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Power Quality Submetering using Iot

P.V.L. Narasimha, K. Sandeep babu, Y. Venkata sai, Y. Raghuvamsi

Abstract: ***Electric energy is an important need now a day. Everyone utilize the energy to an extent in such a way that the usage of various kind of equipments under the Building Management System increases, it is crucial and important to ensure the perfect operation of the equipments. Uninterrupted power supply is very important for every house, and also maintaining the quality of power given to the system and reliability of supply are essential. Also monitoring the operation of equipment can play a major role. Submetering, is a concept of calculating the power consumed by individual ones or the entire system in any building management system. An Internet of Things (IoT) platform, which allows a kind of environment for the accessing the information in a building management system. Also it would be useful for ensuring safe operations. This submetering work deals with an IoT platform for monitoring the quality of power at the input of the system, provides the early detection of faults and analysis which is used to control the system. Moreover, the measured power quality problems can be processed in the IoT system by which the analysis will be done with the comparison of standard values of the system. The Power quality submetering is built around by arduino with internet of things platform, which provides an energy submetering Integrated Circuit (IC). The data obtained from the submeter by internet of things is wirelessly transferred to the user and also measured for power quality analysis, load and energy management.***

Keywords: ***Internet of Things (IoT), Power Quality, Submetering.***

I. INTRODUCTION

Today electrical energy is an important need for everyone. The generation, transmission and distribution of electrical energy give the power system. Power system has its role for the energy usage [1]. Every consumer need the power in a way that equipment run in proper and safe way where electrical power quality is an essential requirement. With the poor quality of power, there may be a chance of equipment failure which is more important consequence. The common thing running through all these reasons for increased concern about the electrical power quality is the continued hit for increasing productivity for all customers. Generally, most of the manufacturers need faster, highly productive and more efficient machinery.

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***** Correspondence Author
P.V.L. Narasimha*, EEE department, Lakireddy Bali Reddy college of Engineering (A), Mylavaram, Andhra Pradesh, India.
K. Sandeep babu, EEE department, Lakireddy Bali Reddy college of Engineering (A), Mylavaram, Andhra Pradesh, India.
Y. Venkata sai, EEE department, Lakireddy Bali Reddy college of Engineering (A), Mylavaram, Andhra Pradesh, India.
Mr. Y. Raghuvamsi, EEE department, Lakireddy Bali Reddy college of Engineering (A), Mylavaram, Andhra Pradesh, India.

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Utilities support this because the customers can be benefitted which in turn gets the goodwill and profits to the company and also helps put off large investments in power generating and transmission stations with the use of highly efficient load equipment. Sometimes the power quality issues come from equipment side. As, now a days, every industry is looking for automation and the working of the equipment used for automation and control is very important which decides the power quality in the building management system [2].

Now a days, power quality is a simple concept, but it defines a variety of problems found in every electrical power system and it is a relative concept. The definition of power good or bad depends on the end user. Where a piece of equipment works satisfactorily, the consumer thinks the power is fine. If the equipment does not operate as expected or fails unexpectedly, there is a feeling of bad control. There could be a lot and variety of power quality problems in between these, depending on the power user's perspective. Knowing power quality problems is a strong starting point to solve ever power quality problem [3].

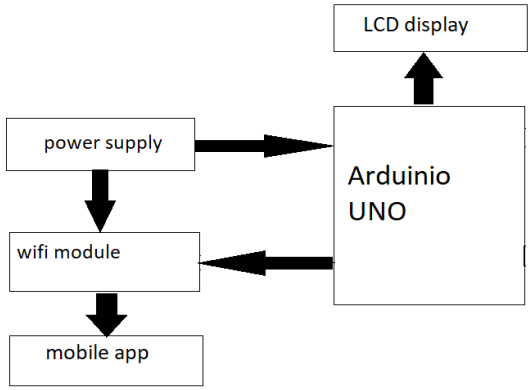

Fig. 1. Introduction diagram of energy submeter using IOT

II. VARIOUS POWER QUALITY POBLEMS

A. Voltage Sag:

The reduction of the Root mean square voltage from the nominal voltage level around 10 to 90 percent at the rated frequency, over a particular period of time. According to standards of IEEE-1159, Voltage Sag or Voltage Dip is defined as the reduction in the RMS voltage level to 10% - 90% to nominal, at the rated frequency for durations of half cycle to one minute.

B. Undervoltage:

An undervoltage is a decrease in the root mean square value of voltage to less than 90% at the rated frequency, over a period longer than one minute.

A load switching on or a capacitor bank switching off can cause an undervoltage. Until voltage regulation equipment on the system can bring the voltage back to within tolerances undervoltage appears.

C. Voltage Swell:

A rise in the Root mean square voltage from the nominal level around 10 to 90 percent at rated frequency, over a particular period of time. According to IEEE 1159Voltage Swell is defined as the rise in the Root Mean Square voltage level to 110% - 180% of nominal, at the power frequency for durations of half cycle to one (1) minute.

D. Overvoltage:

An overvoltage is an increase in the root mean square ac voltage greater than 110% at the rated frequency for duration longer than one minute. Overvoltages are usually the result of heavy load switching (e.g., Switching a capacitor bank). The over voltages results because either the system is too weak for the proper voltage regulationor voltage controls are insufficient. Desirable tap changings on transformers can also result in overvoltages.

E. Over Current:

Over current is the current drawn in excess by the load which is beyond the rating of the equipment or a conductor which carries current to the load. Over current occurs from an overload, short circuit and a ground fault.

III. BLOCK DIAGRAM

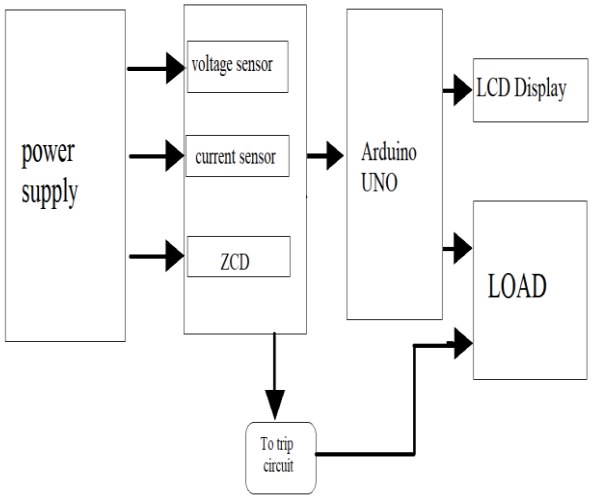

Fig. 2. Block diagram of power quality submeter using IOT

In this block diagram we will illustrate how the circuit diagram is basically related. The total arrangement of power quality submetering is setup between power supply and load. The power supply is alternating current power in which the various power quality problems are to be measured. The voltage of the power supply is measured from the voltage sensor similarly the current is going to be measured from the current sensor. In order to measure the frequency a zero crossing detector is used. All the parameters voltage, current, frequency is interfaced with the arduino UNO. With these parameters a program is written on the arduino software and dumped it on to the arduino using the USB cable. The output is given to the relay module and there to load. The measure parameters are displayed in the LCD display. The relay module is to protect the load from various problems like faults. If any variations in the input parameters sensed by the respective sensing equipment are going to be measured and processed in the arduino then the power quality event or problem is considered. If that problem is continued for more than the standard duration then arduino activates the relay to protect the load. For further advancement the measured data is stored in the cloud system by internet of things. This helps in the energy management and another analysis [4].

IV. HARDWARE DESIGN

The prototype model is designed around Arduino UNO. For measurement of various power quality problems, certain electrical parameters like voltage, current, frequency are to be known. The total model is setup between the source and the load.

A. Sensors to Arduino Uno:

The input parameters to Arduino UNO are voltage, current and frequency. The basic input voltage required to Arduino UNO is 5V. The voltage sensor is connected parallel to the load. Similarly the current sensor is connected in series with the load.

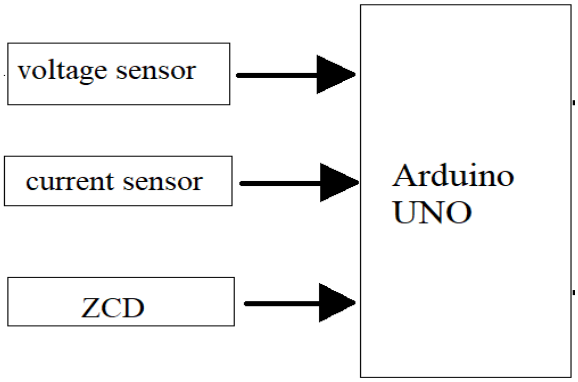

Fig. 3. Sensors to ARDUINO UNO

B. Arduino Uno to LCD:

The measured parameters voltage, current, frequency and power are displayed in the LCD screen. If any power quality problem is observed, it also displayed on the screen.

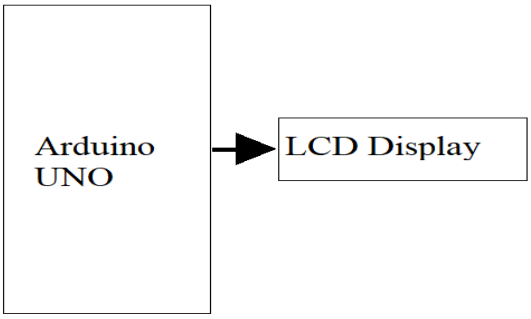

Fig. 4. Arduino Uno to LCD display

C. Arduino Uno to Relay:

In order to have the protection for the load from various power quality problems a trip system is setup around ARDUINO i.e.., relay.

If any problem exceeds the standard limits the ARDUINO trip the load from the source with the help of relay.

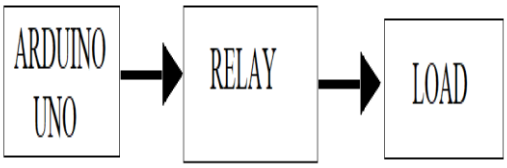

Fig. 5: Arduino Uno to Relay

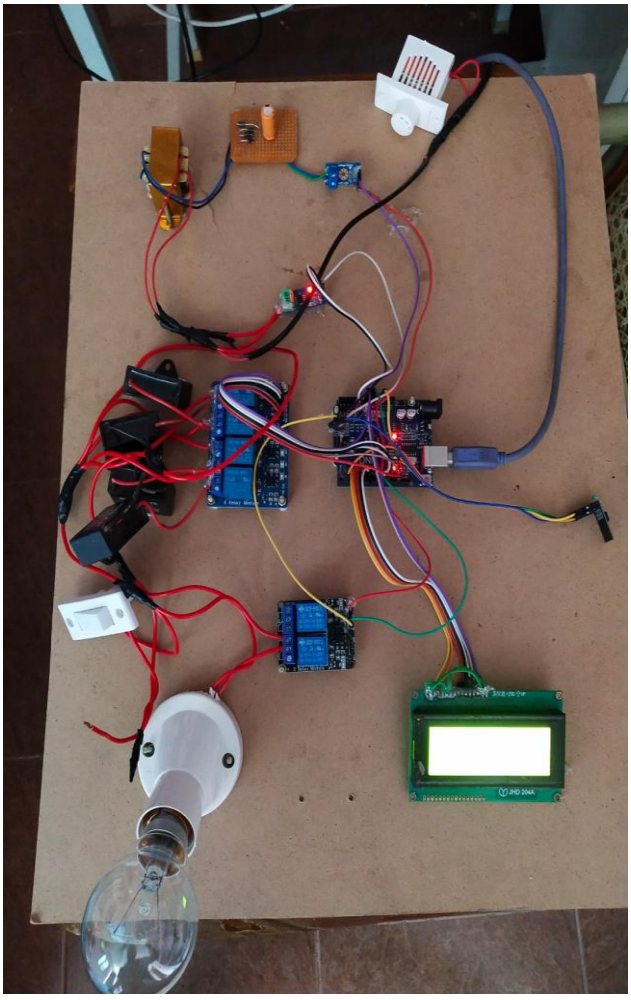

Fig. 6. Hardware implementation of Power Quality Submetering Using IoT

D. Software System Design:

In this paper, ARDUINO is used to monitor the measured values. Arduino (IDE) Integrated Development Environment is a multi-use platform (for WINDOWS, macOS, Linux) composed of C and C++ capabilities. It is used to build many automation systems, and is used to execute projects on the Internet of Things (IOT) [5].

After selecting the correct Arduino board i.e., Arduino UNO will write the code in the IDE and dump the code in the Arduino UNO board by testing errors if errors are not found, then upload it to the Arduino board. The main thing to remember the code is compiled correctly or not. Port insertion is done properly or should not be checked.

V. RESULTS OBTAINED

A. Initial State:

In the arduino we initially set a voltage known as reference voltage. From the power supply with the help of regulator reference voltage is set to the load. In order to create power quality problems say over voltage, under voltage, over current, and under frequency the regulator is varied accordingly.

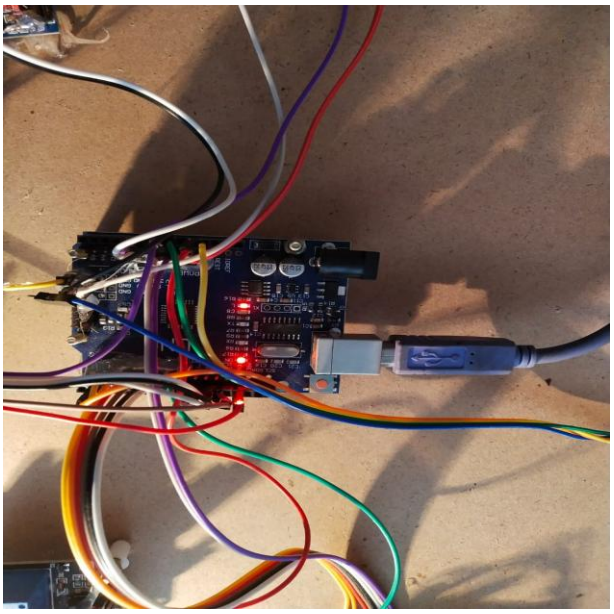

Fig. 7. Initial state of an arduino

B. Overvoltage Condition:

By using voltage regulator we adjust the voltage value more than the reference value (that is initially given to the arduino). So that due to increase in the voltage the over voltage value is displayed in the LCD display and trips the circuit.

Fig. 8. Overvoltage condition

C. Undervoltage Condition:

By using voltage regulator we adjust the voltage value less than the reference value (that is initially given to the arduino). So that due to decrease in the voltage the under voltage value is displayed in the LCD display and trips the circuit.

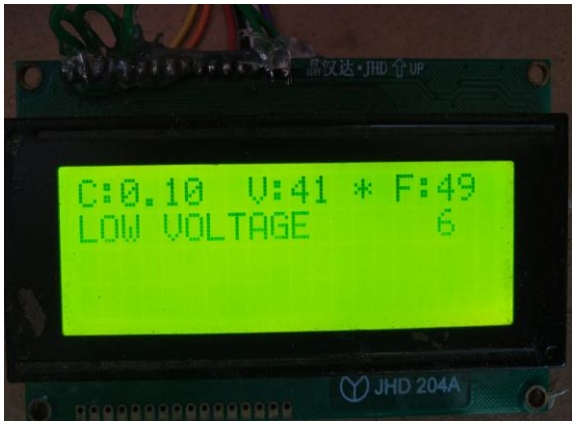

Fig. 9. Undervoltage condition

D. Over Current Condition:

The load is changed such that it draws more current, that is more the reference value(initial value that is given to the arduino).so that the over current problem is created in the circuit ,that value is displayed in the LCD display and relay acts accordingly to protect the circuit.

E. Advantages:

a) Ensures power system reliability.
b) Determines the needs of mitigation equipments.
c) Reduces the energy expenses.
d) Protect the equipment from the power quality problems.
e) Monitors the system.
f) Monitoring systems enable the identification of the most sensitive equipment and the installation of power conditioning systems where necessary.

VI. CONCLUSION

Now a days, every automated industry needs the safe, uninterrupted power with less disturbances. So, the power quality has an extreme role for the efficient operation of industries. Power quality is a complex area, having different types of problems. The quick sensing and analyzing the power quality problems are very important for improved quality of operation and build up the level of functioning of the system. Now a days, most energy taking industries effect from various power quality problems, even having solutions to such problem. However, there are multiple solutions. The advantage of the proposed system presented is that it could also be used to indicate the equipment performance giving the efficiency and power quality level. With the present proposed system, the user will be able to detect problems such as voltage sag, swell etc also to monitor the energy utilization. Up to the knowledge, there was not any IoT system applied to Power Quality monitoring. This proposed one is very good for industrial and commercial. Through the IoT platform, the measured data can be analyzed with the standard values and also the data can be stored for future requirements and then data is processed through different connecting devices in user understandable way.

FUTURE SCOPE

This work can be extended for analyzing more power quality problems by using the data that is related to a particular individual part of system or whole system with the help of IoT [6]. The power factor calculation and Total Harmonic Distortion (THD) calculation also can be added, thereby the related information can be send to user through IoT or automated correcting equipment can be incorporated for connecting power factor correction. In the way, measurement of data can be used to detect source of problems which may occur in the future using various strategies. This cloud based data on IoT platform support higher understanding of the consumption of electricity. Moreover, the identification of power quality problem is very easy and fast which can be detected in the early stage based on the data processed by IoT.

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AUTHORS PROFILE

Mr. P.V.L. Narasimha pursuing B.Tech (EEE) in Lakireddy Bali Reddy College of Engineering (A), Mylavaram, Andhra Pradesh. His areas of interest are power systems, automation and power electronics.

Mr. K. Sandeep Babu pursuing B.Tech(EEE) in Lakireddy Bali Reddy College of Engineering (A), Mylavaram, Andhra Pradesh. His areas of interest are power systems, automation and power electronics.

Mr. Y. Venkata Sai pursuing B.Tech(EEE) in Lakireddy Bali Reddy college of Engineering (A), Mylavaram, Andhra Pradesh. His areas of interest are power systems, automation and power electronics.

Mr. Y. Raghuvamsi, Assistant Professor, Department of Electrical and Electronics Engineering, Lakireddy Bali Reddy College of Engineering (A), Mylavaram, Andhra Pradesh. His areas of interest are power system stability, optimization techniques and renewable energy technologies.