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Internet of Things (IoT) Smart Energy Grid System By cloud data logging system using ThingSpeak

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Abstract— **The smart grid is the key element of the power system modernization strategy. Energy generation Companies supply electricity to all the households via intermediate controlled power transmission hubs known as Electricity Grid. Sometimes problems arise due to the failure of the electricity grid leading to blackout of an entire area that was getting supply from that particular grid. This project aims to solve this problem using IoT as the means of communication and also tackling various other issues that smart systems can deal with to avoid unnecessary losses to the Energy producers.**

Keywords— **Internet of Things (IoT), Smart grid, node MCU (Esp8266), Smart Energy meter, Digital energy meter.**

I. INTRODUCTION

A **smart grid** is an approach in which user safety should be ensured while monitoring, [2-4] updating, and continuously reliably distributing the electricity grid by adding smart meters and monitoring systems to the power grid in order to ensure communication between suppliers and consumers.

It is an electrical grid that uses information and [2] communications technology to gather and act on tasks received, such as information about the behaviours of suppliers and consumers, automatically to improve the efficiency, cost, and sustainability of the production and distribution of electricity.

A [4] **smart grid** also facilitates the switch from conventional energy to renewable energy. In case of having a source of renewable energy in the facility, the grid allows easy access to integrate it into the grid. The [4] **smart grid** permits greater penetration of highly variable renewable sources of energy, such as wind power and solar energy.

It is a new gateway to a green future. It not only provides better energy benefits but also opens up new avenues of employment for youngsters. For example, the conversion of normal operating units into smart ones capable of connecting to the smart grid is full of new and exciting opportunities.

With the help of **Smart grid** detecting of current spike is simple and quick. The continuous monitoring of the system helps in knowing the current used on the load side and can be compared to the rated current to know the percentage spike which reveals the [1] theft current. With which the current crisis can be monitored and the theft detection is done in a simpler manner.

II. Methodology Adopted

1. We Have two grid power to supply load.
2. If there is any interruption in any grid which will be communicated to controller with the help of **Node MCU.**
3. As soon as any interruption is detected in any grid, automated isolator and connector will get triggered connecting two grid lines resulting in no power interruption and same will be updated in **IoT** platform.
4. ThingSpeak is used as the platform for monitoring the data.
5. Current sensor will detect any unusual change in current and will be updated in **IoT** platform.
6. Load is connected with **IoT** enabled **smart energy meter** which will evaluate the power consumption and same will be updated in **IoT** platform.

A. Block Diagram

There will be two grid lines, each consisting of current sensors, Node MCU (Esp8266), Connected to single channel relay, these relays will be having separate neutral connections and will pass through energy meters to loads. One side will be connected to

digital energy meter and another is connected with PZEM 004T module which is used as **Smart Energy meter**. Bulbs are used as Loads. Fig.1 shows the Block diagram of the project.

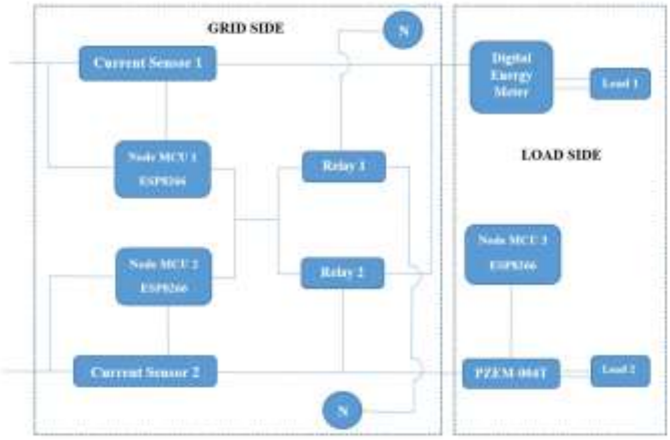

Fig.1 Block diagram

Node MCU (ESP8266)

Fig.2 Node MCU (ESP8266)

The Node MCU ESP8266 board comes with the ESP-12E module containing the ESP8266 chip having Tensilica Xtensa 32-bit LX106 RISC microprocessor. With Node MCU connected on both the side of the grid line we can easily moniter and also have automated high and low command given to relay when any side of the line goes down and an interruption in current is seen. We have used 3 Node MCU (esp8266) modules, two for grid side and one for load side where the output of PZEM-004T sensor is updated on **IoT** platform. Fig.2 shows an Image of **Node MCU (Esp8266).**

Relay – Single channel – 5V

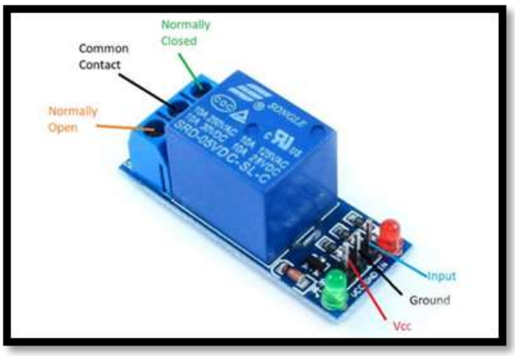

Fig.3 Pin description of Single channel relay

Relay is an electromechanical device that uses an electric current to open or close the contacts of a switch. Supply voltage – 3.75V to 6V, Quiescent current: 2mA, Current when the relay is active: ~70mA, Relay maximum contact, voltage – 250VAC or 30VDC, Relay maximum current – 10A. Which is used as a switching device in case of any interruption due to faults [3] occur in any side of the grid so that we can shift and connect the load with the other line. Fig.3 shows an image of the single channel relay used with its pin details.

Current Sensor ACS-712

Fig.4 Current Sensor ACS-712

The ACS712 is a fully integrated, hall effect-based linear current sensor with 2.1kVRMS voltage isolation and integrated low-resistance current conductor. Technical terms aside, it's simply put forth as a current sensor that uses its conductor to calculate and measure the amount of current applied. Having current sensor on both the sides of grid side, we can calculate the grid side flow of current. If any fault occurs on any side of the grid and the current sensor doesn't sense any current then it gives signal to **Node MCU (esp8266)** to trigger the relay Fig.4 shows an image of a Current sensor.

Digital Energy Meter

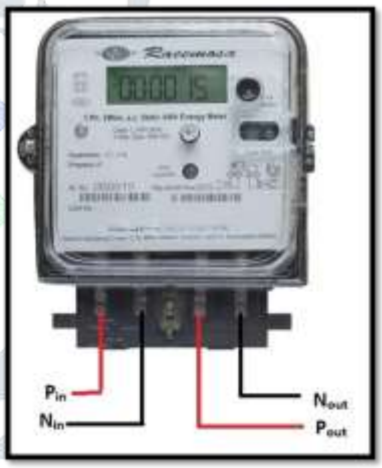

Fig.5 **Digital energy meter**

Digital energy meters also called advanced meters or smart meters, are intelligent devices that automatically record the user consumption of water and electricity. After the data is collected, digital meters electronically report all the gathered information to the utility company at regular intervals. At Schneider Electric India, we have exclusively developed a modern and smart range of Conserve **energy meters** that reduce energy costs, ensure proper wiring, and enable easy navigation with beneficial modifications in the display pages. They are typically calibrated in billing units, the most common one being the Kilowatts hour, which is equal to the amount of energy used by a load of one kilowatt over a period of one hour, or 3,600,000 joules. Here we have used the **digital energy meter** as reference to how a normal meter is used and to know how different the **Smart energy meter** is. Fig.5 shows an image of **Digital energy meter**.

PZEM-004T Sensor

Fig.6 PZEM-004T sensor

PZEM-004T is an electronic module that functions to measure: Voltage, Current, Power, Frequency, Energy and Power Factors. Measurement function (voltage, current, active power).Power button clear / reset, Energy (PZEM-004T V2.0), Power-down data storage function (cumulative power down before saving), TTL Serial Communication, Power Measurement: 0 ~ 9999kW, Voltage Measurement: 80 ~ 260VAC, Current Measurement: 0 ~ 100A. This module is the most important module in this project as it measures voltage, current, power factor, power and frequency and updates it to **IoT** through the **Node MCU (Esp8266).** Fig.6 shows an image of **PZEM-004T module.**

Load – LED Bulb

LED bulbs use a semiconductor device that emits visible light when an electric current passes through it. That property is known as electroluminescence. Compact fluorescents, the most common alternative to incandescent bulbs, use electricity to excite mercury gas until it emits ultraviolet (UV) light. In this bulbs are used as loads to project the results of uninterrupted grid line connection even though one line is down. The bulbs can work for 50000 hours, if not run outside of the specified temperature range. They use about 8-11 watts of power to replace a 60-watt incandescent with at least 806 lumen and 9.5 watts for a 75-watt equivalent. This capacity provides an efficiency gain of up to 80% over incandescent bulbs.

ThingSpeak – IoT Platform

Fig.7 **ThingSpeak**

ThingSpeak is a data analytical platform service where we can monitor live data of the working projects with visualization and graphical representations. We need to sign into ThingSpeak by creating a new account, we need to open new channels where we need to monitor our required readings, first we need to check the API key generated in Things speak and match it in the codes used in esp8266. Once the connected server detects the same api key it automatically start reading the output of the connected sensors and give the output data. Fig.7 shows an image of the outlook of **ThingSpeak.**

Esp8266 webserver

Fig.8 ESP8266 Webserver

ESP8266 – Node MCU connects to an existing Wi-Fi network and act as a Web Server, it can also set up a network of its own, allowing other devices to connect directly to it and access web pages. Fig.8 shows an Image of the outlook of **Esp8266** webserver.

III. Result

Smart Energy Meter using IoT

Parameters	Value	Units
Voltage	207.00	Volts
Current	0.06	Amperes
Power Factor	1.00	XXXX
Power	11.80	Watts
Frequency	50.0	Hz

Fig.9a Power output at load side at **Smart energy meter (PZEM-004T)**

Fig.9b Current flow graph at the load side

Fig.9a shows the output of from the **Smart energy meter** from the load side, where it has recorded voltage, current, power factor, power and frequency.

Fig.9b Shows the current flow graph at the load side, where any variations will be observed and will be updated. If any major variations such as spike in current intake will give rise to suspicion of current theft and display a warning sign as the load side is taking more than the rated current. With this one of the major current crisis can be monitored and protected.

IV. AKNOLEDGEMENT

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