



Low cost portable oscilloscopes

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Abstract

The aim of this project is to design an oscilloscope by minimizing the hardware used, make the system as small and as fast as possible. The system is implemented using PSoC developed by Cypress Semiconductors. In PSoC, the analog and digital subsystems cohabit on the same chip. Having all the systems on the same chip reduces the cost, size, noise and increases the speed of operation. The data is transmitted to the PC via UART and plotted.

Keywords: programmable system on chip, ADC, conversion, virtual oscilloscope, virtual instrumentation

Introduction

An oscilloscope is a device that provides visual representation of the input signal [1]. This help us to locate and identify the irregularities in the input. An engineer may thus locate the cause and correct it at once. This is especially useful in the field of telecommunication. Fault detection and testing of newly designed systems are just few of the applications of the oscilloscope. The ECG monitor used in medical field is a variant of oscilloscope. The scopes available today are digital, light weight and contain a multitude of features compared to their predecessors. Furthermore, the development in semiconductor technology allows us to manufacture a mixed signal chip without compromising the computing performance. So now hand held scopes are manufactured. Despite the decreasing size, the functionalities offered have increased.

Most of the products available in the market lack one feature: uploading the signal on your workstation and processing it simultaneously. The proposed project attempts to cover this loophole. Besides providing the time and voltage measurements of the signal, the user may export the signal in the form of samples to a text file.

Previous work

1. Ameya Wagh, Zalak Dave, Gaurav Singh, Varun Dange, Abhay Tambe, Sachin Gengaje: "A Low Cost Portable Oscilloscope for Educational Platforms using a Programmable System on Chip" [5] This paper describes the use of PSoC to make a cheap, light weight oscilloscope using various functions in PSoC. A graphic LCD is used as a display. The time/div is implemented by adding delay to clock. To get the volt/div within the required range, the overhead in the MSB of the converted signal is removed. The signal lost its shape as the signal frequency increased and the input voltage range was from 0V to 5V and maximum operating frequency of 2.2 KHz. The working of the system is described in an algorithm.
2. Ishtiaq Ahmed Karim: "A Low Cost Portable Oscilloscope Based on Arduino and GLCD" [6] The paper explains a portable oscilloscope operating at voltage range of 8V to 20V and bandwidth 10Hz to 7.7KHz. The notable feature of this project is the auto acquisition of parameters (such as

frequency, maximum voltage, minimum voltage, peak-to-peak voltage) of the input signal. To operate over a large voltage range, a signal conditioning circuit is used to ensure that the input to ADC is always between 0V to 5V. It is a dual channel oscilloscope capable of plotting both the signals at the same time.

3. Mary Anne Peters & Joseph Tylka: "Digital Sampling Oscilloscope" [7] This paper summarizes the construction and operation of a digital sampling oscilloscope, built from discrete analog and digital components, providing an overview of the primary components of the oscilloscope.
4. Chandan Bhunia, Saikat Giri, Samrat Kar, Sudarshan Haldar, and Prithwiraj Purkait: "A Low-Cost PC-Based Virtual Oscilloscope" [8]. This implementation provides a maximum of eight channels to the user. There is an auto ranging circuit providing the input range of $\pm 100V$. ADC is used in single ended mode and protection circuit is used. The samples are sent to the PC through parallel port continuously, the microcontroller used is not mentioned. The acquired values are transmit to the PC and displayed using a software developed using Visual Basic.

Proposed Work

For implementing the project, PSoC is used. PSoC is a powerful computing platform developed by Cypress Semiconductors. It has modified 8051 or ARM processor as core, ADC with maximum sampling rate of 384000 samples per second [2], on chip among other peripherals [3]. The samples transmitted to the computer are plotted in real time. These values can be saved and reproduced in MATLAB if required. On the fly, up to ten wave forms may be stored viewed one at a time. Only one signal can be plotted at a time. For programming the PSoC, PSoC Creator is required. The required modules are dragged and dropped in the schematic and configured.

Appropriate pins are assigned and code is written in C. The User Interface for the computer will be developed in Visual Studio, C# language is used for programming. It has an easy drag and drop programming for developing application for Windows [4]. Visual Studio exports an executable file, this is another advantage. The UI should contain a control for Volt/Div, Time/Div, display the maximum, minimum and

peak to peak voltage and the frequency of the signal. The saved wave forms can then be exported to text file. This text file can be used to recreate the same signal in MATLAB. FT and other transforms may be applied.

Conclusion

There have been many implementations of oscilloscope using various processors. While all the implementations detect voltage, none of them detect and display frequency. One might consider the IEEE Std 1057 ^[9] for the same. In digital instrumentation, this is a challenge given the poor SNR at high frequencies. This is a major hurdle restricting the operating frequency to 7.7 KHz in all the paper reviewed. We may consider implementing a moving average filter at the transmitter side on the samples obtained. The length of this filter will depend on the number of samples approx. obtained for the highest operating frequency. Cubic interpolation may be used at the receiver side to plot the signal to obtain smooth curves, in case the sample points are not closely spaced.

List of Abbreviations

- PSoC : Programmable System on Chip
- FT : Fourier Transform
- UART : Universal Asynchronous Receiver Transmitter
- ECG : Electro Cardiogram
- ARM : Advanced RISC Microprocessor
- SNR : Signal to Noise Ratio
- ADC : Analog to Digital Converter

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