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Power theft identification using ZIGBEE based technology

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ABSTRACT

Wireless electricity theft detection system using ZIGBEE technology present an efficient and less costly way to adulterate the wireless technique used in this research paper. This wireless system is used to overcome the theft of electricity via bypassing the energy meter and hence it also controls the revenue losses and utility of the electricity authorized agency. There is always a contract between the consumer and the supplier that the consumer will pay for the electricity consumed by him. But in India near about 32 % of the electricity is consumed but not paid for it i.e. it is being stolen by the consumer hence the need of a system arises that would overcome this theft of electricity but mostly the electricity is being stolen via bypassing the energy meter hence this system recognizes such type of theft of electricity. Mainly this system consists of microcontroller, energy meter and a ZIGBEE module to check for the theft of electricity and then to send a message to the authorised agency which looks after the electricity consumed. The wireless technique used in this system provides the major advantages such as low power consumption and also the low cost of the ZIGBEE module. This system can also have the advantages that it can also be used to detect the theft of the gas, fuel and oil simply by changing the measurement meter used in this system and excellently the theft can be detected at tables by the authorised agencies.

INTRODUCTION

The theft of the electricity is the major concern of the transmission and distribution losses in the supply of the electricity worldwide. Mainly the electricity is being stolen via bypassing the energy meter therefore this wireless system is utilizes to overcome this type of the theft of the electricity and is very beneficial for the authorised agency to control its revenue loss as all of us know that the cost of fuel is increasing day by day hence the intensity of stealing the electricity and using it as a substitute is also increasing therefore it is needed much to design a system that can detect the theft of the electricity. There are two types of techniques to deliver the information to the authorised agency to control the theft of the electricity via bypassing the energy meter.

- Wired techniques-
  - Electrical cables
  - Coaxial cable
  - Optical fiber
- Wireless techniques-
  - ZIGBEE technology
  - GSM technique
  - WI-FI
  - InfraRed
  - Wi-max
  - Bluetooth

Here this system utilizes the technique named ZIGBEE because all the problems associated with the wired techniques. There are a lot of problems related with the wired techniques such as installation problem, complexity and cost also matters in the case of long haul. The main problem associated is about

the rural areas where it's really very much difficult to install the wired system to convey the information. The ZIGBEE module provides an efficient way to convey this information to the authorized official at low cost as compare to that of the GSM Modem and also utilizes a cell-phone to send the message to the officials having a long battery life. The other wireless techniques such as Bluetooth, infrared etc are having the limitations of range and also of the efficiency. The wireless system based on GSM/GPRS is well known. But the fee is needed of using GSM/GPRS network, and also the cost of hardware system is very high. In this system ZIGBEE technology which works in international free frequency band and access self organization function is adapted to solve the problem in this wireless electricity theft detection system.

ZIGBEE TECHNOLOGY OVERVIEW

An IEEE 802.15.4 standard ZIGBEE is used for data communications with business and consumer devices in free frequency band. It is designed around low-power consumption allowing the batteries to essentially last forever. Operating on Top of the IEEE 802.15.4 Medium Access Control (MAC)and Physical Layer (PHY) wireless standard the ZIGBEE standard provides network security and application support services. Employing a suite of technologies it enables scalable, self-organizing, self-healing networks that can manage various data traffic patterns. ZIGBEE is a low-cost, low-power, wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control applications; the low power-usage allows longer life with smaller batteries, while the mesh network provides high reliability and larger range of operation. ZIGBEE has been developed to meet the growing demand for capable wireless networking between various low power consuming devices. The ZIGBEE alliance is working with the IEEE to ensure an integrated, complete, and interoperable network for the competitive market. The ZIGBEE Alliance will also serve as the official test and certification group for ZIGBEE devices. ZIGBEE is the only standards based technology that addresses the needs of most remote monitoring and control and sensory network applications. The 802.15.4 specification only covers the lower networking layers (MAC and PHY). To achieve inter-operability over a wide range of ZIGBEE module it follows wireless mesh network topology. It's low cost made this to be widely deployed in wireless control and monitoring application worldwide. It uses very low power and hence has a very long battery life. It uses unlicensed 2.4 GHz ISM band which is available worldwide. ZIGBEE has range between 10 m to 2 km and it works well with networks such as Wi-Fi, Ethernet and GPRS and also provides scalable networking solution which makes it suitable to be used in controlling and monitoring application.

I.ZIGBEE Coordinator device

- It is the device of ZIGBEE which starts the signal. It coordinates the signal at the transmitting time in which signal are easily transmitted.
- There is one and only one coordinator per ZIGBEE network.
- This device has the unique responsibility network tree and might bridge to other networks.
- There is exactly one ZIGBEE coordinator in each network.
- It is able to store information about the network, including acting as the repository for security keys.

II. ZIGBEE Router device-

- It is provided the path to the signal at the signal transmitting time.
- A ZIGBEE is a logical device type that can route messages from one node to another.
- Routers can act as an intermediate router, passing data from other devices.

III. ZIGBEE End device

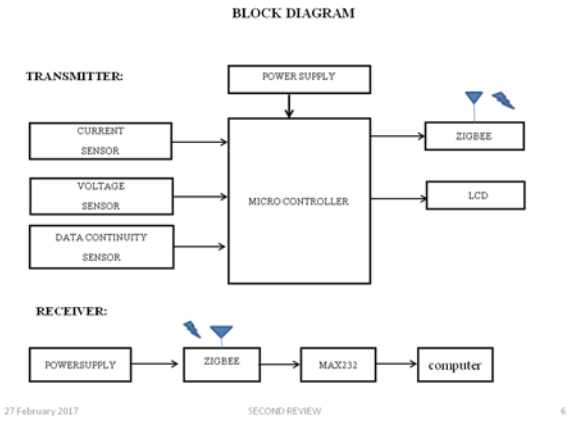
- This is a ZIGBEE term that indicates the device in question has no routing capability.
- It can only send and receive information for its own use.
- An end device functions as a leaf node in a cluster tree network.
- Then nodes in a star network are all end devices except for the coordinator.
- It is used for long battery life.
- It contains just enough functionality to talk to its parent node (either the coordinator or a router); it cannot relay data from other devices.
- It requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC.

3. ZIGBEE Module

ZIGBEE is the standards-based wireless technology designed to address the unique needs of

low-cost, low-power wireless sensor and control networks in just about any market. ZIGBEE can be used almost anywhere, is easy to implement and needs little power to operate. With hundreds of members around the globe, ZIGBEE uses the 2.4 GHz radio frequency to deliver a variety of reliable and easy-to-use standards anywhere in the world. ZIGBEE is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE such as wireless light switches with lamps, electrical meters with in-home-displays, electronic equipments via short-range radio. The technology defined by the ZIGBEE specification is intended to be simpler and less expensive than other
.

BLOCK DIAGRAM



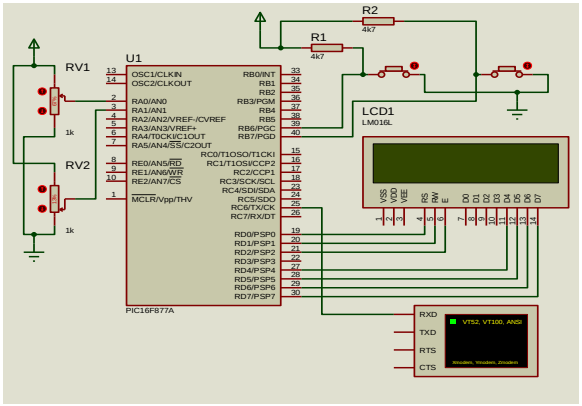
CONSUMER SIDE

Consumer Side of module consists of energy meter, microcontroller, LCD display, voltage sensors, ZigBee Module and power supply unit. The microcontroller continuously monitors the energy meter reading and stealing of electricity. The theft is detected when consumer tempers the meter by by-passing it. The fuses at either side of meter are directly connected through a conducting wire hence the meter will be completely bypassed that actuates voltage sensors. The meter tampering signal is given to microcontroller through opt coupler. The PIC IC is directly interfaced with ZigBee module. This theft signal is displayed on LCD display on consumer side and transmitted to EB side via ZigBee Transmitter. The LCD display indicates the energy consumption in terms of unit consumed, power down, theft detection,

ELECTRICITY BOARD SIDE

Electricity Board Side (EB) can also be called as management side. It includes ZigBee module and Personal Computer System. This end displays units consumed, theft status, and power status (ON/OFF),current bill according to units consumed.

CIRCUITDIAGRAM



A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another and, as a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads.

An AC power supply typically takes the voltage from a wall outlet (mains supply) and lowers it to the desired voltage. Some filtering may take place as well.

A transformer is a device that transfers electrical energy from one circuit to another through inductively coupled conductors, the transformer's coils or windings. Transformer is used here to step down the supply voltage to a level suitable for the low voltage components. The transformer used here is a 230/ (12V-0-12V) step down transformer.

Even though output of rectifier circuit is DC it is not smooth or fixed DC. So filter circuits are

used to convert rippling DC to smooth DC. The filter circuit is a capacitor, connected parallel to the output of rectifier circuit. This smooth DC voltage will be in the range of +12 volts. But we require only 5V supply for the operation of micro controllers and its supporting components. Here again regulator ICs such as 7805 is used to regulate the incoming 12VDC to fixed regulated 5V as output. This DC regulated 5V is applied to the circuits.

For most no critical applications the best choice for a voltage regulator is the simple terminal type. It has only three connections (input, output, and ground) and is factory-trimmed to provide a fixed output. Typical of this type is the 78xx. The voltage is specified by the last two digits of the part number and can be any of the following: 05, 08, 10, 12, 15, 18, or 24. It is to make a +5 volt regulator, for instance, with one of these regulators. The capacitor across the output improves transient response and keeps the impedance low at high frequencies (an input capacitor of at least 0.33□F should be used in addition if the regulator is located a considerable distance from the filter capacitors).

Transistor safe operating area is by reducing available output current for large input to output voltage differential. These regulators are in-expensive and easy to use, and they make it practical to design a system with many printed-circuit boards in which the unregulated dc is brought to each board and regulation is done locally on each circuit card.

Microcontrollers are destined to play an increasingly important role in revolutionizing various industries and influencing our day to day life more strongly than one can imagine. Since its emergence in the early 1980's the microcontroller has been recognized as a general purpose building block for intelligent digital systems.

Microcontroller is a general purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has inbuilt CPU, memory and peripherals to make it as a mini computer. A microcontroller combines on to the same microchip

Markets for microcontrollers can run into millions of units per application. At these volumes of the microcontrollers is a commodity items and must be optimized so that cost is at a minimum.

The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the first RISC based microcontroller fabricated in CMOS (complementary metal oxide semiconductor) that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

Various microcontrollers offer different kinds of memories. EEPROM, EPROM, FLASH etc. are some of the memories of which FLASH is the most recently developed. Technology that is used in pic16F877a is flash technology, so that data is retained even when the power is switched off. Easy Programming and Erasing are other features of PIC 16F877a. The PIC start plus development system from microchip technology provides the product development engineer with a highly flexible low cost microcontroller design tool set for all microchip PIC micro devices. The picstart plus development system includes PIC start plus development programmer The PIC start plus programmer gives the product developer ability to program user software in to any of the supported microcontrollers. The PIC start plus software running under mplab provides for full interactive control over the programmer.

RESULT

The successful development of the prototype hardware has been done and correctly tested for the purpose it is being implemented.

Normal Case
Output

Neutral line cut output

Data line cut output

Voltage output

CONCLUSION

This wireless ZIGBEE technique based system is much useful to detect the stealing of the electricity worldwide. To control the revenue losses the authorized officials needs to detect the theft of the electricity it means the theft of the bypassing is the most effective one over the whole world comparing to the other techniques used to steal the electricity i.e. the unauthorized consumption of the electricity. This system ensures the accurate billing of the electricity consumed hence to provide the best way to prevent from the electricity theft. The supply cut by this system can only be reset by the authorized person of the electricity authorised department therefore this system helps to reduce the manual error and provide an excellent way to detect the bypassing of the energy meter.

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