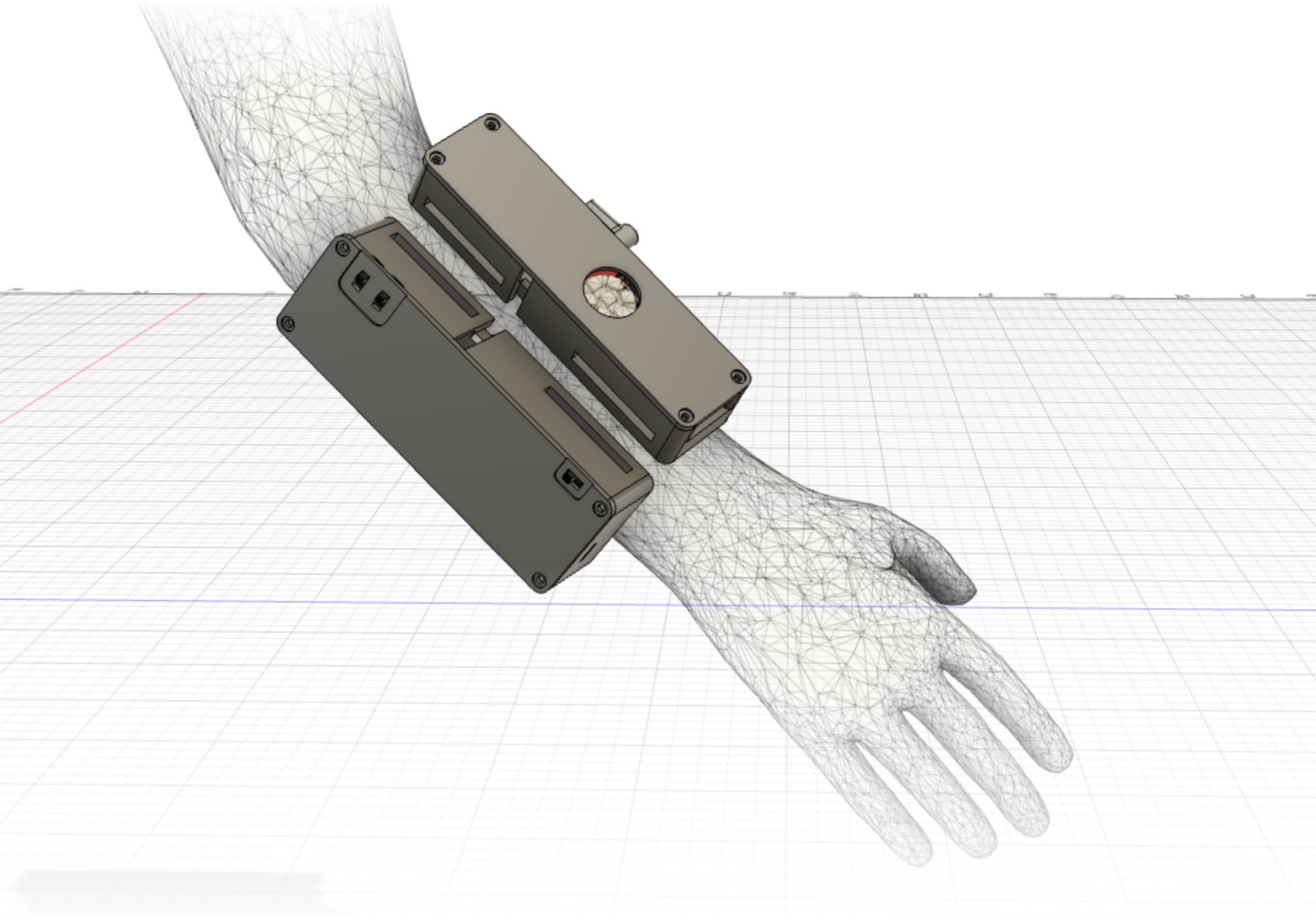
Accessible Wireless EMG Switch

User Manual

Updated: May 2023

V 2.0



Author: Yifan Zhou
yifanz1108@gmail.com

Features

This is a Wireless EMG (Electromyography) sensor that is designed to be wearable and intuitive to use.

Detects Muscle Activity

- The device detects muscle movements associated with certain action, such as gripping fist, or raising arm and sends a trigger signal both wired and wirelessly.

Wired and Wireless Connectivity

- The Wireless connection is done via Wi-Fi, and the Wired connection is done via a 3.5mm mono audio connector.

Customizable LED indicator

- The Device features an LED that can be customized to different colors. This LED will also serve as status indicator and display dynamic animations when activated.

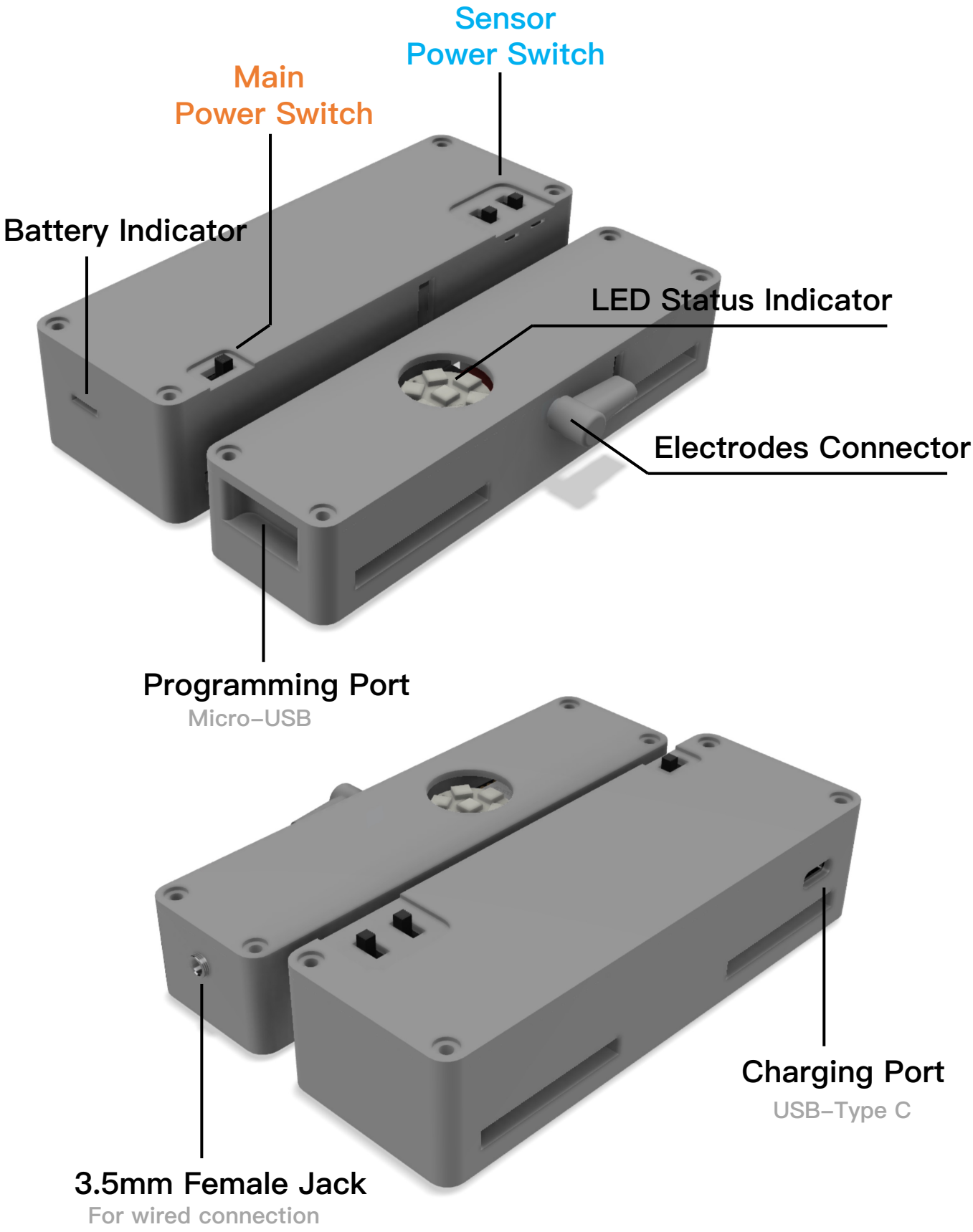
Vibration Motor

- The device features a built-in vibration motor that will provide necessary haptic feedback to the user.

Note: Please handle device with care.

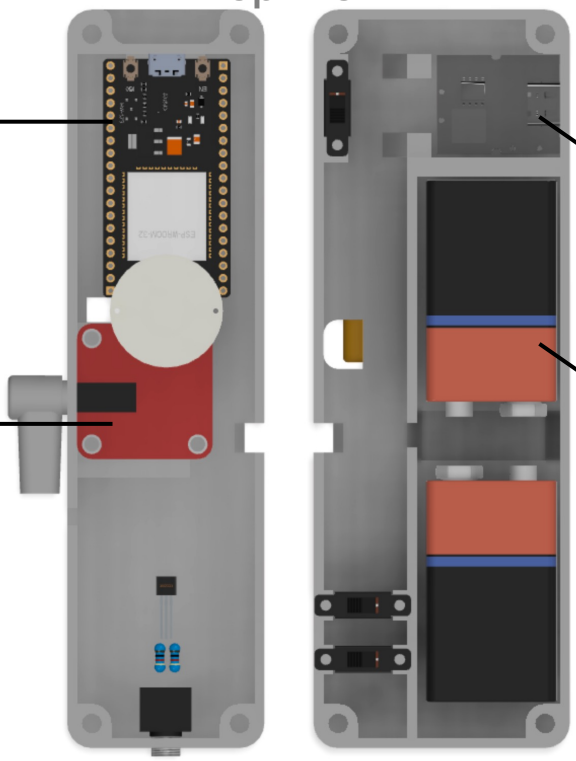
- Do not poke or hard press, or overcharge the Lithium-ion battery
- Prevent the device from falling or hitting a surface too hard.
- Do not exert excessive force on the wires as these forces many break electric connections and may cause short circuit!

Hardware


Sensor
Power Switch
Main
Power Switch
Battery Indicator
LED Status Indicator
Electrodes Connector
Programming Port
Micro-USB
Charging Port
USB-Type C
3.5mm Female Jack
For wired connection

Hardware

Top View



ESP-32

Main Controller

EMG Sensor

Independently powered

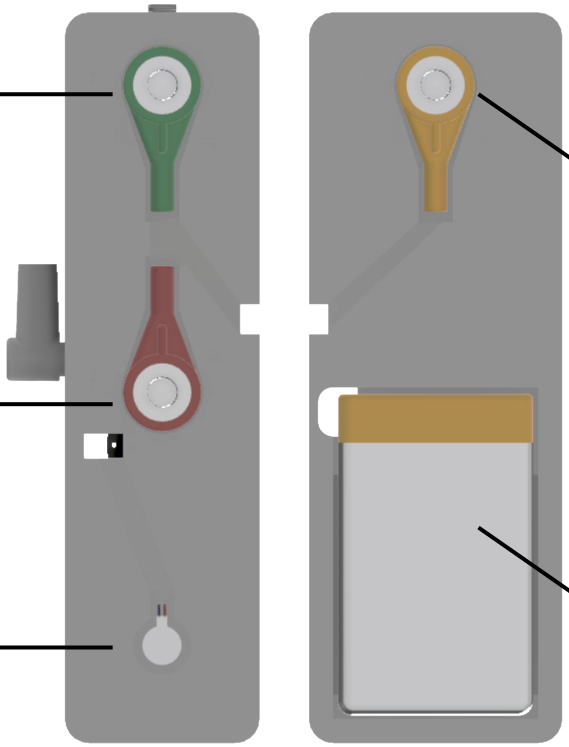
Boost Converter

Output 5v 2A

Sensor Batteries

2 x 9v Batteries

Bottom View



Muscle electrode

Muscle electrode

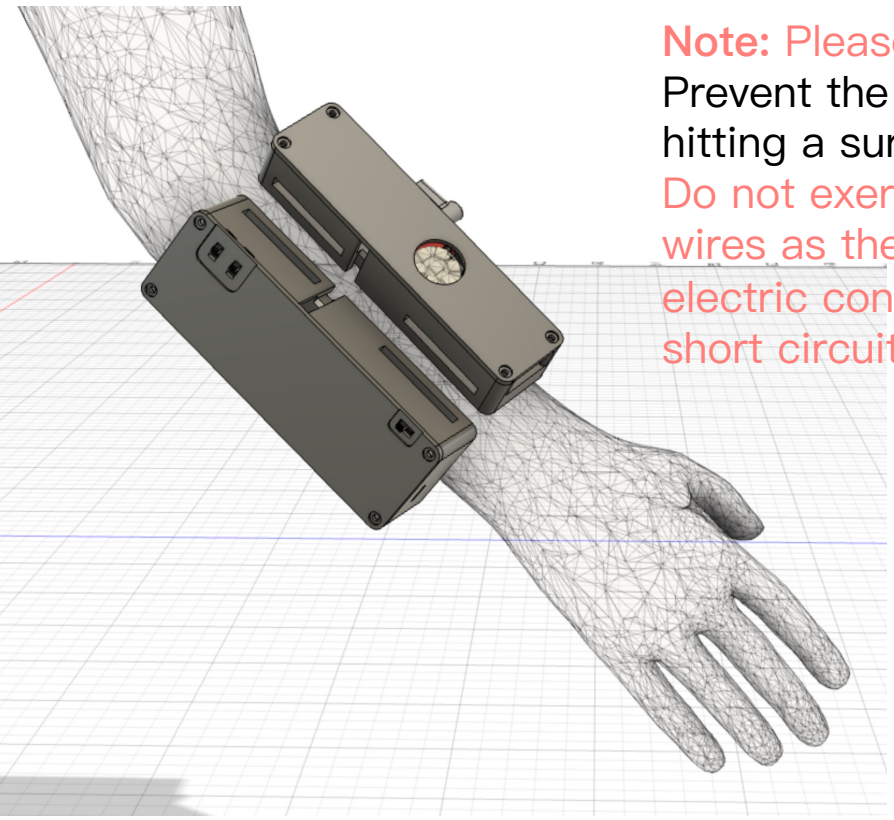
Vibration Motor

Reference Electrode

Main Battery

Lithium-ion
3.7v 2000mAh

How to position the sensor



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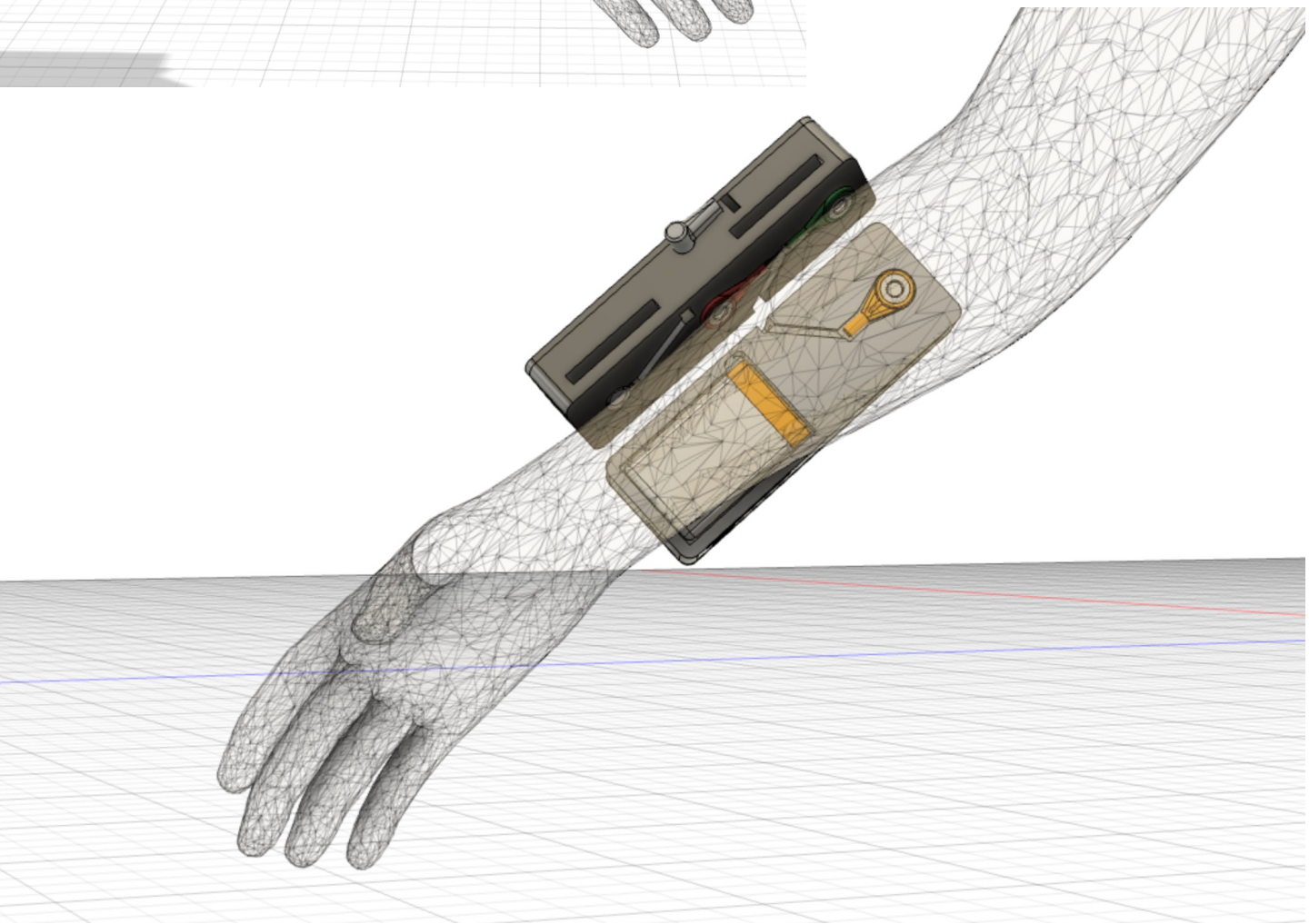
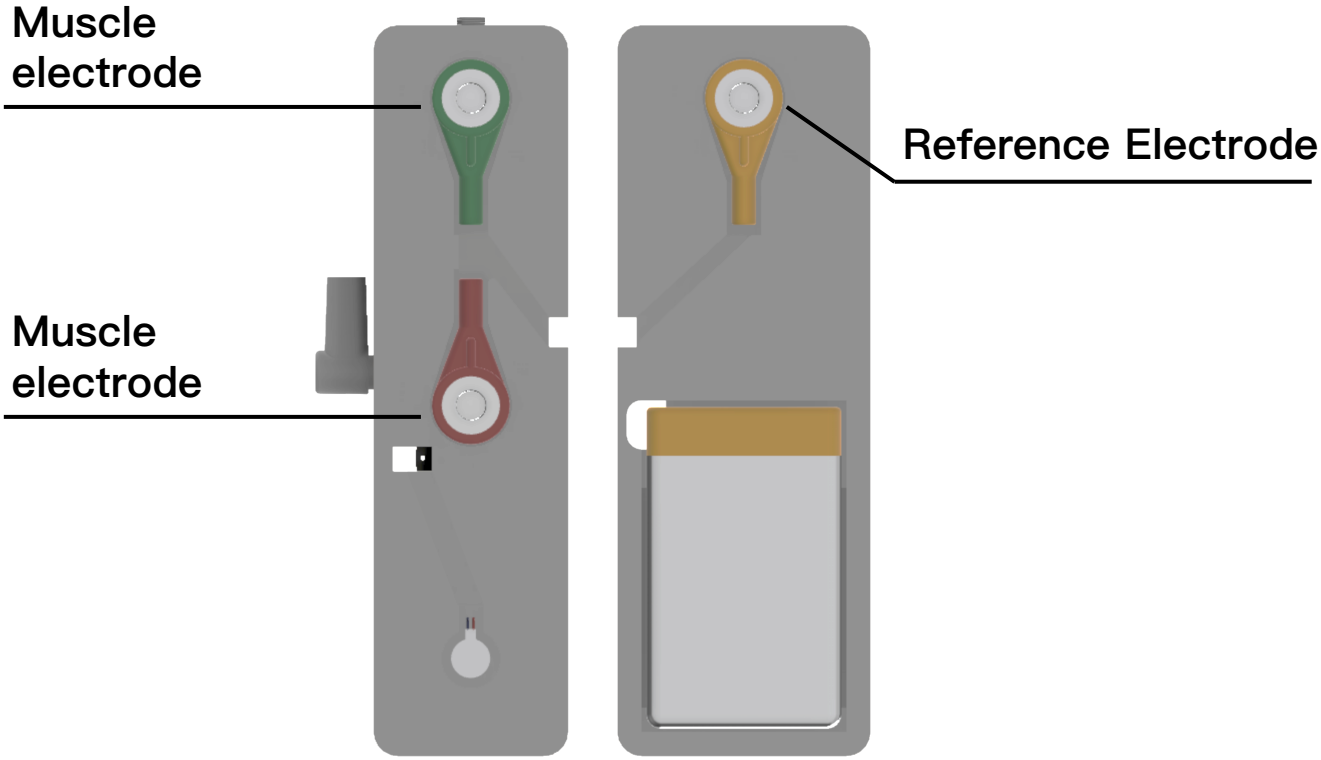


How to position the sensor



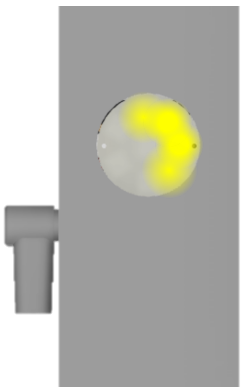
Step 1:
After determining which muscle group you want to target, clean the skin thoroughly.

Step 2:
Position the GREEN muscle electrode in the middle of the muscle body.

Step 3:
Position the RED muscle electrode in the end of the muscle body.

Step 4:
Position the YELLOW reference electrode on a bony or non-muscular part of your body near the targeted muscle.

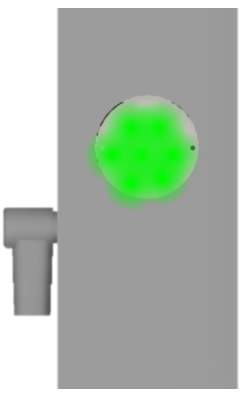
Usage



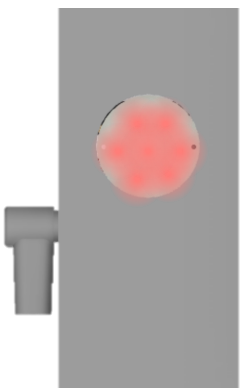
Step 1

Turn on the main power switch
If successful, the LED will display a yellow loading animation.

Then turn on BOTH sensor power switches



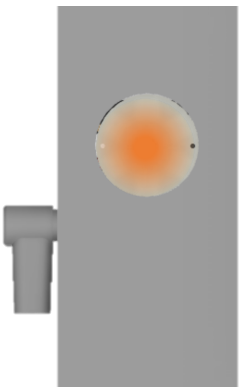
Connected to WiFi



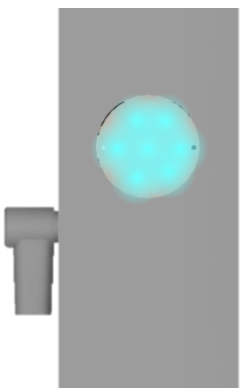
Connection Unsuccessful

Step 2

Green indicator means successful Wi-Fi connection, Red Light means Wi-Fi connection failed.



Normal Stand-by



Activated Switch Engaged

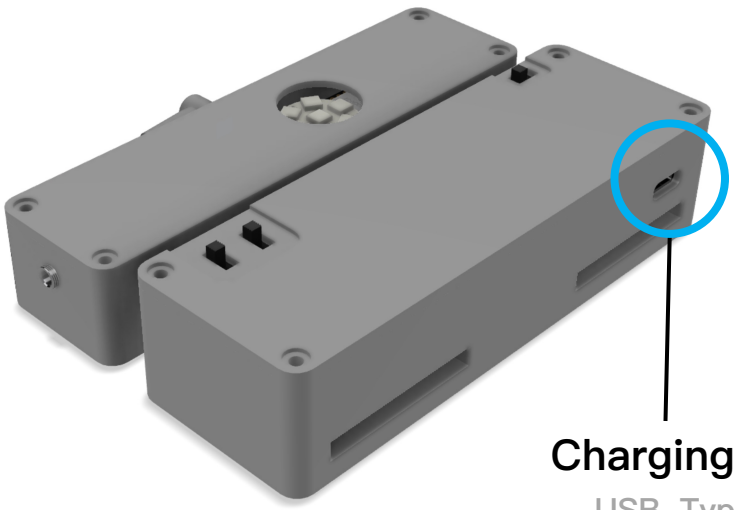
Step 3

After successful connection, the device will turn on a single colored LED indicator and entering stand-by, waiting for activation.

Power and Charging

The EMG Switch has TWO Power Sources.

01: Lithium–Ion Rechargeable Battery



- Do not poke or hard press, or overcharge the Lithium–ion battery

A 3.7v 2000mAh Lithium–Ion Battery is located on the Bottom of the device (refer to “Hardware” page). This Battery will power everything except the EMG Sensor.

This battery can be charged through the USB–C port on the side of the EMG Switch (As indicated above)

Note: The other Micro–USB Programming port will power on the device but will not charge the device.

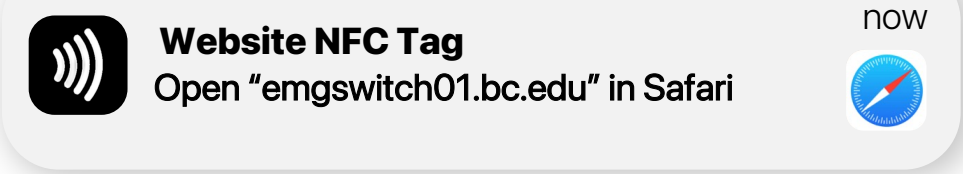
02: Two 9v Alkaline Batteries

These 9v batteries are required to provide reference voltage to the EMG sensor. Please make sure to switch on these batteries when using the device, otherwise the EMG sensor will only read and return zero value.

Visit Device Settings

Step 1

Make Sure your phone is connected to the same Wi-Fi Network as the EMG Switch



Step 2

Tap your phone just below the LED indicator to access the website hosted by the EMG switch.

Alternatively

If the EMG Switch is connected to Boston College "eduroam" network, manually visit http://emgswitch01.bc.edu on your browser.

If the EMG Switch is connected to other home Wi-Fi, manually visit http://emgswitch01.local on your browser.

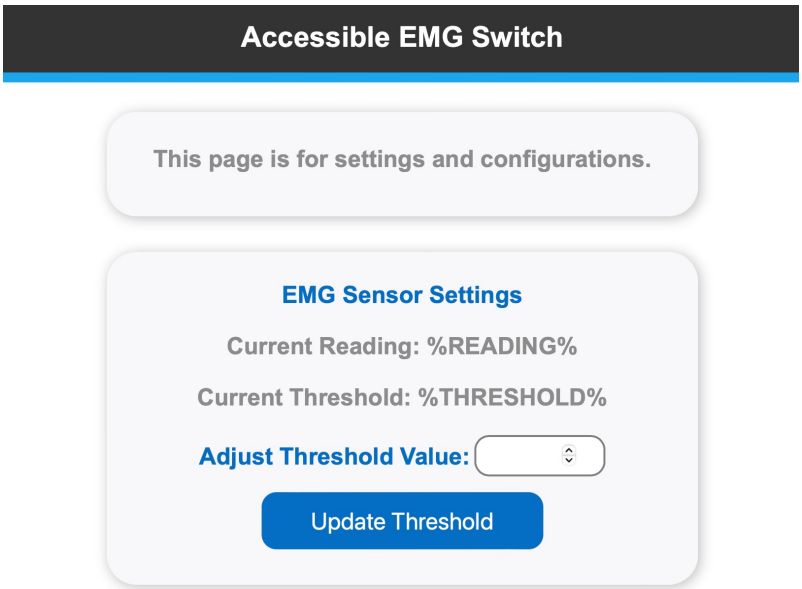
* If the webpage failed to load, check if the EMG switch is turned on and connected to the network,
Or restart the EMG Switch if necessary.

Visit Device Settings

Change Activation Threshold:

The EMG Sensor will read a value between 0 and 4095. When the muscle is exerting force, the higher the force (e.g. the tighter you grab the fist), the higher the reading.

The EMG Switch is set to trigger when the reading is above the threshold value.



As muscle strength differs from people to people, you might want to set a custom activation threshold for optimal user experience. You can do this by visiting device settings on any browser.

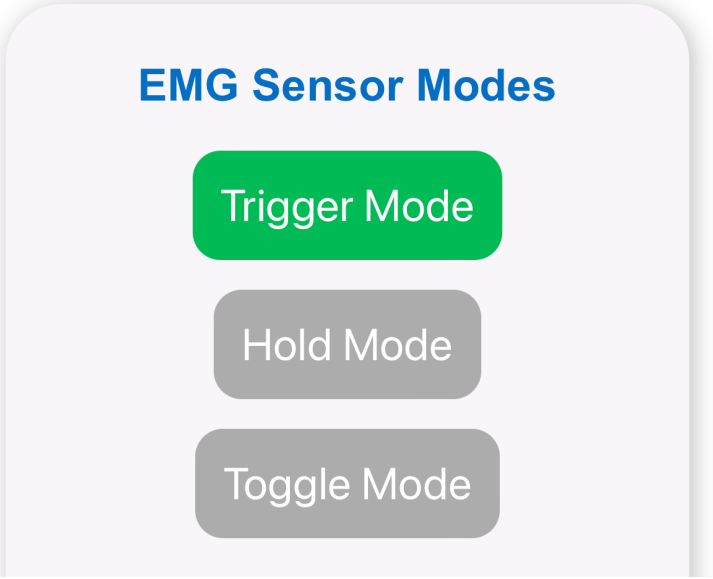
WARING:

The EMG Switch uses EEPROM to remember your settings, it has a limited number of write/erase cycles (you are only allowed to update threshold value ~100,000 times before unpredictable corruption in the EEPROM memory). Therefore, do not frequently update this value!

Visit Device Settings

Change Device Modes

The EMG Sensor has three Modes which can be configured in the settings page.



Trigger Mode (Default)

This is the Default mode for the EMG Switch. In this Mode, the switch will engage only for 0.5 seconds upon each activation.

Hold Mode

In this Mode, the switch will remain engaged as long as the reading is above the threshold. (i.e. the switch will stay on until the use loosen the muscle)

Toggle Mode

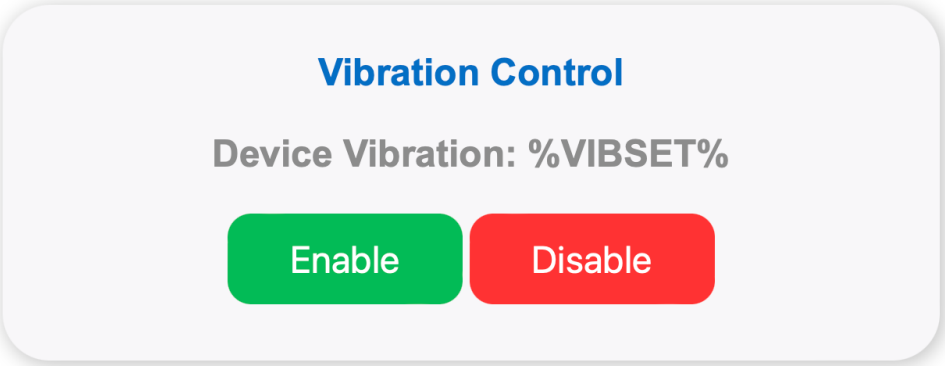
In this Mode, the first activation will engage the switch, and the next activation will disengage the switch.
(i.e. grip once to turn on, and grip again to turn off the switch)

Visit Device Settings

Enable/Disable Device Vibration:

The EMG Sensor is equipped with a vibration motor that will provide user haptic feedback when being activated.

You can enable and disable this behavior by visiting device settings on any browser.



WARING:

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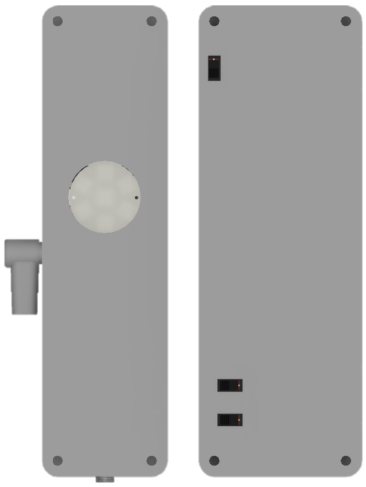
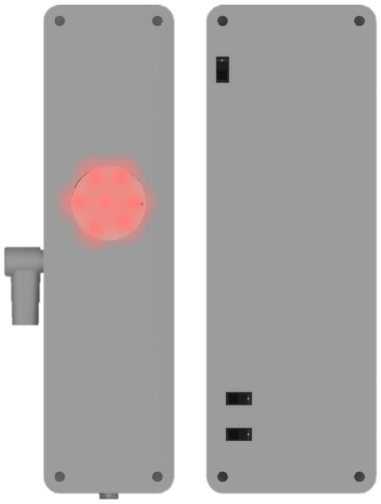
Troubleshoot



Q: After I turn on the switch, there is no yellow light?

A: Switch off, wait for the blue battery indicator to go off and try again.



Q: What to do if I got red lights on?

A: This means that the Wi–Fi connection is unsuccessful. Check Wi–Fi availability/signal strength/ or check if Wi–Fi password is changed.

By default, the EMG Switch is configured to connect to Boston College's **"eduroam"** network (unless someone changed ***wireless_config.h*** file in the source code)

In the case of changed Wi–Fi credentials (password, login), refer to **"How to configure Wi–Fi"** page and reupload the program.

However, you can always keep using the device (regardless of internet connection) by connecting a 3.5mm mono audio cable to the switch accessible device that you wish to control.

Troubleshoot

Q: I can't activate the switch with my gripping action, or the switch activates itself when I don't want it to?

A: First check if the sensor power switch is on, Or check if the sensor 9V batteries are depleted.

You can then adjust the threshold (sensitivity) of the EMG switch by visiting device settings on the browser

See "Visit Device Settings" page for details.

How to configure Wi-Fi

Step 1:

Find the source code for this project under:
https://github.com/EvanZhou1999/Accessible_EMG_Switch
download it, and open with Arduino IDE.

Step 2:

Locate “wireless_config.h” file and open it.

```
1  // ========================================================
2  // This is the header file for storing wireless configurations
3  // ========================================================
4
5
6  // WiFi - Configuration
7  //=================================================
8  const char* ssid = "ENTER YOUR WIFI NAME HERE";
9  const char* password = "ENTER YOUR WIFI PASSWORD HERE";
10 //=================================================
11
12 // WiFi - WAP2 Enterprise Configuration
13 // set this to true if you want to connect to eduroam
14 // set this to false if you want to connect to other Wi-Fi
15 bool UseWAPEnterprise = true;
16 //=================================================
17 const char* WAP2_SSID = "eduroam";
18 const char* EAP_IDENTITY = "ENTER YOUR EDUROAM USERNAME WITH @BC.EDU";
19 const char* EAP_PASSWORD = "ENTER YOUR EDUROAM PASSWORD";
20 //=================================================
21
22
23 // new Mac Address (not used)
24 // !!Becareful with reuse this code and cause duplicated Mac Address!!
25 uint8_t newMACAddress[] = {0x32, 0xAE, 0xA4, 0x07, 0x0D, 0x66};
26
27 // Server Configuration
28 // Once domain/Host name is changed, wait sometime for it to propagate (1-2h)
29 const char* domainName = "wifiswitch01";
```

If you want to connect to eduroam:

1. Put your username on line 18 after EAP_IDENTITY (with double quotes)
2. Put your password on line 19 after EAP_PASSWORD (with double quotes)
3. Change line 15 to:

    bool UseWAPEnterprise = true;

How to configure Wi-Fi

Continued

If you want to connect to other Wi-Fi networks:

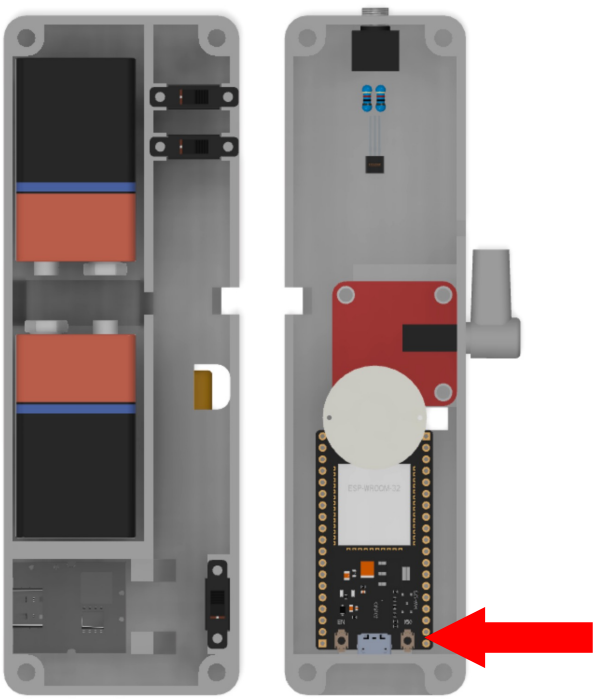
1. Put your Wi-Fi name on line 8 after ssid (with double quotes)
2. Put your password on line 9 after password (with double quotes)
3. Change line 15 to:

    bool UseWAPEnterprise = false;

Step 3:

Save file and hit upload button to upload the program to device

Follow instructions online to setup Arduino IDE for Esp32-WROOM-DA Module:



Remove top panel of the EMG Switch and use a micro-USB cable to connect the device to the computer.

Hold down this button while the console says “Uploading....”,