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Online monitoring of Electricity Data through wireless transmission using Radio Frequency

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ABSTRACT: Power system is becoming more complex with the passage of time, as non-linearity of the system invite major dynamic kind of problems. One of major problems in power system is the acquisition of electricity data. Energy meter reading is a tiresome and pricey concern. Planned system of energy meter data reading will allow to control room to access the customer's energy meter and also allow the service provider to monitor and control the whole energy consumption, acquisition of energy data and fault or energy theft case in its zone. Digital wireless meter is technological enhanced and improved version of meter reading with safe prestigious time of energy providing company employees as there is no need of manpower for manual meter reading while visiting home to home. Radio frequency is proposed source of wireless communication for data integration. Online monitoring of electricity is being addressed first time in this research paper for Pakistan's Distribution system using radio frequency (RF). Telemetry will really be helpful for safety purposes for both utility and consumers. This Microcontroller Based Electricity Data Acquisition and Wireless Transmission system is established in Rachna College of Engineering & Technology, Joura-sian in Region of 220KV Ghakar Grid station, Gujranwala under the control of National Transmission and Dispatch Company Pakistan.

KEYWORDS: Power System, MATLAB, Proteus, Microcontroller, Radio Frequency.

1 INTRODUCTION

International Journal of Innovation and Applied Studies (IJIAS) is a peer reviewed multidisciplinary international journal publishing original and high-quality articles covering a wide range of topics in engineering, science and technology [1]. IJIAS is an open access journal that publishes papers submitted in English, but also in French, Spanish and Arabic. It is published four times per year. The journal aims to give its contribution for enhancement of research studies and be a recognized forum attracting authors and audiences from both the academic and industrial communities interested in state-of-the art research activities in innovation and applied studies [2], [3], [4].

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This research paper is related to the acquisition of electricity data. Electricity data nowadays is being achieved by a line man, going door to door for attaining electricity data from energy meter and that line man goes back to Gujranwala Electric Power Company (GEPCO), one of the Distribution companies (DISCO's) of Pakistan Electric Power Company (PEPCO). These is very time consuming, costly due to pays of meter readers, and have chances of corruption and electricity theft [4]. So, to improve it a research is conducted at RCET, Pakistan.

This work has already been done in Georgia using radio frequency (RF) and in Singapore with Bluetooth [5,6]. The idea behind this research is to develop a proto type model which can be used as bench mark for comprehensive simulation of integrated network at National level to address the problems regarding electricity data acquisition and any mischief made by consumer.

Pakistan Electric Power Company (PEPCO), the only power sector utility in Pakistan, consist of nine power distribution companies along with national transmission and power dispatch company but unfortunately no online monitoring is currently being performed. It is first time in the history of Pakistan that analysis and complete online monitoring is conducted by getting voltage (V), Currant (A), Power factor (pf), Apparent Power (S) and Active Power (P) from prototype model for 24 hours. Although in some of the 3rd world counties and at some places in Pakistan electricity data acquisition is done using Global system for mobile communication (GSM) technology [7]. This has made some improvement in our data acquisition method like manpower has reduced. Thus saving valuable time and money, but there are still many problems in this data acquisition system like; data is sent to the supplier after a period of one month or according to the time set in programming. Otherwise, supplier has to ask for data transmission by making a call to the point from which data is required.

Data Acquisition and Wireless Transmission consists of a Microcontroller, encoder to encode, a Transmitter, a Receiver and decoder to decode. Microcontroller is used to control Transmitter and Receiver and to keep system noise free.

A powerful computer Windows eXPerience (Xp) built-in software HyperTerminal is used in this research paper for getting telemetric data [8].

Analysis performed during this research paper is based upon practical system comprising of single room load for 24 hours. A room consists of a fan, two energy savers and two bulbs.

2 BLOCK DIAGRAM AND CIRCUIT DIAGRAM OF EXPERIMENTAL WORK

In this research, in first section we design an energy meter by using microcontroller Atmega32L. Section 2 consists of interfacing of encoder PT2262 and modulator with Atmega32L. Section 3 deals comprises of interfacing of decoder with microcontroller Atmega8L and also interfacing of Atmega8L with computer serial port through MAX232 and DB9 [9].Section 4 deals with collection of telemetric data that is being displayed on HyperTerminal window and plotting a graph to study the behavior of power flow in Power system.

2.1 DESIGNED ENERGY METER

Energy meter is designed by using microcontroller ATmega32L.Energy meters operate by continuously measuring the voltage (V) and current (A) and finding the product of these to give electrical power and measured quantities are displayed on Liquid crystal display (LCD) which is interfaced with microcontroller. Energy meter was designed because of two reasons; one was limitation of funds and second was the interfacing problem of Solid state energy meter with transmission module. Alternating voltage is measured by using a simple method of rectifying the alternating voltage and converting it to a equivalent DC voltage. Then use voltage division rule as shown in Fig.2 .Finally A resistor is placed in series to the analog to digital converter (ADC) and a zener diode at the pin microcontroller to protect the microcontroller from transients that may destroy it. Current is measured with current transformer (CT) that is loaded with burden resistor i.e. place it across the terminals of the CT and for linearity it must be able to carry the full current of the CT at its maximum pass current. We had used a CT of rating as 30:5 which means if the main conductor is carrying 30A then the output of the CT will be 5A. Apparent power is measured by using S=V*I and Active power is measured by CT with burden resistor and by employing a formula $P=I^2*R$ (burden resistor).Power factor is measured by using a relation All these quantities are measured in microcontroller Armega32L and programming is done in C language.

$$\text{Power factor (pf)} = \frac{\text{KW (Active Power)}}{\text{KVA (Total Power)}}$$

2.2 INTERFACING OF PT2262 WITH MICROCONTROLLER

The Microcontroller ATmega32L is interfaced to the Encoder PT2262 which converts the displayed data into suitable transmitting form and then it is transmitted toward the receiver nibble by nibble through radio frequency of range 300-315MHz.

2.3 INTERFACING OF PT2272 WITH MICROCONTROLLER

The Microcontroller ATmega8L is interfaced to the decoder PT2272 which converts the received data into suitable form and then it is referred toward the MAX232.

Microcontroller ATmega8L is used to connect the receiver module and decoder with the Hyper Terminal to display the received data on Computer screen.

3 WORKING

All Fig (2) represents the complete circuit diagram of proto type hardware and representing the whole procedure of getting the displayed data from microcontroller through Port C, first four pins (as at one time one nibble is being transmitted). Microcontroller is interfaced through these four pins with Encoder PT2262 through its four pins. While doing interfacing optcouplers are employed to separate the circuits which are operating on 5V and 12V. After this PT2262 convert the code and values present at address A0 ~ A5 and A6/D5 ~ A11/D0 into a special waveform and give it to Dout when output (TE) Transmission Enable is put to zero (Low state) For example, where the transmission data in 4 data type ,has address of 8 bit then the transmission format given in fig. 06.

The transmission being made by above mentioned waveform fed to RF modulator. The RF demodulator rephrases the received potential waveforms and decode via decoder. PT2272 decodes the waveform data and Fitch it to DIN pin. The codes of the decoded data contain the address, data and synchronized bits are shown in fig 07.

PT2272 ensures the valid transmission code, either it is permitted for transmission codes. For valid transmission following points to be suited

1. Complete code word
2. Ensure that address bit and address pins must synchronized.

After two consecutive valid transmission, PT2272 (1) drives the data pins according to the data bits received, and (2) raises VT to high voltage (high state)

The Transmitting media is Radio Frequency (RF) and some important features are

1. Frequency: 315 MHz,
2. Modulation: ASKA

Amplitude shift keying (ASK) is a form of modulation that represents the digital data as a variation in the amplitude of a carrier wave. The amplitude of an analog carrier signal varies in accordance with the bit stream. In modulated signal, logic 0 is represented by the absence of a carrier, thus giving OFF/ON keying operation and hence the name given [13]

3. Receiver Data, Output: High - 1/2 V_{cc}, Low - 0.7v,
4. Transmitter Input Voltage: 3-12V (high voltage = more transmitting, power),
5. Receiver input Voltage: 5V,
6. Have range up to 500 feet

The decoder is interfaced with another Microcontroller ATmega8L, this Microcontroller is used to connect the receiver module and decoder PT2272 with the Hyper Terminal and display the received data on Computer. IC MAX232 is used for Serial Communication with the computer through DB9.In this way the whole data from the consumer end is transmitted to the destiny and display on computer, saving valuable time, man power, and keeping the process corruption free.

4 ANALYSIS

For the purpose of analysis we have connected a load almost equivalent to a room load for 24 hours and values of different parameters obtained as tabulated in table.1 up to five readings are taken in an hour from both, transmitter and receiver. Average of all the values is calculated. These values along with the respective time are written in the tables. By

using the telemetric data as given in the table.1 we draw a plot between different values with the help of MATLAB. The curve shows the variation of the load throughout the day. The points where the magnitude of the Active power is zero indicates the absence of electricity (i.e. Load Shedding). It also gives the indication of peak load hours and the maximum load in 24 hours. The consistency of load during midnight and early morning gives the indication of the high and constant power factor during these hours and its value is mostly graeater than 0.9 but, it decreases and show variations during hours of peak demand as voltage depressed.In this way one can learn the behavior of the system when connected to measure the load of a room. In the same manner one can use this system at different places like for distribution network, institution or a specified region. This will have advantages like improved accuracy, expanded set of features, saving of precious time, money and lessening of bribery. But one has to make some modification to use it for a large system because our scheme has some limitations due to components of small power ratings. We will do it for a large area when components of high power ratings are reachable. However it is more suitable to build with digital signal processing (DSP) chips for a quick response of change in load. While at service provider end a data base management system for manipulating the data received from the telemetric system will be quite helpful for load management and load forecasting.

5 APPLICATIONS

This arrangement can be used for different purposes and few of them require some enhancements. The most basic application of this project is online monitoring of electricity data. It can be employed at different locations in a plant for continuous monitoring the working and production rate of machines and checking the fluid levels in storage tanks. The same technology can be used in gas and water meters for online monitoring of gas and water flow rate.

6 TABLES AND FIGURES

6.1 TABLES

Table 1. Telemetric Data obtained for 24 hours of load equivalent t to room load

Sr. No	Voltage (V)	Currunt (A)	Apparent Power (VA)	Active Power (W)	Power Factor (pf)	Time (PST)
1	229	0.14	512	450	0.88	20:00-21:00
2	233	0.19	306	468	0.87	21:00-22:00
3	243	0.4	95	86	0.9	22:00-23:00
4	242	0.48	116	111	0.92	23:00-00:00
5	244	0.39	95	89	0.94	00:00-01:00
6	246	0.19	46	44	0.95	01:00-02:00
7	244	0.24	58	53	0.92	02:00-03:00
8	247	0.28	73	65	0.91	03:00-04:00
9	240	0.46	111	99	0.89	04:00-05:00
10	0	0	0	0	0	05:00-06:00
11	239	0.45	107	98	0.91	06:00-07:00
12	237	0.34	80	70	0.88	07:00-08:00
13	236	0.33	77	69	0.88	08:00-09:00
14	235	0.55	131	111	0.85	09:00-10:00
15	237	0.53	136	109	0.86	10:00-11:00
16	237	0.68	161	137	0.85	11:00-12:00
17	238	0.7	166	139	0.84	12:00-13:00
18	0	0	0	0	0	13:00-14:00
19	238	0.78	162	137	0.84	14:00-15:00
20	238	0.75	178	15	0.86	15:00-16:00
21	238	0.8	190	162	0.85	16:00-17:00
22	235	0.72	438	365	0.83	17:00-18:00
23	231	0.8	512	436	0.85	18:00-19:00
24	0	0	0	0	0	19:00-20:00

6.2 FIGURES

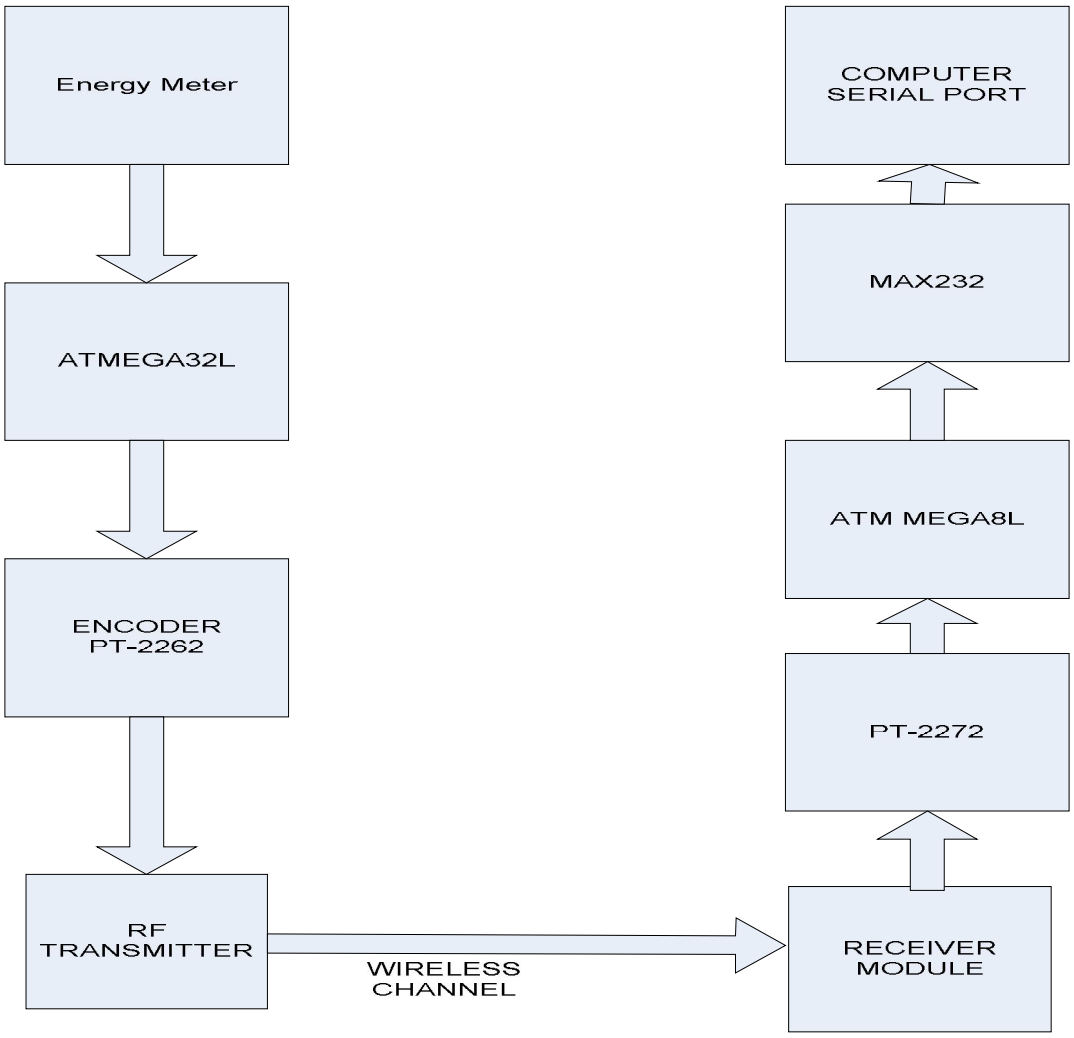

Fig.1 Block Diagram of Experimental Work

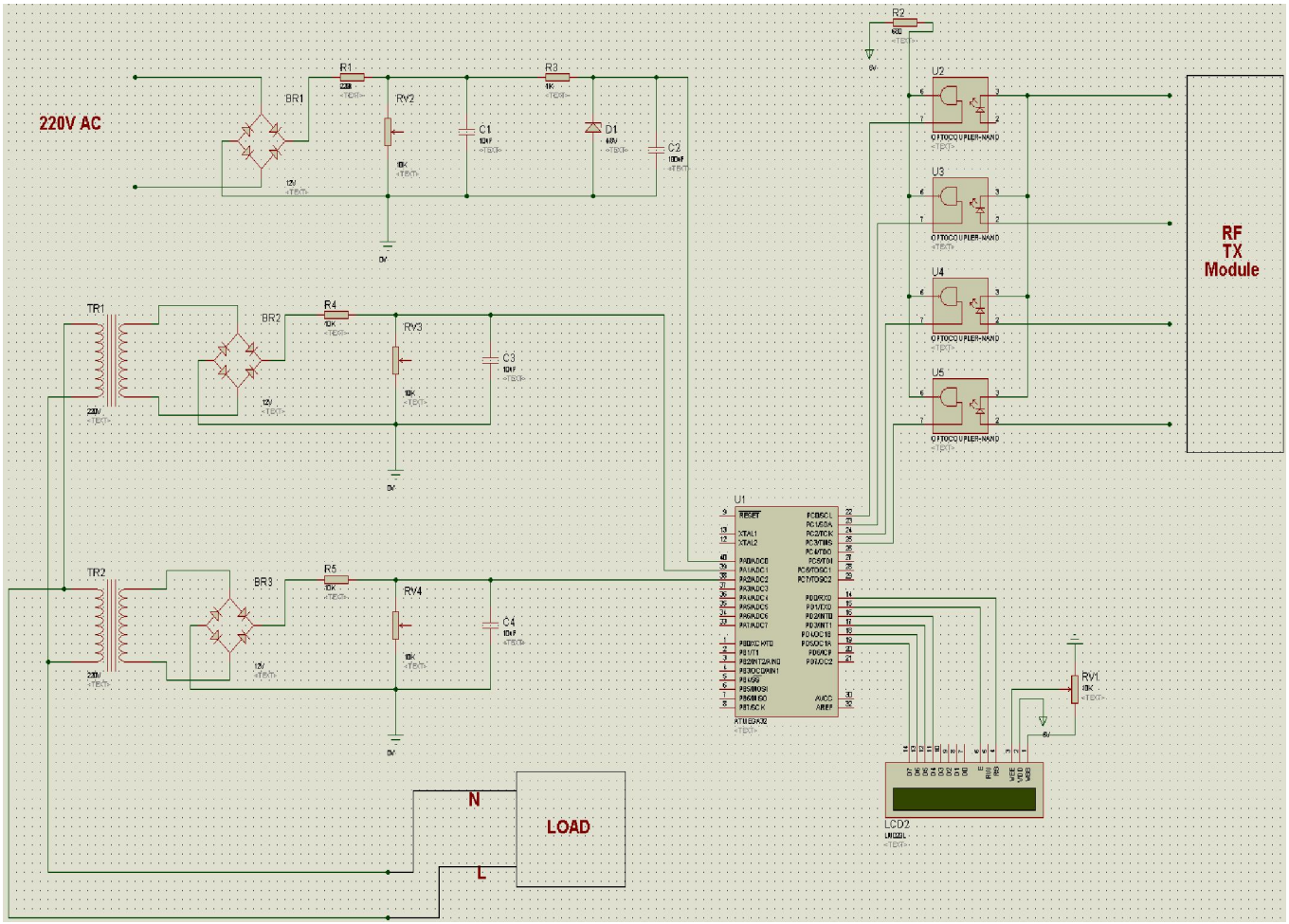

Fig.2: Circuit diagram of an Experimental Work of Energy Meter and Transmitter side

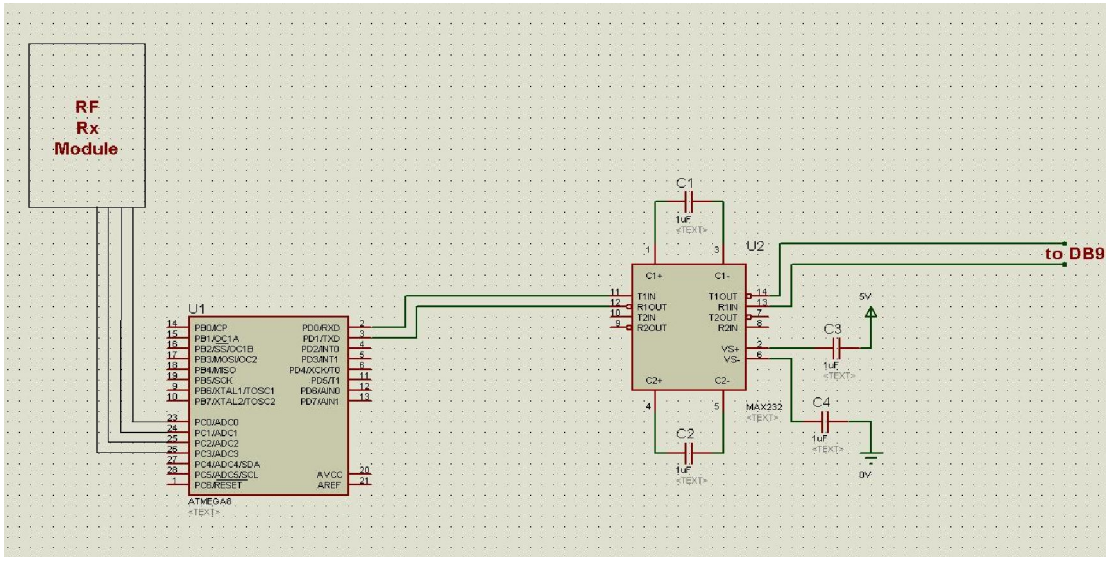

Fig.3: Circuit diagram of an Experimental Work of Receiver side

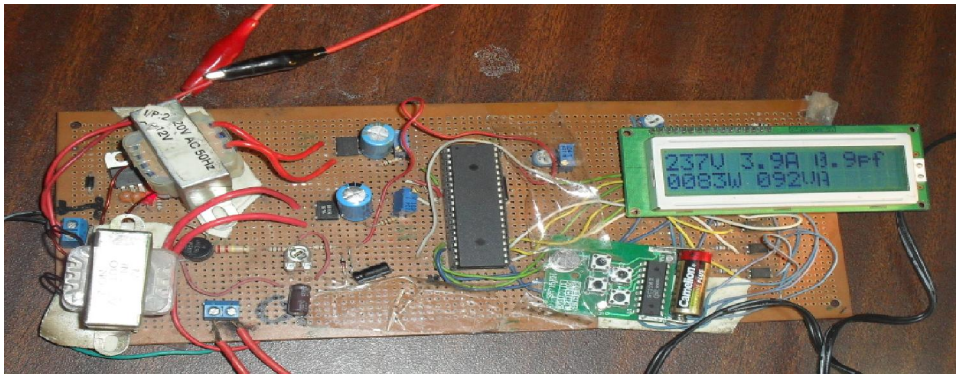

Fig.4: Energy Meter and Transmitter

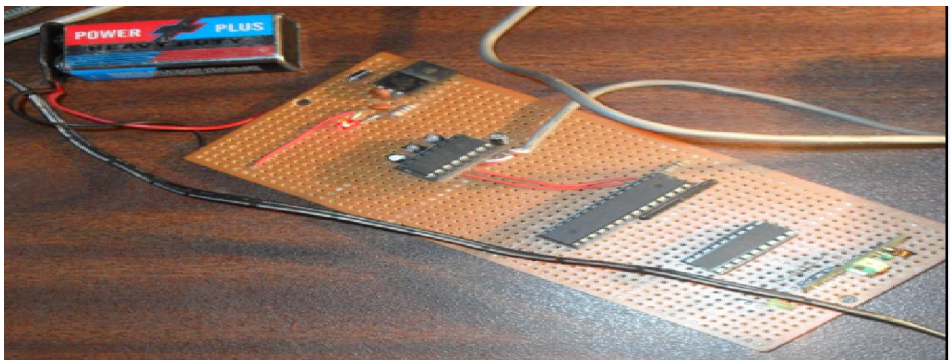

Fig.5: Receiver connected to through serial port to computer

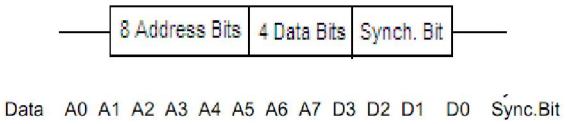

Fig.6: Transmitting Format [10, 11]

PT2272:

A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	SYNC

Fig.7: Code Word [10, 11]

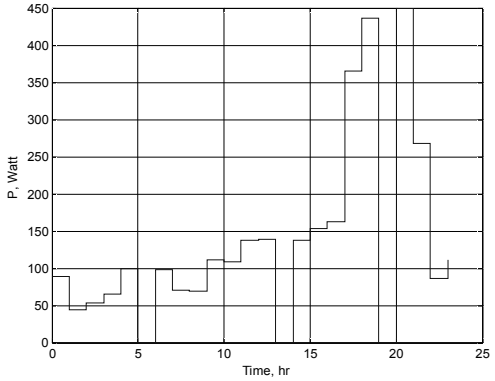

Fig.8: Variation of Load with PST

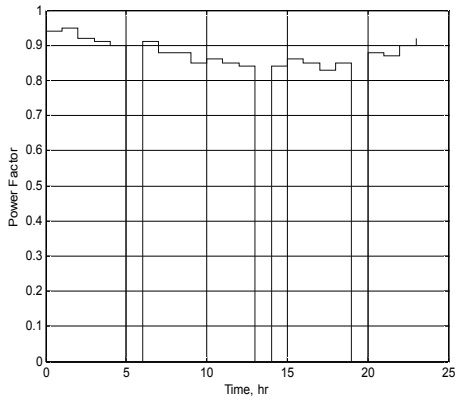

Fig.9: Variation of Power Factor with PST

Fig.10: Applications of online monitoring

7 CONCLUSION

Telemetry is a technology that allows remote measurement and reporting of information. Telemetry concept is an advanced approach for enabling Electric Energy Supplier to perform online monitoring of Electric Energy consumption, error detection, and acquisition of whole data at the electric utility grid. Thus there is no need of line man for attaining the reading from energy meter. In addition of it from analysis of telemetric data one can guess about load management, installment of capacitor bank at particular place and also can study the enhancement of existed power system. The major purpose for telemetric studies on this power system is to find dynamic performance which has great impact in the design and operation of the system. Usually it is owned by a Distribution Company like GEPCO.

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