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# GSM Based Distribution Transformer Monitoring and Controlling System

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**ABSTRACT:** This paper provide the design and implementation of a mobile embedded system to monitor and record key parameters of a distribution transformer like load currents, overvoltage, oil level and winding temperature. The idea of on-line monitoring system integrates a global service mobile (GSM) Modem, with a single chip microcontroller and different sensors. It is installed at the distribution transformer site and the above parameters are recorded using the analog to digital converter (ADC) of the embedded system. The obtained parameters are processed and recorded in the system memory. If any abnormality or an emergency situation occurs the system sends SMS (short message service) messages to the mobile phones containing information about the abnormality according to some predefined instructions programmed in the microcontroller. This mobile system will help the transformers to operate smoothly and identify problems before any failure.

## I. INTRODUCTION

In recent years, electrical power system is spread all over the word; hence there is transfer of large electrical power from generating station to the end users. Hence it is necessary to monitor the operating condition of distribution transformer when it is loaded. However, there life is significantly reduced if they are over loaded, resulting in unexpected failures and loss of supply to a large number of customers. Thus effecting system reliability .Few power companies use Supervisory Control and Data Acquisition (SCADA) system for online monitoring of distribution transformer is an expensive. Distribution transformers are connected directly to the load side hence most of the possibility of fault is at distribution transformer due to sudden variation in load. Shut down of large load .distribution transformers are currently monitored by manual monitoring does not gives current value of some parameters like overload current and overheating of transformer oil. This factor can reduce transformer life. Our system is designed based upon online monitoring of operational parameters of distribution transformer can provide useful information about the health of transformers. Which will help the utilities to optimally use their transformers and keep the control in operation for a longer period.

## II. LITERATURE SURVEY

### A. ONLINE MONITORS KEEP TRANSFORMERS IN SERVICE

-T. Leibfried

The trend toward a deregulated global electricity market is raising utility cost consciousness. An important aspect of cost savings is equipment investment for the power transmission system, and power transformers are among the most expensive elements of a high voltage power system. Cost savings can be realized through a delay in the procurement of transformers and a reduction in maintenance effort. Monitoring systems for power transformers can help to achieve these aims. They provide detailed information about the transformer's condition and help minimize the probability of an unexpected outage.

**B. INTERNET BASED TRANSMISSION SUBSTATION MONITORING**

-W.L. Chan, **A.T.P. So,** L.L. Lai.

At the IEEE T&D Conference and exposition held in 1996 in Los Angeles, the authors presented the development of an on-line distributed information monitoring system for keeping track of the condition of HV equipment in transmission substations, such as status of each SF/sub 6/ circuit breaker (CB) together with other operational parameters, transformer temperature, capacitor bank unbalanced currents and auxiliaries including pumps, batteries and compressors etc. Each group of CBs is monitored by a standalone microcontroller where information can be exchanged between them on a local area network.

**C. ON-LINE MONITORING OF PARTIAL DISCHARGES IN POWER CAPACITORS USING HIGH FREQUENCY CURRENT TRANSFORMER TECHNIQUE**

- K. Mallikarjunappa, **M.C. Ratra**

A novel technique has been designed and developed for online monitoring of partial discharges in power capacitors by employing high-frequency current transformers. Experimental investigations have been carried out in the laboratory on simulated capacitor banks in order to study the possibility of locating a defective unit in the bank. To check the feasibility and the suitability of the technique under operating conditions of the capacitors, field trails have been carried out on 3.3 and 11 kV capacitor banks maintained by some industries and electricity boards.

**D. ON-LINE TRANSFORMER WINDING'S FAULT MONITORING AND CONDITION ASSESSMENT**

- Hui Cai , XiaoQun Ding

This paper presents a comprehensive method for the online monitoring of transformer winding faults and identifying the position of the faults, as well as transformer condition monitoring based on parameter identification and artificial intelligence technology. By using online monitoring three phases of electric quantities and DGA, the parameters and operation states of a transformer can be identified and tracked. This method can also improve the accuracy of fault diagnosis.

## III. BLOCK DIAGRAM

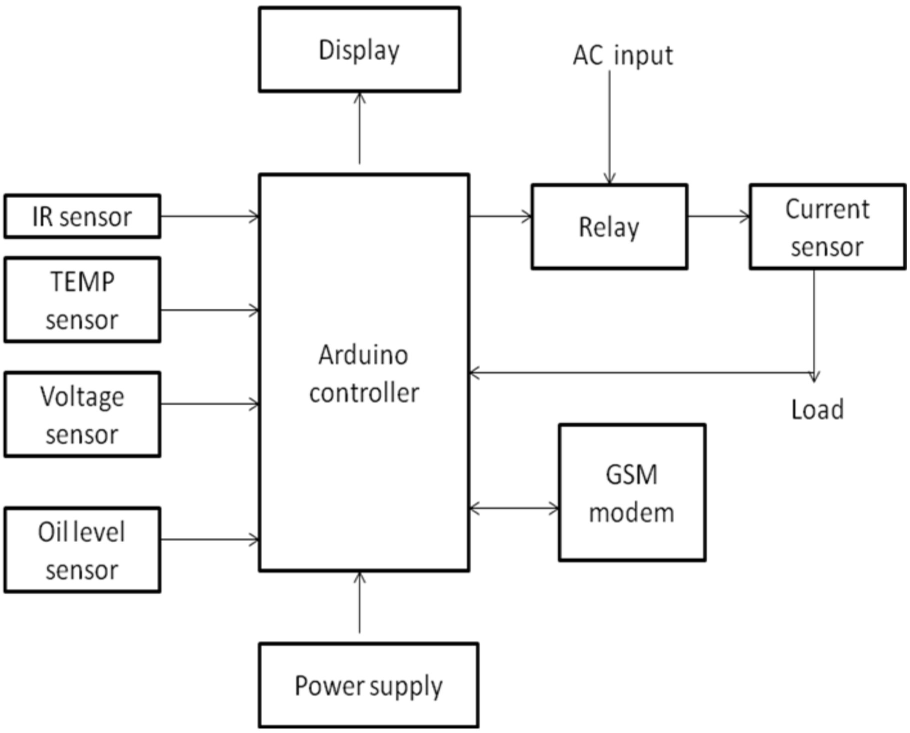


**Figure 1.** Block diagram

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## IV. COMPONENTS OF HARDWARE IN SYSTEM

### A. Arduino Nano :

Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a smallest, complete, and breadboard friendly. It has everything that Decimal has (electrically) with more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano is automatically sense and switch to the higher potential source of power, there is no need for the power select jumper. Nano's got the breadboard-ability of the Board and the Mini +USB with smaller footprint than either, so users have more breadboard space. It's got a pin layout that works well with the Mini or the Basic Stamp (TX, RX, ATN and GND on one top, power and ground on the other). This new version 3.0 comes with ATMEGA328 which offer more programming and data memory space. It is two layers. That make it easier to hack and more affordable.

**Figure 2.** Arduino Nano controller

### B. GSM Modem

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone. When a GSM modem is connected to a microcontroller or computer, this allows the microcontroller or computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS as well as for control applications using GSM.

**Figure 3.** GSM Modem

### C. Relay Circuit

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are

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often use to interface an electronic circuit to an electrical circuit which works at very high voltage. In basic relay there are three contactors normally open (NO), normally close (NC), a common (COM).At no input state, the COM is connected to NC. When the operating voltage is applied to relay coil gets energized and COM changes to NO contact.

**Figure 4.** Relay Circuit

### D. Sensors

Sensors are installed on transformer site which reads and measures the physical quantity from the distribution transformer and then it converts it into the analog to digital. Sensor are used for sensing load current, voltage, temperature, oil level and any obstacles. A sensor is a device which receives and responds to a signal when touched or condition occurs in given parameters sensor. A multitude of different measurable variables can be collected for on-line monitoring. However, it is very rarely useful to use the entire spectrum. Therefore, sensor technology must be adjusted to the specific requirements of a particular transformer depending on their age and condition. These sensors as follows

1. These sensors have a permanent magnet in the float. It helps to sense the level of oil present in the overhead tank or sump.
2. RTD PT 100 for temperature of transformer.
3. For current and voltage used model cs-sc-200.
4. LM358 IC 2 for IR transmitter and receiver pair.

### E. LCD Display

The liquid-crystal display has the distinct advantage of having low power consumption than the LED. It is typically of the order of microwatts for the display in comparison to the some order of milliwatts for LEDs. Low power consumption requirement has made it compatible with MOS integrated logic circuit. Its other advantages are its low cost, and good contrast. The main drawbacks of LCDs are additional requirement of light source, a limited temperature range of operation (between 0 and 60° C), low reliability, short operating life, poor visibility in low ambient lighting, slow speed and the need for an ac drive.

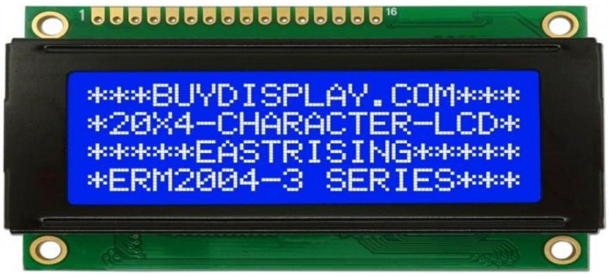


**Figure 5.** 20×4 LCD Display

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## V. SPECIFICATIONS

### 1. Arduino Nano:

| Pin no | Name | Type |
|---|---|---|
| 1-2, 5-16 | D0-D13 | I/O |
| 3,28 | RESET | Input |
| 4,29 | GND | PWR |
| 17 | 3V3 | Output |
| 18 | AREF | Input |
| 19-26 | A7-A0 | Input |
| 27 | +5V | O/p or I/p |
| 30 | VIN | PWR |

### 2. Relay circuit:

Voltage: +5v
Current: 10A
PCB size: 45.8mm×32.44mm

### 3. GSM Modem-RS232

Operating voltage: +12v DC
Weight: <140g
Frequency: 900/1800 HZ
Current: 1A

### 4. LCD Display

Voltage: +5v
Format: 20×4 character
Duty cycle: 1/16

### 5. Sensors

**i. Current Sensor-ACS712**
Supply voltage: 4.5V-5.5V DC
Current range: 20A
Sensitivity: 100 mV/A

**ii. IR Sensor:**
Voltage: 3.3-5 DC Volts
Distance: 2-10 cm
Detection angle: 35˚
Board Size: 3.1 CM×1.5 CM

**iii. Temperature Sensor**
Voltage: +5V DC
Moisture: digital value is indicated by output pin.

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## VI. RESULTS AND OBSERVATION

TABLE 1: Shows the variation in current for different values of incandescent bulbs.

| INCANDESCENT BULBS | | | |
|---|---|---|---|
| **VOLTAGE (V)** | **CURRENT (A)** | | |
| | **40W** | **60W** | **100W** |
| 150 | 0.32 | 0.4 | 0.5 |
| 160 | 0.33 | 0.4 | 0.52 |
| 170 | 0.33 | 0.4 | 0.52 |
| 180 | 0.33 | 0.4 | 0.53 |
| 190 | 0.35 | 0.4 | 0.55 |
| 200 | 0.35 | 0.43 | 0.56 |
| 220 | 0.35 | 0.43 | 0.58 |
| 230 | 0.35 | 0.43 | 0.59 |
| 240 | 0.36 | 0.45 | 0.6 |

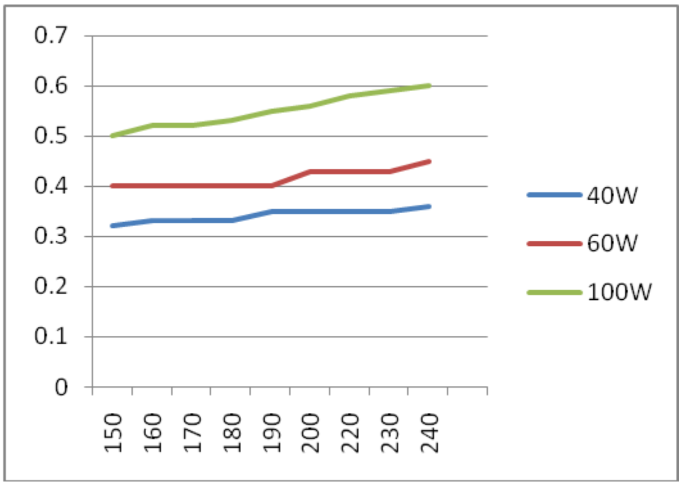


**FIGURE 6.** Graphical Representation of Table 1

The above graph shows the variation in the current for various voltages for different ranges of incandescent bulbs. If current exceeds 0.7A (200W) then the entire circuit trips.

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**TABLE 2: Shows the variation in current for LED bulb.**

| LED BULB | |
|---|---|
| **VOLTAGE** | **CURRENT (40W)** |
| 150 | 0.369 |
| 160 | 0.39 |
| 170 | 0.37 |
| 180 | 0.37 |
| 190 | 0.36 |
| 200 | 0.36 |
| 220 | 0.35 |
| 230 | 0.35 |
| 240 | 0.33 |

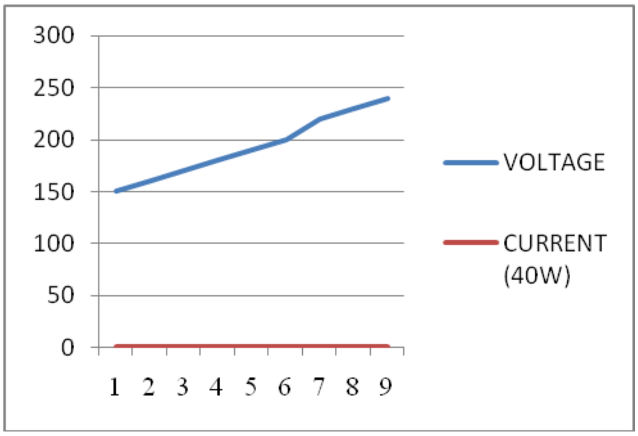


**Figure 7.** Graphical Representation of Table 2

The above graph shows the variation in the current for various voltages for 40W LED bulb.

**TEMPERATURE GRAPH**

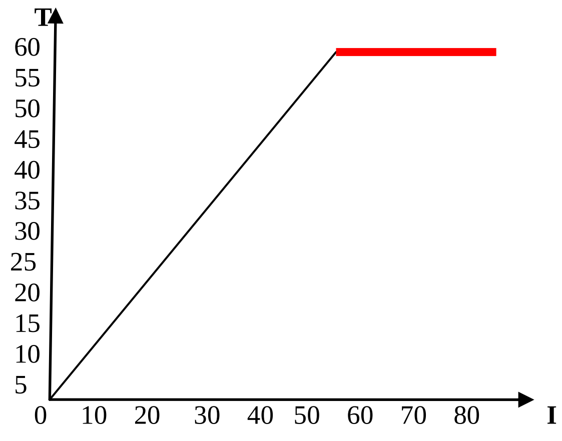


**FIGURE.8** Plot of Temperature V/S Current

- Normal temperature
- Over temperature

The above graph shows that the temperature below the range of 55˚ is considered as normal temperature and above 55˚ is considered as abnormal temperature.

## VII. CONCLUSION

The GSM based monitoring of distribution transformer is quite useful as compared to manual monitoring and also it is reliable as it is not possible to monitor always the oil level, temperature rise, load current and over voltage manually. After receiving of message of any abnormality we can take action immediately to prevent any catastrophic failures of

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distribution transformers. We need not have to check all transformers and corresponding phase currents and voltages and thus we can recover the system in less time. The time for receiving messages may vary due to the public GSM network traffic but still then it is effective than manual monitoring.

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