Automatic Phase Changer

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Abstract: -

power interruptions are a significant issue, leading to wasted time and financial losses for consumers. About 70% of faults in the power system are single-phase faults, where power remains available in the other two phases. However, the inability to utilize this available power without manual intervention poses risks of fire accidents and reliability issues.

An Automatic phase changer would automate the process of switching to the phase with available power, eliminating the need for manual intervention and reducing the risks of accidents and unreliability. This solution would greatly enhance the efficiency and safety of power distribution systems in residential areas.

Introduction: -

To ensure uninterrupted power supply, an automatic change-over switch system can be implemented. This system would monitor the presence of supply to the three phases and display the condition of each phase on an LCD screen. Typically, manual intervention is required to start the generator and switch from the public supply to the generator when the supply is interrupted. However, in critical facilities like hospitals and airports, where uninterrupted power is crucial for saving lives or maintaining operations, manual switching poses risks and delays.

An automatic change-over switch system would eliminate the need for manual intervention in such critical situations. The electronic control unit would continuously monitor the incoming public supply voltage and detect when it drops below a level where electrical gadgets cannot function reliably. At that point, the system would automatically switch from the national power supply to the generator, ensuring a seamless transition without any interruption.

This automation addresses several limitations of manual switching:

1. Elimination of manual gear turning: Manual intervention is no longer required to switch between power sources, reducing reliance on manpower and streamlining the process.

2. Selection of the phase sequence: The automatic system can intelligently select the optimal phase sequence for power supply, ensuring efficient operation without the need for human intervention.

3. Ability to select between phases: Unlike manual switching, where the phase selection is limited, the automatic system can dynamically select the best phase based on the availability and quality of the power supply, enhancing reliability and efficiency.

Methodology: -

A. Design Development and Considerations

When designing the phase selector control, several conditions and considerations need to be taken into account to ensure its effectiveness and reliability, especially in regions like Nigeria where power supply fluctuations are common and notification systems may be lacking. Here are some key conditions and questions to consider:

1. Voltage and frequency specifications: Assume a power supply of 240V single-phase for the three-phase system, operating at a frequency of 50Hz. These specifications are crucial for designing components that can handle the expected voltage and frequency levels.

2. Load requirements: Consider a load of 10 kilowatts (kW). This load specification will influence the design of the phase selector to ensure it can handle the required power output without overloading or causing issues with the electrical system.

3. Handling simultaneous power loss: Address the scenario where the entire three-phase system experiences a power outage simultaneously. In such cases, the phase selector needs to determine how to select one phase out of the available options to maintain power supply to essential loads.

Incorporating these conditions and questions into the design process will help ensure that the phase selector control is tailored to the specific requirements and challenges of the local power supply environment. It will also help in developing a robust and reliable system that can effectively manage power supply fluctuations and ensure uninterrupted operation of critical equipment.

B. Operation Description of the Circuit

The operation of the circuit is designed to ensure uninterrupted power supply to equipment in three-phase applications, even if low voltage is available in one or two phases. Here's how the circuit works, focusing on the operation of the R phase:

1. Voltage Stepping Down: The voltage of the R phase is stepped down by transformer X1 to deliver 12V, 300mA.

2. Rectification and Filtering: The stepped-down voltage is rectified by diode D1 and filtered using capacitor C1 to produce the operating voltage for the operational amplifier (IC1).

3. Voltage Comparison: The voltage at the inverting pin 2 of operational amplifier IC1 is compared with the reference voltage set by resistor R1 and variable resistor VR1. The reference voltage at the non-inverting pin 4 is fixed to 5.1V through zener diode ZD1.

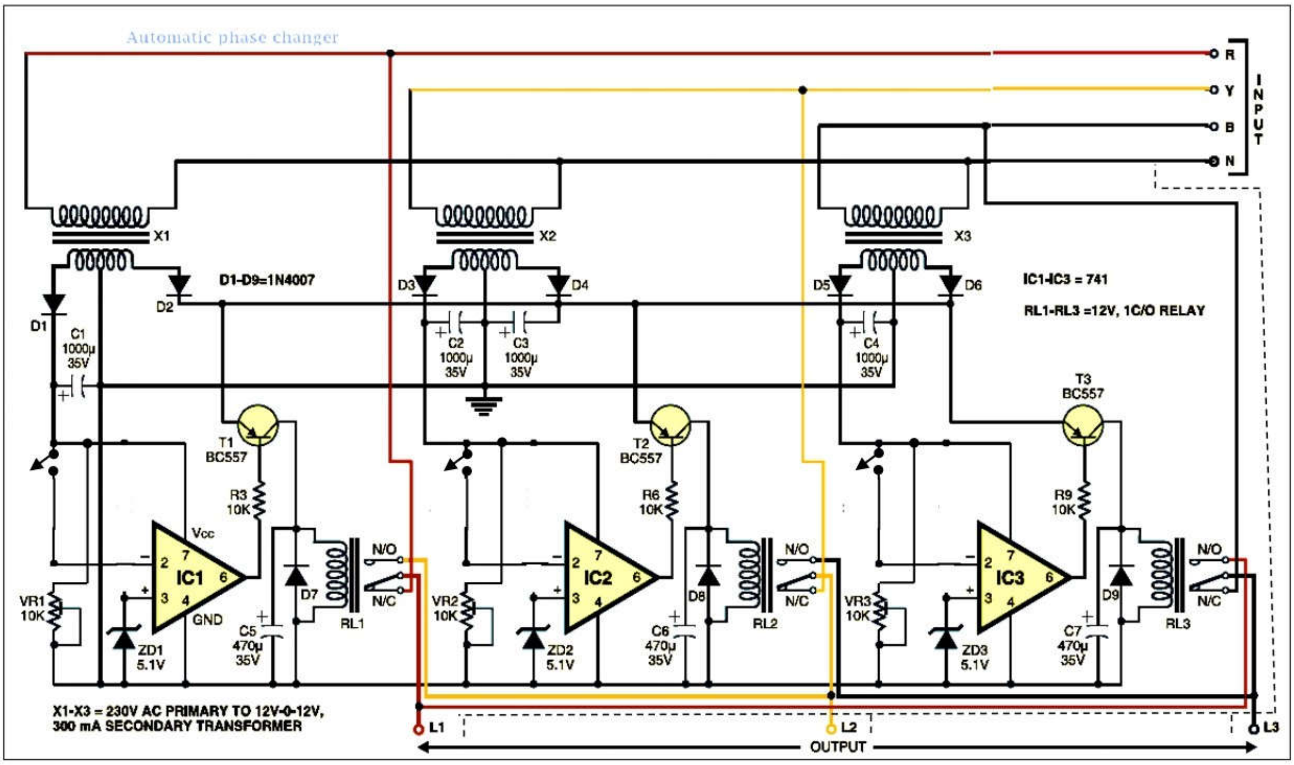
4. Relay Control: When the supply voltage available in phase R is within the range of 200V-230V, the voltage at the inverting pin 2 of IC1 remains higher than the reference voltage of 5.1V. As a result, the output at pin 6 of IC1 remains high. This keeps transistor T1 non-conducting, and relay RL1 remains de-energized. The load L1 is supplied power via the normally closed (N/C) contact of relay RL1.

5. Phase Changeover: If the voltage of phase R drops below 200V, the voltage at the inverting pin 2 of IC1 falls below the reference voltage of 5.1V, causing the output at pin 6 to go low. This activates transistor T1, energizing relay RL1. Consequently, load L1 is disconnected from phase R and connected to phase Y through relay RL2.

6. Additional Phases: Similar operations are carried out for the remaining two phases, via phase Y and phase B, ensuring seamless auto phase-change to maintain uninterrupted power supply.

7. Mains Power Switch: Switch S1 serves as the mains power on/off switch, controlling the overall operation of the circuit.

By utilizing this circuit design, equipment can be operated even when correct voltage is available on any single phase in the building, ensuring reliability and continuity of power supply



. Fig.1 : Circuit Diagram of Automatic Phase Change

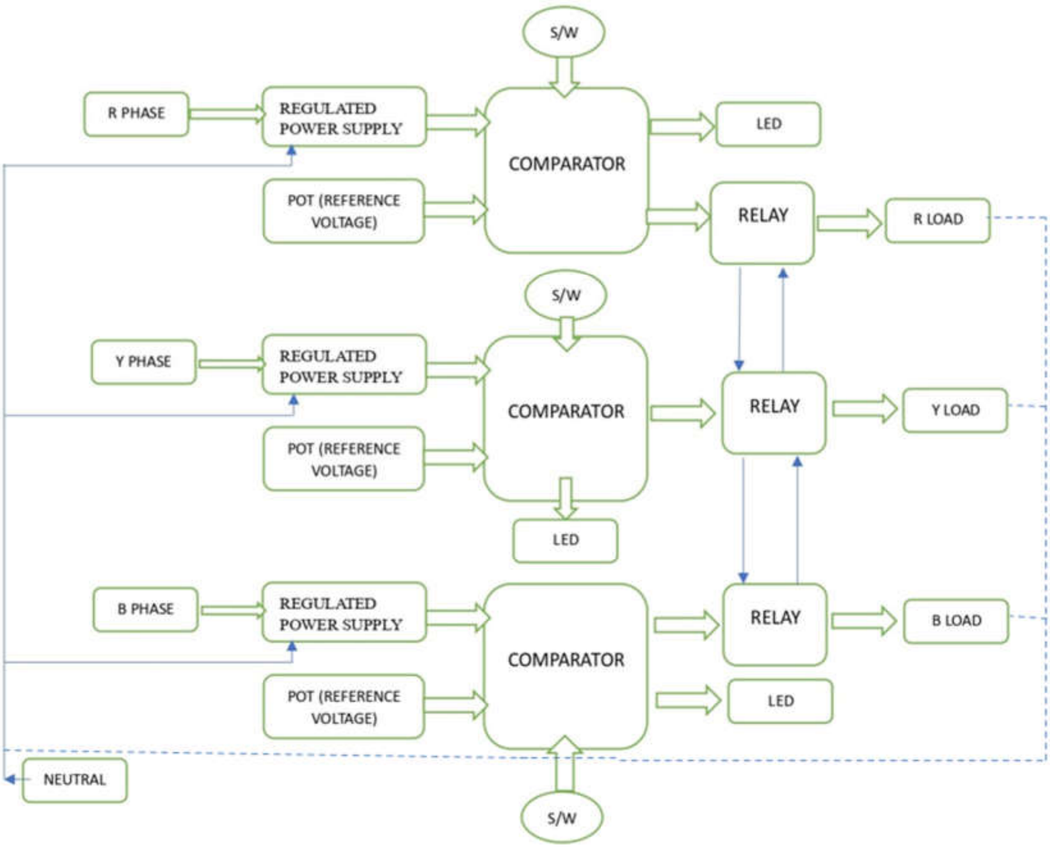


Fig 2. Block Diagram of Automatic Phase Change

Components & Equipment Required: -

Component names	Rating	Quantity
Step down transformer	(220v -9v),300Ma	3
Transistor	(T1-T2-T3) Bc=557	3
Relay	(RL1-RL3)12v 1c/o relay	3
Zener diode	(ZD1-ZD3) -5.1volts	3
Variable resistances	(VR1-VR3)=10k	3
Resistances	(R1-R2-R4-R5-R7-R8)=3.3k,R3-R6-R9=10k)	9
Diode		9
Capacitor	(C1-C4=100uf)25v,C4-C7=470uf)35v	7
Wires		As req.

Result: -

In an Automatic Phase Changer, three Op-amps function as comparators. The reference voltage at the inverting pin (pin 2) is set to 5.1V through a POT. Under normal conditions, the voltage at the non-inverting pin (pin 3) remains high, keeping the output of the comparator at 12V. Consequently, the PNP transistor remains off. When the input phase voltage drops to zero, the voltage at pin 2 becomes higher than at the non-inverting pin 3, causing the output of the comparator to go low. This triggers the PNP transistor to conduct, which in turn energizes relay RL1, disconnecting the load from the affected phase and connecting it to an alternate phase through another relay.

As a result:

1. "If the input voltage of the R phase is zero or if any fault occurs in the R phase, then the R phase load switches to phases Y and B. The load is then equally distributed across these phases with the assistance of a compensator and relay."

2. "If the input voltage of the Y phase is zero or if any fault occurs in the Y phase, then the Y phase load switches to phases R and B. The load is then equally distributed across these phases with the assistance of a compensator and relay."

3. "If the input voltage of the B phase is zero or if any fault occurs in the B phase, then the B phase load switches to phases R and Y. The load is then equally distributed across these phases with the assistance of a compensator and relay."

4. "If the input voltage of the two-phase RY is zero or if any fault occurs in the RY phase, then the load from the RY phase switches to phase B. However, the load on the RY phase may fluctuate due to an overload in phase B."

5. "If the input voltage of the two-phase RB is zero or if any fault occurs in the RB phase, then the load from the RB phase switches to phase Y. However, the load on the RB phase may fluctuate due to an overload in phase Y."

6. "If the input voltage of the two-phase YB is zero or if any fault occurs in the YB phase, then the load from the YB phase switches to phase R. However, the load on the YB phase may fluctuate due to an overload in phase R."

Future Scope: -

The automatic phase changer has become indispensable in today's world, offering solutions to power interruptions that previously required manual intervention. In the past, during power failures in any of the three phases, manual switching to an available phase was necessary. However, with the implementation of automatic phase changers, this process is automated, seamlessly shifting to a phase where current voltage is available without the need for human intervention. This advancement has greatly improved efficiency and reliability in managing power supply interruptions, demonstrating the importance of technology in modernizing essential infrastructure.

Conclusions: -

The automatic phase changer project aims to deliver an uninterrupted power supply to the load, offering superior performance. Ensuring continuous power at a low cost is crucial for optimal system operation. An automatic phase changer efficiently maintains a consistent power supply by monitoring voltage levels across three phases. It continuously measures and compares the voltage of each phase. If it detects a deviation from the desired voltage, it automatically switches to another phase, ensuring a seamless power supply.

This technology enhances system reliability and represents an advancement over previous designs that required three transformers. The new design reduces the size of the printed circuit board (PCB) and the overall complexity of the circuit, resulting in cost savings. Its reliability makes it suitable for use in various settings, and its affordability broadens its range of applications.