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Energy Efficient Multimode Photonic Switch

Manan Garg, Aditya Agarwal
Department of Electronics and Communication Engg
S.R.M University, NCR Campus
Modinagar

ABSTRACT
As the title suggests it is a light controlled switch offering multiple modes of operation. The aim of the project is to design an energy efficient circuit that can provide multiple mode switching options. The user can easily switch over between automatic and manual switching mode. The automatic switching mode is further divided into two sub automatic modes as listed below: closed switch during sunshine and open switch during dark.
open switch during sunshine and closed switch during sunlight.
Hence this kind of multipurpose switch can be used for domestic/industrial purposes where synchronization with sunlight is required. Moreover, such kind of switches can widely be used for automatic switching of the street lights.

Keywords: Introduction, Block Diagram, Circuit Diagram, Electronic Components Used, Working, Prototype model, Advantages, Applications, Results, Future Research.

INTRODUCTION

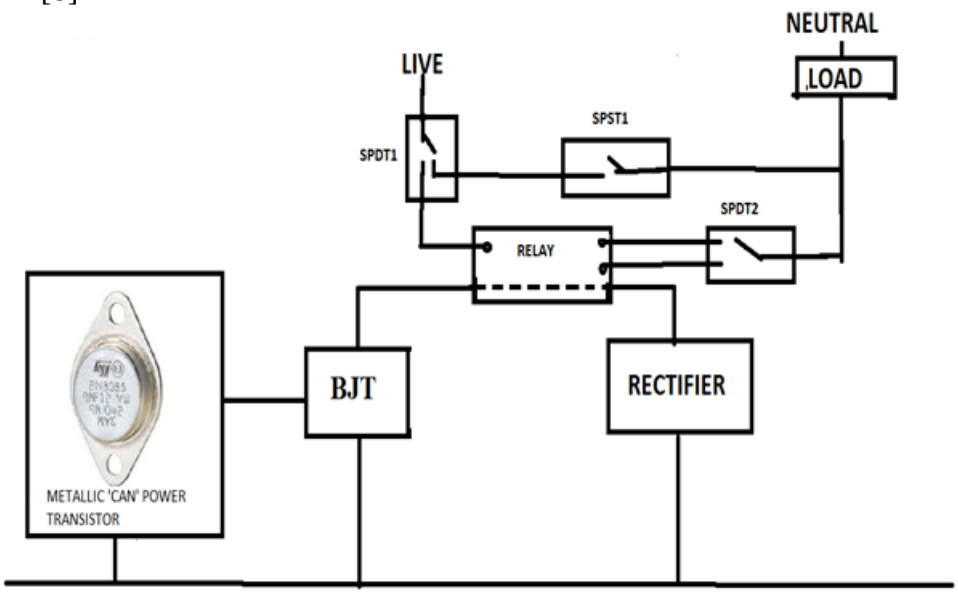
Multimode photonic switch is a photosensitive device used in automatic switching applications. Its monolithic circuitry is so designed that it can replace the ordinary (ON-OFF) switch mounted on the switch boards, traditionally used for domestic or industrial switching. Unlike, ordinary available photonic switch this switch will operate in following major modes as discussed below:

1) AUTOMATIC MODE
1.1) CLOSED switch during sunlight and OPEN switch during dark.
1.2) OPEN switch during sunlight and CLOSED switch during dark.

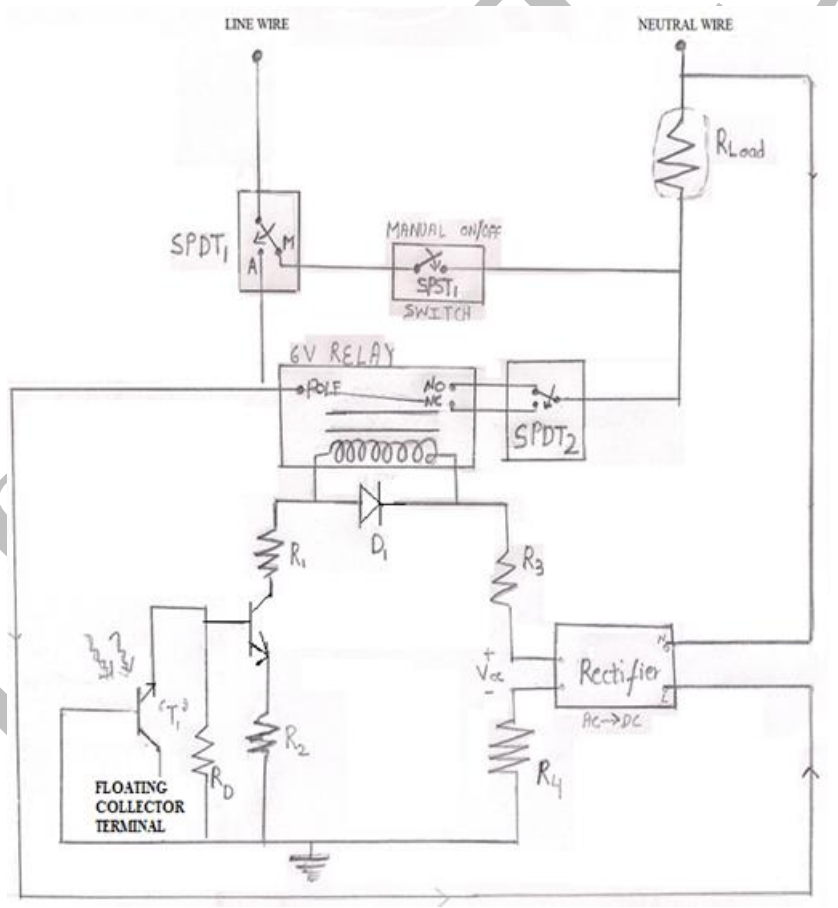
2) MANUAL MODE:
In the manual mode it would act as a conventional ON-OFF switch which is operated manually.
The user can easily switch over to any of the three modes (1.1/1.2/2) as represented above.
Moreover, its circuitry is energy efficient as it uses an open 'CAN' power transistor to sense the sunlight and hence acting as an active device sensor (like solar cell) unlike LDR (passive device) that leads to resistive power loss across it.

The circuit is using BJT which operates in linear/saturation or cut-off region to provide the desired switching. The circuit assembly is monolithic and is self driven, all that we need to have is an A.C. load (for which switching is required) and the power required to drive the electronic components of the switch would come from the Line and Neutral connected across the load. The scope of the project is quite high as it is provides energy efficient automatic switching. Moreover, the circuit is cost efficient and space efficient as well.

BLOCK DIAGRAM [8]



CIRCUIT DIAGRAM



ELECTRONIC COMPONENTS USED

S No.	NAME OF COMPONENT	QUANTITY
1.	Power Transistor	2
2.	BJT	1
3.	5V SPDT Relay	1
4.	Rectifying Diode & Flyback Diode	2 & 1
5.	SPDT & SPST Switch	2 & 1
6.	Load (as per application, For ex. Street lights)	As per application
7.	9-0-9 Centre Tap Transformer	1
8.	Filter Capacitor	1
9.	IC 7806	1

WORKING

(Role of each component)

1. METALLIC 'CAN' POWER TRANSISTOR (2N3055)/(T1):

The metallic cap of the power transistor is being removed, after removing the metallic cap the silicon wafer used inside the power transistor is visible to us [4,5,6,7]. Now, when this silicon wafer is exposed to sunlight its emitter-base junction produces a built in potential of 0.44V (approx.)

If 'N' such power transistors are connected in series connection then the net voltage generated is 0.4N Volts. Hence, this built in photo voltage is applied at the base terminal of the BJT which in turn controls the flow of current from collector to emitter and hence provide the desired switching of relay.

2. BJT

Bipolar junction transistor is used as the vital switching component [1]. It helps in varying the resistance of the channel/path by changing the voltage across its base terminal. This successful modulation is achieved because the transistors working in two different modes as discussed below:

- LINEAR/SATURATION REGION: When Vbe is greater then or equal to 0.7V then the transistor comes in the linear region and hence offers a finite resistance from collector to emitter.
- CUT-OFF REGION: When Vbe is less than 0.7V then the transistor is said to be in the cut-off region and hence it offers the infinite resistance from collector to emitter and thus acting as an open circuit loop.

3. RELAY

A 5V single pole double throw (SPDT) relay is being used which acts as an interface between electrical and electronic circuit [9]. Now, when BJT used is in cut-off region then relay coil is not energized and hence relay offers a conducting path between Pole (P) and Normally Closed (NC) terminals and hence acts as an closed switch between P & NC terminals but at the same time it offers infinite resistance between P and N.O.(Normally Open) terminals.

Now, when BJT is in Linear or Saturation region then current flows through the relay coil and hence 5V voltage drop is produced across the relay coil which in turn energises the relay coil and hence the magnetic field thus produced attracts the coil from N.C. terminal to N.O. terminal. This in turn provides a closed conducting path between P and N.O. terminals.

4. FLY BACK DIODE

A fly back diode is put parallel to the Relay Coil in order to discharge the Relay Coil when the BJT changes its region of operation from Linear / Saturation to Cut-off region , so that Relay can discharge properly and thereby comes to its rest position (at N.C. terminal) [10] .

RECTIFYING DIODE

Two rectifying diodes are being used in making the circuit of centre tap full wave transformer in order to obtain the D.C. voltage used for driving the electronic components of the circuit [1].

5. Switches

6. The Circuit Broadly Uses Two Categories Of Switches Namely[11]:

6.1) SPDT: Single Pole double throw switch.

a) SPDT1: Manual to auto mode change over switch.

b) SPDT2 : It is used to switch over between two sub automatic modes that are listed below:

b.1) Closed switch when illuminated (during day light)

b.2) Closed switch when not illuminated (during night dark)

6.2) SPST: Single Pole single throw switch.

a) SPST1 : It is used for ordinary ON/OFF switch , when the switch is operating in the manual mode

7. LOAD

Using this multimode photonic switching circuit we can operate switching operation of any A.C load. The load can be domestic or commercial depending upon the requirement. For example we can control the automatic switching of street lights so that they can automatically OFF during the day light, so as to avoid wastage of precious energy.

8. TRANSFORMER

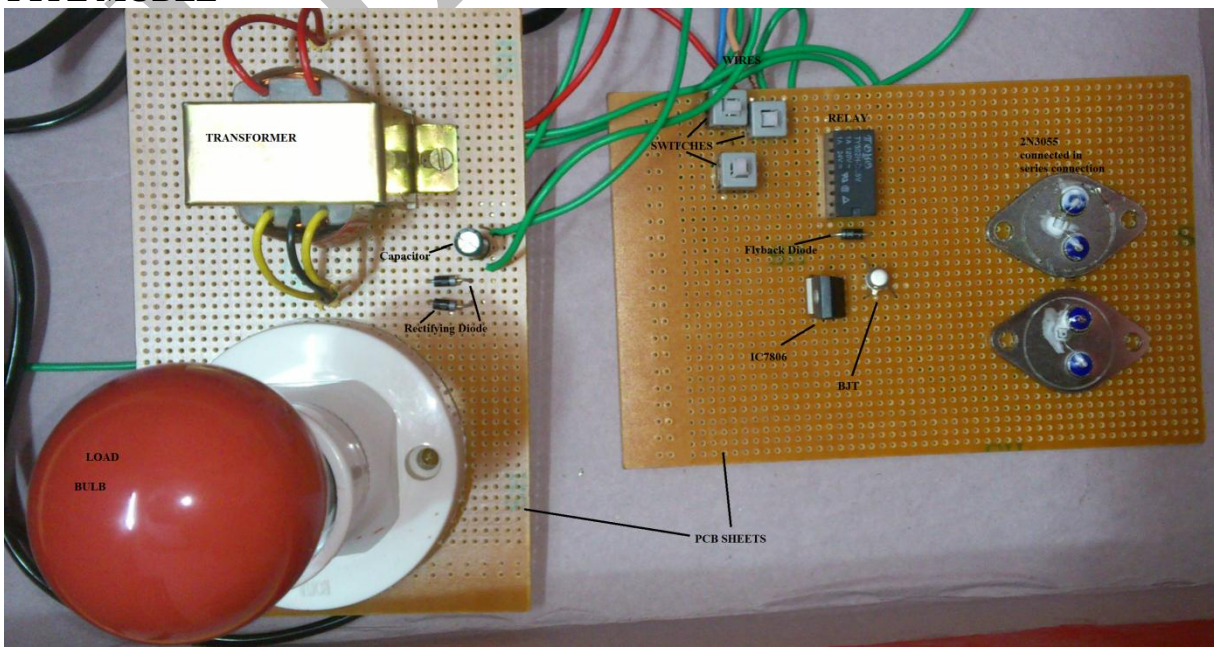
A 9-0-9 Transformer is being used to step down the 220V A.C. supply to 9V and thereby forming a centre tap transformer using the rectifying diode's in order to obtain the D.C. voltage. The D.C. voltage thus produced is used to drive the electronic components of the circuit.

9. FILTER CAPACITOR:

A 100 microfarad (25V) Capacitor is used to filter out the pulsating D.C. and hence giving out a smooth D.C. voltage across it.

10. IC 7806 It is used to convert the 9V filtered D.C. voltage from the transformer into the regulated 6V voltage which is used to drive the electronic components of the circuit [12].

PROTOTYPE MODEL



ADVANTAGES

- Energy efficient circuitry
- Multiple switching options
- Minimum electronic components used
- Low cost
- User friendly switching options.

APPLICATIONS

- Domestic outdoor switching solutions
- Industrial switching solutions
- Automatic street light switching solutions.

RESULTS & CONCLUSIONS

This circuit of multimode photonic switch provides versatile switching options and hence meets the switching demands for industrial as well as domestic switching. Moreover, the use of the power transistor to sense the sunlight has effectively contributed in providing energy efficient automatic switching. Use of minimal number of electronic components has further reduced the cost for designing the circuit. Thus we can conclude that the circuit offers energy efficient, user friendly multiple switching options.

FUTURE RESEARCH WORK

Experiments are being carried out to make the circuit further more energy efficient. Efforts are done to replace BJT with the ultra low threshold voltage MOS devices so that there can be reduction in the number of 2N3055 power transistors used. Moreover by using the MOS technology the circuit results would become more accurate.

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