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Invent and Investigation of Effective Electric Power Utilization in Secondary Distribution Side with Wireless Power Monitoring System

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ABSTRACT

This paper presents a new wireless automation in secondary distribution to avoid the discomfort and reduce the errors raised by the humans for effective electric power utilization. This automation process is controlled by the microcontroller programmed with the embedded system. The transformers of secondary distribution side are connected in parallel so that the transformers can be share the load based upon the base load or peak load. So, the efficiency and the lifetime of the transformers can be improved and the losses can be reduced. The power used by the consumer is monitored and metered automatically for every specific mentioned time. And also the power failure can be monitored and detected by the circuit which is accompanied in the energy meter circuit. These messages are encoded and transmitted through RF signals.

Keywords: Secondary distribution transformer, Energy metering, Power failure detection, Wireless communication.

I. INTRODUCTION

Rising energy costs and a greater sensitivity to environmental impact of new transmission lines necessitated the search and application of new effective electric power utilization to minimize losses and maximize the stable power-transmission capacity of existing lines [1]. The Electricity is a converted form of energy used in the industrial, domestic, commercial and transportation sectors. Electric power system deals with the generation, transmission and distribution electric energy associated with the unique features of control of the flow of or demands of energy at desired nodes throughout the power network [4]. After generation, transmission plays a vital role in transporting the power from the generating station to load canters. The common

Transmission voltages across the globe are 33kV/66kV/114kV/132kV/138kV/161kV/220kV/230kV/345kV/400kV/500Kv in the HV and EHV ranges and 765kV/800kV/1000kV/1500kV in the UHV ranges in the world is 6KV/11KV/12.47KV/13.2KV/13.8KV [3]. The distribution level consists of the distribution circuits in the overall region of distribution. The larger consumers, i.e. high tension (H.T.) have been termed as primary distributors while low tension (L.T.) consumers are the secondary distributors. The consumers consuming energy between 3kV and 23kV are H.T. consumers while the consumers in the category of 110V-400V/440V lie in the class of secondary or L.T. consumers [2]-[5]. One of the distribution circuit is transformer, is a static device used to transform the voltage from one level to the other level without changing its frequency. The increase in demand on the electrical energy led to the proper utilization and reliability of the electric power. This, in turn, has necessitated the load sharing in the distribution transformer to reduce the no load, other losses. So that the power can be used in an efficient manner and the life time of the transformer can be increased. An electric meter or energy meter is a device that measures the amount of electrical energy consumed by a residence, business, or an electrically powered device.

Electric meters are typically calibrated in billing units, the most common one being the kilowatt hour. Periodic readings of electric meters establish billing cycles and energy used during a cycle. Moreover there are many types of energy meters are used in reality; still it requires a manual operation for metering the consumed power by the consumers. And also there is huge revenue loss for the distribution companies due to the energy theft and non-paying of the bill amount. In order to avoid these problems, an energy meter is designed to measure the consumed electrical power and to prevent the energy theft problems and also the next concept added is to detect the power failure in the consumer section.

II. BLOCK DIAGRAM OF PROPOSED SYSTEM

The concept of the project can be understood with the following block diagram. This is Secondary distribution section, Consumer section and EB/Substation section. Figure.1 shows the overall view of the process. The power supply from the main transmission line is stepped down by the secondary side transformer. The secondary transformers of two nearby areas are connected in parallel. The load is shared based upon the peak load or base load. The stepped down power is sends to the consumer. A circuit contains the voltage detector to detect the voltage and the digital energy meter to metering the power usage by the consumer.

The signals from the various places are encoded in their respective circuits and sends to the EB sectors where it contains the receiver and the decoder. The data received is stored in the personal computer to help in retrieving the data in the future for analysing purpose.

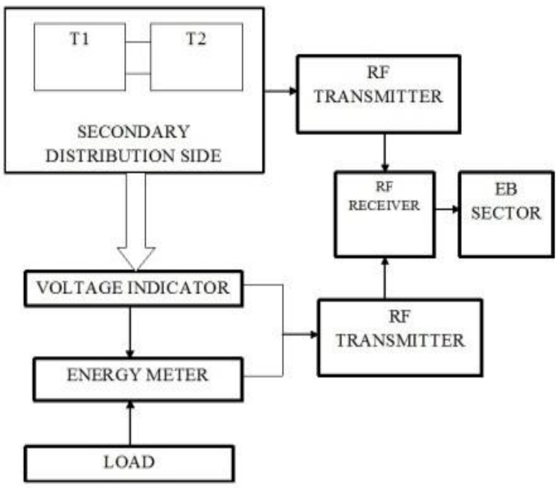

Figure 1 Shows that Overview Block Diagram of the Process

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2.1 Distribution transformer section

From figure 2, the microcontroller used here is PIC16F877A. Whenever the microcontroller gets the exceeded power limit signal from the current transformer it switches transformer through the relays. The transformer T1 and T2 is allotted transformer for two nearby areas. These transformers are connected in parallel connection.

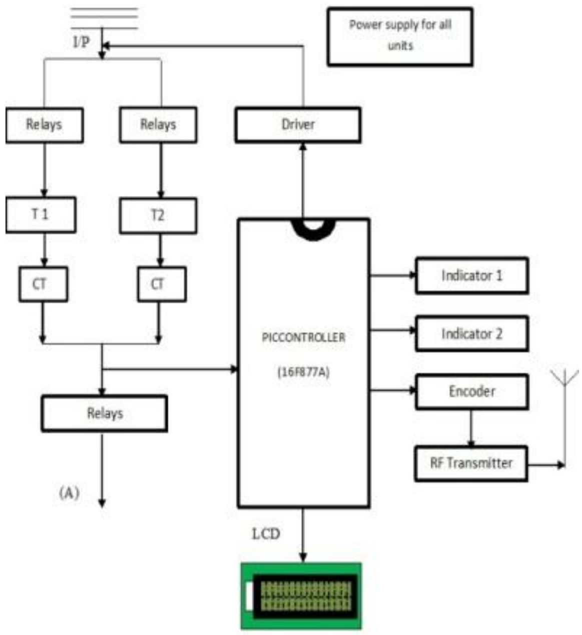

Figure 2 Shows that Secondary Distribution Side

The microcontroller doesn't have the enough power to drive the relay. So a driver is used to drive the relay. An indicator is used for every transformer to indicate which one is in the ON state. The encoder merges all the information from the microcontroller and transmits to the EB sector through radio signals. The LCD is installed for the purpose of our convenience to know the status.

2.2 Consumer Section

In the consumer section, the PIC microcontroller is used. This circuit can be even installed in every home in an area/village or in a single place based on the installation place. Here, the voltage detector is used to detect the presence of voltage in the end user side. The signal from the voltage detector is sends to the microcontroller. The energy meter is a device used to metering the power used by the consumer. Here, a digital energy meter is used for an Accurate reading and for better efficiency. Here the energy meter used is a single phase 2 wire static energy meter with 3200imp/KWh.

The LED in the energy meter is removed and connected with the LED of an optocoupler. In optocoupler a Darlington transistor pair is used. A Darlington transistor is a compound structure consisting of two bipolar transistors connected in such a way a current amplified by the first transistor is again amplified further by the second. These amplified currents send the meter reading to the microcontroller. Both the signals get amplified and merged by the Encoder and sends to the EB sector through the transmitter. The radio frequency signals are used in the frequency of 433MHz.

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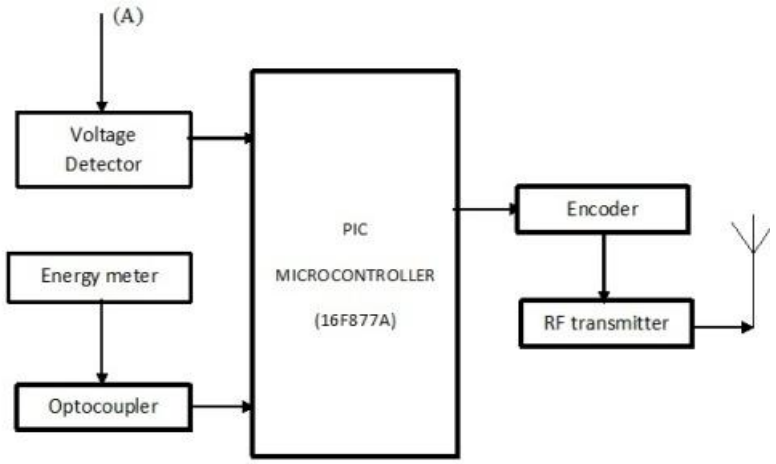

Figure 3 Shows that Block Diagram of Consumer Section

This circuit can be installed in various places and it can be in same bandwidth. Since it have same bandwidth, the signals of an individual customer can be identified through the individual service number of an energy meter.

2.3 EB /Substation Sector

Figure 4 Shows that Block Diagram of EB Sector, from is the circuit placed in EB/Substation sector to receive the signals from the both distribution and consumer sector. The 433MHz receiver is used to receive both the signals and decode by the decoder. The decoded signals are sends to the microcontroller.

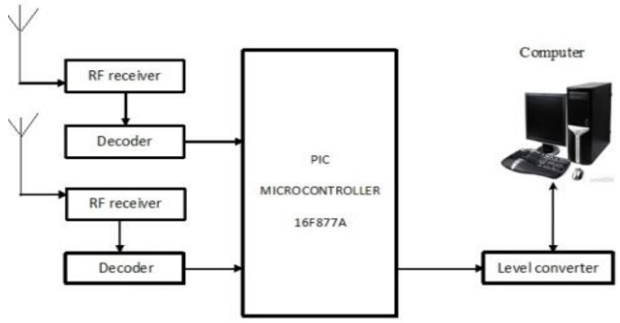

Figure 4 Shows that Block Diagram of EB Section

The level converter is a Signal Conditioning Unit used to amplify and conditioning the decoded signal from the microcontroller. Then, the signal is stored in a computer installed with the program known as VB.net. This is programmed as per our requirement. The entire process is controlled by embedded programming.

III. VB.NET SIMULATION

Visual basic is a multi-paradigm, low level programming language, implemented on the NET framework. Most of visual studio editions are commercial; the only exceptions are Visual Studio Express and Visual Studio Commity, which are freeware. In addition, .NET Framework SDK includes a freeware command-line compiler called vbc.exe. Mono also includes a command line VB.NET compiler.

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3.1 Syntax of VB.NET Framework

VB.NET uses statements to specify actions. The most common statement is an expression to be evaluated, on a single line.

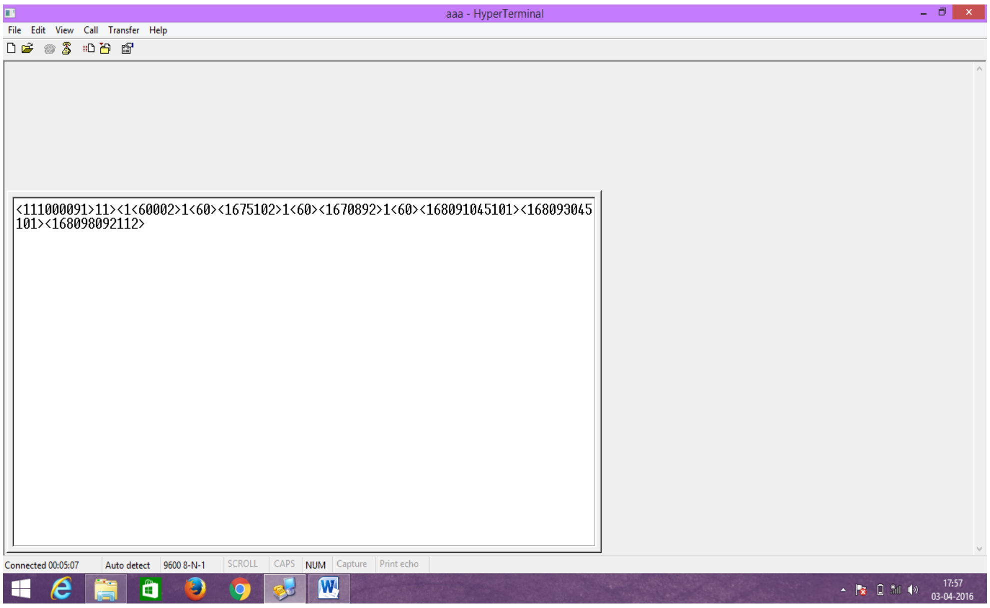

Figure5. Output Reading of Hypertrm Software

As part of that evaluation, functions or subroutines may be called and variables may be assigned new values. To modify the normal sequential execution of statements, VB.NET provides several control-flow statements identified by reversed keywords. Structured programming is support by several constructs. The result is in 12 digits format. In these 12 digits we have the readings of the voltage reading from the consumer section, no. of units from the energy meter, value of the current from the current transformer, and the details of ON/OFF transformer and also details of the loads in ON/OFF .

For an example, in this figure 5, we have the reading as <168091045101>. This is the reading when a single load is connected. In this reading, 168 is the voltage rating in consumer section, 091 is the no. of units measured from the energy meter at that instant, 045 is the value of the current from the current transformer, 1 is denoting the transformer 1 is in ON state and 0 denoting the Transformer 2 is in OFF state and finally the 1 is mentioning the no. of load in ON state i.e., 1 load is in ON state. In the same figure 7.1, the next reading is <168098092112>. In this reading, 168 is the voltage rating in consumer section, 098 is the no. of units measured from the energy meter at that instant, 092 is the value of the current from the current transformer, 1 is mentioning the Transformer 1 is in ON state and next 1 is also mentioning the Transformer 2 is in ON state and the last digit 2 is denoting the 2 loads is switch on.

IV. VB.NET SIMULATION OUTPUT

The output in this simulation is shown in 3 cases through the following figures, the output simulation window done with all the three sections. The transformer 1 (T1) and the 79 transformer (T2) is used and mentioned below. The three cases of working process are explained below. The output in this simulation is shown in 3 cases through the following figures. The transformer 1 (T1) and the 79 transformer (T2) is used and mentioned

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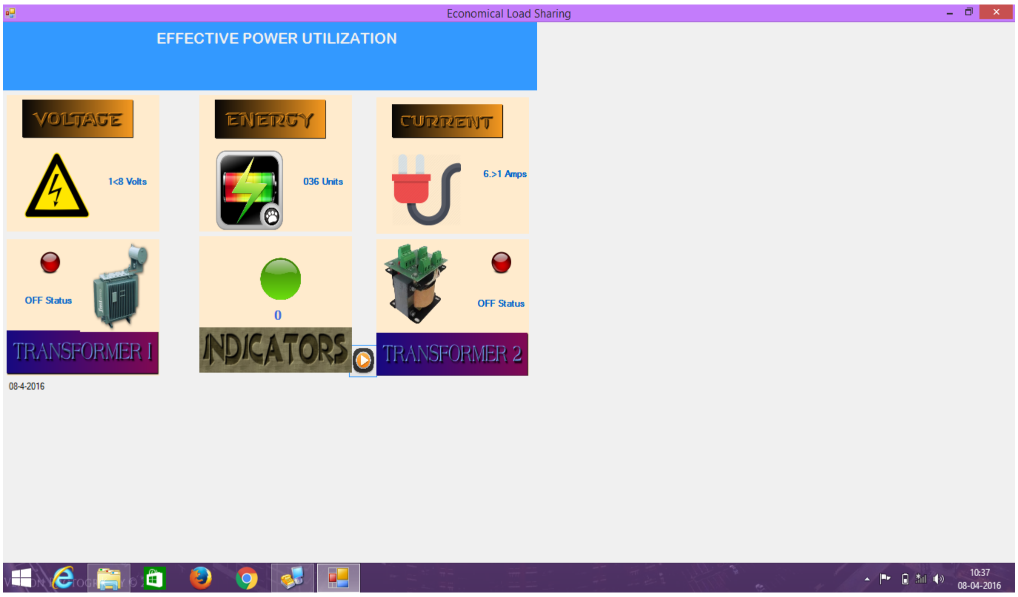
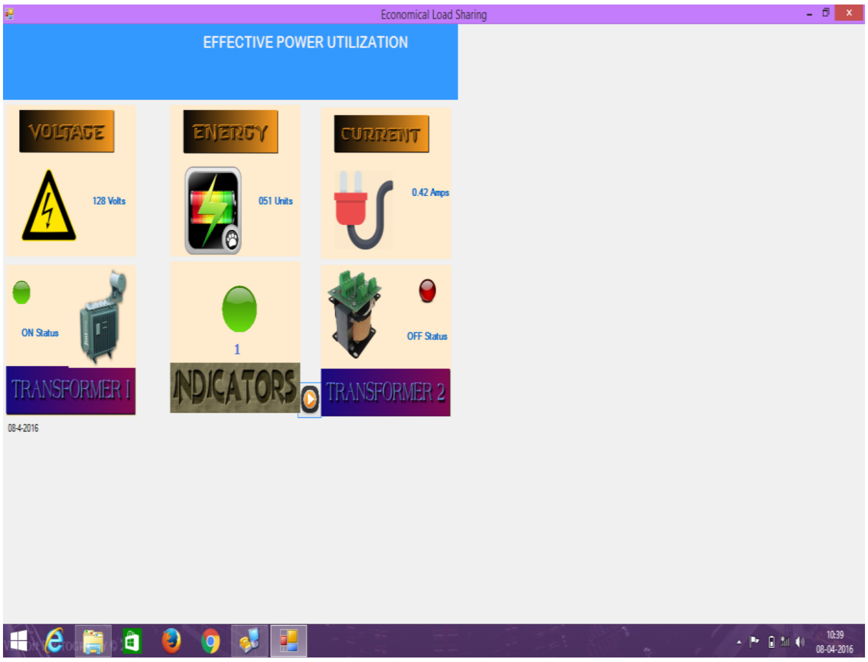
below. The three cases of working process are explained below, through this simulation, we can know about the voltage rating and current rating in the consumer section and also we can come to know the total no. of loads is in on conditions. The following are the three cases in which the process gets operated.

(i) When the entire load is in off condition



(ii) When the single load is in on condition



(iii) When the entire load is on Condition

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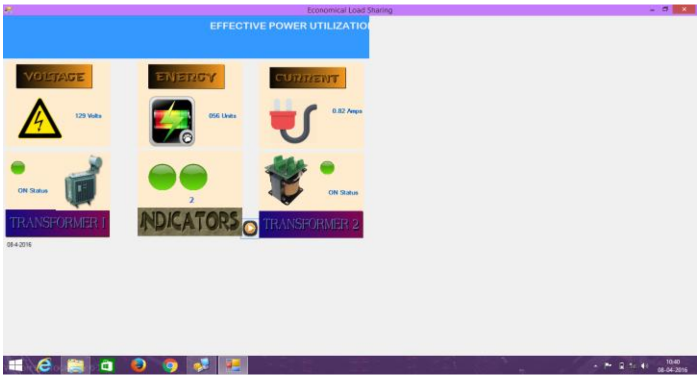

V. HARDWARE CONFIGURATION

4.1 Distribution Transformer Section

In figure 6, distribution transformation sector, the entire process is controlled by the PIC microcontroller. This is the heart of this section and also the project. The current transformer measures the value of the current from the transformers and sends that signal to the microcontroller. The controller controls the value of the measured current value with the assigned value in the coding. Based on the result of the compared value, the microcontroller switches the other transformer through the relays.

The transformer can be cut from the supply and a single transformer can give the supply to two various areas at the time of base load. At the time of peak load, the transformer can operate at their own state. Here the encoder HT12E is used which encodes the signal from the controller. The operating voltage of this encoder is 2.4V to 5V which is enough good in RF transmission. In this paper, for our convenience a LCD is connected with the controller to know the status of the value of the transformers and also a power supply is designed to give the power to the transformers.

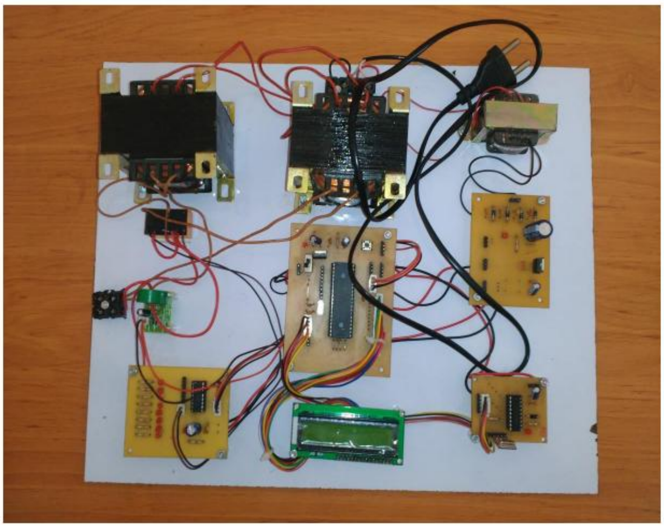

Figure 6 Shows that Section of Distribution Transformer

The frequency used here for the transmission is 433MHz. The driver ULN2803 is used to drive the relays because the voltage from the microcontroller is not enough to drive the relay, to amplify such voltage the driver is used. A Darlington transistor is used for the mechanism. The transformer is switched by the switching mechanism with the help of the relays.

4.2 Consumer section

The heart of this figure 7 consumer section is the PIC microcontroller 16F877A. In this section there are two operations which get hybrid and send that to the microcontroller. The voltage detector is used to detect the failure of power in the transmission line and in the energy meter. In the place of voltage detector, we will get normally “0”V when 230V is applied at the main terminals in the sensor but in case of a power failure “5”V will be sense in the power pin. By this way we can detect the power failure in the end user section, with the help of the energy meter the power is get metered manually. In order to avoid such manual process metering, and provide the automatic process for this function. The energy meter used here is a digital meter which is efficient and provides an accurate value. The optocoupler used here is MCT2E which is very efficient. This is functioning for two purposes; one is for isolation purpose and another for metering the power used by the consumer. The energy meter is coupled with the optocoupler (3200pulse/KWhr energy meter). Whenever the pulse generated in it, the LED glow and triggers the transistor. This is helpful to know the accurate power usage by the consumers.

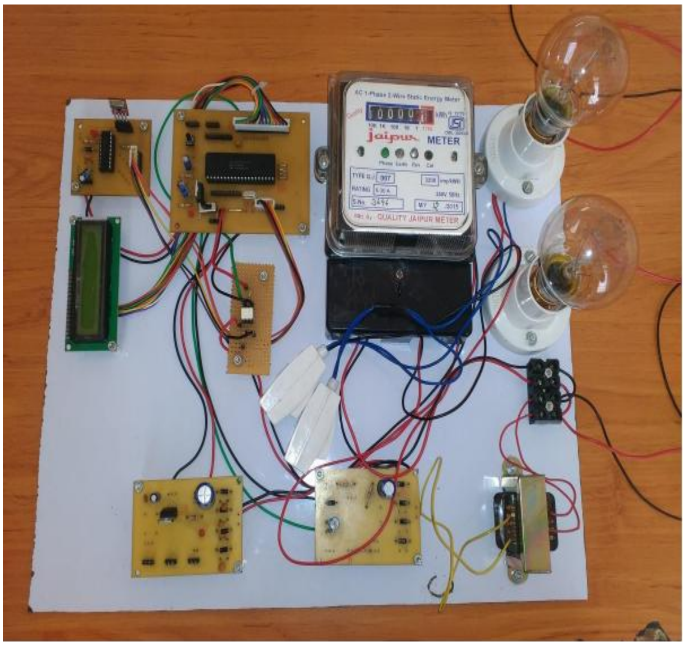

Figure 7 Shows that Section of Consumer

If any fault occurs in the energy meter or in line then the optocoupler acts as isolation device and separate the faulty section from the rest of the parts. So that can be protect the equipments are using. Both the signals from voltage detector and from the energy meter are sends to the microcontroller. The signals send to the EB section through encoder and transmitter. The encoder used here is same HT12E and transmitted through the 433MHz RF transmitter.

4.3 EB section

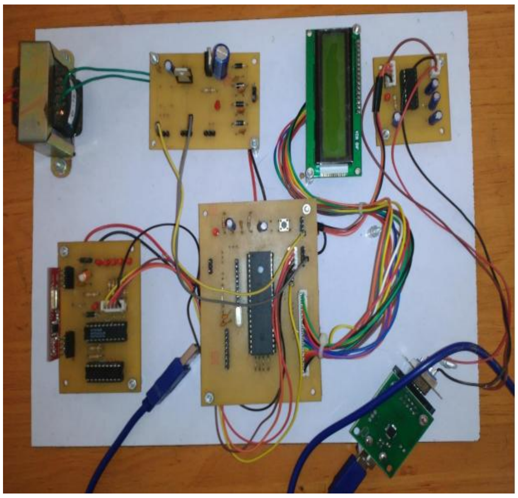

Figure 8 Shows that Section of EB

The data from the other two sections get received by the AM type RF receiver. The received signal is not strong enough for further process. For that, a buffering circuit is used in the receiver board to buffer the signal. The buffered signal is decoded by the decoder and passes to the microcontroller pins. The controller passes the signal to the level converter where the signal is converted as TTL signal. This is suitable signal to communicate with the computer system. The amplified data from level converter is stored in the computer through the connection using USB USART port. The data corresponds to the other sections will be updated in the system automatically in a certain time delay.

VI. CONSLUSION

The lifetime of the transformer and its efficiency is very important parameter to maintain always in the power system. They will be reduced during the operation at no load/ half load. So the transformers of two areas are connected in parallel for the purpose of sharing the load based on the base load/ peak load of the areas. By this a transformer can operate and share the base load of two areas. This leads in reduction of core losses and the transmission losses of a transformer. In order to avoid the raising inconvenience by the absence of consumer at the time of metering the power usage, an automatic process of metering the power usage without any human presence can help to take the accurate reading of power usage and eliminate such inconvenient for the humans.

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