TechnoSmArt

AGM

Micro Accelerometer Magnetometer and Gyro datalogger with Temperature and Pressure sensors for tracking free-moving animals

Operating manual

(Version 1.0, June 2018)

www.technosmart.eu

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1. System description

AGM is a datalogger which includes an Accelerometer, a Magnetometer, a Gyroscope and optionally also temperature and pressure sensors. The AGM can thus provide new and interesting information about the movements and the behavior of a large variety of animal species.
AGM communicates with a PC by means of a USB cable provided by Technosmart Europe which usually works also as charging cable (unless non-rechargeable batteries are used).

1.0 What is what?

The AGM comes in different shapes and sizes, according to battery type, size, and set of sensors.
The most common version is the one with a pressure sensor, ideal for seabirds and sea mammals (Fig. 1.1).
In this version you can find a waterproof connector and on its side the pressure sensor.

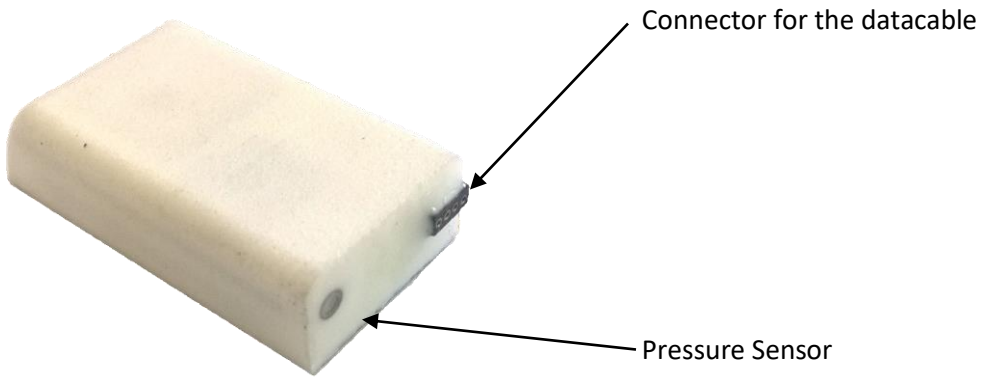


Fig. 1.1 AGM with ceramic antenna and pressure sensor

1.1 Orientation of the logger in space

Figures 1.2 and 1.3 show the positive orientation of the accelerometer, gyroscope and magnetometer axes. The connector is highlighted on the top left.

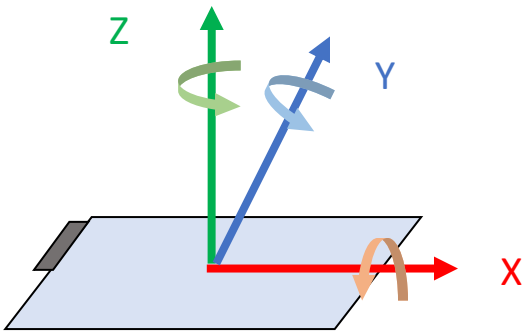


Fig. 1.2 Accelerometer and Gyroscope axes of the AGM unit oriented in space, on the top left the connector. The arrows show the direction of positive gyroscope values

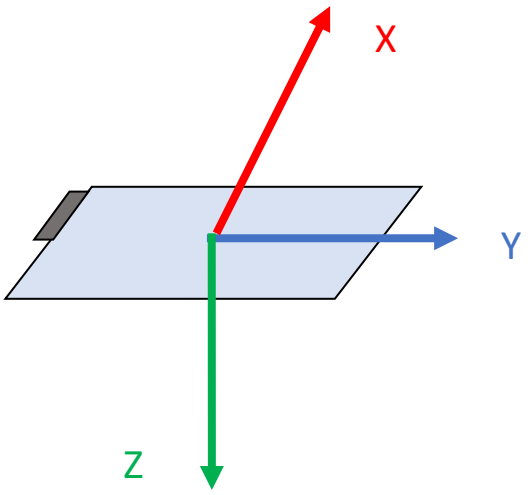
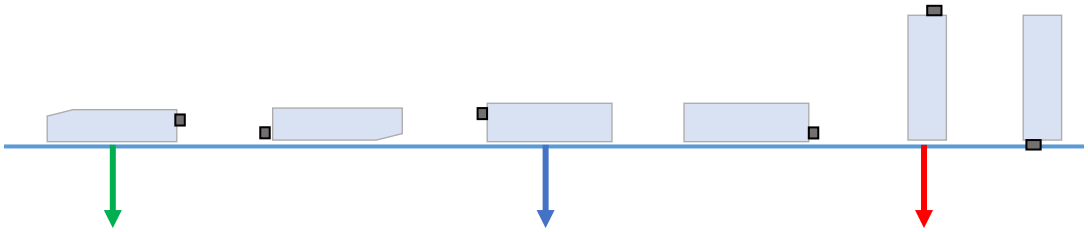


Fig. 2.3 Magnetometer axes of the AGM unit oriented in space, on the top left the connector

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.



X	0	0	0	0	1	-1
Y	0	0	1	-1	0	0
Z	1	-1	0	0	0	0

Fig. 1.4 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.

1.2 Software and drivers

The AGM works with the software Axy Manager 2, created and distributed by Technosmart Europe. It should be downloaded from 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 please contact Carlo at Technosmart (sales.carlo@technosmart.eu) before each field season to know if a new update for your loggers is available.

Axy Manager 2 works only under Windows operating systems, and the minimum operating system required is Windows 7. 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.

1.3 Turning on/off the loggers

In order to turn 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 ***AGM***.
After this period the accelerometer will start to record at the frequency you selected.

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

To turn the logger OFF, swipe the magnet close to the unit opposite 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, when the LED is off it should be 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 passage of the magnet.

1.4 Connecting to the Axy Manager 2 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, software section.

To connect to **Axy Manager 2** 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". As 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. 1.3). 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.

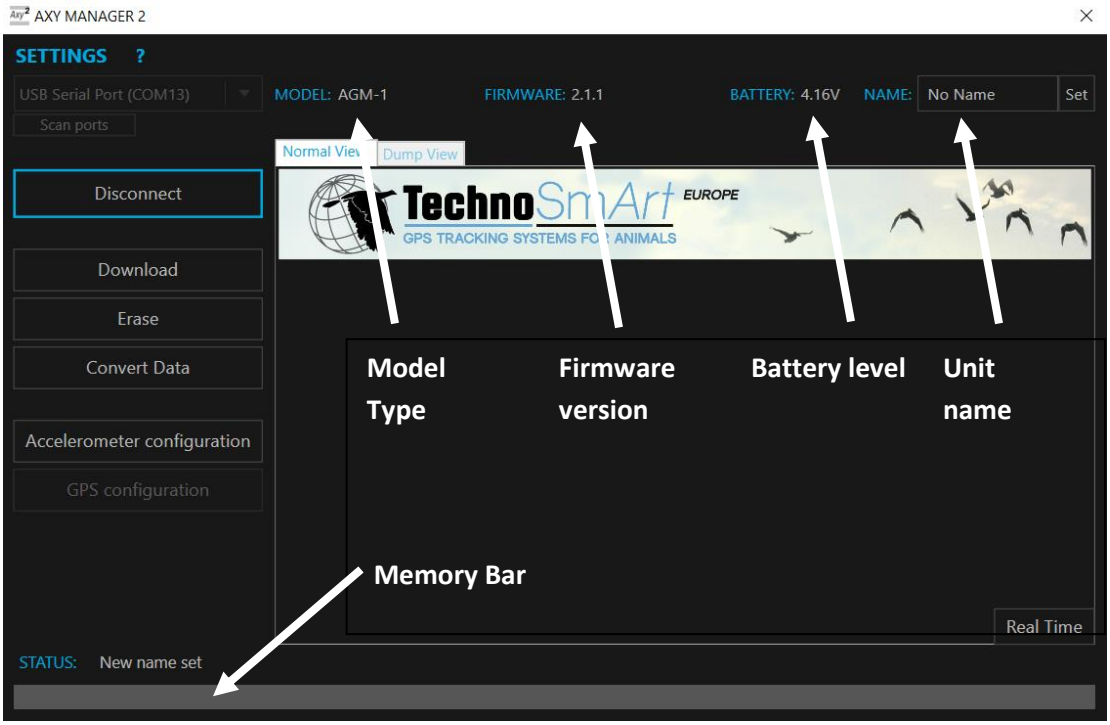


Fig. 1.5 Main window of Axy Manager 2

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

2.0 Accelerometer configuration

The accelerometer configuration window will allow you to configure the accelerometer, the Magnetometer, the Gyro, and if present the pressure/temperature sensors.
To send the configuration of the accelerometer configuration, please click on the button "send configuration" on the bottom of the window.
Note: when you open this 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 not affect battery usage but only 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).

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 plunge diving bird like a gannet/booby requires even 16g not to saturate the acceleration during the dive.

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 16bits. Practically, with 16 bits you have 256 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 65536 values at 16bits, increasing the resolution substantially. However, it will occupy twice the memory. If memory is not limiting in your case, use 16 bits to have higher resolution.

2.2 Gyroscope

A first thing to note, is that the gyroscope is not an inclinometer. So it does not record the orientation of the device, but rather the rotatory movement of the device. Indeed the measurement unit is degrees per second (DPS). Therefore it has a meaning only if recorded at relatively high frequencies, in order to obtain a real recording of the rotation.

The gyroscope in the AGM can be set to be off completely and thus save battery, to record at 1 Hz or to record at the same frequency as the Accelerometer (Acc-Linked). We strongly recommend the Acc-Linked option, if you want good measures of the gyroscope.

The fullscale, as for the accelerometer, determines the maximum value of rotation per second the logger can detect.

2.3 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 ***AGM*** 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”).

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 AGM move it a 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.

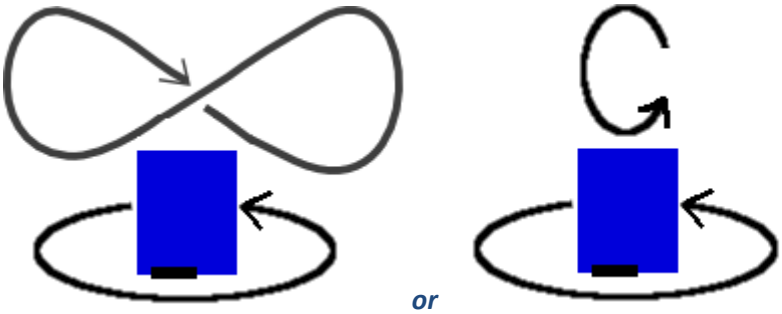


Fig. 2.1 Calibration movements, make a 8 pattern and rotate the device on its own axis or rotate it on its axis while rotating yourself

2.4 Temperature and Depth Logging

The ***AGM*** can be configured to have a pressure and temperature sensor. Unfortunately the temperature sensor is only available together with the pressure sensor.

The pressure sensor can be of two different ranges: “Water sensor” which can withstand pressures up to 30 bars (300m underwater) and an “Air sensor” which can withstand only 10m depth but has a much higher resolution in air (about 20cm). This second pressure sensor can be used therefore as an altimeter with very high resolution.

If you check the “Enable” option, the logger will record pressure and temperature with the frequency selected in the box on the right (“1” means 1 per second, “2” means one every 2 seconds).

Note: the logger has no way of knowing if the pressure sensor is present but broken or not present at all. In either case if you enable pressure logging the device will not start and will make a double blink once per second instead. In these cases, if you don’t have the pressure sensor, disable the logging. If you have it, it is unfortunately broken and you should contact us for replacement.

3. File downloading and data conversion

Once you successfully retrieved 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. The default name for the file is the name of the device set in “Device name” on the top right of the main window.

The button “Erase” 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, an .ard file is created, which can be converted to more useful formats.
In the conversion panel you have a number of options about the conversion format (date format, pressure format etc.). By default, pressure data is expressed in millibars, but in the case of a “Water” pressure sensor (see par. 2.4) it can be converted to meters under sea surface. For this conversion, the value of air pressure at sea level must be provided. This can be done by calculating median pressure in millibars from the data at hand. When dealing with animals that do not perform very deep dives, a slight error in air pressure at sea level might produce very inaccurate pressure values, therefore this method is not recommended.

The Start Time on the bottom right is the time when you turned on the ***AGM*** and is necessary to convert the data with the correct date and time.

What you obtain from the conversion of the .ard file are:
- **text with all data (Acceleration and all sensors)** (.csv),

Binary is the more compressed format containing all data. Data in *Binary* format are not to be viewed or edited with other software, as it is a proprietary format, but is very useful to store data on computers given its reduced size. Binary files can be converted with the **Axy-Manager 2** into one of the other formats according to the parameters selected in the converting option panel.

Text .csv are text files, suitable for editing the data with *Excel, Word,* and importing in common software like R. Consider that in normal deployments the files are too big to be imported on Excel.

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. AccX: Acceleration X axis
4. AccY: Acceleration Y axis
5. AccZ: Acceleration Z axis
6. GyroX: Gyroscope X axis
7. GyroY: Gyroscope Y axis
8. GyroZ: Gyroscope Z axis
9. CompX: Magnetometer X axis
10. CompY: Magnetometer Y axis
11. CompY: Magnetometer Z axis
12. Activity: not yet implemented on ***AGM***
13. Pressure: the pressure recorded by the device
14. Temp.: Temperature in Celsius degrees
15. Battery Voltage: the voltage of the battery in Volts.

Note that most of these are present only if the sensor is activated. So for example if you did not turn on the magnetometer, those columns will be missing.

Note: 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 **Axy Manager 2.** There you can select "CSV separator" and determine how the columns are going to be separated.

3. Re-charging the batteries

Batteries can be recharged either using the provided USB datacable.
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 device with thionyl batteries let us know and we will provide you a new cable without the charging electronics!

4. Troubleshooting

Although Technosmart Europe has always tried to provide the best devices possible, sometimes you might encounter some issue in the working of the ***AGM.*** These 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 turning on properly 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 move 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 sales.carlo@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 program 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 program settings select "Download speed" and then 1MBaud

6.2 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 as well

1. ***The logger does not blink at all:*** this is the biggest problem, clearly. In the best case the battery is so discharged that 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 recharge the battery first and let us know if this is not solved.

3. ***When starting the logger does a double blink once per second:*** This might mean 2 things: low battery (but enough to start the logger) or no functioning pressure sensor. 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, which 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.

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