CO326: Industrial Networks

Lab 06 - USB Port I/O

Deadline- 17/04/2022

Introduction

In Lab 06, you will be focusing on creating a USB interfacing device. You will be creating the device using the PIC18F4550 microcontroller and the device will be simulated using Proteus.

Required Tools

You will need the following software and tools to carry out this lab.

- MPLAB X IDE
- MPLAB XC8 compiler for 8-bit PIC
- MPLAB Libraries for Applications
    - Microchip Libraries for Applications - MLA(latest version)
        - https://ww1.microchip.com/downloads/en/softwarelibrary/mla_v2018_11_26_windows_installer.exe
- Proteus
- Virtual USB Driver for Proteus
    - http://downloads.labcenter.co.uk/VirtualUSBDriver.exe
- Tera Term
- HDD Monitoring Studio

Steps to Complete the Lab

1. As the initial step, you need to create a Proteus project with the following setup. When creating the project, please remember that you need to create a Firmware Project in the last step of the *New Project Wizard* and choose *PIC18F4550* as the controller.

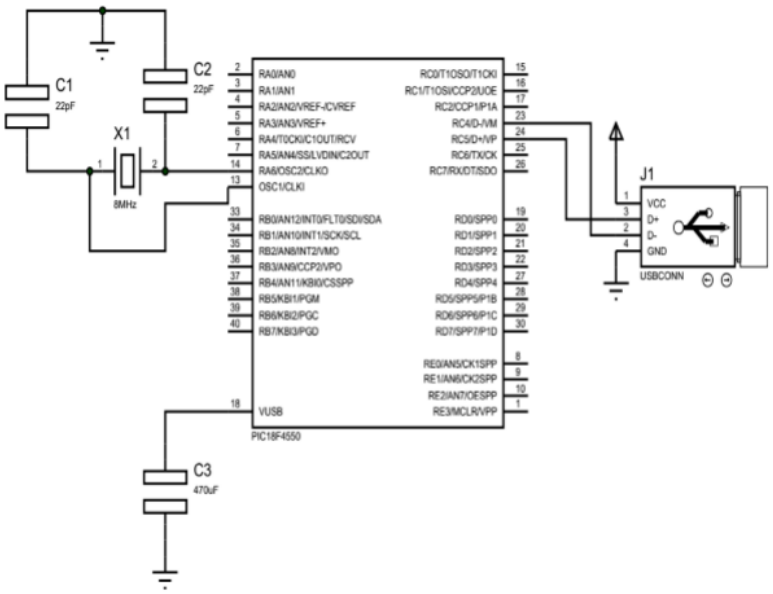

Figure 1: Circuit diagram of the Proteus setup to be implemented

2. Next, you have to use *MPLAB X IDE* to program the Microcontroller. Use the following process.
    a. First, open the project under the following directory using *MPLAB*.
    C:\microchip\mla\v2018_11_26\apps\usb\device\cdc_basic\firmware\picdem_fs_usb.x

NOTE: You are opening a project that is installed by the MPLAB Libraries for Applications (MLA). "picdem_fs_usb" is a development board that contains PIC18F4550.

b. Next, you have to change the following configuration based on the circuit you implemented in Proteus. You can find the configurations in Project -> Source files -> system.c
   - PLLDIV : 2
   - MCLRE : OFF

   EXPLANATION: Since we use an 8 MHz crystal you have to change the PLLDIV to 2. (USB 2.0 requires a 48MHz clock. For that, PIC uses a PLL circuit to multiply the frequency. The PLL circuit here always expects a 4 MHz input. Hence 8 MHz should be first divided by 2. That is why we put PLLDIV as 2. If the crystal was 16 MHz we have to divide by 4 to get 4 MHz and in that case, PLLDIV will be equal to 4.)

   Since we do not use the MCLR pin of the PIC in our circuit as an on/off button, we need to set the *MCLRE* bit to OFF.

   NOTE: Please refer to the PIC18F4550 datasheet for understanding the required configurations. You can find the datasheet in the following link
   - https://www.microchip.com/wwwproducts/en/PIC18F4550

   Read the OSCILLATOR CONFIGURATIONS section from page 25 to understand the clock configurations bits. Also, read UNIVERSAL SERIAL BUS (USB) section from page 163 to understand the configurations required for USB.

c. After the configurations are done in the code, clean build the project to generate the ".hex" file. You may find the generated ".hex" file at ..\picdem_fs_usb.x\dist\PICDEM_FSUSB\production of your directory.

3. Now you have to load this generated program code (".hex file") to the PIC microcontroller in the Proteus setup.

4. Then you can run the Proteus simulation. If your setup is correct, a USB analyzer window will appear as in Figure 2. If not, enable the USB debugger from *Debug -> USB Analyzer* in Proteus. If you can't find that option there, that means something is wrong with your previous steps.

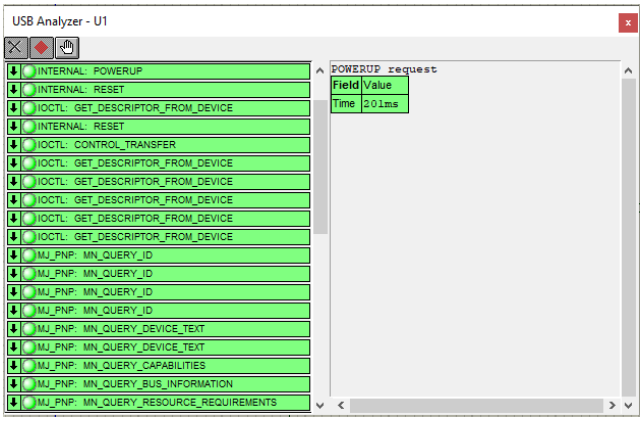

Figure 2: Screenshot of USB Analyzer

5. Further, as soon as you simulate the project, a new USB device should be recognized by the computer. Open "Device Manager" to view the new USB Device. Windows operating systems will install the drivers for the device from the internet. If the installation is successful it should be listed as a virtual COM port in the device manager as in Figure 3.

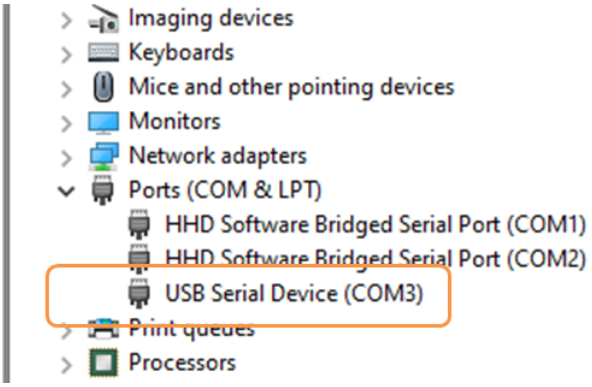

Figure 3: Screenshot of Device Manager with the new Serial USB device.

6. Now open TeraTerm. Connect to the corresponding virtual COM port. Type something on the terminal. You will see that each letter you enter is shifted by one. That is because the program in the PIC implements a Caesar cipher with a key that is equal to 1.

7. When typing letters one by one, click on the new lines that appear in the USB analyzer and identify the transfer type and observe the packet details.

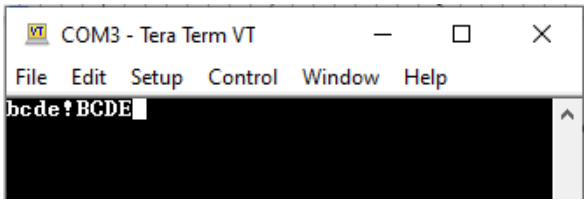

Figure 4: Screenshot of Tera Term terminal when the input is "abcd ABCD"

Using the HDD Monitoring Tool, you can see how the data is transmitted over USB as follows.

NOTE: If your installed HDD monitoring tool has already expired. Uninstall it and try downloading it from this link: https://freeserialanalyzer.com/

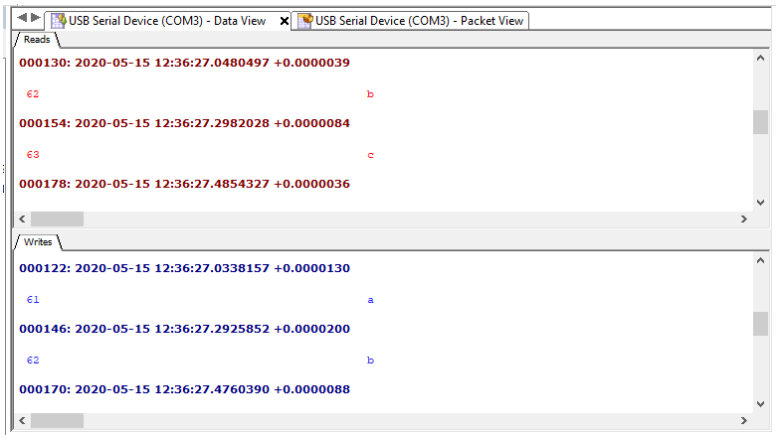

Figure 5: Screenshot of Packet view in HDD Monitoring tool

Lab Task

You need to modify the USB example you followed above such that it takes a complete sentence from the user up to the return character (\r) and convert only the simple English characters to capital letters and print back. This should happen in a loop.

Hi How Are You ? -----> HI HOW ARE YOU?

Lab Submission

Prepare a report from the Lab example and the Lab Task including the following

- Screenshots of the Design
- Screenshots of Tera Term Terminal
- Code from MPLAB for the Lab Task
- Problems and issues you encountered and how you solved them
- Explain followings
    - Give a letter you typed and what is observed on the Tera Term
    - Give screenshots of the USB monitor relevant to the letter you type and the letter displayed on the Tera Term.
    - One type of packet is IN and the other is OUT. Explain each case discussing why they become IN and OUT packets.

The report should be named Lab06_GroupXX where XX is your group number and in “pdf” format. Submit a zipped folder named Lab06_GroupXX.zip including the report, .hex files, and the proteus project file.

NOTE: If the file size is increased with the project file and exceeds the given file size, upload the proteus project file to a cloud space (GDrive) and share the link with permission in a text file along with the report and hex files.