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Automatic Load Sharing By Transformers With Cut Off & Overheat Protection Using Arduino

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Abstract: Power failure is a short- or long-term loss of electric power to an area mostly cause by short circuit, damage to electric transmission line, overvoltage, faults at power stations and more commonly failure due to overloading. The possible damage areas are affected by losing power. The one inherent problem with standard power sharing and monitoring units is their broadcast strength.
As we know that, transformers are the most important component in the electric power transmission and distribution system. Apart from this, the demand for electricity is increasing due to the increasing population and their unavoidable demands, the existing systems have become overloaded. Due to overload on the transformer the efficiency reduces and the windings get overheated and may get burnt. It takes a lot of time to repair and lot of expenditure. So, by reducing the extra load, the transformer can be protected.

This can be done by operating another transformer in parallel with main transformer that is "Parallel operation of transformer". The project aims to demonstrate the protection of the transformer during overloading by sharing load on another transformer whenever load on the first transformer is increased for certain value. Further, it will also exhibit the sensing capacity of the circuit with respect to the overload current on transformer which will cut off the extra load.

I. Introduction

Automatic load sharing by parallel transformer with cut-off system is a method used in power distribution systems to efficiently manage loads among multiple transformers operating in parallel.This system ensures that the load is evenly distributed among the transformers,optimizing their performance and preventing overloading. The main purpose of employing parallel transformers is to increase the reliability and capacity of the power distribution system. By having multiple transformers operating in parallel, the system can handle higher loads and provide redundancy in case of failure of any single transformer. However, in order to ensure optimal performance and longevity of the transformers, it's essential to distribute the load evenly among them.Non-uniform loading can lead to imbalances in the system, causing some transformers to be overloaded while others operate below their capacity. This not only reduces efficiency but also increases the risk of premature failure of the overloaded transformers.

II. Methodology

1. A transformer is an electrical device that enables the transfer of electrical energy between multiple circuits through electromagnetic induction. It effectively changes AC voltage from one level to another with minimal energy loss. Transformers operate on electromagnetic induction principles, ensuring mutual induction. This study utilizes a one-to-one transformer, allowing direct connection to measuring instruments through rectification. For successful parallel operation, transformers must meet various criteria.

2. The power supply is an electrical apparatus that provides electrical power to an electrical load. Its main function is to convert electrical current from a source to the appropriate voltage, current, and frequency needed by the load. This process involves transforming mains AC to low-voltage regulated DC power and enabling wireless energy transfer to power loads via wired connections.

3. Voltage regulators create a stable DC output voltage from fluctuating DC input, which may contain small amounts of AC. This steady output is achieved by connecting the voltage regulator to the filtered DC output. They can also be used in circuits to reduce high DC voltage to lower levels, such as using a 7805 regulator to obtain 5V from a 12V source. Voltage regulators are classified into two main types: fixed voltage regulators (like 78xx and 79xx) and variable voltage regulators (such as LM317).

III. Block Diagram

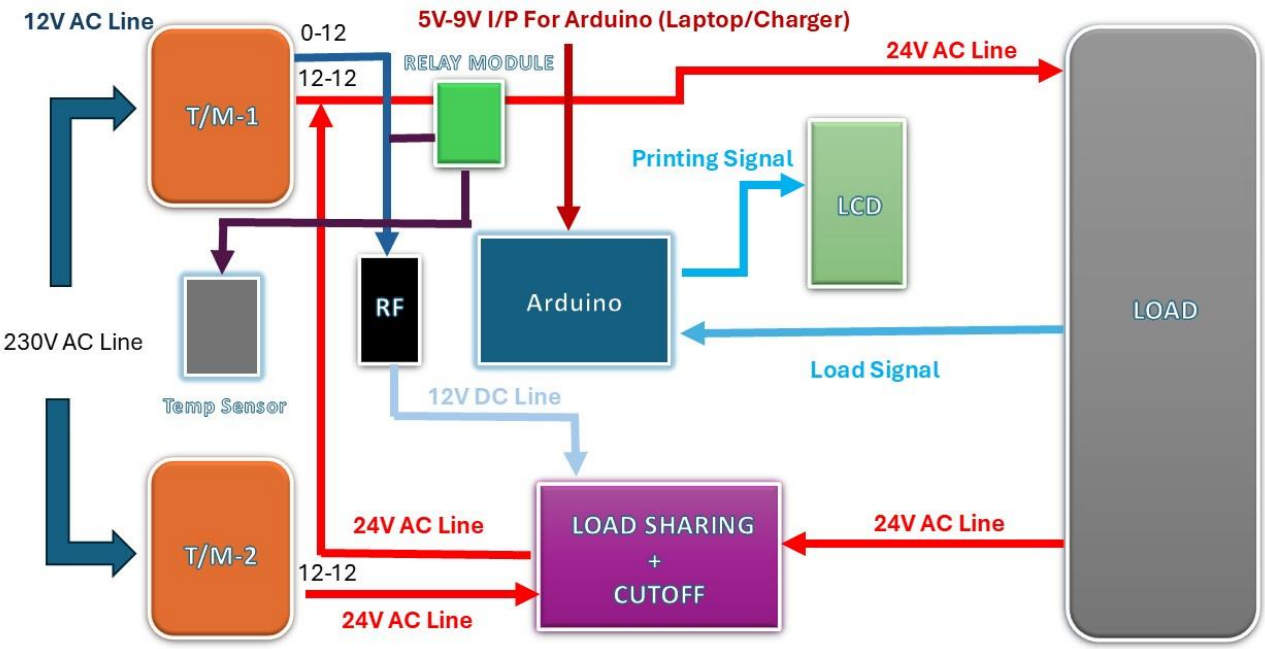


Fig.1. Block diagram

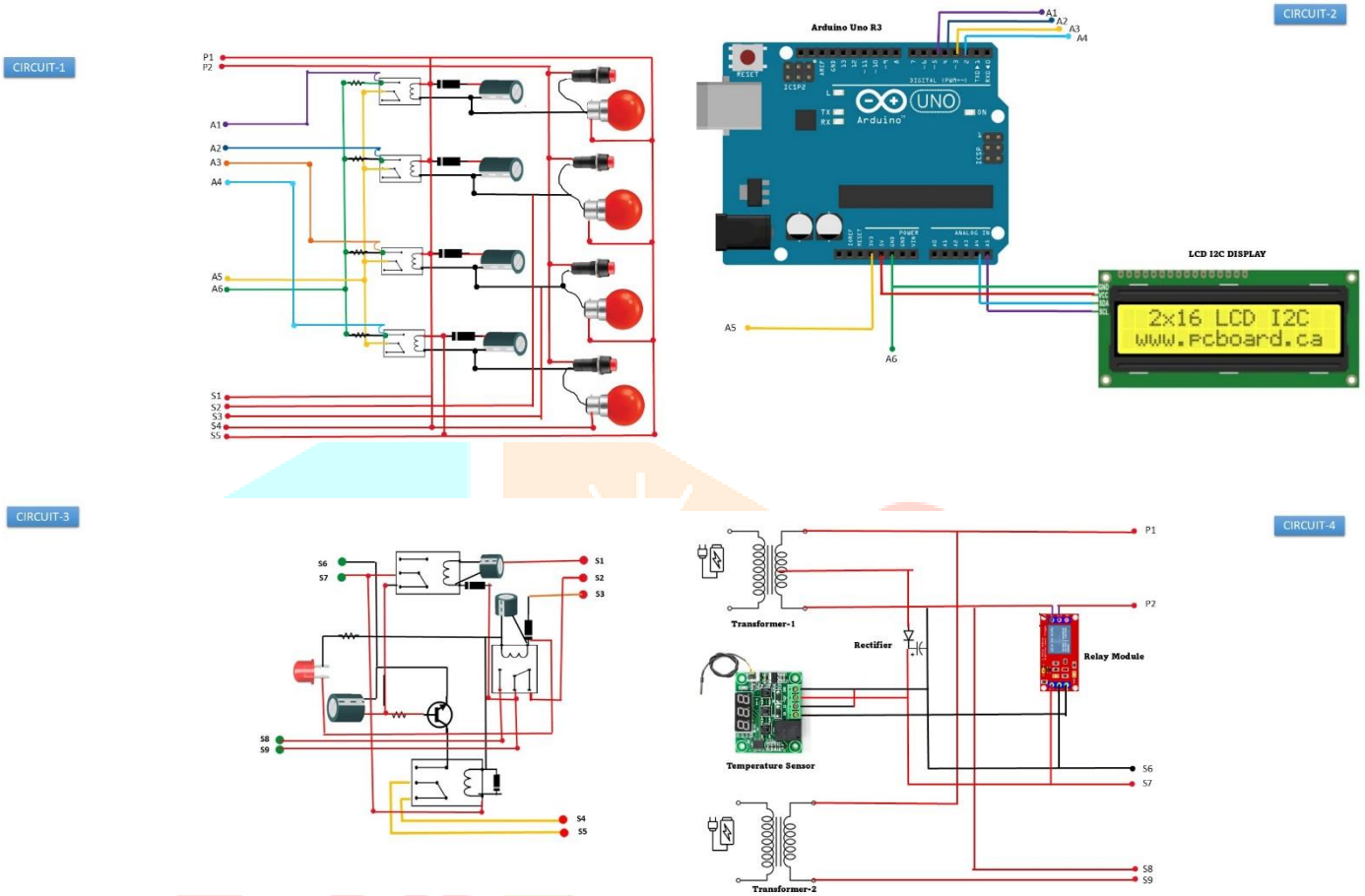
IV. Block Diagram Description

The block diagram represents an electrical circuit designed with multiple components to manage and control power distribution effectively. The circuit begins with an input supply that provides 230V AC, which is then stepped down to 12V AC by two transformers, each rated at 230V/12V and 750mA. The 12V AC output from these transformers is used in two primary pathways. In the first pathway, the 12V AC is directed to a 6V relay, which acts as an electromechanical switch controlled by a sensing circuit. This sensing circuit, which receives a stable 6V DC supply from a 9V battery, monitors various parameters and can activate the relay to control other parts of the circuit.

In the second pathway, the 12V AC is sent to a rectifier with a filter, which converts the alternating current to a stable 12V DC. This rectified DC voltage powers several LEDs, which serve as indicators for different operational statuses of the circuit. Additionally, an overloading circuit connected to the sensing circuit and the rectifier output ensures protection against current overloads, preventing potential damage by disconnecting the power if the current exceeds safe levels. This setup ensures reliable operation, efficient power management, and safety in the electrical system.

The data is collected from the sensor and sent to the Controller, where various algorithms are executed. The Controller then transfers the data to the BLYNK display, which presents performance parameters such as State of Charge (SoC),Voltage, Current, and Temperature on the BLYNK interface. The microcontroller plays a important role in this process by measuring the current from the sensor. It integrates this measurement over time to determine the net charge that has either left or entered the battery. After performing some mathematical calculations, the microcontroller displays the results on the BLYNK interface.

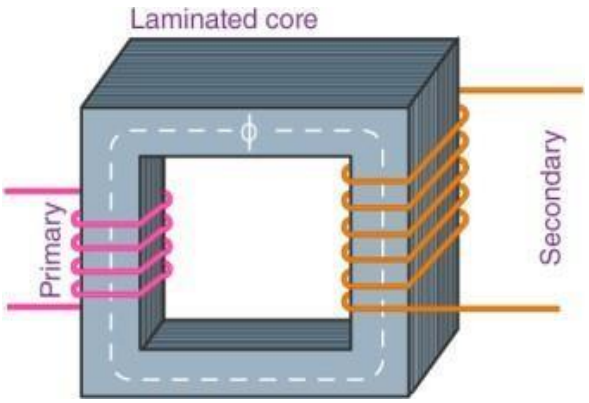
❖ **Circuit Diagram**



V. Components Used

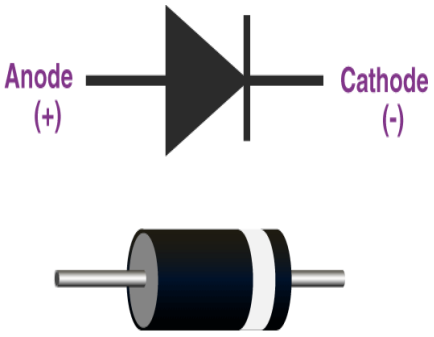
1. Transformer

The transformer, in a simple way, can be described as a device that steps up or steps down voltage. In a step-up transformer, the output voltage is increased, and in a stepdown transformer, the output voltage is decreased. The step-up transformer will decrease the output current, and the step-down transformer will increase the output current to keep the input and output power of the system equal.



2. Diode

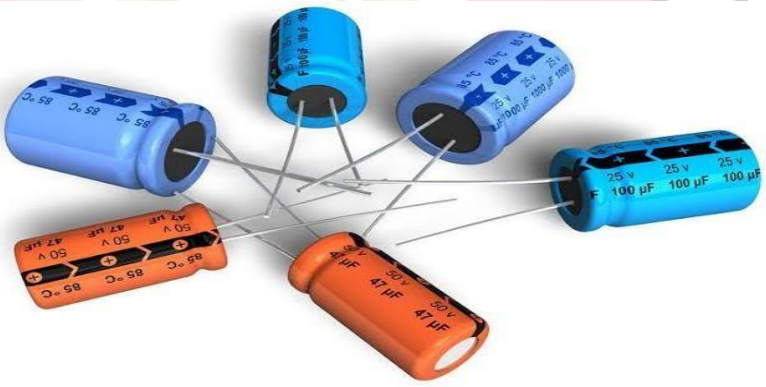
A diode is a two-terminal electronic component that conducts electricity primarily in one direction. It has high resistance on one end and low resistance on the other end. Diodes are used to protect circuits by limiting the voltage and to also transform AC into DC. Semiconductors like silicon and germanium are used to make the most of the diodes. Even though they transmit current in a single direction, the way with which they transmit



differs. There are different kinds of diodes and each type has its own applications.

3. Capacitor

A capacitor is a two-terminal electrical device that can store energy in the form of an electric charge. It consists of two electrical conductors that are separated by a distance.
The space between the conductors may be filled by vacuum or with an insulating material known as a dielectric. The ability of the capacitor to store charges is known as capacitance.
Capacitors store energy by holding apart pairs of opposite charges. The simplest design for a capacitor is a parallel plate, which consists of two metal plates with a gap between them. But, different types of capacitors are manufactured in many forms, styles, lengths, girths, and materials.



4. Resistor

The resistor absorbs the electrical energy in the process where it acts as a hindrance tothe flow of electricity by reducing the voltage, and it is dissipated as heat. In today's world of electronic circuits, the heat dissipation is typically a fraction of a watt. Ohm'slaw states that if I is the current flowing through the resistor in amperes, and R is the resistance in ohms, then V is the voltage drop that is imposed by the resistor (it is the electrical potential difference between the two contacts that are attached.).

$$V=IR$$

Another way of saying this is that the 1Ω resistor will allow a current of 1 amp whenthere is a capacity difference between the ends of the resistor of 1 volt.

If P is the power in watts dissipated by the resistor, in a DC circuit:

$$P = VI$$

By substitution of Ohm's law, we can express power (watts) in terms of current andresistance:

$V=I^2R$

We can also express power (watts) in terms of voltage and resistance:

$P=V^2/R$

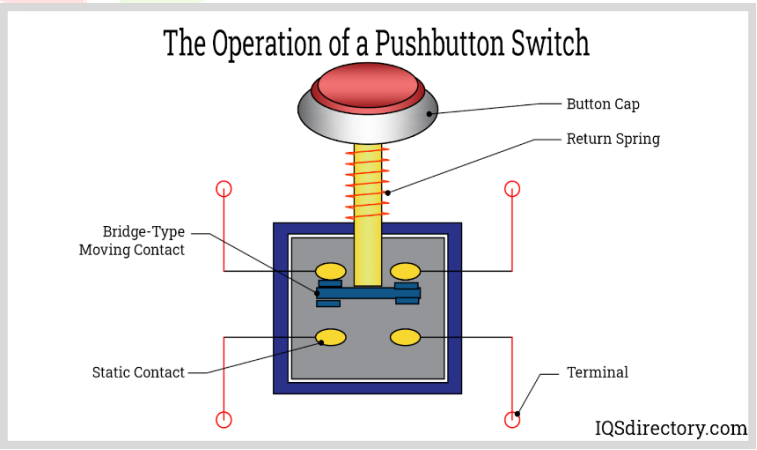
These alternative equations can be used when you do not know the value of the voltagedrop or the current, respectively.

Approximately similar relationships exist when using alternating current, although thepower will be a more complex function of the resistor.

5. Push Button

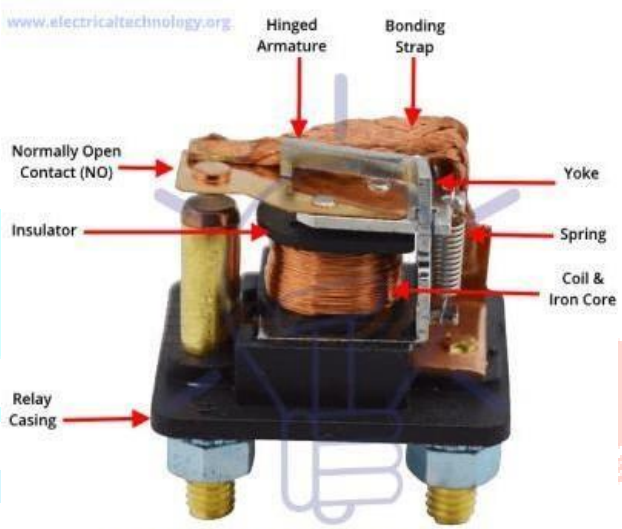
Push button switches, like all other types of electrical switches, are used to reconfigurethe electrical circuits to which they are attached. When an electrical circuit is open, electricity cannot continually flow through it, stopping the operation of the electric equipment to which the circuit is connected. When a push button switch is used to closean electric circuit, electricity can flow freely across the circuit, allowing the device to operate. Depending on their design, push button switches can allow for either sustained

or temporary circuit closure. Push buttons are sometimes supplied with springs that cause the switch to retract when not depressed, keeping the circuits open.



6. Relay

Relay acts as an electrical switch that is operated by a circuit of small power rating to control circuit of larger power rating. Electromechanical Relay operates on electromagnetic principle. It has a magnetic coil which is energized by electric currentto behave as a magnet. These relays which prevents faults are called as Protective relays. Nowadays microcontroller-based relays are gaining more popularity than the traditional Electromechanical relays and used extensively to prevent faults due to its faster response, reliability, less cost, compact size, etc.



Construction of a Relay

7. Battery

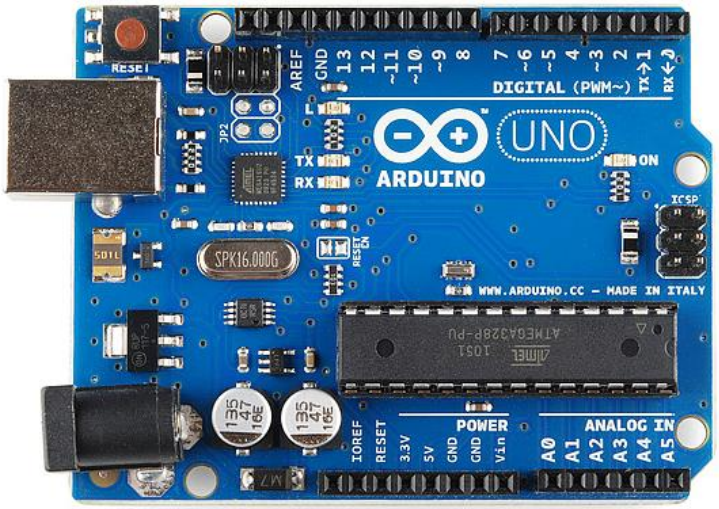
An electric battery is essentially a source of DC electrical energy. It converts stored chemical energy into electrical energy through an electrochemical process. This then provides a source of electromotive force to enable currents to flow in electric and electronic circuits. A typical battery consists of one or more voltaic cells.

The voltage of electric batteries is determined by:

- **Chemistry**. The potential difference of the materials that compose the positive and negative electrodes in the electrochemical reaction.
- **Number of cells**. Batteries in series produce a voltage equal to the number of batteries multiplied by the voltage of each individual battery.

8. Arduino

Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board



VI. Limitations

Parallel load sharing of automatic cut off load in transformers refers to the distributionof load among multiple transformers such that they share the load efficiently and automatically disconnect in case of overload conditions. However, there are some limitations to this approach:

1. Increase short circuit current that increase necessary breaker capacity.
2. Diminish load capacity and increase losses.
3. Parallel performance reduces the transformer impedance.
4. The control and protection of these unit is more complex.
5. The supply bus rating could be too high.

VII. Advantages

- Maximize electrical system availability.
- Maximize electrical system flexibility.
- Increase power system reliability.
- Increase electrical system efficiency.
- The load is shared by transformer is automatically.
- No manual errors are taking place.
- It prevents the main transformer from damage due to the problems like overload and overheats.
- Un-interrupted power supply to the consumer is supplied.

VIII. Applications & Future Scope of Advancements

Applications

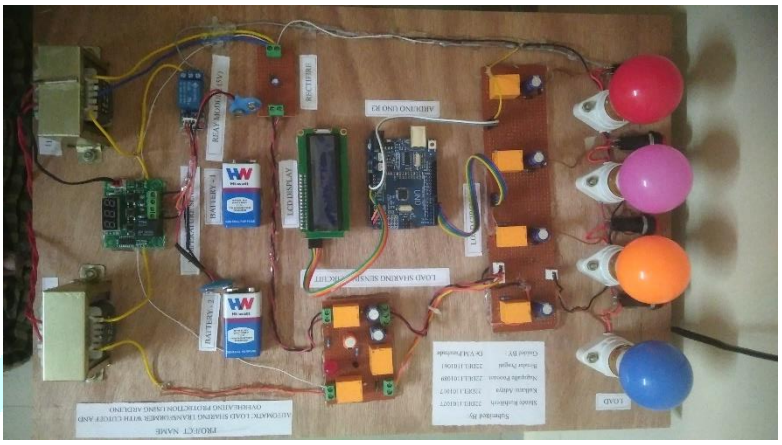
- Power generation & distribution system.
- Process Industry.
- Protection from overloading of transformers.
- Uninterrupted power supply.

technologies not only promises cost efficiency but also provides environmental advantages, establishing it as a vital asset for industries, households, and electric vehicles within a continually evolving IoT and energy monitoring framework. Overall, the BMS offers a holistic solution that enhances battery operation, prolongs its lifespan, and safeguards user safety. This project exemplifies the effective integration of numerous components and algorithms to develop an efficient and reliable Battery Monitoring System for lithium-ion batteries.

IX. Results

In this project, observed that if load on one transformer increases then the relay will sense the change in current and another transformer comes automatically in operation to share the load.

The work on "Automatic load sharing by parallel transformer with cut off system" is successfully designed, tested and a demo unit is fabricated for operating two transformers in parallel to share the load automatically with the help of change over relay and timer sensor circuit and also to protect the transformers from overloading and thus providing an uninterrupted power supply to the customers



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X. Conclusion

In conclusion, automatic load sharing by parallel transformers with a cut-off system offers a robust solution for distributing electrical loads efficiently while safeguarding transformers from overload conditions. By implementing mechanisms such as load- sharing reactors or impedance matching transformers, along with sophisticated control systems, parallel transformers can effectively balance the load and ensure even distribution among them.The integration of automatic cut-off loads adds an extra layer of protection, disconnecting the load from the transformer in the event of overloading or faults, thereby preventing damage and ensuring system reliability. This combination of load- sharing mechanisms and protective features helps optimize the performance of the transformer system while minimizing the risk of downtime and maintenance costs.However, achieving effective load sharing and protection requires careful design, regular maintenance,

and monitoring of the transformers and associated control systems. By adhering to best practices in design, operation, and maintenance, parallel transformers with automatic cut-off systems can provide a dependable and efficient solution for power distribution in various industrial and commercial applications.

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