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Monitoring and Protection of Remote Area Transformers Using GSM Technology

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***Abstract*--This paper proposes the structure of cost effective method for monitoring and protection of distribution transformers with help of GSM technology. At many times the failure of the remote area transformer and transmission lines gets unnoticed. Also the transformers are located in far off places in remote corners of towns, cities and villages. In all these cases it's very difficult to appoint a person to monitor those transformers. Here we have a unique way of monitoring and protecting the key operation indicators of transformers like load currents, voltages, oil level and winding temperature with the help of GSM technology using the existing mobile phone towers. The project houses a GSM modem and a smart electronic monitoring device attached to the transformers.**

I. INTRODUCTION

In electrical system transformers are important device to supply power from generating station to consumers. Distribution Transformers have a long service life if they are operated under rated conditions. The operation of these transformers under these conditions such as overloading and voltage unbalance for a long time will reduce their life significantly also low oil level and high winding temperature leads to insulation failure resulting breakdown. To be aware of occurring these conditions, the operation of these transformer should be controlled continuously .Most power companies use Supervisory Control and Data Acquisition (SCADA) system for online monitoring of transformers within company but extending the SCADA system for monitoring of distribution transformers at remote area is an expensive proportion due to long distance. The project houses consists a GSM modem and a smart electronic monitoring device attached to the transformer.GSM devices such as GSM modems have a large attraction in wide area network applications many parameters of the transformer such as winding and oil temperature, Oil level, load current and voltage output are monitored continuously by the electronic device. If there is deviation in any of the parameters the system acts immediately and forms a SMS that is automatically transmitted via GSM modem to the authorized persons also the transformer is disconnected from the source.

II. METHODOLOGY

A. Existing System

The failure of transformers and transmission line at remote area is unnoticed. The consumer thinks power has been shut down and the EB personal do nothing as they do not know about their failures. The identifying the exact location of faulty transformer is difficult due to no indication. If the transformers are working without parameters monitoring such as voltage, current, oil level and winding temperature etc. leads to break down during abnormality. System reliability is less.

B. Proposed System

This system can detects the fault during under voltage, over current, low oil level and high winding temperature and isolate the transformer from the source. It can communicate which transformer fault, what type of fault to authorized person (line man, engineer, substation and power house etc..) via SMS using GSM technology. No wires required for communication. We can use existing mobile phone towers for communication. We can communicate more than one person if necessary. This project will reduce the failure level so system reliability is increased.

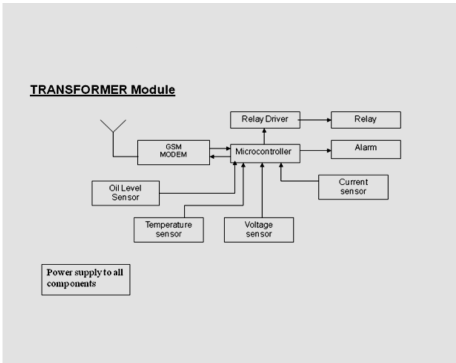

fig.1 Block diagram

- Voltage Analysis

The Voltage unbalance is a condition which the three phase voltages differ in amplitude or are displaced from their normal 120 degree phase relationship or both of these situations occur simultaneously. Voltage unbalance will occur in power systems as well as distribution systems, especially those systems with large number of single-phase consumers. Considering the significant affect of the voltage unbalance on transformers lifetime and system reliability

→ NEMA Definition

According to NEMA definition of voltage unbalance also known as the line voltage unbalance rate (LVUR), is given by

%LVUR=Max (|VAB-VLav|,|VBC-VLav|,|VCA-VLav|) *100 / VLav

The average line voltage designed as follows,

VLav = [VAB+ VBC+ VCA /3]

Here VAB, VBC, VCA are line voltages

→ IEC Definition

The "IEC definition" of voltage unbalance defined as the ratio of the negative sequence voltage component to the positive sequence voltage component and given by

%VUF = (negative sequence voltage component/Positive sequence voltage component) *100

- Overload analysis

An overloading can occur when at least one of the phase currents exceed its rated value. In distribution transformers, overloading is a complicated problem (an important tissue) that needs overall understanding of loads behaviours, effective parameters in transformers and environmental conditions. Whereas the load variation in distribution system is so much more than transfer system, then one phase could be in overloading condition in a longer time. A long time overloading beyond standard duration, causes serious damages to transformer and will reduce its life time. Considering the importance of the value and duration of transformer overloading, we can use following standards to determine allowable values. In which is according to ANSI standard, the approximate value of the overloading peak that transformer can endure while not affect its life time, has been showed. The environmental temperature is assumed to be 30. But the loading capability for each degree of temperature rise above 30 will reduce as 1.5 percent. . Also by decreasing the temperature, it will increase as 1 percent for every one degree.

- Temperature Analysis**:**

Temperature is one the most important factor that reduces transformers lifetime. Thus, using transformers in an optimum and standard temperature will help to keep transformers working for longer time. We can use transformer model to calculate the Hot-spot temperature of transformer. To accomplish that, we have used the IEEE presented model. Considering these models and after simplifying, the transformer hot spot temperature is computed as :

$\theta hot=\theta top+\theta hr\ k$

θhot= maximum legal temperature of hot spot

k is the ratio of load current and nominal current

m is the transformer design factor

III. Simulation Results & Hardware Function

In this project we have used labview for simulation. Labview is a system-design platform and development environment for a visual programming language from National Instruments. LabVIEW is an entirely graphical language which looks somewhat like an electronic schematic diagram on the one hand and a 1950's vintage style electronic instrument on the other -

these are the concepts of the block diagram and the front panel LabVIEW is a program used to automate testing and data gathering. It is basically a graphical programming language in which the user can set up the program to manipulate and store data.

The four basic functions of labviews are

Virtual instruments mean that the operation and appearance imitates actual instruments. Virtual instrument can be used as a top level program.

Front panel The user interface is known as a front panel

Block diagram we can construct a block diagram that wires together objects that sent or receive data, Perform specific function and control the flow of execution.

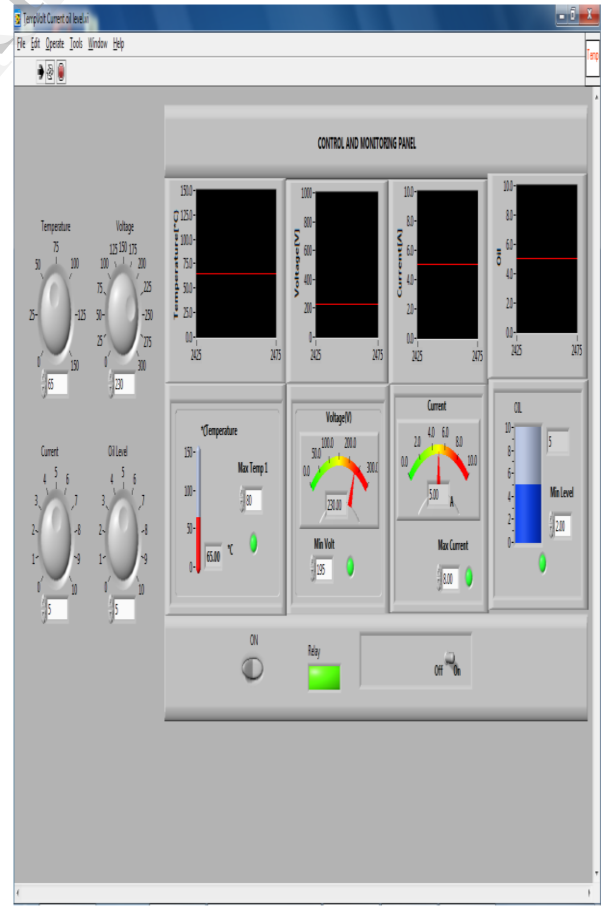

fig.2. Transformer normal working view

From the fig.2 we have understood that when the transformer working in normal operating condition i.e every parameters value is less than preset value. Now the relay is on (load) condition also in control and monitoring panel shows all green indication which means all parameters like temperature, voltage, current and oil level are normal value.the graph window indicates the actual values of parameters.when all parameters are normal condition the output relay is on condition.

Table.1
parameters during normal condition

	Actual value	preset valuez
Winding temp.:	65deg. C	80 deg.C
Output voltage:	230V	195V
Load current :	5A	8A
Oil level :	5%	2%

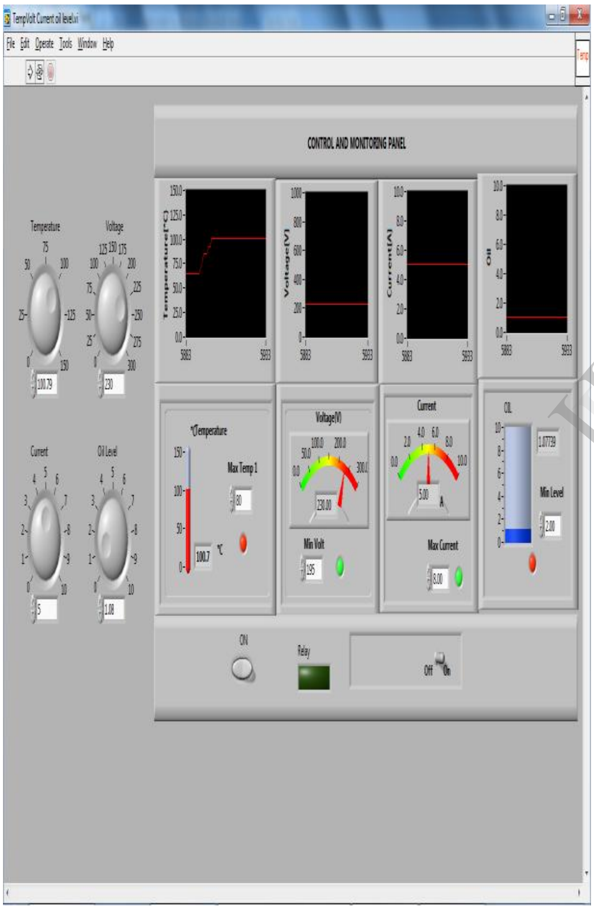

fig.3. Transformer high temperature and low oil level view

when seeing fig.3 the winding temperature and oil level actual value increasing the preset value the pic microcontroller sense the abnormality via sensors and gives command to relay to disconnect the transformer from the source and load and indication change from green to red.

Table.2
parameters during high temperature and low oil level

	Actual value	preset value
Winding temp.:	105.87deg.C	80 deg.C
Output voltage:	230V	195V
Load current :	5A	8A
Oil level :	1.077%	2%

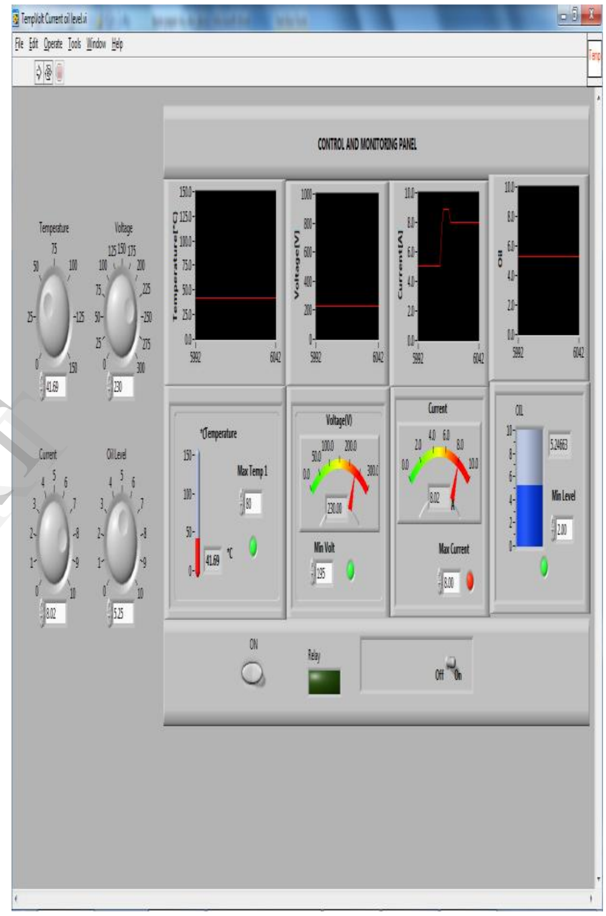

fig.4. Transformer overload view

From the fig.4 we have understood that when the transformer actual load exceeds the maximum load the current goes higher than preset value. It means actual current exceeds 8.02A but set value is 8A.Now load is disconnected from the transformer. It is confirmed by relay color changes from light green to dark green.also indication for overload comes from green to red. Now graph indicates the current view during abnormality.the ACS 712 current sensor are used to sense the actual current flows through the transformer.

Table.3
parameters value during overload

	Actual value	preset value
Winding temp.:	65deg. C	80 deg.C
Output voltage:	230V	195V
Load current :	8.02A	8A
Oil level :	5.24%	2%

Table.4
parameters during under voltage

	Actual value	preset value
Winding temp.:	65deg. C	80 deg.C
Output voltage:	105.87V	195V
Load current :	2.66A	8A
Oil level :	5.24%	2%

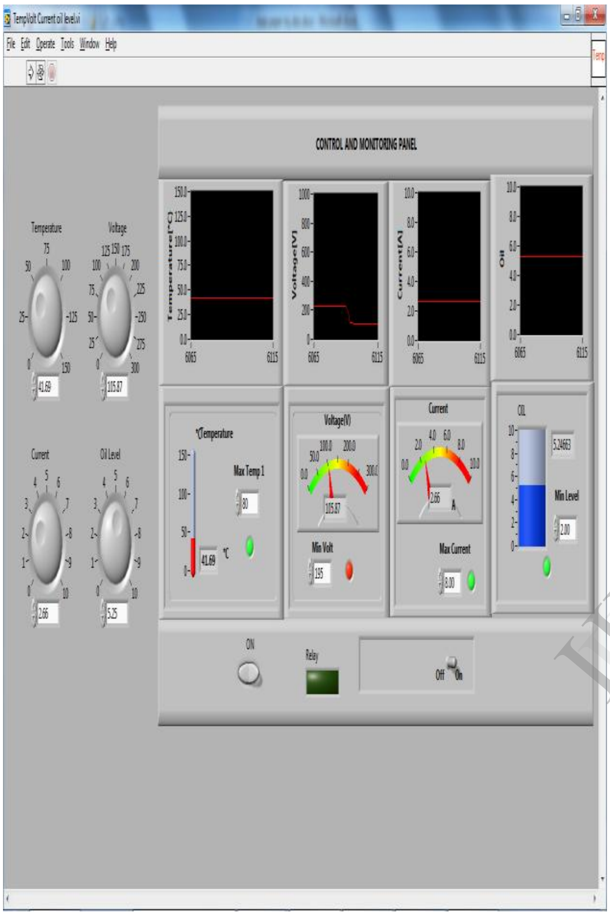

fig.5. Transformer undervoltage view

When seeing fig.5 we have observed that when the transformer output voltage comes less than the preset value the voltage sensor i.e potential transformer sense the abnormality and gives feedback to the PIC controller.It gives command to the relay to disconnect the load from the source.It observed by color chages of relay from light green to dark green. The voltage sensor sense the fuse failure problem also.Also graph indicates the change of voltage.the set point of under voltage is 195V. but actual voltage is less than the set point i.e 105.87V.

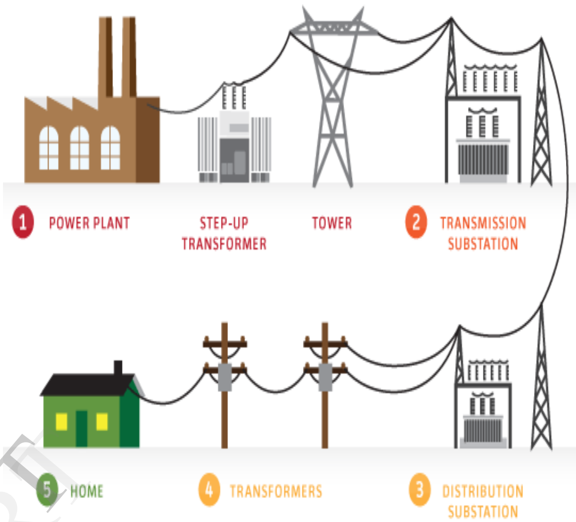

fig.6 Basic structure of electrical system

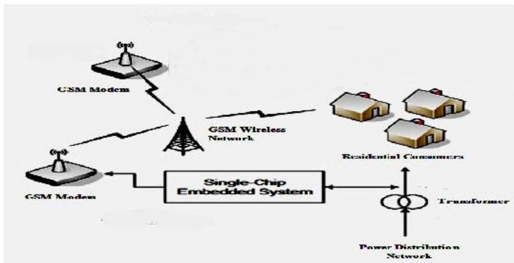

fig.7 Hardware structure

Hardware Components:

1. Embedded Microcontroller PIC18LF45K22
2. GSM Modem
3. Relay Driver
4. Relay
5. Thermal Sensor
6. Oil level Sensor
7. Alarm

Software Tools:

1. MPLAB IDE – For controller programming
2. OrCAD – For circuit design
3. Eagle – For PCB design

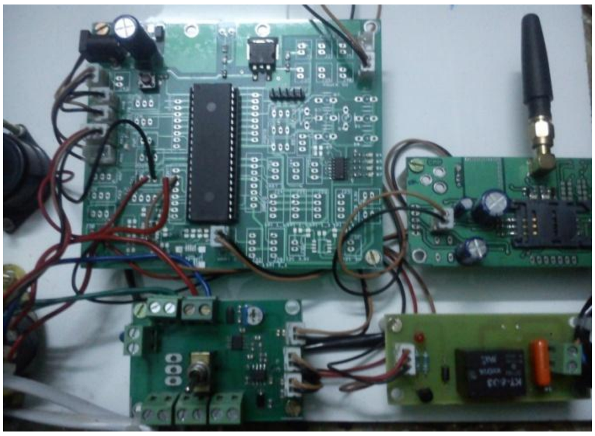

fig.8 Hardware kit

Hardware kit includes:

- PIC microcontroller module
- Power supply module
  - i. 3.3v dc
  - ii. 5v dc
  - iii. 12v dc
- GSM module
- current and voltage sensor module
- relay driver module
- LM 35 temperature sensor
- MPX 5050 pressure sensor
- ACS 712 current sensor
- 230/12v ac potential transformer.

Hardware description:

Here PIC 18F45K22 low-power high performance microcontroller are used. It is a 40pin IC. It has inbuilt Analog to digital and digital to analog converters also it has high performance RISC CPU. The GSM Modem is a device which is very similar in function to a conventional mobile phone. Like a mobile phone it can be used for making voice calls over any GSM network, and also send and receive SMS. Here we have used SIM 900 manufactured by simcom.

IV. CONCLUSION

In this paper, we have described an advanced remote monitoring and protection system for distribution transformers and utilizing the existing GSM communication network, which has low investment and operation costs. It is also easy to install and use. Also if we are monitoring the different transformer parameters such as voltage, current, oil level and winding temperature, the failure level is reduced. So system reliability increased.

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