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Performance Assessment of Automatic Changeover Switch for 3.5 kVA Inverter

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Abstract

Power instability in developing countries has led to a growing demand for alternative power sources to supplement utility supplies. In this study, an automatic changeover switch for a 3.5KVA inverter was developed, allowing seamless switching between mains supply and inverter supply. The system comprises a mains supply, inverter supply, transducer, transformer, rectifier, relay, and load, utilizing a 12V, 500mA, 50Hz transformer along with a bridge rectifier, capacitor, and relays. The research findings confirmed that the design met most specifications, with a minor timing discrepancy of 0.02ms in switching between the mains and inverter supplies. Overall, the performance of the developed changeover switch was satisfactory and is deemed suitable for use with a 3.5 kVA inverter.

Keywords: Inverter; Diode; Relay; changeover

1.0 INTRODUCTION

In modern control systems, electronic intelligence controls some physical process. However, control systems are based on automations which use automation pilot and automation washer. The machine itself makes the routine decisions, while the human operator is forced to do other things [1]. In many cases, machine intelligence is better than direct human control because it can react faster or slower more precisely and maintain an accurate lot of the system's performance [2]. Thereja and Thereja [3] postulated that the switching transistor switches, the relay, which select between the generators as a switch operated in class A mode can be switched on when the flip-flop is in set mode. Thereja and Thereja [3] proposed that the switching transistor activates the relay, which selects between the generators, allowing the switch to operate in class A mode. This relay can be turned on when the flip-flop is in the set position. Also, in the work of Agbetuyi et al [4], Dagar et al. [5] and Anwar et al. [6] reported on automatic changeover switch of a generator and ac mains. The authors revealed that an automatic changeover switch consists of microcontroller. It was also revealed that integrated circuit which has been already configured with transformer, diode, resistor and transistor to achieve. This change over switch box separates the generator and public supply, when there is power supply outage from the mains, the changeover switch has to switch over to generator without human intervention. Also, it changes by itself thereby switching off the generator and vice versa. Additionally, Ahmed [7], reported on how to overcome a power failure on a system automatically. The authors explained the need

for an automatic change-over switch in the case of power failure. Also, Khan [8], designed and constructed an automatic changeover switch, which involves automatic changeover between the main power supply and an auxiliary power supply. The author developed an automatic switching or starting off the power generator whenever the mains power fails. In addition, Andrew et al. [9] used mechanical comparators, D flip-flops, logic gates, 555 timers and relays to construct an automatic change over switch. But mechanical comparator has got more moving part than other types. Due to more moving parts, the friction is more and ultimately the accuracy is less. But electrical comparators have got small number of moving parts. Also, the limitation of D flip flop has one data input and a clock input only.

Additionally, the primary function of the automatic changeover switch is to ensure a stable power supply through mechanisms that automatically switch to the inverter [10]. In the event of a power failure from the utility, the system disconnects the inverter and reverts to the mains supply when it becomes available. The system incorporates an electronic control circuit that includes a relay, capacitor, diode, and transformer [11]. This forms the foundation for this study. Therefore, this study implements an automatic switching or starting up the inverter whenever the main power fails. The circuit used consists of logical control units and relay switches. The automatic changeover switch allows switching from a primary power source to a secondary power source. The changeover switch is employed where emergency power is required to back up power from the utility source. The changeover switch is supposed to allow the safe switching. In addition, the study seeks to provide a smooth changeover between two sources of power supply and to solve most problems associated with manual changeover as stated above. The system uses an electronic control circuit involving integrated circuits, relay, transistor, capacitor diode, resistor and electromechanical device. An integrated circuit is use to achieve the timing abilities and relay to effect switching. In the rest of the study, four sections are presented, section 2 provides the materials and methods, section 3, results and discussion, and section 4 remains the conclusion

2.0 MATERIALS AND METHODS

2.1 Materials

The materials utilized for this study include; Diode (12V, 1N4006), Transformer (240/12V 300MA 50Hz) Relay (12Vdc) Capacitor (998.5μF). These materials were locally sourced from a commercial shop in Maiduguri-Nigeria.

2.2 Methods

This study was achieved by drawing a block diagram of automatic changeover switch, designing and calculation of automatic changeover switch of an inverter, study the components of automatic changeover switch, in related to 3.5kva inverter and constructing an automatic changeover switch, in related to 3.5kva inverter. As specified by Orjiewulu et al. [12], a transformer of capacity, 220V/12V 50Hz was selected

2.2.1 System Block Diagram

The block diagram of the system presented in Figure 1 is made up of seven blocks namely; mains supply, DC supply (battery), transducer, transformer, rectifier, relay, and the load.

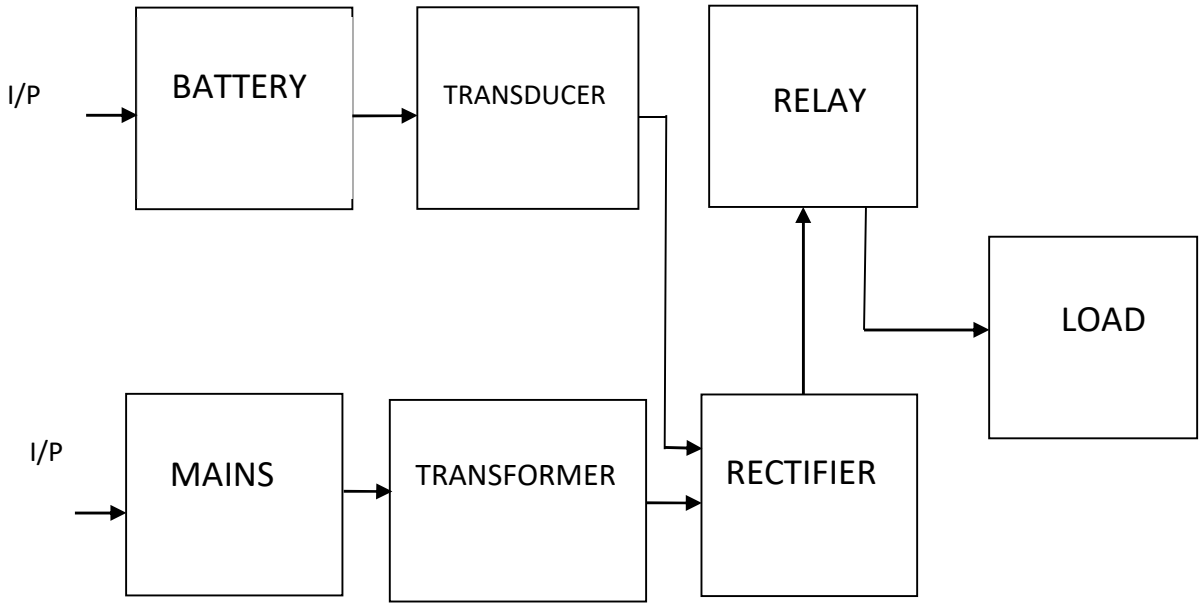


Figure 1: Block Diagram of Automatic Changeover Switch

2.2.2 Design analysis

a. The Diode

The current at the output of transformer is 500mA. Hence, as recommended by Orjiewulu et al. [12], the diode 1N4007 which can withstand the current 500mA was selected from standard table.

b. Relay selection

In this study, an electromagnetic relay was selected in preference to other relay due to its availability and market cost. It enhances electrical isolation between the control circuit and the high-power circuit, ensuring safety and preventing interference. Additionally, it offers high reliability and a long operational life. The relay selected was 12V DC coil voltage. Ehiabhili et al. [11] revealed that the contact can withstand continuous current flow of 15A since the output current of the inverter source is 15A. Hence, load current (IL) and switching time was calculated using Eqn. 1 and 2 respectively

Selected Coil voltage 12V

Output power = 3500VA

Voltage = 220V

$I_L = \frac{3500}{220} = 15A$ (1)

Switching time

F = 50 Hz

$$T = \frac{1}{50} = 0.02 \text{ mins} \quad (2)$$

2.2.3 Operation of the circuit

Automatic change over circuit was installed to switched between the mains supply and inverter supply which is built upon 12V, 500mA 50Hz transformer, a bridge rectifier, capacitor and relays. The rectifier rectifies the 12V AC output of the transformer to 12V DC to energize the relay coil. In addition, the inverter source is connected to the normally close contact of relay while the mains source is connected to the normally open contact of the same relay to ensure that when the 12V DC from the rectifier energies the relay coil, the normally close contact will open while the normally open will close to give AC at the output

In addition, the oscillator switched is connected to the normally close contact of relay and the charge indicator is connected to the normally open contact of relay so that when the 12V DC from rectifier energizes the coil of relay, normally close contact will open and normally open contact will close to indicate battery is charging.

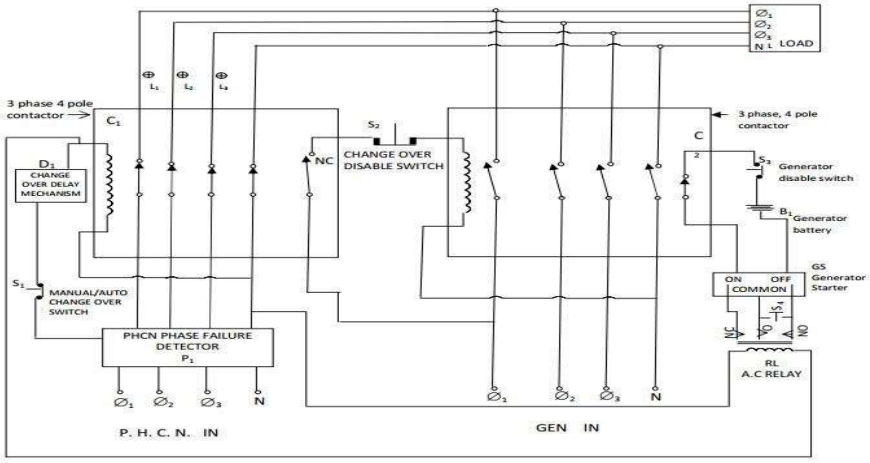


Figure 2: Circuit diagram

3.0 RESULTS AND DISCUSSION

3.1 Experimental Results

The results obtained from testing the automatic changeover switch are presented in Table 1-4. In any properly designed system, the result obtained is often close agreement with the performance of the system in particular. But in most cases, such expectation might not hold due to some practical assumptions and approximations of component values. It has always been very difficult to obtain an ideal result. This is because of the inherent problems that are associated with component manufacturing and approximations made in design procedures.

In this study, the constructed circuit was tested and found to confirm the design consideration, except for the slight differences in the timing of 0.02m when switched between the main supply and the inverter supply

Table 1: Test Result for Rectifier

N/S	INPUT	OUTPUT
1	12Vac	12Vdc

Table 2: Test Result for Transformer

N/S	INPUT	OUTPUT
1	220V	12V

Table 3: Test Result for Relay

S/N	Items	Voltage
1	Coil	12Vdc
2	NO	220V
3	NC	220V
4	COM	220V

Table 4: The test results for switching period

S/N	TEST	DURATION
1	Switching	0.02ms

4. CONCLUSION

The design of the automatic changeover switch was implemented and observed to work within the design specifications, though with some slight deviations. This idea of designing the module is of great significance due to the erratic nature of our power supply and has proved that simple equipment and systems could be conceived, designed and fabricated locally, thereby reducing the effect of importation from foreign countries.

However, the successful implementation of the automatic changeover switch not only addresses immediate power supply issues but also promotes local innovation and manufacturing. This initiative underscores the potential for developing countries like Nigeria to create sustainable solutions tailored to their unique challenges while reducing dependency on external sources.

Conflict of Interest

The authors have no known personal conflicts of interest.

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