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Transformer Health Monitoring System

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Abstract: - Transformers are a dynamic part of the transmissions and distribution systems. Monitoring transformers for problem before they occurs can prevent fault that are costly to repair & results in a loss of services. Present system can afford information about the state of a transformers, but are either offline or very expensive to implement. Because of the costs of scheduled &unscheduled maintenance, especially at distant site, the utility industry has begun capitalizing in instrumentation &monitoring of transformers. Upkeep of power transformer is obligatory; as they are located at different geographical areas periodical monitoring is not possible all the time due to inadequate manpower. Due to this reason transformer failure may occur which leads to sudden power cut. To overcome this power cut due to transformer failure we suggested a system for monitoring the transformer .The goal of our project is to monitor and protect oil level, oil quality, temperature, voltage and current level& phase shift measurement of transformer without involving man power. If any serious condition occurs the SMS will be send to the control unit .This monitoring system consist of PIC 18F4520 micro controller, LM35 temperature sensor, Phase voltages Sensor(PT), current Sensor(CT),V_{zcd} and I_{zcd} for phase shift measurement, Transformer temp. sensor, Transformer oil Level Probe, Transformer oil quality using IR sensor, Relay Driver as circuit breaker, GSM and LCD.GSM is an open digital cellular Technology use for transferring mobiles voice &data services. This project impartial is to develop low cost solution for observing the health conditions of distantly situated distributions. Transformers using GSM technology to prevent impulsiveFiascos of distributions transformers &improving reliability of Services to the customer.

Keyword:-PT; CT; Oil quality; LM35; Circuit breaker; PIC18 microcontroller; GSM.

I. INTRODUCTION

Power transformers are one of the most important electrical equipment that are used in power transmission system as they accomplish the function of transforming the voltage levels. Hence upkeep of power transformer is obligatory. As they are situated at different physical areas reviewintensive care is not possible all the time due to insufficient man power. Due to this purpose transformer fiasco may occur which leads to unexpected power shutdown. To overcome this power failure due to transformer failure we proposed a system for monitoring the transformer. The aim of our project is to monitor and protect oil level, temperature, voltage and current levels of transformer without involving man power. If any critical condition occurs, the SMS will be sent to the control unit. This monitoring system consists of PIC18F4520 micro controller, LM35 temperature sensor, level sensor, CT PT voltage and current sensor, GSM and LCD. The proposed hardware results are obtained using miniature model of transformer. Result obtained in the proposed system with suitable modification can be applied to the real time system. To avoid this situation, we have chosen this project. In this project microcontroller will sense the phase signal. If any phase is disconnected or cut by any abnormal condition, then microcontroller will turn ON the respective relay, which will disconnect the supply from distribution line. Therefore, the line becomes safe. So there is no dangerous situation. After removing the problem, the relay turns OFF automatically and the supply is given to the distribution line.

II. PROPOSED DESIGN

a.PIC18F4520:- It is a low-power, high-performance CMOS 8-bit microcomputer with 32K bytes of Flash Programmable and Erasable Read Only Memory (PEROM). The device is manufactured using MICROCHIP high-density nonvolatile memory technology.

b.. Phase Voltage measurement Block:- This block senses the phase voltage. In our project we are doing the simulation by using DC signal. In reality for sensing the phase we have to use PT (Potential Transformer) which converts 230 Vac into 12 Vac. The output of PT is given to signal conditioning block. This block has rectifier, filter and regulator. The rectifier will convert AC into DC. This DC has some AC ripples, So Capacitor filter is used to remove the AC ripples. The output of filter is pure DC 12 volts. But microcontroller requires only +5Vdc.

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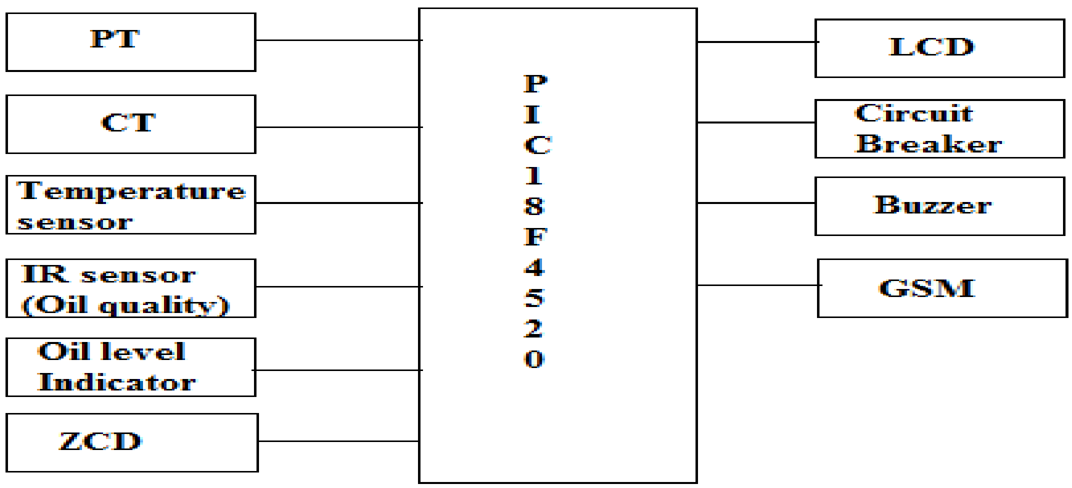


Fig.1 Block Diagram of Transformer health monitoring system

Therefore we are using zener of 5 volts. So when phase is present we are getting +5 Vdc and when phase is not present we are getting logic zero i.e. zero volts.

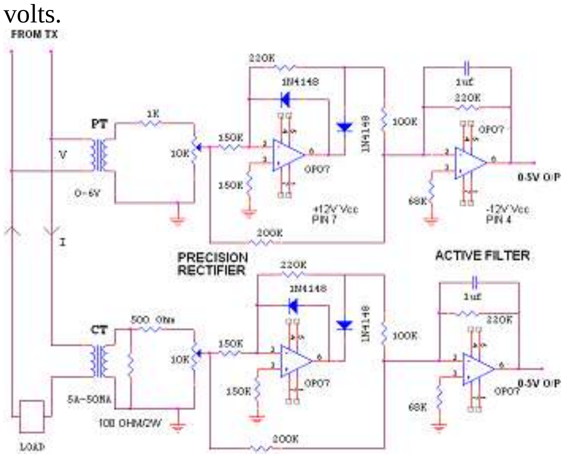


Fig. 2Circuit diagram of Voltage and Current measurement

c. Phase current measurement Block:- This block senses the phase current. In reality for sensing the phase current we have to use CT (Current Transformer) which converts 5A primary current to proportional 50ma secondary current. The output of CT is given to signal conditioning block. This block has rectifier, filter. The rectifier will convert AC into DC. This DC has some AC ripples, So Capacitor filter is used to remove the AC ripples. The output of filter is pure DC.

d. Phase shift measurement Block:-This block is implanted using zero crossing detector of voltage and current. Measuring the time between two we can calculate the phase shift in deg. From the phase shift reactive and active power delivered from the transformer may be calculated.

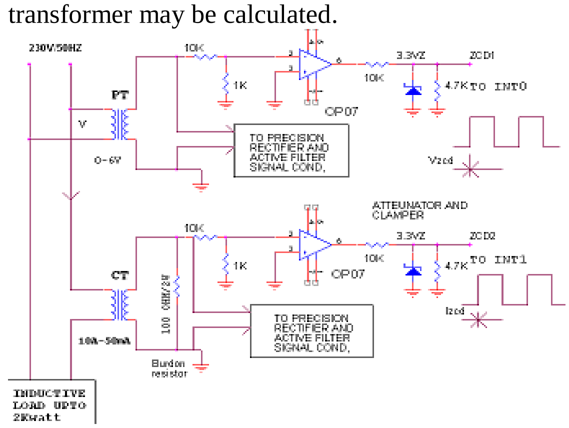


Fig. 3Circuit diagram of Zero crossing detector

e.Temperature measurement Block:-Temperature of transformer is measure by using LM35 temp. sensor**.** LM35 temp. Sensor is more accurately than a using a thermistor. It has an output voltage that is proportional to the Celsiustemperature.

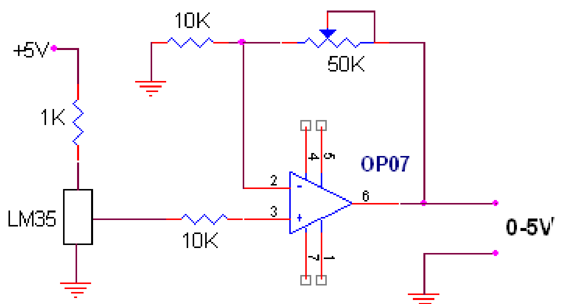


Fig. 4 Circuit diagram of Temp. Measurement

f. Oil quality measurement Block:- Oil quality of transformer can be measured using IR pair LED and detector. Pure Oil is transparent; its quality may defined from its transparencies which changes the conduction of IR detector.

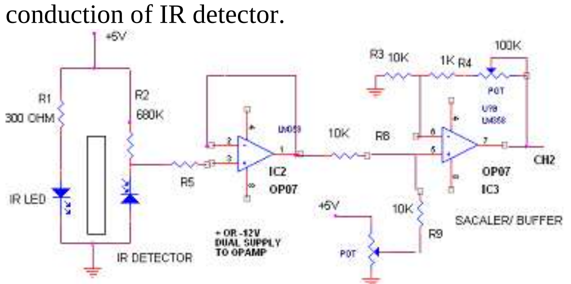


Fig.5 Circuit diagram of Oil quality measurement

g. Oil level Measurement:-Oil level of transformer is measure by using oil level signal conditioning circuit by 4 level.As shown in the circuit diagram transistor based is connected to the oil level probes which are immersed in transformer at unit level. oil is pure conductor of electricity whenever the probe is in contact with oil transistor will goes into conduction and generates a logic of zero at its collector.

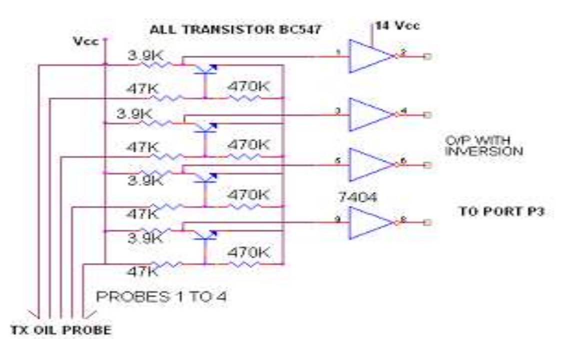


Fig. 6 Circuit diagram of Oil level measurement

h. GSM Module:- The GSM module may be connected to CPU using serial interface max232. It helps to transmit and receive the SMS with UART .

i. Relay Driver Breaker and alert system:-
In our project we are controlling the phase voltages to output side only when the voltage and current are in within limit. A relay connected in line acts as a switch. The Phase supply is connected to NC terminal of the relay. When relay is OFF then the supply is ON. And when relay is ON then phase supply is disconnected from it.
j. LCD display:- LCD display is used to display the status of phase whether phase available or not. i.e. phase is present or absent.
For our project we require 16 X 2 LCD display.

- Software Tools :-

i. MP lab/ccs8 – Microcontroller programming Compiler

ii. PROTEL - For PCB

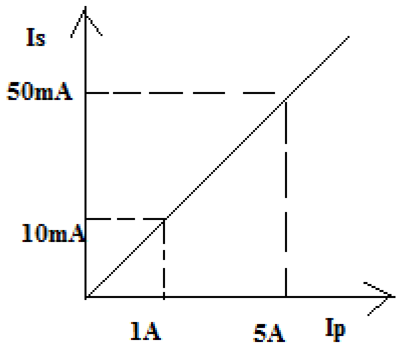
iii. pkit2:- microcontroller programmer

III. PROPOSED RESULTS

In order to verify the performance of the proposed microcontroller based transformer protection system, a hardware prototype was implemented with a PIC 18F4520 Microcontroller with a 12MHz crystal oscillator. During this test, an autotransformer was used for varying the input voltage of the transformer in order to create the over voltage fault. Bulbs were used as loads to build the over current fault. Voltage and current sensing circuits were intended for sensing the transformer voltage and current. The validity of this project prototype is verified through this test system.

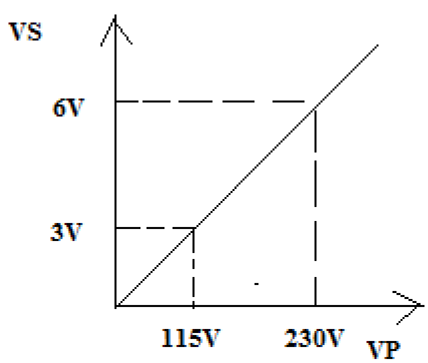
a. Transformer current analysis: -
When no overcurrent sensed by the microcontroller through the current sensor, the microcontroller energizes the overcurrent relay on. If loads are added to the subordinate side of the transformer, the subordinate current rises. Therefore, the load is proportional to the subordinate current. If the load connected does not exceed the rated Current of the transformer which 1.2 A, the relay remains to be on. But once the Load current exceeds the transformer rated current, the microcontroller sends a trip signal

to the overcurrent relay and it goes off., thus defending the transformer from burning due to overloading. When the overcurrent is rectified, the relay goes on and remains to allow the flow of electric current through the load.



Graph 1. Primary current Vs Secondary current

b. Transformer voltage analysis:-When no overvoltage detected by the microcontroller through the Voltage sensing circuit, the microcontroller energize the overvoltage relay on which permits the flow of electric current and voltage through the transformer main. When the Input AC voltage is varied through the autotransformer above the rated voltage of the Transformer which is 230V AC, the microcontroller detects an overvoltage condition Through the voltage sensing circuit, therefore it sends a trip signal the overvoltage relay, and the relay cuts off the main of the transformer from the input AC voltage thereby redeemable the transformer from harm due overvoltage. As soon as the microcontroller detects normal voltage, it sends back a switch on signal to relay thereby permitting the flow of electric current and voltage through the transformer primary

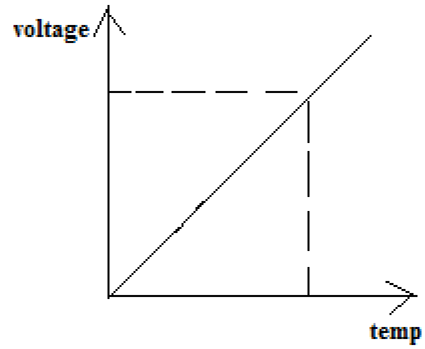


Graph 2.Primpary Voltage Vs secondary voltage

c. Oil quality and level:-Oil quality is directly proportional to oil level, as oil level decrease oil quality also decreases. The oil level probe which are immersed in transformer at unique level. oil is pure conductor of electricity whenever the probe is in contact with oil transistor will goes into conduction and generates a logic of zero at its collector. The different eight probes are inserted at four levels to differentiate the water level.

d.Temperature: -Output voltage is directly proportion to temperature i.e. as output voltage increase the temperature of transformer is increase.

$V_{out} \alpha$ temperature.



Graph 3. Temp. Vs Voltage

d. Phase shift measurement: - We can measure power factor (reactive power and active power) by phase shift measurement. We know that resistive load has zero phase shift, therefore it has unity power factor. We get some phase shift (Φ) for inductive load by using zero cross detector (V_{zcd} and I_{zcd}). To calculate active power and reactive power by,

Active power = V.I.COSΦ

Reactive power = V.I.SINΦ

Total power = Active power + Reactive power

IV. CONCLUSION

In this project, the transformer protection using a microcontroller is recommended. For transformer voltage and current sensing, a current sensing circuit and voltage sensing circuits were designed and the results have been tested with proteus simulation. Hardware with a PIC microcontroller wasimplemented to verify the proposed technique and the performance of the real time hardware was equated with the proteus computer simulation. Through the transformer current analysis , we can see that the current of the transformer rises as load increases, whenever the load current goes beyond the transformer rated current, the microcontroller senses an overcurrent and it Sends a trip signal to over current relay thus protecting the transformer from burning. As the load current goes lower the rated current of the transformer, the microcontroller senses normal there by sending an on signal to the overcurrent relay. Moreover, through the transformer voltage examination, we can see that the voltage of the transformer increases as the input voltage of the transformer is increased through varying an autotransformer. Whenever the input voltage goes above the transformer rated voltage (230 V AC), the microcontroller senses an overvoltage and it sends a trip signal to over voltage relay thereby defending the transformer from burning. The results designate that the microcontroller based transformer protection accomplishes.

Numerous advantages over the existing systems in use: 1) fast response, 2) better isolation, 3) accurate detection of the fault.

To conclude that practical results matched with the simulation perfectly, therefore the aim and objectives of the project were all accomplishedeffectively and project is said to be industrious and fully automatic with no manual interface required.

Oil quality is directly proportional to oil level, as oil level decrease oil quality also decrease. Output voltage is directly proportion to temperature. We can measure power factor (reactive power and active power) by phase shift measurement.

V. FUTURE SCOPES:-

Any work and research on transformer protection is very beneficial and thought-provoking. Based on the present time, it can be observed that the world's population is increasing rapidly. Therefore demands of electricity will be high and these will lead to demands of greatly refined protection devices, which will be incorporated in transformer protection systems. Based on the effort done in this project which protecting transformer using microcontroller, some developments need to be made in the upcoming work. It was noticed that use of current sensor inhibit the protection from high performance application because the current sensor requirements some amount of time to sense the load current and transfer the signal to the microcontroller ADC. Correspondingly, a current transformer can be used as an alternative of current sensor, switching semiconductor device such as thyristor can be used as an alternative of relay, very advanced microcontroller such as 16bit PIC microcontroller or a digital signal processor can be used for high speed analogue to digital (ADC) conversion of the transformer voltage and current.

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