AGM and Axy-5 user manual

Alessia Biondi

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1 Software

The Axy-5 and AGM sensors work with the software X Manager (Technosmart Europe), that runs only under Windows operating systems (minimum operating system required is Windows 10). It can works with Apple computers emulating Windows 10 but it will require some extra configuration (if you are using an Apple device, contact Technosmart Europe (info@technosmart.eu)).

Both the sensors has the same settings in terms of usage, thus the following user guide will cover both of them. If some differences arise, it will be explicitly highlighted.

2 Switch ON and turn OFF

Power ON for turning the unit ON, follow these steps:

1. Swipe the magnet close to the connector.
2. A white light indicator (LED) will start blinking about once per second, for nearly 20 seconds (ending with a double blink).
3. After the blinking phase, the sensor will stop blinking and start a new recording session (if it has been ON for at least 30 seconds) at the frequency selected.

During the first 20 seconds of blinking it is possible to connect to the sensor using the X Manager SW and the cable (as described in sec.3). Note that you can only connect to the unit in this first 20 seconds.

Shut down for turning the unit OFF, follow these steps:

1. Hold the magnet close to the connector, still on the same point as for switching it ON. The white LED will be on continuously (no blinking) up for 1 second.
2. Immediately after this second, the LED goes off: at this point, you need to move the magnet away very quickly.

3. The switching OFF is signalised by a long blink (continuous lighting for about 1 second) followed by fast blinking of the LED, which indicates that the instrument is OFF.

Note: In the first 20 seconds of blinking the unit will switch OFF after a single, quick passage of the magnet. You don't need to keep the magnet close until the LED turns off.

Every time if you pass the magnet near the connector (without keeping it close to the sensor for prolonged time):

1. If it starts flashing 1 time/second it means that it was OFF and it is turning ON.

2. If the LED lights up continuously for about 1 second and then stops, it means that it is ON (it can be turned OFF with the procedure described above) and it will remain ON.

Every time the module is switched ON it will start a new recording session (if ON for more than 30 seconds). Each session will be recorded as a separate file. Therefore, when data are downloaded, these will result in as many files as many recording sessions over 30 seconds have been performed. More detail about the download procedure are included in sec.4. If the logger is switched OFF during the first 30 seconds, no sessions will be recorded. This delay has been introduced to avoid the starting of undesired recording sessions when connecting to the PC.

3 Connecting to the X Manager SW

To program the instrument or download the data, the sensor must be connected to the PC when it is switched off. To do so, follow the procedure reported below:

1. Launch X Manager.

2. Connect the USB side of the cable to a PC port.

3. To be sure that the data cable is properly recognised by the software, click on **Scan ports** on the top left of the software window and select the COM port from the drop-down list.

4. Insert the other side of the connector to the sensor by ensuring that the lights on the connector (coloured LEDs) are on the same side (up) of the LEDs on the device (that is, by placing the sensor with the wide base downstairs, the lights must be upstairs). Inverting the cable will not cause any damage, but you will not be able to communicate with the device.

5. With the data cable plugged into the computer, turn ON the sensor (see sec.2).

6. During the flashing of 20 seconds and after 1-2 seconds from the starting of the blinking, click on **Connect**.

If the logger is correctly connected, you should see the main window of the X Manager populated with different values, such as model type, firmware version, battery level and unit name (see fig.1).

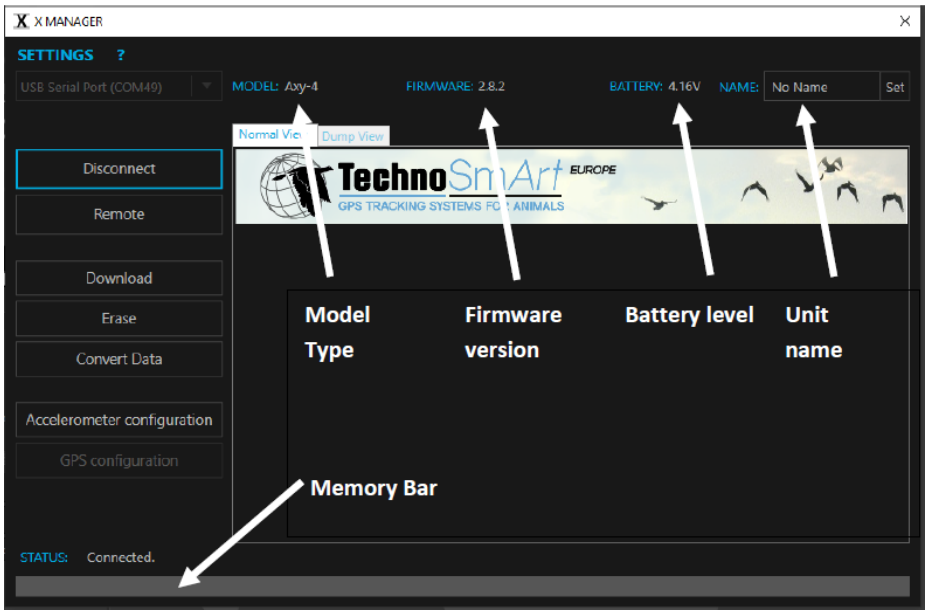

Figure 1: X Manager GUI once the sensor is connected correctly.

At the bottom a memory bar indicates memory occupation, with blue and grey representing used and free space, respectively. Clicking on **Disconnect** will switch the logger OFF (indicated as usual by fast blinking, see 2), this will allow the logger to be properly disconnected.

4 File download and data conversion

4.1 raw .ard files and conversion into .csv files

Once the device has been retrieved after deployment, you have to download collected data.

- To **download** the data click on the **Download** button after having connected to the device. A new window will open which will prompt you about file name and directory to save the file in. The default name for the file is the one appearing in the *Name* cell on the top right of the main window.

- Once you download the data, one or more .ard files are produced, according to how many sessions have been recorded. The files will be saved with the chosen name followed by a progressive index indicating the session number (i.e. "Filename_S1.ard", "Filename_S2.ard", and so on). The .ard files contain raw data and need to be converted to be opened in spreadsheet/text editing software, but are useful to store data on computers given their reduced size. The Axy-5 has an internal timer which allows the sensor to know the time when connected to the X Manager. It works in UTC time, not in local time.

- To **convert** the data into .csv file, click on the **Convert data** button. A window will be opened for choosing the .ard file to be converted and, once selected, another window will appear for setting some parameter for the conversion. Here, please select the pressure data as to be converted in meters and choose the "at sea level" pressure that was present during the release of the turtles (in order to obtain depth information).

- To **erase** the memory of the data logger, click on the **Erase** button. Note: if you erase the memory by mistake, turn OFF the logger immediately and send it to Technosmart for retrieving the data.

NOTE: if during the connection the unit is unable to download the time, upon restarting it will blink continuously with a double flash and will not start a recording session. If this happens, try again by connecting it to the software.

When you convert the data the time is taken directly from the device, so the accelerometer works in UTC time. However, if you prefer to work with local time, you can take the power on time (write it down) and click *override device time* and set a starting time in the box.

4.2 Data structure in .csv files

From the conversion of the .ard file you obtain a text with data from all sensors (.csv). This file is suitable for editing the data. Consider that in normal deployments the files are too big to be imported in Excel or Notepad.

Specifically, from left to right the columns of the .CSV for the Axy-5 indicate:

1. TagID: the name of the tag set in the main window
2. Timestamp: The date and time as selected in the conversion panel
3. X: Acceleration X axis
4. Y: Acceleration Y axis
5. Z: Acceleration Z axis
6. X: Magnetometer X axis

7. Y: Magnetometer Y axis
8. Z: Magnetometer Z axis
9. Temp.: Temperature in Celsius degrees
10. Battery Voltage: the voltage of the battery in Volts

While for an AGM we find:

1. TagID: the name of the tag set in the main window
2. Timestamp: The date and time as selected in the conversion panel
3. X: Acceleration X axis
4. Y: Acceleration Y axis
5. Z: Acceleration Z axis
6. X: gyroscope X axis
7. Y: gyroscope Y axis
8. Z: gyroscope Z axis
9. X: Magnetometer X axis
10. Y: Magnetometer Y axis
11. Z: Magnetometer Z axis
12. Depth: depth information (obtained from the conversion of the pressure)
13. Temp.: Temperature in Celsius degrees
14. Battery Voltage: the voltage of the battery in Volts

All text files can be separated by either a comma, a semicolon or a tab. This can be selected in the settings of the main window of X Manager. There you can click **CSV separator** and determine how the columns are going to be separated.

5 Calibration

5.1 Procedure

calibration data: the calibration data collection must be executed **before** the deployment of the logger, in the same session of the data of interest (thus, at the beginning of the session and without turning OFF the logger in the meantime). Moreover, the following advice should be considered:

1. Stay far from any magnetic interference (cars, computers, buildings etc). In your case, the beach may be a good option.

2. If you are going to deploy the device close to metal objects (for example other devices), execute the calibration in the exact same configuration you will use to deploy the device.

3. Repeat the sequence of movements described below for at least 2 minutes for any slot, to be sure to take enough data, and perform the movement slowly.

4. Try to keep the sensor as the centre of your rotation (thus, to keep it in the same position in the 3D space).

5. The advised frequency should be higher (above 25 Hz), but for experiment limitations it will be 1 Hz for the AGM, thus repeat the movement for enough time.

For the calibration data collection, you will slowly rotate the device in all possible directions on all axes, so that all axes will have realistic minimum and maximum values. There are many options, as wave your device in a figure of 8 pattern, by also rotating it in different directions as you do this.

A good procedure (already tested) may be the following:

1. Rotate the sensor around the longitudinal axis and in the meantime rotate yourself on your feet, by keeping the sensor on your hand horizontally (hold the sensor horizontally with the wide base downwards or upwards, and rotate it around an imaginary transversal axis that goes from one of your hand to the other hand). Refer to the left image of fig.2.

2. Repeat the same procedure around the transversal axis (hold the sensor vertically with the wide base in front of you, and rotate it around an imaginary transversal axis that goes from one of your hand to the other hand). Refer to the right image of fig.2.

3. Repeat the same procedure but, instead of rotating the sensor around a single axis, perform an 8 pattern. Refer to the left image of fig.3.

5.2 Configurations

For this specific data collection, where it is difficult to evaluate the best configuration to be chosen for the calibration data collection, a good idea can be those of register a single long track where at the very beginning we can isolate more than one calibration section (without switching OFF the device in the meantime), each of which is registered in slightly different conditions.

Before describing the chosen configuration, it is important to highlight the following aspects:

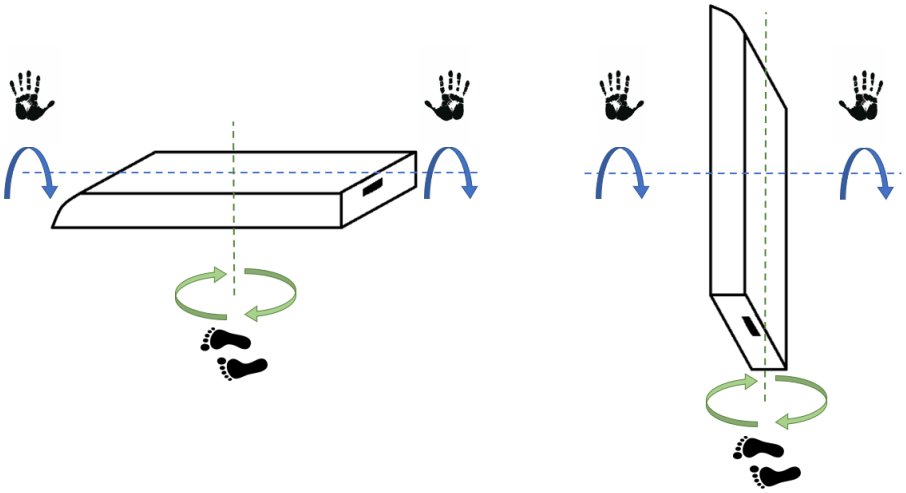

Figure 2: calibration movement: first and second movements described.

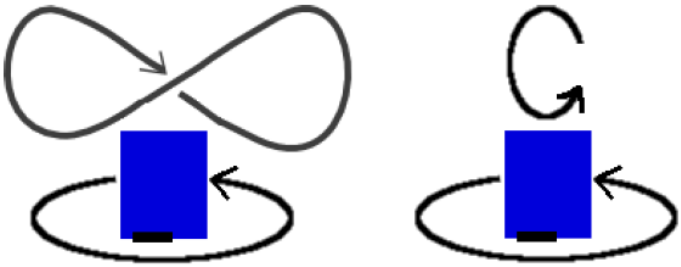

Figure 3: calibration movement: eight example.

- All the trials will be performed on the beach, far from electromagnetic disturbances, and by registering also the exact timestamp at which each trial starts and stops (to facilitate its isolation once the sensor will be recover and the data will be downloaded and elaborated). Time can simply be written down on a piece of paper by looking at a wristwatch, please avoid to use your mobile phone since it can be a disturb for the calibration procedure.
- The calibration procedure MUST be executed one sensor at a time, by keeping the others far from the one under calibration. Performing this procedure with more than one sensor at a time creates a cross-disturbance

among the sensors that does not reflect the real situation on which the sensor will find itself during the following deployment.

- The calibration data collection should be done in the exact same situation in which the logger will be during the real experiment, as already specified in par.5.1. It implies that if another device will be placed close to it for the experiment (and that device will remain in the same relative pose with respect to the sensor to be calibrated), then the system should be placed already in the final configuration and also the other sensor should be present during the calibration movement execution. In practice it means that you must also move the other device in solidarity with respect to the logger, that is, without ever changing their relative position.

Lets see now the configuration in which to collect data for the calibration of a single sensor. It is worth mentioning that this procedure has to be repeated for every logger, both AGMs and Axy-5, once at a time. After switching ON the sensor, repeat the calibration movements described above (5.1) by writing down every start and stop timestamp in the following configurations:

1. Single sensor (AGM or Axy-5).
2. Only for Axy-5, single sensor placed inside its hosting base without the magnet.
3. Only for Axy-5, single sensor placed inside its hosting base with the magnet (probably redundant).
4. Sensor and Satellite transmitter attached to a wooden rod with tape at a relative distance similar to what we will later have on the carapace of the turtle. Also the relative orientation of the two sensors should be the same that those during the deployment. This may be done with the AGM and, eventually, also with the Axy-5 inserted in its hosting base, by changing the distance with respect to the Satellite transmitter based on the real situation.

The advice is to execute all these collection one after the other in the morning before the release of the turtles offshore. If you want, you can also execute a first calibration collection the day before, still on the beach (maybe only for the single sensor configuration) and then switch OFF the sensor, in order to have a sort of backup collection in case something goes wrong for the other calibration sessions.

6 Sensor axes orientation

In fig.4 and in fig.5, there are represented the orientation of the accelerometer, magnetometer and gyroscope (only for the AGM) sensors with respect to the outer structure. Note that the wide base (opposite to the curved base) should

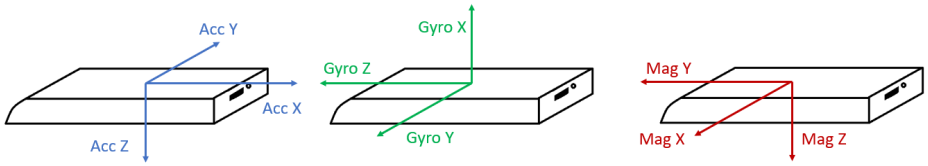

Figure 4: AGM sensors orientation: in red the magnetometer, in blue the accelerometer, and in green the gyroscope.

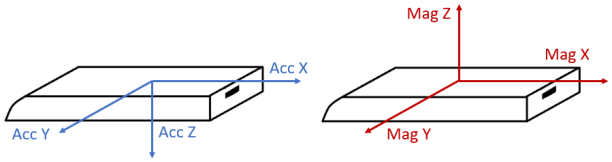

Figure 5: Axy-5 sensors orientation: in red the magnetometer, and in blue the accelerometer.

be the one to be chosen as the one to be placed in contact with the carapace, with the curved side directed toward the turtle's head (longitudinal direction).

The last image shows how to ideally fix the sensor on the turtle carapace in terms of its orientation. See fig.6 for more clarity.

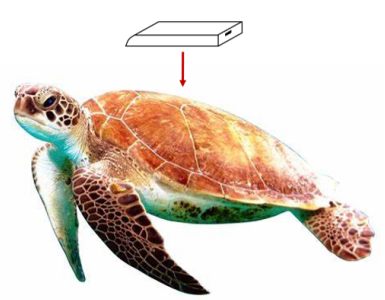

Figure 6: Device orientation with respect to the turtle carapace.

For more information, refers to the Technosmart teams and consult the provided datasheet (both for AGM and Axy-5 devices) that can be found on their website `https://www.technosmart.eu`.