Research on Hardware Control Circuit of Intelligent DC-Motor

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Abstract: With the continuous improvement of industrial level, the intelligent control level of DC motor will require higher, for this purpose, this study will take the hardware control circuit of DC motor as the research object, through the hardware circuit design of intelligent DC motor, under the support of software, realize the forward rotation, stop, reverse and speed control of DC motor, The design has the characteristics of simple circuit, saving space and low cost, and it will be widely used in "artificial intelligence" and so on.

1. Introduction

With the continuous development of integrated circuit design and manufacturing technology, the function of circuit system is more and more powerful, but the composition is more and more simple, the importance of software design is gradually improved, but the importance of hardware circuit design can not be ignored. Software design is perfect, if the hardware circuit design is unreasonable, the performance index of the system will not be satisfied, serious even can not work properly. Intelligent DC Motor Hardware control circuit design is the same, so scientific and reasonable design of DC motor control hardware circuit is very important, based on the characteristics of Intelligent DC motor control circuit, its design is generally divided into: Design requirements analysis, schematic design, PCB design, process file processing and other principles, based on the design principles of hardware circuit, In this study, the hardware circuit of DC motor control system is designed and studied.

2. Design Requirements and Scheme

2.1. Design Requirements

This research takes STC89C52 as the core, designs a digital and intelligent DC motor speed control system through motor drive module, data storage module, LCD1602 LCD display, key control, power module. The design requirements are as follows: 1. Realize the real-time storage and reading of data storage module. (2) Real-time adjustment and display of PWM values. (3). Realize the forward and reverse of LED display motor. (4) Implement keyboard input and speed adjustment.
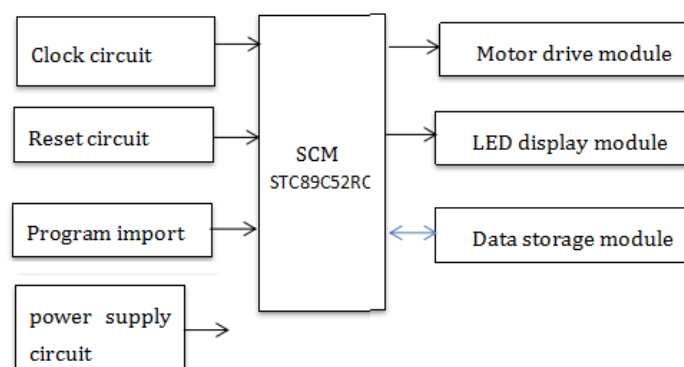
2.2 Design Block Diagram

Fig.1. hardware design block diagram

Based on the design requirements, the hardware control circuit of DC motor is designed by STC89C52RC, as shown in Figure 1, which includes motor drive module, key module, display module, LED module, data storage module and so on.

3. Hardware Design

3.1. MCU Minimum System Circuit Design

The smallest system of a single chip microcomputer is composed of a master chip, a reset circuit and a crystal oscillator circuit. It is equivalent to the brain of the whole system. In the circuit, pressing the reset key, the RST pin needs a continuous high level of 2 S to ensure reset. When the single chip is disturbed by the environment, the program is wrong, it needs to press the reset button to restart the program.

The crystal oscillator circuit is the core of the smallest system of the monolithic integrated circuit. The capacitance of the crystal oscillator circuit acts as a starting vibration. It provides the clock signal to the **MCU** and ensures the normal operation of the **MCU**. The circuit diagram is shown in Figure 2.
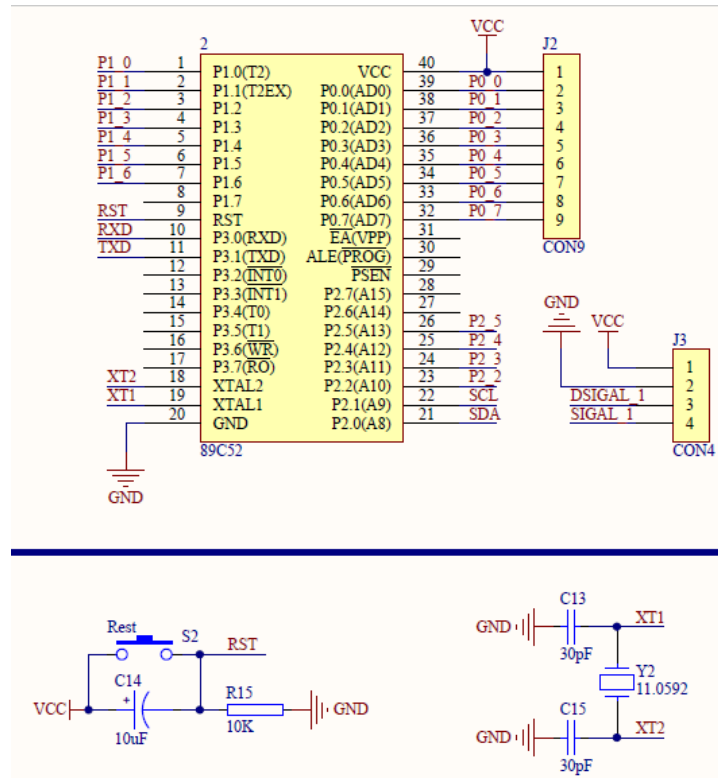

Fig.2. minimum system of single chip microcomputer

3.2. Motor Forward / Reverse Indication Circuit Design

In the design of DC motor speed control system, two LED lights are used as the indication of the positive and negative rotation of the motor. This not only makes the program control instruction less, but also the circuit design is very simple.

Because the working voltage and working current of LED are very small, so every LED lamp in the design is directly connected to the pin of the MCU and GND. By changing the level of the pin, the flickers of the two LED lamps can be controlled, so that the work of the positive and negative rotation of the motor can be observed. This circuit is composed of a red LED and a green LED lamp . When the motor is rotating, the green LED lamp blinks, and the red LED lamp blinks when the motor reverses. The specific circuit is shown in Figure 3.
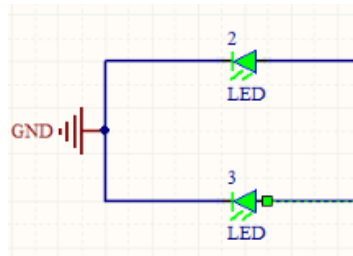
Fig.3. motor forward and reverse indicator circuit

3.3. Matrix Key Input Circuit Design

The matrix key input design circuit is shown in Figure 4. In this design, in order to meet the user can set the DC motor speed value, so the use of 4*4 matrix key circuit, the specific set of PWM value of the function of the key is: Confirm the key, delete the key, accelerator key, deceleration key, motor forward/reverse function toggle key, etc., a total of 16 keys.
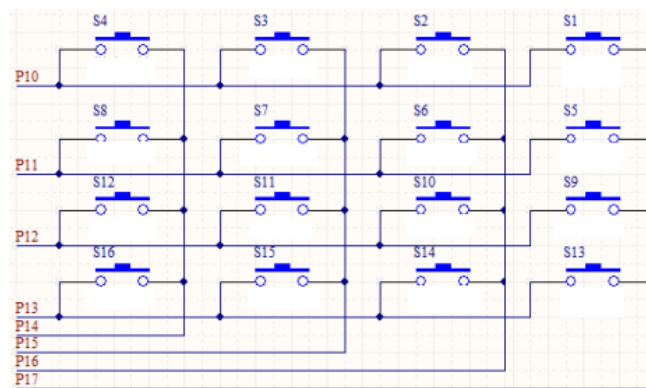

Fig.4. matrix key input circuit

3.4. DC Motor Drive Circuit Design

3.4.1. L298N Chip Introduction

L298N has four channels of logic drive circuit, which can receive TTL logic level signal. The combination of L298N and MCU can realize the accurate control of DC motor speed. The specific characteristics of L298N device are as follows: (1) it can drive two H-bridge motors; (2) the working voltage range is 2V-10V; (3) the input voltage of the signal terminal is 1.8V-7V; (4) the single working current is 1.5A, the peak current can reach 2.5A, and the standby current is less than 0.1uA; (5) the anti-commonality conduction circuit is built-in to avoid the wrong operation of the motor; (6) the TSD circuit with hysteresis effect is built-in, without worrying about the motor stopping.

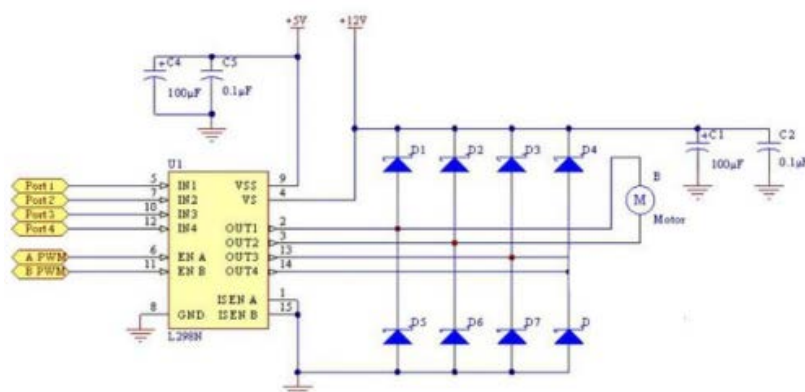### 3.4.2. Design of the Motor Drive Circuit

Fig. 5 L298N drive circuit

In this design, in order to control the forward/reverse operation of the motor, different circuits are needed to control the DC motor. Because the driving circuit may produce a large recharge current, in order to avoid the influence of the recharge current on the MCU, the L298N motor driving module is directly selected here. The specific circuit diagram is shown in Fig. 5.

3.5. Design of Data Storage Modules

3.5.1. AT24C16 Chip Introduction

In this design, the memory chip selects the AT24C16, the characteristics of the chip: (1) single power supply. (2)operating voltage: 1.8V ~ 5.5V. (3)low operating current. (4) 2-Line serial interface. (5) Schmidt triggers, noise suppression filter input.(6)bidirectional transport Protocol. (7)100khz (1.8v,2.5v,2.7v) is compatible with 400kHz (5V); (8) analog voltage range: VSS~VDD. (9)write protection pins are used for hardware data protection; (10) has the application function of 64 bytes and local page write mode devices: (11) has a discharge circuit and a power-down protection system;(12) has a functional storage system.
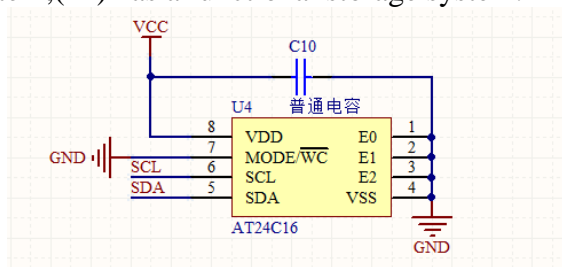

Fig. 6 AT24C16 Storage circuit

3.5.2. Storage Circuits

AT24C16 interacts with SCM through IIC communication protocol. Its circuit is shown in Figure 6.

3.6. Design of Display Circuit

In this design, the LCD1602 LCD is used as the display circuit, which is directly connected to the I/O port of the MCU. In addition, the potentiometer in the circuit adjusts the brightness of the display, and enables the port, the read control port and a write control port. They are directly connected to the I/O port of the MCU, and the circuit structure is simple, as shown in Figure 7.
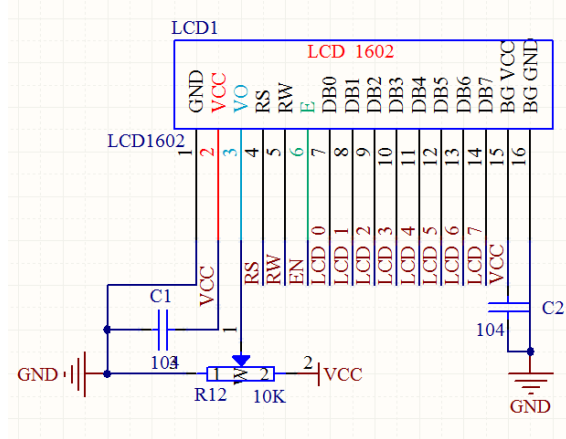

Fig. 7 display circuit

3.7. Design of Power Supply Circuit

In this design, the AMS1117-5 chip is used to stabilize the circuit. As shown in Figure 8, the DC-9V input from the J1 port is stabilized by AMS1117-5, and the output DC-5V is supplied to all the modules of the circuit system. C3 and C4 are the filter capacitors of the input circuit of the voltage regulator chip, C3 filters out the low frequency ripple voltage, C4 filters out the high

frequency ripple voltage, and C1 and C2 are the output filter capacitors, in which C2 filters out the low frequency ripple voltage, and the C3 filters out the high frequency ripple voltage. As shown in Figure 8.
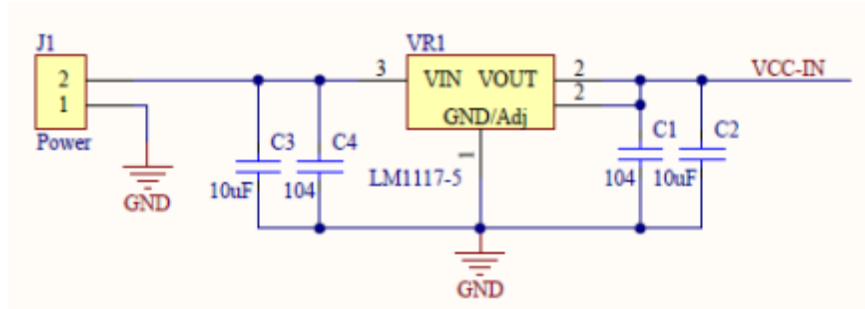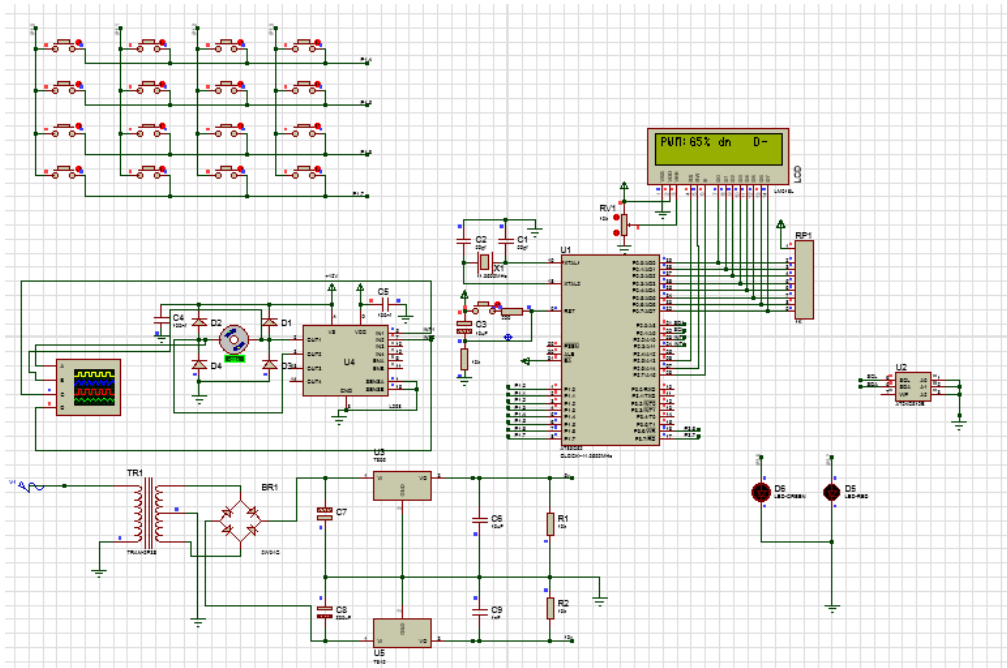

Fig. 8. Power supply circuit

Fig. 9 system simulation

4. Simulation of Hardware Circuit

The LCD display module, l298n Drive module, key input module, AT24C16 storage module and single chip microcomputer minimum system are cascading. Through the circuit simulation of Proteus Software, the results show that all modules can work properly, the measured PWM value duty-free ratio and the set PWM value are consistent, and any PWM value within 0 to 99 can be set by the key module. The motor forward and reverse control is realized, while the acceleration and deceleration of the motor can change according to the gradient of 20%, the input confirmation value and the deletion value can also achieve the expected effect, the AT24C16 can successfully realize the storage, the LED completes the expected flicker function.

5. PCB Design and System Assembly

Altium Designer 9 software is used for the design of intelligent DC motor hardware circuit PCB board. its specific design method is as follows: ① determine the appropriate component package; ② generate grid table: View the encapsulation of each component; ③ planning circuit board; ④ load component encapsulation and network; ⑤ component layout; ⑥ Set wiring Specifications (line width and wiring level).

After the design of the PCB board of the hardware circuit, the system assembly should be

assembled according to the drawn PCB and circuit schematic diagram. When installing the components, we need to pay attention to the order of the components. When the components are welded, we should pay attention to controlling the temperature of the soldering iron.

After assembly, the circuit system can achieve all the functions of the design by testing and achieve the design purpose.

6. Conclusion

The design of the intelligent DC motor hardware circuit system has been tested. The test shows that the circuit system realizes all the functions of the DC motor, such as forward, reverse, acceleration, deceleration and setting of custom values. At the same time, the IIC protocol is used to enable AT24C16 to achieve the function of power failure protection and storage. This design has the characteristics of simple circuit, space saving and low cost. It will be widely applied in artificial intelligence.

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