PORTABLE OSCILLOSCOPE

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Abstract— **Oscilloscopes are very useful electronic instruments that enable one to see voltage wave-shapes in an electronic circuit. But these instruments are very expensive and average students can hardly afford to buy one. This project is design and development of a low-cost portable oscilloscope based on Arduino and Processing IDE. This project is to design and develop to achieve the same functionality that traditional oscilloscopes have. An Atmel microcontroller is used for data acquisition which will then be displayed as a waveform on a Processing IDE PC screen as it would have appeared on a traditional CRT oscilloscope. The oscilloscope displays waveforms in real-time by reading a finite number of samples and storing them into its internal RAM. Once the memory is full the Microcontroller will stop sampling and transfer the data to the PC. This handheld oscilloscope is very cheap, uses low power, generates low internal noise, uses very few components and easy to operate.**

Index Terms—**Arduino, Handheld, Microcontroller, Oscilloscope, Portable.**

I. INTRODUCTION

It is valuable to briefly examine the history of oscilloscopes. Andre-Eugene Blondel invented the electromagnetic oscillography in 1893 which used a galvanometer to trace a pen across a roll of paper to capture a waveform. These first oscillographs were limited to a frequency range of 10 to 19 Hz due to the mechanical recording limitations (i.e. how fast the pen could move across the paper). The light-beam oscilloscope used a mirror and photographic plates to record the data improved upon this design. It could capture higher frequency signals up to about 500 Hz. Ferdinand Braun invented the cathode ray tube (CRT) oscillograph in 1897. In the late 1930s, the company A.C. Cursor designed a dual-beam oscilloscope. It applied an oscillating saw tooth reference signal to horizontal deflector plates and the measured input signal to vertical deflector plates, creating a "sweep" of the input signal as a function of time on a phosphor display screen. However, this oscilloscope still had issues with drift because there was no fixed reference point for synchronizing the horizontal and vertical signals. In order to obtain a steady, repeating the signal on the display, the user had to tune the reference saw tooth signal until the signal no longer drifted across the display. In 1946 this problem was addressed by Howard Vollum's and Jack Murdock's invention of the triggered oscilloscope, which synchronizes of oscillatory waveforms by triggering at a given point on the signal. The Tektronix foundation (founded by Vollum and Murdock) refined this design for the commercial market and became the first manufacturer of the calibrated oscilloscope. In 1981, Walter LeCroy filed a patent for the first digital oscilloscope. This eliminated the necessity for horizontal and vertical plates to be used to display a sweep in the analog CRT oscilloscope. A digital oscilloscope uses an ADC to convert the analog inputs to digital signals, and saves those signals to memory to be displayed on a digital screen (e.g. an LCD display). Modern oscilloscopes feature very high input impedance (typically _ 1 M) to effectively isolate the circuit being measured from the oscilloscope, and are able to measure signals with frequency content up to _ 10 GHz. However, this bandwidth is often limited by the capacitance of the cables used to probe the circuit. Another common feature of modern oscilloscopes is a "scope probe" with an adjustable input impedance allowing the user two choose between an input impedance of 1_ or 10_ that of the oscilloscope. This probe is designed to have very little capacitance to ground, to allow a higher frequency range than typical coaxial BNC cables. Modern day instruments also have the ability isolate the AC component of a signal, by setting the oscilloscope to the "AC coupling" mode. This is particularly useful when the input signal has a large offset, but the user is only interested in rapid fluctuations in the signal. However, this removal of the DC offset is often achieved by simply introducing a "blocking" series capacitor, which will tend to filter out low frequency signals in addition to removing the DC offset. Alternatively, oscilloscopes have a DC coupling mode, which does not employ a series capacitor. Thus to maximize the bandwidth of the oscilloscope, users typically utilize the scope probe on the DC coupling mode. The oscilloscope we have built and will discuss in this report is a digital sampling oscilloscope that operates on the same principles at the one patented by LeCroy in 1981.

II. MARKET SITUATION:

The oscilloscopes market is expected to witness significant growth over the forecast period, which can be attributed to the technological advancements ensuring the storage of higher number of signals in the oscilloscopes.

Oscilloscopes have profound use in areas including differential measurement, bandwidth measurement, time & voltage measurement, and phase & rise time. Product reliability, capability, and product efficiency in signals' storage are some of the key factors expected to drive the oscilloscopes market growth. Limited screen display is expected to hamper market growth owing to inability to measure signals from multiple sources.

Life sciences and consumer electronics are expected to be key opportunity areas for market growth over the next six years.The market can be segmented on the basis of product and end-use. Products can be categorized as Cathode Ray Oscilloscopes (CRO), traditional oscilloscope, dual beam oscilloscope, Digital Storage Oscilloscope (DSO), software defined

oscilloscope and analog storage oscilloscope. Key end use verticals served by the market include engineering, telecommunications, science, and medicine.

III. PROJECT DEFINITION

In this project we use Arduino to capture multiple input values and pass them via the USB connection to a host computer running a program that decodes the values and displays them on screen. Because the Arduino itself is not providing any particular intelligence and simply passes on any values it reads, this project is very flexible and the behavior of the system can be changed simply by altering the software that runs on one's computer.

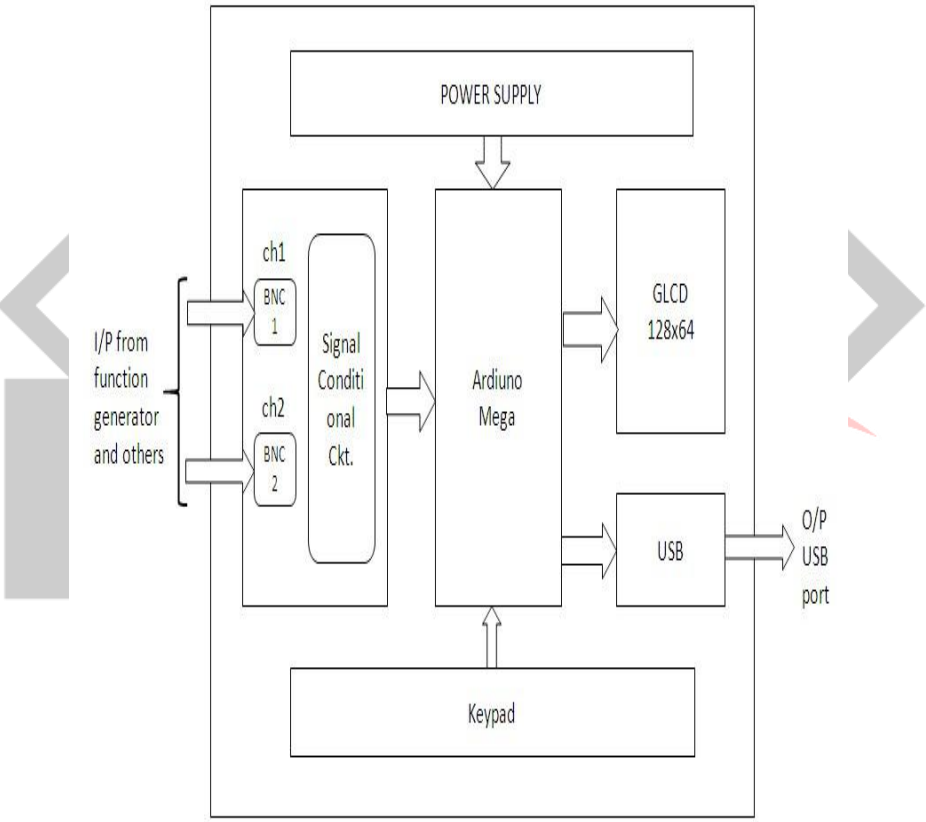
IV. OBJECTVE

It is proposed to develop Portable Oscilloscope with following objectives:

1. To identify the proper waveform
2. To compare the waveforms
3. To store and display waveform on the TFT display.
4. To eliminate the size of oscilloscope.
5. To make portable and low cost.

V. METHODOLOGY

Block Diagram



Working

In this project we are going to present a portable oscilloscope to display the waveform. The input is connected to A0 pin of the Arduino Mega2560 board. The board is interface with TFT and 4 SPST switches. The input will coming from A0 pin is encoded by the Arduino Mega2560 board. This will encoded the data an pass to the TFT from AD0 to AD7. The TFT display the waveform of a circuit given to Arduino Mega2560. If a user wants to change frequency use the time/division keys or to change voltage use the voltage / division keys. With the help of the interfacing of SPST micro switches pin no PB4 TO PB6. And this will displays on the TFT.

Signal Conditioning Circuit

Signal conditioning is the manipulation of a signal in a way that prepares it for the next stage of processing. Many applications involve environmental or structural measurement, such as temperature and vibration, from sensors. These sensors, in turn, require signal conditioning before a data acquisition device can effectively and accurately measure the signal.

Arduino Mega

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. 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.

Keypad

A keypad is a set of buttons arranged in a block or "pad" which bear digits, symbols or alphabetical letters. Pads mostly containing numbers are called a numeric keypad. Numeric keypads are found on alphanumeric keyboards and on other devices which require mainly numeric input such as calculators, push-button telephones, vending machines, ATMs, Point of Sale devices, combination locks, and digital door locks. Many devices follow the E.161 standard for their arrangement.

TFT

A thin-film-transistor liquid-crystal display (TFT LCD) is a variant of a liquid-crystal display (LCD) that uses thin-film transistor (TFT) technology to improve image qualities such as addressability and contrast. A TFT LCD is an active-matrix LCD, in contrast to passive-matrix LCDs or simple, direct-driven LCDs with a few segments. TFT LCDs are used in appliances including television sets, computer monitors, mobile phones, handheld video game systems, personal digital assistants, navigation systems and projectors.

BNC

The BNC (Bayonet Neill–Concelman) connector is a miniature quick connect/disconnect radio frequency connector used for coaxial cable. It features two bayonet lugs on the female connector; mating is fully achieved with a quarter turn of the coupling nut. BNC connectors are used with miniature-to-subminiature coaxial cable in radio, television, and other radio-frequency electronic equipment, test instruments, and video signals. The BNC was commonly used for early computer networks, including ARCnet, the IBM PC Network, and the 10BASE2 variant of Ethernet. BNC connectors are made to match the characteristic impedance of cable at either 50 ohms or 75 ohms. They are usually applied for frequencies below 4 GHz and voltages below 500 volts.

USB

USB, short for Universal Serial Bus, is an industry standard initially developed in the mid-1990s that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices. It is currently developed by the USB Implementers Forum (USB IF). USB was designed to standardize the connection of computer peripherals (including keyboards, pointing devices, digital cameras, printers, portable media players, disk drives and network adapters) to personal computers, both to communicate and to supply electric power. It has become commonplace on other devices, such as smartphones, PDAs and video game consoles.

RESULTS

Figure1: Portable oscilloscope results for sine wave

Advantages

The advantages of Portable Oscilloscope are:-

1. Easy to carry
2. Portable
3. Small size
4. Low cost

Applications

1. Educational purpose
2. Site Engineers
3. Testing of components
4. Electronic labs

Conclusion

We conclude that Arduino can be used as Oscilloscope for displaying waveforms Arduino Oscilloscope also has the ability to perform various operation on the applied inputs such as addition, subtraction, etc. This makes analysis simpler and overcomes the drawbacks of the conventional CRO's. We built hardware interface circuit to make the functioning of a oscilloscope much easier with few affordable electronics components so as for the conversion and processing of the analog signal into the digital form.

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