Controlled Automatic Charged Battery Operated Street Light Switching System

Mr. Pralay Majumdar;
Saumi Mondal; Nabyendu Roy Kayet; Sakshyigopal Ghosh.
Birbhum Institute of Engineering & Technology, Suri, Birbhum.
West Bengal University of Technology.
Arabinda Pally, P.O.: Suri; Dist.: Birbhum, PIN: 731101

Abstract - The aim is to develop a circuit which will be able to turn the light on at the time when the supply power is turned off. The brightness of the light has also been controlled with the insertion of a suitable POT. The arrangement can be made with the combination of the three individual circuit comprising the battery charging, Illumination control of street light and light activated solid state switching.

Keywords: Automatic battery charging, Illumination control, Light activated solid state switching, combinational circuit, software and hardware result.

INTRODUCTION:

The overall block diagram of the project is being shown in figure 1.

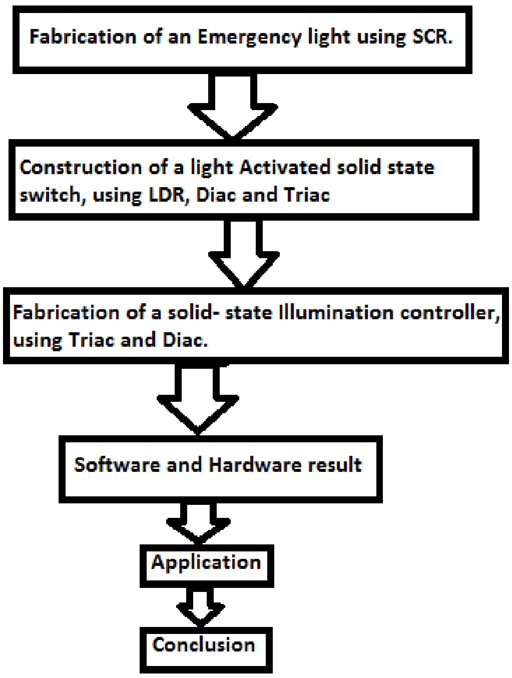

Figure1.

Emergency light is designed for emergency purposes. Depending upon the rating of the lamp it works on low voltage d.c. The lamp starts glowing immediately when the a.c. supply is disrupted. In the presence of a.c. power, the lamp does not glow because the SCR is in OFF state and simultaneously the battery is charged. When the main supply fails; the storage battery will keep the lamp lighted for a period which depends upon amp-hr rating of the battery. In normal case, when the supply is present, another bulb will glow which is being connected with the a.c. supply and it is automatically controlled with the variation of day light by light-dependent resistor (LDR). When the natural light falls below a certain level, this bulb is automatically switched on. This is switched OFF automatically, when the natural light attains a certain level of intensity. The brightness of the light can also be controlled by using a triac-diac pair along with an R-C triggering circuit. A potentiometer and a capacitor of proper values form the R-C triggering circuit.

Design of the overall system: Overall design of the controlled automatic charged battery operated street light switching system can be combined by the following individual circuit.

- Fabrication of an Emergency light using SCR.
- Construction of a Light-Activated Solid-State switch, using LDR, Diac & Triac.
- Fabrication of a solid – state Illumination controller, using Triac and Diac.

The circuit diagram for fabrication of an emergency light using SCR is shown in figure2 below.

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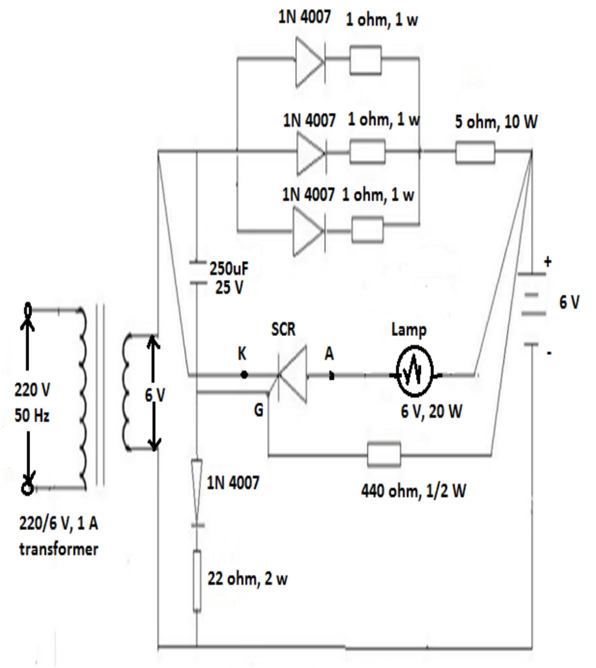

Figure2: Circuit diagram for SCR controlled emergency light.

When mains supply is available the 250 µF capacitor gets charged in the positive half cycle of the supply through 22 Ω resistor and it retains its charge such that its upper plate acquires (+) ive charge and the lower plate acquires (-) ive charge. Because of the (-) polarity applied at the gate, the SCR remains in OFF state. The capacitor is unable to get charged in the negative half cycle of the supply because of the blocking diode (1N 4007). The lamp is not connected in the circuit and therefore it does not glow. At the same time, d.c. source, i.e. the 6 V battery, gets charged from a.c. mains through a rectifier. One diode of proper rating may be used as a half wave rectifier; but in this circuit three diodes have been purposely used in parallel for increasing the current rating required for the charging purpose. Single-phase a.c. is stepped down to 6 V and rectified by the three diodes used in parallel. The direct current through the 5 Ω, 10 w resistor will start charging the 6 V battery connected in the circuit. The current will flow through the secondary winding of the transformer. The SCR being in the non-conducting mode will remain in OFF state. The battery will be continuously charged so long as the a.c. power is available. The moment a.c. power fails, the 250 µF capacitor will start discharging through the diodes, 1 Ω, 5 Ω and 440 Ω resistor. After getting fully discharged it will start charging in the opposite direction causing reversal of polarities of the capacitor. Now because of positive polarity at the gate, the SCR will immediately get triggered and start conducting. This will connect the lamp in the circuit with the battery. Thus the lamp will start glowing instantaneously by drawing current from the battery. The moment a.c. power is reinstated the SCR will automatically commutate thus the lamp will immediately be switched OFF and the battery will again start getting charged. 1 Ω, 1 w are connected in series with each diode (1 N 4007) connected in parallel configuration. This has been done as a precaution for saving the diodes from getting damaged due to unequal turn – ON times of the diodes. The charging current of the battery for positive half cycle is shown in figure 3 below.

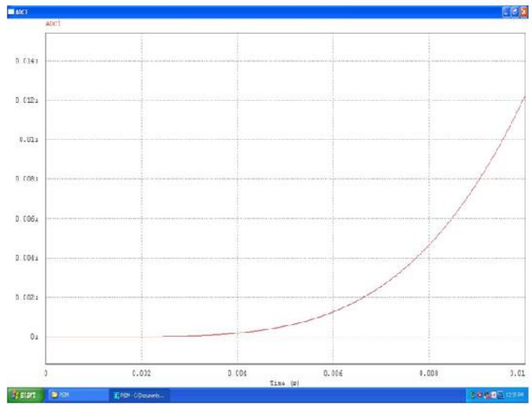

Figure 3: Charging current of the battery for positive half cycle.

The circuit diagram for Light – Activated Solid state switch, using LDR, Diac and Triac is shown in figure 4 below.

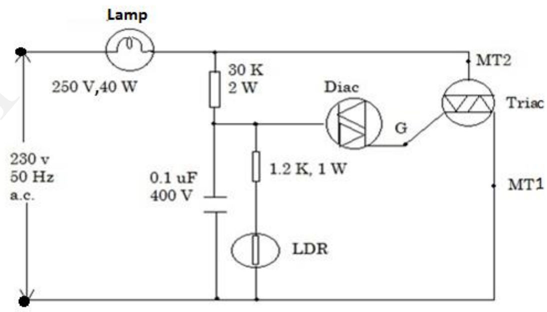

Figure 4: Light – Activated Solid state switch.

In the presence of sufficient quantity of light flux, the value of resistance of the LDR will become quite low and therefore maximum current will flow through it. This will prevent the capacitor ‘c’ to get fully charged, hence the voltage across the capaciotor will not reach up to the breakover level of the diac; as a result, the diac will not conduct. The diac being in OFF state, the triac will remain OFF and the lamp will not glow. As the surroundings gradually become dark the amount of light falling on the LDR surface will be reduced. Thus the value of resistance of the LDR will become very high preventing any flow of current through it. This will enable the capacitor to get fully charged and the voltage across it will become more than the breakover voltage of the diac. Immediately diac will send triggering pulse to the triac gate and, in turn,the triac will be switched ON. This will complete the path for current to flow through the lamp which will immediately start glowing. The triac will remain ON till the illumination level of the surroundings is up to a certain value. The lamp will also continue to glow till the triac is ON. In the ON state of the triac the total supply voltage will appear across the lamp and the current will flow through the lamp and the triac. As soon as the amount of light falling on the LDR surface is increased the diac will be switched OFF which, in turn, will switch OFF the triac resulting in switching OFF the lamp.

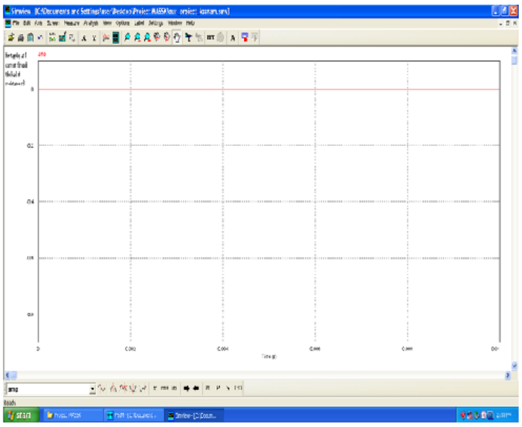

Figure 5: Zero current through the lamp when the light falling on the LDR.

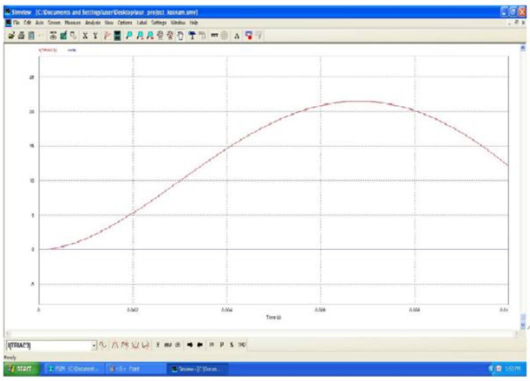

Figure 6: Current through the lamp when no light falling on the LDR.

The circuit diagram for solid – state illumination controller, using triac and diac is shown in figure 7 below.

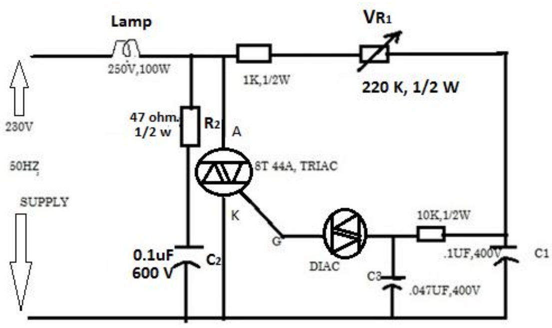

Figure 7: Solid state illumination controller using diac and triac.

The triac is fired with the help of diac by means of the R-C triggering process. VR_1 and C_1 form the R-C network for triggering. When the voltage across the capacitor of the R-C network is equal to or more than the breakover voltage of the diac, it starts conducting and thus fires the triac. The firing angle of the triac can be varied by changing the value of R (in the R-C network) with the help of the POT. Depending upon the firing angle of the triac the illumination intensity will vary. Less the value of firing angle of the triac, more will be the voltage across the lamp and hence more will be its intensity of illumination and vice-versa. Diac is often used as a triggering agent for triacs which require either positive or negative pulse to turn it ON. During the positive half cycle of the supply, the triac requires a positive gate signal to turn ON. If VR_1 is sufficiently large, the capacitor voltage V_C does not exceed the diac breakover voltage. In this case the diac will not conduct and as a result the triac will remain in OFF state. As VR_1 is decreased the capacitor voltage V_{C1} increases and at some point when V_{C1} equals or exceeds the breakover voltage of the diac, the diac will breakover and in turn will trigger the triac gate. A similar operation will take place in the negative half cycle and therefore, a negative gate pulse will be applied when the diac breaks down in the reverse direction. The 47 Ω, ½ w resistance R_2 and the 0.1 µF, 600 V capacitor C_2 form a R-C network connected across the supply. This is known as the snubber circuit and is used to suppress the undesired transients appearing in input mains supply. Capacitor C_3 of 0.047 µF, 400 V has been used as a filter.

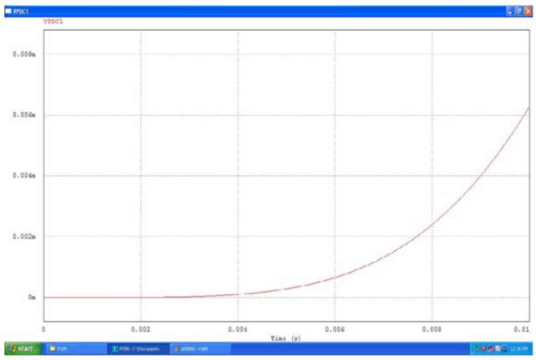

Figure 8: variation of voltage across the lamp with the variation of POT.

The overall circuit diagram for controlled automatic charged battery operated street light switching scheme is shown in figure 9 below. This circuit is the combination of the above three individual circuit arrangement.

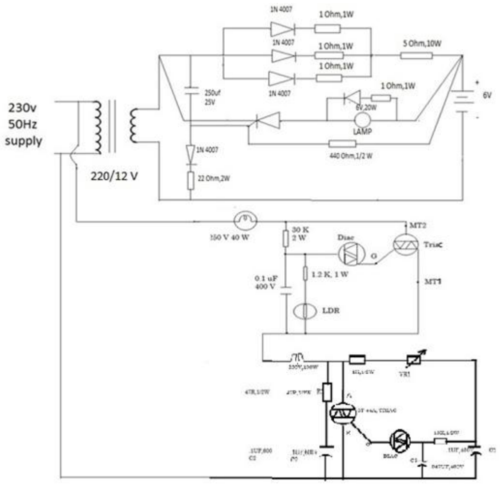

Figure 9: overall circuit diagram.

Figure 10: Prototype of the overall circuit diagram.

Figure 11:
Lamp is illuminated by the main supply and is being controlled by varying

POT.

Figure 12: Emergency light is illuminated when no supply is available by the battery backup.

Figure 13: Control of lamp by LDR. When the light is falling on LDR, the lamp is going to be in OFF condition.

Advantages and disadvantages:

- ➢ Automatic and efficient switching ON and OFF during dark and day light condition.
- ➢ Requirement of manpower is being reduced.
- ➢ Complete blackout can be avoided and is usable in border areas as requires no attention.

Disadvantages:

- ➢ It can't be mounted in regions where experiencing low and subzero temperatures, as the battery backup unit might not start due to cold, hindering the emergency supply of the apparatus.
- ➢ The battery has a certain life period, so it requires changing the battery after expiry of its life period.

Future scope:

1. Automatic street lighting system will be capable of further up gradation into a solar supply unit by addition of a solar panel.

2. Traffic junctions can be provided with high power systems inculcating the present system so that it can be used at busy crossings, and also when foggy conditions prevail.

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