To Design and Measure Physical Signal from a USB-Based Data Acquisition System

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Abstract: **Nowadays Universal Serial Bus (USB) has emerged as a very popular, inexpensive and easy-to-use short range (5m) communication media for data transfer with a PC (host), where the communication device acts as a client. The USB was originally designed to connect PC with its peripherals (keyboard, mouse etc.). However, it has proven useful for many other applications, including measurement and automation.**

An approach to develop a USB based data acquisition system is presented; where a PIC microcontroller (Microchip's 18F2550) based standalone embedded system is used as a front-end data collection and also field control device. The developed USB based device continuously scans its input analog and digital channels sequentially and updates the PC with these values, which are updated in a Visual BASIC based application GUI (Graphical User Interface). Here USB device has been programmed as Human Interface Device (HID) class, which provides an additional advantage of not requiring any device specific driver.

The firmware used in the microcontroller is developed in PicBASICPro platform. A second Generation JDM programmer has been developed, which is used along with WINPIC800 to program the microcontroller. This device can accept an analog input voltage between 0 – 5Vdc from any real life sensor(s) and generate digital output (8 bits) as control action.

Keywords: **USB, Microcontroller, PIC, Acquisition, Data Acquisition, Programmer, Digital.**

I. INTRODUCTION

With the introduction of low-power, fast performing, miniature embedded circuits in Instrumentation; data acquisition devices have become more compact, versatile and easy to use. Added with this, the computational power of digital computer is ever increasing, which has resulted data acquisition, presentation, processing and control operations to become more PC-centric. Small, compact DAQ devices, popularly known as DAS cards are very popular as front-end data collection units in all PC-based instrumentation systems. Primarily these cards offer analog conditioning functions (like filtering, isolation, excitation, amplification etc), followed by digitization of the signal. Finally, high-end microcontroller converts the digitized samples to a formatted data conforming a (serial) protocol for delivery to a desktop, laptop or even PDA device.

Universal Serial Bus (USB) has emerged as a very popular, inexpensive and easy-to-use short range (5m) communication media for data transfer with a PC (host), where the communication device acts as a client. The USB was originally designed to connect PC with its peripherals (keyboard, mouse etc.). However, it has proven useful for many other applications, including measurement and automation.

Use of Graphical User Interface (GUI) in Windows compatible application softwares have become an integral part of the software and are given equal importance with the algorithm development. GUI based system employ the use of graphical widgets like menu, edit box, pushbuttons, charts, displays etc to create an user friendly interface so that an inexperienced user can become quickly conversant with a complex applications.

This work discusses the development of USB based acquisition system which can acquire the the signal from real world sensors and display it in a computerized environment with the help of another software.

An engineer first formalizes requirements as *assertions*, or small models, which may be thought of as monitors that observe the behavior of the system as it executes. The engineer then develops the instrument based on the model and develops test suites with the aim of highlighting where assertion violations occur.

The idea of this project originated from the fact that USB is a fast, technologically advanced communication mode which can be used for various type of communication and instrumentation based projects. USB is getting advanced day by day and is becoming the major concern for people working in research and development activities.

Various journals and papers have been studied for modeling the project.

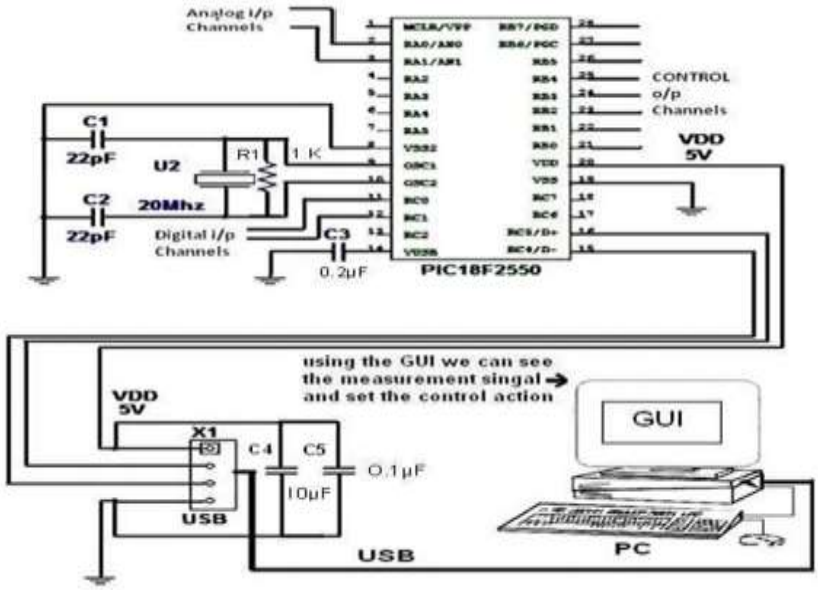
There have been works like developing ECG acquisition system composed of a single recording and storage device (personal computer). The communication link used is USB. In the mentioned work the USB capable device had has been configured in Communication Device Class (CDC), so a device specific driver is required.

A study has been conducted on a novel temperature measurement system, with direct connection to the PC used to measure temperature in an optical system of concentration of solar radiation. This system measures the temperature in the focus of the parable of the system and transmits the information via the USB (Universal Serial Bus) to a computer for later analysis. The system is based on a microcontroller PIC 18F2550. A bulletin have been studied which deals with the subject "**USB connectivity for microcontrollers**".

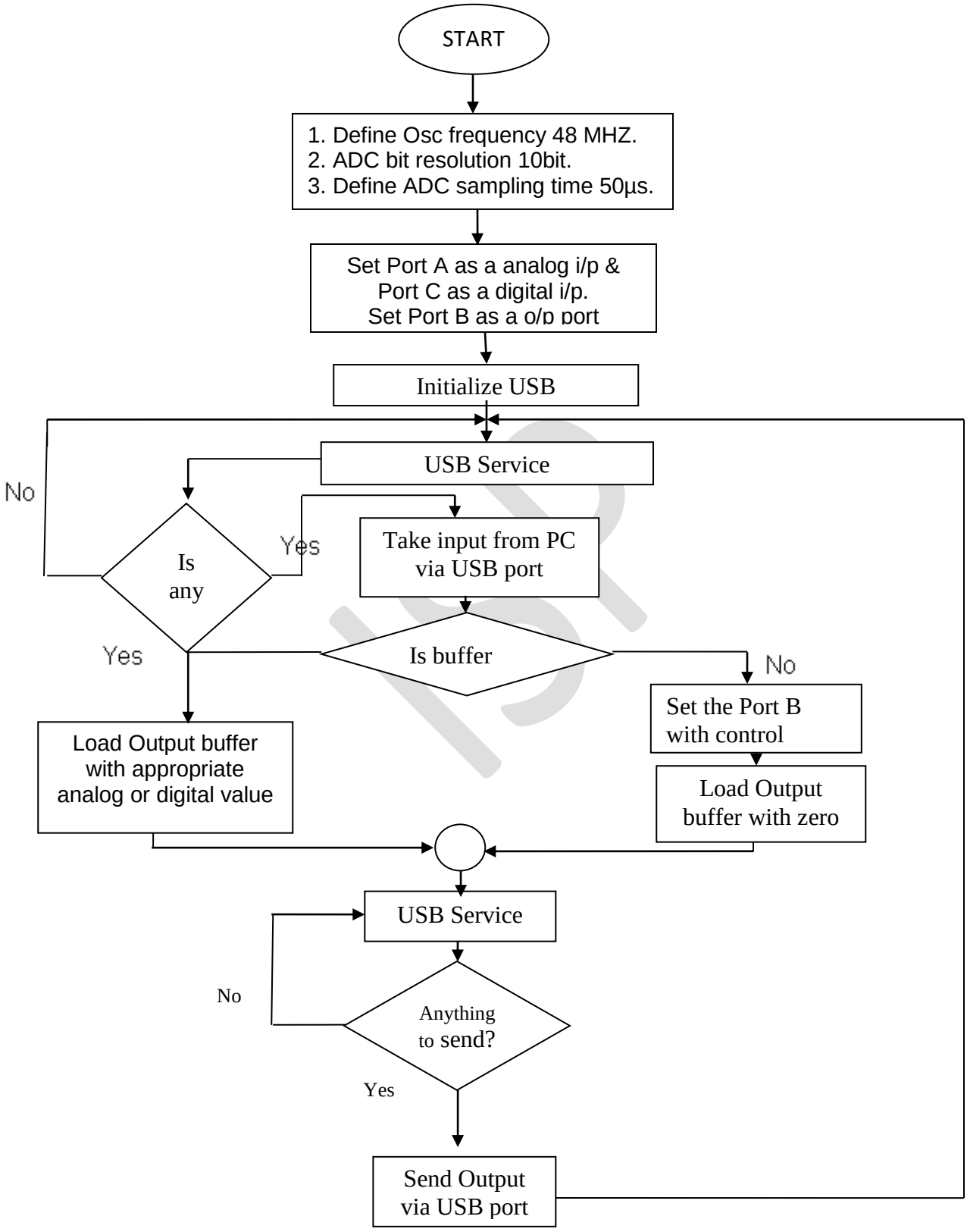
II. METHODOLOGY

- The programmer (Hardware-part) is developed. The circuit diagram of a 2nd generation JDM programmer is included in "Illustration of Hardware and Software" part.
- The first step is to write the program (firmware) for the PIC microcontroller. The program (firmware) is written in PicBasicPro language. The programming configures the USB descriptor so that the device is set under HID class. One of the benefits of a well-defined specification (like the USB HID class) is the availability of device drivers available in most modern operating systems.
- The program is written in notepad (a software which is found in the accessories part of WindowsXP) and is saved in .pbp format.
- The program is compiled and converted it to HEX code before loading the program into the microcontroller's EPROM. Microcode Studio (front end) & PicBasicPro header files (compilation engine) is used in this project for compiling the program (firmware). After compilation a HEX file is generated
- This HEX file is burnt into the PIC microcontroller using WinPic800 software & JDM programmer. This programmer (JDM) is a high voltage programmer, since low voltage programmers are not suitable for USB programming. The Winpic800 configuration bit settings needs to be configured properly. The proper configuration bit setting diagram is included.
- The PIC18F2550 microcontroller can be connected to PC through USB port. As the device belongs to HID class so when it is connected to PC the operating software recognizes it as a HID device. One can check the properties of the device through USBView (a free tool from Microsoft Corporation) or Control Panel→ Device Manager.
- The GUI is developed using VB6 (Visual Basic 6) software. The GUI recognizes the USB device, by its VID (Vendor ID) and PID (Product ID) when it is connected to a USB port. After the device is detected the user program can communicate with it. The flowcharts represent the program which have been written to create the GUI are included.
- Here we measured a Voltage from a D.C. source and varying it using a potentiometer. We can measure any kind of electrical from of data/signal in the range 0-5v (DC) and display it in the computer.

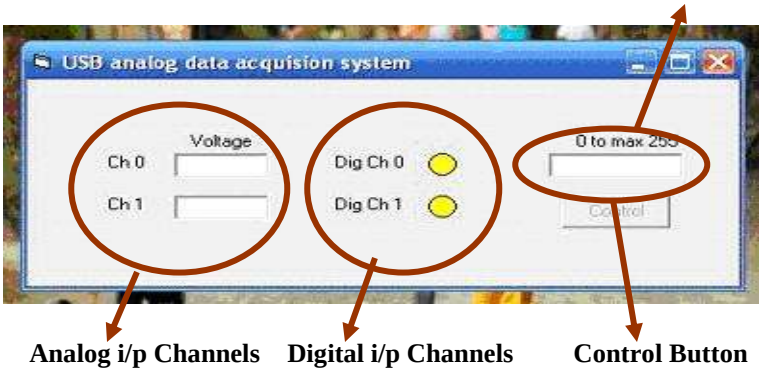
III. CIRCUIT DIAGRAM



The flowchart of the firmware which has been loaded into the PIC18F2550

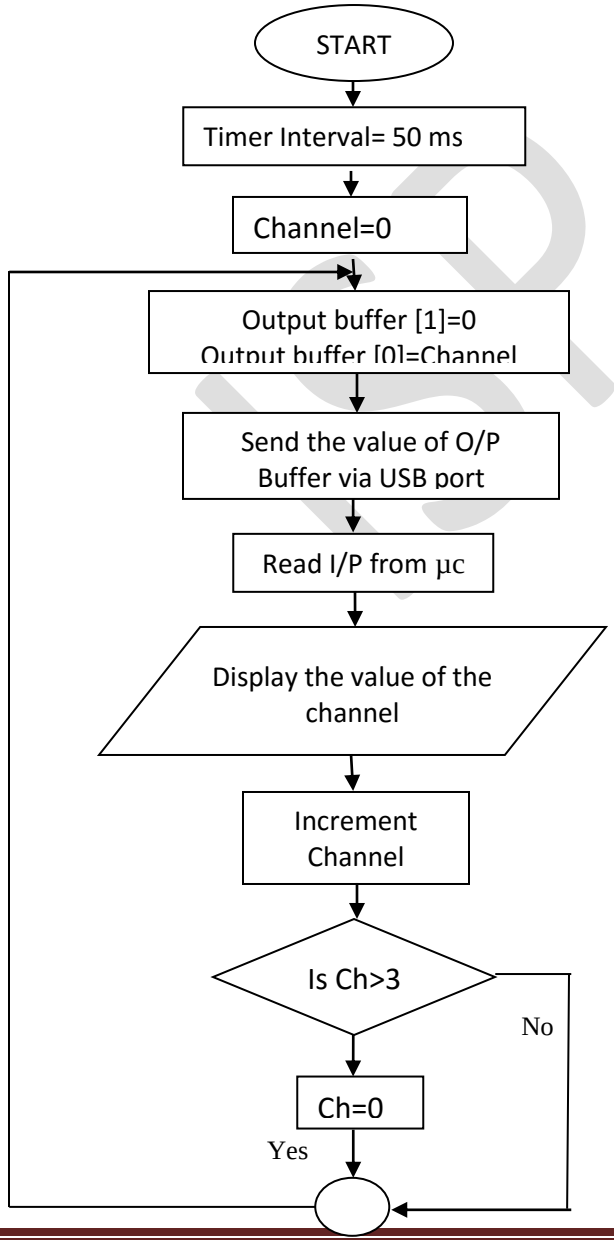


Developed VB based GUI **Control Action**

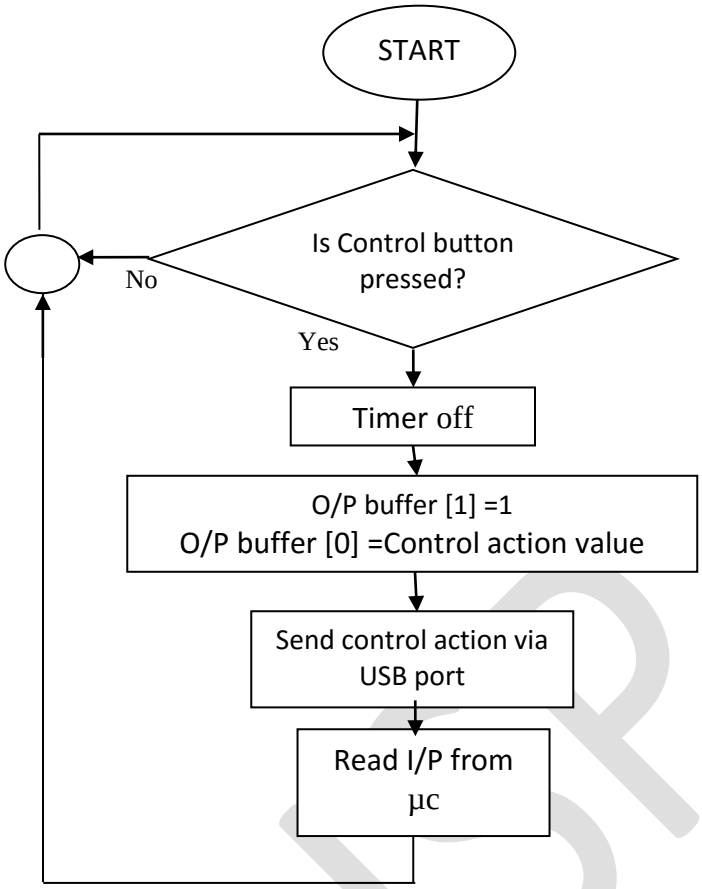


Analog i/p Channels **Digital i/p Channels** **Control Button**

Flowcharts: **Flowchart of VB program to receive analog and digital channel values**

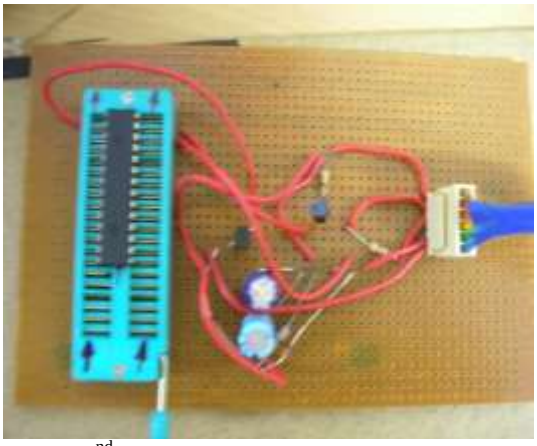


Flowchart of VB program for control action generation

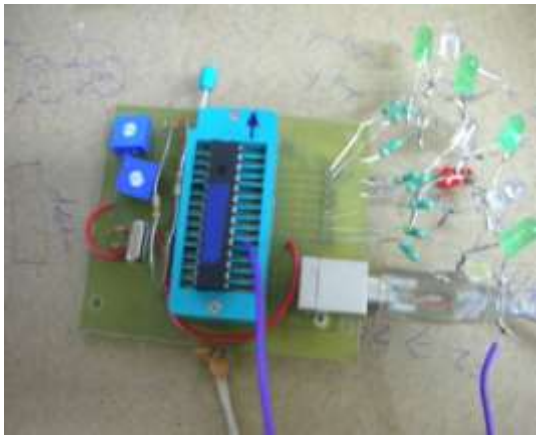


IV. RESULTS AND DISCUSSIONS

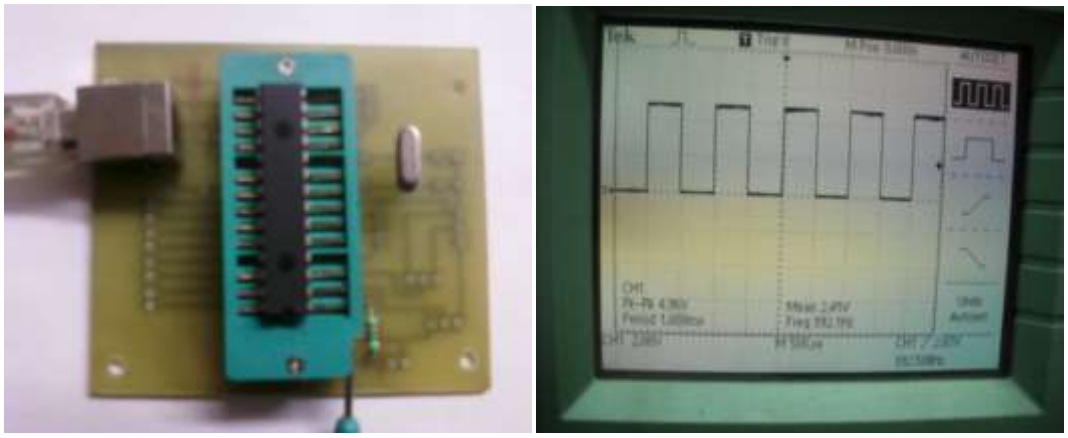
Snapshots of Work are given below



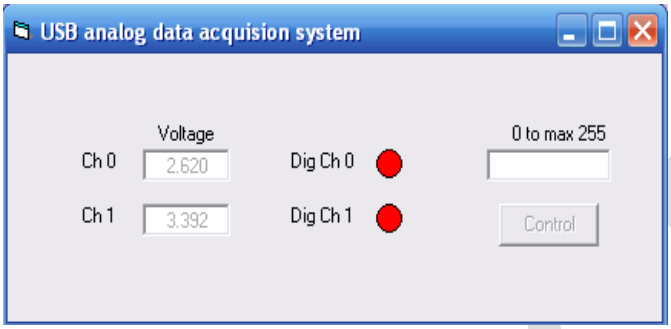
2nd Generation JDM programmer



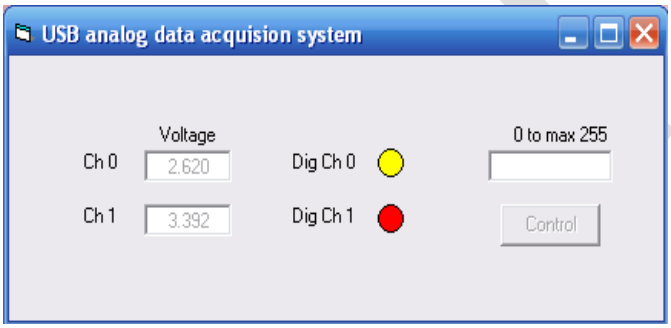
USB based DAQ device



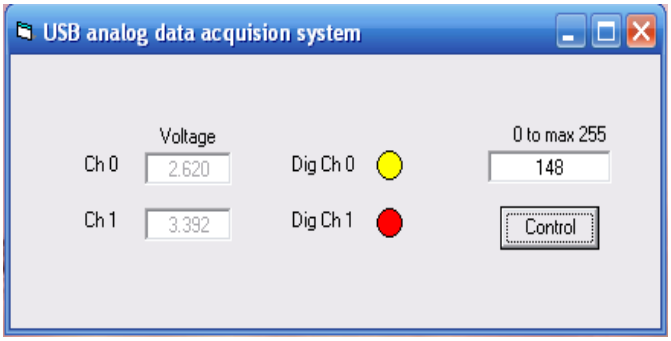
Microcontroller connected with USB and Square wave generated in CRO



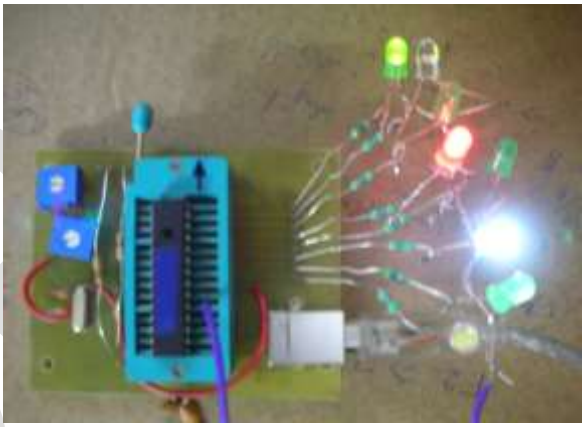
Analog data is being displayed and both digital channels are at logic '0



Digital channel 0 is at logic '1'



Control action is being given through the GUI



The control output at microcontroller's output port: $(148)_{10} = (10010100)_2$

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