International Journal of Engineering Research
Volume No.6, Issue No.8, pp : 382-387

ISSN:2319-6890 (online),2347-5013(print)
1 Aug. 2017

A Smart Monitoring of Faults in Power Transformers and Maintenance Based on Wi-Fi

[1]R.Kavin, [2]T.Kesavan, [3]S.Anbumani

[1&2]EEE Department, Sri Krishna College of Engineering & Technology, City??state??

[3]Bio-Medical Engineering Department, Vellalar College of Engg & Tech, City??state??

Email: [1]kavin882@gmail.com, [2]t.kesavan87@gmail.com, [3]anbumaniexcel@gmail.com

Abstract— This paper proposes and experimentally validates the functionality of a smart IEC 61850 merging unit (MU) that supports self-healing and asset management functions of future power grids. The proposed MU can operate in a standalone or as an integrated element within a primary substation. The MU communicates with a supervisory control and data acquisition (SCADA) system over Ethernet and WiFi-5 GHz links. A dynamic wavelet-based windowing technique is implemented in the proposed MU to process signals and report limited situation awareness (SA) features. The SA features serve two purposes. First, they can be used by asset management functions to monitor and diagnose the equipment heath condition. Second, they can be employed by self-healing functions in order to detect and anticipate early stages of impending faults masked by high noise. This information is received by a specially designed application interface running on a PC connected through wifi wireless link. All the parameters are sensed by Arduino board built in with ADC, through the comparators and it transmit by 2.4GHz Wifi.

Keywords: SCADA, LDR, THERMISTOR, CT, MU & SA

INTRODUCTION

The distribution transformers are costing approximately several lakhs of indian rupees. So if the load side is misued by the consumers or if there exists a natural electrical accident, then there exists no techniques to protect the transformer. Hence a protection scheme is proposed in this project. transformer is an electrical device that transfers energy from one electrical circuit to another by magnetic coupling, where relative motion between the parts is not required to transfer energy between the circuits. It is often used to convert between high and low voltages, for impedance transformation, and to provide electrical isolation between circuits the transformer is one of the simplest of electrical devices. Its basic design, materials, and principles have changed little over the last one hundred years, yet transformer designs and materials continue to be improved. Transformers are essential in high voltage power transmission providing an economical means of transmitting power over large distances. The simplicity, reliability, and economy of conversion of voltages by transformers was the principal factor in the selection of alternating current power transmission in the "War of Currents" in the late 1880's. In electronic circuitry, new methods of circuit design have replaced some of the applications of transformers, but electronic technology has also developed new transformer designs and applications. Transformers come in a range of sizes from a thumbnail-sized coupling transformer hidden inside a stage microphone to gigawatt units used to interconnect large portions of national power grids, all operating with the same basic principles and with many similarities in their parts.

Transformers alone cannot do the following:

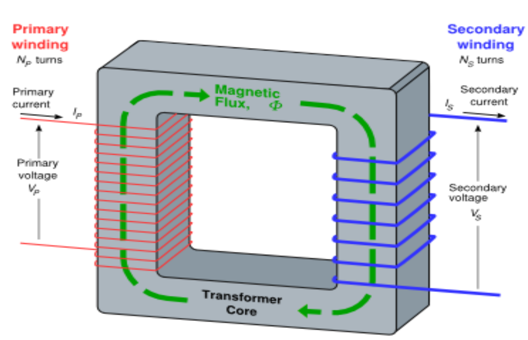
- Convert DC to AC or vice versa
- Change the voltage or current of DC
- Change the AC supply frequency.

However, transformers are components of the systems that perform all these functions.

Basic principles

An analogy The transformer may be considered as a simple two wheel 'gearbox' for electrical voltage and current. The primary winding is analogous to the input shaft and the secondary winding to the output shaft. In this comparison, voltage is equivalent to shaft speed, current to shaft torque. In a gearbox, mechanical power (speed multiplied by torque) is constant (neglecting losses) and is equivalent to electrical power (voltage multiplied by current) which is also constant. The gear ratio is equivalent to the transformer step up or down ratio.

Flux coupling



International Journal of Engineering Research
Volume No.6, Issue No.8, pp : 382-387

ISSN:2319-6890 (online),2347-5013(print)
1 Aug. 2017

A single-phase step-down transformer

A simple single phase transformer consists of two electrical conductors called the primary winding and the secondary winding. The primary is fed with a time-varying (alternating or pulsed) electric current which creates a varying magnetic flux in the transformer core (shaded grey). The secondary, which is wrapped around the core and surrounds the time-varying flux, develops an induced electromotive force or EMF. If the ends of the secondary are connected together to form an electric circuit, this EMF will cause a current to flow in the secondary. In this way, the electrical energy fed into the primary winding is delivered to the secondary winding. In most practical transformers, the primary and secondary conductors are coils of conducting wire because each turn of the coil contributes to the magnetic field, creating a higher magnetic flux density than would a single conductor.

Winding inductance

Although transformer windings usually heve considerable inductance (of the order of henries), this is only done to limit the magnetising current in the primary winding. It has no effect on the normal operation of the transfomer as the effect of the primary inductance is totally cancelled by the current flow in the secondary winding due to the fact that the net flux in the core due to the external currents is zero.

Electrical laws

If a time-varying voltage is applied to the primary winding of turns, a current will flow in it to establish a varying magnetic flux in the core, and induce a back electromotive force (EMF) in opposition to . In accordance with Faraday's Law, the voltage across the primary winding is proportional to the rate of change of flux:

$$v_P = N_P \frac{d\Phi_P}{dt}$$

Similarly, the voltage induced across the secondary winding is:

$$v_S = N_S \frac{d\Phi_S}{dt}$$

With perfect flux coupling, the flux in the secondary winding will be equal to that in the primary winding, and so we can equate and . It thus follows that:

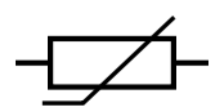
$$\frac{v_P}{v_S} = \frac{N_P}{N_S}.$$

Hence in an ideal transformer, the ratio of the primary and secondary voltages is equal to the ratio of the number of turns in their windings, or alternatively, the voltage per turn is the same for both windings. This leads to the most common use of the transformer: to convert power at one voltage to power at a different voltage by means of windings with different numbers of turns.

THERMISTOR

A thermistor is a type of resistor whose resistance varies significantly with temperature, more so than in standard resistors. The word is a portmanteau of *thermal* and *resistor*. Thermistors are widely used as inrush current limiters, temperature sensors, self-resetting over current protectors, and self-regulating heating elements. Thermistors differ from resistance temperature detectors (RTD) in that the material used in a thermistor is generally a ceramic or polymer, while RTDs use pure metals. The temperature response is also different; RTDs are useful over larger temperature ranges, while thermistors typically achieve a higher precision within a limited temperature range [usually −90 °C to 130 °C]. Thermistor, a word formed by combining *thermal* with *resistor*, refers to a device whose electrical resistance, or ability to conduct electricity, is controlled by temperature. Thermistors come in two varieties; NTC, negative thermal coefficient, and PTC, positive thermal coefficient, sometimes called posisitors.

The resistance of NTC thermistors decreases proportionally with increases in temperature. They are most commonly made from the oxides of metals such as manganese, cobalt, nickel and copper. The metals are oxidized through a chemical reaction, ground to a fine powder, then compressed and subject to very high heat. Some NTC thermistors are crystallized from semiconducting material such as silicon and germanium.



Thermistor symbol

Assuming, as a first-order approximation, that the relationship between resistance and temperature is linear, then:

$$\Delta R = k\Delta T$$

where

ΔR = change in resistance

ΔT = change in temperature

k = first-order temperature coefficient of resistance

Thermistors can be classified into two types, depending on the sign of k. If k is positive, the resistance increases with increasing temperature, and the device is called a positive temperature coefficient (**PTC**) thermistor, or **posistor**. If k is negative, the

DOI : 10.5958/2319-6890.2017.00043.5

International Journal of Engineering Research ISSN:2319-6890 (online),2347-5013(print)
Volume No.6, Issue No.8, pp : 382-387 1 Aug. 2017

resistance decreases with increasing temperature, and the device is called a negative temperature coefficient (**NTC**) thermistor. Resistors that are not thermistors are designed to have a *k* as close to zero as possible (smallest possible k), so that their resistance remains nearly constant over a wide temperature range.

Instead of the temperature coefficient *k*, sometimes the *temperature coefficient of resistance* α (alpha) or α_T is used. It is defined as

$$\alpha_T = \frac{1}{R(T)}\frac{dR}{dT}.$$

For example, for the common PT100 sensor, α = 0.00385 or 0.385 %/°C. This α_T coefficient should not be confused with α parameter below.

Steinhart-Hart equation

In practice, the linear approximation (above) works only over a small temperature range. For accurate temperature measurements, the resistance/temperature curve of the device must be described in more detail. The Steinhart-Hart equation is a widely used third-order approximation:

$$\frac{1}{T} = a + b\,\ln(R) + c\,\ln^3(R)$$

where *a*, *b* and *c* are called the Steinhart-Hart parameters, and must be specified for each device. *T* is the temperature in Kelvin and *R* is the resistance in ohms. To give resistance as a function of temperature, the above can be rearranged into:

$$R = e^{\left(x-\frac{y}{2}\right)^{\frac{1}{3}} - \left(x+\frac{y}{2}\right)^{\frac{1}{3}}}$$

where

$$y = \frac{a - \frac{1}{T}}{c} \quad \text{and} \quad x = \sqrt{\left(\frac{b}{3c}\right)^3 + \frac{y^2}{4}}$$

The error in the Steinhart-Hart equation is generally less than 0.02 °C in the measurement of temperature. As an example, typical values for a thermistor with a resistance of 3000 Ω at room temperature (25 °C = 298.15 K) are:

$$a = 1.40 \times 10^{-3}$$
$$b = 2.37 \times 10^{-4}$$
$$c = 9.90 \times 10^{-8}$$

B parameter equation

NTC thermistors can also be characterised with the *B* parameter equation, which is essentially the Steinhart Hart equation with $a = (1 / T_0) - (1 / B)ln(R_0)$, $b = 1 / B$ and $c = 0$,

$$\frac{1}{T} = \frac{1}{T_0} + \frac{1}{B}\ln\left(\frac{R}{R_0}\right)$$

Where the temperatures are in Kelvin's and R_0 is the resistance at temperature T_0 (usually 25 °C = 298.15 K). Solving for *R* yields:

$$R = R_0 e^{B(1/T - 1/T_0)}$$

or, alternatively,

$$R = r_\infty e^{B/T}$$

where $r_\infty = R_0 e^{-B/T_0}$. This can be solved for the temperature:

$$T = \frac{B}{\ln\left(R/r_\infty\right)}$$

The B-parameter equation can also be written as $\ln R = B/T + \ln r_\infty$. This can be used to convert the function of resistance vs. temperature of a thermistor into a linear function of ln*R* vs. 1 / *T*. The average slope of this function will then yield an estimate of the value of the *B* parameter.

Conduction model

Many NTC thermistors are made from a pressed disc or cast chip of a semiconductor such as a sintered metal oxide. They work because raising the temperature of a semiconductor increases the number of electrons able to move about and carry charge - it promotes them into the *conduction band*. The more charge carriers that are available, the more current a material can conduct. This is described in the formula:

$$I = n \cdot A \cdot v \cdot e$$

I = electric current (amperes)

n = density of charge carriers (count/m³)

A = cross-sectional area of the material (m²)

v = velocity of charge carriers (m/s)

Applications

PTC thermistors can be used as current-limiting devices for circuit protection, as replacements for fuses. Current through the device causes a small amount of resistive heating. If the current is large enough to generate more heat than the device can lose to its surroundings, the device heats up, causing its resistance to increase, and therefore causing even more heating. This creates a self-reinforcing effect that drives the resistance upwards, reducing the current and voltage available to the device. PTC thermistors are used as timers in the degaussing coil circuit of most CRT displays and televisions. When the display unit is initially switched on, current flows through the thermistor and degaussing coil. The coil and thermistor are intentionally sized so that the current flow will heat the thermistor to the point that the degaussing coil shuts off in under a second. For effective degaussing, it is necessary that the magnitude of the alternating magnetic field produced by the degaussing coil decreases smoothly and continuously, rather than sharply switching off or decreasing in steps; the PTC thermistor accomplishes this naturally as it heats up. A degaussing circuit using a PTC thermistor is simple, reliable (for its simplicity), and inexpensive.NTC thermistors are used as resistance thermometers in low-temperature measurements of the order of 10 K. NTC thermistors can be used as inrush-current limiting devices in power supply circuits. They present a higher resistance initially which prevents large currents from flowing at turn-on, and then heat up and become much lower resistance to allow higher current flow during normal operation. These thermistors are usually much larger than measuring type thermistors, and are purposely designed for this application. NTC thermistors are regularly used in automotive applications. For example, they monitor things like coolant temperature and/or oil temperature inside the engine and provide data to the ECU and, indirectly, to the dashboard. NTC thermistors can be also used to monitor the temperature of an incubator. Thermistors are also commonly used in modern digital thermostats and to monitor the temperature of battery packs while charging.

EXISTING SYSTEM

- Through automatic trips are installed in any distribution system, it does not find the nature of the problem, by which the transformer is failed.
- Also, there are no means to communicate the status of failure to a remote EB control panel.
- GSM based alerts usually takes more time because of the delay introduced in public network.

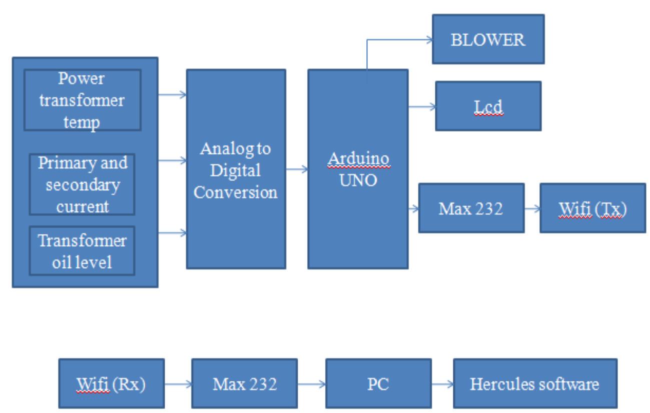
Problems in existing system

- In case of wired feedback for control system, interference is likely to occur.
- The system is not equipped with cooling arrangements and it must be sized for the worst-case condition which only occurs when the system is under full load (or fault conditions) in high ambient temperature conditions for prolonged operating periods.
- This is an unusual situation, however, and, under practical conditions, the system operates significantly below the worst case. The design for worst case leads to increased cost due to excess heat sink requirements and increased energy usage in the active cooling system. Secondly, where active cooling is not controlled, temperatures rapidly increase and decrease with system load which can lead to significant thermal cycling.

PROPOSED SYSTEM

- To design and acquire measurement systems for temperature, oil level and no load primary and full load primary current.
- To interface the sensors with arduino and further communication to remote receiver using wifi standards based merging the nodes.

BLOCK DIAGRAM



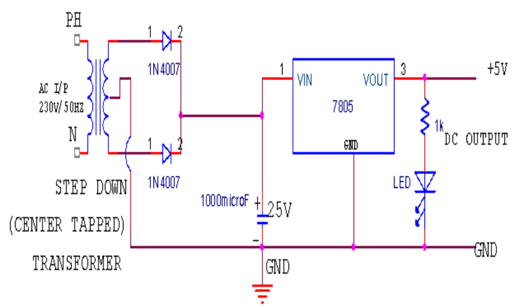
Block explanations

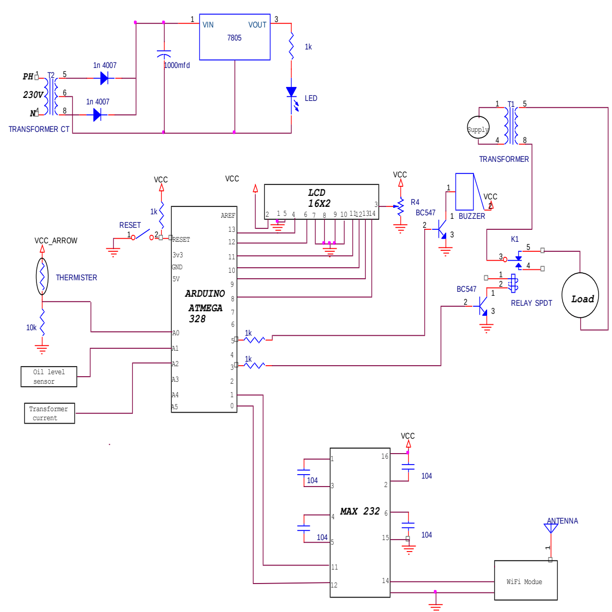
Thermistor : Range 0 – 100’C – Negative resistance sensor. Primary and secondary current – Using current transformer Transformer Oil level : 0 – 10cm.Analog to digital converter – Built in ADC – 8 bit length word. Arduino : ATMEGA 328 LCD – 2 line , 16 characters.

CIRCUIT DIAGRAM

Power supply circuit

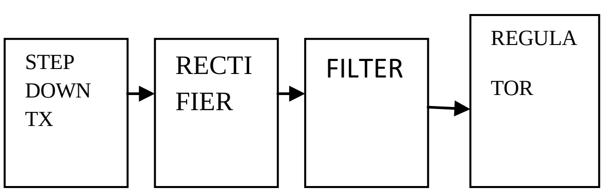
ISSN:2319-6890 (online),2347-5013(print)
1 Aug. 2017





CIRCUIT OPERATION

POWER SUPPLY BLOCK



Step down transformer

Step down transformer converts a line voltage of 230 V into a voltage of 4.5 volts ac without any change in the frequency. It remains unchanged as 50 Hz. The current capability that it can withstand is about 500 mA. The voltage will be usually slightly higher than the specified voltage. At load conditions the voltage will be the same as it has been mentioned in the transformer. The value specified in the transformer is just the RMS value of the voltage.

Rectifier

Rectifier is of two types, As it is known already as center tapped rectifier and bridge rectifier in the case of full rectifier. It is known that we are not going for half wave rectifier because it will give an efficiency of only 40% approximately. Bridge rectifier needs four diodes whereas the center tapped rectifier requires only two diodes. We have used a center tapped transformer.

Filter:

The rectified components are still Ac in nature because it never stays constant at a particular voltage so it may be told as a varying DC or pulsating DC. So it has to be properly filtered. In other words we can say that the line frequency has to be eliminated from the voltage. In order to get the pure DC we have to employ the capacitor filter. Because it is the cheapest filter available in the market. Even we can go for inductive filter. We are not doing so because it is bulky in nature and also by cost wise it is not compatible with capacitors, the micro controller initiates all the communications. When an abnormality is detected that creates a '1' at opamp output. (for vibration, and LDR for oil level). Temperature is given to the ADC and converted into digital signal. The values are instantaneously transmitted to smart phone via wifi. When a abnormality is detected it gives a buzzer sound via port 2.0 via a transistor current driver. The circuit is powered by a +5v signal derived from a mains power supply.

1. Assembly code to be written to interface the arduino with wireless transmitter and receiver.

2. Temperature (thermistor), primary and secondary currents (ct), transformer oil level (level sensor), values are sent to micro controller via ADC which is built-in in the arduino board.

3. The digitized values are transmitted via wireless transmitter. before transmission, an encryption is performed in order to maintain the best security based on AES encryption (advanced encryption system).

ADVANTAGES

1. Analysis carried out in this work gives a new way to generate and also to predict the load consumptions based on transformer parameters.

2. Interference problem because of wired feedback is totally avoided through wireless feedback.

3. Consumes less power for transmission and reception of all these parameters like speed, efficiency, temperature etc.

4. All the data is transmitted in encrypted manner.

5. Not affected by any noise.

6. No delay is introduced.

7. The wireless scheme precludes the need for the cable that feeds the position from the sensor to the controller, thereby minimizing feedback noise pickup and cost for some applications.

DOI : 10.5958/2319-6890.2017.00043.5

8. It also raises the possibility of using a low-resolution, low-cost sensor, for grids.

APPLICATIOINS

1. Used by all EB substations.

2. Applicable for all domestic costly load protection systems

3. Useful for protecting high precision equipment in test laboratories.

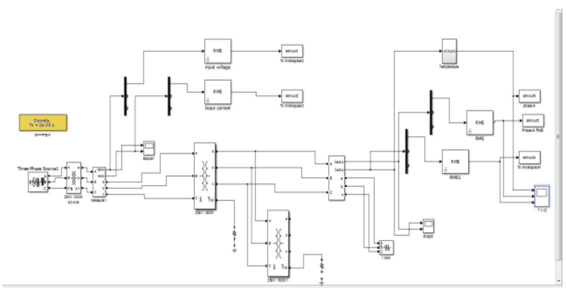
Future scopes

1. The project can be designed using ASIC (application specific integrated circuit) chip so that high complex circuits can be put in a small chip.

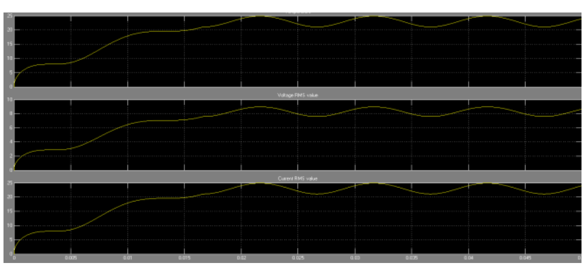
2. The project may be extended for high wattage.

3. The project can be implemented in other micro controllers or PLC (programmable logic controller)

SIMULATION DIAGRAM



SIMULATION OUTPUT



CONCLUSION

The project thus designed to test oil level, temperature and high load current if any generated from a transformer. The parameter is sensed by the micro controller ATMEGA series mounted on Arduino uno board through the comparators. The sensors we have used are LDR, thermistor and CT sensor. Our project is very use full to EB stations, where the manpower cannot work in that field. In future we can implement RF also, to reduce the cost of the overall system.

REFERENCES

i. *A. M. Gaouda, - "A Smart IEC 61850 Merging Unit for Impending Fault Detection in Transformers" IEEE Trans. On Industry Applications, Doi 10.1109/TSG.2016.2600680,2016*

ii. U. S. DOE, "GRID 2030‖ A National Vision for Electricity's Second 100 Years," Office of Electric Transmission and Distribution2003.

iii. U. S. DOE, "A Vision for the Smart Grid," National Energy Technology Laboratory2009.

iv. A. Zidan and E. F. El-Saadany, ―A cooperative multiagent framework for self-healing mechanisms in distribution systems,‖ IEEE Trans. on Smart Grid, vol.3, no.3, Sept. 2012, pp.1525-1539.

v. M. Kezunovic, "Smart Fault Location for Smart Grids," Smart Grid, IEEE Transactions on, vol. 2, pp. 11-22, 2011.

vi. B. Don Russell, and Carl L. Benner, ―Intelligent Systems for Improved Reliability and Failure Diagnosis in Distribution Systems,‖ IEEE Trans. On Smart Grid, Vol. 1, No. 1, June 2010.

vii. M. Kezunovic, Ce Zheng, and Chengzong Pang, ―Merging PMU, Operational, and Non-Operational Data for Interpreting Alarms, Locating Faults and Preventing Cascades,‖ 2010 43rd Hawaii International Conference on System Sciences, Doi: 10.1109/HICSS.2010.271.

viii. G. A Hussain, L. Kumpulainen, M. Lehtonen, ―Preemptive Arc-Fault Detection Techniques in Switchgear and Control gear—Part II,‖ IEEE Trans. On Industry Applications, Vol. 49,No. 4, pp. 1911-1919, 2013.

ix. C. J. Kim, ―Electromagnetic Radiation Behavior of Low-Voltage Arcing Fault,‖ IEEE Trans. On Power Delivery, Vol. 24, No. 1, pp. 416-423, Jan. 2009.