



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

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**Key words:** PIC microcontroller, FSUSB framework, MPLAB IDE, MPLAB C18 compiler, USB communication, bootloader

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**Abstract:** In this study, researchers attempt to describe a study and development of PIC microcontroller-to-PC communication via USB. The microchip FSUSB framework utilized the PIC18F4553 with 20 MHz crystal. Port B pin RB4 has been used as bootloader and RD0 and 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 Studio (Visual C/C Sharp). Demonstration and Development of a complete USB2.0 communication solution has been verified by using USB Device-CDC-BASICDEMO Software on Proteus 7.7 Simulation platform.

## INTRODUCTION

USB as its name would suggest is a Universal Serial Bus (USB). It uses 4 shielded wires of which two are power (+5 V and GND). The remaining 2 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.

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<sup>[1-3]</sup>. 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 USB device-CDC-BASICDEMO Software on Proteus 7.7 Simulation platform.

## MATERIALS AND METHODS

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 20 MHz crystal. Block diagram, microchip FSUSB framework, circuit description and demonstration for the system have been presented accordingly (Fig. 1).

### Block diagram

**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 as:

**Input power filter circuit:** A power supply must provide stable and ripple-free DC output voltage independent of line and load variations<sup>[4, 5]</sup>. Therefore, the input power filter circuit consists of capacitors C1 and C2.

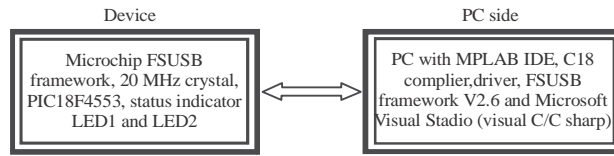


Fig. 1: The block diagram of the microchip FSUSB framework

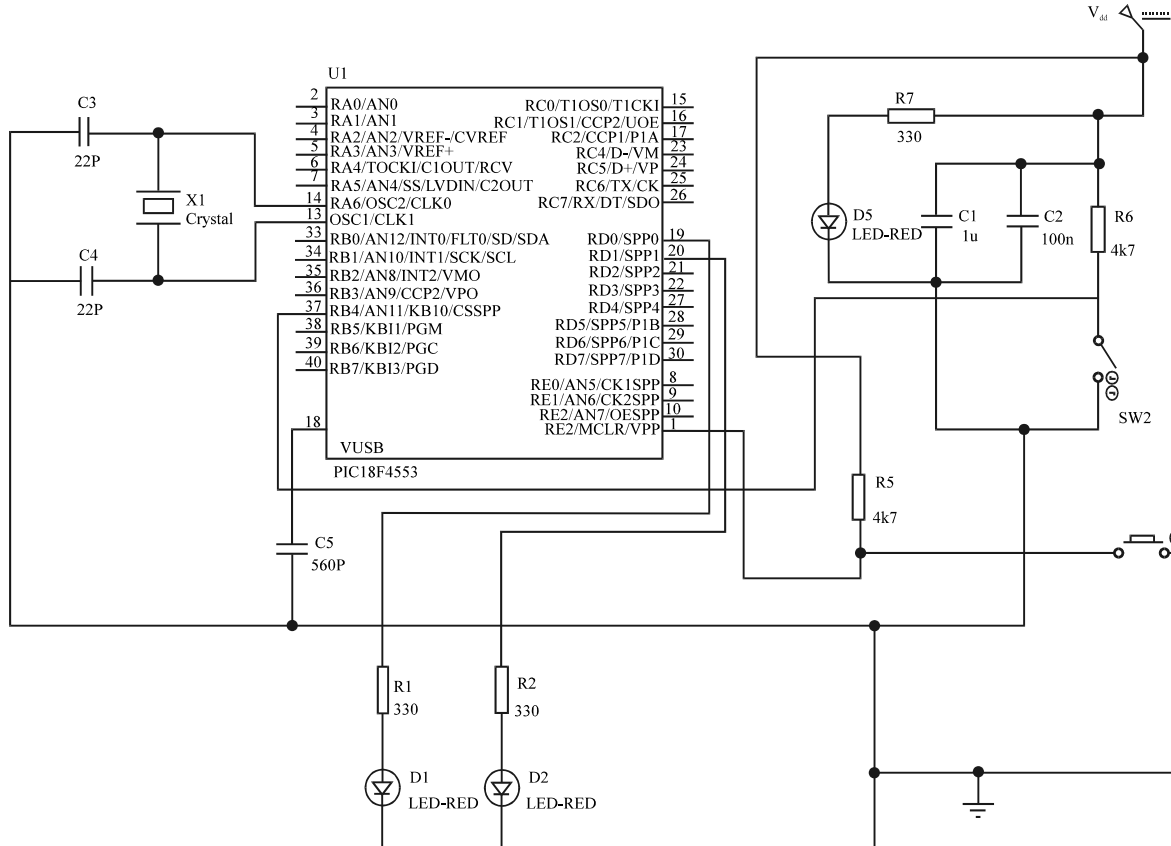


Fig. 2: The primitive hardware used in the microchip FSUSB framework on Proteus 7.7 Simulation platform

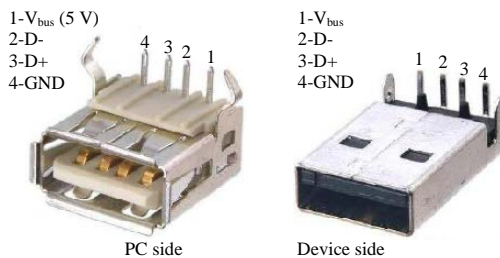


Fig. 3: USB connectors and their pin configurations for PC side and device side

**Input power indicator circuit:** The input power indicator circuit comprises of resistor R7 and light emitting diode (LED-RED) D5.

**Bootloader circuit:** The bootloader circuit has been constructed with resistor R6 and SPST switch SW2.

**Master clear (reset) input circuit:** Master clear (input) or programming voltage (input) or master clear (reset) input circuit consists of resistor R5 and push switch. This pin is an active-low reset to the device.

**Oscillator circuit:** The oscillator circuit comprises of crystal oscillator X1, capacitors C3 and C4 (Fig. 3).

**Processor circuit:** The processor circuit is the heart of the developed system comprises of PIC18F4553 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<sup>[6]</sup>. A high level language program developed using C controls the function of the processor.

**Status indicator and USB:** The status indicator circuit constructs with resistors R1, R2 and LEDs D1, D2 (RED). And RC5 and RC4 of PortC have been used as USB D+ and D-.

## RESULTS AND DISCUSSION

### Software arrangement

**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<sup>[6]</sup>.

**MPLAB C18 compiler:** MPLAB C for PIC18 MCUs, publisher microchip, Version 3.47.

**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.

**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, 2 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.

**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.

**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\Pdfsub".

**Driver:** The current research 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<sup>[7]</sup>.

**Demonstration and analysis:** The demonstration and development of the PIC microcontroller-to-PC USB communication has been presented in this research. 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 (RB4) 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 Led1 and Led2 and will be recognized by the PC.

The demonstration and development/verification of the complete USB 2.0 communication solution by using USB device-CDC-BASICDEMO Software in Proteus 7.7 Simulation platform has been completed but continuous ignition in RD0 instead of blinking in RD0 and RD1 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 RB4 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.

## 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 USB 2.0 communication solution has been verified by using USB device-CDC-BASICDEMO Software.

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