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TRANSFORMER OVERLOAD, OVER-CURRENT AND OVER-TEMPERATURE PROTECTOIN CIRCUIT

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ABSTRACT-This project presents a transformer protection system that includes temperature monitoring and an inverter-based overload protection mechanism. A step-down transformer reduces 230V AC to 24V AC, which is then rectified and regulated. A buck converter steps down 24V DC to 12V DC, supplying power to an inverter kit that converts 12V DC to 24V AC. The inverter kit features overload protection using IGBT and MOSFETs to safeguard the transformer. A step-up transformer (12V-0-12V) restores the voltage to 230V AC, and the output is applied to a load bank consisting of three lamps. A temperature sensor is used only for sensing and displaying the temperature of the transformer. It does not send any ON/OFF command or control the cooling system. Instead, a timer relay is used to operate a 24V DC exhaust fan, which runs based on a preset ON/OFF cycle. This ensures proper cooling of the transformer.

I. INTRODUCTION

Traditional transformer protection methods, like fuses and circuit breakers, provide basic protection against short circuits and overcurrent conditions but lack real-time monitoring and proactive thermal management. To address these issues, this project combines temperature monitoring and inverter-based overload protection into a single transformer protection system. Transformers are crucial parts of electrical power systems, responsible for voltage regulation and power transmission, but they are prone to overheating and overload conditions, which can result in efficiency loss, insulation breakdown, and eventual failure.. The inverter kit uses IGBT and MOSFET components for overload protection, ensuring safe operation by preventing excessive current flow. Additionally, a temperature sensor continuously monitors and displays the transformer's temperature but does not control the cooling fan. Instead, a timer relay is employed to manage the exhaust fan's operation, allowing precise cooling control independent of temperature variations.By incorporating a step-down and step-up transformer, rectification, DC-DC conversion, and inverter-based protection, this system provides a cost-effective and efficient solution for transformer safety. The inclusion of a timer-controlled cooling mechanism helps maintain optimal transformer performance while reducing unnecessary power consumption. This project demonstrates how a combination of modern power electronics and automated cooling techniques can enhance transformer protection, improving safety, reliability, and operational lifespan.

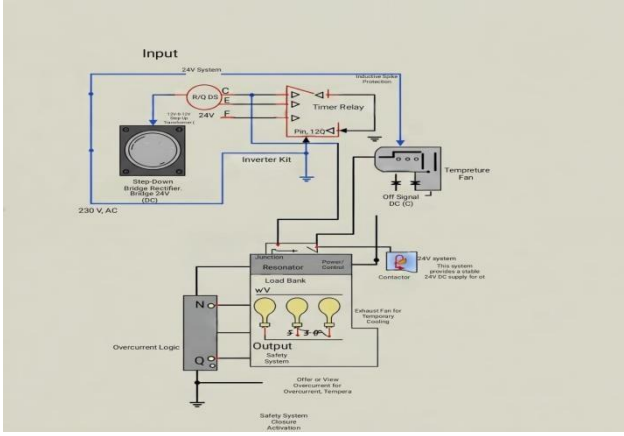
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II. SYSTEM DESCRIPTION

Temperature monitoring, inverter-based overload protection, and an automatic cooling system are all integrated into the transformer protection system to improve safety and efficiency. An inverter kit (12V DC to 24V AC), a step-up transformer (12V-0-12V to 230V AC), a bridge rectifier, a buck converter (24V DC to 12V DC), a step- down transformer (230V to 24V), a load bank (three lamps), a temperature sensor, a timer relay, and a 24V DC exhaust fan are its components. The temperature sensor does not regulate the cooling system; it merely detects and shows the transformer's temperature. In order to provide enough heat dissipation and avoid an excessive temperature rise, a timer relay is utilized to operate the exhaust fan at predetermined intervals. The inverter kit converts 12V DC to 24V AC and includes overload protection using IGBT and MOSFETs, which safeguard the system from excessive current flow. The step-up transformer restores the voltage to 230V AC, supplying power to the load bank.This system effectively prevents transformer overheating, enhances protection against overload conditions, and ensures stable performance, making it a cost-effective and reliable solution for transformer safety

Circuit diagram

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III. DESIGN ARCHITECTURE

A. Working:

To guarantee safe and effective operation, the transformer protection system regulates voltage, keeps an eye on temperature, and manages cooling. A bridge rectifier is used to convert the 230V AC to 24V AC after it has been reduced by the step-down transformer. The inverter kit is powered by a buck converter, which further reduces the voltage to 12V DC. In addition to converting 12V DC to 24V AC, the inverter kit has integrated overload protection that uses MOSFETs and IGBTs to guard against damage from excessive current. After that, a step-up transformer raises the voltage once more to 230V AC, which is then sent to the load bank made up of three lamps. For temperature monitoring, a sensor continuously measures and displays the transformer's temperature but does not control the cooling process. Instead, a timer relay is used to operate a 24V DC exhaust fan at user-defined intervals. The fan runs for a set duration, cools the transformer, and then turns off, repeating the cycle as programmed. This prevents overheating while ensuring energy efficiency. By combining voltage regulation, overload protection, and automated cooling, this system enhance transformer safety, prevent failure, and ensure reliable operation.

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B Methodology

To guarantee safe and effective operation, the transformer protection system is built with automated cooling management, overcurrent protection, overload protection, and voltage regulation. After lowering the voltage with a step-down transformer (230V to 24V AC), a bridge rectifier converts the AC to DC. The inverter kit is powered by a buck converter, which reduces 24V DC to 12V DC. In addition to converting 12V DC to 24V AC, the inverter kit has protection features including MOSFETs and IGBTs that can identify overload and overcurrent situations. To avoid damage, the device immediately cuts off if too much current is detected. For testing and demonstration, a step-up transformer brings the voltage back to 230V AC, powering the load bank (three lamps)..

For temperature monitoring, a sensor continuously measures and displays the transformer's temperature but does not control the cooling system. Instead, a timer relay automatically operates the 24V DC exhaust fan at preset intervals, ensuring effective heat dissipation. This prevents overheating and maintains stable transformer operation.

By integrating overcurrent protection, overload protection, voltage regulation, and automated cooling, this system provides enhanced transformer safety, prevents failures due to excessive current or overheating, and ensures reliable performance.

C Technically specification:

- Input Voltage: 230V AC
- Step-Down Transformer: 230V AC to 24V AC
- Rectifier Type: Bridge Rectifier (AC to DC Conversion)
- Buck Converter Output: 24V DC to 12V DC
- Inverter Kit: 12V DC to 24V AC (with IGBT & MOSFET-based protection)
- Step-Up Transformer: 12V-0-12V to 230V AC
- Load Bank: Three incandescent lamps
- Overcurrent Protection: IGBT & MOSFET-based automatic shutdown
- Temperature Monitoring: Sensor displays transformer temperature
- Cooling System: 24V DC exhaust fan controlled by timer relay
- Timer Relay Function: Cyclic ON/OFF operation for fan cooling

IV. Hardware Required

- Step-down transformer (230V to 24V AC)
- Bridge rectifier module
- Buck converter (24V DC to 12V DC)
- Inverter kit (12V DC to 24V AC, with protection)
- Step-up transformer (12V-0-12V to 230V AC)
- Load bank (incandescent lamps)
- Temperature sensor

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- Timer relay
- 24V DC exhaust fan
- IGBT and MOSFET modules for protection
- Connecting wires and electrical components
- Plywood board for mounting components

1 Timmer relay:

The timer relay is compatible with a variety of power sources because it operates within the voltage range of 6V to 30V. The cooling system may be precisely controlled thanks to its capability for time interval adjustments ranging from 0.1 seconds to 999 minutes. The relay responds to various input sources because it is activated by a high- level signal that ranges from 3.0V to 24V. It can also effectively manage both DC and AC devices thanks to its output capacity of up to 30V DC at 5A or 220V AC at 5A. The relay has optocoupler isolation for increased safety and dependability, which helps shield the system from electrical interference.



2 Inverter kit:

In order for the transformer protection system to operate properly, the inverter kit is essential for converting 12V DC to 24V AC. Its safety against overcurrent and overload situations is aided by its IGBT and MOSFET -based design. The kit effectively manages voltage conversion while preserving power supply stability and effectiveness. Additionally, by offering a steady AC output, it guarantees the load bank's (three incandescent bulbs) seamless operation. The system's dependability is increased and harm from electrical fluctuations is avoided with this inverter kit.



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2.Transformer



The 230V to 24V step-down transformer reduces high-voltage AC to a safer 24V AC. This output is then converted.

3 Bridge wave

The bridge rectifier is used to convert 24V AC to DC for further processing. It consists of four diodes arranged in a bridge configuration, ensuring full-wave rectification by utilizing both halves of the AC cycle. This results in a more stable DC output with reduced ripple. The rectified DC is then filtered and regulated for system operation.

1 Advantages:

- Overcurrent and Overload Protection – Prevents damage by shutting down the system during excessive current flow.
- Automated Cooling System – Ensures transformer temperature control without manual
- intervention.Efficient Voltage Regulation – Provides stable voltage conversion for reliable operation.
- Enhanced Safety and Reliability – Protects the transformer from overheating and electrical faults.

2 Disadvantages:

- Power Dependency – The system needs a continuous power supply to function properly.
- No Real-Time Adjustments – Cooling operates on a fixed cycle instead of adjusting to temperature changes instantly.

3 Application:

- Transformer Protection – Prevents overheating and overcurrent failures.
- Industrial Power Systems – Ensures stable operation of electrical.
- transformers.Educational Demonstrations – Useful for students to understand transformer safety.
- mechanisms.Small-Scale Power Distribution – Helps maintain efficiency in low-power applications.

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Future Scope

- Overcurrent and Overload Protection – Prevents damage by shutting down the system during excessive current flow.
- Automated Cooling System – Ensures transformer temperature control without manual intervention.
- Efficient Voltage Regulation – Provides stable voltage conversion for reliable operation.
- Enhanced Safety and Reliability – Protects the transformer from overheating and electrical faults.

IV. CONCLUSION

The transformer protection system ensures safe operation by preventing overcurrent and overheating issues. It uses automated cooling and voltage regulation to maintain efficiency. The system is cost-effective and reliable for small-scale applications. Future improvements can include real-time monitoring and IoT integration for better performance.

REFERENCES

[1] S. Sharma, R. Patel, and A. Verma, "Transformer Protection System Using Automated Cooling and Overcurrent Prevention," International Journal of Electrical Engineering Research (IJEER), Vol. 10, Issue 2, pp. 45-52, March 2023.

[2] K. Singh and M. Rao, "Design and Implementation of an Inverter-Based Transformer Protection Circuit," International Journal of Power Electronics and Drive Systems (IJPEDS), Vol. 14, No. 1, pp. 112 - 119, January 2024
.

[3] P. Kumar, L. Deshmukh, and S. Nair, "Overcurrent Protection and Temperature Monitoring in Low- Power Transformers," Journal of Advanced Research in Electrical Engineering (JAREE), Vol. 8, No. 3,
pp. 67-74, May 2022
.

[4] A. Mishra and V. Tiwari, "Application of Timer Relays for Transformer Cooling Automation," International Journal of Industrial Automation (IJIA), Vol. 5, Issue 4, pp. 39-45, August 2023.

[5] R. Bose and T. Prasad, "Bridge Rectifier and Voltage Regulation in Transformer Protection Circuits," IEEE Transactions on Power Electronics, Vol. 18, No. 6, pp. 1589-1597, November 2022.