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Smart Energy Management System with Load Balancing for Three Phase Power Supply

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ABSTRACT: This project is designed to efficiently manage and distribute power across a three-phase power supply system. The goal of this system is to reduce energy consumption, lower energy costs, and auditing the energy consumption. The system uses a combination of hardware and software to monitor and control the power supply system. The hardware includes sensors and controllers that measure the amount of energy being used by each load, while the software analyses this data and makes decisions about how to distribute power in real-time. The load balancing feature of the proposed system ensures that power is distributed evenly across all three phases, which reduces the risk of overloading any one phase. This is important because overloading a phase can lead to equipment failure and downtime. This allows for proactive maintenance, which reduces downtime and extends the life of equipment. The web page also shows the bill amount, and allows the user to switch between modes such as high-power mode or high efficiency mode etc.

KEYWORDS: Energy Auditing, Energy Management, Load Balancing, Three Phase Supply

I. INTRODUCTION

A smart energy management system with load balancing for three-phase power supply is a sophisticated control system that optimizes the use of electricity in a three-phase power supply system. The system consists of a combination of hardware and software that enables the management and control of electricity consumption in an efficient manner. The three-phase power supply system is commonly used in commercial and industrial settings because it is more efficient and reliable than single-phase systems. However, managing the energy consumption in a three-phase power supply system can be challenging due to the complexity of the system and the varying power demands of different loads. The smart energy management system with load balancing addresses this challenge by monitoring the electricity consumption of individual loads and distributing the load evenly across the three phases. This ensures that each phase carries an equal load, reducing the risk of overload and improving the overall efficiency of the system. The system uses sensors and meters to measure the energy consumption of each load and a central control unit to analyze the data and make real-time adjustments to the system. The control unit can automatically switch off non-essential loads when the system is approaching its maximum capacity or adjust the power supply to individual loads to maintain a balanced load across all three phases. In addition to load balancing, the system also includes features such as energy monitoring, power quality monitoring, and remote access to the system for real-time monitoring and control. These features enable facility managers and building operators to optimize energy usage, reduce energy costs, and improve the reliability and performance of the three-phase power supply system. Overall, a smart energy management system with load balancing for three-phase power supply is an essential tool for any facility or building that relies on a three-phase power supply system. It enables efficient energy management, reduces the risk of system overload, and improves the overall reliability and performance of the system.

II. LITERATURE SURVEY

In the low-voltage (LV) distribution network, a three-phase unbalance problem often exists. It does not only increase line loss but also threaten the safety of the distribution network. Therefore, the author designs a residential load transfer device for a LV distribution network that can deal with a three-phase unbalance problem by changing the connecting phase of the load. It consists of three parts user controller for phase swapping, central controller for signal processing and monitoring platform for strategy calculation. This design was based on message queuing telemetry transport

(MQTT) communication protocol, and Long Range and 4th Generation mobile telecommunications (LoRa + 4G) communication mode is used to realize the wireless connection between equipment and monitoring platform, and a control scheme is proposed. The improved multi-population genetic algorithm (IMPGA) with multi-objective is used to find the optimal swapping strategy, which is implemented on the monitoring platform. Then the phase swapping is realized by remote control, and the function of reducing three-phase unbalance is realized. The practical experimental result shows that the method can help to reduce the three-phase unbalance rate by changing the connection phase of the load, and the simulation results verify the effectiveness of the algorithm in the phase-swapping strategy.

III. BLOCK DIAGRAM

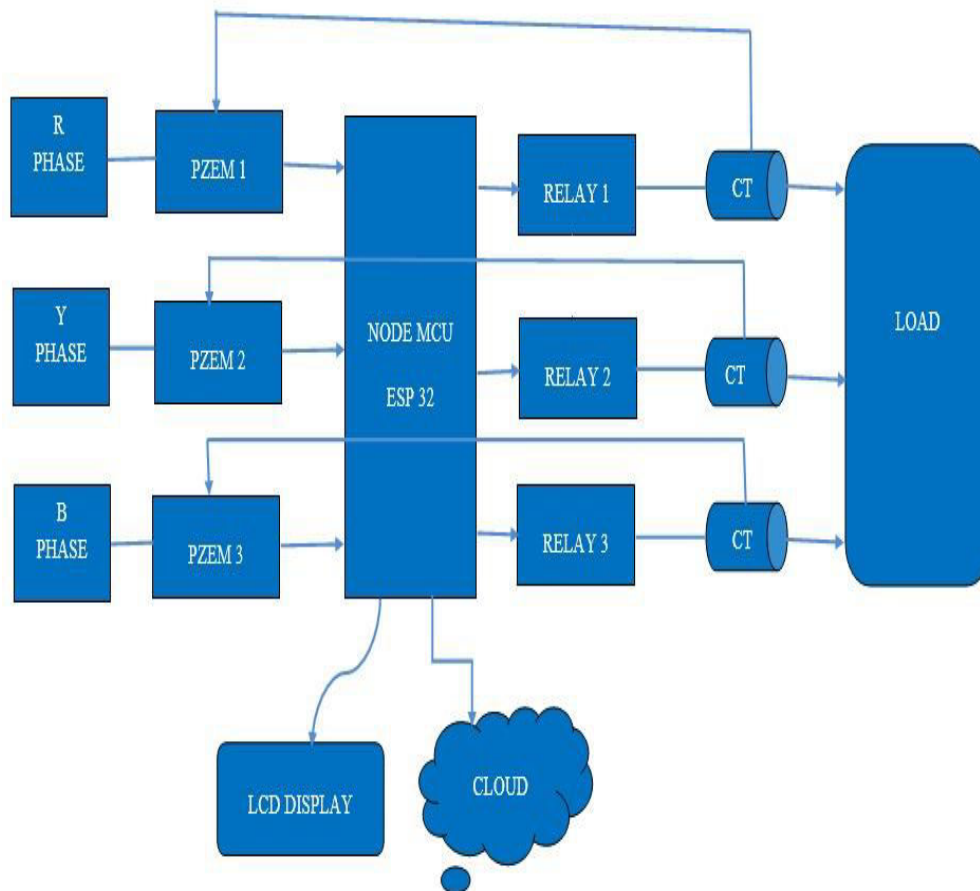


Fig 1: Block diagram of the proposed system

Figure 1 represents the proposed system of the three-phase efficiency enhancer using sensors. Microcontroller, relay and displaying the data work into LCD; by getting the 3 phase values from the sensors and it feeds the data to the microcontroller. The microcontroller is analyzed the power, energy and voltages to switch the supply as per the given algorithm, it switches the supply phases to balance the load. The microcontroller is also linked to a local internet where it displays every information of the 3 phase that we are handling with. The web page also shows the bill amount, and allows the user to switch between modes such as high-power mode or high efficiency mode etc.

IV. EXPERIMENTAL RESULTS

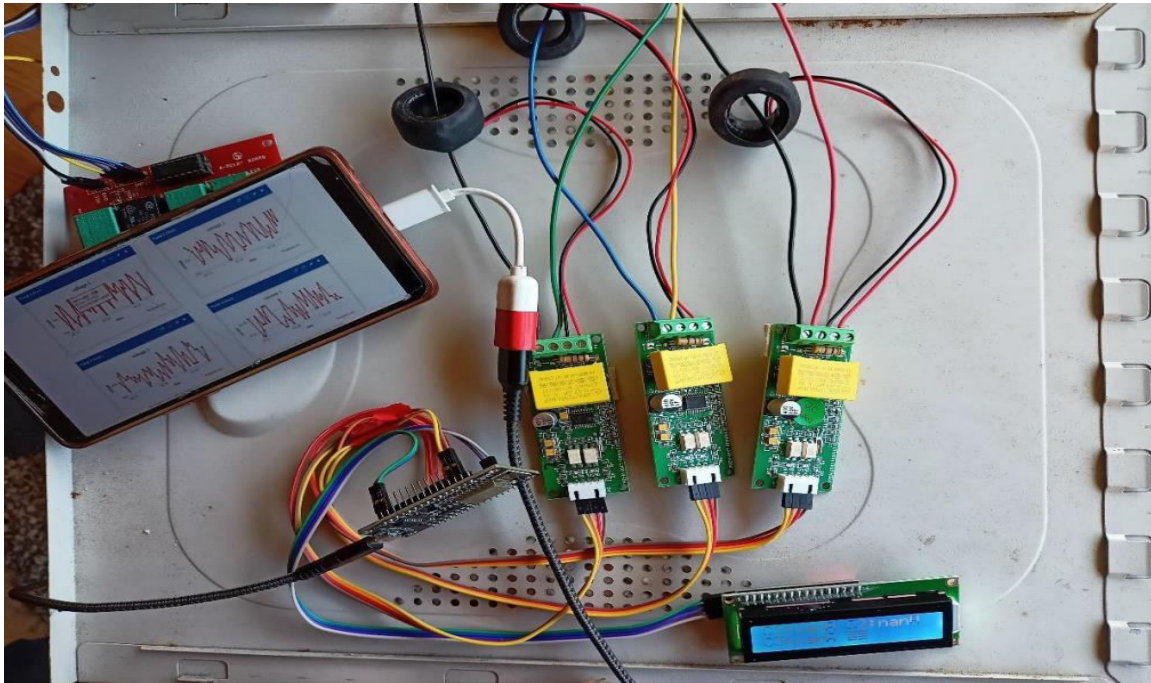


Fig 2: Result

Fig2 represents the overall hardware result for the proposed system. Thus, the load phases will be detected by PZEM-004T of the amount of current from the Current Transformer, the Microcontroller Node MCU will give access the data of the electrical quantity like voltage, current, power, energy, frequency and power factor into LCD display; the microcontroller received signal from sensors will function accordingly from the algorithm of the unequal voltages from the three-phases to make it balancing. A capacitor banks were used to improve the powerfactor where it is lagging.

LOAD POWER CONNECTED ON EACH PHASE

The load connected in each phase is given, this load variation is sensing by PZEM004T and Node MCU give signal to the fast-switching relay to connect our desired single load to least loaded phase among three -phase. There is no flow of neutral current to variation of load from 0W to 1000W on each phase.



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Table 1: Power status on each Phase of the loads

Sl.no	Red (R)	Yellow (y)	Blue (B)
1.	0W	0W	0W
2.	400W	315W	320W
3.	100W	215W	60W
4.	300W	215W	260W
5.	100W	315W	120W

CONNECTION STATUS OF EACH CURRENT PHASE

Table 2: Status of each Current Phase to a singlePhase Load

Sl.no	Red (R)	Yellow (y)	Blue (B)	Connected output status
1.	0A	0A	0A	Red
2.	1.86A	1.41A	1.47A	Yellow
3.	0.45A	0.97A	0.27A	Blue
4.	1.42A	0.96A	1.19A	Yellow
5.	0.46A	1.52A	0.54A	Red

With the above range of variation there will be no neutral flow of current, the system will be stable. This hardware is design up-to 5A load variation, we also change equipment and its rating for higher load variation, according to our requirements.

V. CONCLUSION

In this project, we have rectified the unbalanced, harmonics and losses in the system distributed in three phase system. The same benefits translate to the data centre, a three-phase circuit provides greater power density than a one phase circuit at the same amperage, keeping wiring size and costs lower. In addition, three phase power makes it easier to

balance loads, minimizing harmonics currents and the needs for Large neutral wires. It also optimizes utilization of electrical capacity for increased power efficiency and its performance.

VI. FUTURE SCOPE

As the power and the energy is demanding to the nationwide and worldwide, with the modern lack of natural resource it can be available to maintain even the small losses in the system for the future increasing of the load demand and with the tariff introducing to the consumer used. The three-phase imbalance has not only adverse effects in the distribution grid, but also can affect the safe and stable operation of the whole power grid. Because the three-phase balance is one of the fundamental to stable the operation in power grid. Through the study of the three-phase unbalance, we can stabilize the operation of the power grid and reduce the loss of electric energy to ensure the safe use of all kinds of electrical appliances. Therefore, it has very important practical significance for the research of three-phase imbalance. In this paper, unbalanced load in low voltage distribution grid in our country are analysed and researched, and the three-phase unbalanced load control system was developed. The system composition, working principle and control strategy have carried on the simple analysis. Through theoretical analysis and practical experiments test, the application of three-phase unbalanced load control system is showed. It is certified reducing the three-phase current unbalance and improving power quality as well as reduce labour costs. The three-phase unbalanced load control system has obvious effect on the three-phase unbalanced governance and achieves good social and economic benefits. At the same time, the system has advantages such as low cost, strong real-time performance, good balance effect, and uninfluenced load power supply, which is suitable for application in power system

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