Automatic Load Sharing of Transformers Using PLC with Remote and Manual Control

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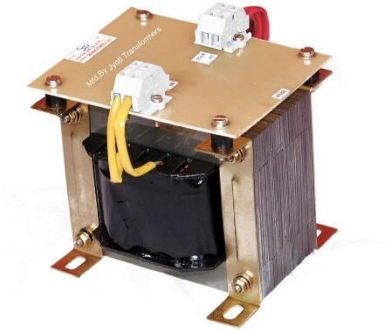
Abstract:
In the world of improving how transformers work in power systems, Programmable Logic Controllers (PLCs) have become really important. They help us manage how electricity flows, making sure power grids stay stable and reliable. This summary talks about how we can use PLCs specifically to share loads between transformers, explaining why this matters and how it works. PLCs are like the brains behind smart load-sharing systems. They use complex instructions and quickly process data to make sure transformers share the load evenly. Using PLCs allows us to keep a close eye on how electricity is distributed and adjust it as needed, especially when demand for electricity goes up or down. PLC-based load sharing works by connecting sensors, switches, and communication tools together. This lets PLCs gather real-time information about things like how much electricity is being used and the condition of the system. With this data, they can make smart decisions about how to balance the load between transformers. To make PLC-based load sharing work well, we need to create custom instructions that fit the needs of each transformer. These instructions tell the PLCs how to read data, predict changes in electricity usage, and adjust the load sharing accordingly. PLCs also help different parts of the system talk to each other smoothly. This means they can easily share information and work together to balance the load across the whole power grid. Using strong communication tools, PLCs create a unified system for monitoring and controlling how transformers work, no matter where they are. One great thing about PLCs is that they're really flexible. They can be adjusted to work in different situations and with different types of power systems. This means PLC-based load sharing can be added to existing power grids without much hassle, making it easier to handle changes and growth in demand for electricity. In short, using PLCs to share loads between transformers is a smart way to make power systems work better. They help us keep a close watch on things, adjust as needed, and make sure everything runs smoothly, improving efficiency, reliability, and resilience of the whole system.

Keywords: PLC, Relay, remotely controlled,

1. INTRODUCTION:



In the realm of power distribution systems, ensuring the optimal performance and reliability of transformers is paramount. Automatic load sharing techniques, particularly those leveraging Programmable Logic Controllers (PLCs), have emerged as a sophisticated solution to address this challenge. By seamlessly integrating PLC technology, these systems enable both remote and manual operation, offering a versatile approach to transformer load management. This introduction provides an overview of the significance and functionality of PLC-based automatic load sharing for transformers, emphasizing its ability to enhance efficiency, reliability, and operational flexibility in power grids. Transformers play a critical role in power distribution networks, regulating voltage levels and ensuring the smooth flow of electricity to consumers. However, uneven distribution of loads among transformers can lead to inefficiencies, premature wear, and even system failures. Automatic load sharing mechanisms aim to mitigate these risks by dynamically redistributing loads across transformers based on real-time demand and system conditions. At the heart of automatic load sharing systems lies the integration of PLCs, versatile control devices capable of executing complex instructions and interfacing with various sensors, actuators, and communication modules. PLCs serve as the intelligence hub, continuously monitoring load conditions, voltage levels, and other parameters to make informed decisions regarding load distribution. One of the key advantages of PLC-based automatic load sharing is its ability to operate both remotely and manually. Remote operation allows operators to monitor and control transformer performance from a centralized location, leveraging real-time data and advanced communication networks. This remote accessibility enhances operational efficiency and facilitates rapid response to changing conditions, minimizing downtime and optimizing system performance. Additionally, manual operation provides operators with the flexibility to intervene and adjust load distribution parameters as needed. Whether responding to unexpected changes in demand or conducting routine maintenance, manual control capabilities empower operators to optimize transformer performance and ensure system reliability. In summary, PLC-based automatic load sharing systems represent a versatile and effective solution for optimizing transformer performance in power grids. By enabling both remote and manual operation, these systems offer enhanced efficiency, reliability, and operational flexibility, contributing to the overall stability and resilience of electrical networks.

2. LITRATURE SURVEY :

2.1 Problem Statement:

When we observe the need of the hour automation, commencing it with hardcore industrial process several factors are to be taken into account. Their lies a high scope when it comes to combining these processes into a reliable and sustainable standard operational process. To start this evolution in the existing processes we decided to start with fundamental processes of the industry that can be atomized and productivity and be therefore increased. After visiting industries and substations it was observed that Parallel operations of Transformers and their load sharing in by far done manually by operators and it was also observed that this conventional system lacks deep technicality which involves.

1. Delay in response actions
2. Overloading
3. Endangered operational processes
4. Continuous monitoring and evaluation burden.

This Ideology of Systematic automation can be carry forwarded to DG sets, also Industrial standby transformers which are to be taken into frequent Preventive Maintenances.

2.2 Objective Of Project:

The aim of this project is to design and implement an automatic load sharing system for transformers using Programmable Logic Controllers (PLCs), capable of remote as well as manual operation. This system aims to optimize transformer performance within power distribution networks by dynamically redistributing loads based on real-time demand and system conditions. The objectives of this project include:

1. Developing a PLC-based control architecture that integrates seamlessly with existing transformer systems, enabling automated load sharing functionality.
2. Implementing sophisticated control algorithms within the PLCs to monitor load conditions, voltage levels, and other parameters, and to make intelligent decisions regarding load distribution.
3. Designing a user-friendly interface for remote operation, allowing operators to monitor transformer performance and adjust load distribution parameters from a centralized location.
4. Incorporating manual operation capabilities into the system, providing operators with the flexibility to intervene and adjust load sharing settings as needed.
5. Testing the system under various operating conditions to validate its effectiveness in optimizing transformer performance, enhancing system efficiency, and ensuring reliability.
6. Evaluating the scalability and adaptability of the system to different transformer configurations and operational scenarios, ensuring compatibility with diverse power distribution networks.

3. METHODOLOGY :

3.1 Proposed System:

The proposed system employs PLC technology to automate load sharing among transformers Utilizing predefined algorithms, the PLC monitors transformer conditions and calculates load sharing ratios. Control logic within the PLC adjusts tap settings or activates/deactivates transformers accordingly. Communication interfaces facilitate monitoring and control via HMI or SCADA systems, while built-in safety features ensure protection against faults. Following thorough testing and commissioning, ongoing maintenance and monitoring sustain reliable system operation.

3.2 Components:

Sr. No.	Component	figure
3.2.1	**Transformer** A transformer is an essential electrical device used to transfer electrical energy from one circuit to another through electromagnetic induction. It is commonly found in power distribution systems, where it helps regulate voltage levels for efficient transmission and distribution of electricity. Transformers work on the principle of electromagnetic induction, which involves the interaction of magnetic fields and conductors. They typically consist of two coils of wire, known as the primary and secondary windings, wound around a magnetic core made of laminated iron or steel.	 Fig No.3.2.1
3.2.2	**Relay Board: -** A relay is an electromechanical device used to control the flow of electricity in an electrical circuit. It works by using a small electrical signal to control a larger electrical current, allowing it to switch circuits on and off without direct human intervention. Relays are widely used in various applications across industries due to their reliability, versatility, and ability to isolate control and power circuits.	 Fig No.3.2.2
3.2.3	**PLC:** A Programmable Logic Controller (PLC) is a specialized industrial computer used to automate electromechanical processes in manufacturing plants, machinery, and other industrial settings. PLCs are designed to control and monitor various types of equipment, such as motors, pumps, valves, conveyor belts, and robots, by executing programmed instructions.	 Fig No.3.2.3
3.2.4	**12 module & 6 module surface and plate:** The "6-module" designation suggests the physical size or capacity of the switchboard. In electrical installations, a module typically refers to the standardized size of a single unit within the switchboard. The size of a module can vary depending on regional standards or specific manufacturer specifications.	 Fig No.3.2.4

3.2.5	**MCB:** A Miniature Circuit Breaker (MCB) is a crucial safety device in electrical systems, designed to protect circuits from overloads and short circuits. It serves as an automatic switch that interrupts the flow of electricity when it detects abnormal current conditions, preventing damage to equipment and reducing the risk of electrical hazards such as fires and electric shocks. MCBs are compact and widely used in residential, commercial, and industrial applications due to their reliability, ease of installation, and cost effectiveness.	 Fig No.3.2.5
3.2.6	**SMPS:** Switched Mode Power Supply (SMPS) is a type of power supply that uses switching regulators to convert electrical power efficiently. Here's a concise overview of SMPS. SMPS converts electrical power from one form to another by switching the input voltage on and off rapidly. This switching action allows the SMPS to regulate the output voltage and current with high efficiency.	 Fig No.3.2.6
3.2.7	**Indicators:** Electrical indicators are devices used to visually signal the status or condition of electrical circuits, systems, or equipment. These indicators provide valuable information to operators, technicians, or users about the operation, performance, or potential issues in electrical installations.	 Fig No.3.2.7
3.2.8	**Buzzer:** A buzzer is an electromechanical device that produces a continuous or intermittent sound signal to alert or notify users of specific events, conditions, or alarms. Buzzer devices typically consist of a transducer, which converts electrical energy into mechanical vibrations, and a resonating chamber or diaphragm that amplifies the sound produced.	 Fig No.3.2.8
3.2.9	**Cable Duct:** A cable rack, also known as a cable tray or cable ladder, is a structural system used to support and organize electrical cables, wires, and conduits in various types of installations, including industrial facilities, commercial buildings, data centers, and telecommunications infrastructure.	 Fig No.3.2.9

3.2. 10	**Terminal Block:** A fuse with a case refers to a type of electrical fuse that includes a protective housing or casing around the fuse element. This casing serves several important functions in the operation and Fig No.2.10 safety of the fuse.	 Fig No.3.2.10

Table No. 3.2

3.3 Detail of Components:

Sr. No.	Components	Quantity	Amount
1	240VAC/230VAC 250VA TRANSFORMER	2	3600/-
2	12 MODULE SURFACE AND PLATE	1	165
3	6 MODULE SURFACE AND PLATE	1	130
4	CAP	1	90
5	100 MM CABLE TIE	1	85
6	1 WAY 5A ROKER SWITCH	12	180
7	3PIN 5A SOCKET	4	152
8	100W BULB	4	320
9	8 CH 1NO 1NC RELAY BOARD	1	1150
10	DVP12SA2 DELTA PLC	1	6500
11	2P 4A MCB	1	726
12	1P 2A MCB	1	300
13	240VAC / 24VDC 5A SMPS	1	1003
14	INDICATORS (R, G, B)	1 each	450
15	BUZZER	2	160
16	DRAIN RAIL	2	200
17	CABLE DUCT	2	200
18	3 PIN TOP	1	20
19.	TERMINAL BLOCK	4	200

Table No. 3.3

4. EXPERIMENTAL WORK :

4.1 Connection Diagram:

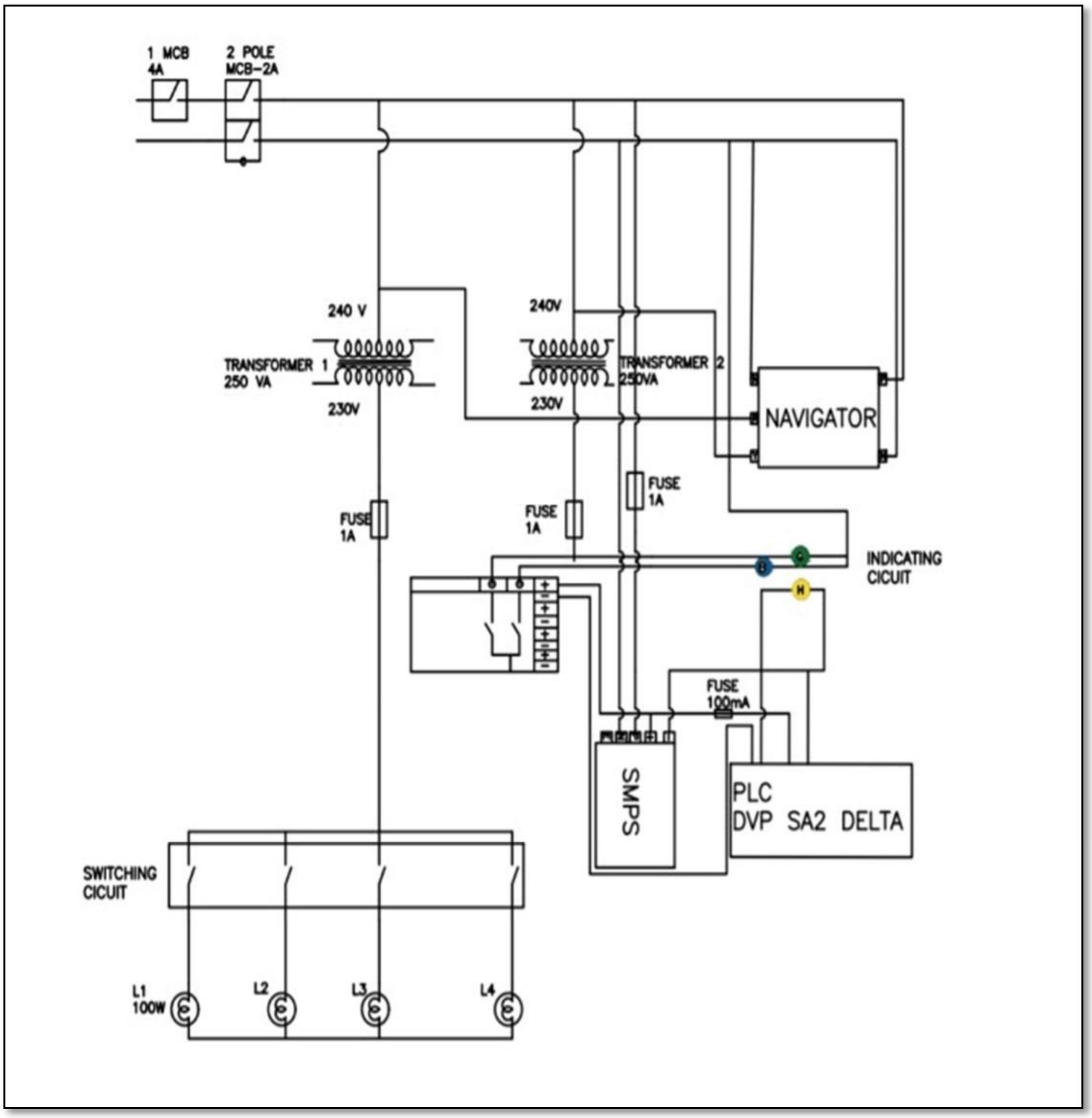


Fig No.4.1

4.2 Construction:

The automatic load sharing of Transformer using PLC with manual and remote control consists of 2 identical 250 KVA transformer, different ratings of MCB and fuses, relay, PLC, Navigator, 10 and 6 module switch board,100 W lamp, indicators, hooters, SMPS, NO switch etc. Transformers are connected in such a way that whenever Transformer 2 get overloaded then remotely or manually the Transformer 1 is connected with T2 such that they equally share the loads and take more loads. The relay is operated with the help of PLC output ports, whenever the input to PLC is provided then it will actuate the Relay and connects the T1 in parallel with T2. Indicators are also connected such that at normal condition and overloaded condition then will indicates the respective indicators. All the four lamps are connected in parallel with supply terminal for getting same voltage across it. Navigator is connected to measure the voltage of both Transformers.

4.3 Working:

- Firstly, take the supply from the mains. Then this supply is given to three devices first one is for SMPS and other two for Transformer 1 and Transformer 2.
- The Transformer 1 is connected is such way that when it's primary winding is connected with the supply terminals then it will provide supply to loads. At this time green indicator is on to indicate Transformer 1 is operating.
- As our one load is take 0.4347 A current approximately and each transformer full load rated current capacity is 1.04 A, 2 loads are enough to meet rated current of transformer approx.
- So, when switch on load 3 then transformer 1 is overloaded which we sense and the input command is given to the PLC which will actuates relay and transformer 2 is comes into picture to shares the load.
- At the same time a blue indicator and a buzzer is also get switched on and gives indication of parallel operation.
- In this parallel mode we further increase the load upload 2 A as both transformers are identical, they will carry 1A each which will increase load capacity of system.
- Further if load decreases then manually as well as remotely, we can open the contact between both T/F which will transfer load to single T/F 2.

4.4 Ladder Diagram:

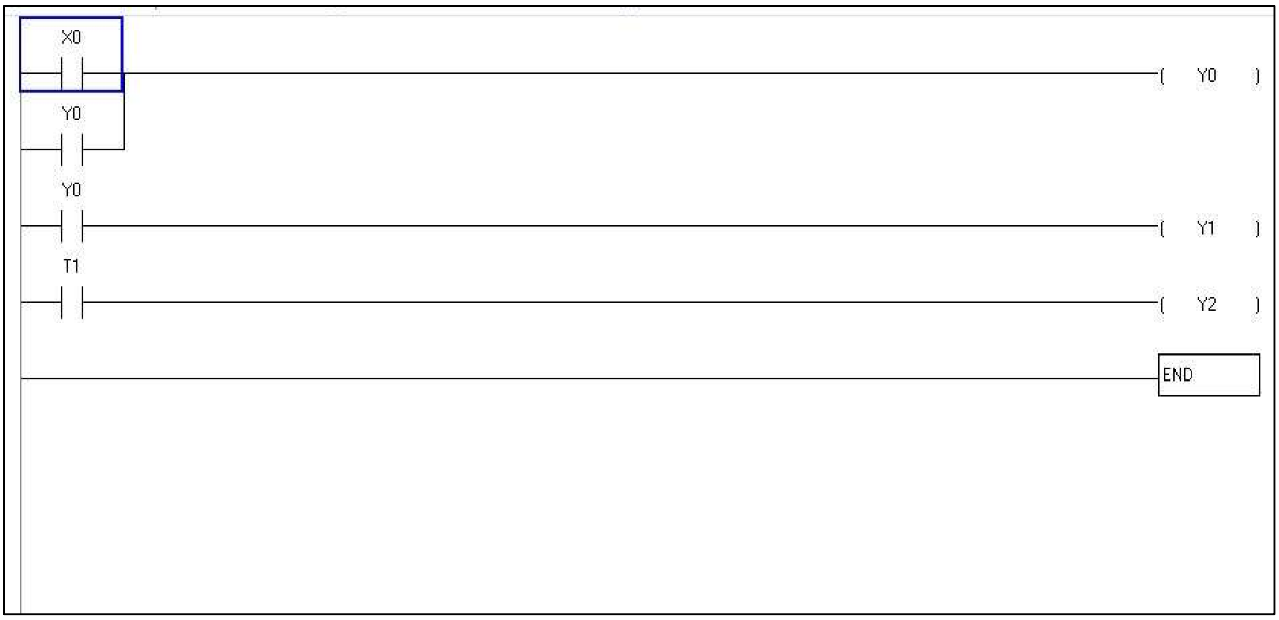


Fig No.4.4

5. RESULT AND DISCUSSION :

5.1 Analytical Calculation:

Voltage at Primary	240 V
Voltage at secondary	230 V
VA rating of each Transformer	250 VA
Full Load Rated Current at Primary	1.0416 A
Full Load Rated Current at secondary	1.086 A
Wattage of 1 Lamp	100W
Current of 1 Lamp	0.4347 A
Resistance of 1 Lamp	520 Ω

Table No. 5.1

5.2 Experimental Data:

Sr. No.	Secondary Voltage	LOADS				Transformer	
		Lamp1 Current	Lamp2 Current	Lamp3 Current	Lamp4 Current	Transformer 1	Transformer 2
1	230V	ON 0.41A	OFF	OFF	OFF	ON 0.41A	OFF
2	230V	ON 0.41A	ON 0.41A	OFF	OFF	ON 0.834A	OFF
3	230V	ON 0.41A	ON 0.41A	ON 0.41A	OFF	ON 1.23A	OFF
.NSFORMER 1 IS OVERLOADED (PARALLEL OPERATION)							
4	230V	ON 0.41A	ON 0.41A	ON 0.41A	OFF	ON 0.615A	ON 0.615A
5	230V	ON 0.41A	ON 0.41A	ON 0.41A	ON 0.41A	ON 0.82A	ON 0.82A

Table No. 5.2

5.3 Simulation Result:

NO LOAD CONDITION: -

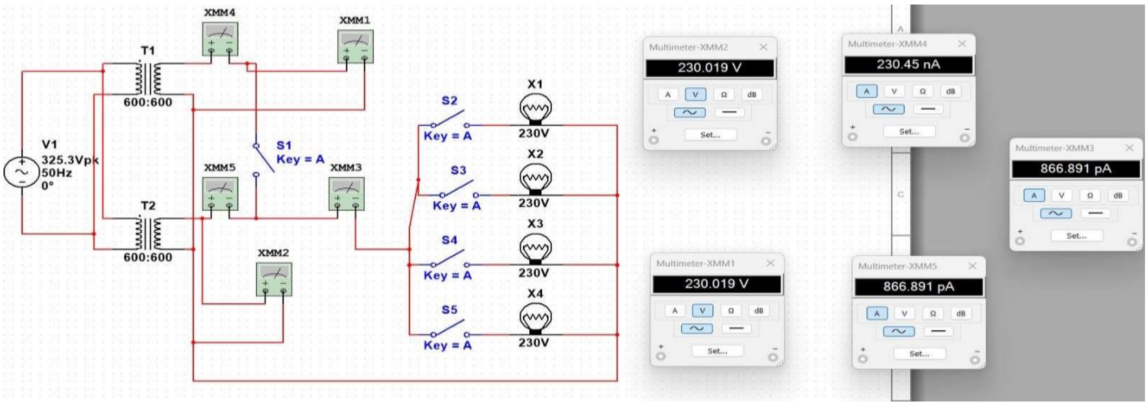


Fig No.5.3.1

AT NORMAL CONDITION (2 lamp ON):

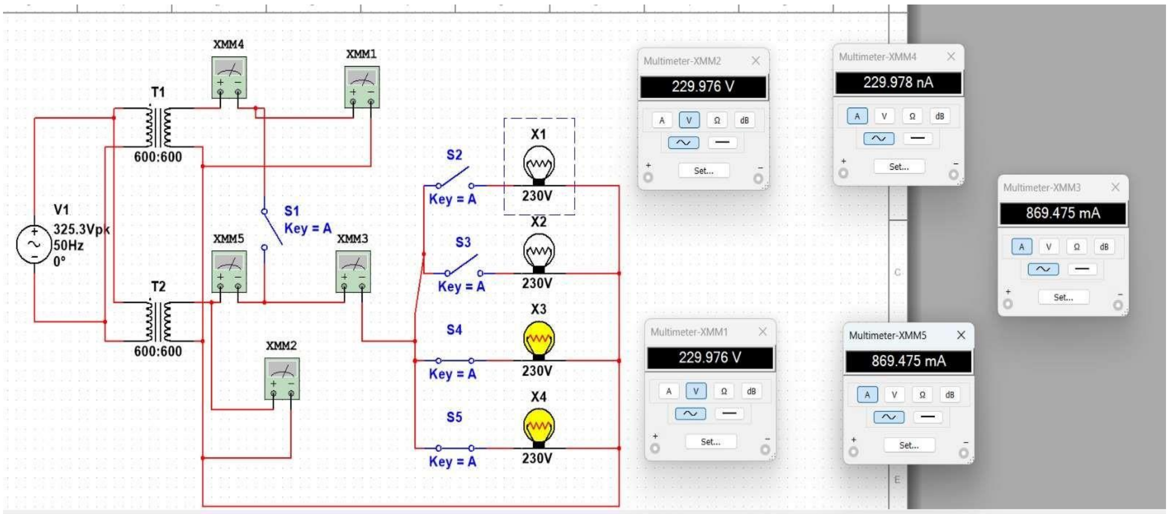


Fig No. 5.3.2

OVERLOAD CONDITION:

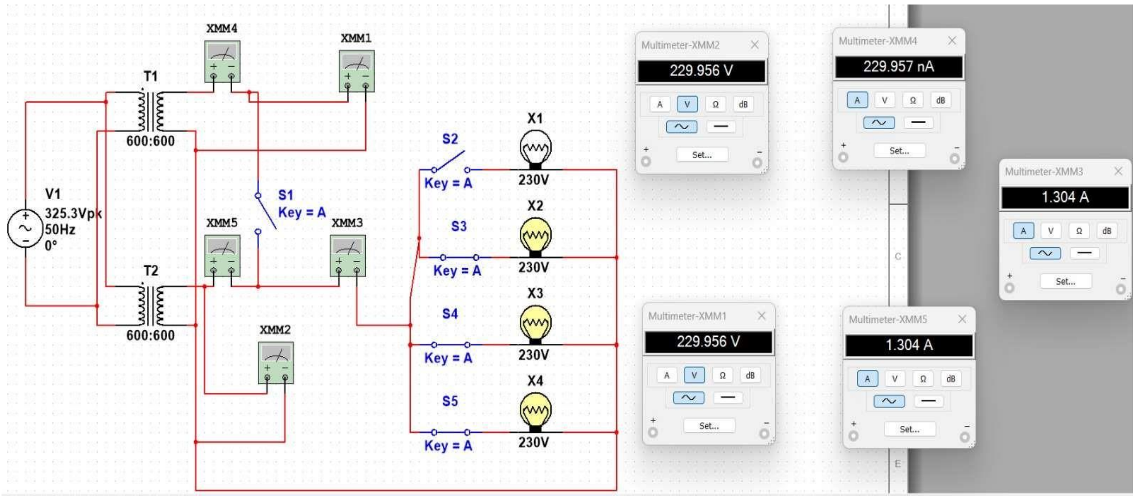


Fig No. 5.3.3

AFTER PARALLEL OPERATION:

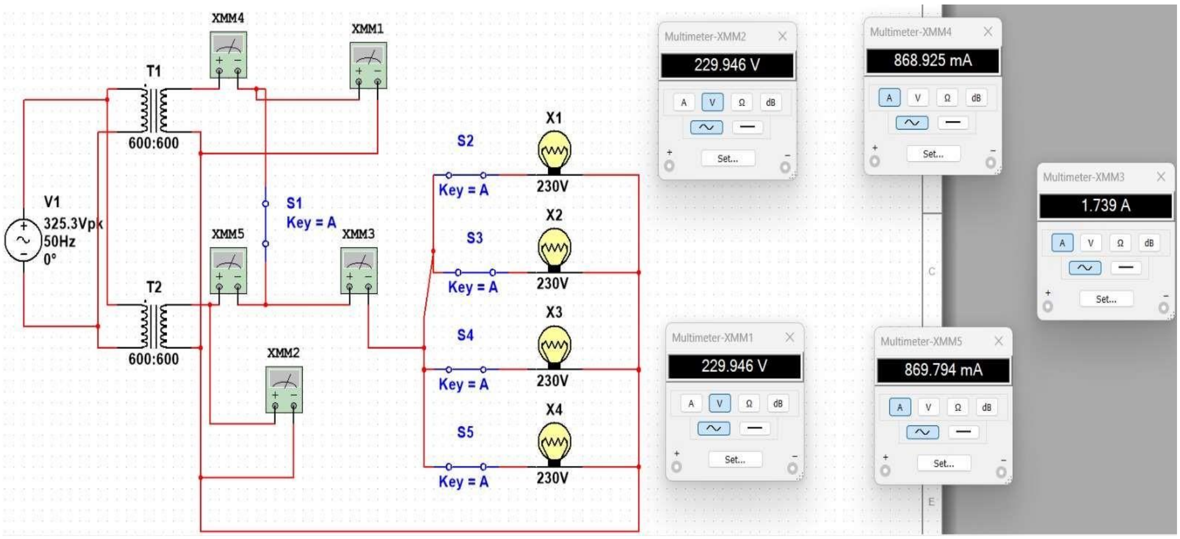


Fig No. 5.3.4

5.4 Features of Project:

- Enhanced Efficiency
- Improved Reliability:
- Flexibility and Adaptability:
- Rapid Response to Changes:
- Simplified Maintenance:
- Centralized Monitoring and Control:
- Scalability and Compatibility:
- Cost-Effectiveness:

6. CONCLUSION AND FUTURE SCOPE :

6.1 Conclusion:

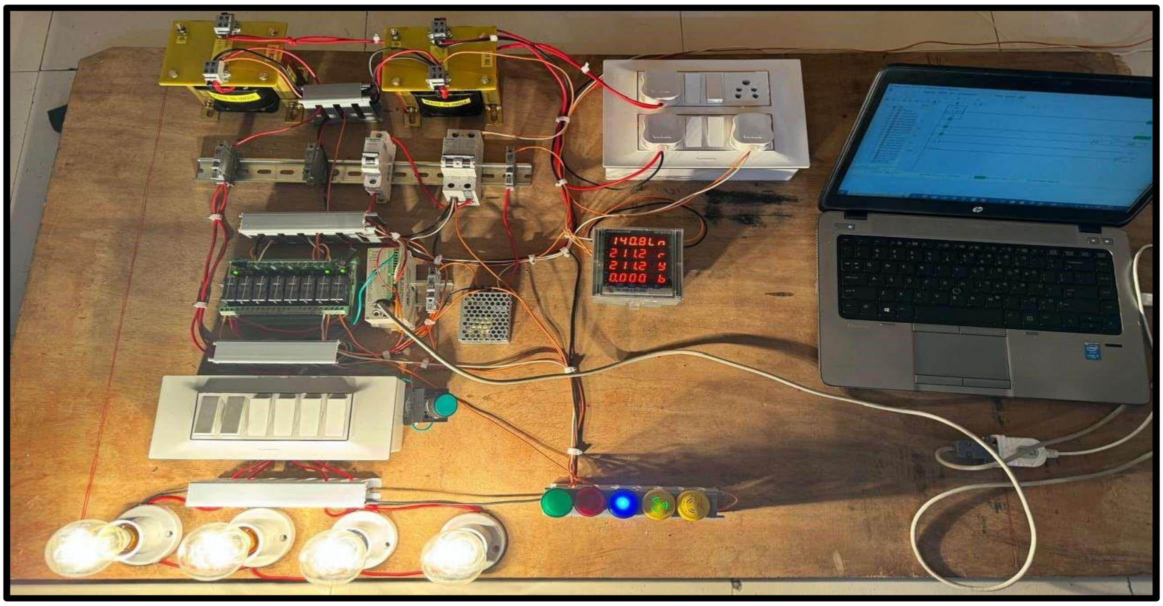
Through this project, we've effectively implemented parallel operations for the Transformer, significantly reducing its workload. This not only enhances the Transformer's health but also amplifies its overall efficiency. By distributing tasks across multiple channels, we alleviate strain, prolonging the Transformer's lifespan while optimizing its performance.

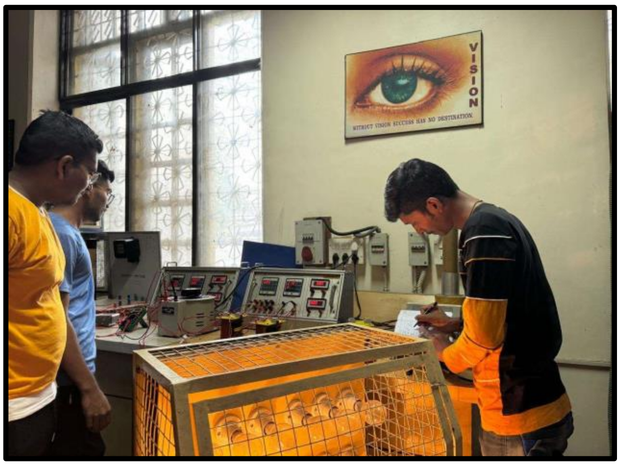
This innovative approach marks a pivotal advancement in power distribution systems, promising sustained reliability and improved operational outcomes.

6.2 Future Scope:

- Health Monitoring of Transformer
- Remote Monitoring and Management
- Smart Grid Integration
- Implementation of SCADA system
- Advanced Control Algorithms
- Advanced Power Systems

7 EXPERINMENTAL WORK AND PROTOTYPE MODEL :





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