UART Communication

Wired UART Communication

Students should establish a wired UART connection between the microcontroller and the PC first. Echo all introduced characters on the terminal to make sure the connection is functioning correctly. Follow the steps below for UART set up and programming:

1. The message from the microcontroller to the PC is sent through UART interface. Please read chapter 3.4 and 4.1 of the document LPCXpresso Base Board Rev B User's Guide carefully.
2. UART configuration example:
    - BAUD RATE: 115 200
    - DATA BITS: 8
    - PARITY: none
    - STOP BITS: 1
    - FLOW CONTROL: none
3. Connect the Baseboard to PC via the USB-to-UART bridge.

    1. The recommended terminal is [Tera Term](). Select the corresponding UART port after opening Tera Term. Do not forget to verify the UART configuration. The UART port may be determined through the computer's device manager by looking for the USB Serial Port as shown in Figure 1 below.

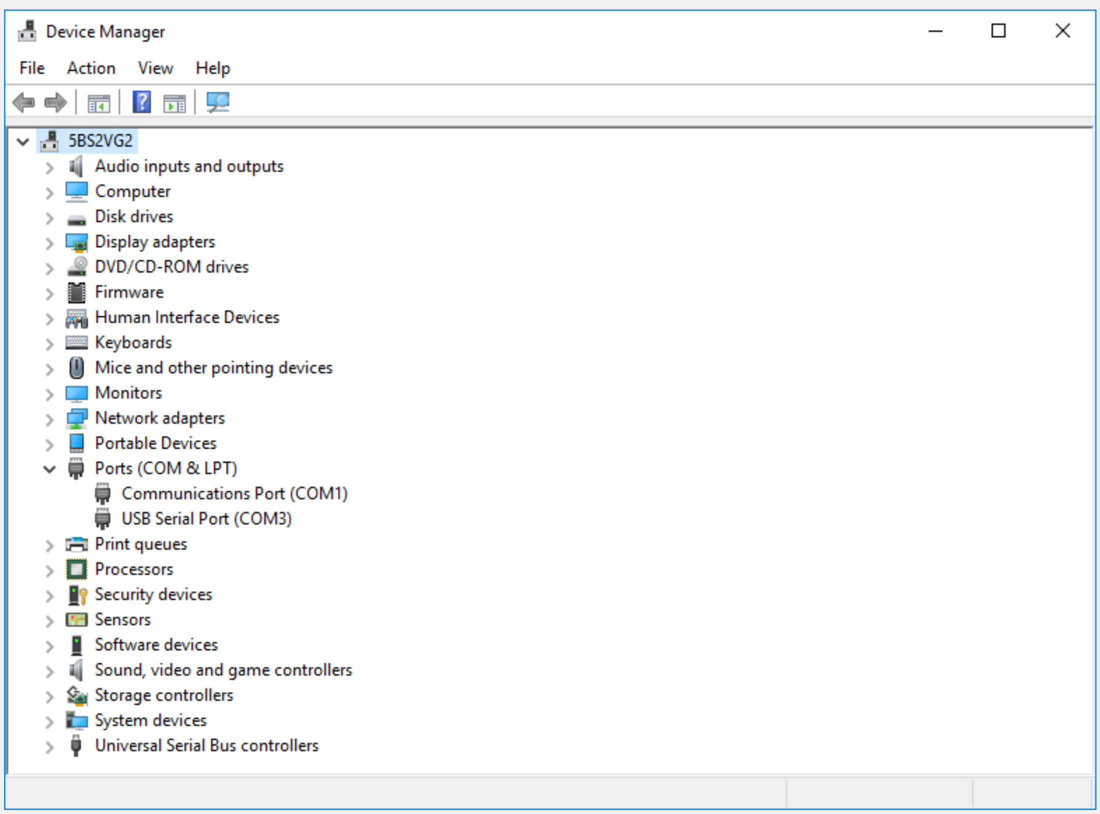

Figure 1: Verify UART (USB Serial) Port

The settings for the Tera Term program are as depicted in Figure 2 and Figure 3. UART port setup in Tera Term is available from the menu : Setup -> Serial.

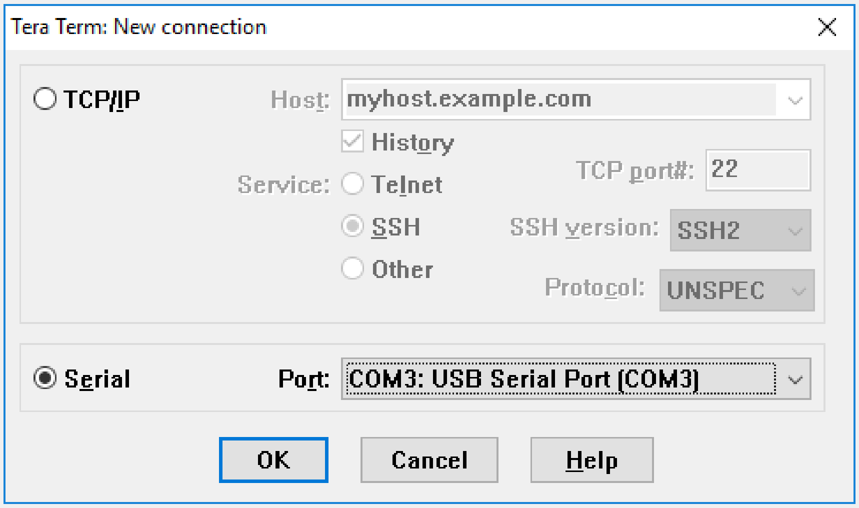

Figure 2: Choose UART (USB Serial) port in Tera Term

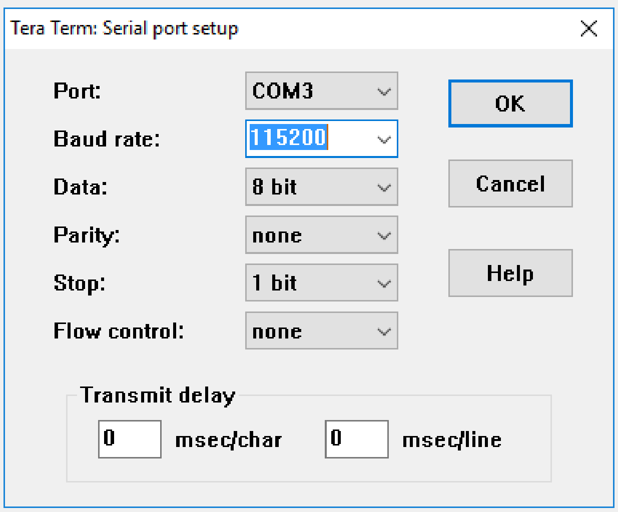

Figure 3: UART port setup in Tera Term

NOTE: If you debug a project when your terminal remains open, the window shown in Figure 4 may pop up. Click on LPCLink Probe v1.0 (id=T!S6RGRIA) [wire=hid] and then press OK.

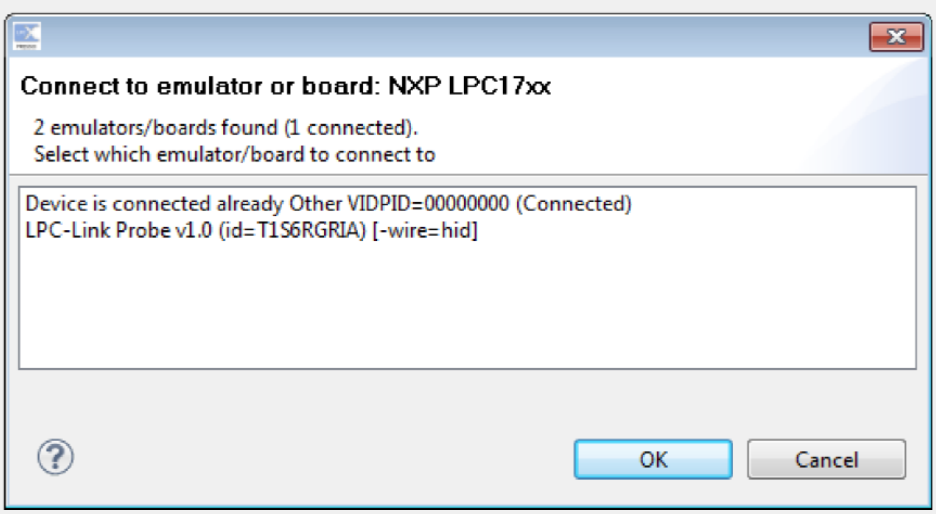

Figure 4: LPCXpresso IDE pop-up window when having connection

with Tera Term

Wireless UART Communication

The objective is to simulate a scenario where CUTE will communicate with CEMS (Tera Term) over-the-air via RF communication. Prior to this, you should have successfully achieved the wired UART communication described in the previous page.

Students will be provided with two pieces of XBee RF modules. An XBee module is shown in Figure 5.

Figure 5: An XBee Series 1

RF Module

XBee radios are products from Digi International and are based on the IEEE 802.15.4 standard for physical layer and MAC control specifications targeting low-cost, low-speed and low-power communication devices. XBee radios communicate with each other within the ISM 2.4GHz frequency band at wireless data rate of 250kbps. The indoor communication range is up to 100 ft. (30m). Detailed specifications and information on operation and configuration can be referenced from the datasheet.

An XBee module also includes an on-chip UART, hence it is fairly straightforward to communicate with an XBee module from any micro-controller SOC that implements a UART such as the LPC1769. By default, an XBee module operates in ‘Transparent Mode’, i.e., acts as a serial line replacement – all data received on the UART is queued up for RF transmission (RF data rate is 250kbps). Any RF data received is sent out over the UART. Both the XBee UART and the host UART should be configured to the same settings. The default on XBee modules is 9600bps, 8N1. The baud rate and parity settings are configurable.

One of the modules you issue out of the DE Lab is mounted on a USB-UART adapter dongle from Sparkfun Electronics, with examples shown in Figure 6. The dongle consists of the USB-UART adapter chip FT232R from FTDI International Ltd., similar to the one on your LPC Xpresso Baseboard. This chip creates a virtual COM port on your PC that effectively behaves as a UART.

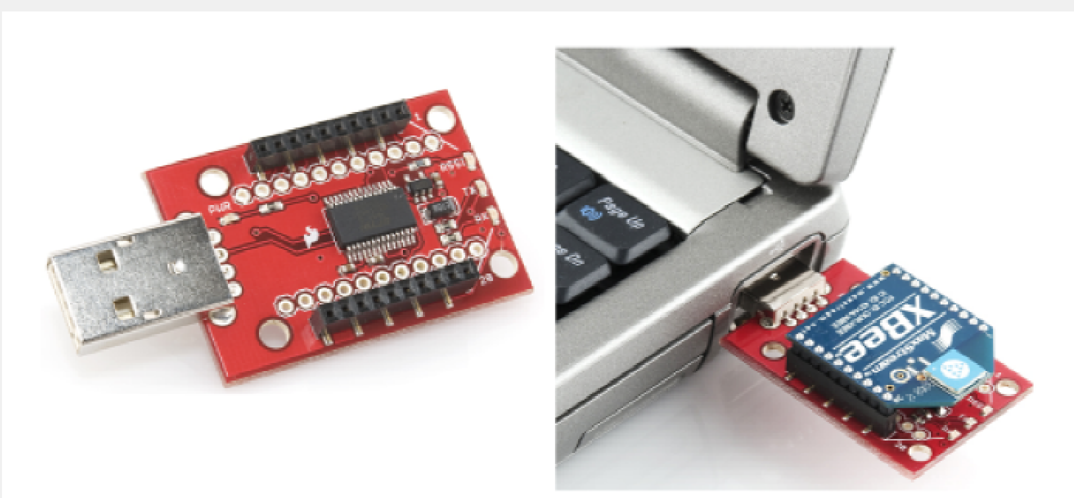

Figure 6: (Left Picture) A Sparkfun XBee Explorer Dongle. (Right Picture) An Xbee module mounted on the dongle and plugged into a host PC USB port

Getting Started with the XBee Modules

Plug one of the XBee modules, mounted on the USB dongle, into your PC. The drivers should install automatically, especially if previously your LPCXpresso baseboard USB-UART adapter also installed successfully. If you run into problems at this step, you can always download the device driver manually from FTDI.

Now mount the other XBee module on to your LPCXpresso Baseboard through the socket reserved for U23. Only one jumper needs to be modified: remove the jumper B on J7 as shown in Figure 7 below. Refer to LPCXpresso Baseboard Schematics (LPCXpresso_Base_Board_revB.pdf available in IVLE) for more details.

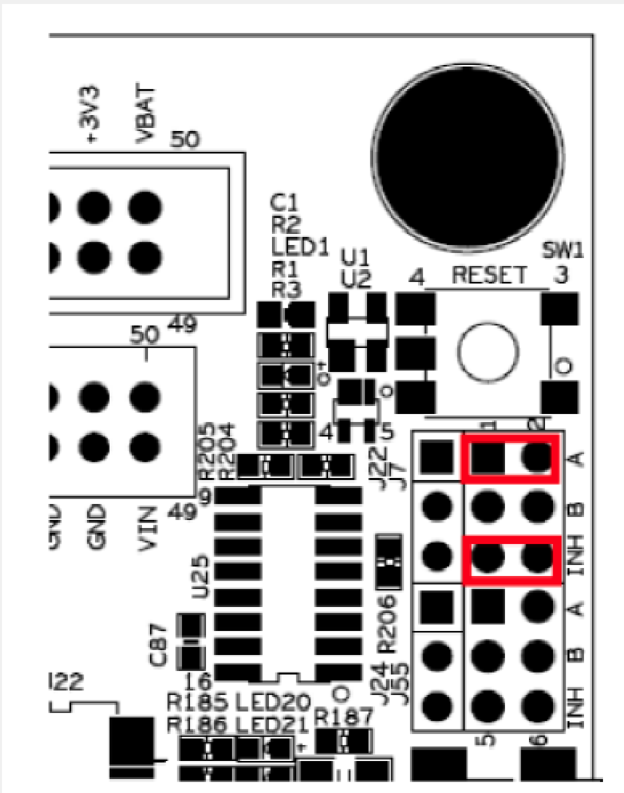

Figure 7: Jumper configuration for XBee module mounted on the LPCXpesso Baseboard

This disconnects the USB-UART bridge on the baseboard that we have so far been using for UART communication with the PC, and alternatively routes all UART signals from LPC1769 to and from the XBee module. If the UART data rate is below the XBee RF data rate (250 kbps), one need not implement flow control and leave J59 in the default state.

Configuring Tera Term on your PC and the LPC1769 UART to 9600bps 8N1 should allow them to communicate with each other. The following section describes how to configure XBee addresses to avoid interference with other XBees in the lab during RF communication.

Configuring the XBee UART Baud Rates

We require the LPC1769 and Tera Term to communicate with the XBee modules at their respective ends at a data rate of 115.2 kbps. We shall mount each XBee module one by one on to the USB dongle, plug it into the PC and configure their baud rate via Tera Term.

Once an XBee module is plugged into your PC, set up Tera Term to connect to the appropriate COM port and configure it to 9600bps, 8N1. Also, turn on 'Local echo' by checking the option in Setup Terminal. This ensures whatever you type into Tera Term console is also displayed on the console. Now follow the procedure outlined in the table below.

AT COMMAND (Tera Term Sends to XBee)	RESPONSE (Tera Term Receives from XBee)	DESCRIPTION
+++	OK <CR>	Commands XBee module to enter the AT Command Mode
ATBD <Enter>	{current value} <CR>	Commands XBee to return its current UART baud rate (3 indicates 9600 bps)
ATBD7 <Enter>	OK <CR>	Modifies XBee UART baud (7 indicates 115200 bps)
ATWR <Enter>	OK <CR>	Write changes to XBee's non-volative memory
ATCN <Enter>	OK <CR>	Exit AT Command Mode

Ensure there is a 1s gap before and after you send the "+++" string to the XBee in order to successfully enter into AT Command Mode of the XBee module. Pressing <Enter> into Tera Term sends a carriage return, i.e, '\r'. Similarly, on successful execution of a command, the XBee returns a "OK\r" signal. Ensure you follow Table 2 carefully and only send and expect carriage return characters where indicated. Also note if no commands are sent within 10s of the last command sent, the XBee automatically exits the AT Command Mode. You will need to re-enter Command Mode by issuing "+++" again to issue more commands. Changes take effect as soon as the XBee exits the command mode, whether due to the 10s timeout, or by response to "ATCN\r". Changes not committed to non-volatile memory will only take effect for current session and be lost once the power to the XBee is turned off.

Upon successful completion of the command sequence in the above table, you should configure Tera Term to 115200 bps to issue any further commands to this XBee module. Repeat the process with your other module.

Configuring XBee Addresses

Conforming to the IEEE 802.15.4 specifications, each XBee RF packet contains a Source Address and Destination Address besides the actual data (payload). By default, all XBee modules are configured to a source address of 0 and to transmit to a destination address of 0. Effectively, this means all XBees transmit data to every other XBee module! If multiple XBees are transmitting within a short range of each other, such as in the DE lab, RF interference is inevitable.

One method to avoid interference is to use the unique 64-bit IEEE source address assigned to each XBee module at the factory which can be read using SH and SL commands in the AT Command mode. Another is to use short 16-bit addresses. Note your XBee modules have been tagged by the DE lab with unique IDs corresponding to your boards. For example, for a board asset tag ID 13, the XBees are tagged 13a and 13b. These are valid 16-bit hex addresses. The table below shows a command sequence to configure an XBee to use a source address of 13a and a destination address of 13b. Note that this process continues after configuring the XBee UART Baud rates, and is carried out with Tera Term configured at 115200 bps.

AT COMMAND (Tera Term Sends to XBee)	RESPONSE (Tera Term Receives from XBee)	DESCRIPTION
+++	OK <CR>	Commands XBee module to enter the AT Command Mode
ATMY <Enter>	{current value} <CR>	Commands XBee to return its current 16-bit source address (returns 0)
ATMY13A <Enter>	OK <CR>	Sets XBee 16-bit source address to 13a
ATDL <Enter>	{current value} <CR>	Commands XBee to return its current Destination Address Low (lower 32 bits). (returns 0)
ATDL13B	OK <CR>	Sets XBee 16-bit destination address to 13b
ATDH	{current value} <CR>	Commands XBee to return its current Destination Address High (higher 32 bits). (returns 0)
ATDH0	OK <CR>	To transmit using a 16-bit address, DH parameter should be set to 0.
ATWR <Enter>	OK <CR>	Write changes to XBee's non-volatile memory

ATCN <Enter>	OK <CR>	Exit AT Command Mode

Mount the other XBee module on to the USB dongle, and repeat the process configuring its source and destination addresses to be 13b and 13a respectively. Now both your XBee modules should communicate only to each other and not receive any data packets as interference from other XBee modules in the vicinity.