# High Speed Data Acquisition System

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Abstract - ***Many advantages of USB like plug and play, hot plug, portability, etc. is advantageous for PC peripheral devices. In this paper data acquisition (DAQ) system using FT2232H mini-module have been introduced. An Analog Front End card consisting the ADC and buffer is used an add-on card for digitalizing the data. The application program have been created using LabVIEW tool and USB drivers D2XX have been used for interfacing FT2232H mini-module to PC.*** *The system hardware developed is low cost alternative to commercially available system that uses USB controllers. The card can be connected to portable computer to acquire data at any time in area such as laboratories, workshops and other remote places.*

*Key Words: USB, data acquisition, FT2232H*

## 1. Introduction

Traditionally data communication between computer and peripheral uses communication methods like RS232 serial communication, parallel data communication and universal serial bus. But all this methods are not commercially viable. RS232 based serial port has low transmission speed to meet real-time requirements; connection of parallel port is complex and expensive [1]. On the other hand peripheral buses like PCI, PCI express, PXI, Ethernet or wireless are costly and complex compared to USB.

As a standard USB has advantage of high-speed throughput, feasibility, support to plug and play and automatic configuration (enumeration). USB DAQ using FT2232H is reliable mode of communication for devices providing parallel data.

## 2. USB In Brief

USB systems consist of a host, which is typically a personal computer (PC) and multiple peripheral devices connected through a tiered-star topology. This topology may also include hubs that allow additional connection points to the USB system.
USB device communication is done through pipes. These pipes are a connection pathway from the host controller to an addressable buffer called an endpoint. An endpoint stores received data from the host and holds the data that is waiting to transmit to the host. A USB device can have multiple endpoints and each endpoint has a pipe associated with it. This is shown in Figure below.

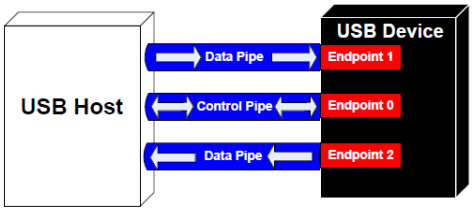


Fig -1: USB Pipe Model

There are two types of pipes in a USB system, control pipes and data pipes. The USB specification defines four different data transfer types. Which pipe is used depends on the data transfer type.

- *Control Transfers* Used for sending commands to the device, make inquiries, and configure the device. This transfer uses the control pipe.
- *Interrupt Transfers* Used for sending small amounts of bursty data that requires a guaranteed minimum latency. This transfer uses a data pipe.
- *Bulk Transfers* Used for large data transfers that use all available USB bandwidth with no guarantee on transfer speed or latency. This transfer uses a data pipe.
- *Isochronous Transfers* Used for data that requires a guaranteed data delivery rate. Isochronous transfers are capable of this guaranteed delivery time due to their guaranteed latency, guaranteed bus bandwidth, and lack of error correction. Without the error correction, there is no halt in transmission while packets containing errors are resent. This transfer uses a data pipe.

When a USB device is first connected to a host, the USB enumeration process is initiated. Enumeration is the process of exchanging information between the device and the host that includes learning about the device.

 

Advantage of USB peripherals is that it does not require external power supply. There are two lines $V_{BUS}$ and GND that provides the required power supply for the device. The other two pins D+ and D- are used for differential data transmission.

USB specification limits distance between computer and device or hub to 5m. By using maximum 5 hubs you can achieve a distance of upto 30m.

Currently, the USB specification defines four speeds for a USB system: low-speed, full-speed, high-speed, and super-speed. Low, full, and high-speed devices are often advertised as 1.5 Mb/s, 12 Mb/s, and 480 Mb/s, respectively.

Figure 16. USB Transfer Speeds

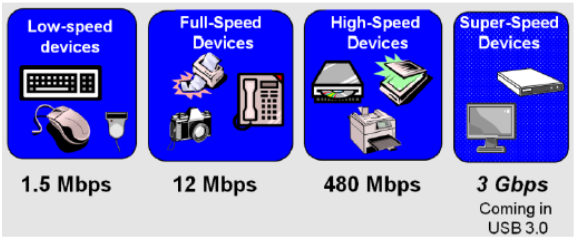


Fig -2: USB Speeds

## 2.1. FT2232H mini-module

FT2232H mini module is used as USB module which utilizes USB hi-speed two port bridge chip and handles all USB signaling and protocols. The device features two interfaces that can be configured for asynchronous or synchronous serial or parallel FIFO interface [5]. In order to communicate with device drivers provided by manufacturer has been utilized.

Fig -3: FT2232H mini-module

The USB module can be configured in different mode based on the type of application. Table 1 below summarizes this modes.

Table-1: Modes Summary

| S.R. No | *MODE* | *Serial/Parallel Mode* | *Remark* |
|---|---|---|---|
| 1. | Asynchronous Serial Mode (RS232) | Serial | Used for serial data transmission using RX and TX lines |
| 2. | Synchronous 245 Mode | Parallel | Suitable for 60 MHz and 8-bit data only |
| 3. | Asynchronous Bit Bang Mode | Parallel | Used for both 8-bit and 16-bit data. Variable data possible |
| 4. | MPSSE Mode | Serial | Used for industry standard serial interface protocols like SPI, JTAG, I2c, etc. |
| 4. | Fast Serial Interface Mode | Serial | Used for High-Speed optical bi-directional isolated serial data transfer |
| 5. | CPU style FIFO Mode | Parallel | Allows CPU to interface USB via FT22232H |
| 6. | Host Bus Emulation Mode | - | Used to emulate standard 8048 or 8051 MCU host so that this device can be directly connected to USB |

For the designed acquisition system Asynchronous mode is selected. Operating rate of this mode has been tested from 300 Bauds to 12 MBauds.

## 3. Hardware design

In order to use the USB module it has to be biased first and the drivers for communication between PC and device needs to be installed. Biasing as suggested in the data sheet of the device had been done and the D2XX drivers provided by the manufacturer had been installed in the PC.

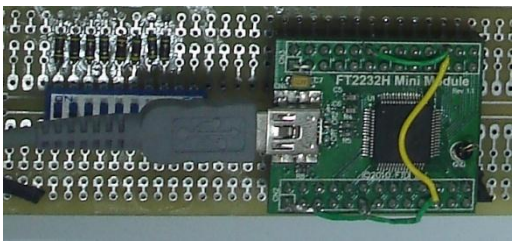

Fig-4: Hardware Connection

## 4. Software Design

LabVIEW is a graphical programming language offering extensive libraries of functions and development tools designed specifically for data acquisition and instrument control [6].

 

LabVIEW application for the USB module is developed using commands specific for the D2XX drivers. The application developed is dynamic which support various modes and data rates. Thus as per the requirement one can control the acquisition rate. The DAQ system designed has been tested for data rates from 9600 Bauds to 12 MBauds for 8-bit and 16-bit.

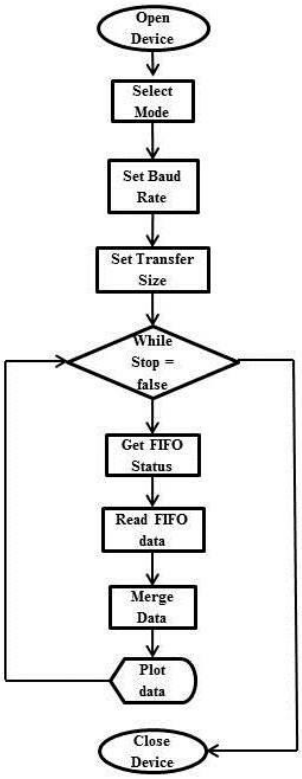


Fig -5: Flowchart

The flowchart shown in figure shows the flow of program. The first task is to configure the device as per requirement. It includes selecting the appropriate mode, setting the mask, selecting the baud rate and selecting the transfer size. This is a one time configuration.

## 5. TEST RESULTS

The 16-bit counter data was generated in EPLD card and applied to the input of the USB module. The application program is used to acquire this data into PC and the final result of acquisition is displayed in the graph.

The graph below shows the lower 8-bit result. This data linearly increases from 0 to 255. There is no discontinuity in this graph

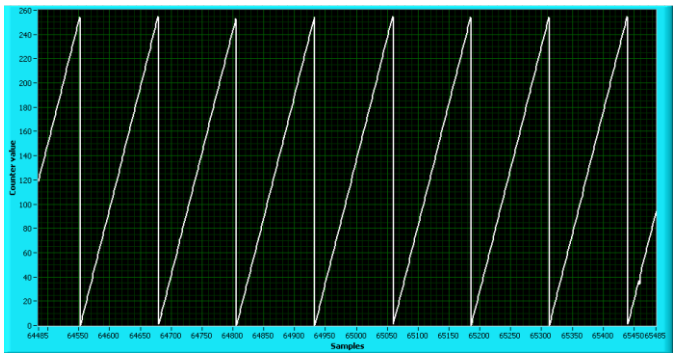

Fig -6: Lower Byte of Counter

The graph below shows the higher 8-bit result. This data linearly increases from 0 to 255. There is no discontinuity in this graph

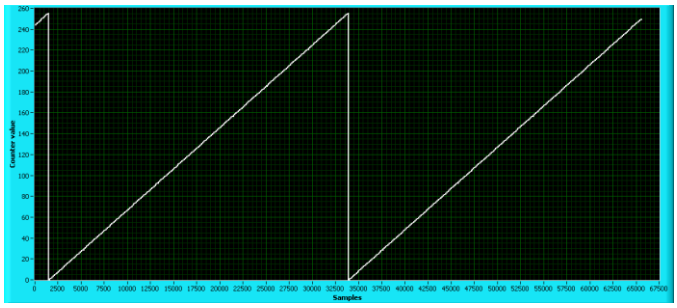

Fig -7: Higher Byte of Counter

Finally both the data of lower byte and higher byte is combined to produce 16-bit digital output data. This data is then plotted into the graph. The figure below shows the test result of one of the ramp. This data linerely increases from 0 to 65535 without any discontinuity.

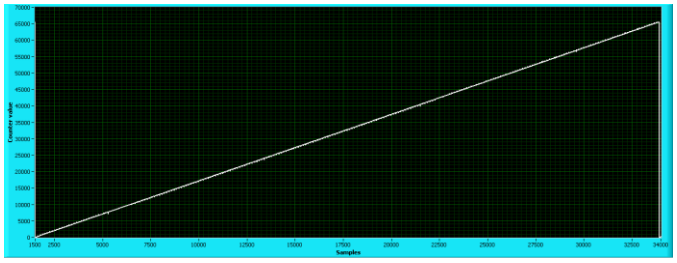

Fig -8: Combined 16-bit data output

## 6. CONCLUSION

The system hardware developed is low cost alternative to commercially available systems that use USB controllers. The data of experiment indicates that this equipment has high stability and high precision. The card can be connected to portable computer to acquire data at any time in areas such as laboratories, construction sites, workshops and other remote places.

 

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## BIOGRAPHIES

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