

# PROTECTION OF DISTRIBUTION TRANSFORMER USING ARDUINO PLATFORM

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**ABSTRACT**-The aim of the research paper is to protect the distribution transformer from dysfunctional due to the overloading currents, high voltage spikes and over-heating of transformers oil. . Distribution transformer is a key component for electrical energy transfer in power systems. So, appropriate protection of transformer is essential for continuity of electric power supply. In this research paper, protection scheme is implemented using Arduino Microcontroller that is very high speed and cost effective device with enhanced accuracy. Microcontroller sense the current of load and temperature of transformer continuously. As the value of current and voltages increases from pre-set values, protection scheme operates and trips the load. Likewise, as the temperature increases to a set value, a fan would be turned on for cooling the transformer. Complete design of protection scheme with hardware has been presented. At the end, successful results have been shared justifying the proposed technique.

**Keywords:** Microcontroller, Arduino, Distribution transformer, Potential Transformer, Current Transformer, Relay

## I. INTRODUCTION

Distribution transformer is an electrical device which is used to step down the voltage without change in frequency. Normally distribution transformer step down the voltage of 11kV to 440V. But faults and excessive increase in load can lead to the malfunction, insulation breakdown and complete failure of transformer that can cause the blackout [1]. In this research paper a protection system has been designed in such a way that designed system is monitoring the real time based, operating parameters of the transformer continuously and these parameters are displayed on the LCD display. In the LCD display unit we can view the continuous parametric information of transformer. In this research work a P.T is used for step down the line voltage for measuring purposes and for sensing the line currents a C.T is used. C.T is connected in series and P.T is connected in parallel to the terminals of transformer Thermistor is used to measure the temperature of transformer oil. Relays are used to perform the tripping operation. Voltage and currents are measured using analog to digital converter of microcontroller. Analog to digital converter converts the values of analog current and voltage value to the digital value. Then according to the code, values are compared with the preset values in the controller if excess in any parameter occur a relay would trip the transformer upon exceeding the limit of current and voltage. If temperature increases from preset value, a fan would be turn on using relay. The voltage, temperature and current values are displayed on the LCD.

## II. PROBLEM STATEMENT

Transformer is electrical device which change the voltage from one level to other level without change in frequency. Transformer is more expensive device in electrical system. As the load increase at secondary side of the transformer form its rated value. Due to faults or sudden increase in load can cause overloading, over-voltages and overheating that can damage the insulation of transformer windings and severe damage can be occur on the secondary side. The different types of faults that cause the transformer failures are winding faults, faults due to over currents, over voltage faults, earthing faults, insulation failure faults and bushing flashover faults [2].

So, for overcoming above problems a reliable and speedy protection with greater accuracy is needed. In this research paper a protection scheme is purposed that addresses the above stated problems.

## PROPOSED TECHNIQUE

Methodology of purposed protection scheme is shown in figure 1 with the help of block diagrams. The brain of the scheme is Arduino board [3]. Detailed description and circuit of each block is given below.

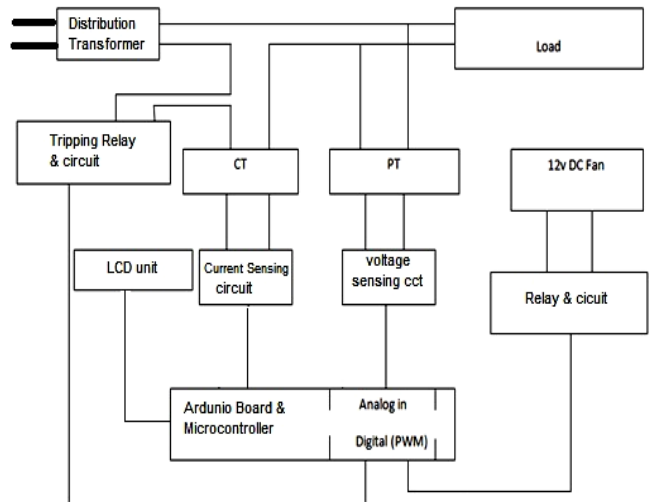
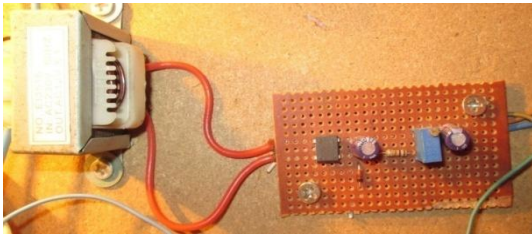


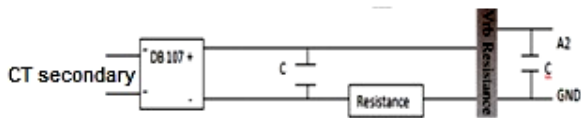
Fig. 1: Project Block Diagram

Basic purpose of current transformer is to step down and measure the current. C.T is placed in series to the load and it is acting like a current sensor. C.T burden of 10Ω is attached on secondary side of C.T.Variable resistor is used for calibration reasons [4]. Then AC signal rectification DC analog signal is transferred to the analog pin of Arduino Board Platforms analog pin. Real time picture and current sensing circuit is given below.

**Fig. 4. Relay Circuit**

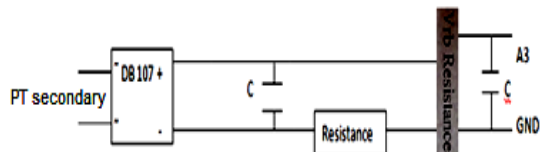
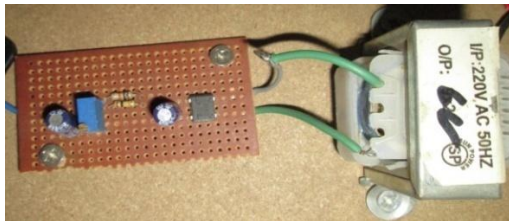


Purpose of relay is to disconnect the load in abnormal condition. The relay circuit is connected to Arduino Board with using of opto-coupler (pc817). Opto-coupler is used for the isolation purpose and it protects the microcontroller from high voltage spikes [4]. In the relay circuit a transistor (945) is used to operate the relay. As the Arduino output pin become high, the relay circuit will operate and trips the load. Real time picture and relay circuit is also shown in fig 4.

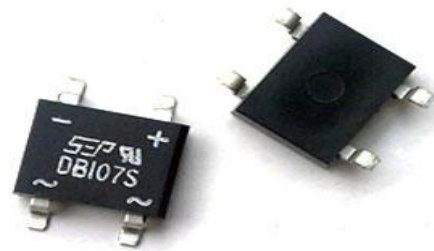
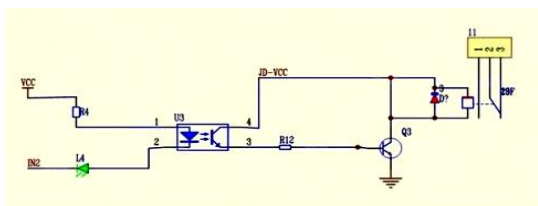


**Fig. 2: Current sensing circuit**

Potential transformer is used to measure the voltage and it is placed in parallel to the load. This transformer is acting like voltage sensor [4]. Primary side voltage of P.T is 220V and secondary side voltage is 6V.Using bridge rectifier DB 107 AC voltages is converter into DC voltage and attached to the analog pin of microcontroller. Variable resistor is used for calibration purposes. Real time picture and voltage sensing circuit is shown.

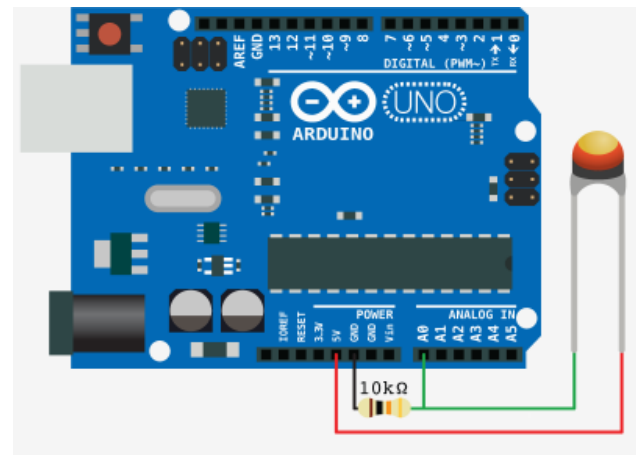


**Fig. 3: Voltage Sensing Circuit**



**Fig. 5: Bridge Rectifier**

Thermistor is inexpensive and easily-obtainable temperature sensors.it is very easy to use and adaptable. Circuits with thermistor can have reasonable output voltages not the mV outputs thermocouples have. Because of these qualities thermistor are widely used for simple temperature measurements. Thermistors are not used for high temperatures. Resistor of 10 k-ohms is used to linearize the output of thermistor. Hardware connections are shown in the given figure 6.



**Fig.6: Temperature sensor interfacing with Arduino**

LCD is used to show all result on screen. In research 16pin (LMB162AFC) LCD is used to display the parameters of transformer such as voltage, current and temperature. Arduino Platform communicates with the LCD using serial communication protocol. Hardware connections are shown in figure.

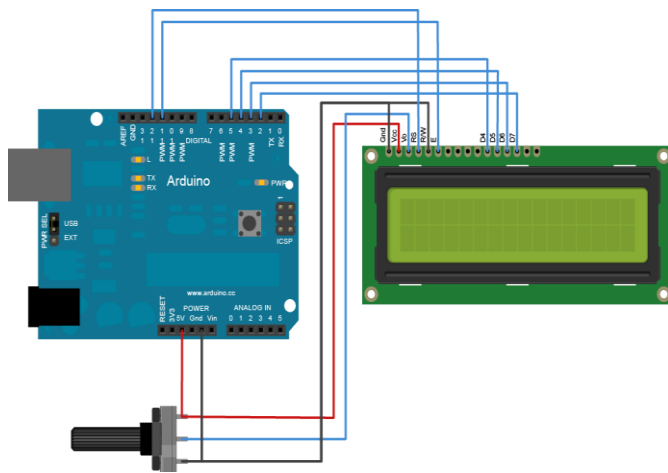


Fig.7: LCD interfacing with Arduino

Arduino Uno is used for implementing the digital controller. Arduino Uno is an AVR based microcontroller board. It has ATmega328 microcontroller and other onboard peripherals including 16 MHz crystal [6]. Programming is done in C language [7]. Detailed Arduino board diagram is shown in figure 8.

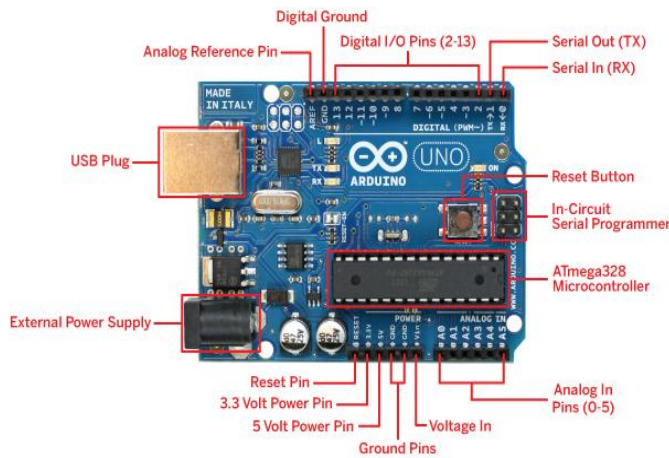


Fig.8: Arduino Circuit

Complete hardware diagram is shown in figure 9 with labels.

**IV. RESULTS/LAB TESTING**

Lab testing is done in the Power Electronics lab of University of Lahore.

Lab testing is performed on 1A current, 270V voltages and 40C temperature settings. If current would or voltage would crosses its defined limits then load would be cut-off and as the temperature limit reaches, cooling fan would be turn ON. Testing results are as follows

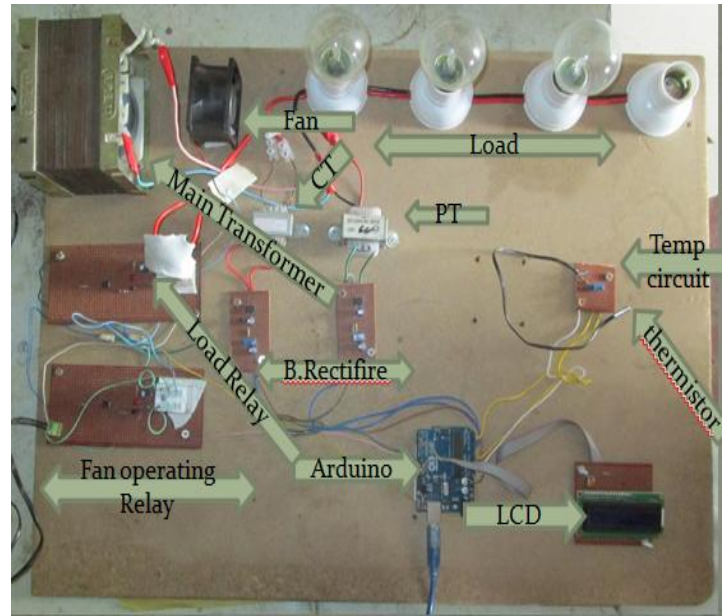


Fig. 9: Hardware and testing circuit

Table 1. Effect of load variation

Sr.No.	Voltage	Current	Load
1	220 V	0.3 A	1 Lamp
2	221 V	0.55 A	2Lamp
3	221 V	0.87 A	3Lamp
4	219 V	1.21 A	4 Lamp/Load Trips

Voltage variation is tested using Auto-transformer. Load trips as 260 voltage is applied to the load.

Table 2. Effect of temperature variation

Sr.No.	Temp (C°)	Output Voltage	Fan
1	25	2.5 V	Off
2	30	3.0 V	Off
3	35	3.5 V	Off
4	40	4.0 V	On

**V. CONCLUSION**

The proposed technique with results has shown that this protection scheme works properly with accuracy. Sensitivity and reliability of this scheme is very high for the abnormal and faulty conditions, as this protection scheme operates within the fractions of seconds when fault or abnormal condition occur. This protection scheme is fully automated and requires no manual interface. In future, this work can also be done using PLCs, and similar technique can also be applied for construction of numerical relays.

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**REFERENCES**

- [1] Blower, R.W, Klaus, D.W. Adams “Trends in distribution transformer protection” Third International Conference IET conference Publication Year: 1990
- [2] Cristina CIULAVU, Elena HELEREA “Power Transformer Incipient Faults Monitoring “Annals of University of Cariova, Electrical Engineering Series, No, 32, 2008; ISSN 1842-4805
- [3] Thien-Bach Huynh, Leon Hardy, Mark Pezzo, and Otis Wilder “The Testing and Design of an Arduino Microcontroller Board for the Study of Proxemics” University of South Florida St. Petersburg Student Research Journal Volume 2 Issue 1: 01 October 2012
- [4] Hobson, A “Instrument Transformers” IET Journals & Magazines Volume: 91, Issue: 20 January 2010
- [5] Thomas L. Floyd, David M. Buchla, “Electronics Fundamentals: Circuits, Devices, and Applications”, 8th Edition, Pearson, 2010
- [6] Don Wilcher, “Learn Electronics with Arduino”, illustrated Edition, Apress, 2012
- [7] Yashavant P.Kanetkar, “Let us C”, 12<sup>th</sup> Edition, BPB Publications, 2010