

# Automatic Phase Changeover Switch

Uneet Kumar Singh<sup>#1</sup>

<sup>#1</sup>Student, Bachelor of Technology, Department of Electrical Engineering  
Madan Mohan Malaviya University of Technology  
Gorakhpur, India

**Abstract--** An automatic phase change over switch is designed primarily to disconnect load from its power source and transfer it to a standby source say generator, in case there is a power outage. The switching process is done in a controlled manner so as to prevent the false starting of generator at very short power outages. Once the supply is restored, the load is transferred back to mains supply. The entire process is controlled by a control unit that keeps sensing to detect that whether the main supply is available or not.

**Keywords --** Switching Relay; Generator; Motor; Mains Supply; Transistor; Timer; Latch

## I. INTRODUCTION

The project aims to design a prototype for automatic switch that transfers the load from mains to an auxiliary source, such as a generator, in an event of power failure or regular power outages. The project implements the starting of a generator as soon as the outage occurs. The circuitry comprises of relays and a control unit. Though the project remains to be a prototype, various precautions are taken to adapt to real life situations.

There are certain realistic assumptions that are made while designing the prototype. These are:

- i. To Turn ON a generator we only need to switch ON a kick-starter (an electric motor that starts a generator).
- ii. A reserved battery powers the kick-starter as well the switching circuitry once the outage occurs.
- iii. The generator needs to be switched ON only if the power outage occurs for more than 2 seconds.
- iv. Actuator needed to switch off the Generator will carry out its function once it is triggered by mains supply.

With the above mentioned conditions, the aim of the circuit is to start a kick-starter by connecting it to reserved battery and as soon as generator achieves steady state, generator is loaded after a predetermined interval. Time gap is maintained between the starting of the generator and its loading to normalize the

armature current. An overall outlay of the prototype is depicted in the block diagram as shown in figure 1

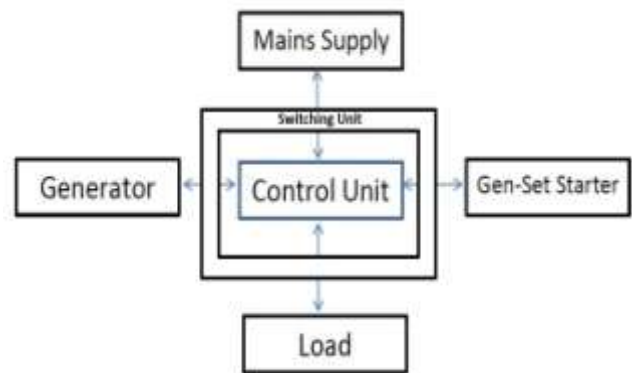


Figure 1: Block Diagram of the Prototype circuit

## II. POWER SUPPLY FOR THE CIRCUIT

Since all the IC's work on DC, it is essential to convert the mains supply to DC for it to be sensed by the sensing circuitry. A 220/12V transformer (TR1) is used to step down the voltage. The step down voltage is rectified through a bridge rectifier (BR1). A 1000uF (C1) is used to make the output ripple free

A Voltage regulator (IC 7812) is used to regulate the rectified voltage to 12V [1]. It is optional to put 1uF capacitors in parallel to input and output ports. It will further reduce the ripples to an optimum level. The DC Output is used to reset the timer U2 (4060)[3], Motor latch U3 A, Switching relay latch U3 B once Mains supply is restored. The circuit for supply is shown in figure 2

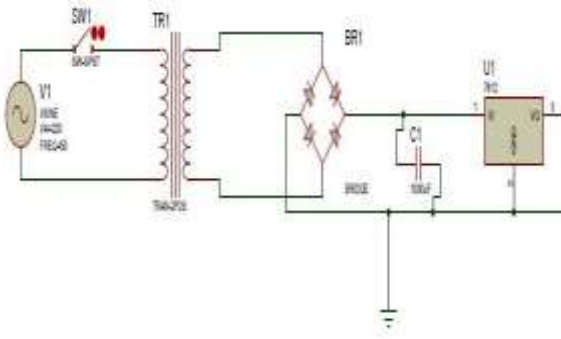


Figure 2: Power supply circuit

### III. CONTROL CIRCUIT

A 14 stage frequency divider U2 (IC 4060) is central to the control circuit and provides all time delays required in the circuit. It can be operated either with RC or Crystal oscillator [2]. If it is used in RC mode, then the oscillation frequency is given by the relation:  $F_m = 1 / (1.5 * R_{TC} * C_{rc})$  Hz

The frequency of the each output pin (say x) is given by the relation:

$$F_{Qx} = F_m / 2^x \text{ Hz}$$

Since it is a simulation, oscillator frequency can be directly set through the simulator. In this project the frequency was set at  $F_m = 1.024 \text{ KHz}$ . Q11 and Q13 were used to set the motor (starter) latch and Changeover latch respectively. Hence:

$$\begin{aligned} F_{11} &= F_m / 2^{11} = 0.5 \text{ Hz} \\ T_{11} &= 1 / F_{11} = 2 \text{ seconds} \\ F_{13} &= F_m / 2^{13} = 0.125 \text{ Hz} \\ T_{13} &= 1 / F_{13} = 8 \text{ seconds} \end{aligned}$$

Another important component of the control unit is the D type Flip Flop (4013)[4]. Two D type Flip Flops are used as latches in the circuit. One is used to latch the kick-starter (U3:A) to the reserved battery while the other latch (U3:B) is used to transfer load between the mains and the generator. These two latches perform their functions once they are set by the output pin Q11 and Q13. Figure 3 shows the control unit of the circuit

### IV. SWITCHING RELAY UNIT

Switching unit consists four relays of 12V rating each. It also consists of two transistors BC547 Q1 and Q2. Functions of the different relays are described below:

- i. RL 1: This relay is primarily used to reset the Counter U1 when power supply is available. It also puts the reset pin to logical

zero by connecting it to earth, when there is no mains supply.

- ii. RL 2: Kick-Starter is turned ON by this relay. Transistor Q1 drives this relay once Q1 is triggered by motor latch U3:A .
- iii. RL 3: Transferring of load(D2) between mains and the generator is done by this relay.
- iv. RL 4: This relay is used to turn OFF the Kick-Starter by resetting the motor latch(U3:A), once the generator has picked its optimal speed.

The configuration of the different relays is shown in figure 4.

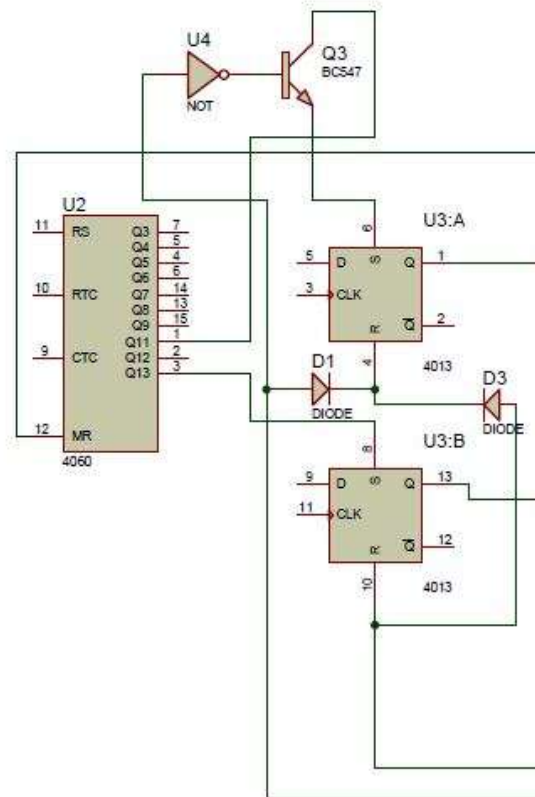


Figure 3: Control Unit

### V. METHODOLOGY

The process of phase changeover involves the interaction between the control unit and the power supply, generator, starter and load through the switching circuit. Various steps involved are described below:

- i. When the mains supply is restored, relay R1 resets the counter U2, the motor latch U3:A through diode D3 and changeover latch are also reset.

- ii. Relay R3 transfers the load (D2) to Mains supply. Since the Proteus 7 does not support any AC load, the load was transferred back to the rectified DC(from mains supply) instead of directly transferring it to AC Mains (It indirectly transfers the load to the Mains supply, it just happens to be rectified mains instead of AC Mains).
- iii. Once the power outage occurs, pin 12 of counter U2 gets connected to logical zero (ground) through relay R1. As a result of which, the counter starts functioning.
- iv. After a predetermined interval of 2 seconds, the motor latch is set which in turn turns ON the transistor Q1. Once Q1 is turned ON, relay R2 turns ON the starter of the generator. This short duration of 2 seconds is taken into consideration to prevent false turning ON of the generator in case of very small duration outages (< 2 seconds).
- v. After starting the generator the next task is to changeover the load from mains to the generator. The generator is given sufficient duration of 6 seconds to normalize its current. Once the current gets normalized, load is transferred to the generator from the mains with the help of relay R3.
- vi. The kick-starter also needs to be turned OFF after transfer of the load. This is done with the help of relay R4 and transistor Q3. After 8 seconds of power outage, the transistor Q3 is turned OFF with the help of a NOT gate U4. The logic 1 is taken to transistor Q3 as logic 0, which in turn disconnects the Q11 pin of counter U2 from the set pin of the motor latch U3:A. At the same time U3:A is reset through diode D1. Relay R2 then disconnects the starter from the reserved supply.
- vii. Again when the mains is restored, counter U2 is reset along with U3:A through D3 and U3:B.

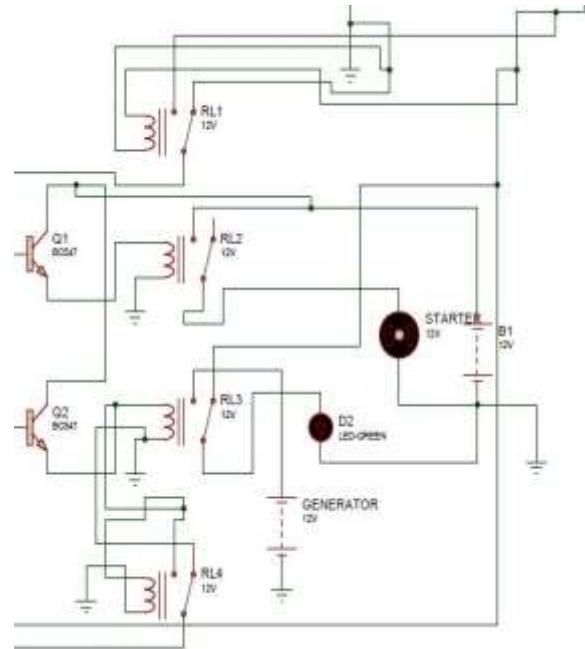


Figure 4: Switching Relay Circuit

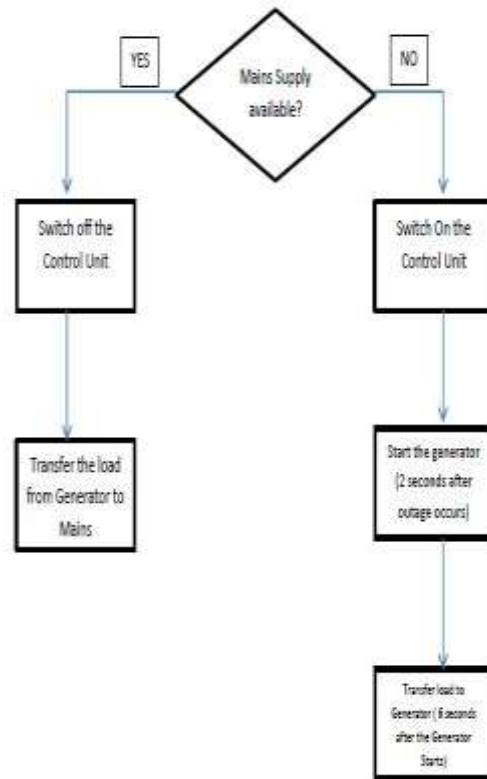


Figure 5: Flow of control in circuitry

D1 and D3 are used to prevent the voltages from mains and the auxiliary source to get transferred to unwanted locations at unwanted instants [5].

Figure 5 depicts the flow of control in the circuitry. Figure 6 shows the complete circuitry of the prototype.

Note that switching off of the generator is not modeled here since there is no viable method to switch off the generator electrically. An actuator can be separately installed to turn off the fuel supply of the generator.

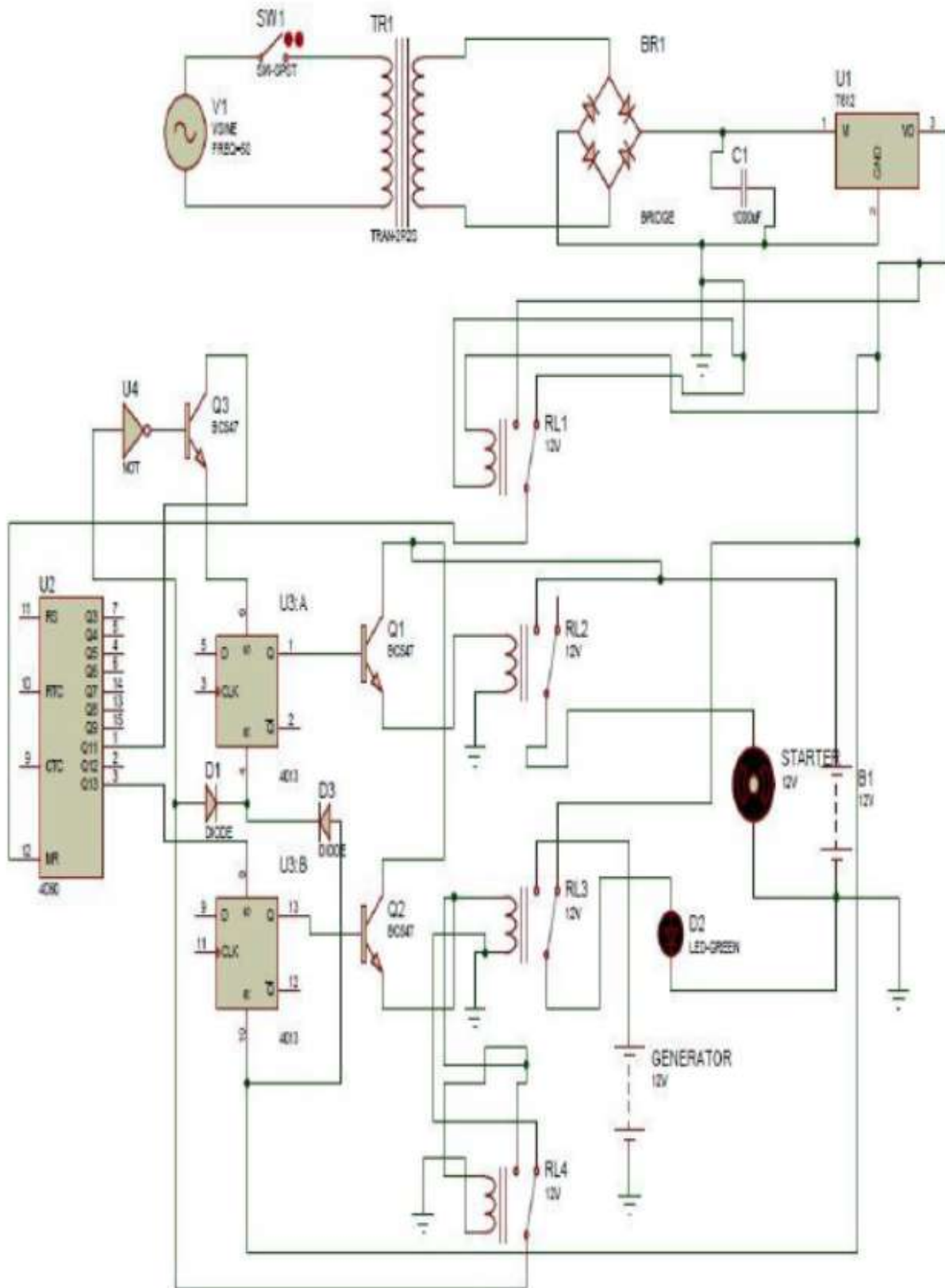


Figure 6: Complete circuit diagram of Automatic phase changeover switch

## **VI. CONCLUSION**

An automatic power changeover switch was successfully designed and simulated. Working of the automatic phase changeover switch was in accordance with the specifications and satisfactory. Economic viability, reliability and easy handling are some of its advantages. In event of power outage, stress of manual changeover is reduced greatly.

## **VII. REFERENCES**

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