IOT Based Real Time Transformer Health Monitoring System and Phase Preventor

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Abstract – Transformer is one of the important electrical equipment that is used everywhere. Monitoring transformer's health had become a fiery task. Since incase of any damaged in the internal properties of the transformer will result in huge drawback. So it is mandatory to regularly keep an eye of the transformer. The main objective of this proposal is to acquire live data of transformer health remotely over the internet using Internet of Things (IOT) technology. We are going to monitor the transformer parameter such as temperature, current and voltage. These data will be sent over internet using MQTT protocol. In case of any power failure the user will be notified with an alert message using GSM Module. It also has a unique feature of detecting the phase failure. If any phase gets defect then it will indicated in the development board by an LED. These parameters will be displayed in an Android Application. By this process we can get to know the health of the transformer regularly and necessary step can be taken to maintain it in a proper way.

1. INTRODUCTION

The distribution transformer is electrical equipment in power system which distributes power to the users directly, and its operating condition is important to the distribution network operators. The operation of distribution transformers underrated 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 power system reliability.

Overloading and insufficient cooling of transformers are the main causes of failure. The monitoring device systems which are presently used for monitoring distribution transformer exist some problems and deficiencies. Few of them are mentioned below.

- Ordinary transformer measurement system only detects a single transformer parameter, such as power, current, voltage, and phase. While some ways could detect multi-parameter, the time taking and operation parameters are too long,
- Testing speed is not so fast.
- Detection system itself is not reliable. The performance is the device itself instability, poor jamming capability, low measuring accuracy data, or even another system should is not affected.
- Timely detection data will not be sent to monitoring centers in time, which cannot judge distribution transformers three-phase equilibrium.

2. EXISTNG SYSTEM

This is presents design and implementation of a mobile embedded system to monitor and record key operation indicators of a distribution transformer like load currents, transformer oil and ambient temperatures. The proposed on-line monitoring system integrates a global service mobile (GSM) Modem, with standalone single chip microcontroller and sensor packages. It is installed at the distribution transformer site and the above mentioned parameters are recorded using the built-in S-channel analog to digital converter (ADC) of the embedded system.

The acquired parameters are processed and recorded in the system memory. If there is any abnormality or an emergency situation the system sends SMS (short message service) messages to designated mobile telephones containing information about the abnormality according to some predefined instructions and 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 mobile system will help the utilities to optimally utilize transformers and identify problems before any catastrophic failure.

Demerits of Existing System

- It is purely based on SMS services. It doesn't include android application (Mobile App).
- Practically at some points this system could not work efficiently. Since SMS will be based on carrier charge a d continues monitoring is made impossible.
- Making cost is too expensive.

- Since SMS service is used it doesn't provide live tracking because SMS will have some latency on reception.
- If you want to make the latency minimum service provider will charge extra amount for it.
- There is no point of contact with consumer in the system.
- As a result the consumer will not get any knowledge about the power failure or system maintenance.
- It doesn't include the feature of Phase prevention which is any of phase fails there is no indication.

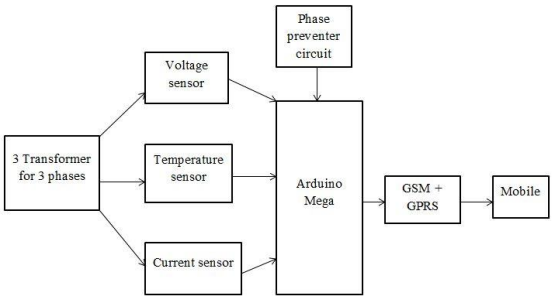
3. PROPOSED SYSTEM

The main objective of this proposal is to acquire live data of transformer health remotely over the internet using Internet of Things (IOT) technology. We are going to monitor the transformer parameter such as temperature, current and voltage. These data will be sent over internet using MQTT protocol. In case of any power failure the user will be notified with an alert message using GSM Module. It also has a unique feature of detecting the phase failure. If any phase gets defect then it will indicated in the development board by an LED.

Merits of Proposed System

- It is purely based on SMS along with MQTT services.
- It include android Mobile application
- Practically at every points this system could work efficiently. Since along with SMS.
- MQTT also used so continues monitoring is made possible.
- Cost effective.
- Since MQTT service is used it provides live tracking.
- There is common point of contact with consumer in the system.
- As a result the consumer will get any knowledge about the power failure or system maintenance.
- It includes the feature of Phase prevention which is any of phase fails there is no indication.

System Design



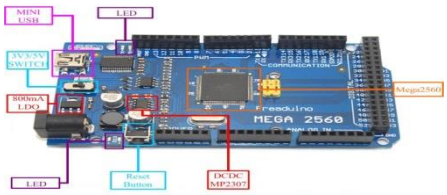
Arduino mega

Atmega2560 Controller

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (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.

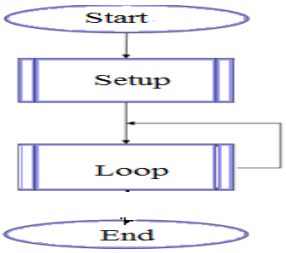
4. MODULE DESCRIPTION

Schematic Diagram



Ardunio MEGA

Fundamental Flow of an Arduino Program



Flow Chart in Arduino Program

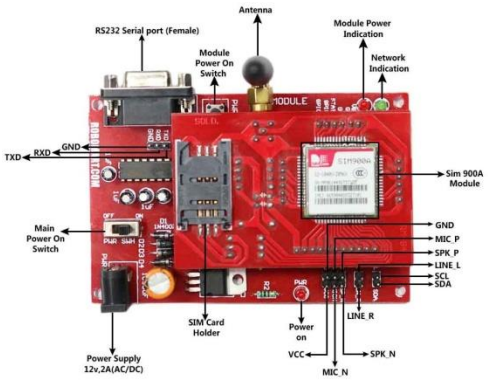
5. GSM SIM 800c

SIM 800c is a Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5V DC TTL interfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600-115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IP stack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter).

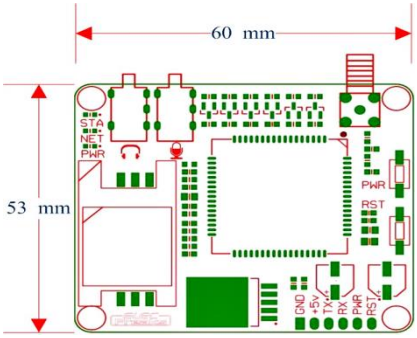
FEATURES

- Quad Band GSM/GPRS : 850 / 900 / 1800 / 1900 MHz.
- Built in RS232 to TTL or vice-versa Logic Converter (MAX232)
- Configurable Baud Rate
- SMA (Sub-miniature version A) connector with GSM L Type Antenna
- Built in SIM (Subscriber Identity Module) Card holder
- Built in Network Status LED.

PIN DIAGRAM:

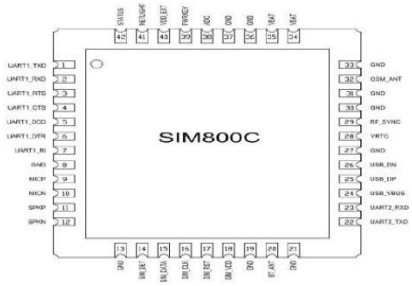


Pin Diagram



Measurement Size of GSM

PIN DESCRIPTION



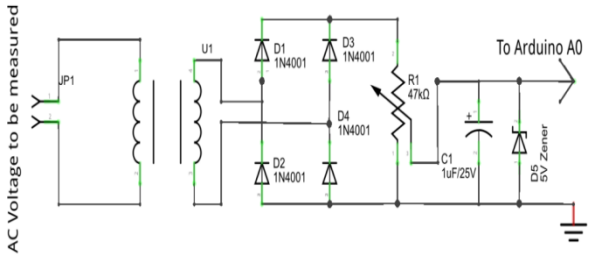
SIM800C Pin

6. VOLTAGE MEASUREMENT

Components Used for AC Voltage Measurement

1. 1N4007 Diodes – Qty. 4
2. Arduino MEGA
3. Connecting Wires
4. Step down transformer 230V to 6V
5. Variable resistor 47K Ohm
6. Capacitor 1uF 25V
7. 5V Zener Diode

Arduino AC Voltage Measurement Circuit



AC Voltage Measurement Circuit

To connect Arduino as per circuit make ground common for Arduino and circuit shown in figure. Adjust the resistor R1 to get proper reading. When AC Voltage is 250V we get 5V output.

So calibration formula is

AC Voltage = (230/1024) * ADC_ Value

In case if the voltage reading is fluctuating then increase the value of C1 from 1uF to 10uF.

7. CURRENT SENSOR

Current Sensor (ACS712)

ACS712 current sensor interfacing with Arduino for ac and dc current measurement: In this tutorial you will learn how to interface acs712 hall effect current sensor with arduino? And How to measure dc current using asc712 hall effect sensor and how to measure ac current using acs712 hall effect sensor? Acs712 is a cheap solution for current sensing in industry, power sector and communication applications. I will also show in this tutorial how to display measured value of currents on Lcd and how to send this data to computer using serial communication of Arduino.

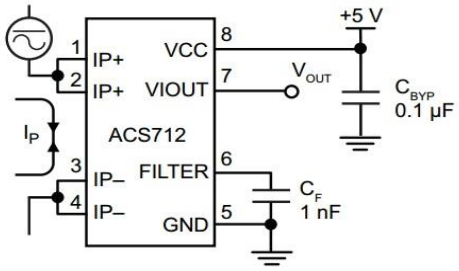
Working

This ACS712 sensor consists of a linear hall effect circuit along with copper conduction path. Copper conduction path is

located around the surface of the die. When ac or dc current passes through a copper conduction path, it produces magnetic field. This electromagnetic field interacts with hall effect sensor. Hall effect circuit converts this electromagnetic filed into proportional voltage either ac or dc depending on input current type. This output voltage is measured with the help of Arduino or any microcontroller. After measuring this voltage, we convert it back into current using sensitivity equations which I will explain later on.

Pin Diagram

Pin out of ACS712 current sensor is given below. Pin number 1, 2 and 3,4 are used for current sampling. In other words you will connect these pins in series with the load of which current you want to measure.



Pin Diagram of ACS712

Pin number is ground connection of 5 volt power supply and pin number 6 is used to connect filter capacitor. One terminal of filter capacitor should be connected with pin number 6 and other terminal should be connected with ground. Similarly pin number 8vcc is a power supply pin and you should connect dc 5 volt with it. Pin number 7 is the output pin of acs712 current sensor. From output pin, we will measure voltage with the help of arduino and we will see later on how to do it. Make sure to not connect your load in parallel with IP+ and IP+ it will damage your device and can also harm you if you are dealing with AC power supply or AC load.

Pin Diagram Description

NUMBER	NAME	DESCRIPTION
1 and 2	IP+	TERMINALS FOR current being sampled, fused internally
3 and 4	IP-	Terminals for current being sampled, fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VOUT	Analog output signal
8	VCC	Device power supply terminal

Types

There are three types of ACS712 sensors available according to current rating of sensors. Below tables provides the rating and all the details of three types of ACS712 hall effect sensors.

Types of ACS712

PART NUMBER	PACKING	T_A	OPTIMIZED RANGE	SENSITIVITY (mV/A)
ACS712ELCTR-05B-T	Tape and reel,3000 pieces/reel	-40_85	5	185
ACS712ELCTR-20A-T	Tape and reel,3000 pieces/reel	-40_85	20	100
ACS712ELCTR-30A-T	Tape and reel,3000 pieces/reel	-40_85	30	66

- ACS712ELCTR-05B: It sensor can measure current in the range of plus minus 5 Ampere and output sensitivity is 185mV/A. It mean the output voltage which will appear at the output pin of current sensor is 185 milli volt for every ampere passes through hall effect sensor. Similarly for other sensors but sensitivity is different for them.
- ACS712ELCTR-20A-T: It can measure 20 and -20 ampere current very easily and output sensitivity is 100mv/A.
- ACS712ELCTR-30A-T: It can measure 30 and -30 ampere current very easily and output sensitivity is 66mv/A.
- How to measure current from output voltage of ACS712 sensor

To calculate current from output voltage of acs712 current sensor, you should make calculations according to following points:

- When there is no current flowing through the sensor, output voltage will be Vcc / 2. Where Vcc is power supply voltage given to acs712 to current sensor.
- If the Vcc = 5 volt, then the output voltage of current sensor will be equal to 2.5 when there is no current passing through a sensor.

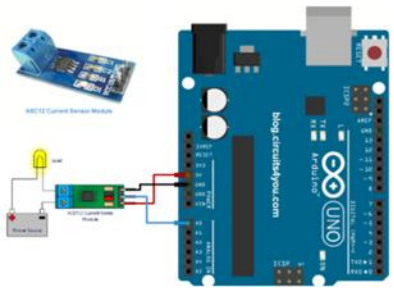
- 2.5 volt is the offset voltage or base voltage of the sensor which should be subtracted from the measured voltage.
- The output voltage decreases when current passing through the sensor.
- So we can calculate dc current by using following commands:

```
Adcvalue = analogRead(A0);

Voltage = (adcvalue / 1024.0) * 5000;

current = ((Voltage -voltage_offset) / mVperAmp);
```

We can measure current by using above three lines of Arduino code.

ACS712 Hall Effect Sensor Interfacing with Arduino

Figure below shows the connection diagram of interfacing ACS712 current sensor with arduino. This sensor is also available in the form of module as shown in picture below.



Current Sensor (ACS721)

8. TEMPEATUE SENSOR

Temperature Monitoring (DS18B20)

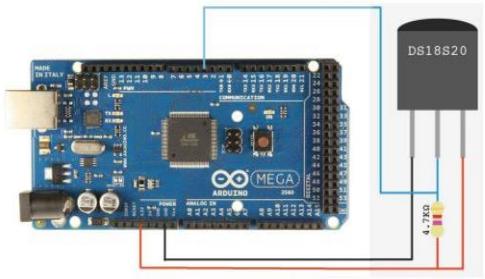
The DS18B20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with Arduino. It has an operating temperature range of -55°C to +125°C and is accurate to ±0.5°C over the range of -10°C to +85°C. In addition, the DS18B20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

Each DS18B20 has a unique 64-bit serial code, which allows multiple DS18B20s to function on the same 1-Wire bus. Thus, it is simple to use one microprocessor to control many DS18B20s distributed over a large area. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery and process monitoring and control system.

Description

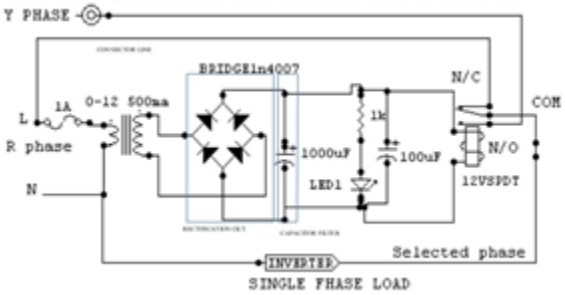
The DS18B20 digital thermometer provides 9 to 12 bit (configurable) temperature readings which indicate the temperature of the device. Information sent to/from the DS18B20 over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor to a DS18B20. Power for reading, writing, and performing temperature conversions can be derived from the data line itself with no need for an external power source. Because each DS18B20 contains a unique silicon serial number, multiple DS18B20s can exist on the same 1-Wire bus. This allows for placing temperature sensors in many different places.

DS18b20 Interfacing with Arduino MEGA:



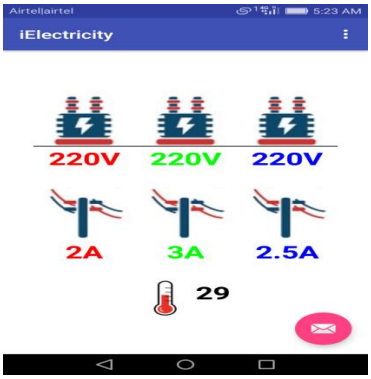
DS18b20 Interfacing with Arduino MEGA

9. PHASE PREVENTOR CIRCUIT



Phase preventor circuit

10. SIMULATION



Simulation

11. 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.

REFERENCES

[1] Abdul-Rahman AI-Ali, Abdul Khaliq & Muhammad Arshad "GSM-Based Distribution Transformer Monitoring System," IEEE MELECON 2004, May 12-15,2004, Dubrovnik, Croatia.

[2] Buyung Sofiarto Munir, Johan J. Smi:"Evaluation of Various Transformations to Extract Characteristic Parameters from Vibration Signal Monitoring of Power Transformer"2011 Electrical Insulation Conference, Annapolis, Maryland, 5 to 8 June 2011.

[3] Suresh D S, Prathibha T, KouserTaj," Oil Based Transformer Health Monitoring System" International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358 Volume.

[4] Drasko Furundzic, Zeljko Djurovic, Vladimir Celebic, and Iva Salom, "Neurel Network Ensemble for Power Transformers Fault Detection,"11th symposium on Neural Network Applications in electrical Engineering NEUREL-2012.

[5] Mallikarjun Sarsamba, Prashant Sangulagi, Dr. Raju Yanamshetty,"The Load Monitoring and Protection on Electricity Power lines using GSM Network," International Journal of Advanced Research in Computer Science and Software Engineering, Volume 3, Issue 9, September 2013 ISSN: 2277 128X .

[6] Mohamed Ahmed Eltayeb Ahmed Elmustafa Hayati, Sherief F. Babiker," Design and Implementation of Low-Cost SMS Based Monitoring System of Distribution Transformers," 2016 Conference of Basic Sciences and Engineering Studies (SGCAC).

[7] Monika Agarwal, Akshaypandya," GSM Based Condition Monitoring of Transformer,"IJSRD - International Journal for Scientific Research & Development| Vol. 1, Issue 12, 2014 | ISSN (online): 2321-0613 .

[8] Pathak A.K, Kolhe A.N, Gagare J.T, KhemnarSM ,"GSM Based Distribution Transformer Monitoring And Controlling System" Vol-2 Issue-2 2016, IJARIIE-ISSN (O).

[9] RavishankarTularamZanzad, Prof. Nikita Umare,Prof Gajanan Patle , " ZIGBEE Wireless Transformer Monitoring, Protection and Control System", International Journal of Innovative Research in Computer and Communication Engineering (An ISO 3297: 2007 Certified Organization), Vol. 4, Issue 2, February 2016. 2395-4396.

[10] Sachin Kumar B S, Dr.NageshPrabhu ,"Simulation And Analysis Of Compact Remote Monitoring System", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering Nitte Conference on Advances in Electrical Engineering NCAEE-2016 , Nitte Vol. 4, Special Issue 2, April 2016.

[11] Satya Kumar Behera,RaviMasand,Dr. S. P. Shukla,"A Review of Transformer Protection by Using PLC System,International Journal of Digital Application & Contemporary research, (Volume 3, Issue 2, September 2014).

[12] Suraj Pardeshi, Ramakant Mahajan, Uma Mahesh Pasumarthi, Rohit Kumar Arora,," Multiprocessor based architecture for On-line Condition Monitoring of Transformers," 2012 IEEE International Conference on Condition Monitoring and Diagnosis 23-27 September 2012, Bali, Indonesia.

[13] U.V.Patil, Kathe Mohan, HarkalSaurabh ,Warhade Nilesh,"Transformer Health Condition Monitoring Using GSM Technology",Vol-2 Issue-2 2016, IJARIIEISSN(O)-2395-4396.

[14] Vishwanath R, Akshatha V Shetty, Poonam, Shamilli, M Thanuja," A New Approach to monitor Condition of Transformers incipient fault diagnosis based on is voltage grater than generator capacity? Digital read temp analog read vt1,vt2,vt3 calculate power display on Lcd activate alert transmit through Gsm start international journal of current engineering and scientific research (IJCESR) ISSN (PRINT): 2393-8374, (ONLINE): 2394-0697, VOLUME-4, ISSUE-3, 2017 54 GSM & XBEE," International Journal of Science, Engineering and Technology Research (IJSETR), Vol. 4(11),pp. 3826-3829,2015.