Automatic Active Phase Selector for Single Phase Load from Three Phase Supply

Vaibhav Bhagwan Wani, Anjali V. Naik

Department of Electrical Power System, MGM'S Jawaharlal Nehru Engineering College Aurangabad, India

Corresponding author:Vaibhav Bhagwan Wani, Email: vaibhavwani11@gmail.com

Generally, in a three-phase distribution system, almost 60 to 70 percent of faults that occur on a line are single-phase faults. Due to the fault occurring on the single-phase, it automatically cut out that faulty phase from the three-phase system electrically. The load connected to that phase is disconnected from the power supply. And nowadays in industry, office, or domestic use, there is a general problem, which is the phase absence out of the three-phase. Due to the absence of that one or two phases, some electrical system and loads connected on the live phase is ON in one section of the industry and OFF in another section of the industry. It becomes a cause of disturbance in routine work. In this project, the model is designed to check the availability of the active phase. After detecting the active phase load is shifted to it. Even if only one phase is available out of three, electricity will be used to provide the load. All the phases connected to the system are continuously checked by the controller for detecting the live condition of the phase. The controller checks all of the phases linked to the system on a regular basis to see if they are still active or not. The GSM module sends a message of an unavailable or faulty phase to the technician. Relays are used by the controller to link the load to the live phase. And the transistor is used for driving those relays. When two or three phases are live, phase one is always utilized as the default phase to connect the load. On the LCD display, the phase availability is displayed.

Keywords: Active phase selector, GSM module, Relays, Microcontroller, Single phase load, Three-phase supply.

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1 Introduction

There are still many countries in the world where there is not enough electricity generation. As a result, consumers do not get enough power supply. Some developing countries like India are trying to generate abundant electricity and supply it to the consumers. However, due to some technical reasons, the power supply does not reach properly to the consumers. In today's 21st century, electricity has become an essential human resource. Today the load that is readily available in the market is powered by electricity such as electric cars, E-vehicles, medical equipment, and other electrical loads.

It is safe to say that almost all the world's economy is dependent on electrification. In the same way, if the companies and the private sector which are contributing to the economy, get interrupted power supply, it could have a big impact on the company's profit and also on the country's economy. Many of the company's machines, medical equipment, and other such loads need a regular power supply for their operations. But even if the power supply is cut off due to a fault occurring on the phase to which these loads are connected and there is a power supply in the other two phases, we cannot use it [1]. So, we have created a system that we can use the power supply for the rest of the phase. Even if one of the 3 phases is available, the system will continue to supply power to the single-phase load [2][3].

The most common faults in a distribution system are single-phase faults. In which, the power supply in the faulty phase is not available but the rest of the phase has a power supply. Generally, all the three-phase connections are available in any industry or a hospital, and a single-phase load is there in use, in the case of phase absence we can shift the single-phase load to the active phase with the help of an automatic active phase selector [4]. The main problem is that in industry or high power-consuming commercial and residential buildings during fault conditions the single-phase load on the faulty phase are get shifted to the next live phase [5]. If the fault occurred on the R phase, then all the single-phase load connected to the R phase gets shifted to the B phase, and the active load on the B phase get increases. Because the B phase already has some load on it. During this situation the voltage available for each load gets varied. And due to any fault condition, the load connected to that respective phase gets disconnected from the phase, to overcome this problem GSM Module is used for sending the message to the technician. Technician gets the message of exact faulty phase that which phase is unavailable. The technician clears the fault in that phase. The fault can be a breakdown of the fuse, a loose connection between the contactor, etc. After the fault is cleared by the technician the single-phase load will shift to its original phase.

In this project, automatic active phase selection is done with the help of relays. Three separate relays are used in a three-phase supply. Each time a single relay is always connected with the single-phase load for supplying electric power through it [6]-[8]. A separate single-phase step-down transformers are used in each of the three R Y B phases. The step-down transformers are used to convert a voltage of 230v to a 12v supply. The microcontroller continuously detects the supply coming from the step-down transformer. When the output of the transformer is different than the reference value set by the microcontroller or stops giving a signal to the microcontroller ADC port, the microcontroller detects the transformer whose power supply is varied or disconnected. Then the microcontroller will send a signal through the transistor controller to switch to the next relay and shift the load to the next phase. The microcontroller also sends a signal to the GSM module for sending the SMS of the unavailable phase to the technician. The load will shift to the next active phase and the electric supply is continuously supplied to the load without any disturbances.

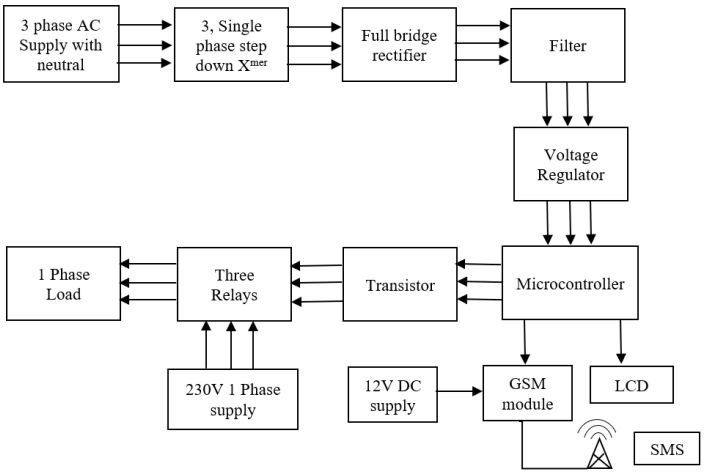

Figure 1. Block Diagram

2 System Configuration

A. Text Block Diagram Description

In the current busy and time punctual world we know the importance of automatic changeover of the system. This project is designed to check the availability of all the live phases, and the load will be connected to the specific live phase only. The load will be connected to that phase and the load will be in ON condition. The block diagram shows the overall structure of the automatic active phase selector. In this block diagram, we use three step-down transformers, three rectifier circuits, three filters, and three thyristor-controlled relays for RYB phases. One microcontroller, LCD display, and GSM module are used, respectively.

1) Power Supply Unit

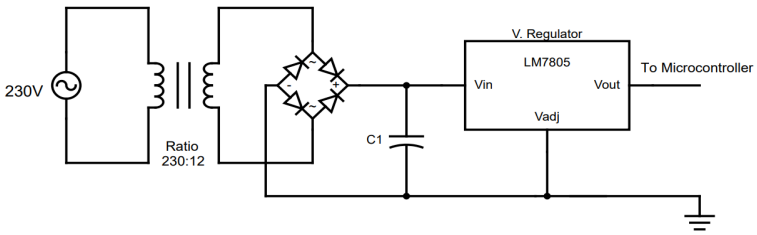

Figure 2. Power Supply Circuit

a) Supply And Transformer: First, the 230V three-phase with neutral wire supply is provided to the system. These three-phase are connected separately to the three separate single-phase step-down transformers. The transformers step down supply from 230v to 12v AC.
b) Rectifier: A Full-bridge rectifier is used for the conversion of AC supply to DC power supply. This rectifier is made up of four diodes that convert AC voltage to DC voltage. For the first positive half cycle of the AC sinusoidal waveform, the first two diodes are works in forward biased and convert AC into DC, and for the negative half cycle, the next two diodes work in forward biased and convert AC into DC supply. And this full AC sinusoidal waveform is converted into pulsating DC.
c) Filter: After that the conversion of AC to DC, the DC supply has some impurities of AC. The impurities in the supply can damage the component of the system due to the heating effect. Therefore, the pulsating DC is converted into pure DC with the help of a capacitor filter. The capacitor used in the system to removes the AC content from the DC supply and makes it pure DC for proper functioning.
d) Voltage Regulator: Next is the voltage regulator, the voltage regulator IC regulates the 12v to 5v DC supply. This regulated supply is for the operation of the microcontroller.

2) Control Unit

a) Microcontroller: Microcontroller is from the 8051 families. The 8-bit, 40-pin AT89S52 microcontroller IC is used for controlling the system. The operating voltage of the microcontroller is from 4v to 5.5v and it has 256 bytes of RAM. The microcontroller identifies the incoming live phase from the three-phase supply.

b) GSM module: GSM module sim 800 is used to send SMS. It can transmit voice, SMS, and data information with lower power consumption. Its size is 24*24*3mm which is small and perfect for transferring wireless data easily. An externally 12v supply is given to the GSM module for its operation. Here message sent from the GSM module of the faulty phase will be received by the technician and he will try to solve the fault problem.

Figure 3. GSM Module

c) LCD Display: The liquid crystal display LCD of 16*2 is used for showing the live status of the phase and phase voltage. The Display interfaced with the microcontroller.

Figure 4. LCD Display

3) Switching Unit

a) Transistor: The transistors are operating as switching devices. The NPN transistor of the three-terminal Emitter, Base, and Collector is used for switching the relays. The output of the transistor is given to the relay circuit primary side.
b) Relay: Relay is used as a switching device in this project for shifting the load from the unavailable phase to the live phase. All three phases are connected to the single-phase load through the secondary side of each relay circuits.

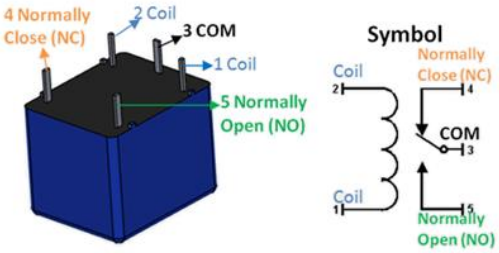

Figure 5. Relay Circuit

B. Working of System

Three RYB phases with one neutral wire are taken from the distribution system and a three-phase supply is provided to an automatic active phase selector in its power section. Three separate single-phase step-down transformers are used in all the RYB phases. The step-down transformer converts the 230v to a 12v AC supply. The automatic active phase selector system works only on a DC power supply, therefore this 12v supply is then given to rectifier circuits to convert it into an AC to DC form. A rectifier with four diodes converts AC into DC supply. But this supply has some impurities of AC which are an abstraction to the working of the system. Next, the 12v DC supply is given to the capacitor filter circuit. This filter circuit removes the impurities of AC in the supply and converts pulsating DC into pure DC supply. The microcontroller of our system controls the 5v DC supply only therefore filtered supply is next given to the voltage regulator to regulate the 12v supply to 5v DC.
Here we used the microcontroller from the 8051 families. The 8-bit, 40-pin AT89S52 microcontroller IC is used for controlling the system. 5v DC supply of all three voltage regulators is given to the ADC port of the microcontroller, and the microcontroller identifies the incoming supply from all three phases and compares it with a reference voltage continuously. The microcontroller detects the live phase continuously. If any phase is missing there or doesn't match the reference voltage, then the microcontroller sends a signal to the thyristor to switch the next relay ON. Then instantly relay shifts the load from the unavailable phase to the next live phase. A 16*2 display shows the live condition of the phase on which loads are connected. The microcontroller identifies the exact faulty phase and gives the

command to the GSM module to send a message of the faulty phase to the technician.

3 Results And Discussion

The system uses the three-phase four-wire with neutral. The automatic active phase selector is connected between the three-phase connection and a single-phase load. The incoming supply which is connected to the step-down transformer is also connected to the single-phase load through the relay's secondary side. Whenever any phase voltage detects a different voltage than the reference value, and the phase is absent, then the relay shifts the load to the next live phase. The system can be used where several single-phase loads are used and it is not possible to provide an external power supply other than the grid main supply for each load.

Figure 6. Microcontroller 8051 with Display

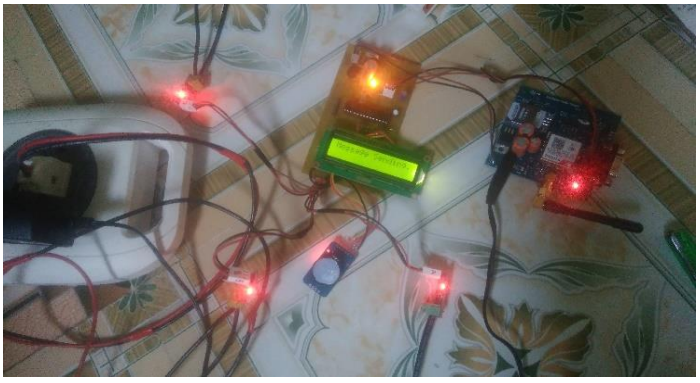

Figure 7. Actual Model Automatic Active Phase Selector

4 Conclusion

The common problem that occurs in the system is when anyone phase is unavailable and can't supply the power to load, that problem is solved by using an automatic active phase selector. By using this system, we can prevent the load from the unavailability of supply during the faulty situation. By automatically detecting the live phase, the load automatically shifted from the unavailable phase to the next available live phase with the help of a relay circuit. And the GSM module is used to send a text message of the faulty phase to the technician. The main objective of this system is to provide an

uninterrupted power supply to the load for its continuous and unbreakable work.

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