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Transformer Protection Using Microcontroller Based Relay & Monitoring Using GSM Technology

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ABSTRACT

Transformers are very important device for transfer electrical energy. To protect transformer against different types of faults, various methods are used like differential protection, microprocessor based relay etc. In this paper, overload and overheating protection is established for protection of transformer. Microcontroller based relay is used for protection of transformer. Simulation circuit is designed in proteus software and programming is done in keil software. In this research, hardware and software of microcontroller based relay has been explained and designed.

***Keywords*—** Microcontroller, relay, overload, overheat, simulation.

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I. INTRODUCTION

The transformer is very expensive and vital equipment in the electric power system. Hence protection of transformer is very important. Transformers are used in many applications ie. From small distribution transformers serving one or more users to very large units [1].

The population is increased day by day, therefore there is increase in demands on electrical power. With increase in demand of power increases load hence system become overloaded. Overload affects the efficiency and protection system. Also tripping of the distribution transformer is due to thermal overload. To prevent the damaging of the transformer, it involves the control against overcurrent tripping of transformer. Differential protection and microprocessor based protection is used for to protect the transformer. Now a days, microcontroller based relay protection is used[4].

The protective relay gives accurate reproduction of normal and abnormal conditions for correct sensing and operation. For this information input is given by current transformer and potential transformer in power system. [1] Most of the transformer uses harmonics for the operating current to distinguish between internal faults due to over excitation [3].From past several years, solid state relays were used for protecting power system. After few years, microprocessor based relays are introduced. Due to advancement in digital technology, low cost of digital hardware circuit also reliable Operation and simple in construction digital relay was used for protection of transformer in electric power system.

Also numerical relays are used for signal processing function and it improves the performance of relay, faster response, more secure and protection dependent for protection of transformer [1].

Therefore a proposed method is chosen to design microcontroller based transformer for overload and overheating protection. The microcontroller based relay provides more adjustable characteristics, high accuracy, more flexibility, increased range of setting, reduced size, minimum cost with many functions such as self-monitoring by GSM technology and checking.

II. PROBLEM FORMULATION

Modern power system require accurate, reliable technique for detection of faults. Also, it requires real time data monitoring. System requires fast response speed. Microprocessor relay does not have fast response speed as compared to microcontroller based relay.

Microcontroller relay has real time data monitoring, detection of abnormal condition, fast processing speed. Microcontroller relay act as multi function relay. It has reduced installation cost and maintenance cost, more flexibility. Due to new development in microcontroller relay offers added benefit by improving relay function.

Due to all above reasons over microprocessor relay, microcontroller based relay is need of hour. Microcontroller relay is a recent development for all types of faults. So microcontroller based relay is used for protection of transformer.

PROPOSED METHOD

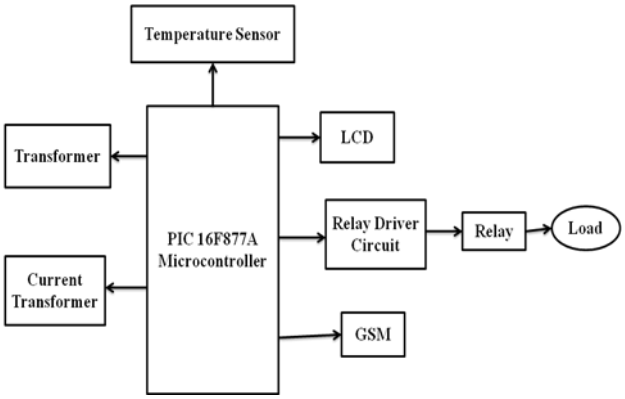

Fig. Block Diagram

III. WORKING PRINCIPLES OF BLOCKS

1) Transformer :

Step down transformer is the device for which we design the protection circuit. The step down transformer having ratings of 230/12 V. Transformer is the essential device which used in electrical power system hence protection of transformer is necessary.

2) Load :

The load given to the transformer may be industrial or residential type load, which is connected to the transformer. Load can be varied with time. In this, industrial load is used ie RL load is used.

3) Current Transformer :

Current transformer is the electrical device which produce an alternating current in the secondary which is proportional to AC in the primary. Here, step down CT is used for the protection purpose. The rating of the CT is 20 A to 20mA.

4) PIC 16F877A Microcontroller :

PIC 16F877A is the brain of this protection circuit. The main advantage of this is, it has inbuilt ADC, which converts analog value to digital value(sampled value). This sampled values compared with preset values and decision is taken according to programming, hence microcontroller is decision making device.

It is simple and compact circuit, and gives fast response as compared to processor. Power consumption is less for PIC 16F877A microcontroller. It can be used anywhere, such as commercial or industrial because it has wide range of temperature. It also provides programmable code protection.

5) Relay Driver Circuit :

In this circuit, NPN transistor is used for controlling operation of relay. Microcontroller sends trip signal to

this circuit, NPN transistor operate in switching region and transformer disconnect from the main supply automatically.

6) Relay :

It is an electrically operated switch. In past several years solid state relays are used for protection purpose, but due to advancement in technology microcontroller based relays are used for protecting the devices.

All relay contains sensing unit, electric coil powered by AC or DC current. When current and voltage exceed their limits, coil actuates which operate either to close open contacts or to open close contacts. Electromechanical relays are electrically operated switch used to isolate circuit and detect fault in the transformer.

It gives high reliability, relative simplicity, safe disconnection from the main supply. It has longer life.

7) Temperature Sensor :

For this protection circuit we used LM35 temperature sensor. It is precision IC temperature sensor. In this output of sensor is directly proportional to the temperature. This is more accurate than thermistor. Also it possess low self heating.

8) LCD Display :

It is used to display condition of overload and overheat as per changes in load and it will be displayed on LCD display. So, we can see normal

and abnormal conditions on display. As per this we can take necessary action.

9) GSM :

Global system for mobile communication is used for digital cellular communication. Its frequency range is 900 MHz to 1990 MHz. PIC microcontroller sends actual load value to authority via SMS by using GSM.

IV. COMPONENTS USED

a) Step Down Transformer: (230/12V)

b) Power Supply Circuit-
1. Bridge Rectifier
2. Capacitor (1000µF, 25V)
3. Regulator (7812 & 7912), +12 & -12
4. Capacitor (470µF, 16V)

c) Current Sensing Circuit-
1. Variable Resistor (10K)
2. Capacitor (100µF,63V)
3. Diode (1N4148), 25V
4. Resistor (10K)
5. LM324 (3V-32V, 100nA, 150ºC Junction Temperature)

d) Current Transformer (230V AC, 2A to 20mA)

e) Relay (7A, 12V)
1. Diode (1N4007), 1A,50-1000V
2. Transistor (BC547), (Vce=45V, Vcb=50V, Vbe=0.7V, Ic= 100mA)
3. Resistor (330Ω)

f) GSM Module (SIM900A)

g) Microcontroller Kit
1. DC Jack
2. Bridge Rectifier
3. Regulator (7805)
4. Capacitor (1000µF, 35V)
5. Resistor (330Ω, 10K)
6. Crystal Oscillator (20MHz)
7. Capacitor (22µF, 5V)
8. Reset Switch
9. Controller 16F877A (5V, 40 Pin IC)
10. LCD (16x2)

V. WORKING OF SIMULATION CIRCUIT

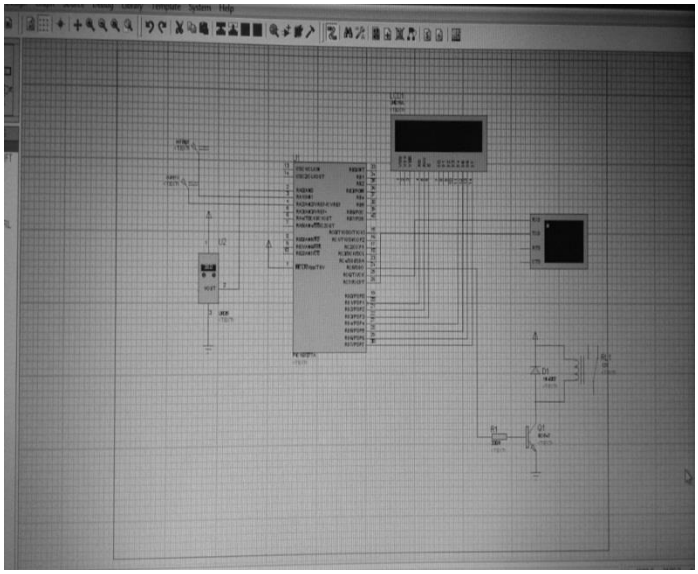

Fig. Normal working of simulation circuit

This circuit is designed to monitor overloading and overheating. The supply voltage is step down by using step down transformer(230/12V).

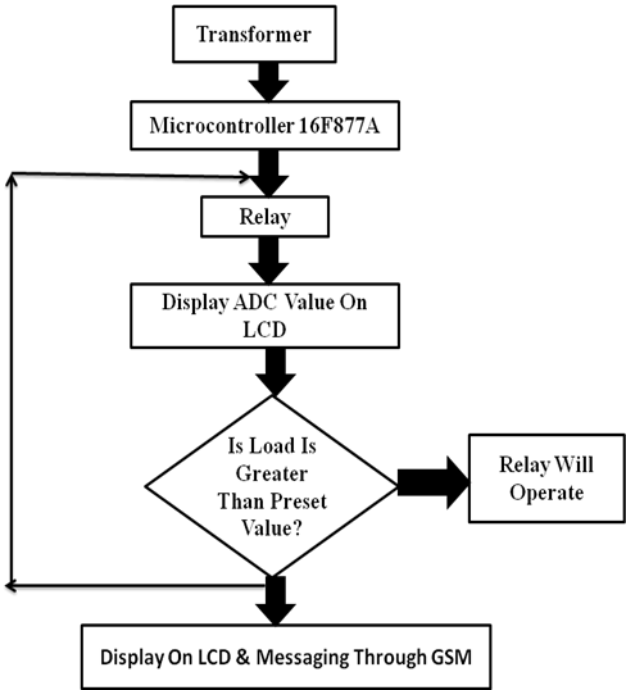

Fig.(a) Flowchart of the circuit for load

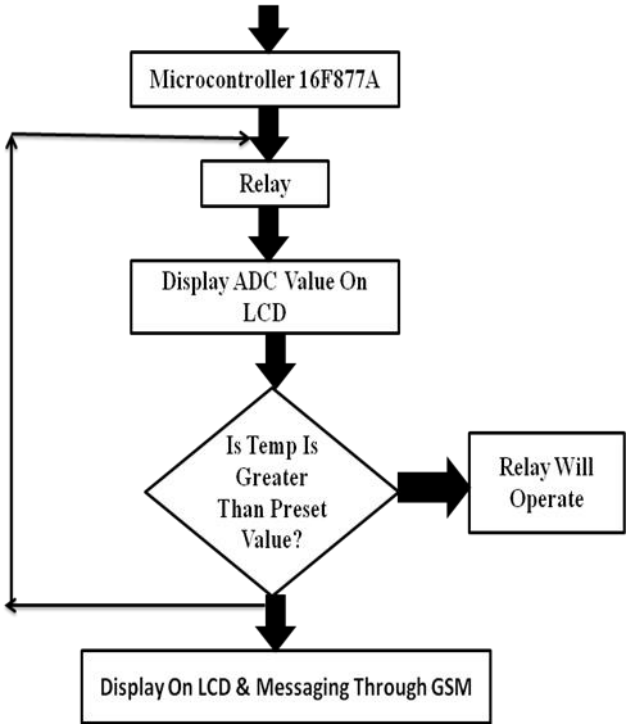

Fig.(b) Flowchart of circuit for temperature.

- Bridge rectifier which rectifies the step down voltage.
- Capacitor is used as filter, harmonic distortion, charging/ discharging purpose and diodes are used for reverse protection.
- Here, Reference value of temperature and load is set.
- Preset value of load is 90 Watt and preset value of temperature is 40ºC.
- If load exceeds greater than 90 Watt then microcontroller send trip signal to transistor and relay will trip within microseconds.
- As relay will trip, transformer will be disconnected from supply. At the same time using GSM technology, GSM module will send "Transformer Overloading" this SMS will send to the prescribed mobile numbers.
- Similarly, if temperature exceeds limit greater than 40ºC then microcontroller send trip signal to transistor and the relay will trip in few microseconds.
- As relay will trip, transformer will be disconnected from the supply. At the same time, GSM module send the "Transformer Overheating" this SMS will send to prescribed mobile numbers.

VI. OBSERVATIONS

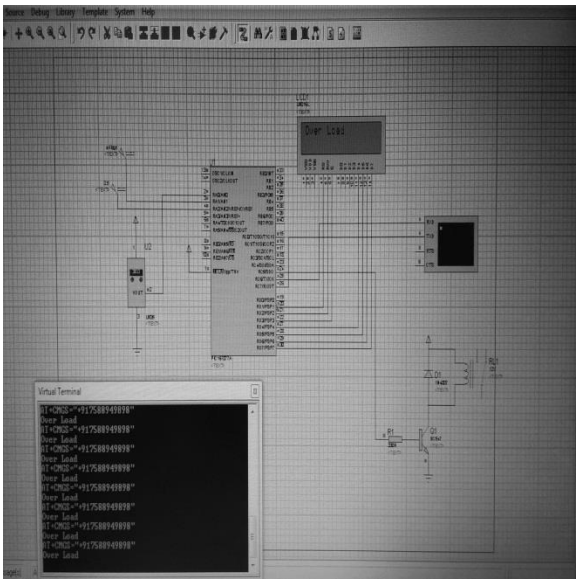

Fig.Circuit diagram during Overload

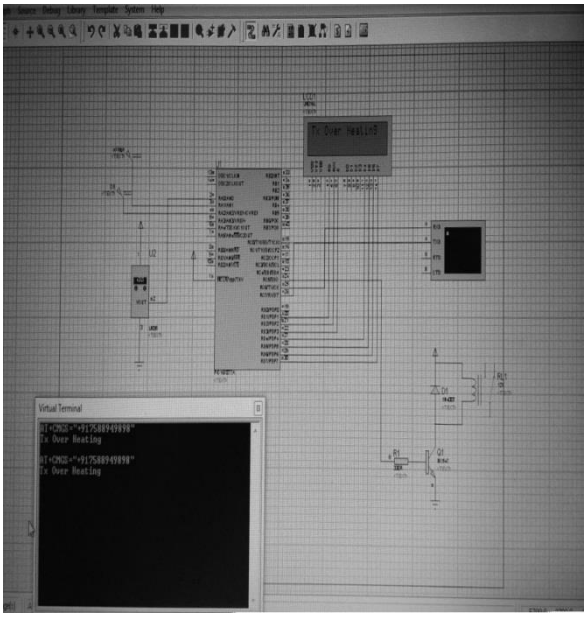

Fig. Circuit diagram during Overheating

- As load and temperature increases above preset value, relay operates within seconds.
- So, transformer is disconnected automatically from supply.
- Voltage decreases to zero immediately.
- Hence, transformer isolates from system and it will avoid the damaging due to overloading and overheating issues. Hence transformer is protected from faults.

VII. CONCLUSION

This system provides transformer protection using microcontroller based relay. For transformer voltage and current sensing, current sensing circuit were designed and result have been verified with proteus simulation. Hardware

with microcontroller is implement to verify proposed technique compared with proteus computer simulation. This system provides better and safer protection than any other method. Proposed method is economical and compact in size. It gives better isolation, accurate fault detection and fast response. Hence protection of transformer is done by using microcontroller relay.

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