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Location Based Smart Energy Meter

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Abstract: The paper deals with monitoring and controlling of electric power consumption on real time basis, thereby generating consumption statistics using IOT. It helps the user to know his/her power consumption. This could sub-sequentially reduce the manual work involved in the process of collecting the number of units consumed and for avoiding the manual costs and errors. The setup of this system is simple and does not require much hardware. The main elements are sensors which are interfaced to Intel Galileo Zen 2 with a Wi-Fi module for transmission of data (to the open source IOT platform Thing speak, where statistics can be viewed, thereby controlling can be done).

Keywords: Internet of Things (IOT), ThingSpeak, Wi-Fi module.

1. INTRODUCTION

Life without electricity is unimaginable since human survival and progress is completely dependent on it. The onset of electrification provides opportunities for new and more efficient metering technologies to be implemented in order to fulfill future residential development needs [1]. The consumption of electricity has increased within a few years. In this paper, we propose to you the smart energy meter system. Which will measure the electricity consumption.

A smart meter is usually an electrical meter that records consumption of electric energy in intervals of an hour or less and communicates that information at least once every day to the utility for monitoring and billing purposes. Smart meters enable two-way communication between the meter and the central system. Unlike home energy monitors, smart meters can gather data for remote reporting.

The term Smart meter often refers to an electricity meter, but it can increasingly also mean a device measuring natural gas or water consumption. The smart energy meter is software based, power efficient device that accurately tracks energy consumption and performs the computation. Meter readings can be transmitted to distributors/utilities over wireless media; thus, eliminating the need for manual meter reading collection process. The smart energy meter offers major benefits to both customers and companies in terms of efficiency, reliability, and cost saving.

Imagine if you knew how much energy you were consuming at home at any time of the day, and knew how much energy each device was used, will you stop using those energy hog appliances? or use them at the time of the day when the energy is cheapest? In the economy turmoil, we are currently in, I believe all of us are willing to make those small sacrifices to lower down.

Smart energy meters are devices that will sit in your home, monitor energy data from your electricity meter, and let you know how much energy you are using – this put more control in your hands on how you spend your energy at home. Conventional electricity meters are normally hidden somewhere on a wall in the basement, and the only time you realize how much energy you've been spending is when the bill hit the door.

The new smart meters will provide Indian consumers with information regarding energy consumption that was not previously available with a traditional meter. This system will allow the easy disconnection of defaulted customers and power connections from a remote site. The new smart system is also able to instantly detect tampering with the power lines and sends signals to security personnel if necessary. Utility employees will also have the ability to change a customer's billing method from pre-paid to post-pay in a matter of seconds, without having to physically visit the meter.

In India, the rate per unit changes according to the usage of units, as unit's consumption per month increases i.e. above threshold unit values the cost per unit increases.

2. RESEARCH METHOD

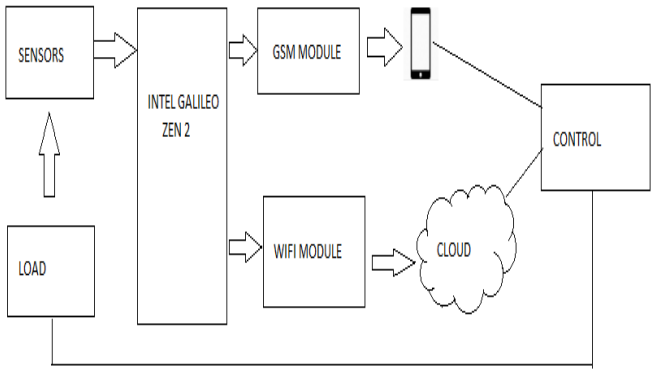

Figure 1: Block Diagram

Figure 1 shows the block diagram of the system architecture, where the installed sensors are connected to the controller board Intel Galileo Zen 2, then with the help of Wi-Fi module it communicates to the server**.**

a. General Description

The primary goal of generating an electricity bill is to calculate a number of units consumed. This depends on three parameters. Current, Voltage.

Time Power = Voltage * Current

Energy = Power * Time

With these basic formulae, we can calculate consumption in units

b. ACS712

Fully Integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor

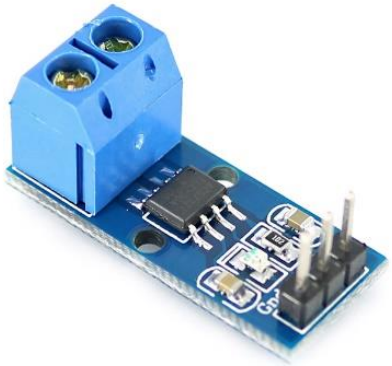

Figure 2: ACS 712

i. Features and Benefits

- Low-noise analog signal path
- Device bandwidth is set via the new FILTER pin
- 5 µs output rise time in response to step input current
- 80 kHz bandwidth
- Total output error 1.5% at TA= 25°C
- Small footprint, low-profile SOIC8 package
- 1.2 mΩ internal conductor resistance
- 2.1 kVRMS minimum isolation voltage from pins 1-4 to pins 5-8
- 5.0 V, single supply operation
- 66 to 185 mV/An output sensitivity

- Output voltage proportional to AC or DC currents
- Factory-trimmed for accuracy
- Extremely stable output offset voltage
- Nearly zero magnetic hysteresis
- Ratiometric output from supply voltage

ii. Description

The ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switch mode power supplies, and overcurrent fault protection. The device is not intended for automotive applications. The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flow through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sampling. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the signal leads (pins 5 through 8). This allows the ACS712 to be used in applications requiring electrical isolation without the use of optoisolators or other costly isolation techniques.

The ACS712 is provided in a small, surface mount SOIC8 package. The lead frame is plated with 100% matte tin, which is compatible with standard lead (Pb) free printed circuit board assembly processes. Internally, the device is Pb-free, except for flip-chip high-temperature Pb-based solder balls, currently exempt from RoHS. The device is fully calibrated prior to shipment from the factory [3].

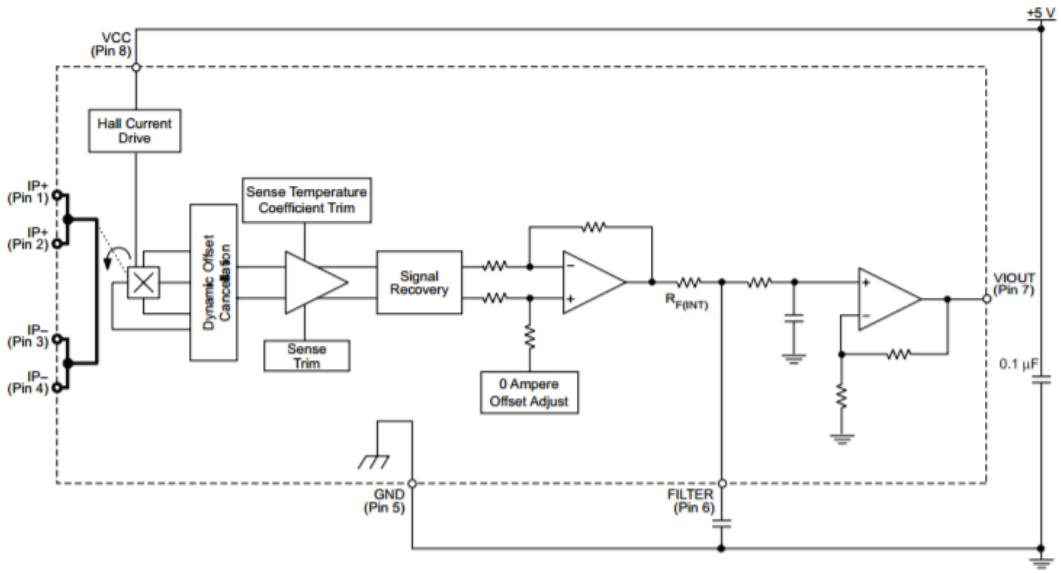

Figure 3: ACS 712 Block Diagram

c. Voltage Sensor

Voltage can be sensed by using an AC adapter, in order to scale down the output voltage to less than 5v a voltage divider circuit is used and DC bias is added to stabilize the signal. The adaptor voltage output (AC) implemented in the system was 9V for 230V input when it is loaded, in no load condition due to the transformer regulation it is 25 % higher which also depends upon the adaptor design conditions. The voltage divider divides the circuit voltage further so that the actual input to Arduino will be less than 5V [2].

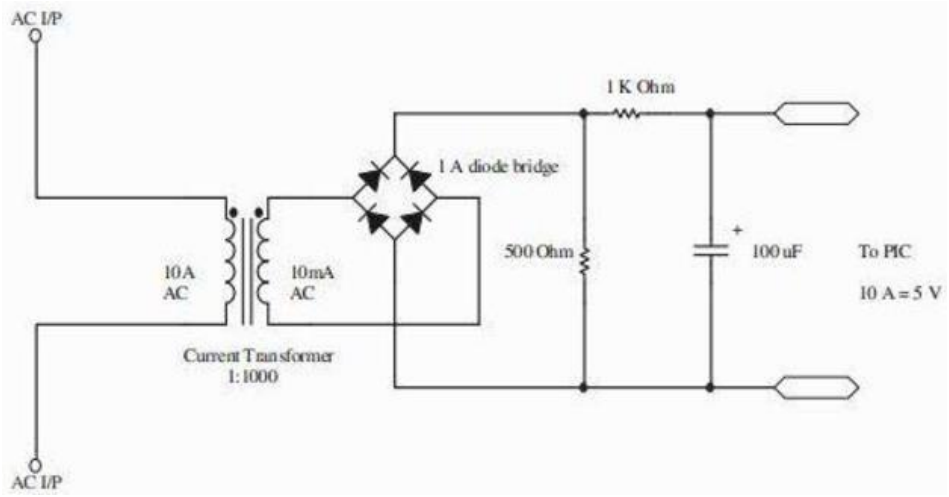

Figure 4: Circuit Diagram for Voltage Measurement

d. Intel Galileo zen2

The Intel Galileo Gen 2 development board is a microcontroller board based on the Intel Quark SoC X1000 application processor, a 32-bit Intel Pentium brand system on a chip (SoC). It is the first board based on Intel® architecture designed to be hardware and software pin-compatible with shields designed for the Arduino Uno* R3.

This platform provides the ease of Intel architecture development through support for the Microsoft Windows, Mac OS, and Linux host operating systems. It also brings the simplicity of the Arduino integrated development environment (IDE) software.

The Intel Galileo Gen 2 board is also software-compatible with the Arduino software development environment, which makes usability and introduction a snap. In addition to Arduino hardware and software compatibility, the Intel Galileo Gen 2 board has several PC industry standard I/O ports and features to expand native usage and capabilities beyond the Arduino shield ecosystem. A full-sized mini-PCI Express* slot, 100 Mb Ethernet port, Micro-SD slot, 6-pin 3.3V USB TTL UART header, USB host port, USB client port, and 8 Mbyte NOR Flash* come standard on the board.

Intel Galileo Gen 2 improves on Gen 1 by replacing the RS-232 console port with a 6-pin 3.3V USB TTL UART header. New additions to the Intel Galileo Gen 2 board include 12-bit pulse-width modulation (PWM), console UART1 redirection to Arduino* headers, 12V Power-over-Ethernet (PoE) capability, and a power regulation system that accepts power supplies from 7V to 15V.

3. TESTING

The Values of the voltage and the current for precision can be tested by establishing a USB connection between Galileo and Computer. The values can be seen using a "Serial Monitor" which is present in the Arduino IDE.

```
You're connected to the networkSSID:
BSSID: 8:4:E8:A0:0:0
signal strength (RSSI):0
Encryption Type:0

IP Address: 255.255.255.255
255.255.255.255
MAC address: BF:9E:71:D8:8:5

Sensor 1=515    224.522mV       0.146Amps       Power 33
Sensor 2=514    224.086mV       0.098Amps       Power 22
lastConnectionTime:
1205
Connecting to ThingSpeak...


Sensor 1=514    224.086mV       0.098Amps       Power 22
Sensor 2=515    224.522mV       0.146Amps       Power 33
lastConnectionTime:
21574
Connecting to ThingSpeak...


Sensor 1=522    227.574mV       0.488Amps       Power 112
Sensor 2=516    224.958mV       0.195Amps       Power 44
lastConnectionTime:
42041
Connecting to ThingSpeak...


Sensor 1=506    220.598mV       -0.293Amps      Power 67
Sensor 2=515    224.522mV       0.146Amps       Power 33
lastConnectionTime:
62619
Connecting to ThingSpeak...
```

Figure 5: Serial Monitor Output

4. RESULTS AND IMPLEMENTATION

a. Prototype for System Architecture

Figure 6 is the prototype of how the system has been implemented for a prototype purpose, where we have a Current sensor in red colour at phase wire, Galileo board, with Wi-Fi module and Antennas for transmitting the data wirelessly. Installing the sensor components is quite an easy task. This implementation had brought a great precision in the values obtained for several different long duration tests.

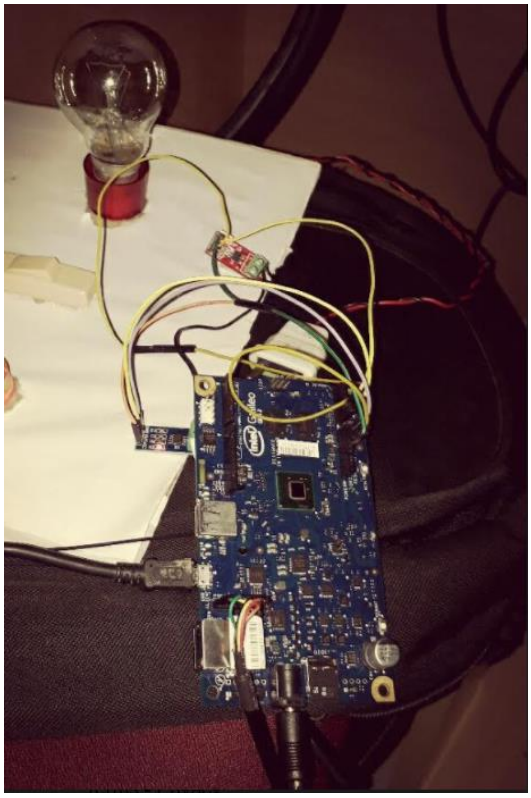

Figure 6: Implementation Prototype

b. Web Implementation

The Internet of Things provides access to a broad range of embedded devices and web services. ThingSpeak is an open data platform and API for the Internet of Things that enables you to collect, store, analyse, visualize, and act on data from sensors or actuators, such as Arduino, Raspberry Pi, BeagleBone Black, and other hardware. For example, with ThingSpeak you can create sensor-logging applications, location-tracking applications, and a social network of things with status updates so that you could have your home thermostat control itself based on your current location.

The primary element of ThingSpeak activity is the channel, which contains data fields, location fields, and a status field. After you create a ThingSpeak Channel, you can write data to the channel, process and view the data with MATLAB code, and react to the data with tweets and other alerts. The typical ThingSpeak workflow lets you:

Create a Channel and collect data

Analyse and Visualize the data

Act on the data using any of several Apps

The ThingSpeak API is available on GitHub and includes the complete ThingSpeak API for processing HTTP requests, storing numeric and alphanumeric data, numeric data processing, location tracking, and status update.

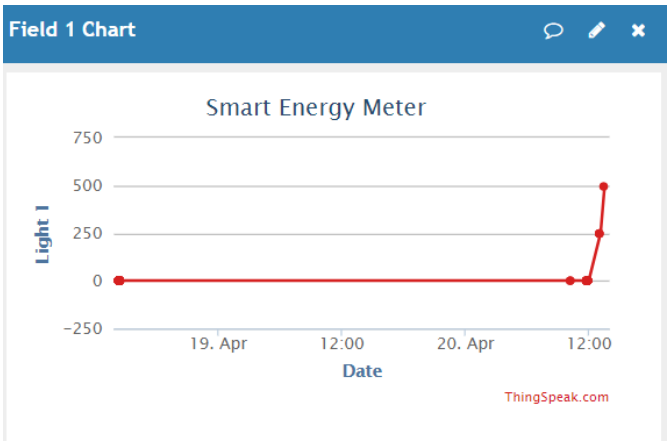

Figure 7: Smart Energy Meter – ThingSpeak Output

CONCLUSION

The proposed system helps the user to login to the thing speak whenever required from any place and he can remotely access the appliances and can control the wastage, And the future scope of the project is to introduce automatic billing therseby generating bill automatically and the user pays with ease.

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