MuSe

Wireless Multi-Sensor system

User Guide

v.1.0

1 INTRODUCTION

This document describes how to use the MuSe as Attitude and Heading Reference System (AHRS) and Inertial Motion Unit (IMU) using Bluetooth wireless connectivity.

1.1 CONTENT OF THE KIT

The kit consists of the following components:

- 1 x Muse system.
- 1 x 3.7V LiPo 130 mAh battery pack.
- 1 x type B microUSB cable.

1.2 GETTING STARTED

System is off when no led is blinking.

In order to use the device, hold pressed the central button for 1 second. The blue led starts blinking and the system is ready for remote communication. To turn off the device just hold pressed the central button for 1 seconds.

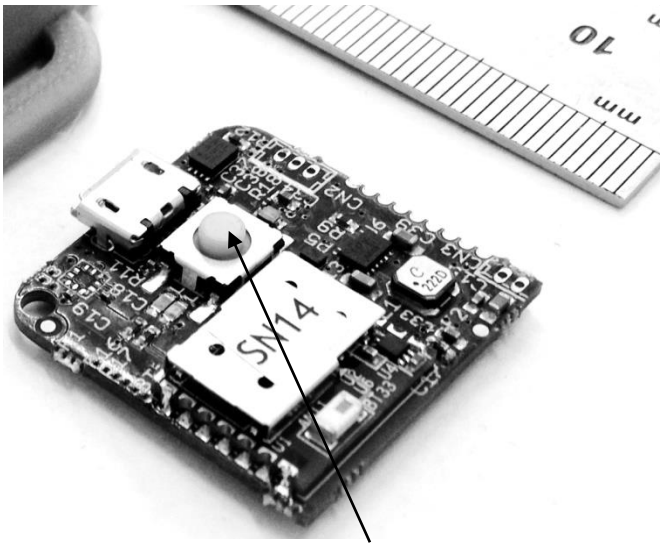

Figure 1 – System ON/OFF button.

1.3 BLUETOOTH ASSOCIATION (WINDOWS)

In order to communicate with the device, first the Bluetooth association with a computer has to be established. This can be done with the following steps (Windows 7 and later versions):

1. Turn on the system.
2. Open the "Devices and Printers" section from the start menu.
3. Press "Add device" and wait for the search procedure (the device will be displayed as a Bluetooth headphone named "MuSe_XXX" where XXX is an integer number greater than 0).
4. Double click on the device or press next.
5. An association pin window should now be displayed with a default pin to be exchanged. Press next.
6. The system will install the drivers and make the platform visible in the "Devices and Printers" section.

The device is now paired to the computer and no further pairing procedure is needed, even though it is afterward turned off.

Since the communication between the system and the computer uses the SPP (Serial Port Profile) Bluetooth profile, knowing the associated COM port number is needed for usage of the software. This can be achieved as follows (see Figure 2):

1. Open the "Devices and Printers" section.
2. Right click on the MuSe device, then select "Properties".
3. Select the "Hardware" tab.
4. The COM number is displayed at the end of "Standard Serial over Bluetooth link" entry.

1.4 BATTERY RECHARGE

To recharge the battery, just plug in the micro-USB cable and connect it to a power source (computer, or wall USB power supply). Charging is indicated by the white LED slow blinking. When fully charged, the white LED will stop blinking and remain solid.

NOTE: In case of low battery, the device automatically switches off; a solid orange LED will display if trying to switch ON the system.

2 SOFTWARE

The software provides an easy to use interface for data visualization and log on file operations. Also, it allows a simple configuration of the settings stored on the device.

2.1 INSTALLATION

To install the viewer software, open the "Viewer" folder coming with the "MuSe.zip" archive and double click on the "setup.exe" file. This will guide the user in a procedure which will install the software. Once the installation is completed the viewer software will be launched.

2.2 DATA VISUALIZATION

To run the software, click on "Start→Programs→221e→MuSe Viewer". The software interface should look as depicted in Figure 2.

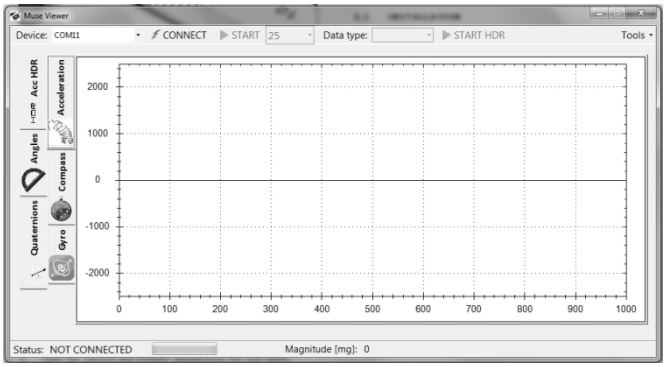

Figure 2 - Interface of the viewer software.

In order to start using the viewer, the connection between the computer and the MuSe has to be created. To do this, just select the COM port associated to the device and press the "CONNECT" button.

The connection procedure will start and its status is shown on the bottom left corner of the user interface.

The viewer provides the following functions:

- Visualization as the 25 Hz, 50 Hz or 100 Hz output rates of the raw data (accelerometer, magnetometer and gyroscope) and of the filtered data (quaternions) and Euler angles.
- Data logging to txt file.

To show the data on the charts, just select the desired output data rate and press the "START" button. The data will be visualized in the relative charts in the main panel.

NOTE: When the device is transmitting, the blue led blinks at the relative ODR frequency.

2.3 STOP DATA TRANSMISSION

To stop the data transmission, press the "STOP" button.

2.4 DATA LOG

After visualization, a series of data is available for logging into a txt file, as described in the next section.

This can be achieved by pressing "TOOLS→SAVE DATA TO FILE..." on the top right corner of the interface, which will open a "SAVE AS" dialog window.

NOTE: The txt format has to be written in the file name.

Each row of the output file will contain the data in the convention described in Table 1.

Column entry	Description
AccX	Acceleration over the x axis
AccY	Acceleration over the y axis
AccZ	Acceleration over the z axis
MagnX	Magnetic field measurement over the x axis.
MagnY	Magnetic field measurement over the y axis.
MagnZ	Magnetic field measurement over the z axis.
GyroX	Angular rate over the x axis
GyroY	Angular rate over the y axis
GyroZ	Angular rate over the z axis
qW	Real component of the quaternion
qX	First imaginary component of the quaternion
qY	Second imaginary component of the quaternion
qZ	Third imaginary component of the quaternion

Table 1 - Convention used in the txt ouput file.

NOTE: The quaternion entry in the file refers to the raw data of the previous row, this is the reason why the first row present a quaternion without mean.

2.5 PARAMETERS SETTING

The software provides an easy to use interface to set the parameters of the device.

This can be achieved by pressing "TOOLS→SETTINGS" on the top right corner of the interface, which will open a dialog window allowing the user to configure the following parameters:

- Calibration parameters of the accelerometer;
- Calibration parameters of the magnetometer;
- Full scale of the accelerometer;
- Full scale of the gyroscope;
- Full scale of the magnetometer;
- Device name.

To change a specific parameter, just use the associated drop-down menu. Once all the desired settings have been updated, just close the dialog window. A message will be prompted to the user requesting confirmation.

The blue LED will stop blinking and for about 2 seconds all the white LED will light up. Once the blue LED goes back to the blinking state, the platform has been programmed with the new settings.

NOTE: During the storage of the parameters, no other operation shall be performed on computer side.

2.6 DISCONNECT DEVICE

To disconnect the application from the device and turn it off, press the "DISCONNECT" button.

2.7 ADD DEVICE

The procedure described in paragraph 1.3 of this document can also be achieved via the provided software by pressing "TOOLS→ADD DEVICE" on the top right corner of the interface.

3 ORIENTATION ESTIMATION

The device uses a sensor fusion algorithm in order to compute an estimation of the attitude (IMU mode) and heading (AHRS mode) of the system in the three-dimensional space.

The AHRS algorithm via on-board Extended Kalman Filter is based on the accelerometer, the gyroscope and the magnetometer in order to detect the Earth magnetic North and provide a reference vector for the calculation of the heading component for a 3D orientation measurement (yaw, pitch & roll).

However, magnetic distortions or interference (proximity to metal objects or electro-magnetic fields) can affect the accuracy of the heading estimation. When using the device, it is therefore recommended to perform a preliminary calibration in order to adapt the algorithm coefficients to the environmental conditions of use.

3.1 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:

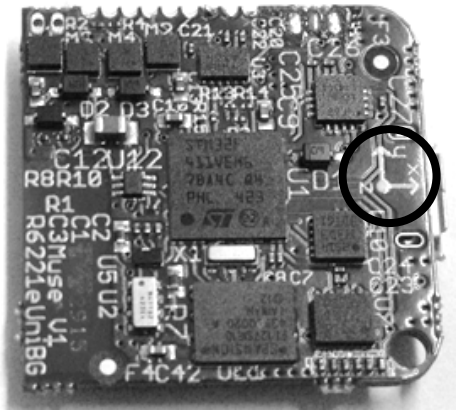

Figure 3 – System coordinate frame on PCB.