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Design Wireless Sensor Network System to Power Management and Protect Electrical Pole Transformers by using Zigbee Model and Microcontroller

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Abstract: This paper discuss design and implementation wireless sensor network system is used for tow purposes , power management system and protection system. The power management system (PMS) is very important factor to manage and control the electrical power, This system consider important tools to safe the power consumption then due to this system can reduce the power consumption to minimum point, and also its charge of coordinate between power consumption capacity and power production capacity to avoid switch off the street lighting and emergency places such as hospitals. And automatic switch on and switch off the consumers diesel generators, by using successful management power can get to stable and efficient distribution power system. And in this paper discuss how can provide protection to remote terminal units (pole power transformers) and safe the money. The powerful devices that use in this system is ZigBee and microcontroller.

Keywords*:* WSN , Zigbee , Microcontroller , CT , VT , PMS.

I. INTRODUCTION

The monitoring system of power transformers has many goals, Important of them are Power management system Rationalize consumption the electrical power because know increasing the electrical load in particular region more than the transformers capacity can give order to decrease the load to rating value and saving the power in addition to that this system consider as protection for the transformers to avoid the damage of the transformers . The protection includes three objects over load , high core temperature and unbalance load. The monitoring of transformers status that located in the cities and villages can avoid damage due to high temperature of the transformer core , Temperature increasing to high level because over load or decreasing the oil level in the tank that using for cooling the transformers frame , the transformer may be firing and its expose to damage .

To alleviate the problems, in this paper we present a communication infrastructure to provide low cost, reliable data delivery. reduce the proportion of losses in electrical transformers to 99.9% when use a good control and follow-up system. There are many distributed electrical transformers in the city streets so the manual monitoring system to be very difficult and it is not accurate because it is mainly based on human observation that there are often mistakes which are called human errors and not able to predict to the transformers status.

But When use electronic wireless monitoring system can know the status for all electrical transformers that distributed in the alleys and streets of cities with minimal effort and cost, The proposed system is characterized with high accuracy, and also can archive all the data for each electrical transformers by using data base server. when occur some problem to any transformer can know that directly by given alarm signal in the personal computer that located in base station or central office and can given order to operator persons to do repair and remove the problem before the electrical transformer damage. In general the power grids consist of the main three parts generation, transmission and distribution of electric power. Figure-1 shows an example of the configuration of a power grid. The electrical distribution system delivers electric power through feeders and pole transformers from distribution substations to end users such as houses, office buildings, and factories.

Generally the power system network is divided into Transmission and distribution networks. The transmission network involves the stepping up of the generated voltage in the generating station and transmit power to the substations through high voltage over head transmission lines. On the other hand the distribution network involves the step-down of voltages into different levels and distributed to different consumers through low

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voltage power lines. The transmission and distribution lines are the back bones of power system network. Therefore monitoring and protection of lines is very important.

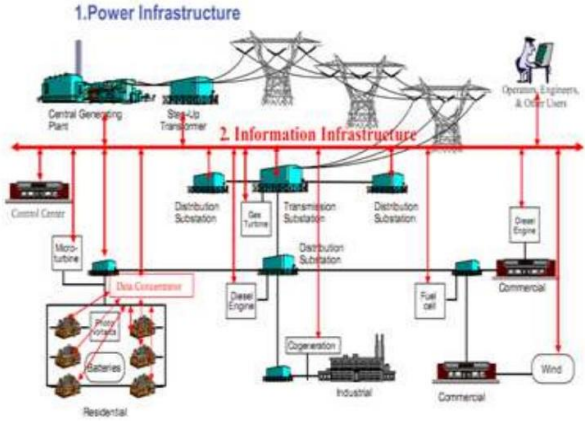

Fig.1. Configuration of a power grid

II. THE PRPOSED SYSTEM

The proposed system include design a reliable wireless sensor network WSN for a power quality monitoring system to provide high data delivery quality with the least cost of communication system installation and maintenance. This system take the information from pole transformers and send them to the base station. The speed of data that transmitted from the pole transformers to the base station 10 times per second that mean the update of information can occur ten times every one second. The information include the phase load, total load for three phase and core temperature for each pole transformer. The more efficient tools that use for this purpose is Zigbee as shown in Figure-2. ZigBee is an IEEE 802.15.4-based specification for a suite of high-level communication protocols used to create personal area networks. The technology defined by the ZigBee specification is intended line-of-sight, depending on power output and environmental characteristics. [1] ZigBee devices can transmit data over long distances by passing data through a mesh network of intermediate devices to reach more distant ones. ZigBee is typically used in low data rate applications that require long battery life and secure networking (ZigBee networks are secured by 128 bit symmetric encryption keys.) ZigBee has a defined rate of 250 kbit/s, best suited for intermittent data transmissions from a sensor or input device. to be simpler and less expensive than other wireless personal area networks (WPANs), such as Bluetooth or Wi-Fi. Applications include wireless light switches, electrical meters with in-home-displays, traffic management systems.

The features of this device are:

- Range-Outdoor line of sight: up to 50 kms with directional antenna.
- Transmit Power: up to 1 watt / 30 dBm nominal.
- Receiver Sensitivity: up to –107 dBm.
- AT Command Modes for configuring Module Parameters
- Direct sequence spread spectrum technology.
- Analog to digital conversion and digital I/O line support.

Fig.2. Zigbee Tools That Use For This Purpose

The microcontroller that will use in the proposed system is PIC16F877A , Then connect the all pole transformers that distributed in the city as wireless network and collocated all the information in one place that called base station to monitor and archiving the information for each transformer . This system is powerful tools for power management system PMS. Its task is to make sure that the electrical system is safe and efficient.

If the power consumption is larger than the power production capacity, load shedding is used to avoid blackout. power management systems to improve the reliability of the electrical distribution system while also increasing the financial and operational efficiency of enterprise then ensure that the electrical distribution system works seamlessly from utility service entrance to plug .The block diagram for the proposed system as shown in Figure-3

In Figure-4 explain the receive circuit block diagram which consist of from zigbee using as router mode and by using Rs232 protocol can interfacing with personal computer and monitoring the status of the remote terminal unite with program design by Microsoft visual basic which consider powerful tools as a software protection and monitoring of the network plays a major role. When any fault occurs in complex network, the information is communicated through information infrastructure.

Fault sensing protective relays at each end of the line must communicate to monitor the flow of power into and out of the protected line section so that faulted equipment can be quickly de-energized and the balance of the system is restored The transmitter sensors are represented by three stages first stage current transformer CT and voltage transformer VT, The connection of CT and VT as shown in Figure-3.Then can compute the power for each phase by using electronic circuit buffer to convert the quantity of the current and voltage to signals that matching with microcontroller circuit . the Zigbee device used as wireless sensor network to transmit the data to base station.

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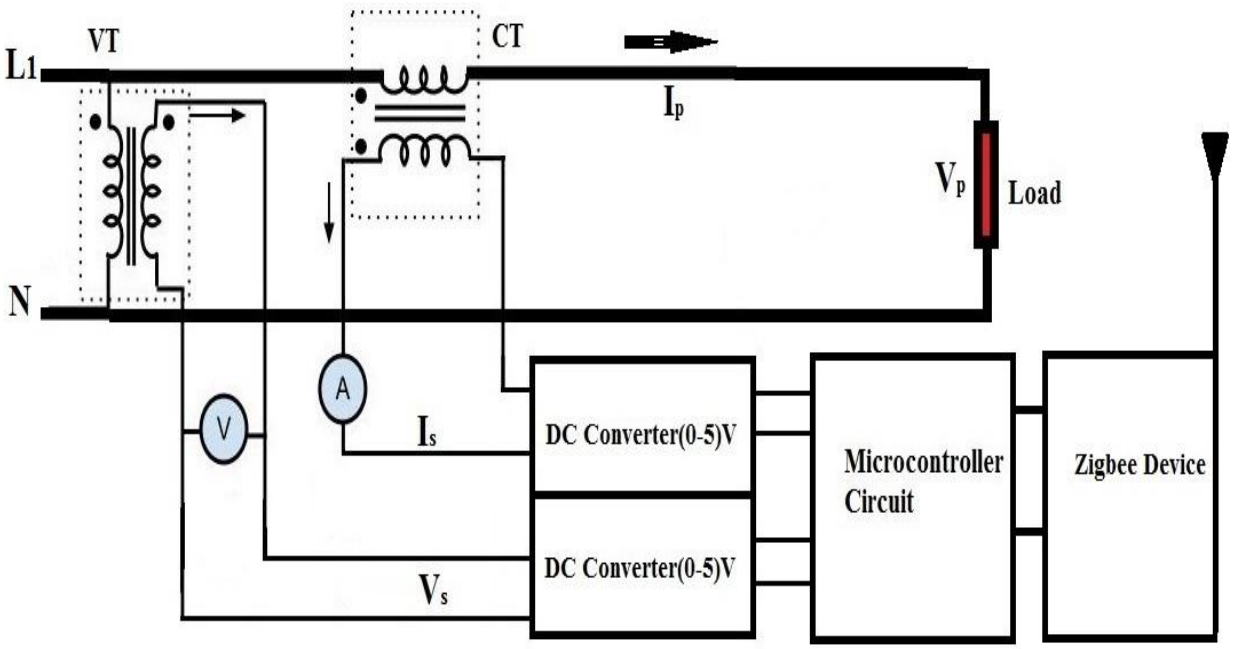

Fig.3. The Block Diagram For The Proposed System Explain Remote Terminal Unit (Installation At Pole Transformer)

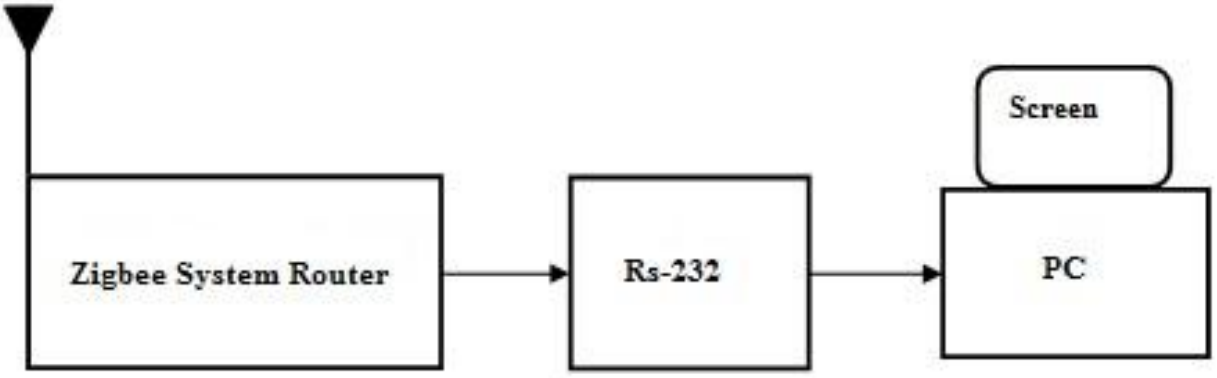

Fig.4. The Block Diagram for Receiver Circuit (Installation At base station)

III. RESULTS

The receiver circuit consist of gate way to collected all the transformers data from wireless network sensors and by using Rs232 protocol interfacing with personal computer to display all the information and monitoring them by operator persons . the software program is designed by Microsoft visual basic version 6 , This program display the information for each transformer , information includes the power in KVA for each phase , total load of each. The ID of transformers is formatted with special way to include identification data , serial number, technical specifications , and located address of the transformer . this information can be formatted and enter them to computer through the program for each transformer and save it in data base server by double click on the text that allocated to that purpose then appear box and write the ID for particular transformer then press ok command to save it in data base , this procedure can do it for all transformers ID that located in the area of wireless network design. This circuit can calculate the load for each phase in KVA unit, total load and core temperature in Celsius unit of the transformer, These information are received directly from the transformer location by wireless sensor network technique and updated ten times per second . available setting for each quantity temperature, overload and unbalance . when set value for each one these consider the threshold levels to give the alarm signals , when the actual reading greater or equal than the set value then the alarm signal flashing will appear with different colors depending on difference value rate between setting value and actual value. The proposed system help operators by observing the appearance of alert signals .The setting signals includes three items temperature setting , overload setting and unbalance setting , by press the two blue button can increase or decrease the setting value .The alarm signals block illustrates three alarm signals for each transformer, the unbalance signal is load difference between each two phase load for three phases of one transformer for ideal operation there are no difference between phases load of transformer that mean the difference equal to zero ,If

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there are high difference the transformer is in bad operation then the system gives alarm signal, the alarm signals colors are change depending on difference value rate between setting value and actual value as shown in the table-1.If the difference is low the alarm signal color is green and converted to yellow color if the difference value is mid and if the difference value is very high the alarm signal color change to red color to explain the operation in dangerous level , The operator person can monitor these signals easily if one is appear then can do the repair for particular transformer the alarm signals will disappear and cancel, but when the problem repeated again the alarm signal will appear and cancel when remove problem.

TABLE I: EXPLAIN THE ALARM SIGNALS COLORS

No	Difference value	Alarm signal colors
1	LOW	GREEN
2	MID	YELLOW
3	HIGH	RED

The software for the system is explain in Figure-5 including all the transformers information , and can add more transformers if the system is extension in the system explain 200 transformers in the network T1,T2,…..,T200 color for each one refer to more dangerous alarm signal that appear in transformer, if the transformer status is normal the color change to gray as the color for background of the program. important feature for the proposed system is archiving all the information in data base server and can searching by date and time which the information that occurred and display the old information that occurred in previous date.

There are many existing protective schemes and technologies are available to identify and transfer information regarding disturbances occurred in power network. These techniques have been quite successful but are not adequate for the present time varying network configurations. This can be achieved by providing fast and effective communication system.

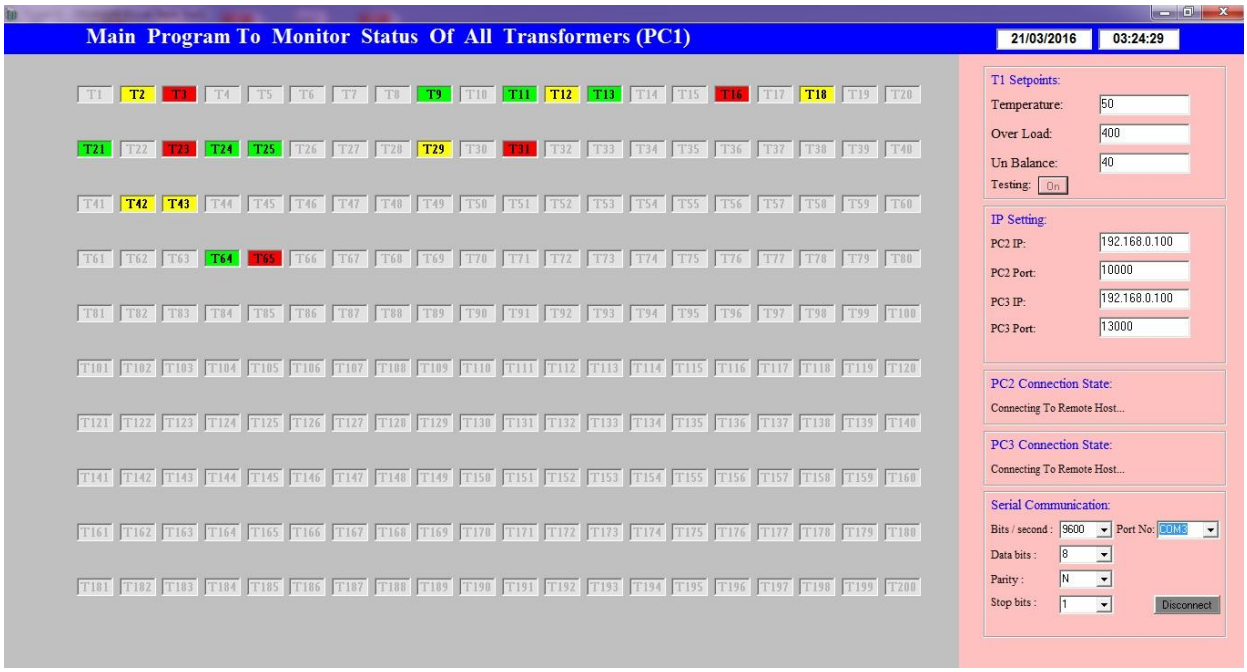

Fig.5. The software for personal computer which have 200 transformers T1,T2,.....T200

IV. CONCLUSION

This paper is proposed system to design and implementation the wireless sensor network which consist of 200 remote terminal unit pole transformers . the proposed system can send ten message per one second . This system use to monitor the power quality of the pole transformers and monitor each transformer details phases load and core temperature . It consider powerful tools useful in power management system due to collect all the load of pole transformers in one system through which can know low and high load consumption region . this system consider as a protection for the pole transformers from high temperatures and over load.

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BIOGRAPHIES

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