TIMBOU-AFRICA PUBLICATION INTERNATIONAL JOURNAL DECEMBER, 2023 EDITIONS.

INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH AND TECHNOLOGY
VOL. 2 NO. 2 E-ISSN 3027-1770 P-ISSN 3027-1991

DESIGN AND CONSTRUCTION OF A SELF-OPERATED SAFETY SWITCH

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ABSTRACT
The design and construction of an automatic change-over from public utility supply to private and vice-versa was aimed at providing a useful system for use in homes, offices, or industries. The system was achieved with a veroboard,1000μf (microfarads), 2-capacitor, 5-diodes, 3 relays, jump wire, transformer, bulb, lamp holder. The system turns on a generator when the public utility (PHCN) is off by cranking when the

Introduction

Since the emergency of electrical and electronic devices, a lot of measures and effort have been put in place to simplify the operation of these devices from complex to simple pulling of levers, pushing of buttons or pressing of switches to operate them.

In early stage of electrical development, heavy metal gears are used for switching purposes and their operations are limited to trained personnel because it involves complex gear combinations. As time went by, levers and switches started replacing heavy gears. Yet their operations were still limited to trained personnel.

In this dispensation, engineers have been able to put in place an easier to-operate switches to replace those complex gears and switching systems, and these new devices can be operated by almost everybody (Theraja, et al, 2002).

This project, "Automatic Changeover Switch" as a switching device focuses on the easiest way to switch-over [change-over] from private power supply to public power supply with zero effort from operators. It works in such a way that when there is power supply from public grid; it automatically changes over from generator set to public supply (Agusiobo, 2006).

generator is fully started. A delay was provided to stop the generator microseconds after the PHCN is restored to avoid unnecessary off and on. A display that shows when PHCN or GEN. is son was provided.

Keywords: GEN, CHANGE-OVER, switching-unit, NEPA, PHCN.

There is increase in the demand in the industries, residential homes, hospital and many more for change of power supply switch for effective and continuity of power supply without a notice in interruption or delay in such process to any alternative supply if the main supply goes off (Thomas, 2007). The installation of manually operated change-over is not the best option in homes, offices, factories or industries. In factories for instance, the time interval of manually changing over to public power supply represents improper time management compare to the automatic switching of automatic change-over which happens within a second. It equally delays work.

Using automatic change-over will solve the problem of time management and delay, because there will not be the need to shut down systems because the switching will be done in microseconds (μs).

However, while the demand for the automatic changeover switch is high, the cost of the unit is equally very high. This brings the need to produce cheaper and affordable change-over switch.

This "Automatic Changeover Switch" will achieve the following automatic actions:

a) To change public power to generator
b) To change back to public supply

This particular type of changeover cannot be used to switch off generator, it only changes over.

History of Changeover

Manual switching has been in existence even before the dominance of electronics. The importance of switches cannot be over-emphasized, they are so important that they are used in virtually all electrical/electronic appliances, even in homes, offices etc. switches are seen everywhere. They are used to "make" or break circuit (Kolo, 2007).

Change-over, as a form of switch is used in our homes, offices, factories, schools etc. to change from public power supply to private supply and vice versa.

Manually operated change-over, though easy to operate can be very disturbing and time wasting. Imagine someone who is very busy in the kitchen or bathroom or even doing laundry with private power supply and the public power supply was restored, going to change over will be difficult, but fuel must be saved. Even in the hospital, in the theatre if there is any electrical interruption life would be lost.

This project AUTOMATIC CHANGEOVER was born out of the need to save us some time and energy and reduce the inconveniences caused by manual change-overs. This work automatically changes from the generator back to public power supply in case of power restoration. Even when the generator is switched off, you have no business with the changeover because the system will take care of it (Horowitz, et al, 1995).

In comparison, manual change-overs, just like its name are manually operated, that is, they have to be changed manually when there is public power supply. Unlike the manual change-over, the automatic change over changes automatically on its own from private power supply to public power supply on its own (Peter, 2002).

Component Description

Relay

Relays are electromagnetic device with mechanical operation that makes or breaks circuit continuity via its contact. Relays are switches with mechanical contacts; it can also be referred to as contact switch. See fig. 1

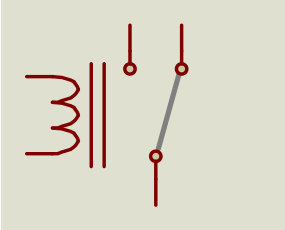

Fig 1 Circuit Symbol of Relay

Diode

Fig 2 shows the symbol of a Diode. Diode is a semi-conductor material, as a PN Junction, it behaves as a switch, when forward biased, it acts as a closed switch but when reverse biased acts as an open switch. It is usually made with silicon or germanium. In this project it is used to form a bridge rectifier which converts AC to DC.

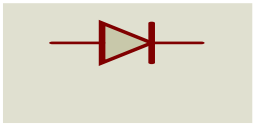

Fig 2 DIODE

Capacitor

Capacitors are devices that temporally stores electric charges. They accept or return this change in other to maintain a constant voltage. They are designed with two inductors separated by an insulator called di-electric. The capacitor functions as a filter to "smooth" out or filter unwanted signal or pulsating signal. Capacitor have two main types, namely; variable and fixed with a large number of different kinds (Kolo 2007). Fig 3a&b for both Fixed and Variable capacitors.

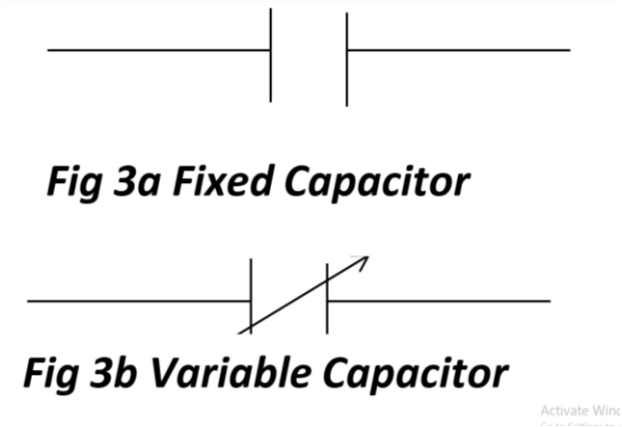

Fig 3a Fixed Capacitor

Fig 3b Variable Capacitor

Transformer

Transformer is a static electromagnetic device that is used to change power from one voltage level to another. It operates by the principle of electromagnetic induction. It is used to step up or step-down voltage or current. It is divided into primary or secondary winding. In transformer, the windings/coils are physically separated but electromagnetically connected. For this project, step down transformer is used to step down the voltage to 12v DC.

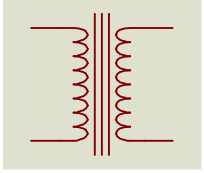

Fig 4 Symbol of a Transformer

LED

Light Emitting Diode is a form of diode that emits light rays when forward biased. In this project, it is used as an indicator to indicate when there is supply from any of the lines.

Connectors

This is used for flexibility of the overall design. It is for connecting to the line-out of this project.

Advantages and Disadvantages of Automatic Change-Over Switch

Advantages:

1) It maintains high quality of service through its fast and prompt response
2) It reduces change-over time to a minimum due to its fast response to power restoration.
3) It minimizes damages to lives and equipment since it has its own monitoring system and its switching requires no human contact with the switch, thus eliminating human error.
4) Free of maintenance.

Disadvantages:

1) May occasionally respond to false signals.
2) It usually costs more than a manual model (http://www.nema.org/engineering/icsstandards.html).
3) This change over cannot be used to switch off generator, it only changes over.

METHODOLOGY

The major aim of this work is to develop a change over switch that can automatically switch between grid supply and generator supply on its own without human interference.

This chapter however comprises of the entire operation of the device, components involved, its units, principles of operation and how you can construct a similar device.

MATERIALS AND METHOD

All the materials required for the design and construction of automatic changeover switch will be purchased at Onitsha head bridge market. They include;

- Transformers
- Diodes
- Relay
- Capacitors
- Vero board
- Jump wire
- L.E.D

- Connector
- Bulb
- Lamp holder
- Pasfet and Pastress(for the casing)

The traditional development methodology was used for the execution of this project and the top-down design approach was adopted for both hardware and software developments. This method comprises of:

- Research and study
- Planning
- Designing
- Implementation
- Testing
- Improvement

HARDWARE INTERFACE MODULE

The hardware of this design comprises of the entire component put together to achieve this design. In this design, several components were put together. However, this section deals with the explanation of this hardware its various components and its hardware unit analysis.

The hardware aspect of this device comprises of the components used and the various connections of the components to form the device. In this design however various electronic components were put together to build a complete system. The various stages play a very significant role in the proper function of the system; in fact, any affected or malfunctioning part would have a drastic influence on the proper function of the device.

The hardware implementation also deals with drawing the schematic on the plane paper according to the application, testing the schematic design over the breadboard using the various ICs to find if the design meets the objective of the design. Fig 5 shows the block diagram of the power supply unit of the designed system.

This device can be categorized into the various units:

- POWER INPUT UNIT
- SWITCHING UNIT
- OUTPUT UNIT

Fig 5: Block diagram of the circuit

POWER SUPPLY UNIT

The A.C voltage, 230v was connected to a transformer which steps down the A.C voltage to the level of the desired D.C output. This unit has two transformers. The first transformer primary coil was connected to the first phase so that when there was current in that phase, the transformer was energized and will trigger the relay connected to it. But when there was no current in the first phase but there was in the second phase, the second transformer conducted and triggered its relay. The output of each of the transformers were being rectified with a bridge rectifier to provide a full-wave rectified voltage that was filtered by a capacitor to remove A.C impurities and produce D.C voltage. This D.C voltage is what is supplied to other components of this device to perform the appropriate function

SWITCHING UNIT

This is the unit that switches between the phases supplied by the line transformer which there is current at every given time and if no current is coming from the line transformer, switches to the generator sector so that you can supply your appliance with any power available at the time.

This unit has three relays to enable it switch properly. These relays were connected to the transformers output so that each relay can switch when each of the transformers conduct so that the output can be taken from the available power supply at the time.

OUTPUT UNIT

This is the unit through which output is taken from the changeover. The output comes from the common terminal of the relay used in the device. This terminal is connected to the building through a connector that will be fixed on the device packaging.

WORKING PRINCIPLE

The main purpose of the project work is to develop a device that will automatically switch between the two power supplies that comes into the house. The major supplies are the NEPA supply and generator supply. The major component that does the switching is the relay. It also determines the maximum load that can be drawn from the changeover. The common terminal of the relay was connected to the output, the normally open connected to NEPA supply and normally closed connected to GEN supply. The power to trigger the relay was connected to the NEPA supply. Whenever there is supply

from the NEPA source, the relay will be triggered to switch to the normally open, making the NEPA source to supply to the output. But whenever there is no supply for the NEPA source, the relay switches to GEN source making the GEN source to supply to the output.

THE PROJECT CIRCUIT DIAGRA

The fig 6 shows the complete circuit diagram of the of the automatic change over. It contains all the stated components that has been discussed.

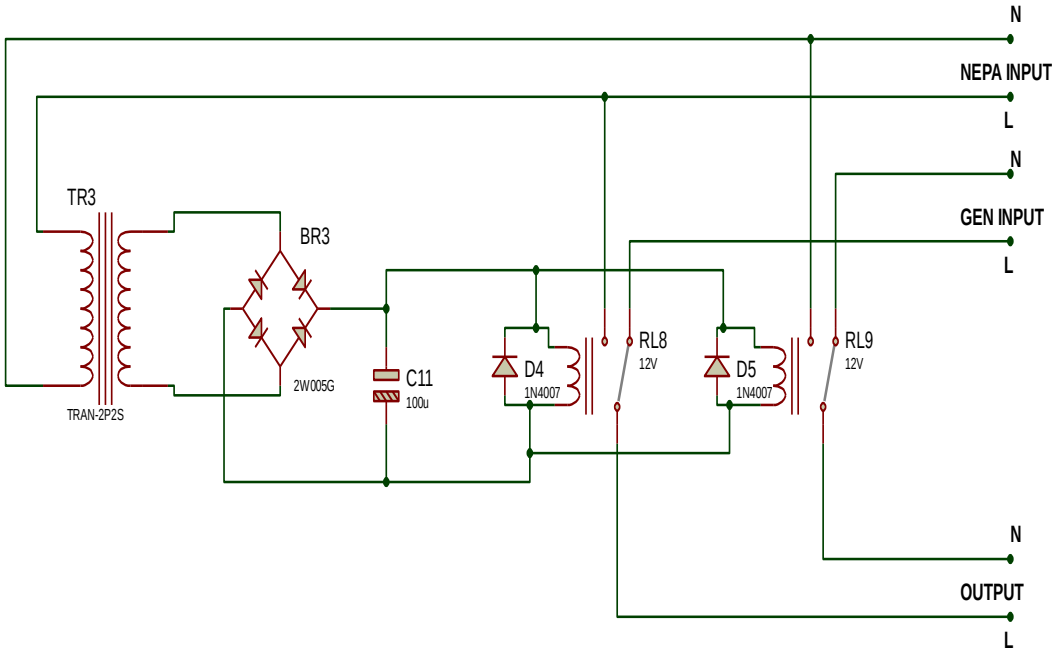

Fig 6 Circuit Diagram of the device.

RESULT AND DISCUSSION

As stated in the sections 1 and 2, this device is meant to switch between the three phase of general power supply line and the generator line. This section however, emphasis on the various tests carried out and the corresponding results obtained. The test was to determine the particular supply line that supplies to the load output whenever there is change or variation in the supplies of the national supply line.

EXPERIMENTAL SETUP

After the development of the device, it was tested to ascertain its functionality. A picture of the functional device is shown below.

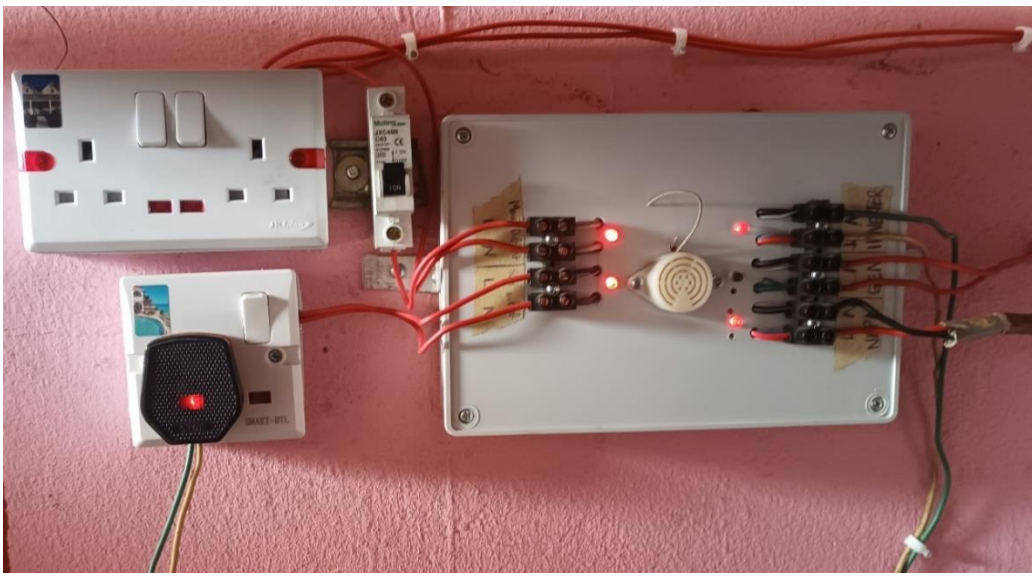

Fig 7 the Designed System been Tested

The device has a connector well label as you can see the diagram above. Through these connectors is where different supply will be connected to the device.

RESULT

When there is supply from each source, the indicator for that source is turned ON to show their power supply coming from the source. The output is connected through a circuit breaker to the appliances. Once there is supply at the grid source, the device switched to it indicating there is supply at the output through the output indicator. Fig 8 shows the connected system undergoing an ore test.

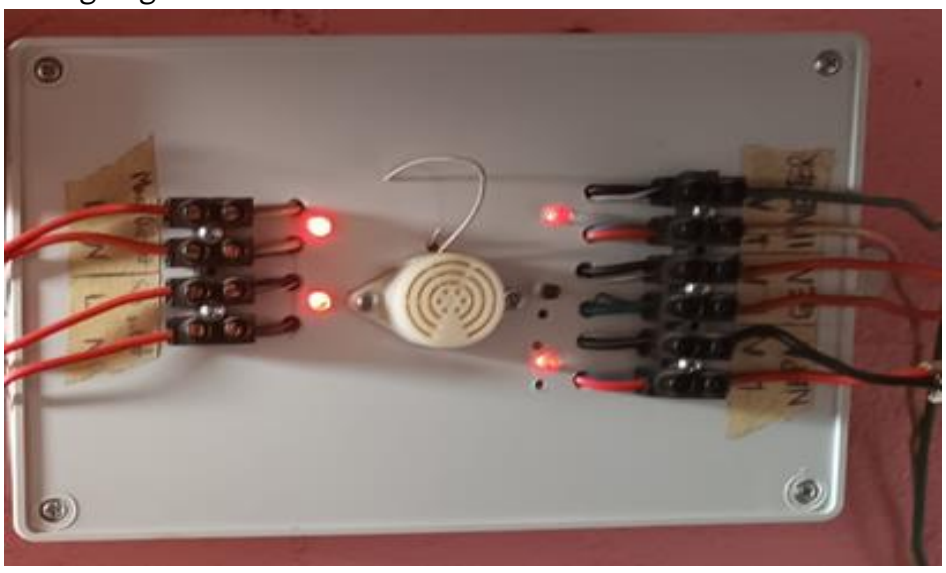

Fig 8 The designed system

DISCUSSION

The device performed excellently with a 90% efficiency. From the test carried out, it performed as designed.

CONCLUSION AND RECOMMENDATION

FINDINGS

From researches carried out so far showed that there has been a tremendous change in technology which has brought about a lot of changes in human life and security. Many new inventions have been developed to make man's activities very easier.

The self-operated changeover switch is more suitable for industries where power interruption can cause great malfunction to production. this will help the machines to keep running even when there is power restoration because the switching is done in milli seconds.

The device can also be built with contactors which is more specific for high load and industrial machines.

CONTRIBUTION TO KNOWLEDGE

Working with this device helps to understand relay logics. This is the use or relay circuits in switching and automation. The device analyzed the following things

i. Relay and its functionality. The electromagnetic principle a relay uses to switch ON/OFF. Using DC power that powers the coils of the relay to switch AC powers.
ii. The electrical isolation in the relay between to trigger power and the switching power.
iii. Relay logic. The proper use of relay for switching and automation.

FURTHER STUDIES

This device can further be improved by developing changeovers more suitable for industrial loads using contactors. From the research carried out, contactor is more suitable for high inductive load. The device can also be improved to have an inbuilt phase select to select between the different phases of the supply before changing over.

CONCLUSION

This device will be very suitable to be used in our homes, offices and industries to minimize the power issues cause by unplanned power outage.

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