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INTERNATIONAL RESEARCH JOURNAL OF MULTIDISCIPLINARY TECHNOVATION (IRJMT)

http://www.mapletreejournals.com/index.php/IRJMT
Received 19 March 2019 ISSN 2582-1040
Accepted 23 March 2019 2019; 1(2); 111-115
Published online 25 March 2019

Smart Distribution Transformer Monitoring and Controlling using IoT

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DOI: https://doi.org/10.34256/irjmt19216

ABSTRACT

Distribution Transformer is used for providing electricity to the consumers. It provides the required voltage to the consumers by stepping down the voltage in distribution side. So, monitoring the distribution transformer is the unapproachable task for the electricity department to monitor those transformers regularly. This paper provides a solution for reducing the man power in monitoring of the transformer in online by analyzing various parameters like voltage, current, temperature, oil level by using various sensors. The sensors are used to monitoring the various parameters in transformer with the help of microcontroller. The IOT server is used to receive the data of operation and abnormal condition of transformer, and these data are stored in the computer server with help of particular web address.

Keywords: Distribution transformer; Sensors; Monitoring; Control.

1. INTRODUCTION

The power transformer plays important role in power generation, transmission and distribution sections. Records say that due to the mechanical issues, 40% of the transformer gets breakdown. In this system, the internet of things based monitoring and controlling may be suitable for manual operating system. For example in case of manual operating system it is not possible to monitor the oil level and temperature level by means of man power. So our system is designed based upon the online monitoring which provide useful data and information the health of transformers and help the utility services to use optimistic for long period of time.

2. PROPOSED SYSTEM

Smart distribution transformer is needed in the future trends electric power system since is going to be digitalized transmission of electricity in future. So the people will contact through the utility and customers by measuring those parameters voltage, current, temperature of a windings, oil Level of a transformer by using various sensors and in the future trends various updates may be come across towards the innovative ideal system.

3. BLOCK DIAGRAM

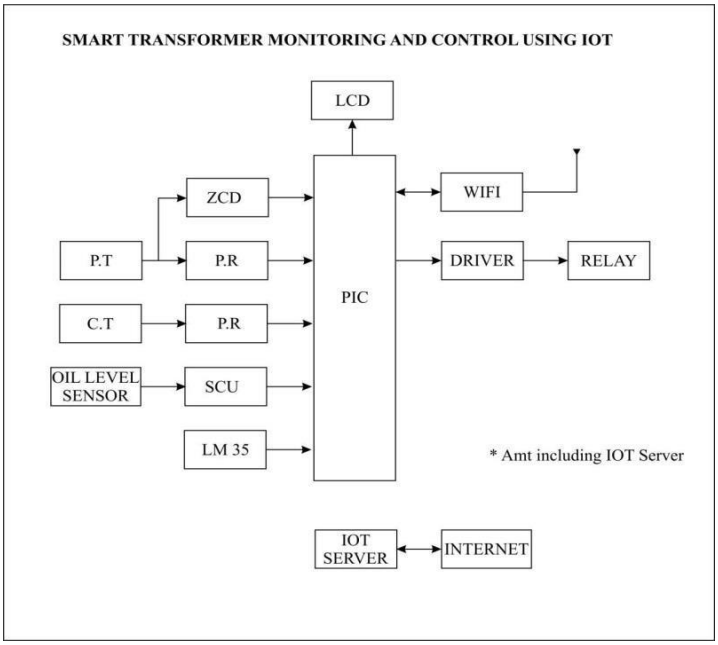

Fig.1 Block diagram for smart transformer monitoring and controlling using IOT

4. HARDWARE STRUCTURE

The major parts of hardware are Current sensor, Voltage Sensor, Temperature Sensor and Oil Level Sensor.

4.1 Current Sensor

The current sensor is based on the Allegro ACS712ELS chip. It's operating with full-scale values of 5A, 20A, and 30A. Linear Hall Circuit with a copper conduction path located near the surface.

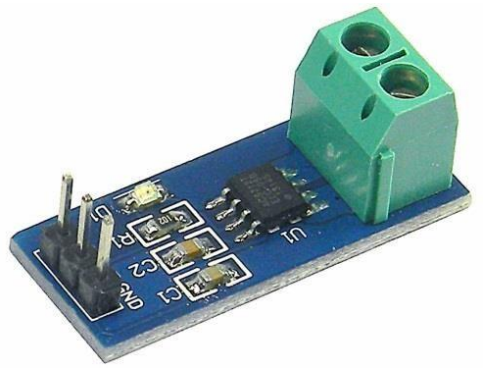

Fig.2 Current Sensor

4.2 Voltage Sensor

It is a potential divider to decrease any input voltage by a factor of 5, Based on the principle of resistive voltage strategy. Because voltage sensor operating range is 0 - 25V.which makes input voltage five times smaller.

4.3 Temperature Sensor

It is a chip that tells what the ambient temperature of transformer by using solid-state technique and to amplify the voltage precisely, which can be done effortlessly to generate an analog signal that is directly proportional to temperature.

- **Power supply:** 2.7V to 5.5V only, 0.05 mA current draw
- **Temperature range:** -40°C to 150°C or 40°F to 302°F
- **Output range:** 0.1V (-40°C) to 2.0V (150°C) but accuracy decreases after 125°

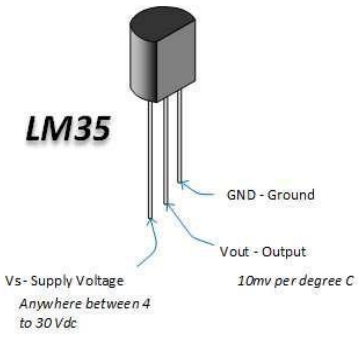

Fig.3 Temperature Sensor

4.3.1 Measurement of Temperature

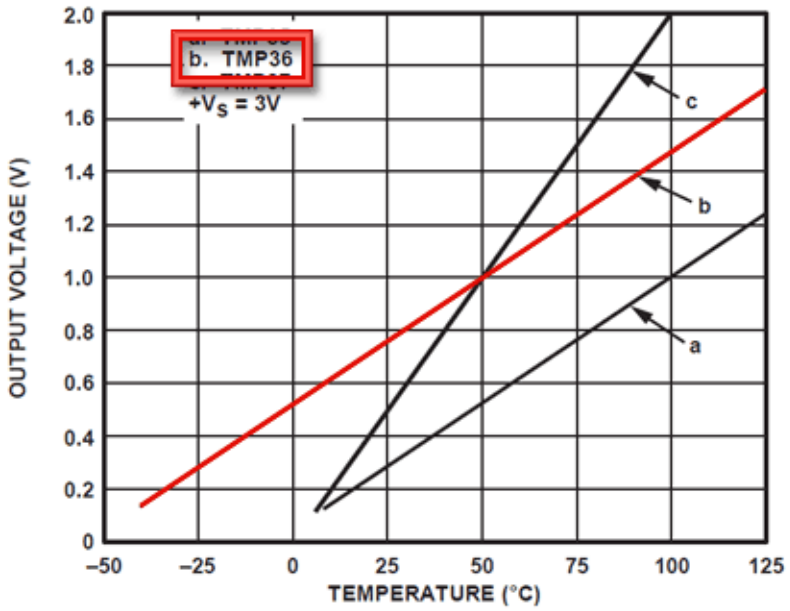

Fig.4 Temperature Measurement versus Output Voltage

Temperature sensor have three pins, left pin of a sensor connected to a power (2.7-5.5V) and the right pin connected to ground. Then the middle pin will have an analog voltage that is directly proportional to the temperature. The analog voltage is independent of the power supply.

To convert the voltage to temperature, simply use the basic formula:

Temp in °C = [(V_{out} in mV) - 500] / 10
So for example, if the voltage out is 1V that means that the temperature is,
Temp in °C = ((1000 mV - 500) / 10) = 50 °C

4.4 Oil Level Sensor

Oil is a main coolant in a transformer. Oil level sensor are used to senses the fluid level of the transformer. Its wetted part is stainless steel. This sensors use a low-voltage, current-limited power source applied across separate electrodes. The input power supply of a Sensor matched to the conductivity of the liquid, with higher voltage versions designed to operate in less conductive (that is higher resistance) mediums.

- **Supply voltage:**18-30 V
- **Maximum load current:** 200mA
- **Voltage drop:**< 2.5 V
- **Current consumption**: < 80 mA.
- **Medium temperature range:** 0-80^{O}C.

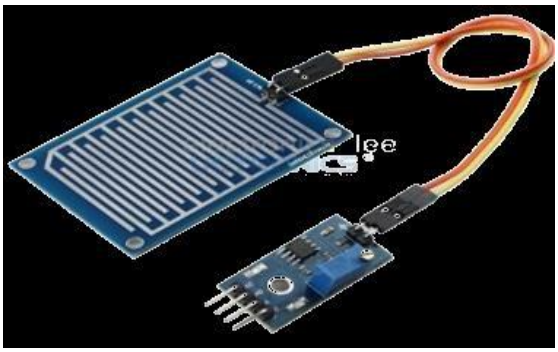

Fig.5 Level Sensor

4.5 Display Module

The display module contains Liquid crystal displays (LCDs), here the display used is 2x16 LCD, which means 16 characters per line by two lines. It receives data from an external source (PIC) and communicates directly with the LCD and to sensor

Fig.6 LCD display

4.6 PIC Microcontroller – PIC 16F877

The specifications of PIC16F877 is

DEVICE	PROGRAM FLASH	DATA MEMORY	DATA EEPROM
PIC 16F877	8K	368 Bytes	256 Bytes

Fig.7 PIC16F877 Microcontroller

4.7 Relay

A Relay Is An Electrical Switch That Uses An Electromagnet To Move The Switch From The Off To On Position Instead Of A Person Moving The Switch. It Takes A Relatively Small Amount Of Power To Turn On A Relay, But The Relay Can Control Something That Draws Much More Power. The AC Unit Probably Runs Off Of 220VAC At Around 30A. Few Watts to Pull the Contacts together.

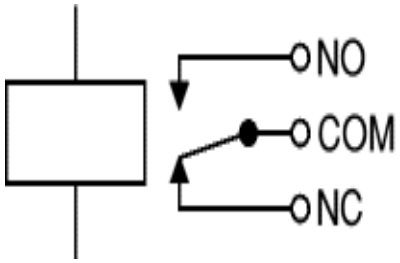

Fig.8 Relay

4.8 Zero Crossing Diode (ZCD)

Zero crossing is a commonly used term in electronics, mathematics, and image processing. In mathematical terms, "zero crossing" basically means the changing of sign (e.g. from positive to negative), that is represented with a crossing of the axis (zero-value) in a graph of a particular function

5. CONCLUSION

Proper monitoring and maintenance can ensure a smooth service life for distribution transformer. The IOT based solution for monitoring and controlling of distribution transformers is quite easy and effective compared to manual monitoring method. Reliable power distribution system must use protective devices which will essentially reduce running cost. Continuous monitoring of Distribution transformer, timely alerts to rectify the abnormality if any, there by extending the lifetime of distribution transformers This study will help in cost minimization by reducing the workforce in maintenance. And real-time load monitoring and control will help to improve system efficiency.

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Conflict of Interest

None of the authors have any conflicts of interest to declare.