



# **CSE 453**

## ***Hardware/Software Integrated System Design II***

# **BCI PROTOTYPE**

## **USER MANUAL**

Revised May 24, 2023

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*This manual applies to the prototype board of CSE453 Capstone BCI project*

# 0 | Overview

The BCI prototype board is a useful device that supports 4-Channel and 100Hz frequency EEG signals acquisition, and even EOG or all other analog signals by changing the code setting.

Below is the general look of our prototype board:

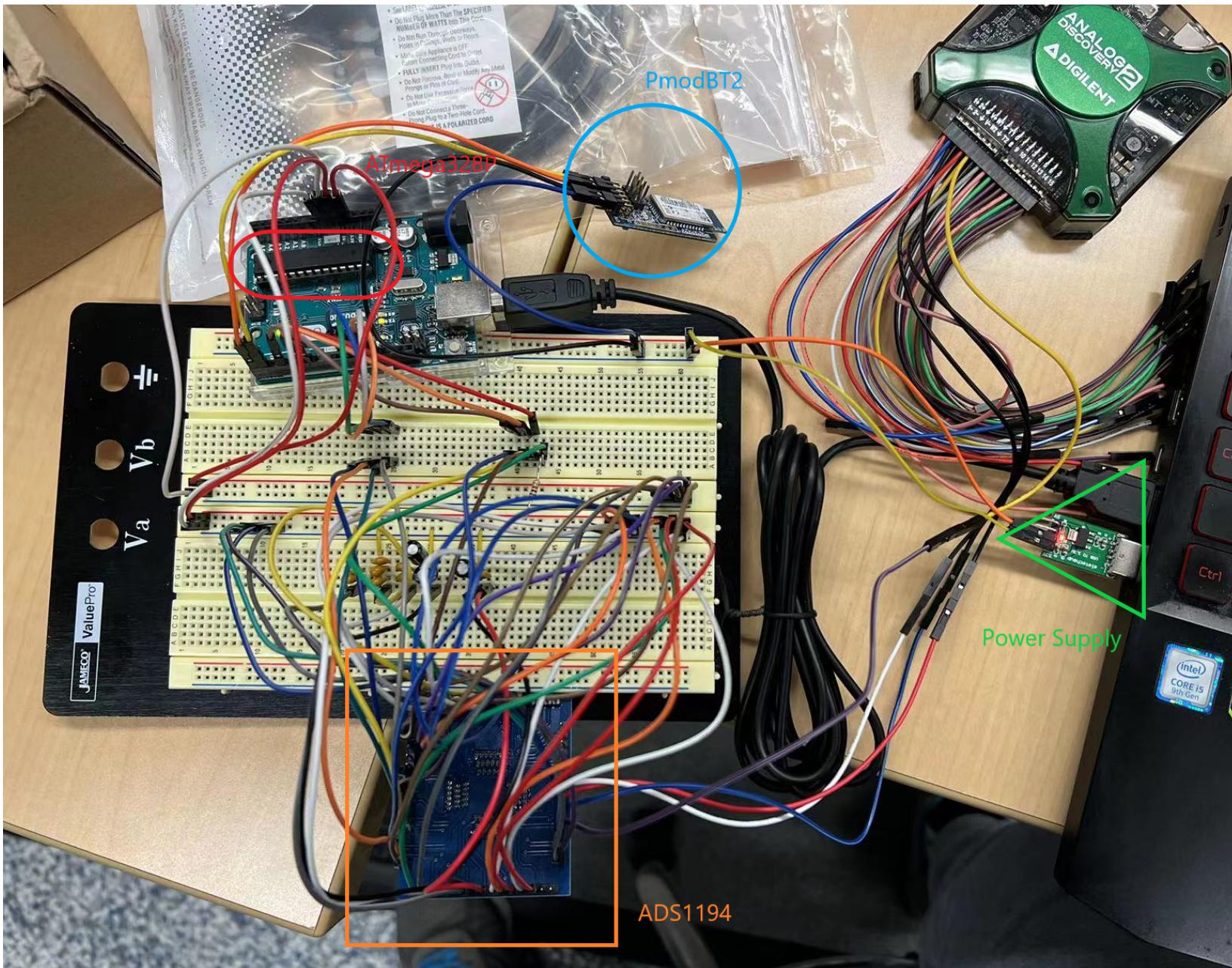


Figure 1. BCI prototype board

The prototype board is built on breadboard with miniment components that are able to capture EEG/EOG signals. It contains Arduino Uno v3, ADS1194, PmodBT2, and a 3.3V Power Supply.

# 1 | Connection

This BCI prototype board uses 8 pins to capture a maximum of 4 analog signals, and output digital data through SPI communication to ATMEGA328P microcontroller, then transfer to PmodBT2 Bluetooth by UART serial.

## 1.1 | Input

The BCI prototype board provides 8 input pins for 4-Channels signal acquisition, which they are

ADS1194 Pin	Description
IN1P / pin16	Analog Input 1
IN1N / pin15	Analog Ground
IN2P / pin14	Analog Input 2
IN2N / pin13	Analog Ground
IN3P / pin12	Analog Input 3
IN3N / pin11	Analog Ground
IN4P / pin10	Analog Input 4
IN4N / pin09	Analog Ground

Each 2 pins are for 1-Channels, and capture 4-Channels signals will use all the 8 pins. For pin01 to pin08, the other 8 pins are for ADS1196 and ADS1198. Also, when connecting to sample inputs, some capacitors can be added between inputs and ADS1194 input pins as analog filters.

## 1.2 | Hardware

To run the BCI prototype board, the USB 2.0 printer cable and power supply should be connected to the computer to enable ATMEGA328P microcontroller and PmodBT2 Bluetooth.

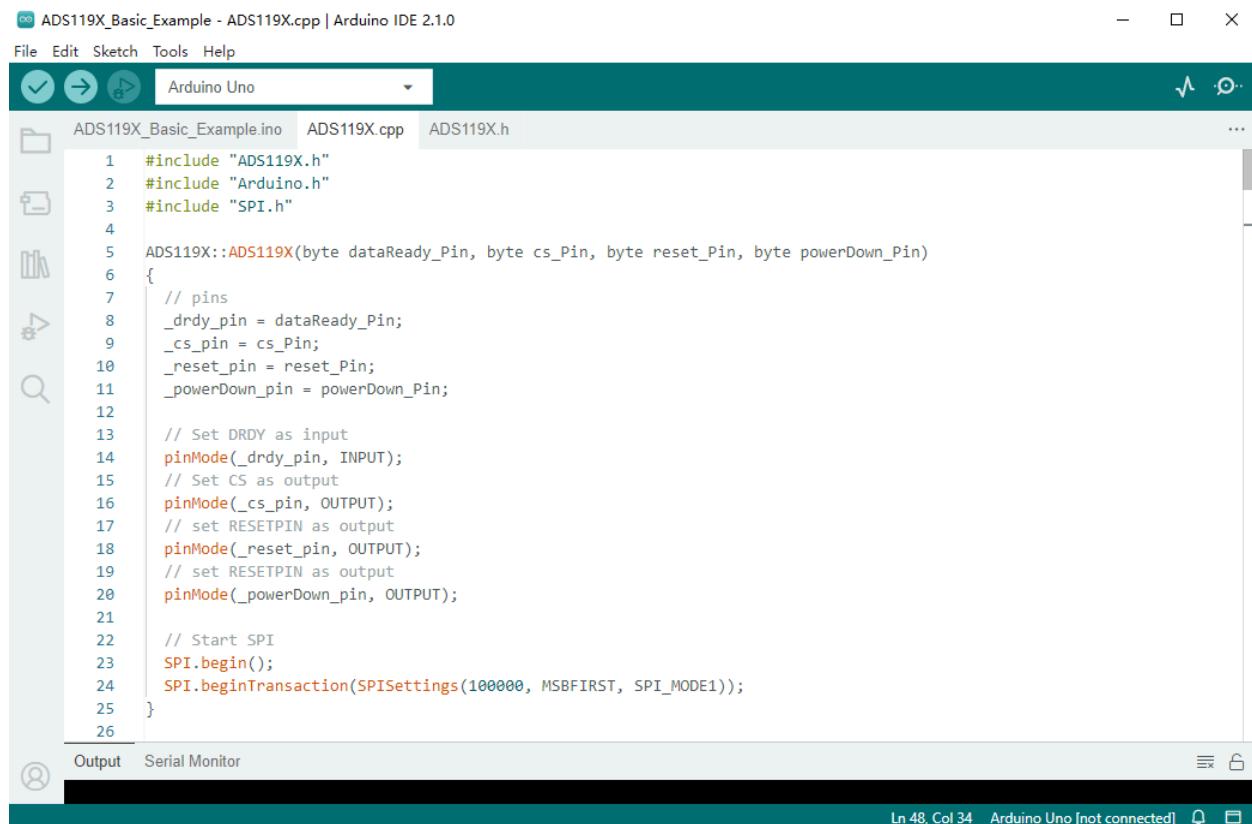
## 2 | Compile

To compile the BCI prototype board, Arduino IDE needs to be installed with the link  
<https://support.arduino.cc/hc/en-us/articles/360019833020-Download-and-install-Arduino-IDE>.

After Arduino IDE Installation, download the BCI prototype board Driver Codes<sup>1</sup> in GitHub  
[https://github.com/Tyson-Hu/Brain-Computer-Interface\\_Project](https://github.com/Tyson-Hu/Brain-Computer-Interface_Project), and store them in one folder.

### 2.1 | Arduino IDE<sup>®</sup>

When opening the folder with Arduino IDE, it will be like



The screenshot shows the Arduino IDE interface with the following details:

- Title Bar:** ADS119X\_Basic\_Example - ADS119X.cpp | Arduino IDE 2.1.0
- Menu Bar:** File Edit Sketch Tools Help
- Board Selector:** Arduino Uno
- File List:** ADS119X\_Basic\_Example.ino (selected), ADS119X.cpp, ADS119X.h
- Code Editor:** Displays the C++ code for the ADS119X driver. The code includes #include statements for ADS119X.h, Arduino.h, and SPI.h. It defines a constructor for the ADS119X class that initializes pins for DRDY, CS, and RESET, and sets up SPI communication with begin() and beginTransaction().
- Toolbars:** Standard Arduino IDE toolbars for file operations (New, Open, Save, Print, etc.)
- Status Bar:** Shows "Ln 48, Col 34" and "Arduino Uno [not connected]"

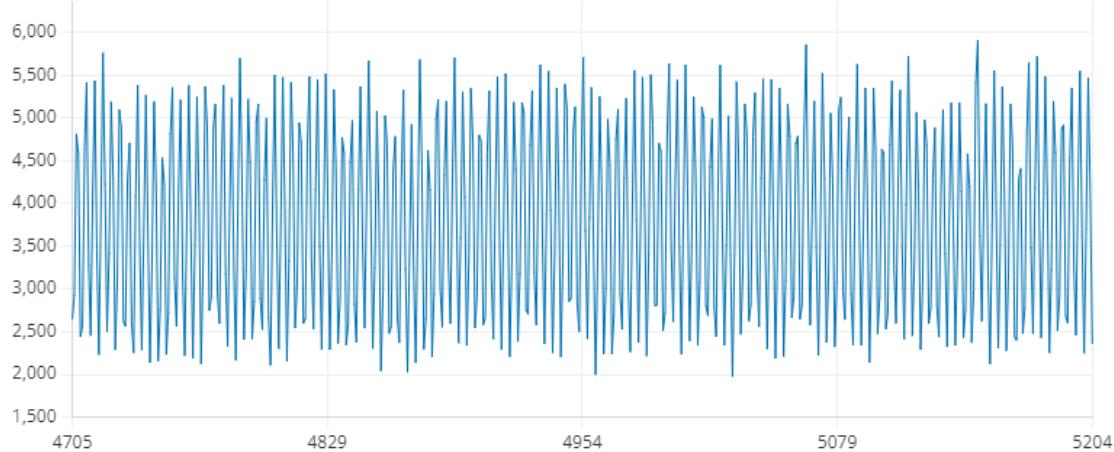
Select the Arduino board that is connected, and click Upload (->) to compile the board. Note that when compiled, the TX and RX pins of Arduino board should not be connected, while the connections between Arduino board and PmodBT2 (TX - RXD and RX - TxD) must be disconnected temporarily, and connect again once compiled successfully.

<sup>1</sup> ADS119X.cpp, ADS119X.h, and ADS119X\_Basic\_Example.ino

## 2.2 | Analog Plots

To visualize the digital data the BCI prototype board captures and transforms

- Click Tool -> Serial Plotter, an analog wave will be generated

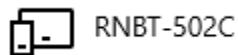


## 3 | Bluetooth & Digital data

The digital data can be seen by clicking Tool -> Serial Monitor in Arduino IDE, but also can be seen on Serial Terminal by using PuTTy, which is recommended. Since the digital data on Serial Terminal is displayed by PmodBT2 Bluetooth, every computer who is connected with PmodBT2 can receive that digital data, no matter if the computer is connected with BCI prototype board.

### 3.1 | BlueTooth Connection

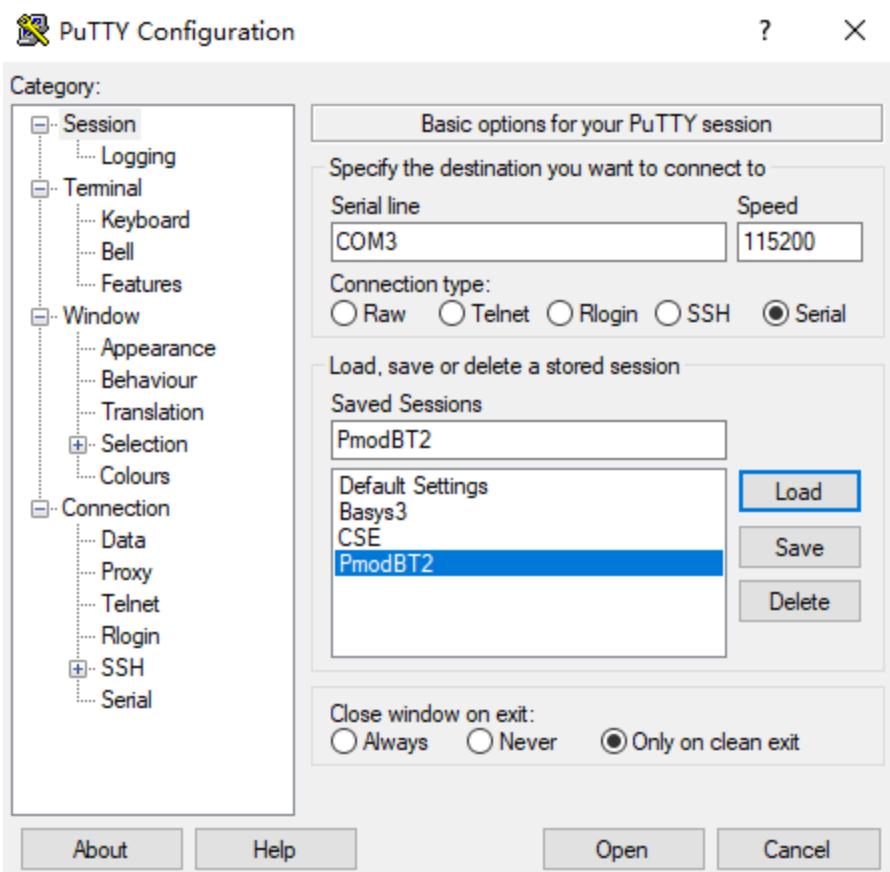
To connect PmodBT2 Bluetooth, open the Bluetooth Setting on the computer and find the one with the name start as RNBT, which means RN family Bluetooth, and click "Connect".



RNBT-502C

### 3.2 | PuTTy<sup>©</sup>

PuTTy, an open-source terminal emulator for Windows, that can be installed from <https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>. Once PuTTy is installed, open PuTTy and select "Serial" with the correct serial line and speed. For PmodBT2, its speed is default 115200 bps, and the PmodBT2 example that is shown below has a serial line of COM3.



The digital data will be automatically displayed on COMx when PmodBT2 is received.

The Putty terminal window titled 'COM3 - PuTTY' shows a continuous stream of digital data being received. The data consists of a series of comma-separated values, likely binary data converted to ASCII. The window includes standard Putty controls like a scroll bar and a status bar at the bottom.

```
4401,4635,4613,-5  
2155,2390,2365,-5  
3983,4217,4194,-5  
6565,6800,6779,-5  
4982,5216,5194,-5  
2376,2611,2586,-5  
3349,3584,3560,-5  
6559,6793,6772,-5  
5651,5885,5864,-5  
2834,3068,3045,-5  
2977,3212,3188,-5  
6402,6636,6615,-5  
6242,6476,6455,-5  
3399,3633,3610,-5  
2527,2761,2738,-5  
5735,5969,5949,-5  
6340,6574,6554,-5  
3776,4010,3987,-5  
2292,2526,2502,-5  
4951,5185,5163,-5  
6549,6783,6763,-5  
4295,4530,4508,-5  
2231,2465,2440,-5
```