NATIONAL UNIVERSITY OF SINGAPORE
Department of Electrical and Computer Engineering

National University of Singapore

EE2024(E) – PROGRAMMING FOR COMPUTER INTERFACES

ASSIGNMENT 2
CARE

Semester 1, AY 2016/2017

SECTION 1: ASSIGNMENT DESCRIPTION

1.1 Objectives

After completing assignment 2, students will:

- be able to apply system design approaches, such as using flowcharts, to design embedded applications
- understand the interfaces between microcontrollers and peripherals
- have the ability to develop C embedded programming controller based applications

1.2 Overview

Taken for granted by many people, clean water is a valuable resource that can greatly enhance a country's prosperity. At the onset of the industrial age, and with a booming population growth throughout the world, clean water free from excessive amounts of pollutants became more scare. As a result, communities from all parts of the globe have been taking different approaches to safeguard this precious substance. Some have taken the approach of educating people since young ages, while others believe that people can treasure water more when they enjoy activities related to it, such as boating and fishing. For even more pristine water sources, law agencies, scientists and engineers have been working together to prevent the human civilisation from destroying the biodiversity of such water sources. Vast water sources can be quite difficult to secure, and monitoring them 24/7 used to be costly and unfeasible when they are located in remote areas.

With the recent advances in sensor devices, the monitoring of water resources has been made easier. Whether it is to monitor water quality for the strategic use of a country's defence, or to detect and prevent the distribution of polluted water in cases of accidents, or to prevent trespassers from exploiting certain water sources, electronic sensors have made them all possible. While advanced analysis of the water quality is still costly and require human interventions in certain cases, simpler analysis or monitoring of the water quality across vast areas of the water environment can be done throughout the day by using embedded systems. At the core, all embedded systems require the programming of computer interfaces to communicate with the multiple sensors and actuators.

For our EE2024(E) assignment, we will assume that a vast reservoir of clean and resource-rich water need to be monitored for pollutants, trespassers and overgrowth of algae, with minimal impact to the ecosystem. As engineers, we will be involved in the initiative meant to design a device to achieve the objective of safeguarding the water reservoir. The initiative has the code name **CARE**, short for **C**aring for **A**quatic **R**esources and **E**nvironments, while the device shall be called **CARES**, short for **CARE S**ystem.

In this assignment, it is assumed that the base board is a larger prototype version of **CARES**, with several output devices to help in the debugging during development. The XBee RF module is assumed to a be a low powered wireless communication device that sends collected data to a centralised water management organisation known as **SAFE**, which is the short name for **S**tate **A**gency for **F**reshwater **E**cosystems.

Students are required to interface with the various devices on the base board for data capture and data transmission. The reasons behind the use of the three main sensors are indicated in **Table 1**.

Sensor	Usage and Potential Implementations
Accelerometer	An accelerometer has an extremely varied range of applications. In a water environment, the accelerometer can be used to detect turbulence. Turbulence can be caused by natural causes, such as heavy rain or strong wind, or by artificial sources due to human activities. In **CARES**, the accelerometer will be used to detect illegal activities caused by humans, including and not limited to illegal dumping of wastes or prohibited activities like boating.
Light Sensor	The light sensor on **CARES** is used as a preliminary detector of potential non-chemical based pollution sources, before more advanced observations are made by other devices or human beings. Whether it is to indicate clear water, water filled with sediments, or solid wastes and dead fishes, the light sensor will provide initial clues.
Temperature Sensor	The temperature module on **CARES** allows for the water temperature to be detected. When the conditions are favourable, algae may grow rapidly and cause severe damage to the reservoir's ecosystem. Warm water, which is more common nowadays due to global warming, and sufficient sunlight, can cause an overgrowth of algae. Using the light sensor and temperature sensor on **CARES**, data can be collected over certain period of time to determine the possibility of algae overgrowth, and to plan ahead for the latter's removal.

Table 1: Usage and potential implementations for the three main sensors

CARES has two exclusive modes of operations: **PASSIVE** mode and **DATE** mode, and will be transmitting to **SAFE** if certain conditions are met. Additionally, other device interfacing is required for **CARES**, and which shall be described in the remaining sub-sections of section 1.

1.3 Detailed Description and Specifications

CARES must be on a horizontal surface when powered on for the first time. Upon powering on, **CARES** must have the following stable state behaviours:

- The SEGMENT_DISPLAY is off
- The GRAPHICS_DISPLAY is off
- The ENERGY_INDICATOR is off
- BLINK_RED is off
- BLINK_BLUE is off
- The TEMPERATURE_SENSOR, LIGHT_SENSOR and ACCELEROMETER are idle and not reading any data
- There are no transmissions to **SAFE**

If MODE_TOGGLE is pressed during the stable state, **CARES** goes into **PASSIVE** mode.

PASSIVE mode

PASSIVE mode for **CARES** represents the situation when the latter is being deployed in a real environment for passive monitoring of the quality of the water source. It is assumed that **CARES** consists of supercapacitors for energy storage instead of potentially harmful chemical battery sources, and enough solar panels to ensure energy self-sufficiency during both daytime and night time. In such situations, the amount of energy source is a limiting factor on how much sensor data can be obtained. Reducing the rate at which sensors are read help in reducing power consumption and processing workload, while frugally transmitting wireless data prevents energy from being used up too quickly. Sensors and transmission devices are placed in sleep mode or low-power mode when not in use but for our case, it is not required to put them in sleep mode or low-power mode when they are not being sampled or transmitting.

As soon as **CARES** enter **PASSIVE** mode, the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER are sampled. The following behaviour occurs in **PASSIVE** mode:

- The following message to **SAFE** is sent once each time **PASSIVE** mode is entered:

  Entering PASSIVE Mode.\r\n

- The GRAPHICS_DISPLAY must include the following word throughout **PASSIVE** mode:

  PASSIVE

- The SEGMENT_DISPLAY hexadecimal value increases by 1 for every second that passes by. After the SEGMENT_DISPLAY shows the last value, it restarts with the first value of the hexadecimal system. The sequence is as indicated below:

  0 1 2 3 4 5 6 7 8 9 A B C D E F

- The TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER are sampled and the values are updated on the GRAPHICS_DISPLAY when the SEGMENT_DISPLAY shows:

  S A F

- Transmission of the currently sampled sensor values from the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER, to **SAFE**, occurs once each time the SEGMENT_DISPLAY shows:

  F

  The format of the transmitted data should be as follows:

  NNN_-_T***_L*****_AX*****_AY*****_AZ******* *\r\n*

  where the temperature value, light value, and x-axis value, y-axis value, z-axis value of the accelerometer are respectively preceded by **T**, **L**, **AX**, **AY**, and **AZ**. * is an optional numerical value, a decimal point, or a minus sign. The special characters *\r\n* indicates that the next data transmission has a carriage return and is on a new line. **NNN** represents a 3-digits value that starts from 000 and increments by 001 each time such set of sensor data is transmitted to **SAFE** from **CARES**. **NNN** never resets itself to 000, unless **CARES** itself is powered on from a power off state. It is assumed that 999 will never be reached.

- Any time between two data transmissions to **SAFE**, if the scheduled sample value from LIGHT_SENSOR is between WARNING_LOWER and WARNING_UPPER, BLINK_BLUE should happen. If the scheduled sample value from LIGHT_SENSOR is below WARNING_LOWER, BLINK_RED should happen. BLINK_BLUE and BLINK_RED simulates the detection of algae and solid wastes respectively.

- BLINK_BLUE and BLINK_RED can happen at the same time. Both must be synchronised if they occur at the same time. BLINK_BLUE and BLINK_RED must not be turned off and unless **CARES** goes into **DATE** mode.

- If BLINK_BLUE is happening at the instant a scheduled transmission to **SAFE** occurs, the following message must also be sent before the usual sensor values from the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER:

  Algae was Detected.\r\n

- If BLINK_RED is happening at the instant a scheduled transmission to **SAFE** is happening, the following message must also be sent before the usual sensor values from the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER:

  Solid Wastes was Detected.\r\n

- Messages due to BLINK_BLUE occurs before messages due to BLINK_RED.

- If MODE_TOGGLE is pressed any time in **PASSIVE** mode, **CARES** will go to **DATE** mode after the SEGMENT_DISPLAY value reaches and shows the following for a minimum of 1 second:

  F

DATE mode

DATE mode simulates the situation where by human interventions to deal with abnormal situations have been completed, such as dealing with false alarms, or removal of wastes that triggered the warning messages. **CARES** will undergo a few evaluations before going back to **PASSIVE** mode. In **DATE** mode, **CARES** run at full performance, where the energy gets provided by a secondary supercapacitor, and the usage of the system becomes unrestricted for a short duration. The energy source is divided into 16 units, as indicated by ENERGY_INDICATOR. Each INDICATOR_TIME_UNIT, one unit of the energy source is depleted, regardless of the action taken. The characteristics of **DATE** mode are:

- The following message to **SAFE** is sent once each time **DATE** mode is entered:

  Leaving PASSIVE Mode. Entering DATE Mode.\r\n

- The GRAPHICS_DISPLAY must include the following word throughout **DATE** mode:

  DATE

- The energy source, as indicated by ENERGY_INDICATOR, is full each time **CARES** enter **DATE** mode

- The GRAPHICS_DISPLAY must not show the values obtained from the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER upon entering **DATE** mode. Instead, the values are replaced with the word:

  DATE MODE

- BLINK_BLUE and BLINK_RED do not occur in **DATE** mode.

- Data is not obtained from the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER, unless GET_INFORMATION is pressed for the active capture of sensor data.

Pressing GET_INFORMATION can occur any time and multiple times during **DATE** mode. Each time, the press results in the following at the *next earliest instance (*See notes at the bottom of this page)*:

- Read the TEMPERATURE_SENSOR, LIGHT_SENSOR, and ACCELEROMETER values.

- Update GRAPHICS_DISPLAY to indicate the latest (values obtained within the last 1 second) temperature value from the temperature sensor, sampled luminance value from the light sensor, and accelerometer values (5 values in all). These values are to remain unchanged on the GRAPHICS_DISPLAY, unless GET_INFORMATION is pressed again or **CARES** goes to **PASSIVE** mode

- The latest (values obtained within the last 1 second) temperature value from the temperature sensor, sampled luminance value from the light sensor, and accelerometer values (5 values in all) need to be sent to **SAFE**, in the same format as described in **PASSIVE** mode.

MODE_TOGGLE is disabled in **DATE** mode. When the 16 LEDs of the ENERGY_INDICATOR are all off, **CARES** automatically enters **PASSIVE** mode.

* Notes regarding "*next earliest instance":* Depending on the way you have written your program, certain tasks may not happen *immediately*. Furthermore, the processor is not natively parallel. "*Next earliest instance*" would mean that the system is very responsive to the commands, such that it appears instantaneous to a user (For example, within a few hundreds of milliseconds)

Specifications:

WARNING_LOWER:	50 Lux
WARNING_UPPER:	1000 Lux
INDICATOR_TIME_UNIT:	208 milliseconds

Devices Used:

ACCELEROMETER:	MMA7455L
LIGHT_SENSOR:	ISL29003 with LIGHT_RANGE_4000
TEMPERATURE_SENSOR:	MAX6576
SEGMENT_DISPLAY:	7-segment LED display
GRAPHICS_DISPLAY:	96x64 White OLED
BLINK_BLUE:	Blue Light for RGB LED, alternating between ON and OFF every 333 milliseconds
BLINK_RED:	Red Light for RGB LED, alternating between ON and OFF every 333 milliseconds
ENERGY_INDICATOR:	LED4 (Energy is low) to LED19 (Maximum Energy) of the PCA9532
MODE_TOGGLE:	SW4
GET_INFORMATION:	SW3
SAFE:	UART terminal program (Tera Term) on a personal computer

1.4 CARES Enhancements

After all the requirements set out in the earlier sub-sections have been met, you are encouraged to use additional peripherals or add features related to **CARES**, such as:

- SW2, SW5, etc.
- Other methods of interfacing such as Timer, ADC, etc.
- Interrupts for the different peripherals connected to the LPC1769
- More complex helper functions from the device libraries

With these additional peripherals, application logic enhancements can be implemented, including and not limited to what is to be done with the values from the different sensors. This is an independent and self-learning task, for which help will be limited in order to prevent such enhancements from becoming too common, and therefore worth less. The more complex and rarer the enhancements, the more impressive your **CARES** will be. Peripherals whose usage and codes have been discussed during the lab sessions will not be given extra credits.

Be aware that your application logic for **CARES** must be related to the given scenario, in order to score higher marks. Furthermore, the enhancements carry limited amount of marks as compared to the basic requirements of the assignment. In other words, a program with excellent enhancements, but poor completion of basic requirements, will not score well. **You are required to focus on one well-thought of application logic to showcase your enhancements, instead of several smaller application logics. Marks are only given for one application logic.**

During the assessment, you will be required to show all the tasks mentioned in sub-section 1.3 without your application logic enhancements. The latter should only be shown after the basic requirements have been demonstrated. You are not allowed to upload multiple programs to your LPC1769 to demonstrate your application logic enhancements. Only one program will be allowed for upload to the LPC1769.

SECTION 2: UART CONNECTION

2.1 Wired UART Communication

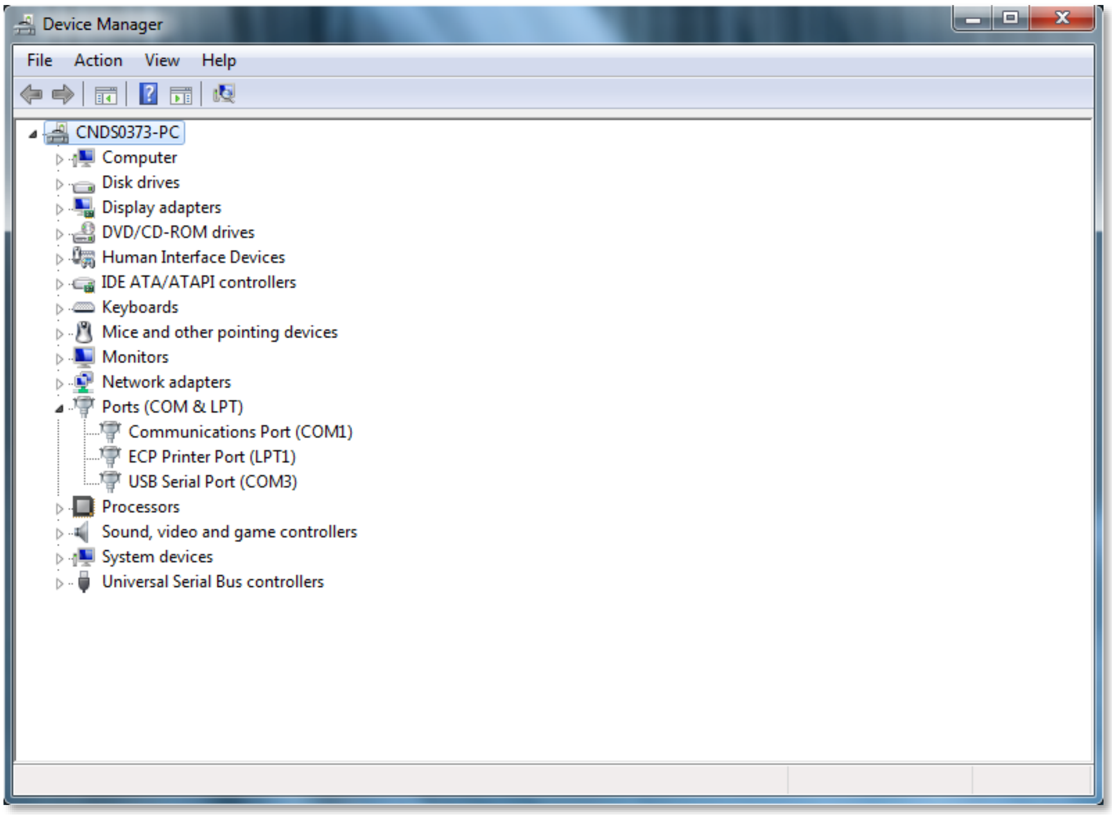
Students should establish a wired UART connection between the microcontroller and the PC first. Echo all introduced characters on the terminal to make sure the connection is functioning correctly. Follow the steps below for UART set up and programming:

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:

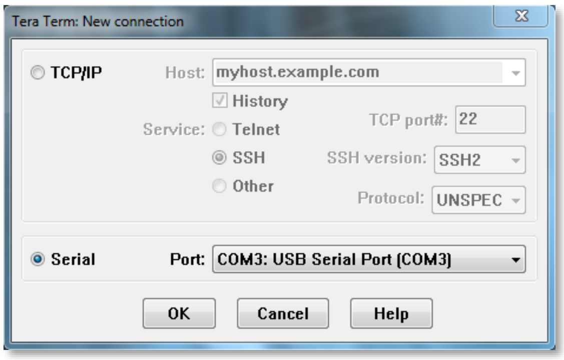
    - BAUD RATE: 115 200
    - DATA BITS: 8
    - PARITY: none
    - STOP BITS: 1
    - FLOW CONTROL: none

3. 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**. The settings for the Tera Term program are as depicted in **Figure 2** and **Figure 3**.



CNDS0373-PC
- Computer
- Disk drives
- Display adapters
- DVD/CD-ROM drives
- Human Interface Devices
- IDE ATA/ATAPI controllers
- Keyboards
- Mice and other pointing devices
- Monitors
- Network adapters
- Ports (COM & LPT)
    - Communications Port (COM1)
    - ECP Printer Port (LPT1)
    - USB Serial Port (COM3)
- Processors
- Sound, video and game controllers
- System devices
- Universal Serial Bus controllers

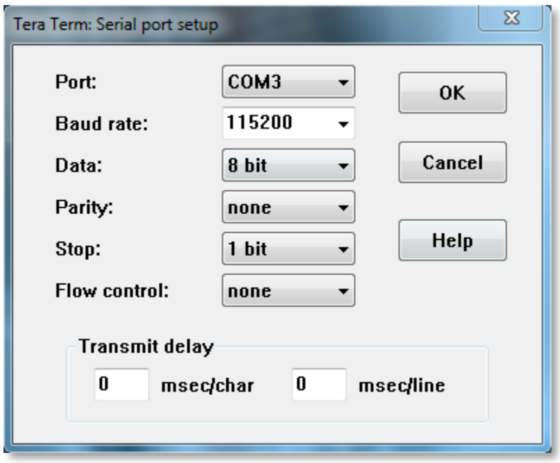
Figure 1: Verify UART (USB serial) port


Tera Term: New connection

( ) TCP/IP Host: myhost.example.com
[✓] History
Service: ( ) Telnet TCP port#: 22
(•) SSH SSH version: SSH2
( ) Other Protocol: UNSPEC

(•) Serial Port: COM3: USB Serial Port (COM3)

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

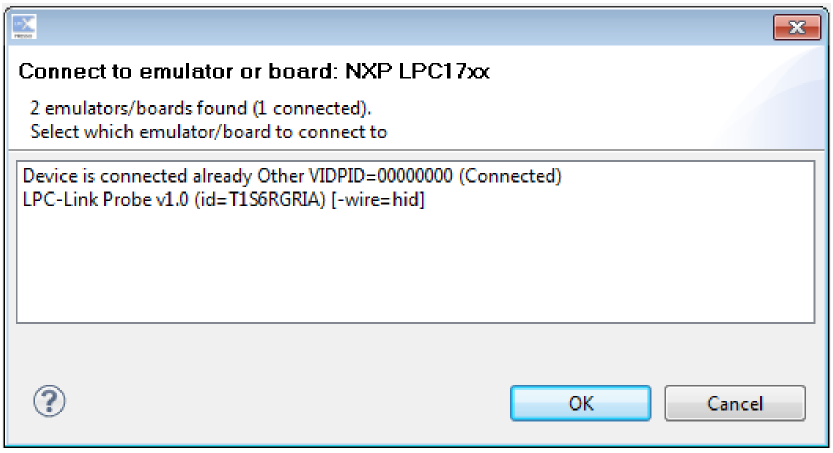

Tera Term: Serial port setup

Port:	COM3
Baud rate:	115200
Data:	8 bit
Parity:	none
Stop:	1 bit
Flow control:	none

Transmit delay
0 msec/char 0 msec/line

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 **LPC-Link Probe v1.0 (id=T!S6RGRIA) [-wire=hid**] and then press OK.


Connect to emulator or board: NXP LPC17xx

2 emulators/boards found (1 connected).
Select which emulator/board to connect to

Device is connected already Other VIDPID=00000000 (Connected)
LPC-Link Probe v1.0 (id=T1S6RGRIA) [-wire=hid]

Figure 4: LPCXpresso IDE pop-up windows when having connection with Tera Term

2.2 Wireless UART Communication

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

Students will be provided with two pieces of XBee RF modules. An XBee module is shown in **Figure 5**. XBee radios are products from Digi International[1] 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[2].

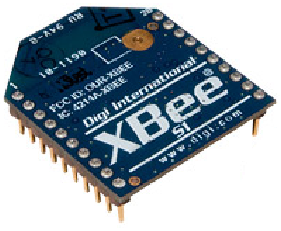


Figure 5: An XBee Series 1 RF Module

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[3], with examples shown in **Figure 6**. The dongle consists of the USB-UART adapter chip FT232R from FTDI International Ltd.[4], 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.

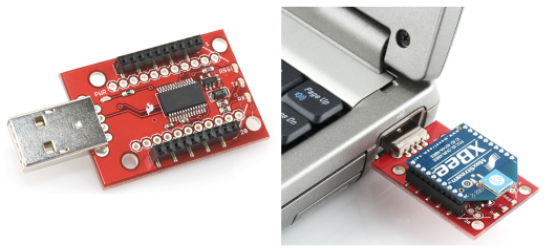


Figure 6: (Left Picture) A Sparkfun XBee Explorer Dongle
(Right Picture) An Xbee module mounted on the dongle and plugged into a host PC USB port

[1] http://www.digi.com/products/wireless-wired-embedded-solutions/zigbee-rf-modules/point-multipoint-rfmodules/xbee-series1-module
[2] http://www.sparkfun.com/datasheets/Wireless/Zigbee/XBee-Datasheet.pdf
[3] https://www.sparkfun.com/products/9819
[4] http://www.ftdichip.com/Products/ICs/FT232R.htm

2.3 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 LPC Xpresso 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[5].

Now mount the other XBee module on to your LPC Xpresso Baseboard into the socket reserved for U23[6]. Only one jumper needs to be modified: remove the jumper B on J7 as shown in **Figure 7**[7]. 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 (250kbps), one needs not implement flow control and leave J59 in the default state.

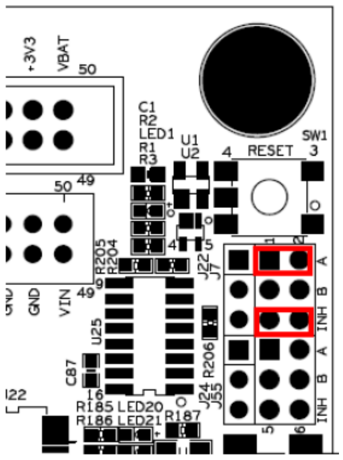


Figure 7: Jumper configuration for XBee module mounted on the LPC Xpresso Baseboard

Configuring Tera Term on your PC and the LPC1769 UART to 9600bps 8N1 should allow them to communicate with each other. Sub-section 5.5 describes how to configure XBee addresses to avoid interference with other XBees in the lab during RF communication

[5] http://www.ftdichip.com/Drivers/VCP.htm
[6] http://www.ftdichip.LPC Xpresso Baseboard Schematics (LPCXpresso_Base_Board_revB.pdf), page 11./Drivers/VCP.htm
[7] LPC Xpresso Baseboard User's Guide (LPCXpresso_BaseBoard_rev_B_Users_Guide_Rev_PA18.pdf), page 31.

2.4 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 115.2kbps. We shall mount each XBee module one by one on to the USB dongle, plug it into the PC and configure their baud 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 **Table 2**:

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-volatile memory
ATCN <Enter>	OK <CR>	Exit AT Command Mode

Table 2: Configuring an XBee module to a UART baud rate of 115200bps

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 soon as the XBee exits the command mode, whether due to the 10s timeout, or by a response to "ATCN\r". Changes not committed to non-volatile memory will only take affect for current session and be lost once the power to the XBee is turned off.

Upon successful completion of the command sequence in **Table 2**, you should configure Tera Term to 115200 bps to issue any further commands to this XBee module. Repeat the process with your other module.

2.5 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. **Table 3** 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 sub-section 5.4, 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 <Enter>	{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

Table 3: Configuring an XBee module’s source and destination addresses

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.

SECTION 3: ASSESSMENT

3.1 Report

Each group is required to submit one report (at least 8 pages, including about 3 to 4 pages reserved for flowcharts). The report should include at minimum the following information:

1. Names and matriculation numbers, Lab day on the first page. G.A. names are not needed.
2. Table of contents
3. Introduction and objectives
4. Flowcharts describing the system design and processes
5. Detailed implementation: Describe the detailed implementation steps, especially indicate and explain your essential steps
6. Application logic enhancements: If you have application logic enhancements for **CARES,** carefully describe the application logic and the enhancements with significant amounts of detail, especially technical details. You might consider including several photos of your working board at some special steps. This will help to distinguish your system and report from others
7. Significant problems encountered and solutions proposed: What did you learn? What are the significant problems you encountered and how did you solve them in this assignment? If your code did not work in the lab, explain why
8. Issues or suggestions: These feedbacks, whether positive or negative, will not affect your marks in any circumstances, but will make the report more complete.
9. Conclusion

3.2 Assignment Demonstration and Submission

In the assessment week (Week 13), you need to present and demonstrate your designed system to an assessing G.A. You are required to have a draft of your report (not the final one), and several basic flowcharts ready, in order to explain your design. You can present to your G.A. through softcopies. **Hardcopies of the report are not encouraged.**

Students will be assessed as a group, but individual questions by the assessing G.A. will determine the marks to assign to each student within the group. Both students need to be familiar with all aspects of the assignment, as the G.A. can choose any one of you to explain any part of the assignment. The G.A. will also ask you additional questions to test your understanding.

The workspace archive should be submitted during the assessment. Please do the following before going for the assessment:

1. Finalise your program before the assessment day
2. In the LPCXpresso software, select File -> Export -> General -> Archive File. Click Next
3. Click on "Select All". For options: Save in zip format, Create directory structure for files.
4. Save the archive file to your personal flash drive and bring it with you for the assessment
5. The archive file must follow this naming template:
   Assignment2_Name of any **one** team member **as indicated on the Matriculation Card**_Matric Number of **all** team members separated by an underscore_Workspace
      Example:
      Assignment2_Parker Gentry_A0131086Y_A0101010X_Workspace.zip
   Marks will be lost if the workspace archive does not reasonably follow the above naming scheme
6. You will not be allowed to use your own notebook to upload your program to the LPC1769, nor allowed to use Tera Term on your notebook. All these must be done using the desktop computer provided in the lab. You are however allowed to use your notebook for presentation purposes (powerpoints, or to show your draft report)

The softcopy of the final report should be uploaded to IVLE, as indicated in the instructions below:

1. Please upload to your assessing G.A. submission folder under "Assignment 2 Submission" within the stipulated deadline in point number 4. Failure to do so will result in no marks being awarded for the report component, forfeiting of the 10 marks for flowchart and the 10 marks reserved for the application logic enhancements
2. Only **one uploaded report** per team in common format (.pdf (preferred), .doc, .docx)
3. Naming of the report to follow this template:
   Assignment2_Name of any **one** team member **as indicated on the Matriculation Card**_Matric Number of **all** team members separated by an underscore_Report
   Example:
   Assignment2_Parker Gentry_A0131086Y_A0101010X_Report.pdf
   Marks will be lost if the report does not reasonably follow the above naming scheme
4. **The IVLE report upload must be completed by Saturday 12th November 2016**

Reminder from the NUS Code of Student Conduct: http://www.nus.edu.sg/registrar/adminpolicy/acceptance.html

"Any student found to have **committed** or **aided and abetted** the offence of plagiarism may be subject to disciplinary action."

Both the **source** and **recipient** are equally responsible in cases of academic dishonesty.

3.3 Grading

Assignment 2 carries a maximum of 60 marks. It is equivalent to 30% of the marks for the EE2024(E) module. Students will be marked based on a set of criteria that includes:

- Explanation, understanding and illustration (in the report) of basic flowcharts for the system design (Worth 10 out of the 60 marks)
- Understanding of the devices that have been used for the assignment
- Ability to use device interrupts and their understanding
- Extent of UART implementation, such as whether wireless UART has been implemented
- Meeting the requirements of each mode: **PASSIVE**, **DATE**
- Responsiveness, performance and robustness of the system
  (Focus and improve on these before working on the application logic enhancements)
- Meeting report and IVLE upload requirement. Marks are awarded for reports that are more complete
- Extent of the application logic enhancements as described in **section 1.4**, and several other factors that demonstrate the ability to learn independently and program for computer interfaces (Worth 10 out of the 60 marks)

Overall, a good design with a full implementation of assignment 2, and a good understanding of the code will give you a good mark. Poor design, lack of functionality, or poor understanding of the code during the assessment will lead to deduction of marks. Failure to be present for the assessment without valid and genuine reasons will lead to zero marks being awarded for assignment 2. There will not be make-up sessions after week 13.

3.4 Statement of Contribution

An online survey where you will need to indicate your contributions to assignment 2 will be made available on IVLE before the assessment week. **It is compulsory to fill in the online survey on time, as it considerably affects your final assignment 2 marks**. **The IVLE survey must be completed by Sunday 13th November 2016.** If any member of the team does not fill in the online survey, the latter will be assumed to have made minimal contribution to assignment 2. If no one from the team (applicable for individual member teams also) fill in the online survey, the assignment 2 marks will be negatively affected.

Further details regarding the assessment and statement of contribution will be communicated closer to the assessment week.

Caring for your learning experience through Assignment 2 😊