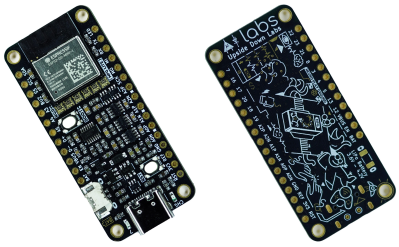
Neuro PlayGround (NPG) Lite

An expandable 3-channel wireless BioAmp for HCI & BCI

Overview

Neuro PlayGround Lite (NPG Lite) is a multichannel Adafruit feather form-factor wireless bio-physiological signal acquisition board. It can be used for Electrocardiography (ECG), Electromyography (EMG), Electrooculography (EOG), or Electroencephalography (EEG). Its compact footprint and hassle-free setup ensure portability, quick deployment and a clutter-free experience, making it ideal for research, education and wearable applications.



Features

- Expandable with NPG Playmate Boards and 3rd party FeatherWing boards, adding features like a vibration motor for haptic feedback, a buzzer for audio feedback, and I2C connectivity
- Works with the open source, cross-platform Chords software suite (Chords-Web, Chords-Python, Chords LSL Connector and Chords LSL Visualizer) to visualize signals in real-time, apply filtering, perform FFT analysis, and much more
- Dedicated NPG Lite Flasher tool to flash pre-built firmware binaries from GitHub or your own binary files
- Bluetooth, Zigbee, Wi-Fi or Thread for mesh networking, to capture bio-physiological signals how you want and where you want it

Specifications

Bio-signal Channels	3-6 Channel BioAmp (ECG, EMG, EOG, EEG)
Microcontroller	ESP32-C6 (RISC-V) with 4 MB Flash
Biopotential(s)	EXG
ADC Resolution	12 Bit
Wireless I/O	Wi-Fi 6, Bluetooth LE 5, Thread, Zigbee
USB & Programming	USB-C for power, charging & programming; UART, JTAG
LEDs	6 addressable RGB LEDs, User LED, Charging indicator LED
Buttons	Reset button + User/Boot Buttons
Power Options	USB-C or LiPo battery
Power Regulation	600 mA LDO with LiPo battery charging onboard
Battery Connector	PicoBlade LiPo
Form Factor	Standard Adafruit Feather (GPIO, Power, RX/TX pins)
Protection	On-board patient & USB ESD protection
Compatible Hardware	NPG Playmates & FeatherWing boards & QWIIC

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1 Neuro PlayGround (NPG) Lite

An expandable 3-channel wireless BioAmp for HCI & BCI



1.4 Board Layout & Pinout Diagram

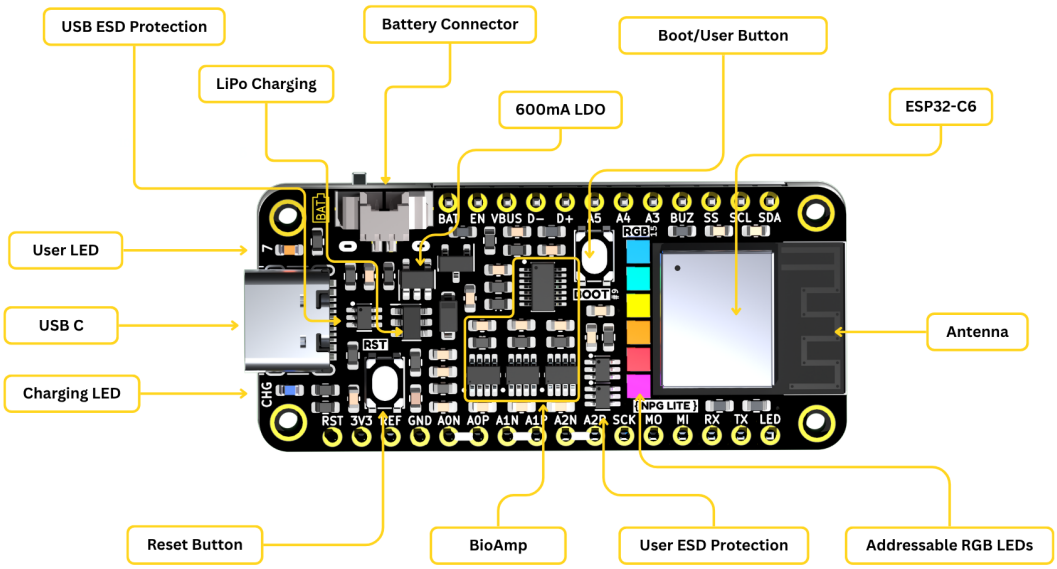


Fig. 1: Neuro PlayGround (NPG) Lite annotations

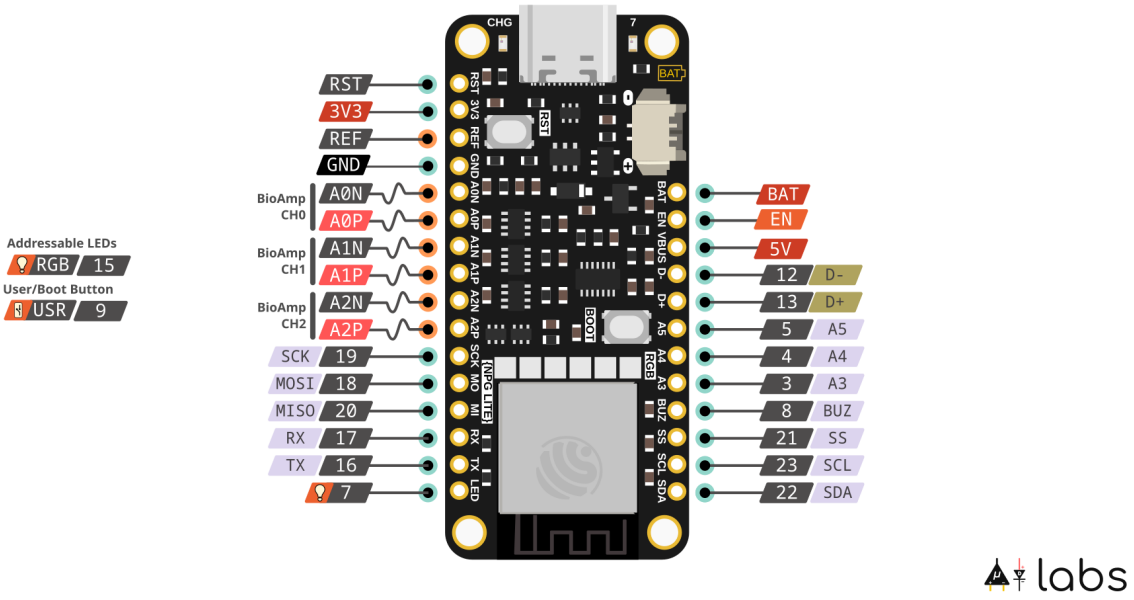


Fig. 2: Neuro PlayGround (NPG) Lite Pinout

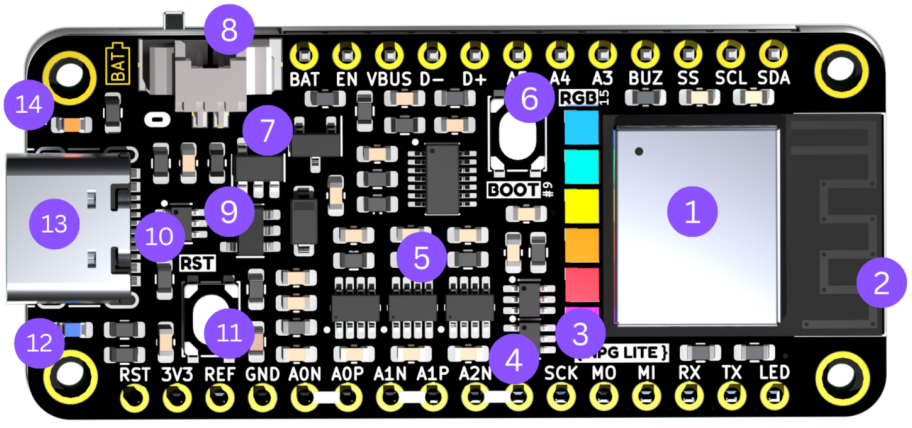


Fig. 3: Neuro PlayGround (NPG) Lite Components

1.5 Components

Number	Components	Description
1	**ESP32-C6**	The ESP32-C6 is a Wi-Fi 6 and Bluetooth 5 (LE) enabled microcontroller developed by Espressif Systems.
2	**Antenna**	The onboard PCB antenna is tuned for 2.4GHz, ensuring strong, stable Wi-Fi and Bluetooth connectivity with low power use.
3	**6 Addressable RGB LEDs**	Enables visualization of device states, signal strength, or neural feedback using dynamic color indicators.
4	**User ESD Protection**	ESD protection components, ensuring durability and reliability when connecting electrodes.
5	**BioAmp**	The onboard BioAmp is a low-noise, high-gain biopotential amplifier that captures and amplifies EMG, ECG, and EEG signals for digital processing by the ESP32-C6.
6	**Boot/User Button**	The Boot/User button enables bootloader mode for firmware flashing and serves as a programmable user input.
7	**600mA LDO**	The voltage regulator converts higher input voltages (USB or battery) into a stable 3.3V output.
8	**Battery Connector**	It offers a safe, port for battery power, allowing portable operation of the board. **Note:** There is no polarity protection.
9	**LiPo Charging**	The integrated LiPo charging controller safely manages charging cycles, supporting automatic termination and trickle charging for optimal battery health.
10	**USB ESD Protection**	USB ESD protection shields the interface from electrostatic and voltage spikes, ensuring reliable data transfer and preventing component damage.
11	**Reset Button**	The reset button restarts the microcontroller and running program without power loss, aiding debugging and firmware testing.
12	**Charging LED**	The orange Charging LED indicates battery charging status, lighting during charging and turning off when fully charged for immediate feedback.
13	**USB C**	USB C port for data transfer and power input.
14	**User LED**	A programmable LED on a GPIO pin used to show board activity, connection status, or custom signals during development.

1.6 Explorer, Ninja, and Beast!

If you're comfortable with soldering and only need a 3-channel wireless BioAmp, the **Explorer Kit** is a great choice. For the most complete NPG Lite experience right out of the box, go with **Ninja Pack**. If you require additional channels for full-body signal acquisition or advanced experimentation, the **Beast Pack** offers the most comprehensive configuration.

Pack Options	Explorer	Ninja	Beast
NPG Lite	Included	Included	Included
Playmate Type	Proto	VibZ	VibZ+
Channel Count	3 Channels	3 Channels	6 Channels
Gel Electrodes	12 Pieces	24 Pieces	24 Pieces
Snap Cables	7 Pieces	7 Pieces	13 Pieces
Alligator Cables	5 Pieces	5 Pieces	8 Pieces
Battery Cable	Included	Included	Included
LiPo Battery	Not Included	Included	Included
3D Printed Case	Not Included	Included	Included
USB Cable	Not Included	Included	Included

1.7 Playmates

Playmates are modular expansion boards designed to enhance the functionality of Neuro PlayGround (NPG) Lite. These add-ons seamlessly integrate with the core system, allowing users to extend their capabilities to create awesome Human-Computer Interface (HCI) & Brain-Computer Interface (BCI).

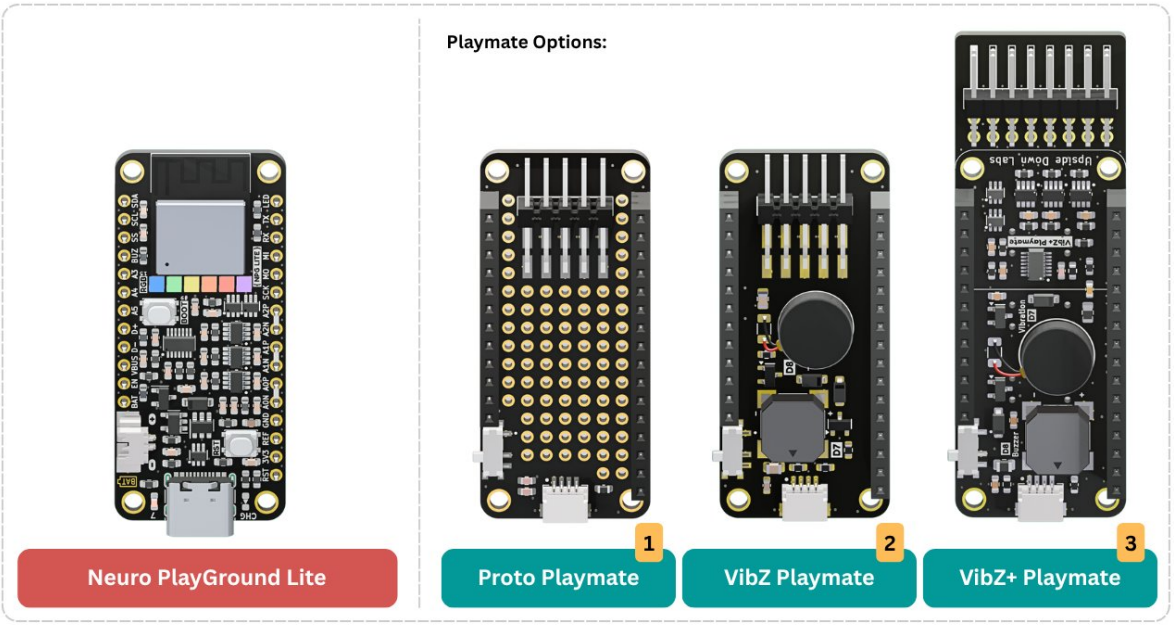


Fig. 4: Neuro PlayGround (NPG) Lite Playmates

1.7.1 Need of Playmate

Playmate offer a convenient way to expand the functionality of your NPG Lite setup without complex wiring or modifications. It easily plug into NPG Lite's Feather compatible headers, providing additional features such as

1. Proto Playmate

a. ON/OFF switch for power control
b. QWIIC/Stemma QT port
c. Electrodes connector
d. Large prototyping area for custom circuits

2. VibZ Playmate

a. ON/OFF switch for power control
b. QWIIC/Stemma QT port
c. Electrodes connector
d. Vibration motor for haptic feedback
e. Buzzer for audio feedback

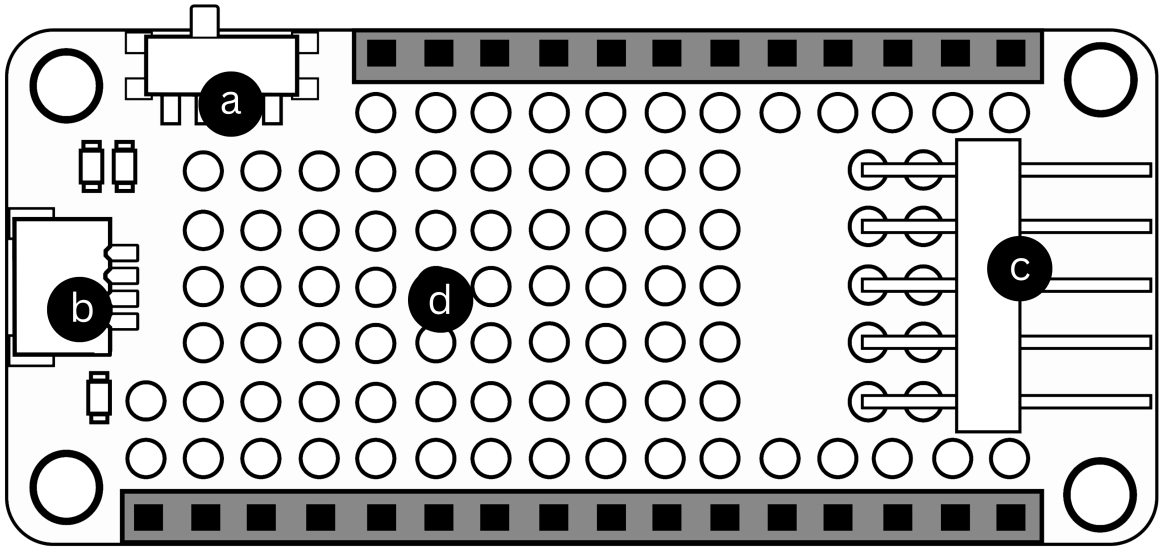


Fig. 5: Neuro PlayGround (NPG) Lite Proto Playmate

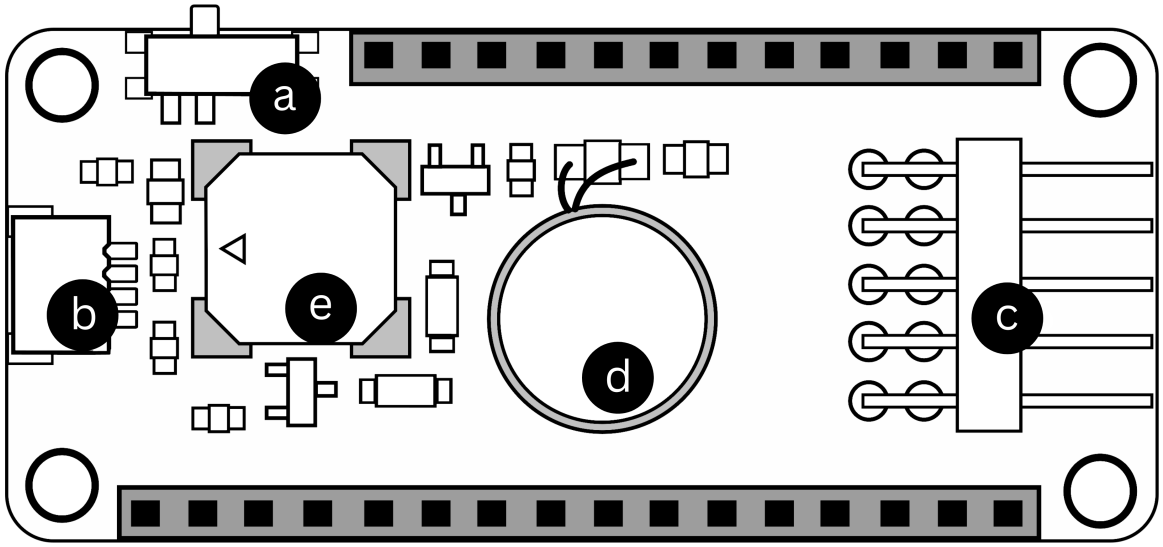


Fig. 6: Neuro PlayGround (NPG) Lite VibZ Playmate

3. VibZ+ Playmate

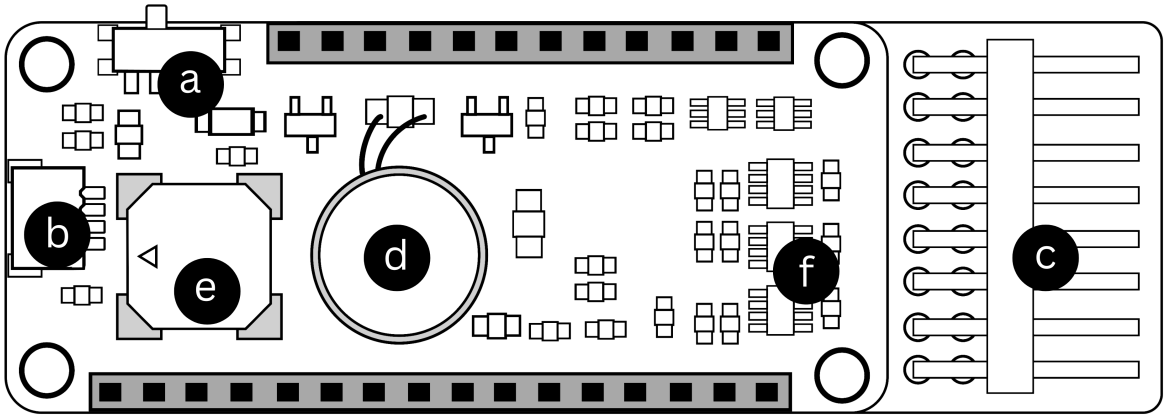


Fig. 7: Neuro PlayGround (NPG) Lite VibZ+ Playmate

a. ON/OFF switch for power control
b. QWIIC/Stemma QT port
c. Electrodes connector
d. Vibration motor for haptic feedback
e. Buzzer for audio feedback
f. Additional 3 channel BioAmp (total 6 channels)

1.7.2 Comparison of Playmates

Feature	Proto	VibZ	VibZ+
Bio Channels	3	3	6
Prototyping Area	Yes(Large)	No	No
Haptic Feedback	No	Yes (Vibration)	Yes (Vibration)
Audio Feedback	No	Yes (Buzzer)	Yes (Buzzer)
QWIIC Port	Yes	Yes	Yes
Power Switch	Yes	Yes	Yes
Electrode Headers	Dupont 2.54 mm	Dupont 2.54 mm	Dupont 2.54 mm
Common Negative	Solder option	Solder option	Switch
Best For	Development	Complete Projects	Research

1.8 Usage Guide

To help you get started quickly, we've prepared a step-by-step video tutorial. This guide walks you through setup, connections, and running your experiments with the Neuro PlayGround Lite.

https://youtu.be/hBrbw9vF-m4

Troubleshooting

Having trouble connecting your **NPG Device** with Chords Web?

If you try to connect the device and the pop-up window for **Bluetooth Connection** doesn't appear, make sure your chromium based browser has following feature Enabled:

1. Open a new tab and go to `chrome://flags`
2. Find and enable the following flags:
   - **Web Bluetooth**
   - **Use the new permissions backend for Web Bluetooth**
   - **Web Bluetooth confirm pairing support**
   - **Experimental Web Platform features**

1.9 Compatible Software

1.9.1 Flasher Tools

NPG Lite Flasher Web

- NPG Lite Flasher Web is a browser-based flashing tool for the Neuro PlayGround Lite and other ESP32-based boards. It needs no Arduino IDE or additional setup: connect your device, select the BLE, Wi-Fi or Serial firmware you need, and flash it directly from the browser in seconds.

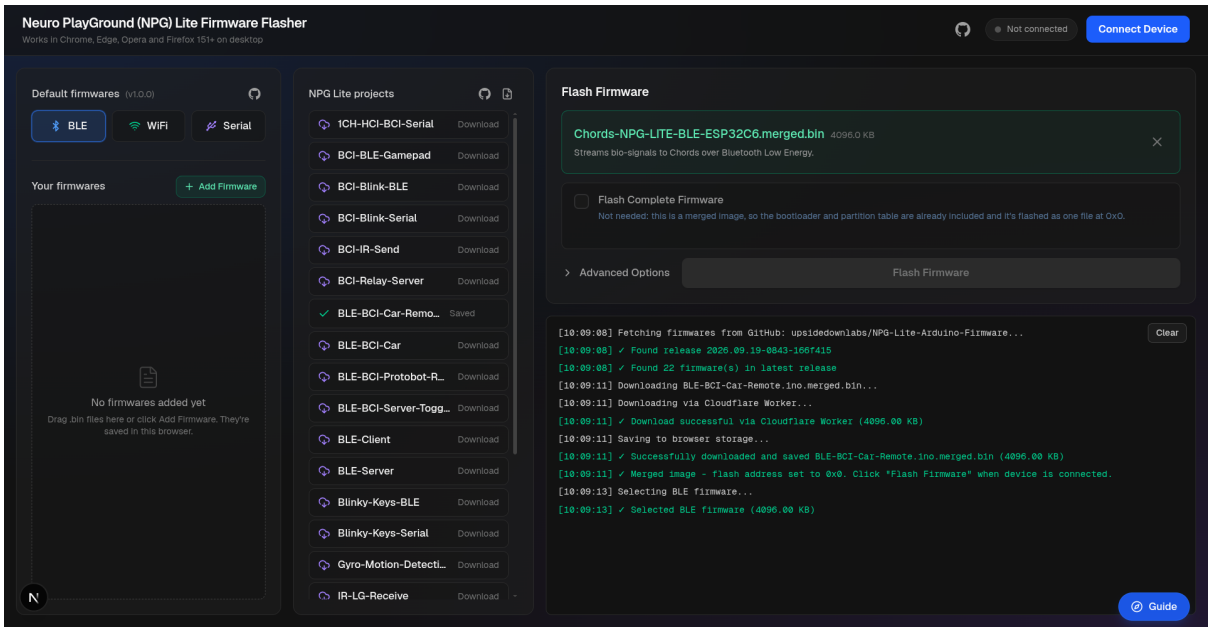


Fig. 8: NPG Lite Flasher Web Landing Page

- To know more about NPG Lite Flasher Web watch the YouTube video.

https://youtu.be/sKYY074Yg3A

NPG Lite Flasher App

- NPG Lite Flasher is a cross-platform, flashing utility for the Neuro PlayGround Lite board, providing seamless firmware updates over serial or DFU via a simple CLI.

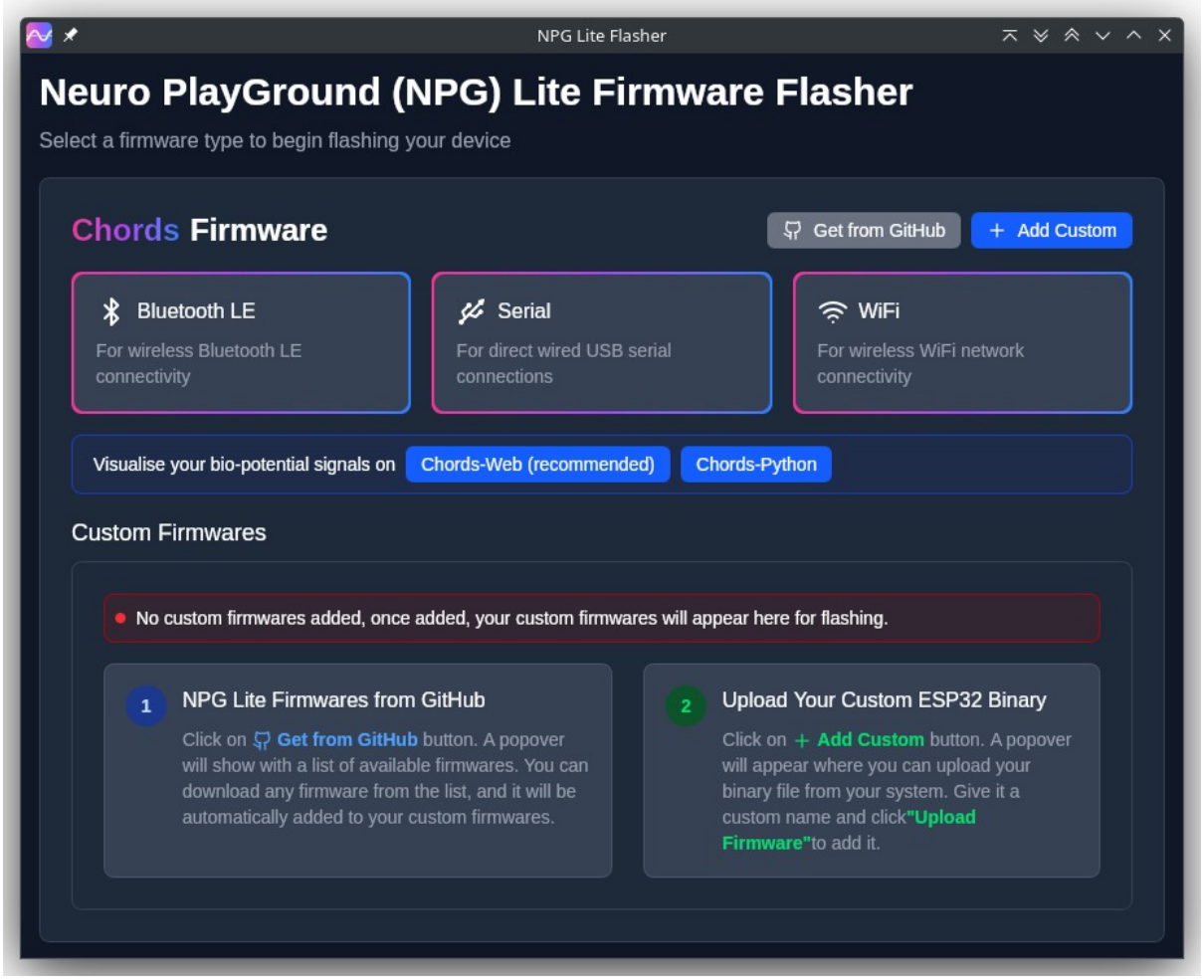


Fig. 9: NPG Lite Flasher Landing Page

- To know more about NPG Lite Flasher watch the YouTube video.

https://youtu.be/NDk-P3nob_0

1.9.2 Chords Web

- Visit Chords Web for real-time biopotential signal visualization (EEG, EMG, ECG, EOG), featuring advanced plotting, filtering, snapshotting and CSV recording. Flash the Chords-Arduino-Firmware on your board to visualize signals on Chords Web.

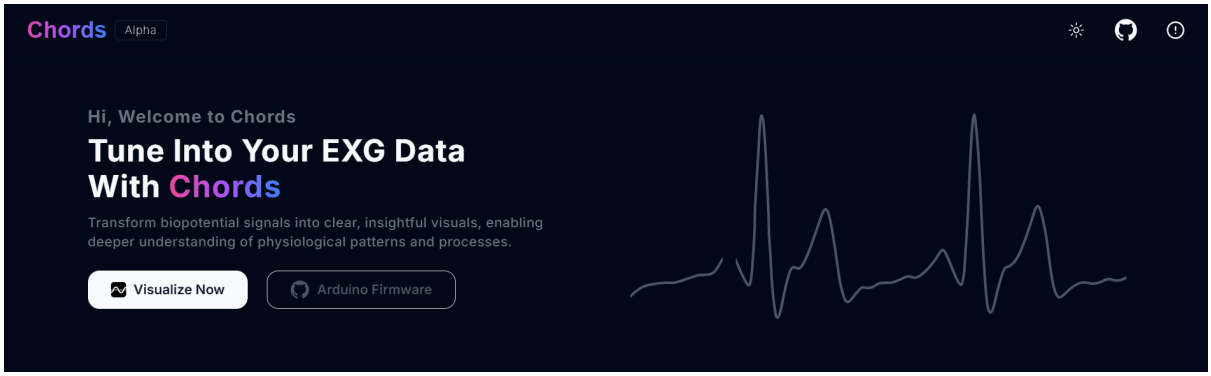


Fig. 10: Chords Web Landing Page

- To know more about Chords Web click here or watch the YouTube video.

https://youtu.be/Tqor4mo2Ji8

1.9.3 Chords Python

- Chords Python is an open-source bag of tools for recording biopotential signals like ECG, EMG, EEG, or EOG, along with visualization using BioAmp hardware.

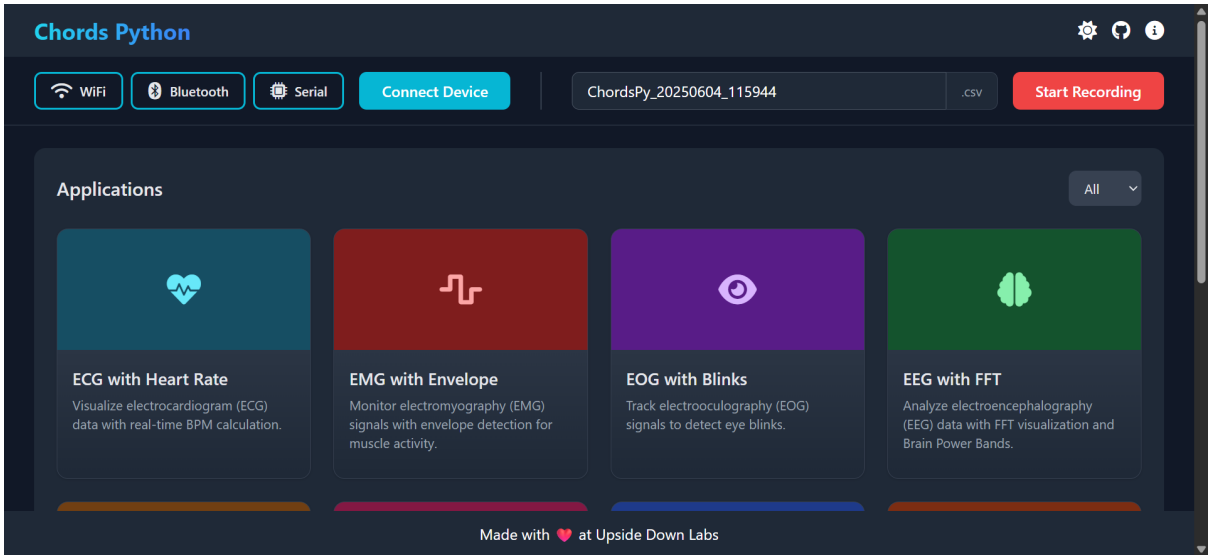


Fig. 11: Chords Python Landing Page

- To know more about Chords Python watch the YouTube video.

https://youtu.be/TiDwSQEY2eY

1.9.4 Chords LSL Connector

- Chords LSL Connector is a Rust based bridge that streams data from devices running Chords firmware into the Lab Streaming Layer (LSL), enabling synchronized acquisition and analysis with BCI/EEG software.

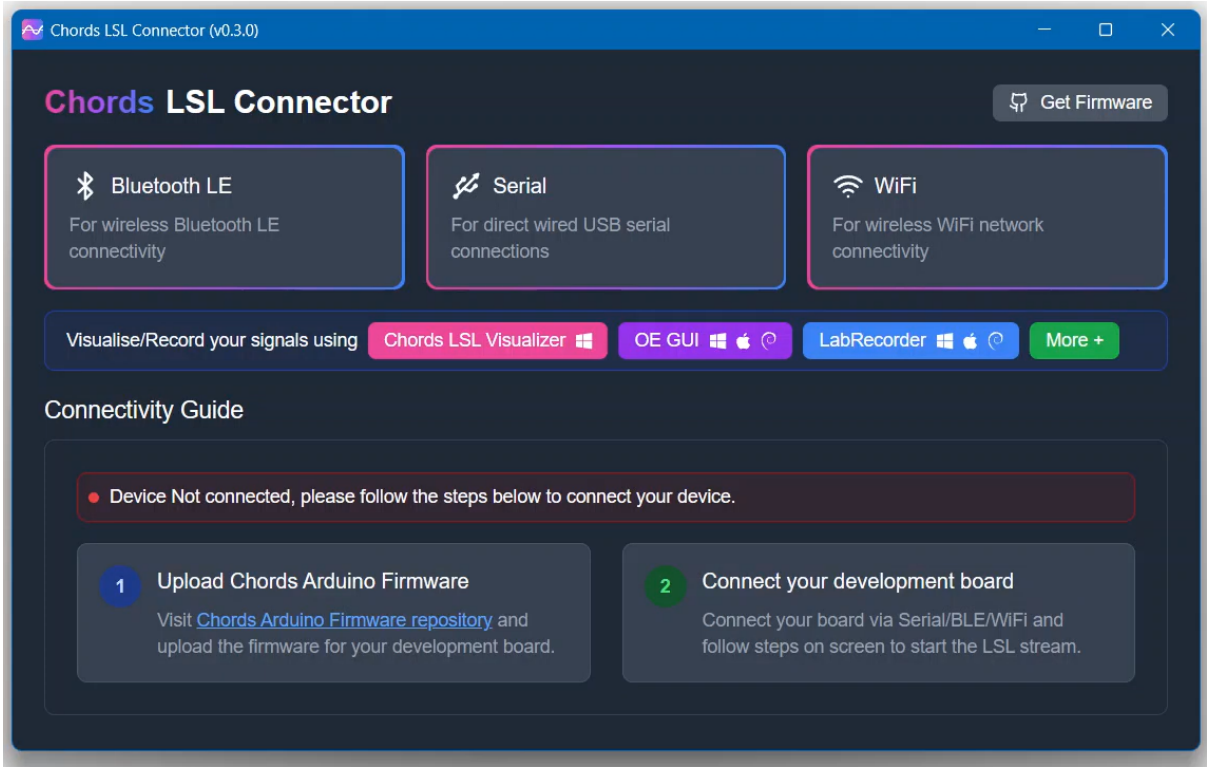


Fig. 12: Chords LSL Connector Landing Page

- To know more about Chords LSL Connector watch the YouTube video.

https://youtu.be/94lPImB0eRo

1.9.5 Chords LSL Visualizer

- Chords LSL Visualizer is a Rust based program to visualize biopotenial signals from any LSL stream.

1.10 Project Tutorials

NPG Lite, with its multi-channel BioAmp, wireless connectivity, battery operation, and expansion interface, allows users to create HCI and BCI applications with ease. We've created projects leveraging ECG, EMG, EOG, and EEG signals to inspire you, but the possibilities cover so many more use cases.

Note

Each of these projects runs on the `BLE firmware`, which you can flash using the following flasher tools:

- For flashing BLE Firmware, you may use either the NPG Lite Flasher Web or the NPG Lite Flasher App.
- Alternatively, you can use Arduino IDE to manually upload the firmware.
- It is recommended to use ESP32 version `3.2.0` to ensure error free operations.



Fig. 13: Chords LSL Visualizer Landing Page

1. Make Muscular Music This is a human-computer interface (HCI) that uses 3-channel EMG data to detect muscle signals from the left hand, right hand, and chest to control virtual musical instruments. When muscles contract, each channel triggers a distinct sound effect, transforming your body into an organic orchestra.

https://youtu.be/O36z_YhaDqg

Note

- To learn about this project, visit our Instructables page for detailed guide: Muscle Melody: Create Music With Your Muscle Movements (EMG)
- Visit the Web Interface to visualize in real time.

2. Track Your Ticker This project focuses on capturing electrocardiogram (ECG) signals to calculate heart rate using Neuro PlayGround Lite and displaying them in a Chrome-based browser on a mobile phone in real-time via a Bluetooth LE connection.

https://youtu.be/2UDBqEsjJSI

Note

- To learn about this project, visit our Instructables page for detailed guide: Monitor ECG and Heartrate on Your Mobile Phone
- Visit the Web Interface to visualize in real time.

3. Jump In the Blink of an Eye Instead of using the keyboard, you can control a game simply by blinking. The setup detects EOG signals from the eyes, sends the data over Bluetooth LE to the PC, detects eye blinks, and then takes the eye blink as a trigger to emulate the spacebar keystroke. You can configure the code to simulate any other keystroke as well.

https://youtu.be/ZJmUUtHJj08

Note

- To learn about this project, visit our Instructables page for detailed guide: Controlling Keyboard With Eye Blinks Using Neuro PlayGround Lite

4. Pop Bubbles With Your Mind This project showcases a brain-computer interface (BCI) application that utilizes EEG (electroencephalography) signals to operate an interactive bubble-popping game in a web browser. The system identifies beta wave activity (12–30 Hz), indicating concentration and attention levels. Bubbles appear and pop as the user maintains focus, but they cease to pop when concentration wanes.

https://youtu.be/MGTNjFtikZE

Note

- To learn about this project, visit our Instructables page for detailed guide: Pop Bubbles With Your Mind (EEG) | Neuro PlayGround (NPG) Lite
- Visit the Web Interface to visualize in real time.

5. CortEX CortEX is an open-source neurofeedback meditation platform that combines EEG and ECG signals to provide real-time feedback on your mental and emotional state. Designed to enhance mindfulness, it visualizes brainwave activity, heart rate, and hemisphere balance to help you meditate more effectively - all from your browser, using the NPG Lite device.

https://youtu.be/O3F-0UWxNfA

Note

- To learn about this project, visit our Instructables page for detailed guide: A Neurofeedback Meditation Journey
- Visit the Web Interface to visualize in real time.

6. Brain-Controlled Car: EEG + EMG Robotic Control The Brain-Controlled Car transforms brainwaves (EEG) and muscle activity (EMG) into real-time robotic control, letting you steer a car without traditional remotes - just focus your mind to move forward, flex your left or right arm to turn, or both arms to reverse. Powered by the Neuro PlayGround Lite, a wireless biopotential device, the system captures your signals via electrodes and transmits them over BLE to an ESP32-based receiver that drives the motors. This project offers a hands-on glimpse into the future of human–machine interaction, where thoughts and movements seamlessly command machines.

https://youtu.be/US_cDCRjV6c

Note

- To learn about this project, visit our Instructables page for detailed guide: Brain-Controlled Car :EEG + EMG Robotic Control

7. Playing GTA V with Your Focus & Muscles Control GTA V using your mind! The Brain-Controlled Gaming system uses the wireless Neuro PlayGround Lite to translate your brainwaves (EEG) and muscle contractions (EMG) into game controls. Focus to accelerate, and flex your left or right arm to steer. This BCI project delivers a mind-bending glimpse into the future of gaming, letting you command your car with nothing but your body signals.

https://youtu.be/LhvBo8MP7iQ

8. Cuboid Cuboid is a neurofeedback-powered game that turns your focus into action. Using real-time brainwave data from the NPG Lite device, the game challenges you to move a geometric cuboid upward by maintaining mental focus. With multiple difficulty levels, live EEG streaming, and visual feedback, Cuboid transforms concentration into an immersive, brain-controlled experience.

Note

- Visit the Web Interface to visualize in real time.

9. Muscle Strength Muscle Strength Game transforms your physical efforts into insightful data. Simply connect to any muscle group you want to focus on, and you'll instantly visualize the raw electrical activity your muscles generate. But it's more than just raw data; the game also processes this information to display your real-time muscle strength. This allows you to track your progress, identify areas for improvement, and engage with your workouts in a whole new, data-driven way. Whether you're an athlete, rehabilitating an injury, or just curious about your body, this project offers a unique window into your muscular capabilities.

Note

- Visit the Web Interface to visualize in real time.

10. Mind-to-Words Using EEG Mind-to-Words (M2W) application is an innovative Assistive Communication tool that enables users to control a menu interface solely through eye blinks. It utilizes the EOG artifacts present in a single channel EEG signal, which is captured by the NPG Lite device. The core functionality relies on a novel algorithm that separates and recognizes distinct control signals: a double blink is used to activate or switch between options, while a triple blink is used to confirm and make a selection.

https://youtu.be/UyXsqCrVxh4

Note

- M2W Web Application: Web Interface

Neuro-PlayGround Lite C3 (Obsolete)

Overview

Neuro Playground (NPG) Lite is a multichannel wireless bio-potential signal amplification device designed for recording EMG, ECG, EOG, and EEG. It comes in a compact Adafruit feather form factor and offers WiFi/BLE wireless connectivity. With the addition of daughter boards called Playmates, users can easily enhance the device's capabilities, enabling the students/researchers/hobbyists to create awesome Human-Computer Interface (HCI) and Brain-Computer Interface (BCI) applications.

Features & Specifications

No. of channels	3
Power options	USB type C or LiPo battery
Microcontroller	ESP32-C3 (RISC-V) with 4MB Flash
Power supply	600mA LDO with filtering
Connectivity options	WiFi, Bluetooth, USB
Debugging options	JTAG, UART
LEDs	User LED, charging LED, 6 addressable RGB LEDs
Buttons	Reset & user button
BioPotentials	EMG, ECG, EOG and EEG
Compatible hardware	NPG Playmates & FeatherWing boards
Protection	Built-in patient & USB ESD protection

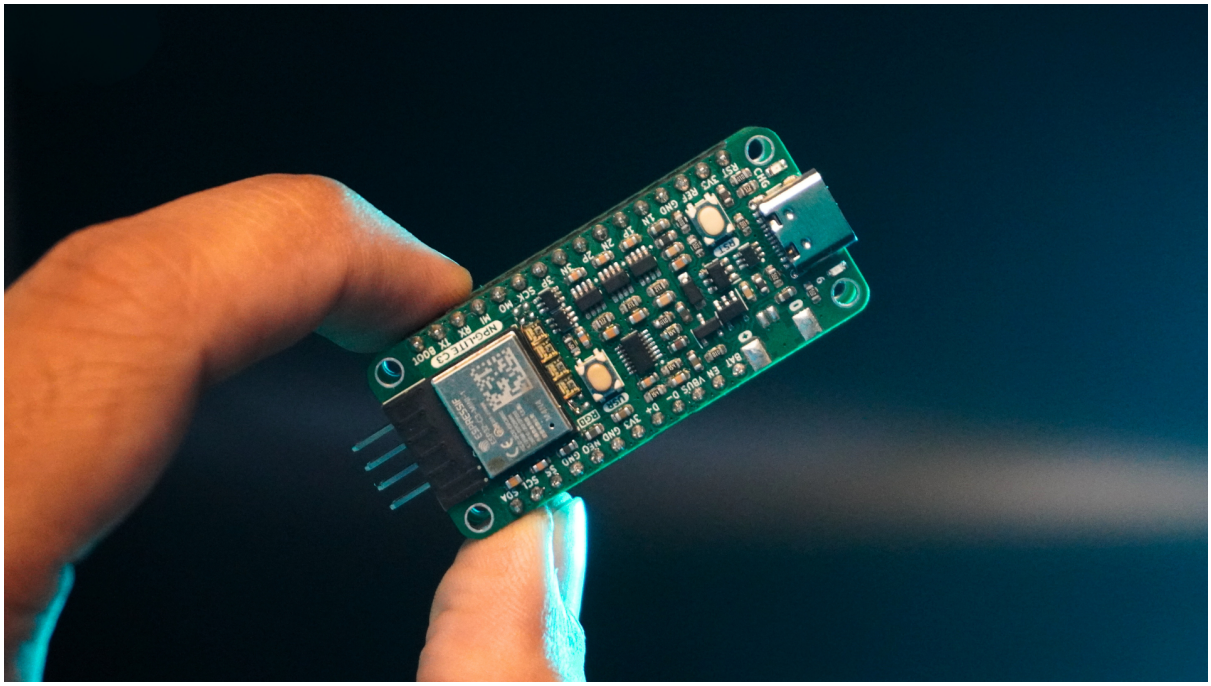


Fig. 14: Neuro PlayGround (NPG) Lite C3

Board Layout

Playmates

Playmates are modular expansion boards designed to enhance the functionality of **Neuro Play Ground (NPG) Lite**. These add-ons seamlessly integrate with the core system, allowing users to extend their capabilities to create awesome Human-Computer Interface (HCI) & Brain-Computer Interface (BCI).

VibZ

The first Playmate, **VibZ**, introduces haptic feedback, a buzzer, a QWIIC port for easy sensor integration, an ON/OFF switch, and electrode header pins. With these Playmates, users can customize their setup for specific applications, whether in research, education, or interactive biofeedback experiments. This modular approach ensures flexibility, scalability, and better user experience.

Features & Specifications

2.54mm Dupont header pin for electrode connection
Vibration motor for haptic Feedback motor
Buzzer for audio feedback
QWIIC / STEMMA QT I2C port
ON/OFF Switch

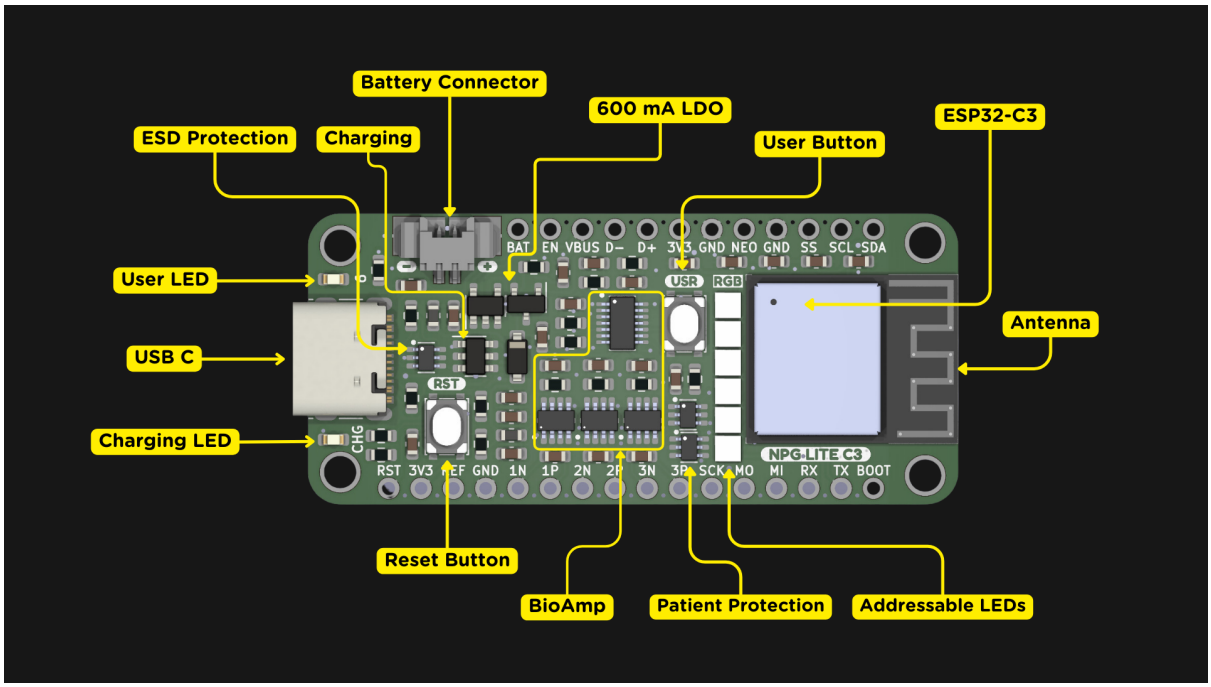


Fig. 15: Neuro PlayGround (NPG) Lite C3 annotations

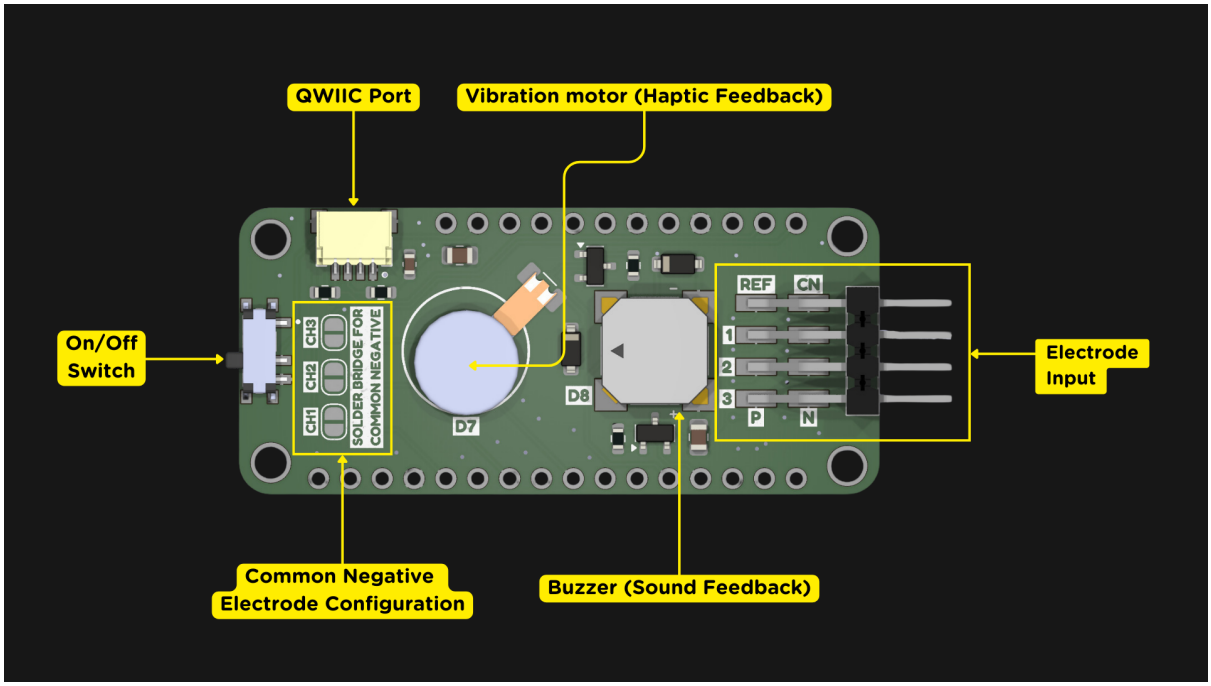


Fig. 16: VibZ Playmate