Power Transformer Monitoring System

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Abstract – Monitoring and diagnosis of power as well as distribution transformer is the most important process for extending the life of transformer. A transformer monitoring system is already developed by Siemens which is based on SCADA system. But that system can't be used in small scale industry because most of the industry lacks in automation. This paper presents the details of a monitoring system which is a standalone device equipped on every transformer individually and this device is able to detect phase failure, unbalanced voltage, and earth fault. Apart from these, the device can also monitor the oil level and oil temperature. The main aim of research is to develop this product and make available on economic rates.

Index Terms – Power transformer, embedded systems, transformer protection

I. INTRODUCTION

Power transformers are the important part of power system which are used to step up and down the power to make usable for electricity consumers. Transformers are vulnerable to failure due to external fault or internal fault or general ageing of parts which can lead to severe damage and results in replacement of the parts due to which the consumer suffers from longer power outage as well as high replacement of the part; it can also cause explosion and fire which is threatening to lives and property.

At present following methods are used for fault detection of transformer –

1) Frequency response analysis (FRA)
2) Dissolved gas analysis (DGA)

However, this method requires disconnecting the system and isolating the transformer which leads to interruption of supply. While DGA is instead an online monitoring method, it has limitations of detecting faults which associated with partial electrical discharge [1].

There are different kinds of faults in a transformer; the internal fault is divided into two i.e. short circuit faults and incipient faults. The internal short circuit faults are caused by turn-to-turn shorting or turn-to-earth shorting in the windings of transformer. The incipient fault is developed over time as the transformer insulation deteriorates. The factors affecting

Transformer failure and deterioration are the environment in which the transformer is being operated, maximum load current, lightening short circuits and switching surges. [2]

In this paper the detailed working of the fault detection system is explained. This system continuously monitors the Transformer in real time and compares the output of transformer with the reference values i.e. of a healthy transformer. This device can monitor the voltage values and determine whether it's a phase failure or earth fault. Apart from this, it can also monitor temperature of oil, moisture level and oil level of transformer.

At present the problem within India is regarding to the monitoring and diagnosis of transformer. Regular monitoring is not carried out by the employees. So to eradicate this problem an automatic and efficient transformer monitoring system is employed. This will help in reduction of duration of power failure. It will also help in overcoming future faults.

II. RESEARCH OBJECTIVES

- To design a system this can compare the output of transformer with the reference output and conclude it with healthiness or unhealthiness of transformer.
- To monitor the oil level of transformer in conservator.
- To monitor the temperature of oil.

III. DESIGN METHODOLOGY

The system consists of –

1) Power supply
2) Potential transformer
3) Microcontroller AVR

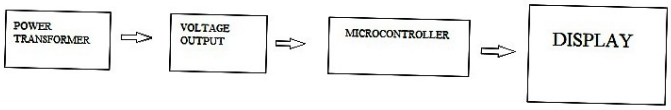

Figure 1: Block diagram of system

IV.I Power Supply Unit

A power supply circuit consisting of a transformer along with rectifier diodes, where the leads of the secondary winding are connected to first terminals of rectifier diodes whose second terminals are connected to output of the power supply circuit. [3] There are basically two types of power supply i.e. linear and switched mode power supply. We are using a linear power supply here.

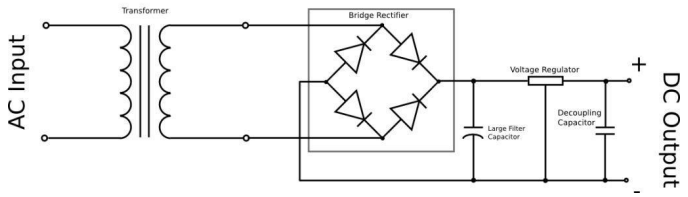

Figure 2: Linear power supply circuit

IV.II Potential Transformer

P.T is an instrument transformer which usually transforms high voltages to a value easy to handle for relays and other instruments. It also insulates the metering circuit from primary high voltages.

Instrument transformers are special kind of transformers used to measure currents and voltages.

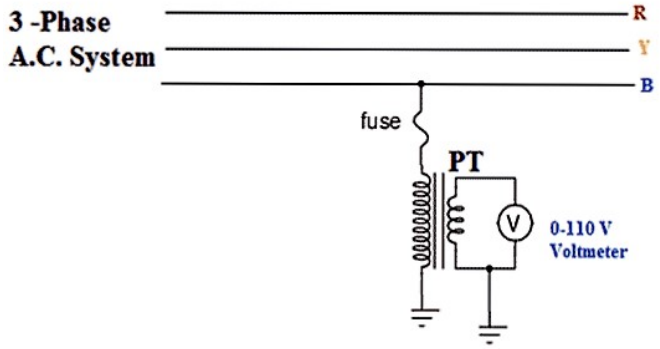

Figure 3: Arrangement of potential transformer

In this system three potential transformers are connected on low voltage side of transformer each is connected on phase and neutral.

IV.III Temperature Sensor

A temperature sensor is a device that collects data which relates temperature from an object or environment and converts it to a form that can be understood by device. These sensors come in many types and are used for a wide range of applications. [4]

We are using TMP36 temperature sensor which is a digital temperature sensor The TMP36 is low power consumption, precise temperature sensor. The Celsius temperature is linearly proportional to voltage output provided by the sensor. It doesn't require any calibration. Its accuracy is ±1°C at +25°C and ±2°C over the −40°C to +125°C temperature.

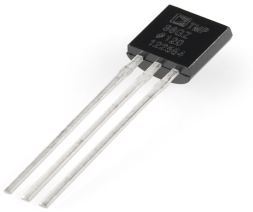

Figure 4: Temperature sensor TMP36

IV.IV Microcontroller

For carrying out a specific function microcontrollers are used. A microcontroller is a device with processor and a memory that can be used as an embedded system. Most consumer products or machinery including mobile phones, automobiles and household appliances or computers are equipped with a programmable microcontroller. [5]

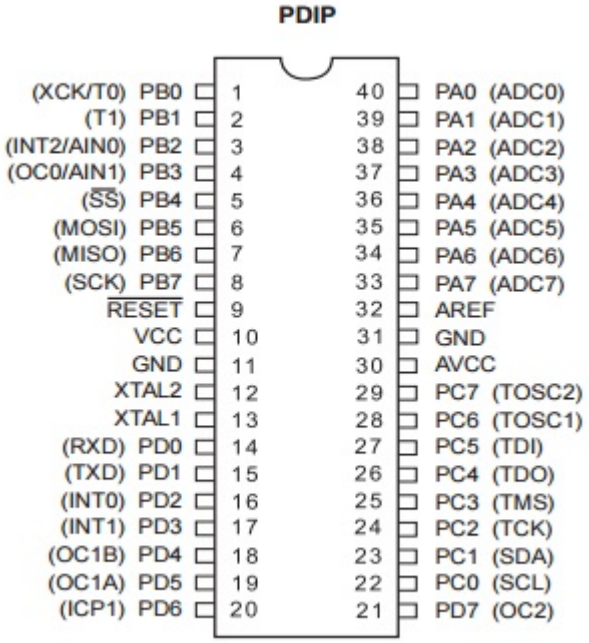

Figure 5: Atmel AVR pin outs

IV.V Conservator Oil Level Indicator

IV.V.I Magnetic Oil Gauge

Magnetic oil gauge is used indicate the oil level in conservator of power transformer. This is a mechanical device. Magnetic oil gauge consists of mainly; float, bevel gear arrangement, indicating dial and terminals. We are using two ways for indicating oil level on device –

1) *Connecting MOG with device* – There are three terminals on MOG; two are phases and one is neutral. On one of the phase we are supplying single phase voltage to power the MOG. The other phase along with the common neutral is connected to the relay of the device. The working of this process is such that a MOG consists of magnetic switch which is eventually activated as the level of float falls which signals the relay to activate the alarm.

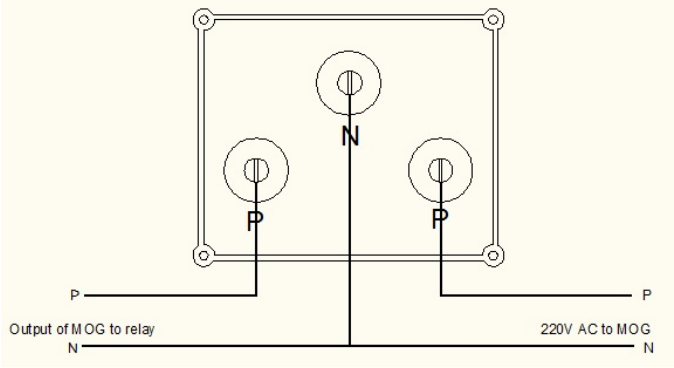

Figure 6: Connection diagram of MOG

2) *Modifications in MOG and conservator* – This method give the real time level of oil. We are using laser and LDR sensors to detect the level of oil and further which can be displayed by the device.

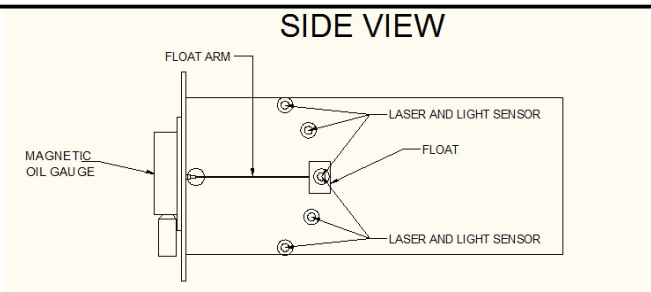

Figure 7: Side view of conservator showing the arrangement of laser and light sensor

There are 5 sets of laser and light sensor which are installed circularly inside the conservator. The lasers are arranged in such a way that the float interrupt the laser penetrating the sensor. Suppose the conservator is half filled as shown in the diagram above, the float will interrupt the laser penetrating the sensor which is further sensed by the sensor and shown on the device. In this way the level of oil can be indicated.

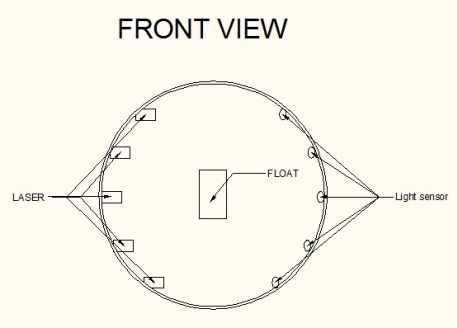

Figure 8: Front inside view of conservator showing the arrangement of laser and light sensor.

IV.VI System Development and Connections

The functions of the system are to check phase failure, unbalanced voltages and earth fault. Apart from these It an also monitor the oil temperature and oil level.

This can be carried out by connecting 3 potential transformers on the low voltage side of transformer to step down the voltage to a safe level which can be read by microcontroller. The microcontroller compares the output voltages of potential transformer to the reference values which is already fed in microcontroller. Further according to that the microcontroller takes the decision about the healthiness of transformer which is then displayed on LCD.

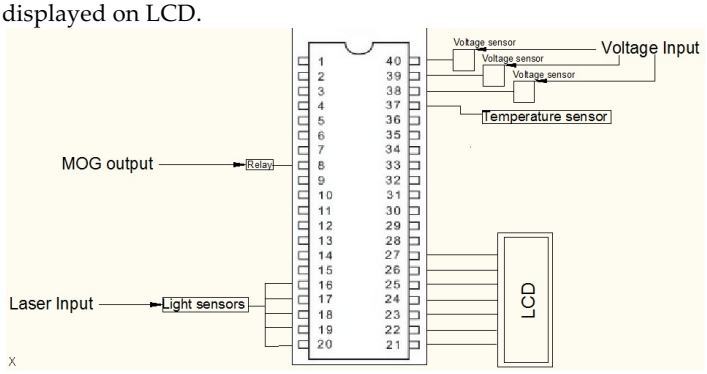

Figure 9: Connection diagram of system

Temperature sensor is interfaced with the microcontroller to monitor the temperature of oil of transformer. The maximum values of oil are fed in microcontroller. If the oil temperature exceeds the safer value then the alarm is activated to alert the authorities.

The output of Magnetic oil gauge is connected to the relay which is then connected to microcontroller. It alerts the system if the level of oil is minimum in the conservator.

The another modifications in the conservator tank for monitoring the real time level of oil in this 5 lasers are used to emit lights on light sensor. The level at which float of MOG interrupt the laser penetrating the light sensor is defined as the level of oil in conservator.

To display all this parameters LCD is used which is interfaced with the microcontroller.

IV. CONCLUSION

In this research paper we have discussed how to detect faults of power transformer. This system provides an easy way to detect faults and monitor the transformer health to avoid future major shutdown.

The Power Transformer Fault Detector provides the following advantages.

- A method that continuously monitor the faults or failures.
- Wide range of features.
- Simple to use.

The testing of power transformer fault detector is under process. After that the device will then progress to product development attached to the power transformers under the collaboration with any company.

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