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DISTRIBUTION TRANSFORMER MONITORING AND CONTROL SYSTEM FOR REMOTE ELECTRIC POWER GRIDS THROUGH GSM

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Abstract- This paper presents design & implementation of a mobile embedded system to monitor and record key operation parameters of a distribution transformer like load current, voltage unbalance, transformer oil & ambient temperatures. The proposed monitoring system integrates a Global Service Mobile Modem, with standalone single chip microcontroller & sensor packages. It is installed at the distribution transformer site & the above mentioned parameters are recorded by using the built-in 8 channel analog to digital converter (ADC) of the embedded system. The acquired parameters are processed & recorded in the system memory. If there is any abnormality or an emergency situation then system sends messages to designated mobile telephones containing information about the abnormality according to some predefined instructions & policies that are stored on the embedded system EEPROM. Also, it sends SMS to a central database via the GSM modem for further processing. This system will able to benchmark the DT measurements to abnormal operation and take action before failure.

Keywords- Protection of distribution transformer, differential protection scheme.

I. INTRODUCTION

In power system network distribution transformer is electrical equipment which distributes power to the low-voltage users directly and its operating condition is a vital part of the operation of distribution network. Operation of distribution transformer under rated condition guarantees their long life. However, their life is significantly reduced if they are subjected to overloading condition, resulting in unexpected failures and loss of supply to a large number of customers thus affecting system reliability. Overloading and rise in oil & winding temperature of transformer are the major causes of failure in distribution transformers.

The GSM based monitoring of distribution transformer is quite useful as compared to the manual operating system. In case of manual monitoring system it is not possible to monitor the oil level, rise in oil temperature, rise in ambient temperature, load current regularly. After receiving the message of any abnormality, we can easily take action immediately to prevent any failure of distribution transformers. In a distribution network system there are many distribution transformers and associating each transformer with such system can easily figure out faulty transformer from the message sent to mobile, thereby no need of checking all transformers phase current and voltage and thus we can recover the system in less time.

Abnormality in transformer is accompanied with variation in different parameters like winding temperature, oil temperature, ambient temperature, load current, dissolved gases in oil and oil level.

The monitoring devices which are presently used for monitoring transformer have some problems and deficiencies such as,

1. Manual monitoring system generally detects a single parameter such as power, current, voltage and phase. While in some ways it could detect multi-parameter. The time for acquiring the data or readings and operating parameters is too long and testing speed is not so fast enough.

2. Detection system is not reliable because poor anti-jamming capability and low measurement accuracy of the data.
3. Timely detection data will not be sent to monitoring centres in time.
4. Cost of presently used monitoring system is very high.
5. Some monitoring systems uses power line carrier communication (PLCC) to send data but it has some disadvantages:

a) Frequency interference in system.
b) Noise problem in network.

According to the above requirements we need a real-time electrical parameters monitoring system to detect all operating parameters and send it to the monitoring Centre in time. It leads to online monitoring of operational parameters of distribution transformer which can provide useful information about the health of transformers which will help the utilities to optimally use their transformers & keep the asset in operation for a longer period. This will help to identify problems before any serious failure which leads to a cost saving and provides greater reliability. Widespread use of mobile networks & GSM devices such as GSM modems and their decreasing costs have made them an attractive option not only for voice media but also for other wide area network applications.

With the help of this GSM module it is possible to send information whenever fault arises i.e. send text SMS to service engineer mobile.

II. METHODOLOGY

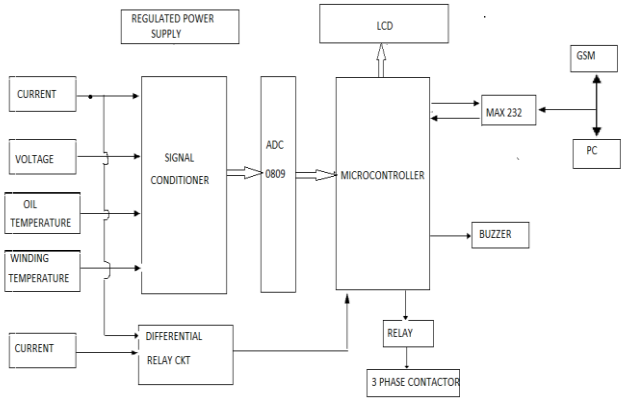

Figure 1-Block diagram

First sensors are installed at the transformer site for sensing the various electrical parameters of transformers and convert into analog signal with the help of signal conditioning circuit. Then the signal is passed through microcontroller .The GSM based modem is interfaced with the microcontroller through MAX232 adapter by which it uploads and downloads SMS that contain information related to the transformer parameters. This GSM Based modem then sends this SMS to mobile users containing information about parameters value of the distribution transformers. When fault occurs in distribution transformer then we can trip the circuit with the help of relay and 3 phase contactor.

III .HARDWARE ARCHITECTURE

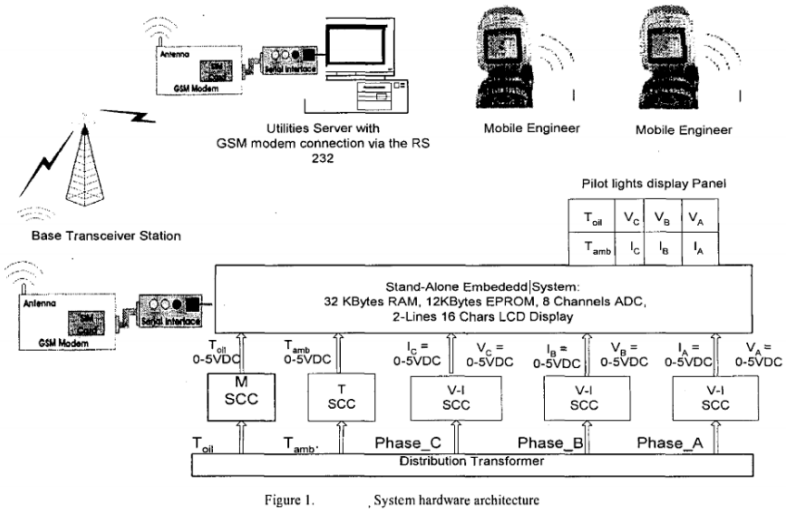

Figure 1. System hardware architecture

Figure 2-sequence of methodologies in the monitoring of distribution transformer via GSM

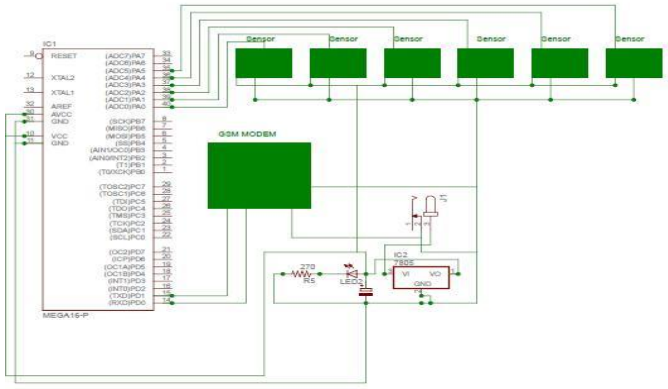

Figure 3-Circuit diagram of the Model

The system hardware has four hardware modules like embedded system, GSM modem, mobile-users & GSM networks and PC-based server. The embedded module is located at the site of transformer. It is utilized to acquire process and display as well as transmit and receive the parameters from the GSM modem. The second is the GSM module is the link between the embedded system and the public GSM network. Then third is utility module that has a PC-based -server located at the utility control center. Then server is attached to GSM modem and received SMS from the transformer site via the GSM module.

Detailed specifications & functions of each module are described as follows: Embedded system module has two blocks: Signal Conditioning Circuit block and Controller block. The SCC block reads the currents, voltages, temperatures from sensors. Then it converts each reading to a compatible signals that can be read by the embedded system built-in ADCs (0-5 volts DC). Each circuit has two Op-amps & set of resistors to adjust the gain and the offset. The current & voltage SCC have small transformers and rectifier circuits that convert and scale the current and voltage values to be compatible levels with the Op Amps circuits. The controller block consists of an 8-bit microcontroller that has 8-channel analog to digital converter (ADC) & several digital input/output ports. The ADC is used to read the parameters, which are built-in EPROM is used to host the embedded software algorithm that takes care of the

parameters acquisition, processing, displaying, transmitting & receiving. The built-in EEPROM is used to save the online measured parameters along with their hourly& daily averages. The system is equipped with 2-lines 16 character each LCD and 16-LEDs that are used as pilot lights to indicate each parameter status. The microcontroller RS-232 is utilized for the GSM modem communication to upload & download SMS messages that contain information related to the transformer parameters and status. GSM Modem

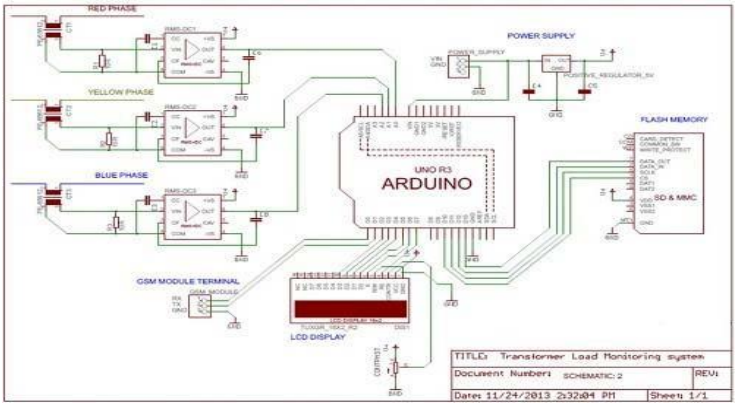

Figure 4-hardware circuit Design

Block offers high speed wireless connection and it is attached to the microcontroller RS-232 data adapter and can be used as a standalone modem. It can be connected to a personal computer, stand alone embedded system or other devices via their serial ports The GSM based modem is used as a short message server (SMS) device. It can send and receive SMS containing a maximum of 160 characters. In this application, the GSM modem is interfaced with the microcontroller via its RS-232 adapter.

Figure 5- GSM Modem

The GSM modem receives a message from the microcontroller that contains the transformer information such as location, load currents and temperature. It will then transmit the parameters as an SMS to pre-stored GSM device numbers according to a preset policy and the receiver can be a utility personnel such as maintenance technician, operation engineer or/and authorized utility personnel. Also, it can receive SMS messages from any one of the above mentioned personnel acquiring information. Mobile users and GSM networks: The mobile users are authorized utilities personnel with GSM mobile set with a valid SIM chip. The GSM network is the public mobile phone network that is provided to users by the mobile service providers. . The PC-based server is off-the-shelf Pentium with sufficient requirement to handle limited database application.

IV.SOFTWARE IMPLEMENTATION

The programming is done in embedded C language then with the help of MPLAB software compilation of the C program converts into machine language file (.hex) which is required for microcontroller. This is the only language the microcontroller will understand and then design microcontroller based circuit diagram on PROTEUS software. The voltage we get from the main supply is 230V AC but the other components of the circuit require 5V DC. Hence we get 12V AC by using step-down transformer which is later converted to 12V DC using a rectifier but output of rectifier still contains some ripples due to Pulsating DC. To remove the ripples and obtain smoothed DC power filter circuits are used. The 12V DC is rated down to 5V using a positive voltage regulator (chip 7805). Thus a fixed DC voltage of 5V is obtained.

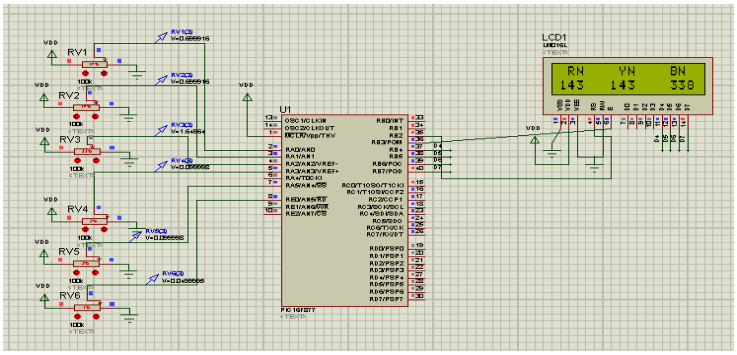

Figure 6-Simulation result

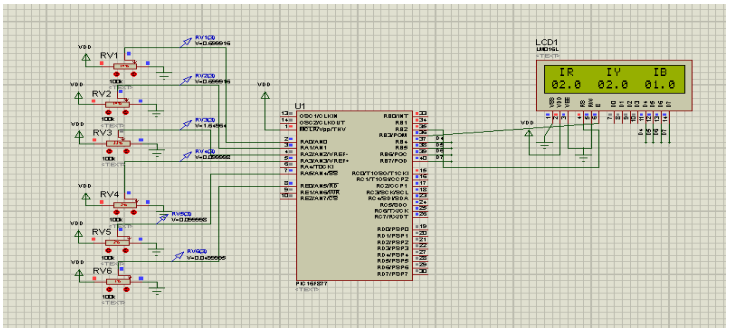

Figure 7- simulation result

SYSTEM PROCESS FLOW

This was developed in system programming as shown in the flow chart in figure

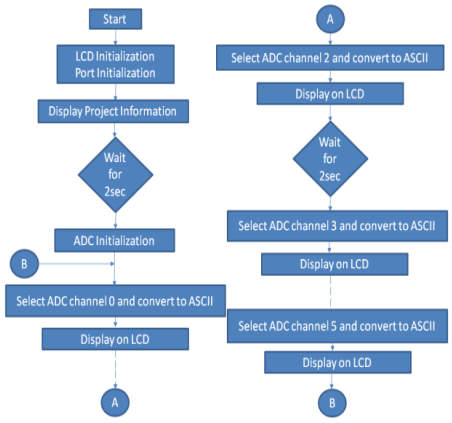

Figure 8-Process flow during start and monitoring

V.TESTING AND CONDITION MONITORING

These currents of high magnitudes can't be fed directly to our designed system. It needs to be scaled down. For this purpose current transformer and potential transformer can be used in practice. The current and voltage after being scaled down is fed to microprocessor based system where it compares it with the reference value and take consequent action.
Regarding taking reference value, we have to take Account the normal current, turn ratio of CT and PT, accuracy and associated errors. For example the we are attempting to give that type situation using potentiometer. Using potentiometer we will vary the voltage and current in different phases. By varying the potentiometer we change the voltage when it is more than the reference voltage then system will send message. The following displays are obtained during the operation.

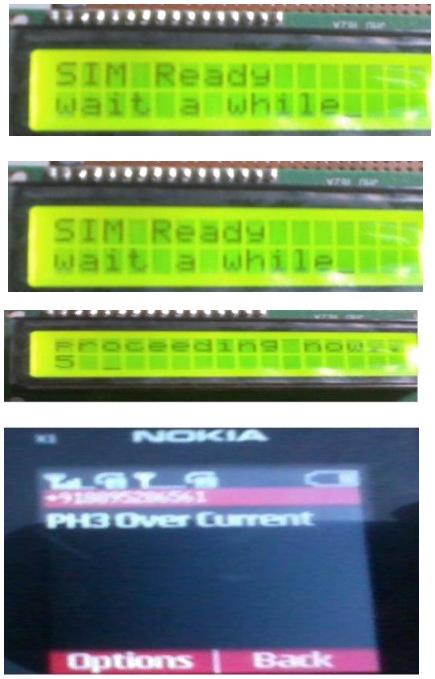

Figure 9-Results

The software and the hardware were set based on the system process flow while carrying out the first system test. The application was configured through the computer serial port to receive the loading data from the transformer via a GSM modem connected to the computer. The data was displayed in real time as it was received from the hardware setup and mobile.

VI.CONCLUSION AND FUTURE WORK

In this project we have design a system based on PIC microcontroller on Proteus software for distribution transformer key parameters like voltage and current which are monitored with employing PIC 16F877A Microcontroller and then LCD interfaced with PIC microcontroller and respective phase voltages and respective phase currents which are displayed on LCD screen. In hardware implementation the necessary components are carry out and interfaced with the PIC Micro controller. The GSM modem

is put in work to transfer the monitored parameters information from the PIC Micro controller to the service engineers mobile.

So we can monitor and control the voltage, current & temperature of a distribution transformer. The proposed GSM based system which has been designed to monitor the transformers essential parameters continuously monitors the parameters throughout its operation. If the micro-controller recognizes any increase in the level of voltage or current or temperature values the unit has been made shutdown in order to prevent it from further damages. The designed system not only controls the distribution transformer in the substation by shutting it down, but also displays the parameter values throughout the process for user's reference and this claims that the proposed design of the system makes the distribution transformer more robust against some key power quality issues which makes the voltage or current or temperature to peak, hence the distribution network is made more secure, reliable & efficient by means of the proposed system.

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