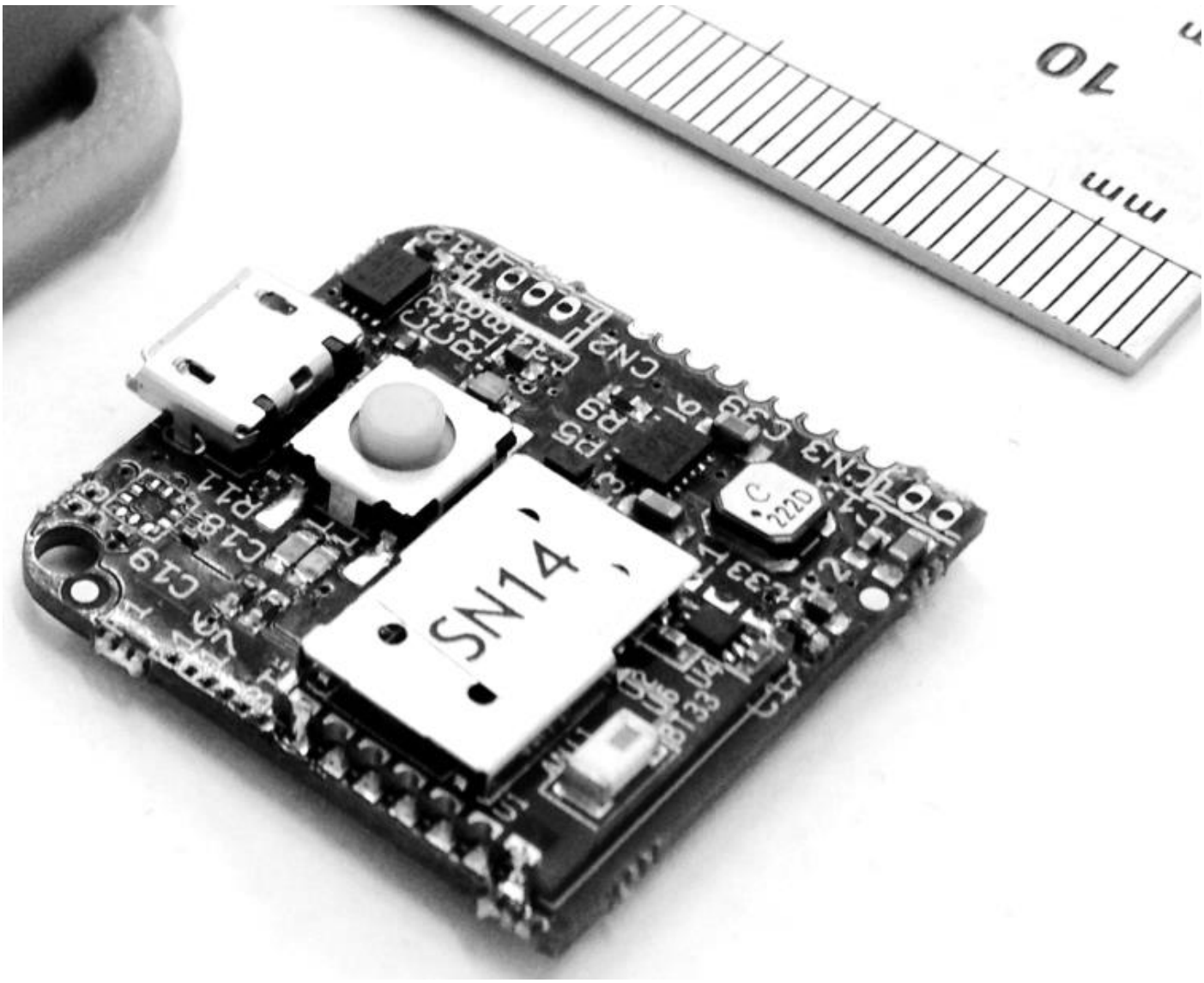
MuSe

Wireless Multi-Sensor system

Datasheet

v.1.2



1 SYSTEM OVERVIEW

MuSe is a miniaturized, wireless, low-power, Attitude Heading Reference System (AHRS); incorporating state-of-the-art sensing technology.

The platform integrates digital 3-axis accelerometer, 3-axis gyroscope and 3-axis magnetometer, a high resolution barometric pressure sensor, a temperature sensor and a 32-bit microprocessor ARM® Cortex®-M4-based.

With Flash storage on board, wireless connectivity (Bluetooth), automated power on/off functions and regulated rechargeable power, MuSe is a versatile system for data acquisition in a multipurpose fashion.

An optional High Dynamic Range (HDR) configuration is also available for applications where high-g accelerations and/or high-dps rotations are required for accurate measurements.

1.1 Measurement output

MuSe features an embedded sensor fusion algorithm capable of computing the device orientation in the three-dimensional space with low latency. The system is able to measure the orientation in 360 degrees about all axes. Output data include:

- *Orientation*
  - Euler angles (Yaw, Pitch and Roll convention);
  - Quaternions.
- *Linear acceleration*
  - Raw and calibrated XYZ measurement up to ± 16g;
  - (Optional: up to ± 24g or ± 400g).
- *Rate of turn*
  - Raw and calibrated XYZ measurement up to ± 2000 °/sec
  - (Optional: up to ± 4000 °/sec).
- *Magnetic field*
  - Raw and calibrated XYZ measurement up to ± 12gauss
- *Atmospheric pressure*
  - Barometric measurement with an absolute measurement range from 260mbar up to 1260 mbar

NOTE: The systems is calibrated at the 221e srl facility in order to compensate MEMS inertial sensors non-idealities such as bias, scale factor, axes misalignments. The calibration parameters can successively be modified by the user via the supplied GUI interface.

1.2 AHRS Embedded Algorithm

The AHRS algorithm is based on the input streamed by the accelerometer, the gyroscope and the magnetometer, for a 9 DOF measurement (yaw, pitch & roll).

MuSe runs a sensor fusion algorithm in order to compute an estimation of the attitude and heading of the device in the three-dimensional space. Sensor data are normalized and processed by Extended Kalman Filter (EKF) in order to optimally estimate the device orientation. EKF provides the highest accuracy in dynamic conditions and operates at a constant 250Hz update frequency.

NOTE: Magnetic distortions or interference (proximity to metal objects or electro-magnetic fields) can affect the accuracy of the heading estimation. It is therefore recommended to perform a preliminary calibration in order to adapt the algorithm coefficients to the environmental conditions of use.

2 HARDWARE SPECIFICATIONS

2.1 Microprocessor

MCU	
Architecture	ARM® 32-bit Cortex®-M4 CPU with FPU and DSP instructions
Max. Frequency	100 MHz
Memory Size	512 Kbytes
RAM	128 Kbytes SRAM

2.2 Sensors

ACCELEROMETER	
Measurement range	±2/±4/±6/±8/±16 g dynamically selectable full scale
Temperature range	-40 to +85 °C
Zero-g offset	±90 mg

GYROSCOPE	
Measurement range	±245/±500/±2000 dps dynamically selectable full scale
Temperature range	-40 to +85 °C
Zero-rate offset	±30 dps

MAGNETOMETER	
Measurement range	±4/±8/±12/±16 gauss dynamically selectable full scale
Temperature range	-40 to +85 °C
Zero-gauss offset	±1 gauss

BAROMETER	
Measurement range	260 to 1260 hPa absolute pressure range
Temperature range	-30 to +105°C
Pressure noise	0.01 - 0.03 hPa RMS

THERMOMETER	
Accuracy	±2 °C (T = 0 ~ +65 °C)

REAL TIME CLOCK	
Functions	Time-of-day clock / Calendar Alarm interrupts

Optional:

HIGH-G ACCELEROMETER	
Measurement range	±100/±200/±400 g full scale
Temperature range	-40 to +85 °C
Zero-g offset	±1 g

HIGH-DPS GYROSCOPE	
Measurement range	±500/±1000/±2000/±4000 dps full scale
Temperature range	-10 to +75 °C
Zero-rate offset	±15 dps

2.3 Inertial/Magnetic sensors' coordinate frame

The system uses a right-handed coordinate system. Each rotation is clock-wise positive with respect to the relative outgoing axis, as depicted in the following picture. The axes direction with respect to the module are indicated on the device.

2.4 Connectivity

USB (for battery charging purposes only)	
Standard	USB 2.0
Connector	Micro USB, Type B

BLUETOOTH	
Standard	Class 2, Bluetooth 3.0
Range	10 m
Transmission rate	Up to 560 kbps with SPP / 250kbps with iAP service
Temperature range	-40 to +85 °C
Multipoint	Up to 7 slaves

Optional:

BLUETOOTH DUAL MODE	
Standard	Class 1, Bluetooth 4.1 Classic and Low Energy
Range	100 m
Transmission rate	Up to 1.5 Mbps
Temperature range	-40 to +85 °C
Multipoint	Implementation dependent

MuSe can stream data via Bluetooth to a host PC or Bluetooth-enabled device. For non-volatile storage, data can be saved on the embedded FLASH memory allowing the system to perform as a standalone logger.

2.5 Power characteristics

POWER SUPPLY	
Type	Li-Poly rechargeable
Capacity	165 mAh

POWER CONSUMPTION	
Idle	6 mAh
Streaming	
at 25Hz	29 mAh
at 50Hz	32 mAh
at 100Hz	35 mAh
HDR at 100Hz	29 mAh

MuSe uses a rechargeable lithium-polymer battery and includes circuitry for both thermal and electrical protections against over-voltage and over-current conditions. As with any lithium-polymer battery-powered device, the following should be observed:

- Do not disassemble, crush, puncture, shred the battery;
- Do not let the battery to get in contact with water or other liquids;
- Do not short the battery contacts to metal objects;
- Do not place the battery near thermal heat sources.

2.6 Form factor

- Electronics Physical dimensions: 25L x 25W x 4H mm
- Electronics Weight: 3.3 gr

A viable casing is available providing housing for the PCB and the 165mAh battery, and featuring two lateral mounting brackets (as depicted in the figure below).

- Dimensions with battery and casing: 42L x 28W x 11.5 mm
- Weight with battery and casing: 15 gr