

TechnoSmArt

GPS TRACKING SYSTEMS FOR ANIMALS

AXY-5

Micro Accelerometer-magnetometer datalogger for tracking free-moving animals



Operating manual

(Version 1.3, Jan 2023)

technosmart.eu

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1. System description

Axy-5 is a data-logger which includes an Accelerometer and a magnetometer. The Axy-5 can thus provide new and interesting information about the movements and the behavior of a large variety of animal species.

Axy-5 communicates with a PC by means of a USB cable provided by Technosmart Europe which also works as charging cable (unless non-rechargeable batteries are used).

1.1 Specifications

The **Axy-5** is a small (9 x 15 x 2 mm), light-weight (0.7 g), ultra-low power 3-axis accelerometer and magnetometer with a temperature sensor. It is a configurable data logger with 8 to 12 bit resolution measurements at up to $\pm 16g$. It measures and stores data related to the static acceleration of gravity as well as dynamic accelerations resulting from the animal's movements. It also records temperature data.

- *Extremely small size from 15x10x4mm and weight from 1.7g with splash-proofing*
- *Very long duration: a 2g device can last up to 20 days at 25hz*
- *Acceleration frequency from 1 to 100 Hz with a range from -1 +1 G to -16 +16 G*
8 - 12 bit acceleration resolution
- *Magnetometer recording frequency 1-2 Hz*
- *Available with a waterproof casing*
- *Can be mounted on lightweight collars (<5g) and backpacks (from 2.0g) for small and medium-sized animals*
- *Rechargeable Li-Po battery*
- *High sensitivity pressure sensor available*
- *Solar panel available*

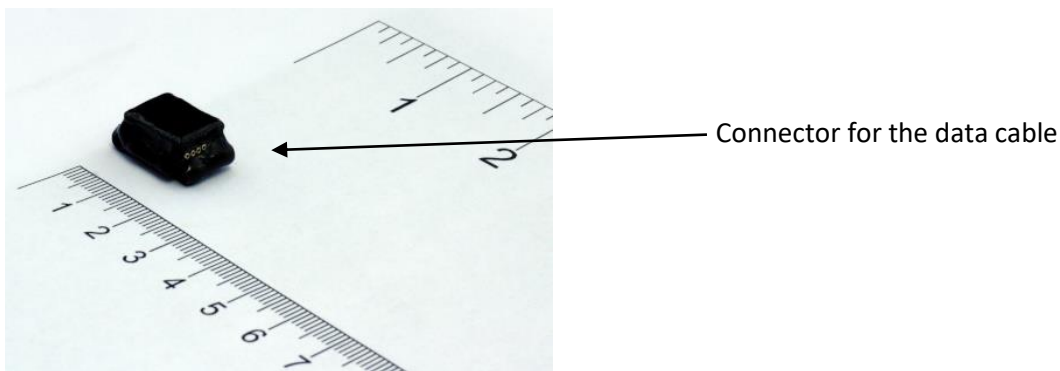


Fig. 1.1 Axy-5 with solar panel

1.2 Orientation of the logger in space

Figure 1.2 shows the positive orientation of the three accelerometer axes. The connector is highlighted on the top left.

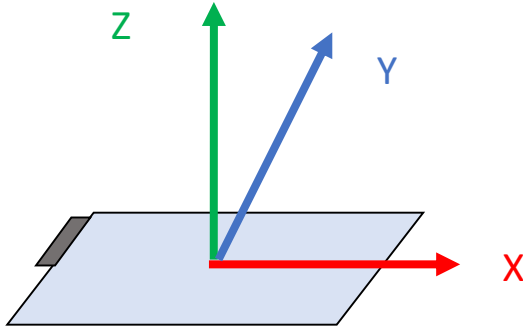


Fig. 1.2 Axy-5 unit oriented in space, on the top left the connector

With the unit in the position shown above, the gravity acceleration is +1 along the Z-axis. Since gravity is always acting towards the centre of the Earth, the position of the unit will affect the acceleration on the other axes, as indicated in Figure 1.3.

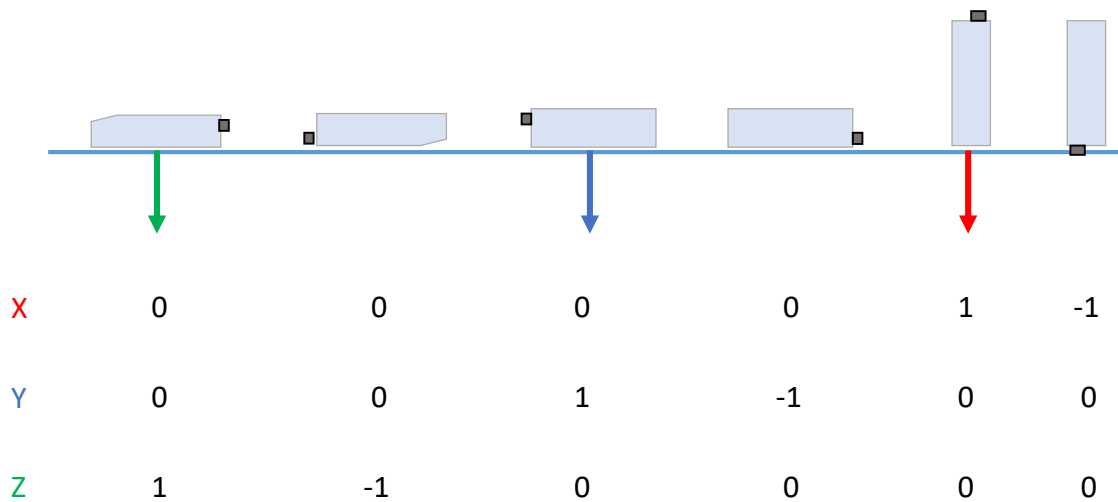


Fig. 1.3 Gravity values for different orientations of the unit. In the last four positions the curved side, which is on top in position n.1, is front-facing.

1.3 Software and drivers

The **Axy-5** works with the software **X Manager**, created and distributed by Technosmart Europe. It can be downloaded from the Support page of our website, so please ask for username and password, if you do not have them already.

Please consider that Technosmart is updating both firmware and software regularly, so it is advisable to contact Technosmart (info@technosmart.eu) before each field season to know if an update for your loggers is available.

X Manager works only under Windows operating systems, and the minimum operating system required is Windows 10. It can work with Apple computers emulating Windows 10 but it will require some extra configuration. If you are using an Apple device, please contact us.

1.4 Turning ON/OFF the logger

Turning the unit ON: swipe the magnet included in the parcel close to the connector. A white light indicator (LED) will start blinking once per second. During the first 20 seconds of blinking it is possible to connect to the **Axy-5**.

After this period the accelerometer will stop blinking and start recording at the frequency you selected.

Note: You can connect to the unit only in the first 20 seconds.

Turning the unit OFF: hold the magnet close to the connector. The white LED will be on for 1 second. After this second you need to move the magnet away very quickly. Essentially when the LED is on the magnet should be close to the unit, as soon as the LED turns off it should be moved away from it. The switching off is signaled by a long blink followed by fast blinking of the LED.

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.

Important: In the first 20 seconds after switching ON the unit will not be waterproof!

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. 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.

1.5 Connecting to the X Manager software

First of all, to be sure that the data cable is properly recognized 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. Usually on a Windows 10 system everything should work flawlessly. However, sometimes the data cable might not be recognized and you might read "no COM port available". This issue can be easily solved by downloading and installing the driver "USB Data Cable Driver (FTDI)" from our website, Support/Software section.

To connect to **X Manager** you should first insert the included data cable into the connector. The cable should be inserted with the LEDs on the same side (up) of the LEDs on the device. Inverting the cable will not cause any damage, but you will not be able to communicate with the device.

With the data cable plugged into the computer turn on the logger with the magnet and after 1-2 seconds click on “Connect”. If the logger is correctly connected, you should see the main window of the manager populated with different values, such as model type, firmware version, battery level and unit name (Fig. 1.4). You can change unit name as you wish, using alphanumerical characters. 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), this will allow the logger to be properly disconnected.

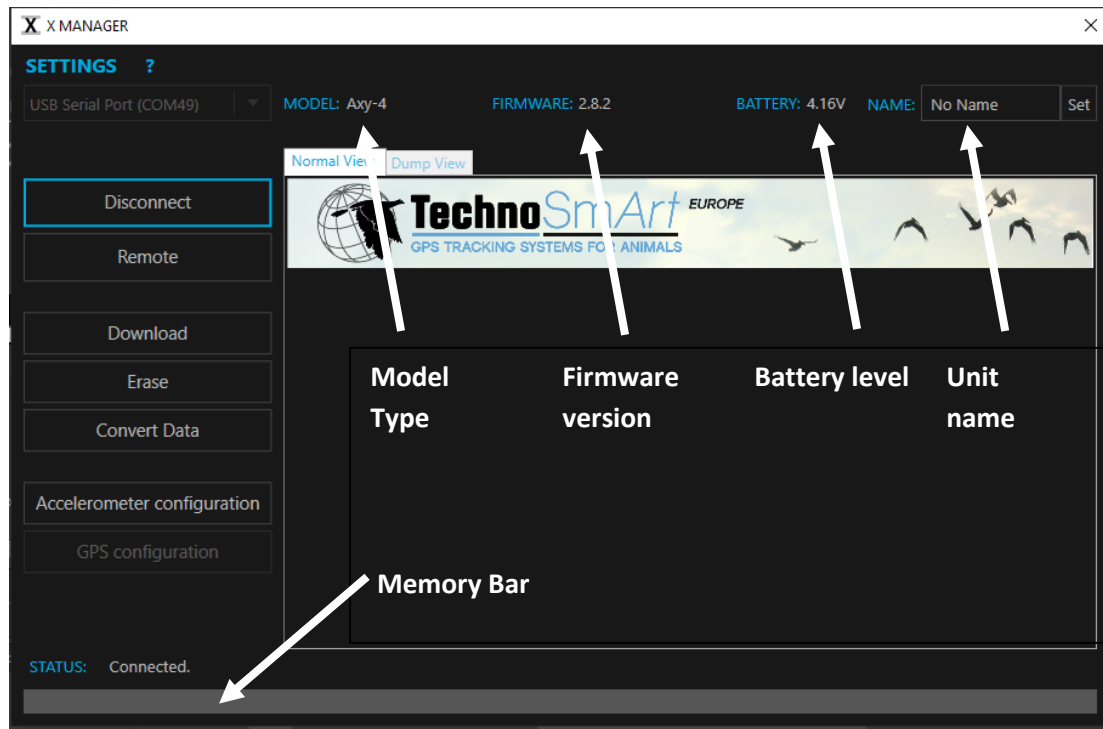


Fig. 1.4 Main window of X Manager

Now you can start to configure your device according to your requirements!

2 Accelerometer and magnetometer configuration

The accelerometer configuration window will allow you to configure the accelerometer and the temperature sensor.

To send the configuration, please click on the button “Send configuration” on the bottom of the window.

Note: When you open the configuration window, the values you see are the values found in the connected datalogger.

2.1 Sample rate, G Fullscale and Resolution

Sampling frequency is the number of acceleration data the logger is taking every second. The frequency goes from 1 per second to 100 per second. This rate does affect both battery usage and memory, so please make sure you have enough free space to save as much data as you wish (refer to us to know how long you can record for).

The **G Fullscale** is the maximum value of acceleration you can record. So if you select 2, any movement with an acceleration above 2 is going to be saturated at 2.

We suggest using 2 only for very slow moving animals. In most cases 4 or 8 is to be preferred. For example, a seabird flying requires at least 4 but is preferable to use 8, so as for swimming penguins.

A medium sized mammal usually requires around 4g but again 8g might be better.

The best way to act, if possible, is to deploy the first device at 16g, check the maximum value of acceleration and then select the lowest G range possible which does not saturate the values. You could clearly always select 16g but remember that the lower the G range value is, the higher the resolution in acceleration will be.

There is also the option to increase the **resolution of the data**, from 8 to 10bits. Practically, with 10 bits you have 4 times higher resolution than at 8 bits. So if for example the fullscale 16g (ranging from -16g to +16g) is divided in 256 values at 8 bits, it will be divided in 1024 values at 10bits, increasing the resolution substantially. However, it will occupy more memory in your logger. If memory is not limiting in your case, use 10 bits to have higher resolution.

Magnetometer can be set to OFF, 1 or 2 Hz. The magnetometer has a low battery and memory consumption compared with the accelerometer. However, we recommend to use it only if you need it for your data collection to maximize the duration.

2.2 Magnetometer - Compass

The magnetometer or compass detects the magnetic field the device is in. This means that every metallic object close to the device (even the battery or the cable) are going to be detected.

The magnetometer is not calibrated, meaning that the three axes might have different sensitivity, and that your data might be decentered and rotated. Gain, offset and rotation values are not fixed and must be calculated individually for each device. To do so, **you need to run a calibration recording with the final configuration you are going to use for your device, then you should calibrate your data using such calibration record.**

Technosmart Europe has developed an R script to help you correct your data. A brief description of how the **Axy-5** should be rotated for a correct calibration follows, but you may also find an explanatory video on our website (<http://www.technosmart.eu/gallery.php>, "How to calibrate your AGM magnetometer", that is the same procedure for the Axy-5).

Note: A calibration recording should be done at the beginning of each deployment. Specifically, the data used to calculate gain, offset and rotation should be recorded in the same session as the data to correct with those parameters, without switching off/on the logger in between. When you retrieve your units, remember that the first few minutes are the calibration round and treat it separately from the rest of the data.

Calibration recording:

To calibrate your **Axy-5** move it as far away as you can from any magnetic interference (cars, computers, buildings etc). If you are going to deploy the device close to metal objects (for example other devices), please run the calibration in the exact same configuration you will use to deploy the device.

Then you should record a calibration session, possibly at high frequency (above 25hz) where you will slowly rotate the device in all possible directions on all axes, so that all axes will have realistic minimum and maximum values.

You could for example wave your device in a figure of 8 pattern, rotating it in different directions as you do this. Or you rotate it on one axis while you rotate as well, so that you are sure all axes really have their full range of values.

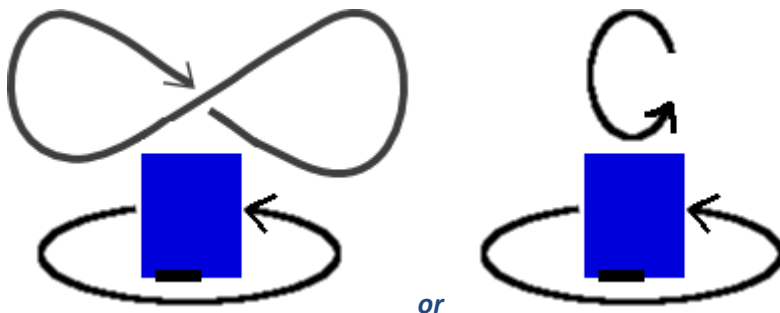


Fig. 2.1 Calibration movements, make a 8 pattern and rotate the device on its own axis or rotate it on its axis while rotating yourself

2.3 Temperature and Pressure Logging

The **Axy-5** is equipped with a temperature sensor which can be enabled in the configuration window of the **X Manager**. If you check the “Enable” option, the logger will record temperature data with the period selected in the box on the right (“1” means once per second, “2” means once every 2 seconds).

If the Axy-5 can be equipped with a pressure-temperature sensor, you will see here also the configuration of the pressure sensor, together with the temperature sensor.

Note: you might find that the temperature sensor is not completely accurate, but it is indeed precise. This means that the data might have a constant offset, which once calculated (for example by measuring temperature with another instrument) can be systematically added to the **Axy-5** data to obtain correct readings.

3. File download and data conversion

Once you successfully retrieve your device after deployment, you wish to download and see your 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.

The “**Erase**” button will erase the memory of the datalogger.

Note: if you erase the memory by mistake, turn off the logger immediately and send it to us, we can retrieve the data.

Once you download the data, one or more **.ard** files are produced, according to how many sessions have been recorded (see par. 1.4). 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.

VERY IMPORTANT: 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 local time.**

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. If the problem persists, contact us.

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.

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 with Excel, Notepad and importing in common software like R. 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 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.

Note: Most of these variables are present only if the sensor is activated. For example, if you did not turn on the temperature that column will be missing.

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.

In the conversion preferences you can set whether you want the output .csv file to have text lines indicating that the logger has received the power off command. If you are interested in tracking all moments when the **Axy-5** has turned off you should enable this option, which might also help in troubleshooting in case the device shows abnormal behavior. Keep this option in mind when reading the converted file in software such as R, because having the power off lines might produce problems.

4. Batteries

4.1 How to recharge batteries

Batteries can be recharged using the provided USB data cable. If you don't have a connector you have a solar powered device. Leave the device under the sun for some hours until the batteries is fully charged.

Please do not leave devices in hot surfaces, especially in hot days. The batteries can be damaged and become not usable.

IMPORTANT: Only LiPo batteries can be recharged. If you use a thionyl battery (those rounded like a AA battery) with a recharging cable, even if only for communicating, the battery MIGHT EXPLODE, representing a major hazard!!! **BE VERY CAREFUL!** If we gave you a cable that has a charger and you wish to use your GPS with thionyl batteries let us know and we will provide you a new cable without the charging electronics!

4.2 How to keep batteries

Monthly, check the battery level. You should check the battery level every month if you plan on storing it long-term. You can charge your battery again if it drops below 3.5 V. This is especially important if you have small batteries.

Keep your battery cool and well ventilated in a dry place. Keep it at room temperature. It should not be stored in a hot place.

5. Troubleshooting

Although Technosmart Europe has always tried to provide the best devices possible, sometimes you might encounter some issue in the working of the **Axy-5**. This might be caused by hardware faults, software faults, or wrong settings by the user.

Here we will analyze the most common issues.

5.1 Software issues

1. **No Com port in the Com list:** Probably the data cable has not been recognized properly by the computer. To solve this issue, download from our support page the FTDI data cable drivers and install them.
2. **Unit not ready while connecting:** First of all be sure you are properly turning on the device and you are trying to connect in the first 30 seconds of blinking. If so, maybe the connector is a little bit loose. Try moving the connector a little bit, in order to increase the contact between the cable and the device. Let us know if that was the problem. If the problem persists, contact info@technosmart.eu

3. **Software crashes during downloading or conversion:** Please contact us and let us know where exactly the software crashed (right at the beginning, at the end, always at the same point, or randomly), and we will try to solve the issue.
If the issue is during the conversion, please send us the .ard file so that we can check if everything is correct in the data.
If the issue is at the end of the downloading (while writing the .ard file), please select in the main window settings “Keep MDP file after downloading” and send it to us.
4. **The downloaded file is every time different:** this issue has happened with Apple computers emulating Windows10 OS. In this case, in the main window settings select “Download speed” and then 1MBaud.

5.2 Hardware issues

These issues are recognized by a different blinking, or no blinking at all when you pass the magnet. Most of them could be serious and we might need to replace the device, unfortunately. Some of them, however, can be fixed by the user.

1. **The logger does not blink at all:** This is the biggest problem, clearly. In the best case the battery is so discharged that it does not manage to power up the logger. Try first to recharge the battery for about one hour and see if this solves the problem. If not, contact us, and we shall replace the logger.
2. **When starting, the logger makes a very strange blinking, and/or turns off immediately:** This is usually due to a low battery level. Try recharging the battery first and let us know if the problem persists.
3. **When starting the logger does a double blink once per second:** This might mean 3 things: low battery (but high enough to start the logger) or no functioning pressure sensor (for axy depth) or the device has not taken a correct time from the computer. First of all, recharge the battery and see if this solves the problem. If not, the problem is due to a nonfunctioning or absent pressure sensor. If you do not have the pressure sensor, just uncheck “Temperature and depth sensor” in the accelerometer configuration. If you do have a pressure sensor, it is probably broken and this usually cannot be repaired. The good thing is that the data can be downloaded and most of it should be onboard. Contact us for the replacement of the logger. You can still use the logger with the pressure sensor disabled.
4. **Upon starting the device the white led is turned on, and turns off after about 1 minute:** It has entered a bootloader mode, which is a special mode which usually reverts automatically. This happens when you touch the connector or plug in the

cable right after turning on the logger. If this happens systematically without you touching the connector, we might need to replace the logger.

Axy-5 data-logger – Operating Manual

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