here to limit the current. The cathode of the diode will be connected to the corresponding P1~P1.7 and P2 on the microcontroller. Secondly, the design of the fault tone circuit, the main function is to use the P2.1 port output level control buzzer to send a tone to the user when a fault occurs during the operation of the single-chip control system, so as to play a warning effect. Since the output signal of the microcontroller is relatively weak, the buzzer cannot work properly. At this time, it is necessary to use transistors to realize the drive of the buzzer, and realize the sound of the fault prompt sound through the corresponding drive circuit.

3.5 Inlet/Drain Circuit Design

The design of the inlet/outlet circuit generally corresponds to the switch control of the inlet valve switch and the drain valve of the washing machine microcontroller. Simply put, it is the single-chip control signal that realizes the disconnection control and pull-in control of the relay. If the control water inlet and drainage command ports of the MCU are set to A and B, when the washing machine needs to enter water, the A pin of the MCU will control the water intake, and output a low level to make the relay in a reversed state to achieve entry, and vice versa Water intake could not be completed. At this time, the B pin controls the drainage, and the relay is disconnected by outputting a high level, so that it cannot be drained, and vice versa. Therefore, the design of the water inlet and outlet circuits can realize the corresponding functions such as drainage control and water inlet control through the microcontroller control program. At the same time, this type of status will be displayed by the indicator circuit lighting.

3.6 Motor Drive Circuit Design

For the design of the motor drive circuit, this paper chooses to use the triac as the control element of the circuit to control the solenoid valve and the motor. The reason is that the gate tube has the advantages of no noise and no interference. The circuit includes NPN transistors, relays and L-type chips. When the VCC terminal and the ENA terminal of the L-shaped chip are connected to the 5V power supply; its GND, ENB, VS, SENSB and other ports are connected to the ground level. At this time, by driving the motor and inputting both ends of IN1 and IN2, the motor can be driven to normally rotate forward, reverse and stop according to the function table. The specific function table is shown in the table. The single-chip microcomputer only needs to use the output levels of pins such as P2.4 and P2.5, combined with transistors, to control the relay to work[5]. The specific schematic diagram is shown in Figure 2. When the control program of the microcontroller runs so that the P2.4 pin outputs a high level, the transistor will control the relay to output a low level. When the low level is connected to the IN1 pin, the single-chip microcomputer will make the P2.5 pin realize a high level output.

Table 1: Function table of L chip

Motor status	IN1	IN1	ENA
Clockwise	1	0	1
Counterclockwise	0	1	1
Stop	X	X	0
Stop	0	0	0
Stop	1	1	0

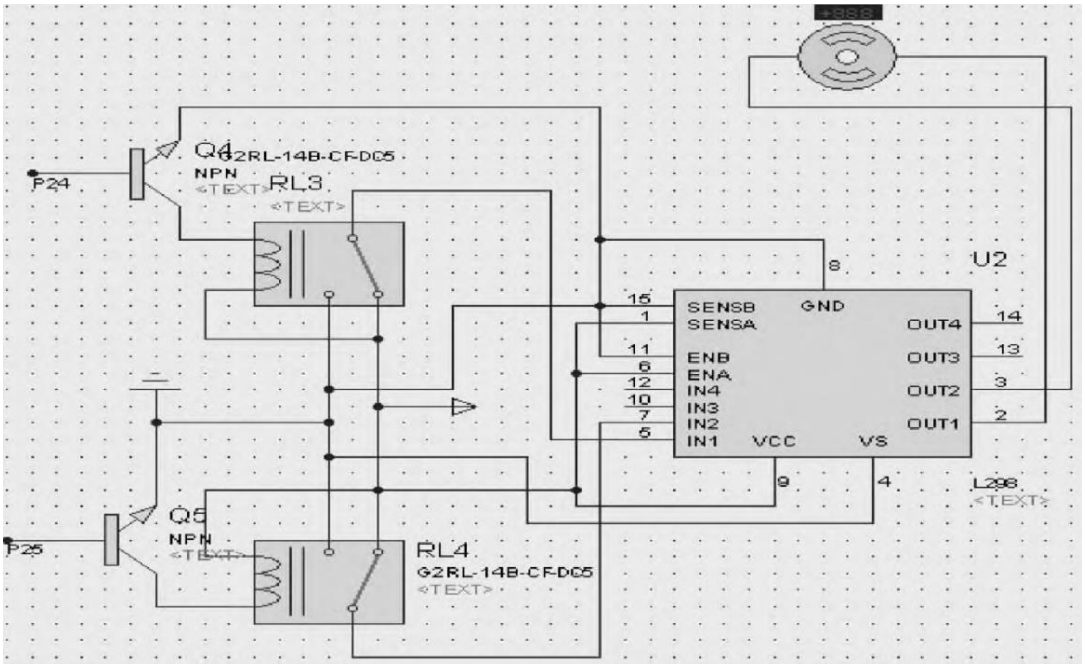

Figure 2: Schematic diagram of the motor drive circuit

4. The Control Software Program Design

The software design of the control circuit based on the single-chip microcomputer adopts the design method of modularization, and realizes the writing of the main program of the control system and the various types of functional subprograms combined with the C language[6]. The flow chart of the main program design of the control circuit of the specific single-chip microcomputer is shown in Figure 3.

First of all, the software part of the washing machine automation control system based on single chip microcomputer is designed, which is divided into key input, program running control and end prompt. Secondly, the operation of each module of the system is based on the single-chip microcomputer, which can realize the automatic operation of its own program. However, the judgment on the requirements of keyboard input and cover closing can only be realized by the instructions provided according to human requirements.

5. Simulation Test Analysis

In order to verify the feasibility of the automatic control circuit design based on single chip microcomputer, this paper mainly uses the Proteus simulation software, and carries out the simulation analysis of the computer and its peripheral components such as motors, capacitors, and resistors according to the hardware circuit design of the control system. At the same time, when the hardware circuit is connected, the frame diagram of the automatic control system of the washing machine is designed by modifying the parameters of different electronic components. Then the main control program is written according to C language, and the source program is compiled by the compiling software, and the object file is generated. Finally, the compiled program is loaded into the virtual single-chip microcomputer, and the simulation of the control circuit is realized by running[7]. When the control system starts, the indicator light circuit is on, which means the system is functioning normally. However, in order to test whether the relevant parameters of the control circuit and the performance index design meet the relevant requirements of the design, according to the output signal of the designed control circuit, the drive motor circuit is connected to the main circuit for testing. It is found that the work of the main circuit is relatively stable, and various functions can not only be realized normally, so this design meets the relevant requirements.

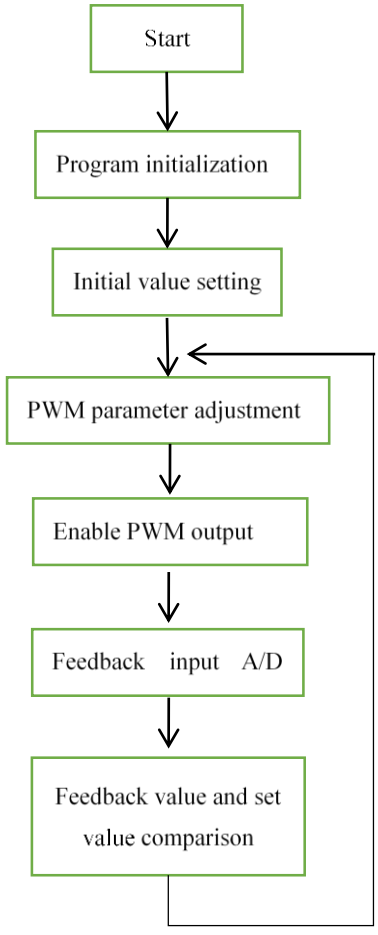

Figure 3: Schematic diagram of the main program

6. Conclusion

To sum up, according to the performance requirements of household appliances for automatic control, the overall structure of the electrical control system is first designed, and then the minimum system circuit, control input circuit and motor drive circuit are designed according to the hardware circuit requirements of the control system. Then combined with the control system hardware circuit design to realize the system software writing. And with the help of keiluvision compiling software to realize and generate the compilation and generation of electrical control system target files. At the same time, combined with Proteus simulation software to simulate the automatic control circuit based on single chip microcomputer. The simulation results show that the design of the automatic control circuit has high control accuracy during use. This is of great significance to the design of the microcontroller control system.

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