Academic Journal of Engineering and Technology Science
ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

Design of Perpetual Calendar Based on STC12C5A60S2 Microcontroller

Liu Gengqi, Bi Jinjie[a,*], Yang Yi

School of Electronic and Information Engineering/School of Integrated Circuitst, Guangxi Normal University, Guilin, China
[a]bjj9217@mailbox.gxnu.edu.cn
**Corresponding author*

Abstract: *This design is based on STC12C5A60S2 MCU calendar design.On account of the fast pace of modern social life, people's awareness of time is more and more strong, in order to facilitate people quickly access to time information, we put forward a product scheme which can clearly display the year, month, minute and second . Optimize the interaction design between users and products, so that users feel convenient and fast. The design of this work mainly interacts with users through IIC display screen, which is divided into five functions, such as time and date display, temperature display and warning, time storage, alarm clock setting and focus mode. Users can control the system by pressing buttons and set the function mode they want. The data reading of the first four interactive interfaces is realized by the external chip, while the time reading of the focused mode is achieved by the internal clock of the single chip microcomputer. After testing, the data can be correctly displayed in the interface of time and date; Accurate temperature reading can achieve the ideal effect; Time storage and alarm Settings can be obtained from the memory chip storage data; Focus mode can be properly timed with the internal clock.*

Keywords: *51 MCU; A perpetual calendar; Embedded development*

1. Introduction

This design is eye-catching and convenient, in some specific places or public places applicable, can quickly provide the year, month, day, hour, minute, second and other information, and this MCU based design calendar can be used offline, without networking. The design simulates industrial design and can be used in activity scenes such as desks and classrooms, as well as crowded public places such as subway stations and hospitals. This perpetual calendar solves the problem that the past perpetual calendar function is not rich enough, is designed to be associated with the lunar calendar time, storage time information and set the alarm clock and other functions combined multi-functional perpetual calendar. For the requirements of the design task, we are divided into three parts, and do the following explanation. The first part for the foundation, has completed the year, month, day, time, minutes, seconds and other information display, to the basic information of the calendar for an adjustment and save.The second is the additional part. The designed calendar can set the alarm clock function and save it. It can realize the OLED display through IIC and has a relatively clear display effect [1], which can display the lunar information on the OLED display. The third is for other play part, the calendar design adds two additional functions: One is high and low temperature warning and the other is focus mode.

2. Scheme Design of The System

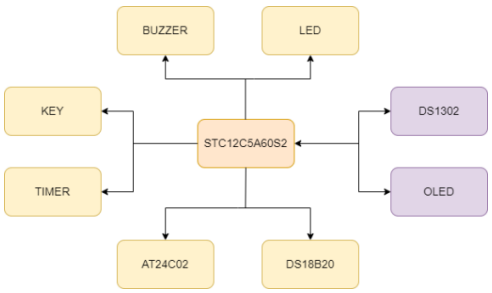

Figure 1: Schematic diagram of module composition

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

This system is mainly divided into user input part and system output part, as shown in Figure 1.

2.1. Output group

2.1.1. Selection of main control scheme

Scheme one: The use of STC12C5A60S2 single chip microcomputer chip.Advantages: convenient, can directly operate on the register, code logic is simple, for the data read directly can use the pin read, do not need additional configuration, and has lower power consumption, the cost is lower. Disadvantages: Compared with STM32 series, chip running speed is slow.

Scheme two: Using STMF103ZET6 microcontroller chip. Advantages: STM32ZET6 chip has a larger running speed, processing power is more powerful, and resources are more abundant. Disadvantages: High cost, complex code writing, requiring initial configuration of I/O ports before reading data.

In summary, considering that this design is a calendar, the processing speed of the single chip microcomputer is not high requirements, but as a product design, we need to consider the cost and easy implementation, so the choice is a scheme using STC12C5A60S2 single chip microcomputer scheme.

2.1.2. Time Display Scheme

Scheme one: The use of MCU internal clock counting time. Advantages: no hardware cost, simple design. Disadvantages: pure software timing a power off MCU reset all data to zero, practical value is not high, for data adjustment and read logic complex.

Scheme 2: Using DS1302 clock chip.Advantages: its accurate timing, simple interface, easy to use, wide working voltage range and low power consumption, in the software for data reading and modification convenient. Disadvantages: DS1302 will be affected by temperature, beyond the suitable operating temperature, the data error becomes larger.

To sum up, considering the accuracy of time and ease of reading, DS1032 has prominent advantages in daily usage scenarios, so the second scheme DS1302 chip is adopted as the scheme of clock part.

2.1.3. Content Display scheme

Scheme 1: Use LCD1602 display screen, advantages: LCD1602 is convenient display, simple command operation, low cost. Cons: Text display is not clear, the screen refresh rate is low.

Scheme 2: Use OLED screen display.Advantages: OLED screen display effect is clear, high refresh rate. Disadvantages: short service life, high cost.

To sum up, scheme two is adopted, which is conducive to better interaction between users and the system, and OLED module can display text information better.

For data storage: this design uses 24C02 memory chip, 24C02 is a 2K serial CMOS EEPROM, containing 256 8-bit bytes, with write protection function. When the main control chip is powered off, data on the chip is protected to prevent data loss.

Status display part: This design uses 4 additional LED lights to inform users of the status of the system, so that users can interact with the system more intuitively.

Temperature sensing part: This design uses the DS10B20 temperature sensor chip to measure the temperature. DS18B20 is a commonly used digital temperature sensor, which has the characteristics of small size, low hardware overhead, strong anti-interference ability and high precision.

2.1.4. User Input

The user input in this design is carried out by four independent keys. In the interaction with users, the keys have the following functions: switching the display interface, users setting the system, storage, data modification, etc. [2]

Status display part: This design uses 4 additional LED lights to inform users of the status of the system, so that users can interact with the system more intuitively.

Temperature sensing part: This design uses the DS10B20 temperature sensor chip to measure the temperature. DS18B20 is a commonly used digital temperature sensor, which has the characteristics of small size, low hardware overhead, strong anti-interference ability and high precision.

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

3. Hardware design

3.1. Main control circuit

The main control circuit uses 5V for power supply, under the stable 5V voltage, the single chip microcomputer works normally. The system uses STC12C5A60S2 single chip microcomputer, compared with the traditional 51 single chip microcomputer, under the same crystal vibration, the speed is 8-12 times that of the traditional 51, has the advantages of greater ROM, lower power consumption and low cost, its circuit diagram is shown in Figure 2.

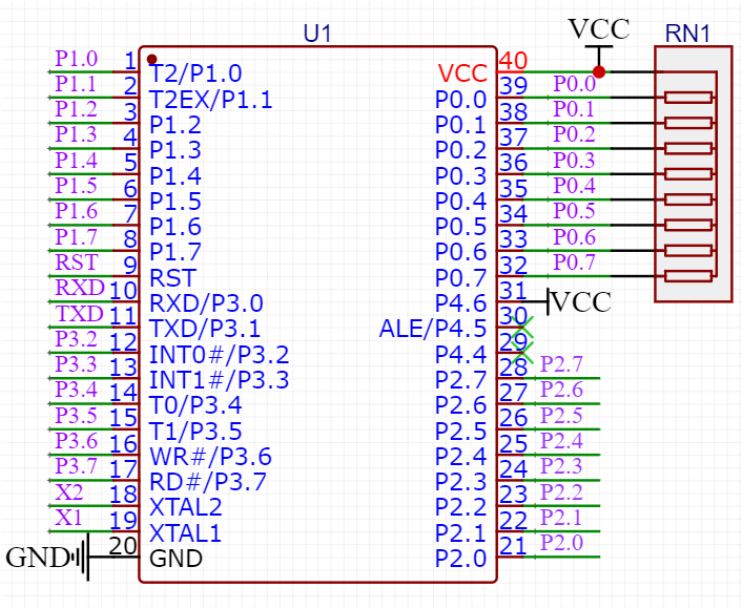

Figure 2: Main control chip circuit

3.2. DS1302 Clock Module

The time information of DS1302 is stored in the chip as a register. The communication interface of DS1302 is composed of three wires, namely RST, SCLK and I/O. Single chip microcomputer and DS1302 communication, using SPI communication interface, because it is half duplex, can only be time-sharing transceiver. Through the SPI interface, the current time value can be obtained and the current time can be set by conducting read and write operations on the corresponding registers. Its circuit diagram is shown in Figure 3.

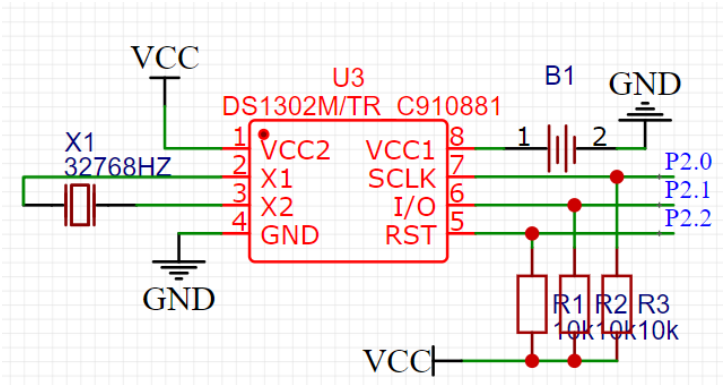

Figure 3: Clock module

3.3. AT24C02 Storage Module

AT24C02 chip is an EEPROM device with IIC bus interface. EEPROM, or live erasable programmable read-only memory, is a user-changeable read-only memory (ROM) that can continue to store data after power failure, and at the same time can be erased and rewritten under the action of higher

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

than normal voltage. EEPROM can be erased and reprogrammed on a computer or dedicated device. Generally used in plug and play, its circuit diagram is shown in Figure 4.

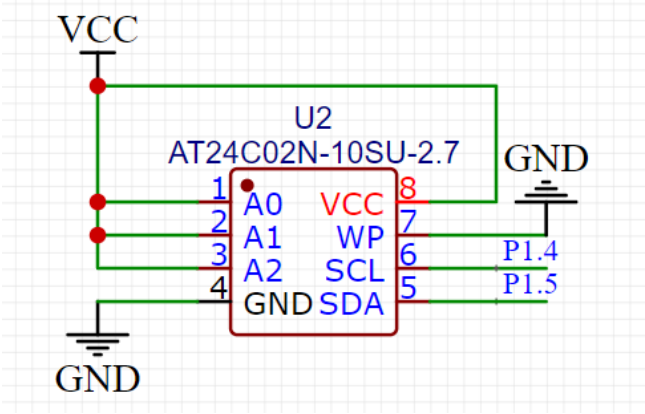

Figure 4: Storage module

3.4. Downloading Circuits

The download circuit is carried out through the serial port, TX and RX of the upper computer, connecting RX and TX of the upper computer. To achieve data download, its circuit diagram is shown in Figure 5.

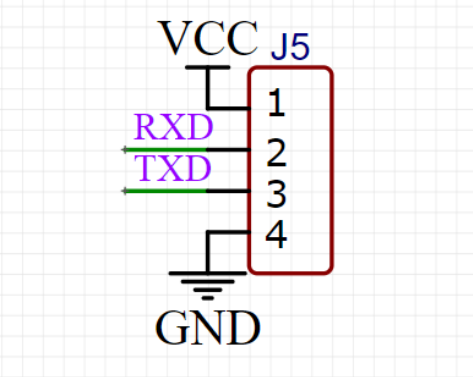

Figure 5: Download the circuit

3.5. DS18B20 Temperature Sensor

The working principle of DS18B20 is that the oscillation frequency of crystal oscillator with low temperature coefficient is little affected by temperature, so it is used to generate pulse signal with fixed frequency and send it to counter 1. With the change of temperature, the oscillation frequency of crystal oscillator with high temperature coefficient changes obviously, and the generated signal is used as the pulse input of counter 2 [2]. The resulting pulse signal of temperature value is converted into voltage value by AD converter. Due to the single bus data transmission, the timing requirements are very strict and its circuit diagram is shown in Figure 6.

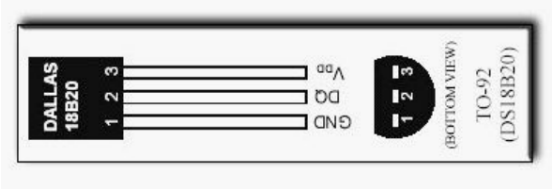

Figure 6: DS18B20 pin diagram

3.6. IIC Display Screen

The use of OLED display makes the display effect of this design delicate [3]. Communication with the

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

main control through the IIC protocol has the advantages of stable effect and accurate display. Its circuit diagram is shown in Figure 7.

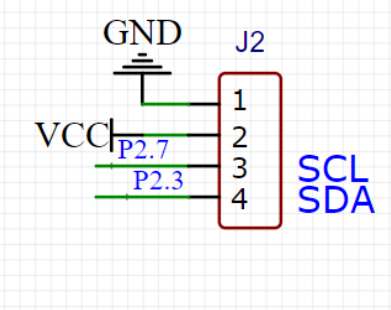

Figure 7: Interface diagram of IIC display panel

3.7. Independent Key Circuit

The work allows users to set and operate the system through four independent key circuits to achieve the purpose of user interaction with the system. Its circuit diagram is shown in Figure 8.

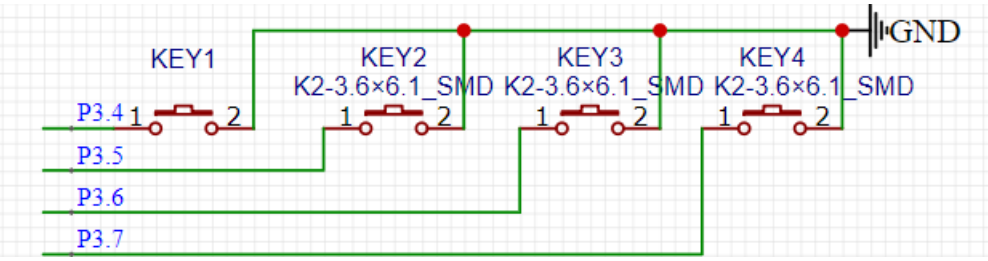

Figure 8: Individual key circuit

3.8. Reset the circuit

A reset circuit is set in the system to prevent the system from crashing or needing to be restarted. Its circuit diagram is shown in Figure 9.

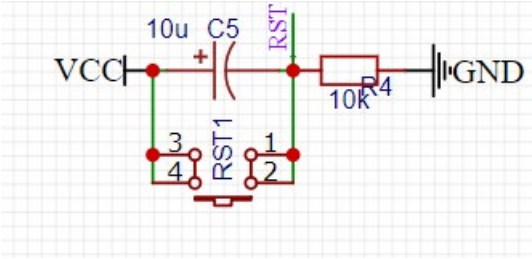

Figure 9: System reset circuit

3.9. Buzzer Module

A buzzer module is added to the design, so that when the time reaches the set time, the buzzer will sound to inform the user of information. Its circuit diagram is shown in Figure 10.

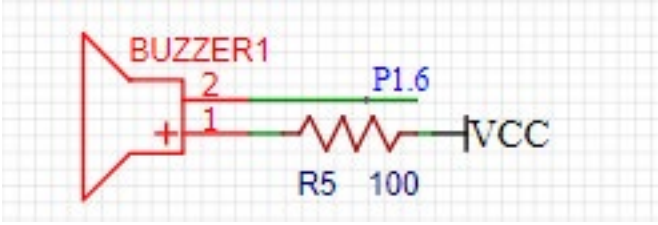

Figure 10: Buzzer module

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

3.10. LED Lamp Module

The design uses four LED lights to play a prompt role in the state of the system, which can let users know the current state of the system and facilitate interaction. Its circuit diagram is shown in Figure 11.

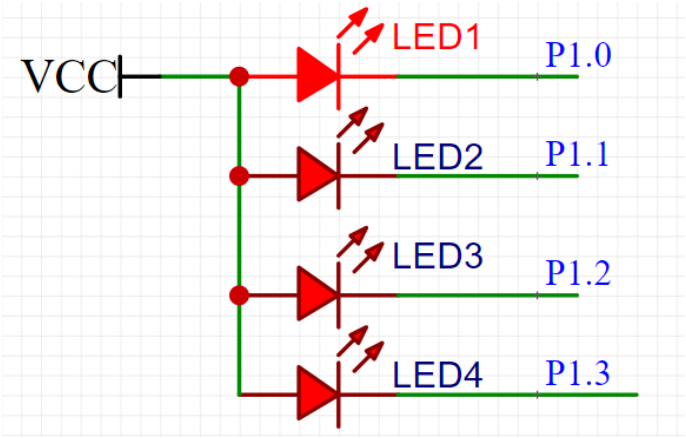

Figure 11: LED module

3.11. Overall Circuit Design

Through the combination and splicing of the above modules, the overall circuit diagram design is formed. Through simulation and comparison, it can be concluded that the circuit has the overall function of realizing the calendar design, and its circuit diagram is shown in Figure 12.

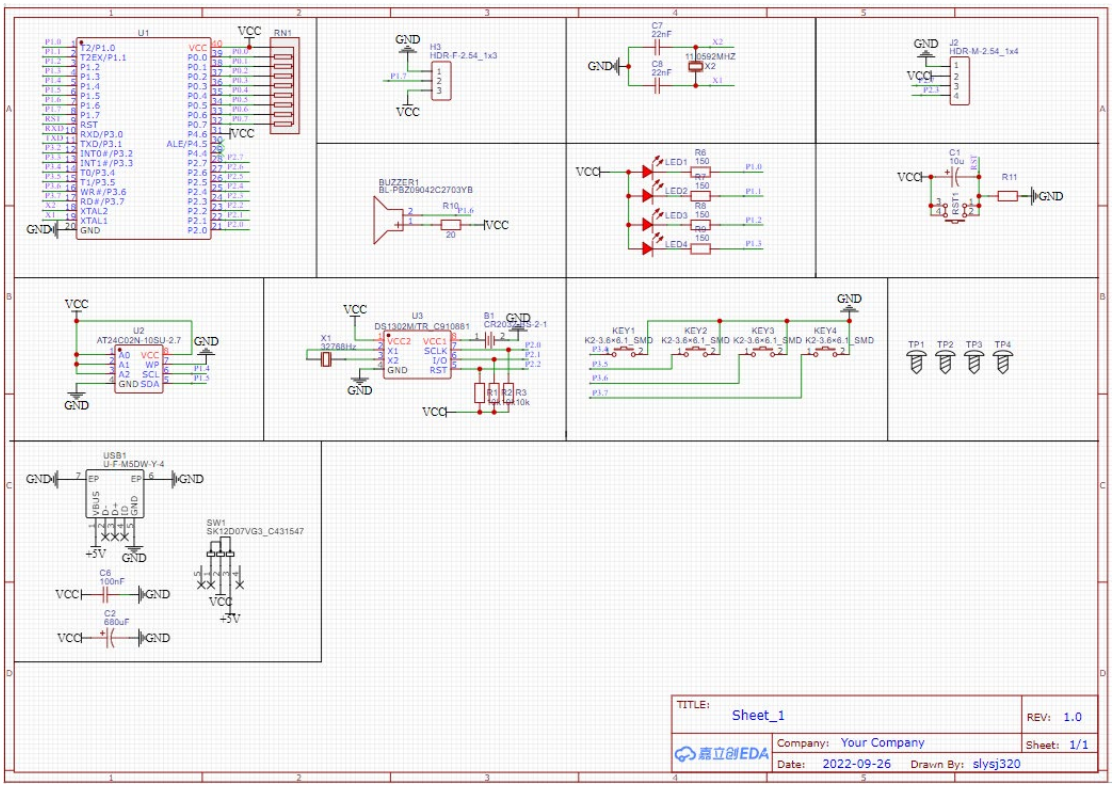

Figure 12: Overall circuit diagram design

4. Software Design

The overall design idea of the software is shown in Figure 13. Below, the software writing method will be introduced by unit modules.

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

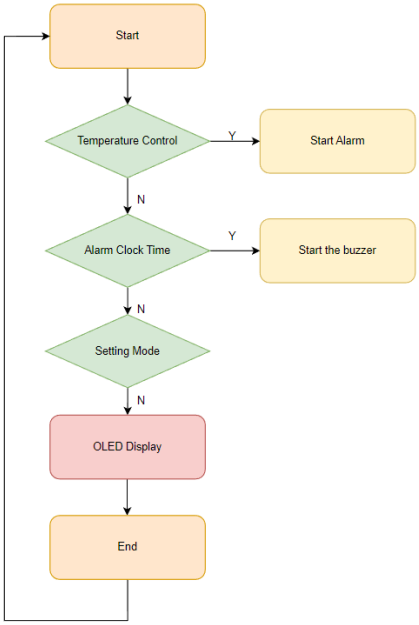

Figure 13: Overall circuit diagram design

4.1. Functions of each module

DS1302 real-time clock: can time year, month, day, week, hour, minute, second, with leap year compensation function. For the use of the chip, the first initialization of the chip, write data to the chip, and then read the data in the register, you can get a group of year, month, day, hour, minute, second, week data.

AT24C02 memory chip: This chip is a data storage chip [3], the data must be written before the data can be read. When using the chip, you need to find the chip address and then the storage address of the chip before storing data. Storing data takes 1 byte.

LED light setting: Through the use of 4 LED lights, single-chip pin pull bottom, light up the LED light, single-chip pin pull high, put out the OLED light. LED lights are used to display the current mode and status of the system.

DS18B20 temperature module: Through the single bus, the single chip microcomputer reads 16 bits of data, and then converts it into the temperature value, to get the current environmental temperature value.

5. System Test

5.1. Time Accuracy Test

As for the time test of the designed system, the stopwatch of the mobile phone is used for correction, and the error is very small, almost meeting the design requirements [3]. The test results are shown in Table 1.

Note: The test times are 10 times, and the data is the result after averaging.

Table 1: Time accuracy test results

Test time	System	Mobile stopwatch walk	Error
10s	10s	10s	0s
30s	30s	30s	0s
60s	60s	60s	0s
10 min 0s	10min 0s	10min 0s	0s
30 min 0s	30 min 1s	30 min 0s	1s
60 min 0s	60 min 1s	60 min 0s	1s

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

Conclusion: The accuracy error range of the system clock is small, which meets the basic performance requirements of the system design.

Error reason analysis: May be due to the complex program of the system, read data slowly, and display screen refresh rate is not enough.

5.2. Temperature Accuracy Test

The temperature test is compared with the products on the market, and the temperature error is required to be less than 1 degree Celsius. The test results are shown in Table 2.

Note: The test times are 10 times, and the data is the result after averaging.

Table 2: Temperature accuracy test results

environment temperature	System test temperature	temperature error
14.4℃	14.8℃	0.4℃
16.9℃	17.1℃	0.2℃
15.4℃	15.7℃	0.3℃
16.3℃	16.6℃	0.3℃

Conclusion: The temperature measurement results are accurate, the error range is small, and meet the performance requirements.

5.3. Storage Time Test

About the storage time, the design before and after the comparison with itself, storage time, test results and measurement results are consistent, to meet the target requirements. As shown in Table 3.

Table 3: Storage time test results

Pre-power data	Post-power data
2022-05-12 15: 30: 16	2022-05-12 15: 30: 16
2022-06-23 18: 30: 44	2022-06-23 18: 30: 44
2022-03-05 12: 30: 32	2022-03-05 12: 30: 32
2022-04-17 18: 30: 25	2022-04-17 18: 30: 25

Conclusion: After multiple system tests, the data stored before and after power failure is consistent, which proves that the storage performance is consistent.

5.4. Alarm Clock Test

About the alarm clock setting, the alarm clock is set at the specified time point of the buzzer response, in order to remind the user, and can stop the buzzer sound in time, have a better use experience.

For the final focus mode technology, the use of single-chip internal timer technology, an hour error is not more than one second. As shown in Table 4.

Note: The test times are 10 times, and the data is the result after averaging.

Table 4: Alarm clock test results

Test time	System	Mobile stopwatch walk	Error
10s	10s	10s	0s
30s	30s	30s	0s
60s	60s	60s	0s
10 min 0s	10min 0s	10min 0s	0s
30 min 0s	30 min 0s	30 min 0s	0s
60 min 0s	60 min 1s	60 min 0s	1s

Conclusion: In focus mode, the timing error of the system timer is low, which meets the performance requirements.

6. Conclusions

After a long time of hardware design and software design, PCB board production results reached the

ISSN 2616-5767 Vol.6, Issue 6: 30-38, DOI: 10.25236/AJETS.2023.060605

expected goal, the hardware is simple and beautiful. The code part has fully completed the basic function and play part of the design, and added the temperature warning display and focus mode two major functions, further complete the design requirements of the system. The system has done sufficient lead out, not only limited to this design, but also can be used to expand other applications, such as can increase the sedentary reminder and other more functions, hope to further improve the system in the future.

References

[1] Li Jingjing. (2016). Design of digital Calendar System based on single chip Microcomputer. Digital World (10), 47-48.
[2] Su Chang. (2013). Production of LCD Display Perpetual Calendar Based on SCM Control. Journal of Yangtze University (Self Science Edition)(22),77-79.
[3] Lu Guangying. (2010). Design and implementation of electronic calendar based on single chip Microcomputer. Silicon Valley (12),57+77.