Distribution Transformer Monitoring Using GPRS

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Abstract— This paper presents a system which works on a wireless, real time, multi-object monitoring system of Distribution Transformer depending on GPRS network. A design based on PIC Microcontroller is developed for monitoring the key parameters of Distribution Transformer in a substation. An algorithm for monitoring the voltage, current and temperature is developed and programmed to the microcontroller. It is observed that the proposed system is effective in monitoring and displaying the data using wireless communication network.

Index Terms— centralized monitoring, Wiriless Transmission system, Distibution Transformer, Temperature Sensing and Microcontroller

1 INTRODUCTION

Distribution Transformer is critical equipment in power system.The reliable operation of the power system depend upon the effective functioning of the distribution transformer. Therefore monitoring of key parameters like voltage, current and temperature are necessary for evaluating the performance of the distribution transformer and also helpful to avoid or reduce disruption due to sudden unexpected failure. [9]

The present method for monitoring of distribution transformer has the following drawbacks

a) Operation in case of equipment failure are done manual
b) Time consuming
c) Demand a lot of labour work
d) Production process also gets affectd at the outmost.

The reliable operation of distribution networks can be improved by implementing centralized monitoring [11]. Centralized monitoring realizes the overwhelming advantage of wireless communticating technology such as convenient, fast and low transmission cost. Therefore it's feasible to implement GPRS to achieve wireless data transimission.In this paper we discuss about monitoring of Distribution transformer parameter using GPRS. The system is capable of communicating in both direction i.e. it can acts as both receiver and transmitter. The parameters that will be monitor include [12]

i) Voltage
ii) Current
iii) Temperature

This paper comprises of the following sections: Section 2 deals with block diagram. In section 3, the system components are presented.Section 4 presents the interfacing various components with PIC micro controller.Section 5 comprises of the system, results and discussions. Section 6 discuss about the conclusion.

2 BLOCK DIAGRAM

The proposed system is based on microcontroller (PIC) that monitors the voltage, current and oil temperature of a distribution transformer.The monitored output will be display on a PC through wireless communication network.The monitored output will be display on a PC through wireless communication network. The monitored outputs are compared with the rated values of the transformer and microcontroller is programmed in such a way when the monitored values exceed the rated values it displays the value in different color so that it attracts the attention of the monitoring person. The microcontroller is programmed in such a manner so as to continuously scan the transformer and update the parameters at a particular time interval.

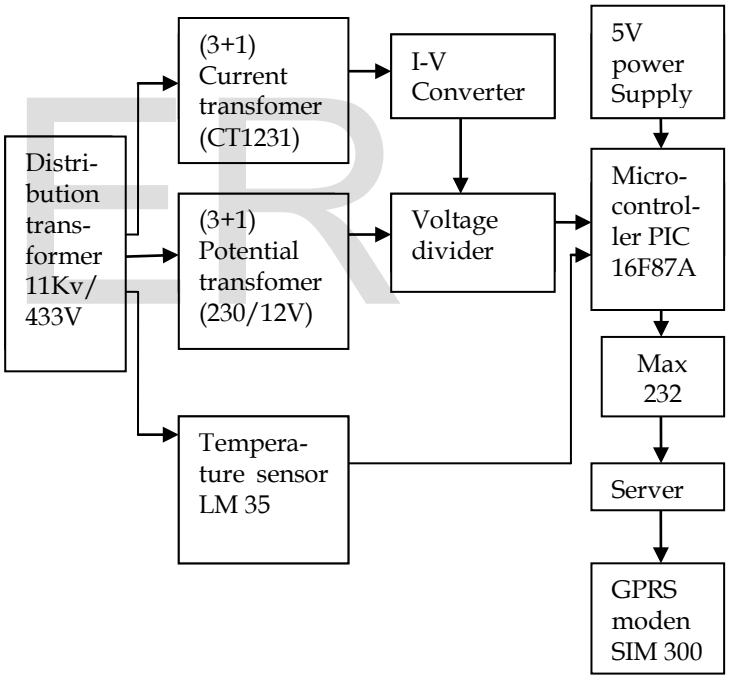

Fig 1 Block diagram of the proposed monitoring system

Since the input voltage to the microcontroller is 5V the voltage and current from the transformer are step down and rectified by voltage transformer (230/12V) and current Transformers (CT1231) the temperature of the atmosphere and the oil are sensed by the temperature sensors (LM35). These values are given as inputs to the micro controller through the ADC channels and are stored. These data are sent to the website through the GPRS modem. The data sent by the GPRS modem is stored in the database and updated to the website as Normal, Critical and over limit values

3 COMPONENTS SPECIFICATIONS

The components used for monitoring of distribution transformer are listed in the table 1.

TABLE 1
Components Specification

Sl. No	Components	Specification	Quantity
1	Microcontroller	PIC 16F877A	1
2	Potential Transformer	1ϕ, 230/12V	3
3	Current Transformer	1ϕ, 0.25 -20 A	3
4	Temperature Sensor	LM 35 (-55° to 150°)	2
5	GPRS MODEM	SIM 300 Data Speed:100kbps	1

3.1 PIC Microcontroller

PIC16F877A is a small piece of semiconductor integrated circuits. The package type is of the integrated circuits is DIP package. DIP stands for Dual Inline Package forsemiconductor IC. This Package is very easy to be soldered onto the strip board. However using a DIP socket is much easier so that this chip can be plugged and removed from the development board. PIC16F877A IC can be reprogrammed and erased up to 10,000 times. Therefore it is very good for new product development phase. It is very popular because PIC 16F877A is very cheap. Apart from that it is also very easy to be assembled. Additional components necessary to make the IC work are just a 5V power supply adapter, Crystal oscillator and 2units of 22pF capacitors.

Fig 2 PIC16F877A

Some of the features are listed below
(i) All single-cycle instructions except for program branches, which are two-cycle
(ii) Operating Speed: DC-20 MHZ clock input DC- 200 ns instruction cycle
(iii) Up to 8K x 14 words of Flash Program Memory, Up to 368 x 8 bytes of Data Memory (RAM), Up to 256 x 8 bytes of EEPROM Data Memory
(iv) Pin out compatible to other 28-pin or 40/44-pin has PIC16CXXX and PIC16FXXXMicrocontrollers.

3.2 Potential Transformer

Instrument transformers are used for measuring voltage in electrical power systems, and for power system protection and control. When a voltage is too large to be conveniently used by an instrument, it can be scaled down to a standardized, low value.
Instrument transformers isolate measurement, protection and control circuitry from the high voltages present on the circuits being measured or controlled.

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Fig 3 Potential Transformer

Voltage Transformers (VTs), also referred to as "potential transformers" (PTs), are designed to have an accurately known transformation ratio in both magnitude and phase, over a range of measuring circuit impedances. A voltage transformer is intended to present a negligible load to the supply being measured.

The low secondary voltage allows protective relay equipment and measuring instruments to be operated at lower voltages. Voltage transformers are designed to have predictable characteristics on overloads.

3.3 Current Transformer

Instrument transformers are used for measuring current in electrical power systems, and for power system protection and control. Where a current is too large to be conveniently used by an instrument, it can be scaled down to a standardized, low value.

Instrument transformers isolate measurement, protection and control circuitry from the high voltages present on the circuits being measured or controlled.

Fig 4 Current Transformer

A current transformer is a transformer designed to provide a current in its secondary coil proportional to the

current flowing in its primary coil. Current instrument transformers are designed to have predictable characteristics on overloads.

3.4 Temperature Sensor

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

Fig 5 LM35 Temperature sensor

Two temperature sensors are used. One Temperature sensor is to monitor the room temperature and the other temperature sensor is to monitor the oil temperature. LM 35 is directly connected to the analog ports of the PIC Microcontroller (AN6, AN7).

3.4.1 Features of LM35

(i) Calibrated directly in ^{o}Celsius
(ii) Linear +10 mv/^{o}C scale factor
(iii) Operates from 4 to 30 V
(iv) Low self heat heating

3.5 GPRS Modem (SIM 300)

SIM300 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz SIM300 provides GPRS multi-slot class 10 capabilities and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4.

With a tiny configuration of 40mm x 33mm x 2.85 mm, SIM300 can fit almost all the space requirement in your application, such as Smart phone, PDA phone and other mobile device. PIC cannot be connected directly to modem. So MAX 232 is used to interface PIC and the modem.

3.5.1 MAX 232

The MAX232 is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels

4. Interfacing the Various Components with PIC Microcontroller

4.1 Interfacing Potential Transformer with PIC Microcontroller

The Figure 6 shows the interconnection of the potential transformer with PIC16F877A Microcontroller.

The Step down transformer is of rating 230/12 V.The output of the potential transformer is fed into the bridge rectifier for the rectification purpose and the rectified output from the bridge rectifier is again fed into the filter circuit inorder to remove the ripples.The DC voltage is stabilized using Voltage stabilizers before it is fed into the PIC Microcontroller.Now the stabilized DC Voltage is fed to the analog ports of the Pic microcontroller.

AN0, AN1, AN2 – Analog input for Voltage sensing unit to A/D convertor

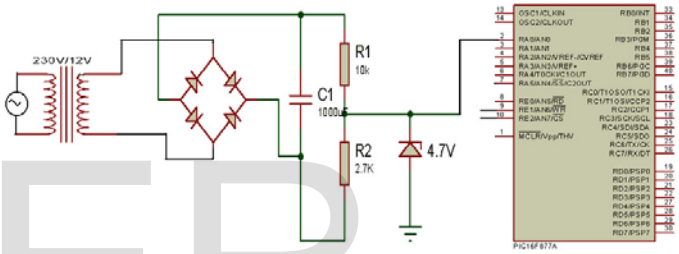

Fig 6 Interfacing PT with PIC 16F877A

4.2 Interfacing Current Transformer with PIC Microcontroller

The figure depicts the interconnection between the current transformer and the PIC Microcontroller.

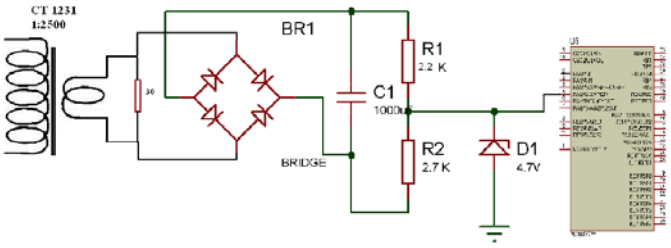

Fig 7 Interfacing CT1231 with PIC 16F877A

In Interfacing of Current transformer with PIC microcontroller the same procedure is followed as mentioned in the interfacing of potential transformer to the PIC Microcontroller except in Current transformer a resistance is connected in parallel inorder to convert the curren to voltage because the PIC Microcontroller accepts only the voltage as its input.

AN3, AN4, AN5 – Analog input for Current sensing unit to A/D convertor

4.3 Interfacing Temperature Sensor with PIC Microcontroller

The figure pictures the interfacing of (LM35) Temperature sensor with PIC Microcontroller.

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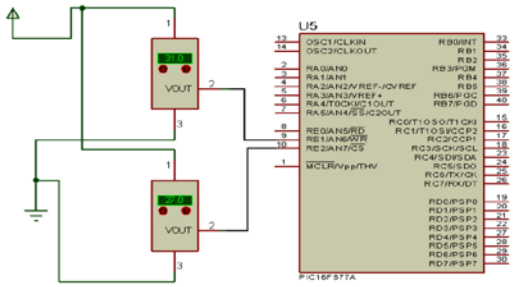

Fig 8 Interfacing of LM35 with PIC 16F877A

In distribution Transformer monitoring, two temperature sensors are used. One temperature sensor oversees the atmospheric temperature and the other temperature sensor monitore the oil temperature

AN6, AN7 – Analog input for Temperature Sensor to A/D convertor.

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5 Algorithms for Centralised Monitoring

The step by step procedure for monitoring the distribution transformer key parameters like voltage, current and temperature are explained as follows and also with the help of the flowchart.

STEP 1: Start.

STEP 2: Check the connection.

STEP3: Verify the hardware for the power supply to the kit.

STEP 4: Input the ith value of Potential Transformer, Current Transformer and Temperature Sensor.

STEP 5: Transfer the values of Potential Transformer, Current Transformer and Temperature Sensor to ADC port.

STEP 6:

i. If the voltage value lies between 240 and 250 V, then the indication is Normal voltage.

ii. If the voltage value lies between 250 and 275 V, then the indication is Critical voltage.

iii. If the voltage value exceeds 275 V, the indication is over voltage.

iv. If the voltage value is lower than 240 V, the indication is low Voltage.

STEP 7:

i. If the current value is lesser than 0.3 and between 0.3 and 12 A, the indication isNormal Current.

ii. If the current value lies between 12 and 17 A, the indication is Critical current.

iii. If the current value exceeds 17 V, the indication is over current.

STEP 8:

i. If the temperature value lies within 80 deg.cel., the indication is Normal temperature.

ii. If the temperature exceeds 80 deg.cel., the indication is High temperature

STEP 9: GPRS modem (SIM 300) is intialised using AT commands. The COM Port is opened to send the data

STEP 10: These data are send by the GPRS modem and are stored in the MySQL Data base.

STEP 11: These values are compared and appropriate indi cations are produced in the website.

STEP 12: Stop.

6 Simulations of the Monitoring System

The figure below depicts the simulation of the project using PROTEUS software simulator.Proteus is software for microprocessor simulation, schematic capture, and printed circuit board (PCB) design. It is developed by Lab enter Electronics. Proteus 7.0 is a Virtual System Modelling (VSM) that combines circuit imulation, animated components and microprocessor models to cosimulate.

Here totally eight Analog to Digital Converter ports are utilized to receive analog inputs from potential transformer, current transformer and Temperature sensor.

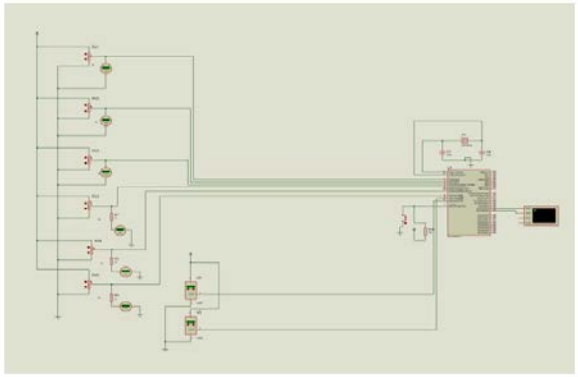

Fig 9 Simulation of the Monitoring Module

The figure below displays the output of the P.T, C.T and two LM35 Sensors. The simulated results shows simulatneously monitored value for the specified interval of time.

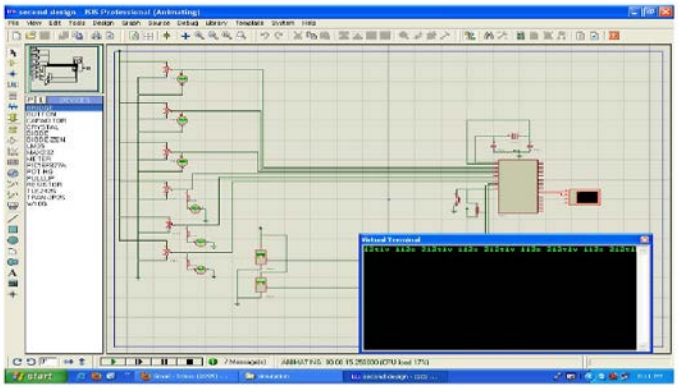

Fig 10 Results for the Simulation Module

7 HARDWARE KIT AND RESULT DISCUSSION

This figure below represents the hardware kit for monitoring of the distribution transformer. The same can be done for each distribution transformer in a particular zone and the input datas to the PIC Microcontroller can be transmitted to the PC using Wireless communtication technology (GPRS is implemented here). The Wireless communication technology can be amending to the technology developed.

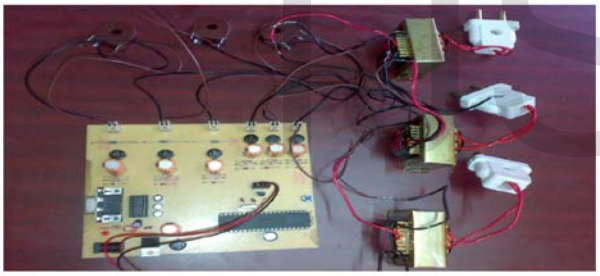

Fig 11 Hardware Kit for Distribution Transformer Monitoring

7.1 WEB PAGES

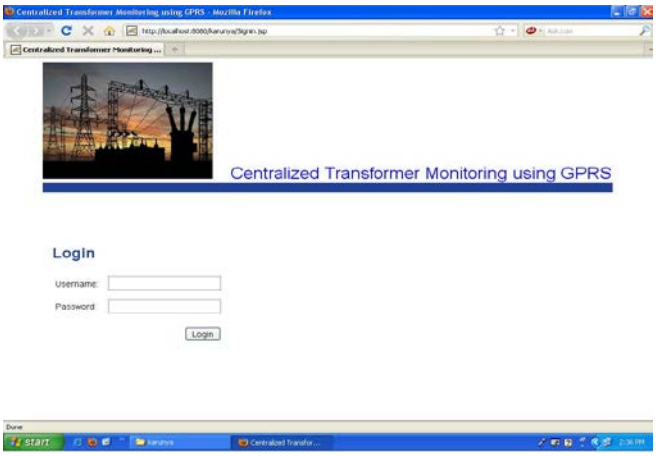

Fig 12 Login Page of the Website Developed

The monitored outputs of the specified parameters are displayed on the Website through GPRS Wireless technology.There are altogether three webpages. The first one is the login page as shown in fig11.

Welcome karunya

View Details

TRANSFORMER NO.	VOLTAGE R-Y	VOLTAGE Y-B	VOLTAGE B-R	CURRENT-R	CURRENT-Y	CURRENT-B	TEMP 1	TEMP 2
1	NORMAL	217.3711	217.7009	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	NORMAL	218.0308	218.6905	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	NORMAL	218.3606	219.0203	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	NORMAL	217.7009	218.0308	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	NORMAL	217.0412	217.3711	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	NORMAL	217.7009	218.0308	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	288.6187	217.7009	218.3606	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	NORMAL	217.3711	217.7009	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	NORMAL	224.6278	225.6173	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	234.1934	219.0203	219.3502	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	235.183	219.0203	219.3502	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	238.8113	223.6382	224.2979	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	239.8009	223.6382	224.2979	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	NORMAL	223.6382	224.2979	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	NORMAL	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	NORMAL	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	NORMAL	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	NORMAL	223.6382	224.2979	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	238.4815	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
3	NORMAL	223.6382	224.2979	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
1	236.1725	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL
2	238.4815	223.3084	223.9681	NORMAL	NORMAL	NORMAL	NORMAL	NORMAL

Fig 13 Monitored Values of Key parameters displayed on the Second page

The second page displays the simultaneously monitored parameter value with the indication in different colour code if it exceeds the critical value or if its about to reach the critical value.

Welcome karunya

TRANSFORMER NO.	VOLTAGE R-Y	VOLTAGE Y-B	VOLTAGE B-R	CURRENT-R	CURRENT-Y	CURRENT-B	TEMP 1	TEMP 2
1	245.4083	217.3711	217.7009	1.001021	9.895158e-1	1.001021	32.99999	32.99999
2	245.7382	218.0308	218.6905	1.840959e-1	1.840959e-1	1.840959e-1	32.99999	32.99999
1	247.7173	218.3606	219.0203	0	0	0	32.99999	32.99999
2	249.0366	217.7009	218.0308	0	0	0	32.99999	32.99999
3	244.7486	217.0412	217.3711	0	0	0	32.99999	32.99999
1	247.7173	217.7009	218.0308	0	0	0	32	32.99999
2	288.6187	217.7009	218.3606	0	0	0	32.99999	32.99999
3	244.0889	217.3711	217.7009	0	0	0	32.99999	32.99999
1	240.4606	224.6278	225.6173	0	0	0	32.99999	32.99999
2	234.1934	219.0203	219.3502	1.737405	1.737405	1.760417	32.99999	32.99999
3	235.183	219.0203	219.3502	2.036561	2.025055	2.059573	32.99999	32.99999
1	238.8113	223.6382	224.2979	9.434919e-1	9.319858e-1	9.434919e-1	32.99999	32.99999
2	239.8009	223.6382	224.2979	1.150599e-1	1.150599e-1	1.150599e-1	32.99999	32.99999
3	240.1307	223.6382	224.2979	1.150599e-2	1.150599e-2	1.150599e-2	32.99999	32.99999
1	240.1307	223.3084	223.9681	0	0	0	32.99999	32.99999
2	240.1307	223.3084	223.9681	0	0	0	32.99999	32.99999
3	240.1307	223.3084	223.9681	0	0	0	32.99999	32.99999
1	241.4501	223.6382	224.2979	0	0	0	32.99999	32.99999
2	238.4815	223.3084	223.9681	0	0	0	32.99999	32.99999
3	240.1307	223.6382	224.2979	0	0	0	32.99999	32.99999
1	236.1725	223.3084	223.9681	0	0	0	32.99999	32.99999
2	238.4815	223.3084	223.9681	0	0	0	32.99999	32.99999
3	238.1516	223.3084	223.9681	0	0	0	32.99999	32.99999

Fig 14 Thrid Page displaying Detailed Values for each Parameter

The third page shows the detailed description of the displayed parameters.

8 CONCLUSIONS

In this paper, the distribution transformer key parameters like voltage; current and temperature are monitored employing PIC 16F877A Microcontroller.

The components necessary to carry out the monitoring are chosen and are interfaced with the PIC Microcontroller.The wireless communication technology (GPRS) is put in work to transfer the monitored parameters from the PIC Microcontroller to the PC.

Ahead of actualizing the HARDWARE of this design the simulation is executed in the PROTEUS environment and the effectiveness of the design is checked.The future scope of the design is to realize the control module.

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