Design of a High Precision Digital Clock Based on Single Chip Microcomputer

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Abstract

Compared with traditional mechanical clocks, digital clocks have higher accuracy and durability and are widely used in people's daily lives. This paper designs a digital clock which uses AT89S52 single-chip microcomputer as the main control chip. It can count hours, minutes, and seconds, and can calibrate the time. It can switch between 24-hour and 12-hour systems. As a smart clock, while displaying the time, it also adds the function of temperature display. The intelligent digital clock designed in this paper has stable performance in theory and has certain practical value.

Keywords: digital clock, DS18B20, single-chip microcomputer

1. Introduction

Digital clocks have become electronic necessities in people's daily life. For example, they have been widely used in personal family life, subway transportation stations, movie theaters, cultural offices and other public places, which greatly facilitate people's life, study, work and entertainment. Compared with the traditional mechanical clock, the accuracy and intuitiveness of the digital clock have been improved. Because it has no mechanical device, the service life of the digital clock is relatively long and has been widely promoted.

The general trend of digital clock development in the current era is gradually moving closer to higher accuracy, smaller size, more functions, and lower power consumption. In this context, the degree of digitization and precision of the clock has become the dominant design direction of the current clock development and progress. The hardware system includes 5 independent touch switch buttons and an LCD liquid crystal display, which can display necessary information. According to the needs of the user, the time can be further calibrated, selected time, and temperature display at any time. In addition, it can convert between 12-hour and 24-hour formats.

2. Overall Design

The digital clock designed in this article mainly includes two parts: hardware and software. The hardware part is the basis for the completion of the operation of the designed system, and the software part effectively and fully supports and utilizes the hardware of the system to meet the functional requirements of the designed system. As shown in the Fig.1, it is the schematic diagram.

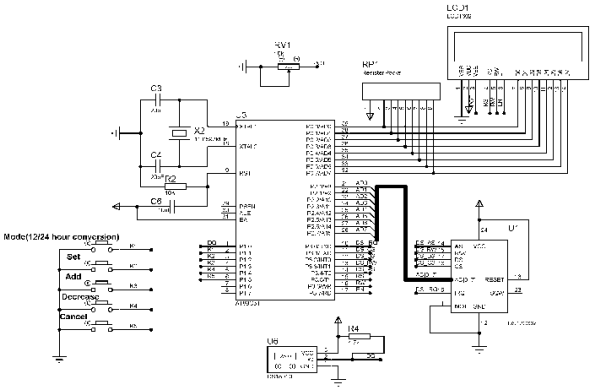

Fig.1 The schematic diagram

The digital clock designed in this paper uses AT89S52 single-chip microcomputer as the main control chip[1], the clock module uses DS12C887 as the clock chip, the temperature sensor DS18B20 chip as the temperature module, the LCD1602 as the display module, and the button control part uses the touch switch button circuit.

In theory, the electronic clock designed in this paper has high practicability and stable performance. The software part of this system runs under the Keil μVision4 software platform environment, and implements specific functions with a single-chip C language program.

3. Hardware

3.1. AT89S52

AT89S52 is a member of MCS - 51 family[2]. It is a low-voltage, high-performance CMOS 8-bit single-chip microcomputer produced by Atmel in the United States. It contains 8KB of program memory that can be written repeatedly and 256 bytes of data memory (RAM). The device is produced using Atmel's high-density, non-volatile storage technology, compatible with the standard MCS-51 instruction system, and is equipped with a general-purpose 8-bit central processing unit (CPU) and Flash storage unit on-chip. As shown in the Fig.2, it is the AT89S52 chip pin diagram.

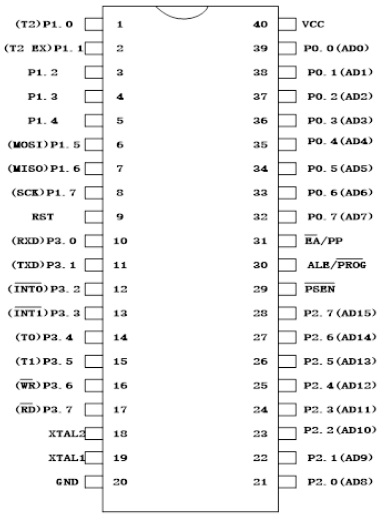

Fig.2 AT89S52 pin diagram

The powerful AT89S52 single-chip microcomputer can be flexibly applied to various control fields. AT89S52 single-chip microcomputer is an enhanced type of AT89C51 single-chip microcomputer, and has extremely high compatibility with Intel's 80C52 series chips in terms of pin arrangement, hardware composition, working characteristics and instruction system. In the system designed in this article, the internal clock mode and the button level reset circuit are selected to form the smallest circuit of the single-chip microcomputer.

The main operating characteristics of AT89S52 are as follows:

- 8k byte independent programmable Flash storage.
- Eight interrupt sources.
- Fully compatible with MCS-51 series single-chip products.
- Fully static command operation: 0Hz～33Hz.
- Three-level encrypted program memory.

3.2. DS12C887

The DS12C887 clock chip is a real-time clock/calendar chip launched by the Dallas Semiconductor Company of the United States[3]. It uses a parallel interface and is made of CMOS technology. It has a crystal oscillator and a lithium battery backup for the clock chip. It is compatible with the pins of MC146818 and DS12887, which are commonly used in daily computers, and can be directly replaced. The clock circuit designed with the DS12C887 clock chip does not require any peripheral circuits and devices, and has a good microcomputer interface. The DS12C887 clock chip has the advantages of low power consumption, relatively simple peripheral interface, extremely high accuracy of time travel, and stable and reliable operation. It is widely used in various real-time clock systems that require higher precision. As shown in the Fig.3, the connection circuit diagram of the DS12C887 clock chip and the microcontroller.

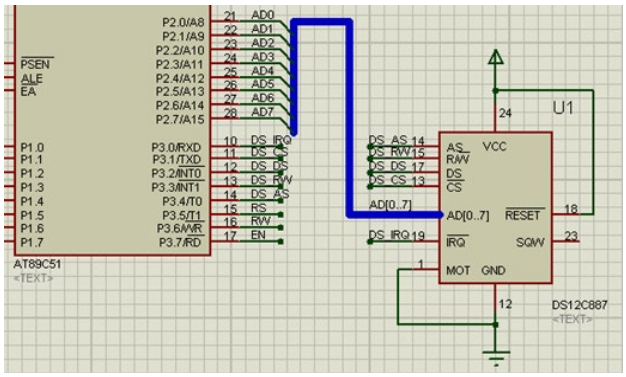

Fig.3 The DS12C887 connection circuit diagram

3.3. DS18B20

DS18B20 temperature sensor is an improved intelligent temperature sensor launched by DALLAS Semiconductor Corporation of the United States. Compared with the traditional thermistor and other components, the sensor can directly read the temperature of the environment where the sensor is currently located, and can achieve 9-12 digital value readings through simple programming according to actual performance requirements[4]. The temperature of the environment is directly used for data transmission in a one-wire bus, which greatly improves the anti-interference characteristics of the sensor itself. This chip is suitable for temperature measurement in harsh environments, such as temperature measurement consumer electronic products of various scales. As shown in the Fig.4, it is the interface circuit diagram of DS18B20 temperature sensor.

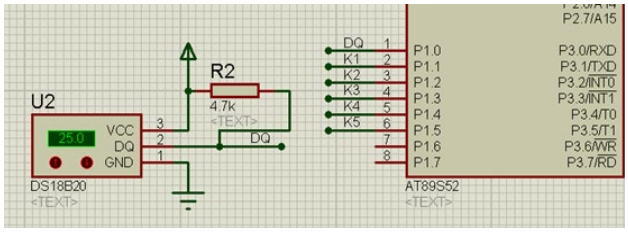

Fig.4 DS18B20 circuit diagram

The performance characteristics of this chip are as follows:

- The unique single-wire interface requires only one port pin for inter-chip communication.
- The temperature measurement range is -55℃ to 125℃, and the maximum resolution can reach 0.0625℃.
- The 3-wire system is connected to the single-chip microcomputer, which reduces the use of external hardware equipment.
- It can be powered by the data line, and the voltage range is 3.0V-5.5V.
- Negative voltage characteristics, when the polarity of the power supply is reversed, the thermometer will not burn out due to heat, but it will not work normally.

3.4. LCD1602

This LCD1602 character liquid crystal display module is a dot matrix liquid crystal module specially used to display letters, numbers, symbols, etc. It is composed of several 5×7 or 5×11 dot matrix character bits. Each dot matrix character bit can display a character. There is a dot pitch between each bit, and there is also a gap between each line that plays the role of character spacing and line spacing, because of this, it cannot display graphics. The 1602LCD display means that the displayed content is 16×2, that is, it can display two lines, each line has 16 characters LCD modules.

The characteristics of LCD1602 are as follows:

- +5V voltage.
- Built-in reset circuit.
- Provide various control commands, such as: clearing the screen, blinking characters, blinking cursor, display shift and other functions.
- There are 80 bytes display data memory DDRAM.
- Built-in character generator CGROM with 192 5×7 dot matrix fonts.
- With user-definable 5×7 character generator CGRAM.

4. Software

The entire software system in this paper uses C language programming. The high-precision digital clock software designed adopts a modular structure and mainly realizes the following functions:

- LCD function realization.
- Time data collection.
- The realization of 12/24 hours conversion.
- Temperature collection.
- Key recognition processing.

5. Conclusion

This text design uses AT89S52 as the main control single-chip microcomputer, the clock module chooses DS12C887 as the clock chip, the temperature module chooses DS18B20 as the temperature sensor, LCD1602 as the display module, and the button circuit for the setting part.

The high-precision digital clock based on the single-chip microcomputer in this design realizes the counting of seconds, minutes and hours, and can switch between the 24-hour system and the 12-hour system. After testing, the system has achieved the goal of aligning

the minutes and hours at any time, and the timing error is less than 0.01s/day.

As shown in the Fig.5, it is the final test result.

Fig.5 Test result

The key functions are as follows:

- K1: Digital clock 12/24 hours conversion button.
- K2: Setting button, used to adjust the hours, minutes, and seconds of the time.
- K3: "+" button, the number increases by 1.
- K4: "-" button, the function of reducing the number by 1.
- K5: Cancel button, cancel the current operation, return to the main page (time display page).

The content displayed on the LCD1602 display includes precise hours, minutes, seconds, and current ambient temperature.

After actual testing, the digital clock designed in this article has high performance and certain usability.

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