RESEARCH ARTICLE   OPEN ACCESS

ARM Based Handy and Portable Oscilloscope Using Graphical Display

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Abstract
The need to have a visual perception of signals in order to monitor events in time and value brought about the development of a measuring instrument referred to as oscilloscope. This is a design of handy and low cost oscilloscope. The user can start/stop the display, adjust the time division and adjust the voltage division. The requirements of the oscilloscope were three-fold: 1) low cost design, 2) capture frequencies at the medium range and 3) construct able with a basic skill of PCB designing.
Keywords: Oscilloscope, ARM Scope, Handy Oscilloscope, ARM
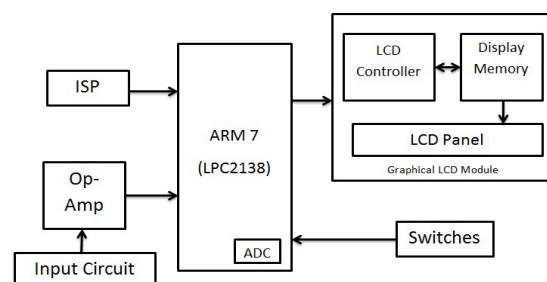
I. Introduction

Oscilloscope is a measuring device which can show various waveforms & voltages, Frequency, time period, wavelength on screen. Graph show the variation of signal amplitude (Y-axis) with time (X-axis). The oscilloscope accepts voltage signals at its input, but virtually any type of signal (vibration, heartbeat, ECG, speed of objects, sound, light ashes, etc.) can be viewed in an oscilloscope with the use of transducers. Today world is moving towards digitization & now days Advanced RISC Machine (ARM) is the most important building blocks in lots of applications. The digital oscilloscopes takes the input signal and convert it into a digital signal, through an analog-to-digital converter (ADC), which is then analyzed and used to plot an image of the original signal on liquid crystal display (LCD) screen. The digital oscilloscope produces every waveform as a sequence of samples. These samples are then saved until it accumulates enough samples to portray a waveform. The advantage of these types of scopes is that a trace can be store and displayed along-side others for comparison or calibration. Digital oscilloscope can allow you to capture and view events that may happen only once transient event. Thus, digital oscilloscopes are widely used all over the world due to its advantages.

The primary parts are microprocessor and display device. ARM microprocessor is used as a controlling element and this will produce output at very fast speed when compared to microcontrollers. ARM consists of in-build ADC thus there is no need to externally interface it. Graphical Display is used for displaying signals because of its better features. The basic parts of oscilloscopes are probes for sensing signal values, and switches to make device user friendly. Switches are provided for adjusting

Voltages, Frequency and its time base. This is a design of oscilloscope for medium range frequencies.

II. System Overview

ARM LPC2138 is used as a controlling device and graphical display for displaying signals. Probes will be there for testing circuit. The probes will be similar to as used in bigger oscilloscopes. By using ARM it will be an easier task to sense a particular signal and control it.

Block Diagram of ARM based Handy and Portable Oscilloscope

As ARM consists of in-build ADC, there is no need to externally interface it. So the sensed signals from probe are directly send to the microprocessor, where it is converted to its digital value. ARM processor will sit ideal until a new data or digital value is sensed at probes. Then it will pass the data to being displayed on GLCD. At some point of time tuning and altering of waveform is also required, for its proper demonstration. Switches are provided for adjusting voltages, frequency and its time base. The values of voltage and frequency are chosen such that the waveform is displayed in an appropriate manner. Triggering is also an important factor because if its value is not properly set then waveforms will not be shown. This will be a design of auto triggering. In

Aditi Trivedi Int. Journal of Engineering Research and Applications
www.ijera.com
ISSN : 2248-9622, Vol. 5, Issue 3, (Part -1) March 2015, pp.106-109

this type of designs user does not have to take care of horizontal and vertical triggering.

III. Hardware Platform

A. LPC2138

LPC2138 (ARM7) is a 32-bit RISC processor with two 8-channels 10-bit ADC, one 8-channel 10-bit DAC, two UART, two I2C , two SPI, three 32-bit Timers, Watch-Dog Timer, Real Time Clock(RTC) with optional battery back-up. It has several advantages such as low power consumption, high speed, and high functionality solutions.

B. A/D Converter

ARM provides an advantage of in-built ADC. This will minimize the hardware requirements of device. ARM has two in-built analog to digital converter, with the features as 10 bit successive approximation method is used for conversion in ARM7, input multiplexing approximation analog to digital converter and Measurement ranges 0 V to VREF (typically 3 V).
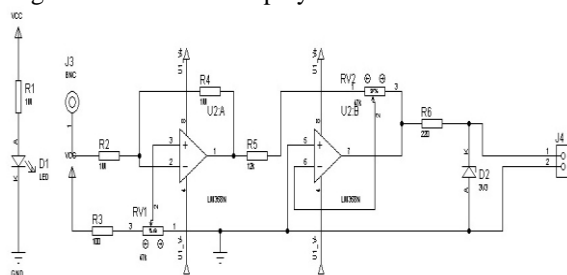
$$\text{Smallest Resolution} = \frac{V}{2^n - 1}$$

here V= voltage and n= number of Bits of ADC
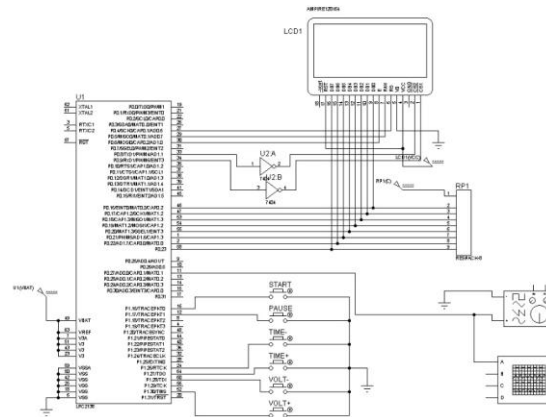Smallest Resolution ≈ 0.003

C. Comparator Circuit

In the comparator circuit, input is captured from an external source via BNC connector. This input signal may be AC or DC. Thus, firstly signal is passed through one op-amp to convert an input signal to DC signal and then the next operational amplifier will compare the input DC signal with a predefined voltage. If input signal is weak then it will amplify with respect to Vref, on the other hand if signal carries some sort of noise or errors it is also attenuated by using comparator. The output of comparator circuit is given to ADC0.0 channel. Only a single channel of Analog to digital converter is used because this is a single channel oscilloscope. Thus a single waveform will display at a time.

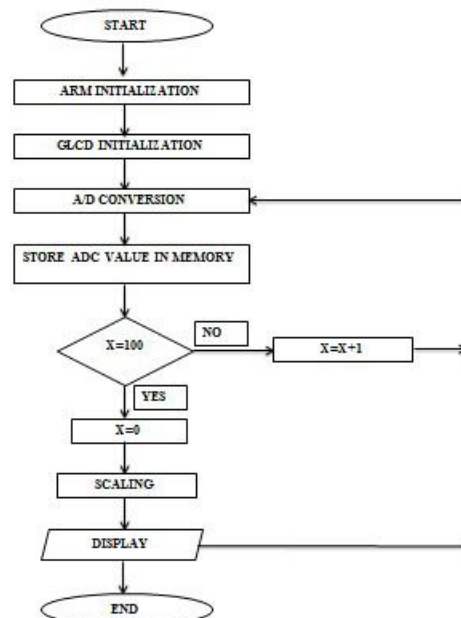
Comparator Circuit

D. Display Device

LCDs are used in a wide range of applications including televisions, computer monitors, aircraft cockpit displays, instrument panels, and signage.

Display Circuit

Consumer devices such as clocks, video players, calculators, gaming devices, watches, and telephones are also some application of LCD. Graphical display devices replaced cathode ray tube (CRT) displays in most applications. Wider range of screen sizes is available for GLCD than CRT and plasma displays, and they do not use phosphors. The LCD screen is more energy efficient and can be disposed of more safely than a CRT.

IV. Software Implementation

Flowchart

After the display of welcome screen, program will be at pause state until a "start" button is pressed. When program shifts from pause state to start state, a grid along with waveform is displayed on the front panel of oscilloscope. Whenever a new digital value appear at Analog to Digital Converter after real time sampling of input signal, that particular digital value is displayed on Graphical Display as a form of pixels.

Graphical Display is of 128 x 64 pixels; in this project we are using 100 pixels for displaying signal and remaining 28 pixels for displaying digital values of voltage, frequency and time base. This process will continue until device is in switch on mode.
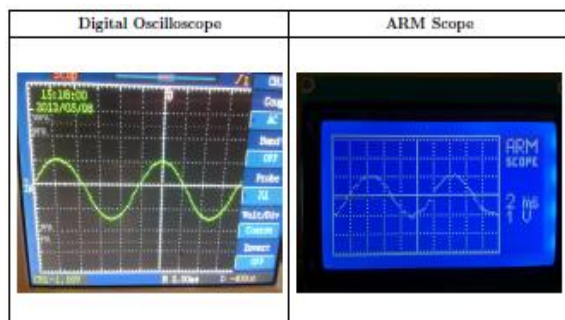
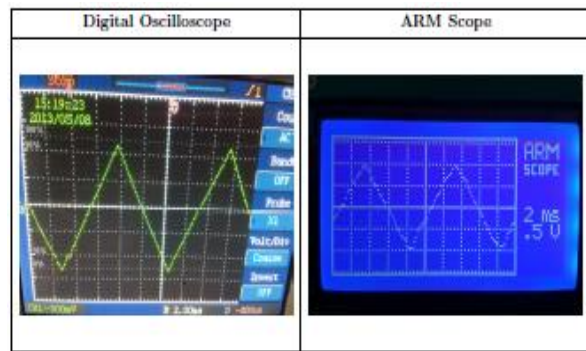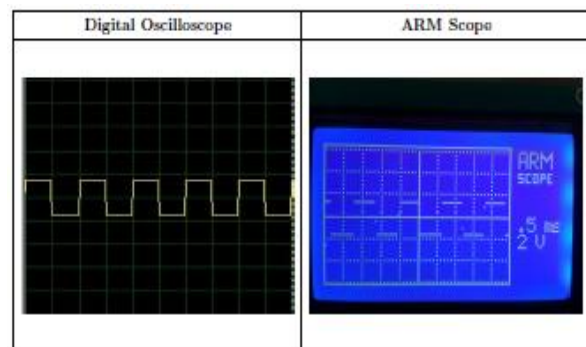## V. Prototype and Experimental Results

Snapshot of Hardware
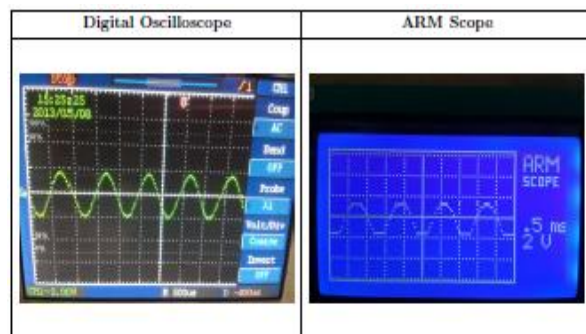

Welcome Screen

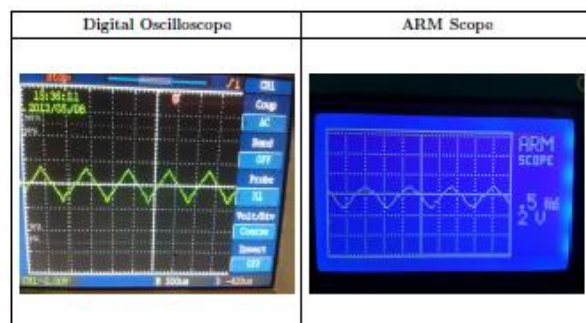**Comparative Analysis of 2V and 100Hz Sinosodal Wave**

Comparative Analysis of 2V and 100Hz Triangular Wave
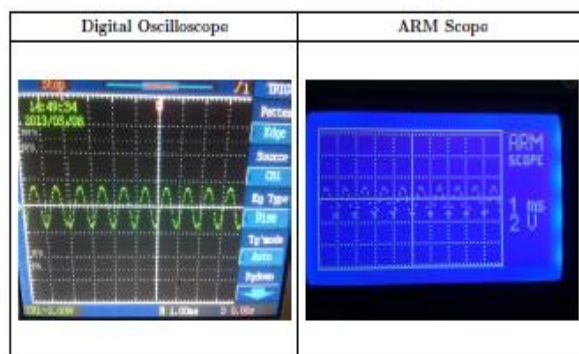

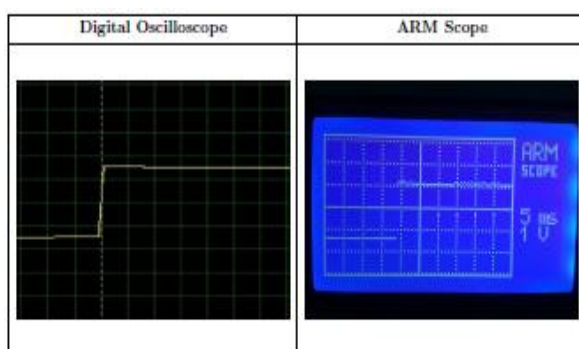**Comparative Analysis of 3V and 1KHz Square Wave**

Comparative Analysis of 3V and 1KHz Sinosodal Wave

Comparative Analysis of 2V and 1KHz Triangular Wave

Comparative Analysis of 2.5V and 1KHz Sinosodal Wave

Comparative Analysis of 3V and 10Hz Square Wave

VI. Conclusion and Future Scope

The GLCD oscilloscope is low cost and void of the complexity use in the development of conventional scopes. It produces comparative results. It is a choice for all non-critical work that goes on everyday in the laboratory and in out-of-lab measurements due to its portability. Initially the ARM-Oscilloscope was tested feeding the signals from function generator. Provided facility for having different sampling rate and variable voltage divisions. The kind of input waveform, like sine wave, triangular wave, square wave or any other function can be continuously changed and tested in this oscilloscope.

In future, handy oscilloscopes can be designed with dual or more channel options. With this approach many additional features like delay, magnifier, and intensity can be added to make device more serviceable. The range of operating frequency can also be increased. By adding these more features it can fully substitute the available bulky oscilloscopes at very low cost.

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