Novelty Journals

ISSN 2394-9678

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 9, Issue 1, pp: (32-38), Month: September 2021 - August 2022, Available at: www.noveltyjournals.com

Design and Development of Seamless Automatic Changeover

[1]Nwosu A. W., [2]Obinwa C. C., [3]Madubuike J.

National Engineering Design Development Institute (NEDDI), Nnewi, National Agency for Science and Engineering Infrastructure (NASENI), the Presidency, Abuja, Nigeria.

DOI: https://doi.org/10.5281/zenodo.6882559

Published Date: 22-July-2022

Abstract: **Power is a key driver of economy. As much as it needed for used, it is also important that power is well utilized to avoid wastage which may incur extra cost of generation. Power failure or outage in general does not promote development to public and private sector. The field of invention is in the area of electromagnetic operations, where an electric current is induced into relays coils, actuating the relays in order to connect the terminals of the load to the available power supply. The switching system selects the available power source without the intervention of the user; hence, ensuring the availability of supply at all times provided that at least one power source is available. The change from one source to another could only be achieved by a device or a system that determines when the change should actually take place and which source is to be given preference to supply the load. Preference would be given to the power sources such that only one source supplies the load at a time and when the (first utilities) source fail, the link immediately connects the (second utilities) source to the load. When the (second utilities) source fails, the link immediately connects the generator to the load. The Automatic changeover device, is designed to switch contact terminals with little no noise within milliseconds, in order to avoid shooting down of any home or industrial appliances or equipment connected to it. The invention switches the load from one power source to the other seamlessly. Meanwhile, with no delay, while the load is connected to a running generator, as soon as mains is restored, it automatically performs the seamlessly changeover activity and at the same time turns of the generator. Three (3) relays were connected to the phases independently in which only one (1) will be active at a time. This system protects the loads to be connected from under voltage power supply which can in-turn cause damages to the loads. Also a voltmeter and an ammeter were connected to the load terminals to display the voltage output and current consumptions. Also, two (2) switches in which one serve the mains and the other serves the generator. They are connected to actuate the Solid-State Contactors used for switching the Load terminators to active power. When any of them is turned OFF, it renders the supply of the power source inactive even when its available.**

Keywords: **Power, Mains, Generator, Changeover, Automatic.**

I. INTRODUCTION

The changeover system is an active and pivotal system. When there is a mains electrical failure, the changeover system would be switched to connect the load to a standby alternative power supply (generator), and as so desired by the operator and returns back the load to the mains supply when it is restored. There are basically three types of changeover switches based on the design and mode of operation namely: manual changeover, electrical changeover and electronic changeover. Electrical and electronic changeover switches are employed for very high amperages. These remote-operated source-changeover systems are the foremost ordinarily utilized system for devices with high ratings (above four hundred Amps). Transfer from the traditional to the replacement supply is controlled electrically by actuating the electrical buttons or electronic sensors. A remote-controlled source-changeover system is formed of 2 or 3 circuit breakers or switch-disconnections connected by an electrical interlocking system that will have totally different configurations. Additionally, a mechanical interlocking system protects against electrical malfunctions and incorrect manual operations (Schneider, 2019).

Manual changeover is the most popular changeover switch in use as it serves the common household amperage. Manual change-over switch consists of a manual change over switch box, switch gear box and cut-out fuse or the connector fuse. This change-over switch box separates the source between the generator and public supply. The contact is manually switched from mains terminal to the generator terminal and vice-versa.

The major drawbacks are that firstly, it requires a lot of human action to operate and also the ceramic insulator can crack during switching which can lead to electric shock if the contact wire touches the metal casing. Secondly, it has led to several deaths and damage to electrical appliances. Rapid wear and tear of the mechanical parts also increased its disadvantages due to continuous up and down movement while changing from one source to another (Nwafor *et. al.,* 2012).

Plate 1: Knife Changeover Switch (Single Phase)

Plate 2: Manual Changeover Switch (Single Phase)

Plate 3: Manual Changeover Switch (Three Phase)

The automatic power changeover switch is a device that links the load and mains supply or the alternative power supply to the load as desired. This enables the use of either the mains supply or an alternative source when there is outage on the mains source or when the alternative power supply is most preferred. This can either come in with three phase or single phase. This device maintains constant power supply to the load by automatically activating the generator when there is need (Ilomuanya and Okpala, 2016). Meanwhile an automatic changeover system allows an immediate and smooth transfer of electrical current.

With the high dependence of home and industrial equipment on power, switching from one form of energy to the other has become a necessity either for integration in the national grid or for use in the standby home or industrial applications. Using a manual changeover device to switch load either from mains or alternative power supply to the other is done with human physical influence. Certain missions on critical appliances and installations which include hospitals, airports, high precision laboratory equipment which require a 100% up time cannot afford to depend on a manual changeover switch (Onipede *et al.*, 2017).

The switching that is obtainable from the conventional change over system is usually manual, whereby, the user would have to move a lever to change from one source to another. This is usually associated with time wasting as well as some health hazards like electric shock. This innovation does not require the use of human effort unlike the conventional changeover device to transfer power from the available source to the load for utilization, rather switching power source is done with some speed and precision, seamlessly with the aid of an electromagnetic devices.The parts and components used are readily available without the involvement or setting up a new parts and components production company.

Also, while using the conventional changeover device, the need for turning off the generator after changeover operation is required manually by the operator, unlike this very innovation. The generator set is automatically turned off immediately by the automatic changeover device, which save cost of running on fuel while mains is restored.

Moreover, the invention comes along with a phase selector which helps to select the appropriate phase having a higher voltage in case of under voltage supply from a particular phase unlike the manual phase selection operations. This helps the appliances or equipment to be powered, run effectively without causing any damage or being damaged.

II. METHODOLOGY

The NEDDI-NASENI Seamless Automatic Change Over is a complete system with various subsystems and components arranged and linked to function primarily as a means of manipulating the supply of electrical power to any desired load.

In this innovation, an adaptable box is utilized, which is relatively cheap to provide the covering for all components to be installed in it and mounted on. A 60A connector was used as connection points for the Load, Mains and Generator. A 60A, 220V circuit breaker was linked between the mains supply and Load, capable of tripping off under an abnormal or short-circuit occurs. Whereas, a 15A, 220V MCB was connected between the Generator and Load which is operated manually by turning it OFF when the operations of the generator are not required. Light indicators were also used to indicate the availability of power either on the Mains, Generator or Load, this easily tells the operator/user which power source is active and which is not, likewise, if the load is connected to the active power source. An electromagnetic device (Relays) of 160-220V actuating voltage were used for phase selections, disengaging and outputting power to actuate the devices responsible for receiving power from any available sources. This invention has reduced the occurrence of wear and tear to its barest minimum caused by the effect of friction for the purpose of tight contacts of the terminals during every operation carried out.

III. MATERIALS AND METHODS

The design is majorly relays and contactors operational combination that ensures the achievement of stated goal.. Its operation is based on the hierarchical rank of contactor relays. It consists of some relays which serves several purposes. In this mode of operation, when there is power failure from national grid supply, there won't be any need of manual changeover as the change-over switch will start the generator automatically, allowing it attaining synchronous speed and connect it to the load. When powers from the mains source returns, the automatic change over switches off the generator and connect the load to national grid supply. This type of automatic changeover switch designed differs from the other (semiconductor controlled switching type) in terms of the type of load transfer or switching panel is the pure relay-contactor switching type. The complete system was simulated using electronics system design software (Proteus). The complete assembly of the Seamless Automatic Changeover as shown in Figure 2, labeling all the parts needed for installations and User interface. The Voltmeter (10) displays the voltage supplied to the load either from the mains or generator, while the Ammeter (1) displays the current consumed by the load during use. Mains and generator power are supplied into the Automatic Changeover through the Connector 60A (11) in which the load points are made available using the same Connector 60A.Whereas, part of the Connector's terminals is used for generator's ignition system.

The several consisting units (Figure 1) are arranged to carry out sequence of operation by way of monitoring the availability and the quality of electrical power supply and consequently take a rational decision either to put **ON or OFF** the alternative power generating set through the various switching circuits, that connects the loads to the available power supply sources, through the contactor coils that closes the contacts of the contactors. The rating of these contactors depends on the total loads expected to be driven from the supply source. There are also some time lags (two seconds each) between each phase to allow for system stability before connecting the loads. The inclusion of power switch 1, is to allow safety maintenance on the national grid sub panel while the power switch 2, is to prevent the alternate power supply generator from coming up when its service is not required in the event of power failure from national grid and also to provide for easy maintenance of generator unit. The time lags between the two phases (national grid supply& Generator switching is 10secs) to allow for power stability before connecting the loads are made possible through the use of Timing-Relays.

The Mains Indicator Light (7) will always switch ON when the mains is available, irrespective of whether the Mains Switch (8) is turned ON or OFF. Likewise, the Generator Indicator Light (4) switches ON, independent of the Generator Switch (5) when the generator is turned ON and power is supplied. Whereas, the Load Indicator Light (6) only switches ON when power from either of the mains or generator power is available. Although, a MCB (9) is connected between the power supplies lines and the load, in order to have either manual control of power supply to the load while the system is still active or breaks power supply when shunt circuit or overload is experienced. As shown in Figure 2, the adaptable Box (3) used for housing all the components has the dimension of (260 x 260 x 95) mm^3 as displayed in Figure 3. The entire parts and components of the Seamless Automatic Changeover system are housed in an Adaptable Box as displayed in Plate 4. As shown in Plate 6, the mains supply phases are represented by the words RED, YELLOW and BLUE. The negative is represented as GND, also known as GROUND.

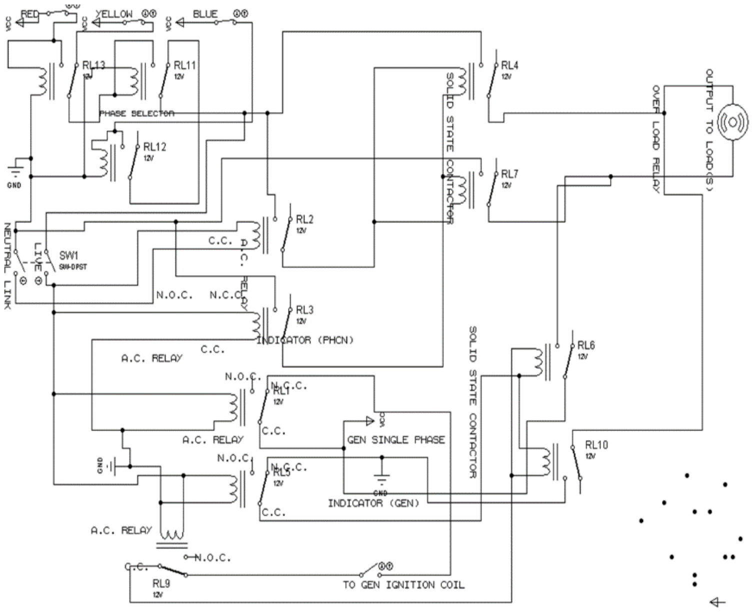

Figure 1: Circuit Diagram of a Seamless Automatic Changeover Device

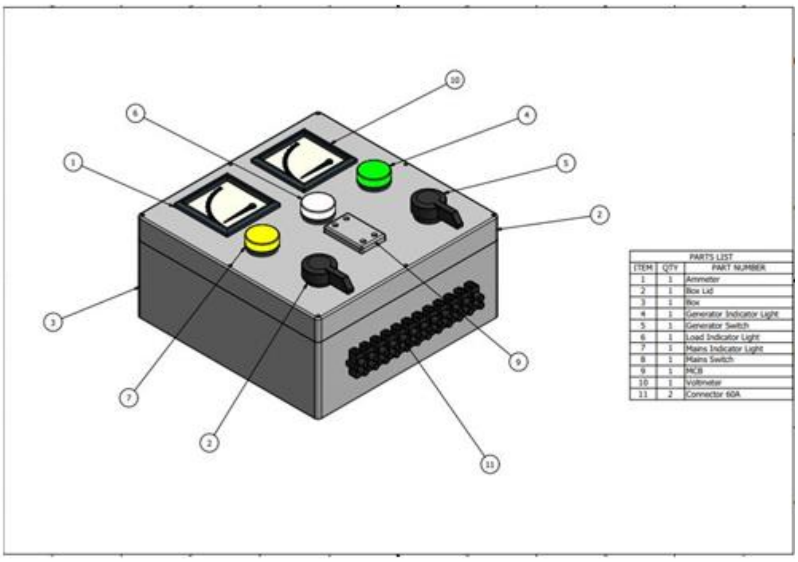

Figure 2: Isometric View and labeled Parts of Seamless Automatic Changeover

The RED phase actuates both the relays (RL13 and RL11). While on RL13, it changes the state of the relay from disconnecting the Common Contact (C.C) with the Normally Closed Contact (N.C.C), to connect the Common

Contact with Normally Open Contact (N.O.C). Thus, relay (RL11) is also actuated in which the Common Contact is disconnected from the Normally Closed Contact and then connects to the Normally Open Contact to close the circuit for conveying the power into and outside the system. Moreover, when RED phase is active, it renders both YELLOW and BLUE phases inactive.

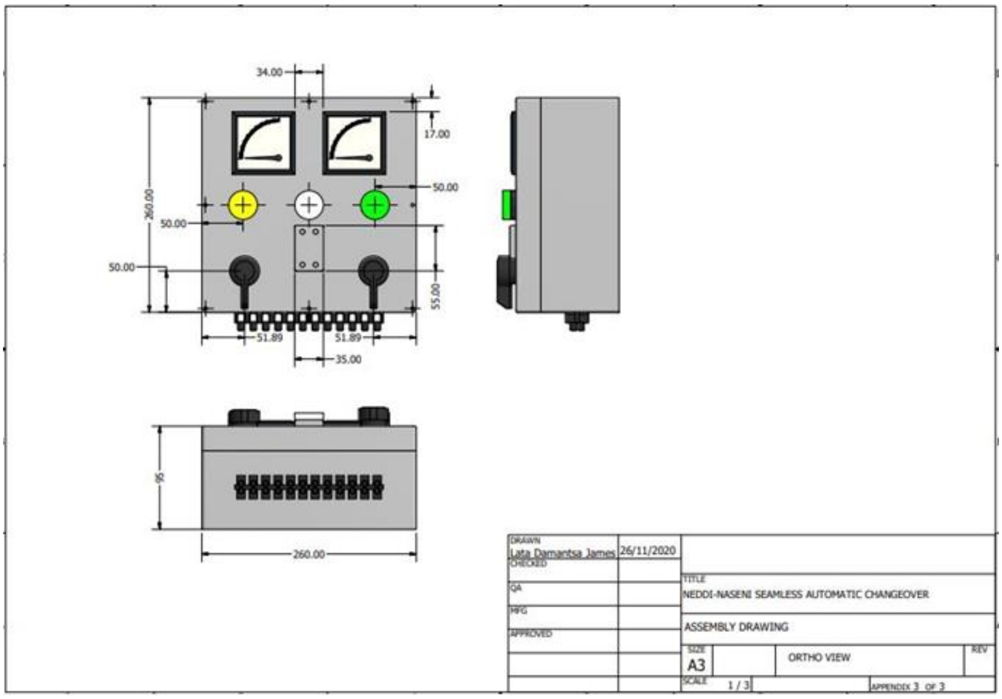

Figure 3: Orthographic View of the Seamless Automatic Changeover

The YELLOW phase only actuates relay (RL11) which disconnects the Common Contacts with the Normally Closed Contact and connects the Common Contact with the Normally Open Contact to deliver power to the entire system. Although, this phase utilizes the Common Contact and Normally Closed Contact connection of the relay (RL13) to complete its power supply.The BLUE phase actuates only relay (RL12). When powered, it disconnects the Common Contact and Normally Closed Contact, when then connects the Common Contact with Normally Open Contact to close its circuit. This phase also utilizes the connection between the Common Contact and Normally Closed Contact of the relay (RL11) to deliver power to the system. In other words, when relay (RL11) is actuated by either RED or YELLOW phase, BLUE phase will be rendered inactive.

This system of connection utilizes only one phase at a time even when all phases are active. It gives priority to RED phase, followed by the YELLOW phase then lastly BLUE phase. Immediately the RED phase has an under voltage supply, it deactivates relay (RL13), allowing YELLOW phase to take control of the power supply seamlessly by actuating relay (RL11). Also, when YELLOW phase has under voltage power supply, it gives preference to BLUE phase to take charge of power supply into the entire system.

The switch (SW1) is mounted to control the activities of the mains supply. When switched ON, it closes the circuits for relays (RL1, RL2, RL3, RL5 and RL9). When actuating relays (RL2 and RL3), they create the Common Contact and Normally Open Contact connections the which closes the circuits of Solid State Contactors (RL4 and RL7). Whereas, the Common Contact terminals of the relays (RL4 and RL7) are connected to the load LIVE and GROUND terminals respectively, while the Normally Opened Contact terminals of relays (RL4 and RL7) are connected to the mains LIVE and GROUND terminals respectively. Thus, connecting the load to the mains when actuated. Meanwhile, the Common Contact terminals of relays (RL1 and RL5) are connected to the LIVE terminal of the generator and GROUND terminals of Solid States Contactors (RL6 and RL10) respectively. The Normally Closed Contact terminal of the relay (RL1) is connected to

International Journal of Novel Research in Electrical and Mechanical Engineering
Vol. 9, Issue 1, pp: (32-38), Month: September 2021 - August 2022, Available at: www.noveltyjournals.com

Normally Closed Contact terminal of relay (RL9) through the GEN IGNITION COIL. And also, the Normally Closed Contact terminal of relay (RL5) is connected to both the generator's GROUND and Solid State Contactor's (RL10) Normally Open Contact terminals. Similarly, relay (RL9) is actuated by switch (SW1) which disconnects the Common Contact with the Normally Closed Contact, in order to turn OFF the generator when mains is restored and deactivating the Solid State Contactors (RL6 and RL19) that supplies the generator's power to the load.

The mains indicator's terminals are connected to the Normally Closed Contact terminals of the relays (RL2 and RL3). Whereas, the generator indicator's terminals are connected to the Common Contact terminal of relay (RL1) and Normally Closed Contact terminal of relay (RL5). And also, the load indicator's terminals are connected to the load's 60A connector points. The process does not require any circuit programming or microchips for it to operate making it rigid for operation and more durable.

IV. RESULTS

The Seamless Automatic Change-Over that is designed and constructed is an improvement on what others have done over the years. The present design is such that it would take two different sources simultaneously and also give preference to this power sources with the unique ability to ensure that there is always power supply to the load as at required. In the course of this design, the following tests were carried out, continuity test of contactor and relay coils, and this is to ascertain low resistance, continuity test on the contacts of the materials used also to ensure free flow of current, conductivity of the wires. The complete system was simulated using electronics system design software (Proteus). The results were successful and the system can be rated to have over 95% efficiency. The photograph of the novel Automatic Changeover Switch is depicted in Plate 4. The top view of the Seamless Automatic Changeover is shown in Plate 5.

Plate 4: Seamless Automatic Changeover

Plate 5: Top View of a Seamless Automatic Changeover

V. CONCLUSION

The NEDDI-NASENI Automatic Changeover Switch (SACO) has been designed, simulated, fabricated and tested. The components were sourced locally in electrical markets within Anambra State of Nigeria. The test result is satisfactory, with an efficiency of about 95%. It is a complete system with various subsystems and components arranged and linked to function primarily as a means of manipulating the supply of electrical power to any desired load. We achieved the aim of this project which is to produce a device that can automatically switch power between mains supply and alternative supply (generator). The Instrument is complete system with various subsystems and components arranged and linked to function primarily as a means of manipulating the supply of electrical power to any desired load.

REFERENCES

[1] Ilomuanya, T., and U. V. Okpala (2016). Implementation of the Designed Automatic Change over System for the Department of Physics, Chukwuemeka Odumegwu Ojukwu University, Uli." International Journal of New Technology and Research, vol. 2, no. 4.

[2] Nwafor C. M., Mbonu E. S. and Uzedhe G., (201). “A Cost-Effective Approach to implementing change over System”, Vol. 2, No. 2, March 2012, ISSN-L: 2223-9553, ISSN: 2223-9944, Pg. No’s 62-72

[3] Onipede, B., Joseph, S. and Odiba, O. (2017). Developing an Automatic Switch for Home or Industrial Power Supply Changeover. British Journal of Applied Science & Technology. 21. 1-7. 10.9734/BJAST/2017/32785.

[4] Schneider Electric (2019). Retrieved January, 2021, from https://www.se.com/ng/en/faqs/FA382632/