



Transformer Health Monitoring And Control Through Arduino

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Abstract Our project is about design and implementation to monitor and record key parameters of a distribution transformer like load currents, oil level, voltage level and temperature. The idea of on-line monitoring system integrates with a stand alone Arduino and different sensors. It is installed at distribution transformer side and the above parameter are recorded using the ARDUINO Microcontroller. The obtained parameters are processed and recorded in the system memory. If any abnormality or an emergency situation occurs in the system, then the values will be displayed in the monitor according to some predefined instructions programmed in the microcontroller. This mobile will help the transformers to operate smoothly and identify problems before any catastrophic failure.

Keywords -Transformer health Monitoring, Distribution Transformer, Power system fault.

I. INTRODUCTION

In power systems, distribution transformer is electrical equipment which distributes power to the low voltage users directly, and its operation condition is an important component of the entire distribution network operation. Operation of distribution transformer under rated condition guarantees their long life. However their life is significantly reduced if they are subjected to overloading, resulting in unexpected failures and loss of supply to a large number of customers thus effecting system reliability. Overloading and ineffective cooling of transformers are the major causes of failure in distribution transformers. Some major problems such as ordinary transformer measurement is too long and testing speed is not fast enough, detection system itself is not reliable, timely detection data will not be sent to monitoring centres in time.

As we are using the microcontroller grid called ARDUINO the above mentioned fault can be easily determined and the faults are displayed in the monitor.

II. TRANSFORMER FAULT ANALYSIS

There are some major faults occurs in the transformer that should be regularly checked and monitored so it can associated with fault which follow as

A. Over Load

Over Load / Over current is the current flowing through the transformer resulting from faults on the power system. 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.

B. Over / Under Voltage

The flux in the transformer core is directly proportional to the applied voltage and inversely proportional to the frequency. Over voltage 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.

C. Temperature

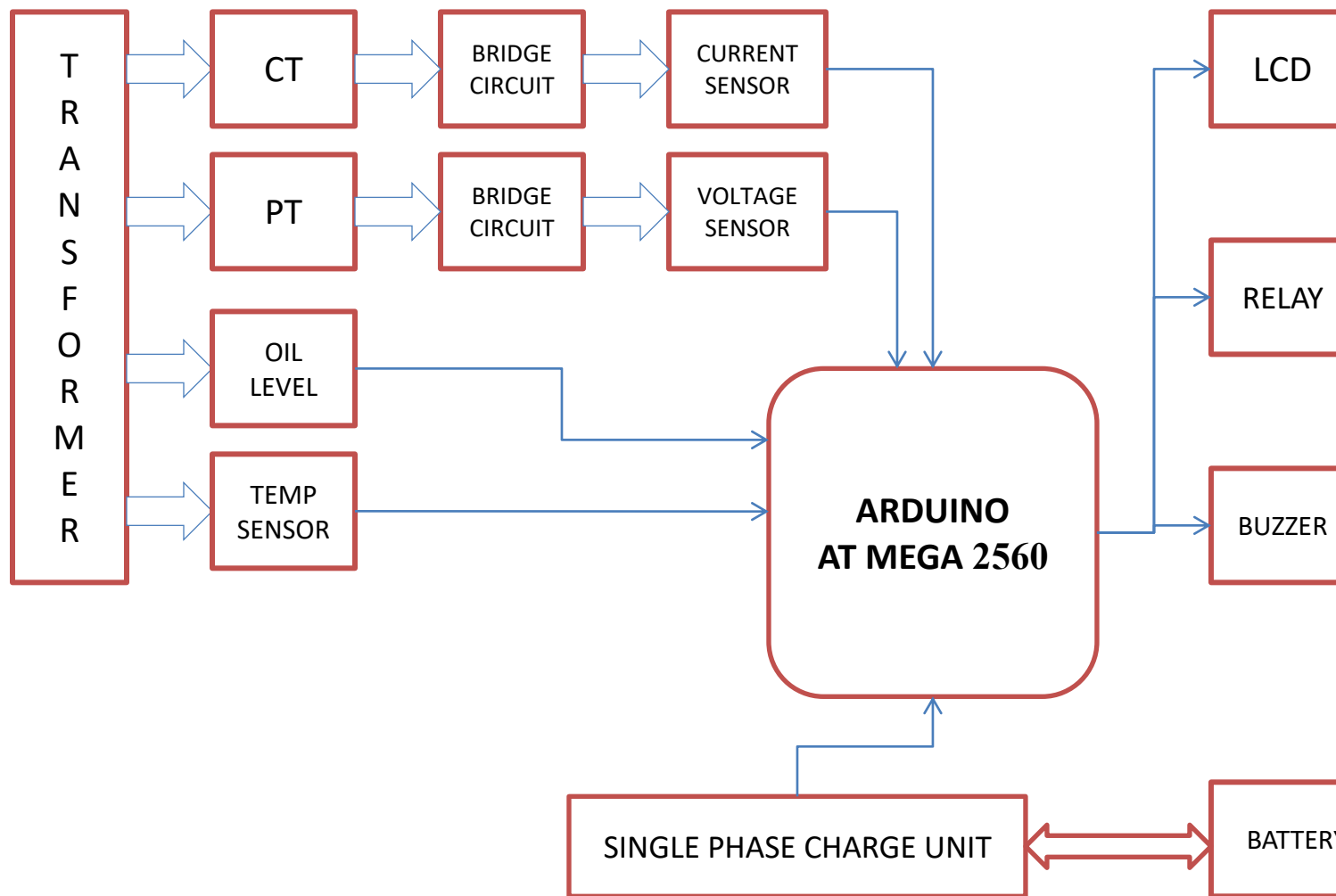
Excessive load current alone may not result in damage to the transformer if the absolute temperature of the windings and transformer oil remains within specified limits. Transformer ratings are based on a 24-hour average ambient temperature of 30°C (86°F). Due to over voltage and over current, temperature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

D. 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.

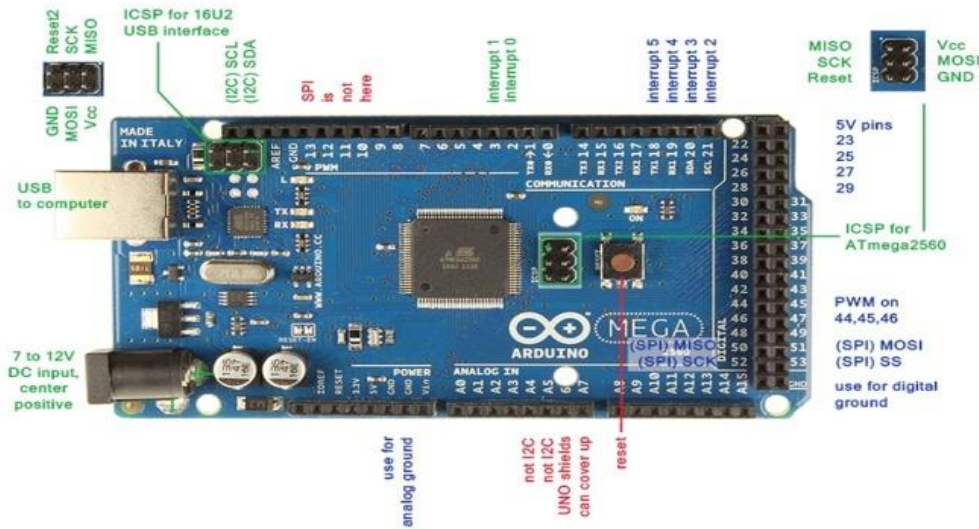
III. BLOCK DIAGRAM OF TRANSFORMER HEALTH MONITORING AND CONTROL THROUGH ARDUINO



It consist of current transformer, power transformer, thermister, oil sensor, Arduino, LCD display, GSM modem and relay. Normally in transformer, failure occurs due to voltage and current fluctuation, overheating, change in oil level etc. In this project, to sense these fault we have used current and potential transformer, temperature sensor, oil sensor respectively. All these sensors are connected Arduino. When fault occurs due to above any reason then change in ratings will be shown on LCD.

IV. ARDUINO AT MEGA 2560

It is a microcontroller board based on the AT-Mega 2560 (datasheet). It has 54 digital input / output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.



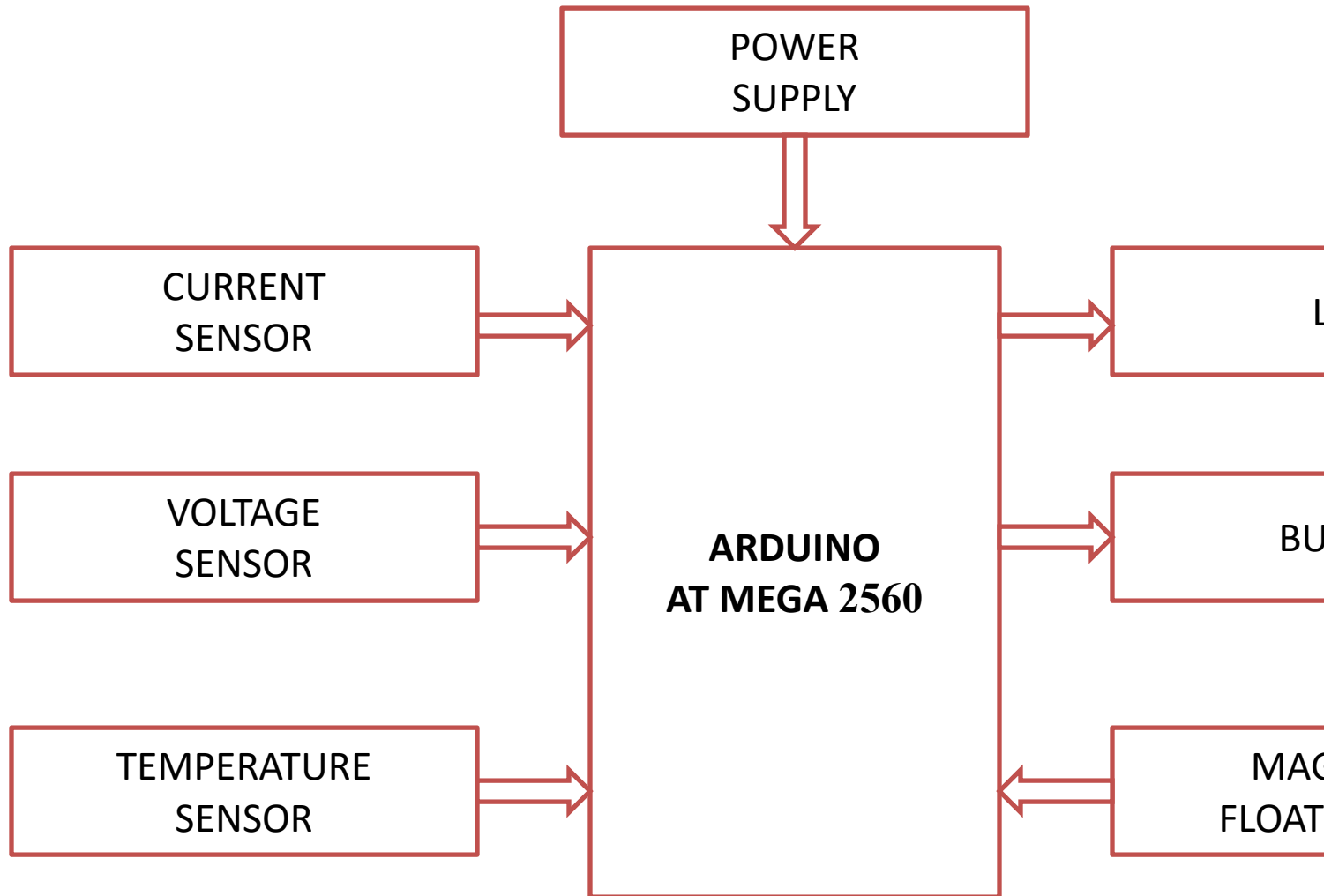
It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

A. Technical Specifications

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	54 (of which 15 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz
LED_BUILTIN	13
Length	101.52 mm
Width	53.3 mm
Weight	37 g

V. SENSORS

Sensor is a device that responds to a physical stimulus such as heat, light, sound, pressure, magnetism or a particular motion and it transmits a resulting impulse as for measurement or operating a control.



A. Current Sensor

The ACS712 Current Sensors offered on the internet are designed to be easily used with micro controllers like the Arduino. These sensors are based on the Allegro ACS712ELC chip. These current sensors are offered with full scale values of 5A, 20A and 30A.

ACS712 current sensor operates from 5V and outputs analog voltage proportional to current measured on the sensing terminals. You can simple use a microcontroller ADC to read the values.

B. Voltage Sensor

It is a simple circuit which turns a large voltage into a smaller one. Using just two resistors in series and an input voltage, it can create an output voltage that is a fraction of the input. Within 250 V AC voltage can be measured. Linear range: 0-1000V 0-10mA (Sampling resistor is 100 ohm) Installation : PCB mounting (Pin Length > 3mm).

C. Oil Level Sensor

Sensors detect the level of liquids and other fluids and fluidized including slurries, granular materials and powders that exhibit an upper level surface.

MFS-02 Magnetic Float Sensor

- No electrical contact with water
- Shock proof

- Light weight, easy to use
- Corrosion free and rust free

D. Temperature Sensor

A temperature sensor is A device which is designed specifically to measure the hotness or coldness of an object. The operating temperature range is from -55°C to 150°C. Lm35 is a precision temperature sensor with its output proportional to the temperature (in °C). With lm35, the temperature can be measured more accurately than with a thermistor.

VI. ARDUINO CODING

Now let us discuss the function used in the programming to display the sensor values.

```
#define interval 1000

int val;
const int current sensor = 0;
int buttonstate = 1;
int voltagedivider = 2;
int tempPin = 3;
int floatsensor=2;
const int buzzer = 9;

float Vout=0.0;
float Vin=0.0;
float R1=30000.0;
float R2=7500.0;
int value=0;

int mVperAmp = 185; // use 100 for 20A Module and 66 for 30A Module
int RawValue= 0;
int ACSoffset = 2500;
double Voltage = 0;
double Amps = 0;

void setup()

{
  Serial.begin(9600);

  pinMode (buttonstate, INPUT); // initialize the button pin as a input
  pinMode (tempPin, INPUT);
  pinMode (voltagedivider, INPUT);
  pinMode (floatsensor, INPUT_PULLUP); //Aurdino internal resistor 10k
  pinMode (buzzer, OUTPUT); // Set buzzer - pin 9 as an output
  pinMode (current sensor , INPUT);
}

void loop()

{
  // voltage divider
  value = analogRead(voltagedivider);
  Vout = (value * 5.0) / 1024.0; // see text
  Vin = Vout / (R2/(R1+R2));
  vs=(38.333 / 1)*vin;

  if (vin > 6.7 )
```

```
{
  digitalWrite(relay ,HIGH);
  delay(interval);
  Serial.println("VOLTAGE HIGH");
}
else
{
  digitalWrite(relay , LOW);
  delay(interval);
  Serial.println("VOLTAGE LOW");
}

Serial.print("OUTPUT V= ");
Serial.println(vin);
Serial.print("INPUT V= ");
Serial.println(vs);

}

{
  //current sensor
  RawValue = analogRead(analogIn);
  Voltage = (RawValue / 1024.0) * 5000; // Gets you mV
  Amps = ((Voltage - ACSoffset) / mVperAmp);

  Serial.print("Raw Value = " ); // shows pre-scaled value
  Serial.print(RawValue);
  Serial.print("\t mV = "); // shows the voltage measured
  Serial.print(Voltage,3); // the '3' after voltage allows you to display 3 digits after decimal point
  Serial.print("\t Amps = "); // shows the voltage measured
  Serial.println(Amps,3); // the '3' after voltage allows you to display 3 digits after decimal point
  delay(2500);

}

{
  //float sensor
  buttonstate = digitalRead(floatsensor);
  if (buttonstate == HIGH)
  {
    digitalWrite(buzzer, HIGH);
    tone(buzzer, 1000);
    Serial.println("OIL LEVEL - HIGH");
  }
  else
  {
    digitalWrite(buzzer, LOW);
    noTone(buzzer);
    Serial.println( "OIL LEVEL - LOW" );
  }
}

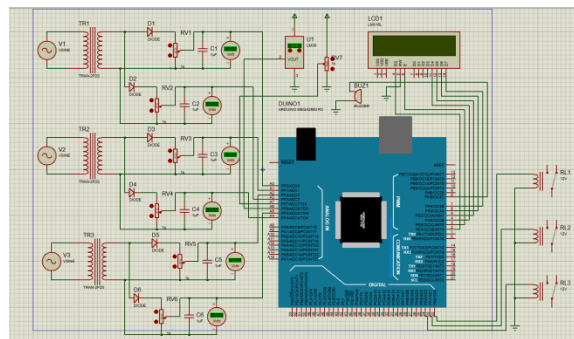
{
  //temperature sensor
  val = analogRead(tempPin);
  float mv = ( val/1024.0)*5000;
  float cel = mv/10;
  float farh = (cel*9)/5 + 32;
}
```

```
Serial.print("TEMPRATURE = ");  
Serial.print(cel);  
Serial.print("*C");  
Serial.println();  
  
Serial.print("TEMPRATURE = ");  
Serial.print(farh);  
Serial.print("*F");  
Serial.println();  
}  
delay(1000);  
  
}
```

Hence, the all values of sensors will be displayed in the monitor with the help of serial monitor.

VII. PROTEUS SIMULATION

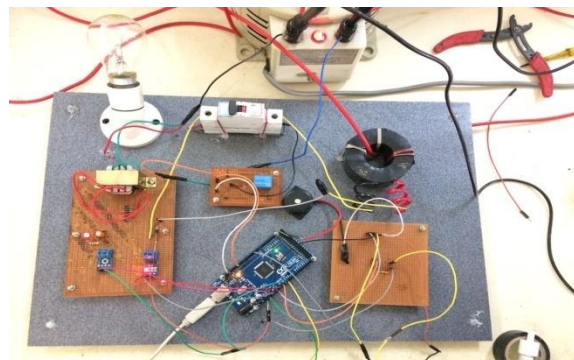
The proteus is a software which helps to simulate a critical circuit which have the proper platform with which the blocks were used to obtain a proper simulation medium with electronic circuits and the required value can be viewed with the initial manner. The Arduino is also interfaced with the proteus simulation to get a proper output and this can be viewed with the proper value.

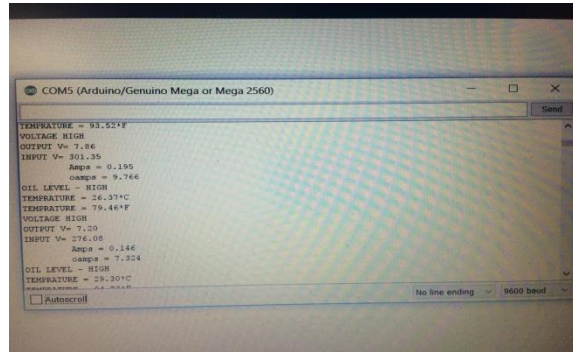


The above picture is a result of our concept and hence the output have been verified with our targeted outputs in the simulation we have used a sensors for a measuring and serial monitor to display the values.

VIII. RESULTS

All the algorithms and methods discussed above were tested on the experimental setup. Some of the hardware results and out puts are discussed in this section.





Fault No.1- Voltage level

When device detects low voltage or high voltage (set values), it will send the message to set number that “Transformer no.--- Low/High Voltage Occur”, also it will trigger circuit breaker for cut off supply.

Fault No. 2- Over Load

When device detects current flowing through system high then it assumed that system is overloaded. After detect overloading device send message “Transformer No. --- Overload Occur”, and will break system through line by opening circuit breaker.

Fault No.3- Oil Level

In this system in transformer oil level is lower high it sense the by using float sensor.

Fault No.4- Temperature

Temperature Ambient temperature of Transformer is high or it will be increase it sense through the sensor LM-35.

IX. 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. Depending upon fault analysis a prototype model of microcontroller based transformer health monitoring kit is developed in laboratory. With the advancement of signal technology now it is possible to receive fault information of transformer through ARDUINO technology remotely to the operator and authorities so one can able to take possible solution before converting fault in to fatal situation. Using digital controller analysis results are regularly updated. During abnormal conditions exceeding specified limit information is immediately analysed through ARDUINO 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 but also increases mean down time of transformer there by increased reliability and decreased cost of power system operations.

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