

Design and Implementation of Zigbee based Sensor Network in Smart Grid System for Power Management Using IOT

P. Loganathan, N. Kokila, T. Revathy, S. Suresh Kumar, S. Ayyasamy

Abstract--- *The current power grid is experiencing a massive change. Smart grid innovation is a radical approach for ad improvisation in the prevailing power grid. Integration of electrical and communication infrastructure is inevitable for the deployment of the smart grid organizes. Brilliant network innovation is described by full duplex correspondence, programmed metering framework, sustainable power source incorporation, appropriation computerization and finish checking and control of whole power matrix. Remote sensor systems (WSNs) are small small-scale electrical, mechanical systems that are sent to gather and convey the information from the environment. WSNs can be utilized for observing and control of grid resources. Security of remote sensor based correspondence arranges a noteworthy worry for scientists and designers. The constrained handling capacities of remote sensor systems make them more defenseless against cyber-attacks. The countermeasures against cyber-attacks must be less mind-boggling with a position to offer classification, information availability, and honesty. The address arranged outline and improvement approach for the regular correspondence organize a change of perspective to plan information situated WSN design. WSN security is an inescapable piece of smart grid cybersecurity. This work is relied upon to fill in as a comprehensive assessment and analysis of communication standards, cybersecurity issues and solutions for WSN based intelligent grid infrastructure.*

Keywords--- *Smart Grid, Integration, Renewable Energy, WSN.*

I. INTRODUCTION

Reducing utilizes and squander is presently generally observed as being useful for all that matters, and also useful for nature. Nonetheless, administrators regularly don't have the data they have to make educated, proactive choices about their building portfolio's vitality utilize. The present business pioneers have centered around simply that: their

business objectives and systems. The way to diminishing vitality utilize and managing diminishes after some time is furnishing administrators with the correct data, to empower educated choices that adjust vitality use with different targets, for example, building solace and representative profitability. Remote vitality checking is a demonstrated arrangement that conveys an unmistakable effect to the primary concern. Utilizing online innovation, remote vitality checking conveys data, examination, and direction that enables business pioneers to comprehend their organization's energy use, take appropriate action, and continually improve energy efficiency building performance. Electric energy occupies the top grade in energy hierarchy. To minimize the problem associated existing non - renewable energy source, nowadays Smart Grid is preferred because it uses both renewable energy and non-renewable energy sources to meet the total demand, digitally send meter to suppliers for more accurate energy usage, control of energy and operate the power plant. Loop network technique helps to maintain reliable and secured transmission data when ZigBee network is used in Smart Grid. This paper presents the ZigBee module. The non-conventional system like a solar energy system, wind energy and energy source from urban waste is also connected to Smart Grid to meet the total demand. A minimum number of wireless junctions is used to cover all consumers with continuous and renewable data supply to control house. The traditional electricity system structure consists of electricity flow in a single direction that is from the grid to thousands of consumers. The challenges with this traditional grid system are to tackle the increasing demand of electricity, reducing the generation, transmission, and maintenance cost, reducing the use of fossil fuel for generation and incorporating non-conventional energy source like wind and PV cell for generation and balancing load consumption and the power generation. Therefore, a solution which considers environment sustainability, power distribution, and generation costs, and total power demand at house must be produced. The technique of monitoring and measuring helps to receive data to find abnormality and grid integrity with an advance reading of meter, elimination of the process of billing and power theft detection. Advanced equipment assists in determining the performance of the grid-condition which helps to maintain quality, reliability, and prevent the outages. ZigBee is a low price advanced technique used in a sensor network.

Revised Version Manuscript Received on 01 February, 2019.

P. Loganathan, BE., ME., Ph.D, Associate Professor, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed To Be University), Salem, Tamilnadu, India.
(e-mail: surya.jp@gmail.com)

N. Kokila, PG Scholar, M.E – Power Systems Engineering, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to Be University), Salem, Tamilnadu, India.

T. Revathy, PG Scholar, M.E – Power Systems Engineering, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to Be University), Salem, Tamilnadu, India.

S. Suresh Kumar, PG Scholar, M.E – Power Systems Engineering, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to Be University), Salem, Tamilnadu, India.

S. Ayyasamy, PG Scholar, M.E – Power Systems Engineering, Department of Electrical and Electronics Engineering, Vinayaka Mission's Kirupananda Variyar Engineering College, Vinayaka Mission's Research Foundation (Deemed to Be University), Salem, Tamilnadu, India.

This paper explains the idea of a Smart Grid system using ZigBee model called as ZigBee model of Smart Grid system. This paper presents a Smart Grid system which consists of a ZigBee model and a control unit as "Microcontroller." The two renewable energy sources like wind and solar energy are considered for the system design and used Embedded C programming language for system configuration. The generated power step-up using transformer to transmit over long distance through an overhead transmission line to the consumer premises. The generated power from different power plants is transmitted to a common point is known as the electrical grid.

II. LITERATURE REVIEW

Advances in micro-electro-mechanical systems (MEMS) and information communication technology (ICT) have facilitated the development of integrated electrical power systems for the future. A recent major issue is a need for solid and maintainable power transmission and distribution that is savvy, dependable and atmosphere agreeable. In this way, toward the beginning of the 21st Century, Government, utilities, and research networks are working mutually to build up a clever framework, which is currently known as a smart grid. The smart grid will provide highly consistent and reliable services, efficient energy management practices, intelligent metering integration, automation, and precision decision support systems and self-healing facilities. The smart grid will also bring benefits of seamless integration of renewable energy sources into the power systems. This paper centers around the advantages and likely sending issues of intelligent grid innovation for a reasonable future both broadly and universally.

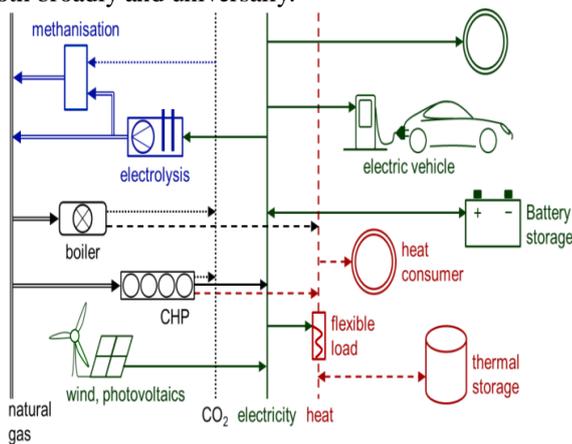


Fig. 1: A Hybrid Wind-Solar Energy System

This work additionally explores the progressing significant research programs in for smart grid and the related empowering advancements. At long last, this examination investigates the prospects and attributes of sustainable power sources with conceivable organization joining issues to build up a spotless vitality smart grid innovation for a smart power framework. Existing force frameworks can be considered as a unique purpose behind nursery or a worldwide temperature alteration impacts that reason natural effects because of utilization of petroleum products, particularly coal. As opposed to petroleum products, sustainable power source RE offers elective wellsprings of vitality which are all in all contamination free, innovatively compelling and ecologically maintainable.

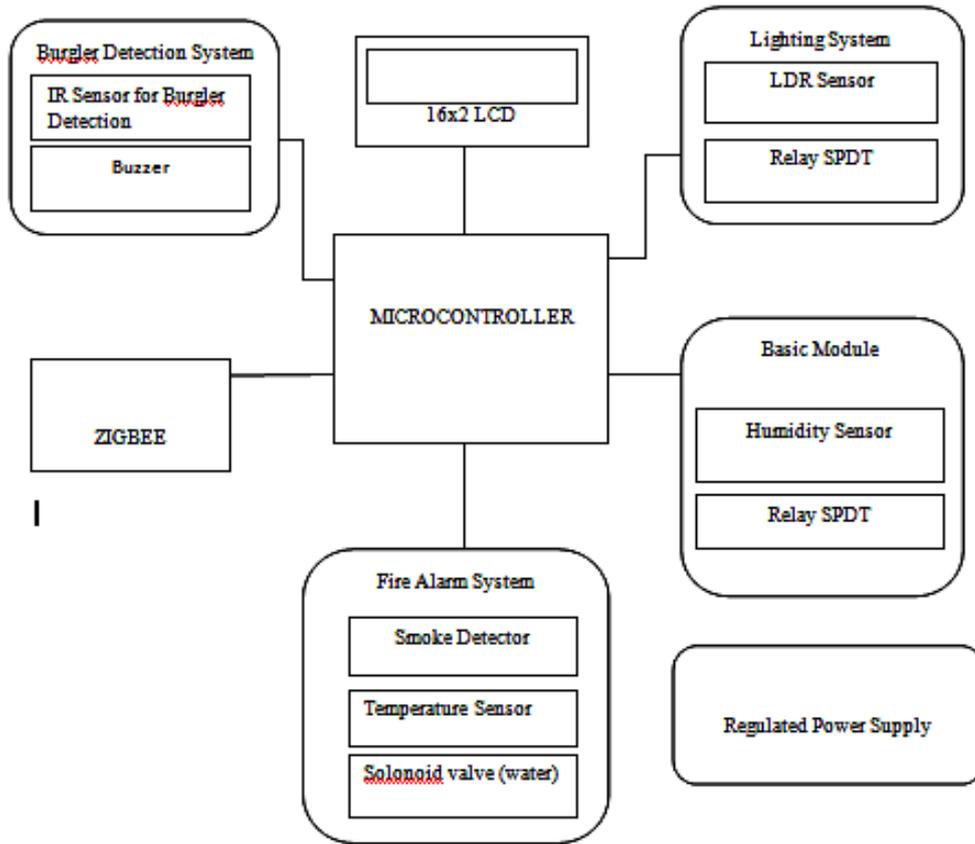
There is an extraordinary consideration regarding RE, especially sunlight based and wind vitality, which gives power without offering to ascend to carbon dioxide emanations. Be that as it may, the greater part of the present transmission and conveyance systems are considered as idiotic frameworks as they are not equipped for sustaining back the wise information required for modern grid operation. Therefore, the introduction of smart grid technology is an essential requirement that reduces overall greenhouse gas GHG emissions with demand management that encourages energy efficiency, improves reliability and manages power more efficiently and effectively. The smart grid is the combination of centralized bulky power plants and distributed power generators that allows multi-directional power flow and information exchange. Its' two-way power communication systems create an automated and energy efficient propelled power delivery system. Then again, in conventional power frameworks, control power just one way, i.e., from creating a station to clients through transmission and dispersion systems. Savvy lattice advances are still new, and numerous are in the improvement arrange. Nonetheless, it is foreseen that keen framework innovation will assume a self-administrative part in control system organizes because of its numerous preferences. The savvy lattice organization issues that include: a brilliant network framework, correspondence advancements, potential boundaries, and improvement of conceivable reasonable answers for such usage were likewise investigated. This investigation likewise went for building up an incorporated stage to proceed with the effects of RE on the smart grid which will help the power utilities to build up an enhanced national power network that will fabricate a feasible society. The proposed coordinated stage involves with an attainability concentrate to research the possibilities of RE in Australian setting; expectation model to evaluate the vitality age from RE sources; ongoing investigations and recreation model to investigate the effects on incorporating RE into the smart grid.

III. PROPOSED METHOD

Industry-based hindrances and their related solutions are discussed in this paper. One of the major factors for operating machines is voltage, and it plays a vital role in the industry on which every device is operated. To work out issues like load shedding major steps need to be taken, and we cannot discontinue related problems of it. The growth rate of any industry will taper's due to these kinds of issues. Sensors and actuators are deployed in different sections of industry to measure various controlling parameters by making use of Zigbee IEEE 802.15.4 standard. This paper demonstrates the priority-based selection of the processes, time and process-based system by which we can save the amount of voltage to be utilized and it also redeems the timing requirement of the methods along with the time-based system. Health monitoring of any machine is one of the major application of this paper, which assists in determining the glitch of any tools.



3.1 (a) Block Diagram for Transmitter



3.1 (b) Block Diagram for Receiver

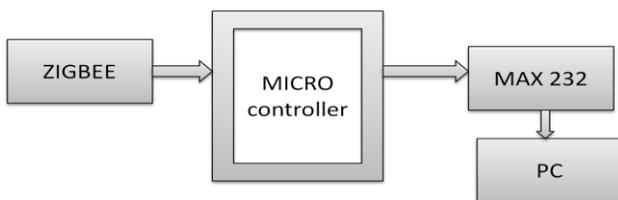


Fig. 2: Block Diagram of Proposed Method

3.1.1 Block Diagram Description

The reason behind using predictive maintenance is that the devices are not kept on for all the time. This, in turn, saves energy. Sensors being periodic devices or non-periodic devices. Whenever an event occurs it wakes up from the sleep mode, checks for the status and performs the function and then again it will go back to sleep mode. If there is failure or violation, there is an alarm which will start warning that there is any violation or failure of some tasks ZigBee protocol stack is never used. This design also updates us with various parameters, and while designing the hardware, we also need to take care of the electromagnetic interferences occurring in the environment due to the radiations. Several techniques are used when energy management has been discussed.

3.2 IR based Security Alarm Circuit

IR Based Security Alarm Circuit can detect any movement and trigger the alarm. This circuit is very useful in, limited zones where an alarm caution is required on any development. This circuit depends on IR sensor where an IR

shaft is constantly falling on a photodiode, and at whatever point this Infrared pillar breaks, by any movement, an alarm is triggered.

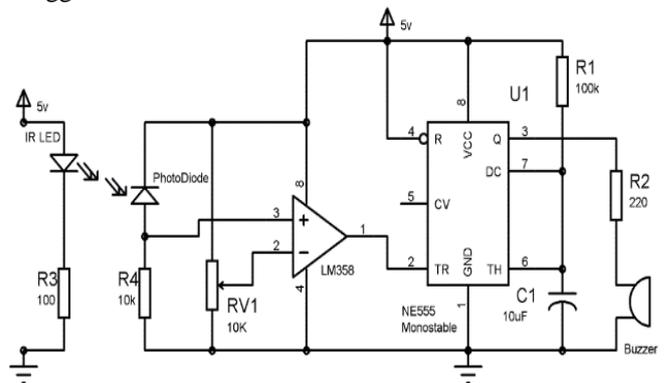


Fig. 3: IR Based Security Alarm Circuit

3.3 Zigbee

ZigBee is an open worldwide standard for remote innovation intended to utilize low-control advanced radio signs for individual territory systems. ZigBee works on the particular and is used to make organizes that require a low information exchange rate, vitality effectiveness, and secure systems administration. It is used in various applications, for example, building computerization frameworks, warming, and cooling control and in therapeutic gadgets.



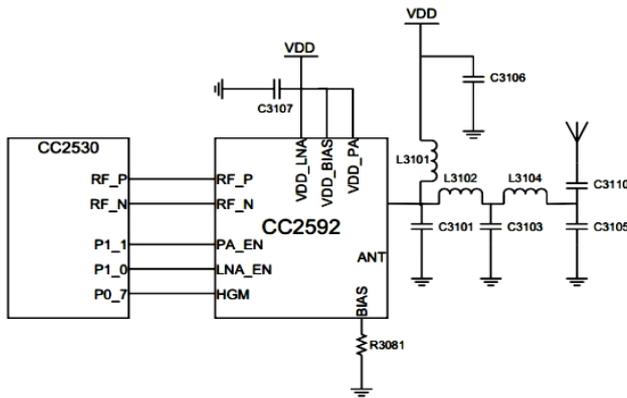


Fig. 5: Zigbee

3.4 PIC Microcontroller

Preparing Interface Controller (PIC) is microcontroller created by Microchip; PIC microcontroller is quick and simple to actualize program when we look at different microcontrollers like 8051. The simplicity of programming and simple to interfacing with different peripherals PIC ended up useful microcontroller.

We realize that the microcontroller is an integrated chip which consists of RAM, ROM, CPU, TIMERS, and COUNTERS, etc. PIC is a microcontroller which also comprises of ram, rom, CPU, timers, counter, ADC (analog to digital converters), DAC (digital to analog converter). PIC also supports the protocols like CAN, SPI, UART for interfacing with other peripherals. PIC mainly used modified Harvard architecture and also supports RISC (Reduced Instruction Set Computer) by the above specification RISC and Harvard we can see easily that PIC is faster than the 8051 based controller which is made-up of Von-Neuman architecture.

3.4.1 PIC Microcontroller Architecture

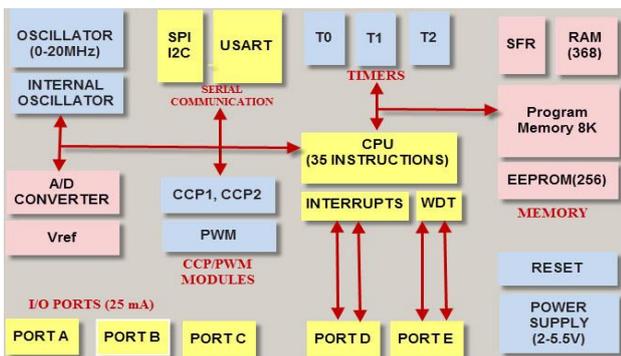


Fig 6: PIC Microcontroller Architecture

The PIC Microcontroller Pic16f877a Is One Of The Most Renowned Microcontrollers In The Industry. This Controller Is Very Convenient To Use, The programming of This Controller Is Also Easier. The Main Advantages Is That It Can Be Write-Erase As Many Times As Possible Because It Uses Flash Memory Technology. It Has A Total Number Of 40 Pins, And There Are 33 Pins For Input And Output. Pic16f877a Is Used In Many PIC Microcontroller Project. Pic16f877a Also Have Many Applications In Digital Electronics Circuits. Where Microcontrollers Have Never Been Used Before As In Coprocessor Applications And Timer Functions.

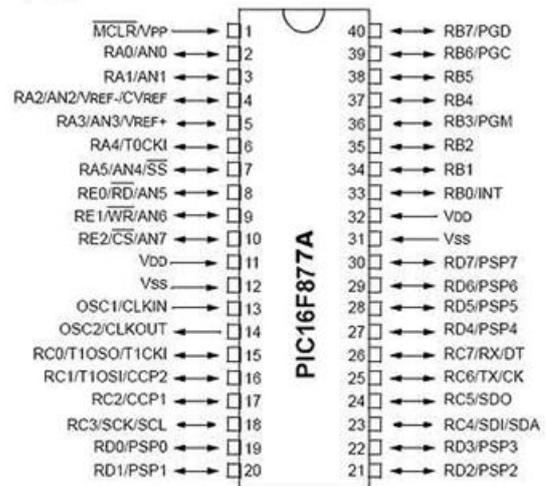


Fig 7: PIC Microcontroller Pin Configuration

3.5 Smoke Detector

If a fire breaks out in the daytime, we can, for the most part, notice it and make a move. In any case, in case we're snoozing during the evening, fire can take the oxygen we have to inhale or create lethal carbon monoxide gas that can send us into a profound and dangerous sleep from which we may never recuperate. In the United States, a more significant number of individuals pass on from house fires than from every catastrophic event consolidated. Luckily, because of present-day innovation, there's a modest and exceptionally dependable method for distinguishing fires: the electronic smoke finder.

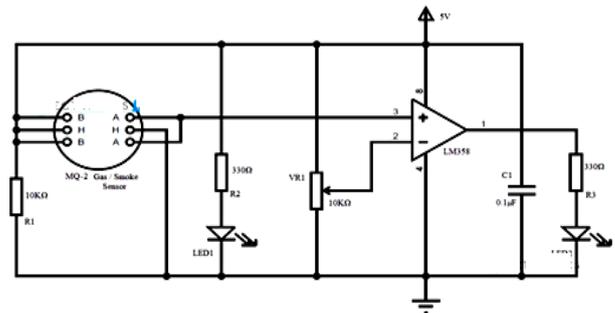


Fig 8: Smoke Detector

3.6 Temperature Sensors

These kinds of temperature sensor shift from essential ON/OFF thermostatic gadgets which control a local boiling water warming framework to an exceptionally delicate semiconductor composes that can manage complex process control heater plants. We recollect from our school science classes that the development of particles and molecules produces warm motor vitality and the more noteworthy the event, the more warmth that is created. Temperature Sensors measure the measure of warmth vitality or even frigidity that is created by a protest or framework, enabling us to detect or recognize any physical change to that temperature delivering either a computerized or straightforward yield.



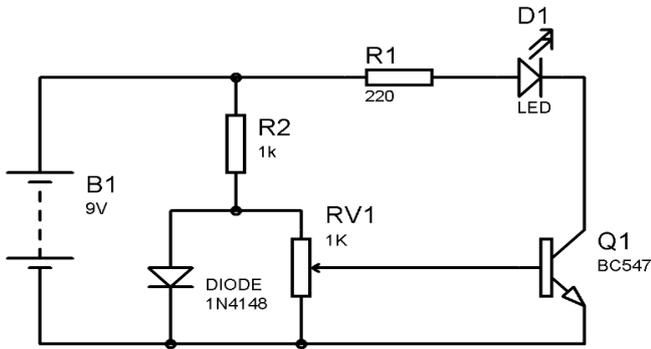


Fig. 9: Temperature Sensors

3.7 Solenoid Valve

A solenoid valve is an electromechanically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core in its center. This core is called the plunger.

In the rest position, the plunger cuts off a little opening. An electric current through the coil makes an attractive field. The beautiful field applies power to the plunger. Thus, the plunger is pulled toward the focal point of the coil, so the hole opens. This is the essential rule that is utilized to open and close solenoid valves.

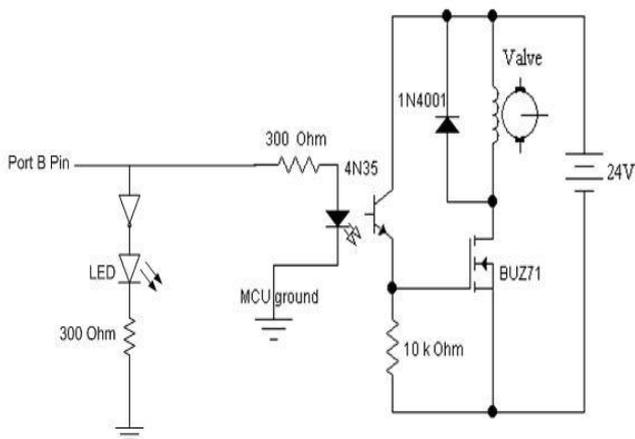


Fig.10: Solenoid Valve

3.8 LDR Sensor

A Light Sensor creates an output signal demonstrating the power of light by estimating the brilliant vitality that exists in an extremely slender scope of frequencies called light, and which runs in recurrence from "Infra-red" to "Unmistakable" up to "Bright" light range. The light sensor is cool gadgets that change over this light vitality whether unmistakable or in the infra-red parts of the range into an electrical flag yield.

Light sensors are all the more regularly known as Photoelectric Devices or Photo Sensors since they change over light vitality (photons) into power (electrons). Photoelectric gadgets can be gathered into two primary classifications, the individuals who create power when lit up, for example, Photovoltaic or Photo messages, and so on., and those who change their electrical properties somehow, for example, Photo-resistors or Photo-channels. This prompts the accompanying arrangement of gadgets.

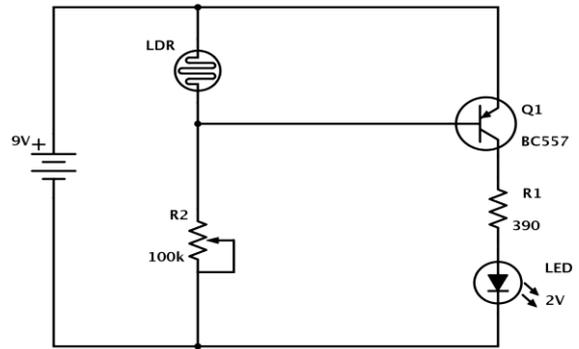


Fig.11: LDR Sensor

3.9 Relay

A relay is an electromagnetic switch worked by a generally little electric current that can kill one or a considerably more significant electric current. The core of a relay is an electromagnet a loop of wire that turns into a brief magnet when power courses through it. You can think about a hand-off as a sort of electric lever: switch it on with a modest current, and it switches on use another machine utilizing a significantly higher current.

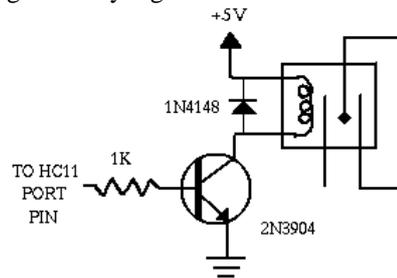


Fig.12: Relay

3.10 Humidity Sensor

A humidity sensor or hygrometer detects measures and reports both dampness and air temperature. The proportion of dampness noticeable all around to the most astounding measure of dampness at a specific air temperature is called relative mugginess. Relative stickiness turns into a vital factor when searching for comfort. Stickiness sensors work by distinguishing changes that adjust electrical streams or temperature noticeable all around. There are three fundamental kinds of stickiness sensors: capacitive, resistive and warm. Every one of the three sorts of sensors screen minute changes in the environment keeping in mind the end goal to ascertain the stickiness noticeable all around.

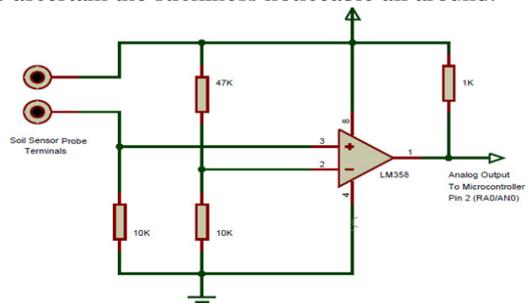


Fig.13: Humidity Sensor

IV. CIRCUIT DIAGRAM

4.1 Transmitter

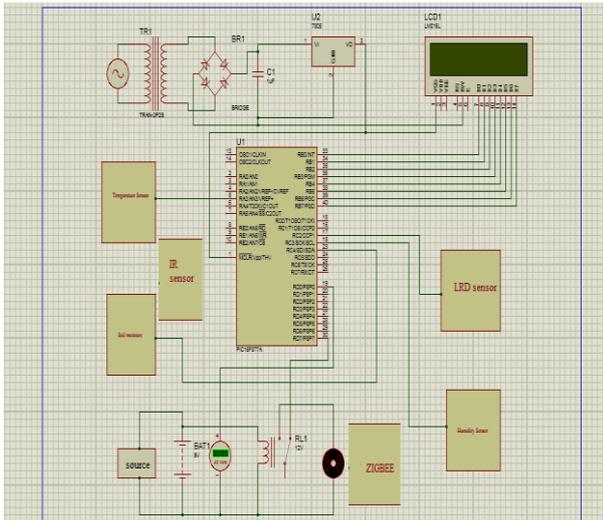


Fig. 14: Circuit Diagram for the Transmitter Model in Smart Grid System

4.2 Receiver

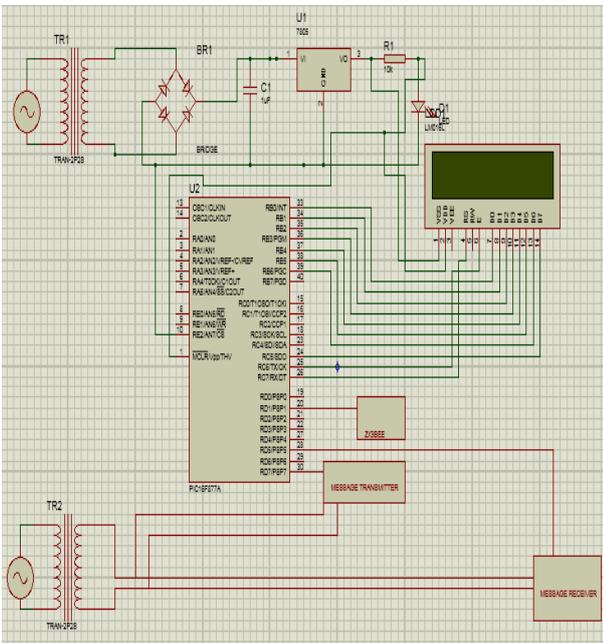


Fig.15: Circuit Diagram for an Receiver Model In Smart Grid System

4.3 Circuit Diagram Explanation

- The ZigBee based wireless sensor network will analyze the distribution devices and its range value.
- Mainly transformer, transmission line parameters value, and its protective range
- Initially, the powers supply +5v is given to the microcontroller.
- The controller monitors the present value of the various sensor. If it exceeds the sensor sent the alert to ZIGBEE receiver will alert its ranges Through IOT.

V. RESULT DISCUSSION

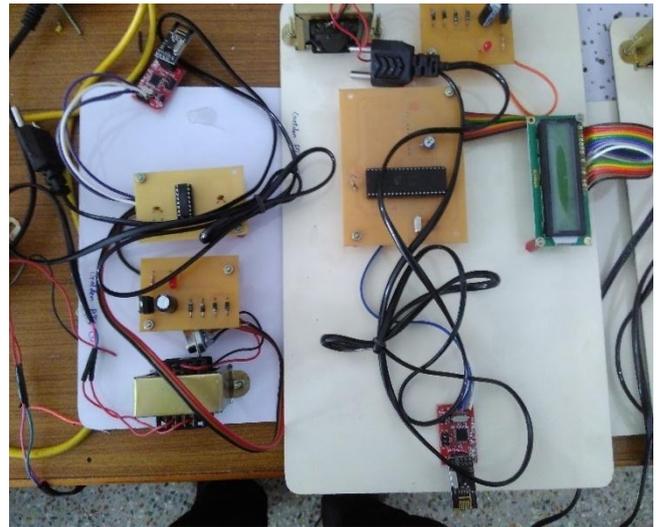


Fig.16: Hardware Model for the Proposed Technique

5.1 Hardware Output

Parameters	Specification	Input	Output
Input voltage, Vin	10-18	Volts	Input voltage, Vin
Output voltage, Vout	24	Volts	Output voltage, Vout
Output current, Iout	05	mA	Output current, Iout
Transformer	Step down	(230Vac-12Vac)	Transformer
Rectifier	Bridge rectifier	(12Vac-12vdc)	Rectifier
Battery	RE-chargeable	Voltage =12VDC Ampere=7.5A	Battery
Voltage sensor	Measurable	(0-230v)	Voltage sensor
Temperature	LM 37	(0-50)	(0-70)
LDR	Light	(0-5)	(0-8)

5.2 Advantages

- The IOT based control proves the smart grid efficiency.
- All the parameters are analyzed and control in this project.
- IOT can be monitored through the global sector.

5.3 Application

- Sub-station
- Smart grid
- Power generation

VI. CONCLUSION

By checking utilization of intensity of the apparatuses, information is gathered by a smart facilitator, which spares all information in the framework for preparing and also for sometime later. The parameters will be entered in the information facilitator in programming from machines incorporate voltage, current, and power. The prepared voltage, current, and power esteems are shown on the graphical UI running on a PC. The prepared information is precise and easy to understand. The detecting framework in the sensor hub measures the parameters (voltage and current). The crude information (i.e., changed over ADC esteems) are transmitted to the coordinator.

REFERENCES

1. Antonello Monti and Ferdinanda Ponci, "Electric Power Systems"© Springer-Verlag Berlin Heidelberg 2015 E. Kyriakides and M. Polycarpou (eds.), Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems, Studies in Computational Intelligence 565.
2. G. M. Shafuallah, Amanullah M. T. Oo, A. B. M. Shawkat Ali, Peter Wolfs "Smart Grid for a Sustainable Future," *Smart Grid and Renewable Energy*, 2013,4,23-34.
3. Jimmy J. Nielsen, Hervé Ganem, Ljupco Jorguseski, Kemal Alic, Miha Smolnikar, Ziming Zhu, Nuno K. Pratas, Michal Golinski, Haibin Zhang, Urban Kuhar, Zhong Fan, and Ales Svigelj, "Secure Real-Time Monitoring and management of Smart Distribution Grid Using Shared Cellular Networks", *IEEE Wireless Communications April 2017*.
4. Aadesh Kumar Arya¹, Saurabh Chanana², and Ashwani Kumar³, "Role of Smart Grid to Power System Planning and Operation in India," *Proc. of Int. Conf. on Emerging Trends in Engineering and Technology*.
5. Backline Hoang, "Smart Grids," Originally published on the IEEE Emerging Technology portal, 2006—2012.