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Zig-Bee System for the Transformer Condition Monitoring & Protection

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Abstract: *Condition monitoring and protection of transformer using ZigBee technology in Distributed transformer. In this protection concerns by distributed transformer networks remote monitoring system (DTRMS) is utilized for protecting of multiple transformer from a high remote control center. In this paper we have monitor and control four parameters of transformer namely Oil level limits, Voltage limits, Temperature rise and Load variation. ZigBee technology is for two way communication between the remote center and transformer. The transformer protection against internal faults such that insulation breakdown and Insulation breakdown and assuring security of the protection strategy for external faults is the important motive of the work. Transformer conditions that indirectly impact transformers often receive less emphasis when transformer protection is specified. The spotting of the fault in the transformer, and the informing to the control room attentiveness fault can be possible with this kind of work.*

Key Words: *Wireless ZigBee Technology, Switchable distribution transformer, DTRMS, Embedded Ethernet, Transformer condition monitoring.*

I. Introduction

Single Phase and Three Phase transformers are very popular in industries because of their vast applications. Hence it becomes necessary to protect them against faults so as to ensure uninterrupted operation and functioning. Various controlling and monitoring systems are there for other types of machine, but in case of transformer the controlling and monitoring systems are not extensively used due to high cost of installation and physical constraints. So as to overcome the limitations in monitoring and controlling, the ZigBee Based System is used which makes it cost effective and simple on the other hand. ZigBee is a wireless communication device like Bluetooth and Wireless Local Area Network (WLAN). The disadvantage of using traditional systems is that it increases the cost whereas digital systems reduce the cost of system. The basic structure of ZigBee based parameter monitoring and controlling system consists of microcontroller board and ZigBee device, one set of microcontroller board and ZigBee device are near to the transformer and acts as transmitter for the other microcontroller and ZigBee device which is near the computer where the parameters are displayed on computer using software application. In addition to ZigBee Device various other sensors are used for measuring different parameters. [1][2]

II. General Description Of The DTRMS System

The DTRMS is divided into two sections:
1. Coordinator
2. End device

The end device contains different types of sensors. The sensors are used to sense the different parameters and send it to microcontroller. Microcontroller transmits through ZigBee transmitter. The Coordinator receives this data and displays it on the LCD. This whole process is real time monitoring parameters of the transformer. It is installed at the distribution transformer site and the parameters are recorded using the built-in 8-channel analog to digital converter (ADC) of the microcontroller. Sensors are used to sense the different parameters and send it to microcontroller. The acquired parameters are processed and recorded in the system memory and transmitted to coordinator unit. On the other hand, the coordinator receives this data and displays it on the LCD. DTRMS system has outstanding three advantages: (1) it can allow for a change from periodic-to condition based maintenance. (2) ad-hoc communication network (3) by monitoring the important functions of the transformer, developing faults can be detected before they lead to a catastrophic failure. The main benefits for WDTMS technology is low installed cost, less time for installation, safe operation and more reliable service. AVR Microcontroller, Temperature sensor (RTDs), Liquid level sensor, Voltage regulators, Operational amplifier, LCD Display and ZigBee are the main component of DTRMS. The block diagram for ZigBee sensor network is shown in fig.1

(a) End Device:

End device is considered to be a transmitter. The main components of End device are a programmable microcontroller, non-volatile memory (RAM), voltage regulators, Op-Amp, Temperature sensor (RTDs), Liquid level sensor, and LCD. End device consists of power supply which provides 5V DC to sensors and MCU. The power supply also produces 3.3V DC for ZigBee module & +15V, -15V DC for Operational amplifier circuit. The condition of the oil level recorded through sensor is send to ZigBee module for transmission using ZigBee protocol at 2.4 GHz. Temperature sensor attached to the In-Built ADC of the ZigBee gives the data in digital frame for the direct transmission. The microcontroller decides the condition of transformer according to the predefined threshold value. The Basic block diagram of the end device is shown in figure 2.

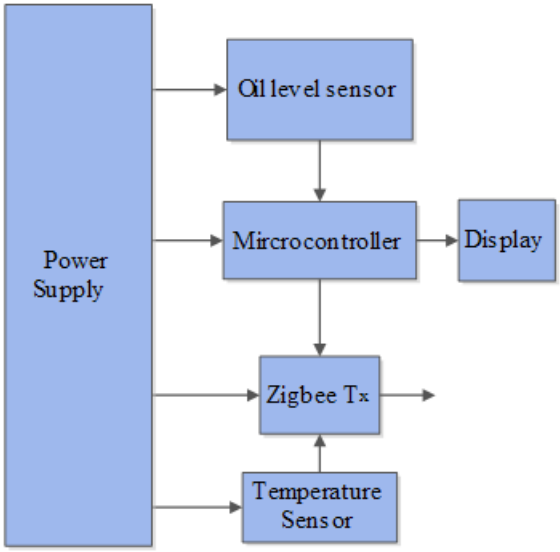

Fig 1. Block diagram of the end device

(b) Coordinator:

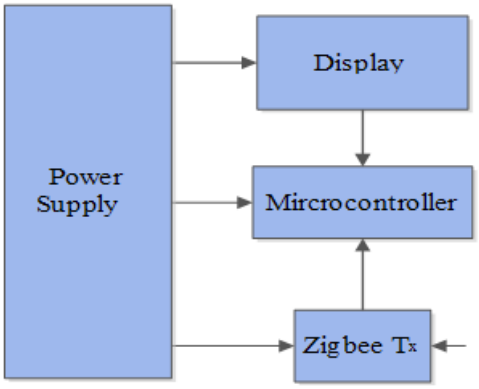

Fig.2. Block diagram of the coordinator unit

The coordinator also consists of power supply which produces 5V for MCU and LCD and 3.3V for ZigBee module.The ZigBee module receives digital data from end device and transfers it to microcontroller serially. Then microcontroller displays the condition of oil and temperature of transformer. Figure 3 shows the basic block diagram of coordinator unit. [4]

III. Circuit Operation

Oil level detector is used for measuring the conservator oil level of the transformer. Temperature sensor (RTD) is used for measurement of the temperature of the oil in the transformer. Full-bridge circuit is used to convert temperature sensor reading to a compatible signals that can be read by the microcontroller built-in ADCs (0-5 volts DC). A set of resistors are used to adjust the gain and the offset of Op-Amp. A set of rectifier circuits and center taped transformer is used to convert and scale the current and voltage values to compatible levels with the Op-Amps circuits. The microcontroller has 8 channels, 10-bit analog-to-digital converter. ADC

is used to read the parameters of sensors. A display unit, which may be an LCD display that receives display signals from the microcontroller and displays the parameters of transformer. Parameters are also transmitted to coordinator unit through ZigBee module. On the other hand coordinator unit has also a ZigBee module for receiving data from transmitted unit. After receiving transmitted data by end device, coordinator unit displays it through microcontroller. The Schematic of hardware is shown in figure 3.

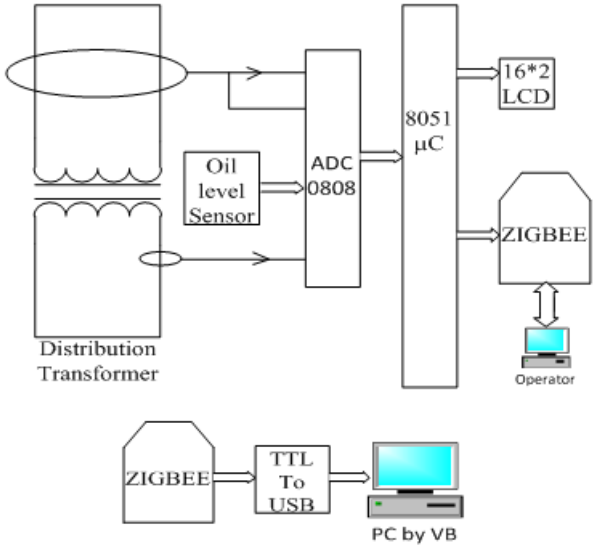

Fig. 3. The hardware structure for the ZIGBEE based transformer protection

IV. Performance Analysis

Based on the above system the result are obtained which shows that we can sense the voltage, current, temperature, and oil level of the transformer , and accordingly we can take the preventive care for the transformer such as incase of excessive heating of the transformer shifting of operation from the current transformer to the another transformer and such.

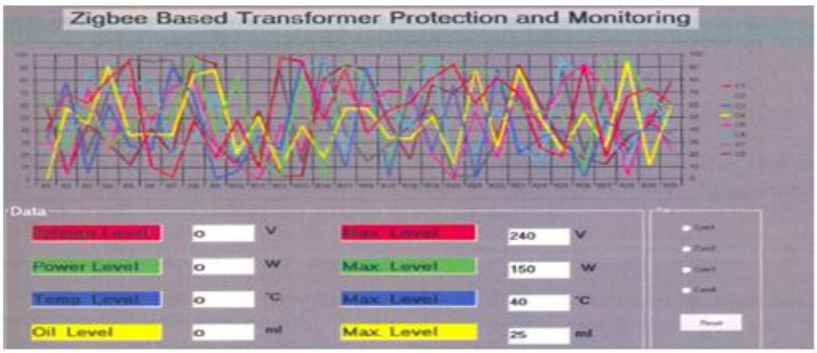

Fig.4. ZIGBEE based transformer protection and monitoring
System Results

V. Conclusion

With ZigBee technology it is possible to monitor a large number of parameters of distributed transformer. WDTMS is able to record and send abnormal parameters of a transformer to concerned office. It works on ZigBee technology that supports multiple network topologies such as point-to-point, point-to-multipoint and mesh networks. It has low duty cycle – provides long battery life. The issue with the functions of the monitoring system and cost has been relatively much more reduced with the ZigBee Technology as compared to the conventional technologies used in today's date.

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