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# Renewable Grid Monitoring and Control Using Internet of Things

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**Abstract—given the huge concerns all over the world regarding carbon emissions from fossil fuels, energy crisis and global warming, the renewable distributed energy resources (DERs) are going to be integrated in electricity grids, which will make the energy supply more reliable and decrease transmission losses. Regrettably, one of the main practical defies in smart grid planning, control and operation with DERs is the voltage regulation at the distribution field level. This problem motivates the deployment of sensors and actuators in electricity grids so that the voltage regulation can be controlled at the desired level. To do that the measurements from the renewable micro grid state information is transmitted to an energy management center via the internet of things (IOT) based communication network. In other words, the proposed IOT communication infrastructure provides an opportunity to address the voltage regulation challenge by offering the two-way communication links for micro grid state information collection and estimation. Based on this smart grid communication infrastructure &estimation method for voltage regulation of the micro grid. Finally, the effectiveness of the, based state estimation method is illustrated using micro grid incorporating DERs.**

**Index Terms**—Communication network, distributed energy resource, internet of things, micro grid, sepi converter.

## I.INTRODUCTION

All over the world, the global warming in one of the major concerns. The key reason behind is the dramatically swelling greenhouse gas emissions from burning fossil fuels and vehicles.In order to diminish this problem, the renewable distributed energy resource (DER) is considered as one of the future electricity generation units . Based on the incentives from governments all over the world, the penetration of DERs is growing promptly. Thus, electricity consumer are participating in the eco-aware global community and the excess amount of energy is sell to the smart grid. Nevertheless, there are significant technical challenges arise in the planning, operation and control of DERs, due to the randomness and weather-dependence in the power generation patterns. Therefore, an unacceptable voltage level may frequently occur at the point common coupling. This can lead to over-voltage or under-voltage problems for the power network, with undesired voltages appearing at buses of the distribution power network. Driven by these factors, voltage regulators should be installed at planned positions of the distributed feeders. Remarkably, the bidirectional smart grid communication infrastructure between the micro grid and the energy management centre can be leveraged to facilitate voltage regulation issues. The key concepts of such intelligent energy management systems are parallel to those of the internet of things (IOT) which can exploit reasonable security and privacy of DERs measurements, seamless interoperability and far-reaching connectivity. To accomplish the goals, the communication network will be the assisting the objectives of the IOT.

DER systems plays a important role in electric power distribution systems as they typically use renewable energy sources, including small hydro, biomass, biogas, solar power, wind power, and geothermal power efficiently .A grid-connected device for electricity storage can also be classified as a distributed energy resources system(DER) and a distributed energy storage system (DESS). Within a smart grid the DER systems can be coordinated and managed by means of interfacing with power electronic components. Distributed generation of energy and storage enables the collection of energy from many sources and improve security of supply and reduces the environmental aspects .Micro grids are modern, localized, small-scale and centralized electricity grids. Micro grids can also be disconnected from the centralized grid and operate separately, strengthen grid resilience and help mitigate grid disturbances. They are normally a low-voltage AC grids, often use for the diesel generators, and are installed by the community for their own usage. Micro grids increasingly employ a mixture of different distributed energy resources, such as hybrid power systems, which reduce the amount of carbon emission significantly .Distributed energy resource systems (DER) are small-scale power generation and storage technologies mostly used to provide an alternate for empowerment of the traditional electric power system. DER systems typically are characterized by their high initial costs per kilowatt used .DER systems also been used as storage device and are mostly called as Distributed energy storage systems (DESS)

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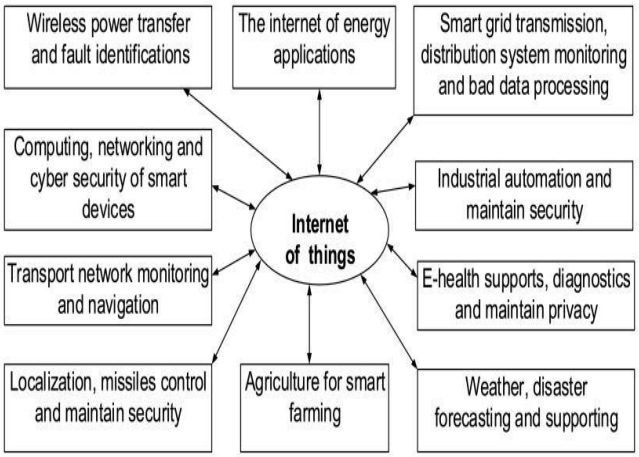
## II. Key Contributions

This paper proposes an approach for micro grid state estimation using the IOT networks. First of all, a renewable micro grid incorporating multiple DERs is modelled as a continuous linear state space model. This model is transformed to the discrete linear state space system considering the uncertainty. Then the sensors are positioned around the grid to obtain the measurements. Afterward, the measurements from the micro grid is transmitted to an energy management center via the IOT based communication network. This IOT communication technology affords an opportunity to address the estimation challenge by offering the two-way communication links for micro grid state information collection and estimation.

### A.ARCHITECTURE AND VISION OF THE IoT

The IOT is a vision that encompasses and surmounts several technologies at the confluence of power systems, information technology, medicines, nanotechnology and bio Technology , . In fact, the application scenarios of the IoT in diverse areas is illustrated in Fig. 1. The IoT has been considered as the latest revolution in the digital technology after the invention of computers and the internet . From the aspect of electricity network, it brings major benefits to the smart grid infrastructure design. Technically, it represents a world-wide network of heterogeneous things such as smart devices, smart objects, smart sensors, smart actuators, radio frequency identification (RFID) tags and readers, global positioning systems (GPS) and embedded computers. Such things can be deployed and exploited in different physical environments to support diversified cyber physical applications such as information collection, information processing, identification, control and actuation . For clarify of




be seen that the information produced in the physical space is transmitted to the cyber space for interpretation, which in turn affects the physical environment such as plug in hybrid electric vehicle and smart grid communications .

Due to the economic, environmental as well as technical reasons, the energy sector has a growing awareness of smart grid technologies to enhance the efficiency and reliability of electricity networks . From this perspective, renew-able DERs such as solar cells, photovoltaic arrays and wind turbines, have been integrated into the grid in the form of smart distribution grids. From the aspect of smart devices and smart metering, they play a vital role for remote monitoring and power systems' state estimation . The reliable state estimation is a key technique to fulfil the automation of power grids. In order to monitor the DER state, the proposed IOT

### B.APPLICATION OF INTERNET OF THINGS

| IoT applications | Vulnerability |
|---|---|
| Smart Home | • Limited AAA services<br>• Security in web based interfaces<br>• Lack of effective cryptographic support |
| Smart City | • Limited privacy<br>• Insecure cloud connectivity<br>• Insecure device connectivity<br>• Lack of effective cryptographic support |
| Smart Health | • Limited privacy<br>• Insecure device connectivity<br>• Insecure cloud connectivity<br>• Insecure Mobile connectivity<br>• Security in web based interfaces<br>• Limited Availability |

Table 1.0 IoT applications and associated vulnerabilities

As mentioned in the previous sections, smart homes have several appliances and some form of renewable energy resources. These appliances and resources can be considered as IOT technologies. Each can upload and download data and commands from utilities and home owners. In addition, the grid at large has many devices that can be considered as IOT objects such as reclosers, switches, capacitor banks, transformers, IEDs, smart sensors, and actuators in the substations. In general, smart grids for large cities or countries may have millions of home appliances and thousands of grid devices

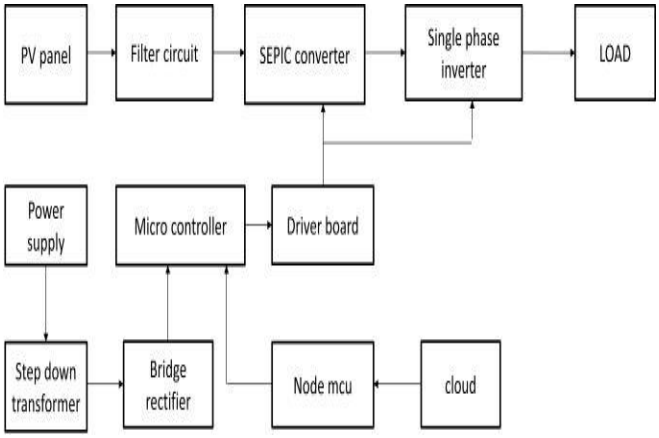
### III. GRID WITH IOT DEVICE

By voltage sensor and current sensor current and voltage are measured in the grid by means of IOT the values are stored in the cloud, by assessing with the cloud the status of the grid is known .The relay connected with the driver circuit can be controlled by microcontroller (pic) by giving pulse low the position of relay will be in off state and giving high pulse the position of relay will be in on state

In case of over voltage condition the current sensor and voltage sensor sense the transient condition and alert will be sent to the IOT cloud and relay will be set to off state .

### IV.SEPIC CONVERTER AND DRIVER CIRCUIT

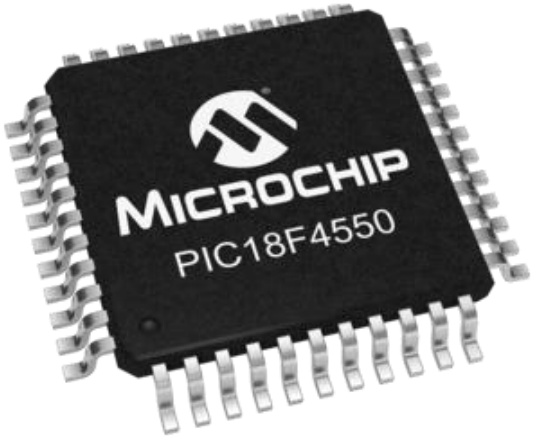
The power generated from the solar panel is filtered as well as boosted with the help of single ended primary induction coil. The sepic circuit has a mutual inductance which no only acts as a filter but also amplifies the supply voltage. This increases the power quality which in turn increases the efficiency of the solar power.




Block Diagram of SEPIC Converter Fed Grid Monitoring System

#### A. PIC Microcontroller

PIC microcontrollers are one of the family of microcontrollers. They are produced by Microchip Technology in Chandler, Arizona. PIC stands for "peripheral interface controller". A microcontroller is a compact microcomputer can be useful in many ways and they are designed to govern the operation of embedded systems in motor vehicles, robots, office machines, medical devices, mobile radios, vending machines, home appliances, and various other devices. A typical microcontroller includes a processor, memory and other peripherals.

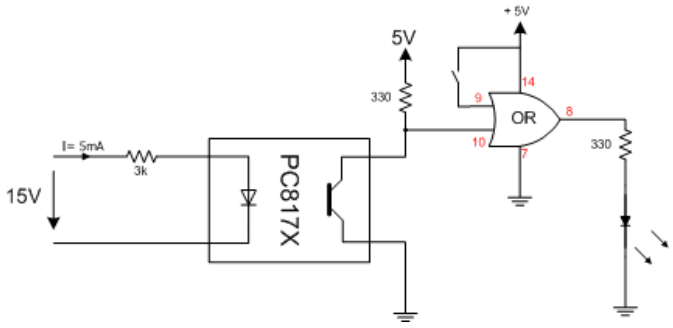



PIC Microcontroller

Every PIC microcontroller has a set of registers that functions as like as the RAM (random access memory) control processing unit(CPU) . There are some Special purpose control registers for on-chip hardware resources and they are also mapped into the data space. Every PIC has a stack that are functioned to save and return the address. The stack has limitation in older versions as it is not software-accessible of the PIC, but this limitation was removed in new devices.

#### B .Optocoupler

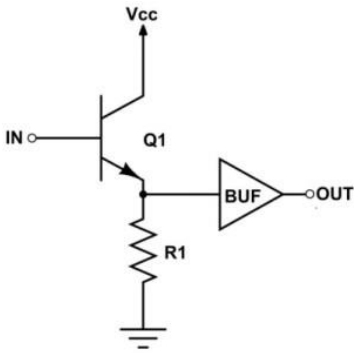
In electronics, an optoisolator also called as an optocoupler, photocoupler, or optical isolator, is a component that transfers electrical signals between two isolated circuits by using light. Optoisolators prevent high voltages from affecting the system receiving the signal .Commercially available optoisolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 25 kV/μs




Optocoupler

**C.BUFFER IC**

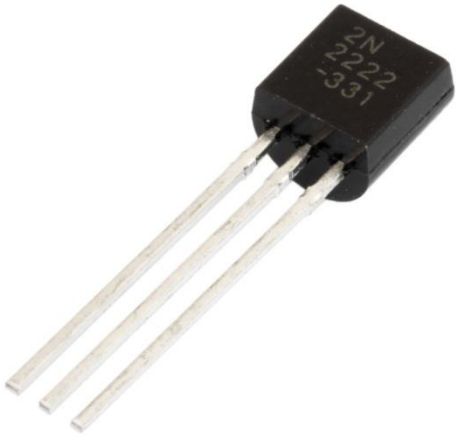
A digital buffer (or a voltage buffer) is an electronic circuit element that is used to isolate the input from the output, providing either no voltage or a voltage that is same as the input voltage. It draws very little current and will not disturb the original circuit. It is also called a unity gain buffer because it provides a gain of 1, which means it provides at most the same voltage as the input voltage, serving no amplification function.




Buffer IC

**D.TRANSISTOR**

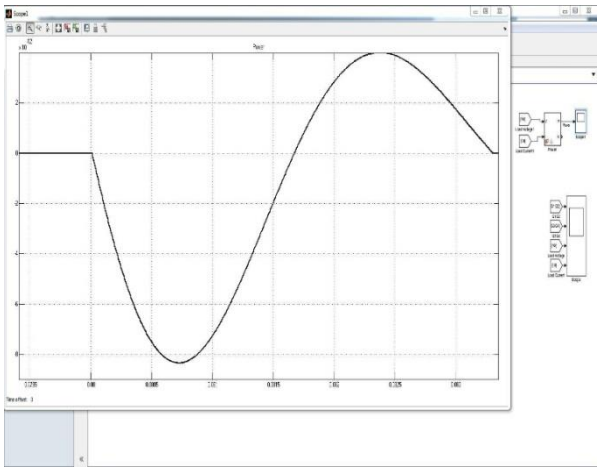
A transistor is also one of the semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal.




Transistor

**V.PERFORMANCE AND ANALYSIS**

By simulink the analysis of project has been done. The waveform correspond to the input DC to output AC waveform . By sepic converter there is a step up in input supply voltage . By changing the duty cycle required wave form has been founded. This paper deals with performance of septic converter to grid which produces the output waveform.The analysis of relay connected to plays vital role . By disconnecting the supply in over voltage situations and connecting when single has been sent to relay.



**VI.ADVANTAGES AND APPLICATIONS**

**ADVANTAGES**

The source used in this technique is renewable source which is of free input cost.
The proposed system is cheaper than the normal conventional method because of the closed loop control strategy used.
Easy to handle because it consists of a single module.
No cost in terms of electric energy because it's not necessary.
Collection of data and storing it is done in the cloud.

**APPLICATIONS**

Offsite monitoring of the grid is applicable.
Statistics analysis of data is simple.
Over voltage cut-off of relay by protecting the load.
Results management assisting in the decision processes of the environment
Discovery and scheduling of tasks and workflow.
Data communications distributing the problem data where and when it is required

## VII.CONCLUSION

The Renewable grid monitoring system employed using Pic microcontroller and IoT is effective operation of monitoring grid in the offsite conditions. The SEPIC converter not only stabilizes input voltage from PV panel also boost some voltage because SEPIC controller is connected in closed loop operation.

In this closed mode is major advantage to other conventional dc converters. The driver circuit is triggered by the microcontroller by giving gate pulse to the driver circuit. It is inversion mode operation to produce the Ac supply in the Grid .

The grid power is connected to the load like BLDC motor. The motor is run by the power in the grid. Nodemcu the operations are monitored and the data are sent to the cloud via arduino.

By storing the data in cloud offsite monitoring of the grid is also possible. The relay connecting the grid can switch when over voltage or transient conditions occurs.

The relay used in the system can be controlled in offsite through the IoT network .For further demand of electricity the system can be connected even with the hybrid mode of power generation.

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