

AUTOMATIC TRANSFER SWITCH WITH THREE PHASE SELECTOR

OKOME ORITSELAJU M*, FOLORUNSO OLADIPO**

DEPARTMENT OF ELECTRICAL/ELECTRONIC, AFE BABALOLA UNIVERSITY, ADO-EKITI, EKITI STATE, NIGERIA

ABSTRACT: Constant supply of power is the wheel of growth to any nation's economy. A country like Nigeria, where total power generation is less than one quarter of total demand, means of augmentation and smooth operation cannot be over emphasized. This paper presents a real laboratory design and construction of Automatic Transfer Switch (ATS) with three phase selector. The design method involves the use of electromechanical type relays, and comparators, etc. The ATS designed demonstrates its ability to perform automatic power change over activities easily without any human interaction.

Keywords: Automatic Transfer Switch (ATS), relay, comparator.



I. INTRODUCTION

In developing countries like Nigeria today, there is the problem of interrupted power supply as insufficient power is being generated to provide consumers with continuous services and satisfactory quality. This leads to constant power failure which in turn affects both the public and private sectors of the economy. Industries, banks, hospitals and so many other public and private establishment all have major critical loads that needs to be powered at all times in order to carry out various processes efficiently. This power instability now brought about the need to create an alternative means of power to back up the public utility supply. The introduction of some of these alternative sources of power supply brings forth the challenge of switching smoothly in a timely manner between the mains supply and the alternative sources whenever there is a failure on the mains source.

Automatic changeover switch is an integral part of the process of power generation, allowing smooth and instant transfer of electric current between multiple sources and load. The function of the automatic change over switch is to monitor the incoming public supply voltage and detect when the voltage

drops below a certain level that electrical/electronic appliances can function depending on the utility supply. The automatic change over switch compares the voltage of the other two phases using a comparator circuit and if the voltages are not available, the system changes over from public supply to generator. When the generator is in operation, the transfer switch prevents any feedback current to the load. It also ensures that the different power sources are synchronized before the load is transferred to them. The transfer switch senses when there is interruption if the mains supply remains absent. The principle of the automatic change-over switch is such that it links the load and mains supply or the alternative supply together. This enables the use of either the mains supply or an alternative source when there is outage on the mains source which can either be a three phase or a single phase.

The automatic transfer switch embedded with a phase selector comprises of a monitoring unit which monitors the three phases and gives a single output as well as monitoring the output that comes from the generator, a control unit that controls the operation of the circuit, the relay drivers necessary for driving the relays used for putting off and on the generator as well as alternating between the

two power supplies, and the stepper motor driver unit which is used for moving the stepper motor that controls the choke in

starting the generator. The block diagram of the circuit is shown in figure 1.1

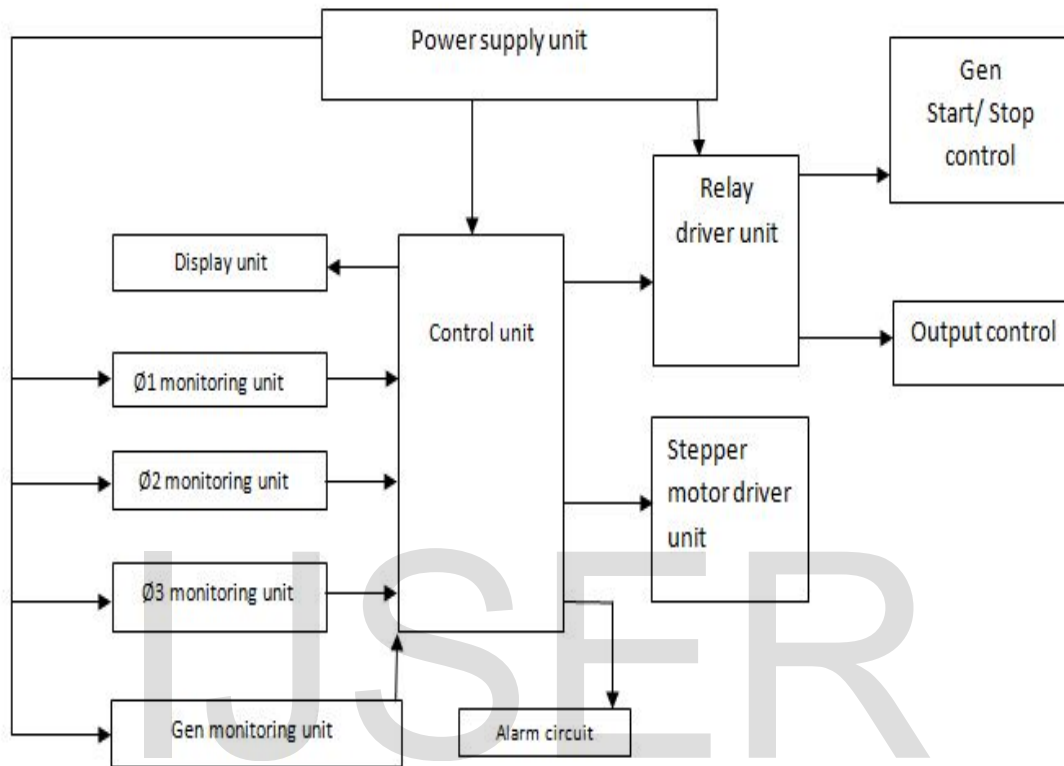


Figure 1.1: Block diagram showing the working principle of an automatic transfer switch with three phase selector.

II. DESIGN METHODOLOGY

The methods and procedures involved in the design and fabrication of the automatic transfer switch with three phase selector that gives a single output involves the following:

- Paper design of the circuit
- Obtaining all the components required to make the circuit of the automatic transfer switch
- The four 240/12v, 300mA transformers, 1000 μ F capacitors, bridge rectifiers, variable resistors are all connected to the LM324 op amp

which is used to monitor if there is voltage in the red, yellow and green phase as well as if the generator is supplying current to the load.

- LEDs are used as indicators for the three phases as well as for the generator. The LM324 is then connected to the micro controller which controls the display of the LCD as well as the starting and stopping of the generator.
- Relay drivers and motor drivers are connected to the microcontroller to drive the relays and the bipolar stepper motor of the generator during

start/stop of the generator as well as switching between the public supply and generator. The whole circuit is powered by a 240/12v, 500mA transformer.

- f) The circuit has a 5secs delay before the generator comes on when there is no supply in any of the three phases. It also has a 5secs delay before the generator comes off when there is supply in any of the three phases.

- g) When the generator refuses to come on after three attempts in starting, the buzzer sounds for 5secs before coming off.
- h) When the reset switch is off and there is no supply in any of the phases, the generator would not also start till that switch is turned on.

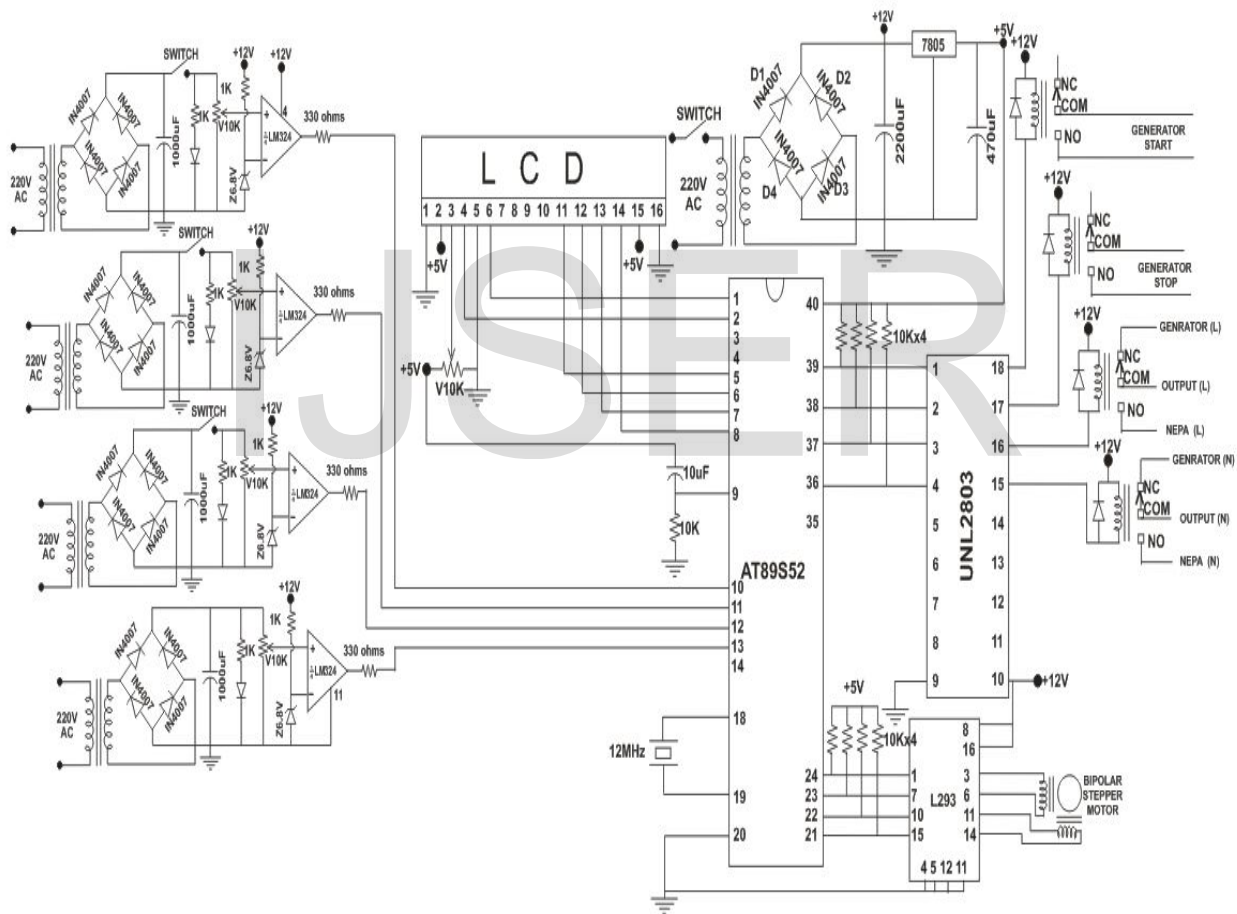


Figure 2.1: Circuit Diagram showing design and construction of the automatic transfer switch.

III. TESTING AND RESULT

The total cost of materials for the laboratory design of Automatic Transfer Switch in

Department of Electrical/Electronic Engineering, Afe Babalola University, Ado Ekiti, Nigeria is 12, 235 Naira (about \$57).

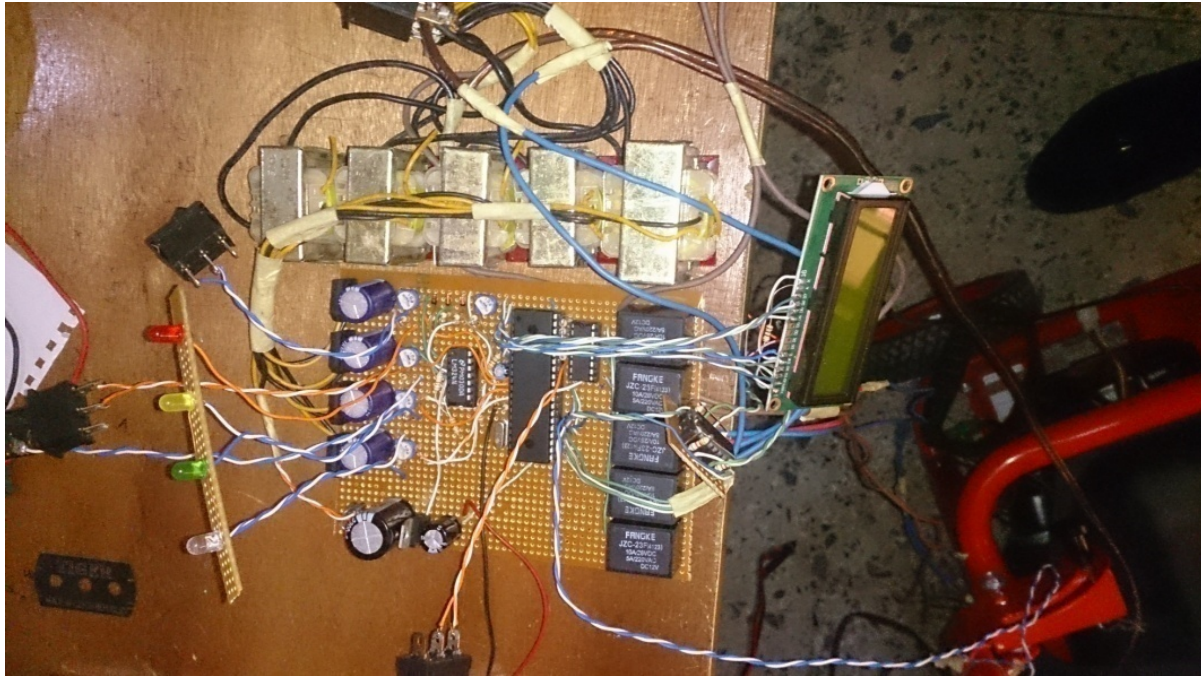


Figure 3.1 Automatic Transfer Switch during under construction

The automatic transfer switch circuit was tested with the three phases power supply available. The switching process was perfectly executed by the control switching

circuit. It put the generator ON and OFF as required and alternated between the two power supplies. The following test results were obtained.

Table 3.1: Tests and results analysis

TESTS	RESULTS
Automatic Switching ON and OFF of the generator	The switching control circuit was able to switch ON and OFF the generator when the mains supply in all three phases was not available and when at least one phase was made available.

Switching between the three available phases.	The monitoring unit in the circuit was able to interchange between the phases circuit whenever anyone was of the phases were not available.
Switching between the two available power supply sources	The switching control circuit did the switching between the two power supply sources correctly avoiding any jam in supply when the two supplies are available simultaneously.
Timing of the delay circuits test	All the timed delay circuits worked satisfactorily within ± 1 secs tolerance.
Buzzer alarm test	The buzzer alarm to indicate when the generator refuses to come on after 3 attempts to start worked satisfactorily.
Reset switch test	When the reset switch is off and there is no supply in any of the phases, the generator did not start till that switch was turned back on.

IV. Performance Evaluation

In other to test the performance of the system, Switch R is the switch controlling the red phase, Switch Y is the switch controlling the yellow phase, Switch G is the switch controlling the green phase, switch O is the reset switch, and the buzzer is the gen fault indicator. During this test, the public supply is available in the three phases. A 60

W bulb is used as the load and a 12 Volts motor is used as the kick-starter to move the choke of the generator.

The following steps were involved in the operation of the circuit:

- a) Switch R opened (OFF) simulates public supply outage.
- b) Switch Y opened (OFF) simulates public supply outage.

- c) Switch G opened (OFF) simulates public supply outage.
- d) Switch R closed (ON) simulates public supply availability.
- e) Switch Y closed (ON) simulates public supply availability.
- f) Switch G closed (ON) simulates public supply availability.
- g) Switch O opened (OFF) simulates unavailability generator.
- h) Switch O closed (ON) availability of generator.
- i) Motor ON means the 12V motor rotates clockwise for 2sec, and anti clockwise for the next 2secs.
- j) Bulb ON means the 60W bulb lights by both source of power supply.

Table 4.1: Summary of performance evaluation

Steps	Switch R	Switch B	Switch G	Switch O	Motor	Buzzer	Bulb	Comments/Observations
1	ON	ON	ON	ON	OFF	OFF	ON	When all three phases are ON, the generator and the buzzer are off and the load would be powered.
2	OFF	ON	ON	ON	OFF	OFF	ON	When two out of the three phases are ON, the generator and the buzzer are off and the load would be powered.
3	OFF	OFF	ON	ON	OFF	OFF	ON	When one out of the three phases is ON, the generator and the buzzer are off and the load would be powered.
4	OFF	OFF	OFF	ON	ON	OFF	ON	When all three phases are OFF, there is a delay of 5secs, before the motor comes on and powers the load.
5	OFF	OFF	OFF	ON	OFF	ON	OFF	When all three phases are OFF and the motor is OFF due to a fault in the generator after three attempts at starting, the buzzer comes ON for 5secs
6	OFF	OFF	OFF	OFF	OFF	OFF	OFF	When all three phases are OFF, and switch O is OFF indicating the non availability of the generator, the motor, load and

								buzzer would also be OFF till switch O is turned ON
--	--	--	--	--	--	--	--	---

V. CONCLUSION

Based on the test results, the whole system performed according to the designed aim and objectives. The automatic transfer switching circuit was able to switch between the two power supply sources according to the set priority and also automatically switches on the generator and switches it

off. The project has been proven to be very reliable and can be deployed in houses, offices, industrial settings and all environments where constant power supply are of great importance. With improved rating of the generator more percentage of loads can be placed on them.

REFERENCES

1. Ahmed .M.S, Mohammed .A.S and Agusiobo .O.B, "Development of a Single phase Automatic Change-Over Switch", Department of Electrical and Computer Engineering, Federal University of Technology Minna, Nigeria, July 2006.
2. Ezema L.S, Peter B.U, Harris O.O, "design of automatic change over switch with generator control mechanism", Electrical Power and Electronic Development Department, Projects, Development Institute (PRODA), Enugu, NIGERIA, November 2012.
3. Jonathan Gana Kolo (2007). Design and Construction of an Automatic Power Change over Switch. AUJ. T. II (2): 113 – 118 (October 2007).
4. Theraja, B.L.; and Theraja, A.K. 2002. Electrical Technology, 21st ed. Ranjendra Ravida, New Delhi, India.