EE107 Project 4 – BLE proximity detection and communication

Due Friday May 17th, 10:00pm. Please submit using Piazza.

Overview

In the last project you'll be familiar with two important Bluetooth Low Energy applications: proximity detection (which can be used to determine location in indoor setting) and communication (via Bluetooth Serial Port Profile). The project includes two steps:

1. **Measure the accuracy of proximity detection –** Set BLE module in iBeacon mode and measure the distance using Cellphone Apps. Compare measurement with ground truth.
2. **Implemented Bluetooth remote control light –** Set BLE module in serial port mode and write Arduino code to control LED lights according to command sent from cellphone.

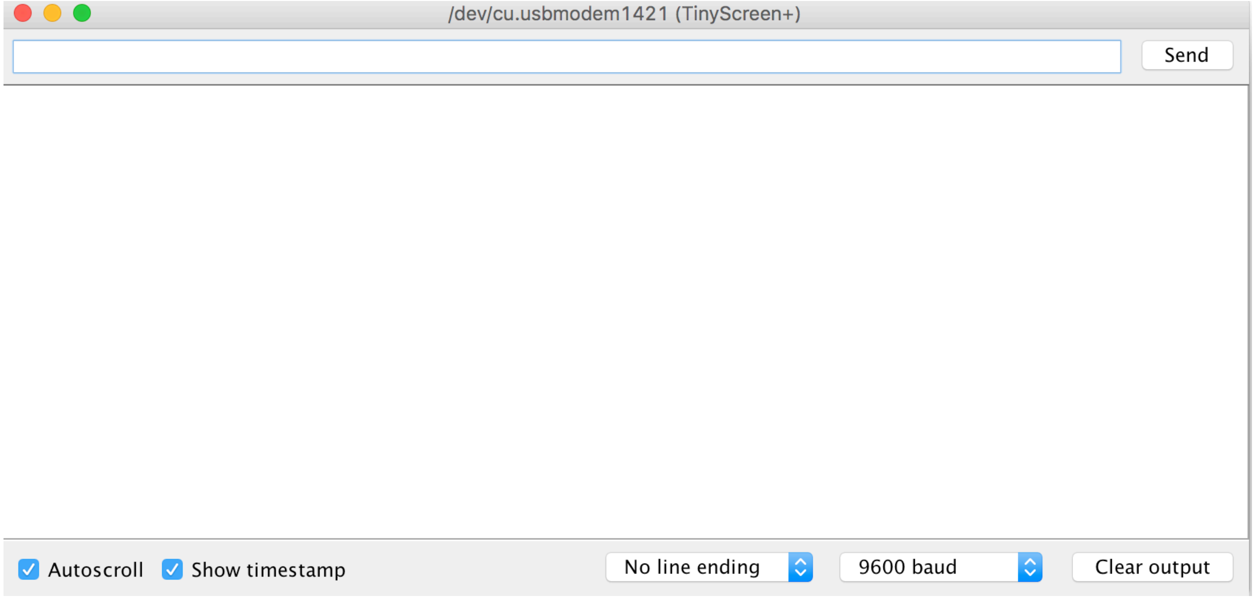
Resources

For this project the most important document is:

- HM-10 Datasheet (especially AT command set from page 20)

Step 0: Get hands on experience with BLE module

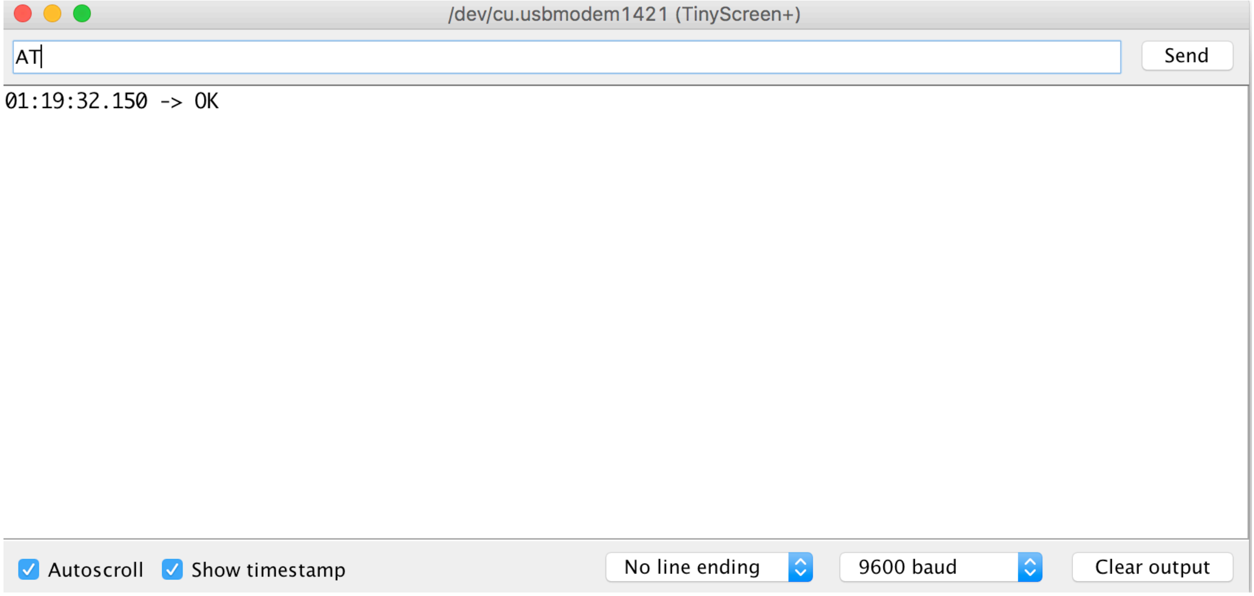
Download UART.ino to TinyZero board. Open Serial monitor:



☑ Autoscroll ☑ Show timestamp No line ending 9600 baud

Make sure "No line ending" is selected.

Send "AT" to the BLE module, you should see a reply says "OK".



/dev/cu.usbmodem1421 (TinyScreen+)

```
AT
```

```
01:19:32.150 -> OK
```

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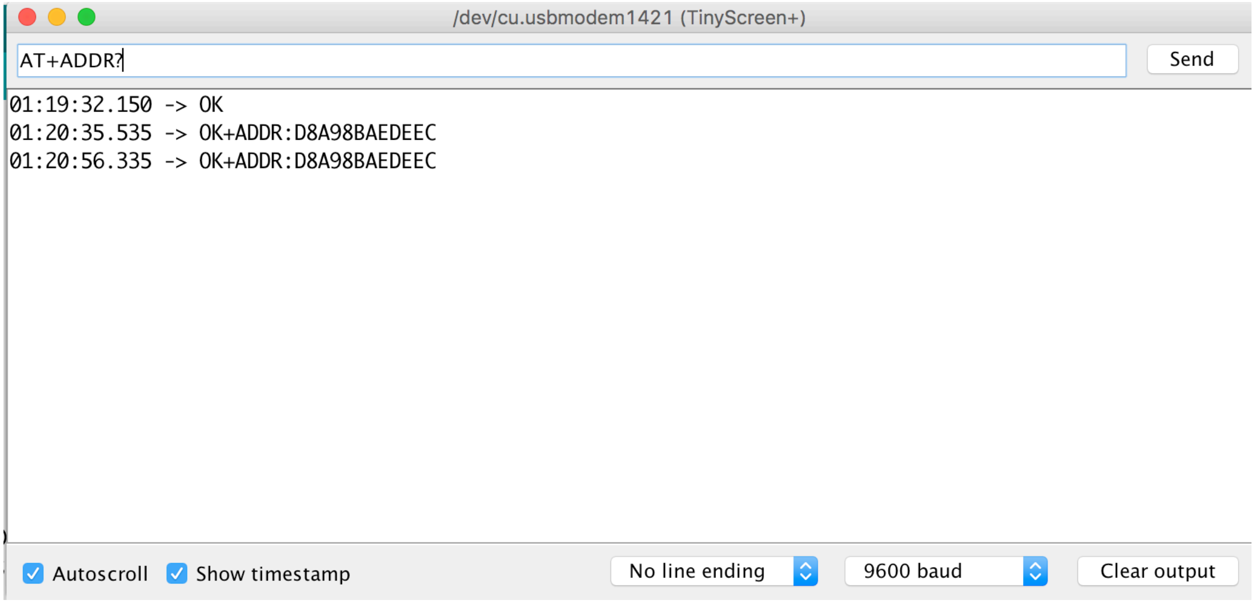
No line ending

9600 baud

Similarly, send “AT+ADDR?” to get the MAC address of BLE module.



/dev/cu.usbmodem1421 (TinyScreen+)

```
AT+ADDR?
```

```
01:19:32.150 -> OK
01:20:35.535 -> OK+ADDR:D8A98BAEDEEC
01:20:56.335 -> OK+ADDR:D8A98BAEDEEC
```

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No line ending

9600 baud

You can also use “AT+RENEW” to restore all settings to factory default and “AT+RESET” to reset the BLE module.

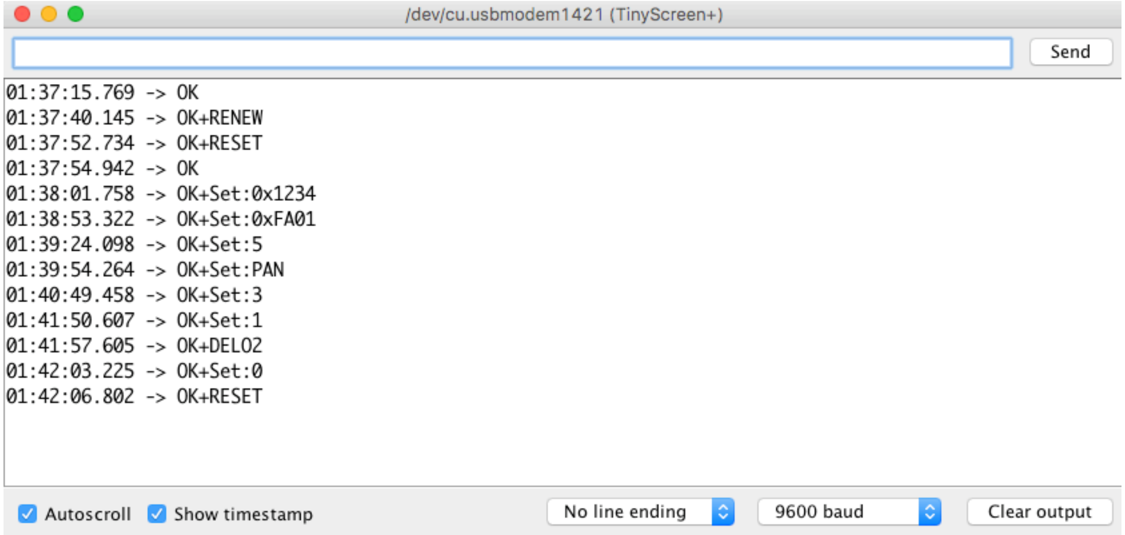
Step 1: Measure the accuracy of proximity detection

Follow the following steps to configure the BLE module in iBeacon mode:

1. AT+RENEW Restore factory defaults, expected reply “OK+RENEW”
2. AT+RESET Rebook BLE module, expected reply “OK+RESET”
3. AT Probe whether finished reboot or not, expected reply “OK”. If no reply, send AT again.
4. AT+MARJ0x1234 Set iBeacon Major number to 0x1234 (hexadecimal). Expected reply: “OK+Set:0x1234”

5. AT+MINO0xFA01   Set iBeacon Minor number to 0xFA01 (hexadecimal). Expected reply: “OK+Set:0xFA01”
6. AT+ADVI5   Set advertising interval to 5 (546.25 milliseconds). Expected reply: “OK+Set:5”
7. AT+NAMEPAN   Set BLE module name to PAN. Try with your name. Expected “Ok+Set:PAN”
8. AT+ADTY3 Make non-connectable (save power). Expected reply “OK+Set:3”.
9. AT+IBEA1 Enable iBeacon mode. Expected reply “OK+Set:1”.
10. AT+DELO2 iBeacon broadcast-only (save power). Expected reply “OK+DELO2”.
11. AT+PWRM0 Enable auto-sleep. Expected reply “OK+Set:0”.
12. AT+RESET   Reboot to apply some settings. Expected reply “OK+RESET”.

Here is sample output:



```
01:37:15.769 -> OK
01:37:40.145 -> OK+RENEW
01:37:52.734 -> OK+RESET
01:37:54.942 -> OK
01:38:01.758 -> OK+Set:0x1234
01:38:53.322 -> OK+Set:0xFA01
01:39:24.098 -> OK+Set:5
01:39:54.264 -> OK+Set:PAN
01:40:49.458 -> OK+Set:3
01:41:50.607 -> OK+Set:1
01:41:57.605 -> OK+DELO2
01:42:03.225 -> OK+Set:0
01:42:06.802 -> OK+RESET
```

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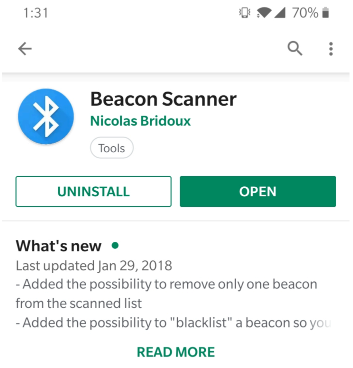
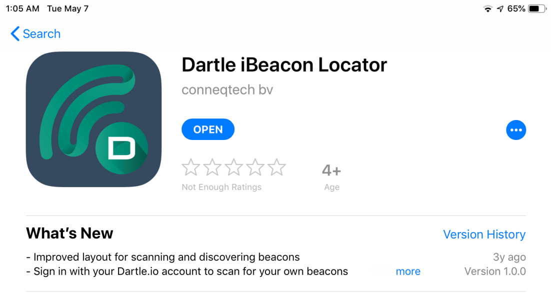
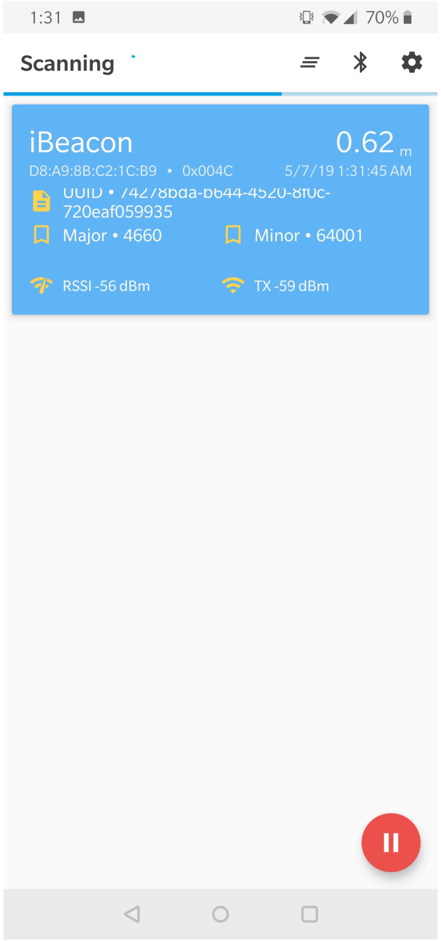
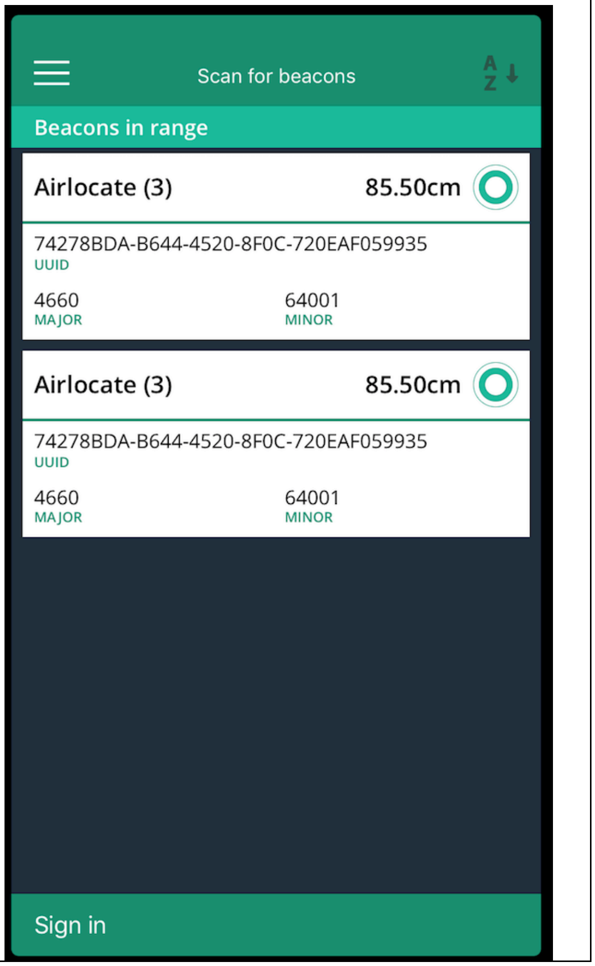
Now you’ve put the module in sleep mode. It may not respond to AT commands after that. To wake it up, reload the Arduino program. The following code in the void setup() function can wake up the BLE module (why?)

```
// magic code to save HM-10 from sleep mode
  for(int i=0;i<100;i++){
    Serial.write(0xff);
  }
```

To exit sleep mode, simply send “AT+RENEW” and “AT+RESET”.

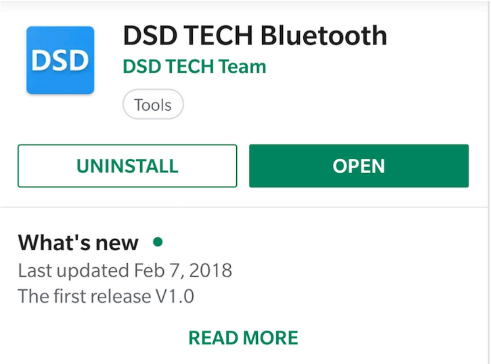
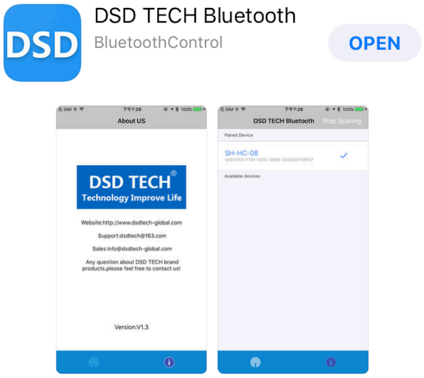
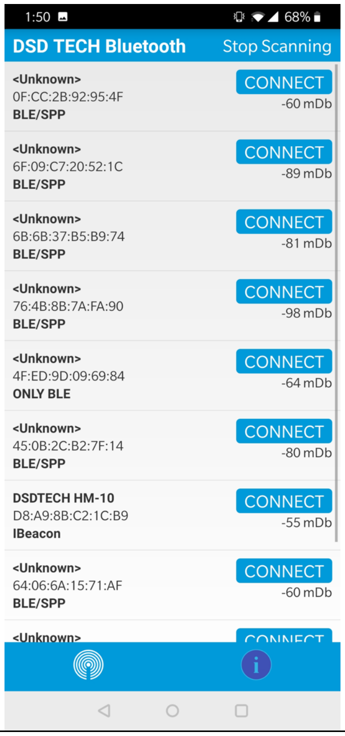
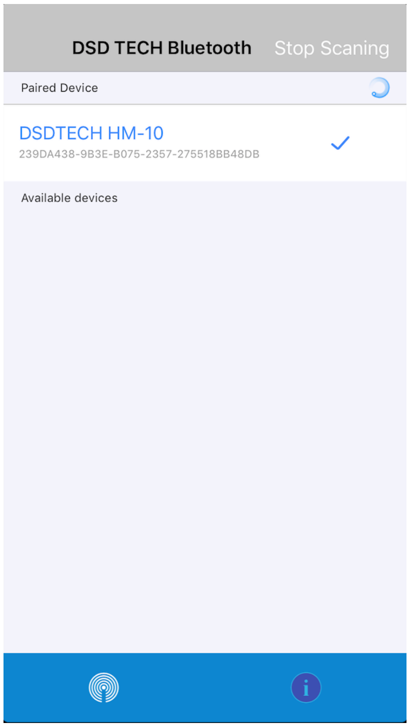
Install the following app on your device to get distance readings based on signal strength of BLE module:

Android	iPhone/iPad
Install the following app  1:31 70% Beacon Scanner Nicolas Bridoux Tools UNINSTALL OPEN What's new Last updated Jan 29, 2018 - Added the possibility to remove only one beacon from the scanned list - Added the possibility to "blacklist" a beacon so you READ MORE	Install the following app  1:05 AM Tue May 7 65% Search Dartle iBeacon Locator conneqtech bv OPEN Not Enough Ratings 4+ Age What's New Version History - Improved layout for scanning and discovering beacons - Sign in with your Dartle.io account to scan for your own beacons more 3y ago Version 1.0.0
Check distance measurement. If there are multiple devices, select the one with correct MAC address obtained from Step 0  1:31 70% Scanning iBeacon 0.62 m D8:A9:8B:C2:1C:B9 • 0x004C 5/7/19 1:31:45 AM UUID • 74278bda-b644-4520-8f0c-720eaf059935 Major • 4660 Minor • 64001 RSSI -56 dBm TX -59 dBm	Check distance measurement. If there are multiple devices, select the one with correct MAC address obtained from Step 0  Scan for beacons Beacons in range Airlocate (3) 85.50cm 74278BDA-B644-4520-8F0C-720EAF059935 UUID 4660 MAJOR 64001 MINOR Airlocate (3) 85.50cm 74278BDA-B644-4520-8F0C-720EAF059935 UUID 4660 MAJOR 64001 MINOR Sign in

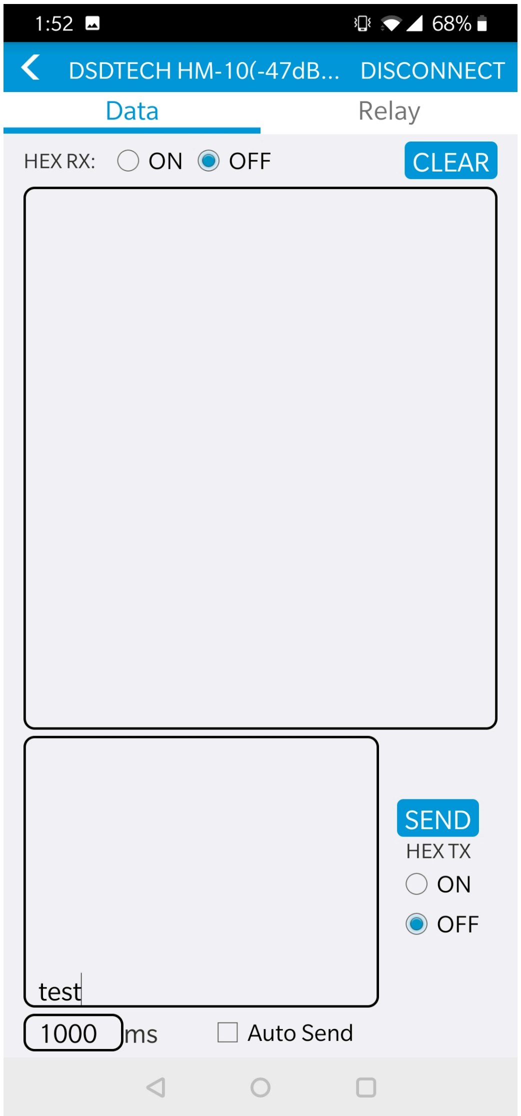
Place the cellphone 10cm, 50cm, 1m, 3m away from the BLE module. Put the cellphone on a flat surface away from the floor rather than hand-held it. Also, don’t block the path between cellphone and BLE module. At each location, wait 20 seconds for the readings to stabilize and take down the readings.

Step 2: Implemented Bluetooth remote control light

Revoke the BLE module from sleep mode according to the red text in the previous section. Now install another app:

Android	iPhone/iPad
Install the following app:  DSD TECH Bluetooth DSD TECH Team Tools UNINSTALL OPEN What's new Last updated Feb 7, 2018 The first release V1.0 READ MORE	Install the following app:  DSD TECH Bluetooth BluetoothControl OPEN About US DSD TECH® Technology Improve Life Website:http://www.dsdtech-global.com Support:dsdtech@163.com Sales:info@dsdtech-global.com Any question about DSD TECH brand products,please feel free to contact us! Version:V1.3 DSD TECH Bluetooth Stop Scaning Paired Device SH-HC-08 Available devices
Click on “Scan” and select “DSDTECH HM-10”  1:50 68% DSD TECH Bluetooth Stop Scanning <Unknown> 0F:CC:2B:92:95:4F BLE/SPP CONNECT -60 mDb <Unknown> 6F:09:C7:20:52:1C BLE/SPP CONNECT -89 mDb <Unknown> 6B:6B:37:B5:B9:74 BLE/SPP CONNECT -81 mDb <Unknown> 76:4B:8B:7A:FA:90 BLE/SPP CONNECT -98 mDb <Unknown> 4F:ED:9D:09:69:84 ONLY BLE CONNECT -64 mDb <Unknown> 45:0B:2C:B2:7F:14 BLE/SPP CONNECT -80 mDb DSDTECH HM-10 D8:A9:8B:C2:1C:B9 IBeacon CONNECT -55 mDb <Unknown> 64:06:6A:15:71:AF BLE/SPP CONNECT -60 mDb <Unknown> CONNECT	Click on “Scan” and select “DSDTECH HM-10”  DSD TECH Bluetooth Stop Scaning Paired Device DSDTECH HM-10 ✓ 239DA438-9B3E-B075-2357-275518BB48DB Available devices

Wait for the connection to be established. After that, try to send a test message to the BLE module. Your message should appear on Arduino serial monitor.



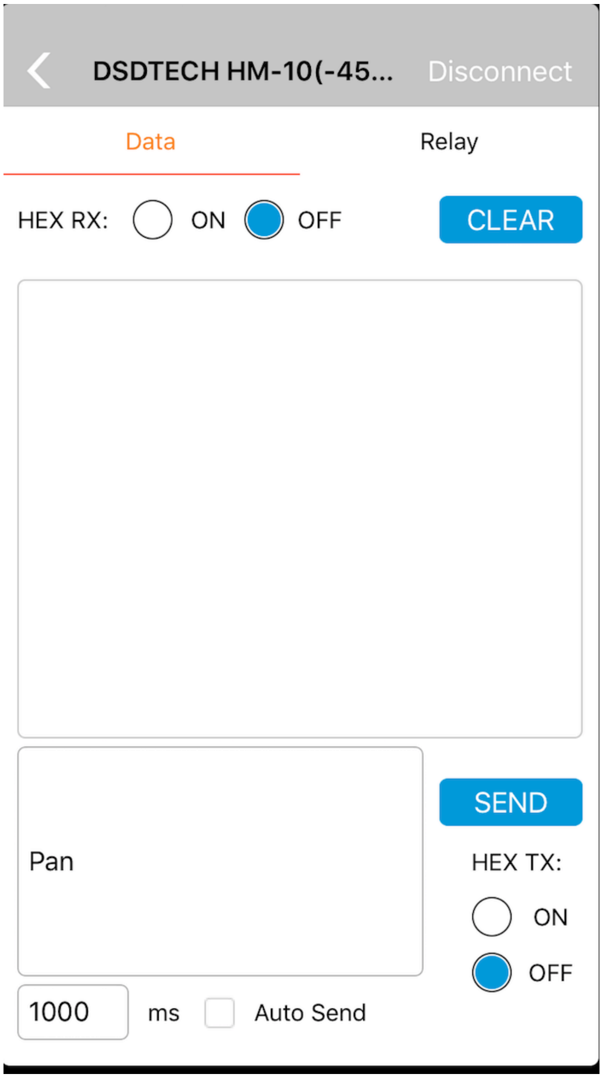
HEX RX: ○ ON ● OFF

test

HEX TX ○ ON ● OFF

1000 ms □ Auto Send

Wait for the connection to be established. After that, try to send a test message to the BLE module. Your message should appear on Arduino serial monitor.



HEX RX: ○ ON ● OFF

Pan

HEX TX: ○ ON ● OFF

1000 ms □ Auto Send

Write an Arduino program that turns all 16 LED on when received “on” from cellphone and turns off when received “off”. Record a short video to demonstrate it works, then enjoy! Also feel free to play with other AT commands described in HM10 datasheet.

Grading Criteria

Submit the following things in a single Zip file: a PDF document that includes your measurement in Step 1; your Arduino code for Step 2; a short, 3 second video demonstrate turn on/off via BLE.

- 40% Correct measurement of distance in Step 1
- 50% Correct implementation and demo of Step 2
- 10% Code readability and writing