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A temperature and humidity measurement method based on single chip microcomputer

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Abstract. With the development of distribution technology , distribution cabinets play an important role in the power system. With the continuous reform of technology, power distribution cabinets continue to use some high-precision integrated electronic equipment, but these equipment and cabinet machinery structures are often affected by the cabinet environment factors to reduce its use performance, such as cabinet temperature andhumidity is too high or too Low will affect the distribution cabinet electrical components of the electrical characteristics and mechanical properties, thus affecting the normal work of the distribution cabinet. So that the distribution of electricity problems on the entire power system has a negative impact, or even an accident caused by alarge-scale power outage or casualties. Therefore , in normal work must ensure that the temperature and humidity inside the distribution cabinet to maintain the appropriate range, then the need for the distribution cabinet temperature and humidity in real-time monitoring .The graduation design is to be combined with such a request This design has the characteristics of high precision, simple circuit, fast response and strong anti-jamming performance. The overall structure includes the hardware structure: the main circuit design， the main circuit design, the main circuit design, Display circuit, keyboard circuit. Software structure: the main program, temperature and humidity collection procedures, display procedures. The program uses the progisp downloader to download the program to the microcontroller.

Keywords: Temperature and humidity; measurement; temperature and humidity; single-chip; digital display

1 Introduction

1.1 Background

Industrial automatic production line is an important part of the industrial production process, which plays an important role in the normal operation and development of the industrial production management system. With the progress of modern science and information technology, the national economy, the further development of social economy and the improvement of ecological environment, the continuous development of production technology level and innovation, the accuracy of production and automation speed, industrial production for the construction of automated production line and work management environment construction have higher technical requirements and standards. Production workshop plays a very important and indispensable role in a variety of industries, public places, industry, national defense and other scientific and technological fields. To ensure the normal and smooth progress of industrial production, in an important history of Chinas economic and social sustainable development, has an important role and significance. The temperature control of micro-industrial production equipment workshop and industrial production environment has always been one of the major technical problems in the system automation of machinery manufacturing enterprises in China.

Currently widely used micro industrial object temperature real-time monitoring device, can put the temperature inside the object of miniature industry or production line of real-time temperature measurement, finally through the monitoring device and production line workers, artificial real-time record production line and industrial object internal temperature, heating and cooling, achieve the purpose of temperature control. However, in many cases for the density of manual detection and detection accuracy is not fully reach certain requirements, lead to industrial object internal temperature is too high or low will directly cause the contact of sensitive components, increased contact resistance, sensitive components internal temperature rise too high even sensitive components burned, cause production safety accidents, also if the air temperature in the production line is too high, also in the environment for some electrical equipment work macro impact, lead to accidents. For high precision production line, due to its internal structure contains high precision, the function of power electronic equipment, and these equipment due to high integration, production line if the temperature is too high or too low will cause the change of the electrical characteristics, affect its normal and stable work, failure and cause safety accidents. In order to avoid such a bad situation, develop a temperature that can produce industrial object equipmentThe monitoring and control system is pressing the eyebrow

1.2 Purpose and significance of the subject research

With the rapid development of network information and the large accumulation of production materials, the traditional temperature management mode: data manual recording and temperature control mode has been unable to meet the development requirements of contemporary production enterprises. In order to realize the real-time collection and data analysis of field data and equipment temperature, remote release of temperature control instructions and control of conveying equipment, it is urgent to use the widely distributed field production data to realize intelligent temperature control. For temperature control systems in industrial process control systems, it is necessary to divide the transport industrial automation pipeline into a number of control subsystems. There is no effective coordination, centralized monitoring, and temperature regulation between these independent control subsystems, and the entire pipeline does not work properly.

Because the traditional temperature monitoring device mainly uses 51 single chip microcomputer, there are disadvantages such as complex circuit structure, slow transmission speed, large error, suitable for poor environment and so on. The Atmega8l-8 AU MCU is rich in internal resources and contains AD conversion module. After eliminating the most instruments to collect the temperature, the amplification and A / D conversion circuit are designed for data conversion and reception. In this way, the design circuit is simpler and more reliable than the traditional instrument, which can adapt to the complex electrical environment in the production workshop, can monitor the internal circuit breaker or power electronic equipment, realize the stable temperature and maintain the normal operation of industrial production.

The temperature sensing control system design for the industrial temperature environment of industrial temperature collection and monitoring to ensure real-time access to production temperature value, through temperature alarm and automatic temperature control to ensure the main equipment of the temperature stability and working objects, realize the real-time protection of internal temperature of industrial production and industrial temperature monitoring function in industrial production environment. The development and research of this design, in line with the practical application needs of the current and future temperature design market, has high application and practical significance, can be widely used in other more industrial application fields, has great R & D application significance.

1.3 Common temperature control methods

Temperature control technology according to the different temperature control target, temperature control technology can be roughly divided into dynamic temperature control tracking and static temperature control two aspects. The control target of dynamic temperature tracking is mainly to automatically change the temperature value of the controlled object and the object according to the temperature curve set by the system. The principle and purpose of static thermostatic control is mainly to make the amplitude of the temperature value of the controlled object and object fluctuate in the constant or critical value, and the amplitude of the steady state fluctuation, that is, the steady state fluctuation error of the thermostat) can not exceed the value given by the thermostat. From the development process and practice of modern industrial thermostat technology, the general situation of temperature control technology can be simply divided into the following types:

Fixed value switch temperature control method

The temperature control method of the fixed value switch is being discussed. This method is to determine the relationship between the current temperature set value and the target size set by the controller, and then start and stop the temperature system of the system heating source (or the system cooling device), and determine the refrigeration controller start and stop according to the current temperature value. It is relatively easy to use this fixed value switch temperature control method, in the current special conditions without any computer controller participation, with a very simple analog temperature control circuit can be completely easily implemented. At present, the constant value switch temperature on-off controller using this method of fixed value switch temperature control is still widely used in the old equipment and industrial production objects of many large factories in China. This method of temperature control is still the traditional way, when the temperature is over the limit, when the temperature set value drops to the stop point set by the controller automatically turn off the power supply, so there is no way to completely solve the complexity of the temperature control process and hysteresis, the temperature set value of the system fluctuates greatly, the control is not accurate, so is not suitable for high precision system softwareIndustrial temperature control

PID linear temperature control method

In 1935, minorsky in the United States proposed the basic design and control method of the ship proportional integral differential controller based on output and feedback in the study, which marked the formal birth of PID ship automatic control in the United States. Since the mid-1980s, the integrated system design theory of multi-circuit control parameters has been gradually developed into the single multi-circuit high-speed PID circuit controller, and then it has gradually entered the key stage of the research and development of high-speed circuit control system technology.

Due to the good adaptability of the traditional PID algorithm and the wide range of applications, in the rapid progress and development of temperature control system technology today, it still occupies an important leading position in the whole process of temperature control in the temperature control industry. Because the traditional PID switch regulator design model fully considers the change of the system control error and the accumulation of temperature control error, the temperature control performance is superior to the temperature control method of the traditional temperature constant value switching system. The specific circuit can directly realize the function of the PID switch regulation by using the analog control circuit or using the computer control software method to control it. The former control system is called the computer analog digital PID switch regulator, while the latter control system is called the analog digital PID switch regulator. At present, this control method is mainly to realize the temperature constant switch controller.

For most industrial need to control the objects, it means to achieve better industrial control performance and effect. However, with the further development of industrial production, the requirements for accurate real-time control and control accuracy are getting higher and higher, and the controlled object is becoming more and more complex. Simply relying on the controller of some conventional PID can no longer meet the overall performance requirements of the industrial control system.

Intelligent control method

Artificial intelligence is a automation engineering control and information processing system with both computer and artificial intelligence. It is a research field closely related to the generation and development of computer and artificial intelligence. Computer and intelligent engineering control technology is a new interdisciplinary subject, which has a very wide range of research and application. Computer intelligence engineering technology can be used to define how humans effectively use the ways and abilities to use information by acquiring, passing, processing, regenerating and optimizing humans so that goals can be successfully achieved in any given time and environment. Computer artificial intelligence technology is a discipline that analyzes and simulates human behavior and thinking process with various computational methods except mathematics and formula, and analyzes and simulates human intelligence with scientific and computer technology. The use range of this method is far greater than the control theory, such as inference, understanding, reasoning, vector machine, identification, planning, learning, decision making, cognition and problem solving, which is a high synthesis of human physical and mental behavior.

A new generation of intelligent temperature control theory is a kind of applied to the artificial intelligence control theory and intelligent control technology and the analysis of operational research and optimization methods, and the combination with intelligent temperature control theory and technology, the third generation

of intelligent temperature control theory and the control of PID, realize the control of temperature of an intelligent control and system.

2 Technical basis of subject research and development

2.1 Atmega8l-8 AU chip

The choice of the main chip for this design to meet the needs of many functions, complex measurement data, at the same time, the physical volume is required as small as possible, so it is necessary to choose a very powerful function and more external pins. The Atmega8l-8 AU single-chip microcomputer has a faster transmission speed, more abundant internal resources, and its stronger driving ability and higher cost-performance.

Advantages of Atmega8l-8 AU

(1) It has good performance Flash program memory, its storage unit address number is 8K, the word length is 1B, support ISP and IAP two modes, make the development of the program and debug very easy. There are 29 power byte EEPROM inside, which is characterized by long use time, long-term data preservation to avoid power loss, etc. Internal RAM capacity is large, which can meet the requirements of high-level language development.

(2) All the external I / O interfaces of the MCU can set the pull-up resistance, and can be set to input and output modes separately, and can also be set to high resistance input. The I / O port is flexible in use, powerful in drive and function.

(3) SCM also supports high-speed synchronization and asynchronous serial port, with powerful performance and stable use, which can realize hardware generation check code, hardware detection and calibration, two-level receiving buffer, and can actively adjust the positioning baud rate when receiving. Because the serial port function is very powerful, the microcontroller speed is fast, the interruption response time is relatively short, can realize high port port rate communication.

(4) The MCU has an automatic power reset circuit, independent watchdog, low voltage detection circuit, and multiple reset sources, which can be set to delay the program after the system starts.

(5) There are also a variety of electrical dormancy modes in the MCU, such as strong anti-interference components.

Programming features

The AVR microkernel has a rich instruction set system, which is a RISC instruction system. There are 32 universal working registers in the register pile, which are available for developers to use freely. All registers are then directly connected to the arithmetic logic unit, allowing the instruction in a clock cycle to access two separate registers without a structural adventure. At the same time, his CPU is used to execute instructions. This configuration and implementation greatly improves the efficiency of code execution, and the throughput is 10 times the orders of magnitude higher than the general CISC microprocessor. Atmega8I Has the following characteristics: 8K word long system programmable flash memory (both read and write), that is, multi-channel access, 512 byte EEPROM is not easy to lose memory, SRAM 32 universal 1K byte I / O port line, 32 universal working registers.

2.2 C language

C language is a process-oriented, easy to learn and highly abstract universal programming programming language, which is widely used in the development and creation of various application systems. The famous Linux operating system kernel is written in C programming language. The C language can be compiled into a machine language in a simple way, and can be executed after linking. C language is very convenient when using low-level memory and registers, and it is also an efficient programming language that can only produce a small amount of machine code and can run without any running environment support. Although C presents many features of low-level processing, it still maintains the features that can be performed in multiple

systems, and C programs written in a standard specification can run stably for a long time in the existing mainstream computing systems.

Characteristics of the C language

(1) Simple and compact, flexible and convenient. C programming language has only 32 basic keywords and 9 programs dominating the statement, and the programming is highly arbitrary. The program of C language can control the bit, byte and address at the same time as the traditional assembly language, and the combination of these three is the most basic program work and control unit of modern computer.

(2) The operators of C contain a wide range of areas. C language is flourishing with 34 operators. Parentheses, assignments, forced type conversion, bit by bit operation, etc., are all treated as operators. Thus, the operation types of C are extremely rich in expression types, and the flexible use of various operators can be difficult to achieve operations in other high-level languages.

(3) C. Integer type, floating point type, character type, array type, pointer type, structure body, enumeration type, etc., which can be used for calculation. At the same time, there is a special type of pointer, to better manage the system memory, reduce the memory consumption, improve the program efficiency. In addition, C language has a powerful graphics function, support for a variety of displays and drives. And the computing function, the logical judgment function is powerful.

(4) C is a structured language. Structured way can make the program hierarchy clear, easy to use, maintenance and debugging. The call of C language is programmed in the form of function, these functions can easily call, corrie, transfer, alias, pointing, higher order, transfer and other operations, and have a variety of loop and conditional statements to control the flow of programs, so that the program is completely structured. At the same time, the C language is a Turing-complete language that can solve any problem.

(5) C grammar programming plasticity. The compilation of C language is very strict in syntax and lexical analysis, so that grammatical errors must be found in the compilation, so that errors are detected at an early stage. Instead of running crashes, C allows the programmer to control the statement.

(6) The C language allows direct access to the linear address of the data, which can directly operate on the memory. C language not only has the basic functions of high-level programming language, but also has the basic control of many low-level languages. Can operate data by bit and by byte, and these three are the most basic hardware and working units of modern computers, which can be directly used to write systems and software.

(7) The C language program generates code of high quality. Because the program is not executed quickly in runtime, it is generally only 10~20% lower than the basic efficiency of the single target format code generated in some traditional digital assembly compilation programs. At the same time, there are some modern-based language compilers that have even far exceeded the basic efficiency of traditional assembly after continuous optimization.

(8) C language has a wide range of application, which can be compiled and executed in a variety of computer architectures, and has good portability.

Advantages of C language

The advantage of C is that it can be run in a wide range of large operating systems, such as linux, mac os, freebsd, unix and other operating systems, and can also be applied to a variety of models. C programming language for the operating system and system often used programming programs and in some need to operate hardware programs, the benefits of using C language are significantly better than other high-level programming languages, many large applications and software are basically written in C language.

C language is more reliable than assembly and can be erased repeatedly. And when designing the same function, the efficiency of C language is much higher than that of assembly. And more convenient for debugging and change. Its programming language can be better compatible with other high-level languages and assembly vocabulary, but also can design the internal register and external interface of the program driver according to the internal characteristics of the hardware as the assembly. C language is a structured programming language that can be used quickly and easily. Each program can be composed of one or more mutually independent programs that can be called to each other. Its language module can also be combined

with the assembly to become a complete program. In the current microcontroller programming language, C language is more and more popular.

2.3 MF52NTC thermistor

NTC (negative temperature coefficient resistance) is the resistance with negative percentage resistance change ℃ per degree. The high precision small volume MF52NTC thermistor probe is smaller and the lead insulation, its design is very reliable, the working environment temperature-50℃ to 125℃, fast reaction time and high reliability make it more suitable for medical equipment and electronic thermometer product series.

1, the main characteristics of the thermistor

(1) Resistance temperature coefficient is large, high sensitivity, usually the temperature changes 1℃, the resistance value changes 1% -6%, the absolute value of the temperature coefficient of Danan group is 10100 times larger than the general metal resistance.

(2) Simple structure and small volume.

(3) High resistivity, small thermal inertia, suitable for dynamic measurement.

(4) Easy to use, the tissue and temperature changes into a non-linear relationship.

2, NTC negative temperature coefficient thermistor composition

NTC (Negative Temperature Coefficient) refers to the thermistor with negative temperature coefficient because of temperature rise.

3, The temperature characteristics of NTC thermistor conform to the exponential law

The NTC resistance value can be approximately expressed as:

$$R_t = R_{t\exp}(Bn(1/T - 1/T_0)) \quad (2\text{-}1)$$

In the formula, RT and RT0 are the resistance values at temperature T and T0 respectively. Bn, as a base coefficient, is determined by the material and the production process. Before use, the base coefficient of the resistance should be understood first.

4, MF52NTC thermistor characteristics

(1) Small size is suitable for narrow space

(2) Response time is very fast, high sensitivity, strong precision

(3) Lead line bending resistance, and easy to weld

(4) Thermistor has excellent electrical insulation performance

(5) The NTC probe lead size can be customized according to the requirements

2.4 Progisp programming downloader

progisp Is a USB programming burning software, almost support for all AVR chip programming, but also can change the data burning mode, comparative recognition word, chip wipe and other options to choose.

functional characteristics:

(1) Adapt to the voltage width (2.7v-5.5v), in line with the mainstream devices.

(2) Provide a clock for the target board (especially useful for AVR lock chips).

(3) It can be downloaded at ultra-low speed (using 32768 HZ precision vibration).

(4) Fast download speed (the 8K program is about 2 seconds).

(5) Implement engineering management of programming projects with progisp.

(6) Supply pulse, select the XTAL pin of the downloader to unlock part of the avr lock chip (ISP mode useful) using the XTAL connected to the XTAL 1 pin of the target board CPU.

(7) Iterative data loading: the loaded file in the data area will reload the data file.

2.5 ICCAVR compiler

The ICCAVR compiler of ImageCraft is a software that uses ANSI standards to develop microcontroller MCU programs with superior performance, easy to use and easy to use.

This software mainly has the following several features:

(1) ICCAVR is an integrated development environment (IDE) that provides a combined compiler and engineering manager.

(2) All the source documents are added to the project to form a large engineering document. Using sln files to manage the project, file editing and construction of the project are also completed in this environment,

errors are displayed in the status window, and when the compilation error is clicked, the cursor automatically jumps to the wrong line.

(3) The compiler can directly compile binary executables that produce INTEL HEX format files (this format file can be supported by most programmers and can be downloaded directly to the chip) and AVRStudio-compliant debugging files (COFF format).

(4) ICCAVR is a 32-bit application that supports file names over 128 bytes, an advantage that other compilers do not have because many files need to be described with longer file names.

(5) ICCAVR is a converged research and development system (IDE) combining editing modules and engineering management modules. It is a pure 32-bit program that can be run in Win XP and Win 10 environments.

(6) The window of ICCAVR can be moved freely moved, embedded, included, full screen and other settings are allowed.

2.6 Temperature sensor technology

Temperature sensing technology is one of the important contents of modern information technology, temperature sensor uses a wide range, configuration, various. It mainly realizes other parameters and available parameters, such as: electricity, current conversion, analog integrated temperature sensor / controller. At present, the new temperature sensor is developing from analog to digital, integrated, intelligent and networked direction. The development of temperature sensors can be roughly divided into the following stages:

(1) Thermal couple sensor. In industry, in the field of temperature measurement sensing, thermocouple sensor is the most widely used one, which is in direct contact with the measured object and is not affected by the intermediate medium.

(2) Simulated integrated temperature sensor. A temperature sensor will be integrated on a chip, completed by the temperature measurement signal and the analog output function. The main characteristics of the simulated integrated temperature sensor are: single function, small temperature measurement error, low cost, fast response speed, long transmission distance, micro-power consumption, used for remote temperature measurement, the calibration does not need to be linear, the peripheral simple circuit.

(3) Optical fiber sensor. Optical fiber sensing uses optical fiber to measure the temperature, but there are disadvantages, the disadvantages are: the measurement is not easy enough, difficult to achieve high accuracy. At the same time, because the process is more complex, and the cost is high, it is inevitably difficult to expand the product.

(4) Digital temperature sensor. The digital temperature sensor has two conversion modes. In the uninterrupted conversion mode, the digital temperature sensor continuously stores the result in the temperature register, the content of the temperature register is read, which does not affect the temperature conversion; the result of the digital temperature sensor in the single conversion mode, which is applied to the temperature-sensitive application when returned to the shutdown mode.

2.7 Light-emitting diode digital tube technology

Light-emitting diode display is a matrix of new light-emitting diode, data show striking, cheap, flexible assembly, programming mode and convenient interface, microcontroller power management control system in the design of application data management operating system commonly used it to directly display the daily working life status and the process of data collected in the input value in the information network, etc.

According to the arrangement and structure of the large screen light emitting dot array diode, the display is divided into the digital tubes and the large screen light emitting diode lattice digital display. In addition to using the specified program, the large screen bright dot matrix digital tube display or LED dot matrix display is mainly used to request special dot matrix display occasions, almost all microcomputer systems application dot matrix display system use large screen light-emitting diode digital dot matrix display.

The digital management display system mainly has two display modes, including static data management display program mode and dynamic display program mode. The static data management display program is very uncomplicated, and the program mode of the static data management display system is very simple to design, which takes up very little memory time of the CPU. The dynamic display program can be called only when the systems display string is changed. To effectively simplify the circuit while reducing the cost, the system design uses a method of dynamic scanning for digital display.

3 System Analysis and Overall design

3.1 System requirements analysis

According to the actual demand of industrial production object, combined with the current situation of industrial production temperature control, various production industry of temperature of standard control requirements, the traditional temperature detection record method is choose and employ persons as the procuratorial object, rely on artificial turns to set up checked posts detection, workers go back and forth to check, tell each other temperature record has obvious disadvantages, artificial access to measure and record environmental information. In this mode, it is not only low efficiency, but also not conducive to the full utilization of human resources, but also lack of science. Many major accidents are caused by human factors, and manual maintenance lacks a complete management system to maintain.

Since the designed products are used in industrial production environment and reference production in technical parameters, the selection of components should meet the technical requirements. In order to realize real-time temperature monitoring, and considering the complex working environment in the production workshop, the system should have a good anti-interference ability, and the measurement results are accurate and can be displayed through the digital pipe, through the indoor temperature value of the corresponding display and alarm. At the same time, as a design adapted to the market, its design appearance should adapt to the space in the production environment, so the requirements of as small in volume as possible, low cost, cost-effective chip and circuit design.

3.2 System design requirements

This paper makes the analysis of the advantages and disadvantages of the traditional industrial environment temperature monitoring method. Combined with the development of current technology, a design of abnormal temperature monitoring and alarm system based on Atmega8-8 AU is put forward to realize the purpose of real-time monitoring of temperature in the production workshop. The system design includes both the hardware and the software parts. The general requirements are provided as follows:

Design principles

Since the designed products are applied in the industrial production environment and the technical parameters, the selection of components in the design should meet the technical requirements. In order to realize real-time temperature monitoring, and considering the complex working environment in the production workshop, the system should have a good anti-interference ability, and the measurement results are accurate and can be displayed through the digital pipe, and the corresponding display and alarm of the temperature value of the production line. At the same time, as a design adapted to the market, its design appearance should adapt to the space in the production environment, so the size is required as small as possible, low cost, cost-effective chip and circuit design.

These specifications should be satisfied in the hardware design:

(1) generality: The design of hardware should not only be able to meet the use of this design, but also can be applicable to other similar designs, that is, using modular design, each module completes its corresponding functions, can be used in the system, and can also be directly used in other systems.

(2) Reliability: the hardware should be able to play its role correctly and reliably, can not be used to be difficult, to be able to complete the specified functions in the specified time and the specified environment, to take anti-interference measures in the design to enhance its reliability.

(3) Economy: Under the condition of maintaining the normal performance of the system, we should save expenses as much as possible, and use chips to make the best use of everything. There is no need to use too powerful chips to cause unnecessary functional waste, and to exchange the maximum profit at the minimum cost.

Implementation method

Because the design workload of a system is very heavy and very complex, then it is necessary to make the system modules divided in the redesign process, and finally complete the design of the whole system through the step-by-step module design.

(1) Implementation of the hardware circuit

The design of the hardware circuit is to transform the function of the design into the actual product. Through the demand analysis, the whole system hardware circuit should include the main circuit, temperature control circuit, power supply circuit, temperature acquisition circuit, and alarm circuit. The main circuit includes the crystal vibration circuit and the reset circuit.

(2) Implementation of the software design

For software plays a very important role in this design, the parameters and drivers of the system are realized by software. Although the amount of measurement in the system only temperature, but because this quantity is non-electrical physical quantity, this needs to add A lot of algorithms and functions in the software design, making the program becomes complex, because the sensor directly collect voltage analog signal temperature to add A / D module, because the characteristics of the thermistor to choose interpolation method or check table method, the temperature is the form of frequency signal transmission, then can take the use of external clock signal to start the timer / counter to measure, it is necessary to start the use of multiple timers and counters in the hardware. Increase the difficulty of the main program, then the modular method should be adopted in the program design to simplify the complex program, and realize the drive of the software program through the mutual cooperation of each module.

(3) Coordination of software and hardware

Some special modules can be implemented with hardware or through software. Through the coordination of software and hardware, the design scheme can be optimized to improve the quality, performance of the design, and reduce the cost and burden of the design. The software-based scheme can reduce the cost, but it takes a lot of time to be invested in the software design. In terms of reliability, the more hardware design, the more devices are selected, the quality of welding will cause many points of failure; and the software will be after troubleshooting, its reliability will not change relatively stable. Therefore, in the specific design, we should combine the design requirements of the system and mutual comparison in some places prone to failure, to determine whether to use software design to replace or through hardware design to eliminate the occurrence of failure, so as to optimize the system.

3.3 System design ideas

In order to provide the requirements to the system, the software must have the following features:

Easy to understand, easy to maintain. In the view of software developers, the most important thing in the development of a software system is scalability. According to the opening and closing principle, writing any software or module, you should make the update open for expansion and close for modification. Therefore, before doing software design, you need to do a lot of abstraction. Because of the software design, development and debugging is not achieved overnight. Some problems constantly need to be solved and fixed in the operation, which requires that the compiled software must be easy to understand and expand. In the software design method, the structural design is the best method. This design method is from comprehensive to one-sided, and then from one-sided to smaller composition, step by step design and development. At the same time, using the modular program structure design scheme also provides great convenience for the expansion and modification of the system functions. So the system should guarantee the following two features.

testability. Metrics that the system can test. Tability system software has two meanings: it is easier to develop test standards and the software.

accuracy. The requirement of accuracy should be very strict to the whole system. The system needs to carry out a lot of operations, and the correctness and accuracy of the algorithm have a direct impact on the control results, so it should be suitable for the standards in terms of algorithm selection and digit number selection.

The microcontroller temperature control system is a microcomputer control system with Atmega8-8 AU as the control core control unit and controlled through the temperature acquisition circuit, drive circuit, alarm circuit, power supply circuit, memory I / O and main circuit. Its basic control principle is to set the temperature threshold into the microcontroller, and save in the microcontroller EEPORM, also displayed in

the light-emitting diode, start and running, through the signal acquisition circuit, the temperature signal acquisition system for interpolation operation, compared with the set temperature threshold, control the temperature lifting components. This design has the characteristics of high precision, simple circuit, fast reaction speed and strong anti-interference performance. The overall structure includes hardware structure: main circuit design, display circuit and keyboard circuit. Software structure: main program, temperature acquisition program, display program. The program uses the progisp downloader to download the program to the microcontroller.

3.4 System architecture diagram

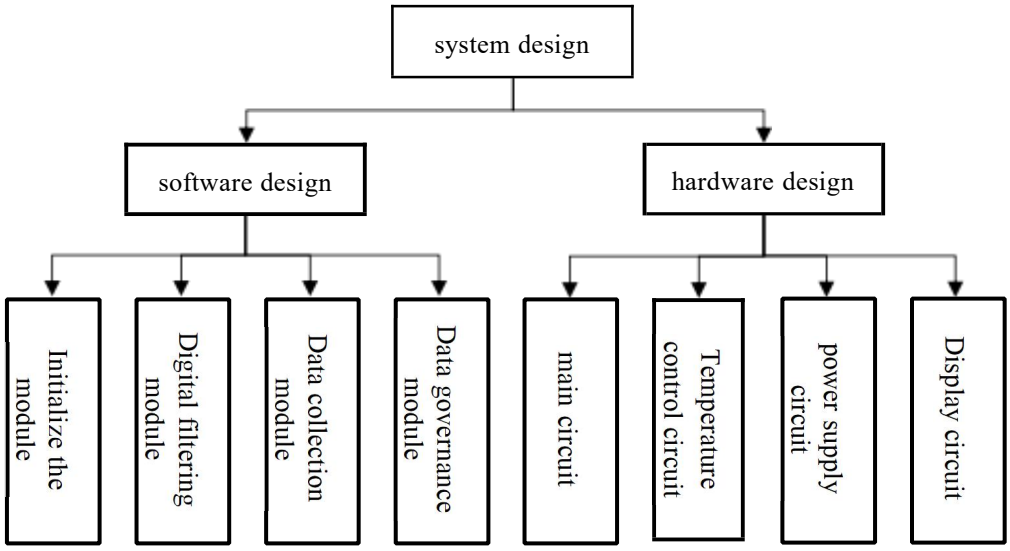

Figure 3-1 The system architecture diagram

Specific functions of the system module are as follows:

(1) Initialize the module

For the software system overall initialization, responsible for mobilizing the overall logic. It is the first module of the software, and also the decisive startup module. The program of this module is an endless loop that never stops.

(2) Digital filtering module

It is used to digital filter the collected data to ensure the correctness of the overall data of the system, ensure that the wrong data does not pollute the overall data of the system, and ensure the stability of the final data results. The current filtering algorithm is the system mean filtering algorithm.

(3) Data collection module

A very important module in software design, responsible for the acquisition of sensor data. Read the data through a hard break. The core part is the drive of the sensor, so that the caller can easily make function calls. At the same time, this way is not coupled with other modules to improve cohesion and simplify the development process.

(4) Data governance module

Responsible for the data governance of the collected data, such as the interpolation algorithm, to calculate the true temperature value and predict it. Used to guarantee the accuracy of the system.

(5) Main circuit

The main circuit includes clock circuit and reset circuit, which provides clock cycle to SCM to ensure the normal execution of the instruction flow of MCU cpu. And it is responsible for the normal oscillation of the timer crystal vibration. The reset circuit is mainly used for initialization of MCCM.

(6) Temperature control circuit

The temperature control circuit is connected to the collector, heating / cooler, responsible for the collection of sensor data, and transmits the data to MCCM through the port for internal procedures. At the same time, the start and stop of the lifting temperature device are controlled by the level of the port potential.

(7) Power supply circuit

The power module is the heart of the whole hardware system, without the power supply microcontroller can not start. At the same time, the power supply module provides the power supply to all the components. And the circuit characteristics provided by the power supply must conform to the index of MCCM, such as fixed voltage, fixed current.

(8) Display circuit

The display circuit is a crucial part of the hardware. Use the display circuit and the LED dot matrix to connect each other to display the encoded display data.

4 System hardware circuit design

The function of the system is mainly to collect the temperature through the sensor, and display through the digital tube in real time, real-time data transmission through the port and the host, in which the microcontroller can control the work of other components, the given temperature of the system is worth setting. The system through the data obtained by the sensor and the control of the program can automatically adjust the temperature change. The block diagram of overall system is shown in Figure 4-1:

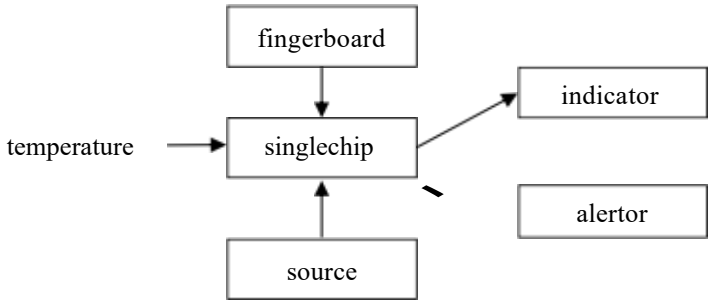

Figure 4-1 A schematic block diagram of the system

4.1 Hardware module

According to the specific functions to be realized, the hardware circuit shall include the following modules: main controller, temperature sensor, digital tube display circuit, keyboard circuit, ISP download circuit, alarm circuit, power supply circuit.

The overall circuit of the system includes the following design, as shown in Figure Figure 4-2:

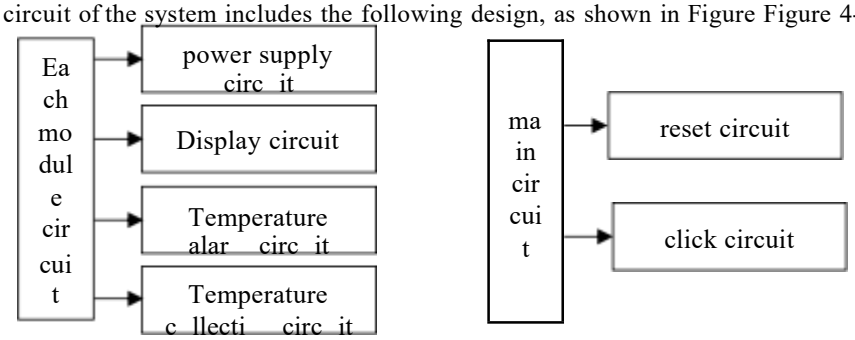

Figure 4-2 Block diagram of the connection principle

According to the above requirements, the following circuit overall circuit diagram is made such as 4-3, the following is the introduction of each module.

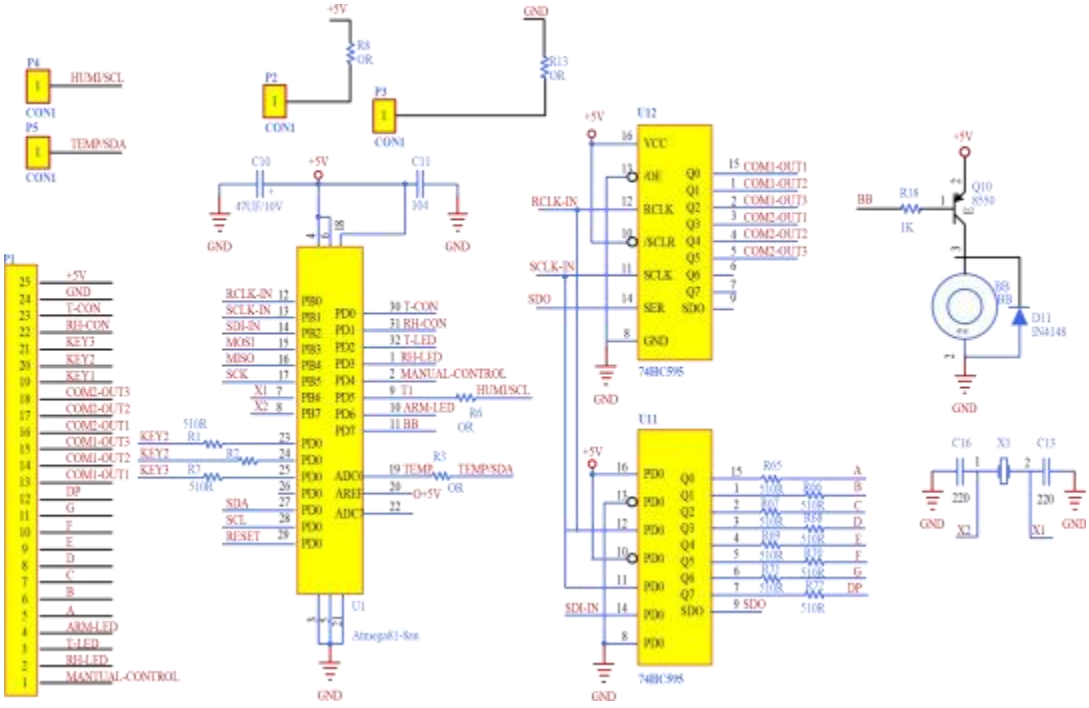

Fig. 4-3 Design of the general circuit

4.2 Main circuit design

Clock circuit design

The standard of clock timing, the design of the clock circuit is based on the characteristics of this microcontroller. This design is the 8 MHZ crystal oscillator circuit in the external connection of the MCU chip, and the function of XTAL 1 and XTAL 2 pins are the oscillator in the MCU as the input and output of the reverse amplifier, and the patch capacitors is added at both ends to ablate the system noise.

Therefore, such a clock circuit is designed to provide a clock oscillation. The use of two capacitors involves mainly to stabilize the system.

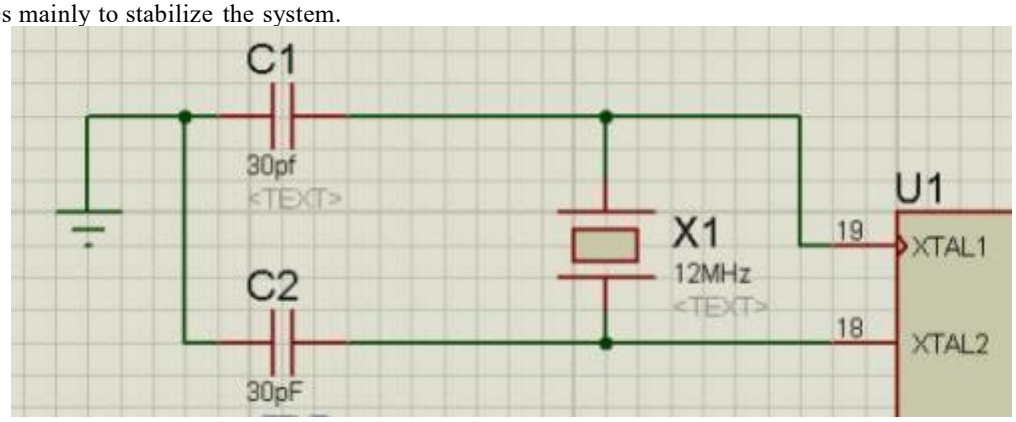

Figure 4-3 Clock circuit

Return circuit design

The reset of microcontroller refers to the use of hardware or software to realize the initialization reset of microcontroller and its internal logic circuit, which is an indispensable step for the system startup and completion. In practice, the reset pin will be affected by many external effects, and the reset pin is usually connected to the ISP port, the wiring will be longer, so an RC series circuit can enhance the anti-interference ability. At the same time, when the system loses power, the capacitor will discharge, giving a high potential, when the power calls, a reset signal to the reset pin. In normal times, the reset pin will always be in the low potential.

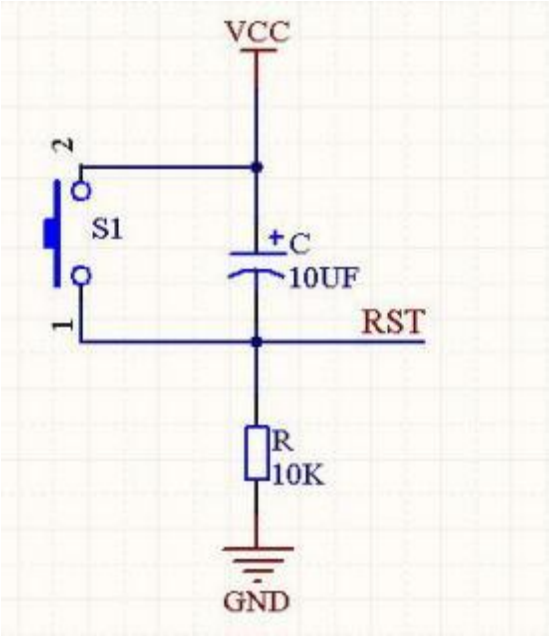

Figure 4-4 Reset the circuit

4.3 Design of each module

Temperature acquisition circuit

Temperature is a common non-electrical physical quantity. In order to measure the temperature, it must be transformed into an electrical signal that can be measured. The temperature measurement circuit uses thermistor as the induction device, and the voltage change is used by separating the voltage to obtain the current ambient temperature value. This design temperature acquisition circuit uses MF52NTC temperature resistor as the induction element, and NTC thermistor, whose resistivity decreases uniformly with the increase of temperature. NTC thermistor is generally made of a mixture of solid polycrystalline semiconductor oxides with large negative resistance coefficient. Temperature measurement, temperature compensation and temperature control circuits can be designed according to this characteristic of the thermistor, and can also be designed as power components used to reduce the surge current of the circuit.

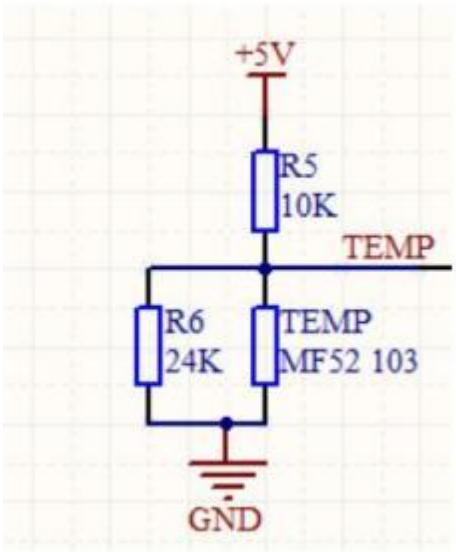

Figure 4-5 Temperature acquisition circuit

It can be seen from the above figure that the resistor and the fixed value resistance R5 form a series partial voltage circuit. The output voltage Vtemp gets a voltage value varying with the change of the partial voltage value, and the NTC resistance can be obtained, and the current temperature value can be calculated. It can be seen from the above figure that the resistor and the fixed value resistance R5 form a series partial voltage circuit. The output voltage Vtemp gets a voltage value varying with the change of the partial voltage value, and the NTC resistance can be obtained, and the current temperature value can be calculated.

For example, the table shows that when the temperature value is 0 degree is the Rt resistance value is 12.6900 kilohms, then the number of the temperature is 572, and so on can get a temperature number.

The relation expression of the output voltage value V temp and the NTC resistance value can be calculated by Ohms law:

$$V_{temp} = \frac{R_t}{(R_t + R_S)V_{cc}} \tag{4-1}$$

Then the number of this temperature point after ADC conversion can be calculated:

$$D_{abc} = 1024 \times \frac{R_t}{R_t + R_S} \tag{4-2}$$

For example, the table shows that when the temperature value is 0 degree is the Rt resistance value is 12.6900 kilohms, then the number of the temperature is 572, and so on can get a temperature number.

Temperature alarm circuit

This design has 1 temperature set lowest point and 1 temperature set maximum point. When a data in the current temperature is above or below the range, the MCcontroller will execute the processing protocol, that is, start the alarm circuit. The principle of buzzer sound is the current through the excitation coil, so that the electromagnetic coil produces a magnetic field to drive the vibrating film sound, so the current needs to reach a certain threshold to drive it, rather than a weak current can be. The current output by the I / O pin is small, and the TTL potential output by the single chip microcomputer basically can not drive the buzzer, so a circuit with current amplification needs to be added. This design uses a triode C8550 used to amplify the drive buzzer. The buzzer alarm circuit is shown in Figure 4-6:

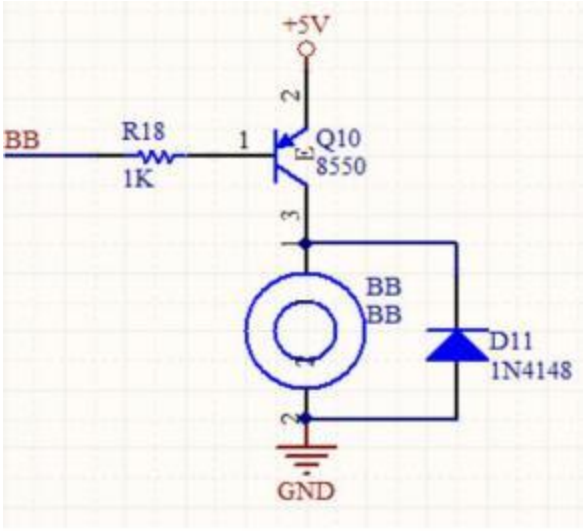

Figure 4-6 The temperature alarm circuit

As shown in the figure, a section of the high potential of the buzzer is connected to the VC power supply, the potential is + 5V, which is connected to the collector of the triode, and the base B of the triode is controlled by the pin R1. When the high potential, the triode T1 shows high resistance, no electronic flow through the wire ring, the buzzer does not work and does not make sound; when the low potential, the triode is connected, so that the current of the buzzer forms a loop and makes sound. Therefore, the buzzer can sound and stop the sound. A diode is connected at the two ends of the buzzer to play the role of continuous flow. When the triode stops conduction, the current suddenly decreases, and the internal coil of the buzzer will produce induced current, so a continuous secondary tube is added to play the role of protecting the circuit[19].

Display circuit design

Light-emitting diode LED is a simple and cheap display output equipment, is currently the most widely used intelligent instrument display equipment, with low voltage, low driving current, fast response, long service life and other characteristics[20]. The digital tube has two kinds of common shade and common anode. This design uses two 3-bit 8-segment digital tubes of the common anode to show the value of temperature. In each section of the digital tube should be connected with a resistance as a limiting limit. When the LED display is connected with the interface of the microcontroller, it is necessary to save the instantaneous information on the bus with the latch to drive the display. There are two ways to drive the display: static drive and dynamic drive.

Static LED drive is a special register corresponding to a bit of the display interface form called static display as long as the display information is sent to the special register, the display will continue to display the information, display brightness is easy to ensure, its disadvantages need more register, current resistance and other hardware, high cost, power consumption is also large. Dynamic drive is that when the number of displays is large, it is suitable for dynamic drive. The residual phenomenon on the human vision is a display lighting in turn. When the refresh rate of each display is more than 50Hz, people can not feel the display flashing.

Since there are three 8-segment digital tubes and there are two, Dynamic drive mode shall be adopted, Utilizing two 74HC595 latches, Where the power supply and the clear short connection to the high potential, Output effective end and low end connected with low potential, Data is access to the latch from the serial number input end, At the ascending edge of each data entry clock, Serial port data is moved into a register within the latch, Every 8 clock cycles at the next clock upedge, Data is located at the travel output terminal point, Due to the use of two latches, When the serial output end is connected to the serial input end of the next latch, Two latches achieve the cascade, The data goes to the next latch, When the output is always an rising edge when the data enters the latch when the output effective end low potential, Data will be transmitted from

ports Q 0 to Q 7, From low level to high level output, here, The latch output is connected to the 8 segments of the Led, Each section of the protected digital tube by the current-limiting resistance will be lit, When the cascade of data into the next latch is by the same latch, It controls the selection of the digital tube, You can choose which digital tube to point to, Such a latch controls the number displayed by, The other controls the digital tube to display the data.

The circuit diagram is shown in Figure 4-7:

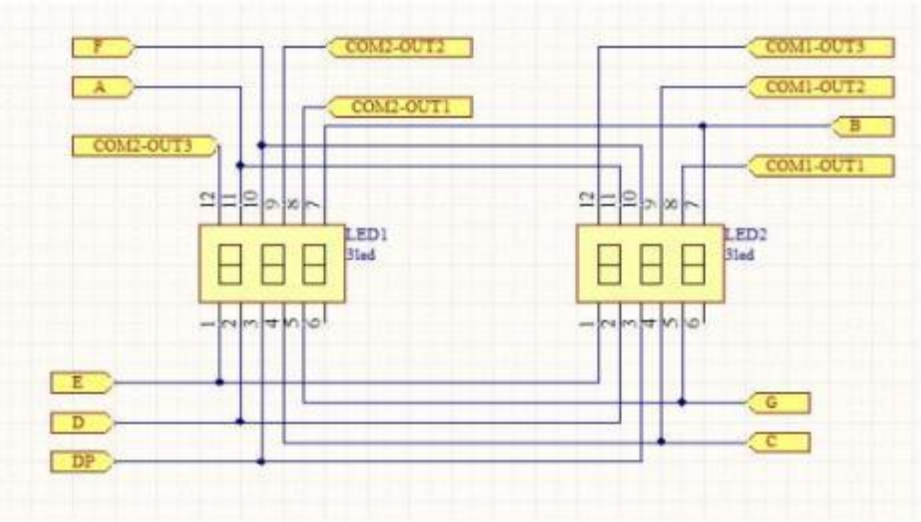

Figure 4-7 shows the circuit

Power supply circuit design

Because the phase voltage of the alternating voltage of the factory is 380V, while the power voltage of the MCU is 5V, a power supply circuit is designed to adjust the voltage through the rectifier bridge and then stabilize the voltage. The system principle is shown in Figure 4-8:

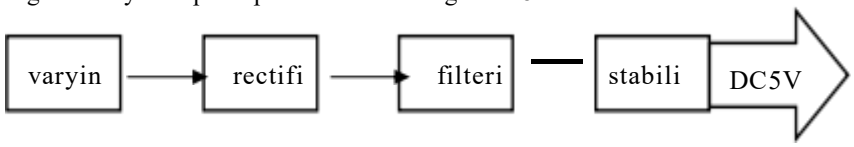

Figure 4-8 Principle of the power supply system

First of all, when the power supply voltage 380V enters the voltage, a 12V AC current but the power supply required by the single chip unit is 5V DC. MB10s rectification bridge reactor is adopted here, the working principle of MB10S rectifier bridge reactor is similar to that of the single-phase full bridge rectifier circuit, which can keep the voltage and current of the transformer in the same direction, but although the voltage direction is single, it contains a large AC component, so direct power supply to the single chip unit is not allowed. So, after the usual rectifier circuit, still need to use the filter circuit will exist sinusoidal pulse dc voltage into no peak trough of DC potential difference, capacitor filter circuit is relatively common and simple filter circuit, capacitor than generally using electrolytic capacitor, capacitor filter circuit using the capacitor charge and discharge effect, make the output voltage tends to smooth.

Although the rectifier filter circuit can ac into smooth dc voltage, but because the output voltage is transformer auxiliary side voltage effective value, when the voltage fluctuations, output voltage fluctuates, and because the internal resistance in the rectifier bridge when the load changes internal resistance voltage will change, thus affecting the average of the output voltage output DC more stable, also need to use voltage regulator circuit, voltage regulator circuit using 7805 three voltage regulator. This is an integrated circuit element that has three pins outside: the input, the output and the public end. According to the function can be divided into fixed type and adjustable type.

The circuit of this design is fixed, and its voltage stabilization circuit is shown in Figure 4-9.capacitor C3 is used to eliminate the high frequency noise of the output voltage. If the input line is very long, a capacitor can also be added to the input to prevent the self-excitation oscillation of the circuit, but if the capacity of C3 is large, once the input is disconnected, C3 will discharge to the regulator, thus damaging the regulator. Therefore, a diode can also be installed between the input and the output to protect the circuit. Like other high-power components, 7085 has both metal and plastic packaging, which is designed to dissipate heat or install a radiator. So the final design of the power supply circuit is shown in Figure 4-9:

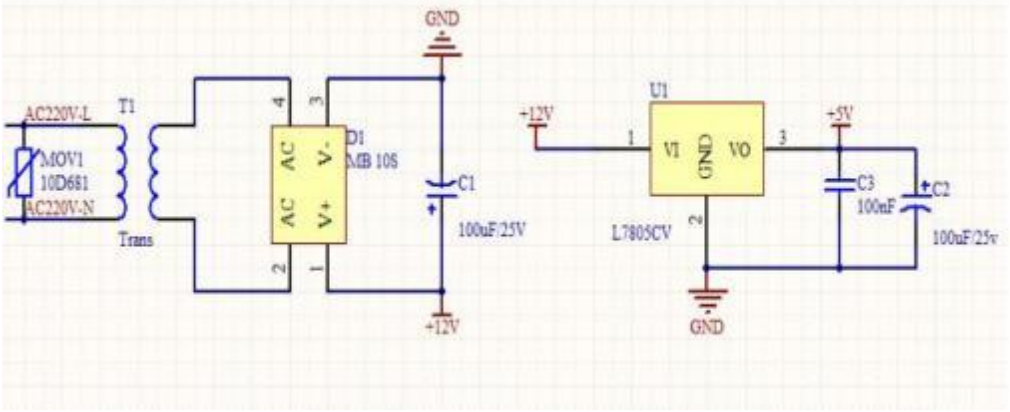

Figure 4-9 Power supply circuit diagram

5 System Software Design and Implementation

Any form of microcomputer is inseparable from the software. Software design is an important part of the hardware design, through the software to realize his function, actually again from the beginning of the design should consider the software design, because the size of the software program, determines the hardware CPU memory selection, which involves the selection of controller, so convenient coordination between software and hardware. When the hardware is done, the software design can be carried out. The software can be written separately and then debugged. When there is no problem on the test tool, the software can be downloaded to the single-chip microcomputer.

5.1 System architecture

Because the whole system software composition is very large, the circuit is complex. In order to facilitate compilation, debugging, iteration, addition and deletion, the adoption of modular design idea is an important factor in the composition of system software. That is, the whole control software is composed of multiple independent small module systems, and the modules are connected through the software interface API, following the principle of close data relationship within the module. At the same time, it strictly follows the principle of abstract design mode, loose data relationship between modules, and no coupling between modules. According to the different function, thus forming a modular structure.

The system software is mainly composed of eight main program modules, including initialization module, startup module, data collection module, data management module, control algorithm module, digital filtering module, etc. The function of the main program module is to establish overall framework and initialization for other modules; the data collection module is to collect and store the A / D conversion in the memory of the microcontroller; the function of the data management module is to conduct a series of processing of the collected data, among which the most important is the digital filtering program:

In this chapter is the specific implementation of each module function, complete the previous design of the microcontroller based temperature control system.

Among them, the main program module uses four subroutines, these are temperature sensor reading program, digital tube display program, keyboard scanning and key processing program, and temperature signal processing program.

Keyboard scanning circuit and key processing program: identify and detect the keyboard input keys and execute the corresponding callback function.

Temperature signal processing program: process the data results transmitted by the temperature chip, judge and display them.

Digital tube display program: copy the data to the display register, and control the display results of the system.

5.2 Main program module

The main program function first completes the partial initialization, including device initialization, timer initialization, watchdog initialization, and EEPROM initialization. Then, the subroutines of each module are called to perform the corresponding functions to realize the modules including temperature display, A / D conversion, temperature control and alarm. As shown in Figure Figure 5-1.

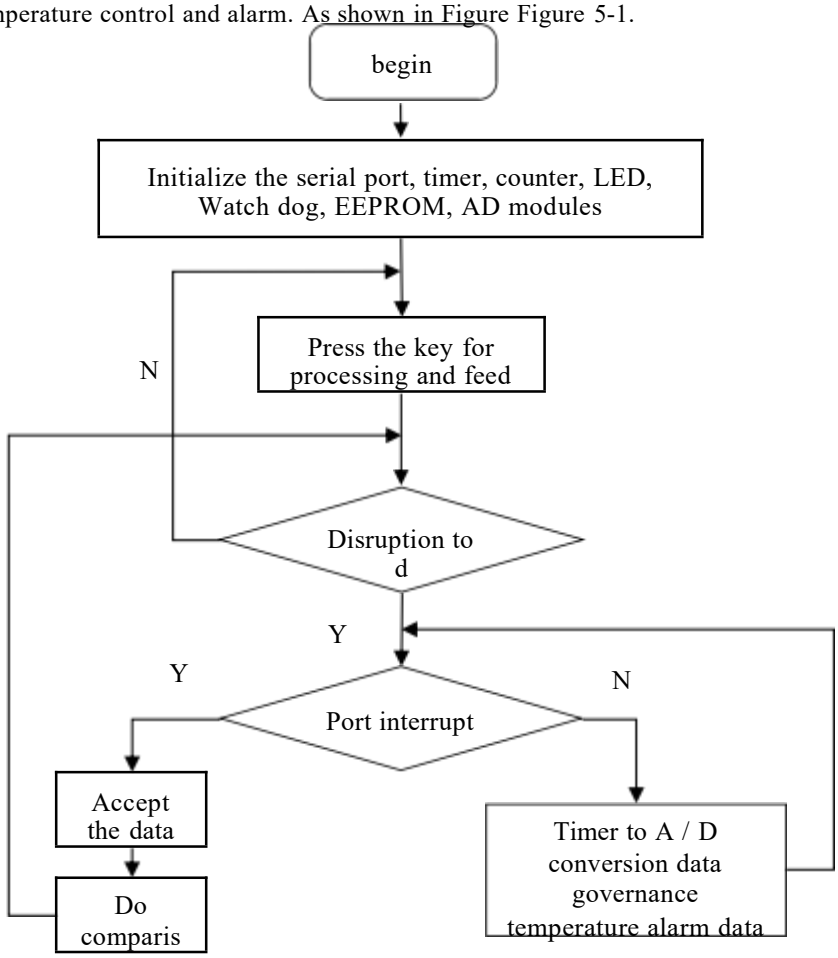

Figure 5-1 Block diagram of the system program

Core program codes and explanations are as follows:

```
// Initialize the module, refresh the watchdog, wait for the button to press, and continue the cycle
  int main()  {
      init_serial_port();
          init_timer();
          init_counter();
          init_led();
          init_dog();
```

```
    init_EEPROM();
    init_AD();
    while(1){
        wait_button();
        flush_dog();
        delay(100);
    }
}
```

5.3 Key press program module

There are only three design keys: set key, add and subtract. The function of these three keys is to set the system parameters by setting the key, and then press the setting button for a certain time to enter the manual mode, where the given range of temperature can be set, and when the temperature is not set for a certain time, the system automatically jumps back to the normal state to display the value of the current temperature. Because the keyboard to press and release two forms, which press temporarily, when stop press the button to the form, because the key state value is only given in the program, but the key is actually implemented in the operation, so should eliminate the key jitter to coordinate the manual operation and the program reading of the uncoordinated problem, the program block diagram as shown in Figure 5-2.

The system adopts two modes in key setting, by default, manual mode. In manual mode, pressing the setting button to switch to the design interface can set the upper threshold and lower threshold of temperature respectively, and the operating parameters can be updated and set through the addition and subtraction buttons. After the completion of these Settings, the system returns to the display state, display the value of the current measured temperature, another mode is automatic mode, the setting mode is to switch the mode to automatic mode, in automatic mode, can automatically determine the current state, if the temperature limit, the alarm signal will be sent.

(1) Judge whether there is a key pressed

One end of the button is connected to the serial port of the microcontroller and the other end is grounded, so when the button is pressed, the microcontroller interface will get a low potential input. So when the key is pressed, the controller interface should receive a value of 0x00 or a value lower than 0 xff.

(2) Determine which key is pressed

There are three keys in this design, so that when the key is pressed, it is necessary to identify which key is pressed, but because the parameters in the instrument are set by the program, as long as the key design is different working mode. You can press that button by switching between the modes.

After the key is pressed, it is necessary to determine whether the key is released to judge the time of the key because the system design for the key mode is divided into one press and long press, so that the release time of the key to make the microcontroller switch to the corresponding mode.

(3) Value of the key button

Because the logo positioning values of different key modes are different, the system needs to read the value of the key to drive the mode switch of the single microcontroller.

(4) Push the button for stabilization processing

Key eliminate jitter way there are two kinds: one to build hardware circuit to eliminate the key jitter, the principle is to use RS trigger interlocking function to eliminate jitter, but this will increase the burden of the design, at the same time is complex circuit, in general, display module generally does not take up too much space, because the production workshop space is limited. Therefore, it is another way of using the delay and stabilization of the program. When the microcontroller first detects the key signal, a period of time, and the state of the button is determined, so that the stable state can be read out. Compared with the hardware, the software does not increase the cost, and the implementation is not complicated.

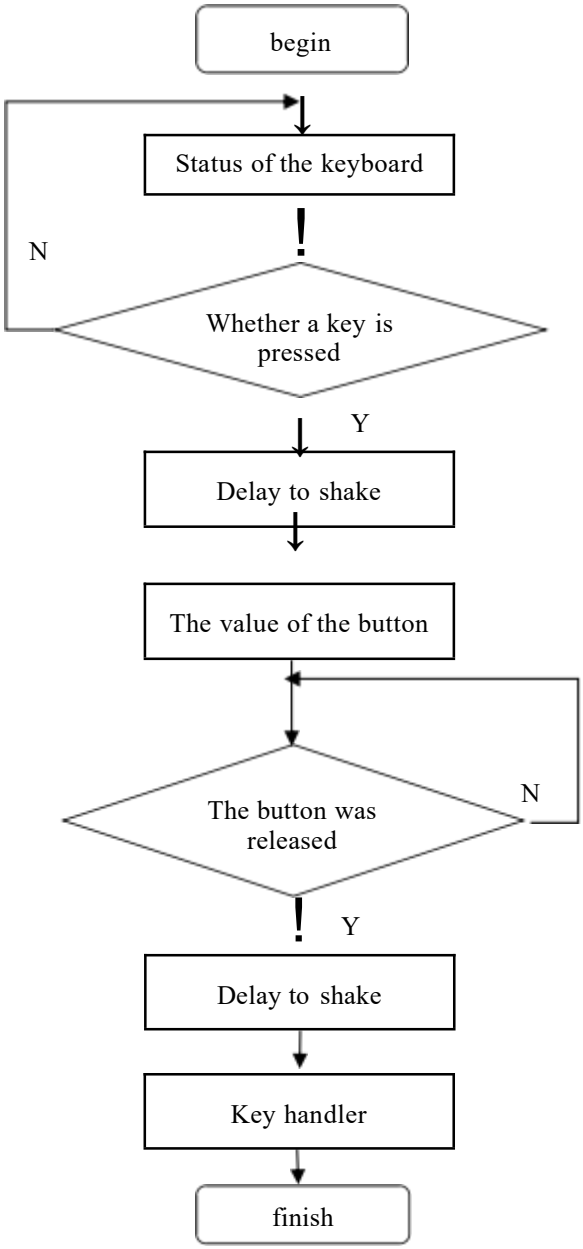

Figure 5-2 Block diagram of the key-pressing program

5.4 Temperature acquisition module

At present, the MCU can only use digital signals directly. But the temperature sensor temperature with voltage acquisition is analog signal, so the atmega8 I AD module for analog conversion, in the hardware design also mentioned the method of temperature calculation can but not every binary AD value corresponds to the integer temperature, so that the measured temperature will have a big error to calibration, so the design chose the interpolation method, the calibration curve is divided into many small interval, each interval using polynomial fitting, according to the input interval to calculate and accurate measurement.

The principle of linear interpolation is shown in Figure Figure 5-3.

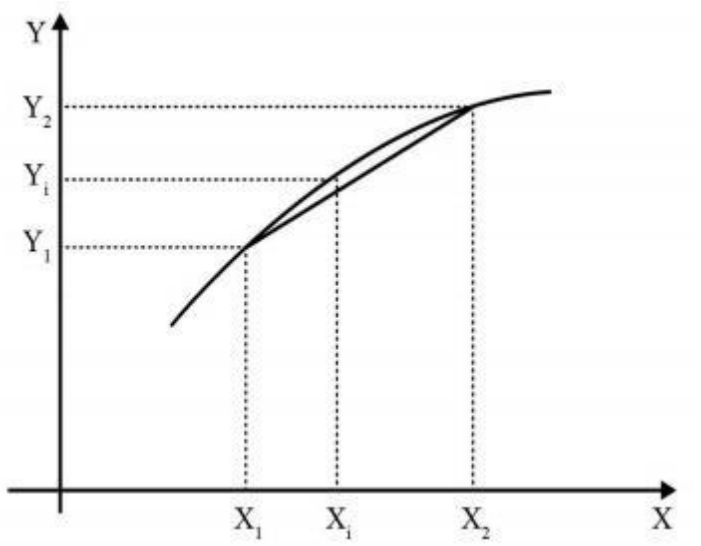

Figure 5-3 Principle of linear interpolation

When the input and outputs of the sensor are segmented as required, the trend of each paragraph can be approximated in a straight line, assuming that between Xi and Xi + 1, its relative output value can be approximately viewed:

$$y=y_i+\frac{y_{i+1}-y_i}{X_{i+1}-X_i}(X-X_i) \qquad (5\text{-}1)$$

Through this calculation, the temperature value can be calibrated, but how to replace Huawei is the program design of the specific implementation process is like this, the first step is to segment the calibration curve, and select the segmented base points. Then determine the specific value of A / D of each interpolation point, and finally calculate the corresponding output value. Finally, check the table to compare, determine its range, and then find the corresponding value according to the formula.

The temperature acquisition procedure is shown in Figure Figure 5-4:

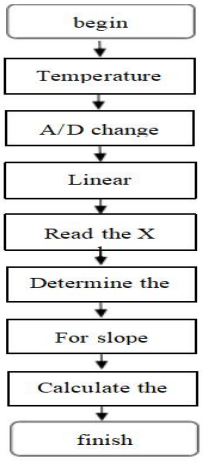

Figure 5-4 Block diagram of the temperature program

The interpolation core code of interpolation is as follows. The function of this function is mainly used for temperature interpolation. The function of this function is to obtain the average of y and x, calculate the fx-fx0 / x1-x 0 of each point, and finally carry out the interpolation calculation, and use the bit-wise inversion method to improve the running speed:

// Linear interpolation function

```
_input_value_ave_(system_real_number __x__list, system_real_pointer___ave_of_x, system_real_pointer_
y, int k);
int calculator(system_real_pointer_ x, system_real_pointer_ y, system_real_number
sum_of_input_value);
int calculator(float *x, float *y, float sum_of_input_value) {
float input_result;
for (int loop_j = 1; loop_j < n; loop_j++)
if (sum_of_input_value <= x[loop_j])
if (loop_j != 1 && sum_of_input_value - x[loop_j - 1] <= x[loop_j] - sum_of_input_value)
loop_j = loop_j - 1;
else
loop_j = n - 1;
loop_j = n - 1;
input_result = _input_value_ave_(sum_of_input_value, x, y, loop_j);
return input_result;
}
// averaging
float_input_value_ave_(system_real_number __x__list, system_real_pointer_ _ave_of_x,
system_real_pointer_ y, system_number k) {
system_real_number y1 = 0, m;
for (inti = k - 1; i <= k + 1; i++) {
m = 1.0;
for (j = k + 1; j <= k + 1; j++) j = k - 1;
~k + 1;
if (j != i)
m = m * (_x_list - _ave_of_x[j]) / (_ave_of_x[i] - _ave_of_x[j]);
y1 = y1 + m * y[i];
}
return y1;
}
```

5.5 Display the program module

The display program mainly uses the single-chip microcomputer to control the value of the digital display temperature, because the hardware is designed for two latches to control the display of two 3-bit 8-segment digital tubes. In this way, the single-chip I / O control line can be reduced, and the saved control line can be designed for other hardware. By using the cascade method of latch, it can be more convenient to choose the digital tube display, convenient program design and circuit design. Using the data transmission type to send, the data can be displayed, so the program design should first transform the number into the corresponding display segment code, and then the display by scanning display, delay 2ms can use the human eye residue phenomenon, to avoid flashing. Then, the digital tube selection is made. Then determine the corresponding value of each digital tube display, make the display setting, and finally set the temperature accuracy display.

The program code is used to display the number on the LED:

```
void show(sys_number x)
{
  unsigned char w， i;
  while(1)
    {
        w=0x01;
        for(i=0;i<8;i++)
        {
```

```
                P1=w;
                P0=led0[ x];
                delayms(1);
                w<<= 1;
            }
        }
    }
```

The program block diagram is as shown in Figure Figure 5-5:

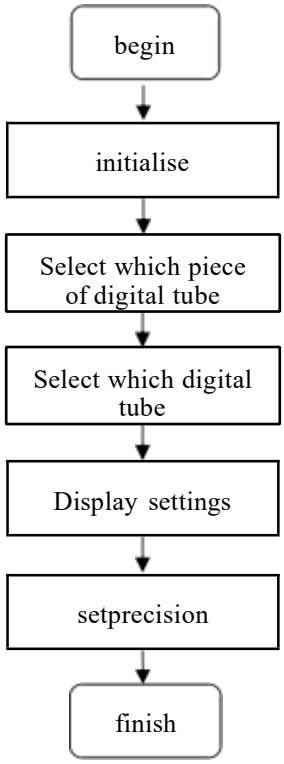

Figure 5-5 shows the module flow chart

5.6 Data storage register module

EEPROM Mainly is to save the data to ensure that the controller can save the current data in the case of power loss. After the single chip microcomputer power, can return to the original state. The data register design program is very simple, basically including judging whether to write the register, setting the storage address, and setting the bit write operation. The program is read in the same way as the writing operation.

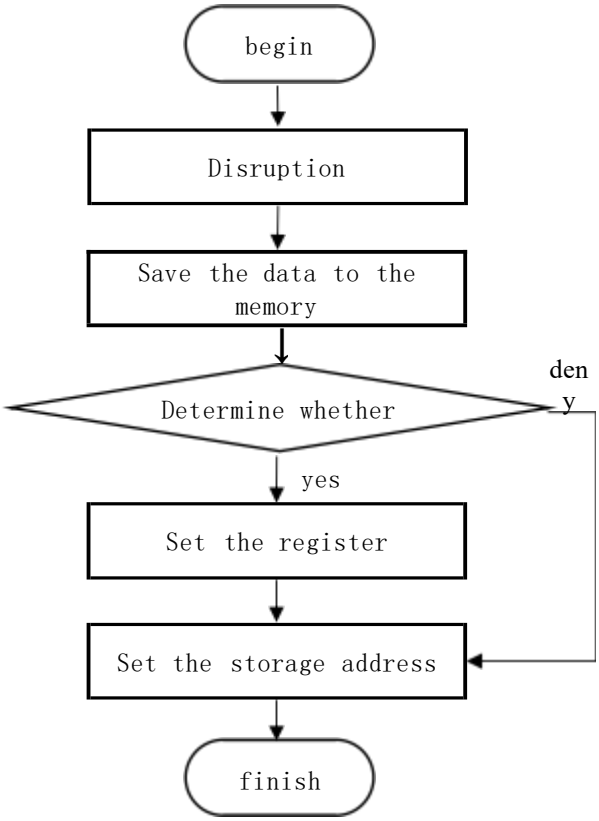

Figure 5-6 shows the module flow chart

5.7 Digital Filter module

Digital filtering principle

A digital filter is an algorithm that transforms an input digital array into another group of output digital array. Let the input of the digital filter be X (n) and the output be Y (n), then the relationship between the input sequence and the output sequence can be expressed by the difference equation:

$$Y(n)=\sum_{K=0}^{N}a_K X(n-K)-\sum_{K=1}^{N}b_K Y(n-K) \tag{5-2}$$

The input signal can be a digital sequence obtained by the analog signal after sampling and A / D transformation, or it can be the output signal of the computer. The current output of the digital filter with the above relationship is related to the present and past inputs, past outputs. Filters composed of such difference equations are called recursive digital filters.

Filtering algorithm design

The function value is required, such as Y, in the arithmetic mean filter so that the sum of the error between the value and each sample value X (K) (K= 1~N) is minimum, namely:

$$E=\min[\sum_{K=0}^{N}e_K^2]=\min[\sum_{K=1}^{N}(Y-X(K))^2] \tag{5-3}$$

From the limit principle of the unary function:

$$E=\frac{1}{N}\sum_{K=1}^{N}X(K) \tag{5-4}$$

The result of finding the limit can satisfy the formula (5-3). Equation (5-4) is the requirement of the algorithm for arithmetic mean filtering.

Let the measurement value of the second measurement include the signal components Si and noise components, then the sum of the signal components of the N measurements be: C_i

$$\sum_{i=1}^{N} S_i = N \cdot S \tag{5-5}$$

The intensity of the noise is measured by the root mean square. When the noise is a random signal, the sum of the noise intensity of the N measurements is:

$$\sqrt{\sum_{i=1}^{N} C_i^2} = \sqrt{N} \cdot C \tag{5-6}$$

In Equation (5-5) and Equation (5-6), S and C represent the average amplitude of signal and noise after N measurements, respectively.

Thus, the signal-to-noise ratio after arithmetic averaging of N measurements is:

$$\frac{N \cdot S}{\sqrt{N} \cdot C} = \sqrt{N} \cdot \frac{S}{C} \tag{5-7}$$

Where S / C is the signal-to-noise ratio before the arithmetic mean. The SNR does double, after arithmetic averaging.

Therefore, random interference for the filtering of the signal is what we adopted. This signal is characterized by the presence of an average value that fluctuates up and down over a range of values. At this point, only one sampling value as the basis, such as temperature, pressure and other signal measurement, is obviously inaccurate. According to equation (5-7), the smooth filtering degree of the signal by the arithmetic average method depends on n. When n is large, the smoothness is high, but the sensitivity is low, that is, the change of the external signal has little effect on the measurement result y; when n is small, the smoothness is low, but the sensitivity is very high. According to the actual needs of the industrial object, the n=4 filtering is applied

The core filter code and its interpretation are as follows:

```
typedef int (*FilterFN)(int， int);
typedef int sys_number;
// Functor, do a single data closure processing
sys_number lineFilter(sys_number sum_from_ad， sys_number size_of_ad){
    if(size_of_ad <= NATURE_NULL){
            return NATURE_NULL;
    }
    int deal_result = NATURE_NULL;
    z = (float) sum_from_ad / size_of_ad;
return deal_result;
}
// Filter function definition, the first boundary check, prevent the wrong data, let the system crash
char filter(sys_number checked_size， fn FilterFN)
{
    if(checked_size == NATURE_NULL){
    return NATURE_NULL;
  }
  sys_number sum = NATURE_NULL;
  sys_number filter_result= NATURE_NULL;
  // Find the average filter, sum, and pass the results to the fuctor functor for calculation
  for (sys_number count= NATURE_NULL;count< checked_size;count++)
  {
```

```
        sum + = get_ad_sign();
                filter_result = fn(sum ,  checked_size);
        delay();
      }
    return (char)(result);
    }
```

6 System Testing and Optimization Analysis

For a single-chip microcomputer system, reliability is not only its performance, function strength and cost, but also a very important index. In the development stage of the system can mainly improve the reliability of the system has the following methods:

1. Improve the reliability of the system itself. The influence of design and production on the reliability of the system should be reduced during the design process.

2. Anti-interference technology. Improving the anti-interference ability of the system can reduce the influence of external factors on the system in the actual operation.

3. fault tolerance design of the system. It is clear that the system can avoid and reduce losses in the event that the system is affected by external factors.

6.1 Hardware testing

The circuit board shall be checked before the power supply, including checking the chip welding direction, checking the chip pin for short circuit, open circuit, and other possible problems.

After checking and confirming that there is no problem in the chip welding, the chip bonding after inspection showed no abnormality. After the power is on, the circuit first determines whether it is abnormal. Disconnect the power supply and check for the circuit fault. No exception was seen.

6.2 Software testing

When debugging the simulated software system is executed according to various modules, first confirm that no error message is detected to be written. After the inspection, there is basically no problem, through the computer program into the system single chip computer kernel compilation, check whether the software and hardware coordination work, and whether there is a problem in each part, check the program, and until the current software system, if not meet the hardware can be properly modified.

(1) Test environment

The current temperature is 28 degrees Celsius, and the production line area is 20 square meters. The test instrument is an electronic digital multimeter, an extreme environment thermometer.

(2) Test method

Start the system, use the thermometer to measure the temperature, and use the system to test the temperature measured by the system. Set the temperature threshold, raise or lower the temperature, and observe the startup of the temperature device.

(3) Test results

Set the temperature from 0 degrees Celsius to 40 degrees Celsius;

Calibration temperature difference <= 1 degrees Celsius;

Adjustment time is 15s (depending on the site situation);

Static error of <=0.5 degrees Celsius;

Maximum overshoot of 1 ° C.

Test results For the temperature control of the actual production line, two methods can be proposed: one is to increase the number of sensors to calculate the data collected by each temperature sensor, so as to obtain a more accurate temperature value. The second is the temperature control of the actual production line, can use large power resistance wire, heater, electric soldering iron, and even high temperature laser. And to cool the temperature in the box through the fan. At the same time, the cooling equipment can use air compressor, freezing laser, molecular stagnation device and other refrigeration equipment.

By testing and analyzing the experimental results, the highest temperature sensor acquisition accuracy was 0.06℃.

6.3 Optimization and analysis

1. In the process of testing the drive circuit, it is found that the digital tube shows errors or even fails, and the main reason is the poor contact of the hardware circuit. Including poor contact between wires and chips. The reason for this phenomenon, or because of their own carelessness, did not weld the circuit. At the same time, during the experiment, sometimes digital tubes will appear. It was found that the connection between the wire and the multimeter was not very stable and could not reach the expected display effect. The solution is to extract the chip and insert it evenly into the holes of the universal plate.

2. Because the components are damaged during welding, the problem cannot be found during debugging. Use the elimination method to find out the damaged parts one by one, replace the new parts, and solve this problem.

3. In the process of connecting the triode, it was found that no matter what the program was, the electronic digital tube always displayed 8 words. Upon examination, the original triode polarity error was found, and the polarity order was adjusted.

4. In the circuit debugging, due to the selection of the opposite type of photoelectric sensor, the debugging is interrupted because of incorrect. Finally, the problem was solved through repeated debugging.

6.4 Experimental results

First of all, the components were welded on the circuit board according to the circuit, and the connection was tested after the hardware physical welding. Then, it was checked whether there is any lack of welding or welding leakage. After checking the pin connection, the hardware physical assembly was conducted, as shown in Figure 6-1:

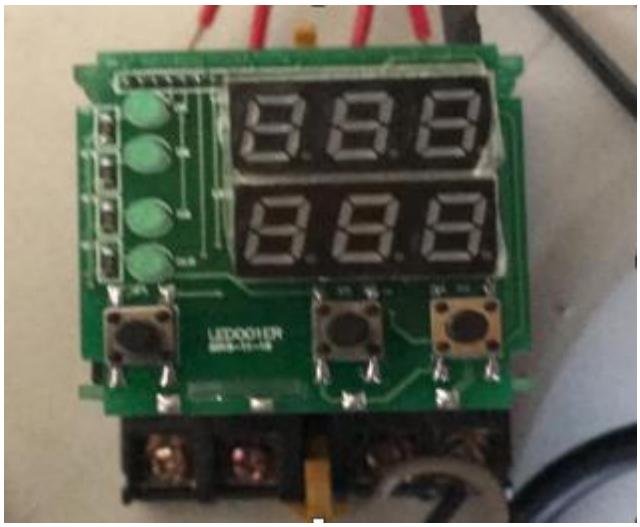

Figure 6-1. the physical picture

Then it is directly energized, and the main reason for this is to test the sensor whether the output temperature is square wave and whether the temperature output is voltage signal. The measurement results are shown in Figure 6-2:

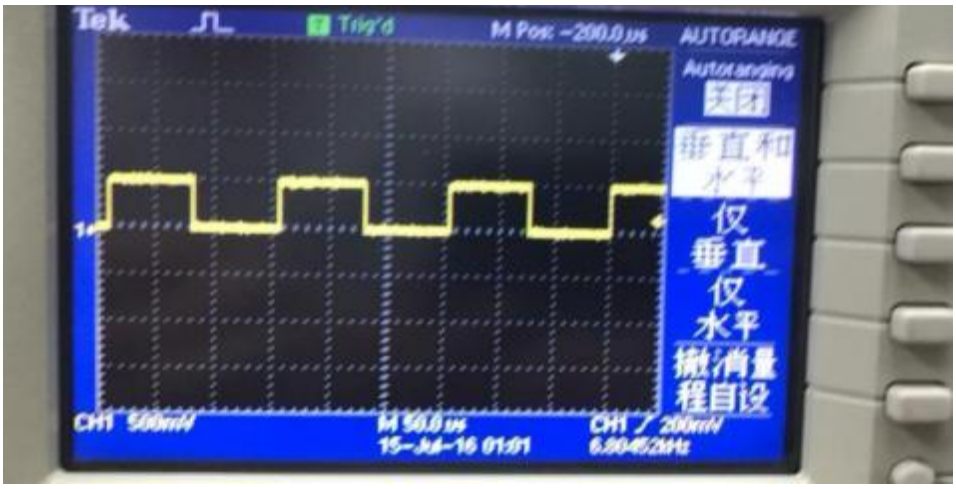

Figure 6-2 Measuring the temperature waveform

It can be seen from the figure that the output waveform of the sensor temperature acquisition circuit is a stable square wave, which is consistent with the theoretical calculation. The sensor has no problem and can conduct data collection. After the hardware test, download the program to controller through the burner. The program download software is downloaded by prognisp software, as shown in Figure 6-3:

Figure 6-3

After downloading the controller program, the temperature alarms because the initial set value is 0, and the upper and lower limits of the current temperature value are displayed as shown in Figure 6-4.

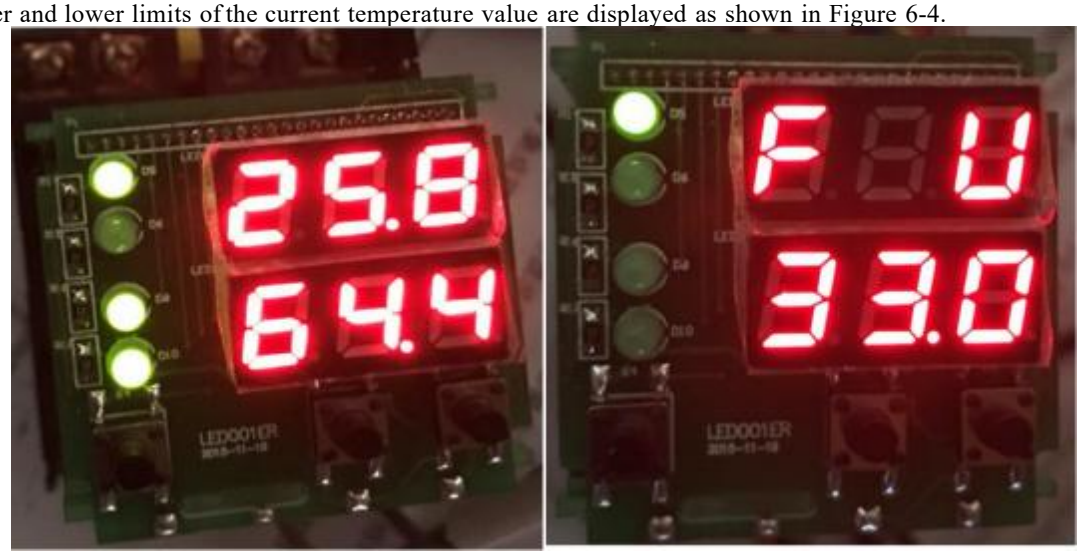

Figure 6-4 After download interface shows Figure 6-5 maximum setting interface

Setting the maximum and minimum temperature values can be set according to the functional design, as shown in Figure 6-5.

After setting, the system can be converted into an automatic mode by long pressing the setting key to set the value of the automatically controlled temperature, as shown in Figure 6-6.

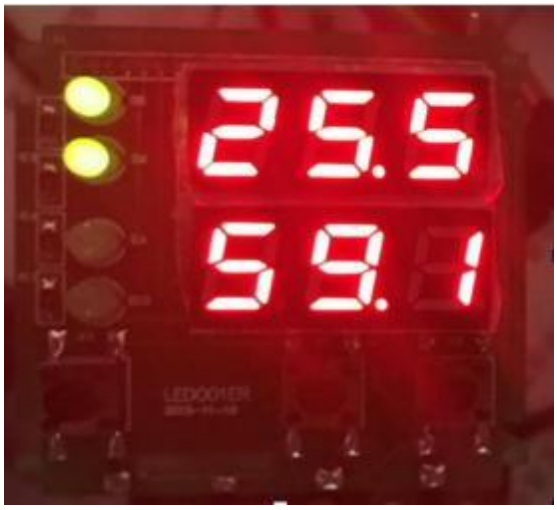

Figure 6-6 Automatic mode

Finally, the control function is set. Since the transmission voltage of the designed environment is 220v, the output voltage is measured as 229V.

After all these steps, the indoor temperature was measured in the following days, and the results are shown in Table 6-1:

Table 6-1. Measured data

date	temperature (℃)	actual temperature (℃)
12	24.1	26
13	25.6	27
14	24.7	27
15	25.5	23.8
16	26.2	28

According to the table, the temperature error is at 1.96℃, and the RH measurement value is relatively accurate.

Program download hardware shows the frequency of the current temperature, not the actual temperature value, so the measurement sensor and no problem, so when measuring the hardware interface voltage found T1 voltage is high, after inspection found that it is the timer of the initialization, after redefining the temperature display is normal, the problem solving.

When the program is just downloaded to the microcontroller, the maximum and minimum temperature values are zero, the alarm signal occurs, the alarm light is on, but the alarm sound is eliminated but the alarm light continues to turn on. After inspection, it is found that the value assigned to the output port of the light in the program is wrong, and the fault is eliminated after correction.

7 Conclusion

This graduation project is very helpful to my growth, but also gave me a great challenge. It gave me a comprehensive understanding and in-depth thinking about the knowledge I learned in college, and made me understand and improve the knowledge I learned as well as my thinking and comprehensive ability. The

process of writing a paper is also an important stage in the process of learning professional knowledge. It enabled me to construct the system using the existing technical expertise. It has improved my ability to solve theoretical and practical problems. And translate knowledge into practical skills.

This system uses single chip microcomputer as the development template, selects C language as the development language, selects Progisp as the programming downloader, and ICCAVR as the compiler, and develops a set of devices suitable for industrial object sensing. The system includes temperature monitoring, temperature alarm, temperature control, temperature setting and other functions. And completed the test and optimization of the system, can realize the precision industrial objects in the industrial production line to do a good temperature detection and control.

Through the result of the final design, I found that only by improving the theoretical level can I combine the knowledge of the textbook with the practice. Theoretical knowledge can serve the teaching practice and improve my practical ability. In general, the graduation design completes the expected goal, the system demand analysis is sufficient, the functional design is comprehensive, the development content is complete, the page design is neat, and the operation is convenient to use. At present, it can better meet the needs of industrial production objects for temperature control, and can greatly improve the temperature control efficiency of industrial production objects. To reduce the pressure of workers, but there are still some deficiencies in the actual use of the system, such as the temperature control is not accurate enough, the filtering algorithm still has room for improvement, the system operation speed is not fast and other problems, these are the need to be gradually considered and improve the key work in the future.

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