

Ultium™ EMG - Internal IMU Quick Start Guide

Getting Started with an Ultium™EMG's Internal IMU

To enable the internal accelerometer:

The Ultium™ Internal accelerometer is always accessible within the software configuration; however, in order to activate the accelerometer data channels for a recording, its channels must be selected within a given configuration. To do this, follow the steps below:

- **Select** a configuration and **Press** the 'edit configuration' button.
- **Drag** in the active device if is not included in the configuration
- **Select** the Ultium device.
- **Press** the plus sign in the second column of the 'Select EMG channels and sensors' section.

NOTE: This will auto-select the accelerometer channels and display them on the screen as: Ax, Ay, Az.

- Check the boxes of the acceleration axis to enable and record each data stream.
- The green check boxes in column 2 , when selected, enables measurement of EMG data from the corresponding EMG sensor unit.
- The green check boxes in the third column will tell the software to measure data for the corresponding accelerometer channel.

See below for an example image where both the EMG and acceleration channels are selected for the first sensor of the list.

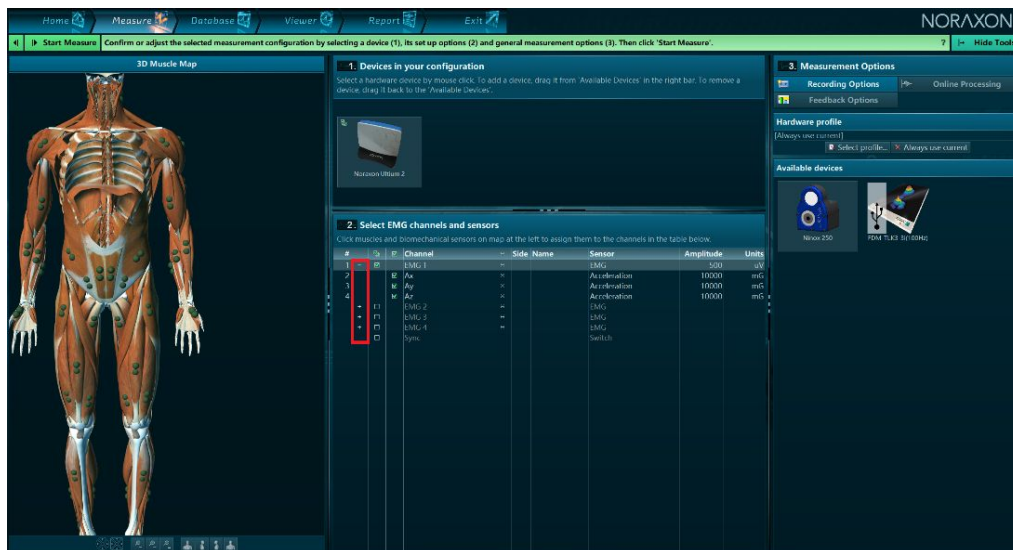


Figure 1- A screenshot of an MR3 configuration with EMG and acceleration selected. The red box has been placed on the image to further emphasize the plus signs that must be selected if you wish to measure acceleration.

To turn on the full internal IMU (Accelerometer, Gyroscope, Magnetometer):

However, to directly measure data from the gyroscope and/or the magnetometer, the user must first enable the IMU channels within the 'Advanced' settings tab of the Ultium™ Hardware set-up (see figure 2).

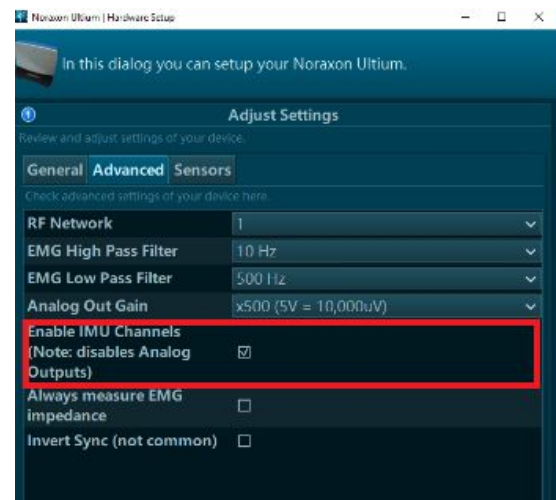


Figure - A screenshot of the advanced tab in the MR3 Ultium™ Hardware set-up. Notice the 'enable IMU channels' option within the red box.

Once enabled, the new channels will be available for selection within the configuration. For a visual of this process, see figure 3 (Both the EMG and all IMU channels are selected for the first sensor in the list).

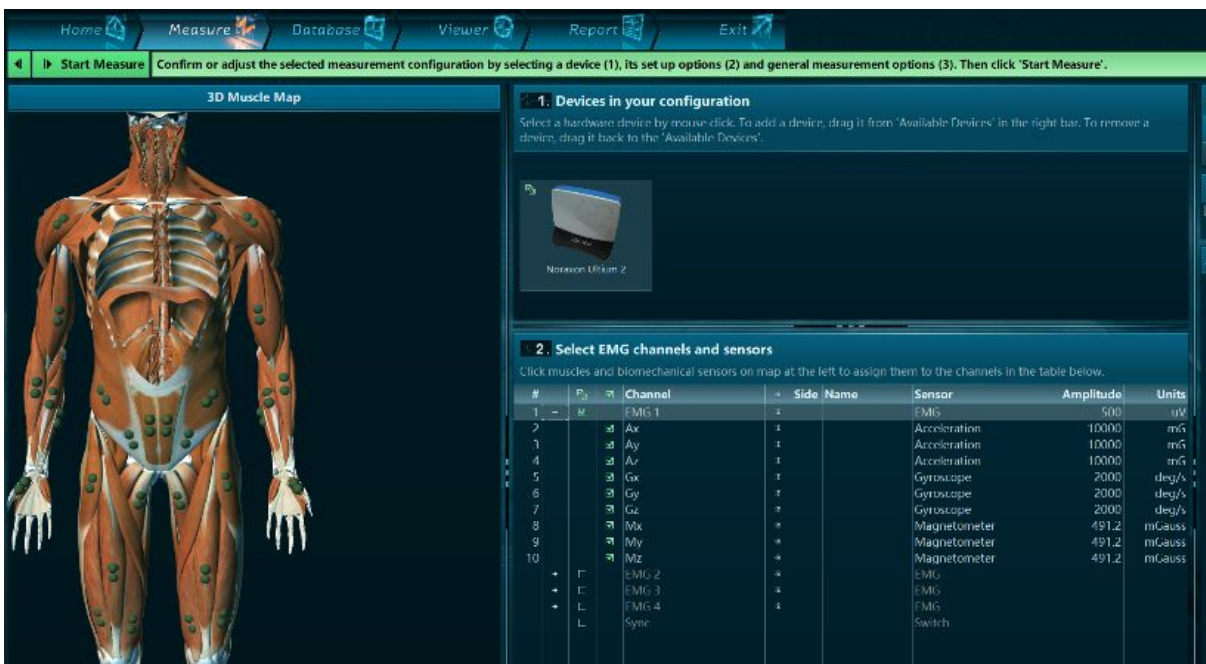


Figure 3 - A screenshot of an MR3 configuration with the EMG, accelerometer, gyroscope, and magnetometer selected for channels #1-10.

Sampling rates

| | EMG Frequency Hardware Set-Up | | |
|--|--------------------------------------|--|--------------------|
| | EMG set at 2000 Hz (EMG selected) | EMG set at 2000 Hz (EMG not selected) | EMG set at 4000 Hz |
| Acceleration Only (Ax,Ay,Az) | 500 Hz | 500 Hz | Not Possible |
| Full IMU (Ax,Ay,Az, Gx,Gy,Gz ,Mx,My,Mz) | 200 Hz | 400 Hz | Not Possible |

Due to the increased amount of data being wirelessly transmitted alongside the EMG data, the sampling rate of these data streams have been optimized to handle inclusion of acceleration and/or other IMU data.

Table 1 - Sampling rates for internal IMU when paired with EMG

Table 1 details the sampling rates at all possible configurations. Note that when exporting, the acceleration and full IMU data will be interpolated to match that of the EMG channel (2000 Hz). For further explanation please review the below examples for reference.

Example 1: Consider a situation in which full IMU is enabled (figure 2) and EMG is set to 2000 Hz in the hardware set-up. If both the EMG and the IMU channels are selected in the measurement configuration (figure 3), then the EMG will collect at 2000 Hz while the IMU channels collect at 200 Hz. However, if EMG is deselected from the configuration (uncheck the corresponding box in the second column of figure 2 while leaving all boxes selected in the third column) the IMU channels will collect at 400 Hz.

Example 2: EMG is set to 2000 Hz and both EMG and acceleration channels are selected in the configuration (see figure 1). For this example, IMU is not enabled (box 2 is unchecked, see figure 2). The EMG will measure at 2000 Hz and the acceleration channels will measure at 500 Hz. This remains true when the EMG channel is deselected from the configuration. However, when EMG is set at 4000 Hz, collecting acceleration data is not possible.

Chip Specifications:

Manufacturer/Part Number: InvenSense (MPU 9250)

Features: 3-Axis Accelerometer, Gyroscope, and Magnetometer

The InvenSense chip (MPU9250) is placed within the Ultium™ sensor so that its 3-axis are oriented as displayed in the image below:

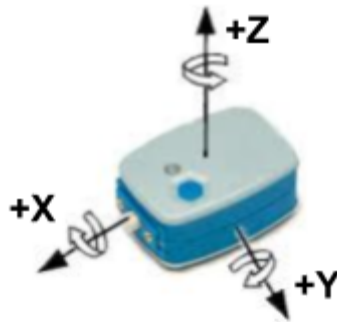


Figure 4. An image depicting the InvenSense chip's orientation within the Ultium sensor.

Further Information: The Ultium™ sensor contains an InvenSense MEMS IMU that allows for the measurement and transmission of angular velocity, acceleration, and magnetic field amplitude. Table 2 displays the range and sensitivities for the IMU data.

| | Range | Sensitivity |
|----------------------|----------------------|---------------------------|
| Gyroscope | ±2000 degrees/second | 16.4 LSB/(degrees/second) |
| Accelerometer | ±16 g | 2048 LSB/g |
| Magnetometer | ±4800 μ T | 0.6 μ T/LSB |

Table 2- Range and Sensitivity of the MPU 9250 IMU (LSB: least significant bit; μ T: microtesla; g: Gravity Unit).