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DESIGN AND DEVELOPMENT OF AN AUTOMATIC SINGLE-PHASE CONTINUOUS LOAD SWITCHING SYSTEM USING THREE PARALLEL TRANSFORMERS

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ABSTRACT -

We encounter phase absence, absence of phase, or drifting phase in almost every sector, home, and workplace. One or two of the three phases of a three-phase supply may not be operational. Because of this, some of those electrical equipment will occasionally be on in one area and off in another. A typical workflow will be disrupted since most tasks will need to adapt to the new standard. Additionally, load demand is rising every day; the issue that most customers are encountering is power failure. Because of this power break lot of havoc is wrought on household gadgets and sometimes even life. The difficulty of power pause rises from single phase faults in a distribution system but power is available in other phases. As it can be noticed, most of the domestic loads are intermittent, and normally have a spanning life smaller than the lifespan of the distributed generation plant, we find that they are connected to a single phase supply and if this fault occurs on any of the phases and the power is available in the other phases we cannot make use of this power.Other considerations One would therefore require to switch from one phase to other and auxiliary supply at any one time there is power failure in the one or the three phases of the power supply.

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I. INTRODUCTION

The solutions being suggested are mainly focused on the availability of electricity for both necessary and non-essential loads due to the frequency of disruptions in emerging nations like India. One of the main problems is suboptimal generation capacity; power outages are common and impact both the public and commercial sectors, including businesses, banks, hospitals, and numerous other facilities. These facilities contain important loads that require constant power supply in order to maximize operations and prevent needless In answer to the requirement, this VP introduced an automated three-phase selector system that guarantees a quick and simple power switch between various sources and loads. The automatic selector is programmed to remain on alert for the supply voltage signals that fall below a level which is sufficient to drive the electrical or electronic devices. As a result of the comparator circuit voltage levels across all the three phases will be assessed. If any two phases running at then the selector moves the load from the mains to the backup generator or the other source. However, the automatic selector system has provision that the feedback current to the load when powered by other sources does not affect the operation this makes it safe to use and ensures continuity. In addition, about power sources it keeps the synchronized status and does not allow varying or rms fluctuations. imbalances during the transition between the two of them. This anti momentary transition ability is critical in circumstances where constant power is important or a must have by sparing the time of the relevant business functions from having to handle power blacks outs.

Implemented as an automatic three-phase selector, the system provides a near-single supply power transfer with limited interruptions of service and maximum efficiency in the sector's consumptions while promoting the constant operation of the necessary services despite the instabilities in power delivery. It is apparent therefore that this system has this significant function of filling voids between supply fluctuations and demand for consistent reliable and steady electric power in the various areas of application.

1.1 PROBLEM STATEMENT

One of the most crucial needs for residential, commercial, industrial, and institutional uses in today's electrical power distribution systems is the maintenance of an uninterrupted power supply. For safe and effective operation, a number of critical electrical loads, including industrial control systems, computer networks, medical equipment, communication systems, and security systems, need constant power. Even a brief power outage can cause equipment malfunction, productivity loss, financial loss, and safety hazards. A single transformer provides electrical energy for the majority of traditional single-phase power systems. When an overload, overheating, or insulation occurs in the transformer breakdown, internal faults, voltage instability, or requires scheduled maintenance, the entire load loses power. Since conventional systems generally depend on manual changeover arrangements, restoring the power supply takes considerable time and requires human intervention. This delay not only affects productivity but also increases maintenance costs and reduces overall system reliability.

Another major challenge is the lack of continuous monitoring of transformer health. In many installations, transformer faults are detected only after the power supply has already been interrupted. The absence of an automatic fault detection and switching mechanism increases the possibility of transformer damage and reduces the operational life of electrical equipment. Moreover, repeated overloading of a single transformer while standby transformers remain unused results in poor utilization of available resources and inefficient energy management.

Existing manual switching systems are also prone to operational errors, delayed response, contact sparking, and safety hazards. These limitations make them unsuitable for applications where uninterrupted power is essential. Therefore, there is a growing need for an intelligent and automated load switching system capable of detecting transformer faults instantly and transferring the electrical load to a healthy transformer without affecting the connected equipment.

II. OBJECTIVES

1. To use three transformers linked in parallel to create an automated single-phase continuous load switching system.
2. To guarantee a continuous power supply by automatically shifting the load to a healthy transformer in the event that the active transformer fails.
3. To shorten the duration of power outages by using dependable and quick automated switching.
4. To increase the power distribution's dependability and continuity for single-phase loads
5. To use automated control logic to shield electrical equipment against voltage loss and transformer failure.
6. To distribute the load evenly across the three parallel transformers in order to maximize efficiency and extend transformer life.
7. To reduce human error and maintenance effort by doing away with manual involvement in transformer switching.

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8. To create an economical and effective automatic load switching system that can be used in both home and commercial settings.

III. LITERATURE SURVEY

1. Study of Parallel Transformer Operation : Previous studies show that operating transformers in parallel increases system reliability, improves load sharing, and allows continuous power supply during maintenance or transformer failure.

2. Automatic Load Transfer Systems: Many researchers have developed automatic load transfer systems using relays and contactors to switch the electrical load from a faulty source to a healthy source with minimal interruption.

3. Relay-Based Protection Systems : Relay logic has been widely used in electrical distribution systems for fault detection, overload protection, and automatic switching because of its simplicity, reliability, and low cost.

4. Microcontroller-Based Switching Techniques: Recent research focuses on microcontroller-based automatic switching systems that monitor voltage and current continuously, providing faster response, higher accuracy, and better control than conventional systems.

5. Voltage Monitoring and Fault Detection : Several studies emphasize continuous voltage monitoring to detect transformer faults such as under-voltage, over-voltage, or complete transformer failure, ensuring quick load transfer and equipment protection.

6. Continuous Power Supply Systems: Literature highlights that uninterrupted power supply is essential in hospitals, industries, communication systems, and commercial buildings, making automatic transformer switching systems highly beneficial.

7. Research Gap : Most existing systems use only two transformers or manual changeover methods. There is limited work on an automatic single-phase continuous load switching system using three parallel transformers, which can further improve reliability, reduce downtime, and enhance power availability.

8. Proposed Contribution : The proposed project develops an automatic control system that continuously monitors three parallel transformers and automatically transfers the load to the next healthy transformer during failure, ensuring uninterrupted power supply, improved reliability, and reduced maintenance effort.

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IV. PROPOSED SYSTEM

The design and development of an automated single-phase continuous load switching system utilizing three transformers linked in parallel is the basis of this project's technique. To identify the proper transformer ratings and protection needs, the system's power requirements and operating circumstances are first examined. To comprehend current transformer changeover systems, relay logic, voltage sensing techniques, and automatic control methods, a thorough literature review is carried out. This research leads to the preparation of an appropriate system design with three parallel transformers, relays, contactors, voltage sensing circuits, circuit breakers, and a control unit.

The system continuously monitors the output voltage and operating condition of each transformer. Under normal conditions, the load is supplied by the primary transformer. If the primary transformer develops a fault, experiences voltage failure, or is unable to supply the load, the control circuit immediately detects the fault and disconnects the faulty transformer. The load is then automatically transferred to the second transformer without manual intervention. Similarly, if the second transformer also fails, the system switches the load to the third transformer, thereby ensuring continuous power supply with minimum interruption.

After completing the hardware assembly, the system is tested under various operating conditions, including normal operation, transformer failure, voltage fluctuation, and overload conditions. The switching response time, voltage stability, load continuity, and overall system dependability is quantified and examined. The effectiveness of the suggested system is confirmed by comparing the experimental findings with the design goals. Circuit schematics, hardware implementation specifics, testing protocols, findings, conclusions, and future scope are all included in the project's documentation. For single-phase residential, commercial, and industrial applications, the designed system offers a dependable, affordable, and effective way to provide an uninterrupted power supply..

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4.1 BLOCK DIAGRAM

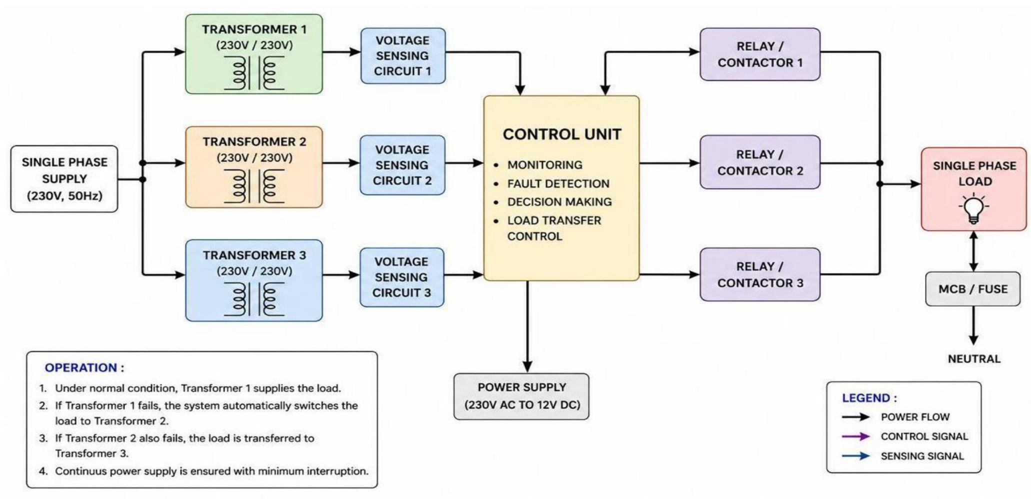

Fig 1: Block diagram

By automatically shifting the load from one transformer to another in the event of a malfunction, the Automatic Single-Phase Continuous Load Switching System Using Three Parallel Transformers is intended to give single-phase electrical loads a steady and dependable power supply. Three parallel single-phase transformers, an Arduino microcontroller, voltage sensor circuits, relay modules, and protective components make up the system. This project's primary goal is to guarantee the continuous operation of vital electrical equipment by removing power outages brought on by transformer failures or voltage swings.When the system is switched ON, all three transformers receive the input supply simultaneously. The voltage sensing circuits continuously monitor the output voltage of each transformer and send the measured values to the microcontroller. The controller compares these values with the preset voltage limits to determine whether each transformer is operating normally. During normal operation, Transformer T1 acts as the primary source and supplies power to the load through Relay-1, while Transformers T2 and T3 remain in standby mode. The controller continuously monitors all transformers to ensure that the supply voltage remains within the acceptable range electrical distribution network, and ensures safe and uninterrupted operation of critical electrical loads

V. SYSTEM DEVELOPMENT

The planned project's system development entails designing, building, and testing a three-parallel transformer automated single-phase continuous load switching system. Three parallel single-phase transformers, voltage sensing circuits, relays and contactors, a control unit (microcontroller or relay logic), a step-down power supply, and safety devices like MCBs and fuses are used in the development of the system. Each of the three transformers receives a single-phase supply of 230 V AC. Through the voltage sensing circuits, the control unit continually keeps an eye on each transformer's output voltage and working state. Transformer 1 provides electricity to the load during regular operation. Should Transformer 1 fails due to overload, voltage drop, or any fault, the sensing circuit immediately detects the abnormal condition and sends a signal to the control unit. The control unit disconnects the faulty transformer by de-energizing its relay and automatically connects Transformer 2 to the load. If Transformer 2 also becomes faulty, the system automatically transfers the load to Transformer 3, ensuring uninterrupted power supply with minimum switching time. Indicator LEDs display the status of each transformer and help identify the active or faulty transformer.

A step-down transformer and regulated DC power supply provide the required voltage for the control circuit and relay coils. MCBs and fuses protect the system from overloads and short circuits, ensuring safe operation. After hardware assembly, the complete system is tested under normal and fault conditions to verify automatic switching, voltage stability, switching speed, reliability, and continuous operation. The developed system successfully minimizes downtime, eliminates manual intervention, and provides an economical and reliable solution for continuous single-phase power supply.

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5.1 CIRCUIT DIAGRAM

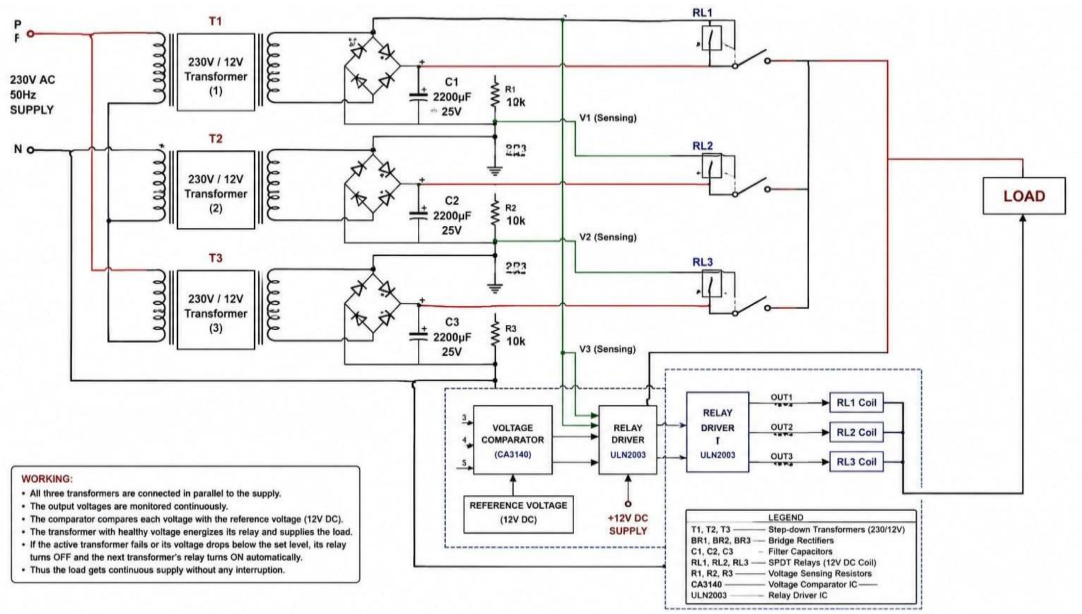

Fig 2: System development

VI. RESULT AND DISCUSSIONS

In order to assess its performance and dependability, the Automatic Single-Phase Continuous Load Switching System Using Three Parallel Transformers was successfully designed, constructed, and tested under a variety of operating situations. The project's primary goal was to guarantee a continuous single-phase power supply by automatically shifting the load from a malfunctioning transformer to a healthy transformer without the need for human intervention. Three parallel transformers, voltage sensor circuits, relay modules, a control unit, safety devices, and a single-phase load make up the entire system. Every components were connected according to the designed circuit diagram, and several tests were performed to verify the proper functioning of the system.

Although all three transformers were initially connected in parallel, under typical operating conditions, only one transformer provided electricity to the load. The active transformer's output voltage was continually observed by the voltage sensor circuit. The control unit maintained the associated relay's activation while the active transformer was functioning normally, providing the load with a steady supply. No unusual circumstances were noted, and the output voltage stayed within the permissible working range. The system was operating correctly under normal circumstances, as evidenced by the linked load's

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constant and uninterrupted operation.

To evaluate the automatic switching capability, different fault conditions were intentionally created. The first test involved disconnecting the primary transformer from the supply. As soon as the voltage dropped below the preset threshold, the sensing circuit detected the fault and sent a signal to the control unit. The controller immediately deactivated the relay connected to the faulty transformer and activated the relay connected to the second transformer. The load was successfully transferred to the healthy transformer within a very short time. The switching process was smooth, and only a negligible interruption was observed, which did not affect the normal operation of the connected electrical load.

VII. CONCLUSION

In order to provide a continuous single-phase power supply in the event of a transformer failure, the Design and Development of an Automatic Single-Phase Continuous Load Switching System Using Three Parallel Transformers was successfully designed, developed, and tested. The project's main goal was to automatically identify a malfunctioning transformer and move the electrical load to a healthy transformer without the need for human interaction. By utilizing relay modules, voltage sensor circuits, and a control unit for automated transformer selection, the created system effectively accomplished this goal. The system successfully identified defects during testing and shifted the load with little disruption, guaranteeing the linked load's uninterrupted functioning. The experimental results confirmed that the proposed system improves the reliability and continuity of power supply while reducing downtime and manual effort. The use of three parallel transformers provides redundancy, allowing uninterrupted service even if one transformer fails. The system also enhances equipment protection, operational safety, and overall efficiency, making it suitable for applications such as hospitals, industries, commercial buildings, educational institutions, telecommunication systems, and other critical facilities where continuous power is essential.

The system's long-term advantages exceed its drawbacks, despite the fact that it requires extra parts and has a greater initial installation cost. The study showed that an efficient and workable option for contemporary electrical distribution systems is automated load switching. In the future, the system's performance and dependability may be further improved by including IoT-based monitoring, PLC control, solid-state switching devices, smart protective features, and renewable energy sources.

In conclusion, by offering dependable, secure, and effective automated load transfer, the automated Single-Phase Continuous Load Switching System Using Three Parallel Transformers effectively fulfilled all project goals. The experiment demonstrates that automated transformer switching is a reliable way to provide a steady supply of electricity and has strong potential for future implementation in industrial, commercial, and smart electrical power distribution systems.

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