



---

## International Journal of Intellectual Advancements and Research in Engineering Computations

---

### A modeling of grid connected PV system with IoT

D.Bhuvaneshwari<sup>1</sup>, S.Saravanan<sup>2</sup>, P.Manikandan<sup>3</sup>, N.Mohananthini<sup>4</sup>, A.Senthilkumar<sup>4</sup>

<sup>1</sup>PG Student, Department of Electrical and Electronics Engineering, Muthayammal Engineering College, Tamil Nadu, India.

<sup>2</sup>Professor, Department of Electrical and Electronics Engineering, Muthayammal Engineering College, Tamil Nadu, India.

<sup>3,4</sup>Assistant Professor, Department of Electrical and Electronics Engineering, Muthayammal Engineering College, Tamil Nadu, India.

---

#### ABSTRACT

This paper proposed for the low cost automation solution based on recent Internet of Things (IoT) technology using embedded processors like PIC micro controller for the automation of a small grid or a substation. This gives the advantage of reduction in cost plus a plethora of connectivity options. In this paper, PIC C compiler software is used to control a feeder with help of IoT module. Analog and digital parameters from field are monitored and controlled using analog pins, interfacing relays and communication ports available in the controller. The automation sequences for control monitoring and protection of the system is defined using C program in such a way that it sends the input parameters in the field side to a remote through the networks, periodically. Similarly, the control signals controls the relays which are all instructed by the operators. At times when current exceeds the limits, the microcontroller automatically trips the circuit breakers. IoT used is ESP8266 module and simulation is verified by the PROTEUS software.

**Keywords:** PV System, Smart Grid, Microcontroller, IoT.

---

#### INTRODUCTION

A large range of smart IoT applications are developed within last few years. Focused on the development of smart grid, this paper introduces the application of IoT in online monitoring systems of smart grid. Such technologies can improve the effectiveness, efficiency, reliability, security, sustainability, stability and scalability of the power grid. And further technology goes to the wireless sensor networks, which mainly use interconnected intelligent sensors to sense and for monitoring. IoT is a concept that considers pervasive presence in the environment of a variety of things/objects that through wireless and wired connections and having unique addressing

schemes which is able to interact with each other and it is user friendly to other things/objects to create new applications and common services and reach their goals. Some of the IoT applications are; smart cities, smart energy and the smart grids, smart transportation and enabling traffic management and control.

The ESP8266 is a low cost Wi-Fi microchip with full TCP/IP protocol stack that can give any microcontroller access to Wi-Fi network. The ESP8266 is capable of functioning consistently industrial environment due to its wide operating temperature range. This project involves the detail design and construction of Smart grid with PV renewable system using ESP8266 module with Internet

---

#### Author for correspondence:

Department of Electrical and Electronics Engineering, Muthayammal Engineering College, Tamil Nadu, India.

connection. The automation may be semi or fully controlled and monitors the utility grid by connected sensors. This project is a demonstration of how to design and built a multipurpose remotely controlled system that can monitor the smart grid by accessing an ESP8266, which is programmed to control the systems in smart grid, when the person is away from work station and enable a person to get the related information on phone. The current state of the system whether it stopped or functioning is obtained by the feedback system.

### Problem Formulation

The goal of the system is to create a small smart environment, where sensor can be monitor and controlled only based on the data received from the grid site sensors. No human interruption is possible because, the system is functioned as a loop. And so it is very adaptive to the environment.

The whole control device of the system it's a small ESP module and PIC controller. This computing system is used due to the fact to prove that the whole grid system can be automated just with a card size computing system or a microchip and the power grid environment data can be viewed or monitored from IoT. IoT technology provides interactive real-time, two way and high speed data sharing across various applications, enhancing the overall efficiency of the smart grid.

### Objective

1. To make Smart grid environment which enables the user to monitor and control grid parameter on real time basis using Mobile device.
2. To monitor the electrical parameters continuously and hence to guard the grid due to the constraints such as overload, over temperature and high input voltage.
3. To monitoring the grid system that will be comprised of a function substation protection relay, wireless communications, a data collection and monitoring device, and a fault recognition and notification system.

The flow of the paper is as follows: Section II describes the related work in the IoT with smart grid operation. Merits & Challenges of the systems are described in section

III and the proposed system is also explained. In section IV result is shown, in section V overall paper is concluded.

### RELATED WORK

In this section, the related work of IOT is explained. There are many ways to develop the system. In Survey paper [1], system is based on ESP 8266 module which enables the cost-effective environment monitoring. The author uses the embedded C programming language to control the power system parameters and access them through IoT and ESP 8266 is the IoT platform which is used in this paper.

Krupal dhimpar, Jenish patel, Yasin sheikh, Anas musani, Krishna [2] has implemented a substation monitoring and control using microcontroller & GSM. In this paper the remote electrical parameters like voltage, current and frequency send these real time values over GSM network using GSM modem/phone along with the temperature at the power station. Here, the user can send commands in the form of SMS messages to read the remote electrical parameters. It also can automatically send the real time electrical parameters periodically that are based on time settings in the form of SMS.

In Survey paper [3], the author's Ghous Buskh narejo, Shahyan pervez Bharucha, Danny Zarir pohwala has discussed the clarification which the prevention of equipments like power transformer from burning by the causes like overload, short circuit fault, over voltages and surges. Under such conditions, entire unit is shut down via control section comprising of relays sensing it, and immediately turning the circuit breaker off. SMS alerts can also be generated to indicate this.

In the Survey paper [6] A.Garrab, A.Ben Abdullah has explained the growing demand of energy, the capacity limitations of energy management, one-way communication, the need of an interoperability of the different standards, the security of the communication and the green house gas emissions, leads to emerge a new infrastructure grid: Smart grid. The end to end application is enhanced by an AMR solution.

It is based on energy meter with low power microcontroller MSP430FE432A and the power line communication standards. The microcontroller includes an energy metering module ESP430CEI. The aim of this work is to realize a real time monitoring to the proposed communication infrastructure. This solution is with great interest in economical and also with the low emission of carbon in the society point of view.

Henning Tresk, Lukasz wisniewski, Emanuele Toscano [7], has designed a paper that flexible approach for real time wireless communications in adaptable industrial automation systems. A new isochronous medium access control (Iso MAC) for WLAN's along with the scheduler, specifically tailored for it. Both mechanisms are part of the overall flex WARE system architecture.

The Iso MAC approach is new medium access control which additionally requires resource reservation along with admission control and scheduling.

The Author's V.Thiyagarajan, T.G.Palanivel [8] has implemented an innovative design to develop a system based on AVR microcontroller that is used for monitoring the electrical parameters of Distribution parameters in a substation. In order to provide the protection to the distribution transformer during faulty conditions, it is necessary to shut down the entire unit with aid of radio frequency communication. The transmitter and the display units in the substation is where the electrical parameters are continuously by AVR microcontroller and is displayed through the display unit. The controlling unit in the main station by means of a PC and RF that are transmitted by the transmitter unit and reacts with accordance to the received signal.

## PROPOSED SYSTEM

The block diagram of the system is shown in fig. 1, here is the proposed system that having mainly IoT module and the PIC controller which is already programmed. Smart grid is own as user friendly technology that the user can check daily consumption from any location

using internet. Smart grid represents one of the most promising and prominent internet of things application. More efficient transmission of electricity is possible. The PIC 16F877A is used as a microcontroller because the faulty percentage is less. It consumes low power for their operation and works on high speed. It provides a wide operating voltage range of 2.0V to 5.5V and it is used in commercial and industrial temperature ranges. Because of using RISC architecture, the performance of the PIC microcontroller is very fast.

The ESP 8266 is an IoT module which is reliable, flexible and cost effective technology with excellent security and scalability. It aims to expand the benefits of connected internet connectivity continuously, the ability to share data, remote control and mainly it can be monitored from anywhere by using the free IoT service provider. The IoT module is to upload the electrical Parameters such as voltage, current and frequency to the web using cloud server. It offers low data rate transmission with the help of things speak website we can monitor the project. The proteus is a proprietary software tool suite primarily for the electronic design automation which is used to show the simulation results instead of using matlab. All PCB design products include basic mixed mode SPICE simulation capabilities and an auto router. Schematic capture in the proteus design suite is used for both the simulation of designs and as well as the design phase of a PCB layout project. Hence it is a core component and it is included with all product configurations.

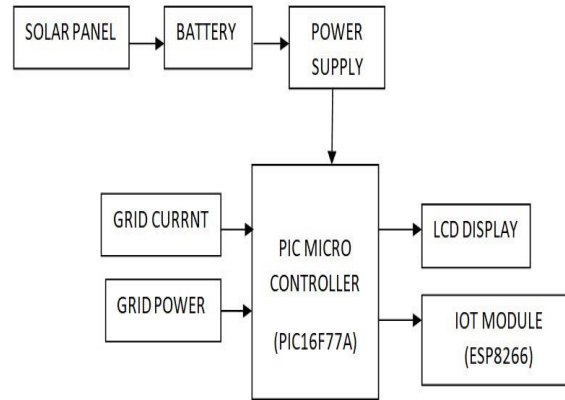
It supports for both interactive and graph base simulations. CPU models are also available for popular microcontrollers such as the PIC 8051 and series. IoT helps in information collection from equipment with the help of its connected IoT smart devices.

It is applied for controlling the smart grid through application interferences. If there is any variation in the current and potential values are to display, the information continues to displaying the values in LCD with the help of the IoT web application servers. This project makes use of a microcontroller with IoT. Reduce operations and management cost

for utilities, and ultimately lowers power costs for consumers. Time saving technology and also tamper detection to reduce electricity theft.

The following parameters are used for consideration. All PCB design products

include basic mixed mode SPICE simulation capabilities and an auto router. Schematic capture in the proteus design suite is used for both the simulation of designs and as well as the design phase of a PCB layout project



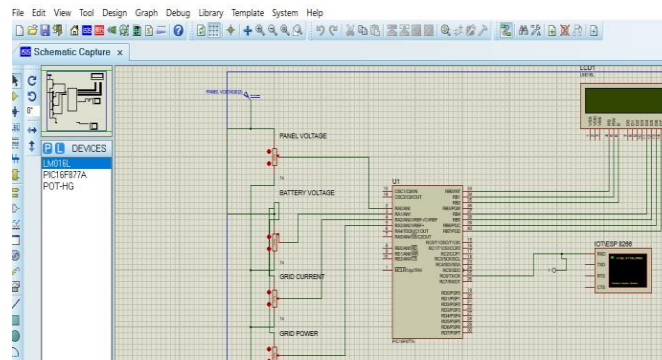
**Fig.1. Block diagram of proposed system**

## RESULT & DISCUSSION

By applying the various Loads under various time period is observe. Thus the equation is formed by the observation and as shown in equation 1.

$$z = 2.3986y * 0.0517x \quad (1)$$

Where 'y' is the current, 'x' is the voltage at signal conditioning output and 'z' is the output power. Observation is also made with various values.



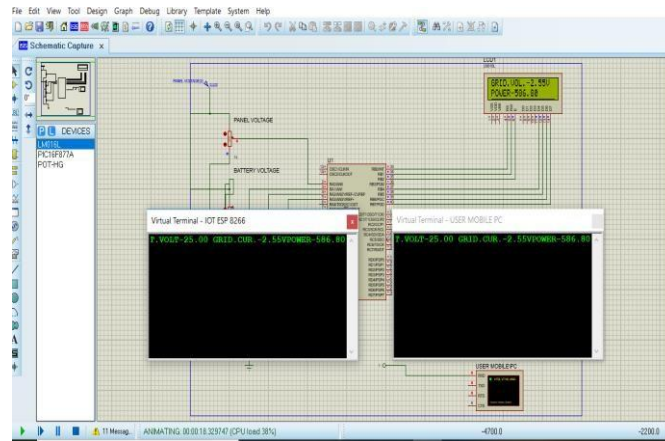
**Fig.2. Schematic diagram of proposed system**

The conventional methods which are used today like SMS are costly. Since, IoT is cost effective compared to SMS, monitoring of energy usage at Lower cost is made possible. The system is more reliable and accurate reading values are collected from energy using Grid. Live readings of Grid can be viewed using android application. Also, the readings can be viewed online from anywhere. The human interface is avoided and all the values are kept maintained in the central server.

There are many applications for smart grid systems that have been developed are still in the development phase. Different applications usually have different requirements for communication. Hence, the decision on whether IoT can be used for specific smart grid applications should be considered case by case. Based on analysis, we can see that IoT is a reliable, flexible and cost effective technology with excellent security, and scalability. It offers

low rate data transmission with an intensive latency.

The tabular column contains the various electrical parameters in the proposed system and their values are calculated and they are tabulated.



**Fig.3. Simulation output of the proposed system**

**CONCLUSION**

As mentioned in the Section II, we get the information of the SOA-IoT that is Service Oriented Architecture IoT. We also get the idea about the System overview of ESP module. We are aware from the new trends in the smart

grid and IoT technologies. The authors also discuss the various challenges in the IoT and also in smart grid constrain. How handling these kinds of challenges were also discussed by the authors. The authors also survey the smart grid considering the IoT

- S. Panel no voltage (volts)
- Battery voltage (volts)
- Grid voltage (volts)
- Grid current (Amps)

Output power (watts) perspective. A good comparison done by the author in which why to use IoT in smart grid is explained. As ESP 8266 is small in size and also consumed less power along with doing complex processing of collected data.

**Table 1 Electrical Parameters**

1	10	12	230	1	230
2	10.5	12	230	1.5	345
3	11	12	230	1.7	391
4	11.5	12	230	1.8	414
5	12	12	230	1.85	425.5

There are lots of wastage in energy at substation by hiding the real status of the installed grid system. This system tries to minimize the energy waste. It is possible by providing sufficient information to the owner or top level hierarchy persons via remotely and it can be used to made appropriate decision. It also helps to analyze the overview consumption of power and material requirement. In this system, a grid

connected PV system with IoT were introduced and analyzed. By utilizing the concept of IoT, each device can hold a unique address that can upload its status and download control commands via internet. Because of these advantages, the proposed system is also suitable for various applications like smart home appliances, substation devices and distributed renewable energy resources.

## REFERENCES

- [1]. Jinhong Liu, Lin Zhou, Bin li, Chen Zheng and Bao Xie, “ Modeling and analysis of a digitally controlled grid connected large scale centralized PV system” IEEE Trans. On Power Electronics 2017.
- [2]. Krupal Dhimpar, Jenish patel, Yasin sheikh, Anas musani, Krishna patel “Substation monitoring and control using microcontroller & GSM” IEEE Trans. Power Electron., 2017.
- [3]. Ghous Buskh Narejo, Shahyan pervez bharucha, Danny Zarir pohwala “Remote microcontroller based monitoring of substation and control through GSM modem” IEEE Trans. Power Electron., 2015.
- [4]. S.Lal, K.Madumathi, S.Saravanan, “Battery Energy Storage Station (BESS) Based Smoothing Control of Photovoltaic (PV) and Wind Power Generation Fluctuations”, International journal of Innovative Research in Science, Engineering and Technology, 4(6), 2015, 1352-1359.
- [5]. N.Yuvaraj, B.Deepan, M.Muruganandam, S.Saravanan, “STATCOM Based of Adaptive Control Technique to Enhance Voltage Stability on Power Grid”, International Journal of Innovative Research in Science, Engineering and Technology, 4(6), 2015, 1454-1461.
- [6]. A.Garrab, A.Bouallegue, A.Ben Abdullah “A new AMR approach for energy saving in Smart grids using Smart meter and partial power line communications” IEEE Trans. Power Electron. 2012.
- [7]. Henning Tresk, Lukasz wisniewsk, Emanuele Toscanco “Flexible approach for real time wireless communications in adaptable industrial automation system” IEEE Trans. Power Electron., 2011.
- [8]. M.Thiyagarajan, T.G.Palanivel “An efficient monitoring of substation using microcontroller based monitoring system” IEEE Trans. Power Electron. 2010.
- [9]. S.Busso and P.Mattavelli, “Digital control in power Electronics”, Ft.Collins, Colorado, USA: Morgan & Claypool, 2006.
- [10]. S.V.Kulkarni and S.A.Kharpade, “Transformer Engineering: Design and practice”, New York: Marcel Dekker, MAY-2004.