WOBBLE WOODEN BALANCE BOARD

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March 10, 2021

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1 User Manual

Thank you for your interest in trying out the Balance Board. You're about to take a step in the improvement of the physical fitness. This takes the fun of a game, changes the fact that exercises are boring and tops it off with an extra bit of swag.
To ensure your safety and the safety of others, please read and follow the guidelines in this User Manual carefully and thoroughly before balancing.

Happy Balancing!

1.1 GENERAL INFORMATION

This User Manual will guide you through the functions and usage of the Balance Board. Before starting this device, read all the instructions for charging and operation.

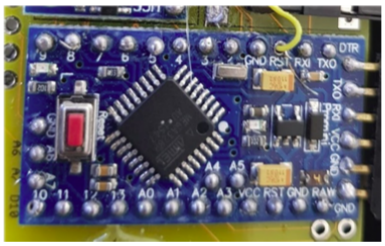
IMPORTANT NOTE: To learn how to charge the Balance Board, please see section 8

2 SAFETY AND GENERAL TIPS FOR BALANCE BOARDS

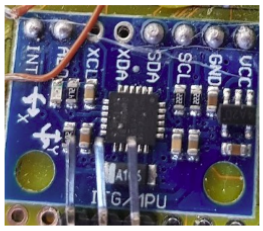
1. **Keep your space clear:** As you are starting out with your balance board, make sure you give yourself plenty of room. Don't pile up objects around you. Instead, practice in an area where you would be comfortable stumbling and falling. Similarly, you should always use your balance board in a well-lit room.
2. **Don't swing around to much:** With a balance board, there can be a temptation to jerk around or swing your arms wildly. This will make falling much more likely. Try to make every movement you do slow, purposeful, and fully conscious.
3. **Look at a point far away:** Keeping your eyes focused on a point far away will help you maintain your natural sense of balance. Resist the urge to look at your feet, and instead move your concentration to the far wall.
4. **Squat to extension:** Perform your squat, but when you lift out of it, straighten your knees and begin to lift your arms all the way over your head. To add more difficulty, come up onto your toes as you fully extend.
5. **Choose a floor that's right for you:** Practicing on a carpeted floor will make balancing easier, whereas using hard floors will present more a challenge. Regardless of which option you choose, make sure there are no spills or unexpected sources of slipperiness on the floor where you practice.
6. **Don't push yourself too hard:** As with any athletic practice, make sure that you are going at a steady pace and not pushing yourself too fast, too soon. Choose a board that fits your skill level, and do exercises you are comfortable with. Once you have mastered those, you will be ready to move on to bigger challenges.

3 Technical Details

The balance board has the following modules:

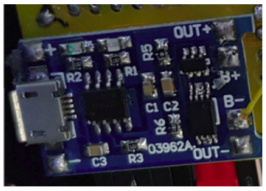


Arduino Mini

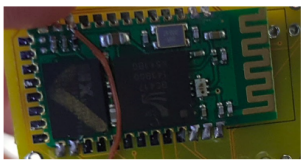


MPU6050-GY-521
Accelerometer_Gyroscope

Figure 1: BalanceBoard electronic components Upper side



Li-ion-Battery
Charge-Controller-MP1405



HC05-BT417-Bluetooth-Module

NRF-M-24L01
Wireless-2.4GHz

Figure 2: BalanceBoard electronic components Backside

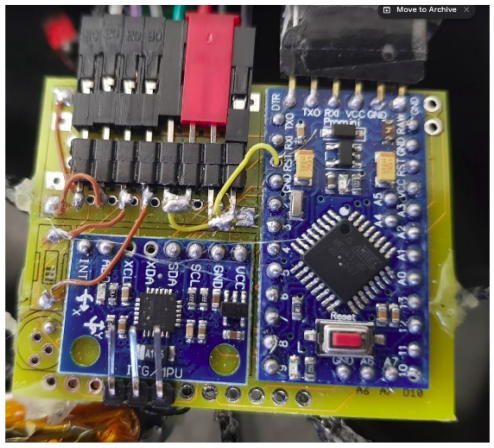


Figure 3: Front View of the Balance Board PCB

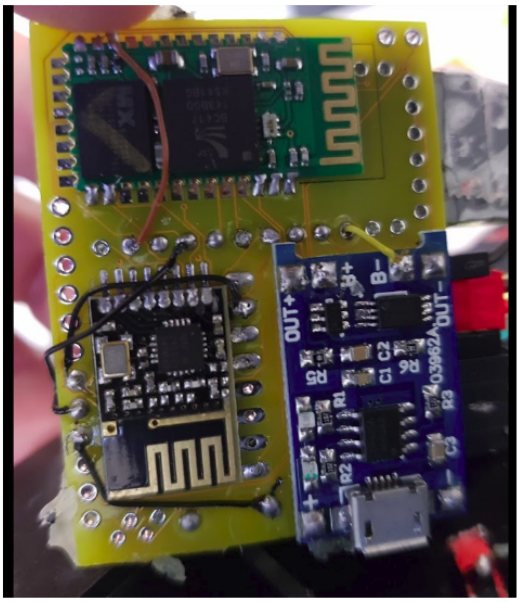


Figure 4: Rear View of the Balance Board PCB

4 HOW TO USE IT

The balance board can be used it two modes standalone mode and the bluetooth mode. If you are using it in bluetooth mode the configuration to your PC has to be made. It is shown below.

4.1 Bluetooth settings

The basic settings if you want to do change the pins of the receiver and transmitter of Arduino and Bluetooth module settings itself.

4.1.1 Modify module defaults:

To modify HC-05 (Bluetooth) defaults, we need to enter AT-command mode. To do this, we take the following steps:

1. Open the “HC05_AT_Commands.ino” file, and upload the program to the board. Note: Pay attention to the Rx/Tx connection pins if they are correct (defaults: 4, 5)
2. After the upload is complete, switch off the module
3. Connect the pin (as in the picture) to VCC line with a wire

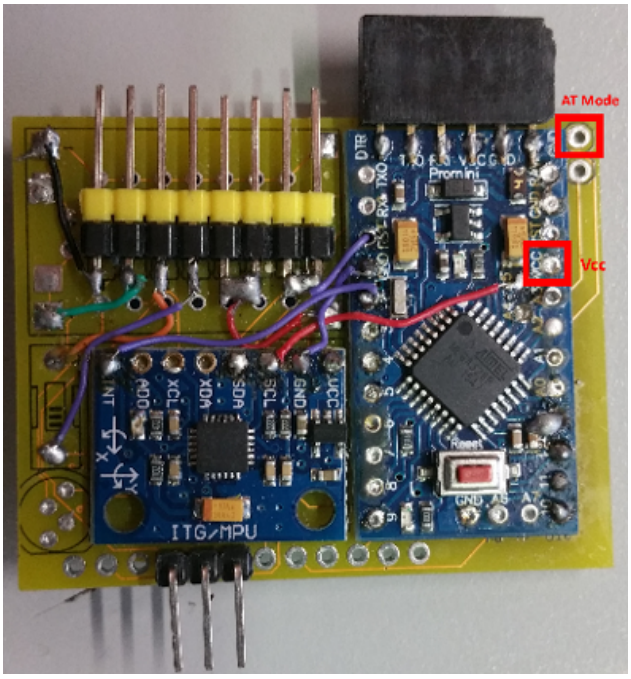


Figure 5: AT mode

4. Switch on the module while keeping the pin-VCC connection.
5. Open Serial monitor (Baud rate e.g. 115200) and choose “Both NL CR” as the line-ending
6. Type “AT” and hit Enter, you should get back “OK” if the setup is successful. The main important settings:

a.	Check the module name:	**AT+NAME**
b.	Setup the module name:	**AT+NAME=USI_BalanceBoard_1**
c.	Check the module PassKey:	**AT+PSWD**
d.	Setup the module PassKey:	**AT+PSWD=1234**
e.	Check the module BaudRate:	**AT+UART**
f.	Setup the module BaudRate:	**AT+UART=115200,0,0**

Figure 6: AT mode commands

7. Disconnect the VCC $<--->$ AT-Pin wire, restart the module (switch on/off) and you are done

4.2 Bluetooth settings on windows

- Open the Device Manager, and scroll to “Ports (COM LPT)”. Remember the available items and their port numbers (i.e. COM##)

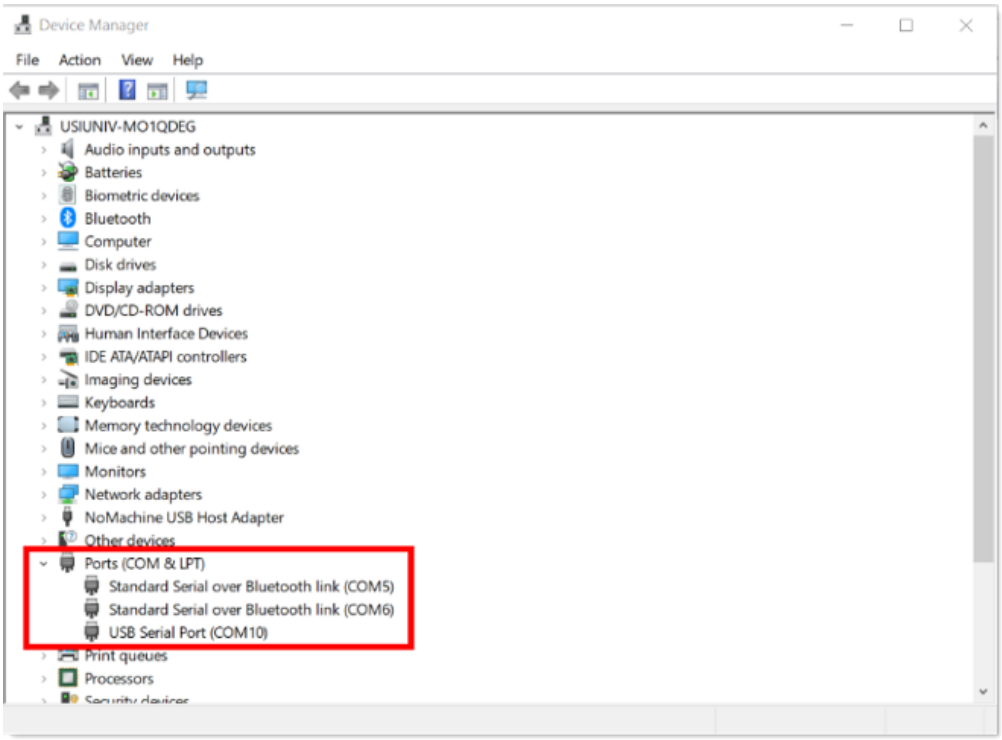


Figure 7: Bluetooth windows

- Search for the Bluetooth connection of the Balance Board, connect and pair with the new board
- Get back to the Device Manager, you'll have new COM ports added for the new board.

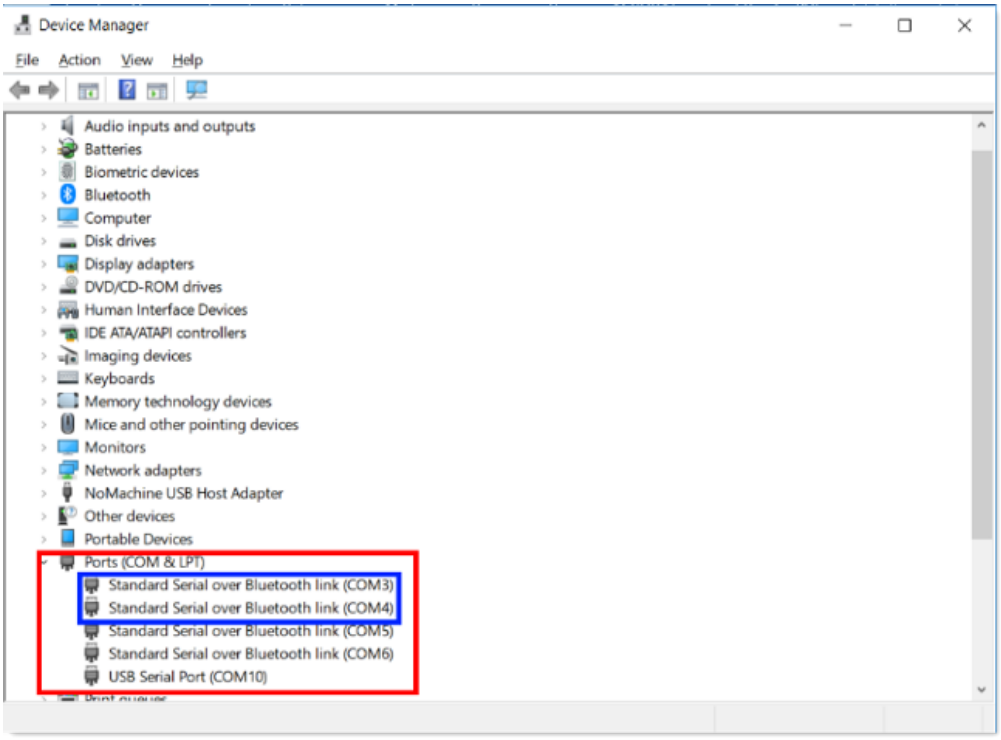


Figure 8: Bluetooth windows

- In windows, each Serial Bluetooth device will have two COM ports created. We will connect to the one with the lower number of them.

4.3 Bluetooth Number

Depending on the used program, the number of the Bluetooth device defer.

- In Arduino, to connect (serial monitor) we care about the COM port Number (e.g. COM3).
- In Processing (the GUI App), we care about the COM port Order (we start counting from 0). For example, in the previous list, before adding the new BT device (the new board) COM5 had the order '0'. But, after adding the new device, COM5 now has the order '2'. So, pay attention when you use Processing to the current order of the port you are trying to connect to.

4.4 operating Bluetooth mode (with Processing GUI interface)

1. Switch on the board.
2. Make sure you are connected to the board and paired with it.
3. Open the "Balance_Board_Processing_GUI.pde' in Processing.
4. Modify the "PORT_NUM" parameter to the corresponding port_order (get this from Device Manager).

5 SOFTWARE INSTALLATION

- **Processing 3:** https://processing.org/download/
- **Arduino 1.8.13** You can go to this webpage https://www.arduino.cc/en/main/software and download the most recent version according to your OS

6 BALANCE BOARD GUI SETUP FOR MACBOOK

1. Download and install Processing from the link above
2. Once installed from the menu on top of the screen go to: Sketch $>$ Import Library $>$ Add Library
3. At this point a window will appear, in the tab "Library" tab search for and install (see screenshot below):
   - HTTP Requests for Processing
   - ToxicLibs

Figure 9: Library window

4. At this point you have everything needed for the GUI program to run. Let's pair the balance board. To do so you have to:
   - Turn on the Balance Board
   - Turn on the Bluetooth on your MacBook
   - You should see the Balance Board as one of the available devices, click on it and enter the pass code: 1234 (By default the MacBook will try with 0000 as pass code, but once it fails you will be presented with the option to change the code)
   - If everything worked correctly you should see the Balance Board paired for few seconds.

   NOTE: The pairing procedure should be done only once. Every time you will run the Processing program it will connect automatically to the Balance Board.
5. At this point you have everything set up for the Balance Board GUI to work. To run the program open "Balance_Board_Processing_GUI.pde" and click on the play button on the top-left.

6.1 GUI EXPLAINED

- For the first time after starting the board, It should show the seconds left for the calibration. Calibration state should last 20 second or so, done at the start of the program.
- After calibration it says step on the board to begin.

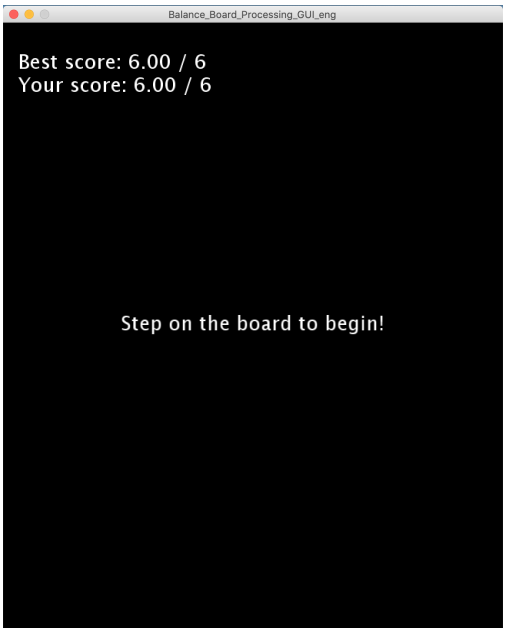


Figure 10: Step on the board to begin

- After stepping on the board, it shows the score, seconds remaining before the end of the current try and also the balance point in the dart board.

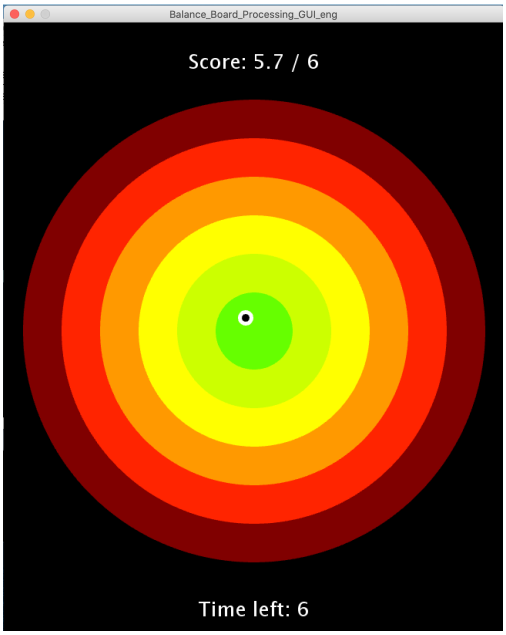


Figure 11: Dart board

- At last the user interface shows the best score and your current score It gives a score out of 6.

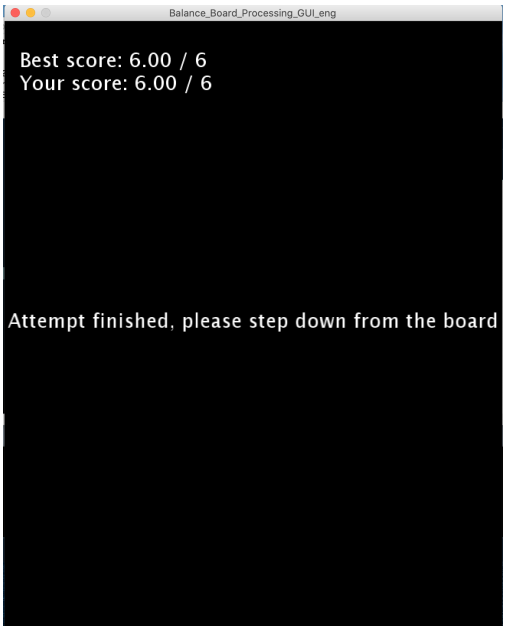


Figure 12: Score

- Then again the cycle repeats until you switch off the board.

7 STAND-ALONE MODE

- Initially when the all the LED's flashes red, the board is calibrating and then it gradually goes off signifying the seconds left for calibration(You can also check the seconds left in the user interface). This has to be done once when you switch on the board.

Figure 13: When the board is Calibrating

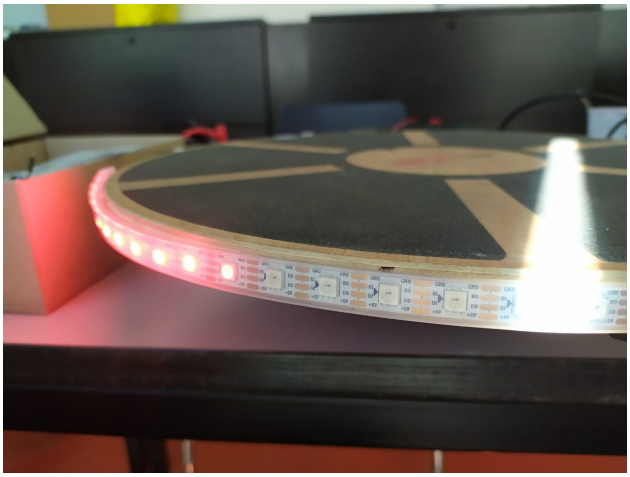


Figure 14: The board showing seconds left for the calibration.

- If it's not the first time then only first two of the LED's glows in green colour and after few seconds it glows in multiple colours as a sign to step on.
- After stepping on the board, the LED flashes sky blue indicating the time left to start counting.
- The LED flashes blue in color indicating remaining time left for the balance.

Figure 15: Blue Led indicating the time left.

- At last the LED's glows both green and blue colour in respected intervals, (10 Green LED's each adding 0.1 point followed by two green LED's marking to show the difference between the points). It gives a score out of 6.

8 CHARGING THE BALANCE BOARD

NOTE: IT IS IMPORTANT TO CHARGE THE BALANCE BOARD AT LEAST 12HRS AFTER FEW HOURS OF USE TO EXPLOIT ITS MAXIMUM EFFICIENCY.

9 REPROGRAMMING THE BOARD

9.1 From scratch:

The order of operations to re-program the board from scratch is the following:

1. Run the 'MPU6050_calibration' program to generate the Accelerometer and Gyroscope calibration values for that particular board.
2. Copy the resulted calibrations and paste them in the corresponding definition in 'BalanceBoard-SelfNRF_Final' code.
3. Inside 'BalanceBoardSelfNRF_Final' code:
   (a) Define the node number (1, 2, 3)
   (b) Define which features to switch on/off (e.g. fading LEDs, rainbow, . . .)
   (c) Define any particular timing values (please use the Timing Settings. xlsx file to generate compatible values depending on the number of LEDs available on the board)
4. Compile/upload the code to the board.

9.2 Modify only the timing values

You can just modify the timing values (as described above in 9.1, 9.1.3.c) with the help of the attached excel file.

9.3 Operating the board:

As said earlier It is possible to operate the board in either standalone or Bluetooth modes.

9.4 Trouble shooting if errors in configuring bluetooth of macbook to Balance Board

In the Processing program at line 7 there is: int PORT_NUM = 0;.

Macbooks have a list of bluetooth devices and this number (PORT_NUM) depends on the number of devices you have paired with the machine and therefore changes from one Mac to the other.

If the program do not start correctly it will see printed to console (in the bottom of the Processing window) the device name that it's trying to connect to. If the name is not the same as the Bluetooth name of the Balance Board you have to change the line 7 to:

int PORT_NUM = 1; or to int PORT_NUM = 2;

And run the program again (with the play button as explained above)

10 CIRCUIT CONNECTION

If you are interested in board's internal circuit connections.

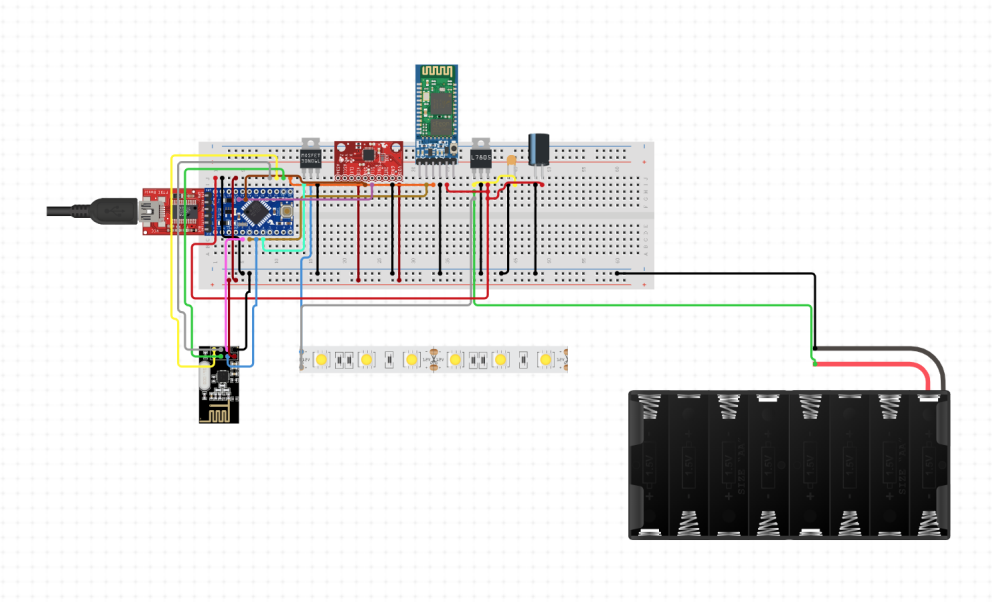


Figure 16: Connection Schema

1. **ArduinoProMini3v3**

- connect ArduinoProMini3v3 GND1 to Bus GND
- connect ArduinoProMini3v3 VCC to Bus POS

2. **Connect NRF24L01**
    - connect NRF24L01 CE to ArduinoProMini3v3 2
    - connect NRF24L01 CS to ArduinoProMini3v3 4
    - connect NRF24L01 GND to Bus GND
    - connect NRF24L01 MISO to ArduinoProMini3v3 12
    - connect NRF24L01 MOSI to ArduinoProMini3v3 11
    - connect NRF24L01 SCK to ArduinoProMini3v3 13
    - connect NRF24L01 VCC to Bus POS
3. **Connect LedStrip**
    - connect LedStripS SIG to TNMOSFETFQP D
    - connect TNMOSFETFQP
    - connect TNMOSFETFQP S to Bus GND
    - connect TNMOSFETFQP G to ArduinoProMini3v3 5
4. **Connect MPU6050**
    - connect MPU6050 VIO to Bus POS
    - connect MPU6050 VCC to Bus POS
    - connect MPU6050 GND to Bus GND
    - connect MPU6050 SCL to ArduinoProMini3v3 A5
    - connect MPU6050 SDA to ArduinoProMini3v3 A4
5. **Connect BTHC05**
    - connect BTHC05 GND to Bus GND
    - connect BTHC05 TX to ArduinoProMini3v3 10
    - connect BTHC05 RX to ArduinoProMini3v3 3
6. **Connect L7805**
    - connect L7805 Vin to CapCeramic100nF con0
    - connect L7805 Vin to Battery8xAA POS
    - connect L7805 Vin to LedStripS VDD
    - connect L7805 0 to Bus GND
    - connect L7805 Vout to ArduinoProMini3v3 RAW
    - connect L7805 Vout to BTHC05 VCC
    - connect L 7805 Vout to CapElectro1uF pos
    - Connect CapCeramic100nF

- connect CapCeramic100nF con1 to Bus GND
- connect Connect CapElectro1uF
- Connect CapElectro1uF neg to Bus GND

7. **Connect to Computer and Power Supply**
    - Connect your Arduino board to the computer using a USB cable.
    - Make sure that your power supply is connected and working properly. (Batteries are charged, wall adapter connected to the wall)
    - In Arduino IDE- don't forget to select the correct Port and Board in the tool menu.
    - compile and upload the code to the board