Oscilloscope using Arduino interface LabVIEW

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Abstract— Oscilloscopes are used to observe the change of an electrical signal over time, such that voltage and time describe a shape which is continuously graphed against a calibrated scale. Due to the size, the cost and complex structure of oscilloscope there is need to alternative solution. This paper is focused on the new technology to use to observe the change of an electrical signal using Arduino interface LabVIEW that provides accurate measurements with small size device (Arduino) that can fit in the pocket which is also cheap device. The paper gives the brief introduction about the LabVIEW and Arduino, also the basic block diagram of the oscilloscope program along with its simulation results.

The project has been test it with multiple signal voltages (+15 to -15) V Ac and DC and multiple frequencies (30Hz to 1 kHz) and it can measure more voltage Depends on signal condition circuit (the circuit that changes the voltage from .Any input voltage to Arduino input voltage (0 to 5) V) .The results that arduino Interface LabVIEW gave was the approximately same results as the actual results that Oscilloscope gave.

Index terms — Lab VIEW, Arduino, oscilloscope, Reference.

I. Introduction

The oscilloscope is a device for drawing calibrated graphs of voltage time very quickly and conveniently. Such an instrument is useful for the design and repair of circuits in which voltages and currents are changing with time. There are also many devices, called transducers, which convert some non-electrical quantity such as pressure, sound, light intensity, or position to a voltage. By using a transducer the scope can make a plot of the changes in almost any measurable quantity. This capability is widely used in science and technology [1]. Oscilloscopes are used in the sciences, medicine, engineering, and telecommunications industry. General purpose instruments are used for maintenance of electronic equipment and laboratory work. Special purpose oscilloscopes may be used for such purposes as analyzing an automotive ignition system or to display the waveform of the heartbeat as an electrocardiogram [2].

II. Introduction to LabVIEW

Laboratory virtual instrument engineering workbench (Lab VIEW), it is a system design platform and environment for a visual programming language from National instruments. It is commonly used for the data acquisition, instrument control and industrial automation on variety of platforms. The Dataflow programming is used as the programming language in Lab VIEW. The execution is determined by the structure of graphical block diagram (Lab VIEW) source code on which the programmer connects the different function codes by drawing wires, these wires propagate variables and any node can execute as soon as all its input data become available. Since there might be the case of multiple nodes simultaneously, hence it is capable of parallel execution. Lab VIEW ties the creation of user interface (called front panels) into the development cycle. LabVIEW programs or routines are called virtual instruments (VI). Each of it is having three components: a block diagram, a front panel and a connector panel. The front panel is built with controls and indicators. Controls are the inputs and they allow a user to supply information to the VI. Indicators are the output, they display the results based on the inputs given to the VI. The connector panel is used to represent the VI in the block diagrams of the other calling VI. The back panel i.e. the block diagram contains the graphical source code. All the objects which are placed on the front panel will appear as the terminals on back panel. The back panel also contains the structures and the functions which performs operation on controls and supply the data. Nodes are also connected to one another using wires. Thus VI can either run as a program with front panel as user interface. The graphical approach also allows non-programmers to build programs by dragging and dropping virtual representations of lab equipment with which they are already familiar. Interfacing to devices: Lab VIEW gives the support to the interfacing of devices, instruments, cameras etc. users interface to hardware either by writing the direct bus command or using high level, device specific drivers that provides native Lab VIEW function nodes for controlling the device [3].

III. Introduction to Arduino

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board. The Arduino platform has become quite

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popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package [4].

IV. THE CONNECTION BETWEEN PC,ARDUINO CARD

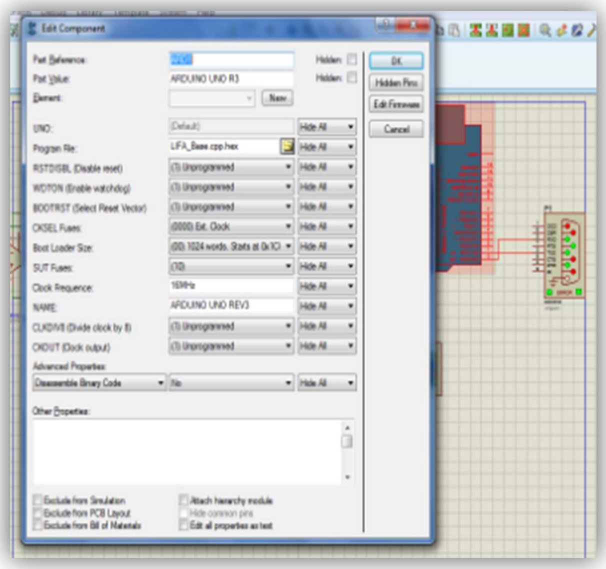

Fig 1: The Arduino connection with LABVIEW

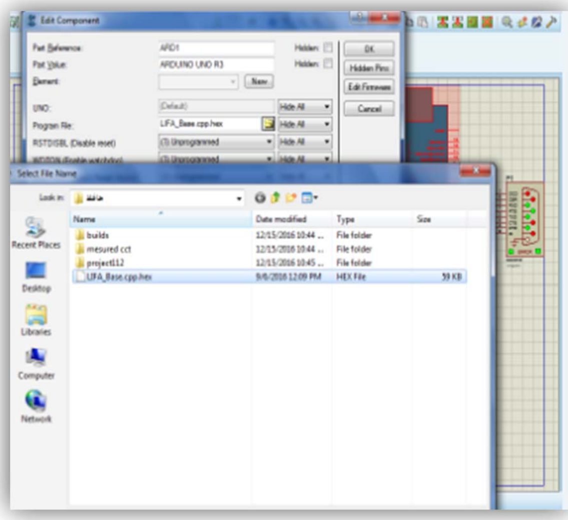

Fig 2: Upload liva base file in Arduino

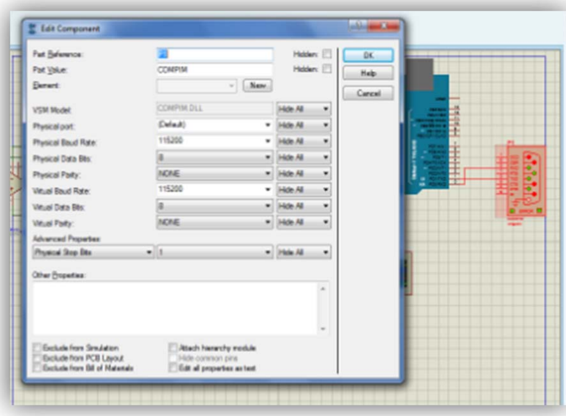

Fig 3:The virtual com connection

V. THE SIGNAL CONDITIONING CIRCUIT

In electronics signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Most common use is in analog-to-digital converters. In control engineering applications, it is common to have a sensing stage (which consists of a sensor), a signal conditioning stage (where usually amplification of the signal is done) and a processing stage (normally carried out by an ADC and Operational amplifiers are commonly employed to carry out the amplification of the signal in the signal conditioning stage. Since the ADC input voltage range of Arduino (0-5) V, and the desired measurement from -15V to 15 V. Using the following equation:

$$V_{out}=mV_{in}+offset \qquad (1)$$

Using the equation (1) the signal conditioning circuit as shown in fig 1:

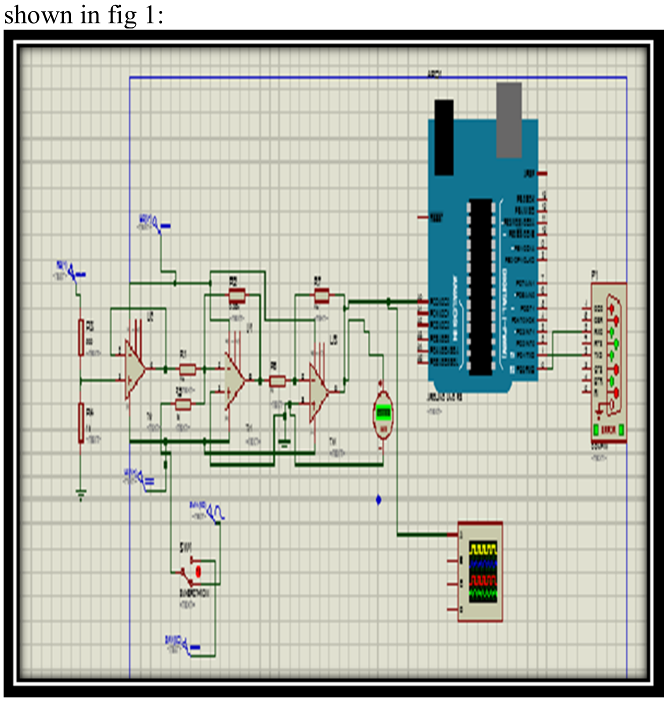

Fig 4: The signal conditioning circuit

VI. THE BLOCK DIAGRAM OF OSCILLOSCOPE PROGRAM

The Fig 5 shows the block diagram of oscilloscope program. Using Nyquist's Sampling Theorem, whenever you measure a waveform, you must ensure that your sampling rate is at least twice as great as the highest frequency you expect to measure. And even though the theorem says "at least twice as great," it's generally better to use an even higher sampling rate say, ten times as great as the highest frequency you expect to measure. The of the components on the block diagram as following:

A. Init

B. Get date/time in seconds

The function modifies the waveform based on the Components you wire. Fig 5 shows get date/time inSeconds which return timestamp? Of to the current time. Lab VIEW Calculates this timestamp using the number seconds elapsed since 12:00AM, January 1, 1904 you wire the waveform input.

C. Get finite analog sample

Fig 5 Get finite analog sample Which **Acquire** infinite number? On samples from the specified Analog input pin at the user specified the rate (up to 5 KHz).

D. Tone measurements

Fig 5 shows Tone measurements which finds the single tone with the highest amplitude or search Specified frequency range to find the single tone with the highest Amplitude. You also can find the frequency and phase for single.

E. Amplitude and level measurement

Fig 5 shows Amplitude and level which measurement Performs Voltage measurements on a signal.

F. Close

Fig 5 shows close which closes the active connection to an Arduino.

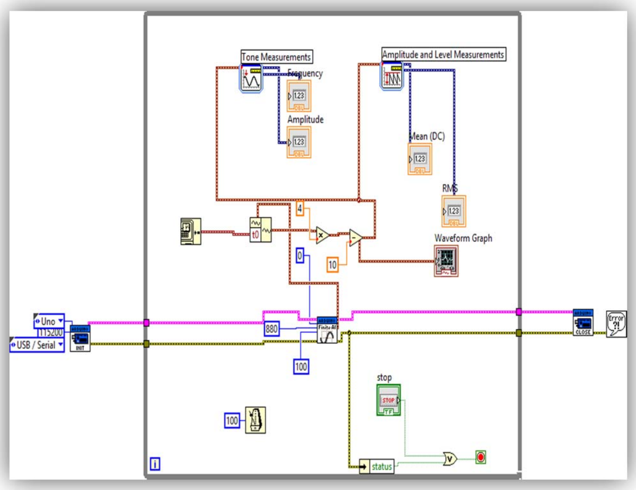

Fig 5: The block diagram of oscilloscope program

VII. THE FRONT PANEL OF OSCILLOSCOPE PROGRAM

The Fig 6 shows the front panel of oscilloscope program.

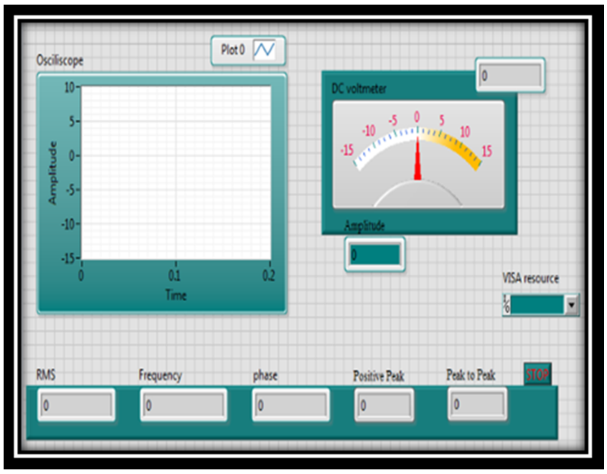

Fig 6: The front panel of oscilloscope program

VIII. RESULTS

After testing the program in real time with Arduino Uno and Lab VIEW program. It has been successfully in the following.

- Successfully measure DC/AC from -15V to 15V. Also it can measure higher voltages if signal condition circuits used.
- Successfully build cheaper oscilloscope which its price less than 20$and has error percentage less than 0.67 % approximate.
- Successfully measure frequency, amplitude, rams value and means DC.

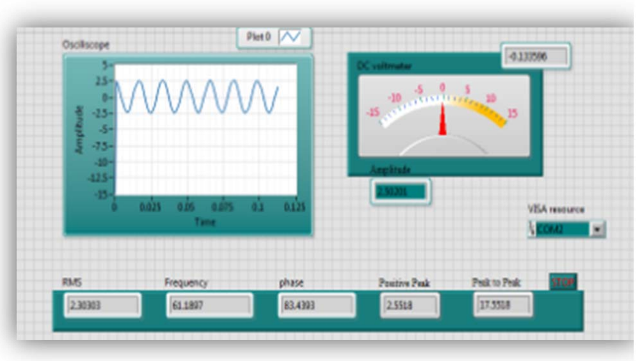

Fig 7 shows one sample of the results with the input 5Vp_p

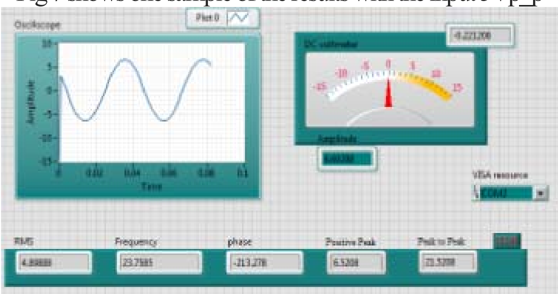

Fig 8 shows one sample of the results with the input 13Vp_p

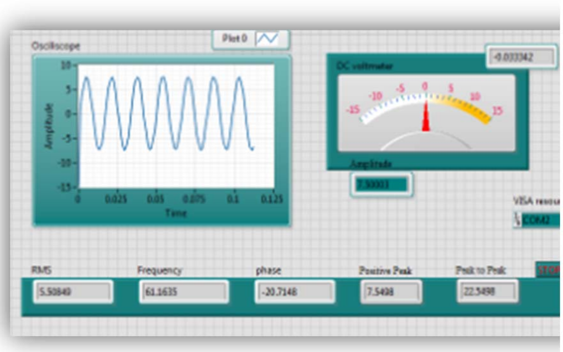

Fig 9 shows one sample of the results with the input1 5Vp_p

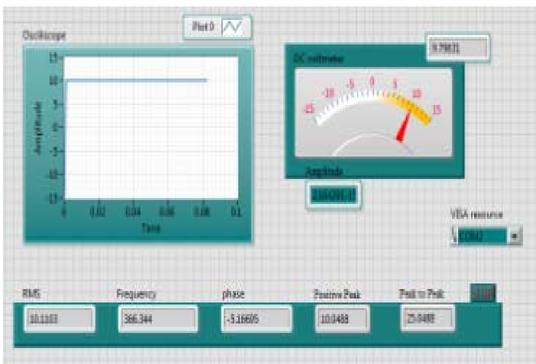

Fig 10 shows one sample of the results with the input1 0V

The following tables shows multiple results of AC / DC

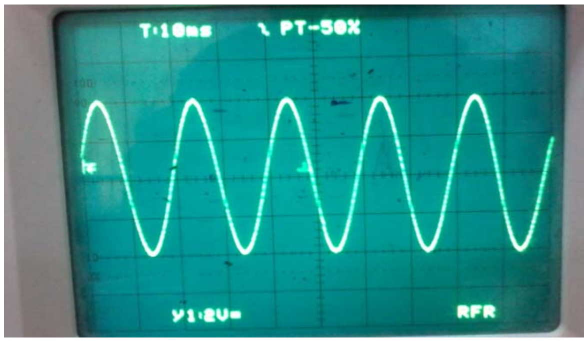

Fig 11 Sample of the results with the input 8Vp_p

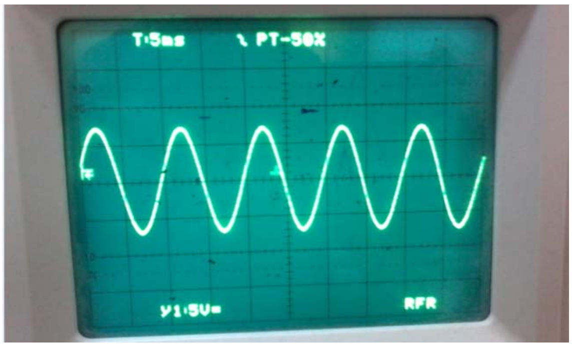

Fig 12 sample of the results with the input 12Vp_p

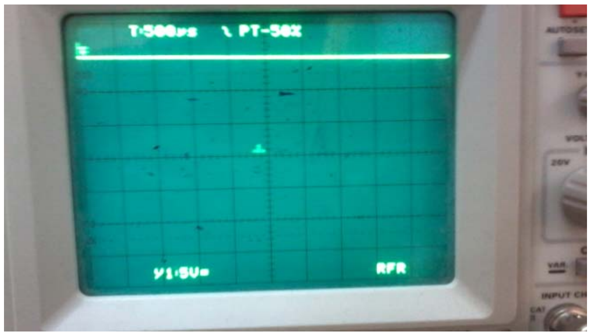

Fig 13 sample of the results with the input 15V

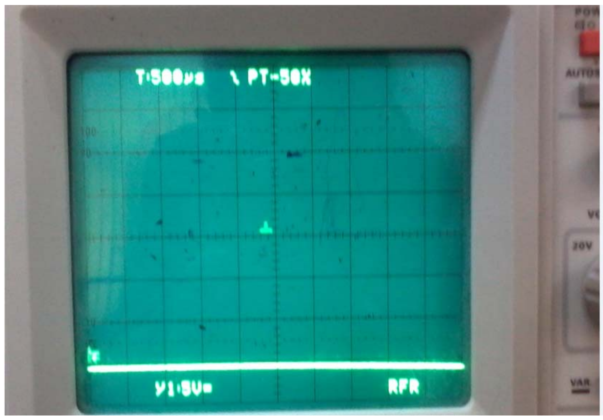

Fig 14 sample of the results with the input -15V

Table 1 shows the results of AC measurement

Frequency (Hz)	Voltage (Vp_p)	Arduino interface LabVIEW	Oscilloscope
20	2	2.1048	2
20	4	4.1048	4
60	5	5.1036	5
60	8	8.1024	8
80	10	10.1016	10
80	15	15.0996	15
100	15	15.0996	15
200	10	10.1016	10
400	12	12.1008	12
600	12	12.1008	12
800	13	13.1004	13
1000	13	13.0416	13

Table 2 shows the results of DC measurement

Voltage (V)	Arduino interface LabVIEW	Oscilloscope
-15	-15	-15
-10	-10.0229	-10
-5	-5.07485	-5
0	-0.097728	0
5	4.8794	5
10	9.82742	10
15	14.7754	15

IX. Conclusion

There are many complex hardware circuits to observe the change of an electrical signal over time like Oscilloscope, already present in the market. It is not easy to fabricate them as IC. So in the world of great competition between hardware and software, the software always wins in case of compatibility and the user friendliness. As they can be easily modified and updated. This paper presented easy solution of measuring that depends more on software than hardware resulting cheaper, less size and accurate device, also possibility of improve the program by the user.

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