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Design and Implimentation of Low Cost SMS Based Monitoring System for Distribution Transformers

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ABSTRACT

In power network the most important equipment is transformer. Monitoring each transformers manually is difficult as it is distributed widely. The important issue is automatic data acquisition and transformer condition monitoring. This project presents the design and implementation of a mobile embedded system to monitor load currents, over voltage and temperature. The implementation of online monitoring system integrates internet of things (GSM) Modem, with single chip Micro controller and sensors. It is installed at the distribution transformer site. The output values of sensors are processed and recorded in the system memory. System programmed with some predefined instructions to check abnormal conditions. According to the predefined data sets, the abnormality will be sent through the SMS services. This SMS service will help in diagnosis catastrophic failure for high performance efficiency and also helps in decreasing human dependency. Thus THMS offers a more efficient transformer monitoring.

INTRODUCTION

In recent years, increased emphasis has been placed on power reliability and economy. In particular, major changes in the utility industry have caused increased interest in more economical and reliable methods to generate and transmit and distribute electric power. In this regard monitoring the health of equipment constituting the system is critical to assure that the supply of power can meet the demand. As has been seen recently in northern grid failure on 30th and 31st July 2012 due to inefficient load management functions lead to wider blackout, leaving almost 700 million people without electricity in six northern states of our country. The main concern with transformer protection is protecting the transformer against internal faults and ensuring security of the protection scheme for external faults[2]. System conditions that indirectly affect transformers often receive less emphasis when transformer protection is specified. Overloading power transformers beyond the nameplate rating can cause a rise in temperature of both transformer oil and windings. If the winding temperature rise exceeds the transformer limits, the insulation will deteriorate and may fail prematurely. Prolonged thermal heating weakens the insulation over time, resulting in accelerated transformer loss-of-life. Power system faults external to the transformer zone can cause high levels of current flowing through the transformer. Through-fault currents create forces within the transformer that can eventually weaken the winding integrity. A comprehensive transformer protection scheme needs to include protection against transformer overload, through-fault, and over excitation, as well as protection for internal faults.

TRANSFORMER FAULT ANALYSIS

A power transformer consists of a set of winding's around a magnetic core. The winding's are insulated from each other and the core. Operational stresses can cause failure of the transformer winding, insulation, and core. The power transformer winding's and magnetic core are subject to a number of different forces during operation:[3]

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1. Expansion and contraction caused by thermal cycling

2. Vibration caused by flux in the core changing direction

3. Localized heating caused by eddy currents in parts of the winding, induced by magnetic flux

4. Impact forces caused by fault currents.

5. Thermal heating caused by overloading. These operating limits only considered the thermal effects of transformer overload. Later, the capability limit was changed to include the mechanical effect of higher fault currents through the transformer. Power transformer faults produce physical forces that cause insulation wear. These effects are cumulative and should be considered over the life of the transformer.[2].

The following discussion highlights on different capability limits of transformer

Over Load Over current

is the current flowing through the transformer resulting from faults on the power system. Fault currents that do not include ground are generally in excess of four times full-load current; fault currents that include ground can be below the fullload current depending on the system grounding method. Over current conditions are typically short in duration (less than two seconds) because protection relays usually operate to isolate the faults from the power system. Overload, by contrast, is current drawn by load, a load current in excess of the transformer nameplate rating. In summary, loading large power transformers beyond nameplate ratings can result in reduced dielectric integrity, thermal runaway condition (extreme case) of the contacts of the tap changer, and reduced mechanical strength in insulation of conductors and the transformer structure. Three factors, namely water, oxygen, and heat, determine the insulation life of a transformer. Filters and other oil preservation systems control the water and oxygen content in the insulation, but heat is essentially a function of the ambient temperature and the load current. Current increases the hottest-spot temperature (and the oil temperature), and thereby decreases the insulation life span.

Over Temperature

Excessive load current alone may not result in damage to the transformer if the absolute temperature of the windings and transformer oil remains within specified limits. Transformer ratings are based on a 24-hour average ambient temperature of 30°C (86°F). Due to over voltage and over current, temp. of oil increases which causes failure of insulation of transformer winding.

Over Excitation

The flux in the transformer core is directly proportional to the applied voltage and inversely proportional to the frequency. Over excitation can occur when the per-unit ratio of voltage to frequency (Volts/Hz) exceeds 1.05 p.u. at full load and 1.10 p.u. at no load. An increase in transformer terminal voltage or a decrease in frequency will result in an increase in the flux. Over excitation results in excess flux, which causes transformer heating and increases exciting current, noise, and vibration.

Oil Level Fault

Oil mainly used in transformer for two purposes one is for cooling of transformer and another use is for insulation purpose. When temperature of transformer goes high, oil level in transformer tank decreases due to heating effect. For normal operation of transformer oil level should maintain at required level. If oil level decreases beyond required level, it affect cooling and insulation of the transformer

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BLOCK DIAGRAM

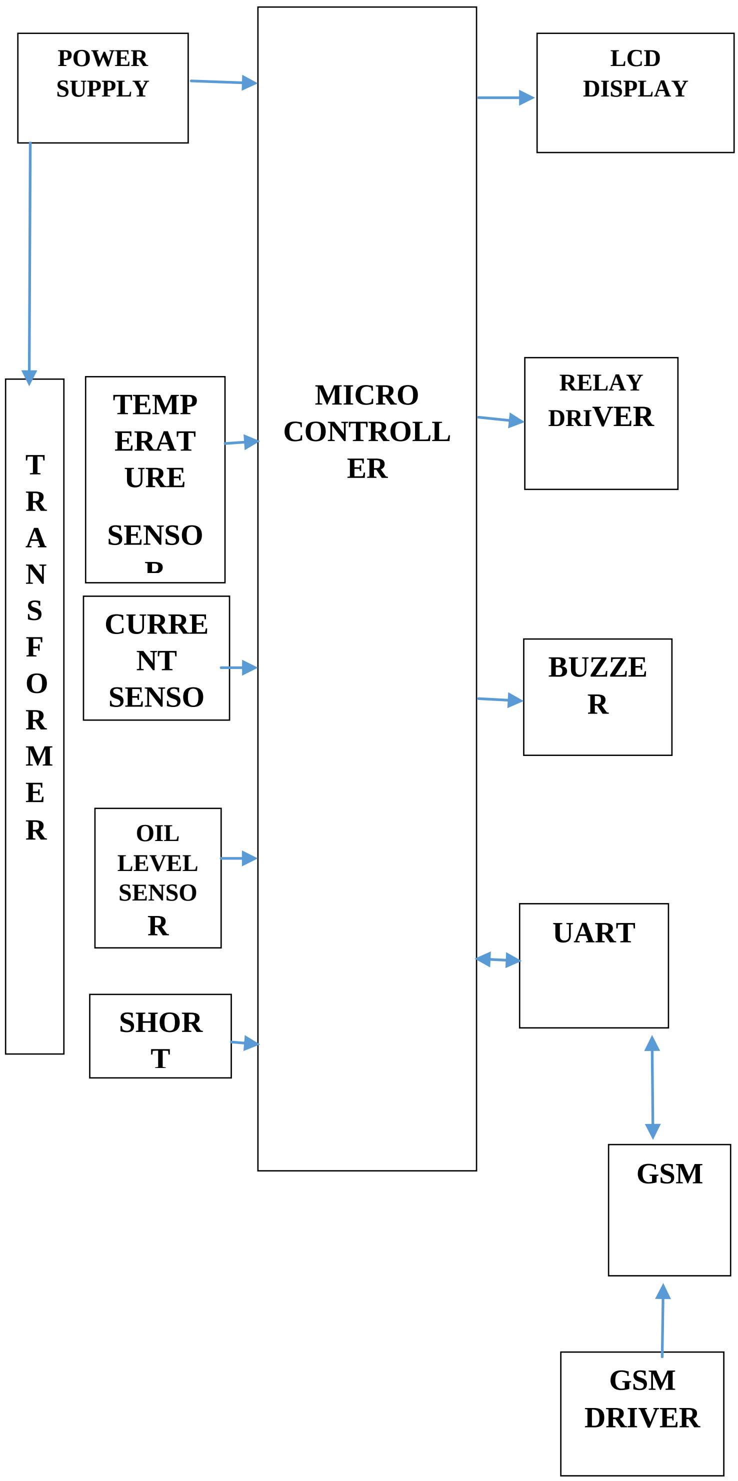

FIG 1: Transformer monitoring for GSM based module.

METHODOLOGY:

The project is based on micro-controller programming. The program for microcontroller in embedded C language. program written burned into microcontroller and saved as Hex file. For AT89S51 controller Atmel programmer is used. Program hex file is compiled in µcontroller flash compiler. This compiler converts program into machine language code as well as check program for error if any error found notifies and these errors are corrected manually. Then it successfully executed in compiler. After compiling program in µcontroller flash compiler, it is burned into AT89S51 microcontroller with the help of universal program burner kit FP8903 programmer which is connected to computer. After successful program burning, microcontroller becomes ready for use. In testing, after successful program burning, microcontroller is mounted on its base and kit becomes ready for testing. For testing In program kit has provided with following four parameter of transformer:

1. 180 >Voltage > 260 -- Voltage Fault

2. Temperature > 400C--- Temperature fault

3. Power > 125W -- Over load

4. Oil level < 10 ml --- Oil level fault

Therefore any change occurred in above rating during running of project model, these changes is shown in LCD and same data obtained in SMS and at the same time transformer gets disconnected from supply with the help of relay.

HARDWARE:

- Pic 16f877a Micro Controller
- Transformer
- Temperature Sensor (Lm35)
- Current Sensor
- Voltage Sensor
- Oillevel Sensor
- Short Circuit Sensor
- LCD Display
- GSM Sim 300
- GSM Driver Circuit

SOFTWARE:

- Embedded C Programming

- Mp Lab Ide
- Ccs Compiler
- Pic Kit 2 Flasher
- Express PCB

CONCLUSION

Transformers are among the most generic and expensive piece of equipment of the transmission and distribution system. Regular monitoring health condition of transformer not only is economical also adds to increased reliability. In the past, maintenance of transformers was done based on a pre-determined schedule. With the advancement of communication technology now it is possible to receive fault information of transformer through GSM technology remotely to the operator and authorities so one can able to take possible solution before converting fault in to fatal situation. Depending upon fault analysis a prototype model of microcontroller based transformer health monitoring kit is developed in laboratory. Using digital controller analysis results are regularly updated. During abnormal conditions exceeding specified limits information is immediately communicated through GSM technology to the operator and also to concerned authority for possible remedial action. This type of remote observation of health condition of transformer not only increases the life of transformer increases mean down time of transformer there by increased reliability and decreased cost of power system operations.

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