Design of Soil Moisture Detection System Based on Single Chip Computer

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Abstract

The soil moisture detection system based on single chip microcomputer which can be used to detect the real-time soil moisture. The soil moisture sensor collects soil information, processed by the single-chip microcomputer, and intuitively feeds back the soil moisture information through LCD display. According to the different requirements of soil moisture in different environments, the required humidity range can be set by using the buttons. When the soil moisture exceeds the set range, the red light will be on and the buzzer will sound. Achieve the purpose of reminding people to add moisture to the current soil. The design is based on single-chip microcomputer as the main control system. The hardware system includes 51 single-chip microcomputers, HS1101 soil moisture sensor, LCD display, buttons, LED lights, and buzzer.

Keywords

MCU; Humidity Sensor; LCD; Buzzer.

1. Introduction

Humidity is a very important element in nature, and many links in life are closely related to it. Soil moisture refers to an index of soil moisture content. By detecting soil moisture, people can predict crop growth or yield. If the humidity of the target soil is collected by intelligent means, and the humidity of the target soil is adjusted by manual intervention, to achieve the purpose of increasing yield or making the results better, the soil humidity detection can be beneficial to the development of many industries. In terms of agriculture, China has a vast territory and nourishes more than one billion people. In this era, the development of science and technology is changing with each passing day, and agricultural technology is constantly updated with the development of science and technology. However, the modern agricultural irrigation technology has not been well promoted and popularized. Most of the western regions and remote mountainous areas of my country still use traditional irrigation methods. There is no scientific basis for the irrigation of crops. Most of it depends on the farmers' experience and it is difficult to provide crops provide the best growing environment. Water resources are difficult to use rationally. If the soil moisture of the farmland is tested and irrigated according to the different requirements of soil moisture for the growth of each crop, the crops can grow in the most suitable environment. At the same time, it also achieves the purpose of saving water resources and providing water utilization [1,2]. In terms of potted plants and greening. With the improvement of national living standards. People want to have a green home environment and quality of life. While meeting material needs, people also began to pay attention to spiritual needs. The design is a soil moisture detection system based on a single chip microcomputer. It is composed of single chip microcomputer, humidity sensor, buzzer, LCD display, peripheral circuit and other parts. With the single-chip microcomputer as the core, the current soil humidity information is collected in real time through the HS1101 humidity sensor. After processing by the single-chip microcomputer, the LCD1602 display screen feeds back the results of the single-chip processing to the user. The user can set a suitable humidity range for him according to the different requirements of the soil humidity in different environments. If the current humidity is within the set range, the yellow LED will be on. Conversely, if the current soil humidity is lower than the lower limit of the set value or higher than the upper limit of the set value, the red LED will light up and the buzzer will sound to remind the user to humidify the current soil or stop adding water to the soil [3,4].

2. Scheme design

In the program selection, after comparison and demonstration, it was decided to use the single-chip microcomputer as the control system of this design. When using the single chip microcomputer, the power consumption is low and the internal capacity is large. Using single-chip microcomputer to control, high reliability, relatively simple operation, easy to modify and maintain. Nowadays, there are a large number of complete open source programs on the Internet, which are convenient to call during debugging and save time. The microcontroller can continue to expand other functions through its external modules. These characteristics can make the design of the one-chip computer occupy an advantage in the later popularization and promotion. The MCU selected for this design is the STC89C52RC MCU. The instructions and codes of this microcontroller are fully compatible with traditional 8051 microcontrollers. If the chip needs to be replaced with other 51 microcontrollers, the program can be directly transplanted. The physical diagram, schematic diagram, and pin diagram of the single-chip microcomputer are shown in Figure 1.

STC89C52 MCU pin function:

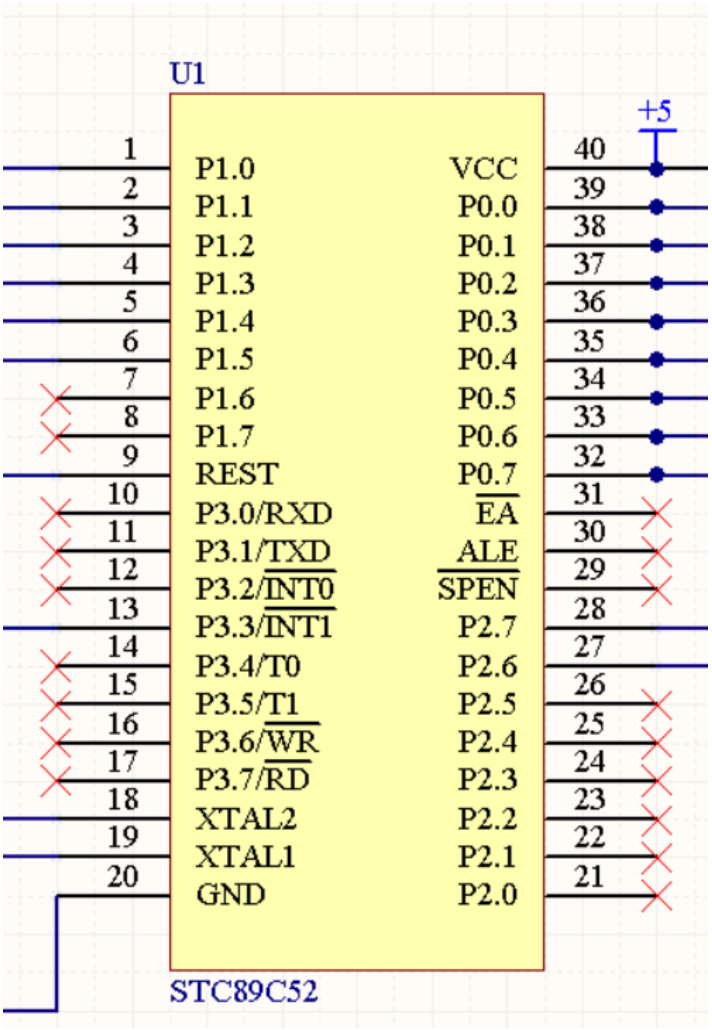

Fig 1. STC89C52 schematic

As can be seen from the above figure, the STC89C52 microcontroller has a total of 40 pins.

1. Power supply pin: The 20th pin VSS is grounded (GND), and the 40th pin VCC is connected to the main power supply of the microcontroller +5V.

2. Reset pin: The 9th pin RST is the reset pin. Used as a reset input, if you want to reset the microcontroller, generate a high level of two machine cycles in this pin to complete the initialization operation.

3. Crystal oscillator pins: The 18th and 19th pins are external crystal oscillator pins. Between these two pins, the external crystal oscillator and the internal amplifier of the microcontroller form an oscillator circuit.

4. I/O pins: STC89C52 MCU has 4 8-bit parallel input and output ports, P0, P1, P2, P3. A total of 32 pins are corresponding. Through the program, you can send signals to each pin for independent control. P0 is a bidirectional three-term input and output port. P1, P2, and P3 are 8-bit bidirectional input and output ports with internal pull-up resistors. When the pin is input 1, the internal resistor will pull the port to a high potential, so When the P1, P2, and P3 pins are used as output terminals, there is no need to connect an external pull-up resistor.

5. Memory access control pin: Pin 31 (EA/VPP) accesses external program memory control signal.

6. External memory control signal pin: the 30th pin (ALE/PROG) is the same as the multiplexing pin, and the 29th pin (PSEN). The two pins here are used during system expansion.

The humidity sensor used in this design is HS1101 humidity sensor. The sensor is a capacitive sensor, which is widely used in occasions where humidity detection and compensation are required. The HS1101 humidity sensor has the characteristics of reliability, long-term stability, and rapid response time. It does not require calibration during use and is completely interchangeable. The required information can be fed back in real time. Since the humidity sensor is a capacitive component, it is replaced by a capacitor in the schematic diagram and simulation circuit. The capacitance value will change with the humidity of the measured object. In the range of relative humidity of 0%-100%RH, the corresponding capacitance value ranges from 160pF to 200pF. The error is within ±2%RH. The physical picture of HS1101 humidity sensor is shown in Figure 2.

Fig 2. HS1101 physical picture

Here we use LCD1602 to display on the display. LCD1602 display is a liquid crystal display. Looking up the information, it is found that most of the devices that need to display letters, numbers or characters choose this display. The working voltage when in use is +5V, and the contrast of the display can be adjusted according to different needs. The display has its own reset circuit. In order to facilitate the user's operation, the display provides various control commands for different functions: clear Screen, character flashing, cursor flashing, shifting, etc. The liquid crystal display has the characteristics of low power consumption, full display information, and no radiation when in use. The 1602 LCD is often used in micro-small meters and low-power systems. There are two standards for this LCD, one is with 14 pins without backlight, and the other is with 16 pins with backlight. Considering the use in poor light environment, this design uses 16-pin LCD with backlight. Ensure that the detected information can be clearly displayed under any circumstances. The physical map is shown in Figure 3 below.

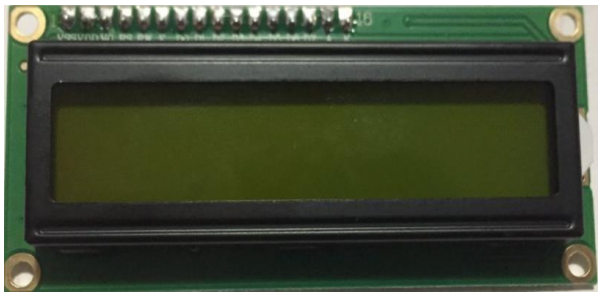

Fig 3. LCD physical picture

The LCD liquid crystal display screen 1 pin is connected to GND, 2 pin is connected to VCC+5V power supply, 3 pin is the gray scale adjustment of the liquid crystal, generally the resistance between the 3 pin and the ground is 1.5k, between the 3 pin and the power supply The resistance value is about 10k (if the resistance selected between this pin and the power supply is not appropriate, it will be displayed as an abnormal LCD screen). The function of the No. 4 pin (RS) of the display is register selection. When using the data register, input a high level signal, and if you want to use an instruction register, input a low level signal. The No. 5 pin (R/W) is the read and write signal line. A high-level signal is required for reading and a low-level signal for writing. When RS and R/W are both at low level, the instruction or display address can be written. When RS is low and R/W is high, the signal can be read. When RS is high and R/W is low, data can be written. The sixth pin is the enable terminal. When the enable terminal changes from a high level signal to a low level signal, the display screen starts to execute instructions. Pins 7 to 14 of the liquid crystal display module are connected with P0.0-P0.7 of the single-chip microcomputer.

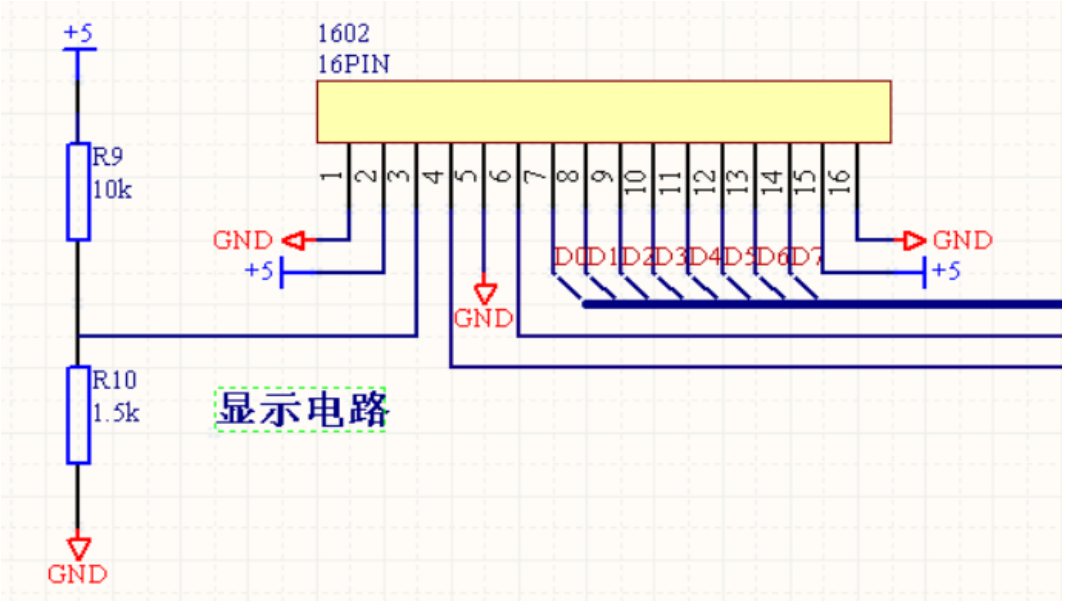

Fig 4. Display circuit

In order to provide a stable working environment for the design system, the reset circuit is an indispensable part. Reset is to restore the device to a certain state that has been initialized or set. When the single-chip microcomputer is disturbed or the program goes into an infinite loop during operation, it needs to be reset. The reset of the one-chip computer is realized by the external circuit, the signal is input by the RESET pin, and the high level is effective. In this design, a 5V power supply, a capacitor and a 10k resistor are connected in the reset circuit, and the microcontroller is reset immediately when the power is turned on. When the microcontroller is running, we can use an external button to reset the microcontroller.

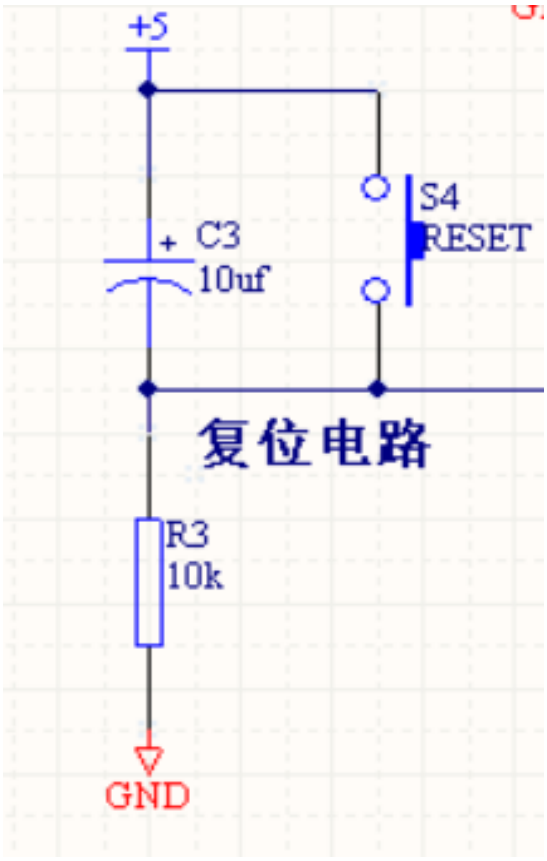

Fig 5. Reset circuit

The crystal oscillator circuit is also called a clock circuit, which generates a clock signal for the internal work of the microcontroller. Provide a time reference for various operations of the microcontroller. The design adopts the internal oscillation method, using the inverting amplifier inside the single-chip microcomputer to form an amplifying circuit, and connecting the crystal oscillator and two capacitors between the 19-pin and 18-pin of the single-chip microcomputer to make the internal oscillator generate stable self-excited oscillation. The crystal oscillator circuit is shown in Figure 6.

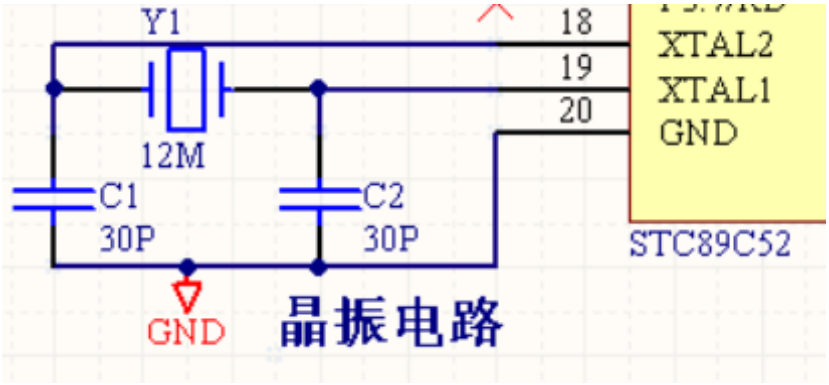

Fig 6. Crystal oscillator circuit

The power supply module, the external +5V power supply is inserted into the DC power interface, and the entire design system is powered by the self-locking switch. The introduced power supply is connected to the two normally open contacts of the self-locking switch. When the switch is pressed, the system gets power. If you need to power off the device, press the switch again.

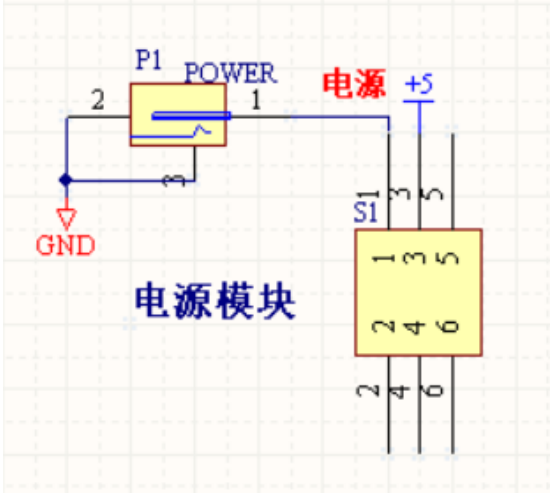

Fig 7. Power circuit

In order to ensure the design goal of simple production and operation, the design only uses three buttons to control the system. The three buttons are all connected to GND. When the button is pressed, a low level will be input to the corresponding MCU I/O port. The microcontroller program detects the low-level signal and executes the control operation on the corresponding part. The functions of the three buttons here are to enter parameter settings, adjust parameters up, and adjust parameters down. Use three keys to complete the setting of the humidity range, which has the characteristics of quick and easy operation. It is convenient for users to operate.

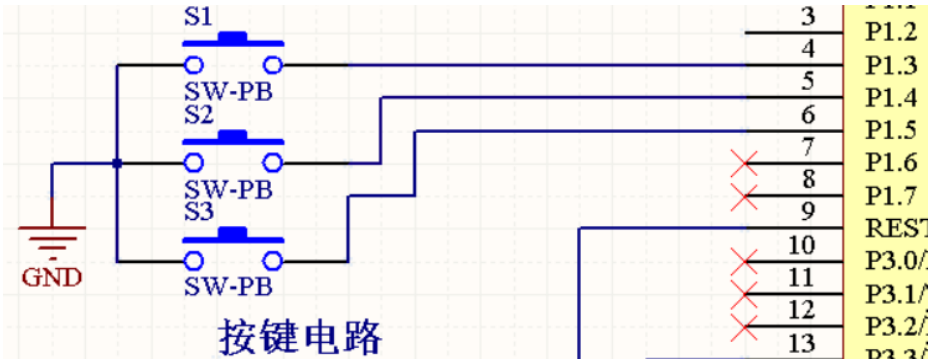

Fig 8. Button circuit

The alarm circuit in this design consists of two parts, which are the buzzer drive module and the LED display part. The buzzer drive module consists of a 2.2K resistor, PNP type transistor and buzzer. The 2.2K resistor plays the role of current limiting in this part, and the triode here is the switch. If the microcontroller outputs a low level to this pin, the low level signal will flow through the current-limiting resistor. At this time, the transistor is turned on, and the current flows from VCC to the buzzer and the transistor returns to GND. Therefore, when the microcontroller sends a low-level signal to this port, the buzzer will sound. The display module of the alarm circuit is composed of red and yellow LED lights and two 2.2K resistors. Each LED lamp is connected in series with a resistor, because the working voltage of the LED is 3V, but the power supply used in this design is a +5V power supply, so the LED is connected in series with a resistor of 2.2K resistance. The role of the resistor here is to boost pressure. When the MCU outputs a low level to the port, the corresponding LED light will light up. In this design, if the humidity detected by the sensor is within the set range, the P1.1 port outputs low level, and the yellow LED lights up. If the detected humidity exceeds the set range, the microcontroller will output low-level signals to the P1.0 and P1.2 ports, and the buzzer will sound and the red LED will light up.

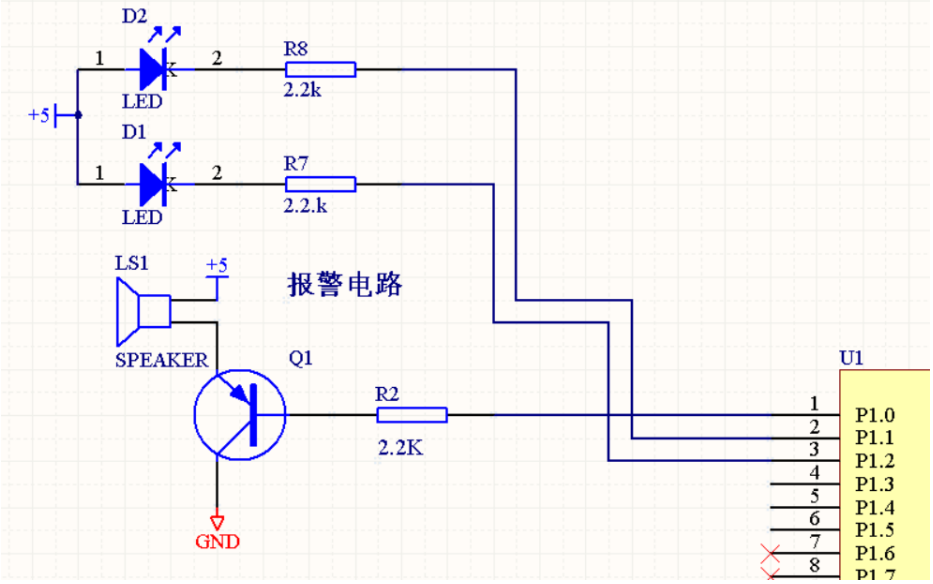

Fig 9. Alarm circuit

The HS1101 sensor used in this design is equivalent to a capacitor in the circuit schematic and simulation, and its capacitance value will change as the humidity of the measured object changes. In order to convert the variation of the capacitance into a signal that is easy for the microcontroller to receive and process, the design places the capacitance in the NE555 oscillator circuit. The 555 integrated circuit was originally used as a timer, so it was also called a 555 timer. After subsequent development, the circuit has a better and wider application range. In addition to being used as a timer, it can be used in many occasions that need to control or detect multiple elements such as light, temperature, humidity, and speed. Due to its low price, high reliability, and convenient use, the use of 555 integrated circuits can be seen in many electronic products. In the 555 oscillation circuit, the oscillation frequency read by the capacitance is different. In this part of the circuit, the change in capacitance is converted into a voltage frequency that is inversely proportional to it. The single-chip microcomputer reads the oscillation frequency generated by the humidity measurement circuit through the P3.3 port (INT1), which is the external interrupt port 1.

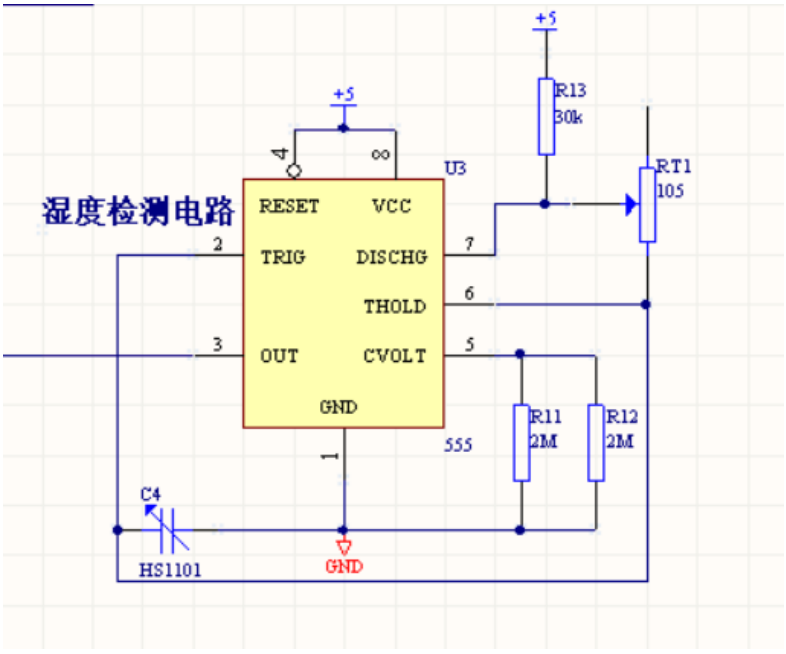

Fig 10. Humidity detection circuit

Figure 11 is the overall schematic diagram.

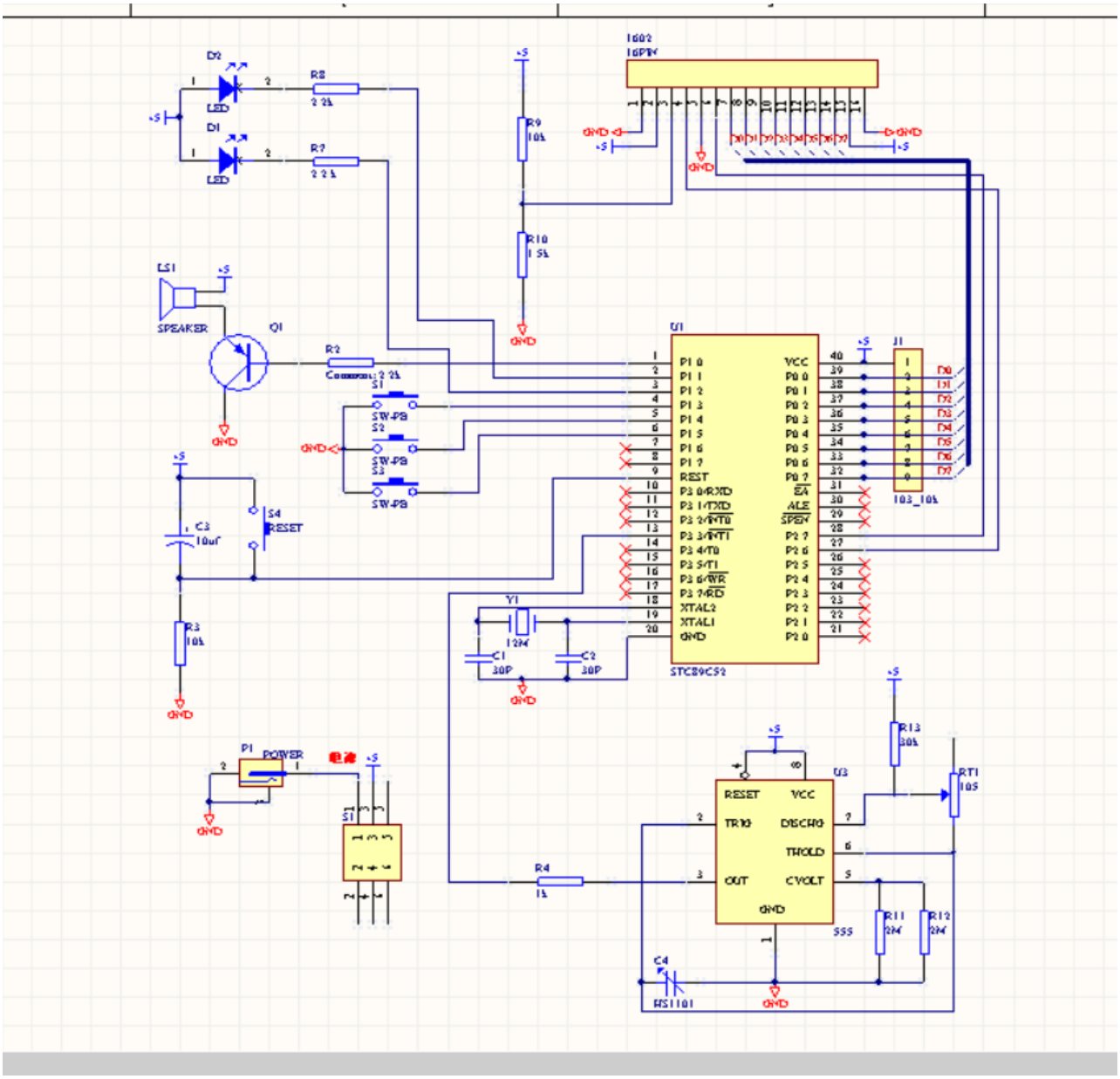

Fig 11. Overall schematic diagram

3. Conclusions

The design is based on the design of the soil moisture detection of the single chip microcomputer. STC89C52 is used as the main control chip of the design system, the HS1101 humidity sensor is used to collect the soil humidity information, the upper and lower limits of the soil humidity range are set with the buttons, and the LCD1602 liquid crystal display is used to realize the real-time display of the current measured soil humidity percentage. When the soil moisture is within the set range, the yellow light in the alarm circuit will be on. When the soil moisture exceeds the set range, the red light will be on, and the buzzer will sound to remind the user. The actual measurement with the manufactured objects can effectively detect the soil moisture and quickly issue an alarm when the soil moisture exceeds the range.

Acknowledgments

This work was supported by 2020 Jiangsu Province University Student Innovation and Entrepreneurship Training Program Project.

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