

# Lab 8: Bluetooth Projects

COEN-4720 Embedded Systems

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## 1. Objective

The objective of this lab is to use an HC-06 Bluetooth module connected to the Nucleo board and to create several projects including: sending temperature data to a smartphone and controlling the board's LED wirelessly from a smartphone. **This is a more challenging lab, so please allocate plenty of time and plan ahead!**

## 2. Background on Bluetooth Wireless Technology

Bluetooth is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Invented by telecom vendor Ericsson in 1994, it was originally conceived as a wireless alternative to RS-232 data cables. It can connect several devices, overcoming problems of synchronization [1]. In short, Bluetooth is a standard for the short-range wireless interconnection of cellular phones, computers, and other electronic devices.

Please take some time and read through the pointers included in reference [1] to read more about Bluetooth. It is outside the scope of this lab to teach details about it. However, you are encouraged to look into it more on your own.

## 3. HC-06 Bluetooth Module

In this lab, we will use the JY-MCU BT\_BOARD V1.07 (also referred to as HC-06): Wireless Bluetooth Transceiver Module [2,3], which is shown in Fig.1.

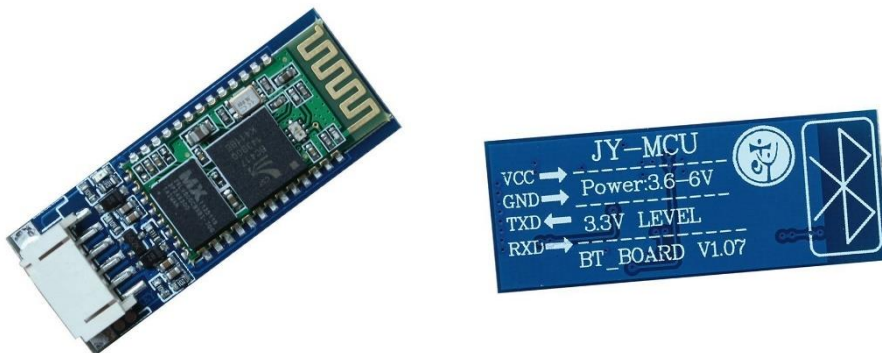


Figure 1: Photographs of the "JY-MCU BT\_BOARD V1.07" Bluetooth module.

This is a popular serial Bluetooth module, which uses the Bluetooth Specification v2.0. It can work either as a master or a slave. It is built around the **BC417 Bluetooth to Serial chip**, which is a single chip radio and baseband IC for Bluetooth 2.4 GHz systems including enhanced data rates (EDR) to 3Mbps [4]. This chip is loaded with features, including **UART interface** with

programmable baud rate up to 3Mbaud with an optional bypass mode. By default, it works as a Slave, 9600 baudrate, N, 8, 1, and Pincode 1234.

While very popular (there are several other versions, such as HC-03, HC-04, and HC-05 among others) and easy to use, it somewhat lacks in up-to-date documentation. Nevertheless, the manual of version 1.05 is a good starting point to read and find out more about this module. Please take some time to briefly read the manual available for download at [3].

Some of the features of the HC-06 Bluetooth module include [3]:

- Serial port operation voltage 3.3V
- Baudrate set at 9600, but you can change it using AT commands
- Operation current, pairing at 30mA, after pairing 8mA during communication
- Can pair and communicate with laptops, laptop Bluetooth adapters, Bluetooth Shields on Arduino, smart phones such as Android, etc.

The module has six pins:

- **VCC**: supply voltage with range 3.6 V to 6 V (BC417 chip needs 3.3V generated with the help of a voltage regulator on the same PCB).
- **GND**: ground.
- **RXD**: Serial RX. Note, this would be connected to the TX pin of the Arduino board.
- **TXD**: Serial TX. As you would expect, this this would be connected to the RX pin of the Arduino board.
- **KEY**: Not used.
- **STATE**: Not used.

#### 4. Example #1: Sending text message from MCU board to smartphone via BlueTooth

This is a simple project which basically uses the Bluetooth module connected to the Nucleo board to broadcast a message, "Cris says hi! periodically. The message is received on smartphone and displayed using a "Bluetooth to serial" app installed on the smartphone. You can search on google play for example for "serial bluetooth terminal" and download and install any free such app on your smartphone.

Note: The initial version of this project was for Arduino and described is the "Experiment 1" of the following lab: [http://dejazz.com/geen1200/resources/G1200\\_EECE\\_Lab3.pdf](http://dejazz.com/geen1200/resources/G1200_EECE_Lab3.pdf) The Arduino source code is included as "**bluetooth\_ex1**/" in the archive for this lab, but, you will not need it for this example.

To do this example, create a new project in STM32CubeIDE. Let's say we'll use also the LCD display to print messages; so, inside STM32CubeMX Tool, right after you created the new project, select to use the **SPI1** peripheral and configure it the same way we did it the first time we used the LCD display.

Then, enable also the **USART1** peripheral, which we will use to connect to the BlueTooth module. A snapshot of this peripheral configuration is shown in Figure 2 below.

Finally, you should configure the **GPIOs** used for connecting to the LCD display pins D/C, CS, and RST as shown in Figure 3 below (alternatively the same result is achieved by editing directly later inside main.c and configuring these GPIOs accordingly; see example from Cris.).

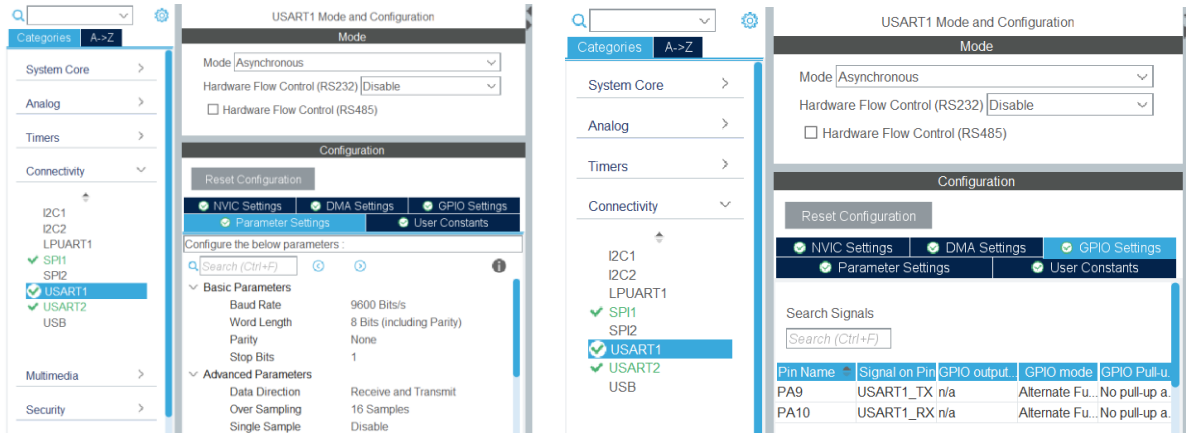


Figure 2: Configuration of UART1 peripheral.

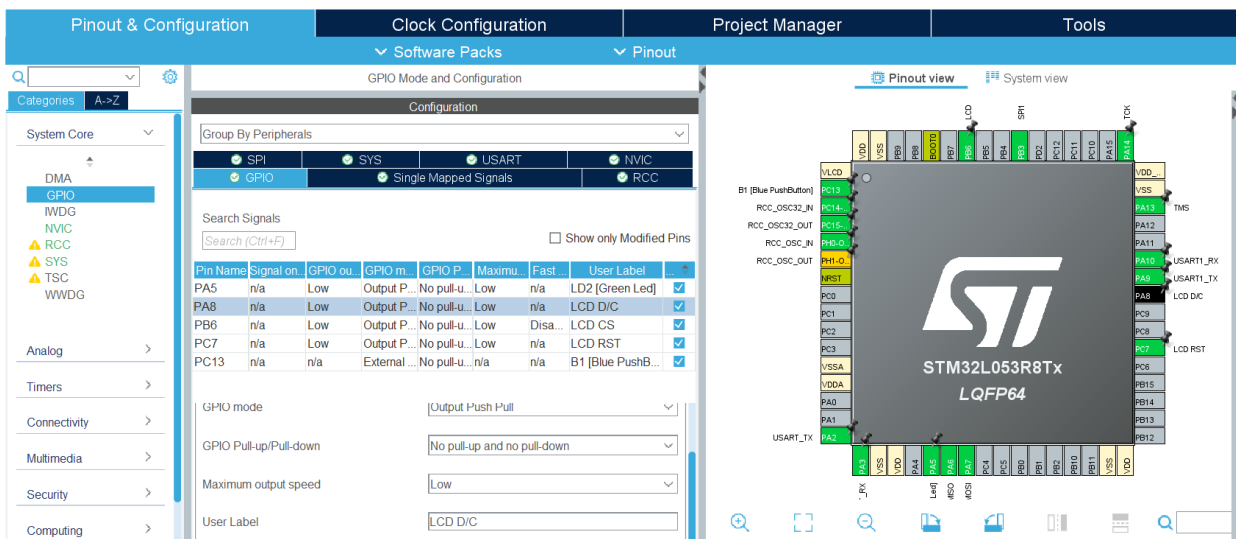


Figure 3: GPIO configuration and user labels.

Note that the TX and RX of UART1 are connected inside the MCU to pins PA9 and PA10. Hence, you will make these connections:

**Nucleo Board -> HC-06 BT Module**

- PA9 (TX of UART1) -> RX of HC-06 module
- PA10 (RX of UART1) -> TX of HC-06 module
- GND from Nucleo -> GND of HC-06 module
- 3.3V or 5V from Nucleo -> VCC of HC-06 module

And, again, the connections to the LCD display:

### **Display -> Nucleo Board**

GND -> GND

VCC -> 5V or 3.3V

SCK -> PB3 (SCK of SPI1 peripheral of MCU)

MISO -> PA6 (MISO of SPI1 peripheral of MCU)

MOSI -> PA7 (MOSI of SPI1 peripheral of MCU)

CS -> PB6

RST -> PC7

Data or Command (D/C) -> **PA8**

SDSC -> *left disconnected*

BL -> *left disconnected*

***IMPORTANT NOTE: PA9 is in this lab used as (TX of UART1). However, we had it used also for connecting to D/C of the LCD display. Therefore, in this lab we select another pin, specifically PA8 to use to connect to D/C of LCD display. This requires the appropriate change to be made inside lcd.h!***

Copy the implementation of this example from the main.c of lab8\_ex1/ provided for this lab. Use jumper wires to create all connections between Nucleo board and the LCD display and the BT module.

Compile the project, program the MCU, and observe operation as demonstrated by Cris in class.

## **5. Assignment #1: Wireless control of LED on Nucleo board**

This is a project where you use a smartphone to send via BlueTooth commands to the Nucleo board, which has attached to it the HC-06 BT module.

You must use a smartphone (or your laptop) to send control commands via Bluetooth to the HC-06 module connected to the Nucleo board. The commands that can be sent are "1" or "2". When you send a "1" command, the Nucleo board should turn ON the LED. When you send a "2" command the LED should be turned OFF by the Nucleo board.

You should start from the given example #1 discussed earlier and modify to implement the functionality of this example. On the smartphone you can use the same app as in example #1 (Cris will demo an example of such an app in class). You can also use your laptop and not a smartphone as discussed and demoed in class. If you however, would like to get into Android app development, then, the following two resources should be helpful:

- Arduino source code of a very similar project - should be helpful in doing this assignment - is included as "**arduino\_hc06/**" in the archive for this lab. Cris will also demo this in class as well.
- Complete Android App that Cris' demo-ed in class, find it here (at the bottom of the page): <http://www.dejazzer.com/eece4920/index.html>

## 6. Assignment #2: Wireless temperature data acquisition system

You must replicate the functionality of a project provided but implemented for Arduino. This Arduino project uses the Bluetooth module connected to the Arduino board to send temperature data to the smartphone. This is essentially a simple data acquisition (DAQ) system. Its block diagram and brief description are presented as “Experiment 2” in the same lab:

[http://dejazz.com/geen1200/resources/G1200\\_EECE\\_Lab3.pdf](http://dejazz.com/geen1200/resources/G1200_EECE_Lab3.pdf)

The Arduino source code is publicly available at the above link and included as “**bluetooth\_ex2/**” in the archive for this lab. Please take time to investigate it Now.

So, in this assignment, you must create a similar project for the Nucleo board. Again, you can work on this by starting from the given example #1 of this lab. You need to attach the HC-06 module to the Nucleo board, which must be programmed to pass the temperature data to the bluetooth module, which in turn sends that to the smartphone, where they are printed in the serial terminal. If you do not have your own DHT22 temperature sensor, please use a transistor-based temperature-sensor; you should be able to find transistors and other necessary electronic components in the DLL lab. Read the following resources for how to do that and/or search more on your own [5].b. In that case, you will also need to read and learn from the Textbook how to use the ADC – see chapter 12 from Textbook for examples.

**Please allocate plenty of time for this assignment. It may be more challenging than any before.**

## References

- [1] Bluetooth information;  
<https://en.wikipedia.org/wiki/Bluetooth>  
<https://www.bluetooth.com/learn-about-bluetooth/tech-overview/>  
<http://www.wirelessdevnet.com/channels/bluetooth/features/bluetooth.html>  
[http://www.radio-electronics.com/info/wireless/bluetooth/bluetooth\\_overview.php](http://www.radio-electronics.com/info/wireless/bluetooth/bluetooth_overview.php)
- [2] JY-MCU BT\_BOARD V1.07: Arduino Wireless Bluetooth Transceiver Module Slave 4 Pin Serial + DuPont Cable; [https://www.amazon.com/Solu-Bluetooth-Transceiver-Baseboard-Transceiver/dp/B00XDNBV8Q/ref=sr\\_1\\_1?crid=26ASAIX0JQP4T&keywords=JY-MCU+HC-06&qid=1697847983&prefix=jy-mcu+hc-06%2Caps%2C136&sr=8-1](https://www.amazon.com/Solu-Bluetooth-Transceiver-Baseboard-Transceiver/dp/B00XDNBV8Q/ref=sr_1_1?crid=26ASAIX0JQP4T&keywords=JY-MCU+HC-06&qid=1697847983&prefix=jy-mcu+hc-06%2Caps%2C136&sr=8-1)
- [3] Bluetooth Transceiver RF Module Wireless Serial TTL V1.05 Manual; [http://www.ram-e-shop.com/ds/general/Bluetooth\\_TRx\\_Module\\_New.pdf](http://www.ram-e-shop.com/ds/general/Bluetooth_TRx_Module_New.pdf)
- [4] BC417 Bluetooth to Serial chip Datasheet by CSR; <https://cdn.sparkfun.com/datasheets/Wireless/Bluetooth/CSR-BC417-datasheet.pdf>
- [5] Temperature measurement using diodes/transistors  
a--<http://www.cypress.com/file/128126/download>  
b--<http://cds.linear.com/docs/en/application-note/an137f.pdf>