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# Synchronizing Xsens with the BTS Bioengineering FREEMG System

Step – by – step manual

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# 1 Synchronization Workflow

The steps described below show how to configure Xsens systems to control, start, and stop a recording of the BTS Bioengineering FREEEMG System, and how to configure the BTS FREEEMG system to control, start, and stop a recording in an Xsens system.

1. Perform the calibration and get both systems fully set.
2. Set the specifications for synchronization in both systems and connect sync cable(s)
3. Start the recording on the slave software. The slave software will wait for a trigger from the Master software to start recording.
4. Start the recording on the Master software. Then, both systems will start recording at the same time.
5. Stop recording on the master software. Then both systems will stop recording at the same time.

Depending on the type of synchronization performed different specifications are required for both systems. A detailed explanation of the different characteristics according to the desired synchronization are described below.

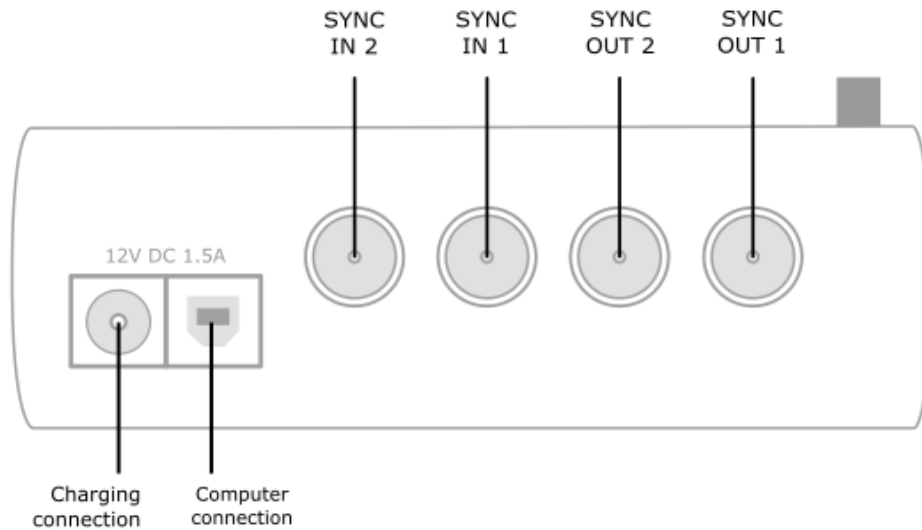
This document is written to synchronize the XSens Awinda system. However, most of the steps performed in the MVN software are the same for the MVN Link system. You can see the differences in the setup of the system in the last chapter of this document "Using MVN Link to synchronize".

## 2 Required Hardware

BTS Hardware	XSens Hardware
<ul style="list-style-type: none"><li>• FREEEMG System</li><li>• BTS Trigger Box</li></ul>  <p>Figure 1 – BTS trigger box</p>	<ul style="list-style-type: none"><li>• MVN Awinda or MVN Link</li><li>• Awinda station</li></ul>  <p>Figure 2 - Awinda Station. 4 BNC ports: SYNC IN 1, SYNC IN 2, SYNC OUT 1, SYNC OUT 2.</p>
<ul style="list-style-type: none"><li>• BNC-BNC cables</li></ul> 	

## 3 Hardware connections scheme

### Awinda Station/Sync Station



The Xsens Awinda and Sync Stations have four BNC connectors, with two Sync IN and two Sync OUT possibilities. These hardware connections are shown in Figure 1.

#### 3.1 Sync IN

The Sync IN ports are for a third party device to send a signal to the Awinda or Sync Station. The Awinda or Sync Station can detect polarity changes on the input lines. When a trigger is detected on one of the input lines, the Awinda or Sync Station can be configured to perform a specific action.

#### 3.2 Sync OUT

Sync OUT enables the Xsens system to send a trigger pulse via the Awinda or Sync Station to third party hardware. As with Sync IN, a combination of events are possible, based on a number of parameters.

#### 3.3 Pulse Polarity

A trigger may be a rising or falling edge, as illustrated in the figure below.

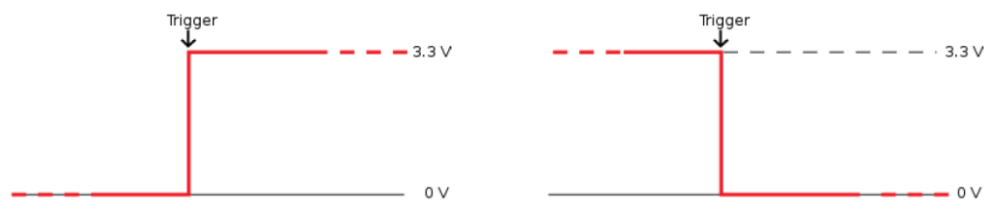
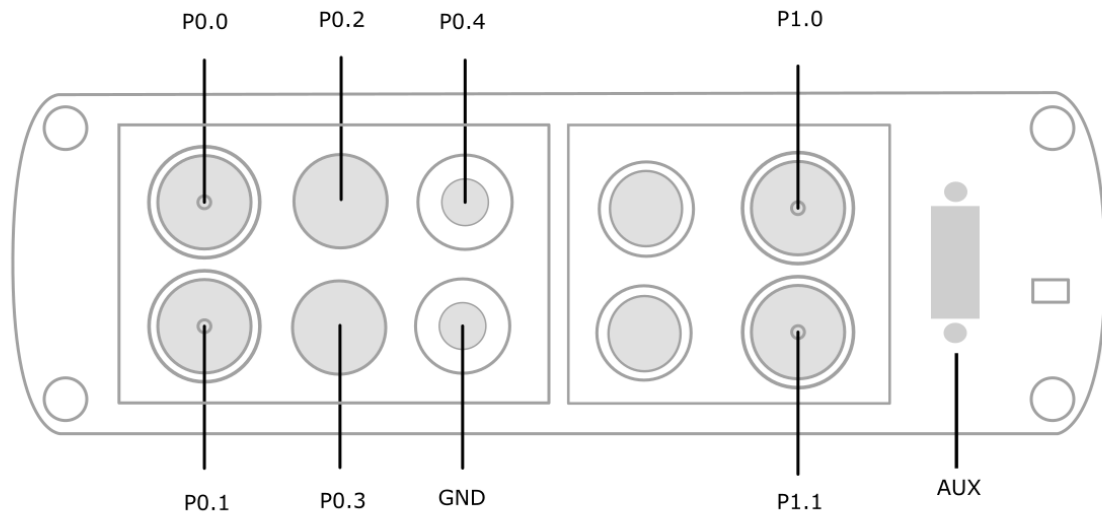


Figure 3 - Polarity: Rising/ falling edge (Sync IN) or positive / negative pulse (Sync OUT).

## FREEEMG Trigger Box



The FREEEMG Trigger Box can be used for sending, receiving, or generating trigger signals of 0 or 5 V to synchronize the FREEEMG with third party systems. The inputs are separated into two different sections. The section on the left (including P0.0 and P0.1) receives TTL signals. The section on the right (including P1.0, P1.1, and two blue buttons) generate TTL signals.

Port 0 Line 0 (P0.0) and Port 0 Line 1 (P0.1) can both receive a falling edge or rising edge signal of 3.3 V or 5 V. These will be used to receive a trigger signal from the Xsens Awinda Station. Port 1 Line 0 (P1.0) and Port 1 Line 1 (P1.1) can both be used to send a rising or falling TTL signal. Finally, the two blue buttons can manually generate a TTL signal to be received by both the FREEEMG system and third party systems. The top blue button sends a falling edge signal and the bottom blue button sends a rising edge signal. Note that the signal sent and generated by the BTS Trigger box is 0 to 5 V. This signal may damage the Awinda Station if a converter is not used.

## 4 MVN Analyze as Master and FREEEMG as slave

### 4.1 Start and Stop a recording

#### 4.1.1 Hardware connections

1. Connect one BNC connector from Sync OUT 1 of the Awinda Station to the P0.0 connector on the BTS Trigger Box.
2. Connect the other BNC connector from Sync OUT 2 of the Awinda Station to the P0.1 connector on the BTS Trigger Box.
3. Connect the BTS Trigger Box to the computer via USB (Data link port on back of Trigger Box)



Figure 4 - Connection with BNC-BNC cable scheme to Start and Stop a recording.

#### 4.1.2 MVN Analyze

1. In the Configuration window, in the Sync tab you should select:

Start recording (out)	Stop Recording (out)
<ul style="list-style-type: none"><li>• Out 1</li><li>• Polarity: Falling Edge</li><li>• Skip Factor = 0</li><li>• Skip First = 0</li><li>• Pulse width 10 ms</li><li>• Trigger once: uncheck</li></ul>	<ul style="list-style-type: none"><li>• Out 2</li><li>• Polarity: Rising Edge</li><li>• Skip Factor = 0</li><li>• Skip First = 0</li><li>• Pulse width 10ms</li><li>• Trigger once: uncheck</li></ul>

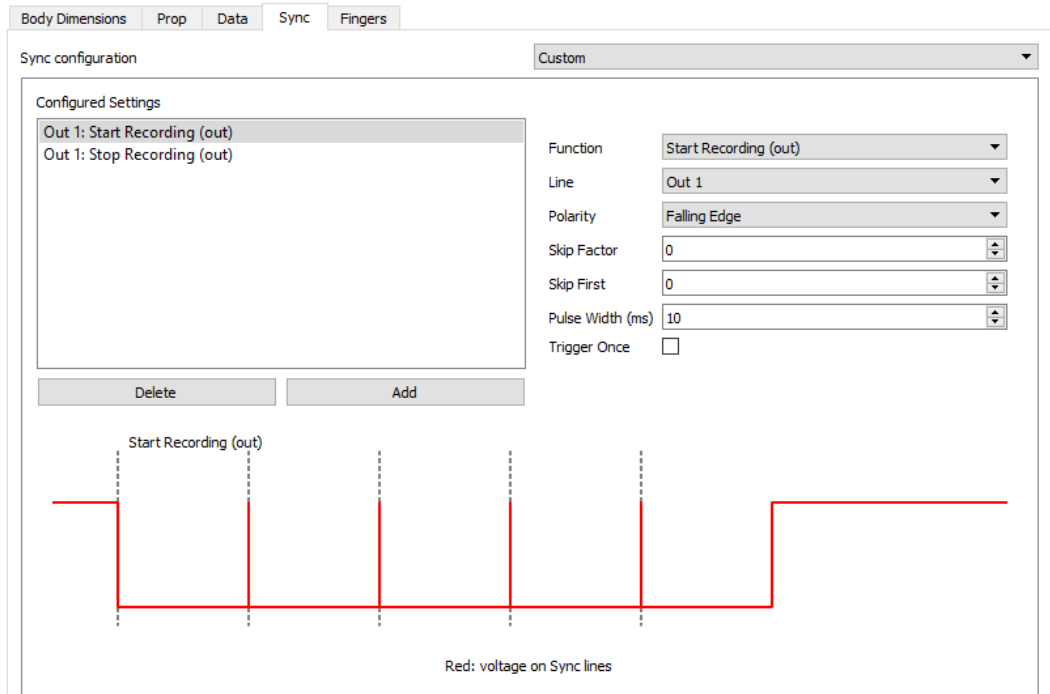


Figure 5 - Sync out start recording settings in MVN.

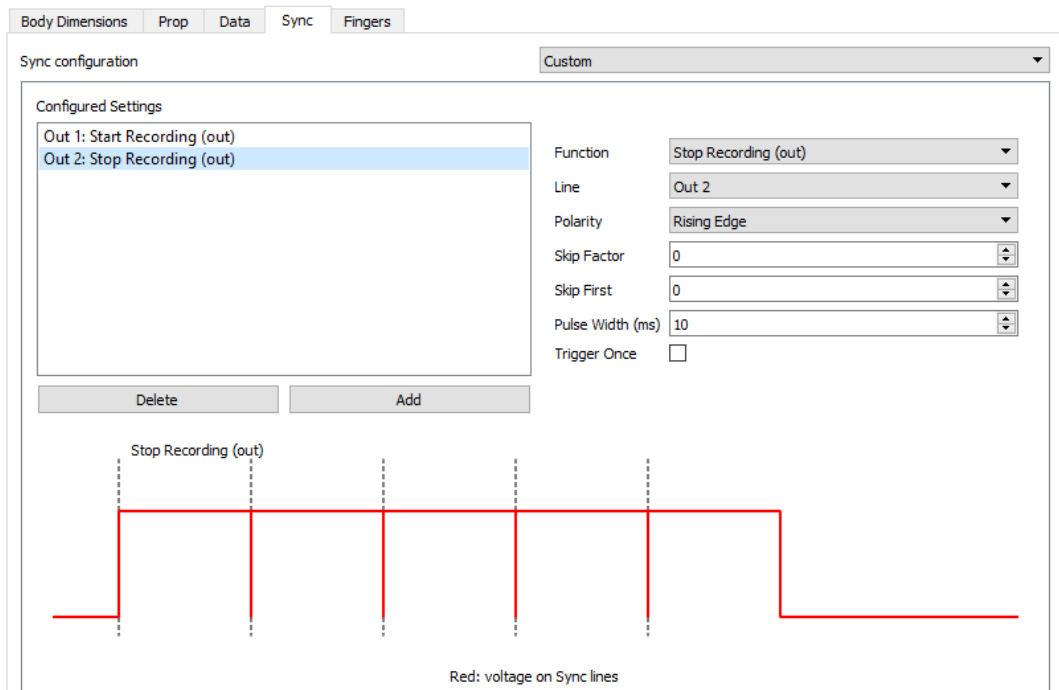
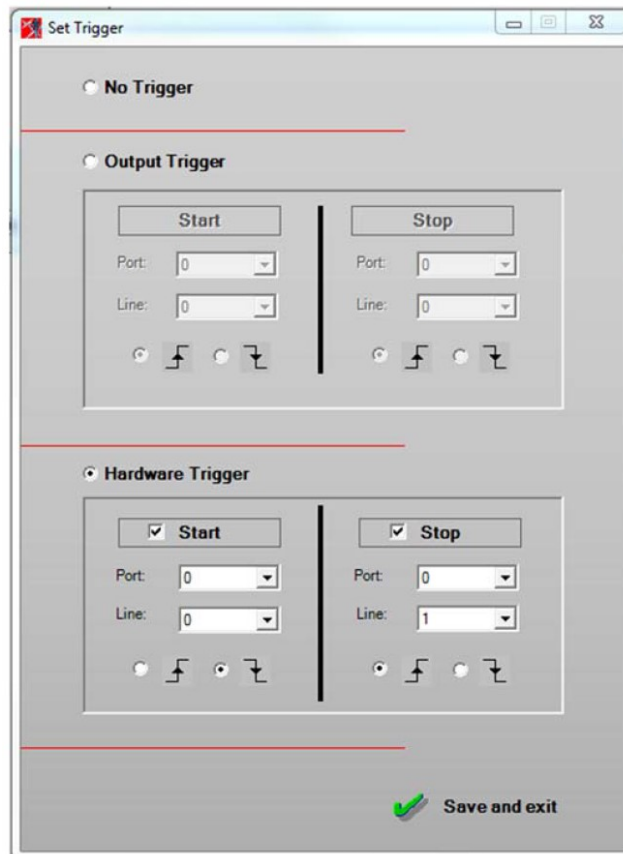


Figure 6 - Sync out stop recording settings in MVN.



### 4.1.3 BTS EMG Analyzer

1. Click on the Laboratory tab at the top left of the EMG Analyzer software
2. Select Set Start and Stop (or Set Trigger depending on software version)
3. In the window that opens configure the settings as shown below
4. Click Save and Exit
5. Create a new Patient, Session, and Trial
6. In the Acquisition Window, click View to begin streaming the EMG data. Note that the signals are not being recorded yet, only streaming.
7. Click Record in Xsens software to control the start and stop of both systems.



## 5 Using the Link System

To use the XSens Link system instead of the Awinda system you need to have an Awinda Station. Then you should activate the Awinda station in the "Motion Capture Configuration window" by turn on the bottom on the sync station configuration tab. In this tab you can find all the details described above.

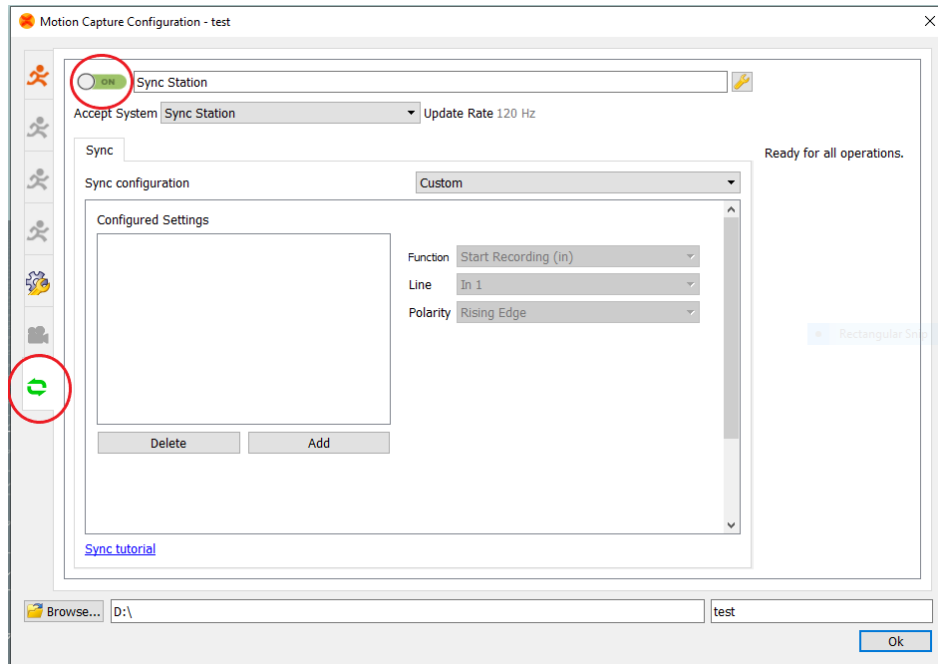


Figure 7 - Motion Capture configuration window in MVN Analyze. Indications to activate the Awinda station as sync station with the Link system.

Note: When using the Xsens Link system, which has an output rate of 240Hz, you will still need to use an Awinda Station to send synchronization signals. As our Awinda station has a maximum frame rate of 120Hz, you will realise that the maximum frame rate that the output signal will have is 120Hz. Practically, this entails that every other frame of Xsens will be synchronize with the frame of the other party system. This still gives an optimal synchronization between both systems.

If you would like to have both systems with the same sampling frequency you should downsample the file while export. To do so follow the following steps:

- Go to "File" tab - > "Export"
- Select the format you would like to export the data
- Click "Show options" and select the right "Exporter frame skip (for downsampling)" value.