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Design of Water Temperature Control System Based on Single Chip Microcomputer

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Abstract. In this paper, we mainly introduce a multi-function water temperature controller designed with 51 single-chip microcomputer. This controller has automatic and manual water, set the water temperature, real-time display of water and temperature and alarm function, and has a simple structure, high reliability, low cost. The current water temperature controller on the market basically use bimetal temperature control, temperature control accuracy is low, poor reliability, a single function. With the development of microelectronics technology, monolithic microprocessor function is increasing, the price is low, in all aspects of widely used. In the water temperature controller in the application of single-chip, with a simple design, high reliability, easy to expand the advantages of the function. Is based on the appeal background, so this paper focuses on the temperature controller in the intelligent control of the discussion.

1. Introduction

The purpose of "single-chip course design" is to enable students to complete the design and programming of small system target board based on MCS-51 single-chip multi-resource application and comprehensive function on the basis of theoretical study so that students can not only Classroom knowledge and practical application of the combination of knowledge, but also to electronic circuits, electronic components, printed circuit boards and other aspects of knowledge to further deepen understanding, while software programming, debugging debugging, welding technology, related equipment The use of skills and other aspects of a more comprehensive exercise and improve for the future to be independent of some of the SCM application system development and design work to lay a certain foundation.

2. Overall Design

2.1. Design requirements

The overall design of the program is mainly based on single-chip water temperature controller system design, to achieve automatic heating of water temperature, and to detect the size of the water temperature and temperature display. The specific requirements are divided into the following aspects: the program design is reasonable, simple; self-design detection and related processing circuit; complete single-chip data acquisition and processing hardware circuit design and related software programming; auxiliary circuit and components optional; optional sensor type; Range 20 to 60 degrees celsius.

2.2. Design purposes
The rapid development of modern science and technology, with profound knowledge is the basis of the future ambitious. Experience is also important as knowledge, if not in the practice of students practice hard work, alone classroom learning class, is bound to theory and practice out of touch And the application of the situation out of touch. How easy it is to use a single-chip microcomputer technology, how useful is it, and how easy it is for the students to feel that it is just a pilgrimage to the air, or that you will lose interest in it, or you will feel it Measured no way to start, these circumstances will make the effect of classroom teaching greatly reduced.

3. Design
This paper introduces a multi - function water temperature controller designed with 51 single - chip microcomputer with automatic and manual water supply, set water temperature, real - time display water quantity and temperature and alarm function, and has the characteristics of simple structure, high reliability and low cost. The current water temperature controller on the market basically use bimetal temperature control, temperature control accuracy is low, poor reliability, a single function. With the development of microelectronics technology, monolithic microprocessor function is increasing, the price is low, in all aspects of widely used. In the water temperature controller in the application of single-chip, with a simple design, high reliability, easy to expand the advantages of the function.

Water temperature controller mainly to achieve the control of water temperature, and to meet the individual needs of different users. So a more complete controller should have the following functions: Water temperature measurement and display; water measurement and display; user settings (such as water temperature settings, timing settings, etc.); on the heating tube control function; some function keys (such as regular automatic water, constant temperature control, manually add water, Manual heating, etc.). The flow chart of the concrete design scheme is shown in Fig 1.
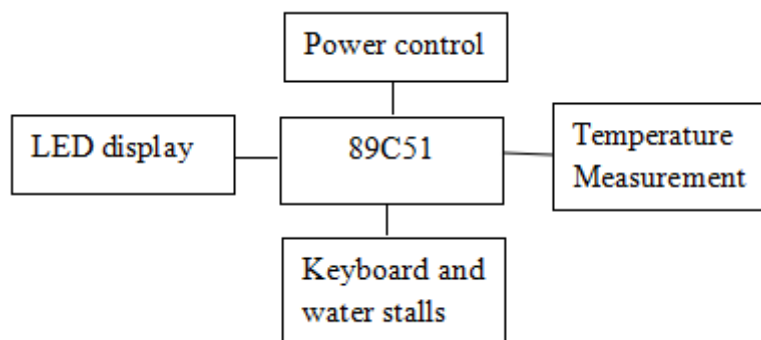

Figure 1. 51 single-chip design of the water temperature control system design

4. Hardware Circuit Design
According to the functional requirements of the water temperature controller and combined with the resource analysis of the 51 series single chip microcomputer, the mainstream model 89C51 in this series is adopted as the control core of the circuit system. The basic hardware circuit shown in Figure 2 (a) ~ (c) below. In this system, P0.0 ~ P0.3 for seven-segment code display, P2.6 control the water lock switch, P2.7 control electric heating tube, P3.3 ~ P3.5 for key design and read water, P3.0 ~ P3.2 for the DS1820 communication for water temperature measurement, P2.0 ~ P2.1 on the seven-paragraph code to scan, P2.2 ~ P2.5 LED indicator, P3.7 control the speaker for the alarm And instructions.

4.1. Water temperature measurement circuit

Water temperature measurement circuit temperature measurement components using DALLAS single-wire digital temperature sensor DS1820. DS1820 provides nine temperature readings, measuring range -55 ℃ ~ 125 ℃, using a unique 1-WIRE bus protocol, only one port line that is to achieve two-way communication with the MCU, with a simple connection, high precision, high reliability and so on The At work, through the bus to provide power, the microcontroller issued a script to read the temperature value.

The DS1820 is available in a 3-pin PR-35 or 8-pin SOIC package with pinout shown in Figure 2. Figure 3 pin for the GND, 2 pin I / O for the data input / output (ie, single-wire bus), the pin is open-drain output, under normal state was high. Lead # 1 is an external + 5V power supply terminal and should be grounded when not in use. NC is empty. The internal block diagram of the DS1820 includes the parasitic power supply, the temperature sensor, the 64-bit laser ROM single-wire interface, the high-speed memory (including the scratchpad RAM) for storing the intermediate data, and the TH and TL for storing the user's set temperature upper and lower limits The processor memory and control logic, 8-bit cyclic redundancy check code (CRC) generator and other seven parts.

4.2. Parasitic power supply circuit

The parasitic power supply consists of diodes VD1, VD2 and parasitic capacitance C. The power supply detection circuit is used to determine the power supply mode. When the parasitic power is supplied, the VDD pin is grounded and the device obtains power from the single-wire bus. When the I / O line is low, the voltage Vc on C continues to supply power to the device. The parasitic power supply has two advantages: first, the detection of remote temperature without local power; second, the lack of normal power can also read ROM. If external power supply VDD is used, power is supplied to the device via VD2.

4.2.1. Principles of temperature measurement. The DS1820 measures temperature using unique temperature measurement techniques. DS1820 internal low temperature coefficient oscillator can produce a stable frequency signal f0, high temperature coefficient oscillator will be measured temperature into the frequency signal f. When the count gate is open, the DS1820 counts f0 and the counting gate turn-on time is determined by the high-temperature coefficient oscillator. There is a slope inside the chip accumulator, the frequency of the non-linear to be paid. The measurement results are stored in the temperature register. In general, the temperature value should be 9 (symbol 1 bit), but the sign bit is extended to 8 bits, so it is read by 16 bits.

4.2.2. High Speed Register. In the case of normal temperature measurement, DS1820 temperature resolution of 0.5 ℃, can be obtained by the following high-resolution temperature measurement results: First, with the DS1820 read the register instructions (BEH) read at 0.5 ℃ (LSB) in the measurement result to obtain the integer part Tz of the measured actual temperature, and then use the BEH instruction to take the count residual value Cs of the counter 1 and the per-count value CD The Taking into account the DS1820 measurement of the integer part of the temperature to 0.25 ℃, 0.75 ℃ for the relationship between the carry limit, the actual temperature Ts can be calculated using the following formula: Ts = (Tz - 0.25 ° C) + (CD - Cs) / CD.

4.3. High temperature automatic alarm circuit

DS1820 to complete the temperature conversion, the measured temperature and TH, TL for comparison. If T> TH or T <TL, the alarm flag in the device is set and the alarm search command sent by the host is responded. Therefore, more than one DS1820 can be used to measure the temperature and alarm search. Once the temperature limit is exceeded, the host uses the alarm search command to identify the device that is being alerted and read out its serial number, regardless of the non-alarm device.

A cyclic redundancy check (CRC) is stored in the most significant byte of the 64-bit ROM. The host calculates the CRC value based on the first 56 bits of the ROM and compares it with the CRC value stored in the DS1820 to determine if the ROM data received by the host is correct. The CRC expression for the CRC is: $CRC = X8 + X5 + X3 + 1$. In addition, the DS1820 is required to generate an 8-bit CRC for the data in the scratchpad to ensure that the scratchpad data is transmitted correctly.

4.4. Basic temperature water temperature measurement circuit
In this system, a DS18B20 temperature sensor, three seven-segment code display with four LED lights, four function keys and water volume setting buttons use the same set of keys. The priority of the key is higher than the water signal, and the high-grade signal of the water is higher than the low-level signal to ensure that the key is given priority.

4.5. Display circuit and keyboard circuit
Display circuit temperature using two seven-segment code display, display range 0 ℃ ~ 99 ℃. Water with a seven-segment display, display 1,2,3,4, four file water level. Perform a cyclic scan of temperature and water. Four LEDs are used for the current key function setting. So in the design process, we need to set the button two, a ten key, one by one button.

4.6. Water temperature and water control circuit
Water temperature and water control circuit As shown in Figure 2 below, the microcontroller through the photoelectric coupling of the relay control, used to cut off or turn on the heating tube power, close or open the water valve, so as to achieve water temperature and water control.
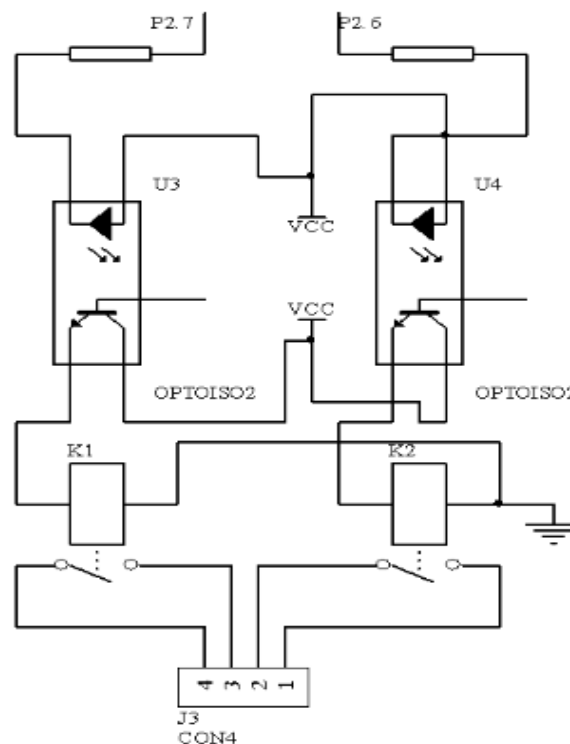

Figure 2. Water temperature and water control circuit

5. System software Design
The system software is written in assembly language. The system of keyboard scanning, leakage detection and other subroutines are achieved through the query, and the use of 12MHz clock frequency,

the instruction run time for accurate calculation and design to ensure the reliability and stability of the software.

5.1. Keyboard and display

The system has four function keys: regular water, constant temperature control, manual water and manual heating; three seven-segment code display with four LED lights.

(1) press the timer when the water button, the timer LED light up, and the current time for the timing of the standard, every 24 hours automatically add water to set the water; if this button for more than 5 seconds, the timer LED off, and hear "Duo" sound to set the water, then every time you press the button, water display plus a file, 1 ~ 4 file cycle display, do not press the button for more than 5 seconds, once again hear the "beep" sound, water set up. The timing function of the system is mainly done by software.

(2) Press the thermostat control button, constant temperature LED light, said the temperature control, and then click the LED off, cancel the temperature control. Similar to the water setting, press and hold the temperature setting.

(3) Press the manual heating button, the heating LED light, heated to 65 ℃, such as water less than 1 file, then add water to 1 file, then press once to cancel the heating.

(4) Press the manual water button, add water to set the amount of water, long press to set the water. In the process of adding water manually, press again to cancel the water. Normally, two seven-segment codes show the current water temperature and the other shows the current water level.

5.2. Water temperature measurement

The temperature reading is done by communicating with the DS1820. The DS1820 communication function is done on a time-sharing basis, and it has a strict time slot concept. So the system on the DS1820 various operations must be carried out by agreement. DS1820 is the United States DALLAS company's single-wire digital temperature sensor, it has a miniaturization, low power consumption, high performance, anti-interference ability, easy to deal with microprocessors, etc., is particularly suitable for forming a multi-point temperature measurement and control system, The temperature is converted into a serial digital signal for microcomputer processing, and each chip DS1820 has a unique product number and can be stored in its ROM, so that constitute a large temperature measurement and control system in a single line linked to any number of DS1820 chip. Read or write from the DS1820 DS1820 information only need a mouth line, read and write and temperature conversion power from the data bus, the bus itself can also be connected to the DS1820 power supply, without the need for power. The DS1820 provides nine temperature readings, making it easy to configure the temperature detection system without any peripheral hardware.

6. Conclusion

The curriculum design is an important part of cultivating students' comprehensive application of the knowledge, discovering, proposing, analyzing and solving practical problems and exercising practical ability. This design is also the actual work ability of the students specific training and inspection process. With the rapid development of science and technology. MCU has become an unprecedented field of application in today's computer applications. In life can be said to be everywhere. So as the twenty-first century, the University of the master of the development of single-chip technology is very important.

After the design to some of the design experience: 1. In the design process, be sure to use the internal structure of the microcontroller has a system to understand, know what the chip chip resources, its pin function should understand; 2 . It is not very important to design a programming language. The key is to have a clear idea and a complete software flow chart. 3. In the design process, you can not imagine the whole process will be designed, "repeated changes, continuous improvement "Is the only way to design the program; 4. In the process of designing the program encountered a problem is

normal, but we should each time the problem is recorded, and analysis clearly, so as not to encounter the same next time the same problem.

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