

Load Sharing Transformer Using Microcontroller

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ABSTRACT

Transformers are essential components of electrical power distribution systems and are required to operate continuously while supplying varying consumer loads. Sudden increases in load beyond the rated capacity of a transformer may result in overloading, excessive heating, insulation deterioration, and interruption of the power supply. This paper presents a microcontroller-based automatic load-sharing system designed to distribute the load between two transformers and thereby reduce the possibility of transformer overloading. A current transformer continuously monitors the load condition, while a PIC16F877A microcontroller processes the sensed information and controls relay switching. Under normal load conditions, the main transformer supplies the connected load. When the load exceeds the predefined limit, the controller automatically activates the second transformer so that the load current is shared between both transformers. An LCD and LED indicators provide information regarding system operation. The proposed system improves transformer utilization, enhances reliability, minimizes overload conditions, and supports uninterrupted power delivery.

Keywords— Load Sharing, Transformer, PIC16F877A, Microcontroller, Current Transformer, Relay, Overload Protection, Power Distribution.

INTRODUCTION

Transformers play a significant role in electrical power transmission and distribution by transferring electrical energy between circuits at appropriate voltage levels. Distribution transformers normally operate continuously and are subjected to varying load conditions. When the connected load exceeds the rated transformer capacity, excessive current causes increased heating and may deteriorate the insulation, consequently reducing transformer life and potentially causing supply interruptions.

The proposed system addresses this problem through automatic load sharing between two transformers. The load current is continuously monitored using a current transformer. When the load exceeds the predetermined limit, the control system automatically activates an additional transformer through relay switching.

Consequently, the voltage remains approximately unchanged while the load current is distributed between the transformers. A PIC16F877A microcontroller acts as the central controller and coordinates the sensing, decision-making, indication, and switching operations.

The incorporation of automatic control reduces the requirement for manual intervention and provides rapid response to changing load conditions. The system therefore aims to improve transformer utilization, reliability, operational safety, and continuity of the electrical supply.

LITERATURE SURVEY

Several researchers have investigated microcontroller-based automatic load-sharing techniques for transformers. In [1], Shanmuganantham *et al.* presented an automatic load-sharing transformer system that monitors the load current and voltage and distributes power according to the load requirement. In [2], Vijayakumar *et al.* proposed a microcontroller-based automatic load-sharing system for balancing the load among transformers by continuously monitoring their current and voltage. Bharathi *et al.* [3] developed a three-phase transformer load-sharing system in which the electrical parameters are monitored and transformer operation is adjusted to achieve balanced loading.

Reddy *et al.* [4] presented a microcontroller-based automatic load-sharing technique for three-phase transformers, where voltage and current are monitored to distribute the load among the available transformers. Similarly, Kumar *et al.* [5] proposed an automatic load-sharing transformer system using a microcontroller to improve load balancing and power distribution. These studies [1]–[5] demonstrate that microcontroller-based load-sharing systems can provide automatic and efficient power distribution while reducing manual intervention and the possibility of transformer overloading. The reviewed approaches provide the basis for developing the proposed automatic transformer load-sharing system.

PROBLEM STATEMENT

Electrical distribution transformers experience continuously changing load conditions. When the demand exceeds the rated capacity of a single transformer, the transformer may become overloaded, resulting in overheating, insulation deterioration, reduced service life, and possible interruption of supply. Manual load-sharing methods require human intervention and may not respond sufficiently quickly to sudden load changes. Therefore, an automatic system is required to continuously monitor transformer loading and connect an additional transformer whenever the predefined loading limit is exceeded.

OBJECTIVES

1. To prevent overloading of the main transformer by continuously monitoring the load and automatically activating the second transformer when the load exceeds the rated capacity.
2. To achieve automatic load sharing between two transformers using a microcontroller-based control system, thereby improving the reliability and continuity of the power supply.

PROPOSED SYSTEM

The proposed transformer load-sharing system consists of two transformers, a current transformer, PIC16F877A microcontroller, relay and relay-driver circuitry, regulated power supply, LCD display, LED indicators, crystal oscillator, and connected load. The current transformer continuously senses the load condition and provides the required information to the control section. The PIC16F877A analyzes the sensed condition and determines whether the main transformer can independently supply the load.

During normal loading, Transformer 1 supplies the connected load. When the load rises beyond the specified operating limit, the controller sends an appropriate control signal to the relay-driver circuit. The relay subsequently connects Transformer 2 so that the electrical load is shared between the two transformers. The controller therefore provides automatic switching according to the prevailing load condition without requiring manual intervention.

BLOCK DIAGRAM

The Fig. 1 integrated block diagram illustrates the microcontroller-based transformer load-sharing system, where the current transformer continuously monitors the load and provides the sensed signal to the PIC16F877A microcontroller. When the load exceeds the specified limit, the controller operates the relay driver to connect the second transformer, enabling automatic load sharing and preventing overloading.

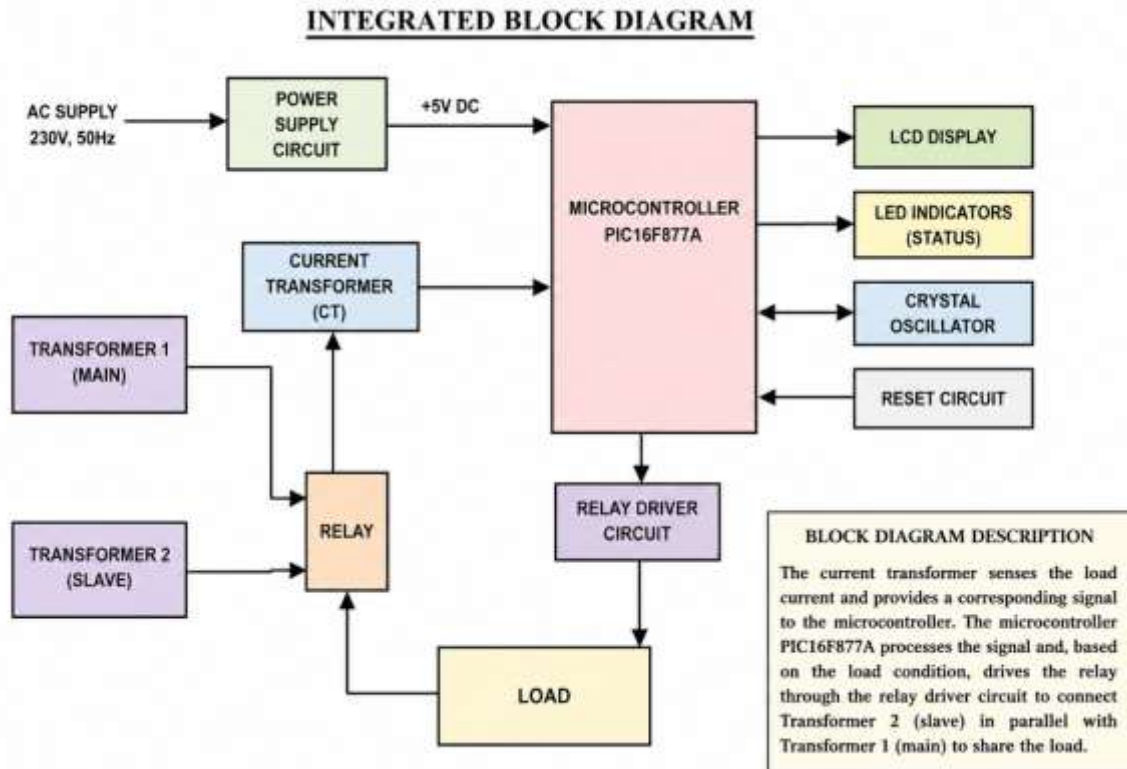


Fig 1 Block Diagram

CIRCUIT DIAGRAM

The Fig. 2 shows the complete interfacing of the PIC16F877A microcontroller with the current-sensing circuit, LCD, LED indicators, power supply, and relay-driver circuit. Based on the detected load condition, the controller operates the relay to connect the second transformer and enables automatic load sharing between the two transformers.

INTEGRATED CIRCUIT DIAGRAM

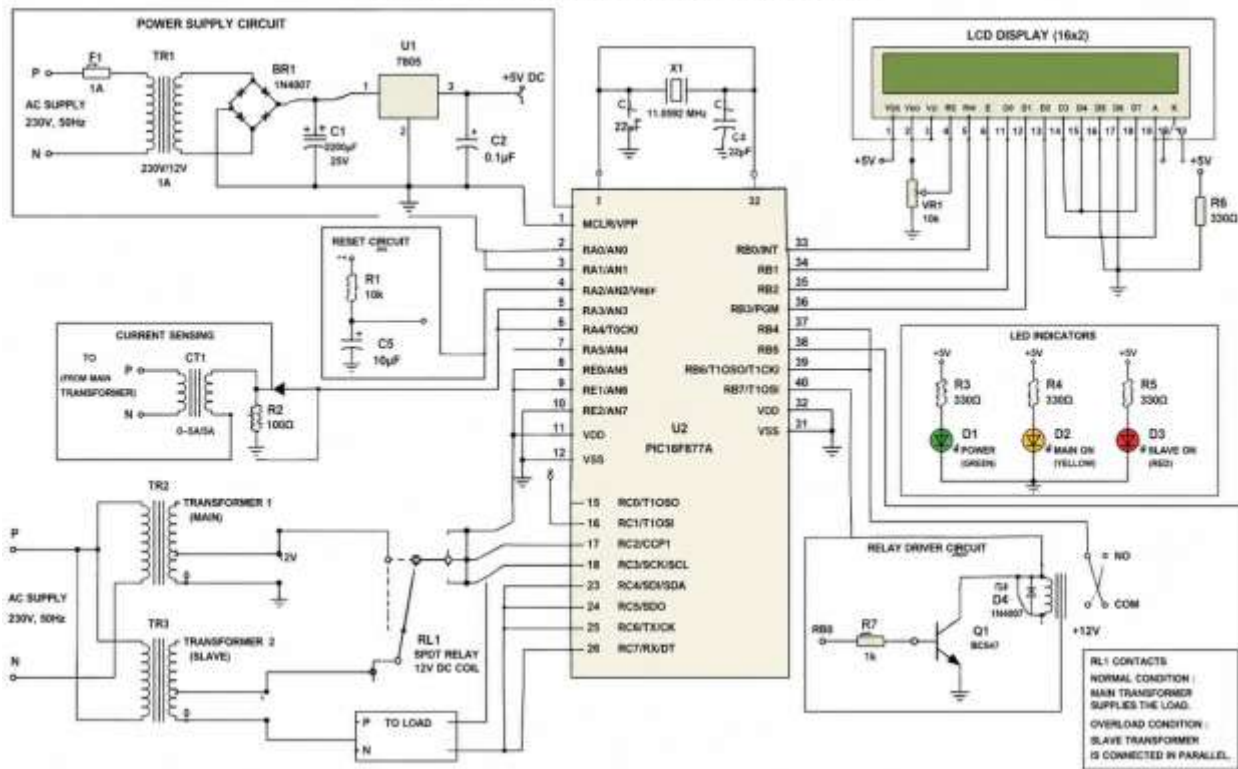


Fig 2 Circuit Diagram

METHODOLOGY

The system implementation begins with designing the transformer load-sharing circuit and selecting the required sensing, switching, control, and display components. The PIC16F877A microcontroller is programmed using Embedded C to execute the required control algorithm. The current transformer senses the load current and supplies corresponding information to the controller.

The controller continuously compares the detected loading condition with the predefined operating limit. When the load is within the normal range, only the primary transformer supplies the load. When the load exceeds the specified limit, the microcontroller generates a control output that activates the relay-driver circuit and connects the second transformer.

The connected transformers then share the load current. LCD and LED indications provide information about the operating condition. The assembled prototype is finally tested under different load conditions to verify the automatic switching and load-sharing operation.

RESULTS AND DISCUSSION

The Fig. 3 developed transformer load-sharing prototype demonstrates the automatic sharing of load current between two transformers. Under normal operating conditions, the primary transformer supplies the entire load; however, when the load exceeds the predefined limit, the current transformer detects the overload condition and the microcontroller automatically activates the second transformer through relay switching, allowing both transformers to share the load efficiently.

The implementation demonstrates that automatic transformer load sharing can reduce the possibility of overloading an individual transformer. By connecting an additional transformer when required, the system distributes the electrical demand and thereby improves overall operating stability. The automatic control mechanism also minimizes the requirement for manual switching and provides faster response to changing load conditions. The project results indicate that the developed system can improve transformer utilization, reduce the risk of overheating, enhance system reliability, and support continuity of power supply.

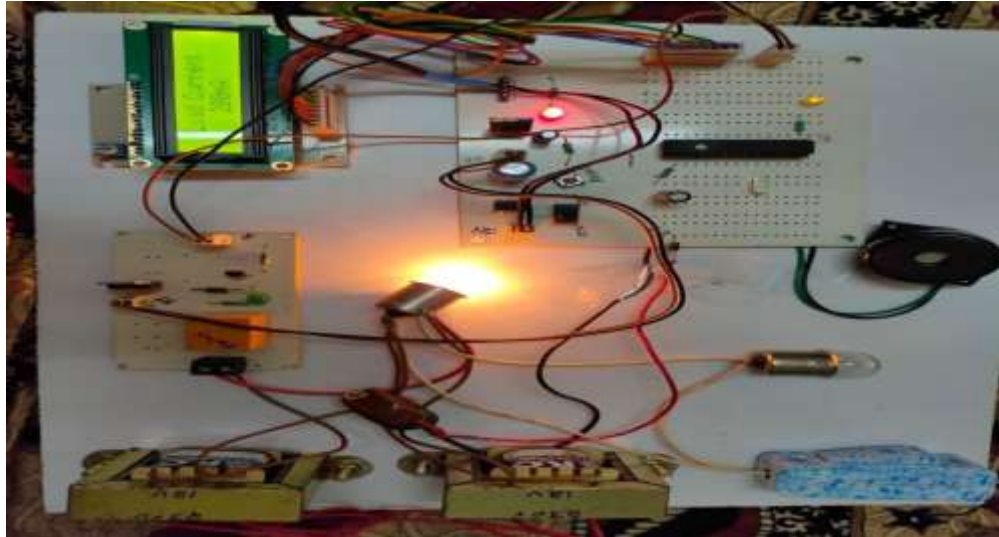


Fig 3 Hardware Setup

CONCLUSION

A microcontroller-based automatic transformer load-sharing system has been presented for protecting transformers against excessive loading and improving continuity of electrical supply. The PIC16F877A microcontroller monitors the load condition and automatically controls the connection of an additional transformer through relay switching. When the load exceeds the specified limit, the second transformer is activated and the load current is shared between the transformers. The developed prototype demonstrates the feasibility of automatic load management and provides advantages including improved reliability, reduced transformer stress, enhanced safety, and reduced dependence on manual operation. The system can therefore provide a practical approach to transformer load management in electrical distribution applications.

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