# Smart Metering and Health Monitoring Of Distribution Transformers Using RF Technology

**Akshaykumar R. Dharappanavar**
Department of Electrical and Electronics Engineering
KLE Dr. M.S.Sheshgiri College Of Engineering And Technology, Belagavi.

**Shivaraj Jolad**
Department of Electrical and Electronics Engineering
KLE Dr. M.S.Sheshgiri College Of Engineering And Technology, Belagavi.

**Swati Machakanur**
Department of Electrical and Electronics Engineering
KLE Dr. M.S.Sheshgiri College Of Engineering And Technology, Belagavi.

**Sarita Beeraldinni**
Department of Electrical and Electronics Engineering
KLE Dr. M.S.Sheshgiri College Of Engineering And Technology, Belagavi.

***Abstract:*** ***The main objective of this paper is to design and develop an intelligent energy metering system and health monitoring of distribution transformers and monitoring it real time on PC using RF wireless technology. The primary circuit range of distribution is 11 to 22KV. The distribution branded as the distribution transformer which is installed near the consumer's sites with the range of 240/415V three-phase four wire. About 75% of the total system losses occur during distribution. More than 90% of system faults are in the distribution area. So if the fault occurs at or near the distribution transformer this will not be known by the substation automatically, nearby consumers has to inform them. Even a small fault may lead to a very big loss. In order to overcome these faults, monitoring of distribution transformers is very essential. In this project various parameters like current, voltage, temperature, power etc., of the distribution transformer are monitored and the data is sent to the sub-station. Also, this provides hardware kit of Intelligent Energy Meter (IEM) for superior metering and billing system also controls power theft. The proposed system uses RF based system for the continuous monitoring and recording of energy consumption thus helping in energy auditing. The recorded data is sent continuously for every interval of time using RF and the data are stored in the database in the Electric Board (EB) substation.***

***Keywords — Iintelligent energy meter, Distribution transformer, power theft.***

## I. INTRODUCTION

An electric power system is a network of electrical components deployed to supply, transfer, store, and use electric power. An example of an electric power system is the grid that provides power to an extended area. An electrical grid power system can be broadly divided into the generators that supply the power, the transmission system that carries the power from the generating centers to the load centers, and the distribution system that feeds the power to nearby homes and industries. It is estimated that power transmission losses cost the country between Rs.50,000crore and Rs.1,00,000crore annually.

Power losses can be divided into two: Technical losses and Commercial losses. Technical loss means loss in the transmission and distribution of power. Commercial loss means power theft. Technical losses in India are estimated to be around 30% of all in the power system, acquisition of data and monitoring them is an important issue. According to a new study published by Northeast Group, India is looking to smart grid infrastructure to help tackle an out-of-control electricity theft problem and improve reliability. Theft costs the Indian power sector $16.2bn per year.

The main backbone for any power distribution network is distribution transformer The main function of distribution transformer is to convert high AC voltage to low AC voltage[1]. Life of distribution transformer is dependent on the rated condition. Distribution Transformers have a long service life, if they are operated under rated condition. However their life is significantly reduced if they are overloaded, resulting in unexpected failures and loss of supply to large number of consumers thus effecting system reliability[2].

Consumers of electricity from different sectors need and like reliable power supply. In providing reliable service distribution transformers which are the heart of the distribution system plays a major role. The number of distribution transformers currently in service in India is nearly 4.3million and the number is increasing at an annual rate of approximately10%. Distribution Transformer failure rate in India is in the order of 12to15%, which is a cause of worry to all power distribution utilities. The failure rate of repaired transformers is about twice that of a new transformer, which is mainly due to improper repairs. The failure of the transformers causes inconvenience and financial loss to both the consumers as well as to the distribution power utility.

Now a days where a person visits into a transformer site distribution transformers are monitored manually for maintenance and recording of parameters. Manual monitoring
cannot give information of causes of oil and winding such as overloads and overheating of transformers. All these factors can significantly reduce transformer life. Gathering information from the distribution transformer such as voltage,
current and temperature is very important in order to monitor and sometimes control the entire distribution network efficiently and reliably. It helps the operating engineers with the monitoring of the electric distribution grid which is definitely increase the life time of the transformer and maintain the stability of the grid[3].

The survey says maximum part of total financial loss in power sector of India is due to unpaid bills. The unpaid bills may be from industrial household or agriculture consumer but

the key roll is played by agricultural sector as it recorded highest consumption(18-20% of total national consumption) among all countries in 2015-16.The agriculture sector pulls highest subsidy from the government but still the utility has lowest revenue collection from this sector. While in case of other 2 sector pending amount is less compare to the agricultural sector. So as to take legal action against the unpaid billed consumer utility member has to face many problems at ground zero location[4].

In this paper we have discussed about solutions for the problems above mentioned. Here we are collecting the parameters like voltage, current, power supplied and temperature of transformer and sending those data to the substation in real time using RF technology. We provided solutions to overload, overvoltage, overheating of transformer. And we also discussed about solutions to the power theft and unpaid bills.

A case study has been carried out considering transformers of ratings.10/15 KVA: 2758 25 KVA: 84313 50/63 KVA: 51936 100 KVA : 47473 160/200 KVA: 782 250 KVA and above: 19598 Number of Transformers existing in Bangalore Electricity Supply Company along with the KVA ratings as at the end of March 15 is depicted in below fig.1:

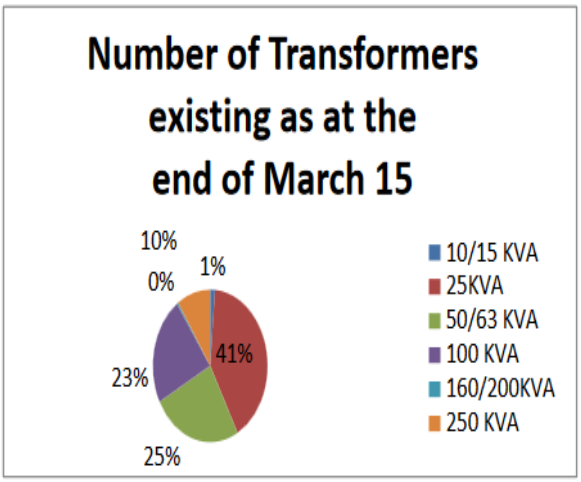



Fig .1

The number of distribution transformers currently in service in India is nearly 4.3 million and the number is increasing at an annual rate of approximately 10%. [1] Distribution

Transformer failure rate in India is in the order of 12 to 15 %, as against 0.8% in USA, 3% in Canada, and 1 % in Australia, which is a cause of worry to all power distribution utilities. The failure rate of repaired transformers is about twice that of a new transformer, which is mainly due to improper maintenance.

## II. PROBLEM DEFINATION

In the existing system unit of distributed energy at distribution transformer is calculated by an employee of electricity board form an electromechanical or a digital meter at that particular place. This reading is taken once in a month. So from this we are unable to know in which area at what particular time how much energy is supplied. And presently the transformer maintenance department will do inspection of transformer once in 3 months. This will lead to poor maintenance of transformer. For monitoring the temperature, voltage and current separate controller is needed. If the fault occur at or near the distribution transformer this will not be known by the substation automatically nearby consumer has to inform them.

Till date there are many papers which have proposed some development in conventional energy meter. But they are unable to avoid power theft and meter will not give any information about power theft. So this is the big problem to the utility company. In present system if consumer is fails to pay his bill in a given time, then a employee of electricity board should go to his or her home to cut the power.

## III. PROPOSED SYSTEM

The proposed system overcomes the above mentioned difficulties by replacing the existing energy meter with a smart meter. The energy distributed at distribution transformer is calculated and smart meter transmits the data to the data base created in the electricity board substation using Radio Frequency(RF) technique and the consumer can view the status of energy consumed in LCD display. If suppose user fails to pay the bill within a given period then power supply will be cut off automatically from electricity board substation using drivers. In this system voltage, current, power factor and temperature of oil in the distribution transformer is also monitored using the same controller and its data is sent to the data base of electricity board substation using Radio Frequency(RF) technique. Also in this paper we discussed about the protection of the transformer under various faults like overvoltage, overloading and overheating.

## IV. BLOACK DIAGRAM

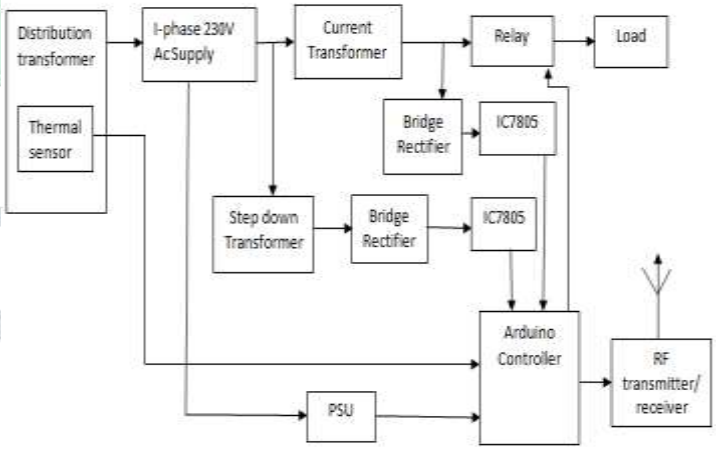



fig.2. block diagram

a) Distribution Transformer:

A transformer is a static device that transfers electrical energy from one circuit to another through inductively coupled conductors the transformer's coils. Distribution transformer or service transformer is a transformer that provides the final voltage transformation in the electric power distribution system by stepping down the voltage and providing it to the customer. Distribution transformers with power ratings from 10 kVA to 2500 kVA intended to be used on 11 kV and 22 kV networks. Distribution Transformers are costly so that they should be maintained properly. Distribution transformer is designed for

maximum efficiency at 60% to 70% load as normally doesn't operate at full load all the time.

b) Arduino(Uno):
Arduino is an open source platform and easy to use. Arduino senses the digital as well as analog signals from many external sensors. It consist of 8bit Atmega328P microcontroller, 14 digital input/output pins from which 6 can be used as PWM output, 6 analog pins with 16MHz crystal frequency. It also consists of 8 bit analog to digital converter with 32 KB flash memory and 1KB EEPROM. Arduino provides facility of boot loader which allows to upload new programmed code to it without the use of external hardware programmer. Arduino UNO has various facilities for communicating with the other interfering modules such as Wi-Fi, Bluetooth, and SIM etc. Arduino board provides UART TTL serial communication for better communication with these interfering devices Arduino integrated development environment (IDE) is based on Basic programming language C/C++.

c) 16x2 Alphanumerical Liquid Crystal Display:
The LCD display pays a vital role in many embedded project. The most commonly used LCD module is 16x2 LCD module. This module consists of 16 rows and 2 columns of 5x7 LCD dot matrix. It is computable with contrast and back light adjustment. This LCD module can easily interface with Liquid crystal library specially designed for the arduino board with simple command and connections files.

d) Relay:
A relay is an electromagnetic operated switch. Relay consist of single or dual coil device. A type of relay which used to handle the high power required to directly control electric motor is known as contactor. For this proposed work static 6V single coil relay is used to cut-off the power supply in several conditions. This relay operates only in one direction whenever the power supply is applied to the relay.

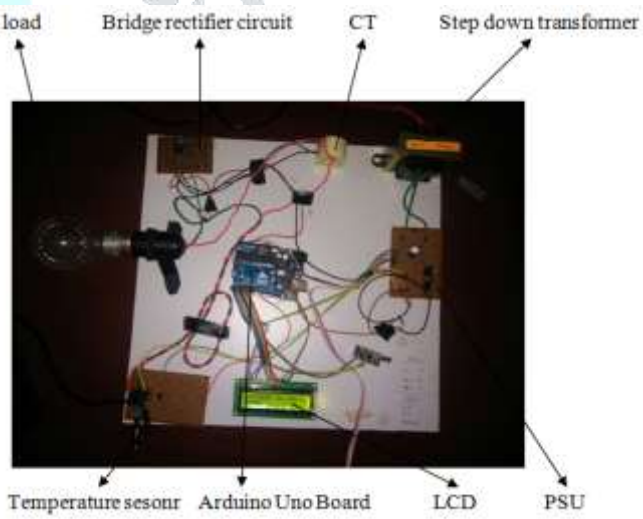
e) Power supply unit:
PSU is an electronic device that supplies electrical power to an electrical load or PSU is component which supplies electrical power to at least one electrical load. In this proposed work electrical load is IEM. The PSU used in this proposed work consist of step down transformer of rating 230/12V and single phase full wave rectifier. The 230V single phase supply from utility will be given to transformer which will convert it into 12V AC supply. The output of transformer is an input to rectifier which will convert it into 12V DC. Finally the output of rectifier will be given to Arduino module and GSM kit via IC7805 and IC7809 respectively.

f) RF module:
An RF module (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver. They are of various types and ranges. Some can transmit up to 500 feet. An RF transmitter module is a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a micro controller which will provide data to the module which can be transmitted. An RF receiver module receives the modulated RF signal, and demodulates it.

## V. METHODOLOGY

When circuit is connected at distribution transformer, Microcontroller will calculate the real power consumed by direct multiplications of signals from current transformer and potential transformer. The parameters like voltage, current and energy consumed (KWH) these all readings are send to the substation in real time along with these parameters temperature of oil of the transformer is also sent.
When Current, Voltage or Temperature values exceed predetermined values the microcontroller will send alert message to the substation and also disconnect the transformer from the load.

When circuit is connected to consumer side the real time energy consumption is displayed on LCD display. When consumer tries to bypass the energy meter the alert message will send to the electricity board along with the meter ID and name of consumer. When consumer unable to pay the bill in given period then from electricity board we can cut power supply to his home by sending signal to the relay.




## VI. RESULTS

**1)** The proposed system model:

Fig.3. model

The fig 3. Shows the proposed paper model which consists of various components used in work.

2) Value of current, voltage, unit supplied and temperature of transformer oil.

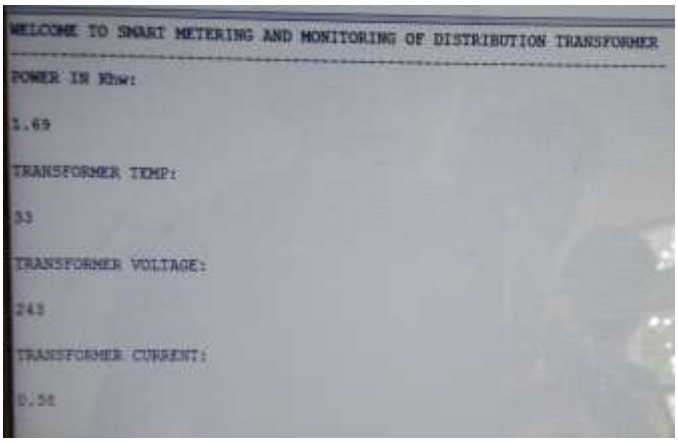



Fig 4.

Fig 4. Shows the real time values of current, voltage, unit supplied and temperature of transformer on PC in substation. The value of each parameter is sending to the substation for every 5 seconds.

3) When transformer is over loaded:

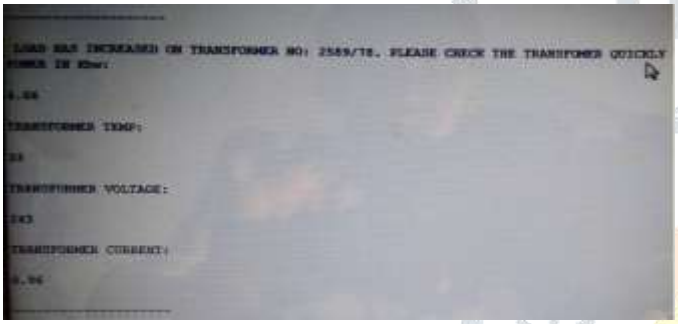


Fig 5.

When transformer is overloaded current exceeds predetermined value, then Arduino will send alert message to the substation using RF technology. The fig.4 shows the alert message on PC.

4) When transformer is overheated.

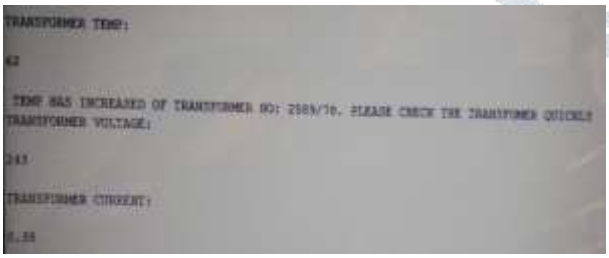


Fig.6.

When transformer oil is overheated due to any problem then, using temperature sensor and Arduino alert message is sent to the electricity board. Fig.6 shows the alert message on screen when transformer oil is overheated.

5) Real time energy consumed at consumer side.


Fig 7

When model is connected at consumer side then the energy consumed is displayed on LCD display. Along with energy consumed current and voltage is also displayed. Fig.7 shows the energy consumed message on LCD display.

## VII. CONCLUSION

The RF based solution for monitoring and controlling of distribution transformers is quite easy and effective compared to manual monitoring method. The paper focuses on transmitting real time data from each transformer to electrical substation modules. Selected advantages of this method are like, continuous monitoring of DTs, timely alerts to rectify the abnormality if any, there by extending the lifetime of distribution transformers, simplifying the trouble shooting in distribution network and providing continuity of power supply to the consumer. This RF technology will result in receiving alerts on the PC in the rated values of parameters, so that an immediate action can be taken to avoid any dangerous failures in the distribution network. The parameters are sent to the substation for every 5sec. so real time monitoring is possible.

The power theft and unpaid bills are most prominent issue in the power system form power utility perspective. So this paper proposed an intelligent energy meter technique to tackle this issue.

## REFERENCE:

**[1]** Rohit R. Pawar, Priyanka A. Wagh, Dr. S.B.Deosarkar ,'Distribution Transformer Monitoring System Using Internet of Things (IoT)'; 2017 International Conference on Computational Intelligence in Data Science(ICCIDS).

**[2]** Rohit R. Pawar, Dr. S.B.Deosarkar. 'Health Condition Monitoring System For Distribution Transformer Using Internet of Things (IoT)' , IEEE 2017 International Conference on Computing Methodologies and Communication

**[3]** Mohamed Ahmed Eltayeb Ahmed Elmustafa Hayati,' Design and Implementation of Low-Cost SMS Based Monitoring System of Distribution Transformers ',2016 Conference of Basic Sciences and Engineering Studies (SGCAC).

**[4]** Nikhil V. Patil, 'Intelligent Energy Meter with Advanced Billing System and Electricity Theft Detection', 2017 International Conference on Data Management, Analytics and Innovation (ICDMAI) Zeal Education Society, Pune, India, Feb 24-26, 2017.

**[5]** Poonam Borle, Ankitha Saswadhar, Deepali Hiwarkar, Rupali S Kali, "Automatic Meter Reading for Electricity", International Journal of Advanced Research, Volume-2, Issue 3, March 2013.

**[6]** Muhammad Ali Mazidi , Janice Gillispie Mazidi, Rolin D.Mckinlay, The 8051 Microcontroller And EmbeddedSystems Using Assembly And C,Second Edition, Pearson Education, 2008, India.

**[7]** Namita N. Jinde, Rashmi K. Bhojane, Reetesh V. Golhar, "Power line Communication Based on Energy Meter Automation", International Journal of Electronics Communication and Computer Engineering Volume 4, Issue (2) REACT-2013.

**[8]** "Electric Power Distribution" Book by Amarjeet Singh Pabla.

**[9]** "Electric Power Distribution Engineerning" Third Editon Book by Turan Gonen.

**[10]** Bhushan D. Sawarkar, Mrs. Snehal S. Golait International Journal of Advanced Research in Computer and Communication Engineering Vol. 4, Issue 1, January 2015.

**[11]** Power Transmission: Failure of Distribution Transformers in India. Manojbpl.blogspot.com/2014/19

**[12]** 'Causes of Failure of Distribution Transformer and Remedial Measures' By Hitendrasinh C. Chawda; www.worldwidejournals.com.

**[13]** 'Case Studies of the transformer Failure Analysis', Manish N Sinha and others; Electrical India, July 5, 2015.

**[14]** Mohamed Ahmed Eltayeb Ahmed Elmustafa Hayati, and Sherief F. Babiker, " Design and Implementation of Low-Cost SMS Based Monitoring System of Distribution Transformers",2016 Conference of Basic Sciences and Engineering Studies (SGCAC).

**[15]** U.V.Patil, Kathe Mohan, Harkal Saurabh and Warhade Nilesh "Transformer Health Condition Monitoring Using GSM Technology", Vol-2Issue-2 2016, IJARIIE-ISSN(O)-2395-4396.