

The Design and Manufacture of Automatic Lighting Control Circuit

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Abstract. This page proposed an automatic lighting control circuit sent the light brightness analog signal to the AD conversion chip which detected by the photosensitive resistance, and converted the analog signal to a digital signal the AD conversion chip, then send the converted digital signal to the LED driver circuit for open LED lamp lighting, so as to realize the function of intelligent lighting. At the same time, the circuit show the walking time and power outages by using a real time clock chip memory, to make the control circuit can be achieved within a certain period of time to open the LED lamp lighting.

1. Project design

1.1 The functional requirements of the design

The basic requirement of the design: The length of lighting time segments can be adjusted and the ambient light brightness can be detected through the the detection circuit with the combination of natural light to determine whether the lighting circuit is open.

Extended requirements: The detection of ambient temperature; Travel time and time display for the outage; Adjusting the illuminating brightness according to the ambient brightness

1.2 Optimized design of street lamps

(1) Optimizing the basis for opening the street lamps to save the lighting electricity

For that the time street lamps cannot light based on the environmental needs, which greatly reduced the effectiveness of lighting, the light detection function should be added for the time circuit.

(2) Optimizing the brightness of street lamps to avoid light pollution

For that the light control circuit cannot turn on the lighting according to the time segments needs, which greatly affected people's work and life, the time segments control and dimming control should be added for this type of circuit.

1.3 Solution selection

(1) Photosensitive device selection

Photoresistor is very sensitive to lighting, and its reaction speed is very fast. Moreover, in the harsh environmental conditions of high temperature and humidity, the photoresistor can still maintain a high degree of stability and reliability. The relative changing values between the resistance value (dark resistance) irradiated by the lighting and the resistance value (light resistance) irradiated by the lighting are large [8]. The photodiodes are susceptible to temperature changes and require signal amplification circuitry. The response time of the phototriode lighting is long, and it is sensitive to the temperature. According to the above content, in the street lamp design, because the street lamps are often installed under the burning sun, which are rarely affected by the temperature or not affected by the temperature, so the street lamps design should use photosensitive resistors as the sensor for light signal detection.

(2) Control chip selection

The STC12C5A60S2 AD Single Chip Microcomputer has no difference in the programming with the STC89S52 Single Chip Microcomputer which has no AD transfer function. Although the STC89S52 Single Chip Microcomputer can simulate the signal to achieve the control of the brightness

of the lamps, the the desired effect of controlling the brightness of the lamp is difficult to achieve which is because the analog circuit is easy to drift with time and is sensitive to the noise, where any noise will affect the size of the current value. However, STC12C5A60S2 AD Single Chip Microcomputer achieves the PWM control through the digital signal which is hardly affected by the noise and it can easy to achieve the deal lighting brightness control. Therefore, the STC12C5A60S2 AD Single Chip Microcomputer is used as a control chip.

2. Circuit design

2.1 Circuit chip control module

STC12C5A60S2 microcontroller is a new generation of 8051 microcontroller, with high speed, low power consumption and super anti-jamming characteristics, which is not only fully compatible with the traditional 8051 code instructions [1], and is 8 to 12 times faster than the traditional microcontroller. It has the MAX810 dedicated reset circuit, and 2-way PWM (P1.3 serial port and P1.4 serial port), along with the 8-way high-speed 10-bit digital-analog conversion, and it can be used in strong interference environments.

The operating voltage of the STC12C5A60S2 microcontroller: 3.3V - 5.5V. Operating frequency range: 0 MHz - 35 MHz. The STC12C5A60S2 microcontroller used in this design has 40 pins which are ground port, a power port, two internal clock ports, 36 general I/O port s(P0 port, P1 port, P2 port, P3 port and P4 port), respectively.

2.2 Control module circuit design

The 20th pin of the STC12C5A60S2 microcontroller is connected with the ground, and the 40th pin is connected with +5 V power supply. The 9th pin reset port is designed to reset button. A decoupling capacitor [2] should be connected to the reset pin to avoid that interference signal connecting with the reset terminal causing error reset of some of the internal register, whose typical value is 10 μ F(When the crystal frequency is 12MHz). The pull-up resistor will be 8.2K and the size of the voltage limiting resistor in parallel with the button is 1K. The internal clock circuit uses crystal 12MHz, and the non-polar capacitor size is 30p.

3. Dimming circuit design

The LED light used in this design is a small power (2W) SMD LED, and its operating voltage is 12V. As the LED lights in this design not only need to achieve the lighting function, but also control the on/off of the lamps and dim the lamps through the microcontroller. Therefore, the lead wire of the EA side of the driver chip 9910B of the LED is extracted to be connected with P1.3 port (PWM port) of the STC microcontroller to open the LED lights and dimming port and achieve the soft start and dimming function of the lamps. The positive of the LED lamp is connected with + 12V power supply, and the negative is connected to the ground. The light control wiring is shown in Figure 1.

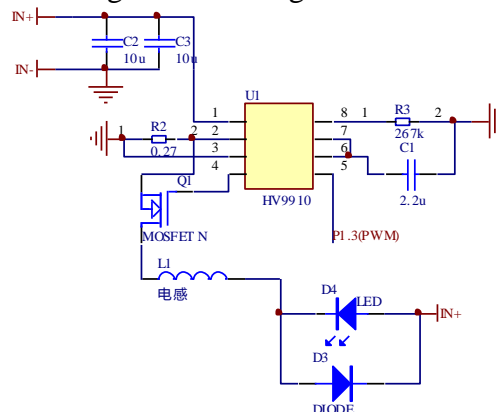


Figure 1. lighting circuit

4. Circuit production and debugging

4.1 Circuit debugging

After the completion of the circuit board production, the preparation of procedures [7] is downloaded to the STC12C5A60S2 AD microcontroller, then you can start the practical debugging phase of the circuit. The debugging process can be divided into modules for the debugging, and the debugging of the light detection module is the first. The time is set to day and the lighting is blocked by hand, which will make the photoresistor to detect the lack of light. Then the LED lamp will light up automatically. During the process that the lighting brightness detected by the photoresistor gradually increased until the light is almost enough, the brightness of the LED lamp changes little. The time is set within the time segment which is needed for the opening of the LED lamp and the time setting button is pressed to select the time option to be set. The add "1" button (minus 1 button) can be pressed to change the time and then the setting button is pressed to modify the time successfully. The Led lamp will light up automatically. Finally, the temperature detection debugging is carried out. The LCD1602 LCD temperature display is observed and is compared with the standard thermometer, where the temperature error is small. The DS18B20 temperature sensor is blocked by hand, and the temperature is increasing and close to the human body temperature.

During the process of circuit debugging, the circuit can achieve the functions such as the temperature detection, time display, light detection etc. preset in the graduation design, but it cannot achieve the function of dimming LED lights.

4.2 Results analysis

For the result that the LED lights cannot be obvious to achieve the dimming, after the discussion and analysis with the instructor, it is believe that because the constant current circuit of the LED drive circuit has the almost constant current integration on the dimming current which makes the difference between the dimming current and the rated current is close to each other, the brightness change of the LED lamps is very very small which cannot be identified by naked eyes. What's more, the field-effect tube in the LED driver circuit magnifies the circuit power, so the current changes regulated by the microcontroller changes to the tiny current regulation under the effect of the field-effect tube.

5. Summary

The auto lighting control circuit uses the intelligent technology and the circuit can control the lighting brightness needed by the environment based on the brightness of the ambient light to avoid the light source pollution, which plays a very great role in easing the domestic power resources shortage and has the broad application prospect.

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