



Design And Construction Of An Automatic Phase Selector For 3-Phase Power Supply

Isah Usman

**Department of Electrical Electronics Engineering Technology
Federal Polytechnic of Oil and Gas, Bonny, Rivers State, Nigeria
Usmanisahnabila@gmail.com**

ABSTRACT

This research work is on the design and construction of automatic phase selector for 3-phase power supply. It is aimed at providing a means of switching from one phase of alternating current (AC) mains to another in the case of failure in the existing phase. This research was conceived with the intention of improving on the existing type of electromechanical devices that are currently in use. The result from the current research has shown the capacity to automatically switch power from national grid to generator and vice versa, once there is power failure in any of the two power supplies and at the same time has the capacity of shutting down a generator set once the mains grid is been restored and this has been achieved by the use of operational amplifier, timing circuit and high current relay switches that is powered by 12V (DC) power supply.

Keywords: Power, Selector, Current, Electricity, 3-Phase

INTRODUCTION

Power failure under and over voltage in a country, state or city is highly detrimental to development in public and private industries. The insecurity associated with these problems brings about limitation to power consistent investments, thus hampering the development of industries and multinational ventures. Processes like carrying out surgical operations in hospitals, laboratories which require constant power supply for research, money transactions between banks and more require constant use of uninterrupted power. In other to solve this problem, an automatic changeover switch was invented. In Nigeria today the problems of power outage across phases is so rampant thus leading to some sensitive equipment and appliances being redundant, this could sometimes be the cause of one phase going out with respect to the other according to (William D, 1975) .

It may surprise one to note that in an attempt to solve this problems, so many unskilled electricity consumers has in recent past resorted to some crude means of swapping between phases to obtain power. So many souls have been lost in this act. This is an undesirable condition to consumers and the need now arises to design a device that can automatically select among the phases and make power supply available at the consumer's terminal (William D, 1975).

However, this can only be possible if one have a three phase meter and there is supply from any of the service line or the entire line, this project known as a three phase automatic phase selector has been constructed with a view of solving the problems stated above. The design and construction was based on the principle of Electro magneto-Dynamism and alignment as demonstrated in the contactor arrangement.

Among other components are the timers miniature-circuit breakers the contactors and indicator bulbs, the ease with which the device is operated is well elaborated to ensure simplicity effort were made to present a step by step operation of the project. As much as there is no project without limitation and applications, we have as well dedicated a section of this paper to look into it (William D, 1975).

In order to ease the effort of technicians in restoring the devices should there be any malfunction associated.

Faults and how they are cleared is presented, however, there are no user serviceable parts in the device therefore all maintenance should be referred to a qualified electrical personnel (Cotton H, 1950).

Literature Review

This is a major characteristic of an AC electricity supply that requires explanation -phases. A DC circuit has two wires through which the current in the circuit flows from a source of electricity through a load and back to the source (Brittain J. E, 2007). A single-phase AC circuit also has two wires connected to the source of electricity. However, unlike the DC circuit in which the direction of the electric current does not change, the direction of the current changes many times per second in the AC circuit. The 220 volt electricity supplied to our homes is single phase AC electricity and has two wires - an "active" and a "neutral".

The distribution line supplying your home may be single phase and have only two wires strung between the poles (we will use the overhead power lines as examples because they can be easily seen). However, the distribution line may be made up of 4 lines. What are the others? The other lines carry the currents from two other electrical circuits, making a total of three circuits or phases. The reason why there are only 4 lines is because the 3 phases have a common neutral line (i.e. 3 active lines and 1 common neutral line) according to (Fowler, 2011).

Because the magnitude and direction of the electricity flowing in each of the phases is slightly displaced in time from the electricity flowing in the other phases, the current flowing in the common neutral will be the sum of the neutral currents from the 3 phases. The resultant current in the common neutral is smaller in a 3 phase system than in systems with other numbers of phases. This ability to use a common neutral of relatively small capacity has large economic advantages and is the main reason why 3 phases are used (Fowler, 2011).

Three phase electricity has another advantage. We mentioned above that, in Canada, the voltage between the active and neutral in the single phase, low voltage supply to our homes is 220 volts and that this phase is only one of the phases in the 3 phase system. The voltage between the phases of a 120/208V 3 phase system is 208 volts (in Canada). A 208 volt, 3 phase supply is able to deliver more energy than a 120 volt, single phase supply. 3 phase supplies are normally restricted to large electrical loads, such as large electric motors. Commercial buildings are often wired for three phase power. Air conditioners for instance are run on the three phase power while single phase power is typically used for most electrical, electronic and lighting equipment.

A single phase supply must have a neutral, whereas a 3 phase supply does not require a neutral. More complicated reasons deal with fixing the voltage of the single phase supply relative to the ground (because domestic appliances have their metal enclosures connected to ground) and for fault protection purposes. 3 phase, medium voltage, distribution systems and high voltage transmission systems therefore use one wire for each phase and no neutral (Fowler, 2011).

The above discussions focused on active and neutral conductors (wires) as being the means to convey the electricity. One type of system uses the ground as the return path, with only the active being conveyed by a wire conductor. This type of single-phase supply system is called the Single Wire Ground Return system and is use to supply small loads which are located far from the main distribution networks (Brittain J. E, 2007).

RESEARCH METHODOLOGY

This work started with the studying of the block diagram, followed by the studying of the circuit diagram and gathering of the parts used in the construction.

Block Diagram

The block diagram of the system is as below:

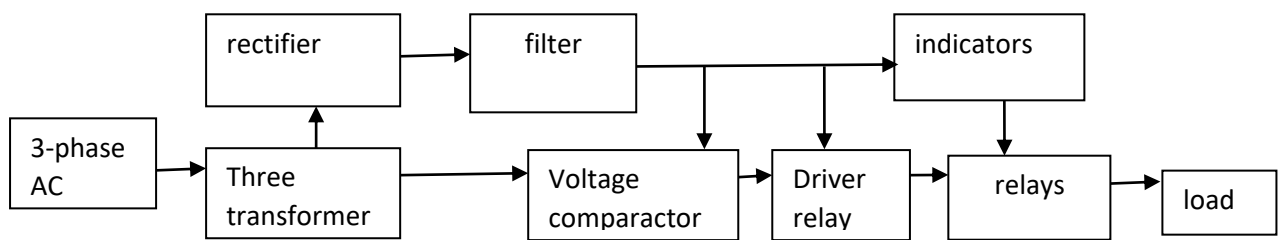


Fig 1. Block diagram of the system

CIRCUIT DIAGRAM

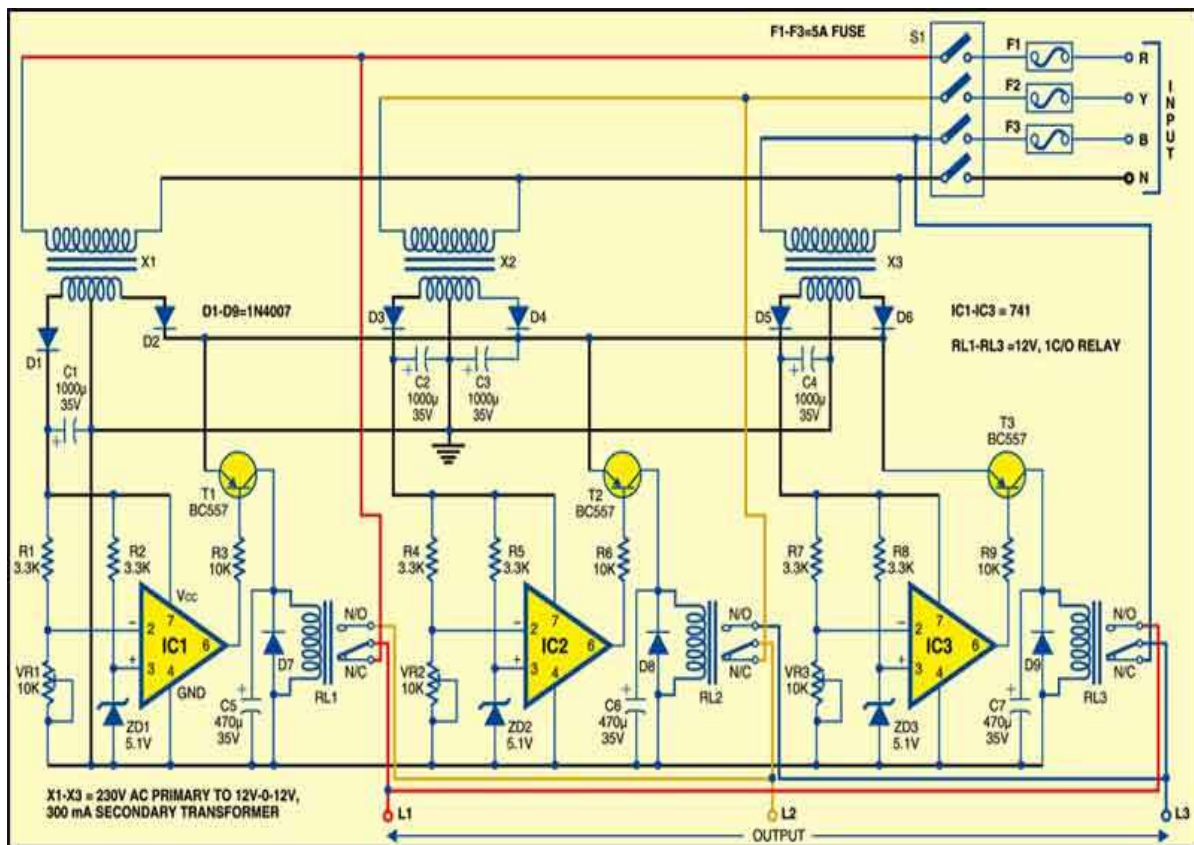


Fig 2 Circuit Diagram

WORKING PRINCIPLE

An automatic phase selector for three power supply provides a means of switching from one phase of AC mains to another in the case of failure, low or over voltage in the existing phase.

In three-phase applications, if low voltage is available in any one or two phases, and you want your equipment to work on normal voltage, this circuit will solve your problem. However, a proper-rating fuse needs to be used in the input lines (R, Y and B) of each phase. The circuit provides correct voltage in the same power supply lines through relays from the other phase where correct voltage is available. Using it you can operate all your equipment even when correct voltage is available on a single phase in the building.

Components of the Circuit Deployed For the Construction

In this project, the following components are deployed for the construction of the circuit. They are as follows:

1. Transformer
2. NPN Transistor
3. resistor
4. Zener diode
5. capacitor
6. Light-emitting diode (led)
7. Rectifying Diode
8. Relay

RESULT ANALYSIS AND DISCUSSION

circuit is built around a transformer, comparator, transistor and relay. Three identical sets of this circuit, one each for three phases, which is used to provide a means of switching from one phase of AC mains to another in the case of failure, low or over voltage in the existing phase.

Hence, in the construction of this circuit, the following procedures were properly considered,

- I. Purposing of the entire materials / Components needed
- ii. Resistance check of the components bought with the help of ohmmeter before making the necessary connection with the components
- iii. Drafting out a schematic diagram or how to arrange the materials / components.
- iv. Testing the completed system to see if the design works and
- v. Finally, implementation of design of the project.

Having procured all the materials, I processed into the arrangement of the components into the zero board, proper soldering of the components then followed. The components were all soldered into the board after which it was correctly confirmed done.

Casing And Packaging

The casing of this project comprises of internal and external packaging. Internal parts of the circuit was soldered and fixed inside the case. Then after that, follow by external components such as indicators, switch.

Assembling Of Sections

Having provided the casing and having finished the construction of the sections of this system, the assembling into the casing followed. The sections were properly laid out and assembled into the casing where the general coupling and linkages into the peripheral devices took place.

Finally; the indicator, switch were carefully brought out from the internal part of the casing through the holes made on the body of the casing, the input cable plug outlet mounted on the body of the casing where power source terminals will be connected

Testing Of System Operation

In this stage, the system was due for testing and operation. The system operation was tested where all its required performance was maintained.

First; the device was connected and switch ON with the toggle switch, then the system is set for operation. The indicator light is also connected whose function is mainly to indicate the presence of voltage into the system.

During testing, we used a 12V, 200-ohm, single phase change over relay with 6A current rating. Similarly, ampere-rated fuses were used.

2. If the input voltage is low in two phases, loads L1 and L2 may also be connected to the third phase. In that situation, a high-rating fuse will be required at the input of the third phase which is taking the total load.

OUTCOME



Pic 1



Pic 2

Problems Encountered

As we all know that every engineering work goes with one or more problem, which enhances research and probably technological advancement to engineers while endeavoring to resolve such problem. Therefore the project on discussion suffers some noticeable drawback, which includes:

- i. Mechanical problem: we found it difficult to install all the external components. But after the effort was made, our aim was later achieved.
- ii. we found it difficult to select the right potentiometer that will be used to control the voltage of the op-amp.

RECOMMENDATION AND PRECAUTION.

This work was built with quality wiring and contains many connections, I recommend that if failure occur, it should be troubleshoot by a qualify personnel along with the circuits diagram.

Use relay contacts of proper rating and fuses should be able to take-on the load when transferred from other phases. While wiring, assembly and installation of the circuit, make sure that you:

1. Use good-quality, multi-strand insulated copper wire suitable for your current requirement.
2. Use good-quality relays with proper contact and current rating.
3. Mount the transformer(s) and relays on a suitable cabinet. Use a Tag Block (TB) for incoming/outgoing connections from mains.

CONCLUSION

The mains supply in Nigeria fluctuates widely due to overloading, ageing and improper distribution of loads among the three phases of the consumers' substation transformer.

Appliances such as video cassette player, television as well as those containing compressors like air conditioners, refrigerators, etc could be damaged due to this variation and fluctuation in voltage mains.

The automatic three-phase selector is an electronic circuit that is capable of detecting voltage levels by means of a controller that does some level of comparison before initializing a logic combinational circuit that does some logic combination before initializing an electronic relay switch action. The relay is energized only when the mains voltage is within an accepted predetermined limit, outside of which the relay remains dormant. Voltage levels below the desired range are ignored. This device is designed to work with a 3-phase input signal. The device functions in the form of an automatic electronic switch, switching between three potentials, with the aim of supplying the highest potential to the load (Theraja B. L et al, 2005).

REFERENCES

- Brittain, J. E. (2007). "Electrical Engineering Hall of Fame: Charles F. Scott". *Proceedings of the IEEE* **95** (4): 836–839.
- Cotton, H, *Electrical Technology*, 6th Ed., Pitman, London, 1950, p. 268
- Fowler, Nick (2011). *Electrician's Calculations Manual* 2nd Edition. McGraw-Hill. pp. 3–5. ISBN 9780071770170.
- Theraja, B. L and Theraja, A.K, “*Electrical Technology* (5th edition, S Chand New Delhi, India, 2005).
- William D. Stevenson, Jr. *Elements of Power System Analysis* Third Edition, McGraw-Hill, New York (1975). ISBN 0-07-061285-4, p. 2