

Design, Development and Analysis of IOT based Energy Meter

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Abstract- The energy meter is one of the commonly used instruments in the field of electricity. This device keeps track of power consumption and help to prepare bill to the consumer. This device has been used from many years and continuously evolving to provide better option. It has been shifted from mechanical energy meter to electronic energy meter. In case of a standard energy meter the power providing company employ or outsource person to collect the data, which time consuming same time at huge amount of recurring investment. If the data can be transmit to a centralize location or server the entire process will save time as well as cost to the company. In this field many improvement has been added by using different communications like GSM communications, XBEE s etc. Currently the IoT is the most buzzing word in the field of auto machine industry. An IoT based energy meter is present in our project work.

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I. Introduction

The energy meter is one of the commonly used instruments in the field of electricity. This device keeps track of power consumption and help to prepare bill to the consumer. This device has been used from many years and continuously evolving to provide better option. It has been shifted from mechanical energy meter to electronic energy meter. In case of a standard energy meter the power providing company employ or outsource person to collect the data, which time consuming same time at huge amount of recurring investment. If the data can be transmit to a centralize location or server the entire process will save time as well as cost to the company. In this field many improvement has been added by using different communications like GSM communications, XBEE s etc. Currently the IoT is the most buzzing word in the field of auto machine industry. An IoT based energy meter is present in our project work. The primary objective of the project work is to design an electronic system which can be attached with a conventional energy meter. The system will collect the pulse from the energy meter and calculate the unit consume and transmit the data directly to a data base server over a Wi-Fi communication. Followings are the primary feature of the system

- ✓ Microcontroller based designing for flexibility and upgradability
- ✓ Implementation of optical data pulse capturing for non-invasive method.
- ✓ Wi-Fi communication for reliable and economical way of long distance communication over internet or intranet.
- ✓ Use of free ware and open source system like MySQL and PHP along with WAMP server.
- ✓ Easy porting from windows server to Linux base server.
- ✓ Use of easily available component with low cost.

Smart energy meter-It is an advanced metering technology involving placing intelligent meters to read, process and feedback the data to customers. It measures energy consumption, remotely switches the supply to customers and remotely controls the maximum electricity consumption. Smart metering system uses the advance metering infrastructure system technology for better performance.

IoT (Internet of things)-The Internet of Things (IoT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. The IoT allows objects to be sensed or controlled remotely across existing network infrastructure, creating opportunities for more direct integration of the physical world into computer-based systems, and resulting in improved efficiency, accuracy and economic benefit in addition to reduced human intervention. When IoT is augmented with sensors and actuators, the technology becomes an instance of the more general class of cyber-

physical systems, which also encompasses technologies such as smart grids, virtual power plants, smart homes, intelligent transportation and smart cities.

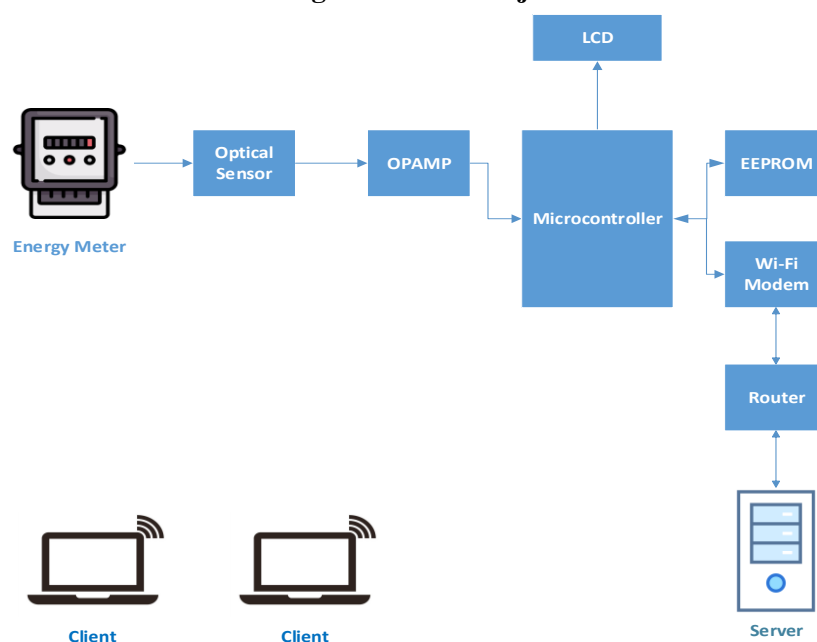
Wi-Fi Communication-WiFi or Wi-Fi is a technology for wireless local area networking with devices based on the IEEE 802.11 standards. Wi-Fi is a trademark of the Wi-Fi Alliance, which restricts the use of the term Wi-Fi Certified to products that successfully complete interoperability certification testing. Wi-Fi most commonly uses the 2.4 gigahertz UHF and 5.8 gigahertz SHF ISM radio bands. Anyone within range with a wireless modem can attempt to access the network; because of this, Wi-Fi is more vulnerable to attack (called eavesdropping) than wired networks. Wi-Fi Protected Access is a family of technologies created to protect information moving across Wi-Fi networks and includes solutions for personal and enterprise networks. Security features of Wi-Fi Protected Access constantly evolve to include stronger protections and new security practices as the security landscape changes. Increasingly in the last few years (particularly as of 2007), embedded Wi-Fi modules have become available that incorporate a real-time operating system and provide a simple means of wirelessly enabling any device which has and communicates via a serial port. This allows the design of simple monitoring devices. An example is a portable ECG device monitoring a patient at home. This Wi-Fi-enabled device can communicate via the Internet.

II .Objective Of The Project

The primary objective of the project work is to design an electronic system which can be attached with a conventional energy meter. The system will collect the pulse from the energy meter and calculate the unit consume and transmit the data directly to a data base server over a Wi-Fi communication. Followings are the primary feature of the system

- Microcontroller based designing for flexibility and upgradability.
- Implementation of optical pulse capturing for non-invasive method.
- Wi-Fi communication for reliable and economical way of long distance communication over internet or intranet.
- Remote Monitoring Of the Energy Meter
- Auto POSTING of data into Server
- Removal of Redundant human involvement
- Remote power cut-off for non Payment of bill
- Remote cut-off of loads from Consumer side
- In-built data storage of maintain data integrity
- Use of free ware and open source system like MySQL and PHP along with WAMP server.
- Easy porting from windows server to Linux base server.
- Use of easily available component with low cost.

III. Block Diagram of The Project



IV. Circuit Diagram

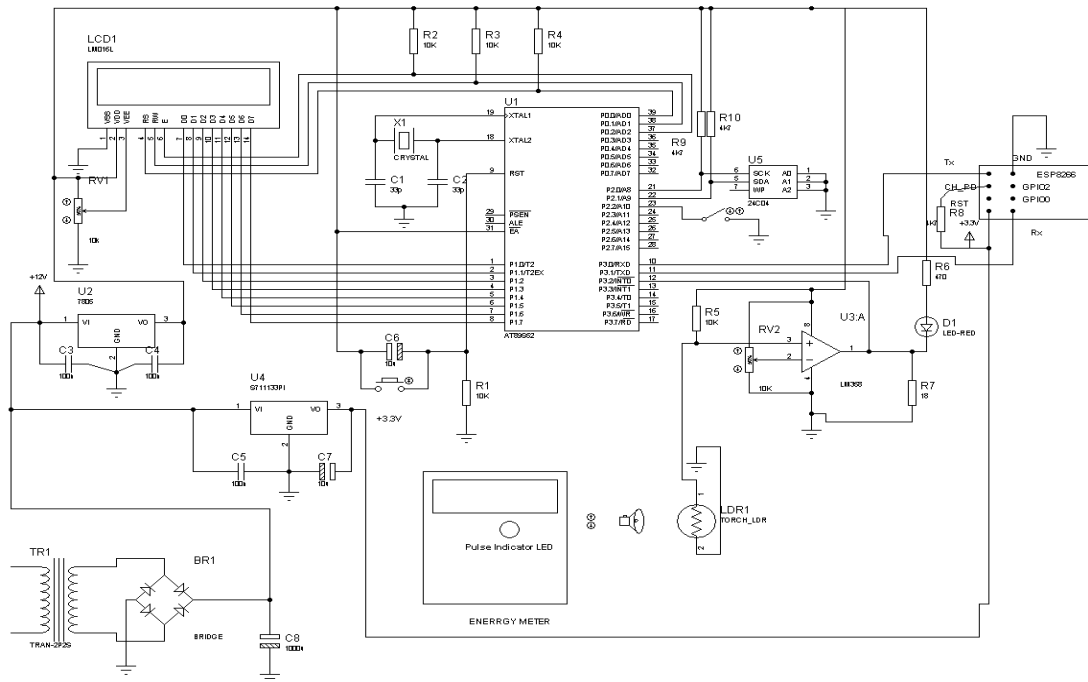


Fig: Circuit diagram of the system

V. Flow Chart of The System

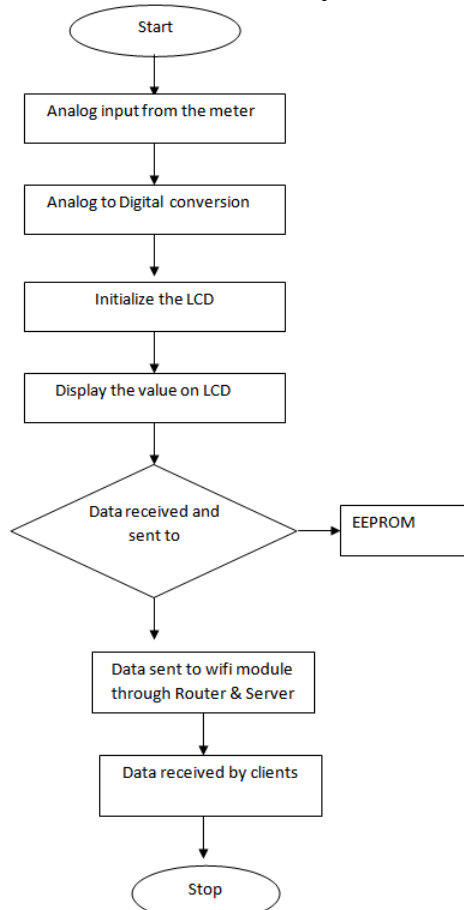


Fig: flow chart of the system

VI. Working Principle

The Internet of Things (IoT), also sometimes referred to as the Internet of Everything (IoE), consists of all the web-enabled devices that collect, send and act on data they acquire from their surrounding environments using embedded sensors, processors and communication hardware. These devices, often called "connected" or "smart" devices, can sometimes talk to other related devices, a process called machine-to-machine(M2M) communication, and act on the information they get from one another. Humans can interact with the gadgets to set them up, give them instructions or access the data, but the devices do most of the work on their own without human intervention. Their existence has been made possible by all the tiny mobile components that are available these days, as well as the always-online nature of our home and business networks.

Connected devices also generate massive amounts of Internet traffic, including loads of data that can be used to make the devices useful, but can also be mined for other purposes. All this new data, and the Internet-accessible nature of the devices, raises both privacy and security concerns.

But this technology allows for a level of real-time information that we've never had before. We can monitor our homes and families remotely to keep them safe. Businesses can improve processes to increase productivity and reduce material waste and unforeseen downtime. Sensors in city infrastructure can help reduce road congestion and warn us when infrastructure is in danger of crumbling. Gadgets out in the open can monitor for changing environmental conditions and warn us of impending disasters.

These devices are popping up everywhere, and these abilities can be used to enhance nearly any physical object.

VII. Implementation Of The Smart Energy Meter

A. Software implementation

Proteus is one of the most famous simulators. In this case Proteus ISIS is for simulation from the schematic form of the hardware and also the micro-controller code. It is possible to develop and test designs before a physical prototype is constructed. Proteus ISIS (Intelligent Schematic input system) is used to draw schematics and simulate the circuits in real time. Embedded system is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Keil C Compilers are based on the ANSI standard and include extensions necessary to support the 8051, 251, and 166 microcontroller families. The optimizer in our compiler is tuned for each specific architecture and provides the highest level of code density and execution speed.

MySQL has received positive reviews, and reviewers noticed it "performs extremely well in the average case" and that the "developer interfaces are there, and the documentation (not to mention feedback in the real world via Web sites and the like) is very, very good". It has also been tested to be a "fast, stable and true multi-user, multi-threaded sql database server". Database is a collection of related data and data is a collection of facts and figures that can be processed to produce information. Mostly data represents recordable facts. Data aids in producing information, which is based on facts. A database management system stores data in such a way that it becomes easier to retrieve, manipulate, and produce information.

Traditionally, data was organized in file formats. DBMS was a new concept then, and all the research was done to make it overcome the deficiencies in traditional style of data management.

B. Hardware implementation

1. MICROCONTROLLER 8052 (AT89S52)

The AT89S52 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

This is a Low Cost Development Board that can be used to quickly evaluate and demonstrate the capabilities of microcontrollers. The microcontroller is held on a 40 pin IC base provided on the board. In general case a quartz crystal is used to make the clock circuit. Clock frequency limits (maximum and minimum) may change from device to device. Standard practice is to use 12 MHz frequency. If serial communications are involved then it is best use 11.0592 MHz frequency.

The AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port and interrupt system to continue functioning. The Power-down Mode saves the RAM contents but freezes the oscillator disabling all other chip functions until the next hardware reset.

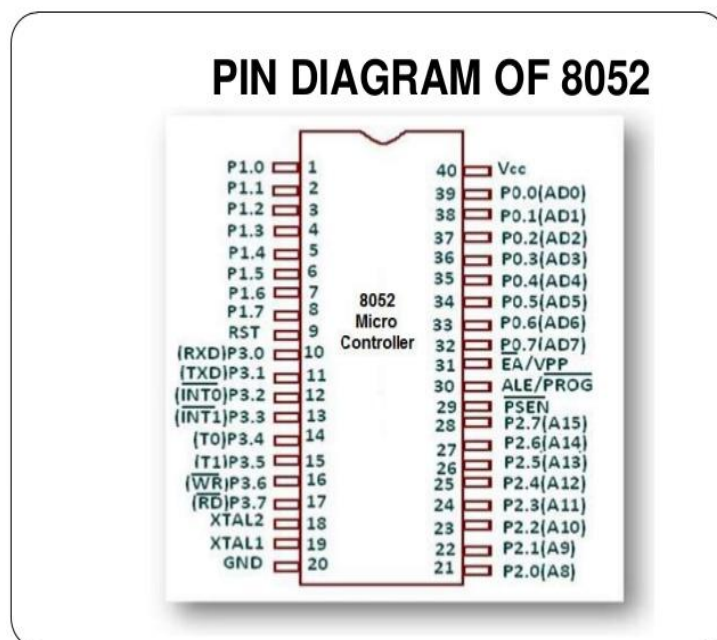


Fig: Pin diagram of AT89S52

2.. LCD

A liquid crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals (LCs). LCDs do not emit light directly.

The display is a standard 2x16 LCD which displays 2 lines of 16 characters. Each character is 40 pixels, making it 1280 pixels overall. The display receives ASCII codes for each character at the data inputs (D0–D7). The LCD module can be used in 4-bit or 8-bit mode. 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. LCDs are used in a wide range of applications, including computer monitors, television, instrument panels, aircraft cockpit displays, signage, etc.

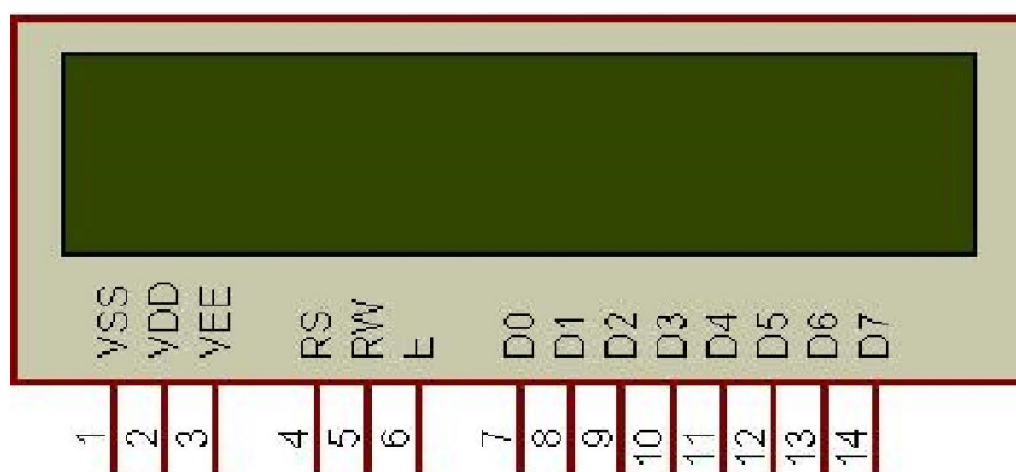
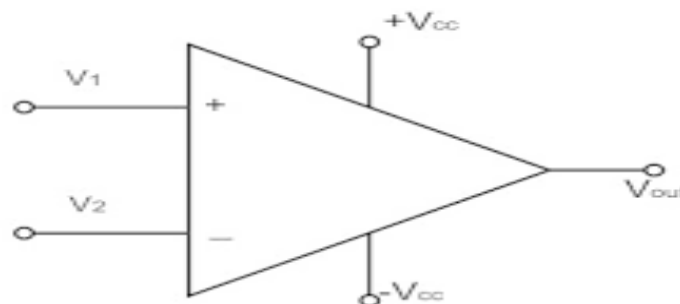


Fig : pin diagram of LCD

3. Operational Amplifier

Operational amplifiers or Op-Amp are the basic building blocks of Analogue electronic circuits. Op-amp is basically a multistage amplifier in which a number of amplifier stages are interconnected to each other in a very complicated manner. An Op-amp has two input terminals and one output terminal. The op-amp also has two voltage supply terminal as seen above. One of the inputs is called the Inverting Input, marked with a

negative or “minus” sign, (-). The other input is called the Non-inverting Input, marked with a positive or “plus” sign (+). A third terminal represents the operational amplifiers output port which can both sink and source either a voltage or a current. The output signal is the amplifiers gain multiplied by the value of the input signal. As seen from the circuit symbol above it has two input power supply terminals +VCC and -VCC. For the operation of an op-amp a dual polarity DC supply is essential. In the dual polarity supply the +VCC is connected to the positive supply of one power source or battery and the -VCC terminal is connected to the negative supply of another source. The output of an Op-amp is given by the equation:



Op-Amp Symbol

Fig: Circuit for Op-amp

4. LM358

The LM358 IC is a great, low power and easy to use dual channel op-amp IC. It is designed and introduced by national semiconductor. It consists of two internally frequency compensated, high gain, and independent op-amps. This IC is designed for specially to operate from a single power supply over a wide range of voltages. Applications of this op amp include conventional op-amp circuits, DC gain blocks and transducer amplifiers. LM358 IC is a good, standard operational amplifier and it can handle 3-32V DC supply & source up to 20mA per channel.

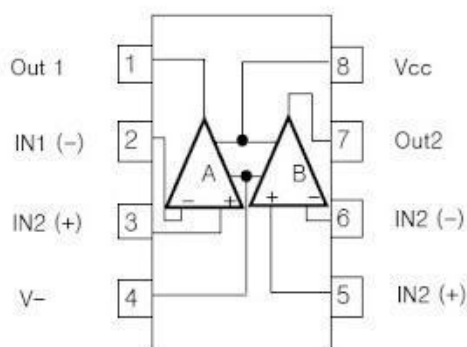


Fig: Diagram for LM358

5. LDR

LDR is a device whose sensitivity depends upon the intensity of light falling on it. The resistance of LDR decreases when intensity of light falling on it increases and vice versa (resistance increases when intensity of light falling on it decreases). In dark or in absence of light, LDR exhibits a resistance in the range of mega ohms, which decreases to few hundred ohms in presence of bright light. It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light. It is made up of cadmium sulphide (CdS).

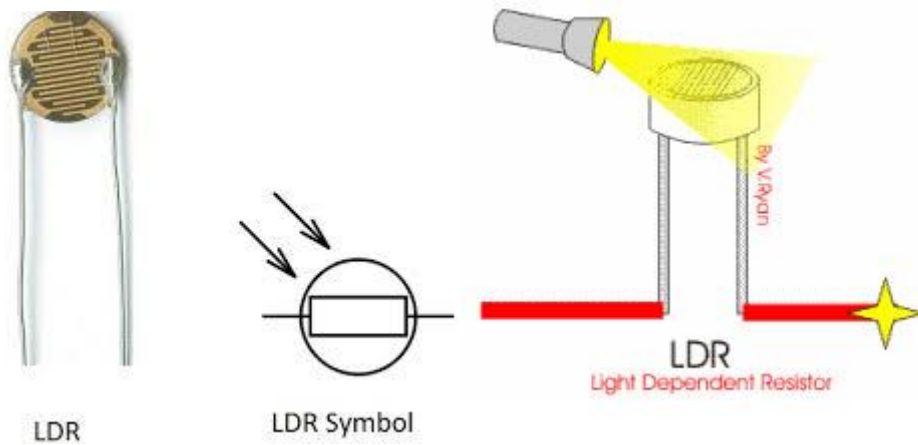


Fig: Diagram for LDR

6. LM7805

LM7805 provides +5V regulated power supply. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

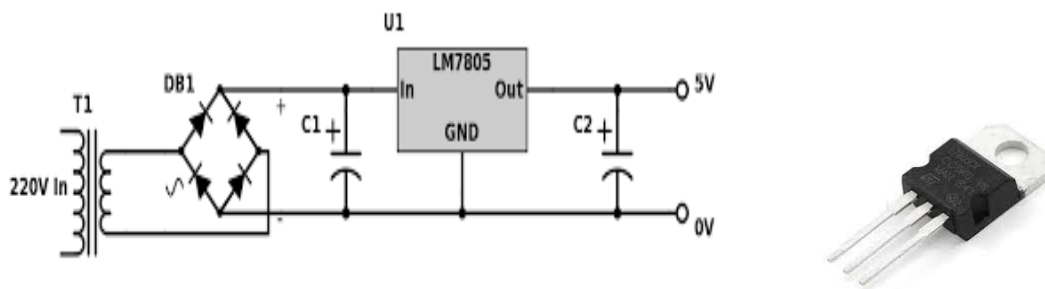


Fig: Diagram for LM7805

VIII. LCD Display of Meter Unit

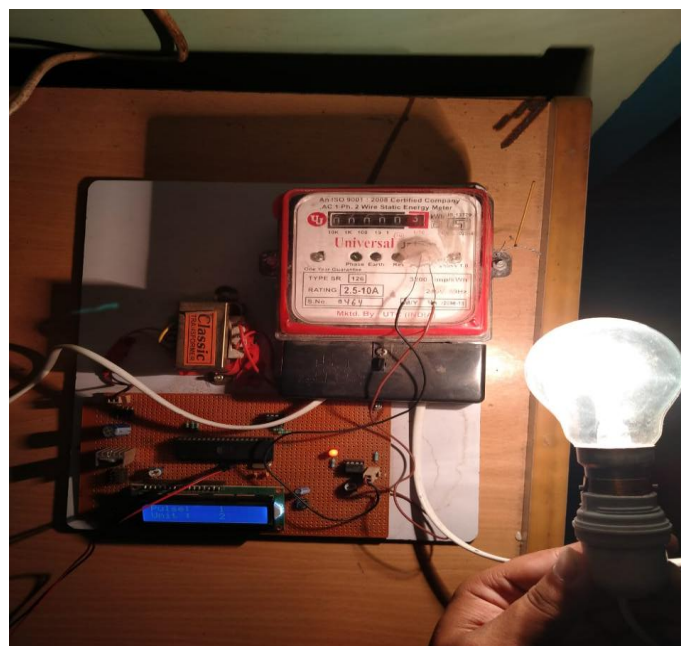


FIG: VIEW OF THE COMPLETE HARDWARE SYSTEM

CHANGE IN THR METER READING WITH INCREMENT OF PULSE

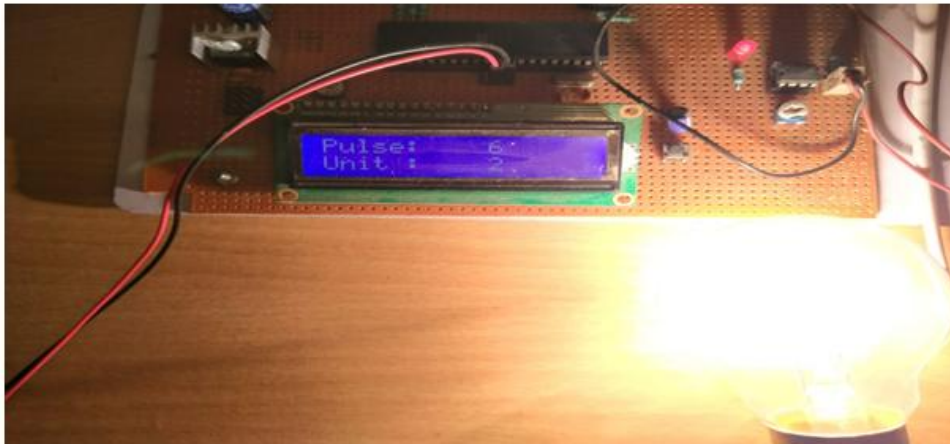


FIG : DISPLAY OF READING – UNIT =2, PULSE=6

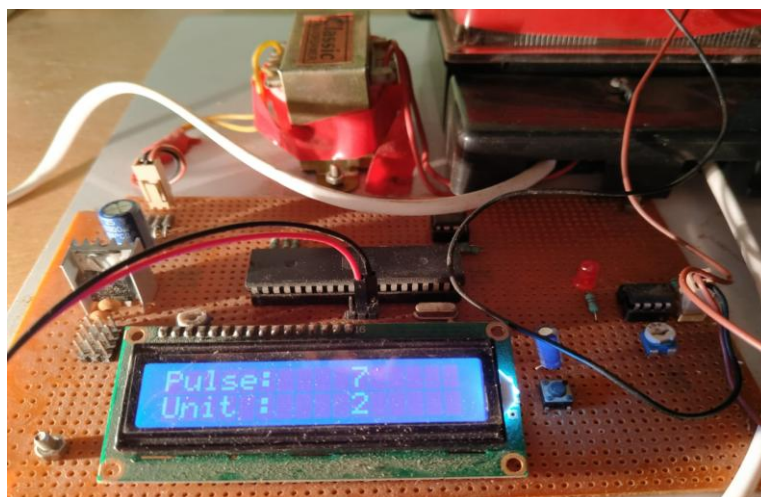


FIG : DISPLAY OF READING – UNIT =2, PULSE=7

IX. Result And Analysis

Result Descriptions

The following results and analysis are obtained during our project execution:-

1. As we have taken 10 Pulse = 1 unit in our program, so after 10 Pulse of the energy meter the unit is increasing by one and displaying on LCD.
2. It is displaying both Pulse and UNIT
3. when we start the unit (Power up) it is reading the last Unit from EEPROM and continue from that Unit
4. The system is successfully storing the Unit value in EEPROM

X. Conclusion

We are successfully capturing the pulse from the Energy meter and counting the Unit .It's our attempt to make a practical model of “Design, Development and Analysis of IOT based Energy Meter”. It is storing the updated Unit in EEPROM and retrieving the last data from the EEPROM after power resuming. Every house holders and House owners can check the meter of reading from anywhere without any physical contact. This year Corona Virus has affected lots of people and this device will also help to maintain social distancing among people.

Hence it will deduct the manual intervention and reduce the human effort too and also bringing a transparent activity among the house owner and house holders.

Acknowledgment

It was a great experience and pleasure for us to work on the paper “Design, Development and Analysis of IOT based Energy Meter” .We would like to thank our internal guide Prof.Gurjit Singh and Prof. Baharul Islam of

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FUTURE SCOPE

This project has number of perspective to extend its work. Some of them are as follows:-

1. It can be introduced on Dept. of Power and Energy (Govt. of India) and can be sanctioned for the collection of details of the consumption units for each and every customer.
2. Further it can be linked with any payment gateway so that the electricity bill payment can also be done online with it.

Reference

- [1]. In the year of 2017 , a paper was published by Mrs Sandhya Shinde , Miss. Bharati Sontakke, Mr.Yogesh Yadav, Miss Pratiksha Zapake from Pune University ,Dypiemr, India IOT based Energy Meter. In this particular paper they are using IOT based meter system primarily detection of theft in monitoring the meter bill. Their system had some disadvantages basically their system is cannot be used as commercial because they are using an arduino which will be high in price if we install it in a large area of connectivity . Secondly, the author is using Wifi ESP to communicate, they are not mandatory . To eliminate this problem we have came up with embedded Wi-Fi modules that incorporate a real-time operating system and provide a simple means of wirelessly enabling any device which has and communicates via a serial port. This allows the design of simple monitoring devices.
- [2]. A work paper was published by the author Garrab, Ben Addallah in the year 2012 presented as “ A AMR approach for Energy saving in smart Grids using Smart Meter and Partial Power line Communication”, the main objective of the paper was increasing demand of energy and limitation of energy management with one way communication although the outcome product has a economical value and low carbon society point of view.
- [3]. A work paper was published by the author Y.H.Sng, B.S.Koay, X.Y. Wang was titled as “ Design and implementation of Bluetooth energy meter” It used the bluetooth as the mode of communication in the meter device to individual connectivity. So it has a disadvange in the aspect of range as the Bluetooth has a lesser range than using a wireless device for connectivity.
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Gurjit Singh (PhD pursuing) received **M.Tech** in Energy Technology from Tezpur University, Assam. His research interests include Green Energy, Smart hybrid technology package, Smart green electricity, Solar energy. Presently, he is working as Assistant Professor (Electrical) in Faculty of Engineering and Technology, Assam down town University



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