SMART ENERGY METER

A B-Tech Project submitted in partial fulfillment

for the Degree of B. Tech in EE

of

MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY

by

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Project Report

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Under

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Certificate of Recommendation

This is to certify that the project entitled "**SMART ENERGY METER**" submitted by **Ritam Giri (10701616038), Suman Mollick (10701616014), Kuntal Khanra (10701616046)** for the award of Bachelor of Technology in Electrical Engineering at College of Engineering and Management, Kolaghat under Maulana Abul Kalam Azad University of Technology (formerly known as West Bengal University of Technology) is absolutely based upon their own work under the supervision of ***Prof. Shankar Prashad Ghosh*** and that neither their project nor any part of the project has been submitted for any Degree/Diploma or any other academic award anywhere before.

CERTIFICATE OF APPROVAL

The foregoing project entitled "**SMART ENERGY METER**" is hereby approved as a creditable study of B.Tech in EE and presented in a manner satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion there in but approve this thesis only for the purpose for which it is submitted.

Committee for
Evaluation of the Thesis

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ACKNOWLEDGEMENT

We consider it our privilege to express our ideas through the pages of this report a few words of gratitude and respect to all those who guided, supported and inspired us in the partial completion of the project entitled as “SMART ENERGY METER”.

We owe our thanks to our project guide prof. Shankar Prasad Ghosh for his kind and timely help offered to us during our studies and execution of our project. His untiring effort is a big reason for our success. We are grateful to Electrical Engineering department, College of Engineering and Management, Kolaghat, for giving us this opportunity to develop our practical skills and knowledge by introducing this kind of project.

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Ritam Giri Suman Mollick Kuntal Khanra

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CHAPTER 1

1.1 INTRODUCTION

There are two types of Domestic Ordinary Power Consumers meters single phase and three phases. The energy consumption is measured by all electrical services using kilowatt- hours meter with refer to kilowatt-hours (kWh). Then electronic meters were introduced with similar function with the electro-mechanical, but it replaces from analog to digital system. With this system users can note down the voltage, power reading unit, current and the time, date of the energy consumption. This system just gives some advantages over the previous meter reading. After the electronic ones, the meter reading developed with the Bluetooth based technology which is the wireless communication and also known as Automatic Meter Reading (AMR). This system is wireless and the personal computer could be used to record the power consumption of energy meter. The reading meter will be saved to the database and bill will be generated. The latest technology is using a Global System for Mobile Communication (GSM).

1.2 HISTORY OF ENERGY METERS

- In past years, the common type of energy meter was the electromechanical induction watt-hour meter. The electromechanical meters operates by counting the revolutions of a nonmagnetic, but electrically conductive, metal disc which is made to rotate at a speed proportional to the power passing through the meters. The number of revolutions is thus proportional to the energy uses.
- From previous decades, electronic meters were widely used. Electronic meter displays the energy used, on an LCD or LED display, and some can also transmit readings to remote places. In addition to measuring energy used, electronics meter that can also records other parameters that can also load and supply such as instantaneous and maximum rate of usage demands.
- Today Solid-state energy meters being used. Solid-state of energy meter has a power supply, a metering engine, a processing and communication engine (i.e. a microcontroller), and other add- modules such as RTD, LCD display, communication port/modules and so on.
- The metering engine is given by the voltage and current input and has a voltage reference, samples and quantizes followed by and section and yield the digitized equivalents of all the inputs. These inputs are then processed using a digital signal processor to calculate the various metering parameters such as powers, energies etc.
- The processing and communication section has the responsibility of calculating the various derived quantities from the digital values generated by the metering engine. The also has the responsibility of communication using varies protocols and interface with other add-on

modules connected as slaves to it.

1.3 OVERVIEW OF THE SYSTEM

The System consists of hardware and software part. Figure, the hardware parts, shows the block diagram of energy meter project that the users can monitor their home current power consumptions anytime and anywhere. As for the software part, all the program located in Arduino UNO, using programming language. Arduino UNO, as the main controller, connects energy meter, GSM module, and other sensors/peripherals so they can communicate each other. And Arduino UNO can only work after we uploaded the designed program into it.

By introducing this kind system the need of manpower (those issued by electricity board for collection of data) will be minimized because customer can directly access the data related to energy consumption of his/her house.

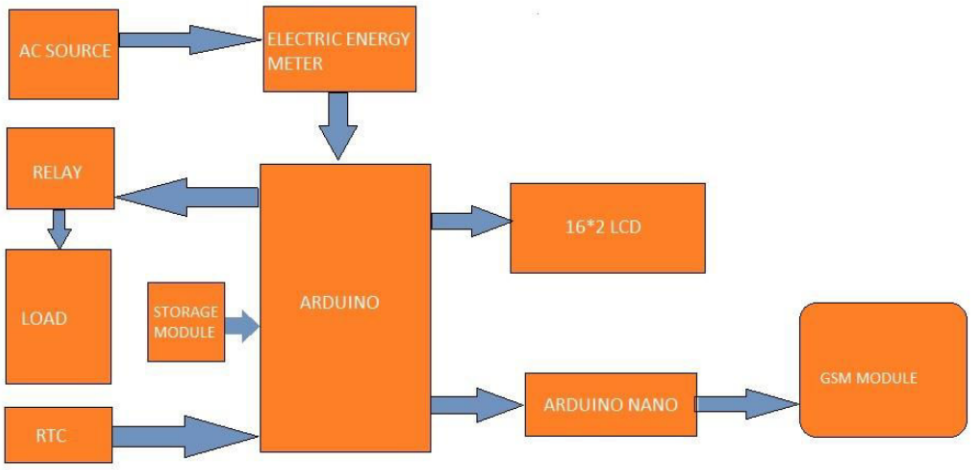


Fig: Block diagram of the system

CHAPTER 2

2.1 CIRCUIT DIAGRAM

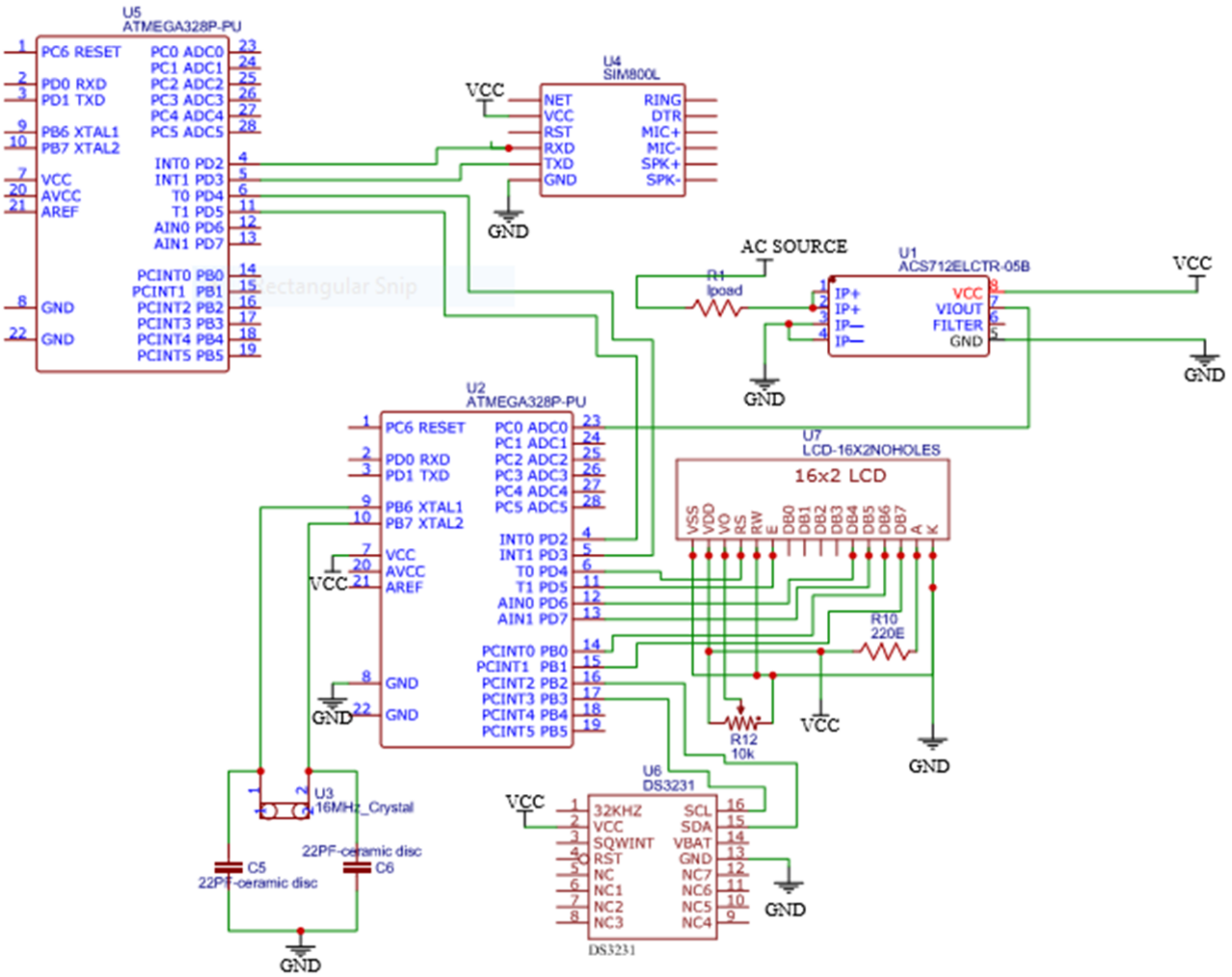
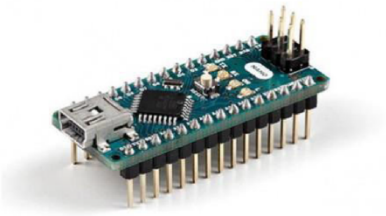


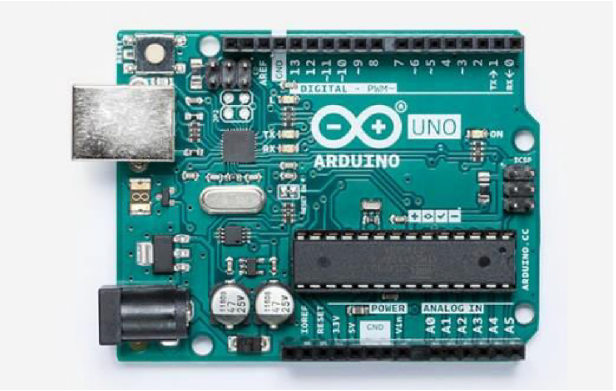
Fig: Circuit diagram of the smart energy meter

2.2 HARDWARE OF THE SYSTEMS

- **MICROCONTROLLERS:**

  A microcontroller is an integrated circuit that contains processor core, memory and programmable input and output peripherals. It also known as small computer that designed for embedded applications. Here we use two microcontrollers' arduino Nano and arduino Uno. The arduino Nano is a small, complete and breadboard friendly board based on the ATmega328P. It lacks only a DC power jack, and works with a mini B USB cable instead of standard one. Arduino Uno is an open source microcontroller board based on the microchip ATmega328P microcontroller and developed by arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.



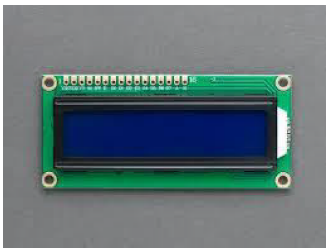


- **GSM 800A Module:**

  The SIM800A Quad Band GSM/GPRS Module with RS232 Interface is a complete Quad-band GSM/GPRS solution in a LGA (Land grid array) type which can be embedded in the customer applications. SIM800A support Quad-band 850/900/1800/1900 MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 100 x 53 x 15 mm, it can fit into slim and compact demands of customer design. The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to Serial connector or to the micro-controller using the RS232 to TTL converter. Once you connect the SIM800A modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manger of the USB to Serial Adapter. Then you can open Putty or any other terminal software and open a connection to that COM port at 9600 baud rate, which is the default baud rate of this modem.

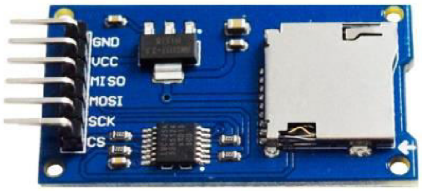
- **LCD Display:**

  LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen,setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD.



- **Storage Module:**

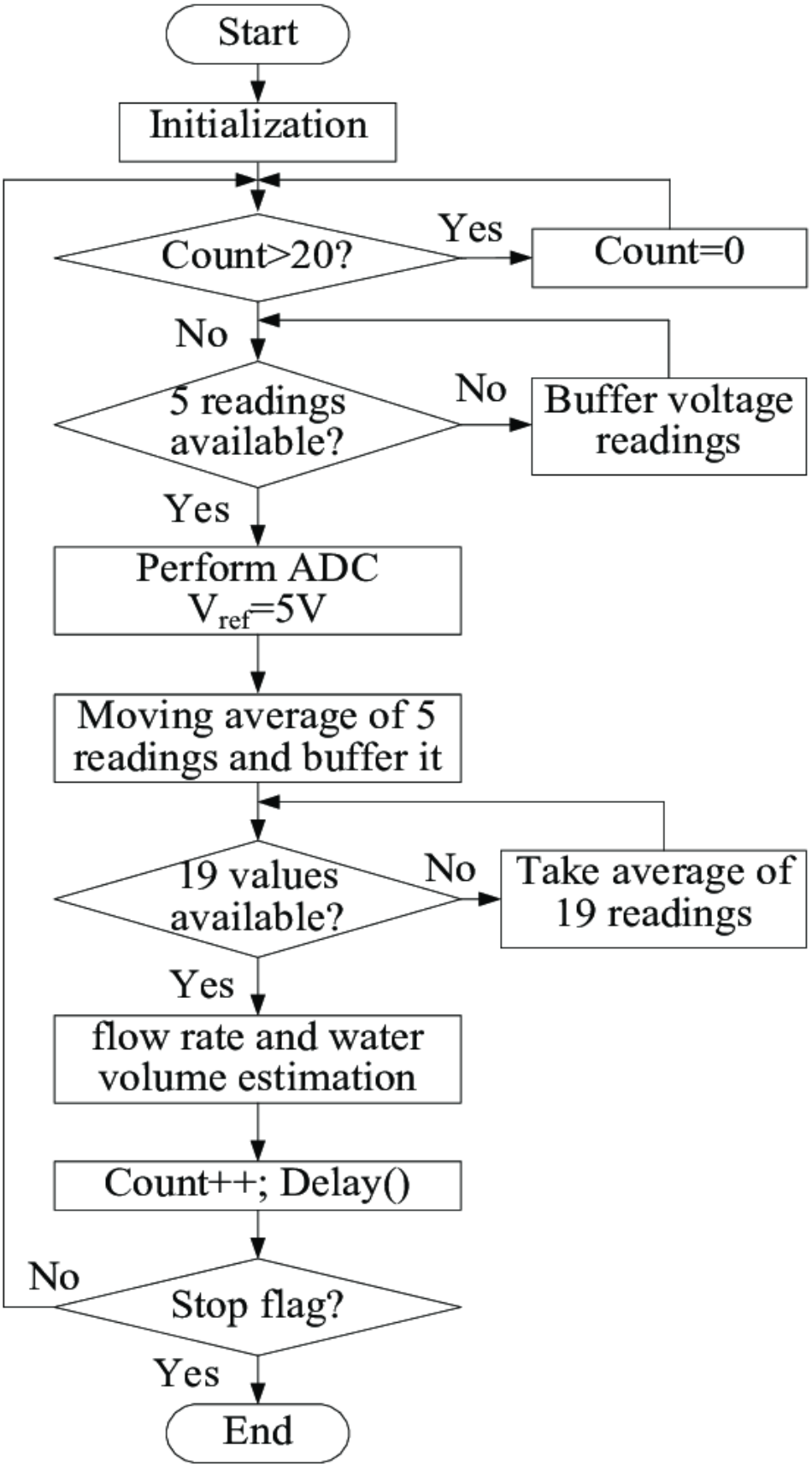
  The micro- SD Card Module is a simple solution for transferring data to and from a standard SD card. The pin out is directly compatible with Arduino, but can also be used with other microcontrollers. It allows you to add mass storage and data logging to your project. This module has SPI interface which is compatible with any SD card and it use 5V or 3.3V power supply which is compatible with Arduino UNO/Mega.SD module has various applications such as data logger, audio, video, graphics.This module will greatly expand the capability an Arduino can do with their poor limited memory.



2.3 SOFTWARE OF THE SYSTEMS

Figure shows the flowchart of the program used in the project, developed in C language with the Arduino syntax in the Arduino IDE. The software is also used for loading the program code into Arduino board. In this project, the arduino IDE was used to program, create, debug and upload the coding into the microcontroller. There are parts that need to be program which are digital write input/output, GSM network, Real time clock and EEPROM. Each program need to include the libraries of the coding such as for GSM use GSM.h or SIM900.h and other type of libraries but it depend on the coding requirement.In the RTC coding, the real time get the time from the laptop for the first time when the program uploaded, and then it will continue as normal watch until we upload the new time. For the EEPROM coding, it writes 2 byte and read back 2 byte the data we write. To save the space, the EEPROM just store the bill for every 30 minutes pulse count and it can store up to 1 Kb. The data will not delete even the power breakout because EEPROM is non-volatile memory. ‘Count’ is the unit of pulse for every 1Wh. In this project, if the Count is less than and equal to 10, the unit will be multiple with RM 0.22 but in the real tariff for the first 200KWh must be multiple by RM0.218. For the next 100KWh the tariff is 0.334 while the net 300KWh is RM0.516. For this project, the tariff block and the bill range in small scale for simplification. The whole flowchart of the software system will be given on the next page which gives the details of the program, its execution.

 Flowchart of the system



CHAPTER 3

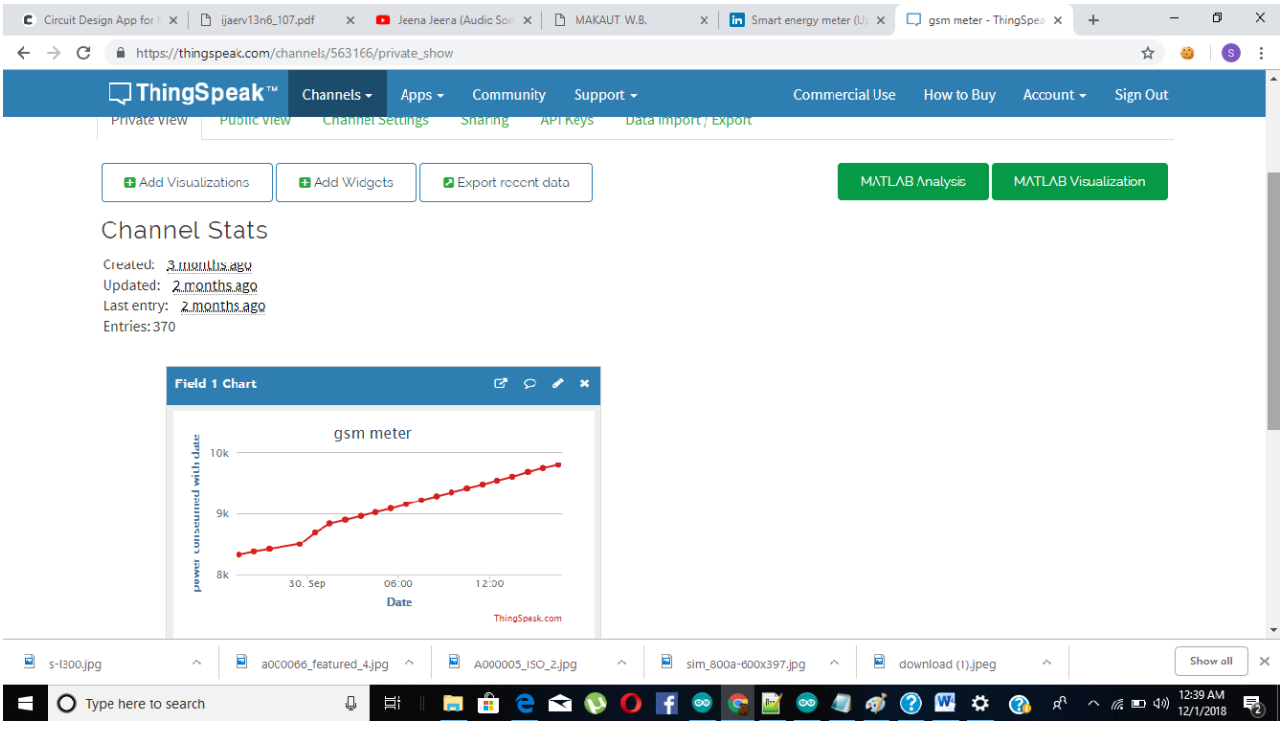
3.1 ACCESSING THE DATA

The data is send to the server through Arduino Nano from where we can access the data. Here we use thingspeak server. By giving the corresponding API keys to the server we can access the data. For accessing the data related to the energy consumed by this smart meter we have to give the following data in the thingspeak server:

Channel id: 563166

API keys: LQNMRNIUD56UKFOM

Figure shows the representation of the data that can be accessed by the electricity service provider as well as the customer w.r.t the above mentioned id and API keys:



3.2 RESULT & DISCUSSION

There are two parts that was combined to make the system. The two parts that was combined were circuit for interfacing energy meter to arduino and interface from GSM module to Arduino. Circuit operation was in good condition with the right sequence of program that uploaded into microcontroller. For the light to voltage sensor part, Arduino with microcontroller ATmega238 was used to count the input, calculate the bill and store it into EEPROM. Real Time Clock was used to set the reset counter every month. LED indicator was blinking when input from sensor detected. The value of unit and bill price was display at the LCD display as set in the microcontroller. At the program, the number of mobile phone user was set to receive a message when limit reach. In GSM network, the network plan SIM card was used to transmit data to mobile phone. To combine this two part system, the GSM module Tx and Rx was connected to pin 2 and 3 respectively to Arduino while RTC used analog pin A4 and A5 at Arduino for CLOCK and RS. The other components such as LCD, LED and light to voltage sensor were connected to digital port 4 to 13. If the users want to check their current bill, they open the thingspeak server and after that they have to give customer id and API keys to access the data which they have consumed.

3.3 FUTURE ASPECTS

This smart energy meter provides high accuracy, real time operation, live billing display facility, previous units display facility which is far more acceptable, useful compared to standard energy meters. It also reduces the human labor. For this reasons smart meter has the potential to replace standard meters in future. Despite of its advantages it has some disadvantages also. Such as billing system fails with the absence of GSM network, charges may be applicable for network use, requires fix GSM number. Smart meters are racing to eclipse the antiquated rate design of fixed charges and estimated bills. However, you don't need to throw the baby out with the bathwater. Utilities can optimize rate design with other demand-side management or distributed energy resources (DER) to achieve defined targets. One design in particular, time-variant pricing, communicates to customers when it is less costly to consume energy — more efficiently than ever before. When energy demand peaks, system costs climb, too. Those increases, in turn require more expensive generation capacity and physical infrastructure. As a result, customers who can't benefit from alternative rate designs are subject to imbalanced prices and don't have the ability to manage their usage in a cost-effective way. With these needs and shortcomings in mind, utilities are exploring mechanisms to reduce peak load and thereby provide cost savings to all customers.

3.4 CONCLUSION

This article proposed new approach of energy meter monitoring system by using Arduino UNO as microcontroller and GSM module as interface with the users in the purpose of the flexibility of the customers to monitor their current bill or power consumptions usage from anywhere with their mobile phones. The results showed that the system works successfully. Future research is controlling the energy meter; meaning instead of just monitoring the meter, usage, power consumption, controlling them will be one step further, so that the users can even control their bill, usage, power consumptions by themselves remotely from their mobile phones

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3.5 REFERENCES

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