Transformer Health Condition Monitoring Using GSM Technology

U.V.Patil[1], Kathe Mohan[2], Harkal Saurabh[3] , Warhade Nilesh[4]

[1]*Professor, Department of Electronics and Telecommunication, Loni, Tal-Rahata, Dist- Ahmednagar, Maharashtra, India*

[2]*BE, Department of Electronics and Telecommunication, Loni, Tal-Rahata, Dist- Ahmednagar, Maharashtra, India*

[3]*BE, Department of Electronics and Telecommunication, Loni, Tal-Rahata, Dist- Ahmednagar, Maharashtra, India*

[4]*BE, Department of Electronics and Telecommunication, Loni, Tal-Rahata, Dist- Ahmednagar, Maharashtra, India*

ABSTRACT

Transformer are a vital part of the transmissions and distribution systems. Monitoring transformers for problem before they occurs can prevent fault that are costly to repair & results in a loss of services. Current system can provides information about the state of a transformers, but are either offline or very expensive to implement. Transformer is essential part of power transmission system, are costly, as is the cost of power interruption. Because of the costs of scheduled & unscheduled maintenance, especially at remote site, the utility industry has begun investing in instrumentation & monitoring of transformers. Online transformer diagnostics using conventional technologies like carrier power line communications & Radio frequency based control systems & Supervisory controls & data acquiring system, Distributed control systems & Internet based in communications are having their own limitation. GSM is an open digital cellular technology use for transmitting mobiles voice & data services.

This project objective is to develop low cost solution for monitoring health conditions of remotely located distributions transformers using GSM technology to prevent premature failures of distributions transformers & improving reliability of services to the customers.

Keywords—*GSM,Transformer.*

1. INTRODUCTION

In recent years increase emphasis has placed on powers reliability & economy. In particular major change in utility industries have caused increased interest in more economical and reliable method to generate & transmit & distributes electric power. In this regards monitoring the health of equipments constituting the systems is critical to assure that the supply of power can be meet the demand. As has seen recently inner then grid failures on 30th and 31st July 2012 due to inefficient load management function lead to wide blackout, leaving almost 700 million peoples without electricity in six northern state of our country.

The main concern with transformers protections is protecting the transformers against internal fault & ensuring security of the protections scheme for external fault. System condition that indirectly affects transformer often receive less emphasis when transformers protections is specified. Overloading power transformer beyond the nameplate rating can causes a rise in temperature of both transformers oil & winding. If the windings temperature rise exceed the Transformers limit, the insulation will deteriorate & may be fail prematurely. Prolonged thermal heating weaken the insulations over time, resulting in accelerated transformers loss of life. Power systems fault external to the transformers zone can cause high level of current flowing through the transformers. Through faults current create forces within the transformers that can eventually weaken the winding integrity. A comprehensive transformers protection scheme need to include protection against transformers overload, through fault, and over excitation, as well as protection for internal fault.

2. TRANSFORMER FAULT ANALYSIS

A power transformer consists of a set of winding around magnetic cores. The winding are insulated from each other's & the cores. Operational stresses can caused failures of the transformers winding, insulations & cores. The power transformer windings & magnetic core are subjects to a numbers of different forces during operations.

1. Expansions & contraction cause by thermal cycling
2. Vibrations cause by flux in the core changing directions.
3. Localized heating caused by eddy currents in part of the winding, Induces by magnetic flux
4. Impact forces cause by faults current.
5. Thermal heating cause by overloading.

These operating limit only consider the thermal effect of transformers overload. Later the capability limits was change to include the mechanical effect of higher faults current through the transformers. Power transformers fault produces physical force that causes insulation wear. These effects are cumulative & should be considered over the life of the transformers. The following discussions highlight on different capability limit of transformers.

2.1 Over Load

Over current is the current flowing through the transformer resulting from fault on the power systems. Faults current that do not includes ground are generally in excess of four time fullload currents, faults current that includes ground can be below the full load currents depending on the systems grounding methods. Over current condition are typically short in duration (less than two second) because protection relays usually operates to isolates the fault from the power systems. Over load, by contrast, is currents drawn by load, a load currents in excess of the transformers name plate rating. In summary, loading large power transformer beyond name plate rating can result in reduced dielectric integrity, thermal runaway condition of the contact of the tap changer, & reduced mechanical strength in insulation of conductor & the transformers structure. Three factors, namely water, oxygen, & heat, determine the insulation life of a transformers. Filter & other oil preservation system control the water and oxygen content in the insulation but heat is essentially a function of the ambient temperature & the load current. Current in crease the hottest-spot temperature (and the oil temperature), and thereby decrease the insulation life span.

2.2 Over Temperature

Excessive loads current alone may not results in damage transformers if absolute temperature of winding & transformers oil remain within specified limit. Transformers rating are based on 24 hour average ambient temperature of 30°C (86°F). Due to the over voltage & over currents, temperature of oil increase which cause failures of the insulation of transformers windings.

2.3 Over Excitation

The flux in transformer core is directly proportional to applied voltage & inversely proportional to frequency. Over excitation can occurs when the per unit ratio of voltages to frequency (Volts/Hz) exceed 1.05 per unit at full load & 1.10 per unit at a no load. An increases in the transformers terminal voltages or a decreases in the frequency will result in an increase in flux. Over excitation result in the excess flux, which cause the transformer heating & increase exciting current, noise, & vibrations.

2.4 Oil Level Fault

Oil mainly used in the transformers for two purpose one is cooling of transformer & another use is insulation purpose. When temperature of the transformer goes to high, oil level in the transformers tank is decrease due to heating effects. For normal operation of the transformers oil level should maintains at a required level. If oil level is decrease beyond required level then it affect cooling & insulation of transformers.

3. DESIGN OF MICROCONTROLLER BASED TRANSFORMER HEALTH CONDITION MONITORING KIT

It consists of current transformer & power transformer, CT, PT, oil level sensor, temperature sensor (LM35), PIC18F4520 microcontroller, LCD display, GSM modem, MAX 232 & relay. Normally in the transformers, failure occurs due to the voltage & current fluctuations, overheating, change in the oil level etc. In this project to sense these fault we have used current & power transformers, temperature sensor & oil sensor respectively.

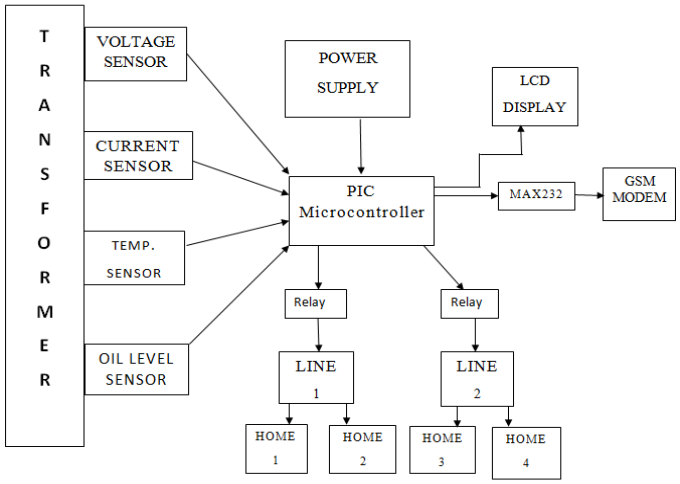

Fig 1 -Block diagram

These entire sensors are connected to the transformer & digital output is given to the PIC microcontroller. PIC microcontroller has five ports to which we will be connected to the address lines, GSM model & LCD respectively. When faults occur due to the above any reason then there is changes in the rating will be shown on the LCD & quick SMS will go to the control room via GSM modem. A brief discussion about the component are used is as given below Sensor play a vital role in the effective implementation of project. As we are interested in the monitoring over currents, over temperature & oil level following sensor are selected & suitable designed with respect to the prevailing condition of the power system & rating of the transformer to be protected.

3.1 Current and Voltage Transformer

Currents or voltages instruments transformers are necessary for isolating protection and controls. The behavior of currents & voltages transformers during & after occurrence of the faults is critical in the electrical protections since error in the signal from transformers can causes operation of relays.

3.2 Temperature sensor

The LM35 series are precision integrated circuit temperature sensor, whose output voltage is a linearly proportional to Celsius (Centigrade) temperature. LM35 thus has an advantages over linear temperature sensor calibrated in ° Kelvin, the user is not required to subtracts a large constant voltages from its output to obtain convenient Centigrade scaling.

LM 35 is a directly connected to the analog port of PIC microcontroller which directly give to the temperature of the windings. As second connection of the temperature sensor is to the winding of the transformers.

3.3 Oil Level Sensor

Oil level sensor is a float connected to the angular potentiometer. Float is immersed in the oil & its mechanical output is given to the angular potentiometer. When there is any mechanical movement of the float, there is a voltage generation corresponding to the mechanical movements of float. That voltage is used for the oil level monitoring.

3.4 PIC Microcontroller

PIC microcontroller is defined as system on computer chip which include number of peripheral like RAM, EEPROM required to performs some predefined tasks. There are the number of popular families of microcontroller which are used in the different application as per their capability & feasibility to perform various tasks, mostly used of these are 8051, AVR & PIC microcontroller.

PIC18F4520 is a great PIC MCU to start working. It has many features & easily affordable. This PIC is re-programmable many times because it has a flash memory & programming can be done using IC program. The PIC18 family has a special features to reduce the external component, thus minimizing cost, enhancing system reliability & reducing power consumption.

Features

- 32kb of on chip static RAM and 32kb of on chip flash program memory.
- Single 10 bit DAC provides variable analog outputs.

- Data EEPROM (Bytes) = 256.
- One WDT, 77 Instructions and 10 MIPS.
- Operating voltage range is 2 to 5.5 volts.
- Temperature range -40 to 125 C.

3.5 GSM Modem

A GSM modem is specialized type of modem which accept a SIM card & operate over subscription to a mobile operator, just like a mobile phone.

Fig 2- GSM Modem

This is powerful GSM/GPRS Terminal with compact & self contained unit. This has a standard connector interface & has an integral SIM card reader. The modem has a DB9 connectors through which a speaker & microphone can be connected allowing audio call being established but this feature is not utilized.

In this project as only a data transfer is needed.

Features & Specification

- Cellular frequency is 900/1800MHz
- Easy to used.
- Serial port DB9 connector.
- Antenna length 120mm

3.6 MAX 232

The MAX232 device is dual driver or receiver that include capacitive voltage generator to supply EIA-232 voltage level from a Single 5V supply. The MAX232 was first IC which in one package contain necessary driver (two) and receiver (also two) to adapt the RS232 signal voltage levels to the TTL logic. It become popular, because it just need one voltage (+5V) & generate the necessary RS232 voltage level (appro. -10V and +10V) internally. This greatly simplified the designs of circuitry. The pin configuration of MAX 232 is as shown in figure.

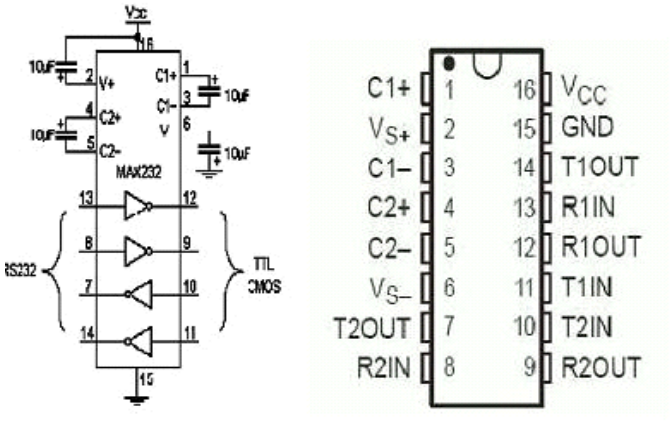

Fig.3- Pin configuration of MAX 232

It has a features like operating from Single 5V Power Supply operate up to 120 kbps Two Driver and Two Receiver 30V Input Level Low Supply Current 8mA Typical.

4. PROTOTYPE MODEL DEVELOPMENT

As shown in fig. Microcontroller PIC18F4520 is main controlling element to which PT a on input side, CT on a load side, LM35 & float sensor are connected. These four sensors are

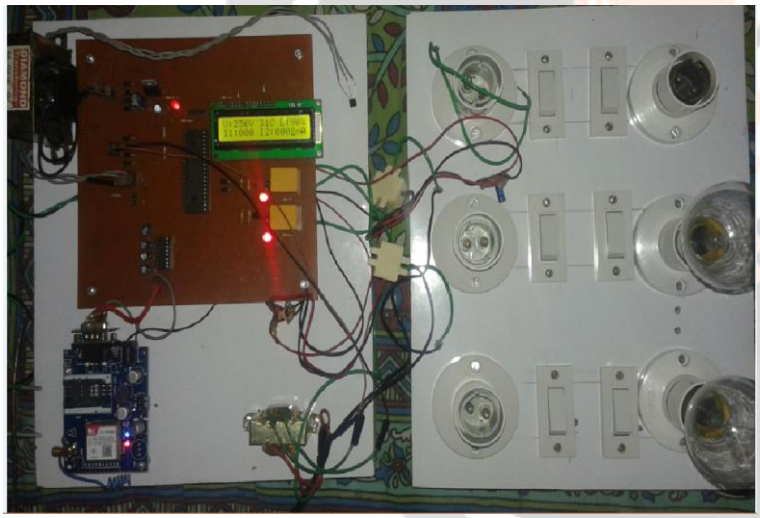

Fig.4. Prototype model of microcontroller based transformer health condition monitoring kit.

used to monitoring transformer parameter (voltage, current, temperature and oil level) Initially input from the main line to the load is monitored by CT current transformer. This CT gives current level based on a load used by costumers. Output of CT is current & ac which is rectified & made voltage by a signal conditioner circuit consisting of 10ohm resistor; diode & capacitor. When a power supply is switched on, then microcontroller, start program execution from zero memory location.

5. Program Execution & Testing

The project is the based on PIC microcontroller programming. Program for PIC microcontroller in embedded C language. Program written burned into the PIC microcontroller & saved as a Hex file Program. Hex file is compiling in microcontroller flash compiler. This compiler convert programs into machine language code and also check programs for error, if any error found notifies & these error are corrected manually. Then it successfully executed in the compiler. After compiling program in PIC microcontroller flash compiler, it is burned into the PIC18f4520 microcontroller with the help of universal programs burner kit FP8903 programmer which connected to computer. After successful program burning, PIC microcontroller becomes ready for use.

In testing, after successful programs burning, PIC microcontroller is mounted on its base & kit becomes ready for testing. For testing in a program kit has provided with following four parameters of transformer:

1. Voltage > 250V = Voltage Fault
2. Temperature > 40C = Temperature fault
3. Power > 120W = Over load
4. Oil level < 30 ml = Oil level fault

Therefore any changes occurred in the above rating during running of project model, these change shown in the LCD & same data obtained in SMS & at the same time transformer get disconnected from a supply with the help of relay. Result obtained during testing as per given input & fault condition on a LCD.

6. Result

1. Voltage > 250V = Voltage Fault
2. Temperature > 40C = Temperature fault
3. Power > 120W = Over load
4. Oil level < 30 ml = Oil level fault

7. Conclusion

The GSM based monitoring of a distributions transformers is quite useful as compared to the manual monitoring & also it is reliable as it is not possible to monitor always oil level, oil temperature rise, ambient temperature rise and load current manually. After receiving a message of any abnormalities we can take action immediately to prevent any failure of a distribut ion transformer. In distribution network there are many distributions transformer & associating each transformers with such a system, we can easily figure out that which transformers is undergoing fault from message sent to mobile. We need not have to check all transformer & corresponding phase current & voltage & thus we can recover system in less time. The time for receiving message may vary due to public GSM network traffic but still then it is effective than manual monitoring.

8. References

[1] Bajjuri Praneeth Kumar and Boda Vamsee Krishna Babu, “SMS Remote Controller” papers presented in Embedded Systems Fall 2005.

[2] Ali Kazemi and Casper Labuschagne ,“Protecting Power Transformer From a Common Adverse Condition”, papers presented at Ga-Tech & Western Protective Relay Conference, New Berlin” in 2005.

[3] T.S.Madhavrao, “Power Systems Protection Static Relay”. TMH Pub location.

[4] National Semiconductors Corporation, “ADC 0808”, journal published, America, October 1999.

[5] Atmel Corporations, “ AT 89S51”, literature journal published, CA, December 2003 3. National Semiconductors Corporation, “ Voltage Regulator LM 7805” journal published, America, May 2003.