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DEVELOPMENT OF MICROCONTROLLER BASED AUTOMATIC POWER SWITCH WITH GENERATOR START AND STOP CONTROLS

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ABSTRACT

The erratic nature of power supply and use of generators as alternative source of electricity in the developing countries like Nigeria has necessitated the need for a mechanism that switches power to a given load between two sources of supply.. This study was therefore initiated to focus on the design and implementation of an automated system that executes switching functions usually from public supply to generator and vice versa when mains supply is unavailable and when it is restored. The device consists of power supply unit for converting from alternating current (A.C.) to direct current (D.C.), logic circuit for detecting when mains power is restored, relay unit for performing power switch as well as control unit for starting and stopping a generator. It was observed that the device eliminates the stress and possible downtime associated with manual operation of a change over switch. The study recommends the device to be essential in hospitals, banks, government and private agencies where critical operations requiring constant availability of power are carried out.

Keywords: *alternating current, display control, microcontroller, relay.*

INTRODUCTION

In Nigeria, there is wide gap between energy demand and supply as the power from the national grid is abysmally low and with ever increasing energy demand of Nigerians which is evolving at 7% annually (Adejumobi *et al.,* 2013), the Power companies which have been unbundled into Generation companies (Gencos), transmission companies (TCN) and distribution companies (Discos) are finding it difficult to generate, transmit and distribute adequate power in order to cope with the demand trend. Consequently, few hours of power is available daily for social and economic well-being of the teeming populace. In order to supplement daily conventional power supply, individuals, business organizations and educational institutions have resorteded to the utilization of alternative power sources such as inverters and generators. Inverters exist in various forms ranging from square waveform, modified sine waveform and pure sine waveform (Babarinde *et al.,* 2014). Unlike square and modified sine wave inverters whose output voltage are characterized by undesirable phenomenon known as harmonics which affects the reliability of connected devices (Adejumobi *et al.,* 2017), pure sine wave inverters generate A.C signals similar to that of conventional source (Raji, 2018).

However, in a bid to prevent loss of lives, stress of starting and turning off generators when public supply is switched off and on, as well as to reduce human error involved in the manual changeover from public supply to alternative sources in hospitals, industrial buildings, banks and other strategic places, the need becomes imperative to incorporate an automated system in the power supply network for the purpose of switching load between public supply and alternate sources.

The quest for automated systems that perform switching functions in supply system has spawned research findings in the literature including (Kolo, 2007), (Ahmed *et al.,* 2006) which developed a single phase change over switch using integrated circuits, transistors and relays. Ezema *et al*., (2013) designed and implemented a circuitry for turning on and off a 12KVA generator for the purpose of power switch to the available load while Ilomuanya *et al.,* (2016) on the other hand designed automatic changeover using artificial intelligence for switching between the available power. This study developed a microcontroller based automatic switching system that makes use of electromagnetic device (relay) for switching load between the mains and generator. The system a has facility for starting and turning off generators which is facilitated by PIC microcontroller which senses when mains supply is unavailable and when it is restored. It is interfaced with a digital display mechanism for showing the available power source and control circuitry which ensures that the generator starts and stops immediately the mains power is turned off and on.

MATERIALS AND METHODS

The block diagram used for the study is shown in Figure 1. The designed system which depicts the interconnection among various units of the system show the two sources of power termed Mains and Gen. (generator) supplies. The control circuit consists of microcontroller and other electronic components which start and stop the generator supply and whose controlled output is displayed. The power relay, switches power to either of the sources depending on the one available. The system is divided into three sections which include Power supply section, relay stage and generator control circuit.

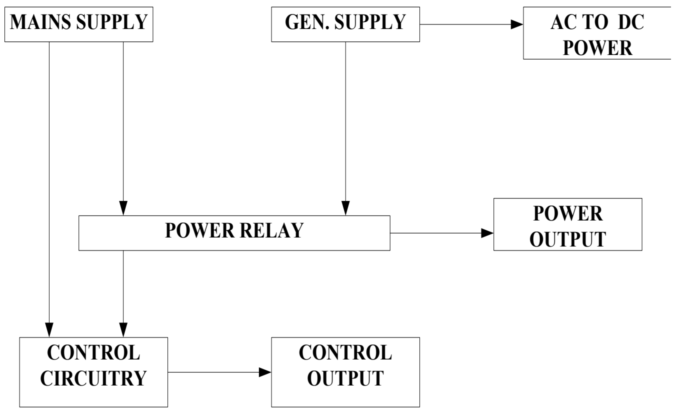

Figure 1: Block diagram of the system

Power Supply Stage

This stage converts A.C. signal into perfect D.C. signal. Figure 2 shows the power supply stage of the system. The step down transformer (T) in the figure steps down 220 A.C. voltage into 12V A.C. which is rectified into D.C. form using the bridge rectifier (D). The ratings of the transformer include, input voltage , output voltage , maximum output current , and power output requirement . The rectification process is achieved by using four diodes (1N4007), chosen because of high current carrying capacity, low voltage drop and ruggedness.

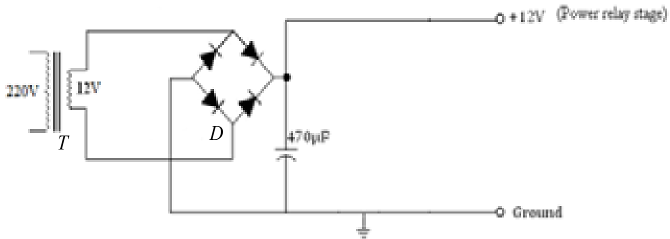

Figure 2: Power supply stage

A filtering capacitor is used to remove ripples present in the rectified output in order to have a perfect D.C. signal.

Power Relay Stage

This is the stage where the actual switches from public (mains) supply to generator and vice versa are effected. Figure 3 shows the circuit of the power relay stage which consists of a 120A relay that performs the switching functions, and energized by 12V D.C source.

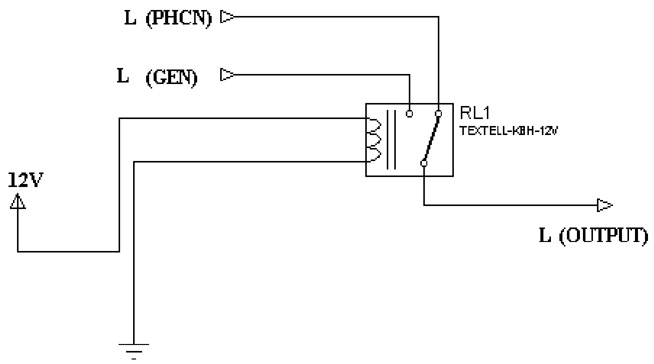

Figure 3: Power Relay stage

Generator Control circuit

This is the control section that performs functions involving the start and stop of generator, with the help of timer circuitry. It consists of PIC microcontroller, start and stop relays and other electronic components, powered by 5V D.C. source which is obtained by regulating the 12V source using 7805 voltage regulator. The PIC16F72 microcontroller used in this work is shown in Fig. 4 while Fig. 5 displays the circuit diagram of generator control circuit. The microcontroller has 28 pins when counted from left; the first pin is designated with a dot which is the master clear.

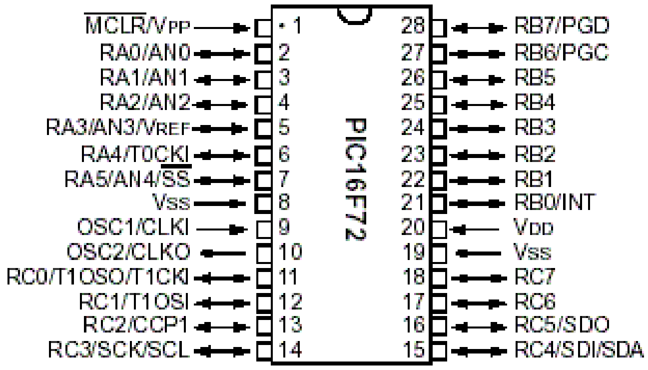

Figure 4: PIC16F72 Pin Configuration

Out of the 28 pins, 6 pins are used for connection on the control board while the other 22 pins are input/ output pins, used for timing and display functions. When the PIC microcontroller senses that mains power is unavailable, it sends signals by starting the generator. The start relay is energized and the load is connected to the generator. On the other hand, when public supply is available, the microcontroller sends signal that stops the generator and the stop relay is energized which connects the load to the public supply.

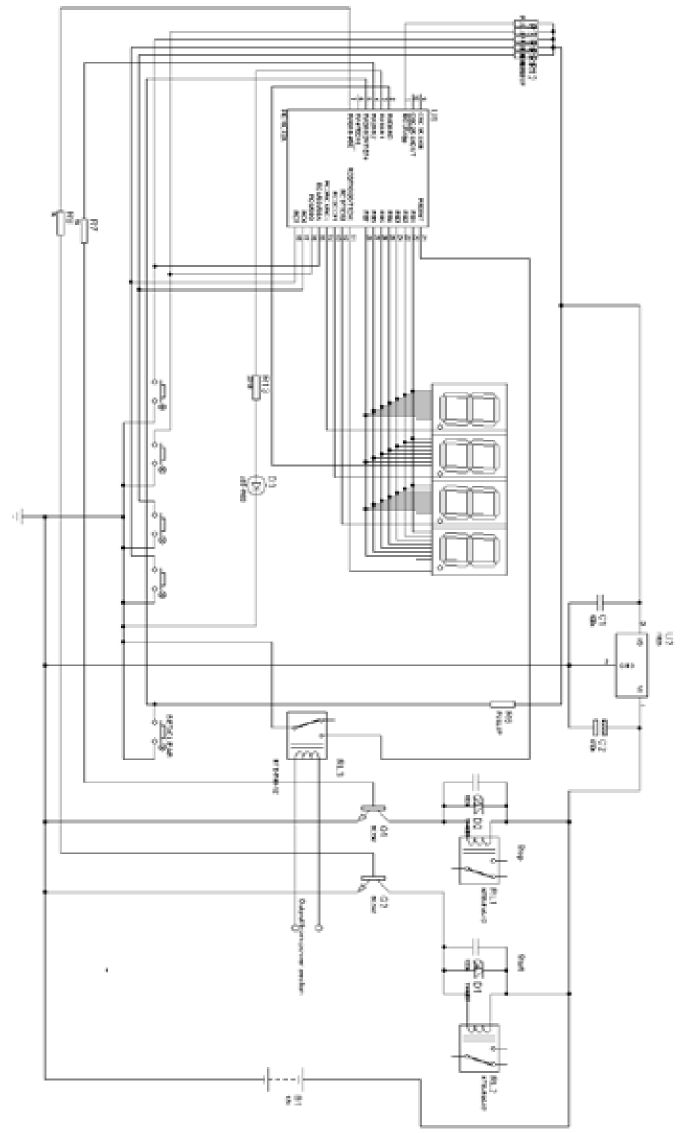

Figure 5: Generator control circuit

RESULTS AND DISCUSSION

Figures 6a and b show the automated system implemented based on the circuit diagrams depicted in Figs. 2, 3, and 5 respectively. While Figure 6a depicts the internal feature of the constructed device, Fig. 6 b shows the constructed device, enclosed in a PVC container. The PVC container is an adaptable, durable box used by designers to house electronic circuits.

(a)

(b)

Figure 6: Constructed device, (a) internal feature of the constructed device (b) Automated system enclosed in a container.

At each stage of design implementation, a digital multi-meter was used to check whether those stages were fed with the required voltage and which showed that the output voltage of the transformer was 12V, output voltage of voltage regulator, and frequency were 5V and 50Hz, respectively. Other tests carried out on the system included, relay switching test, automatic generator start/stop test. These tests all gave satisfactory results which revealed that, when the power supply was unavailable, the automated system quickly switched the load to the generator and when power supply was restored, the load was disconnected from the mains source to the generator.

CONCLUSION

A Microcontroller based automated system was developed which switches power between mains supply and alternative power sources. The device eradicates stress, downtime and possible human error that may result in financial loss in production system, when manual switching system is used. It ensures constant supply of power in hospitals and contributes in no small measure in preventing loss of life that may result from power failure at a time when critical activities like surgical operations are carried out. Further research work should focus on designing a circuitry that will incorporate as part of its system an overload protection system.

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