

BMEN 428/ECEN 489

CSCE 489/BMEN 689

ECG Signal Processing – Part #1

Please **SIGN IN** at the front!

Turn in all **POST LABS** at the front!

Safety

If you have any questions at all, or feel uncomfortable performing the experiments please let the TA know!

Make sure that whenever you have electrodes connected to your body, your device is connected to a portable battery or personal computer (unplugged laptop), **NOT TO THE OUTLET.**

In other words, there should **NEVER** be an electrical path from your body to the wall outlet. If any of the TAs see you not complying with these guidelines, you will get an

AUTOMATIC F GRADE

Project Description

Part #1

Collect and wirelessly transmit your ECG data, in addition to reporting the heart rate (in bpm) as well.

Part #2

Read data from the computer (wirelessly) that contains an ECG signal corrupted by noise, apply digital filters and filter out noise (in MSP430), and then send “filtered” data back to computer.

Project Goal

In addition to applying filtering algorithms in the MSP430, you have to explore the limitations of the microcontroller.

Major Limitations:

- 1) Computational Power**
- 2) Precision and Accuracy**
- 3) Available Memory**

Project Gantt Chart

1st Week

Design algorithm to detect heart rate.
Implement in MSP430.

2nd Week

Finish heart rate detection algorithm. Design filters and test out with MATLAB. Begin to implement in MSP430.

3rd Week

Finish filter designs and implementation in MSP430. Submit results to Kaggle.com.

Project Gantt Chart

4th Week ???

There should be no 4th week. “Buffer” time to debug/troubleshoot any problems arising in previous parts of the lab.

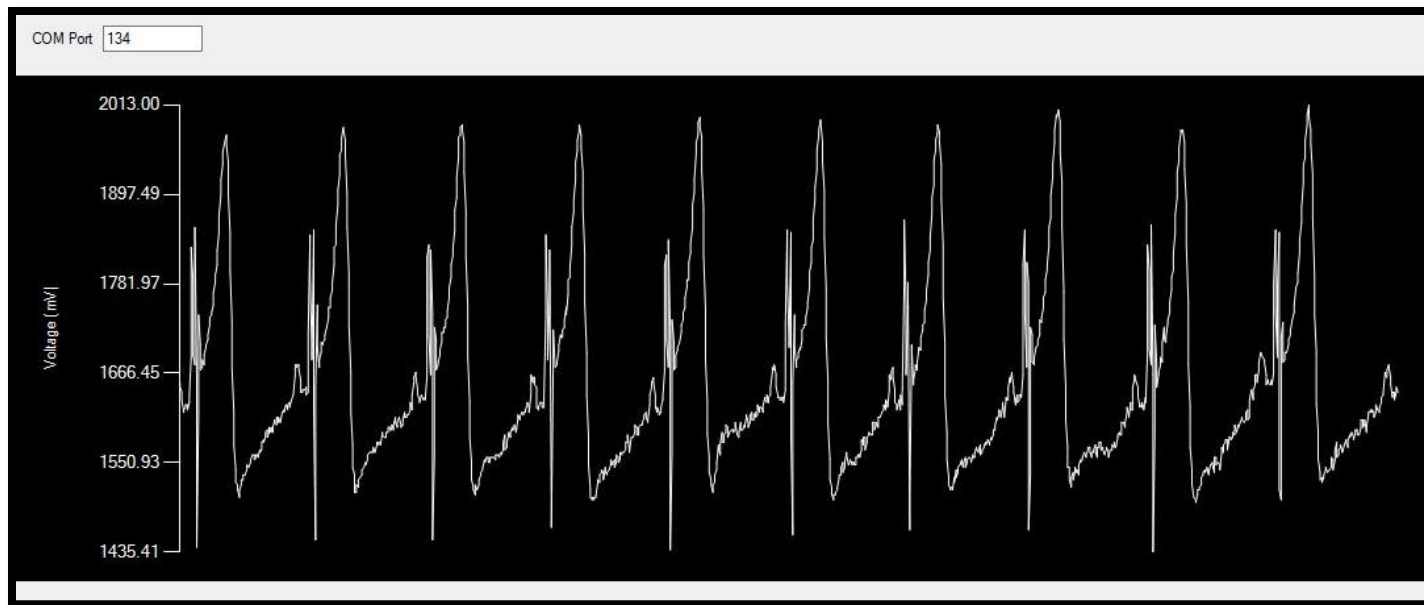
If you don't set strict deadlines for each part of the project you might run the risk of not finishing on time! Remember that the project is 16% of your grade.

Part #1

Heart Rate Detection

This part of the project constitutes an extension of Lab #6.

You are expected to output the same ECG signal from your body, in addition to your heart rate.



No time dependence on x – axis. Need to define an algorithm that “counts” the number of beats per period, and use that to calculate “bpm”.

Heart Rate Detection

You are free to develop and implement whatever heart rate algorithm you like, as long as it works and you are able to explain how the algorithm works to the TAs.

You are also free to employ any digital signal processing on the MSP430 if you feel it would help your algorithm. You cannot however use any additional hardware other than what we provide in the lab.

For every beat after the first heartbeat, you need to calculate the time since the last heartbeat and report this as a heart rate in bpm.

Heart Rate Detection

In addition to the two bytes you will be sending for the digitized ECG data like you did in Lab 6, you will also need to send a third byte that encodes the heart rate in bpm.

So for every sample, you need to first send 2 bytes of the ADC-converted ECG data, and then 1 byte of a heart rate value.

You will not get a new heart rate every sample, so just send the number '0' whenever a new heart rate is not available. In other words, the only time you will not send the number '0' is when your algorithm has detected a new heartbeat and can calculate an updated heart rate.

When the GUI receives a "0" it will output the heart beat previously calculated. In other words, the GUI will only "update" the heart rate when it does not receive a "0".

Heart Rate Detection

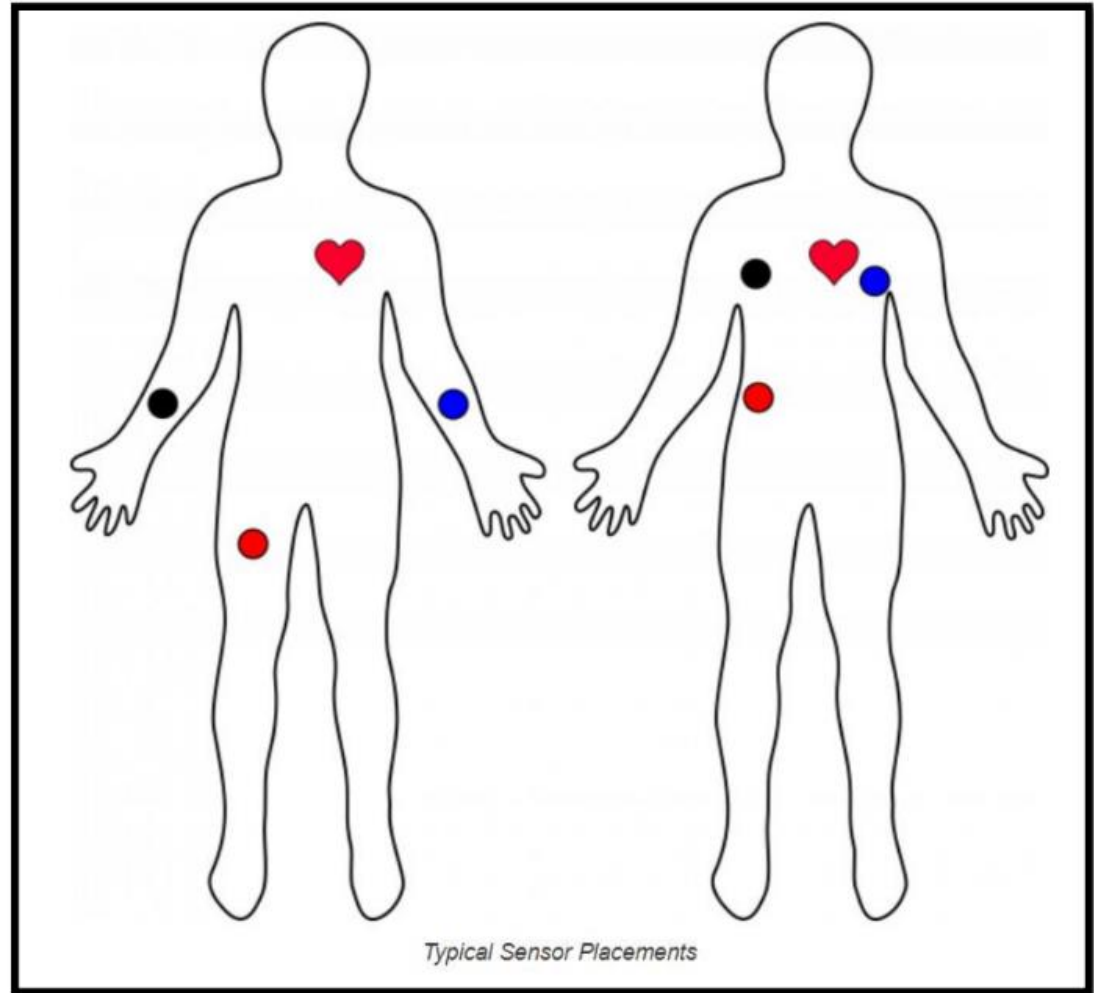
The overall flow will be initiated by the PC GUI, details of which will be explained further in the next subsection. The GUI will send the letter 'a' to initiate the data transfer.

Therefore you must set up a UART receive ISR that looks for the letter 'a' and only then starts sending out the converted ADC results as well as the heart rate to the PC.

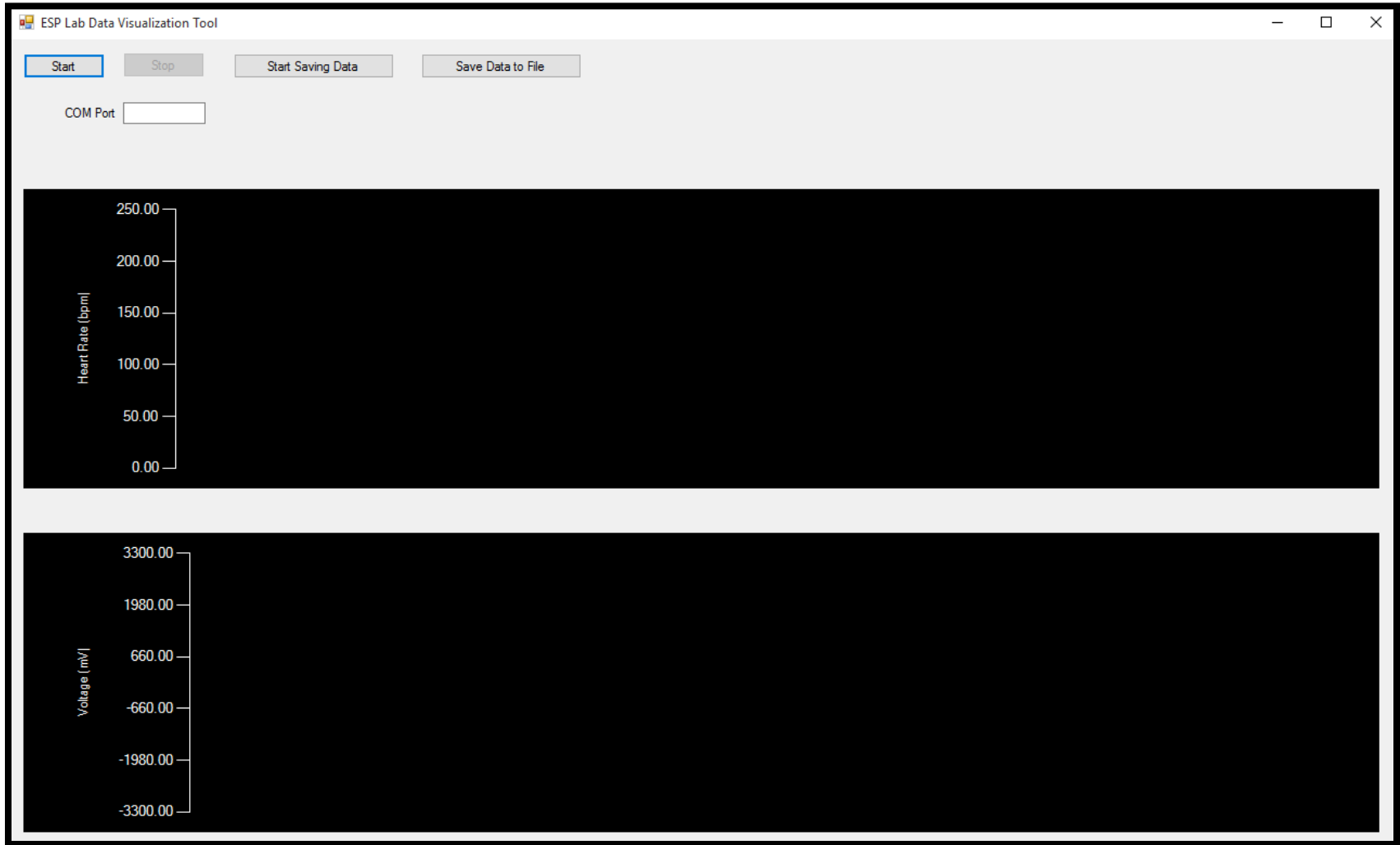
Once the transfer is initiated in this manner, the MSP430 must continuously send the samples to the PC at the predetermined sampling rate. The PC GUI will automatically handle receiving the incoming packets and plotting the signal on a graph. The heart rates that you send will also be plotted on a second graph.

Sensor Placement

Pay attention to where the **RIGHT** and **LEFT** sides are! Your signal may be inverted!



“SimpleSerial_ECG+HR_Voltage.exe”



Setting up the Bluetooth module (1)



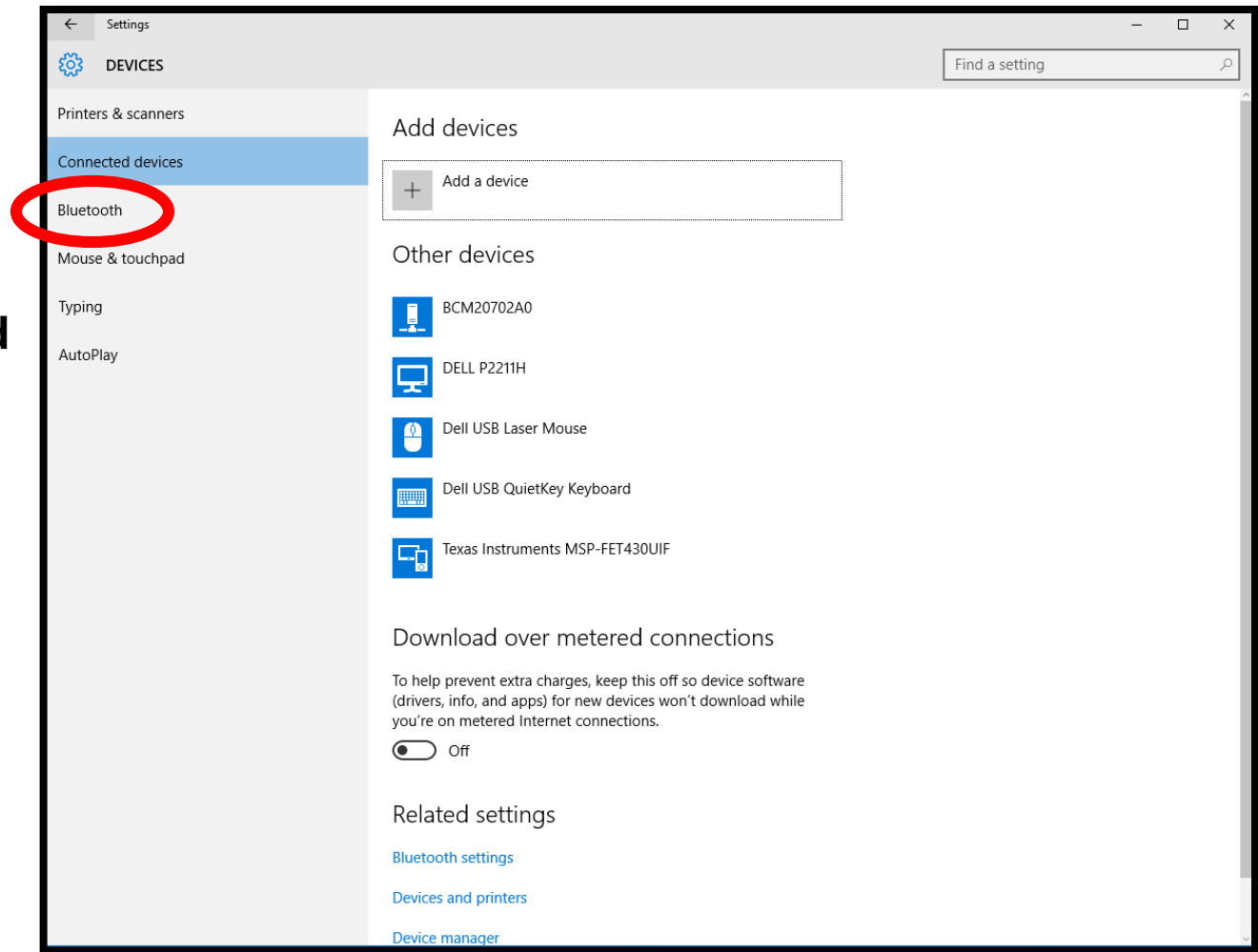
Connect the USB to your computer.

Setting up the Bluetooth module (2)

Click on the Windows icon and type:

“Add or remove devices”

Click on the Bluetooth tab



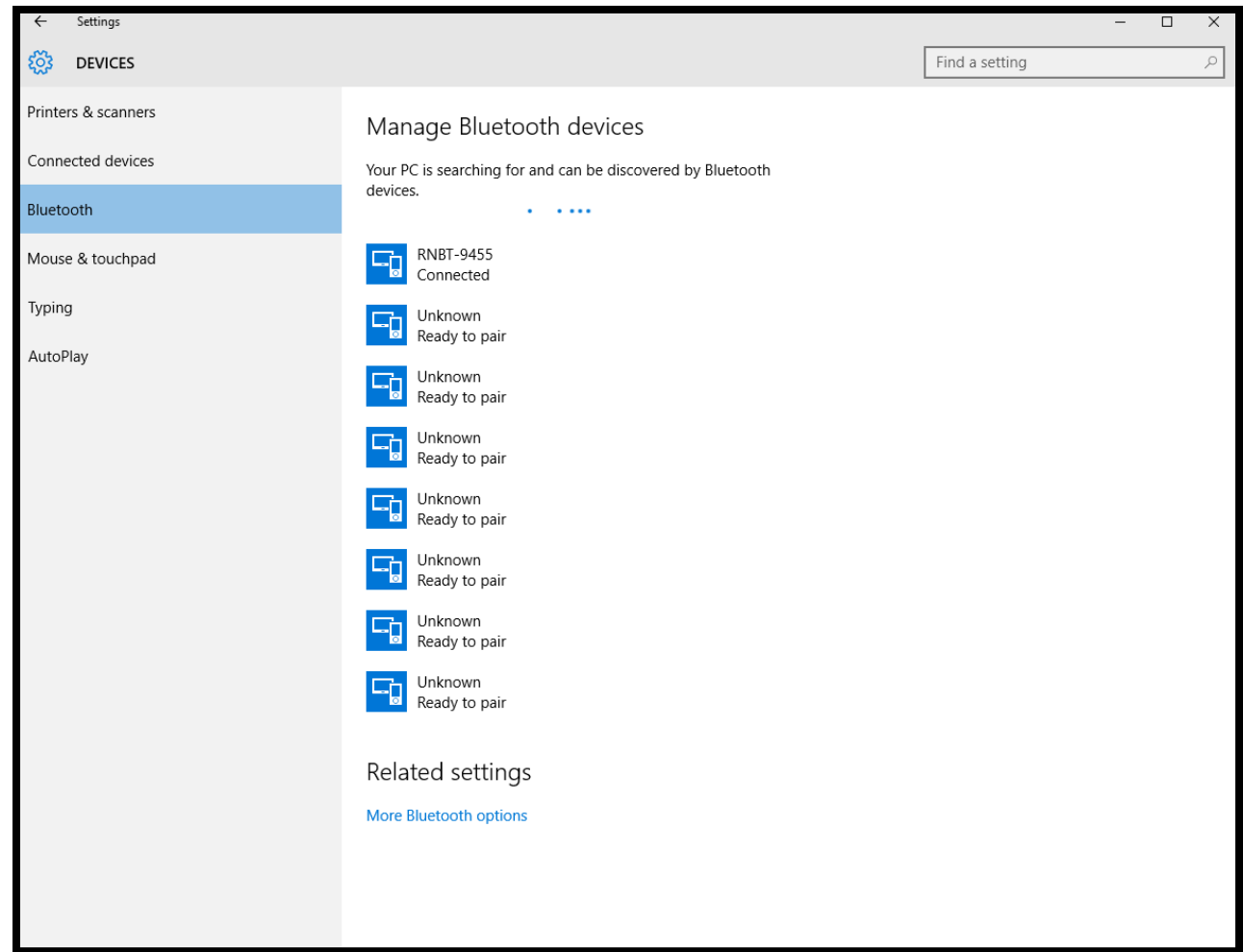
Setting up the Bluetooth module (3)

Look up your device!

Your device name should be:

RNBT – XXXX

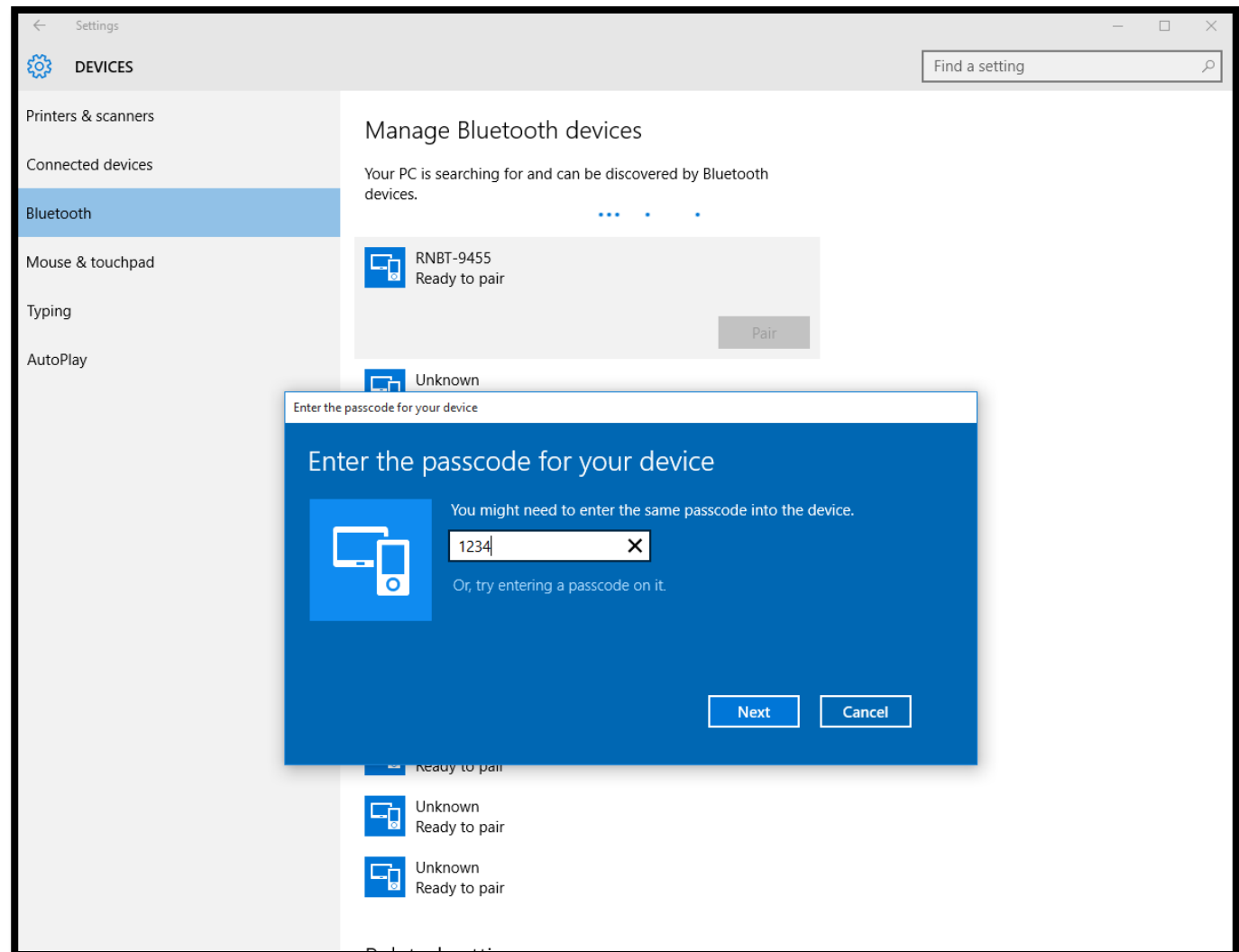
Where the XXXX correspond to the last 4 digits of the MAC ID in your Bluetooth module.



Setting up the Bluetooth module (4)

Password:

“1234”

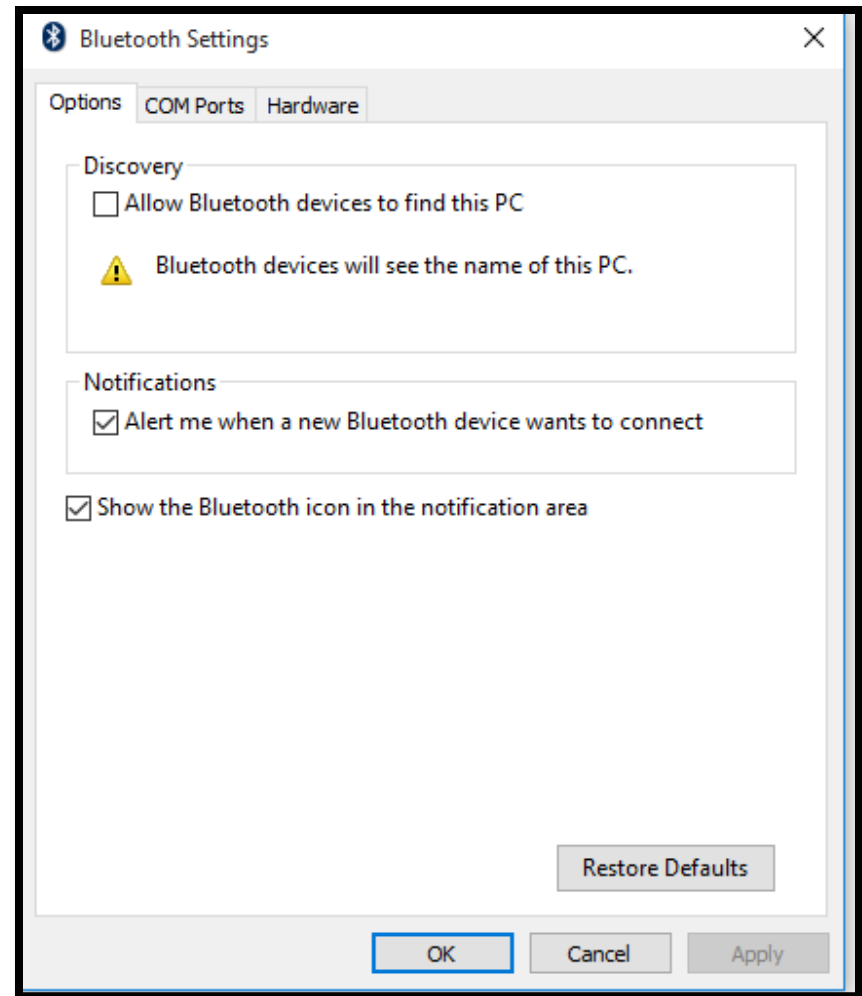


Setting up the Bluetooth module (5)

Once you've paired your device, click below on the

“More Bluetooth Settings”

And the window on the right should pop-up.

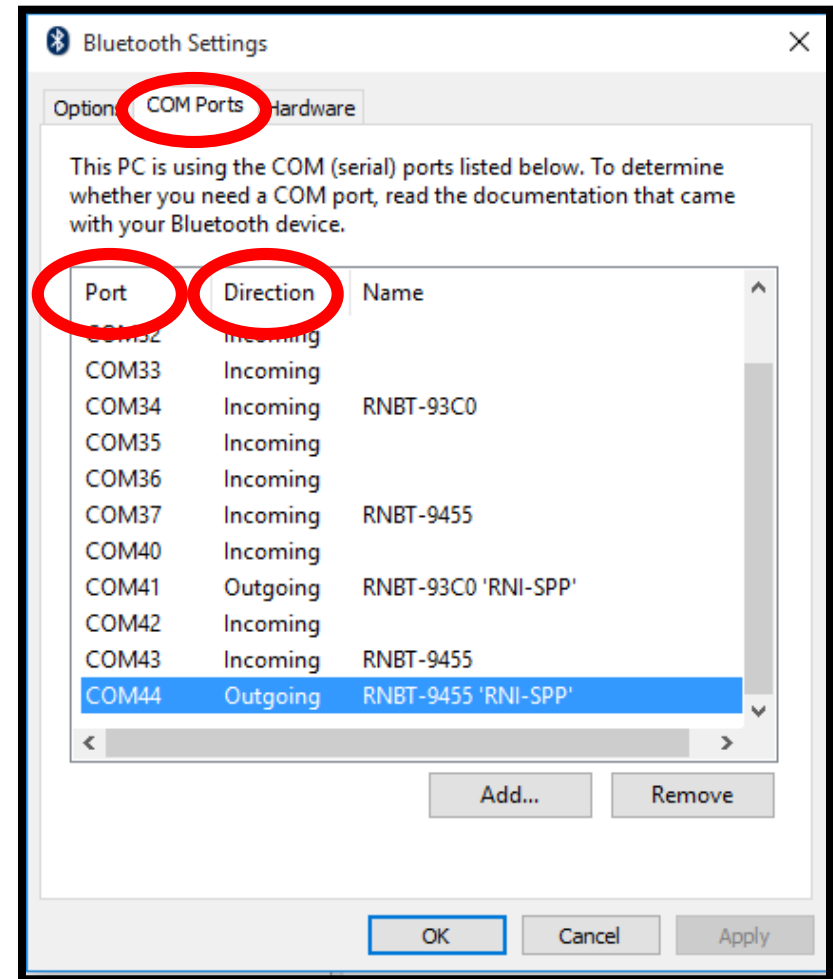


Setting up the Bluetooth module (6)

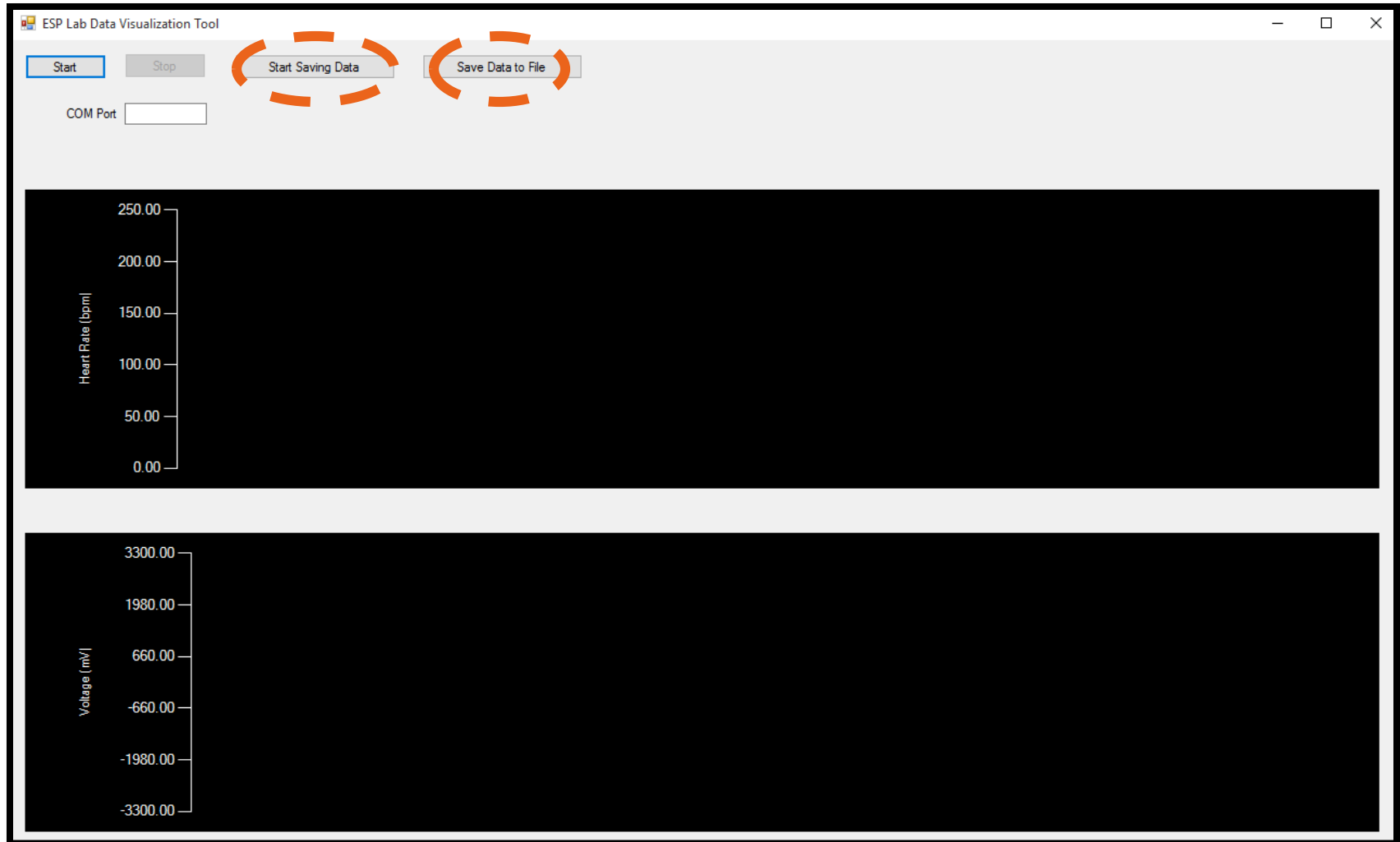
Search for the COM port of your device and write it down.

Look for the “**Outgoing**” direction.

The name of the device may have a “RNI-SPP” embedded to it after the device name.



Take some measurements!



ECG + Heart Rate



Expected Results

