

# Energy Monitoring, Assessment and Control System Based on ZigBee

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## Abstract

The aim of this paper is monitoring, control, and assessment of electrical energy consumption. Through an integrated wireless system that saving energy and current, ZigBee Wireless Technology is the leading global standard for implementing low-cost, low-data-rate, short-range wireless networks with extended battery life. The ZigBee alliance is an association of companies working together to enable reliable, cost-effective, low-power, wirelessly networked monitoring and control products based on an open global standard. This Project is implemented using microcontrollers Arduino Uno and ZigBee s2. ZigBee s2 has the ability to send data in a very fast time wirelessly, and this system working according to the programmed Arduino Uno and ZigBee s2. The process is done by linking (ACS712 sensor) to the consumer side (load) and the current value can be reading by the existence of the digital screen which connected to the Arduino. This project was designed to do by reading the current value spent by the consumer. Also, protect consumer from cut off by the monitoring station when the values determined. In Monitoring and follow-up station GSM system has been used. Through this system, we can send a text message writes the consumption of electric current value and the total amount to be paid. This is a very low cost and simple Arduino GSM and GPRS shield. We use the module SIMCom SIM900A.

**Keywords:** *Electrical Energy Consumption, ZigBee, monitoring, control.*

## 1. Introduction

Wireless communication based home automation system has gained a high momentum for the last couple of years. Wireless communication reduces the complexity related to the installation and maintenance compared to its wired counterpart. A typical wireless home automation system. Home automation system has been around for more than a decade comprises battery operated and low power wireless sensors and actuators [1]. Bluetooth, WiFi, and ZigBee are the popular choice for the backbone of such systems. Wireless network based smart home systems have become very popular as they provide comfort [2].

The wireless communication control has advantages in installation and wiring. Consequently, this article designs represents a smart home controlling system because it has a low cost, low power dissipation and easy and simple to

handle and high-range wireless networks with extended battery life. The ZigBee Alliance is an association of companies working together to enable reliable, cost effective, low power. This paper provides a full explanation of ZigBee wireless networking and this smart system consists of three parts. These are, Local Maintenance and Monitoring Station (LMMS) Customer Smart Sensor Units (CSSU) and Global System for Mobile communications (GSM).

This system working with three methods as follow:

- 1- The method of transmitting data from the consumer using ZigBee s2 (Consumer Smart Sensor Unit).
- 2- The method of receiving data in the observation and monitoring station across ZigBee s2 (Local Maintenance and Monitoring Station).
- 3- The method of sending data in a text message to the consumer using GSM system.

## 2. The Method of Work

The proposed system is a wireless low-power scalable sensor network composed of multiple sensor nodes and a link node used as master to establish communication with the remote monitoring center (host node and server) [3]. ZigBee s2 is a wireless electronic piece contains precision parts and it is a pattern developed of Bluetooth and Wifi but it is characterized of them by its ability to broadcast to farther regions, which reach to one mile. Also, ZigBee s2 has other technical characteristics that it does not consume high energy and amperage during working. This project is based mainly on ZigBee s2 according to its ability to send and receive data because it has the ability to send data to one mile of distance. Thus, the basic infrastructure of the project is based on Microcontroller (ATMega328) that existed in the products of Arduino Uno which has high ability to transmit data across Arduino shield to the wireless ZigBee s2 [1]. Fig. 1 bellow show the Energy Monitoring, Assessment and Control System Based on ZigBee by connecting the circuit to ACS712Sensor [4].

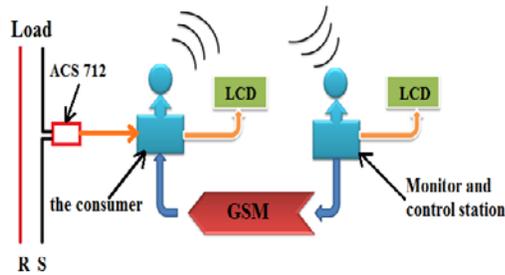


Fig. 1 Energy monitoring, assessment and control system based on ZigBee.

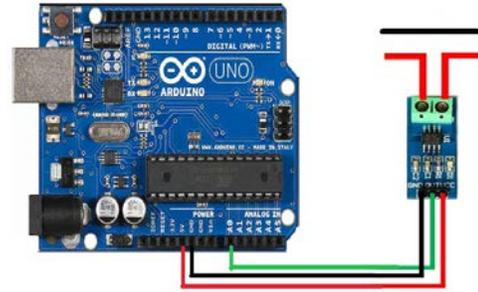


Fig. 3 Sensor ACS712 connect with Arduino.

The used parts in the manufacture of the system is as in Table 1 bellow.

Table 1: The used parts in the project

Name of the Item	Number
ZigBee S2	2
Arduino Uno	2
Arduino Shield	2
Sensor ACS712	1
LCD	3
GSM Kart	1
Arduino GSM Shield	1

### 2.1 Consumer sensor unit

**The method of sending data from the consumer:** First, the load was connected to the current sensor ACS 712 and the ZigBee s2 and LCD were linked to Arduino Uno [5]. Thus, the linked circuit to digital screen is registered the value of the consumed stream. It must be mentioned that, ZigBee s2 is linked with Arduino Uno by using Arduino Shield as showed in the Fig. 2 bellow (Fig. 3).

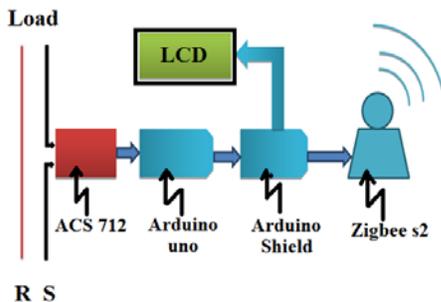


Fig. 2 Sending data from the consumer across the ZigBee s2.

### 2.2 Local maintenance and monitoring station

**The way of receiving data from the observation and following station:** The second part of the project is the unit of receiver or the observation and following station. This side is specialized to receive data from the first side (Consumer Sensor Unit) and this can be done by using ZigBee s2 which receive digital data in the stream value from the consumer and since the ZigBee s2 element is programmed with ZigBee s2 of the consumer and this data which it receives is digital data in (0/1) format .Due to the existence of pins  $D_{in}$  and  $D_{out}$ , the data being sending and receiving where the pin of  $D_{out}$  sends the digital data which received by Arduino Uno and the pin of  $D_{in}$  which found in the receiver side, receives the data as showing bellow in the Fig. 4.

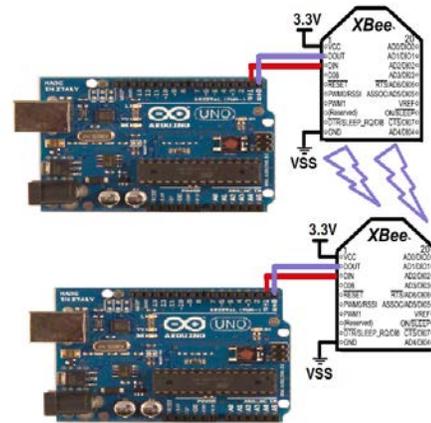


Fig. 4 Communication between Arduino and ZigBee.

This part contains of Arduino Uno, which programmed and linked to LCD screen, which has an 8-bit data bus. This LCD1602 screen contains 2 lines and 16 column. The pins and connection of LCD with Arduino Uno can be shown in Fig. 5 bellow.

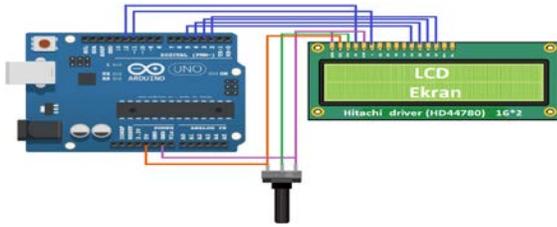


Fig. 5 Connect of Arduino with LCD screen.

The LCD connection pins with the Arduino Uno are as shown in Table 2.

Table 2: The LCD connection pins with the Arduino Uno.

LCD Pins	Arduino Pins
LCD Rs	D12
LCD Enable	D11
LCD D4	D5
LCD D5	D4
LCD D6	D3
LCD D7	D2

The receiver circuit the block diagram can be shown in Fig. 6.

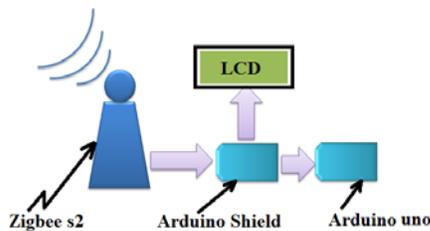


Fig. 6 Receiving data in the observation and monitoring station across ZigBee s2.

Fig. 7 bellow showing the way of linking LCD screen with piece of Arduino Uno according to fritzing program.

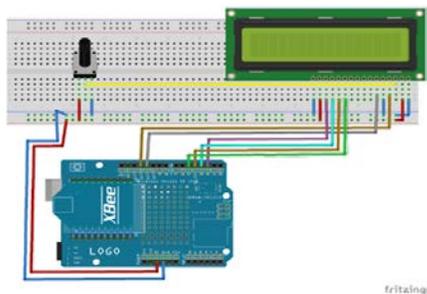


Fig. 7 Fritzing program.

### 2.3 The method of sending data to the consumer across (GSM) unit

This unit is representing the complementary unit of our project. At the unit a text message is sending to the consumer unit, which is, contain amount of the amount to be paid and the quantity of consumed current. This process is done by using the (GSM) system technology with Arduino Uno and this unit is characterized by the existence of microcontroller works in frequency of 850 MHz and 900 MHz and transmit the data with speed of 85.6 Kbps linked through the transmitting ports TX to the second Arduino piece ATmega2560 and this microcontroller is characterized by the existence of 54 digital input and output entrances. This technique is used because it gives the communication ability with 54 mutual and the feature of this microcontroller is that it has the ability of compatible with each Arduino Shields. The programming of ATmega2560 is done by IDE program. The circuit can be linked as showed in the figure 10 bellow. Also, it includes on 16 outlet analogue for each one of them with (10 bits) of different values which may reach to 1024 (Fig. 8)[2].

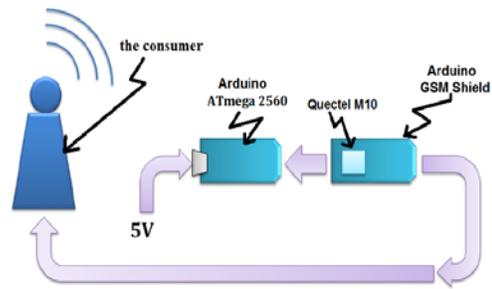


Fig. 8 Global System for Mobile communications (GSM).

### 2.4 Algorithms

The goal of this paper is represent by this project was designed to do by reading the current value spent by the consumer. Also, protect consumer from cut off by the monitoring station when the values determined. The algorithms of our project are shown in Fig. 9 and Fig. 10.

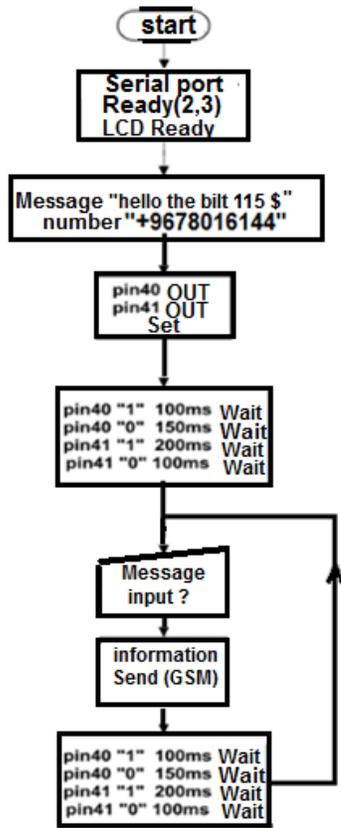


Fig. 9 The algorithm of the control system (GSM).

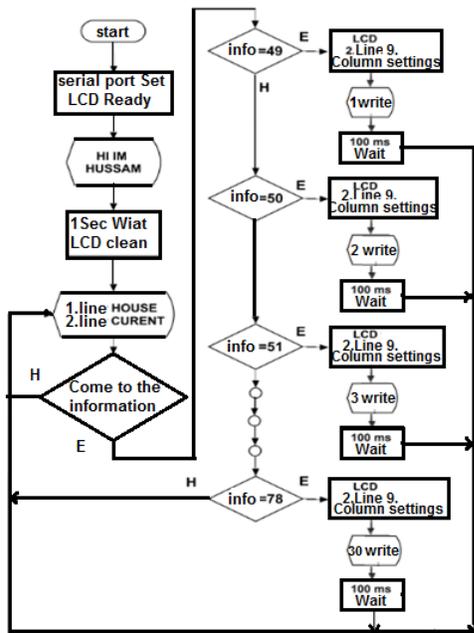


Fig. 10 The algorithm of the control system (Local Monitoring Station).

### 3. Conclusions

This project has an integrated system for monitoring and following up, which called ZigBee s2, and this system has the ability to send data wirelessly and this project is a simplified model that can be expanded in the future.

This project might work as excellent and modern energy counter by using sensors work with a higher than 30 ampere (available is 30 A) by adding Ram to save the data at consumer and monitoring station sides.

This project works for single phase and it can be developed to monitor the three lines three phase by using three pieces of the project at the consumer side or by using integrated expanded project.

### References

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