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Implementation on Intelligent Lighting Control System of Infrared Wireless

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Abstract

Based on STC microprocessor as a center of the transmitting and receiving parts, apply the interrupt systems, timers, counters integrated. Using Code-Division infrared coding, infrared receiver distinguishes the light pulse , judges and makes the corresponding control actions to complete the all infrared remote control transmitter and receiver process. Combination of the software programs, after commissioning the system can achieve multiple dimming function, such as LED lamp PWM dimming, alternating current filament lamp dimming, multiple channel switches. The system realized the function that weak power can control not only flea power but also strong power. This system has the feature of simple hardware circuit, sophisticated software capability, high cost performance. At the same time the study of intelligent lighting control system contributes to the improvement and development of the intelligent home system.

Keywords*: Single chip microcomputer, Infrared transmitter, Infrared receiver, Dimming control, Smart Home*

1. Introduction

Along with the scientific and technological progress and the improvement of people's material and cultural living standards, various electrical devices are invented and gradually appear on people's life. The requirement of automatic, intelligent control of electrical equipment is higher. As a convenient way of close remote control, infrared control has continued to develop. Traditional IR controller uses dedicated remote control and decoding integrated circuits, the range of application is limited because the number of function keys and the function is subject to specific limitations. The design of infrared remote control system using single-chip microcomputer has the advantage of flexible programming and setting operation code number as required. Intelligent lighting control as a part of the intelligent home control not only changes people's lifestyles but also improves the quality of life.[1][2]

2. Basic Function Instructions

Circuit IR emitting part is composed of the button circuit, LCD display, and infrared emission. Control button status display shows the key name and control function.

IR receiver circuit includes LED light dimming circuit, incandescent dimmer circuit, LED digital display, multiple channel switch control circuits and IR receiver circuit. PWM pulse width modulation by changing the pulse duty cycle can control the brightness of LED. Use photo coupler P521 and the AC zero synchronous signal produced by full-wave bridge trigger the external interrupts of SCM. Use the timer interrupt to produce pulse signal for controlling the conduction of bi-directional silicon controlled rectifier (SCR). [3]The conduction time of SCR depends on the timing. Thus realize the

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incandescent lamp brightness by different luminous power. Using one channel of the multi channel to control the blinking lights by 74HC00 to realize the function of multi-channel switch controlling external power devices.[4]

3. Infrared Coding

The main title (on the first page) should begin 1 3/16 inches (7 picas) from the top edge of the page, centered, and in Times New Roman 14-point, boldface type. Capitalize the first letter of nouns, pronouns, verbs, adjectives, and adverbs; do not capitalize articles, coordinate conjunctions, or prepositions (unless the title begins with such a word). Please initially capitalize only the first word in other titles, including section titles and first, second, and third-order headings (for example, "Titles and headings" — as in these guidelines). Leave two blank lines after the title.

3.1. Infrared Remote Control

Near-infrared light of 0.75～1.5μm wave length is used as instruction carrier of remote control. Use near-infrared light as a control source because the glow and received light peak of the infrared emitter (IR led) and IR receiver (photo sensitive diode, transistor and solar cell) is generally 0.8~0.94μm which can achieve higher efficiency and reliability because their spectra is just coincide.

The launcher consists of command key, instruction coding system, and modulation drive and transmission circuit. Press the command key, the coding circuit produces the necessary instruction code signal that modulates the carrier. After power amplifier, the transmission circuit extracts the instruction encoded signal. The whole process of infrared signal is shown as Figure 1. The receiver is generally composed by the receiving circuit, amplifier, modulation, instruction decoder circuit, driving circuit and implementing agency. Receive the code directive signal modulated, amplify and send to demodulation circuit to revert to the coded signal. Instruction decoder decodes the coded signal, and the driver circuit drives the executed circuit to achieve the operation control. The whole process of infrared signal is shown as Figure 2. [5]

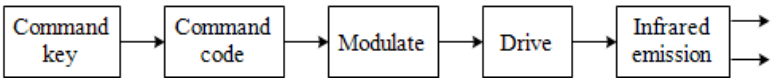

Figure 1. The Whole Process of Infrared Signal

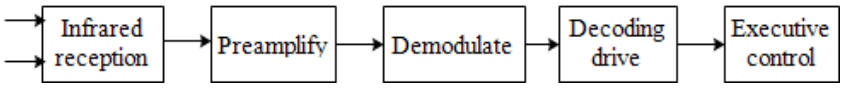

Figure 2. The Whole Process of Receiving Infrared Signal

3.2. Infrared Encode Method

3.2.1. PWM Pulse width Modulation Serial Code: According to NEC standard, remote control carrier frequency is 38 KHz, when a key is pressed, system sends a complete code at first. If the pressed key has not released for 108ms, the next launched codes (fire code) are composed of start code (9ms) and end code (2.5ms). A complete code includes boot code; user code, data code and data negative code, among those, the high level and low level of boot code are all 4.5ms. 8 bits system code and 8 bits data code, the total is 32 bits. The top 16 bit is the

identification number for user which can distinguish different infrared remote control devices to prevent different type remote control code from interfering with each other. The behind 16-bit includes 8-bit operation code and 8-bit operation negative code to check whether the data received is correct. The receiver judges what kind of action to perform according to the data code. Press key continuously to send fire code to inform the receiver that a key is pressed continuously. It is as shown in Figure 3.

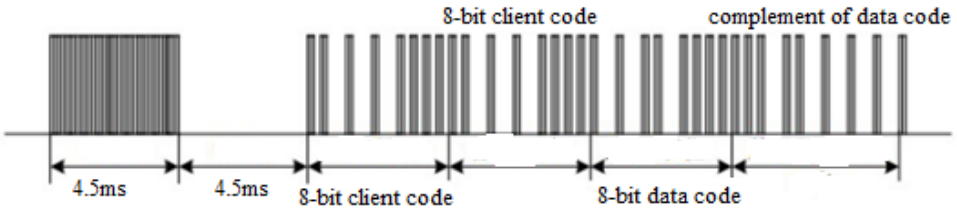

Figure 3. The Launch Code express of NEC

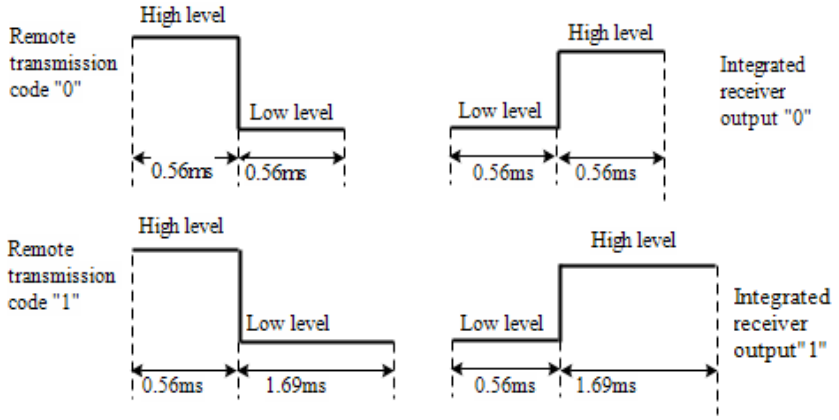

Figure 4. Remote Transmission Wave and Integrated Receiver Wave

The elapsed time of transmitting data 0 includes 0.56ms high level and 0.565ms low level. The time of data 1 is 0.56ms high level and 1.69ms low level. That is, launching code "0" means launch IR 0.56ms and stop firing 0.565ms,the time of code "1" includes launch IR 0.56ms and stop firing 1.69ms. When receiving 38KHz infrared signal, the output is low level otherwise it is high level. So the output waveform of the integrated receiver is reverse with the launch waveform, as shown in Figure 4. [6][7]

3.2.2. PWM Pulse Position Modulation: In PHILIPS standard, the carrier frequency is 38KHz, no simple code, when press a key, the control code switches between 1 and 0. If press continuously, the code is unchanged. A complete code includes start code 11, control code, user code. Output data 0 of the integrated receiver expresses as 889μs low level and 889μs high level, output data 1 is 889μs high level and 889μs low level. Continuous code delay 114ms. It is as shown in Figure 5. [8]

3.2.3. Infrared Code Division: Use the pulse number to code, different pulse number represents different control command, 38 KHz carrier frequency. The program is relatively simple which is obvious advantage in the case of less press. This system designs a minimum of 3 pulses up to 18 pulse. In order to receive reliably, sent the start code for 3ms wide, effective script for 1ms, valid interval of 1ms, end code for 0.5ms. The data frame interval of remote control code is greater than 10ms. It is shown as Figure 6.[9]

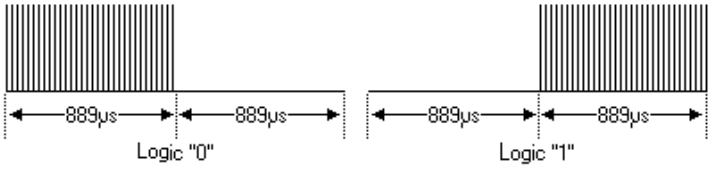

Figure 5. PPM Code Modulation Map

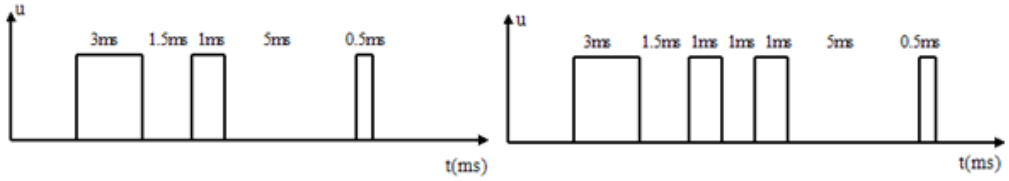

Figure 6. The Chart of Infrared Code

4. Hardware Design

4.1. Design of the Micro Controller System

Reset circuit is to make CPU or other components be in a certain initial and start to work from this state including power on reset circuit and press the reset circuit. The first circuit uses capacitance charging principle. The second makes use of resistor voltage divider function.The parameter selection of reset circuit should guarantee the high level to continue more than two machine cycles. This system uses the press reset circuit. Choose 5 $K\Omega$ and 1 $K\Omega$ resistance and 22 μF capacitor. In order to ensure the implementation of synchronization works smoothly, the circuit should work strictly in a single clock signal control. Connect quartz crystals and two compensation capacitors to self-excited oscillators between XTAL1 and XTAL2 pins. According to needs, choose quartz crystals of 6MHz, 12MHz or 24MHz,30pF ceramic capacitor as compensation capacitor.[10]

4.2. Related Hardware Circuit Design of Infrared Emission

The shape of common infrared light emitting diodes inspired by current is similar to the normal light-emitting diode. The pressure drop is about 1.4v, the working current is generally less than 20mA. In order to adapt to the different operating voltage, series current-limiting resistors in circuits. This design uses 5V DC power supply. $\frac{5v-1.4v}{R_{11}} < 20mA$, $R_{11} > 180\Omega$, so adapt $0.2K\Omega$.

The working pulse duty ratio often used 1/3-1/4. Reduce the pulse duty ratio can increase the transmission distance of LED because the distance is proportional to the transmission power control, the effective transmission distance of pulsating light is proportional to the pulse peak current. To reduce the pulse duty ration can increase peak current. In order to ensure the control distance, adapt 1/3 duty ration in this system. The process that infrared coded signal modulates 38KHz carrier signal is shown in the Figure 7. The modulation process is equivalent to phase the coded signal with the carrier signal. The modulated voltage signal using timer interrupt and delay to phase is to P3.1 directly. The circuit of infrared transmitter and the whole launch are as shown in Figure 8 separately. [11]

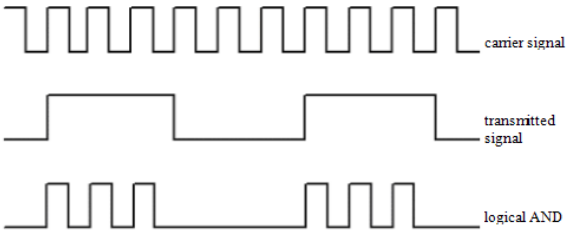

Figure 7. The Process that Infrared Coded Signal Modulates 38KHz Carrier Signal

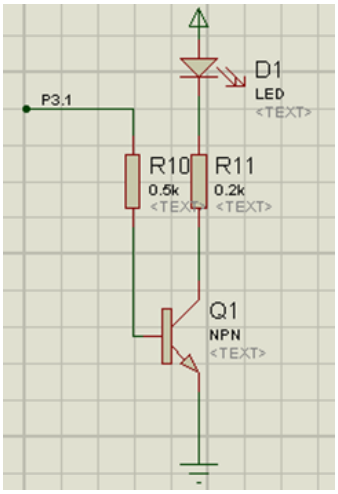

Figure 8. The Circuit of Infrared Transmitted

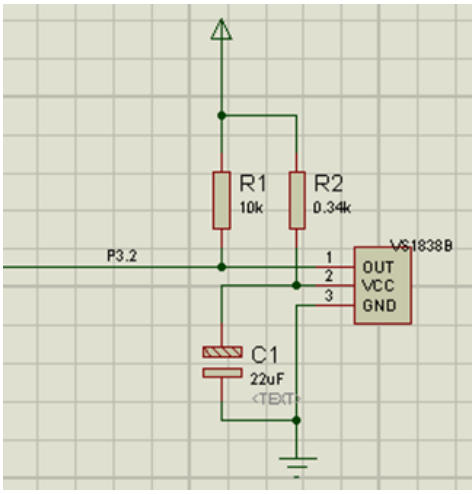

Figure 9. The Circuit of Infrared Received

Independent push button circuit is used to realize different infrared emission control function. More specifically, P1.0 controls LED, P1.1 is incandescent lamp switch, P1.2 is for dimming, P1.6 controls the light or extinguish, P1.7 is for the blinking lights, P2.5 is the confirmation key and P2.6 is the cancel key.

4.3. Infrared Receiver Hardware Design

Choose infrared receiver VS1838B. Because the internal amplifier is large, prone to interference, add filter capacitor between GND and VCC pin, C1 is 22μF. Connect R2(0.34K) between the VCC and high level pin to reduce power supply interference. R1 （10KΩ） between the OUT and external high voltage is to pull the OUT pin level to ensure that the high level of VS1838B is high enough. The circuit of infrared received is as shown in Figure 9. [12]

4.4. LED Dimmer Circuit Design of DC Lamp

PWM(Pulse Width Modulation):an effective technology that the analog circuit controlled by the digital output of the microcomputer, adjust voltage current and power. PWM can realize digital-encoding of analog signal levels. The counter with high resolution can encode a special analog by the modulated duty cycle wave. The PWM signal is digital. Add the current source or voltage source to the simulated load by the way of a disconnected or conducting repetitive pulse sequences. If the bandwidth is wide enough, any analog values can be encoded with PWM. [13]

LED dimming circuit is shown in the Figure 10. The parameters include 3～5V working voltage, not more than 350mA, 1.2V forward voltage. This design chooses 60Ω

as the limiting resistance. P1.0 controls the turn-on and shut-down of PNP transistor. When P1.0 is the low level, the transistor conducts, otherwise close. The voltage pulses with different duty cycle from P1.0 can change the break over time of the transistor, at the same time change the time of current through LED. Change the brightness of LED to achieve the aim of dimming. [14]

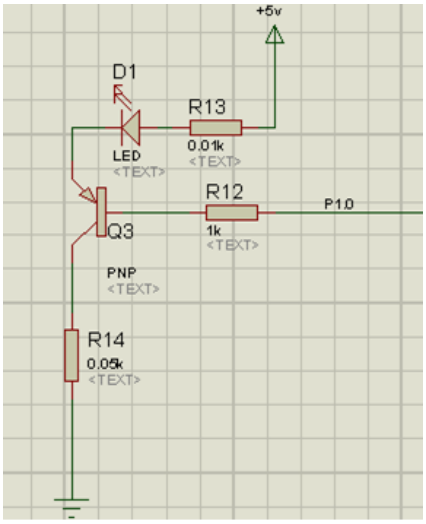

Figure 10. The LED Dimming Circuit

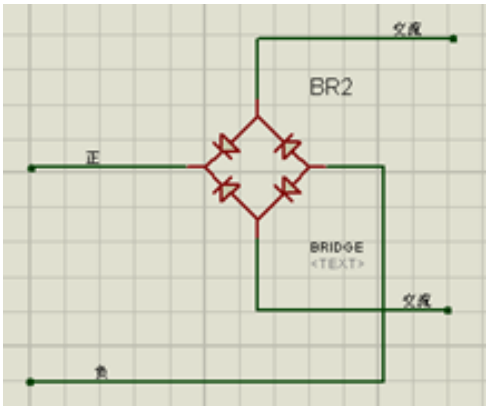

Figure 11. The Full Wave Bridge Rectifier Circuit

4.5. AC Incandescent Dimmer Circuit Design

(1) Optical-coupler choice

OC is the abbreviation of optical coupler that is used in the switching power supply circuit. OC transfers electrical signals through light as a medium. Usually the IR LEDs and photosensitive semiconductor are packaged in the same shell. When there is an input signal, IR LEDs emit infrared rays then the photosensitive semiconductor produces light current flows from the output in order to achieve the conversion of elecrro-optic-electric.

(2) Full wave rectifying circuit

Using the one-way conductive of semiconductor diode to change the alternating current to one-way pulsating direct current. At least composed of two rectifiers and merged, the one is responsible for the positive direction the other one is for the negative direction. The bridge rectifier consists of four diodes is the most typical full wave rectifier circuit. The full wave bridge rectifier circuit is shown as Figure 11.This system adopts the supplied rectifier bridge 2W10 which is a medium power and frequency full bridge rectifier element. The parameters are AC input voltage of 1000V (max), DC output voltage 1000V (max), DC output current 2A (max), peak forward voltage 1000V; repetitive peak reverse voltage 1500V, repetitive peak reverse current is 1500mA, the insulation voltage of 1000V.

(3) The TRIode AC semiconductor switch (TRIAC)

When crystallographic plane is under reverse voltage, the thyristor does not conduct regardless of whether there is a gate trigger current. Under positive voltage, the conduction condition is trigger current in the gate. Once conduction, it keeps conducting state.

Connect a pair of ordinary thyristor by inverse parallel to the TRIAC,a triode AC switch. TRIAC is a three-terminal element, a main electrode T1, a main electrode T2 and

gate G.Different points from SCR are that TRIAC conducts either in forward or reverse voltage. Because it is a two-way element, T1 and T2 are in a conducting state when the gate G has the trigger signal whether their voltage polarity. Otherwise without the gate trigger signal high impedance exists between T1 and T2. This system chooses bidirectional controllable silicon Z0409MF. The main parameters include current /IT (RMS): 2A; voltage /VDRM: 600 ~ 800 (V); trigger voltage /VGT: 1.3V; trigger current /IGT: 3 ~ 10mA, the operating temperature: -40 ~ +125 C.

(4) Principle of incandescent lamp dimming

Control the conduction of TRIAC by single-chip microcomputer to realize the incandescent lamp dimming. TRIAC is in conduction and keeps on until the AC voltage crosses zero. By controlling the start conducting time, brightness of the light can be controlled. Use the relay or the combination of optocoupler and SCR (thyristor SCR) to drive AC. Because relay is mechanical movement and slow response, it cannot meet the requirement of control. So select the controlled silicon of fast response. The load is incandescent lamp of purely resistive load.

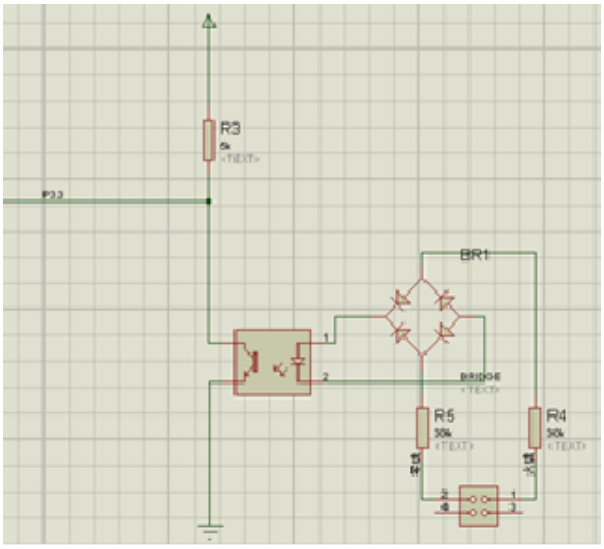

Figure 12. The Extraction Circuit of AC Zero Crossing Sgnal

(5) The extraction circuit of AC zero crossing signal is as shown in Figure 12.The calculation of resistance selection is as follows: 5V/R3<IC, while IC is desirable to 2mA, so R3>2500Ω.In order to ensure P3.3 is high enough to select R3 value of 5K.The input current of optocoupler P521 is desirable to 15mA, the input voltage is to be 1.5V. In order to limit the voltage and current, join the appropriate resistance, R=220V/0.015A=14.7KΩ, here choose 30KΩ resistance. That is R4=30KΩ, R5=30KΩ. The waveform of the AC zero crossing signals are shown as Figure 13.

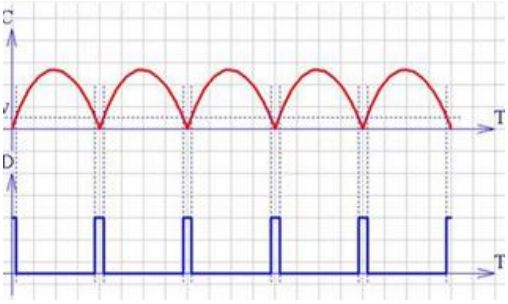

Figure 13. The Waveform of the AC Zero Crossing Signal

(6) The dimming and drive circuit of incandescent lamp is shown as Figure 14.The calculation of resistance selection is as follows:(5V-0.7V)/R6<15mA,so R6>287Ω, choose 300Ω as R6. Because current /IT (RMS) is 2A, 220·1.414V/R7<2A, so R7>156Ω, choose 200Ω as R7.

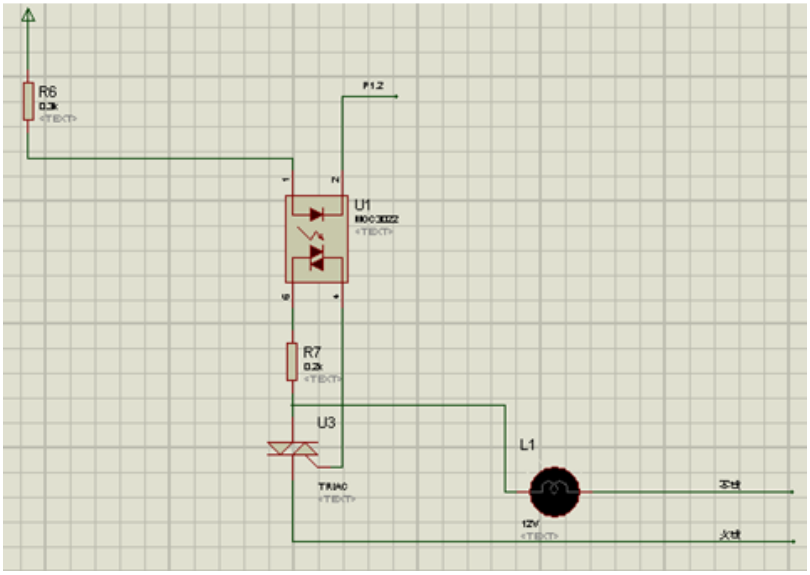

Figure 14. The Dimming and Drive Circuit of Incandescent Lamp

(7) the realization process of incandescent lamp dimming

①Provide 220V, 50Hz alternating current by the municipal electricity; ②extract synchronous signal through the zero crossing detection circuit and interrupt at the falling edge of sync signal;③Open the timer to work in the interrupt service program, timing end to let P1.2 port output of a low level pulse in order to generate the trigger signal to conduct TRIAC. The timing time decides not only the length of alternating current through the incandescent lamp, but also the degree of light and dark. The function of trigger signal is shown as Figure 15. [15]

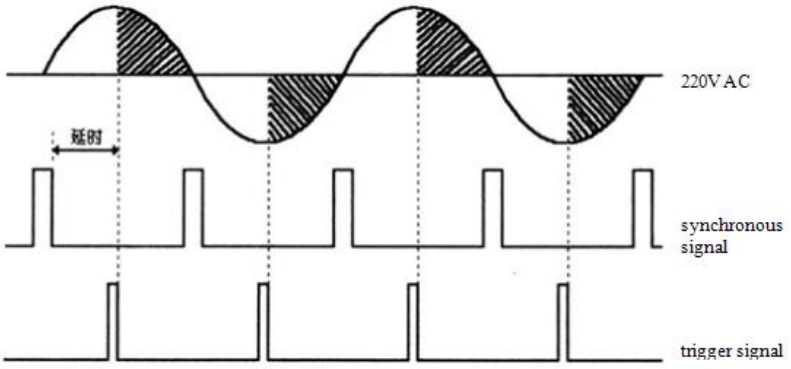

Figure 15. The Function of Trigger Signal

5. System Software Design

5.1. Program Flow Chart of the Transmitting Terminal

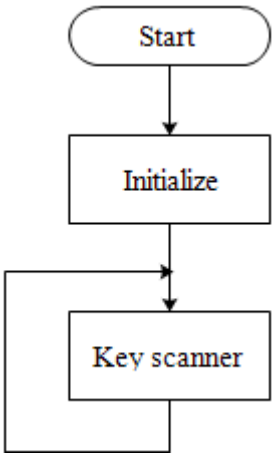

Figure 16. The Flow of Transmitting

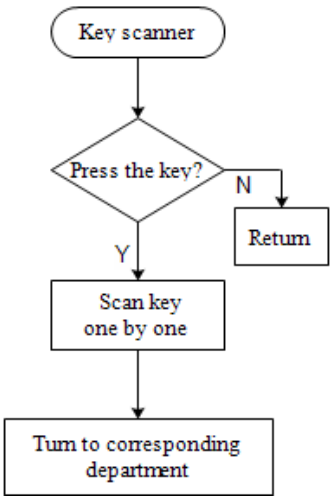

Figure 17. The Flow of Key Scanner

The main program flow of the infrared transmitting end is shown as Figure 16.First, initialize program, then execution key scanner shown as Figure 17.Key scan: first, judge whether a key is pressed. If a key is pressed, find this key one by one. Then transfer to the corresponding infrared emission process. Flow chart is shown as Figure 18.

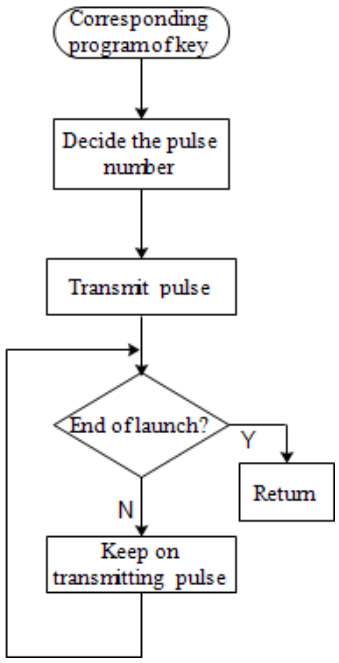

Figure 18. The Flow of Infrared Emission

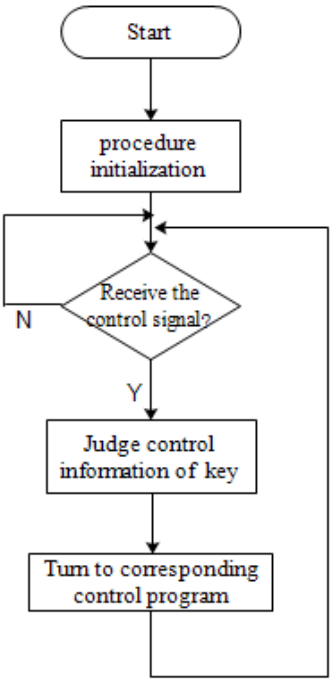

Figure 19. The Flow of the Receiving End Part

5.2 The Program Flow Chart of the Receiving End

The main program flow chart of the receiving end part is shown as Figure 19. The flow chart of using interrupt to judge infrared signal is shown as Figure 20.

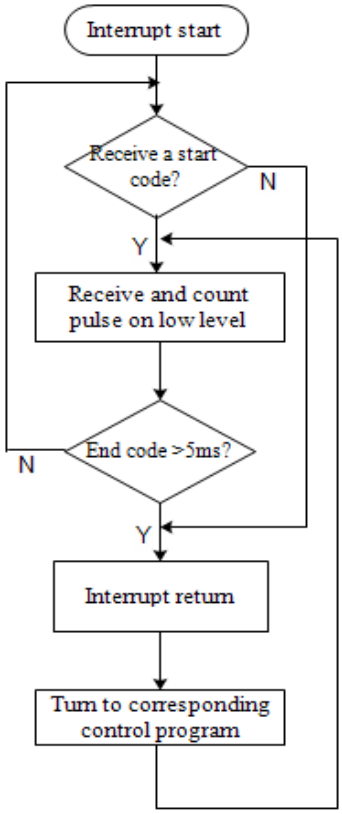

Figure 20. The Flow Chart of Judging Infrared Signal

6. Conclusion

The project is the infrared remote control system based on STC89C52 MCU. Through hardware weld successfully, integrated debugging of software and hardware, this system can work normally according to the set and achieve the intended function. It has the characteristics of high reliability, convenience concise and intelligence. This design meets with people's production and life closely, has the advantages of low cost, and is suitable for close non-contact control of all kinds of daily life. So this system has a high practical value.

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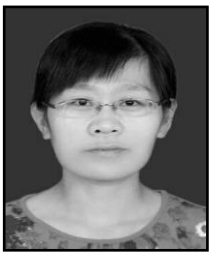

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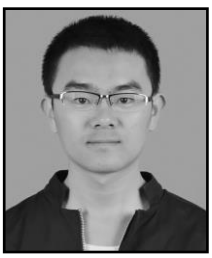

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