

Muse™

Miniaturized Multi-Sensor IMU

Acquire Motion and Environmental Data in Real Time
Using State-of-the-Art Sensor and AI Technology

Product Code: A3b1v03 / A3b2v03



∞ General Information

Fields of Application

- Intelligent wireless sensing node
- Inertial Measurement Unit
- Environmental conditions monitoring
- Wearable, Sport and e-Health
- Motion tracking
- Vibration and Structural monitoring
- Industrial predictive maintenance
- Drones, Robotics & Navigation systems
- Sensing beacon and/or Data logger

System Description

MUSE is a low power, miniaturized, wireless multi-sensor logger, incorporating state-of-the-art sensing technology into a compact, robust, customizable, and easy-to-use solution. MUSE combines inertial and environmental sensors together with on-board flash storage, wireless connectivity, automated on/off functions and regulated rechargeable power, providing a versatile system for data acquisition in a multipurpose fashion. It's a fully certified, safe, production and professional research platform for wearable and connected industrial use cases.

MUSE has been used in a variety of wearable and IoT devices created by global enterprises, innovative startups and world-leading researchers. It can measure acceleration, angular rates, 3D rotation, magnetic fields, temperature, humidity, proximity, ambient light, ambient pressure and signals intensity. The platform can run 221e proprietary algorithms and embedded AI software libraries to boost intelligent precision sensing to the next level.

System Summary

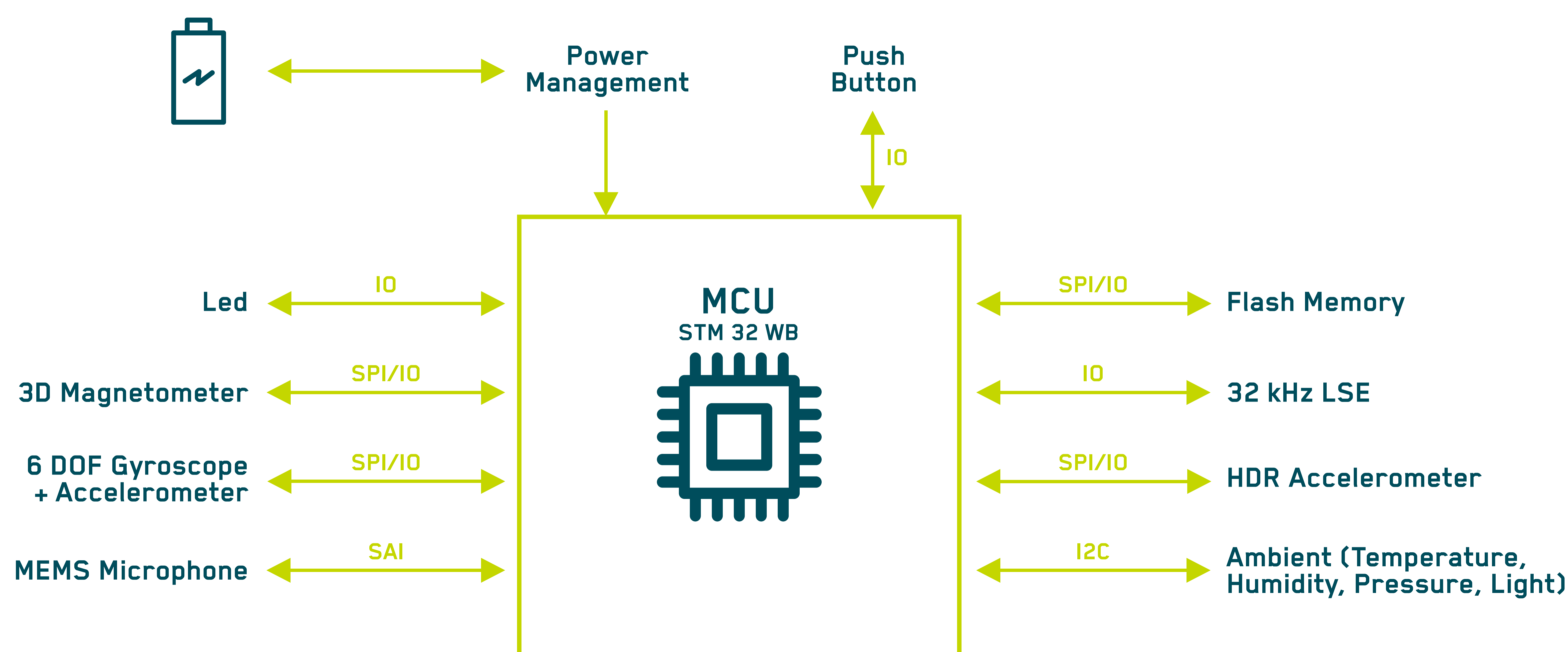
- Inertial (accelerations/angular rate) data sampling up to 1600 Hz
- Magnetic data sampling up to 1000 Hz
- Environmental (temperature/relative humidity/pressure) data sampling at 25 Hz
- Log files to internal memory up to 1600 Hz
- Download files via USB or Bluetooth
- Stream data via Bluetooth (up to 200 Hz) or USB (up to 200 Hz)
- System power via rechargeable battery, USB or external board-to-board connector
- Ultra-low power standby mode (6 uA current consumption)
- Battery duration more than 1 year in storage, 1 day in the most power-intensive mode

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∞ Block Diagram



∞ Ordering Information

| Product number | Description |
|----------------|---|
| 221e-A3b1v03 | Multisensor system, config. FULL |
| 221e-A3b2v03 | Multisensor system, config. INERTIAL |

∞ Contact Information

For the latest specifications, additional product information, worldwide sales, and distribution locations, as well as information about 221e:

• Web: www.221e.com

• Email: info@221e.com

• For technical questions: support@221e.com

∞ Certification

Muse is CE certified. CE conformity corresponds to the device being in compliance with the following European directives: ElectroMagnetic Compatibility (Directive 2014/30/EU), Radio Equipment Directive (Directive 2014/53/EU) and Safety (Low Voltage Directive 2014/35/EU). Standard compliance: EN 62368-1, RED / ETSI RADIO / EN 300 328 / 301 489, EMC EN 55032 / EN 55035, EMF IEC 62479:2010, IEC 62133, ROHS. Bluetooth qualified module: CE, FCC, IC, KCC, MIC and Anatel certified.

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∞ System Specifications

Microcontroller

| | | |
|-----------|---|------------------|
| Core 1 | → | Arm® Cortex®-M4 |
| Core 2 | → | Arm® Cortex®-M0+ |
| Frequency | → | Up to 64 MHz |

Data Rate

| | | |
|---------------|---|---|
| Log | → | 25 / 50 / 100 / 200 / 400 / 800 / 1600 Hz |
| Ble Streaming | → | 25 / 50 / 100 / 200 Hz |
| Usb Streaming | → | 25 / 50 / 100 / 200 Hz |

Communication Interface

| | | |
|----------|---|---------------------------|
| Wired | → | USB 2.0, type C connector |
| Wireless | → | Bluetooth Low Energy v5.2 |

Data Storage

| | | |
|-------------|---|------------|
| Data Memory | → | 1 Gbit |
| Memory Type | → | NAND Flash |

Expansion Interface

| | | |
|-----------------|---|---|
| Expansion Port* | → | 1x SPI BUS 1x I²C BUS 1x UART Up to 2x IRQs Up to 11x GPIOs |
|-----------------|---|---|

User Interaction

| | | |
|----------|---|--------------------------|
| Visual | → | Red, Green and Blue LEDs |
| Acoustic | → | Low-intensity buzzer |
| Touch | → | Programmable Push Button |

Embedded Software Libraries

MPE - Motion Processing Engine

MPE library enables IMU sensor fusion algorithm to estimate device orientation based on the input of linear accelerations (3-axis accelerometer) and angular velocities (3-axis gyroscope). Orientation is provided in quaternion form and it is referred to the earth gravity reference frame. The library includes logics and procedures for offset calibration of sensors, and the tuning of the internal Kalman filter.

NeuraSense

NeuraSense is a set of intelligent sensing libraries optimized for the edge. It provides real-time inertial sensor data analytics for activity tracking, man down detection, vehicle monitoring and vibration analysis.

*Available with firmware customization. Contact support@221e.com for more information.

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Sensors - Raw Data

| Inertial Sensor | |
|-------------------|--------------------------------------|
| ACCELEROMETER | |
| Measurement range | ±4 / ±8 / ±16 / ±32 g |
| Sensitivity | 0.122 / 0.244 / 0.488 / 0.976 mg/LSB |
| ODR | max 1600 Hz |
| GYROSCOPE | |
| Measurement range | ±250 / ±500 / ±1000 / ±2000 dps |
| Sensitivity | 8.75 / 17.50 / 35 / 70 mdps/LSB |
| ODR | max 1600 Hz |
| MAGNETOMETER | |
| Measurement range | ±4 / ±8 / ±12 / ±16 Gauss |
| Sensitivity | 0.15 / 0.3 / 0.43 / 0.58 mGauss/LSB |
| ODR | max 1000 Hz |
| HDR ACCELEROMETER | |
| Measurement range | ±100 / ±200 / ±400 g |
| Sensitivity | 49 / 98 / 195 mg/LSB |
| ODR | max 1000 Hz |

| Environmental Sensor | |
|----------------------------|------------------|
| TEMPERATURE | |
| Measurement range | -40 °C ~ +125 °C |
| Accuracy | ±0.2 °C |
| ODR | fixed 25 Hz |
| RELATIVE HUMIDITY | |
| Measurement range | 0 - 100% rH |
| Accuracy | ±1.8% rH |
| ODR | fixed 25 Hz |
| BAROMETER | |
| Measurement range | 260 ~1260 hPa |
| Sensitivity | ±1 hPa |
| ODR | fixed 25 Hz |
| MICROPHONE | |
| Acoustic overload | 122.5 dBSPL |
| Sensitivity | -26 dBFS |
| TIME OF FLIGHT DISTANCE | |
| Measurement range | up to 10 cm |
| AMBIENT AND INFRARED LIGHT | |
| Measurement range | 2.2 mlx ~ 73 klx |
| Sensitivity | 1.1 lx/LSB |

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Electrical Specification

| Power Supply | |
|--------------------------|---|
| BATTERY (LI-ION BATTERY) | |
| Core voltage | 3.3 V - 4.2 V |
| Capacity | 110 mAh |
| Full charge time | 2 hr |
| USB - C | |
| Core voltage | 5 V |
| EXPANSION CONNECTOR | |
| Core voltage | 5 V |
| Absolute Maximum Rating | |
| Rated voltage | 6.5 V |
| Protection Circuit | |
| Cell protection | Over-charge, Over-discharge, Over-current detection |
| Input protection | Over-voltage, Reverse-voltage detection |
| Power Consumption | |
| Standby | 6 µA |
| Log | 4.3 mA |
| Streaming | 3.4 mA |
| Temperature Range | |
| Minimum / Maximum | -20°C ~ 60 °C |

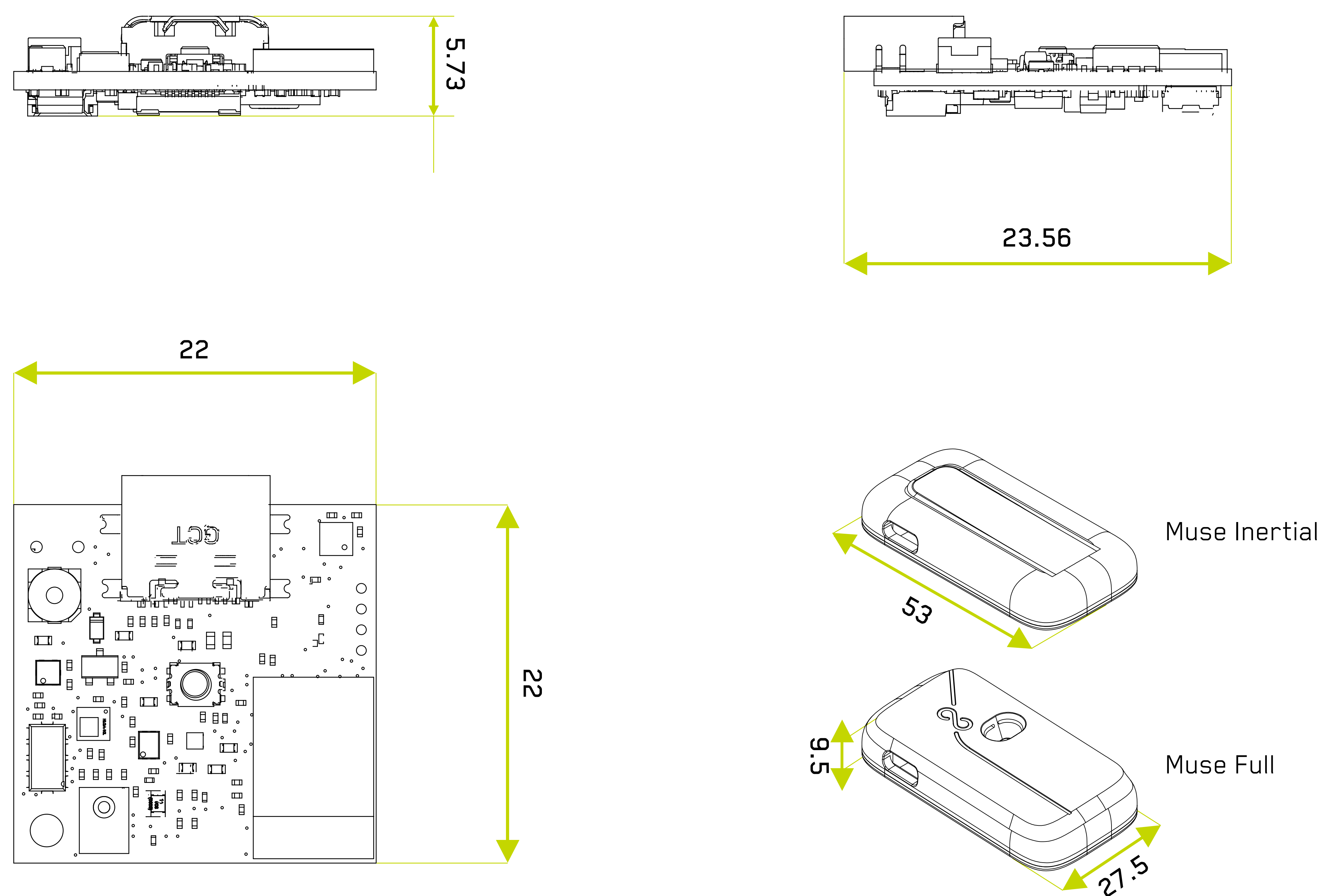
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Mechanical Specification

| Mechanical Dimension | |
|----------------------|---|
| Board | 22 W x 22 L x 5.85 H mm |
| Housing | 33 W x 28 L x 16.27 H mm |
| Weight | |
| Board | 2 gr |
| Housing | 10 gr |
| Enclosure | |
| Material | PLA |
| IP Rating | IP30 (protected against solid objects over 2.5mm) |



All dimensions in mm.

Faqs & Further Informations

Q:What is the duration of the memory? For how long can I save data?

A: The internal memory dedicated to data is 1Gbit. The duration depends on the frequency of data sampling and the number of sensors sampled; a rough estimate of the memory duration can be computed using the following equation:

$$D = \frac{1}{F_s} \cdot \frac{6.185 \cdot 10^3}{N_s}$$

Where D is the memory duration in hours, F_s is the selected sampling frequency and N_s is the number of sensors logged. Keep in mind that for very low sampling frequencies, it is likely that the battery will run out before the memory.

Q:How long will it take to download my saved files?

A: That depends on how big the file is, and how it is downloaded. We suggest using USB for better performances; the entire memory can be downloaded in roughly 15 minutes if using USB, or around 4 hours if using BLE.

Q:Can I log or stream inertial and environmental data at the same time?

A: Yes. Please note that environmental data is sampled at a fixed 25 Hz rate, meaning that if, for example, a 1600 Hz log is selected, the file will contain a lot of repeated environmental data values due to their up-sampling.

Q:Can I log and stream data at the same time?

A: No, log and stream are two different modes of the device, which is capable of handling them one at a time.

Q:How can I control the system?

A: The system can be configured and controlled via Bluetooth commands; we provide a software to seamlessly interface with the system, implementing all the functionalities in a more intuitive way. To avoid using the software on the field, a pre-configured log mode can be started with a press of the button; Bluetooth commands or the use of the software is still needed to configure this mode the first time.

Q:What software/SDK is provided alongside the system?

A: A Windows application is provided with the system in order to control it. A C# (for Windows) and C++ (for both Unix and Windows) SDK are available to ease the integration of the system in other pre-existing applications.

Q:How can I save power when I'm not using the system?

A: The system, if not connected via Bluetooth, will automatically enter standby after 30 seconds of inactivity. You can force the standby mode by pressing the button for a duration between 2 and 5 seconds. The system can be removed from the standby mode with the same button press.

Q:How can I recharge the system?

A: You can recharge the system battery by connecting it via a standard USB-C cable. A full system charge will take around 2 hours.

Q:How far is the Bluetooth connection range?

A: The Bluetooth range greatly depends on the obstacles between the system and the host (usually a PC or a smartphone), but can reach a maximum of 30 meters. Metal objects or peoples in between the system and the host can lead to a reduction in this figure.

Q:What happens if the system runs out of memory or battery during a log?

A: If the system runs out of memory during a log, the log will be automatically terminated and the file will be available for download up to the point of interruption. If the system runs out of battery during a log, when the system is recharged, it will attempt to recover the last file: if the recovery is successful, the file will be available for download up to the point of interruption.

Q:Can I customize the system firmware to my needs?

A: At the time, no. A structure to enable a degree of customization of the firmware is in the works.