Low Cost Power Analyzer

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Abstract **– The aim of this paper is to design and develop a power analyzer for power system operating at a nominal frequency of 50Hz and sort out related issues in sensing, measurement, calculation of different important electrical quantities and displaying the monitoring quantities. This paper gives main emphasis on acquire voltage and current signals from the supply mains, track the frequency of the acquired signals and calculate the magnitude, total harmonic distortion, active power from voltage and current signals on a fast, low-cost Arduino or NI-DAQ (Data Acquisition) and to communicate to the PC via standard A/B cable (Arduino cable) and display it on the screen using LabVIEW.**

Keywords – Data Acquisition, power quality monitoring harmonic distortions, LabVIEW.

1. Introduction

In today's world, the variety of loads in the power system is increasing tremendously. The traditional loads were lighting load, induction motors, heating loads. But due to technological advances in last few decades, the pattern of loads is transformed to loads like SMPS, AC & DC drives, fluorescent lighting, arcing devices and furnaces and many more. These advances in the applications have impacted the power system immensely on the basis of quality of the electrical power delivered to the end user. The severity of these impacts on the power system is becoming more and more severe day by day due to ever increasing usage of digital devices and power convertors. Thus, it is very important to monitor whether the quality of power delivered to end user (may be an industry or commercial/residential user) is up to the mark or not.

The parameters that decide the quality of power are the parameters same as those of voltage and current which constitute power. These parameters consist of various factors like availability, reliability, wave shapes and values of voltage and current, power magnitudes, power factor, harmonic distortion etc. The project incorporates many advanced devices like sensing elements, data acquisition systems, data processing software's etc.

This project will be able to provide information about following electrical quantities which will enable the observer to conclude about power quality.-

A. Voltage and current waveforms

The voltage and current waveforms are very important in determining the quality of power. This is because power is multiplication of voltage and current magnitudes. These waveforms also determine the frequency and the nature of voltage supplied to the load and nature of current taken by the load. For ideal power system both voltage and current waveforms should be sinusoidal. But new devices work on different currents. Therefore it is required to study the voltage and current waveforms at many points in the power system.

B. Average voltage and average current

The average voltage or current of a periodic waveform whether it may be sinusoidal or not is defined as the quotient of area under waveform with respect to time. In other words averaging all instantaneous values of voltage over a period of time gives the average value. These values are necessary for DC power calculations.

C. RMS voltage and RMS current

RMS values of voltage and current value of AC voltage and current which are equivalent to DC values of voltage and current in aspect of electrical work. Determination of RMS values enables us to find out actual work which will be done by the supply voltage and current.

D. Voltage and current THD's

Total harmonic distortion is a factor vitamins amount of harmonics present in the supply voltage and current it can be defined as the ratio of RMS values of harmonic components to the fundamental component. THD place a vital role in design of an electrical device and it determines quality of the product. Many high power applications provide information about THD that they introduce in the system. This forces to measure the THD of the devices before using them for industrial, commercial and domestic purposes.

2. Hardware

The hardware consists of a source connected to the load through voltage and current sensor kit. The current sensors are connected in series with source to the load while voltage sensors are connected in parallel. This forms input part of the measurement system. The output of the sensors are connected to the respective analog input pins (AI pins) of NI USB-6009 with proper ground connections as shown in fig below.

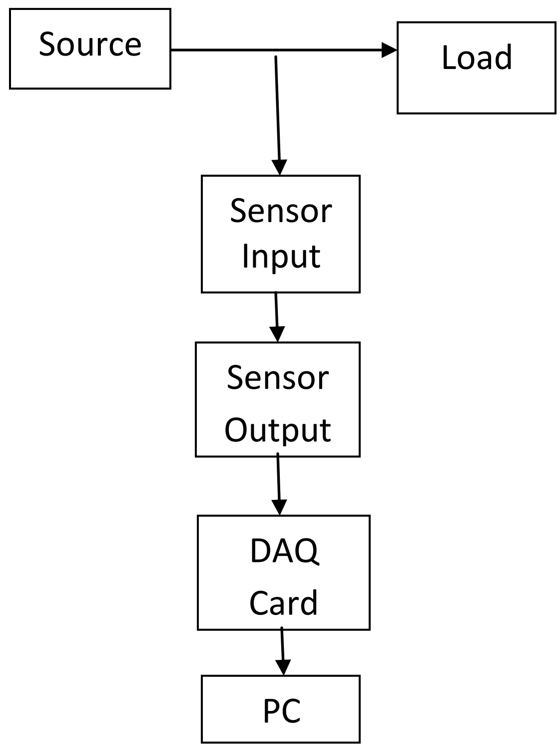


Fig.(a)- General block diagram

As we are not concerned with differential measurement of signals, the DAQ card must be operated in RSE (Reference single ended) mode. The sampling frequency NI USB-6009 is 48KS/sec while the sampling frequency for each channel must be set to 8KSps as we are using 6 analog input channels of DAQ card.

The hardware consists of (I) Arduino ATmega 328 card (II) Standard USB2.0 cable type arduino (III) Potentiometer SATO B-1K

3. Software

This scheme has some software requirements (I) LabVIEW 2015 (II)LabVIEW run time (III) Arduino Driver.

LabVIEW (short for Laboratory virtual Instrument workbench) is a platform and development environment for a visual programming language from National Instruments. Originally designed for the Apple Macintosh in 1986, LabVIEW is commonly used for data acquisition, instrument control and industrial automation on a variety of platforms including Microsoft Windows, various versions of UNIX, LINUX and Mac OS X. The connection diagram in LabVIEW is given below.

4. Result

These are some of the results which we get on the LabVIEW front panel.

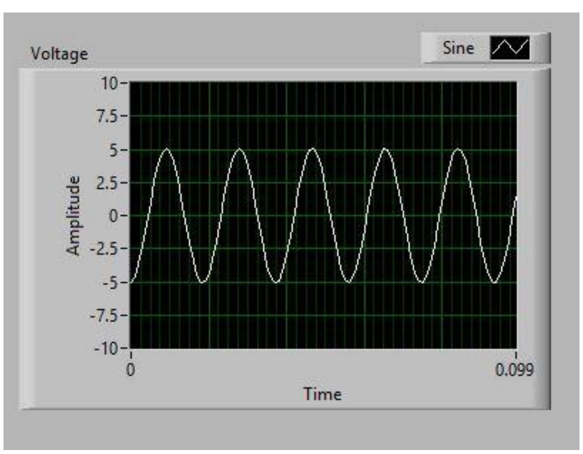
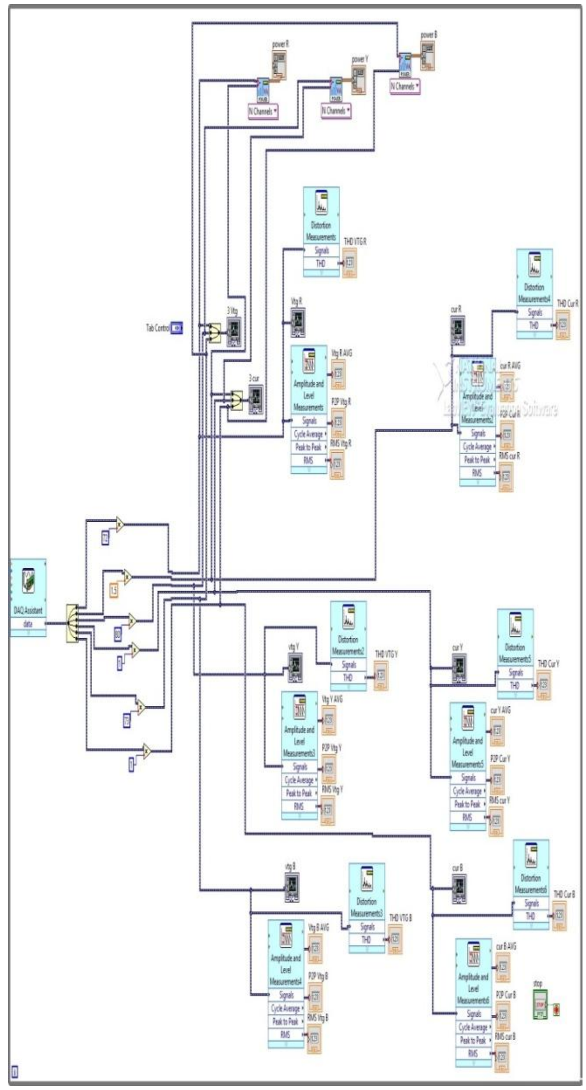


Fig (c)- Shows instantaneous voltage



Here we can see the amplitude varies between +5V to -5V.

Fig (b) Shows connection diagram

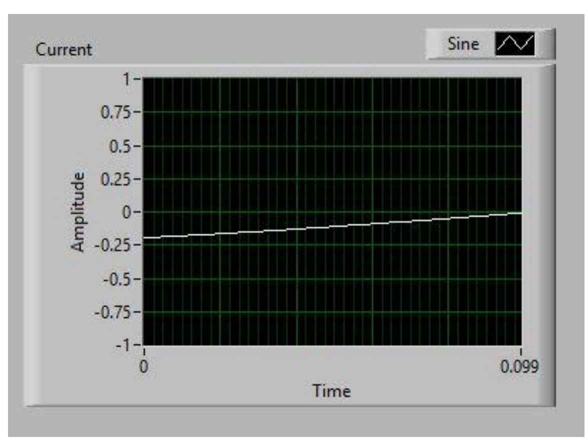


Fig (d)- Shows current waveform
Here the current varies from+0.25Ato-0.25A

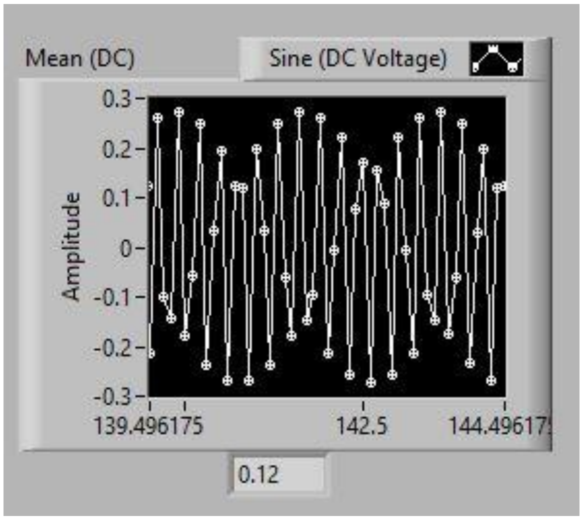


Fig (e)- Shows mean DC values
Here mean d.c. values of a.c. voltage is plotted against time.

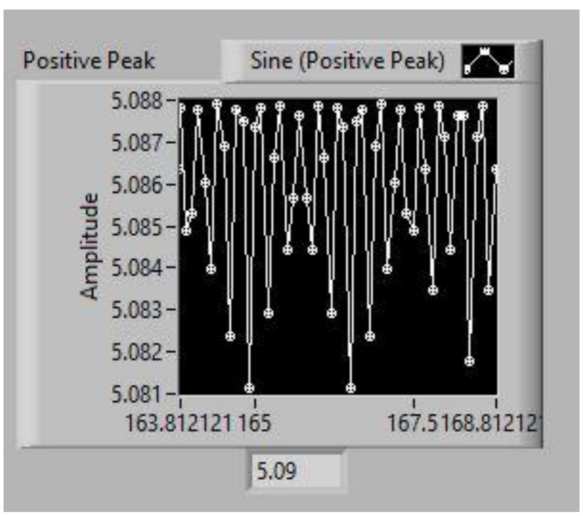


Fig (f)- Shows the positive peak
Here the positive peak of voltage is plotted against time and the exact value is given by the magnitude in the box given below the graph.

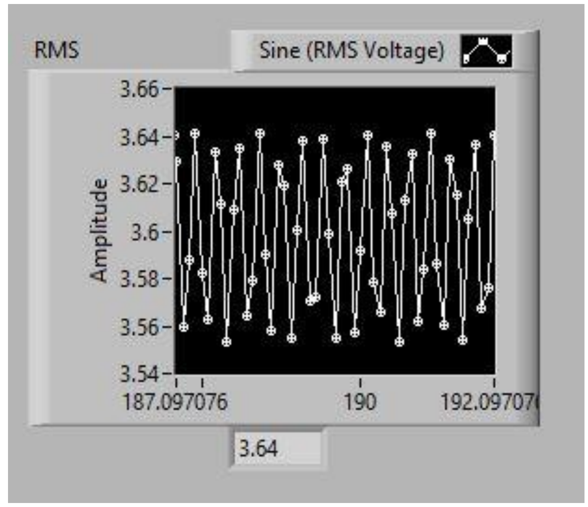
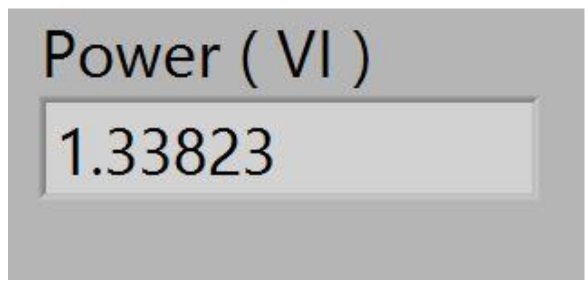


Fig (g)- Shows RMS voltage
Here RMS values of voltage are plotted against time.



Fig(h)- Shows instantaneous power
Here the instantaneous power is calculated by multiplying instantaneous value of voltage and current and is given in Volt-Amps (VA).

5. Conclusion

In this paper we learnt about the hardware and software details required to make a prototype model of power analyzer for learning and understanding power parameters and plotting them on front panels of LabVIEW. A further work in this paper would lead us to detecting power quality indices and also its mitigation techniques.

6. References

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