Study and Development of PIC Microcontroller-to-PC Communication via USB

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ABSTRACT

In this article, authors attempt to describe a study and development of PIC Microcontroller-to-PC communication via USB. The Microchip FSUSB Framework utilized the PIC18F4553 with 20MHz crystal. PortB pin RB4 has been used as Bootloader and RD0 & RD1 as the status indicator. Moreover, RC5 and RC4 of PortC have been used as USB D+ and D-. Firmware tools consist of Mplab IDE, Mplab C18 Compiler, Driver, FSUSB Framework v2.6 and Microsoft Visual Stadio (Visual C/C Sharp). Demonstration and Development of a complete USB2.0 communication solution has been verified by using USBDevice – CDC – BASICDEMO software on Proteus 7.7 simulation platform.

KEYWORDS: PIC Microcontroller, FSUSB Framework, Mplab IDE, Mplab C18 Compiler, USB communication

1. INTRODUCTION

USB as its name would suggest is a universal serial bus (USB). It uses 4 shielded wires of which two are power (+5v & GND). The remaining two are twisted pair differential data signals USB D+ and D-. It uses a Non Return to Zero Invert (NRZI) encoding scheme to send data with a sync field to synchronise the host and receiver clocks [1]. Therefore, serial communication between Microcomputer and Microcontroller has been presented that describes a data transmission system where the data can be transmitted from a personal computer to a microcontroller chip and vice-versa [2, 3, 4]. In the present research, a study and development of universal serial bus (USB) communication between a PIC Microcontroller and the Personal Computer (PC) has been presented. A complete USB2.0 communication solution has been verified by using USBDevice – CDC – BASICDEMO software on Proteus 7.7 simulation platform.

2. Methodology

A study and development of PIC Microcontroller-to-PC communication via USB has been presented in this research. The System consists of Microchip FSUSB Framework utilized the PIC18F4553 with 20MHz crystal. Block diagram, Microchip FSUSB framework, circuit description and demonstration for the system have been presented accordingly.
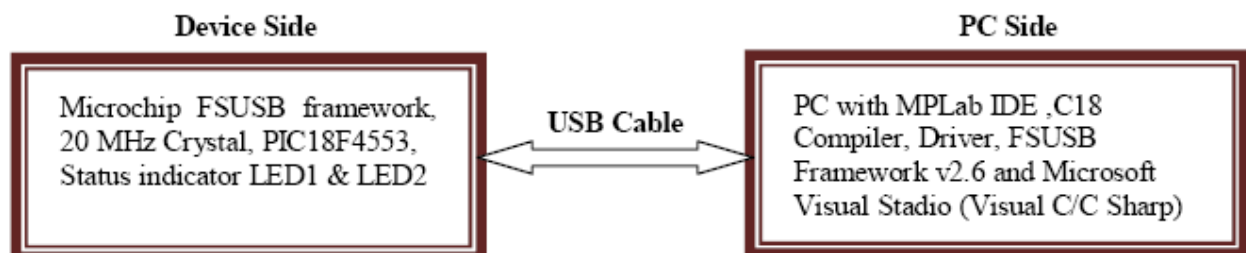
2.1. Block Diagram

Fig.1: Shows the Block Diagram of the Microchip FSUSB framework.

2.2. Schematic Diagram

Complete simulation model of the primitive hardware used in the Microchip FSUSB framework on Proteus 7.7 simulation platform has been shown in fig.2. The description of schematic diagram has been presented below:
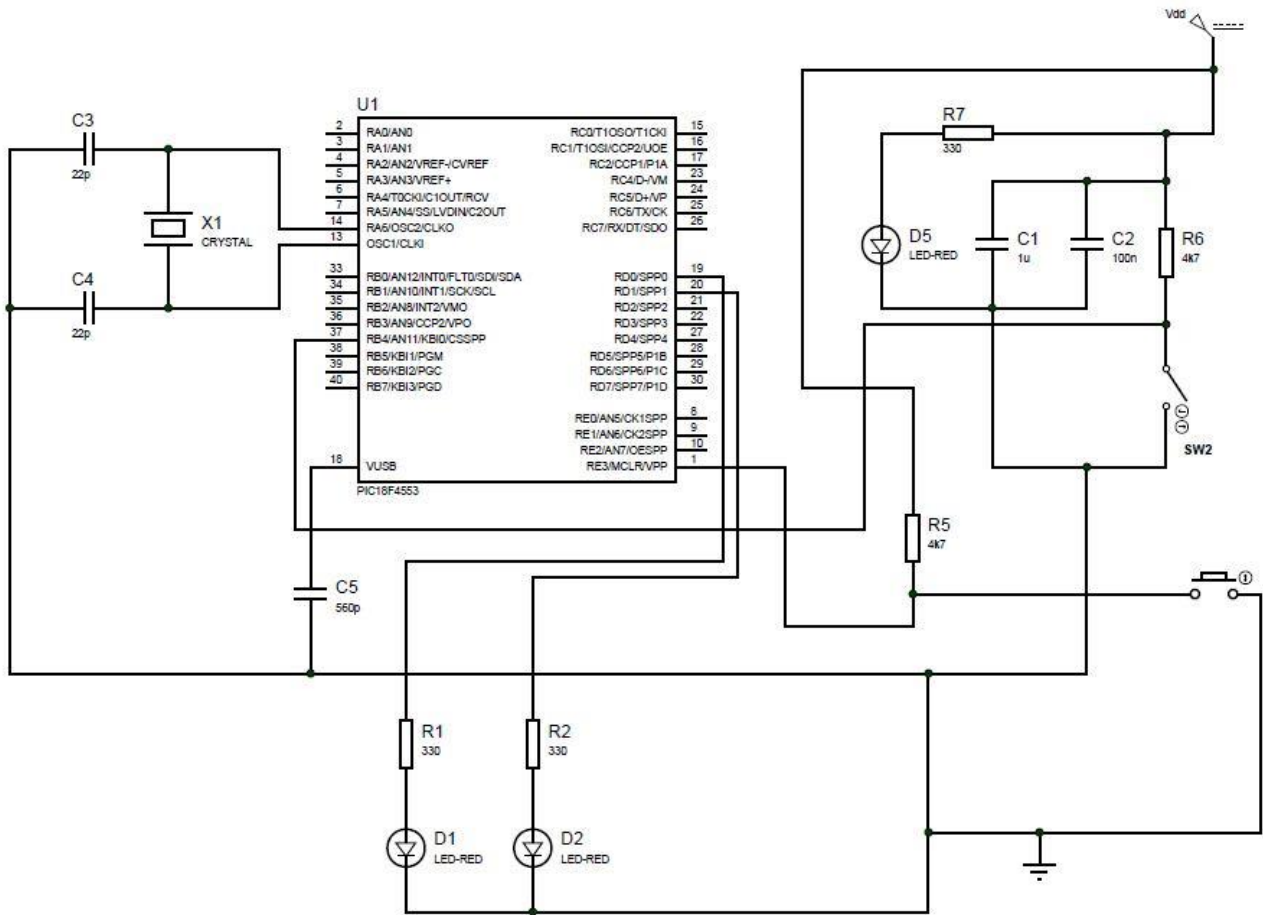
Fig.2: The Primitive Hardware used in the Microchip FSUSB framework on Proteus 7.7 simulation platform.

2.2.1. **Input Power Filter Circuit:** A power supply must provide stable and ripple-free DC output voltage independent of line and load variations [5, 6]. Therefore, the input power filter circuit consists of capacitors C_1 and C_2.

2.2.2. **Input Power Indicator Circuit:** The input power indicator circuit comprises of resistor R_7 and light emitting diode (LED-RED) D_5.

2.2.3. **Bootloader Circuit:** The bootloader circuit has been constructed with resistor R_6 and SPST switch SW_2.

2.2.4. **Master Clear (Reset) Input Circuit:** Master Clear (input) or programming voltage (input) or Master Clear (Reset) input circuit consists of resistor R_5 and push switch. This pin is an active-low Reset to the device.

2.2.5. **Oscillator Circuit:** The oscillator circuit comprises of crystal oscillator X1, capacitors C_3 and C_4.

2.2.6. **Processor Circuit:** The processor circuit is the heart of the developed system comprises of PIC 18F4553 40 pin DIP Package, High-Performance, Enhanced Flash, USB Microcontrollers with 12-Bit A/D and nanoWatt Technology. It consists of Oscillator crystal or external clock input. CPU, 4-ports, Reset, Memory for data and Program, Interrupts and free-run timer TMR0 [7]. A high level language program developed using C controls the function of the processor.

2.2.7. **Status Indicator & USB:** The status indicator circuit constructs with resistors R_1, R_2 and LEDs D_1, D_2 (RED). And RC_5 and RC_4 of PortC have been used as USB D+ and D-.
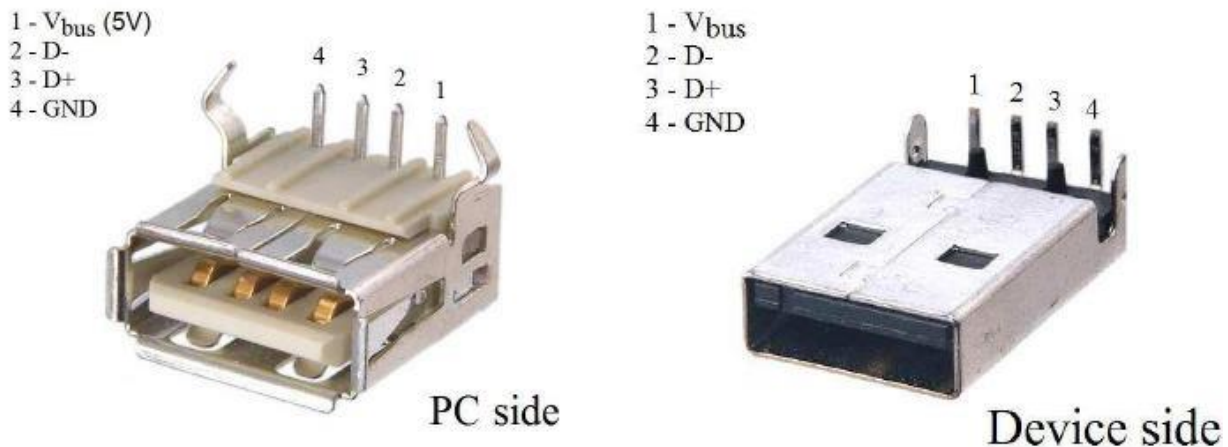

Fig.3: USB Connectors and their Pin Configurations for PC side and Device side.

2.3. Software Arrangement

2.3.1. MPlab IDE: The MPLAB IDE software brings an ease of software development previously unseen in the 8/16-bit microcontroller market. The MPLAB IDE is a Windows based application in which main.c program has been developed to control the operation of the PIC Microcontroller-to-PC communication via USB [7].

2.3.2. MPlab C18 Compiler: MPLAB C for PIC18 MCUs, publisher microchip, version 3.47.

2.3.3. Linker Script File: For working with 18F4553 instead of 18F4550, its need some modifications on the MCHPUSB linker script. Open the rm18f4550 – MCHPUSB Bootload.lkr file by double clicking on it. Change the line containing p18f4550.lib as p18f4553.lib, save the file by ctrl+S. Right click on the workspace containing the codes for the linker file.

2.3.4. Main Program: The Main Program is a file named main.c contains codes related to the default configuration of the supported devices and their programming environment. There are also code protection, watchdog timer, PLL division etc. Moreover, the file included header files, global variable and function prototype declarations. In the variables section, two char arrays like the USB_In_Buffer and USB_Out_Buffer, both having character length 64. Here, USB_In_Buffer is the array used to send the data to PC and USB_Out_Buffer is the one used to receive the packages from PC.

2.3.5. The User Interface: The programming environment chosen to implement the user interface for the USB application is Microsoft Visual Studio.NET 2005 Professional Edition. Open the directory C:\Microchip Solutions\USB Device - CDC - Basic Demo\PC Software Example\VCsharp 2005\Basic Communication. Run the "Csharp Simple CDC Demo" solution file.

2.3.6. FSUSB Framework: After it has been confirmed that accurately implemented the circuit on board, plug it into one of the USB ports. Run the bootloader application "PDFUSB.exe" located on "C:\Microchip Solutions\USB Tools\Pdfsusb".

2.3.7. Driver: The current work is a simulation in the Microchip FSUSB framework on Proteus 7.7 simulation platform. Otherwise, its need driver file installation for introducing the device to PC. The same thing goes for the user interface and FSUSB Framework with suitable version [8].

2.4. Demonstration and Analysis

The demonstration and development of the PIC Microcontroller-to-PC USB communication has been presented in this article. One can easily understand the operation of the code by looking at the events and function declarations. It is a well commented code allowing the programmer to understand the basic operations used to send and receive functions used in USB communication. The demonstration is, at first, press and hold the bootloading button (RB_4) and while holding that press reset button. Thereafter, release the reset button and after that release the bootloading button. The bootloader firmware start to run on PIC device that means there is a blinking on Led_1 & Led_2 and will be recognized by the PC.

The demonstration and development/verification of the complete USB2.0 communication solution by using USB Device – CDC – BASICDEMO software in Proteus 7.7 simulation platform has been completed but continuous ignition in RD_0 instead of blinking in RD_0 & RD_1 alternately. For solving this problem/further investigation as well as hardware test of the PIC Microcontroller-to-PC Communication via USB, the PICDEM FS USB Demo Board (PIC18F4553/PIC18F45K50), Part Number DM163025-1 is needed.

The user interface for the USB application in PICDEM FS USB Demo Board /Circuit Board, type 5 to the textbox next to the button "Send Data" and push "Send Data". One will see that the data is (char by char) incremented by 1 and sent back to PC. Press the button RB_4 and observe the screen "Button Pressed".

The USB communication has some advantages as compared to the other communication protocols (RS232, RS485, parallel communication) such as high bandwidth in transfer, serial communication etc. Moreover, the USB (Universal Serial Bus) is an industry standard that was developed to define cables, connectors and protocols for connection, communication, and power supply between personal computers and their peripheral devices. And it has become commonplace on a wide range of devices. USB connectors have replaced other types for battery chargers of portable devices [9].

3. Conclusion

An elaborate study and method of development for PIC Microcontroller-to-PC communication via USB has been presented in this research. The Block diagram representation, schematic diagram which includes complete simulation model of the primitive hardware used in the Microchip FSUSB framework on Proteus 7.7 simulation platform and demonstration also have been presented. Demonstration and Development of a complete USB2.0 communication solution has been verified by using USBDevice – CDC – BASICDEMO software.

REFERENCES:

[1] http://www.beyondlogic.org/usbnutshell/usb1.shtml #Introduction, Available Online 2017.

[2] Mahbubul Hoq and Md. Abu Sayid Haque, serial communication between Microcomputer and Microcontroller, J. Bangladesh Electronic Society, Vol.5, No. 1, 2005.

[3] Mahbubul Hoq, Yasmeen Mawla, Md. Abu Sayid Haque and Saleh Mahmud Jahangir, Design and Development

of microcontroller based traffic light control system, Proceedings, Bangladesh Electronics Society Conference, Dhaka, Bangladesh, pp.122-126, 24-26 April, 2003.

[4] PIC 16F84A Data Sheet DS35007B, Microchip Technology Inc., 2001.

[5] Selected Topics in Nuclear Electronics, IAEA TECDOC-363, 1986.

[6] M. N. Islam, F. Akter, K. Asaduzzaman, M. A. S. Haque and M. S. Islam, Design, Fabrication and Performance Study of a Low Cost High Voltage Power Supply, Nuclear Science and Applications, Vol. 21, Number 1 & 2, ISSN: 1016 – 197X, June-December 2012.

[7] PIC18F2458/2553/4458/4553 Data Sheet DS39887B, Microchip Technology Inc., 2007.

[8] Tutorial 1: Implementation of a USB based PIC-to-PC communication, Available Online 2015.

[9] https://en.wikipedia.org/wiki/USB, Available Online 2018.