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IOT Based Frequency and PF Measurement System

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ABSTRACT: This paper presents the IoT based frequency and power factor measurement system. It is a continuous monitoring device which is very essential in today's drastically developing era of energy consumption with vastly varying load systems. Whatever is the type of load or nature of supply, the power factor and frequency must be in desirable limit for smooth operation of equipment and also for its longer life. This device continuously monitors the frequency of supply whether it is lying in acceptable limit and also keep an eye on the system power factor. This is very essential that it allow the user to turn on safety devices in case of any abnormality in supply avoiding the possible hazards to the equipment.

KEYWORDS: Frequency Monitoring, Power Factor Monitoring, Safety Of Equipment

I. INTRODUCTION

This is the modification of the complex and cumbersome power system monitoring equipment that are available in market right now. The major simplification here that can be seen is it employs Arduino UNO instead of ESP32 and other complex boards. The Arduino is a much better choice for new makers. Anyone who is not familiar with Arduino programming, can be able to handle the device in short period of time. Arduino is much simpler to program. It is more forgiving, as well, to problems and mistakes in the wiring. It's more robust, so it's easier to set up. Here the device is intended to monitor two major parameters of power system that are very essential when it comes to the quality of power supply. Those are power factor and frequency of the supply. Generally, it is assumed that grid voltage and frequency are independent of each other. But in fact, any kind of fault in power system can affect the supply voltage and frequency. This device alerts to the operator in case of any changes in the frequency beyond permissible value so that safety devices can be turned on. Another thing this system keep an eye upon is the power factor of the system. It continuously provides the value of the power factor so that the best quality of supply is assured.

For measurement of frequency, zero crossing method is employed. It is the simplest method to calculate frequency of any quantity as it measures the time period of the quantity as it passes through the zero. Then this measured quantity is reversed using Arduino because frequency is reciprocal of time. For measurement of power factor, again the measurement of time is essential. Here the time difference between the current wave and voltage wave is measured. This is nothing but the phase difference between two waves. The cosine of this quantity is taken using Arduino to calculate final power factor. All this data can be transferred, stored and used from anywhere using IoT. It allows the system to be operated remotely and it will maintain convenience eliminating confusion between different operators of the device.

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The overall system layout is shown in following figure.

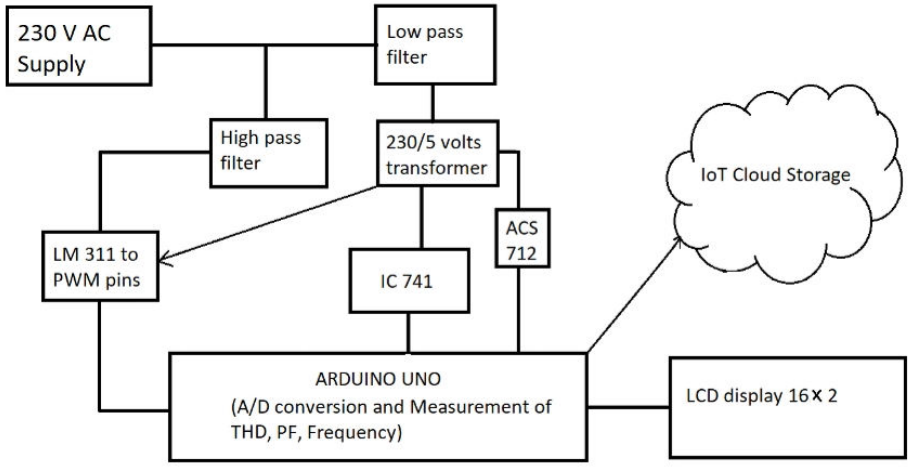

Fig. 1 Block Diagram Of Proposed System

II. LITERATURE SURVEY

1) In paper "Measurement of low frequency signal of power grid using Arduino" Written by Mohd Firdaus bin Mohd Ab Halim, Mohamad Haniff Harun, Khalil Azha Mohd Annuar, Suziana Ahmad and Mohd Hanif Bin Che Hasan, the author explains how grid frequency monitoring is essential to the energy provider and its relevant stakeholder. Nowadays PMU provides the means to perform the grid frequency monitoring task. Monitoring the quality and reliability of the grid is also important to the consumer especially to the heavy industrial player because it uses large portion of the electricity for its activity. The data from the monitoring activity also helps liven research activities in energy transmission area. PMU user does not share the data publicly due to business reason. In Europe for instance, the energy is traded in daily basis. By having the data of demand and supply, it gives an upper hand to these traders usually TSO's company and energy provider over its competitor. In Malaysia the energy is not traded and supply - demand balancing is managed solely by Tenaga Nasional.

2) Development of Power Factor Meter using Arduino First Teddy Surya Gunawan, Muhamad Hadzir Anuar, Mira Kartiwi, Zuriati Janin. This paper has presented the development of power factor meter using Arduino. To measure the current, a non-invasive current sensor was used for ease of installation. The accuracy of the selected sensor was calibrated using the manual ammeter, in which the difference is around ±1.79%. Further research includes experiments on various electrical appliances, data logging, and automatic power factor improvement using selected switch on parallel connected capacitor bank.

3) Shodhganga.com From this research website I learned about the basic frequency measurement method i.e. zero crossing method. Then I implemented it into my project.

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III. PROPOSED SYSTEM DEVELOPMENT

1. Frequency Measurement:

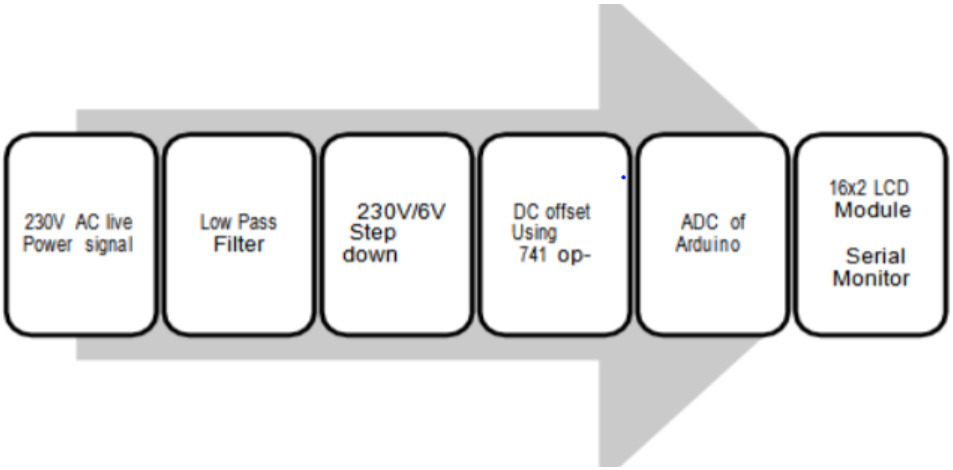

Fig 2: Block diagram for frequency measurement

Pass the input signal through a low pass filter such that all the higher order harmonics present in the input signal are eliminated and the signal is just left over with the fundamental frequency. Now feed this filtered signal to the 230V/6V step down transformer. The voltage is first brought down to 6V. This signal is now fed to the inverting pin of a 741 Op-Amp (operational amplifier). Refer to the figure 2. To the non-inverting pin of the 741 Op-amp, give a DC signal of magnitude less than 5V. Adjust the output by feeding the AC and the DC signals individually so that the net signal obtained at the output terminal of the 741 op-amp is: $Vo = 2.5 + 2.5\sin(\omega t)$. The voltage thus varies sinusoidal between 0 to 5V and can be safely given to the analogue pin of the micro-controller.

2. Power factor:

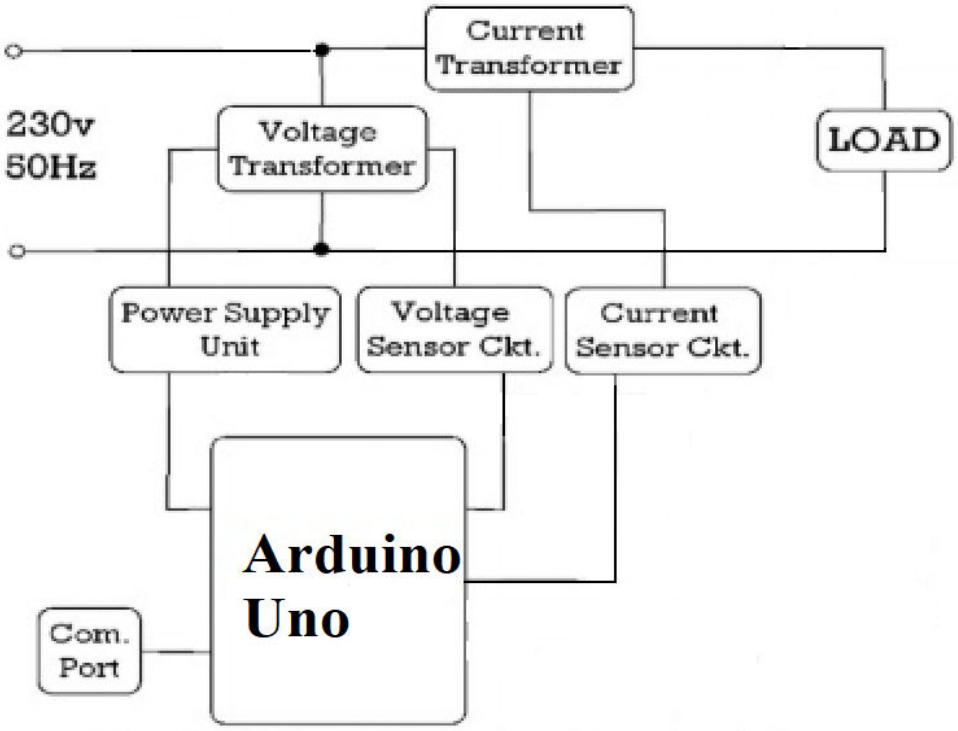

Fig 3: Block diagram for PF measurement

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Arduino measures the time difference between current waveform and voltage waveform. The time difference between current wave form and voltage wave form is basically, a phase difference between two waves. This phase difference is used to calculate power factor with the help cos function that is cos (phase difference). 5V supply is taken from step down transformer and ACS 712 is used for current sensing.

IV. CONCLUSION

Zero crossing method is simpler to implement and can be implemented where only measurement is required and not for protection system. IOT based frequency and PF measurement system is highly accurate system. Which continuously monitors the power quality through frequency and PF measurement and stores the data at easily accessible universal portal. The loads under observation can be easily changed making this device perfect for experimental purposes. Th is system is accurate than conventional frequency meters. Unlike analogue and digital frequency meters its readings are not affected by warming of instrument. This is very easy to install and use. High voltage is stepped down using transformer also the harmonics are eliminated hence no external means for conditioning power supply are needed. Frequency measurement using zero crossing conditions works effective during sinusoidal conditions and is prone to error under multiple zero crossings, harmonics and sub-harmonic conditions. The time required to compute the frequency is more than one cycle.

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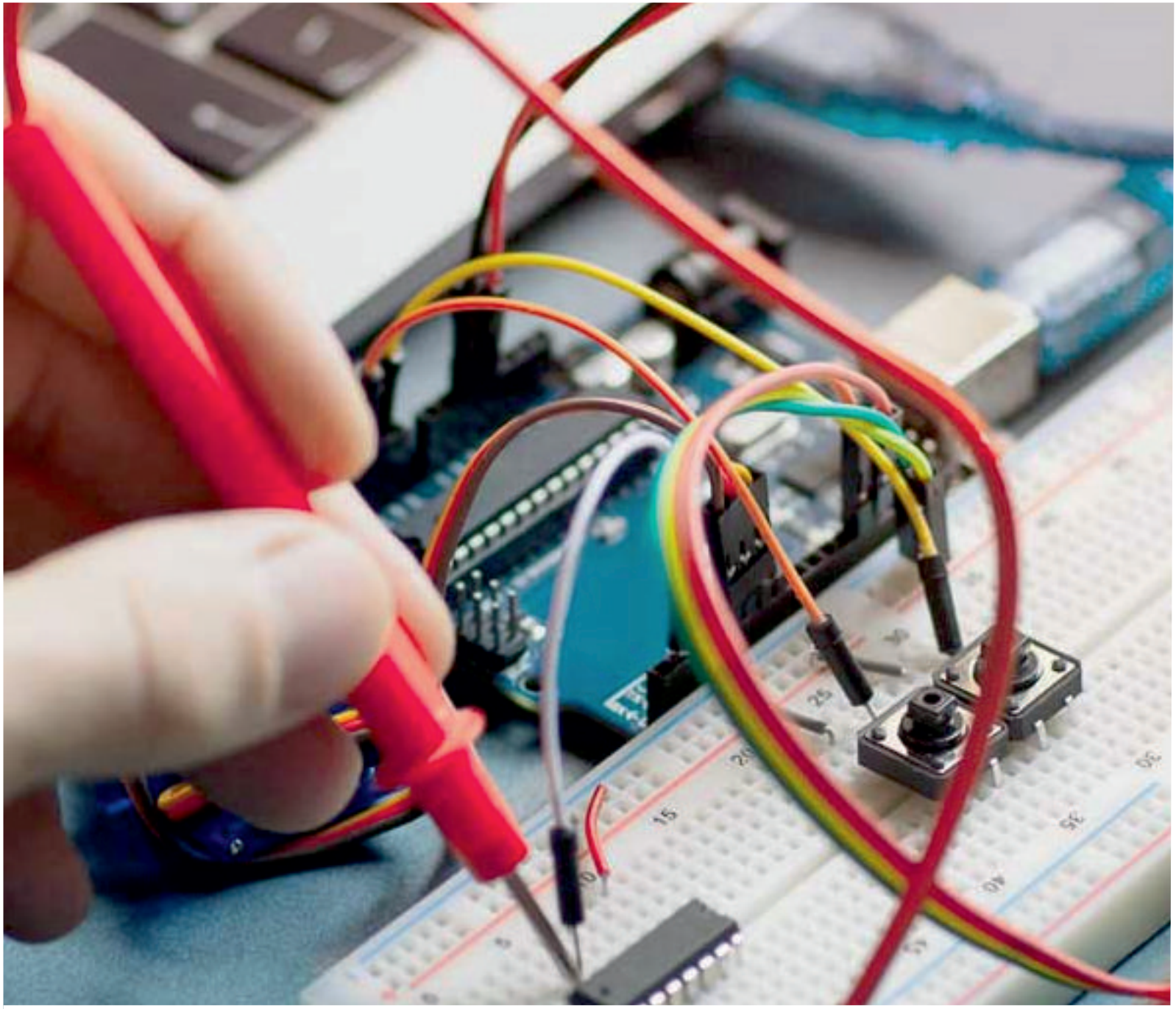

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