Design of Rapid Detection Equipment for Gun Control Box

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Abstract: Because the principle of a certain type of tank fire control system is complex and the control signal is transient, the fire control system of a certain type of tank mainly depends on the distribution of detection equipment for fault detection, but there is no corresponding rapid detection equipment for the maintenance personnel in the process of its work, resulting in a single detection means. Troubleshooting is difficult. By studying the core component of gun control system, the detection port of gun control box. Measuring the signal of the detection port of the gun control box is the basic method to eliminate the fault of the fire control system. It is very necessary to measure the signal of the detection port quickly and conveniently. Therefore, the demand of rapid detection equipment for gun control box is obvious. This paper designs and manufactures the rapid detection equipment of the detection port, which provides the corresponding technical means for the rapid detection and fault diagnosis of a certain tank fire control system in the army. The signal value of each pin of the socket of the test port of the gun control box is to show the status value of the normal operation of the fire control system, and to detect the signal of each pin can quickly isolate the components of the system fault, and determine the fault location by signal fault tree analysis, so as to improve the speed of judging the fault. The test equipment of gun control box is mainly used to measure the signal of the test port of gun control box. When fault detection is carried out, the signal to be measured can be obtained quickly and conveniently for analysis. Therefore, the starting point of designing and manufacturing the rapid detection equipment for the gun control box is mainly to provide a simple and convenient detection equipment for troubleshooting a certain type of tank fire control system, and to provide data information for fault analysis.

1. The Design Principle of the Detection Box

A certain type of tank gun control box rapid detection equipment, mainly is the gun control box detection port signal acquisition input to the multi-channel conversion circuit, through the single-chip computer keyboard management design, control keyboard input to select the signal to be measured, analog channel switching circuit design, can be the gun control box detection signal of any signal value on-off, in the display Dynamic display of data and signal waveform on the oscilloscope (using a small "digital oscilloscope", digital oscilloscope can not only display the size of the signal, but also display the waveform and transient state of the signal. Corresponding detection signals can be quickly obtained, which is convenient for quantitative analysis of the system, and then to determine the failure parts. The block diagram is shown in the diagram[1] .

When the function of the detection box is expanded, the detection ports of other components can be connected. Just connect the pin number of the port according to the programming address, the pin number and keyboard program can be used for other port measurement. Of course, the number of ports connected is limited[2] .

2. The Realization Principle of the Detection Box

Detection box uses the management and control function of single chip microcomputer to realize selective and purposeful detection of signal pins to be measured. The signal pins of gun control box

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are all connected to the detection box by means of switching connectors. When the signal value of a pin needs to be measured, the corresponding number is input on the keyboard and controlled by single chip microcomputer to be connected to the detection box. The signal circuit in the measuring box is connected with the oscillograph and the magnitude of the measurement is displayed on the oscilloscope. The numeric value of keyboard input is displayed by digital tube, which is convenient for accurate input.

3. Circuit and Software Design

Hardware design principle: the detection box mainly consists of five parts: gun control box signal acquisition interface, multi-switch conversion circuit, keyboard input and read, single-chip microcomputer using Atmel AT89C52 core processor, micro-digital oscilloscope temporary selection model, the system uses 11.090MHz crystal oscillator, two digital tubes, single-chip microcomputer for the P0 port. At the input control end of the keyboard, the lower four bits are rows, the higher four bits are columns, the P1 port is used for the display of the digital tube, the P2 port is the output port, the P2.0-P2.3 is the segment selection, and the P2.4-P2.7 is the bit selection input terminal[4] .

The technical route of the scheme is to collect signal by interface line, input data by keyboard, control signal conduction by AT89C52, display signal value by micro-digital oscilloscope, read by 4 ×4 matrix keyboard, draw schematic diagram by Protel software, and complete software programming by keil software.

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3.1. Core Processor AT89C52.

89C52 is the basic product of the MCS-51 series microcontroller of INTEL company. It adopts the reliable CMOS technology of Atmel company to manufacture the high-performance 8-bit microcontroller. It belongs to the standard MCS-51 HCMOS product. It combines the high-speed and high-density technology of CMOS with the low-power characteristics of CMOS. It is based on the standard MCS-51 microcontroller, architecture, and Instruction system. It is an enhanced version of 89C51 MCU, which integrates clock output and up or down technology, and is suitable for various control applications. 89C52NEIZHI 8-bit CPU, 256-byte internal data memory RAM, 8K on-chip program memory (ROM), 32 bidirectional input/output (I/O) ports, 3 16-bit timing/counter and 5 two-stage interrupt structures, a full-duplex serial communication port, on-chip clock oscillation circuit. In addition, 89C52 can also work in low power mode, and can select idle and power down mode through two kinds of software. Freeze CPU in idle mode, while RAM timer, serial port and interrupt system maintain its function. Power down mode, to maintain RAM data, always stop and stop other functions in the chip. 89C52 has PDIP (40 product pin) and PLCC (44pin) two package forms.

Structural features: 8-bit CPU; on-chip oscillator and clock circuit; 32 with I/O interface; external memory addressing range ROM, RAM64K; 2 16-bit timing/counter; 5 interrupt sources, 2 interrupt priority; full duplex serial port; Boolean processor.

3.2. 4×4 Matrix Keyboard.

The parallel port P0 of the MCS-52 is connected with a 4*4 matrix keyboard. The low 4-bit P 0-P 0.3 is used as the row and the high 4-bit P 0.4-P 0.7 is used as the row. Matrix keyboard can effectively save chip port and high efficiency. Matrix keyboard is shown in Fig.1.

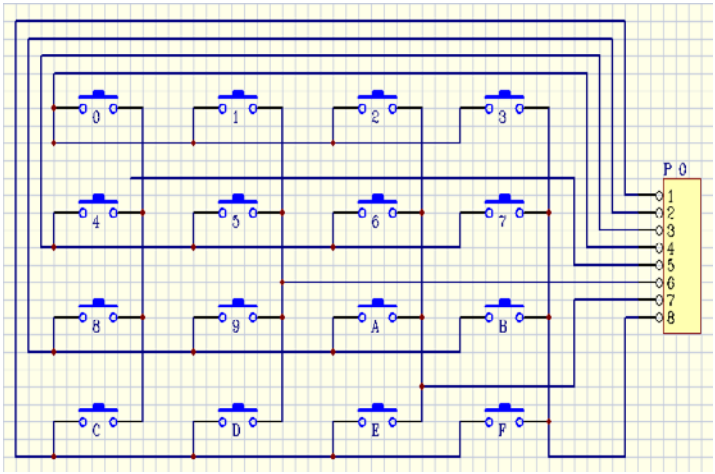

Figure 1. Matrix keyboard

3.3. 74LS138 Decoder.

74LS138 is a 3 line 8 line decoder with two lines of 54LS138 and 74LS138.74LS138 is a common three-line-eight-line decoder. It has three input lines and can input three-digit binary digits. There are eight state combinations and eight output signals can be translated.

When one gate (E1) is high and the other two gates ((/ E2) and /(E3)) are low, the binary encoding of the address (A0, A1, A2) can be translated at a low level at the output corresponding to Y0 to Y7. For example, when A2A1A0=110 is used, the Y6 output terminal outputs a low level signal. E1, E2 and E3 can be cascaded into 24-line decoder, and 32-line decoder can be cascaded with an external inverter. If one of the selected terminals is used as the data input terminal, 74LS138 can also be used as a data distributor. It can be used in 8086 decoding circuit to expand memory.

A0,A2: Address Input, STA (E1): Gate End / STB (/ E2), / STC (/ E3): Gate End (Low Level Effective) / Y0 ~ / Y7: Output (Low Level Effective) VCC: Power positive GND: A0 ~ A2 corresponds to Y0 - Y7; A0, A1, A2 are input in binary form, then converted to decimal form, corresponding to Y sequence number output low. The other level is high[8] .

3.4. Micro Digital Oscilloscope.

Digital oscilloscope is a kind of high-performance oscilloscope produced by a series of technologies, such as data acquisition, A/D conversion, software programming and so on. The digital oscilloscope generally supports multi-level menus, providing users with multiple choices and multiple analysis functions. There are also oscilloscopes that can provide storage, waveform storage and processing, because of its waveform trigger, storage, display, measurement, waveform data analysis and processing of unique advantages, small digital oscilloscope because of its good practical performance, users are increasingly popular.

3.5. Verify the Function of The Detection Box.

The software function of the test box is realized by the NT-1 development board purchased by Xi'an NeXT Electronic Technology Co., Ltd. NT-1 is a development and learning platform for beginners of microcontroller. It is easy to operate and rich in resources. It provides program burning tools, microcontroller development software and other information. It provides convenience for the realization of software function design. The development board has a backplane, a single chip microcomputer (STC89C52) one piece (the same function as AT89C52X), two crystal oscillators (11.0592M and 12M), matrix keyboard, digital display tube, LED display lamp, etc., and USB print line.

By making full use of the hardware resources of NT-1 development board, the software function of rapid detection and design of tank gun control box can be developed and realized on the development board. Development board is the best assistant tool for beginners to learn MCU. After logical analysis of the functions that need to be completed by MCU, and programming, it can be

realized on the development board. Therefore, the function of the rapid detection device of the gun control box can also be verified on the development board. Moreover, it can save a lot of resources and expenses.

STC89C52 is the core processor, P3 is connected with matrix keyboard, P2 is connected with digital tube to display digital, P1 is connected with LED display lamp, LED lamp is used to simulate the output control of SCM, that is, 8 LED lights are set to binary code, the number of digits is lit to represent the relay work of multiple switches, that is, SCM output control.The flow lamp is lit by binary number, indicating the corresponding relay work, so that the relay control signal pin electrical signal and oscilloscope connected and displayed. (see the appendix for the functional logic diagram on the development board)[9].

Software design: the program consists of two parts: the key scanning program and the main program. Key processing part of the function: to determine whether there is a key press, no key press, return; when there is a key press, first scan the keyboard, get the key column value and row value, then delay 10 ms to jitter, and then determine whether there is a key press, if there is, according to the row value and column value of the key to calculate the key value, and save the key value, and then turn in The key value interpretation part is processed. The main program records the keyboard value and outputs the LED lamp to light the address.

3.6. Matrix Keyboard Detection.

Keyboard detection principle is to give P3 an initial state 0xfe, and then read back the state of P3 assigned to temp variable, because the lowest bit that is the first row has been zero, if the first row has a key press, the corresponding column must be pulled down, and the formula is four bits high, as long as the temp high four bits which is pulled down can be judged from which column. And determine which key presses and gives its key value. Similarly, the P3 port is given a state 0xfd, one analogy, a total of four low four-bit scan, complete a complete matrix keyboard scan. The S15 key is set as the confirmation key, and the S16 key is reset.

3.7. LED lamp coding.

Set 8 LED lights to binary code, low-level lights, when the keyboard input digital, corresponding binary lights on. LED lamp is shown in Fig.2.

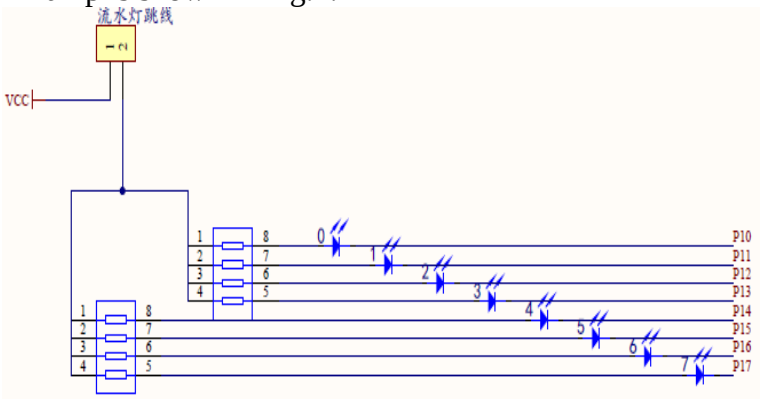

Figure 2. LED lamp

4. Application Analysis of Failure Cases

One of the existing tanks is in use, and the fire control system is in trouble, so it can not be used normally. After receiving the maintenance task, the fire control system of the vehicle is tested by

References

[1] Huijing piao tank gun control system construction principle and repair. National Defense Industry Press, 2008.

[2] Huijing piao. tank fire control system construction principle and repair. Defense Industry Press, 2013.

[3] Zhao Yao. Construction principle and repair of armored vehicle fire control system. Weapon Industry Press, 2009.

[4] Xin Yang. 51 MCU development and application technology detailed explanation. Tsinghua University press 2010.

[5] Qiushi technology. An example of SCM application system development. people's post and Telecommunications Publishing House.

[6] Jia Guo Yang. Application of MCU and timing of C51 program (Second Edition). Tsinghua University press 2006.

[7] Seeking science and technology. Typical module design of single chip microcomputer navigation (2nd edition). People's Post and Telecommunications Publishing House 2008.

[8] Jingbo Zhao. Circuit design and board making Protel99SE from introductory to proficient. Machinery Industry Press 2010.

[9] Jiaguo Yang, MCU application and C51 programming. Tsinghua University press.