Design and Research of Three-in-One Microcomputer Experiment Box for Project Teaching

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Abstract: In order to help students master the knowledge of single-chip hardware circuit and enhance programming ability, a three-in-one multi-function single-chip experimental box suitable for project teaching method and integrating simulation, download and experiment is designed. The I/O port of the experiment box and the hardware resources of the peripheral function modules are all open, enabling the operator to complete the experimental project by using assembly language and the C51 language design program. Through experiments, it is found that the three-in-one single-chip experimental box has hardware simulation and debugging functions, and can download the machine code produced by the compiler into the single-chip microcomputer through the serial port of the computer, thereby realizing experiments of 18 projects. In practical use, the self-made single-chip experimental box is cost-effective, and can meet the needs of single-chip experimental teaching, curriculum design, and open laboratory projects.

1. Introduction

"Single-chip principle and application" is an important professional course in electronic information and automatic control subjects, which plays an important role in the course. The course needs to be based on digital electronics, analog electronics and C programming, and has a significant impact on embedded systems and DSP technology. Since most universities now purchase single-chip experimental platforms from teaching companies, the prices of single-chip devices in teaching companies are high, and because many technical materials of teaching companies are not open to the public, it affects students' mastery of software and hardware principles. It also caused students to lack openness and innovative experimental projects. Although there are some inexpensive MCU templates on the Internet, only some download experiments can be performed. This paper aims to meet the daily teaching needs by designing a three-in-one multi-function single-chip experimental box suitable for project teaching method, integrating simulation, download and experiment.

2. Hardware system design

By using Altium Designer software to design the hardware circuit schematic, the PCB circuit diagram is drawn, then the PCB board is produced by the circuit board factory, the components are soldered on the PCB board, and finally the circuit board is installed in the experiment box. Must pay attention to the configuration and expansion of the experimental box hardware, need to adopt new technology, and universal, and choose a more typical circuit. In the system, it is necessary to use the system to develop in the direction of the on-chip system, and the selection of the expansion interface should use devices such as field programmable peripheral chips. When meeting the functional requirements of the application system, it is more important to pay attention to standards and modularity, so that students can be faster and more convenient during the experiment.

The three-in-one single-chip experimental box is designed by adopting the modular concept, and is composed of single-chip microcomputer system, simulation and download interface, input and output module, AD conversion module, DA conversion module and other components (Table 1). And can achieve 18 experimental projects.

Table 1Experimental items that can be realized in the experiment box

Numbering	Experiment name
1	8-channel LED water light
2	Timer and external interrupt
3	8-bit digital tube dynamic scanning
4	Independent button recognition
5	Matrix keyboard scan
6	MCU-PC serial communication
7	12-bit AD conversion
8	Analog voltage acquisition and transmission system
9	8-bit DA conversion
10	8×8 dot matrix
11	Buzzer playing music
12	Infrared remote control receiving and decoding
13	1602 character LCD display
14	DS18B20 temperature sensor
15	DS1302 real time clock
16	Stepper motor
17	Small RTOS51 Operating system porting
18	µC/OS-II Operating system porting

The system of the single-chip experimental box includes: a single-chip microcomputer, a power supply, a reset circuit, and a clock circuit (as shown in FIG. 1). The 51 single-chip microcomputer of DIP-40 package is used in the system, thereby improving the replacement efficiency of the single-chip microcomputer, and the crystal oscillator of 12MHz and 11.0592MHZ can be selected according to actual conditions. By using 220V AC power supply, and then regulating the voltage through the switching regulator power supply in the experiment box, plus a 2A fuse, to protect the power supply. The three-in-one single-chip experimental box is mainly composed of an input interface, an output interface, a serial bus module, an AD conversion module, a DA conversion module, and other modules. The input interface generally consists of a 1×8 self-locking switch, a 1×4 independent button, a 4×4 matrix keyboard, and an infrared receiving head. The main function of the input interface module is to enable students to distinguish the function of each button by understanding the principle of each button. The output interface is composed of 8 LED water lamps, 8 digits common digital tube, 8×8 dot matrix and 1602 liquid crystal. The serial bus data transmission rate is continuously improved, which provides an effective solution for solving the multi-function and miniaturization of the single chip microcomputer. The AD conversion module and the DA conversion module are indispensable in the three-in-one single-chip experimental box, thereby achieving the acquisition of the 8-channel 0~5V analog voltage signal and the effect of outputting the 0~5V analog voltage. By combining the single-chip system with various functional modules, a three-in-one single-chip experimental box adapted to school teaching is designed.

3. Software system design

3.1 programming method

The MCU has been transformed from the traditional assembly programming language to the C51 programming language. With the development of the MCU, the program memory, data memory and other resources of the MCU are increasing continuously, and the running speed of the MCU is greatly improved. In addition, the Small RTOS51 operating system and the µC/OS-II operating system commonly used in embedded systems make today's microcontrollers more powerful. For beginners, through the study of traditional assembly language, to enhance the promotion of C51 language, and constantly improve their programming skills, and master the operating system, thereby improving their professional level.
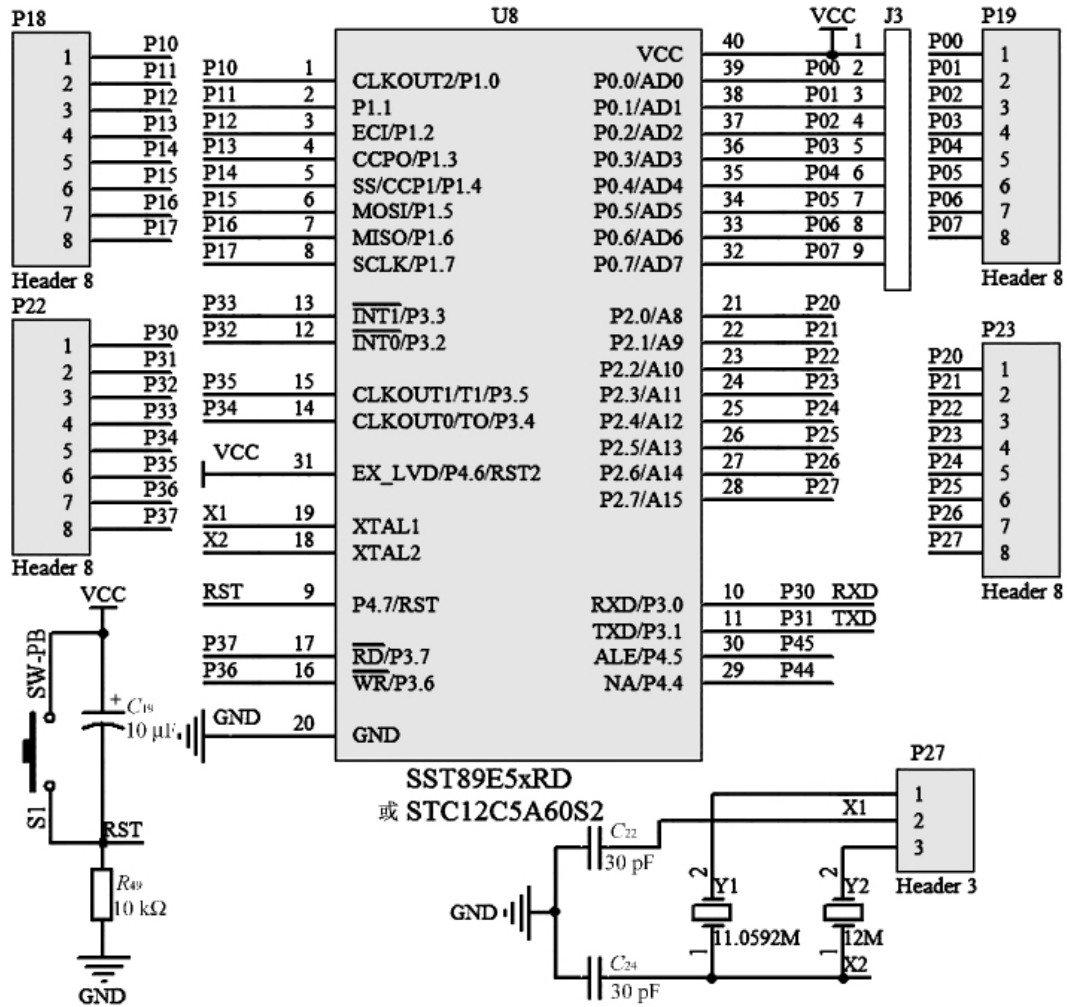
Figure 1 51 Single Chip System

3.2 hardware simulation debugging method

Beginners need to master the debugging method of the single-chip microcomputer to find out the problems in the design program. This is the ability that beginners must master. Because the price of the MCU emulator on the market is too high, we combine the Proteus and Keil software to achieve the effect of MCU hardware and software simulation. Although the combination of Proteus and Keil software can be used to find errors in the design program, it does not reflect the hardware function of the MCU more quickly, and there is still a certain gap with the MCU emulator. By installing a 51mini embedded emulator on the MCU lock seat, you can achieve rapid single step while reducing resource consumption, thus realizing the function on the professional emulator.

Usually when using the hardware emulation debugging method, you need to correctly set the Keil uVision project properties (Figure 2), and select the "KeilMonitor-51 Driver" emulator in the Debug tab, and then pass the computer and microcontroller experiment box. Combined serial port selection, and adjust the value to 9.6kbit/s in the baud efficiency option of serial communication, and set the 51mini embedded emulator to 115.200kbit/s. Check all Cache options to be effective. To improve the simulation speed, if you want to stop the simulation debugging normally, you need to select "Stop Program Execution with Serial Interrupt".
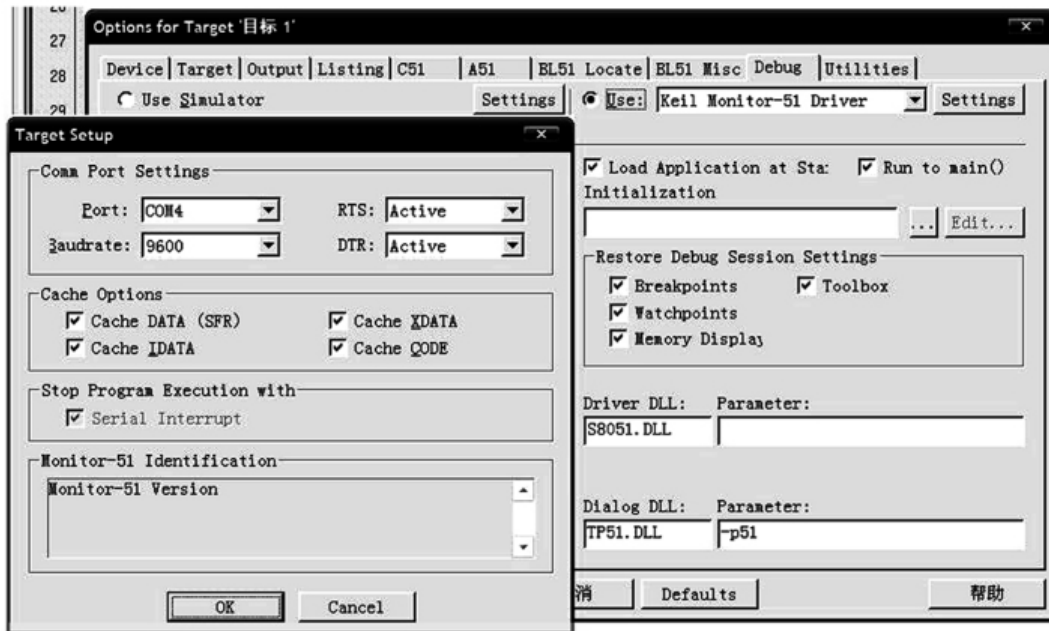
Figure 2 Hardware Simulation Keil uVision Setup Method

3.3 target file download method

By debugging the source code and then correcting the syntax errors and logic errors, the source code can be compiled to generate the object file (machine code) with the extension Hex, and then the target file is downloaded to the microcontroller. In order to get rid of the shackles of the computer, the effect of running the program independently can be achieved. Generally, when the STC-ISP download software is run on the computer, the program can be downloaded from the serial port 51 series of the computer, so that the beginner can grasp the principle of the ISP.

4. Experimental results and application effects

Designed a three-in-one single-chip experimental box (Figure 3), the single-chip experimental box can achieve the successful completion of 18 experimental projects in Table 1, and the cost of construction is lower than other microcontroller teaching products on the market. of. By applying the self-made single-chip experimental box to the actual teaching classroom, and then combining with the Keil uvision software on the teaching computer, the program code of the design can be gradually tracked on the computer and imported into the experiment box, thereby the operation result is directly reflected in the box. Through the combination of software teaching and hardware teaching, the students can truly understand the knowledge of the single-chip computer and indirectly relieve the teaching pressure of the teacher. Through the use of the modular design of the experimental system, it is conducive to teachers to reform the teaching methods, thus transforming the traditional theoretical teaching into the current project teaching method combining theory and practice, and has played a good effect in the actual teaching.

By using the self-made modular experiment box in the experimental teaching, the students can select one of the 18 items in Table 1 to perform the actual operation, and also can select the experimental item content independently. For example, the input interface experiment can select one or more of the switch and the independent button by the ability that it has mastered; the output interface experiment can select one or more when selecting the LED digital tube, the dot matrix and the liquid crystal. Through the single-chip experimental box experiment, students can deepen their understanding of the experiment and connect them in the process of actual experiment, so as to further clarify the role and effect of the hardware. The three-in-one single-chip experimental box can fully mobilize the students' enthusiasm for learning, and can also improve the students' self-observation ability, thus improving the comprehensiveness and innovation of students' design experiments. For the three-in-one single-chip experimental box, it can become a pre-match training

instrument for students to participate in the college electronic design competition and the challenge cup competition, so as to promote learning in the competition and promote learning in the competition.

Figure 3 Three-in-one single-chip experimental box photo

5. Summary

The three-in-one single-chip experimental box developed by the company can simultaneously have simulation, downloading and experiment functions, so as to meet the daily teaching needs, and greatly help the experimental teaching, so as to improve the students' extracurricular practice ability. The self-developed three-in-one single-chip experimental box can solve the problem of flexibility and adaptability of the previously purchased teaching products, thus more directly reflecting the teacher's teaching philosophy and work experience, thereby enhancing teaching creativity and strengthening the practical ability of students. As well as the purpose of creating ability, and playing a key role in enhancing students' enthusiasm for learning, we can achieve the goal of reducing the funding for teaching construction while not falling behind the previous teaching instruments. The emergence of the three-in-one single-chip experimental box has improved the teaching environment and teaching methods, fundamentally improved the teaching quality of colleges and universities, and can be widely used in electronic product design, development and debugging, etc., and won the praise of the academic community and the outside world. .

References

[1] SR4F/SR4TF three-in-one tuner component board evaluation and receiving experiment [J]. Satellite TV and Broadband Multimedia, 2013 (04): 48-53.

[2] Zhu Xiangqing, Li Dongtao, Su Chaoyi, Qiu Zuguo, Zhang Xuecheng. Design of three-in-one single-chip experimental box suiTable for project teaching method [J]. Laboratory Technology and Management, 2013, 30(07): 55-59.

[3] DU Liang, SU Wei, QIN Yiping. Design of a three-in-one multi-function single-chip microcomputer development system [J]. Information and Communication, 2013(06): 48-49.

[4] Chen Fei, Gu Qimin, Wang Wei. Application of Project Teaching Method Based on Proteus and Keil in Single-chip Teaching [J]. Experiment Science and Technology, 2013, 11(05): 48-52.