# Auto Switching of any Available Phase in a Three Phase Supply System

**Nathu Ram Galwa[1] Neeraj Kumar[2] Md. Zawed Ansari[3] Narendra Kumar Meena[4] Pramjeet Singh[5]**
[1,2,3,4,5]Student
[1,2,3,4,5]Swami Keshvanand Institute of Technology, Jaipur, Rajasthan, India

*Abstract*— This paper presents the analysis of the concepts and algorithms of Auto Switching of any Available Phase in a Three Phase Supply System. Power failure is a common problem. It happens generally. It is often noticed that power interruption in distribution system is about 70% for single phase fault while the other two phases are in normal condition. So we can take power by other phases by manual switching of the system to other phase. But it is time consuming as certain time is required to switch onto the other phase i.e. power is interrupted for certain time. Thus this system is useful in any commercial or domestic power supply system where three phases are available and automatic phase switching system is required for uninterrupted power to critical loads in the event of power failure in any phase. The main aim of this paper is to present the real idea of an automatic phase switch for 220V alternating current. Although, there are many designs that can perform almost similar functions. But this model is about an automatic phase changeover which is designed for only three phase AC input power to single phase output application. The benefit of this work is that the time required for switching between the phases have been drastically reduced, more automatic operation with the elimination of selector switch and the problem of sparking between the selector switch and the phase connection does not arise.

***Key words:*** Automatic Phase Switching, Relay, Single Phase Load, Relay Driver, Logic Gate

## I. INTRODUCTION

Three-phase electric power is a common method of alternating current electric power generation, transmission, and distribution. It is a type of polyphase system and is the most common method used by electrical grids worldwide to transfer power. Three-phase systems may also have a fourth wire, particularly in low-voltage distribution. This is the neutral wire. The neutral allows three separate single-phase supplies to be provided at a constant voltage and is commonly used for supplying groups of domestic properties which are each single-phase loads. The connections are arranged so that, as far as possible in each group, equal power is drawn from each phase. Further up the distribution system, the currents are usually well balanced.

Most household loads are single-phase. In residences, three-phase power might feed a multiple-unit apartment block, but the household loads are connected only as single phase. In lower-density areas, only a single phase might be used for distribution. Some high-power domestic appliances such as electric stoves and clothes dryers are powered by two or three phases instead of one in order to use lower currents, so households with such appliances must be provided with more than one phase.

Phase selector is a system that is capable of comparing three phases and switching automatically to any of the three phases which is available. The system consists of three main parts namely; the transformer, logic gates and electrical switching device (relay).The transformer used here is the step down type of transformer (it step down 240v to 12v) and these transformer is feed in with different phase voltage, rectified and smooth. Then fed into the opto-coupler that has positive output. The opto-coupler outputs were connected to logic gates. Here AND & NOT gate is used. We call the logic gates as the brain of the system because these logic gates are connected in a way that each of them will give out an output.

## II. CIRCUIT DIAGRAM & COMPONENTS

Commercial or domestic power supply system where three phase is available, it is advisable to have an automatic changeover system for uninterrupted power to critical loads in the event of missing phase. In this system auto switching is achieved by using a set of relays interconnected in such a way that if one of the relay feeding to the load remains energized always. Under the phase failure condition the corresponding step down transformer secondary delivers zero voltage which is duly rectified to DC and then fed to the logic gates comprising of AND & NOT to switch on the next relay that delivers the power to the load. It also has a provision of connecting to an inverter source which delivers uninterrupted power to the load in case all the 3 phases go missing. The project is supplied with three transformers connected to the 3 phases supply. Further the project can be enhanced by incorporating power semiconductor devices such as thyristors /IGBTs for instantaneous changeover to the next available phase. This overcomes the drawback of the changeover time generally witnessed by relay switching operations.

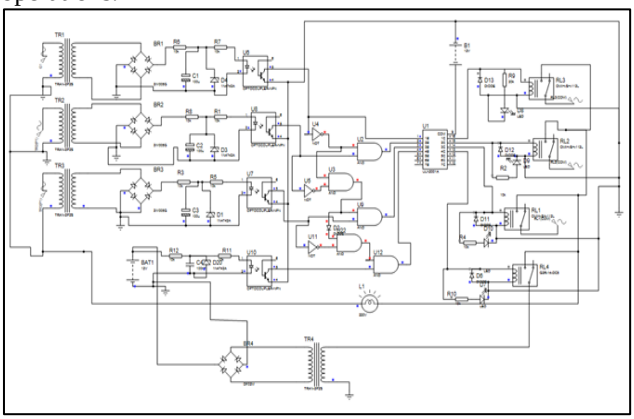

Fig. 1: Circuit Diagram

| 12 Resistors | | |
|---|---|---|
| Quantity: | References | Value |
| 12 | R1-R12 | 10k |
| 4 Capacitors | | |
| Quantity: | References | Value |
| 3 | C1-C4 | 100u |
| 13 Integrated Circuits | | |

 

| Quantity: | References | Value |
|---|---|---|
| 1 | U1 ULN2001A | |
| 5 | U2, U3, U9, U12, U22 | AND |
| 3 | U4, U5, U11 | NOT |
| 4 | U6-U8, U10 | OPTOCOUPLER |

Table 1: Component List

| 13 Diodes | | |
|---|---|---|
| Quantity: | References | Value |
| 4 | D1, D3, D4, D20 | 1N4742A |
| 5 | D2, D6, D11-D13 | DIODE |
| 4 | D7-D10 | LED |
| 15 Miscellaneous | | |
| Quantity: | References | Value |
| 2 | B1, BAT1 | 12V |
| 3 | BR1-BR3 | 2W005G |
| 1 | BR4 | DF02M |

| | | |
|---|---|---|
| 1 | L1 | 220V |
| 3 | RL1-RL3 | OMIH-SH-112L |
| 1 | RL4 | G2R-14-DC5 |
| 4 | TR1-TR4 | TRAN-2P2S |

## III. WORKING PRINCIPLE

The main 3 phase supply is stepped down to 12 V by 3 single phase transformers attached to each phase and an Inverter. Then the 12V is passed through full bridge rectifier and we obtain 12 V DC supply which is required for running the opto-coupler, relay drivers , NOT and AND gate. The opto-coupler isolates the circuit from the supply. The three phases are connected with the relay driver via the NOT & AND gate.

In normal working condition when there are no faults, the first phase supplies the single phase load and the relays of the other phases remain normally open. When fault occurs in that phase, the NOT & AND gate sends a low signal to the relay driver and the relay connected to the next healthy phase becomes normally closed and thus the supply to the single phase load remains unaffected. If three phase fault occurs and all the phases are unavailable then a separate connection can be made by another port of relay driver, relay and NOT & AND gate connected to alternate power source like inverter or battery.

### *A. Priority Switching of the Active Phase*

1) When no fault or any two phases ‘b-phase’ or ‘c-phase’ create fault then ‘a-phase’ terminal 1 is not connected to any gate and direct HIGH signal through U6 opto-coupler goes to relay. Hence the active phase is ‘a-PHASE’.
2) When fault occurs in ‘a’- phase', the output from opto-coupler 1 is LOW i.e. 0. Thus the output of U6 NOT gate is 1 and the output of U6 opto-coupler is also HIGH i.e. 1. Hence we get HIGH output from the U2 AND gate. Output of U5 NOT gate is LOW which is fed to U3 AND gate. The other input of U3 gate is from U6 and thus we obtain LOW output from U3 gate which is again fed to U9 AND gate. The other input for U9 AND gate is from U8 opto-coupler which is HIGH. Thus the overall output of U9 gate is LOW. Hence the active phase is ‘b- PHASE’
3) When fault occurs in b –phase and ‘a-phase’, the output from U6 & U7 opto-coupler is LOW i.e. 0. The other one phases and inverter are available, so the output of U8 opto-coupler is HIGH. The output of U6 NOT gate is HIGH i.e. 1 and ‘b-phase’ is LOW. Thus we get LOW output from the U2 AND gate. Output of U5 NOT gate which is fed by the HIGH output of U7 opto-coupler is LOW which is fed to U3 AND gate. The other input of U3 gate is from U6 and thus we obtain HIGH output from U3 gate which is again fed to U9 AND gate.

The other input for U9 AND gate is from U7 opto-coupler which is HIGH. Thus the overall output of U9 gate is HIGH. Hence the active phase is ‘c PHASE’

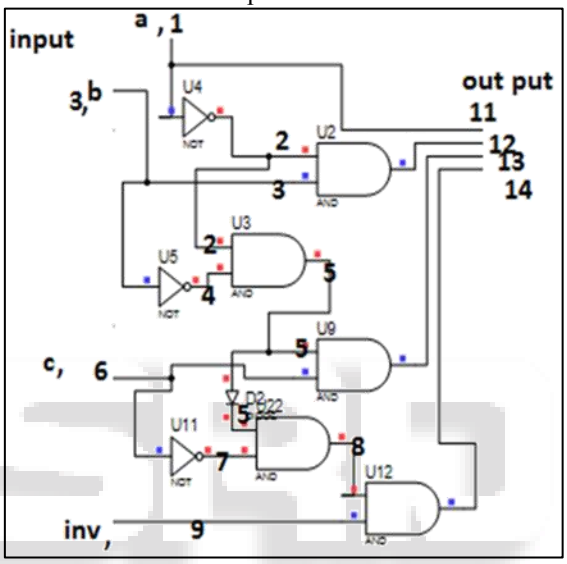


Fig. 2: Logic Circuit

4) When fault occurs in all -phase, the output from inverter U10 opto-coupler is HIGH i.e. 1. The ALL phases are unavailable, so the output of U6 opto-coupler is LOW. The output of U6 NOT gate is LOW i.e. 0 and ‘b-phase’ also LOW. Thus we get LOW output from the U2 AND gate. Output of U5 NOT gate this is fed by the HIGH output of U7 opto-coupler is LOW which is fed to U3 AND gate. The other input of U3 gate is from U6 and thus we obtain HIGH output from U3 gate which is again fed to U9 AND gate.

The other input for U9 AND gate is from U8 opto-coupler which is LOW. Thus the overall output of U9 gate is LOW. Output of U3 AND gate which is fed by the HIGH output of U22 and other input of U22 from U11 NOT gate HIGH output i.e. 1 . U8 opto-coupler is LOW which is fed to U11 NOT gate. U22 AND gate output is HIGH i.e. 1. Output of U22 AND gate which is fed by the HIGH output of U12 and other input direct inverter i.e. 1.Hence the active phase is ‘inverter’.

| Input | | | | | | | | | Output | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a | b | c | inv | | | | | | A | B | C | INV |
| 1 | 3 | 6 | 9 | 2 | 4 | 5 | 7 | 8 | 10 | 11 | 12 | 13 |
| 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

Table 2: Input & Output Table

| a | b | c | inv | SWITCHING OF PHASE |
|---|---|---|---|---|
| 0 | 0 | 1 | 1 | c phase activated |
| 0 | 1 | 0 | 1 | b phase activated |
| 1 | 0 | 0 | 1 | a phase activated |
| 0 | 0 | 0 | 1 | Inv Inverter activated |

Table 3: Priority Table

## IV. RESULT

When there is fault in any one phase it automatic switches to another available phases. By doing this, the time required for switching between the phases have been drastically reduce. It reduces the effort of manual operation and switches to another phase very quickly. So this auto selection can reduce the problems faced due to single phase faults.

### *A. Advantages*

1) More Reliable.
2) Provide Constant Voltage.
3) High Stability.
4) Zero man-made Errors.
5) Continuous running of single phase loads.
6) Better Customer Service.

### *B. Application*

1) Residential.
2) Commercial offices.
3) Factories operating with single phase machineries.
4) Hospitals/Banks.
5) Institutions.
6) It automatically supplies voltage in case of power failure or low voltage in up to 2 of the 3 incoming phases.

## V. CONCLUSION & FUTURE SCOPE

### *A. Conclusion*

The AUTO SWITCHING OF ANY AVAILABLE PHASE IN A THREE PHASE SUPPLY SYSTEM is an advanced technique which is used not only for automation but also is one of the techniques for power quality improvement. This is a safe method for changeover of phases as it uses IC MCT2E OPTO COUPLER which is high frequency switch that works on infrared radiation and it does not contain any mechanical contacts. This digital phase selector also takes power from inverter which made this devise highly reliable and its compact size made this device to be used for house hold purposes.

### *B. Future Scope*

This auto switching of any available phase in a three phase supply system is used for house hold purpose and by development of high power opto couples we can extend the use of this device in substations and power stations.

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