muscleBAN BLE

Datasheet

muscleBAN BLE
Designed & Made in Portugal

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For a getting started guide, visit the following article:
https://support.pluxbiosignals.com/knowledge-base/muscleBAN-ble-getting-started/

For support visit
www.support.pluxbiosignals.com

MUSCLEBAN BLE (2024)

General Information

Introducing muscleBAN BLE, your go-to wireless wearable for hassle-free EMG and motion data collection.

Designed with your comfort in mind, it's the solution for seamless research in any setting. Say goodbye to bulky, uncomfortable devices – muscleBAN is designed to ensure user comfort, even during dynamic activities. Plus, it's ready to use as a medical device OEM. Talk to our team for more info.

Specifications

> On-Board Sensors:	1x Single-Lead EMG 1x Triaxial Accelerometer 1x Triaxial Gyroscope
> Sensor Ranges	EMG: ±2.5mV Accelerometer: ±8g Gyroscope: ±500dps
> Communication:	Bluetooth Low Energy (BLE) (v.5.3)
> Communication Range:	Up to 10m (in line of sight)
> Internal Memory:	Up to 10h
> Battery:	Rechargeable 155mA 3.7V LiPo
> Battery Lifetime:	Up to 10h in continuous streaming
> Charging Port:	Micro-USB compatible with an standard USB Charger
> Size:	31x71x11mm
> Weight:	27g

Features

> Wearable for single-channel EMG & motion data acquisition
> EMG measurements with virtual ground (the reference point is internally created)
> Raw signal acquired at 1000Hz
> Miniaturized and bendable form factor for better adaption to the body shape

Applications

This product is designed for life science education and research. It is not a medical device and is not suitable for any kind of medical use.

> Life sciences studies
> Biomedical studies
> Human-Computer Interaction
> Robotics & Cybernetics
> Physiology studies
> Psychophysiology
> Biomechanics
> Ergonomics

Electrical Specifications

	EMG	ACC	GYR
Number of channels	1	3	3
Resolution	16 bit	16 bit	16 bit
Input full-scale	+/- 2.5mV	+/-8G	+/-500dps
Analog bandwidth	[0.05Hz to 150Hz]	[dc to 415Hz]	[dc to 315Hz]
Sample rate	1000Hz	1000Hz	1000Hz

Application Notes

A detailed Getting Started guide covering everything needed around the muscleBAN is available on our support page:

https://support.pluxbiosignals.com/knowledge-base/muscleBAN-ble-getting-started/

Turning the Device On & Off

Figure 1: muscleBAN On (left) & Off (right) switch

Electrode Setup

muscleBAN EMG signals are measured using a bipolar setup, which means that two measuring electrodes with a positive (IN+) and a negative (IN-) lead are placed on the muscle of interest to measure the voltage imbalances.

The negative electrode collection is located on the backside of the device part that contains the Status LED. The positive electrode is located on the backside of the device, which contains the muscleBAN logo and the Battery LED.

The polarity of the electrodes is interchangeable in muscleBAN EMG sensors, i.e., you can place the muscleBAN in both ways to measure EMG data correctly. The position of the electrodes is the key element to pay attention to.

Generally, the straightforward approach to find the best positioning is to place the muscleBAN along the center of the muscle with the electrodes being placed along the muscle fibres. As shown in the folllowing illustration using the Biceps muscle as an example:

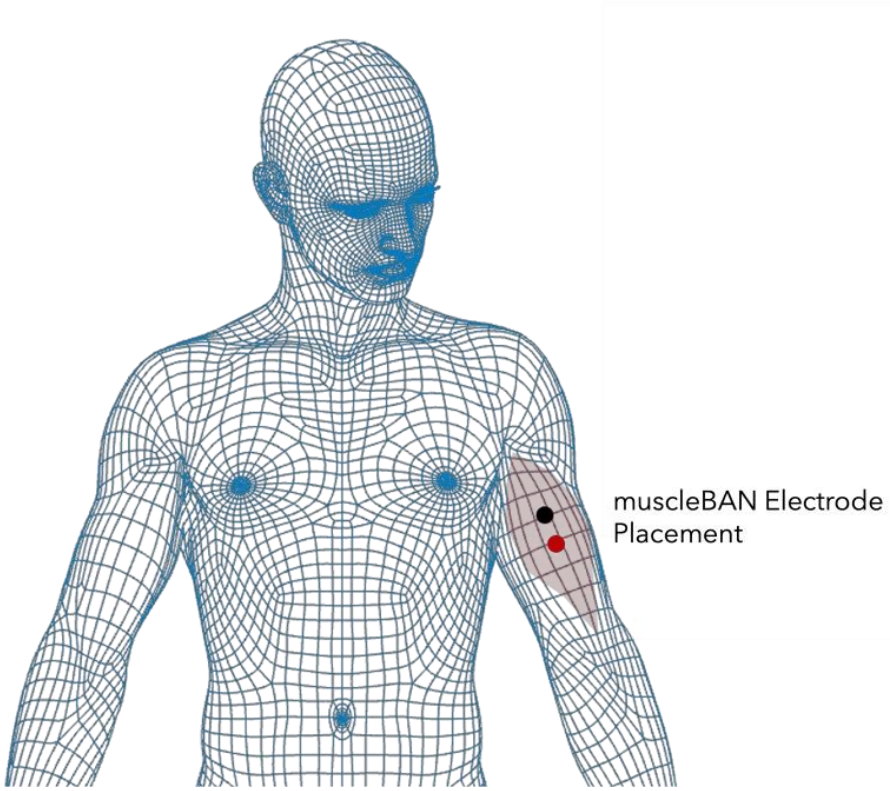


Figure 2: muscleBAN example placement.

We recommend reviewing also the following articles for additional instructions on skin preparation and further example placements for EMG recordings:

- https://support.pluxbiosignals.com/knowledge-base/electrode-skin-preparation-tutorial/
- https://support.pluxbiosignals.com/knowledge-base/where-should-i-place-my-electromyography-emg-electrodes/

Motion Sensor Axes & Orientation

muscleBAN comes with built-in triaxial Accelerometer and Gyroscope for motion sensing. The default axis layout for the triaxial motion of the Acceleroemter is set as follows:

Figure 3: muscleBAN motion sensor axes.

Depending on the orientation of your sensor, the axis can change. It's recommended to test the orientation of your muscleBAN with your sensor data to identify the matching signals. In an Accelerometer, the most prominent axis to identify is the vertical Z-axis, which is naturally offset by approximately 1G because the Earth's gravitational force accelerates along this axis.

LED Color Codes

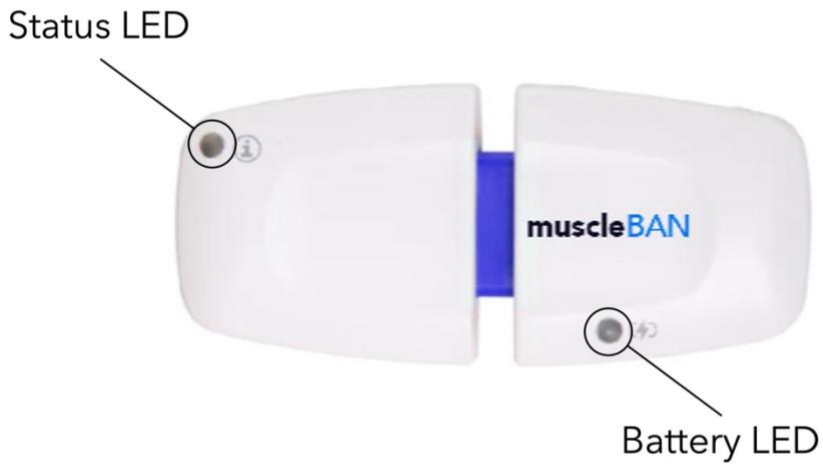


Figure 4: muscleBAN's feedback LEDs

System LED States

State	Description	LED effect
OFF	The device is switched off	Off, no lighting effect
IDLE	The device is turned on and waiting for some interaction.	Blinking yellow at 0.5Hz
IDLE + SCHEDULED	The device is turned on and waiting for some interaction, but it has a schedule loaded in memory to start an acquisition.	Alternates between yellow and blue at 0.5Hz
IDLE + CONNECTED	The device is turned on and waiting for some interaction, but a BLE Bluetooth connection has been established with a host machine.	Blinking green at 0.5Hz
IDLE + CONNECTED + SCHEDULED	The device is turned on and waiting for some interaction. It has a schedule loaded in memory to start an acquisition. A BLE Bluetooth connection has been established with a host machine.	Alternates between green and blue at 0.5Hz
START_ ACQUIRING	The device has started an acquisition.	Fast blinking blue at 5Hz during 1 second
ACQUIRING	The device is in aquation mode.	Blinking blue at 0.5Hz
ERROR	The device is in an error state.	Blinking red at 2Hz

Battery LED States

State	Description	LED effect
NORMAL/CHARGED	The LED being off occurs in two situations: (a) Device has an appropriate charge level for its operation. (b) Device is fully charged.	Off, no lighting effect
CHARGING	Device is charging	Solid red, always on
LOW_BATT	The device's battery level is getting low; it is recommended to put the device on charge.	Blinking red at 1Hz
DISCHARGED_BATT	The device's battery level is critically low. The device must be charged immediately.	Blinking red at 10Hz

Transfer Functions

Electrocardiography (EMG) Sensor

The EMG input voltage range = [-2.5mV, 2.5mV]

$$V_{EMG}[V] = \frac{V_{REF}(ADC - 2^{n-1})}{2^n \times Gain}$$

$$V_{EMG}[mV] = V_{ECG}[V] * 1000$$

Where:
V_{REF} - ADC voltage reference, 2.5[V]
$Gain$ - Analogue voltage gain, 500
$V_{EMG}[V]$ – Raw EMG value in Volt [V]
$V_{EMG}[mV]$ – Raw EMG value in millivolt [mV]
ADC – Value sampled from the channel
n - ADC number of bits, 16 bit

Accelerometer

Range: [-8G, 8G]

$$Acc(g) = \left(ADC - \frac{2^n}{2}\right).\left(\frac{16}{2^n}\right)$$

$Acc(g)$ – Accelerometer value in g
ADC – Value sampled from the channel
n – Number of bits of the channel[1]

Gyroscope

Range: [-500dps, 500dps]

[1] *The number of bits for each channel depends on the resolution of the Analog-to-Digital Converter (ADC); in muscleBAN the default is 16-bit resolution (n=16)*

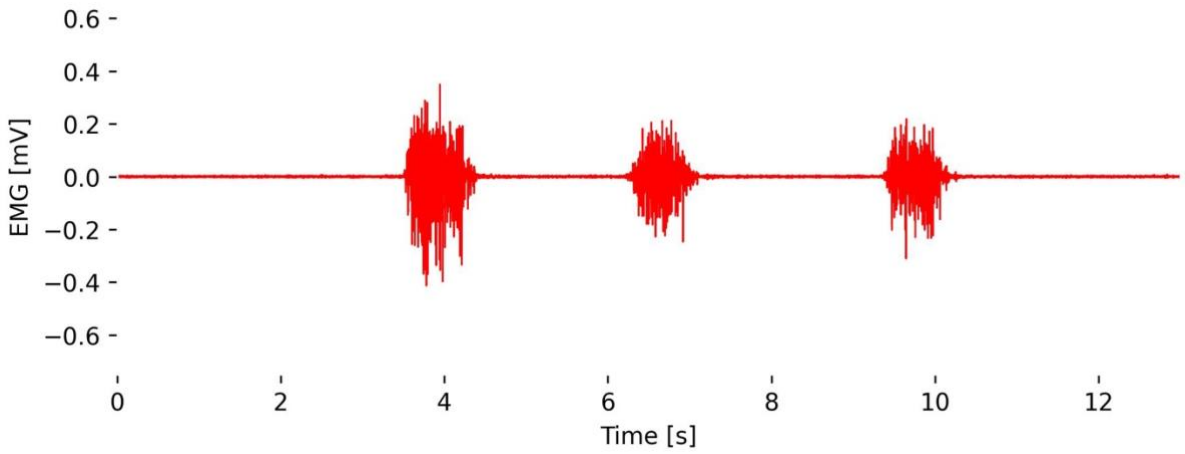
$$Gyr(dps) = \left(ADC - \frac{2^n}{2}\right).\left(\frac{1000}{2^n}\right)$$

$Gyr(dps)$ – Accelerometer value in degrees per second (dps)
ADC – Value sampled from the channel
n – Number of bits of the channel[1]

Sample Signals

The following signals show typical using a muscleBAN sensor data.

Normal EMG



Observation:
Muscle activations are visible as burst of signal amplitudes with flat, low-noise baseline between the individual bursts.

Accelerometer

The Accelerometer measures acceleration along the three axes (x, y, z). The amplitude of the signal correlates with the acceleration that occurs along each axis.

In the following signal, this ampltiude change is visualized in the following intervals:

- 0s to 10s: No acceleration / movement
- 10s to 20s: Moderate acceleration / movement
- 20s to 30s: Intensive acceleration / movement
- 30s to 40s: No acceleration / movement

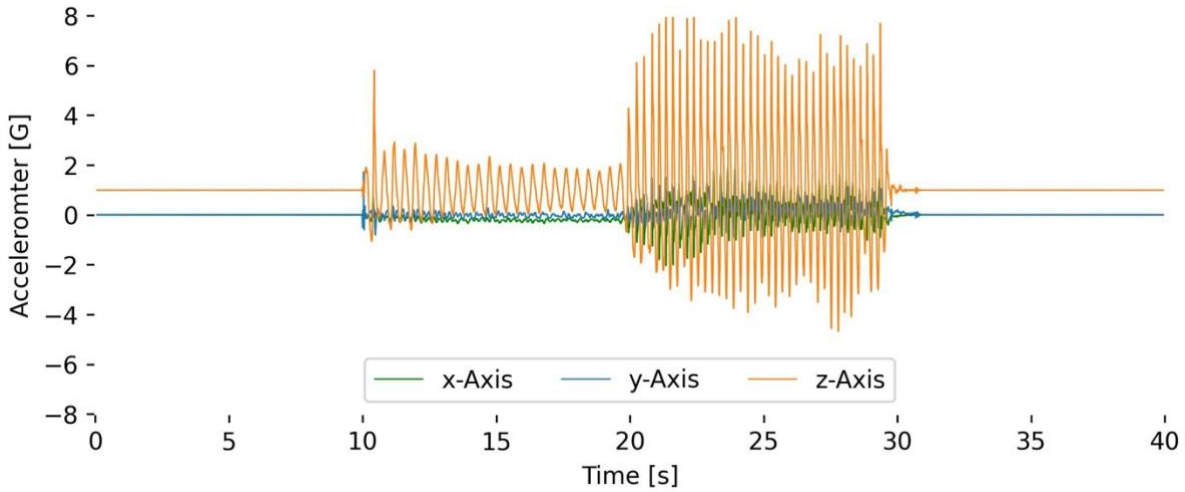


Figure 5: Motion data of different intensities in muscleBAN Accelerometer data.

For further information about the orientation of the Accelerometer axis, see the section Motion Sensor Axes & Orientation.

Gyroscope

The Gyroscope measures angular velocity, which is the rate at which an the muscleBAN rotates around the axes (x, y, z). The amplitude of the signal correlates with the acceleration that occurs around each axis.

The following signals show the results of the Gyroscope when conducting the same motion pattern of the previous Accelerometer sample signal.

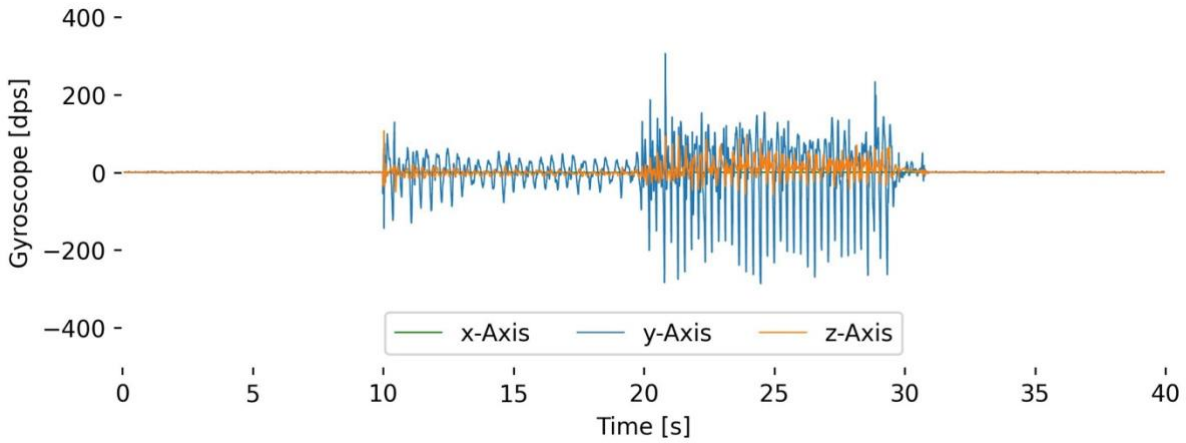


Figure 6: Figure 7: Motion data of different angular velocities in muscleBAN Gyroscope data.

Disclaimer

PLUX products, including muscleBAN BLE products, are **intended for use in life science education and research applications; they are not medical devices nor are they intended for medical diagnosis, cure, mitigation, treatment or prevention of disease**.

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