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Power Line Communication Based Automatic Electrical Billing Meter and Power Supply Control Using Frequency Shift Keying Modulation

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Abstract—In every aspect of human life, electronics plays an important role. Power line communication (PLC) is an electronic solution for remote meter reading and power supply control. If such system via PLC is developed for power distribution network then automatic electrical billing can be possible. Power lines which already exist and connect every household in a particular area is more advantageous as it does not require any new installation for establishment of communication channels, and thus it is not a time consuming one. The advantages of this system are less labor, quick updates, no manipulation and cost effective. The transmitted data over power line is Frequency shift keying (FSK) modulated. The architecture of the system is presented. In this paper, the above said process is totally automated and the communication is made possible entirely through the power line.

Keywords— *Remote meter reading; power supply control; power line communication (PLC) modem.*

I. INTRODUCTION

Electricity is the building block for the development of any nation. It directly affects the economic growth of the country. So it becomes necessary to monitor and control usage of electricity. As the billing is done manually the probabilities of errors and manipulations while observing will be more. Using automation the drawbacks of the present system can be eliminated and the system can be made more efficient. A system can be developed which will monitor the energy consumption of subscriber. The system should also be able to communicate with central authority through power line. Thus electricity theft detection system has become a necessity for most energy suppliers. Power line communication has many services on the data transfer via power line without using extra cables Remote meter reading system is an important application in this regard due to every user connected to each other and central station through power line. It is a technique to facilitate remote energy consumption reading. It is clearly known that using electricity illegally may indirectly affect the economic state of a country negatively. On the other hand, planning of national energy for a country becomes difficult in case of unrecorded usage. Illegal electricity may be a serious problem in many countries like India. This problem has been attempted to be resolved by special skills of humans, such as the police, special security etc. These methods could not give the optimum solutions due to their impracticalities. Today, we have many chips which can be used for digital energy metering and PLC modems. At this point of technological development, the problem of illegal usage of electricity must be solved electronically, without any human control [1]. In the proposed system, the analog energy meters are replaced by digital meters. The meter readings in the form of digital data are transferred from the customer end to the EB office through power line [2].

A. Automatic Electrical billing

Power is the soul of world which is related to the electricity and "electricity" is the word which now rules the world. So, proper utilization of this valuable thing is of great important to us. Hence, it is

necessary to measure electric power consumption. The block diagram of proposed system for measure power consumption is shown in fig 1.

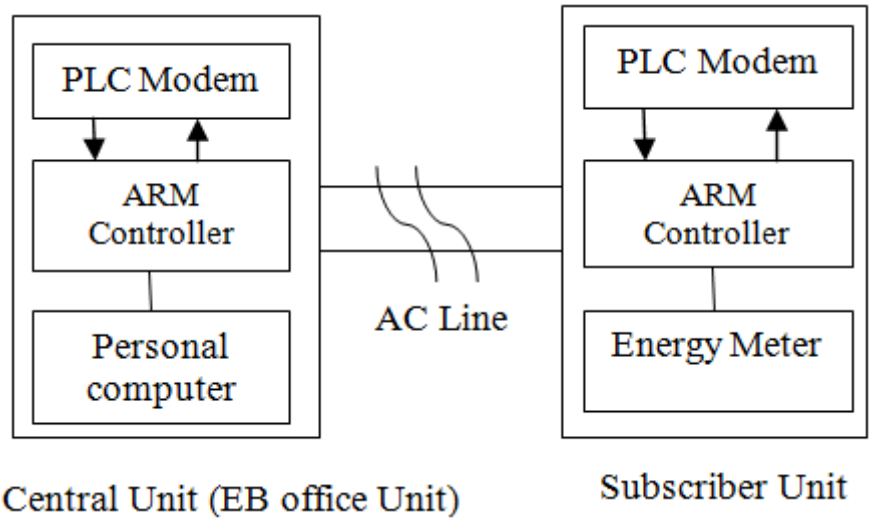

Fig. 1 Measure power consumption

B. control system

Overview of system is shown in fig. 2. The system consists of two units situated at two different locations. There is a unit at central station, second unit at subscriber. Central station controls the other two unit that is subscriber unit.

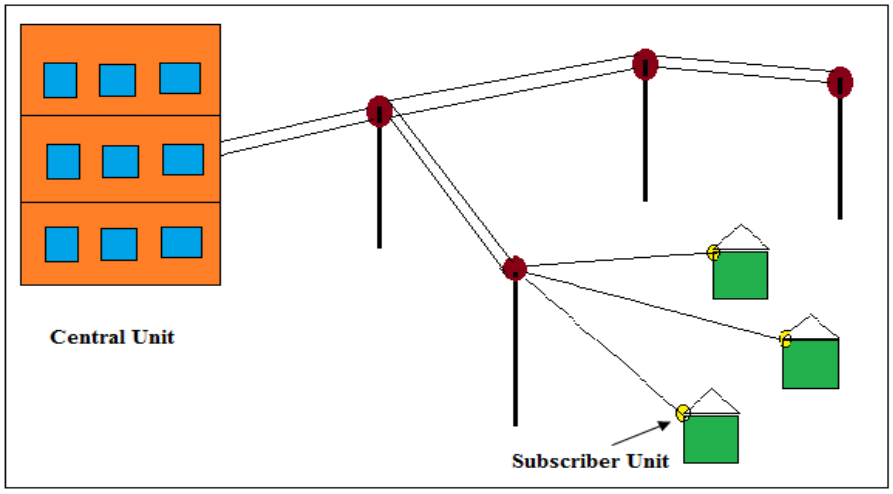

fig. 2. Overview of system

The block diagram of proposed control system for the detection of illegal electricity usage is shown in fig 2. PLC data transfer is only valid over low voltage 230 VAC power line. The system should be applied to every low voltage distribution network. The system given in fig.3 belongs to only one distribution network and should be repeated for every distribution network.

II. WORKING PRINCIPLE

An electricity theft detection system is a real time power monitoring system. It consists of three units situated at different locations. The different units are namely as follows

1. Central unit
2. Subscriber unit

The central unit controls the other two units situated far away from it. The control is done via power line communication (PLC). The second unit is situated at subscriber's house and repeated for every subscriber.

In the automatic Electric billing system the value of power consumed by the subscribers is stored at subscriber's unit. The recorded data for every subscriber is sent to central unit. In response to the reading central unit send bill amount on the LCD display at the subscriber unit with paying date. If bill will not paid in given time span then cut that subscriber power supply using contactor.

In this system the value of power consumed by the subscribers is stored at subscriber's unit. The recorded data for every subscriber is sent to host unit. The transmission and reception of data and control signals between the two units is done via power line. A contactor is included to the system at subscriber's location to turn off the power automatically.

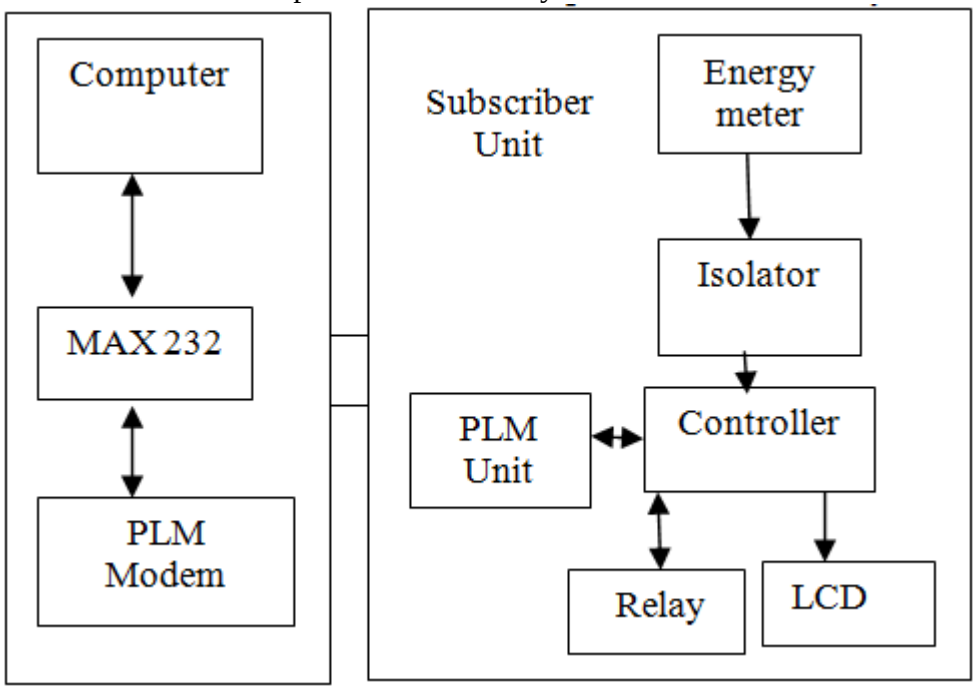

Fig.3 Design content of system

A. System design

The design contents of each block are shown in Figure 3. The three units are namely as follows

1. Central unit

2. Subscriber unit

I. *Central unit:*

The central unit or EB office unit consists of microcontroller, power line communication (PLC) modem and personal computer. The microcontroller is interfaced with personal computer (PC) and PLC modem (TDA5051). To control the operation, various commands from PC can be given to microcontroller.

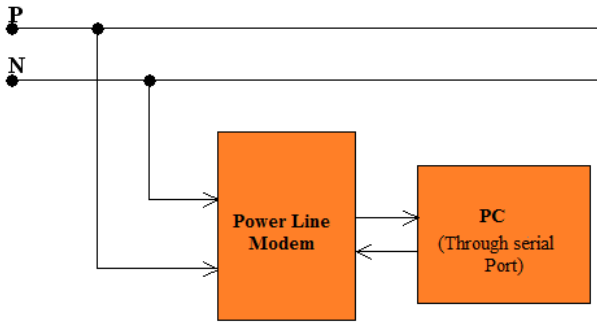

Fig.4 Central Unit (EB office End)

II. *Subscriber's Unit:*

The subscriber's unit contains microcontroller, power line communication modem and energy meter. This unit is repeated for every subscriber. The subscriber's unit keeps the record of power consumed by respective subscriber and transmits the reading to the host unit via power line. PLC modem performs FSK modulation for transmission of digital data over power line. The unit also follows various commands given by host unit.

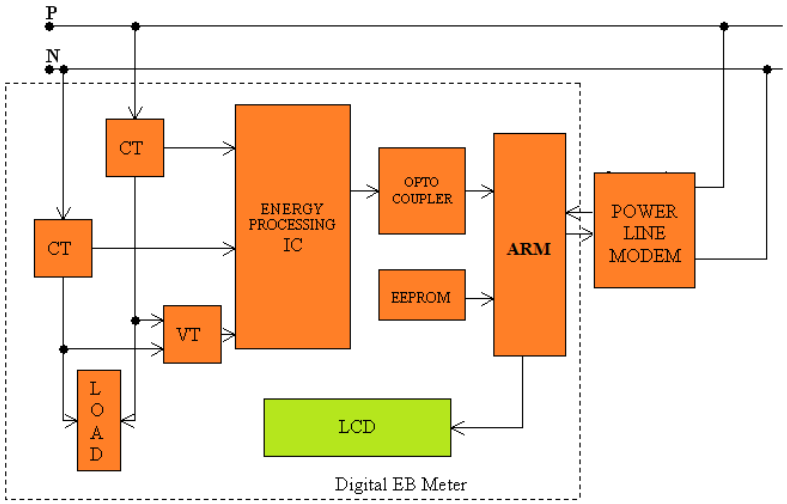

Fig.5 Subscriber End Unit [3]

B. Current Transformer (CT) And Potential Transformer (PT):

The **Current Transformer** (**CT**), is designed to produce an alternating current in its secondary winding which is proportional to the current being measured in its primary.

The **Potential Transformer** (**PT or VT**) is used to step down the voltage to a lower range that will work with a Watt Node meter [4].

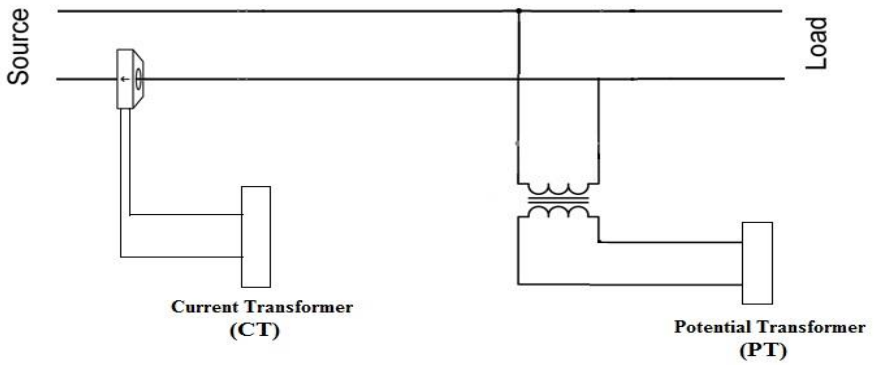

Fig. 6 CT-PT connection Diagram

C. Abbreviations and Acronyms

Power line communication abbreviated as PLC. Current transformer and potential transformer are abbreviated as CT and PT respectively. Frequency shift keying is abbreviated as FSK. Electric Billing Office is abbreviated as EB Office Units.

D. Schematics

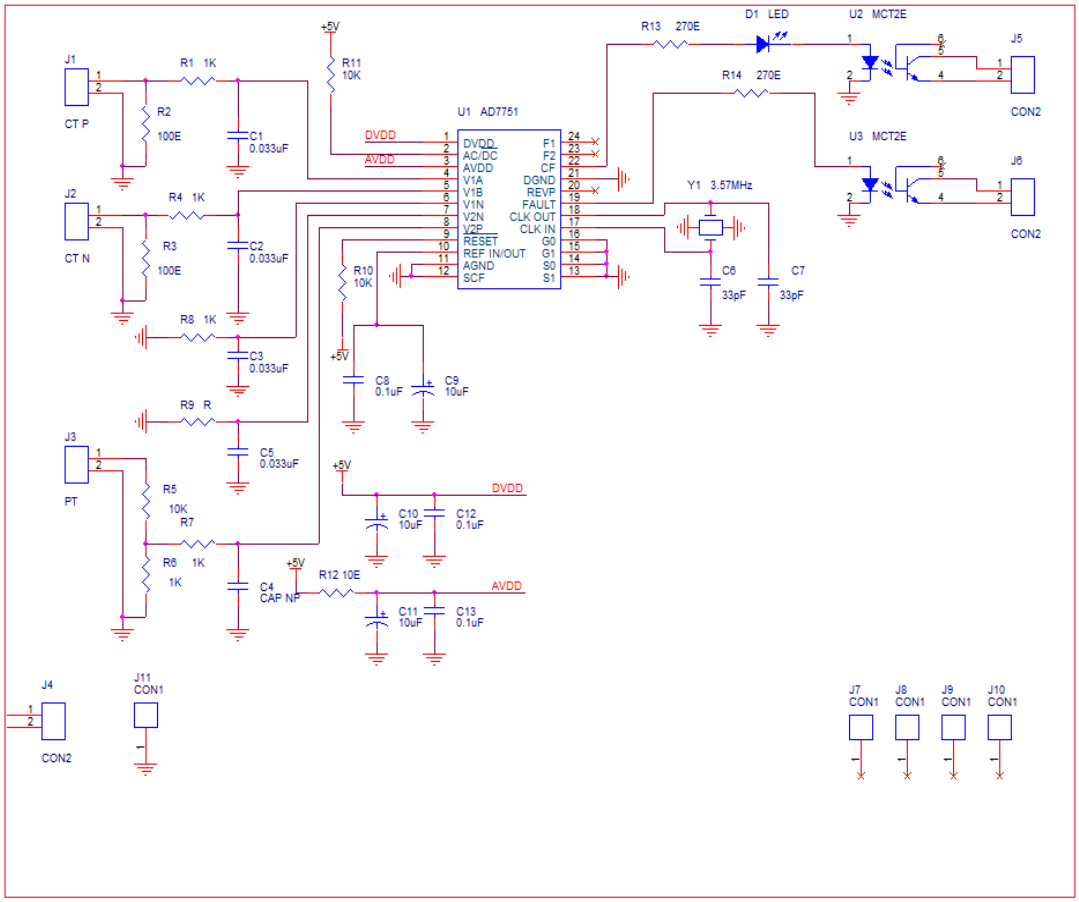

Fig.6 Circuit for energy meter.

E. Testing Results

To test the system required loads to be applied at the subscriber/distribution end. The loads needed to be different to show corresponding difference in the consumed power. The number of pulses

produced at the output of ADE7751 is proportional to the power consumed by the load attached at the subscriber/distribution end. Practically, in the EB system, 25000 pulses are considered as one unit, i.e. the power consumed by a 1000 watts load for one hour is equal to one unit.

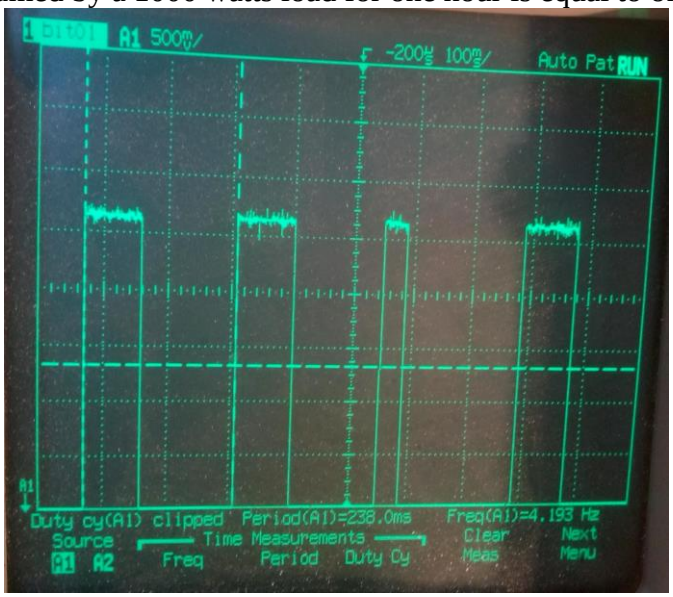

Fig. 7 Output Pulses at pin CF in ADE7751 when a 100 W LOAD is Connected

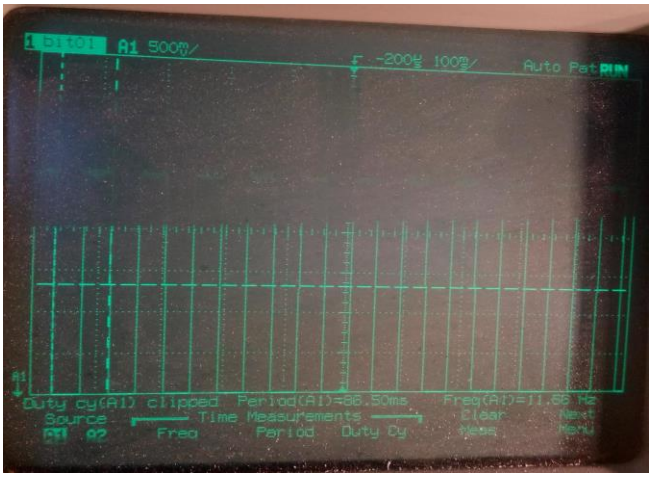

Fig. 8 Output Pulses at pin CF in ADE7751 when a 300 W LOAD is Connected

To make the system user friendly would need a graphical user interface. The GUI could be programmed in Microsoft Visual C++ or Java to communicate with the low level instructions in the Power PC micro-controller to give a user-friendly interface for both the transmitter and receiver. Here we using visual basic graphical user interface software 6.0 for communication.

III. CONCLUSIONS AND FUTURE IMPROVEMENTS

The interesting feature about the device is that it communicates solely through the power lines. This is an implementation of data transmission through power lines. A successful implementation of this technology would open the door to new data services that could also be provided through the power lines. The system is entirely designed to work on single phase, but this can be further extended to work on 3 phase also. Transmission distance for the designed power line modem is few meters, can be improved by upgrading the power line modem. For higher loads exact design of current transformers will provide efficient output. By cryptography the communications can be made much

secured. The present system is used for meter reading for electricity using power line communication. The system can be further modified to detect power theft between pole and individual subscribers by installing the units at each subscriber end.

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