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DESIGN AND CONSTRUCTION OF AN AUTOMATIC CHANGE OVER SWITCH WITH OPTION OF GSM-BASED REMOTE CONTROL USING GRAPHIC USER INTERFACE (GUI)

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Abstract — *Consumers of power in underdeveloped countries have been faced with electricity challenges which has resulted to economic retardation, poor Gross Domestic Product (GDP) and weak industrialization. This project looks at method to improve power stability and reliability. To achieve this, alternative power sources that works efficiently with minimum time delay are required. The automatic changeover switch with Graphic User Interface (GUI) capability effectively solve the problem of unreliable power supply. This GSM based remote control, supports the automatic control functionality and allows for effective energy management and monitoring which is achieved using GUI, PIC microcontroller, GSM module, Transistors, Relays, Light Emitting Diodes (LED) and Liquid Crystal Display (LCD).*

Keywords- *Microcontroller, Transistors, GSM module, Relays, Graphic User Interface, LED.*

I. INTRODUCTION

The poor state of power supply in developing countries, calls for automated alternative power sources to act as backup to the power supply from the national grid [1]. Over time, automation of electrical power supply has become so vital, as the rate of power outage becomes predominantly high. This inconsistency in power supply is not profitable for production processes in industries and it also retards national development.

With recent advancement in science and technology, it has become essential to integrate automation to every sphere of life. These include but not limited to industrial and domestic automation [2], [3].

One of the major areas in which automation has become necessary is in power supply to industries. This is because the need for continuous and reliable power supply to improve efficiency in the industrial sector cannot be over emphasized. This necessity is most desirable in developing countries, like Nigeria and many other African countries, where the mains power supply is very erratic and unreliable affecting industrial efficiency, productivity and hence economic development. When devices are completely taken over by the machines, the aspect of monitoring and reporting becomes more important [4]. To achieve monitoring, management and reporting, the entire switching process will be incorporated with P.C control. For effective P.C control, a Graphical User Interface (GUI) allows flexibility and ease in control of the changeover switch. This has several advantages over the completely automated change over switch, such as energy management and reduced billing [8].

II. DEVELOPMENT OF BLOCK DIAGRAM

The block diagram of the automatic changeover switch with graphic user interface is shown in Figure 1.0.

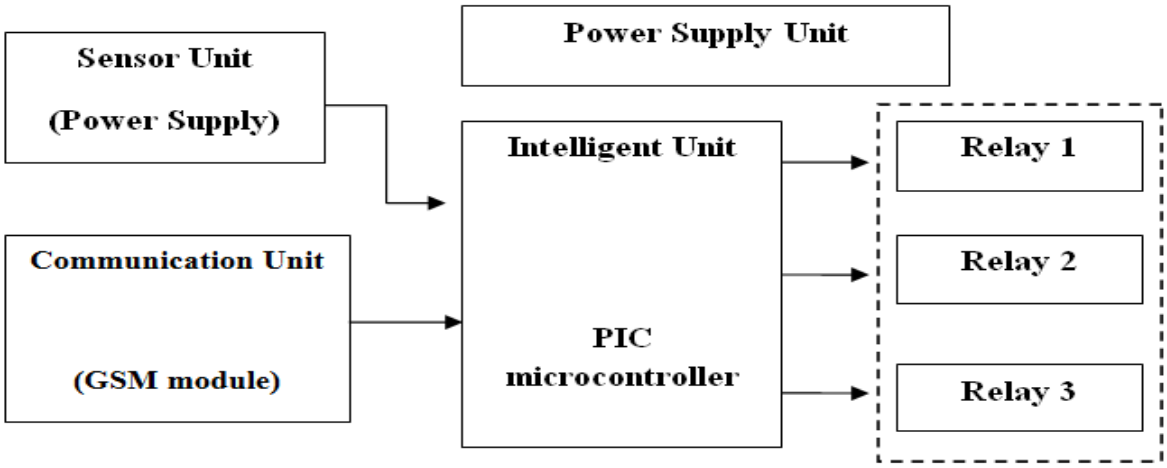

Figure 1: Block diagram of the transmitter

Figure 2: Block diagram of the receiver

Automatic Change-Over-Switch with GUI control incorporates a computer GUI, which serves as an interface for monitoring, control and management. It is a modification of the fully automatic Change-over switch and works just like the automatic change-over switch. Only that in this system, when the mains supply fails, there is also a provision for the signal to be sent directly to the switch mechanism, it signals the operator through the various indictors, such as the LEDs, LCD and buzzer. This gives the operator the option of switching to the generator or not, via the GUI. The GUI from the computer system can communicate with the switch to take appropriate action. The advantage of this system is basically in the monitoring, reliability and control of the system which brings about conservation and efficient use of energy.

III. RELIABILITY OF THE SYSTEM

Higher system reliability is usually aimed at during production, as every means to prevent breakdown before useful life is over, is implemented. Attention to this reliability –critical areas by introduction to redundancy and attention to maintainability during the design phase of new plant can lead to dramatic improvements in profitability during the component lifetime [5].
Various factors can influence the failure of automatic electrical components, like poor maintenance practice, operating environment, which becomes a vital element in the evaluation of likely reliability performance. In this case we are referring to temporary failure, due to some malfunction, and not damage of components.
The aspect of redundancy comes to play because of the chances of failure of purely automatic systems. An element is redundant if it contains backups to do its work, if it fails. A system is redundant if it contains redundant elements- this can mean having several elements/options that work simultaneously but are capable of carrying the load by themselves if required [6].
In this case the backup is the GSM control, initiated by GUI remotely. This will work efficiently only when proper feedback is developed. The GUI communication will incorporate feedback for efficient monitoring.
Some of factors that can cause a changeover switch to fail temporarily include:

1. Frequent failure or spikes in mains supplied power
2. Issues with electrical wiring
3. Change over duty cycles exceeded
4. Continuous excessive load [7]

Redundancy is indispensable to a world where technological risks must be closely regulated and where ‘reliability’ is construed as a variable that can be defined, calculated and designed [6].
Knowing that the change-over switch is controlled wirelessly via SMS, the GUI was used to send the SMS. The GUI IN Figure 3 displays the status of the change-over switch via a static text after reading SMS through serial communication from computer serial port. The block diagram in Figure 2 serves as the receiver that receives a response signal sent as SMS from the PIC microcontroller.

Figure 3: Graphic user interface of the system

IV. MATERIALS AND METHOD

A. PROPOSED SYSTEM DESIGN

The complete circuit diagram of the proposed system is given in Figure 4.

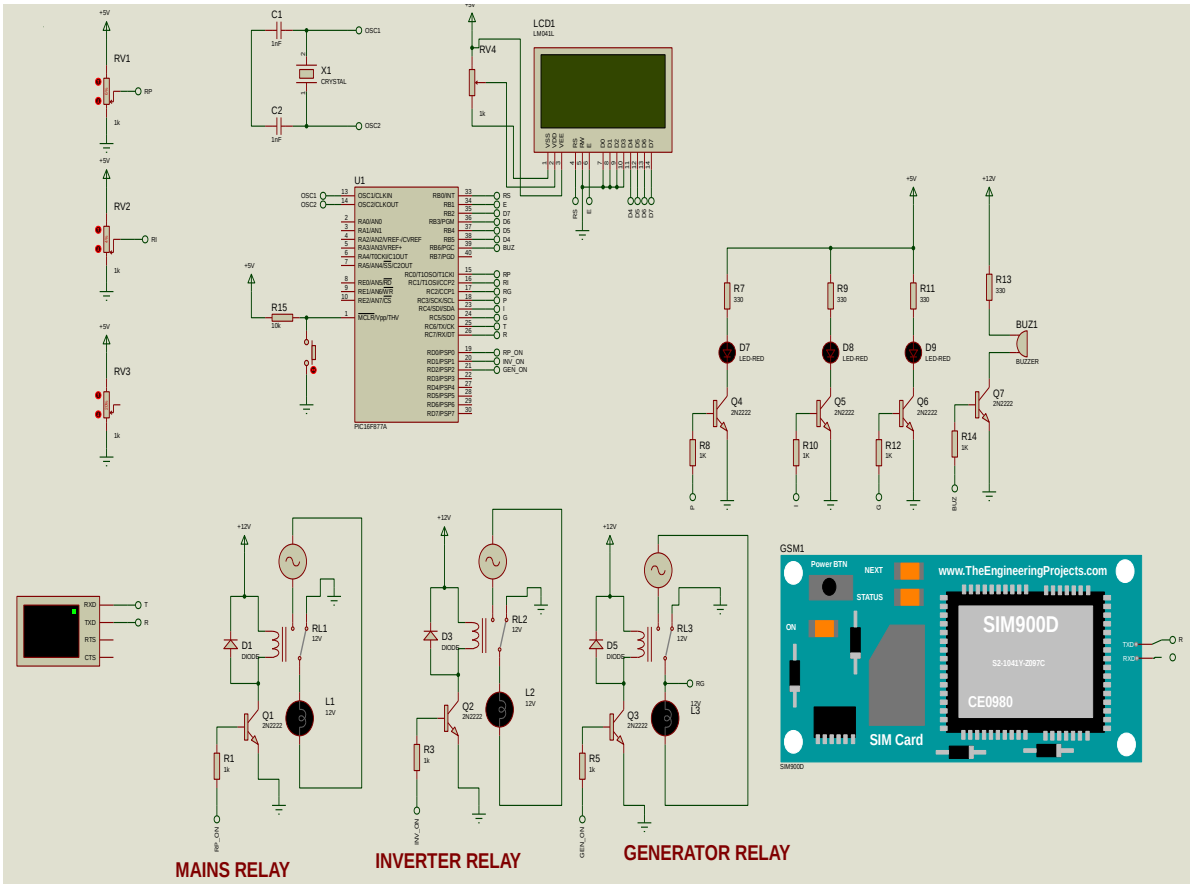

Figure 4: Circuit diagram of change-over switch

The changeover system discussed here switches between three sources of power and also take appropriate decisions. The switching can also be done remotely via a Graphic User Interface. The output voltages of the PIC at the output pins is an average of 0.6V, but due to the pull up resistors connected to ports C3, C4, C5, D1, D2 and D3 the voltage output becomes approximately 5V. The indicator LEDs and Relays are controlled through a transistor serving as switch. The LCD displays the status of the changeover switch, the LEDs serve as indicators for the power source in supply and the load LEDs indicates which relay is in operation. When the mains supply is available, the load is connected via RELAY 1, the red LED comes on and the buzzer beeps for four seconds, and finally the LCD displays “MAINS ON WORKING”. When the mains supply is out, the load is immediately connected to inverter via RELAY 2, only the blue LED indicates and the LCD outputs “INVERTER ON WORKING”. Immediately the inverter source is out, the load is automatically connected to the generator, which is indicated by the green LED and LCD displays “GENERATOR ON WORKING”. When the generator supply goes out, in the case of fault or a fuel shortage, the load is automatically connected back to inverter supply.

For the GUI control, the A6 GSM module sends SMS strings to the changeover switch which receives it with SIM 800L GSM module and responds back the status of the switch changer at every point it receives. This alternative switching of the changeover switch, using the GUI can be done from anywhere anytime. This alternative is relevant in case of a fault, or to conserve energy. If the switching is operated via GSM, the LCD indicates, by displaying “GSM CONTROL” at the second line. This method increases the efficiency of the device.

B. FIRMWARE DESIGN

The flowchart used for the development of the system’s firmware is shown in Figure 5. Upon application of power to the circuit, the program checks for the power source that is available and selects it in order of priority.

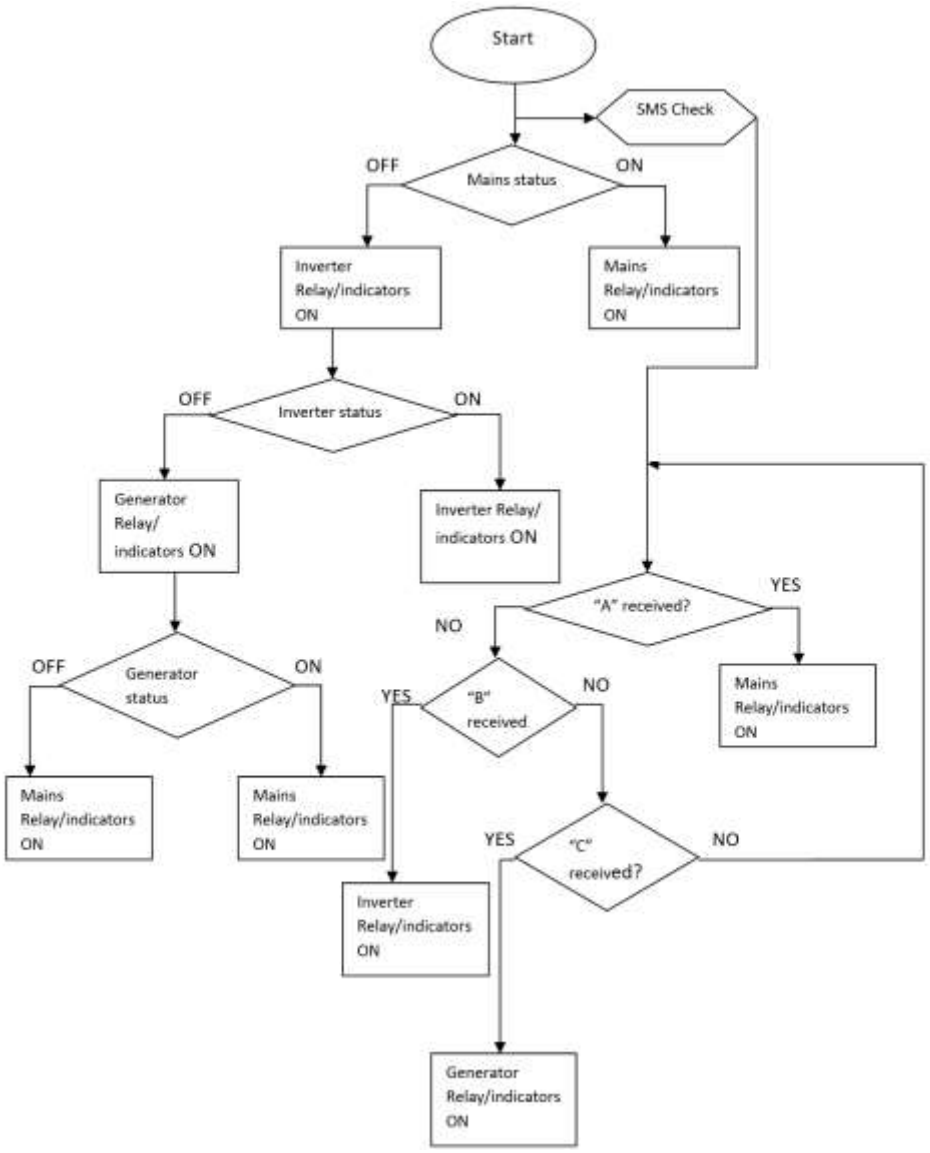

Figure 5: Flow chart of the switching operation

V. RESULTS AND DISCUSSION

This circuit was simulated using the Proteus professional environment. Each stage of the circuit implementation was first simulated on the Workbench before coupling of the next phase for possible fault detection and effective synchronism. Figure 6 shows the simulation where the power supply from Mains is used to drive the connected load; this is handled by PPS switching circuit. Figure 7 gives an illustration of the simulation process for inverter as energy source to the load; this is handled by inverter switching circuit as indicated. The generator switching unit handles switching to generator in the event of other sources being unavailable as given in Figure 8. The simulation results were accurate and successfully simulated in real time. The images below show the simulation results.

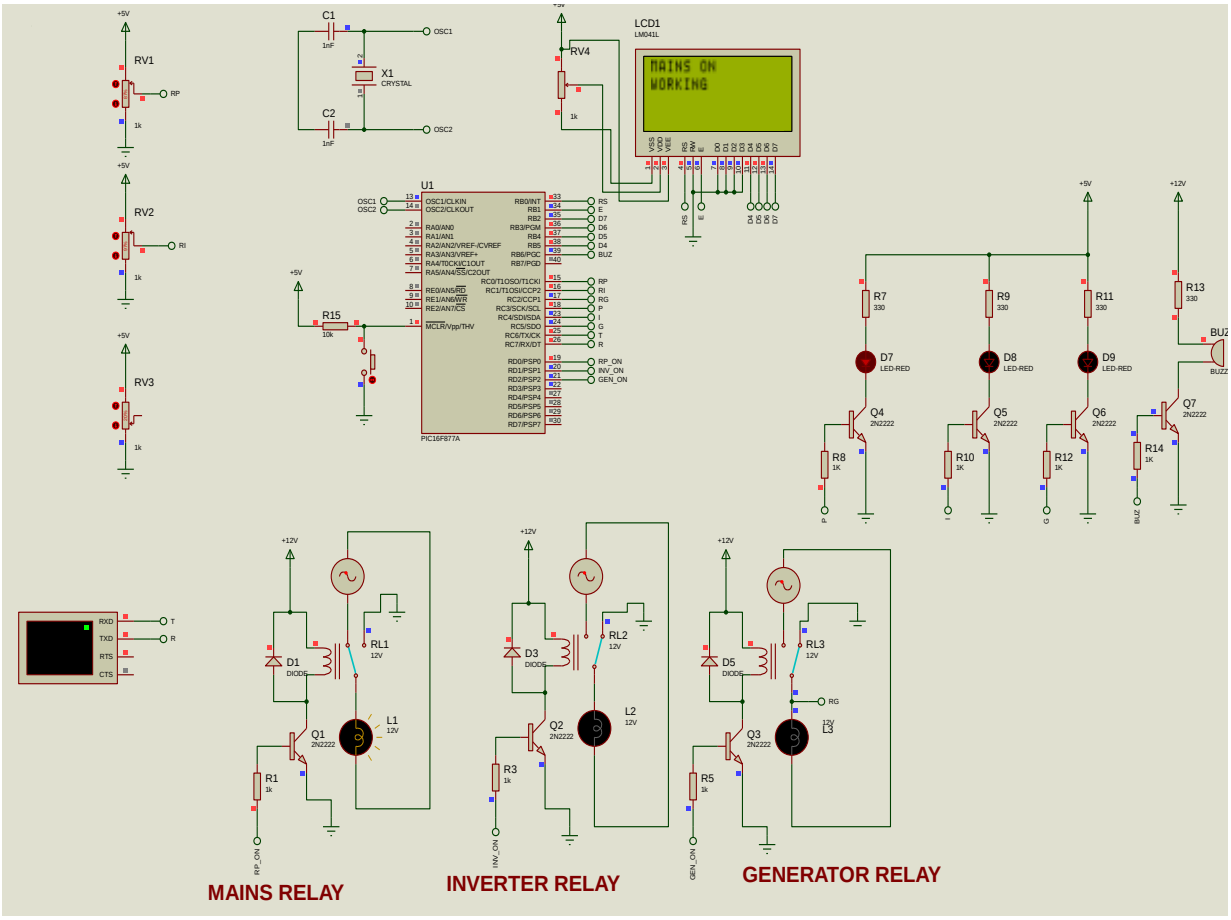

Figure 6: Proposed system showing mains as source of power supply to connected load.

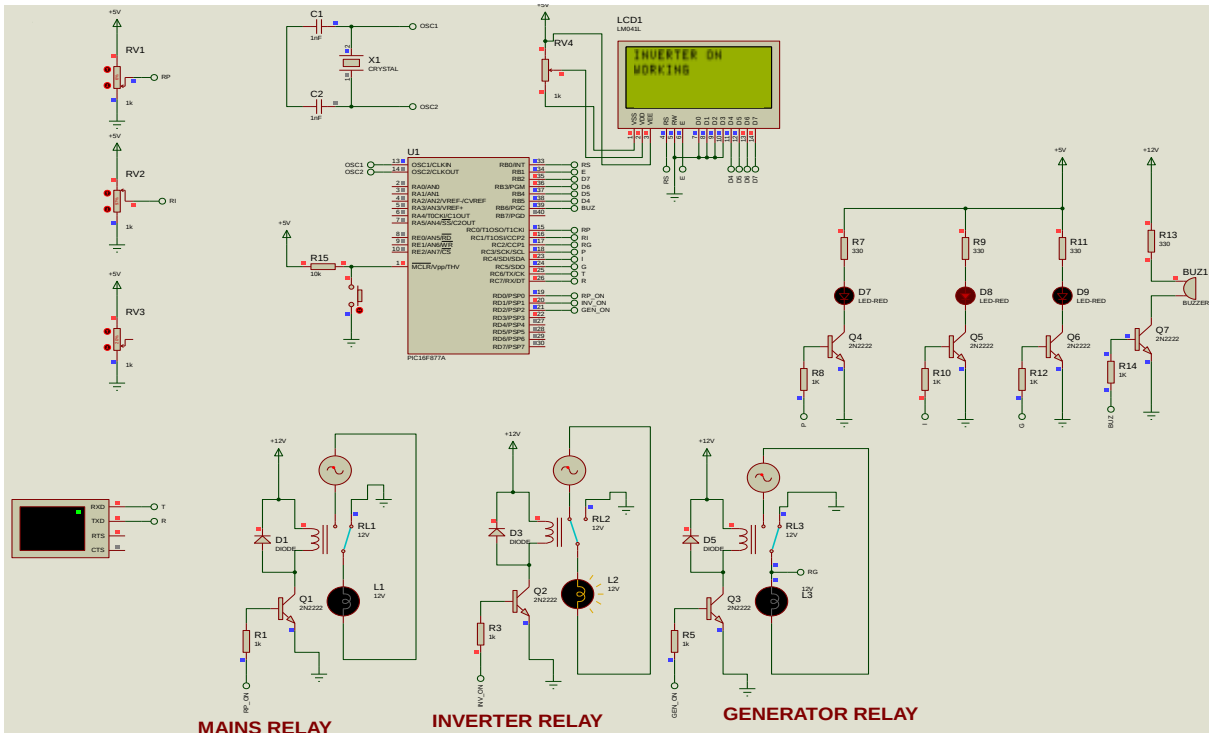

Figure 7: Proposed system showing Inverter as source of power supply to connected load.

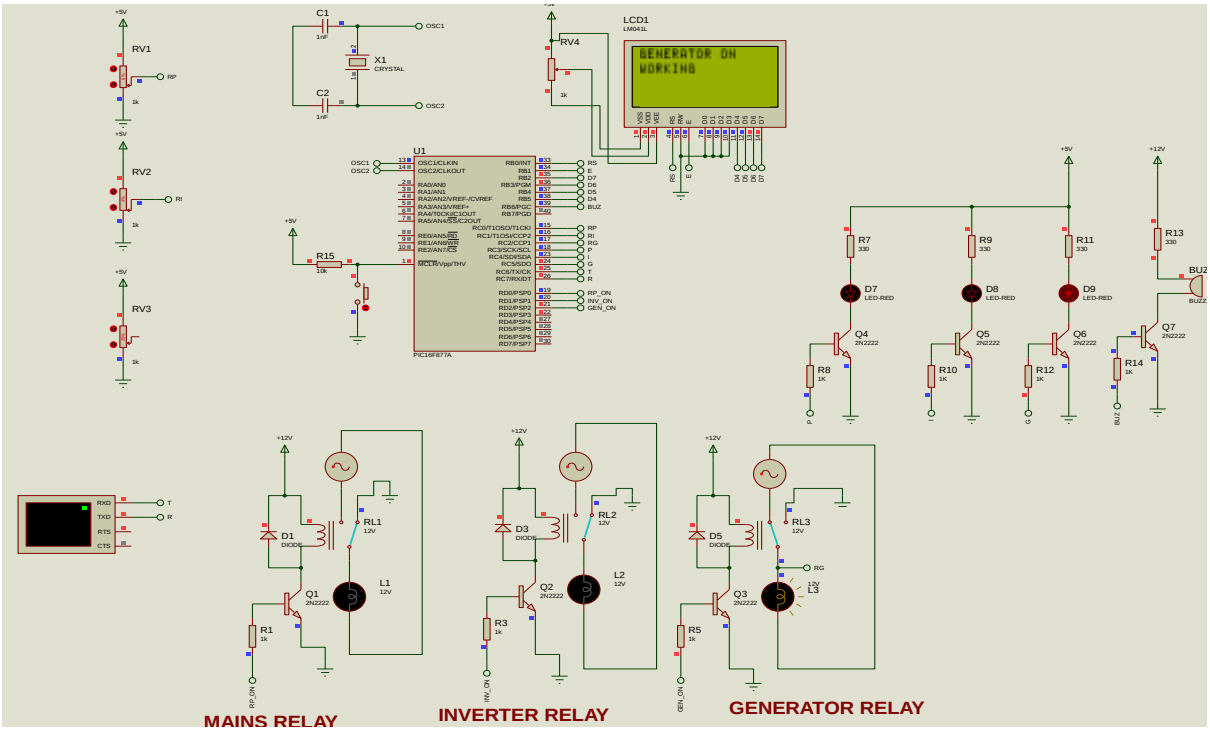

Figure 8: ***Proposed system showing generator status in real time.***

VI. CONCLUSION

The quest to have an effective, smart and automatic change-over-switch with the capacity to handle multiple energy sources that can ensure stable and uninterrupted power to homes and industries was realized from the proposed system. Three sources of power were considered - public power supply, inverter and backup power generator - at every instant, a particular source of energy is supplying power to the load, ensuring uninterrupted supply without the need for manual change-over as the change-over is done wirelessly with the help of the integrated GSM Module using the MATLAB GUI interface.

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