

**WIRELESS ELECTRICITY THEFT DETECTION SYSTEM USING  
ZIGBEE TECHNOLOGY**SONAL VARSHNEY<sup>1</sup>, ABHINANDAN SINGH<sup>2</sup><sup>1</sup>Electronics and Communication, Galgotias University<sup>2</sup>Electronics and Communication, Galgotias University,

**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 authorised 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 recognises 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

**Keywords-** ZIGBEE TECHNOLOGY, ELECTRICITY THEFT DETECTION, MEDIUM ACCESS CONTROL. INTRODUCTION

**1. INTRODUCTION**

The theft of the electricity is the major concern of the transmission and distribution losses in the supply of the electricity world wide. 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.

- a. Wired techniques-
  - Electrical cables
  - Coaxial cable
  - Optical fiber
- b. 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 authorised 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.

## **2. 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 world wide. 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.

It is having 3 types of device-

### **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.
- A complete mesh network would not contain any end devices, but in practice a design may call for one or more of them.
- It is present at the end.
- 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.

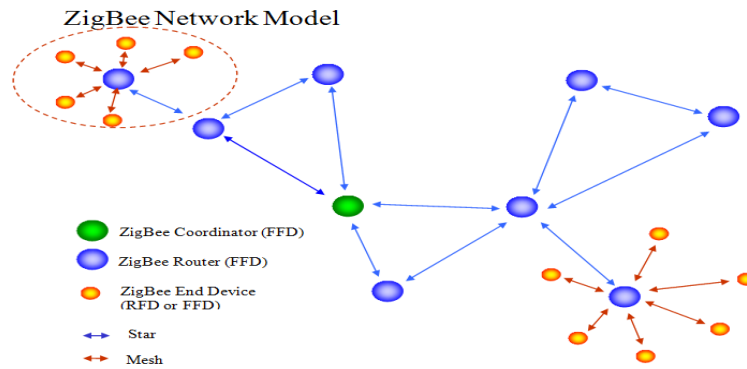


Fig 1. Zigbee network model

### 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 802.15.4-2003 standard for wireless home area networks (WHANs), 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 WPANs, such as Bluetooth. ZIGBEE is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.

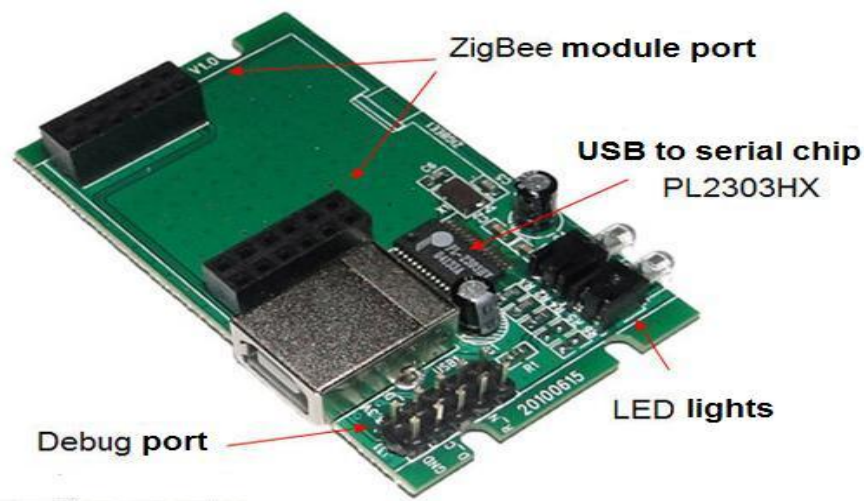


Fig 2. Zigbee module

#### ZIGBEE TYPES-

- ZIGBEE simple
- ZIGBEE pro

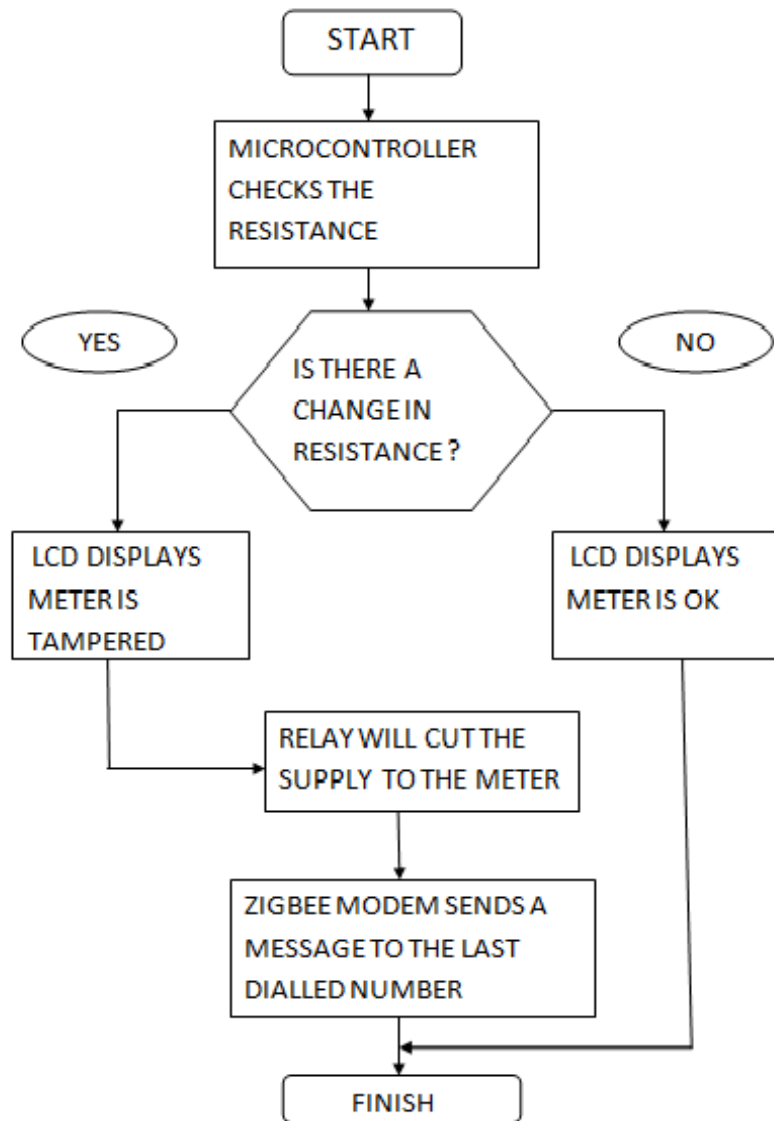
Specification	XBee	XBee-PRO
<b>Performance</b>		
Indoor/Urban Range	Up to 100 ft (30 m)	Up to 300 ft. (90 m), up to 200 ft (60 m) International variant
Outdoor RF line-of-sight Range	Up to 300 ft (90 m)	Up to 1 mile (1600 m), up to 2500 ft (750 m) international variant
Transmit Power Output (software selectable)	1mW (0 dBm)	63mW (18dBm)* 10mW (10 dBm) for International variant
RF Data Rate	250,000 bps	250,000 bps
Serial Interface Data Rate (software selectable)	1200 bps - 250 kbps (non-standard baud rates also supported)	1200 bps - 250 kbps (non-standard baud rates also supported)
Receiver Sensitivity	-92 dBm (1% packet error rate)	-100 dBm (1% packet error rate)
<b>Power Requirements</b>		
Supply Voltage	2.8 – 3.4 V	2.8 – 3.4 V
Transmit Current (typical)	45mA (@ 3.3 V)	250mA (@3.3 V) (150mA for international variant) RPSMA module only: 340mA (@3.3 V) (180mA for international variant)
Idle / Receive Current (typical)	50mA (@ 3.3 V)	55mA (@ 3.3 V)
Power-down Current	< 10 $\mu$ A	< 10 $\mu$ A
<b>General</b>		
Operating Frequency	ISM 2.4 GHz	ISM 2.4 GHz
Dimensions	0.960" x 1.087" (2.438cm x 2.761cm)	0.960" x 1.297" (2.438cm x 3.294cm)
Operating Temperature	-40 to 85° C (industrial)	-40 to 85° C (industrial)
Antenna Options	Integrated Whip, Chip or U.FL Connector, RPSMA Connector	Integrated Whip, Chip or U.FL Connector, RPSMA Connector
<b>Networking &amp; Security</b>		
Supported Network Topologies	Point-to-point, Point-to-multipoint & Peer-to-peer	
Number of Channels (software selectable)	16 Direct Sequence Channels	12 Direct Sequence Channels
Addressing Options	PAN ID, Channel and Addresses	PAN ID, Channel and Addresses
<b>Agency Approvals</b>		
United States (FCC Part 15.247)	OUR-XBEE	OUR-XBEEPRO
Industry Canada (IC)	4214A XBEE	4214A XBEEPRO
Europe (CE)	ETSI	ETSI (Max. 10 dBm transmit power output)*
Japan	R201WW07215214	R201WW08215111 (Max. 10 dBm transmit power output)*
Australia	C-Tick	C-Tick

Table 1. shows also IEEE, ZIGBEE Alliance, and ZIGBEE product end manufacturer particular responsibility for ZIGBEE

The ZIGBEE Alliance specifies the logical network, security, and application software, which are implemented in a firmware stack. It is the ZIGBEE networking stack that creates the mesh networking capability. Each microcontroller/RF chip combination requires its own ZIGBEE stack due to the differences in microcontrollers and RF chips. Typically, the ZIGBEE stack is included with either the microcontroller or RF chip. The stack may belong to the chip vendor, be provided by the chip vendor from a third party source, or be provided by a third party source for a specific microcontroller/RF chip combination. the application layer is defined by profiles, of which there are two types: public profile those certified by the ZIGBEE Alliance for interoperability purposes, and private profiles are for use in closed systems ZIGBEE network model does not use presentation, session or transport layer and user application is directly tied into Application layer (APL). This figure shows also IEEE, ZIGBEE Alliance, and ZIGBEE product end manufacturer particular responsibility for ZIGBEE certified product as well as hardware and software proportion in ZIGBEE.

#### 4. SYSTEM OPERATION

The operation of this system can be explain on the basis of flow chart. Flow chart for explaining the operation is given below-



This flow chart shows that how the system is used to prevent the electricity theft i.e. it firstly the microcontroller 89S51 checks for the resistance and if there is the change in the value of the resistance the supply would cut off and LCD shows that the meter is tampered, but to operate the microcontroller via the relay there is a need of the amplifier circuit because there is no direct access of the relay to the microcontroller. When the load is made off by the microcontroller the ZIGBEE Modem sends this result to the authorised official.

## **5. RESULT**

The successful development of the prototype hardware has been done and correctly tested for the purpose it is being implemented. Here are two types of cases –

1. **Normal condition-** The two of the LED will glow and the meter displays that “meter is OK”.



Fig 2.\_Initial Condition LCD Display

2. Bypassing condition- The resistance change is monitored by the microcontroller and the load will cut out by showing the message that “meter is tempered”.



Fig 3. LCD Display for Bypassing

This system now cannot be reset by the consumer i.e. it now needs a person from the authorised agency to reset the whole of the system. The microcontroller conveys the information to the relay and switches from ON to OFF and power supply to the meter is cut down by the system. Hence the LCD displays the message, “Meter is tempered” and this message is conveyed to the authorised official.

## **6. CONCLUSION**

This wireless ZIGBEE technique based system is much useful to detect the stealing of the electricity worldwide. To control the revenue losses the authorised officials need 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 unauthorised 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 authorised 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. The low cost and the low power consumed by the ZIGBEE module makes it to deploy in most of the wireless system because it uses a cell-phone to send the information and due to the low power consumption it provides long battery life to use this cell-phone. Hence further more and more improvements can be done to make the system much more efficient and excellent also for the long haul. This wireless system provides much better results at short haul but the concern of the long haul depend upon the service employed by the network.

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