SPECIALIZED MICROCONTROLLER SYSTEM FOR STREET LIGHTING CONTROL

Ivan Ivanov, Atanas Ivanov, Valentin Hristov

Department of Computer systems and Technology, South-West University "Neofit Rilski", Blagoevgrad, Bulgaria, phone:(+359)738999132, e-mail: v_hristov@aix.swu.bg

Conventional devices for automatic switching of the Street Lighting are: photo relays developed by old schemes, but they are not corresponding with the new standard; Or electromechanical clocks with stiff time setting that are not effective. The purpose of this paper is to describe steps of development of a new device that intelligently controls the Street Lighting of two instances: lighting and time, which means the two of old methods are united into one device.

Keywords: street lighting, intelligent control, robust control.

INTRODUCTION

To controlling of street lighting in Bulgaria are diffusion photo relays and electromechanical clocks, which are developed long ago. They are simple electric or electromechanical devices. Their primary defect is the mechanical part. Also the way of management – with relay, that is expensive and comparatively heavy element, because it is constructed by old technology. The basic parameter of the relays is the commutation count, which is limited. The large power that the relay switching means the device will be out of order after several years. When this period expired the device have to be changed with a new. The modern electronics gives option to build a control that intelligently controls the street lighting, as this way can be reached requirements about low energy consumption. Contactless switcher, who will be very refusalless. The contactless switcher can be made with triac or thiristor and diode bridge.

The controlling of street lighting with microcontroller allows some additional options: Signalizing when the photo sensor is covered by dust; Preserving from temporally incorrect switching on at the day of street lighting by changeable cloudiness; also preserving from switching off at the night caused by criminal subjects. They can light the photo sensor to try to defy switching off, but this won't happen.

PURPOSE

The purpose of the paper is to presents a modern microcontroller management for street lighting, who can intelligently control the street lighting with the assistance of photo sensor and internal timer. This allows the device to adapt toward changing of duration of day and night.

The tasks which have to be resolved are counted bellow.

At first place must be specified the hardware of the device:

- Type of photo sensor to use e. q. photo transistor, PIN photo diode and s. o;
- Method to input the information from the photo sensor to the microcontroller;
- What type indication is needed and what exactly will be indicated with it;
- Type of switching part;
- Method to prevent from reaction of temporally anomaly of lighting (if this will be resolved by hardware);

At second place must be specified the general construction of the program:

- The subprogram "timer";
- The subprogram for collecting of statistical information from the photo sensor;
- The correlation between the photo sensor and the timer;

At third place must be specified constructional details:

- Preserving corpus for the device;
- The installation place for the device;
- Preserving corpus for the photo sensor;
- The installation place for the sensor;
- Needed materials for the corpuses;

HARDWARE

There are two options for a photo sensor. Photo transistor or PIN photo diode (the others photo elements like photo resistor and photo diode are not enough sensitive). Beforehand has been constructed microcontroller photo relay with photo transistor. The test shows the photo transistor is not enough sensitive too. Which means the PIN photo diode is only option.

There are two ways to input the data from the photo sensor into the micro-controller. With using of the internal ADC (analog to digital adaptor), but not all microcontrollers have ADC. By this way the voltage from the PIN photo diode is converted directly in binary number stored into output register of the ADC. This method represents comparison between one beforehand added numeric constant and the data from ADC. The other method is by using of internal analog comparator. One of comparator's inputs is connected to changeable resistor. The other input is connected to the point between the PIN diode and the pull up resistor. The method with ADC is more expensive and more complicated because the microcontrollers with internal ADC are more expensive and the tuning is more complicated because it is digital. Witch means there are needed buttons and display. Otherwise the operator can't see what does him tuning. The other method is simpler. There is one changeable resistor connected to +5V and GND. Its middle pin is connected to the one of comparator's inputs. So the tuning is easy and quickly. There are not needed displays and buttons.

About indication for the dust protection: It's needed one LED who will light when the PIN diode is dusted.

There are two schemes of contactless switchers. The one of them is with triac [1]. The second scheme is with thyristor and diode bridge [1]. The second scheme has

been chosen, because the bridge disconnecting the variable high voltage from low voltage part of the scheme. To avoid reaction oscillation of the device to temporally darkling can be making this: An amplifier is set after the pull up resistor and the PIN diode. Then amplifier's out is connected to one of comparator's inputs. To increase the input reacting threshold the comparator is connected like Shmit's trigger. This can be done with putting of positive reverse connection. For this it's needed the one of programmable pins of the microcontroller to be associated with comparator's output, which is not bringing out of the controller. The feed back is realized between the associated output and one of comparator's inputs via changeable resistor, which of them is described on (fig.2).

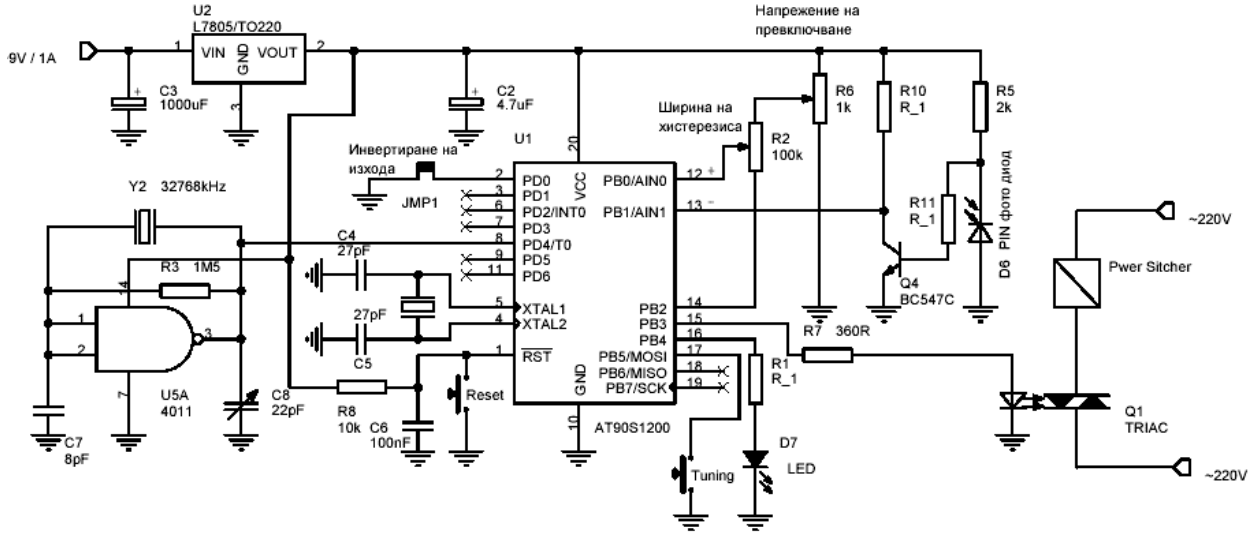

Fig.2 Principle Scheme of Microcontroller Management.

The scheme is equipped with tuning of the switching point, tuning of the height of the threshold (which changing the sensitivity), jumper for inverting of output's level (light = "logic 0", dark = "logic 1" or reverse). The scheme has an external generator which working only for the timer.

SOFTWARE

The subprogram timer is fundamental part of the program. It is one of the two instances, which dependence the street lighting from. Also it makes collecting the information for the graphic of the switching moments.

The moment of becoming of the civil semi-darkness [2] is changing through the year. Six months the day growing but the night decrease. The others six months are reverse. Which means the device have to automatically adjust the moments of switching "on" and "off"?

There are a several methods to adjust the moments. The simplest method is by addition of calendar into the microcontroller. The calendar contents the moments of sunrise and sunset for each date of year. The defect is, it necessity too large memory and not all microcontrollers has that much memory.

Another method is by developing of mathematical algorithm for dynamic computing of the moments by the microcontroller it self. This method needs more little memory. The mathematical algorithm has a many steps [3].

The data from this photo sensor are writing into an array. Every array's element presents a one day. The number array's elements are chosen arbitrarily or that much as microcontroller memory allows. The content of array's elements is representing graphic of switching off moments of street lighting , in space of time that corresponds of the number of array's elements (the days). The moment of switching on about tomorrow's day is computed with this graphic. The computation is getting of the middle value of every day, qualification of this; must be summed up the middle value with the value of last day or to be extracted.

The algorithm is:

$$Mid = \frac{day_1 + day_2 + ... + day_n}{n}$$, then

if ($day_{n-1} > day_n$) then $Switch\_moment = day_n - (day_n - Mid)$

else $Switch\_moment = day_n + (day_n - Mid)$

Every one of these three methods can be used. The best dependence between the photo sensor and the timer is the logical function AND. To have switching on is necessity the two instances to give signal to switching on.

Every thing said above is about to switching on. To switching off it is needed one more algorithms with same steps and conditions.

CONSTRUCTION AND INSTALLATION

The microcontroller management must work at relatively strong electromagnetical fields, which can disturb the normal work of the device. Also it must work in dusted environment. It must work in comparatively large temperature yearly. Changeable dampness of air, which can be cause for corrosion: Because these factors the device must be putted into a box. What material is needed for the box is explained below?

The corpus must be metal and tightly closed, to avoid the electromagnetic shocks and the dust and the dampness.

It is not recommended the device to be installed into electric panel, because the electromagnetic shocks caused by circuit closers can disturb the work of the controller. But if the electric panel is the only comfortably place the box must be constructed of better magnetically soft material.

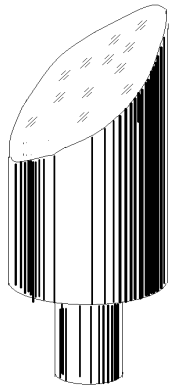

Fig.3 form of sensor's corpus.

As the device and photo sensor must be placed into a corpus. It must reduce to minimum possibility of dusting in side the corpus. The corpus must have form which avoids detention of dust out side the corpus (fig.3).

The photo sensor must be installed on a place which is illuminate form the sun all day. Extremely important is the photo sensor to be installed on a place which hasn't any lighting from the street lighting. Otherwise will be caused a positive feed back and the street

lighting will start to blink.

On top of the corpus has a frosted glass. It reduces the direct lighting from the Sun. The material of sensor's corpus must be aluminum, because it don't corroding and don't grow old.

CONCLUSION

In this paper is described a device for street lighting control which receives data from two factors (light and time). By that way the reliability is increased, the street lighting is controlled optimally. There is contactless switching, which additional increase the reliability. With this all the purposes are reached.

REFERENCE:

[1] Ian R. Sinclair, Practical Electronics Handbook, Technics 1983

[2] Кенаров Н., PIC микроконтролери, Варна 2003

[3] Slavov Z., V. Hristov, Designing an algorithm calculating sunrise and sunset for street lighting control with a microcontroller, FMNS'2005, accepted