Micro Phasor Measuring Unit

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Abstract

A phasor measuring unit measures voltage, frequency, current, phase angle between voltage and current at a node. It uses voltage and current sensors to collect samples of voltage and current waveforms, displays them in its serial monitor. With time synchronization of the samples of voltage and current waveforms, phase angle between voltage and current, frequency of voltage can be calculated and displayed instantaneously, at a speed of 1sample/second using a real time clock module. The accuracy of samples depends on sensors' accuracy and speed depends on real time clock module's delay.

Keywords: *frequency, synchronization, node , voltage and current sensors ,time clock modules , arduino software, zero crossing detector, phasor measuring unit, speed of the data.*

1. Introduction

The load transmit centers during a huge grid control and supervision over the transmission network and it takes protective measures to stay away from any kind of system collapse which might get in the way electricity distribution. With ever increasing size and complexness of the ability system, the flexibility to determine any faults within the grid is greatly gripped on the $64000time data presented to the operator. Historically, analog and digital data (type of breaker, power flow and frequency) is consider at the end transmitted to load dispatch center victimization super victimisation management and information acquisition system (SCADA) or energy management system (EMS). The primary constraint of SCADA or EMS is that the incapability to determine the phasor quantities quicker and require of your time synchronization. Phasor mensuration Units (PMU) overcomes the limitations of SCADA and EMS by quicker computation and assessment of a variety of quantities at a node.In mid 1980's synchronous phasor measuring units were introduced for answer the necessity of a set of financial and safer surveillance devices for power Systems (EPS).Since then, measure power System (EPS) parameters of voltage and current in moderately remote buses has expected notice from researchers. Such mensurations square measure performed by phasor measurement units (PMUs), synchronous by global Positioning System (GPS) satellites. The benefit of mensurations synchrophasors to a worldwide reference time is useful in capturing the wide space snap shot of the ability system. Effective utilization of this technology is extremely helpful in mitigating blackouts and learning the $64000 time behavior of the ability system. Since the bus voltage and frequency of an influence system is extremely closely joined with the behavior of a network, its real time mensuration could

be a powerful tool for operational a network. An announcement of PMU measures the voltage and current angle of a preferred grid at 25-40 samples per second. The section data is synchronous with world Positioning Systems (GPS) satellite and is transmitted to Phasor information Concentrator (PDC) through a high speed communication network. The time conserved section data is term synchrophasor. There square measure many reward of PMU like watching of EPS and network protection. The mensuration of voltage and current in remote bus permits the operator to form a existing call regarding the repairs and safety of the system within the face of mixed worries.

2. Literature Review

The voltage phase angles are measured by using synchronized clocks for power system applications in the early 1980s when measurements of voltage phase angles were accepted out between Montreal and septiles and parallel efforts by Bonanomi in1981. However, the synchrophasor technology available today emerged from the early efforts by Phadke et al. at Virginia Tech. Phadke demonstrated the first synchronized PMU in 1988, and in 1991, the first commercial PMU product was launched by Macro dyne Inc. launched. Due to the charge of near the beginning PMU devices, PMU technology has historically been limited to transmission system applications where the trade holder necessary expensive phasor study the equipment. One of the early applications that are important to mention is the implementation of the wide-area protection system Syclopes in France in the early1990s, which was the first functional application of early forms of PMUs. The costs of the components from which PMUs are assembled (such as GPS receivers, microprocessors, and storage devices) have been dropped significantly due to the recent developments across the electronics sector. As a consequence, PMUs have reached price points that have made them an attractive tool for the distribution systems and embedded generation. Many PMUs are sold as dedicated devices which offer event recorder type functionality. Costs for such units vary between US $6000 and US $15000 depending on the specification. Many equipment vendors have begun to offer PMU functionality as a supplementary feature on other products in their range, such as protection relays.

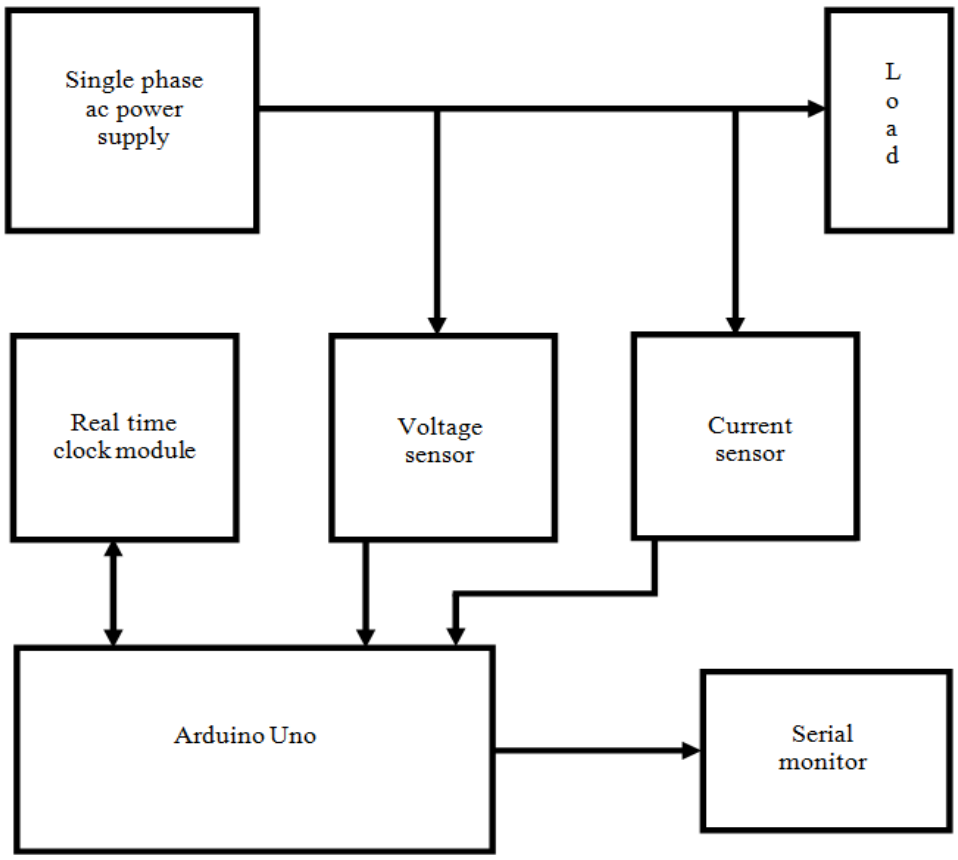
The standard for PMU devices is maintained by the IEEE C37.118 Working Group. IEEEStd. C37.11 was released in 2005 and subsequently updated in 2011. The latest release comes in two parts; IEEE C37.118.1-2011 explains how synchrophasors should be expected and gives certification requirements while IEEE C37.118.2-2011 describes data representation and data transfer. Concerns have been raised regarding the transient performance of PMUs under the 2005 standard. These concerns are addressed in the 2011 discharge of the standard. IEEE C37.118.1-2011 states that it defines synchrophasors, frequency, and rate-of-change-of frequency measurement under all in service conditions. A significant barrier regarding the use of PMU technology in research is the closed philosophy under which commercial PMU devices are developed and sold. Commercial vendors tightly guard their hardware and software designs, meaning that the measurement processes and algorithms are not known to researchers. This has led to some research departments developing their own PMU systems. Many designs utilize low cost hardware, such as described in. Two university projects are described in this section. Duplication of such work leads to lost time and resources. The Open PMU project provides a general set of capital for PMU development and research collaboration. The successful open-source Phasor Data Concentrator, open PDC, is discussed, and the rational for using an open-source model is developed.

3. Methodology

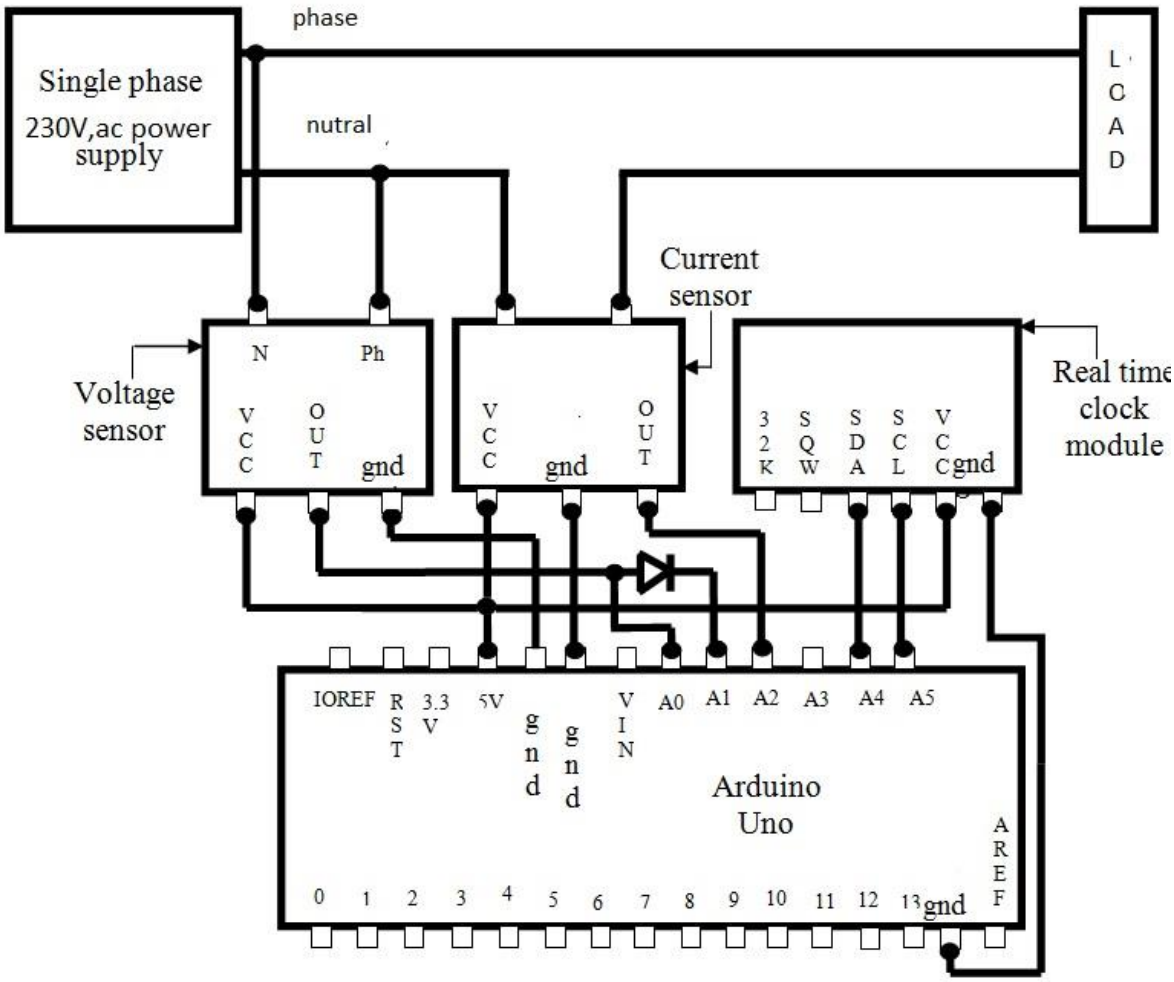
Shortcomings of currently developed Micro PMU:

The given work is very build to duplicate the behavior of actual PMU. The sensors used to collect and estimate the magnitude of voltage and current phasors. Arduino board has been coded to indicate the values of voltage, current and frequency at a speed of 4 samples per second. the foremost disadvantage of presently planned PMU is that it works only for single phase circuits and doesn't use any filters to eliminate disturbances in voltage and current waves, since the rule or methodology of but associate actual PMU operates, but it eliminates the sampled voltage and current signals' disturbances, and so the shape of rule it follows etc. are also guarded by copyright laws business PMUs square measure already on the market at intervals the market, but they usually keep company with a awfully high tag and strict copyright limitations.. The schematics of the PMUs do not appear to be openly on the market as their business policies go against it These PMUs do not allow to be used for tutorial or tutorial analysis functions. Therefore academic degree open hardware platform is desired which can be reconfigured to suit the requirement of the consumer. Building a occasional worth hardware platform for the PMUs would possibly want verified {a worthy|a dear|an expensive} endeavor inside the past but recent advances and wide accessibility of low price high performance micro-controllers and Arduino board platforms have given rise to many prospects that perhaps exploited to create the specified PMU.

4. Block diagram of micro PMU:



Circuit Diagram And Its Operation:



Initially when the **micro phasor measurement unit** connected to the single phase ac power supply which is under measurement, corresponding sensors senses the samples of voltage and current, and sends them to Arduino where they can be read and respective waveforms can be reconstructed using data mapping and/or regression analysis. The values can be displayed in serial monitor of Arduino software.

The signal from voltage sensor taken into two parallel signals and they are given to the Arduino, one is directly to analog pin A0 for voltage measurement and the other one through a series diode to analog pin A1 for frequency calculation.

Signal, which fed through diode, clips half of the signal to an average level so that the measurement of time period of 1cycle is comparatively easy. The rectified or clipped wave appears as shown in the figure below.

Here, time period of the signal at rising and falling instances will be calculated. So, period of time during rising instant is important and clipping the next half cycle to an average level

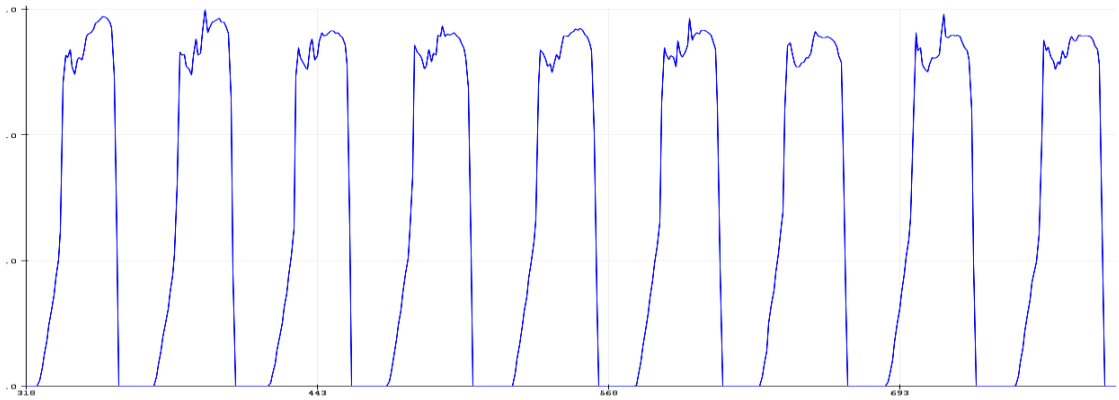


Figure Rectified voltage signal

doesn't make any error in the measurement. Also, ambiguity for the Arduino in the measurement of time period will be reduced by clipping the wave, as the signal may have many spikes (noise signal interruption) at rising or falling instants which are error prone for measurement of instantaneous time.

Arduino has been coded to calculate the frequency of the voltage waveform, also for the measurement of phase angle between voltage and current.

With the time synchronization of these values of voltage, current, frequency and phase angle they can be displayed on the serial monitor of the Arduino software. The speed of the data displayed can range from 1 sample per second to 5 samples per second.

5. Results and Discussions

The proposed work presents the values of voltage, current, frequency, and phase angle at a node with time synchronization, at a speed of 1 sample per second to 5 samples per second on the serial monitor of Arduino IDE.

The data, thus, obtained from the sensors' is used for calibration against standard meters, so that sensed results merely indicate actual values of the circuit parameters. They are then plotted on the serial monitor of the Arduino software.

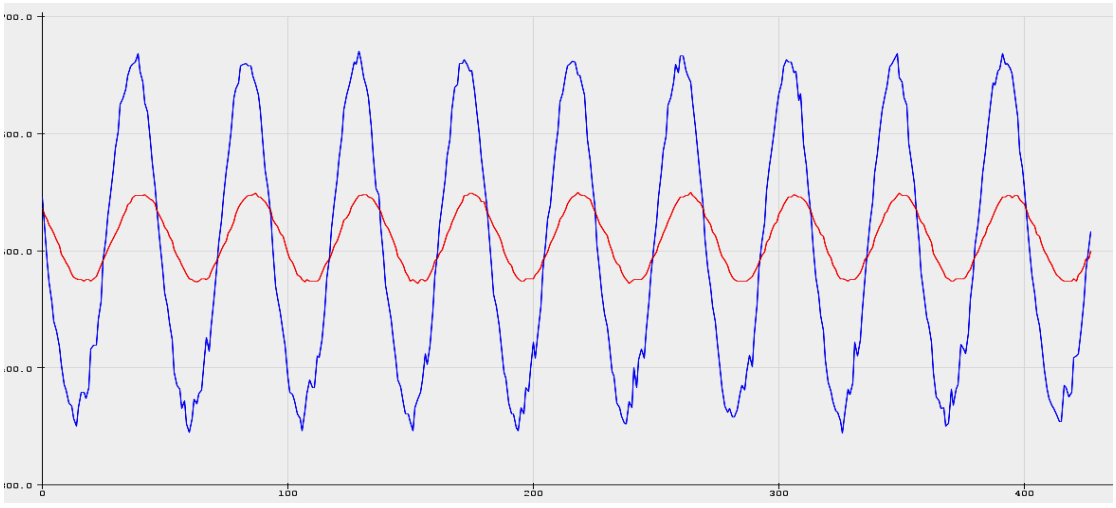


Figure Voltage and current waveforms

The Waveform with high amplitude is voltage and the other one is current. Figure shown below indicates variations of parameters of the node under consideration, such as voltage, current and frequency in the descending order of the amplitude.

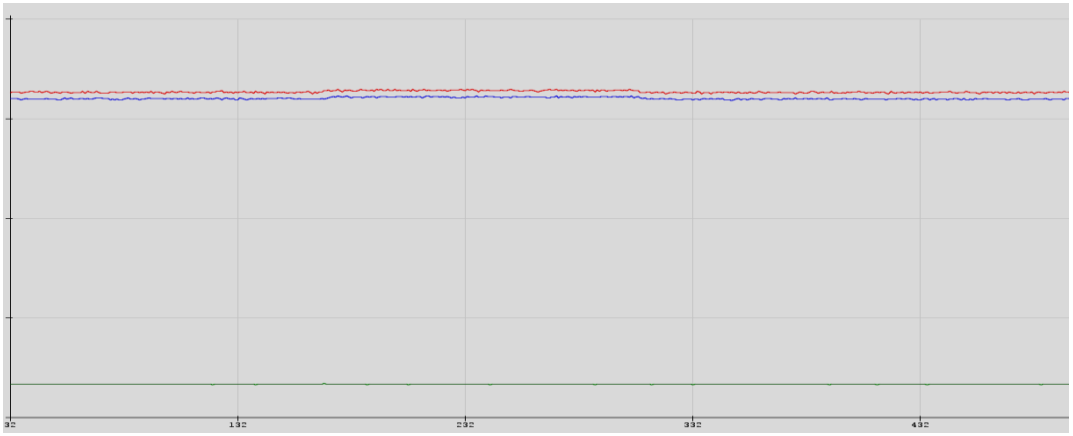


Figure .Variations in voltage, current and frequency

production of the project which is of main anxiety, is shown in the figure below. Serial monitor exhibits time, date, day of week and parameters measured up to 5 samples per second.

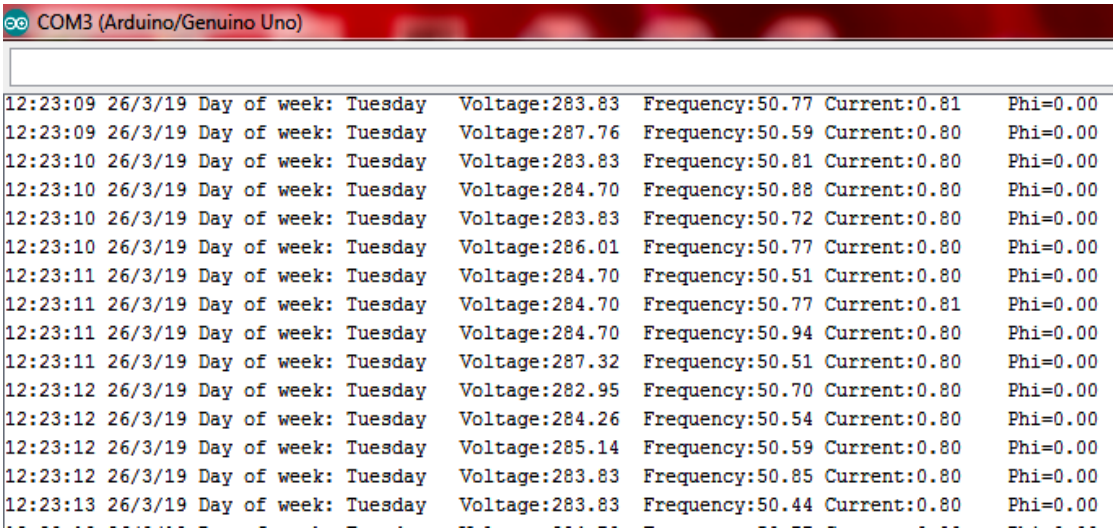


Figure Samples of parameters under measurement

The obtain data can be feed to a data logger where it can be stored and use as a upcoming reference for grid report find out.

6. Conclusions and Future Scope:

The Phasor Measurement Units are available to be the essential building blocks for monitor the Smart Grid of the upcoming. The increased number of dynamic PMUS in the Electric Grids day by day, the condition of real time of the Grid is going to give a better results as expected. Therefore so many manufacturers are going to fabricate their own versions of PMU, the much needed IEEE Standard C37.118.X.2011 is definitely a welcome guidance to make the different PMUs well-suited with each other and with the PDC.

The objective of developing a low prize PMU is not to compete with other manufacturers who provide commercial PMUs, but to facilitate the research in the academics and the R&D organizations which incorporates the data from the PMU to design and simulate the various projects related to the Electrical Grids. The intent is to make easier the hardware presentation development of Phasor measurements such that a PMU can be build with the many profitable open hardware work out platforms accessible now a day. The Arduino Uno board was selected because of its user forthcoming development location in terms of software. It facilitates the use of the device both by a learner as well as an professional.

The work that has been proposed may not follow the standards that are predefined for capacity of phasor quantities but our simple thinking is to implement a prototype of PMU for research purpose and gained the detailed knowledge of power grid.

Future scope:

Image PMUs Mostly represented in literature and one that has been thought of here, should not think the crucial options of a level headed PMU like use of a GPS synchronous clock, a real signal acquisition system and a user friendly PMU information presentation system. Whereas quite few tries of building an OpenPMU are created within the past, the thought of mistreatment Open supply Hardware to make a PMU has not been thought of. Although, it's several short comings, the merchandise holds Brobdingnagian business potential because PMU has designed under consideration of the economic limit of large scale setting up in facility. The optimisation concerned is important, from ill-treatment of low cost Arduino boards to cheaper and flexible modules for sensing. the products may be commercialised because the measure tool adhere to synchrophasor technology for distribution systems of power system.

7. Applications:

- State estimation of power system
- Detecting and tracing the faults
- Detecting power system oscillation
- Relays are protected
- Detection of harmonics in power power system
- By using this identify the post fault

8. References:

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