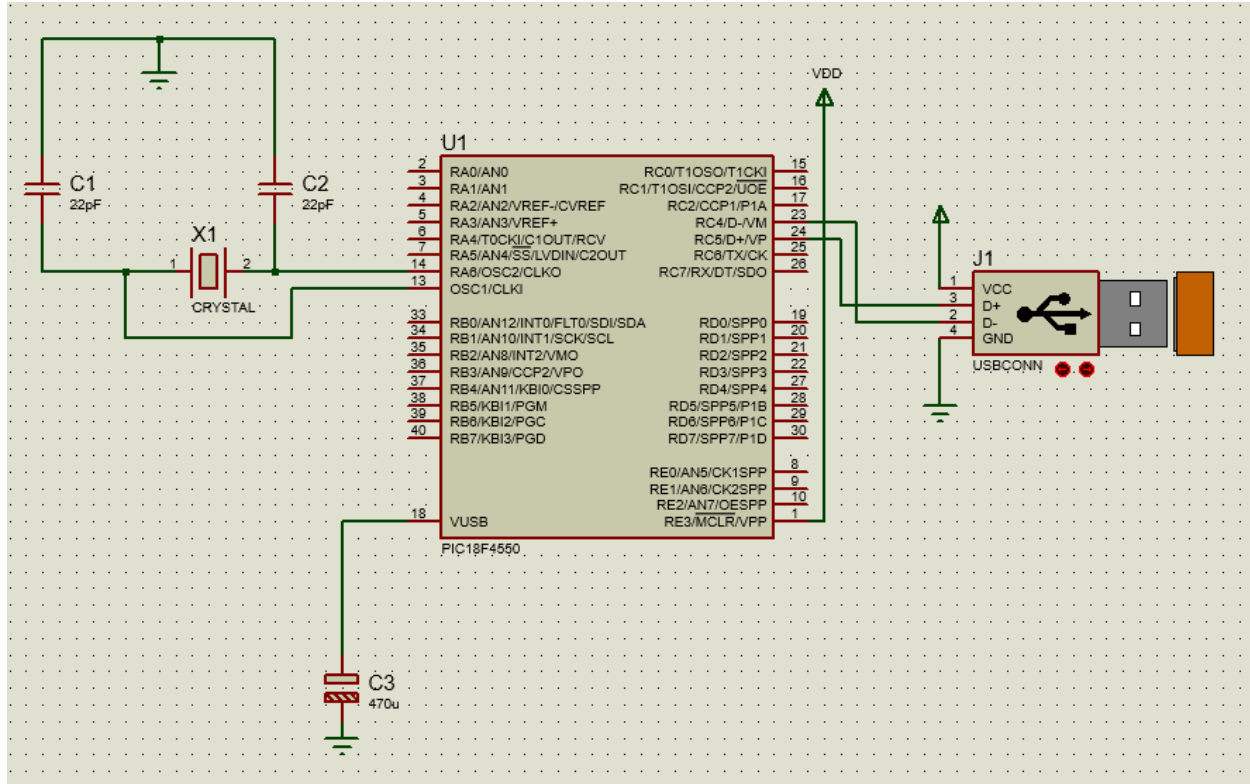


CO326 - Lab 3

Jayathunga W.W.K.

E/19/166

Proteus Setup



USB Analyzer

USB Analyzer - U1

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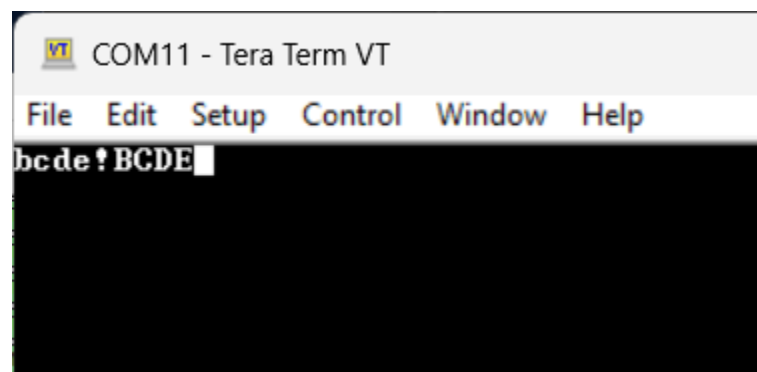
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_DEVICE_TEXT
↓	MJ_PNP: MN_QUERY_DEVICE_TEXT
↓	MJ_PNP: MN_QUERY_CAPABILITIES
↓	MJ_PNP: MN_QUERY_BUS_INFORMATION
↓	MJ_PNP: MN_QUERY_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_QUERY_RESOURCES
↓	MJ_PNP: MN_DEVICE_ENUMERATED
↓	MJ_PNP: MN_QUERY_LEGACY_BUS_INFORMATION
↓	MJ_PNP: MN_QUERY_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_FILTER_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_START_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_STATUS_FROM_DEVICE

POWERUP request

Field	Value
Time	201ms

Lab Example (When the input is abcd ABCD)

Tera Term Terminal Window



Device Monitoring Studio Screen

USB Serial Device (COM11) - Data View

Reads

000012: 2024-04-06 12:12:30.7282073 +0.0000053

62b

000036: 2024-04-06 12:12:33.5346882 +0.0000044

63c

000060: 2024-04-06 12:12:34.1652031 +0.0000043

64d

000084: 2024-04-06 12:12:34.7800547 +0.0000045

65e

000108: 2024-04-06 12:12:37.4073667 +0.0000053

21!

000132: 2024-04-06 12:12:40.6051273 +0.0000051

42B

000156: 2024-04-06 12:12:41.1142434 +0.0000048

43C

000180: 2024-04-06 12:12:41.5661422 +0.0000050

44D

000204: 2024-04-06 12:12:41.9725428 +0.0000049

45E

USB Serial Device (COM11) - Data View

Writes

000005: 2024-04-06 12:12:30.6854392 +0.0000190

61a

000028: 2024-04-06 12:12:33.5169584 +0.0000201

62b

000052: 2024-04-06 12:12:34.1108524 +0.0000201

63c

000076: 2024-04-06 12:12:34.7633200 +0.0000225

64d

000100: 2024-04-06 12:12:37.3790831 +0.0000189

20

000124: 2024-04-06 12:12:40.5818576 +0.0000187

41A

000148: 2024-04-06 12:12:41.1108366 +0.0000192

42B

000172: 2024-04-06 12:12:41.5502178 +0.0000195

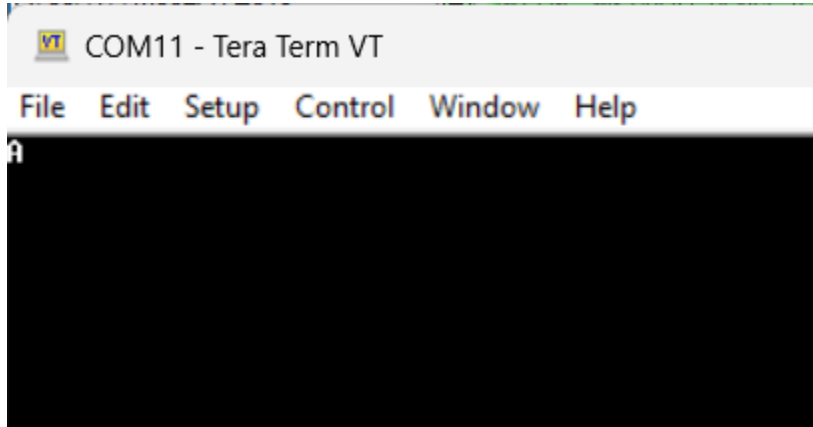
43C

000196: 2024-04-06 12:12:41.9311471 +0.0000183

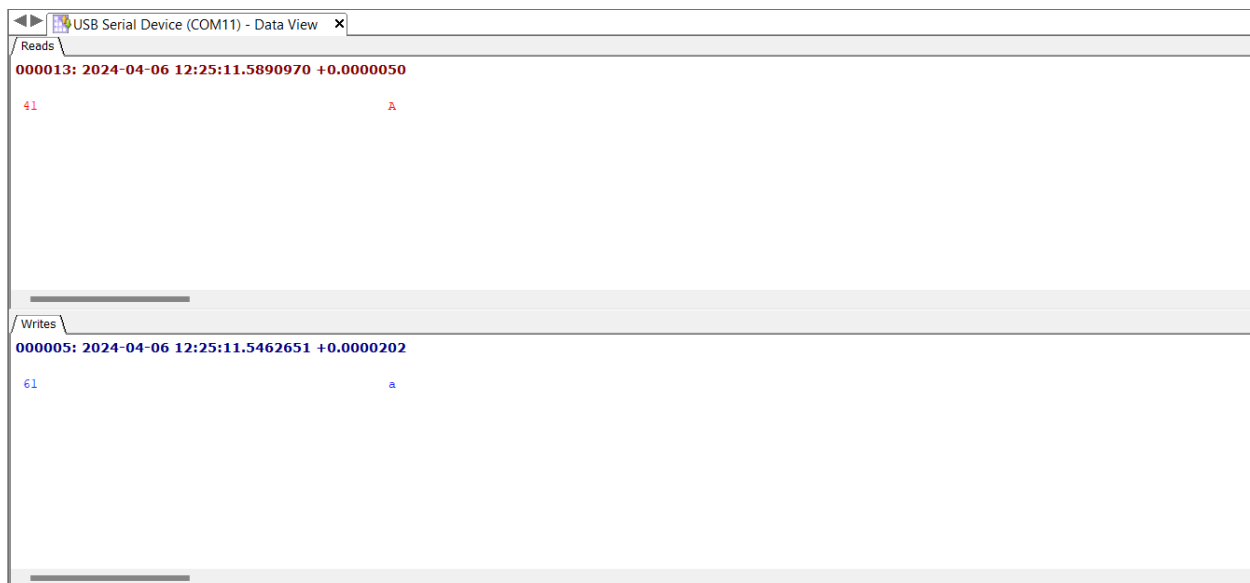
44D

Lab Exercise (When the letter 'a' is typed)

Tera Term Terminal Screen



USB Monitoring Studio Screen



'a' is sent to the microcontroller through the USB port and the microcontroller converts it to 'A' and sends it back through the USB port.

USB Analyzer

USB Analyzer - U1



↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_ID
↓	MJ_PNP: MN_QUERY_DEVICE_TEXT
↓	MJ_PNP: MN_QUERY_DEVICE_TEXT
↓	MJ_PNP: MN_QUERY_CAPABILITIES
↓	MJ_PNP: MN_QUERY_BUS_INFORMATION
↓	MJ_PNP: MN_QUERY_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_QUERY_RESOURCES
↓	MJ_PNP: MN_DEVICE_ENUMERATED
↓	MJ_PNP: MN_QUERY_LEGACY_BUS_INFORMATION
↓	MJ_PNP: MN_QUERY_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_FILTER_RESOURCE_REQUIREMENTS
↓	MJ_PNP: MN_START_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: GET_STATUS_FROM_DEVICE
↓	MJ_PNP: MN_QUERY_INTERFACE
↓	MJ_PNP: MN_QUERY_INTERFACE
↓	IOCTL: GET_DESCRIPTOR_FROM_DEVICE
↓	IOCTL: SELECT_CONFIGURATION
↓	IOCTL: SELECT_INTERFACE
↓	IOCTL: CONTROL_TRANSFER
↓	IOCTL: SELECT_CONFIGURATION
↓	MJ_PNP: MN_QUERY_CAPABILITIES
↓	IOCTL: CONTROL_TRANSFER
↓	IOCTL: CONTROL_TRANSFER
↓	MJ_PNP: MN_QUERY_CAPABILITIES
↓	MJ_PNP: MN_QUERY_PNP_DEVICE_STATE
↓	MJ_PNP: MN_QUERY_DEVICE_RELATIONS
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: CONTROL_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: SELECT_CONFIGURATION
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: CONTROL_TRANSFER
↓	IOCTL: CONTROL_TRANSFER
↓	IOCTL: SELECT_CONFIGURATION
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER
↓	IOCTL: BULK_OR_INTERRUPT_TRANSFER

IRP Structure

Field	Request	Reply
MajorFunction	0x0F (MJ_INTERNAL_DEVICE_CONTROL)	0x0F (MJ_INTERNAL_DEVICE_CONTROL)
MinorFunction	0x00	0x00
Status	0x00000000 (STATUS_SUCCESS)	0x00000000 (STATUS_SUCCESS)

URB Structure

Field	Request	Reply
Time	26s 202ms	26s 204ms
UrbHeader.Function	0x0009 (BULK_OR_INTERRUPT_TRANSFER)	0x0009 (BULK_OR_INTERRUPT_TRANSFER)
UrbHeader.Length	72	72
UrbHeader.Status	0x00000000 (SUCCESS)	0x00000000 (SUCCESS)
UrbHeader.UsbdDeviceHandle	0x0B464B38	0x0B464B38
UrbHeader.UsbdFlags	0x00000000	0x00000000
UrbBulkOrInterruptTransfer.PipeHandle	0x0B47A0B8	0x0B47A0B8
UrbBulkOrInterruptTransfer.TransferFlags	0x00000000	0x00000000
UrbBulkOrInterruptTransfer.TransferBufferLength	1	1
UrbBulkOrInterruptTransfer.TransferBuffer	0x00000000	0x00000000

OUT Data

Offset	Data	Text
0x00000000	61	a

USB Analyzer - U1

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

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IOCTL_GET_DESCRIPTOR_FROM_DEVICE

⬇

MJ_PNP_MN_QUERY_ID

⬇

MJ_PNP_MN_QUERY_ID

⬇

MJ_PNP_MN_QUERY_ID

⬆

MJ_PNP_MN_QUERY_ID

⬇

MJ_PNP_MN_QUERY_DEVICE_TEXT

⬇

MJ_PNP_MN_QUERY_DEVICE_TEXT

⬆

MJ_PNP_MN_QUERY_CAPABILITIES

⬆

MJ_PNP_MN_QUERY_BUS_INFORMATION

⬇

MJ_PNP_MN_QUERY_RESOURCE_REQUIREMENTS

⬆

MJ_PNP_MN_QUERY_RESOURCES

⬆

MJ_PNP_MN_DEVICE_ENUMERATED

⬆

MJ_PNP_MN_QUERY_LEGACY_BUS_INFORMATION

⬇

MJ_PNP_MN_QUERY_RESOURCE_REQUIREMENTS

⬆

MJ_PNP_MN_FILTER_RESOURCE_REQUIREMENTS

⬇

MJ_PNP_MN_START_DEVICE

⬇

IOCTL_GET_DESCRIPTOR_FROM_DEVICE

⬇

IOCTL_GET_DESCRIPTOR_FROM_DEVICE

⬇

IOCTL_GET_DESCRIPTOR_FROM_DEVICE

⬇

IOCTL_GET_STATUS_FROM_DEVICE

⬆

MJ_PNP_MN_QUERY_INTERFACE

⬇

MJ_PNP_MN_QUERY_INTERFACE

⬇

IOCTL_GET_DESCRIPTOR_FROM_DEVICE

⬇

IOCTL_SELECT_CONFIGURATION

⬇

IOCTL_SELECT_INTERFACE

⬇

IOCTL_CONTROL_TRANSFER

⬇

IOCTL_SELECT_CONFIGURATION

⬇

MJ_PNP_MN_QUERY_CAPABILITIES

⬆

IOCTL_CONTROL_TRANSFER

⬆

IOCTL_CONTROL_TRANSFER

⬇

MJ_PNP_MN_QUERY_CAPABILITIES

⬇

MJ_PNP_MN_QUERY_PNP_DEVICE_STATE

⬇

MJ_PNP_MN_QUERY_DEVICE_RELATIONS

⬆

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬆

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬇

IOCTL_CONTROL_TRANSFER

⬇

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬆

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬇

IOCTL_SELECT_CONFIGURATION

⬇

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬆

IOCTL_CONTROL_TRANSFER

⬆

IOCTL_CONTROL_TRANSFER

⬆

IOCTL_SELECT_CONFIGURATION

⬇

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬆

IOCTL_BULK_OR_INTERRUPT_TRANSFER

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IOCTL_BULK_OR_INTERRUPT_TRANSFER

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IOCTL_BULK_OR_INTERRUPT_TRANSFER

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IOCTL_BULK_OR_INTERRUPT_TRANSFER

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IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬇

IOCTL_BULK_OR_INTERRUPT_TRANSFER

⬇

IOCTL_BULK_OR_INTERRUPT_TRANSFER

IRP Structure

Field	Request	Reply
MajorFunction	0x0F (MJ_INTERNAL_DEVICE_CONTROL)	0x0F (MJ_INTERNAL_DEVICE_CONTROL)
MinorFunction	0x00	0x00
Status	0xC00000BB (STATUS_NOT_SUPPORTED)	0x00000000 (STATUS_SUCCESS)

URB Structure

Field	Request	Reply
Time	26s 208ms	31s 351ms
UrbHeader.Function	0x0009 (BULK_OR_INTERRUPT_TRANSFER)	0x0009 (BULK_OR_INTERRUPT_TRANSFER)
UrbHeader.Length	72	72
UrbHeader.Status	0x00000000 (SUCCESS)	0x00000000 (SUCCESS)
UrbHeader.UsbdDeviceHandle	0x0B464B38	0x0B464B38
UrbHeader.UsbdFlags	0x00000000	0x00000000
UrbBulkOrInterruptTransfer.PipeHandle	0x0B47A0CC	0x0B47A0CC
UrbBulkOrInterruptTransfer.TransferFlags	0x00000003	0x00000003
UrbBulkOrInterruptTransfer.TransferBufferLength	4096	1
UrbBulkOrInterruptTransfer.TransferBuffer	0x00000000	0x00000000

IN Data

Offset	Data	Text
0x00000000	41	A

There are two different kinds of packets that can be observed when using the USB analyzer: IN packets and OUT packets. In USB communication, IN and OUT packets refer to the direction of data transfer between a USB device (like your PIC microcontroller) and the USB host (usually your computer)

- The packet that the PIC18F4550 microcontroller sends into the USB port is referred to as IN, (Data that the USB port reads). The device is considered to be "initiating" the data transfer by pushing information towards the host. The host expects this data and has issued a request for it beforehand (often through control transfers).
- OUT denotes the packet that is transmitted to the microcontroller via the USB port.(data that the USB port wrote). The host is considered to be "sending out" instructions or data for the device to process. This could be commands to control the device, data for the device to display, or files to be transferred to the device.

Code from MPLAB for the Lab Task

```

/*****
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To request to license the code under the MLA license
(www.microchip.com/mla_license),
please contact mla_licensing@microchip.com
*****/

/** INCLUDES *****/
#include "system.h"

#include <stdint.h>
#include <string.h>
#include <stddef.h>

#include "usb.h"

#include "app_led_usb_status.h"
#include "app_device_cdc_basic.h"
#include "usb_config.h"

/** VARIABLES *****/

static bool buttonPressed;
static char buttonMessage[] = "Button pressed.\r\n";
static uint8_t readBuffer[CDC_DATA_OUT_EP_SIZE];
static uint8_t writeBuffer[CDC_DATA_IN_EP_SIZE];

/*****
* Function: void APP_DeviceCDCBasicDemoInitialize(void);
*

```

```

* Overview: Initializes the demo code
*
* PreCondition: None
*
* Input: None
*
* Output: None
*
*****/
void APP_DeviceCDCBasicDemoInitialize()
{
    line_coding.bCharFormat = 0;
    line_coding.bDataBits = 8;
    line_coding.bParityType = 0;
    line_coding.dwDTERate = 9600;

    buttonPressed = false;
}

/*****
* Function: void APP_DeviceCDCBasicDemoTasks(void);
*
* Overview: Keeps the demo running.
*
* PreCondition: The demo should have been initialized and started via
* the APP_DeviceCDCBasicDemoInitialize() and APP_DeviceCDCBasicDemoStart()
demos
* respectively.
*
* Input: None
*
* Output: None
*
*****/
void APP_DeviceCDCBasicDemoTasks()
{
    /* If the USB device isn't configured yet, we can't really do anything
    * else since we don't have a host to talk to. So jump back to the
    * top of the while loop. */
    if( USBGetDeviceState() < CONFIGURED_STATE )
    {
        return;
    }

    /* If we are currently suspended, then we need to see if we need to

```



```

    * issue a remote wakeup. In either case, we shouldn't process any
    * keyboard commands since we aren't currently communicating to the host
    * thus just continue back to the start of the while loop. */
if( USBIsDeviceSuspended()== true )
{
    return;
}

/* If the user has pressed the button associated with this demo, then we
 * are going to send a "Button Pressed" message to the terminal.
 */
if(BUTTON_IsPressed(BUTTON_DEVICE_CDC_BASIC_DEMO) == true)
{
    /* Make sure that we only send the message once per button press and
     * not continuously as the button is held.
     */
    if(buttonPressed == false)
    {
        /* Make sure that the CDC driver is ready for a transmission.
         */
        if(mUSBUSARTIsTxTrfReady() == true)
        {
            putsUSBUSART(buttonMessage);
            buttonPressed = true;
        }
    }
}
else
{
    /* If the button is released, we can then allow a new message to be
     * sent the next time the button is pressed.
     */
    buttonPressed = false;
}

/* Check to see if there is a transmission in progress, if there isn't, then
 * we can see about performing an echo response to data received.
 */
if( USBUSARTIsTxTrfReady() == true)
{
    uint8_t i;
    uint8_t numBytesRead;

    numBytesRead = getsUSBUSART(readBuffer, sizeof(readBuffer));

```

```

/* For every byte that was read... */
for(i=0; i<numBytesRead; i++)
{
    /* If we receive line feed command, the program stops
    scanning */
    char c = readBuffer[i];
    if(c == 0x0D)
    {
        writeBuffer[i] = c;
        break;
    }
    else if (readBuffer[i]>96 && readBuffer[i]<123)
    {
        /* if a lowercase character is read, convert it to
        uppercase */
        writeBuffer[i] = readBuffer[i]-32;
    }
    else
    {
        writeBuffer[i] = readBuffer[i];
    }
}

if(numBytesRead > 0)
{
    /* After processing all of the received data, we need to send out
    * the "echo" data now.
    */
    putUSBUSART(writeBuffer,numBytesRead);
}

CDCTxService();
}

```

Problems Encountered

1. Compilation Errors:

Problem: I have encountered errors related to function redefinition, where the same function is defined multiple times.

Solution: Checked for duplicate inclusions of header files or functions defined in both a header and a source file. Ensured each function is declared (prototyped) only once in a header and defined (with function body) only in the corresponding source file.

2. No USB Recognition:

Problem: The computer has not recognized the simulated USB device.

Solution: Verified the virtual COM port selection in Tera Term matches the one created by the simulation. Ensured the virtual USB driver for Proteus is installed and functioning correctly. I had to reinstall it.

3. Incorrect Data Transmission:

Problem: The received data on the terminal was not be what I expected (e.g., missing characters, incorrect capitalization).

Solution: Carefully reviewed my code for logic errors in character conversion and loop implementation. Ensured the conversion only applies to lowercase English alphabets (a-z) and the loop continues reading characters until the carriage return. Utilized debugging tools within MPLAB X IDE to step through my code line by line. This helped identify where the conversion might be failing.

4. Difficulty Understanding Code Modification:

Problem: I struggled to understand how to modify the code to achieve the desired functionality.

Solution: Referred to online resources and tutorials on C programming for conditional statements (if/else) and lookup tables for character conversion. Searched for examples of similar code modifications related to USB communication and character manipulation.

5. Crashing of Proteus

Problem: After the simulation mode was left on for a few minutes, Proteus continued to crash. After that, each time Proteus crashed, the.hex file needed to be uploaded.

Solution: To some extent, the problem was resolved by turning on the simulation mode only when necessary, which removed the requirement to repeatedly upload the.hex file.